Oyster Restoration
Pre-construction Site Assessment of the Manokin River Sanctuary

Prepared by Oyster Recovery Partnership for Maryland Department of Natural Resources

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Introduction

As part of the 2014 Chesapeake Bay Watershed Agreement, Maryland committed to restoring oyster populations in five tributaries in Maryland's portion of the Chesapeake Bay by 2025. The fifth tributary selected for restoration within Maryland's waters is the Manokin River. This tributary is located on the lower eastern portion of Maryland's Chesapeake Bay and has been closed to wild commercial harvest since 2010. The mouth of the river empties into Tangier Sound and this area has historically exhibited strong oyster recruitment.

The Maryland Interagency Workgroup (hereafter Workgroup), tasked with overseeing the restoration of the tributary, used data from Maryland Department of Natural Resources (DNR) patent tong surveys conducted in 2012, 2015, 2017 and 2018 to determine the status of the oyster populations on habitat within the sanctuary. The National Oceanic and Atmospheric Administration (NOAA) completed additional GIS analysis to classify the condition and distribution of oyster habitat, and this information was used to determine initial restoration construction areas: premet (defined as already meeting density and biomass targets), seed-only, and substrate and seed. Premet reefs were estimated to be 20 acres, seed-only restoration reefs were estimated to be 305 acres, and substrate and seed restoration reefs were estimated to be 438 acres (Table 1).

The accuracy of pre-classified habitats is assessed through groundtruthing using patent tongs. Therefore, the goal of this survey was to collect patent tong data to evaluate all habitats and determine the final classification for planning of planting in 2020 and beyond. In fall of 2019, a systematic patent tong survey was used to evaluate roughly 75 acres of habitat. Additional surveys will take place over the next several years, encompassing between 401 to 763 acres.

TABLE 1. THE GENERAL GUIDELINES FOR DETERMINING THE MOST APPROPRIATE TYPE OF RESTORATION.

	General Premet Criteria	General Seed-Only Criteria	General Substrate and Seed Restoration Criteria
Depth	4-20 ft	4-20 ft	7-20 ft
Bottom Type	on shell dominant bottom, sand, sand & shell, muddy sand, muddy sand & shell, and sandy mud & shell (not on shell dominant bottom) also on hard subsurface sediments identified by sub-bottom profiling sonar	on shell dominant bottom	sand, sand & shell, muddy sand, muddy sand & shell, and sandy mud & shell (not on shell dominant bottom). also on hard subsurface sediments identified by sub-bottom profiling sonar
Oyster Density	> 50 per m^2 (also oyster biomass > 50 g per m^2)	<50 per m^2	< 5 per m^2
Lease Proximity	Not within 150 ft of leases	Not within 150 ft of leases	Not within 150 ft of leases
Navigation Aid Proximity	Not within 250 ft of navigation aids	Not within 250 ft of navigation aids	Not within 250 ft. of navigation aids
Dock Proximity	Not within 50 ft of private docks	Not within 50 ft of private docks	Not within 250 ft. of private docks
SAV Proximity	No intersection with SAV beds	No intersection with SAV beds	No intersection with SAV beds

This report details the methods and results for the first round of pre-construction habitat assessment.

Methods

Ten days of sampling were conducted in September and October 2019 aboard a contracted vessel, the F/V *Billie Jean.* After conversations with DNR staff, seven sites were chosen for the first round of surveys (Table 2). Project partners wanted to focus on sites in the 7-20ft depth range, and sites that would allow for at least 50 acres of seeding in spring 2020. Additionally, areas located near sites classified as needing substrate and seed restoration with little existing patent tong data were targeted.

TABLE 2. SEED-ONLY SITES DESIGNATED FOR THE FIRST ROUND OF MANOKIN SANCTUARY PRE-CONSTRUCTION SURVEYS. PATENT TONG DATA COMES FROM DNR SURVEYS OVER THE PERIOD OF 2012-18.

