CRUISE INSTRUCTIONS: NOAA SHIP NANCY FOSTER

Cruise Title: **Characterization of midwater seafloor habitats of western Puerto Rico**

Cruise Number NF-07-06-USVI HAB

Period of Cruise:
DEP: 4/14/07 NF-07-06-USVI HAB
ARR: 4/24/07

Area of Operation: West side of Puerto Rico and Mona Island (See Figure 1)

1.0 Scientific Objectives:

The Center for Coastal Monitoring and Assessment (CCMA) will be conducting the fourth year of an ongoing scientific research mission onboard the NOAA ship Nancy Foster funded by NOAA's Coral Reef Conservation Program. The purpose of the cruise will be to collect swath bathymetry and acoustical backscatter data in high priority conservation areas within Puerto Rico (Bajo de Cico, Tourmaline Bank, and Abrir la Sierra Bank), Mona Island, and Monito. Scientists will collect high resolution multibeam in mid-water depths approximately 10 to 300 meters so as to continue to characterize seafloor habitats within all U.S. States, Territories, and Commonwealths. The objective of this project is to collect a multibeam bathymetry dataset with 100% seafloor ensonification, along with multibeam backscatter suitable for seafloor characterization. Multibeam data will be collected to conform to IHO Order 1 (<100m) and Order 2 (>100m) accuracy standards. The strategies developed for each survey area will take into account the minimum depths, general bathymetry, and time allotment. The delineation and identification of seafloor habitats will be assisted by the use of a moderate-depth drop camera. The vehicle has video and frame camera capability to depths of 300 meters and will be used to point sampling within areas mapped during this mission.

2.0 Schedule of Operations:

2.1 Daily Schedule:

Actual survey and ground truthing locations will be made available to the Operations Officer during the daily operations meeting. The following are estimates of locations.

12 April (Thursday): Nancy Foster arrives in San Juan, Puerto Rico
Survey NF: Survey team installs survey gear, does a gear shake-down of multibeam unit and survey planning. Install Seabat 8124 multibeam to the moon pool using ship divers.
GT: Ground Truthing (GT) team configures remaining camera gear and conducts USBL, POS/MV, GPS integration with Hypack; and installs hydrophone pole.

13 April (Friday):
Survey NF: Survey team installs survey gear, does a gear shake-down of multibeam unit and survey planning. Conduct dockside calibration tests.
GT: Ground Truthing (GT) team conducts pier side deployment test of drop camera.

All: Team scientists meeting and meeting with ship officers on safety and scientific operations.

14 April (Saturday):
Transit/Survey NF: (0800-2400) Ship transit from San Juan to Bajo de Cico. Survey team conducts Patch Test to calibrate the Seabat 8124 multibeam echosounder (MBES) system and begins shallow water survey.

15 April (Sunday):
Survey NF: (2400-0800) MBES Bajo de Cico.
GT: (0800-1600) Conduct ground truthing of Bajo de Cico.
Survey NF: (1600-2400) MBES Bajo de Cico.

16 April (Monday):
Survey NF: (2400-0800) MBES Tourmaline Bank.
GT: (0800-1600) GT Bajo de Cico
Survey NF: (1600-2400) MBES Abrir la Sierra Bank.

17 April (Tuesday):
Survey NF: (2400-0800) MBES Abrir la Sierra Bank.
GT: (0800-1600) GT Abrir la Sierra Bank
Survey NF: (1600-2400) Abrir la Sierra Bank.

18 April (Wednesday):
Survey NF: (2400-0800) Abrir la Sierra Bank.
GT: (0800-1600) GT Abrir la Sierra Bank. Drop off Jeff Snyder and John Humphrey's group in Mayaguez.
Survey NF: (1600-2400) Abrir la Sierra Bank.

19 April (Thursday):
Survey NF: (2400-0800) Abrir la Sierra Bank.
GT: (0800-1600) GT Abrir la Sierra Bank.
Survey NF: (1600-2400) Abrir la Sierra Bank.

