2017 Oyster Reef Monitoring Report

Analysis of Data from Large-Scale Sanctuary Oyster Restoration Projects in Maryland

November 2018

Produced in partnership with the Maryland Oyster Restoration Interagency Workgroup under the Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team

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Cover photo: Divers from the University of Maryland's Paynter Labs perform monitoring work on Harris Creek in 2017. Photo: Oyster Recovery Partnership

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Definitions

2014 cohort: Reefs that received restoration treatment in 2014, and—per tributary plans—were monitored in 2017, three years post restoration. These include reefs that were treated only by planting with spat-on-shell (seed-only reefs) as well as reefs that were first treated with application of a substrate base (mixed shell, Florida fossil shell, stone, or a combination) and were then planted with spat-on-shell. Reefs that were treated with reef-building substrate prior to planting with spat-on-shell are referred to as 'substrate + seed' reefs in this report.

Average planned reef height: The amount of reef-building material placed onto a reef was calculated by multiplying the desired average reef height (ex: 6"; 12") by the reef area. The actual height of the reef varied across the reef.

Premet reef: Reefs that were assumed to have met the Oyster Metrics density target criteria (50+ oysters per m^2) when surveyed prior to commencement of large-scale restoration efforts. However, the population data collected at that time was over a broader geographic area than the 2017 monitoring data. Thus, it is an assumption that the reefs in fact met the density success metric at that time, but it is not certain. Because these reefs were assumed to have met the oyster density success criterion, they received no restoration treatment. These reefs are monitored every three years, as are other reefs, to determine appropriate adaptive management needs.

Florida fossil shell: Consolidated fossil oyster shell material from Florida used as a base to construct reefs. This is oyster shell cemented into a fossilized limestone, and is a true fossil, mined from 30 to 40 feet under dry land, as opposed to the Chesapeake Bay dredged shell. See Figure 21.

Mixed shell: A mixture of scallop, conch, and clam shell from processing plants.

Oyster Metrics: Success criteria for restored oyster reefs targeted for restoration under the 2014 Chesapeake Bay Watershed Agreement. These are defined in the report "Restoration Goals, Quantitative Metrics and Assessment Protocols for Evaluating Success on Restored Oyster Reef Sanctuaries,"[4] http://www.chesapeakebay.net/channel_files/17932/oyster_restoration_success_metrics_final.pdf. See Table 6 for description of the six reef-level criteria.

Reference reefs: Reefs left unrestored (untreated) to serve as comparisons to restored (treated) reefs. Typically, these would be called 'control' reefs, but they are not true controls, as it is not possible to ensure that restoring nearby reefs would not influence these reference reefs. That is, these reefs might receive larvae from nearby restored reefs, so the term 'reference reefs' is used. Per oyster population data collected prior to commencing large-scale restoration work in Harris Creek, the reference reefs did not meet the 50 oysters per m^2 Oyster Metrics success criterion.

Treatment Name	Reef-building substrate added?	Substrate Material	Cap Material	Reef seeded?	Notes
Reference	No	None	None	No	Did not meet oyster density success criteria; would typically require restoration, but none was undertaken so reefs could serve as reference sites.
Premet	No	None	None	No	Assumed to have met the oyster density success criteria prior to restoration, so no restoration activities undertaken.
Seed Only	No	None	None	Yes (spat-on-shell)	null
Florida fossil shell	Yes	Fossil shell	None	Yes (spat-on-shell)l	null
Stone topped with mixed shell	Yes	Amphibolite (stone)	Mixed shell (scallop, conch, and clam)	Yes (spat-on-shell)	null

Table 1: Description of restoration treatment types for reefs monitored in 2017.

Seed only: Reefs treated only with hatchery-produced oyster seed (spat-on-shell). No base reef-building substrate was added prior to seeding. This treatment was generally used on reefs where the prerestoration population was five oysters per m^2 or greater, but fewer than 50 oysters per m^2 (see Harris Creek Tributary Plan[1] and Little Choptank Tributary Plan[2] for detailed description of how the Workgroup determined treatment type for each reef).

Stone substrate: The stone reef-building material used in Harris Creek, Little Choptank River, and Tred Avon River, which is geologically classified as amphibolite. The material was graded to fit through a six-inch mesh screen. See Figure 21.

Stone reefs topped with mixed shell: Reefs constructed from a stone base, then capped with mixed shell.

Sentinel reefs: A subset of the restored reefs that are monitored annually (rather than only three years and six years after restoration, which is the standard for other restored reefs).

Substrate + seed: Reefs treated with reef-building substrate, generally to a height of six inches to one foot above the surrounding soft bottom. Substrate used for the 2014 cohort was either Florida fossil shell or stone capped with mixed shell. Substrate placement was followed by planting with hatchery-produced spat-on-shell. Substrate-and-seed treatment type was generally used where prerestoration oyster populations were below five oysters per m^2, or where sonar surveys found no evidence of shell.

Executive Summary

Background and Context

The 2014 Chesapeake Bay Watershed Agreement includes a goal to restore oyster populations in ten Chesapeake Bay tributaries by 2025. This has generally been interpreted as five tributaries in Maryland and five in Virginia. In Maryland, partners including the National Oceanic and Atmospheric Administration (NOAA), U.S. Army Corps of Engineers' Baltimore District (USACE), Oyster Recovery Partnership (ORP), and the Maryland Department of Natural Resources (DNR) are working to achieve this goal through the Maryland Interagency Oyster Restoration Workgroup (hereafter, the Workgroup). The Workgroup is convened under the Sustainable Fisheries Goal Implementation Team of the Chesapeake Bay Program.

In Maryland, Harris Creek was the first tributary selected for large-scale oyster restoration, followed by the Little Choptank and Tred Avon rivers (Figure 2). A set of oyster restoration success criteria, commonly known as the Chesapeake Bay Oyster Metrics[4], was developed by scientists and resource managers prior to implementing restoration work. There are six Oyster Metrics success criteria. This report describes the success of each reef relative to these criteria: oyster density, oyster biomass, multiple year classes, shell budget, reef height, and reef footprint (Table 6).

For each of the first three rivers selected in Maryland, partners developed tributary plans[1,2,3] to guide restoration. These plans describe tributary-specific oyster restoration goals, including the locations within a given tributary where restoration was to take place.

Consistent with the tributary plans and the Oyster Metrics success criteria, partners collaboratively monitor each restored reef three years, and again six years, after restoration treatment. This report describes the results from monitoring the 2014 cohort (reefs restored in 2014 and monitored in 2017). In addition, premet, reference, and sentinel reefs were monitored (see Definitions section). The following were monitored in 2017:

- Harris Creek: 14 reefs in the 2014 cohort (64.8 acres), 4 reference reefs (10.73 acres), and 5 sentinel reefs (26.5 acres)
- Little Choptank River: 2 reefs in the 2014 cohort (11.42 acres), 12 premet reefs (45.27 acres), 3 reference reefs (7.75 acres), and 4 sentinel reefs (11.3 acres)
- Tred Avon River: No reefs were in the 2014 cohort; 4 sentinel reefs were monitored (11.8 acres)

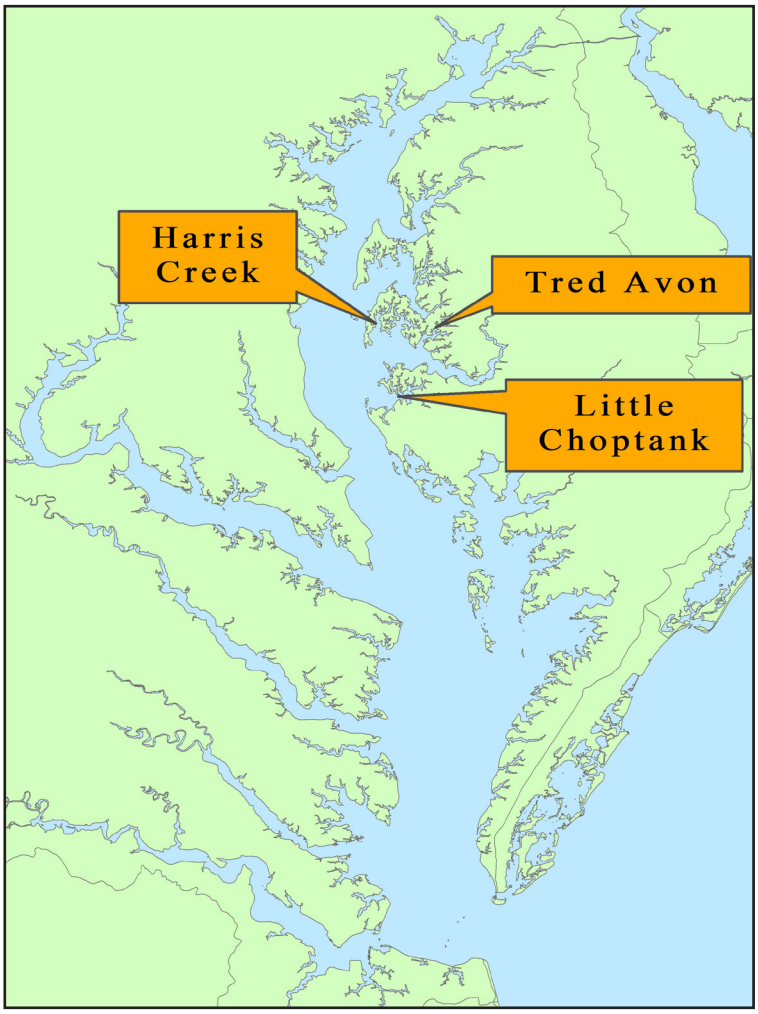

Figure 2: Harris Creek, Little Choptank River, and Tred Avon River on the Chesapeake Bay in Maryland.

Summary of 2017 Monitoring Results

Full results for restored and reference reefs are given in the body of the report. Sentinel reef results are in Appendix D.

In Harris Creek, of the 14 reefs in the 2014 cohort:

- 100% (14 reefs) met the minimum threshold for both oyster density and biomass (Figure 3A).
- 79% (11 reefs) met the higher target level for both oyster density and biomass (Figure 3A). All reefs that met the target level were constructed using a either a Florida fossil shell base, or a stone base capped with mixed shell. No seed-only reefs met the higher target for oyster density and biomass.
- 100% (14 reefs) met the success criteria for multiple year classes. (That is, they had more than one year class present.)
- Of the 13 reefs in the 2014 cohort for which both prerestoration and 2017 structural data were collected, 100% (13 reefs) met the Oyster Metrics criteria for a stable or increasing reef footprint and reef height.
- Because additional data are needed, shell budgets for all 14 reefs will be assessed in 2020.
- Prior monitoring results: From 2015 through 2017, a total of 56 Harris Creek reefs were monitored, each at three years post restoration. Of these, at the time they were monitored, 98% (55 reefs) met the minimum threshold for both oyster density and biomass, and 73% (41 reefs) met the higher target level for both oyster density and biomass (Figures 24 and 25).

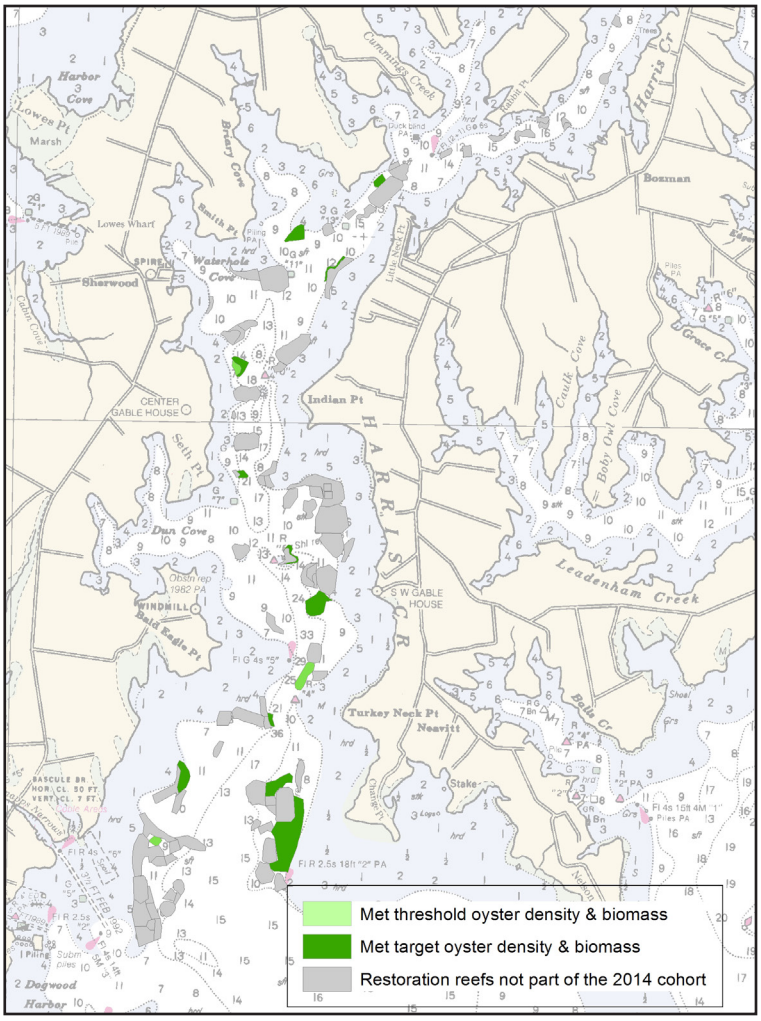

Figure 3A: Performance of each Harris Creek 2014 cohort reef relative to Oyster Metrics density and biomass success criteria in 2017.

In Little Choptank River, of the 2 reefs in the 2014 cohort:

- 100% (2 reefs) met the minimum threshold success criteria for both oyster density and biomass. Both were seed-only reefs (Figure 3B).
- 0% (0 reefs) met the higher target criteria for both oyster density and biomass.
- 100% (2 reefs) met the success criteria for multiple year classes. (That is, they had more than one year class present.)
- Because additional data are needed, the success of these reefs relative to the shell budget, reef footprint, and reef height criteria will be assessed in 2020.
- In addition to the 2014 cohort, 12 premet reefs were monitored. Of these, 83% (10 reefs) met the minimum threshold success criteria for both oyster density and biomass. 43% (5 reefs) also met the higher target criteria for both oyster density and biomass.

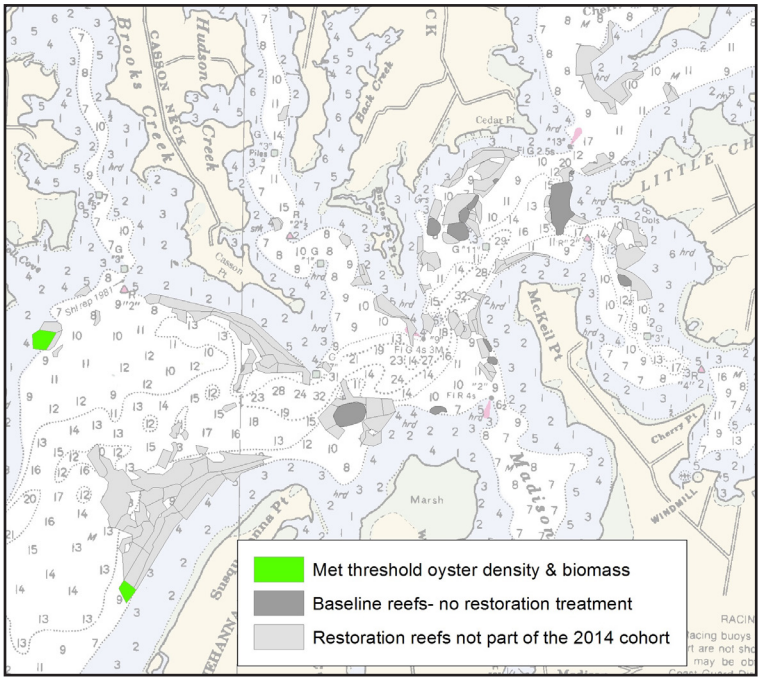

Figure 3B: Performance of each Little Choptank 2014 cohort reef relative to Oyster Metrics density and biomass success criteria in 2017.

Monitoring Type	Reef #	Tributary	Substrate type added	**Did reef meet minimum threshold density?**	Did reef meet target density?	**Did reef meet minimum threshold oyster biomass?**	Did reef meet target oyster biomass?	**Are multiple year classes present?**	**Is shell volume stable/ increasing?**	**Is reef footprint stable/ increasing?**	**Is reef height stable/ increasing?**
Harris 2014 Cohort	H49	Harris	Stone base w mix shell	**Yes**	Yes	**Yes**	Yes	**Yes**	**TBD in 2020**	**Yes**	**Yes**
	H51	Harris	Stone base w mix shell	**Yes**	Yes	**Yes**	Yes	**Yes**	**TBD in 2020**	**Yes**	**Yes**
	H62	Harris	Stone base w mix shell	**Yes**	Yes	**Yes**	Yes	**Yes**	**TBD in 2020**	**Yes**	**Yes**
	H52	Harris	Fossil shell	**Yes**	Yes	**Yes**	Yes	**Yes**	**TBD in 2020**	**Yes**	**Yes**
	H53	Harris	Stone base w mix shell	**Yes**	Yes	**Yes**	Yes	**Yes**	**TBD in 2020**	**Yes**	**Yes**
	H54	Harris	Fossil shell	**Yes**	Yes	**Yes**	Yes	**Yes**	**TBD in 2020**	**Yes**	**Yes**
	H56	Harris	Stone base w mix shell	**Yes**	Yes	**Yes**	Yes	**Yes**	**TBD in 2020**	**Yes**	**Yes**
	H57	Harris	Stone base w mix shell	**Yes**	Yes	**Yes**	Yes	**Yes**	**TBD in 2020**	**Yes**	**Yes**
	H58	Harris	Stone base w mix shell	**Yes**	Yes	**Yes**	Yes	**Yes**	**TBD in 2020**	**Yes**	**Yes**
	H59	Harris	Stone base w mix shell	**Yes**	Yes	**Yes**	Yes	**Yes**	**TBD in 2020**	**Yes**	**Yes**
	H60	Harris	Fossil shell	**Yes**	Yes	**Yes**	Yes	**Yes**	**TBD in 2020**	**Yes**	**Yes**
	H55	Harris	Spat on shell only	**Yes**	No	**Yes**	No	**Yes**	**TBD in 2020**	**Yes**	**Yes**
	H48	Harris	Spat on shell only	**Yes**	No	**Yes**	No	**Yes**	**TBD in 2020**	**Yes**	**Yes**
	H50	Harris	Spat on shell only	**Yes**	No	**Yes**	No	**Yes**	**TBD in 2020**	**TBD**	**TBD**
Harris reference reefs	H14	Harris	NONE	**Yes**	No	**Yes**	No	**Yes**	**TBD in 2020**	**Yes**	**Yes**
	H17	Harris	NONE	**No**	No	**No**	No	**Yes**	**TBD in 2020**	**Yes**	**Yes**
	H15	Harris	NONE	**No**	No	**No**	No	**Yes**	**TBD in 2020**	**Yes**	**Yes**
	H16	Harris	NONE	**Yes**	No	**Yes**	No	**Yes**	**TBD in 2020**	**Yes**	**Yes**
Little Choptank 2014 cohort	L03	Little Choptank	Spat-on-shell only	**Yes**	Yes	**Yes**	No	**Yes**	**TBD in 2020**	**TBD**	**TBD**
	L04	Little Choptank	Spat-on-shell only	**Yes**	No	**Yes**	No	**Yes**	**TBD in 2020**	**TBD**	**TBD**
Little Choptank reference reefs	L53	Little Choptank	None	**Yes**	No	**Yes**	No	**Yes**	**TBD in 2020**	**Yes**	**Yes**
	L54	Little Choptank	None	**Yes**	Yes	**Yes**	Yes	**Yes**	**TBD in 2020**	**Yes**	**Yes**
	L52	Little Choptank	None	**Yes**	Yes	**Yes**	Yes	**Yes**	**TBD in 2020**	**TBD**	**TBD**
Little Choptank baseline reefs	L57	Little Choptank	None	**No**	No	**No**	No	**Yes**	**TBD in 2020**	**TBD**	**TBD**
	L58	Little Choptank	None	**Yes**	No	**Yes**	No	**Yes**	**TBD in 2020**	**TBD**	**TBD**
	L59	Little Choptank	None	**Yes**	Yes	**Yes**	Yes	**Yes**	**TBD in 2020**	**TBD**	**TBD**
	L60	Little Choptank	None	**Yes**	No	**Yes**	No	**Yes**	**TBD in 2020**	**TBD**	**TBD**
	L68	Little Choptank	None	**Yes**	Yes	**Yes**	No	**Yes**	**TBD in 2020**	**TBD**	**TBD**
	L61	Little Choptank	None	**Yes**	No	**Yes**	No	**Yes**	**TBD in 2020**	**TBD**	**TBD**
	L62	Little Choptank	None	**Yes**	Yes	**Yes**	Yes	**Yes**	**TBD in 2020**	**TBD**	**TBD**
	L63	Little Choptank	None	**Yes**	No	**Yes**	No	**Yes**	**TBD in 2020**	**TBD**	**TBD**
	L64	Little Choptank	None	**Yes**	Yes	**Yes**	Yes	**Yes**	**TBD in 2020**	**TBD**	**TBD**
	L65	Little Choptank	None	**No**	No	**No**	No	**Yes**	**TBD in 2020**	**TBD**	**TBD**
	L66	Little Choptank	None	**Yes**	Yes	**Yes**	Yes	**Yes**	**TBD in 2020**	**TBD**	**TBD**
	L67	Little Choptank	None	**Yes**	Yes	**Yes**	Yes	**Yes**	**TBD in 2020**	**TBD**	**TBD**

Table 4: Summary of how each monitored reef performed in 2017 relative to Oyster Metrics success criteria. Bold text shows success criteria. See results section for detailed information. TBD = fall 2017 data will serve as baseline, and will be compared to fall 2020 data to determine success for these criteria. See Section 2.2 for explanation.

In the Tred Avon River:

- Restoration started in 2015. Because the first monitoring is completed three years post restoration, no reefs were of the age to be monitored in 2017.
- Four sentinel reefs were monitored in 2014. These reefs are monitored annually.

Additional patterns in monitoring data include:

- The highest average oyster densities were found on Florida fossil-shell-base reefs and stone-base-reefs topped with mixed shell (Figure 5).
- Many oysters found on Florida fossil-shell-base reefs and on stone-base reefs topped with mixed shell were attached directly to reef base material (Florida fossil shell, stone, or mixed shell) rather than to oyster shell. All oysters attached to materials other than oyster shell are the result of natural recruitment. This is known because all hatchery-produced oysters planted on these reefs were set on oyster shell. This suggests that stone, Florida fossil shell, and mixed shell are suitable settlement substrate for juvenile oysters, and that oysters are setting on these reefs in sizable quantities (Figures 21 and 22). Oysters found on oyster shell could be either the result of natural recruitment or hatchery production. However, smaller oysters (<40 mm) are likely the result of natural recruitment because seed planted in 2014 would typically be >40 mm. See shell height distribution histograms and pie charts on reef pages, Appendix B.

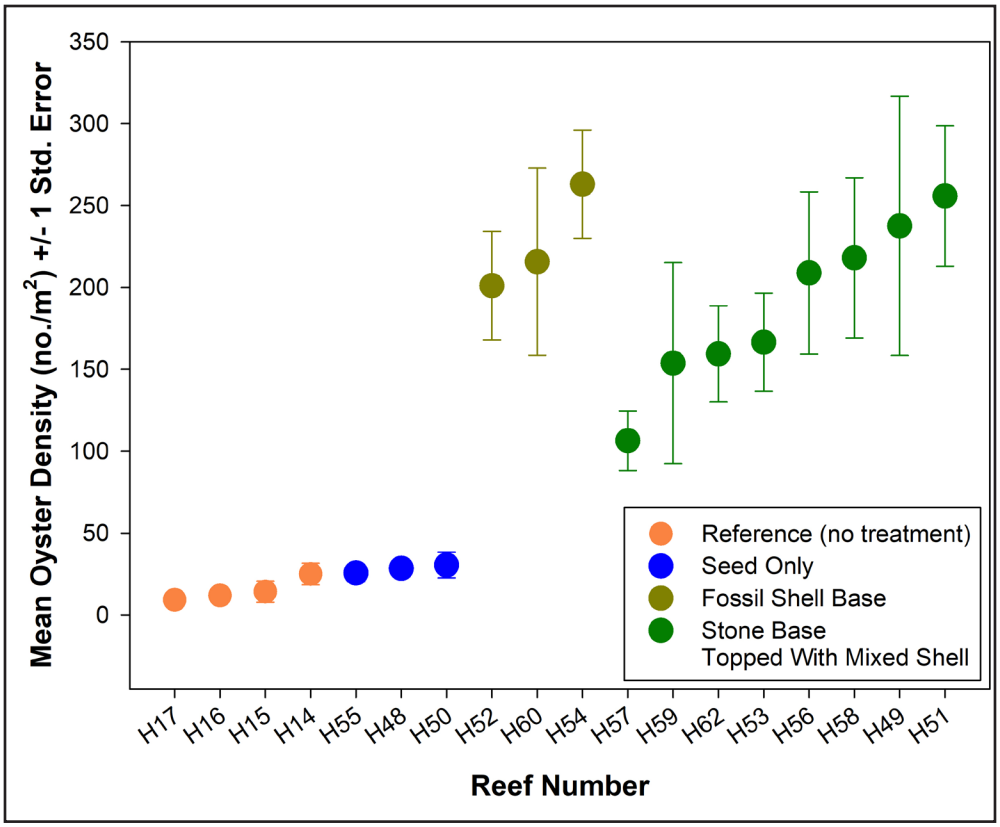

Figure 5: Mean oyster density, by treatment type, for Harris Creek reefs monitored in 2017.

Although the information in this report looks promising for the eventual success of the Harris Creek project, several factors could affect continued success. These include future water-quality issues, oyster disease, funding, and poaching (illegal oyster harvesting).

Data and analysis in this report may be used by the Maryland Interagency Oyster Restoration Workgroup and partners to help inform what adaptive management measures, if any, should be taken on each of the 2014 cohort reefs. It will also be used to guide restoration in other tributaries.

Cumulative results, 2015-2017

Three Harris Creek cohorts have been monitored to date: the 2012 cohort (monitored in 2015), the 2013 cohort (monitored in 2016), and the 2014 cohort (monitored in 2017). See Discussion and Figures 23 and 24 for more information.

Of the 56 reefs that received three-year monitoring between 2015 and 2017:

- 98% (55 reefs) met the minimum threshold success criteria for oyster density and biomass.
- 75% (42 reefs) met the higher, target criteria for oyster density and biomass.
- 2% (1 reef) failed to meet even the minimum threshold for oyster density and biomass.
- 100% (56 reefs) met the multiple year class success criteria.

Section I: Introduction and Background

1.1 Policy Drivers, Oyster Metrics Success Criteria, and Oyster Restoration Planning

The 2014 Chesapeake Bay Watershed Agreement's oyster outcome calls for restoring oyster populations in 10 Chesapeake Bay tributaries by 2025. The Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team (Fisheries GIT) is charged with working to achieve this goal. Driven by Executive Order 13508 (Chesapeake Bay Protection and Restoration) from 2009, some work toward tributary-scale oyster restoration was under way even before the Chesapeake Bay Watershed Agreement was signed in 2014. The Fisheries GIT previously convened the Chesapeake Bay Oyster Metrics Workgroup, which, in its 2011 report "Restoration Goals, Quantitative Metrics and Assessment Protocols for Evaluating Success on Restored Oyster Reef Sanctuaries"[4] (hereafter, Oyster Metrics), established Bay-wide, science-based, consensus success criteria for oyster restoration to be conducted three years and six years following restoration efforts (Table 6).

Biological Metrics	Oyster density	Minimum threshold = 15 oysters per m^2 over 30% of the reef area Target = 50 oysters per m^2 over 30% of the reef area
	Oyster biomass	Minimum threshold = 15 grams dry weight per m^2 over 30% of the reef area Target = 50 grams dry weight per m^2 over 30% of the reef area
	Multiple year classes	Presence of multiple year classes on the reef, as defined by oysters in at least two of the following size classes: market (>76 mm); small (40-75 mm); spat (<40 mm).
	Shell budget	Stable or increasing shell budget on the reef
Structural Metrics	Reef footprint	Stable or increasing reef footprint compared to baseline
	Reef height	Stable or increasing reef height compared to baseline

Table 6: The Oyster Metrics reef-level success criteria.

Once these success criteria were adopted, the Fisheries GIT convened interagency workgroups in Maryland and Virginia to plan restoration work in each state, in consultation with appropriate partners. In Maryland, the Maryland Oyster Restoration Interagency Workgroup (hereafter, the Workgroup) is chaired by the National Oceanic and Atmospheric Administration (NOAA) and includes members from the Maryland Department of Natural Resources (DNR), Oyster Recovery Partnership (ORP), and the U.S. Army Corps of Engineers' Baltimore District (USACE).

The first three Maryland tributaries selected for large-scale oyster restoration were Harris Creek, Little Choptank River, and Tred Avon River. These were selected primarily based upon their status as oyster sanctuaries (areas where harvest of oysters is not allowed) as established by DNR in 2010, historic and ongoing presence of oysters, and current-day water-quality and benthic habitat conditions suitable for oysters. The Workgroup has developed oyster restoration tributary plans for each river,[1,2,3] in consultation with a group of consulting scientists and the public. Restoration work is under way in all three tributaries. DNR, with input from the multistakeholder Maryland Oyster Advisory Commission, recommended the St. Marys River as the fourth tributary in December 2017 and the Manokin River as the fifth tributary in September 2018. Over the next year, data will collected and analyzed toward developing restoration construction blueprints to determine if these two sanctuaries can be selected as tributaries to be restored toward the 2014 Chesapeake Bay Watershed Agreement goal.

1.2 Overview of Report Content

Consistent with the tributary plans for each river[1,2,3] and the Oyster Metrics[4] success criteria, partners collaboratively monitor each restored oyster reef three years, and again at six years, after restoration treatment. A subset of reefs (cohort) in Harris Creek and Little Choptank River have matured to three years, and in 2017 these underwent three-year postrestoration monitoring. In Tred Avon River, only sentinel reefs were monitored, as no restored reefs have matured

Cohort year (year initial restoration occurred)	Three-year monitoring completed	Link to monitoring report
2012	2015	https://chesapeakebay.noaa.gov/images/stories/habitats/hc3ydcheckinjuly2016.pdf
2013	2016	https://chesapeakebay.noaa.gov/images/stories/pdf/2016oysterreefmonitoringreport.pdf
2014	2017	*This report*

Table 7: Restoration cohort monitoring schedule and associated report links.

Tributary	# Reefs	Monitoring category	Restoration treatment type
Harris Creek	14	2014 cohort (64.8 acres)	Seed only = 3 reefs Stone base with mixed shell = 8 reefs Fossil-shell base = 3 reefs
	4	Reference (10.73 acres)	No treatment
	5	Sentinel (monitored annually)	Seed only = 3 reefs Mixed shell base = 1 reef Stone base = 1 reef
Little Choptank	2	2014 cohort (11.42 acres)	Seed only = 2 reefs
	12	Premet (45.27 acres)	No treatment
	3	Reference (7.75 acres)	No treatment
	4	Sentinel	Seed only = 1 reef fossil shell base = 1 reef Stone base = 1 reef Stone base with fossil shell = 1 reef
Tred Avon River	4	Sentinel	Seed only = 1 reef Mixed shell base = 2 reefs Stone base = 1 reef

Table 8: Reefs monitored in 2017.

to three years. Data and analysis for the 2014 cohort, plus premet reefs (Little Choptank only) and reference reefs, are provided in the main body of this report. Information on sentinel reefs is in Appendix D. Table 7 shows which year each cohort was monitored and includes links to past monitoring reports. Table 8 describes which reefs were monitored in 2017 and which monitoring category they fell into. See the Definitions section for monitoring categories.

The 2014 cohort will be monitored again in fall 2020, per Oyster Metrics recommendations and each river's tributary plan. Additional cohorts will be monitored as they mature to three years old, and again when they are six years old. At six years, a determination will be made whether each reef can be considered successfully restored, per the Oyster Metrics criteria.

1.3 Availability Data Related to this Report

Geographic Information System (GIS) data relevant to this report are available in the oyster restoration geodatabases for each tributary, https://www.habitat.noaa.gov/chesapeakebay/gis/Oyster_Restoration_Geodatabases/. In some cases, metadata and/or analyses are provided in the GIS geodatabases. These databases can be accessed using a GIS program or by downloading the free and open-source QGIS program, http://www.qgis.org/en/site/.

Site_ID numbers (used in the GIS geodatabases) were replaced with simpler reef numbers in this report for clarity. Site_ID numbers are consistent throughout the GIS geodatabases. Reef numbers can be crossreferenced with Site_ID numbers in the geodatabase using Table 9.

1.4 Funding and Acknowledgements

Monitoring data for the biological success metrics (oyster density, oyster biomass, multiple year classes, and shell budget) were collected by the Paynter Labs at the University of Maryland, and by Versar, Inc., with funds from:

1. $130,000 award from NOAA to ORP, via the National Fish and Wildlife Foundation (NFWF), and
2. $122,803 programmatic agreement from USACE to ORP.

For the biological Oyster Metrics criteria, monitoring data were managed by ORP and summaries and analysis were conducted by ORP, Paynter Labs at the University of Maryland, and Versar, Inc. Data for the reef structural metrics (reef height and reef footprint) were collected and analyzed by the NOAA Chesapeake Bay Office. This report was drafted by NOAA, with guidance from the Maryland Interagency Oyster Restoration Workgroup. Results of these analyses will be used to document the status of restoration efforts, to guide adaptive management of these reefs, and to inform future oyster restoration efforts. Technical review of this report was provided by the Workgroup members, and by additional technical reviewers, per NOAA research communications guidelines.

Section 2: Methods Summary

This section summarizes the data collection and analysis methods used in this report. For a full description of methods, see Appendix A: Methods for Data Collection and Analysis.

2.1 Summary of Biological Metrics Methods (oyster density, oyster biomass, multiple year classes, and shell budget)

Data to determine success relative to the four biological metrics were collected at the same time, using a systematic survey design. A sampling grid was developed in GIS and superimposed over a GIS layer of constructed oyster reefs. Grid cell sizes were 12.5 x 12.5m, 25 X 25m, 50 x 50m, or 100 X 100m, depending on reef size. Hydraulic patent tongs were used to sample on seed-only reefs, mixed-shell-base reefs, and untreated reefs (reference reefs and premet reefs). Divers were used to sample on Florida fossil-shell-base reefs and stone-base reefs topped with mixed shell. It is possible that there are some differences in sampling efficiency between samples collected using divers and those collected using patent tongs. However, previous field comparisons[5] on natural oyster reefs revealed no difference in sampling efficiency between oyster densities estimated using divers and those estimated using patent tongs. Therefore, for this report, the differences were assumed to be minimal. See Appendix A for full description of methods.

Tributary	Geodatabase Site_ID	Reef #	Bar name
Harris	AltSub_16A	H49	Hunts
Harris	AltSub_19A	H51	Lodges
Harris	AltSub_22A	H62	Walnut
Harris	AltSub_34	H52	Change
Harris	AltSub_41	H53	Mill Point
Harris	AltSub_48	H54	Smith Point
Harris	AltSub_55A	H56	Eagle Point
Harris	AltSub_58A	H57	Mill Point
Harris	AltSub_64A	H58	Little Neck
Harris	AltSub_71C	H59	Change
Harris	AltSub_76	H60	N/A
Harris	Seed_52	H55	Tilghman Wharf
Harris	Seed_56A	H48	Turkey Neck
Harris	Seed_76	H50	Lodges
Harris	CONTROL_1	H14	Eagle Point
Harris	CONTROL_2	H17	Mill Point
Harris	CONTROL_3	H15	Rabbit Island
Harris	CONTROL_4	H16	Rabbit Island
Harris	AltSub_104	H01	Change
Harris	AltSub_20A	H18	Lodges
Harris	EXCEDES_GOAL_2012	H13	Mill Point
Harris	TREATMENT_3	H10	Little Neck
Harris	TREATMENT_4	H11	Lodges
Little Choptank	SO_01	L03	N/A
Little Choptank	SO_16A	L04	Little Pollard
Little Choptank	CONT_SO_01	L53	Susquehanna
Little Choptank	CONT_SO_02	L54	Butterpot
Little Choptank	CONT_SO_03	L52	Town
Little Choptank	EXCEDES_GOAL_2012_2014_01	L57	N/A
Little Choptank	EXCEDES_GOAL_2012_2014_02	L58	Town
Little Choptank	EXCEDES_GOAL_2012_2014_03	L59	Tobacco Stick
Little Choptank	EXCEDES_GOAL_2012_2014_04	L60	McKeils Point
Little Choptank	EXCEDES_GOAL_2012_2014_05	L68	McKeils Point
Little Choptank	EXCEDES_GOAL_2012_2014_06	L61	McKeils Point
Little Choptank	EXCEDES_GOAL_2012_2014_07	L62	Barn Point
Little Choptank	EXCEDES_GOAL_2012_2014_08	L63	Town
Little Choptank	EXCEDES_GOAL_2012_2014_09	L64	McKeils Point
Little Choptank	EXCEDES_GOAL_2012_2014_10	L65	N/A
Little Choptank	EXCEDES_GOAL_2012_2014_11	L66	N/A
Little Choptank	EXCEDES_GOAL_2012_2014_12	L67	Cason
Little Choptank	SO_17	L01	Little Pollard
Little Choptank	SS_02	L02	Susquehanna
Little Choptank	SS_18	L29	N/A
Little Choptank	SS_25C	L34	McKeils Point
Tred Avon	SO_13	T04	Pecks Point
Tred Avon	SS_44	T01	Bamings Cove
Tred Avon	SS_46	T09	Johnston
Tred Avon	SS_56	T02	Bamings Cove Add

Table 9: Reef numbers to GIS geodatabase Site_ID crossreference list and oyster bar names.

2.2 Summary of Structural Metrics Methods (reef height, reef footprint)

Staff from the NOAA Chesapeake Bay Office conducted multibeam bathymetric (depth) surveys following the construction of substrate reefs and again three years post restoration (fall 2017). Results were compared to determine persistence of reef height and footprint. Sonar surveys were not done on seed-only reefs immediately following planting with spat-on-shell. Therefore, no comparison of reef height or footprint can be made at this time. Sonar data will be

collected on these reefs in 2020 and compared with 2017 data to determine success relative to the structural metrics. See Appendix A for full description of methods.

2.3 Diagnostic Monitoring

In addition to monitoring to determine if reefs met the Oyster Metrics success criteria, information—primarily water-quality data and oyster disease data—was also collected to aid in diagnosing why reefs may have succeeded or failed. With funding from The Nature Conservancy, DNR monitored three water-quality stations on Harris Creek (mddnr.chesapeakebay.net/eyesonthebay). Salinity and dissolved oxygen were suitable for oysters throughout 2017. Disease data will be available when DNR publishes its 2017 Fall Survey Report.

2.4 Location of Monitored Reefs

Figures 10, 11, and 12 show the locations of reefs monitored in 2017, along with reef numbers.

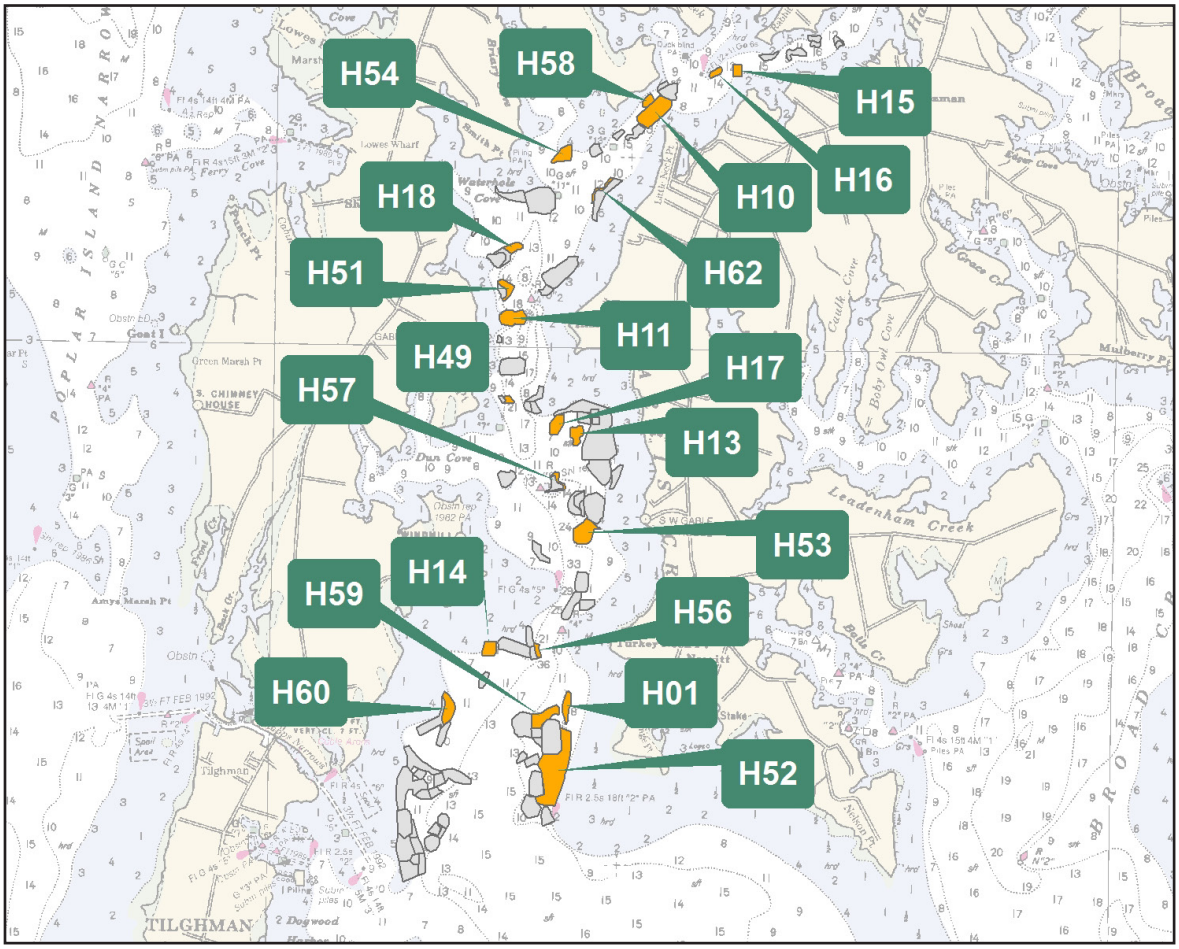

Figure 10: Reefs monitored in Harris Creek in 2017.

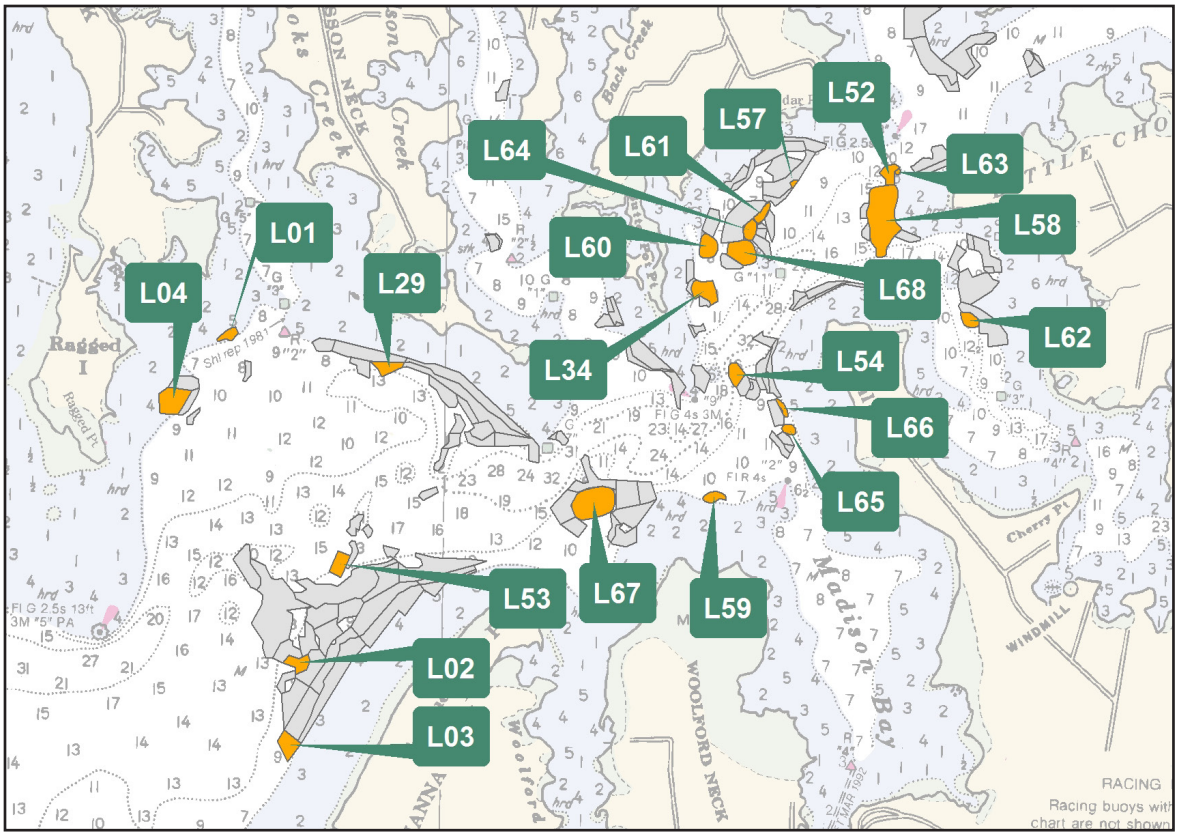

Figure 11: Reefs monitored in the Little Choptank River in 2017.

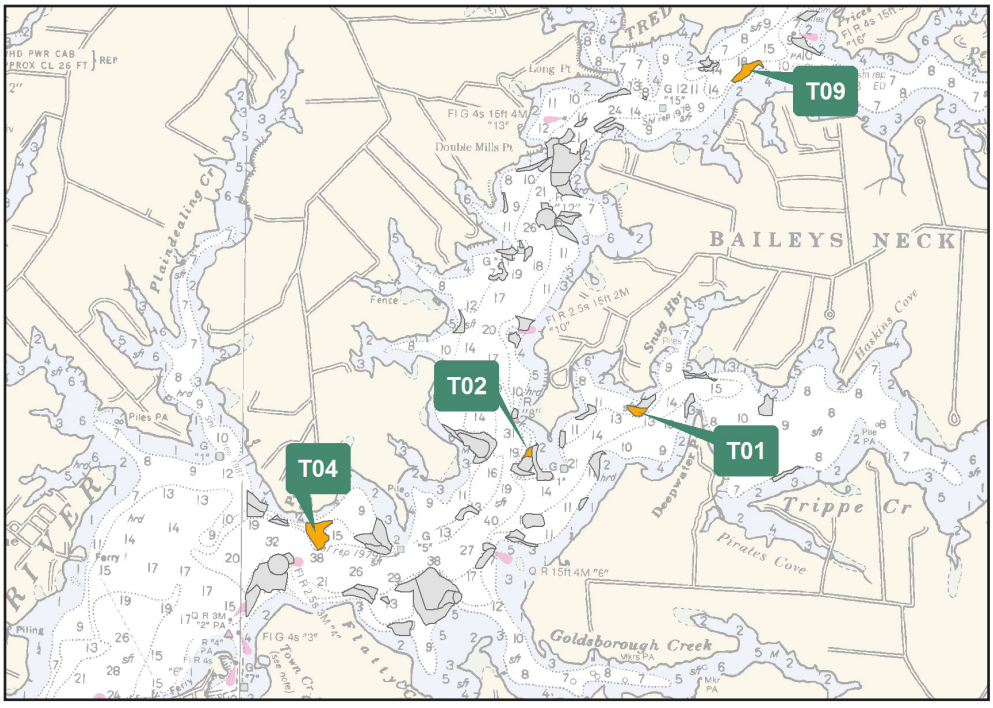

Figure 12: Reefs monitored in the Tred Avon River in 2017.

2.5 Restoration Treatment and Monitoring Information

Tables 13 and 14 show the restoration treatment and sampling information for each reef.

Monitoring Type	Reef #	Substrate type added	Ave. planned reefs height (inches)	Year planted with spat	Spat planted (millions)	Spat planted per acre (millions)	Spat produced by	Spat planted by
Harris 2014 Cohort Reefs	H49	Stone base with mix shell	12	2014	12.69	11.42	ORP	ORP
	H51	Stone base with mix shell	12	2014	14.85	5.33	ORP	ORP
	H62	Stone base with mix shell	12	2014	8.29	5.98	ORP	CBF
	H52	Fossil shell	6	2014	163.81	6.43	ORP	ORP
	H53	Stone base with mix shell	12	2014	39.02	5.06	ORP	ORP
	H54	Fossil shell	6	2014	25.23	6.04	ORP	ORP
	H56	Stone base with mix shell	12	2014	14.32	12.64	ORP	ORP
	H57	Stone base with mix shell	12	2014	13.61	9.76	ORP	ORP
	H58	Stone base with mix shell	12	2014	12.48	7.05	ORP	ORP
	H59	Stone base with mix shell	12 and 6	2014	38.56	6.47	ORP	ORP
	H60	Fossil shell	6	2014	49.16	9.76	ORP	ORP
	H55	Spat-on-shell only	N/A	2014	15.13	9.81	ORP	ORP
	H48	Spat-on-shell only	N/A	2014	21.73	6.05	ORP	ORP
	H50	Spat-on-shell only	N/A	2014	9.18	5.33	ORP	ORP
Harris Reference Reefs	H14	NONE	N/A	N/A	0	0.00	N/A	N/A
	H17	NONE	N/A	N/A	0	0.00	N/A	N/A
	H15	NONE	N/A	N/A	0	0.00	N/A	N/A
	H16	NONE	N/A	N/A	0	0.00	N/A	N/A
L. Choptank 2014 Cohort	L03	Spat-on-shell only	N/A	2014	20.93	5.74	ORP	ORP
	L04	Spat-on-shell only	N/A	2014	23.32	3.78	ORP	ORP
L. Choptank reference	L53	None	N/A	N/A	0	0.00	ORP	ORP
	L54	None	N/A	N/A	0	0.00	ORP	ORP
	L52	None	N/A	N/A	0	0.00	ORP	ORP
Little Chotpank Premet Reefs	L57	None	N/A	N/A	0	0.00	ORP	ORP
	L58	None	N/A	N/A	0	0.00	ORP	ORP
	L59	None	N/A	N/A	0	0.00	ORP	ORP
	L60	None	N/A	N/A	0	0.00	ORP	ORP
	L68	None	N/A	N/A	0	0.00	ORP	ORP
	L61	None	N/A	N/A	0	0.00	ORP	ORP
	L62	None	N/A	N/A	0	0.00	ORP	ORP
	L63	None	N/A	N/A	0	0.00	ORP	ORP
	L64	None	N/A	N/A	0	0.00	ORP	ORP
	L65	None	N/A	N/A	0	0.00	ORP	ORP
	L66	None	N/A	N/A	0	0.00	ORP	ORP
	L67	None	N/A	N/A	0	0.00	ORP	ORP

Table 13: Restoration treatment information for Harris Creek and Little Choptank reefs monitored in 2017.

Monitoring Type	Reef #	Substrate type added	Sample Method	# samples taken	# live oysters measured	# live oysters counted	# dead oysters counted	% of oysters that were dead
Harris 2014 Cohort Reefs	H49	Stone base with mix shll	Diver	4	259	475	82	15%
	H51	Stone base with mix shll	Diver	8	538	1023	137	12%
	H62	Stone base with mix shll	Diver	7	447	558	57	9%
	H52	Fossil shell	Diver	10	625	1005	152	13%
	H53	Stone base with mix shll	Diver	7	392	583	86	13%
	H54	Fossil shell	Diver	4	408	526	49	9%
	H56	Stone base with mix shll	Diver	5	341	522	127	20%
	H57	Stone base with mix shll	Diver	9	398	479	47	9%
	H58	Stone base with mix shll	Diver	5	273	545	50	8%
	H59	Stone base with mix shll	Diver	7	282	538	104	16%
	H60	Fossil shell	Diver	6	373	647	108	14%
	H55	Spat on shell only	Patent Tong	5	169	207	52	20%
	H48	Spat on shell only	Patent Tong	10	278	459	103	18%
	H50	Spat on shell only	Patent Tong	6	161	344	37	10%
Harris Reference Reefs	H14	NONE	Patent Tong	11	182	444	80	15%
	H17	NONE	Patent Tong	11	135	165	20	11%
	H15	NONE	Patent Tong	6	337	138	9	6%
	H16	NONE	Patent Tong	5	149	96	12	11%
L. Choptank 2014 Cohort	L03	Spat-on-shell only	Patent Tong	9	193	615	67	10%
	L04	Spat-on-shell only	Patent Tong	16	402	729	140	16%
L. Choptank reference	L53	None	Patent Tong	7	330	383	40	9%
	L54	None	Patent Tong	8	384	730	115	14%
	L52	None	Patent Tong	7	514	745	97	12%
Little Choptank Premet Reefs	L57	None	Patent Tong	6	96	49	15	23%
	L58	None	Patent Tong	13	419	928	118	11%
	L59	None	Patent Tong	6	365	333	63	16%
	L60	None	Patent Tong	10	407	510	57	10%
	L68	None	Patent Tong	13	237	1087	120	10%
	L61	None	Patent Tong	5	88	300	26	8%
	L62	None	Patent Tong	6	49	1558	84	5%
	L63	None	Patent Tong	3	187	126	12	9%
	L64	None	Patent Tong	5	427	523	49	9%
	L65	None	Patent Tong	5	496	363	31	8%
	L66	None	Patent Tong	7	291	931	109	10%
	L67	None	Patent Tong	6	210	1253	96	7%

Table 14: Biological metrics (oyster density, oyster biomass, multiple year class, shell budget) data collection information for Harris Creek and Little Choptank reefs monitored in 2017.

Section 3: Results Summary

Below are summarized results for each tributary, by Oyster Metrics success criterion. Table 4 in the Executive Summary shows how each Harris Creek reef monitored in 2017 fared relative to the Oyster Metrics criteria. Tables 15-20 (in Appendix C) show more detailed results.

All information for each reef, by reef, including sonar images and graphics of oyster shell height distributions, is in Appendix B: Reef Pages. Information on the sentinel reefs (monitored annually) is in Appendix D.

3.1 Harris Creek Results Summary

Table 4 in the Executive Summary shows how each Harris Creek reef monitored in 2017 fared relative to each Oyster Metrics criteria. Tables 15-17 (in Appendix C) show more specific results.

3.1.1 2014 Cohort Results Summary

Oyster Density Metric (Table 15 in Appendix C)
Oyster density tracked closely with oyster biomass.
Of the 14 reefs in the 2014 cohort:

- 14 reefs (100%) met the minimum threshold oyster density criteria for a successfully restored reef.
- 11 reefs (79%) met the higher target oyster density criteria. These were the Florida fossil-shell-base reefs and the stone-base reefs topped with mixed shell. None of the three seed-only reefs met the higher target oyster density criteria.

Oyster Biomass Metric (Table 16 in Appendix C)
Oyster biomass tracked closely with oyster density.
Of the 14 reefs in the 2014 cohort:

- 14 reefs (100%) met the minimum threshold oyster biomass criteria for a successfully restored reef.
- 11 reefs (78%) met the higher target oyster biomass criteria. These were the Florida fossil-shell-base reefs, and the stone-base reefs topped with mixed shell. None of the three seed-only reefs met the higher target oyster biomass criteria.

Multiple-Year-Class Metric (Table 17 in Appendix C)

- All 14 reefs (100%) had multiple year classes present, as defined by the presence of oysters in at least two of the following size classes: market (>76 mm), small (40-75 mm), and spat (<40 mm). These reefs thereby met the Oyster Metrics success criterion for multiple year classes. See histograms and pie charts of shell height distributions on reef pages, Appendix B.

Shell Budget Metric (Table 17 in Appendix C)

- It is not yet possible to determine whether the 2014 cohort reefs met the success criterion for shell budget (see Appendix A, Section A.2, for full explanation). The shell budget data collected in fall 2017 will be compared to data collected in fall 2020 to determine success against this metric at that time.

Reef Footprint Metric (Table 17 in Appendix C)

- One reef (H50) in the 2014 cohort had no baseline structural data collected. It is not possible, at this time, to determine success of this reef against the reef footprint criterion. For this reef, fall 2017 data will be compared to fall 2020 data to determine success against this criterion at that time (see Appendix A, Section A.2, for full explanation).
- Of the 13 reefs in the 2014 cohort for which baseline data and 2017 data were collected, all 13 (100%) met the Oyster Metric criterion for a stable/increasing reef footprint.

Reef Height Metric (Table 17 in Appendix C)

- One reef in the 2014 cohort had no baseline structural data collected. It is not possible, at this time, to determine success of this reef against the reef height criterion. For this reef, fall 2017 data will be compared to fall 2020 data to determine success against this criterion at that time (see Appendix A, Section A.2, for full explanation).
- Of the 13 reefs in the 2014 cohort for which baseline data and 2017 data were collected, all 13 (100%) met the Oyster Metric criterion for a stable/increasing reef height.

3.1.2 Reference Reefs Summary (Tables 15-17 in Appendix C)

Of the four reference reefs monitored in fall 2017:
- Two reefs (50%) met the minimum threshold oyster density and biomass success criteria.
- None (0%) met the higher target oyster density and biomass success criteria.

For information on the sentinel reefs (monitored annually), see Appendix D.

3.2 Little Choptank River Results Summary

Table 4 shows how each Little Choptank River reef monitored in 2017 performed relative to each Oyster Metric. Tables 18-20 (in Appendix C) show results in more detail. For information on the sentinel reefs (monitored annually), see Appendix C.

3.2.1 2014 Cohort Results Summary

Oyster Density Metric (Table 18 in Appendix C)
Of the 2 reefs in the 2014 cohort:
- 2 reefs (100%) met the minimum threshold oyster density criteria for a successfully restored reef.
- 1 reef (50%) met the higher target oyster density criteria.

Oyster Biomass Metric (Table 19 in Appendix C)
Of the 2 reefs in the 2014 cohort:
- 2 reefs (100%) met the minimum threshold oyster biomass criteria for a successfully restored reef.
- Zero reefs (0%) met the higher target oyster biomass criteria.

Multiple Year Class Metric (Table 20 in Appendix C)
- Both reefs (100%) had multiple year classes present, as defined by the presence of oysters in at least two of the following size classes: market (>76 mm); small (40-75 mm); spat (<40 mm). These reefs thereby met the Oyster Metrics success criterion for multiple year classes.