Site ID	Area (acres)	Patent Tong primary bottom type	CMECS Classification
SO_11	51.7	Mud shell grit	Biogenic oyster rubble, mud
SO_25	3.7	Mud sand	Biogenic oyster rubble, sand
SO_26	4.7	Mud	Biogenic oyster reef, mud
SO_28	5.7	N/A	Biogenic oyster rubble
SO_29	5.1	Mud sand	Anthropogenic shell
SO_34	1.9	Mud	Biogenic oyster
SO_35	2.3	N/A	Biogenic oyster rubble, mud

The methods implemented during the Manokin Sanctuary surveys are similar to the Upper St. Mary's River Oyster Restoration Tributary Plan (ORP, 2019b). Assessment protocols require fine-scale resolution information to determine whether benthic habitats are suitable for oyster population growth. For the first round of pre-construction surveys, a 25 x 25m grid was created in ArcGIS (ESRI ArcMap version 10.7.1) and overlaid on the target sites (Figure 1). When creating sample grids on irregularly shaped polygons, some resulting cells are too small or too narrow to sampled effectively. In this case, cells under 250m^2 were removed. ORP staff then created target sample points in the centroid of each grid cell. Future analysis will be conducted to determine if a 35 x 35 m grid or 50 x 50 m grid could be utilized in future surveys to increase efficiency while producing the same results.

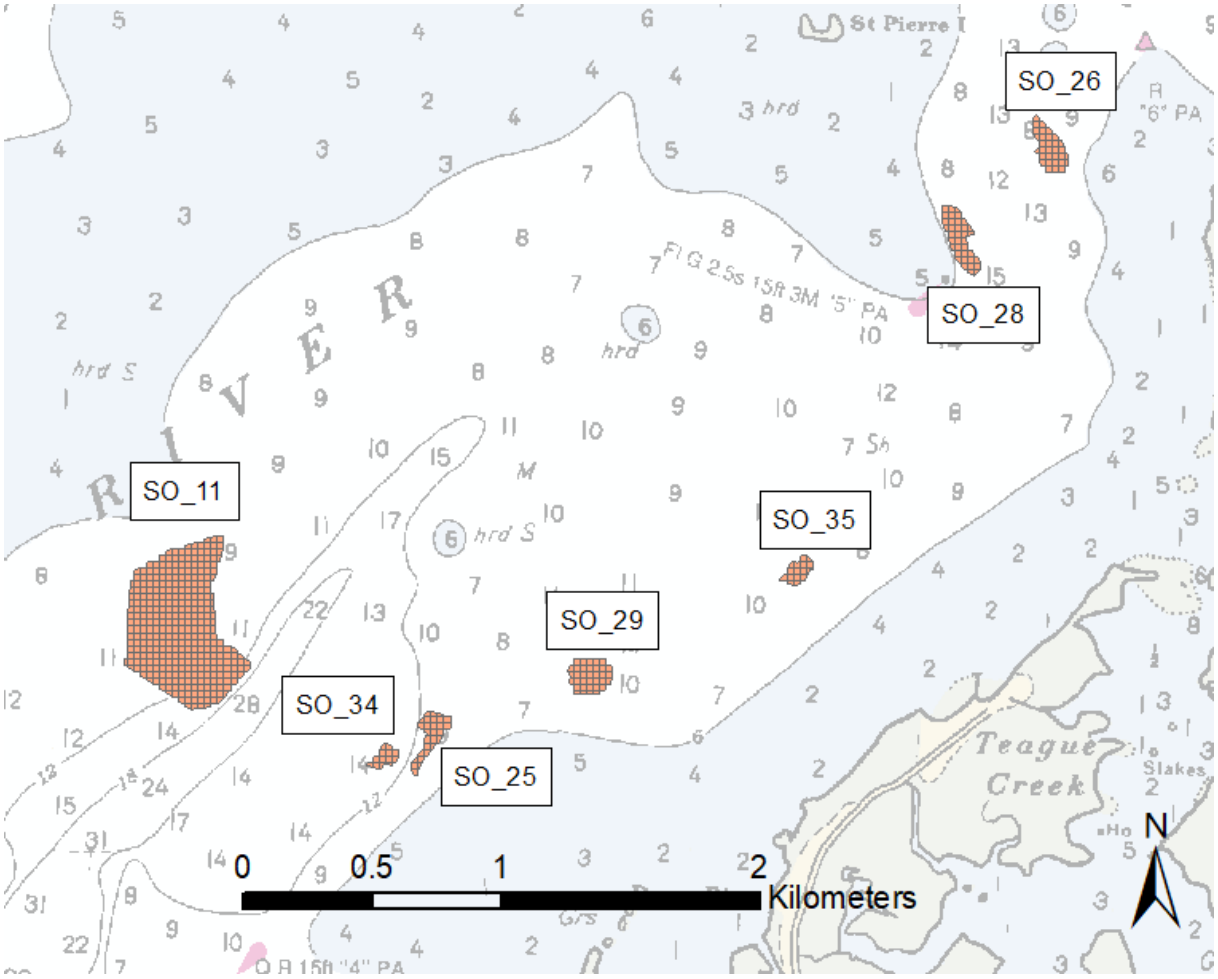

FIGURE 1. SITES CHOSEN FOR FIRST ROUND OF GROUNDTRUTHING IN MANOKIN SANCTUARY, WITH 25 X 25M GRID APPLIED.

