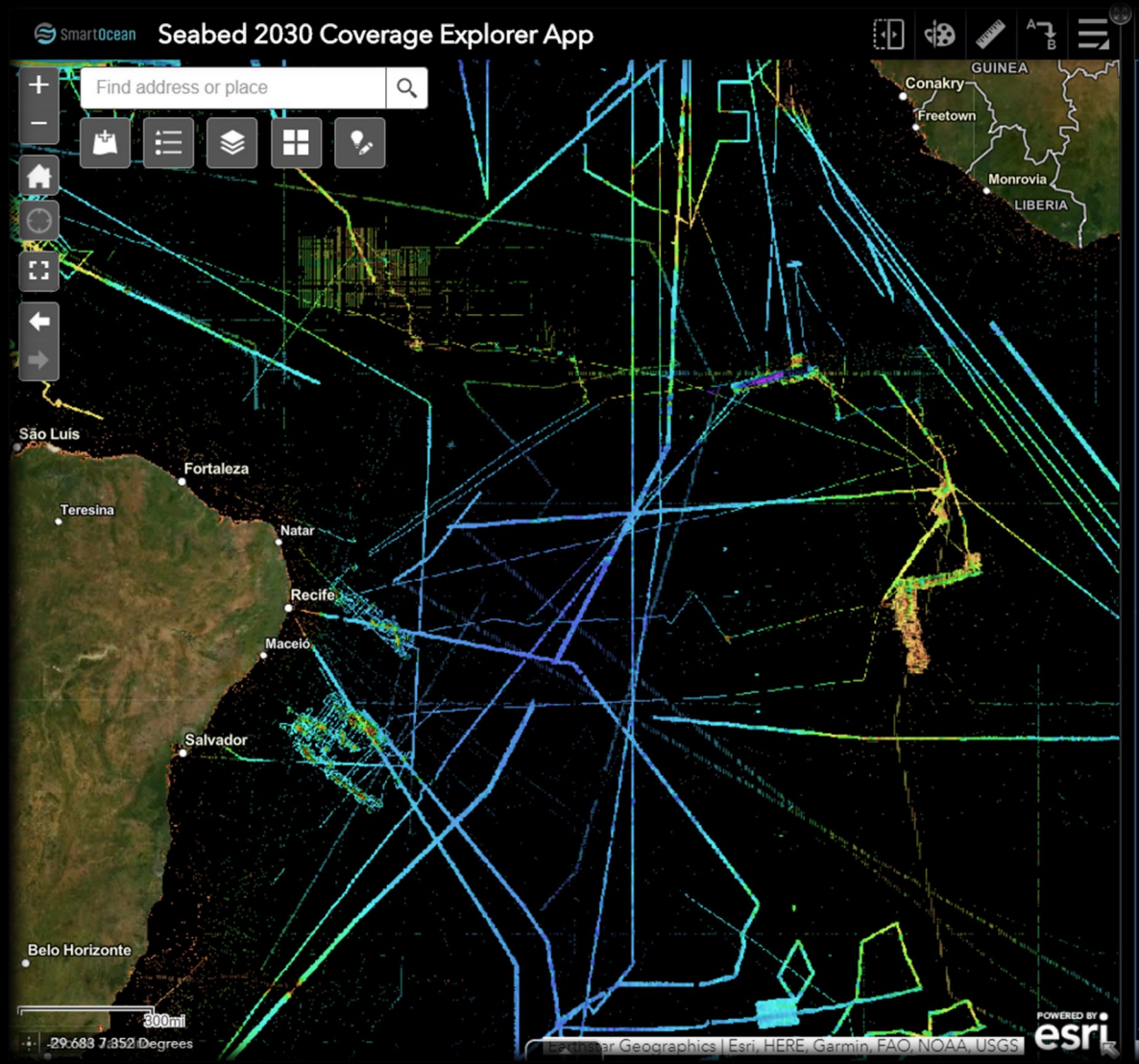
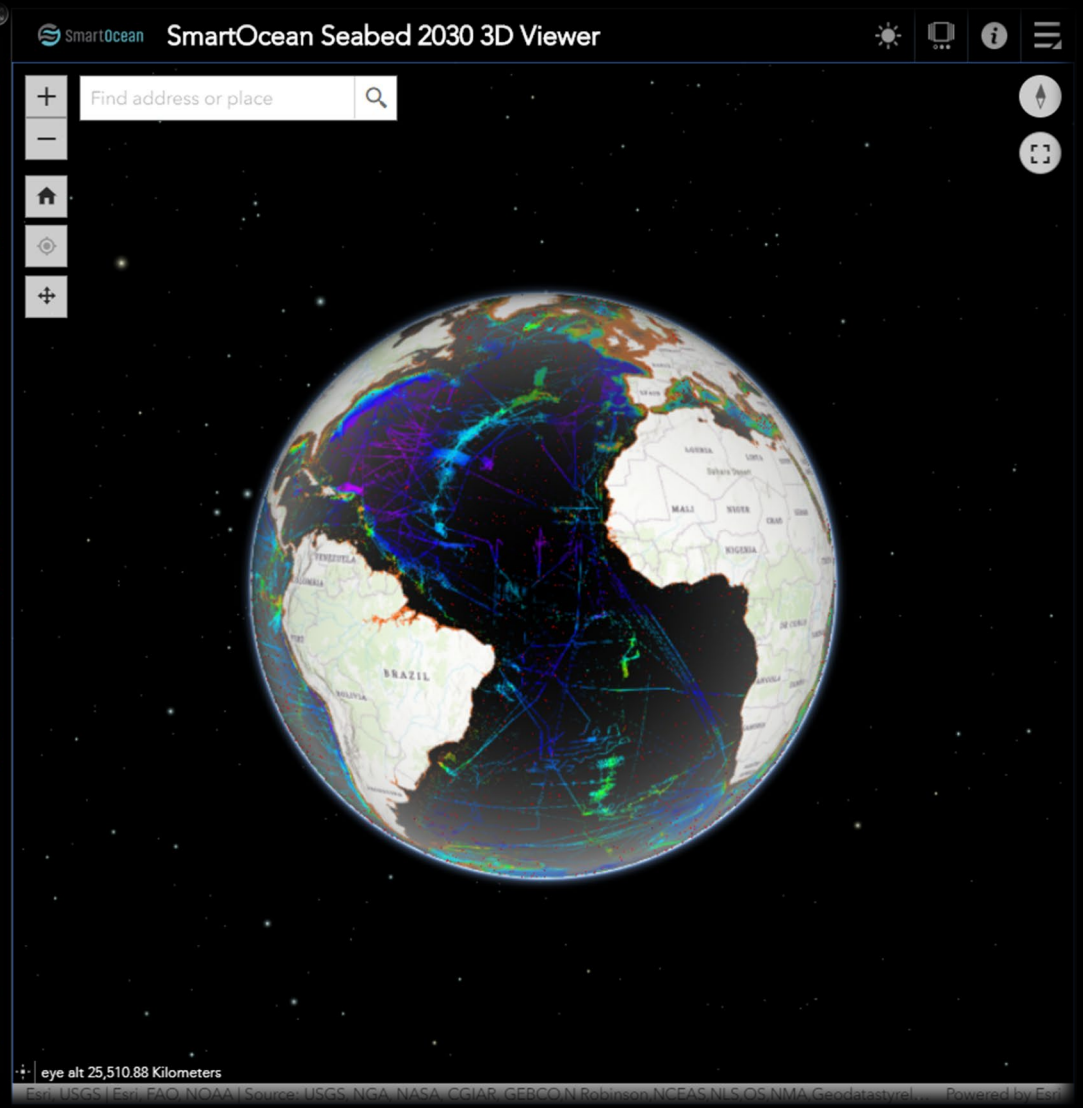
An Overview of Cloud-Based Geospatial Technologies to Help Map the Gaps





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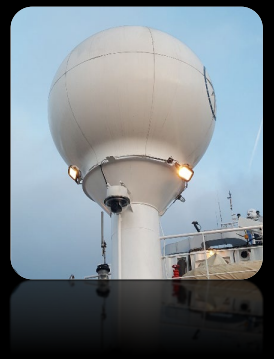
EARTH ANALYTIC

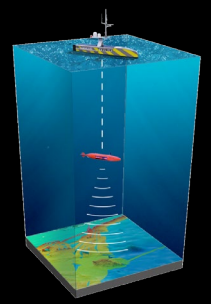
While recent technological advances in underwater survey and mapping technologies have significantly increased the efficiency, rate, quality, and resolution of data collection in ocean, coastal and riverine environments, the persistence of **desktop-based** data processing, localized storage, and proprietary workflows has hampered the adoption of the **Web GIS Pattern**.



The Future is Coming Faster Than You Think

SmartOcean

EARTH ANALYTIC



Cloud Storage

Cloud Processing

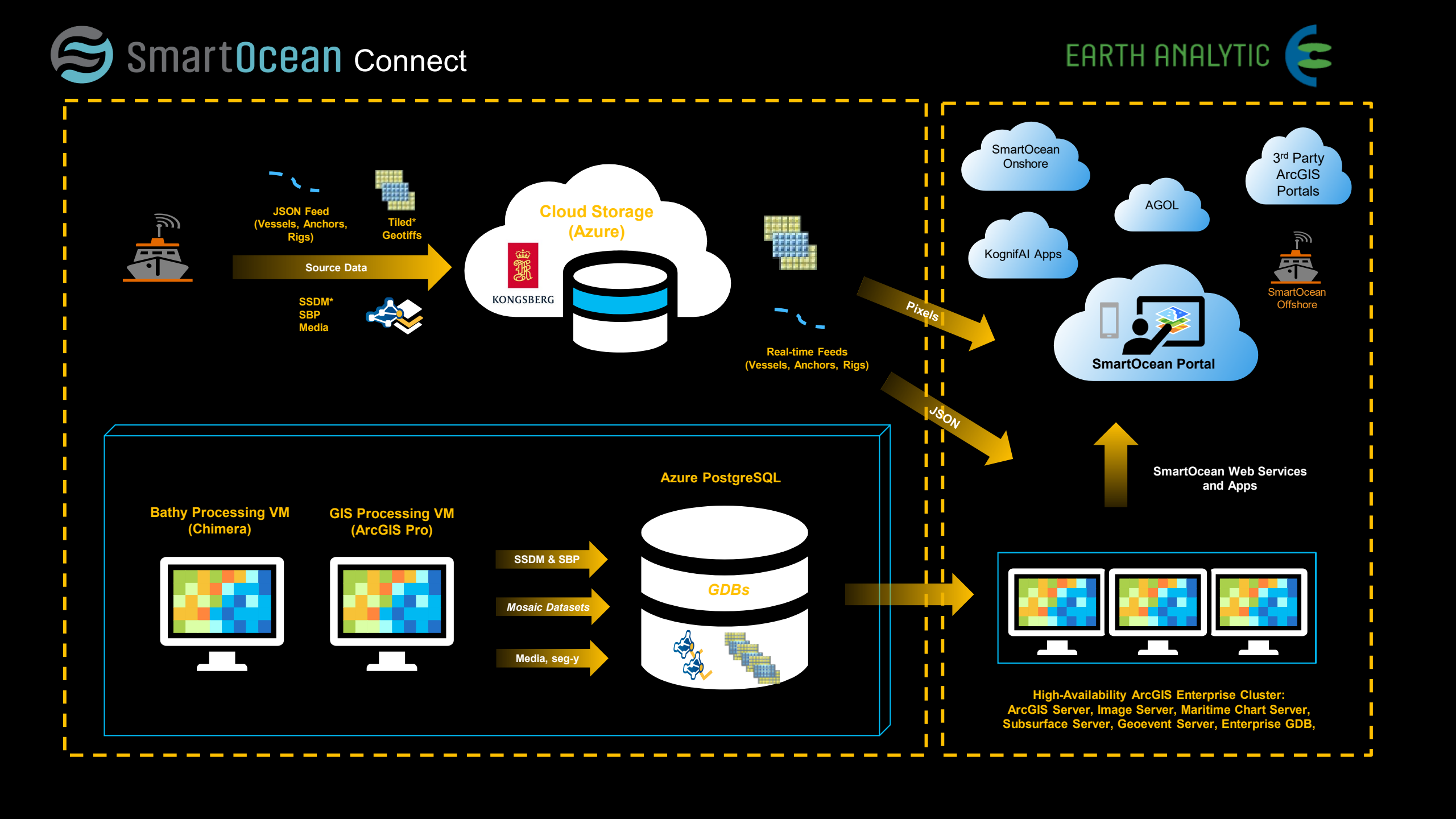
Cloud Services & Apps

Real-time feeds
xyz, ctd, temp., etc.

Seabed Survey Data
Geodatabase, SBP, Video, Water Column

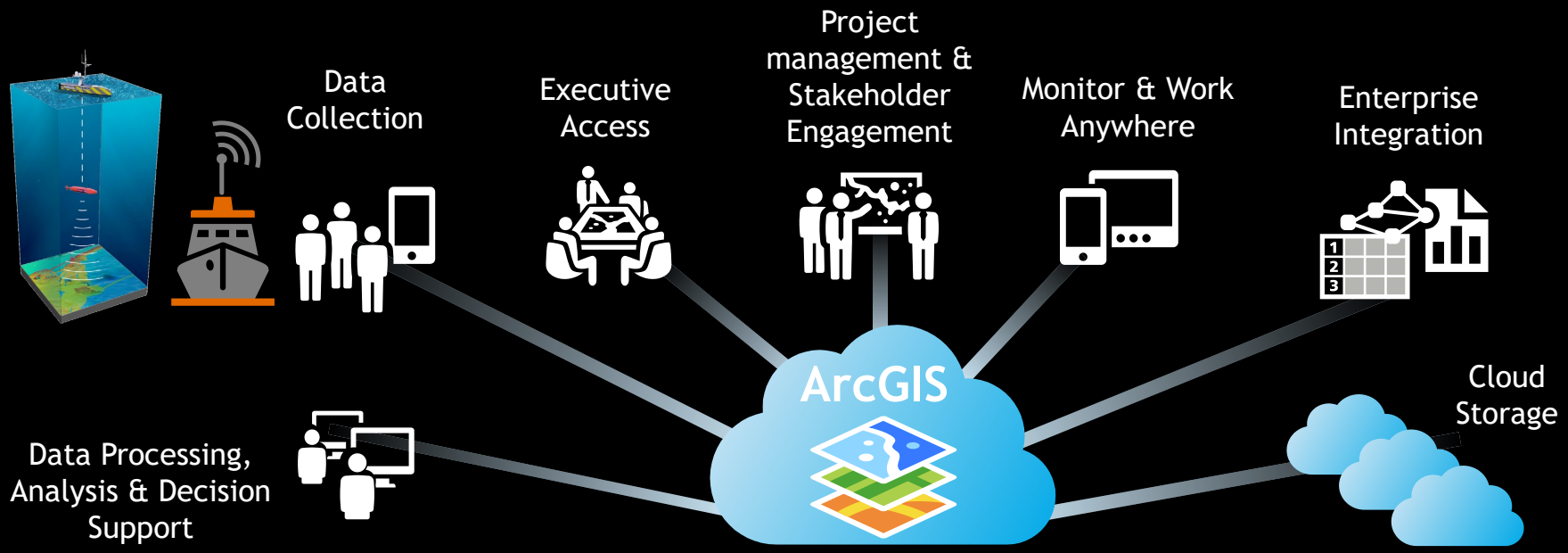
Geotiffs
Bathymetry
Backscatter

Distributed Collaborators


SmartOcean Connect
EARTH ANALYTIC
JSON Feed
(Vessels, Anchors, Rigs)
Tiled*
Geotiffs
Source Data
SSDM*
SBP
Media
Cloud Storage
(Azure)
KONGSBERG
Real-time Feeds
(Vessels, Anchors, Rigs)
Pixels
JSON
SmartOcean
Onshore
3rd Party
ArcGIS
Portals
AGOL
KognifAI Apps
SmartOcean
Offshore
SmartOcean Portal
SmartOcean Web Services
and Apps
Azure PostgreSQL
Bathy Processing VM
(Chimera)
GIS Processing VM
(ArcGIS Pro)
SSDM & SBP
Mosaic Datasets
Media, seg-y
GDBs
High-Availability ArcGIS Enterprise Cluster:
ArcGIS Server, Image Server, Maritime Chart Server,
Subsurface Server, Geoevent Server, Enterprise GDB,

SmartOcean

Apps & Extensions for ArcGIS that make ocean data and analytics available virtually anywhere, on any device, at any time



SmartOcean

A best-in-class COTS geospatial solution for hydrographic survey, ocean research, natural resource management, energy, and conservation

