Galveston Bay Foundation's Oyster Shell Recycling Program

GLO Contract No. 19-041-000-B075

FINAL REPORT
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Prepared by:

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I. Project Summary

In an effort to reestablish hard substrate in Galveston Bay, 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 minimum of 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 23, specifically from April 2019 through June 2020, 136.22 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 to allow for proper sun curing before being returned to the Bay. The shells will be utilized in 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 shell breakwater construction. Cycle 23 also allowed GBF to complete the second edition of the Strategic Development Plan (SDP) in order to determine if an alternative approach to shell recycling was necessary for future expansion.

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 60% 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 (Phase 1) with one restaurant and one curing site, through an initial expansion phase (Phase 2), resulting in 14 restaurant partners and 4 curing sites over the last 9 years. During the evaluation phase (Phase 3), the SDP was created, evaluated, and updated with the goal of assessing alternative recycling methods, participation fees, new outreach materials, and other options for a more sustainable program.

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 shucked oyster shells in recycling receptacles. GBF staff transported these containers of shells via truck and trailer to one of two "curing sites" where shells were stored temporarily. The shells were then left to sun cure or "bleach" for a minimum of six 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 oyster gardening, as well as (separately funded) oyster reef restoration and enhancement projects throughout Galveston Bay. In order to maintain quality control of shell collection weights, GBF periodically re-evaluates the weight of collected oyster shells and updates its tracking accordingly. GBF adjusted its weight of both shell bins (192 to 182 pounds) and shell buckets (23 to 30 pounds) allowing for a variance of *± 5%*.

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

A.2 Curing Site Maintenance

GBF spent Cycle 23 managing and maintaining the two curing sites used for shell storage: Red Bluff Curing Site and Texas City Curing Site. The Red Bluff curing site is a leased property that, under lease terms, GBF is responsible for all maintenance and management. As a much larger property, more time and effort is needed to ensure the Red Bluff site meets the standards for proper and efficient shell curing. GBF staff performed regular mowing for access, as well as shell turning, moving, and piling for proper shell curing. In years past, this site was taken out of circulation during the rainy months, to prevent damage to the property by vehicular traffic, and to ensure the GBF truck and trailer used for shell collection does not get stuck or damaged on the wet, muddy road. However, continuous improvements have allowed for year-round use, and a detailed shell storage plan, as defined in the SDP, provides a more efficient and productive curing strategy.

On both properties, shell at different stages of the curing process, as determined by new GBF Sun Curing Protocols (Phase 1 – Active Collection; Phase 2 – Curing; Phase 3 – Cured) are kept in separate piles in order for GBF staff to keep track of what shell is available for use in restoration projects. In order to better accomplish this, staff has cordoned off sections of Red Bluff and Texas City to more easily monitor each phase of the curing process.

See Appendix B for a schedule of curing site maintenance. A copy of GBF's Sun Curing Protocol can be found in the SDP in Appendix C.

B) Task 2: Volunteer Oyster Gardening

B.1 Volunteer Recruitment

With the assistance of CMP Cycle 23 funds, GBF was able to expand its Volunteer Oyster Gardening Program, by including a new community on Galveston Island. In the Spring of 2019, GBF hosted four oyster gardening events in the waterfront communities of San Leon, Bayou Vista, Galveston, and Tiki Island. GBF provided a presentation to volunteers on the entire Oyster Shell Recycling Program, which included an overview of the Foundation's shell recycling, volunteer oyster gardening, and reef restoration efforts. Volunteers learned why oyster gardening is 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, piers, or bulkheads. Based on Cycle 22's strategy to analyze 3 different gardening methods, in Cycle 23, GBF was able to provide volunteers with the garden type or types of their choice: bags, stringers, or cages.

B.2 Tracking Volunteer Oyster Gardening

Volunteer activity was tracked throughout the entire the Oyster Gardening season in 2019, from the spring gardening events, throughout the summer months of monitoring, and finally to spat collection in the fall. A total of 102 volunteers attended the four separate oyster gardening events in the spring, resulting in the creation of 245 oyster gardens. Once spawning season concluded (per Texas Parks and Wildlife Department), all gardens were collected and spat recruitment was documented. A total of 9,722 new spat were recruited in the volunteers' oyster gardens and successfully returned to the bay at (separately funded) reef restoration sites managed by GBF and/or TPWD.

For detailed oyster gardening tracking documents please refer to Appendix D.

C) Task 3: Outreach & Participation

C.1 Outreach Opportunities

Under Cycle 23 The Oyster Team attended and/or presented at 15 events in which the Oyster Shell Recycling Program was promoted through outreach and educational booths (refer to photographs in Appendix E). 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. The Recycling and the Gardening rack cards, as well as other materials developed under Cycle 22, still proved to be an 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 also gave presentations on the Oyster Shell Recycling Program at all four gardening events. During Covid-19 restrictions, GBF found ways to still engage the communities through virtual means, including a oyster filtration time lapse video.

C.2 Strategic Development Plan

The second edition of the Strategic Development Plan (SDP) was completed during Cycle 23. This version of the SDP delved further into case studies and the different shell recycling methods available to GBF. As a key component of the Evaluation Phase of the Oyster Shell Recycling Program, the SDP was utilized to help determine if an alternative approach to shell recycling should be pursued and if expansion into the inner loop of Houston is feasible. The preliminary results of these evaluations are captured in Steps 3, 4, and 5 of the SDP document.

See SDP in Appendix C

C.3 Restaurant Participation

With the assistance of CMP Cycle 23 funds, GBF was able to expand its partnerships to 2 new restaurants; Swamp Shack (Baybrook) and Sam's Boat (Seabrook). Due to a decline in oyster production and the Covid-19 safety restrictions, Topwater Grille ceased weekly shell collection, however, the partner is still collecting shell on their own, with the hopes for future donation to GBF for use in restoration efforts. BLVD Seafood is also on hold as the Covid-19 pandemic led to a halt in GBF's partnership with Texas A&M University at Galveston for shell collection. A new, potential partnership is being pursued with Moody Gardens for future shell collection and storage.

GBF, with the help of Public Content PR firm, established a Chef Advisory board with prominent restaurant owners and chefs within Houston's inner loop to help promote and support GBF's expansion of the project. GBF also used Cycle 23 to spread word of the program throughout the greater Houston region in preparation of the Inaugural Houston Oyster Festival; this event was unfortunately canceled due to the Covid-19 pandemic but has been rescheduled for April 2021, pending pandemic conditions.

Restaurant	Date Partner began Shell Recycling
Tommy's Restaurant & Oyster Bar	March 2011
Topwater Grill	May 2013 (no longer actively participating as of 2020)
Crazy Alan's Swamp Shack (Kemah)	November 2013
The Aquarium (Kemah)	August 2013
Captain Benny's Seafood (Gulf Freeway)	October 2015
Tookie's Seafood	June 2016
BLVD Seafood	January 2018 (on hold)
Swamp Shack (Baybrook)	July 2019
Sam's Boat (Seabrook)	March 2020

GBF has plans to extend oyster shell recycling services locally, and to Houston's inner loop by 2021, pending Covid-19 conditions and restrictions (please refer to the Restaurant Database as found in the SDP in Appendix C).

IV. Results

A total of 136 tons of oyster shell was collected with CMP Cycle 23 funds. As of June 30, 2020, GBF recycled a total of 1003 tons of oyster shells since 2011, in large part, through support and funding from CMP. All oyster shells collected during Cycle 23 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 (separately funded) oyster reef restoration efforts.

V. Lessons Learned

GBF's Habitat Restoration Manager used Cycle 23 funds to complete the second edition of the SDP, to provide further guidance on the improvement and expansion of GBF's Oyster Shell Recycling Program. The SDP helps GBF address the feasibility of expanding shell recycling operations into the greater Houston area as well as along the existing routes. The new Sun Curing Protocol, also developed under Cycle 23, will be crucial to ensure proper curing methods are applied to all recycled shell.

As GBF expands its efforts, additional and more dedicated restaurant relationships are required to ensure steady shell collection. The Chef Advisory Council will help facilitate these efforts. By working directly with chefs and restaurant owners, GBF can determine the systematic changes required to benefit all parties and ensure sustainable shell recycling operations.

GBF's Habitat Restoration Coordinator used Cycle 23 funds to build stronger relationships with oyster gardening volunteers. Building this aspect of the project resulted in more efficient and knowledgeable gardeners but more importantly, more effective stewards of oyster restoration throughout Galveston Bay and the greater Texas coast. Additional time spent with the public has increased awareness of both GBF's endeavors, as well as the General Land Office's commitment those efforts. Improved outreach can lead to new partners, as GBF strives to make the overall program sustainable for years to come.

VI. References

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VII. Appendix

APENDIX A

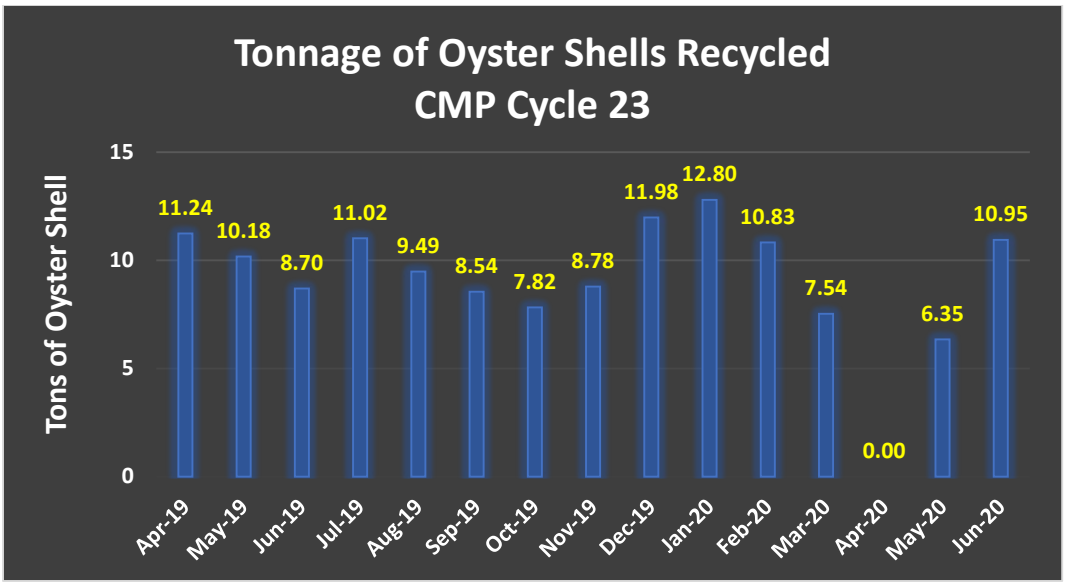
SHELL COLLECTIONS NUMBERS

A.1 Tonnage of Oyster Shells Recycled During Cycle 23

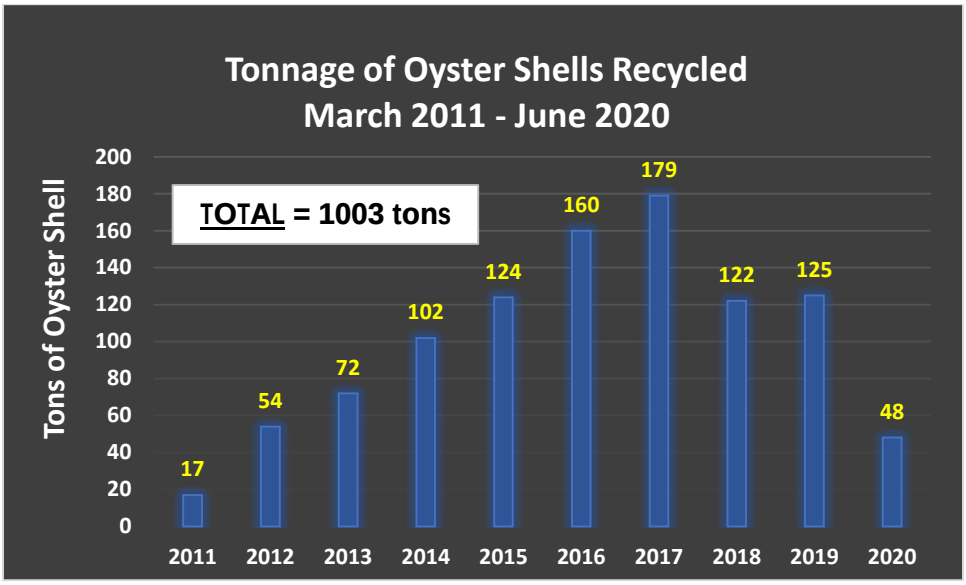
Month	Oyster Shells Collected (tons)
Apr-19	11.24
May-19	10.18
Jun-19	8.70
Jul-19	11.02
Aug-19	9.49
Sep-19	8.54
Oct-19	7.82
Nov-19	8.78
Dec-19	11.98
Jan-20	12.80
Feb-20	10.83
Mar-20	7.54
Apr-20	0.00*
May-20	6.35
Jun-20	10.95
Total	**136.22**

**No shell was collected during April of 2020 due to safety protocols put in place during the Covid-19 Pandemic*

***Oyster shell tonnage is based on an average weight of 180lbs of shell/32-gallon bin and 30lbs of shell/5-gallon bucket and is subject to a variance of ± 5%.*



A.2 Tonnage of Oyster Shells Recycled to Date



APPENDIX B

CURING SITE MAINTENANCE

Date	Curing Site	Maintenance Conducted	Volunteer/Contractor
6/3/2019	Red Bluff	Collected 35 buckets of shell (.68CY) for oyster gardening	GBF Staff
6/21/2019	Red Bluff	Collected 25 buckets of shell (.49CY) for oyster gardening	GBF Staff
6/23/2019	TX City	Property mowed Shell piled to begin curing process	GBF Staff
6/25/2019	TX City	Transported 151 shell bags (3.85CY) to TBDC	GBF Staff
7/10/2019	Red Bluff	Property mowed and maintained	GBF Staff
7/17/2019	TX City	Transported 126 shell bags (3.22CY) to TBDC	GBF Staff
7/23/2019	Red Bluff	Transported 3 truckloads (~39 CY) of shell to Sweetwater Lake for oyster bar construction Piled new shell for 6 month curing	Trucks - GCL Loader, operator - GCL (pro bono)
11/19/2019	Red Bluff	Began clearing middle section to make room for future shell piles	GBF Staff
12/9/2019	Red Bluff	Completion of adding/spreading crushed concrete for the loop and part of the road	GBF Staff
2/27/2020	Red Bluff	Completion of clearing/mowing middle area	GBF Staff
4/2/2020	Red Bluff	Sectioned off areas for piles in middle area; used wooden stakes/yellow nylon rope	GBF Staff (Haille, Shannon)
Discovered on 4/2/2020	TX City	Road filled and graded by neighboring oil & gas affiliate	Unknown
5/28/2020	Red Bluff	New shell pile areas in middle area marked using wooden stakes with designated shell pile letter painted on top of stake	GBF Staff (Shannon)
6/30/2020	Red Bluff	Mowed	GBF Staff (Ricci)
7/14/2020	Red Bluff	Weedeated around stakes/tree in middle area and around shell pile B	GBF Staff (Shannon)
7/20/2020	TX City	Moved shell; Pile B and C got moved to pile A	GBF Staff (Michael)
7/23/2020	TX City	Shell piles marked using wooden stakes with designated shell pile letter painted on top of stake	GBF Staff (Shannon)

APPENDIX C

STRATEGIC DEVELOPMENT PLAN

See Attachment

APPENDIX D

VOLUNTEER OYSTER GARDENING

D.1 Report

A. Tiki Island Bagging Event:
Date: Saturday, June 8, 2019

Michael Niebuhr led the bagging event at the home of a volunteer in Tiki Island along with 45 volunteers. After a presentation about the Galveston Bay Foundation (GBF) Oyster Shell Recycling Program and Oyster Gardening program and it's benefits and the duties of a volunteer oyster gardener, the group created 85 oyster gardens.

B. San Leon Bagging Event:
Date: Saturday, June 15, 2019

Haille Leija led the bagging event at the home of a volunteer in San Leon along with 11 volunteers After a presentation about the Galveston Bay Foundation (GBF) Oyster Shell Recycling Program and Oyster Gardening program and it's benefits and the duties of a volunteer oyster gardener, the group created 63 oyster gardens.

C. Bayou Vista Bagging Event:
Date: Thursday, June 27, 2019

Michael Niebuhr led the bagging event at the home of a volunteer in Bayou Vista along with 25 volunteers. After a presentation about the Galveston Bay Foundation (GBF) Oyster Shell Recycling Program and Oyster Gardening program and it's benefits and the duties of a volunteer oyster gardener, the group created 32 oyster gardens.

D. Galveston Island Bagging Event:
Date: Saturday, June 29, 2019

Michael Niebuhr led the bagging event at the home of a new volunteer in Galveston along with 21 volunteers. After a presentation about the Galveston Bay Foundation (GBF) Oyster Shell Recycling Program and Oyster Gardening program and it's benefits and the duties of a volunteer oyster gardener, the group created 50 oyster gardens.

E. Alternative Gardening Methods:

After using Cycle 22 to test out alternative gardening methods, it was determined that spat recruitment was not necessarily correlated directly to garden design. And while it was determine that there are pros and cons to each design, ultimately, the deicision for what type and how many of each garden was used in Cycle 23 came down to volunteer preference. Each gardener had their own personal prefernce to the design based on previous experience. Because the Volunteer Oyster Gardening Program is as much, if not more, about community engagement and outreach, as it is about direct species recruitment and population management, GBF feels that allowing volunteers to decide for themselves empowers the volunteers to be better stewards of their gardens.

D.2 Number and Location of Oyster Gardens Created

Location of gardens	# of gardens created	Sub-bay system
Tiki Island	88	West Galveston Bay
San Leon	65	Central Galveston Bay
Bayou Vista	37	West Galveston Bay
Galveston	55	West Galveston Bay
	245	

D.3 Oyster Gardening Volunteers

Community	# of Volunteers
Tiki Island	45
San Leon	11
Bayou Vista	25
Galveston	21
	102

D.4 Spat Recruitment

Community	Total Bags Gardened	Avg. Spat/garden	Total Spat per Community
Tiki Island	88	73.49	6467
San Leon	65	0.25	16
Bayou Vista	37	6.41	237
Galveston	55	54.58	3002
TOTALS	**245**	**39.68**	**9,722**

APPENDIX E

PROJECT PHOTOGRAPHS

E.1 Oyster Shell Collection

E.2 Texas City Curing Site

Shell Pile Maintenance

E.3 Red Bluff Curing Site

Shell Piles

Access road maintenance

E.4 Oyster Gardening Events


LET'S
DO
THIS.

E.5 Oyster Recycling Educational Booth

E.6 Conference Presentations

OYSTER SHELL RECYCLING PROGRAM

A GALVESTON BAY FOUNDATION PROGRAM

Strategic Development Plan 2.0 2020-2022

A REPORT FUNDED BY A TEXAS COASTAL MANAGEMENT PROGRAM GRANT APPROVED BY THE TEXAS LAND COMMISSIONER PURSUANT TO NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION AWARD NO. NA18NOS4190153.

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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.

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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).

