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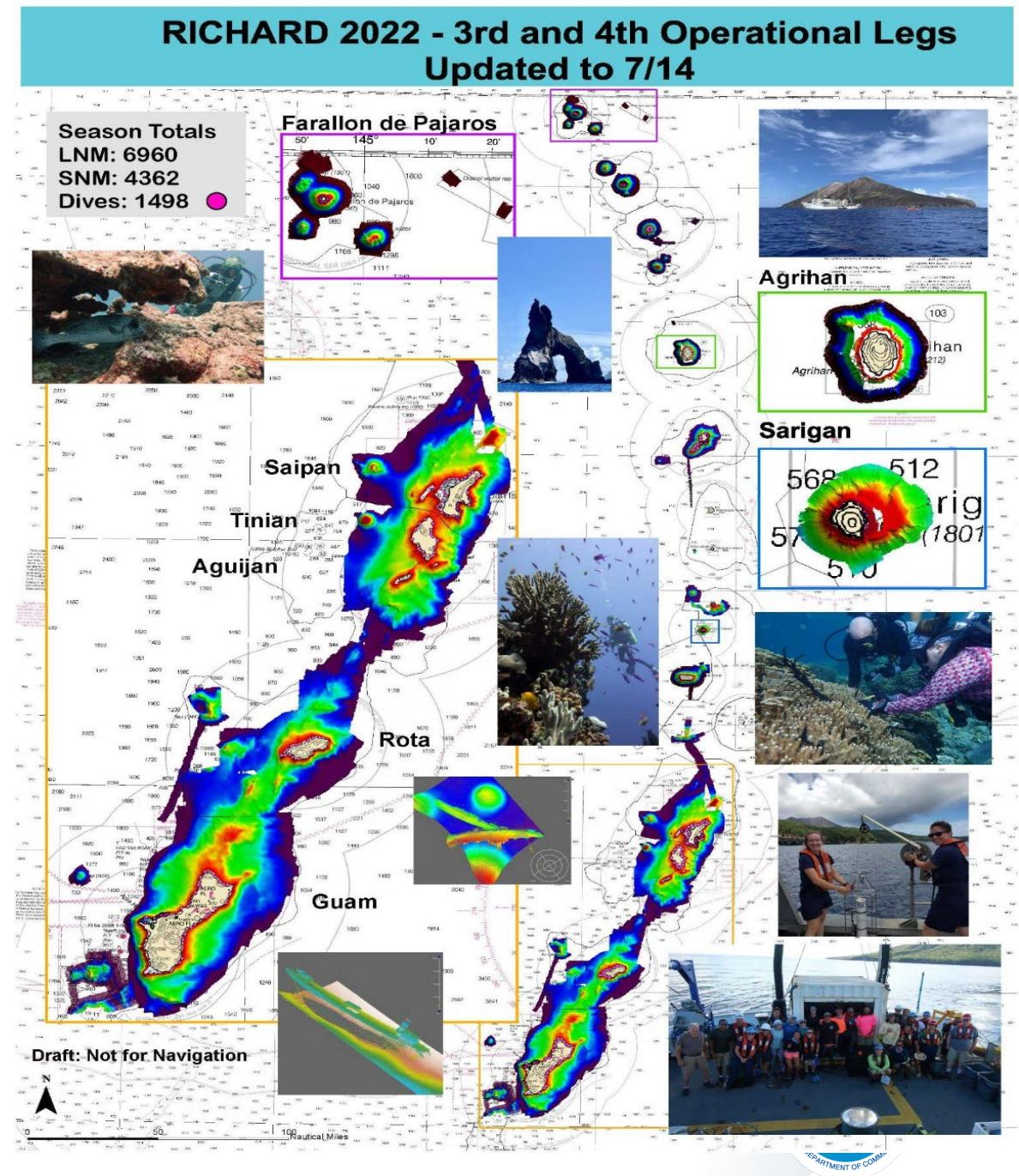
Pacific Islands  
Fisheries Science  
Center

# High Quality Mapping Products to Support and Improve Fisheries Science in the Pacific Island Region

**Dr. Jennifer Samson,**  
**Archipelagic Research Program Lead**

# RICHARD 2022

*Opportunity for Science Center and Hydro Teams to observe and better understand each other.*



# Pacific National Coral Reef Monitoring Program (NCRMP): *Better Maps = More Efficiency*

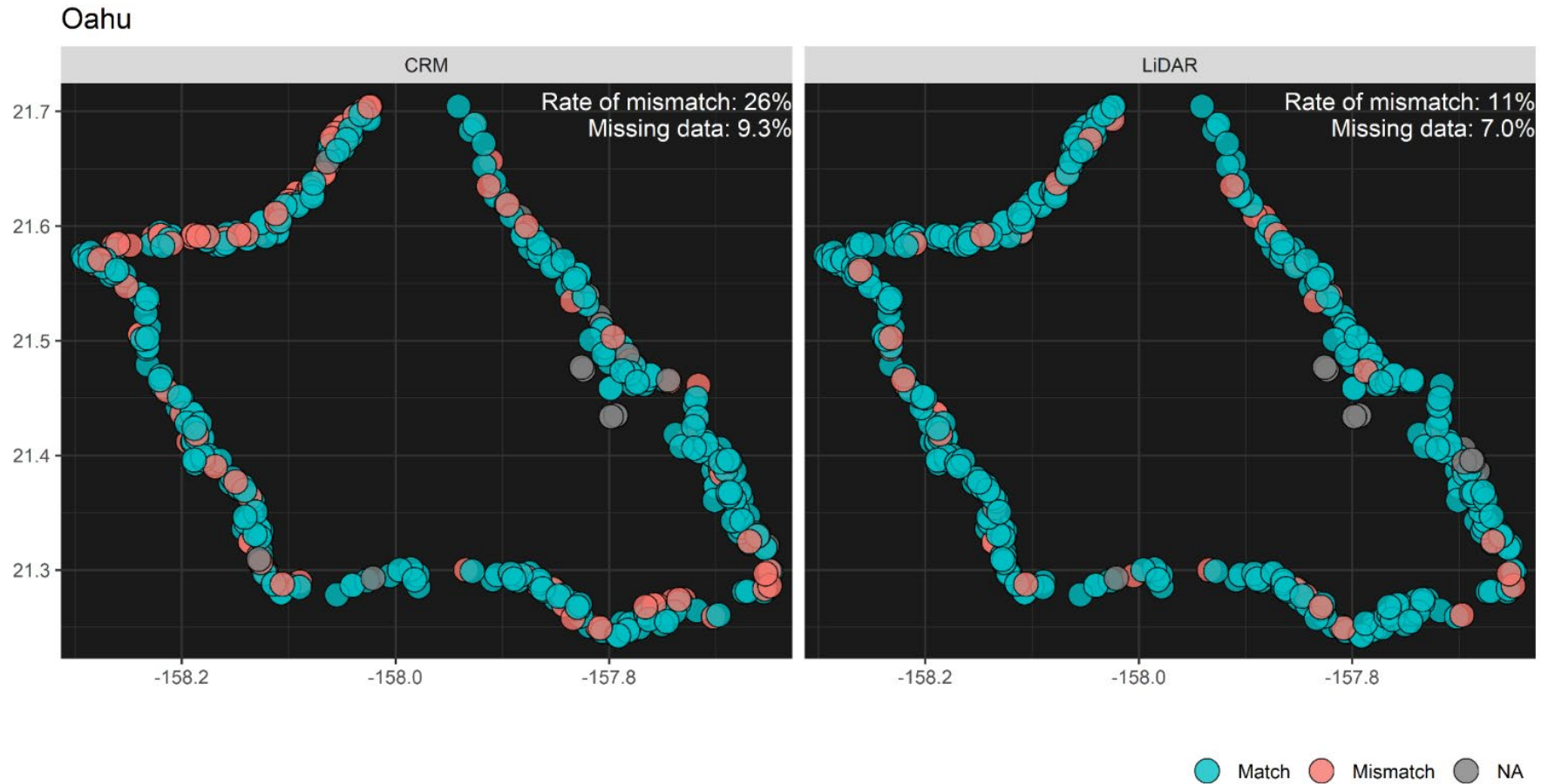
- Stratified Random design for fish and benthic surveys
- Sample allocation currently targets hard substrate from 0-30 meters in 3 depth-stratified bins.
- Improved mapping products may:
  - (1) ***Proximately***: Reduce ***mismatches*** between current map and actual hard/soft and bathymetry during survey