EARTH ANALYTIC

esri THE SCIENCE OF WHERE

SmartOcean Connect - List of Services

Category	Description	Input Data	Output Service Type	Core Products
Location Feeds	Real-time feeds from sensors, vessels, anchors, rigs, etc..	vector, rss/xml, JSON	Geoevent Services	ArcGIS Desktop, /ArcGIS Pro, ArcGIS Enterprise, Geoevent Server
Bathymetry	Image Services w/ raster functions and metadata filters	Processed Geotiffs	Image Services w/ metadata	Image Server
	Geoprocessing Service to convert flagged records in.all/.kmall files to las/i3s	.all/.kmall	Geoprocessing Services	ArcGIS Pro/Server
	i3s Web Services; include/link uncertainty and extended metadata	.las/i3s	i3s web services	ArcGIS Server
	Bathymetric Information System (BIS) / Nautical Information System (NIS)	Derived	Framework	ArcGIS Desktop & ArcGIS Pro, Maritime Charting Desktop Extension, ArcGIS Enterprise, Maritime Chart Server extension
S-57 / S100 & ENCs	Semi-automated generation of S-57 / S-100 and ENC datasets; ENC web services derived from client-provided bathymetry	Derived	Geoprocessing Services, ENC, POD Services	ArcGIS Desktop & ArcGIS Pro, Maritime Charting Desktop Extension, ArcGIS Enterprise, Maritime Chart Server extension
Backscatter	Image Services w/ raster functions and metadata filters	Processed Geotiffs	Image Services w/ metadata	ArcGIS Image Server
SSS/HiSAS	Side-scan sonar / HISAS data stored as geotiffs	Processed Geotiffs	Image Services w/ metadata	ArcGIS Image Server
Images/Video	Geotagged images and video	jpg/mp4	Feature Services	ArcGIS Desktop / ArcGIS Pro, ArcGIS Enterprise
Water Column	Video playback of selected coverage (?)	vector, rss/xml	Feature Services	ArcGIS Desktop / ArcGIS Pro, ArcGIS Enterprise, Full Motion Video Extensions
Location Feeds	Ship tracks, other feeds from sensors, vessels, anchors, rigs, etc..	vector, rss/xml, JSON	Geoevent Services	Geoevent Server
SSDM	SSDM geodatabase, feature templates and web services	vector	Feature Services	ArcGIS Server/SQL
SBP & Seismics	3D Visualization of sub-bottom profiler and seismic data in geospatial context	seg-y, segz	Seismic Server Services	ArcGIS Server, Subsurface Server for ArcGIS (Geocap)*

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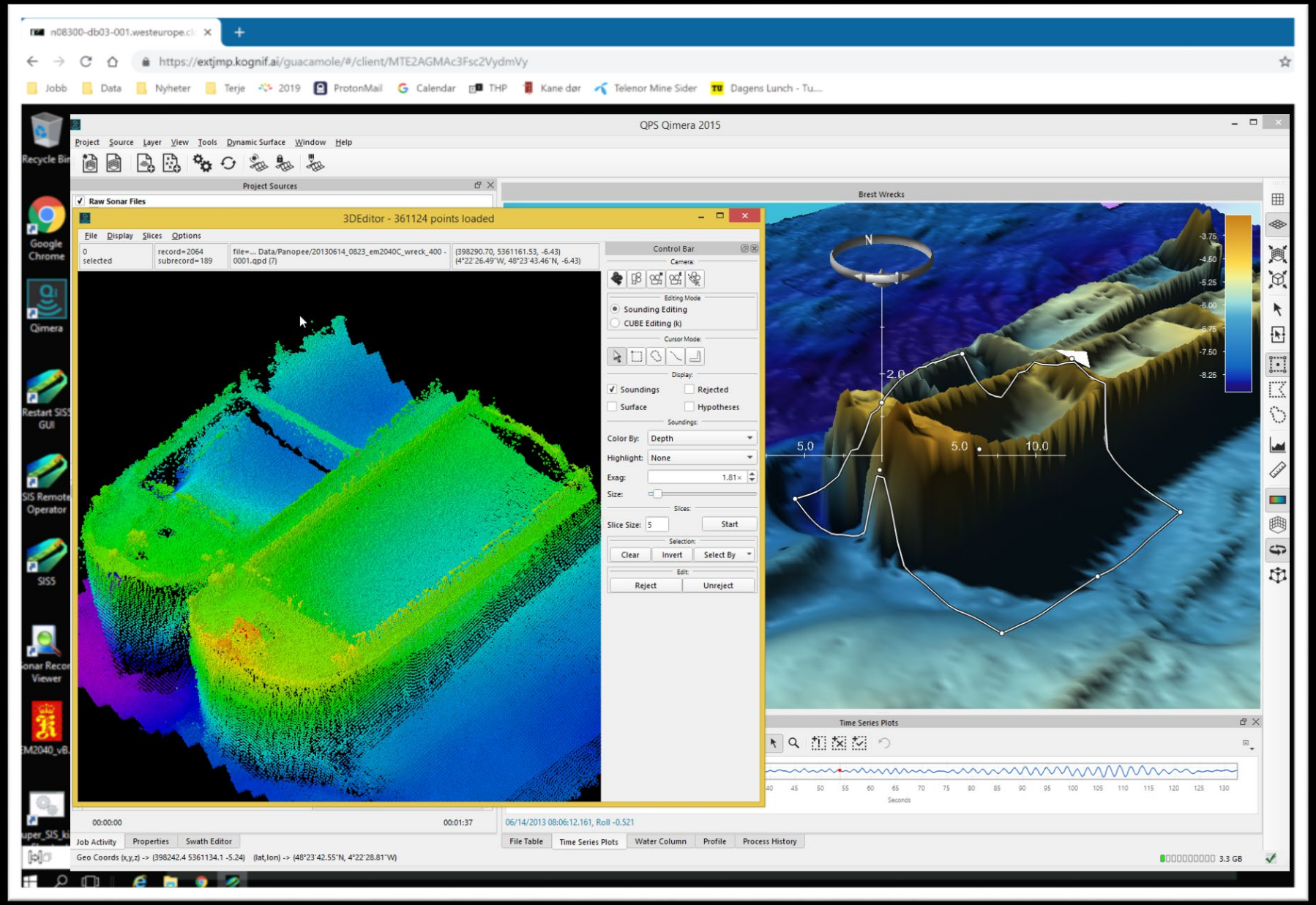
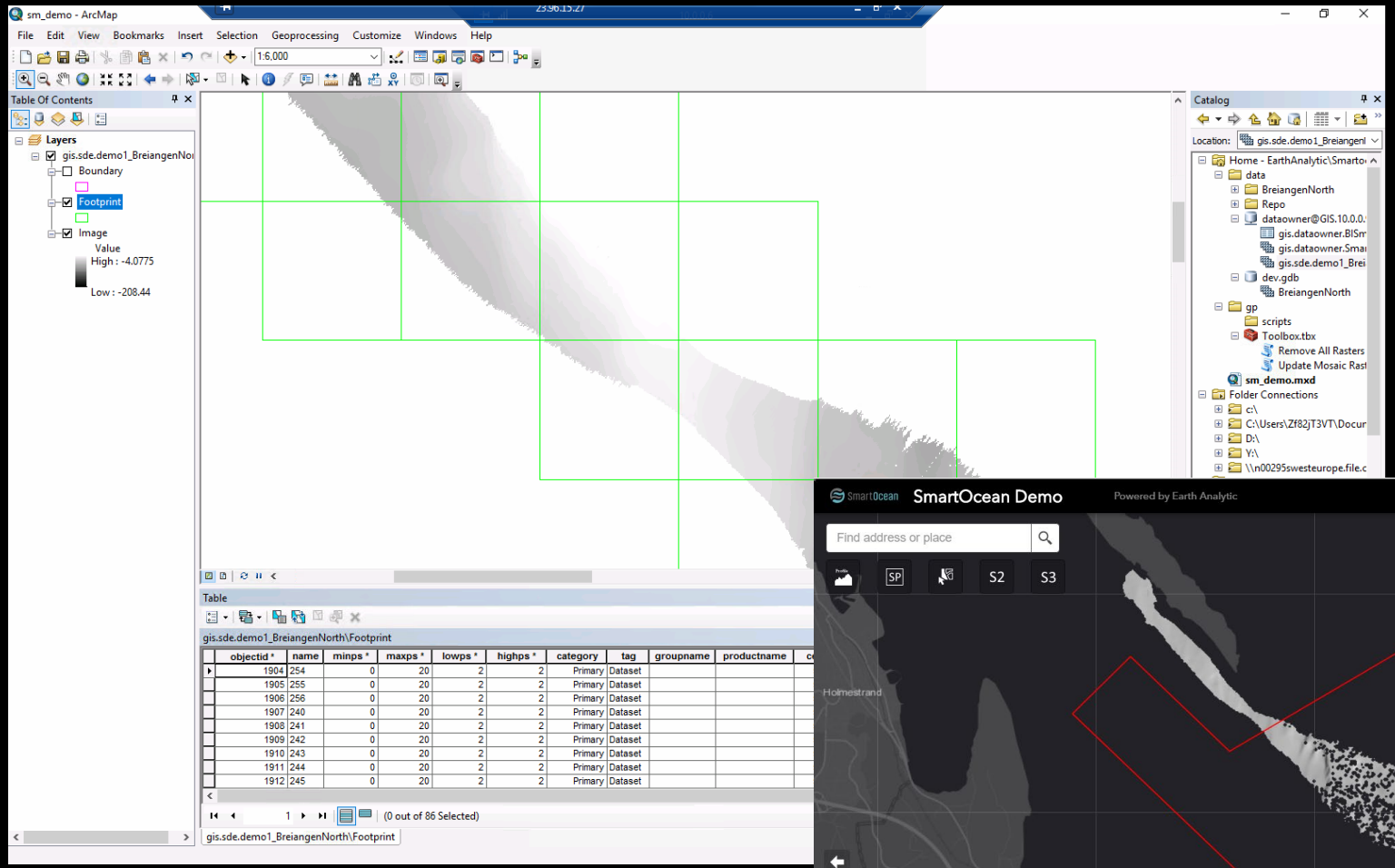
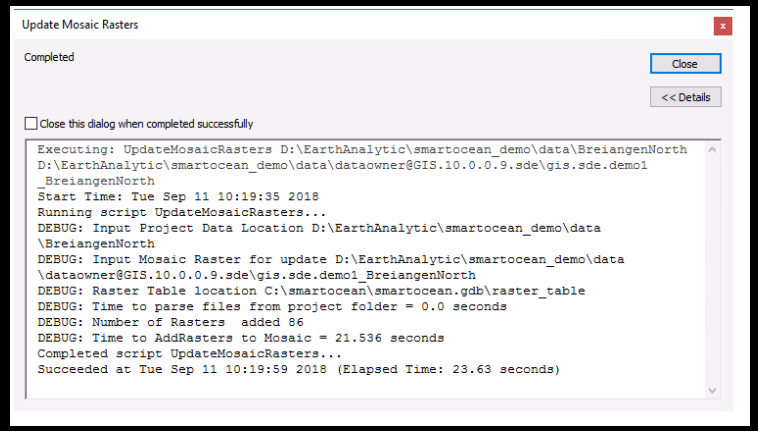
EARTH ANALYTIC

