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

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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. 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 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) completed additional GIS analysis, 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 (Table 1). 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. A systematic patent tong survey was conducted to groundtruth and verify the accuracy of the restoration types determined for areas selected for restoration. This survey is ongoing and is expected to take several years to assess between 401 to 763 acres.

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

The Fall 2020 round of Manokin River groundtruthing took place between September 2020 and May 2021, with delays related to the Covid-19 pandemic. A total of 18 sites were sampled by the Oyster Recovery Partnership, in collaboration with local waterman, Bobby Walters (Table 2).

Table 2. Sites chosen for the Fall 2020 groundtruthing survey in Manokin River Sanctuary.

Restoration Type	Site ID	Area (acres)	Number of PT replicates	Report Reef ID
Exceeds Abundance Goal	EAG_02	3.57	24	MN_02
Seed Only	SO_01	2.11	18	MN_04
Seed Only	SO_03	7.56	52	MN_06
Seed Only	SO_05	1.62	12	MN_08
Seed Only	SO_06	7.05	48	MN_09
Seed Only	SO_09	11.06	76	MN_12
Seed Only	SO_15	3.60	26	MN_18
Seed Only	SO_16	8.46	57	MN_19
Seed Only	SO_17	9.27	60	MN_20
Seed Only	SO_22	2.40	17	MN_25

Seed Only	SO_23	4.49	31	MN_26
Seed Only	SO_30	3.11	20	MN_33
Seed Only	SO_31	2.36	17	MN_34
Seed Only	SO_32	3.06	23	MN_35
Seed Only	SO_33	1.70	10	MN_36
Seed Only	SO_38	1.17	9	MN_41
DNR Fall Survey Control	FS_1	3.51	27	N/A
DNR Fall Survey Control	FS_2	4.03	26	N/A

Two analytical approaches were used to assess the accuracy of the restoration types and determine the appropriate treatment type of areas slated for restoration. 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

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

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 are 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 is 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

A total of 553 patent tong grabs were collected during this phase of groundtruthing. The live density of oysters collected varied widely, with an average of 19.73 individuals/m^2 (Table 4). Nearly 60% of cells had a composite score of 4 or 5, meaning the majority of area surveyed is suitable for seed only restoration.

Table 5. Summary results from the Fall 2020 groundtruthing survey.

Site ID	Dominant Substrate Type	Total Live Oysters Observed	Average Total Volume (L/m^2)	SD Volume
SO_01	Oysters	1302	15.16	6.23
SO_03	Loose Shell	392	7.13	4.62

SO_05	Oysters/Loose Shell	541	8.13	6.55
SO_06	Loose Shell	2541	11.03	5.28
SO_09	Loose Shell	1941	7.64	5.22
SO_15	Mud	1031	9.23	8.32
SO_16	Oysters	5472	13.38	6.89
SO_17	Loose Shell	1076	5.60	4.02
SO_22	Mud	211	6.91	9.26
SO_23	Loose Shell	897	12.45	9.73
SO_30	Mud	212	6.70	4.87
SO_31	Loose Shell	254	8.24	4.55
SO_32	Loose Shell	464	13.32	6.62
SO_33	Loose Shell/Mud	415	12.4	11.29
SO_38	Loose Shell	300	9.94	3.96
EAG_02	Mud/Loose Shell	832	15.24	8.19
FS_1	Oysters	1408	13.52	8.34
FS_2	Oysters	1174	12.12	8.67

The composite score for each cell was displayed in ArcGIS to allow visual review of the results for each site. The Workgroup discussed results of this survey during the June 2021 meeting. While some sites remained unchanged from initial treatment assignments, others were altered to remove particularly unsuitable cells (Figures 1-3).

