Gulf Coast Ecosystem Restoration Council (GCERC) Grant
Apalachicola Bay Oyster Reef Restoration Project
Monitoring Report

Introduction

The Apalachicola Bay Oyster Reef Restoration Project in Franklin County, Florida was funded by a Gulf Coast Ecosystem Restoration Council (GCERC) grant. As a result of the *Deepwater Horizon* oil spill and associated response activities, oyster and benthic secondary productivity along Florida's Panhandle suffered adverse impacts. This project seeks to foster oyster reef habitat development which will help to recover the losses to oyster habitat and benthic secondary productivity. Monitoring for a two-year period will be conducted to ensure project designs were correctly implemented and to evaluate project effectiveness, as budget allows. Performance criteria will be used to determine project success. Monitoring data and adaptive management principles will be used to evaluate the need for corrective actions and to correct deficiencies, as funding allows. This monitoring plan will be implemented by the Central Panhandle Aquatic Preserves (CPAP), an office within the Florida Department of Environmental Protection's (FDEP) Office of Resilience and Coastal Protection (RCP). The monitoring plan and activities conducted may be modified over time based on management needs for the Oyster Reef Restoration Project.

Project Overview

The objective of this Oyster Reef Restoration Project was to promote reef development for oysters by restoring existing oyster reef habitat that had been degraded, depleted, or reached its productive life span. The restoration work included the placement of suitable cultch material on existing oyster bars for the setting of native oyster larvae and oyster colonization. It included placing approximately 95,000 cubic yards of a lime rock aggregate on an estimated 317 acres of debilitated oyster reefs in the Apalachicola Bay system in Franklin County (FDACS, 2017).

Cultch Sites to be Monitored

FDEP acted as the administrator for the GCERC project in the Apalachicola Bay system. As a subcontractor, the Florida Department of Agriculture and Consumer Services (FDACS) was responsible for the administration, planning implementation, management, and successful completion of all aspects of the barge cultch planting component.

FDACS's responsibilities included: the review and approval processes for selecting subcontractors; developing the scope of work for the entire project; allocating staff and equipment to participate and manage project operations; scheduling on-site restoration operations; and managing project coordination. FDACS scheduled meetings with subcontractors to establish project schedules and timelines, coordination, operating parameters, and job-related responsibilities. FDACS staff maintained on-site project management and supervision; delineated project planting boundaries and ensured operations conformed to the terms and conditions of the contracted agreements and purchase orders throughout the duration of the project.

FDACS was also responsible for approving work upon completion to determine that the barge cultch planting component was completed in accordance with contract provisions and job specifications. Staff verified that all jobs listed in the scope of work were completed before approving invoices for payment. From September 26, 2017 through November 30, 2017 (26 working days) the cultch placement of the

Apalachicola Bay system GCERC grant project was completed. Approximately 95,500 cubic yards of lime rock aggregate were deposited onto fourteen degraded or depleted oyster reefs. A total of 317 acres of cultch were planted in the Apalachicola Bay system in Franklin County. This cultching, in areas of Apalachicola Bay where natural reproduction occurs: 1) creates three-dimensional reef structure, 2) stimulates spat setting, 3) accelerates the recovery process, 4) increases natural productivity, 5) sustains oyster fisheries, and 6) enhances ecosystem community functions. The rebuilding of oyster reef infrastructure contributes to a “bottom up approach” to repairing injured, impaired, and damaged natural resources. Improved habitat forms the foundation for oysters, as an engineering species, to contribute to wide reaching fishery and ecological benefits throughout the Apalachicola Bay system. Ecological benefits of cultch deposition are realized through an array of ecological services in the form of increased fishery and wildlife habitat; increased biodiversity and trophic dynamics; increased filtering capacity to improve water quality and recycle nutrients; and increased structural stability to reduce coastal erosion and protect nearshore resources. Economic benefits are realized through harvesting, processing and marketing fishery products and felt locally and regionally by all who enjoy high-quality, wholesome Florida seafood and depend upon commercial fisheries for employment and income.

Monitoring Protocols

1. <u>Site Selection</u>

   Prior to sampling, each reef site is divided into midpoints, the number of which depends on the size of the reef being sampled (i.e. a larger reef site contains more midpoints than a smaller site). Using ArcGIS, midpoints are determined to effectively assess the reef area. These midpoints are the exact location(s) to be sampled.

   For each sampling day, four FDEP staff are needed: two divers, one safety diver, and a boat captain. All divers must be certified to dive for FDEP. Similarly, the boat captain must be certified to operate FDEP vessels. All diving is done in accordance of the FDEP’s Underwater Operation Manual (available upon request).

   Based on weather, winds, and current conditions, the team selects an appropriate site(s) and/or midpoint(s) to sample. Once near the site, the boat captain “zeros out” the boat’s position using GPS, getting as close to the designated midpoint’s coordinates as possible.

2. <u>Sample Collection</u>

   Two divers enter the water on either side (starboard and port) of the boat. Each diver swims a weighted transect line out 10m from the side of the vessel. Each transect line has a mushroom anchor and dive flag with a float attached to the end. The diver then descends and places a 0.25 m^2 quadrat on the bottom in a haphazard manner near the transect line. Live oysters, shell and associated fauna are removed to the depth of the sediment, placed in mesh collecting bags and delivered to the survey vessel. This is repeated five times on each side of the boat, as well as off the bow of the boat. A total of 15 quadrats (five starboard, five port, and five bow) are sampled for each site midpoint.

The boat captain and safety diver label sample bags as they are being collected. A sample ID is given to each sample (quadrat) that includes the site name, midpoint number, side of the boat, and the sample number. For example, the first quadrat from RESTORE site - Cat Point, Midpoint 1, taken from the starboard side of the boat is given the ID: R-CP-MP1-S1. The team onboard also collects water quality parameters at the surface and bottom of the water column, using a Yellow Springs Instrument (YSI) handheld datasonde, which include: water temperature, dissolved oxygen, specific conductance, salinity, and pH. Weather conditions, wind, current, latitude and longitude are also recorded.

3. Sample Processing

Samples are processed once all the quadrats have been collected for a midpoint. If it is not possible to process samples immediately after sampling, they are frozen until processing can be completed.

First, the sample is weighed, in kilograms, using a digital hanging scale. If oysters are present in the collected sample, shell height of the first 100 live oysters is measured to the nearest millimeter (mm) using calipers. Oyster shell height (Figure 1) is defined as the distance from the umbo to the distal margin of the shell (Bagget *et al*, 2014).

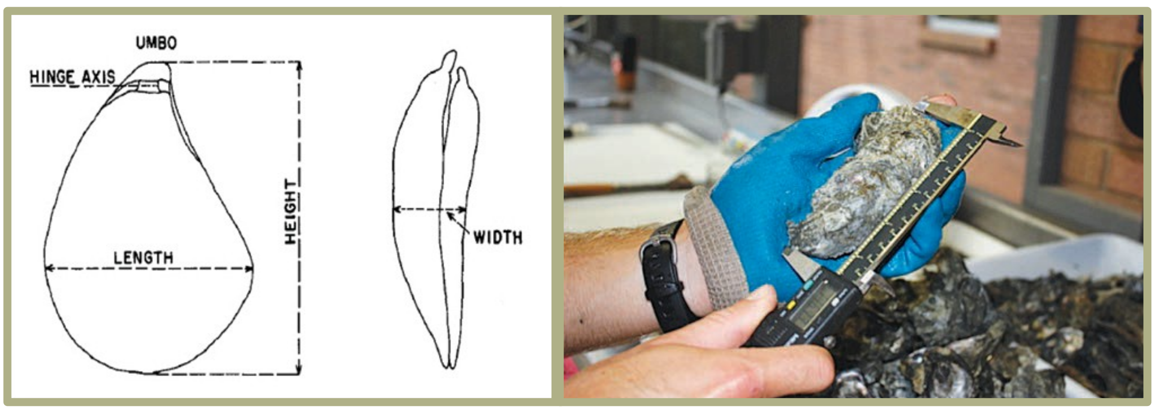

Figure 1: (left) Diagram of the height, length, and width measurements of an oyster shell, from Galtstoff 1964, Chapter 2. (right) An example of shell height measurement in a lab.

If the sample contains more than 100 live oysters, the remaining live oysters are counted. Live oysters are divided into one of three size classes (Table 1): spat (0-25 mm), seed (26-74 mm) and harvestable adult (75 mm and larger). The number of dead oysters in the sample is also counted.

Table 1: Oyster size classes

Size Class	Oyster shell height (mm)
Spat	0-25 mm
Seed	26-74 mm
Adult	≥75 mm

4. Data Entry

The oyster size data are entered into an Excel spreadsheet and entries are separated into the size classes described above. Water quality parameters, weather conditions, wind, currents, latitude and longitude are also entered into Excel. Next, all the data are proofed for quality control/quality assurance, and any errors are corrected. All Excel data and scanned copies of original data sheets are stored on the CPAP server.

5. Data Analysis

Oyster populations will be described by plotting parameters such as: total number of live vs. dead oysters, total number of oysters by size class, density of live oysters, average oyster size, etc.

To determine the relative condition of oyster resources, an estimate of harvestable oysters will be determined using FDACS' Standard Oyster Resource Management Protocol (see Appendix 1). This protocol has been used in Apalachicola Bay since 1982. FDACS uses a scale that states that 400 bags/acre could be harvested from productive artificially constructed reefs within two years of planting cultch. The scale is as follows:

- More than 400 bags/acre = Healthy oyster reefs capable of sustaining commercial harvest.
- More than 200 bags/acre = Oyster reefs capable of sustaining limited harvest.
- Less than 200 bags/acre = Below level necessary to support commercial harvest.
- Less than 100 bags/acre = Oyster reefs considered depleted.

After the first two years of sampling, oyster populations will be compared using the Kruskal-Wallis test to determine significant differences between length-frequency distributions between reef sites.

