

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT ME0401B

East Penobscot Bay, Deer Isle and Isle Au Haut, Maine

Introduction

Coastal Mapping Program (CMP) Project ME0401B provides a highly accurate database of new digital shoreline data for East Penobscot Bay. The project includes all shoreline and islands in an area from Grays Point to High Head, west to Bradbury Island and south past Isle Au Haute including Eastern Penobscot Bay, Eggemoggin Reach, Isle Au Haute Bay, and Deer and Little Deer Islands. Project ME0401B 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.

The natural color scale photography flown September 30, 2004 to June 4, 2005, the B&W IR MLLW photography flown June 2, 2005 to August 26, 2005, and the B&W IR MHW flown June 21, 2005 to October 8, 2006 were processed as individual blocks. 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 all adjusted photographs. 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 February 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 of 2.5 meters at the 95% confidence level. This predicted accuracy of compiled, well-defined points is derived by doubling the circular error derived from aerotriangulation statistics.

See Table 1 for information on all aerial photographs used for project ME0401B.

Table 1 - Compilation Sources

Date	Time (UTC)	Roll Number	Film	Frames	Scale (nominal)	Tide Level* (m)
10/30/2004	1841-1848	0411CN01	Color	0177-0188	1:36000	2.8
05/13/2005	1611-1621	0520CN02	Color	0316-0327	1:36000	1.6
05/13/2005	1633-1637	0520CN02	Color	0339-0349	1:36000	1.8
06/04/2005	2014-2020	0520R01	MLLW-IR	0166-0176	1:36000	0.3
06/04/2005	2031-2037	0520R01	MLLW-IR	0189-0200	1:36000	0.4
06/20/2005	2004-2010	0520R02	MLLW-IR	0239-0250	1:36000	0.2
06/21/2005	1448-1450	0520R02	MHW-IR	0307-0310	1:36000	3.2
06/21/2005	1455-1457	0520R02	MHW-IR	0312-0316	1:36000	3.1
06/21/2005	1512-1513	0520R02	MHW-IR	0331-0333	1:36000	3.0
10/21/2005	1724-1726	0520R05	MHW-IR	0534-0540	1:36000	3.1
10/07/2006	1508-1509	0620R05	MHW-IR	0643-0646	1:36000	3.5
10/07/2006	1521-1523	0620R05	MHW-IR	0656-0659	1:36000	3.5
10/08/2006	1629-1630	0620R06	MHW-IR	0857-0859	1:36000	3.3
10/08/2006	1636-1637	0620R06	MHW-IR	0860-0863	1:36000	3.4

* The gauge used to determine tidal heights within this project is 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 is 0.2 to 3.5 meters.

Final Review

A TMSI team completed the final review in August 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:

- 13303 Approaches to Penobscot Bay, 1:40000, 12th edition, September 2001
- 13305 Penobscot Bay, 1:40000, 28th edition, 5 May 2001
- 13309 Penobscot River, 1:40000, 28th edition, September 2002
- 13313 Approaches to Blue Hill Bay, 1:40000, 20th edition, July 2004
- 13315 Deer Island Thorofare and Casco Passage, 1:20000, 11th edition, 2 March 2002
- 13316 Blue Hill Bay, 1:40000, 22nd edition, May 2003

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 GC10680 file contents

RSD Electronic Data Library:

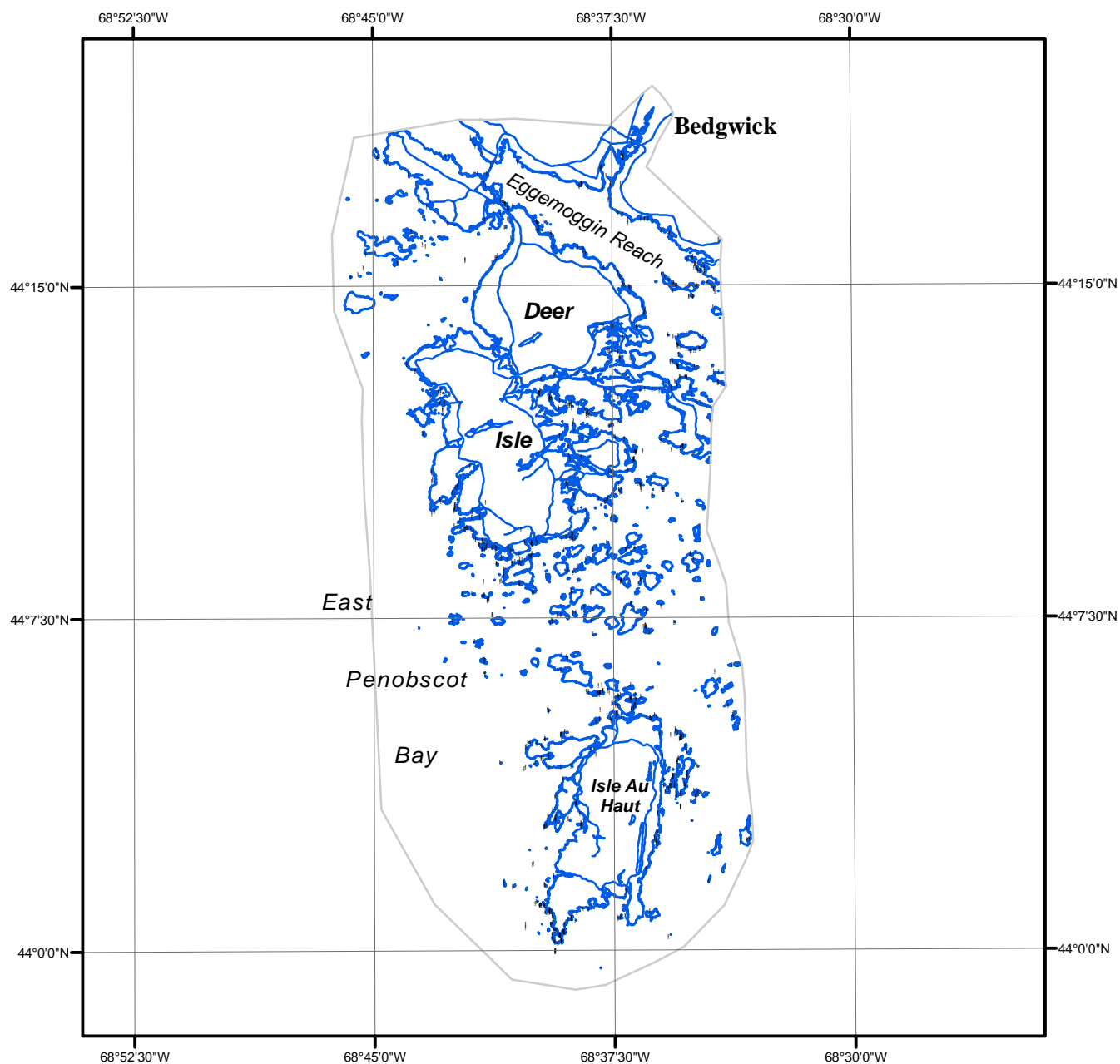
- Project Database
- Digital copy of GC10680 in Shapefile format
- Digital Copy of Project Completion Report in Adobe PDF format

NOAA Shoreline Data Explorer:

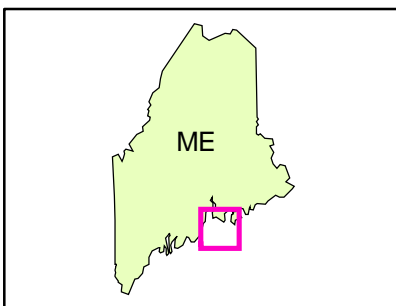
- GC10680
- Metadata for GC10680
- Digital Copy of the Project Completion Report in Adobe PDF format

End of Report

EAST PENOBSCOT BAY, DEER ISLE & ISLE AU HAUT MAINE



Overview



ME0401B

GC10680