

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT MA1101G-CM-N

Cape Cod Bay, Nobscusset Point to Eastham, Massachusetts

Introduction

NOAA Coastal Mapping Program (CMP) Project MA1101G-CM-N provides a highly accurate database of new digital shoreline data for a portion of Cape Cod Bay from Nobscusset Point to Eastham, in Massachusetts. Project MA1101G-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, 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 MA1101G-CM-N included portions of four flight lines of natural color (RGB) and near-infrared (NIR) imagery acquired concurrently using an Applanix DSS 439 dual head digital camera system. The imagery was collected in strict 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 0.34 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 MA1101G-CM-N was processed using Applanix POSPAC MMS (ver. 6.1) software in August 2012 and Applanix POSPAC MMS (ver. 6.2) software in August 2013. 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.

NGS third order control was used to verify the horizontal integrity of the DG data. All stereo models were examined and found to have acceptable levels of parallax for mapping purposes.

Compilation

The data compilation phase of this project was completed by RSD Applications Branch (AB) personnel in May 2020. 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.

Subsequent to completion of compilation, one GeoEye-1 orthorectified pan-sharpened commercial satellite image from DigitalGlobe was obtained in order to verify features within Sesuit Harbor with more recent imagery, at the request of the Marine Chart Division (MCD) of NOAA's Office of Coast Survey. This image was adjusted to match the positioning of existing features in the GC using the Georeferencing tool within Esri's ArcGIS (ver. 10.8) desktop GIS software. Comparison of compiled features with the satellite image was conducted, with no significant differences identified and no changes made.

Spatial data accuracies for project MA1101G-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)	DSS Color Imagery		DSS Infrared Imagery		Tide Level*
		Roll	Images	Roll	Images	
7/17/2012	14:58 – 14:59	12NC46	50-042 / 11971 – 11980	12NR32	7407 – 7417	2.8 m
7/17/2012	15:06 – 15:10	12NC46	50-035 / 11981 – 12006	12NR32	7418 – 7444	2.8 m
7/21/2012	16:39 – 16:43	12NC48	50-044 / 12359 – 12386	12NR34	7796 – 7823	2.8 – 2.9 m
7/21/2012	16:50 – 16:52	12NC48	50-036 / 12387 – 12398	12NR34	7824 – 7835	2.9 m
7/22/2012	12:45 – 12:46	12NC49	50-036 / 12839 – 12850	12NR35	8276 – 8287	0.0 m
7/22/2012	12:51 – 12:52	12NC49	50-042 / 12851 – 12860	12NR35	8288 – 8297	0.0 – 0.1 m

7/18/2013	17:47 – 17:50	13NC42	50-035 / 9601 – 9627	13NR37	8276 – 8302	0.2 m
7/18/2013	17:55 – 17:59	13NC42	50-044 / 9628 – 9655	13NR37	8303 – 8330	0.3 m
Date	Time (UTC)	Sensor	Source File (Tile) ID			Tide Level†
7/7/2020	15:32	GeoEye-1	20200707_GE01_ORI_R1C1.jp2			2.1 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 2.98 – 3.05 meters above MLLW.

† Tide level is given in meters above MLLW and is based on verified observations at the Boston reference gauge, with time and height offsets applied to the tidal substation at Sesuit Harbor.

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 May 2020. 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. 10.8) 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:

- 13246, Cape Cod Bay, 40th Ed., Oct. 2013
- 13250, Wellfleet Harbor; Sesuit Harbor, 9th Ed., Dec 2010
- 13251, Barnstable Harbor, 16th Ed., Jun 2011