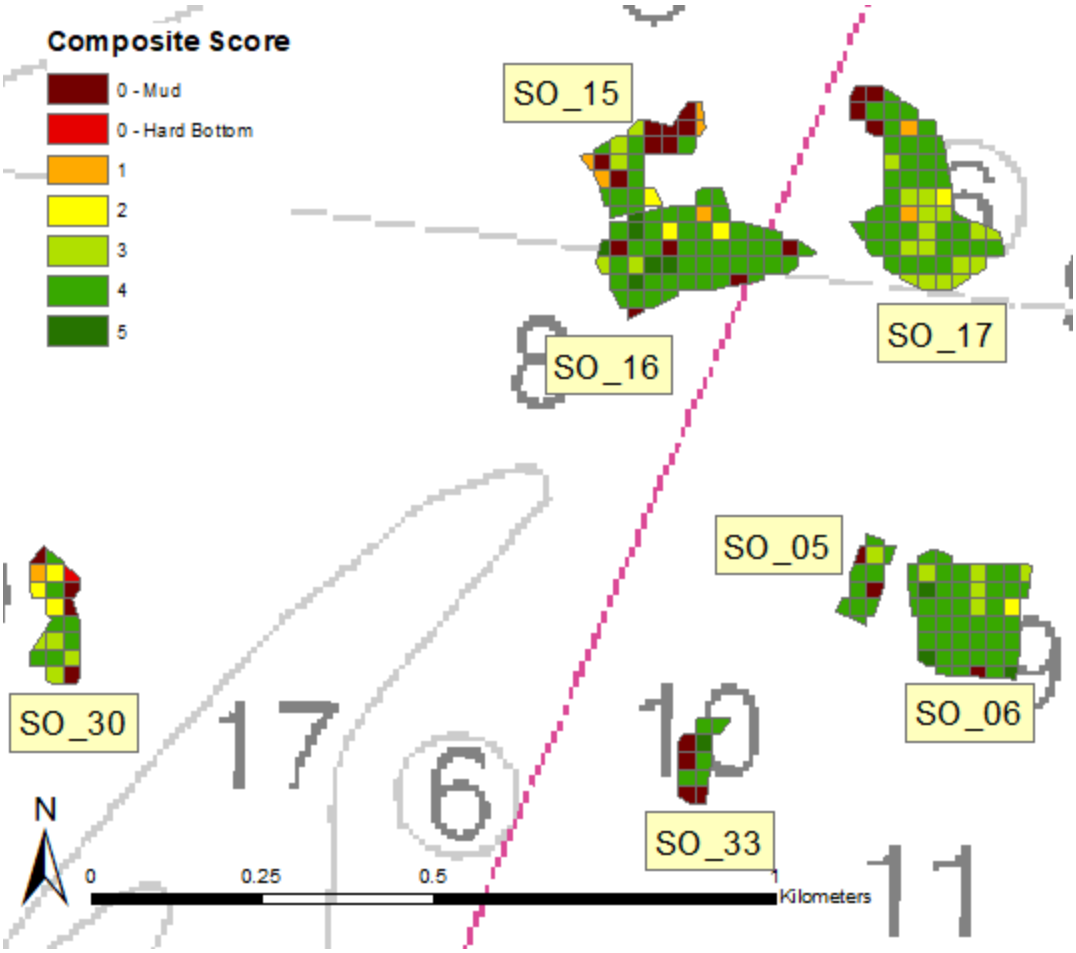

Figure 1. Results of groundtruthing survey for several sites in the Manokin River. Each cell is color-coded to correspond to the final composite score. The Workgroup determined that the northern portion of SO_17 should be removed, and the rest of the site kept as seed only restoration. SO_15 and SO_16 were merged, with the northern poorly scored cells being removed. SO_05 and SO_06 remained as seed only sites. The boundaries of both SO_33 and SO_30 were changed to remove unsuitable areas.