During the fall 2019 survey, habitats were sampled using patent tongs, a specialized commercial fishing gear used to harvest oysters. Patent tongs function much like a benthic grab and are well suited to quantify the condition of benthic habitat through the retrieval of the sediment surface layer which could include oysters, shell, or other sediment features. The coordinates of each patent-tong sample were collected when the patent tongs reached the sediment surface. A Differential Global Positioning System (DGPS) antenna was positioned adjacent to the location where the patent tongs were deployed so no position offset was required. Aboard the *Billie Jean*, the patent tongs sampled 1.875m^2. Several qualitative measurements were made once each grab was brought to the surface, including the depth of sediment covering shell (Surface Sediment), the percent of shell not covered by sediment (Exposed Shell), and the amount of material in the sample (Patent Tong Fullness). The substrate composition was recorded based on observations of the sample during sorting and processing. At least 30 live oysters were measured and all remaining oysters and boxes were enumerated.

Two analytical approaches were used to assess the data. The first approach determines whether a site needs restoration based on the abundance and biomass of oysters currently on the site, while the second approach used an index of habitat quality to determine whether a site is suitable for restoration and the type of restoration required. An index of habitat quality was

developed to determine whether oyster habitat was suitable for seed-only restoration, substrate and seed restoration, or not suitable for either (e.g. an area consisting of all mud that cannot support restoration). Six benthic habitat components observed from samples were used to develop the index:

1. Exposed Shell
2. Primary Substrate and Secondary Substrate
3. Surface Sediment
4. Number of Live Oysters
5. Surface Shell, calculated as (Total shell volume x percent gray shell) – total shell volume
6. Oyster density and biomass data

For the Upper St. Mary's River groundtruthing protocol, the first five benthic components are given a binary score expressed as a 1 or 0, with a result of 1 suitable for restoration construction and 0 being unsuitable (Table 3).

TABLE 3. FIVE BENTHIC HABITAT COMPONENTS USED TO DEVELOP THE INDEX OF HABITAT QUALITY AND THE CRITERIA USED TO ESTABLISH A BINARY SCORE FOR EACH COMPONENT.

Benthic Component	Suitable for Oysters
Exposed Shell	Shell 50% exposed or greater
Bottom Type	Oyster, loose shell, or shell hash
Surface Sediment	Less than 5 cm
Number of Live Oysters	Greater than 5 oysters per square meter
Surface Shell Volume	Greater than 10 liters per square meter

This creates a final habitat suitability score for each grid cell is calculated as the sum of each benthic component score at the individual grid cell using the equation:

$$Habitat\ Suitability\ Score = S1 + S2 + S3 + S4 + S5$$

Where S1 = Exposed Shell Score, S2 = Bottom Type Score, S3 = Surface Sediment Score, S4 = Number of Live Oysters Score, and S5 = Surface Shell Volume Score. The result of habitat suitability scores will determine whether a sampling grid cell is suitable for restoration construction based on a ranking between zero and five. Ranks of one or two are suitable for substrate and seed restoration, ranks of three require additional review, and ranks of four and five are suitable for seed-only restoration.

In the St. Mary's Sanctuary methods, a rank of zero is considered unsuitable for restoration (ORP, 2019b). However, the Manokin sanctuary is very different than the St. Mary's Sanctuary, with a large Yates oyster bar area classified as sand with little to no co-occurring shell. The original Little Choptank Sanctuary groundtruthing methodology is more appropriate to use on the Manokin River Sanctuary given range of bottom types in both rivers.

During the Winslow and Yates surveys, the survey indicated an oyster population was present and, in the past, some of these areas did receive shell plantings under the DNR's historic dredged shell program. However, due to the loss of oyster habitat over time and the transition to sand bottom, it is important to carefully consider the use of sand for oyster restoration. Historically sand has been avoided because oysters can subside and be lost. However, there

are instances of successful restoration on primarily sandy bottom, in both Harris Creek and Little Choptank (ORP, 2019a).