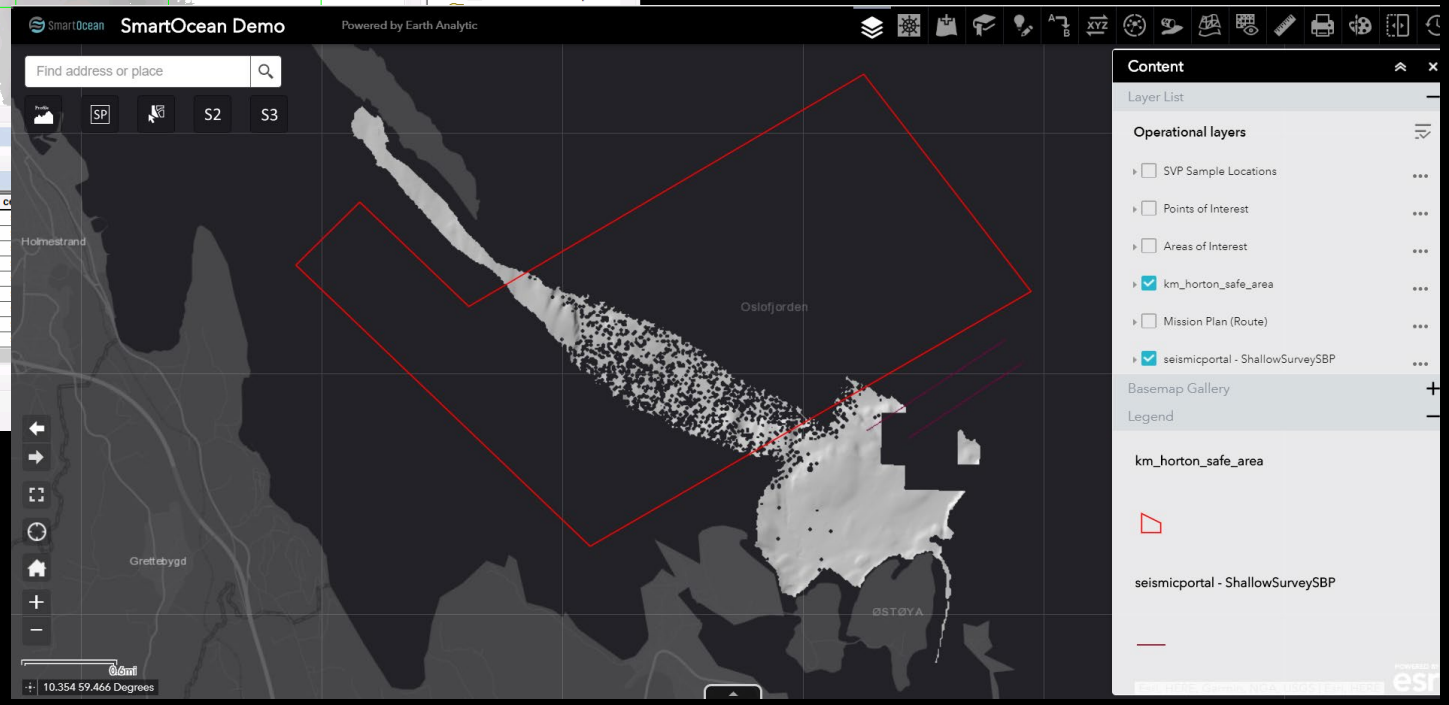


SmartOcean

EARTH ANALYTIC

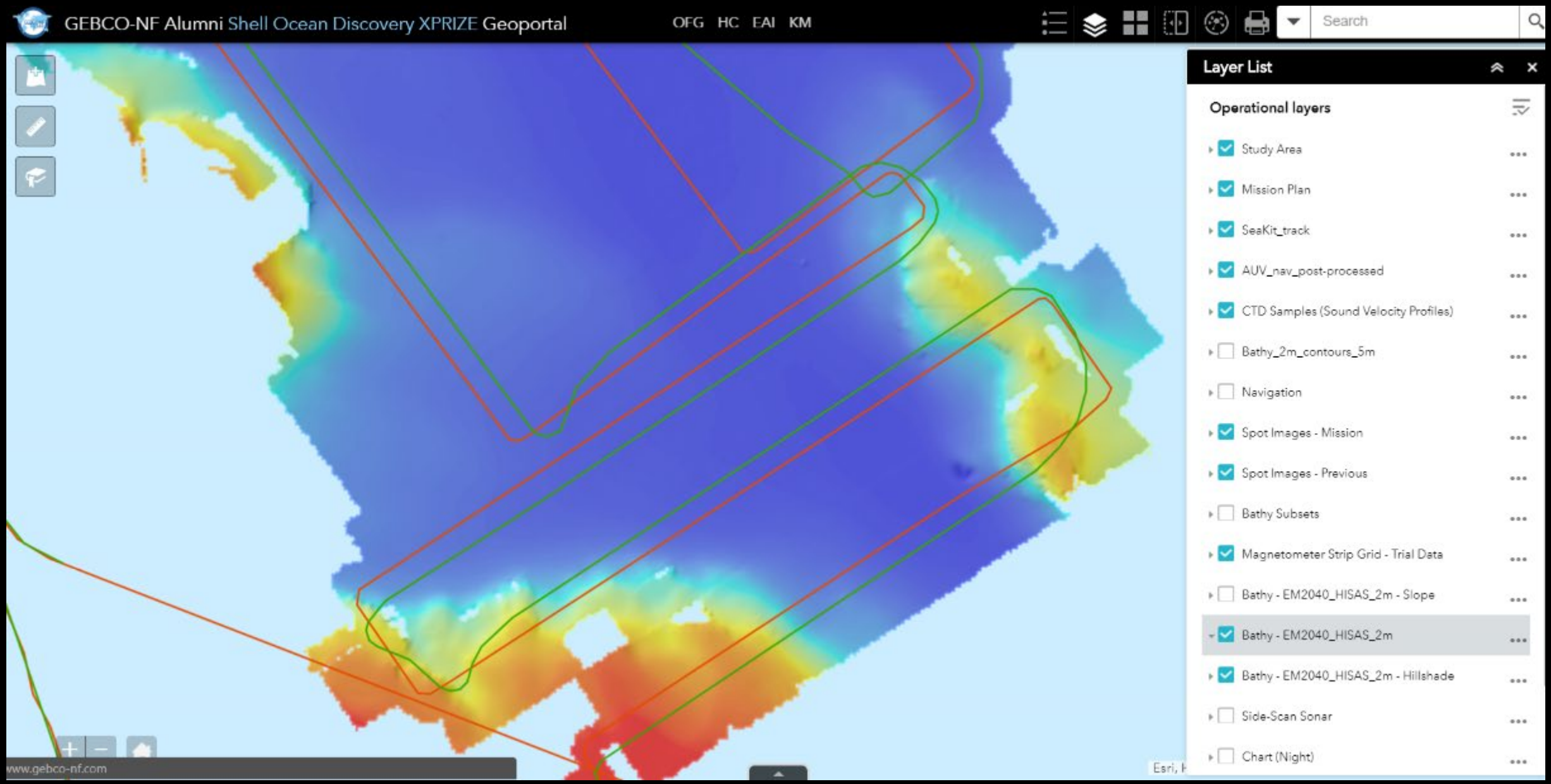




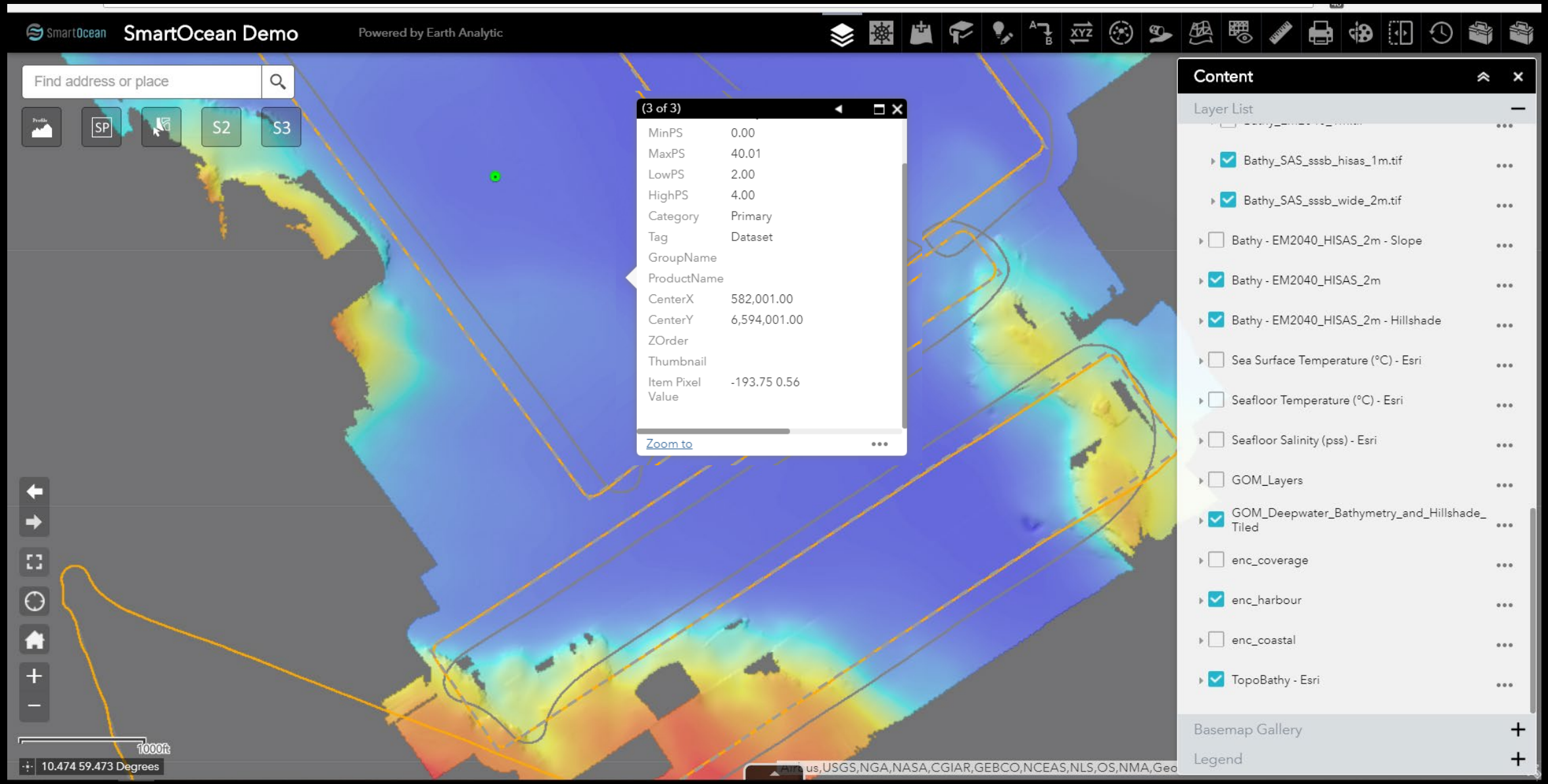


SmartOcean

EARTH ANALYTIC



EARTH ANALYTIC



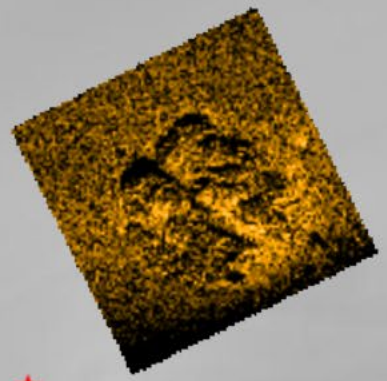
SmartOcean

EARTH ANALYTIC

SmartOcean SmartOcean Demo Powered by Earth Analytic

Find address or place

SP S2 S3



Smart Editor

Points of Interest

Description

Magnetic Anomaly - High Probability

Depth

Rematks

URL_Popup

Attachments:

Choose File No file chosen

Edited seconds ago

Edit Geometry

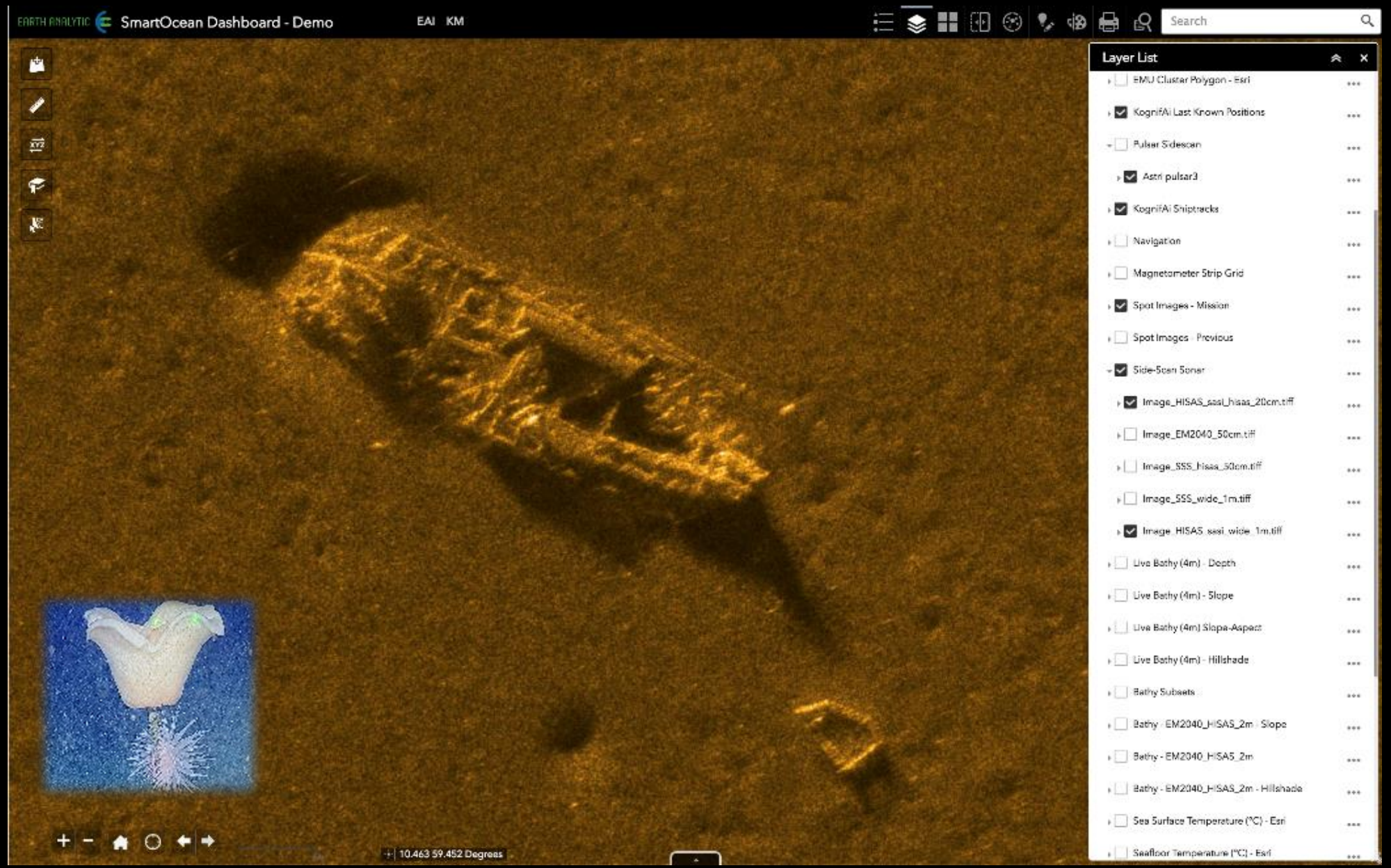
Clear Save

100ft

10.468 59.454 Degrees

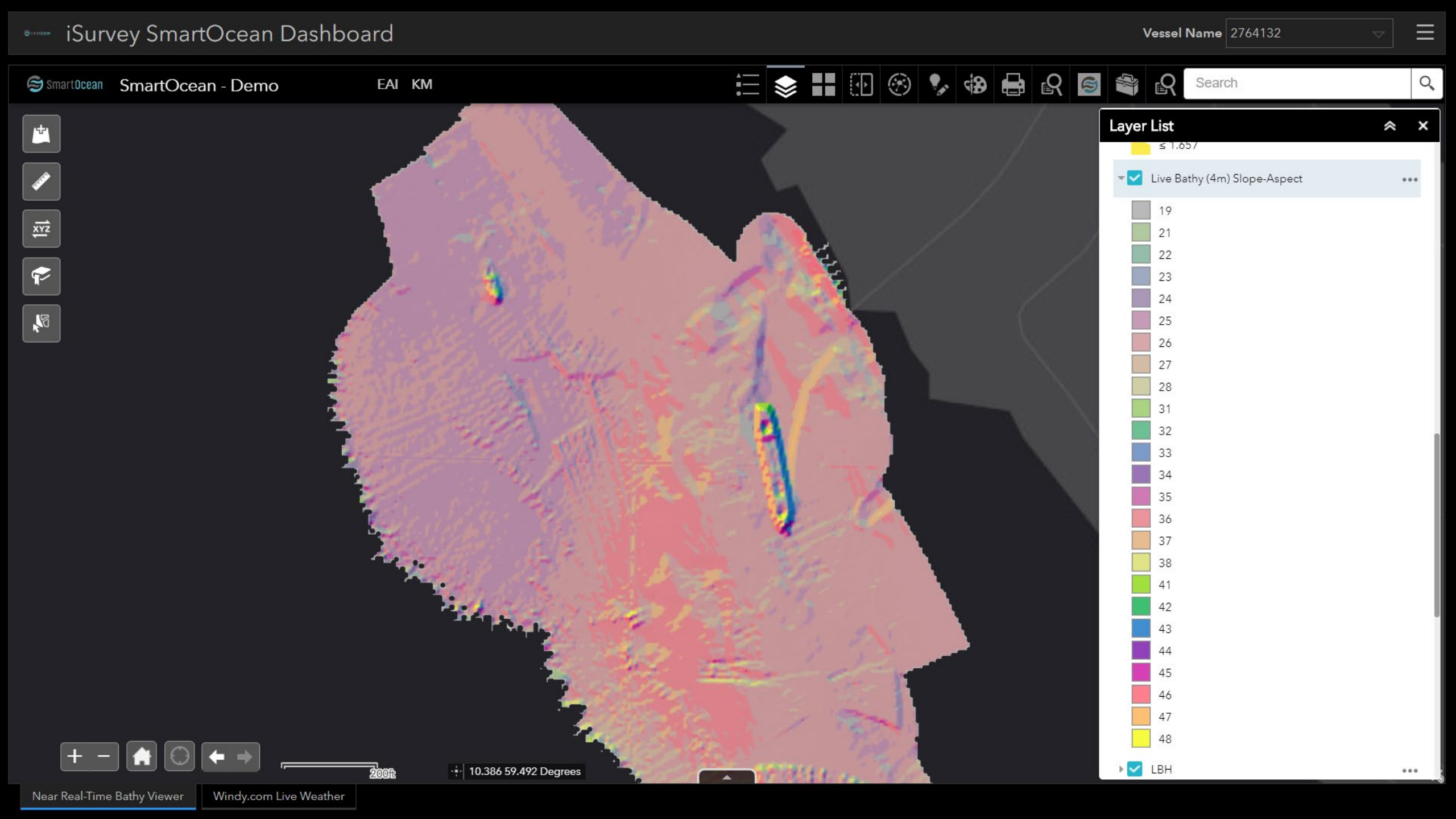
Magnetometer data Inspection/Reporting

SmartOcean EARTH ANALYTIC



SmartOcean

EARTH ANALYTIC


iSurvey SmartOcean Dashboard
Vessel Name
2764132
SmartOcean - Demo
EAI
KM
Search
Layer List
≤ 1.657
Live Bathy (4m) Slope-Aspect
19
21
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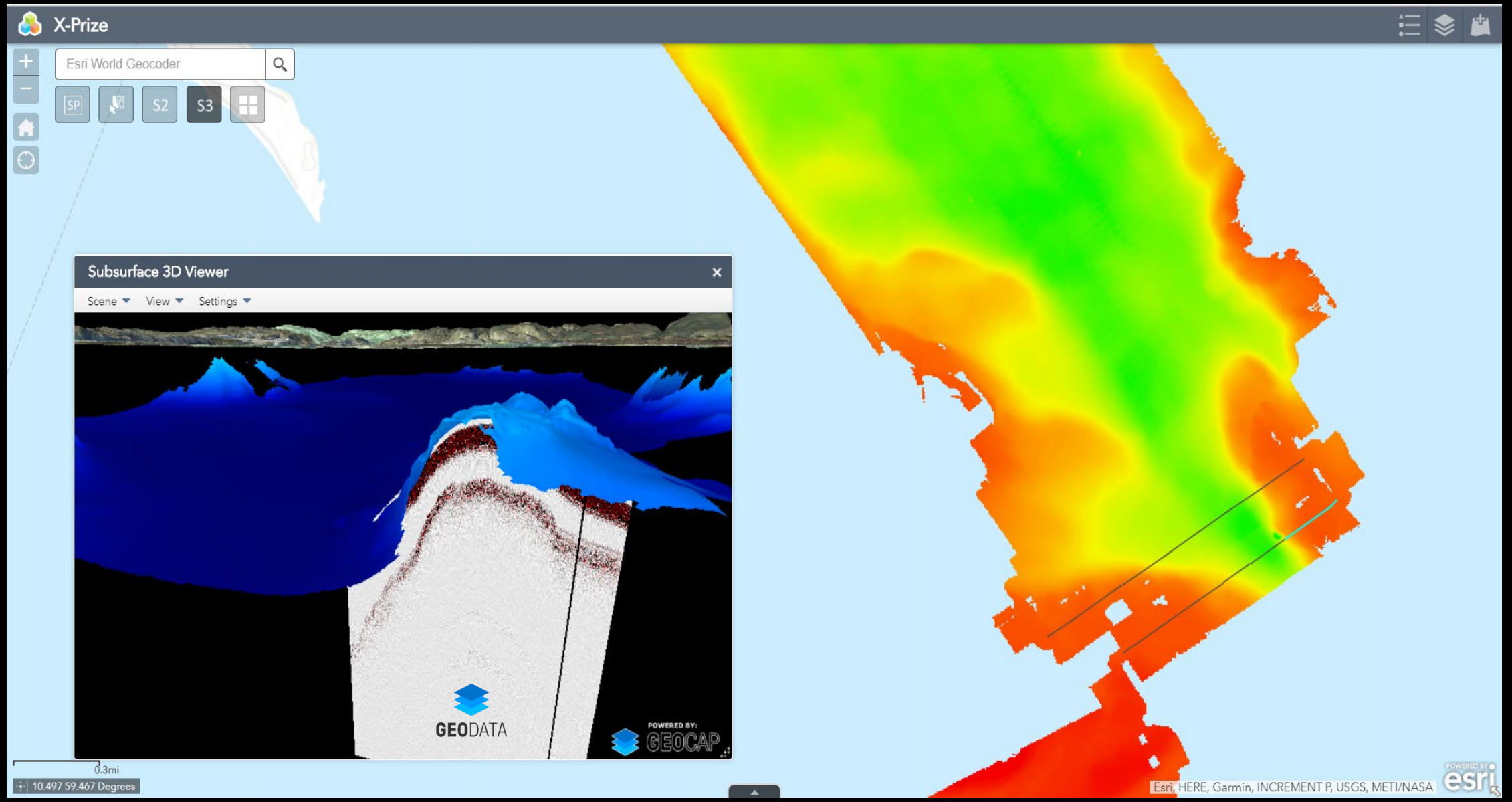
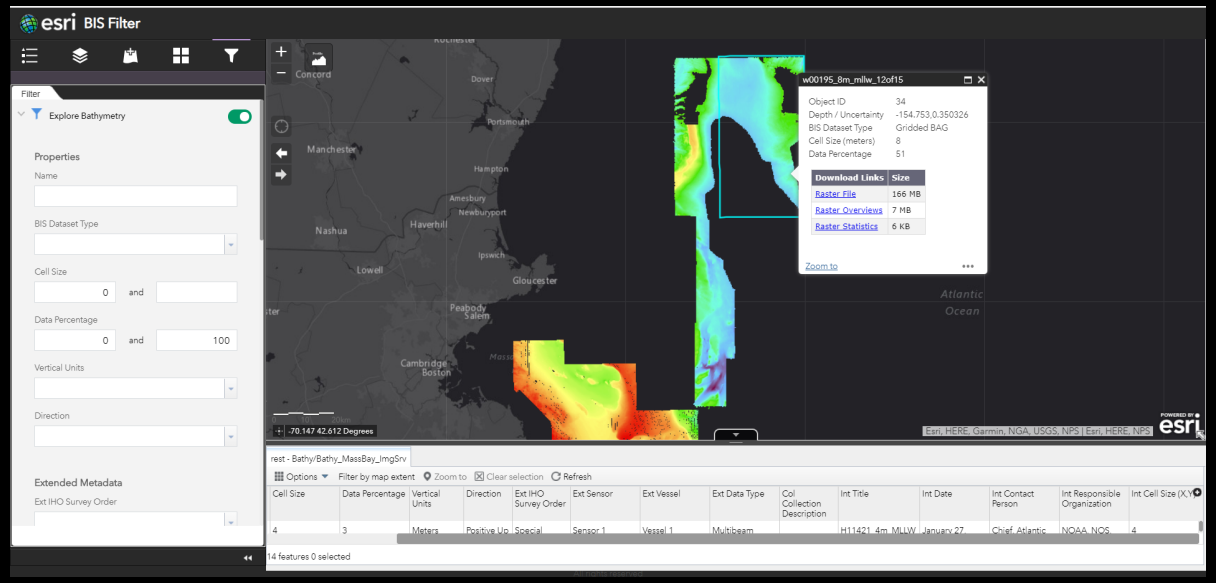
48
LBH
200ft
10.386 59.492 Degrees
Near Real-Time Bathy Viewer
Windy.com Live Weather