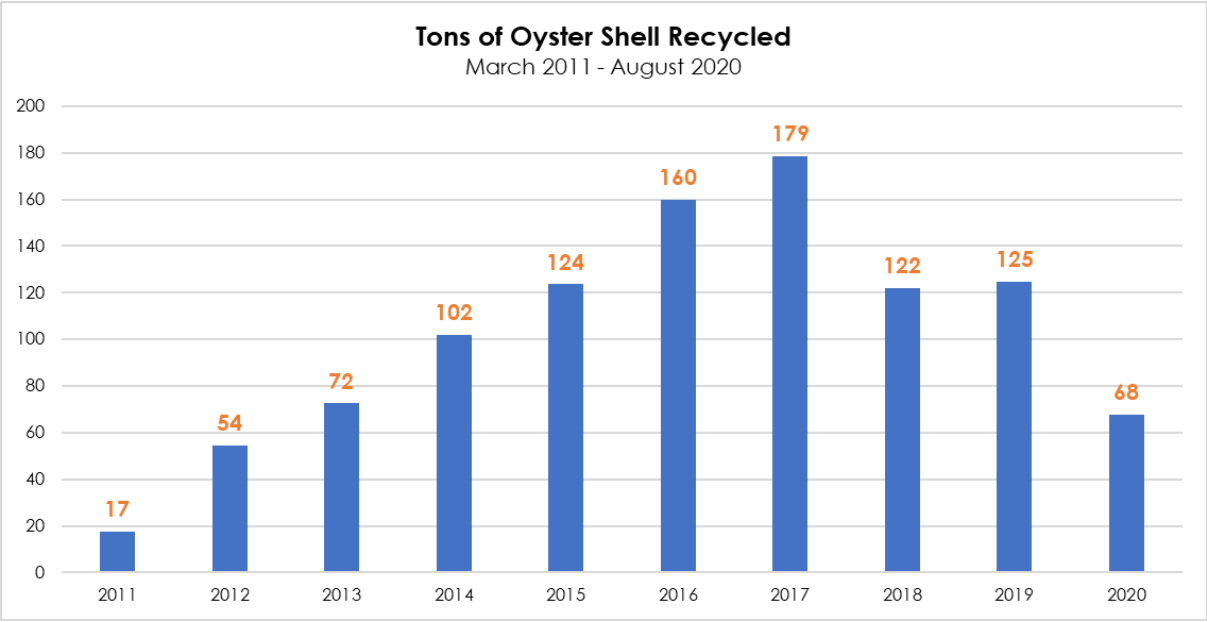
Although the wild larvae supply in Galveston Bay remains abundant (Martinez-Andrade et al, 2005), the removal of shells from the bay has resulted in a shortage of hard substrate, a key component for sustaining oyster populations. Commercial harvest operations in Galveston Bay, along with storm-driven 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, nearly 30 groups across the US are actively recycling oyster shell 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 (Program) in 2011. The Program 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 100 tons (200,000 pounds) of shells a year. Since the inception of the Program and as of the date of this publication, GBF has collected over 1,000 tons (2,000,000 pounds) of oyster shell and returned approximately 530 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 August 31, 2020



GBF initiated the Oyster Shell Recycling Program 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 Program has progressed through the Pilot Phase and initial Expansion Phase, resulting in 14 restaurant partnerships and four shell storage sites since 2011.

Within the first two years of operations, the amount of shells recycled annually increased by 200 percent (see Figure 1). 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 of the program by expanding shell recycling operations to Galveston Island through a partnership with Texas A&M University at Galveston (TAMUG). The beginning of 2019 marked the start of the Evaluation Phase.

During the Evaluation Phase (2019-2020), GBF will determine if an alternative approach to shell recycling should be pursued and if an expansion into the inner loop of Houston is feasible. The preliminary results of these evaluations thus far are captured in Steps 3, 4, and 5 of this document.

To help encourage restaurant participation and provide guidance through the next expansion phase, GBF established a Chef Advisory Council in 2019 with the assistance of a Houston-based public relations firm. The Chef Advisory Council is comprised of local chefs and restaurant owners as well as a public relations specialist. The Council members work in tandem to promote awareness of the Program through customer engagement, fundraising events and media appearances. Unfortunately, the Council was formed only a few months prior to the COVID-19 pandemic and has yet to reconvene. GBF plans to regroup in the fall 2020 with all Council members and discuss expansion plans for 2021. Direct input from these restauranteurs will help GBF understand the best shell collection methodologies to implement upon expansion. Working with the Council will also provide GBF with a better understanding of restaurant operations and allow the Foundation to become more effective at securing new restaurant partners. Furthermore, the direct partnership with the PR firm will provide an avenue for increasing the exposure of the Program to a larger audience.

In addition to the Chef Advisory Council, GBF also re-instated 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.

GBF originally planned to launch the expansion of the Program to Houston in April 2020 with the Inaugural Houston Oyster Festival. Unfortunately, due to the COVID-19 Pandemic, all large events were canceled in the City of Houston by March. GBF made the decision to postpone the event until 2021 in the interest of human health and safety. As restaurants were required to suspend inside dining, oyster sales ceased for a little over a month. Shell recycling operations were temporarily suspended from March 21, 2020 through May 6, 2020. GBF's shell recycling operations began again on May 7, 2020 as restaurants commenced reopening their dining rooms. Pending the status of the pandemic throughout the remainder of 2020, GBF plans to provide shell recycling services to restaurants in the inner loop of Houston as early as 2021 and launch the Inaugural Houston Oyster Festival in April of 2021 in celebration of the 10-year anniversary of the Program.

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 Expansion A	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 Evaluation	2019	125 tons	8	• Created a Strategic Development Plan (SDP) • Established a Chef Advisory Board • Reinstated the Galveston Bay Oyster Workgroup
	2020	68 tons as of 8/31/2020	8	• Secured 1 new restaurant partner • 1 additional new partner pending as of 8/31/2020 • Updated SDP • Created a Sun Curing Protocol ***Proposed Plans:*** • Purchase new recycling equipment • Secure an additional curing site

**Please note, the tonnages shown here reflect the revised shell weights per recycling receptacle: 182 pounds per 32-gallon bin and 30 pounds per 5-gallon bucket. Tonnages shown in Table 1 from the 2019 Strategic Development Plan document were based 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

As of the date of this publication, restaurant dining rooms are currently at 75 percent capacity due to state-mandated social distancing requirements. Although the output of shell has decreased, GBF made the decision to continue shell recycling as long as oysters are still being sold at the restaurants. Pending the status of the pandemic throughout the remainder of 2020, GBF will make the decision whether to move forward with the expansion to Houston as well as the Inaugural Houston Oyster Festival, tentatively planned for April 2021.

Main Recycling Route

At this time, GBF provides oyster shell recycling services free of charge for participating restaurants. 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 is able to store, GBF staff will 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 staff's "main" recycling route.

The baseline cost for GBF's current shell collection operations along the main route averages $2,060.00 per month or $24,720.00 per year (see Table 7 in Step 3). This includes basic travel, approximately 200 miles per week, and personnel expenses, approximately 15 to 20 hours per week, to conduct shell collections three times a week. As of September 2020, the overall annual Program budget, which includes the baseline expenses in addition to Program management, staff oversight, restaurant coordination, grant administration, supply purchases, equipment maintenance, fundraising, community engagement and outreach, and many other components, costs the Foundation, on average, $80,000.00 to $100,000.00 per year. At this time, GBF employs one full-time staff member dedicated to shell recycling operations including the weekly collection of shell from restaurants. A second full-time staff member is also trained in shell collection and serves as a back-up if the primary employee is unavailable.

GBF's main recycling route is located 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 approximately five hours per day, totaling 15 hours per week. This job is incredibly labor intensive and requires driving and trailering skills as well as the ability to manually pull up to 200 pounds up the trailer gate. In 2013, GBF purchased a half-ton Toyota Tundra 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. 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.

GBF staff haul each restaurant's shells via truck and trailer to a storage site (aka "curing site") where the shells are stored temporarily on land. GBF currently has access to two curing sites near the main route known as: Red Bluff and Texas City (see maps in Appendix B). As shells accumulate at the curing sites, GBF staff and volunteers strategically pile the shells using a front-end loader, often provided and operated by a volunteer, or a rented skid steer. The turning of the shell occurs every three to four months 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 draft Sun Curing Protocol which provides additional information on the Foundation's sun curing process. Following the curing process, the oyster shells are ready to be used in oyster reef restoration and enhancement projects throughout Galveston Bay.

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 the Island using a TAMUG-issued truck. Due to the lower volume of shells produced by the current restaurant partner on the Island, BLVD Seafood, a trailer is not required at this time. Instead, BLVD Seafood utilizes five-gallon buckets to collect their shucked shells. The buckets of shell are transferred by TAMUG staff into 14-gallon recycling tubs in the bed of the truck. Each 14-gallon bin holds approximately 475 shells, weighing approximately 81 pounds. These shells are transported to a curing site located adjacent to the TAMUG campus on Pelican Island within the "Wetland Center" property. Please refer to Appendix D for pictures of the recycling operations on Galveston Island and Appendix C for a map of the Galveston Island (TAMUG) recycling route.

As of August 2020, Sea Camp is undergoing restructuring and the original contact for the shell recycling operations at TAMUG is no longer employed by TAMUG. It appears that TAMUG will not be able to provide shell recycling services. Therefore, GBF is in communication with other organizations on Galveston Island to determine if there is another partnership opportunity to facilitate shell recycling. At this time, shell collections from BLVD Seafood are temporarily on hold.

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. 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 recycling bucket.

In April 2020, GBF staff worked with a corporate partner to weigh five bins and five buckets containing cured, dry shell, in order to update the average weight of shell in each receptacle. According to the Warehouse Manager, the industrial scale that was utilized is calibrated every three months. 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 30 pounds of shell, thus averaging approximately six 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 addition, 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 equivalence 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 Bin	81 lbs.	475 shells	238 oysters
5-gallon Bucket	30 lbs.	200 shells	100 oysters
1-gallon equivalent	*6 lbs.*	*40 shells*	*20 oysters*

To further improve the efficiency and accuracy of tracking the amount of shells collected, GBF staff began developing a Microsoft Access Database in 2019. Not only will this database reduce duplicity in data collection and analysis, it will also allow GBF to accurately track the curing process of all recycled shell and how much recycled shell is hauled off each curing site for use in restoration. After attending Access training and consulting with other departments within the Foundation, the first iteration of the database was developed in May 2020. However, GBF is in the midst of improving documentation for the Foundation as a whole and is planning to hire a subcontractor to develop a database for the entire Foundation. Therefore, the implementation of the Oyster Shell Recycling Database has been put on hold. GBF staff will continue to document the amount of shell collected, cured, and returned to the Bay via excel spreadsheets until further notice.

C.1) Program Goals

The goal of GBF's Oyster Shell Recycling Program 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 amount 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 Program beyond current federal funding sources.

Throughout 2020 and 2021, GBF plans to assess the current status and future potential of the Oyster Shell Recycling Program, as demonstrated by this Strategic Development Plan and the previous edition prepared in September 2019. After completing the Evaluation Phase, GBF hopes to achieve the following:

1) Expand shell recycling operations to the Inner-Loop of Houston
2) Secure additional restaurant partners on Galveston Island
3) Secure one reef restoration project every two to three years
4) Continue annual oyster gardening efforts in at least three communities
5) Establish a volunteer-based reef monitoring program
6) Develop best management practices for sun curing oyster shell in accordance with TPWD

The ultimate success of the Program 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 GBF's Oyster Shell Recycling Program, the Foundation 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 amount of shells recycled, a single restaurant can reduce its annual waste production by 75 tons (150,000 pounds) per year, as demonstrated by Tommy's Restaurant and Oyster Bar as well as Tookie's Seafood in 2017.

Based on phone interviews with local waste hauling services in 2019, it is estimated that weekly collection by a waste vendor such as Republic Waste Services or Waste Management may cost a restaurant anywhere from $150.00 up to $800.00 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 a significant cost savings in their waste hauling expenses. Three of GBF's restaurant partners have exceeded this amount on a weekly basis: Tommy's Restaurant and Oyster Bar, Tookie's Seafood, and Topwater Grill. Unfortunately, most of GBF's restaurant partners have not observed a significant cost savings. However, they are making an impact by redirecting oyster shells from landfills to oyster reef restoration through participation in this Program.

Restaurant partners also benefit from the value of the oyster shells donated to GBF for reef restoration. Purchasing shell 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 Rockport, Texas.

As of 2019, Alby's sells shucked oyster shells for approximately $35.00 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). Based on an average of these values, 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 $30.00 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, Tookie's Seafood recycled 75 tons (150,000 pounds), equivalent to approximately 128 cubic yards of shell in 2017. Therefore, the restaurant had the opportunity to deduct the value of this shell, estimated at $3,840.00 from their 2017 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 Oyster Shell Recycling Program.

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, it also allows 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 G. 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 Oyster Shell Recycling Program and involve restaurants in the decision-making process. Restaurants are also promoted on GBF's website and highlighted in social media posts, thus bringing in new clientele to their business. GBF works with restaurants one-on-one to determine the best avenue for delivering the message to their patrons. While the media exposure and outreach items are currently free to partners, GBF is exploring the idea of requiring the purchase of at least two outreach items to prove commitment to the Program.

Furthermore, GBF is in the process of initiating a new social media campaign to raise awareness of shell recycling. To do this, table tents will be distributed to current restaurant partners. Each table tent contains information about the Oyster Shell Recycling Program and identifies the restaurant as an active participant. The table tents also request patrons to share pictures of their oysters on social media (if they choose to order an oyster item), and in the process tag GBF as well as the restaurant, thus giving both entities social media recognition. Not only will this increase social media exposure for both parties, it will also directly engage and inform restaurant customers. At this time, GBF has only developed one template for the table tent design, but as the program expands alternative designs can be created to better suit different restaurants' decor and ambiance. Due to the COVID-19 pandemic, this campaign was put on hold in 2020, however GBF staff plan to kick-start it again in November 2020 to coincide with the beginning of oyster season.

Table 3: Cost Saving Estimates for Restaurant Partners

Cost Saving Method	Annual Expense for GBF	Benefit for Restaurant
Collection Receptacles		
32-gallon Recycling Bins	$709.80/year $70.98/bin 10 bins purchased per year (average)	***FREE*** Save $709.80± per year depending upon the number of bins required.
14-gallon Recycling Tubs	$54.90/year $10.98/tub 5 tubs purchased per year (average)	***FREE*** Save $54.90± per year depending upon the number of tubs required.
5-gallon Recycling Buckets	$101.00/year $5.05/bucket 20 buckets purchased per year (average)	***FREE*** Save $101.00± per year depending upon the number of buckets required.
Recycling Service		
Truck (2013 Toyota Tundra)	Mileage ~ $5,750.00/year • Average 10,000 miles/year • 2020 mileage rate = $0.575/mi Maintenance ~ $1,000.00/year	***FREE*** Save $31,9700±/year
Trailer (12-foot landscape trailer)	Maintenance ~ $500.00/year	
Labor	Staff Time ~ $24,720.00/year • 15-20 hours/week • 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 $30.00 per cubic yard of shells recycled
Outreach Materials		
Labor & Marketing	Coasters: $220/100 units Rack Cards: $175/100 units Check Presenter Insert: $60/100 units	***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 Oyster Shell Recycling Program, 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 Program's inception in 2011. However, it is clear the Program needs additional improvement and assessment, hence the initiation of the Evaluation Phase in 2019. 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 Program.

D.1) Funding

As a non-profit operation, funding for the Oyster Shell Recycling Program 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 eight cycles of CMP funding (NOAA funds administered by the Texas General Land Office), USFWS Coastal Program funding, 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 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 $33,534.00 per year.

Although GBF has been fortunate to acquire substantial funds for the Program 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 Program. For example, GBF established a partnership with Proud Pour, a company that "pairs wines with solutions to local environmental problems" (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 Program as long as 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" (www.toadfishoutfitters.com). For every Toadfish product sold in Texas, GBF receives a portion of the proceeds. GBF staff are also researching options for restaurants to contribute financially to the Program through an annual or monthly participation or service fee, by providing customers with the option to donate, and/or by hosting an annual oyster charity event at each restaurant.

Furthermore, GBF plans to host an annual Houston Oyster Festival (www.houstonoysterfestival.org) starting with the inaugural event in April 2021, pending the status of the COVID-19 pandemic. All proceeds from the festival will benefit the Oyster Shell Recycling Program and all shells produced by restaurants at the event will be recycled by GBF. It is proposed that this festival could provide at least the baseline funding required to sustain minimum shell recycling operations (see Table 7). By securing ongoing/perpetual funding sources such as Proud Pour, Toadfish, and the Houston Oyster Festival, GBF hopes to achieve financial stability for the Program and move away from annual funding requests from state and federal partners.

D.2) Restaurants

The GBF Oyster Shell Recycling Program 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 14 different restaurants. Due to changes in restaurant management, menu revisions, and/or lack of participation, four of these restaurants are no longer partners of the Program. 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 Program, 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 Program must originate from the management or ownership level for a restaurant to be successful in oyster shell recycling.

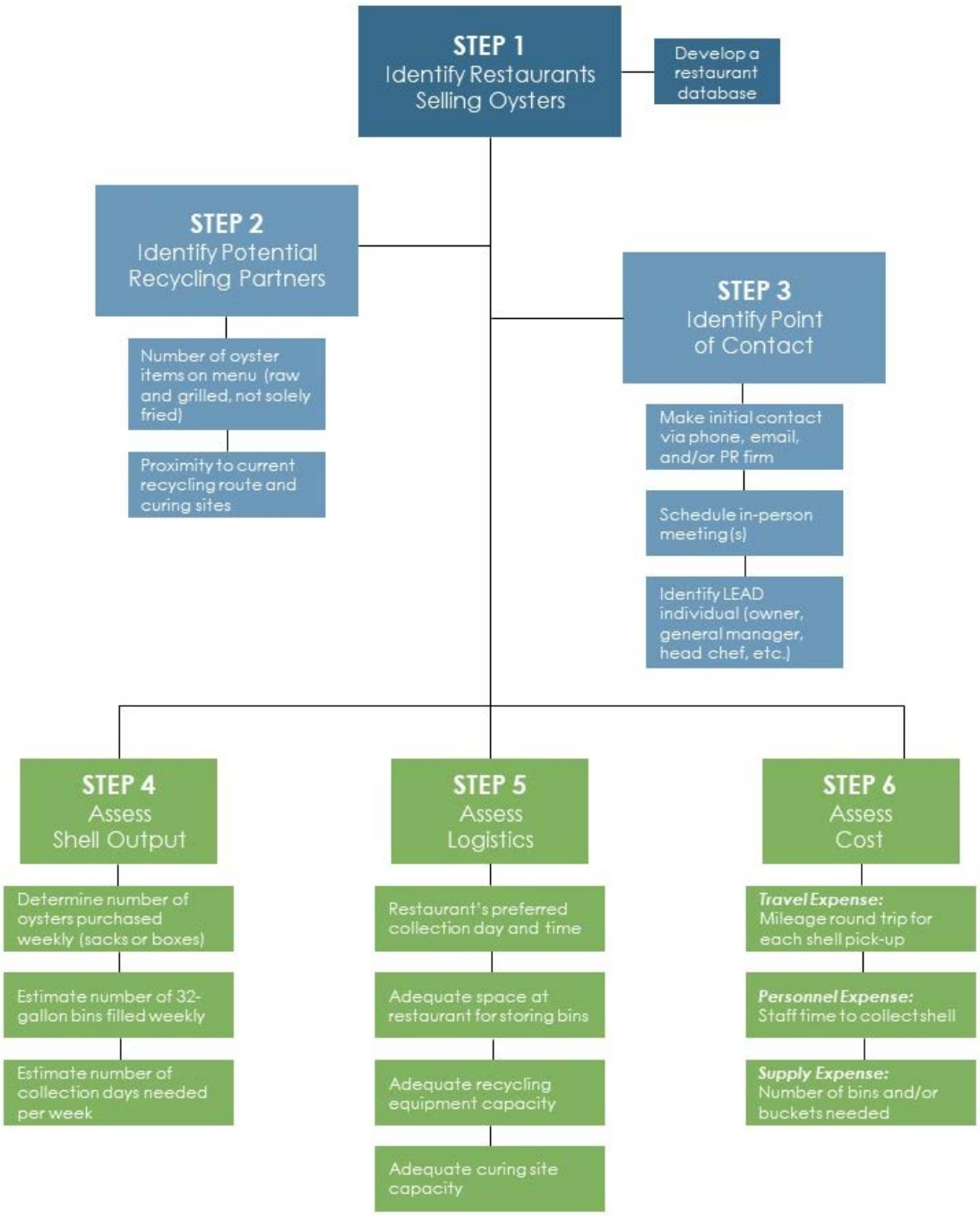
While there are a large number of seafood restaurants selling oysters in the Houston-Galveston region, only some are viable partners for shell recycling. To track the different restaurants serving oysters, GBF staff maintain a restaurant database (Appendix E). This document is updated annually to include 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 138 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 2020 Restaurant Database, there are 92 restaurants in Houston (this includes the major suburbs of Houston to the west, north, and south), 34 restaurants in the Clear Lake region, and 12 restaurants on Galveston Island that serve oysters. Of those 138 restaurants, approximately 50 serve multiple oyster items on the menu, both raw and cooked, and are within a reasonable location for collection services. These 50 restaurants (which includes GBF's current partners) 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 14 different restaurant partnerships, 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 Program 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 Program.

