10-5-2015

Initiatives in Using Crowdsourcing, Satellite Derived Bathymetry, and Other Non-Traditional Hydrographic/Bathymetric Measurements

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NOAA

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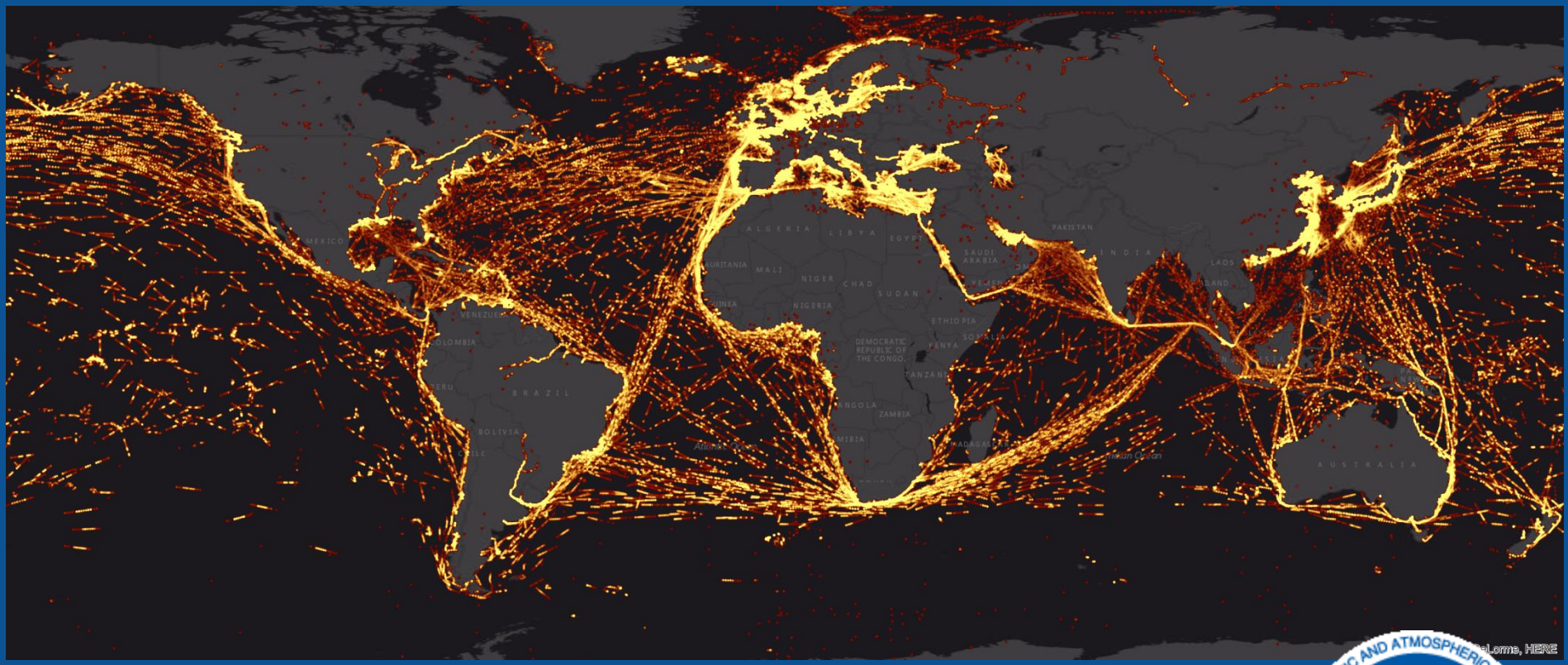
John Nyberg
NOAA

Initiatives in Using Crowdsourcing, Satellite Derived Bathymetry, and Other Non-Traditional Hydrographic/Bathymetric Measurements in the Assessment and Improvement of NOAA Nautical Charts



GEBCO Science Day – Kuala Lumpur, Malaysia – 5 October 2015

LT Anthony Klemm, NOAA – Office of Coast Survey – Marine Chart Division

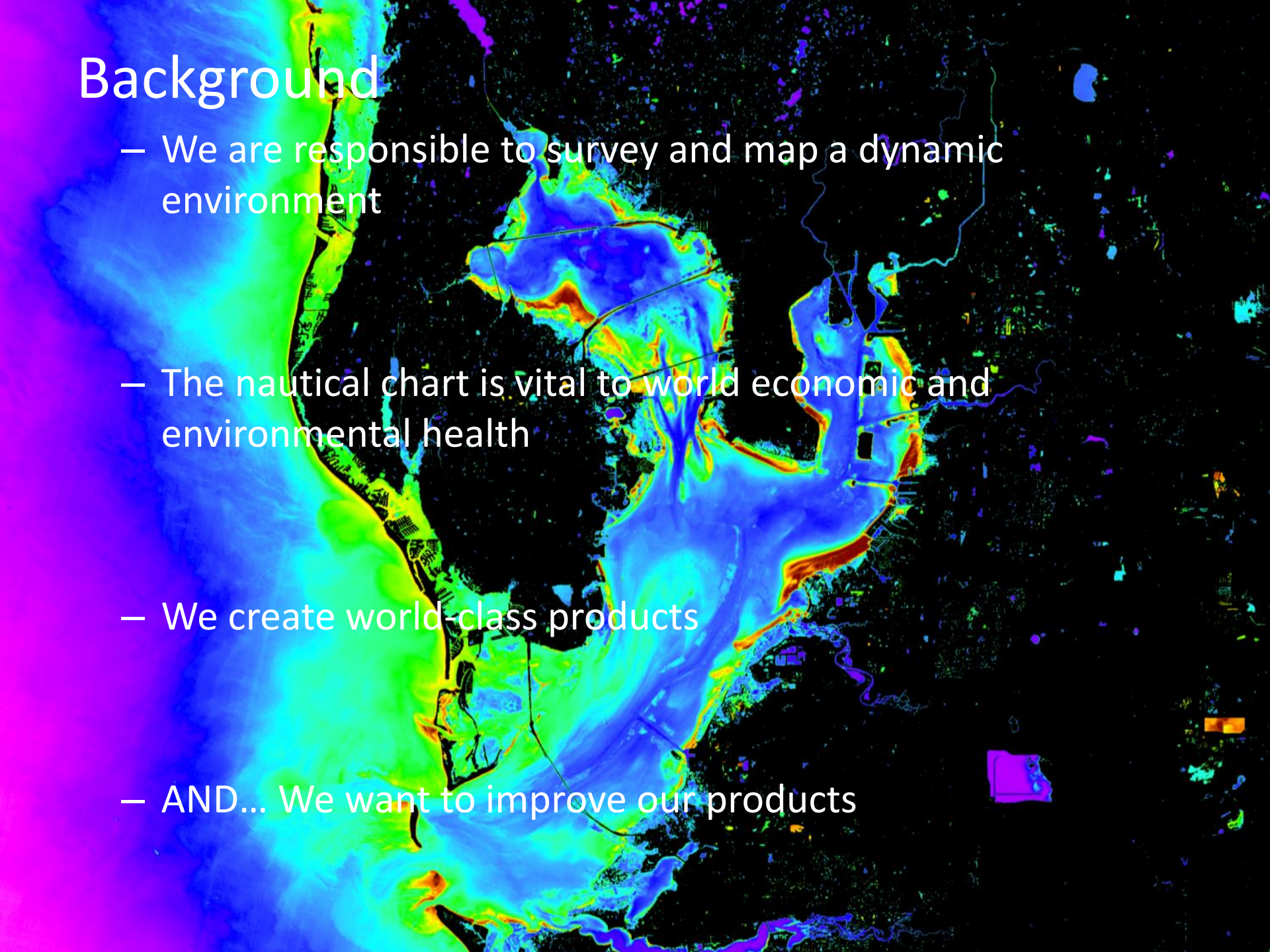
Agenda

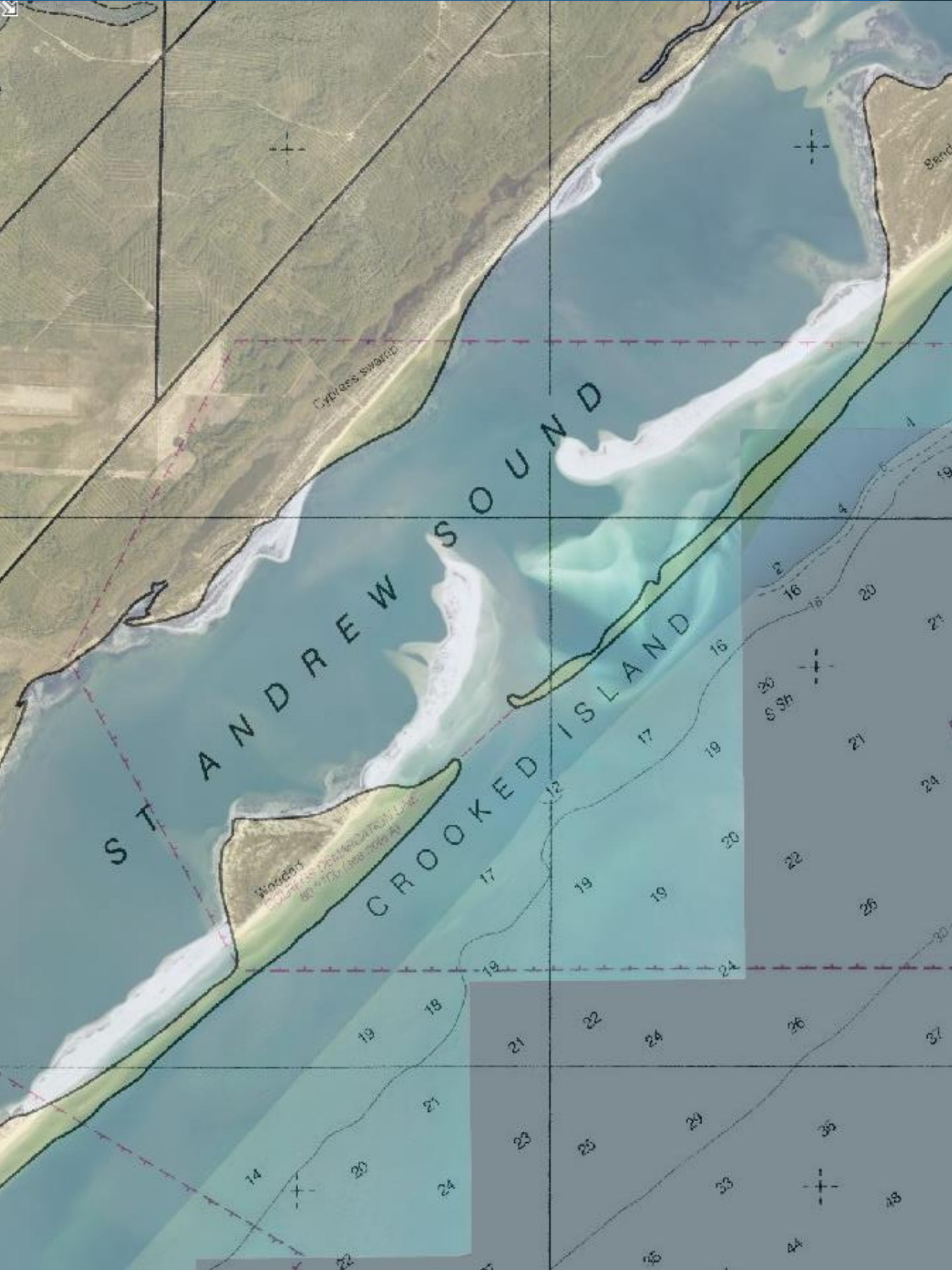
- Chart Adequacy Evaluation Procedure
- 1st NOAA/GEBCO International Chart Adequacy Workshop
- Satellite Derived Bathymetry Applications
- Crowdsourced Bathymetry Initiatives

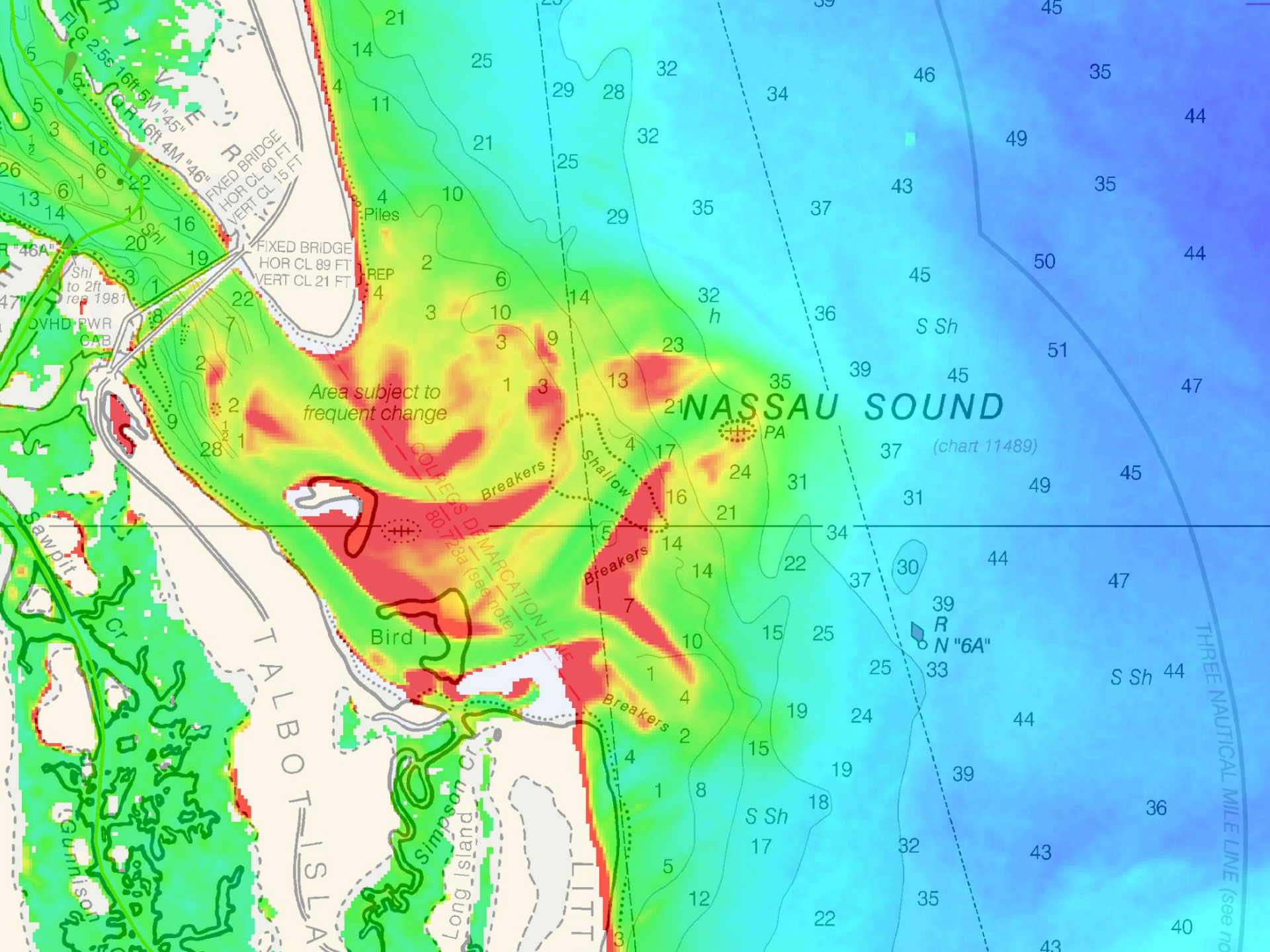
Courtesy: Hydrographische Nachrichten June 2013 (www.dhyg.de)

