

H12384

NOAA Form 76-35A

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Survey

DESCRIPTIVE REPORT

Type of Survey: Hydrographic Lidar

Registry Number: H12384

LOCALITY

State: Florida

General Locality: Florida Keys National Marine Sanctuary

Sub-locality: Vicinity of Halfmoon Shoal

2011

CHIEF OF PARTY
Jose Martinez-Diaz

LIBRARY & ARCHIVES

Date:

HYDROGRAPHIC TITLE SHEET

H12384

INSTRUCTIONS: The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.

State: **Florida**

General Locality: **Florida Keys National Marine Sanctuary**

Sub-Locality: **Vicinity of Halfmoon Shoal**

Scale: **1: 10,000**

Dates of Survey: **10/07/2011 to 11/15/2011**

Instructions Dated: **04/29/2011**

Project Number: **OPR-H355-KRL-11**

Field Unit: **Fugro Lads Dynamic Aviation Aircraft, N89F**

Chief of Party: **Jose Martinez-Diaz**

Soundings by: **SHOALS 1000T**

Imagery by:

Verification by: **Pacific Hydrographic Branch**

Soundings Acquired in: **meters at Mean Lower Low Water**

H-Cell Compilation Units: **meters at Mean Lower Low Water**

Remarks:

Horizontal Coordinate System: UTM Zone 17N. The purpose of this survey is to provide contemporary survey to update National Ocean Service (NOS) charts. All separates are filed with the hydrographic data. Revisions and notes in red were generated during office processing. The processing branch concurs with all information and recommendations in the DR unless otherwise noted. Page numbering may be interrupted or non sequential. All pertinent records for this survey, including the Descriptive Report, are archived at the National Geophysical Data Center (NGDC) and can be retrieved via <http://www.ngdc.noaa.gov/>.

DESCRIPTIVE REPORT TO ACCOMPANY

HYDROGRAPHIC SURVEY H12384

SCALE 1:10,000, SURVEYED IN 2011

FUGRO LADS, INC. (FLI)

SCOTT RAMSAY, HYDROGRAPHER

PROJECT

Project Number: OPR-H355-KRL-11

Original: DG133C10CQ0060

Date of Instructions: April 29, 2011

Task Order: T002

Registry Number: H12384

Sheet: 8

A. AREA SURVEYED

Survey operations covered eight registered sheets over the OPR-H355-KRL-11 project area, Florida Keys National Marine Sanctuary (see Figure 1 and Figure 2). Fugro LADS, Inc. subcontracted Fugro Pelagos, Inc. (FPI) to execute the Task Order utilizing the SHOALS-1000T airborne lidar bathymetry system. FPI mounted this ALB system in a Dynamic Aviation Beechcraft King Air A90 - callsign N89F. John Oswald and Associates were subcontracted to establish supplemental vertical control for the project.

A total of 6841 linear nautical miles were illuminated in the process of flying 471 main scheme survey lines. An additional 1931 linear nautical miles were illuminated flying over 150 reflies and 293 linear nautical miles flying 27 crosslines / investigations. The total seabed area surveyed across the project area, from the Mean High Water (MHW) line to lidar extinction depth, was ~300 square nautical miles (see Appendix III for further information).

The Dynamic Aviation aircraft was based at Key West International Airport, through most of October and the first-half of November, 2011. The official mobilization date for OPR-H355-KRL-11 was October 6, being the day prior to the first survey flight to the Florida Keys National Marine Sanctuary (FKNMS). Survey operations were commenced on October 7 with a reconnaissance / shakedown flight over the FKNMS and the city of Key West. Data acquisition activities were suspended between October 19 and 25 in order to conduct aircraft and system maintenance in Sarasota, FL. The final flight to the FKNMS was completed in the early hours of November 15. Demobilization of the Key West base was completed on November 16, 2011.

Survey operations across the FKNMS were comprised of 27 flights conducted over 16 days in October, and 34 flights conducted over 13 days in November, 2011. The higher rate of flying

in November was achieved through the utilization of an additional Dynamic Aviation flight crew.

The specific dates of data acquisition and flight durations for the FKNMS project were as follows:

Date	Flight Number	Flight Time(s)
Oct-7-11	1	4:12
Oct-8-11	2	1:45
Oct-9-11	3, 4	4:34, 0:56
Oct-10-11	5, 6	4:17, 3:02
Oct-11-11	7, 8	4:22, 3:03
Oct-12-11	9, 10	3:42, 2:47
Oct-13-11	11, 12	4:03, 3:34
Oct-14-11	13, 14, 15	0:47, 3:40, 2:01
Oct-15-11	16	0:23
Oct-18-11	17	0:28
Oct-26-11	18	1:26
Oct-27-11	19, 20	1:19, 3:56
Oct-28-11	21, 22	0:58, 2:06
Oct-29-11	23, 24	2:06, 1:42
Oct-30-11	25	1:24
Oct-31-11	26, 27	1:15, 2:07
Nov-1-11	28, 29, 30	3:20, 0:49, 1:03
Nov-2-11	31, 32, 33	1:02, 3:17, 1:30
Nov-3-11	34, 35, 36	3:28, 2:55, 1:52
Nov-4-11	37, 38, 39	3:34, 3:13, 1:58
Nov-5-11	40, 41	1:50, 1:03
Nov-7-11	42	1:03
Nov-8-11	43, 44, 45	3:26, 2:50, 4:28
Nov-9-11	46, 47, 48, 49	1:54, 3:35, 4:13, 2:33
Nov-10-11	50, 51, 52, 53	3:06, 3:15, 4:30, 2:20
Nov-11-11	54, 55	2:04, 1:25
Nov-12-11	56, 57	1:42, 0:47
Nov-13-11	58, 59	1:12, 1:56
Nov-14-11	60, 61	1:45, 4:14

Table 1: Specific Dates and Duration of Data Acquisition

Environmental factors such as water clarity, tide, wind strength and direction, daylight hours, and cloud base height influenced the area and duration of data acquisition on a daily basis. See Section B.2.3 for further details.

This Descriptive Report describes Sheet 8, which covers the vicinity of Halfmoon Shoal (see Figure 2).

It should be noted that Fugro extended the NOAA-provided sheet limits in order to encompass the southern ‘substitution areas’, ensure sufficient overlap between sheets and incorporate a number of features detected just outside the original eastern and western project extents. The final sheet limits for Sheet 8 are as follows:

H12384 (8)	Latitude (N)	Longitude (W)
NW corner	24° 37' 15.99"	82° 29' 02.45"
SW corner	24° 32' 17.92"	82° 29' 02.45"
SE corner	24° 32' 18.14"	82° 20' 22.64"
NE corner	24° 37' 15.99"	82° 20' 22.64"

