Shell Bank: Oyster shell recycling, restoration resources, and reef resilience

Final Report for GLO Contract # 19-048-000-B082

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Acknowledgements

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Project Partners

— THE —

OYSTER BAR

FOOD. SERVICE. PEOPLE.

SINCE 1983

Fiesta Oyster Bake®

The Heartbeat of Fiesta®

Introduction and project goals

Oyster reefs are fundamental components of healthy estuaries and provide key ecological and economic benefits. Oysters filter and clean bay waters through their suspension feeding activities, build three-dimensionally complex reefs that provide habitat for fish and invertebrates and enhance recreational fishing, protect adjacent shorelines by attenuating wave energies, and support the iconic Texas oyster fishery, generating $16 million annually over the past decade. However, oyster reefs have declined rapidly over the past century, and in the Gulf of Mexico only 15-50% remain compared to historic levels. Because free-swimming larval oysters depend on the shells of older generations for attachment and growth, when the shells of harvested oysters are not returned to coastal waters, essential habitat is lost.

Oyster reef restoration seeks to ameliorate the effects of habitat loss. However, a critical limitation to restoration efforts is a shortage of oyster shell, the preferred and most natural restoration material. Community partnerships that recycle shells from local businesses are an innovative solution to this problem. To this end, the ***first goal of this project was to recycle shucked oyster shells from restaurants, seafood wholesalers, and festivals from Austin to San Antonio to the coastal bend for use in habitat restoration***.

Large-scale oyster reef restoration is typically accomplished using barges and draglines to construct new habitat. However, engaging community volunteers to participate in small-scale restoration activities is equally valuable for creating a local culture of environmental stewardship. ***The second goal of this project was to host two community-based restoration events at Goose Island State Park for volunteers to fill mesh bags with recycled oyster shells to be used as building blocks for a living shoreline funded by TAMU-CC's restaurant partners.***

Current events have increased demand for online resources to support virtual learning experiences for students. Creating videos related to habitat restoration and sharing them publicly and for no charge provides students and teachers maximum flexibility for using the resources on their own schedule and in coordination with their own lesson plans. Therefore, ***the third goal of our project was to create a series of restoration videos on topics including: why habitat restoration is important, what is shell recycling, how to host a community-based restoration, and ways to restore an oyster reef.***

Lastly, coastal habitats on the Gulf coast are frequently subject to disturbances from hurricanes and tropical storms. Hurricane Harvey in particular had strong impacts on the Texas coast, providing the opportunity to assess changes that occurred on natural and restored oyster reefs, to inform future restoration and management actions. ***The fourth goal of our project was to compare oyster density, size, and disease parameters from restored and natural oyster reefs in the Mission-Aransas Estuary from pre- and post-Hurricane Harvey.***

This was a CMP Cycle 23 priority project, addressing needs for "restoration and shoreline protection," "enhancement and restoration of critical coastal areas," and "targeted public education and outreach efforts" as described by funding category 2: Critical Areas Enhancement. This project also supported principal goals and priority issues defined in the Coastal Bend Bays Plan, including Bay Tourism and Recreation (BTR-1, BTR-4), Habitat and Living Resources (HLR-1, HLR-2), and Public Education and Outreach (PEO-3, PEO-5).

Project partners

The Shell Bank Project is the first integrated oyster shell reclamation, recycling, and restoration program in Texas. Founding partners include: Water Street Seafood Restaurants (providing shucked oyster shells), the Harte Research Institute for Gulf of Mexico Studies (HRI) and Texas A&M University-Corpus Christi (TAMU-CC) (project execution and partner coordination), and the Port of Corpus Christi Authority (housing the stockpile location for the recycled oyster shells). The project has evolved to include partners who donate shells from across a larger region of south Texas, including Austin Oyster Festival (Austin), Groomer's Seafood (San Antonio and Corpus Christi), and Fiesta Oyster Bake (San Antonio). We are actively testing out new project partnerships for shell recycling across the region.

Using the shells recycled from the CMP-funded Shell Bank project, we have restored over 25 acres of oyster reef to date with external funds. We have new funding starting in 2021 to restore another large-scale oyster reef in the Mission-Aransas Estuary using reclaimed shells. None of this habitat restoration would have been possible without the investment of the Coastal Management Program to support our oyster shell recycling activities. We are continuing to seek new partners and new funds for habitat restoration, using shells reclaimed as part of the Shell Bank Project.

Project accomplishments

Goal 1: Oyster shell recycling

Oyster populations are decreasing in Texas, the Gulf of Mexico, and globally, prompting an increase in oyster reef restoration efforts to reverse the decline. In areas like Texas where natural oyster populations still exist, restoration typically involves placing hard substrates into suitable locations for oyster recruitment and growth. However, although oyster shell is the preferred material for reef restoration, it is often limited in its availability, affordability, and/or quantity to fulfill large scale restoration needs. As a result, a number of alternative substrates have been used to restore oyster reefs, with varying levels of performance success.

To meet the demand for native oyster shell for use in habitat restoration in Texas, as part of CMP 23, we worked to recycle shucked oyster shells from restaurants, seafood wholesalers, and festivals for use in reef restoration. During the project period, we reclaimed shucked oyster shells from both the central and south Texas regions, including Water Street Restaurants, Austin Oyster Festival, and San Antonio Fiesta Oyster Bake. Groomer's Seafood, a founding project partner, has essentially shut down their operations in Corpus Christi since construction of the Harbor Bridge started in 2019. We will reengage them in the program once their operation has relocated and reopened. We collected approximately 5,000 lbs. of shucked oyster shells and provided educational outreach to festival attendees at Austin Oyster Festival (https://www.austinoysterfestival.com/) on February 23, 2019. We also collected approximately 10,000 lbs. of oyster shells and provided educational outreach at St. Mary's Fiesta Oyster Bake (https://oysterbake.com/) on April 12-13, 2-19 in San Antonio.