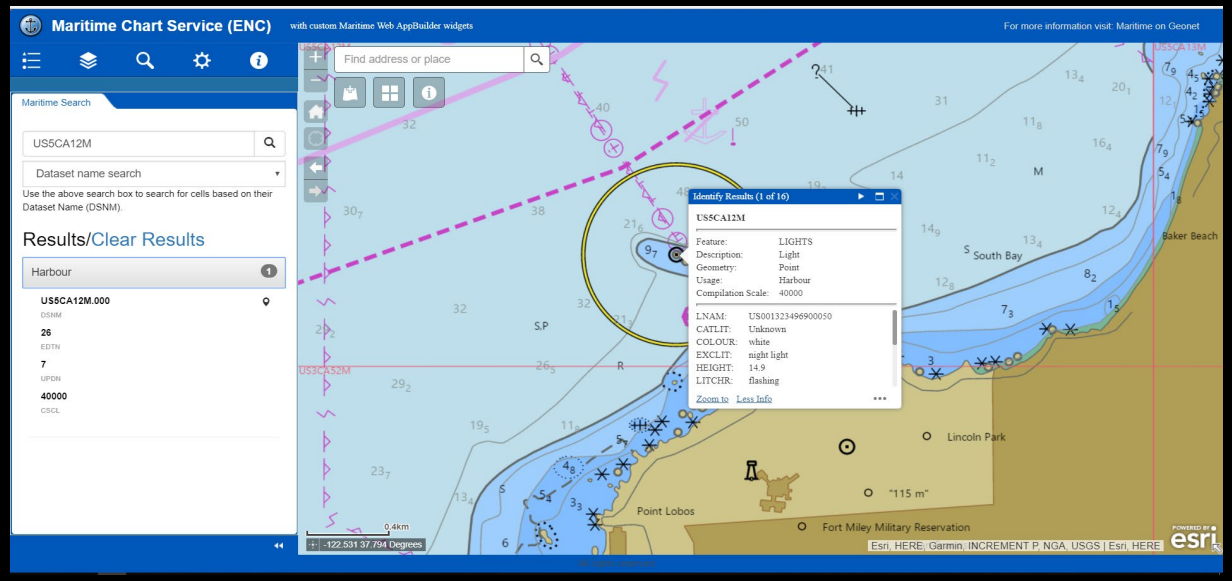


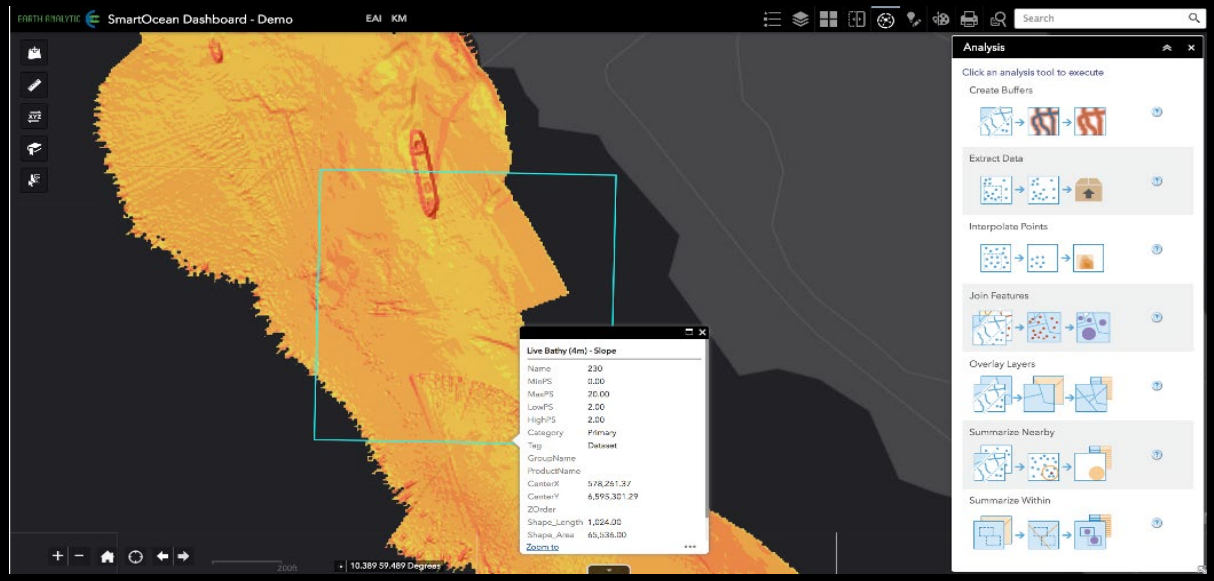
SmartOcean

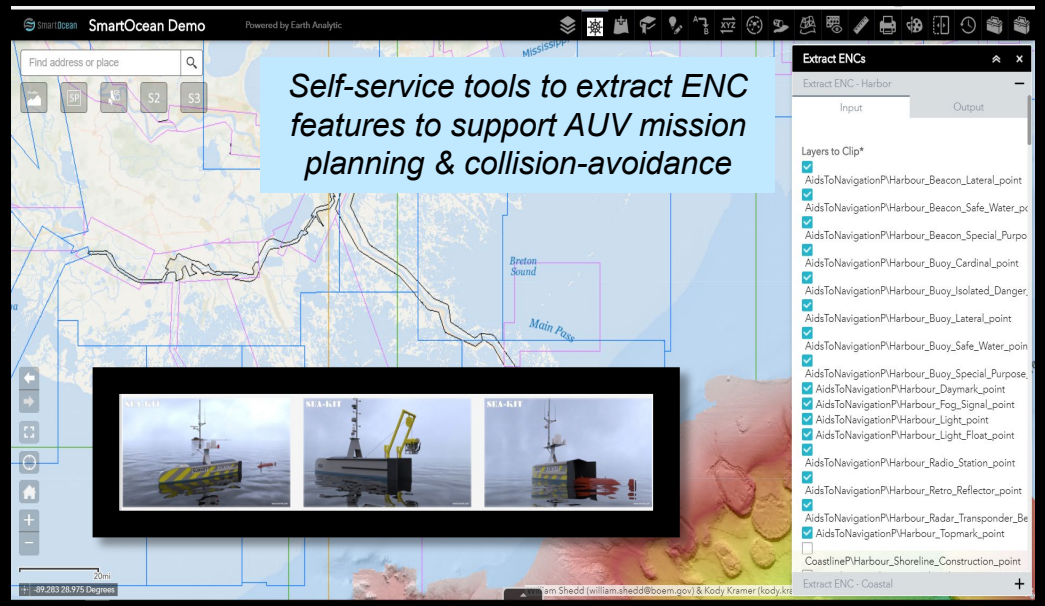
EARTH ANALYTIC

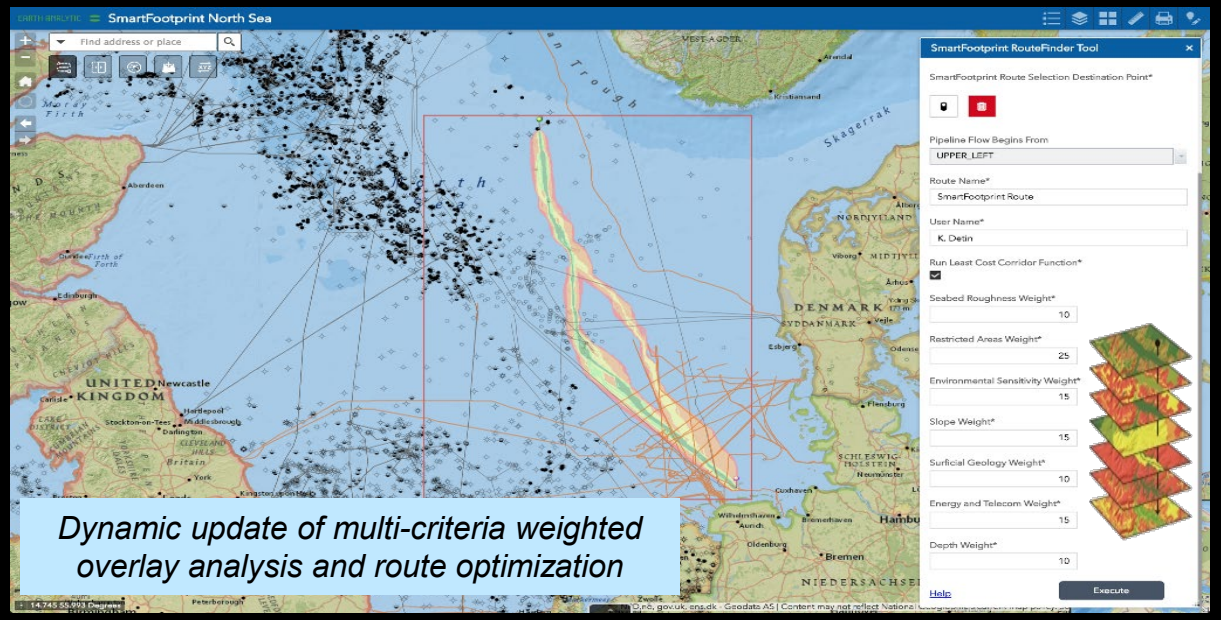


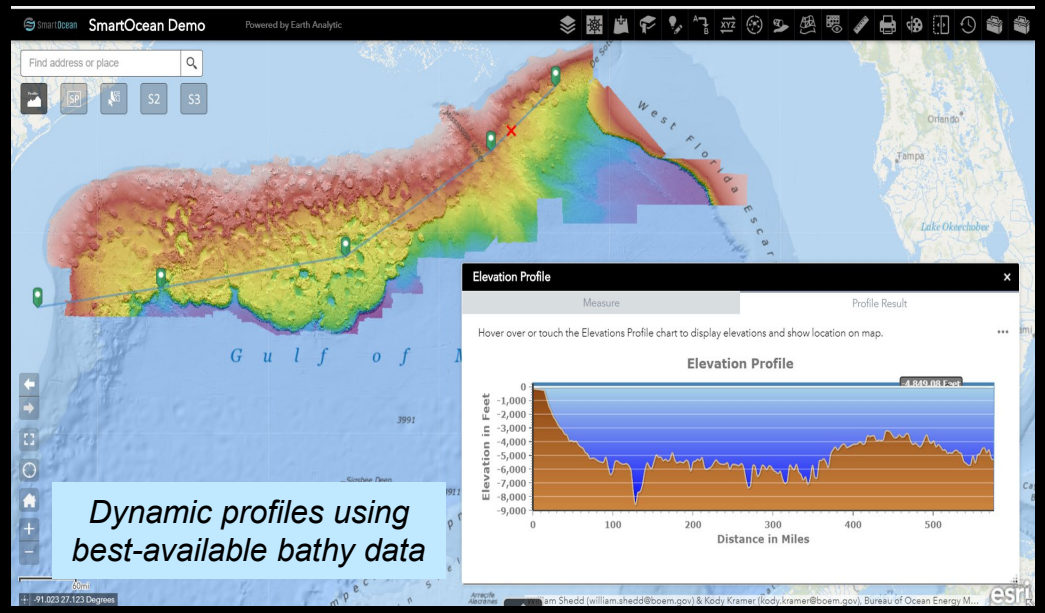
As solutions for the data processing become more autonomous, the final challenge will not be the real-time acquisition or processing of the data, but ***what to do*** with the data once a bathymetric surface is created.

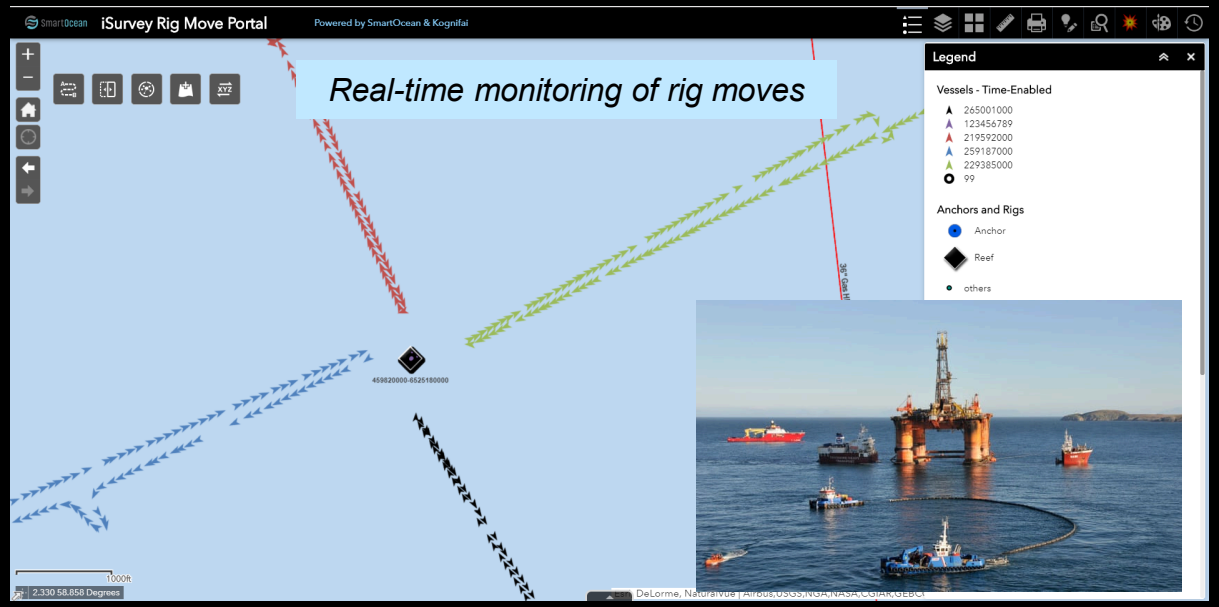





SmartOcean Demo
Powered by Earth Analytic
Find address or place
Extract ENCs
Extract ENC - Harbor
Input
Output
Layers to Clip*
AidsToNavigationP\Harbour_Beacon_Lateral_point
AidsToNavigationP\Harbour_Beacon_Safe_Water_pc
AidsToNavigationP\Harbour_Beacon_Special_Purpo
AidsToNavigationP\Harbour_Buoy_Cardinal_point
AidsToNavigationP\Harbour_Buoy_Isolated_Danger
AidsToNavigationP\Harbour_Buoy_Lateral_point
AidsToNavigationP\Harbour_Buoy_Safe_Water_poin
AidsToNavigationP\Harbour_Buoy_Special_Purpose
AidsToNavigationP\Harbour_Daymark_point
AidsToNavigationP\Harbour_Fog_Signal_point
AidsToNavigationP\Harbour_Light_point
AidsToNavigationP\Harbour_Light_Float_point
AidsToNavigationP\Harbour_Radio_Station_point
AidsToNavigationP\Harbour_Retro_Reflector_point
AidsToNavigationP\Harbour_Radar_Transponder_Be
AidsToNavigationP\Harbour_Topmark_point
CoastlineP\Harbour_Shoreline_Construction_point
Extract ENC - Coastal
Breton Sound
Main Pass
Self-service tools to extract ENC features to support AUV mission planning & collision-avoidance