Table 2: Sheet Limit Coordinates for H12384

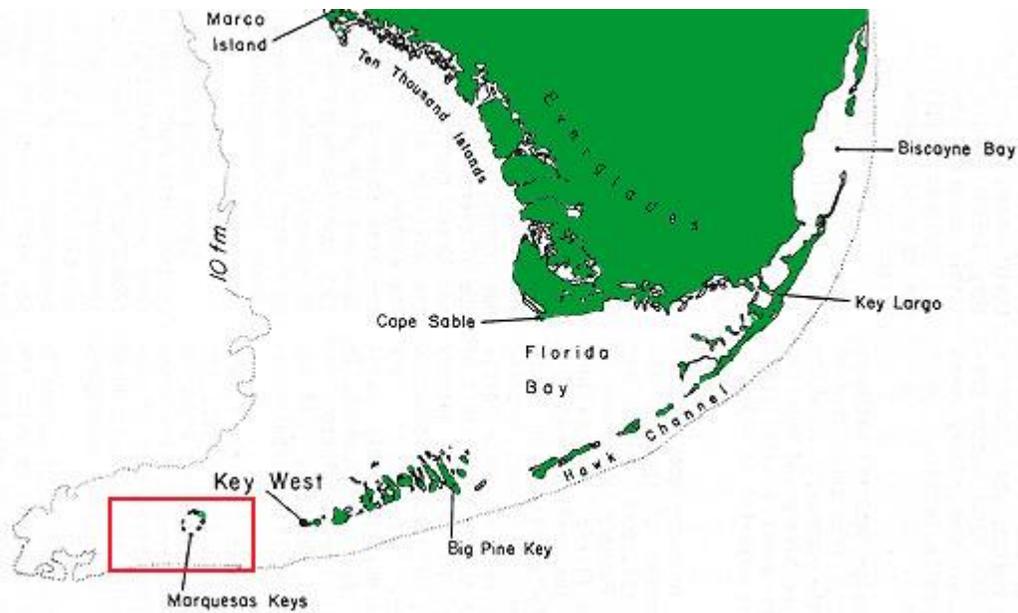


Figure 1 – General Locality of OPR-H355-KRL-11

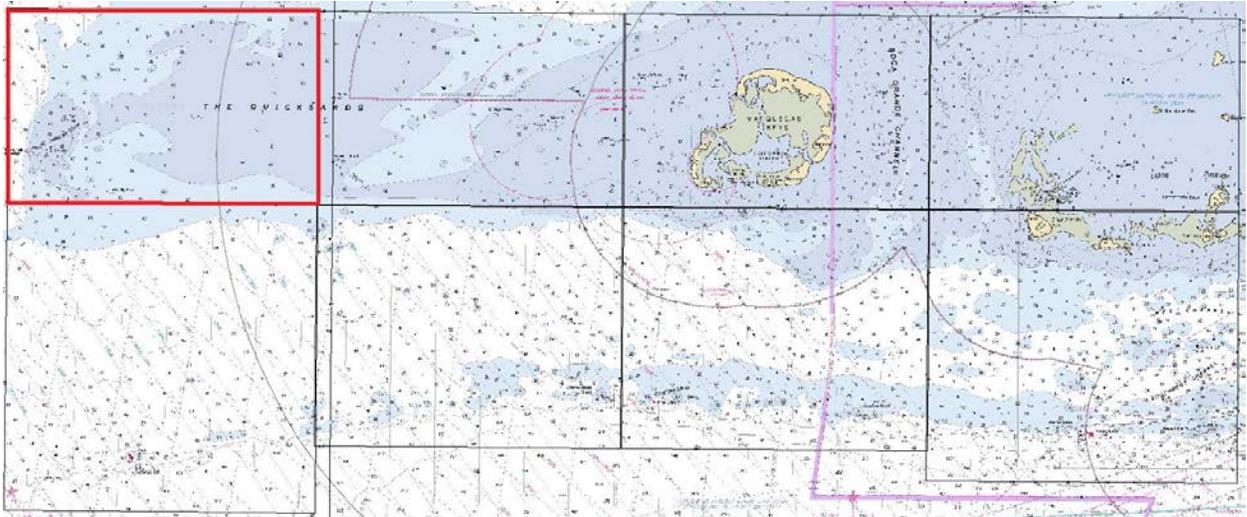


Figure 2 – Sub-Locality of H12384

B. DATA ACQUISITION AND PROCESSING

Refer to the Data Acquisition and Processing Report for a detailed description of the equipment, processing, and quality control procedures used during Fugro Pelagos, Inc. surveys. A general description and items specific to this survey are discussed in the following sections.

B.1 EQUIPMENT

Data collection was conducted using the SHOALS-1000T Airborne System (AS), data processing using the Ground Control System (GCS), data visualization and quality control using IVS Fledermaus v7.2.2 and final products using CARIS HIPS and SIPS 7.1, CARIS Bathy DataBase Editor 3.2, ERDAS IMAGINE v9.3 and ENVI v4.7.

B.1.1 Airborne System

The SHOALS-1000T AS platform for OPR-H355-KRL-11 consisted of a Beechcraft aircraft, which has a transit speed of 175kts, at altitudes of up to 9,000ft, and an endurance of up to five hours. Survey operations can be conducted from heights between 1,000 and 1,300ft, at ground speeds of between 125 and 180kts.

The SHOALS-1000T ALB system is capable of acquiring 1,000 soundings per second in bathymetric mode. SHOALS soundings are acquired by the transmission of laser pulses from the aircraft through a scanning system and detecting return signals from land, the sea surface, the water column and the seabed. The scanning (transmitting) occurs on a stabilized platform that compensates for aircraft pitch and roll. The return signals are electronically amplified and conditioned prior to being digitized and logged.

The height of the aircraft is recorded by the POS AV subsystem. Real-time positioning of the SHOALS-1000T system is derived from an integrated Trimble receiver with differential GPS corrections from a Fugro OmniSTAR receiver (Wide Area DGPS mode). Post-processed

kinematic GPS positioning is achieved by simultaneous data logging with Novatel DL-5 dual frequency GPS receivers at the FPI GPS reference station and onboard the aircraft.

The SHOALS-1000T contains an integrated digital camera, which provides geo-referenced images of the coverage being flown. This not only makes data processing and editing much simpler, it provides an additional data product based on the digital photography acquired during each flight. This imagery was geo-referenced, ortho-rectified and mosaiced to produce high quality orthophotography of the survey area. The sophisticated airborne GPS / POS AV system and the relatively low flying heights produce a pixel resolution of 20-30cm (depending upon flying height).

B.1.2 Ground Control System

The GCS supports survey planning, data processing, quality control and data export. Conversion of raw sounding data from the AS to final depth data was accomplished on the field GCS server. This field server was connected to four operator terminals, with all applicable software installed and stringent data archival processes in place. At critical points during the data collection phase full project data saves were conducted and backup media dispatched to the FPI office in San Diego. At the conclusion of field operations a full final field-save was conducted and all copied data transferred to the main computer servers at the FPI office, for in-depth data verification.

B.2 QUALITY CONTROL

B.2.1 Quality Control Checks

The internal relative consistency of the survey data was checked with crossline depth comparisons, total propagated uncertainty determination flight lines and real-time versus post-processed GPS comparisons. System integrity was checked, in an absolute sense, with the local GPS base station site confirmation, the static position check, and dynamic position checks.

B.2.1.1 Crosslines

A total of 5 specific crosslines were planned and flown perpendicular to the main scheme survey lines, on 9 separate occasions. In addition to the planned crosslines a total of 17 investigation lines were flown across the area, and when the investigation lines had an angle of intersection with the main scheme lines of greater than 45°, they were also used for crossline comparisons.

A difference analysis between the cross lines and the main survey lines was performed using the Crosscheck program within Fledermaus. A surface grid is created from the production lines at approximately 3m bin size. The cross line points were then compared to the surface and point-to-surface statistics generated. Elevated standard deviation of the difference occurs over rocky and high gradient seabed. In relatively featureless areas of seabed the differences present much lower variability.

Below are the overall depth comparison results for the crossline / main scheme line intersections. A complete summary is presented in the Separates Report.

GCS Block	Total Number of Comparisons	Mean Depth Difference + 2 SD (m)
Block 1	539,535	0.26
Block 2	74,943	0.34
Block 3	506,098	0.26
Block 4	114,270	0.27
Block 5	94,814	0.16
Block 6	91,128	0.44
Block 7	362,689	0.29
Block 8	196,846	0.36

Table 3: Crossline Comparison Results

Refer to Figure 5 for the location of each GCS Block within the project extents.

B.2.1.2 Total Propagated Uncertainty Determination Lines

In order to accurately determine total propagated vertical uncertainty for all depth data collected as part of the project a ‘TPU’ line was designed and flown on 16 separate occasions. Eight individual areas of low gradient seabed were identified across the TPU line. Once all the depth data had been processed, cleaned and reduced to datum by final tide zoning and verified data, the line exhibiting the optimal water clarity and most accurate data was exported out of GCS. A gridded reference surface was generated for the eight ‘depth benchmark areas’ across this optimal line. Each of the other 15 TPU lines that were flown throughout the project were compared to the reference surface and statistics compiled. While this line was primarily flown for TPU determination, the associated depth comparison statistics serve as another quality control check of the SHOALS-1000T repeatability.

The reference line was flown in the early morning of November 4, 2011. Eight separate seabed areas along this line of survey were identified as being large enough (~200m x 215m), and the seabed flat enough, to be used for TPU assessment. The nominal depth, dimensions and center coordinates for the TPU areas are as follows:

TPU Area Name	Raw Depth (m)	Dimensions (m)	Latitude (N)	Longitude (W)
TPU1	2	750 x 215	24° 32' 44.19"	81° 56' 59.90"
TPU2	3.5	200 x 215	24° 31' 07.11"	81° 58' 31.88"
TPU3	5	200 x 215	24° 30' 55.03"	81° 58' 43.26"
TPU4	8.5	350 x 215	24° 27' 27.06"	82° 02' 00.03"
TPU5	10	400 x 215	24° 27' 07.06"	82° 02' 18.95"
TPU6	14.5	325 x 215	24° 27' 51.58"	82° 01' 36.75"
TPU7	22	200 x 215	24° 26' 26.13"	82° 02' 57.47"
TPU8	32	250 x 215	24° 26' 33.53"	82° 02' 50.54"

Table 4: TPU Area Locations

A difference analysis between the TPU reference line and 15 TPU comparison lines was performed using the Crosscheck program within Fledermaus. A surface grid is created from the TPU reference line at approximately 3m bin size. The TPU comparison line points were then compared to the surface and point-to-surface statistics generated. The statistics generated include the number of points compared, the mean depth difference (MDD) and the standard deviation (SD) between the data sets. Due to the highly variable water clarity conditions across the project area, particularly in the southeast where the TPU line was conducted, comparisons were not always possible due to a lack of ALB data coverage. A summary of the average of the MDD and SD for all TPU area comparisons is presented below. Refer to the Separates Report for detailed results of the TPU determination.