# Current rate of mismatch:

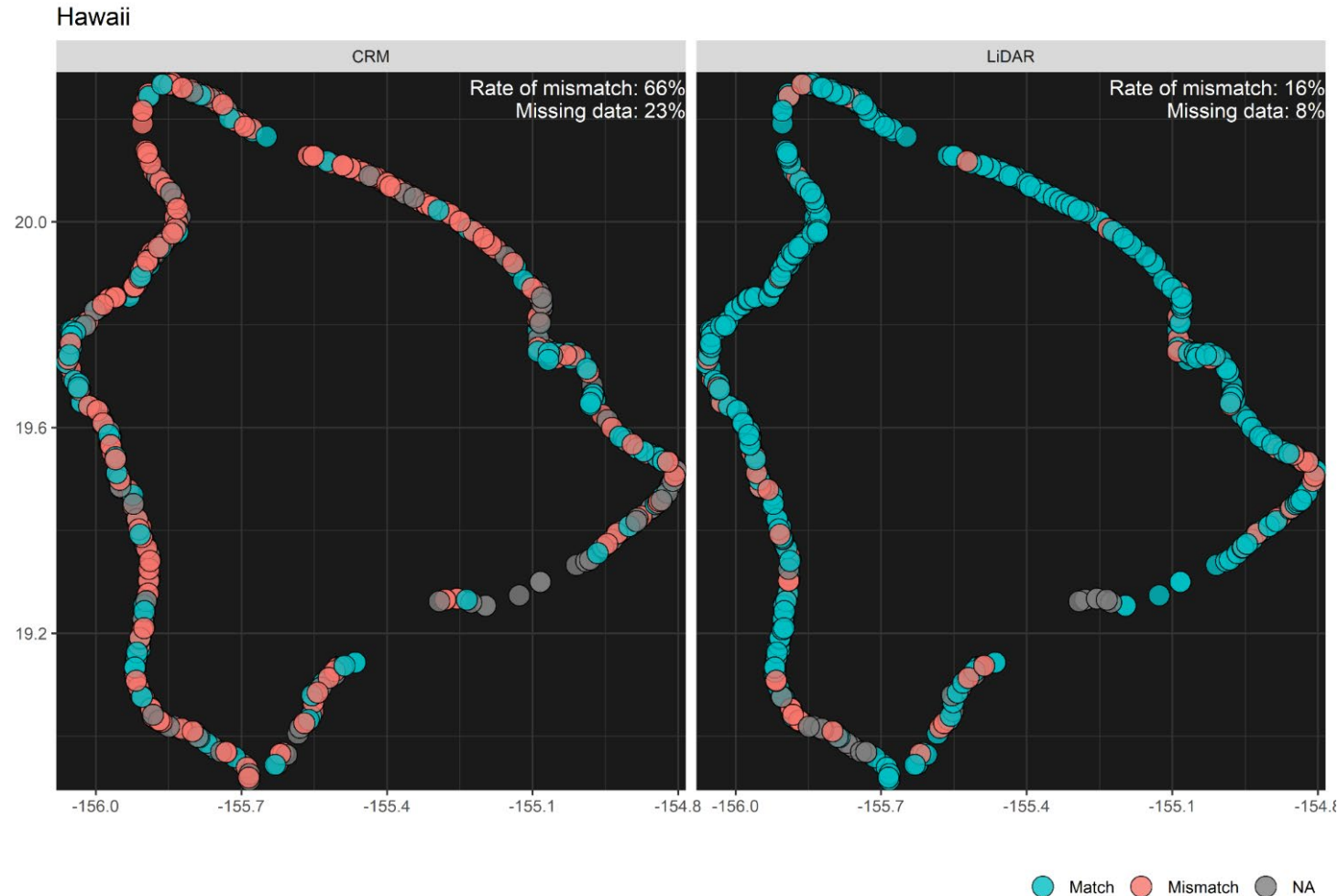
In well-survey areas, not terrible but room for improvement



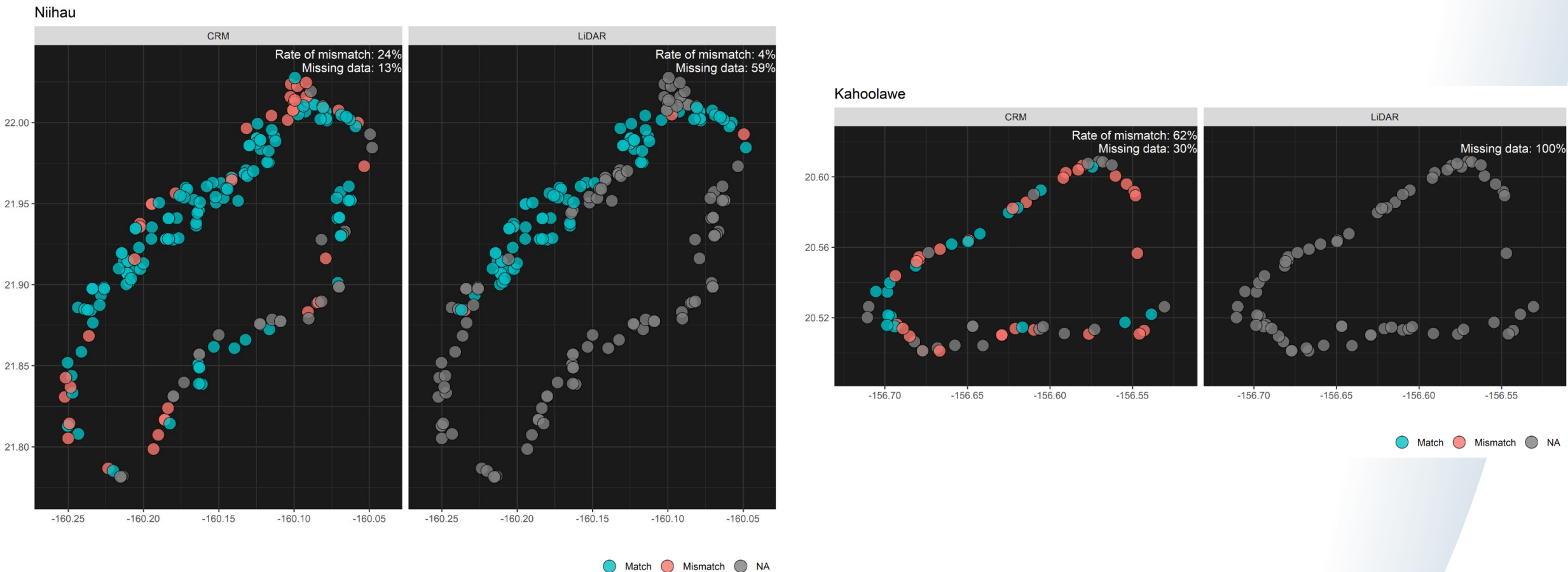
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# Current rate of mismatch:

## In some areas, CRM fails. LiDAR to the rescue!



# Current rate of mismatch: However, LiDAR coverage is variable.



# Pacific National Coral Reef Monitoring Program (NCRMP): *Better Maps = More Efficiency*

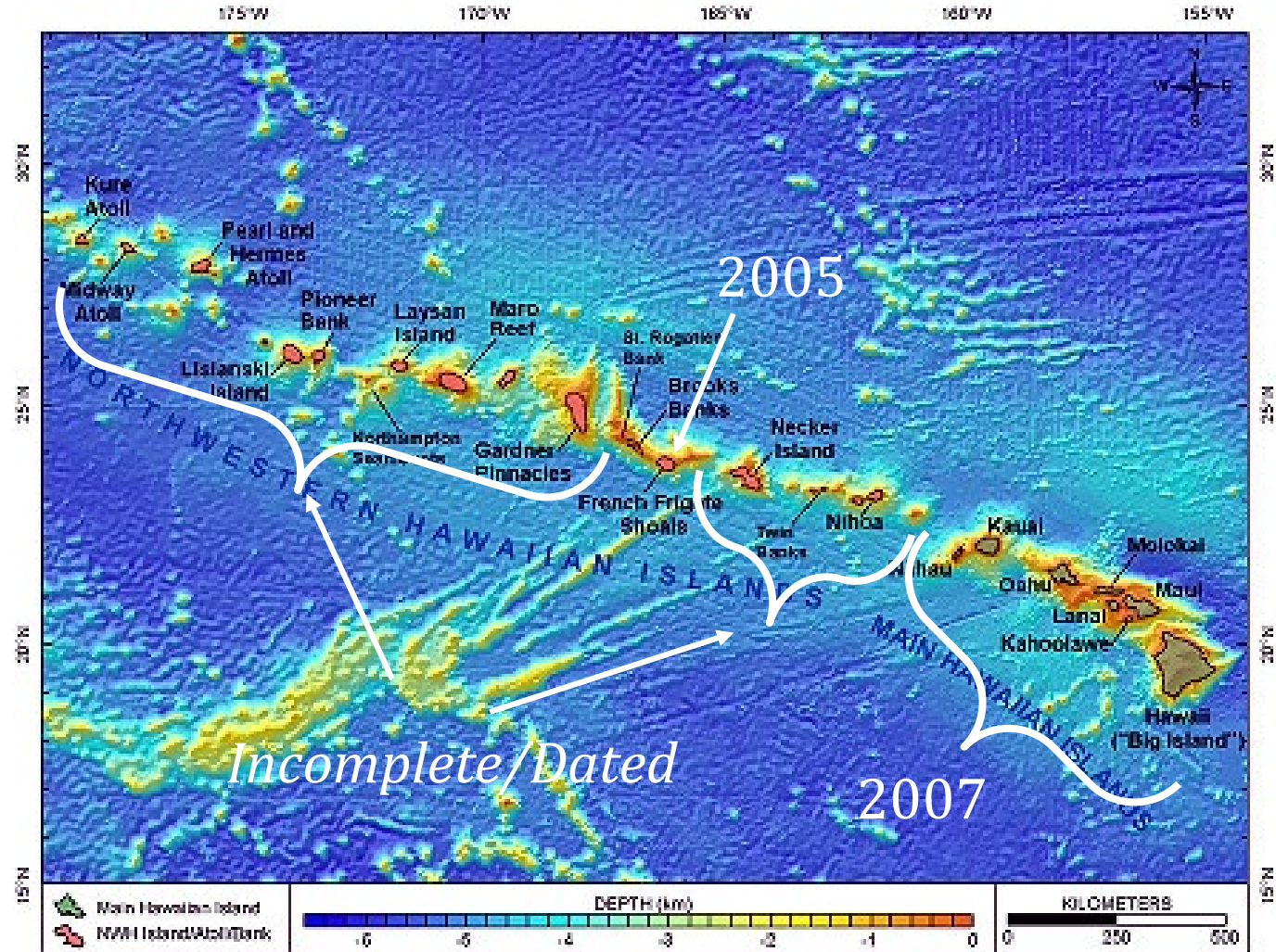
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- Sample allocation currently targets hard substrate from 0-30 meters in 3 depth-stratified bins.
- Improved mapping products may:
  - (1) ***Proximately***: Reduce ***mismatches*** between current map and actual hard/soft and bathymetry during survey
  - (2) ***Ultimately***: Generate improved, survey domain-scale ***benthic habitat maps*** that may provide an improved stratification target, and therefore a more efficient survey.



# Benthic Habitat Map Availability - Rare

There is no domain-scale Benthic Habitat Map product that we could use to re-stratify our survey.

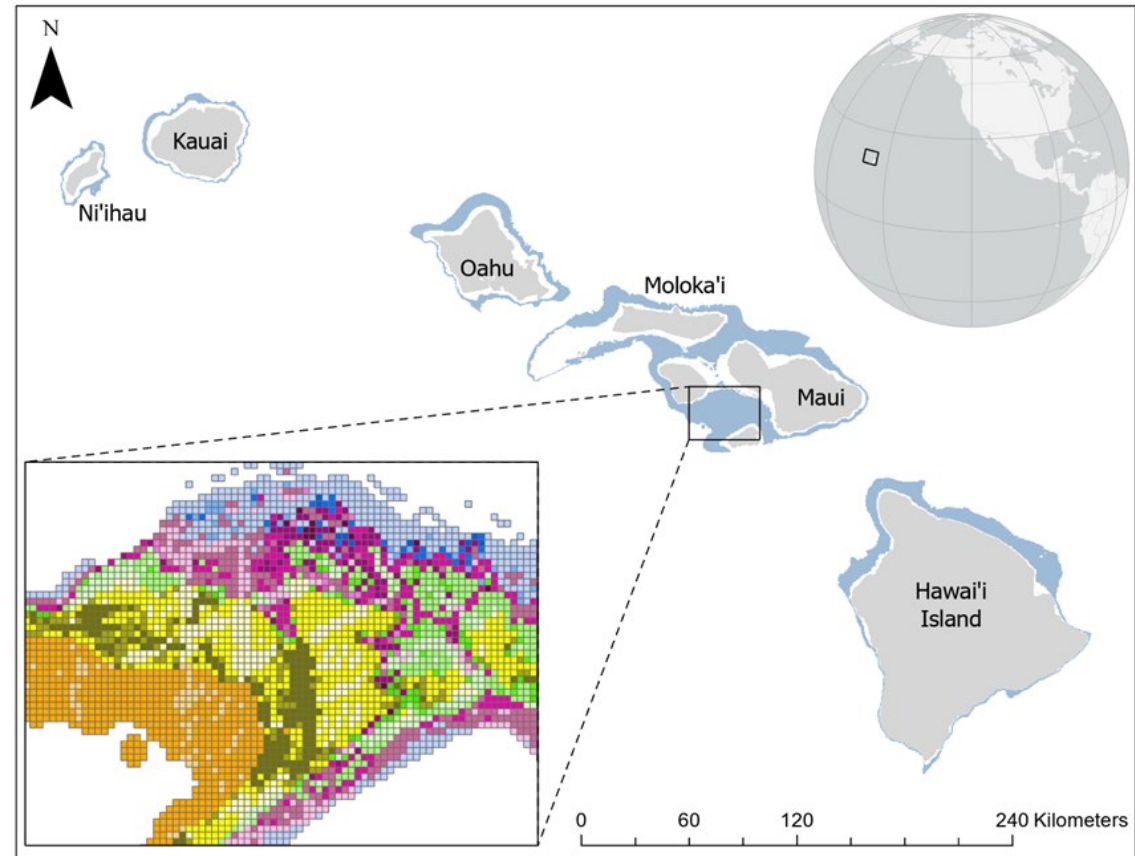
These products are either unavailable or out-dated across our region.





# Multibeam Mapping for Survey Design

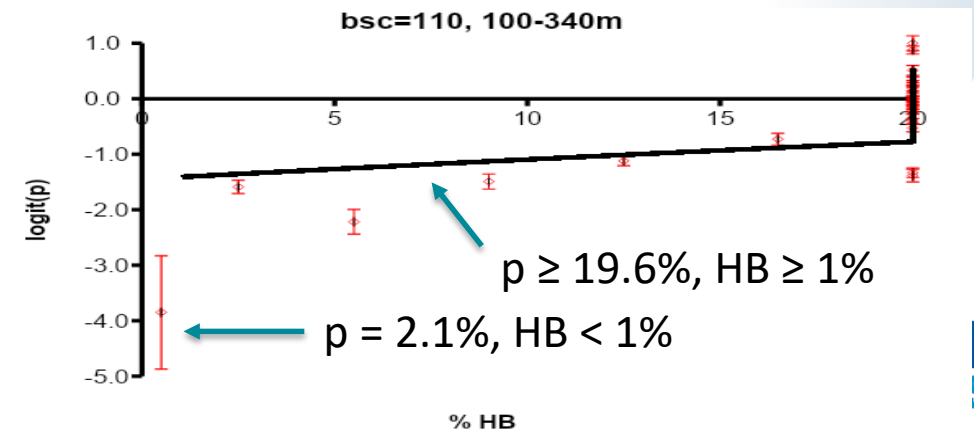
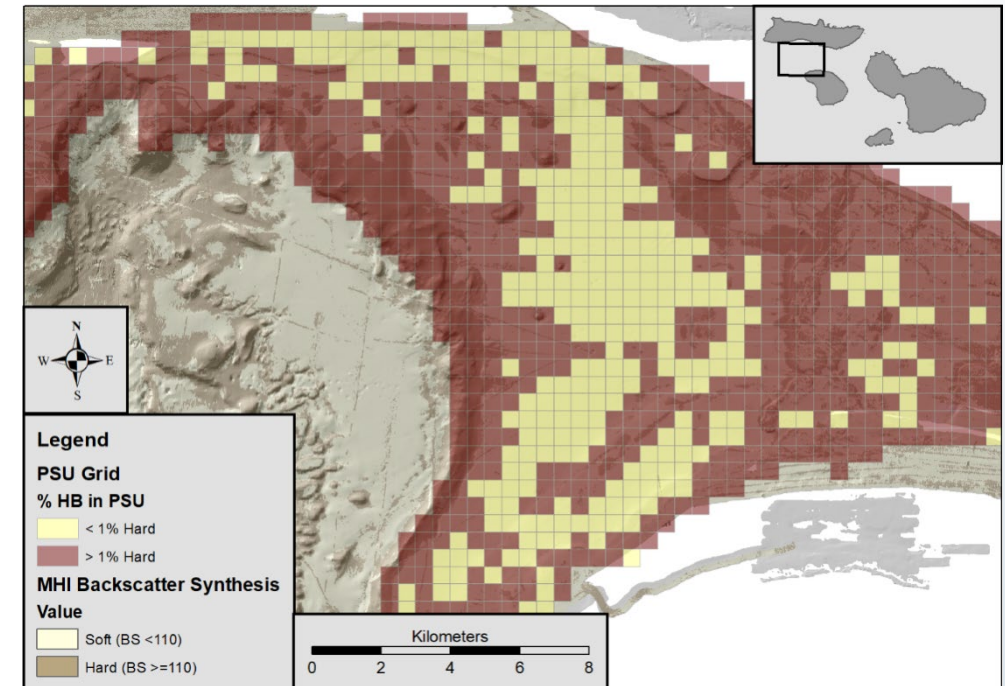
- Efficient domain stratification
- Stratified- vs Simple-Random Sampling
- Bathymetry & Backscatter
- Resolution: 5m