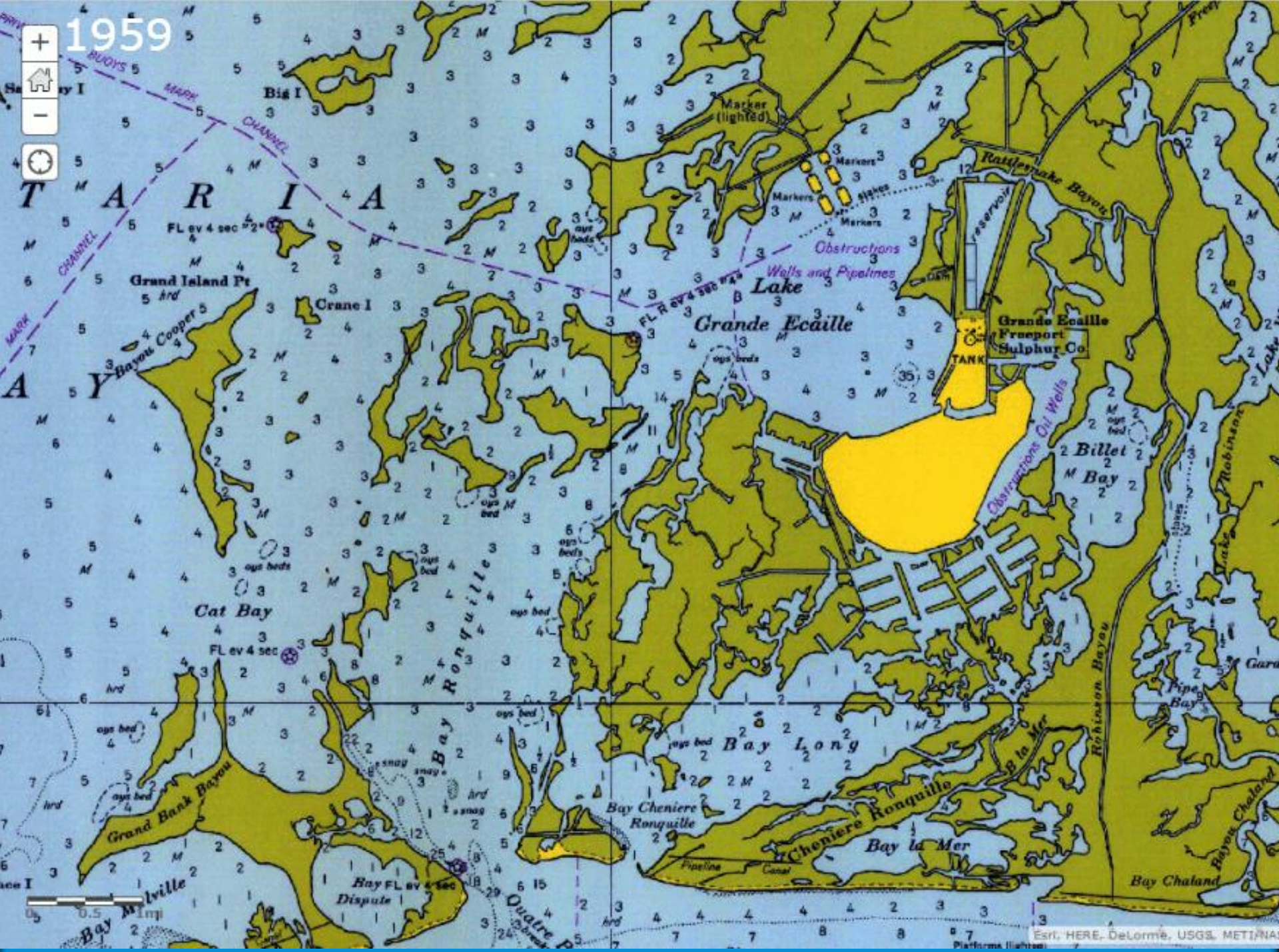
Background

- We are responsible to survey and map a dynamic environment
- The nautical chart is vital to world economic and environmental health
- We create world-class products
- AND… We want to improve our products




ST ANDREW SOUND
CROOKED ISLAND
Cypress swamp
Woodard
S Sh


NASSAU SOUND
(chart 11489)
Area subject to frequent change
COLREGS DEMARCATION LINE 80.723a (see note A)
Breakers
Shallow
Bird I
TALBOT ISLA
Sawpit Cr
Simpson Cr
Long Island
Gunnison
FIXED BRIDGE HOR CL 89 FT VERT CL 21 FT
FIXED BRIDGE HOR CL 60 FT VERT CL 15 FT
Piles
REP
OVHD PWR CAB
Shl to 2ft rep 1981
FLG 2.5s 16ft 5M "45"
Q R 16ft 4M "46"
R "46A"
PA
R N "6A"
S Sh
THREE NAUTICAL MILE LINE (see no


1959
Big I
Marker (lighted)
Markers
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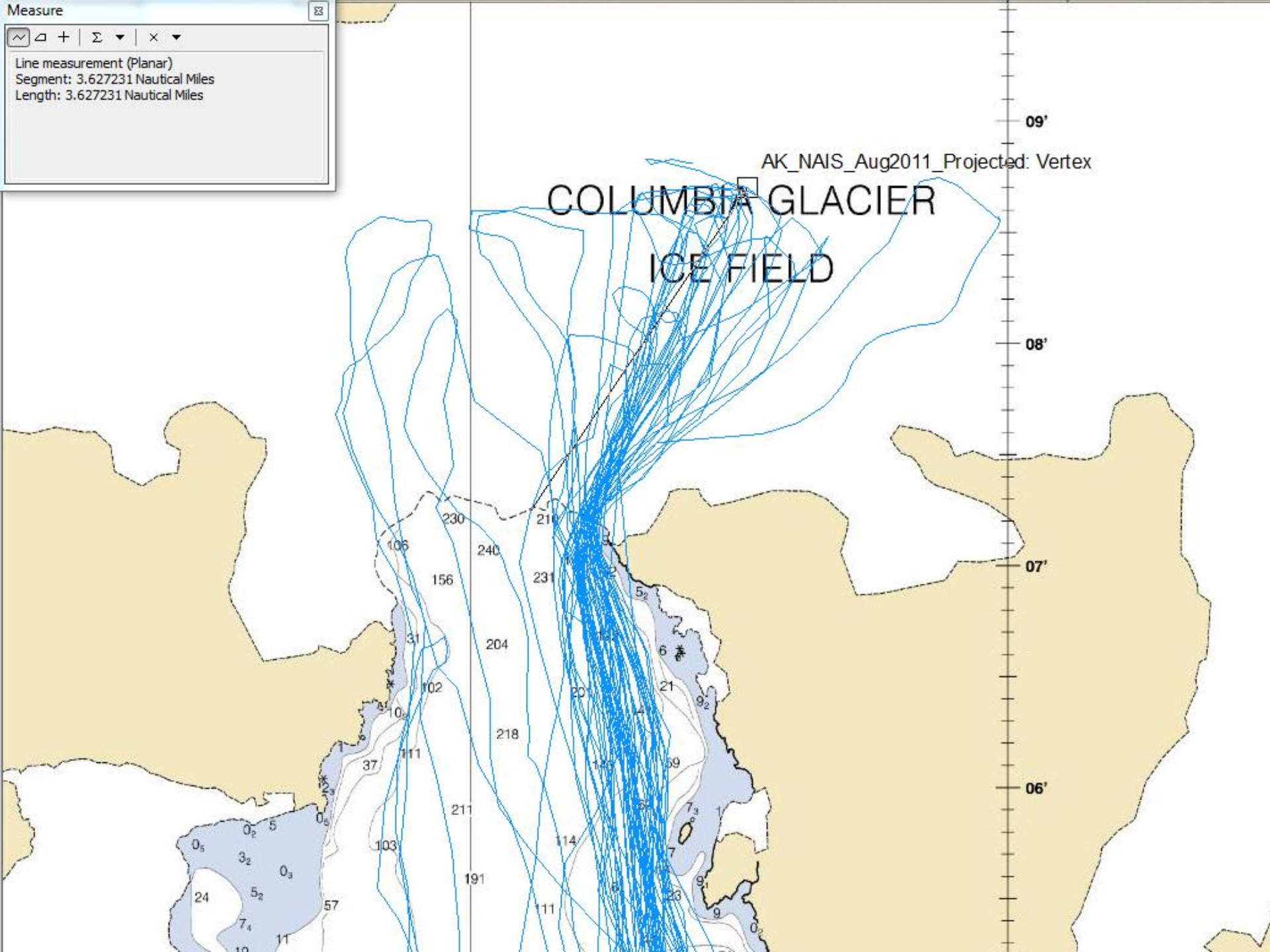
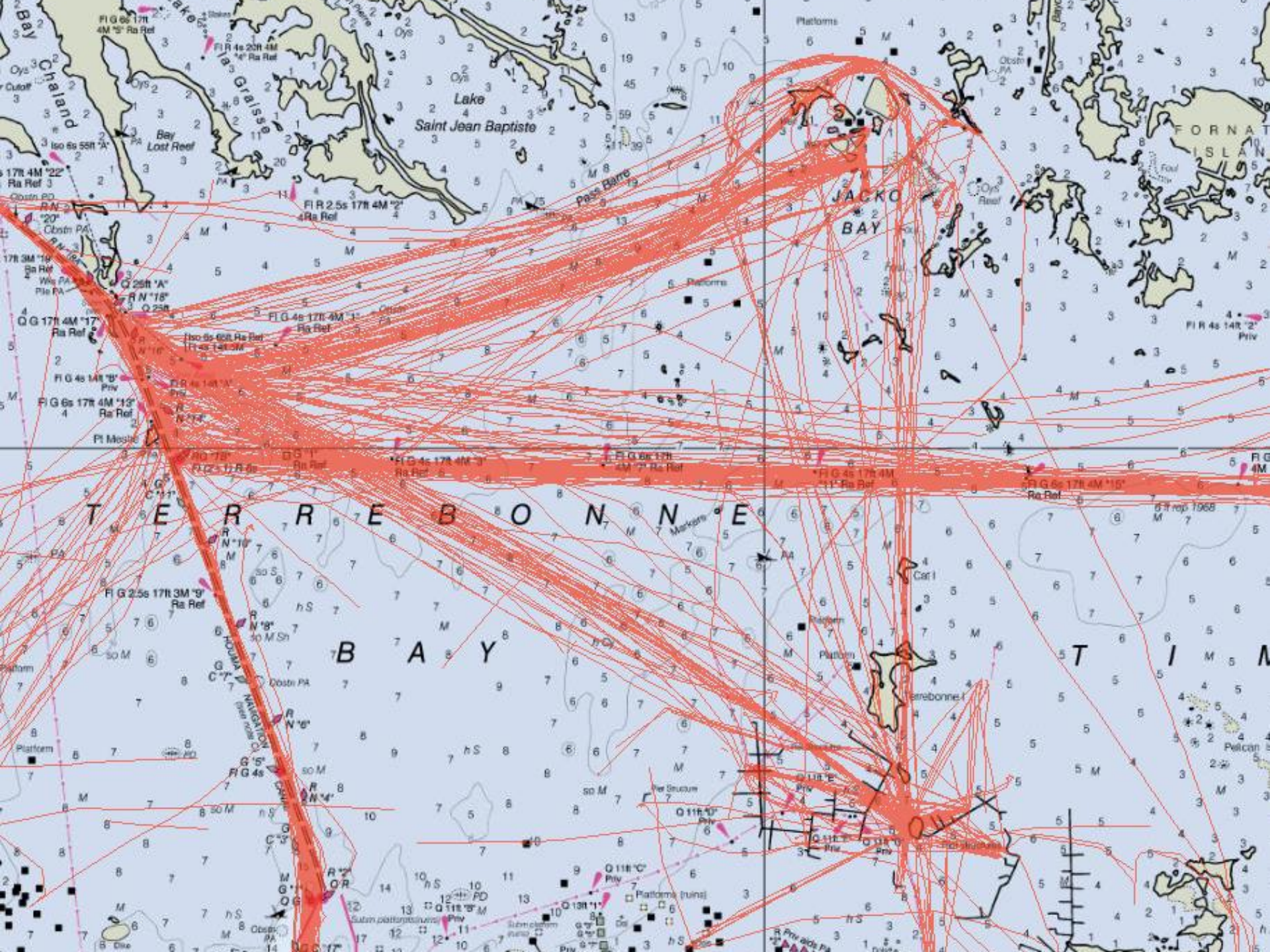
Rattlesnake Bayou
Obstructions
Wells and Pipelines
Lake
Grande Ecaille
Grande Ecaille
Freeport
Sulphur Co.
TANK
Obstructions Oil Wells
Billet
Bay
Lake Robinson
Grand Island Pt
Crane I
Bayou Cooper
FL ev 4 sec
Cat Bay
FL ev 4 sec
Bay Ronquille
Bay Long
Bay Cheniere
Ronquille
Cheniere Ronquille
Bay la Mer
Pipeline
Canal
B la Mer
Robinson Bayou
Pipe
Bay
Bayou Chaland
Bay Chaland
Grand Bank Bayou
Bay Melville
Bay
Dispute
FL ev 4 sec
Quatre
Esri, HERE, DeLorme, USGS, METI/NA