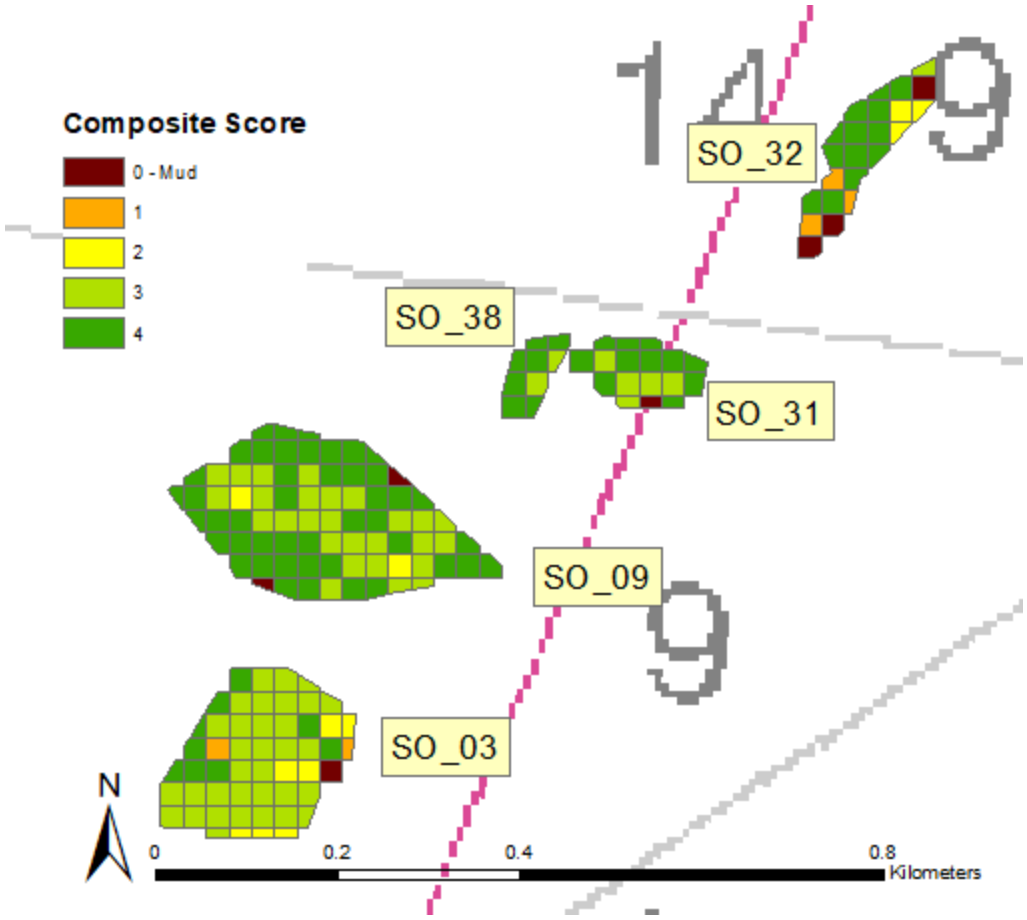

Figure 2. Results of groundtruthing survey for several sites in the Manokin River: SO_32, SO_31, SO_38, SO_09, and SO_03. Each cell is color-coded to correspond to the final composite score. The Workgroup decided that SO_09, SO_38, and SO_31 should remain as seed only sites with existing boundaries. SO_03 was slightly altered to remove poor areas on the eastern border. SO_32 was reduced in size to avoid unsuitable areas on the southern and eastern edges.

