NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT GA0301A

WASSAW ISLAND TO ST CATHERINES ISLAND, GEORGIA

Introduction

Coastal Mapping Program Project GA0301A required that Western Air Maps, Inc. and its affiliated production team members work together to produce all of the required components needed for constructing an accurate feature database of new digital shoreline data from near the southerly end of Wassaw Island, Georgia to St. Catherines Island, Georgia, as well as updated chart maintenance prints of the project area coast to support NOAA's ongoing chart maintenance and production program and other uses. GA0301A is a subset of a larger project, GA0301, which includes the Georgia shoreline from Wassaw Island to Jekyll Island.

The design of project GA0301 encompasses the SOW requirements that NOAA set forth for the project area. The project design covers NOAA's need for aerial acquisition of tide coordinated black and white infrared and natural color photography of the project area, the need for an accurate ground survey to support the one (1) meter or better accuracy at 95% confidence level accuracy requirement and to provide accurate, properly attributed and topologically correct interim deliverable files and final deliverable ESRI shape files using the C-COAST feature attribution scheme.

Project Design

Project instructions for Project GA0301 were received from NOAA's Remote Sensing Division during September 2003. These instructions outlined the purpose of the project, the geographic area of coverage for the project, the photographic requirements for the project, including the need to acquire tide coordinated photography, GPS data collection procedures and guidelines for ground control surveys, data recording, reporting and handling instructions, and contact and communication information. Western Air Maps, Inc. proceeded to derive a work plan that would comply with all of NOAA's requirements for shoreline mapping projects.

Western Air Maps, Inc. personnel prepared a comprehensive work plan based on the project requirements specified in NOAA's project instructions, NOAA's standard SOW, NOAA provided charts and NOAA instructions for contractor determination of tide windows. Western Air Maps personnel began to generate tide windows immediately and submitted them at the beginning of each month for the duration of the aerial acquisition phase. Tide windows generated using "Tides and Currents" software and NOAA's "TIDE 8" software were submitted to the aerial team members. Western Air Maps, Inc. submitted a work plan and flight maps to NOAA for approval. Western Air Maps, Inc. work plan assigned Tuck Mapping Solutions, Inc. the responsibility for acquiring the aerial photography, and Metro Engineering and Surveying Company Inc. the responsibility for conducting the ground control survey. Western Air Maps, Inc. was responsible for softcopy aerotriangulation utilizing ground control and airborne GPS data, as well as for the initial map compilation and attribution of the interim shape files. In addition, Western Air Maps, Inc. had the responsibility for quality

control review and validation of the aerotriangulation results, for extraction and attribution of the features into a SOCET SET feature database for NGS review, for applying any NGS specified changes to the mapping, and for consolidating the shape files and migrating the attribution of the interim feature database to the C-COAST attribution schema and delivering these final files to NGS. Western Air Maps, Inc. would be responsible for preparing the final Project Completion Report. NOAA approved the tentative work plan and the flight maps in the fall of 2003.

Field Operations.

Western Air Maps conducted a survey and aerial photography acquisition planning meeting via conference calls between Western Air Maps and Metro Engineering and Surveying Company, and Western Air Maps and Tuck Mapping Solutions, Inc., to plan and develop an initial production schedule and to coordinate surveying and aerial photography activities for the project. Tuck Mapping Solutions, Inc. was tasked with establishing a single ABGPS base station location as well as using CORS stations to QC the ABGPS results, and Metro Engineering and Surveying Company was tasked with establishing a network of photo identifiable control points to be used in the aerial triangulation process.

Tuck Mapping Solutions, Inc. and eventually Keystone Aerial Surveys, Inc., working under Tuck Mapping Solutions, Inc. supervision, set up two ABGPS base stations during the aerial acquisition missions. Both locations were located at Golden Isles Airport, formerly known as Glynco Jetport. The first ABGPS base station location used was FAA BQK GDL A PID - AA2803. This base station location was used at the airport manager's discretion, as the airport is a secure facility and unescorted travel around the facility on weekends is not allowed. As several of the aerial acquisition missions occurred on weekends, an alternative ABGPS non-NGS base station location needed to be established. Tuck Mapping Solution's, Inc. personnel set a 60d nail near the FBO, at the edge of the runway side of the parking ramp. This alternate ABGPS base station location, referred to as "BR1", was used when access to the NGS control point GDL A location was restricted.