Measure
Line measurement (Planar)
Segment: 3.627231 Nautical Miles
Length: 3.627231 Nautical Miles
AK_NAIS_Aug2011_Projected: Vertex
COLUMBIA GLACIER
ICE FIELD
09'
08'
07'
06'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Lost Reef
Pass Barre
JACKO
BAY
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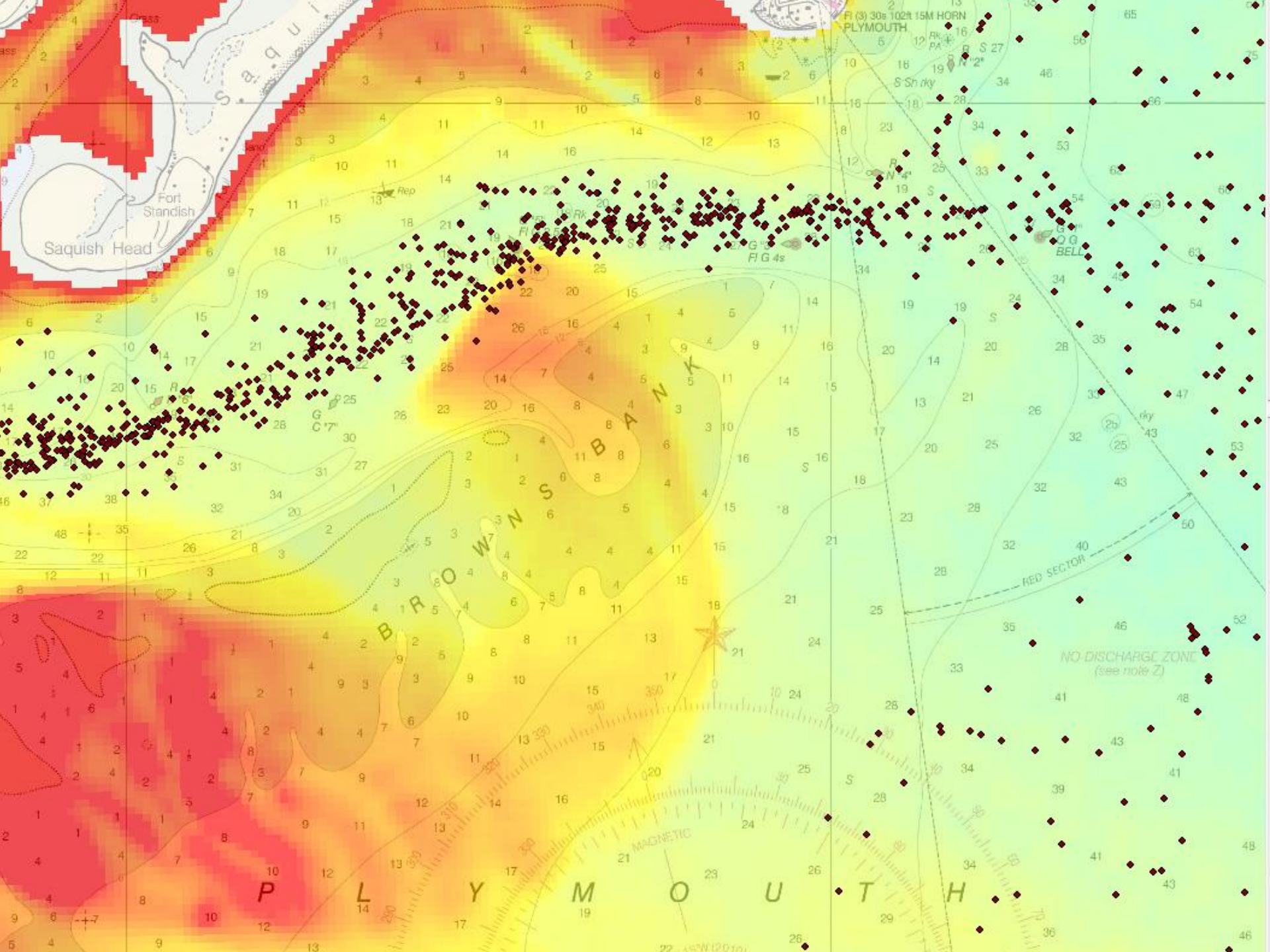
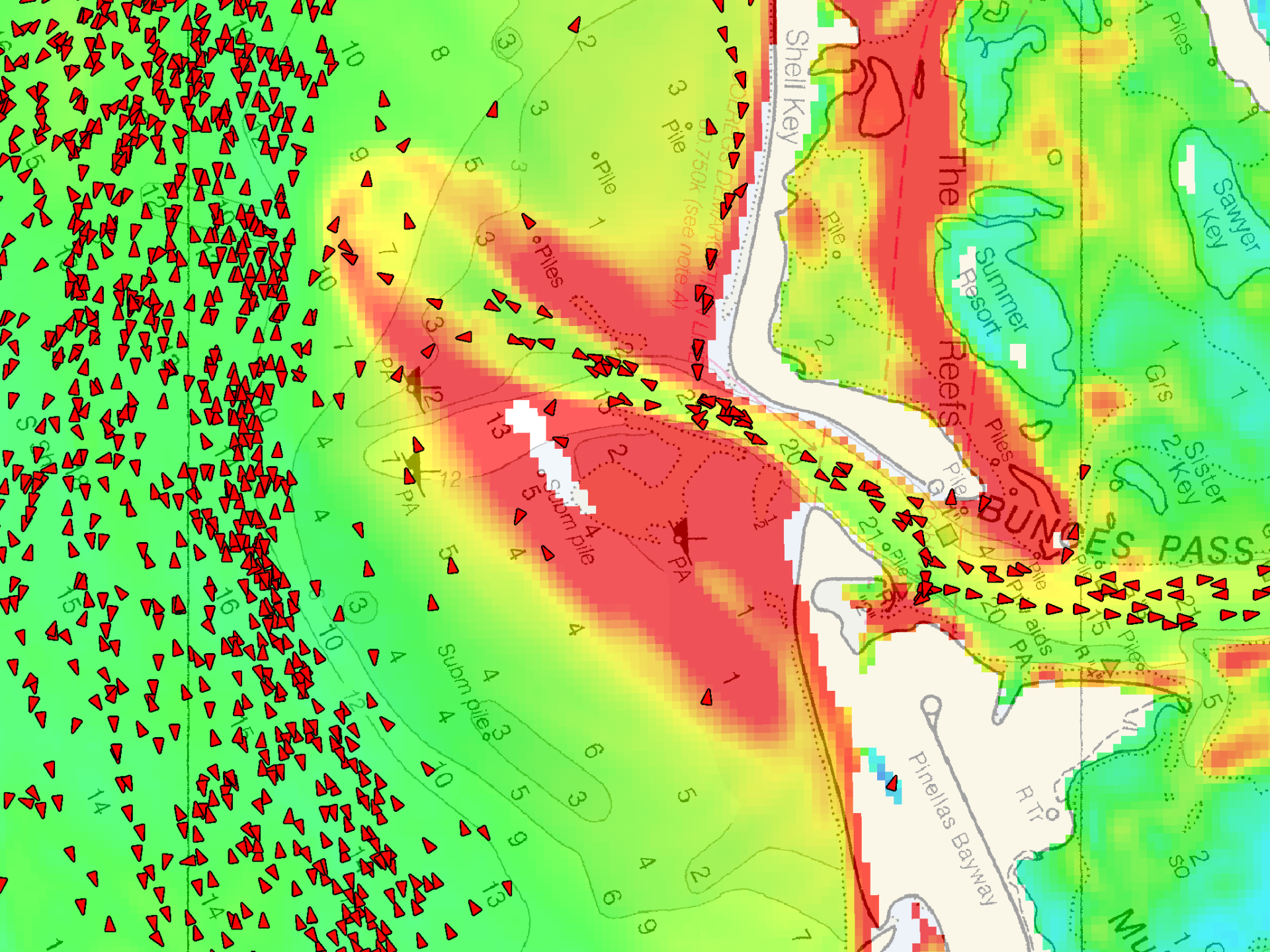
ISLAN
TERREBONNE
BAY
Platforms
Platform
Pt Mesle
Carl
Pelican
Fl R 2.5s 17ft 4M "2"
Ra Ref
Fl G 4s 17ft 4M "1"
Ra Ref
Fl G 6s 17ft
4M "3" Ra Ref
Fl G 4s 17ft 4M
"11" Ra Ref
Fl G 6s 17ft 4M "15"
Ra Ref
Fl G 6s 17ft
4M "5" Ra Ref
Fl R 4s 20ft 4M
"4" Ra Ref
Iso 6s 55ft "A"
Q G 17ft 4M "17"
Ra Ref
Fl G 25ft "A"
R N "16"
Q 25ft
Iso 6s 66ft Ra Ref
Fl R 4s 14ft 3M
Fl G 4s 14ft "8"
Priv
Fl R 4s 14ft "4"
Priv
Fl G 6s 17ft 4M "13"
Ra Ref
Fl G 2.5s 17ft 3M "9"
Ra Ref
Fl G 4s
Q 11ft "E"
Priv
Q 11ft "D"
Priv
Q 11ft "C"
Priv
Q 11ft "B"
Priv
Q 13ft "1"
Platforms (ruins)
Fl R 4s 14ft "2"
Priv


Saquish Head
Fort Standish
Fl (3) 30s 102ft 15M HORN
PLYMOUTH
Fl G 4s
BELL
BROWNS BANK
RED SECTOR
NO DISCHARGE ZONE
(see note Z)
MAGNETIC
PLYMOUTH


Shell Key
The Reefs
Summer Resort
Sawyer Key
Sister Key
BUNCES PASS
Pinellas Bayway
Subm pile
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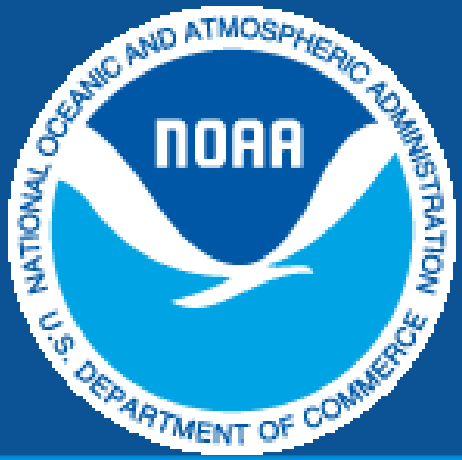
“Why would we ever print a chart we know is wrong?”

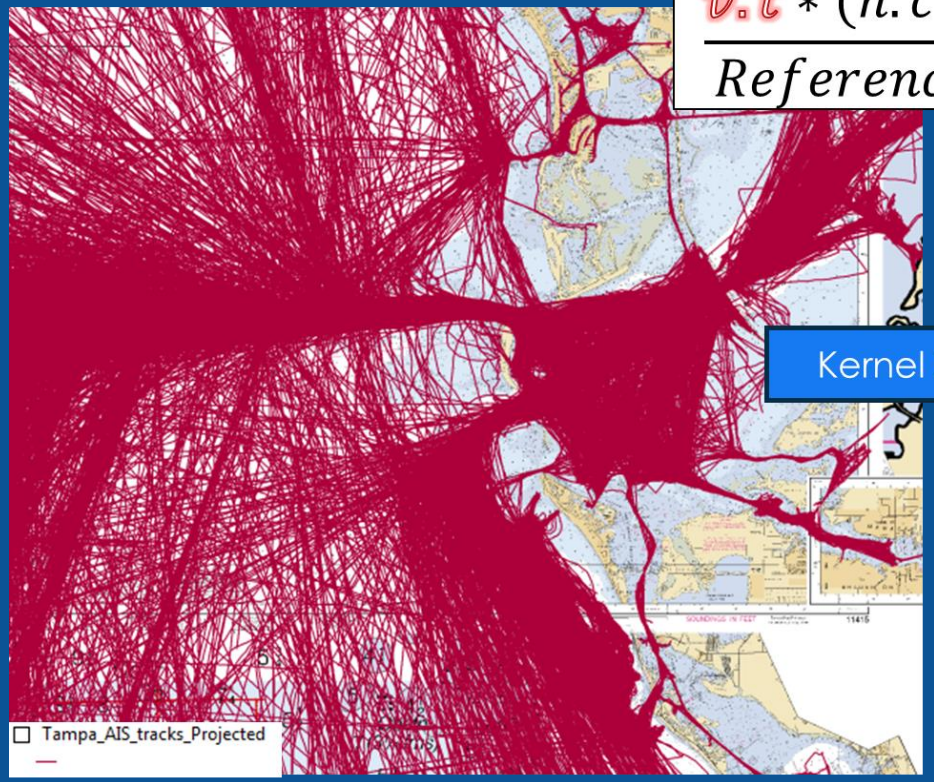
-CAPT Shep Smith
Former Chief,
NOAA Marine Chart Division