Shell Budget Metric (Table 20 in Appendix C)
- It is not yet possible to determine whether the 2014 cohort reefs met the success criterion for shell budget (see Appendix A, Section A.2, for full explanation). The shell budget data collected in fall 2017 will be compared to data collected in fall 2020 to determine success against this metric at that time.

Reef Footprint and Reef Height Metrics (Table 20 in Appendix C)
- The 2014 cohort reefs had no baseline structural data collected. It is not possible, at this time, to determine success of these reefs relative to the reef footprint and reef height criteria. Fall 2017 data will be compared to fall 2020 data to determine success relative to this criterion (see Appendix A, Section A.2, for full explanation).

For information on the sentinel reefs (monitored annually), see Appendix D.

3.2.2 'Premet' Reefs Results Summary (Tables 18-21 in Appendix C)

'Premet' reefs were assumed to have met the Oyster Metrics target criteria for oyster density (50 or more oysters per m^2) when surveyed prior to commencement of large-scale restoration efforts. (See Definitions section for explanation.) These reefs received no restoration treatment. These reefs are monitored every three years, as are other reefs, to determine appropriate adaptive management needs.

Oyster Density Metric (Figure 18 in Appendix C)
Of the 12 premet reefs in monitored in 2017:
- 10 reefs (83%) met the minimum threshold oyster density criteria.

- 6 reef (50%) met the higher target oyster density criteria.
- 2 reefs (17%) failed to meet the minimum threshold oyster density criteria.

Oyster Biomass Metric (Figure 19 in Appendix C)
Of the 12 premet reefs in monitored in 2017:
- 10 reefs (83%) met the minimum threshold oyster biomass criteria for a successfully restored reef.
- 5 reefs (42%) met the higher target oyster biomass criteria.
- 2 reefs (17%) failed to meet the minimum threshold oyster density criteria.

Multiple Year Class Metric (Figure 20 in Appendix C)
- All 12 reefs (100%) had multiple year classes present, as defined by the presence of oysters in at least two of the following size classes: market (>76 mm), small (40-75 mm), and spat (<40 mm). These reefs thereby met the Oyster Metrics success criterion for multiple year classes.

Shell Budget Metric (Table 20 in Appendix C)
- It is not yet possible to determine whether the 2014 cohort reefs met the success criterion for shell budget (see Appendix A, Section A.2, for full explanation). The shell budget data collected in fall 2017 will be compared to data collected in fall 2020 to determine success against this metric at that time.

Reef Footprint and Reef Height Metrics (Table 20 in Appendix C)
- The 2014 cohort reefs had no baseline structural data collected. It is not possible, at this time, to determine success of these reefs relative to the reef footprint and reef height criteria. Fall 2017 data will be compared to fall 2020 data to determine success relative to this criterion (see Appendix A, Section A.2, for full explanation).

3.2.3 Reference Reefs Results Summary (Tables 18-20 in Appendix C)

Of the three reference reefs monitored in fall 2017:
- All three reefs (100%) met the minimum threshold oyster density and biomass success criteria.
- Two reefs (67%) met the higher target oyster density and biomass success criteria.
- It is not yet possible to determine whether the 2014 cohort reefs met the success criterion for shell budget (see Appendix A, Section A.2, for full explanation). The shell budget data collected in fall 2017 will be compared to data collected in fall 2020 to determine success against this metric at that time.
- Reef height/footprint: One of the reference reefs had no baseline structural data collected. It is not possible, at this time, to determine success of this reef against the reef height and reef footprint criteria. For this reef, fall 2017 data will be compared to fall 2020 data to determine success against this criterion at that time (see Appendix A, Section A.2, for full explanation). Of the two reference reefs for which baseline data and 2017 data were collected, both (100%) met the Oyster Metric criteria for a stable/increasing reef height and footprint.

3.3 Tred Avon River Results

Restoration work began in the Tred Avon River in 2015. Per the Tred Avon Oyster Restoration Tributary Plan, reefs in this river will be monitored starting in fall 2018, when they age to three years. A subset of reefs in this river, however, have been designated as sentinel reefs, and were monitored annually starting in 2016. Four Tred Avon sentinel reefs were monitored in 2017. Information on these is in Appendix D.

Section 4: Discussion

Harris Creek, 2014 Cohort

Overall, the 2014 cohort shows substantial success relative to the Oyster Metrics success criteria.

Following a trend similar to that seen in monitoring done in 2016, oyster densities on Harris Creek were higher on reefs with a Florida fossil shell base and on stone-base reefs topped with mixed shell than on reefs with no added substrate (seed-only reefs) (Figures 5 and 21).

Figure 21: Photos of fossil shell substrate (left, DNR, 2014) and stone substrate, with hard hat shown for scale (NOAA, 2014).

It is unknown, at this time, why the Florida fossil-shell-base reefs and stone-based reefs topped with mixed shell show higher average oyster densities than other treatments. Sonar data suggest greater structural complexity and greater elevation above the background soft sediment on Florida fossil-shell-base reefs and on stone-based topped with mixed shell reefs than on seed-only reefs. Greater structural complexity likely results in more exposed surface area. This could affect oyster survival and/or recruitment. Another supposition is that traditional oyster harvest gear (hand tongs, oyster dredges) is ineffective on stone and Florida fossil shell reefs, and therefore these reefs have protection from poaching that seed-only reefs lack. Yet another concept for consideration is that Florida fossil-shell-base reefs and stone reefs capped with mixed shell may shed more sediment from their surfaces and trap more sediment in their interstitial spaces than seed-only reefs, thereby providing a greater window of opportunity for recruitment.

A substantial quantity of the oysters found on Florida fossil-shell-base reefs and on stone-based reefs capped with mixed shell was found attached to reef base material (pieces of stone, Florida fossil shell, mixed shell) rather than on oyster shell (Figures 22 and 23). Oysters found on stone, Florida fossil shell, or mixed shell are the result of natural recruitment; hatchery-produced oysters planted on these reefs were set onto oyster shell. This suggests that stone, Florida fossil shell, and mixed shell are suitable settlement substrate for oysters and that oysters are setting on these reefs in sizable quantities. Oysters found attached to oyster shell could be either natural recruitment or hatchery-produced oysters. However, smaller oysters (<40 mm) are likely the result of natural recruitment (see shell height distribution histograms and pie charts on reef pages, Appendix B). The relative amount of surface area provided by oyster shell vs. stone, Florida fossil shell, or mixed-shell substrate was not evaluated.

Cumulative Harris Creek results, 2015-2017

Three Harris Creek cohorts have been monitored to date: the 2012 cohort (monitored in 2015), the 2013 cohort (monitored in 2016), and the 2014 cohort (monitored in 2017).

Of the 56 Harris Creek reefs that received three-year monitoring between 2015 and 2017:

- 98% (55 reefs) met the minimum threshold success criteria for oyster density and biomass (Figure 24).
- 75% (42 reefs) met the higher target criteria for oyster density and biomass (Figure 25).
- 2% (1 reef) failed to meet even the minimum threshold for oyster density and biomass.
- 100% (56 reefs) met the multiple-year-class success criteria.

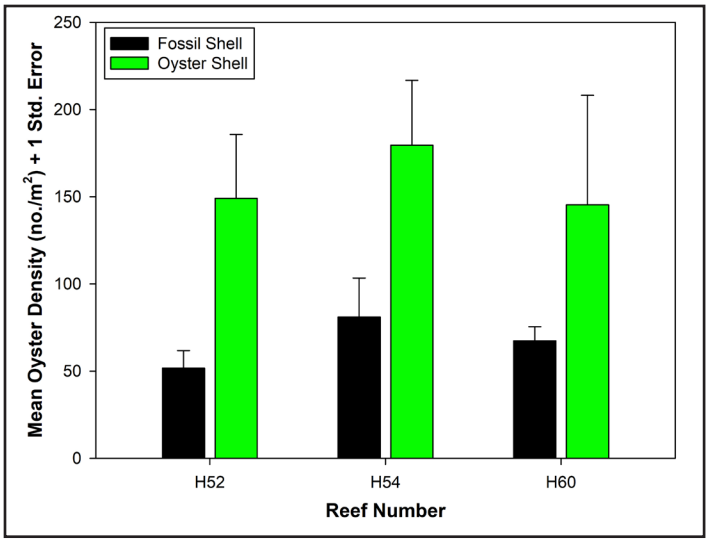

Figure 22: For Florida fossil shell base reefs: Average live oyster densities found attached to Florida fossil shell versus oyster shell. Single oysters and clumps not attached to any visible substrate were counted as attached to oyster shell. Oysters found on Florida fossil shell are the result of natural recruitment; oysters found on oyster shell could be either natural recruitment or hatchery-produced oysters. However, smaller oysters (<40 mm) are likely the result of natural recruitment (see shell-height distribution histograms and pie charts on reef pages, Appendix B).

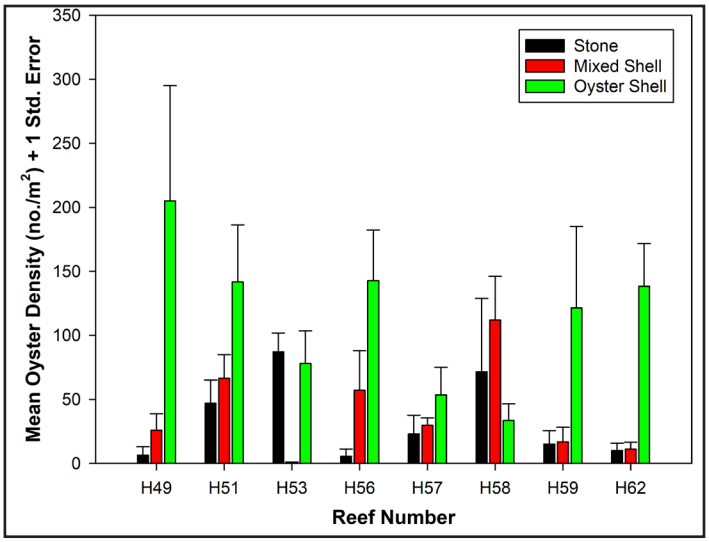

Figure 23: For stone-base reefs capped with mixed shell: Average live oyster densities found attached to oyster shell, stone, or mixed shell. Single oysters and clumps not attached to any visible substrate were counted as attached to oyster shell. Oysters found on stone or mixed-shell substrate are the result of natural recruitment; oysters found on oyster shell could be either natural recruitment or hatchery-produced oysters. However, smaller oysters (<40 mm) are likely the result of natural recruitment (see shell-height distribution histograms and pie charts on reef pages, Appendix B).

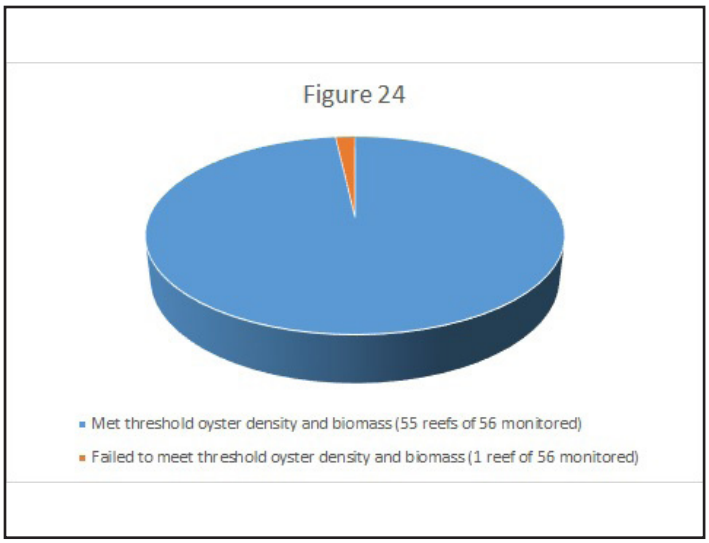

Figure 24: Harris Creek reefs monitored in 2015, 2016, and 2017 that met the minimum threshold success criteria for oyster density and biomass three years post restoration. Excludes reference and sentinel reefs.

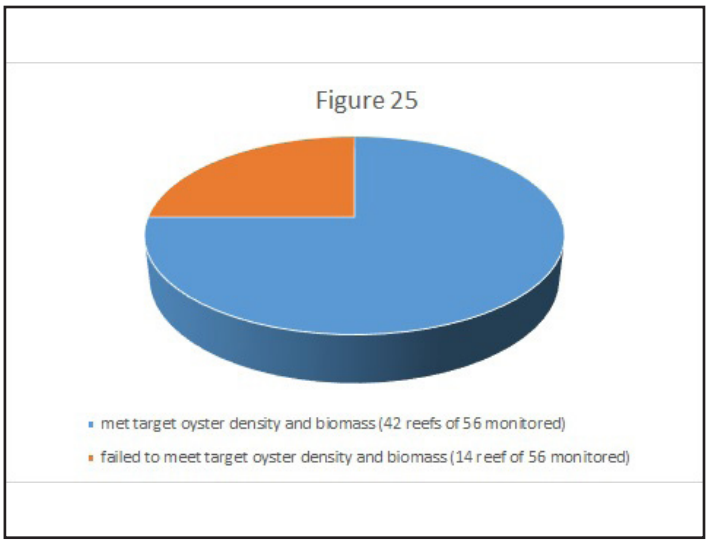

Figure 25: Harris Creek reefs monitored in 2015, 2016, and 2017 that met the higher target success criteria for oyster density and biomass three years post restoration. Excludes reference and sentinel reefs.

Little Choptank River

Only two reefs in the Little Choptank River, both seed-only restoration treatment, were old enough for three-year monitoring in 2017. Both reefs met the minimum threshold oyster density criteria for a successfully restored reef; one reef met the higher target oyster density criteria.

Additionally, 12 premet reefs were monitored in the Little Choptank River in 2017. These reefs were assumed to have met the Oyster Metrics threshold criterion for oyster density when surveyed prior to commencement of large-scale restoration efforts. (See definition of premet reefs in the Definitions section.) These reefs received no restoration treatment. Like treated reefs, these reefs are monitored every three years.

Of these 12 premet reefs, in 2017, 10 met the minimum threshold for oyster density and biomass; five met the higher, target level for oyster density and biomass; two failed to meet even the minimum threshold for oyster density and biomass. It is worth noting that the prerestoration survey that initially determined that these reefs met the oyster density success criterion was done at lower resolution than the 2017 survey. The prerestoration survey may not have been of sufficient resolution to make the assumption that these reefs in fact met the oyster density success criterion.

Tred Avon River

In the Tred Avon River, none of the reefs had matured to three years as of fall 2017, so only sentinel reefs were monitored. See Appendix D for sentinel reef data.

Future Factors to Consider

Taken together, the 2015-2017 monitoring information is promising. However, there are factors that may influence the continued success of large-scale oyster restoration projects. These include:

- Future water-quality issues: Although water quality in Harris Creek, the Little Choptank River, and the Tred Avon River was favorable for oysters throughout 2017 (mddnr.chesapeakebay.net/eyesonthebay), it is possible that extreme low dissolved oxygen events or other water-quality issues in the future could result in substantial oyster mortality. Upstream and upland activity, or watershed-wide water-quality degradation, could also affect oysters.
- Oyster disease: Dermo disease generally has been highly prevalent in oysters in these tributaries in this part of Maryland's Eastern Shore, but at a very low (sublethal) intensity. A dry weather spell, resulting in high salinity, could cause an increase in Dermo intensity, and could lead to significant oyster mortality. Some scientists believe the establishment of sanctuaries may help increase the disease resistance of future generations of oysters through the process of natural selection. This idea has both supporters and detractors in the scientific community. Below is a summary of disease data for each tributary, based on DNR's annual Maryland Oyster Population Status Report Fall Surveys[6]. 2017 data will be available when DNR releases its 2017 Maryland Oyster Population Status Report Fall Survey.
    - Harris Creek Disease 2014-2016
        - MSX prevalence range 0 to 6.7 with average of 2.3
        - Dermo prevalence range 93 to 97 with average of 94
        - Dermo lethal prevalence range 10 to 26.7 with average of 18.9
        - Dermo intensity range 3.6 to 4.2 with average of 3.9
    - Little Choptank Disease 2012-2016
        - MSX prevalence range 0 to 23 with average of 4.6
        - Dermo prevalence range 80 to 100 with average of 91.2
        - Dermo lethal prevalence range 0 to 13.3 with average of 7.9
        - Dermo intensity range 2.2 to 4.2 with average of 3.2
    - Tred Avon Disease 2012-2016
        - MSX prevalence range 0 to 0 with average of 0
        - Dermo prevalence range 70 to 87 with average of 79
        - Dermo lethal prevalence range 0 to 23.3 with average of 3.1
        - Dermo intensity range 2.6 to 3.6 with average of 3.2

- Funding: Funding for the Harris Creek project has come primarily from DNR, NOAA, and USACE. Other funding partners include the Chesapeake Bay Foundation, National Fish and Wildlife Federation, The Nature Conservancy, and CSX. Although initial in-water restoration work is complete in Harris Creek, funds are still needed for monitoring and for smaller second plantings where needed. (The Harris Creek Tributary Plan calls for small second plantings on each reef four years after the initial reefs are seeded. However, thus far, second plantings have not been necessary on reefs restored using stone and fossil shell. The 2014 cohort reefs had not received second year class plantings as of the fall 2017 monitoring.)
- Poaching: Arrests have been made for poaching in the Harris Creek Oyster Sanctuary, http://news.maryland.gov/dnr/2014/01/17/nrp-blotter-21/. It is not possible at this time to quantify the extent of the damage to restoration sites. Unchecked poaching has the potential to do substantial damage by lowering oyster densities and flattening reef structure.

References

1. Harris Creek Oyster Restoration Tributary Plan: A blueprint to restore the oyster population in Harris Creek, a tributary of the Choptank River on Maryland's Eastern Shore. Maryland Interagency Oyster Restoration Workgroup of the Sustainable Fisheries Goal Implementation Team. 2013. https://chesapeakebay.noaa.gov/images/stories/habitats/ harriscreek-blueprint1.13.pdf

2. Little Choptank River Oyster Restoration Tributary Plan: A blueprint for sanctuary restoration. Maryland Interagency Oyster Restoration Workgroup of the Sustainable Fisheries Goal Implementation Team. 2015. https://chesapeakebay.noaa.gov/images/stories/pdf/oystertribplanlittlechoptank.pdf

3. Tred Avon River Oyster Restoration Tributary Plan: A blueprint for sanctuary restoration. Maryland Interagency Oyster Restoration Workgroup of the Sustainable Fisheries Goal Implementation Team. 2015. https://chesapeakebay.noaa.gov/images/stories/habitats/april2015tredavontribplan.pdf

4. Restoration Goals, Quantitative Metrics and Assessment Protocols for Evaluating Success on Restored Oyster Reef Sanctuaries. Report to the Sustainable Fisheries Goal Implementation Team of the Chesapeake Bay Program. Oyster Metrics Workgroup. 2011. http://www.chesapeakebay.net/channel_files/17932/oyster_restoration_success_metrics_final.pdf

5. Chai Ai-Ling, Homer Mark, Tsai Chu-Fa, Goulletquer Philippe (1992). Evaluation of oyster sampling efficiency of patent tongs and an oyster dredge. *North American Journal of Fisheries Management*, 12, 825-832.

6. Maryland Department of Natural Resources, annual Maryland Oyster Population Status Reports, http://dnr.maryland.gov/fisheries/Pages/shellfish-monitoring/reports.aspx

Appendix A: Methods for Data Collection and Analysis

A.1: Methods for determining success against biological Oyster Metrics criteria (oyster density, oyster biomass, multiple year classes, shell budget)

The Oyster Metrics success criteria for each of the four biological metrics are described below, along with the methodology used to evaluate each criterion.

Oyster Density

Oyster Metrics success criteria:

Minimum threshold = 15 oysters per m^2 over 30% of the reef area
Target = 50 oysters per m^2 over 30% of the reef area

Method: Oyster density was calculated as the number of individual oysters collected in the area of a patent-tong grab or diver quadrat standardized to a square meter. The percent of each reef area to meet the minimum threshold or target reef-level restoration oyster density goal criteria was determined by summing the area of all grid cells with standardized oyster densities that met each criteria and calculating the proportion of the reef those grid cells represent.

Oyster Biomass

Oyster Metrics success criteria:

Minimum threshold = 15 grams dry weight per m^2 over 30% of the reef area
Target = 50 grams dry weight per m^2 over 30% of the reef area

Method: Oyster biomass per m^2 was calculated from the size of individual oysters within each sampling grid and then evaluated following the same approach as the density estimates (above).

Multiple Year Classes

Oyster Metrics success criterion: Presence of two or more year classes of live oysters

Methods: Year-class presence was approximated by examining length frequency data of all oyster heights measured at each reef. For simplicity, a reef was determined to have multiple year classes when oysters from at least two standard size-class categories (market: >76 mm; small: 40-75 mm; spat <40 mm) were present.

Shell Budget

Oyster Metrics success criterion: Neutral or positive shell budget on the reef

Method: Changes to the shell budget at individual reefs could not be assessed because baseline information on shell volume did not exist. In the future, the shell budget calculated from 2017 monitoring data will be compared to fall 2020 shell budget data, and a determination of success against the established criteria will be made in fall 2020 (six years post restoration treatment).

Survey Design for Biological Metrics

A systematic survey framework was designed and implemented to quantify interreef scale distributions and densities of oysters and shell to evaluate reef performance in relation to the four biological metrics. The survey followed the same approach as the 2015 three-year check-in, but was optimized in 2016 and 2017 to include unaligned samples that introduced a random component to the choice of all sampling points within a grid cell (see Analysis of Monitoring Data from Harris Creek Sanctuary Reefs, NOAA, July 2016[1] for details of previous survey design).

After application of systematic grid layers to oyster reef restoration sites, sampling points were generated randomly within each cell using ArcMap (ESRI, Version 10.5). Four different grid cell sizes, 12.5 x 12.5m, 25 x 25m, 50 x 50m, and 100 x 100m, were used both to ensure sufficient sample density were collected from reefs of differing sizes, and to account for logistical constraints of various sampling methods (see sampling methods below).

Grid size was assigned as follows:

Diving:

- 12.5 m grid was applied to reefs ≤ 0.5 acres
- 25 m grid was applied to reefs between 0.5 and .99 acres
- 50 m grid was applied to reefs between 1 and 3.99 acres
- 100 m grid was applied to reefs ≥ 4 acres

Patent-tong:

- 12.5 m grid was applied to reefs ≤ 0.5 acres
- 25 m grid was applied to reefs between 0.5 and .99 acres
- 50 m grid was applied to reefs between 1 and 9.99 acres
- 100 m grid was applied to reefs ≥ 10 acres

The sampling framework was completed by creating grids for each cell size and extracting the portions of those grids (Figure App A1). The nature of the application of grids to irregularly shaped oyster restoration polygons created partial grid cells that overlapped the extent of all 2017 three-year check-in reefs. Some partial grids were removed from the sampling frame because they were either too small or too narrow to be sampled using the sampling gear.

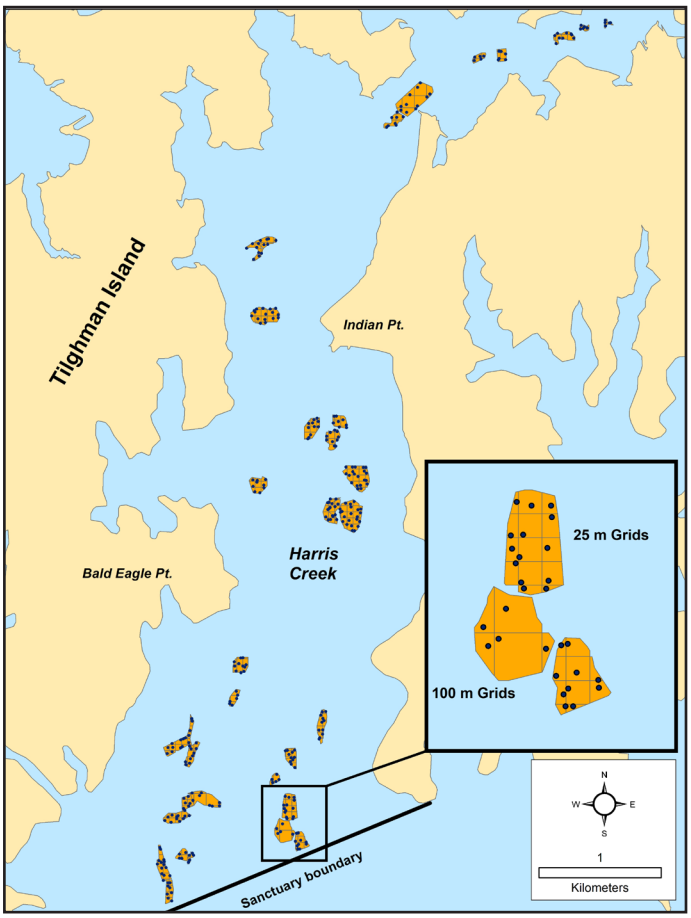

Figure App A1: Map of three-year check-in reefs and systematic sampling grid used to sample oysters in Harris Creek. Insets show examples of 25m and 100m grid cells and the location of samples within them. Reef delineations and the sampling extent were derived from the Harris Creek Oyster Restoration Tributary Plan.

Sampling Methods for Biological Metrics

The density and distribution of oysters and shell were assessed using hydraulic patent-tong and diver sampling. Patent tongs were used to sample oyster reef restoration sites that either had a natural base of oyster shell or were constructed using other natural shell (mixed shell, scallop, conch, clam). Divers were used to collect samples on fossil shell reefs and stone-base reefs capped with mixed shell. It is possible that there are some differences in sampling efficiency between samples collected using divers and those collected using patent tongs. However, previous field comparisons conducted by Chai et al. (1992)[2] on natural oyster reefs revealed no difference in sampling efficiency between oyster densities estimated using divers and those estimated using patent tongs. Therefore, for this report, the differences were assumed to be minimal. Diver sampling was scheduled and implemented by the University of Maryland Paynter Laboratory from the R/V *Callinectes*. Patent-tong sampling was conducted by Versar Inc. from the commercial fishing vessel *Captain's Lady*. Sampling was conducted during daylight hours. Navigation to sampling locations and sample coordinate documentation were done using a differential global positioning system (DGPS) attached to a laptop with ArcView 10.2 used as the navigational program.

Hydraulic patent tongs are a specialized commercial fishing gear used to harvest oysters in the Chesapeake Bay. The patent-tong design functions much like a benthic grab, collecting oysters and underlying substrate from a known fixed area of the bottom. The patent tongs were suspended from a boom over one side of the vessel and deployed to the bottom at each sampling location. One sample was collected within each sampling grid. A DGPS antenna was positioned adjacent to the location where the patent-tongs were deployed, and the geographic coordinates of each sample location were documented when the patent-tong sample was brought to the surface.

Diver surveys were used to collect samples on reefs constructed with a stone base and fossil shell, and were conducted by navigating the vessel to each sampling location and deploying dive flag-labeled buoys with anchors to mark each sample location. Divers descended to the bottom at each buoy with a 0.71m x 0.71m (0.5041m^2) quadrat and sample collection bags. The quadrat was placed up-current of the anchor, with one corner touching the anchor.

Loose oysters, including hatchery oysters and clumps, were removed and transported in bags to the vessel for processing. Oysters attached to the surface of substrate within each quadrat were counted *in situ* and the presence of multiple

size classes of attached oysters was noted. Representative pieces of alternate substrate (stone) were collected at each reef to measure attached oysters.

The contents of patent-tong and diver samples were documented in the field on datasheets. Samples are generally processed onboard the vessels, but time limitations sometimes required diver samples to be transported back to the University of Maryland for processing. The following habitat specific variables were documented from each sample: total volume of shell; amount of shell hash (shell fragments); percent buried shell; and primary, secondary, and tertiary substrate type when present. Total volume of shell was measured for patent-tong by placing the shell portion of the sample in 5-gallon buckets with liter volume increments marked on the outside. Measurements of total loose shell and shell hash from diver samples varied based on the treatment type of each reef. On stone-based reefs, surface shell (loose shell and shell hash) could be removed in sample bags and measured to the nearest liter. Surface shell on stone reefs with shell veneer and on reefs with fossil shell base was estimated by measuring the depth of shell at five locations within the quadrat until the diver reached stone, fossil shell, or mud. The percent of exposed alternate substrate was also documented when it occurred in diver samples.

In each sample, all oysters were counted and identified as live or dead, and a minimum of 30 live oysters were measured for each sample. Live oysters were categorized as market (>76 mm), small (40–75 mm), and spat (<40 mm) size classes. Oyster clumps, the number of oysters associated with a clump, and the substrate type that oysters were attached to were documented. The shell height and total count of dead (old box) and recently dead (gapers) oysters were documented from each sample. The percent of the sample covered by tunicates or mussels was documented for each sample. Surface and bottom water temperature, dissolved oxygen, pH, and salinity were collected during each sampling event at representative locations over each oyster reef using a 6600 multiparameter water quality sonde (YSI Corporation, Yellow Springs, Ohio). Other environmental and station specific variables collected at each site included sample number, date and time, weather information, depth of water, Yates Bar name, vessel name, and staff present.

Statistical Analysis for Biological Metrics and Substrate Treatment Comparisons

Oyster density estimates were standardized to number per m^2 from the area sampled by patent-tong or by diver quadrat. Total counts of live oysters or other variables (e.g., oyster size class, shell volume) were averaged over all samples collected at the individual reef. This analysis was independent of the metrics evaluation and was performed to evaluate reef scale biological attributes.

Oyster biomass estimates were calculated for individual oysters using the equation W = 0.000423 * L1.7475 where W = dry tissue weight in g and L = shell height in mm^3. Biomass was then summed for the entire sample and standardized using the same method as density estimates. Biomass values were averaged over all samples collected at an individual reef. The standard error of the mean is estimated for all density and biomass estimates.

Total sampled shell and surface shell volume were estimated for each individual oyster reef sampled by patent tong. Field measurements of shell resources included total shell volume and the percent of black (buried) shell estimated in a sample. Average shell volumes were standardized by the area sampled by patent-tong. Total sampled shell volume was calculated using average sampled shell volume multiplied by the sampled area. Surface shell estimates were calculated as the percent of the total sampled shell volume that was not considered black shell for patent-tong samples. Total surface shell was estimated using the average percent surface shell multiplied by the total sampled reef shell volume.

Total sampled shell volume was estimated for each individual oyster reef sampled by divers. Average shell volumes were standardized by diver quadrat area. Total sampled shell volume was calculated using average sampled shell volume multiplied by the sampled area. In some instances, estimates of shell volume were very high due to the presence of mixed or fossil deployed in the construction process at some alternate substrate sites. Surface shell volume could not be calculated from diver samples because percent black shell was not assessed in diver samples.

A2: Methods for determining success against Oyster Metrics reef structural criteria (reef footprint; reef height)

Staff from the NOAA Chesapeake Bay Office conducted multibeam bathymetric (depth) surveys following the construction of substrate + seed reefs and again three years post restoration (fall 2017). For the planting years 2012-2015, seed-only reefs were not targeted for survey because bathymetric updates to nautical charts were not required. In a few

instances, survey of constructed reefs overlapped with seed-only sites to provide for post-seeding survey data. Future seed-only plantings (2016 and on) will be surveyed with multibeam to evaluate the structural metrics for all restoration sites. These survey data are acquired and processed to the standards set forth in NOS Hydrographic Surveys Specifications and Deliverables, 20164. Surfaces derived from the processed data are exported from CARIS HIPS software at a 0.25m grid resolution using the BASE Cube Mean Depth, a repeatable method.

Reef Footprint (Spatial Extent)

Oyster Metrics success criterion: Neutral or positive change in reef spatial extent (footprint) as compared to baseline measurements

Methods:

- Substrate + Seed Reefs: Perimeter change was evaluated between the postconstruction bathymetric surface and the three-years-postconstruction bathymetric surface. A visual comparison was conducted to identify differences between the two perimeters in the event that a portion of the reef was lost due to subsidence or removal. If an observable loss was not detected, the reef spatial extent was reported as meeting the metric.
- Seed-Only Reefs: Bathymetric surface data was not collected on seed-only reef sites immediately following seed planting. Therefore, it is not possible at this time to determine whether or not the seed-only reefs meet the reef footprint success criteria. The bathymetric surface data collected at the three-year postrestoration mark (fall 2017) will be compared against bathymetric surface data collected at the six-year postrestoration mark (fall 2020). At that time, evaluation of the two data sets will follow the methods above for the substrate + seed restoration sites. The success or failure of this metric on seed-only reefs is therefore noted as 'TBD.'

Reef Height

Oyster Metrics success criterion: Neutral or positive change in reef height as compared to baseline measurements

Methods:

- Substrate + Seed Reefs: To evaluate reef height, the difference between the postconstruction surface and the three-years-postconstruction surface is calculated by subtracting the former from the latter. To establish a common baseline elevation between multiple surfaces, the depth values for the two sources were compared at eight points around the outside of the restored site. The mean difference from the eight points was calculated and used to adjust the three-year surface to the original surface's elevation. ArcGIS Spatial Analyst extension raster math tool calculated differences between all of the cells within the restoration site polygon. Differences in the bottom on and around the reef can be attributed to oyster growth as well as moving construction equipment, deposition of seed, scouring from currents, deposition of sediments, loss from poaching, loss from subsidence of the site base, or artifacts within the sonar data. If the mean calculated difference for the surface within the site boundary was neutral or positive, then the reef height was reported as meeting the metric. A greater than two-centimeter change must be observed in either growth or subsidence in order to be deemed a meaningful change to reef height. See Table App A1.
- Seed-Only Reefs: Surface data were not collected on seed-only reef sites immediately following seed planting. Therefore, it is not possible at this time to determine whether or not the seed-only reefs meet the reef height success criteria. Surface data collected at the three-year post-restoration mark (fall 2017) will be compared against surface data collected at the six-year post-restoration mark (fall 2020). At that time, evaluation of the two data sets will follow the methods above for the substrate + seed restoration sites to determine whether or not the reef height success criteria was met. The success or failure of this metric on seed-only reefs is therefore noted as 'TBD.'

Reef height change	Did the reef meet the reef height metric?
zero	yes
greater than zero	yes
between zero and -2 cm	yes
reef subsidence greater than 2 cm	no

Table App A1: Determination of whether a reef is considered successful relative to the reef height metric. 'Reef height change' is the difference, per sonar surveys, between mean reef height immedicately postrestoration and the mean reef height three years postrestoration.

Bathymetric Features and Observations

Postrestoration images created from multibeam bathymetric (depth) surveys on each reef are available in Section 3C. Figure App A2 shows interpretation of the various bathymetric features visible in these images.

Having two surveys repeated within a short period of time (2-3 years) provides an opportunity to identify and evaluate specific forms of seabed change at restoration sites. Features present in the three-year assessment sonar imagery (Section 3C) that are not present in the postconstruction imagery can be attributed to events that occurred between monitoring surveys. These features can include scouring or deposition of sediments, growth of oyster clumps, and mechanical scarring from keel drag or commercial harvest (poaching). Each feature form has a somewhat unique signature on the seabed and can usually be attributed to a specific action. For example, oyster dredge drag scars produce a furrowed feature in sonar imagery. In harvest areas (not these restoration areas), these features have been corroborated with video observations and confirmed to be dredge drag scars.

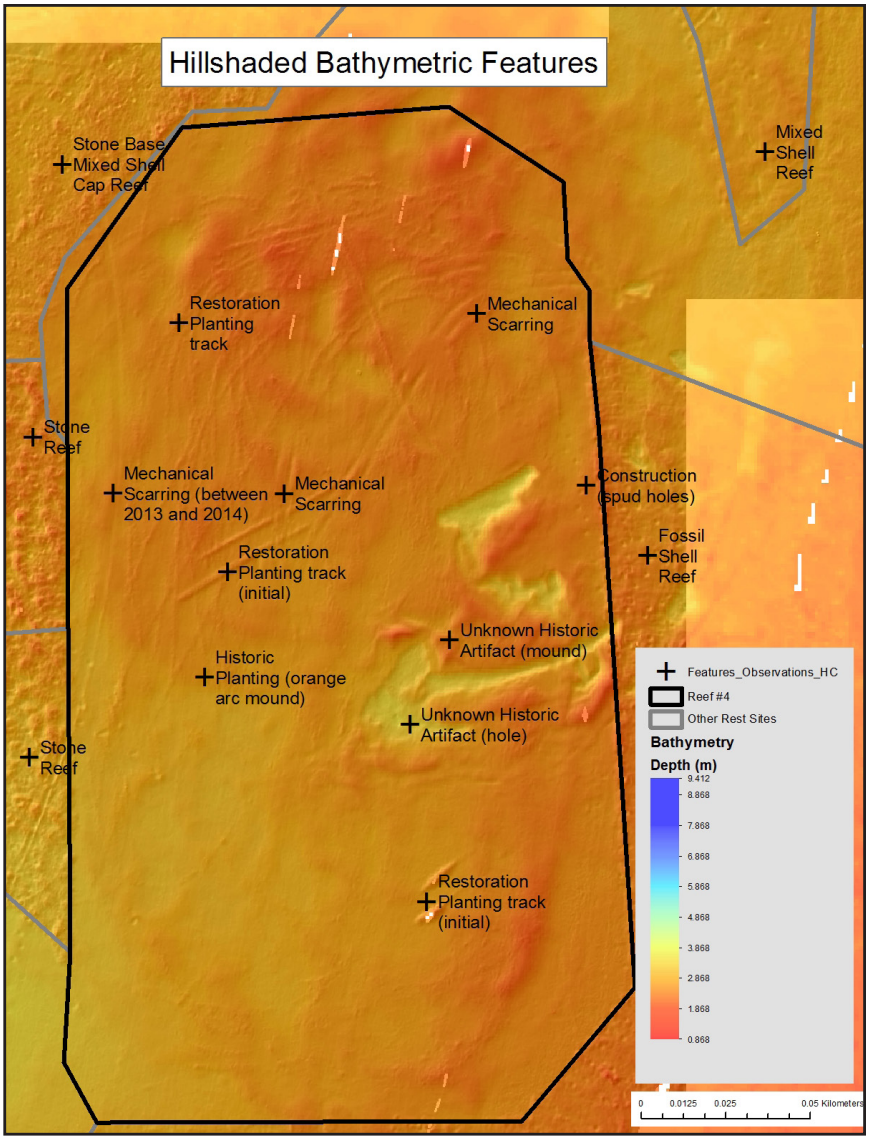

Figure App A2: Interpretation of bathymetric features visible in sonar images of restored reefs.

Diagnostic Monitoring Methods

In addition to monitoring to determine if reefs met the Oyster Metrics success criteria, information was also collected to aid in diagnosing why reefs may have succeeded or failed. These are primarily water-quality data and oyster disease data. With funding from The Nature Conservancy, DNR monitored three water-quality stations on Harris Creek (mddnr.chesapeakebay.net/eyesonthebay). Water conditions were favorable for oysters throughout 2017 except for brief periods of hypoxia in late summer. Oyster disease is a factor that may influence the success of this project. Partners continue to evaluate available disease data and adapt project management as needed.

References for Appendix A

1. National Oceanic and Atmospheric Administration. July 2016. Analysis of Monitoring Data from Harris Creek Sanctuary Oyster Reefs Data on the First 102 Acres/12 Reefs Restored. https://chesapeakebay.noaa.gov/images/stories/habitats/hc3ydcheckinjuly2016.pdf.
2. Chai Ai-Ling, Homer Mark, Tsai Chu-Fa, Goulletquer Philippe (1992). Evaluation of oyster sampling efficiency of patent tongs and an oyster dredge. *North American Journal of Fisheries Management*, 12, 825-832.
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4. Office of Coast Survey, National Ocean Service, National Oceanic and Atmospheric Administration. Hydrographic Surveys Specifications and Deliverables. 2016. Available from www.nauticalcharts.noaa.gov/hsd/specs/specs.htm.

Appendix B: Reef Pages: Detailed Information and Sonar Images for Each Reef

All information for each reef, by reef, including sonar images and graphics of oyster shell height distributions, is on the following pages.

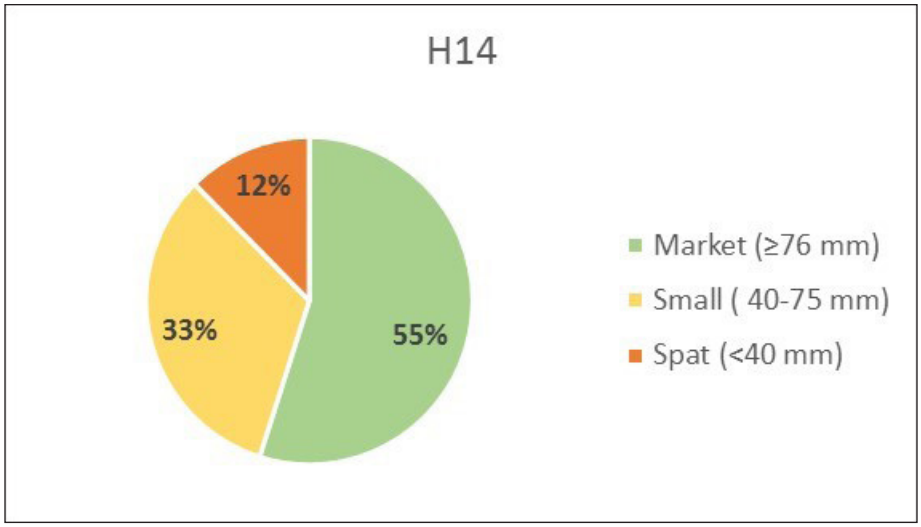
Reef H14 (CONTROL_1) Data and Analysis

		H14
Reef Information	Geodatabase Site_ID	CONTROL_1
	Bar name	Eagle Point
	Tributary	Harris
	Reef area (acres)	3.47
Restoration Treatment	Restoration treatment	NONE
	Substrate type added	NONE
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	reference
	Sample method	Patent Tong
	Sample date	06-Oct-17
	# samples taken	11
	# live oysters measured	182
	# live oysters counted	444
	# dead oysters counted	80
	% of oysters that were dead	0.15
	Sampled area (m^2)	13948.96
	Sampled acreage	3.45
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	No
	Average live density across reef (#/m^2)	25.07
	Standard error of live density (#/m^2)	6.62
	Reef area meeting minimum threshold density (m^2)	9113.94
	Reef area meeting minimum threshold density (%)	0.653377743
	Reef area meeting target density (m^2)	3165
	Reef area meeting target density (%)	0.226898636
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	11297.93713
	Reef area meeting minimum threshold biomass (%)	0.80994835
	Fall 2017: Did reef meet target oyster biomass?	No
	Reef area meeting target biomass (m^2)	3750
	Reef area meeting target biomass (%)	0.268837247
	Average live biomass across reef (g dry weight/m^2)	35.35
	Standard error of live biomass	9.51
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	No
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	9.71
	Standard error of shell volume	2.03
	Total shell volume (liters)	135472.7
	Total surface shell volume (liters)	94215.1
	Average brown shell across all samples (%)	30.45
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3 years postrestoration (cm)	1

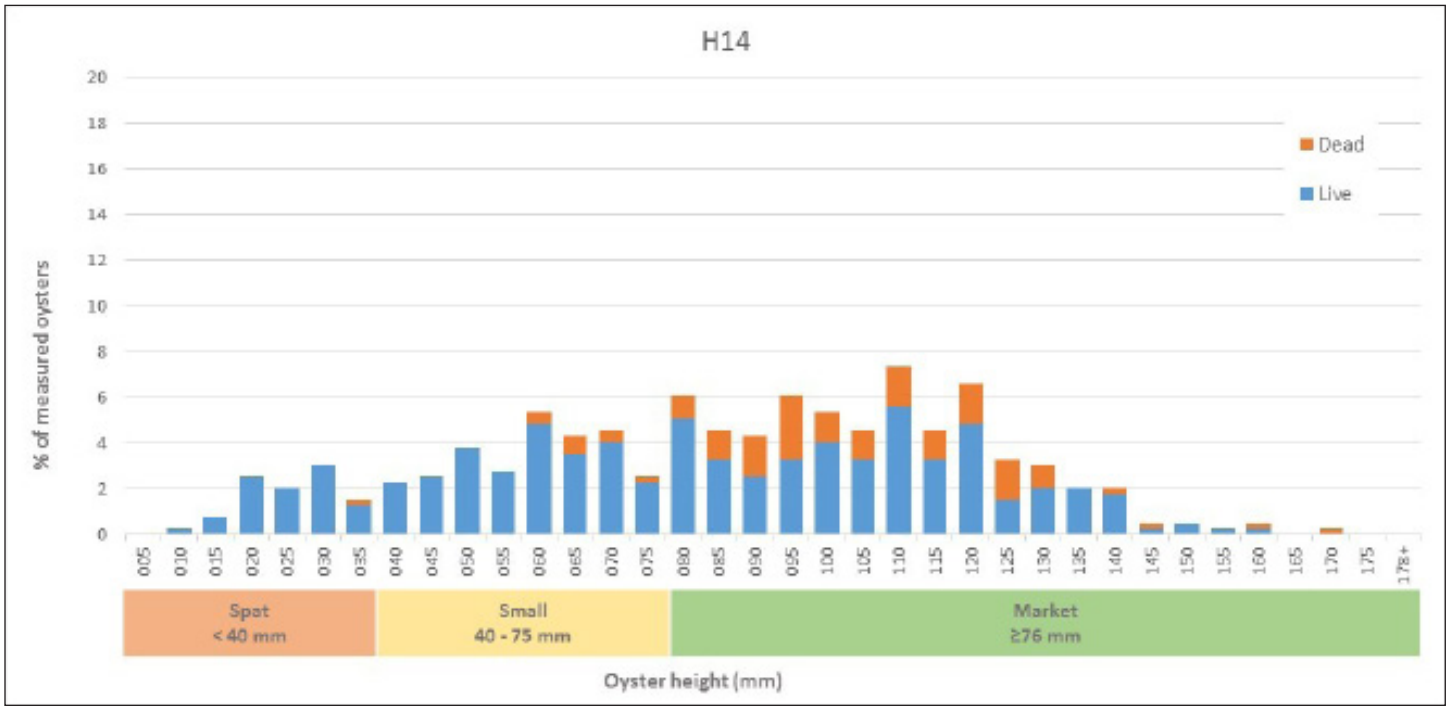
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef H14 (CONTROL_1) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



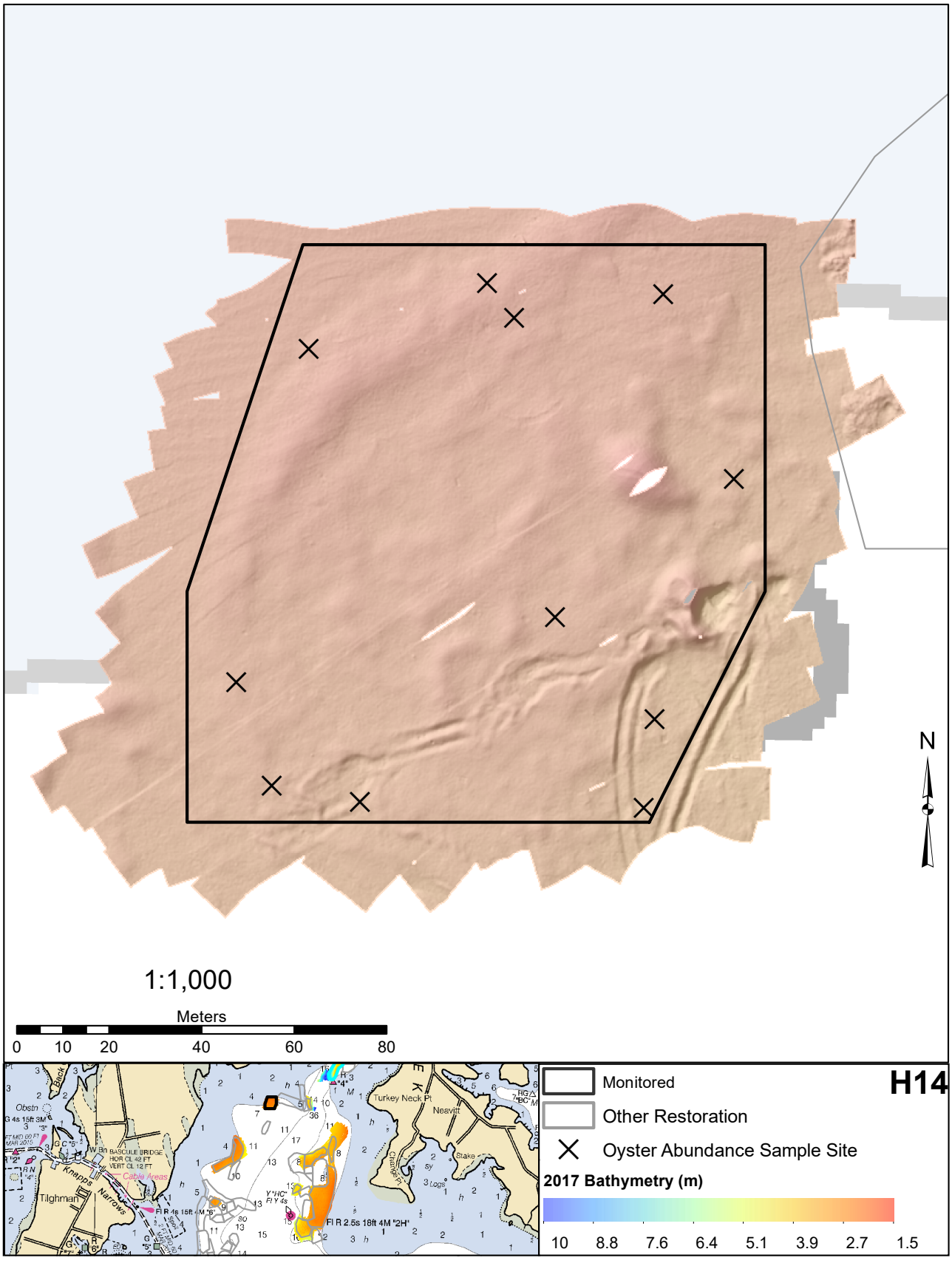
Shell Height of Oysters Measured on Reef



Reef H14 (CONTROL_1) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



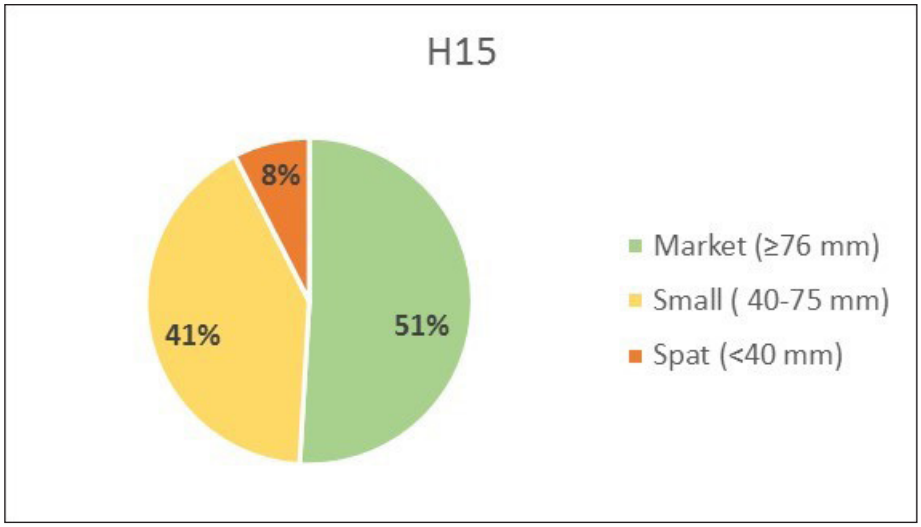
Reef H15 (CONTROL_3) Data and Analysis

		H15
Reef Information	Geodatabase Site_ID	CONTROL_3
	Bar name	Rabbit Island
	Tributary	Harris
	Reef area (acres)	1.85
Restoration Treatment	Restoration treatment	NONE
	Substrate type added	NONE
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	reference
	Sample method	Patent Tong
	Sample date	15-Nov-17
	# samples taken	6
	# live oysters measured	337
	# live oysters counted	138
	# dead oysters counted	9
	% of oysters that were dead	0.06
	Sampled area (m^2)	7219.23
	Sampled acreage	1.78
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	No
	Fall 2017: Did reef meet target density?	No
	Average live density across reef (#/m^2)	14.29
	Standard error of live density (#/m^2)	6.47
	Reef area meeting minimum threshold density (m^2)	2094.77
	Reef area meeting minimum threshold density (%)	0.290165295
	Reef area meeting target density (m^2)	0
	Reef area meeting target density (%)	0
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	No
	Reef area meeting minimum threshold biomass (m^2)	2094.76699
	Reef area meeting minimum threshold biomass (%)	0.290164878
	Fall 2017: Did reef meet target oyster biomass?	No
	Reef area meeting target biomass (m^2)	0
	Reef area meeting target biomass (%)	0
	Average live biomass across reef (g dry weight/m^2)	15.97
	Standard error of live biomass	7.22
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	No
	Did reef meet BOTH target density and biomass?	No
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	5.85
	Standard error of shell volume	1.51
	Total shell volume (liters)	42224.25
	Total surface shell volume (liters)	32934.91
	Average brown shell across all samples (%)	22
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3	-0.1

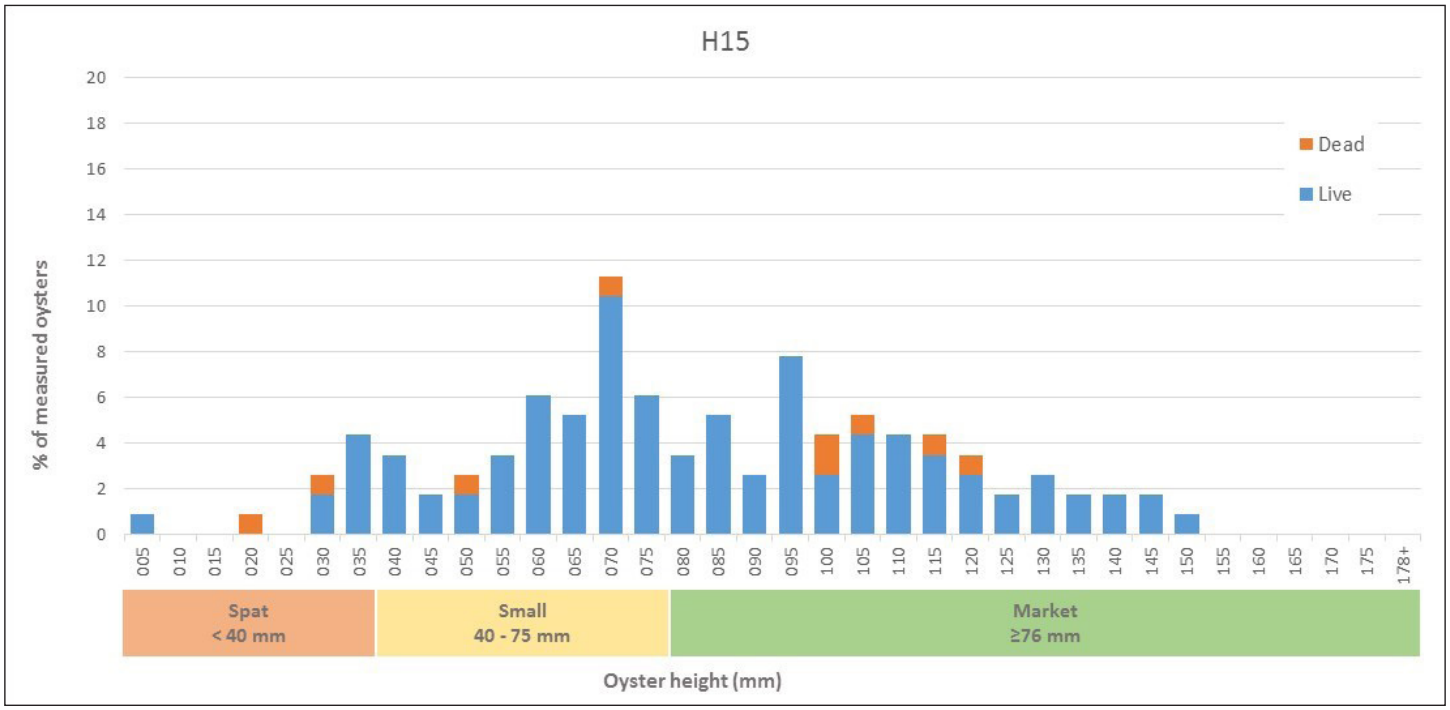
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef H15 (CONTROL_3) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



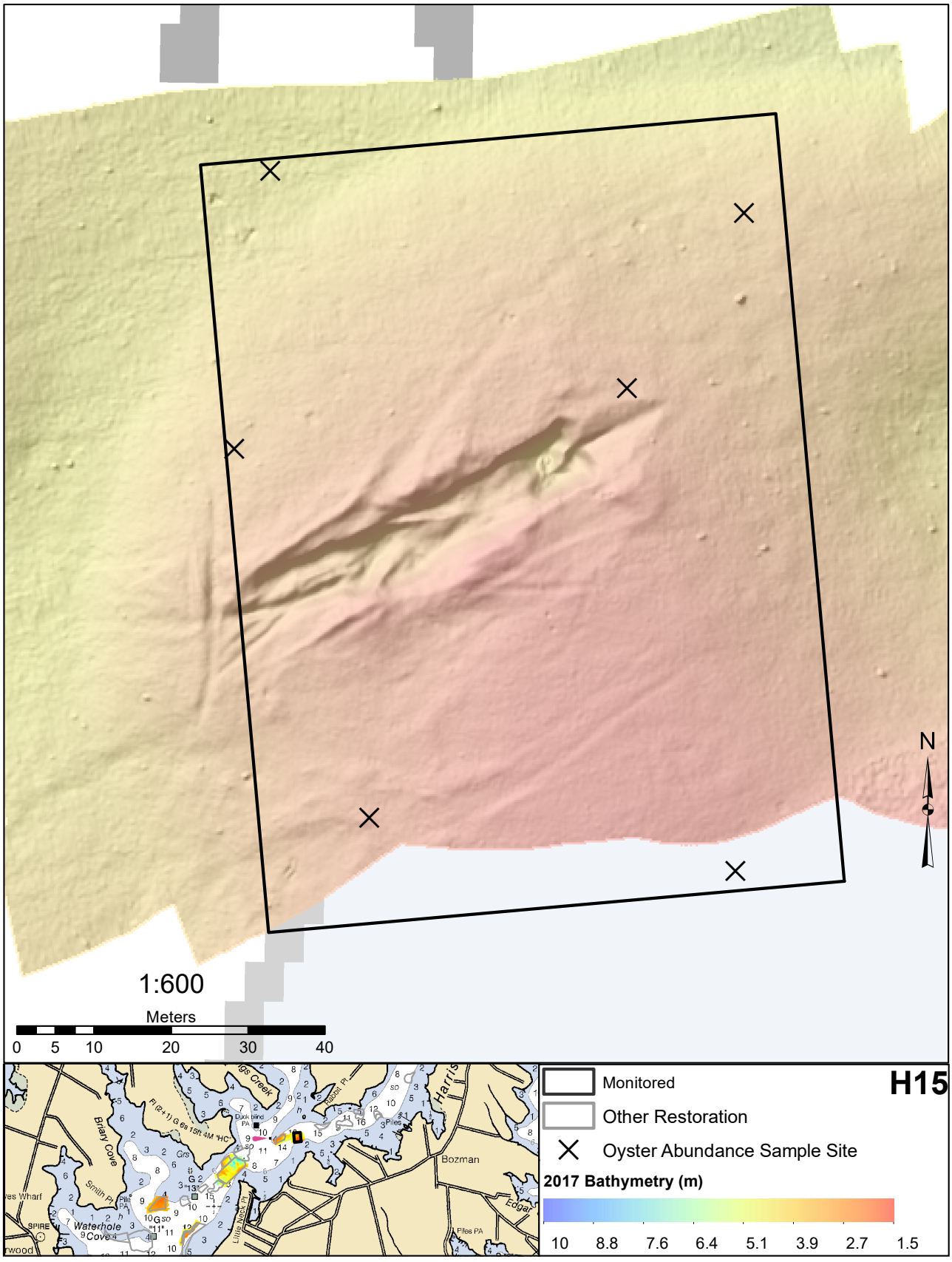
Shell Height of Oysters Measured on Reef