TPU Area Name	Raw Depth (m)	Flight Lines Compared	Mean MDD + 2 SD (m)
TPU1	2	14	0.32
TPU2	3.5	8	0.27
TPU3	5	7	0.36
TPU4	8.5	15	0.35
TPU5	10	13	0.35
TPU6	14.5	6	0.37
TPU7	22	12	0.52
TPU8	32	4	0.39

Table 5: TPU Gridded Surface Comparison Results

The high Mean MDD + 2 SD value for the 22m depth benchmark area (TPU7) is the only outlier noted in the results. This is attributed to the benchmark area being selected across a deep-water ridge, which probably exhibited too much gradient for gridded surface comparison. Despite this one outlier, all TPU comparison results and the crossline comparisons results demonstrate that the SHOAL-1000T vertical accuracy was within project specifications.

B.2.1.3 Positioning Checks

Two independent positioning systems were used during the survey. Real-time positions were determined by Wide Area Differential GPS. Post-processed KGPS positions were determined relative to a local GPS base station that was established by FPI personnel. The post-processed KGPS positions were applied to each sounding during processing.

Position checks were conducted prior to, during, and following data collection as follows:

- a. Local GPS Base Station Site Confirmation. A 24-hour certification of the initial GPS base station established was conducted on October 9-10, 2012. A 24-hour certification of the ‘reset’ GPS base station, utilized from late October until project completion, was conducted on October 22, 2012. The results revealed that the local GPS base stations

were free from site specific problems such as multipath and obstructions. Details are provided in the Horizontal and Vertical Control Report and scatter plots in the Separates Report.

- b. Static Position Check. The coordinates of the aircraft GPS antenna were determined using static GPS positioning and total station measurements at the Key West International Airport. Data was logged by each SHOALS-1000T positioning system while the aircraft was static, enabling the positions to be checked against the known GPS antenna point. The absolute accuracy of the post-processed KGPS solution during the static position check was 0.025m (95% confidence). The results and details of the static position check are enclosed in the Horizontal and Vertical Control Report and Separates Report.
- c. Real-time Versus Post-processed GPS Check. During each sortie, GPS data was logged on the aircraft and at the local GPS base station. This provided a relative check between the real-time and post-processed GPS positions, in all 3 dimensions. The mean difference between the real-time and post-processed coordinates was 2.482m, with an average standard deviation of 0.291m. Details are provided in the Horizontal and Vertical Control Report.
- d. Dynamic Position Check. Dynamic position checks were also conducted over the 4 corner points of the White Street Pier, on the south coast of Key West. This enabled the known position of the points to be checked against the lidar data acquired during overflight. This provided an absolute check of the resultant positioning of real-world features detected by the SHOALS-1000T. The mean difference between the known and observed co-ordinates for the 4 pier corners, from 22 separate overflights, was 2.331m, with an average standard deviation of 1.148m. Further details are provided in the Separates Report.

The position checks were within the expected tolerances and demonstrated that the positioning systems were functioning correctly throughout the survey period.

B.2.2 Uncertainty Values

As described under Section B.2.1.2, a total propagated uncertainty line was designed and flown on 16 separate occasions in order to determine the repeatability of the SHOALS-1000T and assign accurate vertical TPU for all depth data acquired throughout the project. The results of the mean depth differences and standard deviations of gridded surface comparisons are presented in Table 5. As ALB data accuracy is related to depth, the benchmark area depths were plotted against the MDD + 2SD value observed at each location.

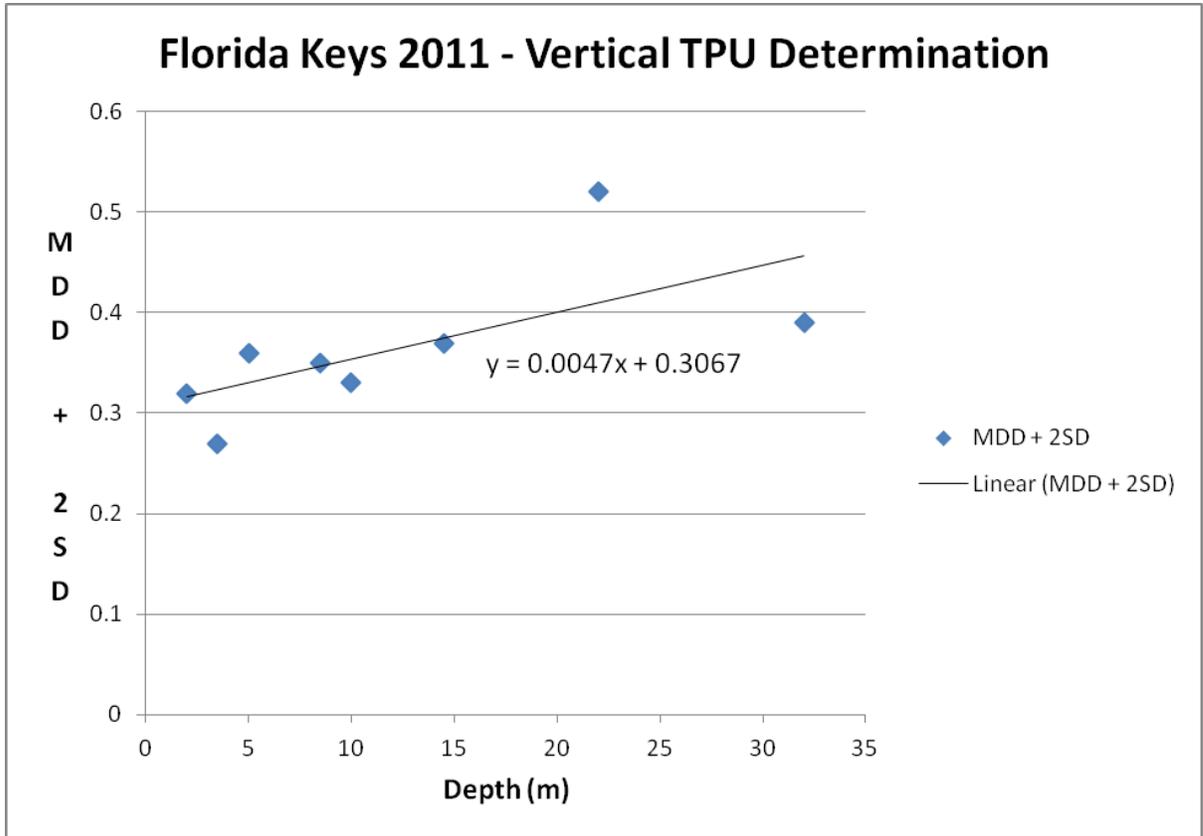


Figure 3 – Vertical TPU Determination

For simplicity, the relationship between depth and data accuracy was considered linear and a trend line was fitted to the scatter plot. The resultant equation was derived for vertical accuracy of the OPR-H355-KRL-11 project:

$$Y = 0.0047x + 0.3067$$

The horizontal TPU for the project was also derived from actual results of the survey, being the dynamic position check comparisons. The mean difference (MD) between the observed and surveyed check point positions was 2.331m with a 2 sigma standard deviation of 2.250m. That results in a value of 4.580m for MD + 2SD and 0.081 for MD – 2SD. Thus, the final horizontal TPU value for all soundings across the project has been assigned as 4.449m.

The final look-up table used for assigning vertical and horizontal TPU to the CARIS BASE Surface was as follows:

Depth	Vertical TPU (m)	Horizontal TPU (m)
-50	0.307	4.499
0	0.307	4.499
2.5	0.318	4.499
5	0.33	4.499
7.5	0.342	4.499
10	0.354	4.499
12.5	0.365	4.499
15	0.377	4.499
17.5	0.389	4.499
20	0.401	4.499
22.5	0.412	4.499
25	0.424	4.499
27.5	0.436	4.499
30	0.448	4.499
32.5	0.459	4.499
35	0.471	4.499
37.5	0.483	4.499
40	0.495	4.499

Table 6: Vertical and Horizontal TPU Look-up Table

However, when the calculated grid node in the final CARIS BASE Surface has a standard deviation greater than the assigned vertical uncertainty, the standard deviation value is used as the uncertainty value. This has occurred in areas of high relief, which is common throughout the survey area. In some cases the standard deviation may exceed IHO Order-1 limits.¹ This is generally attributed to the seabed gradient and a 3m grid resolution being used.