Chart Adequacy Procedure



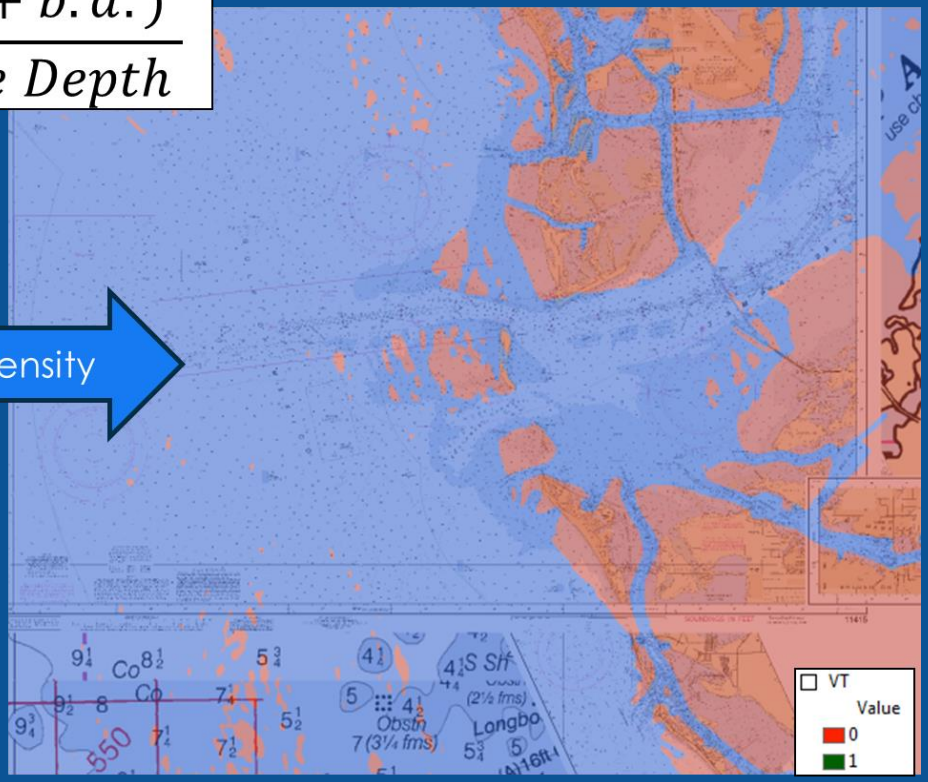
Vessel Traffic Layer – AIS Processing

$$\frac{v.t * (h.c + b.d.)}{Reference\ Depth}$$



One year of historical AIS tracks

Kernel Density

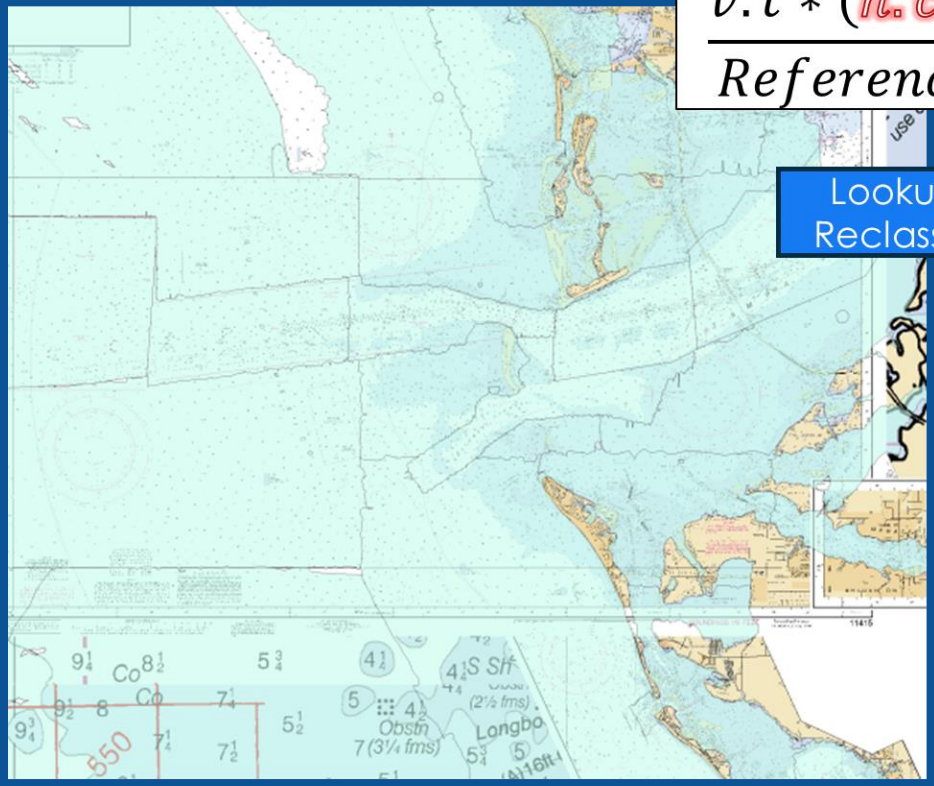


VT Layer – Buffered 300m for 2 or more tracks

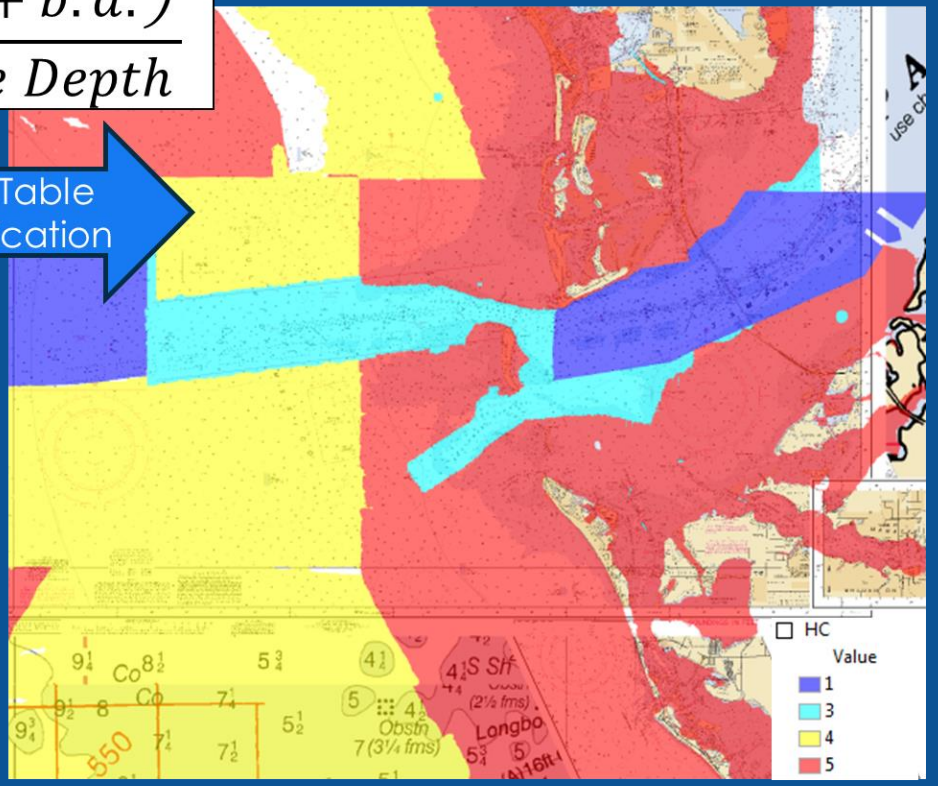
Hydrographic Characteristics Layer

$$\frac{v.t * (h.c + b.d.)}{Reference\ Depth}$$

Lookup Table Reclassification



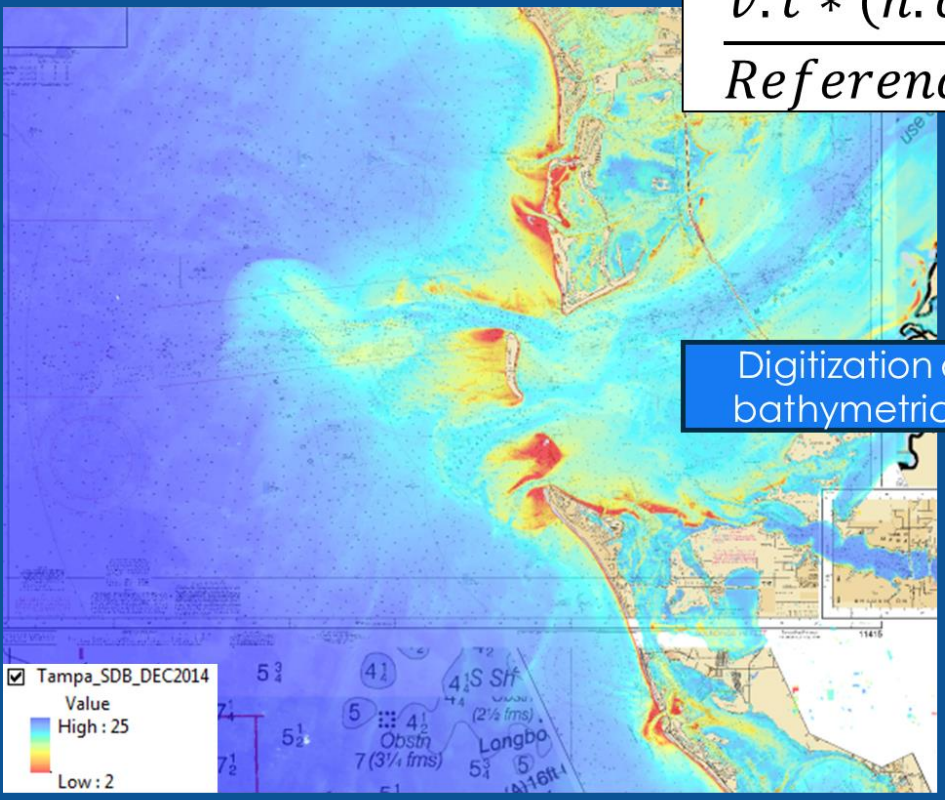
Most recent hydrographic survey outlines



HC Layer – classified based on survey date, technology, and bottom coverage

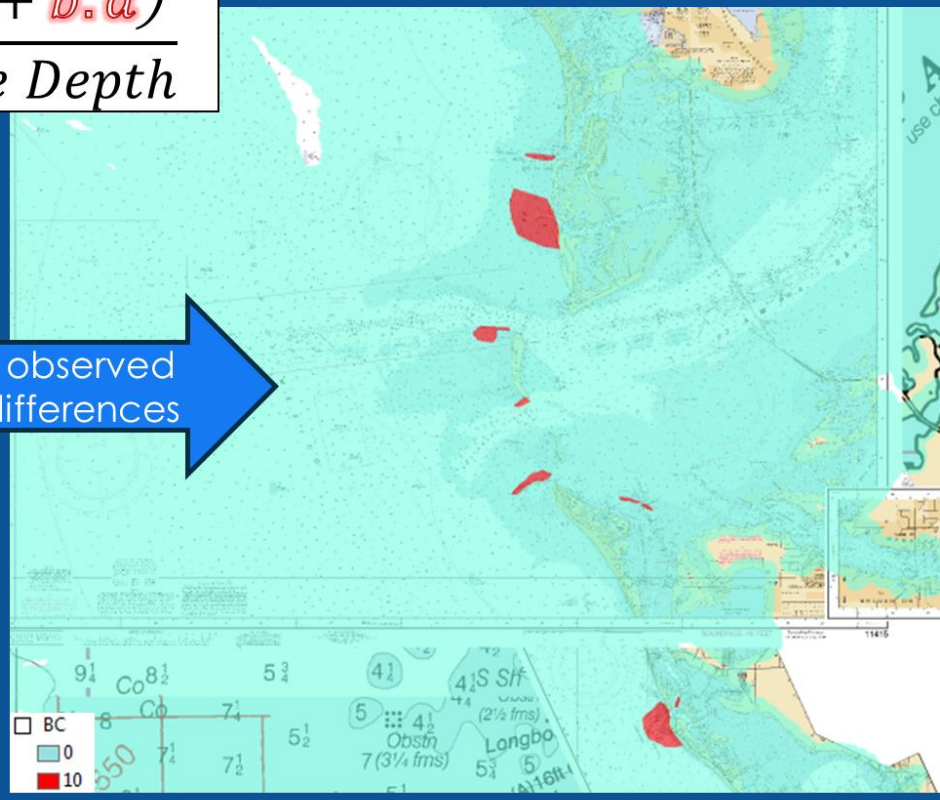
Bathymetric Difference Layer

$$\frac{v.t * (h.c + b.d)}{Reference\ Depth}$$



Satellite-Derived Bathymetry (or survey of opportunity)

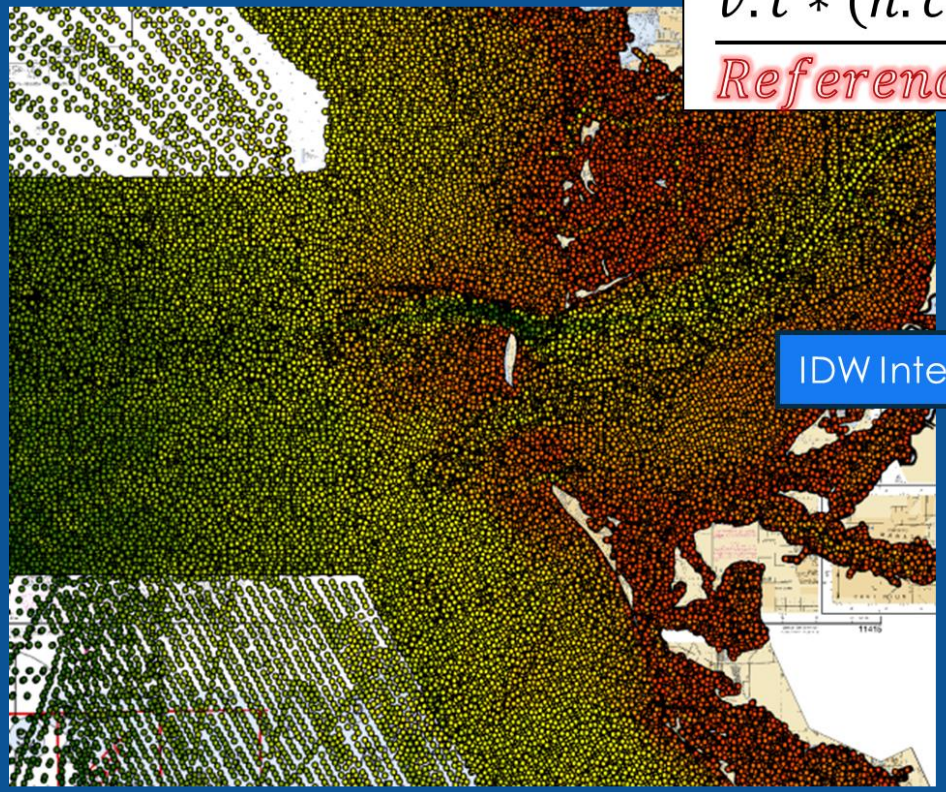
Digitization of observed bathymetric differences



BD Layer – Observed bathymetric chart discrepancies

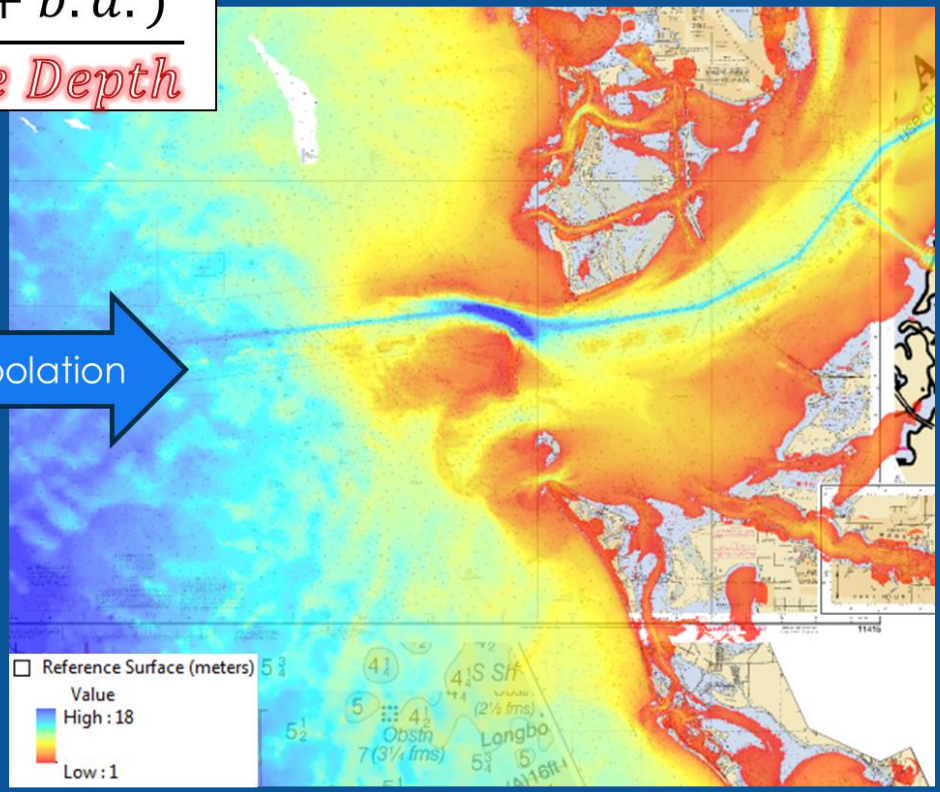
Charted Depth (Reference Depth)

$$\frac{v.t * (h.c + b.d.)}{Reference\ Depth}$$



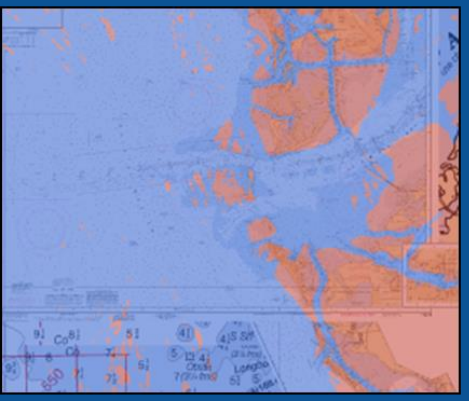
Historical Smooth (Fair) Sheet Soundings

IDW Interpolation



Reference Surface

$$\frac{v.t * (h.c + b.d.)}{Reference\ Depth}$$



V.T. (0,1)

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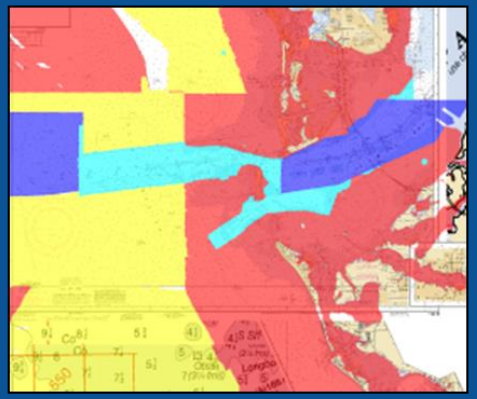
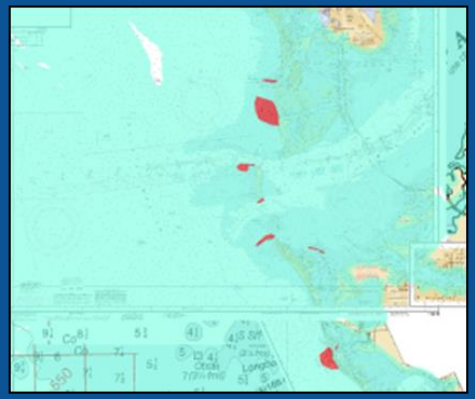


H.C. (1-9)

+



B.D. (0,10)

)

Reference Surface (1 - ∞)

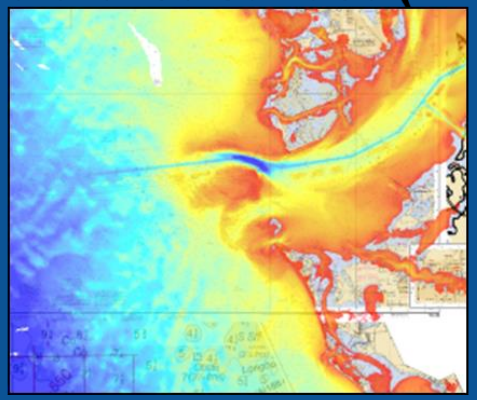


Chart Adequacy Final Product

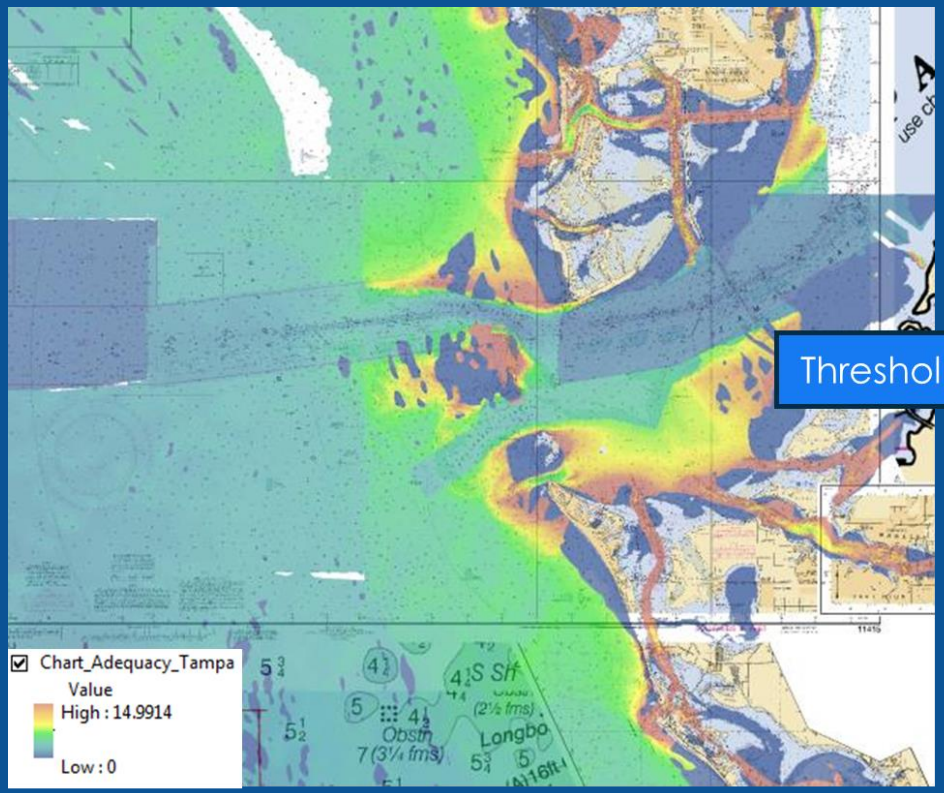
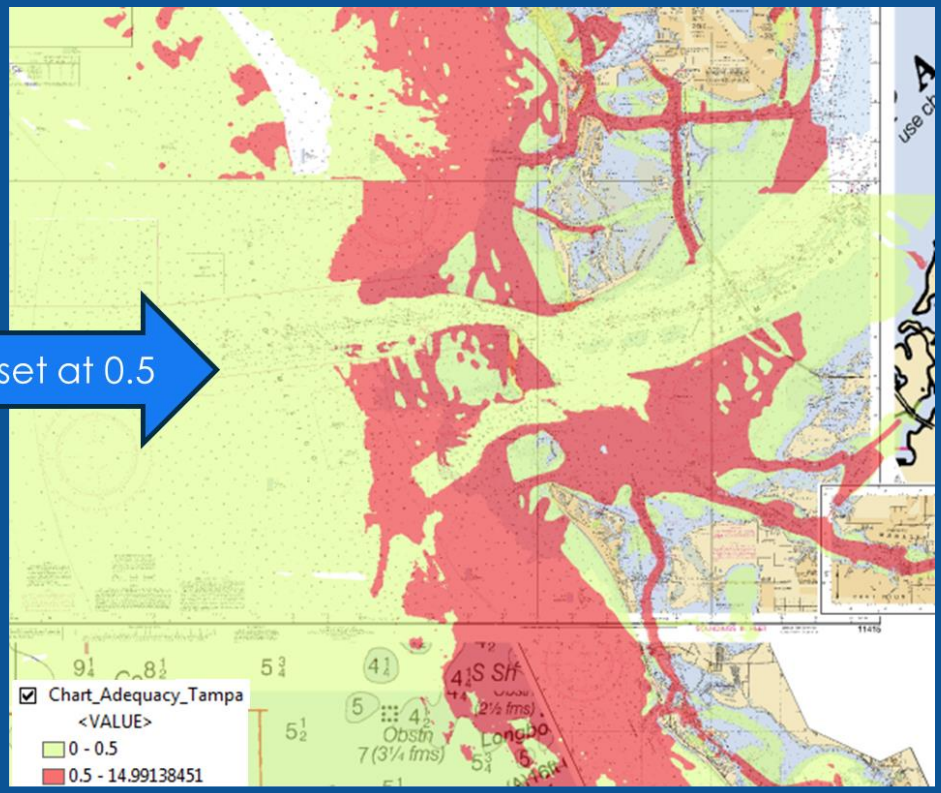