# Refined Stratification

- Based on MHI 5-m synthesis
- Substrate Type
  - Threshold: 110
  - Hard:  $\geq 1\%$  px
  - Soft:  $< 1\%$  px
- Substrate Complexity
  - Slope Threshold:  $10^\circ$
  - High:  $\geq 1\%$  px
  - Low:  $< 1\%$  px

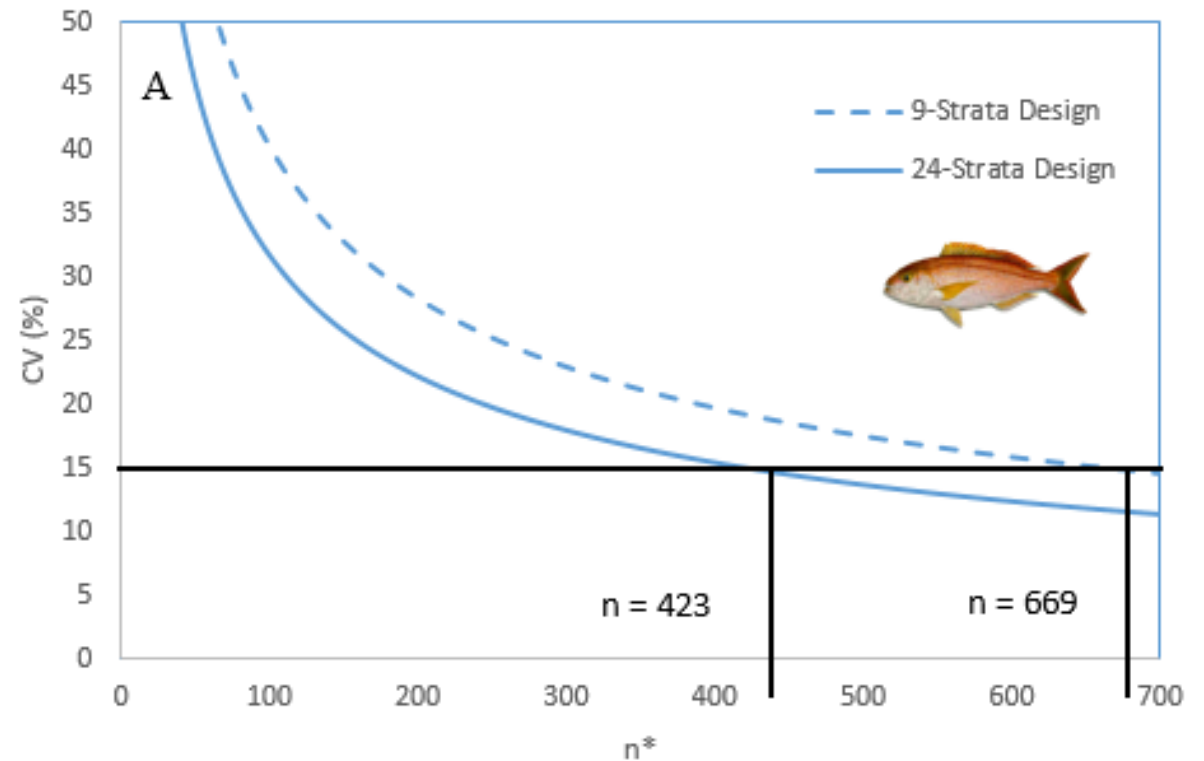
Pure softbottom, low complexity can likely be excluded from survey domain



# Multibeam Mapping for Survey Design

- 9 to 24-level stratification
- 34-57% reduction in sampling effort
  - Depth
  - Hardness
  - Seafloor complexity

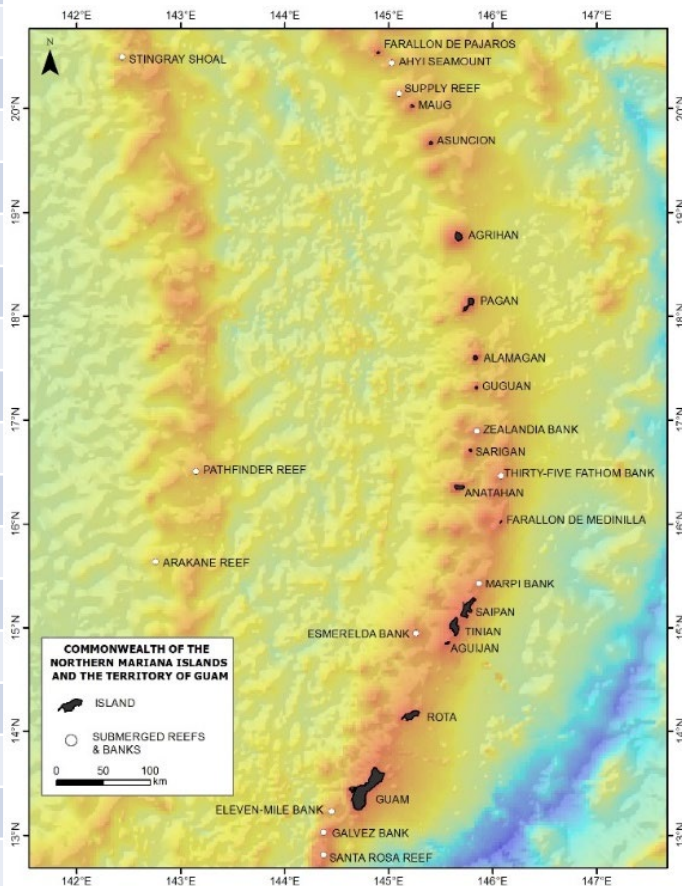
| BFISH Design Strata |     |     | %         |
|---------------------|-----|-----|-----------|
| Species             | 9   | 24  | Reduction |
| Ehu                 | 508 | 335 | 34%       |
| Opakapaka           | 669 | 423 | 37%       |
| Onaga               | 999 | 434 | 57%       |



|                              | Bathymetry (m) |           |           | Backscatter |
|------------------------------|----------------|-----------|-----------|-------------|
|                              | Resolution     | Min Depth | Max Depth |             |
| Farallon de Pajaros (Uracas) | 10             | 4         | 800       | ?           |
| Ahyi Reef                    | 35             | 62        | 2750      | -           |
| Supply Reef                  | 10             | 7         | 260       | ?           |
| Maug                         | 5              | 4         | 500       | ?           |
| Asuncion                     | 5              | 4         | 300       | ?           |
| Agrihan                      | 10             | 4         | 800       | ?           |
| Pagan                        | 10             | 5         | 800       | ?           |
| Alamagan                     | 10             | 4         | 800       | ?           |
| Guguan                       | 10             | 7         | 800       | ?           |
| Zealandia Bank               | -              | -         | -         | -           |
| Sarigan                      | 10             | 10        | 800       | ?           |
| 35-fathom bank               | 5              | 72        | 200       | -           |
| 37-fathom bank               | 5              | 70        | 200       | -           |
| Anatahan                     | -              | -         | -         | -           |
| Farallon de Medinilla        | 5              | 0         | 400       | -           |
| Marpi Bank                   | 5              | 53        | 400       | ?           |
| Saipan                       | 5              | 0         | 400       | ?           |
| Tinian                       | 5              | 4         | 400       | ?           |
| Esmerelda bank               | -              | -         | -         | -           |
| Aguijan                      | 5              | 4         | 400       | ?           |
| Rota                         | 5              | 0         | 400       | ?           |
| Guam                         | 5              | 0         | 400       | ?           |
| 11-mile bank                 | 5              | 23        | 1100      | -           |
| Galvez Bank                  | 5              | 20        | 100       | ?           |
| Santa Rosa Reef              | -              | -         | -         | -           |

# Mariana Archipelago

Multibeam bathymetric products based on 2003 and 2007 Pacific Islands Fisheries Science Center mapping missions of the NOAA Ship Hi'ialakai and RV AHI.

