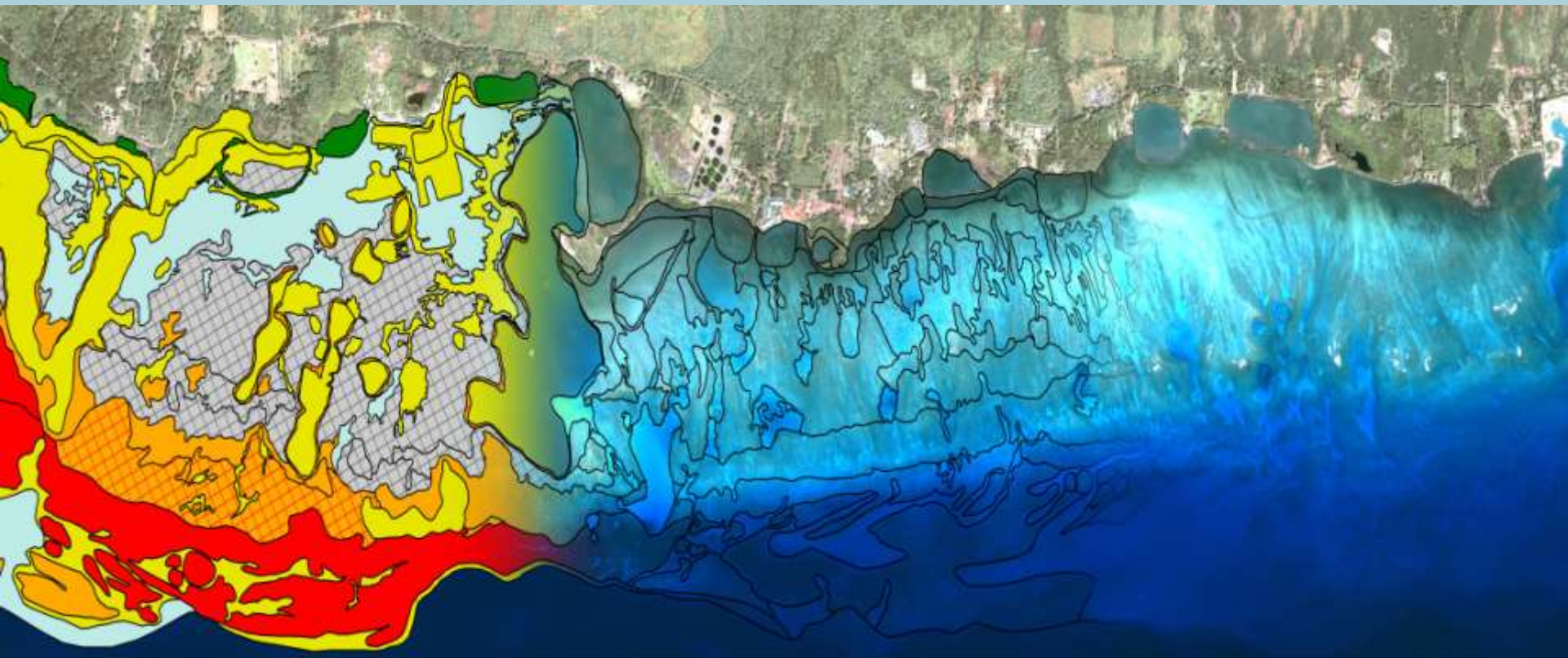


# Shallow-water Mapping of Palmyra Atoll



*A NOAA, DOI, TNC Partnership*

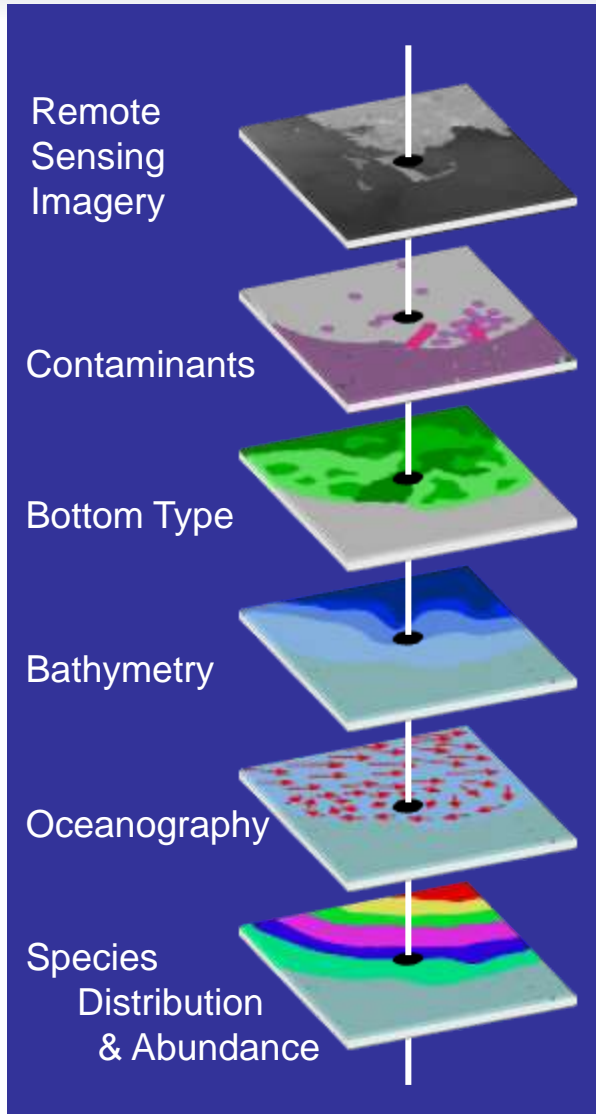
*Tim Battista & Miles Anderson  
NOAA/NCCOS/CCMA Biogeography Branch*

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



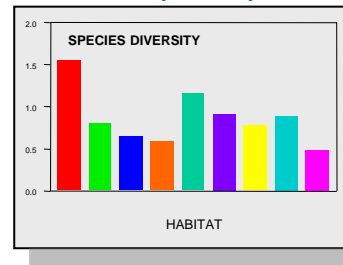
# Marine Biogeography

## Biogeographic Data Layers

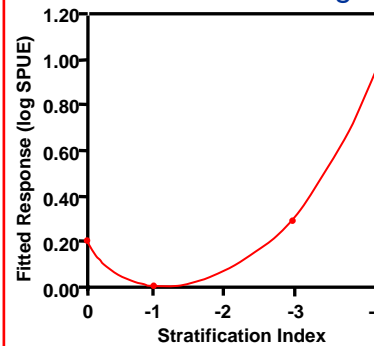


## Analyses

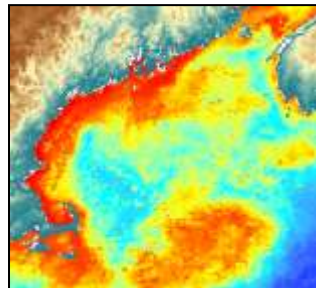
### Community Analyses



### Predictive Modeling



### Geo-spatial Mapping



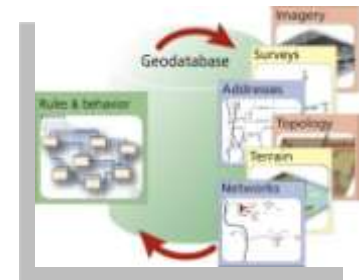
Analytical Products to meet Sanctuary Objectives

## Products

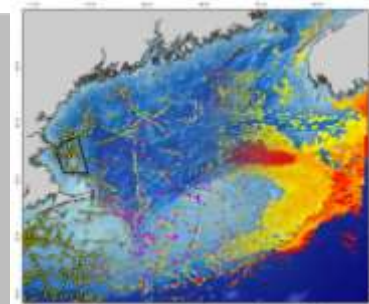
### Report



### Geodatabase



### Geo-spatial Products



# Mapping as a Monitoring Tool

PROVIDES:

Fundamental spatial  
framework

through...