Reef H15 (CONTROL_3) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



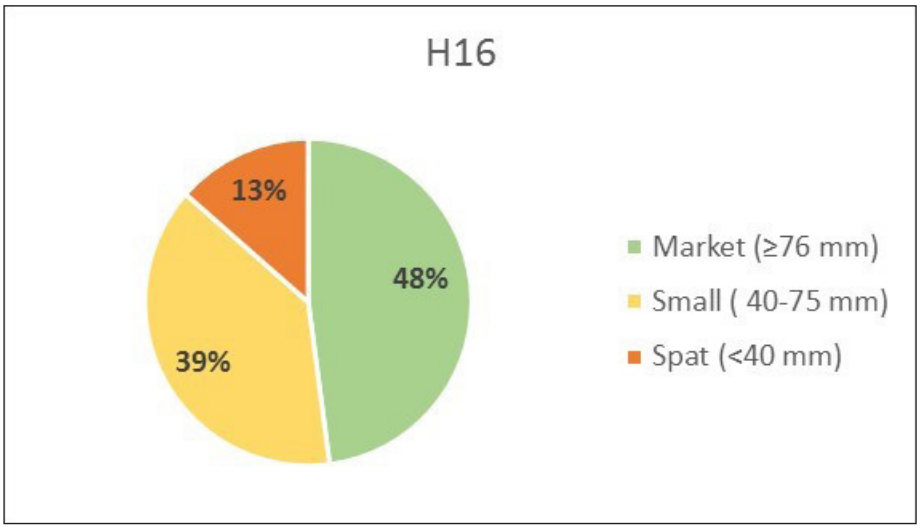
Reef H16 (CONTROL_4) Data and Analysis

		H16
Reef Information	Geodatabase Site_ID	CONTROL_4
	Bar name	Rabbit Island
	Tributary	Harris
	Reef area (acres)	1.39
Restoration Treatment	Restoration treatment	NONE
	Substrate type added	NONE
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	reference
	Sample method	Patent Tong
	Sample date	15-Nov-17
	# samples taken	5
	# live oysters measured	149
	# live oysters counted	96
	# dead oysters counted	12
	% of oysters that were dead	0.11
	Sampled area (m^2)	5428.85
	Sampled acreage	1.34
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	No
	Average live density across reef (#/m^2)	11.93
	Standard error of live density (#/m^2)	3.8
	Reef area meeting minimum threshold density (m^2)	2267.92
	Reef area meeting minimum threshold density (%)	0.4177533
	Reef area meeting target density (m^2)	0
	Reef area meeting target density (%)	0
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	2267.922044
	Reef area meeting minimum threshold biomass (%)	0.417753676
	Fall 2017: Did reef meet target oyster biomass?	No
	Reef area meeting target biomass (m^2)	0
	Reef area meeting target biomass (%)	0
	Average live biomass across reef (g dry weight/m^2)	13.48
	Standard error of live biomass	4.56
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	No
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	7.2
	Standard error of shell volume	1.47
	Total shell volume (liters)	39114.69
	Total surface shell volume (liters)	29336.02
	Average brown shell across all samples (%)	25
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3	4

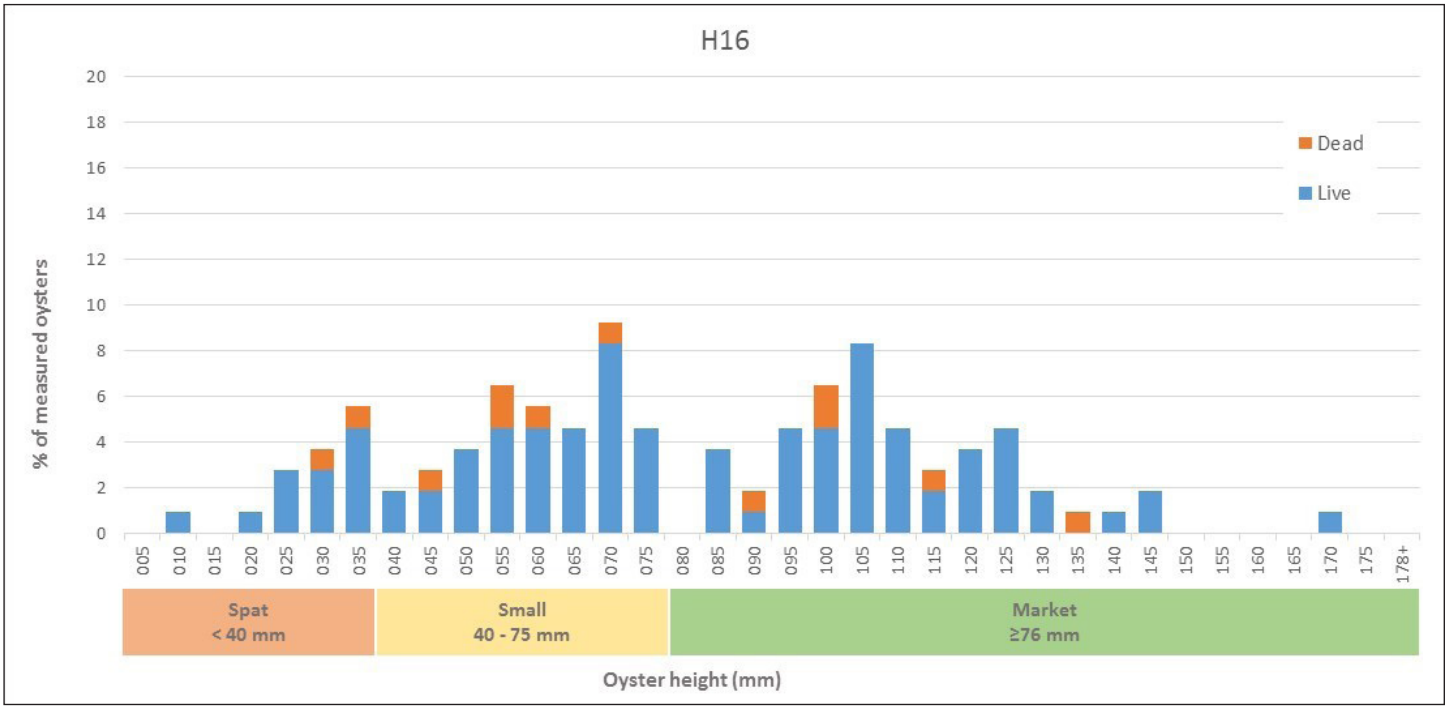
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef H16 (CONTROL_4) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



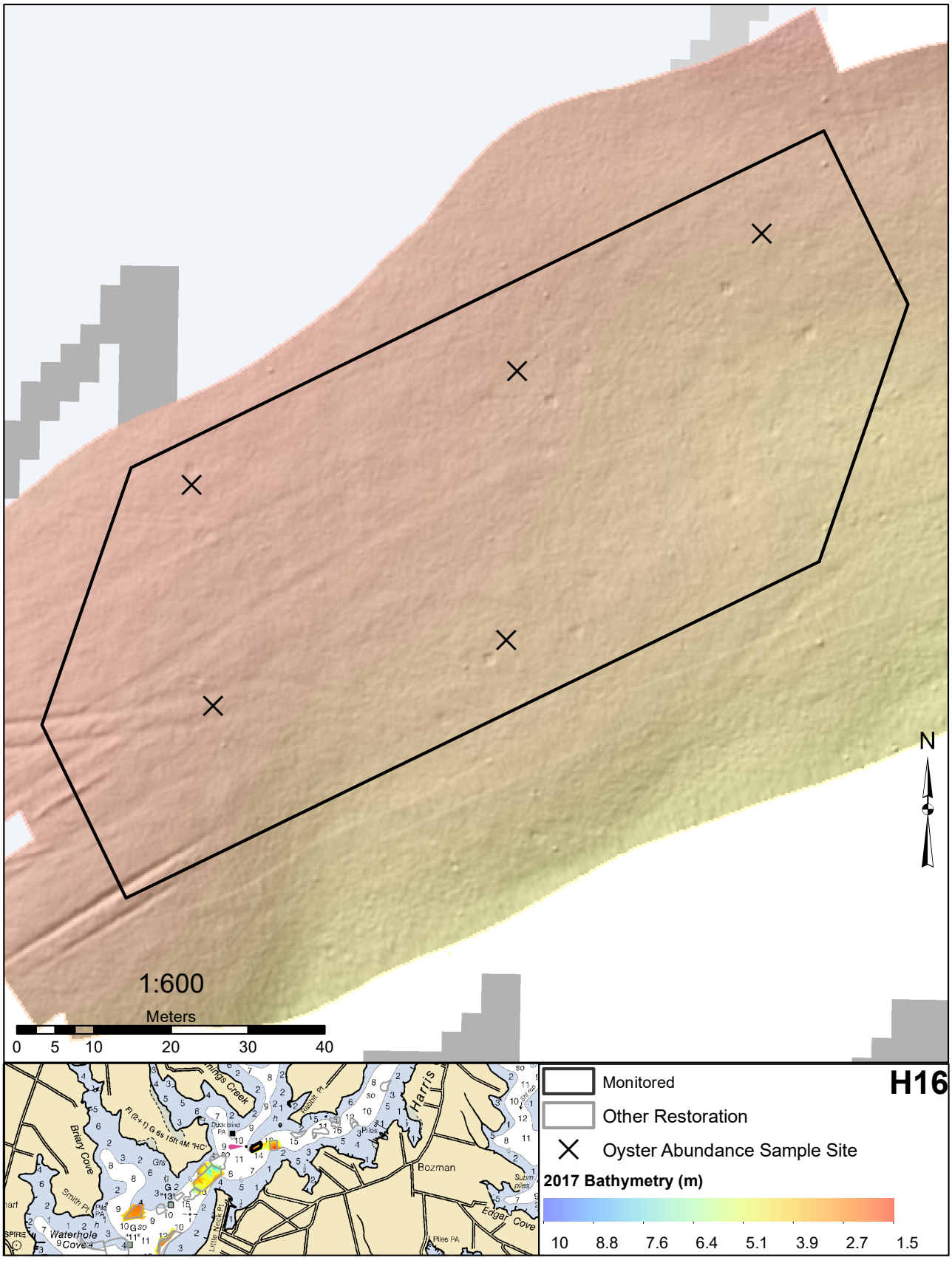
Shell Height of Oysters Measured on Reef



Reef H16 (CONTROL_4) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



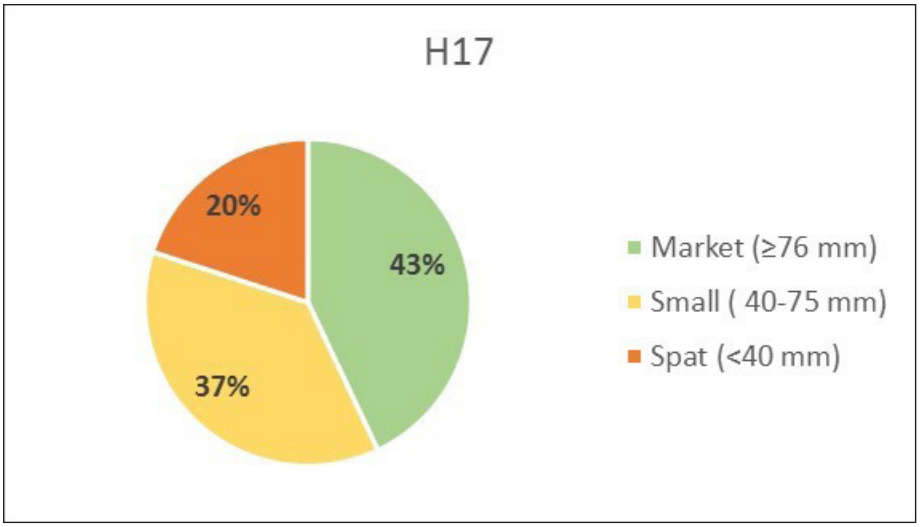
Reef H17 (CONTROL_2) Data and Analysis

		H17
Reef Information	Geodatabase Site_ID	CONTROL_2
	Bar name	Mill Point
	Tributary	Harris
	Reef area (acres)	4.01
Restoration Treatment	Restoration treatment	NONE
	Substrate type added	NONE
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	reference
	Sample method	Patent Tong
	Sample date	03-Nov-17
	# samples taken	11
	# live oysters measured	135
	# live oysters counted	165
	# dead oysters counted	20
	% of oysters that were dead	0.11
	Sampled area (m^2)	16145.92
	Sampled acreage	3.99
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	No
	Fall 2017: Did reef meet target density?	No
	Average live density across reef (#/m^2)	9.32
	Standard error of live density (#/m^2)	4.15
	Reef area meeting minimum threshold density (m^2)	1206.17
	Reef area meeting minimum threshold density (%)	0.074704322
	Reef area meeting target density (m^2)	0
	Reef area meeting target density (%)	0
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	No
	Reef area meeting minimum threshold biomass (m^2)	1206.167556
	Reef area meeting minimum threshold biomass (%)	0.07470417
	Fall 2017: Did reef meet target oyster biomass?	No
	Reef area meeting target biomass (m^2)	0
	Reef area meeting target biomass (%)	0
	Average live biomass across reef (g dry weight/m^2)	10.31
	Standard error of live biomass	4.55
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	No
	Did reef meet BOTH target density and biomass?	No
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	4.16
	Standard error of shell volume	1.15
	Total shell volume (liters)	67236.67
	Total surface shell volume (liters)	56949.46
	Average brown shell across all samples (%)	15.3
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3	-0.9

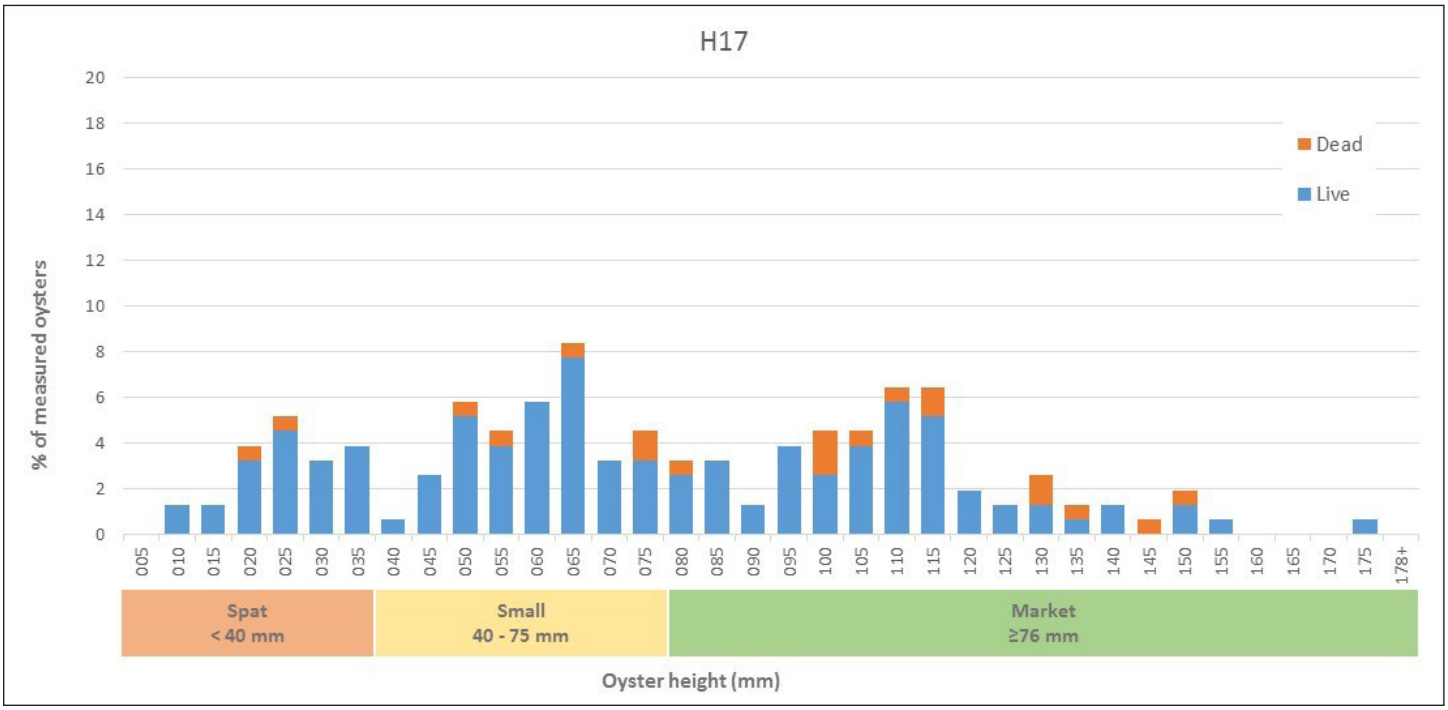
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef H17 (CONTROL_2) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



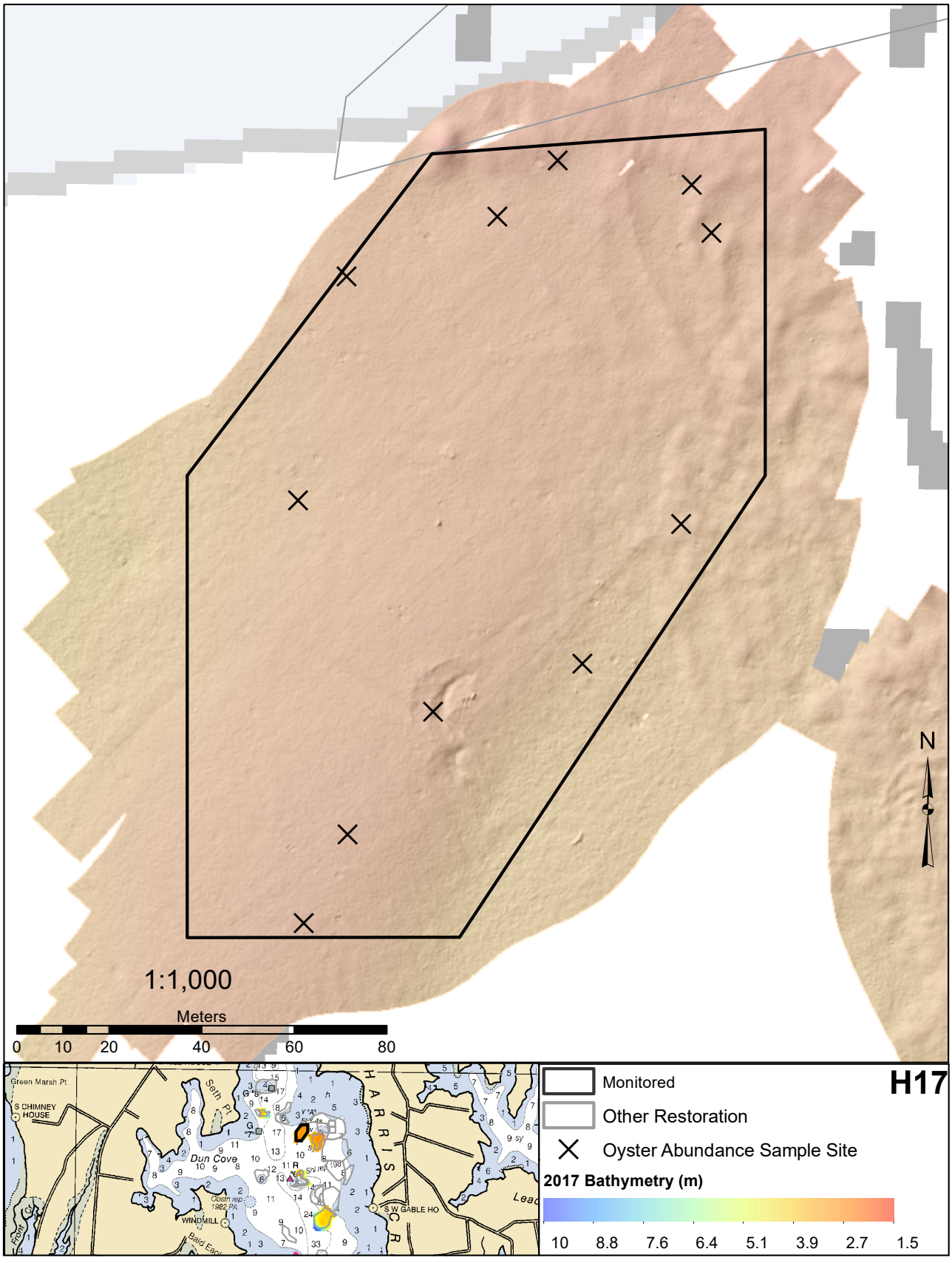
Shell Height of Oysters Measured on Reef



Reef H17 (CONTROL_2) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



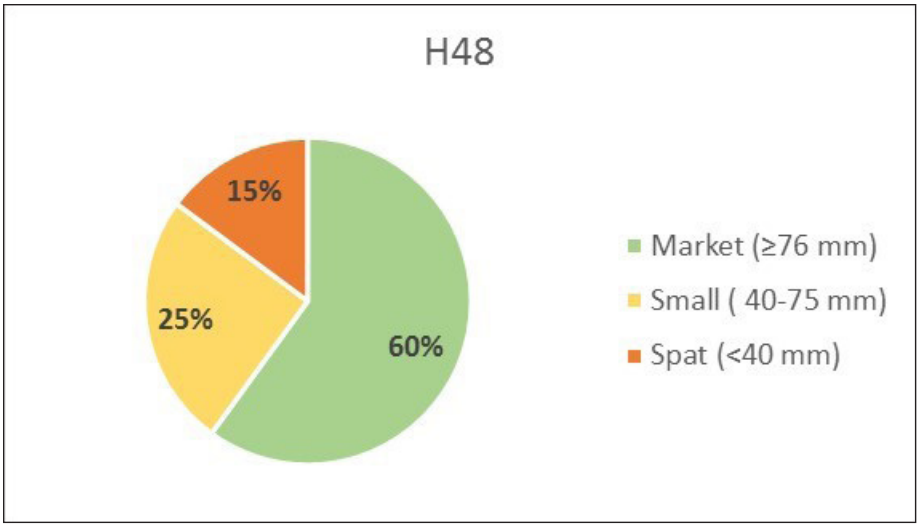
Reef H48 (Seed_56A) Data and Analysis

		H48
Reef Information	Geodatabase Site_ID	Seed_56A
	Bar name	Turkey Neck
	Tributary	Harris
	Reef area (acres)	3.59
Restoration Treatment	Restoration treatment	Seed Only
	Substrate type added	Spat on shell only
	Average planned reef height* (inches)	<Null>
	Year planted with spat	2014
	Spat produced by	ORP
	Spat planted by	ORP
	Spat planted (millions)	21.73
	Spat planted per acre (millions)	6.05
Monitoring Information	Monitoring type	2014 cohort
	Sample method	Patent Tong
	Sample date	06-Oct-17
	# samples taken	10
	# live oysters measured	278
	# live oysters counted	459
	# dead oysters counted	103
	% of oysters that were dead	0.18
	Sampled area (m^2)	14437.87
	Sampled acreage	3.57
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	No
	Average live density across reef (#/m^2)	28.51
	Standard error of live density (#/m^2)	5.05
	Reef area meeting minimum threshold density (m^2)	10969.66
	Reef area meeting minimum threshold density (%)	0.759783819
	Reef area meeting target density (m^2)	3968.54
	Reef area meeting target density (%)	0.274870185
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	14437.87276
	Reef area meeting minimum threshold biomass (%)	1.000000191
	Fall 2017: Did reef meet target oyster biomass?	No
	Reef area meeting target biomass (m^2)	3968.544235
	Reef area meeting target biomass (%)	0.274870478
	Average live biomass across reef (g dry weight/m^2)	37.98
	Standard error of live biomass	6.31
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	No
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	14.29
	Standard error of shell volume	1.1
	Total shell volume (liters)	206255.33
	Total surface shell volume (liters)	137159.79
	Average brown shell across all samples (%)	33.5
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3	11

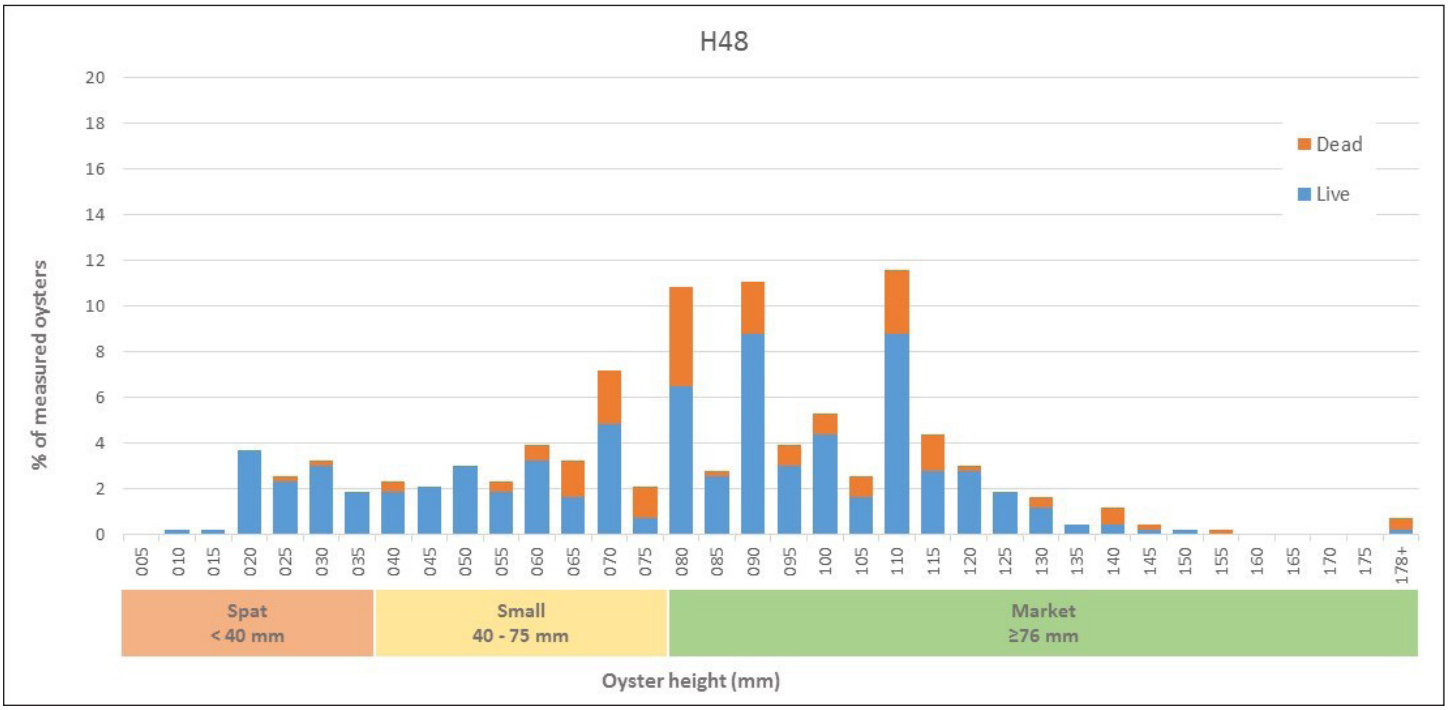
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef H48 (Seed_56A) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



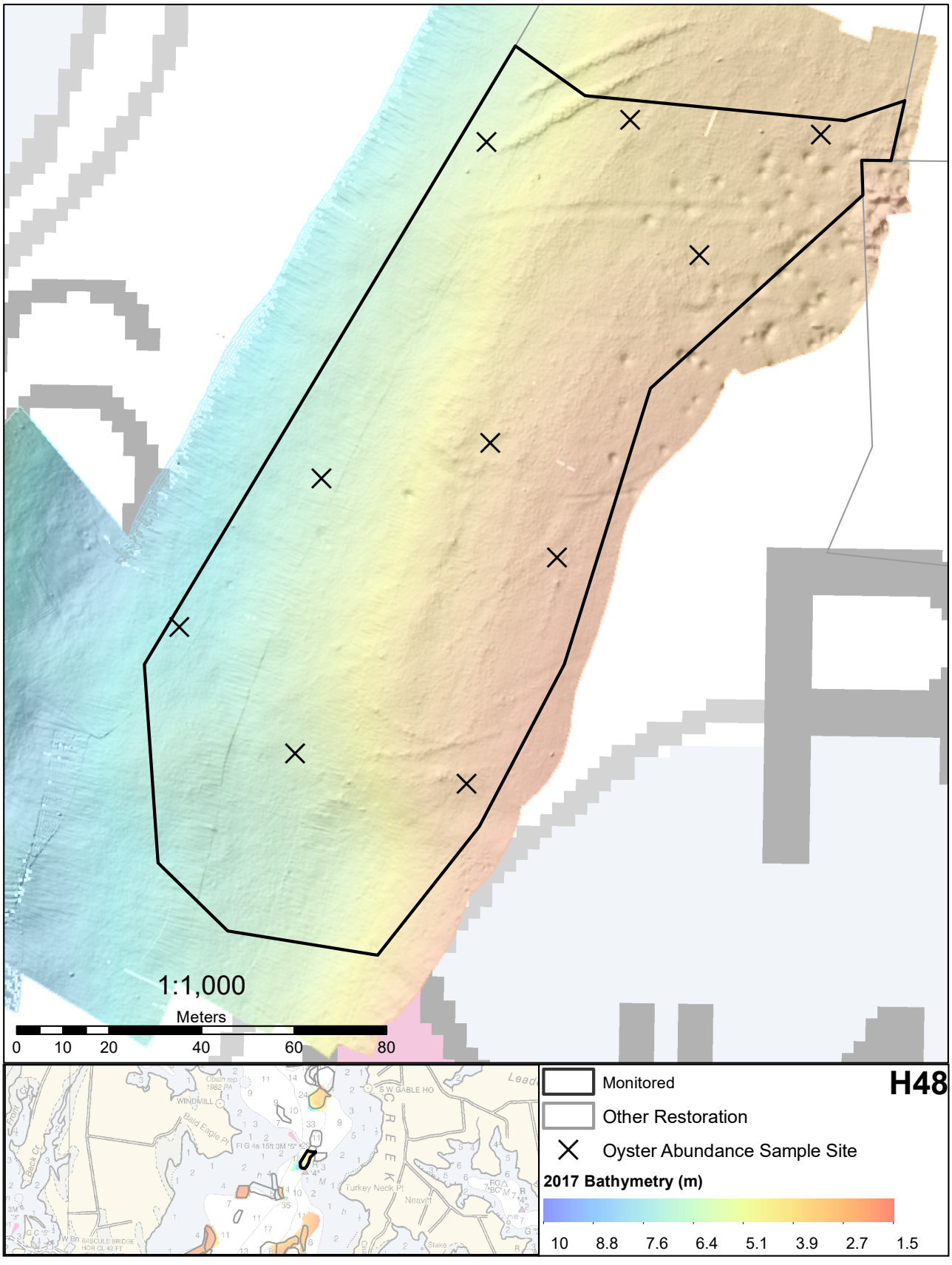
Shell Height of Oysters Measured on Reef



Reef H48 (Seed_56A) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



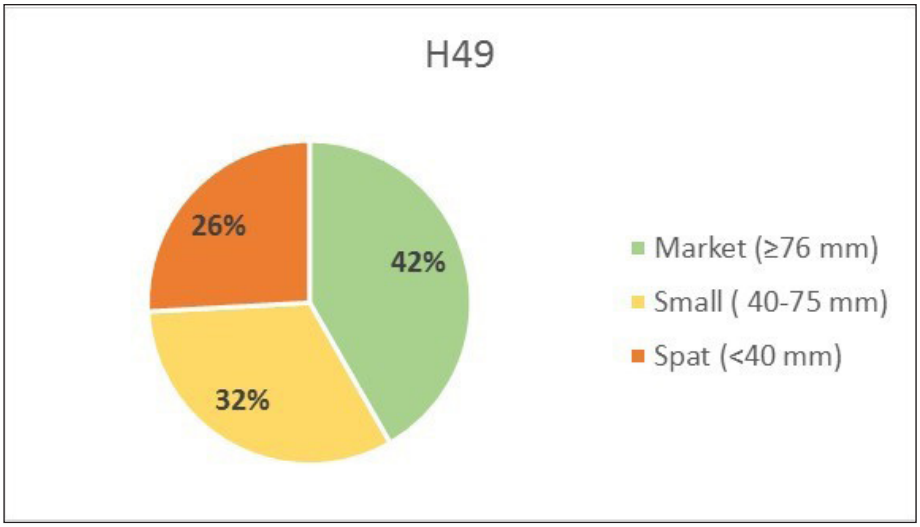
Reef H49 (AltSub_16A) Data and Analysis

		H49
Reef Information	Geodatabase Site_ID	AltSub_16A
	Bar name	Hunts
	Tributary	Harris
	Reef area (acres)	1.11
Restoration Treatment	Restoration treatment	Substrate & Seed
	Substrate type added	Stone base with mixed shell
	Average planned reef height* (inches)	12
	Year planted with spat	2014
	Spat produced by	ORP
	Spat planted by	ORP
	Spat planted (millions)	12.69
	Spat planted per acre (millions)	11.42
Monitoring Information	Monitoring type	2014 cohort
	Sample method	Diver
	Sample date	11/2/2017
	# samples taken	4
	# live oysters measured	259
	# live oysters counted	475
	# dead oysters counted	82
	% of oysters that were dead	0.15
	Sampled area (m^2)	4473.7
	Sampled acreage	1.11
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	237.5
	Standard error of live density (#/m^2)	79.13
	Reef area meeting minimum threshold density (m^2)	4473.7
	Reef area meeting minimum threshold density (%)	1
	Reef area meeting target density (m^2)	4473.7
	Reef area meeting target density (%)	1
	Average live density on stone (#/m^2)	6.5
	Standard error of live density on stone	6.50
	Average live density on shell (#/m^2)	205
	Standard error of live density on shell	90.08
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	26
	Standard error of live density on clam shell	12.78
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	4473.7
	Reef area meeting minimum threshold biomass (%)	1
	Fall 2017: Did reef meet target oyster biomass?	Yes
	Reef area meeting target biomass (m^2)	4473.7
	Reef area meeting target biomass (%)	1
	Average live biomass across reef (g dry weight/m^2)	179.77
	Standard error of live biomass	15.71
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	Yes
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	195.75
	Standard error of shell volume	47.2
	Total shell volume (liters)	875726.77
	Total surface shell volume (liters)	Null
	Average brown shell across all samples (%)	Null
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3	2

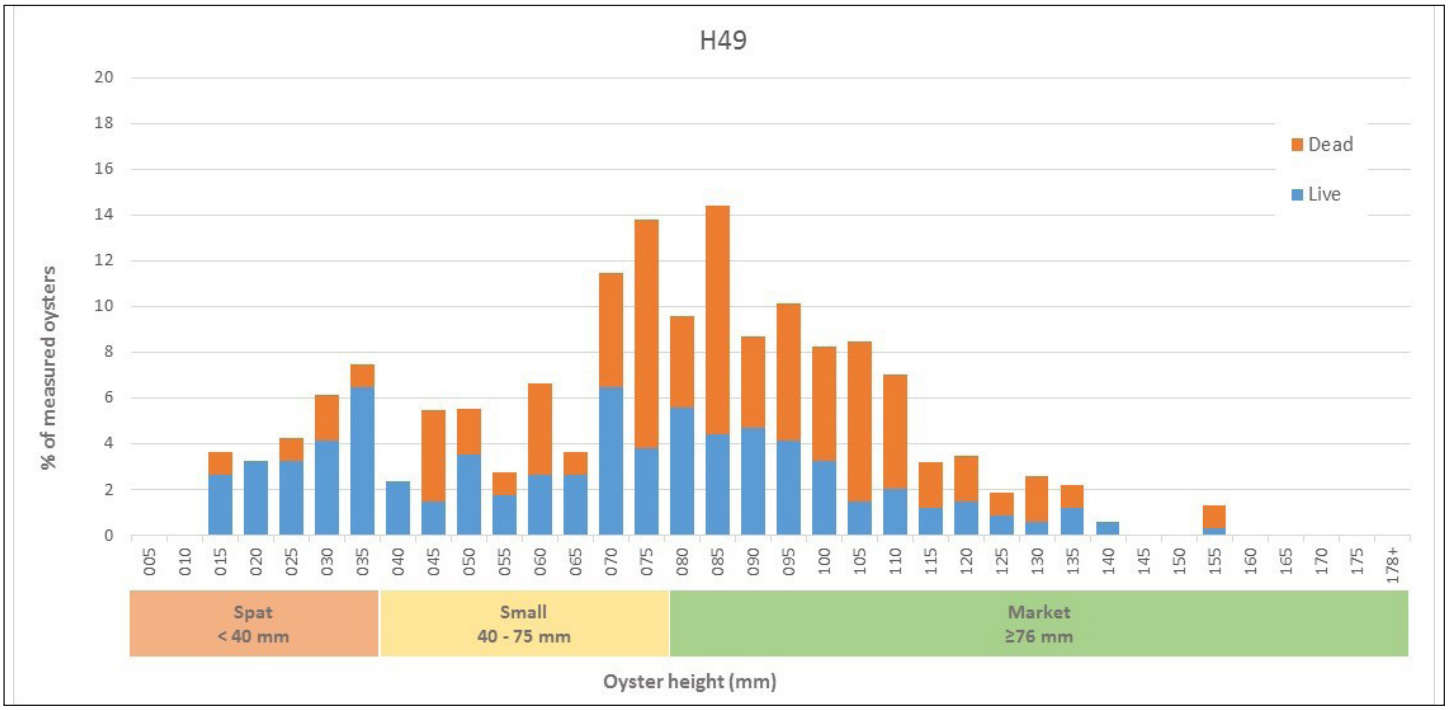
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef H49 (AltSub_16A) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



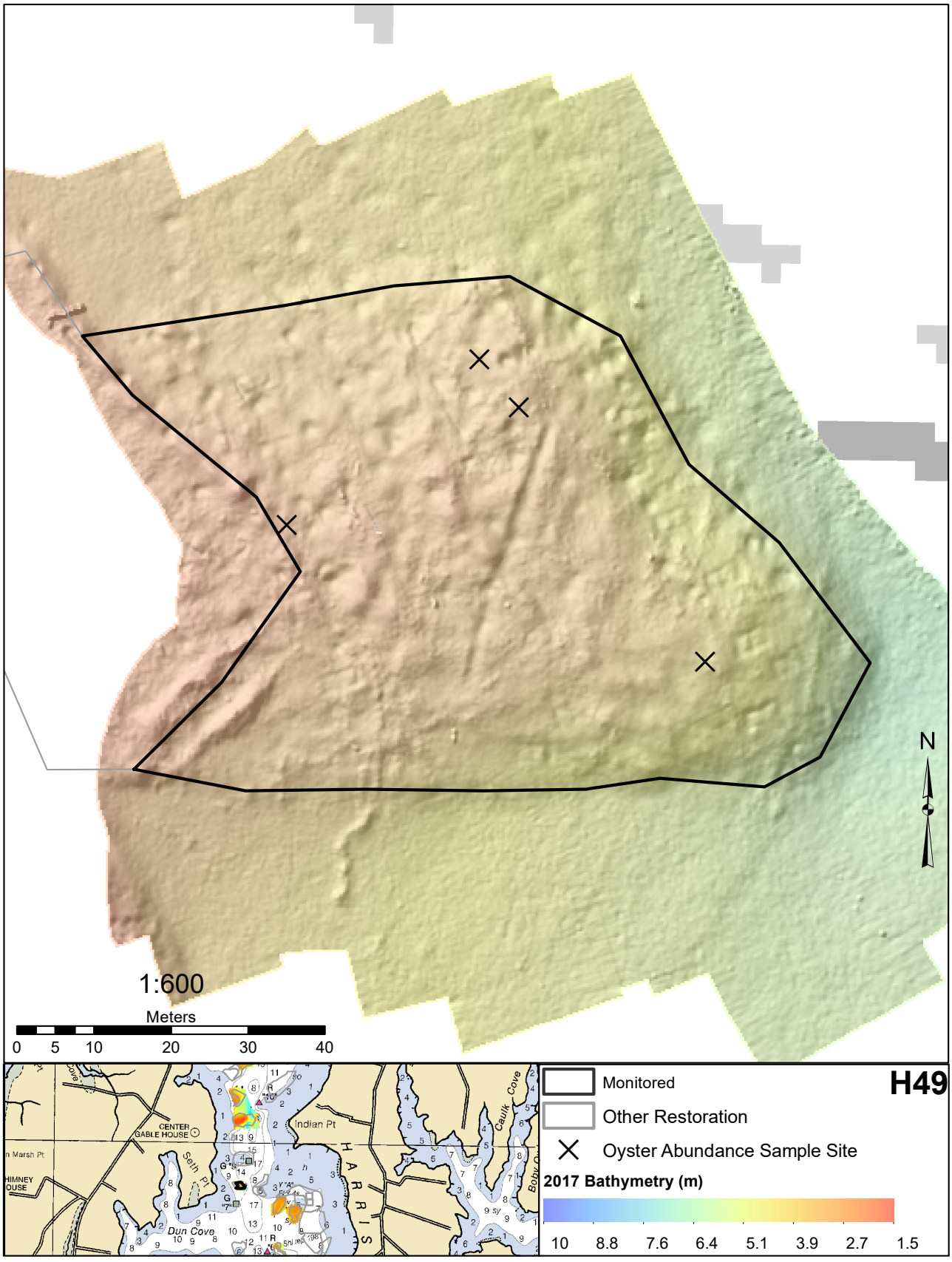
Shell Height of Oysters Measured on Reef



Reef H49 (AltSub_16A) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



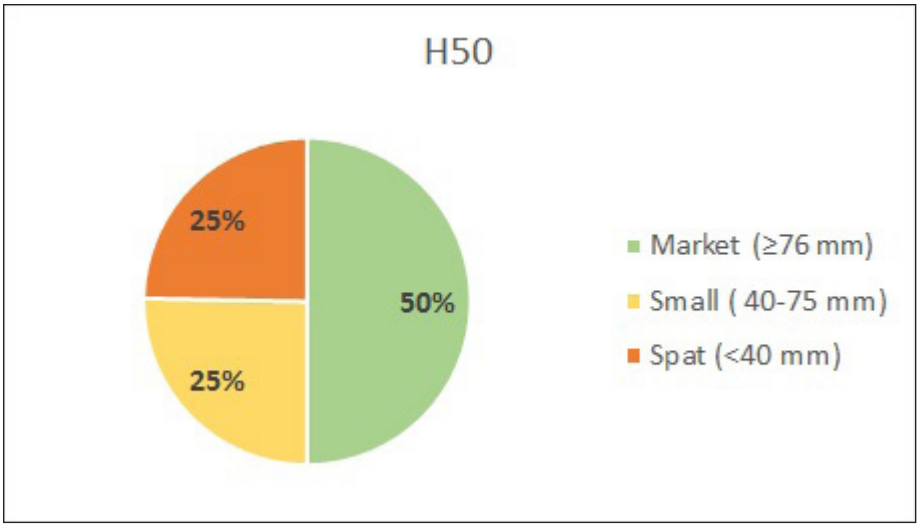
Reef H50 (Seed_76) Data and Analysis

		H50
Reef Information	Geodatabase Site_ID	Seed_76
	Bar name	Lodges
	Tributary	Harris
	Reef area (acres)	1.72
Restoration Treatment	Restoration treatment	Seed Only
	Substrate type added	Spat on shell only
	Average planned reef height* (inches)	<Null>
	Year planted with spat	2014
	Spat produced by	ORP
	Spat planted by	ORP
	Spat planted (millions)	9.18
	Spat planted per acre (millions)	5.33
Monitoring Information	Monitoring type	2014 cohort
	Sample method	Patent Tong
	Sample date	03-Nov-17
	# samples taken	6
	# live oysters measured	161
	# live oysters counted	344
	# dead oysters counted	37
	% of oysters that were dead	0.10
	Sampled area (m^2)	6817.98
	Sampled acreage	1.68
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	No
	Average live density across reef (#/m^2)	30.52
	Standard error of live density (#/m^2)	7.83
	Reef area meeting minimum threshold density (m^2)	5969.14
	Reef area meeting minimum threshold density (%)	0.875499781
	Reef area meeting target density (m^2)	0
	Reef area meeting target density (%)	0
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	5969.141766
	Reef area meeting minimum threshold biomass (%)	0.87550004
	Fall 2017: Did reef meet target oyster biomass?	No
	Reef area meeting target biomass (m^2)	701.1039671
	Reef area meeting target biomass (%)	0.102831626
	Average live biomass across reef (g dry weight/m^2)	31.76
	Standard error of live biomass	8.91
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	No
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	7.51
	Standard error of shell volume	2.35
	Total shell volume (liters)	51170.14
	Total surface shell volume (liters)	23452.98
	Average brown shell across all samples (%)	54.17
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	TBD
	Is reef height stable/increasing?	TBD
	Difference between postconstruction reef height and reef height 3	TBD

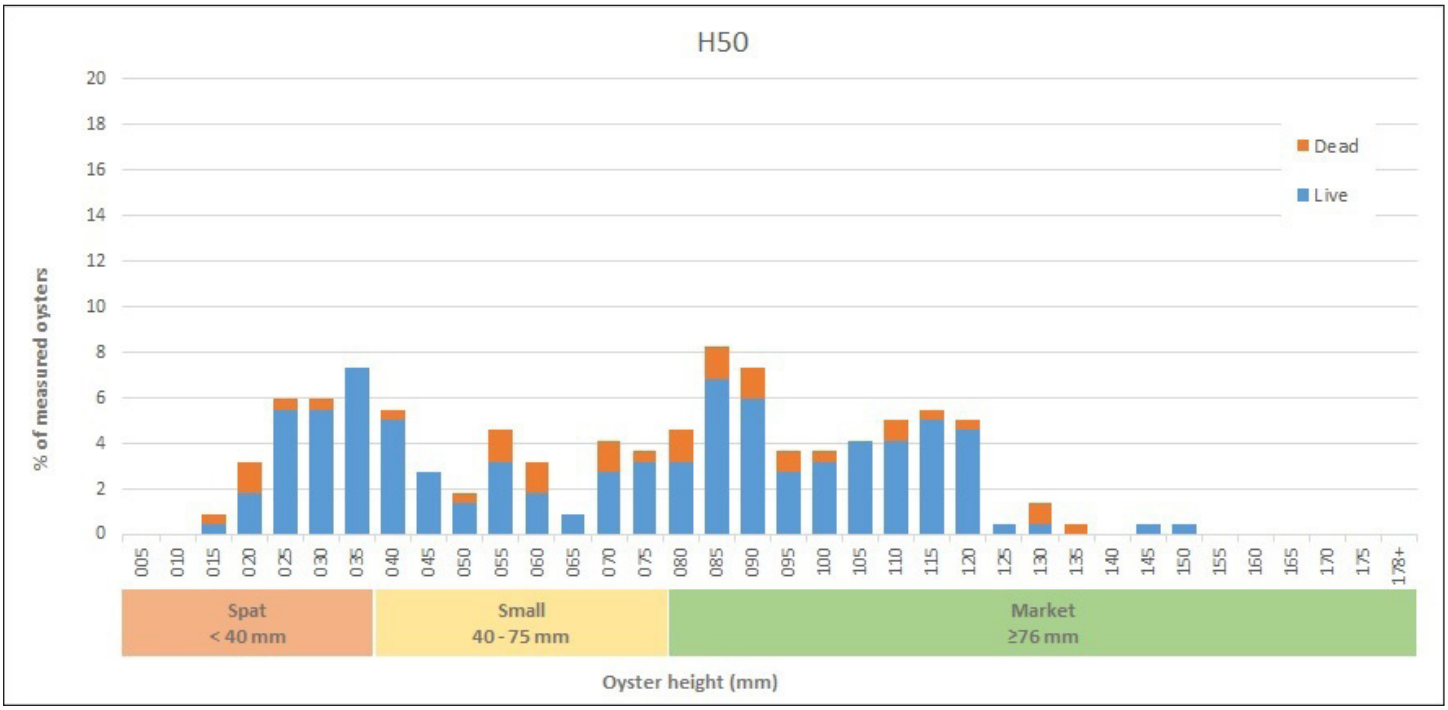
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef H50 (Seed_76) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



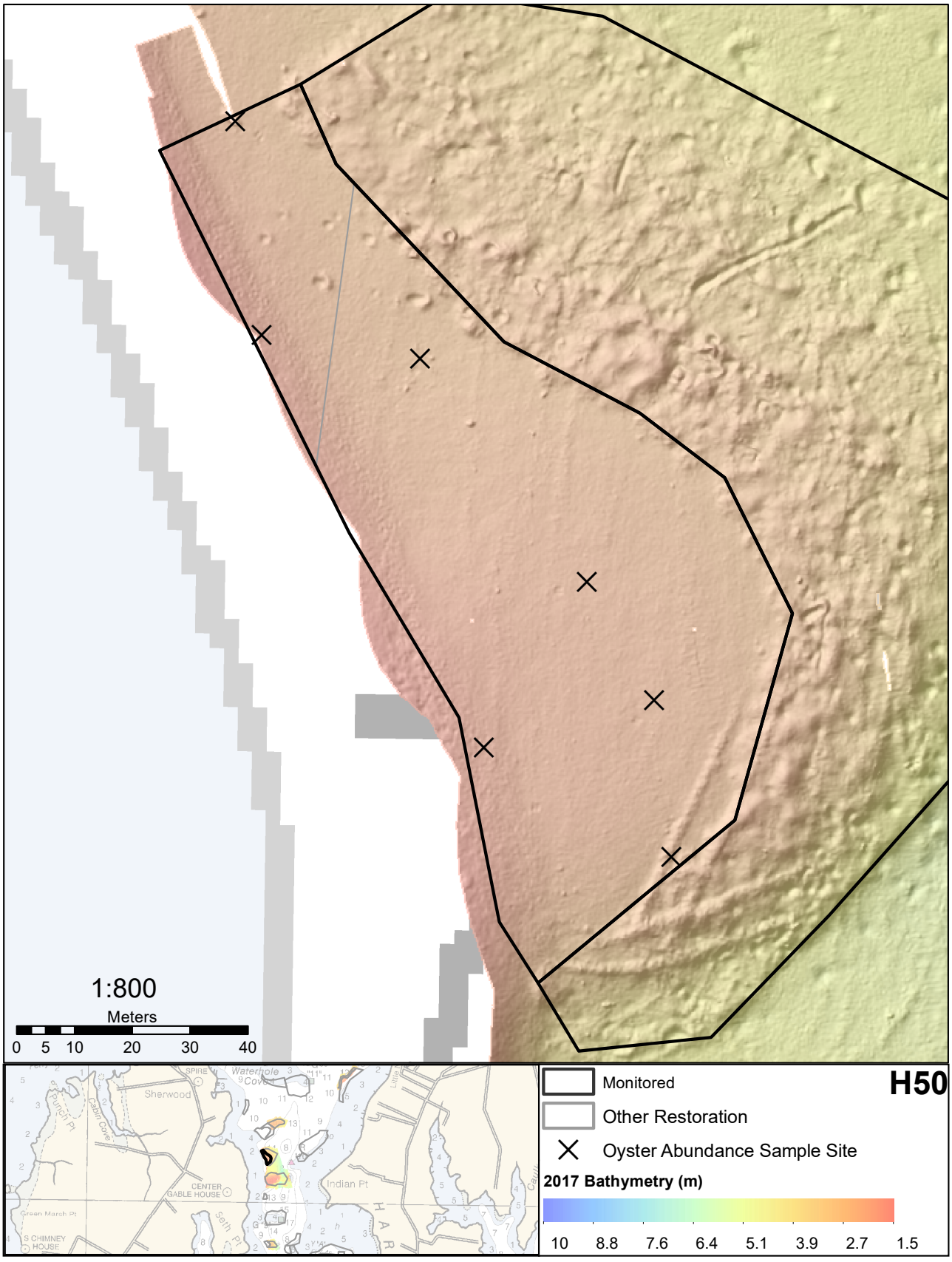
Shell Height of Oysters Measured on Reef



Reef H50 (Seed_76) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



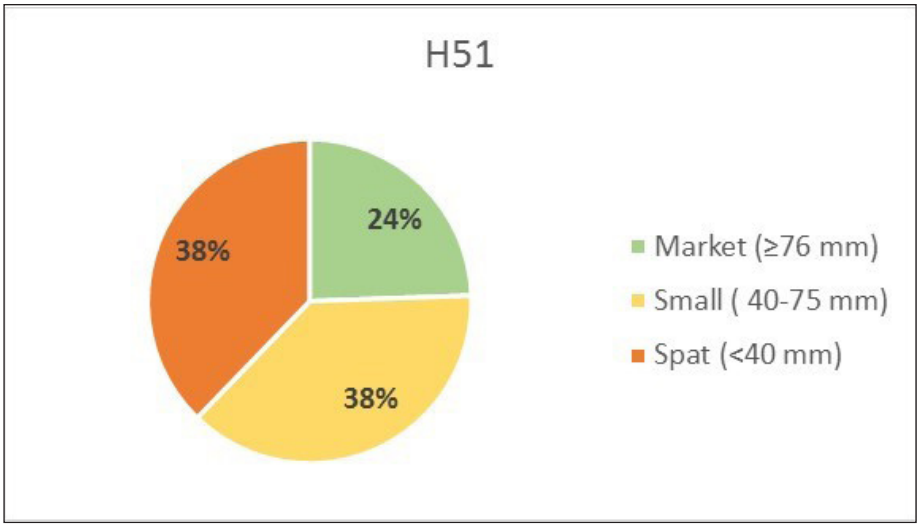
Reef H51 (AltSub_19A) Data and Analysis

		H51
Reef Information	Geodatabase Site_ID	AltSub_19A
	Bar name	Lodges
	Tributary	Harris
	Reef area (acres)	2.79
Restoration Treatment	Restoration treatment	Substrate & Seed
	Substrate type added	Stone base with mixed shell
	Average planned reef height* (inches)	12
	Year planted with spat	2014
	Spat produced by	ORP
	Spat planted by	ORP
	Spat planted (millions)	14.85
	Spat planted per acre (millions)	5.33
Monitoring Information	Monitoring type	2014 cohort
	Sample method	Diver
	Sample date	10/11/2017
	# samples taken	8
	# live oysters measured	538
	# live oysters counted	1023
	# dead oysters counted	137
	% of oysters that were dead	0.12
	Sampled area (m^2)	11002.5
	Sampled acreage	2.72
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	255.75
	Standard error of live density (#/m^2)	42.84
	Reef area meeting minimum threshold density (m^2)	11002.5
	Reef area meeting minimum threshold density (%)	1
	Reef area meeting target density (m^2)	11002.5
	Reef area meeting target density (%)	1
	Average live density on stone (#/m^2)	47
	Standard error of live density on stone	18.21
	Average live density on shell (#/m^2)	141.75
	Standard error of live density on shell	44.51
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	66.5
	Standard error of live density on clam shell	18.37
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	11002.5
	Reef area meeting minimum threshold biomass (%)	1
	Fall 2017: Did reef meet target oyster biomass?	Yes
	Reef area meeting target biomass (m^2)	11002.5
	Reef area meeting target biomass (%)	1
	Average live biomass across reef (g dry weight/m^2)	170.31
	Standard error of live biomass	8.08
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	Yes
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	79
	Standard error of shell volume	13.31
	Total shell volume (liters)	869197.5
	Total surface shell volume (liters)	Null
	Average brown shell across all samples (%)	Null
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3	2.9

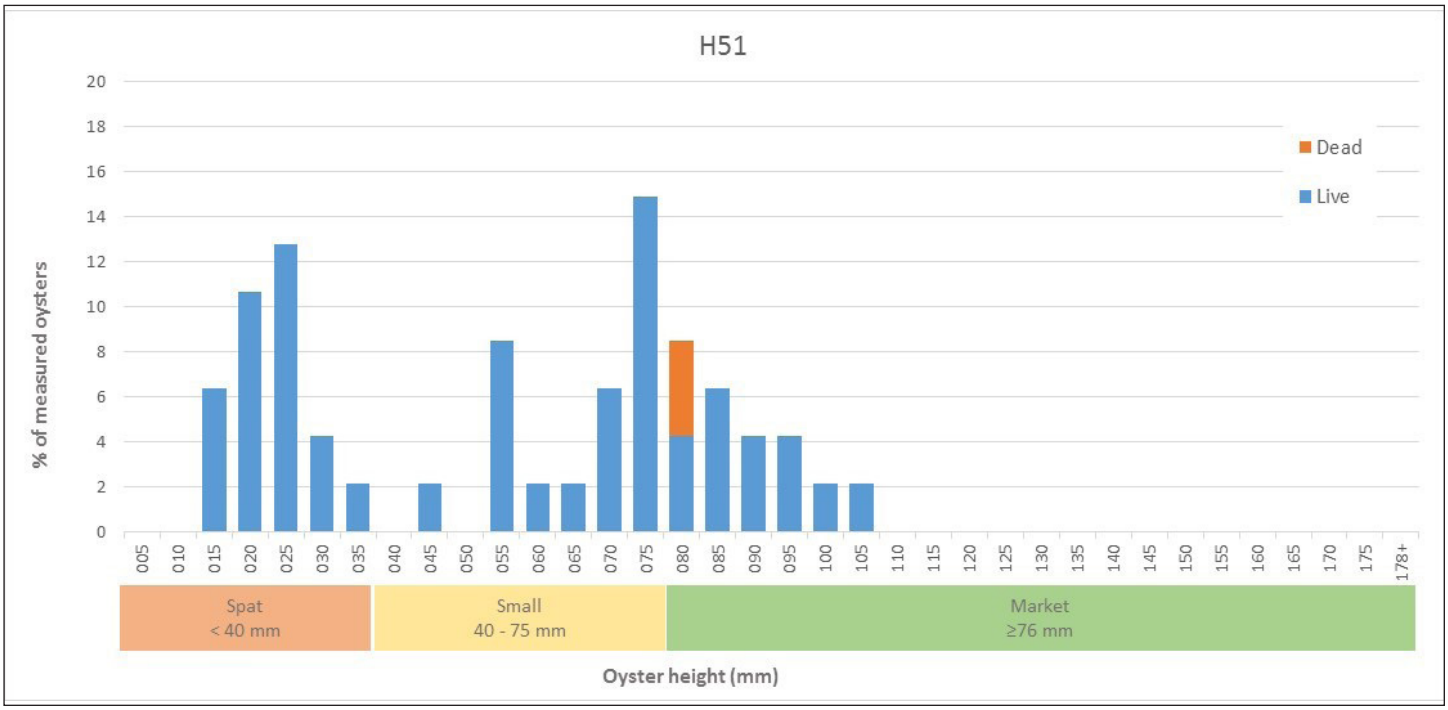
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef H51 (AltSub_19A) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