We also started recycling oyster shells from 2 new restaurants on a pilot basis: Virginia's on the Bay in Port Aransas (https://www.facebook.com/virginiasonthebay/), and Scuttlebutts on Padre Island (http://scuttlebuttsbarandgrill.com/). In both cases, we have been working with the owners & managers to address challenges related to space constraints for storing the shucked shells outside of their restaurants. We had also planned to work with the Corpus Christi Convention and Visitors Bureau to recycle shells from a planned seafood festival in Corpus Christi, but as of today the festival is still in planning stages.

In total, we collected 292,800 pounds of oyster shells throughout the CMP 23 project period. This number was somewhat lower than expected for a couple of reasons. First, widespread oyster

mortalities occurred across the Gulf of Mexico in the spring and summer of 2019 due to tropical weather and persistent low salinities. Therefore, oysters were not readily available for restaurants to purchase and fewer shells were produced for recycling. More recently, toward the end of the project period, complications from the COVID-19 pandemic affected our ability to recycle shells because of restrictions on dining that limited the supply of recycled oyster shells for restoration. We anticipate future increases in the amount of oyster shells reclaimed as vaccines become available and people return to in-person restaurant dining. Also, because we are currently in a La Niña period, which generally translates to warmer, drier weather in our region, we anticipate seeing increases in oyster harvests as bays experience transition from low to more moderate salinities.

Figure 1. Sink Your Shucks team at Austin Oyster Fest in February 2019.

Figure 2. Chatting with a festival attendee at Austin Oyster Fest.

Figure 3. Recognition for the Sink Your Shucks Program outreach on the Austin Oyster Festival Website.

Figure 4. Sink Your Shucks team at St. Mary's Fiesta Oyster Bake in April 2019.

Figure 5. Educational outreach at St. Mary's Fiesta Oyster Bake.

Figure 6. Sink Your Shucks trailers filled with bags of oyster shells from St. Mary's Fiesta Oyster Bake.

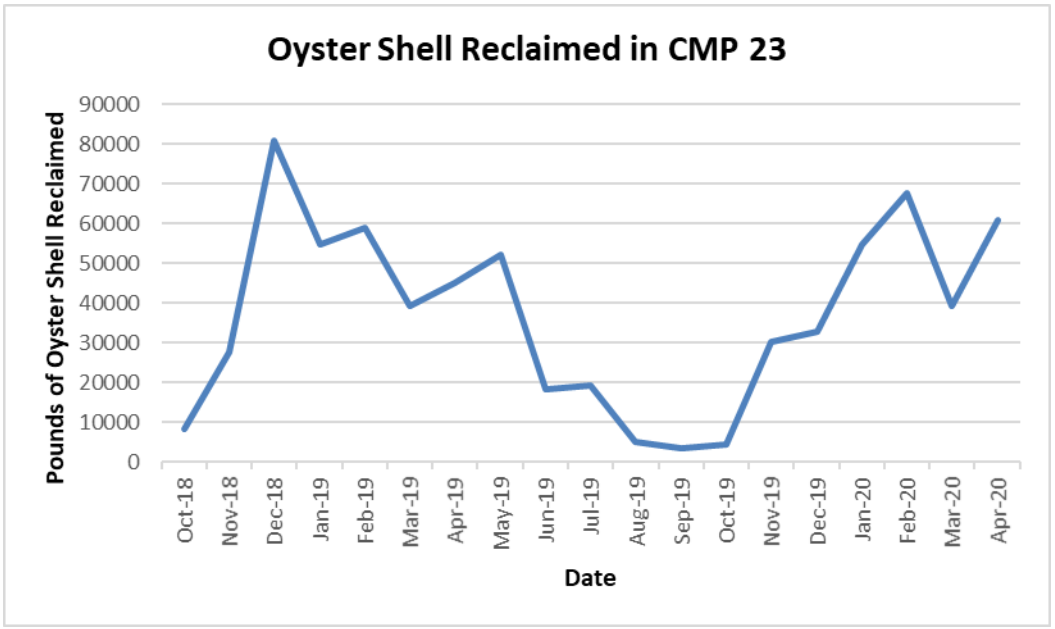

Figure 7. Pounds of oyster shell reclaimed as part of CMP Cycle 23.

Goal 2: Community-Based Living Shoreline

Habitat restoration is primarily carried out to meet ecological or environmental needs, but it can also provide social and cultural benefits. Engaging volunteers in habitat restoration activities can help build relationships between the bay and its stakeholders, increasing the culture of stewardship related to coastal areas and improving the community's sense of place. As a result, public engagement, training, and education on the benefits of restoration are essential components of the Shell Bank program.

As part of CMP 23, we hosted two community-based restoration events, both from 8:30-11:30 am at Goose Island State Park. Events took place on Saturday, April 27, 2019 and Saturday, May 18, 2019 to correspond with the period of highest oyster recruitment. During each event, students and community volunteers made and filled mesh bags with recycled oyster shells to be used as building blocks for a living shoreline funded by TAMU-CC's restaurant partners. Volunteer group that participated included: Judson High School from San Antonio, Moody High School Innovation Academy from Corpus Christi, a Coastal Bend Girl Scout Troop, Texas A&M University-Corpus Christi, and a local Anglers Group, as well as many other local and visiting volunteers. Costs were minimized however possible by utilizing existing supplies including rakes, shovels, PVC, buckets, and mesh bags. In April, 60 volunteers participated, placing 24,750 lbs. of recycled oyster shells into 1,125 bags of shell for use in reef restoration funded by our restaurant partners. In May, 54 volunteers participated, placing 15,180 lbs. of shells into 690 mesh bags. Shell bags were placed into shallow water to minimize wave action along the shoreline and provide habitat benefits for estuarine organisms.

