

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT ME0401D

Muscongus Bay and Southwestern Penobscot Bay, Maine

Introduction

Coastal Mapping Program (CMP) Project ME0401D provides a highly accurate database of new digital shoreline data for Muscongus Bay and southwestern Penobscot Bay. The project extends from the Pemaquid River south to Pemaquid Point then north to Atlantic Point in Rockland Harbor including the eastern shore of Pemaquid Harbor and Johns Bay and all islands east to Large Green Island and south to Monhegan Island. Project ME0401D is a subproject of a larger project, ME0401, which includes the shore of Maine from Pemaquid Point to Naskeag Point and includes the Penobscot River upstream to Bangor, and the offshore islands in Penobscot Bay.

Successful completion of the project resulted in a densification of the National Spatial Reference System (NSRS), a set of controlled metric-quality aerial photographs, and a Geographic Cell (GC) of the coastal zone which compliments the Nautical Charting Program (NCP) as well as geographic information systems (GIS) for a variety of coastal zone management applications.

The project database consists of information measured and extracted from aerial photography and metadata related to photogrammetric compilation. Base mapping was conducted in a digital environment using stereo softcopy photogrammetry and associated cartographic practices.

Project Design

The design of project ME0401 was based on a comparison of image analysis to cartographic detail depicted on the pertinent NOAA nautical charts of the project site. The Remote Sensing Division (RSD) of the National Geodetic Survey, NOAA, formulated the ME0401 Project Instructions (June 9, 2004) which contains the specific field and photo mission operational guidelines. The instructions, as provided to Tuck Mapping Solutions, Inc. (TMSI), discussed the project's purpose, geographic area of coverage, scope and priority; photographic and ground control requirements; flight line priority; tide and sun angle coordination; Global Positioning Systems (GPS) data collection procedures and guidelines for both kinematic and static surveys; data recording and handling instructions; and contact communication information.

Nautical charts provided by RSD showed the limits of the color, black & white infrared (B&W IR) and tide sensitive photography areas. Photo scales for the color and B&W IR photography were determined by RSD staff to attain the required mapping accuracies. A

waiver to utilize a 700nm filter during the acquisition of the B&W IR film was approved previously. NOAA approved waiver for this filter on the camera without requiring a new camera calibration report by the USGS.

Included in correspondence from TMSI to NOAA on July 25, 2002, was a document titled Quality Control Procedures for NOAA Coastal Mapping Projects. These procedures and requirements were followed by TMSI throughout the project.

Field Operations

TMSI photographic mission operations were conducted on September 30, 2004, October 29, 2004, October 30, 2004, May 13, 2005, June 2, 2005, June 4, 2005, June 20, 2005, June 21, 2005, July 21, 2005, August 26, 2005, October 20, 2005, October 21, 2005, October 7, 2006, and October 8, 2006. Aerial photographic coverage of the project site consisted of natural color and black & white infrared photographs at a nominal scale of 1:36000. Tide-coordinated photography was conducted at both the mean high water (MHW) and mean lower low water (MLLW) levels. Natural color and black & white infrared photographs were acquired at MHW and only black & white infrared photographs were acquired at MLLW.

TMSI used two base stations, Z 151 (NGS PID PE1053) and NAIL (a temporary non-NGS station). Z 151, the primary station, was a Leica dual frequency GPS receiver with an antenna mounted on a tripod. NAIL had the same configuration and was a backup for Z 151. There was one data failure on May 13, 2005, for Z 151 that required the use of the backup station data. GPS data was submitted for OPUS solutions to verify the stations. TMSI performed the necessary GPS surveys to locate aerial control and checkpoints. Multiple two hour sessions observed by TMSI were submitted for OPUS solutions and a mean of the values was used to determine the control and checkpoint coordinates.

See the Photographic Flight Reports and Ground Control Reports for additional information.

GPS Data Reduction

GPS data was collected and processed to provide precise positions of the camera centers for application as photogrammetric control in the aerotriangulation phase of the project completion. TMSI acquired static GPS datasets of stations Z 151 and NAIL during all photography missions. After the flight missions, the project data was downloaded and processed using NovAtel's Waypoint GrafNav (versions 7.60.2425 and 7.80.2315) software. Forward and reverse trajectories were compared during the processing phase to ensure accuracy. Camera event file data was then applied to the final trajectory to obtain coordinates for the photo centers. A GPS Data Processing Report was written and is on file with other project data within the RSD Applications Branch (AB) Project Archive.