6. Determining Spatial Extent of Cultched Areas

Assessing subtidal reef dimensions includes defining individual areal reef footprints (the entire area of the reef complex) in addition to defining reef area (the actual area of patches of living and nonliving substrate with or without live oysters) within reef footprints (Baggett et al. 2014). Mapping of the cultched reefs is conducted using side-scan sonar (Humminbird Solix 12 CHIRP MEGA SI GPS). Imagery data is collected by navigating the project vessel over the extent of each reef following predetermined route lines. Data is imported and analyzed using the spatial analysis software ReefMaster 2.0. Each individual boat track collected during side-scan mapping is edited to improve the clarity of imagery data. Reef mosaics displaying the texture of each planting site and map projects displaying bottom composition (i.e. hardness) are generated from the individual tracks, compared for accuracy, and exported as KML Super-Overlay files (mosaics) and Shapefiles (hardness) to be viewed in ArcGIS Pro software. Using ArcGIS Pro, each reef footprint is carefully measured by outlining areas displaying hardness values. Each site is measured by two individuals, and reef area is determined by taking the average of both measurements. Shapefiles of each reef footprint within respective GPS boundaries and a single layer displaying all oyster reefs and respective bottom composition are exported from ArcGIS Pro software. After year two of the project, comparisons between oyster cultch spatial extent will be analyzed to determine any spatial changes in the reef areas. Depth profile maps of each reef are also created utilizing the side-scan sonar imagery. Bottom contours and changes in depth within a reef area provide additional support in determining bottom composition, and in turn distinguishing reef acreage, within the cultched areas.

Note #1: Originally, the spatial extent of all cultched reefs was to occur during the six-month, one-year, and two-year monitoring periods; however, due to unforeseen circumstances (staff medical issues, Hurricane Michael, and boat repairs), mapping of the cultched reefs was not completed at the six-month mark. Mapping was, however, completed at year one and will be completed at year two. If approved, additional mapping will occur beyond the year two sampling period. The funding allocated to the six-month mapping component will not be expended.

7. Generation of Technical Reports
CPAP will submit a monitoring report within 45 business days of each monitoring event to the RESTORE Project Manager detailing the recruitment, size, frequency of live oysters, frequency of dead oysters, and status of the shell material deployed. This report will include an estimate of harvestable oysters at each site, a summary of the spatial extent of each reef area, water quality and environmental parameters measured, and a discussion of notable findings.

Monitoring Schedule

Safety will be the top priority when determining sampling dates, as this type of monitoring is extremely weather dependent. Monitoring will occur on three separate occasions: six months, one year, and two years after the cultch was placed.

Apalachicola Bay

The Apalachicola Bay system is a wide, shallow estuary that covers an area of approximately 210 square miles behind a chain of barrier islands (Gorsline, 1963). Its primary source of fresh water is the Apalachicola River. The estuarine system may be divided into four sections based on both natural bathymetry and man-made structural alterations; East Bay, St. Vincent Sound, Apalachicola Bay, and St. George Sound. Apalachicola Bay has over 4,000 acres of historically viable oyster reefs, with the bulk of the acreage included in the main bars of Cat Point, East Hole and Dry Bar. Approximately 95,500 cubic yards of a lime rock aggregate were placed on an estimated 317 acres of debilitated oyster reefs in the Apalachicola Bay during October 2017. See Figures 2-4 for maps of cultched sites in Apalachicola Bay. GPS coordinates for each monitoring site's midpoint(s) are located in Table 2.

Environmental conditions as well as historical productivity and recruitment were considered when selecting the oyster reefal complexes to be restored. Based on this and input from the Franklin County Seafood Workers Association (FCSWA), the following fourteen (14) viable oyster reefal complexes in the Apalachicola Bay System were chosen for cultch deposition:

West Side

- 8-Mile: An unconsolidated natural oyster reefal complex, lying in an east-west configuration; surrounded by a soft mud substrate. The reef is in St. Vincent Sound, in an Approved shellfish harvesting area.

- King 9-Mile: An unconsolidated natural oyster reefal complex. Reef is comprised primarily of a series of small, natural oyster reefs (lumps/knobs), lying in a north-south configuration; each surrounded by a soft mud substrate. The reef is in St. Vincent Sound, in an Approved shellfish harvesting area.
- 9-Mile B: An unconsolidated natural oyster reefal complex. Reef is comprised primarily of a series of small, natural oyster reefs (lumps/knobs), lying in a north-south configuration; each surrounded by a soft mud substrate. The reef is in St. Vincent Sound, in an Approved shellfish harvesting area.
- Cabbage Top: An unconsolidated natural oyster reefal complex. Historically, portions of the reef have received restoration by cultching. Reef is comprised primarily of a natural and planted oyster shell matrix. The reef is in St. Vincent Sound, north of St. Vincent Island, off Cabbage Top proper, in a Conditionally Approved shellfish harvesting area.
- North Spur #2: A series of reefs around a natural reefal complex; historically, portions of the reef have received extensive restoration by cultching. Reef is comprised primarily of a natural and planted oyster shell matrix. The reef is located mid-bay, in Apalachicola Bay, in a Conditionally Approved shellfish harvesting area.

East Side

- Hotel Bar #1: Reef is a large consolidated natural oyster complex; portions of the reef have received extensive restoration by cultching. The substrate is primarily a natural and processed oyster and clam shell matrix. The surrounding bottom is generally firm with sand shoals landward of the reef. The reef is located offshore of St. George Island, between the Intracoastal Waterway (ICWW) and northern shoreline of St. George Island, near the Bryant Patton Bridge; in an Approved shellfish harvesting area.
- Hotel Bar #2: Reef is a large consolidated natural oyster complex; portions of the reef have received extensive restoration by cultching. The substrate is primarily a natural and processed oyster and clam shell matrix. The surrounding bottom is generally firm with sand shoals landward of the reef. The reef is located offshore of St. George Island, between the ICWW and northern shoreline of St. George Island, near the Bryant Patton Bridge; in an Approved shellfish harvesting area.
- East Hole #1: Large consolidated natural reefal complex; historically portions of the reef have received extensive restoration. The reef is comprised primarily of a natural and planted oyster shell matrix. The surrounding bottom is generally firm. The reef is located north of St. George Island and east of the Bryant Patton Bridge; in a Conditionally Approved shellfish harvesting area.
- East Hole #2: Large consolidated natural reefal complex; historically portions of the reef have received extensive restoration. The reef is comprised primarily of a natural and planted oyster shell matrix. The surrounding bottom is generally firm. The reef is located north of St. George Island and east of the Bryant Patton Bridge; in a Conditionally Approved shellfish harvesting area.
- South Bulkhead: Large consolidated natural reefal complex; historically portions of the reef have received restoration. The reef is comprised primarily of a natural and planted oyster shell matrix. The surrounding bottom is generally firm. The reef is located north of St. George Island

and east of the south end of Bird/Bulkhead Island; in a Conditionally Approved shellfish harvesting area.

- Monkey's Elbow: Large consolidated natural reefal complex; historically portions of the reef have received restoration. The reef is comprised primarily of a natural and planted oyster shell matrix. The surrounding bottom is generally firm. The reef is located north of St. George Island and east of the north end of Bird/Bulkhead Island; in a Conditionally Approved shellfish harvesting area.
- Peanut Ridge: Large consolidated natural reefal complex; historically portions of the reef have received restoration. The reef is comprised primarily of a natural and planted oyster shell matrix. The surrounding bottom is generally firm. The reef is located mid-bay, east of the Bryant Patton Bridge; in a Conditionally Approved shellfish harvesting area.
- Cat Point Spur: Consolidated natural reefal complex; historically portions of the reef have been restored. The reef is comprised primarily of a natural and planted oyster shell matrix. The surrounding bottom is generally firm. The reef is located mid-bay, east of the Bryant Patton Bridge; in a Conditionally Approved shellfish harvesting area.
- Cat Point: A large natural oyster reefal complex; historically portions of the reef have received extensive restoration and re-seeding. Cat Point bar is the prominent natural feature separating eastern Apalachicola Bay and St. George Sound. The reef is comprised primarily of a natural and planted oyster shell matrix. The surrounding bottom is generally firm. The reef is in the western end of St. George sound and south of the city of Eastpoint, in a Conditionally Approved shellfish harvesting area.

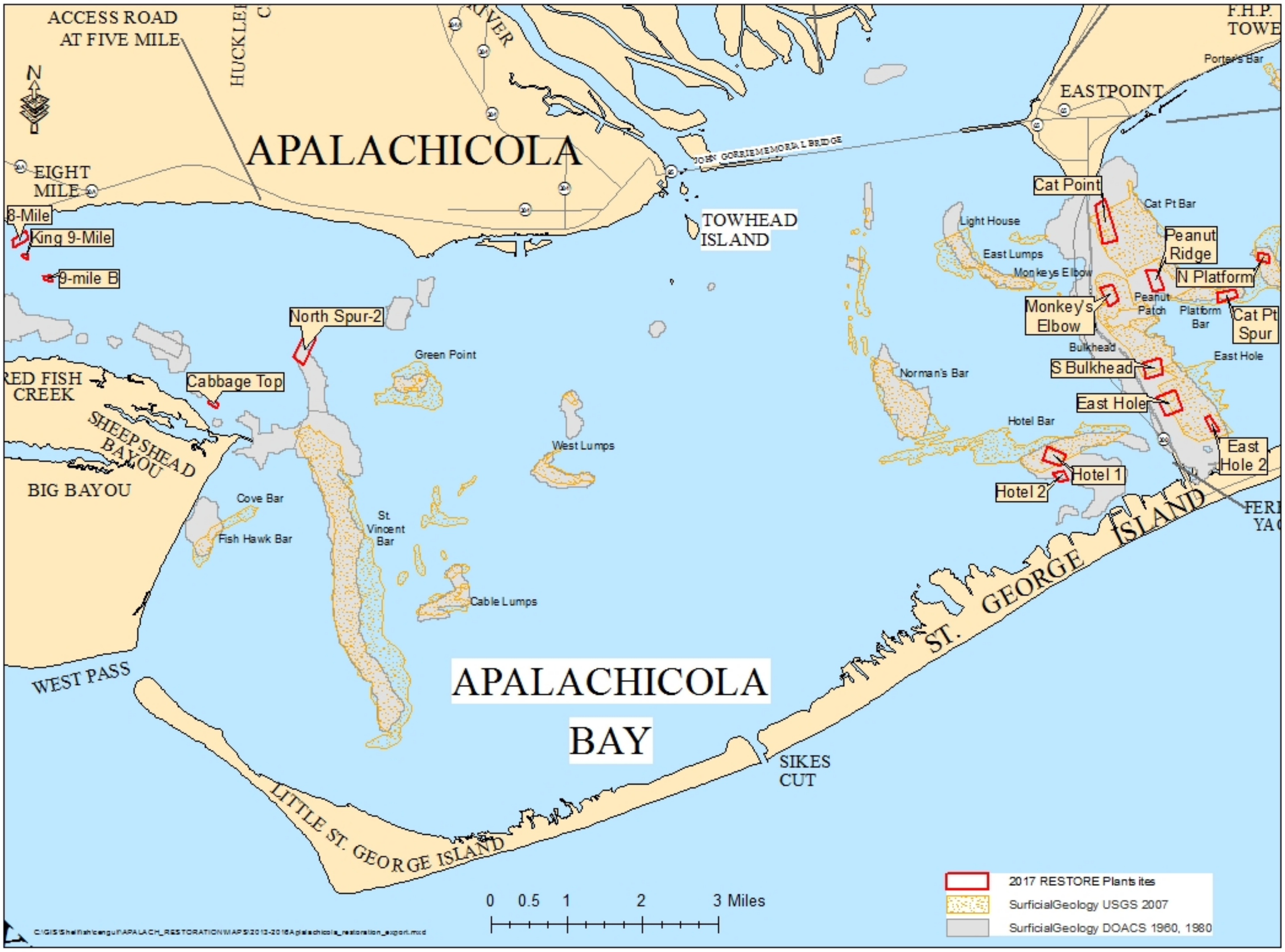

Figure 2: Map of RESTORE reefs in Apalachicola Bay prepared by FDACS. North Platform bar is not included in this report since the cultch placement for this site was funded through an alternate source.

