NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT NH1101

Isles of Shoals, New Hampshire

Introduction

Coastal Mapping Program (CMP) Project NH1101 provides highly accurate digital shoreline data for the Isles of Shoals, including the approaches to Gosport Harbor. These islands are located approximately 10 kilometers southeast of Portsmouth Harbor. The Geographic Cell (GC) may be used in support of the NOAA Nautical Charting Program (NCP) as well as geographic information systems (GIS) for coastal zone management applications.

Project Design

Project NH1101 was designed per a request from the Marine Chart Division (MCD) of the Office of Coast Survey, NOAA, for updated shoreline data in support Nautical Charting requirements. The Requirements Branch (RB) of the Remote Sensing Division (RSD) formulated the photographic mission instructions for this project following the guidelines of the <u>Photo Mission Standard Operating Procedure</u> Version II. The instructions discussed the project's purpose, geographic area of coverage, scope and priority, image requirements, flight line priority, Global Positioning System (GPS) data collection procedures and guidelines for both kinematic and static surveys, data recording and handling instructions and contact and communication information. RB created a Project Layout Diagram, flight maps and input files for the aircraft flight management system.

Field Operations

The field operations consisted of the collection of static and kinematic Global Positioning System (GPS) data and Inertial Measurement Unit (IMU) data and the acquisition of aerial imagery. Aerial survey operations were conducted on June 4, 2011, with the NOAA King Air aircraft. The data were acquired using an Applanix Digital Sensor System (DSS-439) Dual Cam digital camera at a nominal flying height of 5,000 feet, resulting in an approximate ground sample distance (GSD) of 0.17 meters. Four (4) lines of tide-coordinated imagery were utilized in this effort – tandem RGB and IR collected at MLLW and IR collected at MHW. Each of the three data types consisted of 69 images, for a total of 207 images for the project.

Direct Georeferencing Data

The GPS/IMU data were processed by Remote Sensing Division (RSD) personnel to yield precise camera positions and orientations for direct geo-referencing (DG) of the imagery. A local GPS base station was established for use as a reference station for kinematic GPS processing operations. The position of the base station was determined using the NGS Online Processing User Service (OPUS), which computed fixed baseline solutions from nearby CORS stations. The airborne kinematic data was processed using Applanix POSPAC (ver. 5.4) software in June 2011.

The results of the GPS/IMU data processing were utilized to determine the map accuracy of well-defined image features by propagating sensor exterior orientation (EO) and image measurement uncertainties through the photogrammetric collinearity equations (Mikhail et al, 2001). Specifically, an Excel spreadsheet based Exterior Orientation Total Propagated Uncertainty (EO-TPU) Tool has been built that will allow the analyst to calculate the accuracy ("uncertainty") of a defined point, based on 1) the uncertainty in the EO parameters determined in the POSPAC processing, and 2) uncertainty in measured image coordinates of a standard DSS439 image. It does this by propagating these component uncertainties through the photogrammetric collinearity equations to the uncertainty in the *X*, *Y* coordinates of a point on the ground. (Mikhail, E., J. Bethel, and J. McGlone, 2001. *Introduction to modern photogrammetry*. John Wiley & Sons, New York, 479 p.)

In this way, the ground accuracy for a given well-defined point can be computed for both individual images and for the project as a whole. For the NH1101 DG derived camera stations, a predicted horizontal uncertainty of 0.66 meters was computed at the 95% confidence level.

The NGS 3rd- Order geodetic control station *STAR ISLAND CHURCH SPIRE* (PID-MY4804) was used as a check point to test the horizontal integrity of the DG data. Measurements of the church spire in six stereo-models (2 per data type) were compared to the check point coordinates. The mean offset derived from the six measurements = 0.34 meters (see below).

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**** Model and Offset ****

225001_01160/01159 = 0.38m,  225003_01104/01105 = 0.27m
325001_00990/00991 = 0.61m,  325003_00957/00958 = 0.27m
625001_03796/03795 = 0.27m,  625003_03762/03763 = 0.27m
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All stereo-models were examined and found to be free of excessive parallax and suitable for mapping purposes.

