Topobathy Lidar in the Coastal Mapping Program

Stephen White

NOAA

National Geodetic Survey/Remote Sensing Division

National Geodetic Survey

Mission: Define, maintain and provide access to the National Spatial Reference System.

RSD Primary Programs:

Aeronautical Survey Program

Coastal Mapping Program

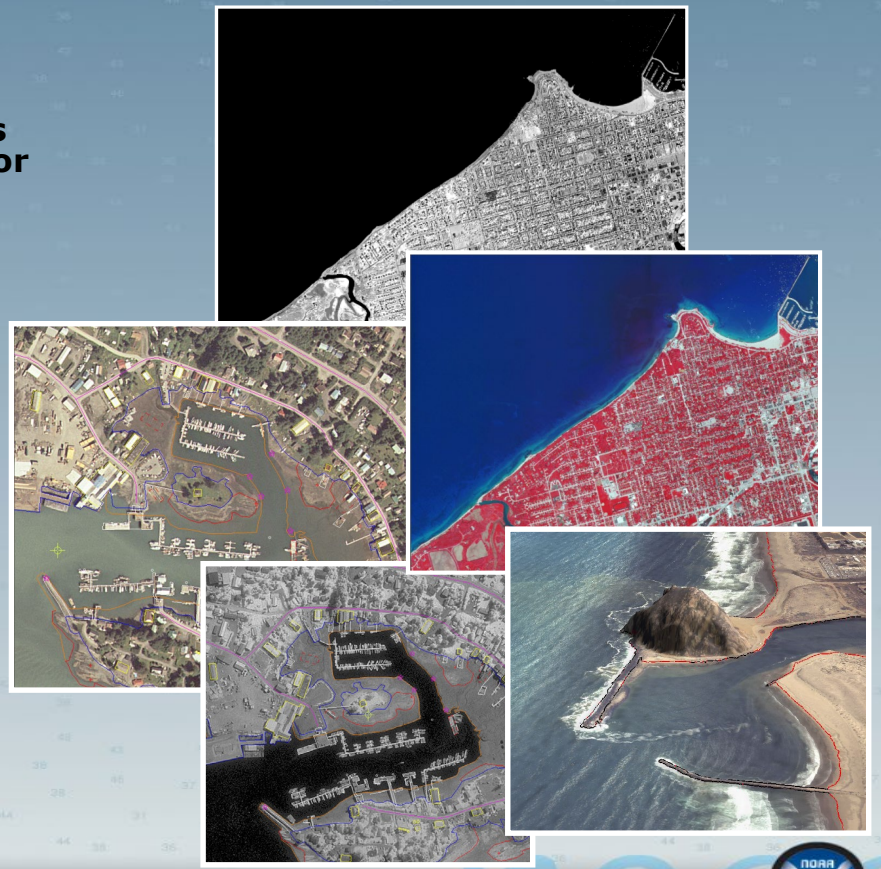
Emergency Response

The RSD Coastal Mapping Program

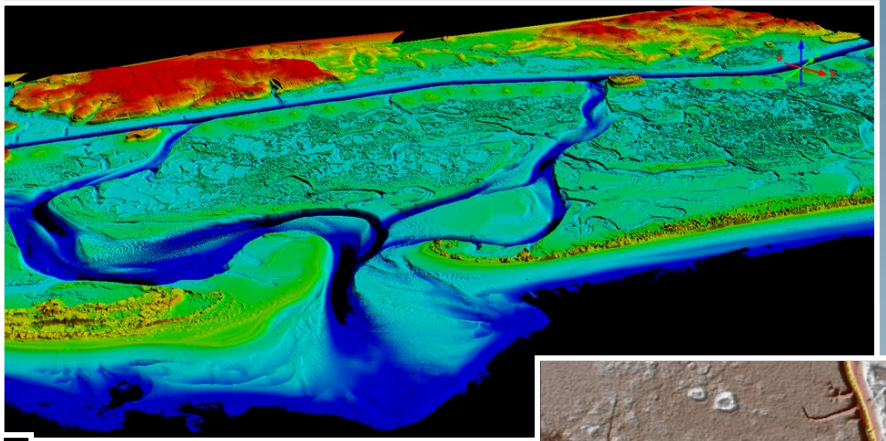
- **A congressional mandate to conduct remote sensing surveys of coastal regions of the United States and its possessions for demarcating the nation's legal coastline.**

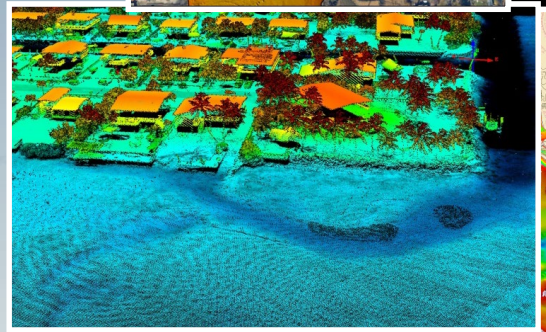
- **Goals:**
  - Provide the Nation With Accurate, Consistent, Up-to-Date National Shoreline
  - Acquire Nearshore Elevation Data

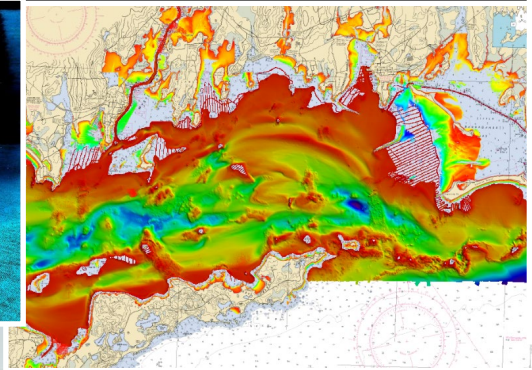
- **Sources:**
  - **Lidar**
  - **Digital Cameras**
  - **High Resolution Satellites**
  - **UAS**

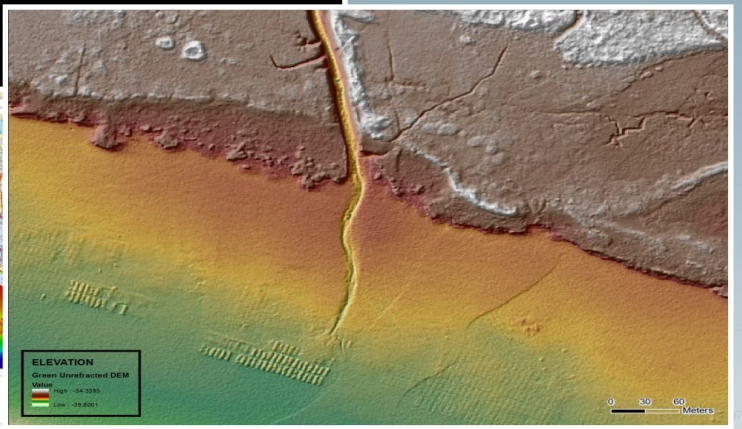


NGS Topobathy lidar data



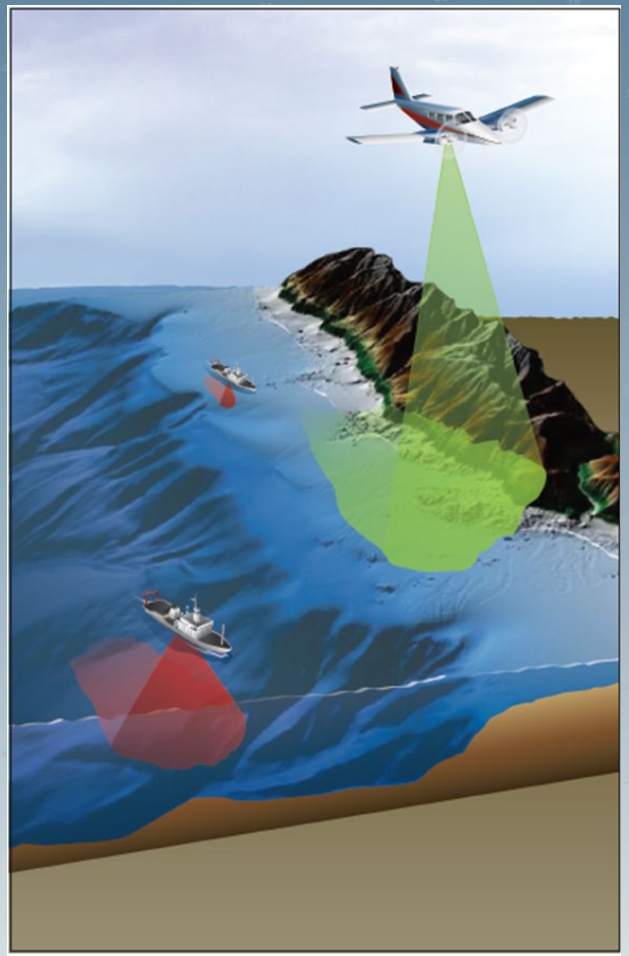






Support of Hydrographic Surveys

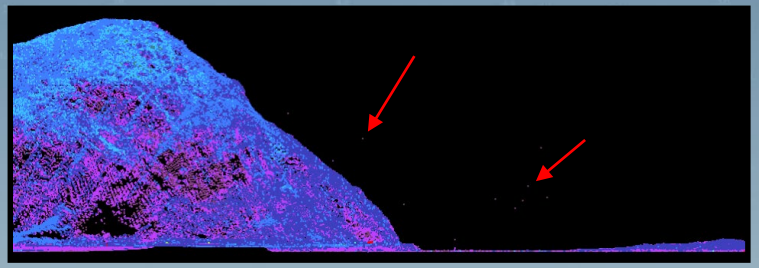
- RSD collects nearshore topobathy lidar to the 4m NALL in the year prior to ship ops
- RSD will provide both shoreline and nearshore bathymetry
- Hydro operations will use this data to plan operations and overall situational awareness
- Increases efficiency and safety of launch and ship operations

