

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT ME0401A

Northern Penobscot Bay and River

Introduction

Coastal Mapping Program (CMP) Project ME0401A provides a highly accurate database of new digital shoreline data for the northern Penobscot Bay and River. The project extends from Northport across Northern Penobscot Bay to Cape Rosier and up the Penobscot River to Bangor, including Islesboro Islands, Bagaduce River and Eastern Channel. Project ME0401A 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 the 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 to 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 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 emulsions. Upon successful completion of the block adjustment, SOCET SET's Multi Sensor Triangulation (MST) module provided the RMS of the standard deviations for all aerotriangulated ground points, which were used to compute predicted horizontal circular errors from 0.5 to 0.9 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 November 2007. Digital mapping was performed using Digital Photogrammetric Workstations (DPWs) in conjunction with BAE SOCET SET ver. 5.3. 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 1.8 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 ME0401A.

Table 1 - Compilation Sources

Date	Time (UTC)	Roll Number	Film	Frames	Scale (nominal)	Tide Level* (m)
09/30/2004	1637-1644	0411CN01	CN	0001-0014	1:36000	3.7
09/30/2004	1710-1718	0411CN01	CN	0057-0072	1:36000	3.8
09/30/2004	1728-1731	0411CN01	CN	0084-0090	1:36000	4.2
09/30/2004	1826-1829	0411CN01	CN	0157-0163	1:36000	3.1
09/30/2004	1837-1841	0411CN01	CN	0169-0176	1:36000	2.8
10/29/2004	1646-1648	0411CN01	CN	0209-0212	1:36000	3.5
10/29/2004	1651-1654	0411CN01	CN	0213-0219	1:36000	3.5
05/13/2005	1500-1503	0520CN02	CN	0283-0287	1:36000	0.8
05/13/2005	1510-1512	0520CN02	CN	0288-0293	1:36000	0.9
05/13/2005	1621-1625	0520CN02	CN	0327-0332	1:36000	1.6
05/13/2005	1631-1633	0520CN02	CN	0333-0338	1:36000	1.8
05/13/2005	1700-1702	0520CN02	CN	0372-0375	1:36000	2.0
06/02/2005	1725-1729	0520R01	IR	0001-0010	1:36000	0.1
06/02/2005	1748-1751	0520R01	IR	0035-0041	1:36000	0.0
06/02/2005	1814-1820	0520R01	IR	0075-0085	1:36000	0.0
06/02/2005	1825-1832	0520R01	IR	0086-0098	1:36000	0.1
06/04/2005	1957-1959	0520R01	IR	0140-0143	1:36000	0.3
06/04/2005	2028-2031	0520R01	IR	0183-0188	1:36000	0.4
06/20/2005	2010-2014	0520R02	IR	0251-0258	1:36000	0.2
06/21/2005	1432-1438	0520R02	IR	0287-0300	1:36000	3.2
06/21/2005	1445-1448	0520R02	IR	0301-0306	1:36000	3.2
06/21/2005	1458-1459	0520R02	IR	0317-0320	1:36000	3.1
06/21/2005	1509-1511	0520R02	IR	0325-0330	1:36000	3.0
06/21/2005	1520-1521	0520R02	IR	0338-0341	1:36000	3.0
06/21/2005	1531-1537	0520R02	IR	0342-0354	1:36000	3.0
07/21/2005	2019-2022	0520R03	IR	0387-0392	1:36000	0.2
07/21/2005	2050-2051	0520R03	IR	0418-0420	1:36000	0.1
08/26/2005	1501-1507	0520R04	IR	0439-0448	1:36000	0.4
08/26/2005	1511-1518	0520R04	IR	0449-0462	1:36000	0.3
10/07/2006	1610-1621	0620R05	IR	0690-0710	1:36000	3.4
10/07/2006	1626-1636	0620R05	IR	0711-0730	1:36000	3.8
10/07/2006	1646-1647	0620R05	IR	0733-0736	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 4.2 meters.

