

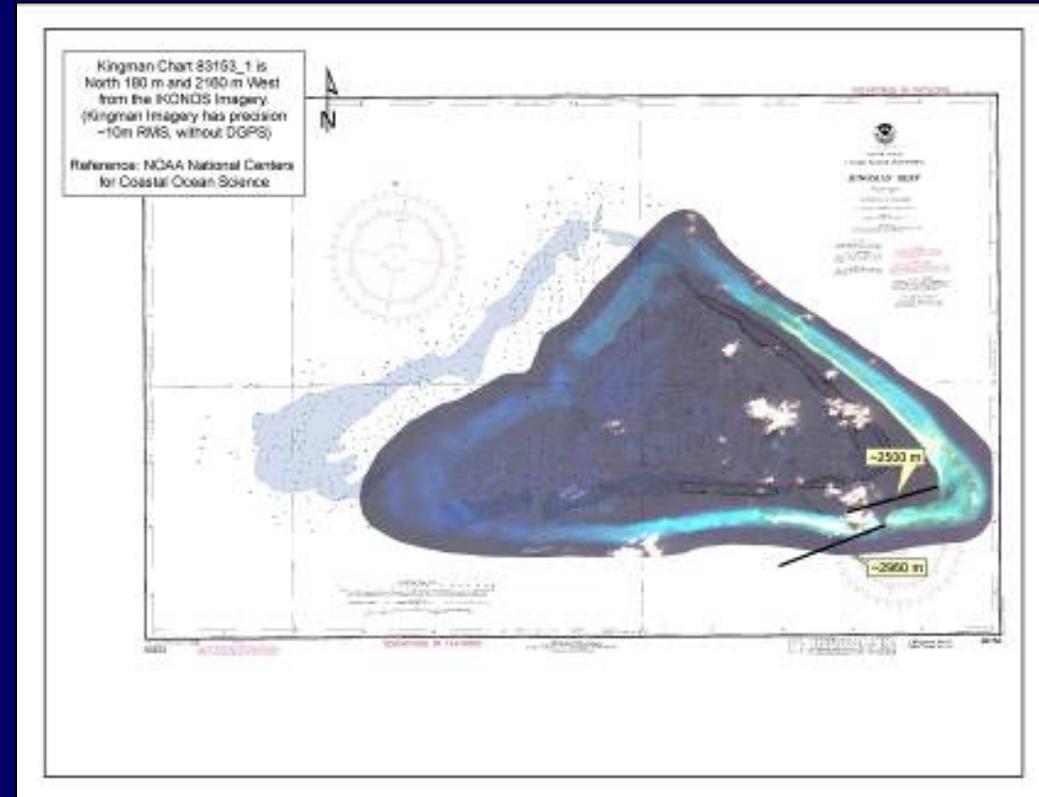
Coral Reef Ecosystem Integrated Observing System (CREIOS): Mapping

Pacific Mapping & Monitoring Workshop
NOAA Coral Reef Conservation Program
November 18-20, 2008



Mapping Status in 2000 (Pre-CRCP):

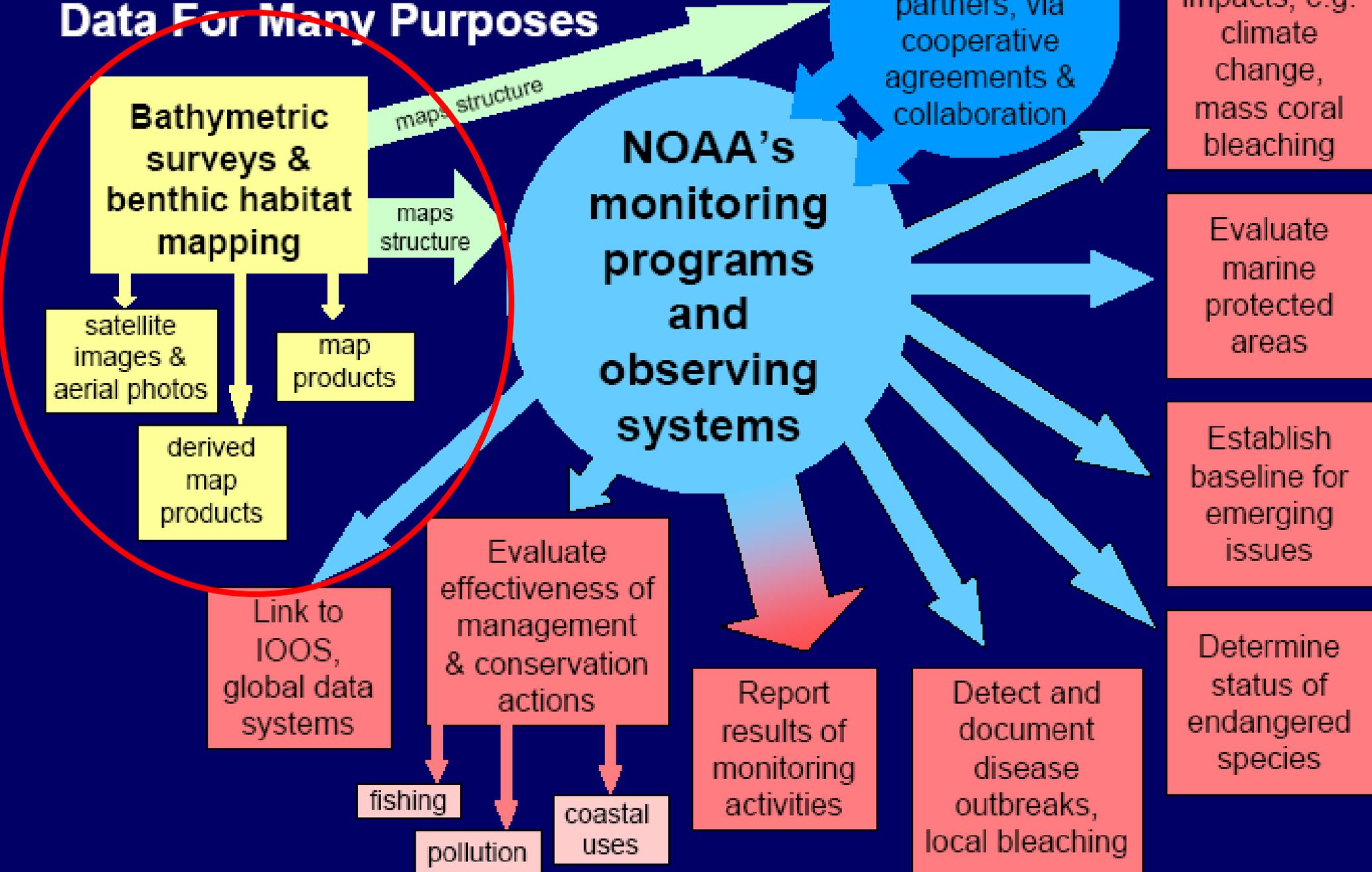
- Lack of info on the extent and distribution of U.S. coral reefs and associated habitats
- Lack of accurate bathymetric and location information, esp. for remote islands, atolls
- Existing data was difficult to discover, obtain, or use
- Lack of maps meant little habitat information available to structure coral reef monitoring activities



Significant (~2 km) chart offsets for many reefs.

Coastline used for seafloor models was 10x larger than actual size of Kingman Reef.