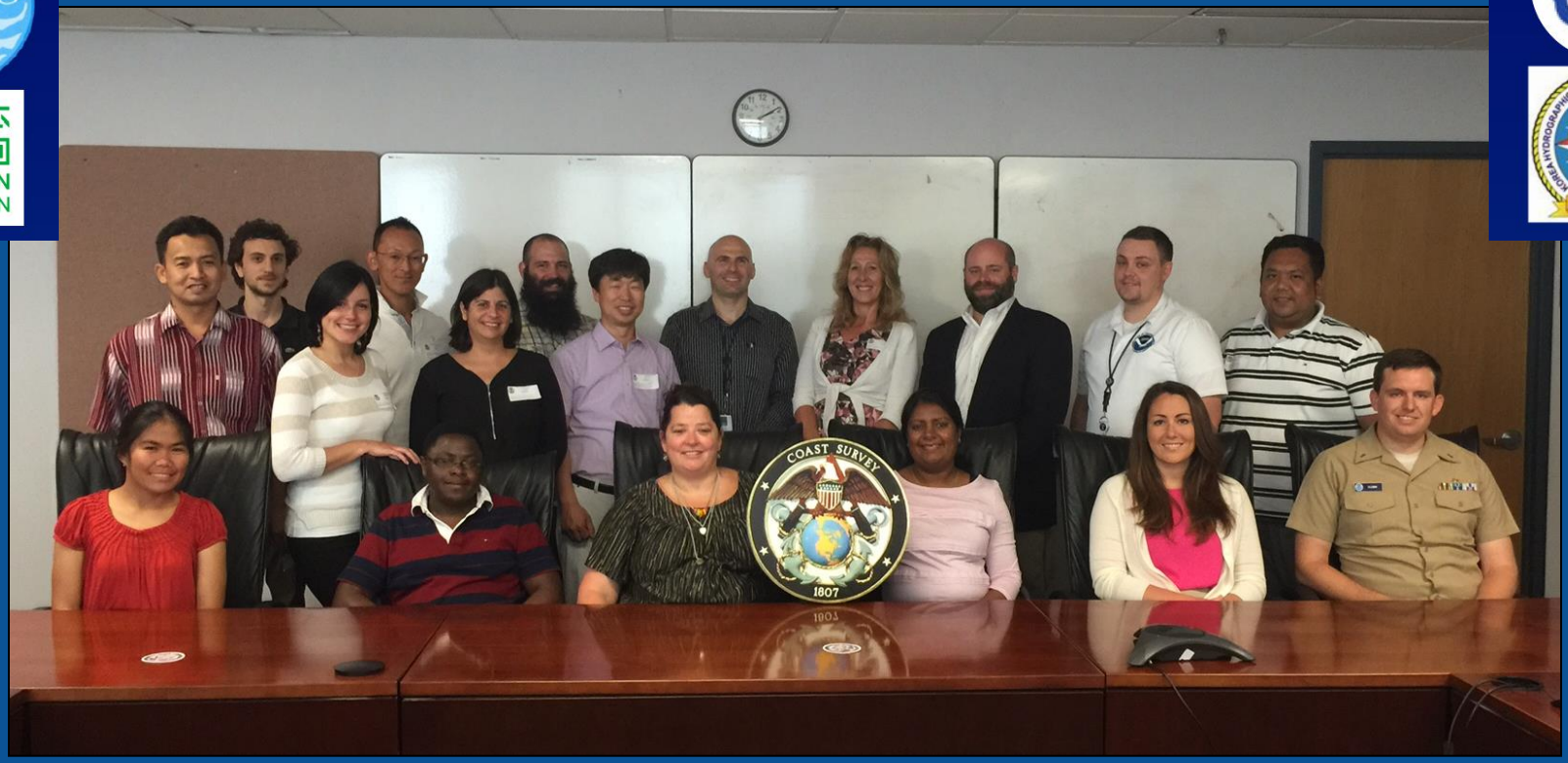
Chart Adequacy Stretched Visualization

Threshold set at 0.5



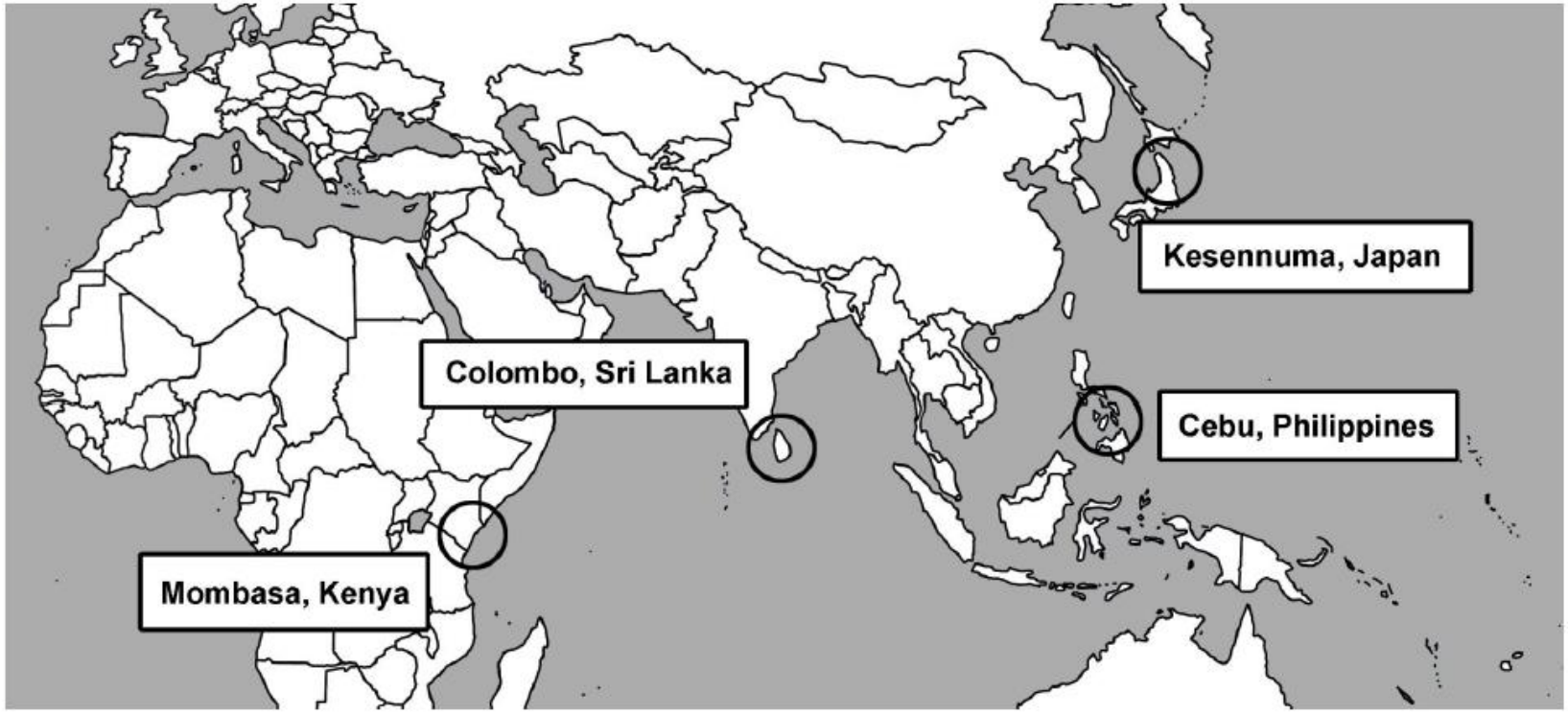
0.5 Chart Adequacy Threshold

1st NOAA/GEBCO Chart Adequacy Workshop – Silver Spring, MD – July 2015



1st NOAA/GEBCO Chart Adequacy Workshop – Silver Spring, MD – July 2015

Study sites used for the GEBCO training



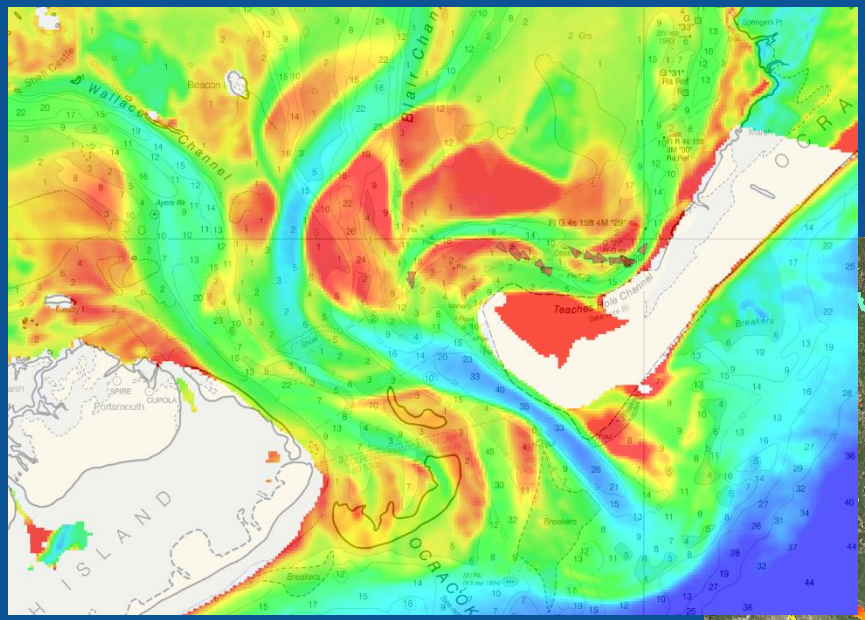
1st NOAA/GEBCO Chart Adequacy Workshop – Silver Spring, MD – July 2015

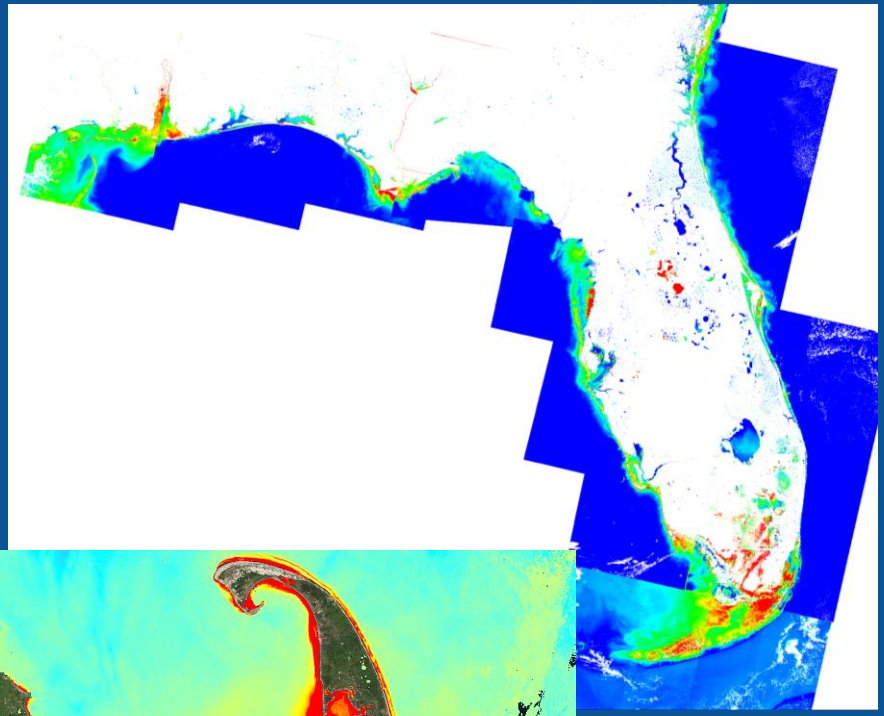
Next Workshop Scheduled for July 2016

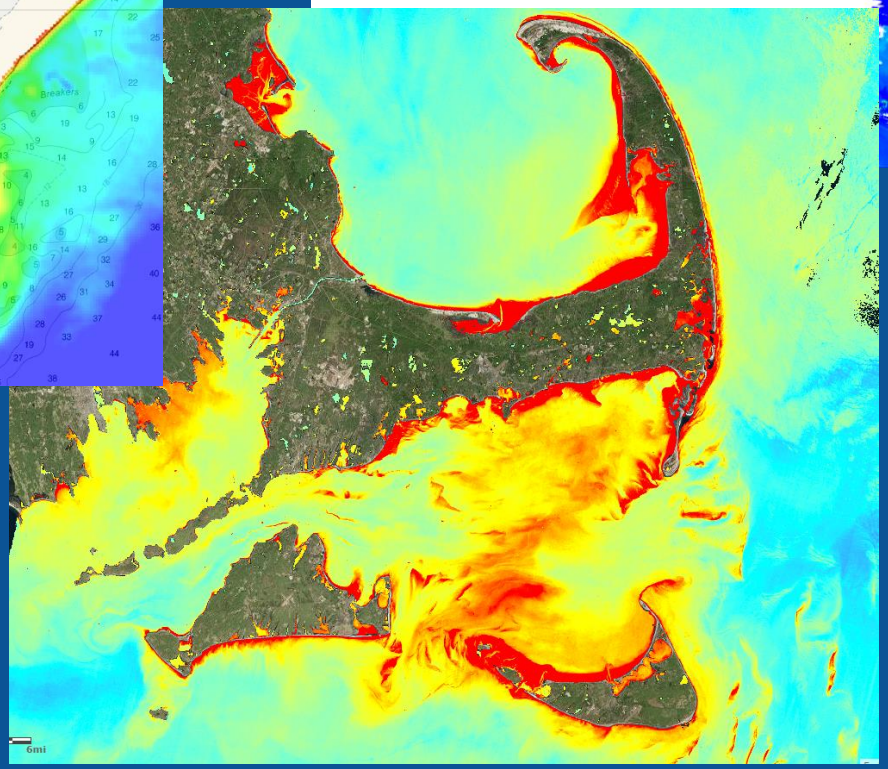
NOAA's vision to use Satellite Derived Bathymetry

- Reconnaissance value
  - Assess chart adequacy
  - Locate possible bathymetric discrepancies
- Selective application to the chart
  - Interim update until traditional survey techniques can be deployed to systematically survey the area
  - Updates are depicted as approximate, with corresponding caveats and notes on the chart

