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

Fall 2021 & Spring 2022

Prepared by Oyster Recovery Partnership

September, 2022

Oyster Recovery® Partnership | ORP

Table of Contents

List of Tables and Figures

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. Progress to complete the 5 tributary restoration strategy is monitored by the Maryland Interagency Workgroup (hereafter Workgroup). The Manokin River is the fifth tributary selected for restoration under the 5 tributary strategy. 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 Workgroup used data from the 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 Manokin River sanctuary. National Oceanic and Atmospheric Administration (NOAA) provided additional spatial information to describe bottom type. These data were used to identify potential sites for restoration and assign restoration treatment types to these areas: premet (already meet density and biomass targets), seed-only, and substrate and seed (Table 1). This process identified 20 acres of premet reefs, 305 acres of seed-only reefs, and 438 acres of areas needing substrate and seed in the Manokin River sanctuary. Oyster Recovery Partnership (ORP) conducted a systematic patent tong survey to verify the predominant bottom type and assess whether the restoration treatments assigned to these areas were appropriate.

Table 1. The general guidelines for determining the most appropriate type of restoration.

	Premet Criteria	**Seed-Only Criteria**	**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

Methods

Oyster Recovery Partnership (ORP) conducted the Fall 2021 and Spring 2022 rounds of Manokin River groundtruthing between April through August of 2022 in collaboration with local waterman, Bobby Walters. The methods implemented during the Manokin sanctuary surveys are similar to previous groundtruthing surveys conducted by ORP. A 25 x 25m grid was created in ArcGIS (ESRI ArcMap version 10.7.1) and overlain on the target sites provided by DNR. When creating sample grids on irregularly shaped polygons, some resulting cells are too small or too narrow to be sampled effectively. In this case, cells under 250m^2 were removed. Target sample points were generated in the centroid of each grid cell. A total of 17 sites were sampled with patent tongs (Table 2).

Table 2. Sites sampled for the Fall 2021 and Spring 2022 groundtruthing survey in Manokin River Sanctuary.

Round	Restoration Type	Site ID	Area (acres)	Number of PT samples	Report Reef ID
Fall 2021	Seed Only	SO_04	8.43	56	MN_07
Fall 2021	Seed Only	SO_07	10.83	74	MN_10
Fall 2021	Seed Only	SO_08	11.08	76	MN_11
Fall 2021	Seed Only	SO_24	7.76	53	MN_27
Fall 2021	Seed Only	SO_39	3.34	24	MN_42
Fall 2021	Seed Only	SO_40	12.65	89	MN_43
Fall 2021	Seed Only	SO_41	8.59	59	MN_44

Fall 2021	Pre-Met	EAG_01	4.84	35	MN_01
Fall 2021	Pre-Met	EAG_03	11.62	82	MN_03
Spring 2022	Seed Only	SO_02	2.87	21	MN_05
Spring 2022	Seed Only	SO_10	18.24	122	MN_13
Spring 2022	Seed Only	SO_12	34.60	228	MN_15
Spring 2022	Seed Only	SO_13	13.32	90	MN_16
Spring 2022	Seed Only	SO_14	9.92	68	MN_17
Spring 2022	Seed Only	SO_19	2.69	18	MN_22
Spring 2022	Seed Only	SO_20	1.92	13	MN_23
Spring 2022	Seed Only	SO_21	3.07	23	MN_24
Totals			**165.77**	**1,131**	

Two analytical approaches were used to assess the accuracy of the pre-assigned restoration types and determine the appropriate restoration treatment type for the sites listed in Table 2. The first approach determined whether a site needs restoration based on the abundance and biomass of oysters currently on the site. The second approach used an index of habitat quality to determine whether a site is suitable for restoration and identify the restoration treatment required (seed-only, substrate and seed, not suitable). A habitat score was assigned to each grid cell overlain on the restoration site. Six benthic habitat components 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

