Mapping Oyster Habitat in Sarasota County Florida Waters

Kathryn L. Meaux, B.S., PMP[1], James D. Grimes, Jr., B.S, GISP[2],
Jon S. Perry, B.S., ESIII, GISP [1], Rene A. Janneman, B.A., ESIII[1]

[1]*Sarasota County Public Utilities, Stormwater, Sarasota, Florida 34240, USA*
[2]*Sarasota County Enterprise Information Technology, Enterprise GIS, Sarasota, Florida 34240, USA*

ABSTRACT:

Seven types of *Crassostrea virginica* (Eastern Oyster) assemblages were mapped in Sarasota County Florida, USA, bays, estuaries and coastal creeks between the fall of 2008 and winter of 2012. Prior to this effort, projects had been conducted by the Sarasota Bay Estuary Program, Charlotte Harbor Estuary Program, Sea Grant, and Sarasota County to document historical oyster habitat and develop current maps depicting the location and extent of oyster habitat in county bays. But, there had been limited efforts to map oysters in coastal creeks. The goal of the project was to produce detailed baseline maps of all oyster assemblage types in Sarasota County bays, estuaries, and coastal creeks. The project objectives were to: 1) Locate and characterize the different types of oyster assemblages; 2) Create detailed baseline maps; 3) Develop "on-the-ground" rapid mapping techniques to complete the mapping process within a reasonable time frame; 4) Develop a Methods and Procedures Manual to allow duplication of efforts in other areas; 5) Identify upstream extent of oyster populations in coastal creeks; 6) Interpret the data using Geographical Information System (GIS) methodology; and 7) Analyze the data to identify potential habitat restoration sites. The project was completed in 2013 with GIS data analysis and interpretation. Scientists, watershed managers, citizens, and other stakeholders will be able to use the data to quantify oyster coverage in areas of interest for restoration efforts and as a baseline to compare with future assessments as alterations are made to watersheds that could impact oyster and estuarine ecosystem health.

KEY WORDS*:* Eastern Oyster, *Crassostrea virginica*, Water Quality, Ecosystem Services, Keystone Species, Bioindicator, Denitrification, Maps

INTRODUCTION

Oyster reefs are vital structural components of bay and estuarine ecosystems. Not only are they important commercial and recreational resources, they are a keystone species in that they play a vital role in sustaining the structure of an ecological community. Without them, many organisms dependent upon oyster reefs for survival would probably not be able to subsist. As a keystone species, oyster reefs provide critical habitat and cover for wide variety of aquatic organisms; the larvae, spat, and adult oysters are an important food source for birds, fish, and other aquatic organisms; they play a crucial role in water quality improvement through their capacity to filter 30 to 60 gallons of water per adult oyster, per day; and, as a result of their sessile nature and adaptation to a wide salinity range, they function as key bioindicators of the relative health of aquatic ecosystems in bays, estuaries, and the tidal extent of coastal creeks.

Regrettably, according to a recent global assessment of oyster reef habitat (Shellfish Reefs at Risk) conducted by the Nature Conservancy and its partners, oyster reefs are one of and likely the most imperiled marine habitat on earth (Beck et al. 2009). The report estimates that about 85% of the earth's oyster reefs have been lost through stressors such as destructive fishing practices, coastal development activities such as dredging and filling, hydrological alterations, construction of dams, poorly managed agriculture, and urban development.

Because of their valuable attributes and the need for a comprehensive data set of oyster habitat, Sarasota County initiated a project to map different types of *Crassostrea virginica* (Eastern Oyster) habitat in county bays and creeks. In recent years, projects had been conducted by the Sarasota Bay Estuary Program, Charlotte Harbor National Estuary Program, Sea Grant, and Sarasota County to develop historical and current maps depicting the location and extent of oyster habitat in county bays. But, there had been limited efforts to map oysters in the county coastal creeks. The project was completed in 2013, and data collected will serve as a baseline to compare with future trends as watersheds are altered through development or restoration processes; to gage oyster die-off, displacement, or landward migration resulting from sea level rise associated with climate change; and to aid in the identification of restoration sites. Future oyster reef restoration projects may be the key to the long-term survival of oysters in the region especially as coastal waters rise as a result of climate change.

OYSTERS AND WATER QUALITY

While providing a wide range of ecosystem services, a highly important one is the association between healthy oyster reefs and water quality. Studies have shown that adult oysters have the capability of filtering between 30 and 60 gallons of water per day. During the filtration process, oysters remove phytoplankton and zooplankton (vital food sources) as well as suspended sediments and excess nutrients such as nitrogen and phosphorus. Nutrients are a necessary food source for plankton; however, excessive levels can result in harmful algae blooms, a reduction in water clarity, the depletion of dissolved oxygen which leads to fish kills, and an overall degradation of water quality. A recent study in the Choptank River in Maryland (Denitrification and Nutrient Assimilation on a Restored Oyster Reef) further supports the significance of the role that healthy oyster reefs play in water quality improvement. The study found that oyster reefs remove a considerable amount of nitrogen through the denitrification process. In fact, one acre of a restored reef was shown to remove up to 543 pounds of nitrogen per year (Kellog, et al 2013).

PROJECT LOCATION

Sarasota County is located on the southwest coast of Florida in the United States (**Figure 1**). Its coastline extends 35 miles along the Gulf of Mexico. Barrier islands running parallel to the shoreline create an elongated shallow lagoon system of nine contiguous bays that include: Sarasota Bay, Roberts Bay North, Little Sarasota Bay, Dryman Bay, Blackburn Bay, Lyons Bay, Dona Bay, Roberts Bay (Venice), and Lemon Bay. These bays are connected to the Gulf of Mexico by three inlets or passes (New Pass, Big Sarasota Pass, and Venice Inlets). See **Appendix A**.

Figure 1. Sarasota County Florida

Seventeen coastal creeks contribute freshwater flow to the estuaries. Whitaker and Hudson Bayous flow into Sarasota Bay; PhillippI Creek flows into Roberts Bay North; Matheny, Clower, Catfish, and North Creeks, and Elligraw Bayou flow into Little Sarasota Bay; South Creek flows into Dryman Bay; Shakett, Curry, and Hatchett Creeks flow into Dona and Roberts (Venice) Bays; and Alligator, Woodmere, Forked, Gottfried, and Ainger Creeks flow into Lemon Bay (**Appendix B)**.

PROJECT GOAL

The project goal was to produce detailed baseline maps of all oyster assemblage types in Sarasota County bays, estuaries, and coastal creeks.

PROJECT OBJECTIVES

The project objectives were to: 1) Locate and characterize the different types of oyster assemblages; 2) Create detailed baseline maps; 3) Develop "on-the-ground" rapid mapping techniques to complete the mapping process within a reasonable time frame; 4) Develop a Methods and Procedures Manual to allow duplication of efforts in other areas **(Appendix C)**; 5) Identify upstream extent of oyster populations in coastal creeks; 6) Interpret the data using GIS methodology; and 7) Analyze the data to identify potential habitat restoration sites.

To accomplish the goal, the project objectives were divided into three phases: Phase 1 – Project Design; Phase II – Mapping; and Phase III – GIS Analysis and Data Management.

PHASE I. PROJECT DESIGN

The project design consisted of the following elements: 1) Habitat identification and characterization; 2) Study area selection and prioritization; 3) Mapping timetable; 4) Materials and methods; and 5) Mapping procedures. For cost effectiveness, the project was designed to be conducted "in-house" using existing resources with minimal staff time.

<u>Habitat Identification and Characterization</u>

It was first necessary to identify and characterize the different habitats to be mapped and develop habitat characterization codes for documentation and data management. The project habitat codes were modeled after an oyster bar mapping project conducted in Tampa Bay by the Florida Fish and Wildlife Research Institute for the Tampa Bay Estuary Program (O'Keife, et al. 2006). While the TBEP effort focused on oyster reefs, mangrove root oysters, shell, and clumps, the county effort included those and went a step further to add seawalls, riprap, pilings, and floating docks (**Table 1**).

Table 1. Oyster Habitat Characterization Codes

Habitat Characterization Codes	
Habitat	**Code**
Shell	S
Scattered Shell	SS
Oyster Clumps	C
Scattered Oyster Clumps	SC
Oyster Reef	R

Habitat Characterization Codes	
Habitat	**Code**
Oyster Clumps/Reef	CR
Mangrove Apron	MA
Mangrove Root Oys.	MRO
Seawall	SW
Riprap	RR

<u>Study Area Selection and Prioritization</u>

Since mapping oyster habitat was a new endeavor, staff determined that it would be easier to begin in the coastal creeks to test the methods and make any improvements before moving into the bays. Most of the oyster habitat in Sarasota County is intertidal, and the creeks are fairly narrow and shallow; therefore, ideal mapping conditions required using a shallow draft vessel at the lowest tide possible and clear weather with minimal wind. The most favorable tides were daytime negative low tides, which occurred in the fall and winter between the months of October and February. Also, since the wet season ends in November, the water is typically clearer during those months allowing for better visibility. Creeks were prioritized and scheduled according to the dates of the optimal daytime negative low tides. There were two exceptions to the low tide rule. North and Catfish Creeks share a common mouth which can only be accessed through a narrow, shallow mangrove tunnel at a two-foot high tide. Those creeks had to be mapped during an outgoing tide.

PHASE II – CREEK MAPPING

Mapping Timetable

There were only a few days with early morning negative low tides available each month to work. Since mapping could only be performed a few months out of the year and staff didn't know exactly how long it would take to map each creek, a timetable could only be estimated at first. Mapping was scheduled to begin on an outgoing tide one hour before slack low. This allowed an approximate mapping window of about 5 hours. After the first creek was mapped, staff discovered that some of the creeks could be mapped in pairs in one day, depending upon the proximity of creeks and upper extent of the oyster habitats. This worked out well for a some, but Phillippi, South, Forked, Gottfried, and Ainger Creeks required 1 full day, and Shakett Creek required 2 days to map. Mapping began in October 2008, and fifteen creeks were completed in twelve days over the next four months. North and Catfish Creeks were mapped in one day in April 2009 during the optimal daytime high tide.

Materials and Methods

A brief description of materials and methods is provided in this section. The *Methods Manual for Field Mapping of Oysters* (**Appendix C**) contains more detailed information.

Staff created aerial maps of the shorelines of each creek in ArcMap at a scale of 1:550 or 1:700 and set up for legal-sized paper. The first map began at the mouth of the creek on the right shoreline (as one faces upstream). Subsequent maps slightly overlapped the previous ones by lining up distinct landmarks. Since the upper extent of the oyster coverage was unknown, creek salinity data were used to approximate how far upstream the team could expect to find oysters. The maps were created to continue a short distance past that point; maps of the opposite shoreline were created from that point back down to the mouth. Where the creeks were narrow, both shorelines could be captured on the same map. They were then laminated to provide a surface on which to draw the habitats and record the codes.

In addition to the habitat characterization codes (**Table 1**), further classifications of seawall and riprap oysters were needed for future quantification because of the various differences in vertical band heights, coverage, and thickness. Codes for the vertical height of the band and the thickness of the oysters on the band are shown in **Table 2**. Coverage is reflected in solid and broken lines, with a solid line denoting continuous coverage and a broken line indicating non-continuous coverage. Field logs on which to record other data, including the coordinates of the upstream extent of the habitat, and to use as a guide for the coding system were then created. **Figure 2** contains photographs of some of the oyster types.

