# Trabue Harborwalk Oyster Reef Restoration
# Three Year Post Installation Results

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**Introduction**

In 2012, The Nature Conservancy (TNC) funded and worked with the Charlotte Harbor National Estuary Program (CHNEP) and the Southwest Florida Oyster Working Group (SWFOWG) – made up of local partners with experience and knowledge in various aspects of oyster reef restoration – to develop Florida's first estuary-wide, science-based oyster habitat restoration plan. In December 2012, the CHNEP Management Conference approved the Charlotte Harbor Oyster Habitat Restoration Plan (Boswell *et al*. 2012). The plan contains a Restoration Suitability Model (RSM) that spatially defines potentially suitable areas in Charlotte Harbor for oyster reef restoration based on 5 criteria: bathymetry, tidal river salinity isohalines, seagrass persistence, proximity to boat channels, and presence of aquaculture lease areas. Output from the RSM indicates that there is over 40,000 acres of highly suitable area for oyster restoration within the Charlotte Harbor System. The plan's long-term project objectives include establishing vibrant and growing oyster reef habitat in the Charlotte Harbor with a restoration goal of 1,000-6,000 acres of oyster habitat.

Funding from The Mosaic Company Foundation enabled TNC to initiate implementation of a pilot oyster reef restoration project in the Charlotte Harbor System. TNC worked with the CHNEP and Florida Department of Environmental Protection - Charlotte Harbor Aquatic Preserves (FDEP-CHAP) to identify an appropriate location for the project. The project location ultimately selected was the shallow intertidal area off Trabue Harborwalk, a linear walking trail and park located in the City of Punta Gorda along tidal portions of the Peace River. Selection of the project location was based on the highly suitable areas identified in the Charlotte Harbor Oyster Habitat Restoration Plan, presence of an oyster larvae source, accessibility for volunteers and adjacency to publicly owned property.

Since no known oyster habitat restoration projects had been conducted in the northern portion of Charlotte Harbor, TNC designed a pilot project to test methods that might typically be used for larger restoration projects in the region. Three methods were selected: loose fossil shell, bags of loose fossil shell, and oyster mats using recycled shell. Fossil shell was selected as a material for the loose and bagged shell reefs due to the limited availability of recycled oyster shell. Both the bag and mat materials used in reef construction are aquaculture grade plastic that are expected to be encapsulated as the reefs grow.

The pilot project was designed to facilitate comparison of how well the three approaches perform. Three reefs of each material approximately 4 m by 9 m in size were constructed (construction completed October 2015) and one control site was established. A reference site could not be found near the project area as the previously observed natural reefs no longer exist. Reference reefs are present further south in the Charlotte Harbor system and have been studied by the Sanibel Captiva Conservation Foundation (Mark Johnson, pers com). A monitoring plan based on the Oyster Habitat Restoration Monitoring and Assessment Handbook Guidelines (Baggett *et al*, 2014) was developed and implemented to assess reef performance and effect on adjacent habitats and native species. Monitoring plan elements included: project footprint and reef area; reef height; live oyster density and size frequency; water temperature,

salinity, dissolved oxygen and clarity/turbidity; oyster recruitment and cluster formation; macroinvertebrate use of the reef; waterbird utilization of the reefs; habitat stability (accretion/erosion between reef and mangrove shoreline) and submerged aquatic vegetation. Results of the monitoring collected during Year 3 post-installation (collected in November 2018) are provided below. Methods are not detailed below as they are available from the Year 1 post-installation monitoring report available at: https://tnc.box.com/s/evwkg0lvkdem7b095xfmd6cw8ge4hdsh. Some results provided below are only the highlights of results from reports provided to TNC from contractors and partners. Full reports on these resources are available upon request.

**Key Results Three Years Post Reef Installation**

Reef Height and Reef Area

Reef height appears to have declined since the time of deployment (Table 1; Figure 1), however, there are two confounding factors: measurement method and possible sedimentation of the reefs during Hurricane Irma (September 2017). Prior to the Year 1 monitoring, the project team changed the measurement method to facilitate collection of data in typical field conditions which sometimes includes choppy waves. The Years 1 through 3 monitoring methods remained the same. If monitoring method had not had a substantial effect on results, the reduction in height for the mat and bagged shell reefs could be explained by initial settlement of the materials into the sandy-mud substrate. This however, would not explain why the loose shell reefs experienced an expansion in Year 1, so it appears the methods used to monitor reef height affected the results.