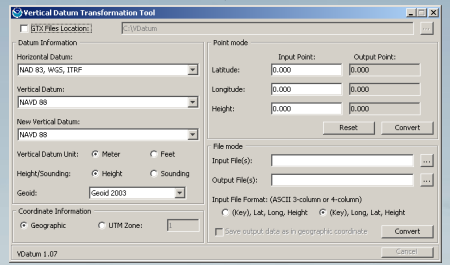


Graphic courtesy of Dewberry

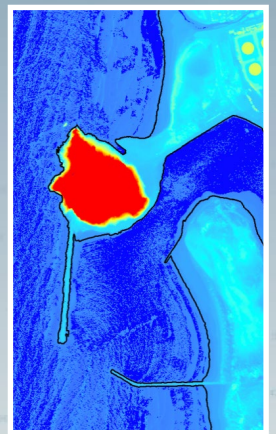
Lidar Shoreline Extraction

Edit Lidar Point Cloud

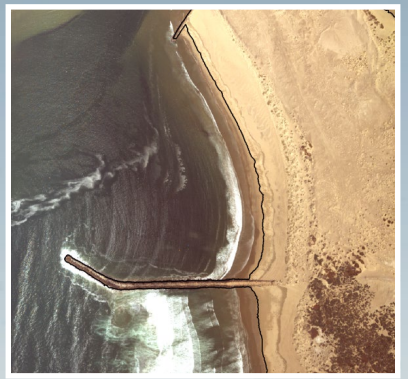




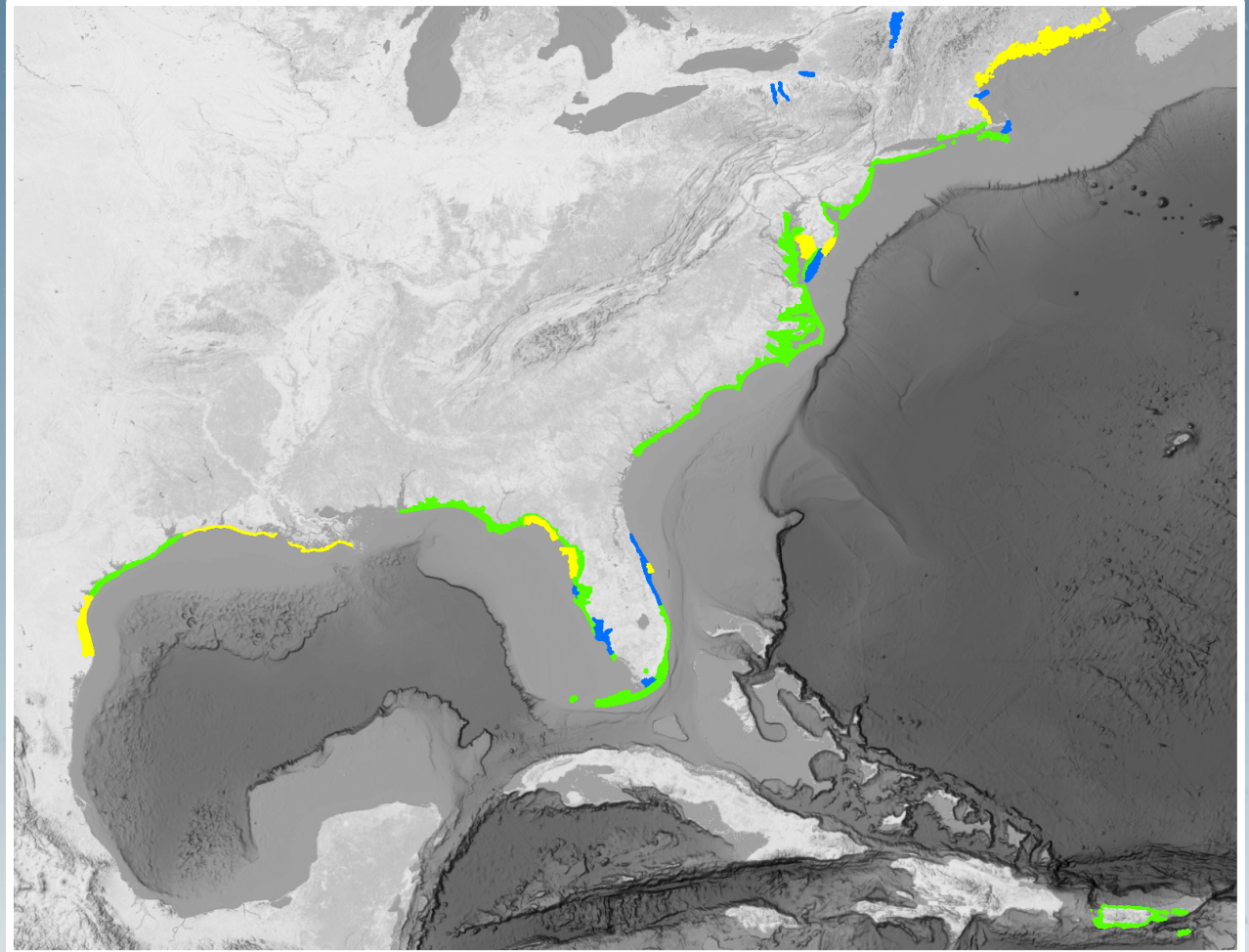
VDatum



Contour Shoreline from DEM



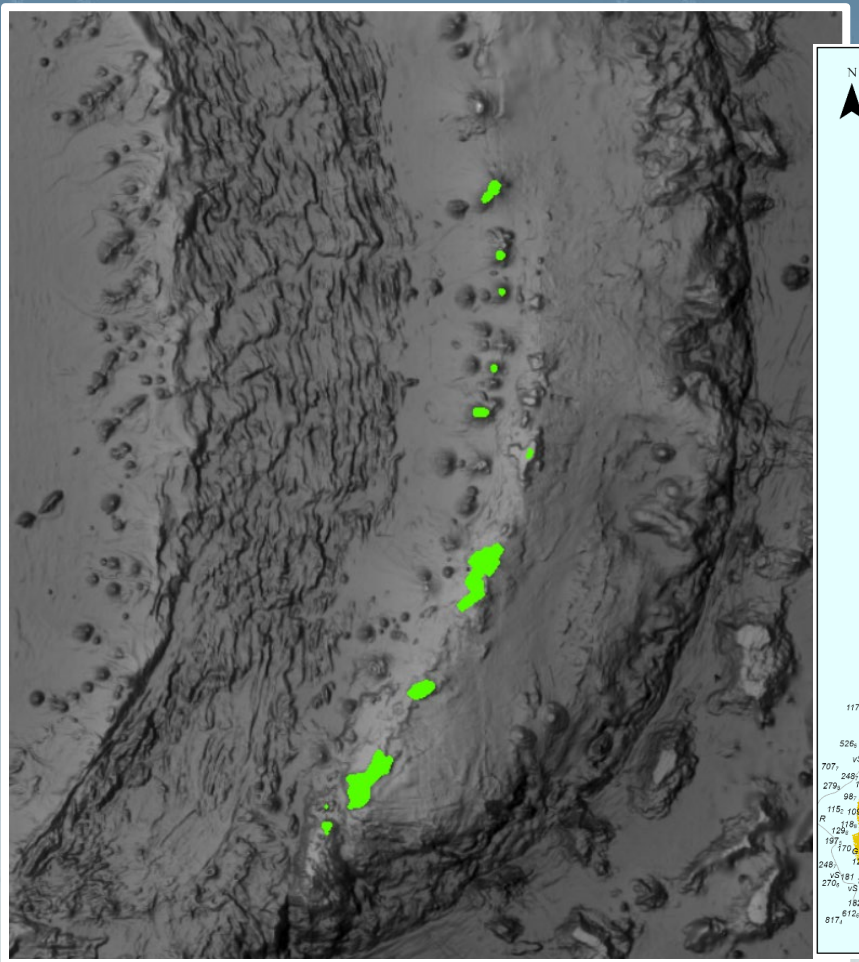
Quality Control &
Feature Attribution

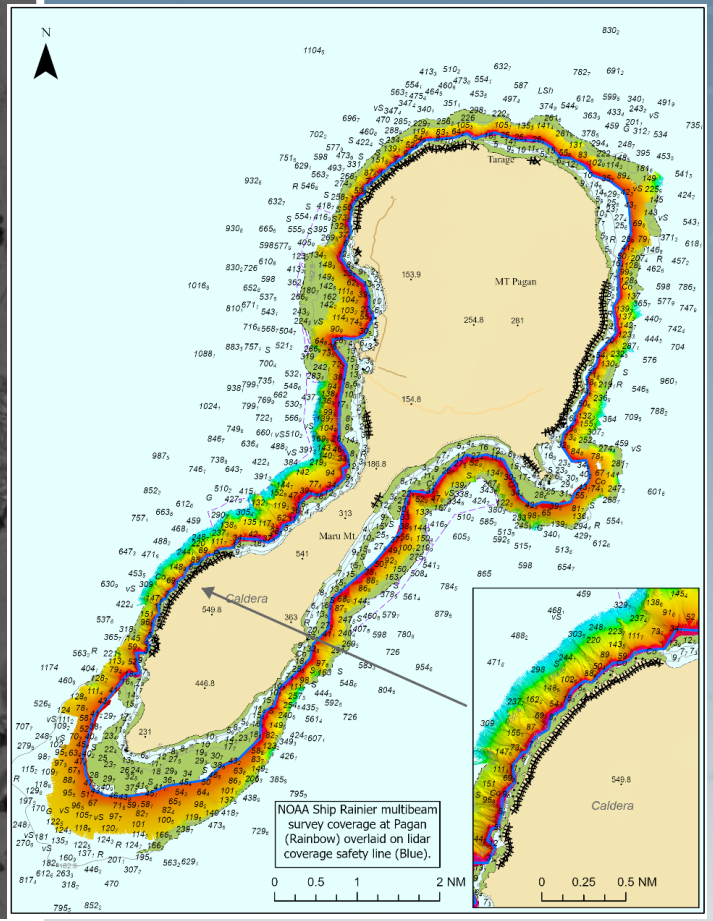

topobathy_tracking_inhouse projects
Planned
Acquired
Completed

Leica HawkEye 4X Deep Bathymetric LiDAR Sensor

The most efficient and powerful sensor for deep bathymetric surveying delivers 4X the point density

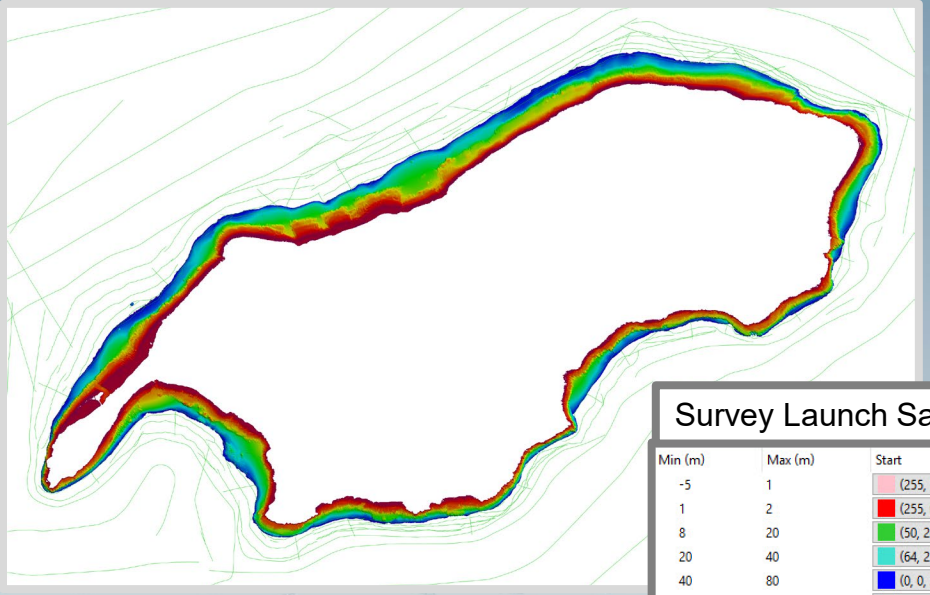
Guam and the Northern Marianas



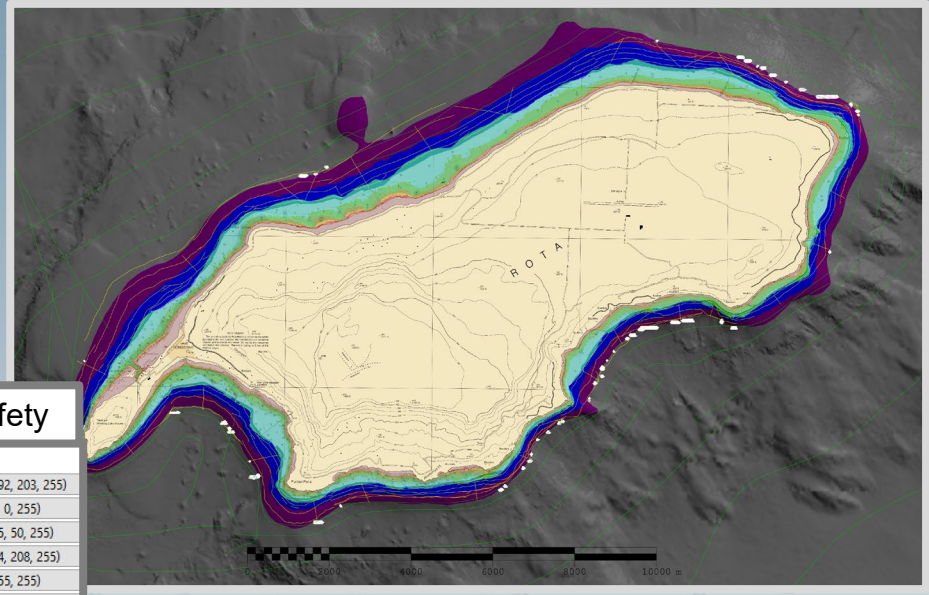


Rota

Lidar



Lidar + MBES

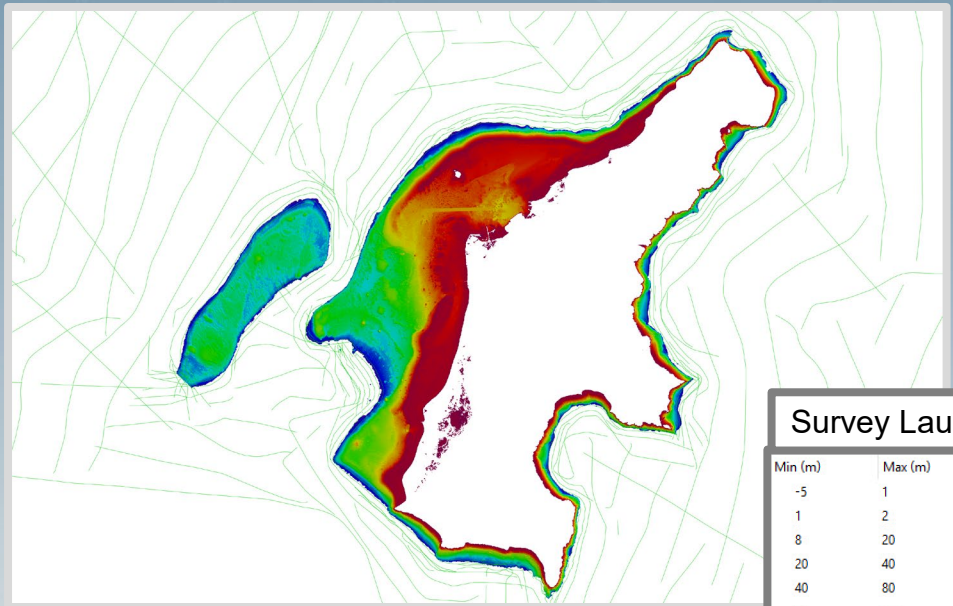


Survey Launch Safety

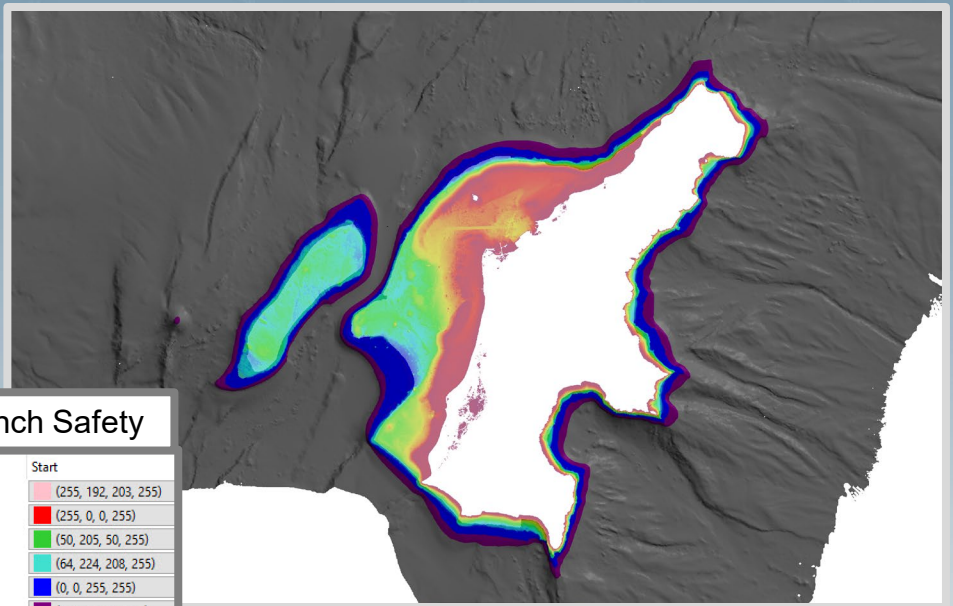
Min (m)	Max (m)	Start
-5	1	(255, 192, 203, 255)
1	2	(255, 0, 0, 255)
8	20	(50, 205, 50, 255)
20	40	(64, 224, 208, 255)
40	80	(0, 0, 255, 255)
80	160	(128, 0, 128, 255)
160	500	(127, 127, 127, 255)
2	3.5	(255, 215, 0, 255)
3.501	8	(139, 139, 0, 255)