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 (see 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 depend 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 the Foundation's best interest to incur additional personnel and travel expenses by adding on 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. Many of the restaurants serving a sufficient number of oyster items on their menu are located a far distance from GBF's main recycling route (see Appendix A and C). This is one of the many reasons GBF is planning an expansion into the Inner-Loop of Houston in the near future. 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.

Last but not least, it is vital that a restaurant has a lead individual with serious investment in the Program. 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 Oyster Shell Recycling Program is necessary. When restaurant staff can explain the Program, 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 Program and not hands-on in implementing shell recycling in their restaurants. Therefore, GBF is considering an annual "participation fee" or "buy-in fee" to ensure each restaurant partner's commitment to the Program, not to mention additional income for the Program.

D.3) Program Capacity

Before GBF launches a second expansion phase of the Oyster Shell Recycling Program and reaches out to new restaurant partners, the capacity of the Program 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 Program'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

Utilizing the half-ton Toyota Tundra 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 Tundra's towing capacity is 8,000 pounds and the landscape trailer is rated for a maximum weight of 7,000 pounds. The trailer alone weighs 1,500 pounds. While the Tundra has the ability to tow more than 20 bins on the 1,500-pound trailer, the trailer itself is not long enough to contain additional bins. Furthermore, 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. However, this means only 12 to 16 full bins can be loaded on the trailer for each trip to a restaurant, resulting in a total of 2,200 to 2,900 pounds of oyster shells per trip. If additional restaurant partners join the Program, GBF will be close to or at max capacity of the trailer in terms of space rather than weight.

The shell recycling effort on Galveston Island is much smaller than GBF's main route in the Clear Lake region. With only one restaurant partner on the Island, a trailer is not required at this time. BLVD Seafood is provided with 5-gallon buckets to collect shell throughout the week. Shell recycling staff, originally from TAMUG, empty the buckets of shell into 14-gallon recycling tubs in the bed of a truck. While this method is effective with a single restaurant partner, the capacity of this method is extremely limited. The truck bed can hold a max of 20, 14-gallon tubs and therefore only 0.80 tons (1,600 pounds) of recycled shell.

When/if additional restaurant partners are secured in Galveston, new equipment will likely be needed. It is predicted the method currently used along GBF's main recycling route (truck and landscape trailer with rolling 32-gallon recycling bins) will be adopted in Galveston if/when additional restaurant partners are secured.

Staff

GBF currently employs one full-time staff member who collects the recycled oyster shells from restaurants three times a week. This individual also oversees shell recycling operations. A second full-time staff member is available to conduct shell pick-ups when the primarily shell recycling staff is unavailable.

As the Program expands into Houston, necessary staff time to perform shell collections will increase as new restaurants are added. As a result, additional part-time staff may be required. Part-time staff are limited to a total of 30 hours per week. In the past, GBF employed two part-time Shell Recycling Assistants to accommodate varying schedules. This may be required again as new restaurant partners are added to the route and the time per collection day increases.

At this time, GBF services seven restaurants along the main route in the Clear Lake area. It has been determined that adding more restaurants along the main route is feasible. However, the number of restaurants added will depend upon their output of shell and whether they require a significant number of bins to be emptied every week. Based on the restaurant database, it appears at least three to five restaurants along the main route are eligible to receive shell recycling services and would not drastically change the current recycling route.

Storage

As of August 2020, GBF has access to two storage sites (aka curing sites) along the main 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 two sites, approximately 0.46-acre (20,600 square feet) is available for the storage of recycled oyster shells. This area has increased since the previous edition of the Strategic Development Plan due to land maintenance performed at the Red Bluff Curing Site. 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	2600 sq ft	6	578 CY	339 tons
TOTALS	**0.46 ac**	**20,600 sq ft**	**NA**	**4,578 CY**	**2,689 tons**

Based on these measurements, it is estimated that GBF can currently store a total of 2,689 tons of recycled oyster shells. At this time, the Foundation collects an average of 100 tons of shell per year. Therefore, it is unlikely these sites will reach capacity any time soon. However, due to the Sun Curing Protocols 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 is in the process of further defining the Sun Curing Protocol with the assistance of research partners from the University of Houston as well as representatives from TPWD. 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 would be helpful to secure a new curing site in closer proximity to the Inner Loop of Houston to reduce travel expenses once the expansion takes place.

Texas City Storage Site:

The original curing site, GBF's privately owned Texas City Preserve, has been utilized for shell storage since the Program 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.

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. Thus, GBF worked with the cattle rancher to install fencing around the entire shell storage area to resolve this issue.

Red Bluff Storage Site:

Thanks to a donation by the Port of Houston Authority (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 valued at $33,534.00 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 do the central location of the property in relation to the main recycling route. This curing site allows for the storage of up to 2,350± tons of recycled shell.

While this site has been invaluable to the Program, 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 the Foundation's primary and largest curing site, the bulk of recycled shell is stored at Red Bluff. In an effort to prepare for the expansion of the program and improve the Foundation's sun curing process, GBF staff have designed a more strategic layout for the Red Bluff Curing Site (Figure 13 and 14 in Appendix C). 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 partner's construction yard, Inland Marine Services, LLC, from June 2016 through September 2018. Approximately 200 tons of recycled oyster shell was 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. GBF now only has access to two curing sites along the main route, the Texas City Curing Site and the Red Bluff Curing Site.

TAMUG Storage Site:

From January 2018 through September 2020, TAMUG allowed the Foundation 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 is currently stored in a small parking area near the sole building on the Wetland Center property. Due to changes at the Wetland Center facility as well as the dissolution of the shell recycling partnership with TAMUG, GBF is in the process of moving the shell to a new curing site location in Galveston.

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 Oyster Shell Recycling Program 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, education of volunteer oyster gardeners and volunteers participating in reef construction, distribution of informational handouts, distribution of coasters 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 the 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 Program 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 the Bay; one way is through the Galveston Bay Report Card (www.galvbaygrade.org). A component of the 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 in regard to 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 Oyster Shell Recycling Program, GBF will continue to face challenges in securing new partners and support for the Program. 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, it will also encourage patrons to return to participating restaurants, therefore benefiting both GBF and their restaurant partners.

Public awareness as well as the success of GBF's shell recycling efforts will exponentially increase upon the expansion of the Foundation's shell recycling operations to the Inner Loop of Houston where the majority of the population and key decision-makers are located.

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 inundated with shell recycling and reef restoration efforts, but only within the last five to 10 years. As shown in Appendix I, there are approximately 30 active oyster shell recycling programs in the United States as of September 2020. These programs range from small-scale student and/or staff-driven operations like both Texas programs, 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. 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	$3,650	16	Yes pickups/ week	1-3
LA	2014	Coalition to Restore Coastal Louisiana (CRCL) Oyster Shell Recycling Program	Dump Truck (vendor)	Contract	$20,000	18	Yes bins/ month	5
NJ	2019	NJ Division of Fish and Wildlife Bureau of Shellfisheries	F450 Truck Dump Trailer with hydraulic lift arm	Staff	$4,600	1 + 1 casino	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	8	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	3	No	5
TX	2011	Galveston Bay Foundation Oyster Shell Recycling Program	½-ton Truck Landscape Trailer	Staff	$2,060 *Main Route baseline cost*	7	No	1-3
	2018		½-ton Truck	Students	$300 *TAMUG Route baseline cost*	1	No	1

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

The Alabama Coastal Foundation's (ACF) 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 $3,600-$3,700 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 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.

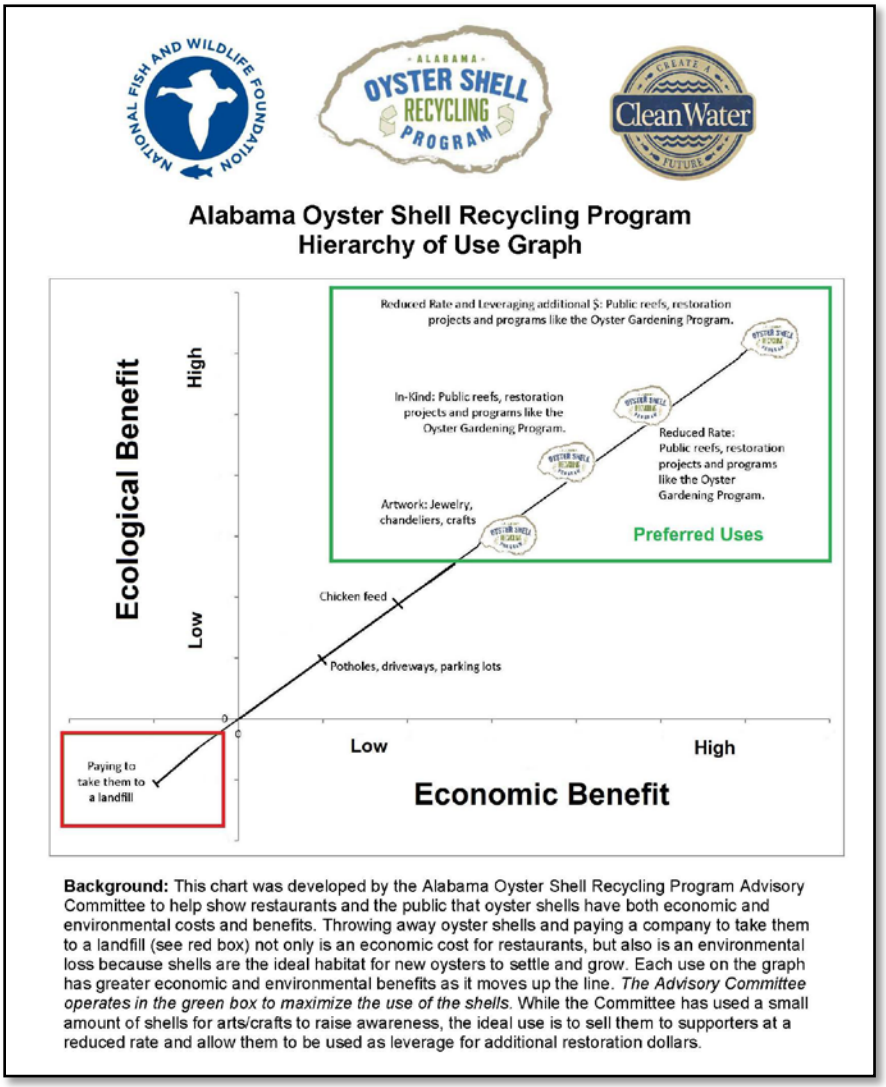


Figure 3. Hierarchy of Oyster Shell Use (Alabama Coastal Foundation)

A.2) Louisiana Case Study: Coalition to Restore Coastal Louisiana – "Oyster Shell Recycling Program"
**Please note this case study was conducted in 2019.*

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, Phoenix Recycling, 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. As a result, CRCL now works with 18 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.

Phoenix Recycling collects shell 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, Louisiana, 60 miles from downtown New Orleans, where it remains for at least six months before being utilized in reef restoration projects. CRCL commented that 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.3) New Jersey Case Study: New Jersey Division of Fish and Wildlife Bureau of Shellfisheries

The state of New Jersey (NJ) took up shell recycling in the fall of 2019 under the 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 shell from one restaurant and one casino utilizing an F-450 pickup truck and 7-foot wide by 14-foot long dump trailer. Originally, they dumped recycled shell 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. 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 the largest oyster shell recycling program 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 to 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 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 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 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.

A.5) Florida Case Study: Choctawhatchee Basin Alliance – "Oyster Shell Recycling Program"
**Please note this case study was conducted in 2019.*

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 three times a week from 12 restaurant partners using a Ford F350 truck and 14-foot dump trailer donated by Northwest Florida State College. Restaurant partners are provided with 30-gallon recycling bins to fill with shell. CBA staff lift those bins onto the trailer by hand. The recycled shells are then transported back to the CBA Headquarters where shell is stored and cured for 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 23 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 F450 truck and dump trailer with a Perkins 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 its 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 three 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 is able to keep their operating costs down. On average, the program requires approximately $5,000.00 per month to operate. Like GBF's Oyster Shell Recycling Program, 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. 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 30 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, like GBF's Program, 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 recent 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 this threshold, although it is clear that an expansion to more restaurants in Houston would be challenging with the current equipment set up, particularly in regard to labor.

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, 14 restaurants have participated in GBF's Oyster Shell Recycling Program. Although GBF's Program 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 Program through more consistent participation. Furthermore, by finding new ways to incentivize restaurants, such as participation in the new Houston Oyster Festival and ongoing social media campaigns, GBF hopes to retain more restaurant partners as the Program 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. 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 of the oyster shell leaving Galveston Bay via harvest is not returned through TPWD's efforts.

GBF's Oyster Shell Recycling Program 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 and often unfeasible.

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 the Foundation'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, 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 Program 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. That being said, 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 the Foundation.

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), Coastal Conservation Association (CCA), and the USFWS Coastal Program, are aware of the existence of the Oyster Shell Recycling Program but have not been engaged in the Foundation'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 Texas A&M University at Galveston (TAMUG) and the University of Houston (UH) to conduct monitoring and research on the Foundation's projects that incorporate recycled shell as well as the Foundation'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 Oyster Shell Recycling Program. The Strategic Development Plan may also serve as a framework for other organizations interested in starting a new oyster shell recycling program or in expanding an existing program.

While GBF's ultimate goal is to provide oyster shell recycling services for the majority of the Houston-Galveston region, it is likely not achievable without significant and consistent financial support as well as additional physical assets such as new equipment and a new property for shell curing. It is feasible in the short-term however, to adapt GBF's current shell recycling methods and restaurant partnerships to help ensure a more efficient and sustainable shell recycling operation.

In planning for expansion, GBF's focus has shifted to the feasibility of providing shell collection services to more restaurants. The feasibility of expansion depends on the program's capacity and associated limiting factors as discussed in Step 1. Approximately 138 restaurants serve oysters in the Houston-Galveston region. GBF's analysis of the restaurant database (Appendix E) indicates that 50 of these restaurants stand out as potential partners based on their location and the number and type of oyster items sold on their menus. At this time, GBF has the capacity in terms of equipment, staff, and curing site space to accommodate up to five additional restaurants along the main route in the Clear Lake region. Another three restaurants could be added to the Galveston route, pending their actual shell output. Yet any additions in Houston would not be feasible as of September 2020 due to a lack of staff time and equipment capacity.

In order to reach the goal of stockpiling enough oyster shells to allow for ongoing gardening efforts as well as reef restoration for years to come, an expansion into Houston is required. To achieve this goal, GBF has established the following objectives:

1) Purchase new shell recycling equipment by December 2020;
2) Begin recycling in Houston with up to three restaurant partners by January 2021;
3) Host the Inaugural Houston Oyster Festival to recycle additional shell, recruit new partners and patrons, and raise money and awareness by April 2021 (pending pandemic conditions);
4) Secure a new curing site in close proximity to downtown Houston by June 2021;
5) Streamline data collection via Access Database by December 2021;
6) Increase annual tonnage of shell recycled annually by ten percent.

Please note, many of the original objectives proposed in 2019 were not achieved due to changes and restrictions associated with the COVID-19 pandemic, hence the shift in the timeline depicted above and in Step 4.

B) Proposed Options

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

As indicated in Step 1, GBF's current truck and trailer can haul additional shell but space is limited on the trailer. The Red Bluff and Texas City curing sites have sufficient space but are located a long distance from downtown Houston. GBF's shell collection staff is tasked with an incredibly laborious job and any additional manual hauling of shell may be a health and safety risk. Therefore, in order to achieve a more sustainable operation and allow for expansion into Houston GBF plans to:

1) Secure new equipment that can haul more shell at one time,

2) Secure a new curing site located closer to downtown Houston, and

3) Hire a part-time assistant to accommodate additional shell collections in Houston and along the main route.

These steps would not only reduce travel and personnel expenses associated with the expansion, they would also decrease the physical labor component of the shell collections.

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 like GBF, to large-scale, vendor-based operations like CRCL and BOP. As shown in Table 6, there is an increase in operational costs as the number of restaurant partners increases and consequently the number of collection days increase.