Given that sand particles vary in size and compaction, sand bottom can range from soft, to moderate, to firm. This will affect the degree to which planted substrate might bury or be covered by shifting sand due to currents and wave action. Areas that have a layer of sand on top of clay or other hard bottom type may be appropriate areas to construct, as they can withstand the weight of the substrate material. Additional surveys and data analysis on sand bottom should be conducted to determine these impacts when considering constructing on sand bottom.

The amended groundtruthing methodology, similar to the one used in the Little Choptank Sanctuary, splits samples with ranks equal to zero into two subcategories:

- 0Mud – a ranking of zero with a predominate mud bottom type. If the majority of the site receives ranks of 0Mud, the sites are not suitable for restoration.
- 0Non-Mud – a ranking of zero with a predominant bottom type that is not mud. If the majority of the site receives ranks of 0Non-Mud, the sites require more information prior to determining if they are suitable for restoration.

Sites that have majority ranking of 0Non-Mud require further assessment to determine the suitability for restoration. Additional surveys using sounding poles, ponar sediment grabs, sediment cores, and an oyster dredge can be conducted on the site to collect more data on site suitability. Additional information can be gained from DNR's old Seed and Shell Program planting geodatabase: a site that is sand now but was once planted may have shells under the sand that add to its firmness and suitability.

The oyster density and biomass data assessment for each grid will be evaluated over the entire reef and if both density and biomass are greater than 50 oysters per m^2 and 50 grams per m^2, the reef will be considered premet.

TABLE 4. RESTORATION TREATMENT DESIGNATION BASED ON HABITAT SUITABILITY COMPOSITE SCORE FOR THE MANOKIN RIVER SANCTUARY.

Habitat Suitability Score		Restoration Treatment Suitability
5		Seed-Only restoration or Pre-met
4		Seed-Only restoration
3		Requiring further review of all variables at the site level to determine suitability for seed-only restoration or substrate and seed restoration
2		Substrate and Seed restoration
1		Substrate and Seed restoration
0	Mud	Not suitable for restoration (bottom type is mud)
	Non-Mud	Requiring further review to determine suitability at the site level for Substrate and Seed restoration (bottom type is sand)

Results

Over 500 patent tong grabs were collected during the first round of Manokin Sanctuary sampling (Table 5). All size classes of oysters were observed, from spat to over 150mm (Figure 2).

TABLE 5. RESULTS OF 2019 PATENT TONG SURVEY AT THE SITE LEVEL. SD REPRESENTS STANDARD DEVIATION.

Site ID	Dominant Substrate Type	Average Live Density (per m^2)	SD Live Oyster Density	Average Total Volume (L/m^2)	SD Volume	Samples taken (N)	% of Cells Scoring 4 or 5
SO_11	Loose shell	14.55	12.09	5.86	2.74	340	74.1
SO_25	Shell hash	2.65	3.75	3.52	2.22	28	14.3
SO_26	Loose shell	4.35	2.69	4.13	1.46	32	34.4
SO_28	Loose shell	4.77	7.05	3.21	1.86	37	21.6
SO_29	Loose shell	12.49	11.06	4.66	2.94	35	62.9
SO_34	Mud	6.07	9.14	3.11	3.37	13	23.1
SO_35	Mud	1.53	1.76	2.73	0.87	16	6.3