Aerotriangulation

Routine softcopy aerotriangulation methods were applied to extend the network of precise camera positions and other control for mapping, and to provide model parameters and orientation elements required for digital compilation. TMSI personnel initiated the softcopy

aerotriangulation work in June 2007, utilizing a digital photogrammetric workstation (DPW), which is a configuration of computer processor and monitor, and BAE Systems SOCET SET ver. 5.3 software equipment and peripheral devices. The softcopy aerotriangulation work was completed in July 2007.

All of the natural color photography flown September 30, 2004 to June 4, 2005, the B&W IR MLLW photography flown June 2 to August 26, 2005, and the B&W IR MHW flown June 21, 2005 to October 8, 2006 were processed as three separate blocks, except for the photography over Metinic Island, which could not be tied to the rest of the photography, and was processed as its own block. Upon successful completion of the block adjustments, SOCET SET's Multi Sensor Triangulation (MST) module provided the RMS of the standard deviations for all aerotriangulated ground points, which were used to determine the radius of the 95% confidence circle to be from 1.1 to 1.3 meters for the main block of photographs, and 3.9 meters for the Metinic Island block. The Aerotriangulation Report is on file with other project data within the RSD AB Project Archive.

The project database consists of camera calibration data, interior orientation parameters for each frame, airborne GPS antenna position and offset data, adjusted exterior orientation parameters for each frame, positional listing of all measured points, the control file and refined image coordinates as listed in the Project Database section of the Aerotriangulation Report. Positional data is based on the North American Datum of 1983 (NAD 83), and is referenced to UTM Zone 19 in meters.

Compilation

The data compilation phase of the project was accomplished by TMSI in January 2008. Digital mapping was performed using Digital Photogrammetric Workstations (DPWs) in conjunction with BAE SOCET SET ver. 5.4. Feature identification and the assignment of cartographic codes were based on image analysis of natural color photography and B&W IR photography and information extracted from appropriate NOAA Nautical Charts and the US Coast Guard Light List. Cartographic feature attribution was assigned in compliance with the Coastal Cartographic Object Attribute Source Table (C-COAST) as required.

Cartographic features were compiled to meet a horizontal accuracy at the 95% confidence level of 2.5 meters for the main block of photographs, and 5.0 meters for the Metinic Island block.

See Table 1 below for information on all aerial photographs used for project ME0401D.