Figure 8. Drone photo of community-based oyster reef restoration event at Goose Island State Park. Photo credit: Jace Tunnell, Mission-Aransas NERR.

Figure 9. Volunteer training ahead of community-based oyster reef restoration event at Goose Island State Park.

Figure 10. Volunteers bagging up oyster shells reclaimed by the Sink Your Shucks oyster shell recycling program for use in reef restoration at Goose Island State Park.

Figure 11. Volunteers bagging up recycled oyster shell for use in reef restoration.

Figure 12. Aransas County Game Warden Scott McLeod supporting the community-restoration event at Goose Island State Park.

Figure 13. Volunteers moving shell bags for use in reef restoration at Goose Island State Park.

Figure 14. Volunteers at the community-based living shoreline event on April 27, 2019.

Figure 15. Volunteers at the community-based living shoreline event on May 18, 2019.

Goal 3: Restoration Resources

The Sink Your Shucks Program has been in existence since November 2009. The program has refined its processes in both the reclamation of shell and the restoration of oyster reefs. To better connect with community partners, students, and resource managers, we developed a YouTube Channel, *Texas Oyster Conservation*, to provide videos of our various processes. Note, our grant proposal originally state we would create a channel called *Gulf Coast Restoration and Sustainability* within the Teacher Tube website; however, the website is not well maintained, and we were unable to get the videos loaded properly. The decision was made to use the more robust and popular website, YouTube.

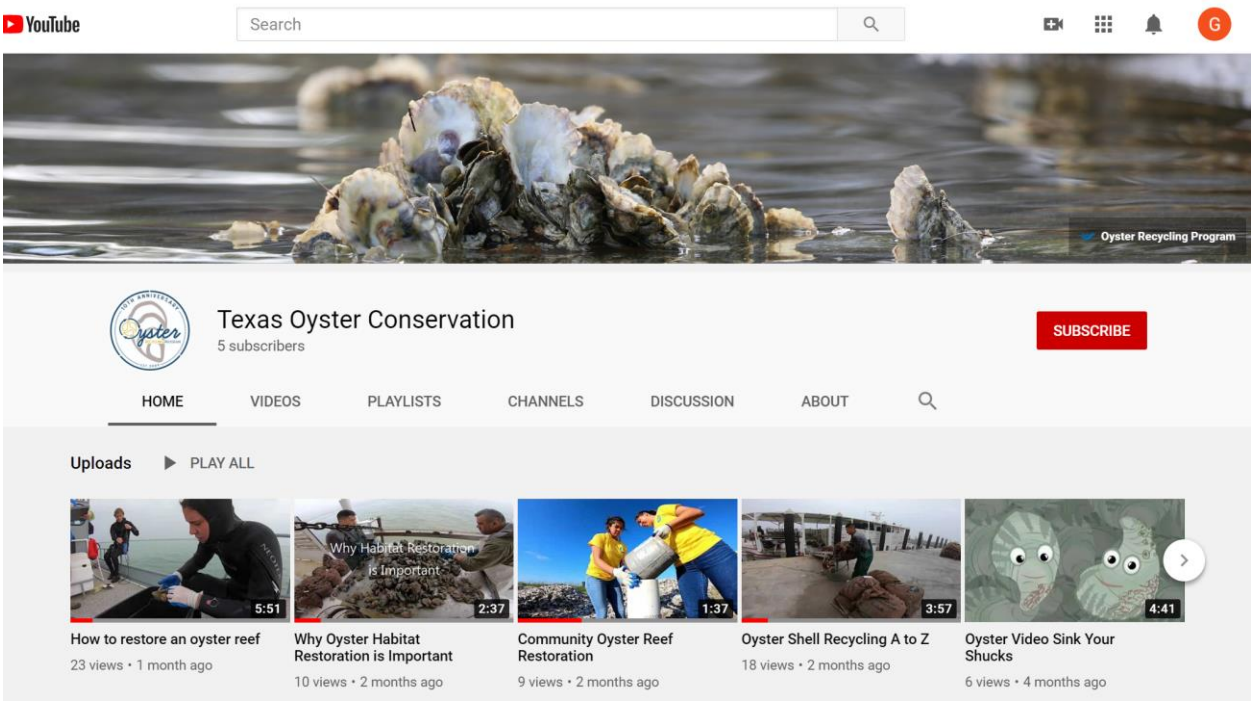

Figure 16. Screenshot of the Texas Oyster Conservation YouTube channel.

