

United States - Canada Hydrographic Commission
Halifax, Canada May 16, 2016

**NOAA Pilot Study Applying Satellite-Derived
Bathymetry to Longboat Pass, Florida**

Submitted by: The United States of America

Executive Summary: In an effort to gain additional understanding on the Satellite Derived Bathymetry (SDB) processing, review, and chart compilation process, a pilot study was conducted in the area of Longboat Pass, Florida, USA. Through this study, NOAA identified additional policy and resource gaps, specifically in the SDB review process. The summary was concluded and adopted December 2015.

Related Documents:

- none

Related Projects:

- none

Introduction/Background

In 2015, NOAA conducted a pilot case study applying satellite imagery, AIS traffic data and recent orthographic imagery together with US Army Corps of Engineers survey data collected in September 2014 to assess the potential application of new information to prior data in the nautical chart. The methodology used is described in the attached Descriptive Report.

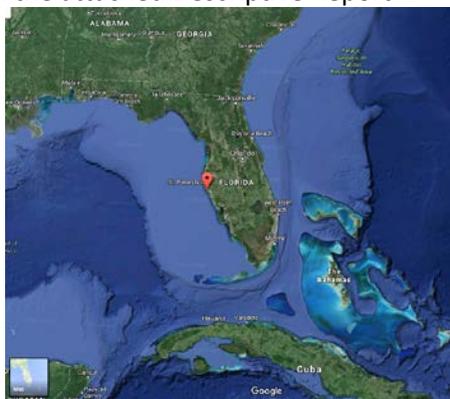


Figure 1 Depiction of location of Longboat Pass, Florida.

Conclusions/Recommendations

As a result of the study, the Office of Coast Surveys concludes the SDB solution augments the USACE in depicting the current general bathymetry, and provides additional context which will assist mariners in safely navigating Longboat Pass. The data provided was adequate to supersede prior data and intended for chart compilation.

Action Required of USCHC

USCHC is invited to:

- a. Note the Descriptive Report for the pilot SDB study
- b. Discuss and offer feedback



MEMORANDUM FOR: John E. Nyberg
 Chief, Marine Chart Division

FROM: LT Anthony R. Klemm, NOAA KLEMM.ANTHONY
 Staff, Marine Chart Division .ROSS.1392701601

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SUBJECT: Satellite Derived Bathymetry from Longboat Pass FL Pilot Study Data

In an effort to gain additional understanding on the Satellite Derived Bathymetry (SDB) processing, review, and chart compilation process, a pilot study was conducted in the area of Longboat Pass, FL.

Through this study, we have identified additional policy and resource gaps, specifically in the SDB review process. Notwithstanding the current policy gaps that must be filled before the use of SDB is institutionalized within Coast Survey, as the SDB Analyst of this pilot study, I recommend using the resultant data to update the affected nautical charts with all due haste. The current depiction of the Longboat Pass Shoal on NOAA Chart 11425 is dangerously inaccurate, and has led to several documented vessel groundings. In my judgement, by using the SDB from the pilot project, the data will greatly increase the navigational safety of those using our products.

With your approval, the SDB deliverables defined in the Descriptive Report, along with this memo, will be sent to NDB to be registered as source, for application to the affect nautical charting products in accordance to the cartographic directives published in the Nautical Chart Manual.

Please refer to the attached Descriptive Report of the SDB Analysis for more information.

Approval		12/3/15
	<i>(signature & date)</i>	
Disapproval	_____	
	<i>(signature & date)</i>	



Descriptive Report

Satellite Derived Bathymetry

Longboat Pass, Bradenton Beach, Florida

SD00001

LT Anthony R. Klemm, NOAA

SDB Analyst
Marine Chart Division
Office of Coast Survey
National Ocean Service
NOAA

27 October 2015

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A - Area Analyzed

Intended Use of Analysis

The intended use of this analysis is to update the location and extent of the shoals at the entrance to Longboat Pass. The current largest scale depiction of bathymetry on NOAA Nautical Charts (Chart 11425, ENC US5FL19M; scale 1:40,000) is dangerously misleading, contributing to multiple vessel groundings as reported through ActiveCaptain Hazard data and comments.

