

South Florida/Caribbean Network

National Park Service
Inventory and Monitoring Division



Standard Operating Procedure SL03

Sample Allocation—Version 1.1

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Purpose

This standard operating procedure (SOP) describes the background and rationale for sample allocation, using a stratified random approach, to monitor lobster in SFCN parks. The allocation for spiny lobster differs from the methods presented in the reef fish monitoring protocols. Initially, samples will be allocated evenly across all strata. Once more information is known about the lobster densities and distribution within a sample domain, the sample allocation scheme will be revised to achieve a more efficient allocation. In general, to improve sampling efficiency, proportionally larger strata and strata with greater variance should have more samples allocated to them than smaller, less variable strata.

Revision Log

Revision Date	Author	Changes Made	Reason for Change	New Version #
6/30/2020	W. Wright	Version number updated	SOPs revised with operational review	1.1

Source Protocol

This SOP is derived from SOP A in the Florida reef fish monitoring protocol and SOP 3 in the Virgin Islands reef fish monitoring protocol:

- Brandt, M. E., N. Zurcher, A. Acosta, J.S. Ault, J. A. Bohnsack, M. W. Feeley, D. E. Harper, J. H. Hunt, T. Kellison, D. B. McClellan, M. E. Patterson, and S. G. Smith. 2009. A cooperative multi-agency reef fish monitoring protocol for the Florida Keys coral reef ecosystem. Natural Resource Report NPS/SFCN/NRR—2009/150. National Park Service, Fort Collins, Colorado.
- Bryan, D. R., A. J. Atkinson, J. S. Ault, M. E. Brandt, J. A. Bohnsack, M. W. Feeley, M. E. Patterson, B. I. Ruttenberg, S. G. Smith, and B. D. Witcher. 2013. A cooperative multiagency reef fish monitoring protocol for the U.S. Virgin Islands coral reef ecosystem. Natural Resource Report NPS/SFCN/NRR—2013/672. National Park Service, Fort Collins, Colorado.

Introduction

This SOP outlines a single-stage stratified random design that draws heavily upon the sample design for the reef fish monitoring protocols for Florida and the U.S. Virgin Islands (Brandt et al. 2009; Bryan et al. 2013). This protocol utilizes the same sample frame and habitat classifications (SFCN SOP SL01 *Sample Frame and Habit Classification—Version 1.0* [SFCN 2020a]) as the reef fish monitoring protocols in the respective regions. The stratification scheme (SFCN SOP SL02 *Stratification—Version 1.1* [SFCN 2020b]) is also the same as the reef protocols, though some of the strata have been combined. This was done primarily to reduce the number of strata so that enough samples can occur in each stratum to allow for sufficient detection of lobsters to allow for robust statistical analyses. There were also cases where strata were too small to warrant separate sampling and were combined with similar strata.

An ideal sample allocation reduces the number of samples required to achieve a target level of variance. Initially we will allocate samples evenly across all strata. Once more is known about lobster density, distribution, and associated variances for each of the strata in the sample domain, the allocation scheme will be revised to make sampling more efficient. In general, to improve sampling efficiency, proportionally larger strata and strata with greater variance should have more samples allocated to them than smaller, less variable strata.

Sample Regions

The SFCN parks included in this lobster monitoring protocol are located in two distinct regions: Florida and the U.S. Virgin Islands. The Florida region, which includes Biscayne National Park and Dry Tortugas National Park, will use the sample frame and habitat classification scheme detailed in Brandt et al. (2009). The U.S. Virgin Islands, which includes Buck Island Reef National Monument, Salt River Bay National Historical Park and Ecological Preserve, and Virgin Islands National Park,

will use the sample frame and habitat classification scheme detailed in Bryan et al. (2013). All hard-bottom habitats within each of the park units are targeted for sampling (Figure 1). The stratification schemes for each park unit are detailed in SFCN SOP SL02. The amount and type of hard-bottom habitat in each stratum in each park are listed in Tables 1, 6, 7, 8 and 9 in SOP SL02. Note that some of the original strata in the reef fish monitoring protocols have been merged for this protocol. For reference, the amount and type of hard-bottom habitat of the original strata in each park is found in Tables 1, 2, 3, 4, and 5 of SOP SL02.

The mapped polygon area of hard-bottom in each stratum is less than that of the summed area of the grid cells in each stratum. This is because many of the grid cells have only partial coverage of habitat. For stratification and analyses, if we were to use the polygon hard-bottom areas, we would likely underestimate abundance because there are hard-bottom areas that are not mapped. If we treat the entire grid cell area as hard-bottom habitat, then we may overestimate abundance. In this protocol (and in the reef fish monitoring protocols) the entire grid cell area is treated as hard-bottom habitat. Because of uncertainty in the extent of benthic habitat coverage, we emphasize that calculated values for abundance are uncertain. Thus, relative density and relative frequency of occurrence are more appropriate and may be estimated for individual strata. However, due to the uncertainty in map weights, when making park-wide calculations we emphasize that relative density and relative frequency occurrence are unit-less indices.

