



Standard Operating Procedure

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Revision History		
Version No.	Effective Date	Description
1.0	01/01/2024	<i>Original composition by M. Kachmar</i>

Procedure Owners:

Date:

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Approved By:

Date:

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1 Purpose

The purpose of this SOP is to provide concise guidance and methodology on how to measure oyster bed rugosity for intertidal and subtidal reefs to determine surface complexity which impacts productivity, larval recruitment, water flow dynamics, and trophic interactions.

2 Scope

This SOP is pertaining to the EPA Long Island Sound Study funded Oyster Health project where oyster bed rugosity will be used to characterize complexity for each oyster reef as part of biannual population surveys.

3 Definitions/Acronyms

4 Safety Precautions

All survey team members will wear appropriate clothing dependent on weather conditions including but not limited to waders, rubber boots or protective footwear, gloves, hats, sunglasses, long sleeve shirts, and pants. Team members will wash hands thoroughly after each sampling day. A first aid kit will be present for any injury. Extra water will be provided to avoid dehydration or heat stroke. Team members will take regular breaks when needed.

Exercise weather-appropriate field safety measures by monitoring conditions before and during the trip. Do not perform fieldwork during dangerous conditions (e.g. lightning, extreme winds, extreme floods). Do not visit field sites alone (use buddy system). Inform PIs of dates and times of fieldwork. Confirm safe return to the lab. At intertidal sites, perform procedures during low tide. At subtidal sites, divers are to follow NOAA diving regulations according to the instructions of the lab diving coordinator (barry.smith@noaa.gov).

5 Supplies/Materials

1. Fine-link chain attached to U-hook (intertidal)
2. Fine-link chain attached to weighted quadrat (subtidal)
3. Measuring tape
4. Waterproof datasheets
5. Digital datasheets
6. Mechanical pencils

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6 Equipment

1. Field tablet

7 Quality Control

All team members will be trained to complete all field tasks, including training on data entry requirements for each specific task. To ensure completeness, [field notebooks](#) will include a checklist of all data that needs to be recorded during each visit. All datasheets will be screenshots as back up in the event data is lost before connecting to the network.

8 Procedures

Note: Methods vary slightly between intertidal and subtidal sites and will be described below. Rugosity measurements are not associated with quadrats excavated for density.

1. Measurements will be taken from 3-4 randomly selected locations on the oyster bed.
2. Intertidal Sites
 - a. Mark the start of the rugosity measurement by inserting the U hook attached to the fine-link chain into the oyster bed in a secure position (Figure 1).
 - b. Lay the fine-link chain located in the field kit to contour the surface of the oyster bed along a straight line. This chain has a measurement of **229 centimeters** (fixed chain length). When contouring be sure not to intentionally shove parts of the chain into overhung crevices (Figures 1 and 2). *Be sure that the entirety of the chain is used to contour to keep measurements and calculations precise and consistent.*
 - c. Mark the place where the chain ends with a red flag to guide measurements
 - d. Using the measuring tape, measure to the nearest 0.5 centimeter the straight-line distance between the beginning and end points of the chain created by the contoured chain line to the nearest centimeter (measured contoured chain length, Figure 1).