Saipan

Lidar



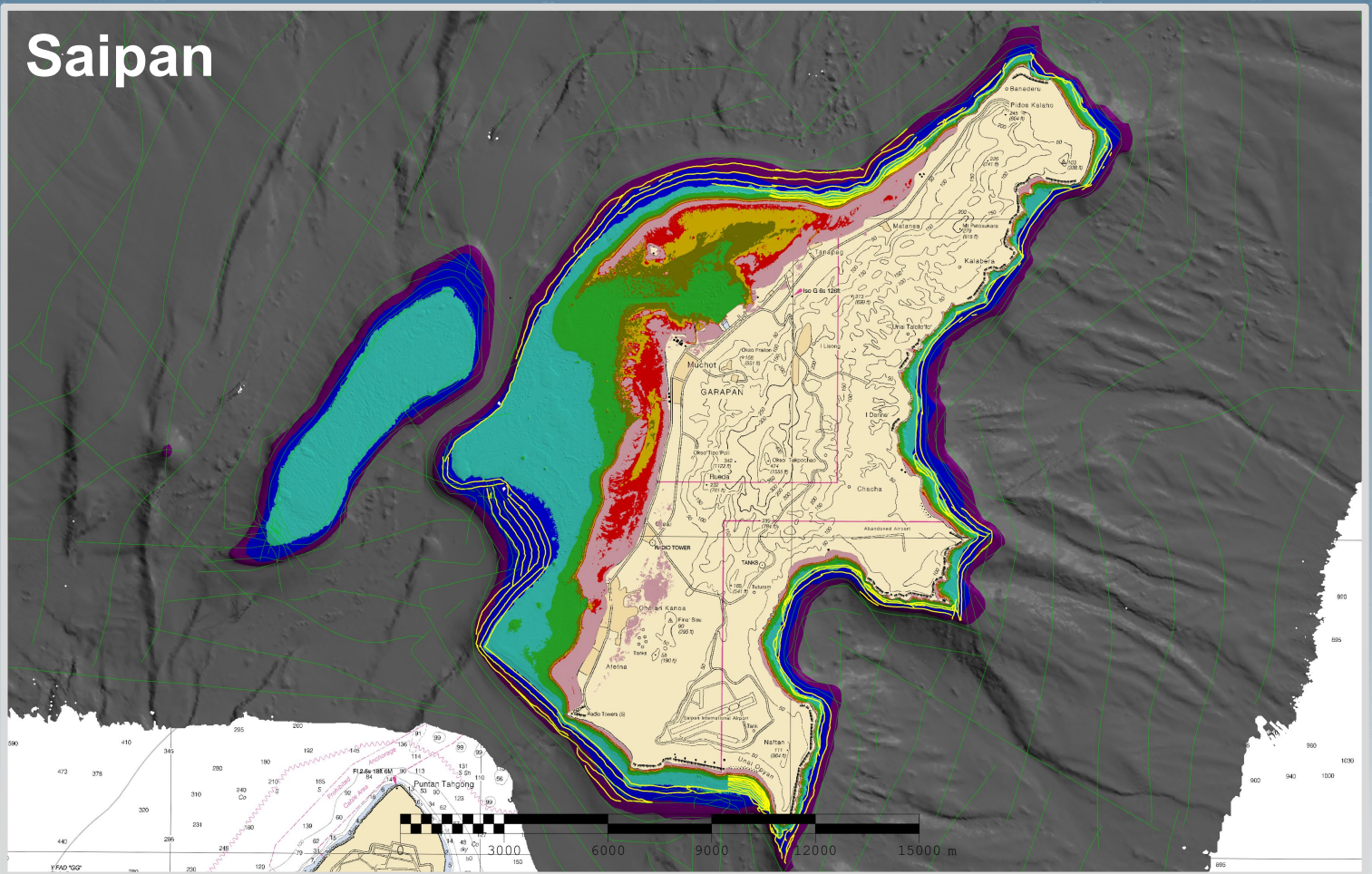
Lidar + MBES



Survey Launch Safety

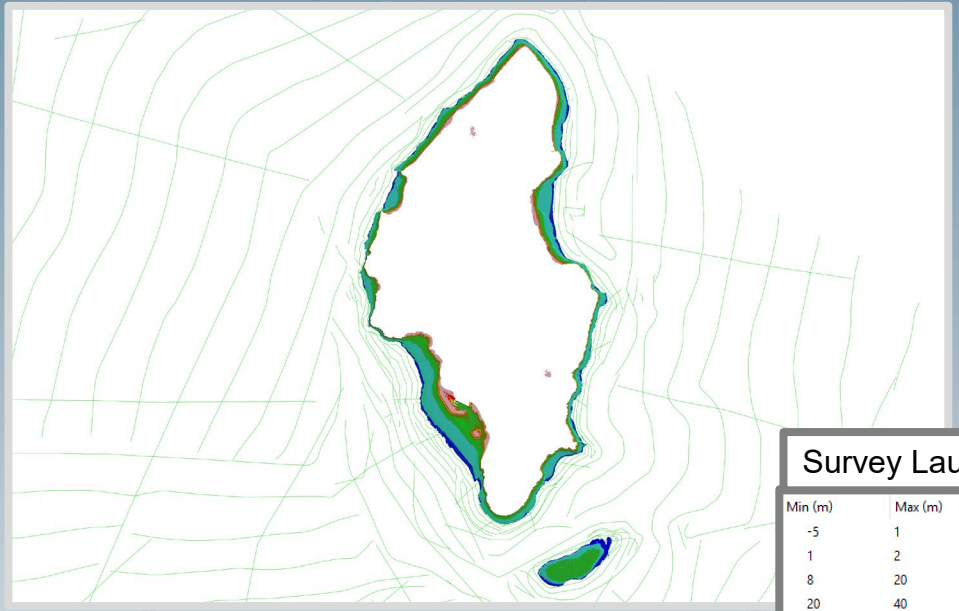
Min (m)	Max (m)	Start
-5	1	(255, 192, 203, 255)
1	2	(255, 0, 0, 255)
8	20	(50, 205, 50, 255)
20	40	(64, 224, 208, 255)
40	80	(0, 0, 255, 255)
80	160	(128, 0, 128, 255)
160	500	(127, 127, 127, 255)
2	3.5	(255, 215, 0, 255)
3.501	8	(139, 139, 0, 255)