Final Review

A TMSI team completed the final review in December 2007. 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:

- 13305 Penobscot Bay, 1:40000, 28th edition, May 2001
- 13309 Penobscot River, 1:40000, 28th edition, September 2002

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 GC10602 file contents

RSD Electronic Data Library:

- Project database
- GC10602 in shapefile format
- Digital copy of the Project Completion Report in Adobe PDF format

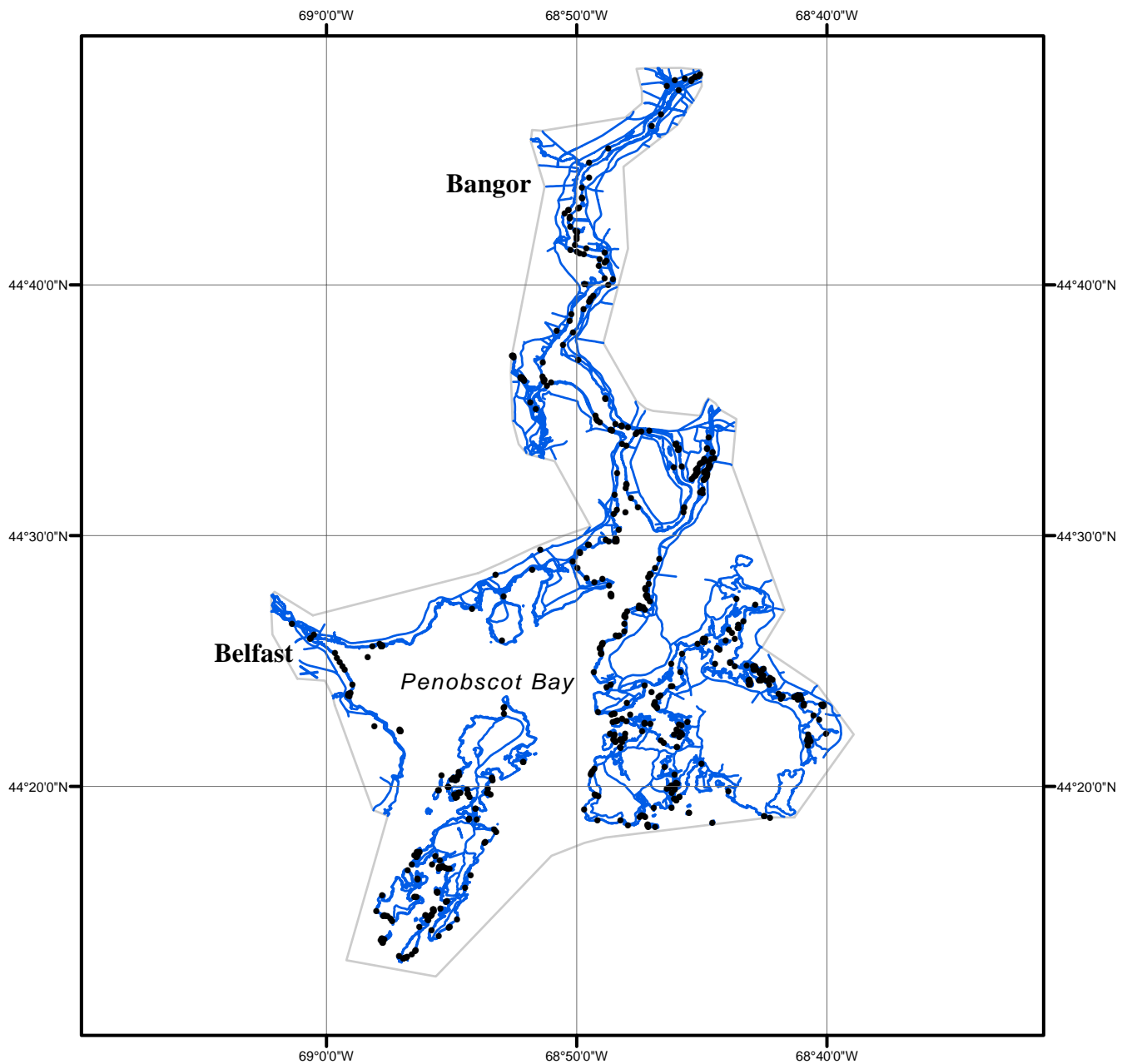
NOAA Shoreline Data Explorer:

- GC10602 in shapefile format
- Metadata file for GC10602
- Digital copy of the Project Completion Report in Adobe PDF format

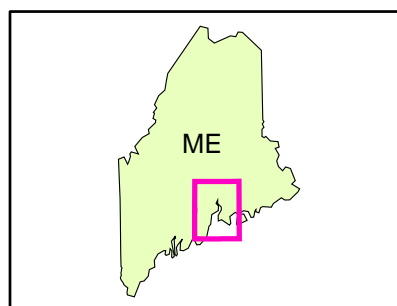
End of Report

NORTHERN PENOBSCOT BAY AND RIVER

MAINE



Overview



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