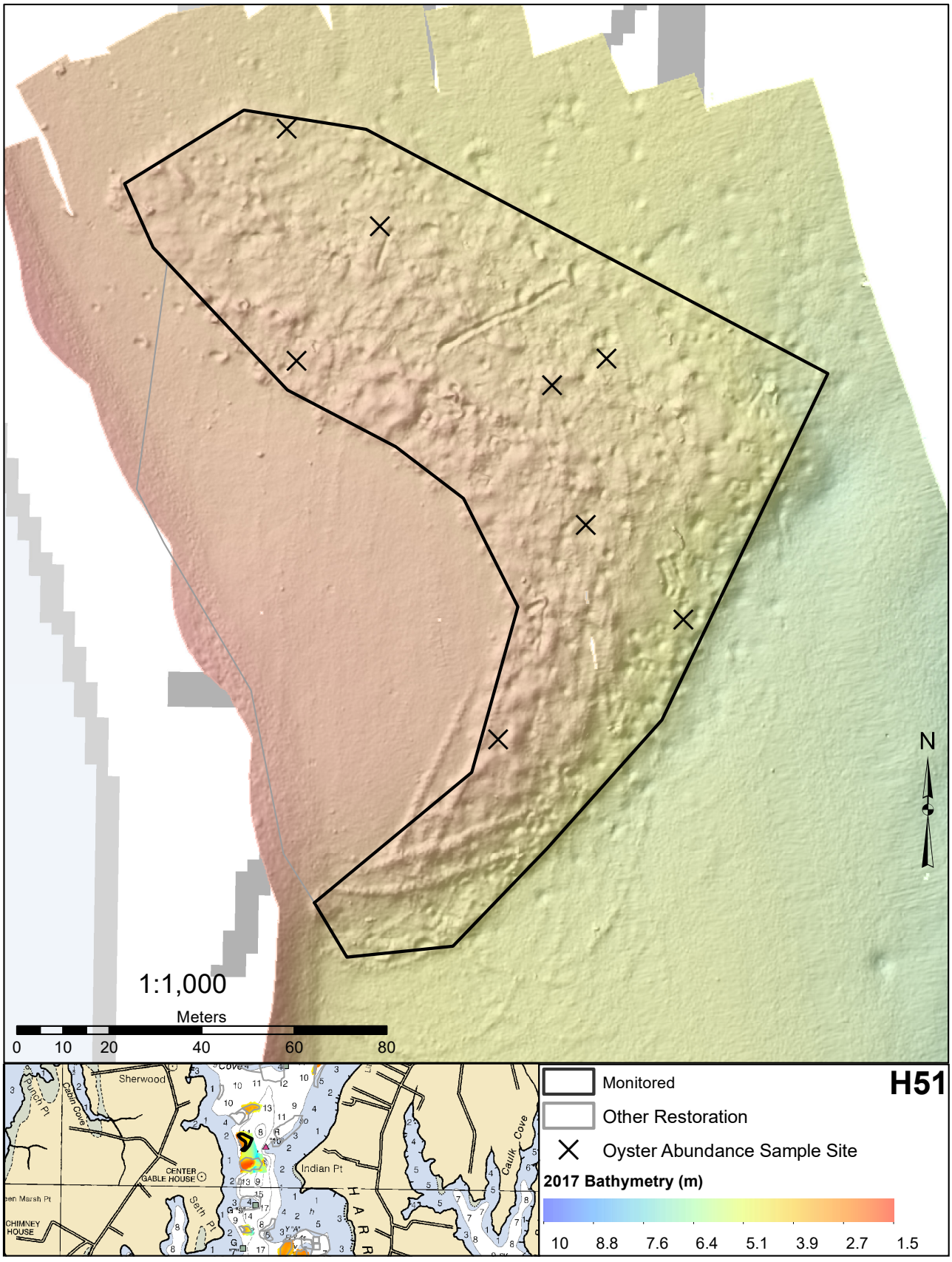
Shell Height of Oysters Measured on Reef



Reef H51 (AltSub_19A) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



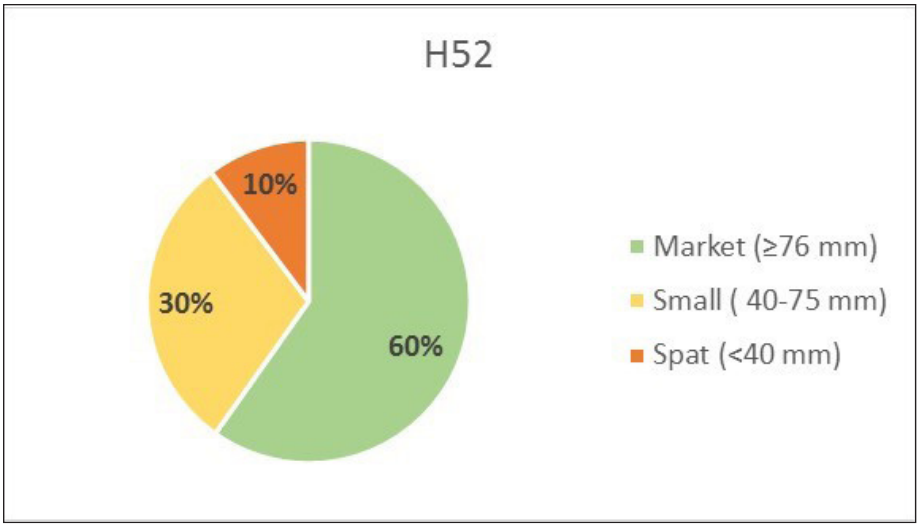
Reef H52 (AltSub_34) Data and Analysis

		H52
Reef Information	Geodatabase Site_ID	AltSub_34
	Bar name	Change
	Tributary	Harris
	Reef area (acres)	25.48
Restoration Treatment	Restoration treatment	Substrate & Seed
	Substrate type added	Fossil shell
	Average planned reef height* (inches)	6
	Year planted with spat	2014
	Spat produced by	ORP
	Spat planted by	ORP
	Spat planted (millions)	163.81
	Spat planted per acre (millions)	6.43
Monitoring Information	Monitoring type	2014 cohort
	Sample method	Diver
	Sample date	2/27/2018
	# samples taken	10
	# live oysters measured	625
	# live oysters counted	1005
	# dead oysters counted	152
	% of oysters that were dead	0.13
	Sampled area (m^2)	65171.1
	Sampled acreage	16.1
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	201
	Standard error of live density (#/m^2)	33.13
	Reef area meeting minimum threshold density (m^2)	65171.1
	Reef area meeting minimum threshold density (%)	1
	Reef area meeting target density (m^2)	65171.1
	Reef area meeting target density (%)	1
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	149
	Standard error of live density on shell	36.65
	Average live density on fossil shell(#/m^2)	51.6
	Standard error of live density on fossil shell	10.08320937
	Average live density on clam shell (#/m^2)	0.2
	Standard error of live density on clam shell	0.20
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	65171.1
	Reef area meeting minimum threshold biomass (%)	1
	Fall 2017: Did reef meet target oyster biomass?	Yes
	Reef area meeting target biomass (m^2)	65171.1
	Reef area meeting target biomass (%)	1
	Average live biomass across reef (g dry weight/m^2)	196.78
	Standard error of live biomass	14.81
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	Yes
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	118
	Standard error of shell volume	14.46
	Total shell volume (liters)	7690189.8
	Total surface shell volume (liters)	Null
	Average brown shell across all samples (%)	Null
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3	1

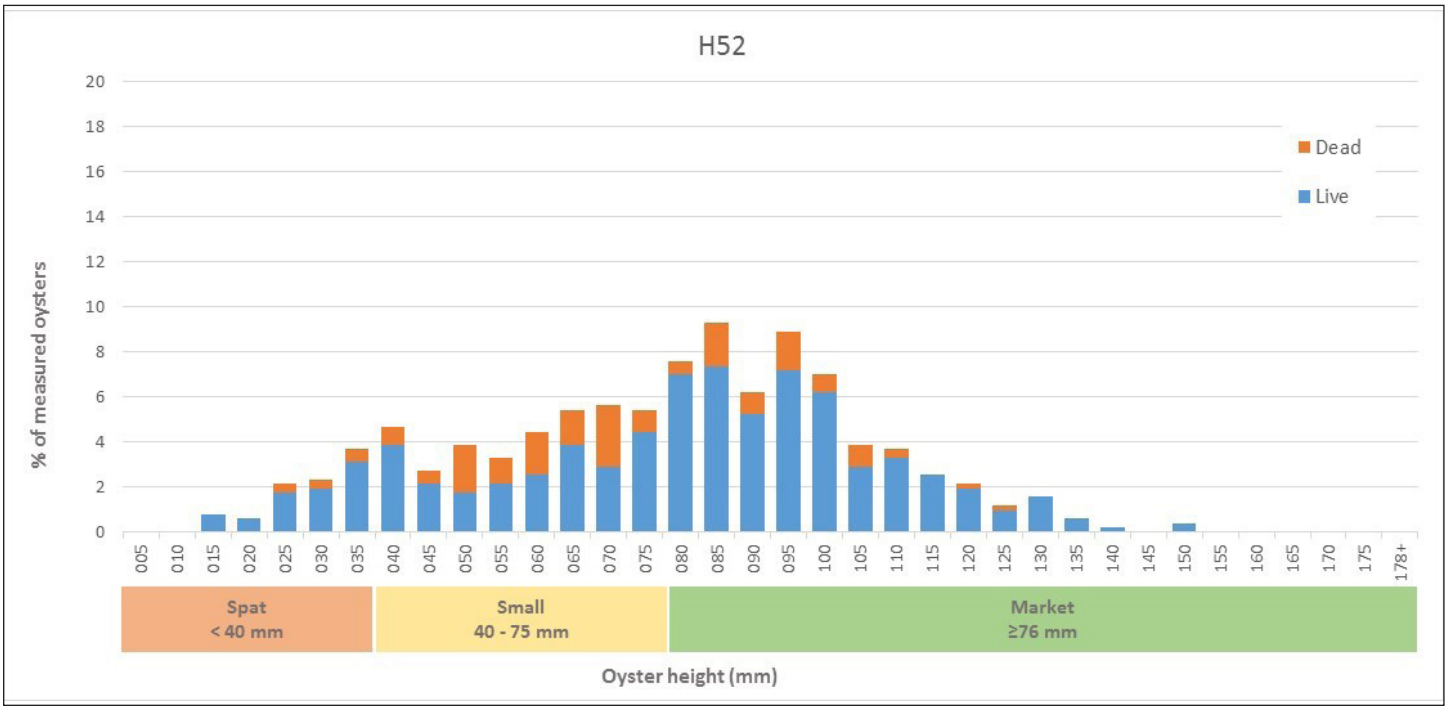
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef H52 (AltSub_34) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



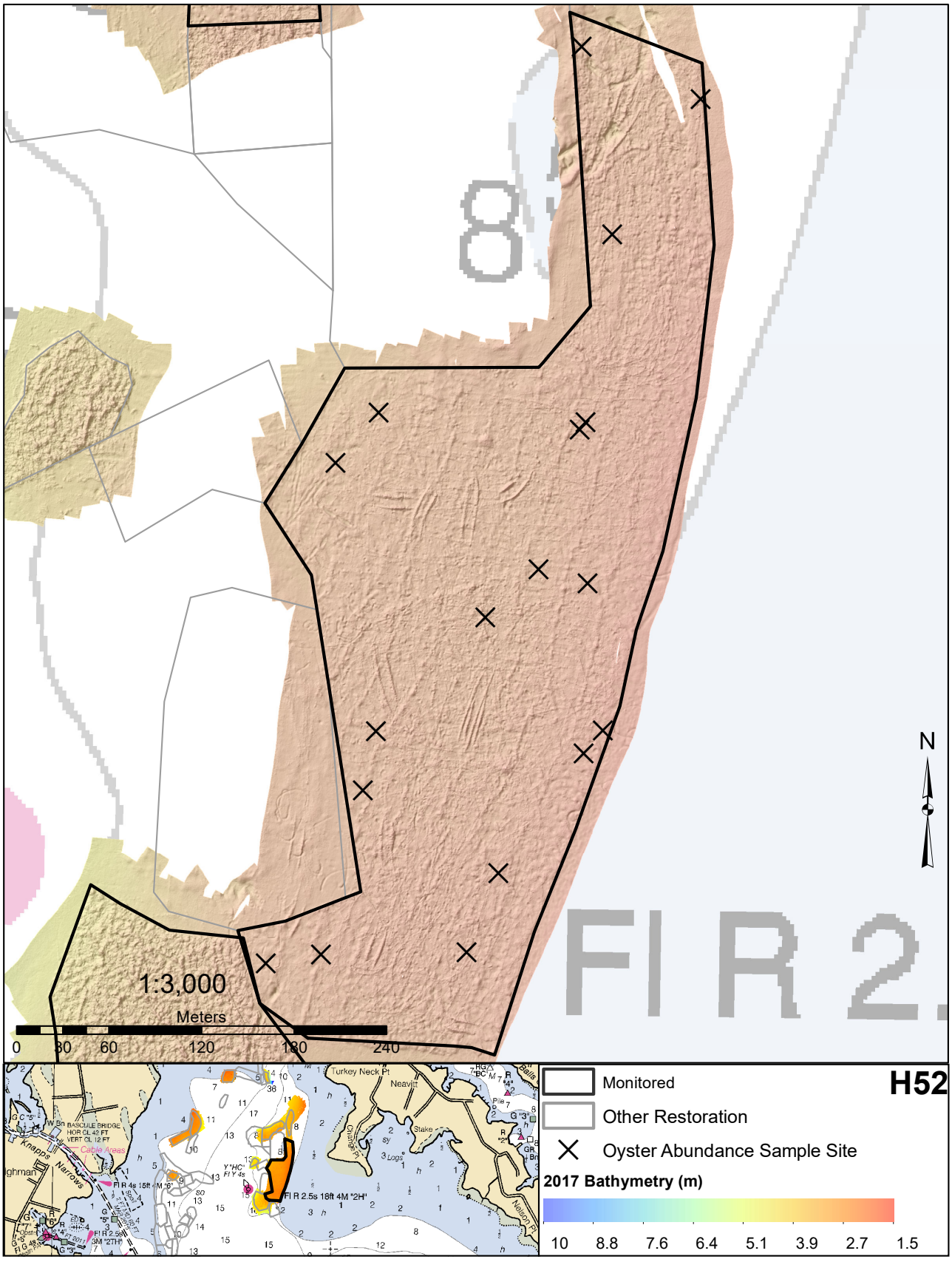
Shell Height of Oysters Measured on Reef



Reef H52 (AltSub_34) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



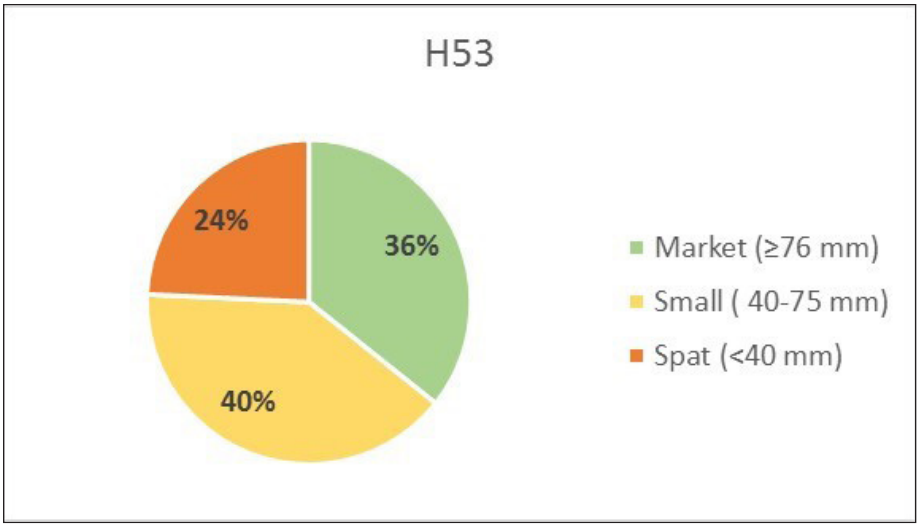
Reef H53 (AltSub_41) Data and Analysis

		H53
Reef Information	Geodatabase Site_ID	AltSub_41
	Bar name	Mill Point
	Tributary	Harris
	Reef area (acres)	7.72
Restoration Treatment	Restoration treatment	Substrate & Seed
	Substrate type added	Stone base with mixed shell
	Average planned reef height* (inches)	12
	Year planted with spat	2014
	Spat produced by	ORP
	Spat planted by	ORP
	Spat planted (millions)	39.02
	Spat planted per acre (millions)	5.06
Monitoring Information	Monitoring type	2014 cohort
	Sample method	Diver
	Sample date	11/1/2017
	# samples taken	7
	# live oysters measured	392
	# live oysters counted	583
	# dead oysters counted	86
	% of oysters that were dead	0.13
	Sampled area (m^2)	31038.9
	Sampled acreage	7.67
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	166.57
	Standard error of live density (#/m^2)	29.92
	Reef area meeting minimum threshold density (m^2)	31038.9
	Reef area meeting minimum threshold density (%)	1
	Reef area meeting target density (m^2)	30484
	Reef area meeting target density (%)	0.982122433
	Average live density on stone (#/m^2)	87.14285714
	Standard error of live density on stone	14.75
	Average live density on shell (#/m^2)	78
	Standard error of live density on shell	25.53
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	0.571428571
	Standard error of live density on clam shell	0.57
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	31038.9
	Reef area meeting minimum threshold biomass (%)	1
	Fall 2017: Did reef meet target oyster biomass?	Yes
	Reef area meeting target biomass (m^2)	26717
	Reef area meeting target biomass (%)	0.860758596
	Average live biomass across reef (g dry weight/m^2)	121.75
	Standard error of live biomass	18.53
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	Yes
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	39.14
	Standard error of shell volume	7.05
	Total shell volume (liters)	1214951.23
	Total surface shell volume (liters)	Null
	Average brown shell across all samples (%)	Null
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3	2.5

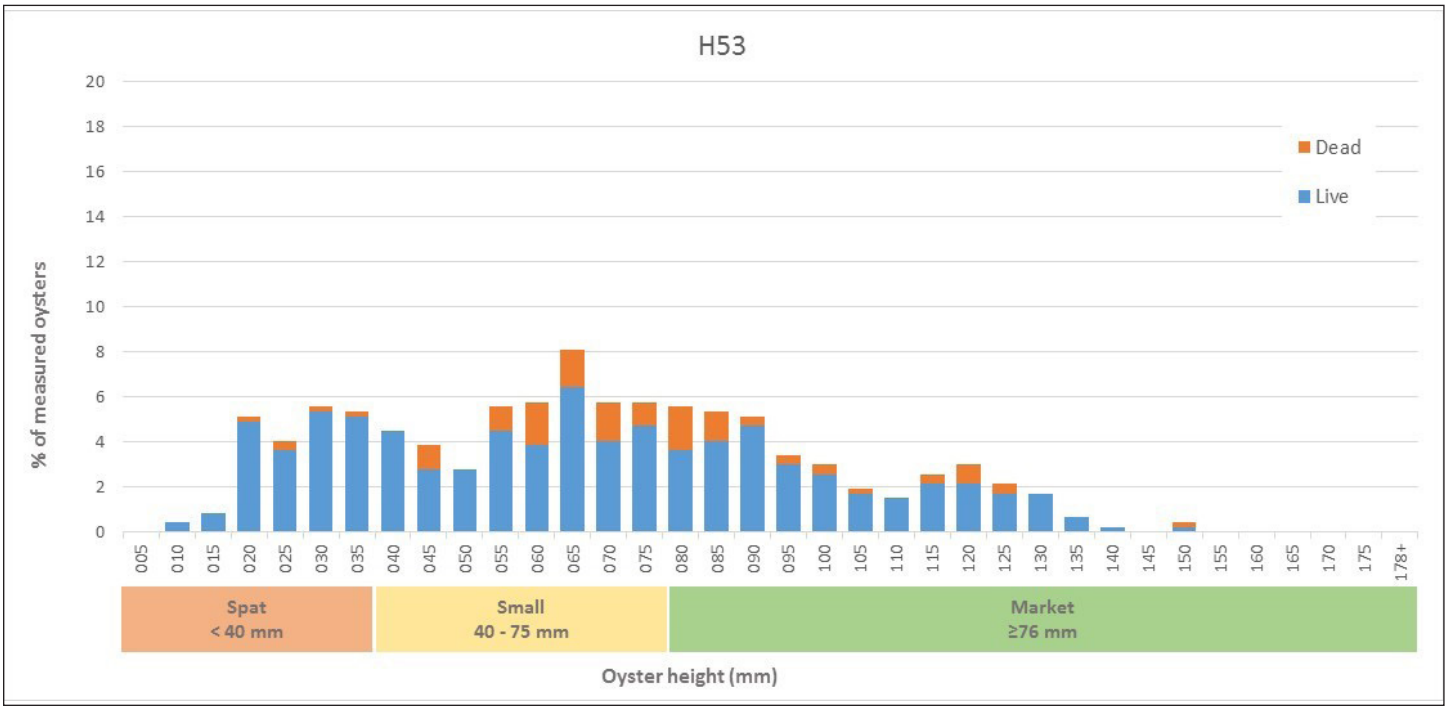
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef H53 (AltSub_41) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



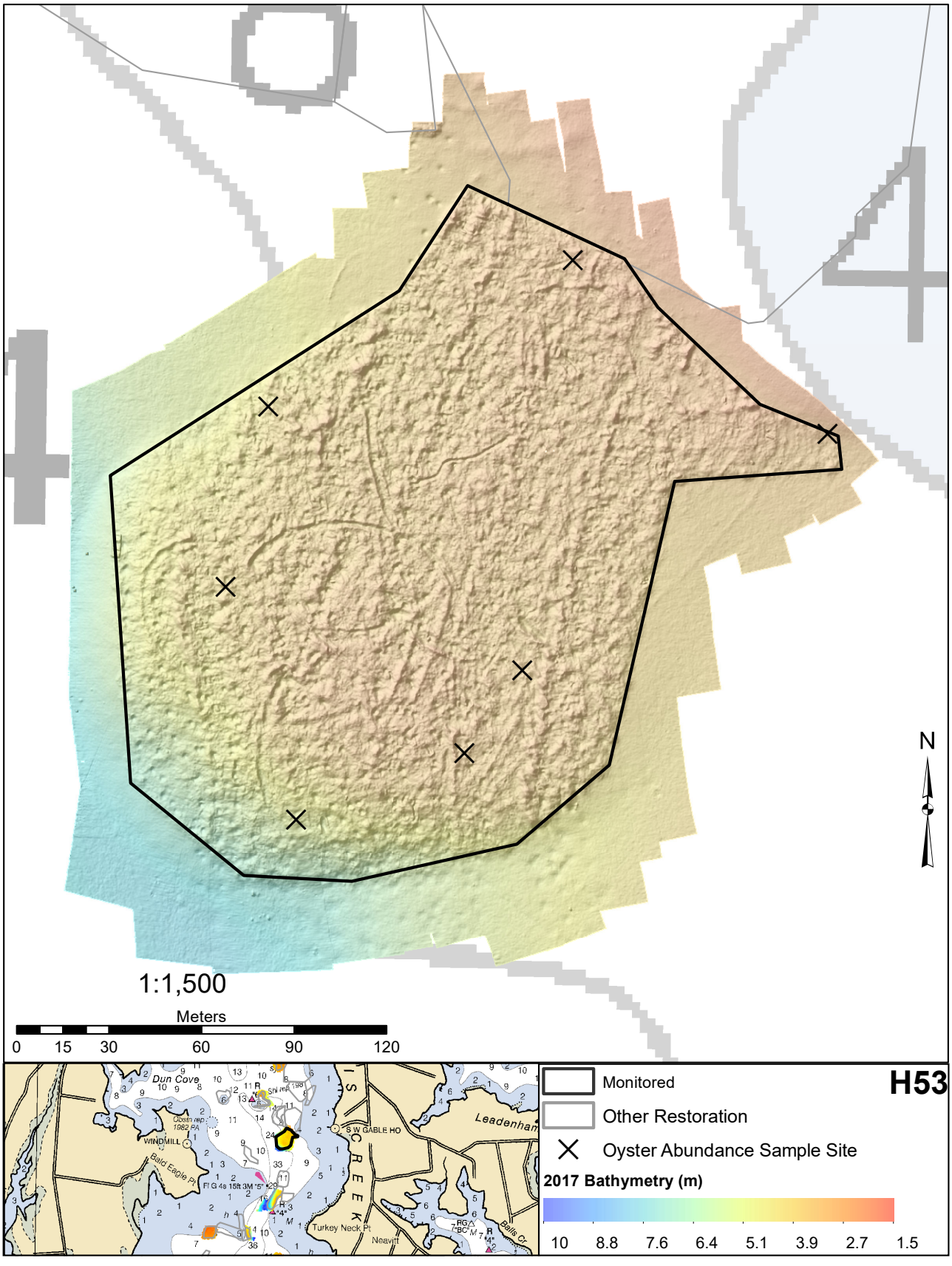
Shell Height of Oysters Measured on Reef



Reef H53 (AltSub_41) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



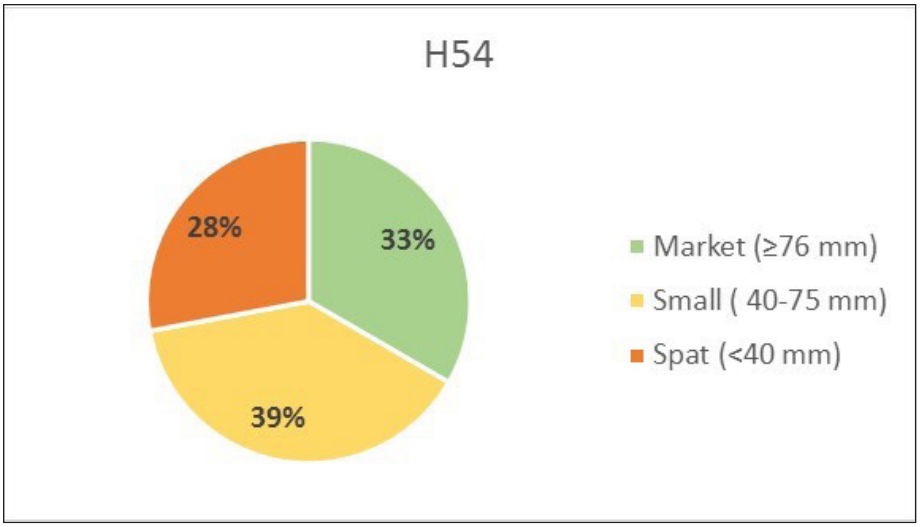
Reef H54 (AltSub_48) Data and Analysis

		H54
Reef Information	Geodatabase Site_ID	AltSub_48
	Bar name	Smith Point
	Tributary	Harris
	Reef area (acres)	4.18
Restoration Treatment	Restoration treatment	Substrate & Seed
	Substrate type added	Fossil shell
	Average planned reef height* (inches)	6
	Year planted with spat	2014
	Spat produced by	ORP
	Spat planted by	ORP
	Spat planted (millions)	25.23
	Spat planted per acre (millions)	6.04
Monitoring Information	Monitoring type	2014 cohort
	Sample method	Diver
	Sample date	10/27/2017
	# samples taken	4
	# live oysters measured	408
	# live oysters counted	526
	# dead oysters counted	49
	% of oysters that were dead	0.09
	Sampled area (m^2)	16904
	Sampled acreage	4.18
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	263
	Standard error of live density (#/m^2)	33.01
	Reef area meeting minimum threshold density (m^2)	16904
	Reef area meeting minimum threshold density (%)	1
	Reef area meeting target density (m^2)	16904
	Reef area meeting target density (%)	1
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	179.5
	Standard error of live density on shell	37.26
	Average live density on fossil shell(#/m^2)	81
	Standard error of live density on fossil shell	22.3383079
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	16904
	Reef area meeting minimum threshold biomass (%)	1
	Fall 2017: Did reef meet target oyster biomass?	Yes
	Reef area meeting target biomass (m^2)	16904
	Reef area meeting target biomass (%)	1
	Average live biomass across reef (g dry weight/m^2)	167.25
	Standard error of live biomass	10.09
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	Yes
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	146
	Standard error of shell volume	21.59
	Total shell volume (liters)	2467984
	Total surface shell volume (liters)	Null
	Average brown shell across all samples (%)	Null
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3	5

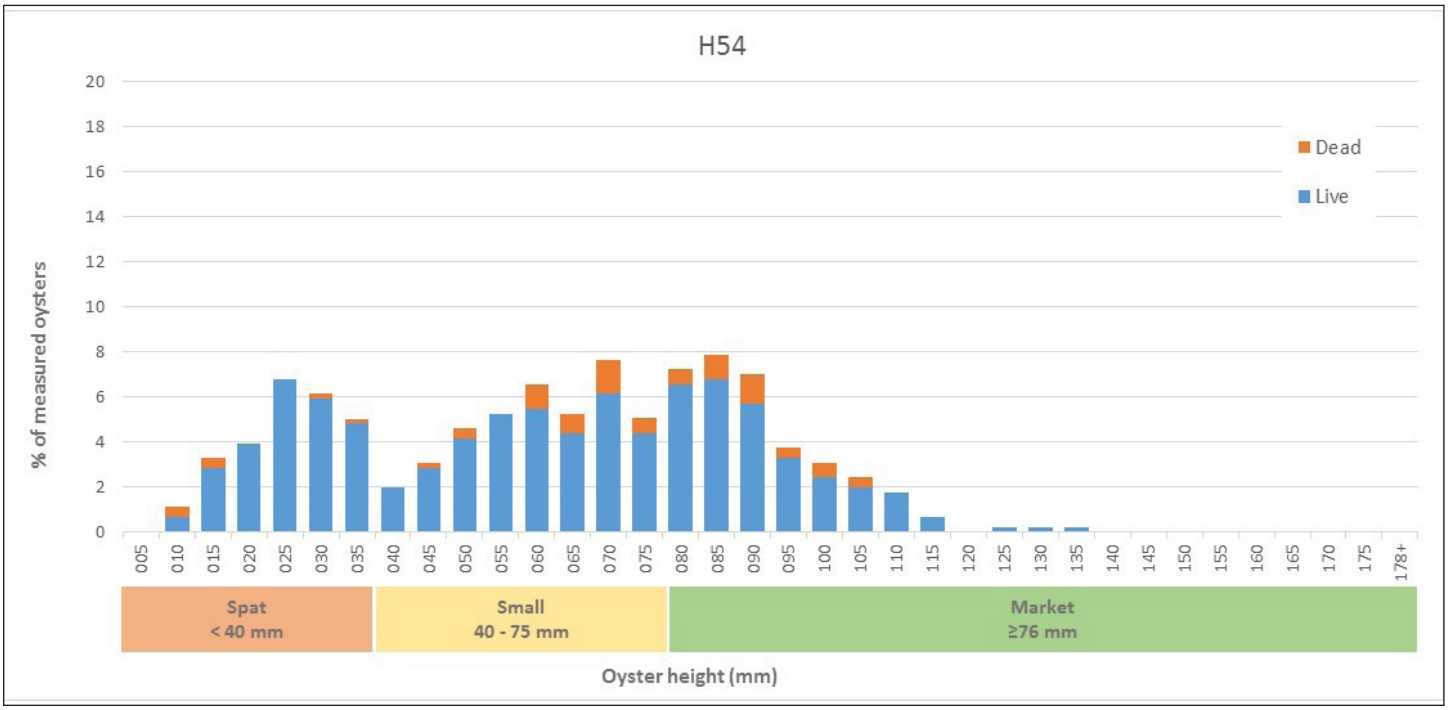
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef H54 (AltSub_48) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



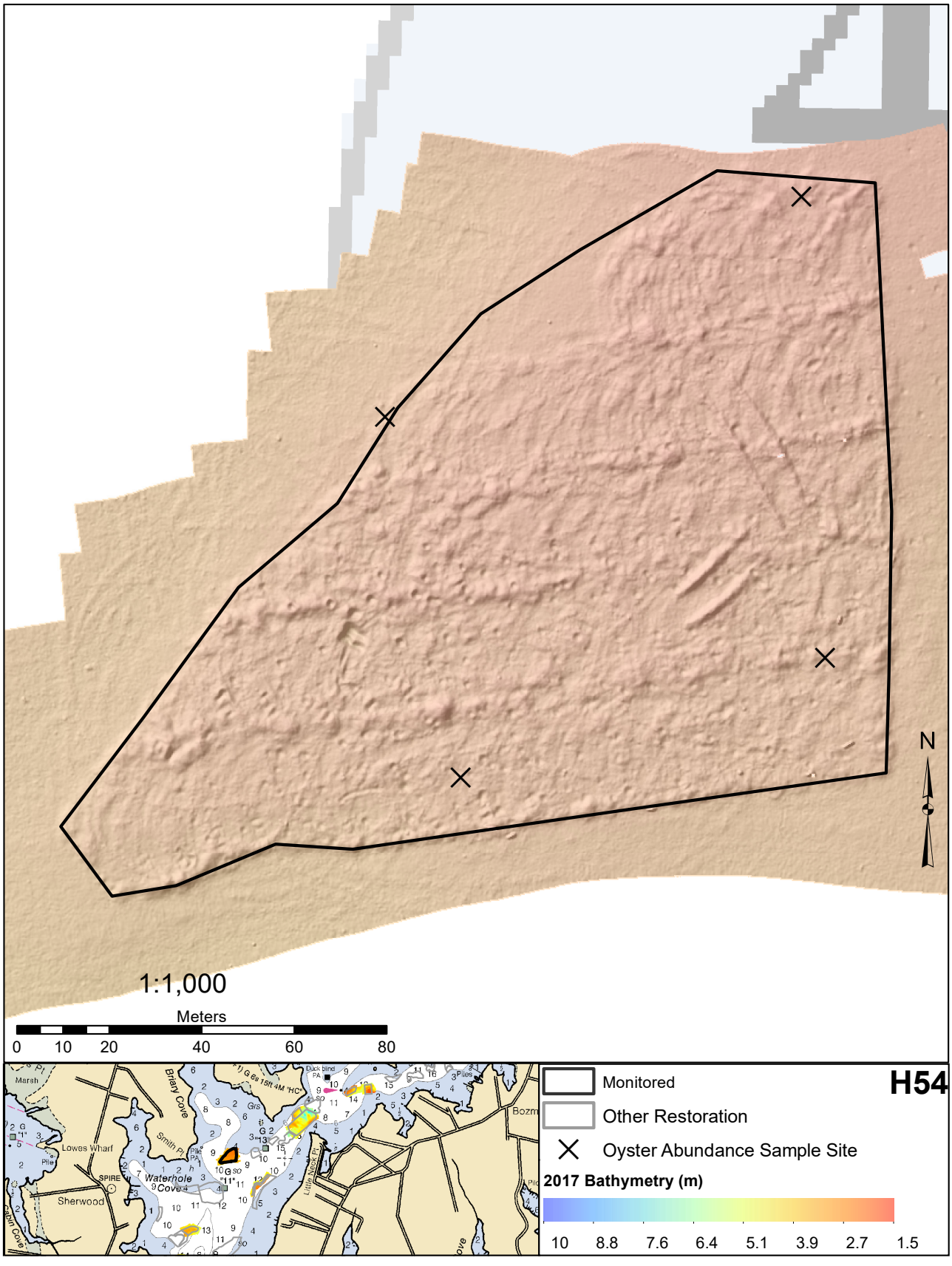
Shell Height of Oysters Measured on Reef



Reef H54 (AltSub_48) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



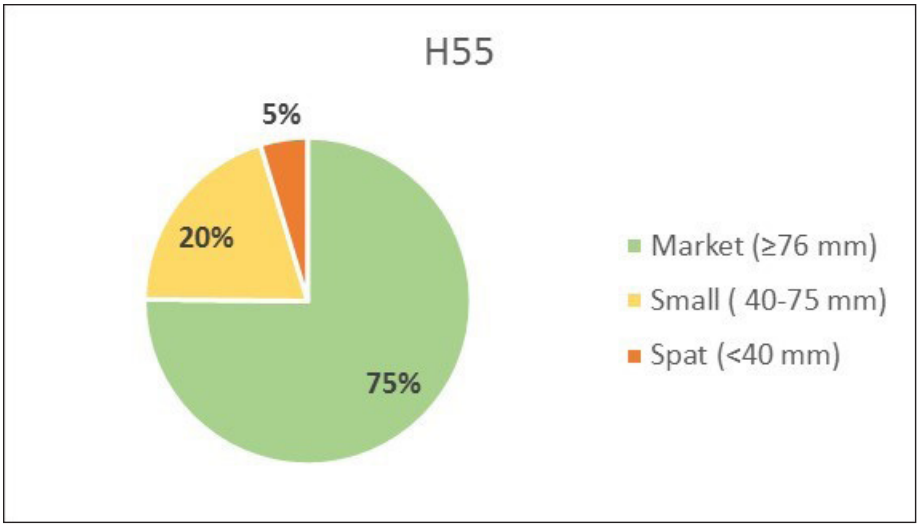
Reef H55 (Seed_52) Data and Analysis

		H55
Reef Information	Geodatabase Site_ID	Seed_52
	Bar name	Tilghman Wharf
	Tributary	Harris
	Reef area (acres)	1.54
Restoration Treatment	Restoration treatment	Seed Only
	Substrate type added	Spat on shell only
	Average planned reef height* (inches)	<Null>
	Year planted with spat	2014
	Spat produced by	ORP
	Spat planted by	ORP
	Spat planted (millions)	15.13
	Spat planted per acre (millions)	9.81
Monitoring Information	Monitoring type	2014 cohort
	Sample method	Patent Tong
	Sample date	02-Nov-17
	# samples taken	5
	# live oysters measured	169
	# live oysters counted	207
	# dead oysters counted	52
	% of oysters that were dead	0.20
	Sampled area (m^2)	5948.68
	Sampled acreage	1.47
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	No
	Average live density across reef (#/m^2)	25.71
	Standard error of live density (#/m^2)	5.18
	Reef area meeting minimum threshold density (m^2)	4506.14
	Reef area meeting minimum threshold density (%)	0.757502505
	Reef area meeting target density (m^2)	0
	Reef area meeting target density (%)	0
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	3452.552508
	Reef area meeting minimum threshold biomass (%)	0.580389684
	Fall 2017: Did reef meet target oyster biomass?	No
	Reef area meeting target biomass (m^2)	1332.679241
	Reef area meeting target biomass (%)	0.224029405
	Average live biomass across reef (g dry weight/m^2)	40.08
	Standard error of live biomass	10.42
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	No
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	9.32
	Standard error of shell volume	0.79
	Total shell volume (liters)	55422.47
	Total surface shell volume (liters)	19952.09
	Average brown shell across all samples (%)	64
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3	7

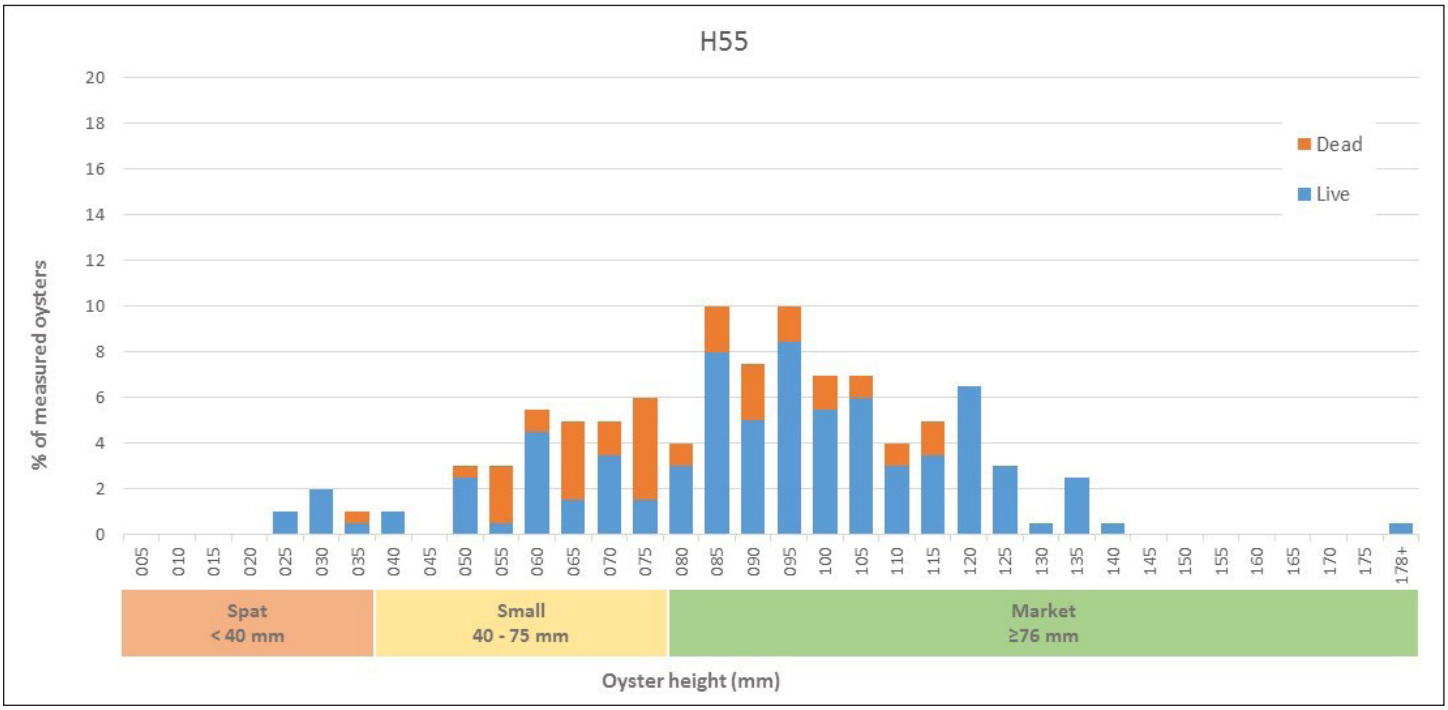
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef H55 (Seed_52) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



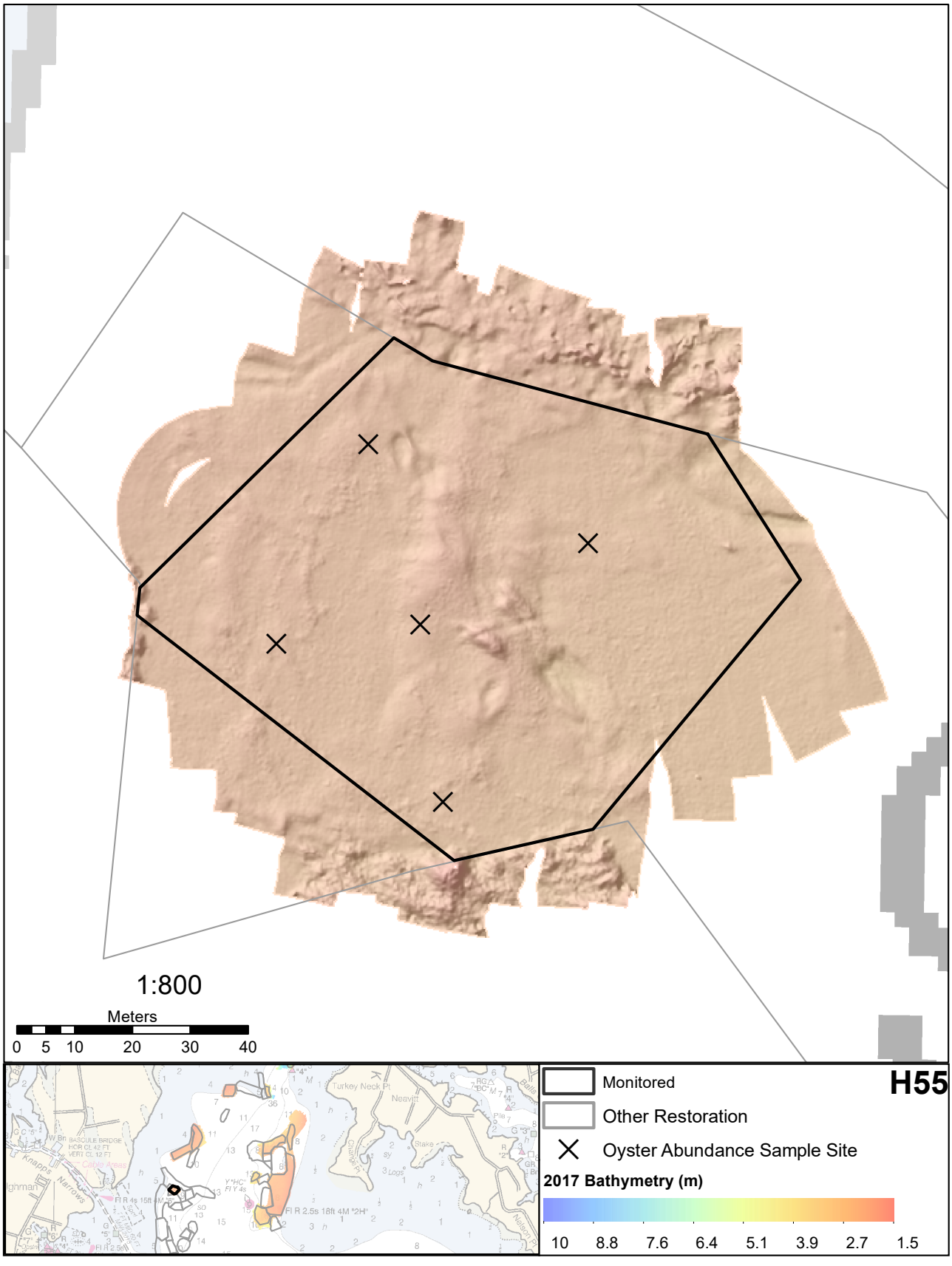
Shell Height of Oysters Measured on Reef



Reef H55 (Seed_52) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



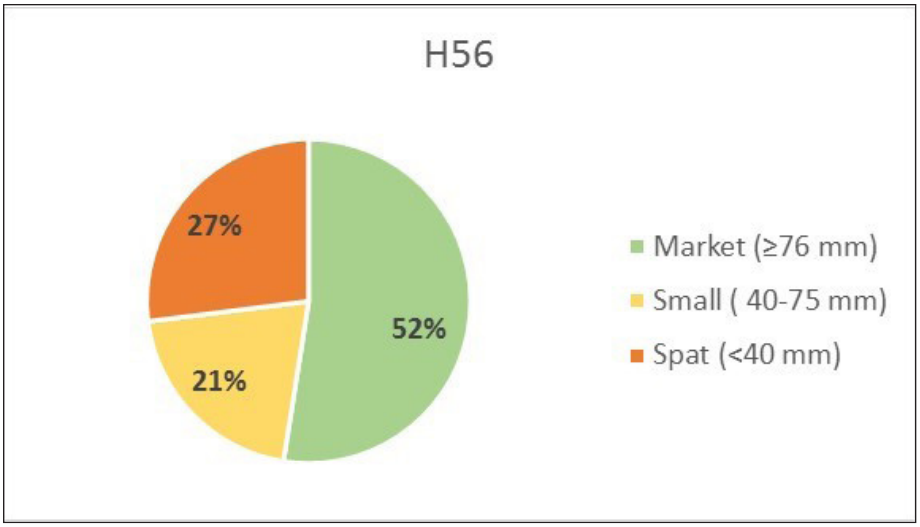
Reef H56 (AltSub_55A) Data and Analysis

		H56
Reef Information	Geodatabase Site_ID	AltSub_55A
	Bar name	Eagle Point
	Tributary	Harris
	Reef area (acres)	1.13
Restoration Treatment	Restoration treatment	Substrate & Seed
	Substrate type added	Stone base with mixed shell
	Average planned reef height* (inches)	12
	Year planted with spat	2014
	Spat produced by	ORP
	Spat planted by	ORP
	Spat planted (millions)	14.32
	Spat planted per acre (millions)	12.64
Monitoring Information	Monitoring type	2014 cohort
	Sample method	Diver
	Sample date	10/25/2017
	# samples taken	5
	# live oysters measured	341
	# live oysters counted	522
	# dead oysters counted	127
	% of oysters that were dead	0.20
	Sampled area (m^2)	4387.5
	Sampled acreage	1.08
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	208.8
	Standard error of live density (#/m^2)	49.55
	Reef area meeting minimum threshold density (m^2)	3971.5
	Reef area meeting minimum threshold density (%)	0.905185185
	Reef area meeting target density (m^2)	3971.5
	Reef area meeting target density (%)	0.905185185
	Average live density on stone (#/m^2)	5.6
	Standard error of live density on stone	5.60
	Average live density on shell (#/m^2)	142.8
	Standard error of live density on shell	39.48
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	57.2
	Standard error of live density on clam shell	30.74
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	4387.5
	Reef area meeting minimum threshold biomass (%)	1
	Fall 2017: Did reef meet target oyster biomass?	Yes
	Reef area meeting target biomass (m^2)	3971.5
	Reef area meeting target biomass (%)	0.905185185
	Average live biomass across reef (g dry weight/m^2)	178.84
	Standard error of live biomass	24.53
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	Yes
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	138.4
	Standard error of shell volume	22.59
	Total shell volume (liters)	607230
	Total surface shell volume (liters)	Null
	Average brown shell across all samples (%)	Null
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3	0.7

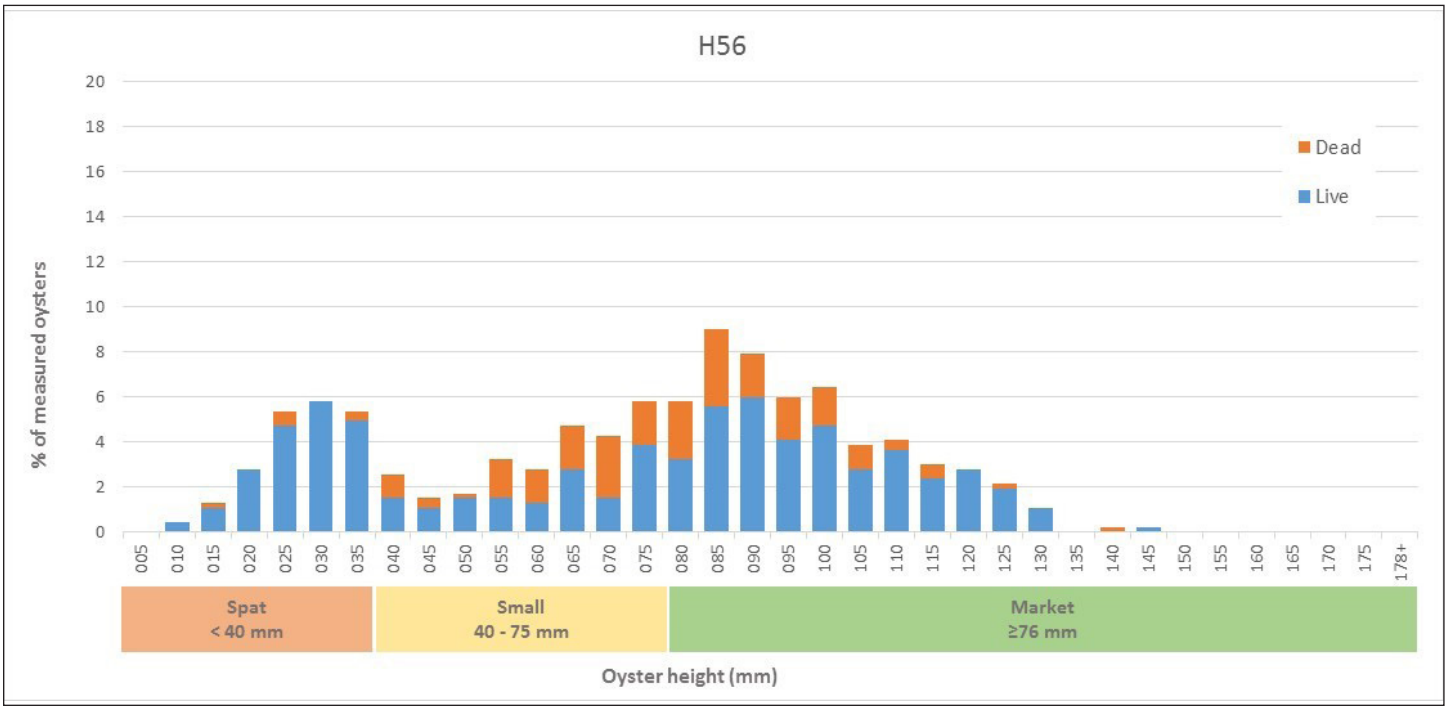
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef H56 (AltSub_55A) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



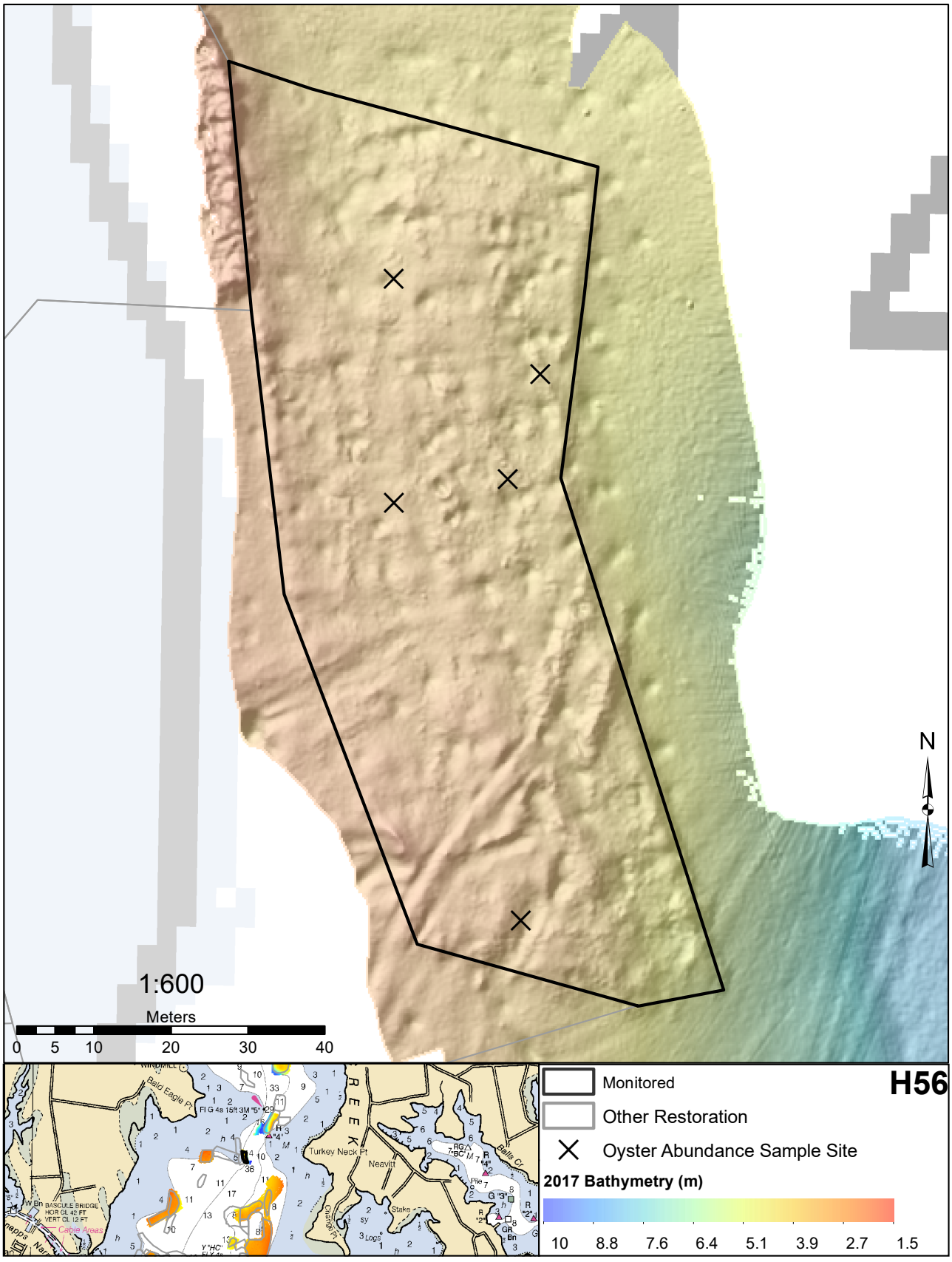
Shell Height of Oysters Measured on Reef