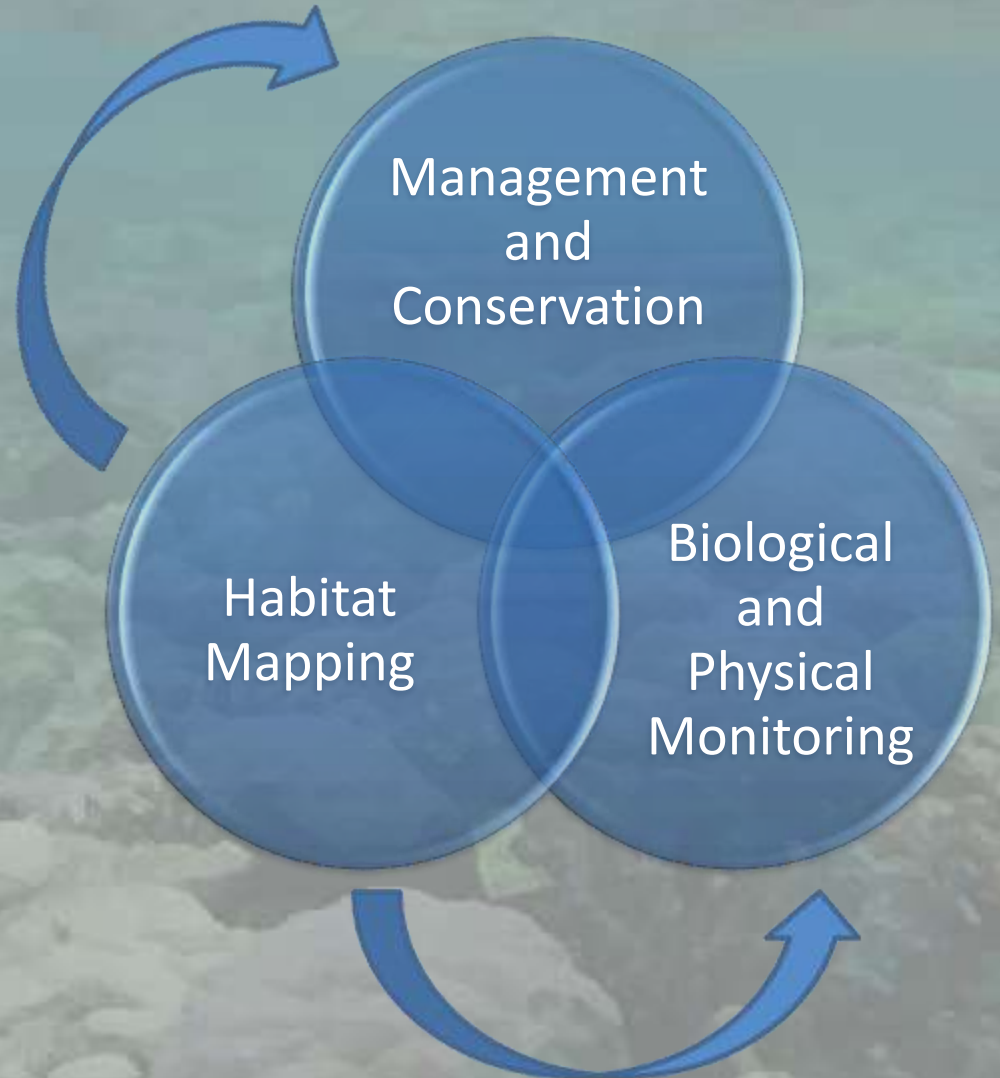
*Comprehensive and  
consistent products*

So as to...

*Strategize monitoring  
design*

*and*

*Inform management  
decisions*



# Mapping Process: *Technologies*

## Optical Imaging

Commercial Satellites  
(0 30 m)  
Multispectral  
Pseudo bathymetry

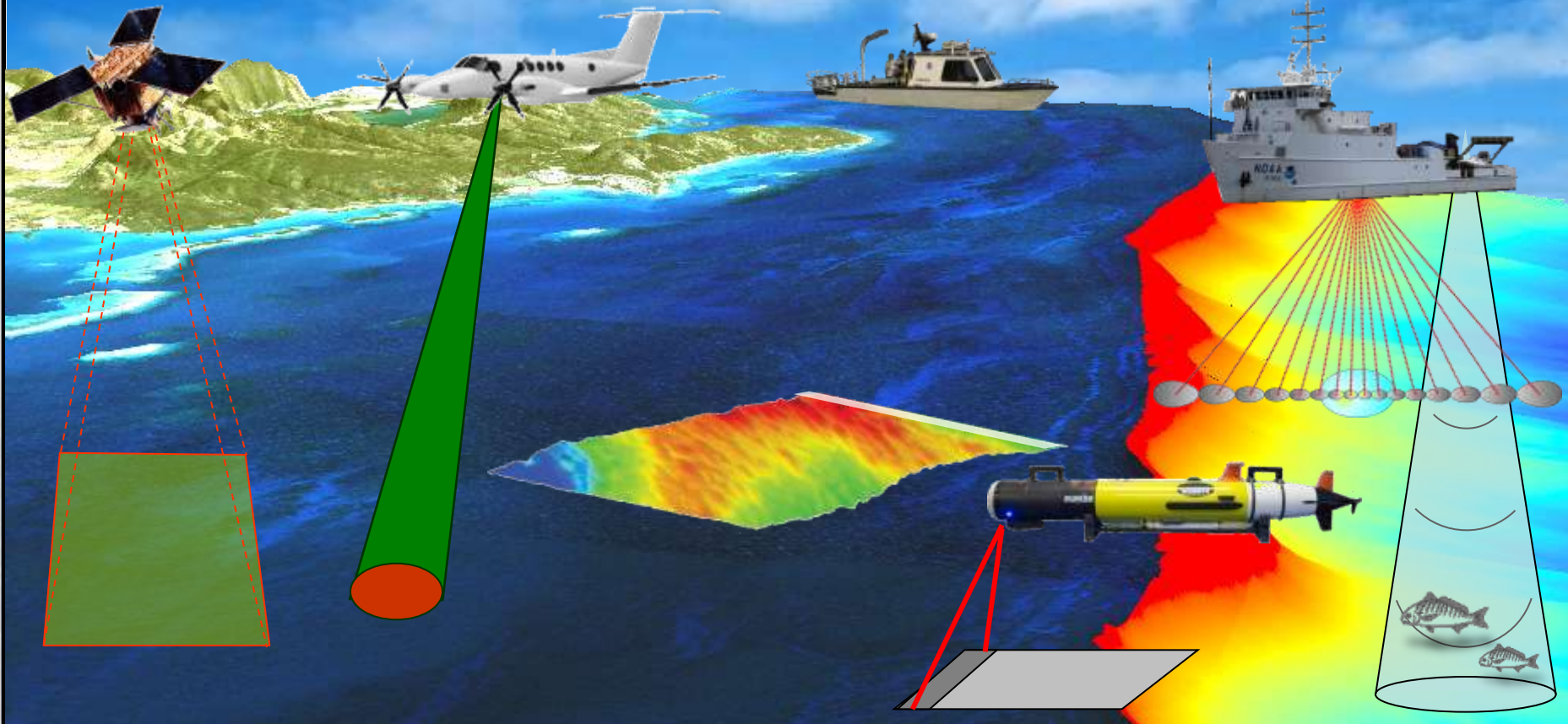
Bathymetric LiDAR  
(0 70 m)  
Bathymetry  
Backscatter