NOAA's Integrated Mapping and Monitoring Activities Provide Data For Many Purposes



Mapping Goals (circa 2000)

Provide a comprehensive suite of digital map products for U.S. coral reefs to define the spatial extent and habitat types of the Nation's coral reef ecosystems.

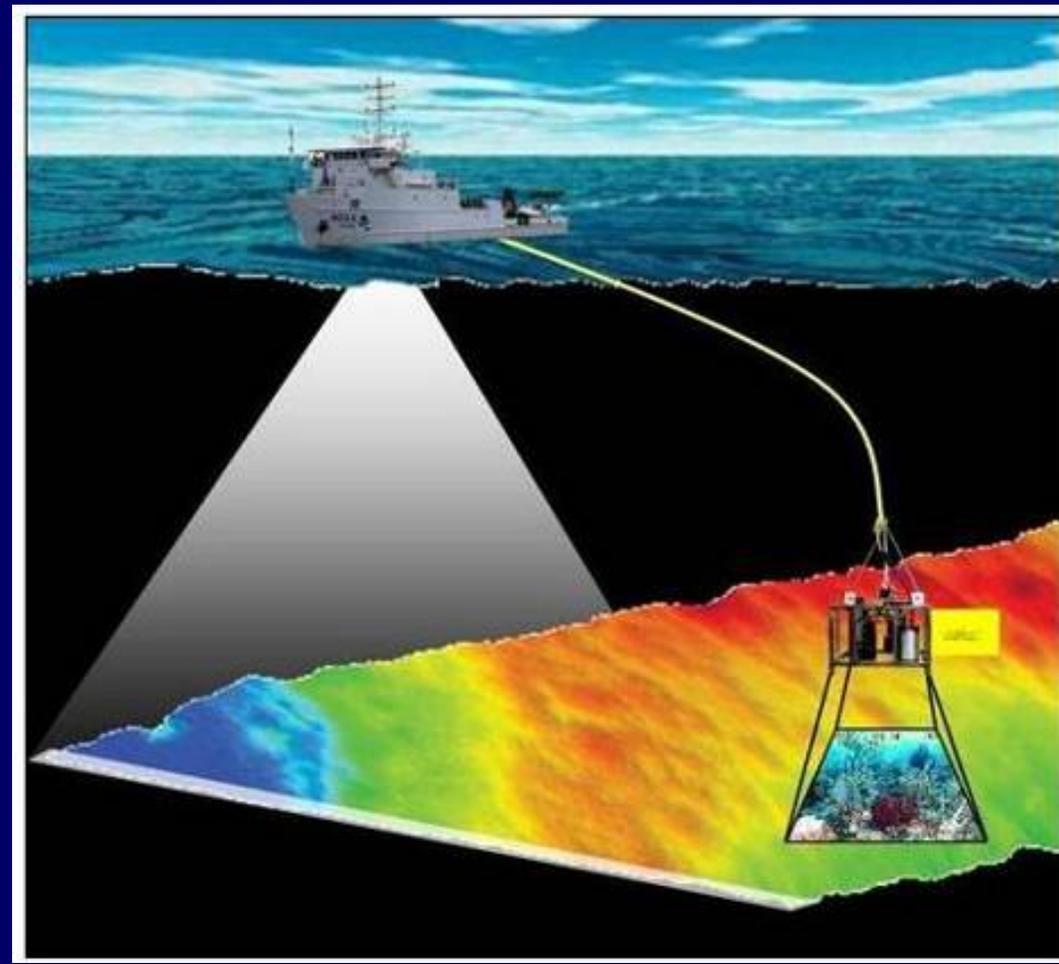
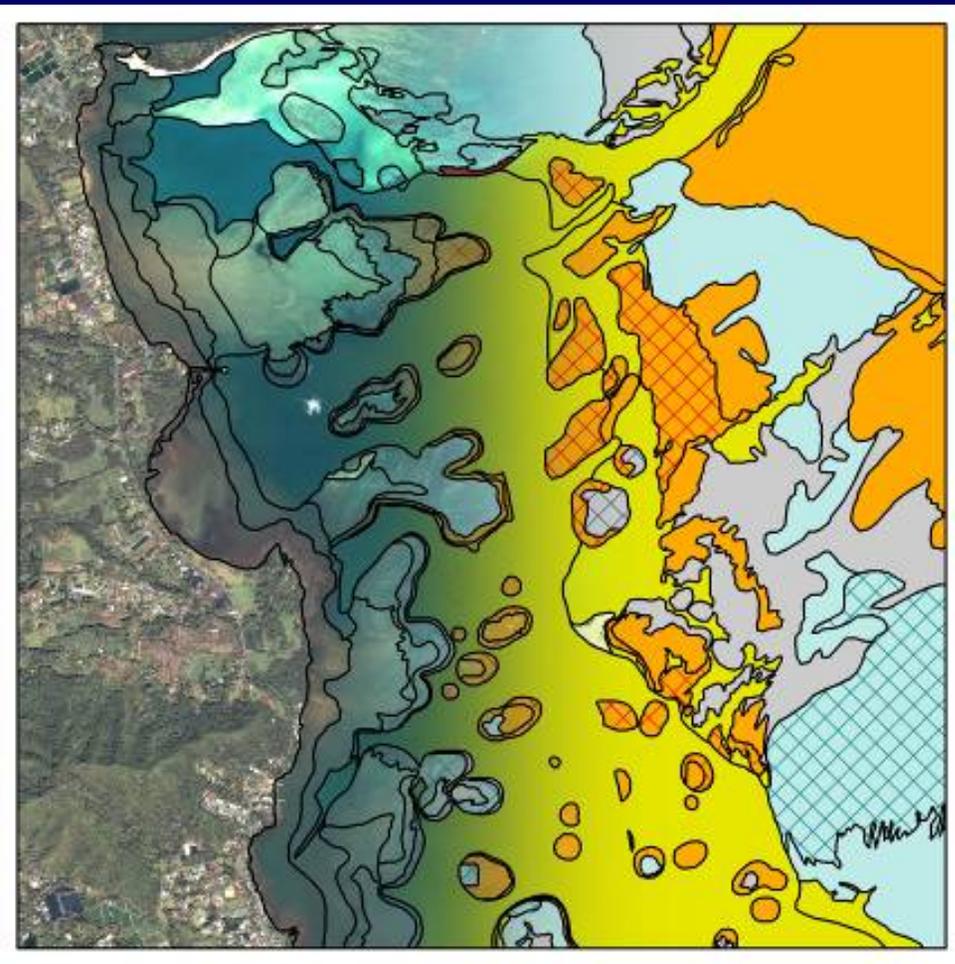
Support Management needs & objectives, such as:

- establish and evaluate MPAs and zoning efforts,
- develop robust sampling designs for monitoring,
- assess damage to natural & cultural resources,
- plan coastal development and mitigation activities,
- prioritize conservation efforts,
- conduct change analysis to detect ecosystem shifts.

Develop technologies to more efficiently map coral habitats.

- move from static to iterative map products,
- reduce cost and increase accuracy,
- increase thematic & spatial resolution,
- integrate shallow and moderate depth map products.

