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Environmental Habitat Mapping Using WorldView-2 Satellite Imagery

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Definition

Habitat: the natural home or environment of an animal, plant, or other organism

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The Challenge: Depicting Habitats Geographically

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The Challenge: Depicting Habitats Geographically

Complexity

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The Challenge: Depicting Habitats Geographically

Complexity

Omissions

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The Challenge: Depicting Habitats Geographically

Complexity

Omissions

Consistency

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The Challenge: Depicting Habitats Geographically

Complexity

Omissions

Consistency

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The Challenge: Defining a habitat list

Mangroves

Sand sheets and dunes

Recreational area

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Mangroves ✓

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The Challenge: Defining a habitat list

Mangroves ✓

Sand sheets and dunes ✓

Recreational area ✓

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Cost Benefit

VHR Satellite

- Continuous
- Consistent
- Fast
- Low Impact

Field Survey

- Discrete locations
- Subjectivity
- Time consuming
- Resource consuming

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- Discrete locations ✗
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- Resource consuming ✗

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Case Study – Abu Dhabi

Human Activity

Dredging

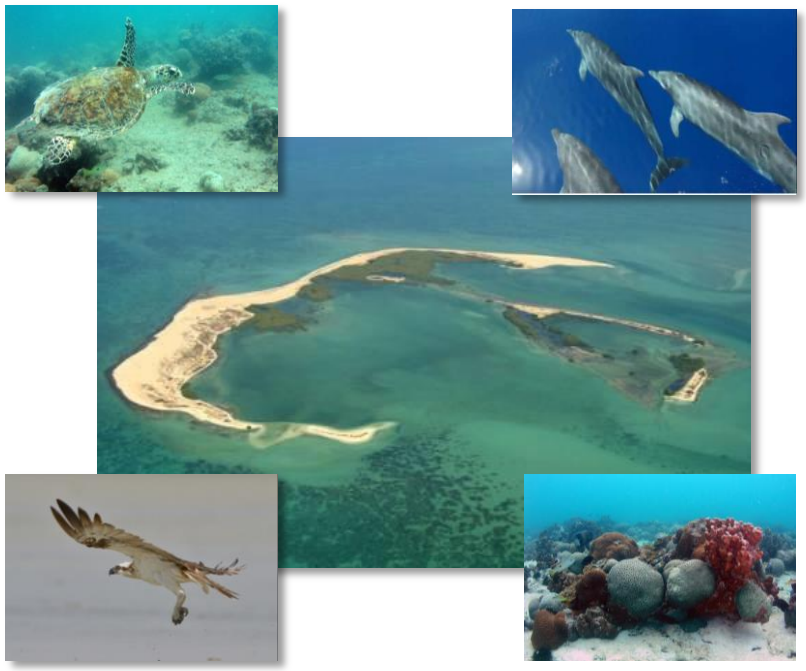
Oil Field Expansion

Pollution

Desalination

Environmental Protection

Bu Tinah



UNESCO:
Marine Biosphere Reserve

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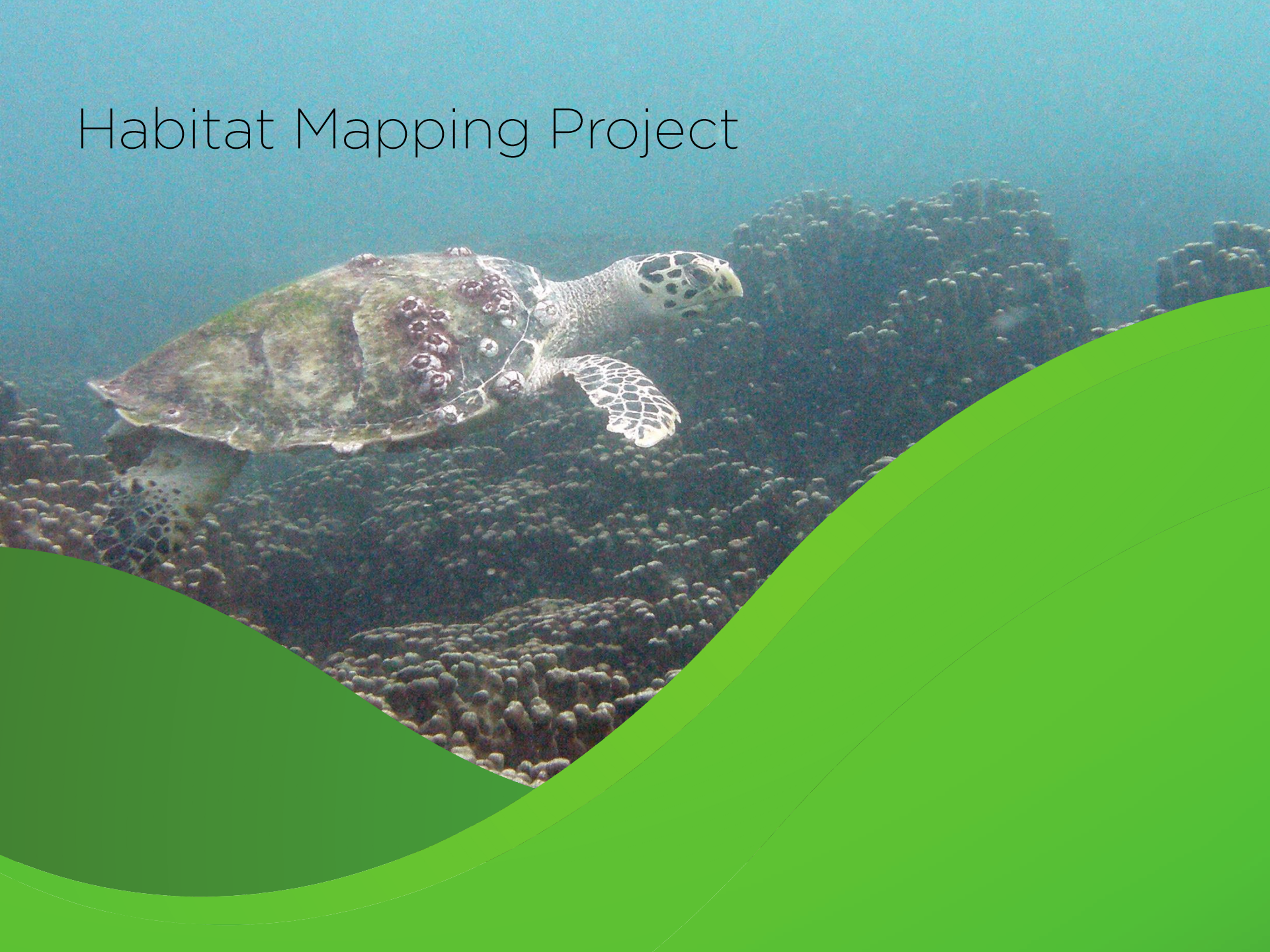
Habitat Mapping Project



Project Goals

- Emirate-wide habitat map production
- Terrestrial and Marine
- 1:10,000 Scale output
- Provide a baseline for future larger scale, focused ecological surveys

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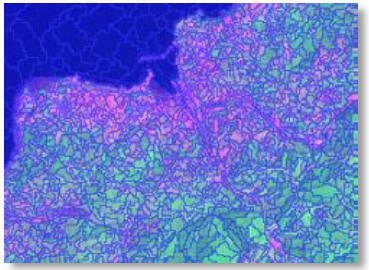
Project Work Flow