SmartFootprint North Sea
Find address or place
SmartFootprint RouteFinder Tool
SmartFootprint Route Selection Destination Point*
Pipeline Flow Begins From
UPPER_LEFT
Route Name*
SmartFootprint Route
User Name*
K. Detin
Run Least Cost Corridor Function*
Seabed Roughness Weight*
Restricted Areas Weight*
Environmental Sensitivity Weight*
Slope Weight*
Surficial Geology Weight*
Energy and Telecom Weight*
Depth Weight*
Help
Execute
Dynamic update of multi-criteria weighted overlay analysis and route optimization

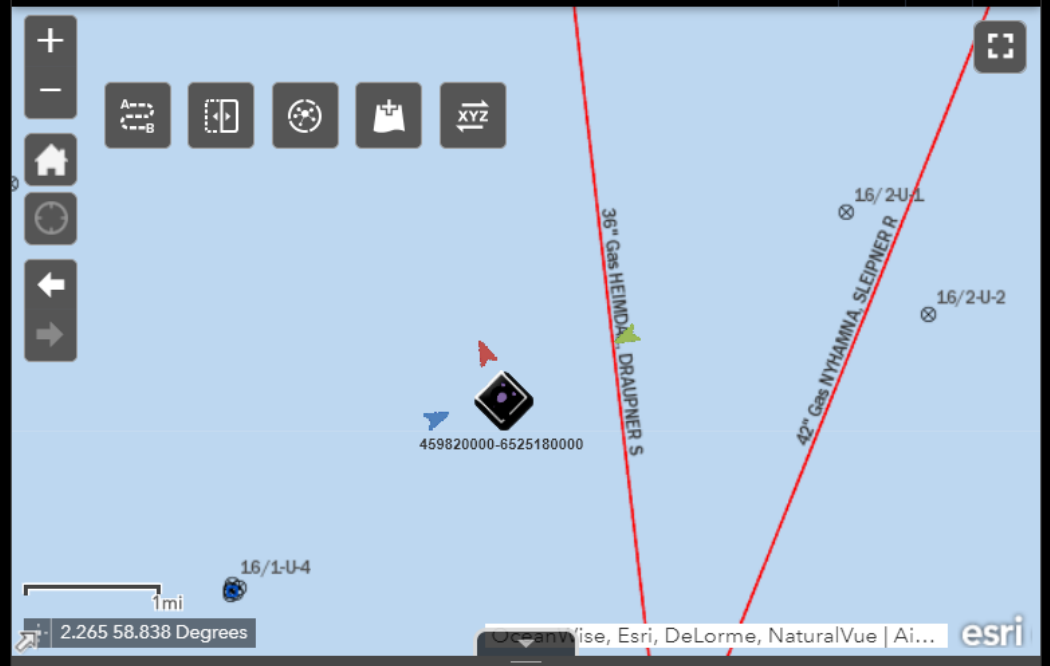

SmartOcean Demo
Powered by Earth Analytic
Find address or place
Elevation Profile
Measure
Profile Result
Hover over or touch the Elevations Profile chart to display elevations and show location on map.
Elevation Profile
Elevation in Feet
Distance in Miles
Dynamic profiles using best-available bathy data


iSurvey Rig Move Portal
Powered by SmartOcean & Kognifai
Real-time monitoring of rig moves
Legend
Vessels - Time-Enabled
265001000
123456789
219592000
259187000
229385000
99
Anchors and Rigs
Anchor
Reef
others

iSurvey SmartOcean Dashboard

Vessel Name 2789992

iSurvey Rig Move Portal



Vessels - Time-Enabled | Anchors and Rigs | Existing Cables | Station ID, Air Temperature (deg F)

Options | Filter by map extent | Zoom to | Clear selection | Refresh

OperationId	Symbol	Id	Time	HeadingTrueNort	VesselId
10,001				220.00	123456789
10,001				336.10	219592000
10,001				243.40	229385000

1187 features 0 selected

Project Location Map | Rig Move Tracker

123456789 | 123456789 | 3/20/2019, 7:34 AM

219592000 | 219592000 | 3/20/2019, 7:34 AM

229385000 | 229385000 | 3/20/2019, 7:34 AM

259187000 | 259187000 | 3/20/2019, 7:34 AM

99 | 99 | 3/20/2019, 7:34 AM

265001000 | 265001000 | 3/20/2019, 7:34 AM

123456789 | 123456789 | 3/20/2019, 7:34 AM

219592000 | 219592000 | 3/20/2019, 7:34 AM

229385000 | 229385000 | 3/20/2019, 7:34 AM

259187000 | 259187000 | 3/20/2019, 7:34 AM

265001000 | 265001000 | 3/20/2019, 7:34 AM

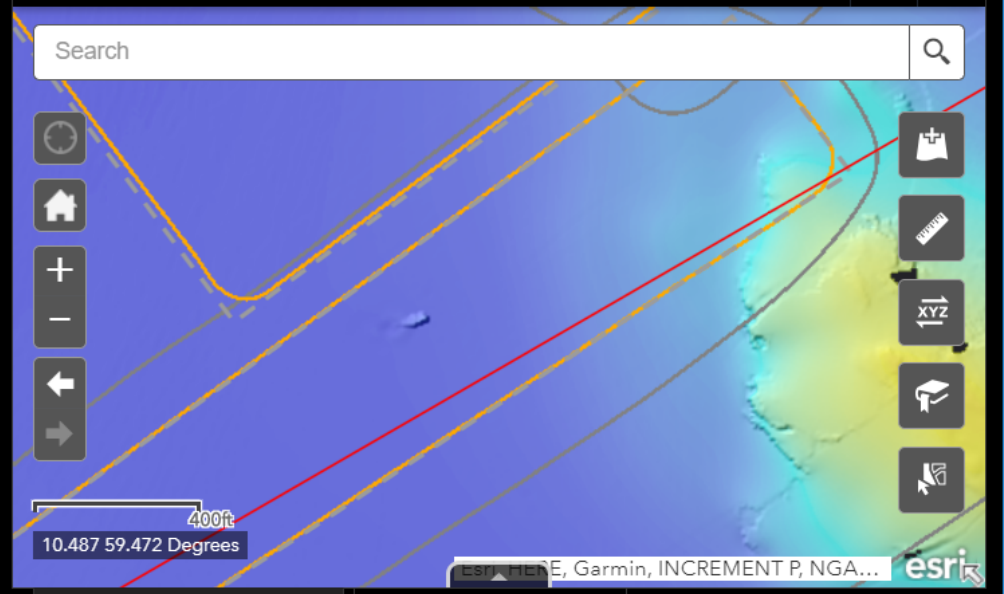
99 | 99 | 3/20/2019, 7:34 AM

123456789 | 123456789 | 3/20/2019, 7:34 AM

Last update: a few seconds ago

SmartOcean - Demo

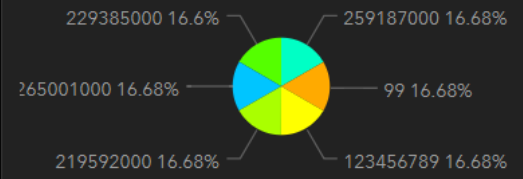
EAI KM



Near Real-Time Bathy Viewer | Windy.com Live Weather

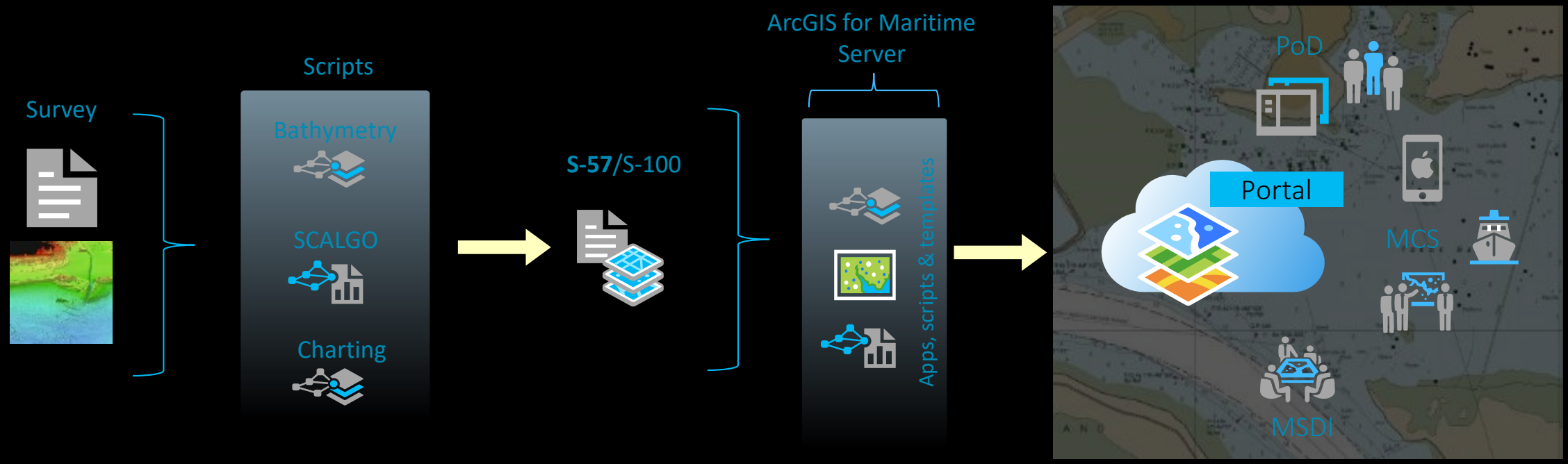
Position Frequency - Current Project

Last update: a few seconds ago



Last update: a few seconds ago

Automated Chart & S-57 File Product Updates



SmartOcean

EARTH ANALYTIC

esri BIS Filter

Filter

Explore Bathymetry

Properties

Name

BIS Dataset Type

Cell Size

0 and

Data Percentage

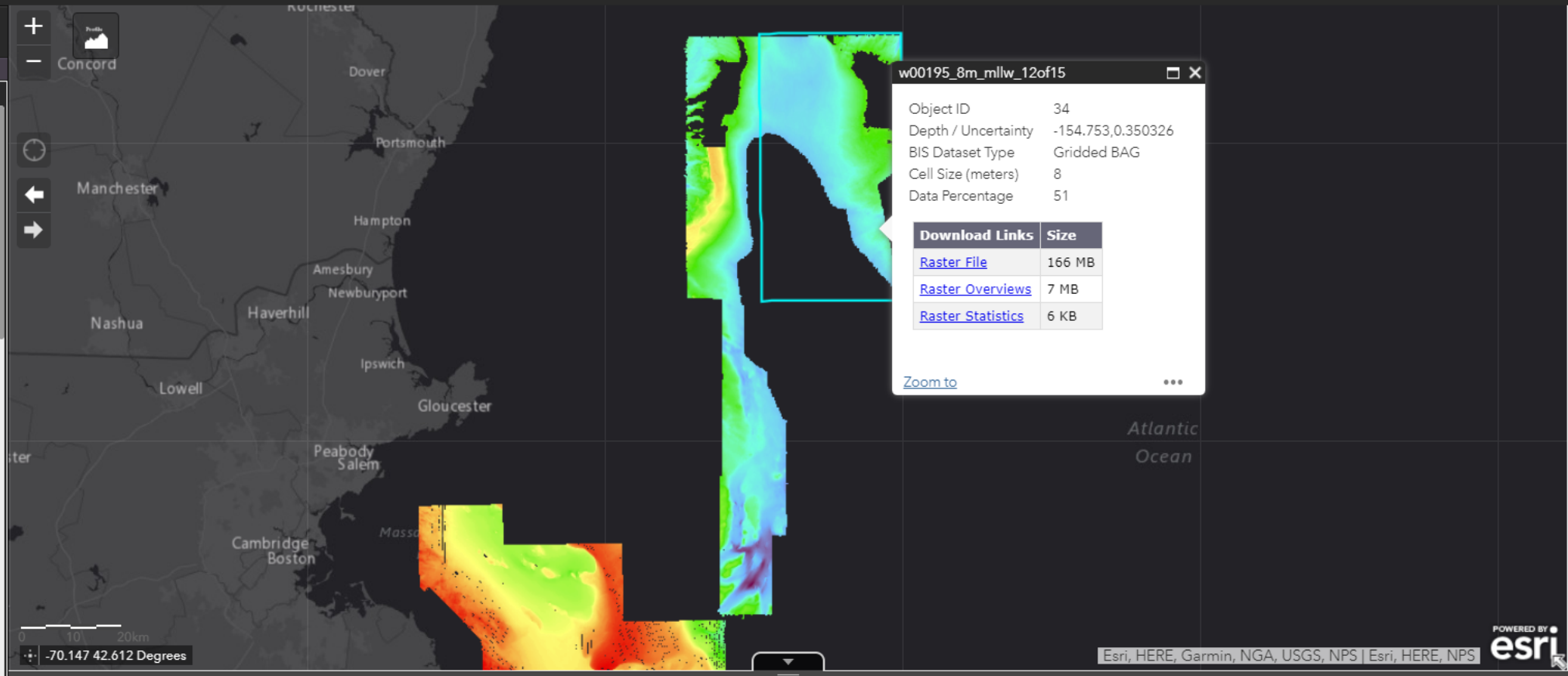
0 and 100

Vertical Units

Direction

Extended Metadata

Ext IHO Survey Order



w00195_8m_mllw_12of15

Object ID	34
Depth / Uncertainty	-154.753,0.350326
BIS Dataset Type	Gridded BAG
Cell Size (meters)	8
Data Percentage	51

Download Links	Size
Raster File	166 MB
Raster Overviews	7 MB
Raster Statistics	6 KB

Zoom to

rest - Bathy/Bathy_MassBay_ImgSrv

Options | Filter by map extent | Zoom to | Clear selection | Refresh

Cell Size	Data Percentage	Vertical Units	Direction	Ext IHO Survey Order	Ext Sensor	Ext Vessel	Ext Data Type	Col Collection Description	Int Title	Int Date	Int Contact Person	Int Responsible Organization	Int Cell Size (X,Y
4	3	Meters	Positive Up	Special	Sensor 1	Vessel 1	Multibeam		H11421_4m_MLLW	January 27,	Chief, Atlantic	NOAA, NOS,	4