Table 1 - Compilation Sources

Date	Time (UTC)	Roll Number	Film	Frames	Scale (nominal)	Tide Level* (m)
09/30/2004	1649-1657	0411CN01	Color	0022-0036	1:36000	3.7
09/30/2004	1700-1706	0411CN01	Color	0037-0048	1:36000	3.8
09/30/2004	1741-1747	0411CN01	Color	0097-0108	1:36000	3.5
09/30/2004	1751-1757	0411CN01	Color	0109-0120	1:36000	3.4
09/30/2004	1804-1806	0411CN01	Color	0121-0126	1:36000	3.2
09/30/2004	1807-1810	0411CN01	Color	0127-0130	1:36000	3.2
09/30/2004	1815-1816	0411CN01	Color	0134-0136	1:36000	3.1
09/30/2004	1818-1821	0411CN01	Color	0140-0147	1:36000	3.1
09/30/2004	1855-1900	0411CN01	Color	0193-0200	1:36000	2.6
09/30/2004	1907-1908	0411CN01	Color	0202-0204	1:36000	2.4
06/02/2005	1755-1756	0520R01	MLLW-IR	0049-0050	1:36000	0.0
06/02/2005	1808-1808	0520R01	MLLW-IR	0062-0063	1:36000	0.0
06/04/2005	1932-1933	0520R01	MLLW-IR	0117-0119	1:36000	0.3
06/20/2005	1924-1929	0520R02	MLLW-IR	0215-0226	1:36000	0.2
06/20/2005	1935-1937	0520R02	MLLW-IR	0228-0231	1:36000	0.1
06/20/2005	1949-1951	0520R02	MLLW-IR	0234-0237	1:36000	0.1
06/20/2005	2026-2028	0520R02	MLLW-IR	0261-0265	1:36000	0.3
06/20/2005	2031-2032	0520R02	MLLW-IR	0269-0271	1:36000	0.3
06/20/2005	2037-2039	0520R02	MLLW-IR	0275-0278	1:36000	0.3
06/20/2005	2040-2042	0520R02	MLLW-IR	0279-0284	1:36000	0.3
06/21/2005	2110-2114	0520R02	MLLW-IR	0366-0373	1:36000	0.2
06/21/2005	2120-2127	0520R02	MLLW-IR	0374-0385	1:36000	0.3
07/21/2005	2031-2033	0520R03	MLLW-IR	0401-0404	1:36000	0.1
07/21/2005	2042-2044	0520R03	MLLW-IR	0407-0412	1:36000	0.1
08/26/2005	1527-1529	0520R04	MLLW-IR	0465-0469	1:36000	0.4
10/20/2005	1719-1721	0520R05	MHW-IR	0472-0476	1:36000	3.1
10/20/2005	1747-1751	0520R05	MHW-IR	0496-0503	1:36000	3.0
10/07/2006	1410-1413	0620R05	MHW-IR	0589-0595	1:36000	3.3
10/07/2006	1542-1543	0620R05	MHW-IR	0667-0668	1:36000	3.3
10/07/2006	1555-1558	0620R05	MHW-IR	0674-0678	1:36000	3.3
10/08/2006	1455-1457	0620R05	MHW-IR	0767-0771	1:36000	3.4
10/08/2006	1527-1529	0620R05	MHW-IR	0803-0806	1:36000	3.3
10/08/2006	1530-1532	0620R05	MHW-IR	0807-0812	1:36000	3.3
10/08/2006	1537-1541	0620R05	MHW-IR	0813-0819	1:36000	3.3
10/08/2006	1543-1544	0620R05	MHW-IR	0823-0825	1:36000	3.3
10/08/2006	1554-1558	0620R06	MHW-IR	0827-0836	1:36000	3.4
10/08/2006	1603-1609	0620R06	MHW-IR	0837-0848	1:36000	3.4
10/08/2006	1645-1647	0620R06	MHW-IR	0864-0866	1:36000	3.2

* The gauges used to determine tidal heights within this project are Bangor (BNG) and Bar Harbor (BH). Tide height for color photography is for actual tide station shown. Tide levels for IR are given relative to MLLW and are based on gauge verified observations then adjusted for COOPS Tidal Zoning. The mean tide range for the project area varies from 0.0 to 3.8 meters.

Final Review

A TMSI team completed the final review in May 2008. The GC was evaluated for completeness and accuracy. The review process included analysis of aerotriangulation results and assessment of the identification and attribution of cartographic features 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 GIS software. All project data was evaluated for compliance to CMP requirements.

Comparisons of the largest scale NOAA nautical charts with natural color photographs and compiled project data resulted in creation of the Chart Evaluation File (CEF). The following nautical charts were used in the comparison process:

- 13301 Muscongus Bay, 1:40000, 20th edition, March 1997
- 13303 Approaches to Penobscot Bay, 1:40000, 12th edition, September 2002
- 13305 Penobscot Bay, 1:40000, 28th edition, 5 May 2001
- 13307 Camden-Rockport & Rockland Harbors, 1:20000, 10th edition, 27 Oct. 2001

End Products and Deliverables

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

RSD Applications Branch Project Archive:

- Hard copy of Airborne Positioning and Orientation Report
- Hard copy of Aerotriangulation Report
- Hard copy of the Project Completion Report
- Page-size graphic plot of GC10682 file contents

RSD Electronic Data Library:

- Project Database
- Digital copy of GC10682 in Shapefile format
- Digital Copy of Project Completion Report in Adobe PDF format

