NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT MA1101C-CM-N

Green Harbor to Warren Cove, Massachusetts

Introduction

NOAA Coastal Mapping Program (CMP) Project MA1101C-CM-N provides a highly accurate database of new digital shoreline data, extending from Green Harbor to Warren Cove, in Massachusetts, and includes Plymouth Harbor. Project MA1101C-CM-N is a subproject of a larger project, MA1101-CM-N, which covers Cape Cod and Cape Cod Bay. The Geographic Cell (GC) may be used in support of the NOAA Nautical Charting Program (NCP) as well as geographic information systems (GIS) for a variety of coastal zone management applications.

Project Design

Photographic mission instructions for MA1101-CM-N were formulated by the Requirements Branch (RB) of the Remote Sensing Division (RSD) following the guidelines of the Photo Mission Standard Operating Procedures. The instructions discussed the project's purpose, geographic area of coverage, scope and priority, image requirements, Global Positioning System (GPS) data collection procedures and guidelines, instructions for data recording and handling, and mission communication protocols. 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 GPS data and Inertial Measurement Unit (IMU) data, and the acquisition of digital aerial imagery. Aerial survey operations for Project MA1101-CM-N were conducted from June 2011 through October 2014 with the NOAA King Air aircraft (N68RF). Project imagery used for sub-project MA1101C-CM-N included portions of seven (7) flight lines of natural color (NC) and near-infrared (NIR) imagery acquired concurrently using an Applanix DSS-439 dual head digital camera system (two 60 mm lenses). The imagery was collected in coordination with both the Mean High Water (MHW) and Mean Lower Low Water (MLLW) tide stages. All imagery was acquired at a nominal altitude of 10,000 feet, resulting in an approximate ground sample distance (GSD) of 0.35 meters.

Direct Georeferencing Data Processing

GPS/IMU data were processed by RSD personnel to yield precise camera positions and orientations for direct georeferencing (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. Airborne kinematic data for subproject MA1101C-CM-N was processed using Applanix POSPAC (ver. 5.3) software in July 2011, Applanix POSPAC (ver. 5.4) software in October 2011, Applanix POSPAC MMS

(ver. 6.1) software in August 2012 and Applanix POSPAC MMS (ver. 6.2) software in October-November 2014. For further information refer to the Airborne Positioning and Orientation Reports (APOR) on file with other project data within the RSD Electronic Data Library.

The processed GPS/IMU data were used to derive precise exterior orientation (EO) values of the camera centers required for digital feature extraction. The predicted horizontal accuracy of the imagery was calculated using an Exterior Orientation Total Propagated Uncertainty (EO-TPU ver. 2.1) tool developed by NGS. Using this tool, the predicted horizontal uncertainty at the 95% confidence level was calculated to be 1.4 meters.

Compilation

The data compilation phase of this project was accomplished by RSD AB personnel in July 2018. Digital mapping was performed using the Feature Extraction software module within SOCET SET (ver. 5.6). Feature identification and attribution within the GC were based on image analysis of the aerial imagery and information extracted from the largest scale NOAA nautical charts and other ancillary sources. 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 MA1101C-CM-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 2.8 meters. This predicted accuracy of well-defined points measured during the compilation phase was derived by doubling the imagery accuracy computed from the EO-TPU tool.

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

Date	Time (UTC)	Color Imagery		Infrared Imagery		Tide Level*
		Roll	Images	Roll	Images	
6/16/2011	17:22 – 17:24	11NC39	7620 – 7636	11NR21	4589 – 4605	3.1 – 3.2 m
6/16/2011	17:29 – 17:31	11NC39	7637 – 7657	11NR21	4606 – 4626	3.0 – 3.2 m
6/16/2011	17:38 – 17:40	11NC39	7658 – 7675	11NR21	4627 – 4644	3.0 – 3.1 m
6/16/2011	17:45 – 17:47	11NC39	7676 – 7693	11NR21	4645 – 4662	2.9 – 3.1 m
6/16/2011	17:52 – 17:55	11NC39	7694 – 7713	11NR21	4663 – 4682	2.9 – 3.0 m
6/16/2011	17:59 – 18:00	11NC39	7714 – 7719	11NR21	4683 – 4696	2.8 – 2.9 m
6/17/2012	14:44 – 14:45	12NC46	11939 – 11947	12NR32	7376 – 7384	2.6 m
4/25/2014	18:37 – 18:38	14NC38	8665 – 8670	14NR31	5745 – 5750	0.2 m
4/25/2014	18:46 – 18:47	14NC38	8671 – 8679	14NR31	5751 – 5759	0.2 m
4/25/2014	18:51 – 18:54	14NC38	8680 – 8697	14NR31	5760 – 5777	0.2 – 0.3 m
4/25/2014	18:59 – 19:01	14NC38	8698 – 8715	14NR31	5778 – 5795	0.2 m

4/25/2014	19:06 – 19:09	14NC38	8716 – 8736	14NR31	5796 – 5816	0.2 m
4/25/2014	19:14 – 19:17	14NC38	8737 – 8756	14NR31	5817 – 5836	0.2 m
4/25/2014	19:21 – 19:24	14NC38	8757 – 8773	14NR31	5837 – 5853	0.2 – 0.3 m

*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 at NOS gauges. The height of the MHW tidal datum in the project area varies between 2.87 – 3.12 meters above MLLW.