The first five benthic components were assigned a binary score expressed as a 1 or 0; 1 indicates a grid cell is suitable for restoration, 0 indicates a grid cell is not suitable for restoration (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 (score = 1)**
Exposed Shell	> 50% Shell 50% is exposed
Bottom Type	Oyster, loose shell, or shell hash
Surface Sediment	< 5 cm
Number of Live Oysters	> 5 oysters m^{-2}
Surface Shell Volume	> 10 liters m^{-2}

A final habitat suitability score for each grid cell is calculated by adding the scores of each individual benthic component:

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

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 resulting habitat suitability score can range from 0 to 5; scores of 4 or 5 are suitable for seed-only restoration: scores of 3 may require additional review: scores of 1 or 2 are suitable for substrate and seed restoration (Table 4). If oyster density and biomass are greater than 50 oysters per m^2 and 50 grams per m^2, the reef is considered premet and does not require restoration.

For other tributaries, a score of 0 was considered not suitable or unable to support any restoration treatment because the dominant bottom type was soft mud and no hard bottom was present (e.g., St. Mary's River; ORP 2019b). In the Manokin River, the groundtruthing survey indicated that a large Yates oyster bar was classified as sand with little to no co-occurring shell.

Historically sand has been avoided because oysters can be buried or reefs can subside. However, there are instances where restoration has been successful on sand in both Harris Creek and Little Choptank River sanctuaries (ORP 2019a). In the Manokin River, historic Winslow and Yates surveys suggested that oysters were present on this reef. In addition, DNR has records of planting shell in this area under their historic dredged shell program. Due to the loss of oyster habitat at this reef over time and the transition to sand, it is important to carefully consider the suitability of sand substrate for oyster restoration.

Given that sand particles vary in size and compaction, sand substrate can range from soft, to moderate, to firm. This will affect the degree to which planted substrate might be buried by sand that is transported or resuspended from currents and waves. Areas that have a layer of sand on top of clay or other hard bottom may be appropriate areas for restoration, as they can withstand the weight of the restoration material. Additional surveys and data analysis on sand bottom should be conducted to determine whether sand in the Manokin River can support restoration.

The Workgroup agreed to implement an amended groundtruthing methodology (similar to ORP 2019a) that splits samples with scores of 0 into two subcategories:

- 0Mud – a score of 0 with a predominant mud bottom type. If the majority of the site receives ranks of 0Mud, the sites are not suitable for restoration.
- 0Non-Mud – a score of 0 with a predominant bottom type that is not mud. If the majority of the site receives ranks of 0Non-Mud, more information is needed to determine if a site is suitable for restoration.

Sites that have a majority of 0Non-Mud scores 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 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 ability to support restoration.

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 Premet
4		Seed-Only restoration
3		Requires 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	Non-Mud	Requires further review to determine suitability at the site level for Substrate and Seed restoration (bottom type is sand)
	Mud	Not suitable for restoration (bottom type is mud)

Results

A total of 1,131 patent tong grabs were collected over 18 days during this phase of groundtruthing. The composite score for each cell was displayed in ArcGIS to allow visual review of the results for each site. A singular cell had a habitat suitability composite score of 5 and 654 cells had a composite score of 4, meaning 57.9% of the surveyed area may be suitable for seed-only restoration. A total of 109 (9.64%) cells received a composite score of 0. Of those, 89 (81.7%) were 0Mud and 20 (18.3%) were 0Non-mud (Table 5). The 0Non-mud cells will require further review to determine suitability for restoration. Nearly every site received a mix of scores from 0 to 4. Samples that received a composite score of 0 do not appear to be dependent on site, but rather were scattered or clustered across most sites (Figures 1-7). The

next step in determining treatment types for these polygons is a discussion at the Workgroup level.

Table 5. Results from composite scores across all sites.