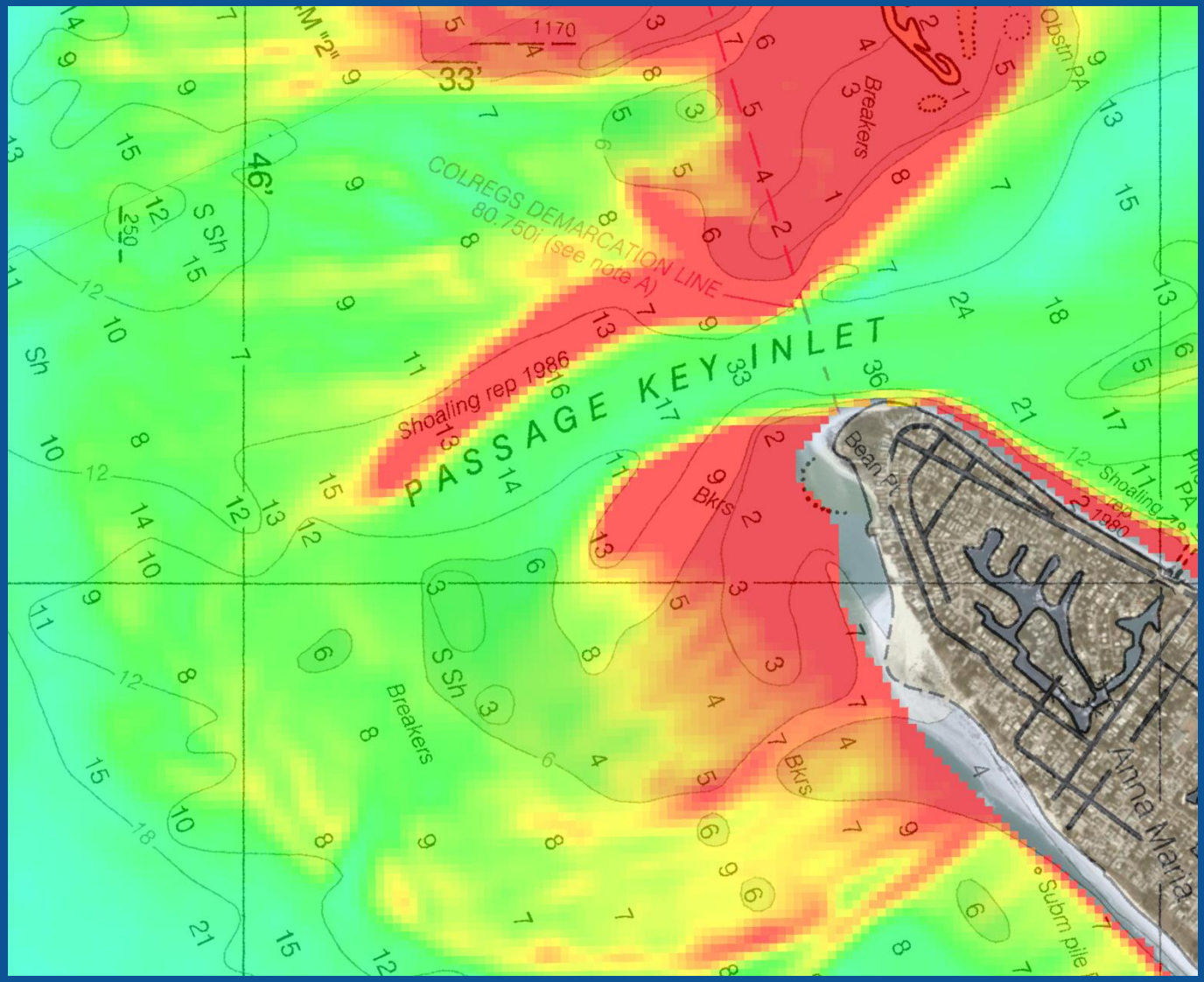
SDB as Reconnaissance

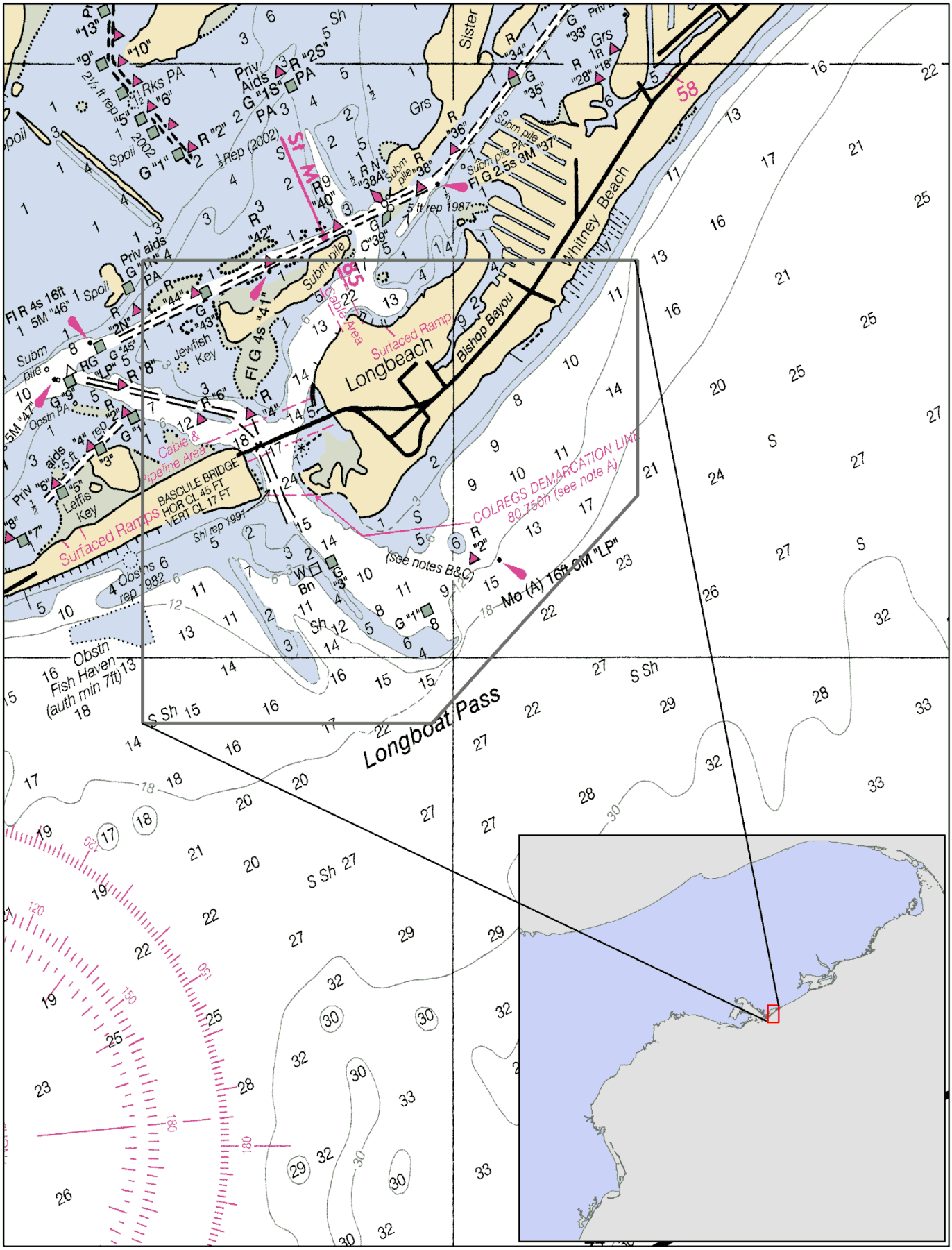


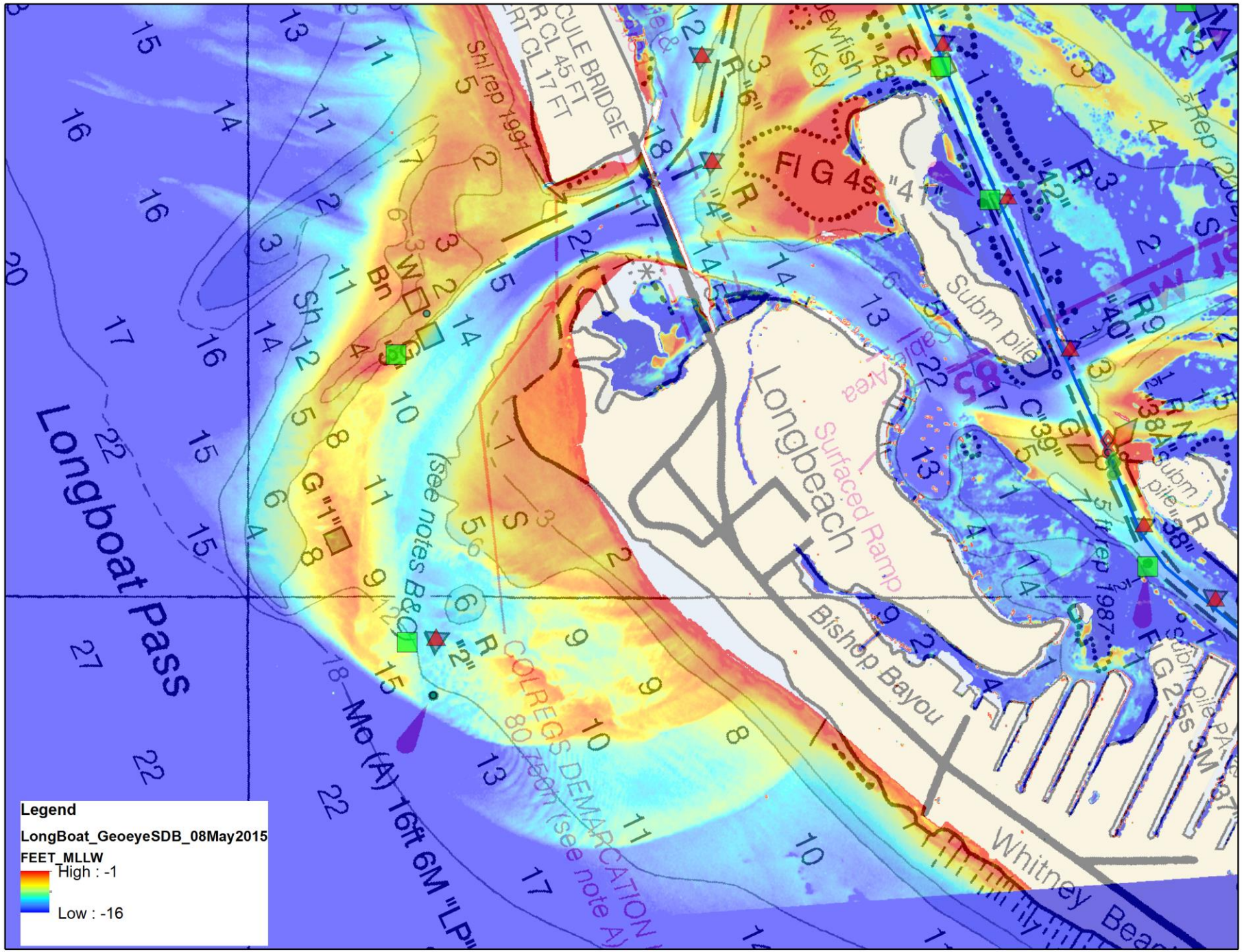


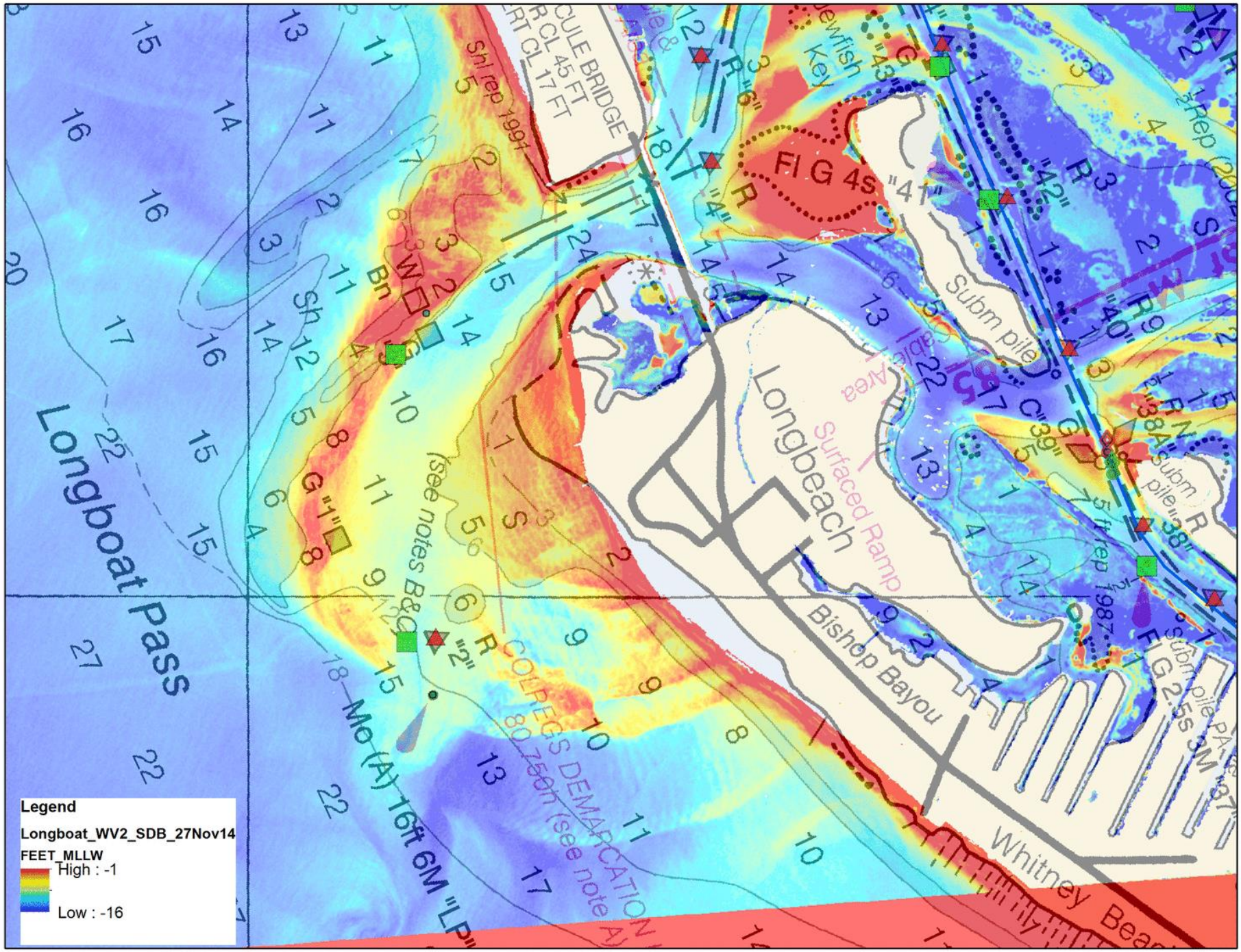


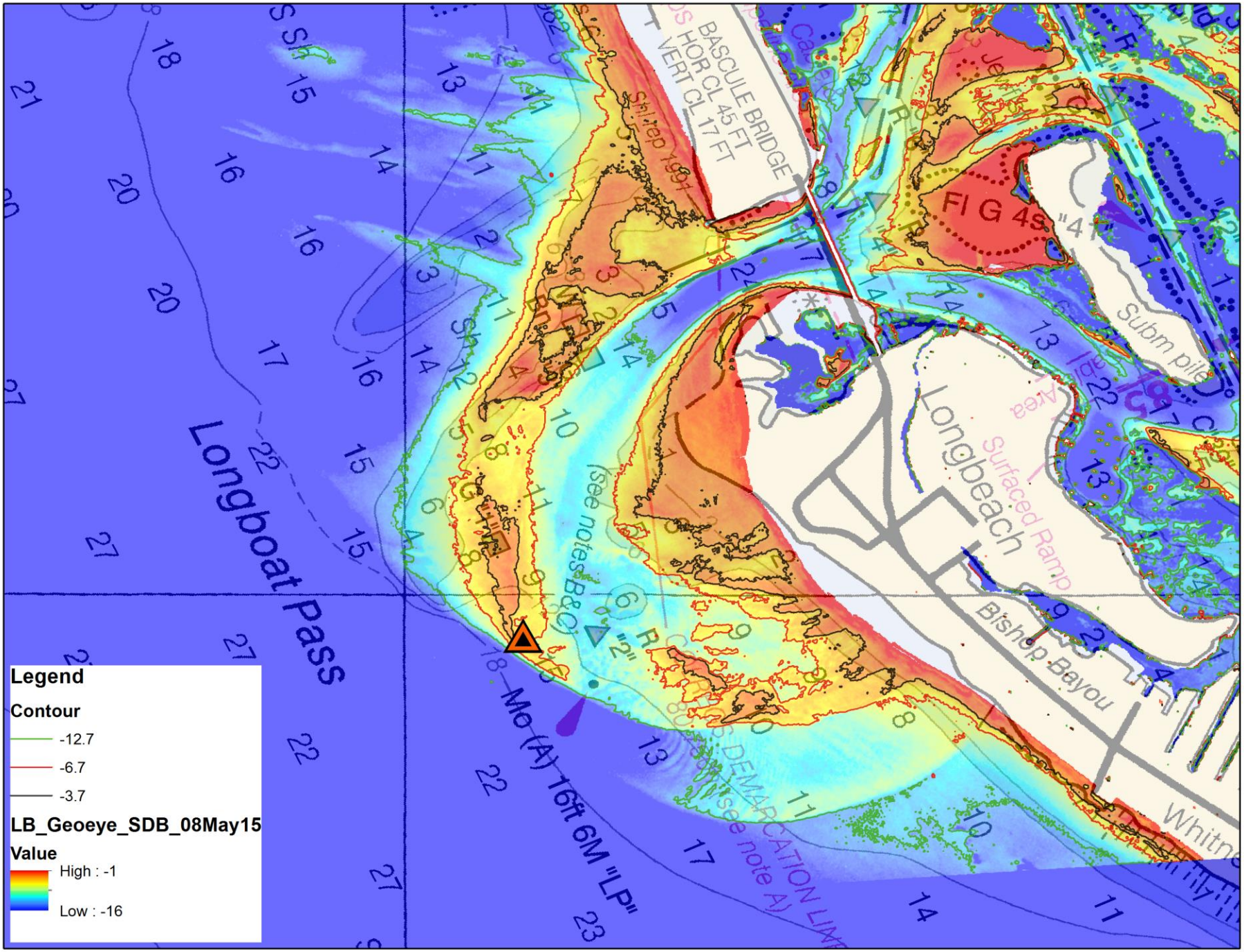
SDB as Reconnaissance



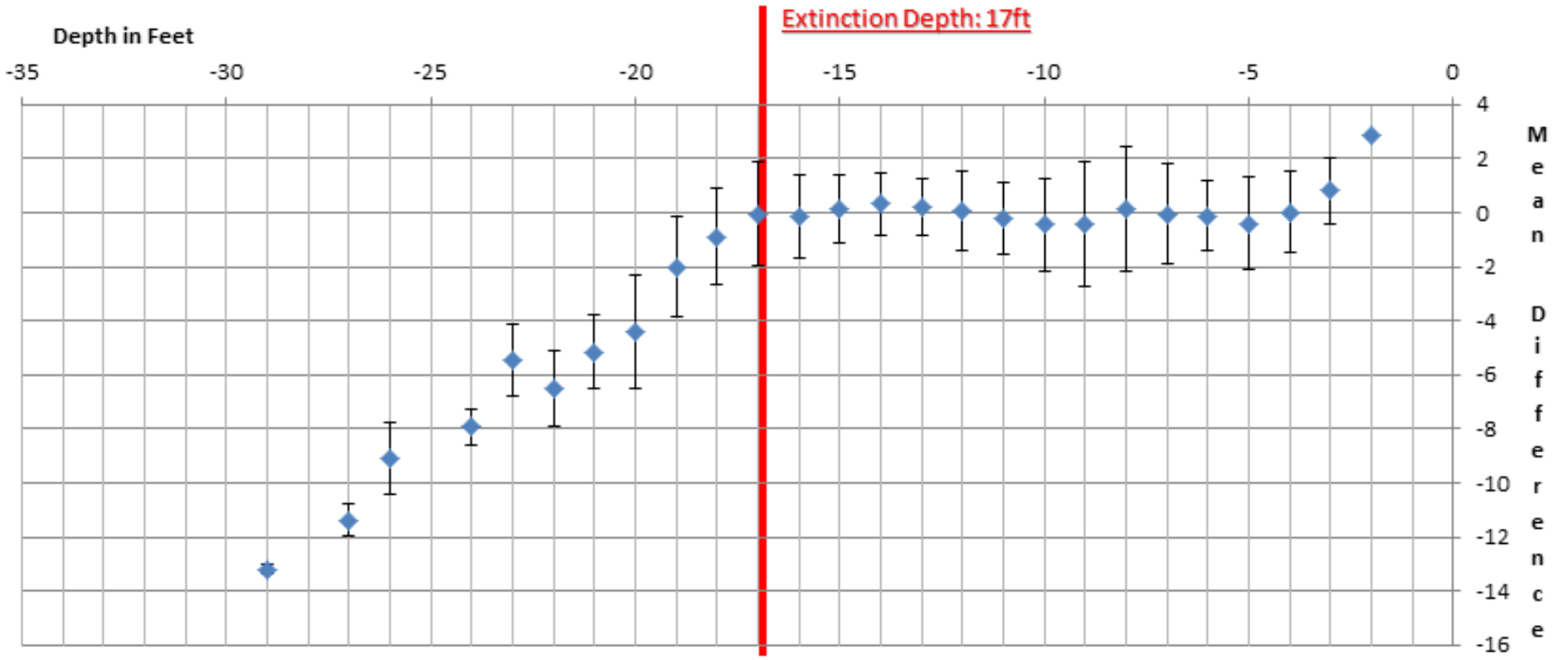

Longbeach
Whitney Beach
Bishop Bayou
Surfaced Ramp
Surfaced Ramps
Jewfish Key
Leffis Key
Sister
Grs
Subm pile
Cable Area
Cable & Pipeline Area
BASCULE BRIDGE HOR CL 45 FT VERT CL 17 FT
COLREGS DEMARCATION LINE 80.7m (see note A)
(see notes B&C)
Mo (A) 16ft 6M "LP"
Fl G 4s "41"
Fl R 4s 16ft 5M "46"
Fl G 2.5s 3M "37"
5 ft rep 1987
Shl rep 1991
4 Obstns rep 982
Obstn
Fish Haven
(auth min 7ft)
Longboat Pass
S Sh
St M
58
155

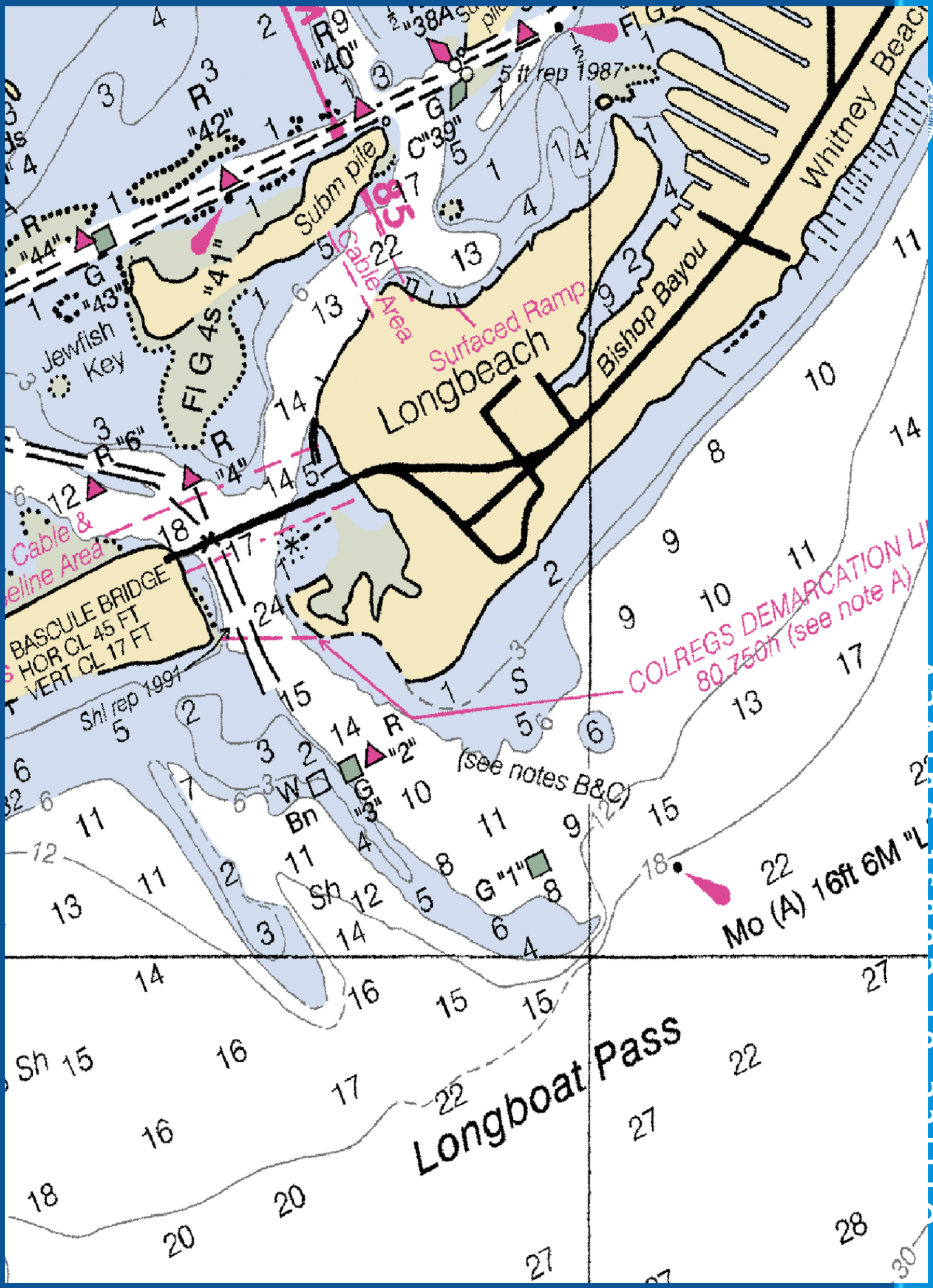

Legend
LongBoat_GeoeyeSDB_08May2015
FEET_MLLW
High : -1
Low : -16
Longboat Pass
Longbeach
Bishop Bayou
Whitney Bea
Surfaced Ramp
Fl G 4s
Mo (A) 16ft 6M "LP"
COLREGS DEMARCATION
Subm pile
Sh! rep 1991
Rep (2
Rep 1987


