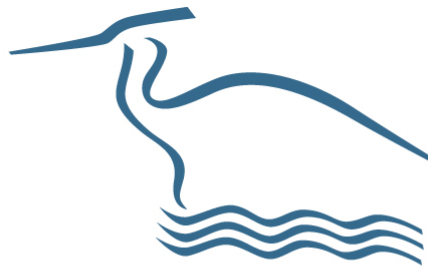


Galveston Bay Foundation's Oyster Shell Recycling Program

GLO Contract No. 17-181-000-9818

**FINAL REPORT
JUNE 2018**

Prepared by:



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I. Project Summary

In an effort to reverse the significant loss of oyster habitat in Galveston Bay, the Galveston Bay Foundation (GBF) works with local restaurants to recycle oyster shells and return them to the bay. Rather than being disposed of in landfills, the oyster shells are returned to the Bay to provide hard substrate and thus enhance the native oyster populations. While oyster larvae find many surfaces suitable for attachment/growth, oyster shells are the preferred substrate for spat recruitment as confirmed by Coen and Luckenbach (2000).

During Grant Cycle 21, specifically from March 2017 through January 2018, 165.74 tons of oyster shells were recycled through GBF's Oyster Shell Recycling Program. These shells are being stored at GBF's "Curing Sites" where they will be turned intermittently with a tractor to allow for proper sun curing before being returned to the Bay. The shells will be used as an aspect of GBF's Volunteer Oyster Gardening efforts and returned to Galveston Bay through (separately funded) oyster reef enhancement and restoration projects such as GBF's "oyster bar" breakwater construction.

II. Background Information

Oyster reefs are a vital component of a healthy estuary. They 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 50% of the oyster reefs have been destroyed, primarily as a result of Hurricane Ike (Hons and Robinson, 2010). Prior to 2008, Galveston Bay provided nearly 80% 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 local oyster restoration efforts, GBF partnered with local restaurant owner Tom Tollet of Tommy's Restaurant and Oyster Bar in 2011 and began recycling oyster shells. Before GBF's Oyster Shell Recycling Program began, oyster shells were discarded along with other restaurant waste and sent to a landfill. To avoid the disposal this vital resource, GBF now partners with multiple local restaurants to collect oyster shells and return them to the bay. The reclaimed shells will serve as new oyster habitat, thus enhancing the local oyster populations.

With the assistance of CMP funding, GBF has expanded the program from the pilot stage with one restaurant and one curing site to a total of eleven restaurant partners over seven years and four curing sites. Under Grant Cycle 21, GBF was able to establish a partnership with Texas A&M University at Galveston (TAMUG) which led to the expansion of recycling efforts onto Galveston Island; including the fourth curing site, on TAMUG property. Shell recycling efforts began through a partnership with BLVD Seafood under Cycle 22. GBF was also able to streamline recycling methods and curing site maintenance, develop new outreach materials and improve the education and awareness of both restaurant patrons and the public in general on the importance of oysters in Galveston Bay.

III. Project Implementation

A) Task 1: Shell Collection & Maintenance

A.1 Shell Collection

GBF staff collected oyster shells from participating restaurants on a weekly basis to relieve the restaurants of their shell waste. Throughout the week, restaurant staff deposited used oyster shells in recycling receptacles. GBF staff transported these containers of shells via truck and trailer to one of three “curing sites” where shells were stored temporarily. As the shells accumulated at the curing sites, GBF staff and volunteers strategically piled the shells every 3 to 4 months using a front-end loader. The shells were then left to sun cure or “bleach” for a minimum of 6 months. As identified by Bushek et al. (2004), sun curing oyster shells for a minimum of 1 month ensures that all bacteria and parasites are eliminated. Following the curing process, the shells were ready to be used in (separately funded) oyster reef restoration and enhancement projects throughout Galveston Bay.

GBF continued to follow the collection schedule utilized in Cycle 20: Monday-Wednesday-Friday. Restaurants producing greater than 1 ton of oyster shells annually were provided with two or more pick-ups per week. Restaurant partners with less output, or those located off the main route, received collection services once a week.

A.2 Shell Tracking

To track the amount of oyster shells recycled, GBF staff maintained spreadsheets that document the tonnage of oyster shells collected daily, monthly, and annually for each participating restaurant. These spreadsheets use standard weight calculations developed in Cycle 20: 192 pounds per 32-gallon bin and 23 pounds per 5-gallon bucket; allowing for a variance of $\pm 5\%$ due to potential human error in measuring the volume of shells, the uneven settling of shells, and other materials/waste often mixed in with the shells.

Please refer to Appendix A for the shell collection numbers and associated graphs.

A.3 Curing Site Maintenance

Red Bluff curing site was maintained on several different occasions throughout Cycle 21. Volunteers came out 3 times to mow the site, to ensure easy and safe access, as well as move, turn, and pile cured/curing shell. Similarly, contracted crews, hired to transport cured shell off site, also generously volunteered their time to help maintain shell piles for proper and efficient curing. At the Inland Marine curing site, staff regularly turned and consolidated shell piles throughout the curing process. Shell piles were kept separate during stages of the curing process to better track the progress. GBF staff maintained a database of all shell at different staging of curing at each curing site.

See Appendix B for a schedule of curing site maintenance.

A.4 Public Disposal Site

In an effort to facilitate oyster shell recycling by local citizens and restaurants located outside GBF's current shell recycling range, GBF staff investigated the possibility of establishing a public oyster shell disposal site. Based on previous research and discussions on public disposal, GBF has determined that under current project conditions, a public disposal site is not the most effective use of time and resources. The most logical method of public disposal would be the construction of a shell drop-off on one of GBF's properties that would contain empty 32-gallon recycling bins, secured to the ground. However, at this time, GBF does not have a suitable property for this type of setup, and thus proper monitoring and collection of recycled shells would be difficult logistically. The most ideal location would be GBF's future headquarters in Kemah, TX, but that property is still a few years from completion.

Currently, there is only minor interest in such a facility from both restaurants as well as private individuals. A public shell disposal facility would require a significant increase in public awareness and marketing. In addition to limited interest, GBF has insufficient funds to proceed with this venture at this time. Further research under CMP Cycles 22 and 23 will be resumed to gauge public interest. In addition, GBF will continue discussion during the preparation of GBF's Kemah Headquarters to determine the viability of a disposal facility onsite and the associated costs such as construction and maintenance.

B) Task 2: Volunteer Oyster Gardening

B.1 Volunteer Recruitment

With the assistance of CMP Cycle 21 funds, GBF hosted three oyster gardening events in local, waterfront communities; San Leon, Kemah, and Bayou Vista (residents from nearby Tiki Island and Galveston were invited to join the Bayou Vista gardening event). GBF provided a presentation to volunteers on the entire Oyster Restoration Program, that included an overview of the shell recycling project and volunteer oyster gardening. Volunteers learned why gardening efforts are important as well as the methods for monitoring and maintaining their gardens for the entire oyster spawning season. These events also included the chance for all volunteers to build their gardens and provided a demonstration on how to properly secure the gardens to docks and piers, or bulkheads.