Interferometric Sidescan  
(1 30 m)  
Bathymetry  
Backscatter

## Acoustical Imaging

Swath bathymetry  
(10 1000 m)  
Bathymetry  
Backscatter

Fish Acoustics  
(10 1000 m)

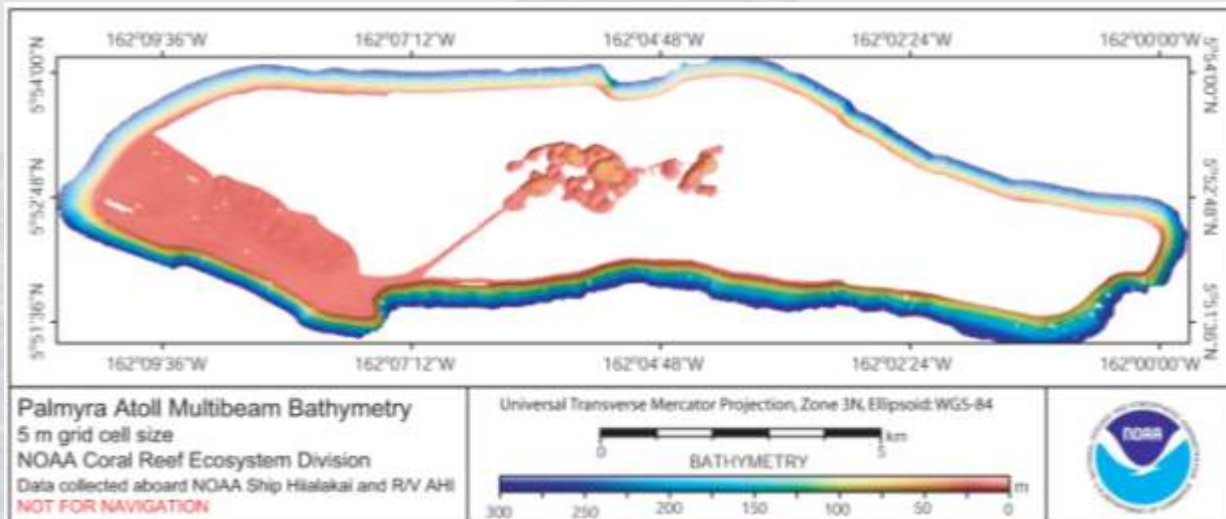
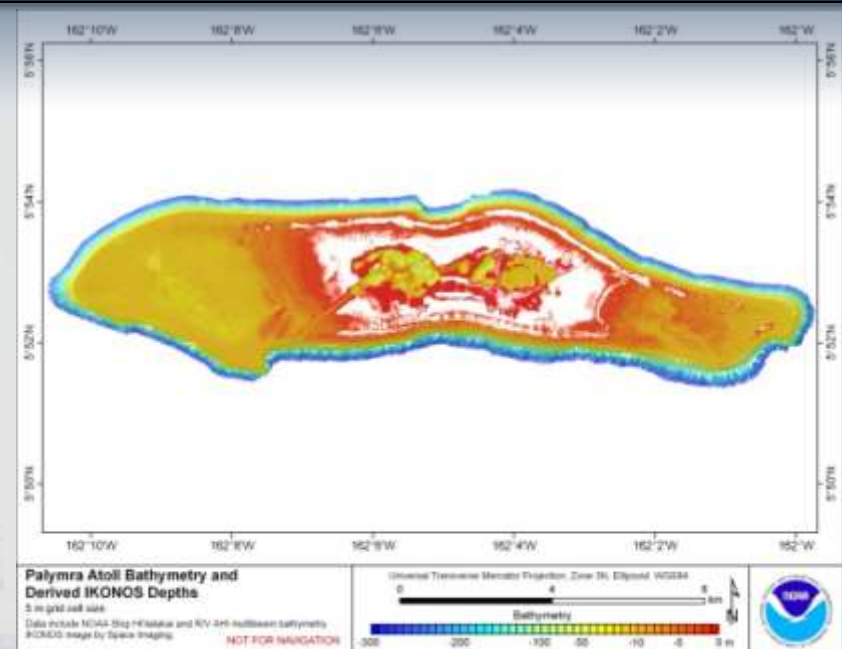
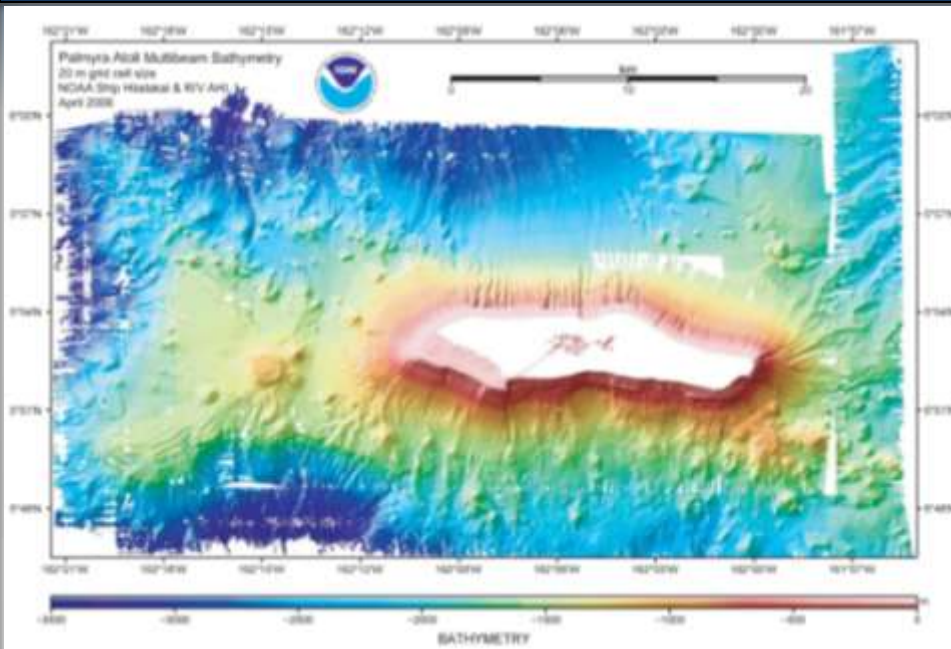


# Geodetic Control

- 15 GPS photo-id points collected
- Survey grade GPS occupation of benchmarks and horizontal datum recomputed NAD83 (2005)
- Reposition NOAA nautical chart based IKONOS imagery and NTM data
- Orthorectify satellite imagery, 1m horizontal accuracy CEP 95