Compilation

The data compilation phase of this project was initiated by RSD in January 2012. Compilation was performed using stereoscopic interpretation of the project imagery, integrated with "heads-up" digitizing from within the Socet Set (SS) Feature Extraction module. The largest scale NOAA nautical charts, the US Coast Guard Light List, and other ancillary sources were also utilized for feature identification and attribution. Feature attribution was assigned in compliance with the Coastal Cartographic Object Attribute Source Table (C-COAST), which provides the definition and attribution scheme for the full range of cartographic features pertinent to the CMP. Selected features were further modified with additional descriptive information to refine general classification.

Spatial data accuracies for project NH1101 were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 1.3 meters. The predicted accuracy of compiled, well-defined points is derived by doubling the CE95 values (noted above) computed from the DG data and statistics derived from the EO-TPU tool.

The following table provides information on the imagery used to complete this project:

Data Type	Date	Strip	Frames	Tide Level*	Time (UTC)	Roll #
MLLW RGB	6/4/2011	625004	03732 - 03752	0.02	11:41	11NC27
		625003	03753 - 03774	0.02	11:49	
		625002	03775 - 03787	0.03	11:53	
		625001	03788 - 03800	0.05	12:00	
MLLW IR	6/4/2011	325004	00927 - 00947	0.02	11:41	11NR10
		325003	00948 - 00969	0.02	11:49	
		325002	00970 - 00982	0.03	11:53	
		325001	00983 - 00995	0.05	12:00	
MHW IR	6/4/2011	225003	01096 - 01117	2.6	17:19	11NR11
		225002	01118 - 01130	2.6	17:25	
		225004	01131 - 01151	2.6	17:33	
		225001	01152 - 01164	2.6	17:39	

* Tide levels are given in meters above MLLW, and were calculated using the Pydro software tool with a TCARI grid referenced to verified water level observations from the NOS station at Fort Point, NH (ID: 842-3898). The elevation of MHW in the project area is about 2.7 meters above MLLW.

Quality Control / Final Review

The final review of the project was completed by a senior member of RSD in February 2012, and included analysis of the DG results and assessment of the identification and attribution of digital feature data within the GC according to image analysis and criteria defined in C-COAST. The quality control process concluded with an inspection of topological connectivity within the GC using ArcGIS 10.0 software. All project data was evaluated for compliance to CMP requirements.

Comparisons of the largest scale NOAA nautical charts with source imagery and compiled project data resulted in creation of the Chart Evaluation File (CEF). The following nautical chart was used in the comparison process:

-   13283, Portsmouth Harbor, 1:20,000 scale, 21st Ed., Mar./11

End Products and Deliverables

The following specifies the location and identification of the products generated during the completion of this project:

RSD Applications Branch Archive
-   Hardcopy of the Airborne Positioning and Orientation Report (APOR)
-   Hardcopy of the Project Completion Report (PCR)
-   Page-size graphic plot of GC10929 file contents, attached to PCR