Saipan

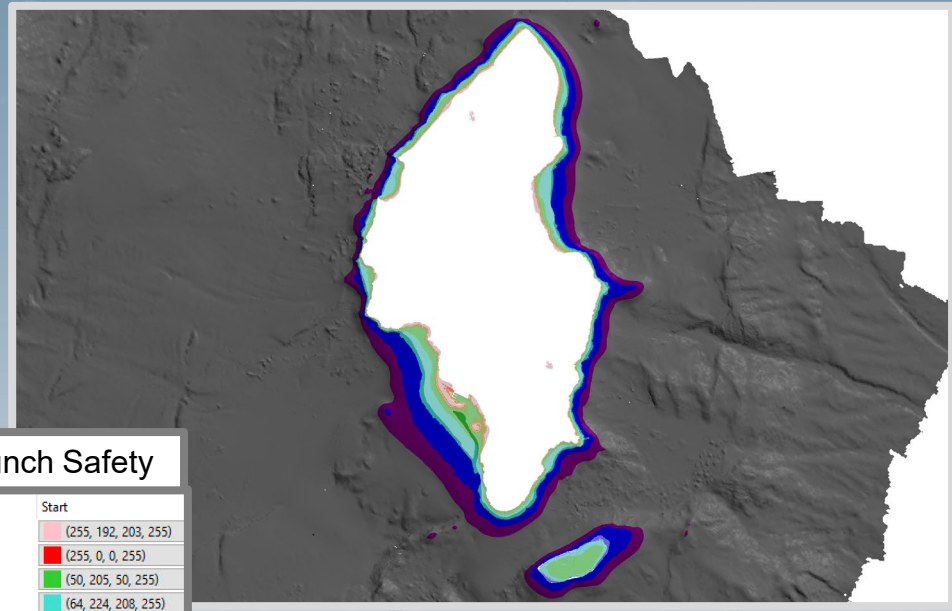

Muchot
GARAPAN
Chacha
Afetna
Nattan
Puntan Tahgong
3000
6000
9000
12000
15000 m

Tinian

Lidar

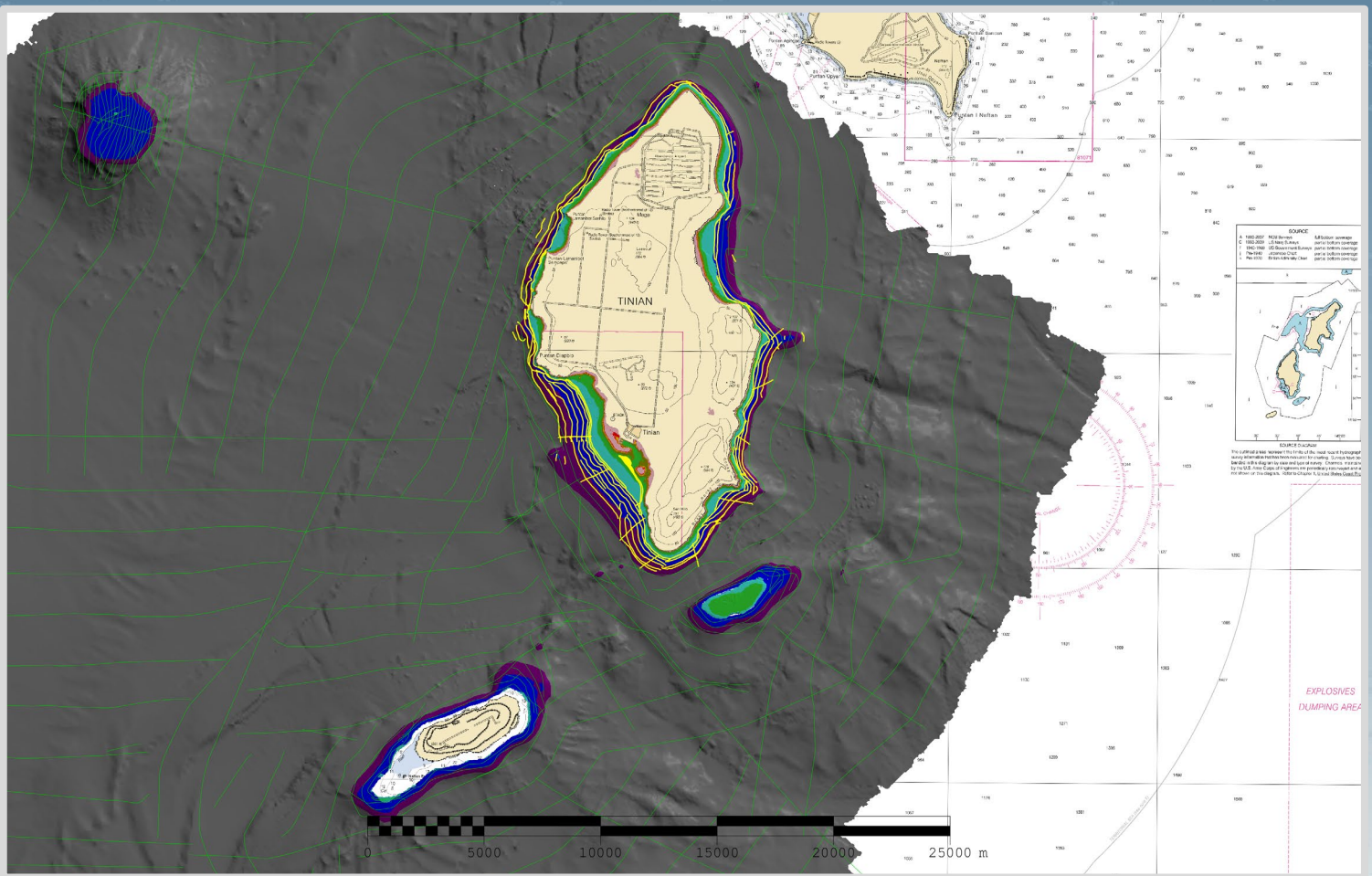


Lidar + MBES



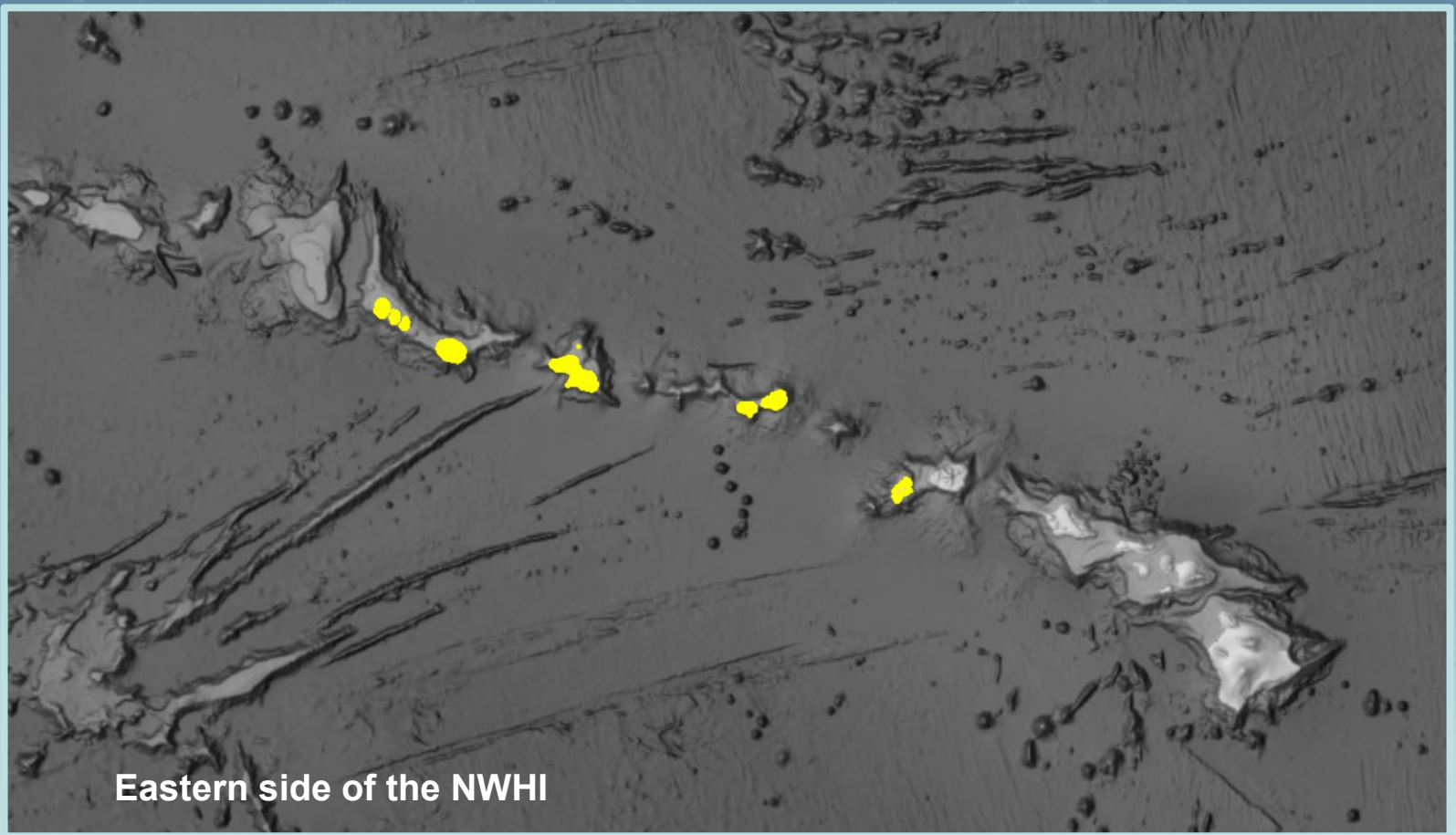
Survey Launch Safety

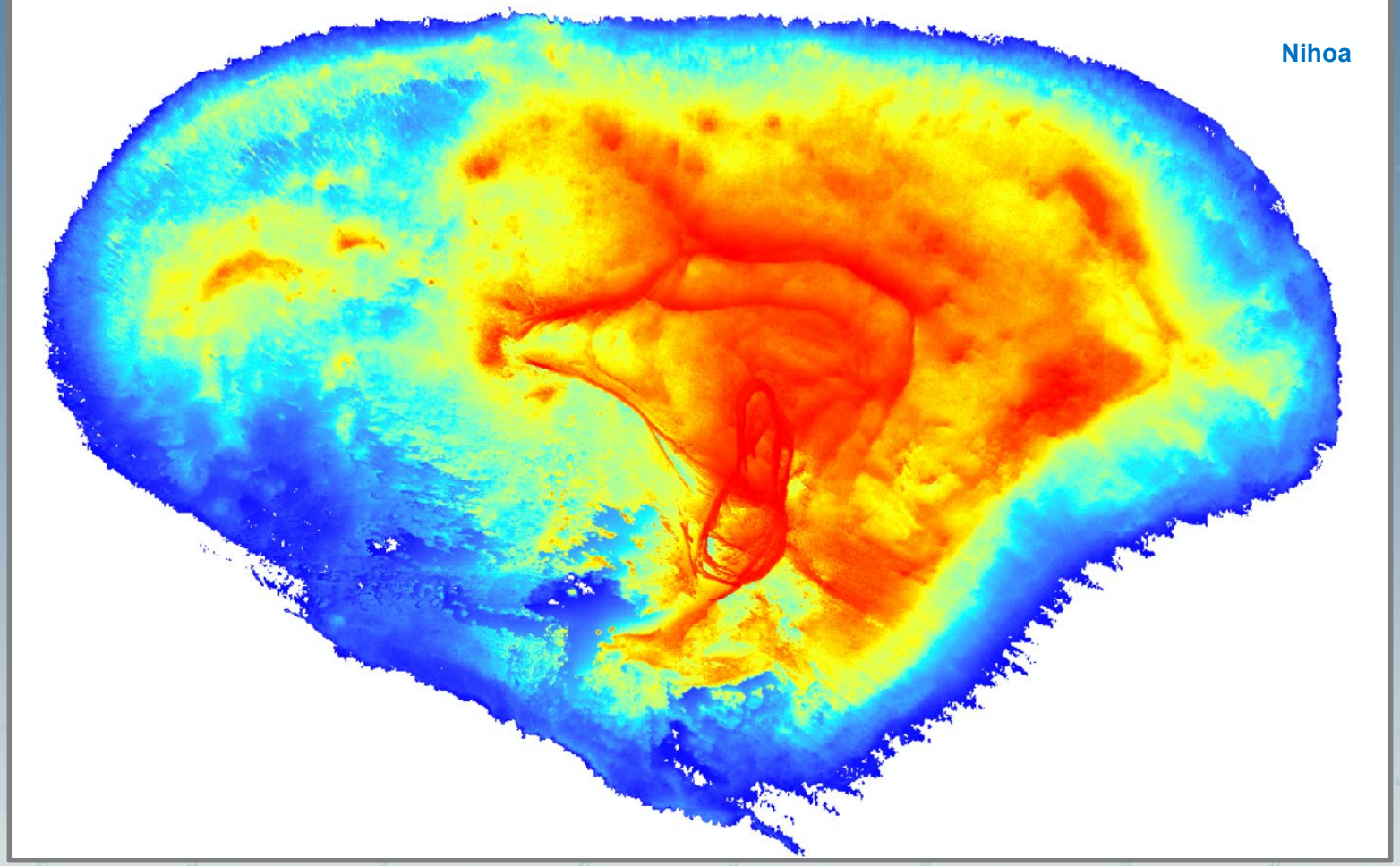
Min (m)	Max (m)	Start
-5	1	(255, 192, 203, 255)
1	2	(255, 0, 0, 255)
8	20	(50, 205, 50, 255)
20	40	(64, 224, 208, 255)
40	80	(0, 0, 255, 255)
80	160	(128, 0, 128, 255)
160	500	(127, 127, 127, 255)
2	3.5	(255, 215, 0, 255)
3.501	8	(139, 139, 0, 255)

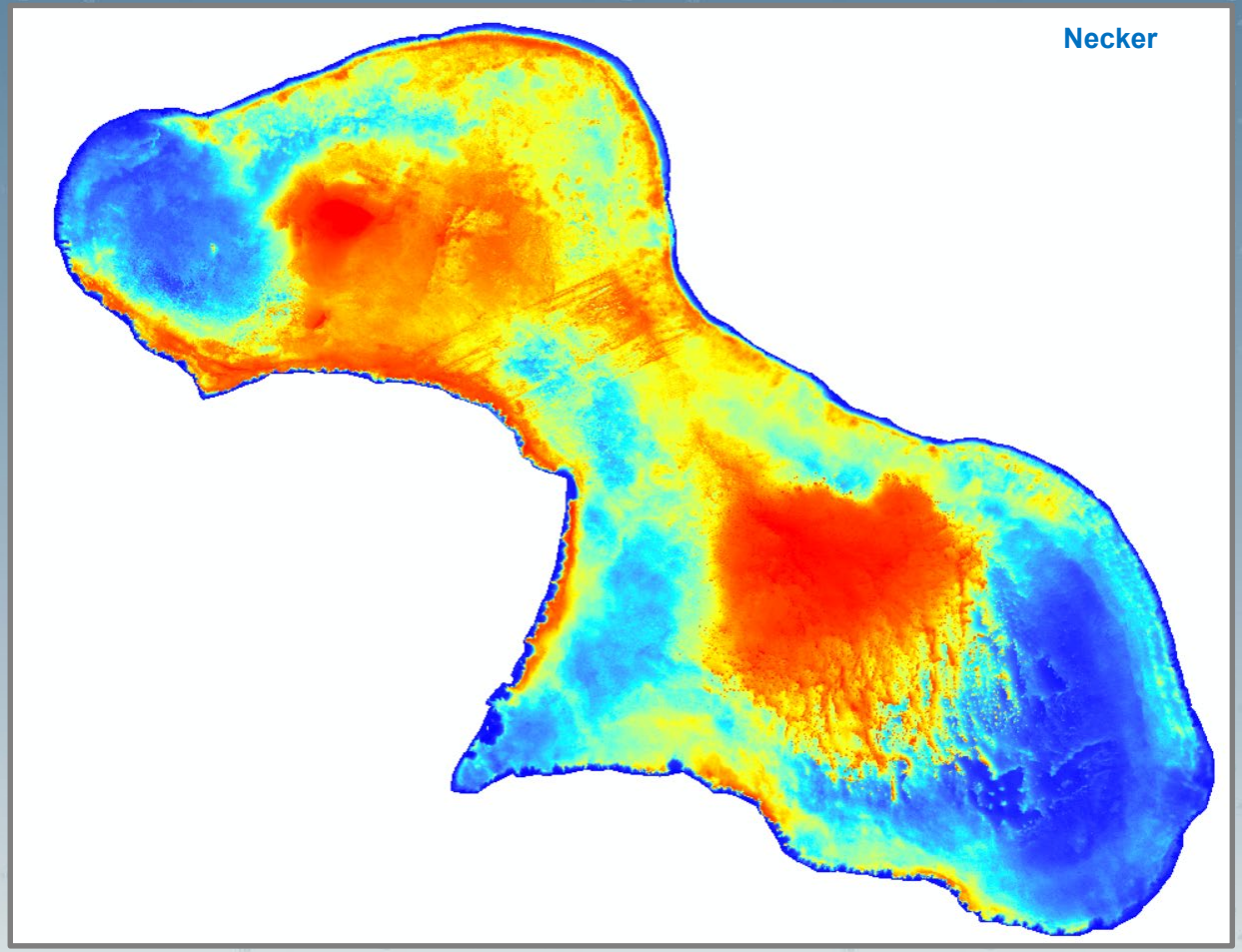

TINIAN
Tinian
EXPLOSIVES
DUMPING AREA
0
5000
10000
15000
20000
25000 m

“Ranier wanted me to share was how valuable the lidar was for not only ship acquisition and safety, but also small boat multibeam surveys. In typical operations, the survey launches use a safety .tif to more easily see where they have safe water and where hazards exist. In many areas in the figures they shared, the launch/ship tracklines (in green) are far from any hazards, and surveying in relatively deep water. For me, anything around 20+ meters is deep from a small boat operational perspective. With this large buffer, I would feel very comfortable both being on board a launch as a hydrographer, and tasking small boat crews to survey these areas. Having high quality lidar like this is very different and improved from how I'm used to operating, which is surveying areas with little awareness of what we are actually going to encounter nearshore, with our only reference being outdated/small scale nautical charts and original georeferenced H/T-Sheets.”

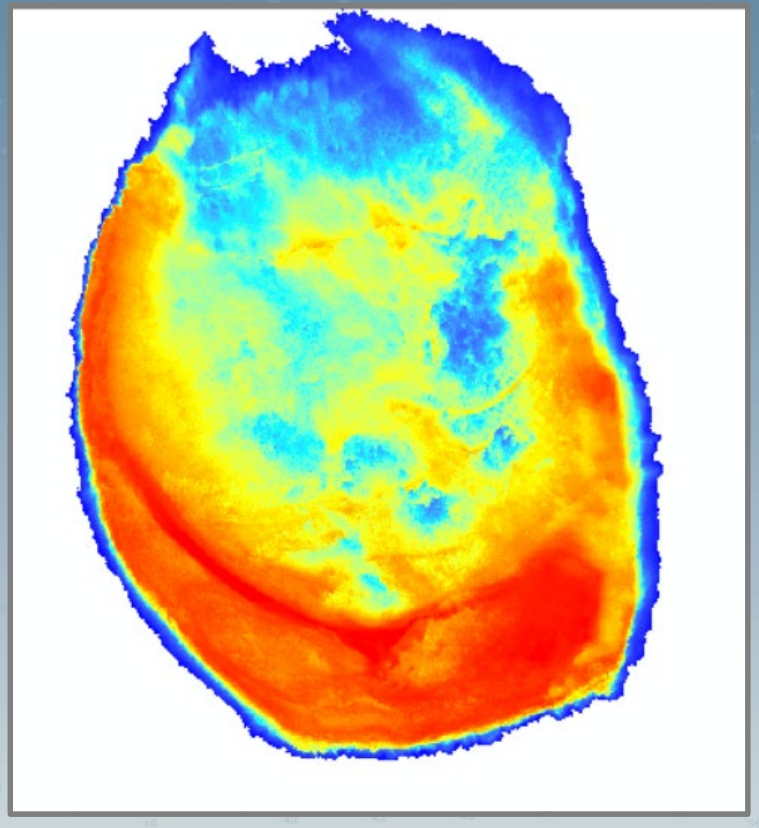
"It is huge in terms of time savings and safety. The work that RSD did was awesome, and would be incredible if we had some for next year."