Table 2. Seawall/Riprap/Piling Classification Codes

Seawall/Riprap/Piling Classification Codes			
Band Height	**Layer**	**Abundance**	**Code**
≤ 6"	1	Sparse	SW-1/RR-1/P-1
> 6"< 12”	>1	Light	SW-2/RR-2/P-2
> 12" < 18”	>1	Medium	SW-3/RR-3/P-3
- >18"	>1	Heavy	SW-4/RR-4/P-4

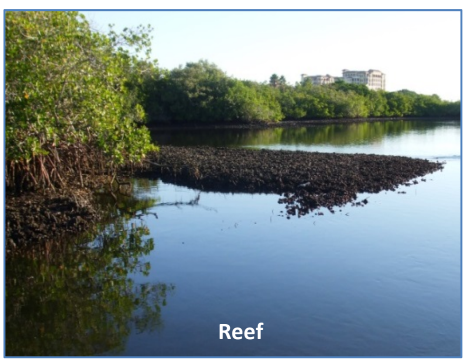
Figure 2. Oyster Types


Seawall: SW-1


Seawall: SW-2


Seawall: SW-3


Seawall: SW-4


Reef


Mangrove Apron


Mangrove Root Oyster

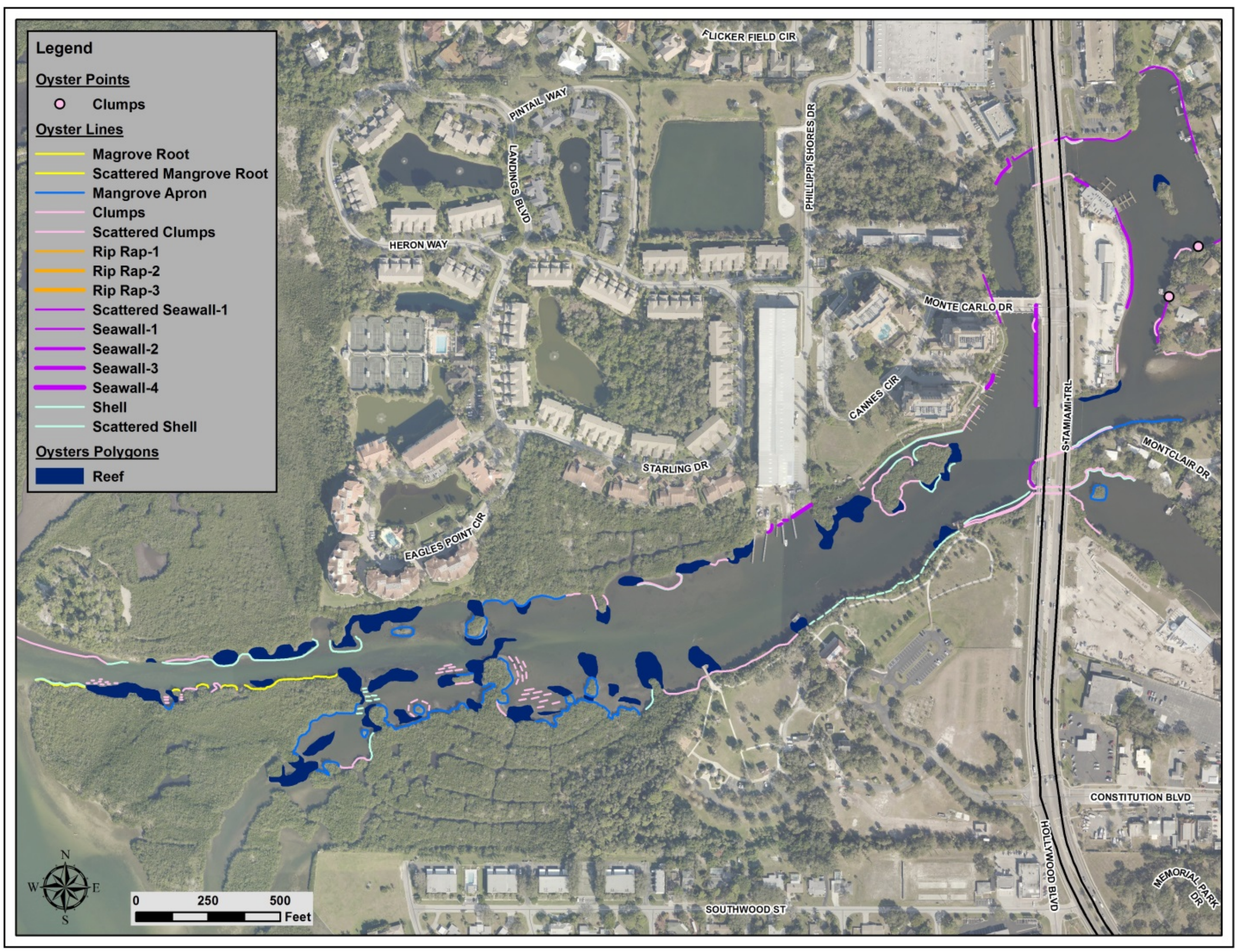

Piling: P-2

Mapping Procedure:

Mapping required a two-person team: the boat captain and the person mapping. The team began at the mouth and progressed slowly upstream while mapping the starboard (right) bank, including any inlets and

canals. Permanent markers were used to draw all habitats on the laminated maps: Points were used for pilings; polygons were used for reefs and areas of scattered shell or clumps; and lines were used for seawalls and riprap. The corresponding habitat code was also recorded for each. For example, SW-1 with a solid line denotes a continuous band sparse oysters occurring in a single layer and equal to or less than 6 inches in height. After reaching the farthest point upstream that contained oyster habitat, the team recorded coordinates of the upstream oyster extent and turned around and followed the same procedures for the opposite bank back down to the mouth. The drawback to this method was that it required "duplicate effort" since the data had to be manually transferred to aerials in ArcMap. An example of a map with the initial creek data drawn in ArcMap and codes is shown in **Figure 3**.

Figure 3. Phillippi Creek Initial Oyster Data



Mapping Results

The population distributions for each oyster type and total acres in each creek are contained in **Table 3**. **Figures 4** and **5** graphically depict the total acreage in the creeks.

Table 3. Creek Oyster Population Distributions and Total Acreage

Creek	Reef	Seawall	Rip/Rap	Mangrove Apron	Mangrove Root	Piling	Clumps	Shell	Total Acres
Whitaker Bayou	0.000	0.243	0.019	0.000	0.000	0.000	0.036	0.038	0.337
Hudson Bayou	0.294	0.151	0.000	0.000	0.033	0.001	0.153	0.089	0.721
Phillippi Creek	3.439	0.151	0.000	0.506	0.034	0.000	1.759	0.765	6.654
Matheny Creek	0.000	0.015	0.002	0.000	0.000	0.000	0.010	0.000	0.028
Clower Creek	0.000	0.000	0.000	0.000	0.036	0.000	0.015	0.010	0.061
Elligraw Bayou	0.000	0.180	0.000	0.000	0.002	0.001	0.019	0.000	0.202
Catfish Creek	0.255	0.000	0.000	0.000	0.014	0.000	0.155	0.000	0.423
North Creek	0.097	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.097
South Creek	0.531	0.036	0.334	0.735	0.171	0.001	0.866	0.045	2.720
Shakett Creek	7.995	0.114	0.470	0.024	0.027	0.008	1.883	0.516	11.038
Salt Creek*	0.000	0.004	0.006	0.000	0.000	0.000	0.134	0.003	0.147
Curry Creek	2.738	0.000	0.000	0.109	0.059	0.001	0.523	0.555	3.985
Hatchett Creek	0.067	0.070	0.003	0.000	0.001	0.001	0.060	0.047	0.250
Alligator Creek	1.096	0.003	0.000	0.842	0.019	0.004	0.596	0.179	2.740
Woodmere Creek	0.068	0.000	0.000	0.000	0.043	0.000	0.165	0.087	0.363
Forked Creek	0.298	0.347	0.004	0.021	0.068	0.001	0.252	0.294	1.286
Gottfried Creek	3.025	0.465	0.189	0.736	0.078	0.000	0.349	0.145	4.988
Ainger Creek	1.721	0.477	0.245	0.075	0.040	0.005	0.249	0.017	2.829

***Flows to Shakett Creek**

Figure 4. Sarasota County Creek Oyster Acreage – North to South

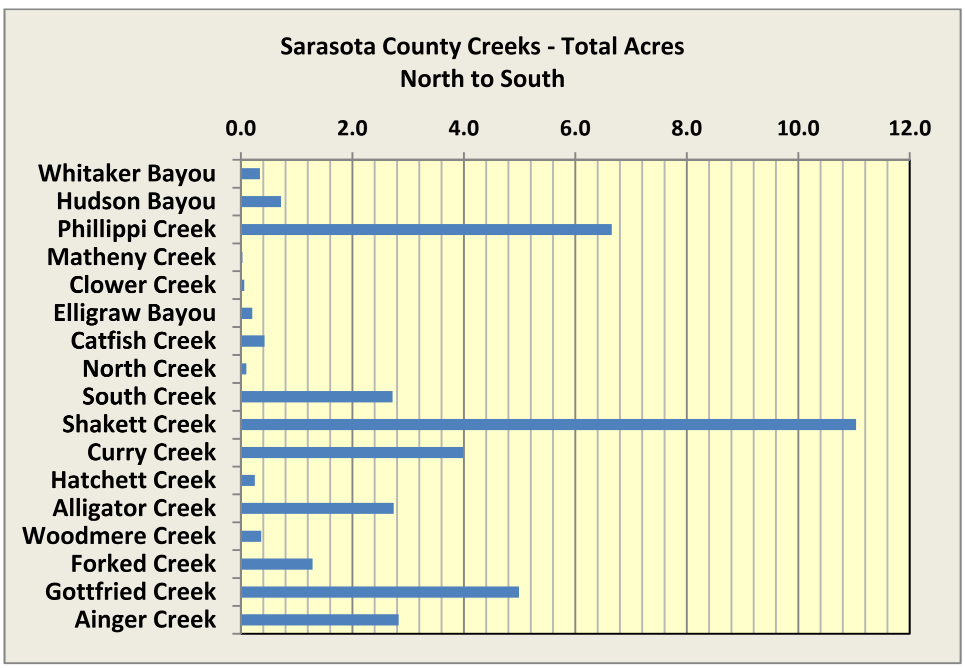
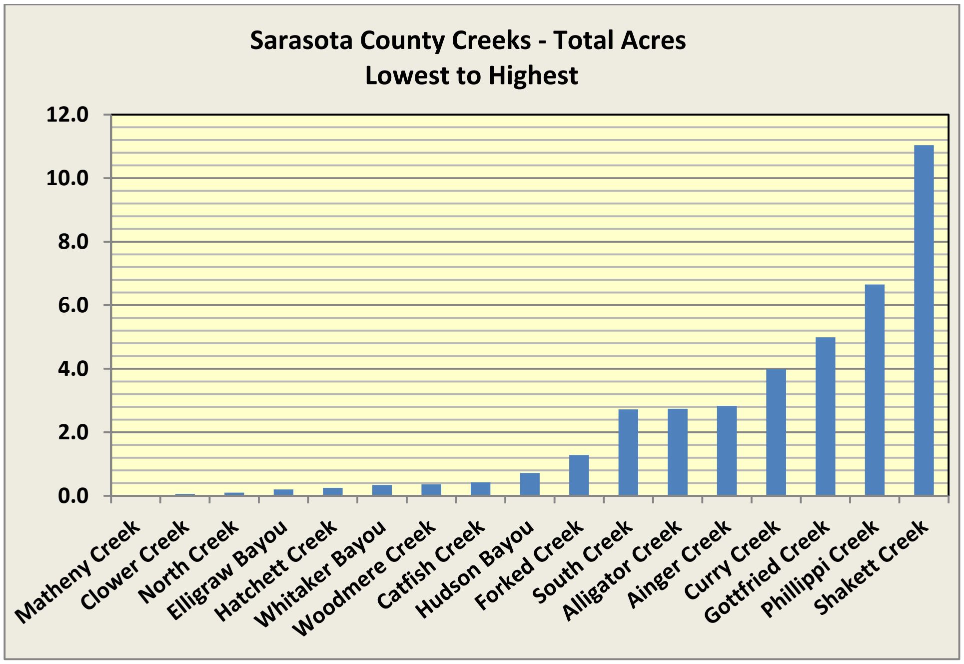


Figure 5. Sarasota County Creek Oyster Acreage – Lowest to Highest



PHASE II – BAY MAPPING

The project became an iterative process that evolved over time as new parameters were considered and technological advancements became available to county staff. After completing creek mapping, a Toughbook rugged laptop computer was acquired in 2010 for field use. The original drawing method was replaced by GIS methodology to map the bays and complete the project. Aerial maps of county bays were uploaded to the tablet computer, which allowed the mapper to draw the habitats directly into ArcMap on the computer's touch screen using either a stylus or a mouse. This eliminated the effort and cost of creating and laminating numerous shoreline aerial maps and the "duplicate effort" of re-drawing the data into ArcMap. For bay mapping, two habitat characterization codes were added to denote oyster habitat on floating docks and pilings, which were not prevalent in the creeks (**Table 4**).