Remote Sensing Division Electronic Data Library
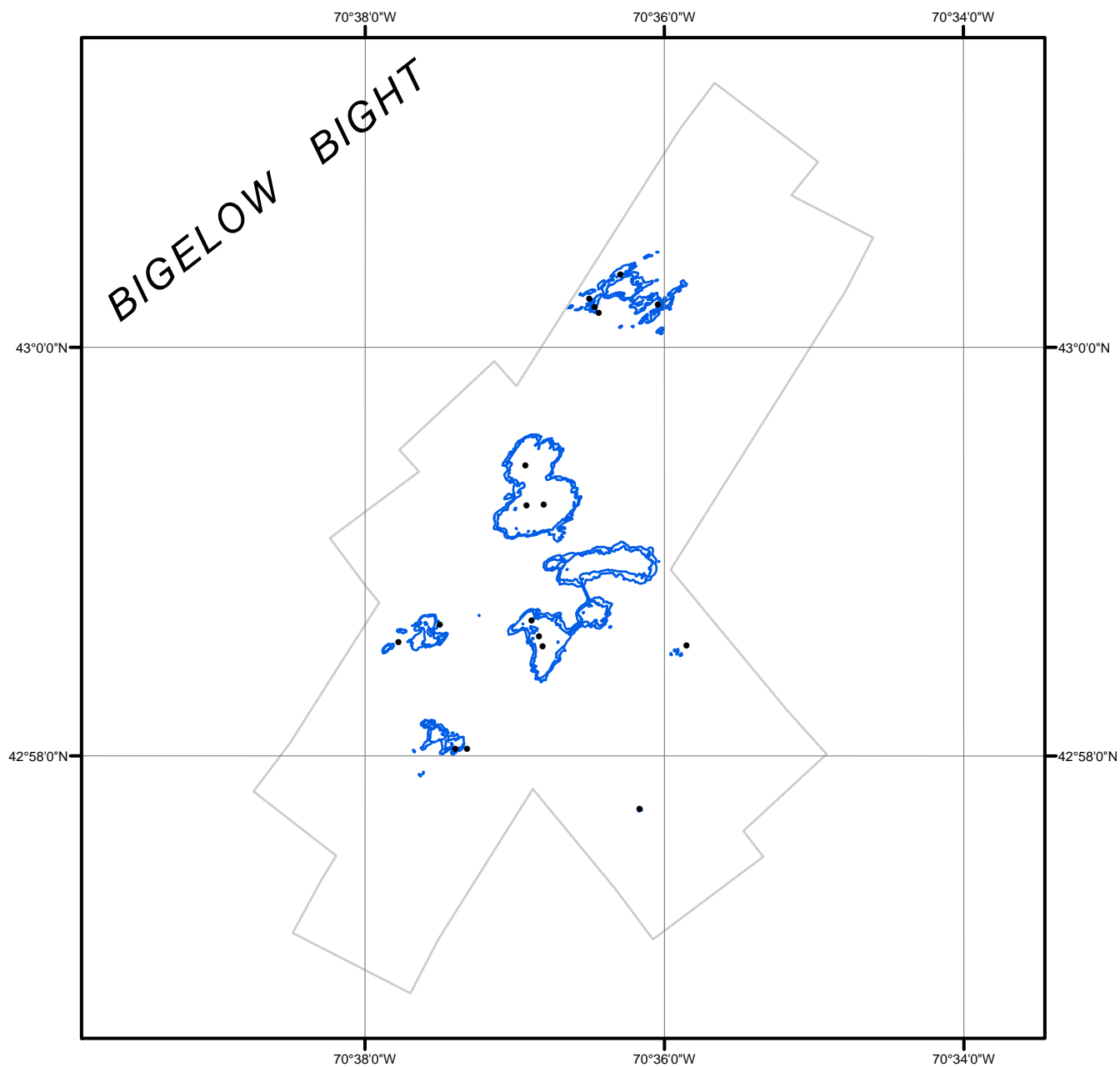-   Project database

- GC10929 in shapefile format
- Digital copy of the PCR in Adobe PDF format
- Chart Evaluation File in shapefile format
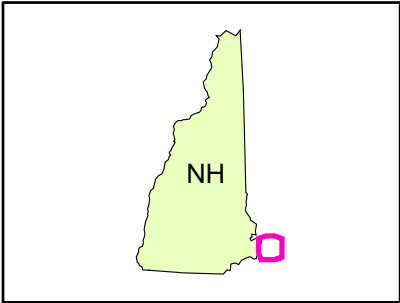
NOAA Shoreline Data Explorer

- GC10929 in shapefile format
- Metadata file for GC10929
- Digital copy of the PCR in Adobe PDF format

End of Report

ISLES OF SHOALS

NEW HAMPSHIRE

70°38'0"W 70°36'0"W 70°34'0"W

BIGELOW BIGHT

43°0'0"N

42°58'0"N

70°38'0"W 70°36'0"W 70°34'0"W

Overview

NH

NH1101

GC10929