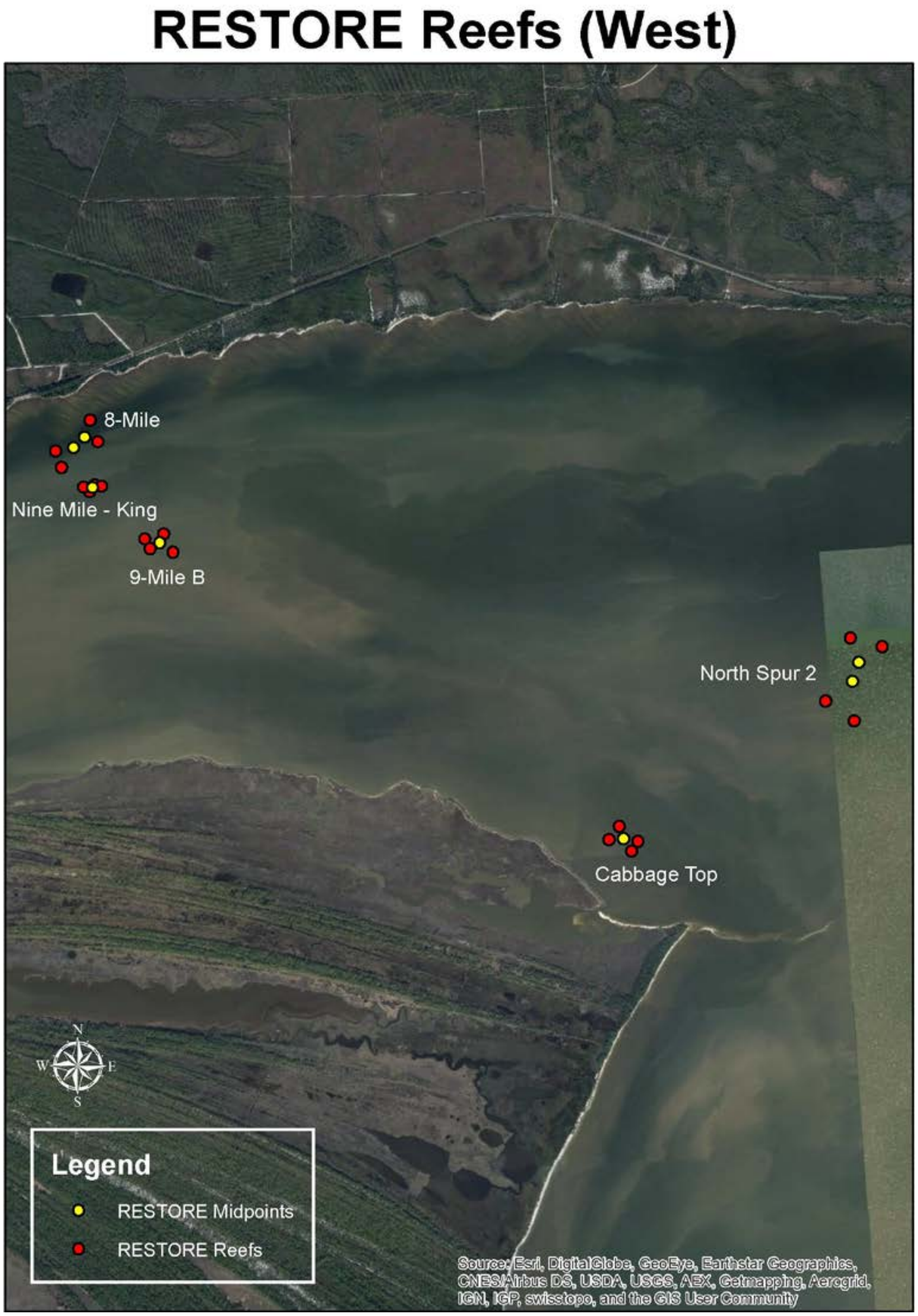

Figure 3: Map of midpoints on the west side of Apalachicola Bay.

RESTORE Reefs (East)

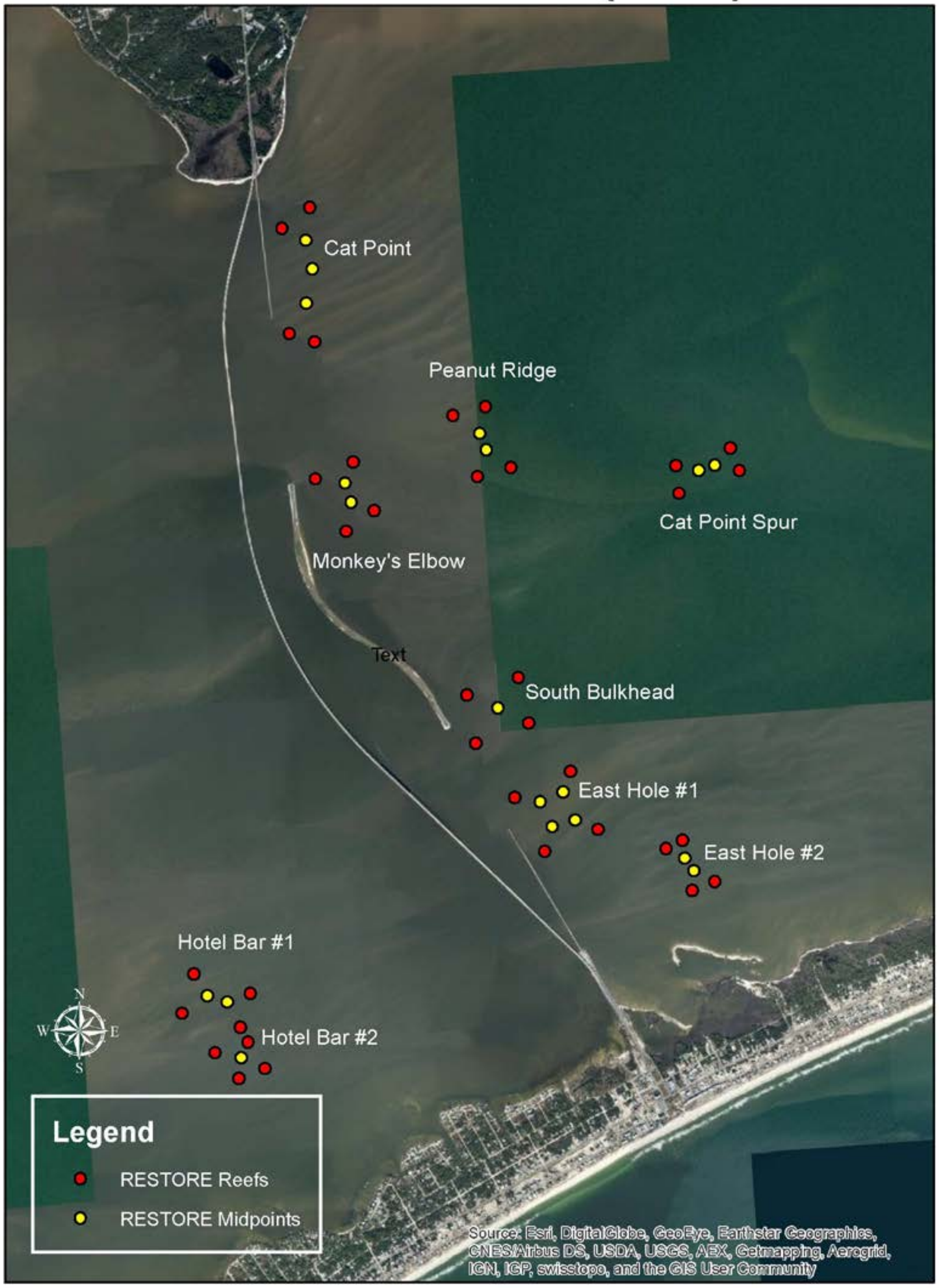

Figure 4: Map of midpoints on the east side of Apalachicola Bay.