Table 4. Revised Habitat Characterization Codes

Habitat Characterization Codes	
Habitat	**Code**
Shell	S
Scattered Shell	SS
Oyster Clumps	C
Scattered Oyster Clumps	SC
Oyster Reef	R
Oyster Clumps/Reef	CR

Habitat Characterization Codes	
Habitat	**Code**
Mangrove Apron	MA
Mangrove Root Oysters	MRO
Seawall	SW
Rip Rap	RR
Pilings	P
Floating Docks	D

Although the original intent was to determine the location of oyster habitat only, it was later decided that documenting oyster condition could be beneficial. Staff developed a coding system to represent the health of the oysters: Code 0 = mostly dead oysters; Code 1 = fairly even distribution of live and dead oysters and Code 2 = mostly live oysters. These were rapid visual assessments only. No *in situ* assessments using quadrats to collect and count the oysters and calculate percent live and dead were conducted.

Mapping Timetable

The process used for scheduling the bays was the same as the one used for the creeks. However, because of the expansive shorelines and numerous inlets, canals, seawalls, piers, and docks, two to three days of mapping were needed for each of the nine bays. Again, the bays could only be mapped during the fall and winter months during periods of daytime negative low tides. Mapping began in January 2011, and the nine bays were mapped over seventeen days through the winter of 2011 and fall and winter of 2012.


Boat Captain Jon Perry and GIS Analyst Jim Grimes

Materials and Methods

A brief description of materials and methods is provided in this section. The *Methods Manual for Field Mapping of Oysters* (**Appendix C**) contains more detailed information.

Materials included a Toughbook rugged laptop computer loaded with aerial maps of all of the bays, a laptop lap tray, mouse, and field logs. A power adapter was also needed to connect the laptop to the boat battery when the laptop battery ran low.

Mapping Procedure

Bay mapping also required a two-person team. The boat captain followed the same procedure as that for creeks by navigating closely along mainland and island shorelines, inlets, canals, boat basins, etc. The tablet was set up for editing the aerial maps directly onto the touch screen using three feature classes: polygons for reefs, areas of scattered shell, and areas of clumps; lines for seawalls, riprap, mangrove root oysters, and mangrove aprons; and points for pilings. The original plan was to alternate staff and/or use volunteers for the bay mapping. Since characterization could be somewhat subjective, staff decided that one person would do all of the mapping to maintain consistency in the data.

As with creek mapping, staff made several improvements to the process. The team quickly determined that drawing with the stylus was very difficult under choppy conditions; therefore, drawing with the mouse became the standard method. The keyboard was then used to type attributes such as the date, name of bay, habitat classification codes, and condition codes for each feature into the attribute table. The team also soon realized that using a single point for each piling became very time consuming because long docks and piers had many pilings, and recording the same data for each piling was not only redundant, but took a long time. The mapping method was changed to drawing a line down the center of the dock or pier and recording the data and number of pilings sharing the same attributes in the table. It was important to save the data often and keep an eye on the battery life so data would not be lost when switching over from the laptop to the boat battery.

As stated previously the major benefits of the new method were the significant savings in staff time and costs associated with creating and laminating shoreline aerial maps and re-drawing the data into ArcMap. Another benefit was the ability to use the Global Positioning System (GPS) in the computer for "real-time" tracking of the vessel, which allowed staff to see their location at all times. The only drawback to the new method was that the glare created by bright sunlight on the screen made it very difficult to see the aerials; so, it was necessary to keep the computer screen shaded as much as possible. Mapping was much easier during cloudy or completely overcast days.

PHASE III – GIS ANALYSIS AND DATA MANAGEMENT

For the final phase, a County GIS Analyst joined the team to analyze, interpret, and standardize the data for county-wide comparability and to help further refine the methods so they could be applied universally.

Before analysis began, it was necessary to "clean up" the dataset. The team did not have creek maps available during bay mapping to tell where the creek mapping left off and bay mapping began. Therefore, overlaps of creek and bay data at the mouths of the creeks had to be eliminated to avoid counting those areas twice. Accidental mouse clicks that created points or small line segments with no data were eliminated. Since coding for pilings had been added after creek mapping, 200 creek points were examined to identify piling points. Those points were then revisited; piling data were segregated and coded accordingly; and condition fields were added.

The first classification system (**Table 2**) was reorganized for better representation of the data (**Table 5).**

Table 5. Revised Classification System

Oyster Type	Habitat	Abundance
Reef	Seawall	Light
Apron	Riprap	Medium
Root	Mangrove	Heavy
Clumps	Pilings	Very Heavy
Scattered Clumps	Floating Docks	
Shell	Substrate	
Scattered Shell		

Eight types and two subtypes of oyster assemblages were identified during the mapping process: 1) Types: Reef, Mangrove Apron, Mangrove Root, Seawall, Riprap, Piling, Clumps, and Shell; 2) Subtypes: Scattered shell and Scattered Clumps. The use of the term habitat was appropriately changed to denote where the oysters were living and growing: Seawall, Riprap, Mangroves, Pilings, and Substrate. The four terms to denote oyster abundance (thickness) were also changed to Light, Medium, Heavy, and Very Heavy, which correspond with the thickness values displayed in **Table 6** later in the report. For example: root oysters grow in mangrove habitat, and the growth can be either light, medium, heavy, or very heavy; reef oysters, shell, and clumps occur in substrate; and clumps of oysters grow on seawalls, riprap, and pilings in either continuous or scattered formations. For those three, the abundance terms describe the thickness of the layers protruding horizontally out from the habitat.

During mapping, it was often impossible to draw contiguous lines for identical oyster types because the mapper had to stop drawing when panning to the next aerial view. This resulted in numerous line features with the same attributes. Adjoining lines having identical attributes were merged together; thereby, consolidating the data and reducing the number of features to work with. This provided a more continuous representation of what was there.

A new objective was added to develop a method to quantify the oyster types without having actual *in situ* measurements. To accomplish this, a final polygon layer was needed to estimate acreages for each oyster type. Polygons had already been created for reefs, shells, and clumps. A buffering system developed by the GIS Analyst was used to create polygons of specified widths around the lines and points for the other oyster types. It transformed the vertical areas of seawall, riprap, and mangrove root oysters and the horizontal areas of the mangrove apron oysters into polygons that produced a visual display of those types on the aerial. In other words, lines and points were converted into a polygon feature class which presents a better visual display of the data on an aerial map. This allows for a rough estimate of oyster coverage (acreage) across habitat type. Volume can also be calculated for those oyster types that were assigned a thickness value (**Table 6**). First, numeric values based on field observations during mapping were assigned to the original height and layer values (**Table 2**) for seawall, riprap, and piling oysters. These values were stored in the attribute table. The lines were then buffered on each side by ½ of the height (buffer distance) to produce a polygon width equal to the original height (**Table 6**). For example, the line for SW-1 oysters having a total band height of 6" has a buffer distance of 3" on each side for a total polygon height of 6". Average values for the mangrove root oyster heights and mangrove apron widths were also assigned, and those lines were also buffered on each side by the buffer distance. The attribute table was set up to automatically calculate the area of the polygons using the assigned values.

Table 6. Values for Height, Thickness, and Buffer Distance

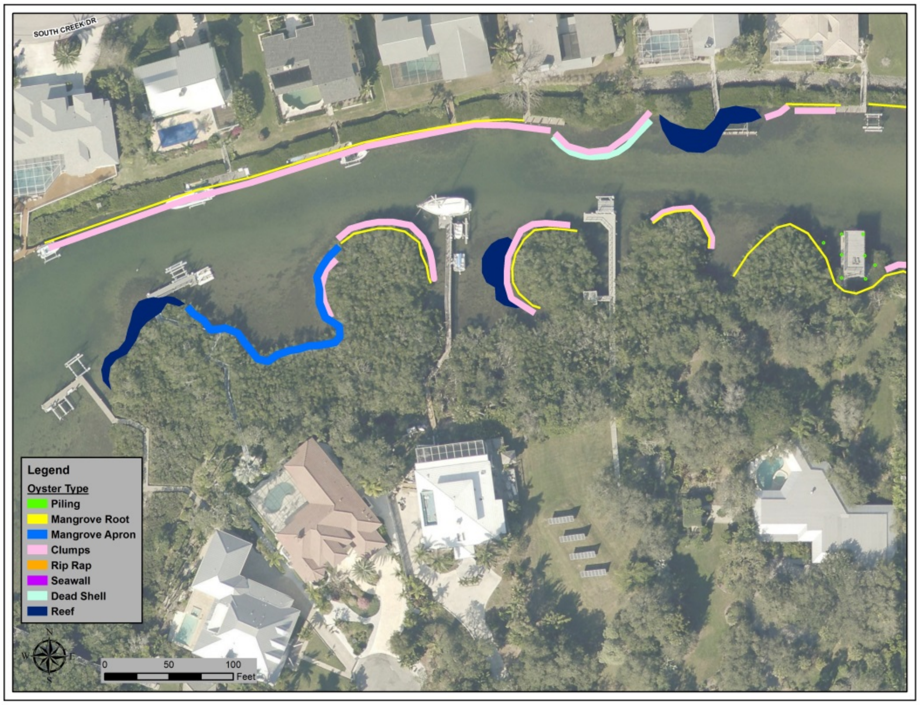
TYPE	HT (IN)	HT (FT)	THICKNESS (IN)	THICKNESS (FT)	BUFFER DIST (IN)	BUFFER DIST (FT)
SW/RR-1	6	0.5	2	0.17	3	0.25
SW/RR-2	12	1.0	6	0.50	6	0.50
SW/RR-3	18	1.5	9	0.75	9	0.75
SW/RR-4	24	2.0	12	1.00	12	1.00
P-1	6	0.5	4	.33	3	0.25
P-2	12	1.0	8	.75	6	0.50
P-3	18	1.5	12	1.00	9	0.75
P-4	24	2.0	16	1.33	12	1.00
MRO	18	1.5	N/A	N/A	9	0.75
MA	72	6.0	N/A	N/A	36	3.0

The piling points were treated differently. As stated previously, piling oysters were first drawn as points using the same data codes as seawall and riprap oysters. To save time, the mapping method was changed to drawing a line down the center of the dock or pier and recording the number of pilings with the same attributes in the number field of the attribute table. The lines were converted back into points by running a python script to distribute the piling points evenly along the length of the dock line. To buffer the point and calculate the oyster area, the piling had to be removed from the equation. It was determined that the average dimensions of pilings in the area were: Circumference – 28"; diameter – 8.91"; and radius – 4.46". From these dimensions, the area of the piling was calculated as 62.46 square inches. For visual purposes, the piling point was buffered by the piling radius to create a polygon of the footprint of the piling. The piling polygon was then buffered using the thickness and buffer distance values. The piling polygon was then removed which created a polygon that resembled a donut. **Figure 6** displays the visual representations of the buffered pilings on the aerial.

Figure 6. Buffered Pilings

Figure 7 displays the visual representations of polygons created through buffering of Mangrove Aprons, Mangrove Root Oysters, Clumps and Shell on the aerial.

Figure 7.