Ground Control GPS Surveys

Metro Engineering & Surveying Co., Inc. used two GPS receivers as base stations and two rovers and ran a 1-hour static survey on the photo control points. Metro Engineering and Surveying Company was responsible for the generation and maintenance, while in the field, of NGS Station Description/Recovery Form (DR Form), photographs of each photo control point surveyed, NOAA Form 76-53 for each panel, Visibility Obstruction Diagrams, and GPS Observation Logs.

GPS Field Survey Data Reduction

Metro Engineering & Surveying used Trimble Geomatics Office, version 1.01, to perform preliminary processing of the collected GPS data. The data imported into Trimble Geomatics Office (ver. 1.01) was reviewed by comparing the antenna heights, antenna types and start and end times to the field GPS. Metro Engineering & Surveying Co., Inc. performed the final data reduction and computation of final coordinates through the NGS online GPS processing tool, OPUS.

A. Time Period – Field work transpired between March 3, 2004 and March 20, 2004.

B. Contact: Metro Engineering & Surveying Co., Inc.
186 Selfridge Road
Hampton, GA 30228
Jim Sease or John Salter
(770) 707-0777

C. Accuracy Standards – The horizontal accuracies of 0.1 meter or better and vertical accuracies of 0.2 meter or better.

D. Conditions Affecting Progress – There were not any equipment failures during the field survey. The climate was warm to cool and always dry.

E. Chronology

1. Reconnaissance of the 25 photo control points and observation was simultaneous.
2. GPS static surveys on the photo control points were made March 3 and March 20, 2004.
3. Processing of GPS data was provided through NGS online positioning user services.

F. Instrumentation

Instruments used during the GPS survey were Trimble 4000 SSE dual frequency receivers.

Type	Serial Number
SSE	3610A14835
SSE	3610A14838
SSE	3616A15486
SSE	3616A15488
SSE	3616A15489

Aerial Photography Acquisition.

Tuck Mapping Solutions, Inc. began aerial acquisition on November 25, 2003, at which time flights 1-6 of the 15000' AMT natural color photography were acquired. A follow-up mission was flown on 12/02/03, at which time the southern parts of flights 1, 3, and 5 were reflown due to cloud cover present on the 11/25/05 photography, and flight 101, the 6000' AMT line over Brunswick Harbor, was flown. Tuck Mapping Solutions, Inc. flew the natural color photography on both dates using a Piper Navajo aircraft equipped with a Leica RC-30 aerial camera (NOAA certified #20) equipped with forward motion compensation and stabilized camera mount. Tuck Mapping Solutions, Inc. produced near vertical, metric quality, tide-coordinated, kinematic Global Positioning System (GPS) positioned, aerial photography exposed along WAM defined flight lines covering the project area. Accurate flight line navigation was maintained using Leica's ASCOT (Aerial Survey Control Tool) flight management system. Airborne kinematic GPS data was collected during the natural color, MHW, and MLLW aerial photographic flights. A Leica SR9500 dual frequency GPS receiver was utilized in the aircraft and a Leica CR334 dual frequency GPS receiver