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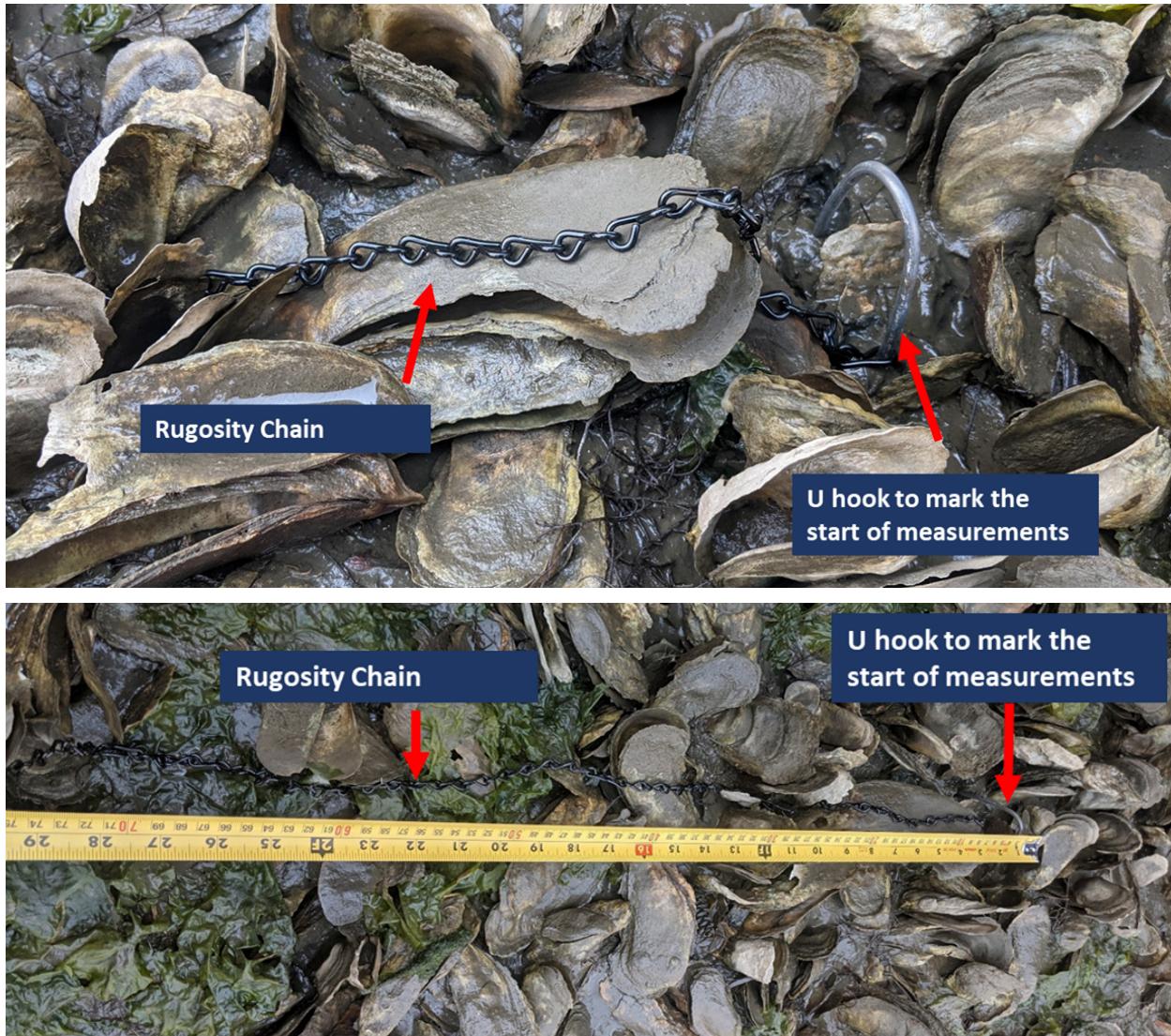


Figure 1: Image of the rugosity chain connected to the secured U hook on an oyster reef (top) and schematic showing method of measuring the contoured chain distance (bottom). Note that the chain is conformed to the surface of the oyster bed without pushing the chain into overhang crevices.

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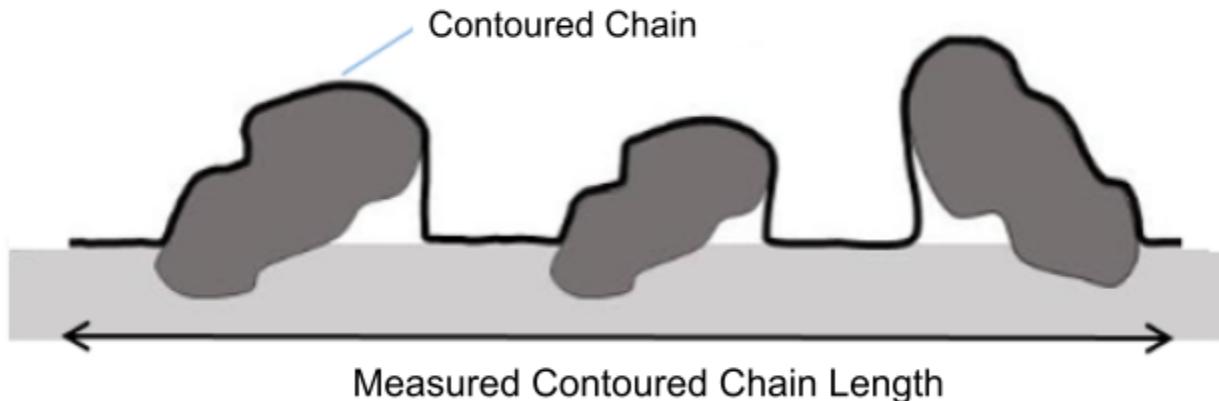


Figure 2: Schematic showing method of measuring oyster bed rugosity. A fine-link chain will be conformed to the surface of the oyster bed without pushing the chain into overhang crevices. Rugosity will be calculated as the measured contoured chain length divided by the fixed chain length (Janiak, 2021).