20 April (Friday):
Survey NF: (2400-0800) Abrir la Sierra Bank.
GT: (0800-1600) GT Abrir la Sierra Bank. Pick-up Michelle Scharer from Mayaguez.
Survey NF: (1600-2400) Abrir la Sierra Bank.

21 April (Saturday):
Survey NF: (2400-0800) MBES Mona Island.
GT: (0800-1600) GT Mona Island.
Survey NF: (1600-2400) MBES Mona Island.

22 April (Sunday):

Survey NF: (2400-0800) MBES Mona Island.
GT: (0800-1600) GT Mona Island.
Survey NF: (1600-2400) MBES Mona Island.

23 April (Monday):
Survey NF: (2400-0800) MBES west shore.
GT: (0800-1600) GT Mona Island.
Survey NF: (1600-2400) MBES Mona Island.

24 April (Tuesday):
Survey NF: (2400-0600) MBES Mona Island
Transit: (0600-1400) Transit to San Juan.
Demobilization: (1400-1800) Demobilization

25 April (Wednesday):
Media: (0900-1200) Media event and school tours.

2.2 Watches:

Vessel operations will typically be a ~ 24 hour workday. A "give and take" operation cycle will be instituted during these workdays via consultation between the Chief Scientist and Commanding Officer in order to balance crew complement with demands of day-night operations. One crew member will be required on deck to work the winch for the ROV and CTD casts.

In Science Party, the Field Party Chief is responsible for organization of operations and data, respectively.

3.0 Map of Operations:

(See Figures 1 and 5)

4.0 Description of Operations:

Multibeam Operations:

Survey Schedule/Personnel:

The EM1002 will be utilized for deepwater multibeam surveying. The CCMA Hydrographer (Mike Stetcher) and AHB will conduct an annual patch of the unit during sea trials 2/13/06. Installation of the Seabat 8124 will occur in San Juan. The 8124 is being configured to mount to the moon pool flange. An additional extended cable is being fabricated to allow the data transmission from the transducer head to the acquisition station located in the dry lab. An ISIS acquisition software license is being investigated for use from within NOAA. If that is unavailable, and ISIS licensed will be rented. The patch test for the 8124 will occur at Bajo de Cico, PR.

Patch Test:

The patch test will be performed before surveying operations commence. The patch test calibration will quantify any residual biases from the alignment between the motion sensor, gyro and the multi-

beam transducer. The patch test also quantifies the time lag (latency) between the time positioning data is received, and the time the computed position reaches the acquisition system. To ensure quality results from the patch test procedure it is necessary to have a relatively calm sea state, collection of clean data and a helmsman that can stay online during the procedure. Static transducer draft, settlement and squat corrections, sound velocity corrections, and preliminary tide corrections will be applied to the data prior to bias determination. The general patch test procedure requires multibeam data collection along a series of transects as described in Figure 3. Alternatively, yaw bias can also be determined by surveying two lines on each side of a submerged object in relatively shallow water (Fig. 4). Patch test results will be calculated with CARIS's v5.4 calibration program in the following order: Latency, pitch, roll and yaw.

An area within the Bajo de Cico conservation area has been identified (Fig. 5) to provide the steep and smooth slope with little change in across track depth to accurately assess the latency, pitch and yaw biases for the NF. Two planned survey lines (1&2) oriented perpendicular to slope are parallel and spaced apart to ensure abundant overlap of outer beams. O