Table 2: Coordinates for RESTORE monitoring sites in Apalachicola Bay

Monitoring Site	Latitude	Longitude
West		
Cabbage Top, Midpoint 1	29.68027	-85.08
8-Mile, Midpoint 1	29.71115	-85.1232
8-Mile, Midpoint 2	29.71185	-85.1222
9-Mile B, Midpoint 1	29.70388	-85.1166
King 9-Mile, Midpoint 1	29.70817	-85.1218
North Spur #2, Midpoint 1	29.69046	-85.0602
North Spur #2, Midpoint 2	29.69181	-85.0596
East		
Cat Point, Midpoint 1	29.71458	-84.8849
Cat Point, Midpoint 2	29.71672	-84.8843
Cat Point, Midpoint 3	29.71851	-84.8846
Cat Point Spur, Midpoint 1	29.70239	-84.8576
Cat Point Spur, Midpoint 2	29.70265	-84.8564
East Hole #1, Midpoint 1	29.68236	-84.8707
East Hole #1, Midpoint 2	29.68287	-84.869
East Hole #1, Midpoint 3	29.68105	-84.8682
East Hole #1, Midpoint 4	29.68076	-84.8699
East Hole #2, Midpoint 1	29.67819	-84.8606
East Hole #2, Midpoint 2	29.67736	-84.86
Hotel Bar #1, Midpoint 1	29.6717	-84.8955
Hotel Bar #1, Midpoint 2	29.67121	-84.8941
Hotel Bar #2, Midpoint 1	29.66765	-84.8934
Monkey’s Elbow, Midpoint 1	29.70315	-84.883
Monkey’s Elbow, Midpoint 2	29.70192	-84.8827
Peanut Ridge, Midpoint 1	29.70567	-84.8731
Peanut Ridge, Midpoint 2	29.70461	-84.8727
South Bulkhead, Midpoint 1	29.68843	-84.8732

Results

Apalachicola Bay RESTORE Oyster Reef Restoration sites were sampled from June – September 2018 (Round 1) and from June – August 2019 (Round 2). A total of 14 reef sites with a total of 26 midpoints (390 quadrats) were sampled during each round of sampling in Apalachicola Bay.

Note #2 **-** On October 10, 2018, Hurricane Michael impacted the Florida Panhandle as a Category 5 hurricane. As a result of the storm surge, the freezers used to store samples were tipped over, damaged beyond repair and without power for several days. Samples from three sites (East Hole #1, East Hole #2, and Monkey's Elbow) thawed, and became very difficult to process, as the oyster flesh had either washed away during the storm or been consumed by maggots. A total of 76 (19.5%) samples were affected, and for this reason, data at these sites are considered suspect. Specifically, the accuracy of the live vs. dead counts, oyster density, and shell height data remains unclear since the oyster samples were altered during the thawing process. Only samples from the previously mentioned sites during Round 1 of sampling were impacted by Hurricane Michael.

A total of 1958.81 kg (4318.44 lbs.) of oysters/shell material/rock was collected during Round 2 of sampling in Apalachicola Bay. To date, a total of 3664.35 kg (8078.51 lbs.) of oysters/shell material/rock has been collected from Apalachicola Bay, with an overall average sample weight of 4.7 kg (10.36 lbs.) across all sites for both rounds. Table 3 shows the average sample weight for both rounds of sampling. Where samples were found, Cabbage Top had the heaviest average sample weight at 8.20 kg, while King 9-Mile had the lightest at 1.94 kg during Round 2.

Table 3: Average sample weights per site for Round 1 and 2.

Site	Round 1 Average Sample Weight (kg)	Round 2 Average Sample Weight (kg)
8-Mile	4.02	2.77
9-Mile B	0.02	0.00
King 9-Mile	1.01	1.94
Cabbage Top	5.88	8.20
Cat Point	3.85	4.77
Cat Point Spur	4.15	7.66
East Hole #1	5.66	4.82
East Hole #2	4.22	4.81
Hotel Bar #1	3.87	4.86
Hotel Bar #2	3.77	4.89
Monkey's Elbow	4.64	6.35
North Spur #2	5.92	6.35
Peanut Ridge	4.05	5.02
South Bulkhead	7.10	6.30

During the second round of sampling, a total of 21,517 live oysters and 4,844 dead oysters were collected in Apalachicola Bay. The number of live and dead oysters increased from Round 1 to Round 2 (19,811 and 2,292, respectively) (Figure 5). A t-test showed that the difference in the number of live oysters in Round 1 compared to Round 2 was not statistically significant ($p>0.05$). Conversely, the difference in the number of dead oysters between rounds was statistically significant ($p=<0.05$).

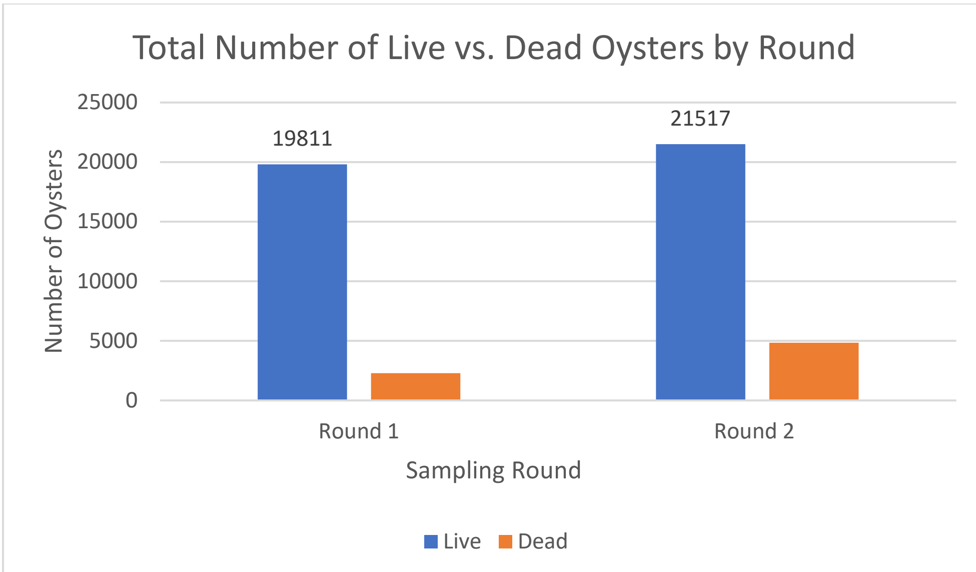

Figure 5: Total number of live vs. dead oysters for sampling round.

When comparing size classes among live oysters, spat-sized oysters were the most prevalent size class among both rounds (Figure 6). Although the overall number of spat-sized oysters decreased in Round 2, both seed and adult counts increased. The number of seed size oysters collected increased from 3,238 individuals to 9,031, and while no adult size oysters were found in Round 1, seven adult individuals were collected in Round 2.

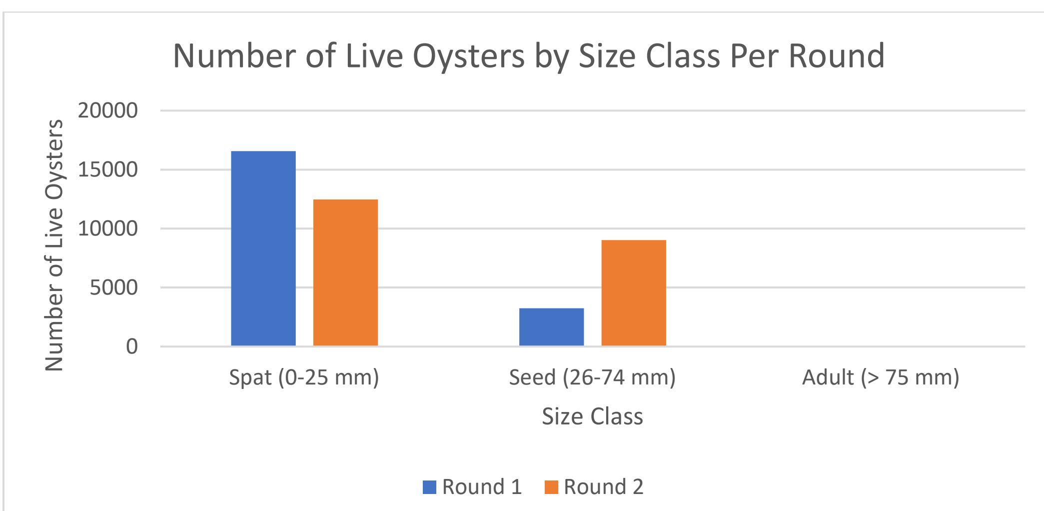

Figure 6: Number of live oysters per size class per sampling round.

Historically, Apalachicola Bay has been divided by geographic location in reference to the Apalachicola River for comparison of oyster success. Sites located to the east of the Apalachicola River (Cat Point, Cat Point Spur, East Hole #1, East Hole #2, Hotel Bar #1, Hotel Bar #2, Monkey's Elbow, Peanut Ridge, and South Bulkhead) were considered "East" sites, and those located to the west of the river (8-Mile, 9-Mile B, Cabbage Top, King 9-Mile and North Spur #2) were considered "West". It should be noted that the east side of Apalachicola Bay consisted of nine reefs and 285 quadrats, while the west side had five reefs and 105 quadrats.

A size class comparison of live oysters by side of bay (Figure 7) shows that the East side contributed more spat and seed sized oysters when compared to the West side for both rounds of sampling. While the number of spat on the East side decreased between Round 1 and Round 2, the number of seed size oysters collected increased from 2,732 to 7,585. The seven adult oysters collected during Round 2 were found on the East side of the bay.

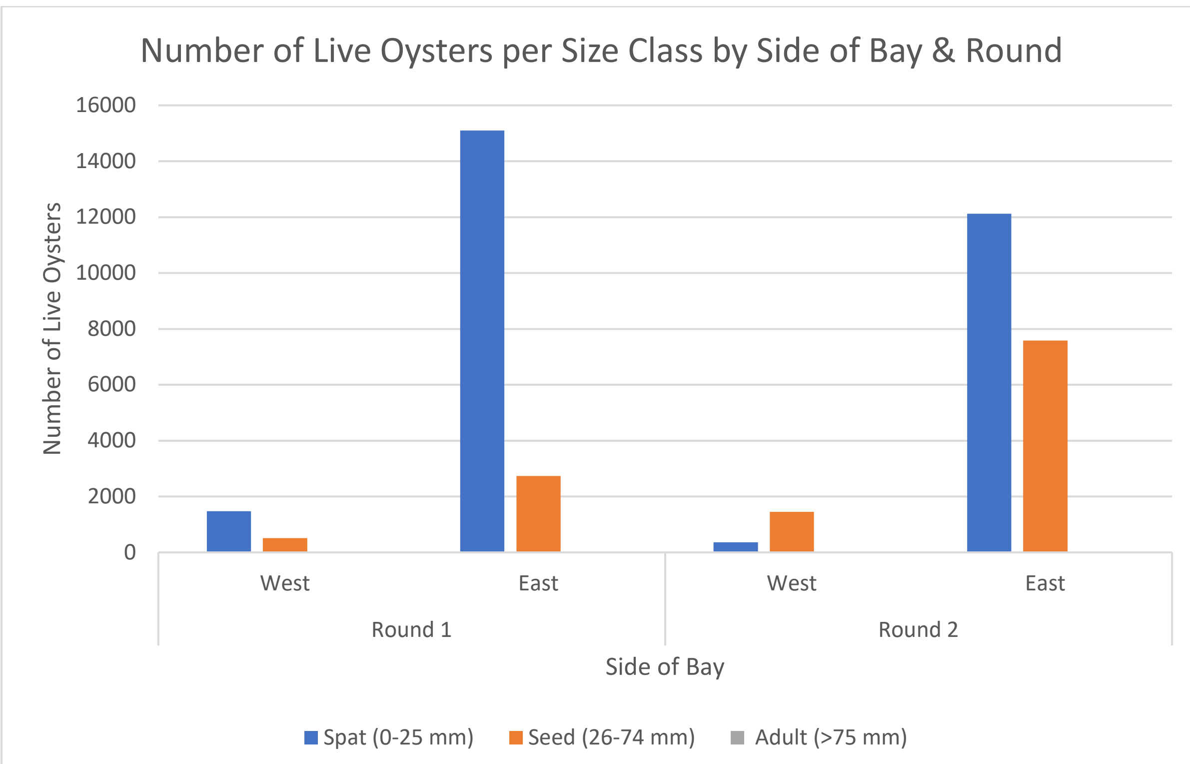

Figure 7: Number of live oysters per size class by side of bay and sampling round.