Legend
Longboat_WV2_SDB_27Nov14
FEET_MLLW
High : -1
Low : -16
Longboat Pass
Longbeach
Bishop Bayou
Whitney Beach
Surfaced Ramp
Subm pile
Fl G 4s
"41"
"42"
"43"
"40"
"39"
"38"
"38A"
"37"
"6"
"4"
"2"
"1"
Sh rep 1991
Rep (2008)
Rep 1987
Mo (A) 16ft 6M "LP"
(see notes B&C)
COLREGS DEMARCATION 80.750m (see note A)


Legend
Contour
-12.7
-6.7
-3.7
LB_Geoeye_SDB_08May15
Value
High : -1
Low : -16
Longboat Pass
BASCULE BRIDGE
HOR CL 45 FT
VERT CL 17 FT
Fl G 4s
Longbeach
Surfaced Ramp
Bishop Bayou
Mo (A) 16ft 6M "LP"
(see notes B&C)
(see note A)
Subm pile

Mean Difference of USACE Survey Reference Data and GeoEye SDB Solution, with Standard Deviation - in Feet

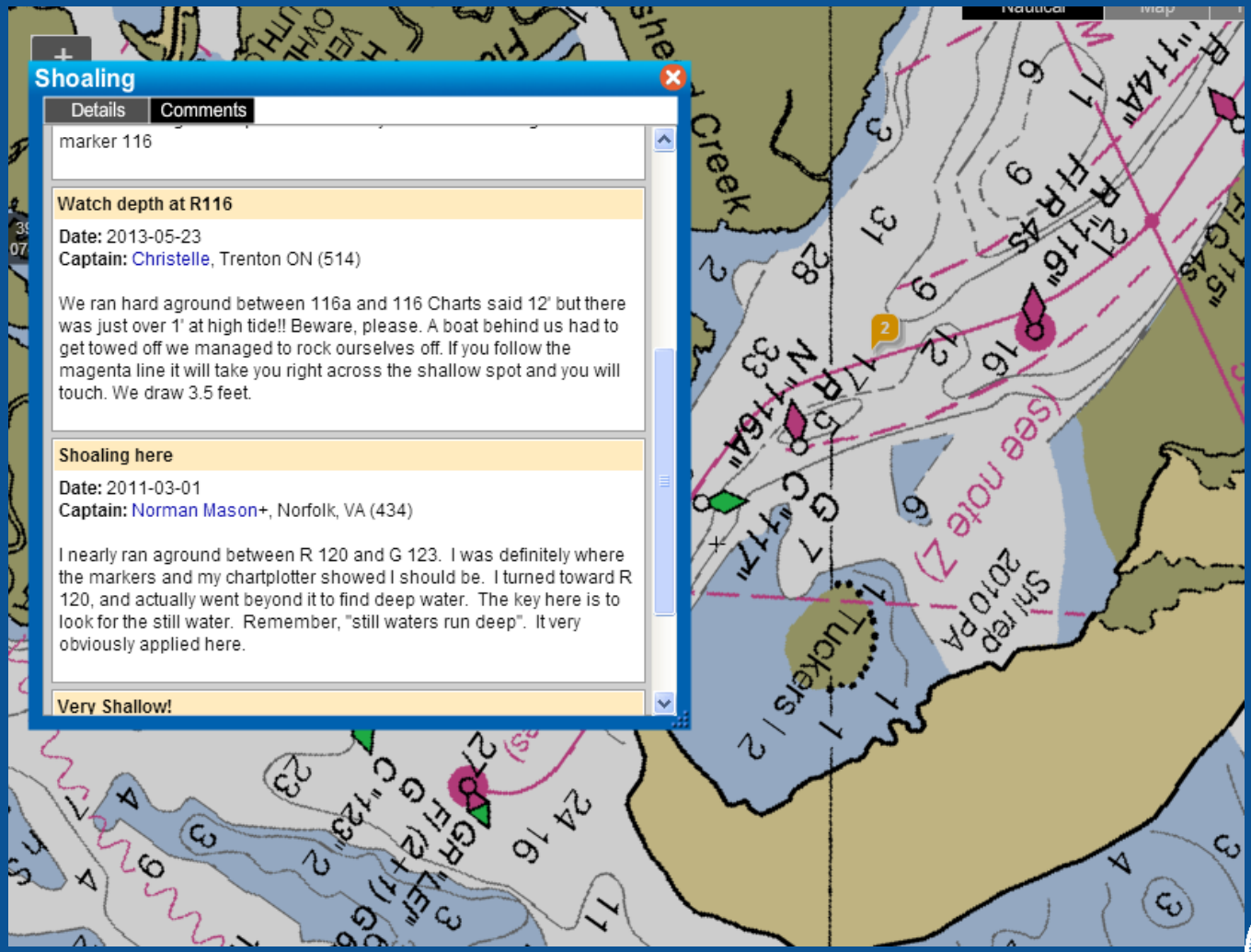



Longbeach
Surfaced Ramp
Cable Area
Subm pile
Jewfish Key
Fl G 4s
Bishop Bayou
Whitney Beach
BASCULE BRIDGE
HOR CL 45 FT
VERT CL 17 FT
Cable &
eline Area
COLREGS DEMARCATION LI
80 750h (see note A)
(see notes B&C)
Mo (A) 16ft 6M "L
Longboat Pass
Sh rep 1997
5 ft rep 1987