Habitat Suitability Score		Number of cells	Percentage of cells
5		1	0%
4		654	57.8%
3		309	27.3%
2		33	2.9%
1		25	2.2%
0	Non-Mud	20	2.6%
	Mud	89	7.9%

Across this round of groundtruthing, approximately 81% of surveyed cells comprising 16 sites were observed to possess a dominant substrate of oyster or loose shell (Table 6). One site (SO_02) served as an exception and had a dominant substrate of mud (10 of 21 cells); however, this was closely followed by oysters (8 of 21 cells). The survey-wide density of oysters was 9.56 individuals/m^2, with only 169 (15%) samples containing no live oysters.

Table 6. Summary results from the Spring 2021 groundtruthing survey.

Site ID	Dominant Substrate Type	Total Live Oysters Observed	Average Total Volume (L/m^2)	SD Volume
SO_04	Oysters	1267	8.425	5.305
SO_07	Loose shell	844	4.058	2.565
SO_08	Oysters	2185	12.787	5.656
SO_24	Oysters	1361	7.475	3.645
SO_39	Loose shell	255	4.713	2.045
SO_40	Loose shell	1044	5.7	2.693
SO_41	Oysters	1411	5.989	4.186
EAG_01	Oysters	1048	6.6	5.432

EAG_03	Oysters	1384	11.952	4.542
SO_02	Mud	293	5.194	2.563
SO_10	Oysters	2524	7.168	3.525
SO_12	Oysters	3677	5.621	3.300
SO_13	Oysters	1465	6.658	5.049
SO_14	Oysters	1123	9.179	4.985
SO_19	Loose shell	106	3.563	2.192
SO_20	Loose shell	218	5.038	2.421
SO_21	Loose shell	61	2.295	1.604