Coral Reef Ecosystem Mapping: Benthic Habitat and Acoustic/Optical Maps



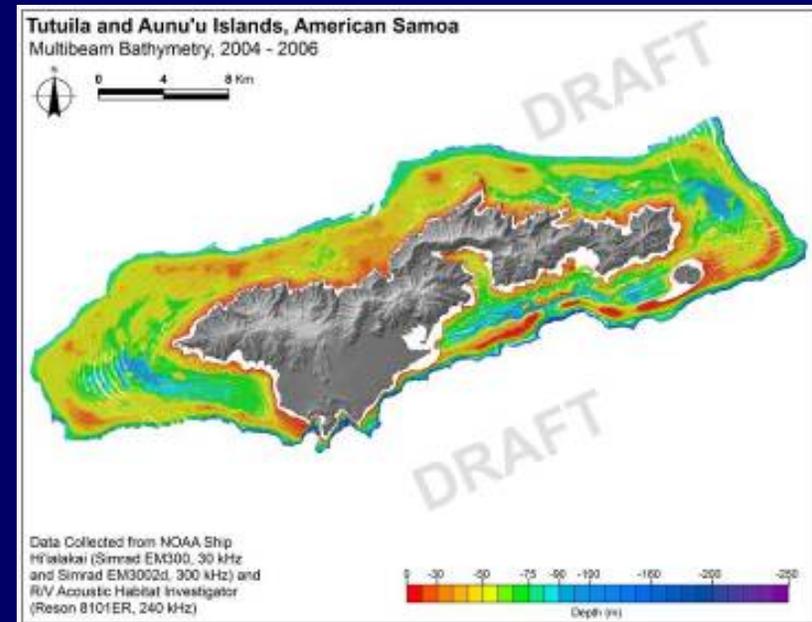
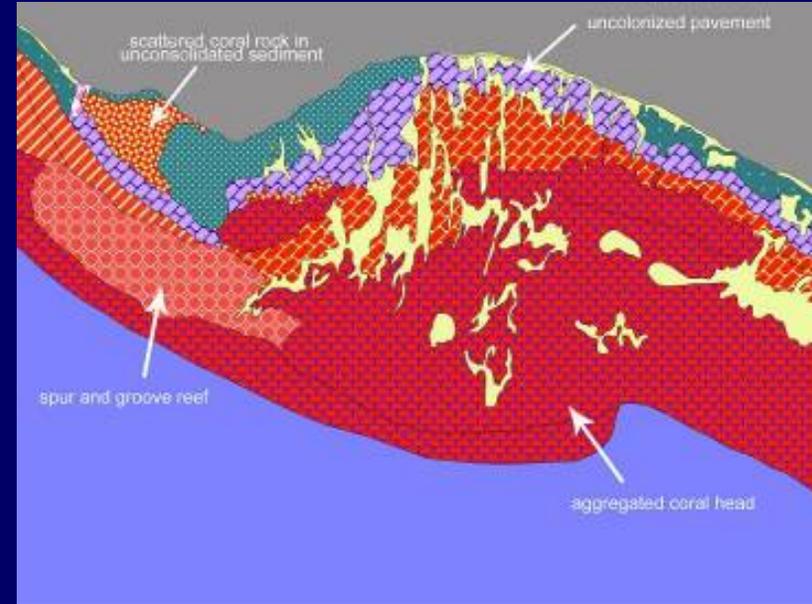
Overview: Mapping Approaches

Habitat Mapping

- Shallow, nearshore to visible depths
- Uses satellite imagery, aerial photos, etc.
- Humans delineate visible habitat boundaries, assign classes
- **Maps: zone, structure, biological cover**
- Validated via accuracy assessment

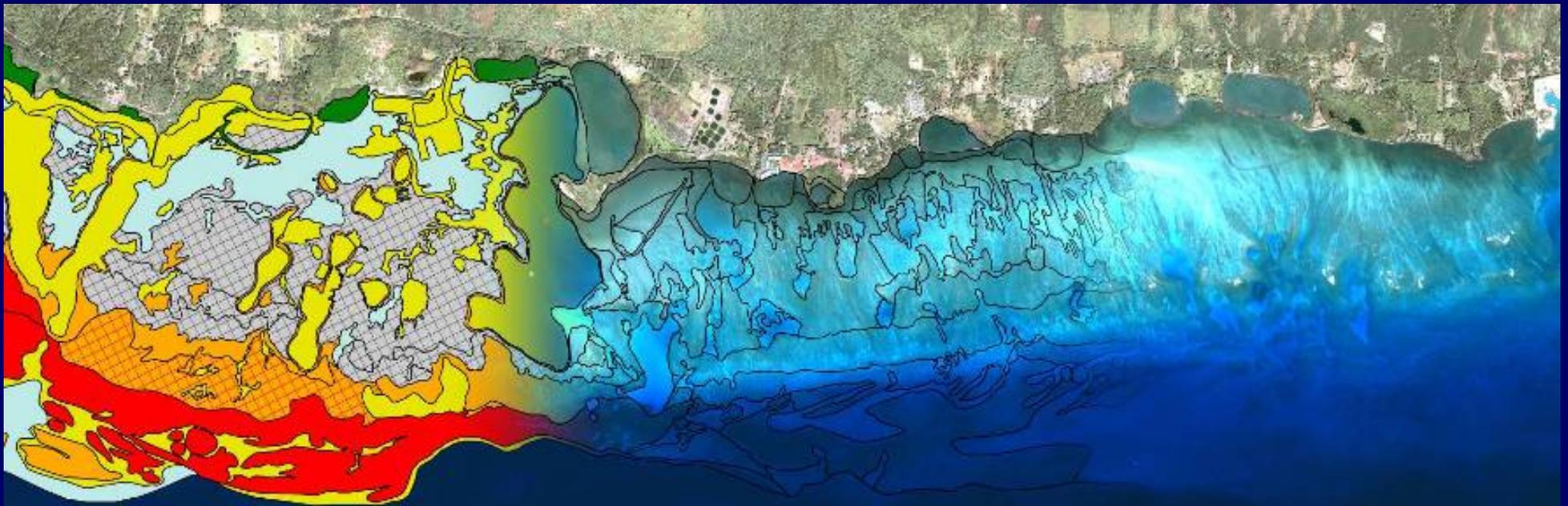
Acoustic & Optical Surveys

- Mid- & deep-water habitats, 15 to 1000+m
- Uses multibeam acoustic technologies
- **Maps: high resolution bathymetry, backscatter, derivatives (e.g. slope and rugosity), and hard and soft features**
- Validated by observations from towed cameras, ROVs, AUVs, etc.

