

South Florida/Caribbean Network

National Park Service
Inventory and Monitoring Division



Standard Operating Procedure CR07

Selecting and Locating Random Sampling Points using GPS—Version 2.1

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Summary

This procedure describes an inexpensive method to conduct random sample selection (as opposed to haphazard) at an underwater study site. Available imagery or benthic maps are used to delineate a study area, which can then be checked by diving/snorkeling. Then GIS tools are used to generate random points within the study area and a range and bearing matrix for underwater navigation. The points obtained by this SOP mark the origin of a transect. The transect bearing is determined to run along a consistent depth contours within the study site. This minimizes transects crossing different reef zones, habitats or structures. (See SOP CR09 *Installing monitoring sites—Version 2.1* (SFCN 2025) for additional information on selecting the transect bearing.

Revision Log

Revision Date	Author	Changes Made	Reason for Change	New Version #
2002	Jeff Miller	Published Protocol: Miller, J. 2002. Using the AquaMap System at a Study Site. U.S. Geological Survey Technical Report.	Original published Aquamap protocol.	1.00
2004	Jeff Miller, Judd Patterson	Established Amanda's Reef site using GPS sealed in floating bag. At the time this was used as an alternative to Aquamap.	Amanda's reef was too shallow to use Aquamap method.	1.01
2012	Lee Richter, Judd Patterson	Updated SOP with detailed descriptions of methods using ArcGIS and latest maps and technology.	SOP updated to reflect latest GIS technology and steps used in SARI site establishment.	1.02
January 2015	Lee Richter, Judd Patterson	SOP revised to meet I&M program, organization and format requirements.	To meet I & M program, organization and format requirements	2.0
June 2020	Judd Patterson	SOP name changed from 7 to CR07.	Renamed according to regional guidance.	2.1

Objectives

- Outline a study site of interest.
- Randomly select sample points.
- Be able to locate those sample points.
- Generate a list of bearings and distances.

Equipment

- Ensure the availability of ESR ArcGIS version 10 (or newer)
- Handheld GPS w/waterproof container
- Floatation device, kickboard, lifejacket, floating dive flag etc.
- Elastic shock cords to secure GPS to floatation device.

Procedures

Outline the Study Site

1. Start by gathering available datasets that provide insight into the benthic environment around the site. These may include benthic habitat maps and aerial imagery. (Note: The blue band in aerial imagery often holds the most benthic detail and may be useful to display as a monochrome image.)
2. Create a new polygon shapefile by opening ArcCatalog and browsing to the folder that will hold the site outline polygon.
 - a. Right-click on the folder and choose “New” and then “Shapefile...”
 - b. Name the shapefile appropriately.
 - c. Change the Feature Type to “Polygon”
 - d. Set the spatial reference by clicking the “Edit...” button, expanding the “Projected Coordinate Systems”, “UTM”, and “NAD 1983” folders. For Florida, choose “NAD 1983 UTM Zone 17N”, and for the U.S. Virgin Islands, choose “NAD 1983 UTM Zone 20N”. Click OK.
 - e. Click OK again to dismiss the “Create New Shapefile” screen.
3. With the new shapefile created, close ArcCatalog and open ArcMap.

4. Click the “Add Data” button and browse to the new shapefile that was just created. Select it and click OK to bring it into ArcMap.
5. Add any additional data layers, such as imagery, that will be used as a guide while outlining the site.
6. To start editing, find the “Editor” button on the toolbar. If it is not visible, right-click in a blank space on the toolbar and select the “Editor” text to turn on the toolbar. With the toolbar visible, click on “Editor” and then choose “Start Editing”. If multiple vector files are open, a dialog box may ask which layer to edit. Choose the name of the shapefile created in step 3.
7. If the “Create Features” tool is not visible on the right side of the screen, click the Editor menu, select “Editing Windows” and then “Create Features.”
8. Inside the “Create Features” tool, click on the name of the shapefile and then down below in the “Construction Tools” pane, click the “Polygon” tool.
9. Using the imagery and other layers as a guide, click on the map to create a vertex on the perimeter of the site. Continue to click additional vertices to encircle the entire site. For the last point, double-click to complete the polygon.
10. When finished, click the “Editor” menu and choose “Stop Editing.” When asked to save edits, be sure to click “Yes” or the work will be lost.
11. An alternative to steps 3–11 would be to visit the site in the field and to snorkel the perimeter of the site with a GPS unit protected in a floating bag. The track file from the GPS unit could be imported into ArcMap and used as the starting point for your site polygon.
12. Subsequent field visits may provide additional information which may be used to edit the polygon shape.