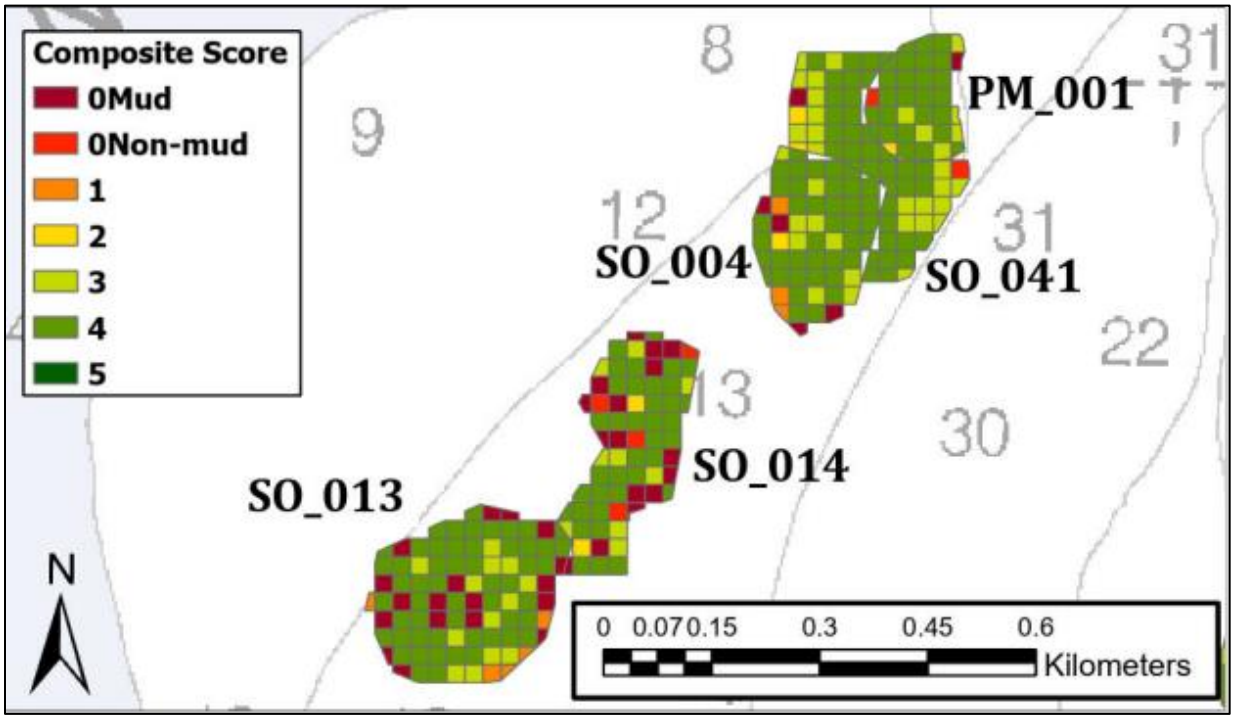

Figure 1. Composite score results for five sites sampled during the spring 2022 phase of groundtruthing (EAG/PM_01, SO_41, SO_04, SO_14, and SO_13). All five sites received a mix of scores between 0 and 4 with no apparent pattern, although the majority of cells received a score of 4.

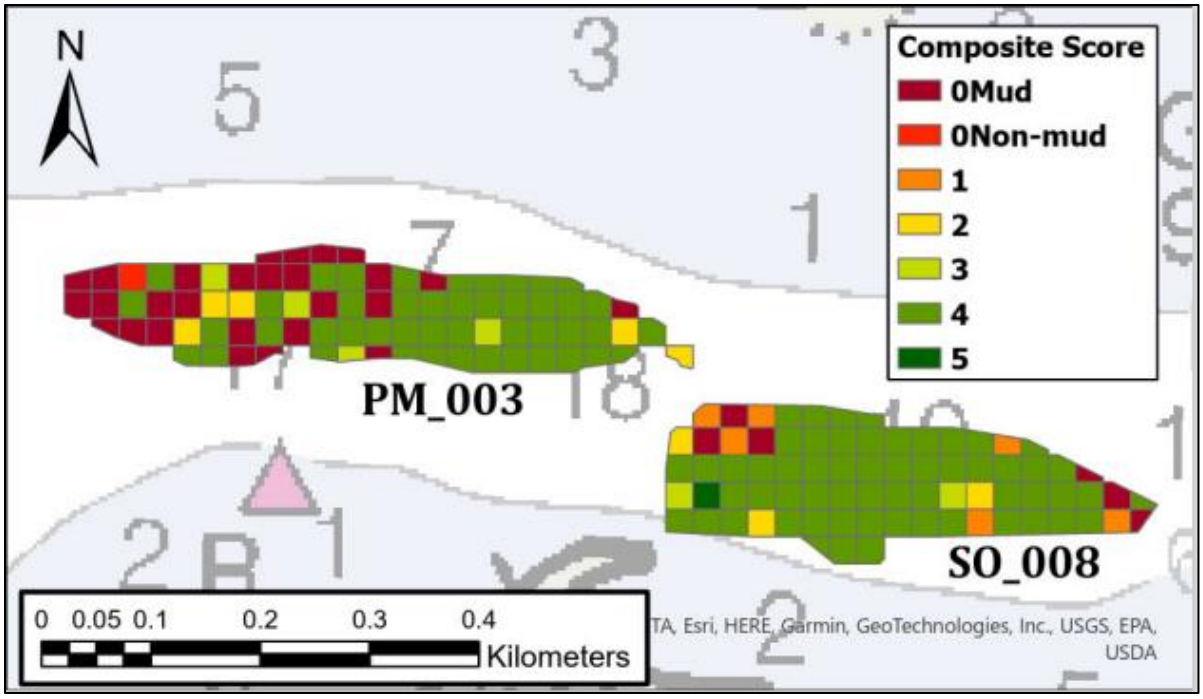

Figure 2. SO_08 received a mix of scores between 0 and 5 with no apparent pattern, although the majority of cells received a score of 4. A majority of cells in site EAG/PM_03 received a score of 4, mostly concentrated on the eastern half of the site. Adjusting the site boundary/proposed treatment type may be appropriate.