3. For subtidal sites, the fine link chain will be attached to a weighted quadrat to assist divers to maintain control of the chain underwater and in currents (Figure 3).
 - a. Lay the chain diagonally across the quadrat so that the chain falls into all the crevices.
 - b. Mark the place where the chain meets the diagonal corner of the quadrat with a white zip tie. The diagonal line of the quadrats is a known distance (fixed diagonal length, 35cm) and is marked with a small black zip tie (Figure 3).
 - c. Using the measuring tape, measure to the nearest 0.5 centimeter the straight-line distance between the attachment point and the white zip tie marker to the nearest centimeter (Figure 3). This is the measured diagonal length.

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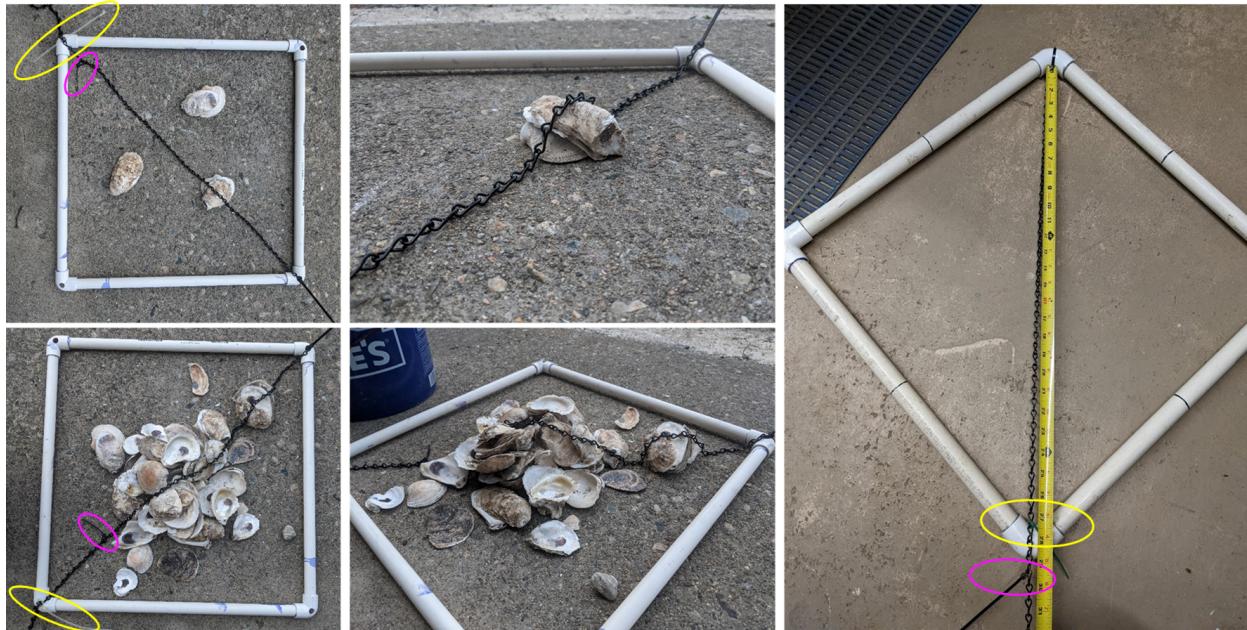


Figure 3: Example of rugosity measurements on low profile and small mound oyster beds. Pink circles mark the length of the chain taught along the diagonal of the quadrat (fixed diagonal length, marked by a black zip tie) and yellow circles mark added zip ties (measured diagonal length). Divers will mark the chain, and the distance between the attachment point and the added zip ties will be measured by the shore team.

4. Calculating rugosity

a. Intertidal sites

$$\text{Rugosity (intertidal)} = \frac{\text{Measured contoured chain length}}{\text{Fixed chain length}^*}$$

*The fixed chain length for intertidal sites = 229cm

b. Subtidal sites

$$\text{Rugosity (subtidal)} = \frac{\text{Fixed diagonal length}^*}{\text{Measured diagonal length}}$$

*The fixed diagonal length using a 25 x 25 cm quadrat = 35 cm

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- c. The rugosity index will be between 0 and 1, where oyster beds with values closer to 1 demonstrate less complex surfaces (the contoured chain distance is closer to the fixed length). Values closer to 0 indicate a more complex surface (contoured chain covers a shorter distance).
- 5. Values should be recorded in the appropriate datasheet based on site. Example data sheet "[characteristics](#)". Divers will record on a PVC sleeve with waterproof paper.

9 References

Janiak, D., 2021. MarineGEO Oyster Reef Habitat Monitoring Protocol. Tennenbaum Marine Observatories Network, MarineGEO, Smithsonian Institution.

10 Appendices

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