Reef H56 (AltSub_55A) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



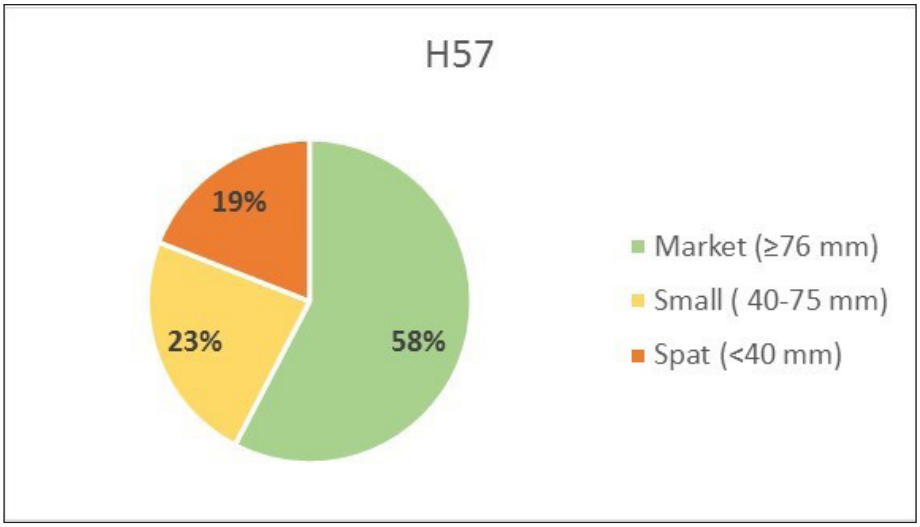
Reef H57 (AltSub_58A) Data and Analysis

		H57
Reef Information	Geodatabase Site_ID	AltSub_58A
	Bar name	Mill Point
	Tributary	Harris
	Reef area (acres)	1.39
Restoration Treatment	Restoration treatment	Substrate & Seed
	Substrate type added	Stone base with mixed shell
	Average planned reef height* (inches)	12
	Year planted with spat	2014
	Spat produced by	ORP
	Spat planted by	ORP
	Spat planted (millions)	13.61
	Spat planted per acre (millions)	9.76
Monitoring Information	Monitoring type	2014 cohort
	Sample method	Diver
	Sample date	11/28/2017
	# samples taken	9
	# live oysters measured	398
	# live oysters counted	479
	# dead oysters counted	47
	% of oysters that were dead	0.09
	Sampled area (m^2)	5641.4
	Sampled acreage	1.39
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	106.44
	Standard error of live density (#/m^2)	18.18
	Reef area meeting minimum threshold density (m^2)	5641.4
	Reef area meeting minimum threshold density (%)	1
	Reef area meeting target density (m^2)	5313.4
	Reef area meeting target density (%)	0.941858404
	Average live density on stone (#/m^2)	23.11111111
	Standard error of live density on stone	14.41
	Average live density on shell (#/m^2)	53.55555556
	Standard error of live density on shell	21.48
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	29.77777778
	Standard error of live density on clam shell	5.81
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	5641.4
	Reef area meeting minimum threshold biomass (%)	1
	Fall 2017: Did reef meet target oyster biomass?	Yes
	Reef area meeting target biomass (m^2)	4959.4
	Reef area meeting target biomass (%)	0.879108023
	Average live biomass across reef (g dry weight/m^2)	89.14
	Standard error of live biomass	13.59
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	Yes
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	80.78
	Standard error of shell volume	21.46
	Total shell volume (liters)	455699.76
	Total surface shell volume (liters)	Null
	Average brown shell across all samples (%)	Null
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3	1.4

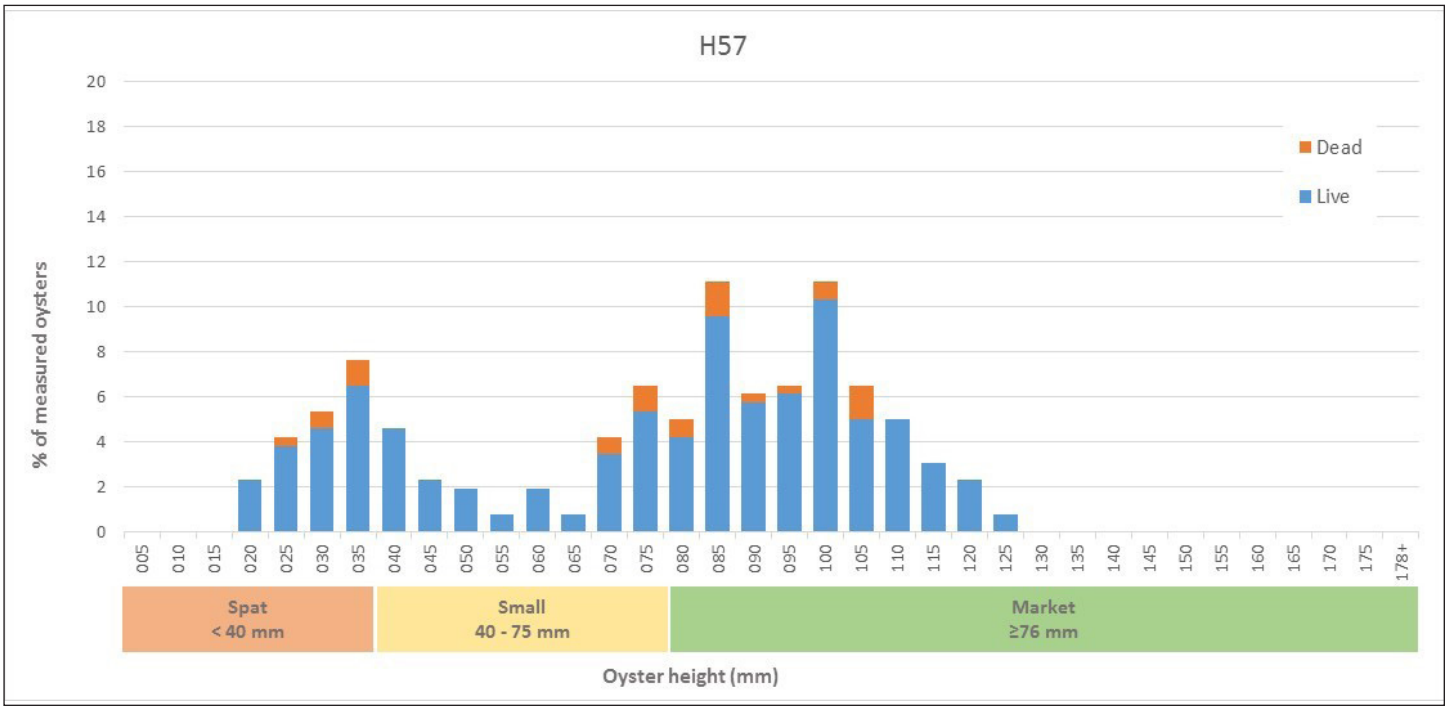
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef H57 (AltSub_58A) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



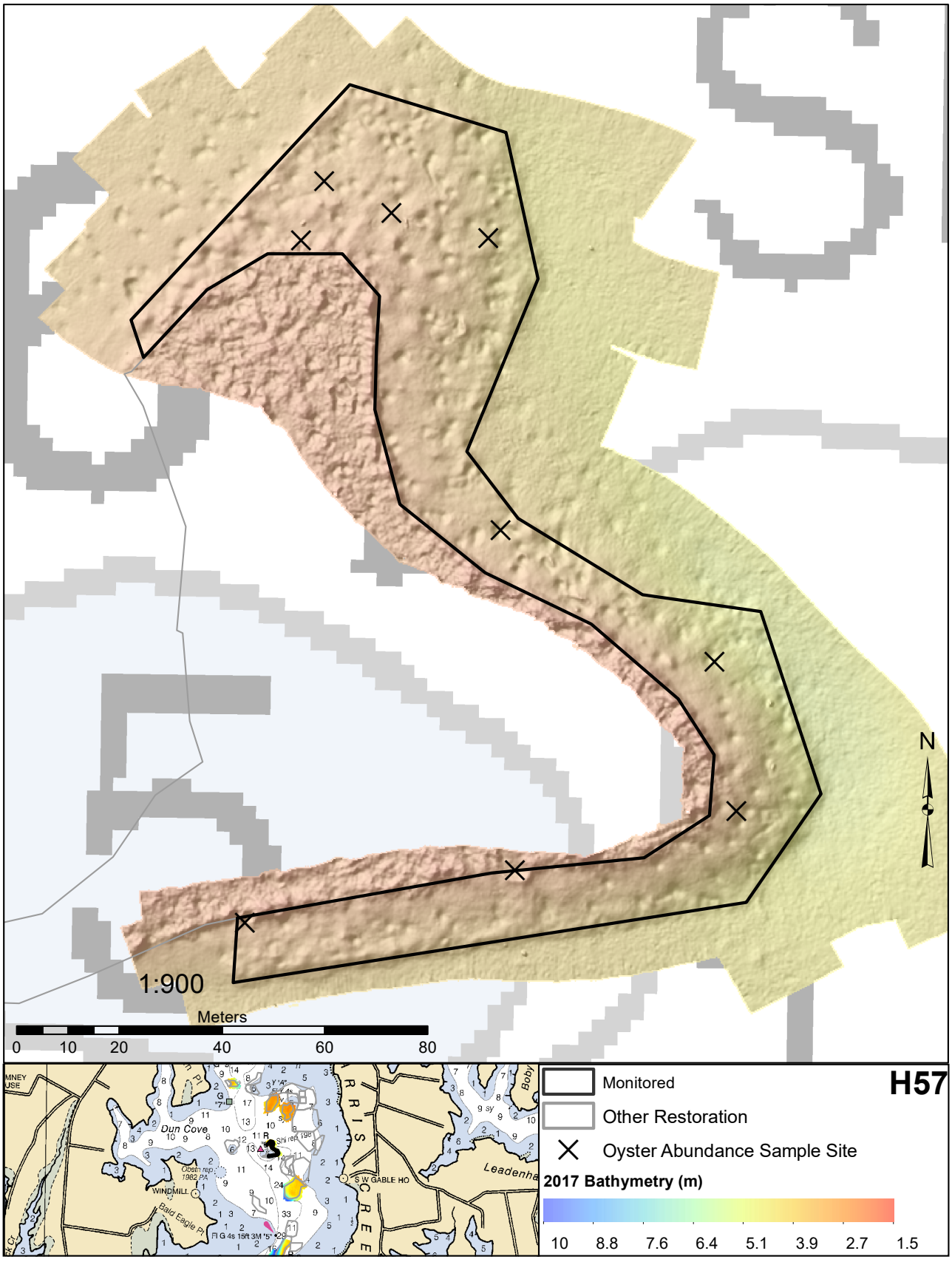
Shell Height of Oysters Measured on Reef



Reef H57 (AltSub_58A) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



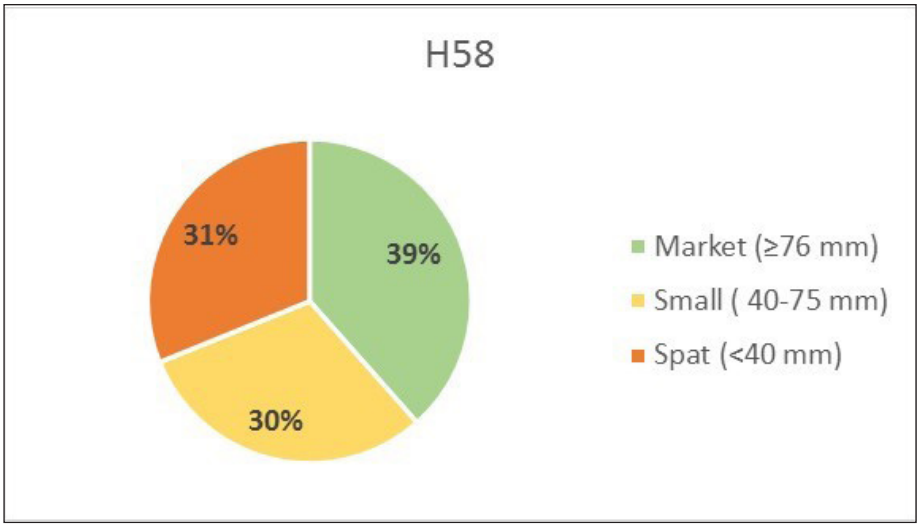
Reef H58 (AltSub_64A) Data and Analysis

		H58
Reef Information	Geodatabase Site_ID	AltSub_64A
	Bar name	Little Neck
	Tributary	Harris
	Reef area (acres)	1.77
Restoration Treatment	Restoration treatment	Substrate & Seed
	Substrate type added	Stone base with mixed shell
	Average planned reef height* (inches)	12
	Year planted with spat	2014
	Spat produced by	ORP
	Spat planted by	ORP
	Spat planted (millions)	12.48
	Spat planted per acre (millions)	7.05
Monitoring Information	Monitoring type	2014 cohort
	Sample method	Diver
	Sample date	10/20/2017
	# samples taken	5
	# live oysters measured	273
	# live oysters counted	545
	# dead oysters counted	50
	% of oysters that were dead	0.08
	Sampled area (m^2)	6859.7
	Sampled acreage	1.7
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	218
	Standard error of live density (#/m^2)	48.97
	Reef area meeting minimum threshold density (m^2)	6859.7
	Reef area meeting minimum threshold density (%)	1
	Reef area meeting target density (m^2)	6859.7
	Reef area meeting target density (%)	1
	Average live density on stone (#/m^2)	71.6
	Standard error of live density on stone	57.27
	Average live density on shell (#/m^2)	33.6
	Standard error of live density on shell	12.92
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	112
	Standard error of live density on clam shell	34.16
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	6859.7
	Reef area meeting minimum threshold biomass (%)	1
	Fall 2017: Did reef meet target oyster biomass?	Yes
	Reef area meeting target biomass (m^2)	6859.7
	Reef area meeting target biomass (%)	1
	Average live biomass across reef (g dry weight/m^2)	132.91
	Standard error of live biomass	6.05
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	Yes
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	53.6
	Standard error of shell volume	16.86
	Total shell volume (liters)	367679.92
	Total surface shell volume (liters)	Null
	Average brown shell across all samples (%)	Null
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3	1.4

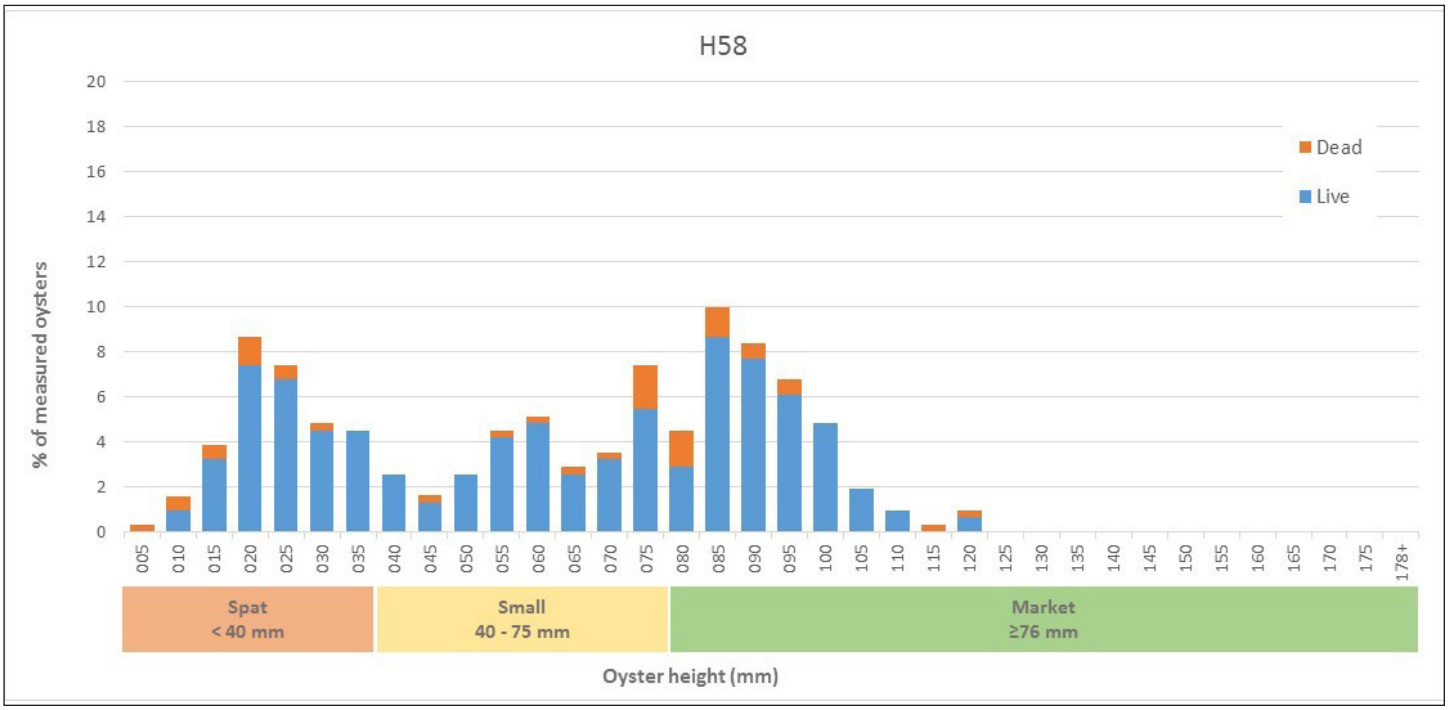
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef H58 (AltSub_64A) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



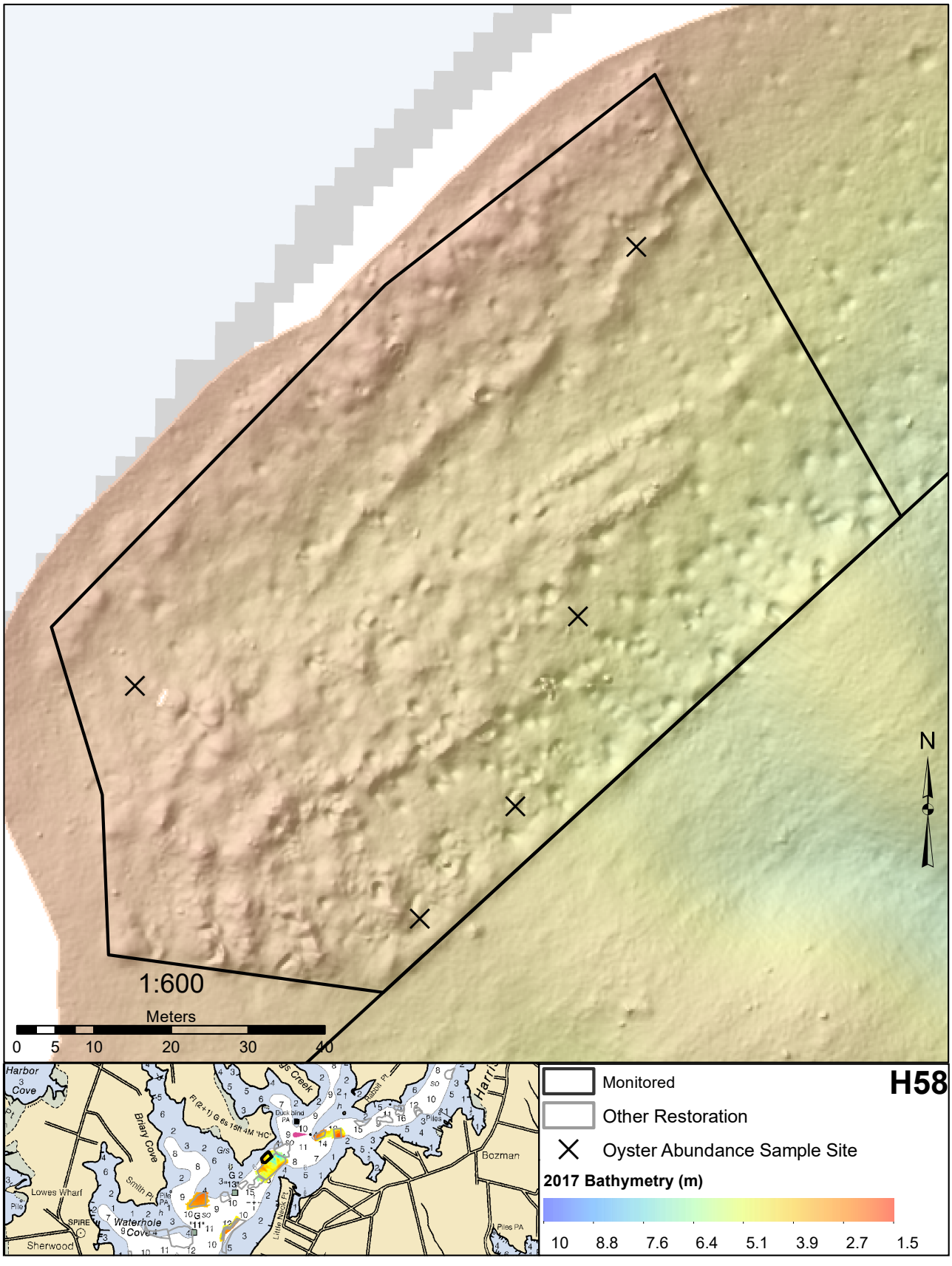
Shell Height of Oysters Measured on Reef



Reef H58 (AltSub_64A) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



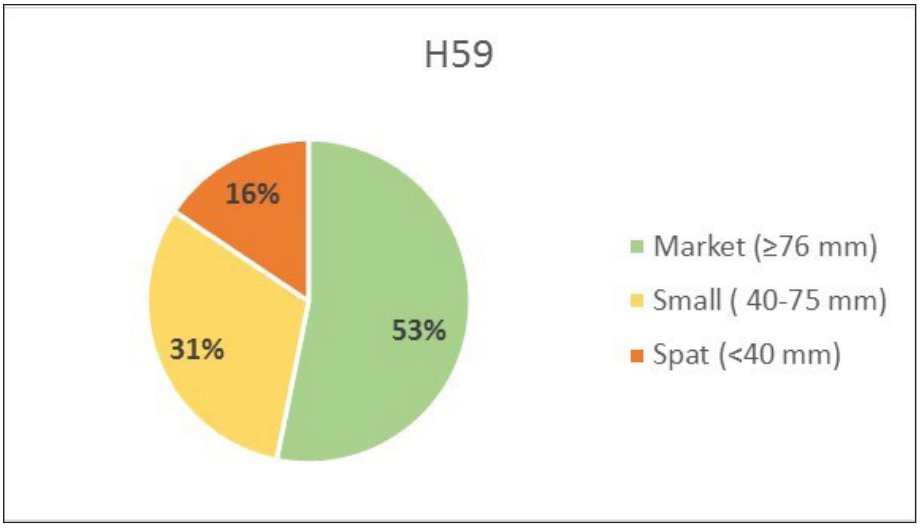
Reef H59 (AltSub_71C) Data and Analysis

		H59
Reef Information	Geodatabase Site_ID	AltSub_71C
	Bar name	Change
	Tributary	Harris
	Reef area (acres)	5.96
Restoration Treatment	Restoration treatment	Substrate & Seed
	Substrate type added	Stone base with mixed shell
	Average planned reef height* (inches)	12& 6
	Year planted with spat	2014
	Spat produced by	ORP
	Spat planted by	ORP
	Spat planted (millions)	38.56
	Spat planted per acre (millions)	6.47
Monitoring Information	Monitoring type	2014 cohort
	Sample method	Diver
	Sample date	11/15/2017
	# samples taken	7
	# live oysters measured	282
	# live oysters counted	538
	# dead oysters counted	104
	% of oysters that were dead	0.16
	Sampled area (m^2)	24102.4
	Sampled acreage	5.96
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	153.71
	Standard error of live density (#/m^2)	61.39
	Reef area meeting minimum threshold density (m^2)	24102.4
	Reef area meeting minimum threshold density (%)	1
	Reef area meeting target density (m^2)	17641.4
	Reef area meeting target density (%)	0.731935409
	Average live density on stone (#/m^2)	15.14285714
	Standard error of live density on stone	10.47
	Average live density on shell (#/m^2)	121.4285714
	Standard error of live density on shell	63.61
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	16.85714286
	Standard error of live density on clam shell	11.50
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	24102.4
	Reef area meeting minimum threshold biomass (%)	1
	Fall 2017: Did reef meet target oyster biomass?	Yes
	Reef area meeting target biomass (m^2)	16705
	Reef area meeting target biomass (%)	0.693084506
	Average live biomass across reef (g dry weight/m^2)	144.76
	Standard error of live biomass	21.58
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	Yes
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	120.57
	Standard error of shell volume	22.91
	Total shell volume (liters)	2906060.8
	Total surface shell volume (liters)	Null
	Average brown shell across all samples (%)	Null
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3	4.4

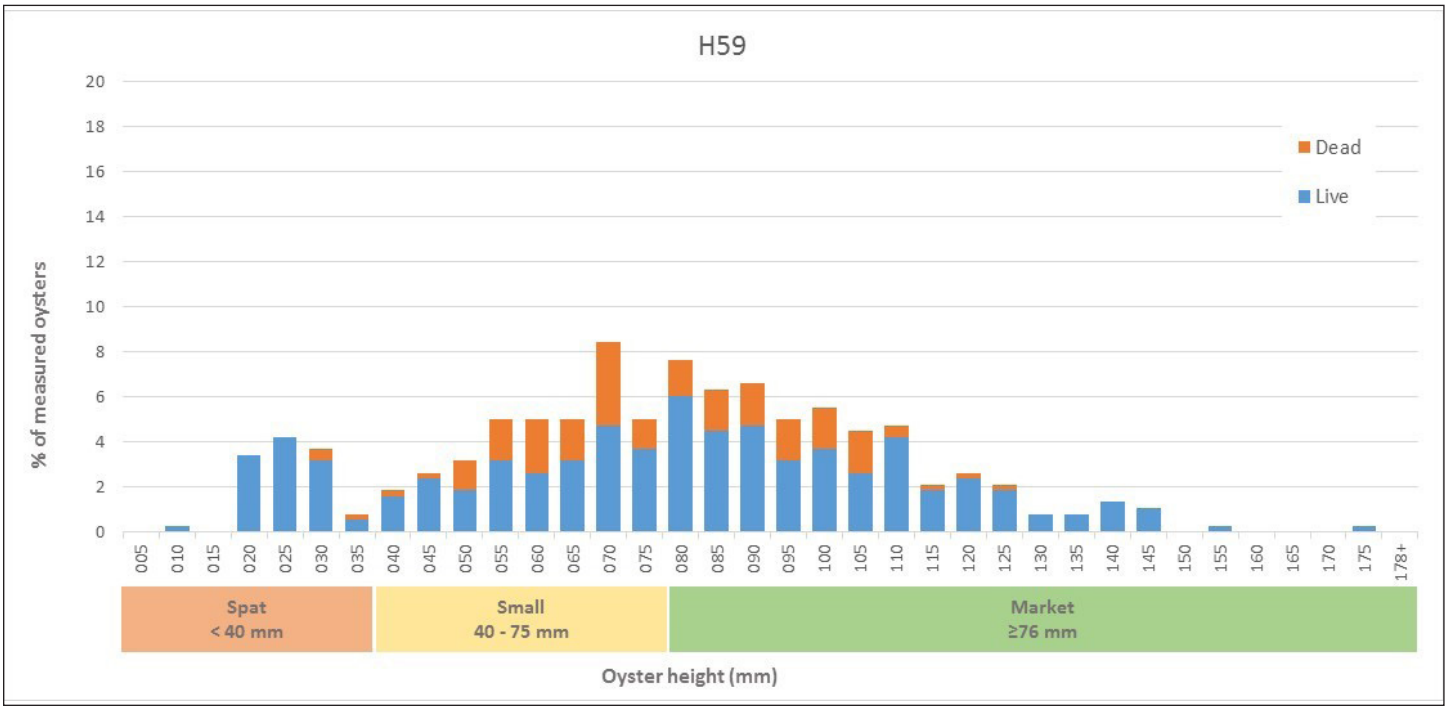
*_**Average planned reef height**_: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef H59 (AltSub_71C) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



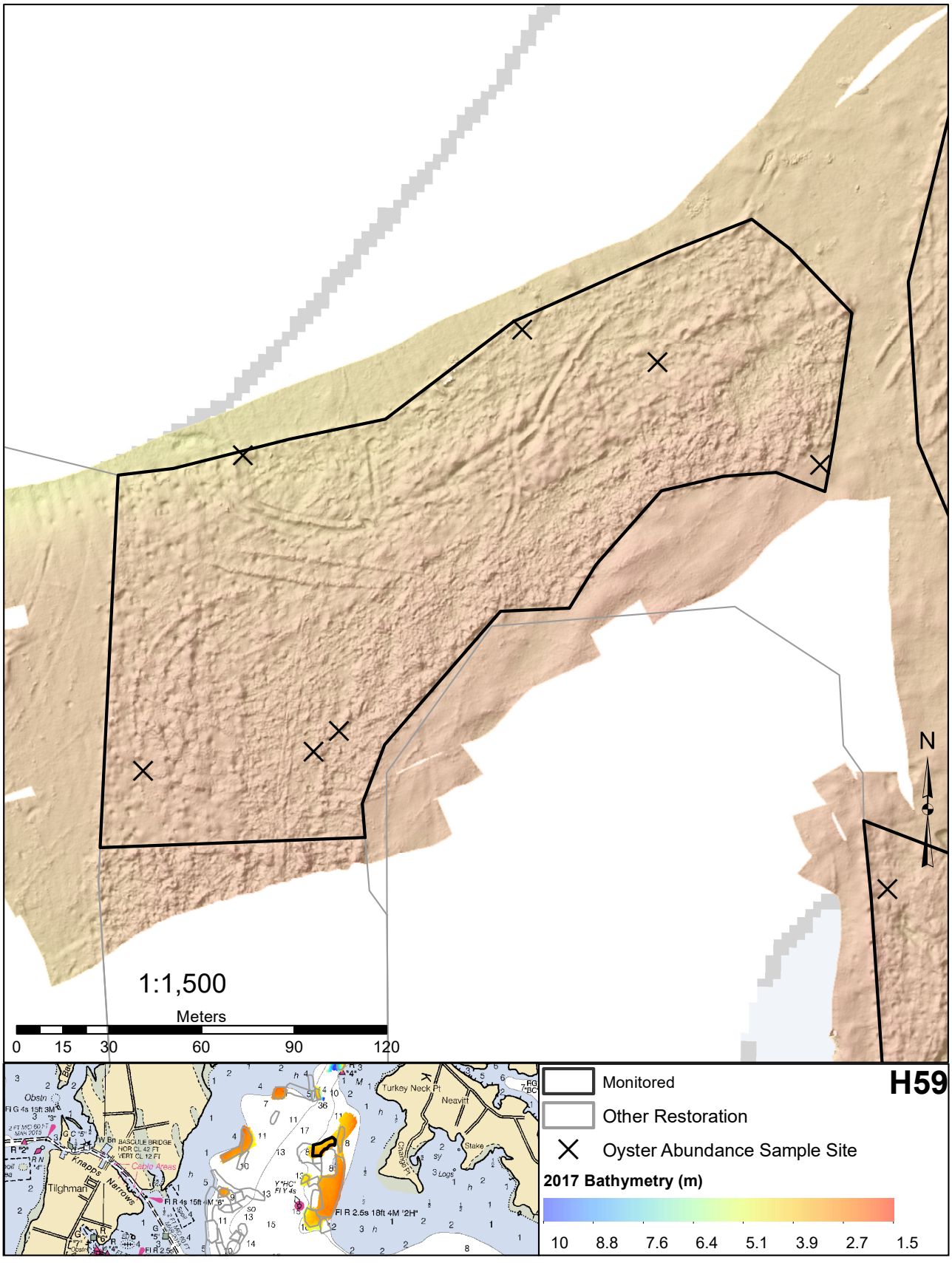
Shell Height of Oysters Measured on Reef



Reef H59 (AltSub_71C) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



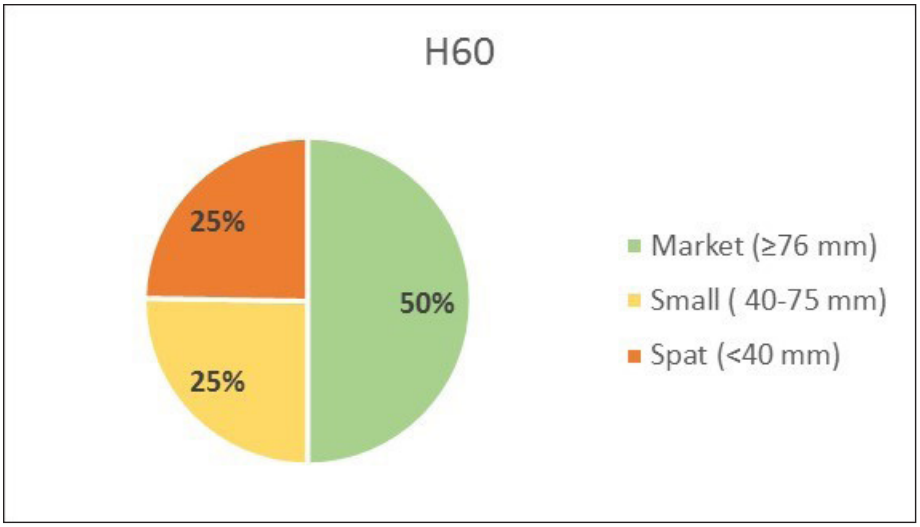
Reef H60 (AltSub_76) Data and Analysis

		H60
Reef Information	Geodatabase Site_ID	AltSub_76
	Bar name	N/A
	Tributary	Harris
	Reef area (acres)	5.04
Restoration Treatment	Restoration treatment	Substrate & Seed
	Substrate type added	Fossil shell
	Average planned reef height* (inches)	6
	Year planted with spat	2014
	Spat produced by	ORP
	Spat planted by	ORP
	Spat planted (millions)	49.16
	Spat planted per acre (millions)	9.76
Monitoring Information	Monitoring type	2014 cohort
	Sample method	Diver
	Sample date	2/27/2018
	# samples taken	6
	# live oysters measured	373
	# live oysters counted	647
	# dead oysters counted	108
	% of oysters that were dead	0.14
	Sampled area (m^2)	20357.2
	Sampled acreage	5.03
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	215.67
	Standard error of live density (#/m^2)	57.12
	Reef area meeting minimum threshold density (m^2)	20357.2
	Reef area meeting minimum threshold density (%)	1
	Reef area meeting target density (m^2)	20357.2
	Reef area meeting target density (%)	1
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	145.3333333
	Standard error of live density on shell	62.80
	Average live density on fossil shell(#/m^2)	67.33333333
	Standard error of live density on fossil shell	8.126773311
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	20357.2
	Reef area meeting minimum threshold biomass (%)	1
	Fall 2017: Did reef meet target oyster biomass?	Yes
	Reef area meeting target biomass (m^2)	16019.2
	Reef area meeting target biomass (%)	0.786905861
	Average live biomass across reef (g dry weight/m^2)	220.52
	Standard error of live biomass	22.78
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	Yes
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	126.33
	Standard error of shell volume	8.17
	Total shell volume (liters)	2571792.93
	Total surface shell volume (liters)	Null
	Average brown shell across all samples (%)	Null
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3	1.9

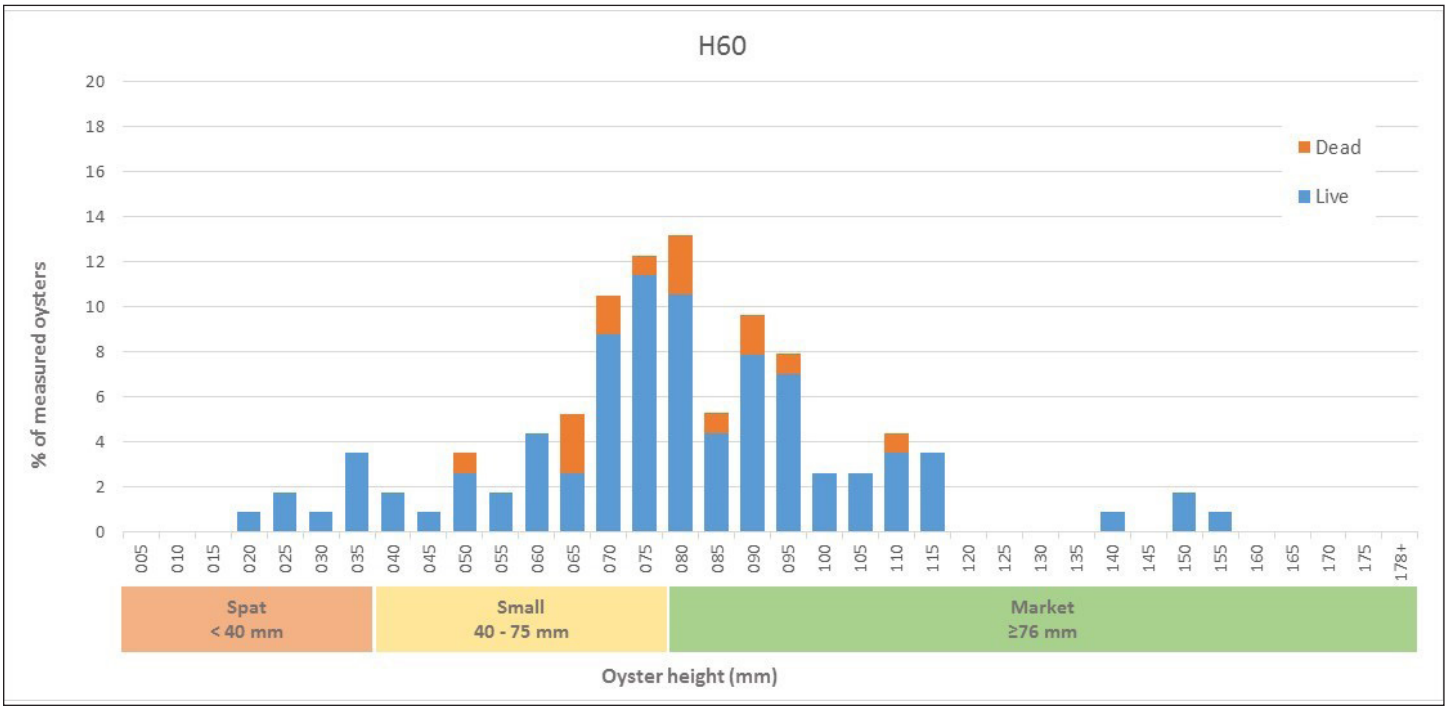
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef H60 (AltSub_76) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



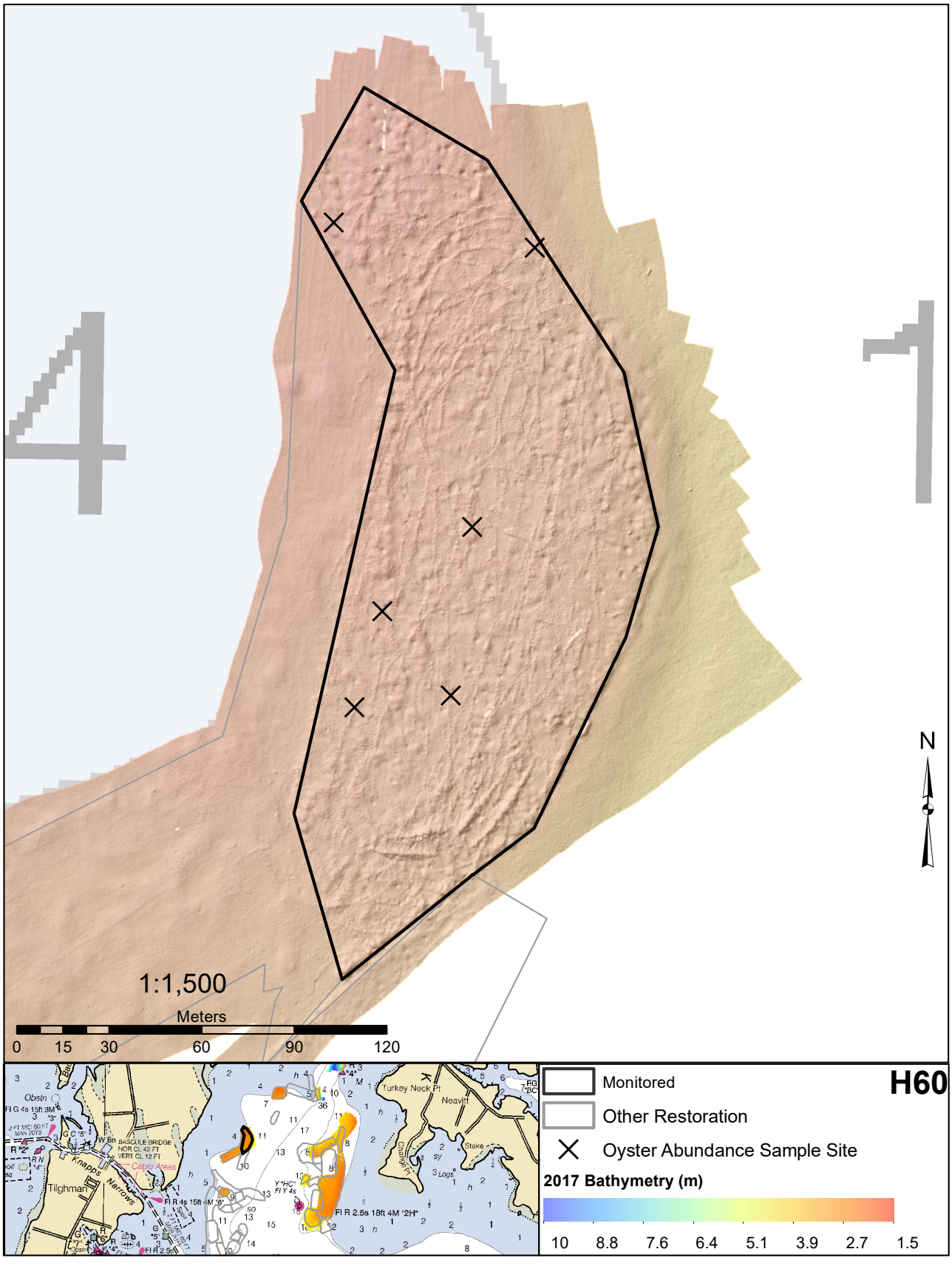
Shell Height of Oysters Measured on Reef



Reef H60 (AltSub_76) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



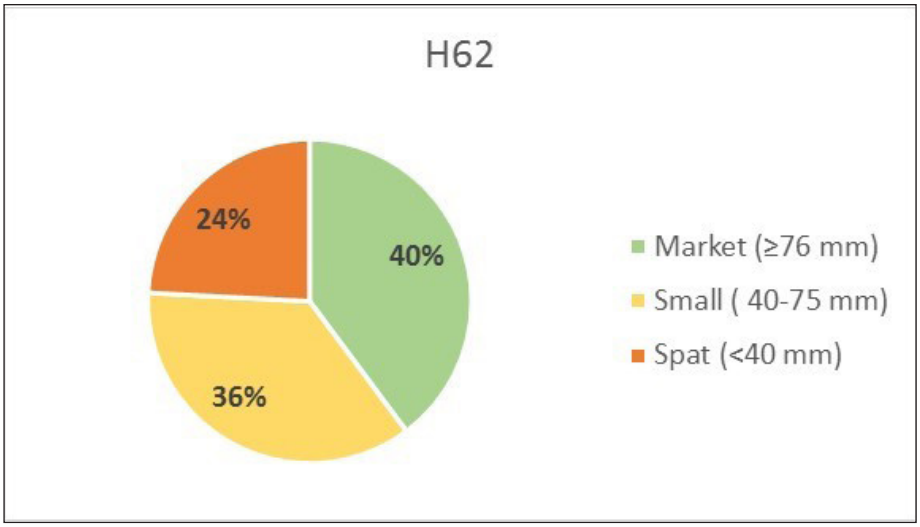
Reef H62 (AltSub_22A) Data and Analysis

		H62
Reef Information	Geodatabase Site_ID	AltSub_22A
	Bar name	Walnut
	Tributary	Harris
	Reef area (acres)	1.39
Restoration Treatment	Restoration treatment	Substrate & Seed
	Substrate type added	Stone base with mixed shell
	Average planned reef height* (inches)	12
	Year planted with spat	2014
	Spat produced by	CBF
	Spat planted by	CBF
	Spat planted (millions)	8.29
	Spat planted per acre (millions)	5.98
Monitoring Information	Monitoring type	2014 cohort
	Sample method	Diver
	Sample date	10/5/2017
	# samples taken	7
	# live oysters measured	447
	# live oysters counted	558
	# dead oysters counted	57
	% of oysters that were dead	0.09
	Sampled area (m^2)	5172.9
	Sampled acreage	1.28
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	159.43
	Standard error of live density (#/m^2)	29.37
	Reef area meeting minimum threshold density (m^2)	5172.9
	Reef area meeting minimum threshold density (%)	1
	Reef area meeting target density (m^2)	5172.9
	Reef area meeting target density (%)	1
	Average live density on stone (#/m^2)	10
	Standard error of live density on stone	5.71
	Average live density on shell (#/m^2)	138.2857143
	Standard error of live density on shell	33.47
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	11.14285714
	Standard error of live density on clam shell	5.40
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	5172.9
	Reef area meeting minimum threshold biomass (%)	1
	Fall 2017: Did reef meet target oyster biomass?	Yes
	Reef area meeting target biomass (m^2)	5172.9
	Reef area meeting target biomass (%)	1
	Average live biomass across reef (g dry weight/m^2)	109.57
	Standard error of live biomass	9.79
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	Yes
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	108.29
	Standard error of shell volume	42.65
	Total shell volume (liters)	560151.17
	Total surface shell volume (liters)	Null
	Average brown shell across all samples (%)	Null
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3	2.2

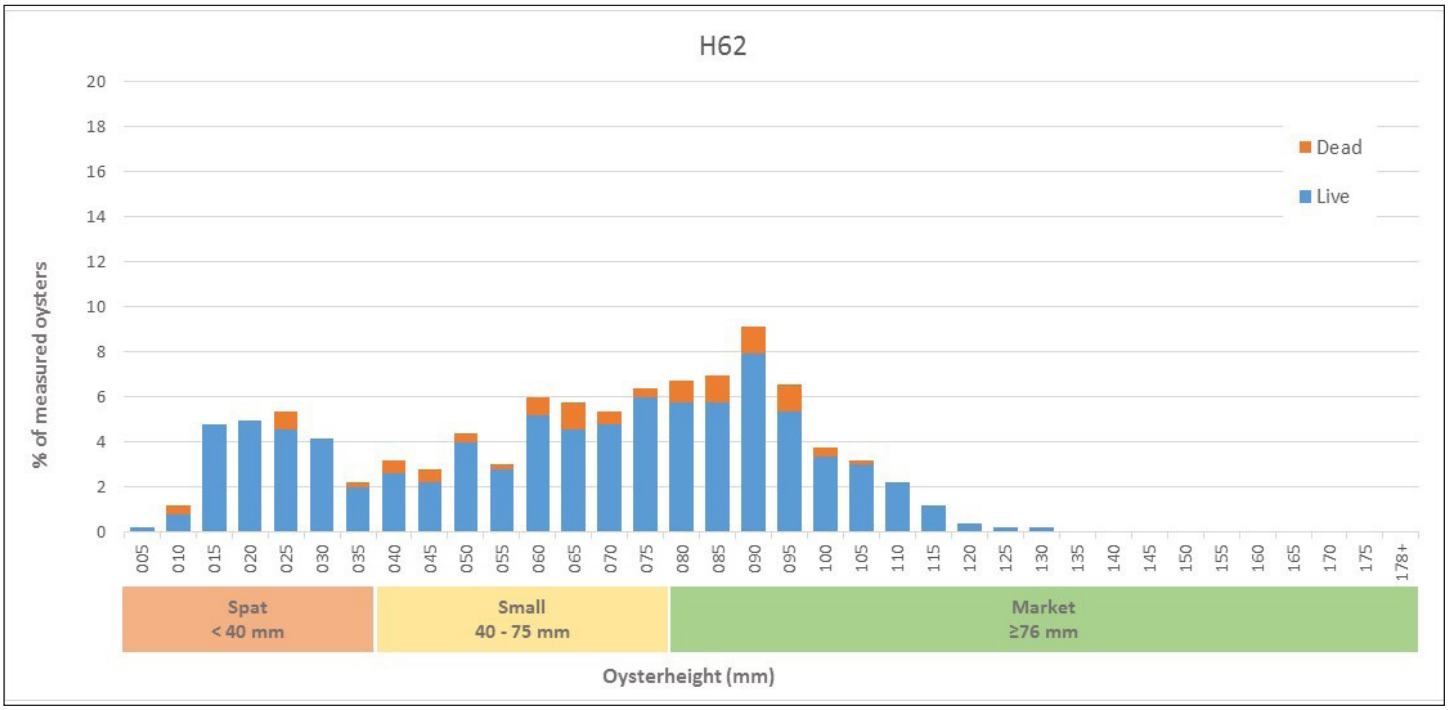
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef H62 (AltSub_22A) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



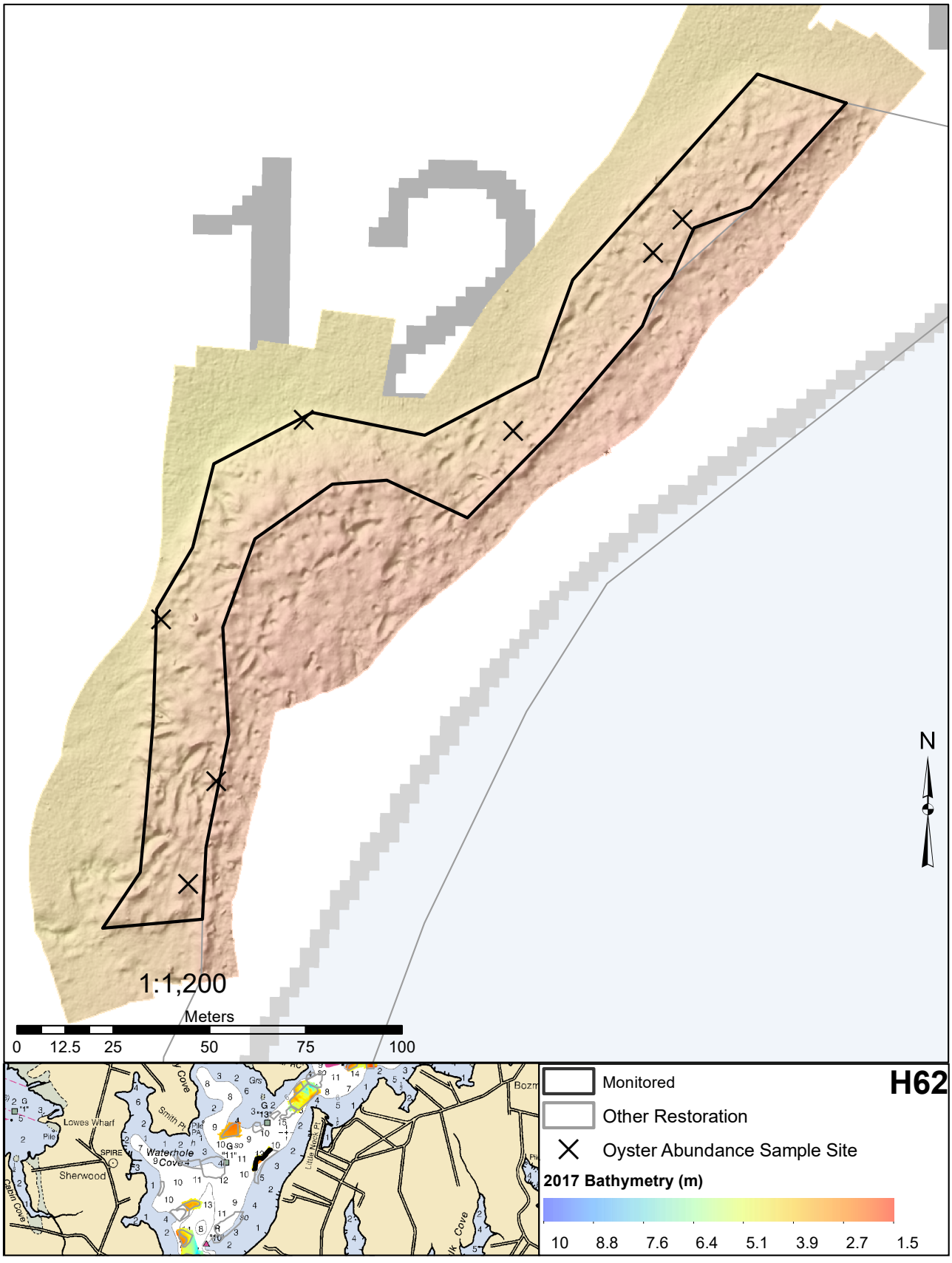
Shell Height of Oysters Measured on Reef



Reef H62 (AltSub_22A) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



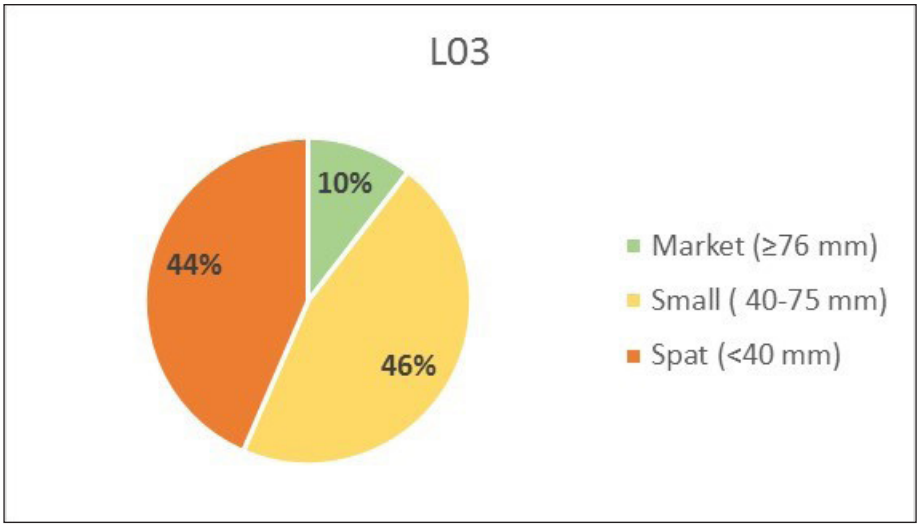
Reef L03 (SO_01) Data and Analysis

		L03
Reef Information	Geodatabase Site_ID	SO_01
	Bar name	N/A
	Tributary	Little Choptank
	Reef area (acres)	3.65
Restoration Treatment	Restoration treatment	Seed Only
	Substrate type added	Spat-on-shell only
	Average planned reef height* (inches)	<Null>
	Year planted with spat	2014
	Spat produced by	ORP
	Spat planted by	ORP
	Spat planted (millions)	20.93
	Spat planted per acre (millions)	5.74
Monitoring Information	Monitoring type	2014 cohort
	Sample method	Patent Tong
	Sample date	27-Nov-17
	# samples taken	9
	# live oysters measured	193
	# live oysters counted	615
	# dead oysters counted	67
	% of oysters that were dead	0.10
	Sampled area (m^2)	13080.17
	Sampled acreage	3.23
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	42.44
	Standard error of live density (#/m^2)	14.07
	Reef area meeting minimum threshold density (m^2)	7915.39
	Reef area meeting minimum threshold density (%)	0.605144276
	Reef area meeting target density (m^2)	5415.39
	Reef area meeting target density (%)	0.414015261
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	7915.394651
	Reef area meeting minimum threshold biomass (%)	0.605144631
	Fall 2017: Did reef meet target oyster biomass?	No
	Reef area meeting target biomass (m^2)	2911.746563
	Reef area meeting target biomass (%)	0.2226077
	Average live biomass across reef (g dry weight/m^2)	23.32
	Standard error of live biomass	7.54
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	No
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	5.95
	Standard error of shell volume	1.54
	Total shell volume (liters)	77767.89
	Total surface shell volume (liters)	14689.49
	Average brown shell across all samples (%)	81.11
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	TBD
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3	4

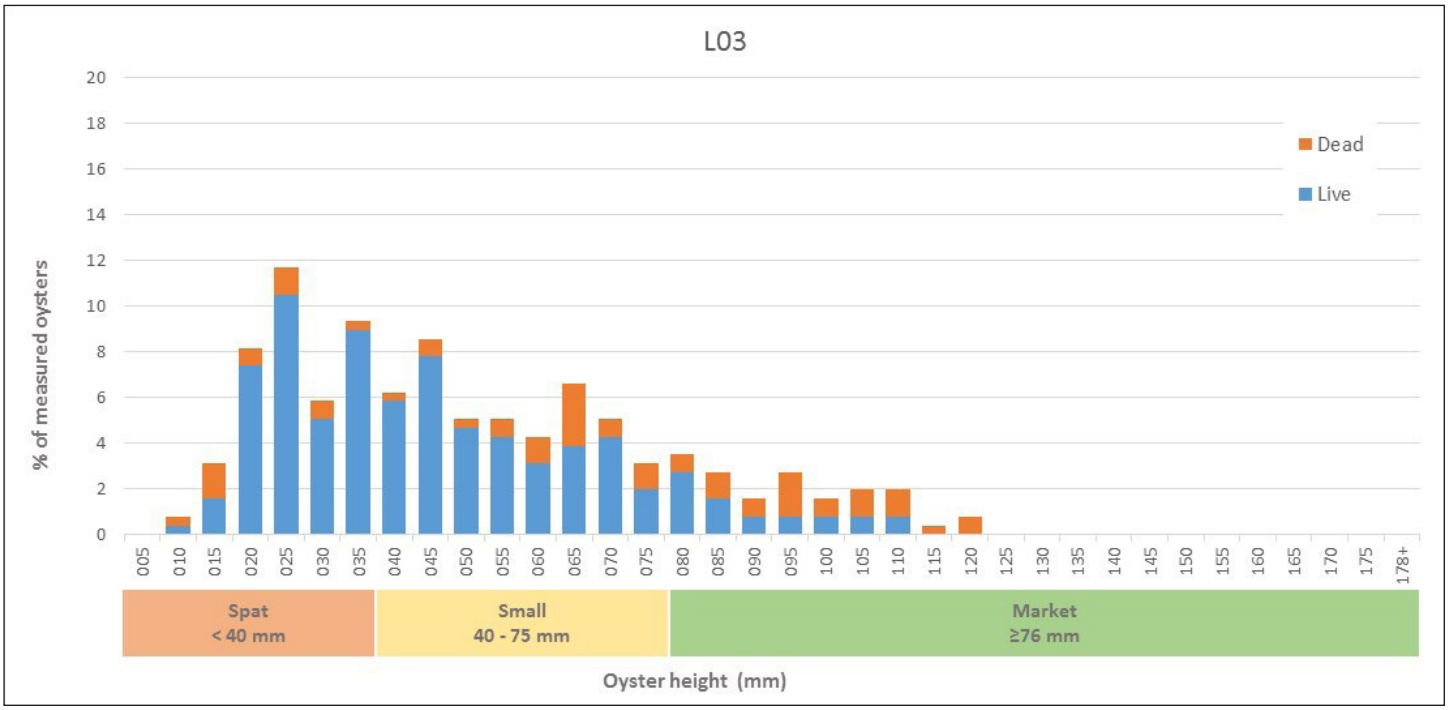
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef L03 (SO_01) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