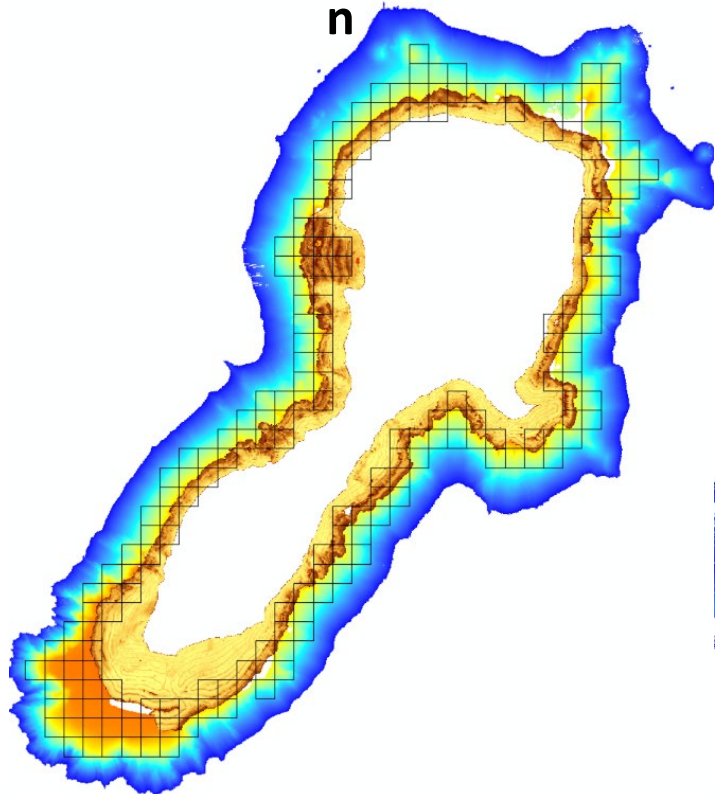


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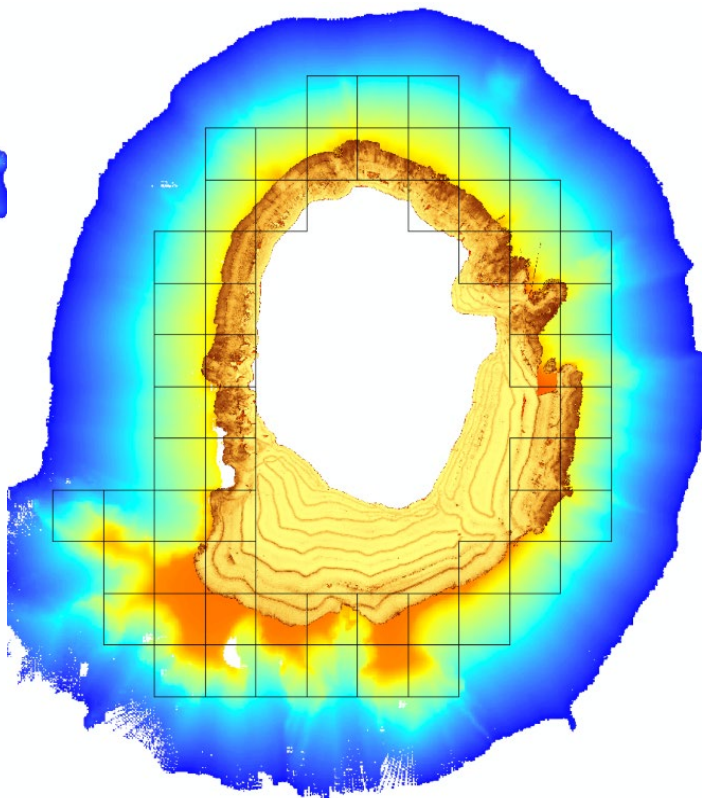


# Mariana Stratification

Pagan



Guguan



- Primary Sampling Units (500 x 500m)
  - Usable bathy: 7302
  - 75-400m: 4501
  - Backscatter: 2206 (49%)
    - Questionable utility
      - Artifacts ...



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# A Report on Utility of Existing Multibeam Mapping Data in Designing a Stratified Bottomfish Fishery-Independent Survey in the Mariana Archipelago

Benjamin L. Richards

NOAA Pacific Islands Fisheries Science Center, Fisheries Research and Monitoring Division, Stock Assessment Program

## Summary

While multibeam and backscatter data have been collected for much of the Mariana archipelago, in its current form, little is usable for designing a bottomfish fishery-independent survey similar to the BFISH survey in Hawaii. Much of the bathymetric data does not exist at a high enough resolution nor does it extend deep enough to cover the presumed bottomfish domain. Backscatter data, while it has been collected in some regions, covers even less of the bottomfish domain and, where it exists, it is of questionable quality or utility.

Essential fish habitat for bottomfish is defined as water depth between 75 and 400 meters. For maximum utility in designing a Bottomfish Fishery-Independent Survey for the Mariana Archipelago (BFISM), mapping data must: 1) be of at least 5-meter resolution, 2) include comprehensive and consistent bathymetry and backscatter, and 3) cover the 50-500m depth range.

A detailed review of existing processed and raw multibeam bathymetric and backscatter data is needed to ascertain the full utility of existing data. Should such data exist, a multibeam and backscatter synthesis, similar to that conducted by Richards et al. (in review), would need to be completed before it was usable. As much of the data was collected using the same or a small number of sensor types, this process should be less complicated for the Mariana archipelago.

However, to ensure comprehensive, high-quality data for use in designing a Bottomfish Fishery-Independent Survey for the Mariana Archipelago (BFISM), a comprehensive multibeam survey to produce both bathymetric and backscatter data should be conducted.

## Background

The Pacific Islands Fisheries Science Center has implemented a Bottomfish Fishery-Independent Survey in Hawaii (BFISH) (Richards et al., 2016). Bottomfish are economically and culturally valuable across the Pacific and are typically found in hardbottom areas at depths of 74 to 400 meters in Hawaii. The BFISH survey utilizes a stratified-random sampling design to achieve maximum statistical precision with minimal sampling effort (Cochran, 1977; Lohr, 2010). The survey domain is gridded at 300-m and each grid cell (primary sampling unit) is assigned to a given strata. Strata are based on 5-meter resolution multibeam bathymetric products and are defined by depth, bathymetric slope, and seafloor hardness (Richards et al., in review). Depth is stratified at three levels: 75-200 m, 200-300m, and 300-400m.