Throughout the spawning season (June to November), GBF oversaw the progress of volunteers, reminding them of proper monitoring techniques. Volunteers were also given the opportunity to engage in optional citizen science by oyster garden data collection. Please refer to Appendix C for an example of one volunteer's data. In addition, GBF's summer Conservation Intern monitored oyster gardens at the Texas Corinthian Yacht Club as her summer project and collected data on spat recruitment and habitat viability for other marine species such as fish, shrimp, and crabs.

B.2 Tracking Volunteer Oyster Gardening

Volunteer activity was tracked throughout the entire the Oyster Gardening season, from the spring gardening events, throughout the summer months of monitoring, and finally to spat collection in the fall. A total of seventy-five volunteers attended the three separate oyster gardening events in the spring, resulting in the creation of 388 mesh bag gardens. Once spawning season concluded (per Texas Parks and Wildlife Department), all gardens were collected and spat recruitment was documented. Only 147 of the original 388 gardens created were still intact, due to the impacts of Hurricane Harvey. Many of the gardening volunteers lost portions of, or the entirety of, their docks or piers and their oyster gardens along with them. Despite the low number of gardens recovered, 1,027 new spat were still recruited in the volunteers' oyster gardens and successfully returned to the bay onto restoration reefs as a part of GBF's (separately funded) Oyster Restoration Program. In reviewing each community's spat recruitment individually, GBF was able to get a better understanding of the productivity of these oyster gardens. The community of San Leon had very high initial recruitment, but also an almost 90% mortality rate, likely as a result of the effects of Hurricane Harvey's significant freshwater inflows. Kemah provided no data as both piers used for gardening were destroyed during Harvey. Bayou Vista, along with the community of Tiki Island, had very high levels of recruitment and very low levels of mortality, even during, and immediately following the effects of Hurricane Harvey. For detailed oyster gardening tracking documents please refer to Appendix C.

C) Task 3: Public Outreach & Education

To improve the outreach and education component of the Oyster Shell Recycling Program, GBF prepared three new outreach materials under Cycle 21 and updated two existing items. New outreach materials have been found to be very successful for both boothing events as well as project presentations. The new and updated versions set out during Cycle 21 have been much more well received by the public than those produced under prior cycles. The new and updated materials are listed below and shown in Appendix D. Many of these materials will be packaged together during the next funding cycle in order to present a variety of options to new and current restaurant partners and help increase the ability to advertise their partnership with GBF's Recycling Program.

- 1) Recycling Rack Card – The Recycling Rack Card was updated under Cycle 21 to include new program logos and the infographic designed in Cycle 20. This handout has been a very effective means of communication at outreach events, from Oyster Team specific events to other boothing and presentation opportunities overseen by other GBF staff. Due to the simplified message on the rack card, it is easily used by other GBF staff to present information on the Oyster Shell Recycling Program and provide different avenues for interested parties to become involved.
- 2) Gardening Rack Card – Similar to the Recycling Rack Card, the Gardening Rack Card was developed to explain the oyster gardening aspect of this project clearly and accurately. This handout allows both the Oyster Team, as well as other GBF staff to promote oyster

gardening and provide potential volunteers an avenue to become involved. Like the Recycling Rack Card, it has proven to be effective at large bothing events.

- 3) Gardening Volunteer Guide – A small, pocket-sized gardening guide was designed to be given to all Oyster Gardening Volunteers. This guide provides detailed, but easy to follow, reminders on how to install, maintain, and monitor oyster gardens during spawning season. It also provides images on how to identify oyster spat, as well as six other species of fauna commonly found in oyster gardens and on oyster reefs. Another goal of this guide is to improve the citizen science aspect of the gardening program by providing a webpage link to the oyster gardening page where the data form is located.
- 4) Oyster Trailer Sign – After the purchase of a new shell recycling trailer (separately funded prior to Cycle 21), two signs were designed to be mounted on each side of the trailer in order to better advertise the program during oyster shell pickup runs. These signs included both the GBF and Oyster Shell Recycling Program logos as well as a modified version of the infographic. This method of simple advertisement has been effective to better show off and explain the program while the truck and trailer are visible to the public on the road.
- 5) Recycling Bin Toppers – GBF’s Oyster Team was invited back to San Leon’s 2nd Annual Oyster Fest in the spring of 2017 to host a booth to advertise the program and recycle all the oyster shells resulting from the consumption of oysters on the half shell by the 4000+ attendees. The Bin Toppers were designed to be secured to the top of the 32-gallon shell recycling bins. The goal of the toppers was to help facilitate the recycling of only oyster shells, while eliminating the possibility of trash and other undesirable materials from being tossed in the bins. Bins containing the new toppers were scattered throughout the festival grounds in order to both advertise the project and encourage shell recycling. As a result of GBF’s presence at the event, as well as the new bin topper, approximately 2,400 pounds of shells were recycled in one day.

The Oyster Team attended eight events at which the Oyster Shell Recycling Program was promoted through outreach and educational booths (refer to photographs in Appendix F). Local citizens were often presented with a display of two aquariums, one containing live oysters and one containing only bay water, demonstrating the filtration ability of oysters. Participants had the opportunity to help prepare oyster gardens and “send a message to an oyster” with a coloring activity, geared particularly towards the youth. Both the Recycling and the Gardening rack cards proved to be a very effective means by which to present the different aspects of the project. Examples of the different shell recycling receptacles were also exhibited during these events. A visual of the entire shell recycling process using a mock oyster tray, toy recycling bin, and toy tractor were typically displayed to help the public grasp the concept of the entire shell recycling process. Through interactions with GBF staff and volunteers, attendees at outreach events were educated on the importance of oysters in Galveston Bay and the significance of returning shells to the bay through the Oyster Shell Recycling Program. Oyster Team members gave presentations on the Oyster Shell Recycling Program at both the San Leon and the Bayou Vista Gardening events. In addition, The Oyster Team was invited as the keynote speaker to present on the program at the Houston Kayak Club’s quarterly meeting.

D) Task 4: Participation

With the assistance of CMP Cycle 21 funds, GBF partnered with the six local restaurants listed below during Cycle 21. Due, in part, to Hurricane Harvey’s effect on oyster harvesting, including the reduced production of the industry and the subsequent decline in consumption, no new restaurants were added during Cycle 21. Instead, GBF staff worked to retain and streamline current partnerships. Potential future partnerships were discussed for Cycle 22 and beyond with Opus Ocean Grille and Sam’s Boat.

Restaurant	Date Partner began Shell Recycling
Tommy's Restaurant & Oyster Bar	March 2011
Topwater Grill	May 2013
Crazy Alan's Swamp Shack	November 2013
The Aquarium (Kemah)	August 2013
Captain Benny's Seafood (Gulf Fwy)	October 2015
Tookie's Seafood	June 2016

GBF’s “Restaurant Database,” as shown in Appendix E, was updated to include additional restaurants serving oysters in the Houston-Galveston region. Through analysis of restaurant location and menu items, GBF staff identifies restaurants as potential future partners to pursue over the next two to three years.