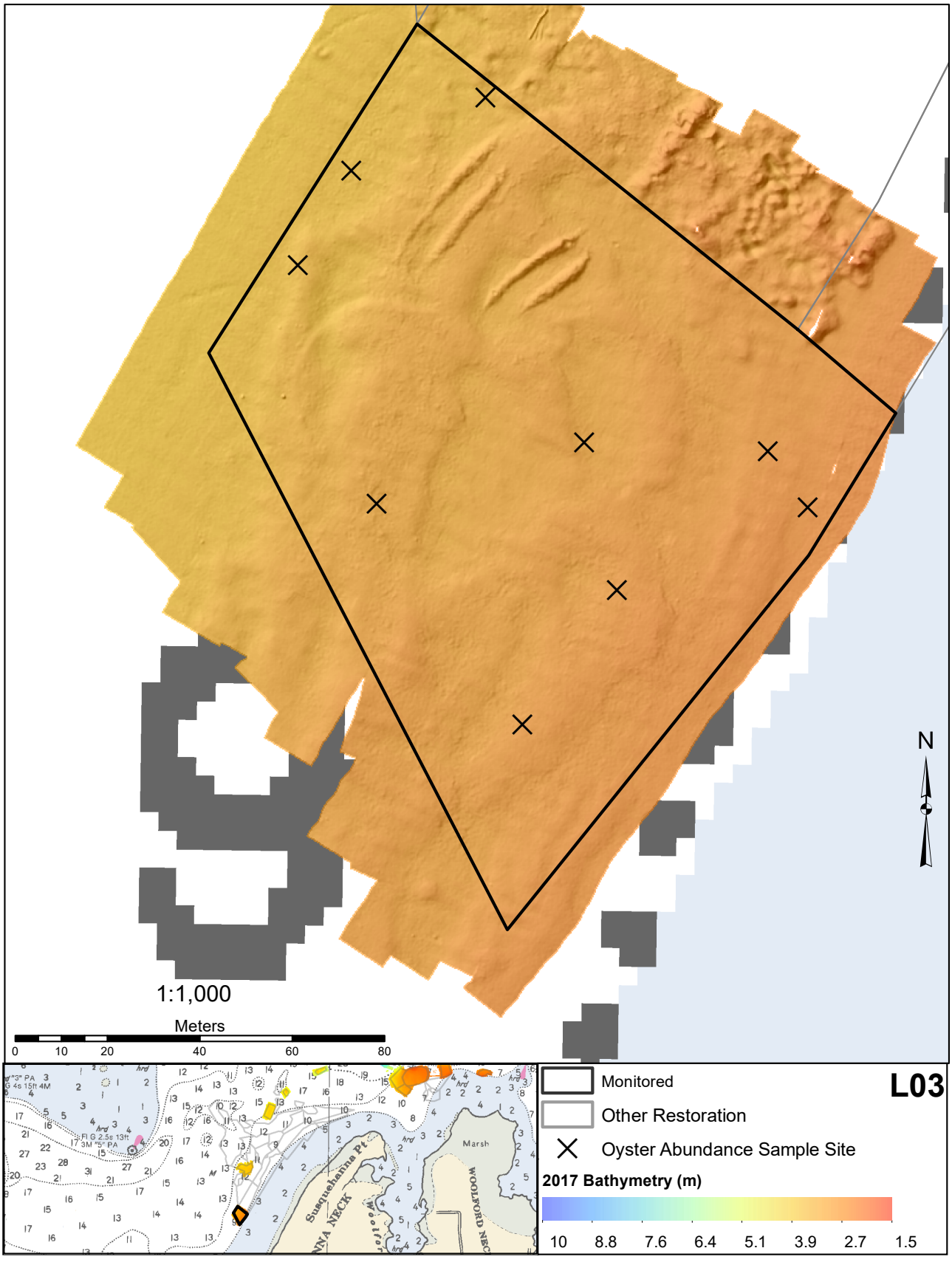
Shell Height of Oysters Measured on Reef



Reef L03 (SO_01) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



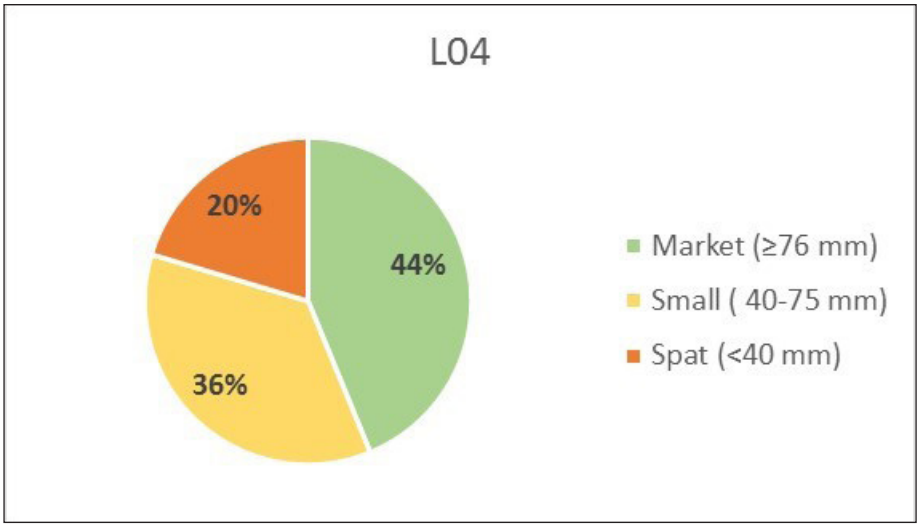
Reef L04 (SO_16A) Data and Analysis

		L04
Reef Information	Geodatabase Site_ID	SO_16A
	Bar name	Little Pollard
	Tributary	Little Choptank
	Reef area (acres)	6.16
Restoration Treatment	Restoration treatment	Seed Only
	Substrate type added	Spat-on-shell only
	Average planned reef height* (inches)	<Null>
	Year planted with spat	2014
	Spat produced by	ORP
	Spat planted by	ORP
	Spat planted (millions)	23.32
	Spat planted per acre (millions)	3.78
Monitoring Information	Monitoring type	2014 cohort
	Sample method	Patent Tong
	Sample date	28-Nov-17
	# samples taken	16
	# live oysters measured	402
	# live oysters counted	729
	# dead oysters counted	140
	% of oysters that were dead	0.16
	Sampled area (m^2)	24887.29
	Sampled acreage	6.15
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	No
	Average live density across reef (#/m^2)	28.3
	Standard error of live density (#/m^2)	9.38
	Reef area meeting minimum threshold density (m^2)	15831.37
	Reef area meeting minimum threshold density (%)	0.636122696
	Reef area meeting target density (m^2)	2016
	Reef area meeting target density (%)	0.081005204
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	12579.75858
	Reef area meeting minimum threshold biomass (%)	0.5054692
	Fall 2017: Did reef meet target oyster biomass?	No
	Reef area meeting target biomass (m^2)	4262.564328
	Reef area meeting target biomass (%)	0.171274748
	Average live biomass across reef (g dry weight/m^2)	31.03
	Standard error of live biomass	10.53
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	No
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	7.43
	Standard error of shell volume	1.92
	Total shell volume (liters)	185012.3
	Total surface shell volume (liters)	58146.72
	Average brown shell across all samples (%)	68.57
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	TBD
	Is reef height stable/increasing?	Yes
	Difference between postconstruction reef height and reef height 3	1

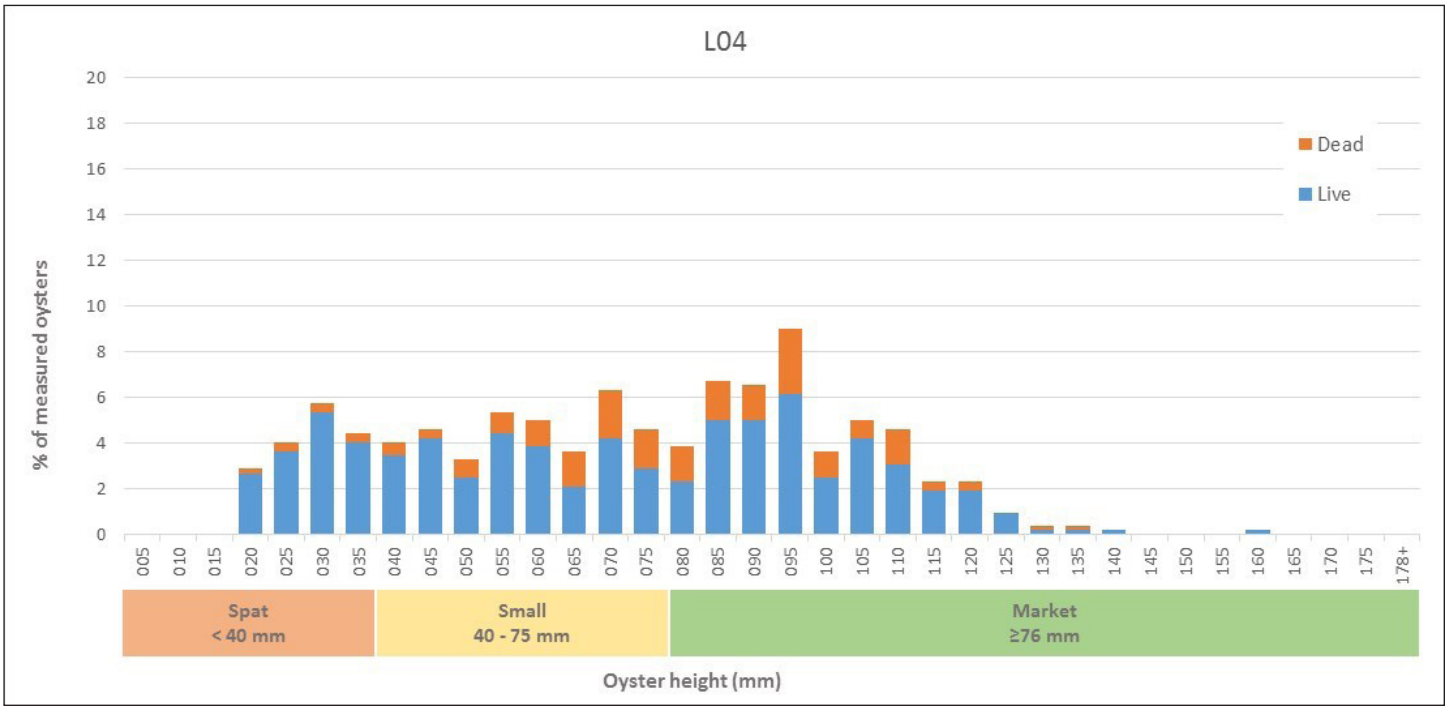
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef L04 (SO_16A) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



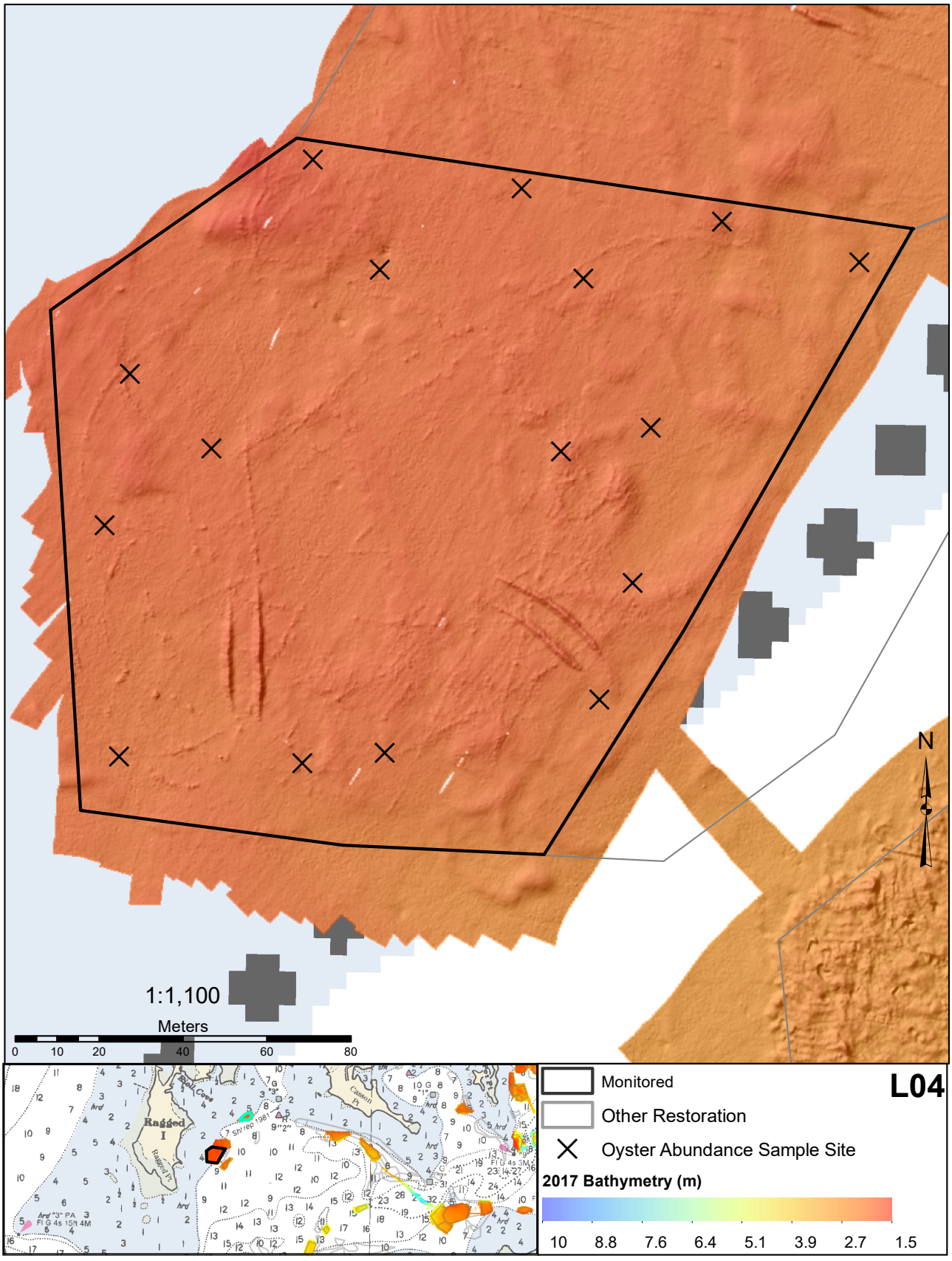
Shell Height of Oysters Measured on Reef



Reef L04 (SO_16A) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



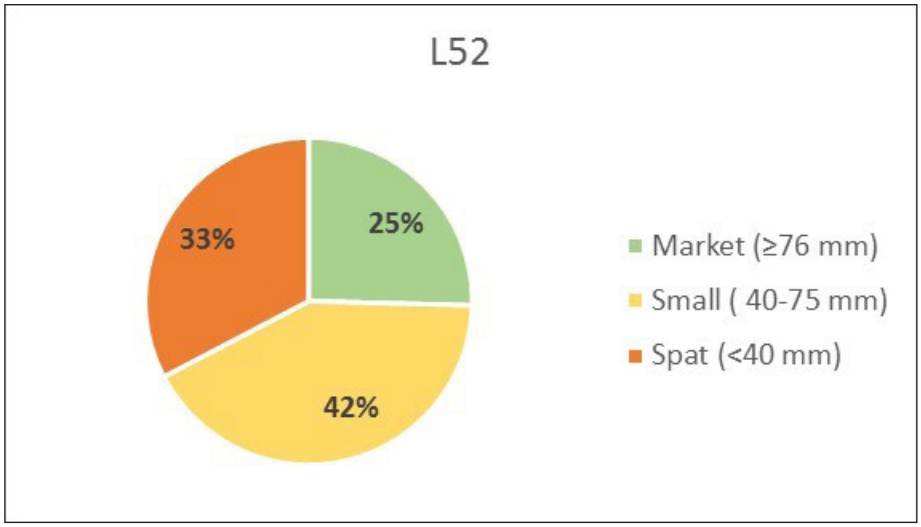
Reef L52 (CONT_SO_03) Data and Analysis

		L52
Reef Information	Geodatabase Site_ID	CONT_SO_03
	Bar name	Town
	Tributary	Little Choptank
	Reef area (acres)	2.32
Restoration Treatment	Restoration treatment	CONTROL - NOT ORES
	Substrate type added	None
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	reference
	Sample method	Patent Tong
	Sample date	29-Nov-17
	# samples taken	7
	# live oysters measured	514
	# live oysters counted	745
	# dead oysters counted	97
	% of oysters that were dead	0.12
	Sampled area (m^2)	9163.21
	Sampled acreage	2.26
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	66.1
	Standard error of live density (#/m^2)	11.24
	Reef area meeting minimum threshold density (m^2)	9163.21
	Reef area meeting minimum threshold density (%)	1
	Reef area meeting target density (m^2)	8398.16
	Reef area meeting target density (%)	0.916508516
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	9163.210797
	Reef area meeting minimum threshold biomass (%)	1.000000087
	Fall 2017: Did reef meet target oyster biomass?	Yes
	Reef area meeting target biomass (m^2)	5345.614293
	Reef area meeting target biomass (%)	0.583377909
	Average live biomass across reef (g dry weight/m^2)	47.98
	Standard error of live biomass	7.29
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	Yes
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	12.95
	Standard error of shell volume	2.23
	Total shell volume (liters)	118707.08
	Total surface shell volume (liters)	37307.94
	Average brown shell across all samples (%)	68.57
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	TBD
	Is reef height stable/increasing?	TBD
	Difference between postconstruction reef height and reef height 3	TBD

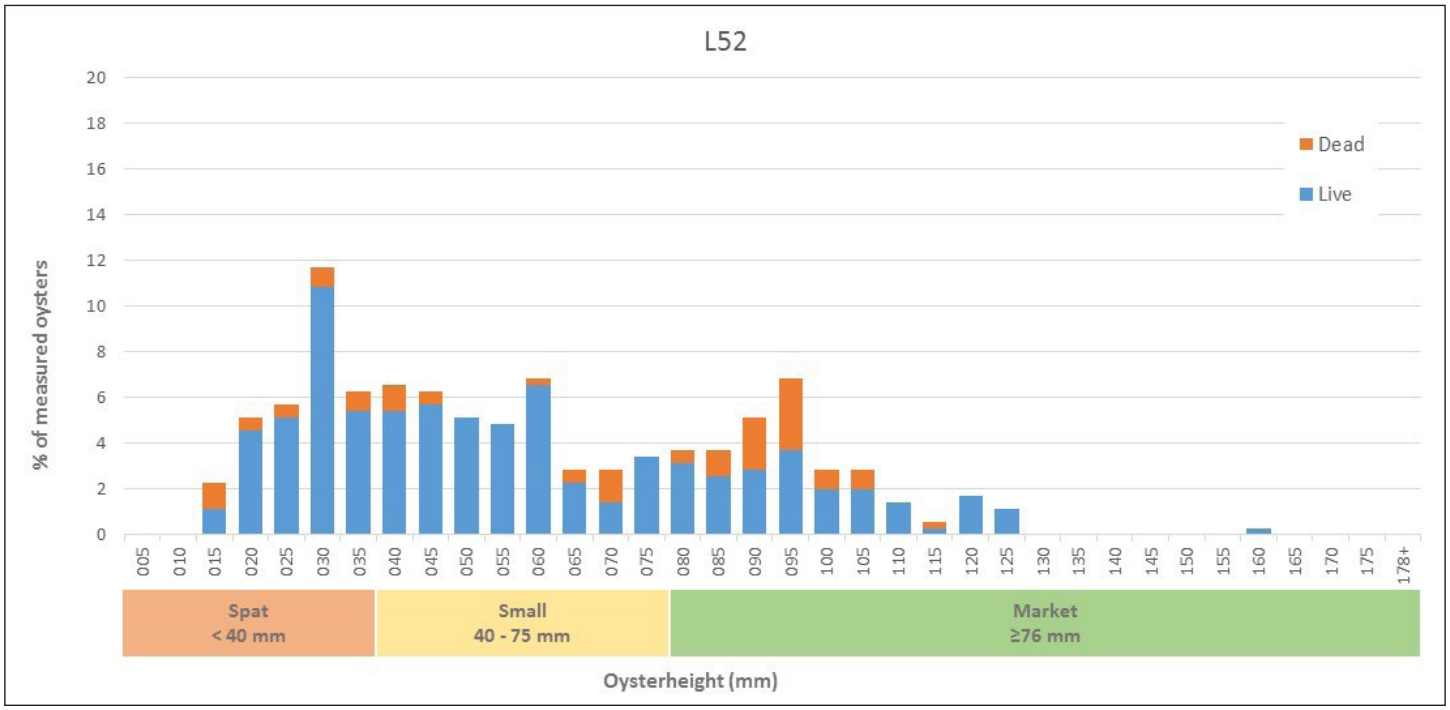
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef L52 (CONT_SO_03) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



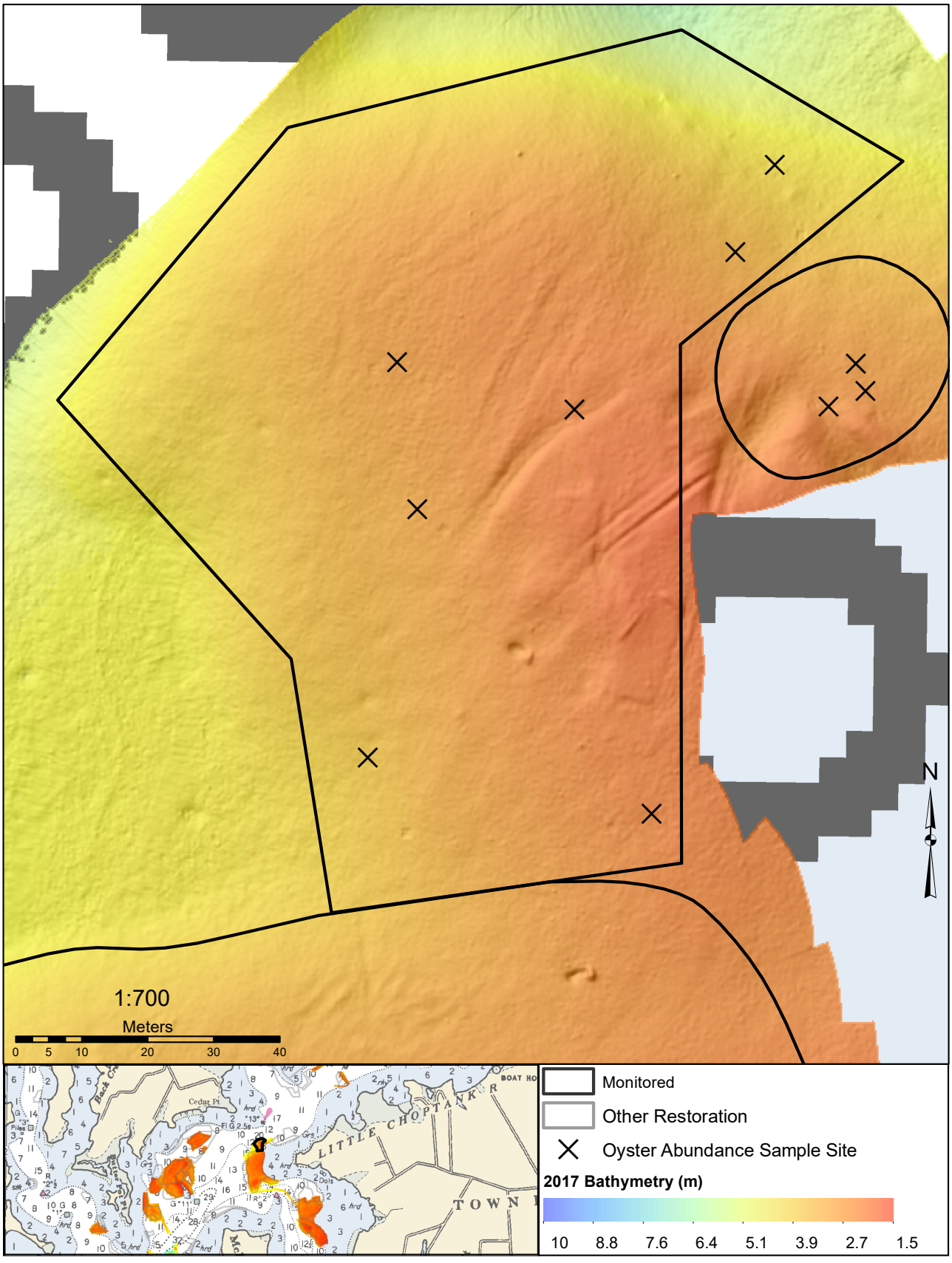
Shell Height of Oysters Measured on Reef



Reef L52 (CONT_SO_03) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



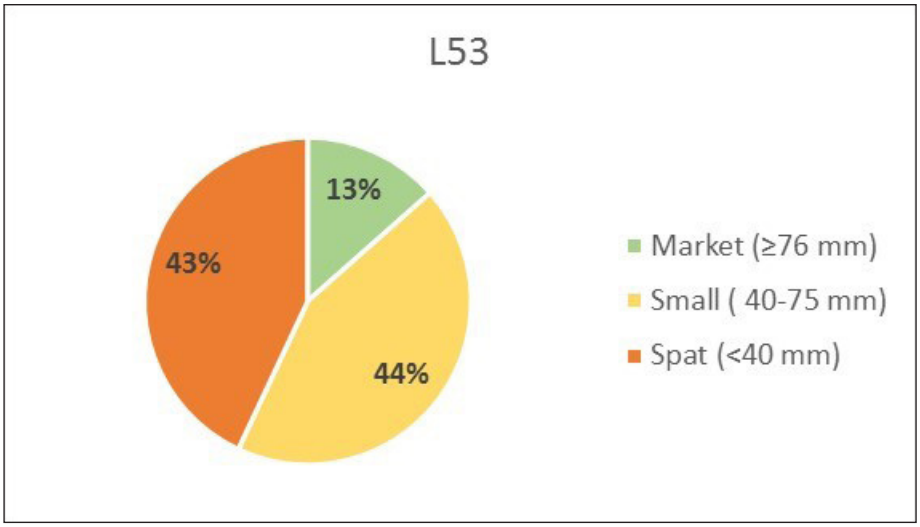
Reef L53 (CONT_SO_01) Data and Analysis

		L53
Reef Information	Geodatabase Site_ID	CONT_SO_01
	Bar name	Susquehanna
	Tributary	Little Choptank
	Reef area (acres)	2.94
Restoration Treatment	Restoration treatment	CONTROL - ORES
	Substrate type added	None
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	reference
	Sample method	Patent Tong
	Sample date	27-Nov-17
	# samples taken	7
	# live oysters measured	330
	# live oysters counted	383
	# dead oysters counted	40
	% of oysters that were dead	0.09
	Sampled area (m^2)	11400.1
	Sampled acreage	2.82
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	No
	Average live density across reef (#/m^2)	33.98
	Standard error of live density (#/m^2)	7.82
	Reef area meeting minimum threshold density (m^2)	10622.06
	Reef area meeting minimum threshold density (%)	0.931751476
	Reef area meeting target density (m^2)	477.06
	Reef area meeting target density (%)	0.041847001
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	8214.973211
	Reef area meeting minimum threshold biomass (%)	0.720605364
	Fall 2017: Did reef meet target oyster biomass?	No
	Reef area meeting target biomass (m^2)	0
	Reef area meeting target biomass (%)	0
	Average live biomass across reef (g dry weight/m^2)	20.45
	Standard error of live biomass	4.76
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	No
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	9.85
	Standard error of shell volume	1.78
	Total shell volume (liters)	112281.41
	Total surface shell volume (liters)	51328.65
	Average brown shell across all samples (%)	54.29
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	TBD
	Difference between postconstruction reef height and reef height 3	TBD

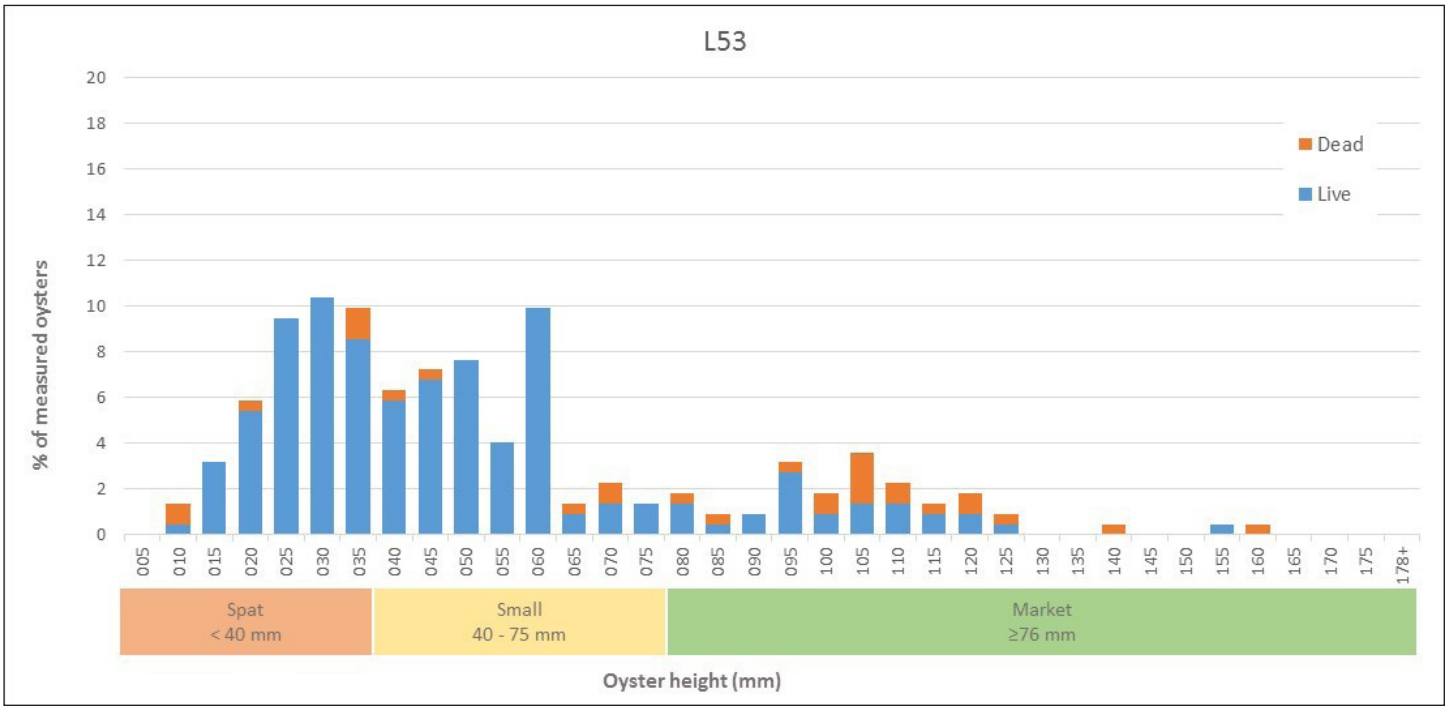
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef L53 (CONT_SO_01) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



Shell Height of Oysters Measured on Reef



Reef L53 (CONT_SO_01) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.

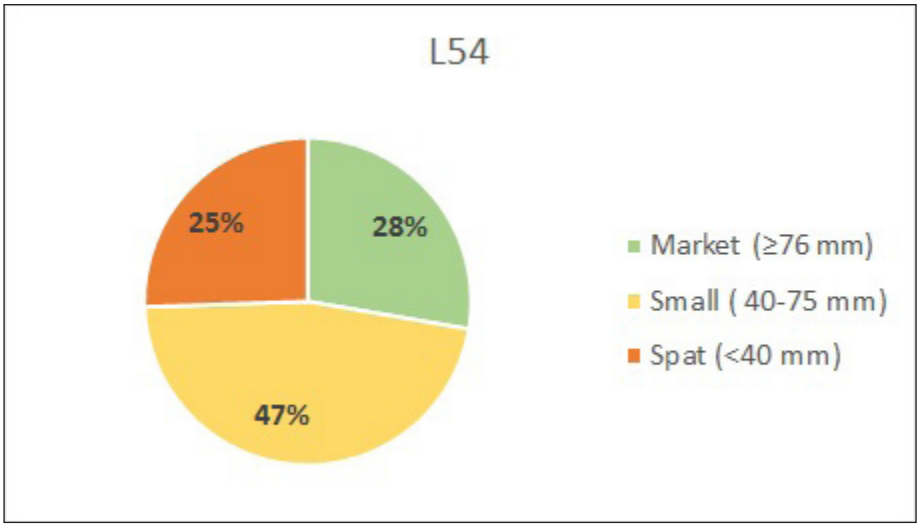
Reef L54 (CONT_SO_02) Data and Analysis

		L54
Reef Information	Geodatabase Site_ID	CONT_SO_02
	Bar name	Butterpot
	Tributary	Little Choptank
	Reef area (acres)	2.50
Restoration Treatment	Restoration treatment	CONTROL - ORES
	Substrate type added	None
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	reference
	Sample method	Patent Tong
	Sample date	28-Nov-17
	# samples taken	8
	# live oysters measured	384
	# live oysters counted	730
	# dead oysters counted	115
	% of oysters that were dead	0.14
	Sampled area (m^2)	9957.19
	Sampled acreage	2.46
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	56.68
	Standard error of live density (#/m^2)	11.93
	Reef area meeting minimum threshold density (m^2)	9957.19
	Reef area meeting minimum threshold density (%)	1
	Reef area meeting target density (m^2)	8394.66
	Reef area meeting target density (%)	0.843075205
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	9957.190546
	Reef area meeting minimum threshold biomass (%)	1.000000055
	Fall 2017: Did reef meet target oyster biomass?	Yes
	Reef area meeting target biomass (m^2)	8394.659694
	Reef area meeting target biomass (%)	0.843075174
	Average live biomass across reef (g dry weight/m^2)	54.26
	Standard error of live biomass	11.52
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	Yes
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	15.92
	Standard error of shell volume	1.94
	Total shell volume (liters)	158480.13
	Total surface shell volume (liters)	50515.54
	Average brown shell across all samples (%)	68.12
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	Yes
	Is reef height stable/increasing?	TBD
	Difference between postconstruction reef height and reef height 3 years postrestoration (cm)	TBD

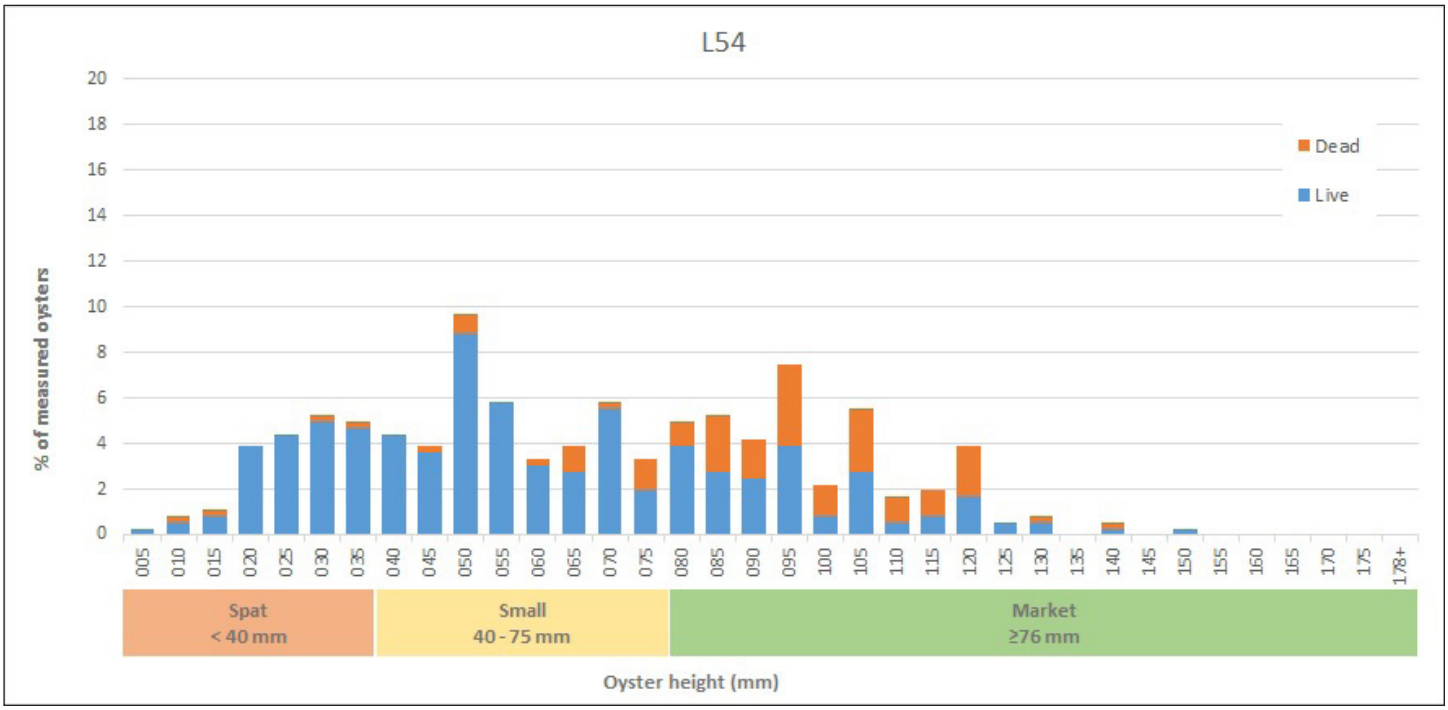
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef L54 (CONT_SO_02) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



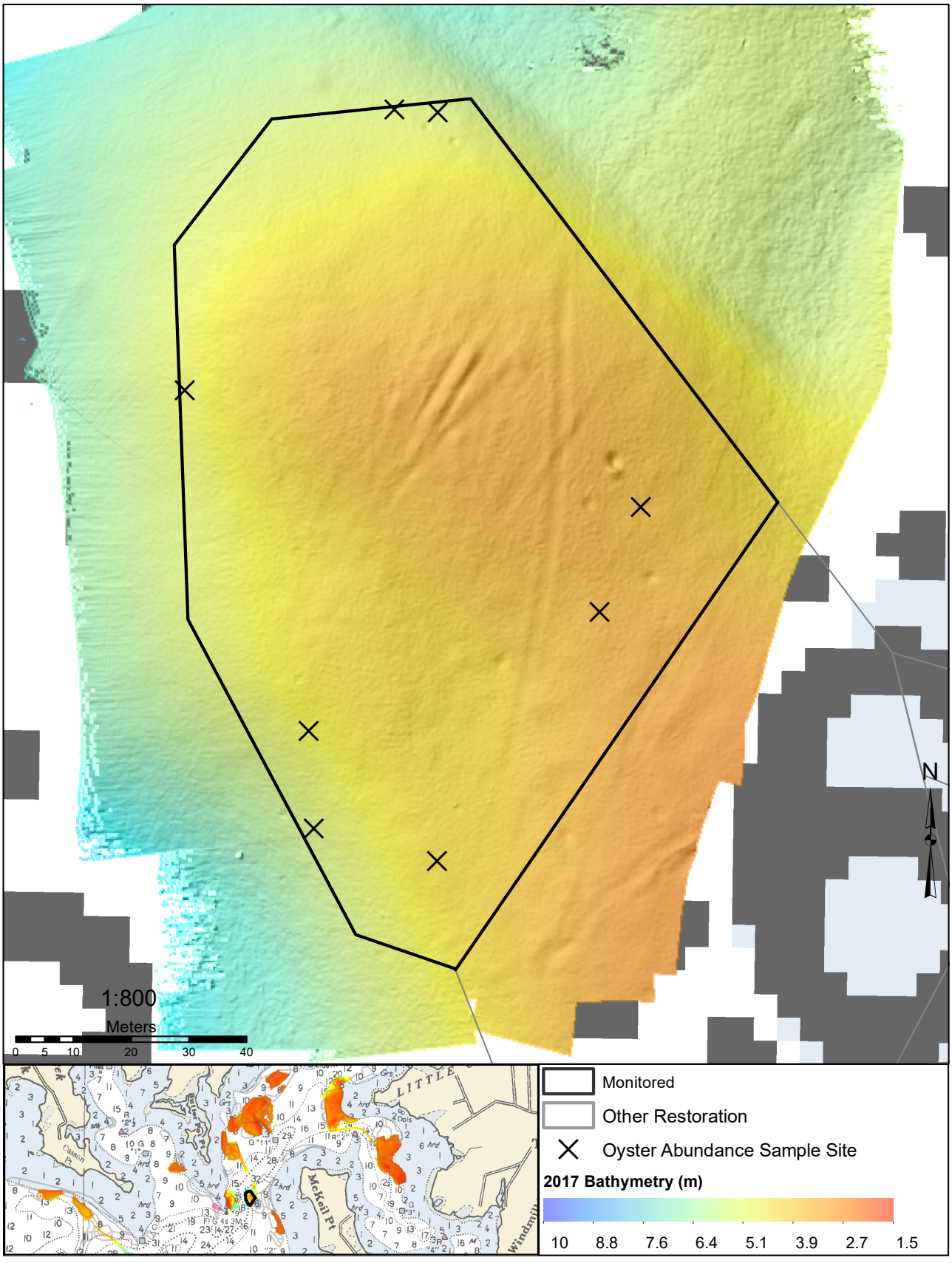
Shell Height of Oysters Measured on Reef



Reef L54 (CONT_SO_02) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



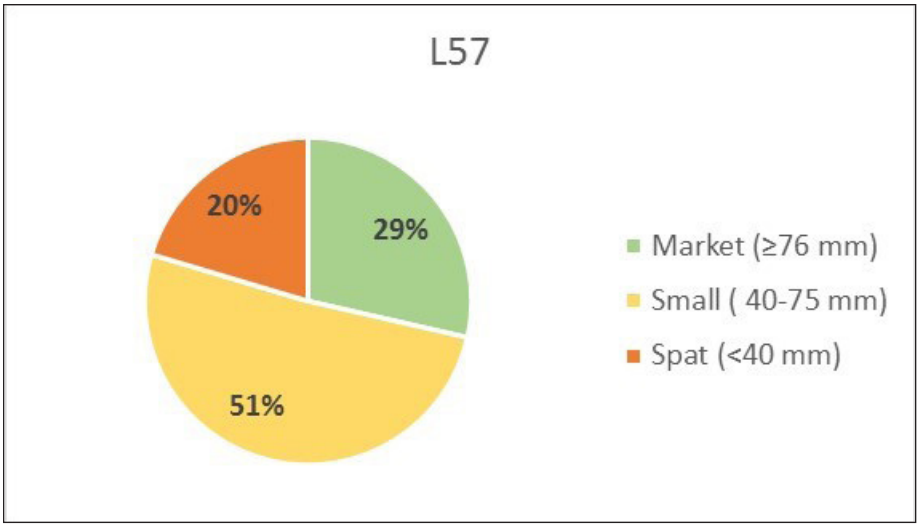
Reef L57 (EXCEDES_GOAL_2012_2014_01) Data and Analysis

		L57
Reef Information	Geodatabase Site_ID	EXCEDES_GOAL_2012_2014_01
	Bar name	N/A
	Tributary	Little Choptank
	Reef area (acres)	0.33
Restoration Treatment	Restoration treatment	None
	Substrate type added	None
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	exceeds goal (baseline)
	Sample method	Patent Tong
	Sample date	29-Nov-17
	# samples taken	6
	# live oysters measured	96
	# live oysters counted	49
	# dead oysters counted	15
	% of oysters that were dead	0.23
	Sampled area (m^2)	883.48
	Sampled acreage	0.22
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	No
	Fall 2017: Did reef meet target density?	No
	Average live density across reef (#/m^2)	5.07
	Standard error of live density (#/m^2)	2.54
	Reef area meeting minimum threshold density (m^2)	156.25
	Reef area meeting minimum threshold density (%)	0.176857427
	Reef area meeting target density (m^2)	0
	Reef area meeting target density (%)	0
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	No
	Reef area meeting minimum threshold biomass (m^2)	156.25
	Reef area meeting minimum threshold biomass (%)	0.176857427
	Fall 2017: Did reef meet target oyster biomass?	No
	Reef area meeting target biomass (m^2)	0
	Reef area meeting target biomass (%)	0
	Average live biomass across reef (g dry weight/m^2)	5.89
	Standard error of live biomass	2.3
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	No
	Did reef meet BOTH target density and biomass?	No
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	4.17
	Standard error of shell volume	1.48
	Total shell volume (liters)	3681.16
	Total surface shell volume (liters)	3386.67
	Average brown shell across all samples (%)	8
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	TBD
	Is reef height stable/increasing?	TBD
	Difference between postconstruction reef height and reef height 3	TBD

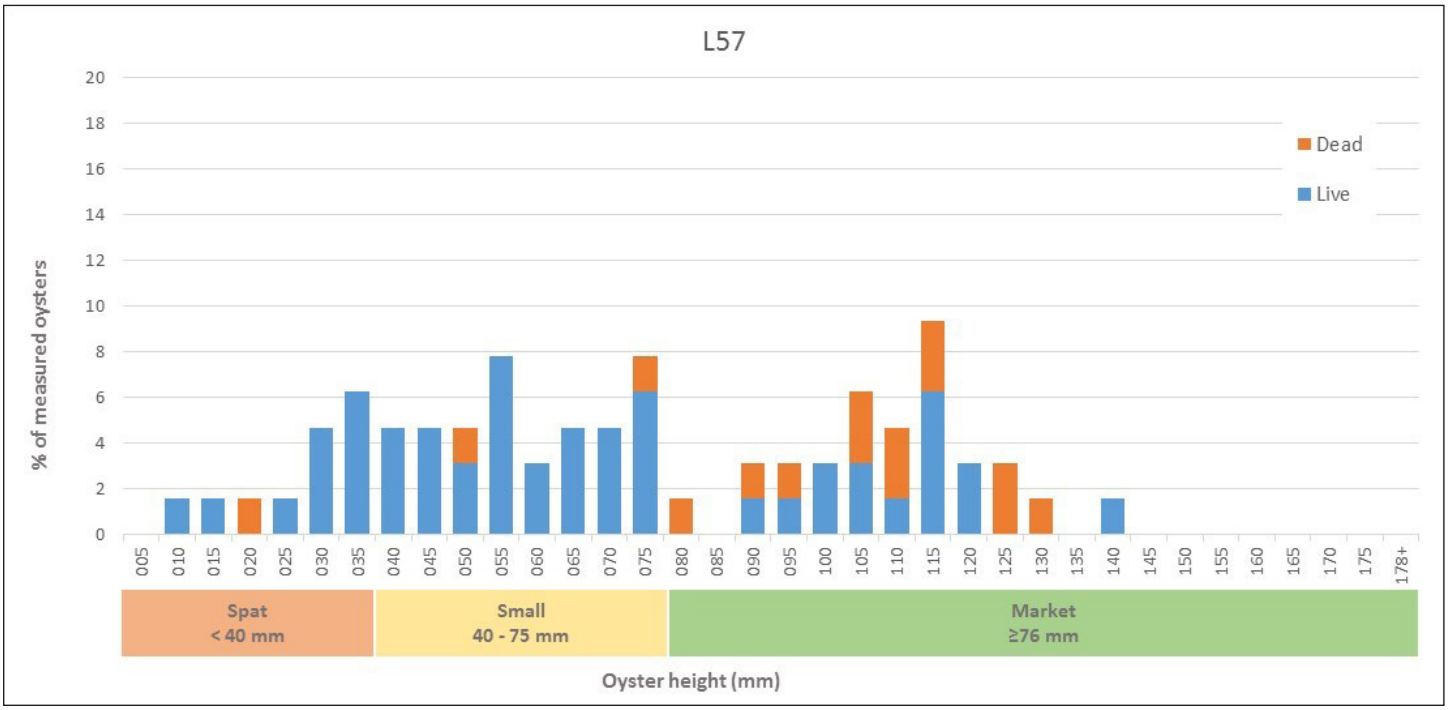
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef L57 (EXCEDES_GOAL_2012_2014_01) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



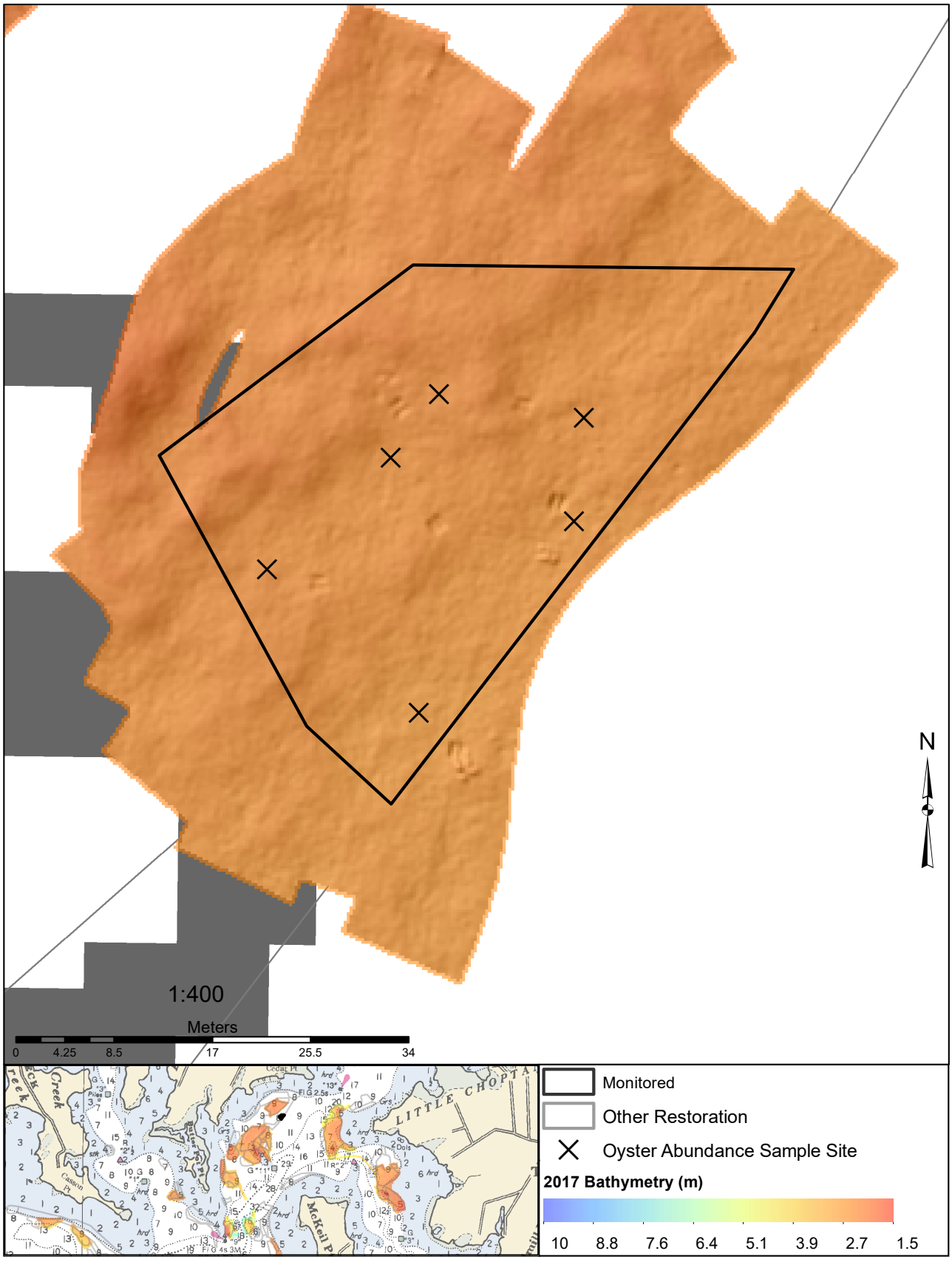
Shell Height of Oysters Measured on Reef



Reef L57 (EXCEDES_GOAL_2012_2014_01) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



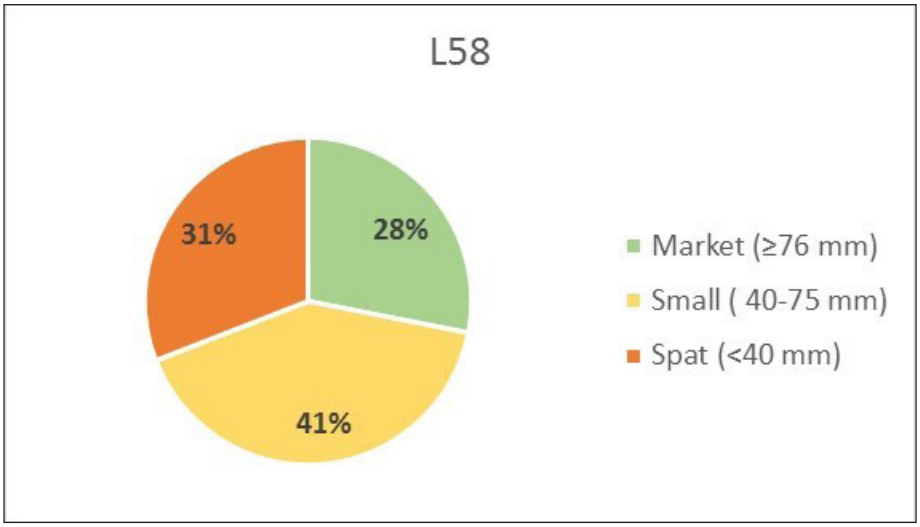
Reef L58 (EXCEDES_GOAL_2012_2014_02) Data and Analysis

		L58
Reef Information	Geodatabase Site_ID	EXCEDES_GOAL_2012_2014_02
	Bar name	Town
	Tributary	Little Choptank
	Reef area (acres)	16.21
Restoration Treatment	Restoration treatment	None
	Substrate type added	None
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	exceeds goal (baseline)
	Sample method	Patent Tong
	Sample date	30-Nov-17
	# samples taken	13
	# live oysters measured	419
	# live oysters counted	928
	# dead oysters counted	118
	% of oysters that were dead	0.11
	Sampled area (m^2)	65600.42
	Sampled acreage	16.21
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	No
	Average live density across reef (#/m^2)	44.34
	Standard error of live density (#/m^2)	12.13
	Reef area meeting minimum threshold density (m^2)	53798.58
	Reef area meeting minimum threshold density (%)	0.820095054
	Reef area meeting target density (m^2)	18100.63
	Reef area meeting target density (%)	0.275922471
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	43842.4819
	Reef area meeting minimum threshold biomass (%)	0.668326238
	Fall 2017: Did reef meet target oyster biomass?	No
	Reef area meeting target biomass (m^2)	5579.767004
	Reef area meeting target biomass (%)	0.085056879
	Average live biomass across reef (g dry weight/m^2)	34.16
	Standard error of live biomass	8.37
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	No
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	8.6
	Standard error of shell volume	1.59
	Total shell volume (liters)	564169.88
	Total surface shell volume (liters)	179508.6
	Average brown shell across all samples (%)	68.18
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	TBD
	Is reef height stable/increasing?	TBD
	Difference between postconstruction reef height and reef height 3	TBD

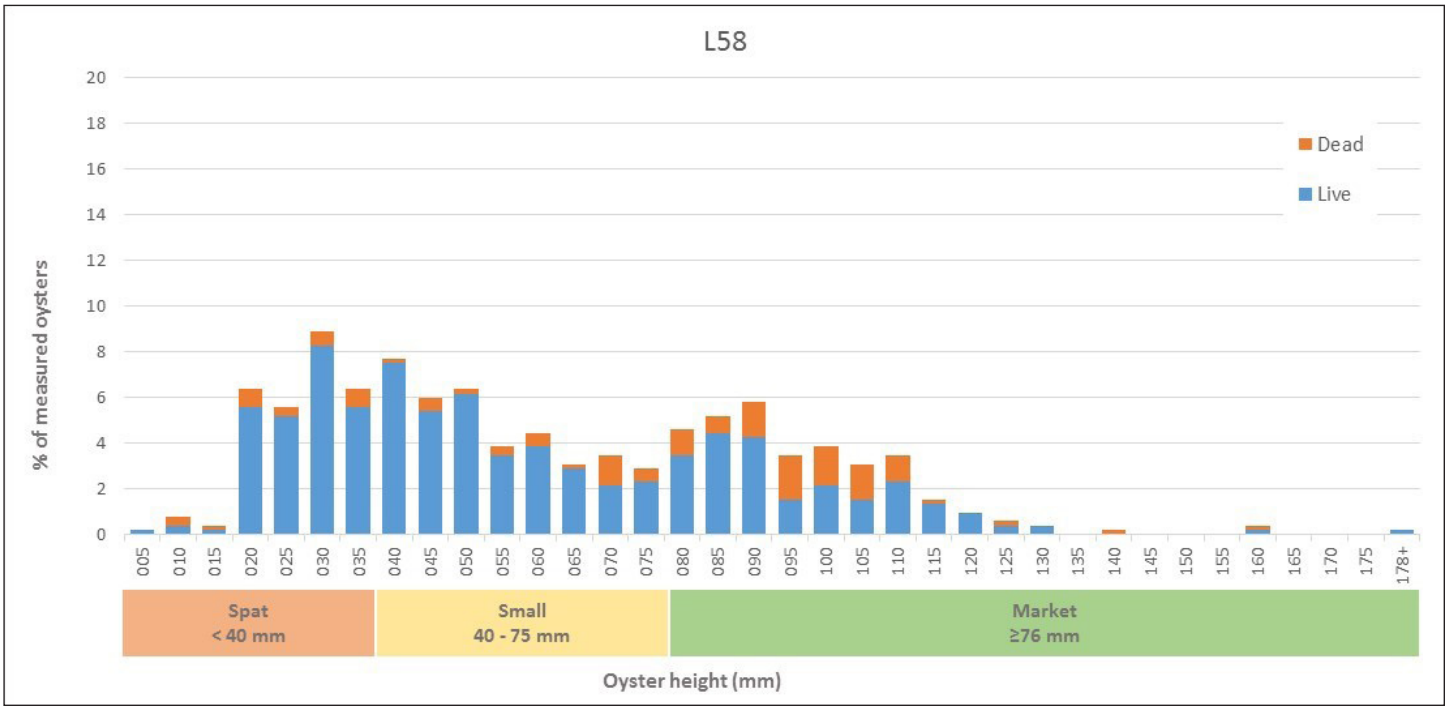
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef L58 (EXCEDES_GOAL_2012_2014_02) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