B.2.3 Environmental Factors

B.2.3.1 Sea Conditions - Sea State, White Water, Calm Seas

The sea state generally ranged from 1 to 3 on the Beaufort scale throughout the survey period. During periods of higher sea state, expansive areas of white water were observed around drying areas and over shallow features, and this data was typically rejected. When such conditions were observed, operations were suspended. Very calm seas were experienced on only two days during the data acquisition period, with the shallow water areas being the calmest. Operations were re-directed to offshore sub-areas to minimize the adverse effects of ‘glassy’ seas. No gaps resulted from calm sea effects.

B.2.3.2 Water Clarity and Area Substitutions

The water clarity varied significantly, both spatially and temporally across the project area. Poor water clarity was mainly driven by moderate to strong winds, particularly from the

north-east. It was apparent that high rainfall and certain tide cycles also played a major role in deteriorating water clarity conditions.

During the 35 day data acquisition period there were only 8 days that were considered to be ideal for ALB data acquisition across the majority of the project area. Even on those optimal weather and water clarity days a persistent turbidity plume was present across the project area, extending from the Northwest Channel, down through the Southwest and West Channels, right out to southwest of the Marquesas Keys. It became apparent that only sparse, poor accuracy data could ever be hoped to be acquired in the centre-east of the project area. It was obvious that there would be expansive areas of no lidar coverage due to very poor water clarity.

This was communicated to the NOAA COTR, during his field-site visit to Key West in mid-October. Two separate substitution plans were officially proposed and approved by the COTR, the first on October 26 and the second on November 1, 2012.² The general principle of the substitutions was to remove flight lines from West Channel and add southern extensions to the H12377 and H12380, where water clarity was generally good under all environmental conditions. The budgeted *time* taken to survey the removed lines was calculated and applied to the number of lines to be flown in the southern extensions. This is why the substituted flight lines are shorter (to fit the general charted bathymetry), but there are significantly more of them.

The resultant removal / addition of flight lines due to persistent poor water clarity are demonstrated in the following graphic. The yellow polygons relate to Substitution 1 and pink polygons Substitution 2. The underlying interim bathymetry coverage image in this graphic demonstrates the difficulty in acquiring good quality data in West Channel during October.

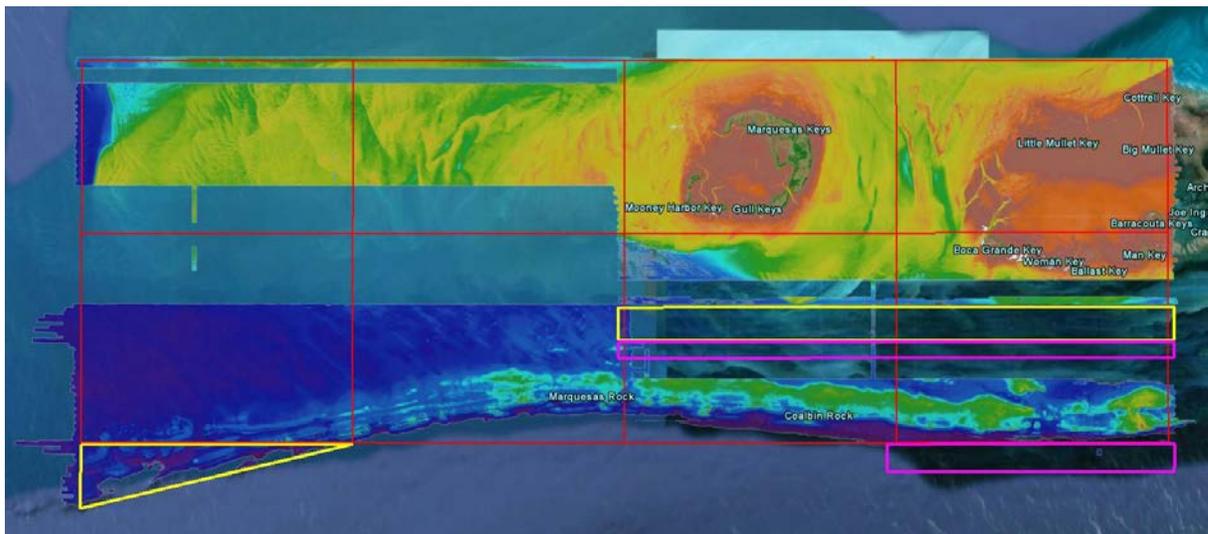


Figure 4 – OPR-H355-KRL-11 Approved Substitution Areas for Poor Water Clarity

Even with the worst water clarity area substituted there were still large areas of no, or limited, lidar seabed coverage, due to turbid water conditions. Despite flying many of these areas on 4 or even 5 occasions, the coverage could not be significantly improved. In some highly

dynamic water clarity areas the first 100% coverage pass yielded good results. However, subsequent 200% flight lines and then re-fly lines only added sparse, in-accurate data to the final coverage. In a number of such instances the 200% coverage and re-fly data was completely rejected to adhere to the project accuracy specifications. The good quality 100% coverage was retained. Special regard was given to shoal features across these turbid seabed areas, and in some cases ‘noisy’ data was accepted to ensure significant seabed objects were rendered as part of the survey.

For the project to be successful, water clarity had to be managed very closely throughout the data acquisition period. ‘Priority Area’ management ensured that the system was operating in the correct area at the optimal time. In general, the water clarity in the southern areas remained good to very good. These areas were typically targeted when the north was extremely turbid. When the water clarity in the northern areas improved, data acquisition efforts were maximized, with the two flight crews brought in, following aircraft maintenance, conducting up to 4 sorties per day. Data analysis following each flight also revealed that best data was often acquired around the high tide period, particularly during Spring tide cycles. Persistently poor to marginal water clarity areas were specifically targeted during high Spring tides to maximize final seabed coverage.

B.2.3.3 Topography

The SHOALS-1000T system can measure topographic heights up to 200m elevation. As the keys within the project area have low elevations, the maximum topographic return for the project was actually from the mast of an exposed wreck, west of the Marquesas Keys. The mast was measured to be ~15m above chart datum.

B.2.3.4 High Ground

There were no high ground or tower issues encountered during the execution of this project.

B.2.3.5 Wind

Survey operations were conducted in wind strengths of up to 25kts during the survey. However, strong winds resulted in lines having to be inefficiently ‘race tracked’ in to the wind, so as to avoid aircraft over speed and resultant stretched sounding patterns. In general, the wind strength during sorties was between 10 and 20kts. In circumstances when wind speeds were forecast to be greater than 25kts, no flights were planned due to the inefficiencies of race tracking lines and white water effects on the sea surface.

B.2.3.6 Cloud

Low cloud coverage and rain was a factor during the survey. When the cloud base dropped below 1300 feet operations were diverted to alternate sub-areas or aborted. Poor weather was monitored using, and decisions on the flying program were based on:

- Local weather conditions at the base of operations – Key West.
- National Weather Service current conditions including radar, and forecasts for Key West.
- Real-time satellite imagery for the Florida Keys and Gulf of Mexico.

B.2.4 Data Coverage and Object Detection

B.2.4.1 Nature of the Seabed

The nature of the seabed in the vicinity of Halfmoon Shoal is quite complex. The area covered by H12384 is characterized by:

- Hundreds of expansive sandwaves throughout most of the sheet.
- The western edge of the large sandwave area named ‘The Quicksands’, west and north of Halfmoon Shoal.
- A number of discrete seabed features in the vicinity of Halfmoon Shoal, in the southwest of the sheet.
- A ‘pock-marked’ seabed in the northwest and center-south of the sheet.

B.2.4.2 Data Coverage

The survey area was illuminated at 4x4m laser spot spacing, resulting in a 215m swath width. Mainlines of sounding were spaced at 86m, which provided the required 200% coverage.