When further breaking down size class data by site, it becomes apparent that more than half of the sites saw a decrease in spat sized oysters during Round 2 (Figure 8), while 8-Mile, Cat Point, King 9-Mile, Monkey's Elbow, Peanut Ridge, and South Bulkhead all had an increase in spat sized oysters.

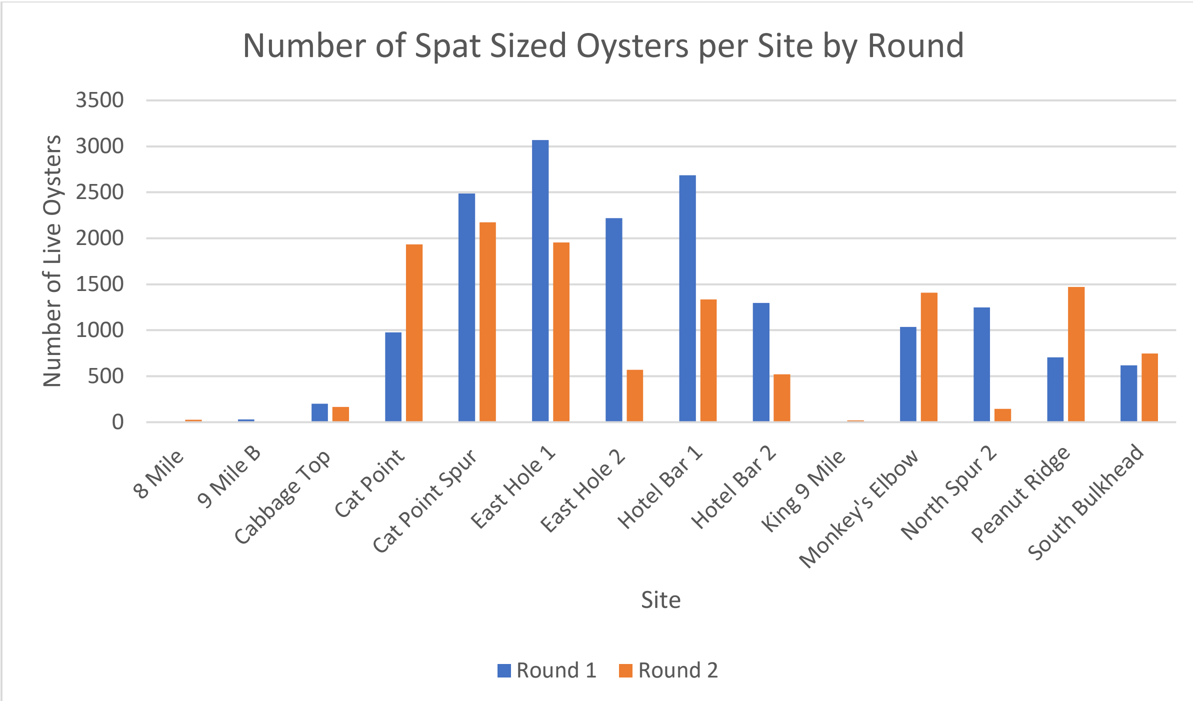

Figure 8: Number spat sized oysters per site by round.

In contrast, many sites in Apalachicola Bay saw an increase of seed size oysters from Round 1 to Round 2. The largest increase observed was at Cat Point Spur where, in Round 1, only 280 oysters were collected whereas in Round 2, 1,346 oysters were collected (Figure 9).

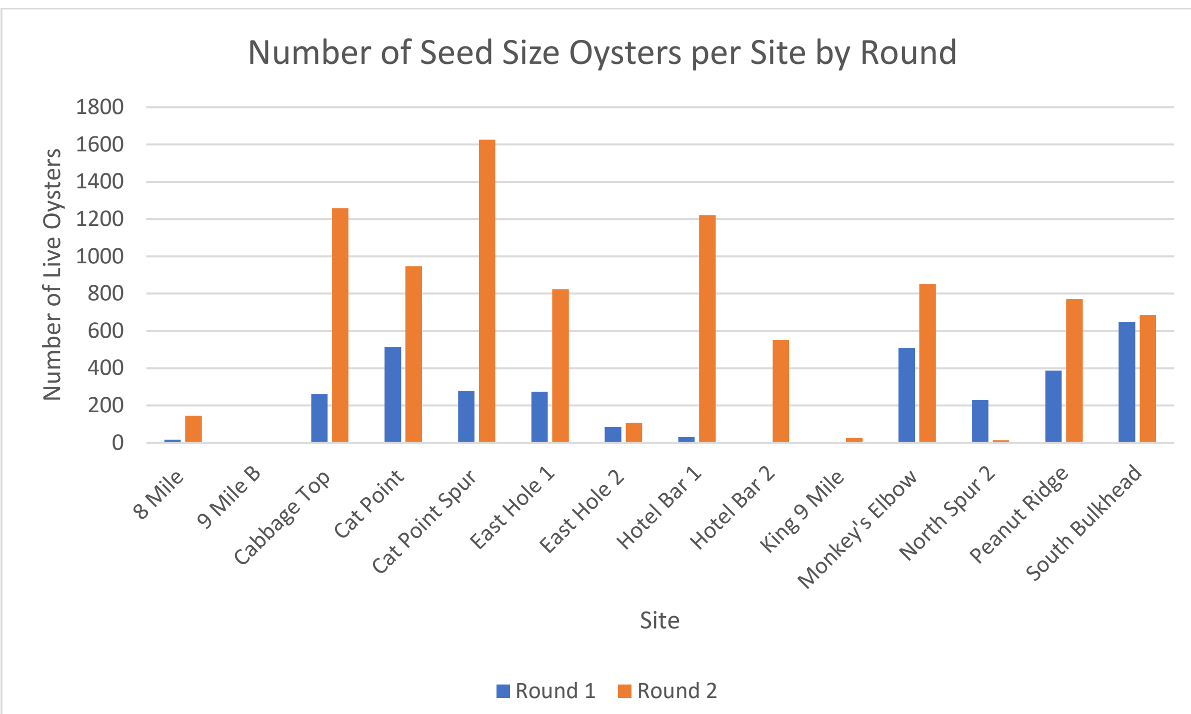

Figure 9: Number of seed sized oysters per site by round.

As previously stated, the majority of the live oysters collected during Round 2 of sampling were spat size. To further investigate the size distribution of live oysters in the bay, shell height distribution was plotted (Figure 10). The average shell height of oysters sampled in Apalachicola Bay increased from Round 1 (17.53 mm) to Round 2 (22.85 mm). A two-sample t-test of unequal variance showed that this increase was statistically significant ($p<0.05$).

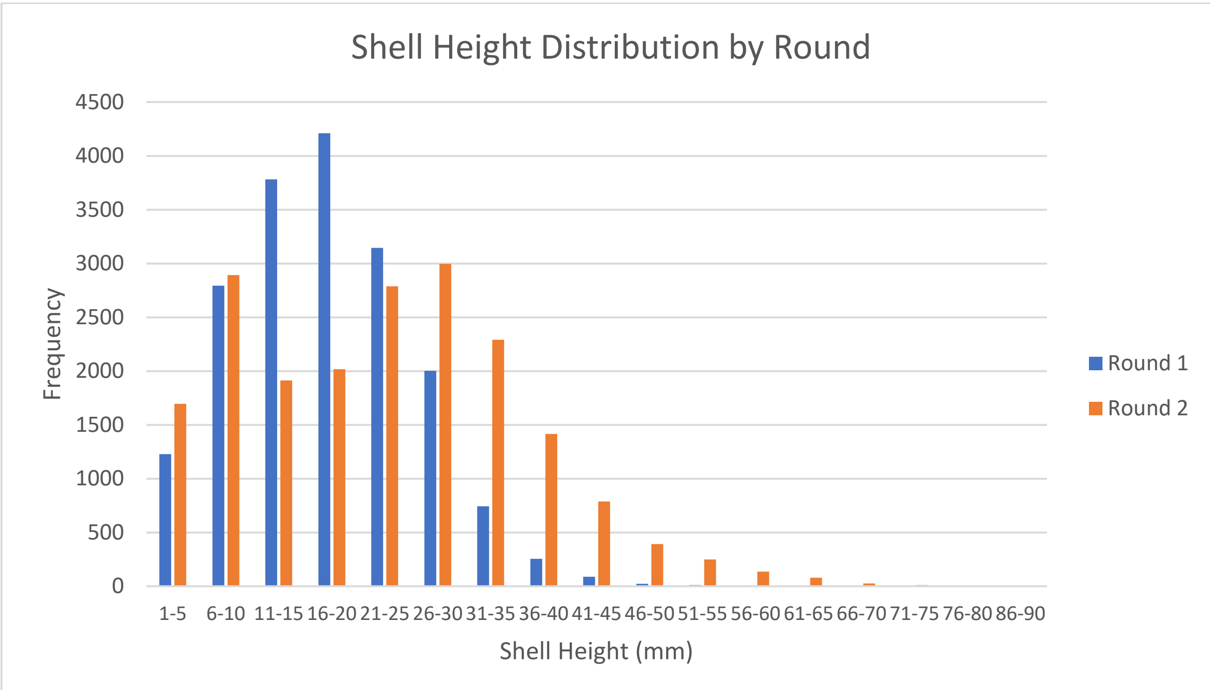

Figure 10: Shell height distribution by sampling round for the entire bay.

