

NOAA/NOS Integrative Mapping, Monitoring & Assessment of U.S. Coral Reef Ecosystems:

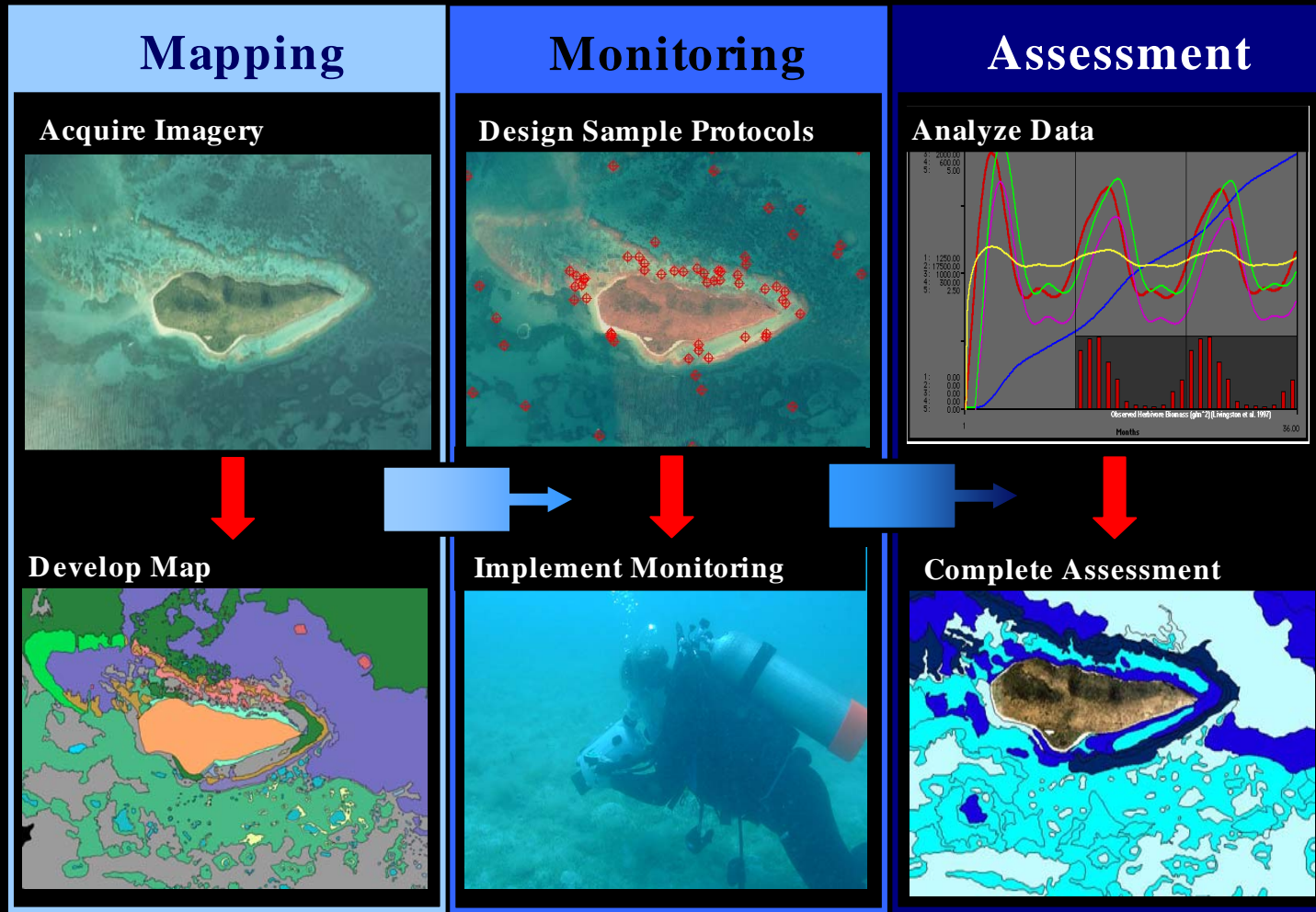
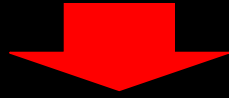
A Partnership Effort Led by the National Centers for Coastal Ocean Science



NOAA/NOS
National Centers for Coastal Ocean Science

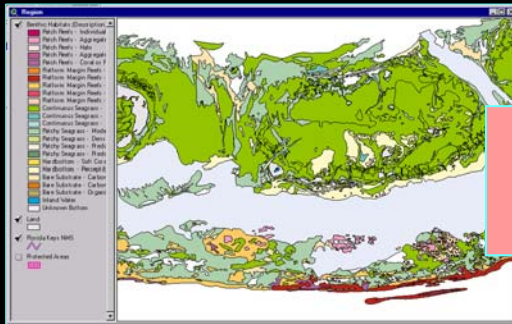
Integrative Mapping, Monitoring & Assessment

National Coral Reef Ecosystem Assessment Process



A Strategy to Map U.S. Coral Reef Ecosystems

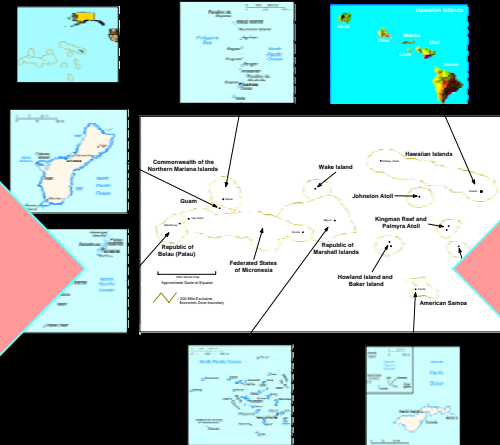
The Mapping Model: Florida Keys Corals, 1992-1998



Aerial photography
Unclassified images
Classified images
Digital Maps

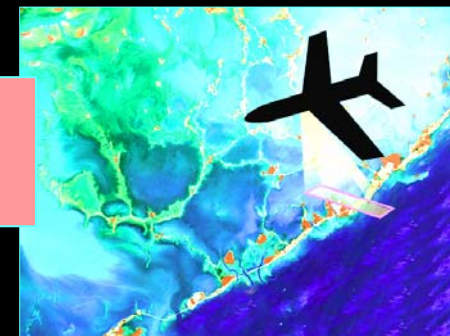
Information transfer:
Website
CD-ROM Product
11" x 17" Atlas Product

The Challenge: Mapping Pacific Corals, 1999-2007



Pacific Coral Reef Study Area:
Main Hawaiian Islands
Northwest Hawaiian Islands
Guam
American Samoa
Northern Mariana Islands
FAS

Improved Mapping Capabilities: Puerto Rico and U.S. Virgin Islands, 1998-2000



Aerial Photography and
Hyperspectral Imaging for
Habitat Classification

Transferable Methods:
Classification Scheme
Digital Imagery
Classified Digital Maps
Methods Manual