To understand the range of expenses associated with each level of program growth, GBF created Tables 7, 8, and 9 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. Furthermore, the costs associated with each option outlined in Tables 8 and 9 are estimates based on quotes and/or online research conducted in 2020. 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	# of Staff Needed	Hours per Week**	Monthly Personnel Expenses	TOTAL Monthly Expenses*	TOTAL Annual Expenses*
Current Route *(Clear Lake Region)*	200	$500.00	1 full-time	20 hrs	$1,560.00	**$2,060.00 per month**	**$24,720.00 per year**
Expansion Option A *(Clear Lake Region)*	250-300	$700.00	1 full-time	10 hrs	$780.00	**$2,455.00 per month**	**$29,460.00 per year**
			1 part-time	15 hrs	$975.00		
Expansion Option B *(Downtown Houston & Clear Lake Region)*	350-400	$950.00	1 full-time	20 hrs	$1,560.00	**$3,800.00 per month**	**$45,600.00 per year**
			1 part-time	20 hrs	$1,300.00		
Expansion Option C *(Downtown Houston & Clear Lake Region)*	400-450	$1,200.00	1 full-time	10 hrs	$780.00	**$4,580.00 per month**	**$54,960.00 per year**
			2 part-time	20 hrs x 2	$2,600.00		

**Please note, the baseline expenses listed above ONLY include personnel time and travel expenses (based on the current federal mileage rate of $0.575/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 $80,000.00 to $100,000.00 for the GBF Oyster Shell Recycling Program based on current operations and equipment in 2020.*

***The hours per week listed above are an estimate based on the current 15-20 hours per week required to service seven restaurants along the main route. It is proposed that an additional 20± hours per week will be required to facilitate recycling in the inner loop of Houston.*

Table 8: Shell Recycling Methodology Options

Option	Shell Recycling Method	Item	Capacity	Cost *Estimate* per Item	Cost *Estimate* Total
1	Truck and Landscape Trailer (*current method*)	1/2-ton Truck	20 recycling bins ~2 tons of shell ** typically carry empty bins to swap out at restaurants*	*Already purchased* ~$29,000.00	$0.00
		12-ft Landscape Trailer + Modifications		*Already purchased* ~$5,500.00	
2	2nd Truck and 2nd Landscape Trailer	1/2-ton Truck	40 recycling bins ~4 tons of shell ** typically carry empty bins to swap out at restaurants*	$30,000.00	$36,000.00
		12-ft Landscape Trailer + Modifications		$6,000.00	
3	1-ton Truck and Dump Trailer	1-ton Truck	7-8 CY 4-5 tons of shell/load	$40,000.00	$65,000.00
		Dump Trailer		$10,000.00	
		Bin Lift		$15,000.00	
4	1-ton Truck with Dump Body	1-ton Truck with dump body	3-5 CY 2-3 tons of shell/load	$70,000.00	$85,000.00
		Bin Lift		$15,000.00	
5	Box Truck	Box Truck (includes lift gate)	20 recycling bins ~2 tons of shell ** typically carry empty bins to swap out at restaurants*	$50,000.00	$50,000.00
6	Dump Truck	Dump Truck (includes bin lift)	10-14 CY 6-8 tons of shell/load	$100,000.00	$100,000.00
7	Recycling Vendor	NA (most likely a dump truck will be used)	10-14 CY 6-8 tons of shell/load	*NA*	$15k to $20k per month $180k to $240k per year

Table 9: Pros and Cons of Shell Recycling Methodology 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
2	2nd Truck and 2nd Landscape Trailer	$36,000.00	1) Operated by GBF Staff 2) Minimal maintenance 3) Increase hauling capacity (facilitate addition of new restaurants)	1) Labor intensive 2) Some additional maintenance 3) Additional storage required 4) Additional registration fees, insurance, etc. 5) Need to carry empty bins for exchange
3	1-ton Truck and Dump Trailer	$65,000.00	1) Operated by GBF Staff 2) Less physical labor required 3) Increase hauling capacity (facilitate addition of new restaurants) 4) Can use equipment to transport shell to restoration sites 5) 1-ton truck can be used to haul tractor or other equipment needed for curing site maintenance	1) Additional maintenance 2) Additional storage required 3) Additional registration fees, insurance, etc.
4	1-ton Truck with Dump Body	$85,000.00	1) Operated by GBF Staff 2) Less physical labor required 3) Increase hauling capacity (facilitate addition of new restaurants) 4) Can use equipment to transport shell to restoration sites 5) No trailer required (easier access to restaurants) 6) 1-ton truck can be used to haul tractor or other equipment needed for curing site maintenance	1) Additional maintenance 2) Additional registration fees, insurance, etc. 3) Dump insert may limit use of truck for other activities 4) Potentially less capacity than dump trailer depending on design
5	Box Truck	$50,000.00	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 be used for other GBF Events	1) Additional maintenance 2) Additional registration fees, insurance, etc. 3) Need skilled/trained driver (increased personnel cost) 4) Box Truck cannot be used to transport shell to restoration sites
6	Dump Truck	$100,000.00	1) Most likely 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) CDL required 4) Need skilled/trained driver (increased personnel cost) 5) **EXPENSIVE** initial purchase
7	Recycling Vendor	$15k to $20k per month $180k to $240k per year	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**

B.2) Cost-benefit Analysis

While GBF's current baseline operational expenses are relatively low, the capacity to collect shell in terms of labor and equipment is not sufficient for additional restaurant partnerships. It is clear that GBF will require an additional vehicle and/or equipment and most likely one additional staff member to facilitate the Houston expansion of the Oyster Shell Recycling Program. It seems logical to split two staff and two sets of equipment between the two routes: inner loop of Houston and Clear Lake region. In this scenario, staff can collect shell from all restaurant partners during the most desirable days and times. As a result, staff would avoid congestion at restaurants during peak delivery hours as well as traffic in downtown Houston. All restaurants would be given the option of collections on Mondays and Fridays to address the increase in shell output over the weekend. Most importantly, this approach would provide the best option for the restaurants, thus keeping the key players in the process happy and participating.

The initial purchase costs for Options 2, 3, 4, and 5 are somewhat comparable. The addition of any new vehicles or equipment will come with added maintenance, registration, and insurance costs. A new trailer will require an additional storage unit. Even the box truck and 1-ton truck with a dump body may require a storage unit depending on what is allowed at GBF's office. While all of these options address the ability to conduct shell collection along the two routes simultaneously, only Option 3 and 4 would allow for the transport of loose shell to restoration sites. This would reduce expenses for GBF's reef restoration projects immensely. A single reef restoration project may require dozens of loads to be transported, depending on the amount of shell needed, resulting in expenses ranging from $500.00 to $5,000.00 or more. Therefore, GBF has narrowed down the options to Option 3, a new one-ton truck and a dump trailer or Option 4, a new one-ton truck with a dump body, to facilitate the Houston expansion.

Eliminated Options

Option 1 is the current shell recycling method used by GBF. Since the goal is to expand the Program and collect more shell, the Foundation would clearly prefer to expand on this current methodology. However, if the additional funds required to expand to Houston are not secured, GBF may focus on only expanding locally first. Option 1 is sufficient for shell recycling with approximately 10 restaurants within a 15 to 20-mile radius. This can be accomplished with one part-time staff or one full-time staff, dedicating 15 to 20 hours per week strictly to shell collection duties. A second part-time staff could also be hired to accommodate additional shell collections, perhaps on Tuesdays and Thursdays, to offset the current staff's schedule of Monday, Wednesday, Friday. However, many restaurants prefer shell collection on Monday and Friday or have specific time restrictions associated with other deliveries that may make the addition of Tuesday and Thursday collections challenging. Option 1 also serves as a baseline operational structure. In the worst-case scenario, if GBF were to expand operations and funding became scarce or fell through, GBF could downsize to the basic truck, trailer, and recycling bin approach once again.

Option 2 was eliminated because the addition of a second ½-ton truck and landscape trailer does not reduce physical labor, does not facilitate access into congested downtown areas, and does not provide a mechanism to transport loose shell to restoration sites.

Option 5 was negated because a box truck would not increase shell collection capacity since spare bins would still need to be stored within the truck to swap out during shell collection. However, a box truck is comparable to Option 4 in that a single vehicle, could be used to access restaurants in congested downtown Houston. A box truck would also reduce the physical labor associated with shell collection via the use of a lift gate to load bins full of shell.

The box truck might also come in handy for other GBF events, such as Bike Around the Bay and Trash Bash, during which box trucks are rented for hauling supplies or trash. However, the box truck would not facilitate transporting loose shell to restoration sites, hence why it was eliminated.

Option 6 was ruled out due to the high initial costs of purchasing a dump truck. In addition, a Commercial Driver's License (CDL) would be required and thus the staff hired to operate the truck would likely require a higher wage. These expenses, coupled with the need for additional maintenance and specialized staff, make it clear that this option is not the best fit for GBF.

Option 7 was eliminated due to the high operating costs associated with subcontracting a recycling vendor. While GBF's personnel and equipment maintenance costs would be greatly reduced, there is concern that the lack of involvement in daily operations would hamper restaurant relationships and prevent GBF from observing/anticipating potential issues as they arise. The financial requirements for this option are not feasible at this time and likely unsustainable if GBF wishes to continue a free, or even low-cost, service for Houston-Galveston area restaurants.

Preferred Options

After a thorough analysis of the options depicted in Tables 7 through 9 in 2019 and again in 2020, GBF has come to the conclusion that the Oyster Shell Recycling Program would benefit from the most from one of two options: Option 3 (1-ton truck with a dump trailer) or Option 4 (1-ton truck with a dump body)

First and foremost, both Option 3 and 4 reduce the physical labor component of shell collection by incorporating a bin lift and dump mechanism so no heavy lifting is required. Both options would increase GBF's hauling capacity since no empty bins would need to be stored on board. However, the dump trailer would likely have more capacity than the truck with a dump body. Please note, the exact capacity of each has yet to be determined since it will depend on the final design specifications. Either dump mechanism would allow GBF staff to easily haul and dump loose shell at restoration sites, thus eliminating the cost of hiring dump trucks and drivers to transport the shell. The purchase of a larger 1- to 1.5-ton truck in either scenario would facilitate hauling a tractor or skid steer to help maintain curing sites and other GBF preserves. The additional equipment would also allow two staff to conduct shell collections along different routes at the same and therefore facilitate the expansion into Houston. For instance, one staff member could conduct the shell collections in Houston using the truck with a dump body or dump trailer and a second staff member could conduct the shell collections in the Clear Lake region using the current truck and trailer.

The main downside to both Option 3 and 4 is the cost. Both would require large upfront purchases as well as additional annual maintenance expenses. The maintenance costs associated with both would be higher than the current truck and trailer due to the hydraulics and other mechanisms required for the dump features and the bin lift. The maintenance costs associated with the 1-ton truck would likely be higher as well as, due to the potential need for a diesel engine and tandem axel.

Since these two options are relatively comparable, an additional diagram was developed to help further identify the pros and cons of each (see Table 10 below).

Table 10: Pros and Cons of Options 3 and 4

Pros	Option 3 *1-ton truck with dump trailer*	Option 4 *1-ton truck with dump body*
Reduces physical labor	X	X
Increases hauling capacity	X 5-8 tons	X 2-3 tons
Can tow tractor for curing site maintenance	X	X
No trailer required (easier access in downtown Houston)		X
Facilitate two shell runs @ one time	X	X

Cons	Option 3 *1-ton truck with dump trailer*	Option 4 *1-ton truck with dump body*
Additional maintenance required	X	X
Additional storage required	X	
Additional registration fees, insurance, etc.	X	X
Limited use		X
High Upfront Cost	X $65K	X $85K

The dump trailer would likely provide more capacity for hauling shell and could double as a trailer to haul a tractor or skid steer to a curing site for maintenance. However, expanding to Houston will require shell collections in crowded neighborhoods and commercial districts. While it could be accomplished via truck and trailer, the lack of a trailer would make accessing restaurants in downtown much easier. Therefore, GBF is leaning towards the truck with a dump body to facilitate the Houston expansion.

Although both options are relatively expensive, either would reduce the physical labor associated with shell collection as well as the costs associated with transporting shell to restoration sites. No matter which equipment option is selected, annual operating expenses will increase with an expansion of the Oyster Shell Recycling Program. However, the benefits of oyster reef restoration far outweigh the costs. As documented by GBF staff and volunteer observations, a single recycled oyster shell can house at least 10 to 15 oyster larvae. Each one of these oysters will grow into an adult that will not only filter up to 50 gallons of water per day but will also spawn and supplement other reefs within the Galveston Bay ecosystem.

STEP 4: IMPLEMENTATION

A) Action Plan

The Analysis (Step 1 and 2) and Planning (Step 3) sections of this document address the feasibility of GBF expanding shell recycling operations into the greater Houston area as well as along the existing routes. Based on the case studies and cost-benefit analysis, it appears that an expansion to Houston would be beneficial to the Foundation's efforts. The largest concentration of restaurants, including those that sell oysters, are located in the inner loop of Houston. Expanding to this region will not only increase the amount of shell recycled, it will also increase GBF's exposure in the community.

It is proposed that the expansion into the inner loop of Houston can be accomplished via the addition of at least one part-time staff as well as the purchase of another vehicle (1-ton truck with a dump body) and/or trailer (1-ton truck with a dump trailer). The initial purchase costs would range from $65,000 to $85,000 (Table 8) and the annual baseline expenses would range from $30,000 to $55,000 depending on the level of expansion (Table 7).

At this time, GBF is planning to move forward with Expansion Option B. This includes one part-time and one full-time staff splitting the shell collection responsibilities and averaging 375 miles per week. It is estimated that these additional expenses will be covered by CMP funds approved under Cycle 24 and 25 as well as a $100,000.00 donation from Phillips66 contributed specifically for the expansion of the Program, including new equipment purchases. Pending pandemic conditions, the Foundation also plans to receive funds via the Inaugural Houston Oyster Festival in April 2021 to support the increase in baseline expenses and/or equipment needs.

The expansion to Houston will also require a new curing site. While both Red Bluff and Texas City have adequate space, they are a long distance from downtown Houston. Utilizing either of these sites would drastically increase the daily mileage during Houston shell runs. Therefore, it is proposed that a third curing site will be secured by December 2021 to store all shell collected in Houston. In the meantime, Red Bluff can be utilized. GBF will site potential locations on the east side of Houston, preferably south of Highway 225 and north of Interstate 45. At this time, GBF is in discussion with PHA regarding a potential property located in the industrial area just east of the inner loop of Houston along Brays Bayou.

In order to move forward with the expansion, GBF will require the participation of at least three new restaurants in Houston. GBF is currently in communication with four restaurants, all of whom are participants on the Chef Advisory Council and will likely be participants in the 2021 Inaugural Houston Oyster Festival. Once these restaurants are officially onboard, GBF will establish a new shell recycling schedule to incorporate the Houston Route as early January 2021.

To support rising costs and recruit new restaurant partners, GBF plans to increase the interest in and knowledge of the Oyster Shell Recycling Program. New outreach initiatives including community presentations and coordination with restaurant partners, particularly via the new Chef Advisory Council, will help reach a wider audience (as discussed in Step 1). The Houston Oyster Festival will also engage more restaurants and citizens in the Program.

In addition to increasing the Program's exposure, GBF will work towards streamlining the current shell recycling operations. GBF plans to create a more consistent maintenance schedule for all vehicles, equipment, recycling bins, and curing sites. This will ensure a smoother transition as the Program grows. By December of 2021, GBF plans to migrate all existing Program data to an Access Database to improve the efficiency of tracking tonnage of shell recycled, stockpiled, and transported to restoration sites. The Access software will allow for easier access to all data which is currently spread across more than 20 Excel spreadsheets. It will also simplify calculations to determine GBF's "shell balance" (the amount of shell currently available for use in restoration).

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

B) Timeline

In order to achieve the goal of expanding the Oyster Shell Recycling Program to Houston, GBF has created a timeline, shown in Table 11, 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, such as the COVID-19 pandemic in 2020, thus rendering this timeline inaccurate. In order to continue moving the Program forward, adaptive management will be required. To address these concerns, Step 5 lays out an adaptive management plan for the Oyster Shell Recycling Program.

Table 11: Proposed Timeline

YEAR	MONTH	PLANS
2020	September	Complete Version 2 of the Strategic Development Plan
	October	Chef Advisory Council Meeting
	November	Bi-Annual Galveston Bay Oyster Workgroup Meeting Purchase new equipment
	December	Secure a minimum of 3 Houston restaurant partners
2021	January	Begin weekly shell collection in Houston *(if feasible pending pandemic conditions)*
	March	Chef Advisory Council Meeting
	April	Inaugural Houston Oyster Festival *(pending pandemic conditions)*
	May	Bi-Annual Galveston Bay Oyster Workgroup Meeting
	September	Hire second part-time staff member *(if feasible/necessary)*
	October	Chef Advisory Council Meeting
	November	Bi-Annual Galveston Bay Oyster Workgroup Meeting
	December	Secure additional Houston restaurant partners Secure new curing site in close proximity to downtown Houston Migrate data into Access Database
2022	March	Chef Advisory Council Meeting
	April	2nd Annual Houston Oyster Festival
	May	Bi-Annual Galveston Bay Oyster Workgroup Meeting
	September	Complete Version 3 of the Strategic Development Plan
	October	Chef Advisory Council Meeting
	November	Bi-Annual Galveston Bay Oyster Workgroup Meeting
	December	Secure additional Houston restaurant partners Increase annual tonnage of shell recycled by 10%

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 to expansion. 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 Oyster Shell Recycling Program on a quarterly basis to provide frequent opportunities for adjustment and improvement. The Strategic Development Plan will also be updated every two years, at minimum, to document these findings.

B) Success Criteria

The goal of GBF's Oyster Shell Recycling Program 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 Oyster Shell Recycling Program on an annual basis:

1) Recruit new restaurant partners along all recycling routes as funding allows

2) Retain at least ninety percent of restaurant partners

3) Maintain or increase tonnage of shell recycled

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 2019 – August 2020*

The first installment of this Strategic Development Plan was completed in September 2019 under CMP Cycle 22. Since that time, GBF has created a Chef Advisory Council and reinstated the Galveston Bay Oyster Workgroup. Both of these efforts were initiated to help guide the expansion of the Program and ensure the proper use of all recycled oyster shell in reef restoration. The COVID-19 pandemic in 2020 delayed the Program's expansion to the inner loop of Houston. The Inaugural Houston Oyster Festival was also postponed until 2021. Active shell collection was put on hold from March 21, 2020 to May 6, 2020 due to dine-in restrictions at restaurants associated with the pandemic. As of this publication, weekly shell collections have returned to normal with seven restaurants along the main route.

One new restaurant was added in March 2020, Sam's Boat, and an additional new restaurant is pending approval along the main route: Barge 295. Topwater Grill ceased participation in weekly shell collection with GBF, however they are collecting shell onsite, in a single pile in their parking lot. The Galveston Island recycling efforts are currently on hold with BLVD Seafood due to recent changes at TAMUG. GBF aims to resolve these issues by the fall of 2020 and reinstate shell recycling on Galveston Island no later than January 2021.

In an effort to reduce costs and streamline the visual appearance of the shell recycling receptacles, GBF purchased two custom brands in February 2020. While the brands are easily applied to the 32-gallon recycling bins, painting is required to make the logos stand out. This results in a very time-consuming process. In addition, restaurants who power-wash their bins incidentally wash off the paint. In the past, stickers were applied to both bins and buckets to indicate their use for shell only. Unfortunately, even outdoor rated decals did not last in the elements. During case study inquires in 2020, multiple organizations mentioned the use of Rehrig Pacific Company for customized bin branding. Although a large purchase is required, GBF is considering shifting to this approach by 2022 to further streamline the recycling bins as the Program grows.

Pending the status of the pandemic throughout the remainder of 2020, GBF plans to provide shell recycling services to restaurants in the inner loop of Houston as early as 2021 and launch the Inaugural Houston Oyster Festival in April of 2021 in celebration of the 10-year anniversary of the Program. GBF will continue to compare the status of the Program to the proposed timeline (Table 11) and success criteria as well as evaluate the need for any changes. Version 3.0 of the Strategic Development Plan will delve further into possible partnerships with commercial oyster companies as well as state agencies, particularly in regard to sun curing oyster shell for use in reef restoration.