Currently, expansion farther into Houston is not feasible due to the high cost of mileage and staff time required to collect shells from downtown restaurants. GBF held meetings with State of Grace to discuss how to improve the awareness of oyster shell recycling as well as how to expand GBF’s reach, into Houston. Other interested Houston-based restaurants that have approached GBF include Liberty Kitchen and The Pearl Restaurant & Bar; all of which have been included in the Restaurant Database as potential partners if/when GBF is able to expand to downtown Houston.

During Cycle 21, GBF did make progress with a new partnership with Texas A&M University at Galveston (TAMUG). TAMUG has committed to provide the staff and truck needed to collect shells from restaurants on Galveston Island starting in Cycle 22. The shell will be stored at TAMUG’s Wetland Center in preparation for sun curing purposes. While coordination was temporarily delayed due to Hurricane Harvey, GBF was able to secure a partnership with BLVD Seafood to begin recycling in February 2018 with Cycle 22 funds. BLVD Seafood will serve as a “trial” restaurant to determine the feasibility and effectiveness of current recycling methods before expansion to other restaurants on Galveston Island.

IV. Results

The shell collected during Cycle 21 resulted in a ten percent increase in shells recycled from 2016 to 2017. As shown on the graph in Appendix A, the tonnage of shells recycled by GBF has steadily increased with each cycle of grant funding. A total of 165.74 tons of oyster shells were recycled during CMP Cycle 21 from March 1, 2017 to January 31, 2018 and over 810 tons of oyster shells have been recycled since 2011. The oyster shells collected during Cycle 21 are currently undergoing the proper sun curing process and will be used in GBF's Volunteer Oyster Gardening Program and (separately funded) reef restoration projects.

V. Lessons Learned

Shell collection during Cycle 21 was affected by the aftermath of Hurricane Harvey. Shell output by the restaurants took a noticeable decline. One partner restaurant put their shell collections on hold due to the decision to suspend serving oysters. These issues however are temporary, and shell collection has already resumed at some locations and is expected to return in full to all partner restaurants during Cycle 22 and 23.

In response to the challenges faced with restaurant partnerships, GBF staff began implementing a "Restaurant Selection Criteria" during Cycle 21 to improve the selection of new restaurant partners based on a minimum required output of shell. Comparing the amount of anticipated shell output with mileage, supplies, and personnel costs, has provided GBF with a better understanding of each restaurant's partnership viability and allowed GBF to be more selective of potential partners when funding is a limiting factor.

Over the last several years, the Oyster Shell Recycling Program has expanded and thus so has the responsibilities of the Oyster Team. Under Cycle 21 the current Program Technician was promoted to Habitat Restoration Coordinator, allowing this individual to dedicate up to 100% of their time to the management of the shell recycling and oyster gardening operations, as well as overall project and grant management. To help facilitate these new changes, the position of Shell Recycling Assistant has expanded to incorporate assistance in the field with oyster gardening and educational outreach events, as well as assist GBF's Habitat Restoration Manager with the Strategic Development Plan, which will be created during Cycle 22.

V. References

Beck MW, Brumbaugh RD, Airoidi L, Carranza A, Coen LD, Crawford C, Defeo O, Edgar GJ, Hancock B, Kay MC, Lenihan HS, Luckenbach MW, Toropova CL, Zhang G, and Guo X (2011). Oyster Reefs at Risk and Recommendations for Conservation, Restoration, and Management. *BioScience*, 61(2): 107-116.

Bushek D, Richardson D, Bobo MY and Coen LD. (2004). Short-term shell pile quarantine reduces the abundance of *Perkinsus marinus* remaining in tissues attached to oyster shell. *Journal of Shellfish Research*, 23(2): 369-373.

Coen LD and Luckenbach MW (2000). Developing success criteria and goals for evaluating oyster reef restoration: ecological function or resource exploitation? *Ecological Engineering*, 15(3): 323–343.

Haby, Michael G., Russell J. Miget, and Lawrence L. Falconer (2009). Hurricane Damage Sustained by the Oyster Industry and the Oyster Reefs Across the Galveston Bay System with Recovery Recommendations. A Texas AgriLife Extension Service / Sea Grant Extension Program Staff Paper. *The Texas A&M University System, College Station, TX. TAMU-SG-09-201*: 51 pp.

Hons C and Robinson L (2010). Recovering from the Storm: Oyster Reef Restoration in Galveston Bay, Texas. *Power Point presentation*. 21 pp.
<https://www.estuaries.org/pdf/2010conference/monday15/schooner/session3/hons.pdf>