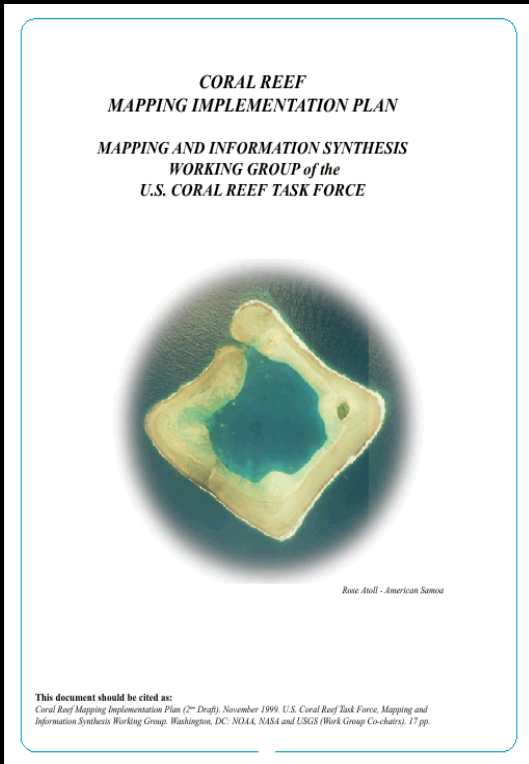


NOAA/NOS

<http://biogeo.nos.noaa.gov/products/benthic/>

U.S. Coral Reef Task Force

Mapping Implementation Plan



- **Digital high resolution maps of coral reef ecosystem habitats**
- **Delineate benthic habitats using hierarchical classification system**
- **Map All U.S. States, Territories, Commonwealths & the FAS by 2007**
- **Integrate maps with research & monitoring activities for use by researchers and managers**



Suite of Remote Sensing Technologies

- **Digital Aerial Photography**

High Spatial Resolution
Visual Interpretation to
Large # of Classes

- **Hyperspectral Imagery**

High Spatial Resolution
Robust Spectral Resolution

- **Satellite**

~ **SeaWifs**

Low Spatial Resolution

~ **Landsat**

Moderate Spatial Resolution

~ **IKONOS**

High Spatial Resolution

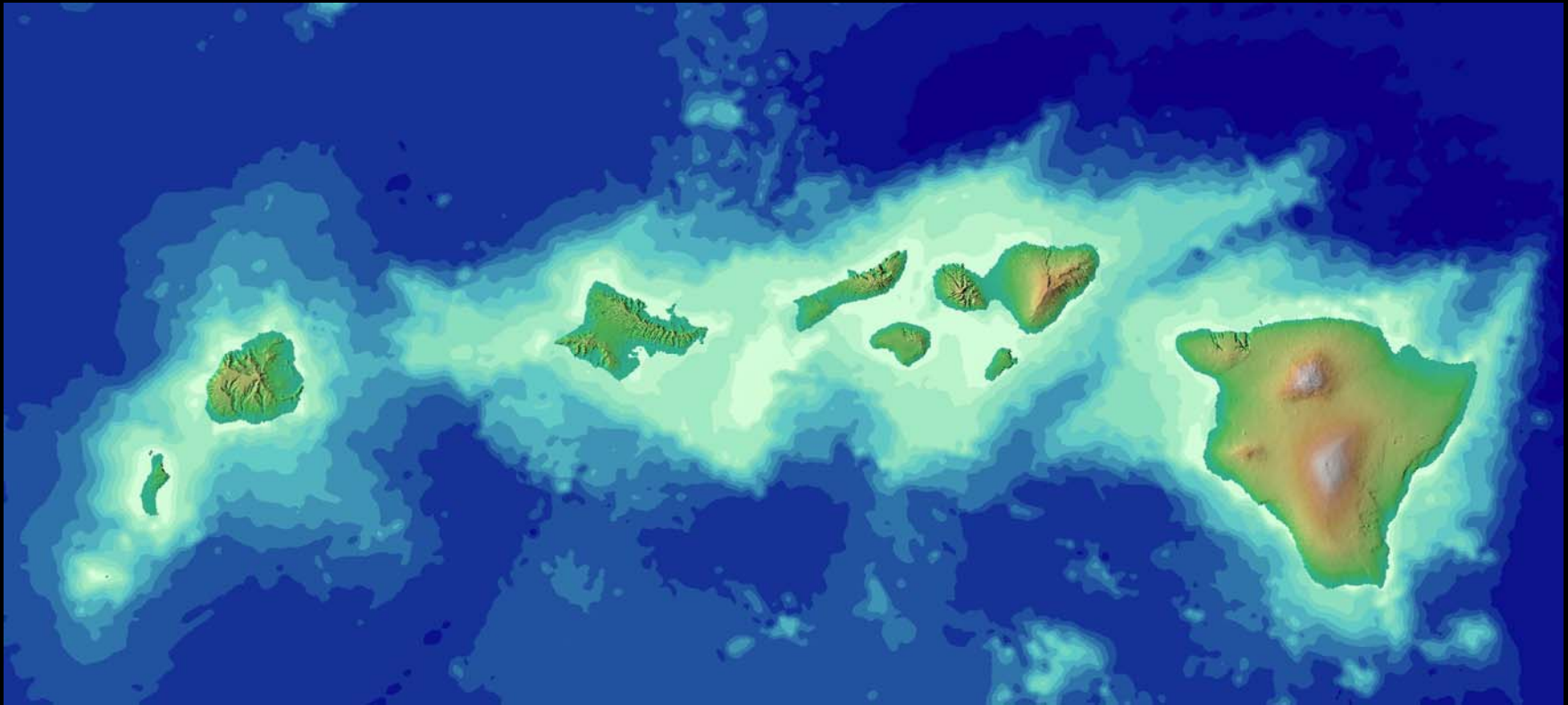
- **In-situ Instruments**

Mini-Bat Validation of
Remotely Sensed Imagery
Roxanne/QTC
Sidescan & Multibeam

- **Diver Validation**



NOS/HI DLNR Mapping of Benthic Habitats in the Main Eight Hawaiian Islands



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Comparison of Remote Sensing Technologies