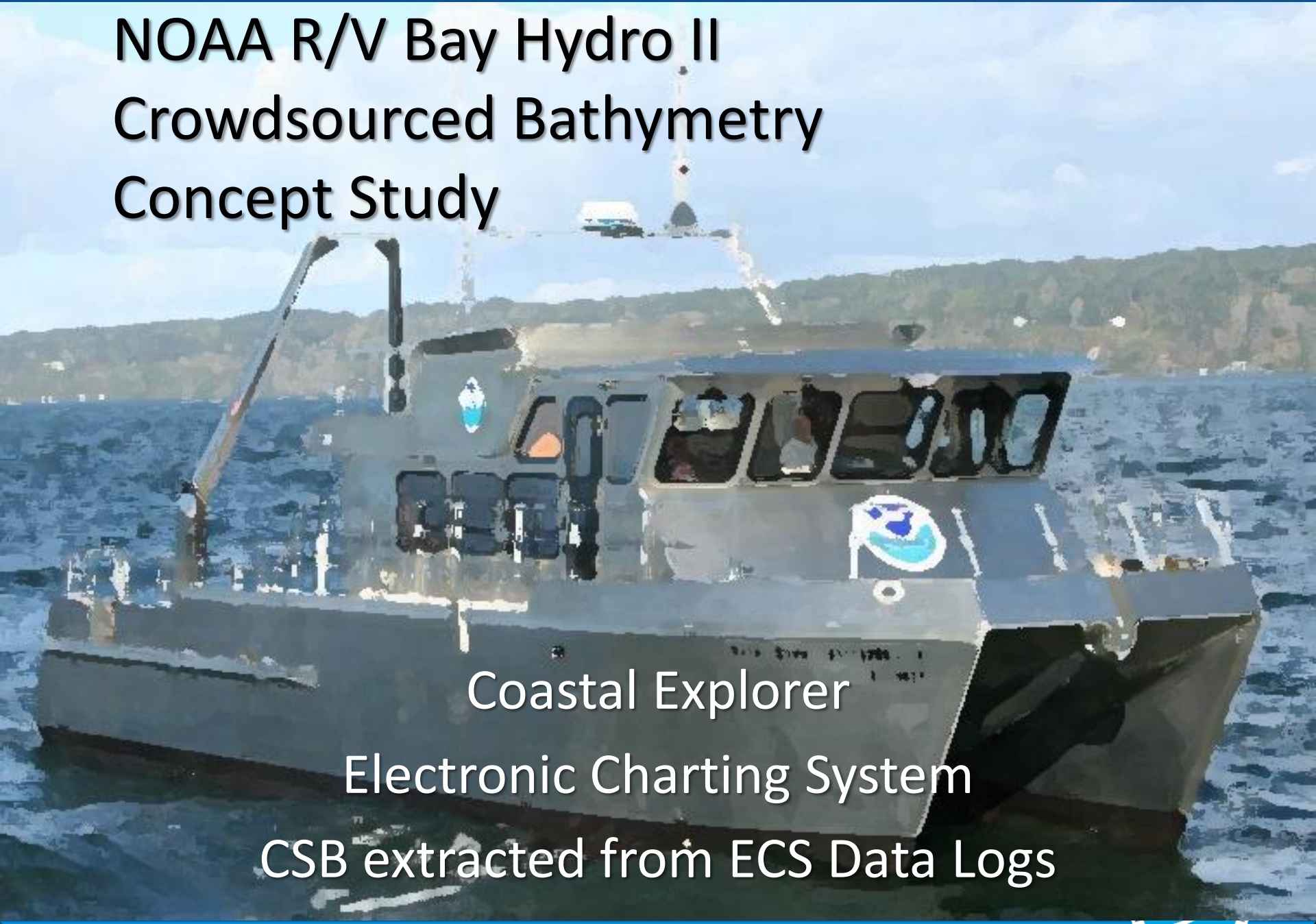
Crowdsourcing Efforts

- ActiveCaptain Navigation Hazards
  - Crowdsourced navigation hazard data
- Crowdsourced Bathymetry (CSB)
  - IHO's Data Centre for Digital Bathymetry
  - Software based solution concept study

ActiveCaptain – Crowdsourced Hazards from social media



NOAA R/V Bay Hydro II Crowdsourced Bathymetry Concept Study



Coastal Explorer

Electronic Charting System

CSB extracted from ECS Data Logs

NMEA Data log file is automatically created for developer troubleshooting within Rose Point Coastal Explorer ECS software

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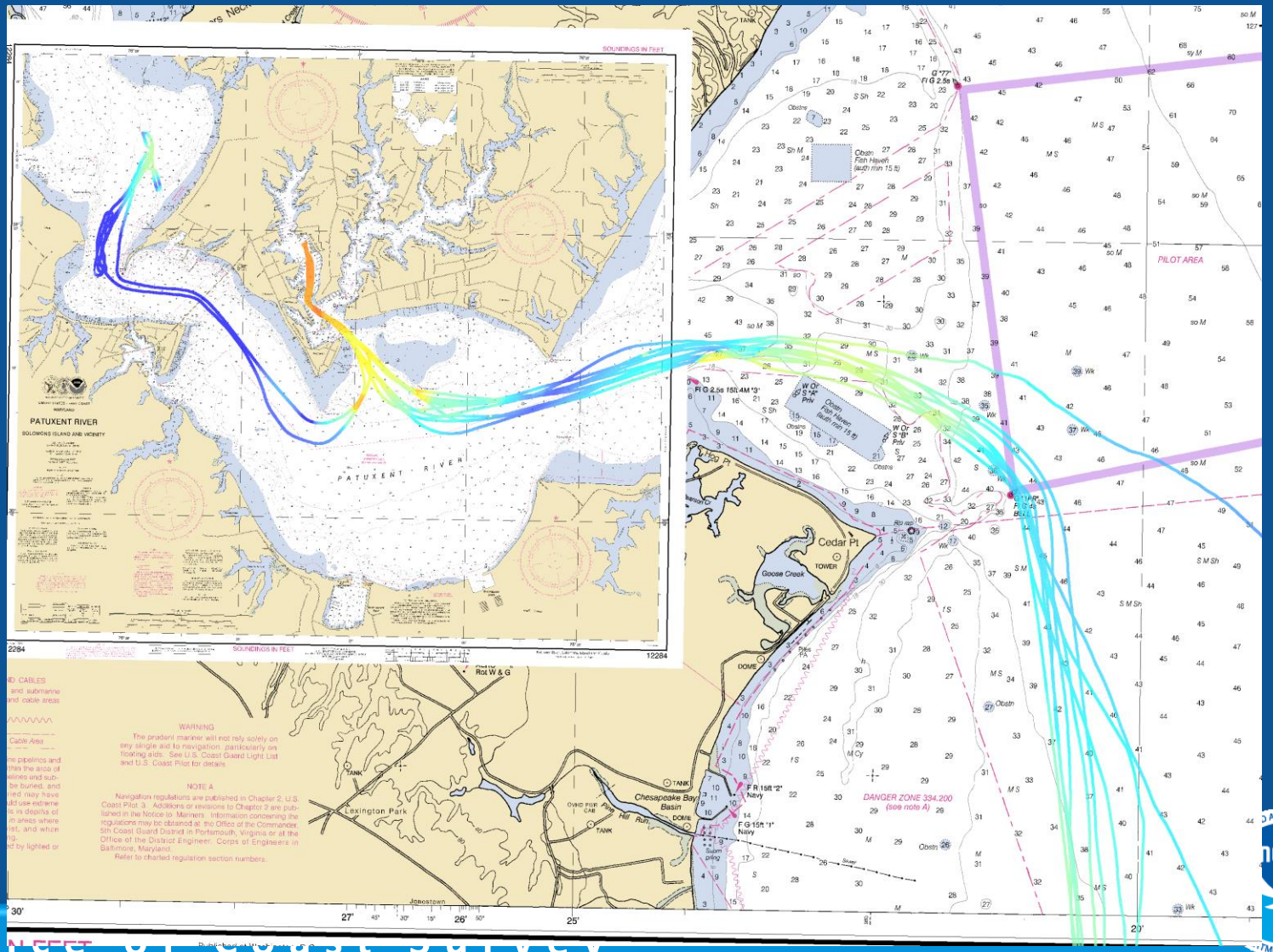
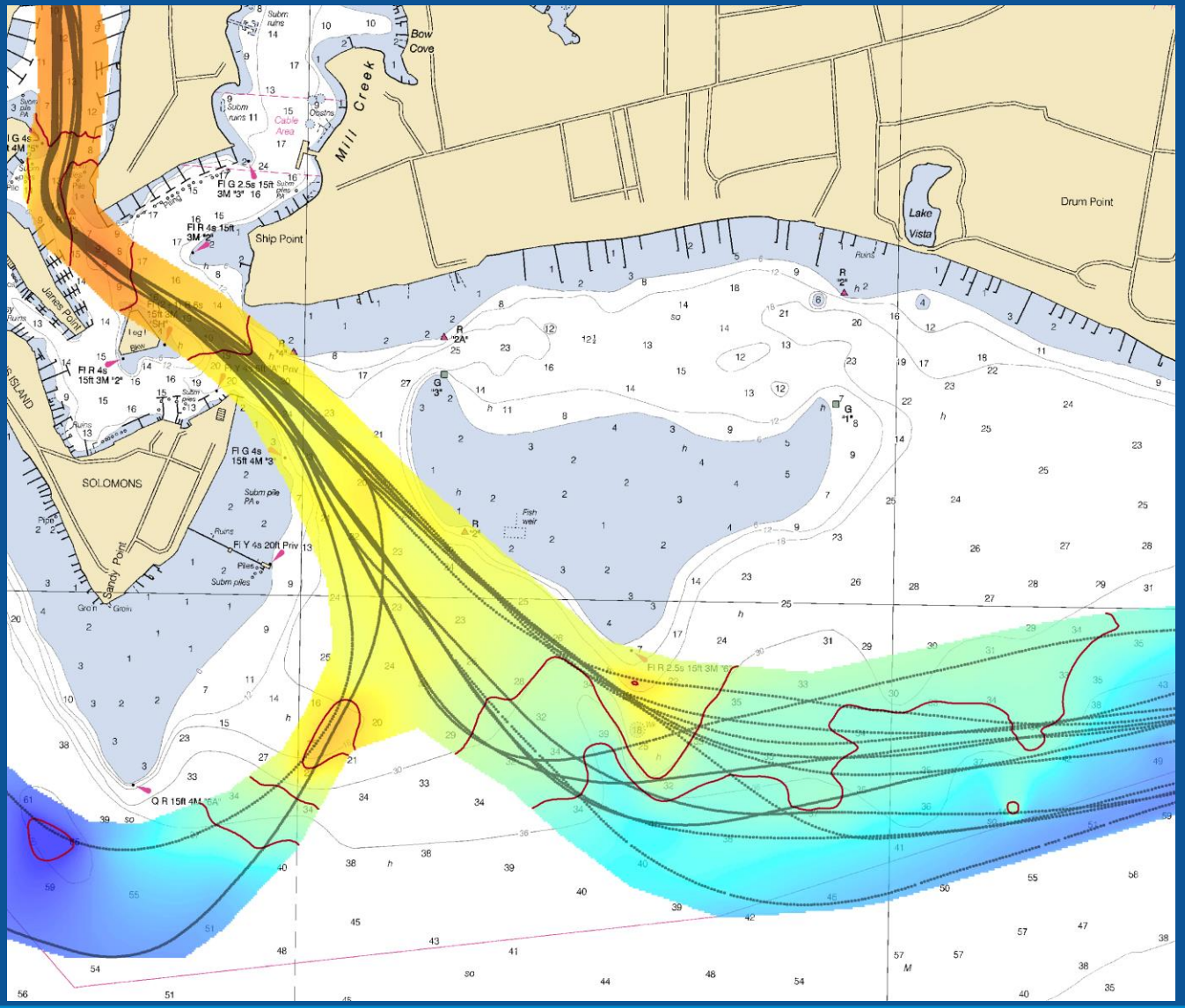
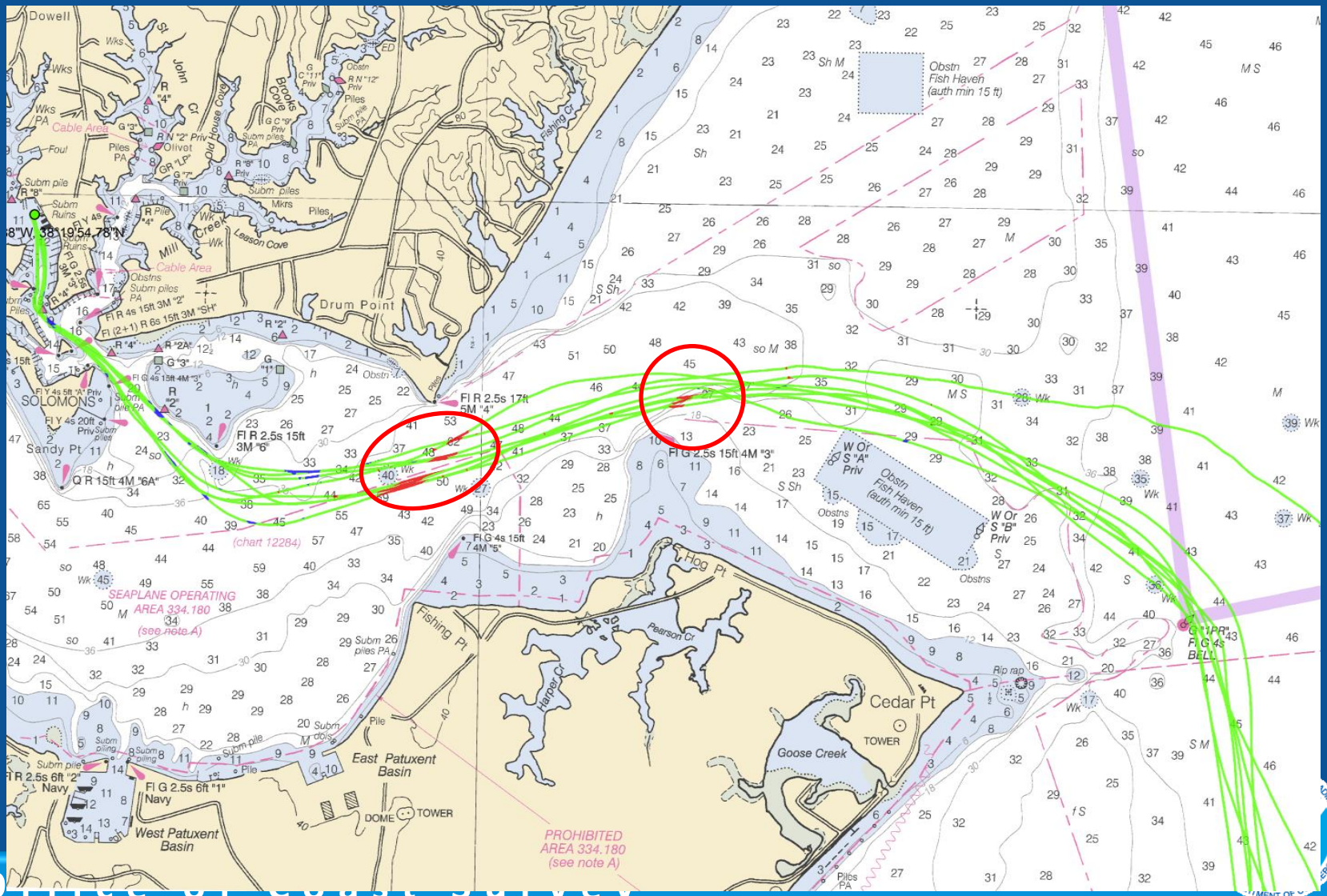
GGA (Time and Position from GPS) and DPT (Depth of water from bridge fathometer) were parsed out and imported into ArcGIS as a point feature class



Six days of data = ~70,000 soundings



Derivative Surface is compared to a reference surface created from Survey Scale (aka fair sheet) Soundings extracted from NOAA's NGDC/NCEI/Coast Survey Bathy Point Store



Derivative Surface is compared to a reference surface created from Survey Scale (aka fair sheet) Soundings extracted from NOAA's NGDC/NCEI/Coast Survey Bathy Point Store

Table

Reclass_diff_25_AUG

Description	Count
CSB deeper than 1 meter of Reference Surface	1633
CSB +/- 1 meter of Reference Surface	104788
CSB shoaler than 1 meter of Reference Surface	717

98% of grid nodes fall within 1 meter of the reference surface

Conclusions and recommended next steps:

- This is a promising potential method to extract Crowdsourced Bathymetry from a typical light-commercial or high-end recreational ECS setup

Next Steps:

- Automate parsing of GGA and DPT strings for input into GIS
- Evaluate solution with cursory tides and transducer offsets applied
- Establish contact with Rose Point Developers
  - Discuss possibility to adopt direct interface with Coastal Explorer and Rose Point ECS software to the IHO DCDB in NCEI – Boulder
- Use this case study to work with other chartplotter software and hardware developers to expand potential crowd contributors

Thank you & terima kasih!

anthony.r.klemm@noaa.gov