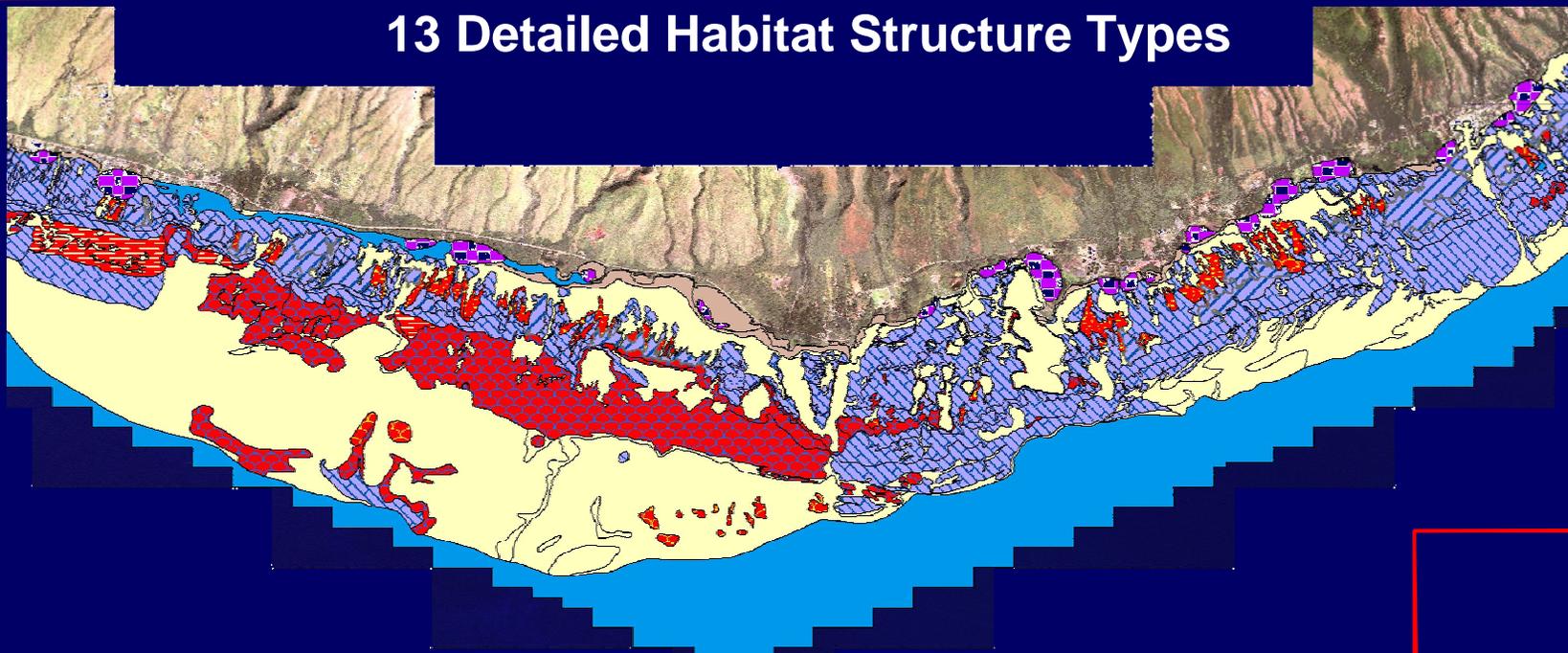


Benthic Habitat Mapping (<30m)

- Limited to habitats that are **VISIBLE** in the imagery
- Process generates various products (e.g., imagery) in addition to maps
- Products meet national-level requirements while providing critical information to regional, state, and local coastal managers
- Method provided best balance re: high spatial resolution, budget and time limitations; 1 acre MMU met needs of most managers at the time.
- Provision of all inputs and customized software enables users to generate finer-scale products if needed. Do users have capacity to create habitat maps? If not, what investment (time/personnel) is appropriate?

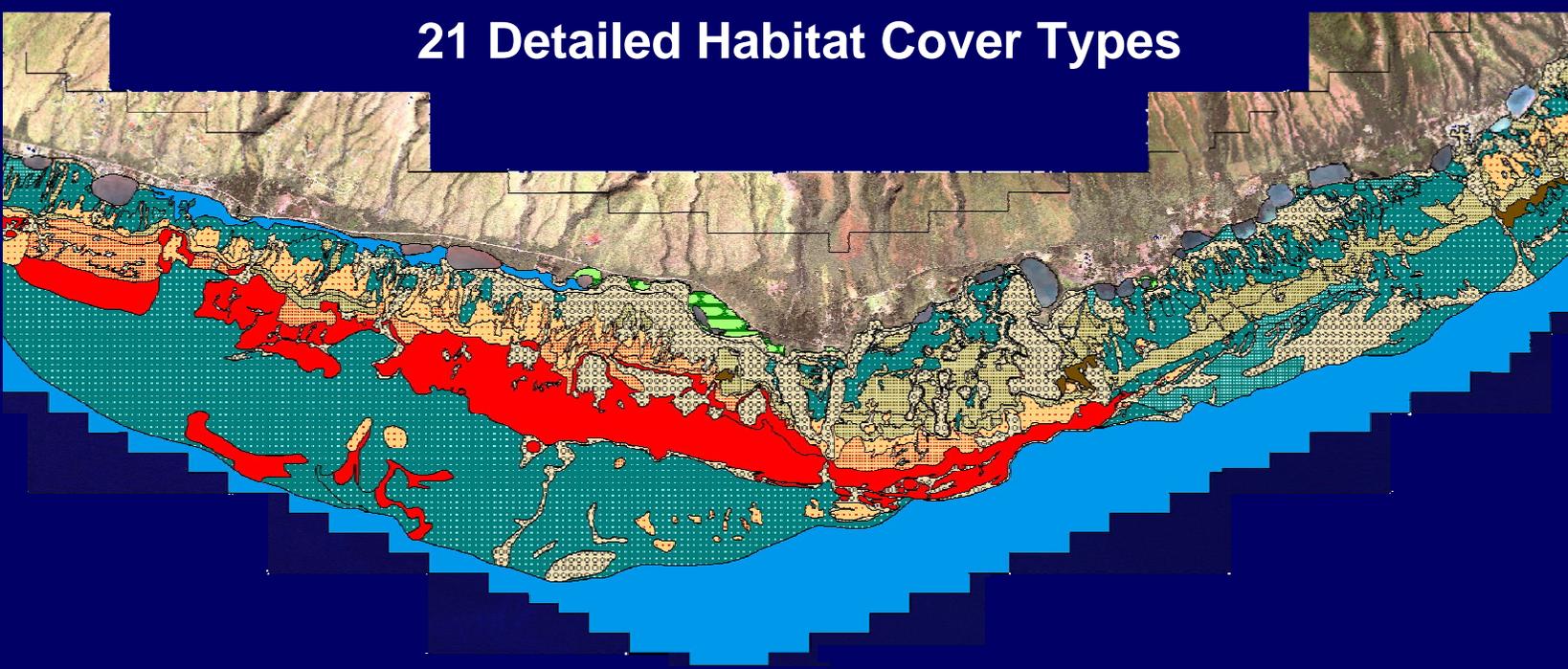


13 Detailed Habitat Structure Types



- ### Habitat Structure
- Sand
 - Mud
 - Spur and Groove
 - Individual Patch Reef
 - Aggregate Reef
 - Aggregated Patch Reef
 - Scattered Coral/Rock
 - Pavement
 - Rock/Boulder
 - Rubble
 - Pavement with Sand Channels
 - Artificial
 - Unknown