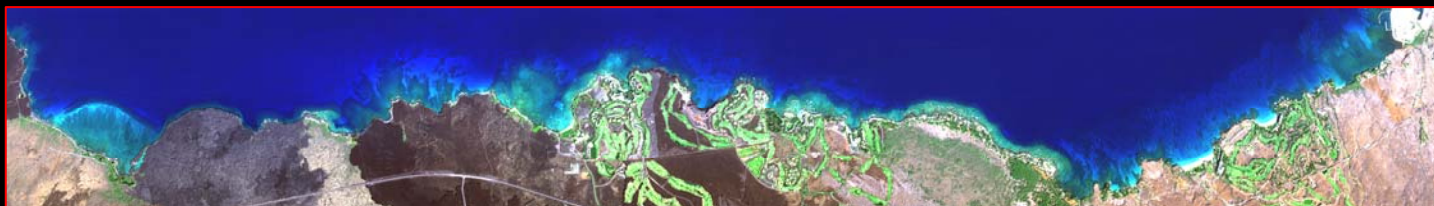
IKONOS – true-color; 4 m pixel



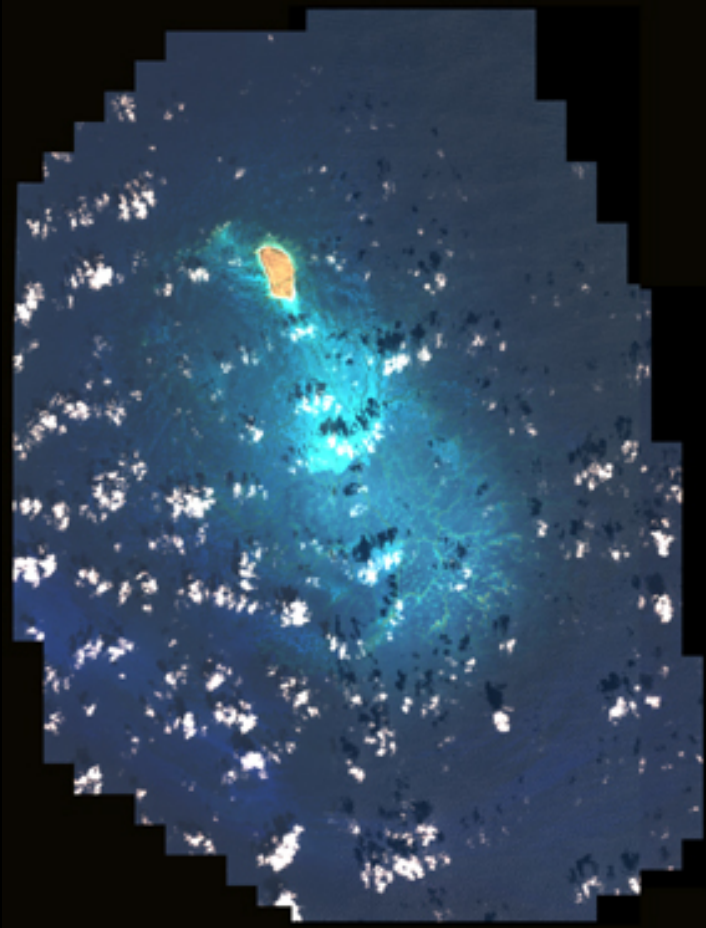
AERIAL PHOTOGRAPHY – true-color; 1.2 m pixel



HYPERSPECTRAL – 72 bands between 350 and 1000 nm; 3 m pixel



NOS/NMFS Coral Reef Ecosystem Mapping Northwestern Hawaiian Islands and other Pacific Locales



Lisianski



Midway



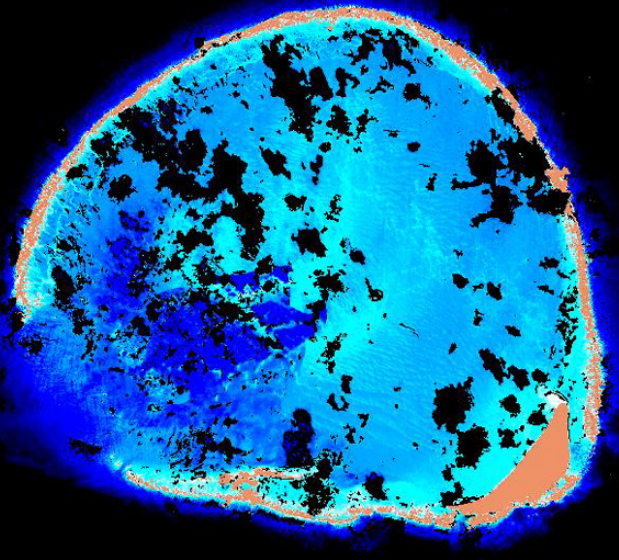
NOAA/NOS
Coral Mapping Program

Imagery copyright Space Imaging;
processed by NOS

NOS/NFMS Northwestern Hawaiian Islands Computerized Image Analysis & Mapping

Depth in Feet

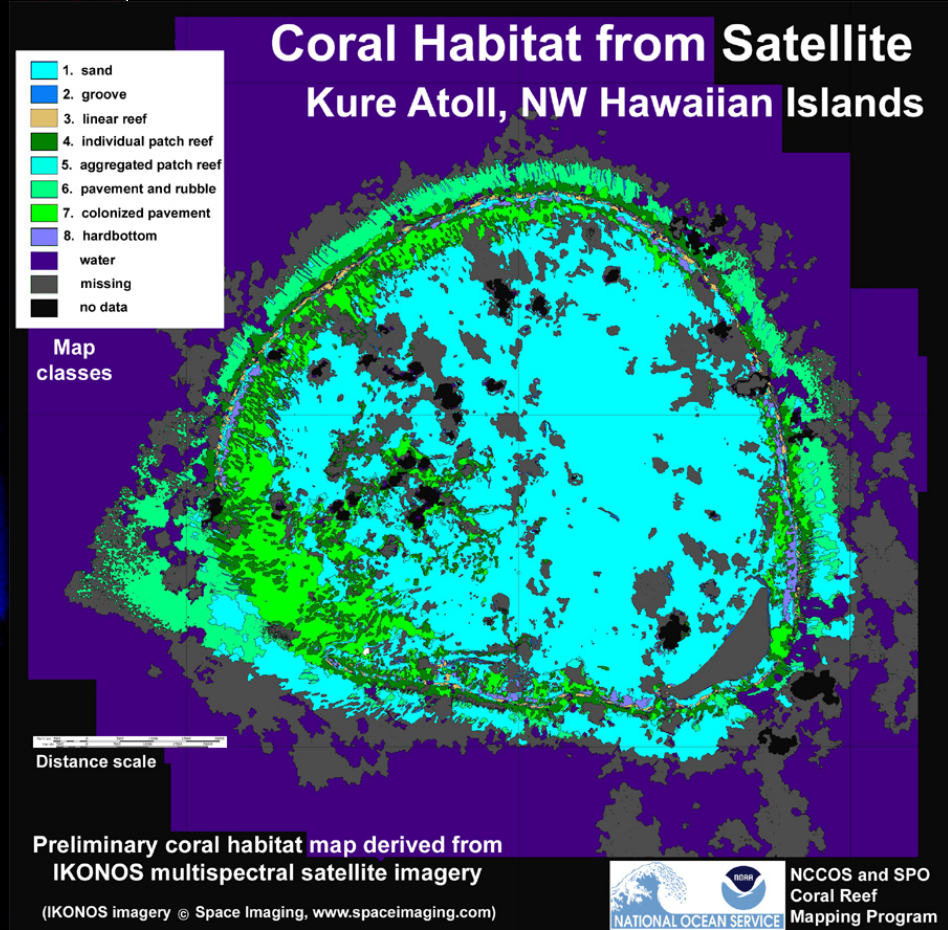
1
10
20
40
60
>80



Kure Atoll. Provisional estimated bathymetry derived from satellite imagery.