To account for any bias based on the difference in sampling effort, estimates of the density of live oysters (live oysters/m^2) were calculated. The estimated average density of live oysters for the entire bay was 203.19 oysters/m^2 for Round 1 and 220.69 oysters/m^2 for Round 2.

When comparing sides of the bay, the estimated density of live oysters was much greater on the East side during both rounds of sampling. The density for the East side of the bay for Round 1 and Round 2 were 250.22 oysters/m^2 and 276.65 oysters/m^2 respectively. For the West side of the bay, the density was 75.54 oysters/m^2 for Round 1 and 68.80 oysters/m^2 for Round 2. The estimated density increased slightly on the East side between rounds while it decreased slightly on the West side.

The estimated density of live oysters varied by site (Figure 11). Cat Point Spur had the highest estimated oyster density during both rounds of sampling, while 9-Mile B had the lowest. The sites that showed an increase in estimated oyster density between rounds include: 8-Mile, Cabbage Top, Cat Point, Cat Point Spur, King 9-Mile, Monkey’s Elbow, Peanut Ridge, and South Bulkhead. Sites that had decreased density estimates between rounds are: 9-Mile B, East Hole #1, East Hole #2, Hotel Bar #1, Hotel Bar #2, and North Spur 2.

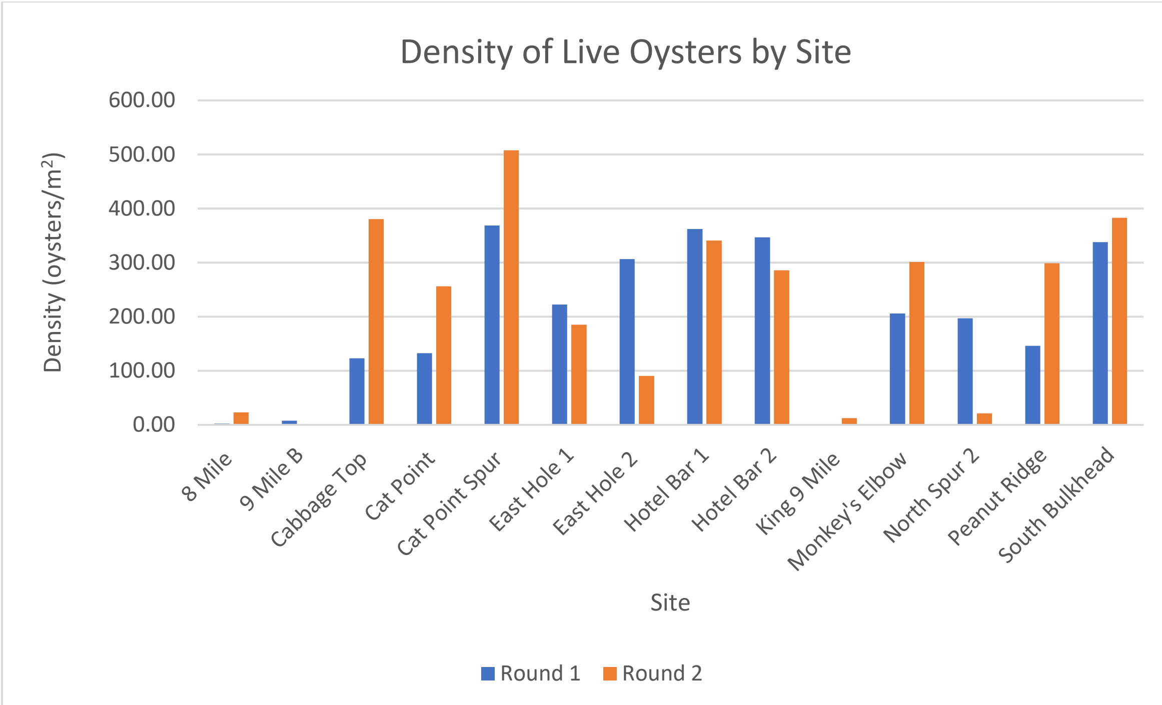

Figure 11: Estimated density of live oysters (oysters/m^2) by site and sampling round.

FDACS Standard Oyster Resource Management Protocol

FDACS protocols were used to estimate the number of bags of harvestable oysters per site (see Appendix 1). The calculations that were performed to estimate the number of bags per acre of legal harvest-sized oysters are shown in Table 4.

During Round 1, none of the sites sampled contained live adult (≥ 75mm) oysters. During Round 2, only seven adult oysters were collected throughout all sites. Therefore, all sites contain an estimated zero bags per acre for both rounds.

Table 4: Estimated bags per acre per site by sampling round.

Site	Round 1	Round 2
8-Mile	0	0.00
9-Mile B	0	0.00
Cabbage Top	0	0.00
Cat Point	0	0.03
Cat Point Spur	0	0.12
East Hole 1	0	0.00
East Hole 2	0	0.00
Hotel Bar 1	0	0.00
Hotel Bar 2	0	0.00
King 9 Mile	0	0.00

Monkey's Elbow	0	0.00
North Spur 2	0	0.00
Peanut Ridge	0	0.00
South Bulkhead	0	0.00

Reef Area

Determining the spatial extent of oyster reefs includes defining individual areal reef footprints (the entire area of the reef complex) in addition to defining reef area (the actual area of patches of living and nonliving substrate with or without live oysters) within reef footprints (Baggett et al. 2014). The bottom composition of each reef site was collected using Humminbird side-scan sonar. ReefMaster 2.0, a spatial analysis software, and ArcGIS Pro were used to process the collected imagery data and measure the average acreage of each RESTORE planting site (Table 5). RESTORE sites with the largest percentage of reef area respective to reef footprint include King 9-Mile (97.94%), Peanut Ridge (92.61%), and North Spur #2 (92.29%), while those with the smallest percentage of reef area respective to reef footprint include East Hole #1 (57.02%), South Bulkhead (58.85%), and Cat Point Spur (62.75%). Patches of substrate with or without oysters represent 75.14% (226.62 acres) of the approximately 302 total acres of RESTORE planting sites. As monitoring continues in year two, comparisons of reef spatial extent will be made to determine how reef area has changed over time.

Note #3: Bottom composition map projects displaying reef hardness were generated in ReefMaster 2.0. Each map project displayed a color palette associated with hardness values. All hardness values >50% were considered reef substrate and were measured in ArcGIS Pro to determine reef area values.

Table 5: Average reef area of cultched RESTORE restoration sites after Round 2 of sampling.

Site	**Reef Footprint (Acres)**	**Average Reef Area (Acres)**	**Reef Area: Footprint Area (%)**
8-Mile	13.89	11.53	82.97
9-Mile B	4.72	3.90	82.61
Cabbage Top	5.49	4.91	89.44
Cat Point	38.74	26.90	69.42
Cat Point Spur	18.82	11.81	62.75
East Hole #1	44.43	25.34	57.02
East Hole #2	12.77	11.07	86.65
Hotel Bar #1	27.51	21.30	77.43
Hotel Bar #2	11.70	10.10	86.32
King 9-Mile	0.97	0.95	97.94
Monkey’s Elbow	25.69	19.78	76.99
North Spur #2	38.80	35.81	92.29
Peanut Ridge	26.87	24.89	92.61
South Bulkhead	31.19	18.36	58.85
Total	**301.59**	**226.62**	**75.14**

Water Quality Monitoring

Water quality parameters (temperature, dissolved oxygen (DO), salinity, and pH) were recorded at each site midpoint, both at the surface and on the bottom of the water column (Appendix 2). This data provides a “snapshot” of the conditions at the time of sampling; as additional sampling occurs, the data, combined with other water quality data being collected in the bay, will be analyzed to investigate long-term trends in water quality at each site and across the bay.

Discussion

The Apalachicola Bay Oyster Reef Restoration project was designed to foster oyster reef habitat creation on existing reefs that had been degraded, depleted, or dormant. Fourteen debilitated oyster reefs received lime rock aggregate cultch material with the goal of recovering losses to oyster habitat and benthic secondary productivity. The cultch material was placed on the reefs to enhance the setting of native oyster larvae and oyster colonization. The FDACS cultching report states that approximately 317 acres of debilitated reef were cultched; however, upon measuring the cultched areas in ArcGIS Pro, CPAP determined that only approximately 302 acres were cultched. This was determined in ArcGIS Pro by measuring the perimeter of the cultched reefs based on the planting boundaries in the FDACS Oyster Cultch Deposition (FDACS, 2017). The cause of this discrepancy is unclear; however, it is the intent of the CPAP office to report any and all findings regarding this project.

Monitoring of the reefs is scheduled to occur for a period of two years beginning within six months (Round 1) of cultch completion, and then years 1 and 2 (Rounds 2 and 3, respectively) after cultching at restoration sites. During Round 1 of sampling, no live adult oysters were collected, which is to be expected, since in optimal conditions, oysters can reach market size in 12 to 18 months after settling (Ingle and Dawson, 1952). Although, some reefs may take 2 to 5 years to become productive due to variable recruitment and survival. The shell height distribution of each round is displayed in Figure 10. The majority of oysters occurred within 0-25 mm height range (spat size) in Round 1, and in ideal conditions, it is expected that those oysters would continue to grow, such that the majority of oysters collected in subsequent rounds would have a larger shell height range (seed or adult size). Overall, this increase in shell height was observed in Round 2; however, a large number of spat size oysters were also observed, especially on the East side of the bay. The West side of the bay exhibited a more anticipated shell height increase, with more seed size oysters being observed in Round 2. Although the majority of live oysters collected during Round 2 sampling were spat sized, the seed size class for the whole bay nearly tripled from Round 1 to Round 2 sampling. When considering site specific differences, the results show that twelve of the fourteen planting sites saw an increase in seed size oysters during Round 2 of sampling, which is to be expected. During Round 2, the only adult sized oysters were found at sites Cat Point and Cat Point Spur (Figure 10); to date, out of the ~3665 kg of oyster/shell/rock material collected, only seven adult size oysters have been observed.