One limitation of the GCS software is that only one operator may have access to a ‘Block’ of flight lines once the data has been collected. Thus, the project area was divided in to 4 separate blocks vertically. In order to manage expected variable water clarity conditions it was also decided that the area should be divided horizontally in to western and eastern sections. This incurred additional aircraft turn times between successive flight lines, but resulted in far fewer refly lines due to poor water clarity. The result was 8 GCS Blocks, aligned with the NOAA registered sheet limits, as described in the following graphic:

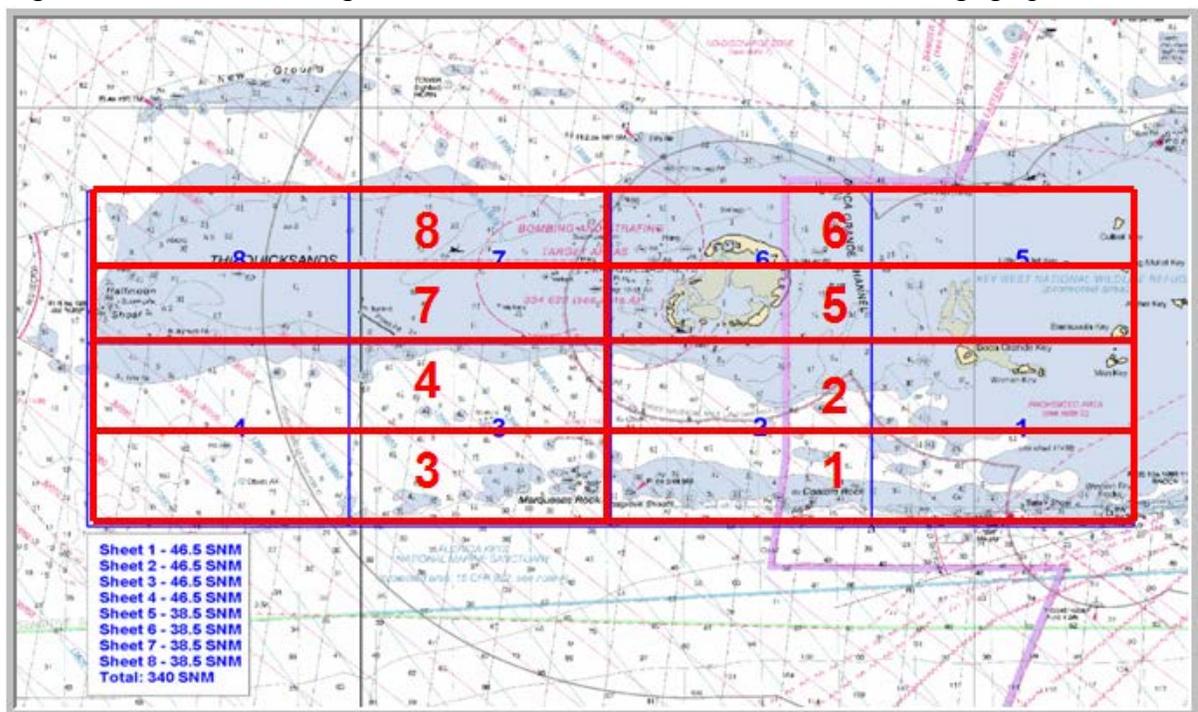


Figure 5 – GCS Blocks Covering OPR-H355-KRL-11 Project Area

The main scheme survey lines were divided in to 2 sub-sections within each GCS Block – 100% coverage lines and 200% coverage lines. The lines in each sub-section were spaced

172m apart. Thus, on one particular flight the 100% coverage lines were flown and full illumination of the seabed was achieved, with sufficient overlap achieved between each successive line. During a flight conducted at least 24 hours later the 200% coverage was flown, again fully illuminating the same area of seabed, under different environmental conditions.

Across areas of very shallow water and coastline, at least one of the 100% or 200% subsections was flown at extremely high water, in order to achieve full seabed coverage in these complex regions. Often the 200% coverage flown across shallow water areas at a lower tide resulted in sparse, noisy data coverage. This data was typically rejected, resulting in only 100% coverage in very shallow water. It was determined that accurate 100% coverage, in very shallow, complex areas was superior to noisy 200% coverage. This was communicated to the NOAA COTR and shallow water data decimation was approved.³

There were also a number of large areas within the project extents where poor water clarity was an ongoing issue. In a number of instances the water clarity was only clear enough to enable accurate data capture on just one of the coverage passes. In many areas, coverage was flown at the required 200% and re-flown at 300%, 400% and even 500% coverage, but turbidity prevented accurate 200% data acquisition. The final coverage for H12384, at both 100% and 200% lidar data density, is represented in the following graphic:

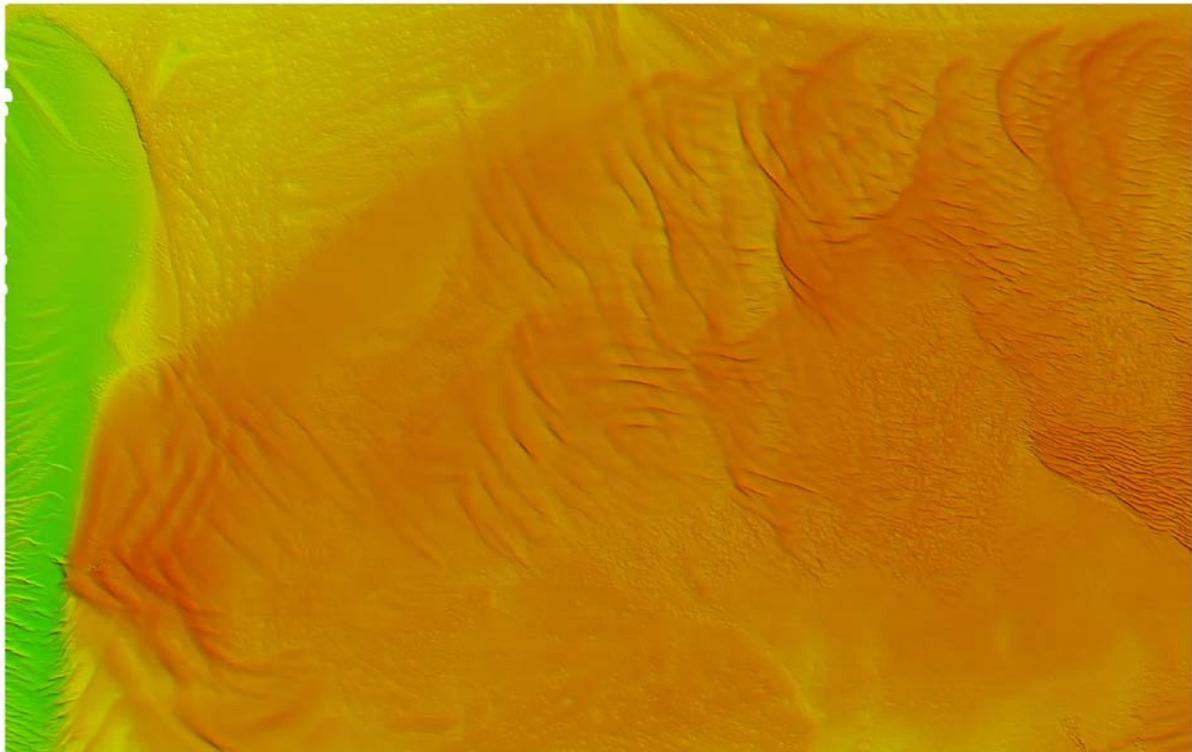


Figure 6 – CARIS BASE Surface Image for H12384

There was only one significant gap in lidar coverage across H12384 due to poor water clarity, located in the northwest of the sheet. Most of the sheet was covered by 200% lidar coverage.

The generally good water clarity observed in the south of the project area, throughout most of the acquisition period, resulted in maximum lidar extinction depths of 45m for the project. H12384 is mainly comprised of shallow water, with maximum depths in the order of 19m.

B.2.4.3 Object Detection

At the sea surface the footprint of the laser beam is approximately 2m in diameter. As the beam passes through the water column, it diverges slightly due to scattering. It should be noted that at 4x4m laser spot spacing, there is a gap of approximately 2m between the illuminated areas of adjacent soundings at the sea surface. There is a possibility that small objects in shallow water may fall between consecutive 4x4m soundings, and not be detected. The additional bathymetry acquired in conducting this project at 200% coverage often illuminated the seabed between adjacent soundings from the first overflight. The 200% coverage often confirmed the presence of small seabed objects detected during the first pass.

The raw lidar data acquired during all sorties was automatically processed on the Ground Control System with the object detection mode of 'first return' switched on, in lieu of the 'strongest return' option. This selection improved the ability of GCS to detect small seabed features at all surveyed depths.

B.3 CORRECTIONS TO SOUNDINGS

Refer to the Data Acquisition and Processing Report for a description of corrections to soundings. There were no deviations from the corrections described therein.

B.4 DATA PROCESSING

B.4.1 Data Management

A detailed table of survey line identifiers is presented in the Data Acquisition and Processing Report.

B.4.2 Data Processing Sites

The data acquired during survey flights were processed at the operating site in Key West following each sortie. Interim, 'rough' data cleaning was performed in the field, particularly during the period of October 19-25, while the aircraft and ALB system were undergoing maintenance in Sarasota, FL. Final data validation, checking, QC, approving, reports and products were conducted at the FPI San Diego office.

B.4.3 CARIS BASE Surface

One BASE Surface covers the entire area defined by the H12384 sheet limits. The Shoal layer of the BASE Surface should be used as the official hydrographic record of the survey. A grid resolution of 3m was used for the BASE Surface. Grid resolution does not change relative to depth, as the laser pulse footprint stays relatively constant regardless of depth. The 3m grid provides the largest amount of detail that can be supported by the lidar density (4x4 laser spot spacing at 200% coverage).