Using the available benthic habitat maps to either influence selection probabilities of the sample allocation or final calculation of strata weights is inadvisable due to the inaccuracies of the maps. This problem will be reduced over time as maps get more accurate, grid cell size gets smaller, and additional methods are developed to use LiDAR and multi-beam sonar to better map benthic habitats.

This general approach is consistent with that used in the multi-agency reef fish monitoring used in the Florida Keys and in the U.S. Virgin Islands (Brandt et al. 2009; Bryan et al. 2013). As those protocols are modified, the spiny lobster protocol will be modified as well.

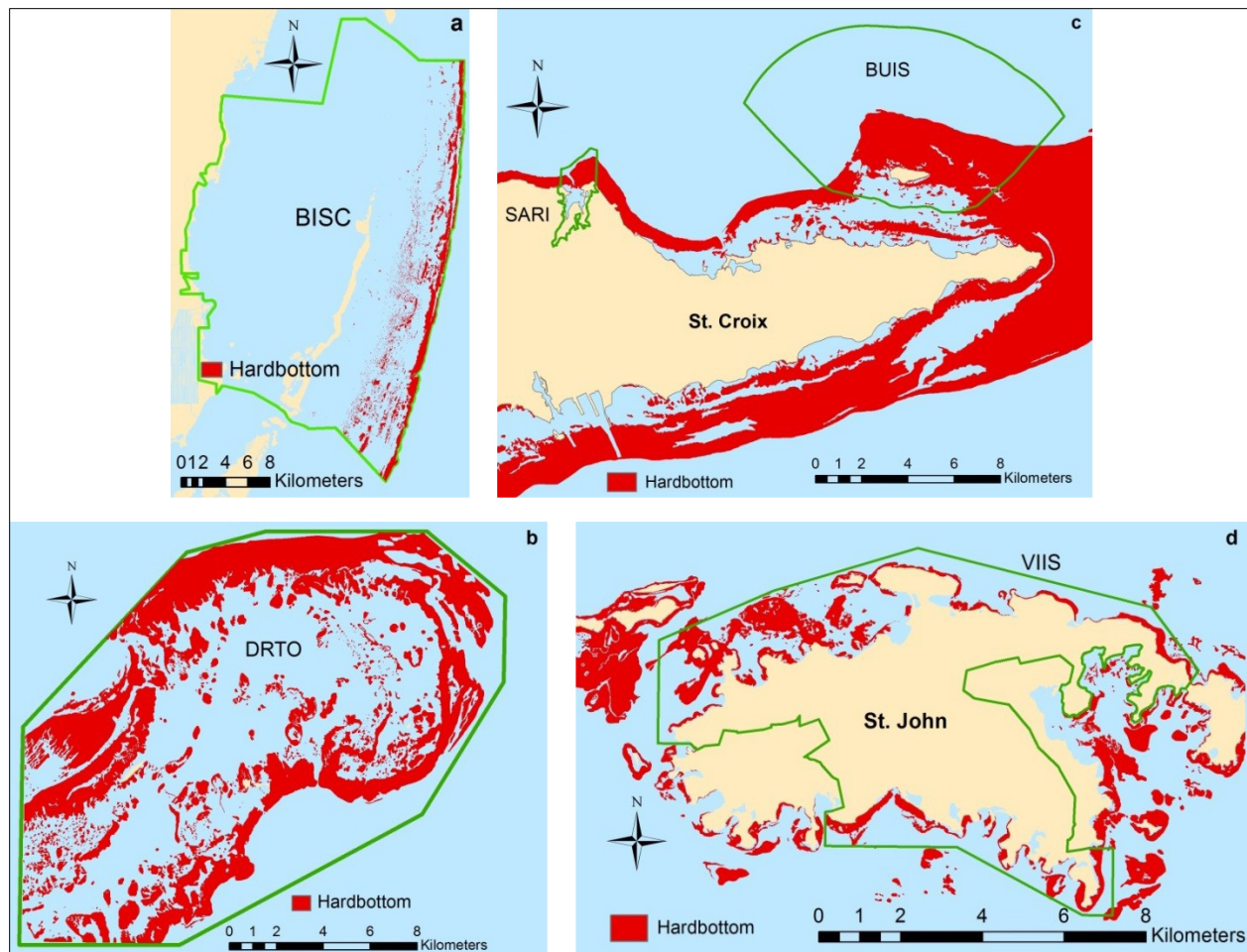


Figure 1 Sampling regions in Florida, (a) Biscayne NP and (b) Dry Tortugas NP); and in the U.S. Virgin Islands, (c) Salt River NHP&EP and Buck Island NM and d) Virgin Islands NP. The red areas indicate hard-bottom habitat. The green outline represents the park boundary.

