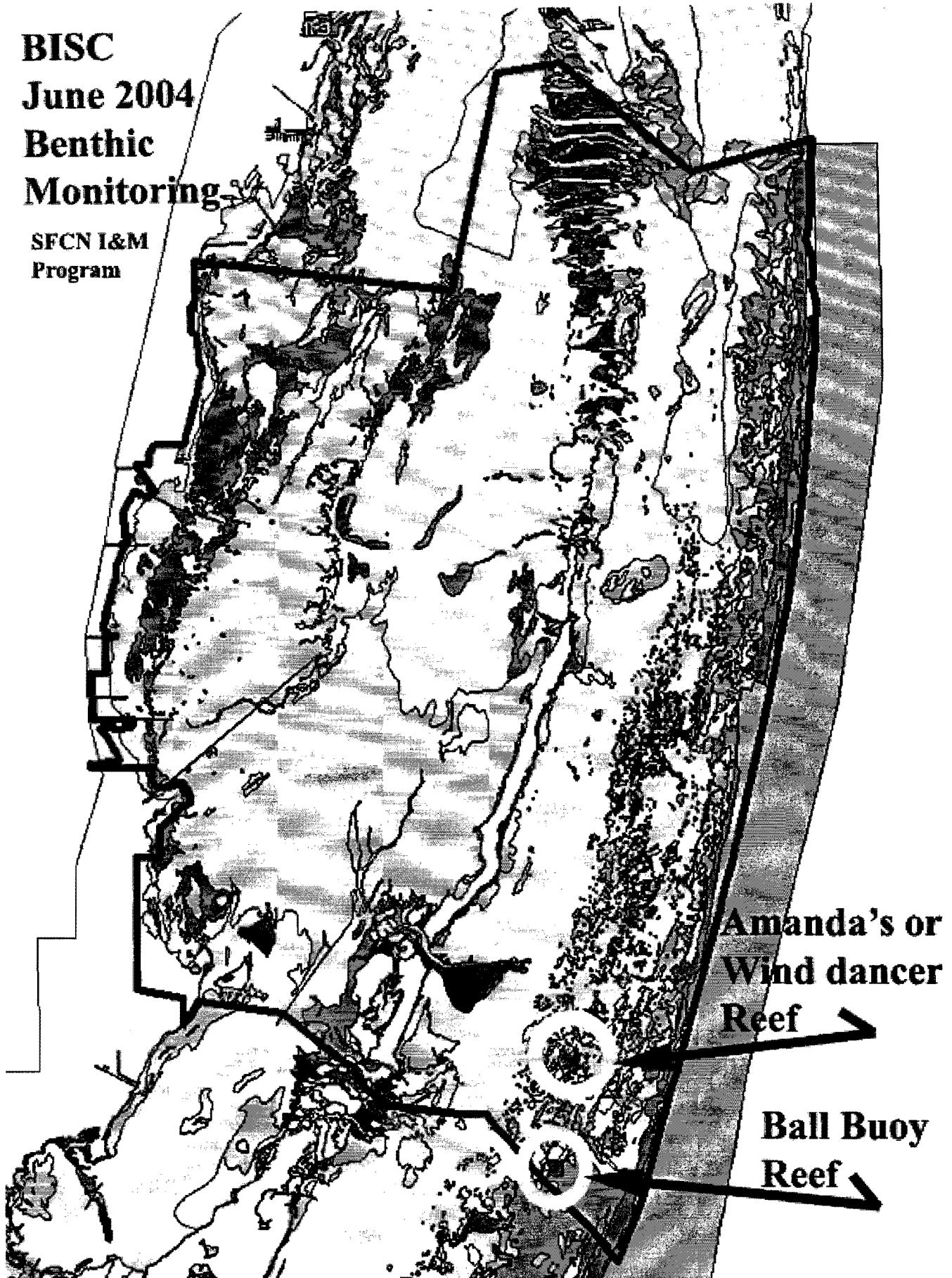


BISC
June 2004
Benthic
Monitoring

SFCN I&M
Program



SITE ONE: Ball Buoy Reef (mooring located near N: 2800494, E: 582105)

The site is at the southern end of a linear reef tract. The following were considered when selecting this site for monitoring:

- 1) An area representative of the southern reef system in BISC.
- 2) Contained a diversity and complexity of benthic organisms that could be monitored using video techniques, including large massive coral colonies of *Montastraea*, *Siderastraea*, *Colpophyllia*, and *Diploria*. There were scattered *Acropora palmata* colonies within this site as well.
- 3) Depth ranged from app. 25' to 5'. We have not used the sonar mapping system in this type of environment but felt it would work, given our experience in other areas, therefore random sampling could be applied.
- 4) We were told there was a history of monitoring at this site by Dr. Jim Porter, and additional monitoring would make for a valuable addition.
- 5) This area was described as being representative of similar reef tracts to the south; areas that are also monitored using video methods, possibly allowing for comparisons.

SITE TWO: Unnamed. (N: 2804245, E: 582774)

Called either Wind Dancer Reef (for the name of the vessel that ran aground there), or Amanda's Reef. **NOTE: We need BISC RM staff to advise of the name they want to use for this as it will be used when images are captured and stored.**

This site is a large patch reef, representative of the southern area of the park. The following were considered when selecting this site for monitoring:

- 1) The patch was well defined allowing us to consistently "define" the boundaries.
- 2) We found it to have a diversity and complexity of hard coral and benthic community cover that could be monitored using the video technique. There were large *Porities porities* colonies near the east facing edge; large *Siderastrea siderea* colonies scattered throughout the patch; and a patchy distribution of *Acropora palamata* primarily on the middle to SW sections of the patch reef. *P. astreoides* was abundant.
- 3) The reef was shallower than any site we had monitored, presenting a number of challenges with the sonar mapping system, but the shallowness would allow for the use of GPS to map random points, if the sonar system did not work effectively.

During the day that we spent with Richard Curry looking at potential monitoring sites, we also evaluated two other "unnamed" patch reefs further to the north; however, those reefs were not well defined (blending isolated coral colonies with seagrass at the edges) and had much lower hard coral cover, and diversity. Small, scattered hard corals were mixed with seagrass, sand, and gorgonians. The reef was a very shallow (less than 10 feet). A monitoring site could be established that is representative of this community, but additional time would need to be taken to pick and define an area. We did not have time for extensive site reconnaissance during this trip, therefore this type of community was ranked as a lower priority at this time.

Another site that was visited and considered for monitoring was "the ledges". This site was a deeper, seemingly remnant spur and groove community with very low coral cover and only scattered isolated hard coral colonies on an algal turf and macroalgal bottom community.

Although this site was more representative of the middle of the park, significant time would need

to be spent finding an area within this type of community for monitoring. Thus it would have to be visited at another time if the BISC RM staff determined it to be an area of interest for long term monitoring.

DETAILS OF THE AREAS MONITORED

BALL BUOY REEF

Navigation: coming out of Caesar Creek Channel, we headed south into Hawk Channel to marker #23. From that marker, we went to a waypoint called “bb nav” located at N: 2800004, E: 581711. This allowed us to get south of the shallow reef flat around the ball buoy site. From “bb nav” we turned north to the mooring located at (or near) N: 2800494, E: 582105. The boat was tied to the mooring.

We used the Aqua-Map™ sonar mapping system to map the perimeter of a study area, and define the sample points randomly. This requires the establishment of three baseline station points (B1, B2, and B3). The sonar system maps locations (e.g.: perimeter and samples) on an X-Y coordinate system based upon the location of those three baseline stations, therefore positions are referenced to the locations of those baseline stations. They were permanently marked as follows:

B1	N: 2800445	E: 582127	TYPE: pin in bottom, marked with submerged float
B2	N: 2800354	E: 582090	TYPE: sand screw
B3	N: 2800485	E: 582067	TYPE: pin in bottom, marked with submerged float