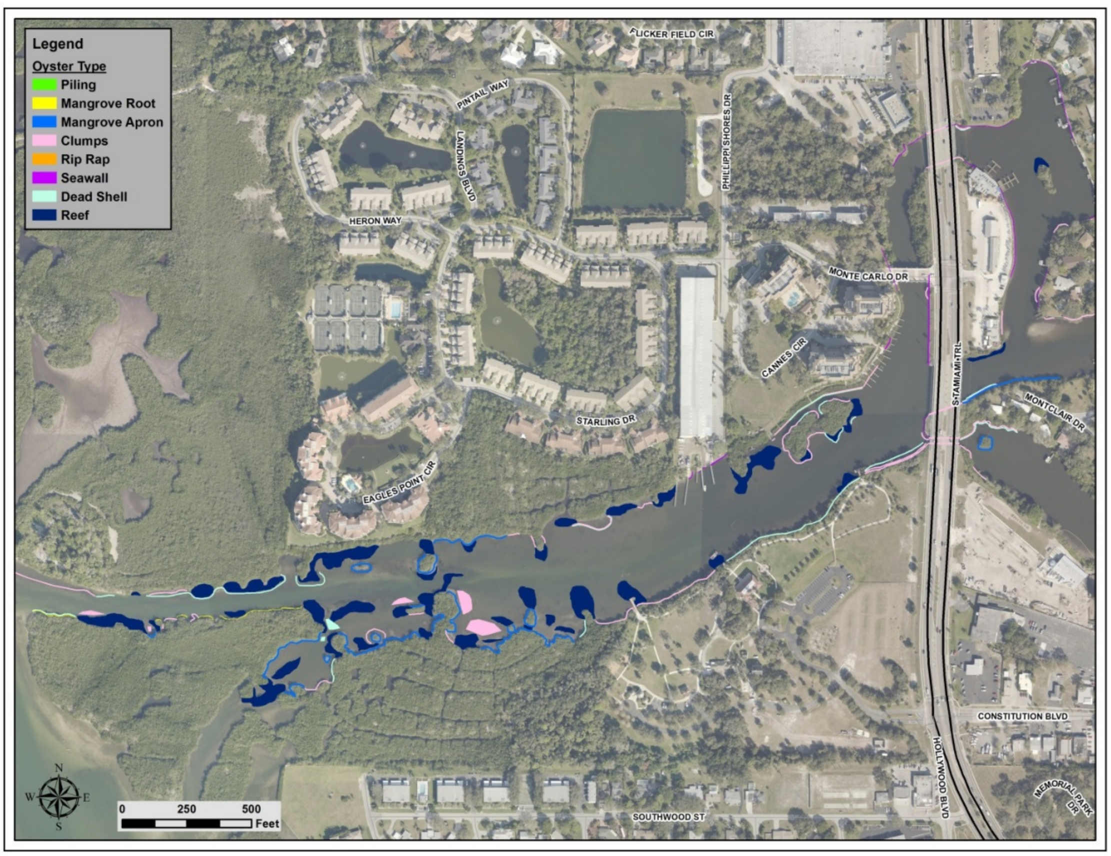


Thickness values represent the distance the layers protrude from the habitat. These values can be used to estimate the volume of the oysters. During mapping, the thickness of the piling oyster layers was observed to be slightly greater than that of seawall and riprap oysters; therefore, those values were adjusted accordingly.

A minor issue arose regarding the overlapping of some of the buffered areas on the aerials. For example, the mangrove root oyster buffers may overlap and visually hide a portion of a mangrove apron or an area of clumps or shells because of their close proximity. A hierarchy based on position was developed to determine which layer type would be on top and show on the aerial. The hierarchy from top to bottom was: seawall, riprap, reef, mangrove apron, mangrove root oysters, clumps, and shell. This is only for visual representation on the aerial and does not affect the data or calculations.

Since all data was converted to a polygon feature class, graphical representation of the data differs from how it was originally displayed. The initial data is shown in the map of the mouth of Phillippi Creek in **Figure 2.** For comparison, **Figure 8** displays the new polygon layer in a map of the same area of Phillippi Creek. As usual in ArcMap, clicking on a polygon using the identify tool will bring up a table with all of its geographic features. Geographic Features include: FID, Location, Oyster Type, Habitat Type, Condition (where recorded), Band Height and Thickness (seawall, riprap, and pilings), Buffer Distance (seawalls, riprap, pilings, mangrove aprons, and mangrove root oysters), Date Collected, Waterbody Name, and Area in acres.

Figure 8
Phillippi Creek Final Oyster Data



Mapping Results

The population distributions for each oyster type and total acres in each bay are contained in **Table 7**. **Figures 9** and **10** graphically depict the total acreage in the nine bays.

Table 7. Bay Oyster Population Distributions and Total Acreage

Bays	Reef	Seawall	Rip/Rap	Mangrove Apron	Mangrove Root	Piling	Clumps	Shell	Total Acres
Sarasota Bay	3.237	2.833	0.328	0.000	0.294	0.148	0.236	0.135	7.211
Bayou Louise*	0.000	0.058	0.000	0.000	0.006	0.000	0.016	0.000	0.081
Roberts Bay Sarasota	3.891	1.442	0.085	0.145	0.634	0.015	0.243	0.225	6.680
Grand Canal**	0.020	2.170	0.037	0.000	0.022	0.003	0.002	0.000	2.254
Hanson Bayou***	0.000	0.099	0.001	0.000	0.047	0.002	0.000	0.000	0.149
Nettie Bayou***	0.038	0.046	0.000	0.000	0.038	0.009	0.017	0.000	0.147
Little Sarasota Bay	13.039	1.326	0.098	0.869	0.758	0.061	1.076	0.151	17.377
Dryman Bay	1.045	0.029	0.005	1.349	0.098	0.007	0.016	0.006	2.554
Blackburn Bay	0.614	0.472	0.180	0.030	0.269	0.121	0.398	0.028	2.112
Lyons Bay	2.397	0.258	0.001	0.020	0.132	0.038	0.000	0.000	2.848
Dona Bay	0.539	0.111	0.029	0.054	0.049	0.026	0.542	0.000	1.351
Roberts Bay Venice	0.555	0.381	0.097	0.000	0.120	0.042	0.285	0.012	1.492
Lemon Bay	4.787	0.780	0.160	0.459	1.004	0.029	0.394	0.121	7.732
Red Lake****	0.027	0.005	0.001	0.000	0.170	0.000	0.007	0.007	0.217

* Small bayou tidally influenced by Sarasota Bay
**Extensive canal system flowing to Roberts Bay Sarasota
***Bayous tidally influenced by Roberts Bay Sarasota
****40 acre lake connected to north Lemon Bay

Figure 9. Sarasota County Bay Oyster Acreage – North to South

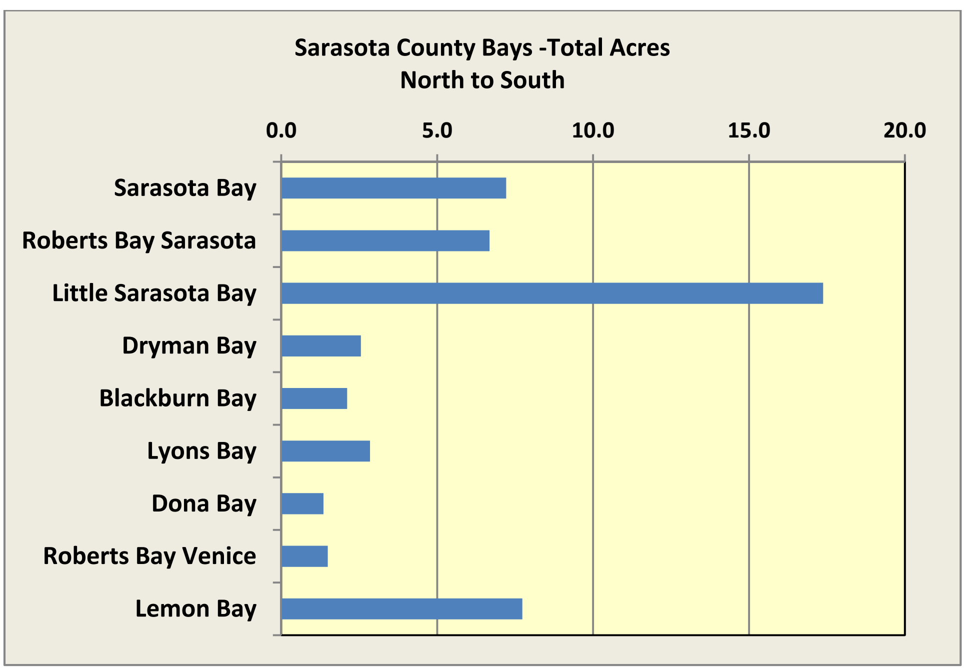
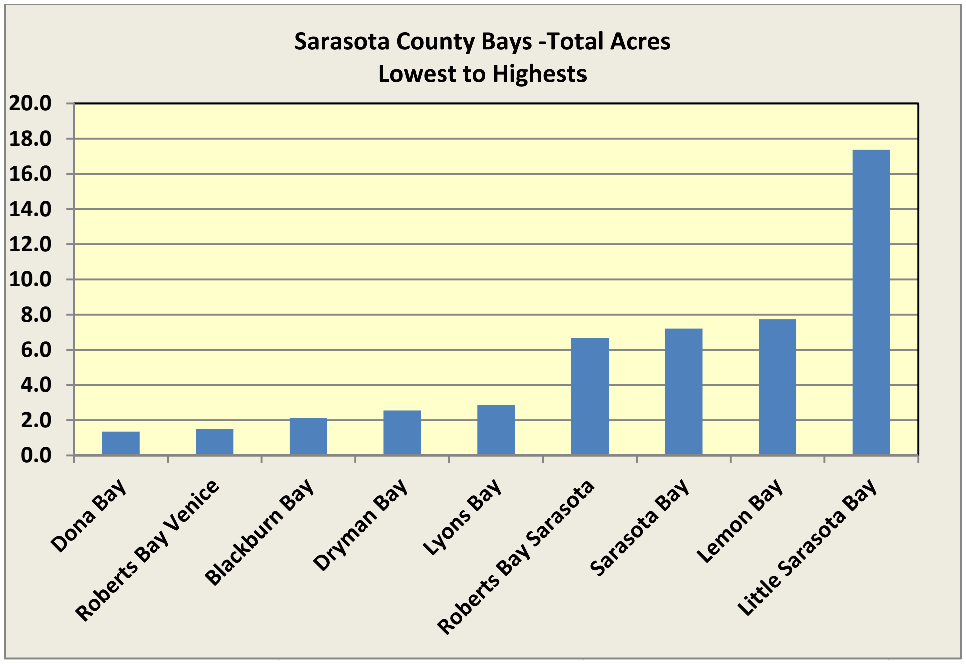


Figure 10. Sarasota County Bay Oyster Acreage – Lowest to Highest



OBSERVATIONS AND DISCUSSION

Where bottom substrate does not adequately support healthy oyster populations, oyster larvae settle on other surfaces such as red mangrove prop roots, vertical seawalls and bulkheads, riprap revetments, docks, and pilings. However, the team observed varying degrees of recruitment and persistence among those alternative surfaces.

- Oysters have recruited profusely on vertical concrete seawalls, piers, and pilings and serve as a distinct delineator of the intertidal zone.

- Oysters appear to favor concrete seawalls over riprap. Contrary to the results of a Virginia Institute of Marine Research study which indicates that oysters thrive on riprap in the lower Chesapeake Bay area. (The Virginian-Pilot 2006), the opposite was observed in Sarasota County waters. Oyster populations were more dense along seawalls and were either very sparse, dead, or totally absent from riprap revetments, even where riprap shorelines were adjacent to or between seawalls and docks with healthy oysters (spat source). Several theories were offered to explain the trend: 1) The crevices allow predators to hide among the rocks and consume the larvae before settlement; 2) To escape predation, the larvae settle so far down into the crevices that they can't receive an adequate food supply, and prolonged exposure at low tide could deprive them of adequate nutrients and oxygen; 3) Since the oysters on the riprap were small and in a single layer, the settling larvae are not afforded the protection from predators and strong currents that multiple layers and large clusters provide; and 4) The rocks provide a platform for birds and wildlife to easily access and eat the juvenile and adult oysters.

- Conversely, acorn barnacles were very common on riprap. Where both were present, the barnacles were usually located in the high intertidal zone above the oysters, and the oysters were very sparse or, more often, dead. The prevalence of barnacles offers additional theories about the paucity or absence of oysters: 1) Barnacles and oysters, as sessile and filter feeding organisms, compete for space and food (Boudreaux et al. 2009); 2) Barnacles are crustaceans encased in a case composed of six solid wall plates which may offer the barnacle more protection from predators; 3) The wall plates, when closed, retain moisture which keeps the barnacle from drying out at low tide, especially when exposed to sunlight (Rainbow n.d.); 4) Barnacles can obtain oxygen from both the air and underwater (Cowles 2005), which could allow them to survive longer at low tide. 4) The presence of barnacles either directly (interference or exploitative competition) or indirectly decreases both the growth rate and survival of *Crassostrea virginica*; therefore, the larvae should avoid settling in locations near barnacles (Boudreaux et al. 2009).

- Oysters were not present on metal seawalls and bulkheads. Similarly to riprap, metal seawalls totally devoid of oysters would be located between concrete seawalls with healthy oysters (spat source). One theory is that the surface is too smooth for the larvae to get a good "grip" for permanent attachment. It was also thought that the larvae could be displaced or detached by strong currents and tides since metal lacks a porous surface such as concrete that appears to be more conducive to larval attachment. This theory is supported by a study conducted in Mosquito Lagoon, an estuary on the east coast of Florida, USA (Boudreaux et al.2009). The study, which compared the effects of sediment and flow rate on oyster and barnacle settlement, concluded that oyster settlement rates are higher in still water and both suspended sediments and increased flow rates decreased oyster recruitment.