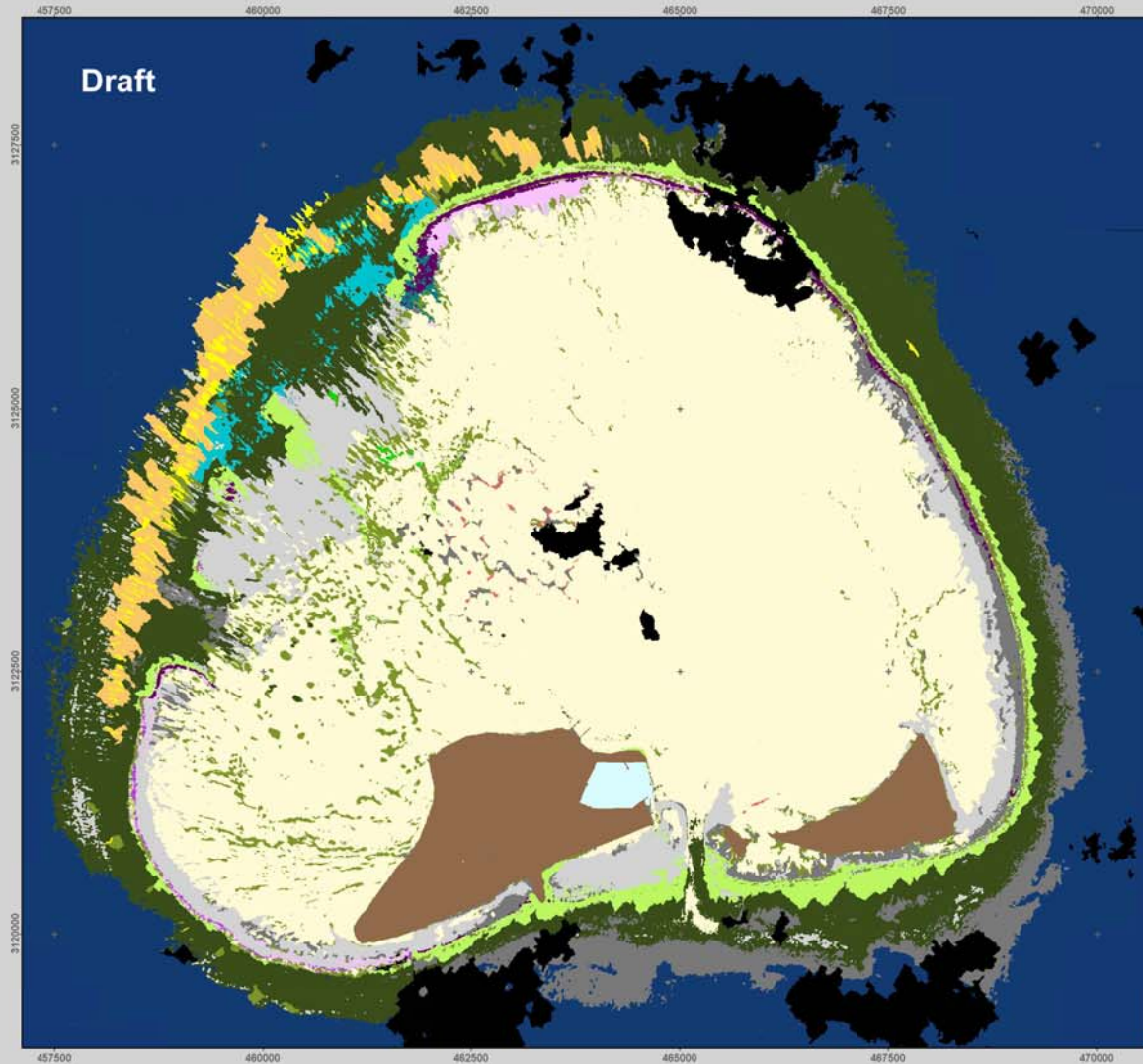


NOAA/NOS
Coral Mapping Program













Kure Atoll. Provisional benthic habitat map.

Midway Islands - benthic habitats derived from IKONOS Imagery



benthic classes

-  corals and colonized hardbottom
-  individual patch reef
-  colonized pavement and rubble
-  colonized pavement with sand channels
-  encrusting coralline algae
-  encrusting coralline algae - intertidal
-  spur and groove
-  pavement with dense algae
-  pavement with sparse algae
-  algal patch reef
-  macroalgae
-  uncolonized pavement with sand channels
-  uncolonized pavement and rubble
-  uncolonized hardbottom
-  sand
-  groove
-  carbonate mud
-  cobble with dense algae
-  land
-  deep water
-  dredged channel
-  no data



NOS/NMFS/Islands US Pacific Coral Reef Ecosystem Mapping



Rota, CNMI



NOAA/NOS
Coral Mapping Program

Imagery copyright Space Imaging;
processed by NOS

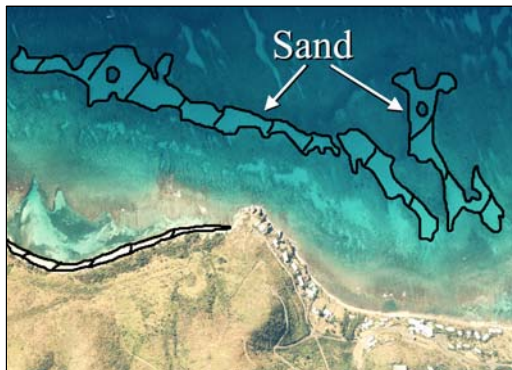
Mapping & Monitoring of Coral Reef Ecosystems

Habitat: n=26

What is it?

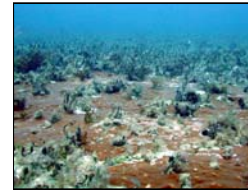
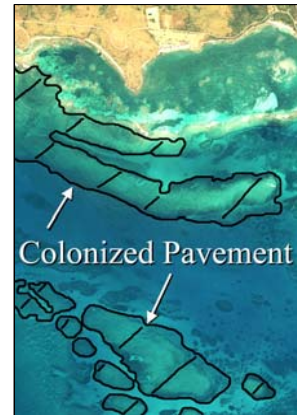
Unconsolidated Sediment

Sand: Coarse sediment typically found in areas exposed to currents or wave energy.



Coral Reef and Hard Bottom

Colonized Pavement: Flat, low-relief, solid carbonate rock with coverage of macroalgae, hard coral, gorgonians, and other sessile invertebrates that are dense enough to partially obscure the underlying carbonate rock.