# NOAA Multibeam & Pseudobathy



# Satellite Imagery

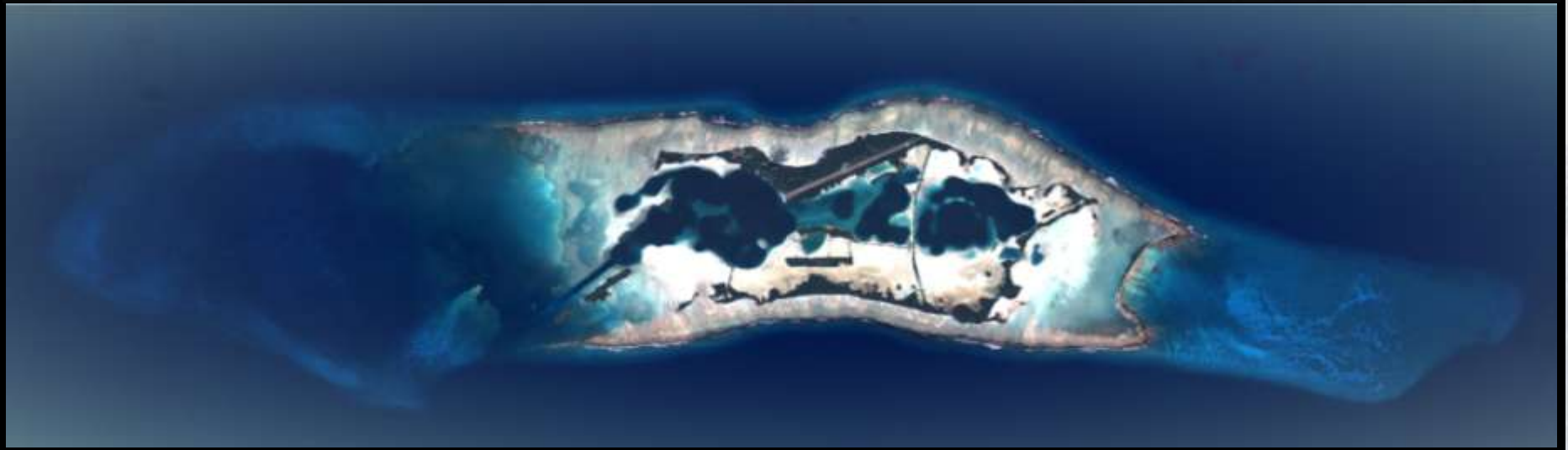
## Shallow-water Benthic Habitat Mapping

*Palmyra Atoll from Space*



SPACE  
IMAGING  
Real Information. Real Results.

IKONOS 1 meter Multispectral  
Collected 12/2001



DIGITALGLOBE

QuickBird 0.5 meter Multispectral  
Collected 2/2006 to 9/2009

# Key Topics

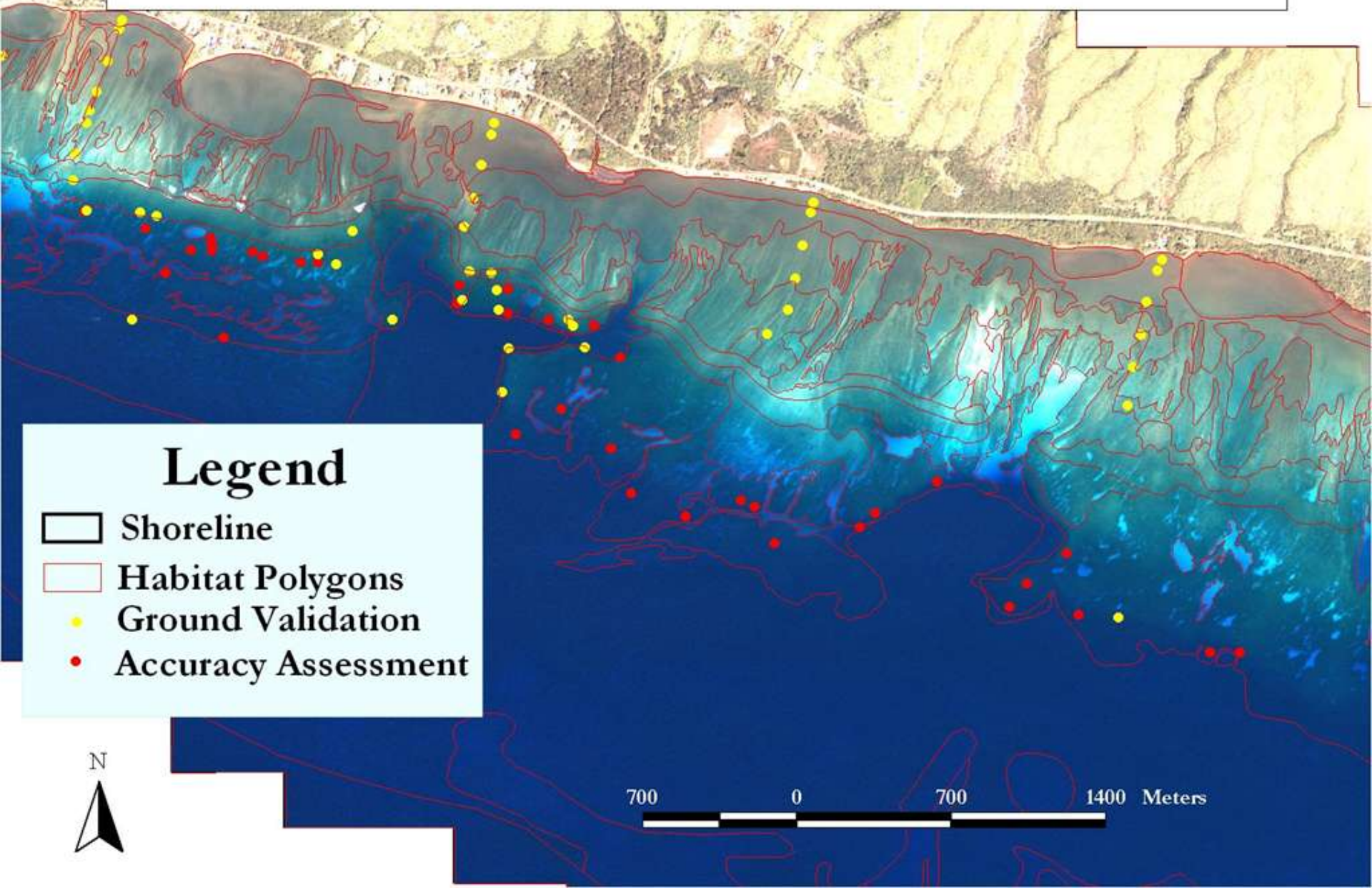
- **Overview of Mapping Methods**
- **Mapping Standards**
- **Habitat Classification Scheme**
- **Five Step Mapping Process**
- **Assessment of Thematic Accuracy of Palmyra Products**



# Overview of Mapping Methods

- **Delineation of habitat boundaries by visual interpretation of remotely sensed imagery**
- **Heads up digitizing (Computer Screen)**
- **GIS shapefile format**
- **Using NOAA Habitat digitizing extension**

# Four Types of Data Generated in this Work



# Mapping Standards

*Spatial Quality*

*QA/QC*

*Thematic Accuracy*

## *Spatial Quality*

- Imagery acquired, processed and provided by Contractor
- Digitizing accuracy (1 meter RMS)
- Digitized at scale of 1:6,000 or Less
- Accuracy assessment GPS (<5 meters)

# GPS Spatial Control



Trimble Geo XH L1 Data Logger  
Differentially post-processed  
To Azhtech Z-Extreme Base Station  
Using NOAA OPUS

**95% sigma RMS Error (m)**

GPS Accuracy: 1.08

GPS Precision 0.96

n=141

Navigation Accuracy 1.36

Navigation Precision 1.11

n=20

## *QA/QC*

- Void polygons
- Overlapping polygons
- MMU: 1 acre or less
- Clean polygons
- Adjacency
- Concatenated field
- Standardized table format