- Oysters were not present on pile wrap, a black high density polyethylene material wrapped around the bases of pilings to obstruct boring animals such as ship worms (*Teredo navalis*). Ship worms (saltwater clams) are "termites of the sea" that bore into and destroy submerged wood such as wooden ships and pilings. The same assumptions as those for metal seawalls could also apply here: The surface is too smooth for the oyster larvae to get a good "grip" for permanent attachment. It was also thought that the larvae could be displaced or detached by strong currents and tides since the material lacks a porous surface, such as concrete, that appears to be more conducive to larval attachment. In addition, sensory regions on the foot of the larvae allow them to "taste" and test the substratum as they crawl around searching for a suitable settling place (Carefoot 2010). Using

physiochemical “cues” (USACE), the larvae may be repelled by a combination of the physical properties (mentioned above), and the chemical make-up of the material causing them move on to find more desirable substrata.

- Unlike oysters, acorn barnacles were common on both metal seawalls and bulkheads and pile wrap. As previously discussed, oysters were totally absent from those substrata while acorn barnacles appeared to thrive. Barnacles appear to be able to settle on a wider variety of substrata. They do not avoid smooth surfaces, as demonstrated by their affinity to submerged fiberglass and wooden boat hulls. They are also able to withstand stronger currents, tides, and boat wakes. In fact, their hard shells and shape better resist wave action (Rainbow n.d.). Also, barnacle larvae can settle at increased flow due to boat wakes or storms which gives them a competitive edge over *C. virginica* larvae; thus, continuous boat traffic during settlement periods favors recruitment of barnacles over the oyster (Boudreaux et al. 2009).

CHALLENGES

There were a few challenges identified during the oyster mapping project:

1. Creating and laminating creek shoreline aerial maps.

   A significant amount of staff time was spent creating and laminating the aerial maps of the shorelines of the seventeen creeks. In addition, laminating supplies were an additional cost. Without knowing the exact upstream limit of tidal influence, staff had to estimate how far oysters would be found upstream and create shoreline maps accordingly. Using the tablet computer for the bay mapping eliminated this challenge.

2. Scheduling mapping days.

   Scheduling was a challenge because early morning negative low tides occurred only two weeks per month during a few months out of the year. Many of the best low tides occurred on weekends when staff was unavailable. So, there was a limited window of opportunity to map during those time periods. Inclement weather was also a factor, since the available months were during the winter when fronts brought cold temperatures and rough seas. Also, since the project was conducted “in-house”, coordinating staff time on the optimal dates was sometimes difficult.

3. Developing a method to quantify areal extent.

   Even though quantifying oyster habitat was not an initial objective of the project, it was determined that finding a way to estimate coverage using GIS could be useful. In the absence of actual measurements, staff recognized that developing a way to quantify the different habitats would be a challenge for the GIS analyst. A buffering system to provide a reasonable estimate of coverage was developed as explained in the Phase III GIS Analysis and Data Management Section.

4. Adapting to changes in the project

   Since the project was an iterative process, staff was able to identify and eliminate processes that didn’t quite work, add new parameters from field observations, and modify or make improvements on the proven methods. This was often challenging because it often added more time to the project, modifications to the tablet editing tools were necessary, and staff couldn’t go back and add the new parameters to the areas already mapped, which created data gaps.

LESSONS LEARNED

Staff found that it would have benefited the project to invite the GIS analyst to participate from the beginning. The GIS analyst would have been able to make recommendations regarding mapping procedures that would make data analysis and interpretation easier to represent in GIS.

The latest technology should be investigated and used in the mapping process from the beginning also. The project would have not only been easier and less time-consuming, but the data would be more consistent between creeks and bays if the tablet computer had been available from the beginning.

Since the creeks were mapped first (drawn on aerial maps), the data were not available in the tablet computer when the bays were mapped. Those feature classes should have been included on the bay aerials to show exactly where creek mapping stopped. This would have eliminated data redundancy, since bay features sometimes overlapped the creek features at the mouths of the creeks. Those data had to be identified and removed during analysis.

Initially, staff thought that volunteers could be used to help with the mapping once the methods and procedures were fine tuned. Even though specific parameters were well defined, staff soon realized that some subjectivity could be involved. It was decided that the actual drawing should be done by one person to ensure more consistent data collection and to eliminate the risk of variations resulting from the potentially diverse interpretations of the parameters.

CONCLUSION

The goal of the project and all objectives were achieved: 1) Locate and characterize the different types of oyster assemblages; 2) Create detailed baseline maps; 3) Develop “on-the-ground” rapid mapping techniques to complete the mapping process within a reasonable time frame; 4) Develop a Methods and Procedures Manual to allow duplication of efforts in other areas **(Appendix C)**; 5) Identify upstream extent of oyster populations in coastal creeks; 6) Interpret the data using GIS methodology; and 7) Analyze the data to identify potential habitat restoration sites.

Because of the many valuable attributes and ecosystem services oysters provide, it is important to have a current comprehensive habitat data set. The maps provide a good baseline dataset of the locations and types of oyster habitat in Sarasota County creeks and bays. The maps can be compared with future assessments to determine habitat loss or gain throughout the county. They can also be used to compare with future trends as watersheds undergo alterations through development, installation of stormwater Best Management Practices (BMPs) and Low Impact Development (LID) components, restoration efforts, and catastrophic events such as hurricanes and floods. They will also be useful to determine the impacts of sea level rise associated with climate change.

An important advantage of the project is that the methods developed may be used to map oyster habitat all over the world. Those desiring to map oyster habitat may be able to further improve upon the methods, data collection, and data analysis. The project was also highly cost-effective since it was conducted “in-house” with minimal staff time and was able to be completed in just a few years

The major drawback with using rapid mapping methods is that time cannot be spent delineating and collecting *in situ* measurements to quantify areal coverage or collect accurate data regarding oyster health and spat recruitment. However, since the maps may be used to help locate potential enhancement and/or restoration sites, time can be spent at selected sites to collect more detailed data such as size, percent live, percent dead, number of spat, etc. Additional data can also be collected to determine the suitability of the site for successful restoration or enhancement.

ACKNOWLEDGMENTS

Project Team: John Ryan, Environmental Manager; Kathryn L. Meaux, B.S., PMP, Project Manager; James D. Grimes, Jr., B.S, GISP; Jon S. Perry, B.S., GISP; and Rene A. Janneman, B.A., ESIII.

The project would not have been possible without the assistance of highly capable boat captains, Rene Janneman and Jon Perry, who were able to maneuver through very shallow waters and narrow finger canals as well as help with identification; Jon Perry, who developed the aerials maps in ArcMap and drawing capabilities on the tablet computer for real-time mapping of the bays; and Jim Grimes, GIS Analyst, who joined the team to analyze and interpret the data and developed a method of quantifying the oyster types. Staff members who also provided assistance were Mike Jones, Joe Kraus, and Amanda Dominguez.

All photographs, unless otherwise credited, were taken by the author.

Information about the project, maps, and data can be found on the Sarasota County Florida Water Atlas at: http://www.sarasota.wateratlas.usf.edu/oysters/

.

LITERATURE CITED

Beck, M.W., R.D. Brumbaugh, L. Airoldi, A. Carranza, L.D. Coen, C. Crawford, O. Defeo, G.J. Edgar, B. Hancock, M. Kay, H. Lenihan, M.W. Luckenback, C.L. Toropova, G. Zhang. 2009. *Shellfish Reefs at Risk: A Global Analysis of Problems and Solutions.* The Nature Conservancy, Arlington, VA. 52 pp.

Boudreaux, Michelle L., L. J. Walters, D. Rittschof. 2009. *Interactions Between Native Barnacles, Non-Native Barnacles, and the Eastern Oyster Crassostrea Virginica.* Bulletin of Marine Science. Vol. 84(1): 43-57. Miami, Florida.

Carefoot, Tom. Learn About Oysters: Settlement and Metamorphosis. *A Snail's Odyssey*. 2010. Web. 1 April 2015. http://www.asnailsodyssey.com/LEARNABOUT/OYSTER/oystSett.php

Cowles, David. *Balanus glandula*. Walla Walla University. 2005. Retrieved April 2, 2015 from http://www.wallawalla.edu/academics/departments/biology/rosario/inverts/Arthrooda/Crustacea/Maxillopoda/Cirripedia/Balanus_glandula.html

Kellogg, M. Lisa, J.C. Cornwell, M.S. Owens, K.T. Paynter, 2013. *Denitrification and Nutrient Assimilation on a Restored Oyster Reef.* Marine Ecology Progress Series. Vol. 480: 1-19.

Life History and Biology: Veliger Stages. (n.d.). Retrieved April 1, 2015, from http://el.erdc.usace.army/mil/zebra/zmis/smishelp4/veliger stages.htm

Mandagere, Nagapramod. *Buffering in Geographical Information Systems*. University of Minnesota (n.d.). Retrieved August, 21, 2015 from http://www-users.cs.umn.edu/.../pramod-enc-bib.doc.

O'Keife, Kathleen, W. Arnold, D. Reed, 2006. *Tampa Bay Oyster Bar Mapping and Assessment: Final Report to Tampa Bay Estuary Program.* Tampa Bay Estuary Program Technical Publication #03-06. Tampa, Florida. 38 pp.

Oysters are Writing Own Survival Manual. June 19, 2006. *The Virginian-Pilot.* Retrieved April 1, 2015 from http://hamptonroads.com/node/116231

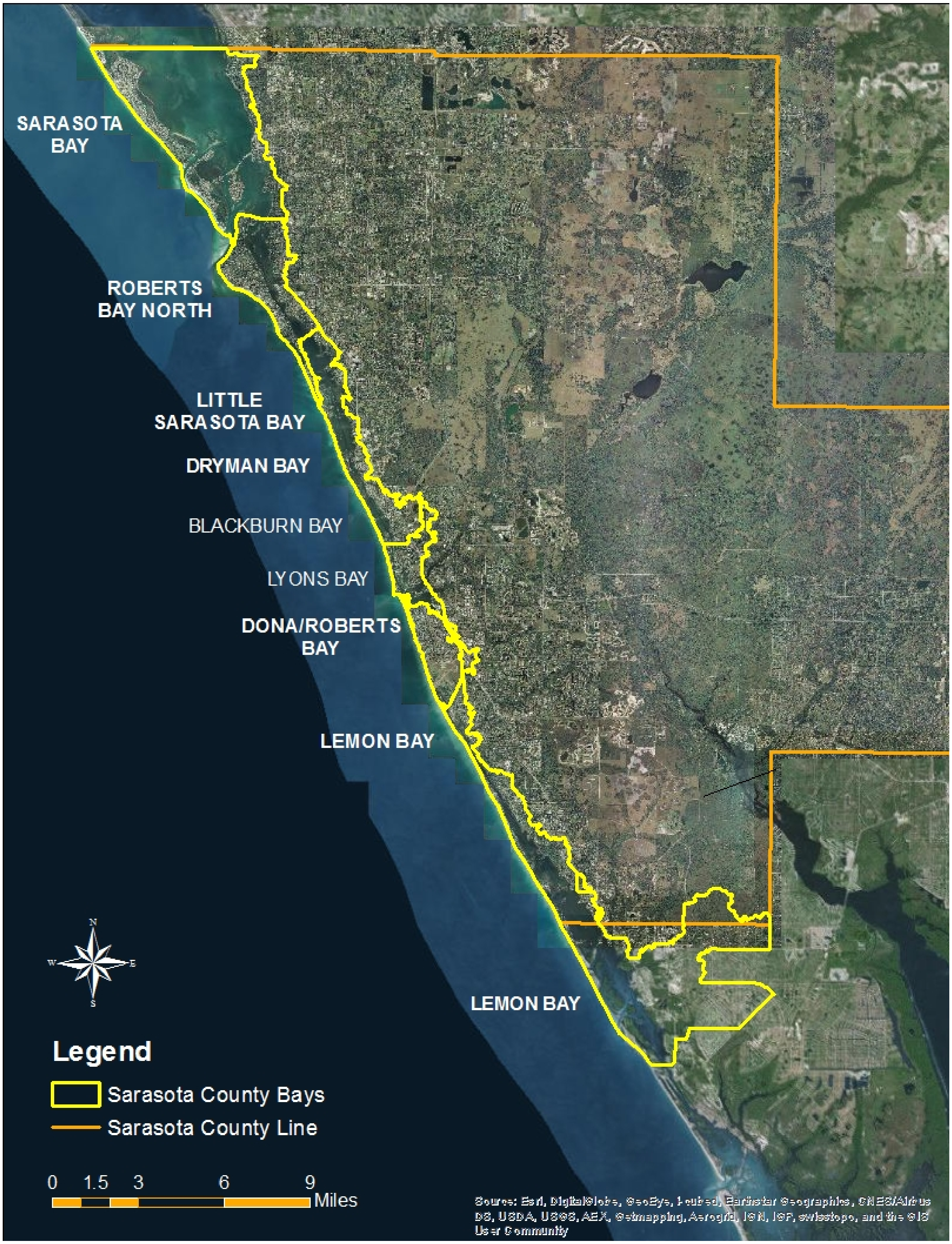
Rainbow, Phil. The Secret Life of Barnacles. (n.d.) *Natural History Museum.* Retrieved April 2, 2015 from http://nhm.ac.uk/resources/10feat-secret-life-of-barnacles-3061.pdf