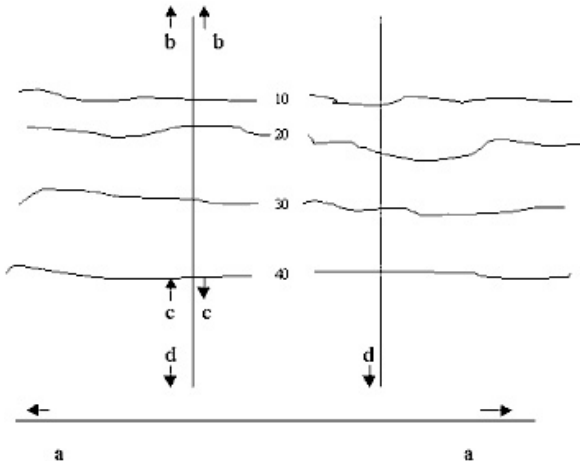

Figure 3: a = Roll, b = Latency, c = Pitch, d =Yaw

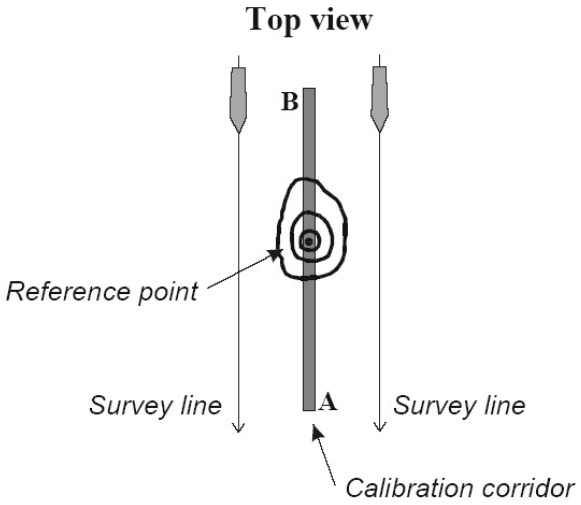

Figure 4: Yaw bias test performed on submerged object

The lines will be surveyed in the following order at the primary patch test location. Vessel speed should be consistent for the roll, pitch and yaw transects. Vessel speeds should be varied up to 5 knots for the latency section of the patch test.

Sufficient time between passes on the same line will be given to ensure ship propeller disturbances have cleared and will not impact data quality. Additional lines can be included and the schedule is preliminary.

Data Acquisition Methodology:

Upon the completion of the verifiable patch test, Bajo de Cico, Abrir la Sierra Bank , followed by Mona Island. Due to the shoal depths along Puerto Rico, a line spacing of 55 meters is required to provide sufficient

coverage. Reducing the anticipated coverage area will be required. The line plan is generally orientated parallel with the contours to maximize swath coverage and improve acoustic returns. The line plan has taken into account water depths, swath width filters and overlap requirements (Table 2). Restricting the swath limit ensures the data will meet IHO standards, and make the data cleaning process more efficient. All deep survey areas will be accepting soundings 55° from nadir, port and starboard, with 10% swath overlap. Areas shoaler than 55 meters will accept 60° port and starboard with a 10% overlap. Surveying operations in the shallow water should ideally be performed during daylight hours at higher tides to maximize swath widths, and for vessel safety reasons. Surveying during calm waters and steady piloting of the vessel will improve data quality. This is a preliminary line plan and field adjustments may be required.

The EM1002 data packets will be logged in Simrad Merlin navigation program to create real time coverage maps to ensure coverage. Seabat 8124 will be logged in ISIS navigation program to create real time coverage maps to ensure coverage. During line turns data will be transferred to CARIS processing stations where preliminary zoned tides, swath filters and SVP cast corrections will be applied. The preliminary data will be used to create preliminary sun-illuminated Base surfaces for QA/QC analysis and then exported into geo tiff format. These geo tiffs will be superimposed on top of the charts in Coastal Oceanographics Hypack for additional line planning and navigation purposes.

Data Quality Assurance/Quality Control Methodology:

To ensure that the data collected meets IHO Level 1 & 2 standards several quality assurance/quality control measures will be implemented. The velocity of sound through the water column will be derived from conductivity, temperature, and depth measurements (CTD casts) collected no more than 4 hours apart. A CTD cast will be will be taken prior to the commencement of daily multibeam operations. Spatial variability will be taken into account as well as temporal variability when determining cast locations. These locations will be recorded and each cast will be compared to the previous to identify any significant changes in the water column. Turns will be limited and vessel speed will be adjusted to ensure that no less than 3.2 beam foot prints, center-to-center, fall within 3 m, or a distance equal to 10 percent of the depth, whichever is greater, in the along track direction. System confidence checks prior to, and during, multibeam operations will be conducted. These include position checks, lead lines and bar checks. Cross lines totaling 5% of main scheme will also be collected across each of the survey areas. Comparison of single beam, priors' and multibeam data will be used as an independent verification of the survey.