It is unfortunate that mapping of the cultched reefs did not occur during the 6-month sampling period, as it would be ideal to compare initial cultched area versus the current reef area. At the end of the Year 1 sampling, based on the imagery collected, it appears that every reef has declined from original clutched reef footprint. Reefs were identified by looking at the textured areas from the mosaics generated in ReefMaster 2.0. It should be noted that this may not be representative of the actual bottom composition if multiple substrates (shell hash, rocks, etc.) are present and/or intermixed. Side-scan sonar mapping can also be complicated by murky and/or shallow waters. In some cases, reefs have become silted over; this can be seen in the mosaic imagery and has been noted in field observations. Lower frequencies of most side-scan sonar instruments can penetrate sediment layers and may indicate an exposed shell bottom where it is not actually present (Baggert, 2014). In addition, reef footprints may have also shifted outside respective GPS boundaries over time (via storms, currents, etc.) and therefore not recorded during the side-scan mapping process. Also, since very few adult size oysters have been collected, it is difficult to determine if the reefs are "growing" in size, whether it be horizontally or vertically. To obtain more accurate reef conditions, additional sampling locations could be added, or ground-truthing the reefs via transects could provide a more precise depiction of the reefs. It may be possible for mapping experts to be able to further process the side scan sonar imagery and produce more accurate reef area determinations.

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Appendix 1: FDACS Standard Oyster Resource Management Protocol

Introduction: The Florida Department of Agriculture and Consumer Services (FDACS) shares responsibility for managing oyster resources in Apalachicola Bay with the Florida Fish and Wildlife Conservation Commission (FWC); more specifically, the Division of Aquaculture manages oysters from both resource development and public health protection perspectives.

Oyster Resource Assessments: The Division has conducted oyster resource surveys on the principle oyster-producing reefs in Apalachicola Bay since 1982. This information is used by resource managers to reliably predict trends in oyster production; to monitor oyster population dynamics, including recruitment, growth, natural mortality, standing stocks; and to determine the impacts of climatic events such as hurricanes, floods, and droughts.

Continuous monitoring and data analyses have allowed resource managers to develop a scale using defined sampling protocol to determine the relative condition of oyster resources based on estimated production parameters. Estimated production exceeding 400 bags of oysters per acre is applied as an indicator of healthy oyster reefs capable of sustaining commercial harvesting. Accordingly, oyster populations are 1) capable of supporting limited commercial harvesting when stocks exceed 200 bags/acre, 2) below levels necessary to support commercial harvesting when stocks fall below 200 bags/acre, and 3) considered depleted when marketable stocks are below 100 bags/acre. Generally, production from Cat Point Bar has been the most accurate indicator of oyster production in Apalachicola Bay, but East Hole Bar and St. Vincent Bar are also reliable indicators of the condition of oyster resources throughout the Bay. This scale forms the basis for the Standard Resource Management Protocol provided in Subsection 68B-27.017, Florida Administrative Code (FAC), which is used as the criteria for setting the number of harvesting days in the Winter Harvesting Season in Apalachicola Bay. Subsection 68B-27.017(2)(a), FAC, provides that oysters may be harvested for commercial purposes on any day of the week from November 16 to May 31 of each year when the Bay is not closed for public health purposes and when the oyster resources on Cat Point Bar and East Hole Bar can sustain a harvest of 300 bags of oysters per acre.

CREATION OF POPULATION ESTIMATES

Background: In 1985, hurricanes Kate and Elena devastated a majority of the oyster reefal complexes in Apalachicola Bay. In 1986, comprehensive management programs and regulatory restrictions were implemented to foster resource recovery and facilitate restoration. During this period, a massive oyster reefal complex refurbishment project was undertaken wherein; 385 acres were planted, using 96,230 cubic yards of clam shell.

Evaluating: Oyster populations were compared using the Kruskal-Wallis test to determine significant differences between length-frequency distributions among replicate samples and between successive sampling intervals.

Transects were established across the restored reef and quadrats were selected along transects by tossing a PVC grid from the survey vessel.

Specifics: a weighted 0.25m^2 PVC grid was used to delineate sample quadrats. Samples were collected by divers; live oysters, shell and associated fauna were removed to a depth of 15cm, placed in mesh collecting bags and delivered to the survey vessel. Live oysters were measured to the nearest lower 0.5cm length.

Oysters ≥25mm were used in population estimates.
Oysters 50-70mm were used to predict growth rates, mortality rates and recruitment into marketable size classes.
Oysters ≥75mm were used to provide estimates of marketable oysters/m^2 and densities were extrapolated to calculate potential production levels.

Ingle and Whitfield (1968 & 1973) estimated that about 400 bu/acre could be harvested from productive artificially constructed reefs within two years of planting cultch. A scale was developed using field surveys of natural and constructed bars in Apalachicola Bay to determine the relative condition of oyster resources based on production estimates.

Production:
Estimates:

- >400 bags/acre – healthy oyster reefs capable of sustaining commercial harvest
- >200 bags/acre – capable of sustaining limited commercial harvest.
- <200 bags/acre – below level necessary to support commercial harvest
- <100 bags/acre – considered depleted

CALCULATIONS FOR ASSESSING POPULATION ESTIMATES FROM FIELD SURVEYS

Example from Cat Point 09/08 data set:

Date	Quadrats (Total #)	Oyster (Total #)	Mean Length	Density (/m)	>50mm (%)	≥75mm (%)	(/m)	1000x (/ac)	Bags (/ac)
09/08	20 [1]	616 [2]	55.2 [3]	123.2 [4]	66.2 [5]	17.21 [6]	21.2 [7]	85.8 [8]	381 [9]

[1] Total # of quadrats sampled
[2] Total # of all oysters in all quadrats
[3] Mean Length derived from Statistical Analysis Software programs
[4] Total Oysters/No. of Quadrats; Oysters/0.25m^2 x 4 = Oysters/m^2
[5] % > 45mm on histograms (use cumulative %)
[6] % > 70mm on histograms (use cumulative %)
[7] % >70mm [6] x Density [4] = Oysters ≥75 m^2
Example: 0.1721 x 123.2 = 21.20 (/m)
[8] % >70mm [6] x Density [4] x 4,047 = oyster ≥75mm / acre; divided by 1,000
Example: 0.1721 x 123.2 x 4,047 = 85,807.4; /1,000 = 85.8 (/ac)
[9] Oysters/Acre divided by 225 oysters/bag
Example: 85,807.4 /225 = 381.36

Explanations:

[1] Total # of quadrats sampled:

The total number of quadrats collected at a sampling station may vary by date based on field conditions, time constraints and sampling rationale (pollution events). This will obviously affect total number of oysters collected and then also affect density of oysters per meter square. This must be taken into consideration when comparing/contrasting multiple sites over time.

[2] Total # of all oysters in all quadrats

As with the total number of quadrats, the total number of oysters collected at a sampling station may vary by date based on field conditions, time constraints and sampling rationale (pollution events). This will also obviously affect the density of oysters per meter square. This must be taken into consideration when comparing/contrasting multiple sites over time.

[3] Mean Length

[5] % >45mm (info to generate histograms)

[6] % >70mm (info to generate histograms)

The entire aforementioned are derived from Statistical Analysis Software (SAS) programs.

[4] Total Oysters/No. of Quadrats; Oysters/0.25m^2 x 4 = Oysters/m^2

Intuitively, the total number of oysters per quarter-meter square quadrat is multiplied by 4 in order to acquire total number of oysters per meter square.

[7] % >70mm [6] x Density [4] = Oysters >75 m^2

The percentage of oysters greater than 70 mm (~ 3 inches; standard legal size oyster) multiplied by the density yields the number of legal size oysters per meter. This information is key for assessing population trends and assessing the productivity of a given oyster reefal complex.

[8] % >70mm [6] x Density [4] x 4,047 = oyster >75mm / acre

The percentage of oysters greater than 70 mm (~ 3 inches; standard legal size oyster) multiplied by the density, and then multiplied by 4,047 (no. of square meters in an acre) yields the total number of oysters per acre.

[9] Oysters/Acre divided by 225 oysters per bag

Through historical sampling of oyster catch volumes it has been determined that the average 60 lb. bag contains approximately 225 legal sized (3 inches or greater) oysters or the approximate number of legal sized oysters which could be contained in two (2) five gallon buckets. The value of legal sized oysters per acre total is the most important result from our calculations as it allows us to make management decisions related to the oyster fishery.

Appendix 2: Water Quality Data, Rounds 1 and 2.