was used for the ground station. Tuck Mapping Solutions, Inc. maintained the tidal-coordinated flight schedule that WAM derived from utilizing Tides and Currents and NOAA provided Tides8+ software and by monitoring the actual tide gauge levels for the area of interest. All natural color photography was acquired using Tuck Mapping Solutions, Inc.'s Leica RC30 (NOAA certified #20) Camera s/n 5364 Lens s/n 13415 camera at an altitude of approximately 15,000' AMT for a nominal photo scale of 1:30,000. Additionally Tuck Mapping Solutions, Inc. flew one natural color flight over Brunswick Harbor, GA at 6000 AMT for a nominal photo scale of 1:12000, to cover an area that required the mapping to be accurate to one meter or less at map scale. Photographic coverage, resolution, photo overlap, and metric quality were adequate for the performance of the aerotriangulation phase. During the conducting of the tide coordinated BW IR photographic missions it was deteremined that Tuck Mapping Solutions, Inc.'s Leica RC 30 (NOAA certified #20) had a hardware defect which eliminated it from being used to collect tide coordinated imagery, although MHW flights 101, flown at 6000' AMT and flights 3-6, flown at 15,000' AMT on January 14, 2004 and MLLW flights 5, 6 and 8-10, flown at 15,000' AMT on February 18, 2004 were acquired using this camera and were accepted by NOAA. Tuck Mapping Solutions replaced the malfunctioning camera with a Leica RC 30 (NOAA certified #11) Camera s/n 5268 Lens s/n 13315, which was used to collect MLLW photography, flights 12-16 at 15000' AMT on May 4, 2004, MLLW photography flight 4 at 15,000 AMT on March 24, 2005, MHW photography, flights 8-16 at 15,000 AMT on May 5, 2004, MHW photography, flights 1,2, and 7, at 15,000 AMT on November 6, 2004 and MHW photography, flights 4-6, at 15,000 AMT on March 13, 2005. In order to complete the job due to heavy commitment of it's own resources, Tuck mapping Solutions, Inc. solicited the aid of Keystone Aerial Surveys, Inc. to fly the remainder of the tide coordinated BW IR photography using a Piper Navajo aircraft and a Leica RC30 aerial camera (NOAA certified #19) Camera s/n 5224 Lens s/n 13241 equipped with forward motion compensation and stabilized camera mount. Accurate flight line navigation was maintained using using KAS Proprietary Photographic Navigation System (Modified for Coastal Mapping) and Track Air TECI Navigation Systems. Airborne kinematic GPS data was collected during the MHW, and MLLW aerial photographic flights. A Trimble ABGPS Receiver Model 4000SSi dual frequency GPS receiver was utilized in the aircraft and a Trimble ABGPS Receiver Model 4000SSi frequency GPS receiver was used for the ground station. Keystone Aerial Surveys Leica RC30 aerial camera (NOAA certified #19) Camera s/n 5224 Lens s/n 13241 was used to collect MLLW photography, flights 1-3, 7 and 11 at 15000' AMT on March 6, 2005, MLLW photography, flight 101 at 6000' AMT on March 7, 2005, and MHW photography, flights 1-3, 5 at 15,000 AMT and flight 101 at 6000' AMT on March 2, 2005.

All flights were conducted to NOAA SOW guidelines concerning acceptable flying weather and allowable solar angle. There were no restrictions to the time of year for conducting the aerial photography acquisition and aircraft navigation to, within, and from the project area was conducted in accordance with FAA regulations using FAA approved navigation devices.

The following is a summary of film types, filters, altitude, and negative scales produced for each type of aerial photographic flights:

Color photography of the entire project area was acquired with Kodak Aerocolor Negative Film 2445 utilizing a 420 nanometer filter at 15,000' AMT, 1:30,000 negative scale on November 25, 2003. Additional color photography was exposed on December 2, 2003 at 15,000' AMT due to clouds at the southern end of flightlines 1,3 and 5 and color photography was flown the same day at 6000' AMT, 1:12000 negative scale over Brunswick Harbor. Black and White Intra-Red photography of the tidal basin areas at MLLW and MHW tidal stages were acquired using Kodak Black & White Infra-Red (IR) Film 2424 utilizing a 700 nanometer filter at 15,000' AMT, 1:30,000 negative scale and over the Brunswick Harbor at 6000' AMT, 1:12000 negative scale. The MLLW black-and-white infrared photography was flown on February 18, 2004, May 4, 2004, March 6, 2005, March 7, 2005 and March 24, 2005, while the MHW black-and-white infrared photography was flown on January 14, 2004, May 5, 2004, November 6, 2004, March 2, 2005 and March 13, 2005.

All film that was exposed was sent to NOAA's film processing contractor, HAS. The color film, upon NOAA's acceptance, was scanned at 16 microns and delivered to Western Air Maps via DVD. The BW IR film, upon NOAA's acceptance, was scanned at 24 microns and delivered to Western Air Maps via DVD.