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APPENDIX

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. TAMUG Curing Site

C) Oyster Shell Recycling Routes *
1. Main Recycling Route Maps
2. Galveston Recycling Route Map

D) Oyster Shell Recycling Photographs
1. Main Recycling 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

G) Sun Curing Protocol *

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

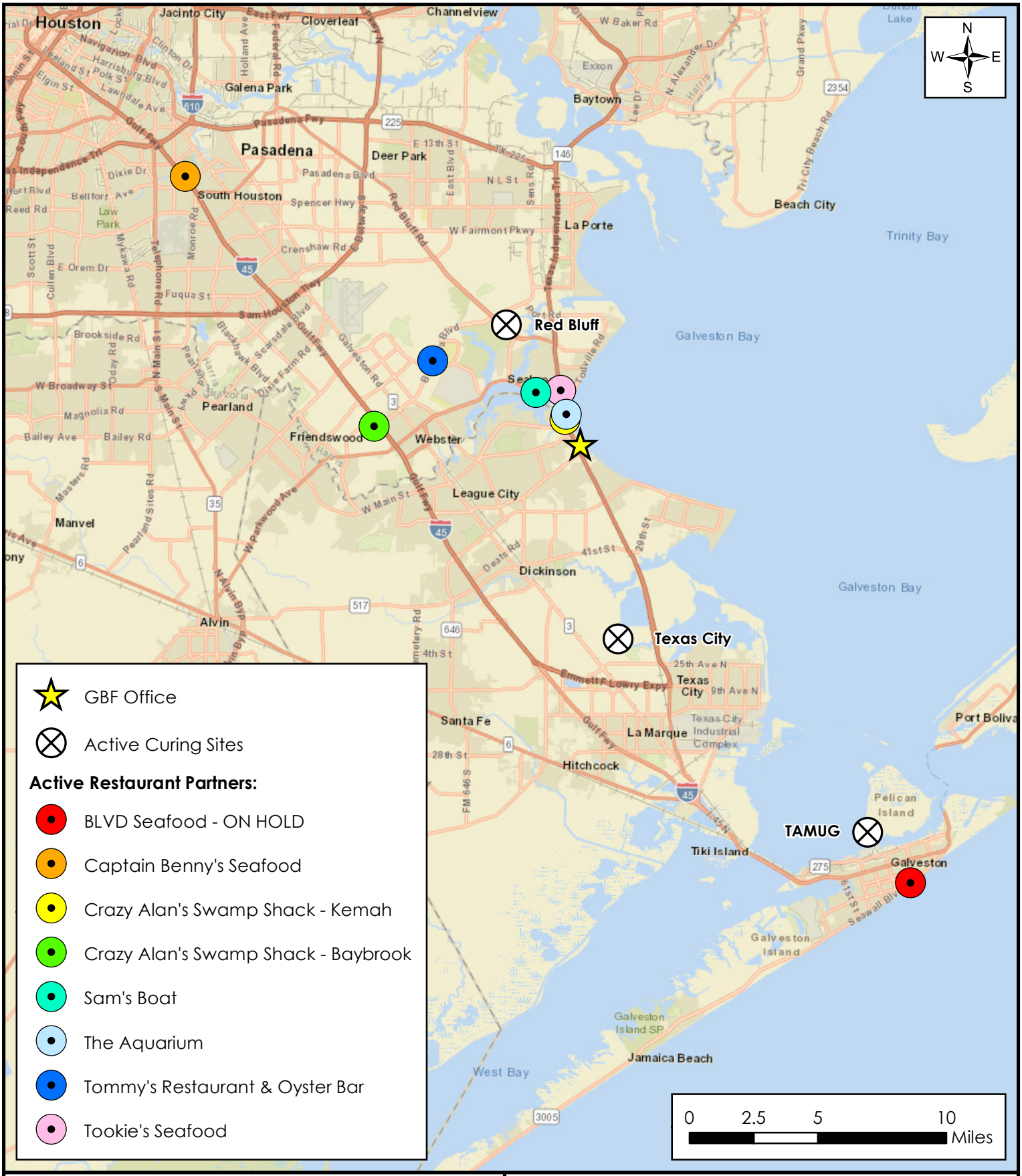
I) Database of Oyster Shell Recycling Programs in the United States *

J) Texas Oyster Regulations

* *Added or Revised September 2020*

APPENDIX A

Restaurant Partner Locations

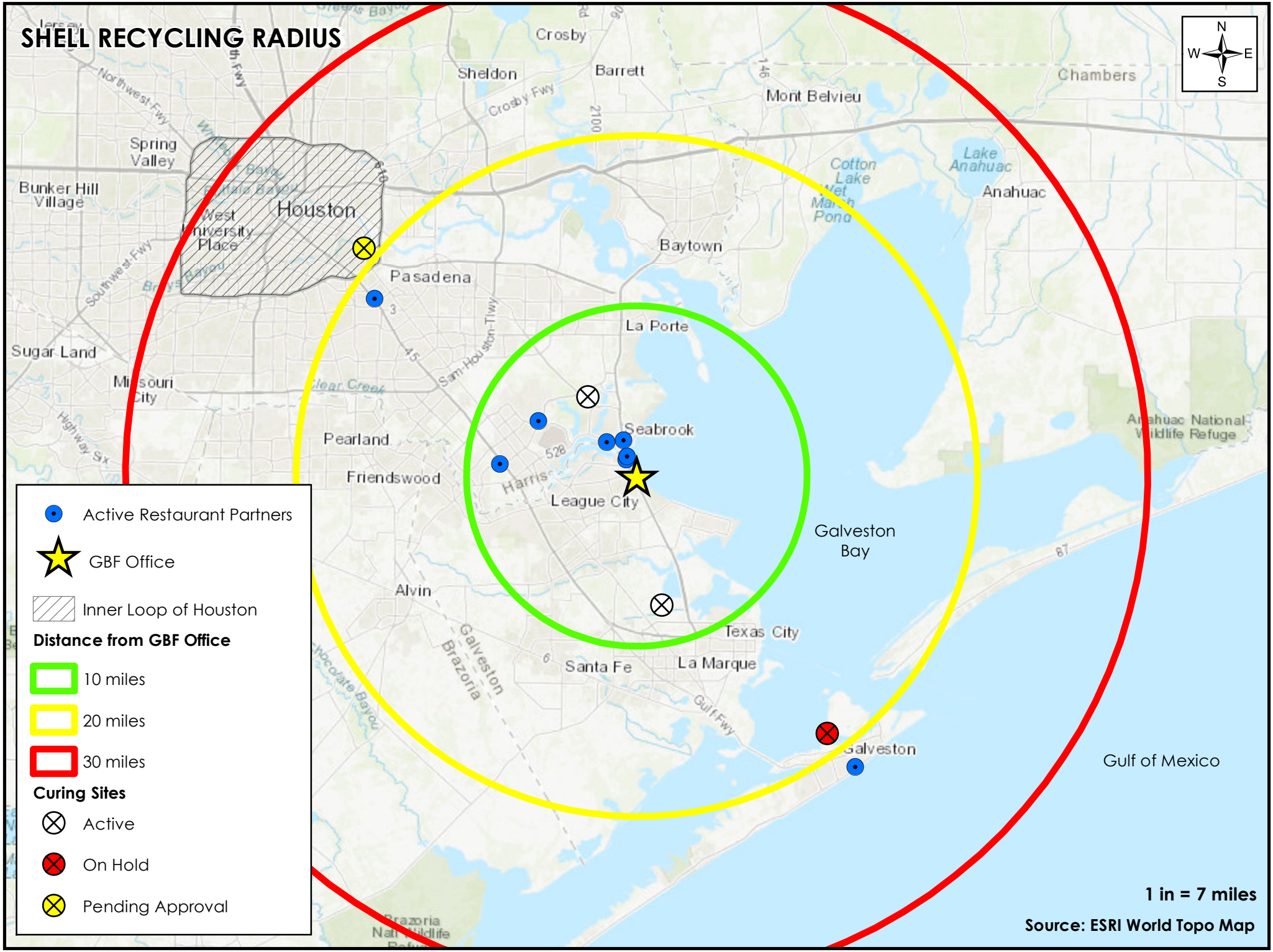


ACTIVE RESTAURANT PARTNERS

Project Name: Oyster Shell Recycling Program	
Project Location: Harris & Galveston County, TX	
Image Source: ESRI World Street Map	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 9/14/2020	Drawn by: H.Leija

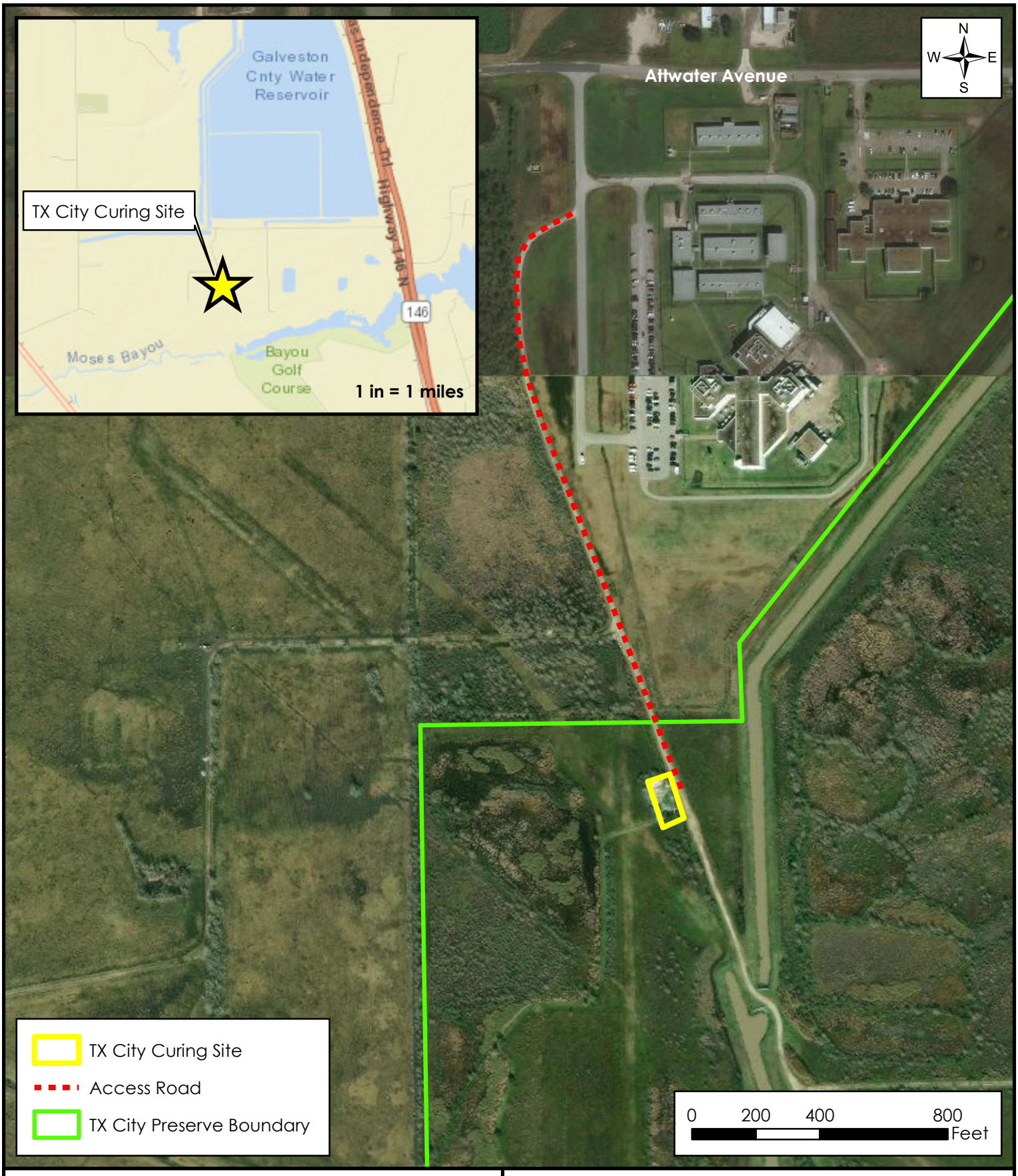
GALVESTON BAY FOUNDATION

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


SHELL RECYCLING RADIUS
N
W
E
S
Crosby
Sheldon
Barrett
Mont Belvieu
Chambers
Spring Valley
Bunker Hill Village
Houston
West University Place
Cotton Lake
Lake Anahuac
Anahuac
Baytown
Pasadena
La Porte
Sugar Land
Missouri City
Pearland
Seabrook
Friendswood
League City
Galveston Bay
Alvin
Texas City
La Marque
Santa Fe
Galveston
Gulf of Mexico
Anahuac National Wildlife Refuge
Active Restaurant Partners
GBF Office
Inner Loop of Houston
Distance from GBF Office
10 miles
20 miles
30 miles
Curing Sites
Active
On Hold
Pending Approval
1 in = 7 miles
Source: ESRI World Topo 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

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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

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TAMUG CURING SITE - LOCATION MAP

Project Name: TAMUG Curing Site; Oyster Shell Recycling Program	
Project Location: Pelican Island, 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

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APPENDIX C

Oyster Shell Recycling Routes

MAIN ROUTE - MONDAY

Project Name: Oyster Shell Recycling Program - Main Route	
Project Location: Clear Lake Region - Harris & Galveston County	
Image Source: ESRI World Street Map	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 5/8/2020	Drawn by: H.Leija

GALVESTON BAY FOUNDATION

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MAIN ROUTE - WEDNESDAY

Project Name: Oyster Shell Recycling Program - Main Route	
Project Location: Clear Lake Region - Harris & Galveston County	
Image Source: 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

MAIN ROUTE - FRIDAY

Project Name: Oyster Shell Recycling Program - Main Route	
Project Location: Clear Lake Region - Harris & Galveston County	
Image Source: ESRI World Street Map	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 5/8/2020	Drawn by: H.Leija

GALVESTON BAY FOUNDATION

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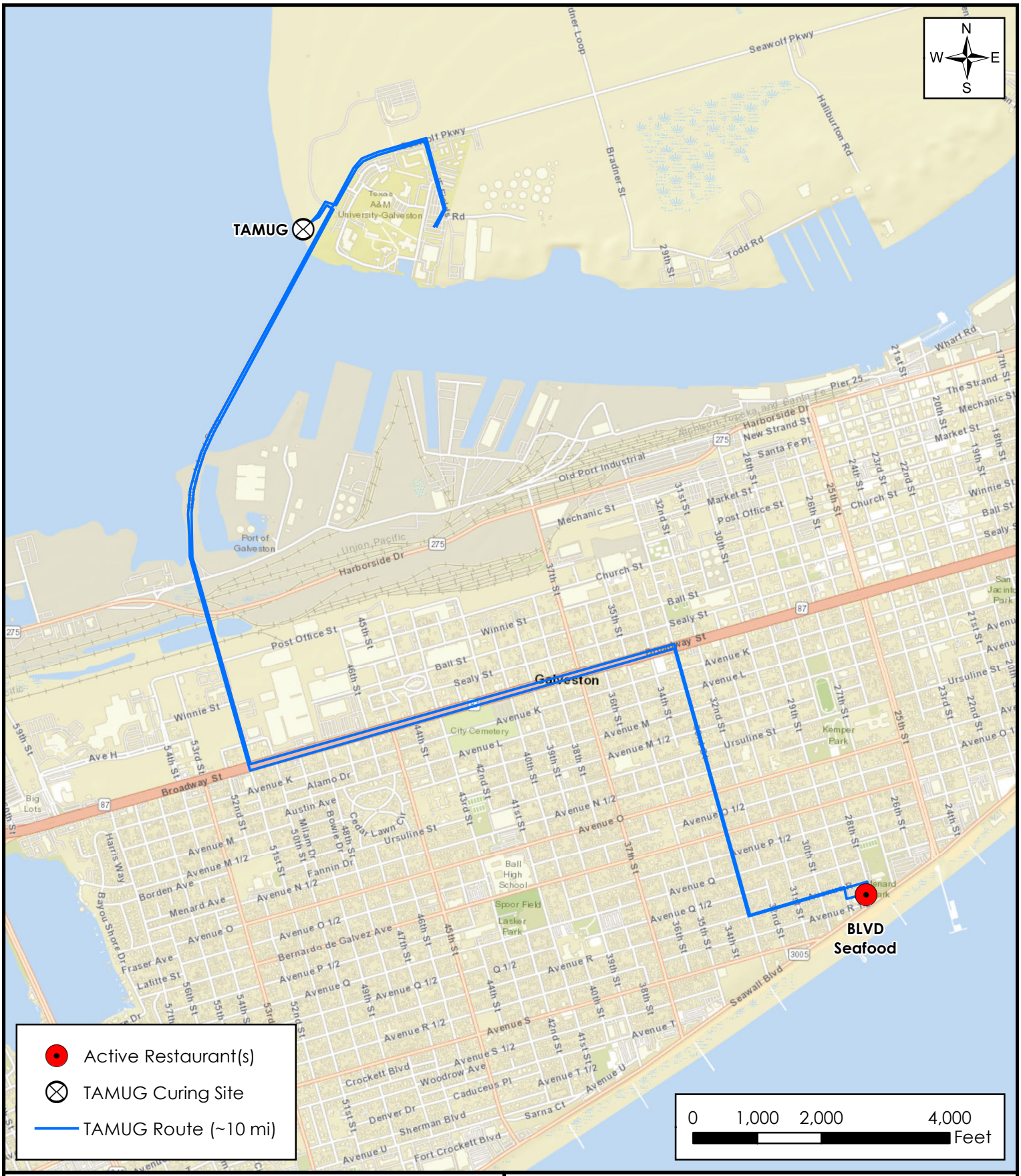

GALVESTON ROUTE

Project Name: Oyster Shell Recycling Program - Galveston Route	
Project Location: Galveston Island, Galveston County	
Image Source: ESRI World Street Map	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 5/8/2020	Drawn by: H.Leija

GALVESTON BAY FOUNDATION

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APPENDIX D

Oyster Shell Recycling Photographs

SHELL RECYCLING PHOTOGRAPHS
Main Recycling Route

Figure 1. Loading recycled oyster shells onto landscape trailer.

Figure 2. Loading recycled oyster shells onto landscape trailer.