Submerged Vegetation

Patchy Seagrass: Discontinuous seagrass with breaks in coverage that are too diffuse or irregular, or result in isolated patches of seagrass that are too small (smaller than the MMU) to be mapped as continuous seagrass.

Representative Species:
Thalassia testudinum
Syringodium filiforme
Halodule wrightii
Halophila baillonis



Visual Aid used for Assigning Degree of Patchiness:

- Patchy Seagrass (70 to less than 90 percent cover)
- Patchy Seagrass (50 to less than 70 percent cover)
- Patchy Seagrass (30 to less than 50 percent cover)
- Patchy Seagrass (10 to less than 30 percent cover)

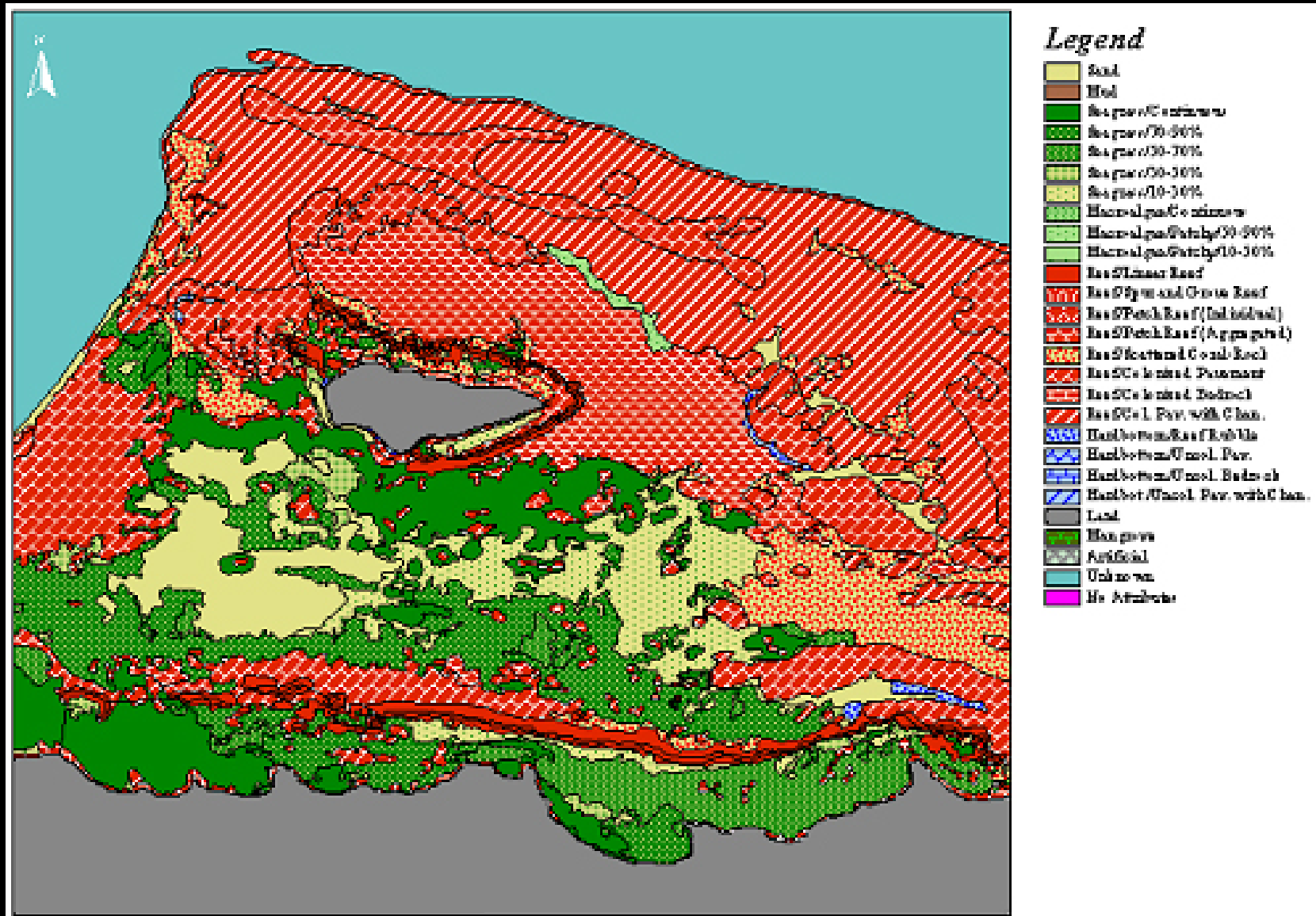


Percent Cover/ Substrate Label	Low	Relative Patch Aggregation	High
90-100% Continuous			
70-90% Patchy			
50-70% Patchy			
30-50% Patchy			
10-30% Patchy			
0-10% No SAV Category			

Note: Large separate blocks indicate mapping unit

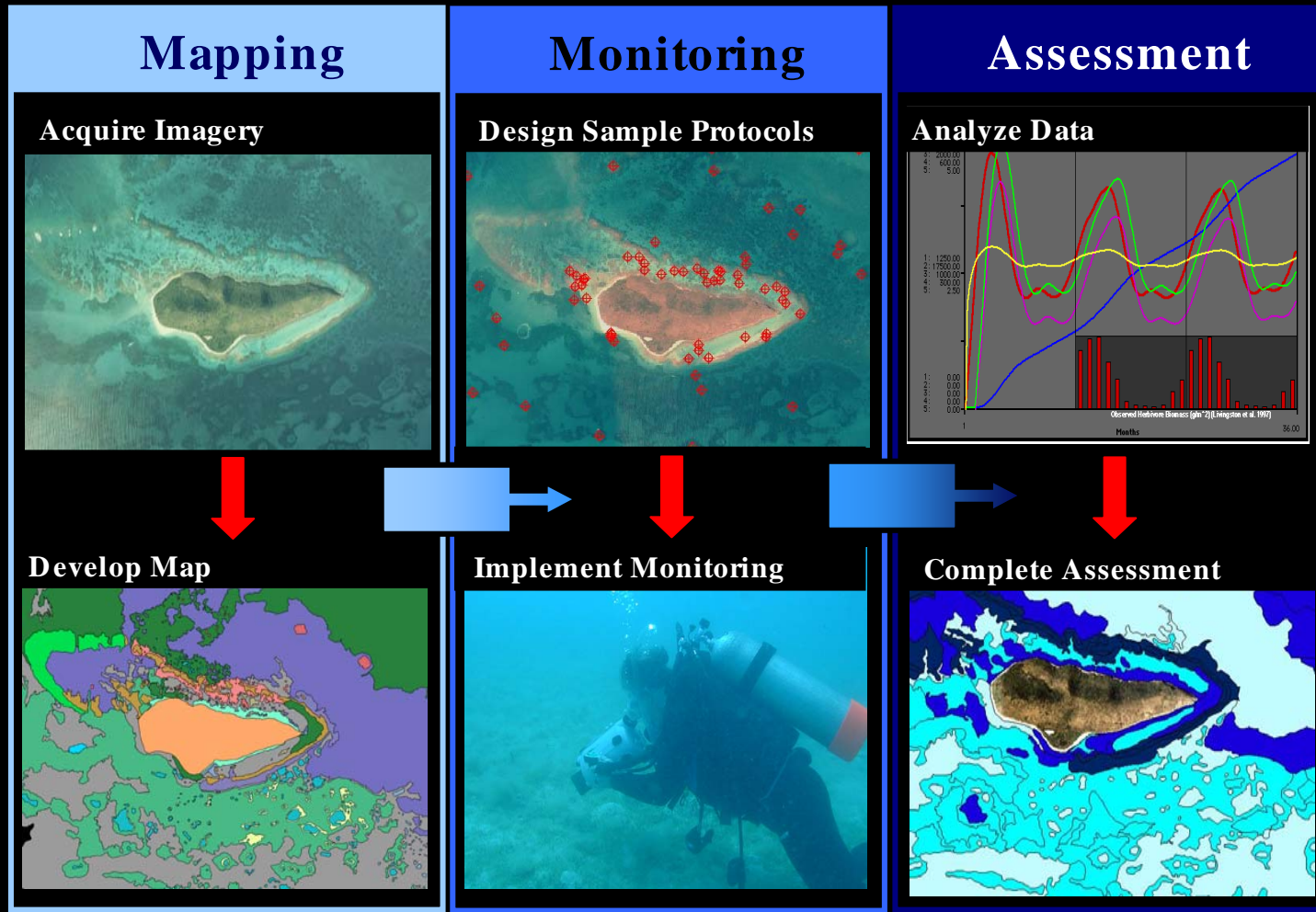
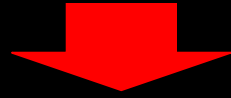