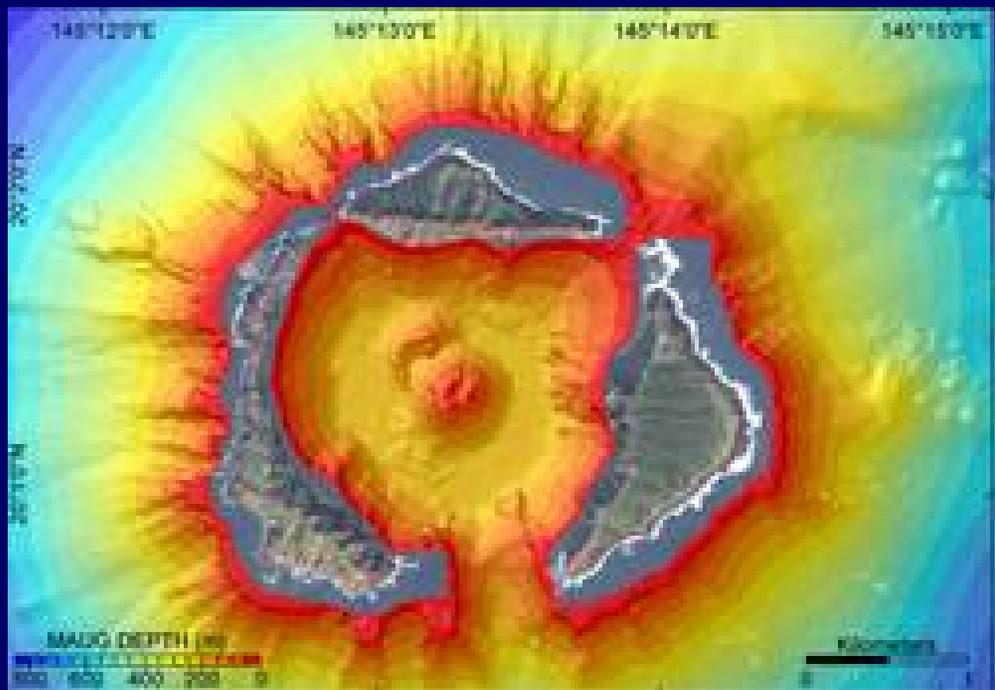
21 Detailed Habitat Cover Types



- ### Habitat Cover
- Unknown
 - Uncolonized 90%-100%
 - Uncolonized 50%-<90%
 - Unclassified
 - Turf 90%-100%
 - Turf 50%-<90%
 - Turf 10%-<50%
 - Seagrass 90%-100%
 - Seagrass 50%-<90%
 - Seagrass 10%-<50%
 - Macroalgae 90%-100%
 - Macroalgae 50%-<90%
 - Macroalgae 10%-<50%
 - Emergent Vegetation 90%-100%
 - Emergent Vegetation 50%-<90%
 - Emergent Vegetation 10%-<50%
 - Coralline Algae 90%-100%
 - Coralline Algae 50%-<90%
 - Coralline Algae 10%-<50%
 - Coral 90%-100%
 - Coral 50%-<90%
 - Coral 10%-<50%

Acoustic Surveys (15-1000+ m)

- Process generates various products in addition to bathymetric contours (e.g., slope, complexity, backscatter)
- Help delineate EFH/HAPC and identify biologically important seafloor features
- Define boundaries delimited by particular isobath or habitat type
- Can be used to update nautical charts if surveys are conducted to IHO standards



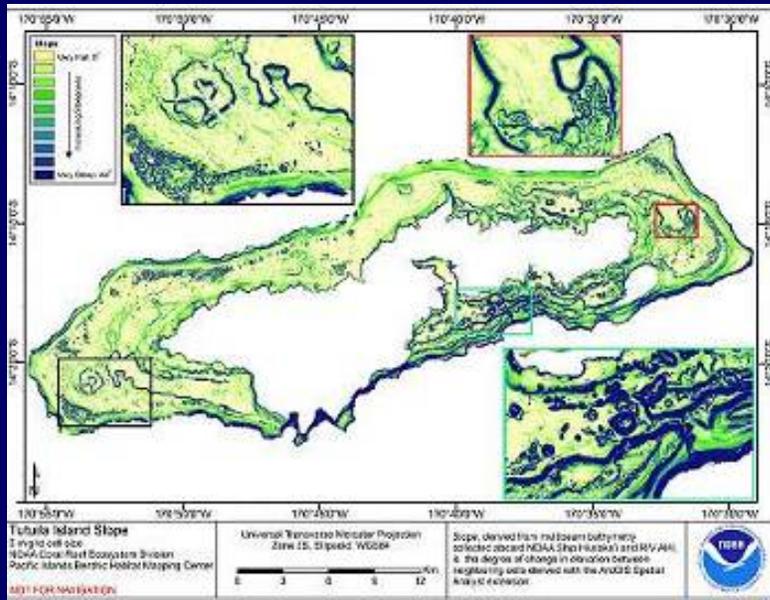
Maug, CNMI



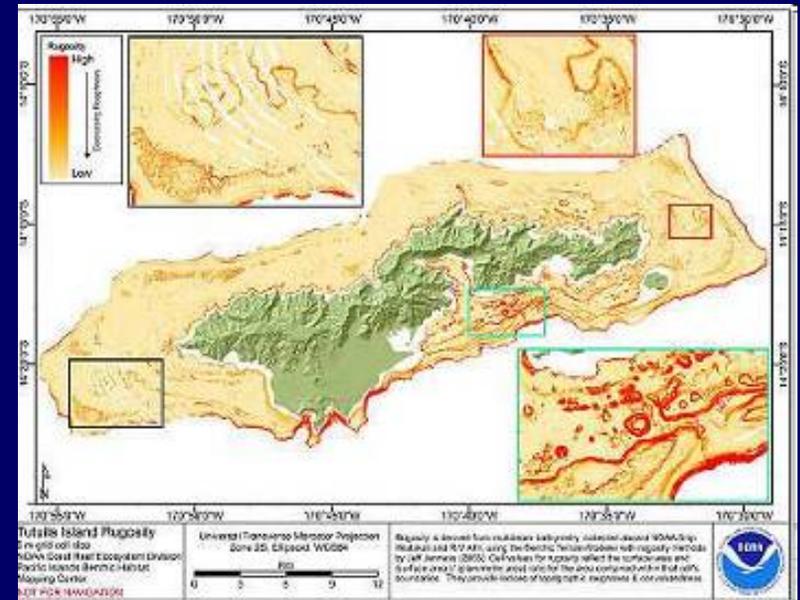
Multibeam bathymetry and backscatter Saipan, CNMI