**Table 1. Reef Height (cm) by reef type**

| | mat average | bag average | loose shell average |
|---|---|---|---|
| **Deployment** | 8.9 | 17.6 | 12.3 |
| **Year 1** | 4.9 | 12.3 | 14.3 |
| **Year 2** | 7.0 | 16.0 | 13.3 |
| **Year 3** | 5.3 | 11.3 | 9.7 |

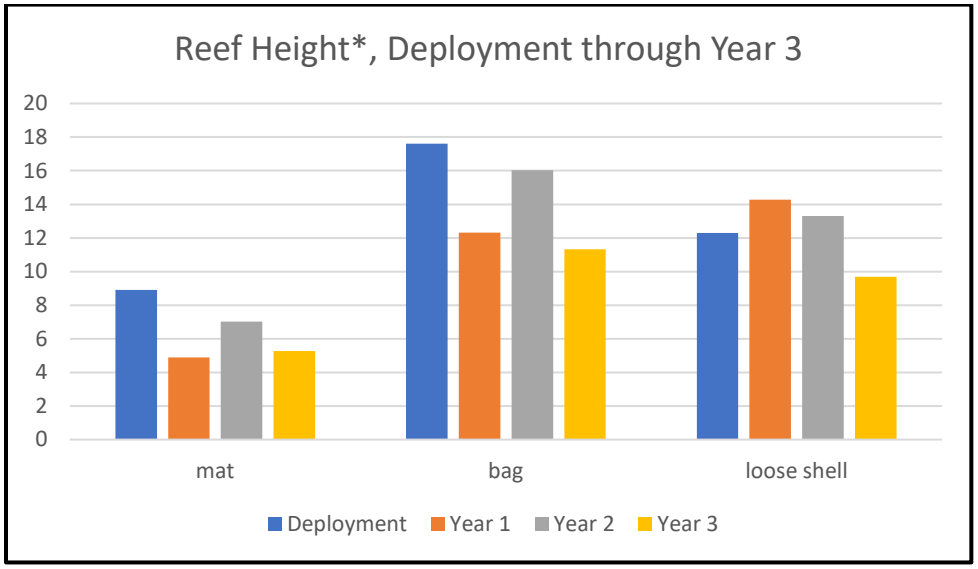


**Figure 1. Reef Height by Type of Substrate Used.**
*Note, height measurement method changed between deployment and Year 1 post-deployment.

Between Years 1 and 2, The mat and bagged shell reefs increased in height and the loose shell reefs experienced a slight decrease in height (Table 1, Figure 1). This slight average decrease in height could be explained by a modest amount of shell that was pushed off the reef to the immediately adjacent area following Hurricane Irma. The reduction in height is small however (1 cm) and could also be explained by sampling variability. In general, the trend in reef height was positive. During the Year 3 sampling, a sizeable decrease in reef height (the distance between the sediments immediately adjacent to the reef and the lengthwise center point of the reef) was measured for all three reef types. This appears to have been caused by accelerated sedimentation of the reefs during Hurricane Irma in September of 2017. Sediments finer than those previously present around the reefs moved into the area and reef materials appeared buried as compared to previous years. An abandoned tire that has been present near the reefs since before deployment illustrates this phenomenon (Figure 2). Although some sedimentation was observed from the time of the deployment through March of 2017, sedimentation following the storm was more pronounced.


**Figure 2. Photos of tire and bagged shell reef at Site B showing sedimentation over time. Sedimentation following Hurricane Irma (Sept 2017) notably increased.**

Areal extent of the reefs has not changed except on the loose shell reefs where some of the shell has been moved off onto adjacent sediments within approximately 0.5 meters of the original reef footprint (Figure 3).


**Figure 3. Loose shell reefs at Site B, January 2018 and November 2018.**

Live Oyster Densities and Totals

Live oysters declined on the mat and bagged shell reefs (by 24.8% and 27.1%, respectively) and increased on the loose shell reefs by 30.7% as compared to the Year 2 monitoring. Overall, loss of live oysters on the reefs averaged 19.2% (Table 2; Figure 4). Heavy sedimentation (as discussed above) appears to have been responsible for some, if not all, of the mortality (see also Figure 2). This is less of a decline than experienced in the previous season following Hurricane Irma. It is unknow if live oysters will recover to on the mat and bag reefs, or if they will continue to decline due to the amount of sedimentation present.

