NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT CA1211A

Smith River, California

Introduction

NOAA Coastal Mapping Program (CMP) Project CA1211A provides highly accurate digital shoreline data for Smith River, California, from its mouth to a point beyond the South Fork of Smith River. Project CA1211A is a subproject and inland extension of a larger project, CA1211, which extends from Shelter Cove to Cone Rock. 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

Project CA1211A was designed as a result of a request from the Marine Chart Division (MCD) of NOAA's Office of Coast Survey for data to correct the charted alignment of Smith River and positions of several bridges along the river. Photographs were acquired for CA1211 in order to accompany lidar data received from the United States Army Corps of Engineers (USACE) Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX). Acquisition project CA1211 was designed and acquired prior to the request received from MCD. Additionally, commercial satellite imagery from DigitalGlobe, Inc. and orthophotography from the US Department of Agriculture's National Agriculture Imagery Program (NAIP) were obtained to augment the CA1211 imagery and JALBTCX data.

Field Operations

Field operations for CA1211 consisted of the collection of static and kinematic Global Positioning System (GPS) data, Inertial Measurement Unit (IMU) data, and the acquisition of aerial imagery. Aerial imagery was acquired using an Applanix Digital Sensor System (DSS 439) camera with the NOAA King Air aircraft (N68RF) between April 27 and May 11, 2012. Orthomosaic tiles derived from a single strip of color imagery acquired May 7, 2012 were used for CA1211A. Airborne kinematic GPS and IMU data were acquired concurrently with aerial imagery.

GPS Data Reduction

GPS and IMU data for CA1211 were processed by Remote Sensing Division (RSD) personnel to yield precise camera positions and orientations for direct georeferencing (DG) of aerial imagery. Local GPS base stations were established for use as reference stations in kinematic GPS processing operations. The positions of the base stations were determined using the NGS Online Processing User Service (OPUS) software, which computed fixed baseline solutions from nearby CORS stations. Airborne kinematic data was processed in June 2012 using Applanix POSPAC software (ver. 5.4.0). Positional data is referenced to the North American Datum of 1983 (NAD83).

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 an Excel spreadsheet based EO Total Propagated Uncertainty (TPU) tool developed by NGS. Using this tool, the predicted horizontal uncertainty at the 95% confidence level was calculated to be 1.4 meters.

External Image and Lidar Data Preparation

Rigorous refinement of the georeferencing of the satellite and NAIP ortho images used for compilation was not necessary since image positioning compared well spatially with sources used to check the geopositioning, and since the vendors provided acceptable accuracy assessments for the imagery. The vendor-reported spatial uncertainty of the GeoEye and WorldView imagery is 3.9 meters RMSE, from which a horizontal accuracy of 6.8 meters at a 95% confidence level (CE95) was calculated. The reported CE95 of the NAIP imagery is 6.0 meters.

JALBTCX lidar data acquired on August 3, 2011 were processed by the following method:

1) Ingestion of lidar point clouds into the GeoCue Workflow Management software.
2) The lidar data was transformed to mean High Water (MHW) utilizing NOAA's VDatum; Oregon/California - Punta Gorda to Cape Blanco, Version 01 grids.
3) GeoCue DEM CuePac processing software was utilized to produce MHW digital elevation models (DEM) at a 1 meter pixel resolution.
4) MHW shoreline vectors (in shapefile format) for the outer coast region were extracted from DEMs through a custom script implemented within Esri's ArcGIS 9.3 desktop GIS software.

Further details on NGS/RSD lidar processing, shoreline extraction and accuracy assessment can be found in the article "LIDAR-Derived National Shoreline: Empirical and Stochastic Uncertainty Analyses" (White, S.A.; Parrish, C.E.; Calder, B.R.; Pe'eri, S.; and Rzhanov, Y.) in *Pe'eri, S. and Long, B. (eds.), Applied LIDAR Techniques,* in the Journal of Coastal Research (JCR), Spring 2011, Special Issue No. 62, pgs. 62-74.

Shoreline features extracted from lidar were compiled to meet a horizontal accuracy of 5.0 meters CE95. This is a conservative estimate based on the expected uncertainty of lidar-derived shoreline as described in the JCR article cited above.

Compilation

Data compilation was accomplished by personnel of the Applications Branch (AB), RSD in February 2015. Digital feature data was compiled in shapefile format using ArcGIS 10.2.2. Feature identification and attribution within the Geographic Cell (GC) were based on image analysis and information extracted from the appropriate 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.

All spatial data accuracies for CA1211A were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features compiled from NOAA-acquired aerial imagery were compiled to meet a horizontal accuracy of 2.8 meters CE95. This predicted accuracy of compiled, well-defined points is derived by doubling the horizontal uncertainty value derived from the DG data. Accuracies for feature data extracted from other sources are indicated in the section above.

The following table provides information on imagery sources used in project completion:

Aerial photos					
Date	**Time** (UTC)	**Roll #**	**Strip / Photo #s**	**~GSD**	**Tide** *
5/7/2012	16:49-16:51	12NC31	50-027 / 8689 - 8704	0.35 m	0.1 m
External satellite/ortho imagery					
Image Source	**Acquisition Date/Time**	**Source Type / ID**		**Resolution**	**Tide** *
NAIP	6/7/2014	Natural color orthomosaic / ortho_1-1_1n_s_ca015_2014__sub.tif		1.0 m	n/a
WorldView-1	7/20/2014 19:24 GMT	Orthorectified panchromatic mosaic / 2014Jul20_192436_WV01_ORI.tif		0.5 m	n/a
GeoEye-1	1/24/2015 19:36 GMT	Orthorectified pansharpened natural color mosaic / 2015Jan24_193607_GE01_ORI.tif		0.5 m	1.3 m

* Tide levels are given in meters above MLLW and are based on actual observations recorded by the NOS gauge at Crescent City, CA with height and time offsets applied to the substation at Brookings, CA (#9430104). The elevation of MHW near the mouth of Smith River is 1.8 meters above MLLW.