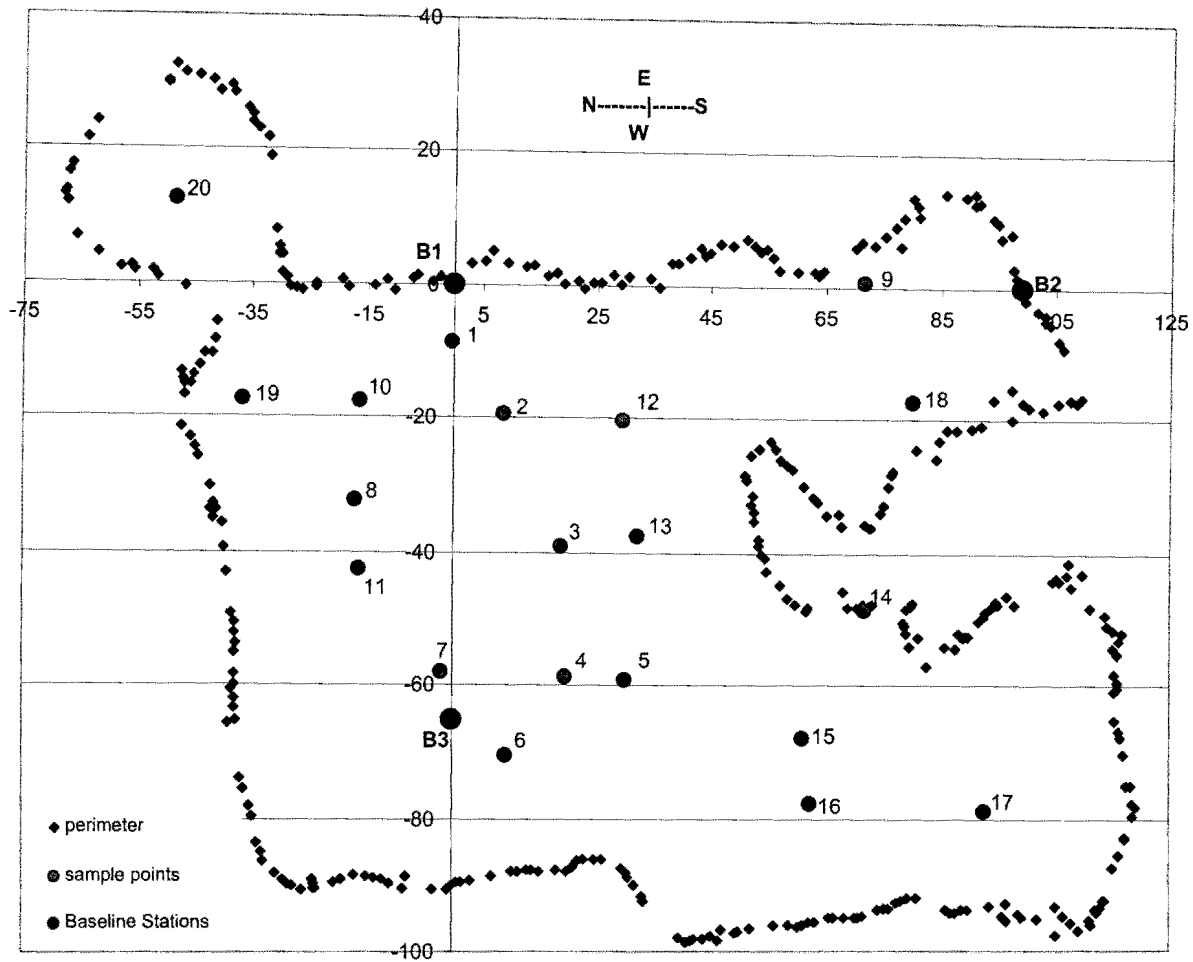
Bearing from B1 to B2: ~ 220 Distance B1 to B2: ~ 99m

Bearing from B1 to B3: ~ 130 Distance B1 to B3: ~ 73m

(See appendix I for photos of B1 and B3.)

Once the baseline stations were established, we swam the perimeter of the “study area”. This area was defined by the reef/sand edge on the east, a depth contour of ~5 feet on the west, and distance considerations on the north and south. From within that area, the size of the study area was derived, along with the total population of sample points (given 10m x 10m spacing). That total sample population was randomized, and the first twenty points were selected to visit. At the coordinates that defined the point, a ten meter transect was run on a compass bearing of 220 (consistent with B1-B2 baseline and approximate depth contours). If more than 5 meters of the 10 meter transect was in sand, the sample (transect) was discarded we proceeded to the next random number. This criteria is used as within any sample area exist sand channels that may be part of the sample area, yet not an area of particular concern for monitoring change in coral cover. For example, we are not interested in monitoring the change in coral cover growing in sand channels within a reef community, our questions concerns the change in reef community structure within substrate that supports reefs. If we could map on more of a “fine” scale we’d excluded those large (>5m) sand channels from our sample area, but since we can’t, we use this decision tree to guide the protocol.