Our measure of success for the Trabue reefs was set at 413 oyster/$m^2$ based on densities found at reference reefs monitored near and around Sanibel Island by the Sanibel Captiva Conservation Foundation (Mark Thompson, SCCF, pers.com). The bagged shell and loose shell reefs exceeded the success criterion in 2018 (1800 and 430 oysters/$m^2$, respectively). The mat reefs fell short of the success criterion (308 oysters/$m^2$). As of the Year 3 monitoring, the Trabue reefs are home to approximately 243,172 oysters (Table 3). The bagged shell reefs continued to have the most live oysters by a wide margin, followed by the loose shell reefs and the mat reefs.

**Table 2. Density of Live Oysters on Reefs (live oysters/$m^2$)**

| | 1 year | 18 months | 2 years | 3 years | *Change from previous year* |
|---|---|---|---|---|---|
| Mat Reefs | 154 | 206 | 410 | 308 | *-24.8%* |
| Loose Shell Reefs | 714 | 769 | 329 | 430 | *30.7%* |
| Bagged shell reefs | 2,186 | 2,674 | 1,800 | 1313 | *-27.1%* |
| | | average: | 846 | 684 | *-19.2%* |

**Table 3. Estimated number of live oysters on the reefs, Year 3**

| Reef Type | 1 year | 18 months | 2 years | 3 years |
|---|---|---|---|---|
| Mat Reefs | 17,270 | 23,072 | 45,920 | 34,533 |
| Loose Shell Reefs | 87,108 | 93,818 | 40,138 | 52,451 |
| Bagged shell reefs | 260,134 | 318,206 | 214,200 | 156,188 |
| Total all reefs | 364,512 | 435,096 | 300,258 | 243,172 |

Approximately 20% of the oysters on the bagged shell reef were recently dead (also known as box oysters), followed by 9% recently dead on the mat reefs and 7% recently dead on the shell reefs (Table 4). This is considerably less than the recently dead on last year's reefs which averaged 54% box oysters.

**Table 4. Box Oysters (i.e., recently dead), Year 3**

| Reef Type | bag | mat | shell |
|---|---|---|---|
| Box oysters | 25 | 5 | 9 |
| Reef Type Total Box (recently dead) Oysters per sample | 78 | 15 | 17 |
| Percent dead oysters by reef type | 19.8% | 9.2% | 7.0% |

Bagged shell and loose shell reefs exhibited strong recruitment during the previous several months (Figure 4). The mat reefs displayed low recruitment in the months leading up to the Year 3 sampling (November 2018). All three reef types displayed a good distribution of size classes, however, missing was the strong showing of live oysters in the mid-range size classes as compared to the previous year (Figure 5). Whereas the mat reefs had more of the largest individual oysters of the three reef types in previous years, this was not the case during the Year 3 sampling and may reflect excessive sedimentation of these reefs.