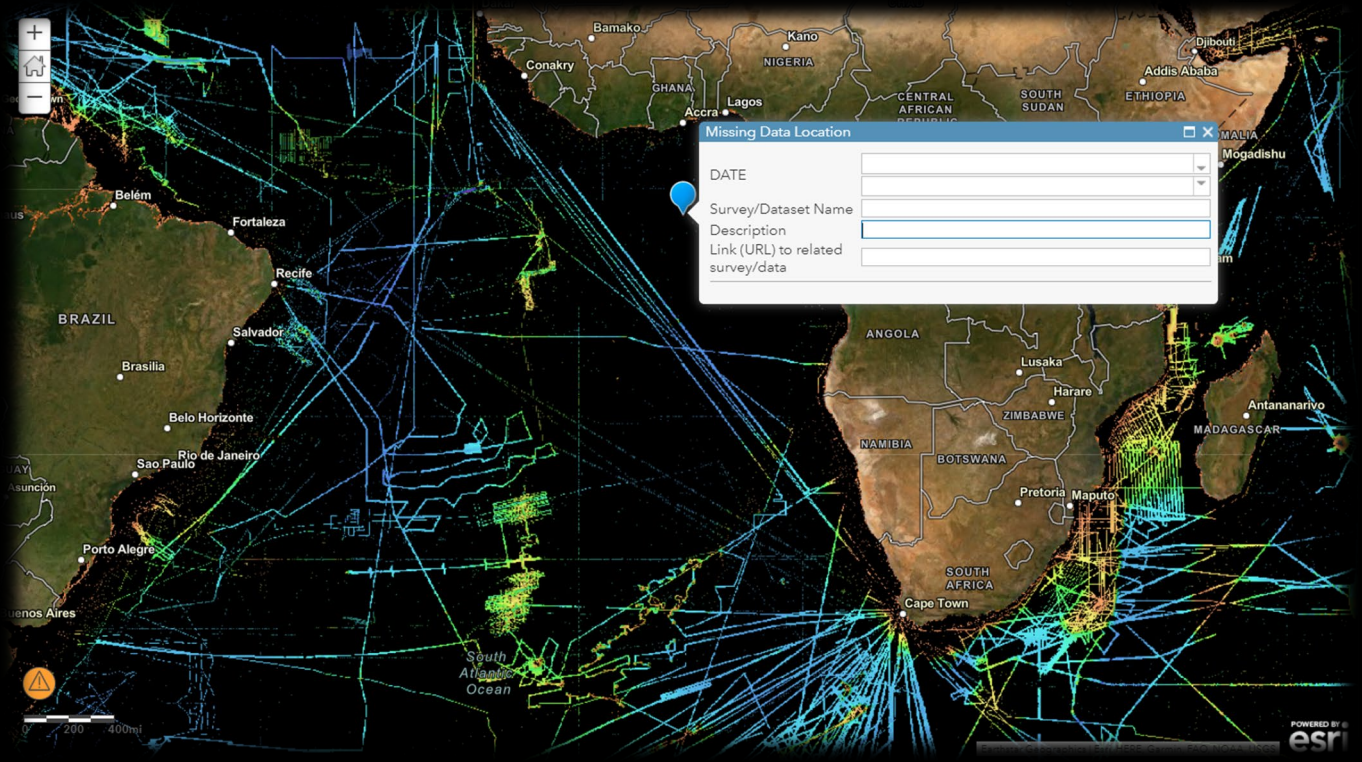
14 features 0 selected

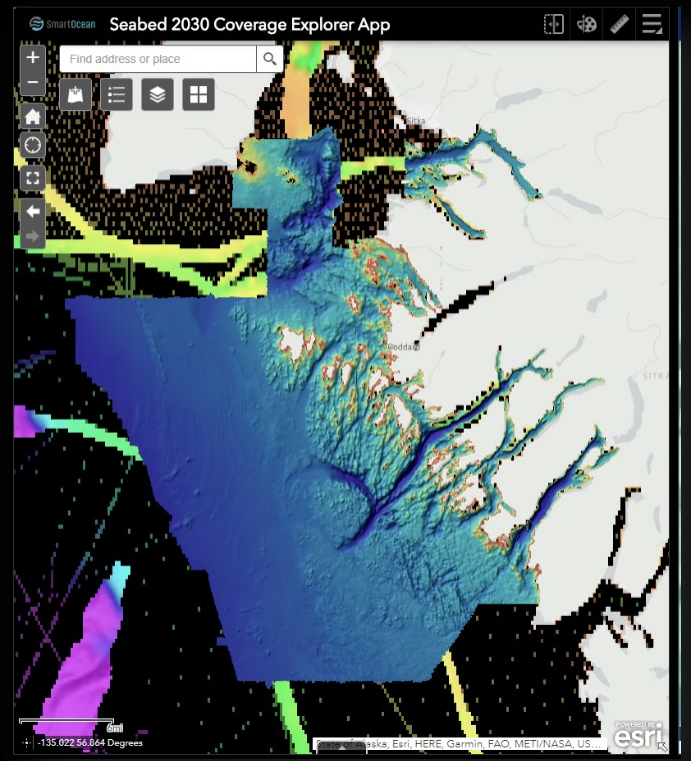
SmartOcean

EARTH ANALYTIC

Seabed 2030 - Map the Gaps Investigator App

Managed Crowdsourcing

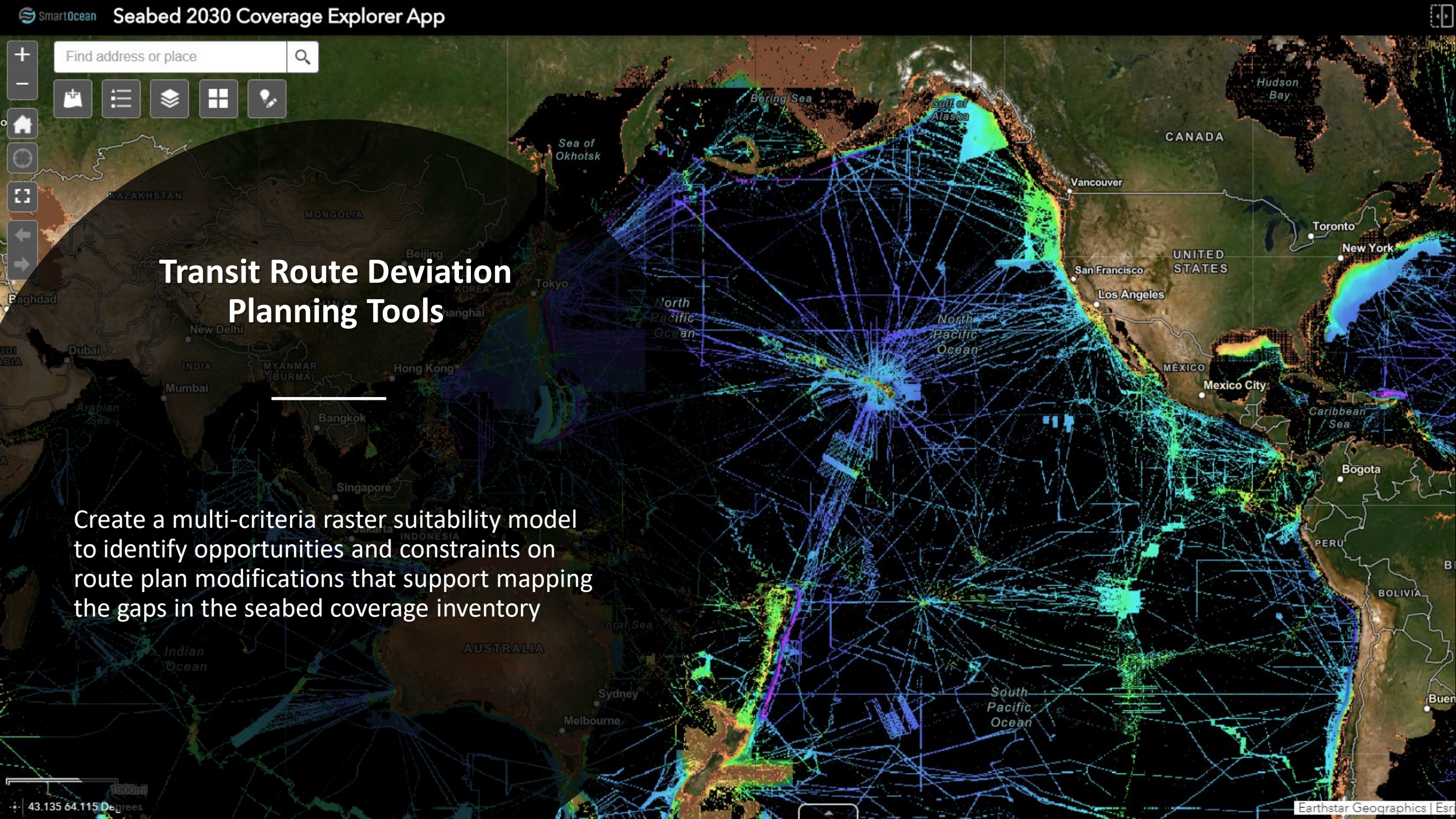




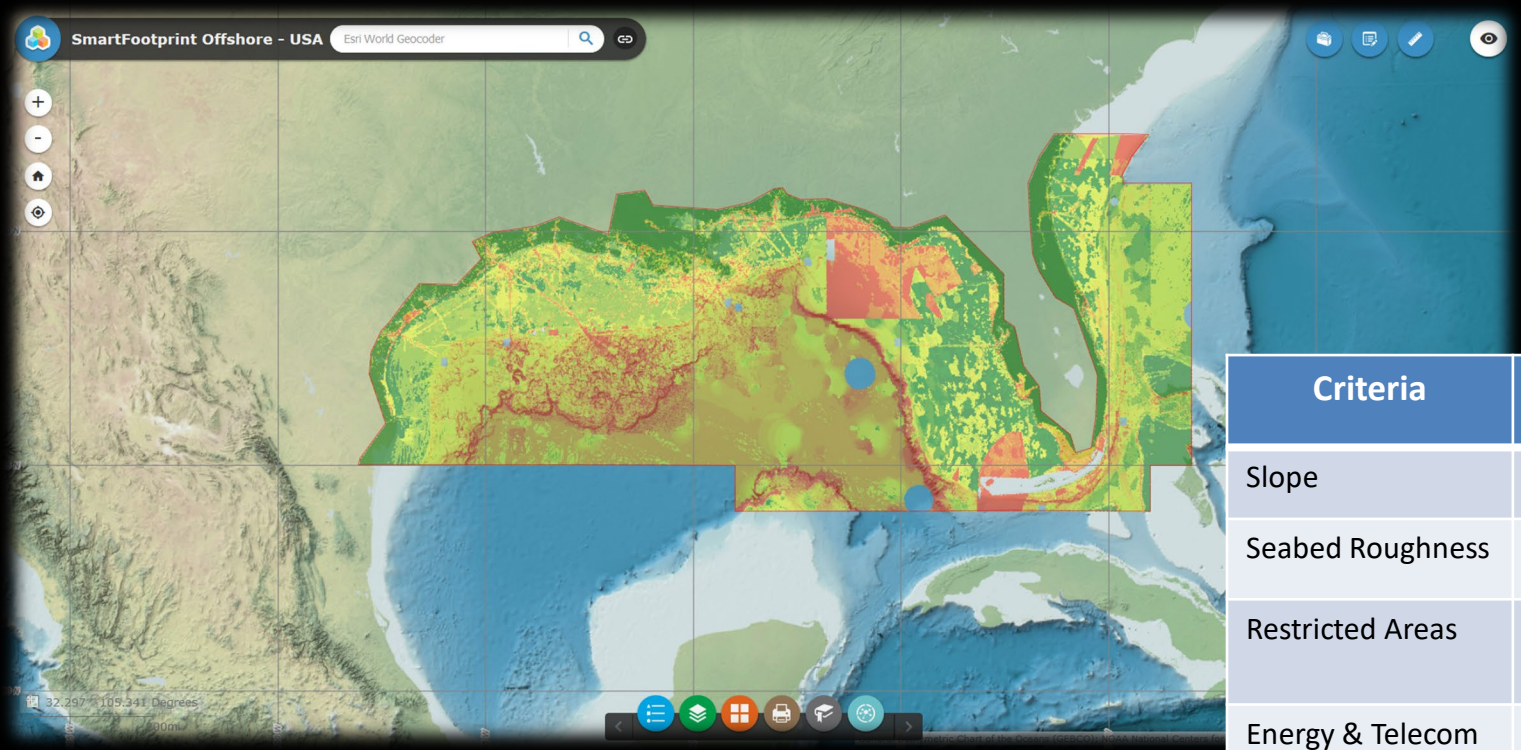
- Showing only mapped (not predicted) areas in apps helps experts and others recognize and point out the gaps that are easy to fix.

- For example, at least some areas in the NOAA “NGDC” are not in the current GEBCO Model (pers. comm. – Guy Noll)

EARTH ANALYTIC

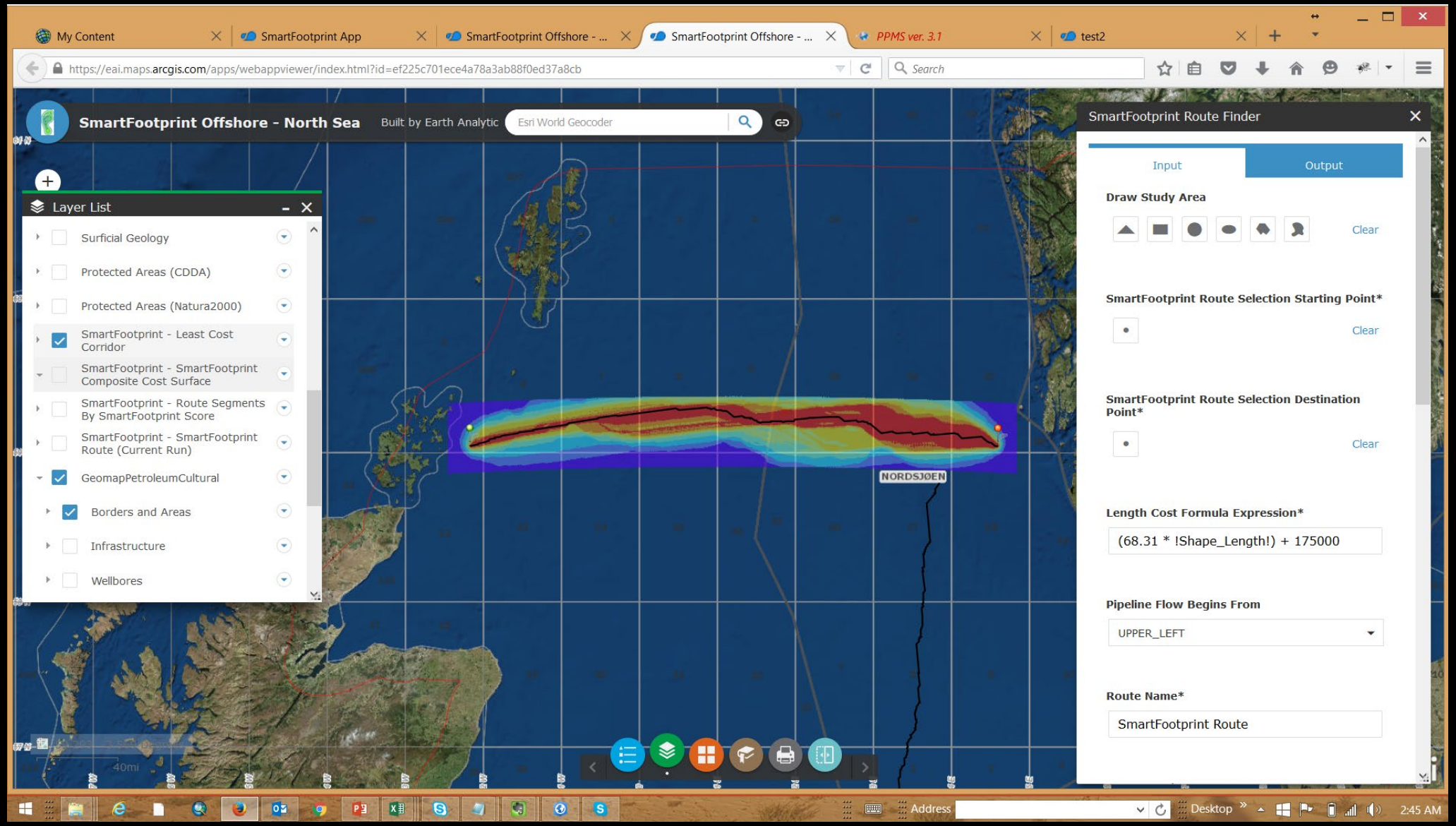

SmartOcean
Seabed 2030 Coverage Explorer App
Find address or place
Transit Route Deviation Planning Tools
Create a multi-criteria raster suitability model to identify opportunities and constraints on route plan modifications that support mapping the gaps in the seabed coverage inventory
Bering Sea
Gulf of Alaska
Hudson Bay
Sea of Okhotsk
CANADA
Vancouver
Toronto
New York
UNITED STATES
San Francisco
Los Angeles
North Pacific Ocean
MÉXICO
Mexico City
Caribbean Sea
Bogota
PERÚ
BOLIVIA
KAZAKHSTAN
MONGOLIA
Beijing
Tokyo
KOREA
Baghdad
New Delhi
Dubai
INDIA
MYANMAR (BURMA)
Hong Kong
Mumbai
Arabian Sea
Bangkok
Singapore
INDONESIA
Coral Sea
AUSTRALIA
Indian Ocean
Sydney
Melbourne
South Pacific Ocean
43.135 64.115 Degrees
Earthstar Geographics | Esri

Offshore Route Selection for Pipelines: Cost Surface Criteria and Weights



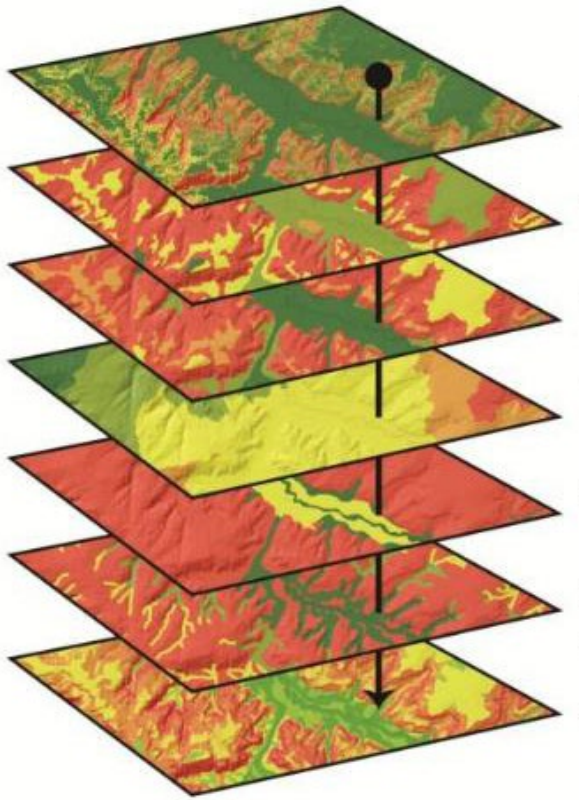
Criteria	Weight	Components
Slope	15%	90m Bathy; Degree Slope
Seabed Roughness	10%	90m Bathy; Roughness Index
Restricted Areas	15%	Unexploded Ordinance, Artificial Reefs, Shipwrecks/Obstacles, , Marine Sanctuaries
Energy & Telecom	10%	Pipelines, cables, platforms; buffer and avoid
Environmentally Sensitive Zones	15%	Seagrasses, Habitats of Particular Concern, Critical Habitats
Surficial Geology	10%	Grain Size/Sediment Type Classes
Vessel (Ship) Traffic	15%	Fairways, Commercial Vessel Density
Depth	10%	90m Bathy; Deeper=more difficult/costly