Aerotriangulation

Six strips of color photography, consisting of 189 photos flown 11/25/03 and 12/02/03 were triangulated during the first phase of the project. This photography is non-tide coordinated and covers the entire GA0301 project area.

The sub project area of six flight lines of the total sixteen strips of BW/IR photography, consisting of 81 photos flown May 5, 2004 were triangulated for the MHW mapping. Also, six flight line of the sixteen strips of BW/IR photography, consisting of 81 photos flown May 4, 2004 were triangulated for the MLLW mapping.

Please refer to the AT Report's Annex 2, Flight Line Diagram for a visual reference of the layout of the flight lines.

All photography was acquired using Tuck Mapping Solutions, Inc.'s Wild RC30 camera at an altitude of approximately 15,000 feet for a nominal photo scale of 1:30,000. Photographic coverage, resolution, photo overlap, and metric quality were adequate for the performance of the aerial triangulation phase.

CONTROL:
Airborne GPS data was used to determine photo centers for the color, MLLW BW/IR, and MHW BW/IR photo missions.

The color photography, BW/IR MHW and BW/IR MLLW triangulation blocks included 21 photo-identifiable ground control points and 10 'check' points.

The control is considered to be adequate for the aerial triangulation and map compilation. Please refer to Ground Control Diagram included with the Ground Surveys Report for a visual reference of the density and distribution of the ground control and 'check' points within the project area.

The aerial triangulation for the color, MHW BW/IR and MLLW BW/IR photography was performed using images scanned at 16 and 24 microns to establish the network of control required for the mapping phase.

Z/I Imaging's ISAT AT software (version 04.03.00.08) operating on an SSK Pro workstation was used for the automatic tie point generation and manual measurements of additional tie points and ground control points.

The bundle adjustments were performed with Z/I Imaging's ISAT AT software and checked with Inpho's PATB-NT software (version 1.2.164).

Compilation

Western Air Maps began photogrammetric compilation of shoreline mapping in a pilot project area now designated as GA0301A that extended from Wassaw Island to the North, and to St. Catherine's Island to the South using SOCET SET Version 5.1 photogrammetric compilation software. Western Air Maps had purchased the SOCET SET software in order to be able to provide NOAA with SOCET SET feature databases as the interim deliverable instead of delivering ESRI shapefiles as the interim deliverable. Also, in order to expedite the chart maintenance markup task, Western Air Maps scanned the NOAA nautical charts 11509,11511 and 11512 which covered the project area and georeferenced the charts so that they could be used as a backdrop to the aerial photography that was being used to compile the shoreline features. Having the charts as a backdrop greatly aided the stereo compilers by providing a reference that could be used to help interpret the features that were being compiled from the aerial photography. Conversely, having the aerial photography and the shoreline feature back versus overlaid onto the chart greatly aided in the creation of the CEF product. Both the shoreline feature compilation and the chart maintenance markup task could be performed almost simultaneously and required that each stereo model only be called up and drawn in one time. Once the feature extraction was completed Western Air Maps, Inc. conducted an extensive QA and QC review using internal resources. The interim GA0301A project Socet Set Feature database was submitted to NOAA for review and was then returned to Western Air Maps for any requisite fixes to topology and/or interpretation or attribution deemed necessary by NOAA cartographers. NOAA cartographers did find some problems with the way some features were collected in the project and conducted a follow-up QC/QA review in which the NOAA cartographic lead person pointed out the remaining errors that existed in the project and specified what corrections needed to be made to the existing mapping in the GA0301A project area.

Once NOAA's areas of concern were addressed the mapping was again diligently reviewed, with the on-line review consisting of reviewing stereo models with a SOCET SET softcopy workstation, reviewing the map features to insure that the proper cartographic feature codes had been used for map feature attribution, and checking and validating the positional accuracies of digital map features prior to release of the SOCET SET feature database for data conversion, data transformation and GIS editing.