Bathymetry Derivatives and Optical Data

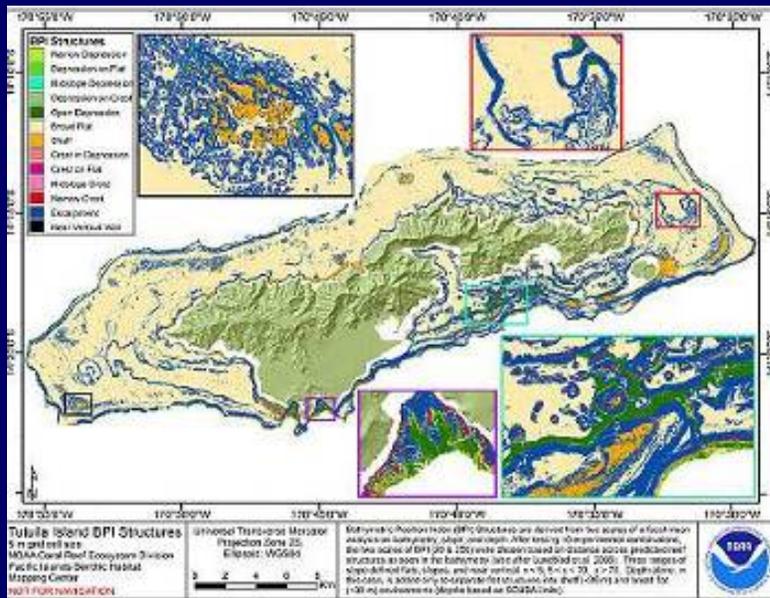
Slope



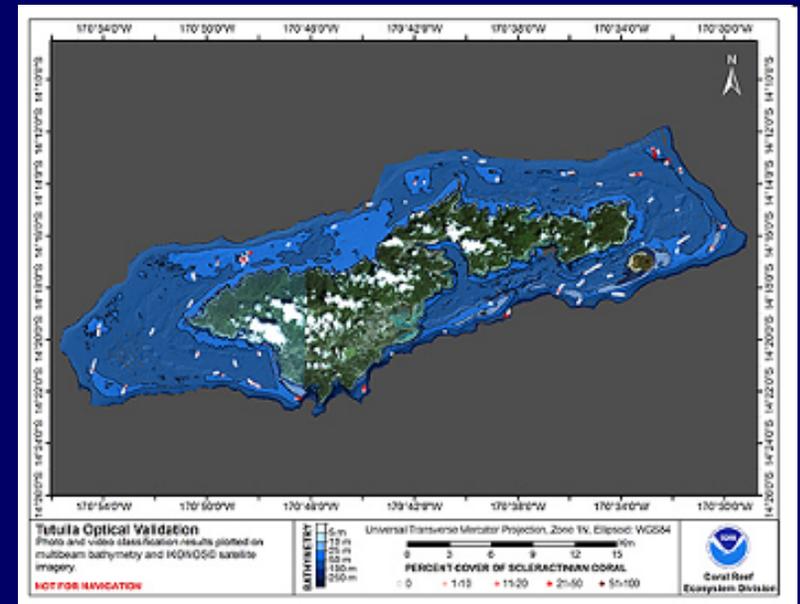
Rugosity



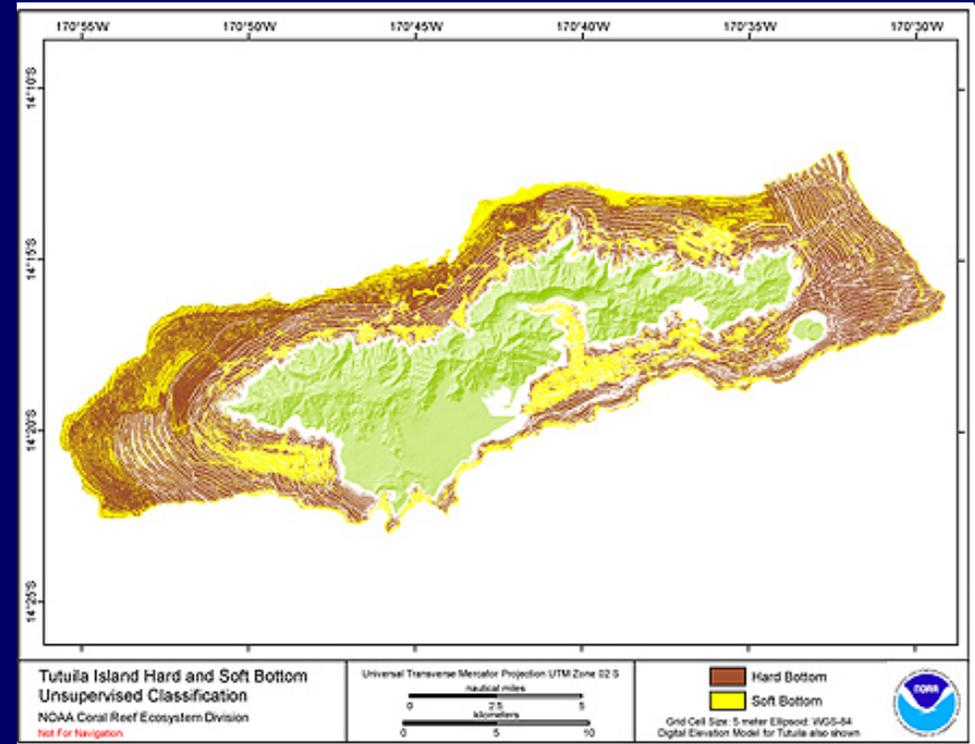
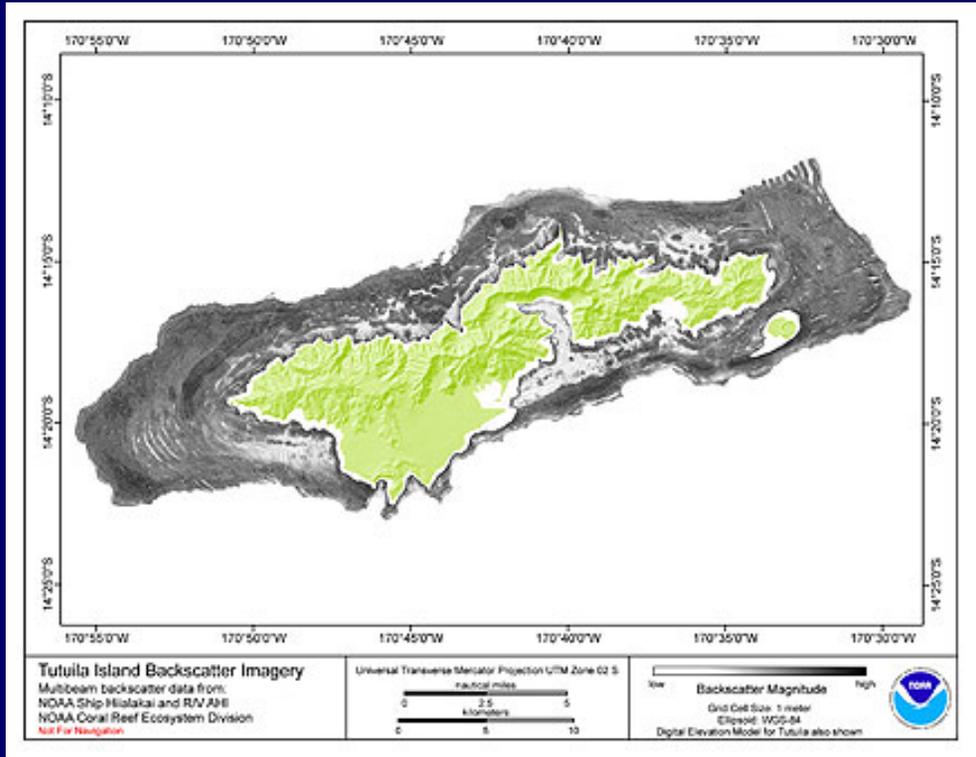
BPI



Coral Cover From Optical Data



Backscatter + Bathy = Hard/Soft



Backscatter data are processed and combined with bathymetric variance information in an Unsupervised Classification to produce Hard/Soft maps. Optical data are then used to judge accuracy of classification. Hard/Soft maps requested by NWHI management to help design sampling protocols for biological studies.

Much More Optical Validation Data Needed



Towed-Diver Surveys



Camera sleds and ROVs



AUV

Mapping Progress to Date

- Most locations now have shallow water benthic habitat maps and moderate depth acoustic and optical maps.
- Detailed benthic habitat maps equivalent to existing shallow maps are difficult to produce from acoustic data. Hard/soft maps simpler.
- High-resolution bathymetric maps are difficult or expensive to produce for shallow-water areas.
- Integration of satellite and acoustic data to produce integrated maps is eventual goal but still under development.