Round	Site	Midpoint	Surface/ Bottom	Depth (m)	Temperature (Celcius)	DO (%)	DO (mg/L)	Specific Conductivity	Salinity (ppt)	pH
Round 1	Cabbage Top	MP1	Surface	0.1	30.1	77.6	4.87	55434	36.6	7.94
Round 1	Cabbage Top	MP1	Bottom	1	30	89.3	5.22	55437	36.62	8.04
Round 1	North Spur 2	MP1	Surface	0.1	29.9	104.9	6.53	55376	36.58	8.09
Round 1	North Spur 2	MP1	Bottom	1.5	29.6	88.2	5.49	55546	36.72	8.03
Round 1	North Spur 2	MP2	Surface	0.1	29.9	104.9	6.53	55376	36.58	8.09
Round 1	North Spur 2	MP2	Bottom	1.7	29.6	88.2	5.49	55546	36.72	8.03
Round 1	Hotel Bar 1	MP1	Surface	0.1	30.1	107.4	7.18	38105	24.02	8.16
Round 1	Hotel Bar 1	MP1	Bottom	1.6	30.1	89.3	5.65	49638	33.19	8.02
Round 1	8 Mile	MP1	Surface	0.1	27.9	92.4	6.74	22730	13.66	7.96
Round 1	8 Mile	MP1	Bottom	1.2	28.4	71.8	5.18	24298	14.59	7.73
Round 1	8 Mile	MP2	Surface	0.1	27.9	92.4	6.74	22730	13.66	7.96
Round 1	8 Mile	MP2	Bottom	1.3	28.4	71.8	5.18	24298	14.59	7.73
Round 1	King 9 Mile	MP1	Surface	0.1	28.1	102.7	7.45	22995	13.83	8.09
Round 1	King 9 Mile	MP1	Bottom	1.4	28.7	78	5.5	26231	15.97	7.87
Round 1	9 Mile B	MP1	Surface	0.1	29.4	98.7	6.18	55562	36.73	7.91
Round 1	9 Mile B	MP1	Bottom	1.6	29.4	97.5	6.1	55659	36.8	7.96
Round 1	Hotel Bar 1	MP2	Surface	0.1	30.1	107.4	7.18	38105	24.02	8.16
Round 1	Hotel Bar 1	MP2	Bottom	1.8	30.1	89.3	5.65	49638	33.19	8.02
Round 1	Hotel Bar 2	MP1	Surface	0.1	31.3	106.7	6.93	39451	24.98	8.16
Round 1	Hotel Bar 2	MP1	Bottom	1.3	30.3	111.9	7.35	40422	25.57	8.17
Round 1	Cat Point	MP1	Surface	0.1	28.8	81.3	5.7	28661	17.58	7.96
Round 1	Cat Point	MP1	Bottom	1.6	29	74.1	5.12	29229	17.97	7.91
Round 1	Cat Point	MP2	Surface	0.1	28.8	81.3	5.7	28661	17.58	7.96
Round 1	Cat Point	MP2	Bottom	1.4	29	74.1	5.12	29229	17.97	7.91
Round 1	Cat Point	MP3	Surface	0.1	28.8	81.3	5.7	28661	17.58	7.96
Round 1	Cat Point	MP3	Bottom	1.4	29	74.1	5.12	29229	17.97	7.91
Round 1	Cat Point Spur	MP2	Surface	0.1	29.1	98.6	6.9	27758	16.98	8.18
Round 1	Cat Point Spur	MP2	Bottom	1.8	29	90.9	6.37	27938	17.1	8.15
Round 1	Cat Point Spur	MP1	Surface	0.1	29.1	98.6	6.9	27758	16.98	8.18
Round 1	Cat Point Spur	MP1	Bottom	2	29	90.9	6.37	27938	17.1	8.15
Round 1	Peanut Ridge	MP1	Surface	0.1	29	89.1	6.09	33730	21.75	8.09
Round 1	Peanut Ridge	MP1	Bottom	1.7	29	87.5	5.98	33731	21.05	8.1
Round 1	Peanut Ridge	MP2	Surface	0.1	29.1	90.1	6.15	33924	21.18	8.1
Round 1	Peanut Ridge	MP2	Bottom	1.6	29.1	89.4	6.09	33923	21.18	8.08
Round 1	Monkeys Elbow	MP1	Surface	0.1	28.9	84.2	5.53	45375	29.26	8
Round 1	Monkeys Elbow	MP1	Bottom	1.8	28.9	80.6	5.26	47531	30.88	7.99
Round 1	Monkeys Elbow	MP2	Surface	0.1	28.9	84.2	5.53	45375	29.26	8
Round 1	Monkeys Elbow	MP2	Bottom	1.7	28.9	80.6	5.26	47531	30.88	7.99
Round 1	East Hole 2	MP2	Surface	0.1	29	91	5.95	46703	30.23	8.08
Round 1	East Hole 2	MP2	Bottom	1.6	29	89.9	5.88	46710	30.23	8.05
Round 1	East Hole 2	MP1	Surface	0.1	29	91	5.95	46703	30.23	8.08
Round 1	East Hole 2	MP1	Bottom	1.2	29	89.9	5.88	46710	30.23	8.05
Round 1	East Hole 1	MP1	Surface	0.1	29.2	89.8	6.01	38031	24.03	8.09
Round 1	East Hole 1	MP1	Bottom	1.1	29.3	87.6	5.88	38042	24.04	8.08
Round 1	East Hole 1	MP2	Surface	0.1	29.2	89.8	6.01	38031	24.03	8.09
Round 1	East Hole 1	MP2	Bottom	1	29.3	87.6	5.88	38042	24.04	8.08
Round 1	East Hole 1	MP3	Surface	0.1	29.4	88.6	5.96	36821	23.15	8.08
Round 1	East Hole 1	MP3	Bottom	1.5	29.4	85.8	5.75	37266	23.5	8.06

Round 1	East Hole 1	MP4	Surface	0.1	29.4	88.6	5.96	36821	23.15	8.08
Round 1	East Hole 1	MP4	Bottom	1.5	29.4	85.8	5.75	37266	23.5	8.06
Round 1	South Bulkhead	MP1	Surface	0.1	29.8	93.7	6.29	35725	22.41	8.15
Round 1	South Bulkhead	MP1	Bottom	1.1	29.8	91.4	6.14	35725	22.41	8.1
Round 2	Hotel Bar 2	MP1	Surface	0.1	28.8	95.2	6.45	34102	23.3	7.94
Round 2	Hotel Bar 2	MP1	Bottom	1.3	28.8	80.6	5.46	38933	24.65	7.88
Round 2	Hotel Bar 1	MP2	Surface	0.1	28.7	97	6.7	32647	20.31	7.96
Round 2	Hotel Bar 1	MP2	Bottom	1.8	28.9	91.7	6.19	38059	24.08	7.93
Round 2	Hotel Bar 1	MP1	Surface	0.1	28.7	97	6.7	32647	20.31	7.96
Round 2	Hotel Bar 1	MP1	Bottom	1.9	28.9	91.7	6.19	38059	24.08	7.93
Round 2	East Hole 2	MP1	Surface	0.1	29.3	99	6.78	33613	20.96	7.92
Round 2	East Hole 2	MP1	Bottom	2.16	29.7	91.8	6.13	38150	24.1	7.97
Round 2	East Hole 2	MP2	Surface	0.1	29.3	99	6.78	33613	20.96	7.92
Round 2	East Hole 2	MP2	Bottom	2.23	29.7	91.8	6.13	38150	24.1	7.97
Round 2	South Bulkhead	MP1	Surface	0.1	29.6	101.9	6.74	41464	26.46	7.95
Round 2	South Bulkhead	MP1	Bottom	1.98	29.6	100.4	6.63	41525	26.49	7.98
Round 2	North Spur 2	MP2	Surface	0.1	29.8	96.9	6.46	37276	23.49	8.04
Round 2	North Spur 2	MP2	Bottom	2.38	29.9	86.2	5.5	45846	29.58	7.95
Round 2	North Spur 2	MP1	Surface	0.1	29.8	96.9	6.46	37276	23.49	8.04
Round 2	North Spur 2	MP1	Bottom	2.44	29.9	86.2	5.5	45846	29.58	7.95
Round 2	8 Mile	MP1	Surface	0.1	30.7	125.7	9	14429	8.3	8.4
Round 2	8 Mile	MP1	Bottom	1.98	30.5	52.4	3.53	32198	20.03	7.92
Round 2	8 Mile	MP2	Surface	0.1	30.7	125.7	9	14429	8.3	8.4
Round 2	8 Mile	MP2	Bottom	2.01	30.5	52.4	3.53	32198	20.03	7.92
Round 2	King 9 Mile	MP1	Surface	0.1	31.1	124.2	8.85	14900	8.59	8.37
Round 2	King 9 Mile	MP1	Bottom	2.29	31	80.1	5.28	35220	22.08	7.89
Round 2	9 Mile B	MP1	Surface	0.1	30.8	117.6	8.46	13599	7.78	8.33
Round 2	9 Mile B	MP1	Bottom	2.26	31.3	117.7	8.47	13925	7.99	8.29
Round 2	Cabbage Top	MP1	Surface	0.1	30.5	115.5	8.26	16407	9.55	8.22
Round 2	Cabbage Top	MP1	Bottom	1.46	30.8	110.5	7.88	17444	10.19	8.18
Round 2	East Hole 1	MP3	Surface	0.1	28.7	94.9	6.28	44112	28.36	7.99
Round 2	East Hole 1	MP3	Bottom	2.19	28.7	94	6.22	44114	28.37	8
Round 2	East Hole 1	MP4	Surface	0.1	28.7	94.9	6.28	44112	28.36	7.99
Round 2	East Hole 1	MP4	Bottom	2.38	28.7	94	6.22	44114	28.37	8
Round 2	East Hole 1	MP2	Surface	0.1	29.2	99	6.53	43283	27.76	7.88
Round 2	East Hole 1	MP2	Bottom	1.77	29.2	98.8	6.51	43287	27.76	7.93
Round 2	East Hole 1	MP1	Surface	0.1	29.2	99	6.53	43283	27.76	7.88
Round 2	East Hole 1	MP1	Bottom	1.77	29.2	98.8	6.51	43287	27.76	7.93
Round 2	Cat Point	MP3	Surface	0.1	30.3	78.6	5.3	31076	19.2	7.96
Round 2	Cat Point	MP3	Bottom	1.77	30.3	77.8	5.26	31076	19.2	8.01
Round 2	Cat Point	MP2	Surface	0.1	30.3	78.6	5.3	31076	19.2	7.96
Round 2	Cat Point	MP2	Bottom	1.83	30.3	77.8	5.26	31076	19.2	8.01
Round 2	Cat Point	MP1	Surface	0.1	30.3	78.6	5.3	31076	19.2	7.96
Round 2	Cat Point	MP1	Bottom	2.13	30.3	77.8	5.26	31076	19.2	8.01
Round 2	Monkeys Elbow	MP1	Surface	0.1	30.4	93.9	6.35	30703	18.95	8
Round 2	Monkeys Elbow	MP1	Bottom	2.29	30.4	92.3	6.24	30811	19.02	8.03
Round 2	Monkeys Elbow	MP2	Surface	0.1	27.7	96.4	6.66	37398	23.63	7.08
Round 2	Monkeys Elbow	MP2	Bottom	2.38	27.7	95.2	6.59	37409	23.64	7.37
Round 2	Peanut Ridge	MP2	Surface	0.1	27.8	99.7	6.89	37290	23.55	7.58
Round 2	Peanut Ridge	MP2	Bottom	2.04	27.8	98.1	6.78	37289	23.55	7.65
Round 2	Peanut Ridge	MP1	Surface	0.1	27.8	99.7	6.89	37290	23.55	7.58

Round 2	Peanut Ridge	MP1	Bottom	1.83	27.8	98.1	6.78	37289	23.55	7.65
Round 2	Cat Point Spur	MP1	Surface	0.1	29	99.5	6.79	35021	21.94	7.91
Round 2	Cat Point Spur	MP1	Bottom	2.59	29.2	83.1	5.56	37074	23.38	7.91
Round 2	Cat Point Spur	MP2	Surface	0.1	29	99.5	6.79	35021	21.94	7.91
Round 2	Cat Point Spur	MP2	Bottom	1.68	29.2	83.1	5.56	37074	23.38	7.91