

# Sampling Nektonic Organisms Around Restored Oyster Reefs in the South Atlantic

A Practitioner's Guide to Regional Sampling

The Nature  
Conservancy



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## Introduction

One of The Nature Conservancy's (TNC) regional marine conservation program's goals is to significantly increase the population of oysters in the U.S. South Atlantic coastal systems to support fish habitat and production, maintain good water quality and mitigate shoreline erosion. The Conservancy is one of the few non-governmental organizations working in the marine environment at a regional level. By analyzing and presenting information at this broader scale, we can guarantee consistent methodologies and enable comparisons across the region. The project focused on (1) scientific monitoring of fish productivity around restored oyster reefs, (2) communication of results to key audiences across the U.S. South Atlantic region, and (3) continuation of in-water reef installations. The outcomes of these activities support the Conservancy's long-term goal of increasing the oyster population by 10% in the U.S. South Atlantic.

The primary focus of this multi-year project was to develop and implement a regional fish productivity monitoring protocol that will document the connection between restored oyster reefs, important fish species and the marine food web. To date, fish productivity sampling in the South Atlantic has occurred on a sporadic, localized basis. There is a need to collectively define and test a fish productivity monitoring protocol that can be used on a larger scale, allowing for consistency and comparison of data. Our project's monitoring methodology builds upon approaches cited in the NOAA/TNC documents 'A Practitioner's Guide to the Design & Monitoring of Shellfish Restoration Projects' (Baggett et al, 2014).

For two years starting in 2015, the Conservancy worked with our science research partners in North Carolina, South Carolina and Georgia to define a regional protocol for collecting species data at restored oyster reefs in the South Atlantic. Those partners included the University of North Carolina (UNC), South Carolina Department of Natural Resources (SC DNR) and University of Georgia's Marine Extension (UGA MAREX). Monitoring included collection of fish presence/absence data and sampling of invertebrate populations. Data collected at the restored reef sites was compared to data from control locations without reef structures. Nekton, aquatic animals that can swim and move independently of water currents, collected around the built reef sites included finfish, shrimp and crabs. The monitoring protocol developed during the project was a critical first step in helping fill the gap between oyster restoration and nekton productivity.

Starting in the spring of 2015, the Conservancy supported quarterly monitoring of productivity at sites across the southeast. The monitoring continued through the winter of 2016. Funding from Boeing in South Carolina supported two years of monitoring at five existing Conservancy reef sites across North Carolina, South Carolina and Georgia. Boeing also support a third year of work dedicated to data analysis and publication development.

The Conservancy is committed to communicating the outcomes of this monitoring project. Key audiences include state and federal natural resource agencies, funding organizations, technical partners, and key public constituencies, such as sports fishermen. One key communication priority is translating the monitoring results for incorporation in future monitoring projects and funding proposals. Significant federal funding for habitat restoration is focused on the potential

contribution to the life cycle of federally managed fish species. Often, oyster reef projects compete against other restoration efforts, such as dam removal or wetland restoration, for funding. The data available to demonstrate the value of restoration to nekton communities varies across project types and locations. Improving the scientific information on the direct and indirect use of restored reefs by commercially and recreationally important nekton could help increase the competitiveness of oyster projects.

This document covers a variety of proven sampling techniques that can be used to capture nekton utilizing oyster reefs. These techniques include drop nets, lift nets, gill nets, seine nets, habitat trays, and nook and cranny traps/shell bags all of which are covered in this document in detail. Different techniques were used at different sites with the goal of capturing as much nekton as possible around the Conservancy's restored reef sites and adjacent controls. Gill nets, seine nets, and nook and cranny traps were used in North Carolina; drop nets, gill nets, seine nets, and habitat trays were used in South Carolina; and lift nets and shell bags were used in Georgia. A step-by-step breakdown of each method's strengths and limitations are covered to help practitioners determine which technique(s) would best suit their needs.

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## Overview of Methods

A brief overview of several proven nekton sampling techniques will be discussed in this section along with their strengths, limitations, and lessons learned. A list of materials are also included so that these methods can easily be replicated.