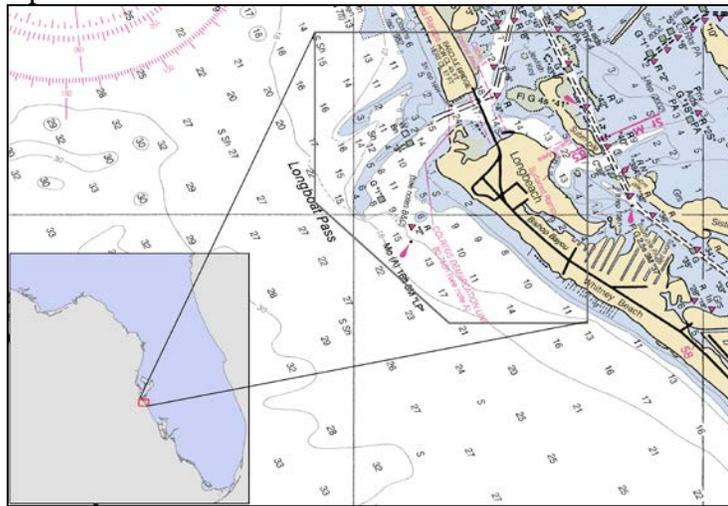


Figure 1: Analysis Area overlaid on NOAA Chart 11425

Currently available reconnaissance data from Satellite Derived Bathymetry (SDB), Automatic Identification System (AIS) historical ship traffic data, and recent orthographic imagery corroborates the reported extent of the dangerous shoals. In addition, the US Army Corps of Engineers Jacksonville, FL District surveyed Longboat Pass in September 2014. (DREG Document# DD-25865) The USACE survey did not cover the extent of the dangerous part of the shoal (see Image 3), and therefore, this survey is intended to augment the USACE survey to update the charted bathymetry, and assist mariners in safely navigating through the inlet.



Figure 2: AIS data (2014) not following charted hydrography; WorldView2 imagery from Sept 2015

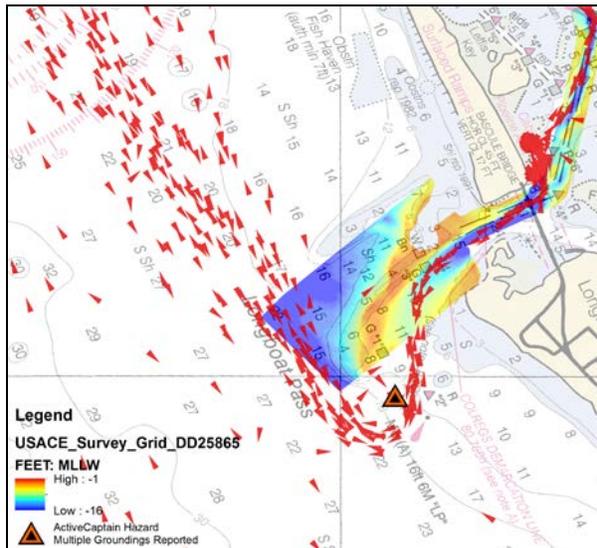


Figure 3: ActiveCaptain Hazard location and extent of USACE Survey September 2014

The purpose of this analysis was achieved. The SDB solution augments the USACE in depicting the current general bathymetry, and provides additional context which will assist mariners in

safely navigating Longboat Pass. The data provided is adequate to supersede prior data and intended for chart compilation.

The imagery sources and image acquisition dates are outlined in the table below (**Table 1**). This area was investigated using Landsat 8, GeoEye, and WorldView2 imagery.

Table 1 – SDB Imagery Sources and Image Acquisition Dates

<i>Imagery Sources</i>	Longboat Pass, Florida NOAA Chart 11425 – SD00001	
Imagery Source	Spatial Resolution	Image Acquisition Date
Landsat8 (NASA/USGS)	30 m	18 Dec 2014
Landsat8 (NASA/USGS)	30 m	20 Feb 2015
WorldView2 Multispectral (DigitalGlobe)	2 m	27 Nov 2014
WorldView2 RGB Pansharpened (DigitalGlobe)	2 m	21 Sep 2015
GeoEye Multispectral (DigitalGlobe)	1.6 m	08 May 2015

B - Data Acquisition & Processing

EQUIPMENT & PLATFORMS

SDB processing procedures and methods were conducted in accordance with the registered NOAA Office of Coast Survey SDB Processing Procedures QMS Document.