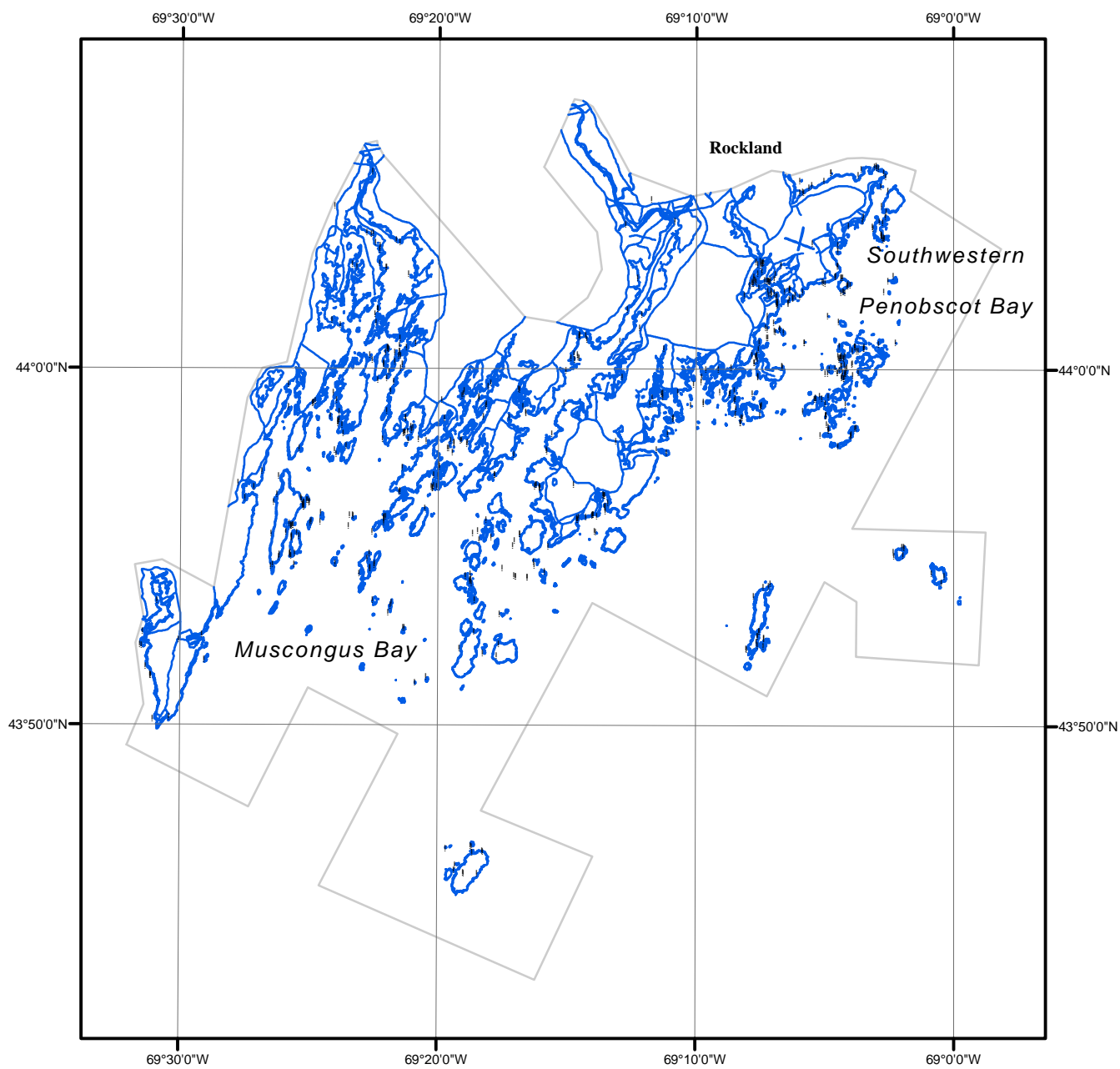
NOAA Shoreline Data Explorer:

- GC10682
- Metadata for GC10682
- Digital Copy of the Project Completion Report in Adobe PDF format

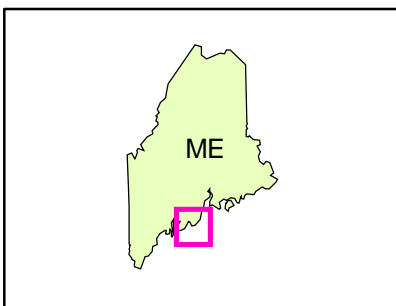
End of Report

MUSCONGUS BAY AND SOUTH PENOBSCOT BAY

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Overview



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