# **Six Layered Classification Scheme for Coral Reef Habitat Maps**

- 1) Coral Reef Zone**
- 2) Major Geomorphologic Structure**
- 3) Detailed Geomorphologic Structure**
- 4) Major Biological Cover**
- 5) Detailed Biological Cover**
- 6) Percent Live Coral**

# Classification Scheme

## Habitat Scheme

Geographic Zone	Geomorphological Structure	Biological Cover
Land	Coral Reef and Hard Bottom	<u>Major Cover</u>
Salt Pond	Rock Outcrop	Algae
Shoreline Intertidal	Boulder	Live Coral
Lagoon	Aggregate Reef	Coralline Algae
Reef Flat	Individual Patch Reef	Mangrove
Back Reef	Aggregated Patch Reefs	Seagrass
Reef Crest	Spur and Groove	No Cover
Fore Reef	Pavement	Unknown
Bank/Shelf	Pavement with Sand Channels	<u>Percent Major Cover</u>
Bank/Shelf	Reef Rubble	10% - <50%
Escarpment	Rhodoliths	50% - <90%
Channel	Unknown	90% - 100%
Dredged	Unconsolidated Sediment	Unknown
Unknown	Sand	<u>Coral Cover</u>
	Mud	<u>Percent Coral Cover</u>
	Sand with Scattered	0% - <10%
	Coral & Rock	10% - <50%
	Unknown	50% - <90%
	Other Delineations	90% - 100%
	Land	Unknown
	Artificial	
	Unknown	

## Zonation

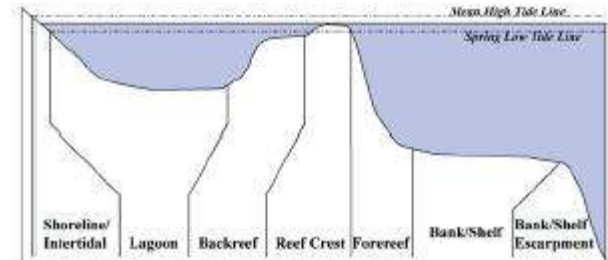


Figure 1. Barrier reef cross-section. Reef separated from the shore by a relatively wide, deep lagoon.

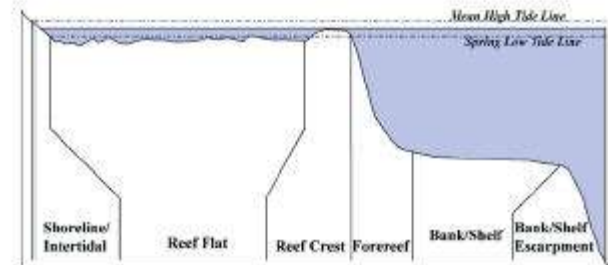


Figure 2. Fringing reef cross-section. Reef platform is continuous with the shore.

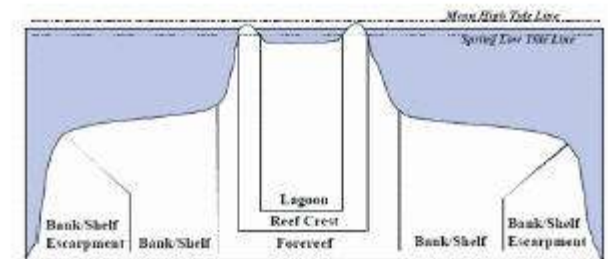


Figure 3. Atoll cross-section. Reef surrounding a lagoon.



# Five Step Mapping Process



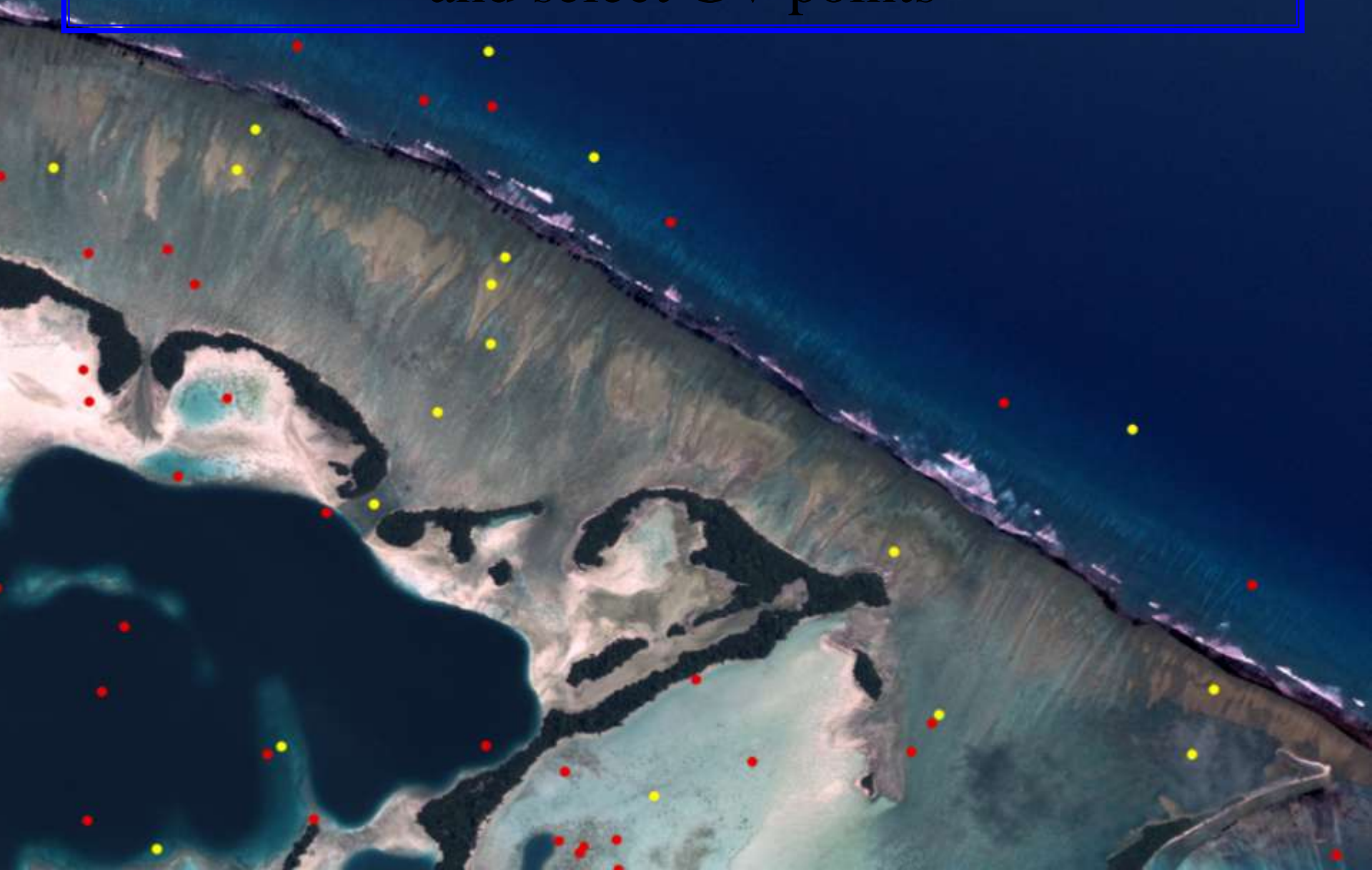
## Step 1:

Using the NOAA digitizing extension delineate as many habitat boundaries as possible