Landsat 8 (NASA/USGS)

The Operational Land Imager (OLI) in Landsat 8 (since mid-2013) has a swath-width of 185 km and an image resolution of 30 m. The number of bands and their spectral ranges are described in **Table 2**.

Table 2 Landsat-8 specifications (<http://landsat.usgs.gov/landsat8.php>).

LANDSAT-8 (Operational Land Imager)	
Spatial Resolution	15 m (Bands 8), 30 m (Bands 1-7, 9)
Dynamic Range	16-bits
Orbit cycle	16 days
Spectral	Band 1 (coastal aerosol), 0.43–0.45 μm
	Band 2* (blue), 0.45–0.51 μm
	Band 3* (green), 0.53–0.59 μm
	Band 4 (red), 0.64–0.67 μm
	Band 5 (near infrared), 0.85–0.88 μm
	Band 6* (short wave infrared 1), 1.57–1.65 μm
	Band 7 (short wave infrared 2), 2.11–2.29 μm
	Band 8 (panchromatic), 0.50–0.68 μm
	Band 9 (cirrus), 1.36–1.38 μm

* Bands used in the SDB procedure.

QUALITY CONTROL

There are two quality control tools to evaluate the SDB products:

Reference soundings

Reference soundings from USACE Survey 14-114 conducted September 2014 refer to NOAA's reported mean lower low water (MLLW) of the 1983-2001 tidal epoch. Survey accuracy performance standards, quality control, and quality assurance requirements were followed during this survey in accordance with *USACE EM 1110-2-1003, Hydrographic Surveying, 30 Nov 2013*. (<http://www.saj.usace.army.mil/Missions/CivilWorks/Navigation/HydroSurveys.aspx>)

Differences between the SDB product and the control points are plotted as a function of depth (**Figure 4**). Table 3 tabulates the extinction depth calculated for each SDB solution, as well as the mean difference and standard deviation between the reference survey points and the SDB solution up to the extinction depth.

Table 3 – SDB Imagery quality

SDB Imagery	Mean difference up to extinction depth (feet)	Standard Deviation (1 sigma)	Extinction Depth (feet)
Landsat8 Dec 2014	0.85	1.93	17
Landsat8 Feb 2015	0.97	2.78	15
WorldView2 Nov 2014	0.37	1.39	12
WorldView2 RGB Sept 2015	0.44	1.57	14
GeoEye May 2015	0.24	1.61	17