Appendix A

Sarasota County Bays

THIS PAGE INTENTIONALLY LEFT BLANK

Figure 3. Sarasota County Bays



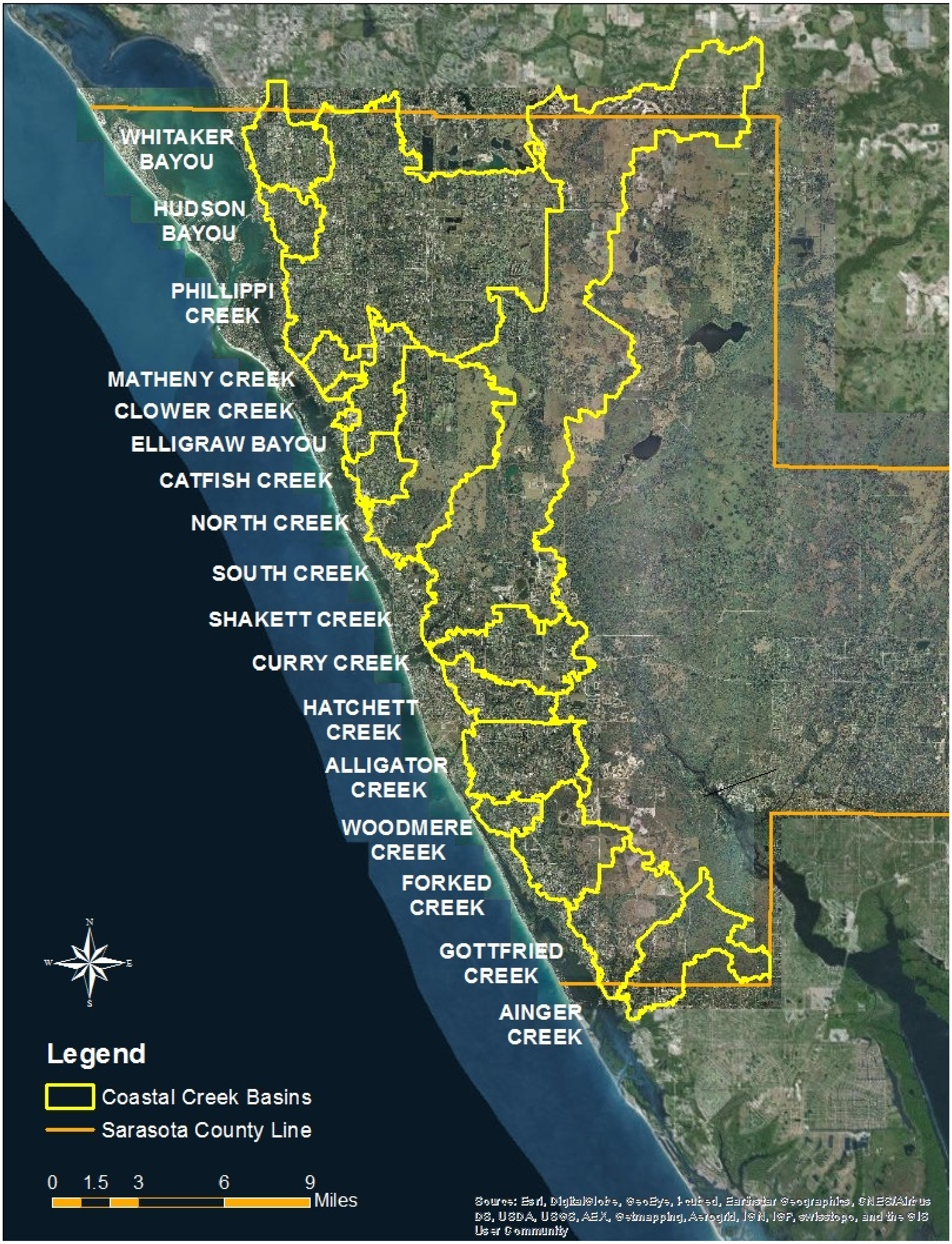
THIS PAGE INTENTIONALLY LEFT BLANK

Appendix B

Sarasota County Coastal Creeks And Basins

THIS PAGE INTENTIONALLY LEFT BLANK

Figure 4. Sarasota County Coastal Creeks and Basins



THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX C

Methods Manual for Field Mapping of Oysters

THIS PAGE INTENTIONALLY LEFT BLANK

SARASOTA COUNTY
WATER QUALITY PLANNING

METHODS MANUAL FOR FIELD MAPPING OF OYSTERS

January 1, 2011

Kathryn L. Meaux
Environmental Scientist

THIS PAGE INTENTIONALLY LEFT BLANK

INTRODUCTION

Oyster reefs are vital structural components of estuarine and bay ecosystems. Not only are they important commercial and recreational resources, they provide essential habitat and cover for numerous aquatic organisms; the larvae, spat, and adult oysters are an important food source for fish, birds, and other aquatic organisms; they play a crucial role in water quality improvement through their capacity to filter 30 to 60 gallons of water per oyster, per day; and, as a result of their sessile nature and adaptation to a wide salinity range, they function as key bioindicators of the relative health of aquatic ecosystems in bays, estuaries, and the tidal extent of coastal creeks. Because of these valuable attributes, it is important to have a current data set of oyster habitat locations throughout the county. These data will serve as a baseline to compare with future trends as watersheds are altered through development or restoration processes. They may also aid in the identification of potential restoration sites.

In recent years, projects have been conducted by the Sarasota Bay Estuary Program, Charlotte Harbor National Estuary Program, Sea Grant, and Sarasota County to develop historical and current maps depicting the location and extent of oyster habitat in county bays. Until now, there has been a limited effort to map oysters in the county coastal creeks. In Phase I of a county-wide oyster mapping effort during late 2008 through early spring 2009, Sarasota County Water Quality Planning staff developed methods and effectively mapped oyster habitat in 17 county coastal creeks: Whitaker Bayou, Hudson Bayou, Phillippi Creek, Matheny Creek, Elligraw Bayou, Clower Creek, Catfish Creek, North Creek, South Creek, Shakett Creek, Curry Creek, Hatchett Creek, Forked Creek, Gottfried Creek, and Ainger Creek. Phase II will entail recruiting volunteers to help map oyster habitat in all county bays.

This manual describes protocols and methods for mapping oyster habitats in county creeks, estuaries, and bays. These methods were based on Florida Wildlife Commission protocols used in Tampa Bay oyster habitat mapping efforts.

OBJECTIVES

The goals and objectives of the mapping project are:

- Develop current, detailed baseline maps of oyster habitat in Sarasota County bays, estuaries, and coastal creeks including even the most seemingly insignificant oyster habitat features (ex. Single clumps).
- Identify upstream extent of oyster habitat in coastal creeks.
- Analyze the data to identify potential habitat restoration sites.

GENERAL CONSIDERATIONS

A two-member team is ideal for the field assessment, since one can operate the vessel and the other can record the various oyster habitats on the maps. They can trade-off duties, if desired.

Team members must be able to operate a vehicle and tow a boat and trailer. They must be proficient in operating a vessel in open and very shallow water and in turning the vessel around in tight spaces such as shallow, narrow canals. The vessel should be a shallow-draft motorboat, such as a Jon Boat, large enough to safely traverse open water and the ICW, with a Bimini top for protection from the sun and inclement weather. The team members should also have a working knowledge of tides, currents, vessel traffic, and local regulations such as Manatee Zones.

PREPARATION

A. Schedule

Mapping must be scheduled at low tide in order for the oyster habitat to be accurately mapped. Consult tide prediction tables for Sarasota Bay, Venice Inlet, and Lemon Bay for the appropriate creeks. (**Table 1**) Two exceptions are Catfish and North Creeks which must be approached through a shallow, oyster-filled, mangrove tunnel that divides the lower creeks from Little Sarasota Bay. It can only be transited during very high tide and it may be necessary to wade on oysters. Time on-site must be kept as brief as possible to prevent being stranded by a falling tide. For some creeks, 2 or more can be mapped in 1 day, with plenty of time allowed for transit. Those pairs or trios are Whitaker and Hudson Bayous; Matheny and Clower Creeks and Elligraw Bayou; Catfish and North Creeks; Alligator and Hatchett Creeks; and Forked and Woodmere Creeks. Phillippi Creek, South Creek, Curry Creek, Gottfried Creek and Ainger Creek all take 1 full day each. Shakett Creek is the only creek that requires 2 full days.

Table 1. Tide Prediction Table for Each Creek

Creek	Tide Prediction Table		Creek	Tide Prediction Table
Whitaker Bayou	Sarasota Bay		Shakett Creek	Venice Inlet
Hudson Bayou	Sarasota Bay		Curry Creek	Venice Inlet
Phillippi Creek	Sarasota Bay		Hatchett Creek	Venice Inlet
Matheny Creek	Sarasota Bay		Alligator Creek	Lemon Bay
Elligraw Bayou	Sarasota Bay		Woodmere Creek	Lemon Bay
Clower Creek	Venice Inlet		Forked Creek	Lemon Bay
Catfish Creek	Venice Inlet		Gottfried Creek	Lemon Bay
North Creek	Venice Inlet		Ainger Creek	Lemon Bay
South Creek	Venice Inlet			

After the creeks are scheduled, send a copy of the schedule to Sarasota County Drainage Operations and Maintenance (DOM) to reserve the vessel and make sure there are no conflicts with the schedules of DOM staff.

B. Maps

Aerial maps of each creek should be created in ArcMap using the GIS.AERIAL2006_COLOR_1FT, which provides a clearer image. They should be set up on legal sized paper and scaled to either 1:550 or 1:700. The first map should begin at the mouth of the creek and be labeled as such (ex. Phillippi Creek – Mouth). Subsequent maps should be labeled with the name of the creek and numbers 1,2,3, etc. As the maps progress upstream, a landmark (tree, boat, dock, etc.) at the upstream edge of the first map should be identified that will overlap and match up with the same landmark on the downstream edge of the next map. It should be marked with an X plus the number of the next map, so the person mapping will be able to line the subsequent maps up quickly and easily. Label the rest of the maps in this manner. When a side canal is reached, label those segments with letters of the alphabet. For example, if a side canal occurs on map 3, the canal segments should be labeled with the name of the creek and 3-A, 3-B, 3-C, etc. After each map is created, export and save it as a JPG. file so that it can be printed out on legal sized paper at a later date.

To protect them and prevent damage from spray, rain, wind or any other unexpected conditions, laminate the maps in 10 mil plastic pouches. Two maps can be laminated back to back in one pouch. Alternate the maps so the person mapping does not have to turn the map over to see the next segment. This way, the landmarks described in the previous paragraph can easily be lined up from map to map. For example, in the first pouch laminate the creek-mouth map on the front and #2 map on the back; in the second pouch laminate the #1 map on the front and the #3 map on the back. Alternate the A, B, and C maps for the side canals in the same way. Continue in this manner until all of the maps have been laminated. Place them in a legal sized file folder for storage.

C. Field Sheet

A field sheet should be prepared for each creek that includes the following information: Date, Time On, Time Off, Crew, Creek, Tide, Upstream Extent (Latitude/Longitude) Sediment characterization, and Habitat Characterization Codes and printed on waterproof paper. (See Example) The Habitat Characterization Codes were modeled after those used in a Tampa Bay oyster habitat mapping project and are in **Table 2**

See Habitat Characterizations Section for detailed habitat descriptions.