Mapping Coral Reef Ecosystems: Buck Island



Integrative Mapping, Monitoring & Assessment

National Coral Reef Ecosystem Assessment Process



National Coral Reef Ecosystem Monitoring Program

- **Build a national database & information system for incorporating disparate data sets.**
- **Provide grants where needed to fill data gaps and sustain monitoring efforts.**
- **Integrate monitoring and habitat mapping to provide spatial framework for assessments.**



NOAA/NOS

National Centers for Coastal Ocean Science

National Coral Reef Ecosystem Monitoring Program

Cooperative Monitoring Studies - Meeting Local Management Needs & National Program Requirements

OBJECTIVES:

- 1) Provide leadership in the development and implementation of a national program to monitor US coral reef ecosystems.
- 2) Develop a “semi-coordinated” National network of monitoring sites,
- 3) Facilitate sharing of monitoring information among partners, and
- 4) Fill gaps in local monitoring coverage.

A coordinated coral reef ecosystem monitoring program provides a national assessment capability to track the status and trends of coral reef health, community structure, and condition of US coral reef ecosystems.



2002 National Coral Reef Ecosystem Monitoring Program

Current Program Partners

- Puerto Rico
- US Virgin Island
- Hawaii (main 8 and NWHI)
- Guam
- American Samoa
- Commonwealth of the Northern Mariana Islands

Fall 02 Program Partners

- State of Florida,
- Members of Freely Associated States

NOAA Complementary Monitoring and Assessment Studies



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MONITORING THEMES

Benthic Parameters



- Cover (live, dead, etc.)
- Abundance
- Condition
- Size class distribution
- Indicator species
- Diversity*

Water Quality Parameters



- Nutrients
- Suspended solids
- Chlorophyll
- Turbidity
- Temperature
- PAR

Fishery Parameters

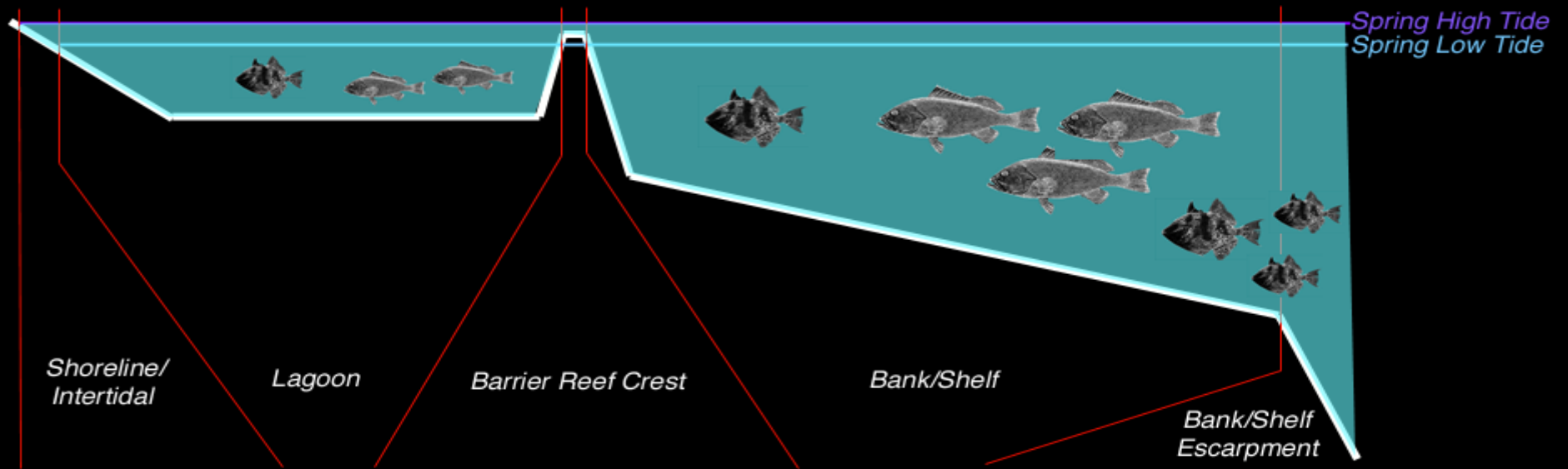


- Abundance & distribution
- Size class distribution
- Indicator species
- Diversity*
- Richness
- Evenness