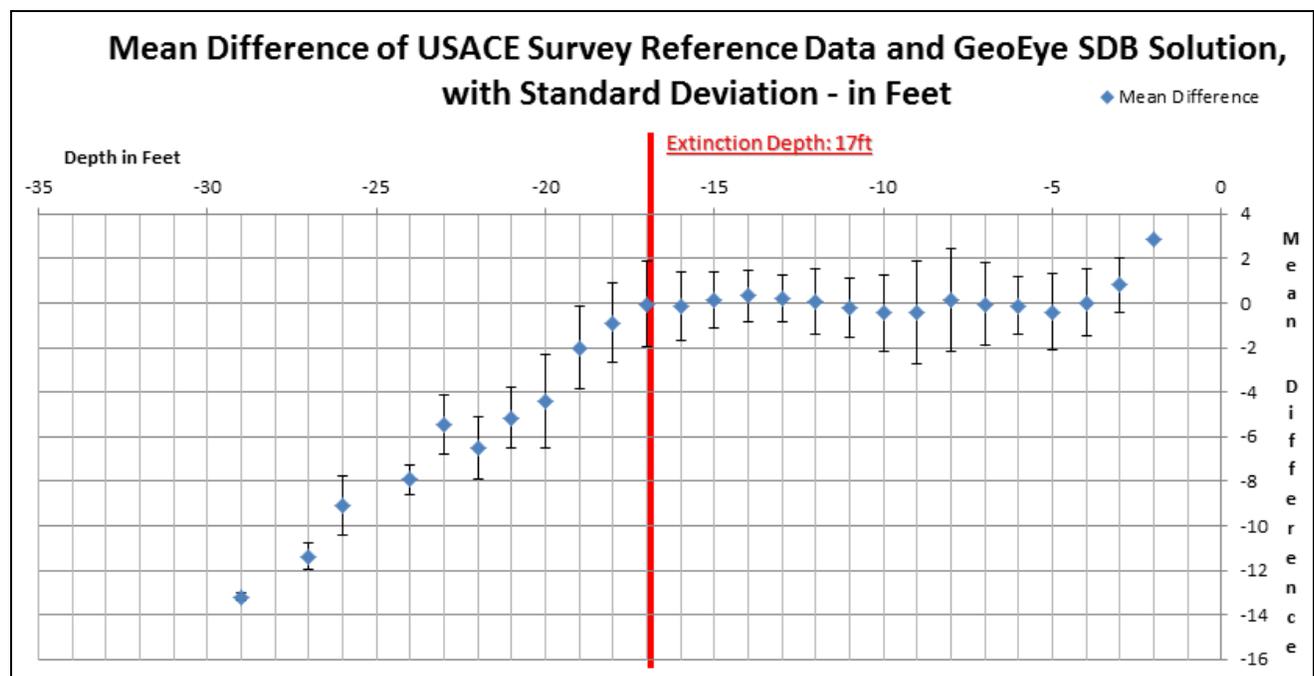


Figure 4: Plot showing the mean and standard deviation of the depth differences between GeoEye bathymetry compared to USACE survey control points.

C – Horizontal & Vertical Control

The horizontal control for SDB generated from Landsat8 is based on the reported horizontal accuracy of Landsat 8 geo-referenced imagery:

U.S.G.S., 2006. *LANDSAT 7 (L7) IMAGE ASSESSMENT SYSTEM (IAS) GEOMETRIC ALGORITHM THEORETICAL BASIS DOCUMENT (ATBD)*, USGS technical paper, LS-IAS-01, Sioux Falls, South Dakota. https://landsat.usgs.gov/documents/LS-IAS-01_Geometric_ATBD.pdf

The Horizontal control is based on the reported horizontal accuracy of GeoEye-1 Basic geo-referenced multi-spectral imagery:

Absolute Geolocation Accuracy Evaluation of GeoEye-1 Basic Stereo Triplets Paul C. Bresnahan, under contract to NGA Image Quality and Utility Program / Civil and Commercial Applications Project (NIQU / CCAP) (703) 264-3027, paul.bresnahan.ctr@nga.mil Civil Commercial Imagery Evaluation Workshop 17 March 2010.
https://calval.cr.usgs.gov/JACIE_files/JACIE10/Presentations/WedPM/Bresnahan_10_005_JACIE_2010_CCAP_Geolocation_Accuracy_GeoEye1_R2-Approved.pdf

Satellite	Horizontal Accuracy 90% Circular Error (m)
Landsat8	12
GeoEye-1 Basic	4

HORIZONTAL CONTROL

The horizontal datum for the all the imagery used is World Geodetic System (WGS) (WGS84) geographic coordinates (Lat., Long.).

VERTICAL CONTROL

The vertical sounding datum of NOAA Chart 11425 is Mean Lower Low Water (MLLW). The vertical control of the derived bathymetry is directly referenced to the chart datum. Vertical referencing calculations, with corresponding gain and offset values, are archived with the final SDB data deliverables package. See SDB00001_Vertical_referencing.xlsx for more information.

D – Results and Recommendations

CHART COMPARISON

Comparison of Soundings

The following are the largest scale RNC and ENC, which cover the analysis area:

Chart	Scale	Edition	Edition Date	LNM Date
11425	1:40,000	39	05/01/2013	08/22/2015
ENC	Scale	Edition	Update Application Date	
US5FL19M	1:40,000	4.7	09/29/2015	

The most recent NOS survey of Longboat Pass (H08035) was from 1954-1956, and although USACE routinely surveys Longboat Pass approximately every two years, it only surveys the federal project limits. Since the federal channel project at Longboat Pass has not been maintained (e.g. dredged) in many years, the USACE surveys do not cover the navigable entrance of the inlet.