Table 2. Habitat Characterization Codes

Habitat	Code	Habitat	Code
Shell	S	Oyster Clumps/Reef	CR
Scattered Shell	SS	Mangrove Apron	MA
Oyster Clumps	C	Mangrove Root Oys.	MRO
Scattered Oys. Clumps	SC	Seawall	SW
Oyster Reef	R	Rip Rap	RR

Since oysters were observed along seawalls and on riprap, it was necessary to develop characterization codes for those as well. **(Table 3)** Four codes that described the vertical size of the horizontal bands of oysters growing on seawalls and riprap were created. For example, the code SW-1 stands for “Light” growth meaning a single or multiple layer of oysters, 6” wide (tall) or less growing on a seawall. The growth can be a solid band or scattered along the wall. The code SW-2 stands for “Medium” growth or single or multiple layers of oysters 6” to 12” wide growing on a seawall. The code SW-3 stands for “Heavy” growth or multiple layers of oysters, 12” to 18” wide growing on a seawall. The code SW-4 stands for “Very Heavy” growth or multiple layers of oysters greater than 18” wide growing on a seawall. The codes RR-1 through RR-4 would be used to describe oyster growth on riprap in the same manner.

Table 3. Seawall/RipRap Classification Codes

Bands	Code
Light: ≤ 6”; 1-2 layers	SW-1/RR-1
Medium : > 6"≤ 12"; >1 layer thick	SW-2/RR-2
Heavy: > 12" ≤ 18"; >1 layer thick	SW-3/RR-3
Very Heavy: >18"; >1 layer thick	SW-4/RR-4

Solid Line: Oysters are mostly solid along wall

Broken line: Oysters are sporatic along wall

MOBILIZATION

In the days prior to the scheduled creek trip, assemble the gear listed in **Table 4**. Use the table as a checklist on the day of departure to avoid leaving anything behind.

Table 4. Equipment Check-List

Vessel
Licenses and Registration
Fuel and Oil
Anchor(s) and Line
Paddle
Fire Extinguisher
Personal Flotation Devices
Throwable Float
Whistle or Horn
Visual Distress Signal
Dewatering Device
Dry Box
Project
Laminated Maps
Field Log/Pens
Permanent Markers - Fine Point Black
Digital Camera/Batteries
GPS
Personal
Cell Phone
Sun Protection (cream, hat, glasses, etc.)
Food and Beverages
Rain Gear
Binoculars

A 2 crew minimum is required to conduct the assessment. In all cases, crew safety is of paramount importance. County staff should refer to and follow the procedures outlined in Section 2: Safety Procedures in the "Sarasota County Water Quality Sampling, Analysis, and Reporting Procedures Manual." Although the mapping work is conducted from within the vessel, it may be occasionally necessary for crew members to wade through survey area. Oyster shells are very sharp and infections from cuts are very serious and can even be life threatening. Heavy boots or shoes must be worn at all times while working in the water around oysters. If a crew member sustains a cut, first aid should be given immediately and medical attention should be sought as soon as\practicable. The crew may at any time judge that local conditions present a threat or hazard to their personal safety and discontinue the work. Examples of natural hazards include high wind, fog, or lightning; extreme waves or currents; and red tides.

Depending upon the size of the creeks, the team should pick up the vessel be on the way to the boat ramp by 7:30 AM and be on-site in the first creek by about 9:00 AM. The team should be out of the creek and at the boat ramp by 2:30 – 3:00 PM in order to have time to clean up the boat, return it to its storage facility, and return to the office.

Under normal conditions, the boat ramps closest to a given creek are listed in **Table 5.**

Table 5. Boat Ramp Access to Creeks

BOAT RAMP ACCESS	
Creek	**Boat Ramp**
Whitaker Bayou	**Centennial Park**
Hudson Bayou	**Centennial Park**
Phillippi Creek	**Centennial Park**
Matheny Creek	**Turtle Beach**
Elligraw Bayou	**Turtle Beach**
Clower Creek	**Turtle Beach**
Catfish Creek	**Turtle Beach**
North Creek	**Turtle Beach**
South Creek	**Turtle Beach or Nokomis Beach**
Shakett Creek	**Higel Park**
Curry Creek	**Venice Marina Park**
Hatchett Creek	**Venice Marina Park**
Alligator Creek	**Manasota Beach Road**
Woodmere Creek	**Manasota Beach Road**
Forked Creek	**Manasota Beach Road**
Gottfried Creek	**Ainger Creek Park**
Ainger Creek	**Ainger Creek Park**

Note: Ainger Creek Park is in Charlotte County and requires a launch fee. Take coins and dollar bills.

STANDARD MAPPING METHODS

Upon arriving at the site, complete the top part of the Field Sheet with the Date, Time On, Crew, Creek, and Tide. Begin mapping on the north side of the creek and proceed slowly upstream. Each oyster habitat should be recorded on the map with a black Sharpie, Fine or Extra-Fine Point Permanent Marker. When a side canal is reached, map it from the port (left) side going in and again from the port side after turning around and proceeding back to the main channel. The canals should be mapped one side at a time, because it is difficult to accurately map both sides at the same time even in narrow canals where the habitat is clearly visible on both sides. The operator of the vessel should go slowly enough for the person mapping to be able to comfortably map the habitat. He/she may even help out by identifying habitat locations. Landmarks such as boat docks, houses, vegetation, bridges, and power lines can be used to orient the vessel location with the aerial map. Since the work is conducted at low tide, it may be difficult to access certain areas as a result of heavy sedimentation or other barriers. Binoculars are very useful in allowing the crew to identify habitats from a distance.

Proceed upstream until no oyster habitat is observed. Record the Lat./Long. of the upstream extent on the map. Proceed upstream past that point for an additional one or two tenths of a kilometer to make sure that no additional oyster habitat is found. After the creek is mapped, complete the field sheet with Time Off, Sediment Types, Upstream Extent, and record any unusual observations or conditions under the Comments Section.

HABITAT CHARACTERIZATIONS

Shell - S

Oyster shell habitat is found along the natural shoreline, altered shoreline such as seawalls, bulkheads, and riprap, under docks, and under water off-shore. This habitat consists of single shells (usually dead) that cover an area densely enough that a person cannot walk across it without stepping on a shell. The shell can act as cultch for oyster recruitment.

Scattered Shell - SS

Scattered shell habitat is the same as Shell habitat, except that the shells are scattered over an area so that a person can easily walk across it without stepping on a shell.

Oyster Clumps - C

Oyster clumps are clusters of 2 or more oysters that are cemented together. The oysters may be live, recently dead, and/or dead. The clumps may be found along the natural shoreline, altered shoreline such as seawalls, bulkheads, and riprap, under docks and on pilings, and under water off-shore. This habitat consists of clumps that cover a small area densely enough that you cannot walk across it without stepping on a clump.

Scattered Oyster Clumps – SC

Scattered oyster clump habitat is the same as oyster clump habitat, except that the clumps are scattered over an area so that a person can easily walk across it without stepping on a clump.

Oyster Reef - R

There are several types of oyster reefs. They are usually classified by their configuration and location relative to the nearest shoreline. Most patch reefs are located in shallow water, are usually detached from the mainland, have irregular but solid outlines, and are ringed by sand or mud. Mangroves may or may not be growing out of this type of reef. Some patch reefs may also form on outcroppings or other solid substrate that is attached to the mainland. String reefs are usually long and narrow reefs that are situated at right angles to tidal currents across the mouths of rivers, creeks, sounds, and lagoons. All of these types of oyster reefs will be denoted by the letter “R”. Fringe reefs usually adjoin the shore and are also called Mangrove Aprons, which are described below.

Oyster Clumps/Reef - CR

This type of habitat is a central area dominated by a solid oyster reef with clumps and/or scattered clumps surrounding the main reef.

Mangrove Apron - MA

A mangrove apron, or fringe oyster reef, can be distinguished from other oyster reefs by their structure and configuration. A mangrove apron is a solid oyster reef growing in a narrow band around the base of mangroves that are not growing in the reef, but, instead, are rooted and growing in a substrate composed of soil, sand, mud, etc. The mangrove apron may grow along the shoreline, or totally encircle a mangrove island that is detached from the mainland.

Mangrove Root Oysters - MRO

Mangrove root oysters are simply oysters that grow on the drop roots of the Red Mangrove. They may be single shells or small clumps.

Seawall – SW and RipRap - RR

Where bottom substrate is not adequate to support healthy oyster populations, oysters will recruit on other forms of solid substrate such as seawalls, bulkheads, and riprap, under docks, and on pilings. A method was developed to characterize the size, thickness, and vertical extent of these habitats using 4 categories: Light, Medium, Heavy and Very Heavy. (See Field Sheet, Section C)

<u>MAPPING TECHNIQUES</u>

All maps must be marked in a consistent manner in ArcGIS ArcMap There are three layers used to identify the oyster habitats: Oyster_Points, Oyster_Lines, and Oyster_Polygons. After marking the map using the appropriate layer, record the appropriate habitat characterization code in its attribute table.

Lines

- Use a solid line to denote area covered by dense shell
- Use a broken line to denote area covered by scattered shell
- Use a solid line to denote area covered by dense clumps
- Use a broken line to denote area covered by scattered clumps
- Use a solid line along seawall and riprap to denote solid bands of oysters
- Use a broken line along seawall and riprap to denote sporadic oysters
- Use a solid line to denote that most of mangrove roots are covered with oysters

- Use a broken line to denote that oysters occur only sporadically among mangrove roots
- Use a solid line to denote a mangrove apron

Polygons

- Use a polygon to denote oyster reef

Points

- Points may or may not be used
- Use a point to denote the extent of oysters upstream, if the last habitat observed is a clump or a few shells.
- Use a point to denote clumps on pilings

VOLUNTEER MAPPING PROGRAM

In order to map oyster habitat in the County bays, it may be necessary to recruit volunteers and develop a county-wide volunteer network. A potential resource is the pool of volunteers participating in the Volunteer Seagrass and Scallop Monitoring Programs. The role of the volunteers would be to survey specified areas of County bays during lowtide, identify all oyster habitats associated with the sites, and record locations using a GPS.

Volunteer Equipment:

- Flats Boat, Jon Boat, Kayak, or Canoe
- GPS
- Oyster Habitat Field Sheet **–** County will provide

Volunteer Procedures:

The volunteers will follow applicable procedures and methods outlined in this manual with the following exceptions:

- The volunteer(s) will use his/her own vessel, be responsible for equipping it with all Coast Guard required and approved safety equipment, and be responsible for following all navigational rules and regulations.
- The volunteer(s) will be assigned a specific area or may choose an area of his/her preference (close to volunteer residence).
- The volunteer(s) will receive training and guidance from County staff.
- The volunteer(s) will be required to sign a liability waiver.

SARASOTA COUNTY VOLUNTEER OYSTER MAPPING PROJECT
Release of Liability

THE UNDERSIGNED being (check one) **____** at least 18 years of age ("Volunteer"), or **____** younger than 18 years of age and accompanied by a parent/guardian hereby (collectively, the "Young Volunteer"), acknowledge reading and accepting the following Release, and state as follows:

1. The Undersigned is/are in good health and is/are physically and mentally capable of performing the volunteer tasks associated with the Oyster Mapping Project.

2. The Undersigned acknowledge receiving training on the operation of any necessary equipment, including safety equipment, Global Positioning System equipment, and depth finders.

3. The Undersigned understands that while participating as a volunteer in the Oyster Mapping Project he/she is not considered to be an employee, agent, or representative of Sarasota County Government and agrees not to hold him/herself out as such to other persons. He/she also understands that he/she will not be compensated monetarily or otherwise by Sarasota County.

4. The Undersigned understands that participating in the Oyster Mapping Project involves the use of watercraft and potential contact or immersion in water during multiple events on different dates. The Undersigned assumes the risks of injury associated with, but not limited to, working outdoors in natural settings, traversing both natural and man-made terrain, exposure to harmful aquatic organisms, and changing weather conditions. The Undersigned understands that whether he/she uses a privately owned/operated vessel, or if Sarasota County government is the owner/operator of the vessel, it does not assume any responsibility for any loss, damage, or injury, including death, to his/her person or property associated with maintenance and operation of the vessel by the county.