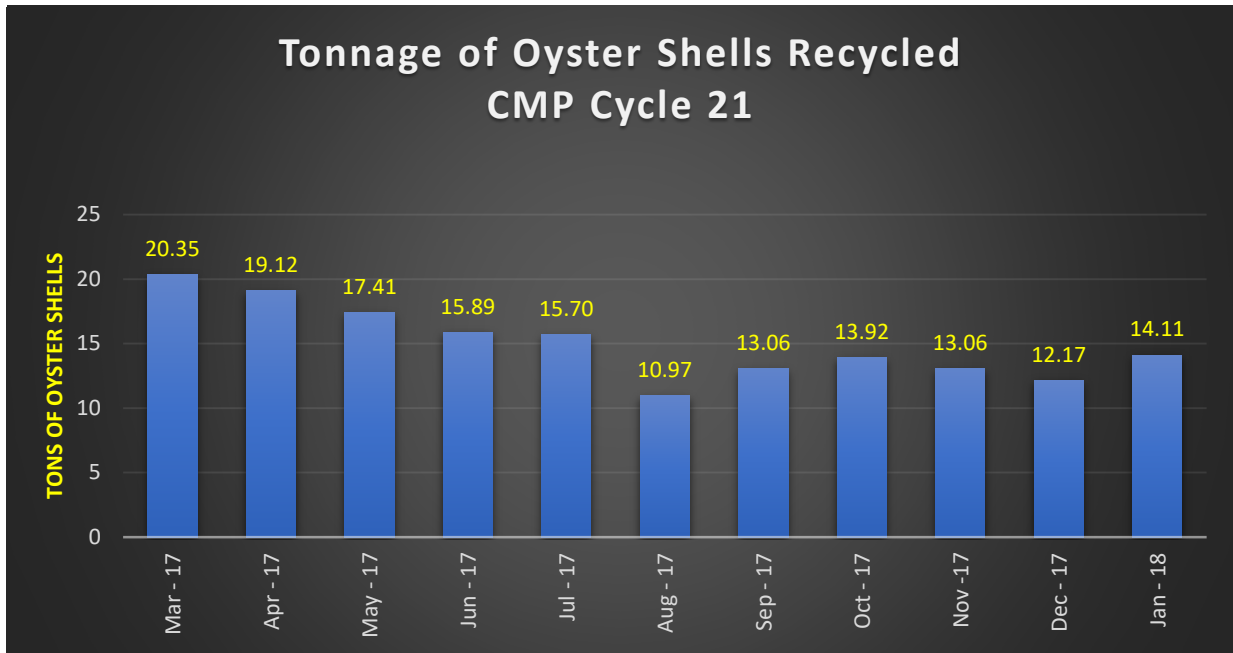
VI. Appendix

APPENDIX A SHELL COLLECTION NUMBERS

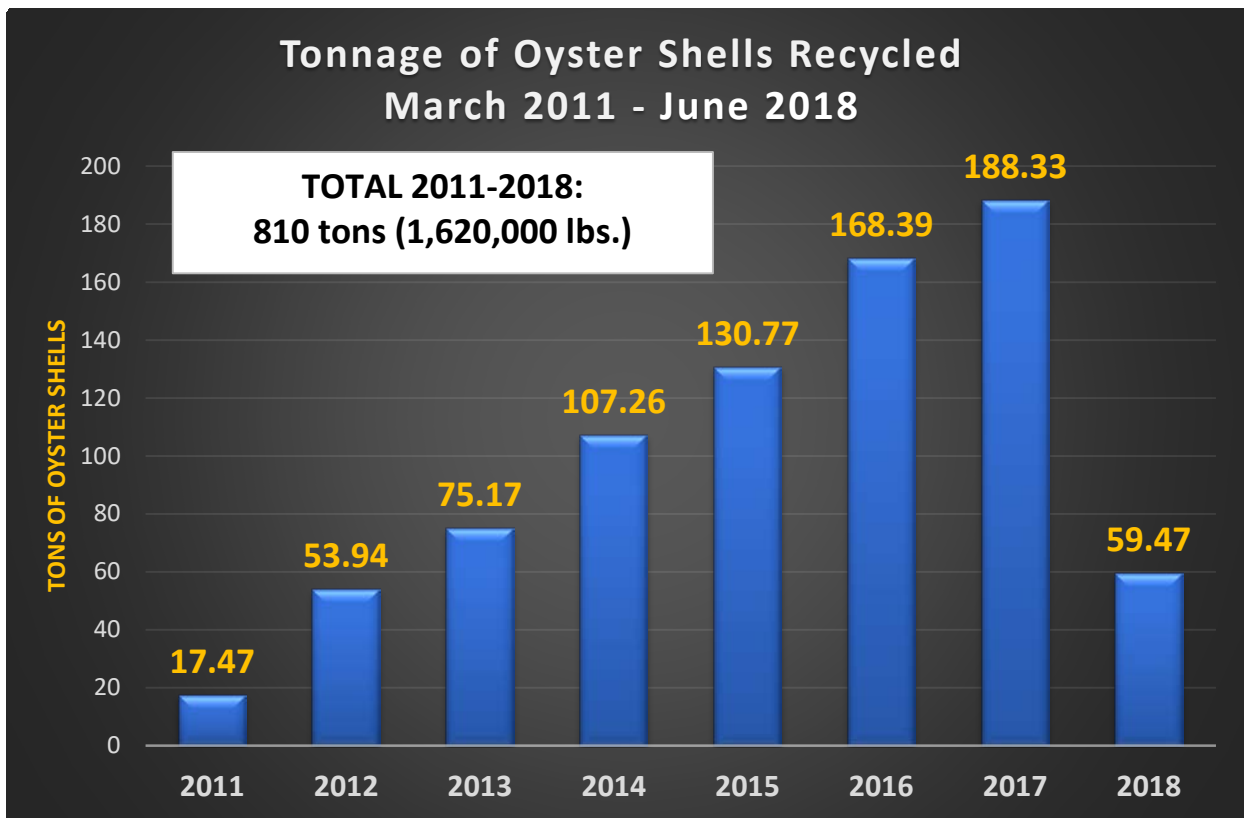
A.1 Tonnage of Oyster Shells Recycled During Cycle 21

Month	Oyster Shells Collected (tons)	Oyster Shells Collected (lbs)
Mar - 17	20.35	40,700
Apr - 17	19.12	38,240
May - 17	17.41	34,820
Jun - 17	15.89	31,780
Jul - 17	15.70	31,400
Aug - 17	10.97	21,940
Sep - 17	13.06	26,120
Oct - 17	13.92	27,840
Nov -17	13.06	26,120
Dec - 17	12.17	24,340
Jan - 18	14.11	28,220
TOTAL	165.76	331,520

**Oyster shell tonnage is based on an average weight of 192 lbs of shell/32-gallon bin and 23 lbs of shell/5-gallon bucket and is subject to a variance of $\pm 5\%$.*



A.2 Tonnage of Oyster Shells Recycled to Date



APPENDIX B

CURING SITE MAINTENANCE

Date	Curing Site	Maintenance Conducted	Volunteer/Contractor	Vol. Hrs.
04/27/17	TX City	Transported 6 truckloads (~78 CY) of shell to Sweetwater Lake for oyster bar construction; Consolidated remaining shell onto cement pad	Trucks, tractor, & operator - JBC	0
04/28/17	Red Bluff Rd	Transported 3 truckloads (~37.5CY) of shell to Baytown Nature Center for oyster bar construction; Consolidated newly dumped shell into new pile	Rental Backhoe - Blueline Operator - Volunteer (A.Leija) Dump Trucks - Gulf Coast Limestone	4
05/02/17	TX City	GBF Staff moved 100 oyster bags (~2.55 CY) of shell via truck/trailer (~30lbs/bag)	GBF Staff	0
05/12/17	Red Bluff Rd	Collected 40 buckets of shell (0.78 CY) for Oyster Gardening	GBF Staff	0
06/29/17	Red Bluff Rd	Mowed	Scott Alford - NRCS partner	4
07/19/17	TX City	GBF Staff moved 100 oyster bags (~5.1 CY) of shell via truck/trailer (~30lbs/bag)	GBF Staff	0
09/13/17	Red Bluff Rd	Mowed	Scott Alford - NRCS partner	4
10/12/17	Red Bluff Rd	Transported 6 truckloads (~78 CY) of shell to Sweetwater Lake for oyster bar construction; Piled new shell for 6-month curing; Mowed	Trucks, loader, operator - JBC	1
Multiple Dates	Inland Marine	Piled shell with tractor/operator 6x/year ~ 1 hour of volunteer work	Inland Marine staff & tractor	6

APPENDIX C

VOLUNTEER OYSTER GARDENING

C.1 Volunteer Derived Oyster Gardening Data

	A	B	C	D	E	Notes
7-Jul	2.22	3.12	2.66*	2.86	4.05	* Float installed
14-Jul	2.19	3.04	2.62	2.83	3.99	
21-Jul	2.15	3.02	2.58	2.78	3.94	
29-Jul	2.20	3.12	2.59	2.85	4.00	
3-Aug	2.26	3.23	2.65	2.94	4.09	
11-Aug	2.24	3.27	2.56	2.92	4.04	Spat!
18-Aug	2.27	3.38	2.56	2.97	4.07	
						Harvey
4-Sep	Missing	3.55	2.55	3.15	4.21	
15-Sep		3.61	2.55	3.21	4.24	
22-Sep		3.70	2.57	3.28	4.33	
29-Sep		3.80	2.58	3.34	4.40	
6-Oct		3.97	2.62	3.43	4.50	
14-Oct		4.14	2.69	3.60	4.70	
23-Oct		4.29	2.73	3.73	4.81	
3-Nov		4.59	2.65	4.00	5.11	
28-Nov		5.31	**	4.66	5.77	** Abrasion against dock caused bag to fail

