Galveston Bay Foundation
Community Outreach through Oyster Shell Recycling and Citizen Science

GLO Contract No. 23-020-002-D596

FINAL REPORT
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Table of Contents

I. Project Summary

To reestablish hard substrate in Galveston Bay, the Galveston Bay Foundation (GBF) partners with restaurants to collect shucked oyster shells. The shells are transported in recycling receptacles by GBF staff to upland storage sites where they are stockpiled and sun-cured for at least six months. The recycled shells are then returned to the bay through shoreline protection projects, reef creation projects and reef enhancement initiatives such as volunteer oyster gardening.

During CMP Grant Cycle 27, 182 tons of oyster shells were recycled through GBF's Oyster Shell Recycling Program (OSRP). The collection of these shells was conducted in Galveston from November 2022 through May 2023 and in the Houston and Clear Lake regions from November 2022 through July 2023. During this time, all recycled oyster shell was stockpiled at one of two curing sites: Red Bluff or Moody Gardens. The shells will continue to be stored at the respective curing sites where they will be turned intermittently to allow for proper sun curing before being returned to the Bay. The shells will be utilized in GBF's Volunteer Oyster Gardening efforts or returned to Galveston Bay through (separately funded) oyster reef restoration projects.

CMP Grant Cycle 27 funding allowed GBF to continue expanding the shell recycling operations in the inner loop of Houston, Clear Lake, and Galveston Island. Due to the expansion effort that began in 2021, GBF has continued to increase shell recycling capacity. A total of 237 tons of oyster shell was recycled in 2023.

The CMP Grant Cycle 27 also funded the 2023 oyster gardening season during which 94 volunteers, managing a single garden or multiple gardens, monitored and cared for their gardens throughout the summer and early fall to promote successful oyster recruitment and growth on the recycled shell. As a result, approximately 4,493 oysters were recruited in the volunteers' 312 gardens. These new oysters were introduced onto restoration reefs in October and November 2023 under separate grant funding.

The CMP Grant Cycle 27 also funded the growth of a citizen science initiative, the reef monitoring program. This program provided hands-on opportunities for volunteers to collect valuable data that can guide decision making for future oyster reef restoration. GBF recruited volunteers and staff over four site visits to assist with documenting oyster growth and spat recruitment on recycled oyster shell at one of GBF's reef restoration sites.

Through CMP Grant Cycle 27, GBF developed and implemented a water quality monitoring aspect to the Volunteer Oyster Gardening Program. One volunteer from five different bayfront gardening communities recorded salinity and water temperature weekly to better understand spat recruitment rates in Galveston Bay. This monitoring will be continued each year moving forward with oyster gardening to continue to gather more data and further expand our knowledge on oyster recruitment and growth.

GBF's Water Monitoring Team also expanded bacteria sampling numbers and disseminated the information more broadly within the community during CMP Grant Cycle 27. Five additional volunteers began delivering bacteria samples to GBF, with more expressing interest in becoming certified in 2024. Standard core monitoring also continued, and more volunteers were trained, so sampling locations that halted during the Covid-19 pandemic could resume with volunteer numbers increasing from 25 to 34 active certified samplers. Training opportunities are ongoing and new volunteers continue to express interest in joining the Water Monitoring Team.

II. Background Information

Oyster reefs are a vital component of a healthy estuary. Oysters filter contaminants from the water, protect shorelines, stabilize sediment, and provide habitat and food sources for other aquatic species. Unfortunately, oyster reefs are the most threatened marine habitat worldwide. Studies show that over 85% of oyster habitat has been lost on a global scale (Beck et al, 2011). In Galveston Bay, over 60% of the oyster reefs have been damaged, primarily due to decades of heavy exploitation combined with multiple storm events, particularly Hurricanes Ike and Harvey (Hons and Robinson, 2010). Prior to 2008, Galveston Bay yielded 90% of the oyster harvest in Texas (Haby et al, 2009). However, the severe sediment deposition resulting from Hurricane Ike smothered oyster reefs across the bay system and eliminated a large portion of the hard substrate required for oyster development.

To help replenish hard substrate in the bay and support oyster reef restoration efforts, GBF partnered with local restaurant owner Tom Tollett of Tommy's Restaurant and Oyster Bar in 2011 and began recycling oyster shells. Before GBF's OSRP began, oyster shells were discarded along with other restaurant waste and sent to a landfill. To avoid the disposal of this vital resource, GBF has established partnerships with local restaurants and research partners to collect their shucked oyster shell. The reclaimed shell is returned to Galveston Bay to serve as new oyster habitat, thus enhancing the local oyster populations.

With the assistance of CMP funding, GBF has expanded the OSRP from the Pilot phase (Phase 1) with only one shell recycling partner through a First Expansion phase (Phase 2). During the First Evaluation phase (Phase 3), a Strategic Development Plan (SDP) was created with the goal of assessing alternative recycling methods to achieve a more sustainable program. The SDP led GBF to expand shell recycling operations to the inner loop of Houston to increase the volume of shell recycled. The Second Expansion phase (Phase 4) was initiated with the purchase of new recycling equipment (the dump truck) in the spring of 2021 followed by the first shell collection in the inner loop of Houston in May 2021. Phase 4 overlapped with the start of Cycle 27, and the program increased from 10 to 31 recycling partners. Phase 5, the Second Evaluation phase, has been focused on assessment and while additional partners are added when feasible, there is not a large push for adding partners. As of March 2024, GBF has secured 37 active shell recycling partners.

GBF staff recruited volunteers to help document oyster growth and spat recruitment on recycled oyster shell at one of GBF's restoration sites in Galveston. Four times in 2023 (throughout spring and fall), GBF worked with volunteers to monitor samples from the oyster shell breakwater located at GBF's Sweetwater Lake Preserve. GBF documented the number of live and recently dead oysters in each sample and measured the shell lengths of these oysters. GBF directed volunteers to document the presence of mussels and other species observed in each sample. GBF returned all live organisms, including the oysters, to the water upon completion of sample analysis. GBF provided all necessary supplies and training for the volunteers. GBF collected data onsite via pen and paper and transferred it into Excel to allow for analysis.

The GBF Water Monitoring Team is one of the earliest water quality citizen science groups in Texas. It started in the early 90's as a program called T.E.S.T. In February 2012, GBF became part of the Texas Stream Team, with the Bacteria Sampling Program launching shortly after in January 2013. This citizen science work has been an important way to empower citizens to be protectors of water quality and active in the monitoring process. The Texas Stream Team program provides Quality Assurance Project Plan (QAPP) backed data to allow for widespread data collection throughout the state. GBF's focus in the Galveston Bay area helps to provide data to understand the bay while recent work has also

expanded to monitor and better understand how water quality is involved in our other restoration and citizen science programs.

Throughout Cycle 27 GBF was focused on continuing its long-term data monitoring program while also expanding water quality data collection with two other citizen science programs within GBF. GBF began to incorporate water quality monitoring with the Oyster Gardening Program for the first time. GBF also explored ways to pair water sampling data with oyster recruitment data at an oyster reef restoration site to consider how water quality changes can be linked with oyster recruitment. With the continuation of water quality data being collected, GBF will better understand oyster recruitment rates throughout the Galveston Bay system.

III. Project Implementation

A) Task 1: Shell Collection, Restaurant Partnerships, and Curing Site Maintenance

A.1 Oyster Shell Recycling Metrics

A total of 182 tons of recycled oyster shells were collected with Cycle 27 funds. This shell was collected in Galveston from November 2022 through May 2023 and in the Houston and Clear Lake regions from November 2022 through July 2023. During this time, GBF and Moody Gardens staff collected oyster shell from a total of 37 shell recycling partners on a weekly basis to relieve them of their shell waste. GBF staff collected shell from recycling partners in the Clear Lake and Houston region while Moody Gardens staff collected shell from recycling partners in the Galveston region.

Throughout the week, restaurant/lab staff deposited shucked oyster shells in recycling receptacles. GBF and Moody Gardens staff transported the containers of shell to one of two curing sites where all shell was stockpiled for future use in reef restoration efforts. GBF and Moody Gardens staff followed the Sun Curing Protocol established in CMP Cycle 24 to ensure all recycled shell will be fully sun-cured prior to being returned to Galveston Bay. During CMP Cycle 26, GBF partnered with the Environmental Institute of Houston at University of Houston Clear Lake and the University of Houston to research the sun curing time needed to reduce the risk of infecting native oysters with Dermo. The study ended in 2023, but more questions were raised, and Phase 2 will begin in fall of 2024. GBF will update the Sun Curing Protocol after Phase 2 has been completed.

The second expansion of the OSRP began in 2021 with the purchase of a heavy-duty truck equipped with a dump bed and bin lift (the dump truck). The dump truck facilitated the expansion of GBF's shell recycling operations to the inner loop of Houston and allowed for the addition of more restaurant partners, growing the OSRP from 10 to 21 recycling partners in one year.

This report captures all shell recycling under Cycle 27 which occurred from November 2022 to July 2023. During Cycle 27, four Houston restaurants, one Clear Lake restaurant, and one Galveston restaurant became shell recycling partners. As of July 31, 2023, GBF was actively recycling shell with 37 partners (Table 1). Additional restaurant partners will be added to the program when feasible.

Please refer to Table 2, Chart 1, and Chart 2 below for the shell collection numbers and associated graphs, and Appendix A for a map of active shell recycling partners during Cycle 27.

Table 1: Oyster Shell Recycling Partners Active Under Cycle 27

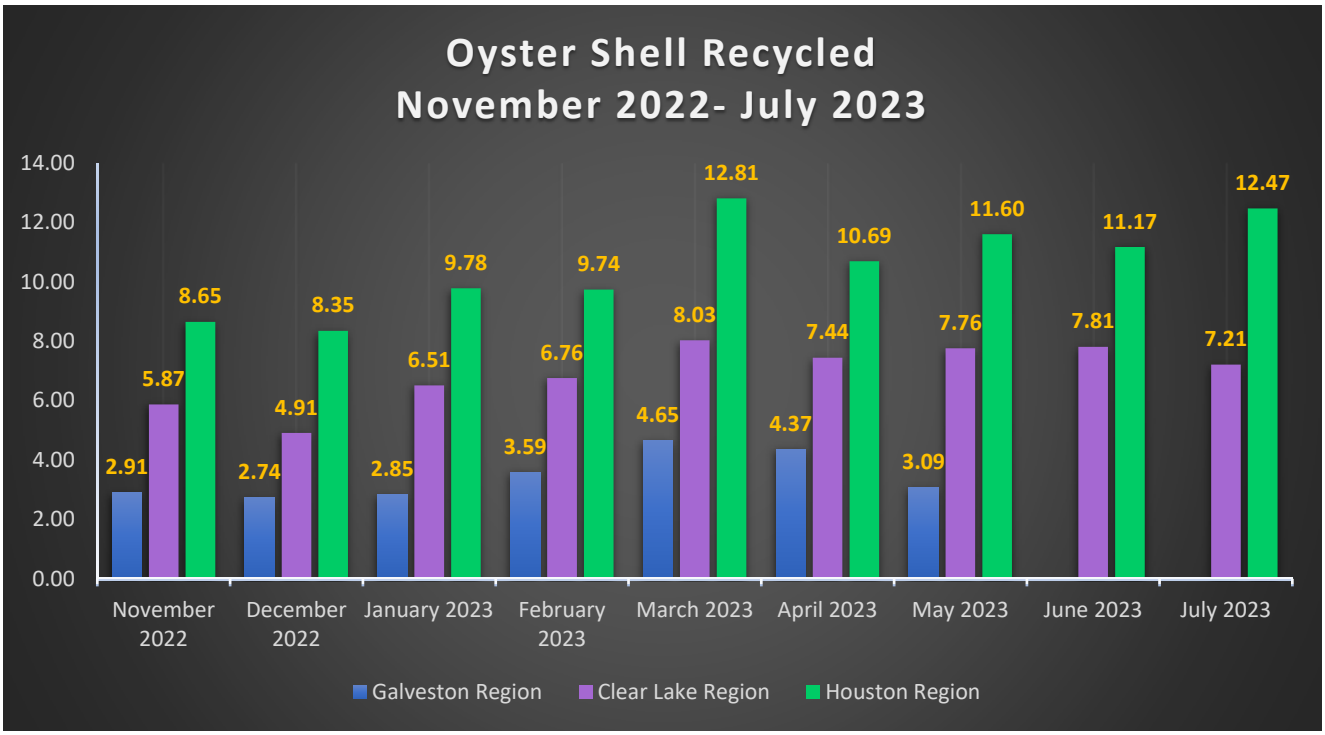
Shell Recycling Start Date	Shell Recycling Partner	Region
March 2011	Tommy's Restaurant & Oyster Bar	Clear Lake
August 2013	The Aquarium (Kemah)	Clear Lake
November 2013	Crazy Alan's Swamp Shack (Kemah)	Clear Lake
October 2015	Captain Benny's Seafood (Gulf Freeway)	Houston
June 2016	Tookie's Seafood	Clear Lake
January 2018	BLVD Seafood	Galveston
June 2019	Crazy Alan's Swamp Shack (Baybrook)	Clear Lake
March 2020	Sam's Boat (Seabrook)	Clear Lake
October 2020	Barge 295	Clear Lake
November 2020	Fisherman's Wharf	Galveston
February 2021	Seafood Safety Lab at TAMUG	Galveston
March 2021	Kritikos Grill	Galveston
April 2021	BB's Tex-Orleans (Webster)	Clear Lake
April 2021	Loch Bar	Houston
May 2021	Bludorn	Houston
June 2021	Eunice	Houston
June 2021	La Lucha	Houston
July 2021	BB's Tex-Orleans (Heights)	Houston
July 2021	BB's Tex-Orleans (Upper Kirby)	Houston
July 2021	State of Grace	Houston
November 2021	Fish Tales	Galveston
December 2021	Goode Company Seafood (Westpark)	Houston
January 2022	Gaido's Seafood Restaurant	Galveston
January 2022	Shuck's Tavern & Oyster Bar	Galveston
January 2022	Cajun Greek	Galveston
March 2022	Acme Oyster House	Houston
March 2022	BB's Tex-Orleans (Oak Forest)	Houston
June 2022	Flying Fish	Houston
July 2022	Mambo Seafood (Edgebrook)	Houston
September 2022	Sunny Seafood	Clear Lake
October 2022	Tiny Champions	Houston
January 2023	BB's Tex-Orleans (Montrose)	Houston
February 2023	Winnie's	Houston
February 2023	Grand Galvez Bar & Grill	Galveston
February 2023	Nancy's Hustle	Houston
March 2023	Floyd's Seafood (Webster)	Clear Lake
April 2023	Low Tide Kitchen & Bar	Houston

Table 2: Tonnage of Oyster Shells Recycled under Cycle 27

MONTH/YEAR	OYSTER SHELL RECYCLED (TONS)		
	Galveston Region	Clear Lake Region	Houston Region
November 2022	2.91	5.87	8.65
December 2022	2.74	4.91	8.35
January 2023	2.85	6.51	9.78
February 2023	3.59	6.76	9.74
March 2023	4.65	8.03	12.81
April 2023	4.37	7.44	10.69
May 2023	3.09	7.76	11.60
June 2023	N/A*	7.81	11.17
July 2023	N/A*	7.21	12.47
Total	**24.20**	**62.30**	**95.26**
Grand Total	***181.76 tons of shell recycled from Nov. 2022 - Jul. 2023***		

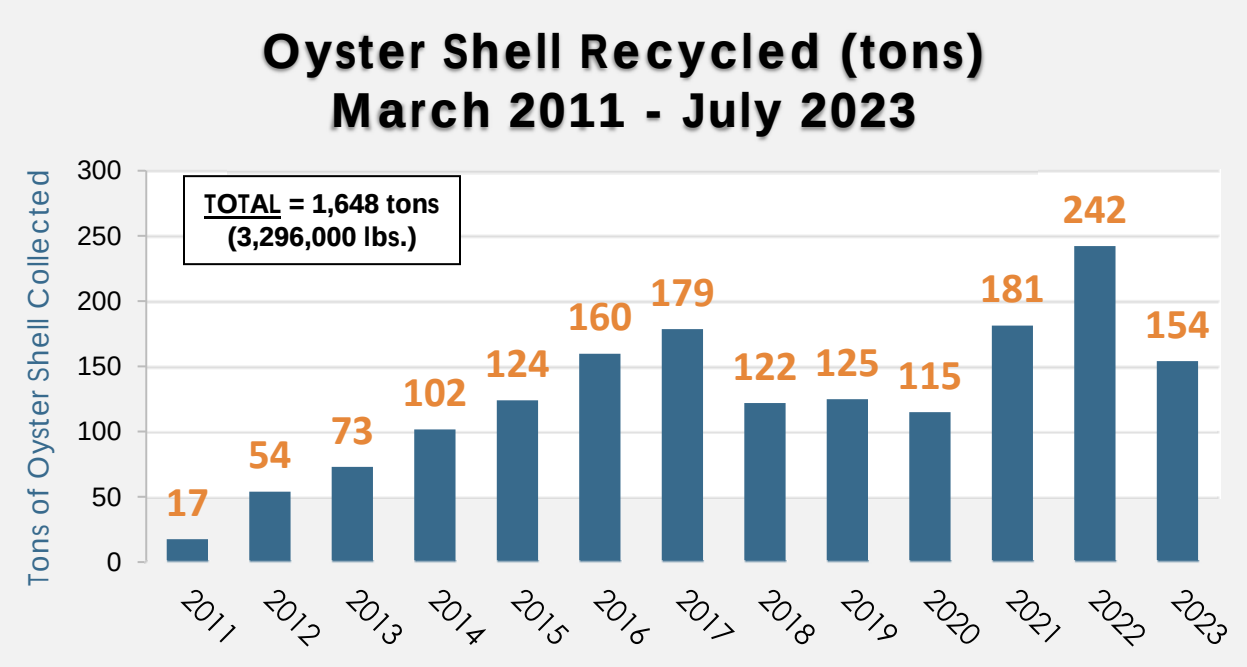
**Cycle 27 match requirements had been met by June 2023 therefore shell recycling for the Galveston region was no longer included.*

Chart 1: Tonnage of Oyster Shells Recycled under Cycle 27



Please note oyster shell tonnage is based on an average weight of 182 pounds of shell per 32-gallon bin and 30 pounds of shell per five-gallon bucket and is subject to a variance of approximately five percent.

Chart 2: Tonnage of Oyster Shells Recycled to Date



**For Cycle 27, 34 tons were recycled during 2022 and 148 tons were recycled during 2023. The remaining six tons noted in this chart in 2023 was the total recycled for the Galveston region in June and July after match requirements had been met.*

To track the amount of oyster shell recycled and where it is stockpiled, GBF and Moody Gardens staff maintain Microsoft Excel spreadsheets in which the date of collection, source of shell (e.g., recycling partner name or special event), amount of shell, curing site name, pile location, and pile rotation is recorded. GBF and Moody Gardens staff also document the date a shell pile is turned during the sun curing process and when cured shell is transported off the curing site property for restoration projects. This allows GBF to maintain an estimate of total shell available for use in reef restoration projects.

During the grant cycle, a total of 182 tons of recycled oyster shell was delivered to two curing sites: Red Bluff and Moody Gardens (Table 3). Due to the close proximity with the Clear Lake and Houston partners, the majority of the shell was deposited at Red Bluff. Red Bluff is also the largest property and can therefore accommodate the largest volume of shell. All shell collected from recycling partners on Galveston Island was delivered to the curing site located on Moody Gardens' property. The Texas City curing site was not utilized during this grant cycle.

Table 3: Tonnage of Shells Delivered to Curing Sites during Cycle 27

Curing Site	Oyster Shell Onsite (Tons)
Red Bluff	157.56
Moody Gardens	24.20
TOTAL	**181.76**

GBF staff developed a Sun Curing Protocol in 2020 to standardize and improve the sun curing process. Shell at different stages of sun curing (Phase 1 – Active Collection; Phase 2 – Curing; Phase 3 – Cured) is kept in individual piles separated by a 10-foot buffer. This allows GBF to track which shell is available for use in restoration projects. To better accomplish this, staff have divided sections of Red Bluff, Texas City, and Moody Gardens to monitor each phase of the curing process more precisely.

During Cycle 27, GBF staff managed and maintained two curing sites for shell storage: Red Bluff and Moody Gardens. No maintenance was required for the Texas City curing site. Red Bluff is leased from the Port of Houston Authority. Per the lease terms, GBF is responsible for all maintenance and management. As a 1.5-acre property, more time and effort is required to ensure the site meets standards for proper and efficient shell curing. GBF staff performed regular mowing and vegetation management for access, as well as shell turning, moving, and piling to comply with GBF's Sun Curing Protocol. The Moody Gardens curing site requires minimal maintenance due to concrete road access. Moody Gardens staff maintains the shell piles according to GBF's Sun Curing Protocol. GBF staff assists Moody Gardens with maintenance of the shell piles when needed, for example when fully cured shell was relocated to a reef restoration site.

Please refer to Table 4 for the curing site maintenance log and Appendix A for a map of the curing site shell piles.

Table 4: Log of Curing Site Maintenance during Cycle 27

Date	Curing Site	Maintenance Conducted
2/16/2023	Moody Gardens	Cured shell moved from Pile B3 to Pile A3
3/31/2023	Red Bluff	Cured shell moved from Pile L1 to Pile E2; Rotated Pile H2, I2, and J2; Dug ditches around Pile H and G and installed PVC pipes to help with draining standing water to behind Pile B
4/1/2023	Moody Gardens	Cured shell moved from Pile C3 to Pile A3
5/12/2023	Red Bluff	Mowed
5/23/2023	Moody Gardens	Fully cured shell from Pile A3 was moved to Sweetwater
9/12/2023	Red Bluff	Mowed, weed-eated, and sprayed herbicide on property; Trimmed the tree at Pile K and L
11/1/2023	Red Bluff	Rotated shell piles D, G, and L; Moved shell piles H, I, and J to pile E; Installed new entrance gate, metal posts, and placed posts in concrete
11/14/2023	Red Bluff	Re-staked and re-roped all shell piles; Weed-eated around shell piles
11/24/2023	Moody Gardens	Cured shell moved from B4 to Pile D3

A.2 Restaurant Database

In 2014, GBF staff created a Restaurant Database to identify all seafood restaurants serving oysters in the Houston, Clear Lake, and Galveston regions. Each year, GBF staff review and update the Restaurant Database to analyze new, potential shell recycling partners. The 2023 Restaurant Database is included in Appendix A.

Through analysis of restaurant location and menu items, GBF staff identified five restaurants in the Clear Lake region and five restaurants in the Galveston region as priority future partners to pursue. Based on the Houston list, GBF staff also identified five restaurants that are in or near the inner loop. Of these 15 restaurants, two to three have high potential to join the OSRP during Cycle 28. GBF staff initiated communications with Brasserie 19, Clark's Oyster Bar, Hudson House, and Pappas Seafood House but have not been successful with receiving a response. Sammy G's District 70 BBQ & Grill located in Clear Lake plans to open in March or April 2024 and are interested in joining the OSRP once they begin serving oysters. GBF staff will continue to reach out to potential partners in hopes of adding them to the OSRP soon when feasible.

A.3 Updated Strategic Development Plan

The beginning of 2019 marked the start of the First Evaluation phase for the OSRP, and it lasted through 2020. The original Strategic Development Plan (SDP) was created in 2019 with the goal of assessing alternative recycling methods to achieve a more sustainable program. The second version of the SDP was updated in 2020 to aid GBF in determining if an alternative approach to shell recycling should be pursued and if an expansion into the inner loop of Houston was feasible. As a result of the second SDP, new recycling equipment (the dump truck) was purchased in the spring of 2021 which allowed for the expansion of shell collection in the inner loop of Houston. GBF's OSRP was able to expand rapidly over the next two years (2021-2022).

After the purchase of the dump truck and the addition of the Houston recycling route, GBF entered a Second Evaluation phase which was initiated in 2023. The third iteration of the SDP was completed to determine if further expansion of the program is necessary and/or feasible. GBF will continue to evaluate the OSRP through 2024 and determine what additional equipment, supplies, staff, routes, curing sites, and/or partnerships might be needed.

Please refer to Appendix A which contains the updated SDP for the OSRP.

B) Task 2: Community Outreach

B.1 Notes from the Oyster Workgroup meeting

GBF staff attended the Oyster Restoration Workgroup meeting which was led by the Texas Parks and Wildlife Department (TPWD) in August 2023. The meeting was held at the TPWD marine lab in Dickinson, Texas. Additionally, GBF staff led the Galveston Bay Oyster Workgroup meeting in December 2023 under the guidance of the Galveston Bay Estuary Program (GBEP) Natural Resources subcommittee. The GBEP meeting was held virtually.

Both meetings were assembled to bring together state agencies, universities, engineers, and conservation non-profits to discuss guidance for reef restoration, facilitate research, provide updates on current projects, and identify funding and partnership opportunities. The TPWD workgroup focuses on statewide issues and includes commercial fishermen, whereas the GBEP workgroup focuses solely on Galveston Bay and local issues. Support from these parties benefited not only the OSRP's efforts, but also TPWD's oyster fishery management goals. Such collaboration will result in a more harmonious approach to sustaining

the Galveston Bay oyster population both as a fishery and as a vital ecological component of the estuary. Both workgroups will meet bi-annually going forward.

Please refer to Appendix B for the notes from the TPWD and GBEP workgroup meetings. Approximately 25 attendees were at the TPWD workgroup, and 35 attendees were at the GBEP workgroup.

B.2 List of presentations, exhibits/events, conferences, etc. and associated attendance

Throughout 2023, GBF conducted nearly all outreach events in person including presentations, boothing activities, a classroom workshop, one-time shell recycling events, and volunteer oyster garden creation and collection events. Table 5 includes a list of all outreach activities that occurred in 2023. Please refer to Appendix B for photos of outreach efforts. In addition to these outreach activities, the OSRP received some media exposure throughout 2023.

On September 21st, the Port of Houston posted an article on their website regarding the Houston Ship Channel's expansion project, known as Project 11. Since the project involves constructing replacement land for oyster pads using dredged material from the expansion project and a layer of cultch material, the article explains the importance of restoring oyster reefs and mentions how the Port of Houston partners with GBF's OSRP. The article can be found in Appendix B.

On November 15th, GBF's President did a live interview featuring the OSRP at KPRC-TV in Houston for National Recycling Day. The link to the segment can be found here: https://www.youtube.com/watch?v=k1Fcczk1M14.

Table 5: 2023 Outreach Activities

No. of Events	Date	Activity	Description	Type of Outreach	Participants
1	1/24/23	Winnie's Oyster Shucking Throw Down	Shucking contest for Houston area chefs vs. bartenders benefiting Oyster Shell Recycling Program sponsored by Montucky	Recycling Community Outreach	~200
2	3/30/23	Oyster Extravaganza	Four course meal that included oysters for each course at Bludorn	Recycling Community Outreach Boothing	~100
3	4/13/23	Dig n' Design Garden Club in El Lago	Oyster Shell Recycling Program presentation	Presentation	~20
4	4/15/23	Oyster Olympics for BB's Tex-Orleans	One-time shell recycling event for BB's oyster shucking contest for their employees	Recycling	~100
5	4/22/23	Houston Oyster and Seafest	Shell recycling fundraising event for GBF's Oyster Shell Recycling Program	Booth/Recycling	525
6	4/29/23	Oyster Garden Creation Event	Volunteers constructed their gardens and took them home to hang on their piers	Community Outreach	~35
7	5/18/23	Oyster Garden Creation Event	Volunteers constructed their gardens and took them home to hang on their piers	Community Outreach	~5
8	5/20/23	Oyster Garden Creation Event	Volunteers constructed their gardens and took them home to hang on their piers	Community Outreach	~12
9	5/27/23	Oyster Garden Creation Event	Volunteers constructed their gardens and took them home to hang on their piers	Community Outreach	~16
10	6/3/23	Oyster Garden Creation Event	Volunteers constructed their gardens and took them home to hang on their piers	Community Outreach	~5
11	6/13/23	Bayou Vista Saltwater Garden Club	Oyster gardening program presentation at the Saltwater Garden Club meeting in Bayou Vista	Presentation	~30
12	8/15/23	Oyster Restoration Workgroup Meeting	Meeting at TPWD with restoration partners to discuss ongoing/future shell recycling and reef restoration activities	Regional Workgroup Meeting	20
13	10/5/23	Gulf Coast Master Naturalists Monthly Meeting in Houston	Oyster Shell Recycling Program presentation	Presentation	~25
14	10/7/23	Oyster Garden Collection Event	Gardening collection, spat counts, spat transplants via volunteer assistance for Clear Lake Shores, Dickinson, Kemah, San Leon, Texas City communities	Volunteer Event	11
15	10/10/23	Texas Watershed Coordinators Roundtable	Panel discussing Total Maximum Daily Loads (TMDL's) and Water Shed Protection Plans (WPP); main focus was Oyster Water's TMDL	Presentation	~40-50
16	10/12/23	Oyster Garden Collection Event	Gardening collection, spat counts, spat transplants via volunteer assistance for Baytown and Beach City communities	Volunteer Event	9
17	10/25/23	RAE Living Shoreline Tech Transfer Workshop in Galveston	Oyster Shell Recycling Program presentation	Presentation	~50
18	11/4/23	Oyster Garden Collection Event	Gardening collection, spat counts, spat transplants via volunteer assistance for Bayou Vista, Hitchcock, Omega Bay communities	Volunteer Event	26
19	11/13/23	All About Oysters classroom workshop	Students at Bayside Intermediate discussed locations of oyster reefs in the bay and why they are an important ecosystem, investigated if they could "out-filter an oyster" by working in teams, and conducted an oyster dissection	Education	75
20	11/18/23	Oyster Garden Collection Event	Gardening collection, spat counts, spat transplants via volunteer assistance for Galveston, Jamaica Beach, Pirates Cove, Sea Isle, Tiki Island communities	Volunteer Event	37
21	12/7/23	Galveston Bay Oyster Workgroup Meeting	Virtual meeting with restoration partners to discuss ongoing/future shell recycling and reef restoration activities	Regional Workgroup Meeting	35

B.3 Outreach materials as developed

To inform and educate restaurant patrons about the Oyster Shell Recycling Program, five window clings were distributed to all new restaurant partners added during Cycle 27. The window clings were displayed on entry doors to identify each restaurant as a participant of the OSRP. To further advertise active shell recycling partners, GBF updated the trailer sign (located on the back gate of the oyster shell recycling trailer) with recycling partner logos each time a new restaurant joined the OSRP. The truck wraps and trailer signage on GBF's recycling equipment also provide continuous advertisement as these vehicles are driven throughout the community three times a week during shell collections.

Please refer to Appendix B for depictions of outreach materials.

C) Task 3: Volunteer Oyster Gardening

C.1 TPWD introduction permit

Please refer to Appendix C which contains the approved Texas Parks and Wildlife Department Introduction Permit.

C.2 Annual report documenting oyster gardening events and metrics

Cycle 27 funded the 2023 oyster gardening season which began in the spring of 2023. GBF hosted a total of five Oyster Garden Creation Events. One event was held in Beach City at GBF's Trinity Bay Discovery Center, two were held in Galveston at Moody Gardens, and two were also held in Kemah at GBF's headquarters. Volunteers and GBF staff worked together to build over 300 oyster gardens. All volunteers were given the option of three garden types: bags, cages, or stringers. A total of 338 oyster gardens were suspended from piers, docks, and bulkheads into Galveston Bay by June 2023 (Table 6). Refer to the Annual Gardening Report in Appendix C for photos of the oyster gardening events.

A total of 338 oyster gardens were suspended off piers, docks, and bulkheads at 94 bayfront homes located within 16 bayfront communities in 2023 (Table 6). Volunteers contributed through spring garden creation efforts, ongoing oyster garden monitoring during the summer, and fall garden collection efforts. Volunteers were instructed to rinse their gardens weekly to help reduce biofouling and predation. Weekly maintenance also allowed volunteers to inspect their gardens for new oyster growth.

In October and November of 2023, GBF staff coordinated the collection of the oyster gardens through five community events in Bayou Vista, Beach City, Galveston, San Leon, and Tiki Island. Volunteers delivered their gardens to these locations where GBF staff received the gardens, documented new oyster growth and prepared the gardens for transport. Volunteers unable to attend a community event were encouraged to arrange with a neighbor attending the collection event to deliver their gardens. If the volunteer could not coordinate delivery with a neighbor, GBF staff collected the volunteer's gardens in each community the day of the collection event. The number of gardens deployed at the beginning of the season (338) was greater than the number of gardens collected at the end of the season (312). The decrease in the number of gardens collected was due to the loss of gardens from storms, potential theft, or not being able to get in contact with the volunteer at the time of the Garden Collection Events in the fall.

Table 6: Oyster Garden Creation and Deployment

Community	Volunteer Homes	Bags Deployed	Stringers Deployed	Cages Deployed	TOTAL Gardens Deployed
Bayou Vista	17	24	16	10	50
Baytown	6	0	4	12	16
Beach City	5	7	7	10	24
Clear Lake Shores	5	8	3	4	15
Dickinson	2	0	4	3	7
Galveston	12	23	10	17	50
Hitchcock	3	1	5	1	7
Jamaica Beach	7	9	8	1	18
Kemah	1	1	0	0	1
Nassau Bay	1	1	0	0	1
Omega Bay	4	4	4	3	11
Pirates Cove	6	4	4	11	19
San Leon	5	20	7	2	29
Sea Isle	6	6	1	10	17
Texas City	1	1	1	1	3
Tiki Island	13	18	30	22	70
Grand Total:	**94**	**127**	**104**	**107**	**338**

Table 7: Oyster Garden Collection and Oyster Recruitment

Community	Gardens Collected	Total Oysters Recruited	Avg. Oysters per Garden
Bayou Vista	42	41	1
Baytown	14	2	0
Beach City	22	336	15
Clear Lake Shores	15	8	1
Dickinson	4	0	0
Galveston	46	367	8
Hitchcock	7	34	5
Jamaica Beach	18	16	1
Kemah	1	0	0
Nassau Bay	0	0	0
Omega Bay	11	15	1
Pirates Cove	16	178	11
San Leon	29	699	24
Sea Isle	15	378	25
Texas City	3	6	2
Tiki Island	69	2,413	35
TOTALS:	**312**	**4,493**	**14**

Thanks to the 94 dedicated oyster gardening households, approximatley 4,493 oysters were recruited in the oyster gardens (Table 7). These oysters were transplanted onto restoration reefs in October and November 2023 under separate grant funding to help improve the local oyster population. For additional information about the 2023 oyster gardening season, please refer to Appendix C which contains the complete Annual Gardening Report.

D) Task 4: Volunteer Reef Monitoring

D.1 Number and location of reef monitoring sites

GBF staff conducted four reef monitoring events in 2023 (Table 8) at GBF's Sweetwater Lake Preserve property in Galveston. One of the events was with a corporate volunteer group, two were with the SAVY volunteer youth group from Moody Gardens, and one was a GBF staff day. See Appendix D for a map locating the Sweetwater Preserve and monitoring bag locations.

Table 8: 2023 Reef Monitoring Events

Date	Site	Bag Location Sampled	Group
4/18/2023	Sweetwater Lake	D66, E43, F39	Vitol, a corporate group
6/15/2023	Sweetwater Lake	C92	Moody Gardens' SAVY volunteer youth group
7/13/2023	Sweetwater Lake	B249, G92	Moody Gardens' SAVY volunteer youth group
9/28/2023	Sweetwater Lake	D66, E43, F39, F112	GBF Staff

During the September event, five GBF staff led a volunteer reef monitoring day and observed four monitoring bags from the oyster shell breakwater reef. A videographer and film crew from German National TV also attended the reef monitoring day to film and interview the staff conducting the reef monitoring. The footage will be included in the next segment of their "Ocean TV" series which will focus on the Texas coast. The segment will potentially air in Germany in March 2024.

D.2 Reef monitoring data and results

The sample locations were established in CMP Grant Cycle 25 with a partnership with Dr. Laura Jurgens at Texas A&M University at Galveston (TAMUG) and were previously monitored by undergraduate students from TAMUG as part of a laboratory course. Since Dr. Jurgens has moved on from TAMUG, GBF has continued using the sample locations to monitor live and recently dead oysters. GBF is continuing to expand the citizen science portion of this monitoring by bringing in volunteer groups to help with the monitoring. Evaluating the data collected could help direct restoration practices for the Sweetwater Preserve and other intertidal oyster reef restoration sites moving forward.

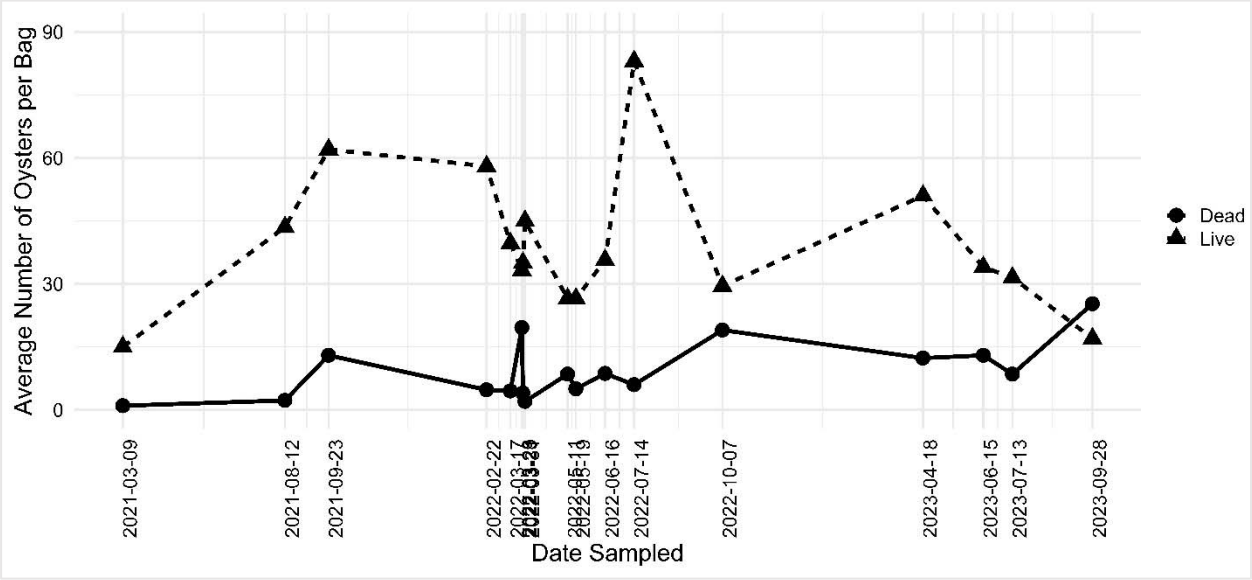
The nearly 2,000 foot long oyster shell breakwater contains seven smaller reef sections labeled A through G. The ten monitoring bag locations were randomly selected across the seven reefs (see maps in Appendix D). One of the goals of monitoring these locations is to understand which sections of the breakwaters are receiving more oyster recruitment and growth. Appendix D shows figures for the number of live and dead oysters found at each sampling location from 2021 through 2023. Some sections, such as D, E, and F, were sampled more often because of their close proximity to the access point.

Overall, the average number of live oysters recorded from 2023 decreased in nearly all sections that were monitored compared to 2022 (Chart 3). And conversely overall the number of dead oysters recorded increased in nearly every section. For the last monitoring event in September, the average number of dead oysters was greater than the average number of live oysters for all sections. There are many variables that could affect this data including changes in salinity, water depth, age of oysters, water temperatures, etc. Even though the data shows an overall decline in the number of live oysters from the previous year,

the reef is continuing to function and attract new growth. The last monitoring event in September 2023 had larger live and dead oysters observed compared to the last monitoring event in October 2022 for all sections (Chart 4). It is proposed the average lengths of live oysters observed for all sections during June and July of 2022 and 2023 were shorter due to it being the middle of spawning season, therefore the oysters observed were shorter. Looking at the average number of live and dead oysters for the sections monitored in 2023, there are far more live oysters than dead oysters per bag (Chart 5).

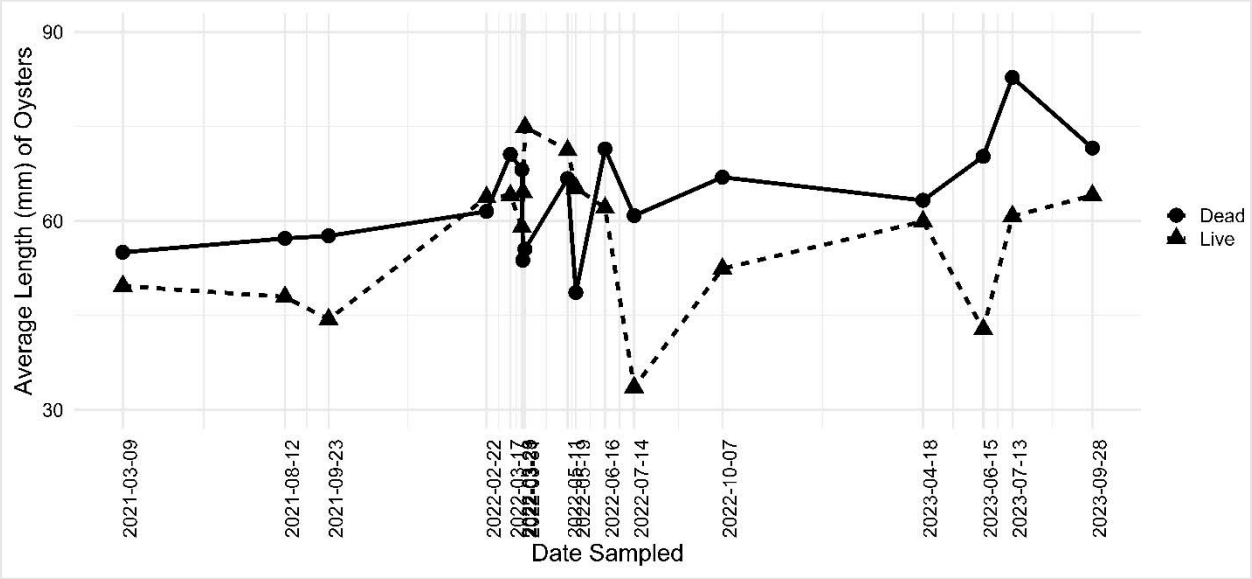
See Appendix D for additional charts depicting the average number and lengths of live and dead oysters separated by section and further broken down by each bag within the section.

Chart 3: Average Number of Live and Dead Oysters for All Sections



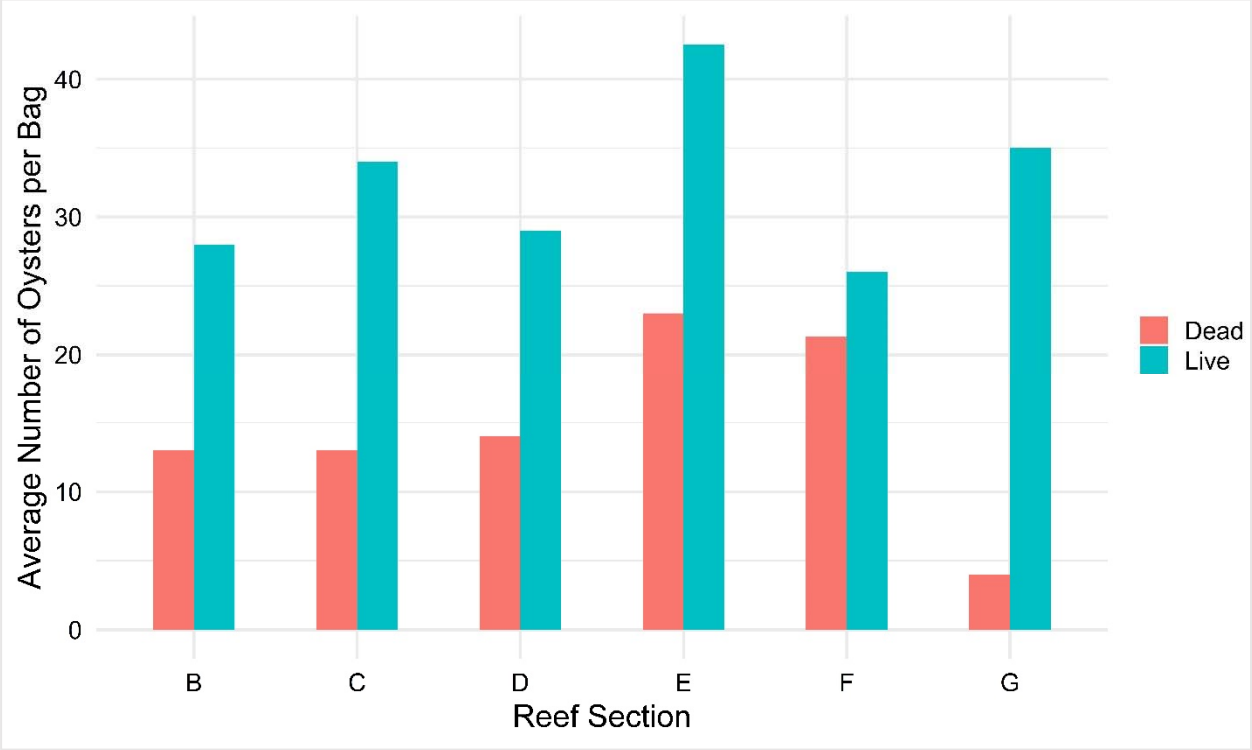
**Three sample dates are very close together on the figure and therefore hard to read. These dates are 2022-03-28, 2022-03-29, and 2022-03-31.*

Chart 4: Average Length of Live and Dead Oysters for All Sections



**Three sample dates are very close together on the figure and therefore hard to read. These dates are 2022-03-28, 2022-03-29, and 2022-03-31.*

Chart 5: Average Number of Live and Dead Oysters for Each Section in 2023



E) Task 5: Volunteer Water Monitoring

The GBF Water Monitoring Team (a group within the Texas Stream Team) was launched in February 2012, with the Bacteria Sampling Program launching shortly thereafter in January 2013. GBF Water Monitoring Team volunteers are certified to sample at sites around Galveston Bay for core water quality parameters (temperature, pH, dissolved oxygen, salinity, transparency, and field observations) and have the option of being trained to collect samples for *Enterococci* bacteria. Core certification consists of a full day, two-phase group training session and a one-on-one Phase III training at the volunteer's site with a GBF staff member. This training process is based on the Texas Stream Team training protocol. Volunteers commit to sampling their site(s) on at least a monthly basis. The entire monitoring program is conducted under an EPA-approved Quality Assurance Project Plan and Quality Management Plan. GBF's team is part of the Texas Stream Team because of its partnership with the Houston Galveston Area Council's region.

GBF maintained its existing volunteer Water Quality Monitoring Program by recruiting and training volunteer water quality monitors and hosting quality assurance trainings to maintain a successful and sustainable program. GBF analyzed water quality data from 27 sites to better determine local Non-Point Source (NPS) impacts on water quality and used the information to educate individuals on safe and unsafe recreation conditions. Throughout Cycle 27, GBF collected samples at 13 locations in Galveston Bay to test for *Enterococci* bacteria and posted the results on Swim Guide and promoted this resource to the project's target communities.

During Cycle 27, GBF expanded water monitoring efforts outside of its typical Water Monitoring Team. GBF staff recruited five volunteers in different bayfront communities to record the temperature and salinity of the water at their location weekly. GBF staff provided equipment and training on how to monitor water temperature and salinity and provided reference guides. GBF staff requested they sample weekly on the same day, during the same timeframe as the rest of the oyster water quality monitors, so all the data collected was as similar as possible. However, due to variations in the volunteer's schedule not all data collection occurred on the same day during the same timeframe. The volunteers were provided with an online data submittal form to make it easier for all parties to submit their data. Data from this water monitoring will be used along with spat recruitment results to gain a better understanding of overall spat recruitment trends within Galveston Bay. This was the first year of collecting this data, but data collection is expected to continue each year GBF's Volunteer Oyster Gardening Program continues. This will allow for additional data collection and further analysis of spat recruitment trends to obtain a more robust understanding.

E.1 List of volunteer water quality monitors and water quality monitoring locations

At the beginning of Cycle 27, GBF had 25 active, fully certified monitors at 23 monitoring sites, with eight sites sampling for *Enterococcus* bacteria. At the end of the project period, the monitoring team had 34 active, fully certified volunteers sampling at 27 monitoring sites, with 13 sites collecting *Enterococcus* bacteria samples. During Cycle 27, volunteers contributed over 547.95 volunteer hours, analyzed 128 water samples, and collected 78 bacteria samples. Additional volunteers went through training sessions with GBF but ended up being certified through Harris Galveston Area Council's Stream Team (HGAC) and began sampling at upstream locations.

Please refer to Appendix E for the list of current active Volunteer Monitors and Monitoring Locations.

E.2 Schedule of WMT volunteer trainings and events

GBF staff implemented an activity review for all water monitoring team members and reached out to those who had not consistently sampled in the last year and offered them an opportunity to resign or to recommit to the program. This included meeting with volunteers to collect their water quality kits if they no longer wished to participate, discussing site changes with continuing volunteers, and other meetings and correspondence. Reconnecting with the volunteers and updating the list of active, dedicated volunteers helped to ensure consistent monitoring and growth of the program.

During Cycle 27, GBF's longtime lab volunteer continued to process bacteria samples alongside a water monitoring volunteer. The water monitoring volunteer completed certification in November 2022 to be a fully certified lab volunteer. This allowed GBF to open the lab on two weekdays per month versus only having the lab open one weekday per month. Also, two additional lab volunteers shadowed existing veteran volunteers and were certified to process samples, which allowed GBF to open the lab for one weekend day per month.

There is currently a waitlist of over 45 people interested in becoming a water quality volunteer. GBF hosted trainings (Table 9), quality control (QC) events, and bacteria certifications during Cycle 27. Coordination between other Texas Stream Team partners in the area occurred to help train and fill monitoring locations across the whole Houston/Galveston region so a more holistic view of water quality in the area can be obtained. Two long time water monitor volunteers began the process of becoming certified Texas Stream Team Trainers and plan to be certified by Fall 2024. This will expand the opportunity for hosting more training courses in the upcoming years and help to fill the gap in case of any future staff turnover. It will also create more engagement and ownership of the Water Quality Program by volunteers.

GBF's Water Quality Programs Manager attended the annual Texas Stream Team Trainer meeting and trainer recertification session in San Marcos, Texas in February 2024. The meeting was beneficial because it allowed recertification for hosting training sessions, discussion of common issues, new sampling methods, and relationship building amongst other Texas Stream Team groups. From this training, GBF is exploring the opportunity to add Texas Stream Team advanced sampling to our repertoire as well as sampling for optical brighteners once sample methods have been finalized.

Table 9: List of All Training Sessions

Date	Training Type	Location	Number of Participants
11/22/22	Phase 3	Houston Yacht Club	1
12/2/22	Phase 1 & 2	Texas Corinthian Yacht Club	7
1/8/23	Phase 3	Sunset Cove	1
2/3/23	Phase 3	Tiki Island RV Park	1
2/19/23	Phase 3	Coastal Cameroons Tex Mex	2
6/2/23	Phase 1 & 2	Clear Lake Park	10
6/22/23	Phase 3	Texas City Dike	1
6/26/23	Phase 3	Portofino Harbor	1
8/22/23	Phase 3	Dickison Bay	1
9/16/23	QC Training	Lee and Joe Jamail Bay Park	5
9/27/23	QC Training	Jarboe Park	4
11/4/23	Phase 1 & 2	Baytown Wetland Center	6
11/5/23	Phase 3	Morgans Point	1
11/14/23	Bacteria Sampling	Galveston Bay Foundation Office	2
12/15/23	Phase 3	South Shore Marina	1
12/19/23	Phase 3	Nassau Bay Marina	1
2/7/24	Trainer Training	San Marcos	40

E.3 Water quality data and analysis – hotspots, trends over time, water quality tracking

During the 2023 oyster gardening season (spring through fall) water temperature and salinity were recorded weekly at five different bayfront gardening communities. This water quality data was collected by volunteers within the Oyster Gardening Program to compare any trends between the water quality data and the spat recruitment data. The water temperatures fluctuated but generally followed expected seasonal trends. The salinities for Beach City and San Leon showed a gradual increase during the entire gardening season. This is likely due to the Stage 2 drought the Houston Area underwent during the summer of 2023. This increased salinity in Beach City likely resulted in increased spat recruitment compared to previous years. Please refer to the Annual Gardening Report in Appendix C for more information about the water temperature and salinity data collected.

Going forward, GBF staff plan to continue to work with volunteers each gardening season to collect water quality data to gather more information to further analyze water quality results with the spat recruitment results to better understand spat recruitment trends for Galveston Bay.

GBF staff analyzed the water quality data along with the reef monitoring data to correlate the temperature and salinity along with the average number of live oysters per bag documented to help determine the reef restoration site's success. There was some correlation between higher temperatures and fewer live oysters, but the stronger correlation was between sustained higher salinities and fewer live oysters (Chart 6 and 7). As salinities were sustained over 30 ppt in 2023, live oyster counts at Sweetwater Preserve declined over time.

GBF staff were not able to perform statistical analysis utilizing the water quality data with the reef monitoring data because not enough data has been collected thus far. GBF will continue to collect water quality data and reef monitoring data at GBF's Sweetwater Lake Preserve where the oyster shell breakwater is located so further analysis can be conducted. Additional possibilities are being explored to expand volunteer water monitoring to incorporate deployable water monitoring devices in the future.