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

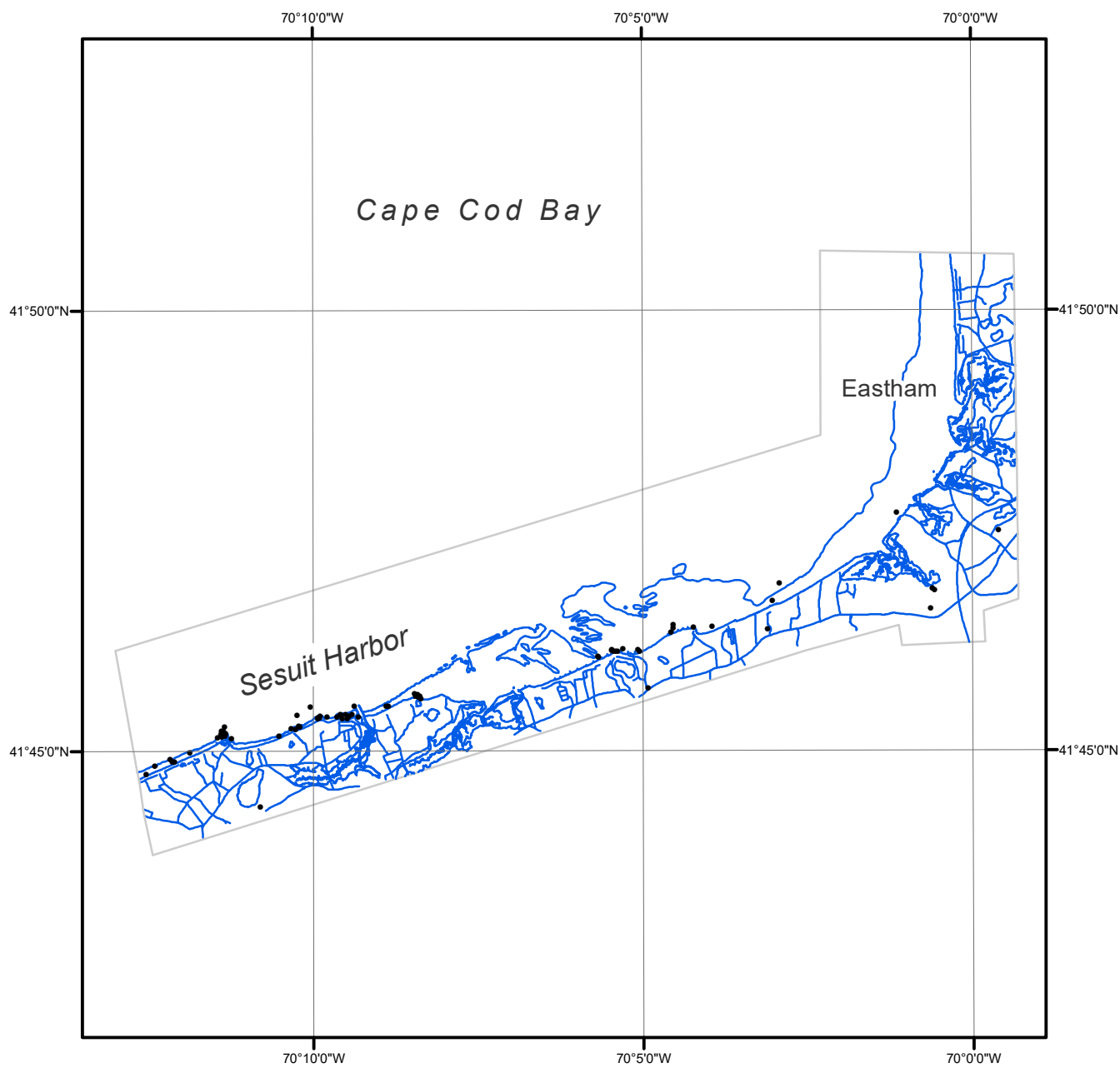
- Project database
- Airborne Positioning and Orientation Reports
- GC11652 in shapefile format
- Project Completion Report (PCR)
- CEF in shapefile format

NOAA Shoreline Data Explorer

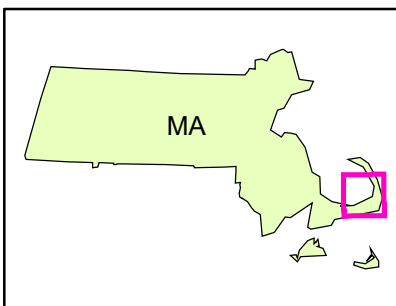
- GC11652 in shapefile format
- Metadata file for GC11652
- PCR in Adobe PDF format

End of Report

CAPE COD BAY, NOBSCUSSET POINT TO EASTHAM MASSACHUSETTS



Overview



MA1101G-CM-N

GC11652