Randomly Select Sample Points:

1. Ensure that ArcToolbox is visible. If it is hidden, click the Geoprocessing menu and choose “ArcToolbox” to make it appear.
2. From ArcToolbox, expand the “Data Management Tools” and then “Feature Class” nodes.
3. Double click to run the “Create Random Points” tool.
 - a. Choose an appropriate output location and name for the points that will be created.
 - b. Create an appropriate name for the random points shapefile in “Output Point Feature Class”
 - c. From the “Constraining Feature Class” dropdown choose the study site shapefile that was created in step 3.

- d. In the “Number of Points” box, type the number of random sample locations to create. It is typically a good idea to draw more than the anticipated number so that unacceptable points can be dropped.
 - e. In the “Minimum Allowed Distance” field type a required separation between each point, and set the appropriate units (10 meters [32.8 feet {ft}]). This is useful for avoiding points that would create overlapping transects.
 - f. Click “OK” to generate the points.
4. The new shapefile of sample locations will be created and shown on screen.

Label the Points:

1. Right-click the random sample point shapefile and choose “Open Attribute Table.”
2. In the attribute table, click the Table Options icon and select “Add Field...”
 - a. Type “Name” as the Name.
 - b. Select “Text” as the Type.
 - c. Click “OK”.
3. While names can be typed for each point, it is often useful to use the OID or FID field to calculate appropriate names. Use of the actual OID or FID field is not recommended, because it can change during some shapefile operations.
 - a. To calculate a name based on the OID or FID field, right-click the Name field in the attribute table and select “Field Calculator...”
 - b. Either OID or FID may be used, depending upon the version of ArcGIS. Double-click on the one that shows up in the “Fields” box for your version. This will add the field to the “Name=” box.
 - c. If desired, a prefix can be added to the number as long as it is enclosed in quotes and followed by an ampersand (e.g., “BISC_AM_” & [OID] would produce “BISC_AM_1”, “BISC_AM_2”, etc.)

Getting the Distance and Bearing between points:

1. Open ArcToolbox again and click to expand the nodes for “Analysis Tools” and “Proximity”.
2. Run the “Generate Near Table” tool.
 - a. Set the “Input Features” to the random sample site shapefile.
 - b. Set the “Near Features” to the same random sample site shapefile.
 - c. Set the location for the “Output Table”

- d. Check the box for “Angle”
 - e. Uncheck the box for “Find only closest feature”
 - f. Click OK
3. The table that is generated will have a row for each pair of points (each labeled with their original FID or OID), including both a Distance (Near_DIST) and Bearing (NEAR_ANGLE). Note that the bearing is measured from the x-axis to the direction of the line connecting an input feature to its nearest feature and is within the range of 0 to 180 or 0 to -180 decimal degrees. 0 represents East, 90 is North, 180 or -180 is West, and -90 is South. These bearings are then converted to positive integers.

Note: the range and bearing table created here is a “rough guide” as it is created with surface derived GPS points and may differ from the measured ranges and bearings pathway obtained underwater (described in SOP CR09 (SFCN 2025)).

Literature Cited

South Florida/Caribbean Network (SFCN). 2025. Installing monitoring sites—Version 2.1. South Florida/Caribbean Network Standard Operating Procedure NPS/SFCN/SOP—CR09. South Florida/Caribbean Network, Palmetto Bay, Florida. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2309548> (last accessed April 2025).