Chart 6: Water Temperature and Average Number of Live Oysters Per Bag

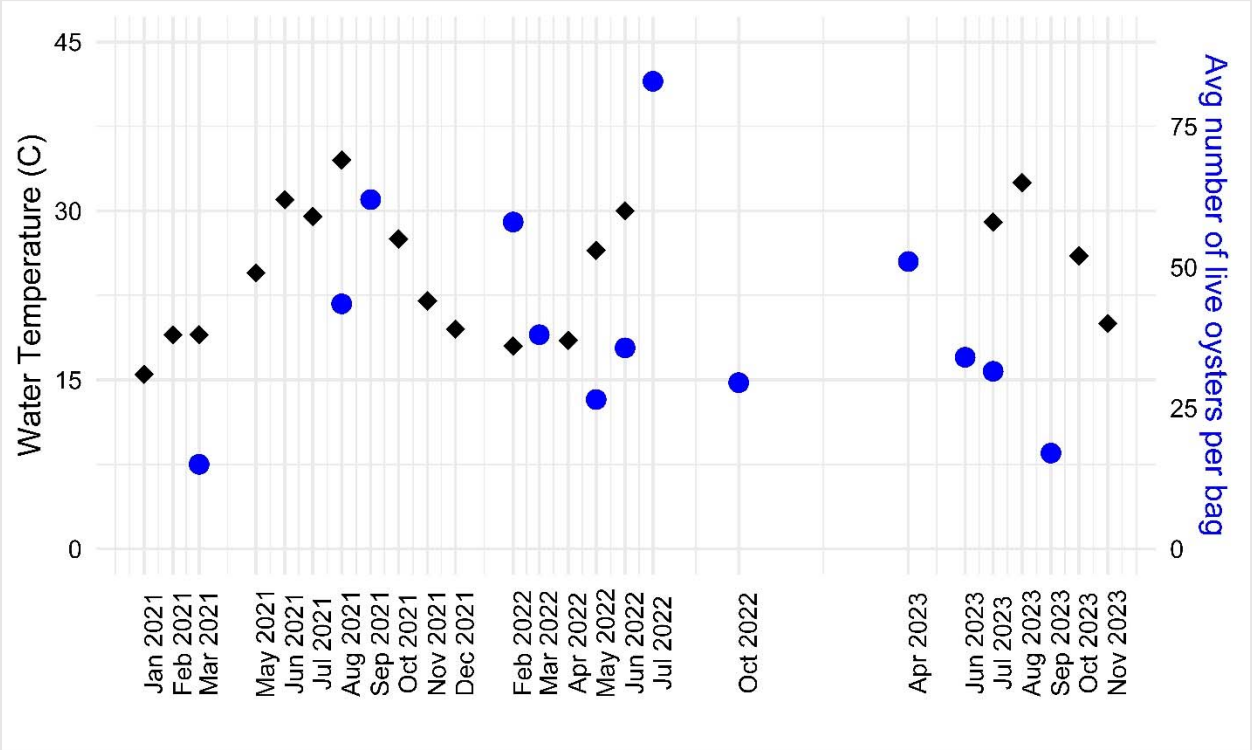
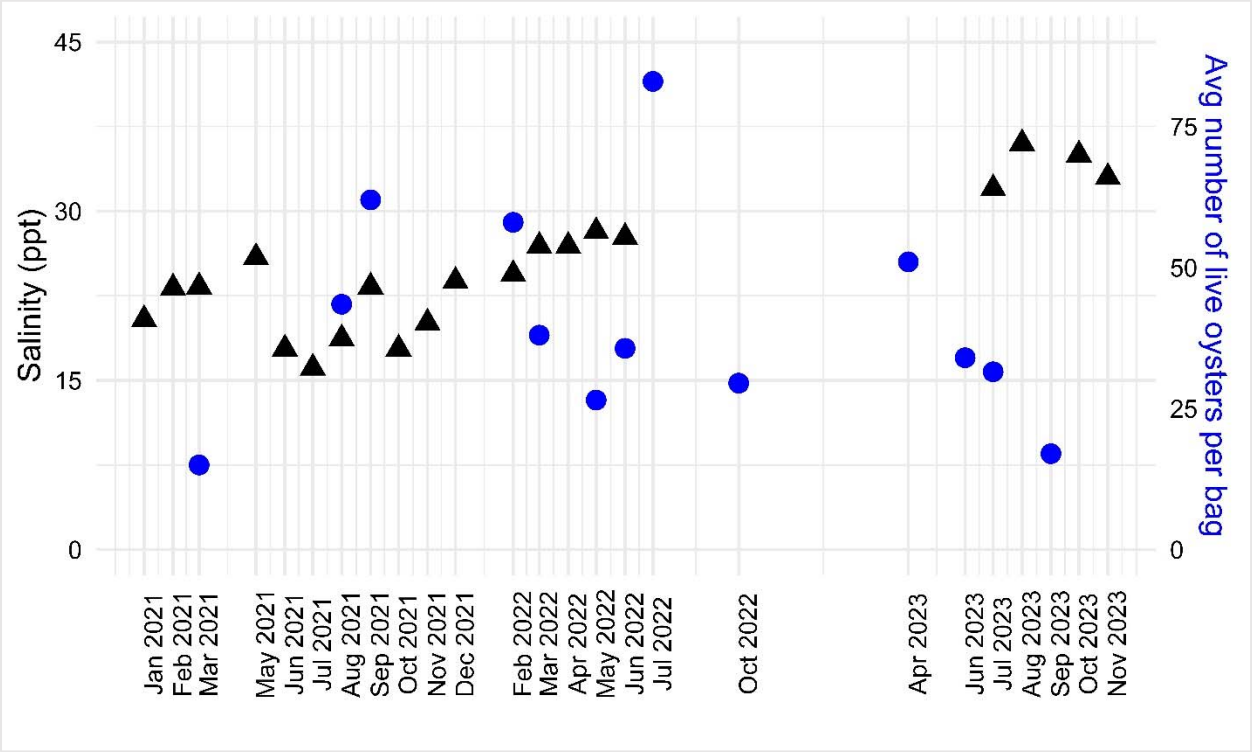


Chart 7: Water Temperature and Average Number of Live Oysters Per Bag



E.4 Copies of information products created from WMT data

Water quality data collected during Cycle 27 was shared on multiple platforms and used in various analyses and reports. A data visualization portal can be found on GBF's website (http://waterdata.galvbay.org/). This data viewer allows visitors to see data and why each parameter is important to the environment and public health at all Water Monitoring Team sites located throughout Galveston Bay. The public and potential researchers are creating/sharing their notes/opinions on ways to improve usage of the data. Local school districts and STEM programs use the data from the website in student-driven research classes. In Appendix E, there is an example of an undergraduate poster created using the data provided on our website and focused on promoting citizen science. GBF staff continued to work to ensure accessing data and downloading data from the website is easy and intuitive.

GBF submitted bacteria data to Swim Guide, which is a website that was maintained during Cycle 27. As new sampling sites start to include bacteria sampling, photos are taken of the sample site and are added to each of GBF's locations on Swim Guide. This helps the public better understand where the samples are being collected and what the location looks like prior to visiting the area. Volunteers wrote descriptions of their sample site, amenities, and recreation options, which helped build volunteer ownership. These descriptions were edited by the Water Quality Manager and added to each Swim Guide location to help inform the public of local waterways.

One report that uses Galveston Bay's water quality results is the annual Galveston Bay Report Card. This report utilizes GBF's data, along with data from Texas Commission on Environmental Quality (TCEQ),

HGAC, and various other agencies, to get an understanding of the state of Galveston Bay. The Report Card for 2023 was released in September and GBF's data collected for dissolved oxygen, pH, water temperature, and bacteria were used to develop the grades along with professional monitoring data and data from other sources. In addition to the overall grades, GBF wrote an article about safe swimming in Galveston Bay, bacteria sampling, and ways to help protect water quality. The article was translated into Spanish and Vietnamese to help increase accessibility. These articles can be found in Appendix E and more information of the grades given to Galveston Bay's water quality and wildlife can be found at https://www.galvbaygrade.org/.

As a partner with HGAC and the Texas Stream Team, GBF's water quality data and sampling sites are also listed on both websites. In the past GBF provided all the data to HGAC, then they were responsible for inputting the data onto their website and providing it to the Texas Stream Team at the Meadow Institute. Since 2022 the Texas Stream Team has been going through a data transition and are moving to a new data viewer platform. Going forward GBF staff will be entering the data directly into the Texas Stream Team's website data viewer. GBF is working with the Texas Stream Team to transition to the new data viewer, setting up GBF's sample sites into their database, and working on getting all GBF's historic data moved into the Texas Stream Team's data viewer. A list of locations GBF's data is currently used and shared is available in Table 10.

During Cycle 27, there were multiple presentations the Water Quality Programs Manager completed in the Houston area to discuss GBF's sampling program and overall water quality trends. Various water quality data and online resources were shared depending on the audience and their interests. Table 11 lists the partner organizations where presentations occurred and one interview with Fox News.

Table 10: List of All Locations Where Water Quality Data and Products are Shared

Website	Agency	Raw Data or Data Product
http://waterdata.galvbay.org/	Galveston Bay Foundation	Raw Data and Data Product
https://www.arcgis.com/apps/dashboards/81c6a11d1315467a8fb4d2ec01c48ac9	Texas Stream Team	Raw Data
https://h-gac.maps.arcgis.com/apps/MapSeries/index.html?appid=30b802d67f5d4a2aa7915cc30bca9318	Houston Galveston Area Council	Raw Data
https://www.epa.gov/waterdata/water-quality-data-upload-wqx	EPA Water Quality Exchange (WQX)	Raw Data
https://www.theswimguide.org/	Swim Guide	Raw Data and Data Product
https://www.galvbaygrade.org/	Galveston Bay Foundation and Houston Advanced Research Center	Data Product

Table 11: Select List of Water Quality Presentations

Date	Type	Audience	Topics Covered	Attendance
3/29/23	Presentation	Port of Galveston	Galveston Water Quality and Non-Point Source Pollution	12
5/20/23	Presentation	Bacteria Implementation Group	Galveston Bay NPS programs and Volunteer Monitoring	20
7/15/23	Interview	Fox News- Galveston	Bacteria in Galveston Bay	Unknown
12/1/23	Presentation	Clean Waters Initiative Meeting	Volunteer Monitoring	14

IV. Results

GBF utilized Cycle 27 funds to continue the OSRP's expansion to the inner loop of Houston. During Cycle 27, 182 tons of oyster shell were collected, and six new shell recycling partnerships were secured. All oyster shells collected during Cycle 27 are currently undergoing the sun curing process. Upon completion of the sun curing process, these shells will be utilized in GBF's Volunteer Oyster Gardening Program and oyster reef restoration efforts.

Due to the new restaurant partnerships in Houston, Clear Lake, and Galveston, GBF recycled a total of 237 tons in 2023. GBF is now collecting an average of almost 20 tons of oyster shell per month. As of mid-March 2024, GBF had recycled a total of 1,766 tons of oyster shells since the inception of the OSRP.

Cycle 27 also funded the 2023 oyster gardening season. Ninety-four volunteers participated in oyster gardening during 2023 and helped grow 4,493 oysters which were transplanted onto restoration reefs under separate grant funding.

Cycle 27 funded the 2023 reef monitoring efforts. GBF staff led four reef monitoring events at GBF's Sweetwater Lake Preserve from spring to fall and collected data on live and recently dead oysters. After GBF staff conducted statistical data analysis it was concluded the reef is functioning well and recruiting new oysters annually within every section of the reef sampled.

During Cycle 27, the water monitoring team had 34 volunteers sampling from 27 locations with 13 sites collecting 113 *Enterococcus* bacteria samples. There were 11 new volunteers who completed the full certification process and adopted a GBF water sampling site. Some additional volunteers proceeded to full certification under HGAC and will continue to help monitor water quality upstream of Galveston Bay. During Cycle 27, volunteers contributed over 547.95 volunteer hours, analyzed 128 water samples, and collected 78 bacteria samples. Bacteria sampling expanded from one lab processing day per month to three days and five additional samples were processed per month. Due to more volunteers expressing interest in becoming trained to collect water samples and the increased lab availability, the number of bacteria samples processed per year will hopefully continue to increase.

V. Lessons Learned

Shell Recycling Operations

GBF plans to continue recruiting additional shell recycling partners as capacity allows. The threshold for expansion will be dictated by the shell-hauling capacity of the recycling equipment (dump truck, landscape trailer, Moody Gardens' equipment), storage capacity at the curing sites, and/or funding availability. To date, neither the shell-hauling equipment nor the curing sites have exceeded capacity. The largest expenses documented thus far are associated with travel, vehicle/equipment maintenance, and staff time (salary and fringe).

The dump truck maintenance requires a significant amount of funds in the event the equipment becomes damaged or needs to be replaced due to normal wear and tear. Fortunately, thanks to federal and state grants and private donations through individuals or corporations, GBF has been able to fund the maintenance costs associated with the dump truck thus far. To save on cost GBF staff perform the necessary maintenance whenever possible. GBF staff also established a plan on how to conduct the Houston region shell collections when the dump truck is out of commission to keep the normal schedule in place as much as possible.

Under Cycle 27, one additional partner was secured on Galveston Island. If the Galveston shell recycling operations continue to expand, additional staff and alternative equipment will be required in the future. Moody Gardens continues to be a great partner for shell recycling with GBF. Moody Gardens hired a new employee in early 2024 that will be dedicated to managing their conservation and sustainability efforts and will be reevaluating Moody Gardens' efforts in terms of shell recycling with the goal of continuing to expand the program with the help of more Moody Gardens' staff and volunteers.

Four more Houston restaurant partners and one Clear Lake partner were added to the OSRP during Cycle 27, and as of July 2023, the OSRP had 18 Houston region restaurant partners. To not exceed hauling capacity for the dump truck GBF staff focused less on securing new restaurant partnerships for the Houston region in 2023. New Houston restaurant partners are added to the OSRP if the restaurant contacted GBF and adding them to the OSRP is feasible or if the restaurant is located directly on the current established route. The Houston shell collections are conducted on Mondays, Wednesdays, and Fridays. Due to the weekend Mondays have the heaviest loads, and at times the dump truck almost reaches max capacity. Therefore, when a new restaurant partner is interested in joining the OSRP it is recommended they receive shell collections on Wednesdays or Fridays to lessen the load on Mondays.

During Cycle 27, GBF staff updated the OSRP's Strategic Development Plan to evaluate the shell recycling operations expansion to determine the future of the OSRP. GBF staff determined for the remainder of 2024 they will be maintaining and evaluating the program.

Volunteer Oyster Gardening

To streamline the Garden Creation Events and reduce expenses, GBF staff decreased the number of events held at the beginning of the season when volunteers meet to learn about the Volunteer Oyster Gardening Program and build their gardens to take home. For 2023 five Garden Creation Events were hosted in central locations rather than in each of the communities to help reduce the number of events. Therefore, some bayfront communities did not have an event hosted in their community like previous years which

upset some volunteers and resulted in less participation. For next season the proposed plan will be to schedule the Garden Creation Events in each of the communities again. However, GBF staff will schedule most of the events during the week rather than on Saturdays. Hosting the events during the week will allow GBF staff to be present for each community without having to devote their weekends for several weeks.

At the end of the season at the collection events, if the cage gardens are still in decent shape GBF staff store the cages during the offseason to be reused for the next year. At the collection events this year, a few volunteers reported their cages fell apart and the recycled oyster shells fell out and were not retrievable. The cause of the oyster shells falling out could be due to the cages being too brittle from being used previously. For next season, GBF staff and volunteers plan to inspect the recycled cages more closely to make sure they are not weakened. The cages are held together by metal hog rings so if the mesh material looks to be in good condition the hog rings will be replaced so the risk of the cage coming apart mid-season is lessened.

GBF staff conducted statistical data analysis for the average number of oysters recruited per garden type for 2022 and 2023 to verify which of the three garden types is more successful for oyster recruitment. From the results it was determined the stringer gardens are the least successful. Next season GBF staff will continue to offer stringer gardens but will inform the volunteers of the statistical results and discuss with them the possibility of eliminating the stringer garden. While the stringer gardens are not costly to construct, the elimination of stringer gardens will reduce staff and volunteer time spent drilling holes into each individual oyster shell.

Volunteer Reef Monitoring

GBF hosted four volunteer reef monitoring events in 2023 and evaluated the data for steps moving forward. There are currently ten sampling locations at the Sweetwater Preserve property. It is difficult to get to all ten sampling locations in one day, especially the sites that are further away from the entry location. This means the ten sites have not all been monitored the same number of times. A lesson learned for the 2024 season would be to reduce the number of bags monitored in order to properly monitor each bag every event day.

The more times a sample location can be monitored in a season allows for more accurate data. GBF will attempt to monitor at least four times every year. Additionally, this was the first year that GBF has statistically evaluated the data with help from GBF's reasearch program. They were able to provide additional support in evaluations and how data can be collected more effectively in the future.

It is the goal to collect data that is useful, understandable, and potentially applicable to restoration best management practices, however, GBF recognizes that this is a citizen science program foremost, rather than a research study. There are lessons to be learned from every data collection event, and it is encouraging to see the reef is recruiting live oysters every season.

Water Quality

GBF staff recruited and trained new water monitoring volunteers throughout Cycle 27. While many of the volunteers completed the full water quality training with either GBF or HGAC, some did not, which has led GBF staff to reevaluate how volunteers are recruited, receive pre-training, and registration communication. Potential volunteers are provided with website resource options to ensure they

understand the full extent of what water quality monitoring entails, the timeframe commitment, training requirements, and sample site availability. The reevaluation has already started to lead to more dedicated volunteers registering for training sessions and having sample sites selected prior to training occurring. This has led to better completion rates for the training process. Discussions are ongoing with HGAC and other local partners to make sure all parties have a plan on how to handle communication and transfer volunteers should any proceed with the initial Phase 1 & 2 training with another agency.

Data submittal transitioned from excel data entry to being entered directly into the Texas Stream Team's website by volunteers and GBF staff. Data was then downloaded from their website to be added into GBF's database. Through this process some issues arose with the lack of how quickly data was visible to GBF staff after it was entered into the online database. At times this delay was over a month, which delayed the QC process, prevented the ability to download volunteer hours quickly for billing, and limited the ability to respond quickly to water quality issues. This led GBF to reevaluate how data entry will proceed moving forward. Volunteers will no longer be directed to enter data online, instead GBF will revert to having volunteers email their datasheet to GBF staff shortly after they have completed their sampling. Once an initial QC has been performed either GBF staff or a dedicated volunteer will enter the data into the online database and there will be a separate database for volunteer hours. This will allow for quicker initial data QC, the ability for data to be sent to partners immediately if there is a water quality concern and having volunteer hours readily available.

Collecting water quality data during the oyster gardening season was a new component included for Cycle 27. The results showed how the extent of the Stage 2 drought impacted the salinity levels in Beach City. The increase in salinity may be the cause of the higher spat recruitment outcome that occurred in that community for 2023. Further data collection each gardening season will help GBF to better understand spat recruitment rates in Galveston Bay.

VI. References

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VII. Appendix

APPENDIX A: Task 1

- Map of Shell Recycling Locations and Curing Sites
- Restaurant Database
- Strategic Development Plan

APPENDIX B: Task 2

- Task 2 Photographs
- TPWD & GBEP Oyster Workgroup Meeting Notes
- Oyster Shell Recycling Program Outreach Materials

APPENDIX C: Task 3

- Texas Parks and Wildlife Department Introduction Permit
- Annual Gardening Report

APPENDIX D: Task 4

- Task 4 Photographs
- Map of Reef Monitoring Locations
- Reef Monitoring Data and Results

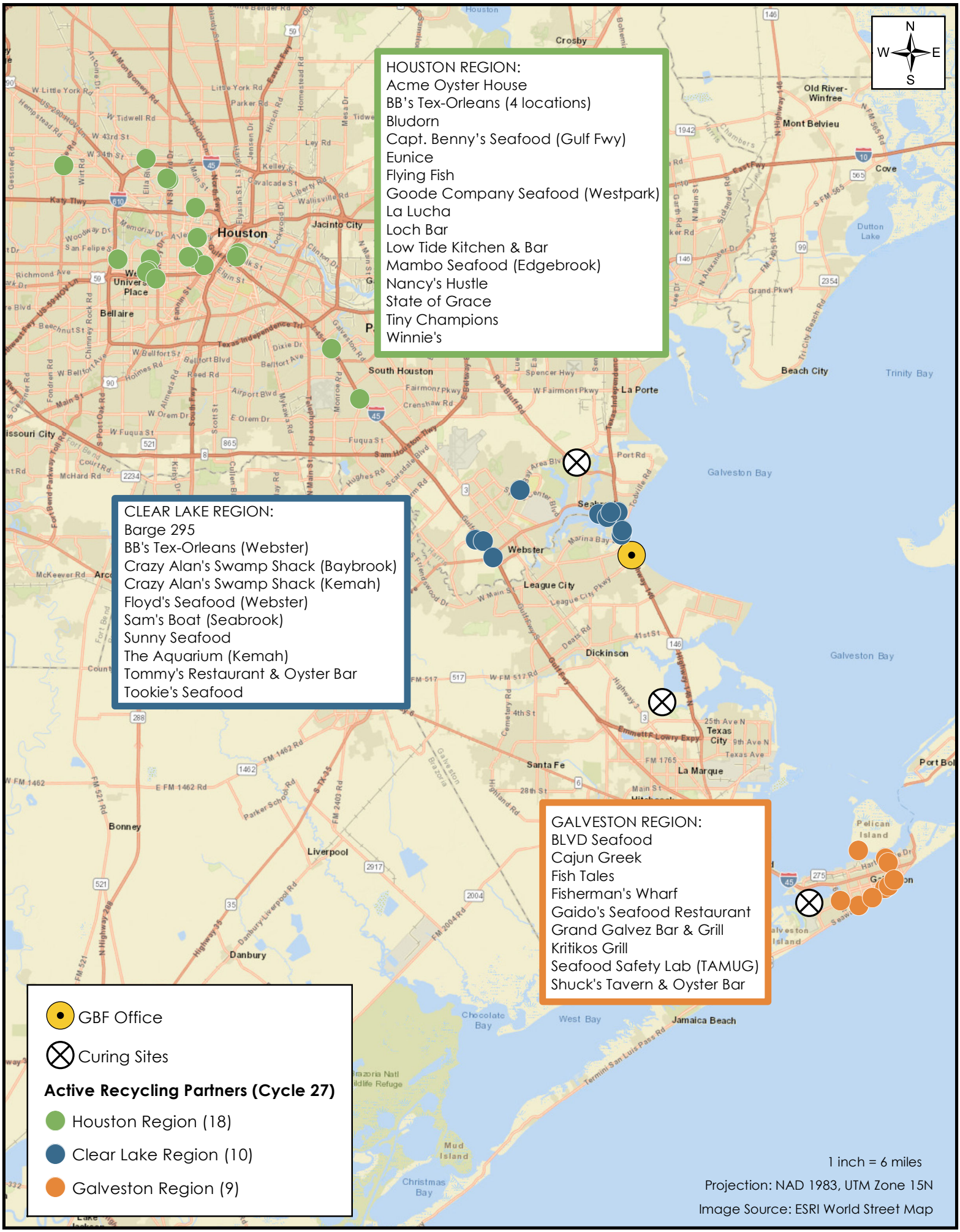
APPENDIX E: Task 5

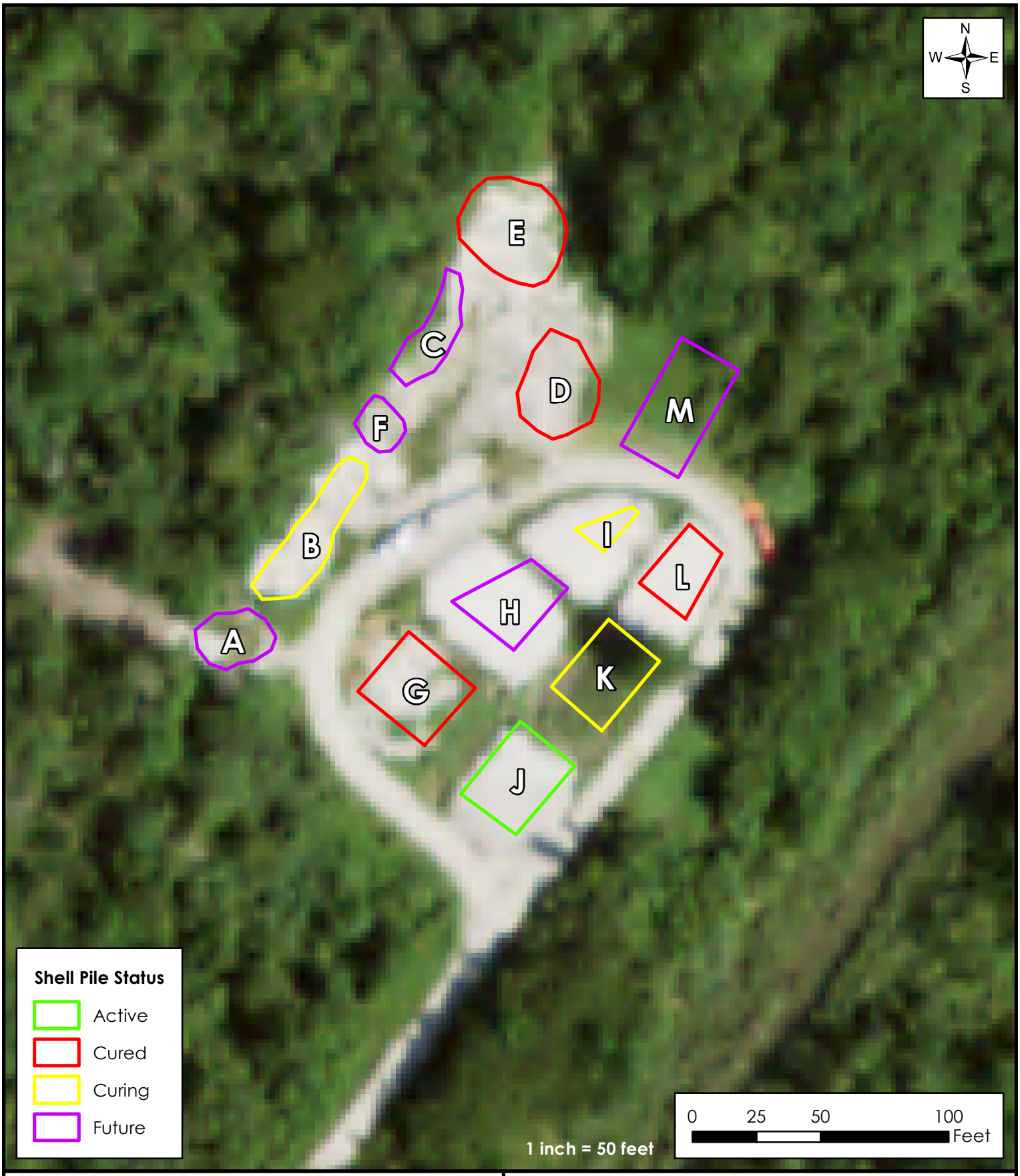
- Volunteer Monitors and Monitoring Locations
- Copies of Information Products Created from WMT Data

APPENDIX A
Task 1 Deliverables

SHELL COLLECTION, RESTAURANT PARTNERSHIPS, AND CURING SITE MAINTENANCE

Task 1
Map of Shell Recycling Locations and Curing Sites


HOUSTON REGION:
Acme Oyster House
BB's Tex-Orleans (4 locations)
Bludorn
Capt. Benny's Seafood (Gulf Fwy)
Eunice
Flying Fish
Goode Company Seafood (Westpark)
La Lucha
Loch Bar
Low Tide Kitchen & Bar
Mambo Seafood (Edgebrook)
Nancy's Hustle
State of Grace
Tiny Champions
Winnie's
CLEAR LAKE REGION:
Barge 295
BB's Tex-Orleans (Webster)
Crazy Alan's Swamp Shack (Baybrook)
Crazy Alan's Swamp Shack (Kemah)
Floyd's Seafood (Webster)
Sam's Boat (Seabrook)
Sunny Seafood
The Aquarium (Kemah)
Tommy's Restaurant & Oyster Bar
Tookie's Seafood
GALVESTON REGION:
BLVD Seafood
Cajun Greek
Fish Tales
Fisherman's Wharf
Gaido's Seafood Restaurant
Grand Galvez Bar & Grill
Kritikos Grill
Seafood Safety Lab (TAMUG)
Shuck's Tavern & Oyster Bar
N
W
E
S
GBF Office
Curing Sites
Active Recycling Partners (Cycle 27)
Houston Region (18)
Clear Lake Region (10)
Galveston Region (9)
1 inch = 6 miles
Projection: NAD 1983, UTM Zone 15N
Image Source: ESRI World Street Map



Red Bluff Shell Pile Layout

Project Name: Oyster Shell Recycling Program (OSRP)	
Project Location: Red Bluff Curing Site, Harris County, TX	
Image Source: 2022 NAIP NC 60cm, Harris Co.	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 3/8/2024	Drawn by: H. Leija

GALVESTON BAY FOUNDATION

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MOODY GARDENS SHELL PILE LAYOUT

Project Name: Oyster Shell Recycling Program (OSRP)	
Project Location: Moody Gardens, Galveston County, TX	
Image Source: 2022 NAIP NC 60cm, Galveston Co.	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 11/29/2023	Drawn by: H.Leija

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Texas City Shell Pile Layout

Project Name: Oyster Shell Recycling Program	
Project Location: Texas City Curing Site, Galveston County, TX	
Image Source: ESRI World Imagery	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 5/10/2022	Drawn by: S. Batte

GALVESTON BAY FOUNDATION

1725 Highway 146, Kemah, TX; (281) 332-3381

Task 1
Restaurant Database

2023 RESTAURANT DATABASE

Houston Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Oysters Purchased (Sacks per week?)	Contacted?	Interested?	Restaurant Phone #
			Raw	Cooked				
1	1751 Sea and Bar	Houston	Y	2		No		(832) 831-9820
2	A'Bouzy	Houston	Y	1		No		(713) 722-6899
3	Acadian Coast	Houston	Y	3		No		(713) 432-9651
4	B&B Butchers & Restaurant	Houston	Y	1		No		(713) 862-1814
5	B.B. Lemon	Houston	Y	0		No		(713) 554-1809
6	BB's Tex-Orleans	Houston- Briargrove	Y	0		No	No	(713) 339-2566
7	BB's Tex-Orleans	Houston- Heights	Y	0	10-15 sacks/wk	Yes	Current Partner	(713) 868-8000
8	BB's Tex-Orleans	Houston- Montrose	Y	0		Yes	Current Partner	(713) 524-4499
9	BB's Tex-Orleans	Houston- Upper Kirby	Y	0	8 sacks/wk	Yes	Current Partner	(713) 807-1300
10	BB's Tex-Orleans	Houston- Pearland	Y	0		No	Yes	(832) 856-3200
11	BB's Tex-Orleans	Houston- Oak Forest	Y	0	6 sacks/wk	Yes	Current Partner	(832) 318-6533
12	Bludorn	Houston	Y	2	28 sacks/wk	Yes	Current Partner	(713) 999-0146
13	Brasserie 19	Houston	Y	1		No		(713) 524-1919
14	Brennan's of Houston	Houston	Y	2		No		(713) 522-9711
15	Cajun Kitchen	Houston	Y	4		No		(281) 495-8881
16	Captain Benny's Seafood	Houston	Y	4	20 sacks/wk	Yes	Current Partner	(713) 643-0589
17	Captain Benny's Seafood	Houston	Y	4		No		(713) 666-5469
18	Captain Benny's Seafood	Stafford	Y	4		No		(281) 498-3909
19	Captain Benny's Seafood	Houston	Y	4		No		(713) 680-1828
20	Captain Tom's Seafood & Oyster	Houston	Y	0		No		(713) 451-3700
21	Caracol	Houston	Y	1		No		(713) 622-9996
22	Chilos Seafood & Oyster Bar	Houston	Y	No menu online		No		(713) 947-8700
23	Christie's Seafood & Steaks	Houston	Y	2		No		(713) 978-6563
24	Clark's Oyster Bar	Houston	Y	1		Yes		(713) 347-8180
25	Crafty Crab	Pearland	Y	1		No		(832) 856-1111
26	Crafty Crab	Houston (FM 1960 Rd)	Y	1		No		(832) 680-1111
27	Crafty Crab	Houston (Fondren Rd)	Y	1		No		(713) 820-6888
28	Crafty Crab	Houston (Jersey Village)	Y	1		No		(832) 856-5656
29	Crafty Crab	Houston (Westheimer Rd)	Y	1		No		(832) 810-3333

2023 RESTAURANT DATABASE

Houston Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Oysters Purchased (Sacks per week?)	Contacted?	Interested?	Restaurant Phone #
			Raw	Cooked				
30	Drake's Hollywood	Houston	Y	Unsure		No		
31	Drunken Oyster	Spring	Y	0		No		(832) 843-6196
32	Eddie V's Prime Seafood	Houston- West Ave	Y	4		No		(713) 874-1800
33	Eddie V's Prime Seafood	Houston- CityCentre	Y	4		No		(832) 200-2380
34	Eugene's Gulf Coast Cuisine	Houston	Y	5		No		(713) 807-8889
35	Eunice	Houston	Y	2	40 sacks/wk	Yes	Current Partner	(832) 491-1717
36	Famous Crab	Houston	Y	3		Yes	Yes, but no response	(281) 484-2722
37	Field & Tides	Houston	Y	1		No	No response	(713) 861-6143
38	Fish City Grill	Pearland	Y	1		No		(713) 340-1493
39	Fish City Grill	Sugarland	Y	1		No		(281) 494-3474
40	Flora	Houston	Y	0		No		(713) 360-6477
41	Floyd's Cajun Seafood and Steakhouse	Sugar Land	Y	6		No		(281) 240-3474
42	Floyd's Cajun Seafood and Steakhouse	Pearland	Y	6		No		(281) 993-8385
43	Flying Fish	Houston	Y	4	9 sacks/wk	Yes	Current Partner	(713) 377-9919
44	Frank's Americana Revival	Houston	Y	Unsure		Yes		(713) 572-8600
45	Georgia James	Houston	Y	1		No		(832) 241-5088
46	Good Vibes Coastal Kitchen	Pearland	Y	1		No		(832) 569-4141
47	Goode Company- Seafood	Houston- Westpark	Y	4	45 sacks/wk	Yes	Current Partner	(713) 523-7154
48	Harold's	Houston- Heights	Y	1		Yes	Maybe	(713) 360-6204
49	Hometown Seafood Company	Pearland	Y	4		No		(281) 416-5419
50	Hudson House	Houston	Y	0		Yes		(832) 648-3210
51	Hugos	Houston				Yes	Yes	(713) 524-7744
52	Julep	Houston	Y	Unsure		No		(832) 371-7715
53	Kata Robata	Houston	Y	0		No		(713) 526-8858
54	LA Crawfish	Houston- Greenway	Y	3		No		(832) 767-1533
55	LA Crawfish	Houston- Memorial	Y	3		No		(713) 461-8808

2023 RESTAURANT DATABASE

Houston Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Oysters Purchased (Sacks per week?)	Contacted?	Interested?	Restaurant Phone #
			Raw	Cooked				
56	LA Crawfish	Houston- Langwood	Y	3		No		(832) 491-1121
57	LA Crawfish	Houston- Wallisville Rd & Beltw	Y	3		No		(281) 416-5352
58	LA Crawfish	Katy	Y	3		No		(346) 251-5902
59	LA Crawfish	Pearland	Y	3		No		(832) 781-4946
60	LA Crawfish	Houston- Gulfgate	Y	3		No		(832) 804-6901
61	LA Crawfish	Missouri City	Y	3		No		(281) 208-7759
62	La Lucha	Houston	Y	3	100 sacks/wk	Yes	Current Partner	(713) 955-4765
63	Liberty Kitchen & Oysterette	Houston- River Oaks	Y	2		No		(713) 622-1010
64	Liberty Kitchen & Oysterette	Houston- Memorial	Y	2		No		(713) 468-3745
65	Little's Oyster Bar	Houston	Y	Unsure		No		(713) 522-4595
66	Loch Bar	Houston- River Oaks District	Y	5	30 sacks/wk	Yes	Current Partner	(832) 430-6601
67	Low Tide Kitchen & Bar	Houston- Spring Branch	Y	2		Yes	Current Partner	(713) 360-6304
68	Mambo Seafood	Houston- 45S & Edgebrook	Y	0	20-50 sacks/wk	Yes	Current Partner	(713) 946-0000
69	Mambo Seafood	Houston- Gulfgate	Y	0		Yes		(281) 712-8298
70	Mambo Seafood	Houston- 290 & Tidwell	Y	0		No		(713) 462-0777
71	Mambo Seafood	Houston- 45N & West Rd	Y	0		No		(281) 820-3300
72	Mambo Seafood	Houston- Airline & Tidwell	Y	0		No		(713) 691-9700
73	Mambo Seafood	Houston- Gessner & Long Point	Y	0		No		(713) 465-5009
74	Mambo Seafood	Houston- Hillcroft & Bellaire	Y	0		No		(713) 541-3666
75	Mambo Seafood	Houston- I-10 & Federal	Y	0		No		(713) 637-0553
76	Mambo Seafood	Katy	Y	0		No		(832) 391-6644
77	Mannie's Seafood	Houston	Y	2		No		(713) 641-5003
78	Marcos Seafood & Oyster Bar	Houston	Y	0		No		(713) 946-1168
79	Mastro's Steakhouse	Houston	Y	1		No		(713) 993-2500
80	McCormick & Schmick's Seafood & Steaks	Houston- Town & Country Villa	Y	4		Yes		(713) 465-3685
81	McCormick & Schmick's Seafood & Steaks	Houston- Uptown Park, Galleria	Y	4		Yes		(713) 840-7900
82	McCormick & Schmick's Seafood & Steaks	Houston- Downtown	Y	4		Yes		(713) 658-8100
83	Musaafer	Houston	Y	1		No		(713) 242-8087

2023 RESTAURANT DATABASE

Houston Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Oysters Purchased (Sacks per week?)	Contacted?	Interested?	Restaurant Phone #
			Raw	Cooked				
84	Nancy's Hustle	Houston	Y	Unsure New to menu	4-5 sacks/wk	Yes	Current Partner	(346) 571–7931
85	Navy Blue	Houston	Y	1	20-30 sacks/wk	Yes	Current Partner	(713) 347-7727
86	Orleans Seafood Kitchen	Katy	Y	1		No		(281) 646-0700
87	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #11	Y	1		No		(713) 921-1800
88	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #1	Y	1		No		(281) 999-3995
89	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #3	Y	1		No		(713) 330-4419
90	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #4	Y	1		No		(281) 447-5061
91	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #5	Y	1		No		(713) 974-6828
92	Ostioneria Michoacan Seafood and Oyster Bar	Woodlands- #6	Y	1		No		(281) 292-6811
93	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #7	Y	1		No		(713) 463-5410
94	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #8	Y	1		No		(281) 877-8855
95	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #15	Y	1		No		(281) 477-7697
96	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #16	Y	1		No		(832) 672-4139
97	Pappadeaux Seafood Kitchen	Houston- Hobby Airport	Y	1		No		(713) 847-7622
98	Pappadeaux Seafood Kitchen	Houston- Galleria	Y	1		No		(713) 782-6310
99	Pappas Bros. Steakhouse	Houston- Galleria	Y	0		No		(713) 780-7352
100	Pappas Seafood House	Houston- Aldine Bender	Y	1		No		(281) 999-9928
101	Perry's Steakhouse & Grille	Houston- Champions	Y	0		No		(281) 970-5999
102	Perry's Steakhouse & Grille	Katy	Y	0		No		(281) 347-3600
103	Perry's Steakhouse & Grille	Houston- Memorial City	Y	0		No		(832) 358-9000
104	Perry's Steakhouse & Grille	Houston- River Oaks	Y	0		No		(346) 293-8400
105	Perry's Steakhouse & Grille	Sugar Land	Y	0		No		(281) 565-2727
106	Perry's Steakhouse & Grille	Woodlands	Y	0		No		(281) 362-0569
107	Ragin' Cajun	Houston- The Original	Y	1		No		(713) 623-6321
108	Relish Restaurant & Bar	Houston	Y	1		No		(713) 599-1960
109	Riel	Houston	Y	1		No		(832) 831-9109
110	Sam's Boat	Pearland	Y	0		No		(713) 436-0201
111	Sam's Boat	Houston	Y	0		No		(713) 781-2628
112	State of Grace	Houston	Y	1	~80 sacks/wk	Yes	Current Partner	(832) 942-5080
113	Steak 48	Houston	Y	0		No		(713) 322-7448

2023 RESTAURANT DATABASE

Houston Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Oysters Purchased (Sacks per week?)	Contacted?	Interested?	Restaurant Phone #
			Raw	Cooked				
114	The Annie Café & Bar	Houston	Y	0		No		(713) 804-1800
115	The Chalet at Rosie Cannonball	Houston	Y	0		No		(832) 380-2471
116	The Crawfish Pot & Oyster Bar	Houston	Y	2		No		(713) 360-6547
117	The Oceanaire	Houston	Y	1		Yes		(832) 487-8862
118	The Original Ninfa's	Houston- Navigation	Y	1		No		(713) 228-1175
119	The Original Ninfa's	Houston- Uptown	Y	1		No		(346) 335-2404
120	The Pearl Restaurant & Bar at The Sam Houston Ho	Houston	Y	3		No		(832) 200-8817
121	The Rouxpour	Sugarland	Y	4		No		(281) 240-7689
122	The Rouxpour	Katy	Y	4		No		(281) 394-5013
123	The Rustic	Houston	Y	2		No		(832) 321-7775
124	Tiny Champions	Houston	Y	0	2-4 sacks/wk	Yes	Current Partner	(713) 485-5329
125	Tobiuo Sushi & Bar	Katy	Y	1		No		(281) 394-7156
126	Toulouse	Houston	Y	1		No		(713) 871-0768
127	Traveler's Table	Houston	Y	3		Yes	Yes, but no response	(832) 409-5785
128	Truluck's Seafood Steak & Crab House	Houston	Y	1		No		(713) 783-7270
129	Truluck's Seafood Steak & Crab House	Woodlands	Y	1		No		(281) 465--7000
130	Turner's	Houston	Y	1		No		(713) 804-1212
131	Weights + Measures	Houston	Y	1		No		(713) 654-1970
132	Willie G's	Houston	Y	8		No		(713) 840-7190
133	Winnie's	Houston	Y	1	~10 sacks/wk	Yes	Current Partner	(713) 520-0660
134	Xochi	Houston	Y	1		No		(713) 400-3330

LEGEND
Current Partner
Priority for Shell Recycling
Contact for Houston Oyster Festival
Low Priority

2023 RESTAURANT DATABASE

Clear Lake Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Oysters Purchased (Sacks per week?)	Contacted?	Interested?	Restaurant Phone #
			Raw (Y/N)	Cooked				
1	Barge 295	Seabrook	Y	5	10-12 sacks/wk	Yes	Current Partner	(281) 549-7603
2	BB's Tex-Orleans	Webster	Y	0	5 sacks/wk	Yes	Current Partner	(281) 767-9644
3	Bou-Shay's	Bacliff	Y	2		No		(832) 864-2862
4	Captain Benny's Seafood	Deer Park	Y	4		No		(281) 476-1513
5	Crafty Crab	League City	Y	1		No		(281) 849-9000
6	Crazy Alans Swamp Shack	Kemah	Y	4	~3 sacks/wk	Yes	Current Partner	(281) 334-5000
7	Crazy Alans Swamp Shack	Friendswood	Y	4	~3 sacks/wk	Yes	Current Partner	(832) 284-4895
8	East Star Chinese Buffet	Webster	Y	0		No		(281) 280-8822
9	Floyd's Cajun Seafood and Steakhouse	Webster	Y	6	~35 sacks/wk	Yes	Current Partner	(281) 332-7474
10	Flying Dutchman	Kemah	Y	4		Yes	*Past partner*	(281) 334-7575
11	Gilhooley's Restaurant	San Leon	Y	4		Yes	No	(281) 339-3813
12	Jackie's Brickhouse	Kemah	Y	1		Yes		(832) 864-2459
13	La Costa Seafood Grill	Alvin	Y	3		No		(281) 824-4384
14	LA Crawfish	Webster	Y	3		No		(832) 905-5154
15	LA Crawfish	Baytown	Y	3		No		(832) 479-8081
16	LA Crawfish	Pasadena	Y	3		No		(832) 288-4494
17	Landry's Seafood House	Kemah	Y	1		Yes	*Past partner*	(281) 334-2513
18	Little Daddy's Gumbo Bar	League City	Y	2		No		(281) 524-8626
19	Main St Bistro	League City	Y	0		No		(281) 332-8800
20	Mambo Seafood	Baytown	Y	0		No		(832) 926-7551
21	Marais	Dickinson	Y	4		No		(281) 534-1986
22	Monument Inn	La Porte	Y	0		No		(281) 479-1521
23	Noah's Ark Bar & Grill	Bacliff	Y	4		No		(281) 339-2895
24	Opus Bistro & Steakhouse	League City	Y	4		Yes		(281) 334-0006
25	Pappas Seafood House	Webster	Y	1		Yes	Have to talk to corporate	(281) 332-7546

2023 RESTAURANT DATABASE

Clear Lake Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Oysters Purchased (Sacks per week?)	Contacted?	Interested?	Restaurant Phone #
			Raw (Y/N)	Cooked				
26	Perry's Steakhouse & Grille	Friendswood	Y	0		Yes	Maybe	(281) 286-8800
27	Pier 6 Seafood & Oyster House	San Leon	Y	4		Yes	No	(281) 339-1515
28	Remton	Webster	Y	2		Yes		(832) 905-5138
29	Sammy G's District 70 BBQ & Grill	El Lago	Y	Unsure		Yes	Yes	
30	Sam's Boat	Seabrook	Y	0		Yes	Current Partner	(281) 326-7267
31	Schafer's Coastal Bar & Grille	Clear Lake Shores	Y	3		Yes	Yes, but don't serve oysters on regular basis	(281) 532-6860
32	The Aquarium Restaurant	Kemah	Y	0		Yes	Current Partner	(281) 334-2521 (Bio and Edu Dept.) (281) 334-9010 (Restaurant)
33	The Reef Seafood House	Texas City	Y	0		No		(409) 945-6151
34	The Rouxpour	Friendswood	Y	4		Yes	Maybe	(281) 480-4052
35	TJ Reed's Flippers	Dickinson	Y	2		No		(832) 340-7340
36	Tommy's Restaurant & Oyster Bar	Houston	Y	5		Yes	Current Partner	(281) 480-2221
37	Tookie's Seafood	Seabrook	Y	6	40-60 sacks/wk Use 8-10 sacks of oysters per day and 15 sacks of oysters on Fridays and Saturdays (8/27/18)	Yes	Current Partner	(281) 942-9445
38	Topwater Grill	San Leon	Y	5		Yes	*Past partner*	(281) 339-1232
39	Valdo's Seafood House	Seabrook	Y	4		Yes		(281) 326-3866

LEGEND
Current Partner
Priority for Shell Recycling
Contact for Houston Oyster Festival
Low Priority

2023 RESTAURANT DATABASE

Galveston Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Oysters Purchased (Sacks per week?)	Contacted?	Interested?	Restaurant Phone #
			Raw (Y/N)	Cooked				
1	Black Pearl Oyster Bar	Galveston	Y	4		No		(409) 762-7299
2	BLVD Seafood	Galveston	Y	3		Yes	Current Partner	(409) 762-2583
3	Cajun Greek	Galveston	Y	0	10 sacks/wk	Yes	Current Partner	(409) 744-7041
4	Fish Tales	Galveston	Y	0		Yes	Current Partner	(409) 762-8545
5	Fisherman's Wharf	Galveston	Y	0	14-20 sacks/wk	Yes	Current Partner	(409) 765-5708
6	Gaido's/Nick's Kitchen & Beach Bar	Galveston	Y	8	20-60 sacks/wk	Yes	Current Partner	(409) 761-5500
7	Grand Galvez Bar & Grill	Galveston	Y	Unsure	5-10 sacks/wk 3 or 4 big weekends around holidays	Yes	Current Partner	(409) 765-7721
8	Katie's Seafood House	Galveston	Y	2		Yes	Yes	(409) 765-5688
9	Kritikos Grill	Galveston	Y	0	2 sacks/wk	Yes	Current Partner	(409) 539-5915
10	Landry's Seafood House	Galveston	Y	1		No	Maybe	(409) 744-1010
11	Little Daddy's Gumbo Bar	Galveston	Y	2		No		(281) 524-8626
12	Number 13	Galveston	Y	0		Yes	*Past partner*	(409) 572-2650
13	Saltwater Grill	Galveston	Y	3		No		(409) 762-3474
14	Shuck's Tavern & Oyster Bar	Galveston	Y	3	5 sacks/wk from Prestige 8-10 sacks/wk from east coast	Yes	Current Partner	(409) 444-1700
15	Willie G's Seafood & Steaks	Galveston	Y	1		No		(409) 762-3030

LEGEND
Current Partner
Priority for Shell Recycling
Contact for Houston Oyster Festival
Low Priority

Task 1
Strategic Development Plan

OYSTER SHELL RECYCLING PROGRAM

A GALVESTON BAY FOUNDATION PROGRAM

Strategic Development Plan 3.0 2023-2024

This report was funded in part by a Texas Coastal Management Program grant approved by the Texas Land Commissioner, providing financial assistance under the Coastal Zone Management Act of 1972, as amended, awarded by the National Oceanic and Atmospheric Administration (NOAA), Office for Coastal Management, pursuant to NOAA Award No. NA22NOS4190148. The views expressed herein are those of the author(s) and do not necessarily reflect the views of NOAA, the U.S. Department of Commerce, or any of their subagencies.

1725 Highway 146, Kemah, TX 77565 • Phone 281-332-3381 • Fax 832-284-4982

GALVESTON BAY FOUNDATION

OUR MISSION

The mission of the Galveston Bay Foundation is to preserve and enhance Galveston Bay as a healthy and productive place for generations to come.

OYSTER SHELL RECYCLING PROGRAM

OUR GOAL

The goal of the Galveston Bay Foundation's Oyster Shell Recycling Program is to reclaim oyster shells from local restaurants, festivals, individuals, and other sources and return those shells to Galveston Bay to restore native oyster habitat and promote a sustainable Eastern oyster population in Galveston Bay.

TABLE OF CONTENTS

STEP 1: INTERNAL ANALYSIS

A) Need for Oyster Shell Recycling

Oyster reefs are a vital component of a healthy estuary and provide a unique suite of benefits as a valuable commercial and recreational fishery as well as habitat for other aquatic species. They filter coastal waters, protect shorelines, stabilize sediment, and provide food and shelter for over 300 different species (Grabowski and Peterson, 2007). Unfortunately, oyster reefs are the most threatened marine habitat worldwide. Studies have shown that over 85 percent of oyster habitat has been lost on a global scale (Beck et al, 2011). Heavy exploitation coupled with severe storm events, disease, pollution, and habitat loss has resulted in serious declines in North American oyster populations.

In Galveston Bay, over 60 percent of the oyster reefs have been destroyed, primarily due to decades of heavy exploitation combined with multiple storm events, particularly Hurricanes Ike and Harvey (Hons and Robinson, 2010). Prior to 2008, Galveston Bay yielded 90 percent of the oyster production in Texas, approximately six million pounds but since that time "has never topped more than 3.5 million pounds in a year" (Haby et al, 2009; Knapp, 2018; VanderKooy, 2012). In addition, four years (2015-2019) of heavy rainfall events, including Hurricane Harvey, led to extremely low salinity levels and thus a reduction in oyster spawning success. As of 2016, only 700,000 pounds of oysters were harvested in Galveston Bay; this low production is equivalent to only 12 percent of Galveston Bay's original high yields prior to 2008 (Knapp, 2018).

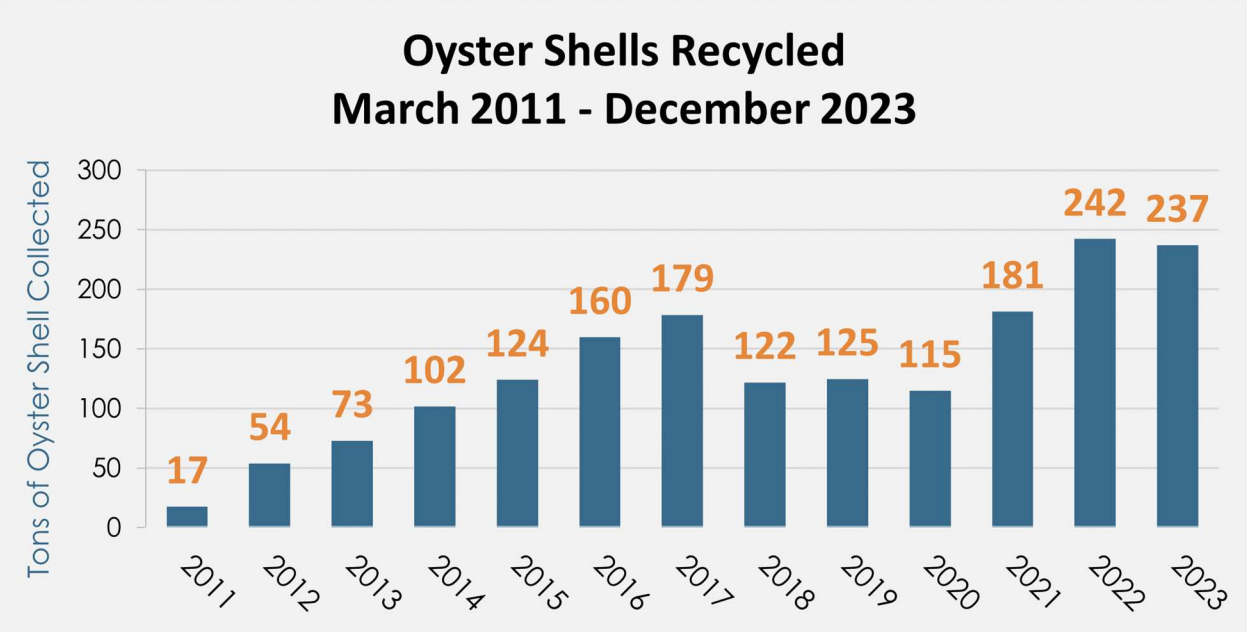
Although the wild larvae supply in Galveston Bay remains abundant (Martinez-Andrade et al, 2005), the removal of shells from the bay has resulted in a shortage of hard substrate, a key component for sustaining oyster populations. Commercial harvest operations in Galveston Bay, along with storm-driven sedimentation, have reduced the elevation of natural reefs, leaving little to no shell (hard substrate) behind. Unlike finfish, when oysters are harvested their entire habitat, the two valves of their shell and the surrounding oysters, is removed with them.

Hard substrate or "cultch" material is required for successful oyster development. While oyster larvae can attach to many surfaces such as rock, wood, porcelain, and even tires, multiple studies have shown that oyster shells are the preferred substrate for larval attachment and growth (Coen and Luckenbach, 2000; George et al, 2014). Over the last five to 10 years, it has become increasingly difficult and expensive to purchase oyster shells. In addition, the purchase and placement of rock cultch (e.g. limestone, concrete, river rock) is expensive and often a limiting factor in the size and scope of a reef restoration project. Therefore, sourcing oyster shells from local seafood restaurants or other end users, such as shucking houses, has become the common approach to securing cultch material for the restoration of oyster habitat. Oyster shell recycling began on the East Coast of the United States (US) in the early 2000's and has expanded along the Gulf Coast over the last 10 years. Now, at least 30 groups across the US are actively recycling oyster shells including the Galveston Bay Foundation (GBF). Without oyster shell recycling, restaurants will continue to discard oyster shells in their dumpsters and the shells will be lost to landfills, thus squandering a valuable resource.

B) History of the Galveston Bay Foundation's Oyster Shell Recycling Program

In response to the decline of Eastern oyster (*Crassostrea virginica*) habitat in Galveston Bay, GBF initiated an Oyster Shell Recycling Program (OSRP) in 2011. The OSRP was piloted through a partnership with local restaurant owner Mr. Tom Tollett of Tommy's Restaurant and Oyster Bar. GBF began recycling the restaurant's shucked oyster shells in 2011 at the request of Mr. Tollett to avoid the disposal of this important cultch material. Since 2011, GBF has expanded its operations through new restaurant partnerships and now collects an average of 160 tons (320,000 pounds) of shells a year. Since the inception of the OSRP and as of December 2023, GBF has collected over 1,730 tons (3,460,000 pounds) of oyster shell (Figure 1) and returned approximately 800 tons of these recycled shells to Galveston Bay to help replenish hard substrate in the bay and sustain the local oyster population.

Figure 1: Oyster Shell Recycled from March 23, 2011 through December 31, 2023



GBF initiated the OSRP with one restaurant in the Clear Lake area near Houston, Texas, and one shell storage site located in Texas City, Texas. With grant funding from the National Oceanic and Atmospheric Administration (NOAA) via the Texas General Land Office Coastal Management Program (CMP) and US Fish and Wildlife Service (USFWS) Coastal Program, donations from private foundations and corporations, and technical assistance from the Texas Parks and Wildlife Department (TPWD), the OSRP has progressed through the pilot phase, initial expansion phase, initial evaluation phase, and a second expansion phase, resulting in 36 restaurant and 1 seafood safety lab partnerships and three shell storage sites at the time of this publication. Please refer to Table 1 below for a breakdown of the phases of the OSRP.

Within the first two years of operations, which was the Pilot phase (Phase 1), the number of shells recycled annually increased by 200 percent. Since that time, GBF has streamlined shell recycling operations by establishing a regular shell collection schedule, purchasing new and larger equipment for hauling shells, and developing long-lasting relationships with restaurant partners. In early 2018, GBF completed the First Expansion phase (Phase 2) of the OSRP by expanding shell recycling operations to Galveston Island through a partnership with Texas A&M University at Galveston (TAMUG).

The original Strategic Development Plan (SDP) was created in 2019 during the First Evaluation phase (Phase 3) with the goal of assessing alternative recycling methods to achieve a more sustainable program. To help encourage restaurant participation and provide guidance through the initial expansion phase, GBF established a Chef Advisory Council in 2019 with the assistance of a Houston-based public relations firm. The Chef Advisory Council was comprised of local chefs, restaurant owners, and a public relations specialist. The Council members worked in tandem to promote awareness of the OSRP through customer engagement, fundraising events, and media appearances. Unfortunately, the Council was formed only a few months prior to the COVID-19 pandemic and did not reconvene in the years after. The Council proved to be a great resource for networking with restaurant partners and expansion into a new geographic region in the inner Loop of Houston. It was determined the Council accomplished the initial goals and did not need to be reformed. Annual networking is now accomplished via the Houston Oyster & SeaFest (described in paragraphs below).

GBF reinstated the Galveston Bay Oyster Workgroup through a partnership with TPWD and the Galveston Bay Estuary Program in 2019. This Workgroup brings together professionals from around Galveston Bay to help site future reef restoration projects, develop best management practices, and provide a forum for connecting partners and leveraging funds to support more effective reef restoration in Galveston Bay.

