

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT MI1001I-CM-N

Inland Route, Crooked Lake to Mullett Lake, Michigan

Introduction

NOAA Coastal Mapping Program (CMP) Project MI1001I-CM-N provides highly accurate digital shoreline data for a portion of the Inland Route from Crooked Lake to Mullett Lake, in Michigan. MI1001I-CM-N is a subproject of a larger project MI1001-CM-N which covers the entire eastern shore of Lake Michigan. 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

The Requirements Branch (RB) of the Remote Sensing Division (RSD) formulated the photographic mission instructions for this project following the guidelines of the Photo Mission Standard Operating Procedures. The instructions discussed the project's purpose, geographic area of coverage, photographic requirements, Global Positioning System (GPS) data collection procedures and guidelines for both kinematic and static surveys, and data recording and handling instructions. RB also created project layout diagrams, flight maps, and input files for the aircraft's 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 aerial imagery. Photographic mission operations for MI1001-CM-N were conducted from September 7, 2010 to July 5, 2011 with the NOAA King Air (N68RF) aircraft. Two hundred and four (204) flight lines of color (RGB) imagery, along with simultaneous black & white infrared (BWIR) imagery were taken with an Applanix Digital Sensor System (DSS) 439 aerial camera at a nominal altitude of 10,000 feet, resulting in an approximate ground sample distance (GSD) of 0.35 meters. For subproject MI1001I-CM-N, only fourteen strips of color imagery were used.

Direct Georeferencing Data Processing

The GPS/IMU data was processed by RSD personnel to yield precise camera positions and orientations suitable for direct georeferencing 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. The kinematic GPS data was processed using Applanix POSPAC (ver. 5.3) software in July 2011. For further information refer to the Airborne Positioning and Orientation Reports (APOR) on file with other project data within the Remote Sensing Division Electronic Data Library. All positional data is referenced to the North American Datum of 1983 (NAD 83).

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 determined by propagating sensor EO and image measurement uncertainties through the photogrammetric collinearity equations using the Exterior Orientation Total Propagated Uncertainty (EO-TPU) tool developed by NGS. Using this tool, the predicted horizontal uncertainty at the 95% confidence level for all project imagery was calculated to be 1.5 meters. NGS third order geodetic control points were used to verify the horizontal integrity of the directly georeferenced imagery. All stereo-models were examined and found to have acceptable levels of parallax for mapping purposes.

Aerotriangulation

Twelve images covering the area around Crooked River Lock were aerotriangulated using routine softcopy aerotriangulation methods to establish a network of precise camera positions and other control for mapping, and to provide model parameters and orientation elements required for digital compilation. This work was performed by RSD Applications Branch (AB) personnel in April 2016 utilizing a softcopy photogrammetric workstation. The images were measured and adjusted as a single block using the Multi-Sensor Triangulation (MST) module of BAE Systems SOCET SET (v 5.6.0) software. Upon successful completion of this process, the MST module provided the standard deviations for each aerotriangulated ground point, which were used to compute a predicted horizontal circular error of 0.7 meters for the block based on a 95% confidence level. An Aerotriangulation Report was written and is on file with other project data within the RSD Electronic Data Library.

Compilation

The data compilation phase of this project was accomplished by a member of AB in April 2016. The work was accomplished on a softcopy photogrammetric workstation utilizing the Feature Extraction module within SOCET SET (v 5.6.0). Feature identification and the assignment of cartographic codes were based on image analysis of the project digital images and information extracted from the appropriate NOAA Nautical Charts, U.S. Coast Guard Light List 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 MI1001I-CM-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features compiled from the aerotriangulated block of imagery were compiled to meet a horizontal accuracy of 1.3 meters at the 95% confidence level, and features compiled for the rest of the project were compiled to meet an accuracy of 3.0 meters. These predicted accuracies of compiled well-defined points are derived by doubling the circular error calculated from either the aerotriangulation statistics or the TPU tool. The table below provides information on the imagery used to complete this project:

Date	Time (UTC)	Color Imagery		Infrared Imagery	
		Roll	Images	Roll	Images
6-30-2011	16:43 – 16:45	11NC48	14912 – 14926	11NR27	8846 – 8860
6-30-2011	16:46 – 16:49	11NC48	14927 – 14944	11NR27	8861 – 8878
6-30-2011	16:53 – 16:57	11NC48	14945 – 14972	11NR27	8879 – 8906
6-30-2011	17:03 – 17:04	11NC48	14987 – 14996	11NR27	8921 – 8930
6-30-2011	17:07 – 17:11	11NC48	14997 – 15020	11NR27	8931 – 8954
6-30-2011	17:56 – 17:57	11NC48	15115 – 15121	11NR27	9049 – 9055
6-30-2011	18:02 – 18:03	11NC48	15122 – 15134	11NR27	9056 – 9068
6-30-2011	18:34 – 18:38	11NC48	15189 – 15218	11NR27	9123 – 9152
7-03-2011	17:15 – 17:19	11NC43	11818 – 11850	11NR22	5752 – 5784
7-03-2011	17:23 – 17:25	11NC43	11851 – 11859	11NR22	5785 – 5793
7-03-2011	17:38 – 17:41	11NC43	11876 – 11897	11NR22	5810 – 5831
7-03-2011	17:45 – 17:47	11NC43	11898 – 11913	11NR22	5832 – 5847
7-03-2011	18:00 – 18:04	11NC43	11926 – 11954	11NR22	5860 – 5888
7-05-2011	18:04 – 18:06	11NC52	17350 – 17365	11NR31	11284 – 11299

* Actual water levels were not determined for this project, but levels in the Inland Route are generally regulated by the Crooked River dam and lock to be between 594.7 feet (above dam) and 593.0 feet (below dam) relative to the International Great Lakes Datum (IGLD) 1985.