SHELL RECYCLING PHOTOGRAPHS
Main Recycling Route

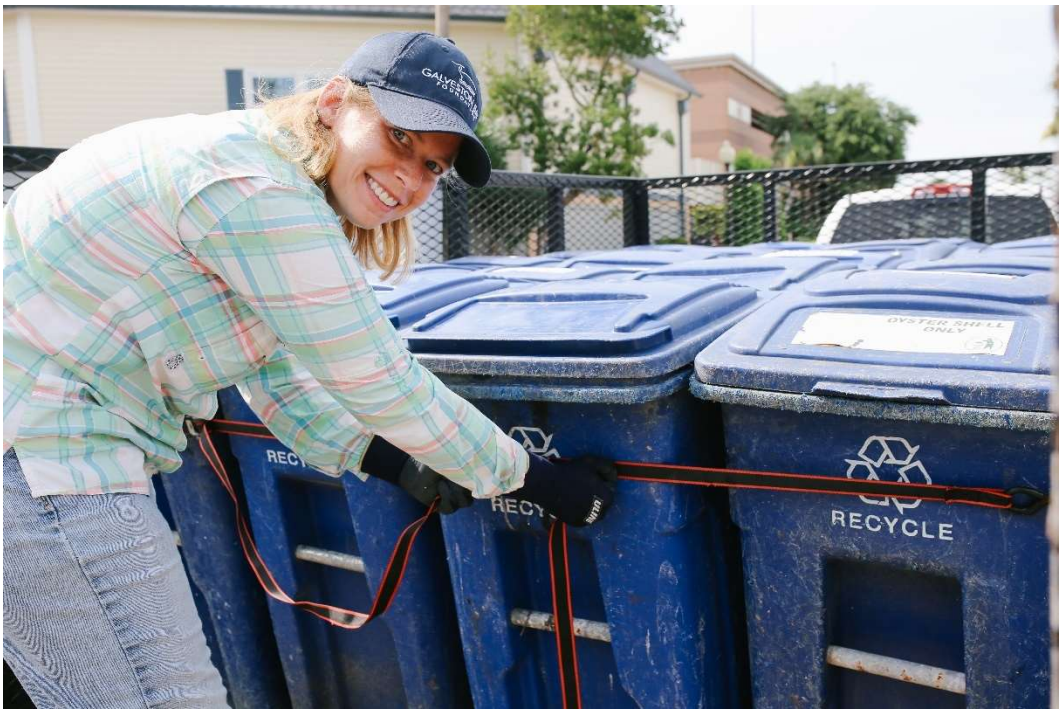

Figure 3. Loading recycled oyster shells onto landscape trailer.

Figure 4. Oyster Shell Recycling Program trailer signage.

SHELL RECYCLING PHOTOGRAPHS
Main Recycling Route

Figure 5. Recycled oyster shells collected at a restaurant.

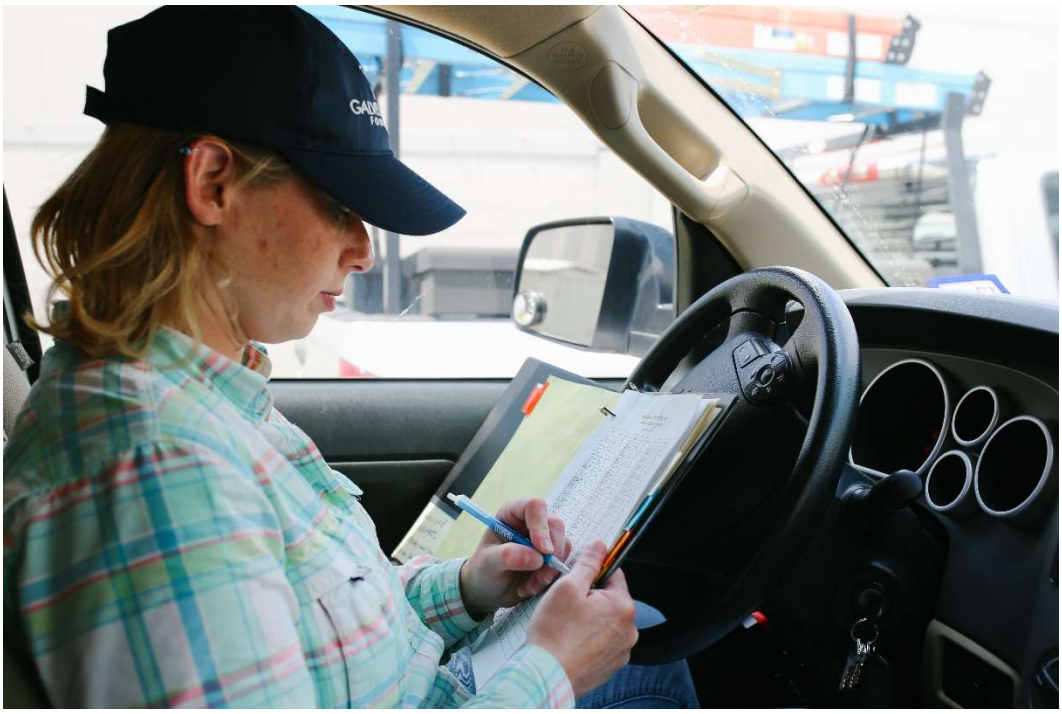

Figure 6. Documenting recycled oyster shells collected from restaurant partners.

SHELL RECYCLING PHOTOGRAPHS
Main Recycling Route

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
Main Recycling Route

Figure 9. Newly recycled oyster shell at Red Bluff Curing Site.

Figure 10. Recycled oyster shell piled for sun curing at Red Bluff Curing Site.

SHELL RECYCLING PHOTOGRAPHS
Main Recycling Route

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

Figure 12. Newly piled shell at Red Bluff Curing Site.

SHELL RECYCLING PHOTOGRAPHS
Main Recycling Route

Figure 13. New storage area at Red Bluff staked/roped-off to mark future shell pile locations.

Figure 14. Additional view of new storage area at Red Bluff.

SHELL RECYCLING PHOTOGRAPHS
Main Recycling Route

Figure 15. Dumping newly recycled oyster shell at TX City Curing Site.

Figure 16. Recycled oyster shell piled for sun curing at TX City Curing Site.

SHELL RECYCLING PHOTOGRAPHS
Main Recycling Route

Figure 17. Cement pad at TX City Curing Site.

Figure 18. Newly piled shell and bagged shell at TX City Curing Site.

SHELL RECYCLING PHOTOGRAPHS
Main Recycling Route

Figure 19. Cured oyster shell piled and consolidated at TX City Curing Site.

Figure 20. Piling recycled shell at TX City Curing Site.

SHELL RECYCLING PHOTOGRAPHS
Galveston (TAMUG) Recycling Route

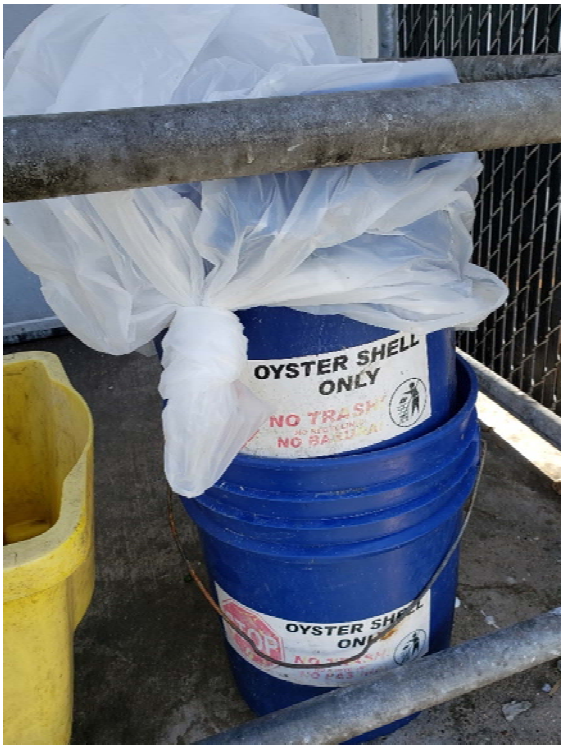

Figure 21-22. 5-gallon buckets with recycled shell stored outside BLVD Seafood on Galveston Island.

Figure 23. Shell collection by TAMUG via 14-gallon tubs.

SHELL RECYCLING PHOTOGRAPHS
Galveston (TAMUG) Recycling Route

Figure 24. Dumping newly recycled oyster shell at TAMUG Curing Site

Figure 25. Dumping newly recycled oyster shell at TAMUG Curing Site

APPENDIX E

Restaurant Database

RESTAURANT DATABASE
Clear Lake Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Restaurant Address	Restaurant Phone #	Restaurant Website
			Raw (Y/N)	Cooked			
1	Captain Benny's Seafood	Houston	Y	4	8253 Gulf Fwy	(713) 643-0589	http://captbennys.com/
2	Captain Benny's Seafood	Deer Park	Y	4	1200 East Blvd	(281) 476-1513	http://captbennys.com/
3	Crazy Alans Swamp Shack	Kemah	Y	4	310 Texas Ave	(281) 334-5000	http://crazyalanswampshack.com/
4	Crazy Alans Swamp Shack	Friendswood	Y	4	1330 Bay Area Blvd	(832) 284-4895	http://crazyalanswampshack.com/
5	East Star Chinese Buffet	Webster	Y	0	1025 W Nasa Pkwy	(281) 280-8822	
6	Flippers Coastal Seafood	Dickinson	Y	2	628 FM 517 W	(832) 340-7340	
7	Floyd's Cajun Seafood And Steakhouse	Webster	Y	6	20760 Gulf Fwy	(281) 332-7474	http://floydsseafood.com/
8	Flying Dutchman	Kemah	Y	4	9 11th Ave Kemah Waterfront	(281) 334-7575	https://www.flyingdutchmankemah.com/
9	Gilhooley's Restaurant	San Leon	Y	4	222 9th St	(281) 339-3813	
10	Hibachi Grill & Supreme Buffet	Webster	Y	0	155 W Bay Area Blvd	(832) 932-5795	
11	Jackie's Brickhouse	Kemah	Y	1	1053 Marina Bay Dr	(832) 864-2459	http://www.jackiesbrickhouse.com/
12	LA Crawfish	Webster	Y	3	939 W. Bay Area	(832) 905-5154	www.lacrawfish.com
13	LA Crawfish	Baytown	Y	3	4609 Garth Rd A	(832) 479-8081	www.lacrawfish.com
14	LA Crawfish	Pasadena	Y	3	4300 Fairmont Parkway	(832) 288-4494	www.lacrawfish.com
15	Landry's Seafood House	Kemah	Y	1	1 Kemah Boardwalk	(281) 334-2513	https://www.landrysseafood.com/location-kemah.asp
16	Little Daddy's Gumbo Bar	League City	Y	2	1615 West FM 646	(281) 524-8626	http://www.littledaddysgumbobar.com/
17	Lowens Seafood	Friendswood	N	2	2111 W. Parkwood Suite: 115	(832) 569-2765	https://lowensseafood.com/
18	Mambo Seafood	Baytown	Y	0	4300 East Freeway	(832) 926-7551	www.mamboseafood.com
19	Marais	Dickinson	Y	4	2015 FM 517 Rd East	(281) 534-1986	
20	Monument Inn	La Porte	Y	0	4406 Independence Pkwy S	(281) 479-1521	https://monumentinn.com/contact_us/
21	Noah's Ark Bar & Grill	Bacliff	Y	4	4438 Boulevard St	(281) 339-2895	https://noahsarkbarandgrill.com/

RESTAURANT DATABASE
Clear Lake Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Restaurant Address	Restaurant Phone #	Restaurant Website
			Raw (Y/N)	Cooked			
22	O2 Bistro	Clear Lake Shores	Y	1	1002 Aspen Road	(281) 532-6860	https://www.o2bistro.com/
23	Opus Ocean Grill	Clear Lake Shores	Y	4	1510 Marina Bay Dr #124	(281) 334-0006	http://www.opusoceangrille.com/
24	Pappas Seafood House	Webster	Y	1	19991 Gulf Freeway	(281) 332-7546	www.pappasseafood.com
25	Perry's Steakhouse & Grille	Friendswood	Y	0	700 Baybrook Mall Drive	(281) 286-8800	https://perryssteakhouse.com/
26	Sam's Boat	Seabrook	Y	0	3101 Nasa Rd 1, Building B	(281) 326-7267	www.samsboat.com
27	Schafer's Coastal Bar & Grille	Clear Lake Shores	Y	3	1002 Aspen Road	(281) 532-6860	https://schaferscoastalbarandgrille.com/
28	The Aquarium Restaurant	Kemah	Y	0	#11 Kemah Boardwalk	(281) 334-9010	https://www.aquariumrestaurants.com/aquariumkemah/
29	The Reef Seafood House	Texas City	Y	0	1301 31st 1/2 St N	(409) 945-6151	http://thereefseafoodhouse.com/
30	The Rouxpour	Friendswood	Y	4	700 Baybrook Mall, Ste H100	(281) 480-4052	www.therouxpour.com
31	Tommy's Restaurant & Oyster Bar	Houston	Y	5	2555 Bay Area Blvd	(281) 480-2221	https://tommys.com/
32	Tookie's Seafood	Seabrook	Y	6	1106 Bayport Blvd	(281) 942-9445	https://www.tookiesseafood.com/?utm_source=local&utm_medium=organic&utm_campaign=gmb
33	Topwater Grill	San Leon	Y	5	815 Ave O	(281) 339-1232	http://www.topwatergrill.com/
34	Valdo's Seafood House	Seabrook	Y	4	4106 Nasa Rd 1	(281) 326-3866	www.valdos.com

LEGEND: Current Partner | Potential Partner

RESTAURANT DATABASE
Galveston Island

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Restaurant Address	Restaurant Phone #	Restaurant Website
			Raw (Y/N)	Cooked			
1	Black Pearl Oyster Bar	Galveston	Y	0	327 23rd St	(409) 762-7299	www.galveston.com/cuisine/find-a-restaurant/blackpearl
2	BLVD Seafood	Galveston	Y	3	2804 R 1/2	(409) 762-2583	www.blvdseafood.com
3	Cajun Greek	Galveston	Y	0	2226 61st St	(409) 744-7041	www.cajun-greek-seafood.com
4	Fish Tales	Galveston	Y	0	2502 Seawall	(409) 762-8545	www.fishtalesgalveston.com
5	Fisherman's Wharf	Galveston	Y	0	2200 Harborside Dr	(409) 765-5708	www.fishermanswharfgalveston.com
6	Gaido's Seafood Restaurant	Galveston	Y	0	3828 Seawall Blvd	(409) 761-5500	www.gaidos.com
7	Katie's Seafood Houston	Galveston	TBD	6	2000 Wharf Rd	(409) 765-5688	katiesseafoodhouse.com
8	Landry's Seafood House	Galveston	Y	1	5310 Seawall Blvd	(409) 744-1010	https://www.landrysseafood.com/location-galveston.asp
9	Little Daddy's Gumbo Bar	Galveston	Y	2	2107 Postoffice Street	(281) 524-8626	http://www.littledaddysgumbobar.com/
10	Number 13	Galveston	Y	0	7809 Broadway St	(409) 572-2650	http://www.number13steak.com/
11	The Spot	Galveston	Y	0	3204 Seawall	(409) 621-5237	www.islandfamous.com
12	Willie G's	Galveston	Y	1	2100 Harbor Side	(409) 762-3030	https://www.williegs.com/galveston/

LEGEND: Current Partner | Potential Partner

RESTAURANT DATABASE
Houston Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Restaurant Address	Restaurant Phone #	Restaurant Website
			Raw (Y/N)	Cooked			
1	1751 Sea and Bar	Houston	Y	2	191 Heights Blvd	(832) 831-9820	https://1751houston.com/
2	a'Bouzy	Houston	Y	1	2300 Westheimer	(713) 722-6899	https://www.abouzy.com/
3	Brennan's of Houston	Houston	Y	2	3300 Smith Street	(713) 522-9711	https://www.brennanshouston.com/
4	Café Annie	Houston	Y	0	1800 Post Oak Boulevard	(713) 840-1111	https://www.cafeanniehouston.com/
5	Cajun Kitchen	Houston	Y	4	6938 Wilcrest Dr	(281) 495-8881	http://cajunkitchenhouston.com/
6	Captain Benny's Seafood	Houston	Y	4	8506 S Main St	(713) 666-5469	http://captbennys.com/
7	Captain Benny's Seafood	Stafford	Y	4	12135 Murphy Rd	(281) 498-3909	http://captbennys.com/
8	Captain Benny's Seafood	Houston	Y	4	10896 Northwest Fwy	(713) 680-1828	http://captbennys.com/
9	Captain Tom's Seafood & Oyster	Houston	Y	0	13955 East Fwy	(713) 451-3700	
10	Caracol	Houston	Y	1	2200 Post Oak Blvd	(713) 622-9996	https://www.caracol.net/
11	Chilos Seafood & Oyster Bar	Houston	Y	No menu online	1150 Edgebrook Dr	(713) 947-8700	
12	Christie's Seafood & Steaks	Houston	Y	2	6029 Westheimer	(713) 978-6563	http://www.christies-restaurant.com/
13	The Crawfish Pot & Oyster Bar	Houston	Y	2	9820 Gulf Fwy #7	(713) 360-6547	https://thecrawfishpotoysterbar.netwaiter.com/houston/about/
14	Drunken Oyster	Spring	Y	0	7110 Louetta Rd Ste B	(832) 843-6196	https://drunkenoyster.eat24hour.com/
15	Eddie V's Prime Seafood	Houston- West Ave	Y	4	2800 Kirby Drive	(713) 874-1800	https://www.eddiev.com/home
16	Eddie V's Prime Seafood	Houston- City Centre	Y	4	12848 Queensbury Lane	(832) 200-2380	https://www.eddiev.com/home
17	Eugene's Gulf Coast Cuisine	Houston	Y	5	1985 Welch Street	(713) 807-8889	https://www.eugeneshouston.com/
18	Eunice	Houston	Y	2	3737 Buffalo Speedway	(832) 491-1717	https://www.eunicerestaurant.com/
19	Field & Tides	Houston	Y	1	705 E 11th St	(713) 861-6143	http://fieldandtides.com/
20	Floyd's Cajun Seafood And Steakhouse	Sugar Land	Y	6	16549 S W Freeway	(281) 240-3474	http://floydsseafood.com/
21	Floyd's Cajun Seafood And Steakhouse	Pearland	Y	6	1300 E. Broadway	(281) 993-8385	http://floydsseafood.com/

RESTAURANT DATABASE
Houston Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Restaurant Address	Restaurant Phone #	Restaurant Website
			Raw (Y/N)	Cooked			
22	Frank's Americana Revival	Houston	Y	Unknown	3736 Westheimer Road	(713) 572-8600	https://www.frankshouston.com/
23	Georgia James	Houston	Y	1	1100 Westheimer	(832) 241-5088	http://www.georgiajamessteak.com/#food
24	Goode Company- Seafood	Houston	Y	4	2621 Westpark Drive	(713) 523-7154	https://www.goodecompany.com/
25	Jimmy G's Cajun Seafood	Houston	Y	1	307 North Sam Houston Parkway	(281) 931-7654	http://www.jimmyg.com/
26	LA Crawfish	Houston- Greenway	Y	3	3957 Richmond Avenue	(832) 767-1533	www.lacrawfish.com
27	LA Crawfish	Houston- Memorial	Y	3	1005 Blalock Road	(713) 461-8808	www.lacrawfish.com
28	LA Crawfish	Houston- Willowbrook	Y	3	17375 Tomball Pkwy, Ste 2H	(281) 809-5722	www.lacrawfish.com
29	LA Crawfish	Houston- Langwood	Y	3	6439 W 43rd Street	(832) 491-1121	www.lacrawfish.com
30	LA Crawfish	Houston- Wallisville Rd & Beltway 8	Y	3	5810 East Sam Houston Pkwy N	(281) 416-5352	www.lacrawfish.com
31	LA Crawfish	Katy	Y	3	569 S Mason Rd, Inside 99 Ranch Market	(346) 251-5902	www.lacrawfish.com
32	LA Crawfish	Pearland	Y	3	1910 Country Place, Ste 150	(832) 781-4946	www.lacrawfish.com
33	LA Crawfish	Houston- Gulfgate	Y	3	3331 Telephone Rd, Ste C	(832) 804-6901	www.lacrawfish.com
34	LA Crawfish	Missouri City	Y	3	3823 FM 1092 Rd	(281) 208-7759	www.lacrawfish.com
35	La Lucha	Houston	Y	3	1801 N. Shepherd Drive	(713) 955-4765	laluchatx.com
36	Liberty Kitchen & Oysterette	Houston- River Oaks	Y	2	4224 San Felipe St.	(713) 622-1010	https://libertykitcheneats.com/
37	Liberty Kitchen at tbe Tree House	Houston- Memorial	Y	2	963 Bunker Hill Rd.	(713) 468-3745	https://libertykitcheneats.com/
38	Liberty Kitchen & Oyster Bar	Houston- Heights	Y	2	1050 Studewood Street	(713) 802-0533	https://libertykitcheneats.com/
39	Loch Bar	Houston- River Oaks District	Y	5	4444 Westheimer Road, Suite G110	(832) 430-6601	https://lochbar.com/houston/
40	Mambo Seafood	Houston- 45S & Edgebrook	Y	0	10402 Gulf Freeway	(713) 946-0000	www.mamboseafood.com
41	Mambo Seafood	Houston- 290 & Tidwell	Y	0	13485 Northwest Freeway	(713) 462-0777	www.mamboseafood.com
42	Mambo Seafood	Houston- 45N & West Rd	Y	0	10810 North Freeway	(281) 820-3300	www.mamboseafood.com