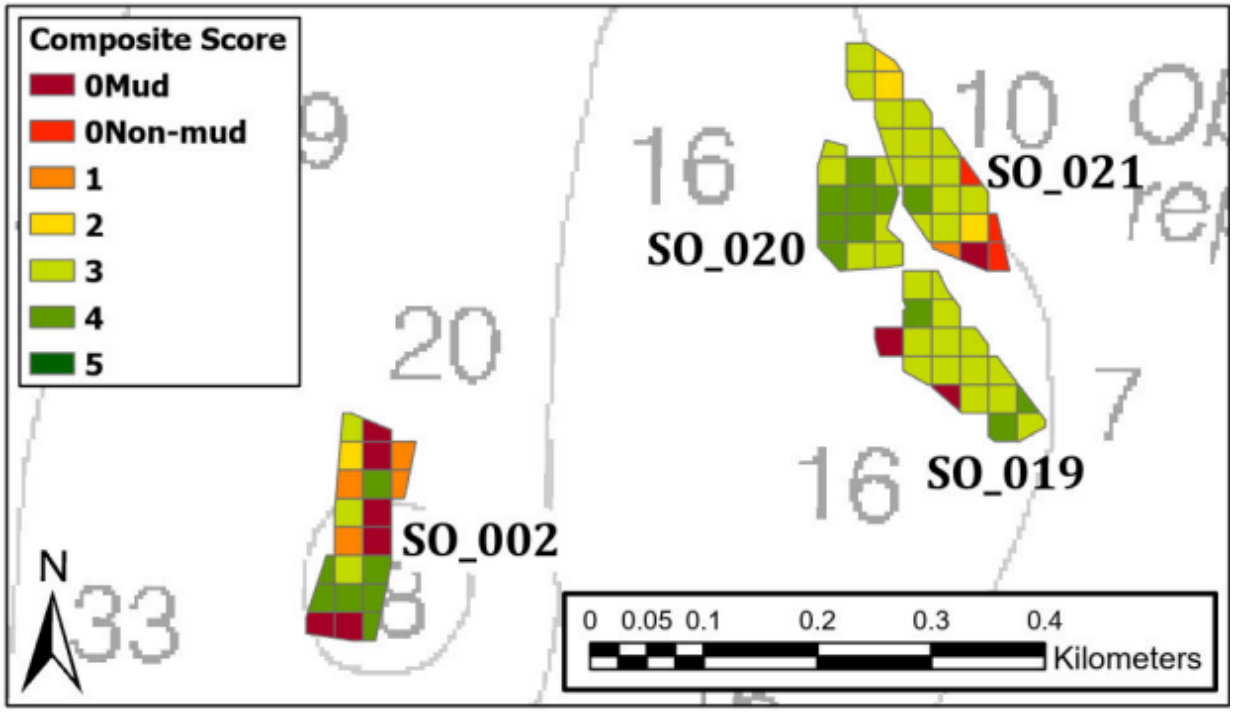

Figure 3. Results for four sites sampled during the spring 2022 phase of groundtruthing (SO_02, SO_19, SO_20, SO_21). SO_02 received scores from 0 to 4 with no discernable trend. SO_19 and SO_21 received primarily scores of 3 and should be further evaluated for suitability of seed only restoration. SO_20 received mostly scores of 4 in the center and 3 along the edges, so this site is likely suitable for seed only restoration.