***Table put together by volunteer gardener. Data is in pounds of each garden over time.

C.2 Number and Location of Oyster Gardens Created

Location of gardens	# of gardens created	Sub-bay system
Kemah	45	Central Galveston Bay
San Leon	305	Central Galveston Bay
Bayou Vista/Tiki Island/Galveston	86	West Galveston Bay

C.3 Oyster Gardening Volunteers by Location

Community	# of Gardeners
San Leon	15
Kemah	3
Bayou Vista	16
Tiki Island	5
Galveston	4

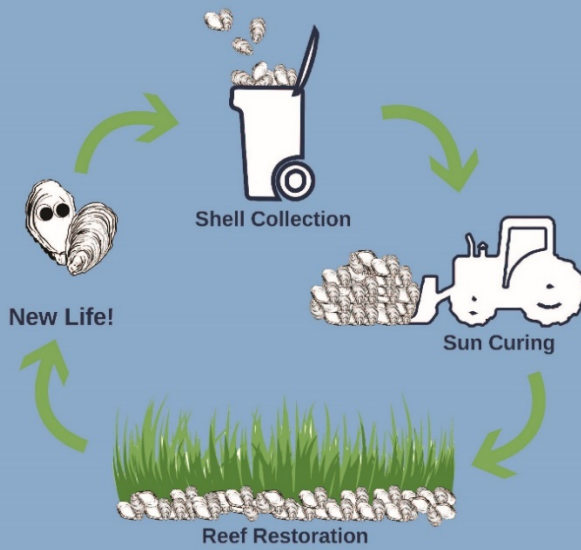
APPENDIX D OUTREACH MATERIALS

D.1 Recycling Rack Card



**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!



****Front**

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?
Contact Haille Carter at hcarter@galvbay.org



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PURSUANT TO NATIONAL OCEANIC AND ATMOSPHERIC
ADMINISTRATION AWARD NO. NA16NCS4190174.



****Back**

D.2 Gardening Rack Card

The front of the rack card features the Oyster Shell Recycling Program logo at the top, which includes a recycling symbol and the text "OYSTER SHELL RECYCLING PROGRAM" and "GALVESTON BAY FOUNDATION". Below this is the title "VOLUNTEER OYSTER GARDENING" and a subtitle: "Galveston Bay Foundation partners with bayfront homeowners to give baby oysters a head-start." The main content is a vertical flowchart with five steps: 1. Shell Collection (a trash bin), 2. Sun Curing (a tractor), 3. Oyster Gardening (mesh bags), 4. New Life (a mesh bag with oysters), and 5. Reef Restoration (oysters on a reef).

**Front

The back of the rack card has a blue header with the text "WHAT IS AN OYSTER GARDEN?". Below is a photo of a wooden dock with oyster mesh bags. The text reads: "An oyster garden is a mesh bag or cage filled with recycled oyster shells collected through GBF's Oyster Shell Recycling Program." The next section has a blue header "WHY DO WE 'GARDEN' FOR OYSTERS?" and a photo of oysters on a wooden surface. The text explains: "The recycled shells in our oyster gardens make new homes for baby oysters! Oyster larvae need a hard surface on which to attach so they may begin to grow. While oyster larvae can attach to just about anything, they prefer other oyster shells. The shells and baby oysters (aka spat) in our oyster gardens are transplanted onto restored oyster reefs to help repopulate native oysters in the Bay." The bottom section has a green header "INTERESTED IN BECOMING A VOLUNTEER OYSTER GARDENER?" and a photo of volunteers. It includes the text: "Complete the [Oyster Gardening Information Request Form](\"http://galvbay.org/oysters\") online at [galvbay.org/oysters](\"http://galvbay.org/oysters\")" and a note: "*Please note: ALL oysters produced in GBF's oyster gardening program are strictly for restoration purposes and are NOT for consumption." At the bottom are logos for the Texas Coastal Management Program, Texas Land Commissioner, and NOAA, along with funding information.

**Back

D.3 Gardening Volunteer Guide



Oyster Gardening Volunteer Guide

Installation

- Suspend oyster gardens from a pier or dock with rope
- Gardens should be fully submerged in water
- Gardens should be at least 1-2 ft. off the bay bottom

Maintenance

- **Once a week:** remove gardens from water for 1-4 hrs
- Rinse gardens thoroughly with freshwater or bay water
- Repair any holes in gardens with zip ties

Monitoring

- **Once a week:** check gardens for spat
- Remember, spat start out very small (freckle size or smaller)
- Check out the critters inhabiting gardens

Citizen Science

- **Once a week:** document the number of spat and other species found in gardens
- Complete data form online: galvbay.org/oysters

****Front**

Spat Identification

- a) When spat (oyster larvae) first attach to a shell, they are typically the size of a pea, freckle, or even smaller
- b) In 4-6 weeks, spat can grow to the size of a dime/nickel
- c) Within 2-3 months, spat can grow 1 to 2 inches or more



Oyster Garden Critters

Common species you may see in your oyster gardens include, but are not limited to, the following:

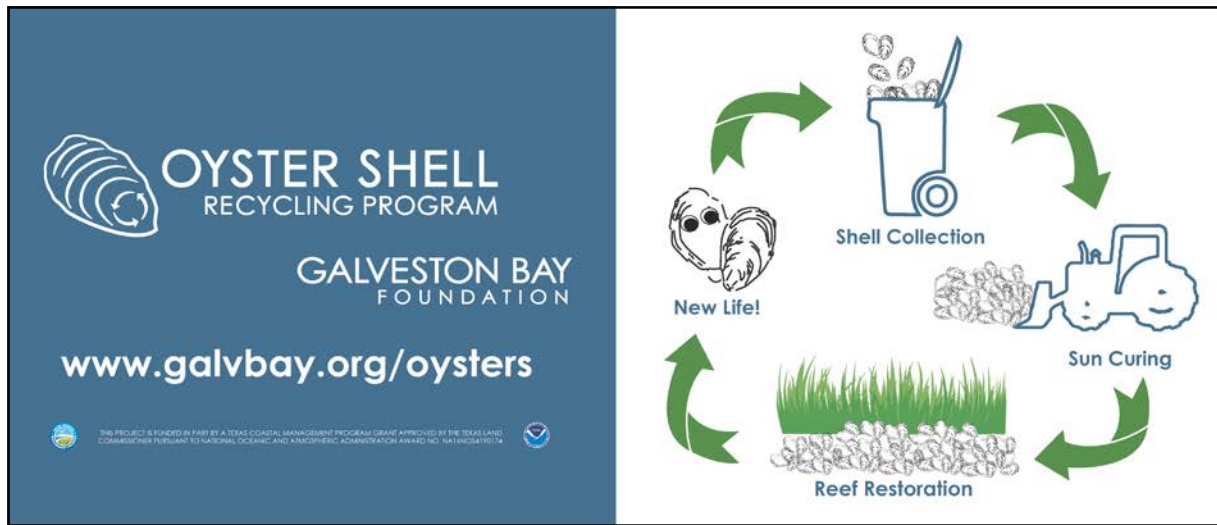
- a) Skillet Fish b) Juvenile Blue Crab c) Oyster Drill
- d) Barnacles e) Stone Crab f) Mussels