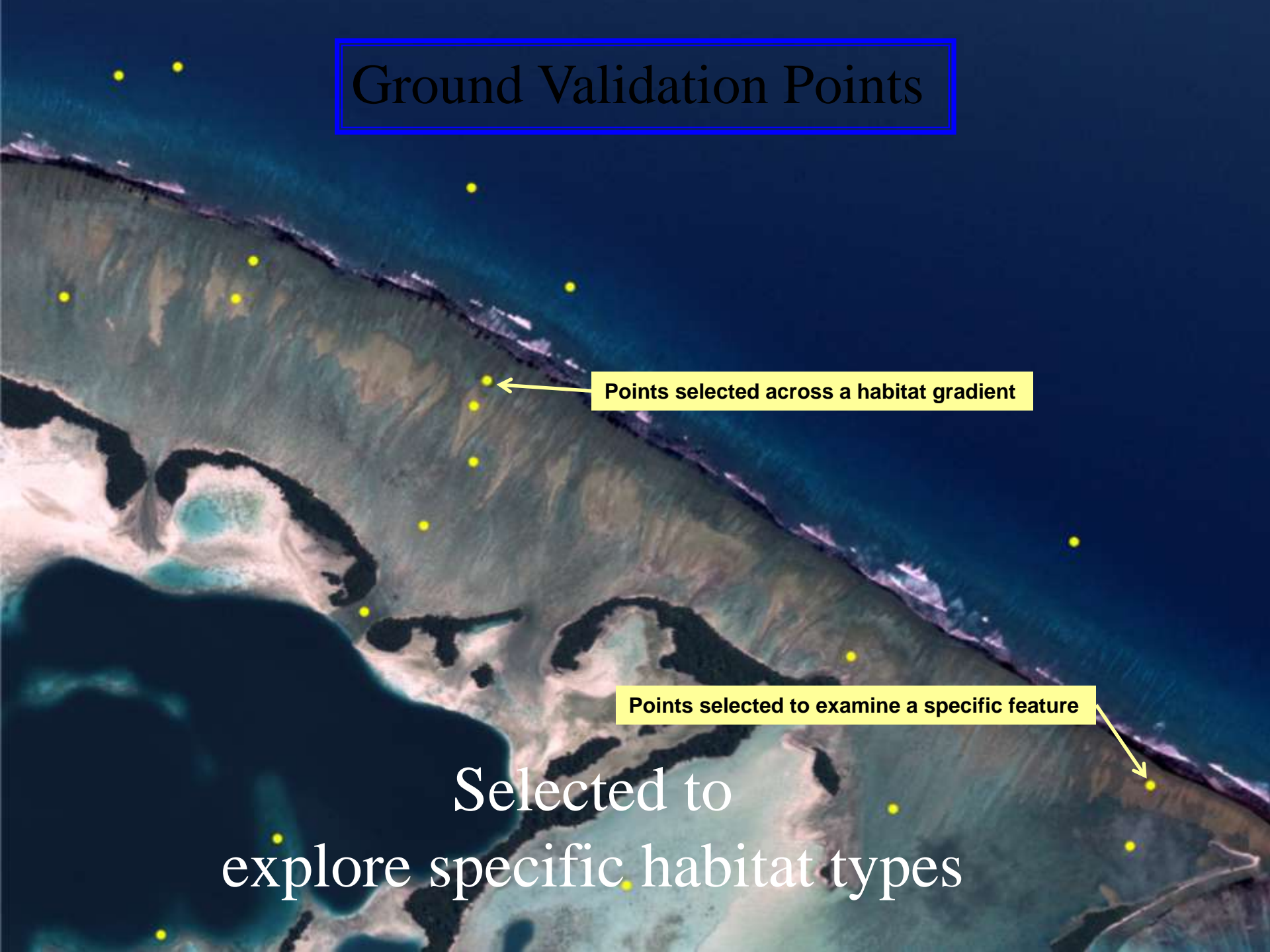
Draft I Map

An aerial photograph of a coastal area with various habitats. Red lines are drawn over the image to delineate these habitats. Yellow dots are scattered across the map, likely representing specific data points or sampling locations. The map shows a mix of dark blue water, light blue/marshy areas, and brownish land.

Step 2: Generate random stratified AA points  
and select GV points



# Ground Validation Points



Points selected across a habitat gradient

Points selected to examine a specific feature

Selected to explore specific habitat types

# Data Collected at Habitat Assessment Site

## Site Data

**Site ID**  
**Study Area**  
**GPS Date**  
**GPS Time**  
**GPS Position**  
**GPS Statistics**  
**Depth**  
**Photo Information**  
**Assessment Method**

## Habitat Data

**Major Structure**  
**Detailed Structure**  
**Major Cover**  
**Detailed Cover**  
**% Cover of Each Class**  
**Zone**  
**Relief**  
**Depth**  
**Comments**



# Video Capture System

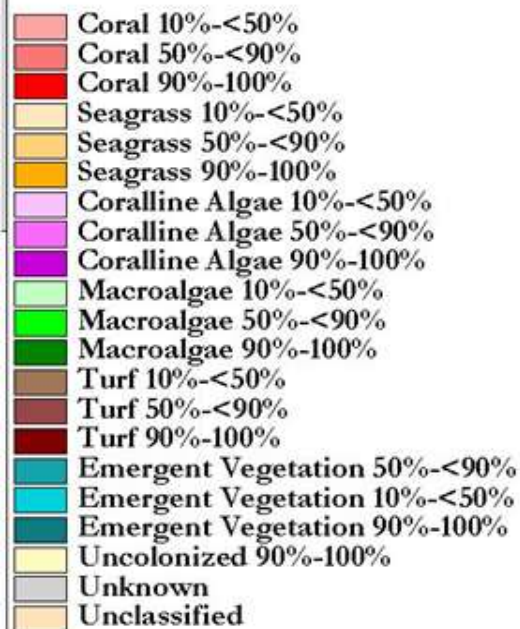
- **Downrigger**
- **UW Video Camera**
- **Video Recorder**
- **A to D Converter**
- **Monitor**
- **Static Memory**
- **Inverter**

# View From Surface



## Step 3:

### Legend



Produce Draft II maps by editing  
Draft 1 maps based on GV  
information



A map of a coastal area, likely a bay or estuary, with red lines representing a draft II map. Numerous red dots are scattered across the map, representing AA points. The dots are distributed across various habitat and structure classes.

## Step 4:

Overlay AA points on draft II map  
Assess Accuracy in the GIS  
Summarize results in an error matrix

~ 25 AA points by habitat and structure classes  
Stratified random placement using Hawth's tools (n=259)  
NOAA Team collected AA 6/09

## *Thematic Accuracy*

- Major Structure  
Accuracy 97.3%/0.959 Tau
- Detailed Structure  
Accuracy 84.2%/0.827 Tau
- Major Cover:  
Accuracy 92%/0.89 Tau
- Detailed Cover  
Accuracy 86%/0.85 Tau
- Live Coral  
Accuracy 86.5%/0.83 Tau