The following provides information on aerial photographs used in the project completion process, for GA0301A:

Date of Time Acquisition	(GMT) of Acquisition	Roll Number	Film Type	Photograph Numbers	Scale (Nominal)	Stage of Tide
11-25-03	15:35 to 17:49	0320CN01	Natural color	0001 thru 0200	1:30,000	N/A
05-04-04	19:23 to 19:28	0411R01	BW/IR	0001 thru 0014	1:30,000	-2.19m
05-04-04	19:32 to 19:38	0411R01	BW/IR	0015 thru 0028	1:30,000	-2.12m
05-04-04	19:43 to 19:48	0411R01	BW/IR	0029 thru 0041	1:30,000	-2.03m
05-04-04	19:53 to 19:56	0411R01	BW/IR	0042 thru 0049	1:30,000	-1.94m
05-04-04	20:03 to 20:08	0411R01	BW/IR	0050 thru 0061	1:30,000	-1.90m
05-04-04	20:14 to 20:22	0411R01	BW/IR	0062 thru 0081	1:30,000	-1.73m
05-05-04	13:04 to 13:07	0411R01	BW/IR	0082 thru 0089	1:30,000	0.10m
05-05-04	13:15 to 13:20	0411R01	BW/IR	0090 thru 0101	1:30,000	0.09m
05-05-04	13:27 to 13:32	0411R01	BW/IR	0102 thru 0114	1:30,000	0.06m
05-05-04	13:38 to 13:44	0411R01	BW/IR	0115 thru 0128	1:30,000	0.06m
05-05-04	13:49 to 13:54	0411R01	BW/IR	0129 thru 0142	1:30,000	-0.04m
05-05-04	14:01 to 14:10	0411R01	BW/IR	0143 thru 0162	1:30,000	-0.05m

The "Stage of Tide" is referenced to MHW. The range of tide (MLLW to MHW) is 2.103 meters. The tide range (MLLW-MHW, 1983 to 2001 Epoch) at Fort Pulaski, GA water level station is 2.103 meters.

GIS Cartographic Editing and Data File Preparation.

The SOCET SET feature database was exported into ESRI 3-D shapefiles. The shape files were then converted into a 3-D personal geodatabase using ESRI Arctoolbox software version 8.3. Using ESRI ArcMAP version 8.3, topology editing and creation rules were defined to process the data and render it topologically correct. The topological rules specified were that the data must not have dangles, must not have pseudo nodes, must not overlap, must not intersect and must not touch the interior. Using these rules, the data was then processed and the resultant errors were edited and the features were validated as being topologically correct. This process was utilized to edit and validate every arc feature type. The required QC information were added and the database fields were populated. The 3-D geodatabase was then converted into 3-D shapefiles, and these 3-D shapefiles were then converted into 2-D shapefiles, conforming to the Coastal Cartographic Object Attribute Source Table (C-COAST) specification and NOAA SOW instructions. All data conversion, datum transformation and editing functions were performed using ESRI ArcGIS version 8.3 tools.

Final Review.

A senior Western Air Maps CMP production reviewer familiar with shoreline mapping initiated the final review. The final deliverable digital cartographic feature file was thoroughly reviewed for completeness and accuracy. Data review consisted of an on-line review of the final deliverable shape files for completeness and the associated shape file database files for completeness of attribution to the C-COAST attribution specification. Since the chart maintenance task was also completed using digital mapping techniques, review of the CEF product was conducted visually. The cartographic feature attribution was reviewed by both the Western Air Map's GIS Manager and by Western Air Map's Lead Cartographic Finisher and judged to conform to C-COAST specification.

Project Final Data and Products

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 GPS Processing Report
- Hard copy of Aerotriangulation Report
- Page size graphic plot of DCFF contents
- Hard copy of the Project Completion Report

RSD Electronic Data Library:

- Project Database
- DCFF: GC-10576
- Digital copy of DCFF in Shapefile format
- Digital Copy of Project Completion Report