Figure 1: Map of Ball Buoy perimeter and random video transects.



The study area size was measured to be 14,136 m² with 143 potential sample (transect) locations (total sample pop.). Copper clad survey stakes were installed at the origin of each transect, and the transect number was stamped into the top of each stake. The locations of each pin were measured using the sonar system based upon the positions of the baseline stations thus are in X:Y coordinate system. Using a conversion program, we have also provided the approximate Northings and Eastings of each of the sample positions (Table 1).

Table 1: BISC Ball Buoy video transect sample locations

Sample Number	X	Y	Northing	Easting	depth (m)	depth (ft)
1	-0.36	-8.76	2800449	582119	6.1	20
2	8.76	-19.46	2800444	582106	5.49	18
3	19	-39.12	2800442	582084	3.96	13
4	19.79	-58.9	2800449	582065	4.27	14
5	30.35	-59.44	2800439	582061	4.57	15
6	9.4	-70.56	2800463	582058	3.35	11
7	-1.96	-58.17	2800469	582074	3.05	10
8	-17.12	-32.38	2800473	582103	3.96	13
9	71.76	0.69	2800378	582101	5.49	18
10	-16.36	-17.5	2800467	582117	5.18	17
11	-16.38	-42.67	2800476	582094	3.35	11
12	29.79	-20.32	2800425	582097	5.79	19
13	32.28	-37.49	2800429	582080	7.01	23
14	71.96	-48.72	2800397	582055	6.71	22
15	61.37	-68.05	2800414	582041	4.57	15
16	62.74	-77.67	2800416	582031	3.66	12
17	92.99	-78.89	2800389	582019	4.88	16
18	80.42	-17.35	2800377	582081	5.49	18
19	-36.6	-17.37	2800485	582125	4.27	14
20	-48.41	12.52	2800485	582157	3.96	13

It is planned to visit each site on an annual basis, re-filming the video transects established in June 2004. To assist in relocating transects, (whether by using the Aqua-Map or GPS) we are also providing a list of compass bearings and distances for a path through the samples based upon the approximate UTM positions of the transect origins (Figure and Table 2).

Figure 2: Map of path through Ball Buoy sample points.

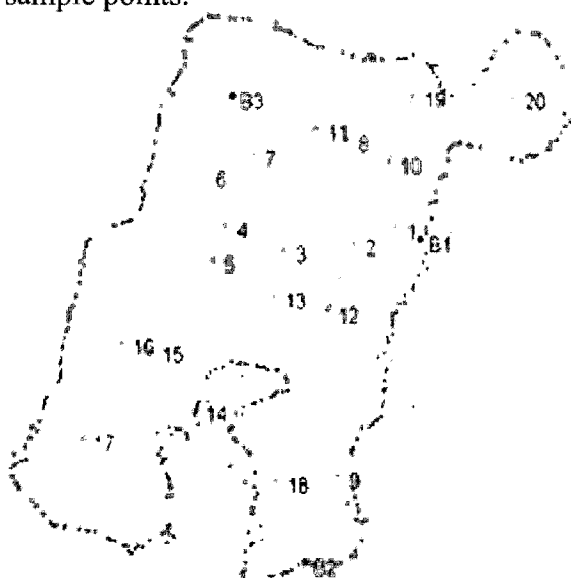


Table 2: Navigation to Ball Buoy points.

From sample #	To Sample #	Bearing (degrees)	distance (m)
1	19	9	37.2
19	10	203	20.2
10	2	207	25.2
2	12	205	21.0
12	8	8	48.4
8	11	288	10.3
11	7	249	21.2
7	6	249	16.8
6	4	154	15.6
4	5	205	10.6
5	3	83	23.3
3	13	195	13.4
13	14	218	41.2
14	15	321	22.0
15	16	284	9.7
16	17	204	30.3
17	18	101	62.8
18	9	87	20.0
9	20	28	120.8

Videotapes of transects will be logged in to the video database located at Virgin Islands National Park (a copy of the tapes can be provided to BISC upon request). Images will be captured, dotted and analyzed. Further, images depicting the layout of the transect will be captured and displayed in a mosaic to help accurately relocate the transects during subsequent sample events.