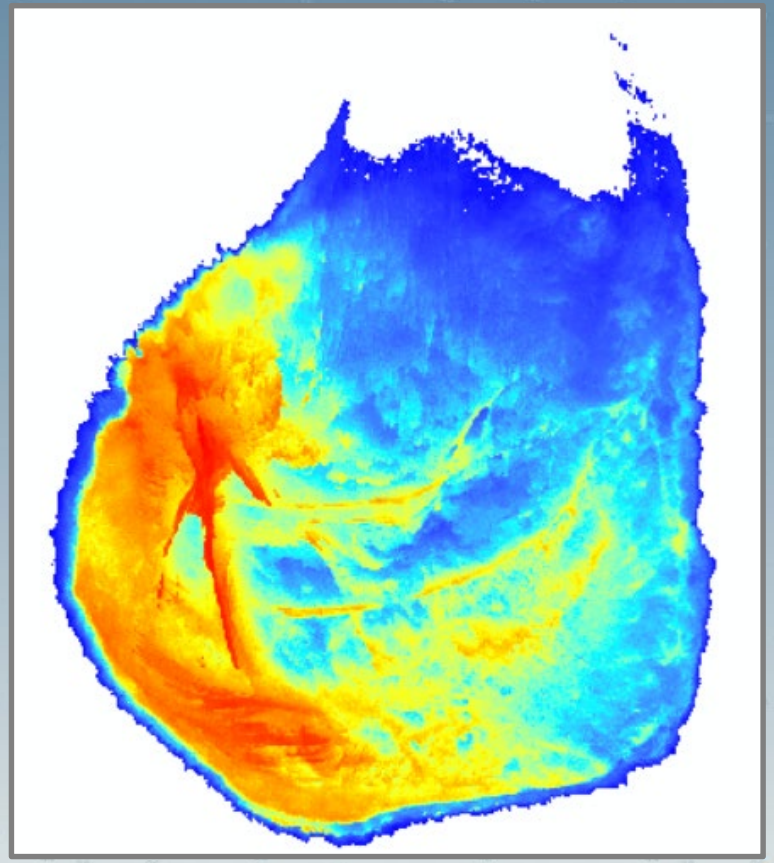

Eastern side of the NWHI

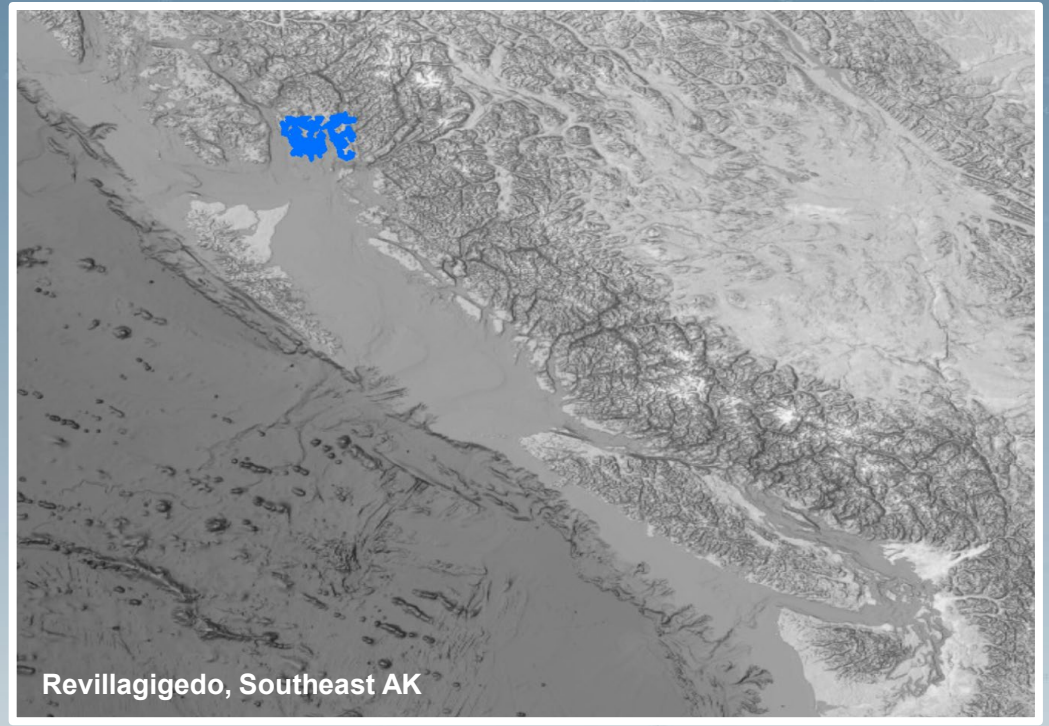

Nihoa

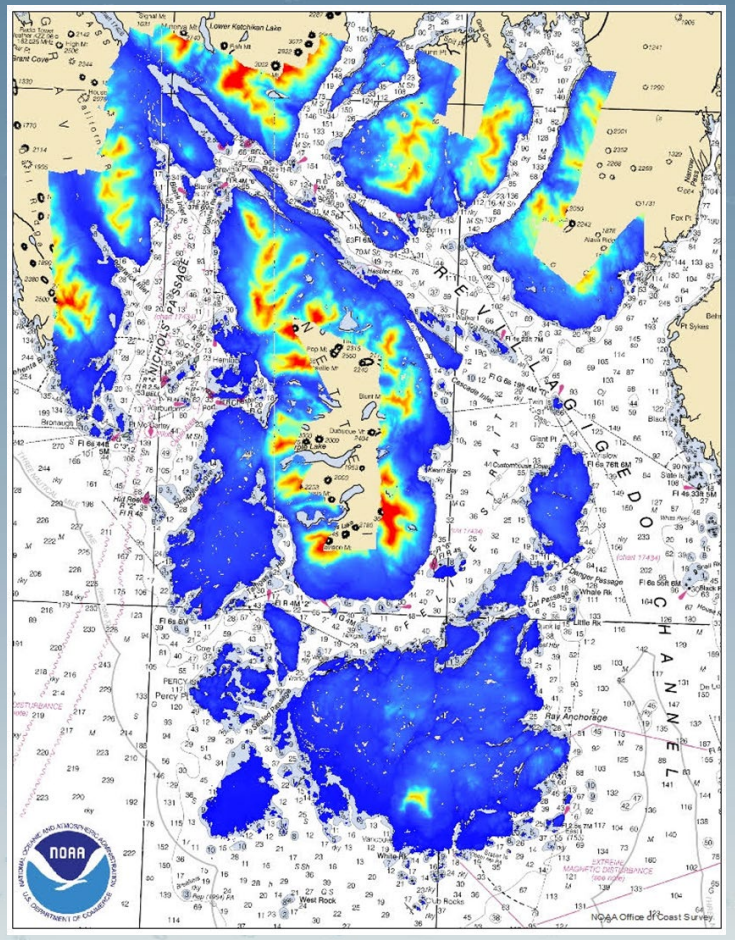

Necker

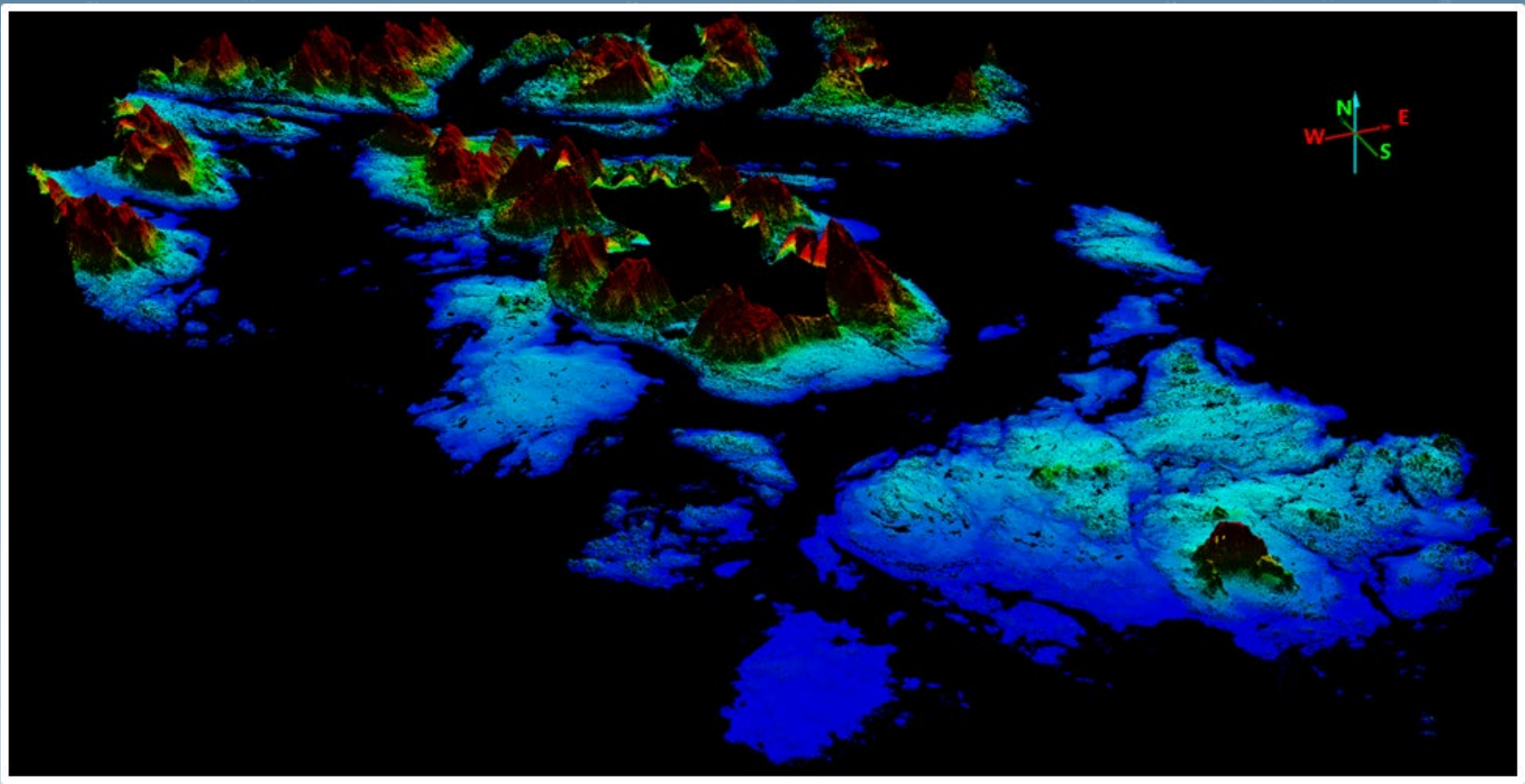
French Frigate

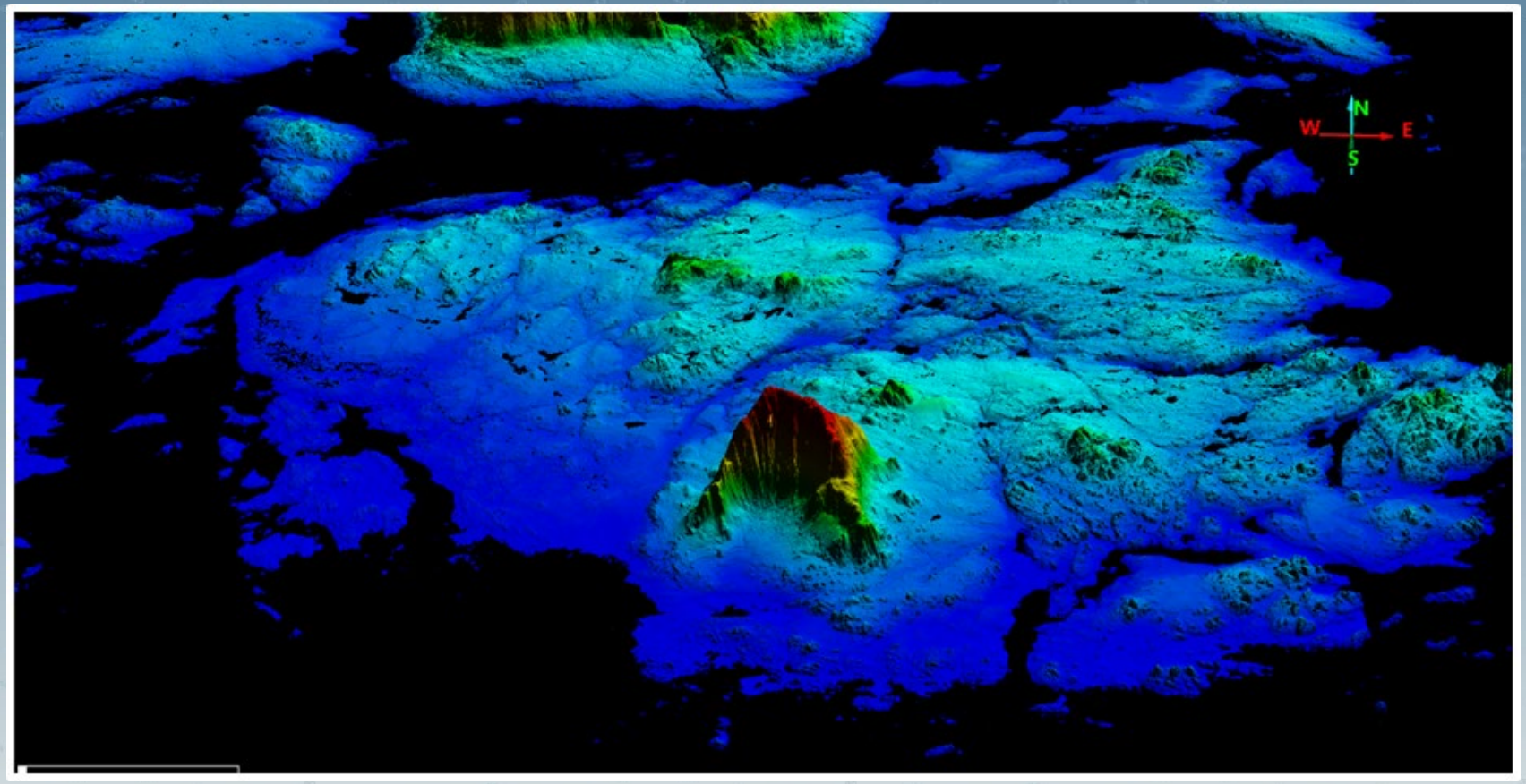


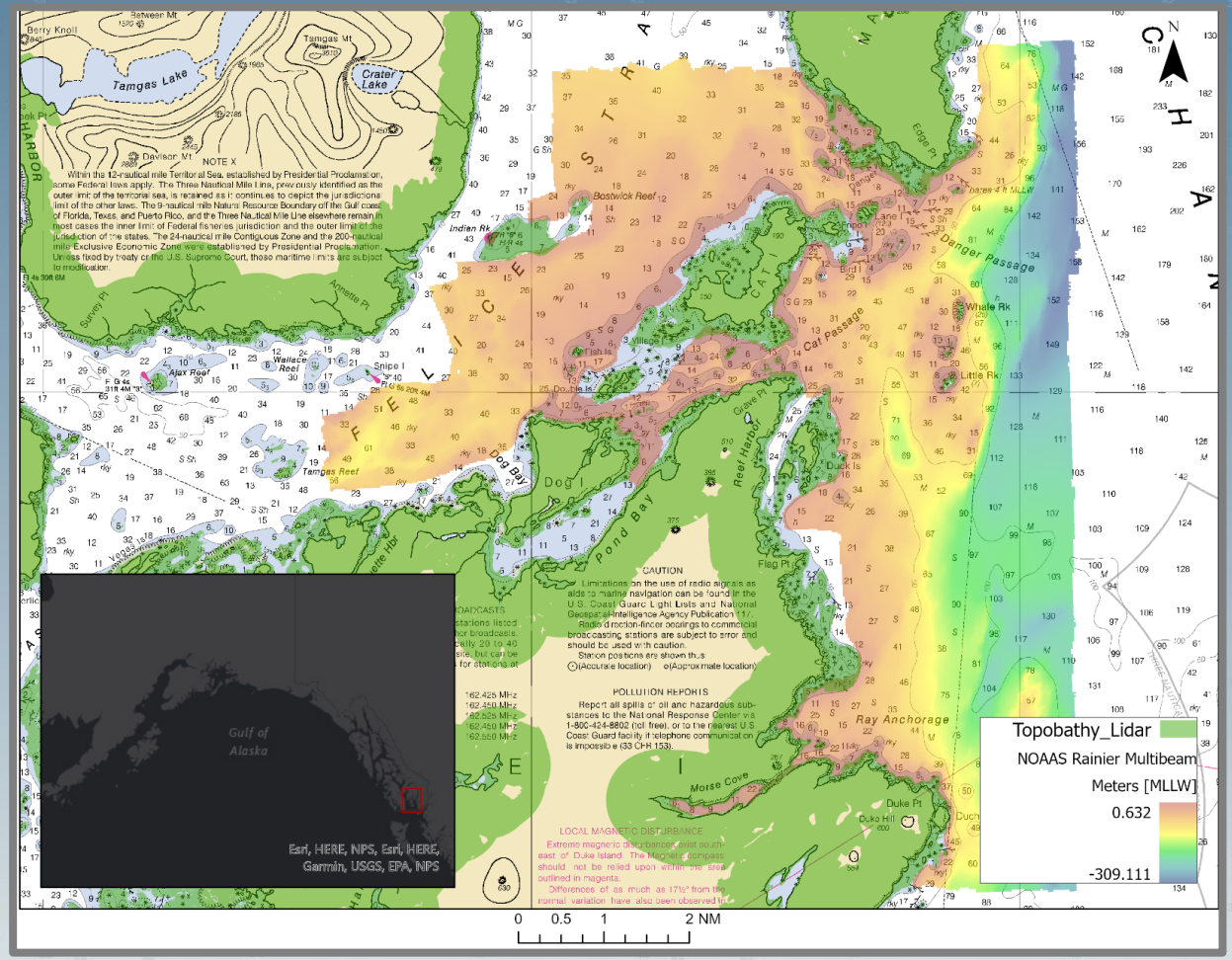


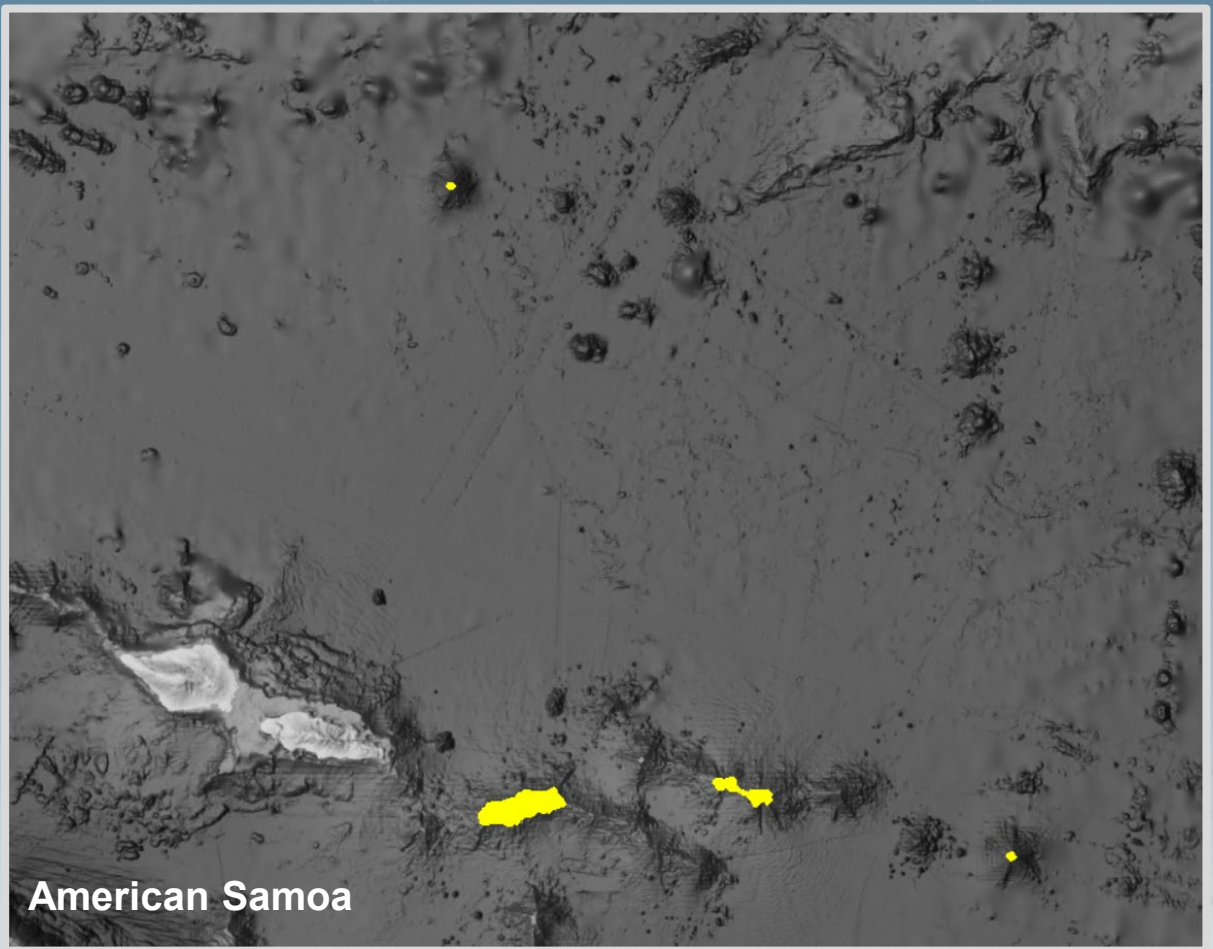

Revillagigedo, Southeast AK


REVILLAGIGEDO CHANNEL
NICHOLS PASSAGE
NOAA Office of Coast Survey

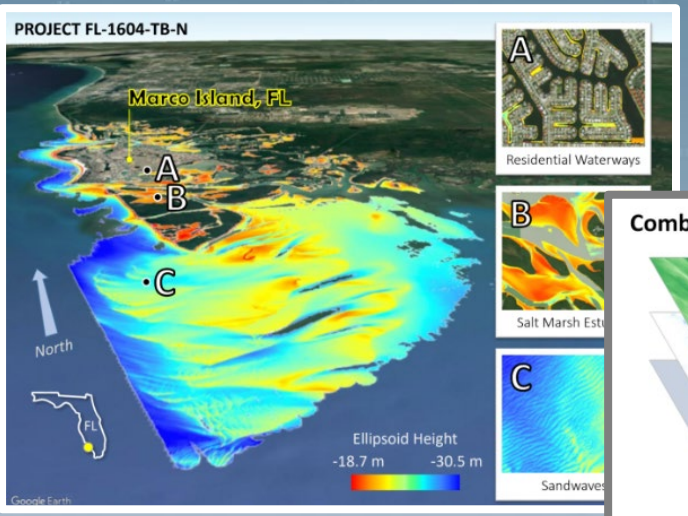

N
E
W
S

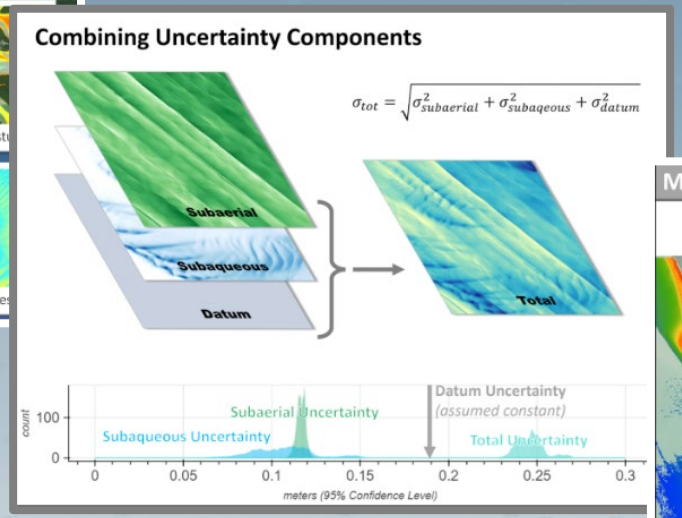

N
W
E
S

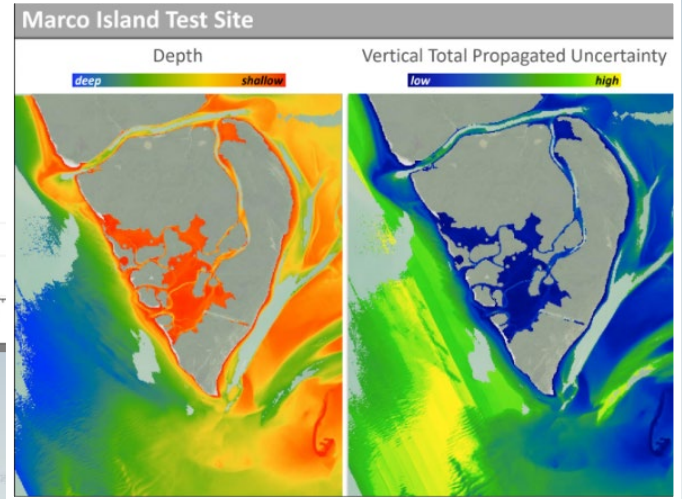

Tamgas Lake
Crater Lake
Tamgas Mt
Davison Mt
Berry Knoll
Between Mt
NOTE X
Within the 12-nautical mile Territorial Sea, established by Presidential Proclamation, some Federal laws apply. The Three Nautical Mile Line, previously identified as the outer limit of the territorial sea, is retained as it continues to depict the jurisdictional limit of the other laws. The 9-nautical mile Natural Resource Boundary of the Gulf coast of Florida, Texas, and Puerto Rico, and the Three Nautical Mile Line elsewhere remain in most cases the inner limit of Federal fisheries jurisdiction and the outer limit of the jurisdiction of the states. The 24-nautical mile Contiguous Zone and the 200-nautical mile Exclusive Economic Zone were established by Presidential Proclamation. Unless fixed by treaty or the U.S. Supreme Court, these maritime limits are subject to modification.