The Second Expansion phase (Phase 4) was initiated in 2021 with the purchase of new recycling equipment (the dump truck) in the spring of 2021 followed by the first shell collection in the inner loop of Houston as well as the Inaugural Houston Oyster & SeaFest in April 2022. During the Second Expansion phase in 2021 and 2022 GBF continued adding restaurants to the Houston, Clear Lake, and Galveston recycling routes, purchased two trailers for recycling operations, added additional part-time staff, and initiated a sun curing study.

GBF is now in the Second Evaluation phase (Phase 5) which was initiated in 2023. GBF will continue to evaluate the OSRP through 2024.

Table 1: Phases of the Galveston Bay Foundation's Oyster Shell Recycling Program

Phase	Year	Oyster Shell Recycled*	Active Restaurants	Accomplishments
Phase 1 Pilot	2011	17 tons	1	• Secured first restaurant partner: Tommy's Restaurant and Oyster Bar • Secured first curing site: GBF's Texas City Preserve
	2012	54 tons		• Increased tonnage of shells recycled annually by over 200%
Phase 2 First Expansion	2013	72 tons	7	• Increased tonnage of shells recycled annually by ~30% • Secured 6 new restaurant partners • Added new curing site: Port of Houston Authority Lease (aka Red Bluff) valued at $33,534.00/year • Purchased a shell recycling truck and trailer
	2014	102 tons	7	• Increased tonnage of shells recycled annually by ~40%
	2015	124 tons	7	• Increased tonnage of shells recycled annually by ~20%
	2016	160 tons	8	• Increased tonnage of shells recycled annually by ~30% • Secured 2 new restaurant partners • Purchased a new shell recycling trailer
	2017	179 tons	6	• Increased tonnage of shells recycled annually by ~10%
	2018	122 tons	7	• Expanded to Galveston Island via partnership with Texas A&M University at Galveston (TAMUG) • Decrease in shells recycled due to repercussions of Hurricane Harvey
Phase 3 First Evaluation	2019	125 tons	8	• Created a Strategic Development Plan (SDP) • Established a Chef Advisory Board • Reinstated the Galveston Bay Oyster Workgroup
	2020	115 tons	10	• Added additional restaurant partners • Updated SDP Version 2 • Created a Sun Curing Protocol • Secured new Galveston Island recycling partnership with Moody Gardens
Phase 4 Second Expansion	2021	181 tons	20 restaurants 1 Seafood Safety Lab	• Purchased new recycling equipment, dump truck • Hired new part-time staff • Expanded recycling operations into Houston • Secured new recycling partners
	2022	242 tons	30 restaurants 1 Seafood Safety Lab	• Continued expanding restaurants in Houston, Clear Lake, and Galveston • Secured new recycling partners • Purchased new equipment, trailers • Hosted the Inaugural Houston Oyster & SeaFest • Initiated Sun Curing Phase 1 research
Phase 5 Second Evaluation	2023	237 tons	37 restaurants 1 Seafood Safety Lab	• Continued evaluation of restaurant partners in Houston, Clear Lake, and Galveston • Hosted second annual Houston Oyster & SeaFest • Completed Sun Curing Phase 1 research study
	2024	TBD	36 restaurants 1 Seafood Safety Lab	• Emphasis evaluation and assessment over expansion • Only add new restaurants along the current routes when feasible • Purchased new replacement truck for Clear Lake route • Updated SDP Version 3 • Host third annual Houston Oyster & SeaFest • Initiate Phase 1 of shell-based restoration research with University of Houston • Initiate Phase 2 of sun curing research with Environmental Institute of Houston

**Please note, the tonnages shown in Table 1 reflect the revised shell weights per recycling receptacle: 182 pounds per 32-gallon bin and 30 pounds per 5-gallon bucket. All tonnages in 2024 will reflect the revised shell weights of 182 pounds per 32-gallon bin and 36 pounds per 5-gallon bucket. Tonnages shown in Table 1 from the 2019 SDP document were based on the original shell weight estimates per receptacle that are now out of date: 192 pounds per 32-gallon bin and 23 pounds per 5-gallon bucket.*

C) Current Program Status

Currently, GBF provides oyster shell recycling services free of charge for participating restaurants along three routes, a Clear Lake route, a Houston route, and a Galveston route. Each restaurant receives an appropriate number of recycling receptacles (32-gallon bins and/or 5-gallon buckets) depending on their weekly output of oyster shell and the amount of space they have available outside to store the receptables. Most participating restaurants collect both halves of the shell, not only at their shucking stations, but also from a variety of cooked oyster dishes. While GBF encourages restaurants to collect both halves of the shell, a few choose to only recycle the top half.

GBF staff follow a collection schedule of Monday, Wednesday, Friday, to maintain consistent and predicable collection times. Regular shell collection also prevents overflow of shells in the receptacles. Depending on the volume of shell produced weekly and the number of bins a restaurant can store, GBF staff provide one to three collections per week for each restaurant. Please refer to Appendix A for a map of the current restaurant partners and Appendix C for maps of GBF's recycling partner locations by region.

The baseline cost for GBF's current shell collection operations along the Clear Lake, Houston, and Galveston routes averages $4,910.00 per month or $58,920.00 per year (Table 7 in Step 3). This includes basic travel, approximately 425 miles per week, and personnel expenses, approximately 54 hours per week, to conduct shell collections three times a week. As of December 2023, the overall annual OSRP budget, which includes the baseline expenses in addition to the OSRP management, staff oversight, restaurant coordination, grant administration, supply purchases, equipment maintenance, fundraising, community engagement and outreach, and many other components, costs GBF, on average, $200,000 to $205,000 per year. At this time, GBF employs one full-time staff member dedicated to shell recycling operations and two part-time staff members dedicated to the weekly collection of shell from restaurants.

Clear Lake Recycling Route

GBF's original recycling route is in the Clear Lake area, the region southeast of Houston and northwest of Galveston. Along this route, one GBF staff member conducts the weekly shell collections, also called "shell runs," which require up to eight hours per day, totaling 24 hours per week. This job is incredibly labor intensive and requires driving and trailering skills as well as the ability to manually pull oyster bins weighing up to 200 pounds up the trailer gate. In 2013, GBF purchased a half-ton Toyota Tundra truck and a 12-foot landscape trailer with federal funds and corporate donations to facilitate the collection of oyster shells in larger quantities. GBF upgraded to a tandem axel 12-foot landscape trailer as a result of a corporate donation. A third tandem axel 12-foot landscape trailer was purchased with funds from the Coastal Conservation Association (CCA) and is still in use at the time of writing. The 32-gallon recycling bins are wheeled onto the landscape trailer at each restaurant during a shell run. Full bins are swapped out with empty bins at each restaurant so restaurant staff can continue recycling shells until the next collection day. In February of 2024, GBF purchased a 2023 Ford F-150 Lightning truck to replace the 2013 Toyota Tundra truck. The Ford truck and the cost to install a charging station at GBF's office was purchased by utilizing some of the funds raised from the second annual Houston Oyster & SeaFest.

Please refer to Appendix D for pictures of the recycling operations for the Clear Lake route.

Houston Recycling Route

GBF's second recycling route is in the inner loop of Houston. Along this route, one GBF staff member conducts weekly shell runs which require up to 8 hours per day plus 6 hours for maintenance or other tasks, totaling 30 hours per week. This job was made less labor intensive with the purchase of a Ford F-550 heavy-duty diesel truck equipped with a dump bed and bin lift. The dump truck was purchased in 2021 with federal funds and a large corporate donation. The 32-gallon recycling bins are dumped into the dump truck and replaced at the restaurant during the shell run. As a result of this purchase, GBF was able to increase shell recycling capacity and reduce staff labor.

Please refer to Appendix D for pictures of the recycling operations for the Houston route.

Curing Sites

GBF staff haul each restaurant's shells via truck and trailer or the dump truck to a storage site (aka "curing site") where the shells are stored temporarily on land. GBF currently stores recycled shell from the Clear Lake and Houston routes at two curing sites known as: Red Bluff and Texas City (see maps in Appendix B). The turning of the shell occurs at least every three to four months by GBF staff with a rented skid steer or an individual contractor with an excavator and skid steer, pending weather and site conditions. The shells are left to sun-cure or sun "bleach" for a minimum of six months per TPWD requirements. As identified by Bushek et al. (2004), sun curing oyster shells for a minimum of one month ensures that the majority of pathogens are eliminated from the shell. The majority of the shells recycled by GBF remain on land for more than six months, often closer to one to two years, due to the lag time between collection and transport to a restoration site. Therefore, all shells returned to Galveston Bay by GBF are thoroughly sun cured. Please refer to Appendix G for GBF's Sun Curing Protocol (written in 2020) which provides additional information on GBF's sun curing process. In 2023 GBF completed a sun curing research project with the Environmental Institute of Houston (EIH) at University of Houston Clear Lake (UHCL) and the University of Houston (UH). This research will be expanded upon in 2024 and the Sun Curing Protocol will be updated based on the results of the follow up study. Following the curing process, the oyster shells are ready to be used in oyster reef restoration and enhancement projects throughout Galveston Bay.

Please refer to Appendix D for pictures of the curing sites.

Galveston Recycling Route

In January 2018, GBF began recycling oyster shells on Galveston Island through a partnership with TAMUG. Due to the distance from the GBF office to Galveston, recycling on the Island was not financially feasible if conducted solely by GBF staff. The partnership with TAMUG resulted in an in-kind donation of labor, travel, equipment, and a new curing site. Students employed by Sea Camp at TAMUG were paid by the university to collect recycled oyster shells on Galveston Island using a TAMUG-issued truck.

In 2020, Sea Camp underwent restructuring and was no longer able to provide shell recycling services. However, in October 2020, GBF secured a new partner, Moody Gardens, to continue shell collection on Galveston Island. The Moody Gardens partnership results in an in-kind donation of labor and travel. Moody Gardens also provides space on their property to store the recycled shell throughout the sun curing process. Moody Gardens staff utilizes five-gallon buckets to collect the shells. The buckets of shell are transported by Moody Gardens staff to a curing site located on the Moody Gardens property.

Please refer to Appendix D for pictures of the recycling operations on Galveston Island.

Documentation

To track the amount of oyster shells recycled, GBF staff maintain Microsoft Excel spreadsheets in which the number of bins and buckets, and the associated weight, of the oyster shell collected is recorded for each participating restaurant. Initially for the first couple years GBF utilized 14-gallon recycling tubs to collect the oyster shells, but later progressed to using 32-gallon recycling bins and 5-gallon buckets. To improve the accuracy of this documentation, GBF staff conduct quality control measures every three to five years to confirm the average weight of recycled oyster shells in each 32-gallon recycling bin as well as the weight of shells in each five-gallon bucket.

In January 2024, GBF staff worked with a corporate partner to weigh eight bins and four buckets containing cured, dry shell, in order to update the average weight of shell in each receptacle. Prior to weighing the full receptacles, the tare weight for an empty bin and bucket was established.

It was then determined that each 32-gallon bin holds approximately 182 pounds of dry shell while each five-gallon bucket holds approximately 36 pounds of shell, thus averaging approximately between six and seven pounds of dry, clean oyster shell per gallon.

It is estimated that the average weight of the shell is subject to a variance of five percent due to potential human error in estimating the volume and weight of the shells in bins or buckets, the uneven settling of shells, added water weight from rain and/or ice, as well as the weight of other materials/waste often mixed in with the shells.

In 2020, GBF staff counted the number of individual shells (half of the bivalve) contained in a single 32-gallon bin and 5-gallon bucket. It was estimated that a 32-gallon bin holds approximately 1,000 shells (or 500 oysters) while a 5-gallon bucket holds approximately 200 shells (or 100 oysters). These estimates are used to help to determine the number of bins and/or buckets needed for potential restaurant partners. For instance, one sack of oysters purchased by a restaurant typically contains 100 oysters. Thus, it is estimated that one sack contains approximately 200 oyster shells or the equivalent of one 5-gallon bucket or a little less than one quarter of a 32-gallon bin.

Table 2: Oyster Shell Weight Estimates per Recycling Receptacle

Recycling Receptacle	**Dry Shell Weight**	**Individual Shells** *(half of the bivalve)*	**Whole Oysters** *(both valves)*
32-gallon Bin	182 lbs.	1,000 shells	500 oysters
14-gallon Tub	81 lbs.	475 shells	238 oysters
5-gallon Bucket	36 lbs.	200 shells	100 oysters
1-gallon equivalent	*6 lbs.*	*40 shells*	*20 oysters*

GBF staff evaluated developing a Microsoft Access Database in 2019. The goal was to improve efficiency and accuracy of tracking the amount of shell collected. After attending Access training and consulting with other departments within GBF it was determined the current method of tracking collected shell is

sufficient. GBF staff will continue to document the amount of shell collected, cured, and returned to Galveston Bay via Microsoft Excel spreadsheets until further notice.

C.1) Program Goals

The goal of GBF's OSRP is to increase the amount of natural hard substrate, or cultch material, in Galveston Bay to facilitate the successful recruitment of oyster larvae and thus promote a sustainable Eastern oyster population in the Galveston Bay estuary. Without hard substrate on which to attach, oyster larvae have a lower survival rate. By encouraging restaurants to recycle their shells, GBF aims to reduce the amount of oyster shells sent to landfills and increase the number of shells returned to Galveston Bay.

In order to achieve these goals, the general public as well as state regulatory agencies and the commercial industry must understand the importance of oyster reefs in Galveston Bay. Through educational programs and outreach efforts, GBF aims to promote the need for shell recycling and reef restoration.

Hands-on reef construction and oyster gardening activities directly engage community volunteers in reef restoration. Through these outreach efforts, GBF hopes to secure additional restaurant partnerships, dedicated volunteers, and new sponsorships to sustain the OSRP beyond current federal funding sources.

Throughout 2024, GBF plans to assess the current status and future potential of the OSRP, as demonstrated by this Strategic Development Plan 3.0 and the previous editions. After completing the Second Evaluation phase, GBF hopes to achieve the following:

1) Secure additional restaurant partners for all three regions when feasible
2) Implement one reef restoration project every two to three years
3) Continue annual oyster gardening efforts in the upper, central, and lower bay systems
4) Continue the volunteer-based reef monitoring program
5) Develop best management practices for sun curing oyster shell in accordance with TPWD
6) Create advisory council for potentially establishing a Pearland region route
7) Evaluate Galveston route and Moody Gardens partnership
8) Secure additional equipment for either Galveston or Pearland routes, as needed

The ultimate success of the OSRP will be demonstrated by GBF's ability to provide recycling services for the majority, if not all, of the Houston-Galveston region. Likewise, by expanding shell recycling efforts to the entire region, GBF aims to have enough oyster shell stockpiled to allow for ongoing gardening efforts as well as reef creation for years to come.

C.2) Current Values & Incentives

Due to current funding availability as well as the operational structure of the OSRP, GBF provides an entirely free service to restaurant partners. Restaurants are provided with recycling receptacles and weekly collection of their shells at no cost. Depending on the number of oyster menu items sold, and thus the number of shells recycled, a single restaurant can reduce its annual waste production by 30 tons (60,000 pounds) per year, as demonstrated by Acme Oyster House as well as Tookie's Seafood in 2023.

Based on researching local waste hauling services in 2024, it is estimated that weekly collection by a waste vendor such as Republic Waste Services or Waste Management may cost a restaurant anywhere from $120.00 up to $745.00 per week depending upon the size of the restaurant's dumpster (typically six or eight yards), frequency of pickups per week (one to three times per week), and the location of the

restaurant. Please refer to Appendix H for further details on waste hauling costs. By recycling oyster shells, restaurants can reduce the volume of waste placed in their dumpsters and therefore reduce the number of pickups required per week from waste vendors. It is estimated that a single restaurant would need to recycle a minimum of six bins, equivalent to 1,092 pounds of shells, per week to see significant cost savings in their waste hauling expenses. In 2023 only two of GBF's restaurant partners exceeded that amount on a weekly basis: Acme Oyster House (which closed their Houston location in December 2023) and Tookie's Seafood. Unfortunately, most of GBF's restaurant partners have not observed significant cost savings. However, they are making an impact by redirecting oyster shells from landfills to oyster reef restoration through participation in the OSRP.

Restaurant partners also benefit from the value of the oyster shells donated to GBF for reef restoration. Purchasing shells is nearly impossible since most commercial oyster companies return their shucked oyster shells to private and/or publicly harvestable reefs in Galveston Bay per TPWD requirements. After speaking with multiple commercial companies as well as TPWD, GBF only received one quote for oyster shell from Alby's Seafood, a wholesale seafood supplier and producer located in Fulton, Texas.

As of 2023, Alby's sells shucked oyster shells for approximately $60.00 per cubic yard; however, this price may increase or decrease depending upon availability and demand. According to a report prepared by Dr. Jennifer Pollack in 2011, one cubic yard of oyster shell was valued at $25.00 (Pollack et al, 2011). GBF provides each active restaurant partner with an in-kind donation form at the end of the year. The donation captures the volume of shell recycled at an average value of $60.00 per cubic yard. This form allows restaurant partners to receive a return on their investment in the form of a tax deduction if desired. For instance, Acme Oyster House recycled 32 tons (64,000 pounds), equivalent to approximately 38 cubic yards of shell in 2023. Therefore, the restaurant had the opportunity to deduct the value of this shell, estimated at $2,280.00 from their 2023 taxes. Please refer to Appendix H for a copy of GBF's in-kind donation form. Table 3 illustrates the variety of cost savings and benefits restaurants can receive by participating in GBF's OSRP.

A less tangible benefit restaurant partners receive via oyster shell recycling is a "green" or "eco-friendly" image portrayed to the community. Not only will this draw in a new customer base, but it will also allow restaurants to explore new marketing tactics. GBF currently provides marketing opportunities for restaurants through free outreach materials and media exposure. In the past, GBF only provided restaurants with informational brochures, aka "rack cards," and coasters. Due to a lack of interest in the brochures, GBF created a variety of infographic-style materials such as table tents, inserts for check presenters, window clings and other options which are presented to new and current partners in an outreach packet as shown in Appendix H. Restaurants are provided with the opportunity to review, select, and implement one or more of these outreach items. The goal of the outreach packet is to help clarify the message of the OSRP and involve restaurants in the decision-making process. Restaurants are also promoted on GBF's website, highlighted in social media posts, and restaurant logos are displayed on the landscape trailer that is utilized for the Clear Lake route, thus bringing in new clientele to their business. Two restaurants have the GBF name on their menus. GBF works with restaurants one-on-one to determine the best avenue for delivering the message to their patrons. The media exposure and outreach items provided to restaurants are currently free to partners.

Table 3: Cost Saving Estimates for Restaurant Partners

Cost Saving Method	Annual Expense for GBF	Benefit for Restaurant
Collection Receptacles		
32-gallon Recycling Bins	Purchased bulk order of 100 bins for $13,081 Average $130/bin For a Restaurant to use 10/year $1,308	***FREE*** Save $1,308.00± per year depending upon the number of bins required.
5-gallon Recycling Buckets	$165.00/year $6.25 + $2/bucket + lid 20 buckets purchased per year (average)	***FREE*** Save $165.00± per year depending upon the number of buckets required.
Recycling Service		
Dump Truck (2021 Ford F-550 + Perkins Dump Bed and Bin Lift)	Mileage ~ $9,380.00/year • Average 14,000 miles/year • 2024 mileage rate = $0.670/mi Maintenance ~ $6,500.00/year (truck and dump bed/bin lift)	***FREE*** Save $55,900±/year
Truck (2023 Ford F-150 Lightning)	Mileage ~ $4,020.00/year • Average 6,000 miles/year • 2024 mileage rate = $0.670/mi Maintenance ~ $1,500.00/year	
Trailer (12-foot landscape trailer)	Maintenance ~ $1,000.00/year	
Labor	Staff Time ~ $41,500.00/year • 24-30 hours/week 2 part-time staffers • 3 collection days/week	
Waste Hauling		
Vendor Expense	NA	Reduction of visits per week by waste hauling vendor Annual savings of $3,250.00± based on a minimum of 6 bins recycled/week
Shell Donation (tax write-off)		
Tax Deduction	NA	Annual savings of $60.00 per cubic yard of shells recycled
Outreach Materials		
Labor & Marketing	Window cling: $120/10 units Restaurant logo sticker placed on trailer sign: $17.50/sticker Restaurant's website linked on GBF's website GBF social media posts with restaurant linked	***FREE*** Provides "green image" for restaurants and enhances appeal to customers.

D) Limiting Factors

Every venture has its obstacles; to determine how to overcome these obstacles, it is crucial to understand the limiting factors. For GBF's OSRP, four limiting factors have been identified: 1) Funding, 2) Restaurants, 3) Program Capacity, and 4) Public Awareness. GBF staff have worked tirelessly to address each of these issues since the OSRP 's inception in 2011. The OSRP expanded tremendously between 2021 and 2022 and GBF continued with a Second Evaluation phase in 2023 and 2024. By reviewing the reasons for each of these limiting factors, GBF hopes to gain a better understanding of how to move forward and continue to enhance the OSRP.

D.1) Funding

As a non-profit operation, funding for the OSRP is an ongoing challenge. GBF has received support from private companies such as Cheniere Energy, Phillips66, Aramco Services, ERM Group, and DOW Chemical to name a few. Federal and state grants have also provided financial stability for GBF's shell recycling operations. These grants include 12 cycles of CMP funding (NOAA funds administered by the Texas General Land Office), USFWS Coastal Program funding, NOAA funds from a grant in partnership with Restore America's Estuaries (RAE), as well as TPWD CO-OP funding. In-kind donations in the form of land, labor, and supplies have contributed to the continuation of GBF's shell recycling efforts as well. A property donation from the Port of Houston Authority (PHA) has provided GBF with an ideal location for stockpiling the recycled shells since 2013. GBF has full access to this land, referred to as the "Red Bluff Curing Site," which is valued at $34,542.00 per year.

Although GBF has been fortunate to acquire substantial funds for the OSRP since 2011, there is always the possibility that major funding sources will terminate at some point. Therefore, GBF is in the process of securing multiple sources of "perpetual income" to support at least the baseline operating costs of the OSRP.

GBF hosted the Inaugural Houston Oyster & SeaFest (https://www.galvbayevents.org/) in 2022, with plans to continue annually. The festival is a one-day event held in the spring (generally early April) at an outside venue. Participants purchase a ticket for entry and partake in oyster and seafood samplings and drinks from participating restaurants. Additional activities include live music, lawn games, and an education/fun zone. All proceeds from the festival benefit the OSRP and all shells produced by restaurants at the event are recycled by GBF. Not only is this festival a fundraiser for the OSRP, but it also allows GBF to reach new and larger audiences in the greater Houston area. The event is usually held in central Houston, where many of the region's top decision makers live. This event also allows the participating restaurants to get publicity and exposure to new customers. It is proposed that this festival could provide at least the baseline funding required to sustain minimum shell recycling operations (see Table 7).

Additionally, there are opportunities for smaller sources of income. For example, GBF established a partnership with Proud Pour, a company that "pairs wines with solutions to local environmental problems" (https://www.proudpour.com/). For each bottle of Proud Pour's Sauvignon Blanc sold in Texas, GBF receives a percentage of the proceeds. These funds will be continually funneled into the OSRP if the specific wine is sold in Texas. Restaurant partners will also be encouraged to incorporate the wine on their menus (as it becomes available in the region) to further support shell recycling efforts. GBF has a similar partnership with Toadfish Outfitters whose mission is "regenerating the world's oyster beds through thoughtfully designed eco-friendly products" (https://toadfish.com/). For every Toadfish product sold in Texas, GBF receives a portion of the proceeds.

By securing ongoing/perpetual funding sources such as the Houston Oyster & SeaFest, Proud Pour, and Toadfish, GBF hopes to achieve financial stability for the OSRP and move away from annual funding requests from state and federal partners.

D.2) Restaurants

The GBF OSRP was piloted by a single restaurant: Tommy's Restaurant and Oyster Bar (Tommy's). As the keystone partner, Tommy's has consistently participated in GBF's shell recycling efforts and set the example for new and future partners. After additional funding was secured in 2012 and beyond, GBF began investigating other potential partners. Since 2011, GBF has partnered with 44 different restaurants and 1 seafood safety lab. Due to changes in restaurant management, menu revisions, restaurant closures, and/or lack of participation, seven of these restaurants are no longer partners of the OSRP. Even Tommy's has faced obstacles and temporarily stopped selling oysters in 2018. After Hurricane Harvey, the oyster population in Galveston Bay remained small and undersized due to limited spawning. Thus, Tommy's ceased all sales of oysters from mid-June 2018 through September 2018. This is a prime example of the unpredictability of the seafood business. Some restaurant partners have come and gone, but others have remained dedicated to the OSRP, particularly Tookie's Seafood, Tommy's, Crazy Alan's Swamp Shack, and Captain Benny's Seafood. Working with such a variety of restaurants has made it clear that dedication to the OSRP must originate from the management or ownership level for a restaurant to be successful in oyster shell recycling.

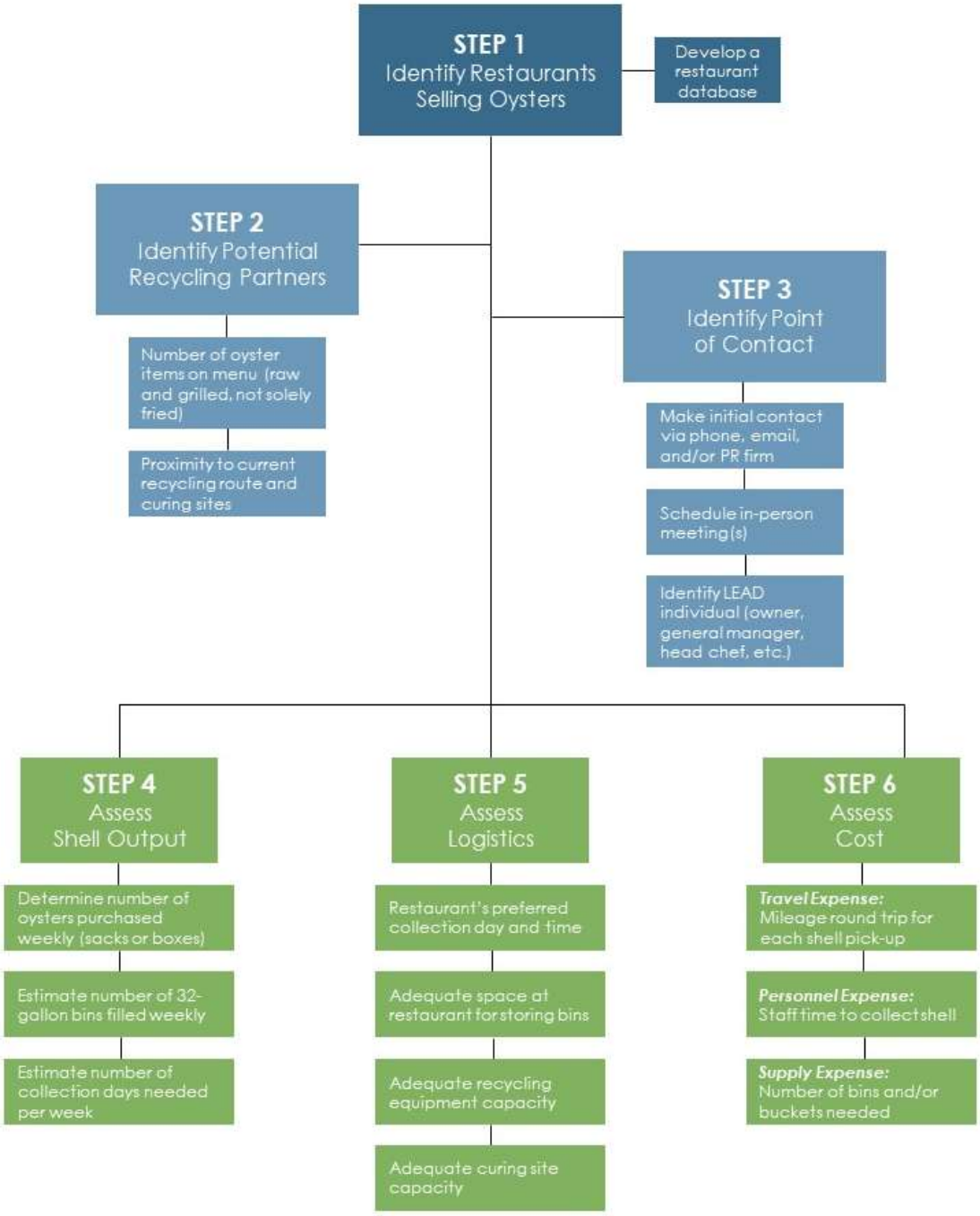
While there are a large number of seafood restaurants selling oysters in the Houston-Galveston region, only some are viable partners for shell recycling. To track the different restaurants serving oysters, GBF staff maintain a restaurant database (Appendix E). This document is updated annually to include new restaurants in the region and remove those that have closed. Although the list is extensive, there is a finite number of restaurants serving oysters in the Houston-Galveston region.

As shown in the database, it is estimated that at least 191 restaurants are currently selling oysters in the Houston-Galveston region. In order to narrow-down potential partners, GBF staff also document how many oyster items, raw versus cooked, are on each restaurant's menu, if available online. This provides an initial idea of the type of oyster sales the restaurant may have on a weekly basis so GBF staff can make a more educated decision on which restaurants to pursue. GBF has observed that restaurants serving multiple oyster items on their menu, not just raw or fried, produce a larger output of shells, thus leading to a more practical shell recycling partnership. Based on the 2024 Restaurant Database, there are 135 restaurants in Houston (this includes the major suburbs of Houston to the west, north, and south), 41 restaurants in the Clear Lake region, and 15 restaurants on Galveston Island that serve oysters. Of those 191 restaurants, approximately 19 are within a reasonable location for collection services and are on the top of GBF's list to pursue next as potential partners.

As a grant funded program, GBF must be selective when it comes to restaurant partners. In response to challenges and lessons learned from the 45 different partnerships over the years, GBF developed a tool, the "Restaurant Selection Criteria" flowchart (Figure 2), to help select new restaurant partners. This flowchart helps narrow down the restaurant database to a smaller list of potentially successful shell recycling partners. GBF staff use the criteria to assess whether the output of shells from an individual restaurant will be beneficial to the OSRP and therefore if the additional mileage, supplies, and personnel costs required to accommodate a new restaurant are justified.

Due to the multitude of factors involved in a shell recycling partnership, it is difficult to pinpoint a single threshold to dictate whether or not a restaurant will be a successful partner. While a significant amount of shell output is necessary, GBF has yet to determine the appropriate minimum quantity since restaurant location can often sway the decision. Therefore, the selection criteria cover multiple components of shell recycling to aid in the decision-making process, not only for GBF but also for the restaurant. Most importantly, these criteria provide a strategic approach to the expansion of the OSRP.

Figure 2: Restaurant Selection Criteria



Once a restaurant is recognized as having potential, GBF staff then reach out by phone, email, and/or in person. This initial interaction with a restaurant is used primarily to gauge the restaurant's level of interest and determine if there is a dedicated individual (manager, head chef, owner) at the restaurant who will lead the shell recycling effort at the restaurant. The first consultations with a restaurant should also include a discussion of the average number of oyster sacks purchased weekly. This number helps GBF and the restaurant decide how many collection days will be needed per week as well as how many recycling receptacles will be required to contain the shell (Table 4). On average, most restaurants purchase whole oysters by the 100-count box or sack from distributors. Based on an analysis of GBF's current restaurant partners, it is likely a restaurant will only need shell collection services once a week if they purchase less than 40 sacks of oysters. Restaurants that purchase 40 or more sacks of oysters per week will likely need at least three collection days. However, the number of collection days also depends on the amount of space the restaurant has available to store the appropriate number of recycling bins. Nevertheless, this information helps verify whether it is in GBF's best interest to incur additional personnel and travel expenses by adding a new restaurant.

Table 4: Shell Output based on 100-Count Sack Purchase

100-Count Sacks	Whole Oysters	Individual Shells	32-gallon Bins Needed
10	1,000	2,000	2
20	2,000	4,000	4
30	3,000	6,000	6
40	4,000	8,000	8
50	5,000	10,000	10
60	6,000	12,000	12
70	7,000	14,000	14
80	8,000	16,000	16
90	9,000	18,000	18
100	10,000	20,000	20

Restaurant location as well as a willingness to cooperate and communicate are key to a successful shell recycling partnership. A high density of restaurants serving oysters are in the inner loop of Houston, however, these restaurants are located a far distance from GBF's curing sites (Appendix A). This is why, to make the drive worthwhile, GBF wanted to partner with multiple restaurants along the Houston route. Once it is determined a restaurant will be a reliable partner, GBF addresses the final logistical requirements such as timing of shell collection (day of the week and time of day), location of recycling bins at the restaurant, and a start date.

Finally, it is vital that a restaurant has a lead individual with serious investment in the OSRP. This individual is typically the chef, kitchen manager, general manager, or owner. No matter the role of this lead individual, GBF has observed on multiple occasions that having someone at the managerial level who has the authority to make decisions and implement the new shell recycling steps, in addition to understanding the importance of shell recycling, is key to a successful partnership.

It has also become evident that educating the service staff about the importance of oysters and the OSRP is necessary. When restaurant staff can explain the OSRP, describe how the restaurant partners with GBF, and discuss the importance of oysters in Galveston Bay, it helps educate the public as well as entice them to purchase additional oyster items from the menu. These additional purchases and in-depth interactions also lead to larger tips for the servers, thus providing more incentive for the staff to encourage and embrace oyster shell recycling.

Although GBF's oyster shell recycling service is currently free of charge, some restaurants are not fully dedicated to the effort. This is why it is important to be selective in choosing a recycling partner while operating on a budget. GBF has observed a lack of cooperation and decline in shell recycling when the owners, managers, or head chefs are not proponents of the OSRP and not hands-on in implementing shell recycling in their restaurants. GBF has considered in the past charging an annual "participation fee" or "buy-in fee" to ensure each restaurant partner's commitment to the OSRP, not to mention additional income for the OSRP. However, several restaurant partners have suggested they would not participate if there were a fee involved. Additionally, in communications with other shell recycling programs around the country, those who implemented a fee for their service saw a decrease in participants. GBF hopes to continue to cultivate private partnerships and grow the revenue from the Houston Oyster & SeaFest to offset the costs of the OSRP and keep it free for participating restaurants.

D.3) Program Capacity

Before GBF continues expansion of the OSRP and reaches out to new restaurant partners, the capacity of the OSRP must be taken into consideration. Additional restaurants will require more recycling bins, more hours dedicated by staff, additional mileage resulting in more wear and tear on equipment, and of course more oyster shells. By assessing the OSRP's current capacity, GBF will be able to determine when and if it is feasible to expand and whether new methods, and additional equipment, staff, and/or storage sites are needed.

Equipment

Clear Lake Route

Utilizing the Ford F-150 and 12-foot landscape trailer currently owned by GBF, staff can haul up to 20 full, 32-gallon recycling bins at one time. Each bin is estimated to hold approximately 182 pounds of shell; therefore, 20 full bins is equivalent to approximately 3,640 pounds (1.82 tons) of recycled oyster shell. However, when the bins are collected from the restaurant, they typically contain water from rain and/or ice as well as food scraps in addition to the shells. Therefore, the weight of a single bin can increase to as much as 225 pounds, resulting in 4,500 pounds for a full 20-bin load. The Ford's towing capacity is 10,000 pounds and the landscape trailer is rated for a maximum weight of 10,400 pounds. The trailer alone weighs approximately 2,500 pounds. While the Ford can tow more weight on the 2,500-pound trailer, the trailer itself is not long enough to contain additional bins. Excess empty bins are stored on the trailer to allow for replacement of full bins at restaurants. This allows GBF to save on mileage costs as staff do not have to make extra trips back to restaurants to return empty bins. A completely full trailer could carry up to 4,500 pounds of weight per trip or 3,640 pounds of oyster shell. Therefore, if additional restaurant partners join the OSRP, the max capacity of the trailer in terms of bin space would be the limiting factor rather than weight. The Monday route (which is generally the largest route) typically collects 8-12 bins, therefore, there is room for growth on the current equipment.

Houston Route

As a result of CMP Cycle 24 funds and private funds from Phillips66, GBF was able to purchase new shell recycling equipment in May 2021. The new equipment, a Ford F-550 heavy-duty truck equipped with a dump bed and bin lift, allowed GBF to pursue the expansion of shell recycling operations in the inner loop of Houston, as well as increase shell recycling capacity and reduce staff labor. The Houston expansion officially began with the first shell collection using the new equipment in May 2021. The dump bed holds a maximum capacity of 6,000 pounds and is currently used for the Houston route. Up to 32 bins equaling 5,824 pounds of shell can be collected.

The Houston route is driven on Monday, Wednesday, and Friday. Monday is generally the largest collection day as it is the longest time between collections and includes shells from the weekend crowd. The dump truck capacity can reach between 50% - 75% capacity on a normal Monday route before dumping the shell at the curing site. To date, the recycling assistants have not had to make two trips to complete a route, however, this is a consideration for future expansion. If the dump bed reaches 100% capacity and the recycling assistants must dump shell at the curing site before going back into town, this will add staff time and mileage, greatly increasing the cost. Because the empty bins are left at the restaurants along the Houston route, the limiting factor is the dump bed, not the individual number of bins. If the dump bed reaches 100% capacity, additional restaurants could be included on a Tuesday or Thursday route to decrease the number of miles driven in one day.

Galveston Route

The shell recycling effort on Galveston Island is different than the Houston and Clear Lake route. The recycling partners are currently provided with 5-gallon buckets to collect shell throughout the week. When TAMUG was the recycling partner (2018-2020), shell recycling staff would take the 5-gallon buckets and dump them into 14-gallon tubs in the back of a truck. The truck bed could hold a max of 20, 14-gallon tubs, therefore up to 0.81 tons (1,620 pounds) of recycled shell could be hauled at once. The shell would then be dumped at a shell curing site on the university's campus. When the recycling partner changed to Moody Gardens in 2020, a Moody Gardens staff member collects the full 5-gallon buckets and swaps them out with empty ones utilizing his personal vehicle and then dumps the full buckets at a shell curing site on the Moody Gardens property.

The number of recycling partners in Galveston has grown and new equipment will likely be needed if the expansion continues. In 2021, with help from CCA funding, GBF purchased a small 6'x 8' trailer with a gate for Moody Gardens staff to use to help with recycling. This method is not extensively used because the staff find it easier to use their own vehicle without having to haul a small trailer through tight roads. A truck and landscape trailer with rolling 32-gallon recycling bins could be a method employed on Galveston Island, however tight roads and close restaurant locations make a trailer difficult to maneuver. Moody Gardens recently hired a full-time staff as their conservation manager who will be dedicated to the oyster shell recycling partnership. GBF is currently meeting with the staff members to evaluate the next steps necessary for improving the OSRP on Galveston Island. Moody Gardens' goal is to get more staff and volunteers involved with the shell collections utilizing a Moody Gardens owned truck.

Staff

GBF currently employs one full-time staff member who oversees shell recycling operations, coordinates with restaurant partners, and manages the program budget including grants. Additionally, GBF employs two part-time Oyster Shell Recycling Assistants who collect the recycled oyster shells from restaurants three times a week.

As the OSRP expands, necessary staff time to perform shell collections will increase as new restaurants are added. As a result, additional part-time staff may be required, or increasing the hours of the current part-time staff. Part-time staff are limited to a total of 30 hours per week. A third part-time GBF staff member is trained in shell recycling and is available to conduct shell pick-ups when needed.

Additionally, as discussed in the paragraphs above, the Galveston route is not currently operated by GBF staff (neither full-time nor part-time). If this were to change in the future, additional evaluations regarding staff capacity will be required.

Storage

As of December 2023, GBF has access to two storage sites (aka curing sites) for the Clear Lake and Houston route and one for the Galveston route where the recycled oyster shells are temporarily stockpiled and sun cured. Location maps of all curing sites can be found in Appendix B. Between these three sites, approximately 0.56-acre (25,000 square feet) is available for the storage of recycled oyster shells. This area has increased since the previous edition of the SDP due to inclusion of Moody Gardens' site in the calculation. Table 5 and Appendix F show the amount of space and equivalent shell storage available at each active curing site.

Table 5: Current Curing Site Capacity

Curing Site	Shell Storage Capacity (acres)	Shell Storage Capacity (sq. ft)	Max Pile Height	Shell Volume	Shell Tonnage
Red Bluff	0.40 ac	18,000 sq ft	6	4,000 CY	2,350 tons
Texas City	0.06 ac	2,600 sq ft	6	578 CY	339 tons
Moody Gardens	0.10 ac	4,400 sq ft	6	978 CY	575 tons
TOTALS	**0.56 ac**	**25,000 sq ft**	**NA**	**5,556 CY**	**3,264 tons**

Based on these measurements, it is estimated that GBF can currently store a total of 3,264 tons of recycled oyster shells. Currently, GBF collects an average of 230 tons of shell per year. Therefore, it is unlikely these sites will reach capacity any time soon. However, due to the Sun Curing Protocol currently in place (Appendix G) the maximum capacity is in reality much less than shown in Table 5 due to the restrictions on pile heights during different phases of the curing process.

GBF defined the Sun Curing Protocol with the assistance of research partners from UH as well as representatives from TPWD in the SDP version 2.0. However, in September 2023 GBF finalized a sun curing research project with partners from EIH at UHCL and UH. This research will be expanded upon in the fall of 2024 and the Sun Curing Protocol will be updated based on the results of the follow up study. Therefore,

the pile heights and other specifications are subject to change. The protocol will help guide the regular maintenance and layout of the shell piles at each curing site and further dictate the capacity at each location.

As new restaurant partners are secured, additional shells will be recycled and stockpiled at the curing sites. While it is unlikely additional storage space will be needed in the next two to three years, it could be helpful to secure a new curing site in closer proximity to the inner loop of Houston to reduce travel expenses.

Texas City Storage Site:

The original curing site, GBF's privately owned Texas City Preserve, has been utilized for shell storage since the OSRP began in 2011. The Texas City site is approximately 0.10-acre, 0.06 acre of which is available for shell storage. This area has the capacity to store up to 339± tons of recycled shell. To improve the storage of shell at the Texas City site, two separate scout groups helped build a cement pad on the northernmost section of the site. The first scout group constructed the initial section of the cement pad in 2011, and a second scout group expanded the pad in 2016, resulting in a 20-foot by 40-foot cement pad. The cement base provides an ideal location for piling shell, not only to separate shell piles in various stages of the curing process, but also to easily facilitate shoveling and other operations to prepare shell for future restoration projects (Figures 19 and 20 in Appendix D).

This site has provided an excellent location away from residential areas for storing newly recycled shell. However, GBF does not maintain ownership of the access road. This road is managed by another company that rarely maintains the gravel road which was only recently repaired after multiple years of being inaccessible at times. In addition, GBF leased the property to a cattle operation to help maintain the prairie habitat. As such, the cattle often wander into the shell storage site and leave their excrement on the shell; not an ideal situation for curing the shell. GBF worked with the cattle rancher to install fencing around the entire shell storage area to resolve this issue. However, GBF stores the majority of recycled shell at the Red Bluff storage site.

Red Bluff Storage Site:

Thanks to a donation by PHA, an additional curing site, Red Bluff, was secured in 2013. The PHA leases 1.5-acres to GBF for a fee of $10.00 per year, although the property is now valued at $34,542.00 per year. Therefore, GBF has been able to utilize the value of this property as match for federal grants. The Red Bluff Curing Site has been essential to GBF's success, not only due to the match value, but also due to the central location of the property in relation to the recycling routes. This curing site allows for the storage of up to 2,350± tons of recycled shell.

While this site has been invaluable to the OSRP, it also has its share of challenges. As an undeveloped property, the dirt/gravel road and shell storage area experience drainage issues during times of inclement weather. In the past, GBF was forced to delay use of the property during heavy rains to prevent further road damage. Adverse road conditions also delayed transporting shell offsite for use in restoration. In 2016 GBF received funding from a private donor to conduct initial repairs on the access road. In 2019, CMP authorized the use of grant funds to purchase road base and as a result, GBF was able to fully repair access to the Red Bluff Curing Site. Although intermittent maintenance will be required, the road now allows unimpeded access for shell delivery and transport.

As GBF's primary and largest curing site, the bulk of recycled shell is stored at Red Bluff. In 2020, GBF staff designed a more strategic layout for the Red Bluff Curing Site (Figure 13 and 14 in Appendix D). The south/southeast portion of the property was cleared of brush and divided into sections to create six new shell pile locations. Using wooden stakes and rope, two parallel lines were marked lengthwise 10 feet apart from each other down the center of the cleared area. The width of the cleared area was then divided into thirds and marked with two parallel lines 10 feet apart. All sections are buffered by 10 feet to comply with the sun curing protocol and to avoid contamination among shell piles in different stages of the curing process. The rope is easily removable to allow for maneuverability of a tractor when mowing or rotating the shell piles. To consistently identify and track the status of each pile, the shell pile locations were labeled alphabetically using wooden stakes.

Inland Marine Storage Site:

GBF temporarily stored shell at a partner's construction yard, Inland Marine Services, LLC, from June 2016 through September 2018. Approximately 200 tons of recycled oyster shells were sun cured at this site and later placed in Dickinson Bay to create 0.25 acres of new oyster habitat. The Inland Marine Curing Site is no longer available due to lack of space on the property resulting from new regulations enforced by the City of Texas City on the landowner.

TAMUG Storage Site:

From January 2018 through September 2020, TAMUG allowed GBF to store all shell recycled on Galveston Island at the Wetland Center, a facility located directly across from the TAMUG campus on Pelican Island. The shell was stored in a small parking area near the sole building on the Wetland Center property.

Moody Gardens Storage Site:

Due the transfer of the shell recycling partnership from TAMUG to Moody Gardens, GBF moved all shell that was at the TAMUG storage site to Moody Gardens. The shell is located on Moody Gardens' property in their recycling facility which is fully fenced and concreted. The current shell located on site appears to take up 0.1 acre of space. There is room for expansion on Moody Gardens' property, however it is uncertain how much space they are willing to allocate to the curing site. Curing capacity will also be discussed with the new Moody Gardens staff member at the beginning of 2024.

D.4) Public Awareness

A key component of GBF's mission is to enhance the knowledge of local citizens so they may become stewards of Galveston Bay with an understanding of the benefits a healthy bay system provides to the entire Houston-Galveston region. Ongoing outreach efforts through the OSRP specifically aim to educate the public on the importance of oysters in Galveston Bay. GBF staff have employed a variety of outreach efforts such as: boothing at public events and at GBF's annual Oyster & SeaFest, presentations at environmental conferences, education of volunteer oyster gardeners and volunteers participating in reef construction and monitoring, distribution of informational handouts, inclusion of oyster content in GBF's education programs in local schools, distribution of marketing materials to restaurant partners, and a webpage hosted on the GBF website (www.galvbay.org/oysters). Unfortunately, there remains a huge gap in public knowledge when it comes to the importance of oyster reefs as well as the actions GBF is taking to restore this essential habitat.

Oyster shell recycling is a relatively new concept, particularly in the Gulf Coast states. The East Coast benefits from a widespread knowledge of oysters as the consumption of oysters is more engrained in their culture. Texas on the other hand is well-known for barbeque and crawfish boils but not oysters. Yet, Texas maintains a productive oyster industry, and Galveston Bay alone was once responsible for nearly 90 percent of the oyster harvest in the State (Haby et al, 2009). With such strenuous fishing pressure placed on the local oyster population, there is even more reason to restore oyster habitat in Galveston Bay, not only to support the commercial industry but also to sustain the native reefs as they are the backbone of the Galveston Bay estuary.

Knowledge of oyster shell recycling in Texas has slowly grown as both GBF's OSRP and "Sink your Shucks," a shell recycling program based in Corpus Christi, Texas, have proven their success over the last decade. For GBF, the first challenge is to increase the public's awareness of Galveston Bay alone. Many of the citizens in the Houston-Galveston region are not aware that such an important estuary exists adjacent to the Houston metroplex; instead, their focus is on the Gulf of Mexico. GBF's Advocacy Team works diligently to enhance the public's knowledge of Galveston Bay; one way is through the Galveston Bay Report Card (www.galvbaygrade.org). A component of Galveston Bay's grade, found in the Report Card, is based on oyster reefs and other shellfish habitat. Unfortunately, there is insufficient data to come to any solid conclusions about the health of Galveston Bay oysters. This reflects the issue of funding, particularly regarding funds for monitoring reef restoration projects conducted by both GBF and the state (TPWD), as well as lack of research.

Without widespread knowledge of Galveston Bay oyster reefs or the OSRP, GBF will continue to face challenges in securing new partners and support for the OSRP. Restaurant partners play a prominent role in the public's education on the matter and still have the potential to grow in this role. GBF is beginning to actively encourage outreach and education at participating restaurants where shells are recycled. Not only will this spread the word about shell recycling, but it will also encourage patrons to return to participating restaurants, therefore benefiting both GBF and the restaurant partners.

Public awareness as well as the success of GBF's shell recycling efforts increased with the expansion into the inner loop of Houston where the majority of the population and key decision-makers are located. Oyster shell recycling branding on the dump truck and trailer is great publicity as they drive through the area three times a week. Additionally, hosting the annual Oyster & SeaFest in Houston has grown GBF's audience to new and larger crowds.

STEP 2: EXTERNAL ANALYSIS

A) Shell Recycling Programs in the U.S.

Although oyster shell recycling is relatively new to the Texas coast, many states on the East Coast have been shell recycling for some time. It appears the Gulf Coast states are also becoming more invested in shell recycling and reef restoration efforts, but only within the last five to 10 years. Appendix I documents approximately 37 active oyster shell recycling programs across the United States. These programs range from small-scale student and/or staff-driven operations, to large-scale operations in which a recycling vendor is sub-contracted to collect the shells. Large-scale operations can be found in Alabama, Louisiana, South Carolina, and New York as shown in Table 6. GBF acknowledges the database is incomplete as there are many small programs that do not have sufficient information available to warrant a database entry. By assessing GBF's current and potential capacity as well as a variety of different shell recycling techniques discussed in the case studies below, GBF hopes to determine the best approach to shell recycling in the Houston-Galveston region.

Table 6: Program Case Studies

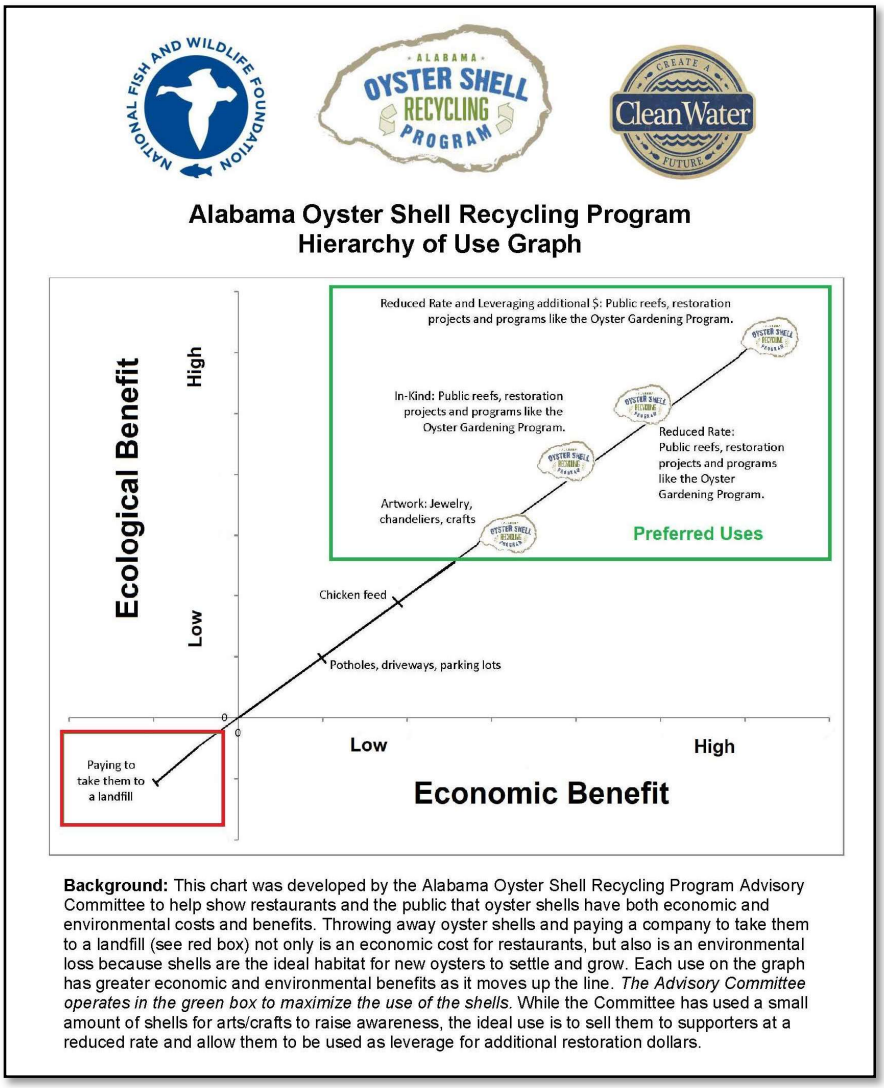
State	Start Date	Organization/ Program Name	Equipment	Labor	Avg. Cost per Month	Restaurant Partners	Fee?	Collection Days per Week
AL	2016	Alabama Coastal Foundation Oyster Shell Recycling Program	Dump Truck (vendor)	Contract	$4,500	18	Yes pickups/ week	1-3
LA	2014	Coalition to Restore Coastal Louisiana (CRCL) Oyster Shell Recycling Program	Dump Truck (vendor)	Contract	$20,000	28	Yes bins/ month	5
NJ	2019	NJ Division of Fish and Wildlife Bureau of Shellfisheries NJ Shell Recycling Program	F450 Truck + Dump Trailer with hydraulic lift arm	Staff	$4,600	9 (including casinos)	No	2-3
NY	2014	New York Harbor School Billion Oyster Project (BOP)	Box Truck (vendor)	Contract	$12,000	75	No	5
FL	2010	Choctawhatchee Basin Alliance Oyster Shell Recycling Program	F350 Truck + Dump Trailer	Staff	$1,500	12	No	3
SC	1999/ 2000	SCDNR – South Carolina Oyster Restoration and Enhancement (SCORE) Program	F350 Truck + Dump Trailer with hydraulic lift arm	Staff	Not provided	32	No	1-2
TX	2009	TX A&M University Corpus Christi - Sink Your Shucks	Truck + Landscape Trailer Dump Trailer	Students	$5,000	6	No	5
TX	2011	Galveston Bay Foundation Oyster Shell Recycling Program	½-ton Truck + Trailer and Dump Truck	Staff	$5,000	36	No	1-3

**Please note all case studies were originally conducted in 2019 and updated in 2024.*

A.1) Alabama Case Study: Alabama Coastal Foundation – "Oyster Shell Recycling Program"

The Alabama Coastal Foundation (ACF) is a fellow member organization of Restore American's Estuaries (RAE). ACF's Oyster Shell Recycling Program started in 2016 upon receiving grant funds from the National Fish and Wildlife Foundation (NFWF). After expanding the program in 2017, ACF's shell recycling services are now available to all restaurants in coastal Alabama. ACF subcontracts Republic Services, a waste disposal company, to collect the recycled shell from participating restaurants for approximately $4,500-$4,800 per month. As mentioned by ACF's Executive Director, they decided to subcontract a vendor for quality control purposes. They also purchase their recycling receptacles in bulk through Rehrig Pacific Company, so each bin is professionally branded with the organization's logo and easily identifiable by restaurants and the recycling vendor. ACF's recycled shells are stockpiled on state property at the Alabama Marine Resources Division in Gulf shores and sun cured for a minimum of six months. Through quarterly meetings with an Advisory Committee, ACF and their partners determine where and when to return the recycled shell to coastal waters. The focus of this committee is demonstrated by the graphic developed by ACF, shown in Figure 3 below. Additionally, all restaurants are members of the Green Coast Council which is a forum where business leaders can promote environmental sustainability principles. It was an initiative of the Alabama Coastal Foundation.