Technique: Drop Net

Project Manager: SC DNR

Reef type: Intertidal preferred

Catch: All finfish and invertebrates within enclosed area

Strengths: Captures several size classes of finfish and invertebrates, known sample area

Limitations: Requires two days to get one replicate sample, tide dependent

Difficulty: High

Number of People: Minimum of 2 per net, 3 or more is recommended

Description: The drop net sampling method involves installing four or more sets of two aluminum poles, depending on net size, with brackets. For example, 5 poles in front (seaward) and 5 in back (landward) spaced 5 meters apart around a known sample area of 5 x 20 meters. Drop nets can be used simultaneously at experimental and control plots and nets are set up at low tide the day before sampling is to occur (Figure 1). The custom made brackets have pre-drilled holes attached to the top of each pole, through which pins are placed to hold the net in place until they are released to deploy (drop) the net. Brackets should be about 1.7 meters above the ground or can be taller, if necessary, depending on water depth at high tide. Our net is made of 0.64 centimeter mesh and is 2.4 meters with 1.27 centimeter foamcore float line on top and lead line on the bottom edges. This net is sufficiently deep enough during typical high tides to ensure that the top will float atop the water surface and the lead line will stretch to remain on the bottom to ensure that no organisms will escape once the net is dropped. The float line of the net is zip tied to the brackets, then the net is placed within the brackets and held up by cotter pins attached to a trip line. Typically, two trip lines are used, one for the back (landward) poles and one for the front (seaward) poles (Figure 2). Nets are dropped at high tide via kayak by pulling the trip lines. Personnel enter the net with dip nets collecting all finfish and invertebrate samples once the tide drops low enough (Figure 3). The net and poles are removed after sampling.

Lessons Learned: It is highly recommended that samplers stay with the net after it has been dropped to ensure that it is protected from large boat wakes or other disturbances that may cause part of the net to come down and release trapped nekton.

Materials:

- Ten 3 meter tall aluminum poles with pre-drilled holes for brackets (per net)
- Ten brackets to hold net that can be attached to aluminum poles (per net)
- Cotter pins (10 per net)
- Trip lines (2 per net)
- Zip ties

- Knotless Seine, 0.64 centimeter square delta mesh, 2.4 meters deep with 50 pound leadcore and 1.27 centimeter foamcore
- Heavy duty trash can to transport and store net
- Dip nets and buckets to collect and store samples



**Figure 1 Drop net set up at low tide around the control plot the day before sampling occurred in South Carolina.**



**Figure 2** Biologists tripping the drop net by kayak at high tide in South Carolina.



**Figure 3** Sampling a reef plot in South Carolina after the net has been dropped and tide has lowered.



Technique: Lift Net

Project Manager: UGA MAREX

Reef type: Intertidal preferred

Catch: All finfish and invertebrates within enclosed area

Strengths: Captures several size classes of finfish and invertebrates, known sample area

Limitations: Requires two days to get one replicate sample, tide dependent

Difficulty: High

Number of People: Minimum of 2 per net, 3 or more is recommended

Description: The bottomless “lift net” (Wenner et al. 1996) used was 5 x 3 x 3 meters made of 3.175 millimeter Delta mesh (Memphis Net and Twine) that have a lead line weighted base that was staked with 20 centimeter stakes in half meter increments around a portion of the living shoreline, natural reef and mud flats. Nets are connected to ten 3.5 meter PVC poles with 90° fittings at the top, using 3.175 millimeter braided nylon rope and attached to aluminum pole, >5 meters from net site, through an eyebolt. Net should be set up at low tide (Figure 4) and raised at high tide the following morning after sunrise (Figure 5). The nets remained raised until the subsequent low tide exposes the substrate, at which time the nets were lowered and all trapped organisms are collected.

Lessons Learned: The footprint of this net can be increased, but would require more personnel to set up, especially in muddy sites.

#### Materials

- Ten 3.5 meter PVC poles
- 3.175 millimeter braided nylon rope
- 5 x 3 x 3 meter 3.175 millimeter delta mesh net with leadcore
- 20 centimeter stakes are recommended for every half meter of net



**Figure 4 Lift net set up prior to sampling in Georgia.**



**Figure 5** Lift net after it has been lifted and sampled in Georgia.

Technique: Gill Net

Project Manager: UNC & NC TNC

Reef type: Intertidal or subtidal

Catch: Large finfish and some invertebrates, mesh size can allow for size-specific selective sampling

Strengths: Captures large nektonic organisms that may be too fast to be captured by other methods, easy to set up, volunteer friendly