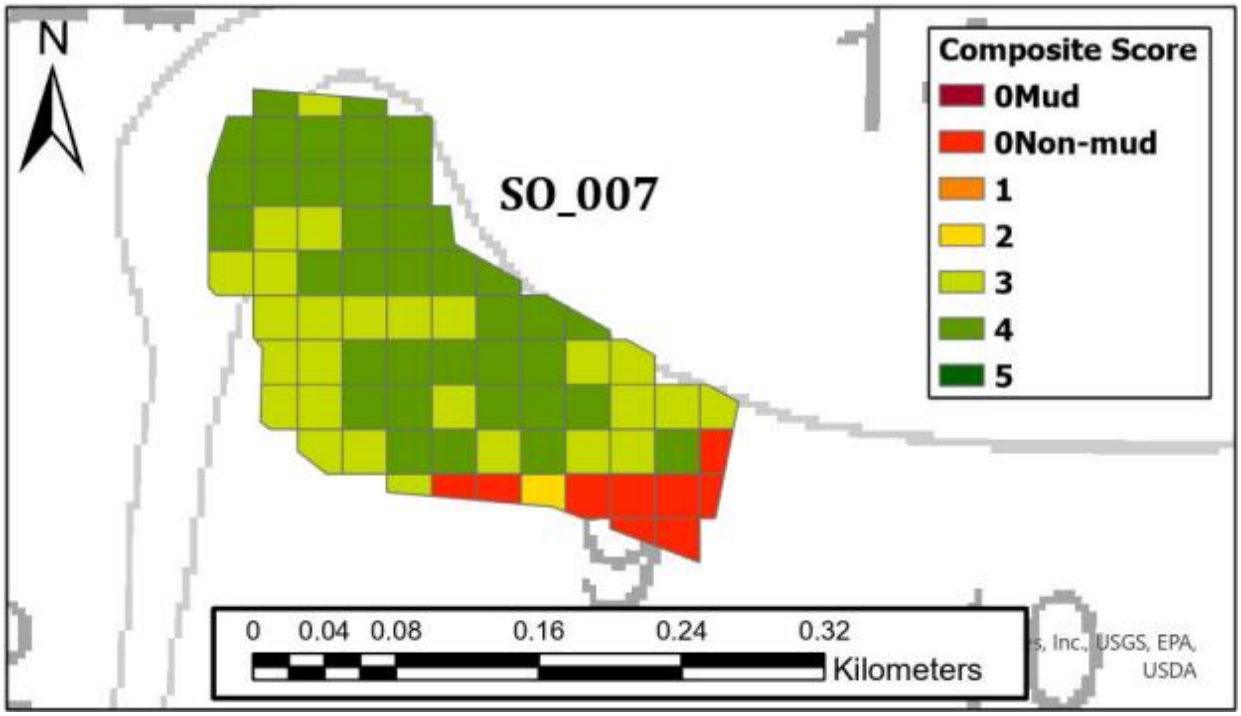

Figure 4. Site SO_07 received mostly scores of 3 and 4, so this site may be suitable for seed only restoration but should be further investigated. However, the cells on the south edge of the site received scores of zero, so adjusting the boundary of this site may be appropriate.