Figure 3: Hierarchy of Oyster Shell Use (Alabama Coastal Foundation)



A.2) Louisiana Case Study: Coalition to Restore Coastal Louisiana – "Oyster Shell Recycling Program"

The Coalition to Restore Coastal Louisiana (CRCL) is a fellow member organization of Restore American's Estuaries (RAE). In 2014, CRCL staff approached GBF about initiating an oyster shell recycling program. Due to a one-time $1,000,000.00 donation, CRCL was able to subcontract a recycling vendor to collect shell from the organization's restaurant partners. Initially, the shell recycling service was free of charge to the 25 plus restaurant partners. However, when those funds ran out CRCL was forced to charge each restaurant for the recycling vendor's services. There was an initial drop in restaurant partners because of the charge, however, over time CRCL was able to grow back the partnerships and now works with 28 restaurants who pay $100.00 per month for each 32-gallon recycling bin they use for shell recycling. In addition to the restaurant fees, CRCL's Oyster Shell Recycling Program is funded via governmental grants and private donations. In return for their participation in the program, restaurants receive regular promotion from CRCL through their website and social media, as well as invitations to participate in CRCL events to increase advertising and publicity.

R&R Recycling collects shell three to five days a week from CRCL's restaurant partners. The vendor also provides a temporary storage site for the recycled shell. Each month, CRCL must transport the shell to a curing site located in Buras or Violet, Louisiana, 60 and 15 miles from downtown New Orleans respectively, where it remains for at least six months before being utilized in reef restoration projects. CRCL commented the use of a private recycling vendor makes for a hassle-free program, however it is very costly, averaging approximately $20,000.00 per month, thus necessitating the need for monthly restaurant fees. In addition, the mileage and time required to transport the shell to Buras is another high-cost element of the program. A new law in Louisiana was established in July 2023 and enables restaurants recycling oyster shells to receive tax credits. Restaurants receive a $1 tax credit for every 50 pounds of shell they recycle.

A.3) New Jersey Case Study: New Jersey Division of Fish and Wildlife Marine Resources Administration

The state of New Jersey (NJ) took up shell recycling in the fall of 2019 under the Marine Resources Administration, Bureau of Shellfisheries. The state's shell recycling operations are centered around Atlantic City where restaurants and casinos are abundant. At this time, staff employed by the NJ Division of Fish and Wildlife collect recycled oyster shells from nine participating restaurant, hotel, and casino partners utilizing a Ford F-450 pickup truck and 7-foot wide by 14-foot-long dump trailer. Originally, they dumped recycled shells directly into the bed of pickup truck but quickly discovered this approach was not sustainable for the employees or the equipment. To reduce labor and increase efficiency, the state switched to the dump trailer approach. They also installed a hydraulic lift arm (purchased from Perkins Manufacturing) to facilitate dumping the shell from recycling receptacles into the trailer and further reduce labor requirements. Space for quarantining the recycled shell has been the largest obstacle thus far for the Bureau. They currently store the shell at one of their field stations near the water to facilitate loading it onto barges for future restoration. The newly recycled shell is spread in thin piles for the first month and then piled higher for storage for the remainder of the curing process. To help recruit additional restaurant partners in Atlantic City, the state developed a "Restaurant Certification Program" that is similar to Trip Advisor. This certification program also helps attract new patrons to participating restaurants.

A.4) New York Case Study: New York Harbor School – "Billion Oyster Project"

New York Harbor School's Billion Oyster Project (BOP) is one of the largest oyster shell recycling programs in the nation, now partnering with 75 restaurants. These restaurants are located throughout Manhattan and Brooklyn, making logistics rather challenging.

Previously, staff and volunteers conducted the shell collections, utilizing two box trucks. Now BOP outsources shell collection to a seafood wholesaler, Lobster Place, which costs approximately $12,000.00 per month. As stated by BOP staff, subcontracting the shell collections is safer and simpler due to complicated driving and parking regulations in New York City. In addition, the subcontractor agreement with Lobster Place has increased their shell collection capacity from 20 to 25 restaurants per day. Restaurants receive one to four collections per week free of charge depending on their output. They have their choice of 5-gallon buckets, 32-gallon bins, or 64-gallon bins, although the bins are only used at a select few restaurants where there is room for outside storage. The majority of the restaurants store their recycled shell in buckets in walk-in freezers until their collection day.

The recycled shell is transported daily by Lobster Place to dumpsters near the recycling route. Once a dumpster reaches capacity, BOP transports the shell to their curing site on Governor's Island where it is

sun cured and stockpiled. The State of New York requires a minimum of six months of sun curing time during which the shell cannot be piled higher than three feet. Per internal guidance, shell collected by BOP sun cures for a minimum of one year. The program is funded by both governmental grants and private donations. Restaurants receive free advertising and promotions through the program's website and social media, as well as invitations to participate in organizational events throughout the year. As of 2021, BOP started public shell collection and partnered with Compost Power in Williamsburg, Brooklyn for drop-off. The program collects hard-shell clam and scallop shells along with oyster shells.

A.5) Florida Case Study: Choctawhatchee Basin Alliance – "Oyster Shell Recycling Program"

Choctawhatchee Basin Alliance (CBA) operates its Oyster Shell Recycling Program with a combination of full-time and part-time staff as well as their AmeriCorps partners. Three staff collect shell two to three times a week from 12 restaurant partners using a Ford F-350 truck and 14-foot dump trailer donated by Northwest Florida State College. Restaurant partners are provided with 32-gallon recycling bins to fill with shell. CBA staff lift those bins into the trailer by hand. The recycled shells are then transported back to the CBA headquarters where shell is stored and cured for a minimum of six months. The curing site is located away from the main building, adjacent to a storage building. CBA staff frequently utilize a skid steer to turn the shells for proper sun curing.

Restaurants receive CBA's recycling service free of charge and are provided recognition through CBA's website and social media. Operational costs, which average about $1,500.00 per month, are supported primarily by governmental grants and other private funding sources. The truck and trailer donation made their initial overhead costs low. However, the need for three staff members to manually load bins onto the trailer increases personnel expenses.

CBA is in the process of streamlining their program to improve efficiency, reduce costs, and increase the amount of shell collected. Their staff reached out to GBF in 2019 for advice and consultation on shell recycling methodologies. As a result, GBF had the pleasure of visiting CBA staff and observing their shell recycling operations in person.

A.6) South Carolina Case Study: South Carolina Oyster Restoration and Enhancement (SCORE) Program

The South Carolina Department of Natural Resources initiated the SCORE Program in 2000. SCORE was one of the first, if not the first, shell recycling program in the United States. The state's shell recycling operations and reef restoration efforts are paid for by fees associated with state-issued recreational saltwater fishing licenses.

The state began recycling shell solely at public drop-off sites and progressed to recycling shell at community events. The SCORE Program has since expanded, and state-employed staff now collect shell from 32 restaurants on a weekly basis and nine seasonally. Restaurants receive shell pick-ups one to two times a week free of charge as well as 32-gallon recycling bins to collect their shell. SCORE staff utilize a Ford F-450 truck and dump trailer with a Perkins Manufacturing hydraulic arm lift to collect the shell from each restaurant. Although the equipment reduces labor and increases efficiency, SCORE staff caution about maintenance expenses, particularly corrosion of the trailer bed which they stated is typically replaced every five years. The dump trailers are also used to collect shell at community events. SCORE leaves the trailers at community oyster roasts and other events over a weekend, securing the trailers with a boot and/or tongue lock. The trailers are then collected the following week and the shells are taken to a curing site.

While shell recycling via restaurants and events combined accounts for 60 percent of SCORE's shell, the public drop-off sites alone account for 40 percent. The public drop-off sites are located throughout the state at various locations such as public recycling facilities, state parks, boat landings, and seafood distributors. SCORE constructs a 10-foot by 10-foot wooden structure at each public drop-off site to indicate where shell can be placed. Shell from these sites is only collected two to three times a year and is then taken to a curing site. SCORE currently maintains four quarantine sites. Fresh shell is dumped in small piles where it's spread in a thin layer for multiple months and then placed in larger piles throughout the six-month sun curing process. Although the state of South Carolina does not have any official regulations regarding sun curing shell, the primary study on sun curing (Bushek et al, 2004) was conducted in SCORE's backyard at the Fort Johnson facility.

A.7) Texas Case Study: TX A&M Corpus Christi – "Sink Your Shucks"

In 2009, the first oyster shell recycling program in Texas was created through a partnership between the Harte Research Institute for Gulf of Mexico Studies at Texas A&M University-Corpus Christi (TAMUCC), the Port of Corpus Christi Authority, and Water Street Seafood Company in Corpus Christi, Texas. Founded by Dr. Jennifer Pollack with TAMUCC, the "Sink Your Shucks" program continues to recycle shells with six restaurant partners and at oyster festivals. Prior to Hurricane Harvey, TAMUCC also collected shell from a local wholesaler, Groomers, who is no longer participating in the program. Since the program is operated entirely by the university, students (some paid and some unpaid) and other university staff are employed to conduct the shell collection activities. Students and staff collect shells from restaurants five days a week using two different methods. The first method is utilized for smaller volumes of shell produced by restaurant partners. In this scenario, students load 30-gallon recycling bins into a dump trailer with the assistance of a tilt lift. The second method is utilized for larger volumes of shell produced. In this scenario the recycled shell is loaded directly into a dump trailer. A three-quarter-ton pickup truck is used to haul both trailers. All recycled shell collected by TAMUCC is transported to a site owned by the Port of Corpus Christi where it is stored for at least six months for proper sun curing.

By employing students and utilizing university-owned equipment (truck and trailer), TAMUCC can keep their operating costs down. On average, the program requires approximately $5,000.00 per month to operate. Like GBF's OSRP, TAMUCC receives the majority of their funds for Sink You Shucks from CMP grants, indicating the state of Texas is in support of these shell recycling efforts. Additionally, CCA recently approved an additional $10,000 for the program to purchase two new trailers and to make trailer repairs. Since the program is operated through Dr. Pollack's lab, the recycled shell is used not only for reef restoration, but also for valuable research on cultch material and oyster habitat in the Coastal Bend region of Texas.

A.8) Case Study Synopsis

Of the 37 shell recycling programs currently in the United States, the seven programs discussed above were chosen to provide a comprehensive overview of the various methodologies used for recycling oyster shell. The smaller operations utilize a basic truck and landscape trailer combination. With fewer restaurant partners, approximately 15 or less, it is difficult to justify more expensive equipment. However, those programs embedded in a state department or in close partnership with the state natural resources department seem to have the most success at securing funds to support their shell recycling operations.

Multiple programs are moving towards dump trailers since they reduce a large amount of labor, particularly when retrofitted with a hydraulic lift arm like the SCORE and NJ programs. In addition, BOP's numerous restaurant partners and shift to subcontracting shell collection is indicative of a certain threshold for outsourcing shell recycling operations. Some organizations such as ACF and CRCL have utilized shell recycling vendors from the beginning to maintain quality control and reduce internal expenses, particularly personnel, travel, and maintenance costs. GBF has yet to determine the threshold for utilizing vendors or contractors. The initial dump truck investment has provided the opportunity for expansion to more restaurants in Houston.

B) Key Players and Target Audience

In addition to on-the-ground operations of shell recycling, the key players involved must also be addressed. This audience is typically composed of restaurants, government agencies, individual donors, and the community. By incorporating the interest of these parties and addressing their potential giving ability, a more successful and sustainable oyster shell recycling program can be developed.

B.1) Restaurants

Restaurants are the key component of any oyster shell recycling program. When initiating a new program or expanding an existing program, GBF has determined it is important to focus on three fundamental elements associated with restaurant partnerships: selection, retention, and incentives.

The focal restaurants targeted for a shell recycling partnership typically include local seafood venues with a variety of oyster items on their menus. Multiple oyster items on the menu indicate a better chance for high shell output. For instance, only fried oyster items on a menu typically means the restaurant purchases their oysters pre-shucked and will therefore have no shell to contribute.

While most shell recycling services are free, as indicated by the case studies discussed above, recycling shells still requires effort from the restaurant and their staff. This includes additional training to ensure wait staff know how and where to recycle shells, space to store the recycling bins and/or buckets, as well as a time commitment from the owner and/or manager(s). If a lead individual from a restaurant is not invested in the process, it is unlikely the partnership will be successful. Therefore, it is imperative to provide incentives for restaurants to participate in shell recycling. The reduction of waste hauling costs is limited and often unnoticed by most restaurants who recycle shell. The tax deduction associated with shell recycling also has a low impact on a restaurant's finances. Thus, it appears the key to engaging restaurants is through new marketing opportunities and more exposure that will recruit new patrons and in return, increase profits.

Since 2011, 44 restaurants have participated in GBF's OSRP. Although GBF's OSRP is free to restaurants, some partners find the additional efforts unmanageable, particularly those without an invested owner or manager. CRCL has also fluctuated in the number of restaurant partners due to new fee requirements. While some restaurants dropped out of CRCL's program when the fee was introduced, the most committed ones remained. As discussed in Step 1 of this document, GBF is beginning to utilize the Restaurant Selection Criteria and Restaurant Database to narrow-down the search for additional partners. This information will help determine which restaurants are the most practical and sustainable partners, in contrast to GBF's past opportunistic approach. By streamlining partner selection methodologies, GBF hopes to stabilize the OSRP through more consistent participation. Furthermore, by finding new ways to incentivize restaurants, such as participation in the Houston Oyster & SeaFest and ongoing social media campaigns, GBF hopes to retain more restaurant partners as the OSRP expands.

B.2) Texas Parks and Wildlife Department (TPWD)

In the state of Texas, TPWD is responsible for managing the natural, public resources including the oyster fishery. TPWD manages both oyster harvest and trade in coordination with the Texas Department of State Health Services. While economic measures associated with harvest are the one of the primary concerns of the TPWD Commission, the conservation and sustainability of wild oyster populations are also addressed by TPWD. An overview of the Texas oyster regulations implemented by TPWD are included in Appendix J.

Tasked with managing this public resource, TPWD aims to restore and sustain oyster reefs along the entire Texas coast. To support these restoration efforts, the Oyster Shell Recovery and Replacement Program was established in 2011. TPWD collects a fee from oyster harvesters for every sack of oysters harvested. Oyster dealers are also required to return 30 percent of their shucked shell back to designated waters or pay a fee to TPWD. These fees allow TPWD to purchase cultch material to be planted on publicly harvestable reefs. TPWD typically uses river rock, limestone, or concrete rather than oyster shell. However, this clutch is sometimes capped with a layer of recycled shell sourced from commercial dealers. Oyster shell is rarely, if ever, sold in the state of Texas, except for use in chicken feed, and is therefore difficult to source for restoration efforts. Based on personal communications with TPWD staff, the Oyster Shell Recovery and Replacement Program can support up to 20 to 30 acres of reef restoration a year for the entire Texas coast (Emma Clarkson, TPWD, 2019).

In addition to sustaining publicly harvestable reefs, TPWD also oversees the permitting and management of private leases. Galveston Bay is the only location in the state where private oyster leases, also known as "Certificates of Location," are permitted. Over 2,000 acres of bay bottom is leased by private companies in Galveston Bay. These private leases are off-limits to other fishermen and the public. Private lease owners pay an initial fee and an annual fee to TPWD and are required to supplement their oyster habitat with cultch material. These individuals can place cultch themselves or they can pay a fee and TPWD will design the project and oversee construction. Most private lease holders invest a significant amount of time and money into their leases to help maintain a sustainable practice.

While the Oyster Shell Recovery and Replacement Program was initiated to help with the "recovery of oyster shell" in an effort "to maintain or enhance public oyster reefs," the shell utilized for these efforts is primarily sourced from wholesalers and distributors but does not address the shells discarded by restaurants or individuals. Thus, all the oyster shells leaving Galveston Bay via harvest is not returned through TPWD's efforts.

GBF's OSRP supplements these efforts but is focused on returning recycled shell to areas off-limits to harvest. With differing goals, collaboration on reef restoration between TPWD and GBF is challenging.

As demonstrated in this document, GBF is in the process of securing more substantial and long-lasting support to sustain shell recycling operations. Additional support from the state level would benefit not only GBF's efforts but also TPWD's oyster fishery management goals. Such collaboration would result in a more harmonious approach to sustaining the Galveston Bay oyster population both as a fishery and as a vital ecological component of the estuary. A first step in this collaboration was taken with the initiation of the Galveston Bay Oyster Workgroup in 2019, as GBF and TPWD co-chair this subgroup of the Galveston Bay Estuary Program.

B.3) Commercial Industry

Seafood dealers as well as oyster harvesters are some of the largest sources of oyster shell. Many of the commercial operations in Galveston Bay, such as Jeri's Seafood, Misho's Oyster Company, and Prestige Oysters, Inc., conduct harvesting operations, process the wild caught oysters, sell to wholesalers, and even handle the distribution of some of their product to local restaurant groups or grocery stores such as HEB and Kroger. Throughout this process, the shell from shucked oysters is typically stockpiled by the harvesters or shucking houses to return to their private leases or to return to public reefs as required by TPWD's 30 percent rule.

Not only are commercial oyster companies the primary source of shell, but they are also a potential avenue for reaching new restaurant partners. A partnership with these companies would be advantageous in large-scale reef restoration efforts which utilize the majority, if not all, of GBF's shell stock for one project. Therefore, GBF is in the process of discussing partnership opportunities with these companies in terms of shell recycling as well as general OSRP support.

Similar to GBF's partnership with TPWD, there is little incentive for commercial oyster companies to assist GBF in reef restoration efforts. GBF's efforts are focused on restoring oyster habitat for preservation purposes, not for harvest. Thus, GBF's oyster reef projects are located in areas off-limits to harvest. It is difficult to promote restoring areas off-limit to harvest when the success of the commercial oyster companies and the livelihood of their employees depends upon a successful oyster fishery. Research has shown that during the first two to three weeks of their life oyster larvae can be transported via tides and currents to set on a reef habitat different than their origin (Luckenbach et al, 1999). Therefore, it stands to reason that oyster habitat restored by GBF in areas off-limit to harvest may provide larvae to harvestable reefs, thus helping to sustain the Galveston Bay oyster population as a whole and improve future harvests on private leases and public reefs.

GBF is currently serving as a partner on the Galveston Bay Sustainable Oyster Reef Restoration Project with The Nature Conservancy (TNC) and TPWD. Upon completion, this project will provide data on larval transport from a sanctuary reef to harvestable reef(s) in upper Galveston Bay. Having this information documented in Galveston Bay will hopefully encourage the commercial oyster industry to consider a partnership with GBF.

B.4) Local Communities

As discussed in Step 1, community engagement is essential to the success of any oyster shell recycling program. The community includes not only individual citizens but also local businesses and municipalities. Their support and investment in an oyster shell recycling program can have immense beneficial impacts, particularly as they transform into advocates for the program. Engaging this audience requires a variety of approaches such as outreach efforts through public events and at participating restaurants.

Oyster roasts and festivals are not engrained in the culture in Texas, especially in the Houston-Galveston region where crawfish boils dominate springtime. Although oyster festivals are slowly becoming more prevalent in Texas, most citizens consume oysters in restaurants. Therefore, the first step in improving public engagement must begin with active restaurant partners. Restaurants can promote the shell recycling program through visual aids in the restaurant itself, such as table tents, information on the menu, or even an insert accompanying the final check. Servers can also be trained to promote shell recycling to patrons, thus promoting oyster sales for the restaurant as well as oyster habitat conservation.

Obtaining exposure in the community can be accomplished via community presentations for local businesses, restoration and funding partners, master naturalist chapters, and a variety of other groups. A wide range of audiences will extend the reach of a shell recycling program and thus educate a larger component of the community. Outreach booths at local events can also accomplish this goal. Visual aids, showing the recycling process and/or an oyster's filtration ability provide a clear message to the audience. In addition, hands-on activities, particularly for children, are an effective method to inciting involvement/interest.

Education is the first step to positive action. By helping the local community understand the importance of oysters, they will be able to make educated decisions on where to eat and how to help. Providing action items for interested citizens is essential in their engagement. Precise recommendations on where to eat oysters, how to volunteer and provide hands-on help, or even how to contribute financially to support shell recycling efforts will provide a clear path forward for truly interested individuals. By tying in the ways oysters affect the lives of local communities, such as helping to clean the water and providing habitat for important recreational fisheries, individuals will be more incentivized to take action.

B.5 Restoration Partners

In addition to restaurant partners and the local community, restoration partners must be included in the ongoing activities of any oyster shell recycling program. By informing local resource managers of ongoing shell recycling and reef restoration efforts, opportunities and ideas will arise for collaboration, funding, and future projects. For GBF, many of these partners, such as TPWD, Texas Commission on Environmental Quality (TCEQ), CCA, TNC, and the USFWS Coastal Program, are aware of the existence of the OSRP but have not been engaged in GBF's ongoing efforts. The reinstated Galveston Bay Oyster Workgroup has spurred these partners to brainstorm ways to improve the shell recycling process as well as reef restoration.

Further collaboration can be accomplished via university partners. GBF is working directly with TAMUG, UH, and EIH at UHCL to conduct monitoring and research on GBF's projects that incorporate recycled shell as well as GBF's sun curing process. Not only do these partnerships help guide future restoration efforts, they also provide a new avenue for community engagement.

STEP 3: PLANNING

A) Objectives

The purpose of this document is to provide guidance for the improvement and expansion of GBF's OSRP. The SDP may also serve as a framework for other organizations interested in starting a new oyster shell recycling program or expanding an existing program.

GBF's ultimate goal is to provide oyster shell recycling services for the majority of the Houston-Galveston region. This requires significant and consistent financial support as well as physical assets and equipment. GBF wants to be aware of the operational expenses and use funds in the most efficient and thoughtful manner.

After evaluation and because of Version 2 of the SDP, GBF purchased a Ford F-550 heavy-duty truck equipped with a dump bed and bin lift. There were many benefits to this method and purchasing the truck in 2021 allowed GBF to create a Houston route and reach additional restaurant partners. During Phase 4 (2021-2022), GBF was focused on providing shell collection services to more restaurants.

GBF has the capacity, in terms of equipment and curing site space, to accommodate additional restaurants along the Houston and Clear Lake routes. However, there are staff requirements and maintenance costs associated with increasing restaurant partnerships. During Phase 5 (2023-2024), GBF will continue to evaluate its current and future capacities.

GBF has consistently recycled over 200 tons of shell for the past 2 years. This is sufficient for the current reef restoration projects, as well as gardening efforts. However, it is important to maintain this level of collection and potentially increase recycling for future large-scale reef restoration needs. To achieve this goal, GBF has established the following objectives:

1) Continue to evaluate purchasing new shell recycling equipment or utilizing a vendor
2) Continue to host the annual Houston Oyster & SeaFest to recycle additional shell, recruit new partners and patrons, and raise money and awareness
3) Streamline data collection
4) Increase annual tonnage of shell recycled annually by ten percent

B) Proposed Options

Sufficient funding is the primary deciding factor in terms of program operations. Therefore, GBF must assess all potential avenues to facilitate continued operations and/or expansion and the costs associated with each option. An assessment of these options will help determine the minimum and maximum financial support required annually.

B.1) Alternative Recycling Methods

The case studies discussed in Step 2 reveal a variety of shell recycling methods. These range from small, grass-roots operations, to large-scale, vendor-based operations like CRCL and BOP. There is an increase in operational costs as the number of restaurant partners increases and consequently the number of collection days increases.

To understand the range of expenses associated with each level of program growth, GBF created Tables 7 through 11 shown below. The baseline shell recycling expenses displayed in Table 7 only include the basic travel and personnel costs associated with weekly shell collection services. These expenses do not include program or staff management, nor do they include ongoing restaurant coordination and outreach efforts. The current shell recycling equipment and the initial investments for that equipment are outlined in Table 8. The potential future options are outlined in Table 9 and the potential additional costs are outlined in Table 10. The pros & cons of the recycling options are outlined in Table 11. Furthermore, the costs associated with each option outlined in these tables are estimates based on quotes and/or online research conducted in 2023 and 2024. These values are solely for the purpose of initial planning activities and are subject to change.

Table 7: Baseline Shell Recycling Expenses for Galveston Bay Foundation

Route	Average Mileage per Week	Monthly Travel Expenses (miles + insurance)	# of Staff Needed	GBF Hours per Week*	Monthly Personnel Expenses	TOTAL Monthly Expenses*	TOTAL Annual Expenses*
Clear Lake Route	113	$600.00	1 part-time	24 hrs	$1,540.00	**$2,140.00 per month**	**$25,680.00 per year**
Houston Route	267	$850.00	1 part-time	30 hrs	$1,920.00	**$2,770.00 per month**	**$33,240.00 per year**
Galveston Route**	45	$0	1 staff from Moody Gardens	n/a	$0	**$0**	**$0**
Current Routes TOTAL	425	$1,450.0	2 GBF part-time	54 hrs	$3,460.00	**$4,910.00 Per month**	**$58,920.00 Per year**

**Please note, the baseline expenses listed above ONLY include personnel time and travel expenses (based on the 2024 federal mileage rate of $0.670/hour) to conduct weekly shell collection. These estimates do NOT include general program management, outreach, supply, equipment maintenance, or other costs. These additional costs result in an overall annual expense of approximately $200,000 - $205,000 for the GBF OSRP based on current operations and equipment in 2024.*

***The Galveston Route is included in this table, even though GBF currently relies on volunteer support from staff members at Moody Gardens.*

Table 8: Current Shell Recycling Equipment

Routes	Shell Recycling Method	Item	Capacity	Cost *Estimate* per Item
Clear Lake	Truck and Landscape Trailer	Ford F-150 Lightning	20 recycling bins ~2 tons of shell	*Already purchased* ~$63,000.00
		12-ft Landscape Trailer + Modifications	*Carry empty bins to swap out at restaurants*	*Already purchased* ~$9,000.00
Houston	Dump Truck	Ford F-550 diesel + dump bed & bin lift	6,000 pounds 3 tons of shell/load	*Already purchased* ~$100,000.00
Galveston	Truck and Trailer	1/2-ton Truck *(Moody Gardens owned)*	21-30, 5-gallon buckets ~756-1,080 pounds of shell	*Already purchased by Moody Gardens*
		6' x 8' Trailer *(GBF purchased)*		*Already purchased* ~$1,100.00

Table 9: Future Options for Shell Recycling Operations

Option	Route	Shell Recycling Method
Option 1 (Continue Current Method)	Houston	Dump Truck
	Clear Lake	Truck & Landscape Trailer
	Galveston	Moody Gardens Equipment
Option 2 (Utilize Vendor for Houston Route)	Houston	Vendor
	Clear Lake	Dump Truck
	Galveston	Moody Gardens Equipment
Option 3 (Invest in 2nd Dump Truck)	Houston	Dump Truck
	Clear Lake	2nd Dump Truck
	Galveston	Moody Gardens Equipment
Option 4.1 (GBF Collects for Galveston Route)	Houston	Vendor
	Clear Lake	Dump Truck
	Galveston	Truck & Landscape Trailer
Option 4.2 (GBF Collects for Galveston Route)	Houston	Dump Truck
	Clear Lake	Truck & Landscape Trailer
	Galveston	Truck & Landscape Trailer on Tues/Thurs Route
Option 5.1 (Utilize Vendor for Houston Route & Expand to a New Region)	Houston	Vendor
	Clear Lake	Truck & Landscape Trailer
	Galveston	Moody Gardens Equipment
	Pearland/Dickinson	Dump Truck
Option 5.2 (Invest in 2nd Dump Truck & Expand to a New Region)	Houston	Dump Truck
	Clear Lake	Truck & Landscape Trailer
	Galveston	Moody Gardens Equipment
	Pearland/Dickinson	2nd Dump Truck

Table 10: Potential Additional Shell Recycling Costs

Shell Recycling Method	Item	Capacity	Cost *Estimate* Total
Recycling Vendor	N/A (most likely a box truck will be used)	Unknown	$6K per month for Houston Route $72K per year for Houston Route
2nd Dump Truck	Ford F-550 diesel + dump bed & bin lift	6,000 pounds 3 tons of shell/load	~$150,000

*The monthly estimate came from one recycling vendor in early 2024, continued evaluation is needed for this cost estimate.

Table 11: Pros and Cons of Shell Recycling Options

Option	Shell Recycling Method	Additional Cost for GBF	Pros	Cons
1	Truck & Trailer (*current method*)	$0.00	1) Operated by GBF Staff 2) Minimal maintenance	1) Labor intensive 2) Limited to 20 bins on trailer 3) Need to carry empty bins for exchange
	Dump Truck *(current method)*	$0.00	1) Operated by GBF Staff 2) Less physical labor required 3) Increase hauling capacity (facilitate addition of new restaurants) 4) No trailer required (easier access to restaurants) 5) Can transport shell to restoration sites	1) Additional maintenance 2) Additional registration fees, insurance, etc.
2	Recycling Vendor	$6K per month for Houston Route $72K per year for Houston Route	1) No physical labor 2) Increase hauling capacity (facilitate addition of new restaurants) 3) No storage required 4) No maintenance costs 5) Reduced personnel costs	1) Hands-off approach 2) Vendor will likely not transport shell to restoration sites 3) Tonnage of shell recycled will be tracked via 3rd party 4) **EXPENSIVE** and continuous cost
3	2nd Dump Truck	$150,000.00	1) Operated by GBF Staff 2) Less physical labor required 3) Increase hauling capacity (facilitate addition of new restaurants) 4) No trailer required (easier access to restaurants) 5) Can transport shell to restoration sites	1) Additional maintenance 2) Additional registration fees, insurance, etc. 3) **EXPENSIVE** initial purchase

B.2) Cost-Benefit Analysis

In the first and second versions of the SDP GBF evaluated even more options for large scale shell collection including a box truck, 1-ton truck with dump trailer, and a 1-ton truck with a dump body. These options were all eliminated, and it was determined the best path moving forward was to purchase the dump truck, which was accomplished in 2021. The dump truck was the best option for large scale equipment and was well documented in the first and second version of the SDP, therefore the additional options were not discussed in this third version of the SDP.

All Options (Table 9)

Option 1 is the current shell recycling method used by GBF.

Option 2 is to pilot using a vendor for the Houston route. This route produces the most shell but is the furthest away from the office and the curing sites. Bringing in a vendor for this route allows the dump truck to be used for the Clear Lake route to collect the shell closer to the office. In this option, Moody Gardens will continue to provide shell recycling for the Galveston route.

Option 3 is to invest in a second dump truck and plan to continue to collect shell internally for the foreseeable future for the Houston and Clear Lake routes. Moody Gardens will continue to provide shell recycling for the Galveston route.

Option 4 is to have GBF staff facilitate the shell collections for the Galveston route. This option was divided into two variations. Option 4.1 is piloting a vendor for the Houston route so the dump truck can then be used for the Clear Lake route, and the truck and trailer can be used for the Galveston route. Option 4.2, is to have the dump truck continued to be used for the Houston route, the truck and trailer continue to be used for the Clear Lake route (Mondays, Wednesdays, and Fridays), and the truck and trailer also be used for the Galveston route on the days it's not being used for the Clear Lake route (Tuesdays and Thursdays).

Option 5 is to expand and add a new route for the Pearland and Dickinson region. This option is also divided into two variations. Option 5.1 is piloting a vendor for the Houston route so the dump truck can be used for the new Pearland and Dickinson region, and the truck and trailer will be used for the Clear Lake route. Option 5.2 is using the dump truck for the Houston route, using the truck and trailer for the Clear Lake route, and investing in a second dump truck to be used for the Pearland and Dickinson region. For both options, Moody Gardens will continue to provide shell recycling for the Galveston route.

Preferred Options

After a thorough analysis of the options depicted in Tables 7 through 11, GBF has concluded the OSRP would benefit the most from one of three options: Option 1 (continue with the current shell recycling method and equipment), Option 5.1 (pilot a vendor for the Houston route and use the dump truck to expand the OSRP to a new region), or Option 5.2 (invest in a second dump truck and expand the OSRP to a new region). For the remainder of Phase 5, GBF will continue operating as usual and will thoroughly evaluate the costs and benefits associated with using a vendor for the Houston route versus investing in a second dump truck.

STEP 4: IMPLEMENTATION

A) Action Plan

The Analysis (Step 1 and 2) and Planning (Step 3) sections of this document address the requirements of the GBF shell recycling operations. Based on the case studies and cost-benefit analysis, it appears maintaining the current operations will be beneficial to GBF's efforts and will provide sufficient shell for restoration projects. Therefore, currently, GBF is planning to move forward with Option 1, maintaining the current recycling method, while evaluating Option 2, piloting a vendor for the Houston route.

In the second SDP, it was discussed that a new curing site would be required that was closer to the Houston route. However, after establishing the Houston route it was determined that both Red Bluff and Texas City have adequate space and are currently providing sufficient curing site needs. There was difficulty in locating a curing site closer to Houston, especially given the high price of real estate within the loop. The current daily mileage during Houston shell runs is manageable and a closer curing site to Houston was not purchased.

GBF will continue to provide services to the 37 recycling partners and increase on a case-by-case basis. The focus is not currently on expansion, however if a restaurant reaches out and is located along one of the current routes, they can be added to the shell recycling schedules. GBF maintains a restaurant database for the Houston-Galveston region and continually updates this resource as restaurants open and close.

GBF plans to increase the knowledge of the OSRP. Outreach initiatives including community presentations and coordination with restaurant partners will help reach a wider audience (as discussed in Step 1). The Houston Oyster & SeaFest will also engage more restaurants and citizens in the OSRP.

In addition to increasing the OSRP's exposure, GBF will work towards streamlining the current shell recycling operations. GBF will continue with a consistent maintenance schedule for all vehicles, equipment, recycling bins, and curing sites. GBF will continue tracking tonnage of shell recycled, stockpiled, and transported to restoration sites. GBF will also continue to monitor the "shell balance" (the amount of shell currently available for use in restoration projects).

Lastly, the Galveston Bay Oyster Workgroup partners are collaborating to guide the development of the OSRP, site reef restoration projects, and determine best management practices and restoration methodologies for Galveston Bay oyster reefs. By working with all the key players in the oyster reef restoration field, GBF plans to ensure the most sustainable use of each oyster shell recycled through the OSRP.

B) Timeline

In order to achieve the goal of continual operations and evaluation of the OSRP, GBF has created a timeline (Table 12) to implement each action item described above. This timeline will be updated with each new version of this document to aid in the strategic planning process in three-year increments. It is expected that unknown challenges and circumstances may arise, thus rendering this timeline inaccurate. To continue moving the OSRP forward, adaptive management will be required. To address these concerns, Step 5 lays out an adaptive management plan for the OSRP.

Table 12: Proposed Timeline

YEAR	MONTH	PLANS
2023	April	2nd Annual Houston Oyster & SeaFest
	May	Bi-Annual Galveston Bay Oyster Workgroup Meeting
	September	Completed Phase 1 of Sun Curing Research
	November	Bi-Annual Galveston Bay Oyster Workgroup Meeting
2024	February	Purchase new truck for the Clear Lake route
	March	Complete Version 3 of the Strategic Development Plan
	April	3rd Annual Houston Oyster & SeaFest
	May	Bi-Annual Galveston Bay Oyster Workgroup Meeting
	June	Conduct Shell-based Reef Restoration Research with UH
	September	Conduct Phase 2 of Sun Curing Research with EIH at UHCL
	November	Bi-Annual Galveston Bay Oyster Workgroup Meeting
	December	Evaluate Success Criteria and Determine if Equipment Purchase or Vendor Partnership is necessary
2025	January	Implement Decision from Evaluation
	April	4th Annual Houston Oyster & SeaFest
	May	Bi-Annual Galveston Bay Oyster Workgroup Meeting
	November	Bi-Annual Galveston Bay Oyster Workgroup Meeting

STEP 5: EVALUATION

Upon implementation of the action plan described in Step 4, GBF will begin documenting the successes and obstacles associated with the proposed approach. By following an adaptive management framework, GBF will be able to continuously address challenges and uncertainties throughout this process.

A) Adaptive Management

Natural resource management is the origin of adaptive management; this strategy can be applied across many disciplines and is thus applied here, to oyster shell recycling operations. Unlike the trial and error method, adaptive management provides a more structured approach with the goal of reducing uncertainty over time. As demonstrated by this document, adaptive management provides alternatives as well as avenues for learning and cooperation between partners, thus leading to a pattern of ongoing implementation, evaluation, and reassessment. Most importantly, this process helps narrow down which approaches are most effective.

This document was designed to facilitate the assessment of GBF's current operations and the operations of other programs (Step 1 and 2), analyze the costs and benefits associated with alternative shell recycling methods (Step 3), and outline an action plan to implement the most appropriate methodology (Step 4). The final step in the process, evaluation (Step 5), allows for reflection on actions taken to determine what is effective and what is not. Moving forward, GBF plans to evaluate the state of the OSRP on a quarterly basis to provide frequent opportunities for adjustment and improvement. The SDP will also be updated every two years, or as needed, to document these findings.

B) Success Criteria

The goal of GBF's OSRP is to reclaim oyster shells from local restaurants and return those shells to Galveston Bay to restore native oyster habitat. Based on this goal, GBF has developed the following success criteria to help document the accomplishments and potential challenges of the OSRP on an annual basis:

1) Recruit new restaurant partners along all recycling routes when feasible
2) Retain at least ninety percent of restaurant partners
3) Maintain or increase tonnage of shell recycled annually
4) Return at least five percent of shells recycled to Galveston Bay
5) Site at least one new reef restoration project in Galveston Bay

C) Updates to the Strategic Development Plan: *September 2020 – February 2024*

The first installment of this SDP was completed in September 2019 under CMP Cycle 22. The second installment of this SDP was completed in September 2020 under CMP Cycle 23. The third installment of this SDP was completed in March 2024 under CMP Cycle 27.

The OSRP has grown substantially since the second SDP. In September of 2020, GBF recycled with eight restaurant partners, as of March 2024 GBF has 37 shell recycling partners. In October 2020, GBF secured a new partner, Moody Gardens, to continue shell collection on Galveston Island. The Moody Gardens partnership results in an in-kind donation of labor and travel. In spring of 2021 GBF purchased a new dump truck which allowed for the expansion of a new route into the inner loop of Houston. Since 2020, the Clear Lake route grew from eight to ten partners, the Galveston route grew from one to nine partners, and the

Houston route was implemented which now has 18 partners. In February 2024, a new all-electric truck was purchased to replace the truck that was being used for the Clear Lake route.

Throughout this expansion GBF has hired new part-time staff and the program consists of the habitat restoration coordinator and two part-time shell recycling assistants. GBF launched the Inaugural Houston Oyster & SeaFest in April of 2022, with plans to continue annually. All proceeds from the festival benefit the OSRP and all shells produced by restaurants at the event are recycled by GBF.

In September 2023 GBF finalized a sun curing research project with partners from EIH at UHCL and UH. The protocol will help guide the regular maintenance and layout of the shell piles at each curing site and further dictate the capacity at each location. GBF has continued meeting with the Galveston Bay Oyster Workgroup. This effort was initiated to help guide the expansion of the OSRP and ensure the proper use of all recycled oyster shells in reef restoration.

GBF will continue to compare the status of the OSRP to the proposed timeline (Table 12) and success criteria as well as evaluate the need for any changes. Version 4.0 of the SDP will delve further into possible partnerships with commercial oyster companies as well as state agencies, particularly in regard to sun curing oyster shells for use in reef restoration.

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APPENDICES

A) Restaurant Partner Locations
1. Active Restaurant Partners
2. Shell Recycling Radius

B) Curing Site Locations
1. TX City Curing Site
2. Red Bluff Curing Site
3. Moody Gardens Curing Site

C) Oyster Shell Recycling Partner Locations
1. Clear Lake Recycling Partner Locations
2. Houston Recycling Partner Locations
3. Galveston Recycling Partner Locations

D) Oyster Shell Recycling Photographs
1. Houston and Clear Lake Route
2. Galveston Recycling Route

E) Restaurant Database
1. Clear Lake Region
2. Galveston Island
3. Houston Region

F) Curing Site Capacity
1. Texas City
2. Red Bluff
3. Moody Gardens

G) Sun Curing Protocol

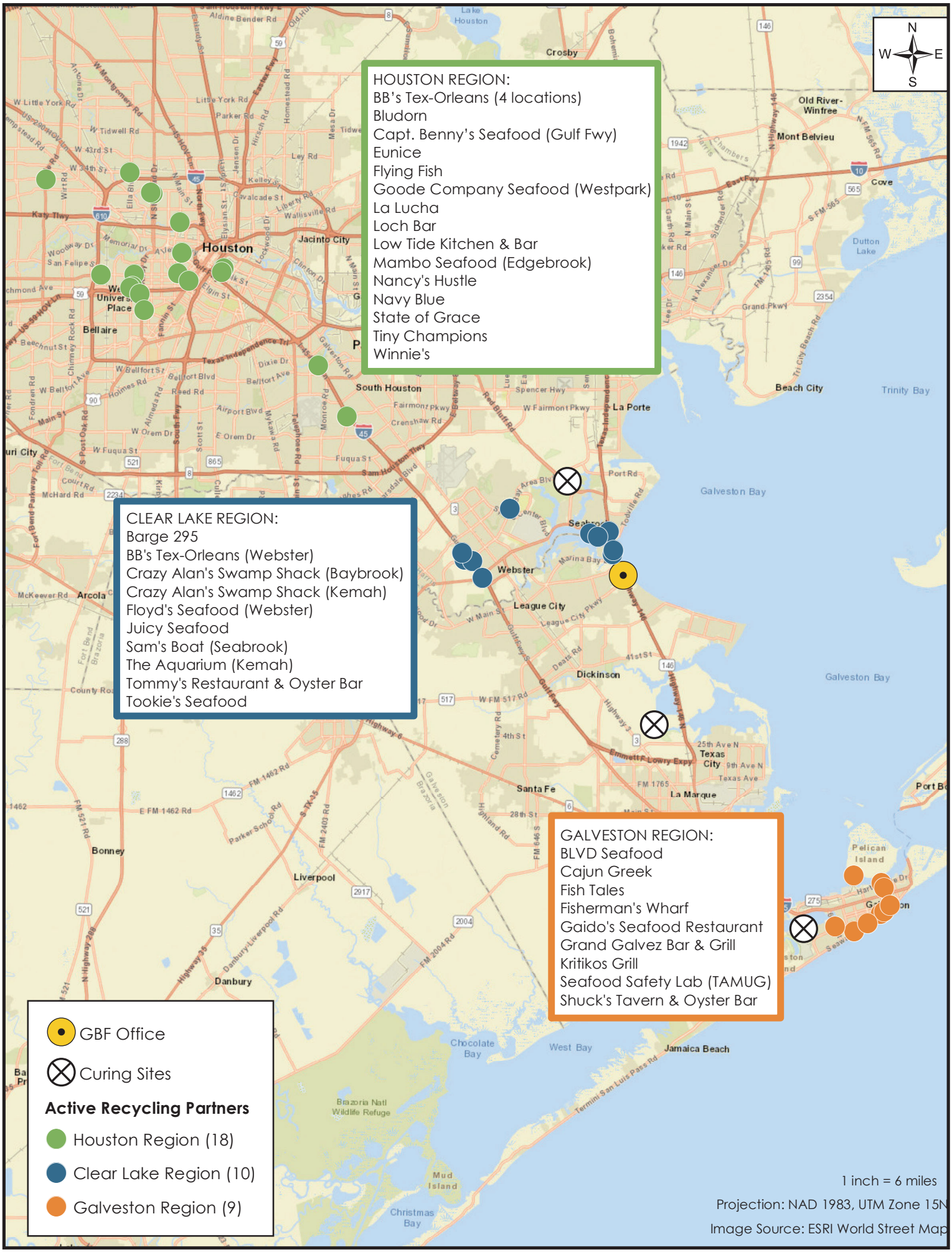
H) Restaurant Materials
1. Waste Hauling Costs
2. In-Kind Donation Form
3. Outreach Material Options

I) Database of Oyster Shell Recycling programs in the United States

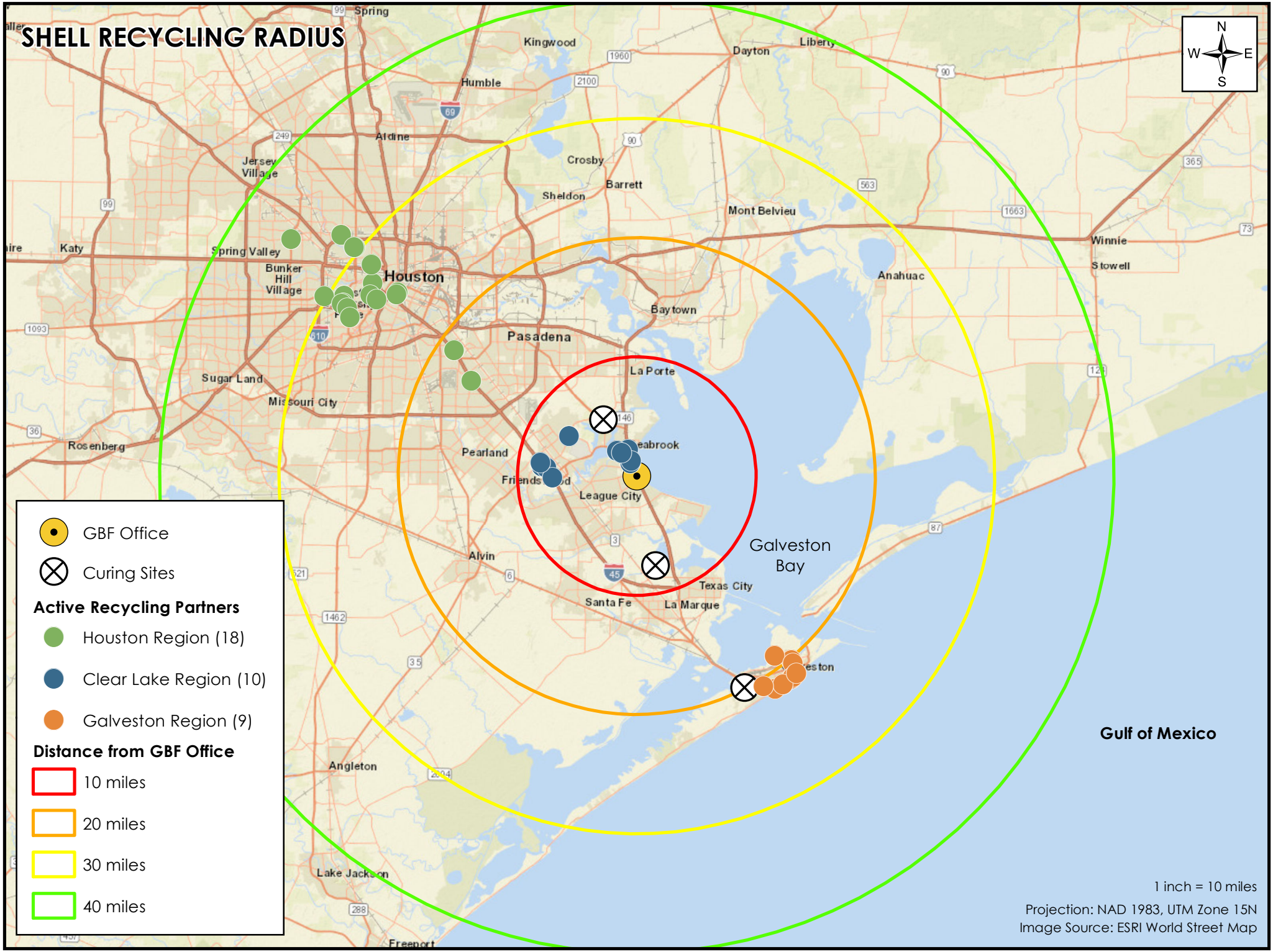
J) Texas Oyster Regulation

APPENDIX A

Restaurant Partner Locations

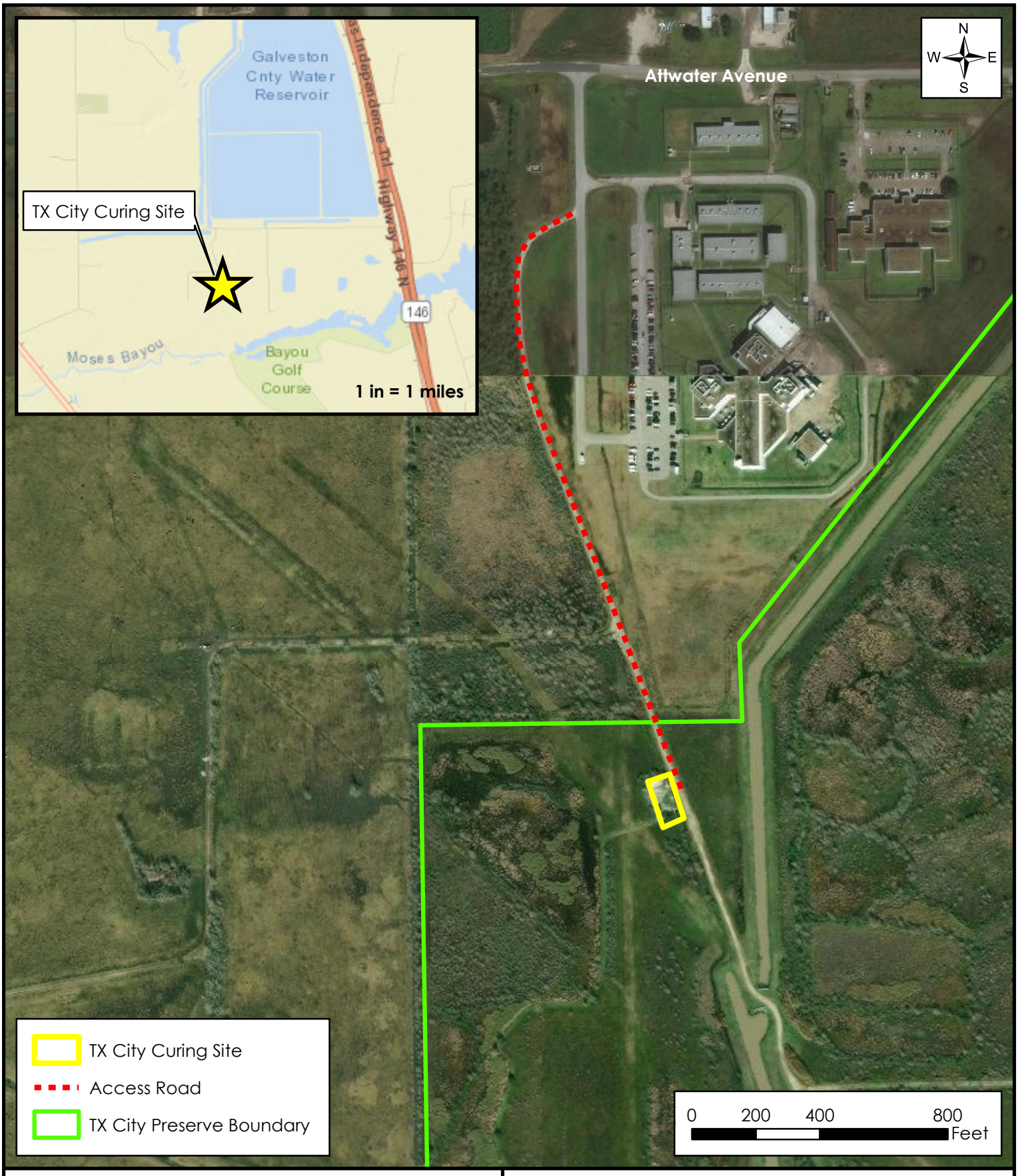


*Please note that the restaurant partners are dynamic and this map is accurate as of 3/09/2024


SHELL RECYCLING RADIUS
N
W
E
S
GBF Office
Curing Sites
Active Recycling Partners
Houston Region (18)
Clear Lake Region (10)
Galveston Region (9)
Distance from GBF Office
10 miles
20 miles
30 miles
40 miles
Houston
Pasadena
Baytown
La Porte
Pearland
League City
Galveston Bay
Gulf of Mexico
Texas City
La Marque
Santa Fe
Alvin
Angleton
Lake Jackson
Freeport
Rosenberg
Sugar Land
Missouri City
Katy
Spring Valley
Bunker Hill Village
Jersey Village
Spring
Kingwood
Humble
Aldine
Crosby
Sheldon
Barrett
Mont Belvieu
Dayton
Liberty
Winnie
Stowell
Anahuac
1 inch = 10 miles
Projection: NAD 1983, UTM Zone 15N
Image Source: ESRI World Street Map

APPENDIX B

Curing Site Locations



TX CITY CURING SITE - LOCATION MAP

Project Name: TX City Curing Site; Oyster Shell Recycling Program	
Project Location: TX City, Galveston County, TX	
Image Source: ESRI World Imagery; ESRI World Street Map	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 5/8/2020	Drawn by: H.Leija

GALVESTON BAY FOUNDATION

1725 Highway 146, Kemah, TX 77565; (281) 332-3381

RED BLUFF CURING SITE - LOCATION MAP

Project Name: Red Bluff Curing Site; Oyster Shell Recycling Program	
Project Location: Pasadena, Harris County, TX	
Image Source: ESRI World Imagery; ESRI World Street Map	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 5/8/2020	Drawn by: H.Leija

GALVESTON BAY FOUNDATION

1725 Highway 146, Kemah, TX 77565; (281) 332-3381

Moody Gardens Curing Site - Location Map

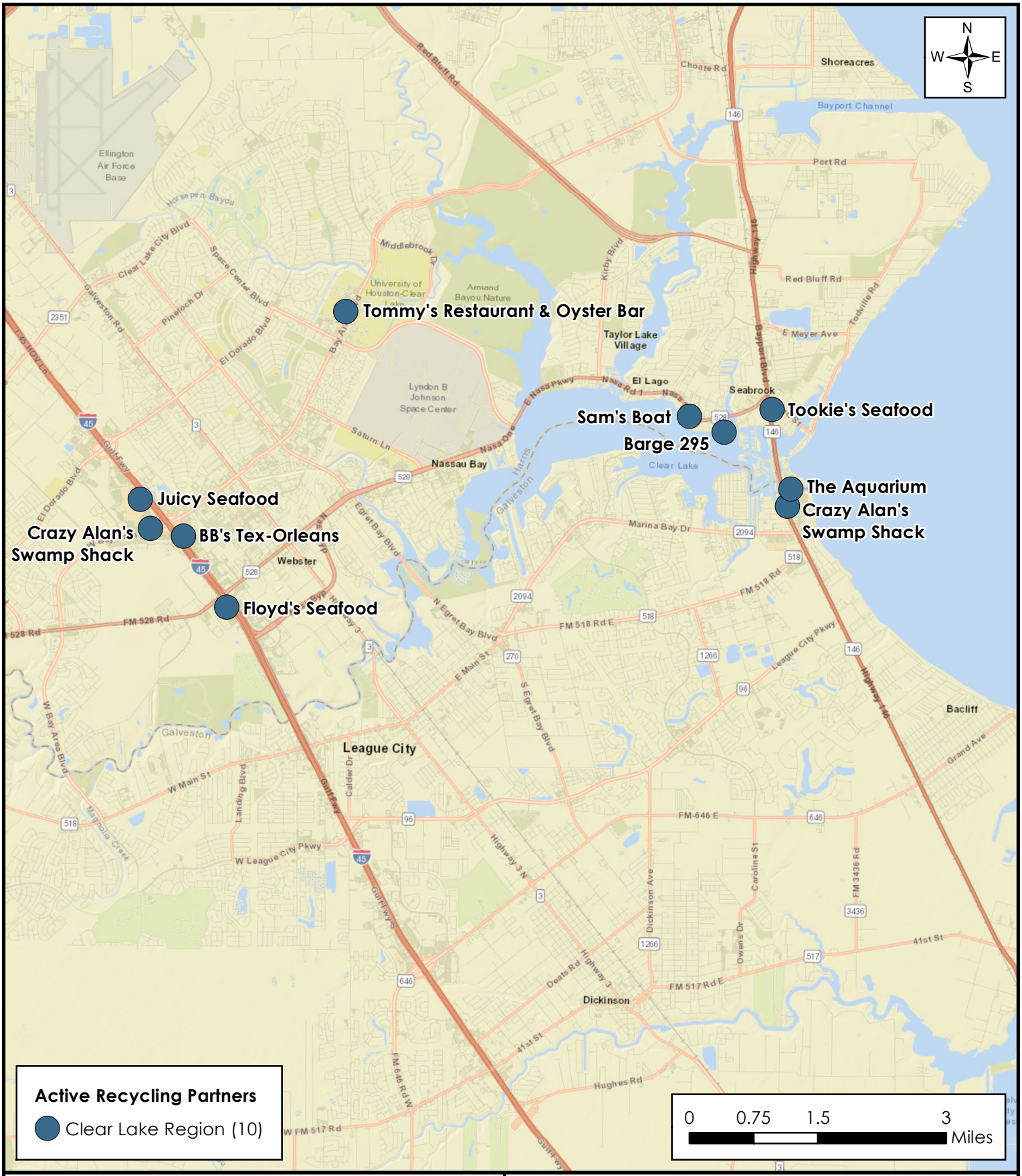
Project Name: Oyster Shell Recycling Program (OSRP)	
Project Location: Moody Gardens, Galveston County, TX	
Image Source: 2022 NAIP NC 60cm, Galveston Co.	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 3/8/2024	Drawn by: H.Leija

GALVESTON BAY FOUNDATION

1725 Highway 146, Kemah, TX; (281) 332-3381

APPENDIX C

Oyster Shell Recycling Partner Locations



Clear Lake Region

Project Name: Oyster Shell Recycling Program (OSRP)	
Project Location: Clear Lake Area, Harris & Galveston County, TX	
Image Source: ESRI World Street Map	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 3/11/2024	Drawn by: H.Leija

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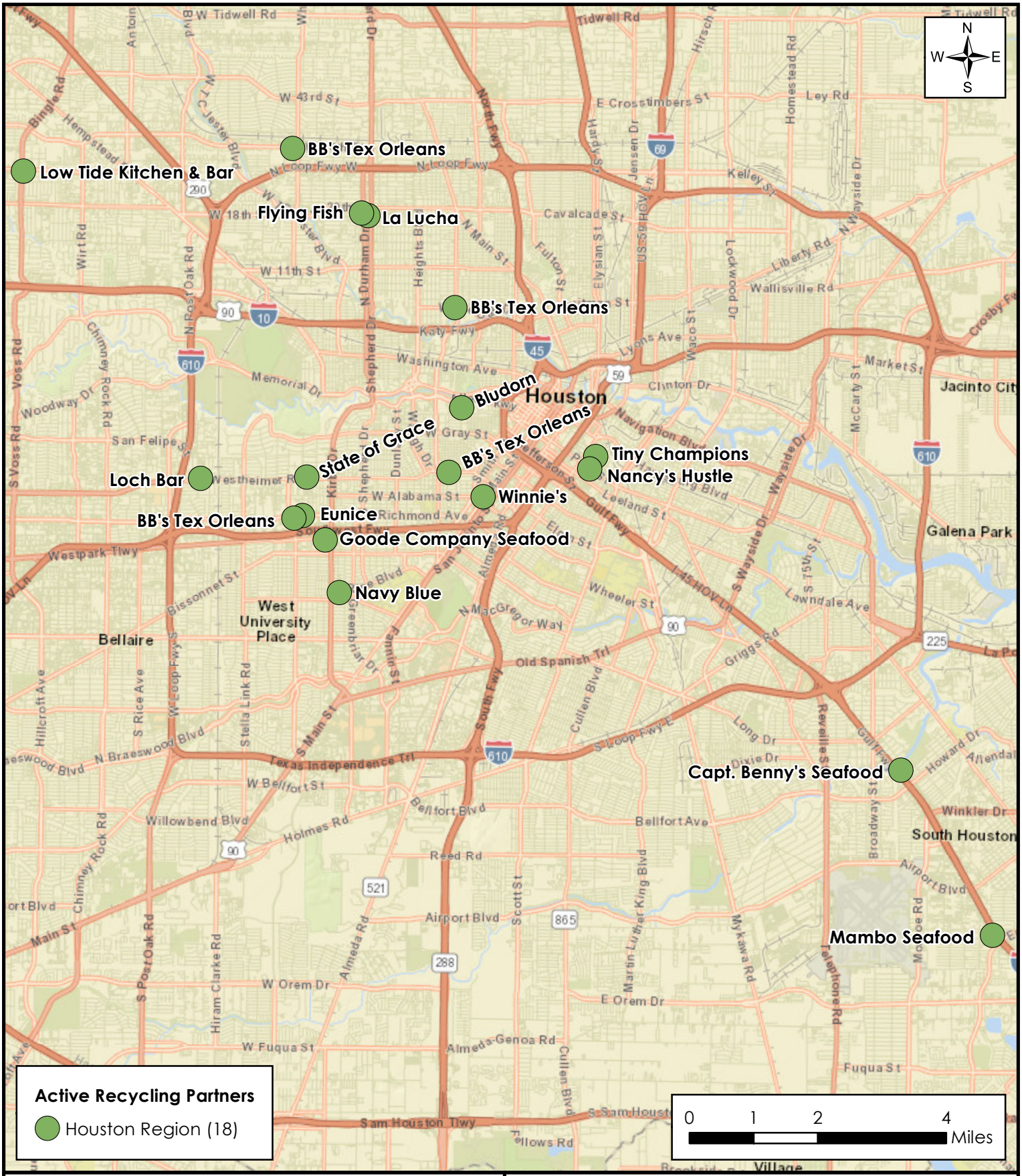

Houston Region

Project Name: Oyster Shell Recycling Program (OSRP)	
Project Location: Houston, Harris County, TX	
Image Source: ESRI World Street Map	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 3/11/2024	Drawn by: H.Leija

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1725 Highway 146, Kemah, TX; (281) 332-3381

Galveston Region

Project Name: Oyster Shell Recycling Program (OSRP)	
Project Location: Galveston, Galveston County, TX	
Image Source: ESRI World Street Map	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 3/11/2024	Drawn by: H.Leija

GALVESTON BAY FOUNDATION

1725 Highway 146, Kemah, TX; (281) 332-3381

APPENDIX D

Oyster Shell Recycling Photographs

SHELL RECYCLING PHOTOGRAPHS
Houston and Clear Lake Recycling Routes

Figure 1. Loading recycled oyster shells onto landscape trailer.