AMANDA'S REEF – WIND DANCER REEF

Navigation: We used the coordinates N: 2804245, E: 582774 to locate the patch reef. To navigate to it, we came out of Caesar Creek Channel and headed to the waypoints previously listed. There are a number of shallow areas that could be encountered, so the captain and crew need to be vigilant and aware. Anchor in sand or set the anchor with prevailing east (SE, E, NE) wind tails the vessel over the shallow patch reef.

We attempted to use the Aqua-Map™ sonar mapping system to map and sample this reef in the same manner described at Ball Buoy (previous). However after several hours of testing, we found that the site was too shallow for successful sonar acoustics. After discussion with Andy Goldstein, of DesertStar System (developer of Aqua-Map™) software engineer, he listed several complications that arise in shallow water:

- 1) blockage of the signals by divers, bottom features and fish (inhibit signal pass)
- 2) bouncing of signals (can cause inaccurate measurements of speed/distance)
- 3) more compact environment has potential for more noise (more difficult to hear station signals = communicate)
- 4) wave/surge action with position of baseline station in shallow water (can cause difficulties in getting repeated measurements)

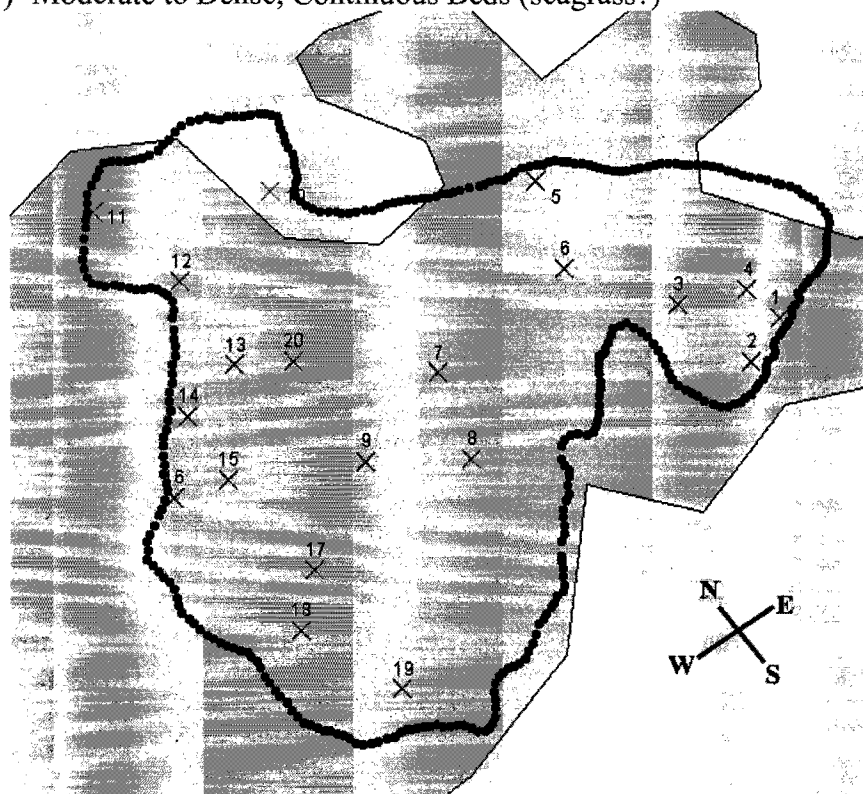
There are ways around some of these challenges but given the time that we had and the conditions (winds and seas were increasing) we felt this site could be mapped and sampled successfully with a hand-held GPS device.

A protocol had been developed using a GPS and ArcView (with extensions) to conduct similar mapping and sample selection as conducted with the Aqua-Map™. Usually, the water depth precludes efficient use of a surface based mapping system (GPS), however the shallow depth of this patch reef made it a viable alternative. Therefore a Garmin *GPSmap76™* was placed in a waterproof bag, and floated upon a boat seat cushion. A track was made of the patch reef perimeter, gathering a location point every three seconds. This track was downloaded from the GPS to ArcView. Then following the protocol (see Appendix II), an area was calculated, a total sample population was created, and then a random sample population was selected and identified. The resulting product was a table containing 25 random points, with the bearing and distance of a path through the points. As with the previous site, each point represented the origin of a ten-meter transect run on a bearing of 180 (selected to be into the prevailing current, and similar depth contour). The same selection criteria was used as Ball Buoy Reef regarding a transect being discarded if >5m was sand (Table and Figure 3.).