SDB analysis has shown the most seaward extent of the northwest shoal at the entrance to Longboat Pass to have moved approximately 420m to the southeast (approximately 27.432°N, 082.697°W), which corresponds with the ActiveCaptain Hazard marker, and the current positions of USCG ATONS.

In addition to the shifting of the main northwest shoal at the entrance to Longboat Pass, shoaling to 6 feet or less was observed at approximately 27.431°N, 082.692°W.

A possible significant shoreline change was also observed at approximately 27.438°N, 082.691°W.

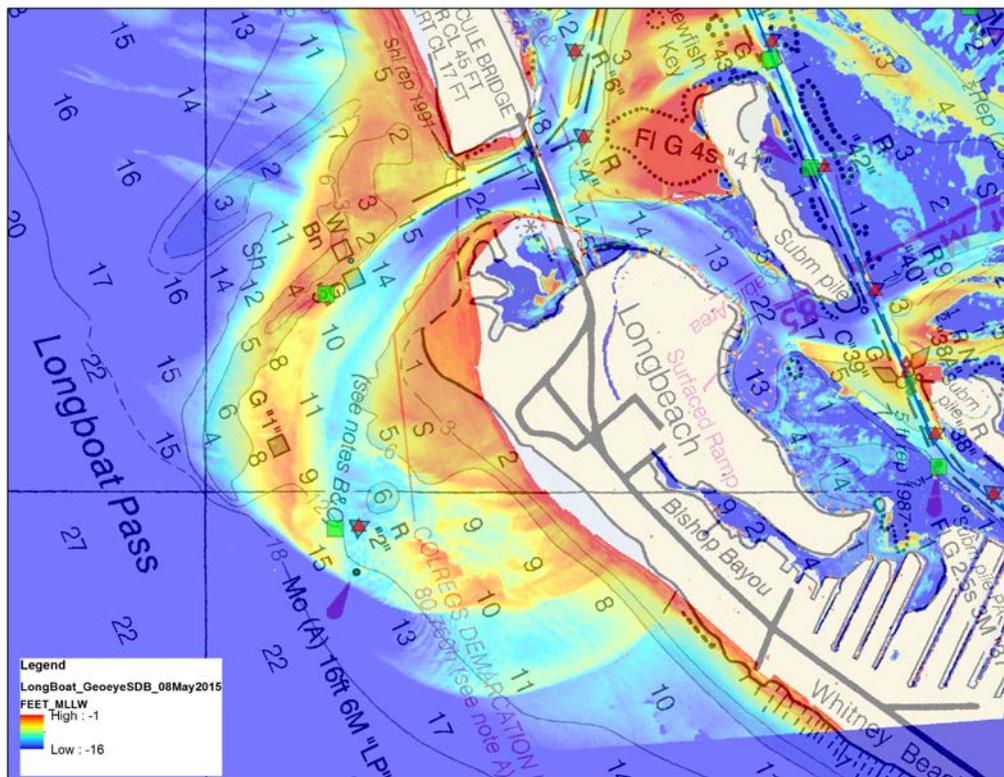


Figure 5: SDB from GeoEye imagery (overlaid on NOAA Chart 11425)