Figure 2. Loading recycled oyster shells onto landscape trailer.

SHELL RECYCLING PHOTOGRAPHS
Houston and Clear Lake Recycling Routes

Figure 3. Loading recycled oyster shells onto landscape trailer.

Figure 4. Oyster Shell Recycling Program trailer signage.

SHELL RECYCLING PHOTOGRAPHS
Houston and Clear Lake Recycling Routes

Figure 5. Recycled oyster shells collected at a restaurant.

Figure 6. Documenting recycled oyster shells collected from restaurant partners.

SHELL RECYCLING PHOTOGRAPHS
Houston and Clear Lake Recycling Routes

Figure 7. Oyster shell recycling truck and trailer at Red Bluff Curing Site.

Figure 8. Dumping newly recycled oyster shell at Red Bluff Curing Site.

SHELL RECYCLING PHOTOGRAPHS
Houston and Clear Lake Recycling Routes

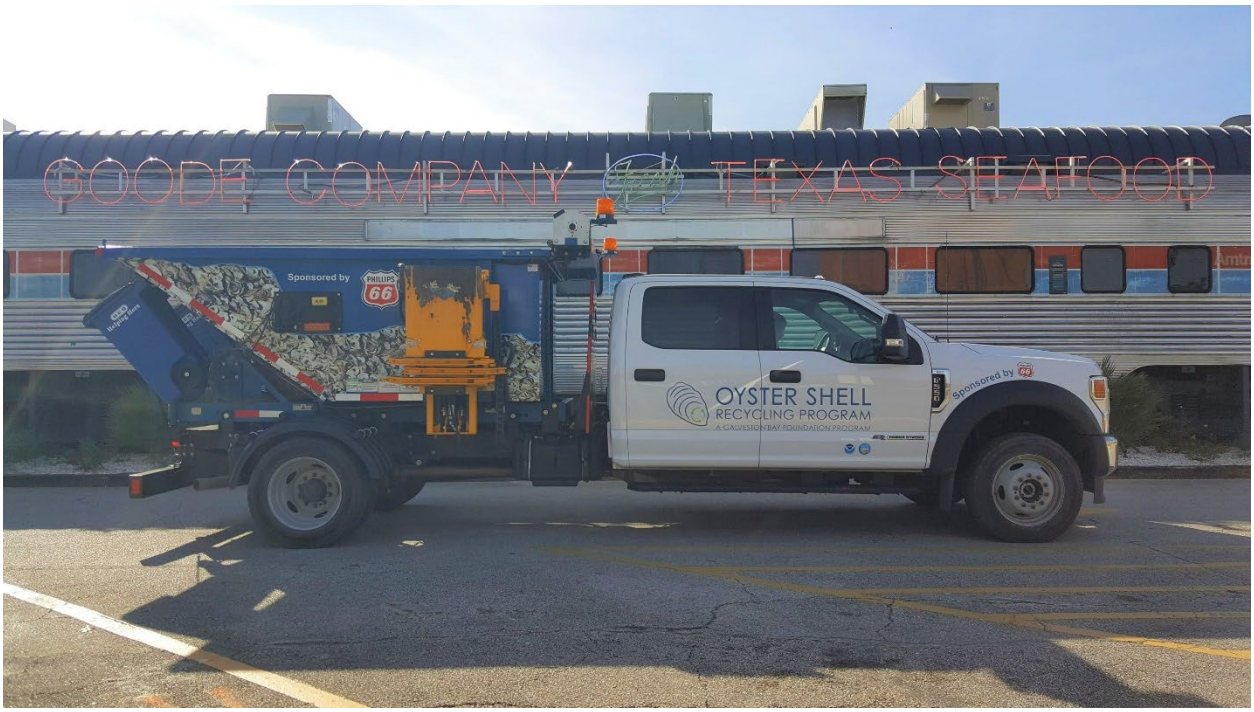


Figure 9. Dump truck in front of Goode Co. Seafood, a Houston region oyster shell recycling partner.

Figure 10. Recycled shell being delivered to the Red Bluff curing site with the new equipment.

SHELL RECYCLING PHOTOGRAPHS
Houston and Clear Lake Recycling Routes

Figure 11. Piling recycled shell at Red Bluff Curing Site.

Figure 12. GBF staff moving cured shell to consolidate piles and make space for future recycled shell at Red Bluff curing site.

SHELL RECYCLING PHOTOGRAPHS
Houston and Clear Lake Recycling Routes

Figure 13. Fully cured shell in the background and partially cured shell that was just rotated in the foreground at Red Bluff curing site.

Figure 14. Re-staked and roped off shell piles at Red Bluff curing site.

SHELL RECYCLING PHOTOGRAPHS
Houston and Clear Lake Recycling Routes

Figure 15. Assembled fenced shell pile (with chicken wire) in preparation for sun curing experiment.

Figure 16. Aerial view of all four shell piles for sun curing experiment.

SHELL RECYCLING PHOTOGRAPHS
Houston and Clear Lake Recycling Routes

Figure 17. Dumping newly recycled oyster shell at TX City Curing Site.

Figure 18. Recycled oyster shell piled for sun curing at TX City Curing Site.

SHELL RECYCLING PHOTOGRAPHS
Houston and Clear Lake Recycling Routes

Figure 19. Cement pad at TX City Curing Site.

Figure 20. Newly piled shell and bagged shell at TX City Curing Site.

SHELL RECYCLING PHOTOGRAPHS
Houston and Clear Lake Recycling Routes

Figure 21. Cured oyster shell piled and consolidated at TX City Curing Site.

Figure 22. Piling recycled shell at TX City Curing Site.

SHELL RECYCLING PHOTOGRAPHS
Galveston (Moody Gardens) Recycling Route

Figure 23. Shell collection by TAMUG via 14-gallon tubs (previous method for the Galveston Route).

Figure 24. Dumping newly recycled oyster shell at TAMUG Curing Site (previous method for the Galveston Route).

SHELL RECYCLING PHOTOGRAPHS
Galveston (Moody Gardens) Recycling Route

Figure 25. Dumping newly recycled oyster shell at TAMUG Curing Site (previous method for the Galveston Route).

Figure 26. GBF staff relocating fully cured shell from Moody Gardens curing site to GBF's Sweetwater Preserve and Moody Gardens staff rotating a semi-cured shell pile.

SHELL RECYCLING PHOTOGRAPHS
Galveston (Moody Gardens) Recycling Route

Figure 27. GBF staff relocating fully cured shell from Moody Gardens curing site to GBF's Sweetwater Preserve.

APPENDIX E

Restaurant Database

RESTAURANT DATABASE

Clear Lake Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Restaurant Phone #	Restaurant Address	Restaurant Website
			Raw (Y/N)	Cooked			
1	Barge 295	Seabrook	Y	5	(281) 549-7603	2613 ½ E NASA Pkwy	https://barge295seabrooktx.com/
2	BB's Tex-Orleans	Webster	Y	0	(281) 767-9644	1039 W Bay Area Blvd.	https://www.bbstexorleans.com/
3	Captain Benny's Seafood	Deer Park	Y	4	(281) 476-1513	1200 East Blvd	http://captbennys.com/
4	Crafty Crab	League City	Y	1	(281) 849-9000	112 Gulf Fwy N	https://craftycrableaguecity.com/
5	Crazy Alans Swamp Shack	Kemah	Y	4	(281) 334-5000	310 Texas Ave	http://crazyalanswampshack.com/
6	Crazy Alans Swamp Shack	Friendswood	Y	4	(832) 284-4895	1330 Bay Area Blvd	http://crazyalanswampshack.com/
7	East Star Chinese Buffet	Webster	Y	0	(281) 280-8822	1025 W Nasa Pkwy	No website
8	Floyd's Cajun Seafood and Steakhouse	Webster	Y	6	(281) 332-7474	20760 Gulf Fwy	http://floydsseafood.com/
9	Flying Dutchman	Kemah	Y	4	(281) 334-7575	9 11th Ave Kemah Waterfront	https://www.flyingdutchmankemah.com/
10	Gilhooley's Restaurant	San Leon	Y	4	(281) 339-3813	222 9th St	https://www.gilhooleystx.com/
11	Guidry's Cajun Kitchen	Deer Park	Y	1	(281) 930-1224	2113 Center St	https://www.guidrycajunkitchen.com/
12	Jackie's Brickhouse	Kemah	Y	1	(832) 864-2459	1053 Marina Bay Dr	http://www.jackiesbrickhouse.com/
13	La Costa Seafood Grill	Alvin	Y	3	(281) 824-4384	1200 Hwy 35 Byp North A	https://www.lacostaseafoodgrill.com/
14	LA Crawfish	Webster	Y	3	(832) 905-5154	939 W. Bay Area	www.lacrawfish.com
15	LA Crawfish	Baytown	Y	3	(832) 479-8081	4609 Garth Rd A	www.lacrawfish.com
16	LA Crawfish	Pasadena	Y	3	(832) 288-4494	4300 Fairmont Parkway	www.lacrawfish.com
17	Landry's Seafood House	Kemah	Y	1	(281) 334-2513	1 Kemah Boardwalk	https://www.landrysseafood.com/location-kemah.asp
18	Little Daddy's Gumbo Bar	League City	Y	2	(281) 524-8626	1615 West FM 646	http://www.littledaddysgumbobar.com/
19	Main St Bistro	League City	Y	0	(281) 332-8800	615 E Main St	No website
20	Mambo Seafood	Baytown	Y	0	(832) 926-7551	4300 East Freeway	www.mamboseafood.com
21	Marais	Dickinson	Y	4	(281) 534-1986	2015 FM 517 Rd East	https://maraistx.com/
22	Monument Inn	La Porte	Y	0	(281) 479-1521	4406 Independence Pkwy S	https://monumentinn.com/contact_us/
23	Noah's Ark Bar & Grill	Bacliff	Y	4	(281) 339-2895	4438 Boulevard St	https://noahsarkbarandgrill.com/
24	Opus Bistro & Steakhouse	League City	Y	4	(281) 334-0006	2500 South Shore Blvd.	https://opusbistro.net/#
25	Pappas Seafood House	Webster	Y	1	(281) 332-7546	19991 Gulf Freeway	www.pappasseafood.com
26	Perry's Steakhouse & Grille	Friendswood	Y	0	(281) 286-8800	700 Baybrook Mall Drive	https://perryssteakhouse.com/
27	Pier 6 Seafood & Oyster House	San Leon	Y	4	(281) 339-1515	113 6th St.	https://www.pier6seafood.com/
28	Remton	Webster	Y	2	(832) 905-5138	132 W. Bay Area Blvd	https://www.remton.net/
29	Sammy G's District 70 BBQ & Grill	El Lago	Y	Unsure	(281) 549-4022	4141 East NASA Rd 1, Suite D	
30	Sam's Boat	Seabrook	Y	0	(281) 326-7267	3101 Nasa Rd 1, Building B	www.samsboat.com

RESTAURANT DATABASE
Clear Lake Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Restaurant Phone #	Restaurant Address	Restaurant Website
			Raw (Y/N)	Cooked			
31	Schafer's Coastal Bar & Grille	Clear Lake Shores	Y	3	(281) 532-6860	1002 Aspen Road	https://schaferscoastalbarandgrille.com/
32	The Aquarium Restaurant	Kemah	Y	0	(281) 334-2521 (Bio and Edu Dept.) (281) 334-9010 (Restaurant)	#11 Kemah Boardwalk	https://www.aquariumrestaurants.com/aquariumkemah/
33	The Juicy Seafood	Friendswood	Y	1	(281) 786-1440	19026 Gulf Freeway	https://juicyseafoodfriendswood.kwickmenu.com/index.php
34	The Reef Seafood House	Texas City	Y	0	(409) 945-6151	1301 31st 1/2 St N	http://thereefseafoodhouse.com/
35	The Rouxpour	Friendswood	Y	4	(281) 480-4052	700 Baybrook Mall, Ste H100	www.therouxpour.com
36	The Rusty Hook Bar & Grill	Bacliff	Y	2	(832) 864-2862	3435 SH-146	http://boushayscajunsmokehouse.com/
37	TJ Reed's Flippers	Dickinson	Y	2	(832) 340-7340	628 FM 517 W	http://www.tjreedsflippers.com/tj-flippers-Menu
38	Tommy's Restaurant & Oyster Bar	Houston	Y	5	(281) 480-2221	2555 Bay Area Blvd	https://tommys.com/
39	Tookie's Seafood	Seabrook	Y	6	(281) 942-9445	1106 Bayport Blvd	https://www.tookiesseafood.com/
40	Topwater Grill	San Leon	Y	5	(281) 339-1232	815 Ave O	http://www.topwatergrill.com/
41	Valdo's Seafood House	Seabrook	Y	4	(281) 326-3866	4106 Nasa Rd 1	www.valdos.com

LEGEND
Current Partner
Priority for Shell Recycling
Low Priority

RESTAURANT DATABASE

Galveston Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Restaurant Phone #	Restaurant Address	Restaurant Website
			Raw (Y/N)	Cooked			
1	Black Pearl Oyster Bar	Galveston	Y	4	(409) 762-7299	327 23rd St	No website; only FB page
2	BLVD Seafood	Galveston	Y	3	(409) 762-2583	2804 R 1/2	www.blvdseafood.com
3	Cajun Greek	Galveston	Y	0	(409) 744-7041	2226 61st St	www.cajun-greek-seafood.com
4	Fish Tales	Galveston	Y	0	(409) 762-8545	2502 Seawall	www.fishtalesgalveston.com
5	Fisherman's Wharf	Galveston	Y	0	(409) 765-5708	2200 Harborside Dr	https://www.fishermanswharfgalveston.com/
6	Gaido's/Nick's Kitchen & Beach Bar	Galveston	Y	8	(409) 761-5500	3802 Seawall Blvd	http://www.gaidos.com/
7	Grand Galvez Bar & Grill	Galveston	Y	Unsure	(409) 765-7721	2024 Seawall Blvd	https://www.grandgalvez.com/bar-and-grille
8	Katie's Seafood House	Galveston	Y	2	(409) 765-5688	2000 Wharf Rd.	http://www.katiesseafoodhouse.com/#section-home
9	Kritikos Grill	Galveston	Y	0	(409) 539-5915	4908 Seawall Blvd.	https://www.kritikosgrill.com/
10	Landry's Seafood House	Galveston	Y	1	(409) 744-1010	5310 Seawall Blvd	https://www.landrysseafood.com/location-galveston.asp
11	Little Daddy's Gumbo Bar	Galveston	Y	2	(281) 524-8626	2107 Post Office Street	http://www.littledaddysgumbobar.com/
12	Number 13	Galveston	Y	0	(409) 572-2650	7809 Broadway St	http://www.number13steak.com/
13	Saltwater Grill	Galveston	Y	3	(409) 762-3474	2017 Postoffice St.	https://saltwatergrill.com/
14	Shuck's Tavern & Oyster Bar	Galveston	Y	3	(409) 444-1700	414 21st St	No website
15	Willie G's Seafood & Steaks	Galveston	Y	1	(409) 762-3030	2100 Harbor Side	https://www.williegs.com/galveston/

LEGEND
Current Partner
Priority for Shell Recycling
Low Priority

RESTAURANT DATABASE
Houston Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Restaurant Phone #	Restaurant Address	Restaurant Website
			Raw (Y/N)	Cooked			
1	A'Bouzy	Houston	Y	1	(713) 722-6899	2300 Westheimer	https://www.abouzy.com/
2	Acadian Coast	Houston	Y	3	(713) 432-9651	2929 Navigation Blvd.	http://acadiancoast.com/
3	B&B Butchers & Restaurant	Houston	Y	1	(713) 862-1814	1814 Washington Ave.	https://www.bbbutchers.com/
4	B.B. Lemon	Houston	Y	0	(713) 554-1809	1809 Washington Ave.	https://www.bblemon.com/
5	BB's Tex-Orleans	Houston- Briargrove	Y	0	(713) 339-2566	6154 Westheimer Rd	https://www.bbstexorleans.com/
6	BB's Tex-Orleans	Houston- Heights	Y	0	(713) 868-8000	2701 White Oak Dr	https://www.bbstexorleans.com/
7	BB's Tex-Orleans	Houston- Montrose	Y	0	(713) 524-4499	2710 Montrose Blvd	https://www.bbstexorleans.com/
8	BB's Tex-Orleans	Houston- Upper Kirby	Y	0	(713) 807-1300	3139 Richmond Ave	https://www.bbstexorleans.com/
9	BB's Tex-Orleans	Houston- Pearland	Y	0	(832) 856-3200	9719 W Broadway	https://www.bbstexorleans.com/
10	BB's Tex-Orleans	Houston- Oak Forest	Y	0	(832) 318-6533	1737 W 34th St. Suite 500	https://www.bbstexorleans.com/
11	Bludorn	Houston	Y	2	(713) 999-0146	807 Taft Street	https://www.bludornrestaurant.com/
12	Brasserie 19	Houston	Y	1	(713) 524-1919	1962 West Gray	https://www.brasserie19.com/
13	Brennan's of Houston	Houston	Y	2	(713) 522-9711	3300 Smith Street	https://www.brennanshouston.com/
14	Cajun Kitchen	Houston	Y	4	(281) 495-8881	6938 Wilcrest Dr	http://cajunkitchenhouston.com/
15	Captain Benny's Seafood	Houston	Y	4	(713) 643-0589	8253 Gulf Fwy	http://captbennys.com/
16	Captain Benny's Seafood	Houston	Y	4	(713) 666-5469	8506 S Main St	http://captbennys.com/
17	Captain Benny's Seafood	Stafford	Y	4	(281) 498-3909	12135 Murphy Rd	http://captbennys.com/
18	Captain Benny's Seafood	Houston	Y	4	(713) 680-1828	10896 Northwest Fwy	http://captbennys.com/
19	Captain Tom's Seafood & Oyster	Houston	Y	0	(713) 451-3700	13955 East Fwy	-
20	Caracol	Houston	Y	1	(713) 622-9996	2200 Post Oak Blvd	https://www.caracol.net/
21	Chilos Seafood & Oyster Bar	Houston	Y	No menu online	(713) 947-8700	1150 Edgebrook Dr	-
22	Christie's Seafood & Steaks	Houston	Y	2	(713) 978-6563	6029 Westheimer	http://www.christies-restaurant.com/
23	Clark's Oyster Bar	Houston	Y	1	(713) 347-8180	3807 Montrose Blvd	https://clarksoysterbar.com/houston/
24	Crafty Crab	Pearland	Y	1	(832) 856-1111	11104 Broadway St	https://www.craftycrabrestaurant.com/
25	Crafty Crab	Houston (FM 1960 Rd)	Y	1	(832) 680-1111	211 Cypress Creek Parkway Suite L	https://www.craftycrabrestaurant.com/
26	Crafty Crab	Houston (Fondren Rd)	Y	1	(713) 820-6888	11105 Fondren Rd	https://www.craftycrabrestaurant.com/
27	Crafty Crab	Houston (Jersey Village)	Y	1	(832) 856-5656	17460 Northwest Fwy	https://www.craftycrabrestaurant.com/
28	Crafty Crab	Houston (Westheimer Rd)	Y	1	(832) 810-3333	11328 Westheimer Rd	https://www.craftycrabrestaurant.com/
29	Drake's Hollywood	Houston	Y	Unsure		1100 Westheimer	https://www.drakeshollywood.com/
30	Drunken Oyster	Spring	Y	0	(832) 843-6196	7110 Louetta Rd Ste B	https://drunkenoyster.eat24hour.com/
31	Eddie V's Prime Seafood	Houston- West Ave	Y	4	(713) 874-1800	2800 Kirby Drive	https://www.eddiev.com/home
32	Eddie V's Prime Seafood	Houston- CityCentre	Y	4	(832) 200-2380	12848 Queensbury Lane	https://www.eddiev.com/home
33	Eugene's Gulf Coast Cuisine	Houston	Y	5	(713) 807-8889	1985 Welch Street	https://www.eugeneshouston.com/
34	Eunice	Houston	Y	2	(832) 491-1717	3737 Buffalo Speedway	https://www.eunicerestaurant.com/
35	Famous Crab	Houston	Y	3	(281) 484-2722	12130 Dickinson Rd	https://www.thefamouscrab.com/
36	Field & Tides	Houston	Y	1	(713) 861-6143	705 E 11th St	http://fieldandtides.com/
37	Fish City Grill	Pearland	Y	1	(713) 340-1493	11200 Broadway Suite 380	https://fishcitygrill.com/pearland/#pearland-menu
38	Fish City Grill	Sugarland	Y	1	(281) 494-3474	15980 City Walk	https://fishcitygrill.com/sugar-land/#sugarland-menu
39	Flora	Houston	Y	0	(713) 360-6477	3422 Allen Pkwy	https://www.florahouston.com/
40	Floyd's Cajun Seafood and Steakhouse	Sugar Land	Y	6	(281) 240-3474	16549 S W Freeway	http://floydsseafood.com/

RESTAURANT DATABASE
Houston Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Restaurant Phone #	Restaurant Address	Restaurant Website
			Raw (Y/N)	Cooked			
41	Floyd's Cajun Seafood and Steakhouse	Pearland	Y	6	(281) 993-8385	1300 E. Broadway	http://floydsseafood.com/
42	Flying Fish	Houston	Y	4	(713) 377-9919	1815 N. Durham	https://www.flyingfishinthe.net/
43	Frank's Americana Revival	Houston	Y	Unsure	(713) 572-8600	3736 Westheimer Road	https://www.frankshouston.com/
44	Georgia James	Houston	Y	1	(832) 241-5088	3503 W. Dallas	https://georgiajamessteak.com/
45	Good Vibes Coastal Kitchen	Pearland	Y	1	(832) 569-4141	1329 E. Broadway St.	https://goodvibesburgers.com/
46	Goode Company- Seafood	Houston- Westpark	Y	4	(713) 523-7154	2621 Westpark Drive	https://www.goodecompany.com/
47	Harold's	Houston- Heights	Y	1	(713) 360-6204	350 W. 19th St., Suite C	https://www.haroldsheights.com/
48	Hometown Seafood Company	Pearland	Y	4	(281) 416-5419	5010 Broadway St	https://htseafoodcompany.com/
49	Hudson House	Houston	Y	0	(832) 648-3210	1966 W Gray St	https://www.hudsonhousehp.com/location/river-oaks-tx-/
50	Hugos	Houston			(713) 524-7744	1600 Westheimer Rd	http://www.hugosrestaurant.net/
51	Julep	Houston	Y	Unsure	(832) 371-7715	1919 Washington Avenue	https://www.julephouston.com/
52	Kata Robata	Houston	Y	0	(713) 526-8858	3600 Kirby Suite H	https://www.katarobata.com/
53	LA Crawfish	Houston- Greenway	Y	3	(832) 767-1533	3957 Richmond Avenue	www.lacrawfish.com
54	LA Crawfish	Houston- Memorial	Y	3	(713) 461-8808	1005 Blalock Road, Inside 99 RanchMarket	www.lacrawfish.com
55	LA Crawfish	Houston- Langwood	Y	3	(832) 491-1121	6439 W 43rd Street	www.lacrawfish.com
56	LA Crawfish	Houston- Wallisville Rd & Beltway 8	Y	3	(281) 416-5352	5810 East Sam Houston Pkwy N	www.lacrawfish.com
57	LA Crawfish	Katy	Y	3	(346) 251-5902	569 S Mason Rd, Inside 99 Ranch Market	www.lacrawfish.com
58	LA Crawfish	Pearland	Y	3	(832) 781-4946	1910 Country Place, Ste 150	www.lacrawfish.com
59	LA Crawfish	Houston- Gulfgate	Y	3	(832) 804-6901	3331 Telephone Rd, Ste C	www.lacrawfish.com
60	LA Crawfish	Missouri City	Y	3	(281) 208-7759	3823 FM 1092 Rd	www.lacrawfish.com
61	La Lucha	Houston	Y	3	(713) 955-4765	1801 N. Shepherd Drive	laluchatx.com
62	Liberty Kitchen & Oysterette	Houston- River Oaks	Y	2	(713) 622-1010	4224 San Felipe St.	https://libertykitcheneats.com/
63	Liberty Kitchen & Oysterette	Houston- Memorial	Y	2	(713) 468-3745	963 Bunker Hill Rd.	https://libertykitcheneats.com/
64	Little's Oyster Bar	Houston	Y	Unsure	(713) 522-4595	3001 S. Shepherd	https://littlesoysterbar.com/
65	Loch Bar	Houston- River Oaks District	Y	5	(832) 430-6601	4444 Westheimer Road, Suite G110	https://lochbar.com/houston/
66	Low Tide Kitchen & Bar	Houston- Spring Branch	Y	2	(713) 360-6304	2030A Bingle Rd.	https://www.lowtidekitchenbar.com/
67	Mambo Seafood	Houston- 45S & Edgebrook	Y	0	(713) 946-0000	10402 Gulf Freeway	www.mamboseafood.com
68	Mambo Seafood	Houston- Gulfgate	Y	0	(281) 712-8298	6945 Gulf Fwy	www.mamboseafood.com
69	Mambo Seafood	Houston- 290 & Tidwell	Y	0	(713) 462-0777	13485 Northwest Freeway	www.mamboseafood.com
70	Mambo Seafood	Houston- 45N & West Rd	Y	0	(281) 820-3300	10810 North Freeway	www.mamboseafood.com
71	Mambo Seafood	Houston- Airline & Tidwell	Y	0	(713) 691-9700	6101 Airline Drive	www.mamboseafood.com
72	Mambo Seafood	Houston- Gessner & Long Point	Y	0	(713) 465-5009	10002 Long Point Drive	www.mamboseafood.com
73	Mambo Seafood	Houston- Hillcroft & Bellaire	Y	0	(713) 541-3666	6697 Hillcroft	www.mamboseafood.com
74	Mambo Seafood	Houston- I-10 & Federal	Y	0	(713) 637-0553	12333 East Freeway	www.mamboseafood.com
75	Mambo Seafood	Katy	Y	0	(832) 391-6644	20210 Katy Freeway	www.mamboseafood.com
76	Mannie's Seafood	Houston	Y	2	(713) 641-5003	8520 Gulf Fwy	-
77	Marcos Seafood & Oyster Bar	Houston	Y	0	(713) 946-1168	917 Edgebrook Dr	-
78	Mastro's Steakhouse	Houston	Y	1	(713) 993-2500	1650 W Loop S	https://www.mastrosrestaurants.com/Locations/TX/Houston/
79	McCormick & Schmick's Seafood & Steaks	Houston- Town & Country Village	Y	4	(713) 465-3685	791 Town and Country Blvd	https://www.mccormickandschmicks.com/
80	McCormick & Schmick's Seafood & Steaks	Houston- Uptown Park, Galleria	Y	4	(713) 840-7900	1151-01 Uptown Park Blvd	https://www.mccormickandschmicks.com/

RESTAURANT DATABASE
Houston Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Restaurant Phone #	Restaurant Address	Restaurant Website
			Raw (Y/N)	Cooked			
81	McCormick & Schmick's Seafood & Steaks	Houston- Downtown	Y	4	(713) 658-8100	1201 Fannin Street	https://www.mccormickandschmicks.com/
82	Musaafer	Houston	Y	1	(713) 242-8087	5115 Westheimer Rd, Suite 3500	https://www.musaaferhouston.com/
83	Nancy's Hustle	Houston	Y	Unsure	(346) 571–7931	2704 Polk Street	https://www.nancyshustle.com/
84	Navy Blue	Houston	Y	1	(713) 347-7727	2445 Times Boulevard	https://www.navybluerestaurant.com/
85	Orleans Seafood Kitchen	Katy	Y	1	(281) 646-0700	20940 Katy Freeway, Suite G	http://orleansseafoodkitchen.com/
86	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #11	Y	1	(713) 921-1800	5819 Gulf Fwy #900	https://www.ostioneriamichoacan.net/
87	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #1	Y	1	(281) 999-3995	11402 North Freeway	https://www.ostioneriamichoacan.net/
88	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #3	Y	1	(713) 330-4419	1006 Federal Road A	https://www.ostioneriamichoacan.net/
89	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #4	Y	1	(281) 447-5061	13433 Tomball Pkwy #16	https://www.ostioneriamichoacan.net/
90	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #5	Y	1	(713) 974-6828	5895 South Gessner	https://www.ostioneriamichoacan.net/
91	Ostioneria Michoacan Seafood and Oyster Bar	Woodlands- #6	Y	1	(281) 292-6811	25919 I-45 North, Ste A	https://www.ostioneriamichoacan.net/
92	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #7	Y	1	(713) 463-5410	1817 Wirt Rd.	https://www.ostioneriamichoacan.net/
93	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #8	Y	1	(281) 877-8855	15125 N. Freeway	https://www.ostioneriamichoacan.net/
94	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #15	Y	1	(281) 477-7697	10865 Jones Rd.	https://www.ostioneriamichoacan.net/
95	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #16	Y	1	(832) 672-4139	12810-B Gulf Freeway	https://www.ostioneriamichoacan.net/
96	Pappadeaux Seafood Kitchen	Houston- Hobby Airport	Y	1	(713) 847-7622	7800 Airport Boulevard	https://pappadeaux.com/home/
97	Pappadeaux Seafood Kitchen	Houston- Galleria	Y	1	(713) 782-6310	6015 Westheimer Rd.	https://pappadeaux.com/home/
98	Pappas Bros. Steakhouse	Houston- Galleria	Y	0	(713) 780-7352	5839 Westheimer Rd.	https://pappasbros.com/home/
99	Pappas Seafood House	Houston- Aldine Bender	Y	1	(281) 999-9928	11301 I-45 N.	https://pappasseafood.com/
100	Perry's Steakhouse & Grille	Houston- Champions	Y	0	(281) 970-5999	9730 Cypresswood Drive	https://perryssteakhouse.com/
101	Perry's Steakhouse & Grille	Katy	Y	0	(281) 347-3600	23501 Cinco Ranch Blvd q100	https://perryssteakhouse.com/
102	Perry's Steakhouse & Grille	Houston- Memorial City	Y	0	(832) 358-9000	9827 Katy Freeway	https://perryssteakhouse.com/
103	Perry's Steakhouse & Grille	Houston- River Oaks	Y	0	(346) 293-8400	1997 West Gray St.	https://perryssteakhouse.com/
104	Perry's Steakhouse & Grille	Sugar Land	Y	0	(281) 565-2727	2115 Town Square Place	https://perryssteakhouse.com/
105	Perry's Steakhouse & Grille	Woodlands	Y	0	(281) 362-0569	6700 Woodlands Parkway	https://perryssteakhouse.com/
106	Ragin' Cajun	Houston- The Original	Y	1	(713) 623-6321	4302 Richmond Ave	https://ragin-cajun.com/
107	Relish Restaurant & Bar	Houston	Y	1	(713) 599-1960	2810 Westheimer Rd.	https://www.relishhouston.com/
108	Riel	Houston	Y	1	(832) 831-9109	1927 Fairview St	https://www.rielhtx.com/
109	Sam's Boat	Pearland	Y	0	(713) 436-0201	3239 Silverlake Village Dr.	www.samsboat.com
110	Sam's Boat	Houston	Y	0	(713) 781-2628	5720 Richmond Avenue	www.samsboat.com
111	State of Grace	Houston	Y	1	(832) 942-5080	3258 Westheimer Road	http://stateofgracetx.com/
112	Steak 48	Houston	Y	0	(713) 322-7448	4444 Westheimer Road	steak48.com
113	The Annie Café & Bar	Houston	Y	0	(713) 804-1800	1800 Post Oak Boulevard, Suite 6170	https://www.theanniehouston.com/
114	The Chalet at Rosie Cannonball	Houston	Y	0	(832) 380-2471	1620 Westheimer Rd	https://www.rosiecannonball.com/
115	The Crawfish Pot & Oyster Bar	Houston	Y	2	(713) 360-6547	9820 Gulf Fwy #7	https://thecrawfishpotoysterbar.netwaiter.com/houston/about/
116	The Oceanaire	Houston	Y	1	(832) 487-8862	5061 Westheimer Road, Suite 8050	https://www.theoceanaire.com/location/houston-tx/
117	The Original Ninfa's	Houston- Navigation	Y	1	(713) 228-1175	2704 Navigation Blvd.	https://ninfas.com/
118	The Original Ninfa's	Houston- Uptown	Y	1	(346) 335-2404	1700 Post Oak Blvd. #1-190	https://ninfas.com/
119	The Pearl Restaurant & Bar at The Sam Houston Hotel	Houston	Y	3	(832) 200-8817	1117 Prairie St	https://www.pearlrestauranthouston.com/
120	The Rouxpour	Sugarland	Y	4	(281) 240-7689	2298 Texas Drive	www.therouxpour.com

RESTAURANT DATABASE
Houston Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Restaurant Phone #	Restaurant Address	Restaurant Website
			Raw (Y/N)	Cooked			
121	The Rouxpour	Katy	Y	4	(281) 394-5013	2643 Commercial Center Blvd Building A300	www.therouxpour.com
122	The Rustic	Houston	Y	2	(832) 321-7775	1121 Uptown Park Blvd. Suite 4	https://therustic.com/
123	Tiny Champions	Houston	Y	0	(713) 485-5329	2617 McKinney St.	https://www.tinychampionshouston.com/
124	Tobiuo Sushi & Bar	Katy	Y	1	(281) 394-7156	23501 Cinco Ranch Blvd Suite H130	https://www.tobiuosushibar.com/
125	Toulouse	Houston	Y	1	(713) 871-0768	4444 Westheimer Rd Ste 100	toulousecafeandbar.com
126	Traveler's Table	Houston	Y	3	(832) 409-5785	520 Westheimer Road	https://travelerstable.com/
127	Truluck's Seafood Steak & Crab House	Houston	Y	1	(713) 783-7270	5350 Westheimer Rd	https://trulucks.com/
128	Truluck's Seafood Steak & Crab House	Woodlands	Y	1	(281) 465--7000	1900 Hughes Landing Blvd, Suite 600	https://trulucks.com/
129	Turner's	Houston	Y	1	(713) 804-1212	1800 Post Oak Blvd.	https://www.turnershouston.com/
130	Weights + Measures	Houston	Y	1	(713) 654-1970	2808 Caroline	https://www.weights-measures.com/
131	Willie G's	Houston	Y	8	(713) 840-7190	1640 West Loop South	https://www.williegs.com/postoak/menus.asp
132	Winnie's	Houston	Y	1	(713) 520-0660	3622 Main St, Suite A	https://www.winnieshouston.com/
133	Uchi	Houston	Y	2	(713) 522-4808	904 Westheimer Road, Suite A	https://uchi.uchirestaurants.com/location/houston/
134	Uchiko	Houston	Y	0	(713) 522-4808	1801 Post Oak Blvd, Suite 110	https://uchiko.uchirestaurants.com/
135	Xochi	Houston	Y	1	(713) 400-3330	1777 Walker Street, Suite A	https://www.xochihouston.com/

LEGEND
Current Partner
Priority for Shell Recycling
Contact for Houston Oyster Festival
Low Priority

APPENDIX F

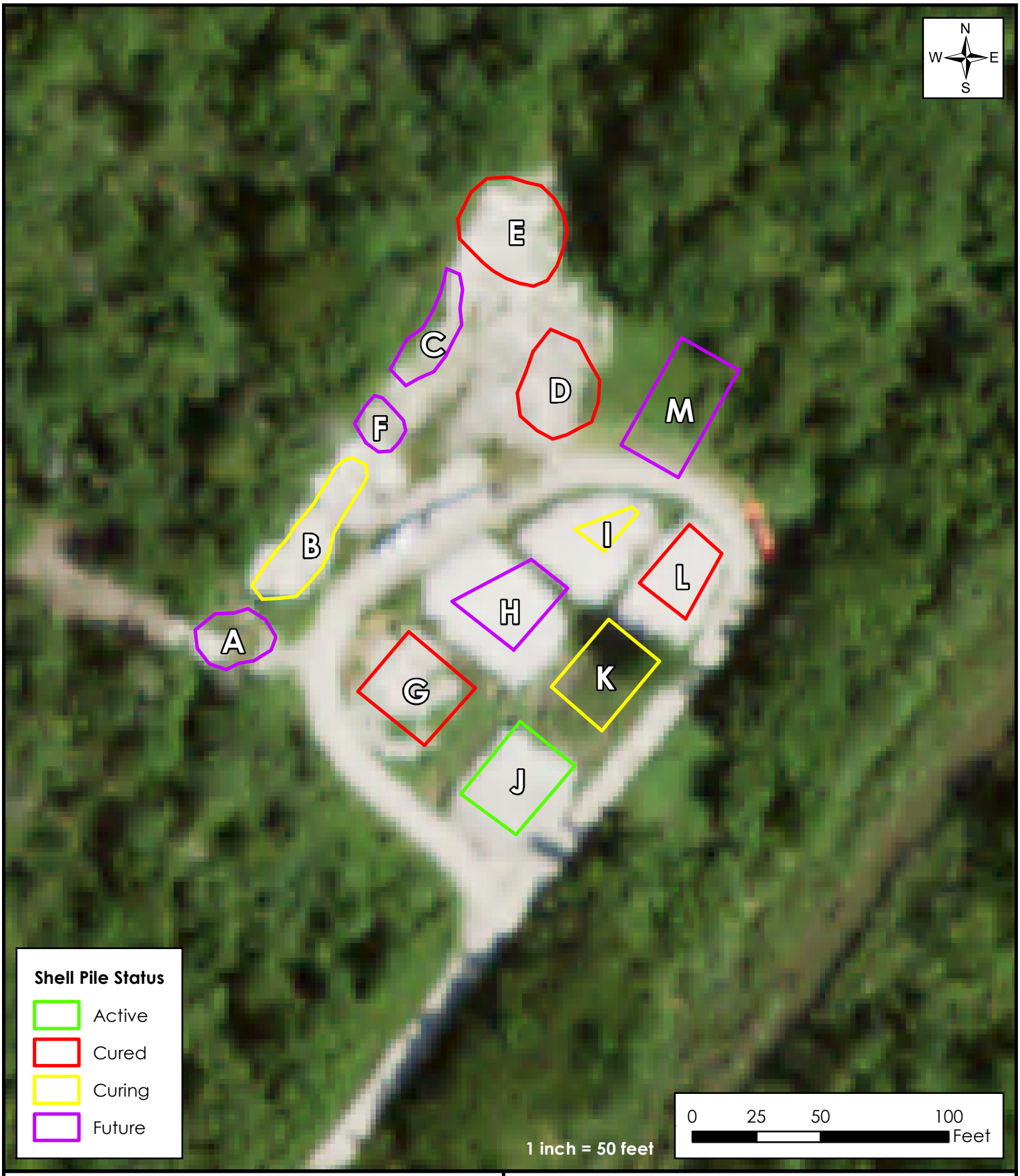
Curing Site Capacity

Texas City Shell Pile Layout

Project Name: Oyster Shell Recycling Program	
Project Location: Texas City Curing Site, Galveston County, TX	
Image Source: ESRI World Imagery	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 5/10/2022	Drawn by: S. Batte

GALVESTON BAY FOUNDATION

1725 Highway 146, Kemah, TX; (281) 332-3381



Red Bluff Shell Pile Layout

Project Name: Oyster Shell Recycling Program (OSRP)	
Project Location: Red Bluff Curing Site, Harris County, TX	
Image Source: 2022 NAIP NC 60cm, Harris Co.	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 3/8/2024	Drawn by: H. Leija

GALVESTON BAY FOUNDATION

1725 Highway 146, Kemah, TX; (281) 332-3381

MOODY GARDENS SHELL PILE LAYOUT

Project Name: Oyster Shell Recycling Program (OSRP)	
Project Location: Moody Gardens, Galveston County, TX	
Image Source: 2022 NAIP NC 60cm, Galveston Co.	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 11/29/2023	Drawn by: H.Leija

GALVESTON BAY FOUNDATION

1725 Highway 146, Kemah, TX; (281) 332-3381

APPENDIX G

Sun Curing Protocol

GALVESTON BAY FOUNDATION

Sun Curing Protocol for Recycled Oyster Shell

Prepared by the Galveston Bay Foundation's Oyster Shell Recycling Team:
Shannon Batte, Haille Leija, and Michael Niebuhr

May 2020

1725 Highway 146, Kemah, TX 77565 • Phone 281-332-3381 • Fax 832-284-4982

Table of Contents

Disclaimer

This protocol was developed in May 2020 to provide guidance for the Galveston Bay Foundation's Oyster Shell Recycling Program. The Texas Parks and Wildlife Department recommended the Foundation use best management practices for ensuring only clean, dry shell be placed in Galveston Bay for restoration purposes. More specifically, the Texas Parks and Wildlife Department stated that a minimum timeframe of 6 months of land-based sun curing should be implemented for all recycled oyster shell collected by the Foundation. This recommendation is based on the study conducted by Bushek et al in 2004, with the goal of providing high quality, clean substrate for spat settlement without spreading pathogens from the former inhabitant of that shell.

The proposed practices included in this document are based on the experiences of the Foundation's staff in oyster shell recycling operations since 2011. While the Bushek et al (2004) study was used as an initial reference for this protocol, additional research is needed to confirm ideal sun curing specifications in the state of Texas. These specifications include, but are not limited to, the curing timeframe, shell pile height, shell pile buffer width, and the frequency of turning the shell piles to ensure maximum sun exposure during the specified sun curing timeframe.

I) SUN CURING PROCESS

Phase 1 - Active Collection

- Collect fresh oyster shell and place the shell at a designated curing site
- Document each placement of shell accordingly (refer to Table 1)
    - Documentation should include:
        - Date
        - Source of the shell (e.g. restaurant name, dealer's name, etc.)
        - Amount of fresh shell placed on that date (pounds, tons, and/or cubic yards)
        - Curing site name
        - Pile location
        - Pile rotation
- Place shell no more than 18 inches high during active collection
- Maintain, at minimum, a 10-foot buffer between shell piles
- Continue to collect and place shell in this manner until an adequate amount of shell is generated for a given project, the shell encroaches on the 10-foot buffer, or the shell pile exceeds the 18-inch height limit
- Shell in this condition, active collection and placement of fresh shell, is designated as "Active"

Phase 2 - Curing

- After placement of fresh shell ceases in a select pile, the curing timeline begins
- No additional fresh shell may be added to this pile upon the start of Phase 2
- A minimum of 6 months of sun exposure is required for proper curing
    - Curing time does not accrue during active collection and placement (Phase 1)
    - If the curing phase occurs during the wet season or during extreme weather conditions (e.g. hurricanes, floods, freezing temperatures), additional weeks or months of curing time may be required
- Shell must be turned (i.e. rotated and piled with a tractor or skid steer) at least once during the curing phase
    - Ensure the turned shell is piled in the designated curing pile location and does not encroach on the 10-foot buffer of any adjacent shell piles
    - Document the date each time a shell pile is turned (refer to Table 2)
    - Do not pile the shell higher than 6 feet
- Shell in this condition is designated as "Curing" and no new, fresh shell should be added

Phase 3 - Cured

- Upon completion of Phase 2, the shell pile is considered fully cured
- The cured shell may be strategically piled to save space and allow for easier access as needed
- Ensure a 10-foot buffer is maintained between the fully cured shell and all other "Active" and "Curing" shell piles
- Shell in this condition is designated as "Cured" and ready to be used as cultch material in reef restoration efforts
- Document all cured shell transported off the curing site (refer to Table 3)

II) RECOMMENDATIONS

- Curing sites should not be located directly adjacent to any waterbodies or drainage features that flow into waterbodies, in order to avoid contamination from uncured shell.

- Curing sites should not be located directly adjacent to residential communities to avoid nuisance odors and conflicts.

- Ideal locations for a curing site include, but are not limited to, construction yards, undeveloped property in industrial/commercial areas, and preserves such as the Galveston Bay Foundation's Texas City Preserve.

- If cattle or other livestock share the curing site property, ensure the shell curing area is properly fenced to avoid contamination of the shell.

- Maintain a map and/or chart to differentiate and track the status of each individual shell pile at the curing site (refer to figure 7 and 8). This map or chart should correlate with the documentation referred to in the table templates below (Table 1, 2, and 3) and should be updated quarterly at a minimum.

- Install signage at each shell pile, labeled with the appropriate shell "pile location" identification (e.g. A, B, C, etc.) to ensure proper documentation.

- To assist with sun bleaching, keep fresh shell spread out during the collection process, Phase 1, and at a maximum height of 18 inches.

- To avoid cross-contamination between cured and uncured shell, all shell piles should be separated by at least 10 feet.

- All shell piles should be turned at least once during the 6-month curing timeframe (Phase 2) to ensure maximum exposure of the shells to sunlight. A tractor or skid steer with a front-end loader is recommended to turn the shell.

- It is recommended that shell turning be conducted quarterly if feasible, weather and site conditions permitting.

- When turning shell in Phase 2, it is recommended that the shell pile height does not exceed 6 feet to allow for adequate exposure to the air and sun.

III) PHOTOGRAPHS

Figure 1. Galveston Bay Foundation's Texas City Curing Site
**please note, these piles do not represent the required 10ft buffer; these shell piles are all fully cured and consolidated to conserve space at the curing site*

Figure 2. Galveston Bay Foundation's Red Bluff Curing Site

Figure 3. Fresh oyster shell placement at Galveston Bay Foundation's Red Bluff Curing Site (Phase 1)

Figure 4. Fresh oyster shell spread out upon placement (Phase 1)

Figure 5. Turning a shell pile during the curing stage (Phase 2)

Figure 6. Consolidating a cured shell pile (Phase 3)

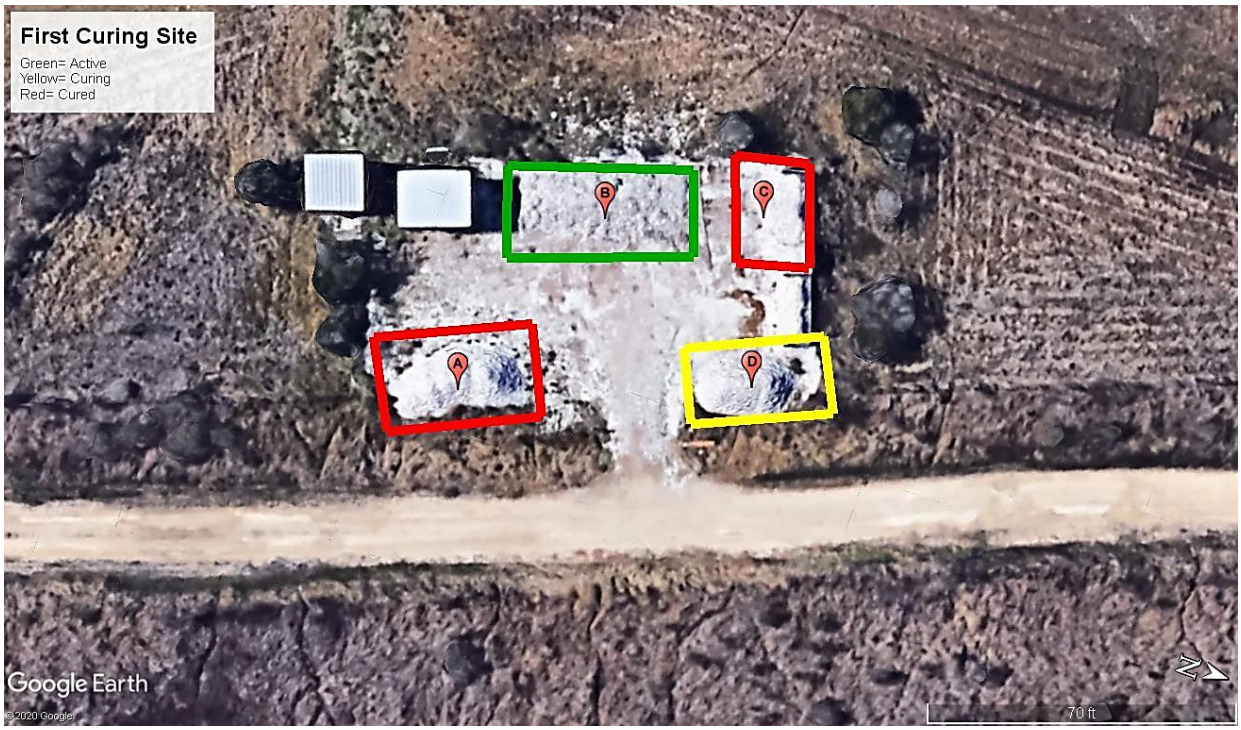


Figure 7. Galveston Bay Foundation's Texas City Curing Site shell pile locations and status

Figure 8. Galveston Bay Foundation's Red Bluff Curing Site shell pile locations and status

IV) TABLE TEMPLATES

Table 1. Incoming Shell Documentation

Collection Date	Source of Shell	Pounds of Shell	Tons of Shell	Cubic Yards of Shell	Curing Site ID/Name	Shell Pile Location	Shell Pile Rotation	Data Entered by

Table 2. Shell Pile Documentation

Curing Site ID/Name	Shell Pile Location	Shell Pile Rotation	Curing Start Date*	Turn Date 1	Turn Date 2	Turn Date 3	Turn Date 4	Curing Complete Date**

**Start of Phase 2; **End of Phase 2*

Table 3. Outgoing Shell Documentation

Transport Date	Curing Site ID/Name	Shell Pile Location	Shell Pile Rotation	Pounds of Shell	Tons of Shell	Cubic Yards of Shell	Project Name/ Shell Destination

V) GLOSSARY

Active	Shell pile designation indicating the placement of fresh shell is ongoing at that location; a shell pile will remain "active" until fresh shell placement is concluded at the specific pile location
Cured	Shell pile designation indicating the oyster shell has been sun bleached for a minimum of 6 months since fresh shell was last placed at that location; "cured" oyster shell is considered fully quarantined and ready to be returned to a waterbody as cultch material
Curing	Shell pile designation indicating the oyster shell is in the process of sun bleaching and the introduction of fresh shell has ceased at that location; the "curing" stage should be a minimum of 6 months and include the rotation of the shell pile at least once
Curing Site	An upland location where recycled oyster shell is stockpiled and quarantined (sun bleached) in preparation for use as cultch material in reef restoration
Fresh Shell	Oyster shell recently collected from restaurants, commercial dealers, or by other means; recycled oyster shell that has not been cured (sun bleached)
Pile Location	The specific location of a pile of recycled oyster shell at a curing site; each pile location should be assigned a letter (e.g. A, B, C, etc.) to differentiate multiple shell piles at one curing site
Pile Rotation	A number assigned to each new mound of shell at a specific pile location; a single "rotation" captures the life of a shell pile from active collection through the cured state when it is hauled off site to be used as cultch (Phases 1 through 3); a rotation begins when fresh shell is first placed at a curing site and ends when that entire pile of cured shell is transported offsite
Shell Pile	An individual mound of recycled oyster shell placed at a specific curing site; each shell pile should be identified by its location and rotation (e.g. A-1)
Sun bleaching	The process of exposing fresh oyster shell to natural sunlight and weathering to eliminate pathogens, grease, and any other foreign substance on the shell including the presence of any invasive species

VI) REFERENCES

Brumbaugh, R.D., M.W. Beck, L.D. Coen, L. Craig and P. Hicks. 2006. A Practitioner's Guide to the Design and Monitoring of Shellfish Restoration Projects: An Ecosystem Services Approach. The Nature Conservancy, Arlington, VA.