JURISDICTION	BENTHIC HABITAT MAP PRODUCTS		BATHYMETRIC PRODUCTS	
	Shallow-Water (<30 m)	Moderate depth (30-1000 m)	Shallow-Water (<30 m)	Moderate depth (30-1000 m)
Main Hawaiian Islands	75-100%	0-25%	75-100%	75-100%
Northwestern Hawaiian Islands	50-75%	0-25%	25-50%	25-50%
American Samoa	75-100%	0-25%	25-50%	75-100%
PRIA	0-25%	0-25%	0-25%	75-100%
CNMI	75-100%	0-25%	50-75%	75-100%
Guam	75-100%	0-25%	75-100%	75-100%

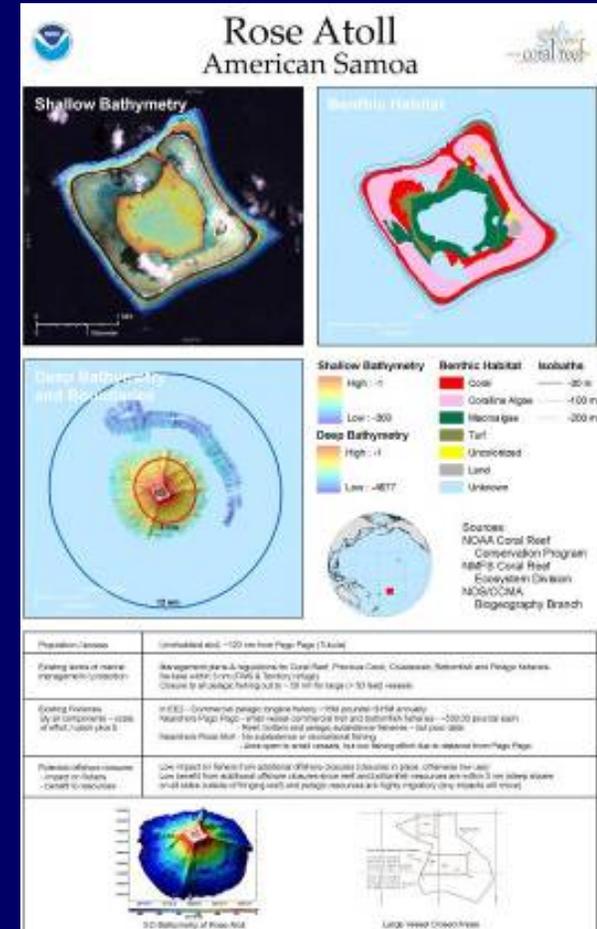
Meeting Management Needs

Federally Managed Areas

- Critical data for Pacific Marine Conservation Assessment in response to CEQ requests
- Influenced the proposed protections for large fish (e.g., bumphead parrotfish) at Wake Atoll
- Help delineate special conservation areas (i.e., critical habitats, EFH, HAPC) required by legislation

Guam

- Integrated CNMI & Guam mapping and monitoring data to assist Navy in minimizing current and future ecological impacts. Report on 5 islands delivered to all agencies 9/2008.
- Managers have requested completion of bathymetric mapping.



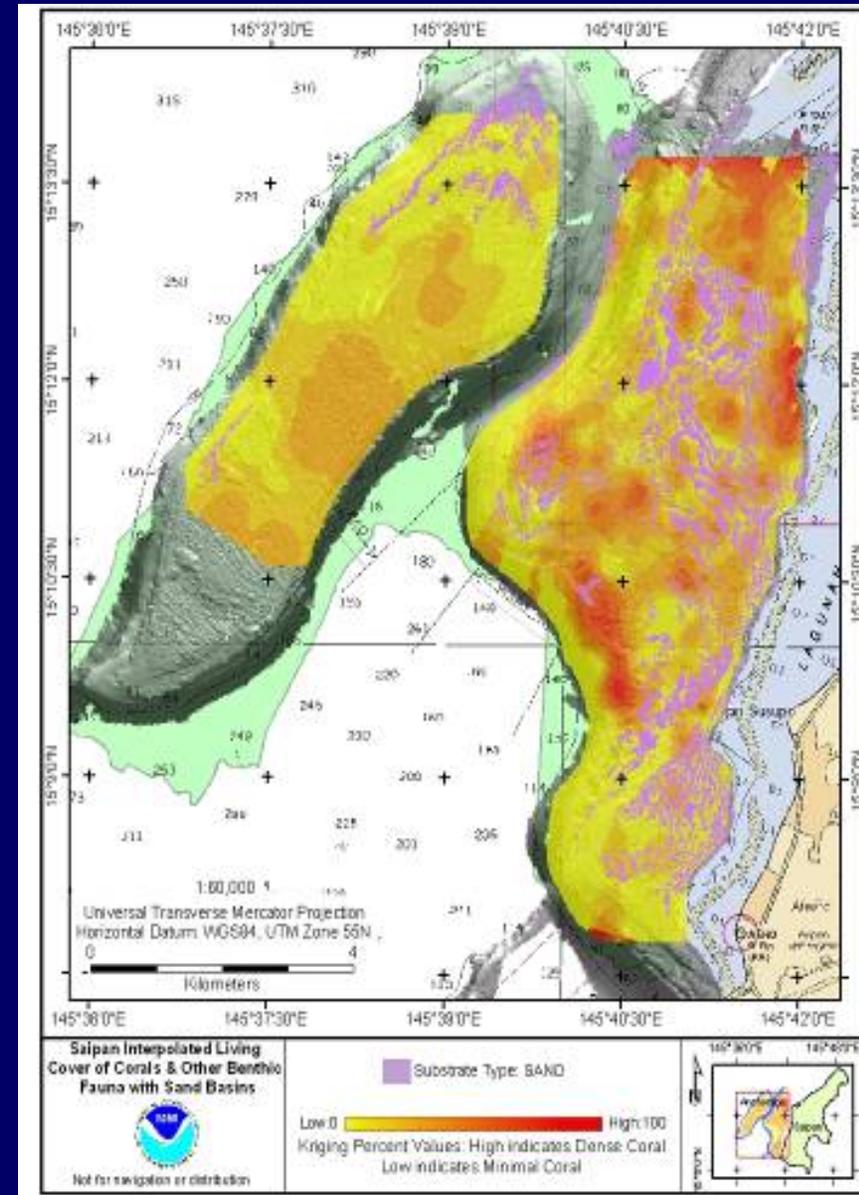
Meeting Management Needs

American Samoa

- Assessment of options for possible Ofu runway extension.
- Optical surveys of outer Tutuila insular shelf to define ecologically significant areas (> 30 m)
- Creation of satellite derived depths where possible (interim product)

CNMI

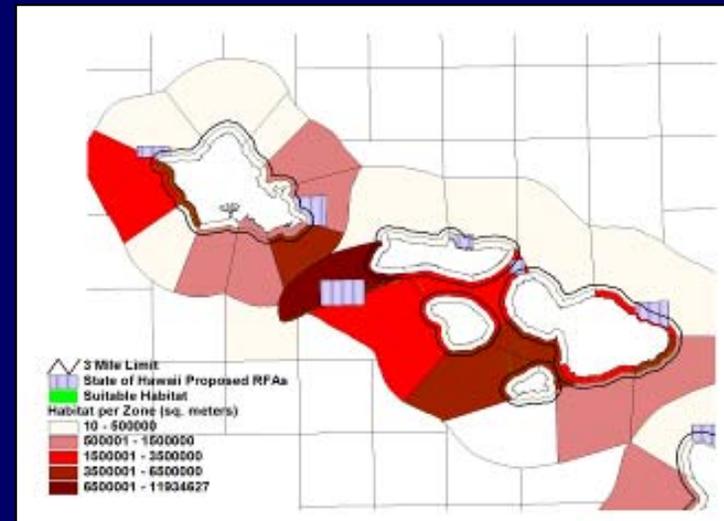
- Saipan and Tinian bathymetric surveys to improve nautical charts
- Assessment of Garapan anchorage to minimize anchoring impacts on coral reef resources.
- Nautical charts of Saipan, Tinian, and Rota harbors help protect corals.