Bostwick Reef
Indian Rk
Ajax Reef
Wallace Reef
Snipe I
Tamgas Reef
Dog Bay
Dog I
Pond Bay
Reef Harbor
Grave Pt
Duck Is
Flag Pt
Cat Passage
Danger Passage
Whale Rk
Little Rk
Bird I
Ray Anchorage
Morse Cove
Duke Pt
Duke Hill
Edge Pt
Annette Pt
Survey Pt
Annette Hbr
CAUTION
Limitations on the use of radio signals as aids to marine navigation can be found in the U.S. Coast Guard Light Lists and National Geospatial-Intelligence Agency Publication 117.
Radio direction-finder bearings to commercial broadcasting stations are subject to error and should be used with caution.
Station positions are shown thus
(Accurate location) (Approximate location)
POLLUTION REPORTS
Report all spills of oil and hazardous substances to the National Response Center via 1-800-424-8802 (toll free), or to the nearest U.S. Coast Guard facility if telephone communication is impossible (33 CFR 153).
LOCAL MAGNETIC DISTURBANCE
Extreme magnetic disturbances exist southeast of Duke Island. The Magnetic compass should not be relied upon within the area outlined in magenta.
Differences of as much as 17½° from the normal variation have also been observed in
Gulf of Alaska
Esri, HERE, NPS, Esri, HERE, Garmin, USGS, EPA, NPS
Topobathy_Lidar
NOAAS Rainier Multibeam
Meters [MLLW]
0.632
-309.111
0 0.5 1 2 NM


American Samoa

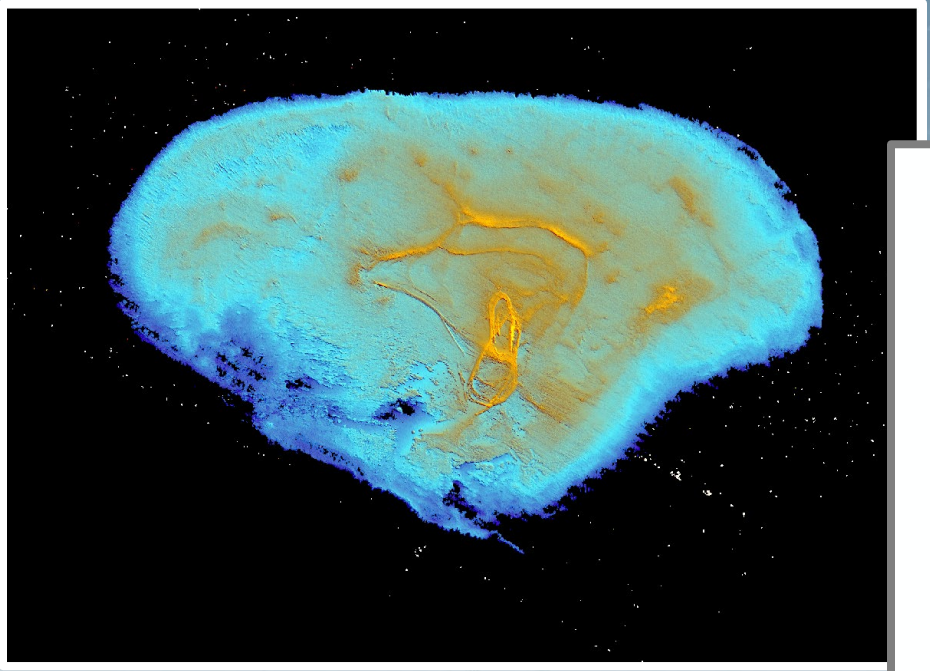
Total Propagated Uncertainty (TPU)