# Pre-RICHARD Mapping Needs

## Bathymetry

- Depth range: 50 – 500 m
- Resolution: 5 m
- Derived products:
  - Depth
  - Slope
  - Complexity

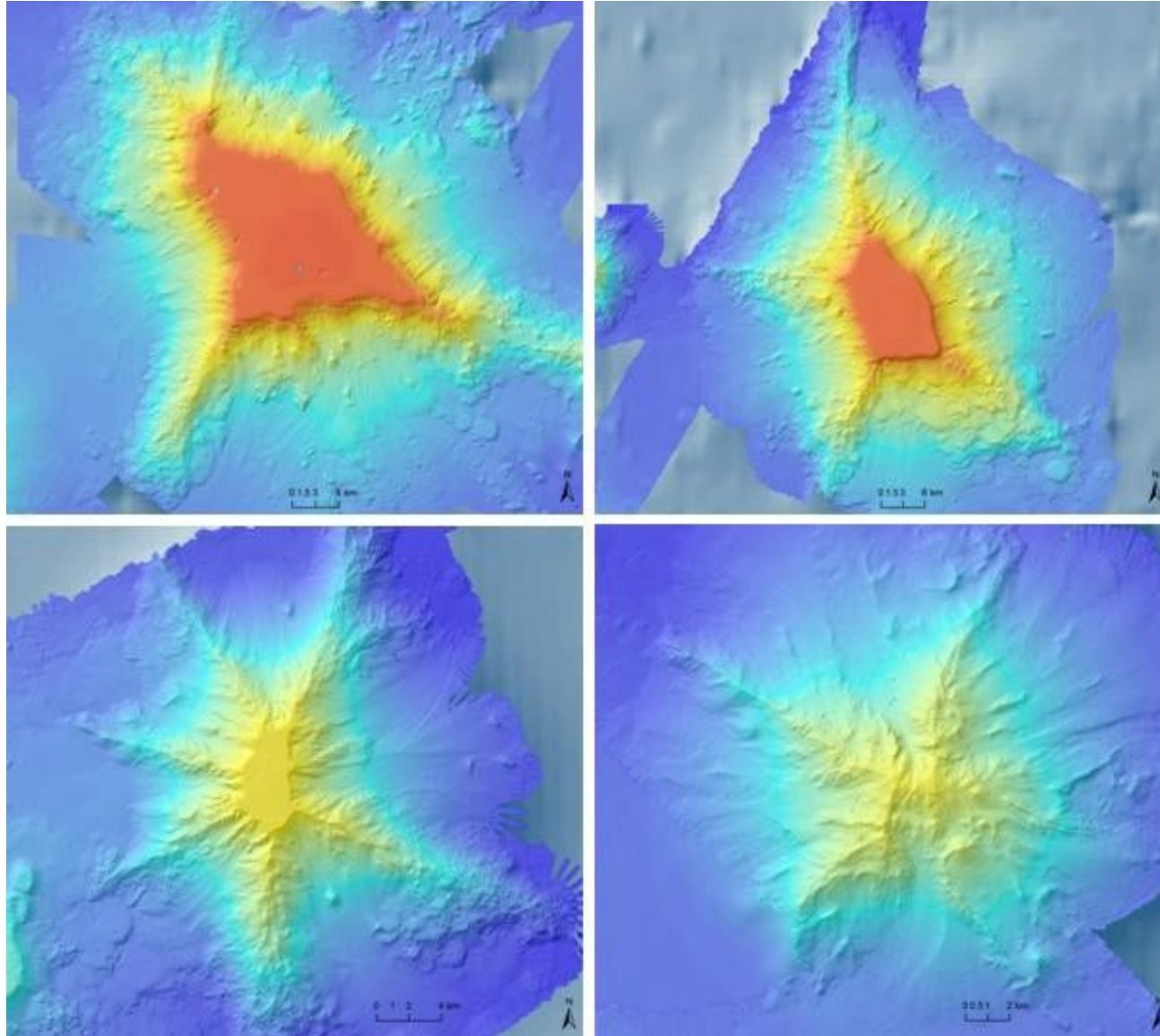
## Backscatter

- Depth Range: 50 – 500 m
- Resolution: 5 m
- Derived Products:
  - Seafloor hardness
- Challenges:
  - Survey design
  - Multi-vessel Calibration
  - Nadir artifacts
  - Hardness ~ slope



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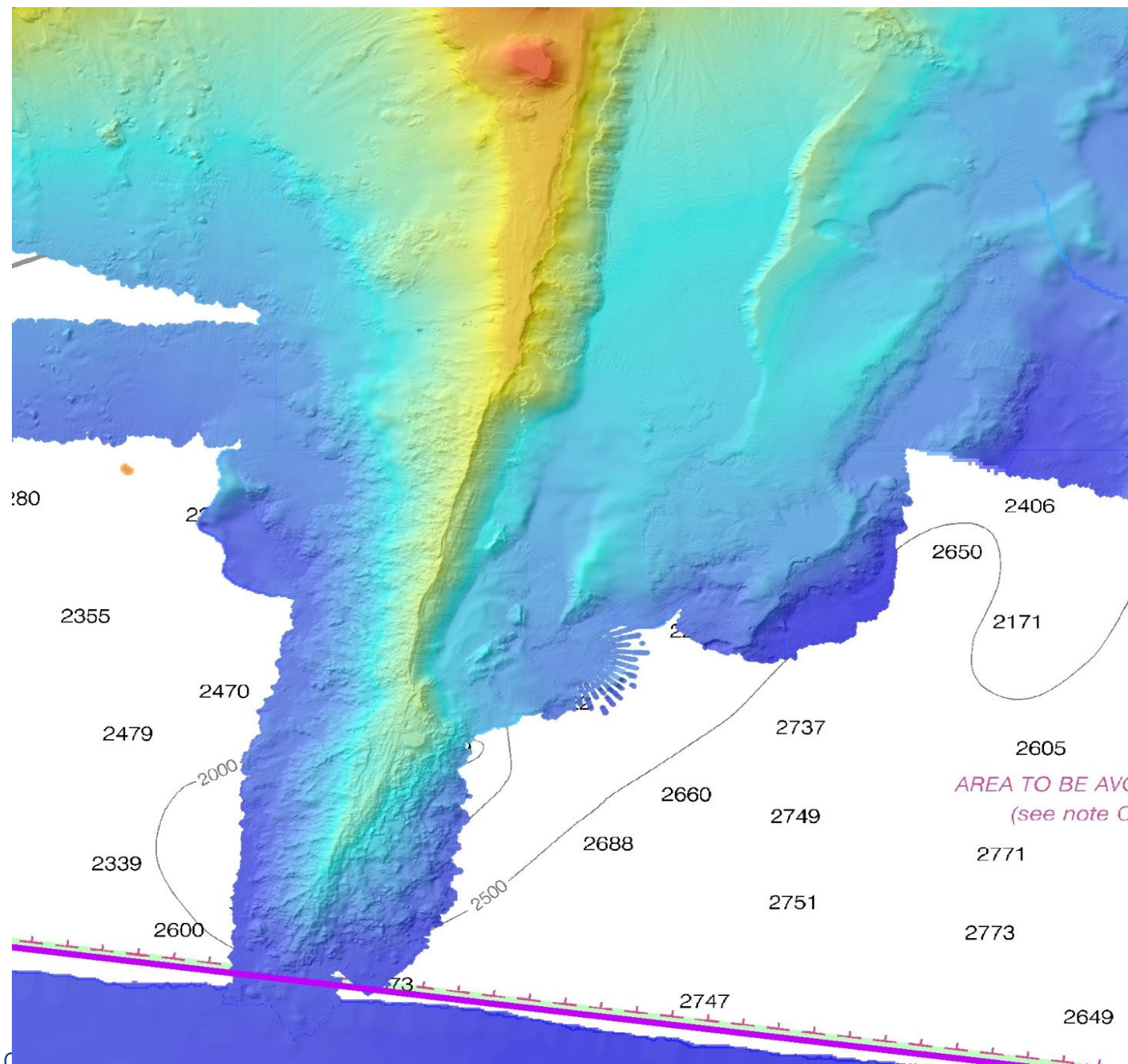
# Mapping the deep sea features of Papahānaumokuākea Marine National Monument