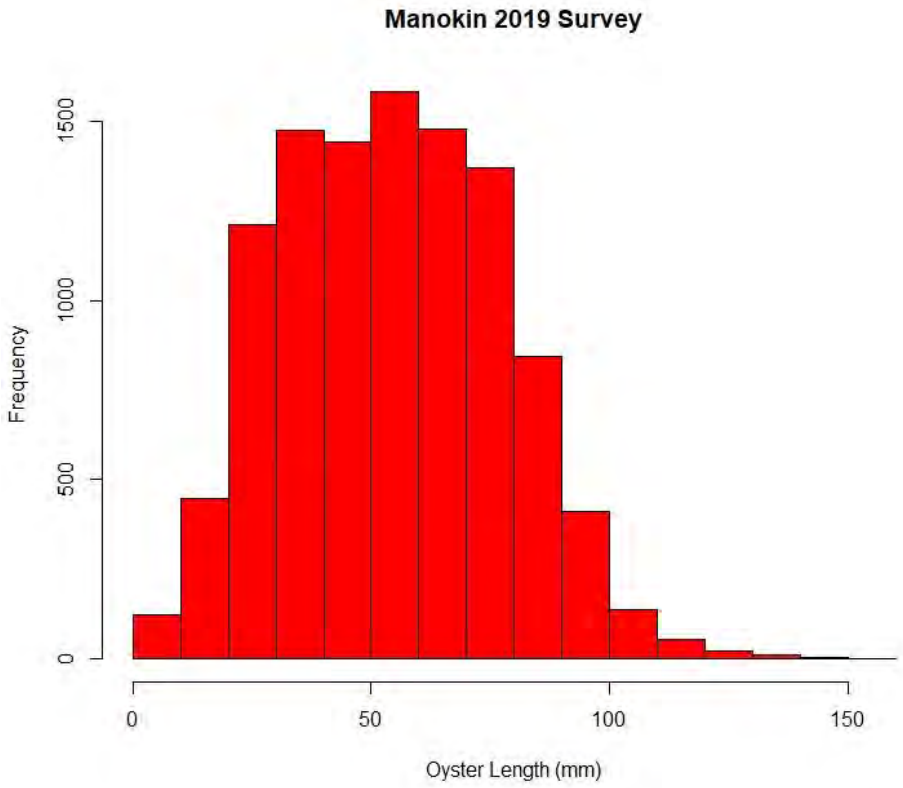

FIGURE 2. LENGTH-FREQUENCY HISTOGRAM FOR ALL OYSTERS MEASURED IN MANOKIN SANCTUARY DURING FALL 2019 GROUNDTRUTHING SURVEY.

Based on patent tong samples, no sites were classified as premet, meaning no areas displayed live oyster density greater than or equal to 50 oysters/m^2 and live oyster biomass greater than or equal to 50 g/m^2. SO_11 had the most samples meeting seed-only restoration requirements,

with nearly three-quarters of cells scoring a four or five. It also had the highest density of live oysters per square meter. This site is recommended for seed-only treatment, with perhaps a slight change in reef boundary to remove the northeast corner (Figure 3). SO_25 and SO_35 had the lowest density of live oysters of the sites sampled.

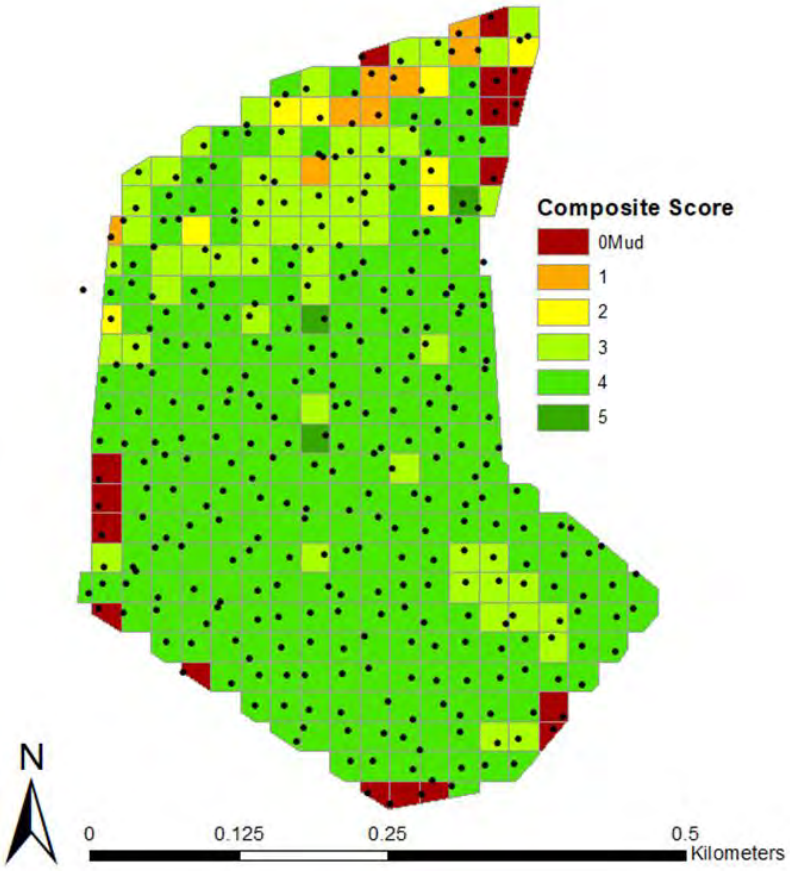

FIGURE 3. COMPOSITE SCORES FOR EACH GRID CELL OF SO_11. BLACK DOTS REPRESENT ACTUAL LOCATIONS OF PATENT TONG GRABS.