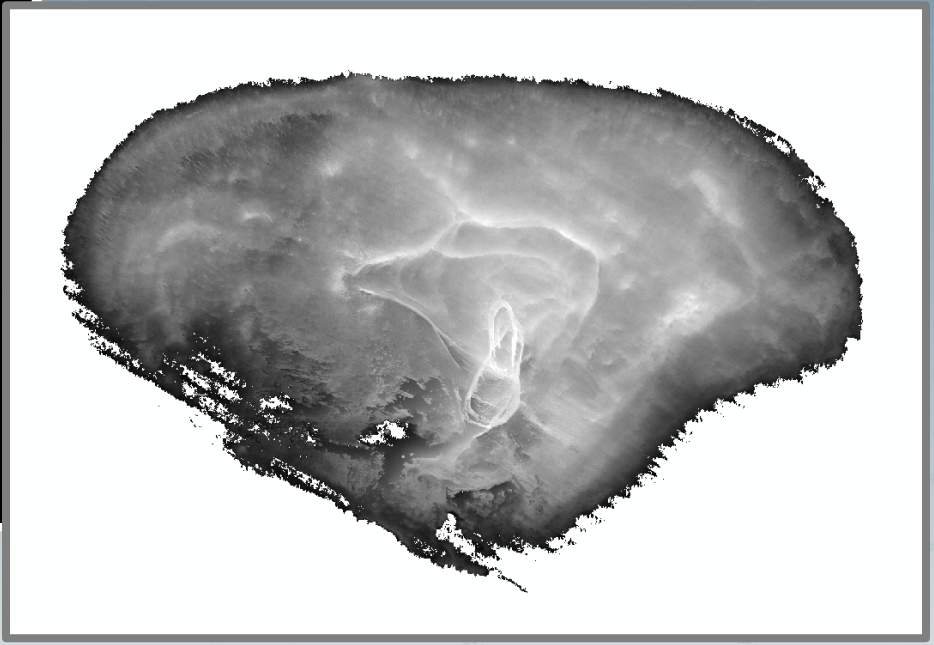




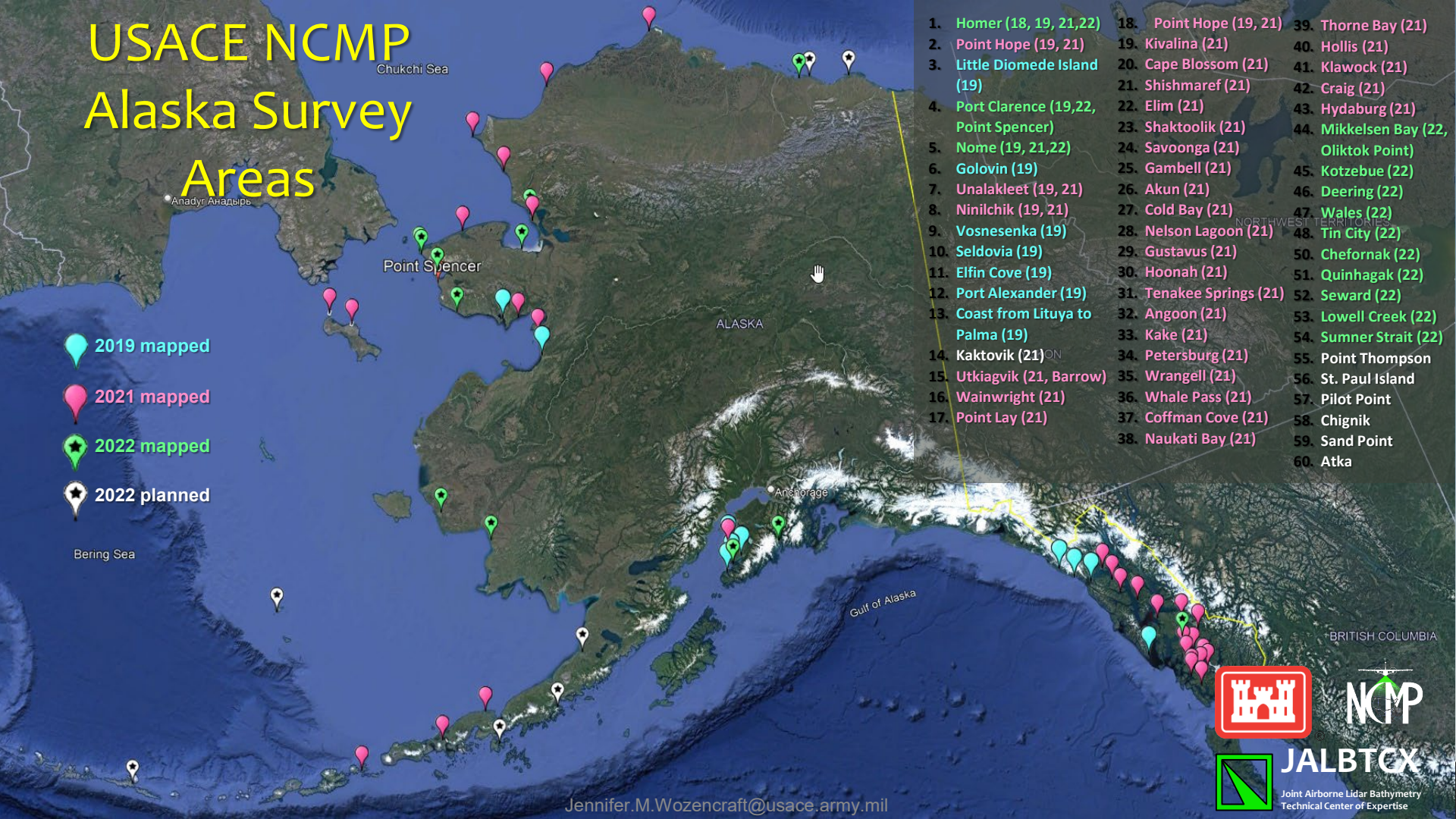


Normalized Intensity





USACE NCMP Alaska Survey Areas

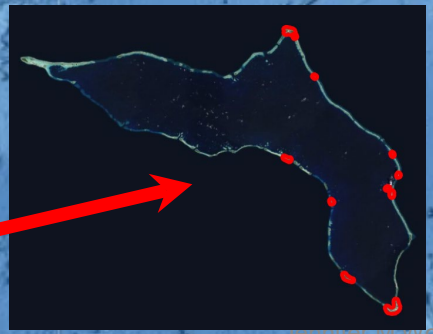


1. Homer (18, 19, 21,22)
2. Point Hope (19, 21)
3. Little Diomede Island (19)
4. Port Clarence (19,22, Point Spencer)
5. Nome (19, 21,22)
6. Golovin (19)
7. Unalakleet (19, 21)
8. Ninilchik (19, 21)
9. Vosnesenka (19)
10. Seldovia (19)
11. Elfin Cove (19)
12. Port Alexander (19)
13. Coast from Lituya to Palma (19)
14. Kaktovik (21)
15. Utkiagvik (21, Barrow)
16. Wainwright (21)
17. Point Lay (21)
18. Point Hope (19, 21)
19. Kivalina (21)
20. Cape Blossom (21)
21. Shishmaref (21)
22. Elim (21)
23. Shaktoolik (21)
24. Savoonga (21)
25. Gambell (21)
26. Akun (21)
27. Cold Bay (21)
28. Nelson Lagoon (21)
29. Gustavus (21)
30. Hoonah (21)
31. Tenakee Springs (21)
32. Angoon (21)
33. Kake (21)
34. Petersburg (21)
35. Wrangell (21)
36. Whale Pass (21)
37. Coffman Cove (21)
38. Naukati Bay (21)
39. Thorne Bay (21)
40. Hollis (21)
41. Klawock (21)
42. Craig (21)
43. Hydaburg (21)
44. Mikkelsen Bay (22, Oliktok Point)
45. Kotzebue (22)
46. Deering (22)
47. Wales (22)
48. Tin City (22)
50. Chefornak (22)
51. Quinhagak (22)
52. Seward (22)
53. Lowell Creek (22)
54. Sumner Strait (22)
55. Point Thompson
56. St. Paul Island
57. Pilot Point
58. Chignik
59. Sand Point
60. Atka

JALBTCX
Joint Airborne Lidar Bathymetry Technical Center of Expertise

Jennifer.M.Wozencraft@usace.army.mil

USACE INDOPACOM NCMP West Coast Survey Areas

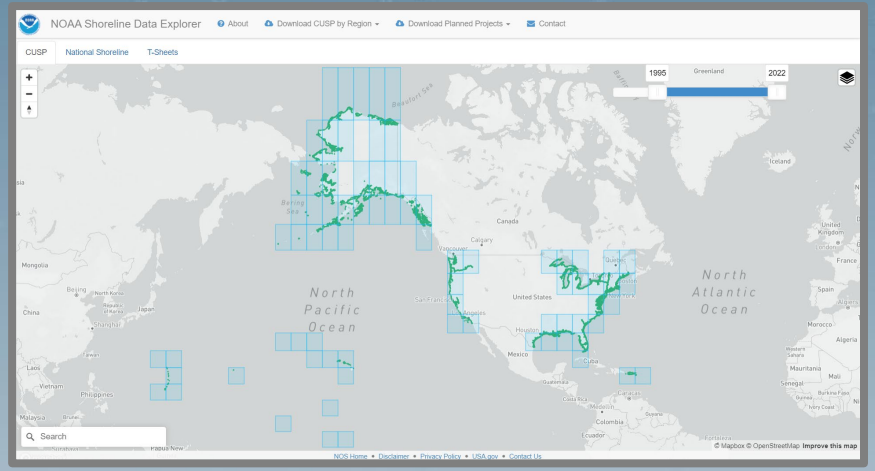


1. 2020 - NCMP Oregon/Washington
2. 2021 - NCMP Southern California
3. 2022 - NCMP Central/Northern California and Southern Oregon
4. 2022 – INDOPACOM Wake Island
5. 2022 – INDOPACOM Kwajalein – Buffered area around 11 Islands (TENTATIVE)

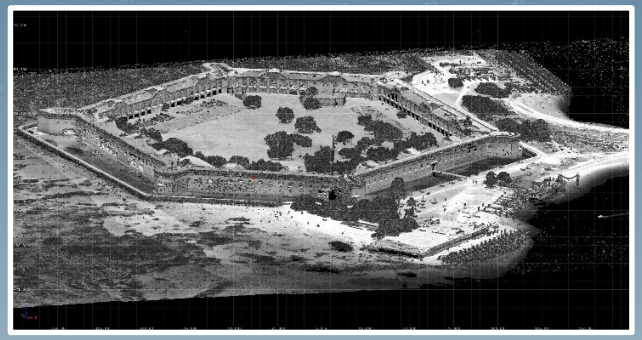
JALBTCX
Joint Airborne Lidar Bathymetry Technical Center of Expertise

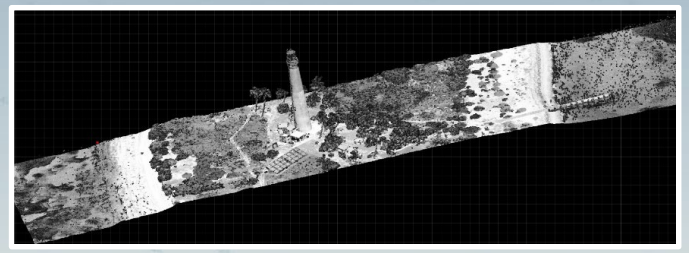
Jennifer.M.Wozencraft@usace.army.mil

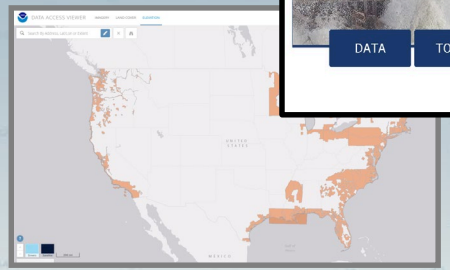
Distribution of Data

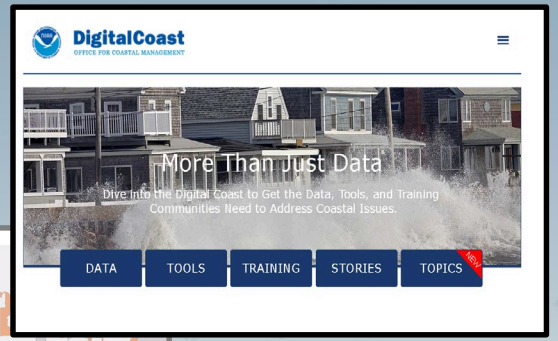


Shoreline (https://nsde.ngs.noaa.gov/)





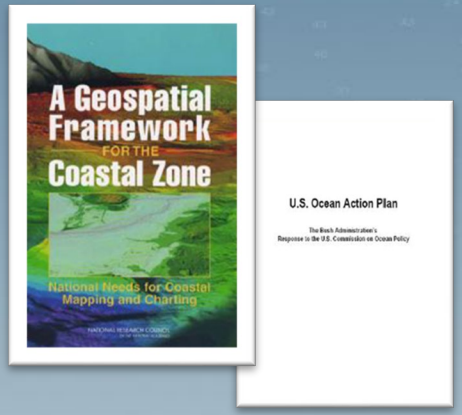




Lidar and Imagery:

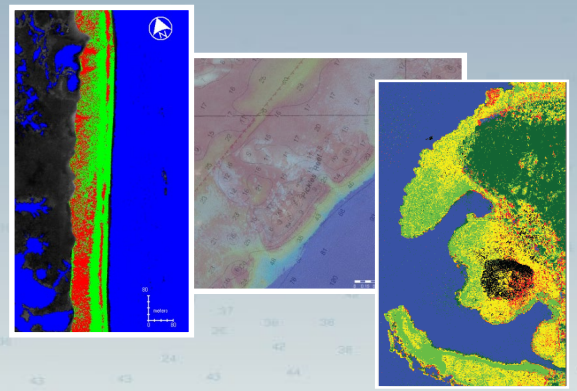
https://coast.noaa.gov/digitalcoast/

Integrated Ocean and Coastal Mapping (IOCM)



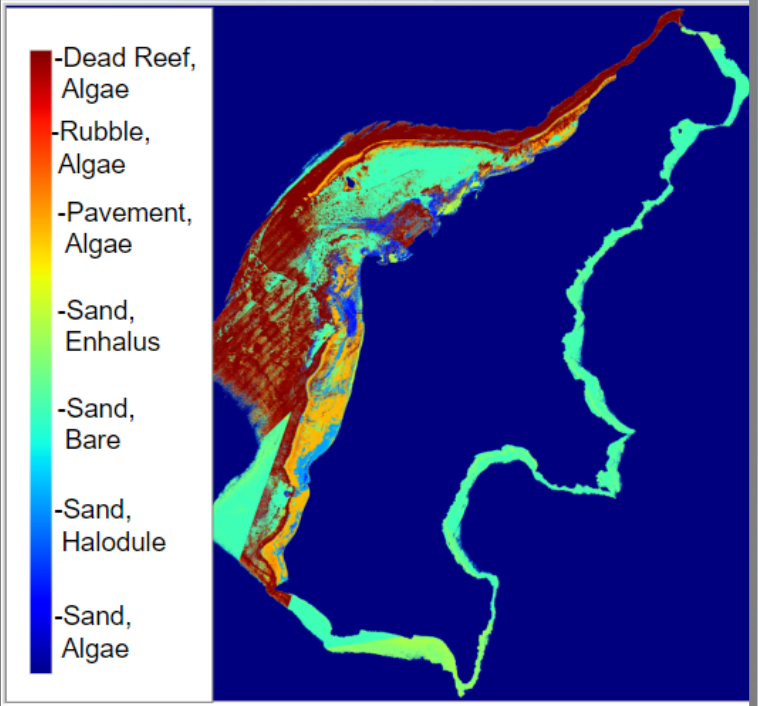
The practice of acquiring, managing, integrating and disseminating ocean and coastal geospatial mapping data in such a manner that permits these data and their derivative products to be easily accessed and used by and for the greatest range of users and purposes.

IOCM requires intra- and inter-agency coordination with a focus on streamlining operations, reducing redundancies, improving efficiencies, developing common standards, and stimulating innovation and technological development.