Stratified-Random Design

In each of the park units, the hard-bottom habitats are split into several strata based upon depth and habitat classification. This was initially done for the reef fish monitoring protocol because fish are heterogeneously distributed among these strata based on physical and biological differences. To determine the efficacy of management zones in protecting and enhancing lobster populations, a management zone stratum may be added if the survey domain expands beyond the park boundaries. Allocation of sites inside and outside protected and unprotected areas allows for direct comparisons between them (Brandt et al. 2009). Brandt et al. (2009) and Bryan et al. (2013) determined that using a stratified random design to sample reef fish improved sampling efficiency over a simple random design. This protocol, while lacking the historical data to show this for spiny lobster, assumes that a stratified random design will also prove more efficient than a simple random design because lobster also exhibit a heterogeneous distribution based on physical and biological differences in habitats.

Sample Allocation

An ideal sample allocation reduces the number of samples required to achieve a target level of variance. The reef fish protocols use an optimal (Neyman) sampling allocation (Brandt et al. 2009; Bryan et al. 2013). While a Neyman allocation has proved successful for reef fish monitoring in the Florida and Virgin Islands, we do not have enough data to do this effectively for lobster. It will likely require several sampling events in order to accrue enough data for it to be practical for lobster. Initially we will allocate samples evenly across all strata. Once more is known about lobster density, distribution, and associated variances for each of the strata in the sample domain, the allocation scheme will be revised to make sampling more efficient.

Site Selection

Once the total number of primary units is determined, the actual selection of sites is carried out in two stages. First, the primary units sampled per stratum are randomly selected from the complete list of (N_h) cells within a stratum using a discrete uniform probability distribution, which assigns equal selection probability to each grid cell (Law 2007). The total area of a stratum is represented by A_h . The NOAA Sampling Design Tool is used for this and procedures described below. Second, when in the field, the survey sample is haphazardly chosen within a primary unit based on the distribution of target habitat within the primary unit and diving safety considerations.

$$N_h = \frac{A_h}{10,000 \text{ m}^2} \text{ (FL) or } N_h = \frac{A_h}{2,500 \text{ m}^2} \text{ (USVI)}$$

In general, the South Florida/Caribbean Network will do its own sample draw. However, when strata are identical between this protocol and the reef fish protocol, the primary unit selection for spiny lobster may utilize the sites generated for the most recent reef fish monitoring sampling event (SOP A in Brandt et al. 2009; SOP 3 in Bryan et al. 2013).

In concern for dive safety and because of possible spatial autocorrelation, each survey sample consists of the average of combined, adjacent 7.5-meter (24.6-foot [ft]) radius circular plots. Each plot is to be completed by both divers to limit diver separation while underwater.

In theory, the location of the survey sample within each primary unit should be random or systematic, and not haphazard, but this is not practical in a field sampling situation. During reef fish monitoring, which employs the same sample unit selection, the distribution of surveys within a primary unit was biased toward the center point (Brandt et al. 2009). This is likely due to a combination of the resolution of the grid and the distribution of the habitat within the primary units, and there is a possibility that spatial autocorrelation could affect the results. However, it is deemed unlikely that this affects the overall results of sampling.

Procedure for Selecting Random Sample Sites (grid cells) using the NOAA Sampling Design Tool

1. Open the NOAA Sampling Design Tool within ArcGIS. If necessary, the tool can be downloaded and installed from the NOAA website:
<https://coastalscience.noaa.gov/projects/detail?key=185>.
2. Within the “Sampling Design Tool” window:
 - a. Under “Sampling type”, choose “Select Samples from Frame.”
 - b. Under “Sampling design”, Choose “Stratified Random.”
 - c. Check the “Export selected features” box.
 - d. ***NOTE: This will export a shapefile of the random sample sites to the location chosen in step 3.g. below.***
 - e. In “Sample frame,” select the grid shapefile from which the random sample sites will be drawn.
 - f. Under “Strata field,” select the field in the attribute table containing the strata of interest.
 - g. Click “Run.”
3. Within the “Select Stratified Inputs” window:
 - a. Under “Allocation Method,” click on the “Even” button.
 - b. In the “Sample units to allocate” box, enter the total number of samples desired.
 - c. ***NOTE: This will evenly allocate samples within each stratum. The “Define the number of sample unites to select in each stratum” window will show the number of samples allocated in each stratum.***
 - d. Do not check the “Keep minimum distance between points” box.
 - e. Click “Run.”
 - f. In the “Save a feature class” window, navigate to the location where the shapefile of the random sample sites will be exported.
 - g. Under “Name:” type an appropriate name for the shapefile.
 - h. Under “Save as type:” select “Feature classes.”
4. Click “Save.”

Literature Cited

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