SO_34 and SO_25 will likely require substrate and seed restoration (Figure 4). While SO_34 did not display the lowest live oyster density of areas sampled, the primary substrate found was mud. Such soft sediments are not ideal for seed-only restoration, as oysters would likely sink into the sediment.

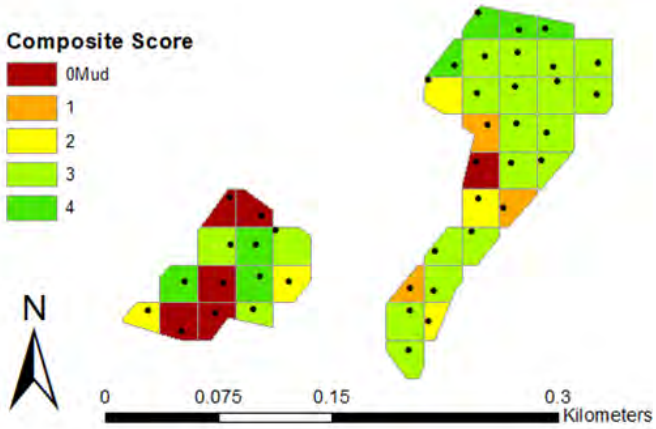

FIGURE 4. COMPOSITE SCORES FOR EACH GRID CELL OF SO_34 (LEFT) AND SO_25 (RIGHT). BLACK DOTS REPRESENT ACTUAL LOCATIONS OF PATENT TONG GRABS.

After SO_11, SO_29 had the highest proportion of samples scoring four or five, meaning it is also suitable for seed-only restoration (Figure 5).

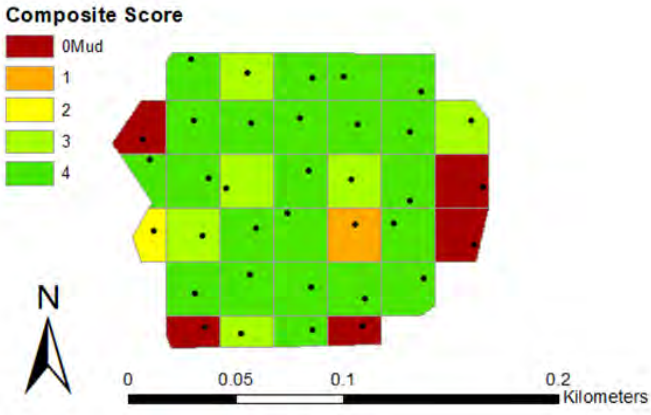

FIGURE 5. COMPOSITE SCORES FOR EACH GRID CELL OF SO_29. BLACK DOTS REPRESENT ACTUAL LOCATIONS OF PATENT TONG GRABS.

SO_35 likely requires substrate addition before seeding (Figure 6). This site had both the lowest average volume of material and lowest density of live oysters per square meter.

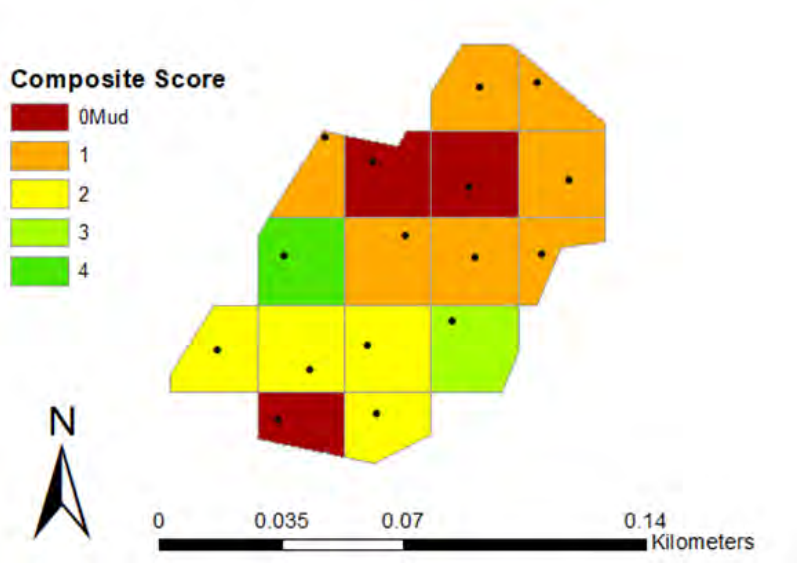

FIGURE 6. COMPOSITE SCORES FOR EACH GRID CELL OF SO_35. BLACK DOTS REPRESENT ACTUAL LOCATIONS OF PATENT TONG GRABS.