YouTube link for the Texas Oyster Conservation Channel:
https://www.youtube.com/channel/UCgQiuD7jdi1lEoTvUgfus1g/

The four videos in the series that were made with our collaborators, the Mission Aransas National Estuary Research Reserve (NERR), are: *Community oyster reef restoration, Why oyster habitat restoration is important, Oyster shell recycling A-Z, and How to restore an oyster reef.*

Video 1: *Community oyster reef restoration* – this video walks the viewer through the process of how the Sink Your Shucks Program executes a community oyster shell bagging event and discusses why the process is so important. The viewer will come away with a good understanding of the importance of oysters in our bays and estuaries and how a person can be a part of the process.
https://www.youtube.com/watch?v=1LnOXdFR3jQ

Video 2: *Why oyster habitat restoration is important* – this video shows the viewer the importance of oyster habitat and what are the results of oyster restoration. The viewer will come away with the fundamentals of oyster reef restoration and why restoration is needed to support or rebuild local habitats.
https://www.youtube.com/watch?v=nqfsOZJIW50

Video 3: *Oyster shell recycling A-Z* – this video shows the viewer how shell is collected in an operating restaurant from delivery of the bagged oyster to the final stage of the shucked shell going to the "Shell Bank" for quarantine. The viewer will see how they can be involved in recycling oyster shell and what comes of the shucked shell after it leaves the restaurant or wholesaler.
https://www.youtube.com/watch?v=iwPqBfVQues

Video 4: *How to restore an oyster reef* – this video shows the viewer how oyster reef restoration is planned, executed, and subsequently monitored. The viewer will come away with a good understanding of the process and the tools used to restore reefs on a small and large scale projects.
https://www.youtube.com/watch?v=o0QfU45x2JU

Goal 4: Reef Resilience

On August 25, 2017, Hurricane Harvey made landfall as a Category 4 storm near Rockport, Texas. The storm moved slowly across coastal Texas for six days, delivering up to 130 cm of rain and producing catastrophic river flooding. Hurricane Harvey had devastating effects on Texas citizens and will have a lasting influence on the U.S. economy, but the disturbances created by this storm also provided an opportunity to evaluate resilience of restored and natural oyster reefs. We collected seasonal field samples to quantify oyster size, abundance, and Dermo disease from restored and natural oyster reefs in the Mission-Aransas Estuary, and compared these data with pre- and post-storm periods. Dermo is caused by the protozoan parasite *Perkinsus marinus* and is a major cause of oyster mortality in the Gulf of Mexico. Infections generally demonstrate a positive relationship with temperature & salinity. See Figures in Appendix A.

First, we examined infection of juvenile oysters by Dermo disease from 2014-2020. Starting in 2014, before Hurricane Harvey, the prevalence (proportion of oysters infected) of Dermo was >50% during a period of relatively high salinities (>35) in the Mission-Aransas Estuary. Both salinity and Dermo prevalence oysters declined in 2015. Infections then steadily increased to >60% right after Hurricane Harvey, after which it sharply declined to ~0% infection. The proportion of infected oysters again increased throughout 2019 to approximately 100%, coincident with increases in salinity. The weighted prevalence, or severity, of oyster infections (ranging from 0 to 5) followed the same pattern as Dermo prevalence. Severity was highest (~0.8) in 2014, declined to <0.2 in 2015-16 with lower salinities, increased to a high of >0.8 just after Hurricane Harvey, briefly dipped down to ~0, and then increased to a high between 1.0-1.2 with higher salinities at the end of the study period.

Next, we evaluated the Dermo infection dynamics of adult oysters from 2014-2020. Both the proportion of adult oysters infected (prevalence) and the severity of infection (weighted prevalence) mirrored the patterns observed for juvenile oysters. However, both Dermo prevalence and severity were slightly higher in adult oysters than in juveniles at the start of the monitoring period in 2014 (e.g. prevalence was ~60% for adults compared to 50% for juveniles, weighted prevalence was 1.5 for adults compared to ~0.8 for juveniles). Results indicate, that for both juvenile and adult oysters, Dermo disease levels temporarily decreased after Hurricane Harvey, likely due to reductions in salinity.

Lastly, we examined the size and density of oysters on natural and restored reefs in the Mission-Aransas Estuary after Hurricane Harvey from 2018-2020. Salinity during this period steadily increased from a low of approximately 12 in Copano Bay and 18 in Aransas Bay in 2018, to a high of approximately 26 in Copano Bay and 32 in Aransas Bay in 2020. On the natural reefs, oyster size (shell height) increased continuously, from a low of ~44 mm in Aransas Bay and ~48 mm in Copano Bay in 2018 to a high of ~60 mm in Copano Bay and ~68 mm in Aransas Bay in 2020. Oyster density on natural reefs in both bays was highest (> 7 oysters m^{-2}) in 2018, decreased throughout 2019 before jumping back up in January 2020, and then declining again to a low of ~2 oysters m^{-2} at the end of the study period. The range of oyster sizes at Goose Island restored reef were similar to those on the natural reefs in Aransas Bay and Copano Bay, except for in April 2019, when oysters were ~20 mm larger at Goose Island. Oyster sizes at the restored St. Charles reef were ~20 mm smaller than all other locations. Oyster densities on the restored reefs were remarkable similar to one another during their overlapping monitoring period in 2020. Oyster densities on the restored reef tended to be lower overall than on the natural reefs. At the end of the monitoring period, oyster densities on all restored and natural reefs were similar, at ~2 oysters m^{-2}. Overall, oyster dynamics on the restored reefs in the Mission-Aransas Estuary were generally similar to those of natural reefs. St. Charles reef was the most recently restored reef, which may account for the differences in oyster size observed compared to the other reefs. Additional monitoring is warranted to compare reef dynamics on restored and natural reefs over time.