Meeting Management Needs

Hawaii

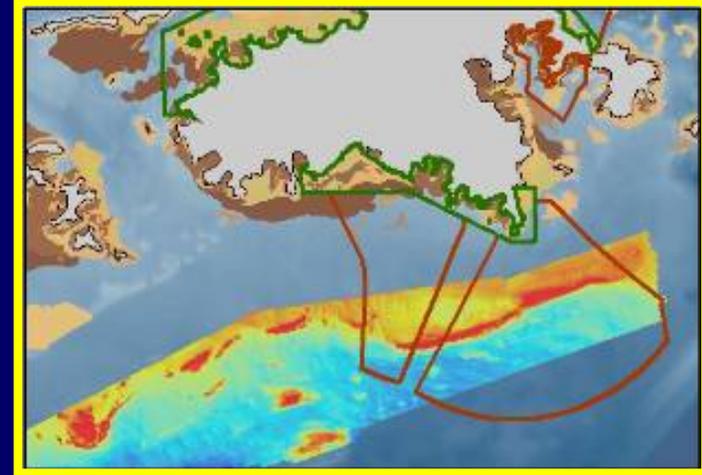
- Integrated data supports damage assessments (e.g., *M/V Casitas*)
- Bathymetric contours defined boundaries of PMNM. Hard/soft used to plan surveys.
- Bathymetric contours defined bottomfish closure areas in the Main Hawaiian Islands
- Bathymetric products defined habitat use by monk seals and humpback whales.
- Study based on habitat maps showed effectiveness of Hawaiian MPAs; data was used to modify legislation
- Helped determine placement of replenishment areas for aquarium trade



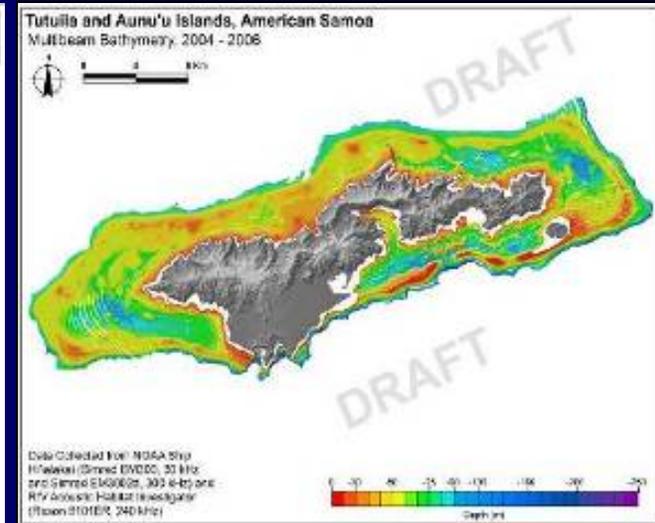
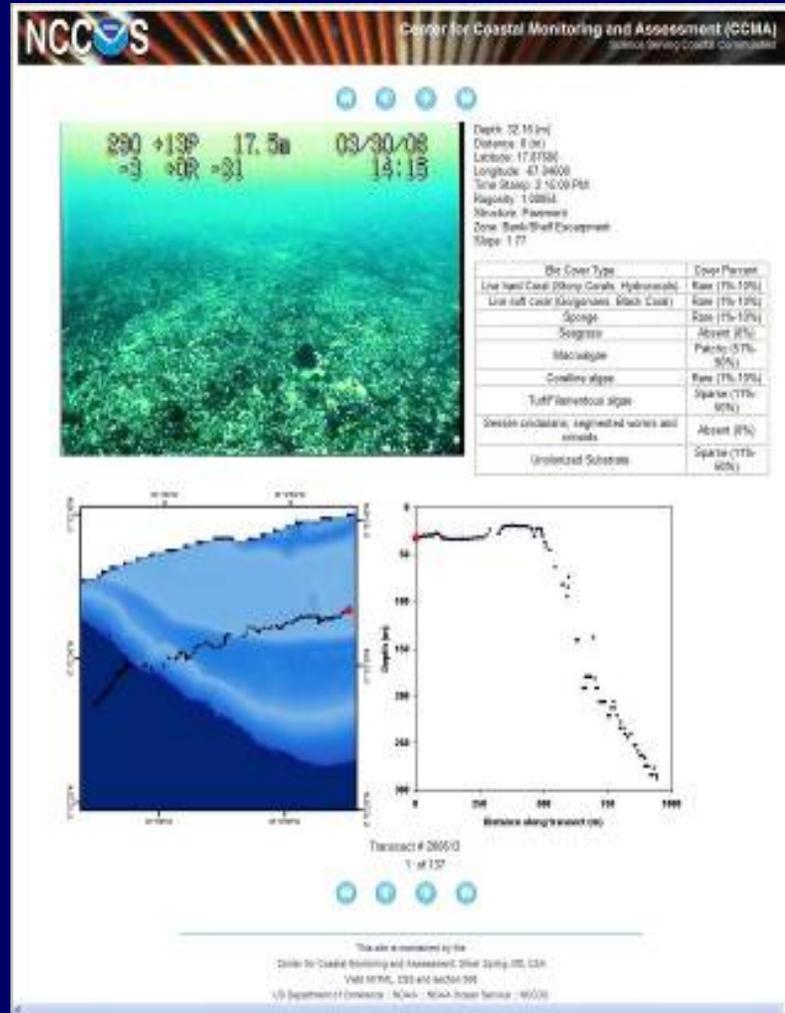
Meeting Management Needs

Atlantic / Caribbean Examples:

- Delineated anchorages in the USVI to minimize damage to reefs
- Show spatial distribution of bleaching and disease data, loss of coral cover
- Potential MPA Boundary modification in St. John
- Siting of new aquaculture facilities in Puerto Rico
- Analysis of *Acropora* distribution to support ESA listing
- Damage assessment for grounding at Johnson's Reef, St John
- IHO compatible data used to update nautical charts for navigation purposes



New Technologies and Data Dissemination



<http://www.soest.hawaii.edu/pibhmc/>

<http://ccma.nos.noaa.gov/about/biogeography/>

http://www.pclab.noaa.gov/content/20_About_Us/About_Us.php

Mapping Challenges/Future Directions

- Provide training on how to use map products to address specific management needs. Aid jurisdictions in efficiently using data and GIS products.
- Continue to invest in development of computer-generated spectral and acoustic map products to reduce costs associated with mapping
- Develop integrated shallow to mid-water mapping products
- Improve efficiency of moderate-depth habitat mapping using AUV technologies and collect much more optical data
- Improve cost effectiveness of shallow-water bathymetry using LiDAR and UAS technologies
- Develop standard suite of habitat mapping schemes (GIS layers)
- Continue to develop biological habitat utilization maps to support living marine resource management
- Initiate iterative mapping for change analysis in targeted locations
- Develop procedures to more effectively get information to managers.