Drop Camera Operations:

Benthic habitats in moderate depth water (>20m and <300m) around the southwestern Puerto Rico and Mona Island will be visually-characterized using a drop camera system. This data will be collected to train and validate an automated benthic habitat characterization technique which uses fine-scale (<5 m) multibeam data. The topside control system will be operated from the Wet Lab. The load bearing umbilical will be deployed using the J-frame. A hydrophone pole will be borrowed from UNCW NURC (Lance Horn) and mounted/deployed over the port side forward of the J frame. The pole can be easily retrieved before transiting to a new location. The drop camera system has been designed to be a stable, easily deployable, operational using ships power, and dependable underwater imaging system. A ship deck hand will be required during recovery and deployment, but can otherwise be operated by the scientists.

The sampling approach will deviate from years past given that the drop camera will not be operated to conduct transects, but rather frequent point samples. The selection of point sampling stations will largely be determined by assessing the results of the backscatter and bathymetry mapping occurring on preceding

survey shifts. Ground truth sampling will be conducted using a modified stratified random sampling approach. Stratified "Regions" of homogeneous acoustical distinction will be identified for deployment based on visual and analytical assessment of the multibeam data. A number of samples station (2-5) will be randomly identified within the "region". The geodetic coordinates will be provided to the bridge as well as targeted in Hypack for display on the bridge. Once the ship is on station, the USBL hydrophone pole will be rotated into position, and the drop camera powered up for deployment. The drop camera has its own contained cable reel system capable of 1 m/s deployment speeds and 1 m/s recovery speeds. Deployment of the drop camera at the deepest depths (300m) will require the most time on station. Time estimates: 1) 15 minutes to deploy the drop camera to the seafloor, 2) 10 minutes of imaging the seafloor, and 3) 10 minutes for retrieval. The scientists anticipate sampling between 20 to 25 stations per day for an 8 hour daylight shift.

5.0 Requirements and Equipment:

5.1 Vessel Provided:

1) Hand held radios for communication between bridge and deck.
2) EM 1002 and Reson 8124 multibeam Shipboard multibeam, CARIS Processing station, Hypack, Velociwin
3) CTD's 100m and1000 m depth rating.

5.2 Program Provided:

Equipment	
1)	Underwater video + camera equipment + tow bodies (Drop camera)
2)	USBL Underwater tracking system and hydrophone pole
3)	6 USB 250GB Maxtor 5000XT hard-drives (CCMA).
4)	Five high end laptops and two flat screen monitors.
5)	CARIS, ArcGIS, ISIS

6.0 Scientific Personnel:

6.1 Chief Scientist Authority

The Chief Scientist has the authority to revise or alter the technical portions of the instructions provided that, after consultation with the Commanding Officer, it is ascertained that the proposed changes will not: 1) jeopardize the safety of the personnel on the ship, 2) exceed the time allotted for the project, 3) result in undue additional expense, or 4) alter the general intent of the Project Instruction.

6.2 Scientific Personnel List:

Chief Scientist: Tim Battista
Lead Hydrographer: Mike Stetcher

Male:	Organization:	GT	Multibeam	Date
Tim Battista	NOAA	X		4/12-4/25
Mike Stetcher	Contractor		X	4/12-4/25
Ed Owens	NOAA		X	4/12-4/25
Garrett Mitchell	UMD		X	4/12-4/25
Bryan Costa	NOAA		X	4/12-4/25
Survey Tech	NOAA		X	4/12-4/25
Charlie Menza	NOAA	X		4/12-4/25
Jeff Snyder	Contractor		X	4/12-4/18
Ken Buja	NOAA	X		4/12-4/25
Michelle Scharer	UPRM	X		4/20-4/24
Jorge Sabater	UPRM	X		4/18-4/24
Rene Esteves	UPRM	X		4/14-4/18

***** CFMC party of five scientists will be joining the ship for one day to observe. Date to be determined.

TASK TEAMS

Ground Truthing

Battista, Menza, Buja, Scharer, Sabater, and Esteves

Multibeam

1) **NF Team A (1600-2400): Stetcher**, Mitchell.
2) **NF Team B (2400-0800): Owens**, Costa, and Foster Survey Tech.