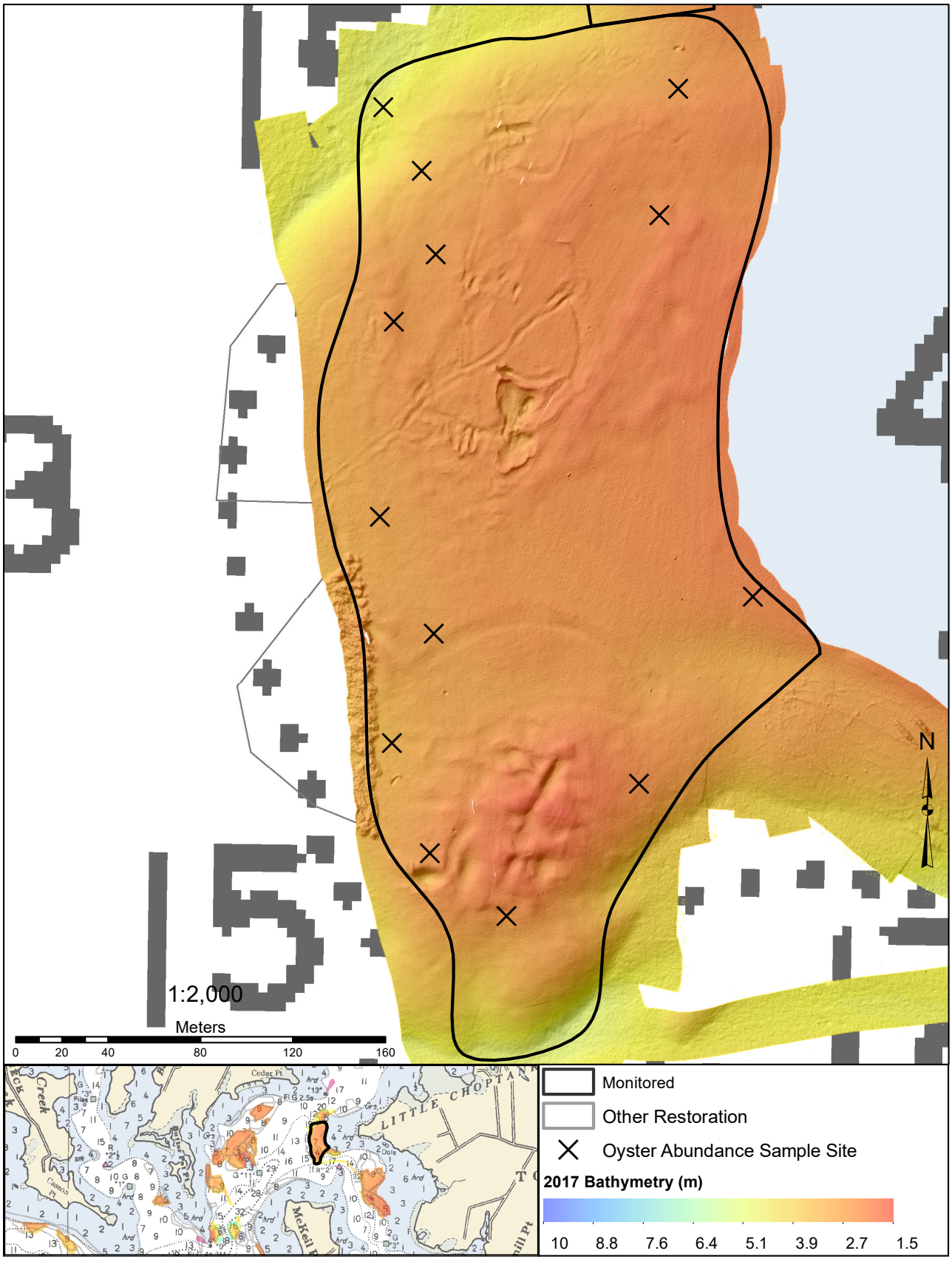
Shell Height of Oysters Measured on Reef



Reef L58 (EXCEDES_GOAL_2012_2014_02) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



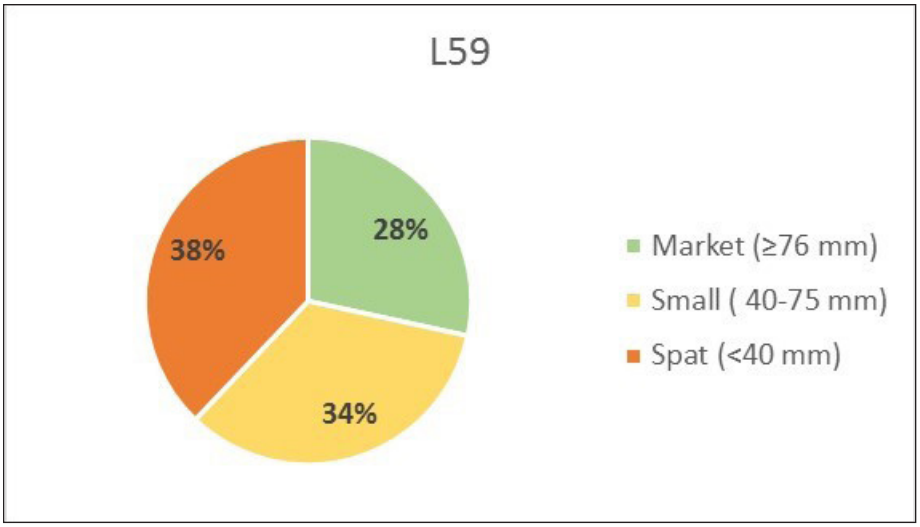
Reef L59 (EXCEDES_GOAL_2012_2014_03) Data and Analysis

		L59
Reef Information	Geodatabase Site_ID	EXCEDES_GOAL_2012_2014_03
	Bar name	Tobacco Stick
	Tributary	Little Choptank
	Reef area (acres)	1.72
Restoration Treatment	Restoration treatment	None
	Substrate type added	None
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	exceeds goal (baseline)
	Sample method	Patent Tong
	Sample date	27-Nov-17
	# samples taken	6
	# live oysters measured	365
	# live oysters counted	333
	# dead oysters counted	63
	% of oysters that were dead	0.16
	Sampled area (m^2)	6919
	Sampled acreage	1.71
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	34.47
	Standard error of live density (#/m^2)	10.52
	Reef area meeting minimum threshold density (m^2)	5949.33
	Reef area meeting minimum threshold density (%)	0.859854025
	Reef area meeting target density (m^2)	3829.97
	Reef area meeting target density (%)	0.553543865
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	5949.329872
	Reef area meeting minimum threshold biomass (%)	0.859854007
	Fall 2017: Did reef meet target oyster biomass?	Yes
	Reef area meeting target biomass (m^2)	3829.967507
	Reef area meeting target biomass (%)	0.553543504
	Average live biomass across reef (g dry weight/m^2)	29.40
	Standard error of live biomass	7.82
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	Yes
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	10.3
	Standard error of shell volume	1.44
	Total shell volume (liters)	71267.16
	Total surface shell volume (liters)	36821.36
	Average brown shell across all samples (%)	48.33
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	TBD
	Is reef height stable/increasing?	TBD
	Difference between postconstruction reef height and reef height 3	TBD

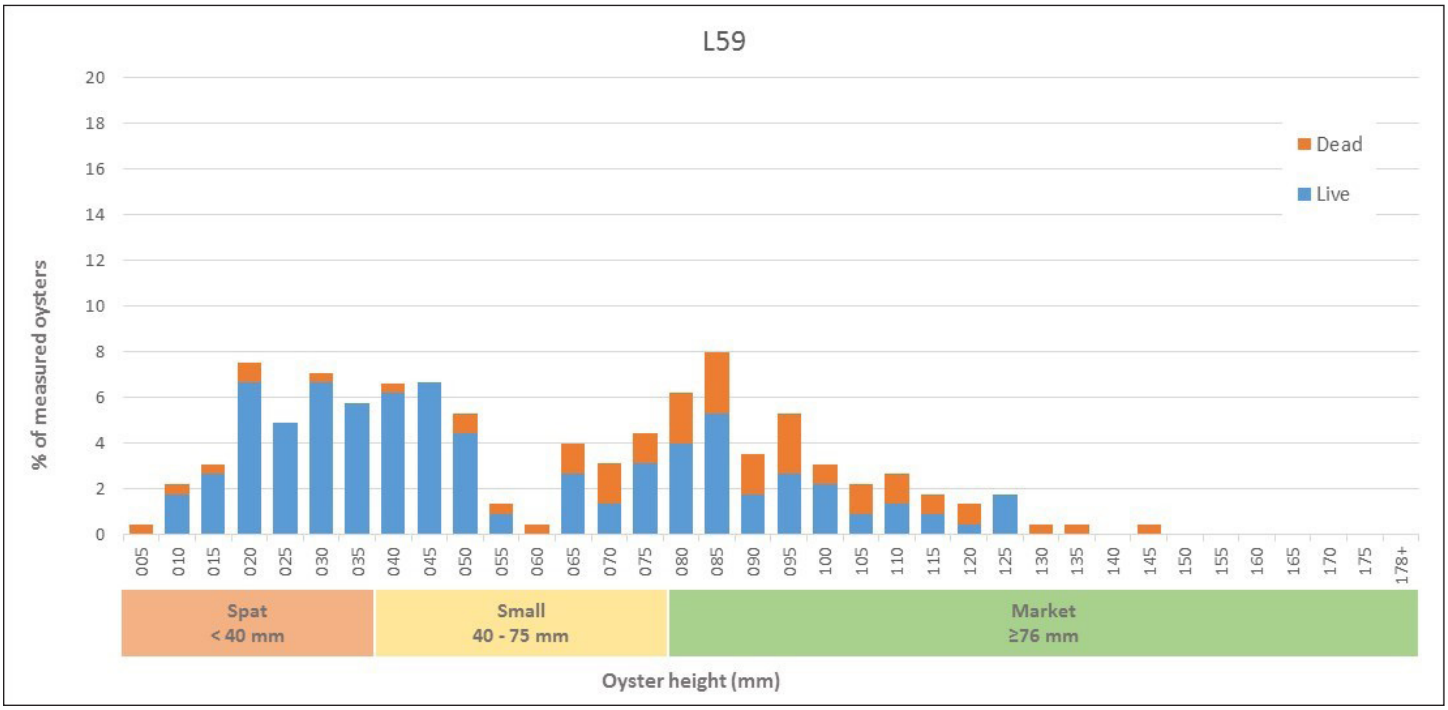
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef L59 (EXCEDES_GOAL_2012_2014_03) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



Shell Height of Oysters Measured on Reef



Reef L59 (EXCEDES_GOAL_2012_2014_03) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.

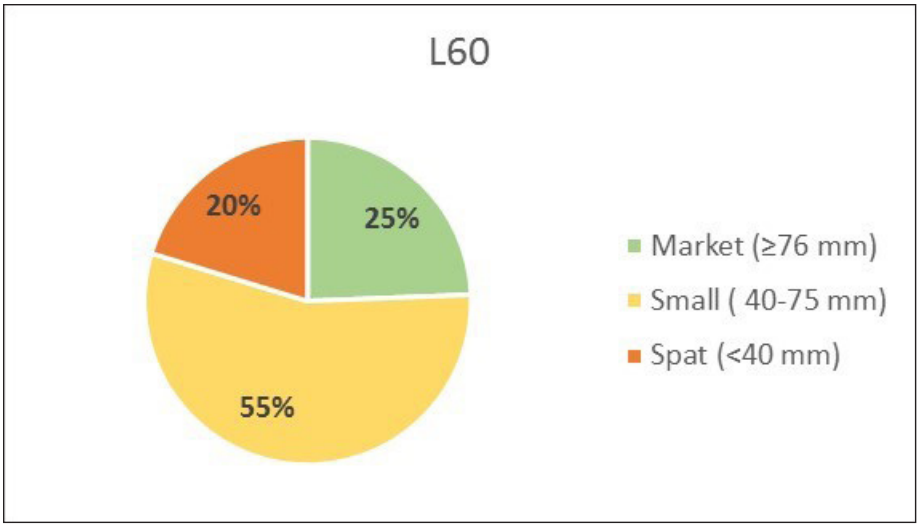
Reef L60 (EXCEDES_GOAL_2012_2014_04) Data and Analysis

		L60
Reef Information	Geodatabase Site_ID	EXCEDES_GOAL_2012_2014_04
	Bar name	McKeils Point
	Tributary	Little Choptank
	Reef area (acres)	3.35
Restoration Treatment	Restoration treatment	None
	Substrate type added	None
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	exceeds goal (baseline)
	Sample method	Patent Tong
	Sample date	29-Nov-17
	# samples taken	10
	# live oysters measured	407
	# live oysters counted	510
	# dead oysters counted	57
	% of oysters that were dead	0.10
	Sampled area (m^2)	13433.94
	Sampled acreage	3.32
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	No
	Average live density across reef (#/m^2)	31.68
	Standard error of live density (#/m^2)	5.12
	Reef area meeting minimum threshold density (m^2)	10502.69
	Reef area meeting minimum threshold density (%)	0.781802658
	Reef area meeting target density (m^2)	1918.81
	Reef area meeting target density (%)	0.142833004
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	9385.749114
	Reef area meeting minimum threshold biomass (%)	0.698659449
	Fall 2017: Did reef meet target oyster biomass?	No
	Reef area meeting target biomass (m^2)	0
	Reef area meeting target biomass (%)	0
	Average live biomass across reef (g dry weight/m^2)	22.77
	Standard error of live biomass	3.22
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	No
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	8.88
	Standard error of shell volume	1.15
	Total shell volume (liters)	119320.07
	Total surface shell volume (liters)	62643.04
	Average brown shell across all samples (%)	47.5
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	TBD
	Is reef height stable/increasing?	TBD
	Difference between postconstruction reef height and reef height 3	TBD

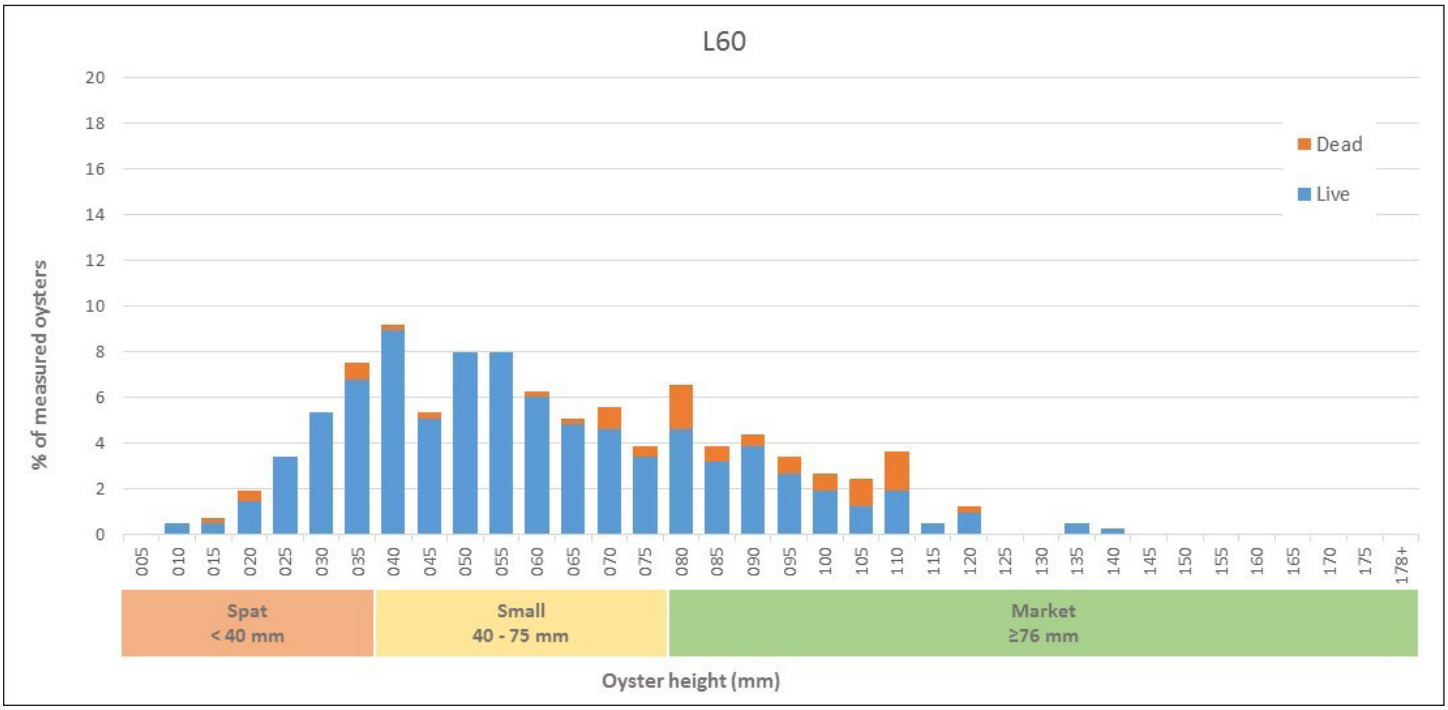
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef L60 (EXCEDES_GOAL_2012_2014_04) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



Shell Height of Oysters Measured on Reef



Reef L60 (EXCEDES_GOAL_2012_2014_04) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.

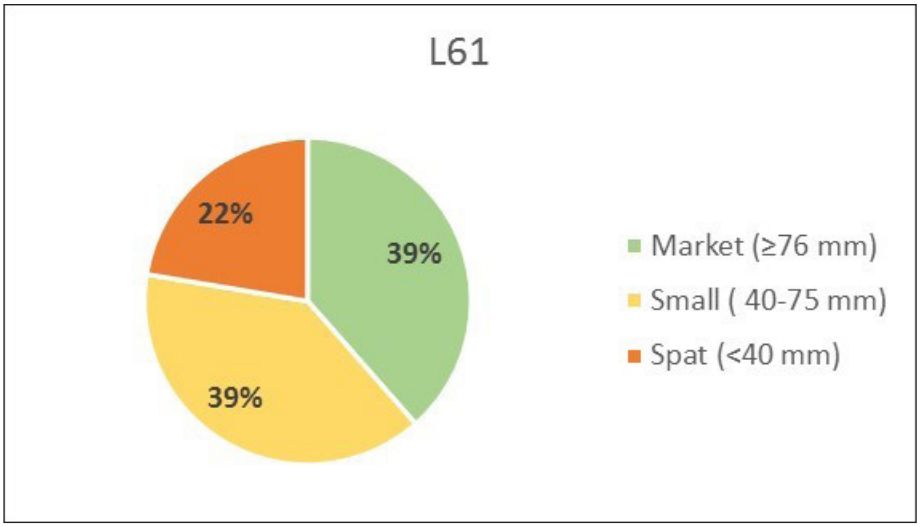
Reef L61 (EXCEDES_GOAL_2012_2014_06) Data and Analysis

		L61
Reef Information	Geodatabase Site_ID	EXCEDES_GOAL_2012_2014_06
	Bar name	McKeils Point
	Tributary	Little Choptank
	Reef area (acres)	1.45
Restoration Treatment	Restoration treatment	None
	Substrate type added	None
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	exceeds goal (baseline)
	Sample method	Patent Tong
	Sample date	29-Nov-17
	# samples taken	5
	# live oysters measured	88
	# live oysters counted	300
	# dead oysters counted	26
	% of oysters that were dead	0.08
	Sampled area (m^2)	5397.62
	Sampled acreage	1.33
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	No
	Average live density across reef (#/m^2)	37.27
	Standard error of live density (#/m^2)	11.09
	Reef area meeting minimum threshold density (m^2)	4992.41
	Reef area meeting minimum threshold density (%)	0.924928024
	Reef area meeting target density (m^2)	1387.47
	Reef area meeting target density (%)	0.257052182
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	4992.410634
	Reef area meeting minimum threshold biomass (%)	0.924928141
	Fall 2017: Did reef meet target oyster biomass?	No
	Reef area meeting target biomass (m^2)	1387.473752
	Reef area meeting target biomass (%)	0.257052877
	Average live biomass across reef (g dry weight/m^2)	32.44
	Standard error of live biomass	8.69
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	No
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	9.63
	Standard error of shell volume	1.42
	Total shell volume (liters)	51964.71
	Total surface shell volume (liters)	29100.24
	Average brown shell across all samples (%)	44
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	TBD
	Is reef height stable/increasing?	TBD
	Difference between postconstruction reef height and reef height 3	TBD

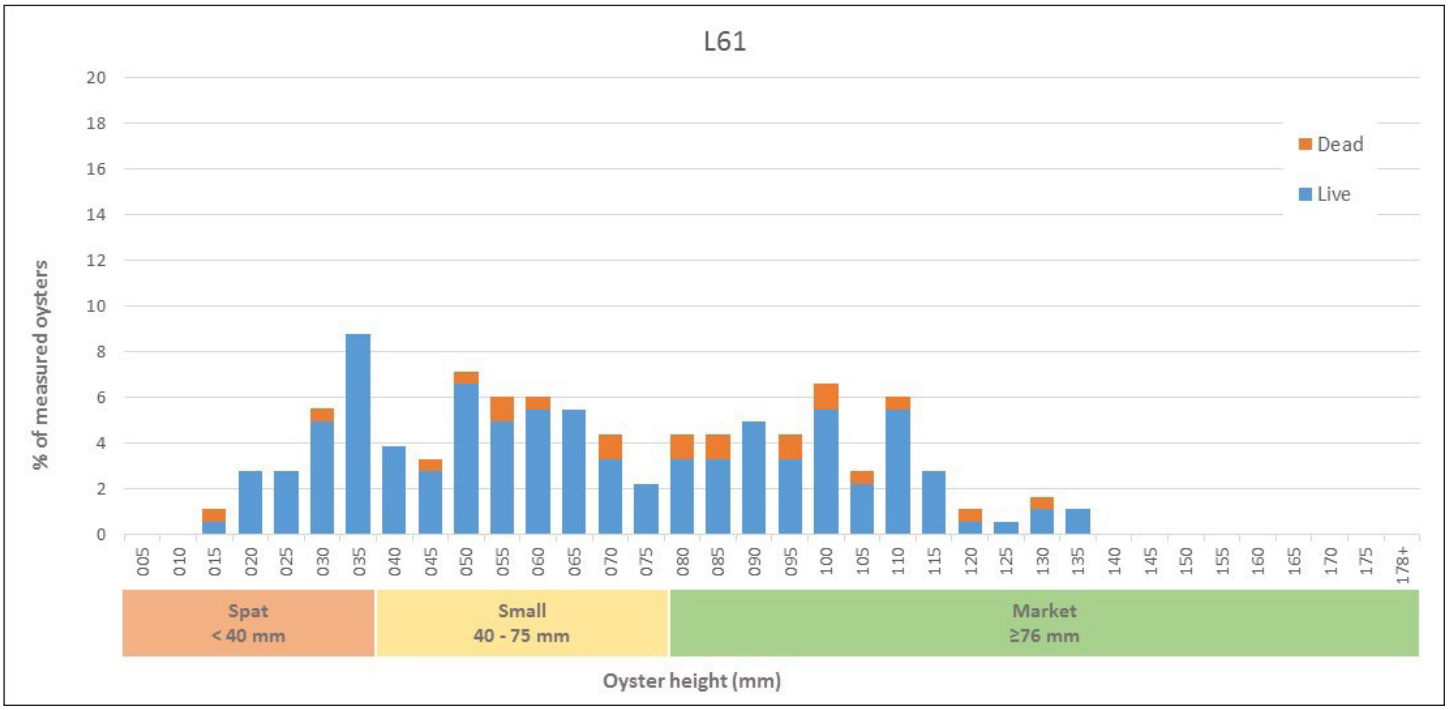
*__*Average planned reef height*__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef L61 (EXCEDES_GOAL_2012_2014_06) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



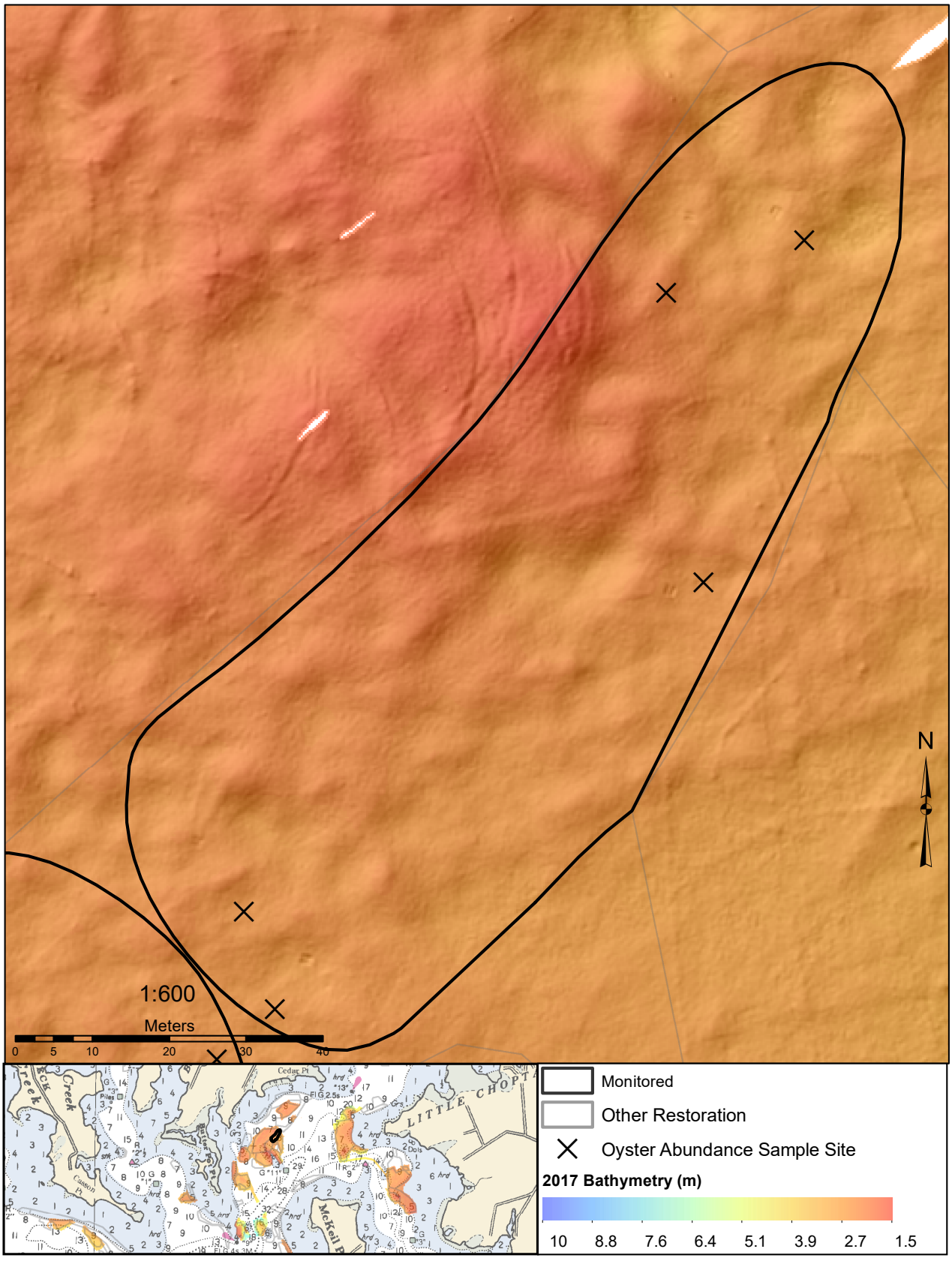
Shell Height of Oysters Measured on Reef



Reef L61 (EXCEDES_GOAL_2012_2014_06) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



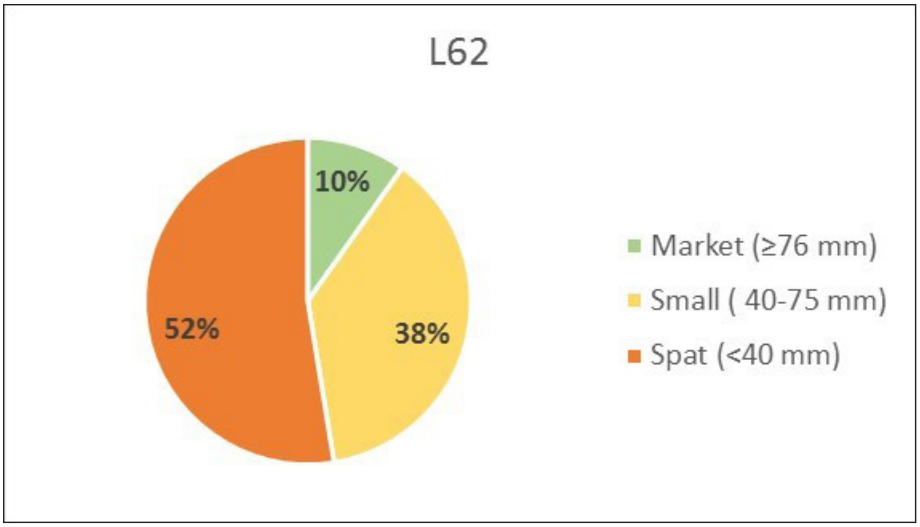
Reef L62 (EXCEDES_GOAL_2012_2014_07) Data and Analysis

		L62
Reef Information	Geodatabase Site_ID	EXCEDES_GOAL_2012_2014_07
	Bar name	Barn Point
	Tributary	Little Choptank
	Reef area (acres)	2.02
Restoration Treatment	Restoration treatment	None
	Substrate type added	None
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	exceeds goal (baseline)
	Sample method	Patent Tong
	Sample date	30-Nov-17
	# samples taken	6
	# live oysters measured	49
	# live oysters counted	1558
	# dead oysters counted	84
	% of oysters that were dead	0.05
	Sampled area (m^2)	8017.46
	Sampled acreage	1.98
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	161.28
	Standard error of live density (#/m^2)	68.97
	Reef area meeting minimum threshold density (m^2)	8017.46
	Reef area meeting minimum threshold density (%)	1
	Reef area meeting target density (m^2)	8017.46
	Reef area meeting target density (%)	1
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	8017.461641
	Reef area meeting minimum threshold biomass (%)	1.000000205
	Fall 2017: Did reef meet target oyster biomass?	Yes
	Reef area meeting target biomass (m^2)	2425.679293
	Reef area meeting target biomass (%)	0.302549597
	Average live biomass across reef (g dry weight/m^2)	54.96
	Standard error of live biomass	11.23
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	Yes
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	13.77
	Standard error of shell volume	0.91
	Total shell volume (liters)	110385.34
	Total surface shell volume (liters)	25756.58
	Average brown shell across all samples (%)	76.67
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	TBD
	Is reef height stable/increasing?	TBD
	Difference between postconstruction reef height and reef height 3	TBD

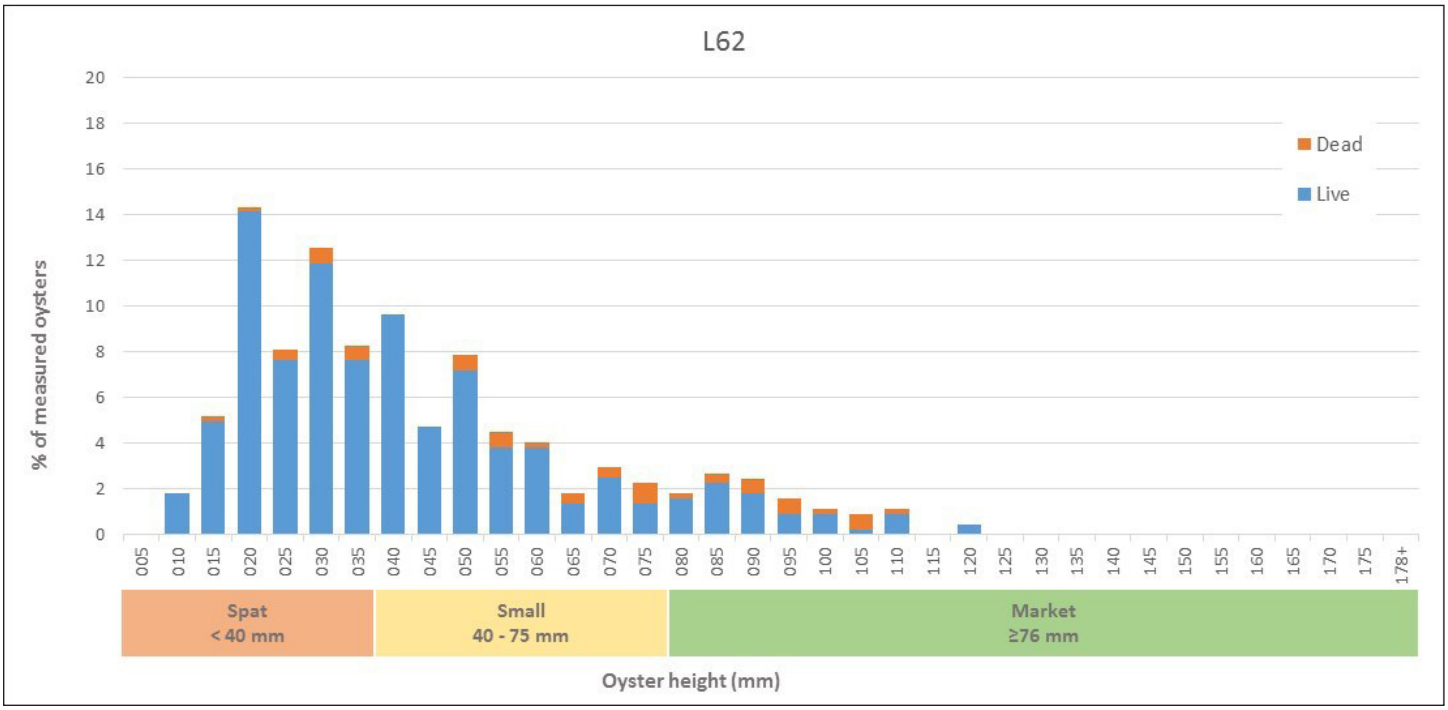
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef L62 (EXCEDES_GOAL_2012_2014_07) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



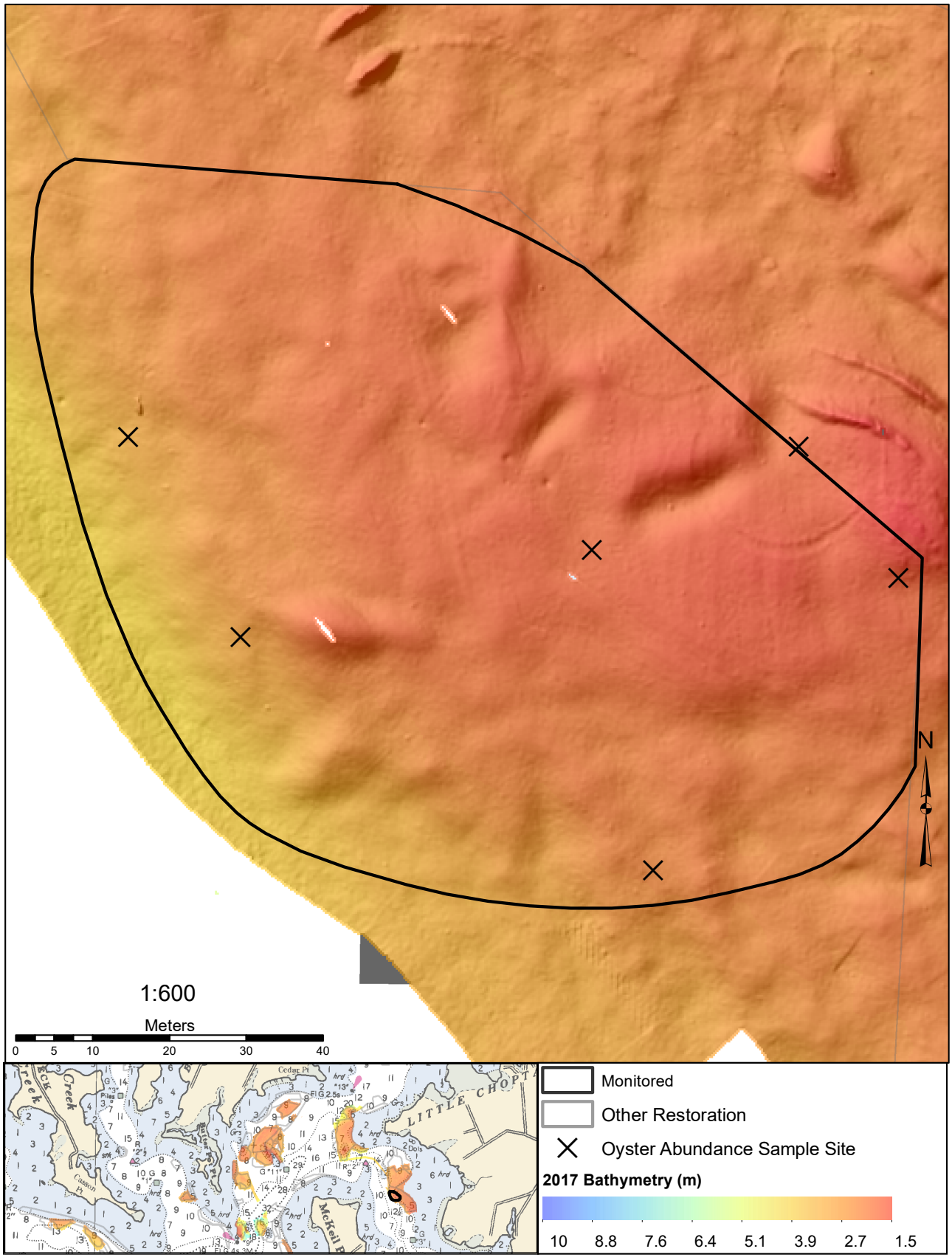
Shell Height of Oysters Measured on Reef



Reef L62 (EXCEDES_GOAL_2012_2014_07) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



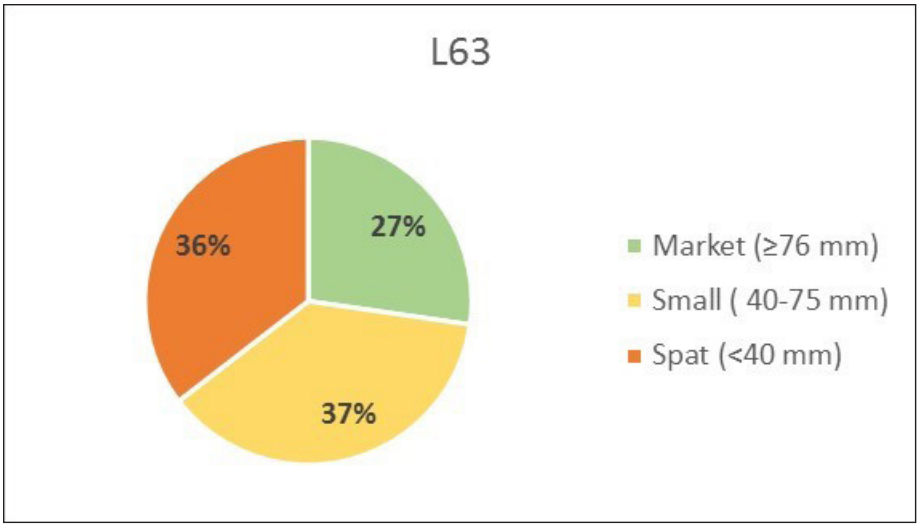
Reef L63 (EXCEDES_GOAL_2012_2014_08) Data and Analysis

		L63
Reef Information	Geodatabase Site_ID	EXCEDES_GOAL_2012_2014_08
	Bar name	Town
	Tributary	Little Choptank
	Reef area (acres)	0.22
Restoration Treatment	Restoration treatment	None
	Substrate type added	None
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	exceeds goal (baseline)
	Sample method	Patent Tong
	Sample date	29-Nov-17
	# samples taken	3
	# live oysters measured	187
	# live oysters counted	126
	# dead oysters counted	12
	% of oysters that were dead	0.09
	Sampled area (m^2)	438.85
	Sampled acreage	0.11
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	No
	Average live density across reef (#/m^2)	26.09
	Standard error of live density (#/m^2)	7.86
	Reef area meeting minimum threshold density (m^2)	282.6
	Reef area meeting minimum threshold density (%)	0.643955794
	Reef area meeting target density (m^2)	0
	Reef area meeting target density (%)	0
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	282.5972449
	Reef area meeting minimum threshold biomass (%)	0.643949516
	Fall 2017: Did reef meet target oyster biomass?	No
	Reef area meeting target biomass (m^2)	0
	Reef area meeting target biomass (%)	0
	Average live biomass across reef (g dry weight/m^2)	17.74
	Standard error of live biomass	6
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	No
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	6.21
	Standard error of shell volume	1.29
	Total shell volume (liters)	2725.76
	Total surface shell volume (liters)	2044.32
	Average brown shell across all samples (%)	25
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	TBD
	Is reef height stable/increasing?	TBD
	Difference between postconstruction reef height and reef height 3	TBD

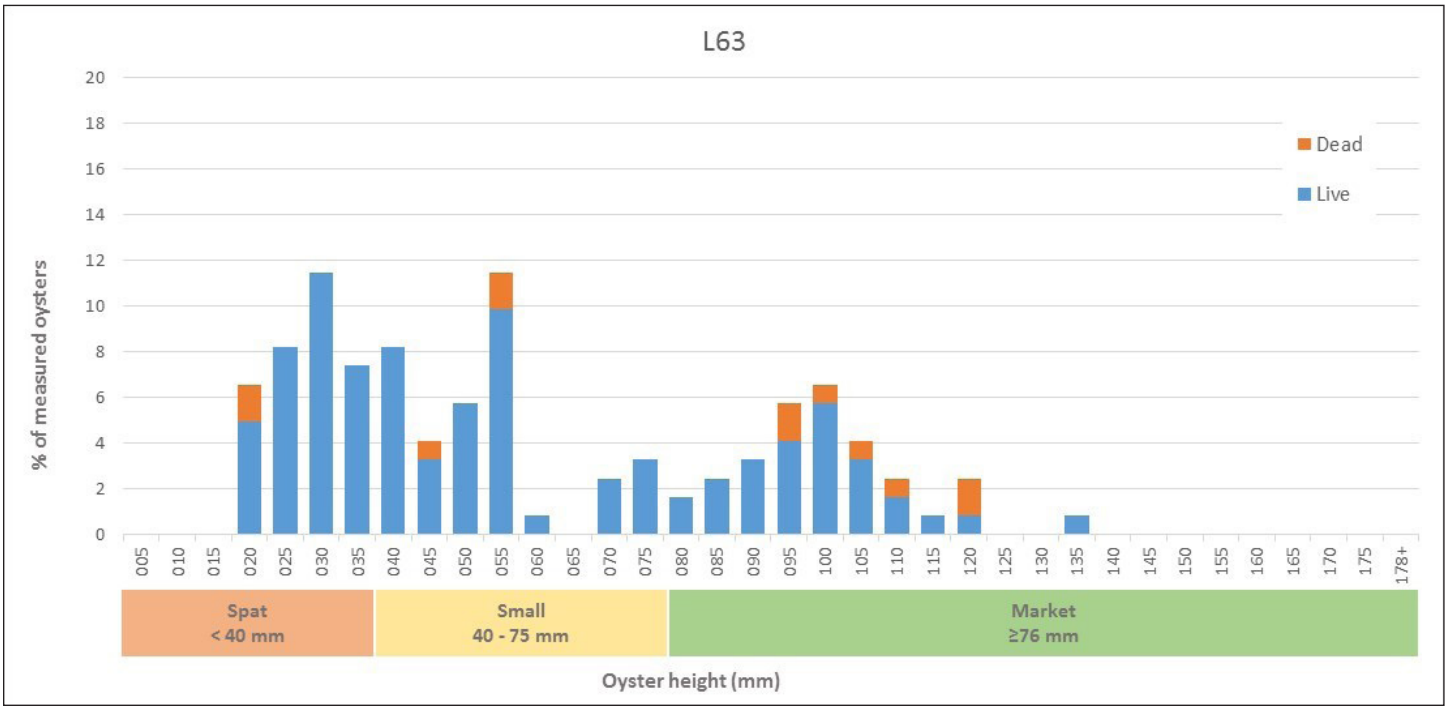
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef L63 (EXCEDES_GOAL_2012_2014_08) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



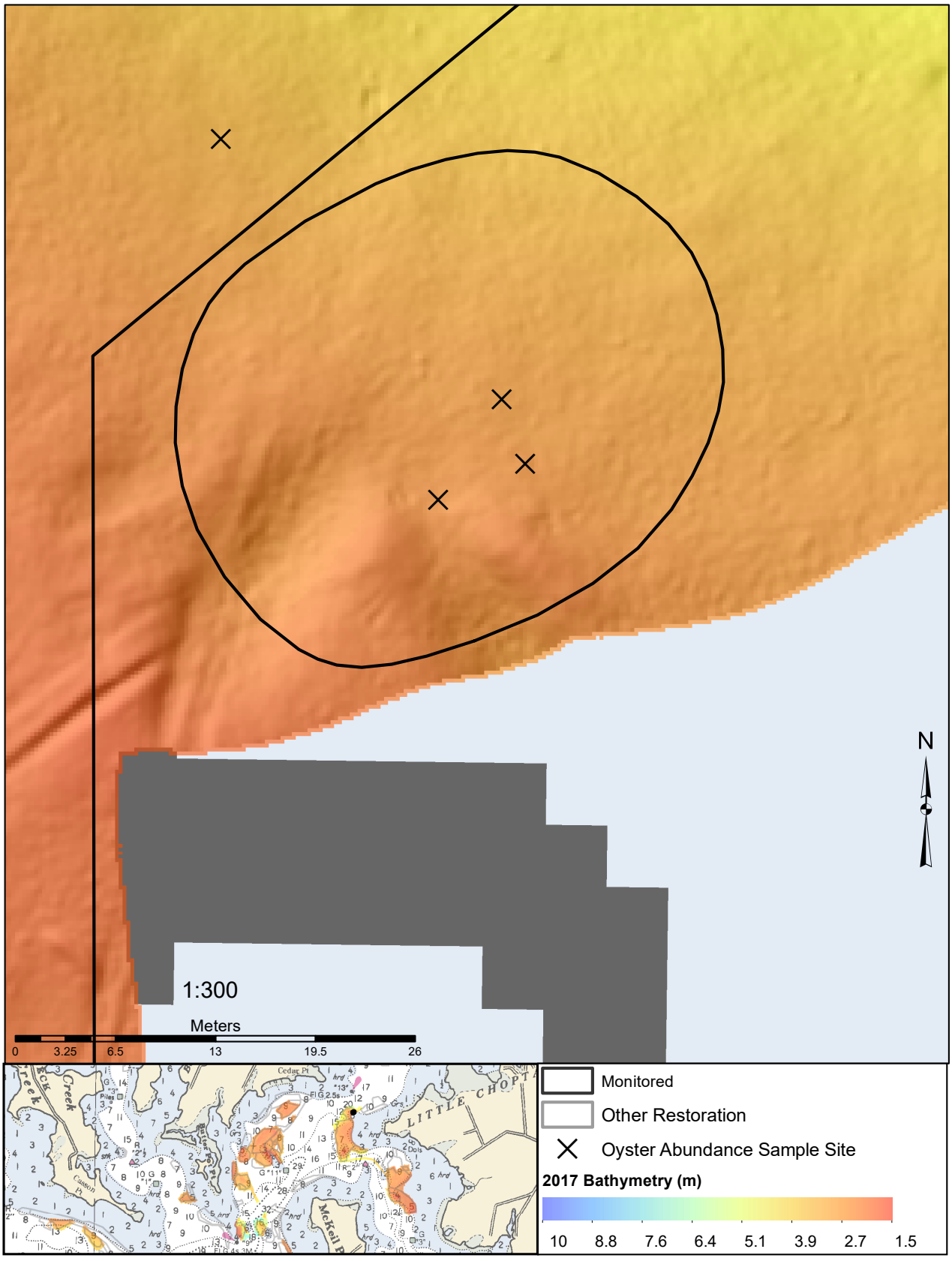
Shell Height of Oysters Measured on Reef



Reef L63 (EXCEDES_GOAL_2012_2014_08) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



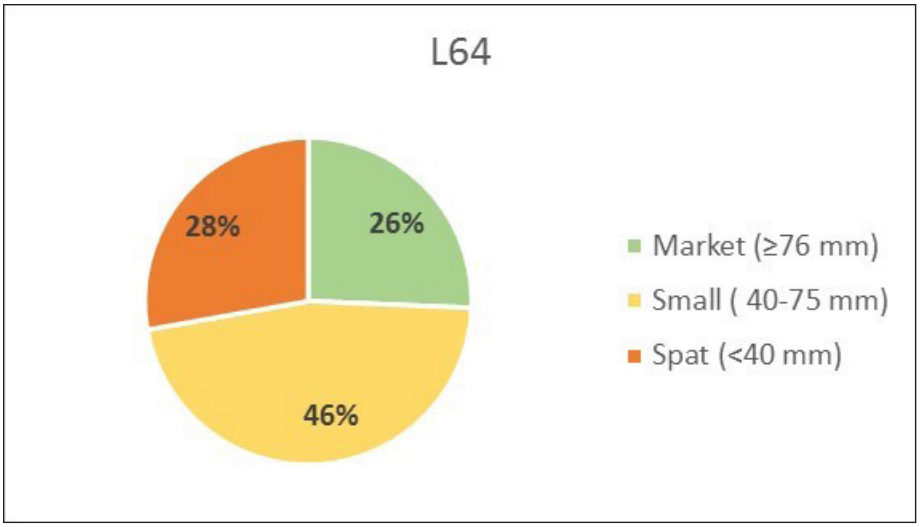
Reef L64 (EXCEDES_GOAL_2012_2014_09) Data and Analysis

		L64
Reef Information	Geodatabase Site_ID	EXCEDES_GOAL_2012_2014_09
	Bar name	McKeils Point
	Tributary	Little Choptank
	Reef area (acres)	2.01
Restoration Treatment	Restoration treatment	None
	Substrate type added	None
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	exceeds goal (baseline)
	Sample method	Patent Tong
	Sample date	29-Nov-17
	# samples taken	5
	# live oysters measured	427
	# live oysters counted	523
	# dead oysters counted	49
	% of oysters that were dead	0.09
	Sampled area (m^2)	7692.7
	Sampled acreage	1.9
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	64.97
	Standard error of live density (#/m^2)	16.49
	Reef area meeting minimum threshold density (m^2)	6499.15
	Reef area meeting minimum threshold density (%)	0.844846413
	Reef area meeting target density (m^2)	6499.15
	Reef area meeting target density (%)	0.844846413
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	6499.151034
	Reef area meeting minimum threshold biomass (%)	0.844846547
	Fall 2017: Did reef meet target oyster biomass?	Yes
	Reef area meeting target biomass (m^2)	4956.318181
	Reef area meeting target biomass (%)	0.644288505
	Average live biomass across reef (g dry weight/m^2)	49.44
	Standard error of live biomass	13.21
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	Yes
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	11.49
	Standard error of shell volume	2.22
	Total shell volume (liters)	88394.42
	Total surface shell volume (liters)	45965.1
	Average brown shell across all samples (%)	48
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	TBD
	Is reef height stable/increasing?	TBD
	Difference between postconstruction reef height and reef height 3	TBD

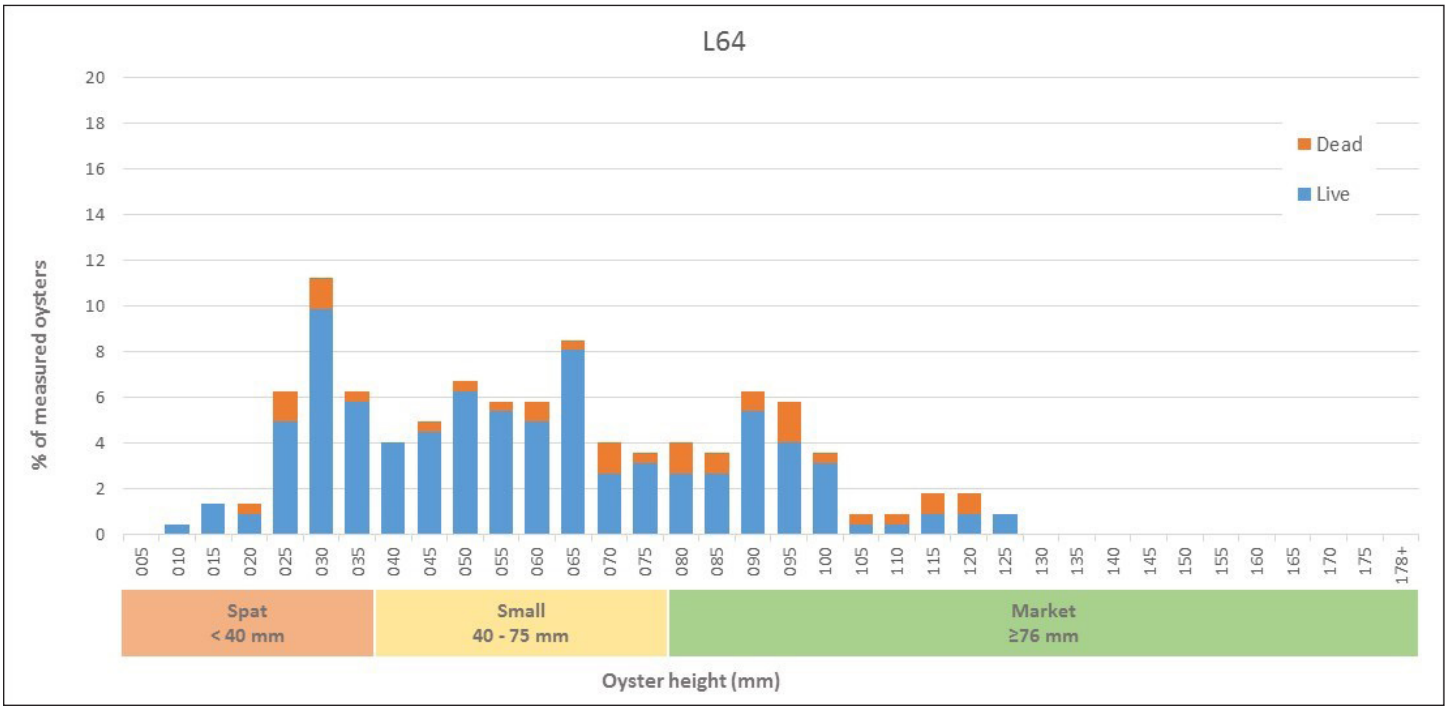
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef L64 (EXCEDES_GOAL_2012_2014_09) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



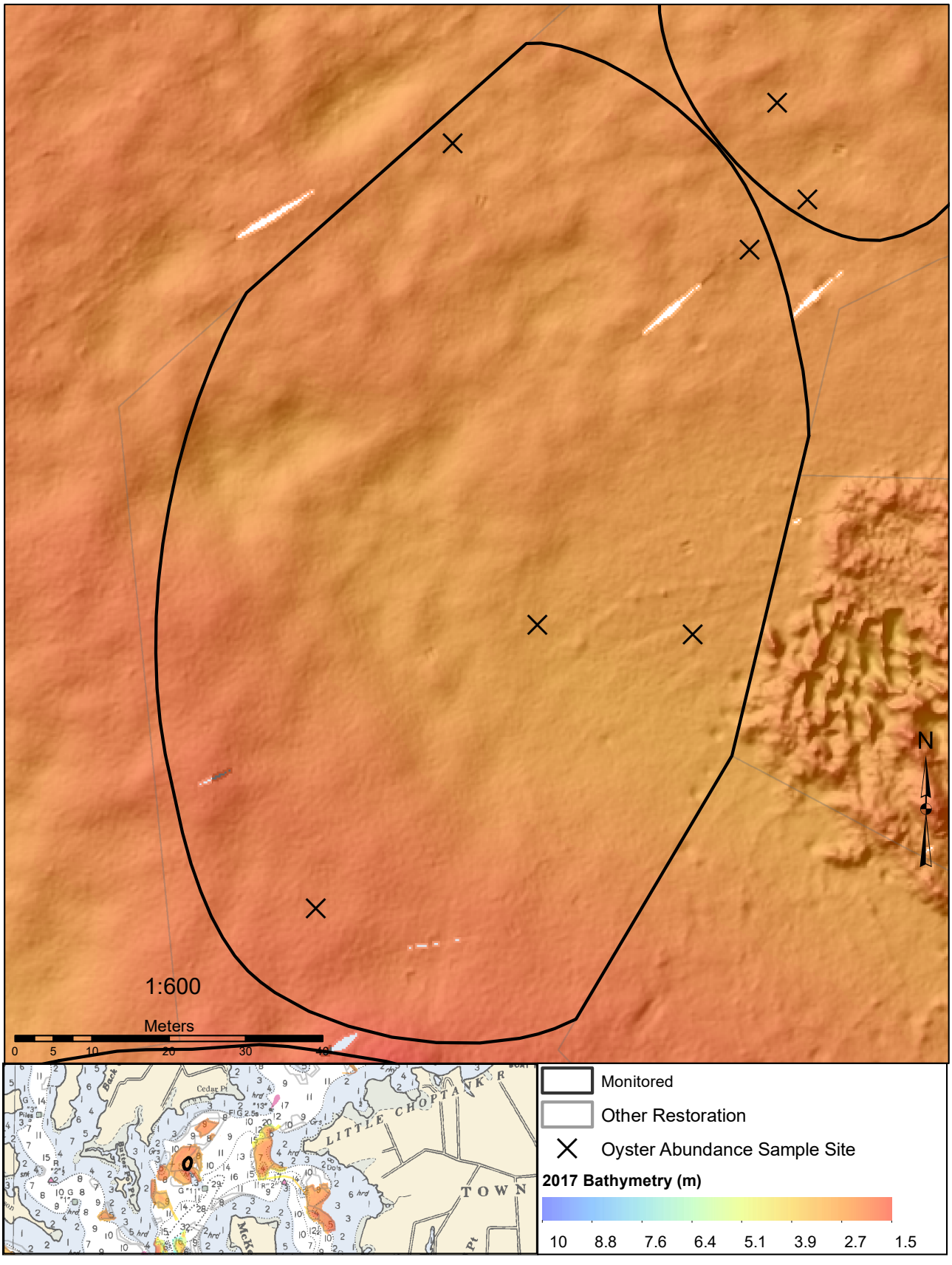
Shell Height of Oysters Measured on Reef



Reef L64 (EXCEDES_GOAL_2012_2014_09) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