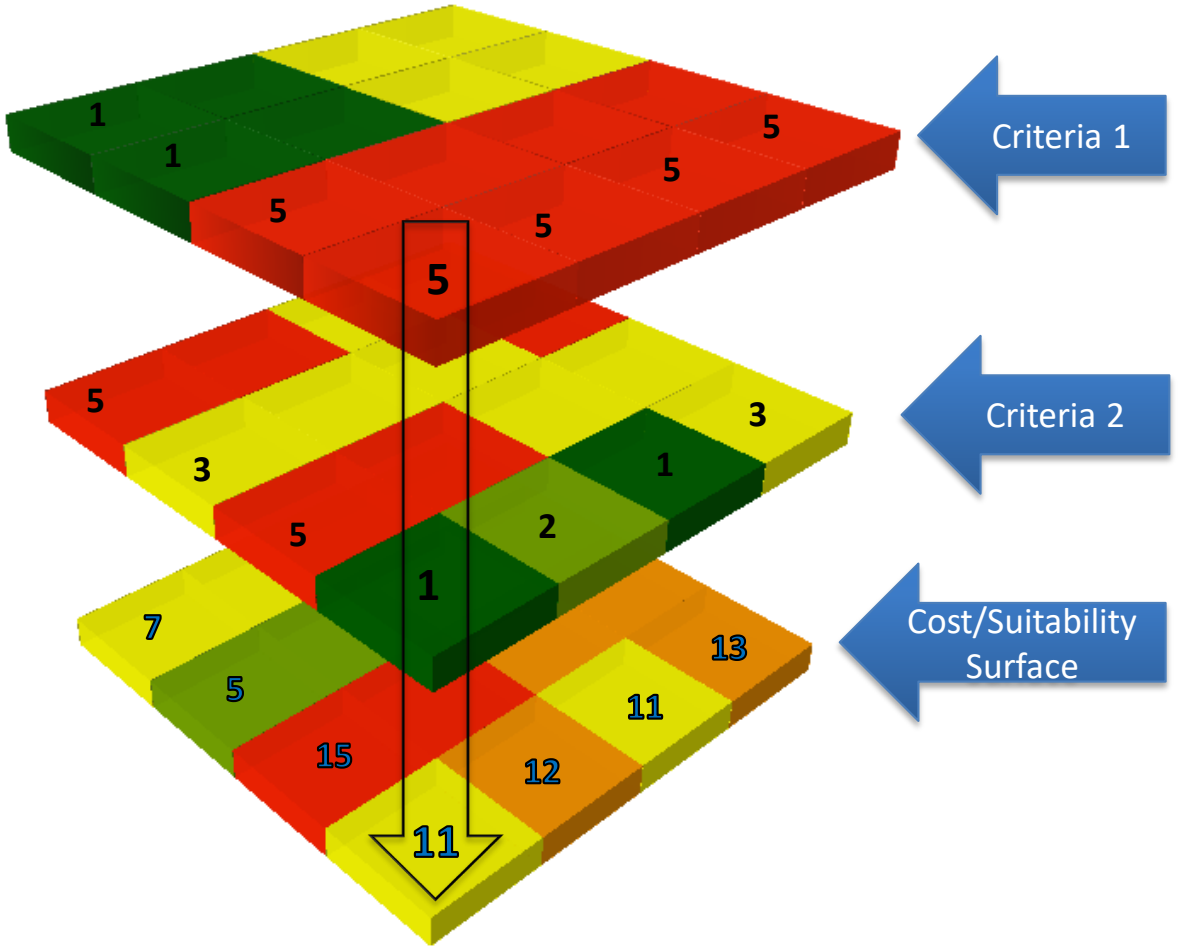
SmartFootprint Route Finder – North Sea Offshore App



EARTH ANALYTIC

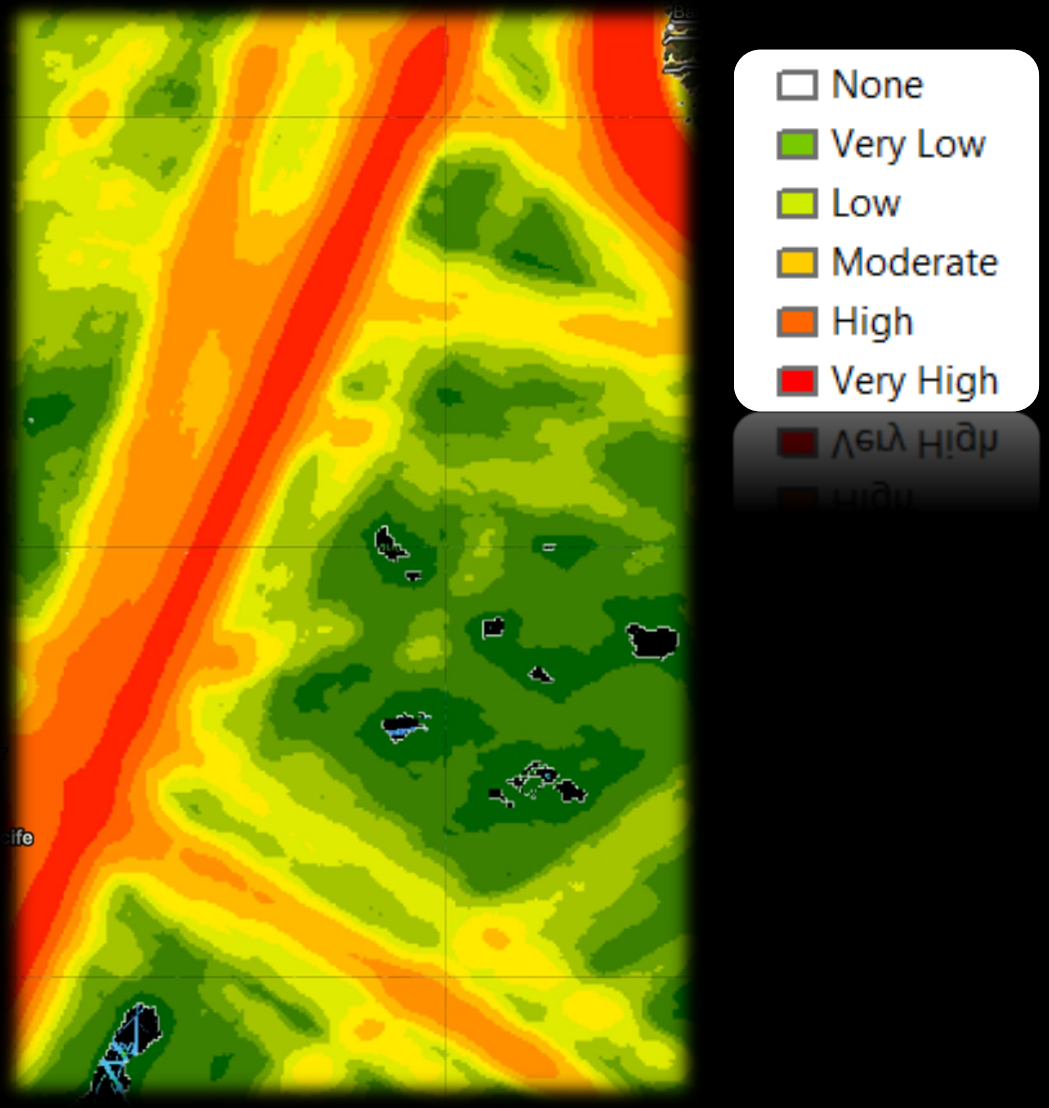
Multi-Criteria Suitability Analysis: Weighted Sum





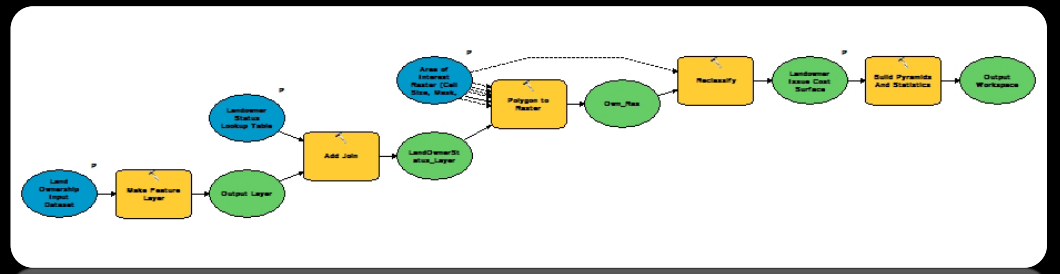
(Criteria 1 * 2) + (Criteria 2 * 1) = Solution

Vessel Traffic Criteria

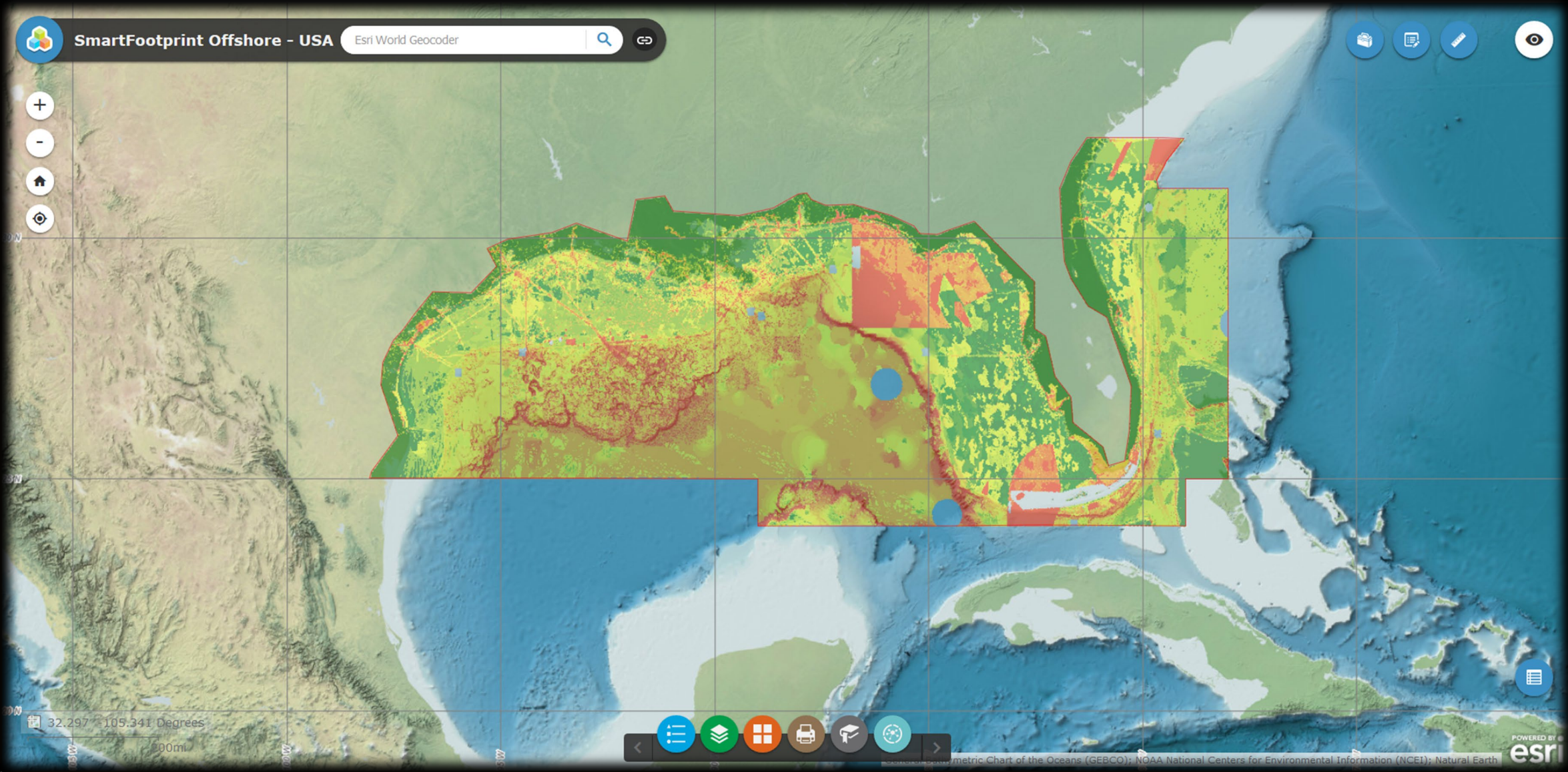


Access/Permission to Survey Criteria

- Restricted Areas | **Score = 4**
- Exclusion Zones | **Score = No Data**
- Envir. Sensitive Areas | **Score = 3**
- All Other Areas | **Score = 0**



SmartFootprint Route Finder – USA Offshore App



SmartFootprint

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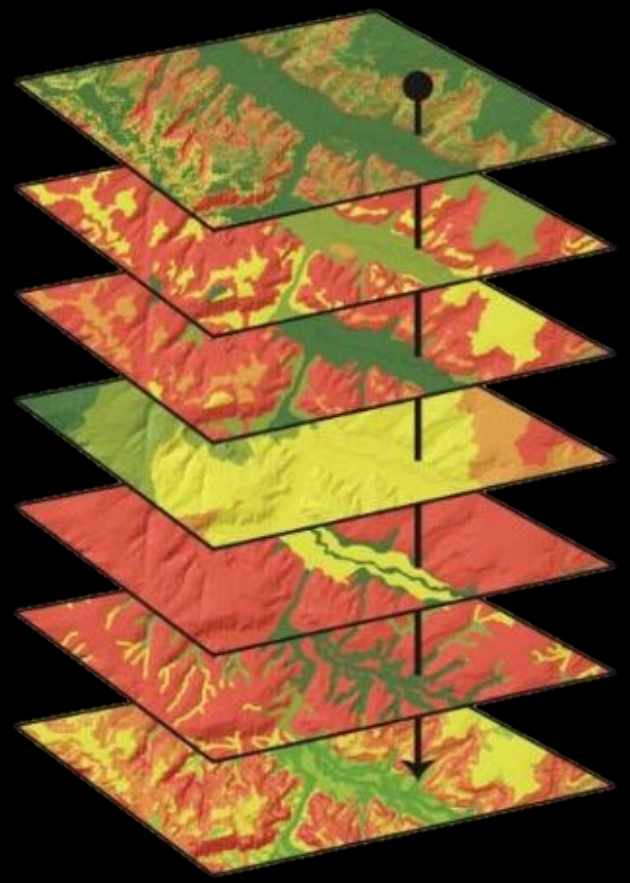
Map the Gaps Transit Deviation Suitability



Criteria	Weight	Components
Follow Seabed Contours	?	GEBCO Grid-Based Slope/Contours
Existing Coverage	?	Presence/Absence, Quality/Resolution, Density
Accessibility Constraints	?	EEZ Authorization, Sensitive areas, Piracy Risk
Energy & Telecom Avoidance	?	Pipelines, cables, platforms; buffer and avoid; likely mapped
Predicted Model Error	?	High Terrain Variability
Surficial Geology	?	Grain Size/Sediment Type Classes
Vessel Traffic Avoidance	?	Fairways, Commercial Vessel Density; Likely Mapped
Current Vessel Capacities	?	Sensor type, depth capability, speed, cost of crew/day, sea-state, AUV (independent coll.)