B.4.4 Gap Delineation

During data processing on the GCS the operators noted the location and nature of any significant gaps in lidar coverage. This enabled accurate delineation and attribution of unsurveyed polygons for the S-57 feature file (US512384.000).

For this survey, the following notes were used to describe the extent of gaps in the lidar seabed coverage:

GS	Bathymetry data gap due to extremely shallow water, particularly where very bright white sand was present.
GT	Bathymetry data gap due to widespread or localized turbidity.

Table 7: Nature of Gaps in Seabed Coverage

B.4.5 Georeferenced Imagery

Digital imagery was captured on each sortie and acquisition timing was managed to ensure that at least 100% coverage was flown during daylight hours. The daylight imagery was used in the validating, checking, and approval stages of survey data cleaning. The daylight images were also combined to produce georeferenced mosaics, with H12384_801_UTM.tif – H12384_806_UTM.tif covering H12384. A project-wide, lower resolution image has also been submitted for the survey, named All_Imagery_UTM_ECW.ecw.

B.4.6 Progress Sketches

Progress sketches were provided to NOAA on a monthly basis. The final progress sketch can be found at Appendix III.

B.4.7 Deliverables Data Formats

Data is provided in the following formats:

- Digital S-57 feature file in .000 format
- GCS screen captures for significant S-57 features in .bmp format
- CARIS BASE Surface file in .csar format
- Lidar coverage and uncertainty images in geotif format
- CARIS compatible SHOALS-1000T data in .hof and .inh formats – soundings and waveforms, which can be imported into CARIS HIPS
- CARIS compatible data in HDCS format – SHOALS-1000T soundings in CARIS HIPS native format
- Tidal data provided in multiple formats
- Digital georeferenced imagery mosaics in geotif format
- Relative Reflectance data in 8 bit ASCII and geotif formats

Refer to the Data Acquisition and Processing Report for specific details.

C. VERTICAL AND HORIZONTAL CONTROL

Refer to the Horizontal and Vertical Control Report for a detailed description of the horizontal and vertical control used during this survey. Refer to Appendix IV for specific times and dates of relevant tide data. A summary of horizontal and vertical control used for the survey follows.

C.1 VERTICAL CONTROL

Vertical control for this survey was based on MLLW at the National Water Level Observation Network (NWLON) stations at Naples, FL (872-5110) and Key West, FL (872-4580), as well as the subordinate station at Smith Shoal Light, FL (872-4671).

The Naples station (872-5110) served as datum control for this project. Data observed at the Naples station was used to conduct a MLLW datum transfer to the short-term subordinate station installed by JOA at Smith Shoal Light. Naples observations were not used for the reduction of soundings. The Key West station (872-4580) was used for preliminary and final reduction of depth soundings and to derive preliminary and final tidal zoning for the project area. The subordinate station at Smith Shoal Light (872-4671) was established in late August, 2011 by JOA and was used for final reduction of depth soundings and to derive final tidal zoning for the project area. The USCG approved JOA's application to temporarily occupy the Smith Shoal Light with the subordinate tide station.

All tide stations recorded continuously during data collection periods and were used for the duration of the survey.

In order to define the most accurate final discrete tide zoning model possible it was proposed, and approved by the NOAA COTR, that short-term deployments of a bottom mounted tide gauge be conducted by JOA at two locations within the project area. The bottom-mounted gauge was deployed in the Quicksands area just prior to the JOA mobilization of the subordinate station at Smith Shoal Light and then moved to the vicinity of Boca Grande Key following install. The bottom mounted tide gauge remained at the Boca Grande Key location throughout the data collection period and was removed during the Smith Shoal Light demobilization. Approval was sought and provided by the Florida Keys National Marine Sanctuary to conduct these deployments.

The data acquired at the Quicksands and Boca Grande Key was not used in the final reduction of soundings. The data was specifically used to analyze the tidal processes between Key West, Smith Shoal Light, Boca Grande Key and the Quicksands. The resultant final discrete zoning provided by JOA models these processes more accurately with utilization of the Boca Grande and Quicksands bottom mounted tide gauge data.

Station details are as follows:

Gauge	Location	NAD83	
		Latitude (N)	Longitude (W)
872-5110	Naples, FL	26° 07.9'	81° 48.4'
872-4580	Key West, FL	24° 33.3'	81° 48.4'
872-4671	Smith Shoal Light	24° 43.1'	81° 55.3'
BMTG	The Quicksands	24° 36.6'	82° 27.3'
BMTG	Boca Grande Key	24° 33.7'	81° 59.7'

Table 8: Tide Station Locations

C.2 ZONING

Fugro Pelagos, Inc. acquires and reviews all preliminary data relative to the ellipsoid. This enables a rapid approach to data quality review shortly after acquisition and automated processing. Verification of ellipsoid referenced data is also more efficient in the FPI workflow. The preliminary tide zoning supplied by NOAA CO-OPS was used only for the manual tide reduction of raw depths over significant features observed during, and just following, the data acquisition period. The reduced depths of these significant features were reported to the NOAA Atlantic Hydrographic Branch as Dangers to Navigation (DTONs).

The final tide zone model was developed and provided to FPI by JOA. This tide model was based on observations at Key West and Smith Shoal Light, the bottom mounted gauge deployments at the Quicksands and Boca Grande Key and the COOPS tide station datum points at West Jetty, Sand Key Lighthouse, Boca Grande Key, Garden Key (Dry Tortugas), Loggerhead Key, Fleming Key, White Street Pier and Snipe Point. Further details are provided at Appendix II of the Horizontal and Vertical Control Report.

Each of the discrete tide zones use time and range correctors relative to the Key West NWLON tide station and the subordinate tide station installed by JOA at Smith Shoal Light. For final tide application, the time and range correctors were applied to NOAA verified and JOA quality controlled tide data, smoothed by JOA. Raw depth soundings were then reduced to MLLW using these final tides. An analysis of depth benchmark and crossline comparisons, and overlaps of the main lines of sounding concluded that final tide zoning was adequate.

The value for the difference between MLLW and MHW at the Key West NWLON tide station is 0.463m. From the final zoning, only Key West data was applicable to Sheet 8.

C.3 HORIZONTAL CONTROL

Data collection and processing were conducted on the AS and GCS in World Geodetic System (WGS84) on Universal Transverse Mercator (Northern Hemisphere) projection UTM (N) in Zone 17, Central Meridian 081° W. These data was post-processed and all soundings are positioned relative to the North American Datum 1983 (NAD83). All units are in meters.

C.3.1 LADS Local GPS Base Stations – Key West International Airport

Throughout the survey the real-time positioning of the SHOALS system was in Wide Area Differential GPS (WADGPS) mode, derived from a NovAtel Millennium GPS card aided by OmniSTAR or Wide Area Augmentation System (WAAS) Differential. The use of WAAS was due to a temporary problem with updating the SHOALS OmniSTAR subscription.

For all sorties, post-processed positions were obtained by simultaneous data logging with the roving receiver onboard the aircraft and a NovAtel DL-V3 GPS L1/L2 reference receiver at the coordinated local GPS base station at the Key West International Airport. The final KGPS solution was then improved by integrating the 200Hz POS AV IMU inertial data.

For each flight, a KGPS navigation solution was processed in Applanix POSPac software. GPS data from the airplane and ground control base stations were input in a POSPac project and post-processed to obtain an optimal inertially-aided KGPS navigation solution. In general, the best possible KGPS solution would present a small separation difference between forward and reverse solutions when combined, ideally <0.10 m RMS and remain fixed throughout the flight period. The final smoothed best estimated trajectory (SBET) was then used by GCS during lidar auto processing.

In late October 2011, the local GPS reference station required re-location due to an aircraft parking overflow issue at the Key West International Airport. The ‘reset’ FPI GPS reference station was established and checked with a 24-hour certification, using the same procedures as those employed for the initial GPS base station.

The derived NAD83 coordinates for the local GPS base stations are:

Station	NAD83 (CORS96)		UTM (N) Zone 17 (m)		
	Latitude (N)	Longitude (W)	Easting	Northing	Ellipsoid Height
KEYW	24° 33' 16.9196"	081° 45' 45.5728"	422763.737	2715855.398	-21.417
KEYW2	24° 33' 17.5360"	081° 45' 51.1661"	422606.486	2715875.226	-21.607

Table 9: Local GPS Reference Station Positions

D. RESULTS AND RECOMMENDATIONS

The results for the H12384 survey are submitted separately to this Descriptive Report as the S-57 feature file, BASE Surface, georeferenced imagery, relative reflectance data etc. on the USB hard drive. Refer to Appendix II of the Data Acquisition and Processing Report for a list of all the deliverable files from H12384.