EXAMPLES

Monitoring Based on Map Structure

Where is it? - ZONE



What is it? - STRUCTURE

Patch Reef, SAV, Rubble, Pavement, Sand, Linear Reef,

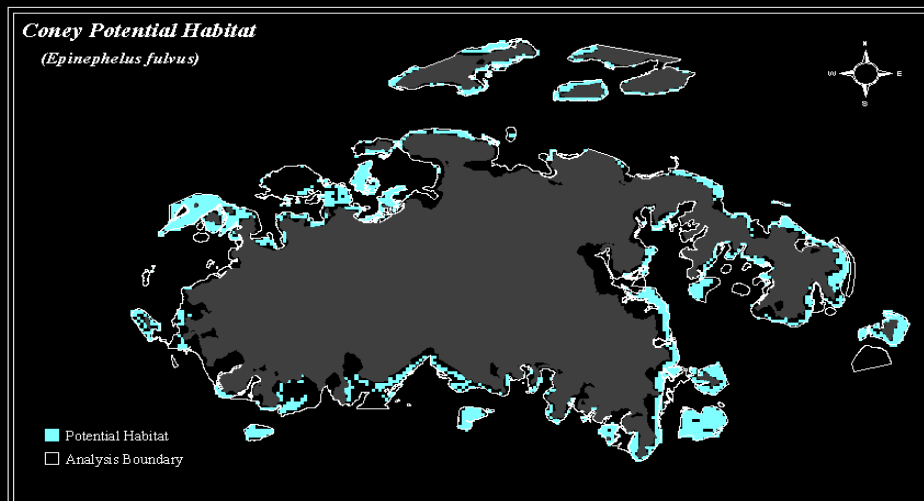


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Coupling Biology with Habitat

Species	Life Stage	Habitat														Depth (m)						Actual				
		Zonation							Structure							Depth ranges used in models										
		Shoreline	Leeward*	Crest*	Windward*	Plain	Shelf Edge	Slope	Planktonic	Seagrass	Reef	Patch Reef	Other Hard Bottom	Reef/S&V Interface	Mangrove	Algae	Sand	Mud	0-5	5-10.0	10-18.0		18-20	20-40	40-75	75-180
	Eggs	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	9	9	9	9	9	9	9	9	
	Larvae	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	9	9	9	9	9	9	9	9	
<i>Epinephelus fulvus</i>	Early Juv.	0	9	9	9	1	0	0	9	1	1	1	9	0	1	9	0	1	1	9	0	0	0	0	0	1-10
	Late Juv.	0	9	9	9	1	0	0	9	1	1	1	9	0	9	9	0	1	1	9	0	0	0	0	0	6-12
	Adults	0	9	0	1	1	1	0	0	1	0	1	9	0	9	9	0	1	1	1	1	1	0	0	0	0-40

- 0 = Not present
- 1 = Present
- 2 = Present Day Only
- 3 = Present Night Only
- 4 = Present Day & Night
- 5 = Seasonally Abundant
- 9 = No Data

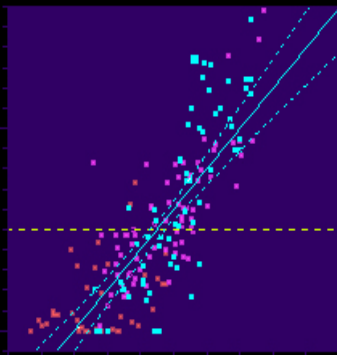
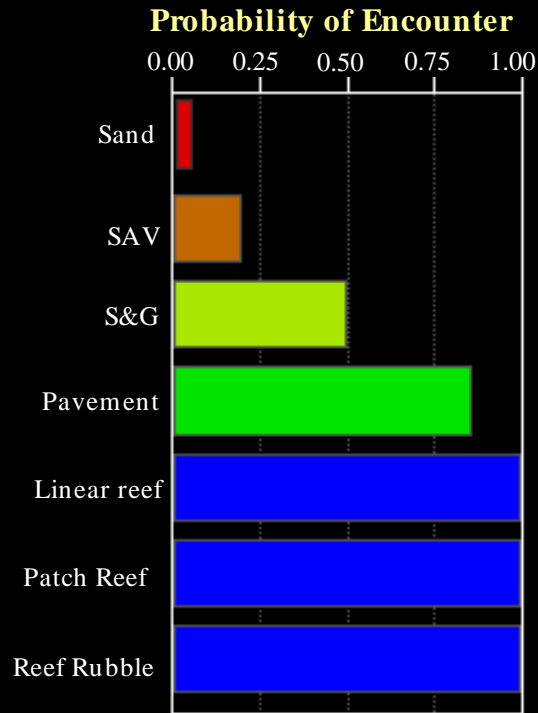


Prepared by NOAA/BCB
For the Caribbean Fisheries Management Council
July, 1998

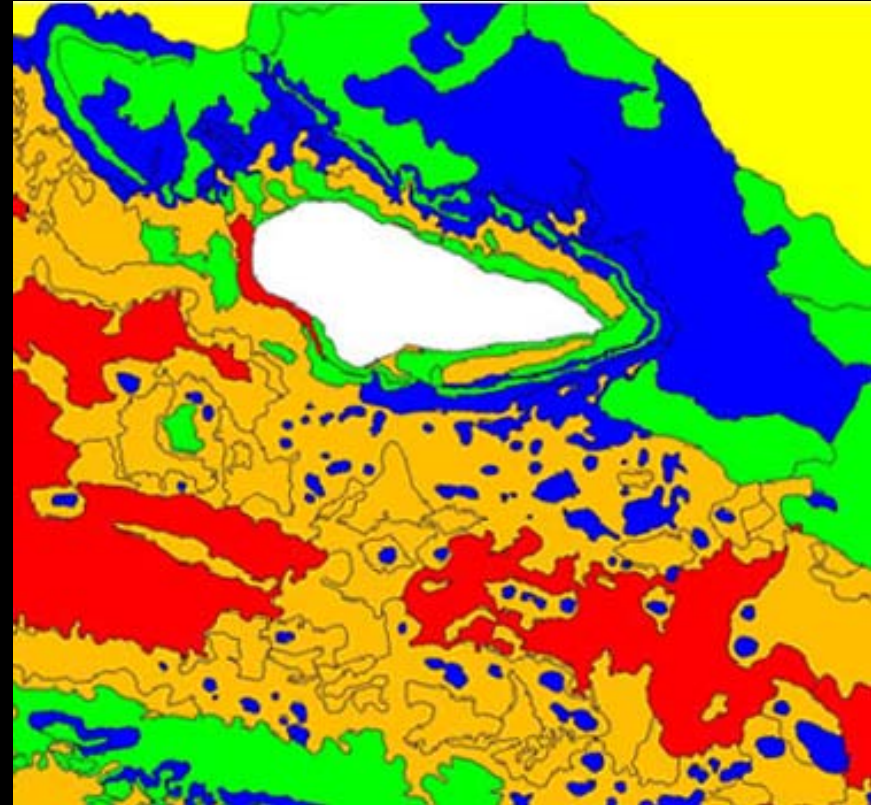
Data Provided by the National Park Service,
the University of Puerto Rico, the University of Miami,
the Caribbean Fishery Management Council, and the CDC