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by a member of the Applications Branch. The final QC review was completed in July 2018. The review process 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 (ver. 10.5) 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 charts were used in the comparison process:

- 13253, 20th Ed., Jul. 2010

End Products and Deliverables

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

Remote Sensing Division Electronic Data Library

- Project database
- Airborne Positioning and Orientation Reports
- GC11421 in shapefile format
- Project Completion Report (PCR)
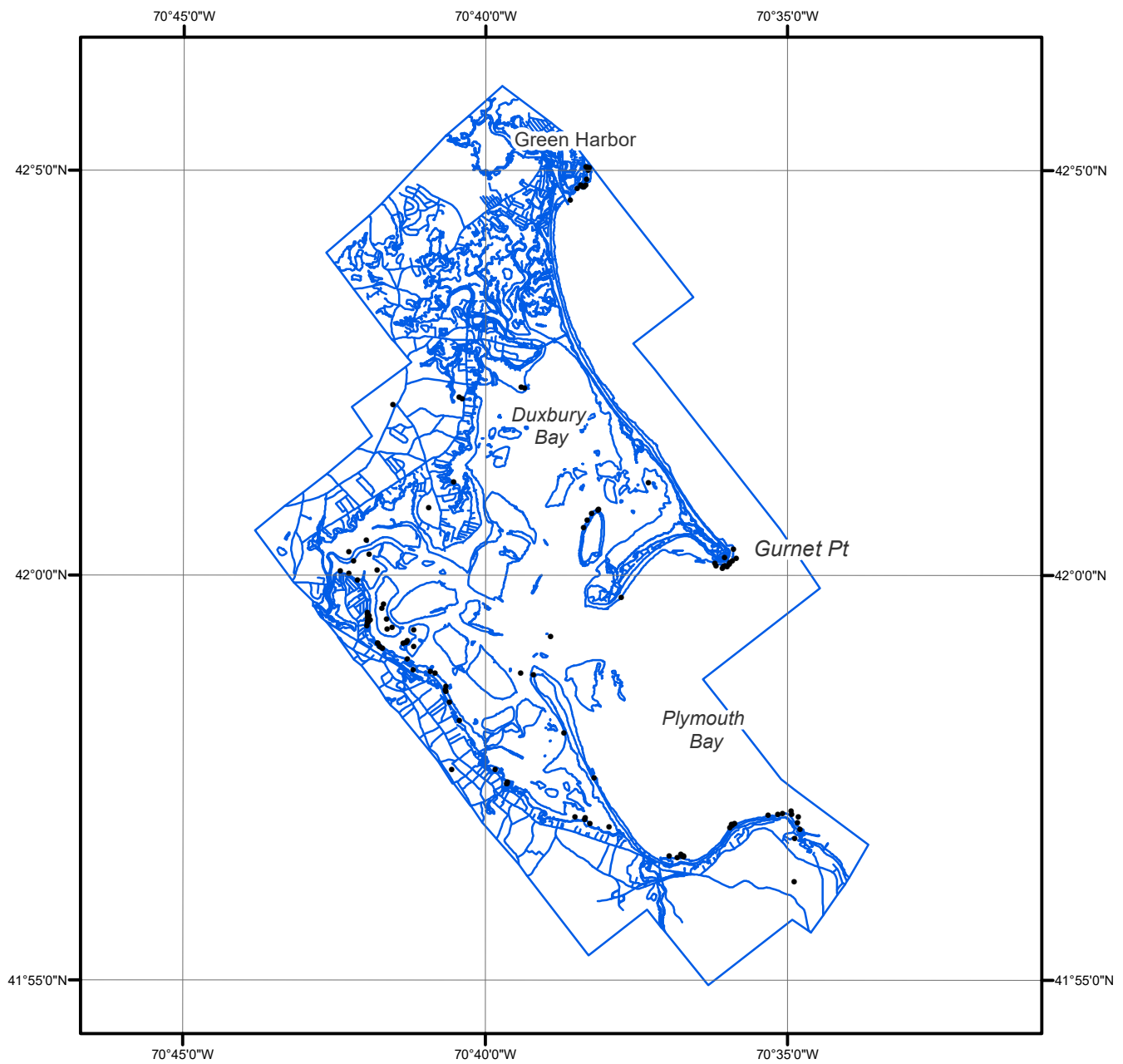- CEF in shapefile format

NOAA Shoreline Data Explorer

- GC11421 in shapefile format
- Metadata file for GC11421
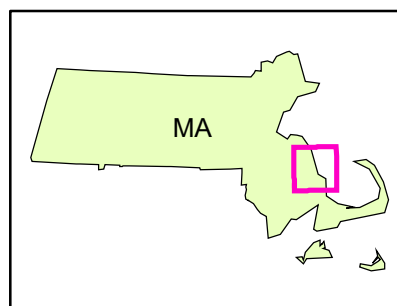- PCR in Adobe PDF format

End of Report

GREEN HARBOR TO WARREN COVE

MASSACHUSETTS

70°45'0"W 70°40'0"W 70°35'0"W

42°5'0"N

Green Harbor

Duxbury Bay

Gurnet Pt

42°0'0"N

Plymouth Bay

41°55'0"N

Overview

MA

MA1101C-CM-N

GC11421