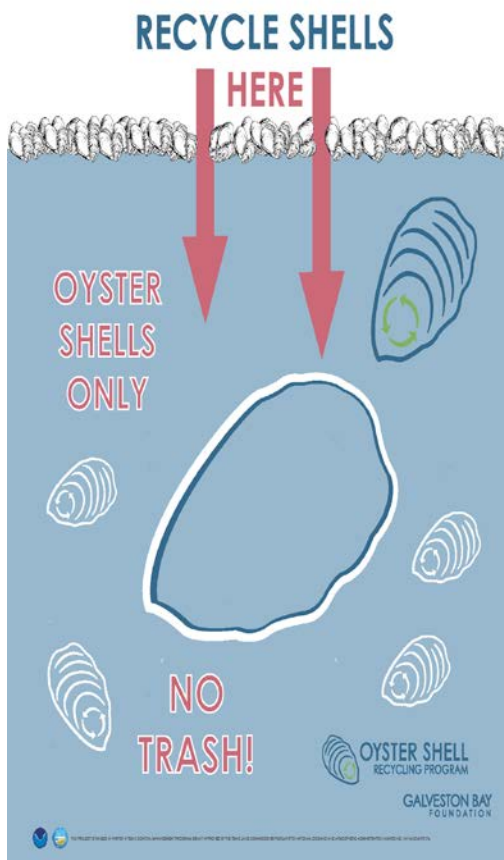
This project is funded in part by a Texas Coastal Management Program Grant Approved by the Texas Land Commissioner Pursuant to a National Oceanic and Atmospheric Administration Award No. NA16NOS4190174

****Back**

D.4 Oyster Trailer Sign



D.5 Recycling Bin Toppers



***Digital Design*



***In use*

D.6 News Articles & Media

6.1) Galveston Bay Foundation's Summer Gazette Article



GALVESTON BAY FOUNDATION

GAZETTE

Cover photo: Boy observes hermit crabs at Galveston Bay Foundation's Bay Day Festival. Story on page 6.

Stories:	
<i>Letter from our President</i>	1
<i>Marsh Mania</i>	3
<i>Dolphins</i>	4
<i>New Schools</i>	5
<i>Bay Day</i>	6
<i>San Leon Oyster Fest</i>	7
<i>Water Challenge</i>	9
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Girl Scouts give back through GBF's Oyster Shell Recycling Program to earn Silver Award

Pearland Troop 27159 Girl Scouts Alaina, Kalie and Natalie tossed around lots of ideas when coming up with a project for their Silver Award, a highly coveted Girl Scout award, but ultimately came to the consensus building an oyster reef with Galveston Bay Foundation was the best project to choose.

Rather than a service project, their project had to be a "take action" project that is sustainable and creates a change. It would also aim to fulfill their Homaday Award through Venture Scouts, a co-ed branch of Boy Scouts.

"I've done a lot of smooth cordgrass plantings with Galveston Bay Foundation," said Kalie Rinhart, one of the three scouts who collaborated on the project. "When my brother and his friend did their Eagle Scout project with GBF, I knew I wanted to work with the organization, too."

Continued on pg. 2 ►

THE MISSION OF THE GALVESTON BAY FOUNDATION IS TO PRESERVE AND ENHANCE GALVESTON BAY AS A HEALTHY AND PRODUCTIVE PLACE FOR GENERATIONS TO COME.

Girl Scouts give back through Oyster Shell Recycling (continued from cover)

On a hot day in May, after much preparation and planning, the girls gathered together friends, family and scouts from other troops to build the oyster reef out of shells recycled from local restaurants through GBF's Oyster Shell Recycling Program.

The shells are first placed into mesh bags and tied, and then the bags are brought into the water in tubs to build the oyster reef.

“It's just always good to give back to the environment because without it, we wouldn't be here. We wouldn't be able to survive.”

-Alaina Scott, Girl Scout

In a break from the rigorous work of bagging oyster shells, Girl Scout Alaina Scott said she was thrilled she and her friends got



(From left to right): Kalie, Alaina, and Natalie on restoration day.

the opportunity to create new life for oysters and learn about conservation.

“Before the project, I didn't realize that we are running out of oysters and that we need to start conserving them,” Alaina said. “Oysters give so much to us - they give us food and they filter out our water, and it's just always good to give back to the environment because without it, we wouldn't be here. We wouldn't be able to survive.”

Each shell put back in the water gives the oyster larvae floating around a hard substrate to attach to and grow into an oyster. Studies indicate that oyster larvae exhibit a preference for attaching to oyster shells over other types of hard substrate.

“The last hurricane damaged the oyster reefs, and we get to help rebuild it through a lot of hard work and teamwork,” said Girl Scout Natalie Salinas. “There's a lot of people I don't know here, and it's fun getting to know them in this setting.”

GBF has a mutually beneficial relationship with Scout groups and has helped many Scouts complete projects over the years. Catherine Rinhart, Kalie's mom and the girls' troop leader, says she is thankful for the Foundation's support.



Boy Scouts helped on the restoration day as well.

“If we don't take care of the Bay, it's going to be further polluted, and the kids won't have anywhere to fish or resources to use,” she said. “Learning how to take care of it and how to respect it – they couldn't learn what they're doing and what they're helping with without the Foundation.”

At the end of Alaina, Kalie and Natalie's oyster reef restoration workday, 50 feet of reef was built with nearly 6 tons of recycled oyster shell. They are currently finalizing their project and should know if they received their Silver Award by the end of summer.

To learn more about GBF's Oyster Shell Recycling Program, visit www.galvbay.org/oysters.

6.2) Coast Monthly Article

<https://www.coastmonthly.com/2018/01/shell-game/>

Shell game

By [Barbara Canetti](#) on January 27, 2018 Filed Under: [Features](#), [Frontpage](#) [Leave a Comment](#)



Bags of recycled oyster shells are removed weekly from docks and allowed to drain to force predators to crawl out as they seek water. The shells are rinsed of sediment and then returned to the bay waters. *Photo courtesy of the Galveston Bay Foundation*

How volunteer gardeners along the bay are helping to revive oyster beds

Bayfront property owners are growing more than vegetables and flowers at home. Many have become oyster gardeners, helping to replenish diminishing and endangered oyster beds in Galveston Bay.

Last year, 83 oyster gardens — some with up to 20 “plots” — in San Leon, Kemah, Bayou Vista, Tiki Island and Galveston were part of the program.

Hurricane Harvey, which struck in late August last year, severely damaged the program’s efforts because of all the fresh water infiltrating the bays, according to the Galveston Bay Foundation, which has sponsored the program since 2011. Still, gardeners were able to see the potential for success, said Michael Niebuhr, program director at the foundation.

Each spring, volunteers are trained to create their oyster gardens by filling mesh bags with recycled oyster shells. They suspend the bags from piers and docks and drop them into the bay waters, where they are meant to attract oyster larvae during spawning season. The larvae, which is drawn to the shells, is called “spat.”

“All of the spat recruited by our gardens come naturally from the bay,” Niebuhr said. “During the spawning season, the amount of mature oysters in a given area will affect how much reproduction occurs and, therefore, how much free floating oyster larvae there is in the water, looking for a hard substrate to attach to — hopefully our shell bags.”