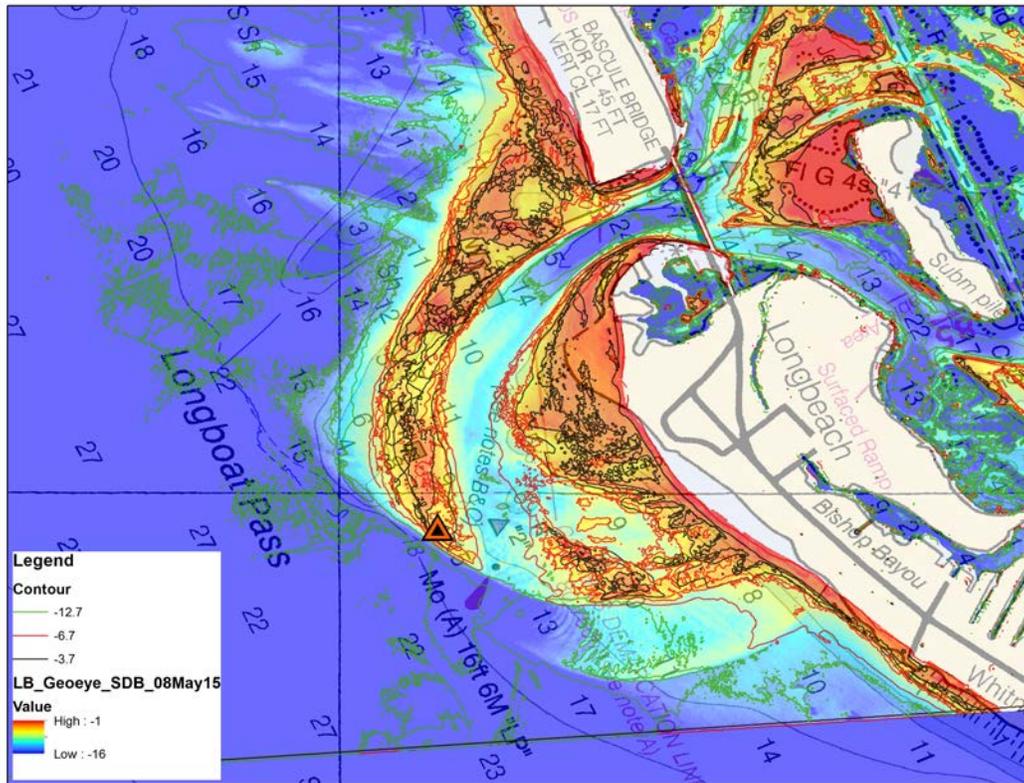


Figure 6: SDB from GeoEye imagery and derived contours from all imagery (overlaid on NOAA Chart 11425)

Dangers to Navigation

The changes to the extent of the main seaward shoal at Longboat Pass poses a significant danger to navigation, as seen in the multiple user comments describing vessel groundings at the ActiveCaptain Hazard marker, and it is recommended to use the supplied data deliverables to update the location of the shoal with all due haste.

ADDITIONAL RESULTS

Additional Item Investigations

A proper systematic hydrographic survey is recommended in this area, especially to define the extent of the shoals, and to verify the controlling deeper depths within the navigable area of the inlet approach.

Results and recommendations

A decision about the depiction of shoal feature(s) on the nautical chart(s) shall be made by the corresponding MCD Production Branch B Chief of NOAA's Office of Coast Survey.

Horizontal accuracy and vertical accuracies of the data meet or exceed CATZOC “C” standards, and a CATZOC “C” designation is the recommended M_QUAL encoding for ENC corrections.

Tidal Range

According to the chart, the tidal range is: 0.6 m.

Bottom Samples

Bottom samples were not available for this project.

Aids to Navigation

Aids to Navigation were not available for this project.

E – Deliverables

GEOTIFF OR BAG FILES

The following GEOTIFF or BAG files are provided. *If no uncertainty is calculated, then an initial uncertainty of 2 m shall be provided based on the 1 sigma standard deviation.*

VECTOR PRODUCTS

1. Features

- a. Raw derived contours (NOAA rounding applied)
- b. Generalized contours of approximate depths as a suggested chart (*MCD Production Branch Chief will have final authority to decide how to use the SDB data*)
- c. Polygon shapefile of the M_QUAL area.

2. Land/water interface

- a. Based on the infrared spectral band, a land/water interface polygon will be extracted. This product is not tidally referenced, and will be used as an indicator in the Chart Adequacy process.

RASTER PRODUCTS

1. Area analyzed (approximate to M_QUAL)

- a. A cropped polygon of the processed images, equivalent to or slightly larger than the M_QUAL of the area surveyed.

APPROVAL

- 1. Data meet or exceed current specifications as certified by the OCS SDB analysis acceptance review process. Descriptive Report and analysis data except where noted are adequate to revise nautical charts in the common area.

The SDB analysis evaluation and verification has been conducted according current OCS Specifications.

Approved: _____ SDB Cartographer/Analyst

(Typed name of SDB Cartographer/Analyst and their MCD title)

The survey has been approved for dissemination and usage of updating NOAA’s suite of nautical charts.

Approved _____