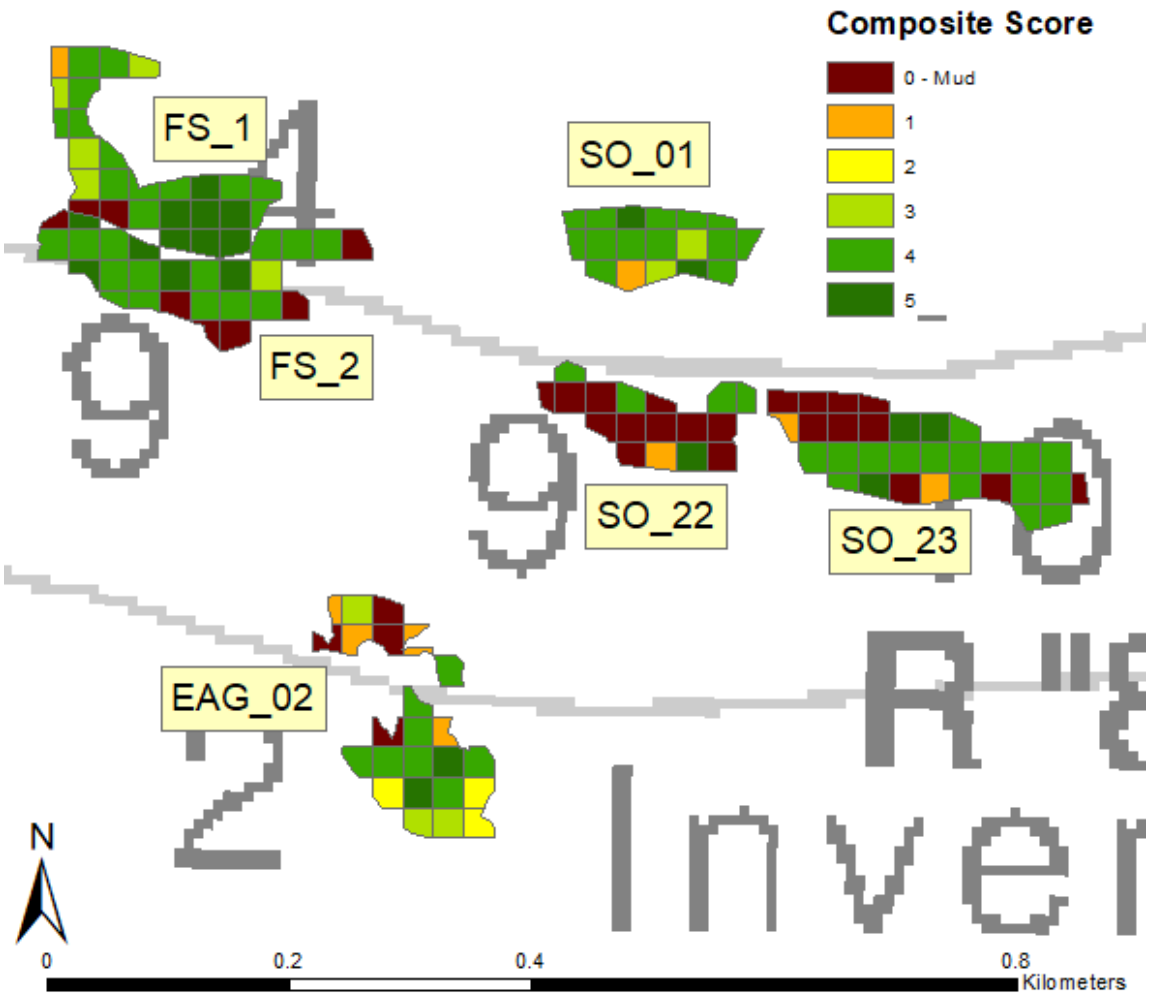

Figure 3. Results of groundtruthing survey for several sites in the Manokin River: SO_01, SO_22, SO_23, EAG_02, and the annual fall survey control sites. Each cell is color-coded to correspond to the final composite score. The majority of SO_01 and the Fall Survey sites are suitable for seed only restoration. Discussions at the Workgroup meeting resulted in the removal of SO_22 from the tributary blueprint. The northern portion of EAG_02 was also removed and the restoration treatment changed to seed only. The cells scoring 0 and 1 on the western side of SO_23 were removed.

Conclusions

For this round of groundtruthing, many sites changed treatment designation or boundaries. EAG_02 was changed to SO_45, and is now 2.25 acres. SO_15 and SO_16 were merged to become one site at 9.92 acres. Additionally, SO_03, SO_17, SO_23, SO_30, SO_32, and SO_33 were all reduced in acreage to avoid areas unsuitable for seed only restoration. SO_22 was removed from the restoration blueprint entirely.

Six sites did not change: SO_01, SO_05, SO_06, SO_09, SO_31, and SO_38. The IAWG determined based on patent tong results, these sites are suitable for seed only restoration in their current locations.

No sites were predominantly sand; of the cells with composite score of 0, they were either mud or hard bottom. Mud is considered unrestorable.

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