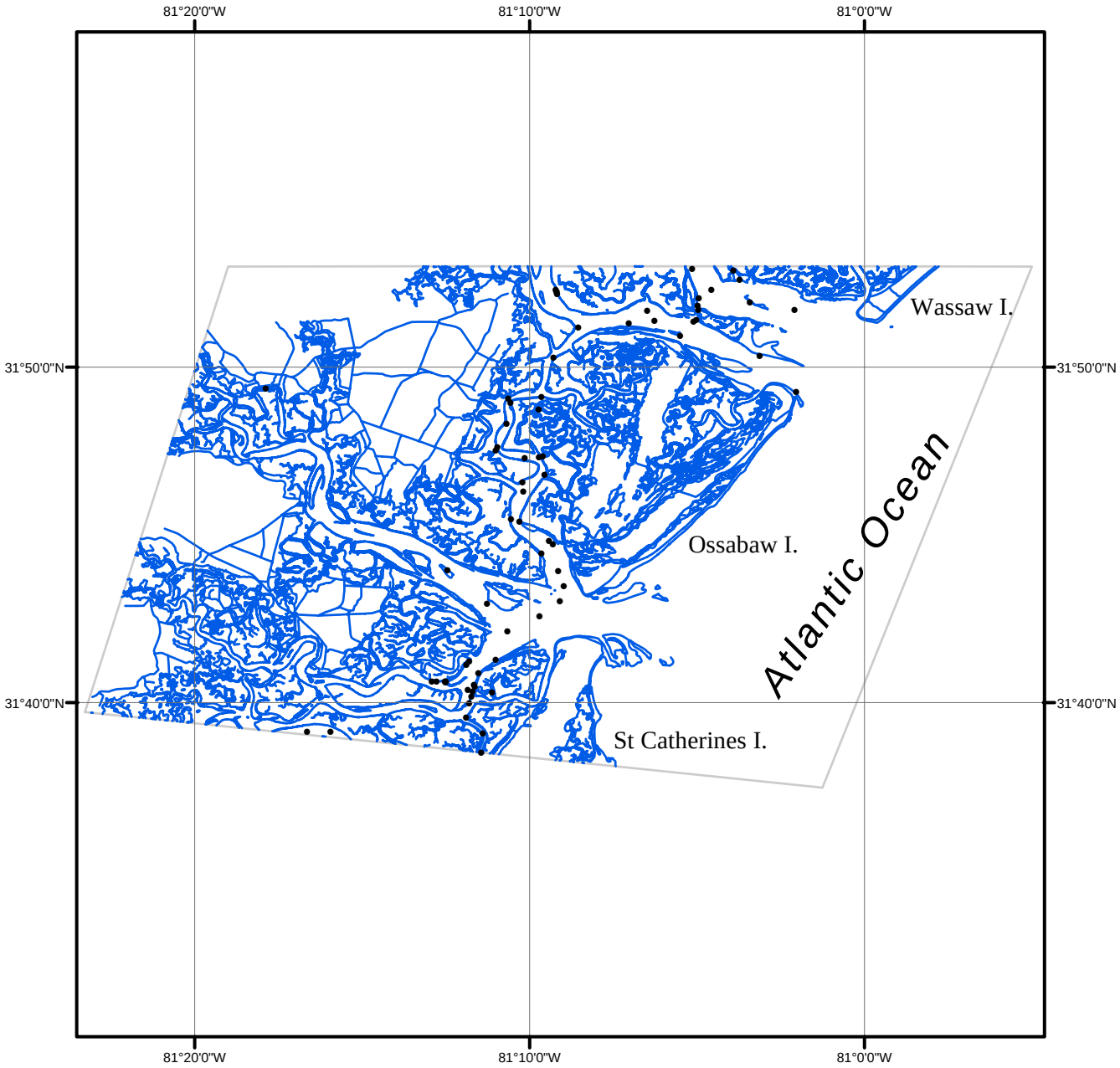
NOAA Shoreline Data Explorer:

- DCFF: GC-10576
- Metadata file for GC-10576
- Digital Copy of the Project Completion Report

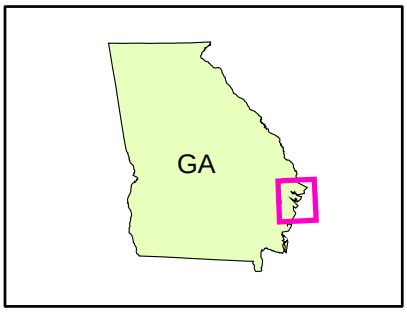
End of Report

WASSAW ISLAND TO ST CATHERINES ISLAND

GEORGIA



Overview



GA0301A

GC10576