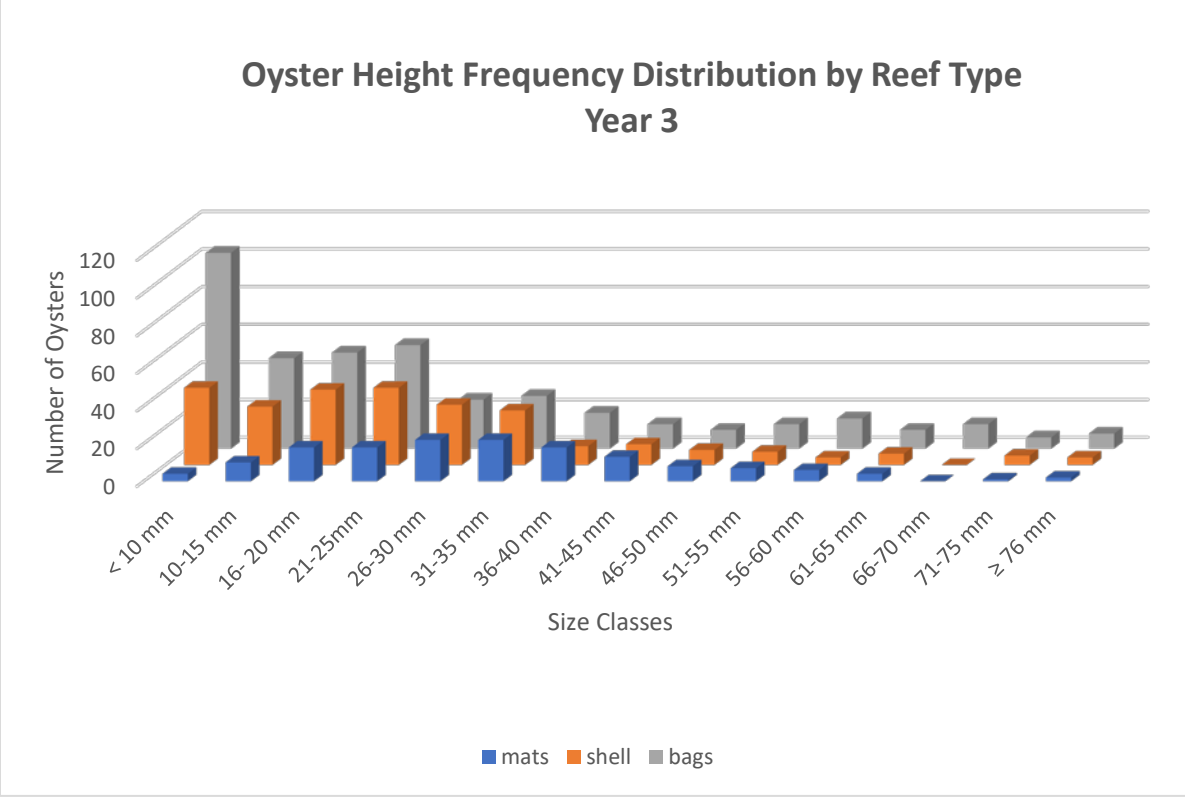

Figure 4. Size frequency of live oysters on the Trabue reefs by type, Year 3 monitoring.