Inputs

Processes



ENVI

eCognition®

Outputs

CERTIFIED OGC COMPLIANT

Figure 1. Certified OGC Compliant service mark with OGC logo

esri

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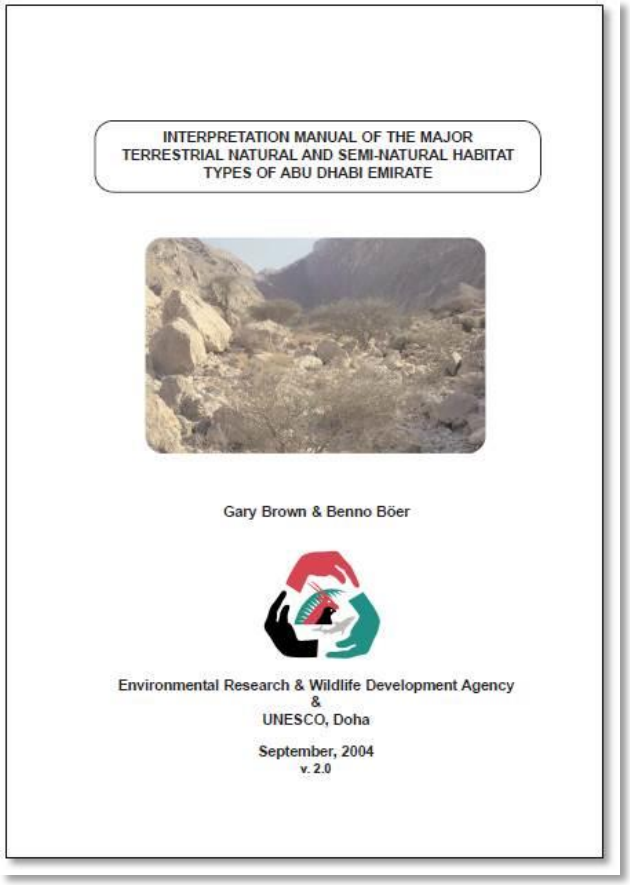
Terrestrial Habitat Classification

Brown and Boer habitat manual



- A terrestrial habitat manual for Abu Dhabi
- Published in 2004
- A tool for describing the natural landscape
- Not designed for satellite application
- Adapted and refined to suit this project

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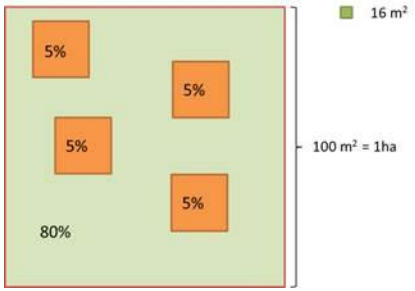
MMUs and Cartographic Rules

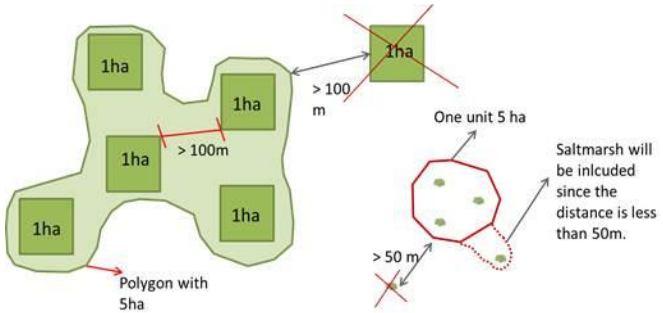
Minimum Mapping Unit: The smallest area that can be displayed on a map.

Spatial Generalisation: Necessary to abstract reality to a map.