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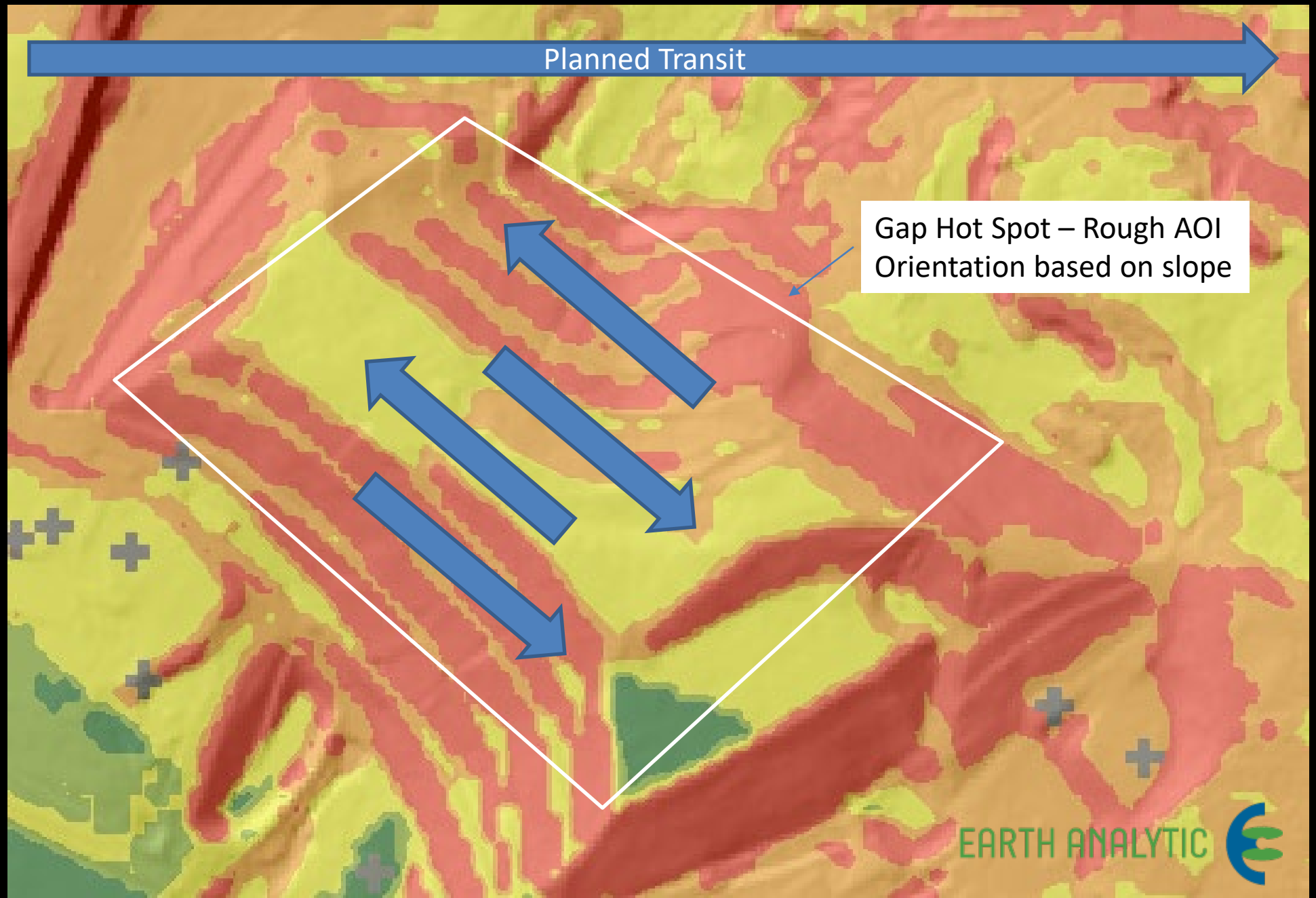
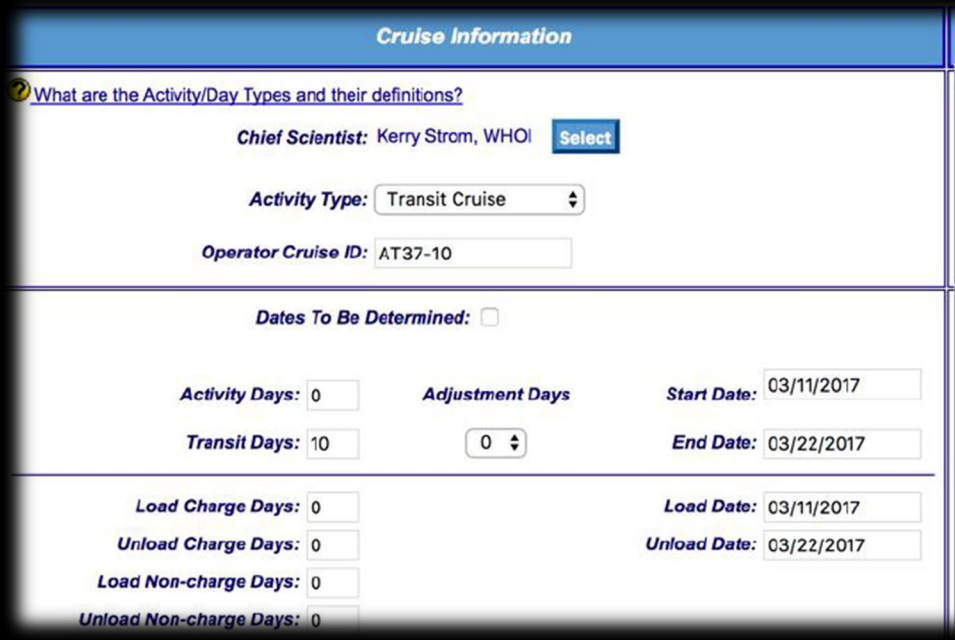
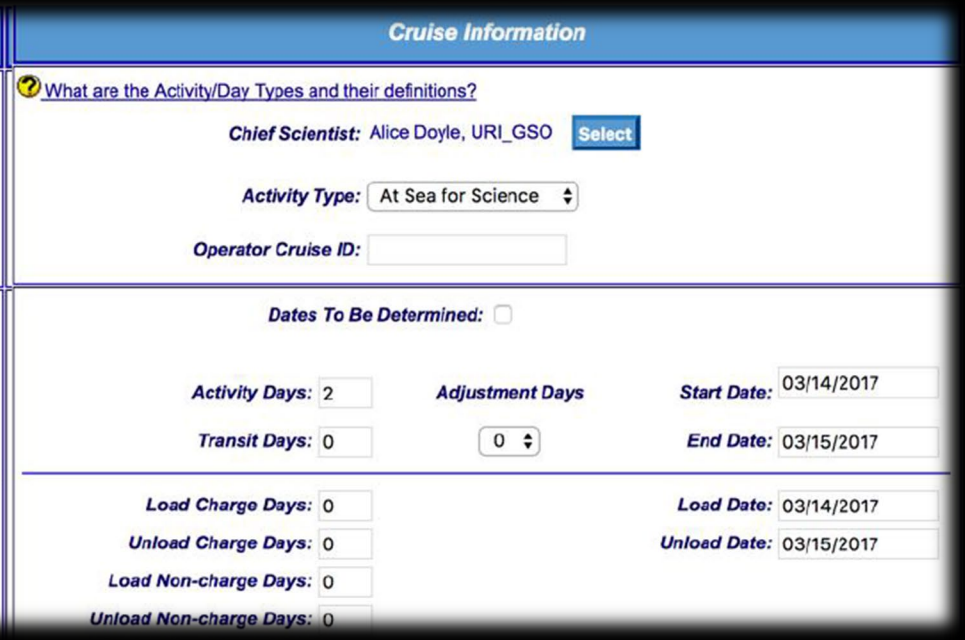
Seabed Slope Criteria Example

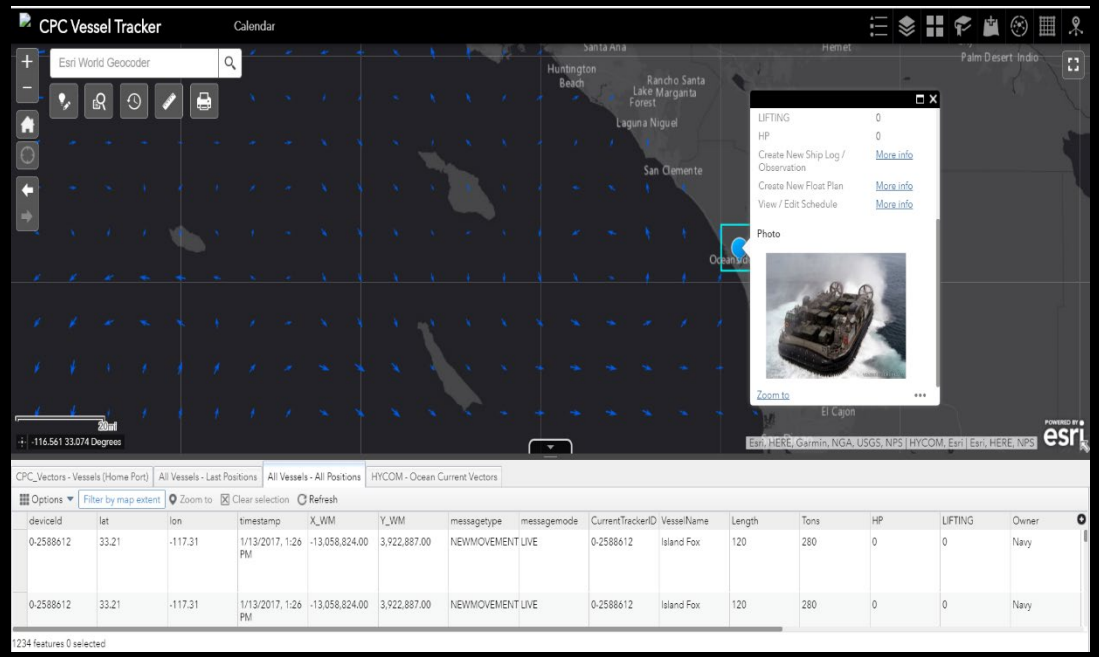


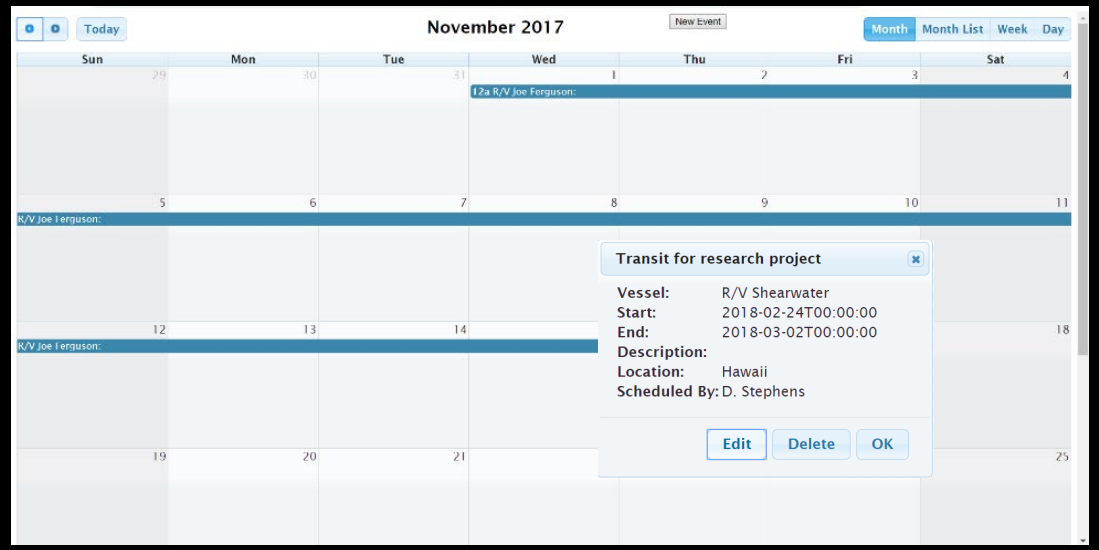
Leverage and Extend UNOLS Cruise Scheduling / Cost Calculator Functionality

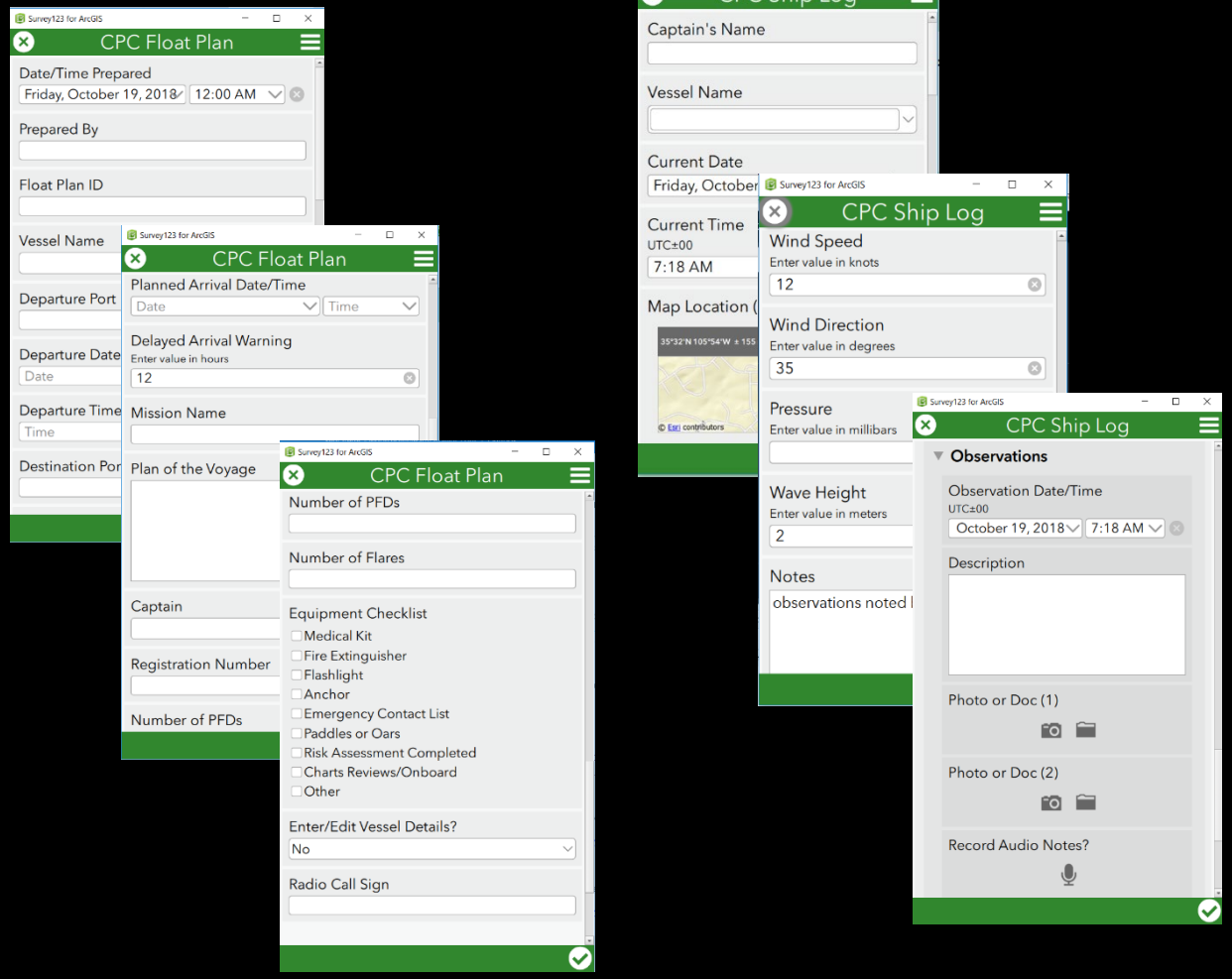




Vessel Tracking, Scheduling, Digital Float Plans and Ship Logs







SmartOcean

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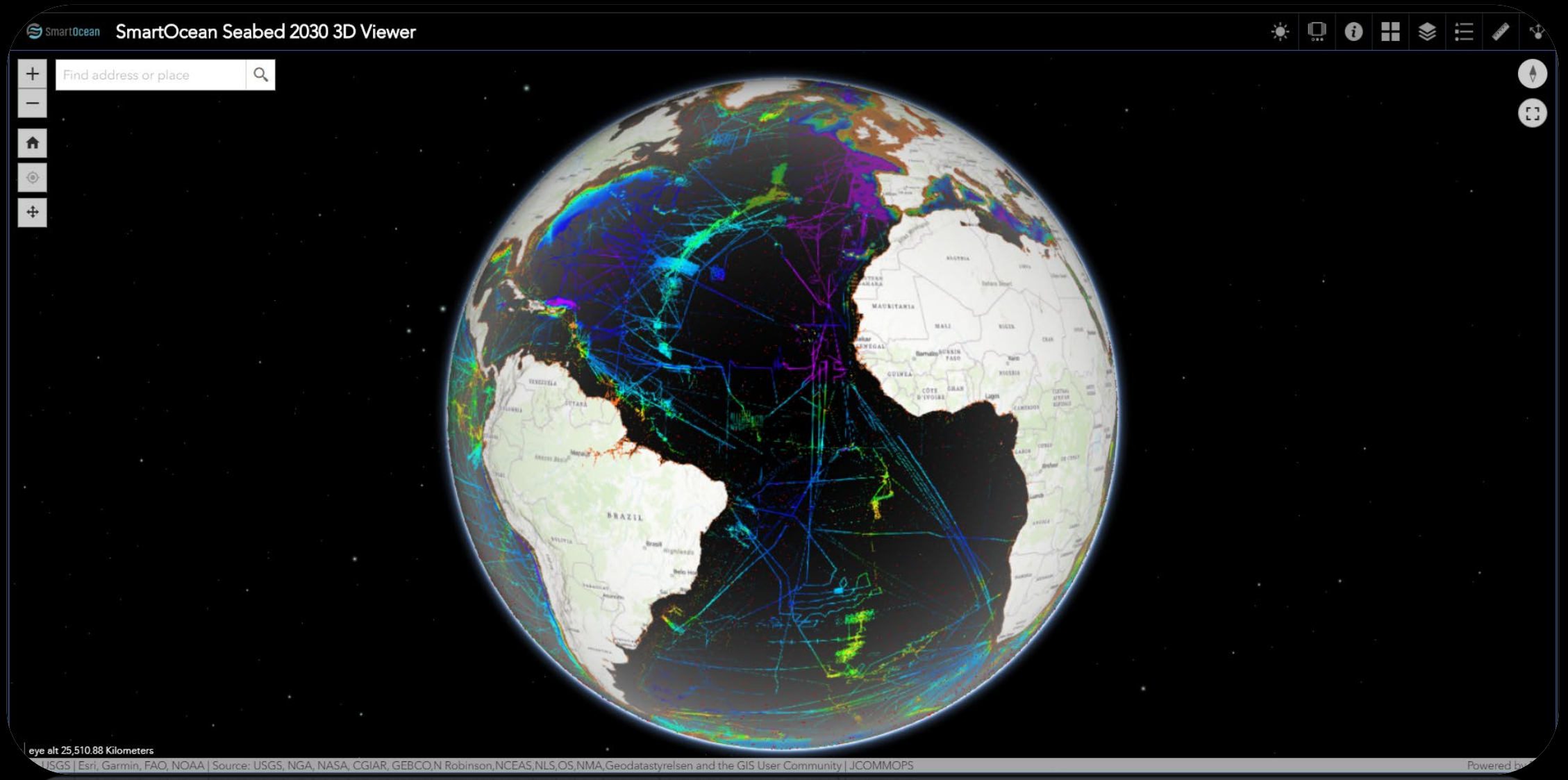
There Be Beasts: Don’t Sugar-Coat It



http://arcg.is/1Pm59D