5. The Undersigned understands that when he/she use his/her own vessel for this project, they are responsible for the conduct and safety of all passengers. The Undersigned will comply with all safety regulations and registrations associated with the operation and maintenance of a vessel.

6. The Undersigned consents, (if a minor, the undersigned parents or guardians consent) to emergency medical treatment or procedures in the event that he/she is unable to give actual consent and agrees to remain solely responsible for all related costs and expenses, if any, and further agree (if a minor, the undersigned parents or guardians agree) to indemnify, defend, and hold harmless Sarasota County Government from payment and/or liability in connection with the costs and expenses.

6. The Undersigned releases and indemnifies Sarasota County, its respective officers, staff, agents, employees, volunteers, and subsidiaries, affiliates, sponsors, and suppliers associated with the Oyster Mapping Project of and from any liability, claims, demands (including attorney fees), actions and causes of action whatsoever arising out of or related to any loss, damage, or injury, including death, which may be sustained by the Undersigned while participating in the Oyster Mapping Project.

THE UNDERSIGNED HAS (HAVE) READ THE FOREGOING RELEASE, UNDERSTAND ITS CONTENTS AND SIGNS IT WITH FULL KNOWLEDGE OF ITS SIGNIFICANCE.

	If Volunteer is under 18 years old:
______________________________	______________________________
Name of Volunteer (please print)	Name of parent/guardian (please print)
______________________________	______________________________
Signature of Volunteer	Signature of parent/guardian
______________________________	______________________________
Address	Address
______________________________	______________________________
City/Zip	City/Zip
______________________________	______________________________
Phone Number	Phone Number
______________________________	______________________________
Date	Date
______________________________	______________________________
Emergency contact: name and phone no.	Emergency contact: name and phone number

SARASOTA COUNTY BAY MAPPING PROJECT

In order to map oyster habitat in County bays and complete the project, a new method using GIS was developed in January 2011 to allow Water Resources staff to efficiently and effectively map the habitat without requiring the help of volunteers or the time, effort, and cost to create and laminate aerial maps of all the shorelines in the county. The SOPs for preparation and mobilization are identical to those when the creeks were mapped. Two habitat characterization codes were added to the bay mapping effort **(Table 6)** to distinguish oyster habitat on floating docks and pilings.

Table 6. Habitat Characterization Codes

Habitat Characterization Codes			Habitat Characterization Codes	
Habitat	**Code**		**Habitat**	**Code**
Shell	S		Mangrove Apron	MA
Scattered Shell	SS		Mangrove Root Oysters	MRO
Oyster Clumps	C		Seawall	SW
Scattered Oyster Clumps	SC		Rip Rap	RR
Oyster Reef	R		Pilings	P
Oyster Clumps/Reef	CR		Floating Docks	D

It was also decided that codes for oyster condition could be beneficial. A coding system was developed to denote the health of the oyster habitats: Code 0 – Oysters are mostly dead; Code 1 – There is a fairly even distribution of live and dead oysters; Code 2 – Oysters are mostly live. **(Table 7)**

Table 7.

Oyster Condition	
Mostly Dead	0
Even Distribution Live/Dead	1
Mostly Live	2

STANDARD MAPPING PROCEDURES

Aerial maps of all county bays were downloaded into a rugged, portable tablet personal computer that was designed to be used in the field. The habitat can be “drawn” directly onto the computer's touch screen using either a stylus or a mouse. Mapping staff follow the following procedures:

- Open ArcMap and choose the appropriate mapping area.
- Turn on the GPS.
- Open the editor drop down box and choose "start editing".
- Open the attribute table.
- Open the keyboard.
- Open the target drop down box and choose either "SC_Oysters_Polygon" for reefs or "SC_Oyster_Lines" for all of the other habitats.
- Using the stylus, draw the identified habitat on the touchscreen.
- Record the appropriate habitat characterization code in the CODE box in the attribute table and the appropriate oyster condition code in the comment box.
- Save edits often.
- Save edits and map at the end of the trip and shut down computer.
- The data can then be downloaded into work computers and be shared among staff.

OYSTER MAPPING FIELD SHEETS

2008 Field Sheet for Creeks
2011 Field Sheet for Bays

THIS PAGE INTENTIONALLY LEFT BLANK

SARASOTA COUNTY WATER RESOURCES
2008 COASTAL CREEK OYSTER MAPPING FIELD SHEET

Date: ______________ Time On: ________________ Time Off: ________________

Crew: ____

Creek: ____________________ Tide: ________________________

Upstream Extent: Latitude ______________ Longitude: ______________

Sediment: Rock Mud Sand Algae Shell Organic

Habitat Characterization Codes

Habitat	Code
Shell	S
Scattered Shell	SS
Oyster Clumps	C
Scattered Oys. Clumps	SC
Oyster Reef	R
Oys. Clumps/Reef	CR
Mangrove Apron	MA
Mangrove Root Oys.	MRO
Seawall	SW
Rip Rap	RR

Seawall Classification Codes

Layers	Code
Sparse: ≤ 6"; 1 layer	SW-1
Light : > 6"< 12"; >1 layer	SW-2
Medium: > 12" < 18"; >1 layer	SW-3
Heavy - >18"; >1 layer	SW-4

Solid line: Oysters are mostly solid along wall

Broken Line: Oysters are sporatic along wall

Comments: ____

Sarasota County Water Resources * 1001 Sarasota Center Blvd., Sarasota, FL 34240 * 941-861-5000

THIS PAGE INTENTIONALLY LEFT BLANK

2011 OYSTER MAPPING FIELD SHEET
SARASOTA COUNTY BAYS

Date: ______________ Time In: ______________________ Time Out: __________

Crew: ____

Bay: ________________ Tide Stage: ____________________

Boat Ramp: ____________________________

Starting Point: ________________ End Point: ____________________________

Habitat Characterization Codes

Habitat	Code
Shell	S
Scattered Shell	SS
Oyster Clumps	C
Scattered Oys. Clumps	SC
Oyster Reef	R
Oyster Clumps/Reef	CR
Mangrove Apron	MA
Mangrove Root Oys.	MRO
Seawall	SW
Rip Rap	RR
Pilings	P
Floating Docks	D

Seawall Classification Codes

Layers	Code
Light: ≤ 6"; 1-2 layers	SW-1/RR-1
Medium : > 6"≤ 12"; >1 layer	SW-2/RR-2
Heavy: > 12" ≤18"; >1 layer	SW-3/RR-3
Very Heavy - >18"; >1 layer	SW-4/RR-4

Solid line: Oysters are mostly solid along wall

Broken Line: Oysters are sporatic along wall

Oyster Condition

Oyster Condition	
Mostly Dead	0
Even Distribution Live/Dead	1
Mostly Live	2

Comments: ____

THIS PAGE INTENTIONALLY LEFT BLANK

OYSTER HABITAT CHARACTERIZATION

THIS PAGE INTENTIONALLY LEFT BLANK

EXAMPLES OF OYSTER HABITAT CHARACTERIZATIONS

SCATTERED SHELL

Shells are scattered along the shoreline and in the water

SCATTERED CLUMPS – SC AND SCATTERED SHELL - SS
Clumps and shells are scattered in the mud along the base of the seawall

OYSTER REEF – R
The reef is detached from the mainland. Mangroves are growing out of the oyster reef

OYSTER REEF - R
The reef is extending out from the mainland

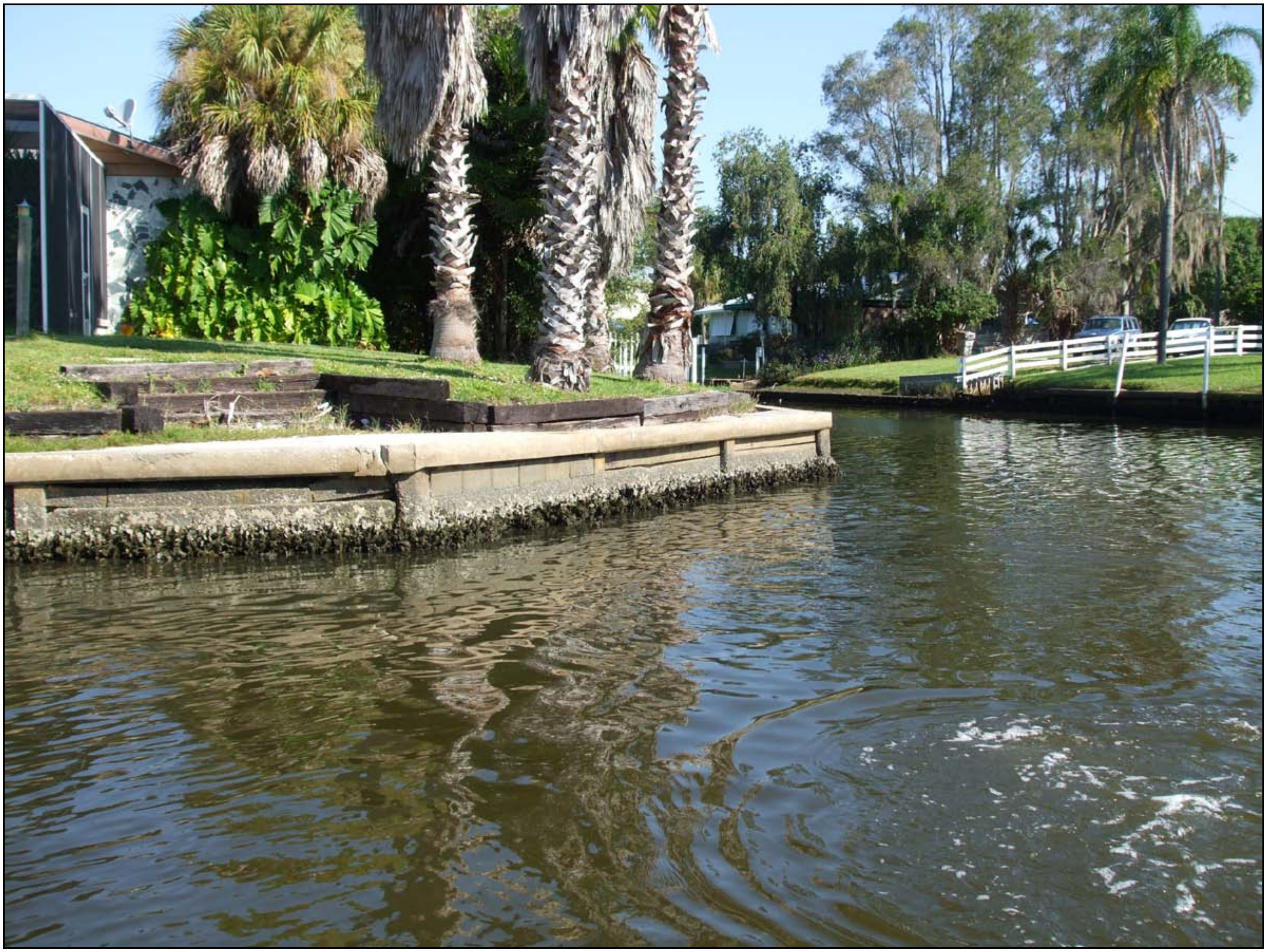
MANGROVE APRON - MA

Also known as a fringe reef, the oysters are growing along the bank and forming an "apron" around the mangroves island. The mangroves are not growing in the reef, but in the sediment that is forming the island.

MANGROVE ROOT OYSTERS - MRO
The oysters are growing on the roots of the Mangrove.

SEAWALL OYSTERS – SW-1

The oyster growth occurs in a single layer or multiple layers and in a thin band less than 6" wide or narrower along the bottom of the seawall. The oyster growth can be solid or scattered along seawall.



SEAWALL OYSTERS – SW-2
The oyster growth occurs in more than one layer thick in a band greater than 6" but less than 12" wide along the seawall

SEAWALL OYSTERS – SW-3
The oyster growth occurs in more than one layer thick in a band greater than 12" but less than 18" along the seawall. Clumps of oysters grow on pilings

SEAWALL OYSTERS – SW-3
The oyster growth occurs in more than one layer thick in a band greater than 12" but less than 18" wide along the seawall

SEAWALL OYSTERS – SW-4
The oyster growth occurs more than one layer thick and in a band greater than 18” wide along the seawall

RIPRAP OYSTERS – RR-2
The oyster growth occurs in more than one layer in a band greater than 6" but less than 12" wide along the rocks.