The home gardeners clean, measure and document information about the contents of the bags weekly. Shells must be rinsed off to eliminate any fouling algae and invading predators, such as crabs and oyster drills, which are snails that prey on new oyster growth.

Maureen Nolan-Wilde and her husband, Alan Wilde, both Master Naturalists, got involved in the program after working for several years focusing on the conservation of nesting bird habitat. They agreed to try five bags of shells to “grow” at their Tiki Island home, monitoring the growth of spat and other interesting predators in the bags. One of their bags was swept away during Harvey, but the other four produced a weight gain of 70 percent, from oyster spat as well as predatory mussels and other shellfish.



Volunteer Alan Wilde pulls up his bag of oyster shells at his Tiki Island dock to conduct his weekly inspection of the spat. *Photo courtesy of Maureen Nolan-Wilde*

“For us, the experience was fun, educational and rewarding,” Nolan-Wilde said. “We were able to share the joy of gardening with our neighbors, as well as learning more about the plight of our oyster populations.”

Noland-Wilde set up a Facebook page to track her garden. She noted one neighbor was disappointed when she thought she had failed. But after a friendly “spat intervention party,” it was discovered that, in fact, she was successful and the oysters were busily growing.

“Fridays were the days we oyster gardened, and each week, we were always rewarded as we brought up our bags hanging off our dock,” she said. “It is amazing how oyster gardening can also bring a neighborhood together.”

In the fall and at the end of the spawning season, the bags are collected and taken to nearby restoration reefs and transplanted under the direction of the Texas Department of Parks & Wildlife, Niebuhr said.

“We keep all the new oysters in the same sub-bay system that they spawned,” Niebuhr said. “Currently, we use the reefs off the Kemah and San Leon shorelines and at Galveston Bay

Foundation’s Sweetwater Nature Preserve in Galveston.” Because oysters are a colonial species, they rely on the accumulation of many to provide a stable environment for new growth.



The 1,500-foot-long dock at Texas Corinthian Yacht Club in Kemah was home to about 60 bags during the 2017 season. *Photo courtesy of the Galveston Bay Foundation*

The oysters, which reach adulthood in two years and can live up to 20 years, are collected and transplanted for restoration purposes only and not for consumption. However, in time, as the oysters mature in the reefs and begin to spawn, new oysters throughout the bay travel and repopulate other reefs, Niebuhr said.

Although oysters appear to be hardy creatures, they’re very sensitive to changes in temperatures as well as salinity of the waters. Until Harvey, the 2017 season looked to be on track for a record year.

“The enormous amount of freshwater sent into the bay almost resulted in 100 percent kill to some gardens,” Niebuhr said, adding that ultimately only about 1,000 new oysters were returned to the bay at the reefs.

Visit www.galvbay.org to learn about becoming a volunteer oyster gardener.

APPENDIX E

RESTAURANT DATABASE

LEGEND
Current Partner
Priority - contact in 2018
Low Priority

Restaurant	Location	Restaurant Phone #	Restaurant Address	Interested?	Notes
a'Bouzy	Houston	(713) 722-6899	2300 Westheimer	Unknown	Click 2 Houston's Top 12 Hottest Oyster Spots in Houston
Aquarium Restaurant, The	Kemah	(281) 334-9010	#11 Kemah Boardwalk	Yes	Partner since 2013
Baybrook's Fresh Seafood	Seabrook	(281) 474-2846	416 11th Ave	Unknown	Added to list in 2015
Black Pearl Oyster Bar	Galveston	(409) 762-7299	327 23rd St	Yes	Added to list in 2014
BLVD Seafood	Galveston	(409) 762-2583	2804 R 1/2	Yes	Partner since 2018
Brennan's of Houston	Houston	(713) 522-9711	3300 Smith Street	Unknown	Few types of oysters
Cajun Greek	Galveston	(409) 744-7041	2226 61st St	Yes	New management, must revisit interest
Cajun Kitchen	Houston	(281) 495-8881	6938 Wilcrest Dr	Unknown	Click 2 Houston's Top 12 Hottest Oyster Spots in Houston, Several types of oysters
Captain Benny's Seafood	Houston	(713) 643-0589	8253 Gulf Fwy	Yes	Partner since 2016; 4 Other locations (2 in Houston, 1 in Deer Park, 1 in Stafford)
Captain Tom's Seafood & Oyster	Houston	(713) 451-3700	13955 East Fwy	Unknown	2 Other locations in Houston and Katy, Click 2 Houston's Top 12 Hottest Oyster Spots in Houston
Caracol	Houston	(713) 622-9996	2200 Post Oak Blvd	Unknown	Click 2 Houston's Top 12 Hottest Oyster Spots in Houston

Restaurant	Location	Restaurant Phone #	Restaurant Address	Interested?	Notes
Chasin' Tail Sports Bar	Clear Lake	(281) 480-3000	2402 Bay Area Ste. M	Unknown	Added to list in 2016
Chilos Seafood & Oyster Bar	Houston	(713) 947-8700	1150 Edgebrook Dr	Unknown	Added to list in 2015
Christie's Seafood & Steaks	Houston	(713) 978-6563	6029 Westheimer	Unknown	Two types of oysters as an appetizer
Clary's Seafood Restaurant	Galveston	(409) 740-0771	8509 Teichman Rd	Unknown	Seasonal Only; added to list in 2014
Crawfish Pot & Oyster Bar, The	Houston	(713) 360-6547	9820 Gulf Fwy #7	Unknown	Added to list in 2015
Crazy Alans Swamp Shack	Kemah	(281) 334-5000	310 Texas Ave	Yes	Partner since 2013
Crescent City Connection Sports & Oyster Bar	Houston	(281) 954-6810	16605 El Camino Real	Unknown	Added to list in 2015
Danton's Gulf Coast Seafood Kitchen	Houston	(713) 807-8889	4611 Montrose Blvd	Unknown	Click 2 Houston's Top 12 Hottest Oyster Spots in Houston, Several types of oysters
Drunken Oyster	Spring	(832) 843-6196	7110 Louetta Rd Ste B	Unknown	Click 2 Houston's Top 12 Hottest Oyster Spots in Houston
East Star Chinese Buffet	Webster	(281) 280-8822	1025 W Nasa Pkwy	Unknown	Raw oysters in buffet line
Fish Tales	Galveston	(409) 762-8545	2502 Seawall	Unknown	Added to list in 2016
Fisherman's Wharf	Galveston	(409) 765-5708	2200 Harborside Dr	Unknown	Seasonal Only
Flippers Coastal Seafood	Dickinson	(832) 340-7340	628 FM 517 W	Unknown	
Floyd's Cajun Seafood And Steakhouse	Webster	(281) 332-7474	20760 Gulf Fwy	Unknown	Added to list in 2014