Below is a table listing the S-57 feature objects found in the S-57 feature file (US512384.000):

S-57 Object Class	S-57 Object Acronym	Geometry	Description	Attribute 1	Attribute 2	Attribute 3	Attribute 4	Comments
Unsurveyed Area	UNSARE	A	An area for which no bathymetric survey information is available.	Information (INFORM)				Used for defining gaps in data coverage as a result of extremely shallow water or very poor water clarity.
Underwater / A wash Rock	UWTROCP	P	A concreted mass of stony material or coral which dries, is a wash or is below the water surface.	Water level effect (WATLEV)	Quality of sounding measurement (QUASOU)	Value of sounding (VALSOU)		For H12384 all submerged rocks are 0.32m and deeper, relative to MLLW.
Sand waves	SNDWAVP	P	A large mobile wave-like sediment feature in shallow water and composed of sand.	Vertical accuracy (VERACC)	Vertical length (VERLEN)			Sand waves were generally attributed when the vertical length was >1m.
Sounding	SOUNDG	S	A measured water depth or spot which has been reduced to a vertical datum.					Used to define least depth on shoals.
Beacon, lateral	BCNLAT	P	A lateral beacon is used to indicate the port or starboard hand side of the route to be followed.	INFORM (Information)	Category of lateral mark (CATLAM)	Object name (OBJNAM)		Coordinates derived from mean position of lidar detects on navigation aid.
Beacon, special purpose / general	BCNSPP	P	A beacon is a prominent specially constructed object forming a conspicuous mark as a fixed aid to navigation or for use in hydrographic survey.	INFORM (Information)	Category of special purpose mark (CATSPM)	Object name (OBJNAM)		Coordinates derived from mean position of lidar detects on navigation aid.

S-57 Object Class	S-57 Object Acronym	Geometry	Description	Attribute 1	Attribute 2	Attribute 3	Attribute 4	Comments
Buoy, safe water	BOYSAW	P	A safe water buoy is used to indicate that there is navigable water around the mark.	INFORM (Information)	Buoy colour (COLOUR)	Object name (OBJNAM)		Coordinates derived from mean position of lidar detects on navigation aid.
Wreck	WRECKS	P	The ruined remains of a stranded or sunken vessel which has been rendered useless.	Water level effect (WATLEV)	Quality of sounding measurement (QUASOU)	Value of sounding (VALSOU)	Category of wreck (CATWRK)	For all wrecks showing masts, the surveyed height is considered approximate.
<i>Meta Objects</i>								
Coverage	M_COVR	A	A geographical area that describes the coverage and the extent of spatial objects.	Category of coverage (CATCOV)	Information (INFORM)			M_COVR: CATCOV = 1 polygons define the extents of good LIDAR data coverage.
Quality of Data	M_QUAL	A	An area within which a uniform assessment of the quality of the data exists.	Category of zone of confidence in data (CATZOC)	Positional accuracy (POSACC)	Sounding accuracy (SOUACC)	Technique of sounding measurement (TECSOU)	The sounding accuracy has been populated with the maximum TPU, at 40m water depth.

Table 10: Attribution for the S-57 feature file (US512384.000)

Recommendations for charting action for registry number H12384 are now provided in the S-57 extended attribution. Under previous Task Orders FLI delivered spreadsheets, '.hob' files and tables in the Descriptive Report to address charting recommendations. These deliverables have been made redundant by the new requirements of the extended S-57 attribution. GCS screen captures of data pertaining to significant seabed features are still provided, and have been linked within the S-57 attribution. A summary of charting actions is provided in Section D.2.2.

D.1 CHART COMPARISON

H12384 LADS survey deliverables were compared to:⁴

- ENC US4FL92M Edition 6, compiled from Raster Chart 11439. ENC issue date December 20, 2010.
- Raster Chart 11439 26th Edition with a print date of July 1, 2004 at scale 1:80,000. Corrected through LNTM on December 20, 2011 and NGA on December 24, 2011.

These charts were downloaded from the NOAA Office of Coast Survey – Nautical Charts and Publications website on January 10, 2012.

(<http://www.nauticalcharts.noaa.gov/staff/chartspubs.html>)

D.1.1 Dangers to Navigation

No Dangers to Navigation (DTONs) were identified within the extents of H12384.

D.1.2 AWOIS

No AWOIS were assigned to this Task Order.

D.1.3 Aids to Navigation

No.	NavAid Name	Charted Position		Surveyed Position		# of Lidar Hits	Difference in Position (m)
		Latitude (N)	Longitude (W)	Latitude (N)	Longitude (W)		
1	Boca Grande Channel Daybeacon 1	24° 37' 16.99"	82° 04' 24.71"	24° 37' 17.12"	82° 04' 24.25"	1	15
2	Boca Grande Channel Daybeacon 2	24° 33' 58.53"	82° 04' 47.40"	24° 33' 58.90"	82° 04' 46.68"	2	25

Table 11: Charted and Surveyed Position of Navigation Aids for H12384

D.1.4 Charted Depths and Features

Registry number H12384 covers part of NOAA ENC US4FL92M and Raster Chart 11439. From the Source Diagram, the H12384 survey area was covered by a combination of early NOS surveys between 1940 and 1969, between 1900 and 1939 and even pre-1900. The existing charts in this area have been relatively well surveyed considering the technology available at that time.

The area surveyed within H12384 is represented by the BASE Surface and S-57 feature file in considerably more detail than is currently shown on the nautical charts. The following general recommendations are relevant when comparing the area surveyed to the ENC:

- a. Coastline. There is no coastline on H12384.
- b. Intertidal Areas. There are no intertidal areas on H12384.
- c. Rocks. One significant rock and a number of shoals have been surveyed within H12384. It is recommended that the chart be amended to match the Fugro survey deliverables.⁵
- d. Sandwaves. A total of 75 sandwaves have been surveyed within H12384 and attributed as such in the S-57 feature file.⁶ As sandwaves are considered a seafloor characteristic, and least depths cannot be attributed in the S-57 feature file for such seabed features, where there is a significant difference between the charted depth and least depth detected on the sandwave by lidar, the 'Recommendations' field has been used to present the surveyed 'value of sounding'. For H12384, there was no migration of sand waves observed between the 100% and 200% coverage data acquisition time periods.

D.1.5 Detailed Chart Comparison

Descriptive Reports under previous NOAA Task Orders have incorporated detailed chart comparisons, with tables fully describing the differences noted between the survey and applicable nautical charts. Excel spreadsheets, with links to relevant screen captures, and .hob files were also submitted as part of the final deliverables. With the new requirements of extended S-57 feature attribution these previous deliverables have been made redundant. The chart comparison is now considered an integral component of the extended S-57 feature attribution.⁷

Extended S-57 feature attribution was conducted by reviewing the electronic and raster charts, the LADS survey deliverables and the georeferenced digital imagery. For each feature identified as requiring a ‘New’ or ‘Update’ charting recommendation, screen captures of the raw waveform display, digital image window and Fledermaus bathymetry surface were extracted from GCS and linked within the S-57 file. All of these screen captures have been provided as part of the final deliverables.

Each S-57 feature has been reviewed in order to make the following assessments:

- a. Special Feature Type – ‘DTON’ for features previously submitted to AHB as DTONs
- b. Description – ‘New’, ‘Update’ or ‘Retain’
- c. Quality of sounding measurement – ‘least depth known’ or ‘depth unknown’
- d. Remarks – ‘Least depth found’ or ‘Shoaler depths may exist’
- e. Recommendations – ‘Insert’ for New features, ‘Replace’ for Update features
- f. Investigation Requirements – ‘Recommend investigation by surface vessel’ for *navigationally significant* features where depth unknown and shoaler depths may exist
- g. Images – GCS screen capture links for all New and Update features

D.2 ADDITIONAL RESULTS

D.2.1 Supplemental Information for MBES Junctioning

For the H12384 survey, the supplemental information for further boat work was compiled by:

1. Defining the seaward limit of good lidar seabed coverage as a M_COVR, CATCOV=1 polygon.
2. Defining investigation recommendations by attributing *navigationally significant* S-57 features with:
 - a. Quality of sounding measurement = ‘depth unknown’
 - b. Remarks = ‘shoaler depths may exist’
 - c. Investigation Requirements = ‘Recommend investigation by surface vessel’

D.2.1.1 Seaward Limit of Lidar Coverage

There is one area across H12384 that exhibited poor coverage due to the presence of widespread turbidity.⁸ This is reflected by a gap in the BASE Surface and an ‘Unsurveyed Area’ in the S-57 feature file, rendered as part of the survey deliverables. Refer to Section B.2.3.2 for an in-depth discussion of the poor water clarity experienced and substitution areas approved by NOAA.