Probability-Based Species Distribution Maps

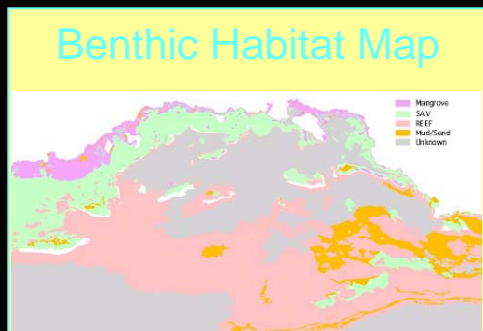


Logistic Model Results



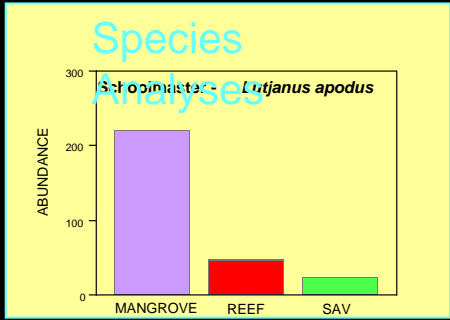
Autecological Analysis:
Logistic Model : Blue tang (*Acanthurus coeruleus*)

Coupling of Maps & Species Habitat Utilization Patterns

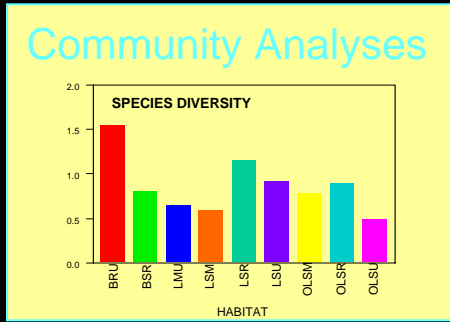
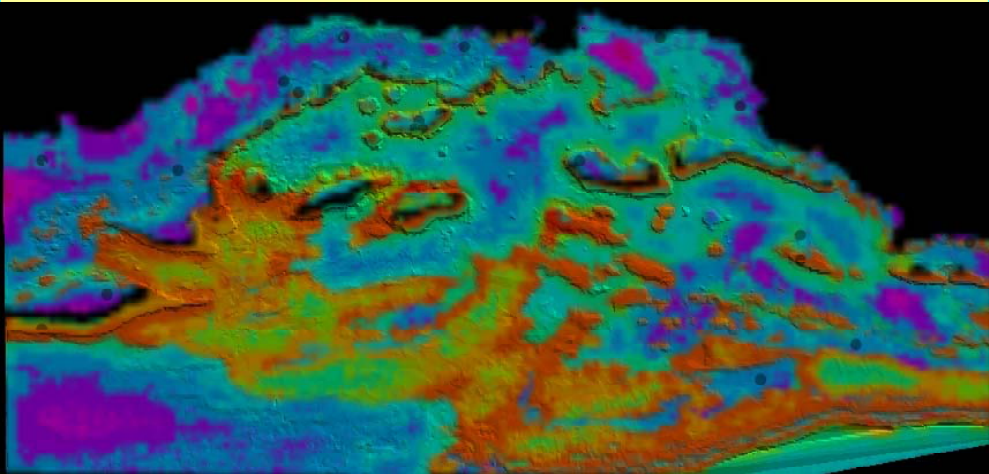


Random Stratified Sampling

Organism Census by Habitat Type



Biological Relevant Boundaries of MPA's and EFH

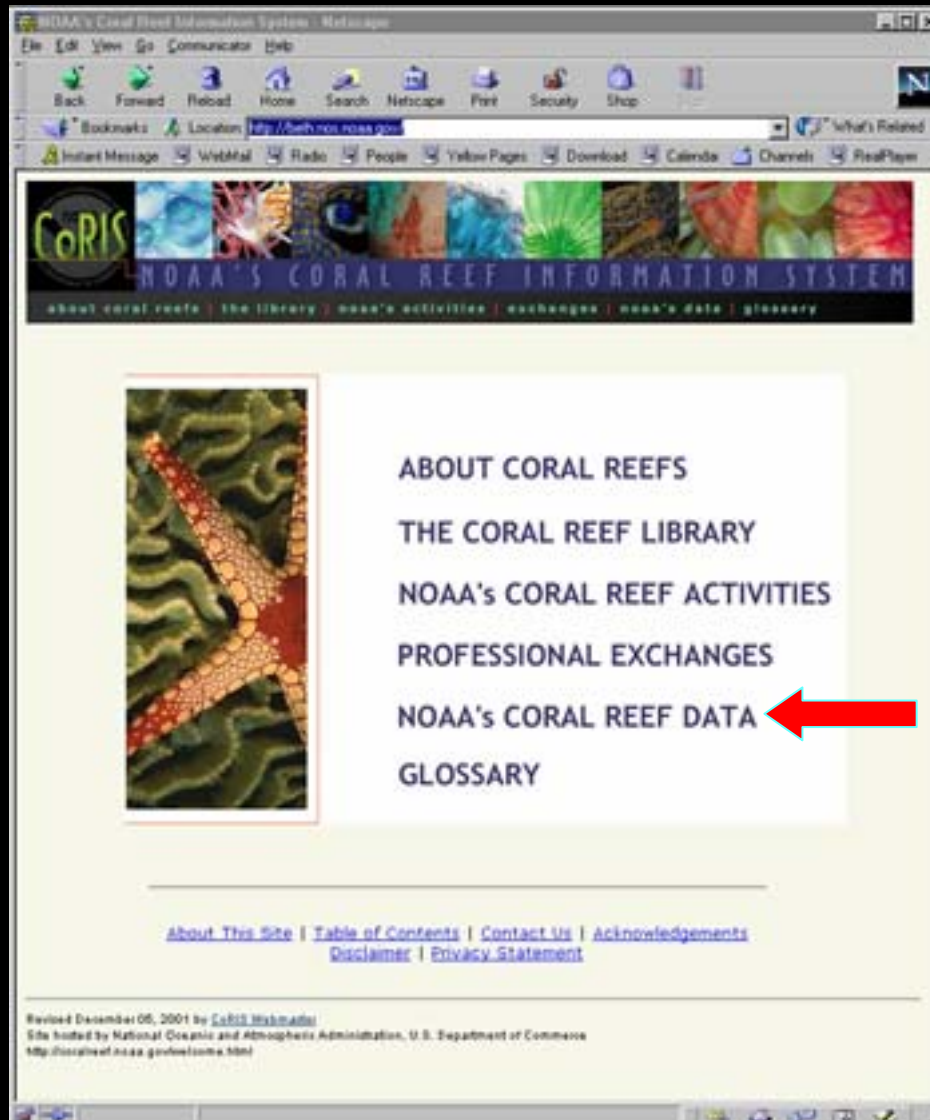


NOAA's Coral Reef Information System

All data must be transferred in a timely manner to NOAA funding programs.

Funding eligibility is contingent upon agreement to provide monitoring data within several months after project completion (exact timing under review).

Data will be made available to the general public through this US coral reef data clearinghouse.



Integrative Mapping, Monitoring & Assessment

National Coral Reef Ecosystem Assessment Process