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by a senior member of AB. The final QC review was completed in April 2016. The review process included analysis of aerotriangulation 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 10.1 software. All project data were evaluated for compliance to CMP requirements.

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

- 14886, Inland Route, Michigan (various scales), 12th Ed., Sep. 2014

End Products and Deliverables

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

Remote Sensing Division Electronic Data Library

- Project database
- Airborne Positioning and Orientation Report (APOR)
- Aerotriangulation Report
- GC11206 in shapefile format
- Project Completion Report (PCR)
- Chart Evaluation File in shapefile format

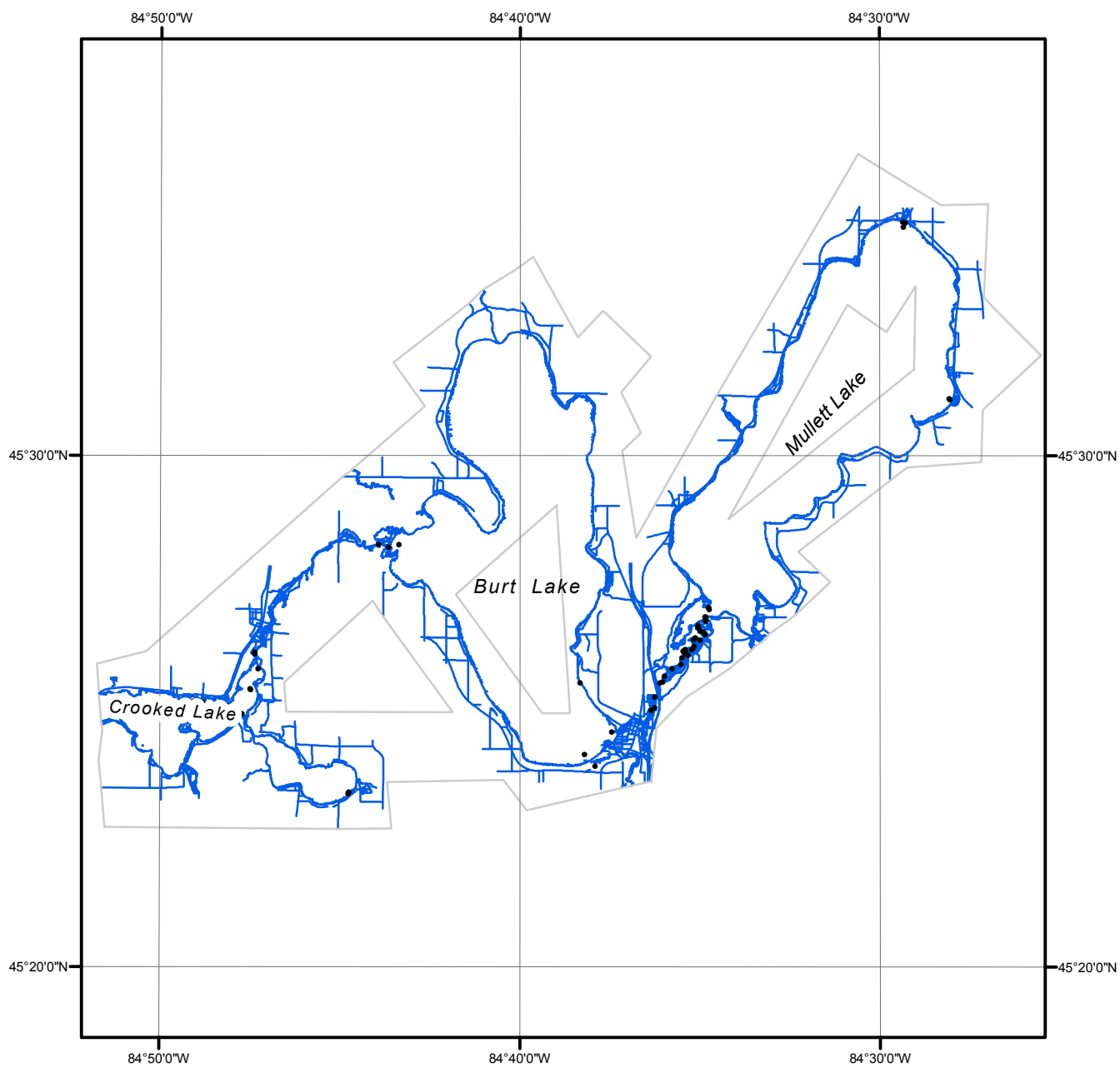
NOAA Shoreline Data Explorer

- GC11206 in shapefile format
- Metadata file for GC11206
- Digital copy of the PCR in Adobe PDF format

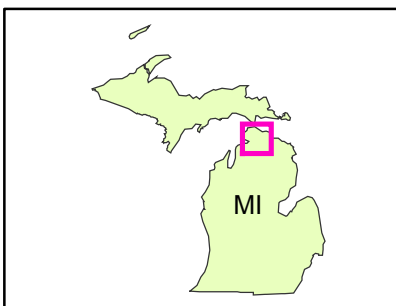
End of Report

INLAND ROUTE, CROOKED LAKE TO MULLETT LAKE

MICHIGAN



Overview



MI1001I-CM-N

GC11206