Limitations: Will usually capture organisms that are large enough to become stuck in mesh

Difficulty: Moderate

Number of People: Minimum of 2 per net, 3 or more is recommended

Description: The experimental gill nets used for subtidal reef sampling were composed of vertical panels of 4, 7, and 10 centimeter square-mesh polypropylene line. Nets were set perpendicular to the living shoreline reefs and were positioned between sampled reefs or reference plots (Figure 6). We used 3 gill nets to sample the gaps between 4 reefs constructed of the same material so as to better isolate the organisms that preferred that type of reef material (marl vs bagged shell at our study site). Gaps between different reef types were not sampled. The center of each gill net aligned with the crest of the reefs or control plots, so that half (15.24 meters) extended both landward and seaward of the reef crests or reference plot midline. The order of the 3 different mesh-size panels of the landward portion of each net was reversed in the seaward portion (e.g., a mirror image or 10, 7, 4 and 4, 7, 10 centimeter mesh panels). Each treatment (reef material) had one of each of the 3 possible mesh-size panel arrangements. Top-line floats and lead-weighted bottom line were added to enable the panels to stretch from the water surface to the estuarine floor. Each gill net is assumed to have sampled 820 square meters (30.48 meters long by 1.2 meters mean water depth by an estimated distance of 12 meters on either side of the net) of water column for 4 hours.

Lessons Learned: For our study site, a 4-hour soak period was chosen so that fishes caught in the nets could be identified before the high density of blue crabs (*Callinectes sapidus*) consumed or otherwise disfigured these fish, which would make species identification impossible. Also, gill nets were deployed only during daylight hours (Figure 7) so that biologists could monitor nets for unintended catch, such as Atlantic or Shortnose sturgeon, marine mammals, or sea turtles. However, gill nets could be used to sample organisms that use the reefs at night, if safety of personnel can be assured.



**Figure 6 Gill nets set between reefs and control plots in North Carolina. The large float in center of net (and this photo) was used to label mesh-size panel arrangement and to guide center of net to reef crest.**



**Figure 7** Completing deployment of gill net from boat (in reverse) at North Carolina subtidal site.

**Materials:**

- Each net was 30.48 meters x 1.83 meters and tagged at 15.24 meters
- 30 lb. lead core rope on the bottom and 0.95 centimeters float line on the top
- Each net will have 6 panels each 5.08 meters that repeat once
- The monofilament mesh sizes were:
  - A. 3.81 centimeter sq. (7.62 centimeter stretch) .33 millimeter twine
  - B. 5.72 centimeter sq. (11.43 centimeter str.) .33 millimeter twine
  - C. 10.16 centimeter sq. (20.32 centimeter str.) .47 millimeter twineThe panel configurations were: ABCCBA, BCAACB, CABBAC

*NOTE: A scientific permit was required to use these mesh sizes that are otherwise illegal in NC. Check laws in the region in which you are sampling. Be sure to monitor gill nets closely while deployed to free air-breathing organisms.*

Project Manager: SC DNR

Description: Intertidal reef sampling with an experimental gill net, 1.83 meters x 38.1 meters with 5 panels of 7.62 meters each using #4 2.54 centimeter and 3.81 centimeter, #6 5.08 centimeter, 6.35 centimeter, and 7.62 centimeter square mesh with 30 pound leadcore and two weights on both ends of the net and 1.27 centimeter foam-core float line was placed parallel to and about 2 meters seaward of the patch of reef adjacent to the reef or control plot. The net was

checked every 20 minutes to limit mortality of organisms captured. This was conducted three times for both the reef and control plots.

Lessons Learned: Strong currents along the Intracoastal Waterway caused the net to move out of position. This could be fixed with stronger anchors at both ends of net and/or possibly use a shorter net.