Predicting Benthic Habitats Using Lidar Waveforms

NCCOS, OSU, Woolpert

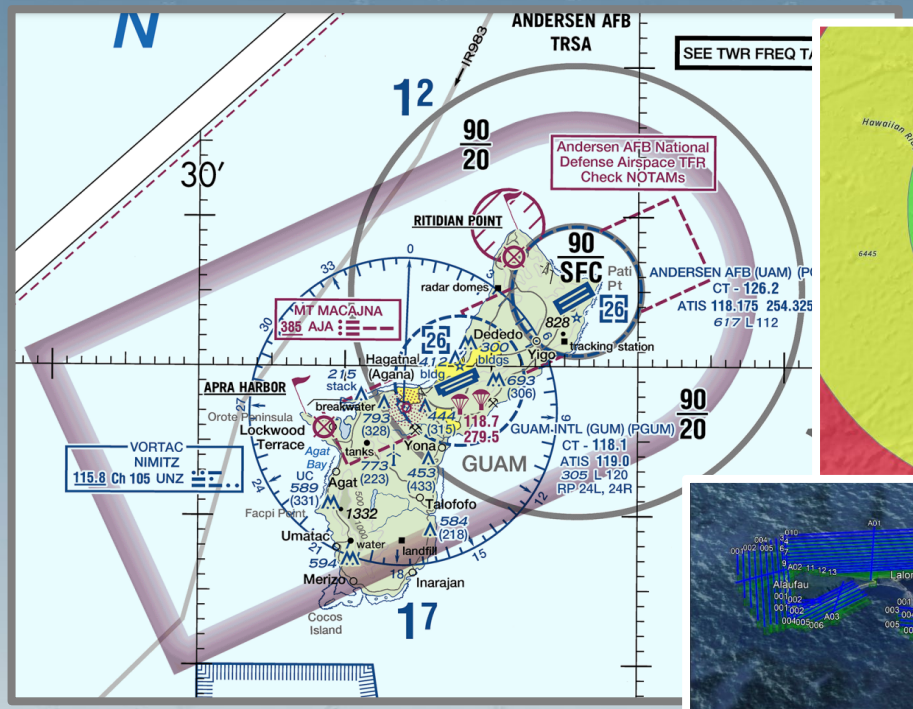


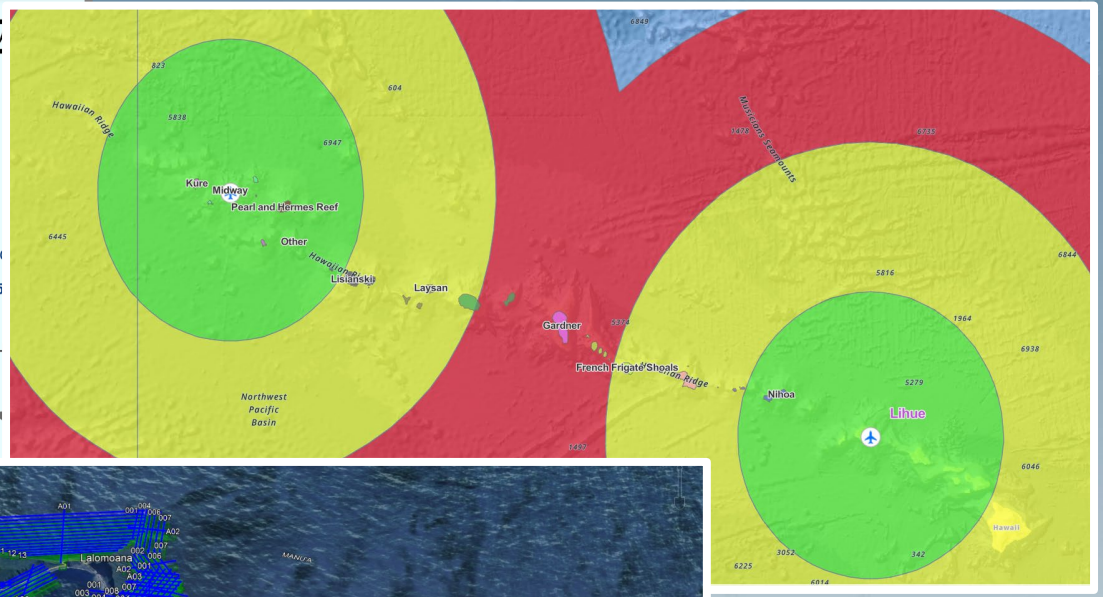
Draft benthic habitat map for Saipan, CNM developed using lidar waveforms.

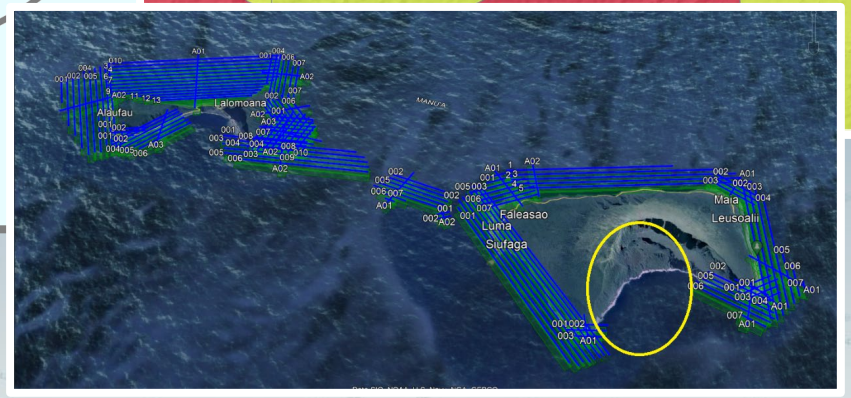
Accuracy= 0.5347222222222222	
mode	0.063331
pearson2	0.063217
mean	0.056657
width	0.041142
auc_r	0.040452
slope_r	0.037864
sigma	0.033249
median	0.032756
SlopeOfSlope_from_Depth	0.028242
Slope_from_Depth	0.026572
intensity	0.023984
Latitude	0.023979
kurtosis	0.023952
Depth_Standard_Deviation_from_Depth	0.023751
skewness	0.021359
coastal blue-yellow	0.020591
slope	0.020217
EuclideanDistance_ReefCrest_Mask	0.020134
EuclideanDistance_Shoreline_Mask	0.018983
pearson1	0.018808
Longitude	0.016836
red-red edge	0.015746
Rugosity_from_Depth	0.015031
amplitude	0.014858
Sin_Aspect_from_Depth	0.014787
green-coastal blue	0.014645
green-red edge	0.014504
Longitudinal_Curvature_from_Depth_Mask	0.014144
green-yellow	0.013723
blue-coastal blue	0.013517

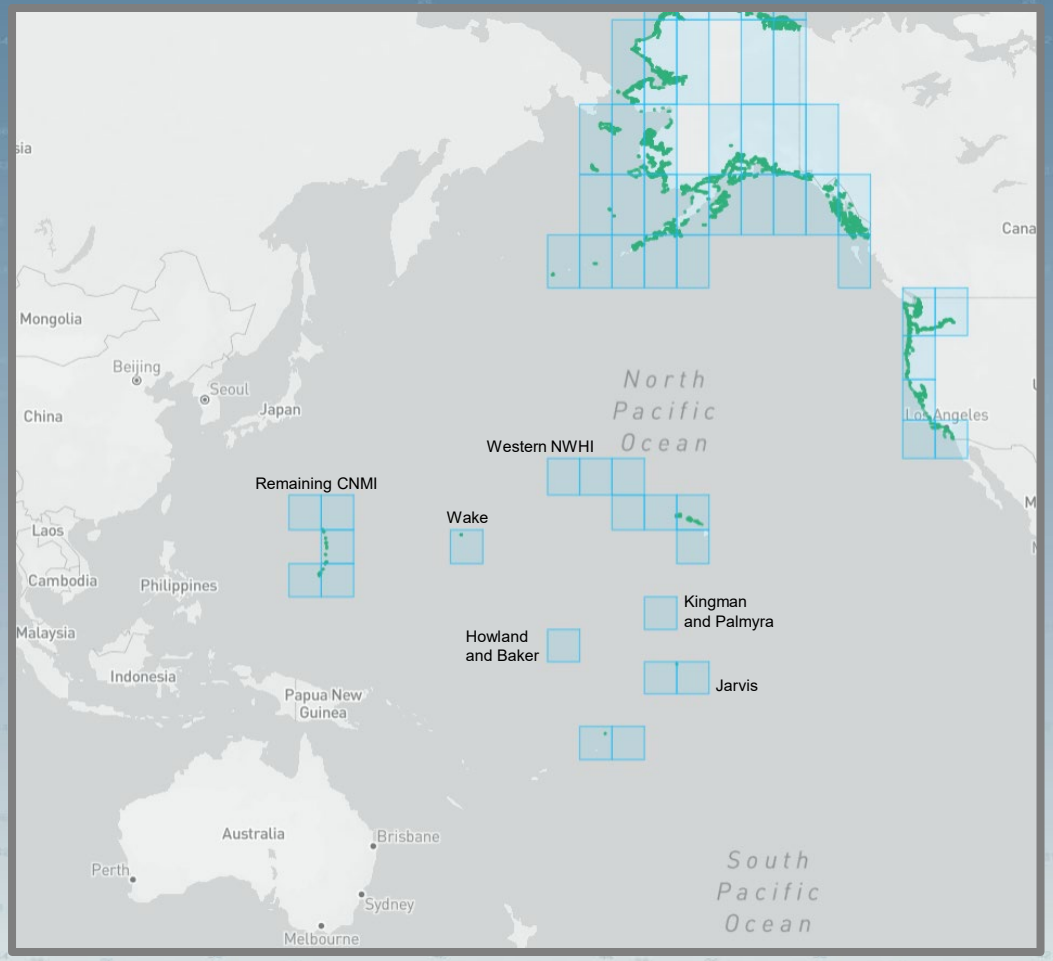
Waveforms (yellow box) were the most important predictors of habitats.

Logistics

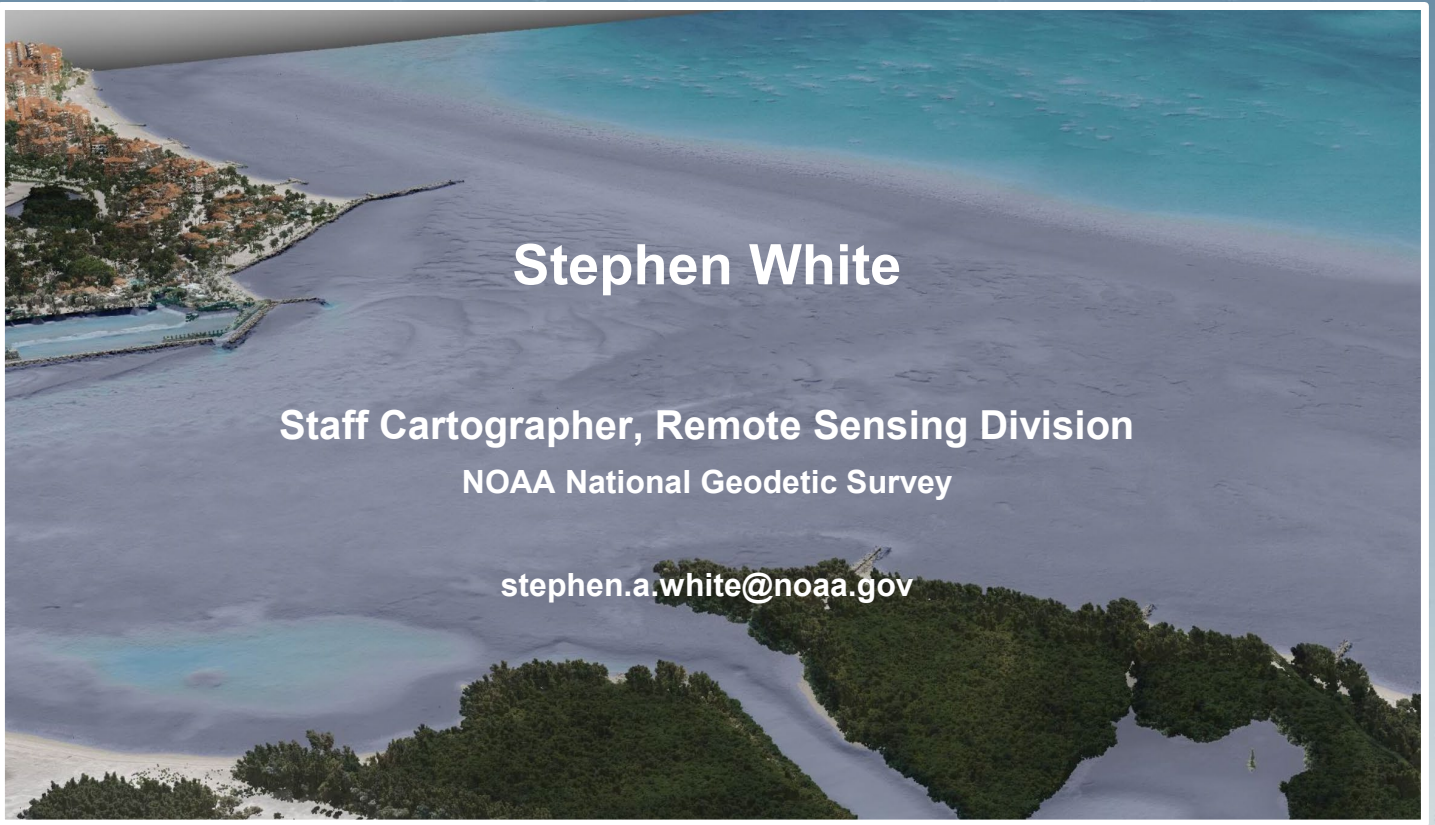

ANDERSEN AFB
TRSA
SEE TWR FREQ T
12
90
20
Andersen AFB National
Defense Airspace TFR
Check NOTAMs
30'
RITIDIAN POINT
90
SFC
Pati Pt
ANDERSEN AFB (UAM) (P
CT - 126.2
ATIS 118.175 254.325
617 L 112
MT MACAJNA
385 AJA
radar domes
Dededo
300
bldgs
828
tracking station
Yigo
Hagatna
(Agana) bldg
APRA HARBOR
215
stack
breakwater
Orote Peninsula
Lockwood
Terrace
tanks
Yona
118.7
279.5
GUAM INTL (GUM) (PGUM)
CT - 118.1
ATIS 119.0
305 L 120
RP 24L, 24R
GUAM
VORTAC
NIMITZ
115.8 Ch 105 UNZ
Agat
Bay
UC
Agat (223)
Facpi Point
Talofofo
1332
Umatac
water
landfill
584
Merizo
Inarajan
Cocos
Island
17


Hawaiian Ridge
Kure
Midway
Pearl and Hermes Reef
Other
Hawaiian Is.
Lisianski
Laysan
Gardner
French Frigate Shoals
Northwest
Pacific
Basin
Emperor Seamounts
Emperor Ridge
Niihoa
Lihue
Hawaii


Lalomoana
Alaufau
Faleasao
Luma
Siufaga
Maia
Leusoalii


Mongolia
Beijing
Seoul
China
Japan
North
Pacific
Ocean
Western NWHI
Remaining CNMI
Wake
Laos
Cambodia
Philippines
Malaysia
Indonesia
Papua New
Guinea
Kingman
and Palmyra
Howland
and Baker
Jarvis
Australia
Brisbane
Perth
Sydney
Melbourne
South
Pacific
Ocean
Los Angeles

Questions?


Stephen White
Staff Cartographer, Remote Sensing Division
NOAA National Geodetic Survey
stephen.a.white@noaa.gov