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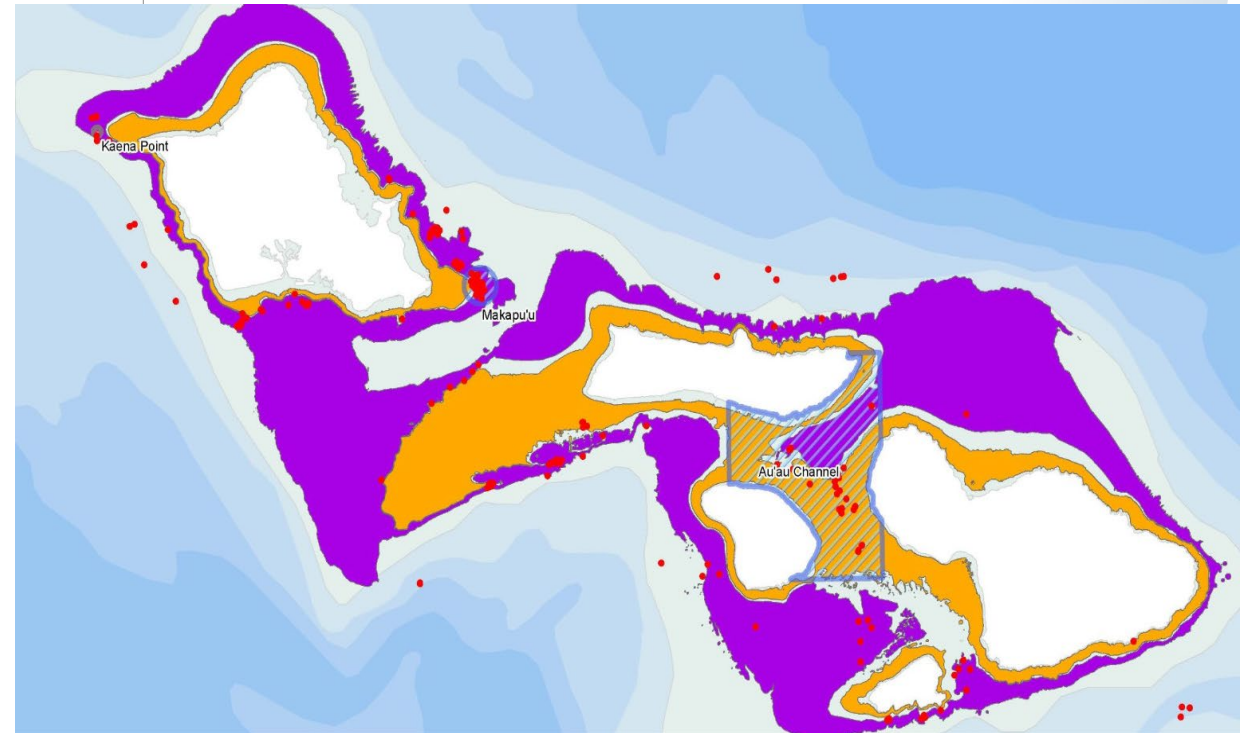
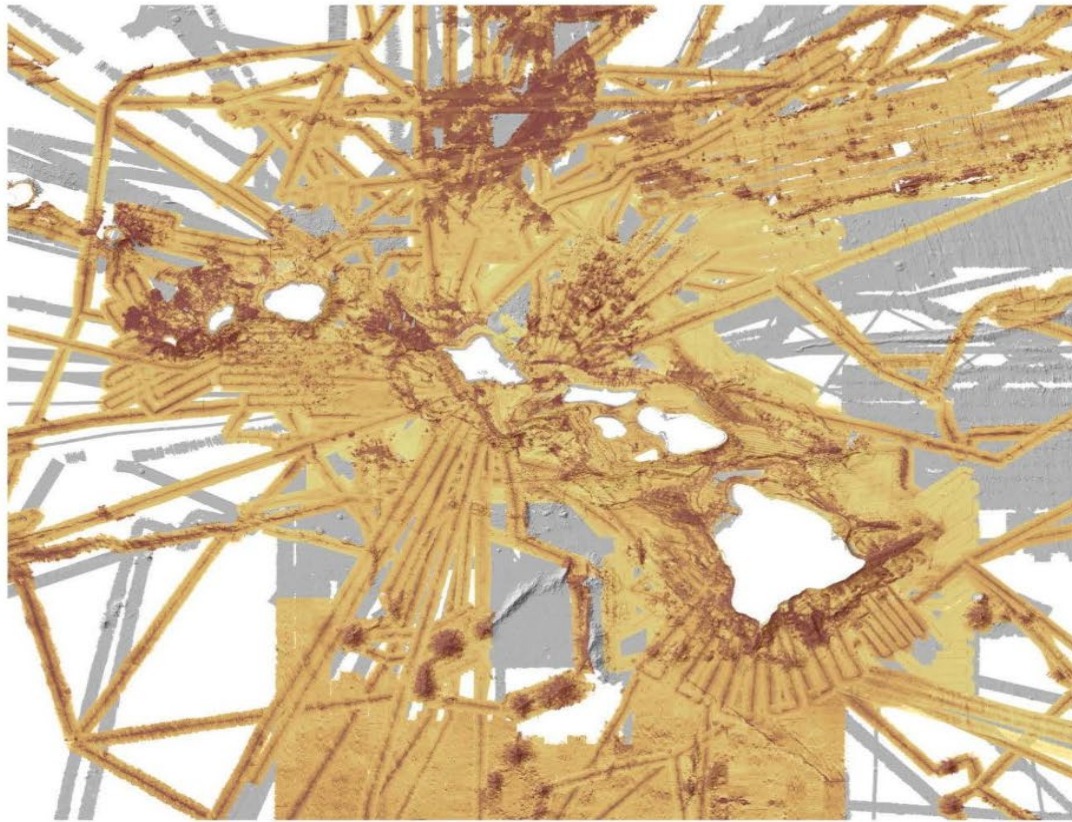
# Pioneer Bank



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# MHI Backscatter and Bathymetry synthesis





# Hydrography/Photogrammetry Co-registration Project

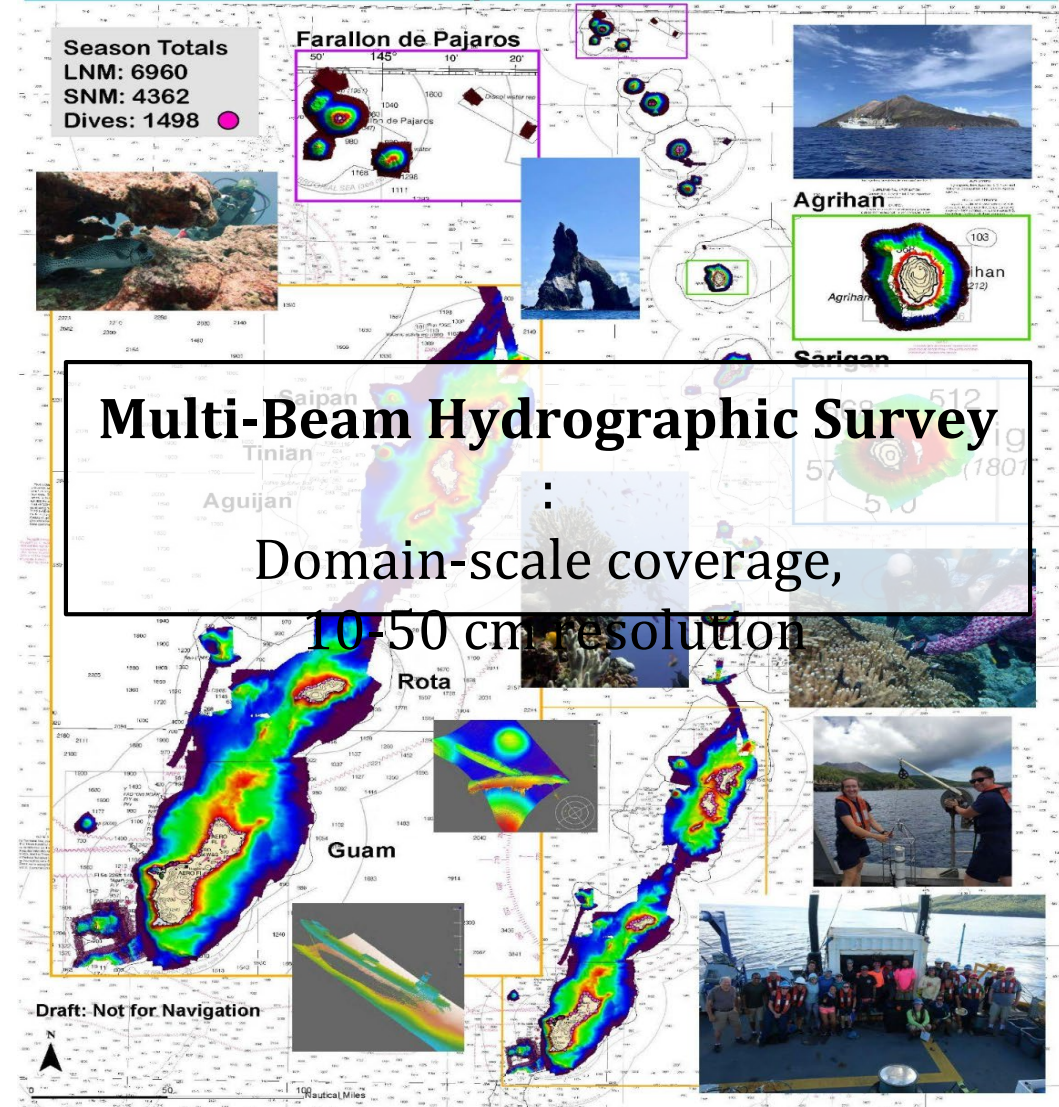


**Diver-Collected Photogrammetry Models (a.k.a. SfM) :**  
10 m diameter, < 1 mm resolution,  
10-100s of sites per archipelago