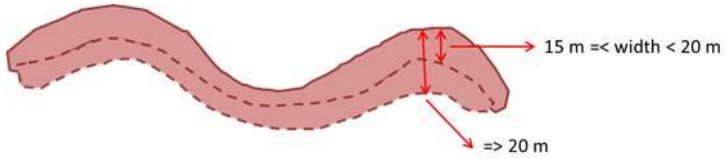
1. Aggregation



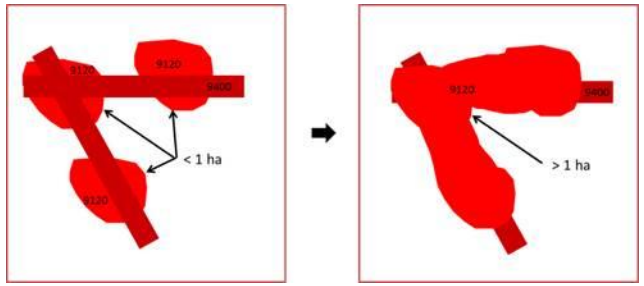
2. Amalgamation



3. Smoothing



4. Simplification



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Terrestrial Schema

Type no.	Sub-type no.	Habitat type	MMUs (ha)
1000		Intertidal habitats	
	1010	Mudflats and sand exposed at low tide	5
	1020	Sheltered tidal flats with cyanobacterial mats	5
	1030	Saltmarsh	5
	1040	Mangroves	5
	1050	Storm beach ridges	5
	1060	Sandy beaches	5
	1070	Beach rock and gravelly beaches	5
2000		Coastal plains, sand sheets and low dunes	
	2011	Coastal plains on well-drained sandy ground	25
	2012	Coastal plains on well-drained rocky or gravelly terrain	25
	2020	Coastal sand sheets and low dunes	5
	2030	Coastal cliffs, headlands, rocky slopes and wadis in coastal situations	5
3000		Coastal sabkha, including Sabkha Matti	25
3100		Coastal sabkha, including Sabkha Matti	25
4000		Sand sheets and dunes	
	4110	Sand sheets and dunes with tree cover	25
	4120	Sand sheets and dunes with shrub cover	25
	4130	Sand sheets and dunes with dwarf shrub cover	25
	4140	Sand sheets and dunes with perennial herbs and graminoids	25
	4200	Mega-dunes	25

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Terrestrial Schema

Type no.	Sub-type no.	Habitat type	MMUs (ha)
5000		Gravel plains (alluvial and interdunal)	
	5110	Gravel plains with distinct tree vegetation	25
	5120	Gravel plains with dwarf shrub vegetation	25
	5130	Gravel plains with sparse vegetation	25
	5200	Inland sabkha	25
6000		Mountains, rocky terrain and wadis	
	6100	Mountain slopes, screes and associated wadis	25
	6210	Jebels (including mesas and burqas)	5
	6220	Escarpments, lithified sand dunes, rocky exposures	5
	6320	Wadis in open terrain, and drainage channels	25
7000		Inland standing water habitats and habitats of moist ground	
	7100	Semi-artificial lakes	1
	7200	Moist ground with Phragmites, Tamarix and grass mats	5
8000		Oases, Farmland and Forestry	
	8100	Date plantations	1
	8200	Farmland	1
	8300	Livestock areas	1
	8400	Forestry plantations	1
9000		Urban habitat types	
	9100	High density urban	1
	9200	Low density urban	1
	9300	Leisure areas	1
	9400	Paved roads	1
	9500	Pipelines infrastructure	1
	9600	Disturbed ground	1

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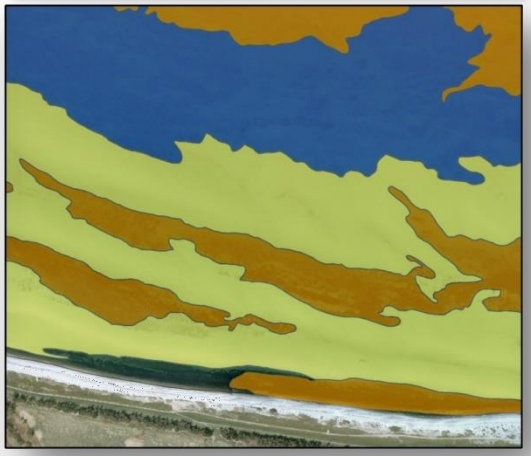
Marine Sea-bed Classification