Table 3. Positions of samples at Wind Dancer – Amanda's Reef

Sample Number	Northing	Easting	depth (m)	depth (ft)
1	2804261	582814	?	?
2	2804249	582806	4.0	13
3	2804265	582786	2.7	9
4	2804269	582805	2.4	8
5	2804299	582747	3.4	11
6	2804275	582755	2.4	7
7	2804246	582720	2.4	7
8	2804223	582729	2.4	7
9	2804222	582700	3.0	10
10	2804296	582674	3.4	11
11	2804290	582625	3.4	11
12	2804271	582649	3.7	12
13	2804248	582664	1.8	6
14	2804234	582651	2.4	8
15	2804217	582662	2.4	8
16	2804212	582647	2.7	9
17	2804192	582686	1.8	6
18	2804175	582682	?	?
19	2804159	582710	2.1	7
20	2804249	582680	1.5	5

Figure 3. Wind Dancer – Amanda's Reef location and sample point overlaid upon NOAA benthic habitat map. Orange (CPIH)= Individual Patch Reef and Halo; Green (SD)=Moderate to Dense, Continuous Beds (seagrass?)



This patch reef measured 20,240 m² and had a total sample population of 199. Copper clad survey stakes with transect numbers engraved in the caps were installed to mark the origins of each transect. The location of each point was mapped by a snorkeler using the GPS device set to the maximum zoom resolution. To assist in relocating the points we are providing their UTM locations and distance/bearing measurements through a selected path to the transect origins (Figure and Table 4).

Figure 4: Map of path through Wind dancer points

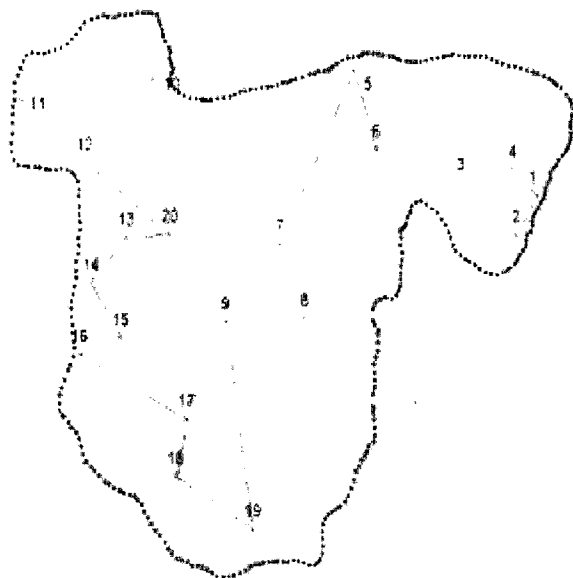


Table 4: Navigation to Wind dancer points.

From sample #	To Sample #	Bearing (degrees)	distance (m)
4	1	132	12.0
1	2	214	14.4
2	3	309	25.6
3	6	288	32.6
6	5	342	25.3
5	7	207	59.5
7	10	317	67.9
10	11	263	49.4
11	12	128	30.6
12	20	125	38.0
20	13	266	16.0
13	14	223	19.1
14	15	147	20.2
15	16	251	15.8
16	17	117	43.8
17	18	193	17.5
18	19	120	32.2
19	9	351	63.8
9	8	88	29.0

As with the Ball Buoy site, the video tapes will be logged in, captured and analyzed. (Copies of the digital videotapes can be obtained by contacting Jeff Miller at VIIS.) Images depicting the orientation of the transects will also be captured to help accurately relocate the transects during subsequent sampling.