Photomosaic

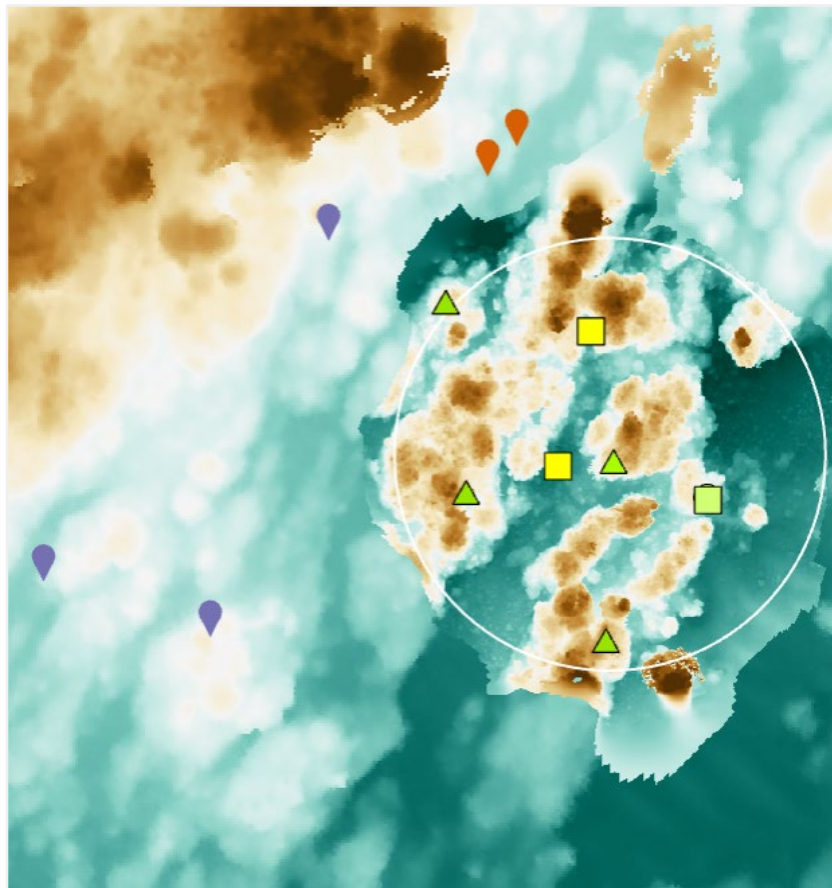
DEM

**RICHARD 2022 - 3rd and 4th Operational Legs  
Updated to 7/14**

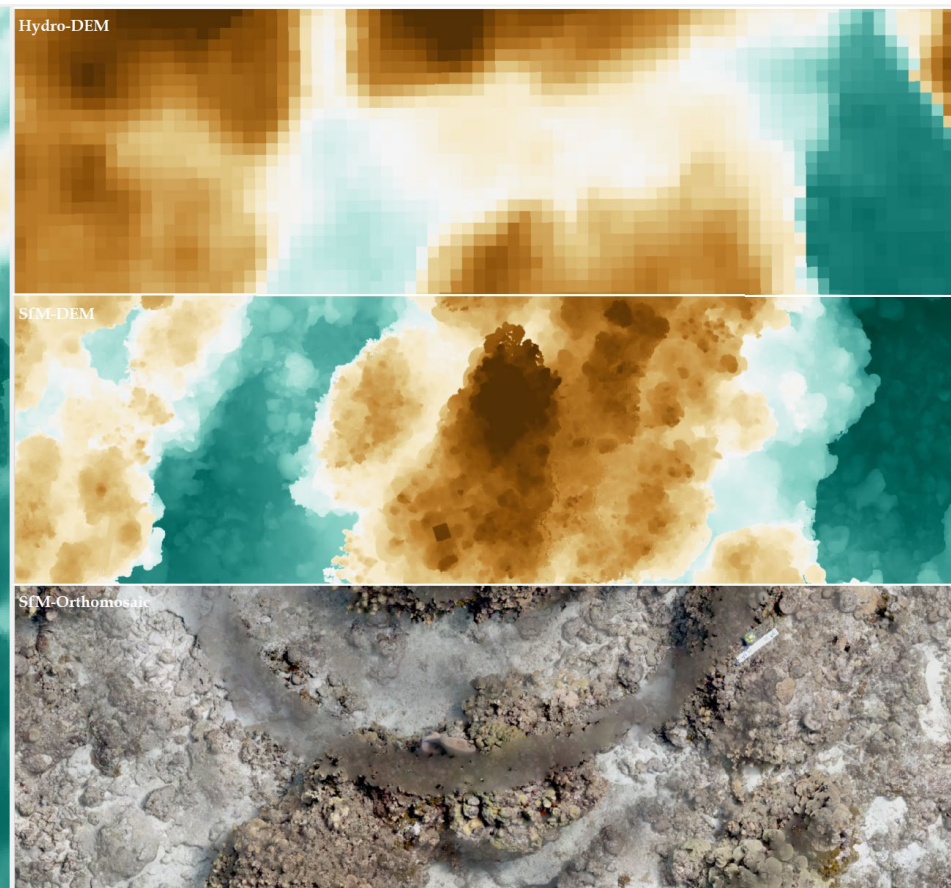




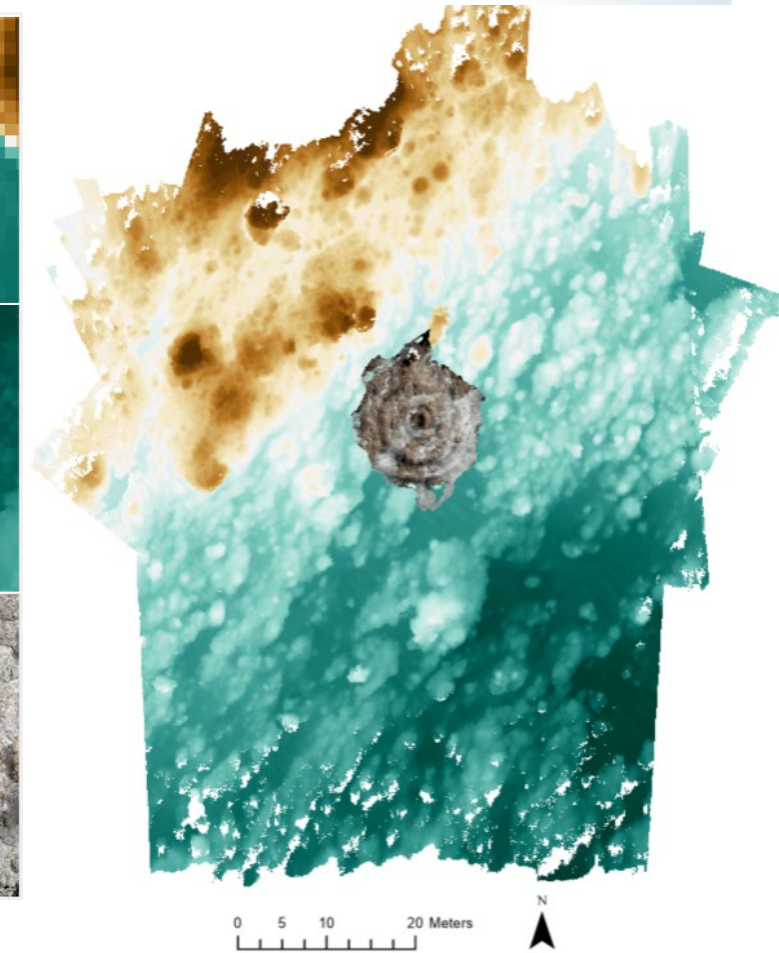
# Hydrography/Photogrammetry Co-registration Project



Co-location method tests



SfM imagery co-registered to sonar DEM



Multi-scale image overlay

**Implications:** expand our research scopes; build partnerships; support large-scale NCCOS benthic mapping; etc.



A WP-3D Orion aircraft, known as "Miss Piggy", is flying in the sky above the NOAA ship Rainier. The ship is a white research vessel with "NOAA" and "S 201" visible on its side. The background features a lush, green, hilly coastline under a clear blue sky. The foreground shows the dark blue, choppy surface of the ocean.

# QUESTIONS?

NOAA RAINIER and WP-3D Orion “Miss Piggy” in CNMI



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