Materials:

- Each net is 1.83 meters x 38.1 meters with 5 panels of 7.62 meters each using #4 2.54 centimeter and 3.81 centimeter, #6 5.08 centimeter , 6.35 centimeter, and 7.62 centimeter square mesh
- 30 pound leadcore
- 1.27 centimeter foam-core
- 2 cement weights, one attached to leadcore on each end
- 2 floats, one attached to the end of each foamcore



**Figure 8** Biologists checking gill net in front of intertidal oyster reef in South Carolina.

Technique: Seine Net

Project Manager: UNC & NC TNC

Reef type: Intertidal or subtidal

Catch: Small finfish and invertebrates

Strengths: Easy to use, inexpensive, permits sampling in areas without tides, volunteer friendly

Limitations: Will only capture small organisms too slow to escape

Difficulty: Easy

Number of People: Minimum of 2

Description: Subtidal seine nets, pulled by two biologists (Figure 9), were used to sample the entire depth of the water column immediately adjacent to (on landward side) and parallel to the reefs or reference plots. Our seine nets (3.2 millimeter mesh) were limited to 3.5 meters in length, (1 meter in height) so that wood snags could be avoided; triplicate 10 meter long tows were conducted for each replicate of all treatment. Our study used 10 meter long tows that sampled 20 square meters of the water column (2 meter long by 1 meter high by 10 meter long tow).

Lessons Learned: It is helpful to have a beach onto which one can bring the net at the end of a run, to prevent fish from escaping; because many organisms are able to escape, those caught in a seine are not necessarily representative of the community using the reefs

Materials:

- 3.2 millimeter mesh or other mesh size appropriate for study, length depends on site characteristics- *longer nets become heavier to pull, and 1 m high or longer, depending on water depth*
- Floats attached to top line
- Wood or PVC poles attached along sides of seine by top and bottom lines of seine





**Figure 9 Biologists towing seine net through reference plot in North Carolina.**

Project Manager: SC DNR

Description: Intertidal seine nets were deployed behind the reef footprint. The nets used were 4.57 meter long, 1.22 meter deep, and have 0.318 centimeter mesh. Two people were used to pull the net between the reef and shoreline (Figure 10). This was repeated three times for each treatment.

Lessons Learned: This method could be easily trained to new individuals prior to sampling.

Materials:

- 4.57 meter long, 1.22 meter deep, 0.318 centimeter mesh net
- PVC poles on either side of net
- Floats attached to top of net



**Figure 10** Biologists pulling a seine net behind an intertidal oyster reef in South Carolina.

Technique: Habitat Trays

Project Manager: SC DNR

Reef type: Intertidal or subtidal

Catch: Small finfish and invertebrates

Strengths: Easy to set up, known sample area, cheap

Limitations: Will only capture small, slow moving organisms that are in or on top of reef

Difficulty: Easy

Number of People: 1

Description: Three habitat trays were placed within each treatment (reef and no reef). These habitat trays were constructed of 2.54 centimeter or 1.91 centimeter PVC and 1.27 centimeter ADPI plastic mesh creating a 48.26 centimeter x 48.26 centimeter x 15.24 centimeter trays that were filled to a depth of 12.7 centimeter with cured oyster shell (Figure 11). Trays were anchored in place with 2-4 pieces of rebar depending on intensity of energy at the site. A 12.7 centimeter high platform was attached to the bottom of the habitat trays to raise them above the sediment surface to reduce the degree of sediment accumulation within the trays. A 2.54 centimeter mesh is placed over the habitat tray to reduce loss of shell by displacement from waves and currents. These trays are deployed for at least one month before being retrieved for processing.

Lessons Learned: These trays were originally placed directly on the sediment, but later placed on 12.7 centimeter tall platforms after being filled with sediment after only a short period of time due to the high levels of erosion and/or being placed on top of soft sediments. These habitat trays did not need platforms if they were placed directly on the reef. Rebar anchors are needed in high energy environments.

Materials:

- 2.54 centimeter schedule 40 PVC (drill holes in PVC so it does not float)
- 4 three-way PVC elbows per tray
- 1.27 centimeter mesh
- 2.54 centimeter mesh
- Zip ties
- Cured oyster shell
- Rebar (#3 J bar 70 centimeter with 10.16 centimeter candy cane bend)
- Soda or bread trays for platform (optional)



**Figure 11 Habitat tray deployed next to intertidal oyster reef in South Carolina.**

Technique: Nook-and-Cranny Traps

Project Manager: UNC & GA MAREX

Reef type: Intertidal or subtidal

Catch: Small finfish and invertebrates, especially those species that prefer the interstices of reef or another structured habitat

Strengths: Easy to set up and use; traps easily emptied aboard boat

Limitations: Will only capture small and generally slower moving organisms; must unify size of traps and emptying (invert and shake into tub of water) of traps to standardize sampling