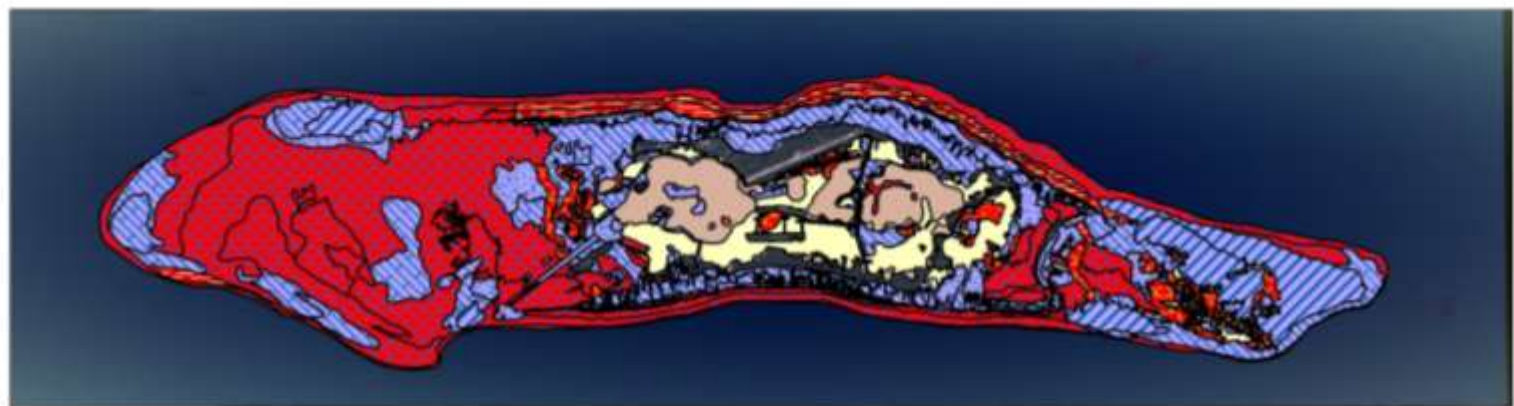
# Confusion Matrix

Error matrix for detailed biological cover.

Accuracy Assessment (i)

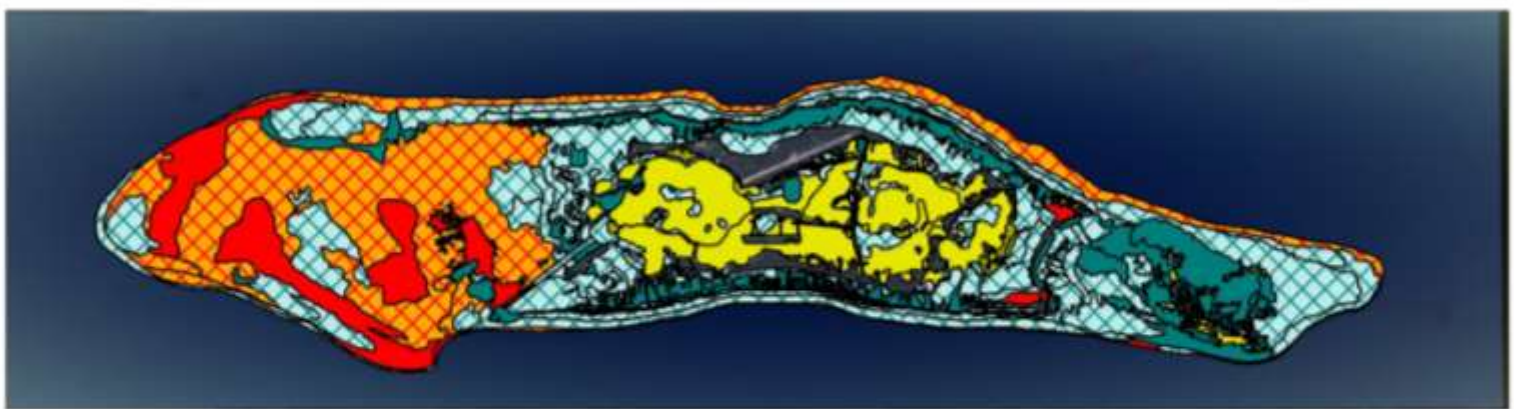
		Algae 10% - <50%	Algae 50% - <90%	Algae 90% - 100%	Live Coral 50% - <90%	Live Coral 90% - 100%	No Cover 50% - <90%	No Cover 90% - 100%	Unclassified N/A	n <sub>j</sub>	User's Accuracy
Map Data (i)	Algae 10% - <50%									0	n/a
	Algae 50% - <90%		105	3	5			2		115	91.3%
	Algae 90% - 100%		5	32						37	86.5%
	Live Coral 50% - <90%		4		25	1				30	83.3%
	Live Coral 90% - 100%				3	2				5	40.0%
	No Cover 50% - <90%		6				1	3		10	10.0%
	No Cover 90% - 100%	2	1	1				50		54	92.6%
	Unclassified N/A								8	8	100.0%
n <sub>i</sub>		2	121	36	33	3	1	55	8	n=259	
Producer's Accuracy (%)		0.0%	86.8%	88.9%	75.8%	66.7%	100.0%	90.9%	100.0%	P <sub>0</sub> =	86.1%
<b>T<sub>e</sub> = 0.841 ± 0.048</b>											

# Map Products (1)



- |                        |                       |                             |                                    |
|------------------------|-----------------------|-----------------------------|------------------------------------|
| Aggregate Reef         | Boulder               | Pavement                    | Sand                               |
| Aggregated Patch Reefs | Individual Patch Reef | Pavement with Sand Channels | Sand with Scattered Coral and Rock |
| Artificial             | Mud                   | Reef Rubble                 | Spur and Groove                    |