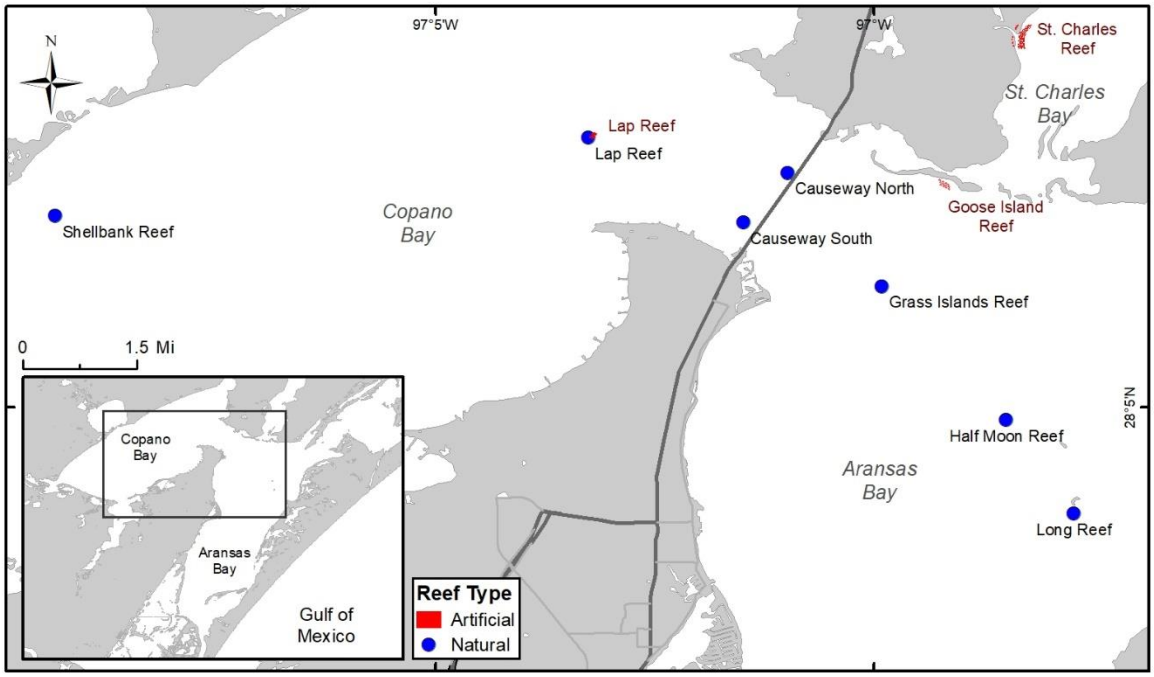

Figure 17. Map of natural and restored (artificial) reefs sampled in the Mission Aransas Estuary.

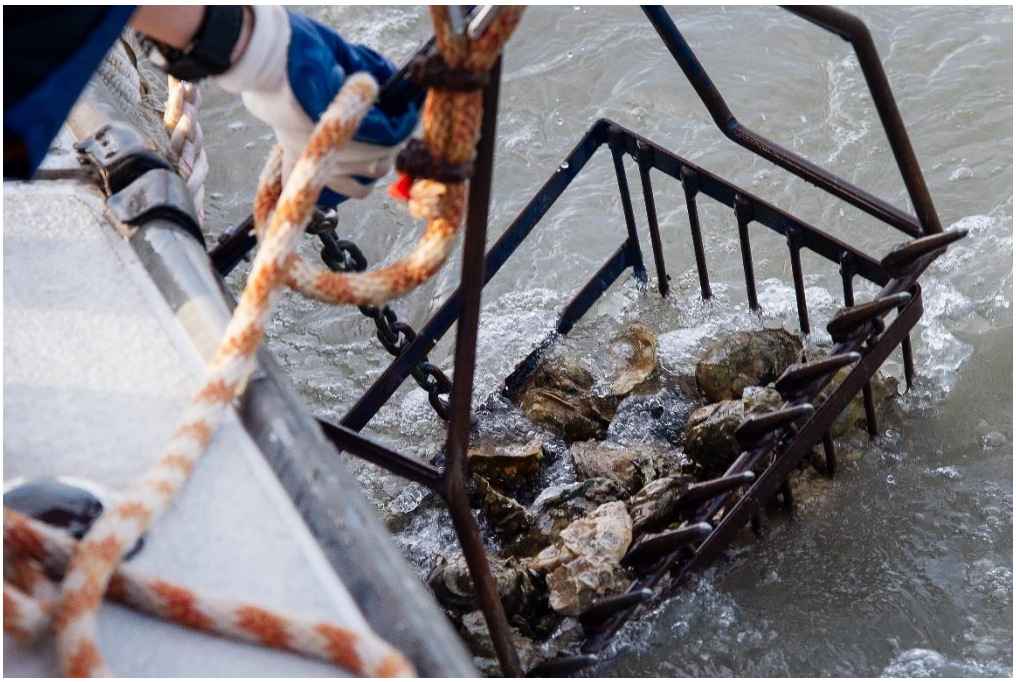

Figure 18. Collecting oysters from the Mission Aransas Estuary.

Figure 19. Measuring oyster size (shell height) using calipers.

Figure 20. Recording field data on oyster density and size.