Quality Control / Final Review

Quality control tasks were conducted on all phases of project completion by a senior member of RSD. The final QC review was completed in February 2015. The review process included analysis 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 10.2.2 software. All project data was evaluated for compliance to CMP requirements.

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

- 18600 Trinidad Head to Cape Blanco, 15th Ed., Mar. /11, scale 1:196,948
- 18602 Pyramid Point to Cape Sebastian, 13th Ed, Feb. /12, scale 1:40,000
- 18603 St. George Reef and Crescent City Harbor, 17th Ed., Mar. /11, scale 1:40,000

End Products and Deliverables

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

RSD Applications Branch Archive

- Hardcopy of the Project Completion Report (PCR)
- Page-size graphic of GC11129, attached to PCR

Remote Sensing Division Electronic Data Library

- GC11129 in shapefile format
- Digital copy of the PCR in Adobe PDF format
- CEF in shapefile format

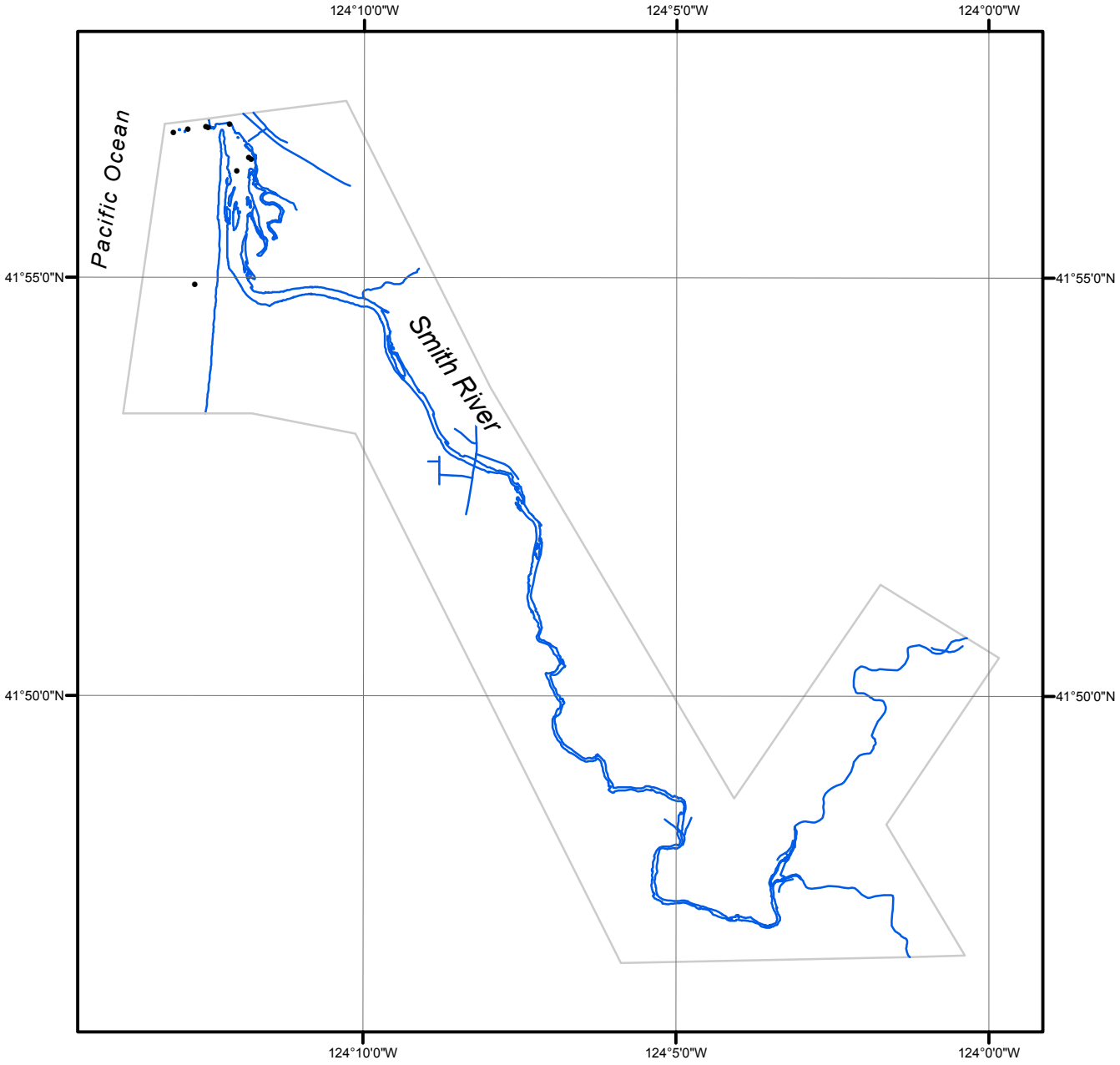
NOAA Shoreline Data Explorer

- GC11129 in shapefile format
- Metadata file for GC11129
- Digital copy of the PCR in Adobe PDF format

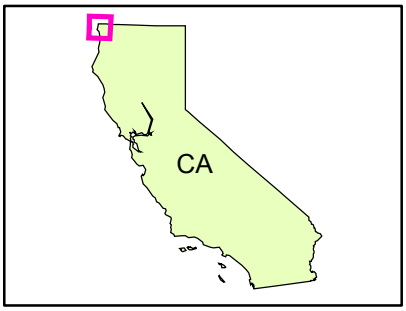
End of Report

SMITH RIVER

CALIFORNIA



Overview



CA1211A

GC11129