RESTAURANT DATABASE
Houston Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Restaurant Address	Restaurant Phone #	Restaurant Website
			Raw (Y/N)	Cooked			
43	Mambo Seafood	Houston- Airline & Tidwell	Y	0	6101 Airline Drive	(713) 691-9700	www.mamboseafood.com
44	Mambo Seafood	Houston- Gessner & Long Point	Y	0	10002 Long Point Drive	(713) 465-5009	www.mamboseafood.com
45	Mambo Seafood	Houston- Hillcroft & Bellaire	Y	0	6697 Hillcroft	(713) 541-3666	www.mamboseafood.com
46	Mambo Seafood	Houston- I-10 & Federal	Y	0	12333 East Freeway	(713) 637-0553	www.mamboseafood.com
47	Mambo Seafood	Katy	Y	0	20210 Katy Freeway	(832) 391-6644	www.mamboseafood.com
48	Mannie's Seafood	Houston	Y	2	8520 Gulf Fwy	(713) 641-5003	
49	Marcos Seafood & Oyster Bar	Houston	Y	0	917 Edgebrook Dr	(713) 946-1168	
50	Mastro's Steakhouse	Houston	Y	1	1650 W Loop S	(713) 993-2500	https://www.mastrosrestaurants.com/Locations/TX/Houston/
51	McCormick & Schmick's Seafood & Steaks	Houston- Town & Country Village	Y	4	791 Town and Country Blvd	(713) 465-3685	https://www.mccormickandschmicks.com/
52	McCormick & Schmick's Seafood & Steaks	Houston- Uptown Park, Galleria	Y	4	1151-01 Uptown Park Blvd	(713) 840-7900	https://www.mccormickandschmicks.com/
53	McCormick & Schmick's Seafood & Steaks	Houston- Downtown	Y	4	1201 Fannin Street	(713) 658-8100	https://www.mccormickandschmicks.com/
54	Nick's Fish Dive & Oyster Bar	Woodlands	Y	1	20 Waterway Ave #105	(281) 419-8885	https://www.nicksfishdive.com/
55	The Oceanaire	Houston	Y	1	5061 Westheimer Road, Suite 8050	(832) 487-8862	https://www.theoceanaire.com/location/houston-tx/
56	Orleans Seafood Kitchen	Katy	Y	1	20940 Katy Freeway, Suite G	(281) 646-0700	http://orleansseafoodkitchen.com/
57	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #11	Y	1	5819 Gulf Fwy #900	(713) 921-1800	https://www.ostioneriamichoacan.net/
58	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #1	Y	1	11402 North Freeway	(281) 999-3995	https://www.ostioneriamichoacan.net/
59	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #3	Y	1	1006 Federal Road A	(713) 330-4419	https://www.ostioneriamichoacan.net/
60	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #4	Y	1	13433 Tomball Pkwy #16	(281) 447-5061	https://www.ostioneriamichoacan.net/
61	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #5	Y	1	5895 South Gessner	(713) 974-6828	https://www.ostioneriamichoacan.net/
62	Ostioneria Michoacan Seafood and Oyster Bar	Woodlands- #6	Y	1	25919 I-45 North, Ste A	(281) 292-6811	https://www.ostioneriamichoacan.net/
63	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #7	Y	1	1817 Wirt Rd.	(713) 463-5410	https://www.ostioneriamichoacan.net/

RESTAURANT DATABASE
Houston Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Restaurant Address	Restaurant Phone #	Restaurant Website
			Raw (Y/N)	Cooked			
64	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #8	Y	1	15125 N. Freeway	(281) 877-8855	https://www.ostioneriamichoacan.net/
65	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #15	Y	1	10865 Jones Rd.	(281) 477-7697	https://www.ostioneriamichoacan.net/
66	Ostioneria Michoacan Seafood and Oyster Bar	Houston- #16	Y	1	12810-B Gulf Freeway	(832) 672-4139	https://www.ostioneriamichoacan.net/
67	Pappadeaux Seafood Kitchen	Houston- Hobby Airport	Y	1	7800 Airport Boulevard	(713) 847-7622	https://pappadeaux.com/home/
68	Pappadeaux Seafood Kitchen	Houston- Upper Kirby	Y	1	2410 Richmond Ave.	(713) 527-9137	https://pappadeaux.com/home/
69	Pappadeaux Seafood Kitchen	Houston- Avenida	Y	1	1001 Avenida de las Americas	(713) 654-5077	https://pappadeaux.com/home/
70	Pappadeaux Seafood Kitchen	Houston- Galleria	Y	1	6015 Westheimer Rd.	(713) 782-6310	https://pappadeaux.com/home/
71	Pappas Seafood House	Houston- Shepherd	Y	1	3001 S. Shepherd	(713) 522-4595	http://pappasseafood.com/home/
72	Pappas Seafood House	Houston- Woodridge	Y	1	6945 I-45 S. at Woodridge	(713) 641-0318	http://pappasseafood.com/home/
73	Perry's Steakhouse & Grille	Houston- Champions	Y	0	9730 Cypresswood Drive	(281) 970-5999	https://perryssteakhouse.com/
74	Perry's Steakhouse & Grille	Katy	Y	0	23501 Cinco Ranch Blvd q100	(281) 347-3600	https://perryssteakhouse.com/
75	Perry's Steakhouse & Grille	Houston- Memorial City	Y	0	9827 Katy Freeway	(832) 358-9000	https://perryssteakhouse.com/
76	Perry's Steakhouse & Grille	Houston- River Oaks	Y	0	1997 West Gray St.	(346) 293-8400	https://perryssteakhouse.com/
77	Perry's Steakhouse & Grille	Sugar Land	Y	0	2115 Town Square Place	(281) 565-2727	https://perryssteakhouse.com/
78	Perry's Steakhouse & Grille	Woodlands	Y	0	6700 Woodlands Parkway	(281) 362-0569	https://perryssteakhouse.com/
79	The Oyster Bar at Prohibition	Houston	Y	6	1010 Prairie St	(832) 301-8833	https://theoysterbarprohibition.com/
80	Ragin' Cajun	Houston- The Original	Y	1	4302 Richmond Ave	(713) 621-3474	https://ragin-cajun.com/
81	Ragin' Cajun	Houston- Westchase	Y	1	9600 Westheimer #80	(832) 251-7171	https://ragin-cajun.com/
82	Riel	Houston	Y	1	1927 Fairview St	(832) 831-9109	https://www.rielhtx.com/
83	The Rouxpour	Sugarland	Y	4	2298 Texas Drive	(281) 240-7689	www.therouxpour.com
84	The Rouxpour	Katy	Y	4	2643 Commercial Center Blvd Building A300	(281) 394-5013	www.therouxpour.com

RESTAURANT DATABASE
Houston Region

No. of Restaurants	Restaurant Name	Location	Oyster Items on Menu		Restaurant Address	Restaurant Phone #	Restaurant Website
			Raw (Y/N)	Cooked			
85	Sam's Boat	Pearland	Y	0	3239 Silverlake Village Dr.	(713) 436-0201	www.samsboat.com
86	Sam's Boat	Houston	Y	0	5720 Richmond Avenue	(713) 781-2628	www.samsboat.com
87	State of Grace	Houston	Y	1	3258 Westheimer Road	(832) 942-5080	http://stateofgracetx.com/
88	The Pearl Restaurant & Bar at The Sam Houston Hotel	Houston	Y	3	1117 Prairie St	(832) 200-8817	https://www.pearlrestauranthouston.com/
89	Tony Mandola's Gulf Coast Kitchen	Houston	Y	2	1212 Waugh Dr	(713) 528-3474	https://www.tonymandolas.com/
90	Truluck's Seafood Steak & Crab House	Houston	Y	1	5350 Westheimer Rd	(713) 783-7270	https://trulucks.com/
91	Truluck's Seafood Steak & Crab House	Woodlands	Y	1	1900 Hughes Landing Blvd, Suite 600	(281) 465--7000	https://trulucks.com/
92	Willie G's	Houston	Y	8	1640 West Loop South	(713) 840-7190	www.williegs.com/postoak

LEGEND: Current Partner | Potential Partner

APPENDIX F

Curing Site Capacity

TX CITY CURING SITE - CAPACITY

Project Name: Oyster Shell Recycling Program	
Project Location: Attawater Ave, Galveston County, TX	
Image Source: ESRI World Imagery	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 9/12/2020	Drawn by: H.Leija

GALVESTON BAY FOUNDATION

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

RED BLUFF CURING SITE - CAPACITY

Project Name: Oyster Shell Recycling Program	
Project Location: POHA Lease, Harris County, TX	
Image Source: ESRI World Imagery	
Projection: NAD 1983, UTM Zone 15N	
Date Drawn: 9/12/2020	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

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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.

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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)

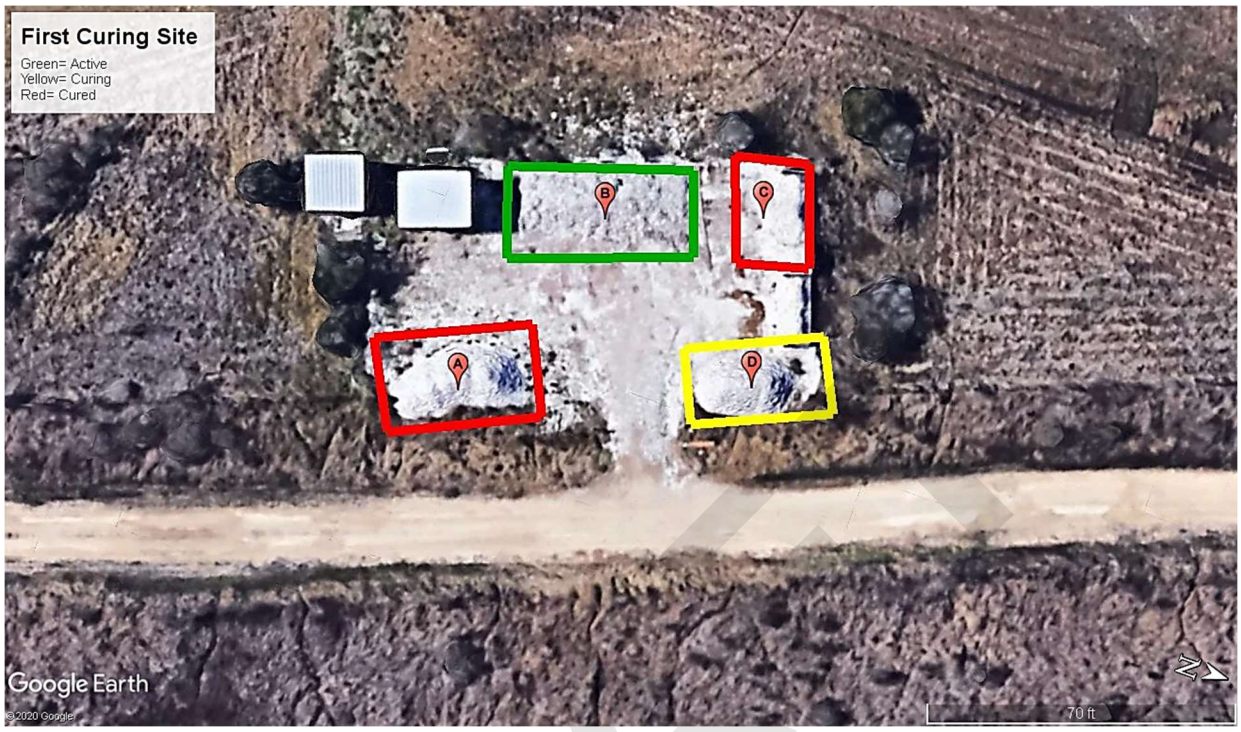

Figure 7. Galveston Bay Foundation's Texas City Curing Site shell pile locations and status

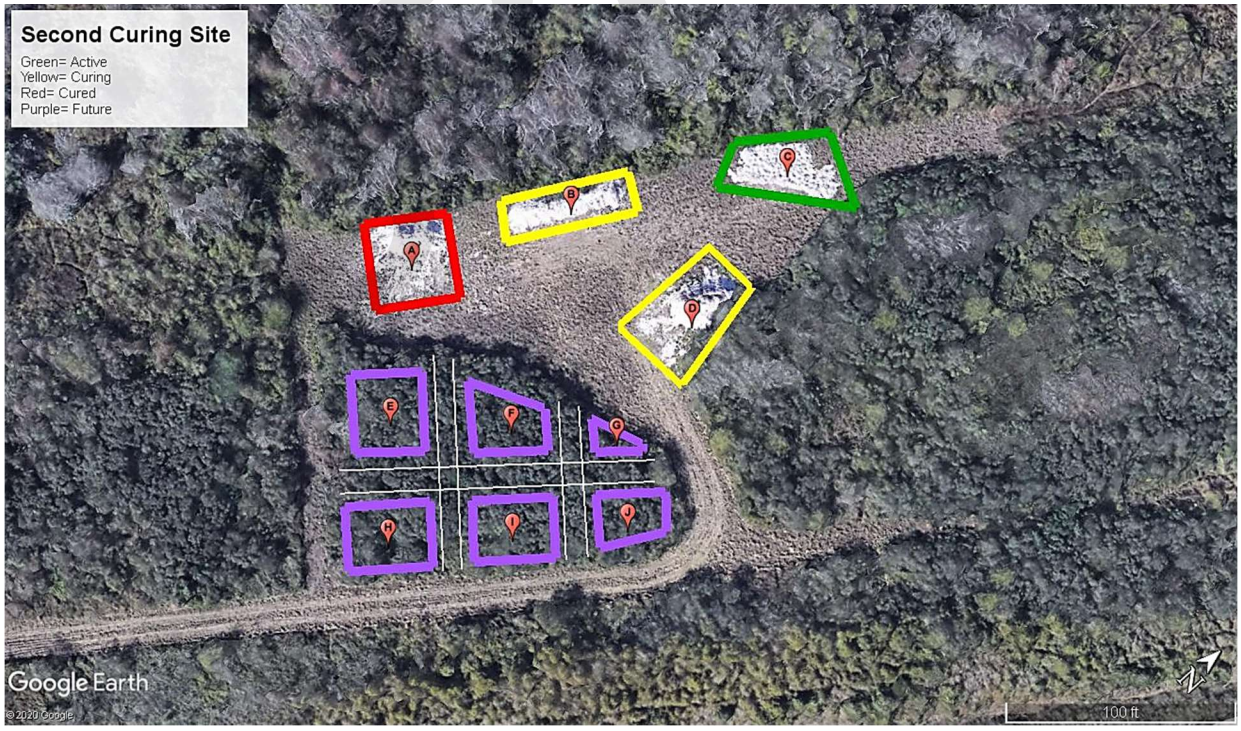

Figure 8. Galveston Bay Foundation's Red Bluff Curing Site shell pile locations and status

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

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APPENDIX H

Restaurant Materials

Waste Hauling Cost Estimates

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	$131.33	Baytown Landfill 4791 Tri City Beach Rd Baytown, TX 77520	One time installation fee of $35.90 Locks are free
			Twice a week	$200.35		
			Three times a week	$269.48		
	6 yard (6'Lx6'Wx5'H) Max weight: 1200 pounds	Galveston (77550)	Once a week	$270.00 plus tax	Coastal Plains Landfill 21000 E Highway 6 Alvin, TX 77511	One time installation fee of $35.90 $20/month for lock Cost varies due to fuel cost
			Twice a week	$486.00 plus tax		
			Three times a week	$703.00 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	$156.95	Baytown Landfill 4791 Tri City Beach Rd Baytown, TX 77520	One time installation fee of $35.90 Locks are free
			Twice a week	$251.39		
			Three times a week	$346.04		
	8 yard (6'Lx6'Wx6'8"H) Max weight: 1600 pounds	Galveston (77550)	Once a week	$305.00 plus tax	Coastal Plains Landfill 21000 E Highway 6 Alvin, TX 77511	One time installation fee of $35.90 $20/month for lock Cost varies due to fuel cost
			Twice a week	$563.00 plus tax		
			Three times a week	$814.00 plus tax		
Republic Services 713-849-0400	6 yard (6'Lx6'Wx5'H) Max weight: 1200 pounds	Houston (77058)	Once a week	$127.00	Galveston County Landfill 3935 Avenue A Santa Fe, TX 77510	One time installation fee of $133.88 $7.50/month for gravity bar/lock
			Twice a week	$223.00		
			Three times a week	$320.00		
	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	$127.00	Galveston County Landfill 3935 Avenue A Santa Fe, TX 77510	One time installation fee of $133.88 $7.50/month for gravity bar/lock
			Twice a week	$223.00		
			Three times a week	$320.00		
	8 yard (6'Lx6'Wx6'8"H) Max weight: 1600 pounds	Houston (77058)	Once a week	$140.00	Galveston County Landfill 3935 Avenue A Santa Fe, TX 77510	One time installation fee of $133.88 $7.50/month for gravity bar/lock
			Twice a week	$245.00		
			Three times a week	$350.83		
	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	$140.00	Galveston County Landfill 3935 Avenue A Santa Fe, TX 77510	One time installation fee of $133.88 $7.50/month for gravity bar/lock
			Twice a week	$245.00		
			Three times a week	$350.83		

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 _____ St _____ Zip _____

Donation information:

Recycled Oyster Shells _____ tons/_____ CY

Items/Services Donated — Quantity (if applicable)

CLAIMED VALUE OF DONATION:
$_____ ($30/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 _____

Please return this form to the Galveston Bay Foundation at the address below.

• 1100 Hercules Avenue, Houston, TX 77058 • Phone 281-332-3381 • Fax 832-284-4982 •

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.