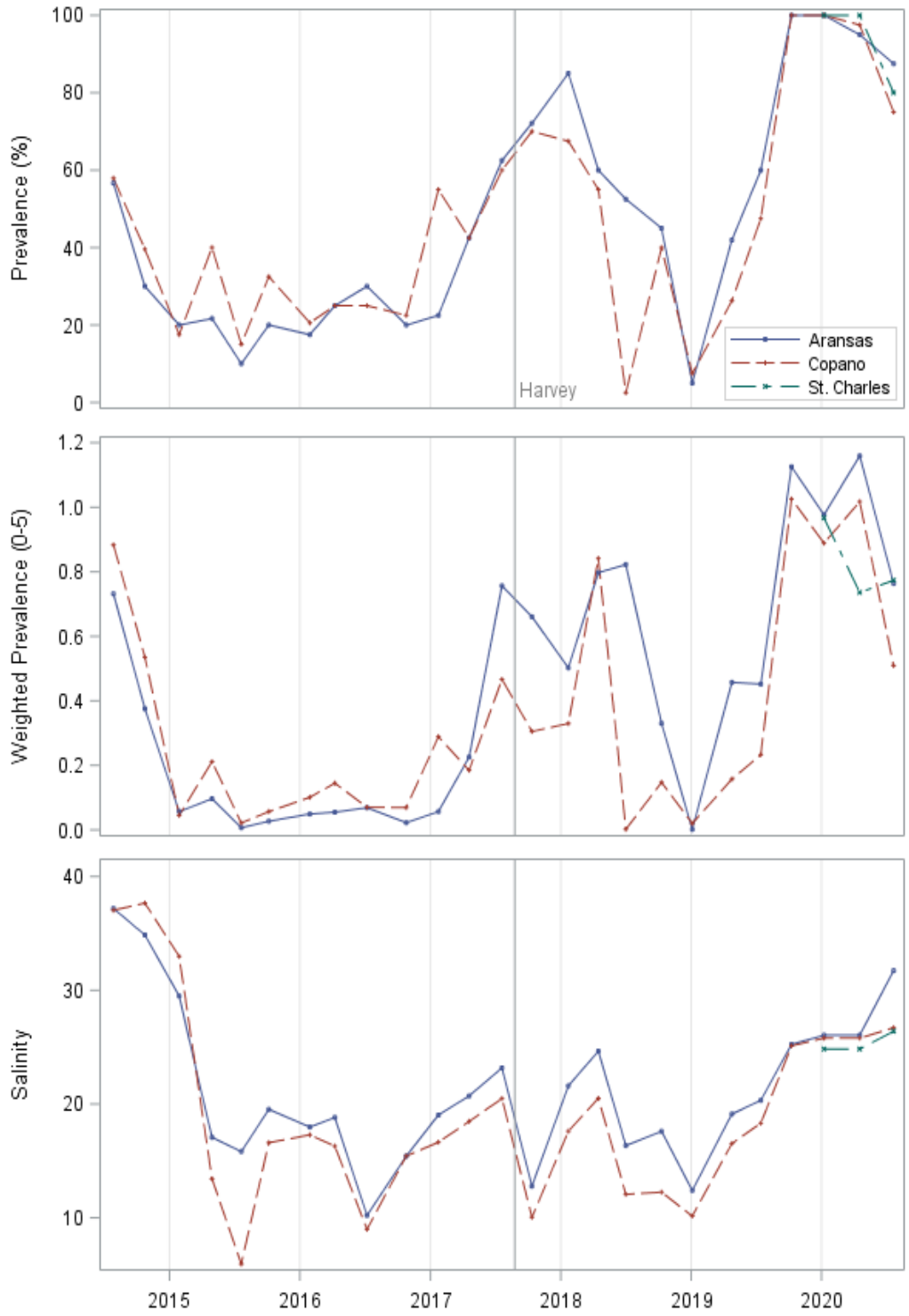

Figure 21. Dermo infection levels for juvenile oysters and coincident salinities collected from reefs in Aransas Bay (blue), Copano Bay (red) and St. Charles Bay (green) from 2014-2020. Hurricane Harvey is indicated as the grey vertical line on the figure.