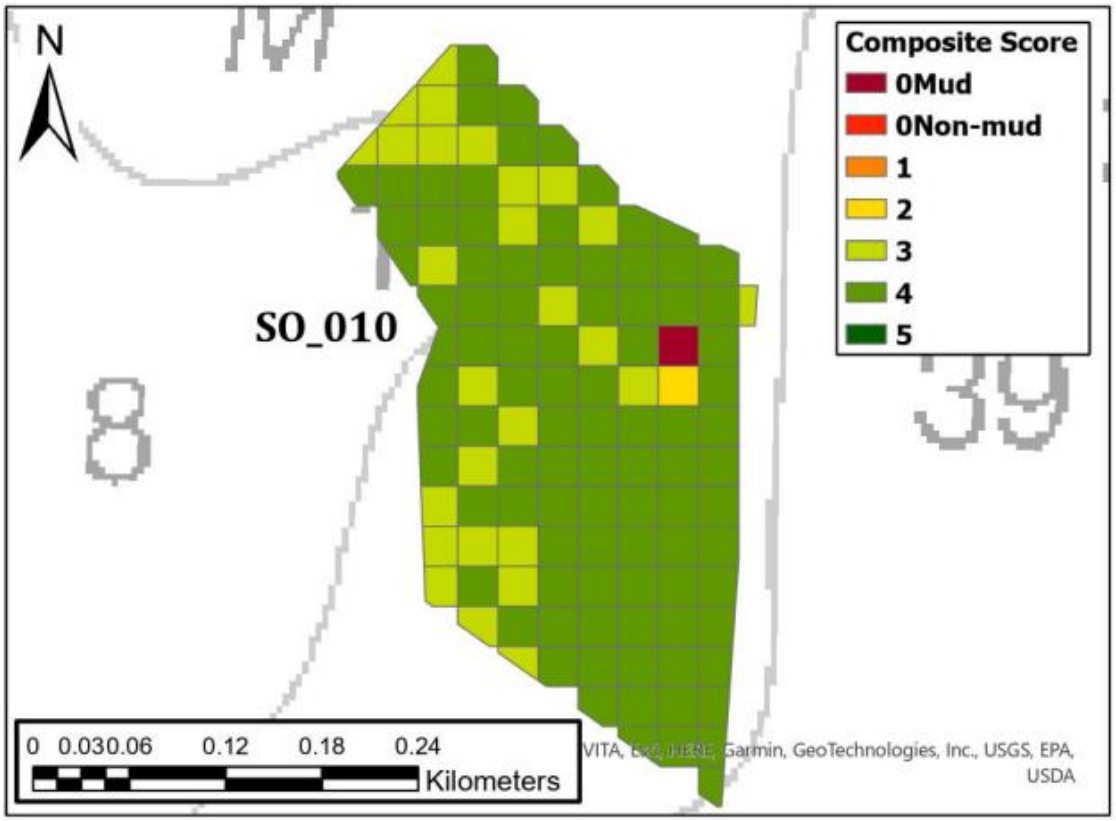

Figure 5. Site SO_10 received scores of primarily 4 and 3. This site may be suitable for seed only restoration, particularly on its eastern side where nearly all cells scored a 4.