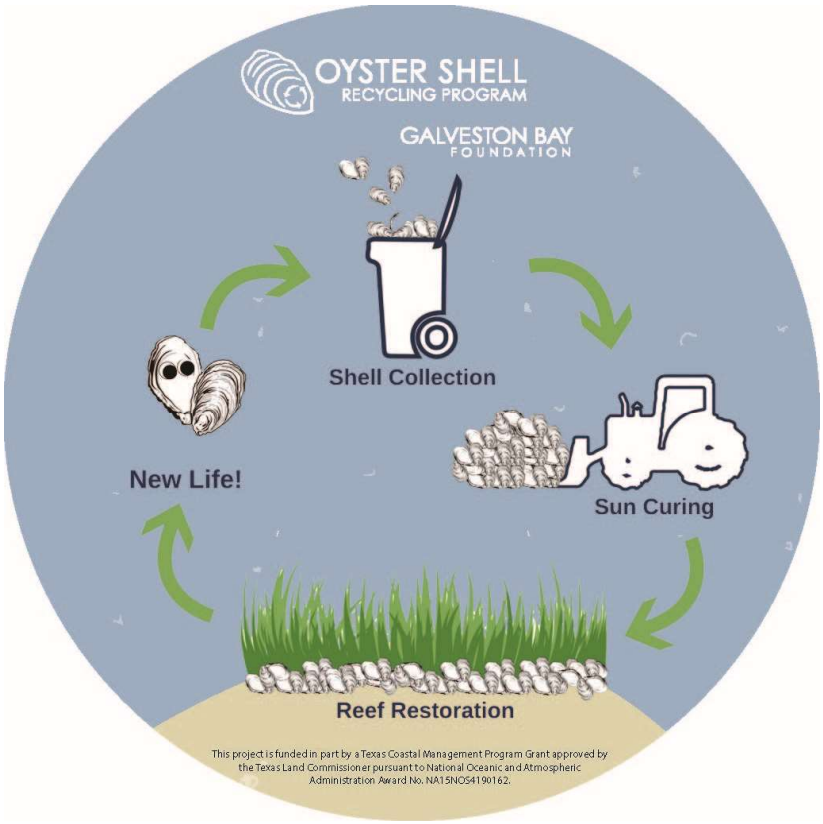
Outreach Options	Estimated Cost	Dimensions
Coasters	$155/2000	4” diameter round
Insert for Check Presenter	$175/500	3.75” x 8.75”
Menu Recognition	$0 (GBF will provide logo; restaurant may incur printing costs)	Menu Specific
Menu Callouts		
Table Tent	$170/250	3” x 5”
Table Tent	$185/250	4” x 4”
Window Cling	$70/10	3” x 6”
Rack Card	$175/500	4” x 9”

prices are quoted estimates, and actual costs may vary

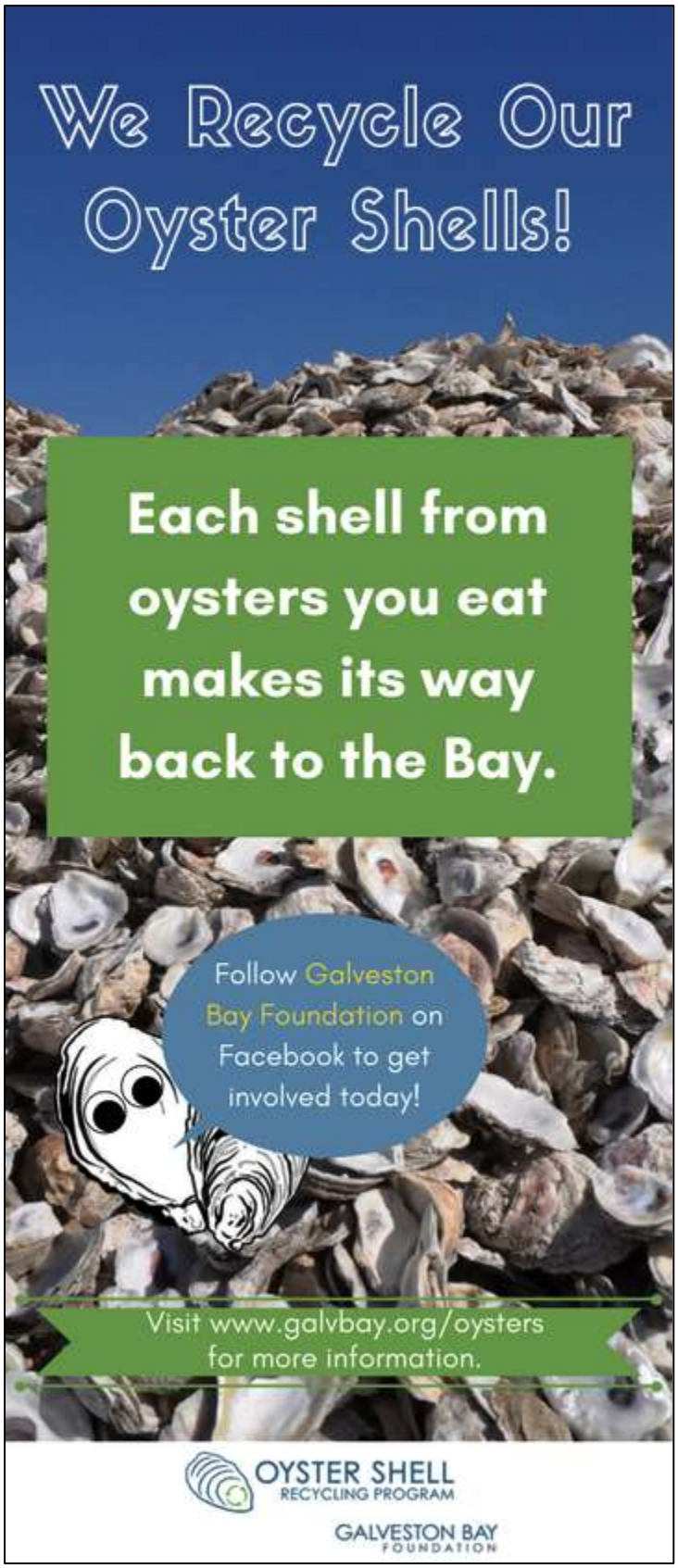
GALVESTON BAY FOUNDATION

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*

OYSTER SHELL
RECYCLING PROGRAM

GALVESTON BAY
FOUNDATION

www.galvbay.org/oysters

A publication funded by Texas Coastal Management Program Grant Approved by the Texas Commissioner pursuant to National Oceanic and Atmospheric Administration Award No. NA16NOS419074.

MENU RECOGNITION

MENU CALLOUTS

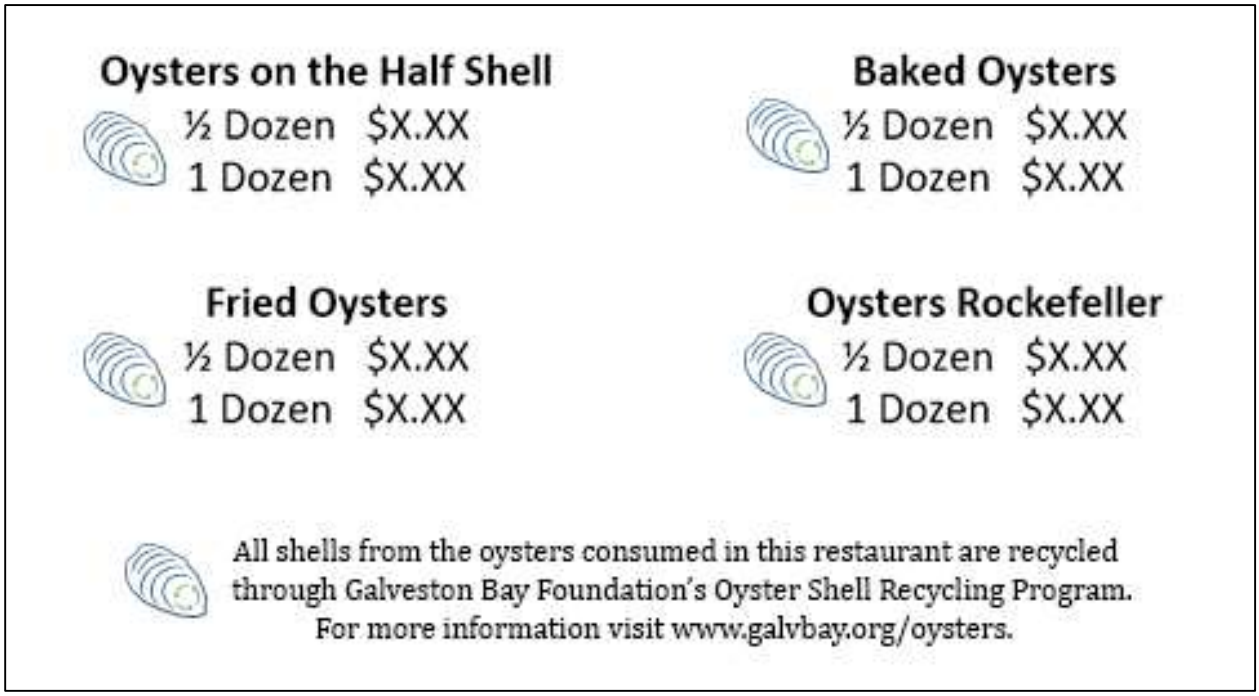
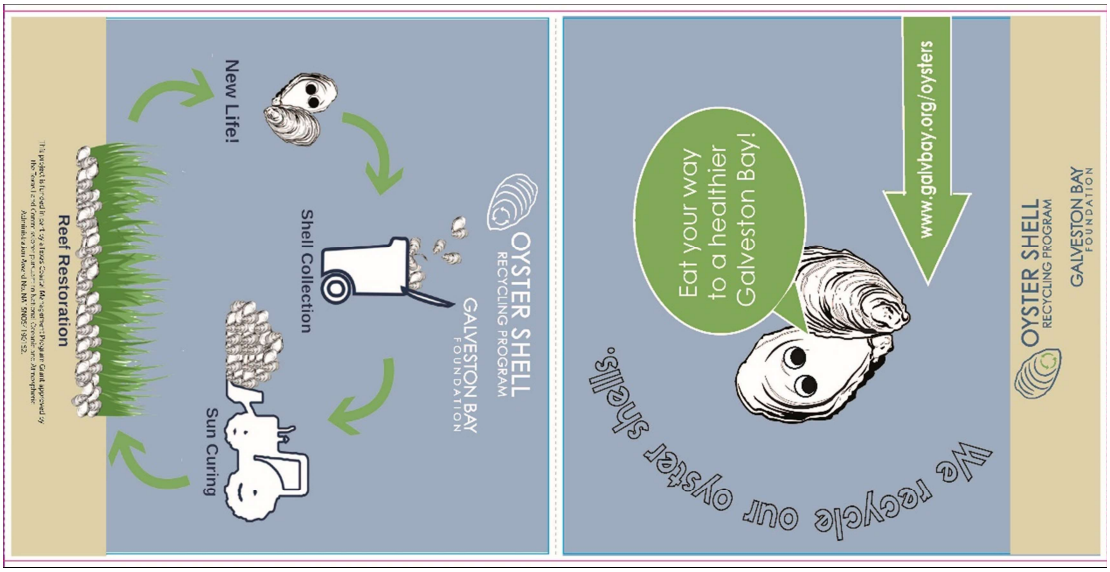


TABLE TENT #1



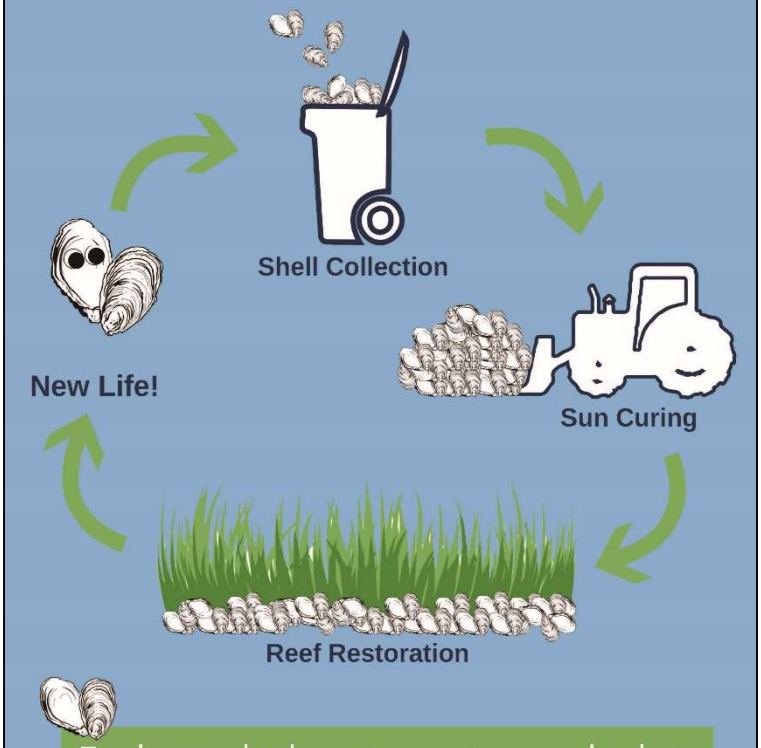
WINDOW CLING

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?
Contact Haille Carter at hcarter@galvbay.org

A PUBLICATION FUNDED BY A TEXAS COASTAL MANAGEMENT PROGRAM GRANT APPROVED BY THE TEXAS LAND COMMISSIONER PURSUANT TO NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION AWARD NO. NA16NOS4190174.

TABLE TENT #2 – *FOR SOCIAL MEDIA CAMPAIGN*

APPENDIX I

Database of Oyster Shell Recycling Programs in the United States

Database of Oyster Shell Recycling Programs in the United States

State	Organization	Name of Program	Start Date	Equipment	Labor	Public Drop-Off Site	Website
Alabama	Alabama Coastal Foundation	Oyster Shell Recycling Program	2016	Dump Truck (vendor)	Contract	No	joinacf.org/oyster-shell-recycling-program
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
Delaware	Partnership for the Delaware Estuary	Delaware Estuary Shell Recycling Program	2016	Truck with Lift Gate	Staff	No	delawareestuary.org/science-and-research/oysters
Florida	Brevard Zoo	Shuck & Share	2014	Unknown	Unknown	No	restoreourshores.org/shuck-and-share
Florida	Choctawhatchee Basin Alliance	Offer Your Shell to Enhance Restoration (OYSTER)	2010	Truck & Trailer	Staff	No	basinalliance.org/what-we-do/in-our-communities/oyster-shell-recyling
Florida	Coastal Connections, Inc.	Shuck & Share	2019	Personal Vehicle	Volunteers	No	www.coastal-connections.org
Florida	Florida Oceanographic Society	Florida Oceanographic Oyster Restoration (FLOOR) *part of Shuck & Share	2014	Unknown	Unknown	No	www.floridaocean.org/floor
Florida	Friends of Gamble Rogers State Park	Shuck & Share	Unknown	Unknown	Volunteers	No	frogrs.wixsite.com/mysite/shuck-and-share
Florida	Guana Tolomato Matanzas National Estuarine Research Reserve	Oyster Shell Recycling Program	2012	Truck & Trailer	Staff & Volunteers	No	gtmnerr.org/stewardship/aquatic-resource-management
Florida	Halls River Alliance	Shuck & Share	Unknown	Truck & Trailer	Unknown	No	hallsriveralliance.org/shuck-share

Database of Oyster Shell Recycling Programs in the United States

State	Organization	Name of Program	Start Date	Equipment	Labor	Public Drop-Off Site	Website
Florida	Keep Pensacola Beautiful	OYSTER Project (Offer Your Shell to Enhance Restoration)	2011	Truck & Trailer	Staff & Volunteers	No	keeppensacolabeautiful.org/what-we-do/recycling/oyster_1/shell-recycling
Florida	Marine Discovery Center	Shuck & Share (organized the program)	2014	Truck (vol.) & Box Truck (vendor)	Volunteers & Vendor	No	shuckandshare.org
Florida	Martin County's Coastal and Water Quality Groups	Oyster Reef Restoration Project *receive shell from FLOOR	2014	Truck & Trailer	Staff	No	oysterrestoration.com
Florida	University of Central Florida	Shuck & Share	2017	Unknown	Restaurants	No	www.cs.ucf.edu/ux/shuck-and-share
Louisiana	Coalition to Restore Coastal Louisiana (CRCL)	Oyster Shell Recycling Program	2014	Dump Truck (vendor)	Contract	No	crcl.org/oyster-shell-recycling
Maryland	Oyster Recovery Partnership	Shell Recycling Alliance (Oyster Shell Recycling Program)	2010	Box Truck (no vendor)	Staff & Volunteers	No	oysterrecovery.org/sra
Mass.	Wellfleet SPAT (Shellfish Promotion and Tasting, Inc.)	Shell Recycling Program	2009	Dump Truck (vendor)	Volunteers	No	wellfleetspat.org
Mass.	Natural Resources Department	Natural Resources Department Shell Recycling Program	2014	Truck with Lift Gate	Staff	No	nantucket-ma.gov/594/Shell-Recycling-Program
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
New Jersey	American Littoral Society	Shuck It, Don't Chuck It	2016	Truck	Staff	No	littoralsociety.org/operation-oyster

Database of Oyster Shell Recycling Programs in the United States

State	Organization	Name of Program	Start Date	Equipment	Labor	Public Drop-Off Site	Website
New Jersey	NJ Division of Fish and Wildlife Bureau of Shellfisheries	NA	2019	Truck & Dump Trailer	Staff	No	www.njfishandwildlife.com/shelhome
New York	New York Harbor School	Billion Oyster Project	2014	Box Truck (vendor)	Contract	No	billionoysterproject.org
North Carolina	North Carolina Division of Marine Fisheries	Oyster Shell Recycling Program	2003	Public Recycling Station	Volunteers	✓	nccoast.org/uploads/documents/factsheets/FS_oysterrecycle
South Carolina	South Carolina Department of Natural Resources	South Carolina Oyster Restoration and Enhancement (SCORE) Program	2000	Truck & Dump Trailer	Staff	✓	score.dnr.sc.gov
Texas	TAMU Corpus Christi Harte Research Institute	Sink Your Shucks	2009	Truck & Trailer & Dump Trailer	Students & University Staff	No	oysterecycling.org
Texas	Galveston Bay Foundation	Oyster Shell Recycling Program	2011	Truck & Trailer	Staff	No	galvbay.org/oysters
Virginia	Lynnhaven River NOW	Save Oyster Shell (SOS) *partners of City of Virginia Beach	2006	Truck & Trailer	Staff	✓	lynnhavenrivernow.org/lynnhaven-oysters
Virginia	Virginia Commonwealth University Rice Rivers Center	Virginia Oyster Shell Recycling Program (VOSRP)	2013	Personal Vehicle	Volunteers	✓	ricerivers.vcu.edu/community-engagement/oyster-shell-recycling
Virginia	Chesapeake Bay Foundation	Save Oyster Shell	2005	Personal Vehicle	Volunteers	✓	www.cbf.org/how-we-save-the-bay/programs-initiatives/virginia/oyster-restoration/save-oyster-shell
Virginia	Friends of the Rappahannock	Oyster Program *part of VOSRP	Unknown	Unknown	Unknown	✓	riverfriends.org/oysters

APPENDIX J

Texas Oyster Regulations

Texas Oyster Regulations
as of September 2019

<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 2019-2020 commercial and recreation guides and are subject to change.

GALVESTON BAY
FOUNDATION

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