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APPENDIX H

Restaurant Materials

Waste Hauling Cost Estimates
(February 2024)

Company	Dumpster Size	City	Frequency of Pickup	Cost/Month	Landfill	Additional Fees
Waste Management 713-686-6666	6 yard (6'Lx6'Wx5'H) Max weight: 1200 pounds	Houston (77058)	Does not service this area			
	6 yard (6'Lx6'Wx5'H) Max weight: 1200 pounds	Seabrook (77586)	Once a week	$119.45 plus tax	Baytown Landfill 4791 Tri City Beach Rd Baytown, TX 77520	$26.00 plus tax/month for lock $25.00 plus tax/month for gate/ enclosure services
			Twice a week	$212.45 plus tax		
			Three times a week	$305.44 plus tax		
	6 yard (6'Lx6'Wx5'H) Max weight: 1200 pounds	Galveston (77550)	Once a week	$232.76 plus tax	Coastal Plains Landfill 21000 E Highway 6 Alvin, TX 77511	$26.00 plus tax/month for lock $25.00 plus tax/month for gate/ enclosure services
			Twice a week	$438.75 plus tax		
			Three times a week	$644.77 plus tax		
	8 yard (6'Lx6'Wx6'8"H) Max weight: 1600 pounds	Houston (77058)	Does not service this area			
	8 yard (6'Lx6'Wx6'8"H) Max weight: 1600 pounds	Seabrook (77586)	Once a week	$134.81 plus tax	Baytown Landfill 4791 Tri City Beach Rd Baytown, TX 77520	$26.00 plus tax/month for lock $25.00 plus tax/month for gate/ enclosure services
			Twice a week	$240.97 plus tax		
			Three times a week	$347.12 plus tax		
	8 yard (6'Lx6'Wx6'8"H) Max weight: 1600 pounds	Galveston (77550)	Once a week	$266.40 plus tax	Coastal Plains Landfill 21000 E Highway 6 Alvin, TX 77511	$26.00 plus tax/month for lock $25.00 plus tax/month for gate/ enclosure services
			Twice a week	$503.83 plus tax		
			Three times a week	$741.23 plus tax		
Republic Services 713-849-0400	6 yard (6'Lx6'Wx5'H) Max weight: 1200 pounds	Houston (77058)	Once a week	$154.31 plus tax	Galveston County Landfill 3935 Avenue A Santa Fe, TX 77510	One time installation fee of $120.97 plus tax $10.78 plus tax/month for lock
			Twice a week	$270.70 plus tax		
			Three times a week	Service not offered		
	6 yard (6'Lx6'Wx5'H) Max weight: 1200 pounds	Seabrook (77586)	Does not service this area			
	6 yard (6'Lx6'Wx5'H) Max weight: 1200 pounds	Galveston (77550)	Once a week	$151.18 plus tax	Galveston County Landfill 3935 Avenue A Santa Fe, TX 77510	One time installation fee of $120.97 plus tax $10.78 plus tax/month for lock
			Twice a week	$264.10 plus tax		
			Three times a week	Service not offered		
	8 yard (6'Lx6'Wx6'8"H) Max weight: 1600 pounds	Houston (77058)	Once a week	$169.60 plus tax	Galveston County Landfill 3935 Avenue A Santa Fe, TX 77510	One time installation fee of $120.97 plus tax $10.78 plus tax/month for lock
			Twice a week	$297.45 plus tax		
			Three times a week	Service not offered		
	8 yard (6'Lx6'Wx6'8"H) Max weight: 1600 pounds	Seabrook (77586)	Does not service this area			
	8 yard (6'Lx6'Wx6'8"H) Max weight: 1600 pounds	Galveston (77550)	Once a week	$165.43 plus tax	Galveston County Landfill 3935 Avenue A Santa Fe, TX 77510	One time installation fee of $120.97 plus tax $10.78 plus tax/month for lock
			Twice a week	$288.76 plus tax		
			Three times a week	Service not offered		

GALVESTON BAY FOUNDATION

In-Kind Donation
Reply Form

Donor information:

First Name _____ M.I. _____ Last Name _____

Donor Title _____

Organization or Company Name _____ Phone _____ Fax _____

Address, Street _____ City _____ State _____ Zip _____

Donation information:

Recycled Oyster Shell
Items/Services Donated

Quantity (if applicable)

CLAIMED VALUE OF DONATION: $ ____(2023 Value $60/CY)

The Galveston Bay Foundation is a 501(c)(3) organization, tax ID # 76-0279876. The information above is needed for our internal recording keeping.

Donor Signature _____ Date _____

OYSTER SHELL
RECYCLING PROGRAM
A GALVESTON BAY FOUNDATION PROGRAM

Outreach & Marketing Options for Active Restaurant Partners

OYSTER SHELL RECYCLING PROGRAM

The Galveston Bay Foundation has designed seven options for public outreach and marketing of the Oyster Shell Recycling Program in participating restaurants. These materials will recognize the efforts of the restaurants contributing to the Oyster Shell Recycling Program in addition to providing educational information about oyster reef restoration to restaurant patrons.

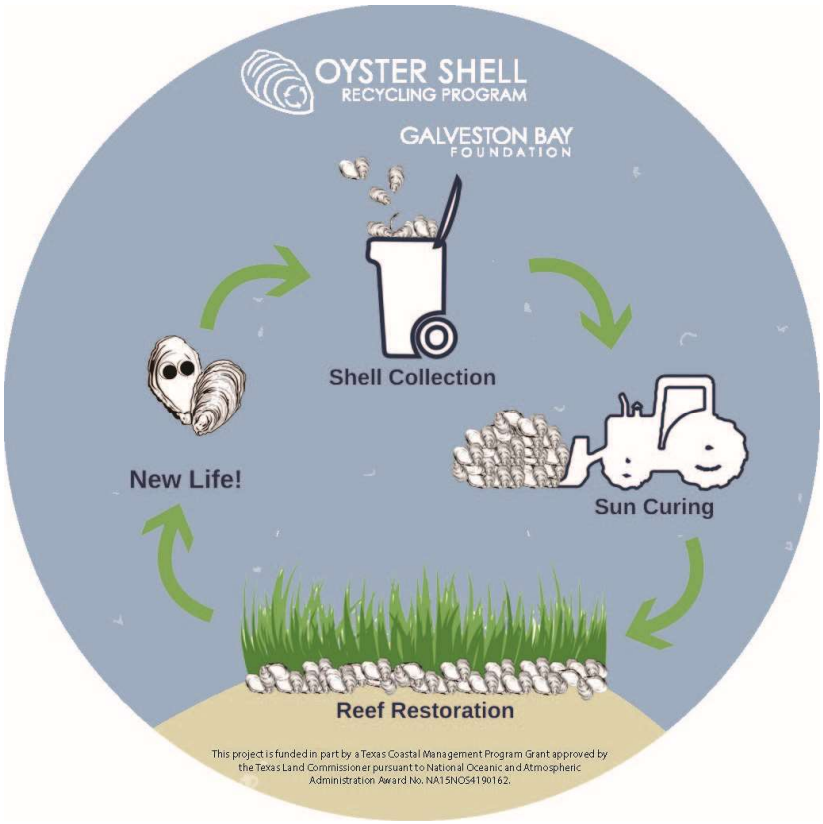
Outreach Options	Estimated Cost	Dimensions
Coasters	$369/1000	3.7” diameter round
Insert for Check Presenter	$182/500	3.75” x 8.75”
Menu Recognition	$0 (GBF will provide logo; restaurant may incur printing costs)	Menu Specific
Menu Callouts		
Table Tent	$150/250	3” x 5”
Table Tent	$178/250	4” x 4”
Window Cling	$80/10	3” x 6”
Rack Card	$200/500	4” x 9”

prices are quoted estimates, and actual costs may vary; updated March 2021

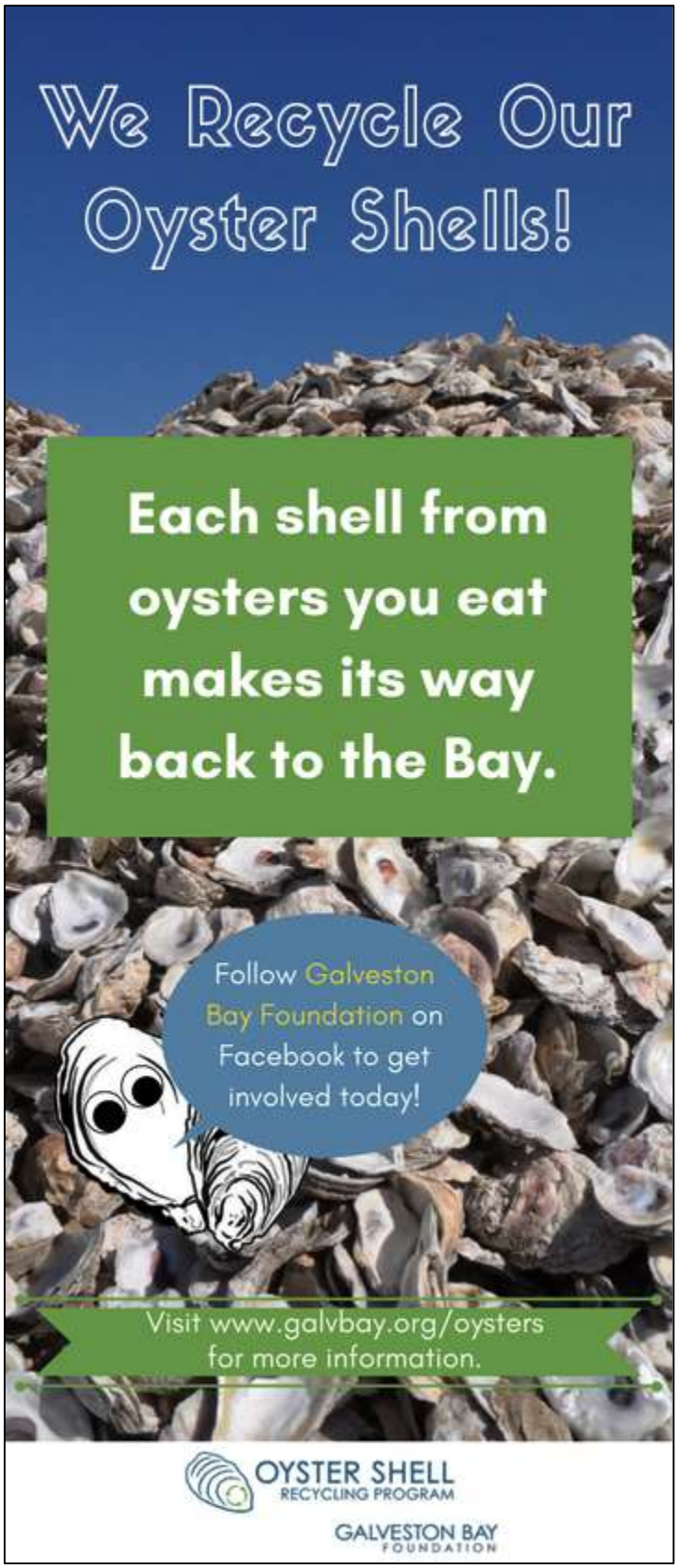
GALVESTON BAY FOUNDATION

COASTER

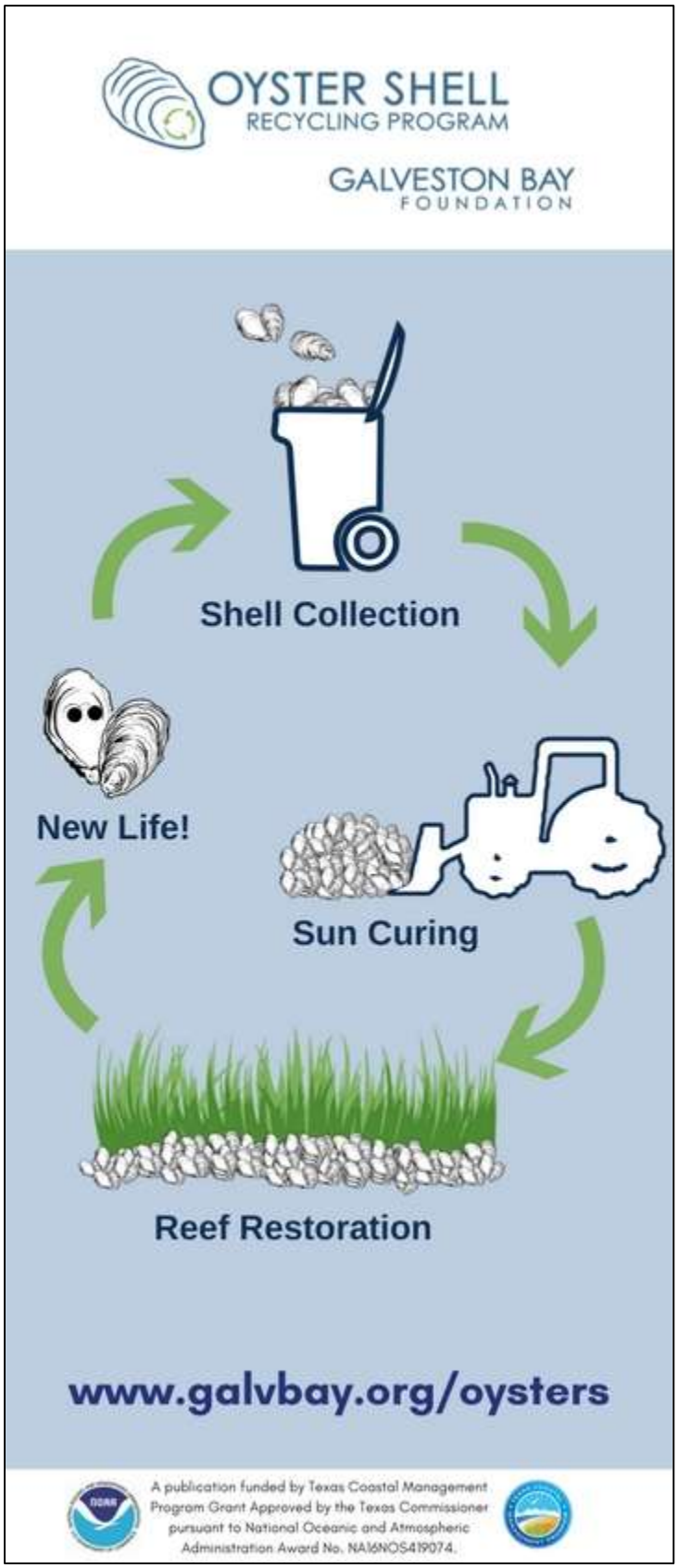

We recycle our oyster shells.
Eat your way to a healthier Galveston Bay!
www.galvbay.org/oysters
OYSTER SHELL
RECYCLING PROGRAM
GALVESTON BAY
FOUNDATION


OYSTER SHELL
RECYCLING PROGRAM
GALVESTON BAY
FOUNDATION
Shell Collection
Sun Curing
Reef Restoration
New Life!
This project is funded in part by a Texas Coastal Management Program Grant approved by the Texas Land Commissioner pursuant to National Oceanic and Atmospheric Administration Award No. NA15NOS4190162.

INSERT FOR CHECK PRESENTER - *FRONT*



INSERT FOR CHECK PRESENTER – *BACK*



MENU RECOGNITION

MENU CALLOUTS

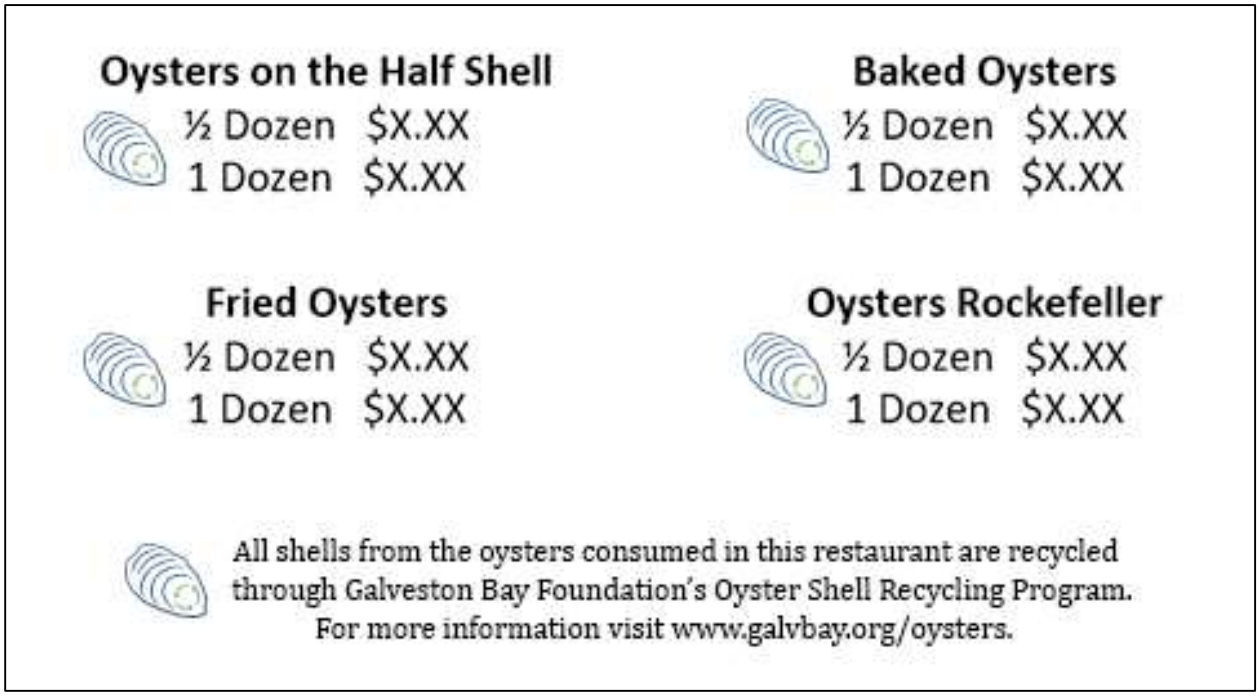
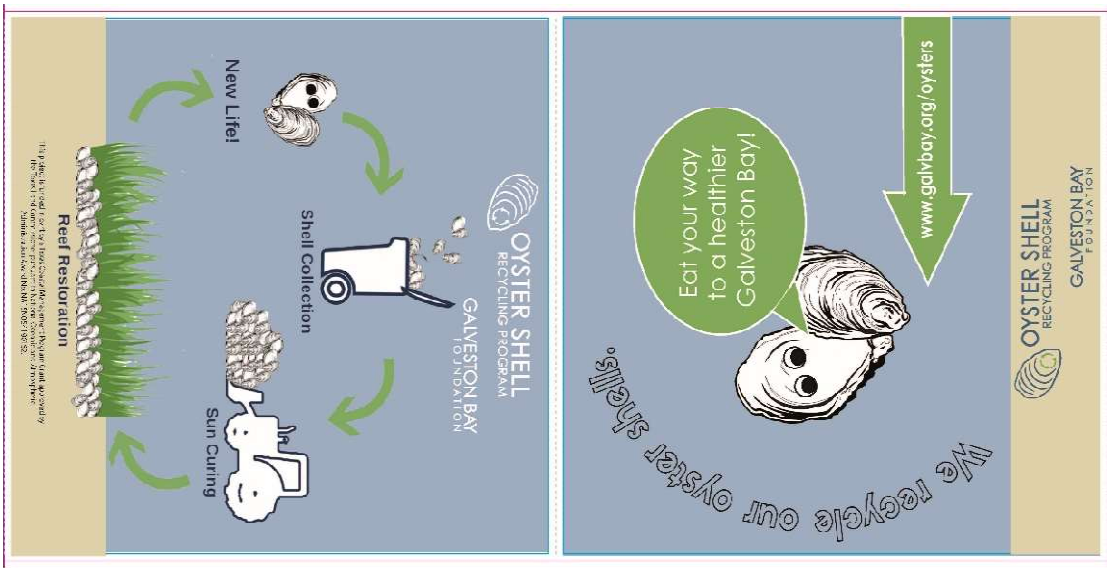


TABLE TENT



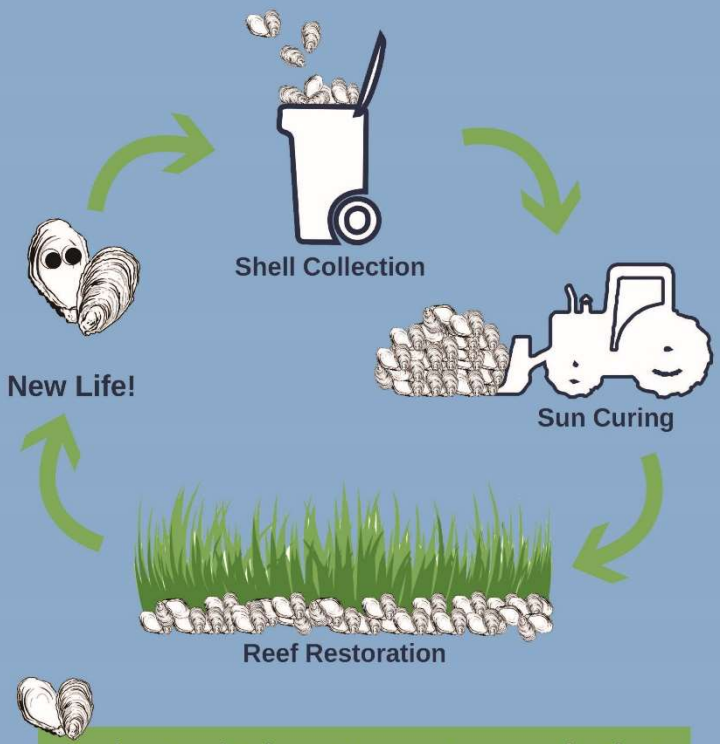
WINDOW CLING

RACK CARD - *FRONT*

OYSTER SHELL RECYCLING PROGRAM

GALVESTON BAY FOUNDATION

Galveston Bay Foundation partners with local restaurants to collect shucked oyster shells after patrons enjoy a tasty meal. The empty oyster shells are sun bleached for a minimum of 6 months to rid them of bacteria. The shells are then returned to Galveston Bay to provide new homes for baby oysters.



Find out which restaurants recycle their shells at **www.galvbay.org/oysters** and eat your way to a healthier Bay!

RACK CARD – *BACK*

WHY ARE OYSTERS SO IMPORTANT?

- Oysters clean the water
- Oyster reefs create homes for fish, shrimp, crabs, and many other species
- Oyster reefs help protect the shoreline
- Oysters are food for people, birds, & crabs

WHY RECYCLE OYSTER SHELLS?

Oyster larvae need a hard surface on which to attach so that they may begin to grow. While baby oysters can attach to just about anything, they prefer other oyster shells!

Galveston Bay lost more than 50 percent of its oyster reefs as a result of Hurricane Ike. To help restore the Bay's oyster population, keep our water clean, and provide habitat for aquatic life, Galveston Bay Foundation returns all recycled oyster shells to the Bay through Volunteer Oyster Gardening efforts and Oyster Restoration Workdays.

Interested in becoming an Oyster Program
Volunteer? Sponsor? Partner?
Call 281-332-3381 or email info@galvbay.org

This project funded, in part, by a Texas Coastal Management Program grant approved by the Texas Land Commissioner pursuant to the National Oceanic and Atmospheric Administration Award No. NA18NOS4190153

APPENDIX I

Database of Oyster Shell Recycling Programs in the United States

Database of Oyster Shell Recycling Programs in the United States

No.	State	Organization	Name of Program	Start Date	Equipment	Labor	Public Drop-Off Site	Website
1	Alabama	Alabama Coastal Foundation	Oyster Shell Recycling Program	2016	Dump Truck (vendor)	Contract	No	joinacf.org/oyster-shell-recycling-program
2	California	Earth Island Institute	Wild Oyster Project Oyster Shell Recycling	2018	Unknown	Unknown	Unknown	https://wildoysters.org/theprograms/oyster-shells-recycling
3	Connecticut	Connecticut Sea Grant	Connecticut Shell Recycling	2023	Unknown	Unknown	Unknown	https://seagrant.uconn.edu/2023/03/28/shell-recycling-initiative-being-introduced-in-connecticut/
4	Delaware	Delaware Center for the Inland Bays	Don't Chuck Your Shucks	2014	Truck with Lift Gate	Staff	No	inlandbays.org/projects-and-issues/all/dont-chuck-your-shucks
5	Delaware	Partnership for the Delaware Estuary	Delaware Estuary Shell Recycling Program	2016	Truck with Lift Gate	Staff	No	delawareestuary.org/science-and-research/oysters
6	Florida	Marine Discovery Center	Shuck & Share (organized the program)	2014	Truck (vol.) & Box Truck (vendor)	Volunteers & Vendor	No	https://marinediscoverycenter.org/conservation/oyster-recycling/
7	Florida	Brevard Zoo	Restore Our Shores Part of Shuck & Share	2014	Unknown	Unknown	No	restoreourshores.org/shuck-and-share
8	Florida	Coastal Connections, Inc.	Part of Shuck & Share	2019	Personal Vehicle	Volunteers	No	www.coastal-connections.org
9	Florida	Friends of Gamble Rogers State Park	Part of Shuck & Share	Unknown	Unknown	Volunteers	No	https://www.frogrs.com/shuck-and-share
10	Florida	Fishcreek Glampground	Part of Shuck & Share	Unknown	Unknown	Volunteers	No	https://www.fishcreekglampground.com/glampground-1

Database of Oyster Shell Recycling Programs in the United States

No.	State	Organization	Name of Program	Start Date	Equipment	Labor	Public Drop-Off Site	Website
11	Florida	Florida Oceanographic Society	Florida Oceanographic Oyster Restoration (FLOOR) Part of Shuck & Share	2014	Unknown	Unknown	No	www.floridaocean.org/floor
12	Florida	Guana Tolomato Matanzas National Estuarine Research Reserve	Oyster Shell Recycling Program Part of Shuck & Share	2012	Truck & Trailer	Staff & Volunteers	No	gtmnerr.org/stewardship/aquatic-resource-management
13	Florida	University of Central Florida	Part of Shuck & Share	2017	Unknown	Restaurants	No	www.cs.ucf.edu/ux/shuck-and-share
14	Florida	Choctawhatchee Basin Alliance	Offer Your Shell to Enhance Restoration (OYSTER)	2010	Truck & Trailer	Staff	No	https://www.facebook.com/choctawhatcheebasinalliance
15	Florida	Keep Pensacola Beautiful	Offer Your Shell to Enhance Restoration (OYSTER)	2011	Truck & Trailer	Staff & Volunteers	No	https://www.keeppensacolabeautiful.org/oyster-shell-recycling/
16	Florida	START Partnership (Chiles Hospitality, the Manatee County Department of Natural Resources, the Gulf Shellfish Institute and University of Florida IFAS/Sea Grant)	Gulf Coast Oyster Recycling and Renewal (GCORR) Shuck 'N Save	2017	Vendor	Contract	No	https://start1.org/gulf-coast-oyster-recycling-renewal-gcorr-program/
17	Florida	Tampa Bay Watch	Shells for Shorelines Oyster Shell Recycling Program	2023	Truck & Trailer	Staff & Volunteers	No	https://tampabaywatch.org/shells-for-shorelines/
18	Louisiana	Coalition to Restore Coastal Louisiana (CRCL)	Oyster Shell Recycling Program	2014	Truck & Trailer (vendor)	Contract	No	crcl.org/oyster-shell-recycling
19	Maryland	Oyster Recovery Partnership	Shell Recycling Alliance (Oyster Shell Recycling Program)	2010	Box Truck (no vendor)	Staff & Volunteers	Yes	https://www.oysterrecovery.org/get-involved/shell-recycling
20	Maryland	MGM Resorts	Oyster Shell Recycling	Unknown	Dump Truck (vendor)	Contract	No	https://www.mgmresorts.com/en/company/esg/protecting-the-planet/materials-and-waste.html

Database of Oyster Shell Recycling Programs in the United States

No.	State	Organization	Name of Program	Start Date	Equipment	Labor	Public Drop-Off Site	Website
21	Mass.	Wellfleet SPAT (Shellfish Promotion and Tasting, Inc.)	Shell Recycling Program	2009	Dump Truck (vendor)	Volunteers	No	wellfleetspat.org
22	Mass.	Town and County of Nantucket Natural Resources	Nantucket Oyster Recycling Program	2014	Truck with Lift Gate	Staff	No	https://nantucket-ma.gov/1425/Shell-Recycling-Program
23	Mass.	Massachusetts Oyster Project	Massachusetts Oyster Project Shell Recycling	2021	Truck	Staff	No	https://massoyster.org/shell-recycling
24	Mississippi	The Nature Conservancy	Oyster Shell Recycling Program Save our Shells (SOS)	2023	Truck	Staff	No	https://www.nature.org/en-us/about-us/where-we-work/united-states/mississippi/stories-in-mississippi/save-our-shells-mississippi/
25	New Hampshire	Coastal Conservation Association of New Hampshire	Great Bay Oyster Shell Recycling Program	2009	Truck & Trailer	Volunteers	No	ccanh.org/oyster-shell-recycling-program
26	New Jersey	American Littoral Society	Shuck It, Don't Chuck It	2016	Truck	Staff	No	littoralsociety.org/operation-oyster
27	New Jersey	NJ Division of Fish and Wildlife Marine Resources Administration	New Jersey Shell Recycling Program	2019	Truck & Dump Trailer	Staff	No	https://dep.nj.gov/njfw/fishing/marine/shell-recycling-program/
28	New York	New York Harbor School OR Billion Oyster Project	Billion Oyster Project Shell Collection	2014	Box Truck (vendor)	Contract	Yes	billionoysterproject.org
29	New York	Seatuck Environmental Association	Half Shells for Habitat	2018	Truck and Trailer	Staff	No	https://seatuck.org/half-shells/
30	North Carolina	North Carolina Division of Marine Fisheries	Oyster Shell Recycling Program	2003	Public Recycling Station	Volunteers	Yes	https://www.nccoast.org/oysters/recycle-oyster-shells/

Database of Oyster Shell Recycling Programs in the United States

No.	State	Organization	Name of Program	Start Date	Equipment	Labor	Public Drop-Off Site	Website
31	South Carolina	South Carolina Department of Natural Resources	South Carolina Oyster Restoration and Enhancement (SCORE) Program	2000	Truck & Dump Trailer	Staff	Yes	score.dnr.sc.gov
32	Texas	TAMU Corpus Christi Harte Research Institute	Sink Your Shucks	2009	Truck & Trailer & Dump Trailer	Students & University Staff	No	https://www.harteresearch.org/oysterrecycling
33	Texas	Galveston Bay Foundation	Oyster Shell Recycling Program	2011	Truck & Trailer Dump Truck	Staff	No	galvbay.org/oysters
34	Virginia	Lynnhaven River NOW	Save Oyster Shell (SOS) *partners of City of Virginia Beach	2006	Truck & Trailer	Staff	No	https://www.lynnhavenrivernow.org/oysters/
35	Virginia	Virginia Commonwealth University Rice Rivers Center	Virginia Oyster Shell Recycling Program (VOSRP)	2013	Personal Vehicle	Volunteers	No	https://ricerivers.vcu.edu/research-and-restoration/virginia-oyster-shell-recycling-program/
36	Virginia	Chesapeake Bay Foundation	Save Oyster Shell	2005	Personal Vehicle	Volunteers	No	https://www.cbf.org/about-cbf/our-mission/restore/oyster-restoration/
37	Virginia	Friends of the Rappahannock	Oyster Program *part of VOSRP	Unknown	Unknown	Unknown	No	riverfriends.org/oysters

APPENDIX J

Texas Oyster Regulations

Texas Oyster Regulations
as of September 2023

<table>
<tr><th>REGULATION</th><th>RECREATIONAL</th><th>COMMERCIAL</th><th>PRIVATE LEASE</th></tr>
<tr><td rowspan="2">General</td><td>Oysters may be taken for personal use (food) with a recreational license but may not be sold

Valid fishing license and a saltwater endorsement is required</td><td>A vessel used while engaged in fishing with tongs or a dredge requires the purchase of an additional Sport Oyster Boat commercial fishing license</td><td>Oysters may not be taken from marked private leases except by permission of the lessee

*TPWD permit required</td></tr>
<tr><td colspan="3">Oysters may be taken only from waters approved by the Texas Department of State Health Services Seafood and Aquatic Life Group. For more information call (800) 685-0361 or check the TDSHS website.

<u>CLOSED to HARVEST</u>: Areas along all shorelines with state health department approved or conditionally approved areas for shellfish harvest extending 300 feet from the water’s edge or exposed oysters inside of the 300-foot area.</td></tr>
<tr><td rowspan="2">Season</td><td colspan="3">Monday through Friday; Sunrise to 3:30pm</td></tr>
<tr><td colspan="2">November 1st through April 30th</td><td>NO closed season</td></tr>
<tr><td>Approved Devices & Harvest Methods</td><td>Harvest by Hand

Tongs

Oyster dredge <u>≤</u> 14” width</td><td colspan="2">Harvest by Hand

Tongs

Oyster dredge <u>≤</u> 48” width
<u>≤</u> 2-barrel capacity
Only 1 dredge allowed onboard</td></tr>
<tr><td rowspan="2">Bag Limits</td><td><u>≤</u> 2 sacks per person</td><td colspan="2"><u>≤</u> 30 sacks per day</td></tr>
<tr><td colspan="3">A sack is defined as 110 pounds of oysters including dead oyster shell and the sack.
No more than 110 lbs. per sack, INCLUDING dead oyster shell and the sack.</td></tr>
<tr><td>Size Limits</td><td colspan="3"><u>LEGAL SIZE</u>: 3 inches or larger as measured by the greatest length of the shell

Oysters 3/4 inch to 3 inches and dead oyster shell > 3/4 inch (measured along any axis) must be culled and returned to the reef from which taken

Oysters 3/4 inch to 3 inches and dead oyster shell > 3/4 inch may not make up more than 5% by number of oysters in possession

No more than the equivalent of 6 sacks of un-culled oysters are permitted on board while on a reef and must remain un-sacked and separate from the culled cargo (Commercial/Private Lease operations)</td></tr>
<tr><td>Oyster Shell Recovery Program</td><td>NA</td><td colspan="2">Harvesters – required to pay $0.20/sack
Dealers – required to return 30% of shell to public reefs or pay fee</td></tr>
</table>

*Please note, these regulations are based on TPWD’s 2023-2024 commercial and recreation guides and are subject to change.

GALVESTON BAY
FOUNDATION

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Haille Leija, Director of Program Operations; hleija@galvbay.org
Sally Clark, Habitat Restoration Manager; sclark@galvbay.org
Shannon Batte, Habitat Restoration Coordinator; sbatte@galvbay.org

APPENDIX B
Task 2 Deliverables

COMMUNITY OUTREACH

Task 2
Photographs

Figure 1. Education booth for the Oyster Extravaganza event at Bludorn (April 2023)

Figure 2. Patrons during the Oyster Extravaganza event at Bludorn (April 2023)

Figure 3. Oyster Fest Booth (April 2023)

Task 2
TPWD & GBEP Oyster Workgroup Meeting Notes

TPWD Oyster Restoration Workgroup

Meeting Notes

Location: Dickinson Marine Lab Conference Room
1502 FM 517 E, Dickinson, Texas
A virtual option was also provided.

Date: Tuesday, August 15, 2023

Time: 1:00pm – 4:00pm

Attendance: Roughly 15 people in person and 5 virtual

Agenda Items

Project Updates:

- TPWD – CARES project:
  - Lindsey is setting up another field visit for new sites next year.
- TPWD – Mesquite project:
  - This project is a maintenance approach in Aransas Bay, 50 acres.
- TPWD – NRDA project:
  - This project investigated region wide intertidal restoration.
  - Three mounds of large clutch were placed in subtidal areas, it was not intended as a project for industry use.
- Lisa – Rett's Reef:
  - This project is waiting to finalize permitting.
  - 10 acres in non-harvestable waters.
  - Potential for Sea Grant money to host workshops.
- TNC – Mad Island, Cohn preserve:
  - This is a three-mile shoreline breakwater project.
- GBF – Oyster shell recycling program
  - Haille Leija gave an update on GBF's recycling programs status.
- Projects from COE review: Proposed Project in Carancahua Bay
  - This project was potentially mentioned at the JV meeting last week, no one attending the meeting had further information.

Restoration in Closed Areas:

- Workshop format
- Workshop invitees
  - It was discussed to put on workshops surrounding this topic at the last oyster workshop meeting, however it did not gather much interest today.

Permitting BMPs/Updates:

- BMPs from NOAA National Marine Fisheries Service

    - There are oyster restoration BMPs from NOAA that TPWD will share with the group.
- Interest special session

“Prepping” reefs prior to cultch placement:

Take off an inch of silt on top before beginning construction.

Dermo on Restored or Closed Reefs:

- Good practice to test before, during, and after restoration projects.
- The group discussed how salinity was slightly more important than temperature in the spread of dermo.
- The heat is still a stressor to the oysters though, so it was discussed to transplant when it is colder as a BMP.
- There is potential interest and need to complete dermo mapping if there is a funding source available.
- What was called Dermo Watch is now Oyster Sentinel.

Additional Discussions:

- Sand and gravel permits are needed if the project is outside of the GLO lease.
- There has been a lot of sediment between San Leon and Dollar Bay due to leveling the area for mitigation from another project (the ship channel).
    - Drone footage was captured for the past few months of construction to document the sedimentation spread.
    - We could look up the construction permits to see if there is any language around sedimentation.
    - TPWD reached out internally to their CAST program – from spills and kills.
- Sea Grant program can potentially help with immediate funding needs during ‘unexpected events’.
- No BMP for beneficial use materials.
- Paten tongs have proven the best way to survey for sedimentation and TPWD now has staff that can work them.

Next Meeting:

- Early December is better for the next meeting to push it out after the opening of the season.

GALVESTON BAY OYSTER WORK GROUP – MEETING NOTES
Thursday, December 7, 2023
Participants – 35

A. **Reviewed Agenda**
B. **Reviewed Work Group Goals**
C. **Project/General Updates**

GBF

- TBDC
  - Marsh restoration/protection is successful
  - Oyster shell BW is not successful in terms of shoreline protection
  - Monitoring oysters at this time
- BNC Crystal Bay
  - City of Baytown partnership
  - Construction tentatively planned for next year
  - Goal – linear reef pad to break wave action
- DBI 1 Reef
  - Need to monitor before next phase
  - Working to secure contractor/consultant to monitor
- Jones Bay
  - Finalizing NRDA agreement
  - Construction planned for 2024
- SW Lake
  - 100 ft shell breakwater remaining to construct
  - Next step is monitoring
  - Research – alternative shell bag study with Marc Hanke starting in March/April 2024

TNC – Kathy Sweezy

- Rhett Reef (San Leon Oyster Fest)
  - Led by Lisa Halili – first example of reef restoration led by commercial oyster fisher
  - TNC assisting with permitting and postconstruction monitoring
  - Permits secured, construction planned for spring 2024
  - 10 acres total – using shell from Pier 6; may need additional shell

CCA – Shane Bonnot

- Board approval $5 million for reef restoration
- Some will go to Mesquite Bay complex
- Interested in funding requests throughout TX including Galv Bay

MBF – Bill Balboa

- E. Matagorda Bay Living Shoreline
  - Permit approval for large breakwater that will protect ICWW
  - "In-bay" living shoreline concept that will connect several oyster reefs
  - Got backing from TXDOT, port authority, GLO, etc; on TXDOT's maritime list

- Open to partnership assistance including GBF
- Reef Restoration, Tres Palacios Bay
  - Living shoreline combined with reef
  - Construction soon?

TPWD – Bill Rodney

- Beezley Reef
- NRDA Projects – Deep Water Horizon funding
  - E Bay Project – intertidal reef mound component along northern shoreline; designed by Freese & Nichols; going out to bid in the next year or two (Bill Rodney)
  - Landscape Scale Project – concept design from TNC/TPWD partnership; aiming to construction in northern Galv Bay; preliminary stages, no E&D but do have funding
- Cares Act Funded Restoration (Lindsey Savage)
  - COVID Relief Act
  - $3 million
  - 30 acres of restoration
  - 9 ac on N. Dollar Reef
  - 21 ac on E. Redfish Reef
  - Just completed in Nov 2023
  - Temp 2-year closures on restored areas
  - Will start monitoring soon
- Giraffe Head Project (Savannah Horton)
  - Agreement with USFWS Coastal Program
  - Putting together stakeholder mtg soon
- HB 51 Dealer Cultch Plant
  - Closed out Todd's Dump – area is filled now
  - 3,000 CY of cultch placed
  - Also seeking to permit new sites for new placement
  - HB 51 passed in 2017 – requires dealers to put back 30% by vol cultch material themselves or paying TPWD a fee
  - Workshops with industry & other interested parties to get input on where restoration is needed
- New Restoration & Artificial Reef Team
  - Lindsey S. is the lead
  - Includes Savannah H. & Bill R.

GLO – Diana Rameriz

- No updates

NMFS – Charrish Stevens

- No updates
- Reviews projects for EFH
- Would like to be on advisory teams to keep in the loop on new projects

USFWS – Adriana Levia

- No updates

EIH – Jenny Oakley

- Recently completed sun curing study in Sept 2023
- Final report is available on EIH's website – will send out in meeting notes
- Phase 2 of study in FY 2025

HDR – Cameron Perry

- No new projects
- Assisting with study in Galv Bay

Freese & Nichols – Aaron P.

- Kicking off project for RAE – monitor & evaluate oyster shell recycling programs across 5 orgs in the US; Gulf of Mexico project which includes GBF

D. **Presentations**

Beezley Reef

- TNC, Kathy Sweezy
  - Reef Restoration Goals – "Restore oyster populations to enable a viable oyster fishery to exist with the simultaneous recovery of oysters as a functional, self-sustaining habitat that provides multiple benefits"
  - Total Reef = 40 ac
    - 15 ac sanctuary; large rocks in rows to prevent harvest
    - 25 ac harvestable; small rocks in mounds to make harvest easier
  - Two phases of construction – 2020/2021; 2023 (filled in remaining permitted area) completed construction in Sept 2023
  - Monitoring through Aug 2024
  - Drought sanctuary b/c area is more susceptible to more fresh water influx
  - Have observed sedimentation on reef – likely due to construction of adjacent Bird Island
  - Considerations of cultch alternatives
  - New publication release – "Oyster Restoration in the Gulf of Mexico"
- TPWD, Bill Rodney
  - WQ, Temp, DO, Salinity monitoring
    - Taken during spat tile & patent tong sampling
  - Reference Reefs – Natural and Restored north & south
  - Spat Recruitment Surveys
  - Nov. 2021 – first time saw spat on restoration reefs
  - Aug. 2022 – tremendous spat set
  - Current data shows multiple cohorts & healthy oyster population
- Cedar Bayou Terminal – future dredging; potential impacts on Beezley Reef

Oyster Mitigation at San Leon & Dollar Reef (AECOM, Ashely Judith)

- Project 11 – HSC Expansion
- Package 4b/5 – San Leon & Dollar Reef
- Assessed existing and historic reefs vs. dredging impacts – resulted in a goal of 260 acres of restoration
- Identified previously buried reefs from Ike
- Chesapeake Bay – did use dredge material as based of reef pad; AECOM used as a reference study
- Construction
    - San Leon – completed July/Aug 2023
    - Dollar Reef – completed Sept 2023
    - Used mechanical dredge to construct to be able to control material and reduce sedimentation
    - Target height of 18" (built in 6" tolerance for settlement)
    - Not exact – areas of high spots and placement outside footprint
    - Used a "drag bar" to level out material
    - Focused on meeting minimum acreage of reef area
    - Capped with river rock & crushed limestone – 6" of cultch; measured with a poll taped off at 6"
- Monitoring
    - 3 years starting 2 years after construction
    - Pad subsidence (anticipate 6"), live oyster density & recruitment, limestone vs. river rock, potential regrowth in barge lanes
    - Concerns with cultch sinking into the clay
- USACE taking over monitoring & maintenance

E. **Wrap Up Discussion**

Oyster Blueprint

- GBF announced goal to pursue a blueprint for Galv Bay – NC blueprint as template
- TPWD and TNC definitely interested
- Set up mtg with Kathy & Lauren at TNC – oyster restoration goals; how we can partner
- GBF also mentioned date of 3rd annual Oyster Fest is April 6th, 2024

Meeting Timing

- Once or twice a year?
- Many votes for twice a year
- Set up shared drive to store meeting notes, slides, reports, etc.
- Next meetings – May & Nov 2024

GBF to Share

- TNC Report
- NC Oyster Blueprint
- EIH Report

Task 2
Oyster Shell Recycling Program Outreach Materials

Oysters Make the Environment Better

Posted on September 21, 2023

Did you know oysters play a vital role in helping marine ecosystems function properly? Oysters are widely enjoyed for their exceptional taste and health advantages, but they also provide numerous environmental benefits. These bivalve mollusks thrive in saltwater and brackish environments and are known as the “ocean’s vacuum cleaner.”

Oysters deliver a host of environmental benefits, starting with their remarkable ability to purify as much as 50 gallons of water daily by extracting nutrients from the bay and returning clean water to it. This process hinges on oysters absorbing nitrogen from the water, contributing significantly to ecosystem cleanliness. Moreover, their presence establishes a sturdy foundation on the bay’s seabed, creating an ideal habitat for other organisms like mussels, barnacles, and sea anemones to flourish.

Furthermore, oyster reefs act as natural defenses, resisting tidal currents and serving as protective barriers during storms and hurricanes. This safeguarding role is particularly vital for Galveston Bay, one of the largest estuary systems in the United States, which receives support from the Galveston Bay Foundation (GBF). GBF collaborates with diverse organizations sharing a common goal of preserving and safeguarding Galveston Bay, the home of the Houston Ship Channel. Port Houston’s decade-long partnership with GBF contributes to regional environmental awareness and conservation initiatives.

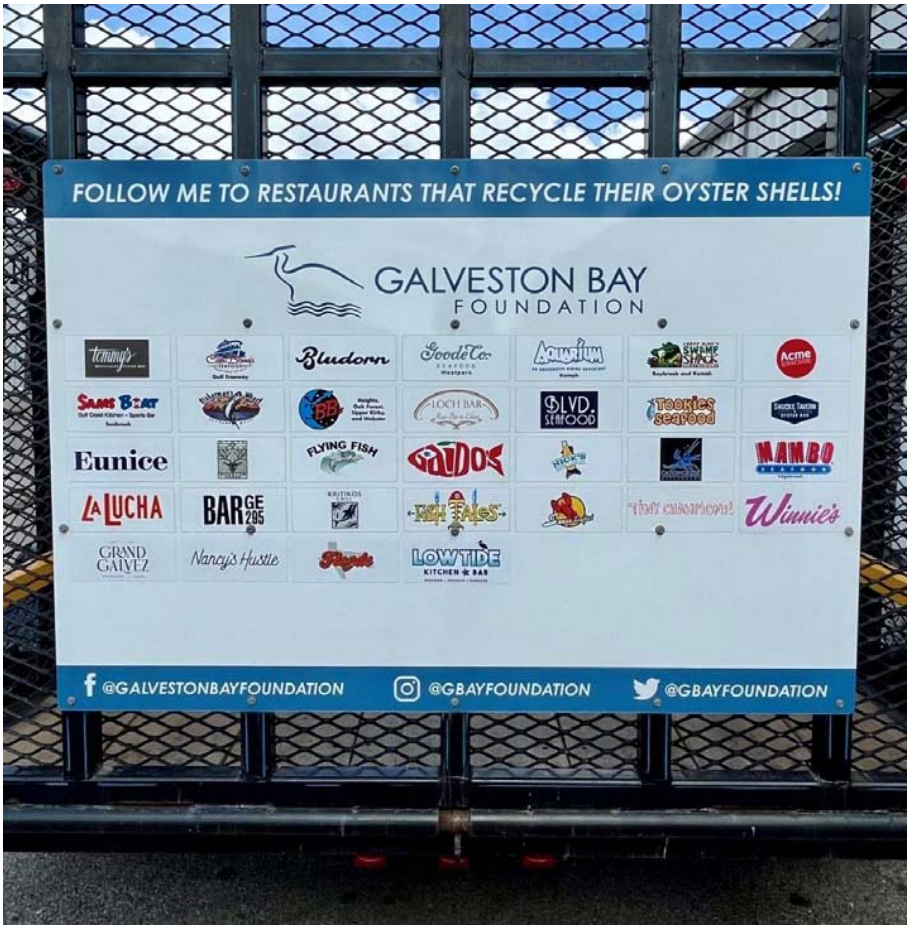
The GBF is a crucial player in the oyster rehabilitation process, and Port Houston participates in its Oyster Shell Recycling Program. With a specific focus on Eastern oysters, the GBF collects shucked oyster shells from nearby restaurants and transports them to a 1.5-acre area in Seabrook, TX. The ownership of this specific property lies with Port Houston, but it has been leased out to GBF for a mere $10 per year as part of our support toward their cause. After the shells have been dried by the sun, the GBF team and volunteers utilize them to construct fresh oyster habitats. These habitats are then returned to the Bay, where they rejuvenate during the spawning season, which typically lasts from late spring to late fall. In the Gulf of Mexico, however, this season occurs year-round due to the warm water. This process results in a healthier bay for local communities.

Currently, the Houston Ship Channel is undergoing an expansion, known as Project 11, which involves widening the waterway by 170 feet along Galveston Bay. Project 11 will enhance navigation safety and prepare the channel for the future which includes careful consideration of the environment. The Port Houston team is working closely with our partners to construct approximately 324 acres of replacement land for oyster pads using dredged material from the Galveston Bay expansion project and a layer of cultch material approximately six inches thick. These new reef pads will provide a habitat for these water-dwelling invertebrates and continue to promote their growth. As these oysters settle at the bottom of the Bay, they will continue to build reef structures, some of which may be harvested in areas that support the oyster fishery industry. This industry is a significant contributor to the Texas economy, generating approximately nine million US dollars annually and supporting local jobs.

The next time you savor oysters during a meal, consider the numerous advantages these tiny creatures offer.

Posted in Blog

Window Cling



Back Gate Trailer Sign

APPENDIX C
Task 3 Deliverables

VOLUNTEER OYSTER GARDENING

Task 3
Texas Parks and Wildlife Department Introduction Permit

TEXAS PARKS & WILDLIFE

Life's better outside.®

October 3, 2023

Shannon Batte
Galveston Bay Foundation
1725 Hwy 146
Kemah, TX 77656

Re: Oyster Transport Authorization Request, IP_UC_11052021b:

Authorization Number: IP_UC_11052021b_1072023

Dear Shannon Batte,

Texas Parks and Wildlife Department (TPWD) has approved your request to transport spat on oyster shell from the communities of Clear Lake Shores, Dickinson, Kemah, Nassau Bay, San Leon, and Texas City (approx 15 homes) to Dickinson Bay Oyster Reef (restoration site) under the TPWD permit IP_UC_11052021b. You are now permitted to transport oysters as described in the below Chain of Custody documentation. Oyster acquisition and transport must conform to all approved permitted plans and permit provisions outlined in your permit. You must keep a copy of this transport authorization and a copy of your permit in your possession while transporting oysters. This authorization is contingent upon complying with all state and TPWD rules and regulations and permit provisions outlined in the referenced permits. This authorization covers transport activities of the described oysters in the Chain of Custody from 6 to 8 October 2023.

Lindsay Glass Campbell

Digitally signed by Lindsay Glass Campbell
Date: 2023.10.04 09:26:34 -05'00'

TPWD COM Official
Dr. Lindsay Glass Campbell
Natural Resources Specialist
Texas Parks and Wildlife Department, Coastal Fisheries Division

4200 SMITH SCHOOL ROAD
AUSTIN, TEXAS 78744-3291
512.389.4800
www.tpwd.texas.gov

Chain of Custody

Type of Oyster Transfer: In-State IN Texas Region

Permit oysters are being transferred under: IP_UC_11042022b

Stage of oysters being transferred: Other

Average Size of oysters being transferred: Spat up to 2"

Broodstock origin of oysters: Galveston Bay

Ploidy of oysters being transferred: 2N

Tetraploid line (if 3N Crossbred):

Number of oysters being transferred: ~56 oyster stringers

Number of containers: TDB

Container ID/description: ~56 oyster "gardens" or stringers of recycled oyster shell that spat have settled on will be collected from participants in the community

The above described oysters are being transferred FROM a Other

Name of Source: Clear Lake Shores, Dickinson, Kemah, Nassau Bay, San Leon, and Texas Ci

Address/GPS of Location: several communities

Bay of Location: Galveston Bay

They are being transferred TO a Other

Name of Destination: Dickinson Bay Oyster Reef

Address/GPS of Location: 29.469668, -94.948274

Bay of Location: Dickinson Bay/Galveston Bay

See the attached Diseased Testing Certification from:

Pathology Lab: N/A

Pathology Case: N/A

Date Certified: N/A

TEXAS PARKS & WILDLIFE

Life's better outside.®

October 3, 2023

Shannon Batte
Galveston Bay Foundation
1725 Hwy 146
Kemah, TX 77656

Re: Oyster Transport Authorization Request, IP_UC_11052021b:

Authorization Number: IP_UC_11052021b_10122023

Dear Shannon Batte,

Texas Parks and Wildlife Department (TPWD) has approved your request to transport spat on oyster shell from the communities of Baytown and Beach City (approx 11 homes) to Trinity Bay Discovery Center Oyster Shell Breakwater (living shoreline restoration site) under the TPWD permit IP_UC_11052021b. You are now permitted to transport oysters as described in the below Chain of Custody documentation. Oyster acquisition and transport must conform to all approved permitted plans and permit provisions outlined in your permit. You must keep a copy of this transport authorization and a copy of your permit in your possession while transporting oysters. This authorization is contingent upon complying with all state and TPWD rules and regulations and permit provisions outlined in the referenced permits. This authorization covers transport activities of the described oysters in the Chain of Custody from 11 to 13 October 2023.

Lindsay Glass Campbell

Digitally signed by Lindsay Glass Campbell
Date: 2023.10.04 09:27:23 -05'00'

TPWD COM Official
Dr. Lindsay Glass Campbell
Natural Resources Specialist
Texas Parks and Wildlife Department, Coastal Fisheries Division

4200 SMITH SCHOOL ROAD
AUSTIN, TEXAS 78744-3291
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www.tpwd.texas.gov

Chain of Custody

Type of Oyster Transfer: In-State IN Texas Region

Permit oysters are being transferred under: IP_UC_11042022b

Stage of oysters being transferred: Other

Average Size of oysters being transferred: Spat up to 2"

Broodstock origin of oysters: Galveston Bay

Ploidy of oysters being transferred: 2N

Tetraploid line (if 3N Crossbred):

Number of oysters being transferred: ~37oyster gardens

Number of containers: TDB

Container ID/description: ~37 oyster "gardens" or stringers of recycled oyster shell that spat have settled on will be collected from participants in the community

The above described oysters are being transferred FROM a Other

Name of Source: Baytown and Beach City

Address/GPS of Location: several communities

Bay of Location: Galveston Bay/Burnet Bay, Tabbs Bay, Trinity Bay

They are being transferred TO a Other

Name of Destination: Trinity Bay Discovery Center Oyster Shell Breakwater (living shoreline

Address/GPS of Location: 29.714685, -94.85427

Bay of Location: Trinity Bay/Galveston Bay

See the attached Diseased Testing Certification from:

Pathology Lab: N/A

Pathology Case: N/A

Date Certified: N/A

TEXAS PARKS & WILDLIFE

Life's better outside.®

October 3, 2023

Shannon Batte
Galveston Bay Foundation
1725 Hwy 146
Kemah, TX 77656

Re: Oyster Transport Authorization Request, IP_UC_11052021b:

Authorization Number: IP_UC_11052021b_11042023

Dear Shannon Batte,

Texas Parks and Wildlife Department (TPWD) has approved your request to transport spat on oyster shell from the communities of Bayou Vista, Galveston, Hitchcock, and Tiki Island (approx 68 homes) to Sweetwater Lake Oyster Shell Breakwater (living shoreline restoration site) under the TPWD permit IP_UC_11052021b. You are now permitted to transport oysters as described in the below Chain of Custody documentation. Oyster acquisition and transport must conform to all approved permitted plans and permit provisions outlined in your permit. You must keep a copy of this transport authorization and a copy of your permit in your possession while transporting oysters. This authorization is contingent upon complying with all state and TPWD rules and regulations and permit provisions outlined in the referenced permits. This authorization covers transport activities of the described oysters in the Chain of Custody from 3 to 5 November 2023.