Difficulty: Easy

Number of People: 1

Description: The nook-and-cranny (NaCT) traps are composed of 2.5 centimeter plastic-mesh bags filled with cured oyster shell and an additional 1 millimeter nylon mesh screening wrapped around the lower 70% of the bag area attached by zip ties so that organisms could migrate in and out of the trap, yet would remain in the trap upon retrieval (Figure 12). Each NaCT can be uniquely labeled by attaching screening with zip ties of a specific color (color-code by treatment) and secured in a unique pattern. We used this system to indicate treatment type and position sampled on reef or plot, in case NaCTs were repositioned by currents or storm waves. Soak time of NaCTs should meet the needs of a given study, yet should remain uniform between treatments and sampling periods (e.g., seasons) for consistency of sampling effort and subsequent statistical analyzes of sampling data. A retrieval line and surface float is recommended so that trap can be easily retrieved from subtidal reefs. Upon retrieval, NaCTs can be pulled up through the water column, keeping the trap oriented such that the 1 millimeter mesh filters the water that had filled the trap, retaining organisms, then carried to the boat or work platform nearby. For our study, each NaCT was then inverted and shaken for 20 consecutive times such that organisms were liberated from the trap, falling through the large-mesh section of the trap, and into a large bin with local estuarine water.

This method was also used in Georgia except that there was no 1 millimeter nylon mesh (outer layer to trap very small organisms) or float used. These Georgia shell bags were approximately 45 centimeter long and 25 centimeters wide. Three of these shell bags were randomly placed at each location to be sampled and left to soak for 4 weeks. The shell bags were retrieved at low tide and immediately placed in a bucket so no organisms would be lost and were later dissected in the lab. These are the typical shell bags used in oyster reef restoration.

Lessons Learned: This low-cost gear enabled sampling of organisms that serve as prey for fishes of recreational and commercial interest, as well as reclusive organisms that are often very challenging to assess. For example, in North Carolina, the NaCTs allowed us to find that juvenile American eels were abundant and using reefs at the Pt Peter Rd site in Alligator River National Wildlife Refuge.

Materials:

- 2.54 centimeter plastic mesh
- 1 millimeter nylon mesh (available as window screening)
- Zip ties
- 1 float (per trap)
- Float line
- Cured oyster shell



**Figure 11 A newly constructed nook-and-cranny trap in North Carolina.**

## Discussion

Oyster reef sites can vary greatly in terms of surrounding substrate, wave energy, boat traffic, tides, depth, etc. Nektonic species that are found at or near oyster reefs also belong to many different trophic levels. These factors make it challenging to sample nekton utilizing restored oyster reefs with a single sampling method. Funding and staff availability can also be a factor when selecting the suitable sampling technique. All the techniques discussed in this document are suitable for sampling nekton around restored oyster reefs, however, to economize among funding sources and personnel availability, it may be wise to share some gear types within a given region. Drop nets and lift nets work well for capturing a wide range of nekton species and across multiple trophic levels, yet these gear types are best suited for an intertidal hydrologic regime, and require significant staff time. Gill nets and seine nets worked well for sampling of nekton using both subtidal and intertidal oyster reefs and can be deployed quickly and easily by trained volunteers without much investment or instruction. These net types are easy to deploy with few people, are easy to acquire, and can be easily modified for ones needs. We found that either drop nets or lift nets were able to sample a broad range of nekton species, whereas a combination of both gill and seine nets were required to capture this same range of species. Overall, drop and lift nets offered better estimates of nekton density, due to knowing exact area sampled. However, the gill net and seine net combination seems to be the easiest method to standardize across the southeast region and can be easily deployed for multiple sampling events.

Habitat trays, nook and cranny traps, and shell bags are very similar in that they passively sample small organisms and they are all easy to set up, deploy, and retrieve. These three methods also capture similar benthic organisms that live within the reef. One advantage to the habitat tray is that they can easily be standardized across a region as far as dimensions and volume of shell.

Future regional monitoring should: (1) include multiple sampling events per year for each site (at least three); (2) occur over multiple years; (3) include multiple sites across states due to variation in abiotic factors; (4) include reference plots; and (4) be standardized between states as much as possible to better compare sampling results and facilitate statistical analyzes. A combination of sampling methods such as gill nets, seine nets, and habitat trays may be the best methods to ensure that we are capturing as many target species as possible, while at the same time making it possible to accomplish this goal with limited resources.

## References

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