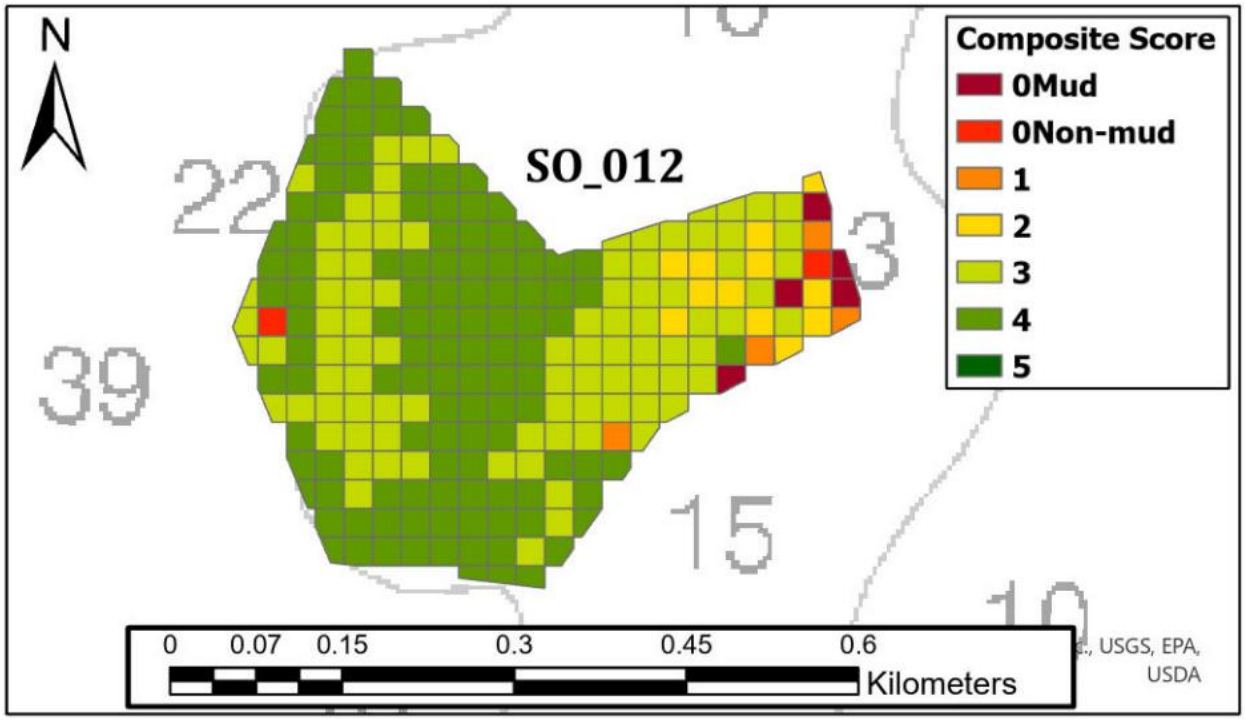

Figure 6. Site SO_12 received a mix of scores from 0 to 4. The east side of the site received primarily scores of 3; however, the composite score tended to decrease along the eastern edge. This portion of the site should be further investigated for suitability of seed only restoration. The west side of the site overwhelmingly received scores of 4 and 3. This portion of the site may be suitable for seed only restoration but should be discussed at the Workgroup level.

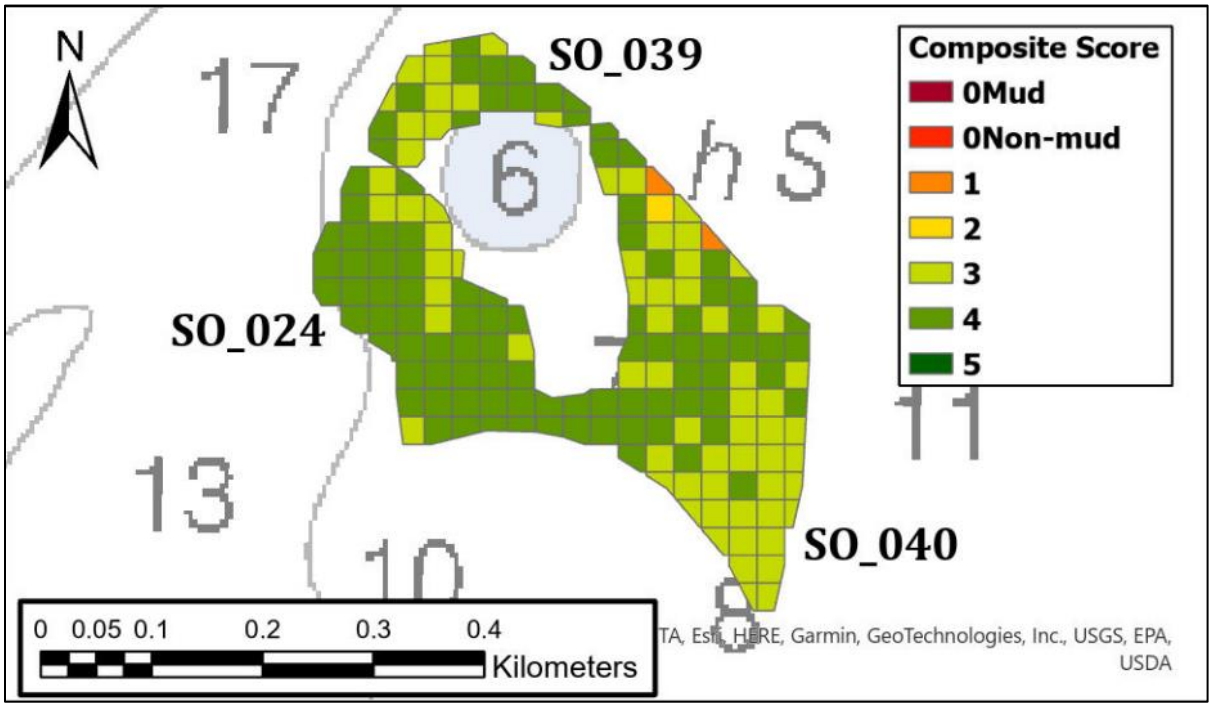

Figure 7. Sites SO_24, SO_39, and SO_40 primarily received scores of 3 and 4. These sites should be further reviewed for suitability for seed only restoration.

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