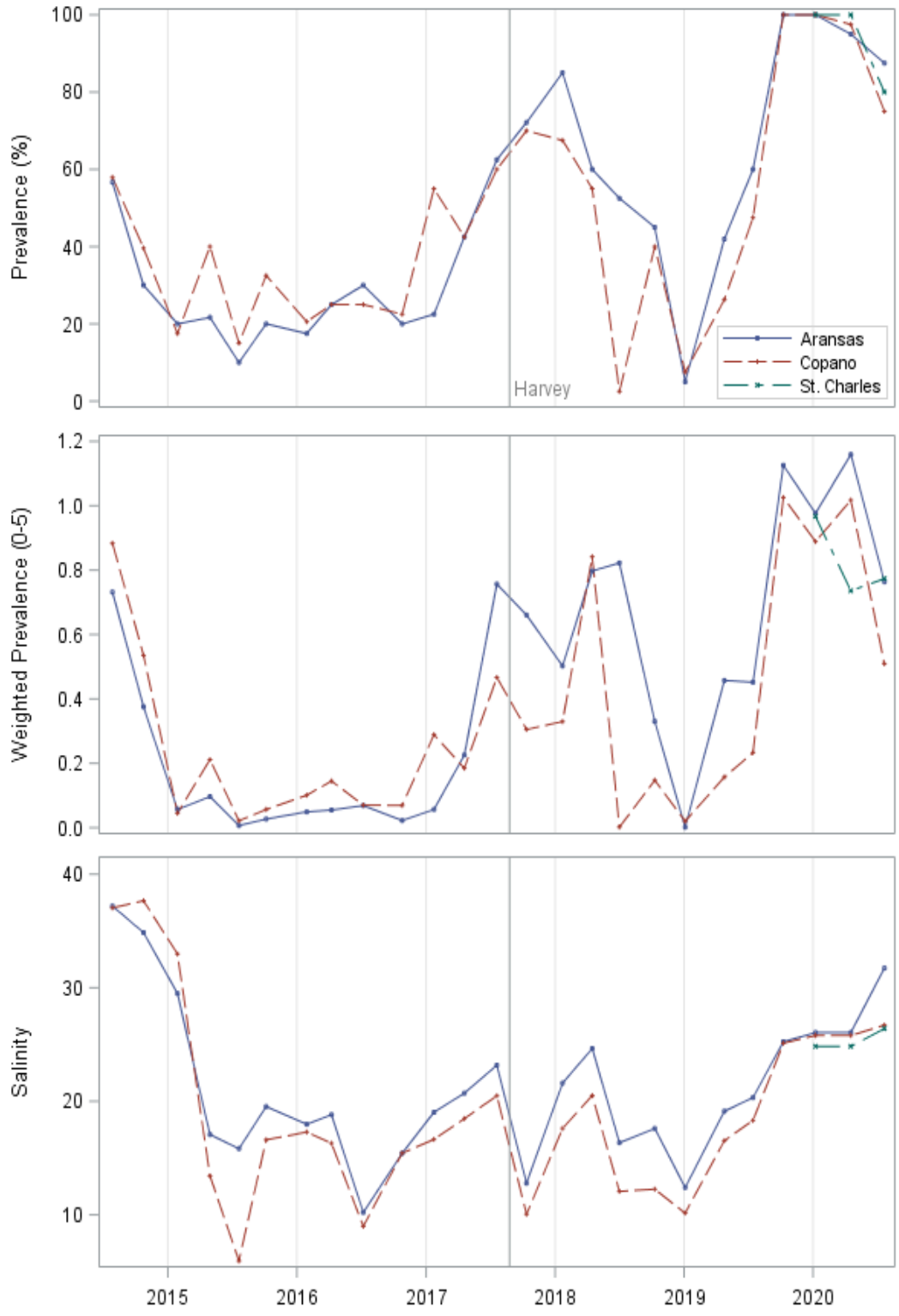

Figure 22. Dermo infection levels for adult oysters and coincident salinities collected from reefs in Aransas Bay (blue), Copano Bay (red) and St. Charles Bay (green) from 2014-2020. Hurricane Harvey is indicated as the grey vertical line on the figure.

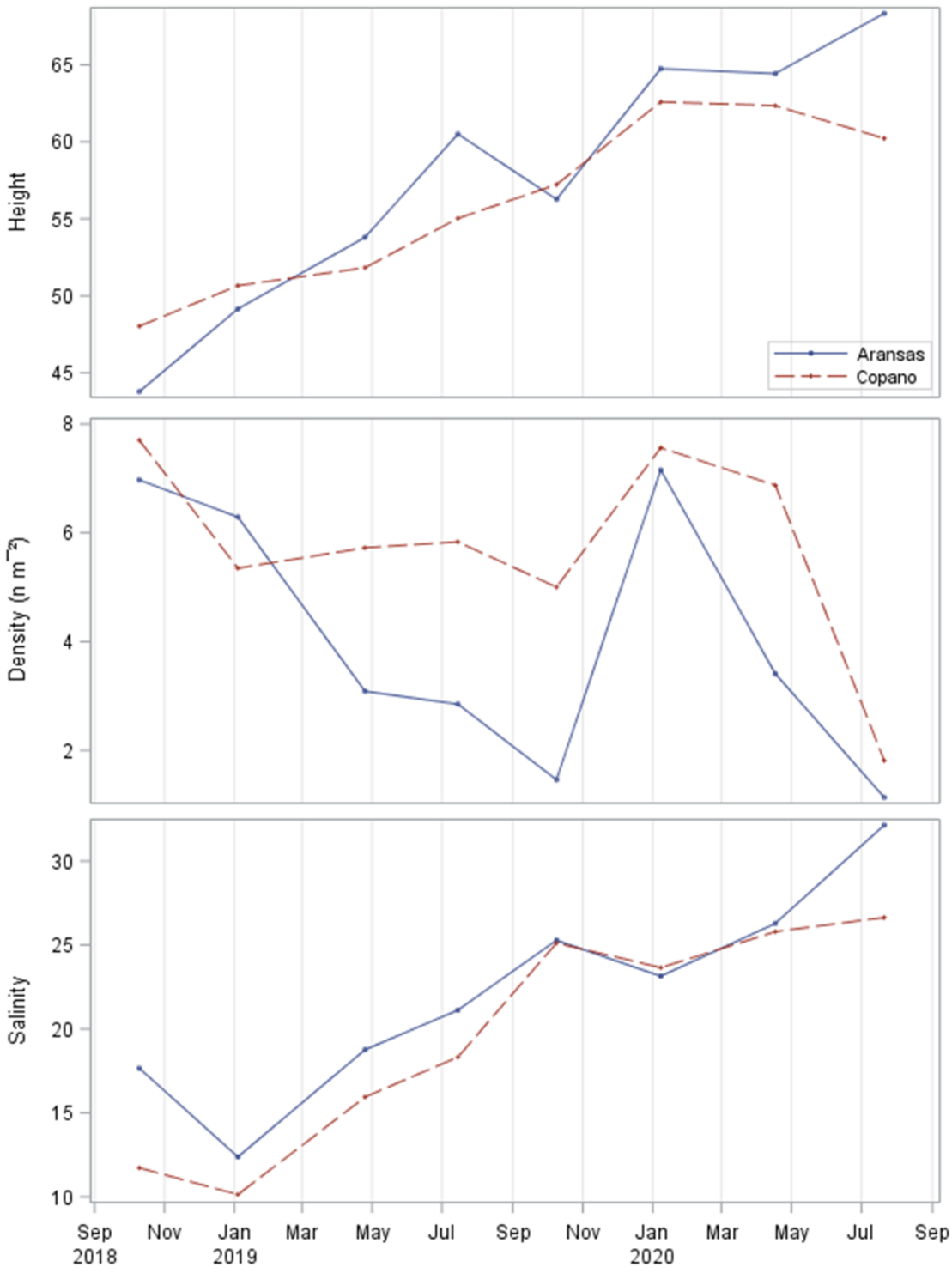

Figure 23. Oyster size (shell height, mm), density (# m-2), and coincident salinities collected from natural reefs in Aransas Bay (blue) and Copano Bay (red).