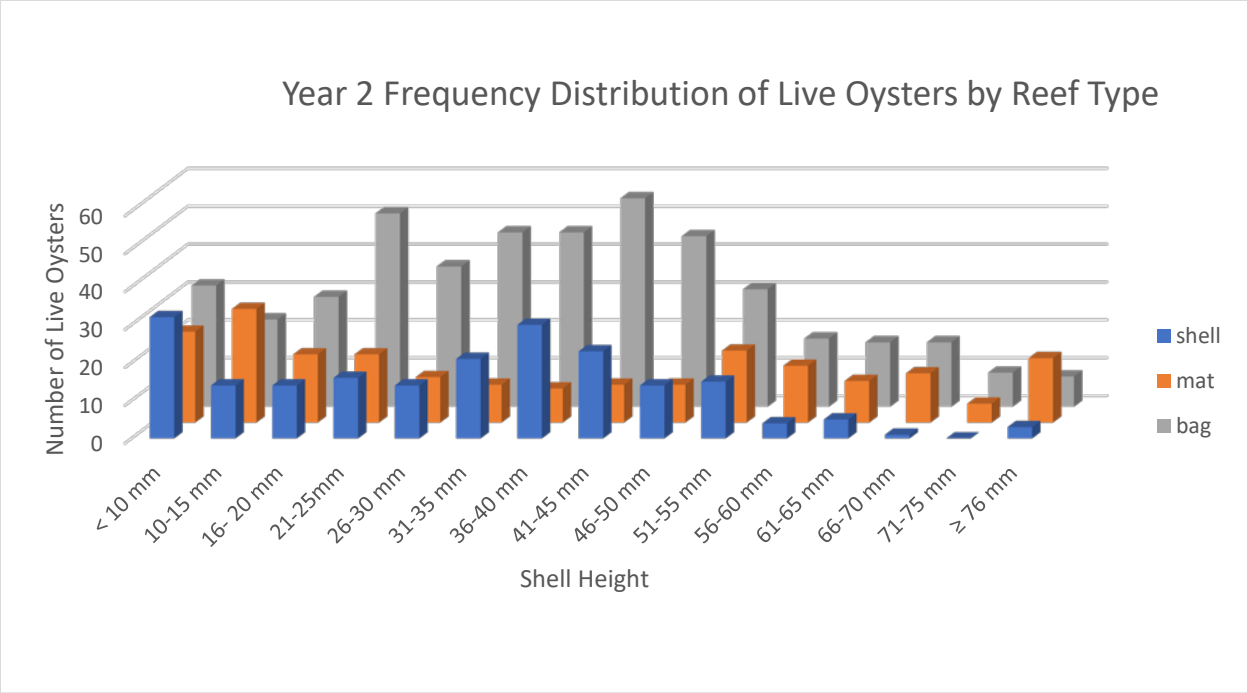

Figure 5. Size frequency of live oysters on the Trabue reefs by type. Year 2 monitoring.

Invertebrate Epifauna on the Reefs

Year 3 sampling results are not yet available. Results will be provided once available.

Waterbird utilization of the restored reefs and surrounding area

Bird observations on and around the reefs during Year 3 post-installation may reflect the aftermath of Hurricane Irma (September 2017). Individual and species numbers were down as compared to Year 2 post installation (Nov 2016 – Oct 2017) and are more like the Year 1 post-installation monitoring results (Nov 2015 – Oct 2016) than last year's results. This may be a result of less food on the reefs due to more sedimentation (Table 5).

Smalltooth sawfish utilization of area around the restored reefs

The smalltooth sawfish were not monitored as part of this study during Year 3 post-installation.

Seagrass

Since seagrass monitoring in previous years at the site and around the reefs revealed no increases or other distinct trends or patterns, the Florida Department of Environmental Protection, Charlotte Harbor Aquatic Preserve staff opted not to conduct the seagrass sampling in Year 3.

**Table 5. Bird counts on and around reefs, Years 1 through 3**

| Species | Nov 2015 - Oct 2016 | Nov 2016 - Oct 2017 | Nov 2017 – Oct 2018 |
|---|---|---|---|
| American Oystercatcher | | 3 | |
| Belted Kingfisher | 2 | | 1 |
| Black vulture | | | 7 |
| Brown Pelican | 2 | 10 | 2 |
| Double-crested Cormorant | 2 | 13 | 1 |
| Grackle | 2 | 2 | |
| Great Blue Heron | | 1 | |
| Great Egret | 1 | 2 | |
| Killdeer | | 7 | |
| Laughing Gull | | 1 | |
| Little Blue Heron | 4 | 13 | |
| Little Green Heron | | 2 | |
| Mottled Duck | 2 | 3 | |
| Mourning Dove | | 3 | |
| Osprey | | 3 | 1 |
| Ring-Billed Gull | | | 5 |
| Snowy Egret | | 3 | |
| White Ibis | 2 | 20 | 2 |
| **TOTAL Individuals** | **17** | **86** | **19** |
| **TOTAL Species** | **8** | **15** | **7** |

Summary and Conclusions

The Trabue Harborwalk Project has demonstrated how to successfully pilot a small-scale project to test different restoration methods and involve the community in all aspects of the work. Oyster recruitment and growth on the reefs was higher than expected until the year following Hurricane Irma which may reflect ongoing hurricane-related impacts namely, excess sedimentation. Waterbird utilization of the reef also seems to have been impacted by the hurricane. Once the third year of invertebrate results are available, we will be able to verify whether the number of individuals was down and therefore food for the birds. Subsequent years of monitoring would help to answer the question of whether the type of reefs constructed can return to pre-disturbance vigor given time. There is promising evidence that this is possible given the strong recent recruitment and growth on the bagged shell and loose shell reefs.

Construction of reef materials, preparation of the reefs sites, deployment of the reefs and monitoring of the restored reefs has all been made possible with numerous project partners and volunteers including the City of Punta Gorda, Charlotte Harbor National Estuary Program (CHNEP), FDEP-Charlotte Harbor Aquatic Preserves, CHNEP Citizen Scientists and numerous other individuals and companies that have donated their funds, time, oyster shell and storage space to this project. The three years of required monitoring is now complete. TNC may however conduct monitoring in future years, possibly years 5 and 10, or may conduct additional monitoring as part of an expanded project at the Trabue reefs.