Restaurant	Location	Restaurant Phone #	Restaurant Address	Interested?	Notes
Flying Dutchman	Kemah	(281) 334-7575	9 11th Ave Kemah Waterfront	No - see notes	<i>Partnership discontinued in 2016 due to lack of shell output</i>
Gaido's Seafood Restaurant	Galveston	(409) 761-5500	3828 Seawall Blvd	Yes	Mtg w/ David 3/22/16; interested in starting in 2017; only sell oysters during season
Gilhooley's Restaurant	San Leon	(281) 339-3813	222 9th St	See Notes	Contacted but not interested as of 2014; Possible future interest
Hibachi Grill & Supreme Buffet	Webster	(832) 932-5795	155 W Bay Area Blvd	Unknown	Raw oysters in buffet line
Hugos	Houston	(713) 524-7744	1600 Westheimer Rd	Yes	Need to meet with Chris - would have to deliver their own shells*
Jackie's Brickhouse	Kemah	(832) 864-2459	1053 Marina Bay Dr	Unknown	Gulf oysters when available, baked oysters on half shell
LA Crawfish	Clear Lake	(832) 905-5154	939 W. Bay Area	Unknown	Added to list in 2016
Landry's	Kemah	(281) 334-2513	1 Kemah Boardwalk	<i>Past partner</i>	<i>Partnership discontinued in 2016 due to lack of shell output</i>
Landry's Seafood House	Galveston	(409) 744-1010	5310 Seawall Blvd	Maybe	Added to list in 2016
Liberty Kitchen & Oysterette	Houston	(713) 622-1010	4224 San Felipe St.	Unknown	Click 2 Houston's Top 12 Hottest Oyster Spots in Houston
Little Daddy's Gumbo Bar	Galveston	(281) 524-8626	2107 Postoffice Street	Unknown	Three types of oysters
Little Daddy's Gumbo Bar	League City	(281) 524-8626	1615 West FM 646	Unknown	Three types of oysters
Lone Star Grill	Bacliff	(832) 864-3788	3435 Hwy 146	Unknown	Added to list in 2016
Mambo Seafood	Houston	(713) 946-0000	10402 Gulf Freeway	Maybe	Bill King has contact at Mambo's; added to list 2016

Restaurant	Location	Restaurant Phone #	Restaurant Address	Interested?	Notes
Mannie's Seafood	Houston	(713) 641-5003	8520 Gulf Fwy	Unknown	
Marais	Dickinson	(281) 534-1986	2015 FM 517 Rd East	Unknown	Five types of oysters
Marcos Seafood & Oyster Bar	Houston	(713) 946-1168	917 Edgebrook Dr	Unknown	Added to list in 2015
Monument Inn	La Porte	(281) 479-1521	4406 Independence Pkwy S	Unknown	Added to list in 2017
Nick's Fish Dive & Oyster Bar	Woodlands	(281) 419-8885	20 Waterway Ave #105	Unknown	Click 2 Houston's Top 12 Hottest Oyster Spots in Houston
Noah's Ark Bar & Grill	Bacliff	(281) 339-2895	4438 Boulevard St	Unknown	Added to list in 2015
Number 13	Galveston	(409) 572-2650	7809 Broadway St	<i>Past partner</i>	Contacted in 2015, no longer willing to participate; Possible future interest
Opus Ocean Grill	Clear Lake Shores	(281) 334-0006	1510 Marina Bay Dr #124		
Orleans Seafood Kitchen	Katy	(281) 646-0700	20940 Katy Freeway, Suite G	Unknown	Two types of oysters
Ostioneria Michoacan Seafood and Oyster Bar	Houston	(713) 921-1800	5819 Gulf Fwy	Unknown	Added to list in 2015
Outriggers	Seabrook	(281) 474-3474	101 Bath Ave	See Notes	Contacted but not interested as of 2014; Possible future interest
Pappadeaux Seafood Kitchen	Houston	(713) 847-7622	7800 Airport Boulevard	Unknown	Added to list in 2016
Pappas Seafood House	Webster	(281) 332-7546	19991 Gulf Freeway	Unknown	Added to list in 2016
Perry's Steakhouse & Grille	Houston	(281) 286-8800	487 Bay Area Blvd	See Notes	Contacted but not interested as of 2014; Possible future interest

Restaurant	Location	Restaurant Phone #	Restaurant Address	Interested?	Notes
Prohibition Supperclub & Bar	Houston	(281) 940-4636	1008 Prairie St	Unknown	Added to list in 2017
Ragin' Cajun	Houston	(713) 621-3474	4302 Richmond Ave 9600 Westheimer #80	Unknown	Click 2 Houston's Top 12 Hottest Oyster Spots in Houston, 2 locations
Reef Seafood House, The	Texas City	(409) 945-6151	1301 31st 1/2 St N	Unknown	Added to list in 2015
Rose's Seafood Inc.	Seabrook	(281) 474-3536	415 11th Ave	Unknown	Added to list in 2014
Rouxpour	Clear Lake	(281) 480-4052	700 Baybrook Mall, Ste H100	Maybe	No reply to July 2016 email - need to call; added to list in 2016
Sam's Boat	Seabrook	(281) 326-7267	3101 Nasa Rd 1	Unknown	Added to list in 2016
Spot, The	Galveston	(409) 621-5237	3204 Seawall	Unknown	Added to list in 2016
Star Fish Coastal Bar & Kitchen	Houston	(832) 831-9820	191 Heights Blvd	Unknown	Click 2 Houston's Top 12 Hottest Oyster Spots in Houston
State of Grace	Houston	(832) 942-5080	3258 Westheimer Road	Unknown	Click 2 Houston's Top 12 Hottest Oyster Spots in Houston, several types of oysters, Added to list in 2016
Tommy's Restaurant & Oyster Bar	Houston	(281) 480-2221	2555 Bay Area Blvd	Yes	Partner since 2011
Tookie's Seafood	Seabrook	(281) 942-9445	1106 Bayport Blvd	Yes	Partner since 2016
Topwater Grill	San Leon	(281) 339-1232	815 Ave O	Yes	Partner since 2013
Valdo's Seafood House	El Lago	(281) 326-3866	4106 Nasa Rd 1	Unknown	Near current route; added to list in 2014, several different options for oysters
Willie G's	Galveston	(409) 762-3030	2100 Harbor Side	Unknown	1 Other location in Houston; added to list in 2014

APPENDIX F

PROJECT PHOTOGRAPHS

F.1 Oyster Shell Collection



F.2 Port of Houston Authority Lease: “Red Bluff Curing Site”



Before: Tractor volunteer mowing and shell piling



After: Tractor volunteer mowing and shell piling



Contractors piling shell after loading shell for transport



Shell piled turned during curing process

F.3 Inland Marine Construction Yard: “Inland Marine Curing Site”



F.4 Texas City Preserve: “Texas City Curing Site”



Cured and bagged oyster shell on cement curing pad

F.5 Outreach Activity: "Send a Message on an Oyster"





F.6 Education & Outreach Events



Outreach table at oyster tasting event.



Outreach table at community event.



Outreach table at San Leon OysterFest.



Shell recycling at San Leon OysterFest with recycling bin toppers.



Outreach booth at Bay Day festival in Kemah.



Kemah community Oyster Gardening garden creation event.



Educational presentation at Kemah community Oyster Gardening event.



Educational presentation at Kemah community Oyster Gardening event.



Bayou Vista community Oyster Gardening garden creation event.



San Leon community Oyster Gardening garden creation event.