Person in **bold** is field party chief – responsible for prepping rest of team. Multibeam team members will rotate positions throughout the cruise.

Identification: All scientific personnel planning to board the ship should have in their possession at the time of boarding, a proper photo identification card (agency ID, drivers license, etc.).

6.4 History Reports:

Upon acceptance of this proposal, and receipt by the Chief Scientist of the forms, the Chief Scientist will forward completed copies of the NOAA Health Services Questionnaire for all embarking scientific personnel to the Commanding Officer for review at lease 7 days in advance of the cruise.

7.0 Miscellaneous Activities:

None known at this time.

7.1 Bridge Activities:

It is requested that a copy of the ship's *Deck Log - Weather Observation Sheet NOAA 77-13d* for and digital SCS data for the entire cruise be provided to the Chief Scientist upon departure of the science

party or transmitted within 2 weeks thereafter.

8.0 Modification of Cruise Instructions:

Additional operations and ancillary projects, not covered under the main project, may be performed on a "not to interfere" basis. The Chief Scientist is responsible for determining the priority of the additional work, provided that any changes are discussed with the Commanding Officer and do not constitute a risk to the safety of the ship or personnel and do not significantly change the schedule for this cruise. If the requirements for the additional work place significantly different requirements on the ship, amendments to the Cruise Instructions must be prepared and approved.

9.0 Ancillary Tasks:

Ship's personnel conduct ancillary tasks. Instructions for ancillary tasks routinely assigned to Marine Operations Center ships are contained in *Marine Operations Center Directive 1803.00, Ancillary Tasks for NOAA Vessels*.

10.0 Hazardous Materials:

An inventory list and a *Material Safety Data Sheet* for each hazardous material will accompany hazardous material brought on board NANCY FOSTER by scientific parties. This information should be provided to the Commanding Officer. On departure from the ship, scientific parties will provide an inventory of hazardous material to the Commanding Officer showing that all hazardous material brought on board have been properly used up or removed in suitable waste containers. No anticipated hazardous materials is anticipated to be brought onboard.

The *Material Safety Data Sheet* is normally available from the manufacturer of the hazardous product. Procedures followed for use of chemicals will be those outlined in the *Chemical Hygiene Plan for Chemical Labs* aboard NOAA ships. The Science Party will provide a small spill containment kit appropriate for these chemicals.

11.0 Navigation:

Survey and ROV operations will be operated using DGPS. Navigation information via Hypack software will be fed to the Bridge monitor from the Wet and Dry labs via cable.

12.0 Communications:

A progress report on operations prepared by the Chief Scientist may be relayed to the program office. Sometimes it is necessary for the Chief Scientist to communicate with another vessel, aircraft, or shore facility. Through various modes of communication, the ship is able to maintain contact with the Marine Operations Center on an as needed basis. These methods will be made available to the Chief Scientist upon request, in order to conduct official business. Due to a new directive from Marine Operations Center, the ship must charge the science party for all calls made on the cell or sky-cell telephone. INMARSAT, Sky Cell and cellular communication costs shall be reimbursed to the ship for telephone calls made by all scientific personnel. Currently, Sky Cell and cellular telephone services are about $0.89 per minute and INMARSAT Mini-M is around $1.68 per minute for voice. These charges will be assessed against the program after NANCY FOSTER receives the bill. There is generally a three-month delay receiving the bill for review. The Chief Scientist will be required to keep a log of all calls made by the science party. The program will also

provide a cell phone to be kept on the bridge.

13.0 Disposition of Data:
The Chief Scientist is responsible for the disposition of data.

14.0 Foreign Nationals
No foreign nationals are expected as science party participants in this cruise.

15.0 Travel orders
All Federal employee scientists will be issued travel orders for participation in the science cruise. Contractors will travel under terms of their respective contracting organizations.