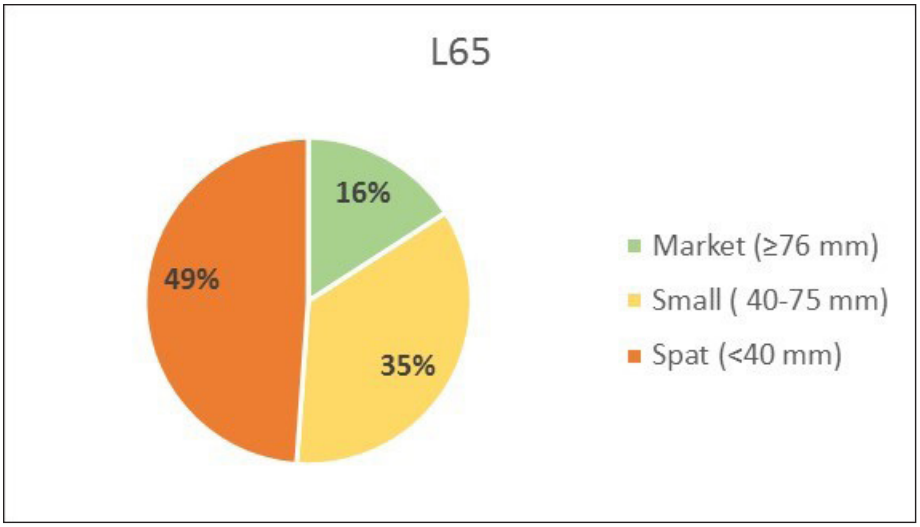
Reef L65 (EXCEDES_GOAL_2012_2014_10) Data and Analysis

		L65
Reef Information	Geodatabase Site_ID	EXCEDES_GOAL_2012_2014_10
	Bar name	N/A
	Tributary	Little Choptank
	Reef area (acres)	1.07
Restoration Treatment	Restoration treatment	None
	Substrate type added	None
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	exceeds goal (baseline)
	Sample method	Patent Tong
	Sample date	28-Nov-17
	# samples taken	5
	# live oysters measured	496
	# live oysters counted	363
	# dead oysters counted	31
	% of oysters that were dead	0.08
	Sampled area (m^2)	4317.2
	Sampled acreage	1.07
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	No
	Fall 2017: Did reef meet target density?	No
	Average live density across reef (#/m^2)	45.09
	Standard error of live density (#/m^2)	39.42
	Reef area meeting minimum threshold density (m^2)	348.25
	Reef area meeting minimum threshold density (%)	0.080665709
	Reef area meeting target density (m^2)	348.25
	Reef area meeting target density (%)	0.080665709
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	No
	Reef area meeting minimum threshold biomass (m^2)	348.2531744
	Reef area meeting minimum threshold biomass (%)	0.080666445
	Fall 2017: Did reef meet target oyster biomass?	No
	Reef area meeting target biomass (m^2)	348.2531744
	Reef area meeting target biomass (%)	0.080666445
	Average live biomass across reef (g dry weight/m^2)	24.10
	Standard error of live biomass	20.65
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	No
	Did reef meet BOTH target density and biomass?	No
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	3.99
	Standard error of shell volume	3.06
	Total shell volume (liters)	17228.56
	Total surface shell volume (liters)	3230.36
	Average brown shell across all samples (%)	81.25
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	TBD
	Is reef height stable/increasing?	TBD
	Difference between postconstruction reef height and reef height 3	TBD

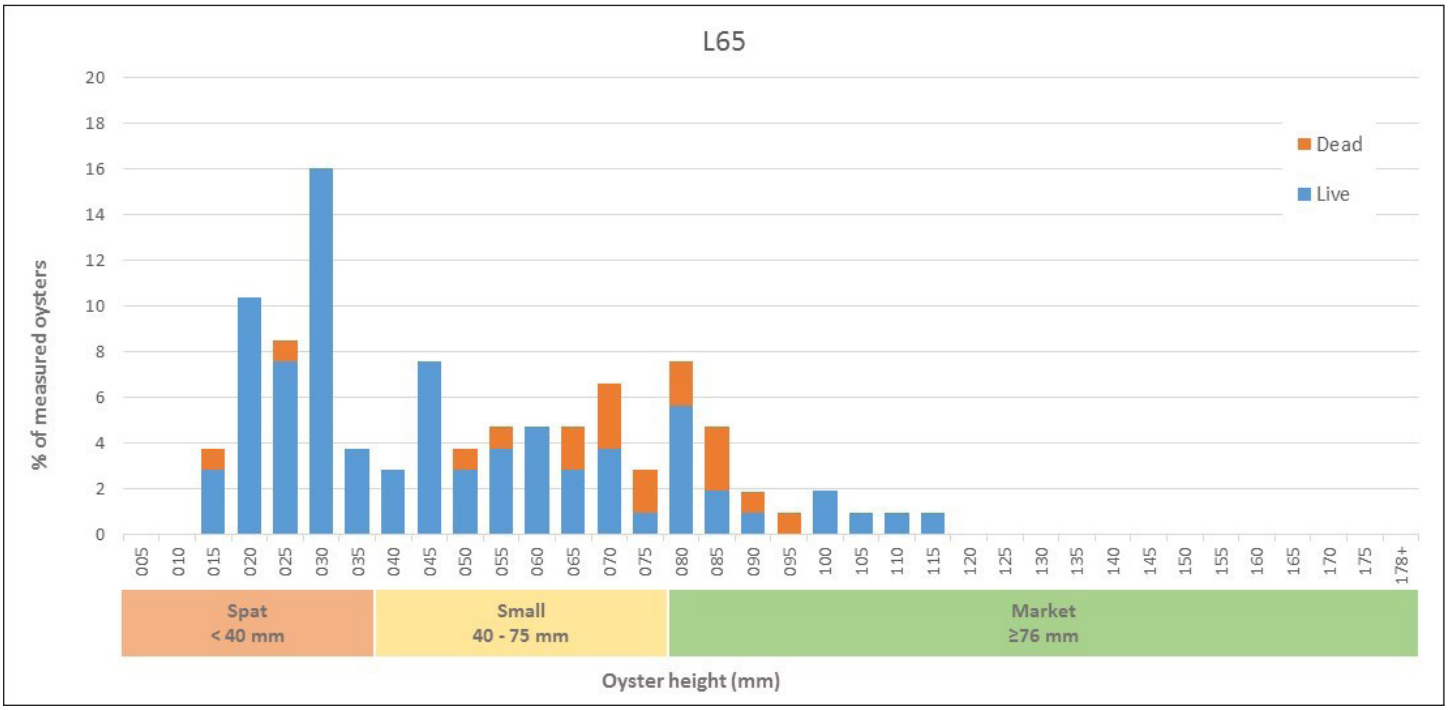
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef L65 (EXCEDES_GOAL_2012_2014_10) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



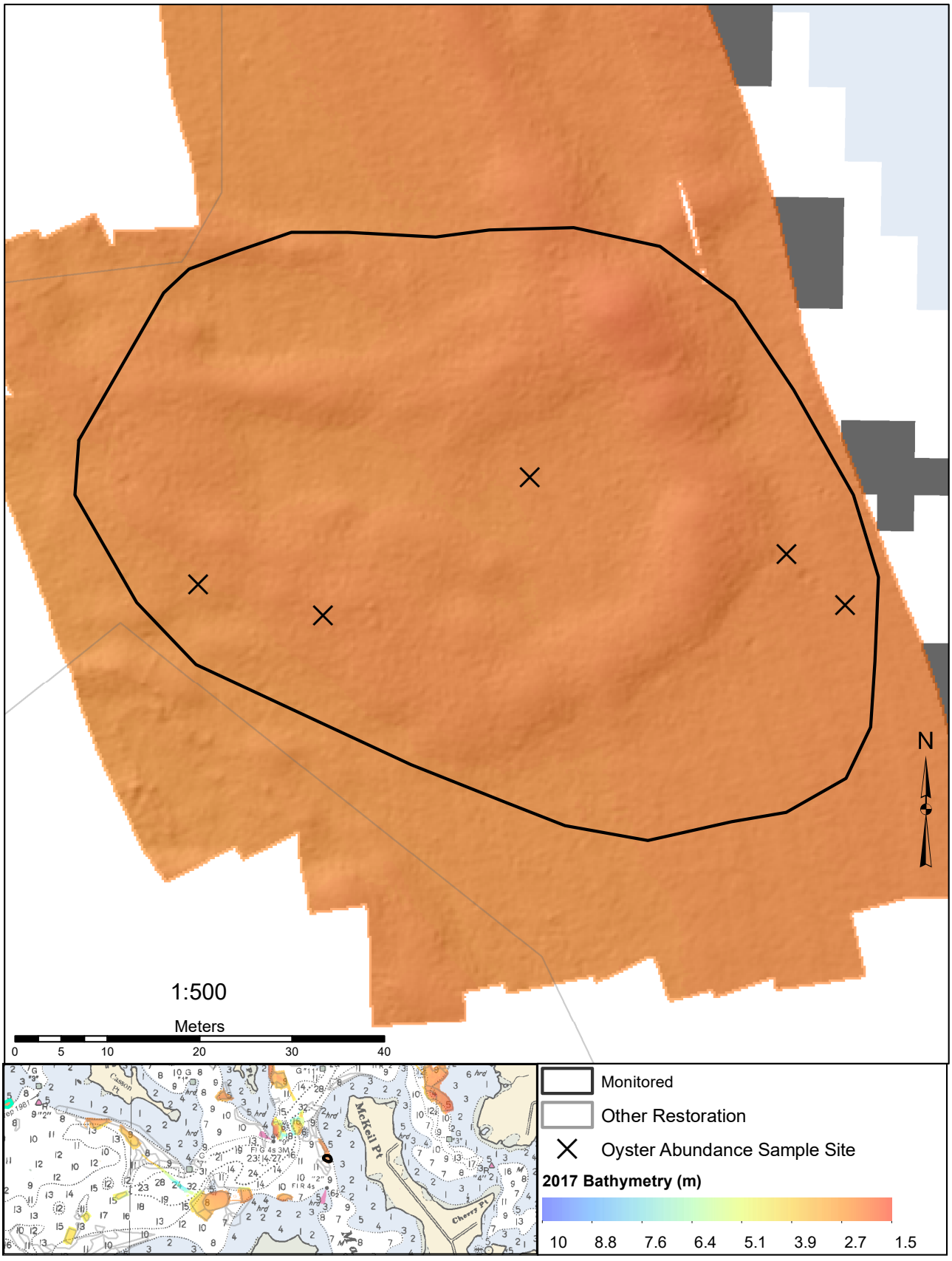
Shell Height of Oysters Measured on Reef



Reef L65 (EXCEDES_GOAL_2012_2014_10) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



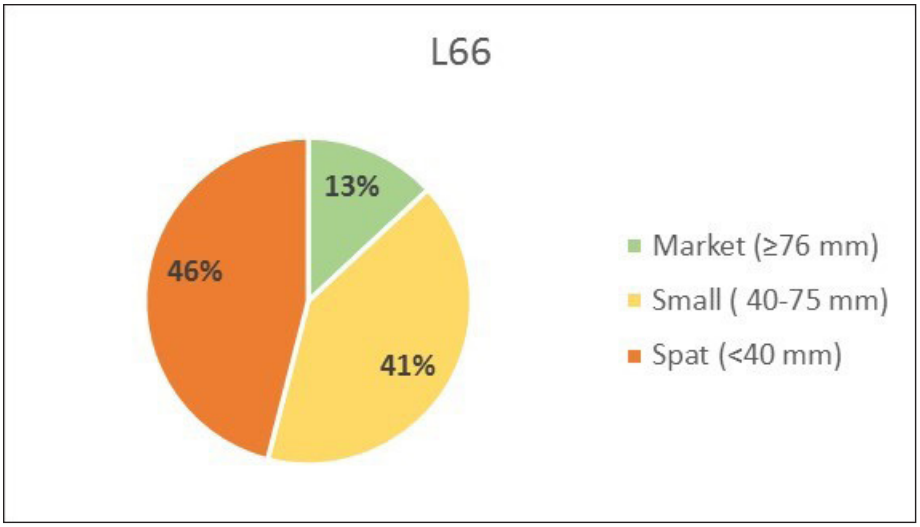
Reef L66 (EXCEDES_GOAL_2012_2014_11) Data and Analysis

		L66
Reef Information	Geodatabase Site_ID	EXCEDES_GOAL_2012_2014_11
	Bar name	N/A
	Tributary	Little Choptank
	Reef area (acres)	0.87
Restoration Treatment	Restoration treatment	None
	Substrate type added	None
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	exceeds goal (baseline)
	Sample method	Patent Tong
	Sample date	28-Nov-17
	# samples taken	7
	# live oysters measured	291
	# live oysters counted	931
	# dead oysters counted	109
	% of oysters that were dead	0.10
	Sampled area (m^2)	3099.71
	Sampled acreage	0.77
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	82.61
	Standard error of live density (#/m^2)	23.78
	Reef area meeting minimum threshold density (m^2)	2707.73
	Reef area meeting minimum threshold density (%)	0.873543009
	Reef area meeting target density (m^2)	2390.78
	Reef area meeting target density (%)	0.771291508
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	2390.777551
	Reef area meeting minimum threshold biomass (%)	0.771290718
	Fall 2017: Did reef meet target oyster biomass?	Yes
	Reef area meeting target biomass (m^2)	1036.516907
	Reef area meeting target biomass (%)	0.334391574
	Average live biomass across reef (g dry weight/m^2)	55.01
	Standard error of live biomass	20.92
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	Yes
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	11.36
	Standard error of shell volume	3.1
	Total shell volume (liters)	35205.2
	Total surface shell volume (liters)	3269.05
	Average brown shell across all samples (%)	90.71
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	TBD
	Is reef height stable/increasing?	TBD
	Difference between postconstruction reef height and reef height 3	TBD

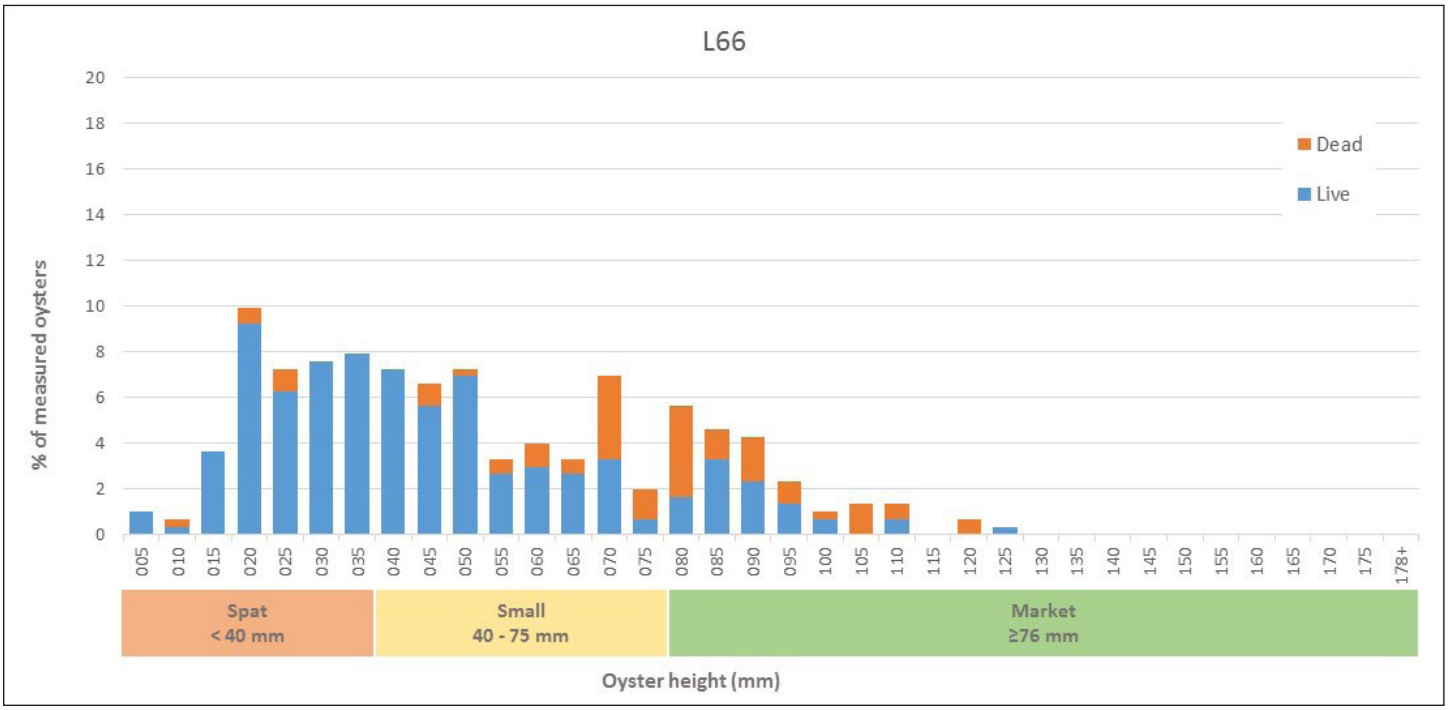
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef L66 (EXCEDES_GOAL_2012_2014_11) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



Shell Height of Oysters Measured on Reef



Reef L66 (EXCEDES_GOAL_2012_2014_11) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.

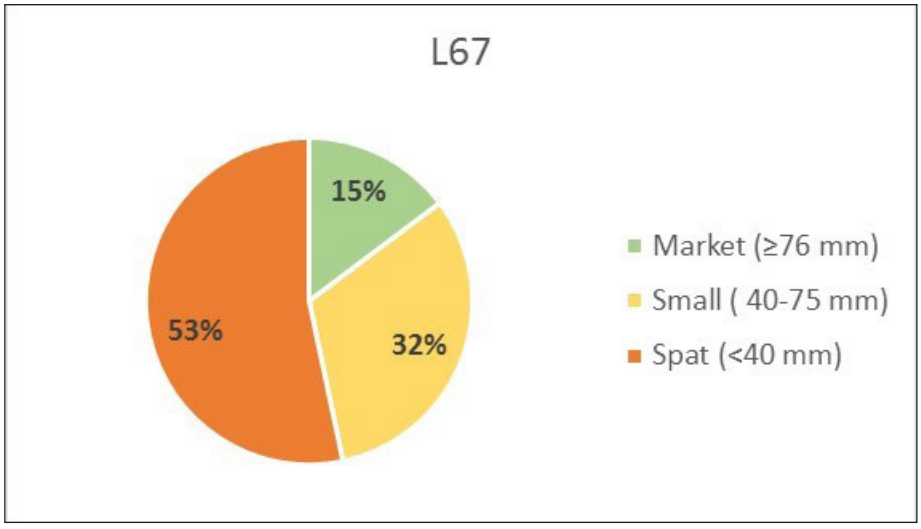
Reef L67 (EXCEDES_GOAL_2012_2014_12) Data and Analysis

		L67
Reef Information	Geodatabase Site_ID	EXCEDES_GOAL_2012_2014_12
	Bar name	Cason
	Tributary	Little Choptank
	Reef area (acres)	10.66
Restoration Treatment	Restoration treatment	None
	Substrate type added	None
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	exceeds goal (baseline)
	Sample method	Patent Tong
	Sample date	27-Nov-17
	# samples taken	6
	# live oysters measured	210
	# live oysters counted	1253
	# dead oysters counted	96
	% of oysters that were dead	0.07
	Sampled area (m^2)	42825.41
	Sampled acreage	10.58
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	129.71
	Standard error of live density (#/m^2)	23.08
	Reef area meeting minimum threshold density (m^2)	42825.41
	Reef area meeting minimum threshold density (%)	1
	Reef area meeting target density (m^2)	42825.41
	Reef area meeting target density (%)	1
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	42825.41471
	Reef area meeting minimum threshold biomass (%)	1.00000011
	Fall 2017: Did reef meet target oyster biomass?	Yes
	Reef area meeting target biomass (m^2)	36844.41855
	Reef area meeting target biomass (%)	0.860340124
	Average live biomass across reef (g dry weight/m^2)	84.77
	Standard error of live biomass	16.75
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	Yes
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	15.73
	Standard error of shell volume	2.05
	Total shell volume (liters)	673857.46
	Total surface shell volume (liters)	39308.35
	Average brown shell across all samples (%)	94.17
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	TBD
	Is reef height stable/increasing?	TBD
	Difference between postconstruction reef height and reef height 3	TBD

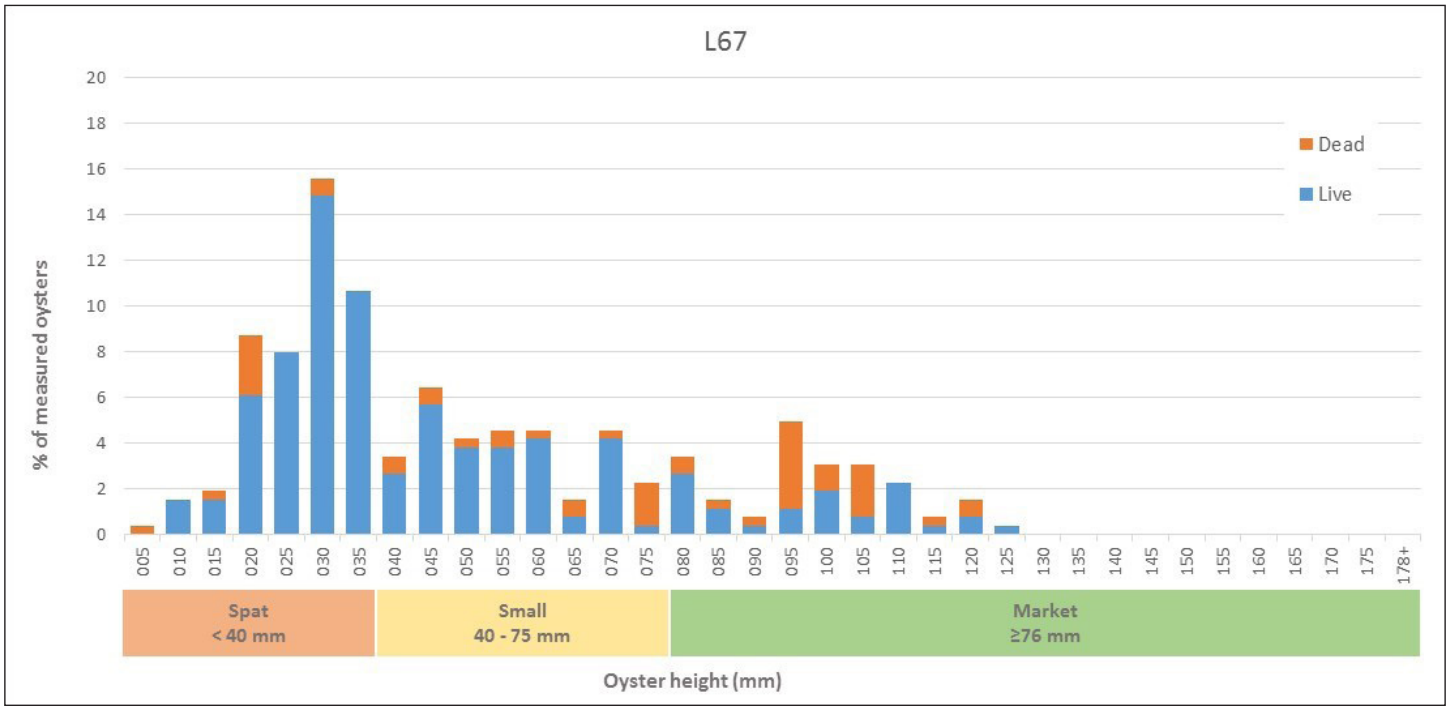
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef L67 (EXCEDES_GOAL_2012_2014_12) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



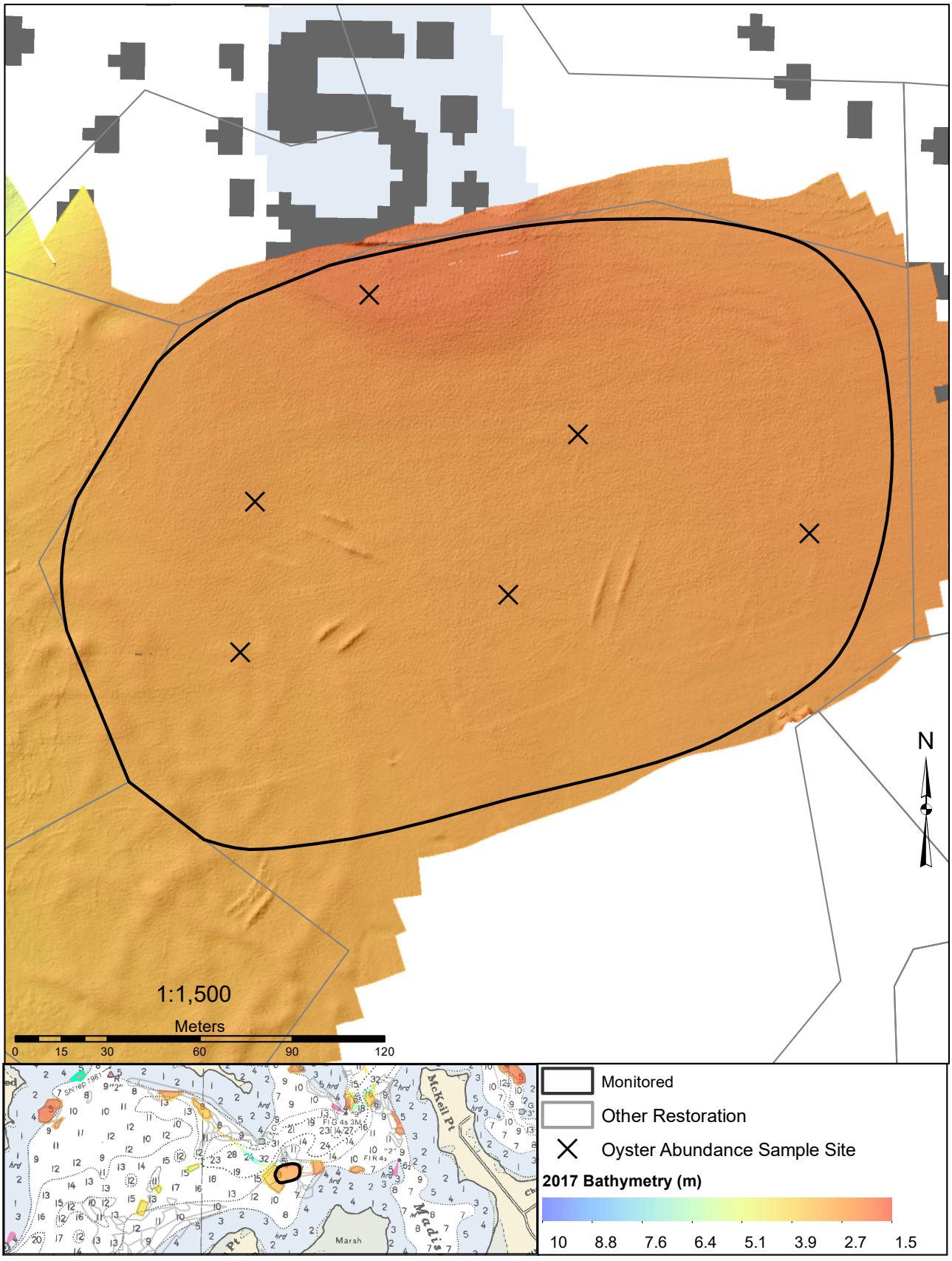
Shell Height of Oysters Measured on Reef



Reef L67 (EXCEDES_GOAL_2012_2014_12) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



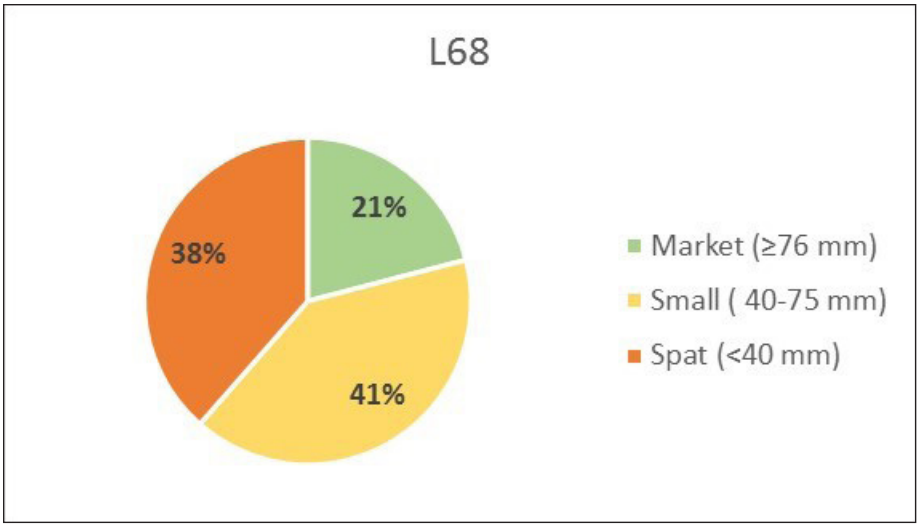
Reef L68 (EXCEDES_GOAL_2012_2014_05) Data and Analysis

		L68
Reef Information	Geodatabase Site_ID	EXCEDES_GOAL_2012_2014_05
	Bar name	McKeils Point
	Tributary	Little Choptank
	Reef area (acres)	5.36
Restoration Treatment	Restoration treatment	None
	Substrate type added	None
	Average planned reef height* (inches)	<Null>
	Year planted with spat	<Null>
	Spat produced by	<Null>
	Spat planted by	<Null>
	Spat planted (millions)	0
	Spat planted per acre (millions)	0.00
Monitoring Information	Monitoring type	exceeds goal (baseline)
	Sample method	Patent Tong
	Sample date	28-Nov-17
	# samples taken	13
	# live oysters measured	237
	# live oysters counted	1087
	# dead oysters counted	120
	% of oysters that were dead	0.10
	Sampled area (m^2)	21297.91
	Sampled acreage	5.26
Oyster Density	Fall 2017: Did reef meet minimum threshold density?	Yes
	Fall 2017: Did reef meet target density?	Yes
	Average live density across reef (#/m^2)	51.94
	Standard error of live density (#/m^2)	14.88
	Reef area meeting minimum threshold density (m^2)	20304.33
	Reef area meeting minimum threshold density (%)	0.953348474
	Reef area meeting target density (m^2)	7866.18
	Reef area meeting target density (%)	0.369340466
	Average live density on stone (#/m^2)	<Null>
	Standard error of live density on stone	<Null>
	Average live density on shell (#/m^2)	<Null>
	Standard error of live density on shell	<Null>
	Average live density on fossil shell(#/m^2)	<Null>
	Standard error of live density on fossil shell	<Null>
	Average live density on clam shell (#/m^2)	<Null>
	Standard error of live density on clam shell	<Null>
Oyster Biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Yes
	Reef area meeting minimum threshold biomass (m^2)	16912.75432
	Reef area meeting minimum threshold biomass (%)	0.794103943
	Fall 2017: Did reef meet target oyster biomass?	No
	Reef area meeting target biomass (m^2)	5366.178482
	Reef area meeting target biomass (%)	0.251957985
	Average live biomass across reef (g dry weight/m^2)	34.94
	Standard error of live biomass	10.57
Biomass & Density together	Did the reef meet BOTH minimum threshold density and biomass?	Yes
	Did reef meet BOTH target density and biomass?	No
Shell Volume	Is shell volume stable/increasing?	TBD in 2020
	Average shell volume across entire reef (liters/m^2)	8.19
	Standard error of shell volume	1.24
	Total shell volume (liters)	174514.62
	Total surface shell volume (liters)	38258.97
	Average brown shell across all samples (%)	78.08
Multiple Year Classes	Are multiple year classes present?	Yes
Reef Height and Footprint	Is reef footprint stable/increasing?	TBD
	Is reef height stable/increasing?	TBD
	Difference between postconstruction reef height and reef height 3	TBD

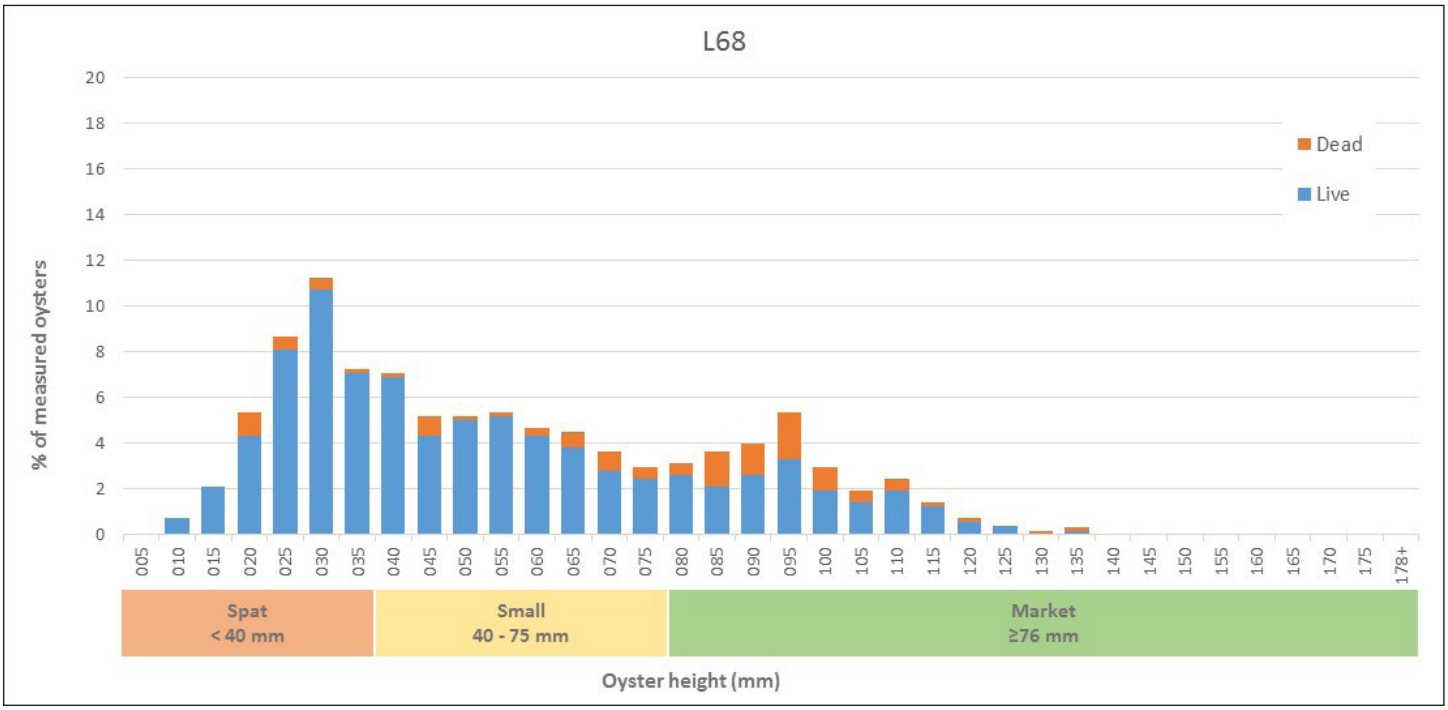
*__Average planned reef height__: The amount of reef-building material placed into a reef was calculated by multiplying the desired average reef height (ex.: 6”; 12”) by the reef area. The actual height of the reef varied across the reef.

Reef L68 (EXCEDES_GOAL_2012_2014_05) Data and Analysis

Percent of Measured Oysters in the Market, Small, and Spat Categories



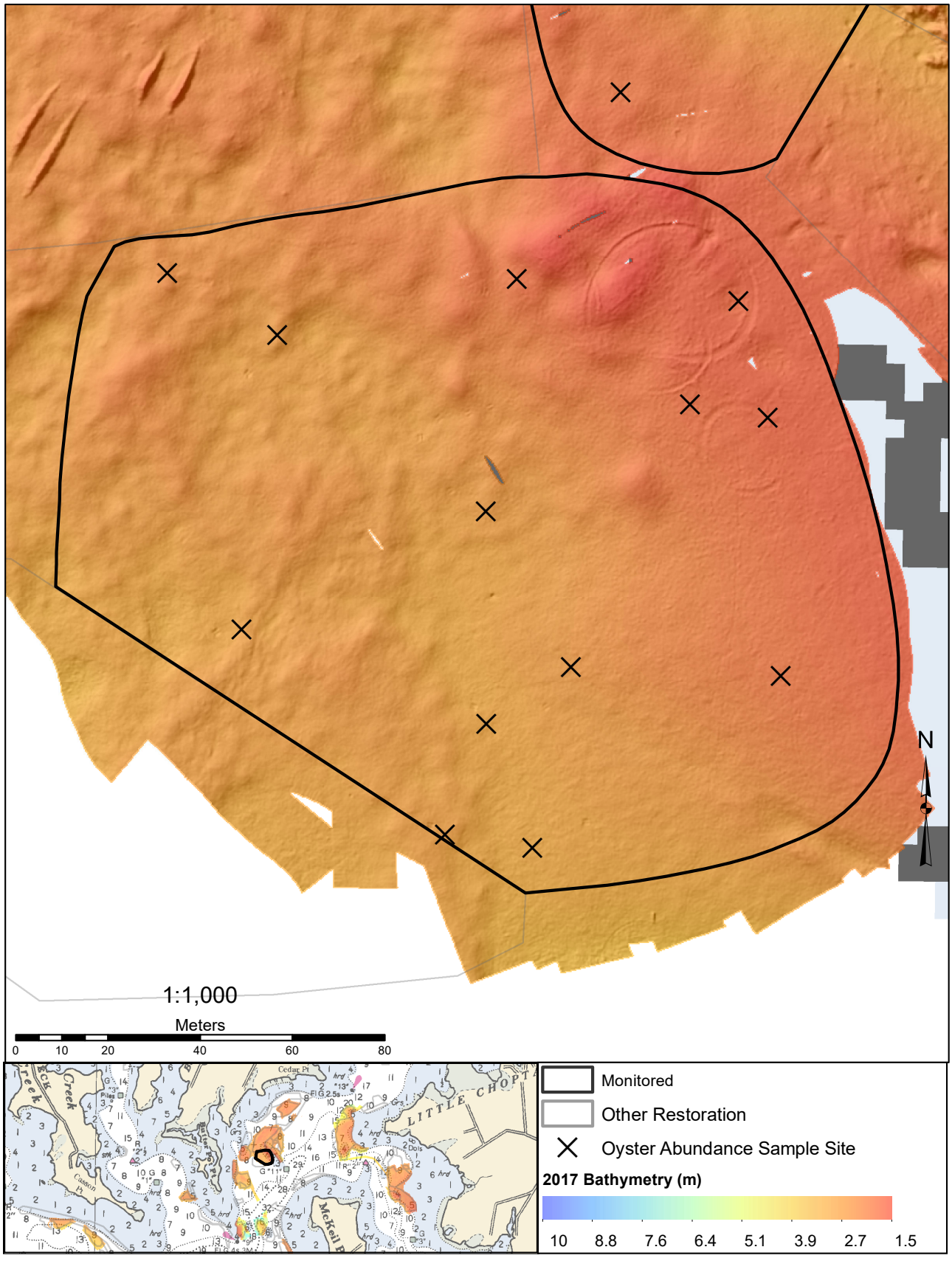
Shell Height of Oysters Measured on Reef



Reef L68 (EXCEDES_GOAL_2012_2014_05) Data and Analysis

Fall 2017 Hillshaded Bathymetry Surface Derived from Multibeam Sonar

For interpretations of features in sonar imagery, see Appendix A: Methods.



Appendix C: Tables of 2017 Monitoring Information (Tables 15-20)

Detailed monitoring results, by tributary, by Oyster Metrics criteria, are in Tables 15-20 below. All information for each reef, by reef, including sonar images and graphics of oyster shell height distributions, is in Appendix B: Reef Pages. Information on the sentinel reefs (monitored annually) is in Appendix D. For sample size for biological metrics for each reef see Table 14, or see corresponding Reef Page in Appendix B.

Monitoring Type	Reef #	Substrate type added	Ave. live density across reef (#/m^2)	Standard error of live density (#/m^2)	Fall 2017: Did reef meet minimum threshold density?	Reef area meeting minimum threshold density (%)	Fall 2017: Did reef meet target density?	Reef area meeting target density (%)
Harris 2014 Cohort Reefs	H49	Stone base with mix shell	237.5	79.13	Yes	100%	Yes	100%
	H51	Stone base with mix shell	255.75	42.84	Yes	100%	Yes	100%
	H62	Stone base with mix shell	159.43	29.37	Yes	100%	Yes	100%
	H52	Fossil shell	201	33.13	Yes	100%	Yes	100%
	H53	Stone base with mix shell	166.57	29.92	Yes	100%	Yes	98%
	H54	Fossil shell	263	33.01	Yes	100%	Yes	100%
	H56	Stone base with mix shell	208.8	49.55	Yes	91%	Yes	91%
	H57	Stone base with mix shell	106.44	18.18	Yes	100%	Yes	94%
	H58	Stone base with mix shell	218	48.97	Yes	100%	Yes	100%
	H59	Stone base with mix shell	153.71	61.39	Yes	100%	Yes	73%
	H60	Fossil shell	215.67	57.12	Yes	100%	Yes	100%
	H55	Spat on shell only	25.71	5.18	Yes	76%	No	0%
	H48	Spat on shell only	28.51	5.05	Yes	76%	No	27%
	H50	Spat on shell only	30.52	7.83	Yes	88%	No	0%
Harris Reference Reefs	H14	NONE	25.07	6.62	Yes	65%	No	23%
	H17	NONE	9.32	4.15	No	7%	No	0%
	H15	NONE	14.29	6.47	No	29%	No	0%
	H16	NONE	11.93	3.8	Yes	42%	No	0%

Table 15: Oyster density information for Harris Creek reefs monitored in 2017.

Monitoring Type	Reef #	Substrate type added	Ave. live biomass across reef (g dry weight per m^2)	Standard error of live biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Reef area meeting minimum threshold biomass (%)	Fall 2017: Did reef meet target oyster biomass?	Reef area meeting target biomass (%)
Harris 2014 Cohort Reefs	H49	Stone base with mix shell	179.7653028	15.71	Yes	100%	Yes	100%
	H51	Stone base with mix shell	170.306686	8.08	Yes	100%	Yes	100%
	H62	Stone base with mix shell	109.5656599	9.79	Yes	100%	Yes	100%
	H52	Fossil shell	196.7827087	14.81	Yes	100%	Yes	100%
	H53	Stone base with mix shell	121.7456068	18.53	Yes	100%	Yes	86%
	H54	Fossil shell	167.2458112	10.09	Yes	100%	Yes	100%
	H56	Stone base with mix shell	178.8384287	24.53	Yes	100%	Yes	91%
	H57	Stone base with mix shell	89.14057944	13.59	Yes	100%	Yes	88%
	H58	Stone base with mix shell	132.9143431	6.05	Yes	100%	Yes	100%
	H59	Stone base with mix shell	144.7619353	21.58	Yes	100%	Yes	69%
	H60	Fossil shell	220.5218307	22.78	Yes	100%	Yes	79%
	H55	Spat on shell only	40.08	10.42	Yes	58%	No	22%
	H48	Spat on shell only	37.98	6.31	Yes	100%	No	27%
	H50	Spat on shell only	31.76	8.91	Yes	88%	No	10%
Harris Reference Reefs	H14	NONE	35.35	9.51	Yes	81%	No	27%
	H17	NONE	10.31	4.55	No	7%	No	0%
	H15	NONE	15.97	7.22	No	29%	No	0%
	H16	NONE	13.48	4.56	Yes	42%	No	0%

Table 16: Oyster biomass information for Harris Creek reefs monitored in 2017.

Monitoring Type	Reef #	Substrate type added	Are multiple year classes present?	Is shell volume stable/ increasing?	Ave shell volume across entire reef (liters per m^2)	Standard error of shell volume	Ave brown shell across all samples (%)	Is reef footprint stable/ increasing?	Is reef height stable/ increasing?
Harris 2014 Cohort Reefs	H49	Stone base with mix shell	Yes	TBD in 2020	195.75	47.2	76.25	Yes	Yes
	H51	Stone base with mix shell	Yes	TBD in 2020	79	13.31	84.38	Yes	Yes
	H62	Stone base with mix shell	Yes	TBD in 2020	108.29	42.65	90.71	Yes	Yes
	H52	Fossil shell	Yes	TBD in 2020	118	14.46	77	Yes	Yes
	H53	Stone base with mix shell	Yes	TBD in 2020	39.14	7.05	89.29	Yes	Yes
	H54	Fossil shell	Yes	TBD in 2020	146	21.59	82.5	Yes	Yes
	H56	Stone base with mix shell	Yes	TBD in 2020	138.4	22.59	80	Yes	Yes
	H57	Stone base with mix shell	Yes	TBD in 2020	80.78	21.46	85.56	Yes	Yes
	H58	Stone base with mix shell	Yes	TBD in 2020	53.6	16.86	94	Yes	Yes
	H59	Stone base with mix shell	Yes	TBD in 2020	120.57	22.91	84.29	Yes	Yes
	H60	Fossil shell	Yes	TBD in 2020	126.33	8.17	80	Yes	Yes
	H55	Spat on shell only	Yes	TBD in 2020	9.32	0.79	64	Yes	Yes
	H48	Spat on shell only	Yes	TBD in 2020	14.29	1.1	33.5	Yes	Yes
	H50	Spat on shell only	Yes	TBD in 2020	7.51	2.35	54.17	TBD	TBD
Harris Reference Reefs	H14	NONE	Yes	TBD in 2020	9.71	2.03	30.45	Yes	Yes
	H17	NONE	Yes	TBD in 2020	4.16	1.15	15.3	Yes	Yes
	H15	NONE	Yes	TBD in 2020	5.85	1.51	22	Yes	Yes
	H16	NONE	Yes	TBD in 2020	7.2	1.47	25	Yes	Yes

Table 17: Information on multiple year classes, shell volume, reef height, and reef footprint for Harris Creek reefs monitored in 2017.

Monitoring Type	Reef #	Substrate type added	Average live density across reef (#/m^2)	Standard error of live density (#/m^2)	Fall 2017: Did reef meet minimum threshold density?	Reef area meeting minimum threshold density (%)	Fall 2017: Did reef meet target density?	Reef area meeting target density (%)
L. Choptank 2014 Cohort	L03	Spat-on-shell only	42.44	14.07	Yes	61%	Yes	41%
	L04	Spat-on-shell only	28.3	9.38	Yes	64%	No	8%
Little Choptank reference	L53	None	33.98	7.82	Yes	93%	No	4%
	L54	None	56.68	11.93	Yes	100%	Yes	84%
	L52	None	66.1	11.24	Yes	100%	Yes	92%
Little Choptank Premet Reefs	L57	None	5.07	2.54	No	18%	No	0%
	L58	None	44.34	12.13	Yes	82%	No	28%
	L59	None	34.47	10.52	Yes	86%	Yes	55%
	L60	None	31.68	5.12	Yes	78%	No	14%
	L68	None	51.94	14.88	Yes	95%	Yes	37%
	L61	None	37.27	11.09	Yes	92%	No	26%
	L62	None	161.28	68.97	Yes	100%	Yes	100%
	L63	None	26.09	7.86	Yes	64%	No	0%
	L64	None	64.97	16.49	Yes	84%	Yes	84%
	L65	None	45.09	39.42	No	8%	No	8%
	L66	None	82.61	23.78	Yes	87%	Yes	77%
	L67	None	129.71	23.08	Yes	100%	Yes	100%

Table 18: Oyster density information for Little Choptank reefs monitored in 2017.

Monitoring Type	Reef #	Substrate type added	Average live biomass across reef (g dry weight/m^2)	Standard error of live biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Reef area meeting minimum threshold biomass (%)	Fall 2017: Did reef meet target oyster biomass?	Reef area meeting target biomass (%)
L. Choptank	L03	Spat-on-shell only	23.32	7.54	Yes	61%	No	22%
2014 Cohort	L04	Spat-on-shell only	31.03	10.53	Yes	51%	No	17%
Little	L53	None	20.45	4.76	Yes	72%	No	0%
Choptank	L54	None	54.26	11.52	Yes	100%	Yes	84%
reference	L52	None	47.98	7.29	Yes	100%	Yes	58%
	L57	None	5.89	2.3	No	18%	No	0%
	L58	None	34.16	8.37	Yes	67%	No	9%
	L59	None	29.4	7.82	Yes	86%	Yes	55%
	L60	None	22.77	3.22	Yes	70%	No	0%
Little	L68	None	34.94	10.57	Yes	79%	No	25%
Choptank	L61	None	32.44	8.69	Yes	92%	No	26%
Premet	L62	None	54.96	11.23	Yes	100%	Yes	30%
Reefs	L63	None	17.74	6	Yes	64%	No	0%
	L64	None	49.44	13.21	Yes	84%	Yes	64%
	L65	None	24.1	20.65	No	8%	No	8%
	L66	None	55.01	20.92	Yes	77%	Yes	33%
	L67	None	84.77	16.75	Yes	100%	Yes	86%

Table 19: Oyster biomass information for Little Choptank reefs monitored in 2017.

Monitoring Type	Reef #	Substrate type added	Are multiple year classes present?	Is shell volume stable/ increasing?	Ave shell volume across entire reef (liters per m^2)	Standard error of shell volume	Ave brown shell across all samples (%)	Is reef footprint stable/ increasing?	Is reef height stable/ increasing?
L. Choptank	L03	Spat-on-shell only	Yes	TBD in 2020	5.95	1.54	81.11	TBD	TBD
2014 Cohort	L04	Spat-on-shell only	Yes	TBD in 2020	7.43	1.92	68.57	TBD	TBD
Little	L53	None	Yes	TBD in 2020	9.85	1.78	54.29	Yes	Yes
Choptank	L56	None	Yes	TBD in 2020	15.92	1.94	68.12	Yes	Yes
reference	L52	None	Yes	TBD in 2020	12.95	2.23	68.57	TBD	TBD
	L57	None	Yes	TBD in 2020	4.17	1.48	8	TBD	TBD
	L58	None	Yes	TBD in 2020	8.6	1.59	68.18	TBD	TBD
	L59	None	Yes	TBD in 2020	10.3	1.44	48.33	TBD	TBD
	L60	None	Yes	TBD in 2020	8.88	1.15	47.5	TBD	TBD
Little	L68	None	Yes	TBD in 2020	8.19	1.24	78.08	TBD	TBD
Choptank	L61	None	Yes	TBD in 2020	9.63	1.42	44	TBD	TBD
Premet	L62	None	Yes	TBD in 2020	13.77	0.91	76.67	TBD	TBD
Reefs	L63	None	Yes	TBD in 2020	6.21	1.29	25	TBD	TBD
	L64	None	Yes	TBD in 2020	11.49	2.22	48	TBD	TBD
	L65	None	Yes	TBD in 2020	3.99	3.06	81.25	TBD	TBD
	L66	None	Yes	TBD in 2020	11.36	3.1	90.71	TBD	TBD
	L67	None	Yes	TBD in 2020	15.73	2.05	94.17	TBD	TBD

Table 20: Information on multiple year classes, shell volume, reef height, and reef footprint for Little Choptank reefs monitored in 2017.

Appendix D: Sentinel Reefs Data

A subset of reefs in each tributary have been designated as sentinel reefs; these are monitored annually. These reefs are not part of the 2014 cohort. This section contains 2017 monitoring information on these reefs.

Tributary	Reef #	Monitoring Type	Reef area (acres)	Average planned reefs height (inches)	Year Planted with Spat	Spat Planted (millions)	Spat planted per acre (millions)	Spat produced by	Spat planted by	Substrate type added
Harris	H01	sentinel	3.37		2012	31.27	9.27	ORP	ORP	Mixed shell
Harris	H18	sentinel	2.35		2013	16.47	7.01	ORP	ORP	Stone
Harris	H13	sentinel	3.40	N/A	2011	51.76	15.23	N/A	N/A	Spat-on-shell only
Harris	H10	sentinel	10.88	N/A	2012	52.09	4.79	ORP	ORP	Spat-on-shell only
Harris	H11	sentinel	6.53	N/A	2012	28.19	4.32	ORP	ORP	Spat-on-shell only
Little Choptank	L01	sentinel	1.61	N/A	2014	15.04	9.33	ORP	ORP	Spat-on-shell only
Little Choptank	L02	sentinel	2.81	6	2015	13.16	4.68	ORP	ORP	Fossil Shell
Little Choptank	L29	sentinel	2.72	12	2016	10.46	3.85	ORP	ORP	Stone & Fossil Shell
Little Choptank	L34	sentinel	4.19	12	2016	20.18	4.82	ORP	ORP	Stone
Tred Avon	T04	sentinel	5.94	N/A	2016	29.07	4.89	ORP	ORP	Spat-on-shell only
Tred Avon	T01	sentinel	1.78	12	2015	6.71	3.78	ORP	ORP	Mixed Shell
Tred Avon	T09	sentinel	3.30	12	2016	15.53	4.71	ORP	ORP	Stone
Tred Avon	T02	sentinel	0.80	12	2015	3.47	4.35	ORP	ORP	Mixed Shell

Table App D1: Sentinel reef restoration treatment information for Harris Creek, Little Choptank River, and Tred Avon River.

Monitoring Type	Reef #	Substrate type added	Sample Method	# samples taken	# live oysters measured	# live oysters counted	# dead oysters counted	% of oysters that were dead
Harris Sentinel Reefs	H01	Mixed shell	Patent Tong	11	315	481	100	17%
	H18	Stone	Diver	7	596	1089	148	12%
	H13	Spat-on-shell only	Patent Tong	10	106	742	107	13%
	H10	Spat-on-shell only	Patent Tong	11	138	1319	162	11%
	H11	Spat-on-shell only	Patent Tong	16	348	1673	164	9%
Little Choptank Sentinel	L01	Spat-on-shell only	Patent Tong	6	146	365	65	15%
	L02	Fossil Shell	Diver	6	416	908	88	9%
	L29	Stone & Fossil Shell	Diver	9	700	2266	170	7%
	L34	Stone	Diver	6	283	826	100	11%
Tred Avon Sentinel	T04	Spat-on-shell only	Patent Tong	17	200	556	44	7%
	T01	Mixed Shell	Patent Tong	6	110	640	19	3%
	T09	Stone	Diver	10	368	628	37	6%
	T02	Mixed Shell	Patent Tong	7	182	138	5	3%

Table App D2: Sentinel reef monitoring information for Harris Creek, Little Choptank River, and Tred Avon River.

Monitoring Type	Reef #	Substrate type added	Average live density across reef (#/m^2)	Standard error of live density (#/m^2)	Fall 2017: Did reef meet minimum threshold density?	Reef area meeting minimum threshold density (%)	Fall 2017: Did reef meet target density?	Reef area meeting target density (%)
Harris Sentinel Reefs	H01	Mixed shell	27.16	4.64	Yes	97%	No	14%
	H18	Stone	311.14	54.77	Yes	100%	Yes	100%
	H13	Spat-on-shell only	46.09	6	Yes	94%	Yes	65%
	H10	Spat-on-shell only	74.48	13.98	Yes	100%	Yes	76%
	H11	Spat-on-shell only	64.95	13.94	Yes	76%	Yes	67%
Little Choptank Sentinel	L01	Spat-on-shell only	37.78	16.7	Yes	65%	No	15%
	L02	Fossil Shell	302.67	79.1	Yes	100%	Yes	100%
	L29	Stone & Fossil Shell	503.56	48.65	Yes	100%	Yes	100%
	L34	Stone	275.33	69.25	Yes	100%	Yes	100%
Tred Avon Sentinel	T04	Spat-on-shell only	20.31	5.16	Yes	49%	No	16%
	T01	Mixed Shell	66.25	11.02	Yes	100%	Yes	52%
	T09	Stone	125.6	45.05	Yes	100%	Yes	67%
	T02	Mixed Shell	12.24	2.05	Yes	44%	No	0%

Table App D3: Sentinel reef oyster density information for Harris Creek, Little Choptank River, and Tred Avon River.

Monitoring Type	Reef #	Substrate type added	Ave. live biomass across reef (g dry weight per m^2)	Standard error of live biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Reef area meeting minimum threshold biomass (%)	Fall 2017: Did reef meet target oyster biomass?	Reef area meeting target biomass (%)
Harris Sentinel Reefs	H01	Mixed shell	37.06	6.37	Yes	97%	No	28%
	H18	Stone	208.04397	10.82	Yes	100%	Yes	100%
	H13	Spat-on-shell only	43.72	6.35	Yes	94%	Yes	34%
	H10	Spat-on-shell only	71.64	15.32	Yes	100%	Yes	76%
	H11	Spat-on-shell only	53.54	11.52	Yes	76%	Yes	54%
Little Choptank Sentinel	L01	Spat-on-shell only	40.09	18.89	Yes	65%	No	15%
	L02	Fossil Shell	184.354916	17.87	Yes	100%	Yes	80%
	L29	Stone & Fossil Shell	330.5340553	9.27	Yes	100%	Yes	100%
	L34	Stone	173.7102888	8.34	Yes	100%	Yes	90%
Tred Avon Sentinel	T04	Spat-on-shell only	23.2	4.78	Yes	78%	No	11%
	T01	Mixed Shell	84.25	11.84	Yes	100%	Yes	64%
	T09	Stone	116.5812748	18.35	Yes	95%	Yes	63%
	T02	Mixed Shell	12.72	2.22	Yes	44%	No	0%

Table App D4: Sentinel reef oyster biomass information for Harris Creek, Little Choptank River, and Tred Avon River.

Monitoring Type	Reef #	Substrate type added	Ave. live biomass across reef (g dry weight per m^2)	Standard error of live biomass	Fall 2017: Did reef meet minimum threshold oyster biomass?	Reef area meeting minimum threshold biomass (%)	Fall 2017: Did reef meet target oyster biomass?	Reef area meeting target biomass (%)
Harris Sentinel Reefs	H01	Mixed shell	37.06	6.37	Yes	97%	No	28%
	H18	Stone	208.04397	10.82	Yes	100%	Yes	100%
	H13	Spat-on-shell only	43.72	6.35	Yes	94%	Yes	34%
	H10	Spat-on-shell only	71.64	15.32	Yes	100%	Yes	76%
	H11	Spat-on-shell only	53.54	11.52	Yes	76%	Yes	54%
Little Choptank Sentinel	L01	Spat-on-shell only	40.09	18.89	Yes	65%	No	15%
	L02	Fossil Shell	184.354916	17.87	Yes	100%	Yes	80%
	L29	Stone & Fossil Shell	330.5340553	9.27	Yes	100%	Yes	100%
	L34	Stone	173.7102888	8.34	Yes	100%	Yes	90%
Tred Avon Sentinel	T04	Spat-on-shell only	23.2	4.78	Yes	78%	No	11%
	T01	Mixed Shell	84.25	11.84	Yes	100%	Yes	64%
	T09	Stone	116.5812748	18.35	Yes	95%	Yes	63%
	T02	Mixed Shell	12.72	2.22	Yes	44%	No	0%

Table App D5: Sentinel reef information on presence of multiple year classes, shell volume, reef height, and reef footprint for Harris Creek, Little Choptank River, and Tred Avon River.