**Geomorphological Structure**

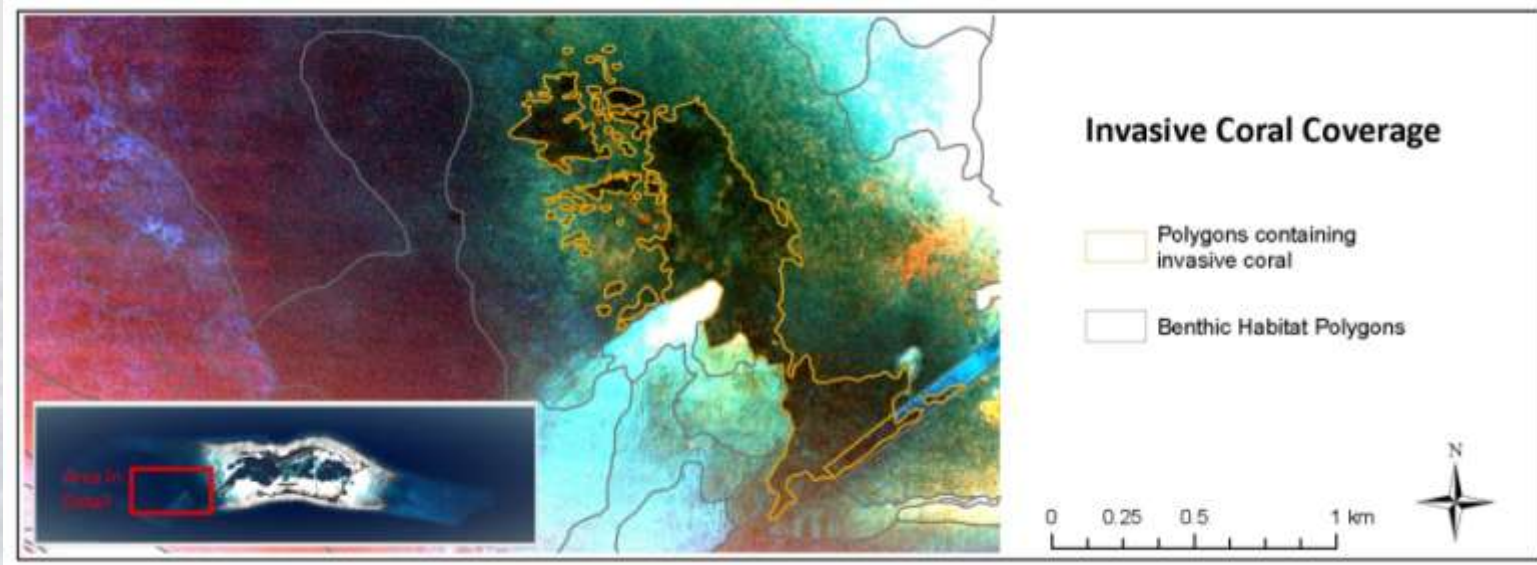
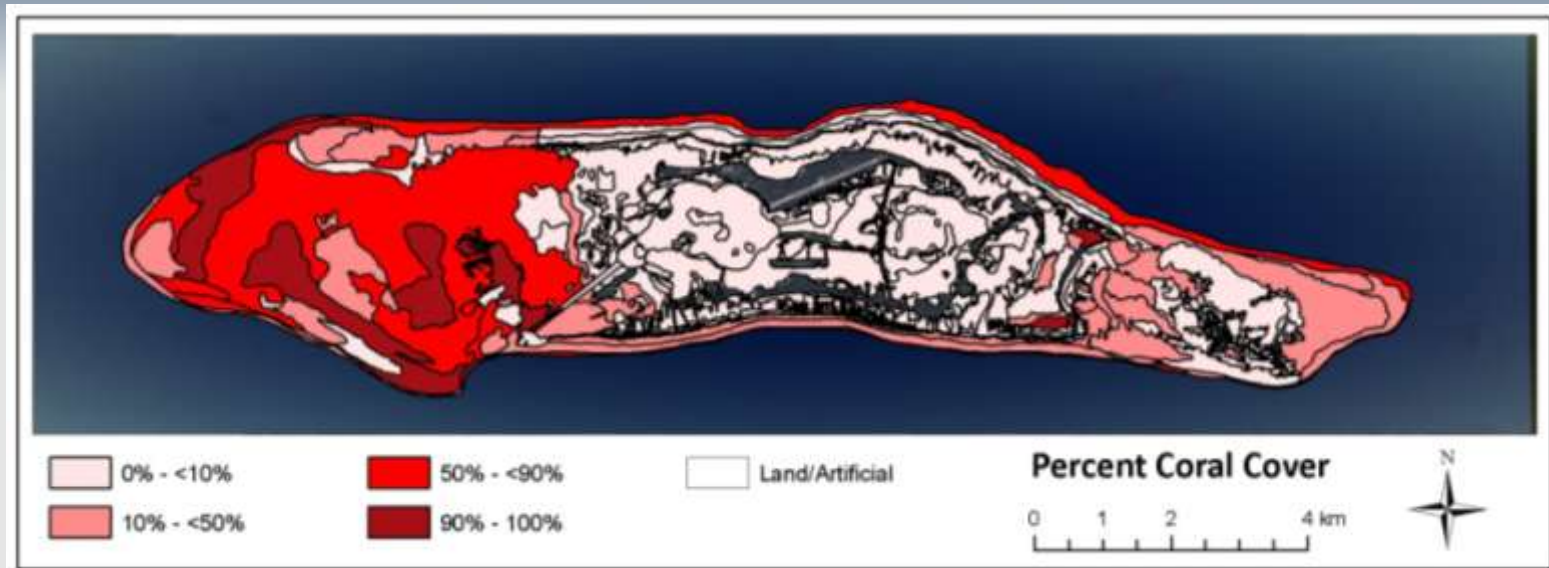


- |                  |                       |                     |
|------------------|-----------------------|---------------------|
| Algae 50% - <90% | Live Coral 50% - <90% | No Cover 50% - <90% |
| Algae 90% - 100% | Live Coral 90% - 100% | No Cover 90% - 100% |

**Biological Cover**



# Map Products (2)



# Areal Statistics (1)

Area of major biological cover types at Palmyra Atoll.

Major Biological Cover	Number of Polygons	Area (sq. km.)	Area (%)
Algae	354	27.94	52.56%
Live Coral	53	19.18	33.02%
No Cover	70	7.58	14.42%
Total	477	50.26	100.00%

Area of detailed biological cover types at Palmyra Atoll.

Dominant Cover Type	Number of Polygons	Area (sq. km.)	Area (%)
Algae 10% - <50%	1	0.013	.025%
Algae 50% - <90%	197	19.00	37.81%
Algae 90% - 100%	156	7.41	14.73%
Live Coral 50% - <90%	14	12.15	24.17%
Live Coral 90% - 100%	39	4.45	8.85%
No Cover 50% - <90%	20	0.39	0.78%
No Cover 90% - 100%	50	6.85	13.63%
Total	477	50.26	100.00%

# Areal Statistics (2)

## Area of detailed geomorphologic structure types at Palmyra Atoll.

Detailed Structure	Number of Polygons	Area (sq. km.)	Area (%)
Aggregate Reef	98	21.06	41.90%
Aggregated Patch Reefs	32	1.68	3.35%
Boulder	1	0.0057	0.011%
Individual Patch Reef	39	0.15	0.29%
Mud	27	3.21	6.39%
Pavement	118	10.96	21.80%
Pavement with Sand Channels	8	3.78	7.52%
Reef Rubble	112	33.29	6.56%
Sand	29	3.81	7.57%
Sand with Scattered Coral and Rock	1	0.15	0.29%
Spur and Groove	13	2.16	4.30%
Total	477	50.26	100.00%

## Area of Percent Live Coral at Palmyra Atoll.

Coral Cover (% Range)	Number of Polygons	Area (sq. km.)	Area (%)
0% - <10%	379	23.16	46.07%
10% - <50%	46	10.52	20.92%
50% - <90%	13	12.14	24.15%
90% - 100%	39	4.45	8.86%
Total	477	50.26	100.00%

# Data Access

## Palmyra Project Page

<http://ccma.nos.noaa.gov/ecosystems/coralreef/palmyra/>

## Palmyra BIOMapper

<http://ccma.nos.noaa.gov/products/biogeography/biomapper/biomapper.html?id=Palmyra>

Palmyra, PRIAS

Site ID: GVS18

Attributes Video

Legend

Site ID	Assessment
GVS13	Drop Camera
GVS14	Drop Camera
GVS15	Drop Camera
GVS16	Drop Camera
GVS17	Drop Camera
GVS18	Drop Camera
GVS19	Drop Camera
GVS20	Drop Camera
GVS21	Drop Camera
GVS22	Drop Camera
GVS23	Drop Camera

About

Project Information | FAQ | Related Publications | Contact Us

### Palmyra BIOMapper

#### Biogeography Integrated Online Mapper

Welcome to the Palmyra BIOMapper, a fully interactive, online feature designed to let users explore benthic habitat mapping data from the Benthic Habitat Mapping of Palmyra Atoll project. This portal contains a comprehensive collection of data, including aerial imagery, acoustic imagery, benthic habitat shapefiles, ground validation sites, underwater video, and still photography. In addition, the BIOMapper tool provides the ability to create customized, printable PDF maps. These data products provide a detailed, contemporary evaluation on the status, abundance, and distribution of marine benthic habitats for Palmyra. The results of these efforts will provide resource managers, scientists, and the public increased understanding and technical capacity for ocean exploration, management and stewardship.

Please visit the [project website](#) for data, reports, and other products.





**For more information, Contact:**

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301-713-3028 x171**

**[Tim.Battista@noaa.gov](mailto:Tim.Battista@noaa.gov)**

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

**In Memory of Miles Anderson (1947-2010)**