Appendix I:
Submerged float and habitat around B1 at Ball Buoy Reef



Submerged float and habitat around B3 at Ball Buoy Reef



Selecting Random Sample Points using GPS

Jeff Miller¹ and Christy Loomis²

Virgin Islands National Park
1300 Cruz Bay Creek
St. John VI 00830
340-693-8950, 227¹, and 245²
e-mail: William_J_Miller@nps.gov
Chirsty_Loomis@nps.gov

The Background: We are trying to develop a way for folks to (inexpensively) conduct random sample selection (as opposed to haphazard). This protocol would involve snorkeling around the perimeter of a study site making a recording of the positions with a GPS in some kind of waterproof bag. They would download that recording/tracing and then load it into ArcView. From there, using scripts and extensions, they can generate random points within that study area, sort them for ease of navigating to them, then get a list of range and bearings from one point to another. Those ranges and bearings would be written on a slate and using a transect tape and compass, the divers could navigate from random one point to another.

If the site were to be monitored "permanently", it would be beneficial to pound in a pin at the random point to aid in return relocation. Additionally, having someone on the surface with the GPS to could increase accuracy of navigating to the random points (in addition to the divers using the range and bearings).

The Objectives:

- 1) Outline a study site of interest.
- 2) Download that outline into ArcView.
- 3) Randomly select a number of sample points.
- 4) Be able to locate those sample points.
- 5) Be able to go back to those sample points over time.

The Protocol:

- 1) You will need the following extensions:

ArcView 3.x (3.2 or 3.3)
Dnrsample.avx
Pathfind.avx
Random_sites.avx
TNCTools.avx

These all go in the Esri\av_gis30\arcview\ext32 folder.

When you open ArcView, you will need to activate these extensions (see below).

- 2) You will need to activate these extensions for this work.
 - a) Open Arcview
 - b) Go to the File drop down menu
 - c) Select Extensions
 - d) You may also want to put a check in the Mr. Sid.
 - e) Scroll down and put a check in the following:
 - DNR Random Sampling Tools
 - Path w/ distance & Bearings
 - Random Points
 - TNC Tools
 - f) You may want to put a check in the box for this to be the default.
 - g) Select OK.

You have activated these extensions within your ArcView program.
- 3) Open a new project in ArcView
 - a) Select TABLE from the ArcView project box.
 - b) Select Add, then browse to the location of the database file of the perimeter trace.
You should see the table name added to the window.
 - c) Select VIEW.
 - d) Select New. A new view window will open for this project.
 - e) Go to drop down menu View, then Add Event Theme.
 - f) TABLE: enter the database (perimeter) table
 - g) X-Field: enter Eastings
 - h) Y-Field: enter Northings
 - i) Select OK.
 - j) Put a check in the box, to display the database. Make this the active theme.
- 4) You need to create a new polygon shape file over the perimeter trace.
 - a) Go the drop down menu View.
 - b) Select "New Theme"
 - c) Select "polygon" as the feature type from the New Theme dialog box by clicking on the down arrow and selecting "polygon" from the list. Select OK.
 - d) Choose the name and storage location for the new theme.
 - e) The new shape file will appear in the active view. It will be ready for editing or creating.

- f) From the tool boxes, select the draw polygon tool. You may have to click on and



hold another tool, to cause new icons to appear below the tools.

- g) Trace the outline of your perimeter with your mouse; double click when you are at the finished tracing. The polygon you created will be selected (highlighted).
 - h) Go to the drop down menu Theme, and select Stop Edits. A save edits dialog box will appear: select YES to save the creation of the polygon.
 - i) Click on the new shapefile's name to make it the active theme.
- 5) You can determine the number of points that can be created within your site within the defined sample area:
- a) From the drop down menu, choose Sampling Tools.
 - b) Select Systematic Point Sample from the list. A Base File dialog box will appear.
 - c) Enter the appropriate sample parameters
 - 1. Spacing X (): 10
 - 2. Spacing Y (): 10
 - 3. Minimum distance from polygon boundary: 0
 - 4. Then select OK.
 - d) Another dialog box will appear requiring you to choose the name and location of the shape file you are about to create. Enter names and storage location, and then select OK.
 - e) The shape file containing the points will appear in the view window. Put a check in the box to see the points displayed and make it the active theme.
 - f) To see the positions and the number of points created, select the Open Theme Table button. Scroll down the table to see the number of point. You can save this shape file/theme or delete it. The value is knowing the number of points that could be created within your study area (given the defined spacing).
- 6) Create Random Points within your polygon
- b) Make the polygon theme the active theme.