SO_28 and SO_26 may need further review, as both had many samples with a composite score of three (Figure 7).

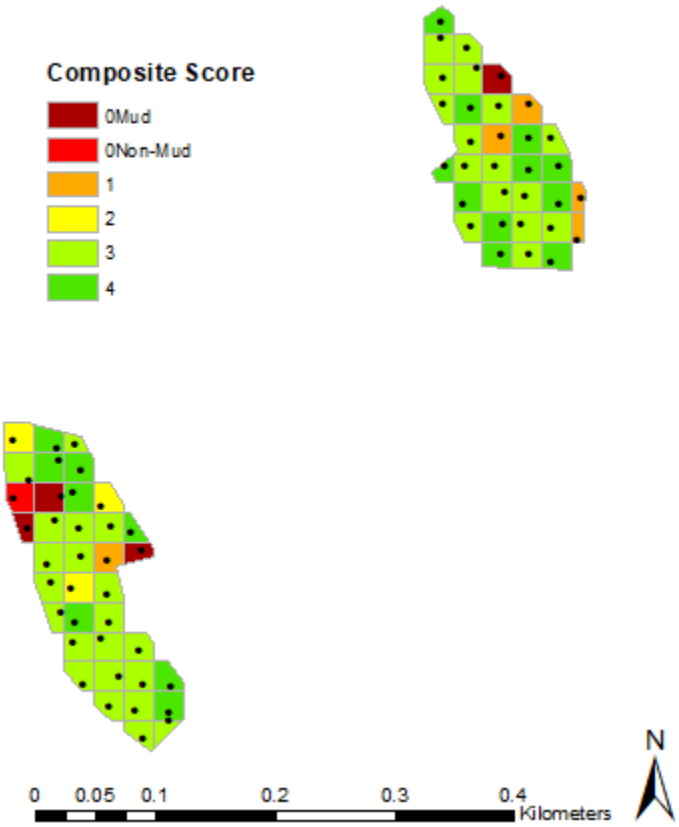

FIGURE 7. COMPOSITE SCORES FOR EACH GRID CELL OF SO_28 (LEFT) AND SO_26 (RIGHT). BLACK DOTS REPRESENT ACTUAL LOCATIONS OF PATENT TONG GRABS.

Conclusions

This first round of groundtruthing in the Manokin River Sanctuary encompassed approximately 75 acres. As expected, the reefs surveyed had a patchy distribution of oysters. Three sites surveyed did not change in size or treatment designation (SO_26, SO_28, and SO_29). Two sites were determined to be not suitable for seed only restoration and instead will receive substrate prior to deployment of spat on shell. SO_25 was reclassified as SS_45 and SO_35 was reclassified as SS_46.

Two sites will remain as seed only restoration but change in size. Both SO_11 and SO_34 were reduced in size to remove some unsuitable cells. As a result, SO_11 is now 48.9 acres and SO_34 is 1.4 acres.

Only 1 cell in this round of groundtruthing received a composite score of 0Non-Mud. If more areas had contained primarily sand or other firm bottom types, additional surveys such as ponar sediment grabs or the use of sounding poles could be employed to better understand the benthic conditions. Going forward, we recommend using a systematic patent tong survey to collect data in areas that have not been monitored in recent years to ensure the best type of restoration treatment is applied

References

Oyster Recovery Partnership (ORP). 2019a. Oyster Restoration Pre-Construction Site Assessment of Oyster Shell Dominated Benthic Habitats in Little Choptank River, Chesapeake Bay. Submitted in partial fulfillment of MOU #605P7400192

Oyster Recovery Partnership (ORP). 2019b. Oyster Restoration Pre-Construction Site Assessment of Oyster Shell Dominated Benthic Habitats in St. Mary's River Sanctuary, Maryland. Submitted in partial fulfillment of MOU #605P7400192