The area of particularly poor lidar seabed coverage is:

- In the northwest of the sheet, at position 24° 35’ 31” N, 82° 28’ 11” W, due to widespread turbidity.

In general, H12384 displays good coverage to the maximum depths of 19m for the sheet. The seaward limit of good lidar data coverage has been described by the S-57 feature object M_COVR in the S-57 feature file (US512384.000).

D.2.1.2 Lidar Features Requiring Further Investigation

There are 2 navigationally significant features attributed with an Investigation Requirement in the S-57 feature file, within the illuminated area of H12384, which require further investigation by surface vessel to ensure least depth is correctly presented on the nautical chart:

- 2.5m wreck surveyed 80m NNE of charted navaid, in the vicinity of Halfmoon Shoal.⁹
- 4.3m possible obstruction surveyed 330m N of charted navaid, in the vicinity of Halfmoon Shoal.¹⁰

D.2.1.3 Recommended Junctioning with Unsurveyed Lidar Areas

The ‘unsurveyed area’ gaps in lidar seabed coverage are defined as polygons in the S-57 feature file. Extreme care should be taken when junctioning with all ‘unsurveyed’ lidar areas that were caused by very poor water clarity.

If multi-beam junctioning is to be conducted with this lidar survey, the seaward limit of good lidar seabed coverage (M_COVR, CATCOV=1) within the S-57 feature file is recommended as the basis for establishing a surface vessel ‘junction line’. Areas of lidar data coverage that do not fall within the limit of good lidar coverage are often 100% lidar coverage only (due to poor water clarity on multiple passes) and shoaler depths may exist on surveyed features.

D.2.1.4 Comparison with prior Surveys

Comparison with prior surveys was not required under this Task Order. See Section D.1 for comparison to the nautical charts.

D.2.2 Summary of Charting Actions - H12384

Total number of significant features reported as DTONs: 0

DTONs submitted from the field: 0

DTONs submitted shortly following completion of data acquisition: 0

DTONs submitted during product compilation: 0

Total number of wrecks detected by lidar: 1

Total number of uncharted wrecks detected by lidar and reported as DTONs: 0

Total number of drying rocks attributed as New: 0

Total number of drying rocks attributed as Update: 0

Total number of rocks awash attributed as New: 0

Total number of rocks awash attributed as Update: 0

Total number of submerged rocks attributed as New: 1

Total number of submerged rocks attributed as Update: 0

Total number of sandwaves attributed as New: 25

Total number of sandwaves attributed as Update: 15

Total number of shoals recommended for Insert: 0

Total number of shoals recommended for Replace: 0

Total number of significant features recommended for Investigation: 2

E. APPROVAL SHEET**LETTER OF APPROVAL – OPR-H355-KRL-11**

This report and the accompanying Fugro Pelagos, Inc. survey deliverables are respectfully submitted.

Field operations contributing to the accomplishment of this survey were conducted under my direct supervision with frequent personal checks of progress and adequacy. This report and the accompanying Fugro Pelagos, Inc. survey deliverables have been closely reviewed and are considered complete and adequate as per the Statement of Work and Hydrographic Project Instructions.

<u>Report</u>	<u>Submission Date</u>
Descriptive Report – H12384	March 16, 2011



Scott Ramsay
Hydrographer
Fugro LADS, Incorporated

Date March 16, 2011

Revisions Compiled During Office Processing and Certification

¹ Higher uncertainty values are expected in areas of dynamic or steep bottom topography. The data is adequate for charting.

² The approval was communicated to the contractor via an official modification to the original project instructions.

³ See endnote 2

⁴ Details of a chart comparison conducted during office processing are as follows:

Chart 11439 (26th Edition, July 1, 2004, NTM Update December 08, 2012)

Soundings from survey H12384 generally agreed within 5 feet of the depths on chart 11439. An exception to this was noted in areas with sandwaves where surveyed depths were found to be 5-10 feet shoaler than what was charted. In these cases, the new, shoaler depths were recommended for charting. Contours generated in CARIS BASE Editor were consistent with charted depth curves in most cases, although it appears that the charted contours are more shoal biased.

US4FL92M (Issue Date April 3, 2012)

The chart comparison details for chart 11439 are also applicable to this ENC.

⁵ The rock was included as a 16 ft. sounding in the chart update product for survey H12380.

⁶ An area of sandwaves delineated using point features submitted by the field was included in the chart update product.

⁷ See endnote 4

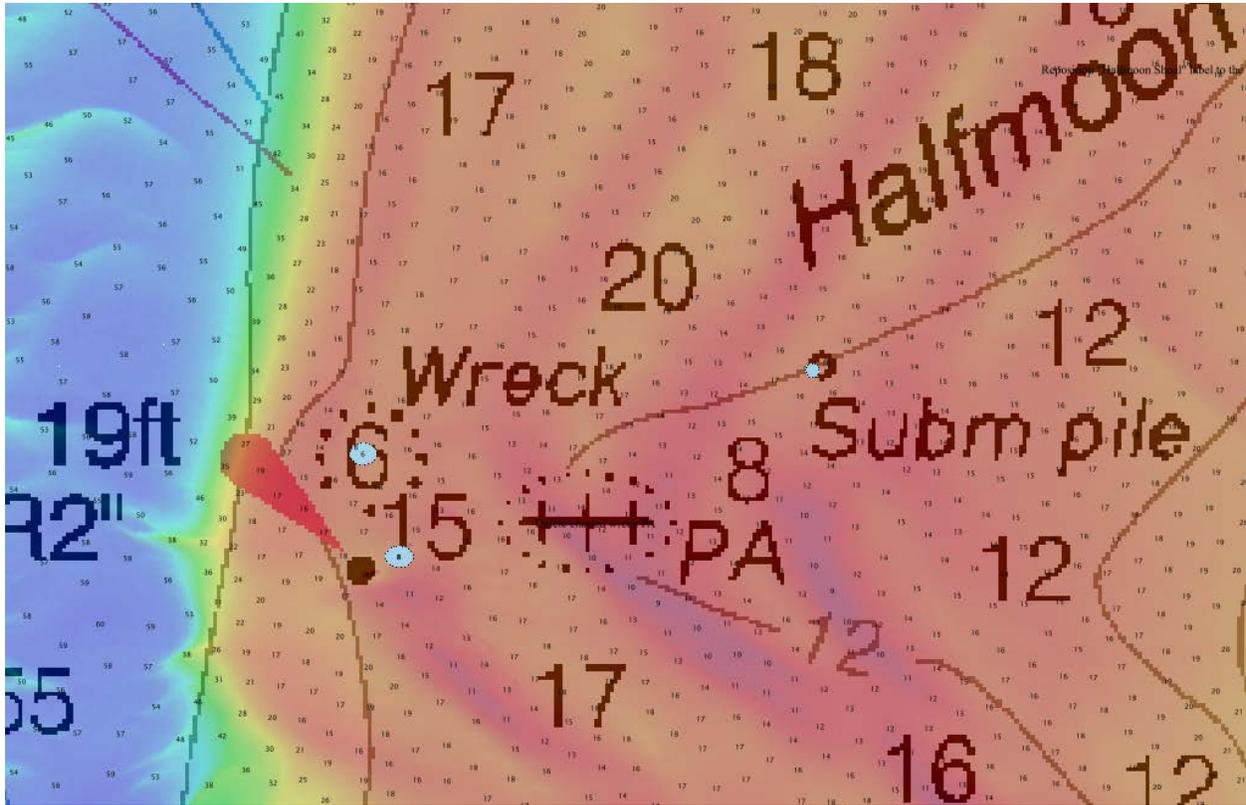
⁸ The gap was not deemed significant and not shown in the chart update product.

⁹ The wreck was included in the chart update product.

¹⁰ The obstruction was not included in the chart update product as the charted 6 ft. obstruction in the immediate vicinity was retained.

H12384 Wreck Report

An uncharted 8 ft. wreck was found at position 24-33-30.4N, 082-28-22.7W in the vicinity of the ATON near Halfmoon Shoal as shown in the figure below.



The wreck PA to the east was recommended to be deleted and the 6 ft. wreck to the north was retained.

APPROVAL PAGE

H12384

Data meet or exceed current specifications as certified by the OCS survey acceptance review process. Descriptive Report and survey data except where noted are adequate to supersede prior surveys and nautical charts in the common area.

The following products will be sent to NGDC for archive

- H12384_DR.pdf
- Collection of depth varied resolution BAGS
- Processed survey data and records
- H12384_GeoImage.pdf

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

Approved: _____

Peter Holmberg

Cartographic Team Lead, Pacific Hydrographic Branch

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

Approved: _____

CDR David Zezula, NOAA

Chief, Pacific Hydrographic Branch