- c) Select the theme. (It should still be selected. If not, choose the select feature button , then click on the polygon in the view window.)
- d) Click on the tool button that Generates randomly-distributed points .
- e) A dialog box will appear. Make the appropriate selections for the following:
1. Polygon Boundary: select the name of the polygon for your site outline.
 2. Number of sites to generate: e.g. 20.
 3. Minimum distance between points: e.g. 10
 4. Minimum proximity to polygon: e.g. 0
 5. Output point theme: select location
 6. Press the button: "Do It". The points will appear in the polygon.
- f) The new theme will appear and the random points will be displayed in the view.
- g) Click on the new theme to make it the active theme.
- 8) Label the points
- a) Make the random point theme/shape file the active theme.
 - b) Go to Theme drop down menu
 - c) Select Auto-label
 1. Label field - ID
 2. Use Theme's Text label placement property.
 3. Scale label should be checked.
 4. Select OK
 - d) The labels should appear by the dots
- 9) Create Attribute Table for the random points.
- a) Click on the icon "open theme table" from the menu bar.
 - b) An attribute table of the active theme containing the coordinates (UTM) for each random point will be displayed.
- 10) We need to arrange the points in the order that we will be visiting them.
- a) Open the Theme Table (use icon or double click on the table from the project menu box).
 - b) Go to drop down menu Table - select Start Editing.
 - c) Go to drop down menu Edit - Select Add field
 - d) In the field definition box
 1. In the space for name, type ORDER
 2. The type option should be NUMBER
 3. Leave all else as defaults
 4. Select OK to close box
 - e) The new field column will be added to the attribute table.
 - f) Press the "edit" icon  to be able to add numbers to the attribute table.
 - g) Evaluate the arrangement of random points. Decide a path through the points. You will want to decide which labeled point you want to visit first, second, third, fourth, etc.....

- h) When you have done this go to the attribute table and find the label for the point you wish to visit first.
- i) Enter in the corresponding ORDER column space, "1".
- j) Find the label for the point you wish to visit second.
- k) Enter in the corresponding ORDER column space, "2".
- l) Find the label for the point you wish to visit third.
- m) Enter in the corresponding ORDER column space, "3".
- n) Repeat these two steps until you have accounted for all the points.
- o) Go to Drop down menu Table, and select Stop Edits. A dialog box will ask if you want to save edits; select YES.
- p) Select the column header "ORDER".
- q) Go the drop down menu FIELD
- r) Select Sort Ascending (or just choose the icon from the task bar).
- s) This will re-arrange the points in the attribute table in the order you wish to visit them.

14) Derive Bearing and Distance between ordered points

- a) Click on the View Window to make it active (blue).
- b) Click the "Find Path" icon from the tool bar. This will open an input theme dialog box. 
- c) Select the following from within the dialog box (see dialog_1.gif):
 - a. INPUT DATA: choose the shape file that contains the randomly generated points.
 - b. Select input data, ID FIELD: choose ID.
 - c. Select input data, SERIES FIELD: choose ORDER.
 - d. Select OK to close this window.
- d) The dialog box titled "Data for RESULTS table" will open. This dialog box is in two columns. The left column represents the "FROM" feature data; the right column represents the "TO feature data. Put a check in the box next to the following items in both columns:
 - a. "FROM" ID (left column) and "TO" ID (right column)
 - b. "FROM" Series ID (left column) and "TO" Series ID (right column)
 - c. Under the sub-header titled: Feature Connection Options, select Distance between Centroids and Bearing between Centroids.
 - d. Under the sub-header RESULTS format, put a check in RESULTS table and Polyline Shapefile of entire path.
 - e. Click OK to close the dialog box.
- e) The dialog box titled "CONNECTION LINES- centroids and closest edges" will open. Select (put a check) the following features:
 - a. Connect CENTROIDS: No lines
 - b. Connect CLOSEST EDGES: No lines
 - c. Select OK to close the dialog box.

- f) A dialog box asking where you would like the results table? Browse to select the location then select OK to close this box. You can also choose to rename the table at this point.
- g) A dialog box asking where you would like the Path shapefile? Browse to select the location then select OK to close this box. You can also choose to rename the shapefile at this point.
- h) The table displaying the bearings and distances will be opened.

You will need to copy this data in some way to take it with you in the field.

Last saved: Sept. 22, 2003