16.0 Meals and Berthing:
Meals and berthing are required for up to 7 scientists. Meals will be served 3 times daily beginning one hour before scheduled departure, extending throughout the cruise, and ending two hours after the termination of the cruise. Berthing requirements, including number and gender of the science crew, will be provided to the ship by the Chief Scientist. The Chief Scientist and Commanding Officer will work together on a detailed berthing plan to accommodate the gender mix of the scientific party taking into consideration the current make-up of the ship's complement.

All NOAA Scientists will have proper travel orders when assigned to any NOAA ship. The Chief Scientist will ensure that all non NOAA or non Federal scientists aboard also have proper orders. It is the responsibility of the Chief Scientist to ensure that the entire scientific party has a mechanism in place to provide lodging and food and to be reimbursed for these costs in the event that the ship becomes uninhabitable and/or the galley is closed during any part of the scheduled project.

Since the watch schedule is split between day and night, the night watch may often miss daytime meals and will require adequate food and beverages (for example a variety of sandwich items, cheeses, fruit, milk, juices) during what are not typically meal hours. Special dietary requirements for scientific participants will be made available to the ship's command at least seven days prior to the survey.

16.0 Medical Forms:
NOAA Fleet Medical Policy requires all personnel embarking on NOAA vessels to furnish a completed copy of the NOAA Health Services Questionnaire (NHSQ) to the Health Services Office of the Marine Operations Center. This form should be submitted 30 days in advance of sailing, but no later than 7 days in advance of sailing. The Chief Scientist is responsible for the timely submission of NHSQs for scientific personnel to the Health Services Office.

16.0 Reports:
The requirement for a formal cruise report by the Chief Scientist is left to the discretion of the CCMA Center Director. A Ship Operations Evaluation Form is to be completed by the Chief Scientist(s) and forwarded to:
Office of Marine and Aviation Operations
Program Services and Outsourcing Division

SSMC3, Room 12872
1315 East-West Highway
Silver Spring, MD 20910-3282

17.0 Cruise Instruction Approvals:

The Marine Operations Center and NANCY FOSTER will acknowledge receipt of these instructions.

Submitted by:

Dr. Russell Callender Center Director, Center for Coastal Monitoring and Assessment	Mr. Timothy A. Battista Biogeographic Team, Center for Coastal Monitoring and Assessment
Date_____	Date_____

Approved by:

Captain Gary Bulmer, NOAA
Commanding Officer, Marine Operations Center Atlantic

Date_____

Figure 1: Puerto Rico Priority (multibeam and ground truthing areas).