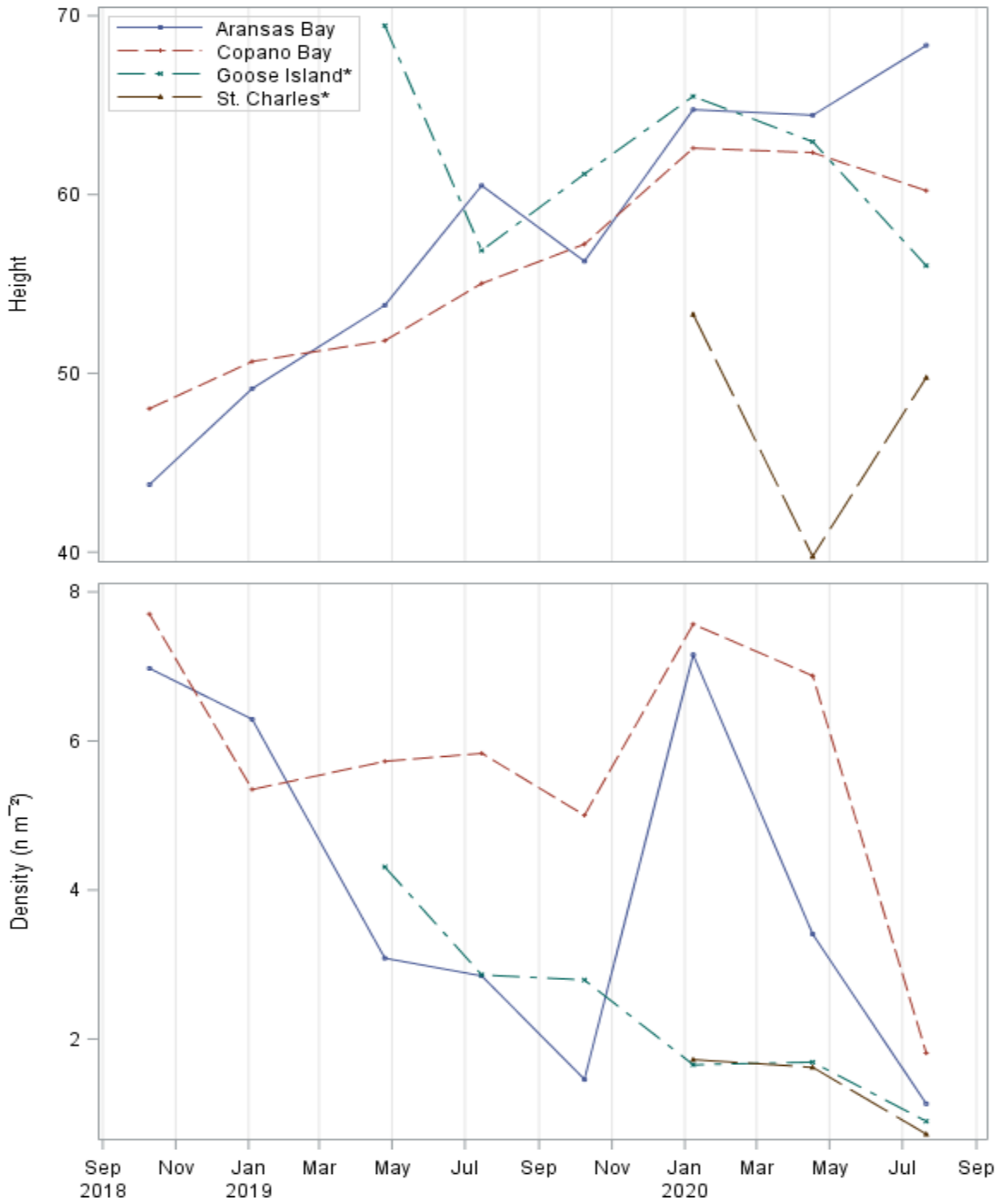

Figure 24. Oyster size (shell height, mm) and density (# m-2) from natural reefs and restored reefs (asterisks).

Conclusion

As part of CMP Cycle 23, we worked to accomplish four main project goals: (1) recycling oyster shells from restaurants, wholesalers, and festivals (2) hosting community-based events to engage volunteers in hands-on restoration activities, (3) creating educational videos and making them freely available for use as an educational resource, and (4) evaluating the resilience of restored and natural reefs. Project accomplishments include (1) recycling 292,800 pounds of oyster shells for use in restoring oyster reefs in Coastal Bend bays and providing public education related to habitat restoration efforts, (2) engaging over 100 community volunteers in hands-on habitat restoration activities, and returning just under 40,000 pounds of shell into St. Charles Bay to restore degraded oyster reef and protect an eroding shoreline, (3) creating four educational videos to expand our educational outreach to groups outside of the Texas coast, including virtual learners affected by the ongoing pandemic, and (4) sampling natural and restored oyster reefs to compare oyster size, density, and disease dynamics over time. We also have received new funding that will allow us to use remaining recycled shells from CMP 23 in 2021 to expand and monitor the restored reef area in St. Charles Bay. We look forward to continued partnership with the Texas General Land Office Coastal Management Program, which has been critical to the establishment and success of the Shell Bank Program by providing natural oyster shell materials for restoring over 25 acres of oyster reef, facilitating public engagement in habitat restoration, and increasing the understanding of restored and natural reefs to improve future restoration efforts.