Lindsay Glass Campbell

Digitally signed by Lindsay Glass Campbell
Date: 2023.10.04 09:27:59 -05'00'

TPWD COM Official
Dr. Lindsay Glass Campbell
Natural Resources Specialist
Texas Parks and Wildlife Department, Coastal Fisheries Division

4200 SMITH SCHOOL ROAD
AUSTIN, TEXAS 78744-3291
512.389.4800
www.tpwd.texas.gov

Chain of Custody

Type of Oyster Transfer: In-State IN Texas Region

Permit oysters are being transferred under: IP_UC_11042022b

Stage of oysters being transferred: Other

Average Size of oysters being transferred: Spat up to 2"

Broodstock origin of oysters: Galveston Bay

Ploidy of oysters being transferred: 2N

Tetraploid line (if 3N Crossbred):

Number of oysters being transferred: ~245 oyster gardens

Number of containers: TDB

Container ID/description: ~245 oyster "gardens" or stringers of recycled oyster shell that spat have settled on will be collected from participants in the community

The above described oysters are being transferred FROM a Other

Name of Source: Bayou Vista, Galveston, Hitchcock, and Tiki Island

Address/GPS of Location: several communities

Bay of Location: Galveston Bay/West Bay

They are being transferred TO a Other

Name of Destination: Sweetwater Lake Oyster Shell Breakwater (living shoreline restoration s

Address/GPS of Location: 29.254973, -94.880110

Bay of Location: West Bay - Galveston Bay

See the attached Diseased Testing Certification from:

Pathology Lab: N/A

Pathology Case: N/A

Date Certified: N/A

TEXAS PARKS & WILDLIFE

Life's better outside.®

October 3, 2023

Shannon Batte
Galveston Bay Foundation
1725 Hwy 146
Kemah, TX 77656

Re: Oyster Transport Authorization Request, IP_UC_11052021b:

Authorization Number: IP_UC_11052021b_11182023

Dear Shannon Batte,

Texas Parks and Wildlife Department (TPWD) has approved your request to transport spat on oyster shell from the communities of Bayou Vista, Galveston, Hitchcock, and Tiki Island (approx 68 homes) to Sweetwater Lake Oyster Shell Breakwater (living shoreline restoration site) under the TPWD permit IP_UC_11052021b. You are now permitted to transport oysters as described in the below Chain of Custody documentation. Oyster acquisition and transport must conform to all approved permitted plans and permit provisions outlined in your permit. You must keep a copy of this transport authorization and a copy of your permit in your possession while transporting oysters. This authorization is contingent upon complying with all state and TPWD rules and regulations and permit provisions outlined in the referenced permits. This authorization covers transport activities of the described oysters in the Chain of Custody from 17 to 19 November 2023.

Lindsay Glass Campbell

Digitally signed by Lindsay Glass Campbell
Date: 2023.10.04 09:28:39 -05'00'

TPWD COM Official
Dr. Lindsay Glass Campbell
Natural Resources Specialist
Texas Parks and Wildlife Department, Coastal Fisheries Division

4200 SMITH SCHOOL ROAD
AUSTIN, TEXAS 78744-3291
512.389.4800
www.tpwd.texas.gov

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Stage of oysters being transferred: Other

Average Size of oysters being transferred: Spat up to 2"

Broodstock origin of oysters: Galveston Bay

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Name of Source: Bayou Vista, Galveston, Hitchcock, and Tiki Island

Address/GPS of Location: several communities

Bay of Location: Galveston Bay/West Bay

They are being transferred TO a Other

Name of Destination: Sweetwater Lake Oyster Shell Breakwater (living shoreline restoration s

Address/GPS of Location: 29.254973, -94.880110

Bay of Location: West Bay - Galveston Bay

See the attached Diseased Testing Certification from:

Pathology Lab: N/A

Pathology Case: N/A

Date Certified: N/A

Task 3
Annual Gardening Report

ANNUAL OYSTER GARDENING REPORT

TASK 3 DELIVERABLE

Project Name: Community Outreach through Oyster Shell Recycling and Citizen Science

GLO Contract No: 23-020-002-D596

Deliverable: Task 3 – Volunteer Oyster Gardening

Due Date: 03/31/2024

I. PROJECT DESCRIPTION

Since 2012, the Galveston Bay Foundation (GBF) has fostered relationships in bayfront communities to "garden" oysters. Waterfront homeowners in these communities volunteer as oyster gardeners and suspend mesh bags, lines (stringers), or cages containing recycled oyster shells ("oyster gardens") from their piers, docks, or bulkheads to recruit oyster larvae. The oyster gardens are submerged in the bay during the spawning season, approximately May through November. Volunteers monitor and care for the oyster gardens throughout the summer and early fall to promote successful growth of baby oysters (spat) recruited on the recycled shell. In the fall, GBF staff collect the oyster gardens and spread the shells and new oysters on nearby restoration reefs to enhance the local oyster population. The volunteers not only learn about the lifecycle of the Eastern oyster and the importance of oyster reefs in the Galveston Bay ecosystem, but they are also exposed to a variety of marine life that find shelter in the oyster gardens. Furthermore, oyster gardening volunteers have the opportunity to participate in citizen science through GBF's oyster recruitment studies.

II. SUMMARY OF 2023 VOLUNTEER OYSTER GARDENING

a) Oyster Garden Creation Events

To reduce the annual supply needs and allow the focus of the Garden Creation Events to be education, GBF suggested volunteers limit the number of oyster gardens managed by each household to a maximum of three. As the number of participating volunteers has increased, the time commitment for staff has risen dramatically, particularly in the fall when gardens are collected. Documentation of oyster growth in each individual garden is a time-consuming process. Therefore, reducing the number of gardens per volunteer will reduce expenses associated with staff time while continuing to facilitate the collection of valuable data. Overall, the volunteers were content with managing up to three gardens. A couple dedicated volunteers have their

grandchildren participate in the gardening process, therefore they requested to build enough gardens for each of their grandchildren, which was accepted. A few volunteers were persistent with building more than three gardens, so while it was suggested to limit the number of gardens to three it was not strictly enforced.

To streamline the Garden Creation Events and reduce expenses, GBF staff decreased the number of events held at the beginning of the season when volunteers meet to learn about the Volunteer Oyster Gardening Program and build their gardens to take home. In 2022 seven Garden Creation Events were held, so for 2023 a total of five Garden Creation Events were hosted by GBF staff in the spring/summer (Table 1). Instead of hosting events for each individual bayfront community, the events were hosted at Moody Gardens in Galveston as well as GBF's headquarters in Kemah. Hosting the Garden Creation Events at Moody Gardens helped to reduce the number of events while still offering a central location to meet for volunteers located in the lower Galveston Bay region. Likewise, hosting the Garden Creation Events at the GBF headquarters helped to reduce the number of events while still offering a central location to meet for the mid Galveston Bay region volunteers. Two events were held at Moody Gardens and two were held at GBF's headquarters to offer multiple dates so all volunteers who wished to participate could hopefully attend one of the events. A Garden Creation Event was also held at GBF's Trinity Bay Discovery Center in Beach City for volunteers located in the upper Galveston Bay region. All the Garden Creation Events were offered to any volunteer no matter what bayfront community they resided in.

Volunteers and GBF staff worked together to build over 300 oyster gardens (Table 2 and Figures 1-2). At the Garden Creation Events, volunteers were also educated on the oyster gardening process and oyster reef ecology. All volunteers were given the option of three garden types: bags, stringers, or cages. A total of 338 oyster gardens were suspended off piers, docks, and bulkheads at 94 bayfront homes in 2023 (Table 2).

Table 1: Garden Creation Events

Garden Creation Event Location	Event Date	Volunteer Attendees
Moody Gardens	04/29/23	31
Trinity Bay Discovery Center	05/18/23	3
GBF Headquarters	05/20/23	12
Moody Gardens	05/27/23	16
GBF Headquarters	06/03/23	5
Total:		**67**

Table 2: Oyster Garden Creation

Community	Volunteer Homes	Bags Deployed	Stringers Deployed	Cages Deployed	TOTAL Gardens Deployed
Bayou Vista	17	24	16	10	50
Baytown	6	0	4	12	16
Beach City	5	7	7	10	24
Clear Lake Shores	5	8	3	4	15
Dickinson	2	0	4	3	7
Galveston	12	23	10	17	50
Hitchcock	3	1	5	1	7
Jamaica Beach	7	9	8	1	18
Kemah	1	1	0	0	1
Nassau Bay	1	1	0	0	1
Omega Bay	4	4	4	3	11
Pirates Cove	6	4	4	11	19
San Leon	5	20	7	2	29
Sea Isle	6	6	1	10	17
Texas City	1	1	1	1	3
Tiki Island	13	18	30	22	70
Grand Total:	**94**	**127**	**104**	**107**	**338**

b) Oyster Garden Monitoring

Throughout the remainder of the 2023 season, volunteers monitored their gardens for oyster recruitment. Volunteers were instructed to rinse their gardens weekly to help reduce biofouling and predation. Weekly maintenance also allowed volunteers to inspect their gardens for new oyster growth. GBF staff sent out maintenance and monitoring reminders via email and Facebook to help support the volunteers throughout the gardening season. Facebook posts and regular emails also provided an opportunity for questions and answers, further supporting volunteers in their gardening efforts.

To capture the volunteers' time committed to monitoring and maintaining their oyster gardens, GBF staff created an online form (https://www.emailmeform.com/builder/form/18cW804zms50) to allow volunteers to log their hours monthly. GBF staff sent out monthly reminders via email containing a link to the form. While this method helps improve documentation of volunteer hours, only a small portion of the volunteers utilized the online form.

In 2023, volunteers were encouraged to document their oyster recruitment throughout the season, rather than solely in the fall at the collection events. A link to an online data form (https://www.emailmeform.com/builder/form/Lv550hdRQj4k6r) was provided to all volunteers to submit their oyster recruitment data as often as they would like. Submitting the data was not a requirement, but available for those who wished to participate. Only three volunteers submitted their oyster recruitment data throughout the season.

For 2023, GBF staff recruited five volunteers located in different bayfront communities to record the temperature (Chart 1) and salinity (Chart 2) of the water at their location on a weekly basis. The five volunteers selected to do water monitoring were in Beach City, Isla del Sol (located near Sea Isle), Pirates Cove, San Leon, and Tiki Island. GBF staff provided equipment and training on how to monitor water temperature and salinity and provided reference guides. GBF staff requested they sample weekly on the same day, during the same timeframe as the rest of the water quality monitors, so all the data was collected as similar as possible. However, due to variations in the volunteer's schedule not all data collection occurred on the same day during the same timeframe. The volunteers were provided with an online data submittal form (https://www.emailmeform.com/builder/form/7Jt8FXLqK0n13) to make it easier for all parties to submit their data. Data from this water monitoring will be used along with spat recruitment results to gain a better understanding of overall spat recruitment trends within Galveston Bay. This was the first year of collecting this data, but data collection is expected to continue each year GBF's Volunteer Oyster Gardening Program continues. This will allow for additional data collection and further analysis of spat recruitment trends to obtain a more robust understanding.

Chart 1. Water Temperature from Five Gardening Communities from May through November 2023.

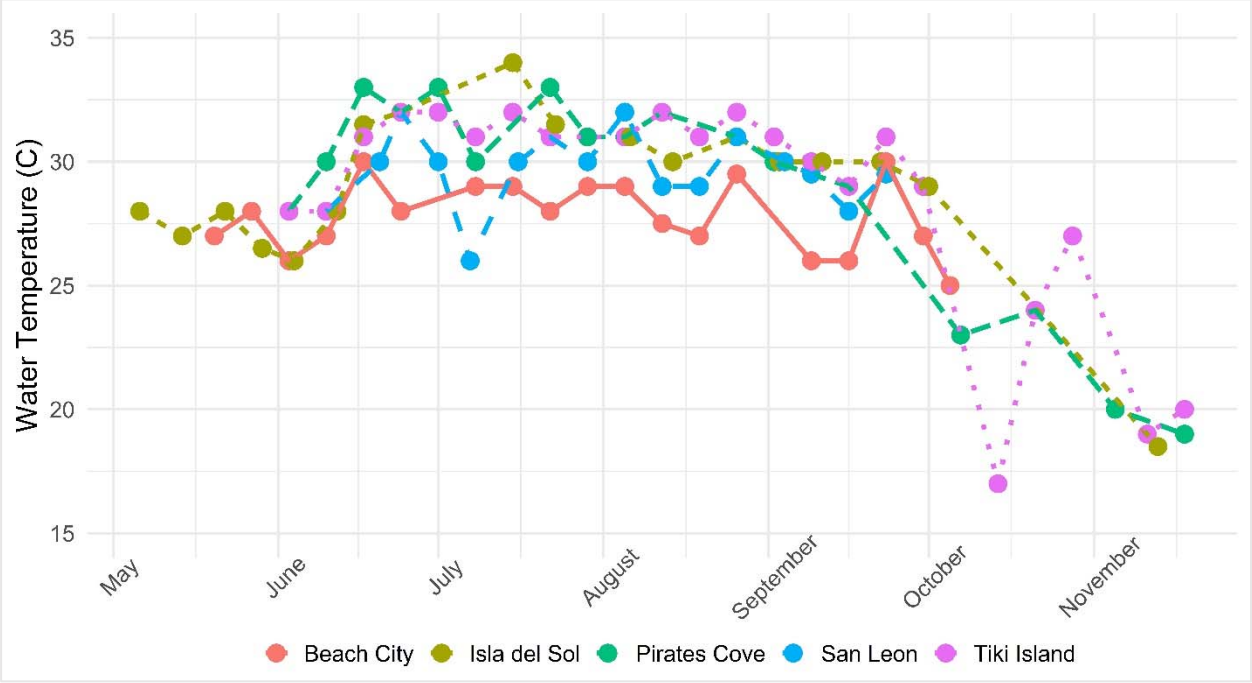
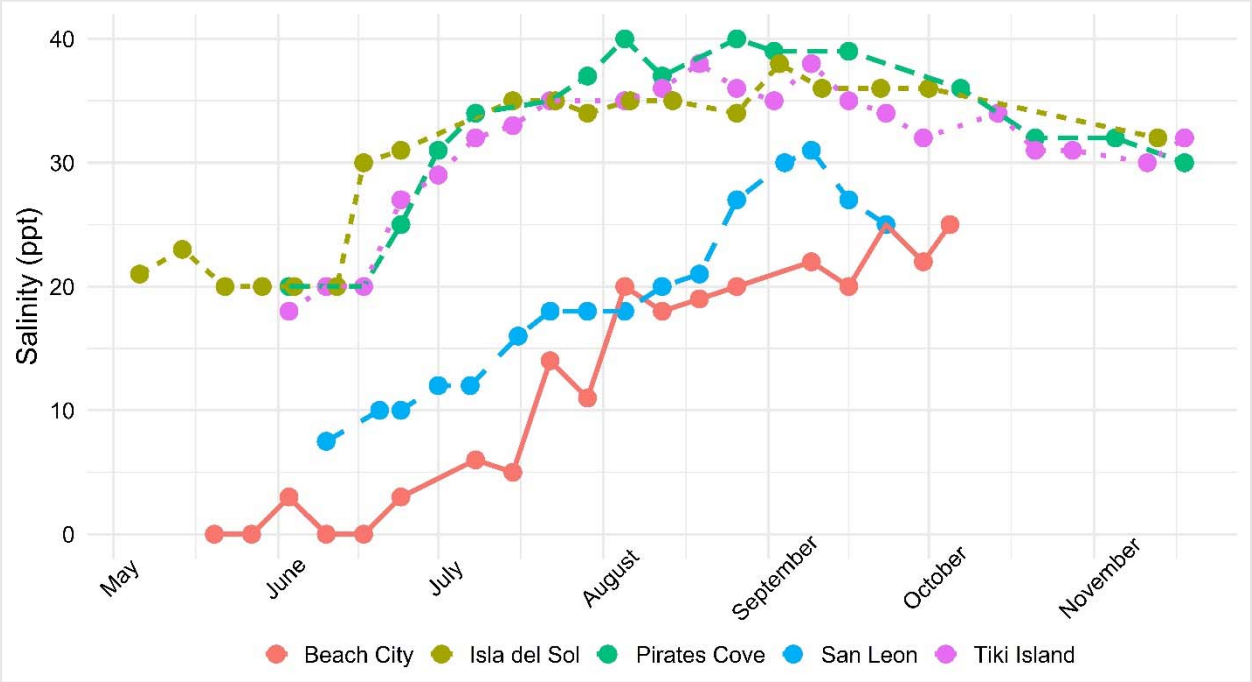


Chart 2. Salinity from Five Gardening Communities from May through November 2023.



c) Oyster Garden Collection

In the fall of 2023, GBF staff coordinated the collection of the oyster gardens through five community events. The first event was held at a volunteer's home in San Leon on October 7, 2023. The second event was held at GBF's Trinity Bay Discovery Center in Beach City on October 12, 2023. The third event was held at Bayou Vista's City Pavilion on November 4, 2023. The fourth and fifth events were both held on November 18, 2023, one was at a volunteers' home in Tiki Island and the other was at Moody Gardens in Galveston. Volunteers delivered their gardens to these locations where GBF staff received the gardens, documented new oyster growth and prepped the gardens for transport (Figures 3-6).

Volunteers unable to attend a community event were encouraged to arrange with a neighbor attending the collection event to deliver their gardens. If the volunteer could not coordinate delivery with a neighbor, GBF staff collected the volunteer's gardens in each community the day of the collection event.

Thanks to the dedicated volunteers across 94 bayfront homes who participated in oyster gardening in 2023, approximately 4,493 oysters were recruited in the oyster gardens (Figures 7-11). Please note, the total number of oysters documented in each garden includes both live and recently dead oysters to provide an estimate of overall recruitment (Table 3). These oysters were introduced onto restoration reefs in October and November 2023 under separate grant funding (Figures 12-13). Table 4 shows the total number of oysters and the total cubic yards of oyster shells transplanted at each restoration site. Please note, GBF holds permits via the Texas Parks and Wildlife Department, Texas General Land Office, and U.S. Army Corps of Engineers to introduce oysters and shell into Galveston Bay and the respective sub-bay systems. These permits are available upon request.

The number of gardens deployed at the beginning of the season (338) was greater than the number of gardens collected at the end of the season (312). The decrease in the number of gardens collected was due to the loss of gardens from storms, potential theft, or not being able to get in contact with the volunteer at the time of the Garden Collection Events in the fall.

To reduce the manual labor and time requirements at the Dickinson Bay Reef introduction site, GBF staff utilized GBF's boat to transport all the spat from the gardens of the volunteers located in Clear Lake Shores, Dickinson, Kemah, San Leon, and Texas City. After all the spat had been counted and recorded, the spat and shells were transferred to 5-gallon buckets. From the volunteer's residence that hosted the Garden Collection Event, the buckets were then transported by boat to the Dickinson Bay Reef where the spat and shells were placed onto the reef (Figure 12). Compared to last year, having a boat available to assist with the transplanting was a better option to help reduce the manual labor of loading and unloading the kayaks to/from the water.

Table 3: Oyster Garden Collection and Oyster Recruitment

Community	Gardens Collected	Total Oysters Recruited	Avg. Oysters per Garden
Baytown	14	2	0
Dickinson	4	0	0
Kemah	1	0	0
Nassau Bay	0	0	0
Clear Lake Shores	15	8	1
Jamaica Beach	18	16	1
Bayou Vista	42	41	1
Omega Bay	11	15	1
Texas City	3	6	2
Hitchcock	7	34	5
Galveston	46	367	8
Pirates Cove	16	178	11
Beach City	22	336	15
San Leon	29	699	24
Sea Isle	15	378	25
Tiki Island	69	2,413	35
TOTALS:	**312**	**4,493**	**14**

Table 4: Oyster Introductions

Date	CY of Shell Transplanted	Total Oysters Introduced	Source Location	Introduction Location	
				Bay/Sub-bay	GBF Project
10/07/23	0.22	713	Clear Lake Shores Dickinson Kemah San Leon Texas City	Dickinson Bay	Dickinson Bay Oyster Reef (Mound 3)
10/12/23	0.15	338	Baytown Beach City	Trinity Bay	TBDC Living Shoreline (Sec. C)
11/04/23	0.28	292	Bayou Vista Galveston Hitchcock Jamaica Beach Omega Beach Tiki Island	West Galveston Bay	Sweetwater Lake Oyster Shell Breakwater (Sec. D)
11/18/23	0.29	2,343	Bayou Vista Tiki Island	West Galveston Bay	Sweetwater Lake Oyster Shell Breakwater (Sec. E)
11/18/23	0.37	807	Galveston Jamaica Beach Pirates Cove Sea Isle	West Galveston Bay	Sweetwater Lake Oyster Shell Breakwater (Sec. E)
	1.31	**4,493**	**Please note, all oyster introductions were conducted under separate funding.*		

III. FINDINGS & LESSONS LEARNED

a) Community Assessment

In 2023, the communities of Tiki Island, Sea Isle, San Leon, and Beach City documented the highest amount of oyster growth in their gardens while the other communities observed lower levels of oyster recruitment. Tiki Island led the way with an average of 35 oysters per garden and the Sea Isle oyster gardens contained an average of 25 oysters per garden, which was the same average for 2022. San Leon had an average of 24 oysters per garden and Beach City had an average of 15 oysters per garden. Pirates Cove and Galveston had slightly lower recruitment with an average of eleven and eight oysters per garden, respectively. Hitchcock, Texas City, Omega Bay, Bayou Vista, Jamaica Beach, and Clear Lake Shores experienced the lowest recruitment with an average of five or less oysters per garden (Chart 3). Please note the community of Nassau Bay is not included on the chart because only one garden was placed in the water and it went missing before the end of the season, therefore no data was available. For all 15 communities, an overall average of 14 oysters per garden was recorded.

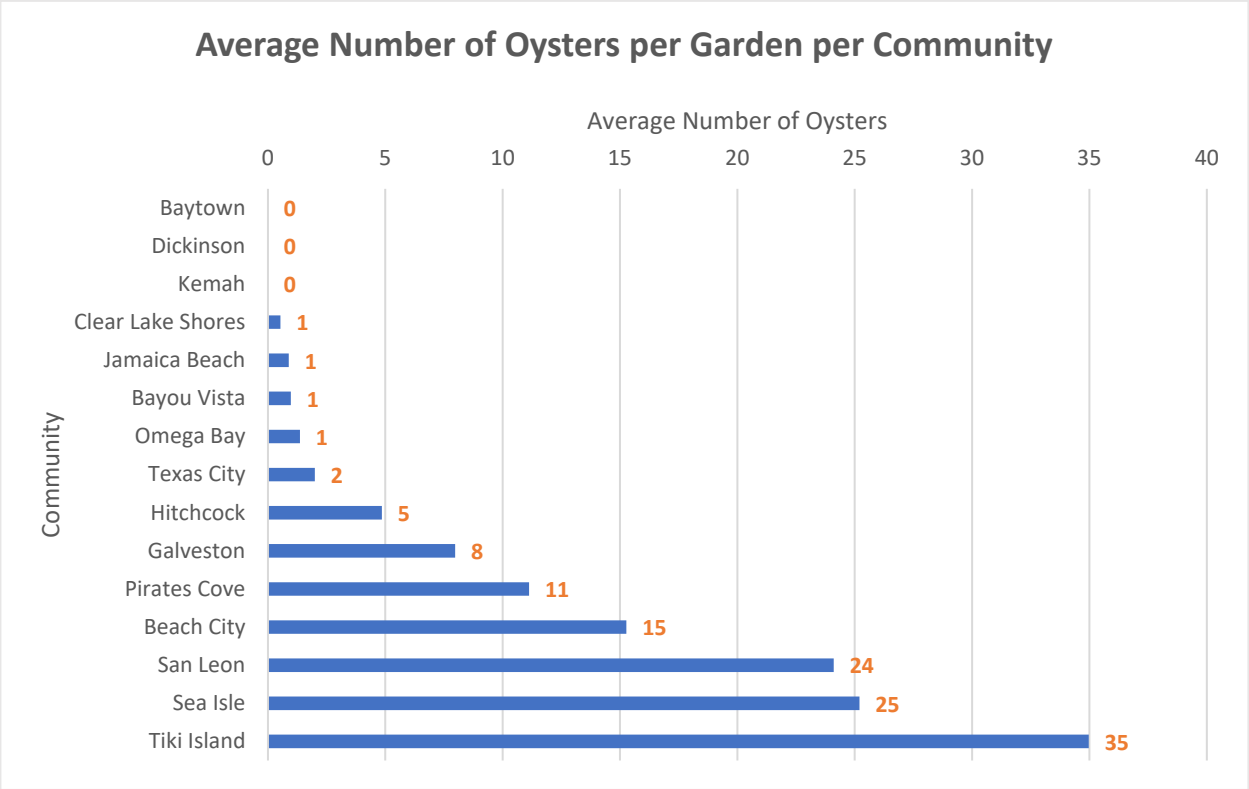
Compared to 2022, the Beach City oyster gardens had higher recruitment levels, specifically for the waterfront homes along Tri City Beach Rd, which have piers located directly in Trinity Bay. In 2022, GBF staff documented 53 oysters in the Beach City gardens, which resulted in an average of only 2 oysters per garden. The increase in oyster recruitment for 2023 could be the result of higher salinities due to the drought during the summer months. A volunteer located in Beach City

recorded the salinity weekly from May 20th to October 5th and the average salinity was 12 parts per thousand during that timeframe. Trinity Bay tends to have relatively low salinity (less than 10 parts per thousand) therefore the oyster recruitment is usually lower compared to other parts of the bay.

Some of the communities located in the upper and lower Galveston Bay regions received relatively low oyster recruitment. One new waterfront community in the upper region, Kemah, attempted oyster gardening for the first time in 2023. Unfortunately, no oyster recruitment was observed in Kemah. Texas City, located in the lower Galveston Bay region, was another new waterfront community that oyster gardened for the first time in 2023. For Texas City, six oysters were recruited out of the three gardens collected, which resulted in an average of two oysters per garden.

Using web-based ArcGIS, GBF staff updated the online map that was created to display every household that has participated in oyster gardening from 2020 through 2023 along with their spat counts and spat averages for each year. The link to the online map (https://arcg.is/08azKm) was shared with the volunteers via email. Positive feedback was received from the volunteers, and they enjoyed viewing the data depicted on a map.

Chart 3: Oyster Recruitment per Community



b) Garden Type Assessment

Since 2018, GBF has utilized three different garden types, bags, stringers, and cages (Figures 14-16), and has continued to assess the pros and cons of each. In 2022, GBF staff modified the construction of the stringer gardens slightly by utilizing weed eater cord instead of metal wire. At the oyster garden collection events in the fall when the oyster shells are removed from the stringer, at times, the shells were very difficult to remove from the metal wire. In 2021, a volunteer used weed eater cord to assemble stringer gardens and at the collection event GBF staff observed the oyster shells slid off the weed eater cord effortlessly compared to the metal wire. A spool of weed eater cord is also less expensive than metal wire. The weed eater cord has been successful for two gardening seasons and will be used again for next season.

In 2022, GBF staff also modified the construction of the cage gardens somewhat by utilizing mesh material with one-inch squares rather than the previous mesh material that had one and a half inch squares. Some oyster shells would fall through the one and a half inch squares, therefore the one-inch squares are a more suitable size for containing the oyster shells inside the cage during the gardening season. The mesh material with one-inch squares has been successful with containing the oyster shells for two gardening seasons and will be used again for next season.

Oyster growth documentation in 2023 indicates cages had the highest levels of oyster recruitment and oyster retention with an average of 21 oysters per cage. The bags were not too far behind the cages with an average of 16 oysters per bag. Stringers had the least oyster recruitment with an average of only six oysters per stringer (Chart 4). These results are consistent with observations made in 2022 (Chart 5), indicating the cages may be more effective in oyster recruitment and retention.

As suggested in the 2020 through 2022 Annual Oyster Gardening Reports, it is proposed that the larger openings in the cages provide more water flow than the bags, thus allowing oyster larvae to easily enter the cages and come in contact with the recycled shells. It appears the stringers have limited room for oyster larvae to attach to the recycled shells because of the way the shells are stacked on top of each other on the weed eater cord. The bags are difficult to rinse and often capture heavier loads of sediment, thus covering viable shell and potentially preventing larvae attachment. An additional benefit of the cages is their ability to be reused for at least one to two years whereas bags and stringers are single use only.

Cages performed better than both bags and stringers in 2022 and 2023. To evaluate how much greater cages performed, an analysis of variance (ANOVA) on the number of oysters recruited was performed separately for 2022 and 2023. In both years, the garden type significantly affected the average number of oysters recruited per garden ($p < 0.05$). Post hoc Tukey tests showed cages recruited significantly more oysters per garden compared to stringers ($p < 0.05$) for both years. However, cages recruited significantly more oysters per garden compared to bags in 2022 ($p < 0.05$) but not in 2023 ($p > 0.05$). GBF plans to continue to offer all three garden types to volunteers next season but may eliminate stringer gardens in the future.

Chart 4**:** Oyster Recruitment in Different Garden Types in 2023. An analysis of variance (ANOVA) on the number of oysters showed garden type significantly affects the average number of oysters per garden, $F(2,169) = 4.182$, $p < 0.05$. A post hoc Tukey test showed that cages recruited significantly more oysters per garden than stringers ($p < 0.05$).

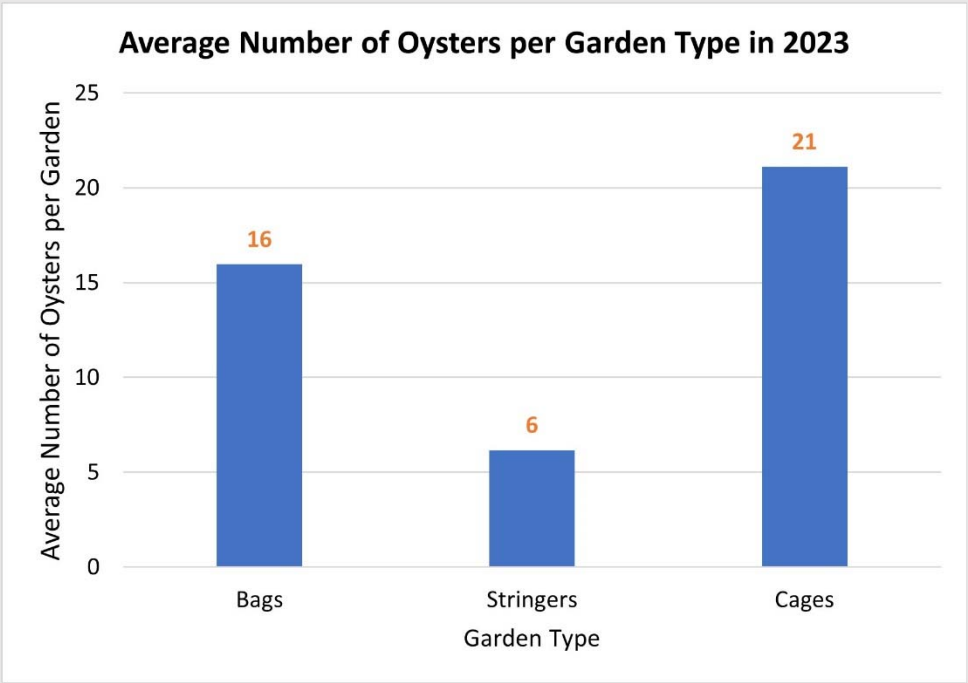
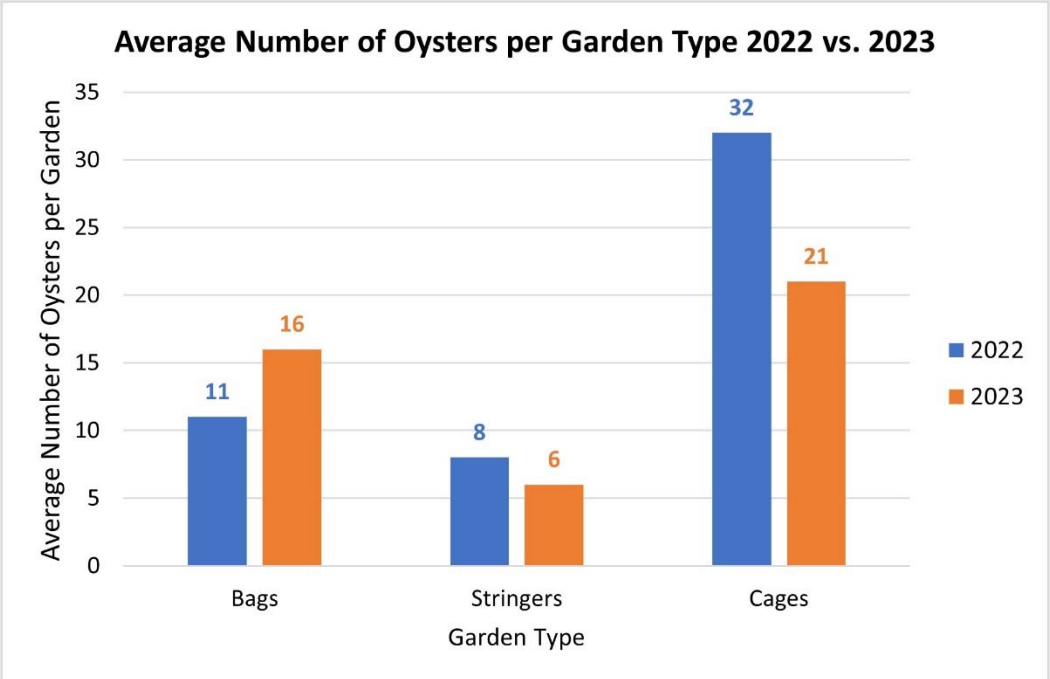


Chart 5: Oyster Recruitment in Different Garden Types 2022 vs. 2023. An extreme outlier (1,539 oysters in two cage gardens) in 2022 was excluded because it strongly influenced the 2022 cage average.



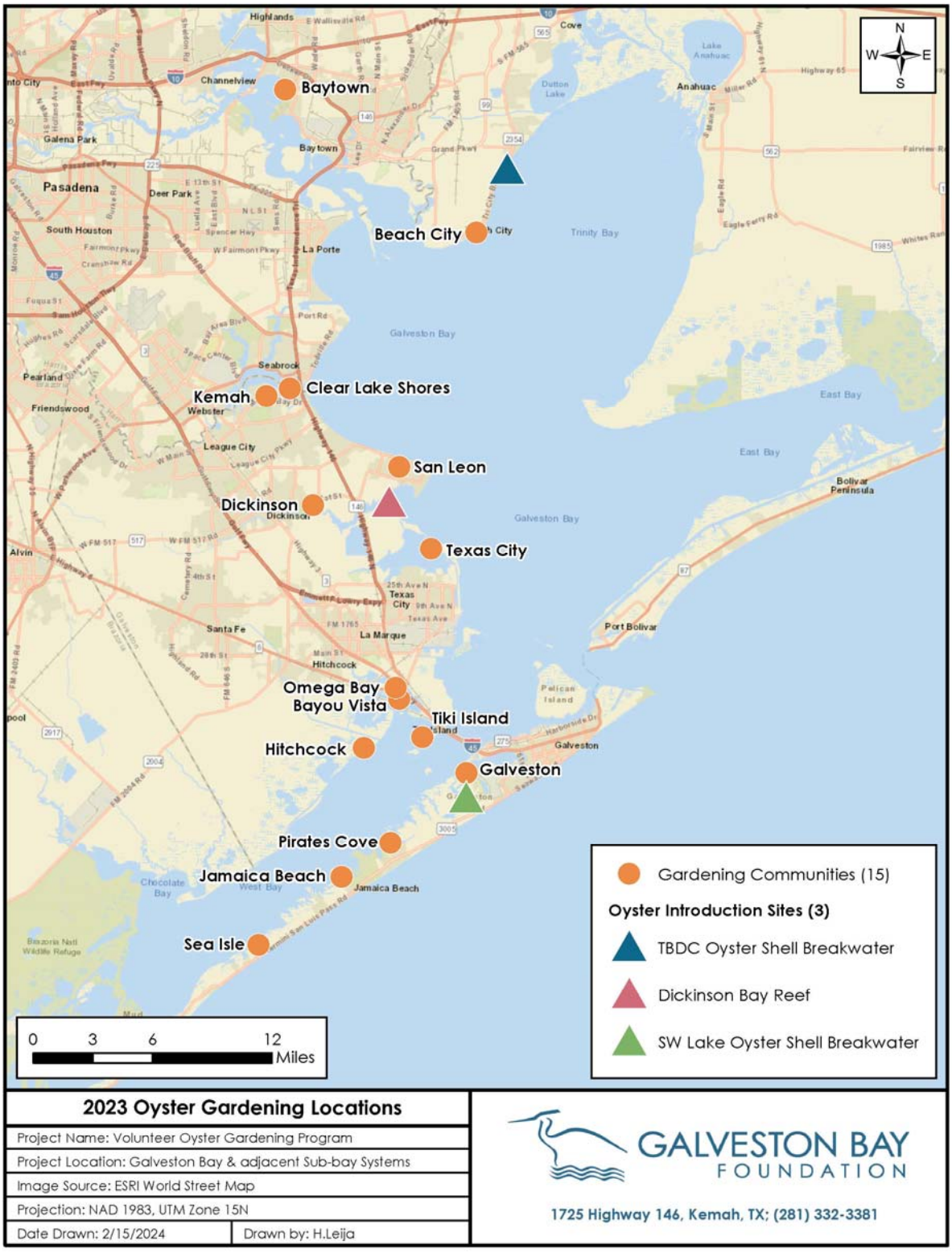
c) Considerations for Future Oyster Gardening

To streamline the Garden Creation Events and reduce expenses, GBF staff decreased the number of events held at the beginning of the season when volunteers meet to learn about the Volunteer Oyster Gardening Program and build their gardens to take home. For 2023 five Garden Creation Events were hosted in central locations rather than in each of the communities to help reduce the number of events. Therefore, some bayfront communities did not have an event hosted in their community like previous years which upset some volunteers and resulted in less participation. For next season the proposed plan will be to schedule the Garden Creation Events in each of the communities again. However, GBF staff will schedule most of the events during the week rather than on Saturdays. Hosting the events during the week will allow GBF staff to be present for each community without having to devote their weekends for several weeks.

At the end of the season at the collection events, if the cage gardens are still in decent shape GBF staff store the cages during the offseason to be reused for the next year. At the collection events this year, a few volunteers reported their cages fell apart and the recycled oyster shells fell out and were not retrievable. The cause of the oyster shells falling out could be due to the cages being too brittle from being used previously. For next season, GBF staff and volunteers plan to inspect the recycled cages more closely to make sure they are not weakened. The cages are held together by metal hog rings so if the mesh material looks to be in good condition the hog rings will be replaced so the risk of the cage coming apart mid-season is lessened.

GBF staff conducted statistical data analysis for the average number of oysters recruited per garden type for 2022 and 2023 to verify which of the three garden types is more successful for oyster recruitment. From the results it was determined the stringer gardens are the least successful. Next season GBF staff will continue to offer stringer gardens but will inform the volunteers of the statistical results and discuss with them the possibility of eliminating the stringer garden. While the stringer gardens are not costly to construct, the elimination of stringer gardens will reduce staff and volunteer time spent drilling holes into each individual oyster shell.

IV. PROJECT LOCATION MAP



Please note the community of Nassau Bay is not included on the map because only one garden was placed in the water and it went missing before the end of the season, therefore no data was available.

V. PROJECT PHOTOGRAPHS

Figure 1. Volunteers building cage oyster gardens at Garden Creation Event (Spring 2023)

Figure. 2. Volunteers building stringer and bag oyster gardens at Garden Creation Event (Spring 2023)

Figure 3. Volunteers and GBF staff documenting oyster growth at Garden Collection Event (Fall 2023)

Figure 4. A volunteer and GBF staff documenting oyster growth at Garden Collection Event (Fall 2023)

Figure 5. Volunteers with spat on shell from their oyster garden (Fall 2023)

Figure 6. Volunteers and GBF staff documenting oyster growth at Garden Collection Event (Fall 2023)

Figure 7. Oyster growth on a single recycled shell from a Galveston oyster garden (Fall 2023)

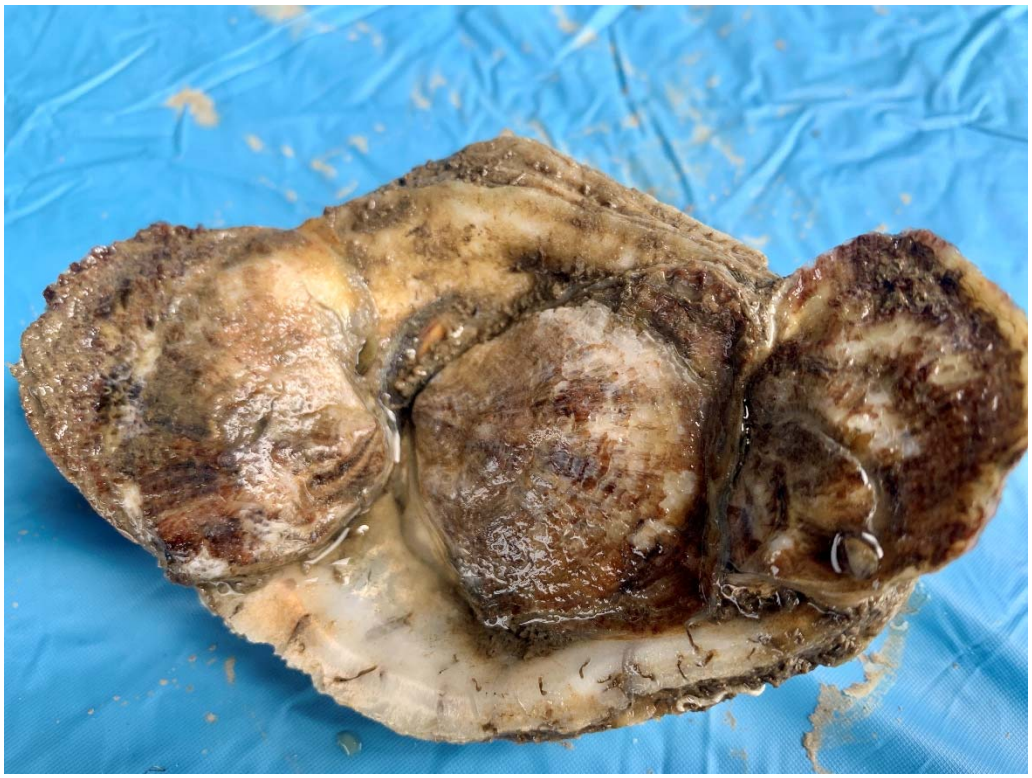


Figure 8. Oyster growth on a single recycled shell from a San Leon oyster garden (Fall 2023)

Figure 9. Newly recruited oysters growing on recycled oyster shell from a Beach City oyster garden (Fall 2023)

Figure 10. Oyster shell from a Tiki Island garden with barnacles, mussels, and oysters (Fall 2023)

Figure 11. Oyster growth on recycled shell from a San Leon oyster garden (Fall 2023)

Figure 12. GBF staff placing oysters and recycled shell onto Dickinson Bay Reef Restoration Project site (Fall 2023)

Figure 13. Volunteers and GBF staff placing oysters and recycled shell onto Sweetwater Lake Oyster Shell Breakwater (Fall 2023)

Figure 14. Bag oyster garden

Figure 15. Stringer oyster garden

Figure 16. Cage oyster garden

APPENDIX D
Task 4 Deliverables

VOLUNTEER REEF MONITORING

Task 4
Photographs

Figure 1. Reef monitoring at Sweetwater Lake with Vitol corporate volunteer group (April 2023)

Figure 2. Reef monitoring at Sweetwater Lake with Vitol corporate volunteer group (April 2023)

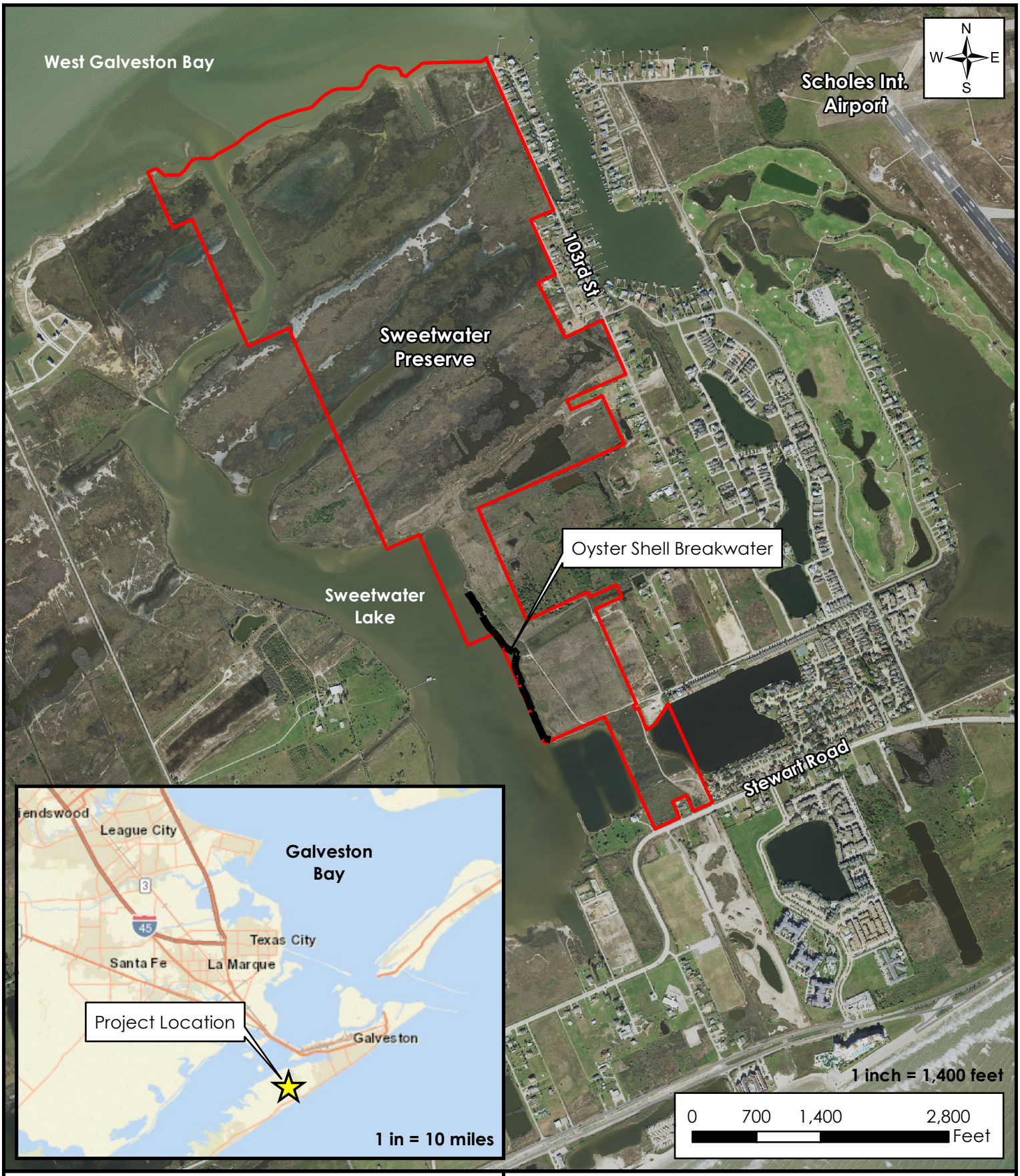
Figure 3. Reef monitoring at Sweetwater Lake with Moody Gardens' SAVY volunteer youth group (June 2023)

Figure 4. Reef monitoring at Sweetwater Lake with Moody Gardens' SAVY volunteer youth group (June 2023)

Figure 5. Reef monitoring at Sweetwater Lake with GBF Staff and a film crew to interview the staff (September 2023)

Figure 6. Reef monitoring at Sweetwater Lake with GBF Staff (September 2023)

Task 4
Map of Reef Monitoring Site Location

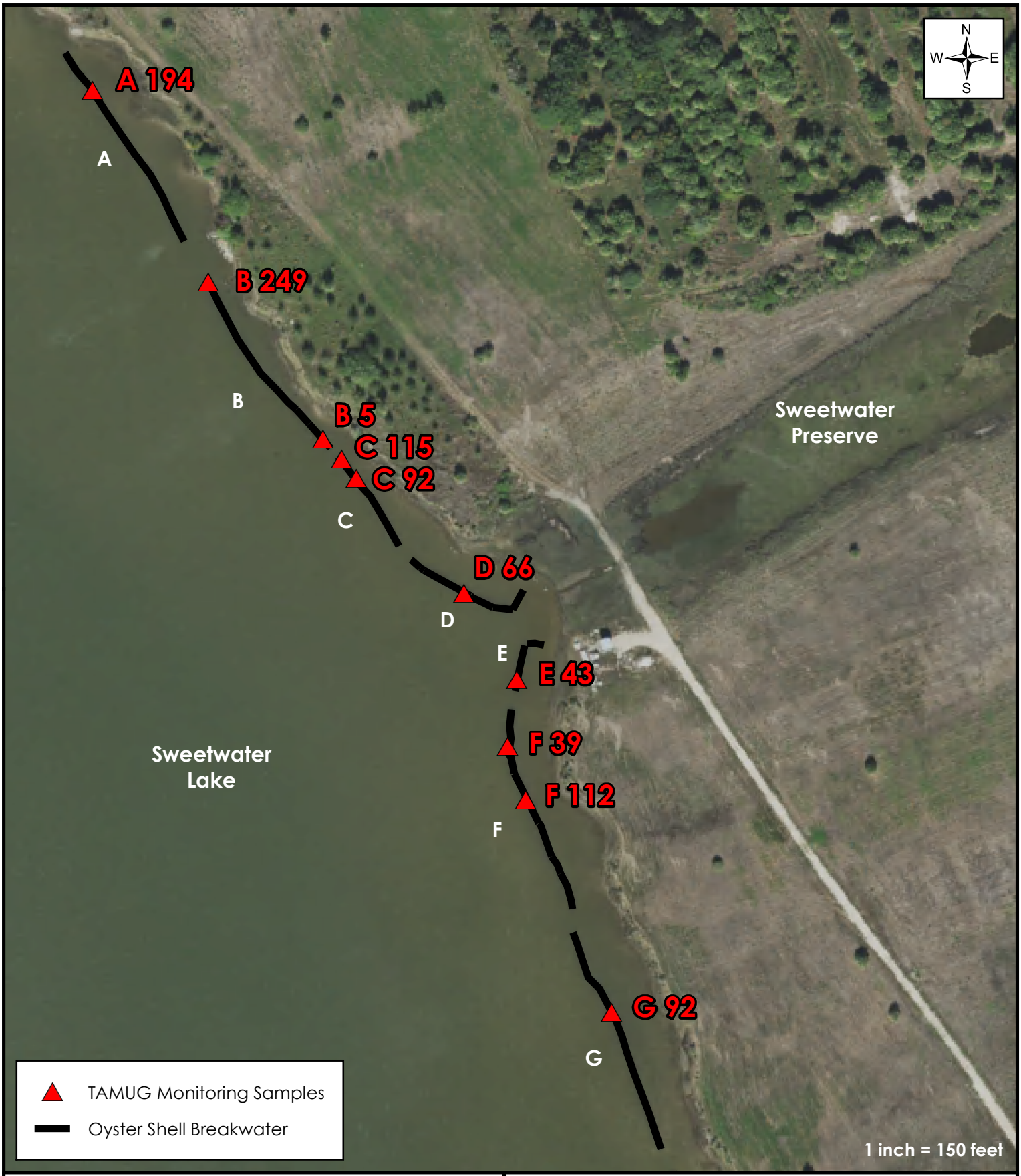


LOCATION MAP

Project Name: Sweetwater Lake Oyster Shell Breakwater	
Project Location: Galveston, Galveston Co., TX	
Image Source: NAIP 2020; ESRI World Street Map	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 1/20/2023	Drawn by: H.Leija

GALVESTON BAY FOUNDATION

1725 Highway 146, Kemah, TX; (281) 332-3381



Oyster Reef Monitoring - Sample Locations

Project Name: Sweetwater Lake Oyster Shell Breakwater	
Project Location: Sweetwater Preserve, Galveston Co., TX	
Image Source: NAIP 2020	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 3/16/2022	Drawn by: H.Leija

GALVESTON BAY FOUNDATION

1725 Highway 146, Kemah, TX; (281) 332-3381

Task 4
Reef Monitoring Data and Results

Galveston Bay Foundation Oyster Reef Monitoring - FIELD DATA

Site Name		GBF Staff Name(s)	
Date		Observer Name(s)	
Monitoring Bag ID		Recorder Name(s)	
Total LIVE Oyster Count		*Total DEAD Oyster Count*	

Live Oyster Lengths (mm)

Recently Dead *(still has both shells)* **Oyster Length (mm):**

Dark False Mussel Count (small, smooth/no ridges, tan/brown in color)

Tally:	Total:

Hooked Mussel Count (hooked, ridged, dark brown in color)

Tally:	Total:

Mobile Species Present

- ☐ Bigclaw Snapping Shrimp
- ☐ Marsh Grass Shrimp
- ☐ Mud Crabs
- ☐ Porcelain Crabs
- ☐ Stone Crabs
- ☐ Fish - Gobies
- ☐ Fish - Toadfish
- ☐ Other:_____
- _____
- _____

Notes:

Chart 1. Average Number of Oysters for Section A

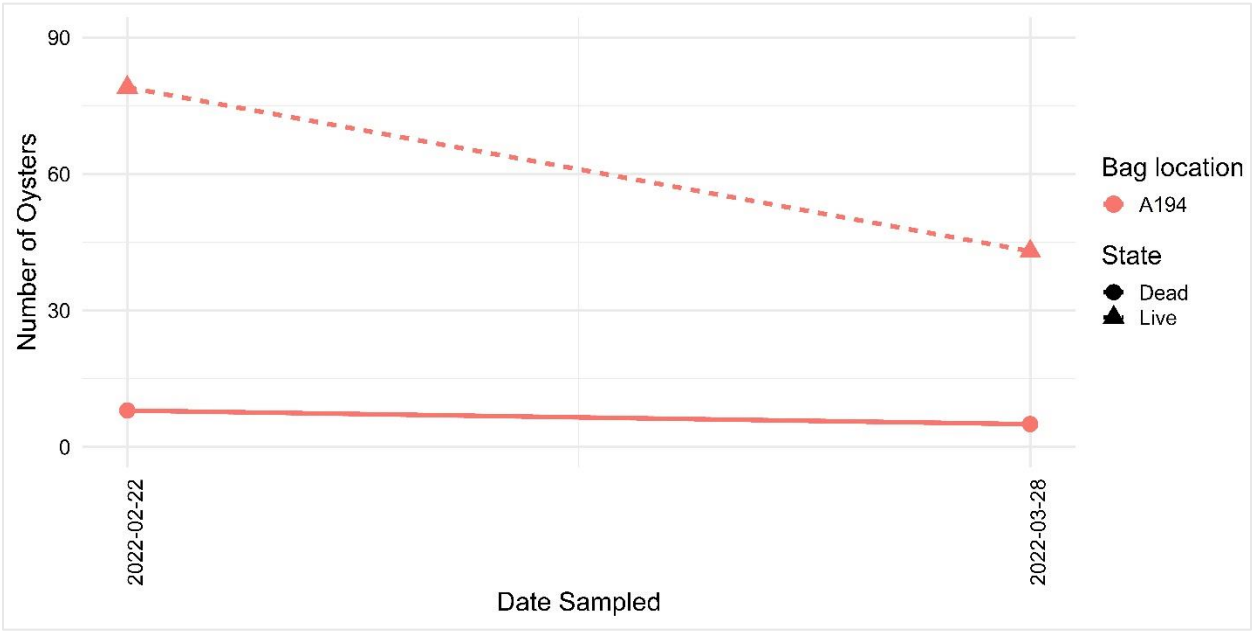


Chart 2. Average Number of Oysters for Section B

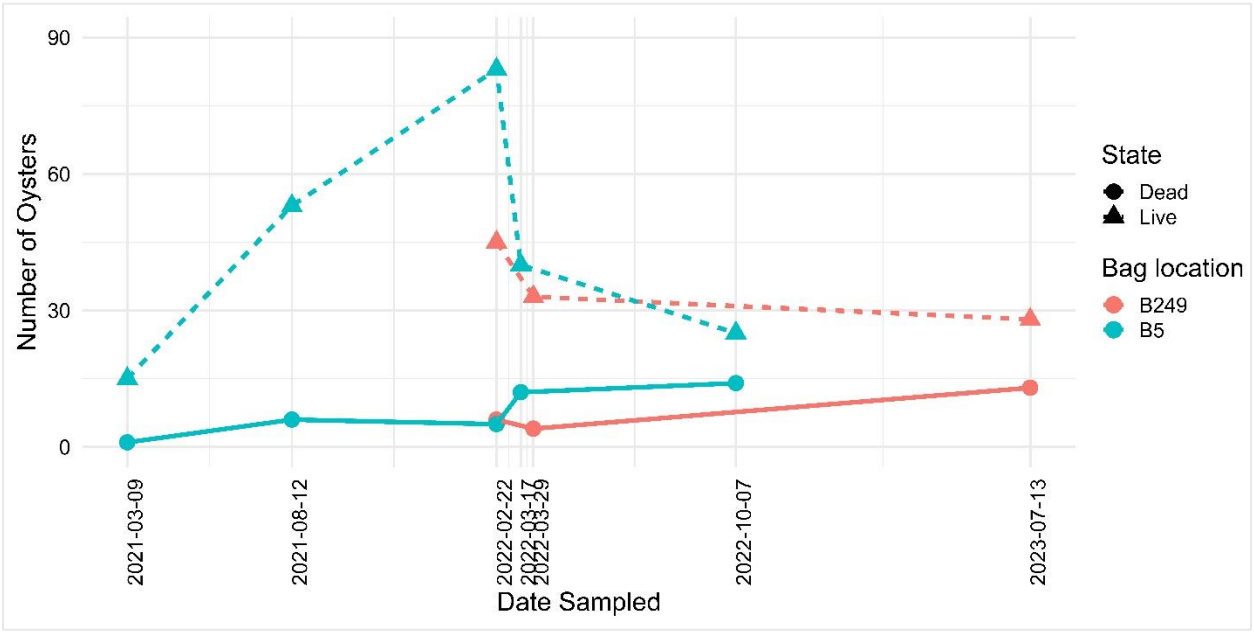


Chart 3. Average Number of Oysters for Section C

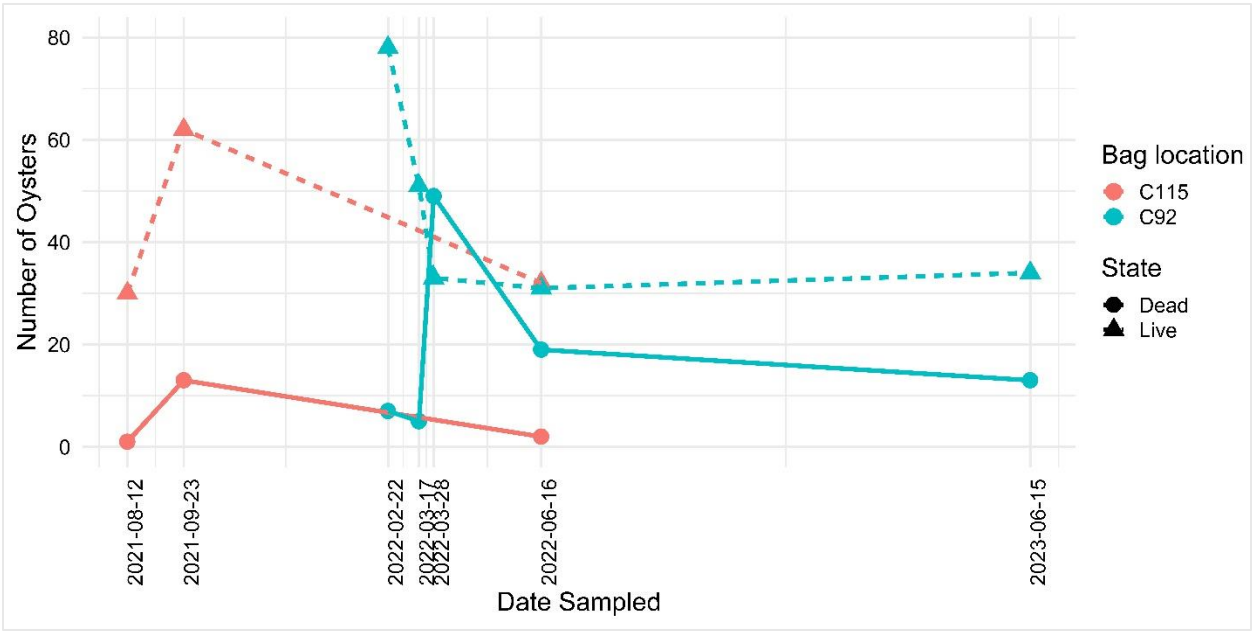


Chart 4. Average Number of Oysters for Section D

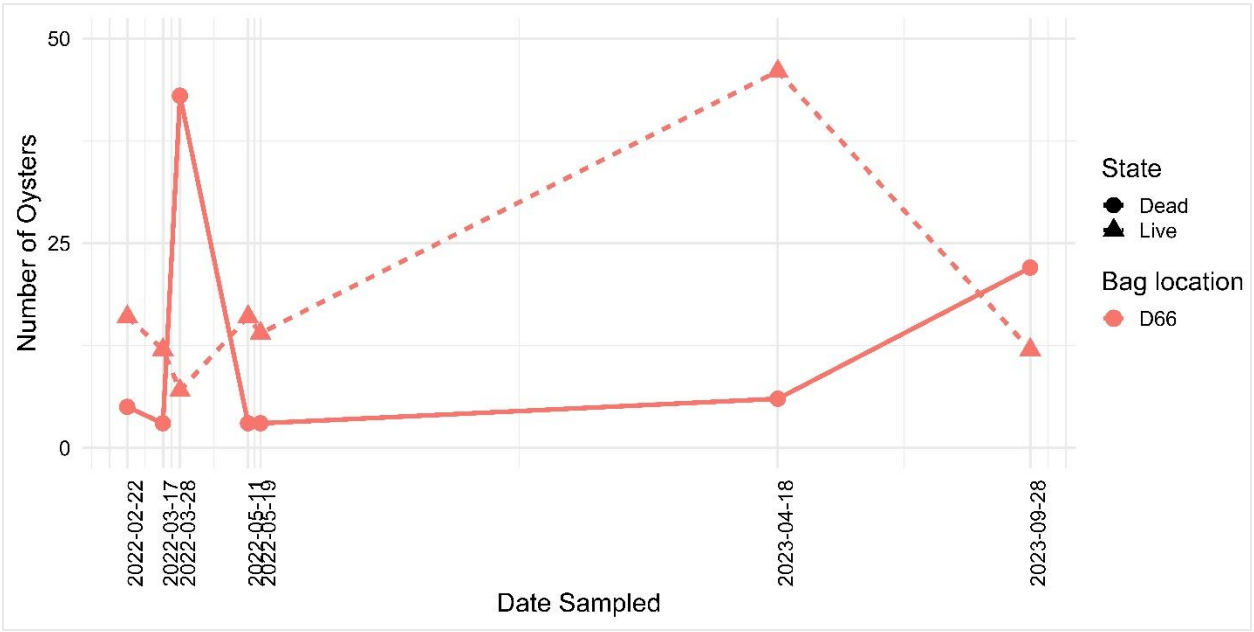


Chart 5. Average Number of Oysters for Section E

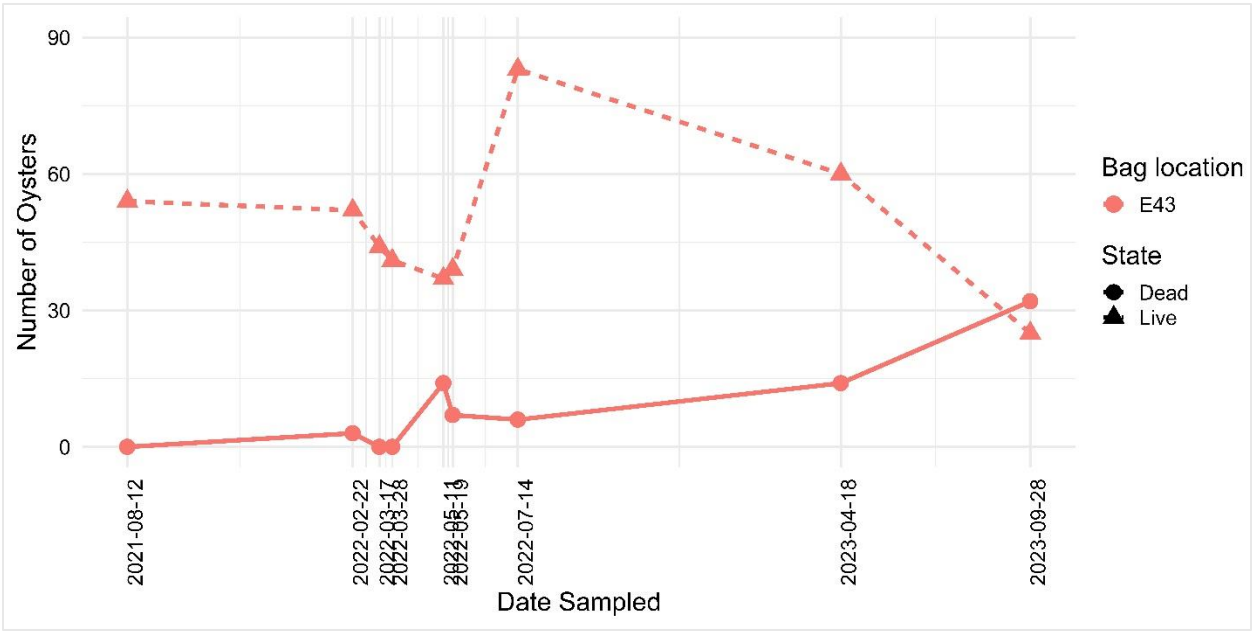
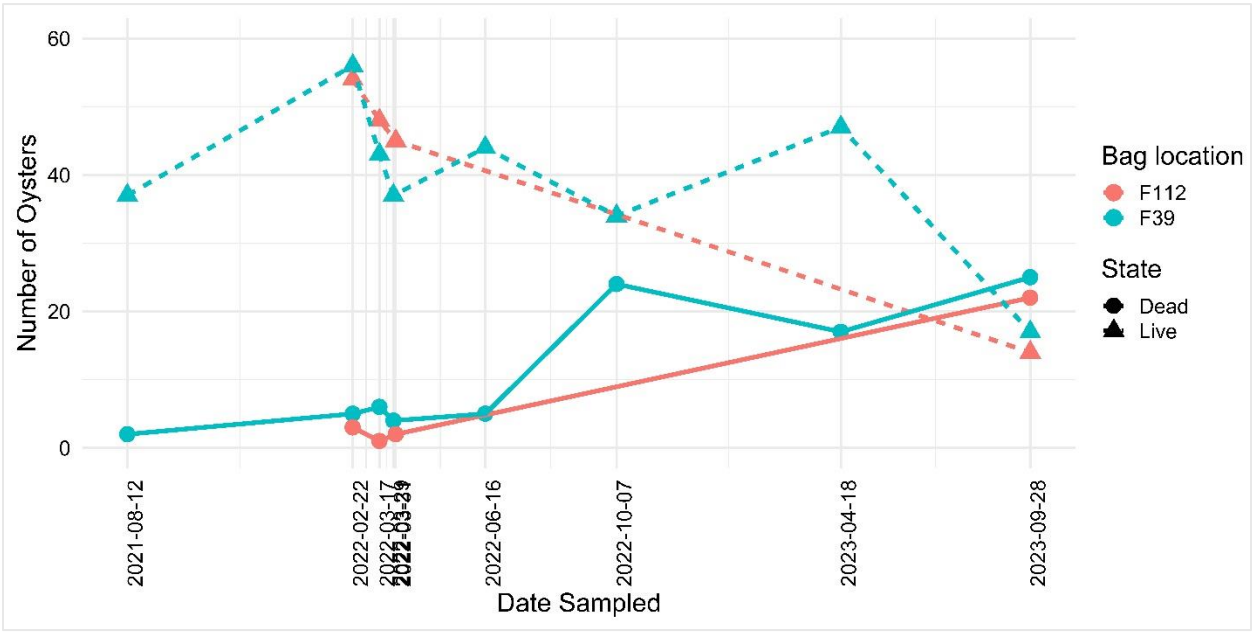


Chart 6. Average Number of Oysters for Section F



** Two sample dates are very close together on the figure and therefore hard to read. These dates are 2022-03-29 and 2022-03-31.*

Chart 7. Average Number of Oysters for Section G

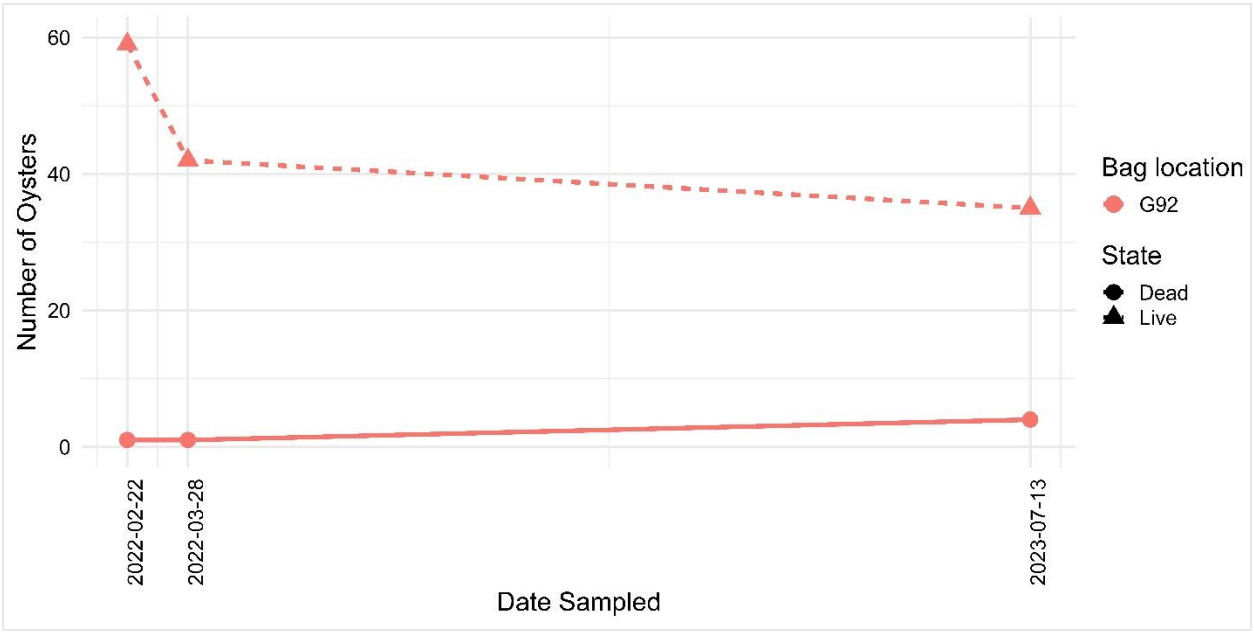


Chart 8. Average Length of Oysters for Section A

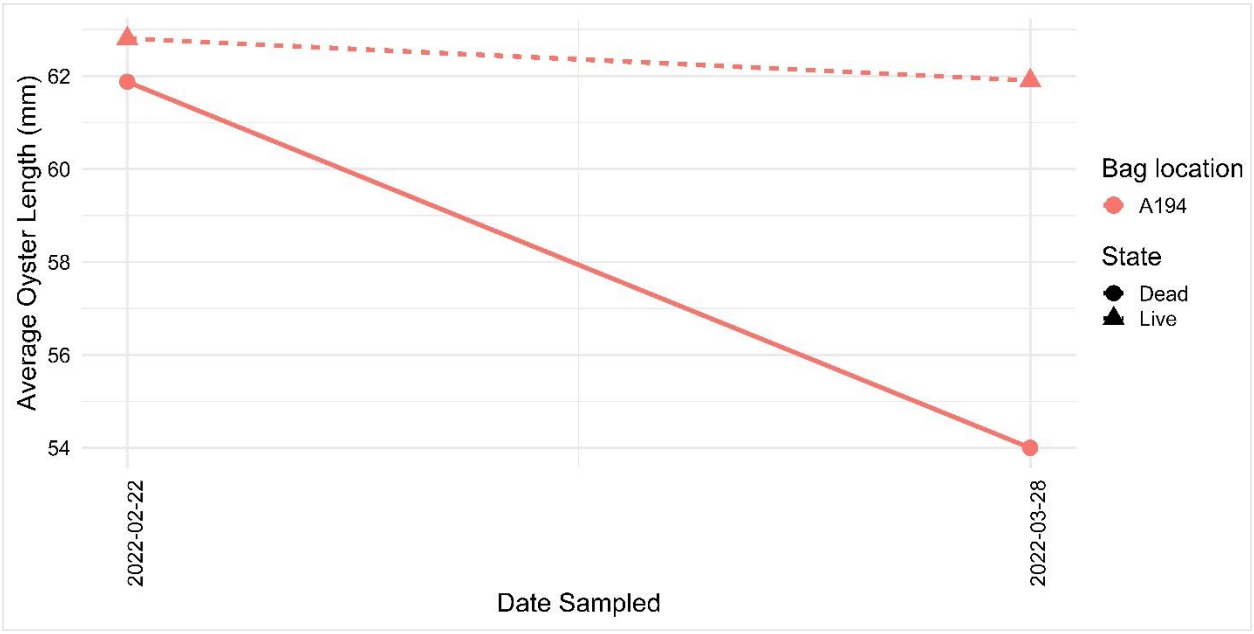


Chart 9. Average Length of Oysters for Section B

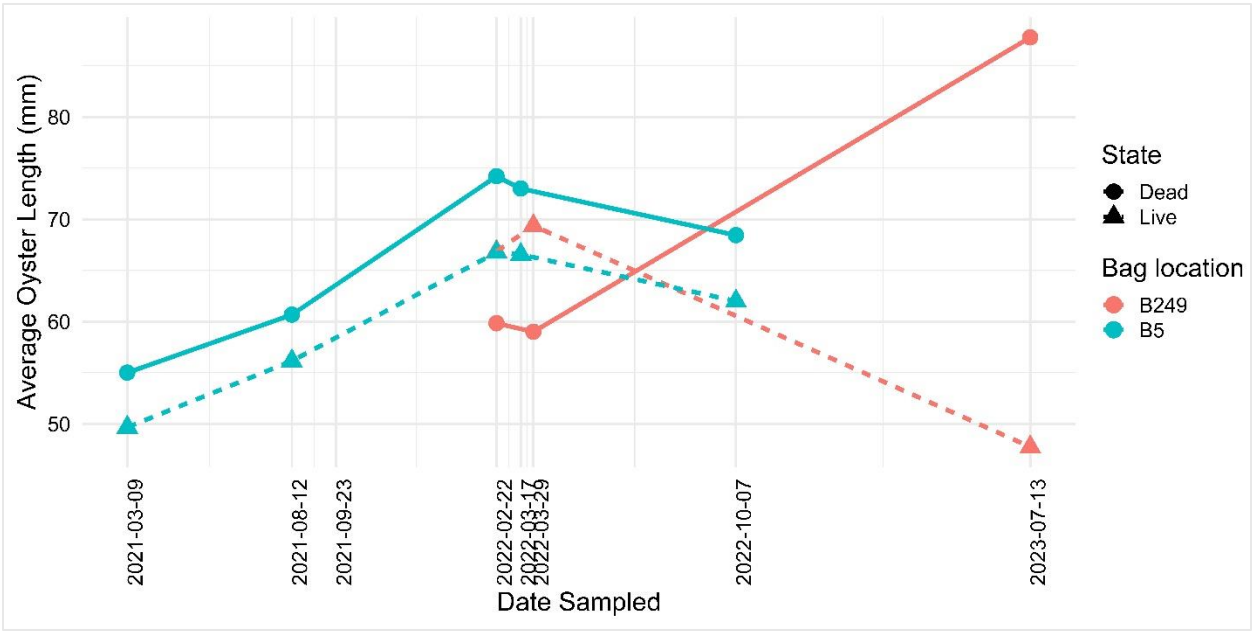


Chart 10. Average Length of Oysters for Section C

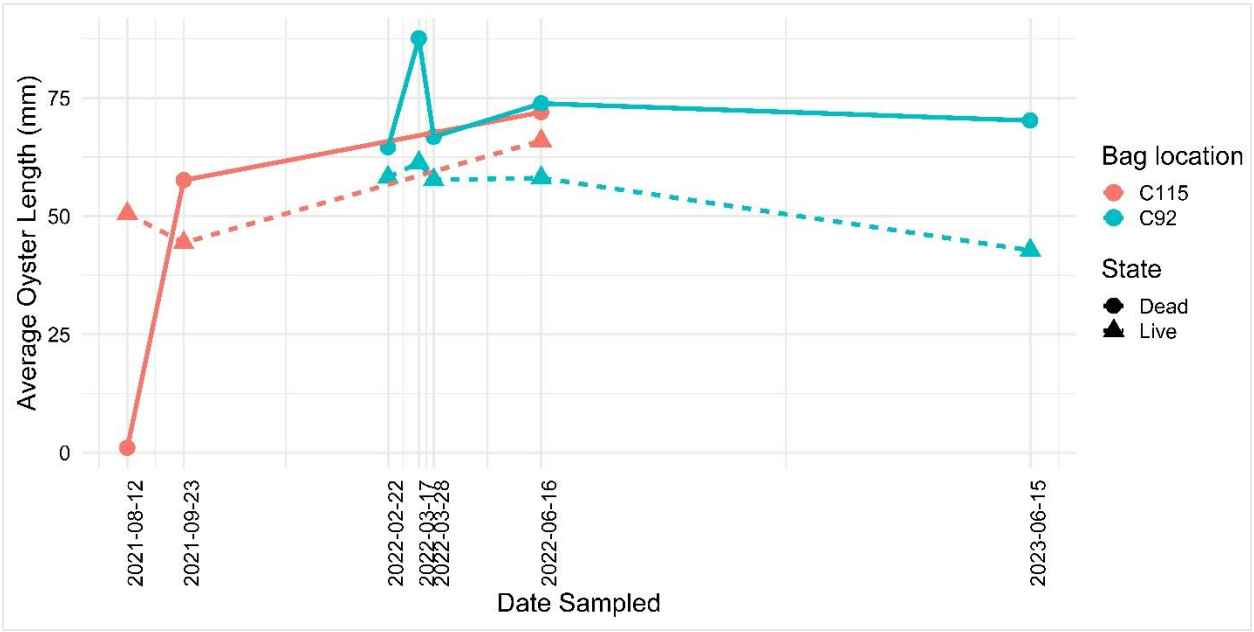


Chart 11. Average Length of Oysters for Section D

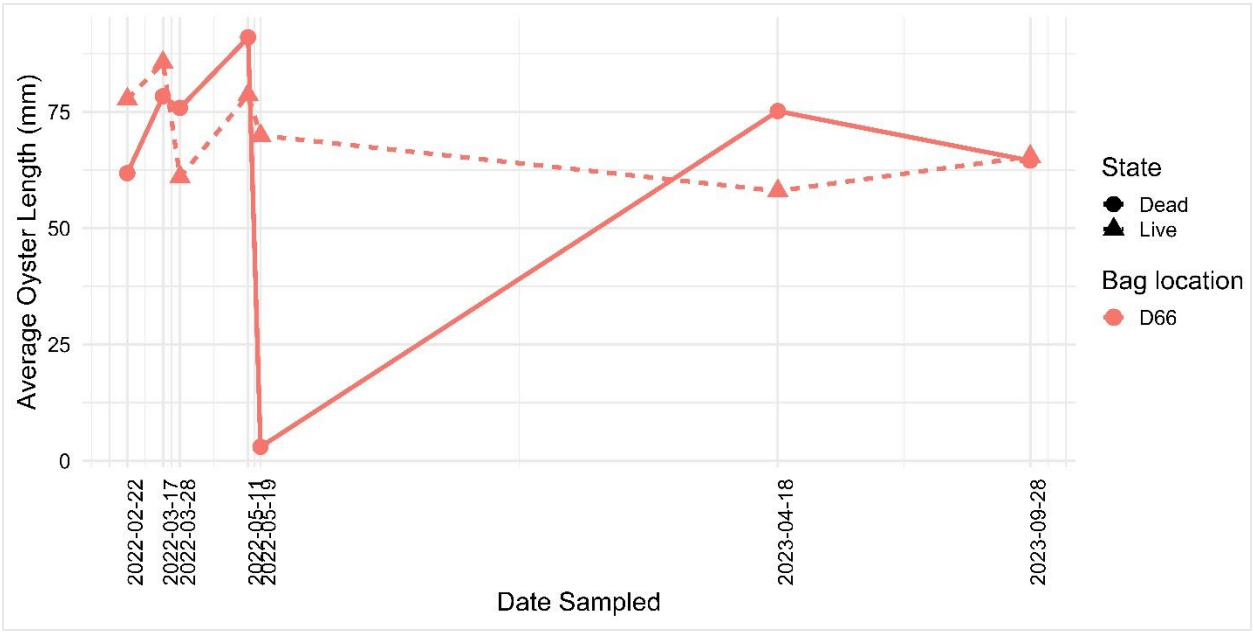


Chart 12. Average Length of Oysters for Section E

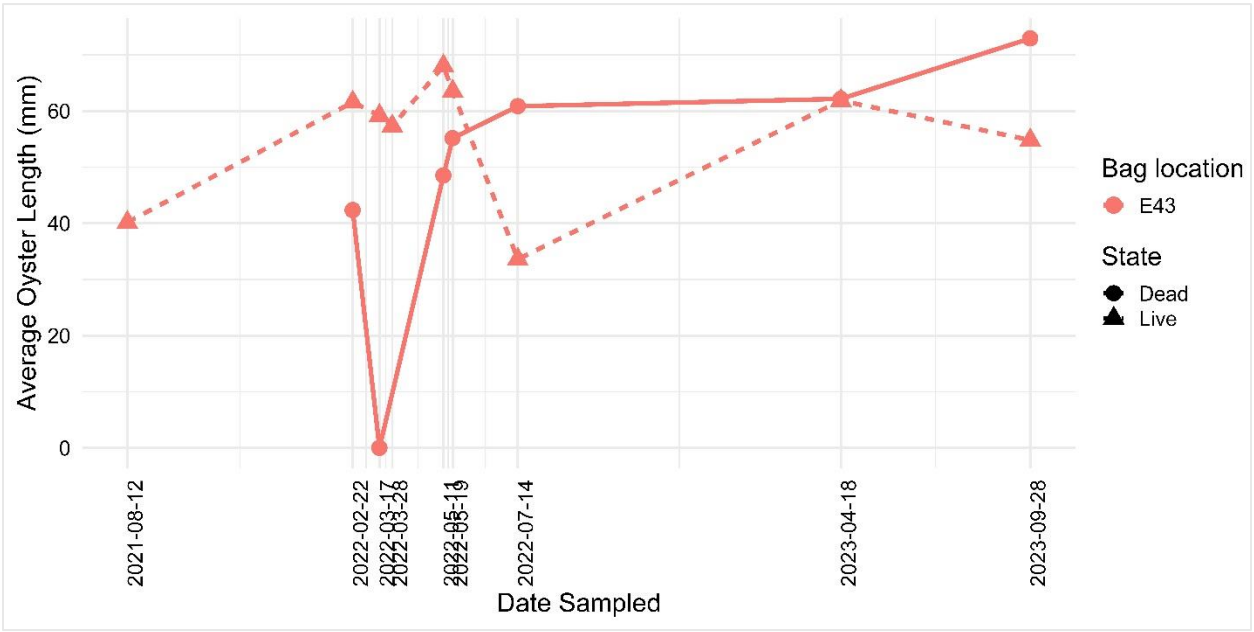
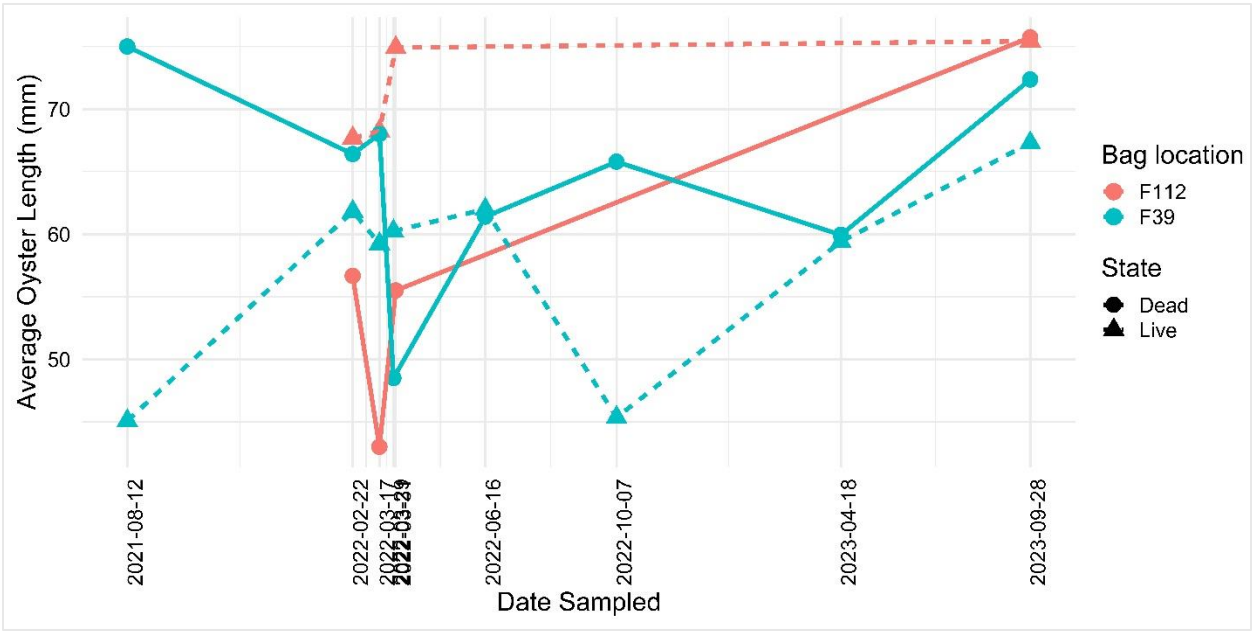
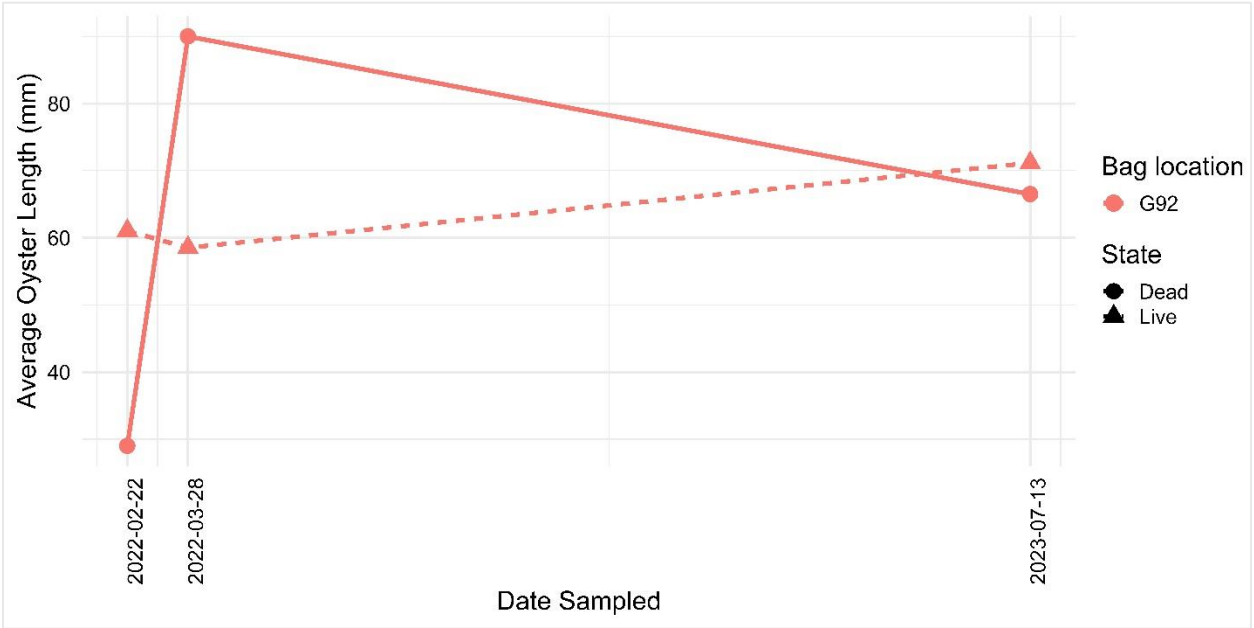


Chart 13. Average Length of Oysters for Section F



** Two sample dates are very close together on the figure and therefore hard to read. These dates are 2022-03-29 and 2022-03-31.*

Chart 14. Average Length of Oysters for Section G



APPENDIX E
Task 5 Deliverables

VOLUNTEER WATER MONITORING

Task 5
Volunteer Monitors and Monitoring Locations

Table 1. List of Active Sampling Locations and Volunteer Monitors

Site ID	Active Site Description	Latitude	Longitude	Sampler
15105	Clear Lake at Clear Lake Park Pier	29.563703	-95.066049	Diane Humes
30013	Galveston Bay at Texas City Dike	29.387027	-94.874629	Brad Ober
80719	Moses Lake at Texas City Prairie Preserve	29.428824	-94.95047	Scott Buckel
80758	Clear Lake at Jarboe Bayou Park	29.542023	-95.030541	Mary Christian
80950	Galveston Bay at Sylvan Beach Park	29.652914	-95.005539	Dan and Ann Hoge
80952	Galveston Bay at 3903 Bayshore Bacliff	29.515548	-94.9857	Dianne Forthman and Joe Cavallaro
80953	Clear Lake at Endeavour Marina	29.559879	-95.042235	Mike Petitt
80955	Clear Lake at Bal Harbor Marina	29.55489	-95.07297	Beverly Morrison
81034	Offatt's Bayou at Sea Star Base Galveston	29.285622	-94.853502	Joe Bryan
81038	West Bay at Eckert Bayou	29.221619	-94.933181	Suzanne Dehart
81046	West Bay at Sweetwater Preserve	29.272506	-94.881102	Cindy Sivon
81217	Clear Lake at Taylor Lake Entrance and Nasa Road	29.565483	-95.053867	Steve Ellerbe
80951	Galveston Bay at Bayshore Park	29.506474	-94.95805	Steve Ellerbe
81444	Burnet Bay at Baytown Nature Center	29.75956	-95.053053	Steve Ellerbe
81158	West Bay at Pirate's Cove	29.217963	-94.949425	Sandra Metoyer
81159	Jones Bay at Bayou Vista	29.323449	-94.946625	Chris Roper
81160	Galveston Bay at Texas Corinthian Yacht Club	29.529115	-95.003242	Kris Johnson
81162	Galveston Bay at Houston Yacht Club	29.619129	-94.999132	James Sowerby
81218	Galveston Bay at Todville Rd	29.569982	-95.009848	Suzanne Milby
81282	West Bay at Jamaica Beach	29.189151	-94.980308	Wayne O'Quin
81301	Trinity Bay at Fort Anahuac Park	29.75533	-94.69028	Laurie Gonzales and Karen Morris
81517	West Bay at Bay Harbor	29.1315278	-95.07128	David and Margaret Labbe
81161	Galveston Bay at Sunset Cove	29.152351	-95.02971	Cliff Shock
30007	Offatt's Bayou at Camarone's Coastal Tex Mex	29.278705	-94.83472	Morgan Heckler and Diego Montes
80958	Jones Bay at Tiki Tom's RV Park	29.304188	-94.906542	Chelsey Hill
81049	Clear Lake at Portofino Harbor Marina	29.547255	-95.025551	Karen Garvin
81757	Dickinson Bayou at 1649 Dick Bay Drive	29.473067°	-94.951750°	Connie Pothier
81284	Galveston Bay at Morgans Point	29.678835	-94.982656	Alex Contreras
81037	Clear Lake at South Shore Harbor	29.54733	-95.064334	Tracy Walpole
81040	Clear Lake at Nassau Bay Yacht Club	29.541451	-95.09718	Jhamila Perrier

Task 5
Copies of Information Products Created from WMT Data

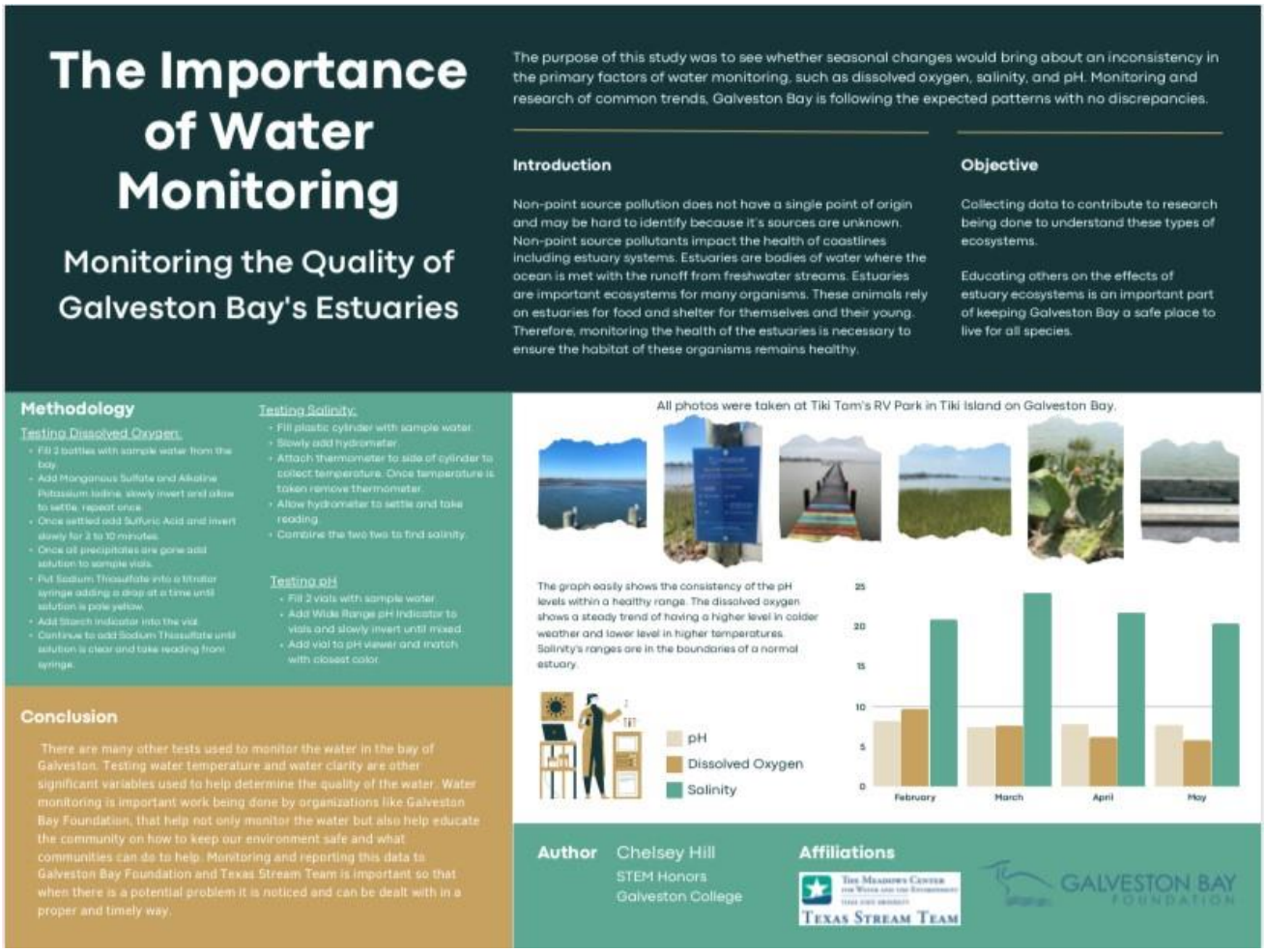


Figure 1. Poster created by undergraduate student using GBF water quality data that they retrieved from GBF Quality Data Viewer (Spring 2023)

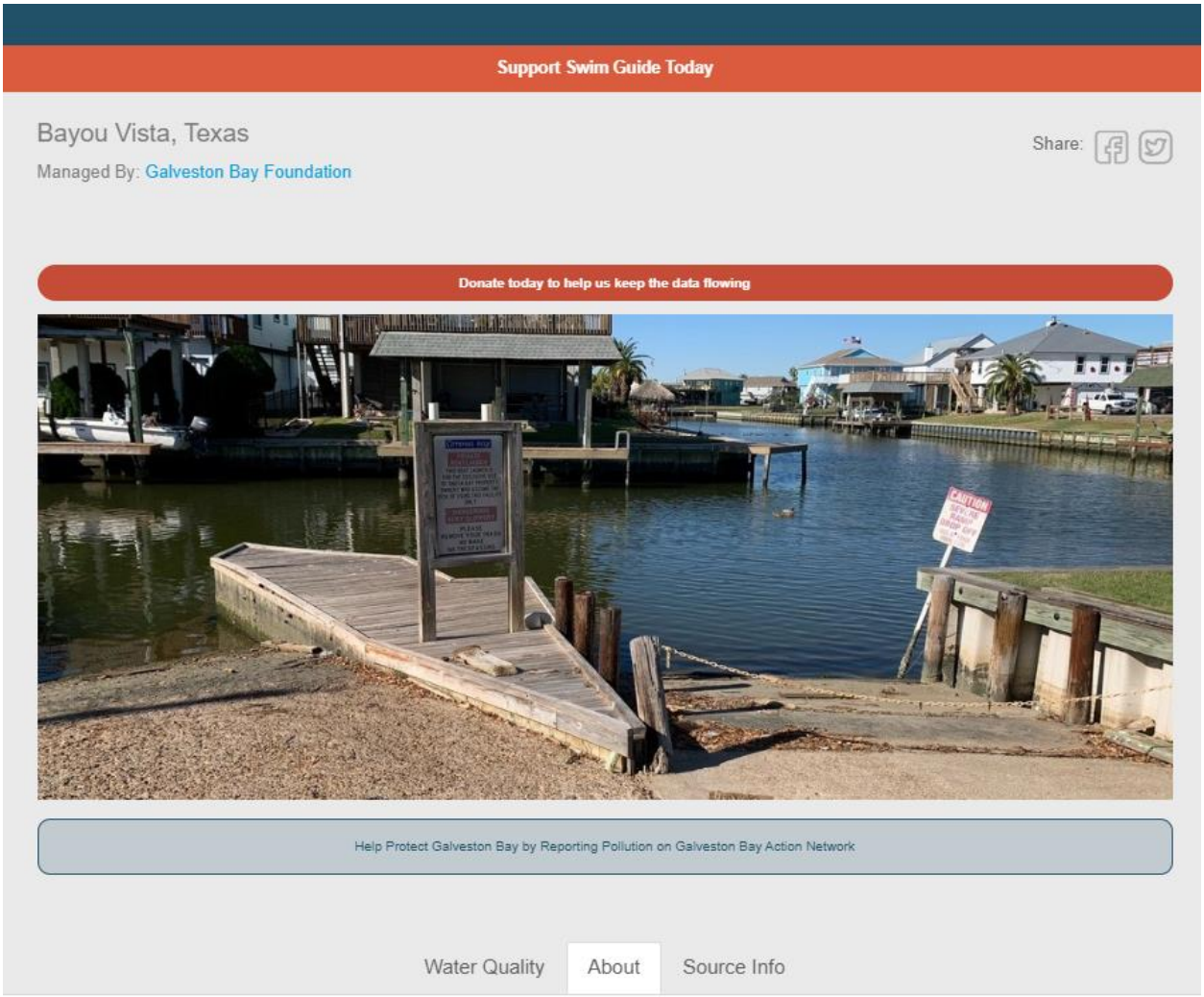


Figure 2. Example of an updated description and photo on Swim Guide. More can be found at swimguide.org

SAFE TO SWIM IN GALVESTON BAY?

February 2, 2024 (https://www.galvbaygrade.org/cover-stories/2024/02/safe-to-swim-in-galveston-bay/) Lisa Scobe (https://www.galvbaygrade.org/cover-stories/author/lscobel/)

Before spending time on the water, you may be questioning if the water is safe to swim in. The Galveston Bay Report Card is here to help you have an easy way to answer these questions through the Human Health – Recreation indicator (/human-health/#recreation). In addition, t and individuals to valuable resources and work being done in th

For example, Galveston Bay Foundation's Water Monitoring Te concentrations, at locations around the Bay monthly. The type c (***Enterococcus sp.***) which is associated with guts of birds and mar sicknesses such as rashes and skin irritation, as well as eye, ea health issues, these bacteria can also impair the oyster harvest

Fecal bacteria are introduced to the Bay system through polluted runoff, malfunctioning wastewater treatment systems, and boater waste discharge. In fact, stormwater runoff is considered a top reason for impaired streams in urban areas! Current efforts are underway to learn more, and Galveston Bay Foundation is working with academic partners to do further research and determine the source of most bacteria entering into Galveston Bay from local tributaries.

Luckily, bacteria monitoring has shown that most of the time bacteria levels in the open water of Galveston Bay are low enough to be considered safe for swimming. However, swimming in certain rivers, streams, and bayous that feed into the Bay may be discouraged.

But before diving in, check out one of the following resources for any advisories and things to watch out for.

- Visit the Texas Beach Watch website (https://cgis.glo.texas.gov/Beachwatch/index.html) to see current measurements along gulf coast Texas Beaches.
- You can also visit https://www.theswimguide.org/ (https://www.theswimguide.org/)to find your closest beaches, know at a glance which ones are safe for swimming, and share your love of beaches with friends and family. Swim Guide delivers free real-time water quality information for over 7,000 beaches throughout the world.
- Watch out for large amounts of algae floating in the water, or dead fish or wildlife in the area. If the water is very cloudy, unusually hot, or if it has just stormed, think twice before swimming!

What can I do to reduce bacteria in Galveston Bay?

- Properly dispose of your cooking fats, oils, and grease. Put them in the trash, never down the drain! ***ceasethegrease.net*** (http://ceasethegrease.net)
- Pump out, don't dump boater waste. ***pumpdontdump.org*** (http://pumpdontdump.org)
- Reduce runoff by using a rain barrel. ***galvbay.org/rainbarrels*** (http://galvbay.org/rainbarrels)
- Pick up after your pet. ***h-gac.com/community/pet-waste*** (http://www.h-gac.com/community/pet-waste/default.aspx)
- Properly maintain your septic system

Cover Story (https://www.galvbaygrade.org/cover-stories/category/cover-story/). permalink (https://www.galvbaygrade.org/cover-stories/2024/02/safe-to-swim-in-galveston-bay/).

< 2023 GALVESTON BAY REPORT CARD SUMMARY (HTTPS://WWW.GALVBAYGRADE.ORG/COVER-STORIES/2024/02/2023-GALVESTON-BAY-REPORT-CARD-SUMMARY/)

COVER STORIES

Care about Galveston Bay?

Sign up to get the latest Report Card update and new cover stories!

¿ES SEGURO NADAR EN LA BAHÍA DE GALVESTON?

febrero 2, 2024 (https://www.galvbaygrade.org/es/cover-stories/2024/02/es-seguro-nadar-en-la-bahia-de-galveston-2/)

Lisa Scobe (https://www.galvbaygrade.org/es/cover-stories/author/lscobel/)

Antes de pasar tiempo en el agua, es posible que se pregunte si el agua es segura para nadar. El boletín de calificaciones de la Bahía de Galveston está aquí para ayudarlo a obtener las respuestas a estas preguntas de manera fácil a través del indicador de recreación de salud humana (/es/resumen-sobre-los-riesgos-para-la-salud-humana/#recreacion). Además, el boletín de calificaciones es una forma de conectar a comunidades e individuos con recursos valiosos y trabajos que se están llevando a cabo en la zona.

Por ejemplo, el Equipo de Monitoreo de Agua de la Fundación Bahía de Galveston recolecta mensualmente datos sobre la calidad del agua, incluidas las concentraciones de bacterias, en distintos puntos de la bahía. El tipo bacteria controlada es una bacteria indicadora de contaminación fecal (***Enterococcus sp.***) que se asocia a lo

intestinos de aves y mamíferos. La exposición a las bacterias fecales puede ocasionar enfermedades como erupciones cutáneas e irritaciones de la piel, así como infecciones oculares, respiratorias y del oído. Además de los problemas de salud humana, estas bacterias también pueden perjudicar a la industria de cosecha de ostras.

Las bacterias fecales se introducen en el sistema de la bahía a través de la escorrentía contaminada, el mal funcionamiento de los sistemas de tratamiento de aguas residuales y los desechos liberados por las embarcaciones. De hecho, la escorrentía de las aguas pluviales se considera una de las principales causas de deterioro de los arroyos en las zonas urbanas. En la actualidad, la Fundación Bahía de Galveston colabora con instituciones académicas para seguir investigando y determinar el origen de la mayoría de las bacterias que llegan a la Bahía de Galveston procedentes de los ríos afluentes locales.

Afortunadamente, el control de las bacterias muestra que la mayor parte del tiempo los niveles de bacterias en el mar abierto de la Bahía de Galveston son lo suficientemente bajos para que sea seguro nadar en ella. No obstante, puede desaconsejarse nadar en determinados ríos, arroyos y pantanos que desembocan en la bahía.

Antes de sumergirse, consulte uno de los siguientes recursos para conocer las advertencias y las cosas que hay que tener en cuenta.

- Visite el sitio web de Texas Beach Watch (https://www.theswimguide.org/) para consultar las mediciones actuales en las playas de la costa del golfo de Texas.
- También puede visitar https://www.theswimguide.org/ (https://www.theswimguide.org/) para encontrar las playas más cercanas, saber rápidamente cuáles son seguras para nadar y compartir su amor por las playas con amigos y familia. La Guía de natación le proporciona información gratuita de más de 7.000 playas alrededor del mundo en tiempo real.
- Fíjese si hay grandes cantidades de algas flotando en el agua o peces o vida silvestre muertos en el área. Si el agua es muy turbia, inusualmente caliente o si hubo una tormenta recientemente, ¡piénselo dos veces antes de nadar!

¿Qué puedo hacer para reducir las bacterias en la Bahía de Galveston?

- Deseche de manera apropiada las grasas y los aceites para cocinar. Colóquelas en la basura, ¡nunca las tire al desagüe! ***ceasethegrease.net*** (http://ceasethegrease.net/)
- Extraiga los desechos con una bomba, no los descargue en el agua. ***pumpdontdump.org*** (http://pumpdontdump.org/)
- Reduzca la escorrentía con un barril de recolección de aguas de lluvia. ***galvbay.org/rainbarrels*** (http://galvbay.org/rainbarrels)
- Recoja los desechos de sus mascotas. ***h-gac.com/community/pet-waste*** (http://www.h-gac.com/community/pet-waste/default.aspx)
- Mantenga adecuadamente su sistema séptico.

Cover Story (https://www.galvbaygrade.org/es/cover-stories/category/cover-story-es/), Cover Story (https://www.galvbaygrade.org/es/cover-stories/category/cover-story-es/). Enlace permanente (https://www.galvbaygrade.org/es/cover-stories/2024/02/es-seguro-nadar-en-la-bahia-de-galveston-2/).

BƠI Ở VỊNH GALVESTON CÓ AN TOÀN?

Tháng Hai 2, 2024 (https://www.galvbaygrade.org/vi/cover-stories/2024/02/boi-o-vinh-galveston-co-an-toan/) Lisa Scobe (https://www.galvbaygrade.org/vi/cover-stories/author/lscobel/)

Trước khi hòa mình vào làn nước xanh mát, có lẽ bạn vẫn sẽ tự hỏi nước nơi này có an toàn để bơi không. Báo cáo Vịnh Galveston sẽ giúp bạn giải đáp mọi thắc mắc một cách dễ dàng thông qua Chỉ số sức khỏe con người – Vui chơi giải trí. Ngoài ra, Báo cáo còn là một phương thức kết nối cộng đồng và cá nhân với các nguồn lực quý báu và dự án đang thực hiện trong khu vực.

Ví dụ: Hàng tháng, đội Giám sát Nguồn nước của Galveston Bay Foundation sẽ thu thập dữ liệu về chất lượng nước, bao gồm cả nồng độ vi khuẩn, tại các khu vực xung quanh Vịnh. Loại vi khuẩn được giám sát là vi khuẩn chỉ thị ô nhiễm phân (Enterococcus sp.) từ đường ruột của chim và động vật có vú. Phơi nhiễm vi khuẩn ô phân có thể gây ra các bệnh như phát ban, kích ứng da, nhiễm trùng mắt, tai và đường hô hấp. Ngoài cá sức khỏe con người, những vi khuẩn này còn có thể gây hại cho ngành đánh bắt hàu.

Vi khuẩn ô nhiễm phân đi vào hệ sinh thái Vịnh thông qua dòng chảy bề mặt ô nhiễm, hệ thống xử lý nước thải bị trục trặc và dòng xả thải của tàu thuyền. Trên thực tế, dòng chảy bề mặt từ nước mưa là nguyên nhân hàng đầu gây suy giảm các dòng chảy ở đô thị! Galveston Bay Foundation đang tiếp tục nỗ lực tìm hiểu và hợp tác với các đối tác học thuật để nghiên cứu sâu hơn và xác định nguồn gốc của hầu hết vi khuẩn xâm nhập vào Vịnh Galveston từ các nhánh sông địa phương.

May mắn thay, kết quả giám sát vi khuẩn cho thấy hầu hết nồng độ vi khuẩn trong vùng nước tự nhiên của Vịnh Galveston đều thấp, an toàn cho bơi lội. Tuy nhiên, không khuyến khích bơi lội ở một số sông, suối và nhánh sông đổ vào Vịnh.

Trước khi bơi vui lòng truy cập một số nguồn sau để tham khảo lời khuyên và những điều cần chú ý.

- Truy cập vào Trang web Texas Beach Watch (https://cgis.glo.texas.gov/Beachwatch/index.html) để xem chỉ số dọc theo bờ vịnh Texas Beaches hiện tại.
- Bạn cũng có thể truy cập https://www.theswimguide.org/ (https://www.theswimguide.org/) để tìm những bãi biển gần nhất, bãi biển an toàn bơi lội cũng như chia sẻ tình yêu biển với bạn bè và gia đình. Swim Guide mang đến thông tin chất lượng nước theo thời gian thực tại hơn 7.000 bãi biển trên khắp thế giới, hoàn toàn miễn phí.
- Hãy chú ý đến lượng lớn tảo nổi trên mặt nước, cá chết hoặc động vật hoang dã trong khu vực. Nếu nước đục, nóng bất thường hoặc vừa có bão, hãy suy nghĩ kỹ trước khi bơi!

Tôi có thể làm gì để giảm vi khuẩn ở Vịnh Galveston?

- Vứt bỏ chất béo, dầu và mỡ nấu ăn đúng cách. Hãy bỏ dầu thải vào thùng rác, đừng bao giờ đổ xuống cống! ***ceasethegrease.net*** (http://ceasethegrease.net/)
- Hãy bơm chất thải vào nơi chứa, đừng đổ chất thải từ tàu xuống biển. ***pumpdontdump.org*** (http://ceasethegrease.net/)
- Giảm dòng chảy bề mặt bằng cách dùng thùng chứa nước mưa. ***galvbay.org/rainbarrels*** (http://ceasethegrease.net/)
- Dọn sạch chất thải thú cưng. ***h-gac.com/community/pet-waste*** (http://ceasethegrease.net/)
- Bảo trì hệ thống tự hoại đúng cách

Cover Story (https://www.galvbaygrade.org/vi/cover-stories/category/cover-story-vi/). permalink (https://www.galvbaygrade.org/vi/cover-stories/2024/02/boi-o-vinh-galveston-co-an-toan/).

< TÓM TẮT BÁO CÁO VỊNH GALVESTON NĂM 2023 (HTTPS://WWW.GALVBAYGRADE.ORG/VI/COVER-STORIES/2024/02/TOM-TAT-BAO-CAO-VINH-GALVESTON-NAM-2023/)

CÂU CHUYỆN TRÊN BÌA

Tháng Hai 2024 (https://www.galvbaygrade.org/vi/cover-stories/2024/02/)