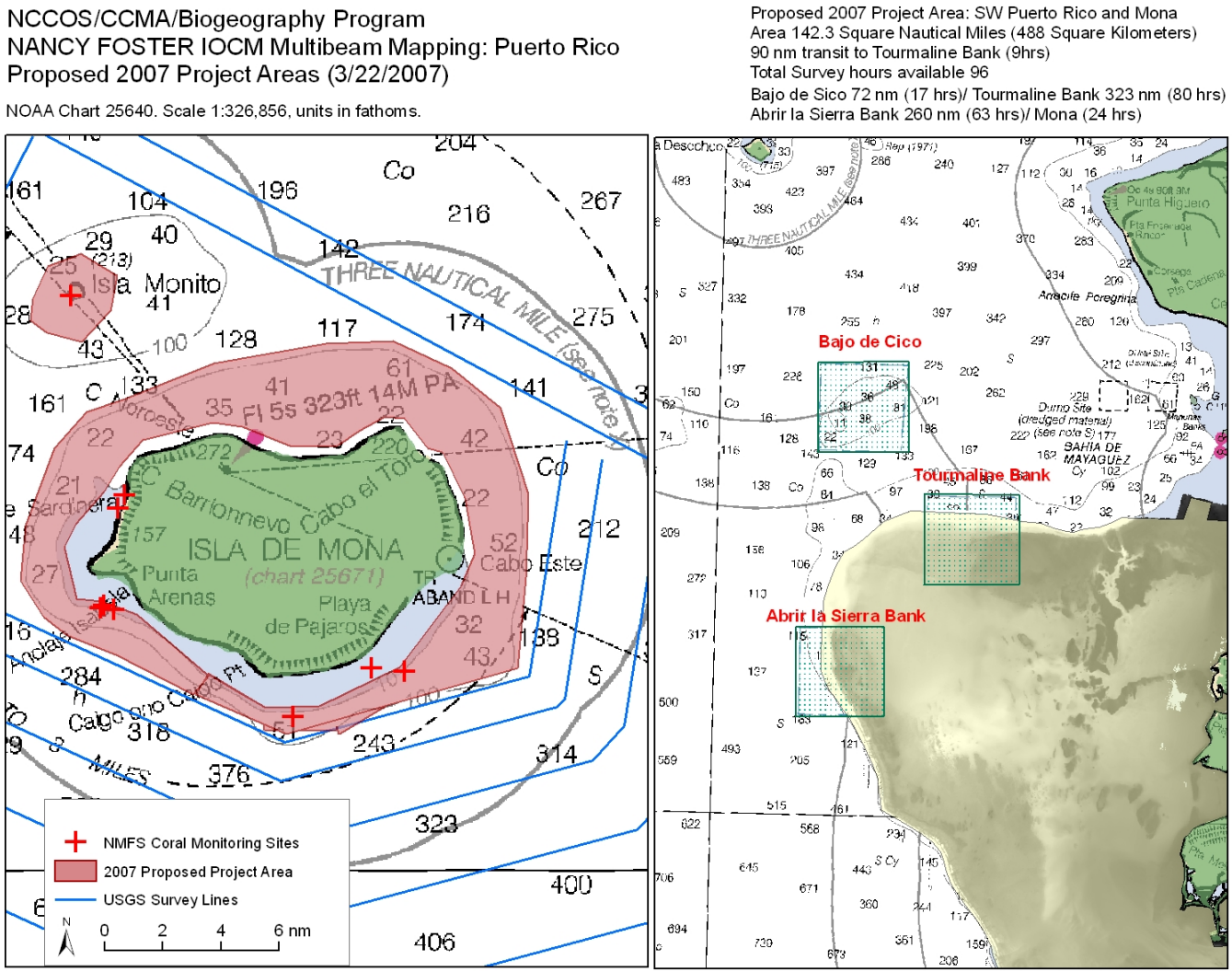

Table 2: Line Spacing Specifications

Depth (Fath)	Depth (M)	Depth (ft)	Swath Angle (Degrees)	Swath Overlap (%)	Line Spacing (M)	Line Spacing (ft)
5	9.1	30.0	55	10	23.5	77.1
10	18.3	60.0	55	10	47.0	154.2
15	27.4	90.0	55	10	70.5	231.4
20	36.6	120.0	55	10	94.0	308.5
25	45.7	150.0	55	10	117.5	385.6
30	54.9	180.0	55	10	141.0	462.7
40	73.2	240.0	55	10	188.0	617.0
50	91.4	300.0	55	10	235.1	771.2
75	137.2	450.0	55	10	352.6	1156.8
100	182.9	600.0	55	10	470.1	1542.4
125	228.6	750.0	55	10	587.7	1928.0
150	274.3	900.0	55	10	705.2	2313.6
175	320.0	1050.0	55	10	822.7	2699.2
200	365.8	1200.0	55	10	940.2	3084.8
250	457.2	1500.0	55	10	1175.3	3856.0
300	548.6	1800.0	55	10	1410.4	4627.2
350	640.1	2100.0	55	10	1645.4	5398.4
400	731.5	2400.0	55	10	1880.5	6169.6
450	823.0	2700.0	55	10	2115.6	6940.8
500	914.4	3000.0	55	10	2350.6	7712.0
550	1005.8	3300.0	55	10	2585.7	8483.2
600	1097.3	3600.0	55	10	2820.7	9254.4
650	1188.7	3900.0	55	10	3055.8	10025.6
700	1280.2	4200.0	55	10	3290.9	10796.8

L=2 d tan (a/2) * (1-s)

a = Multibeam Swath Angle

d = Water Depth (ft)

s = Swath Sidelap

Figure 5: Bajo de Cico, Puerto Rico patch test location.