From image to classification

Satellite image

Segmentation

Classification



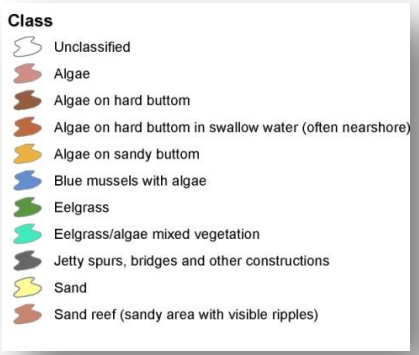
Spectral bands

Texture, context

Bathymetry

Water column correction

In situ data



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Marine habitat list

Type no.	Sub-type no.	Habitat type	Legend
11,000		Coral reef	-
	11,100	Fringing reef	
	11,120	Macroalgae on Fringing reef	
	11,200	Patch reef	
	11,220	Macroalgae on Patch reef	
12,000		Seagrass bed	
13,000		Hardbottom	
	13,020	Macroalgae on Hardbottom	
14,000		Unconsolidated bottom	
	14100	Deep Unconsolidated bottom	
15,000		Marine construction	-
	15,100	Rock armouring / artificial reef	
	15,200	Marine structure	
16,000		Dredged areas	-
	16,100	Dredged seabed	

- Biologically driven, NOT just satellite derived

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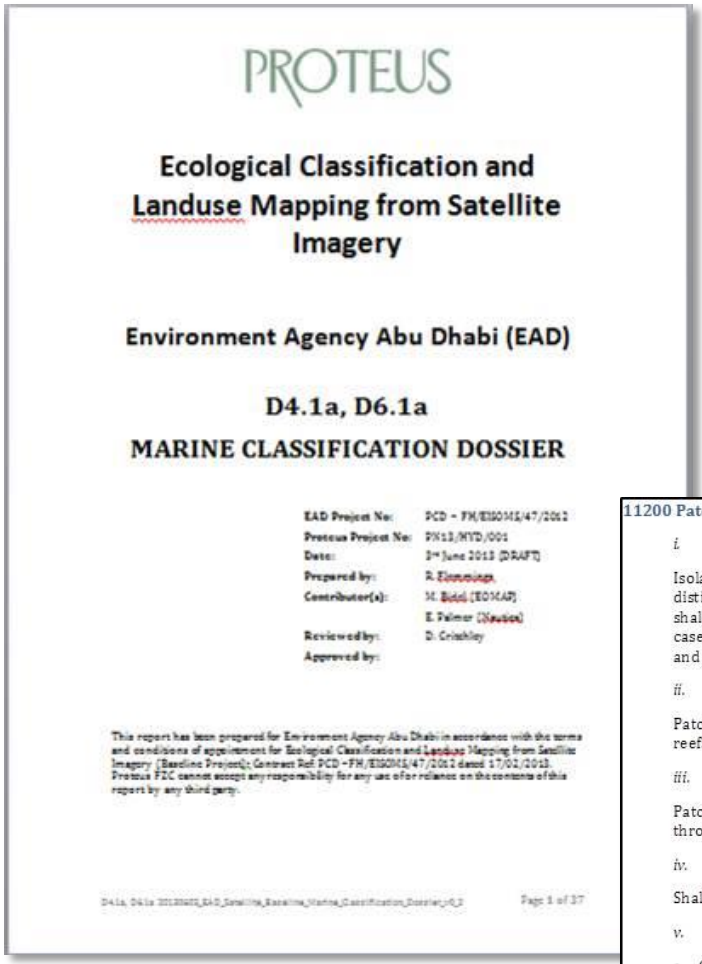
CMRECS Habitat Manual



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Ecological Classification and Landuse Mapping from Satellite Imagery

Environment Agency Abu Dhabi (EAD)

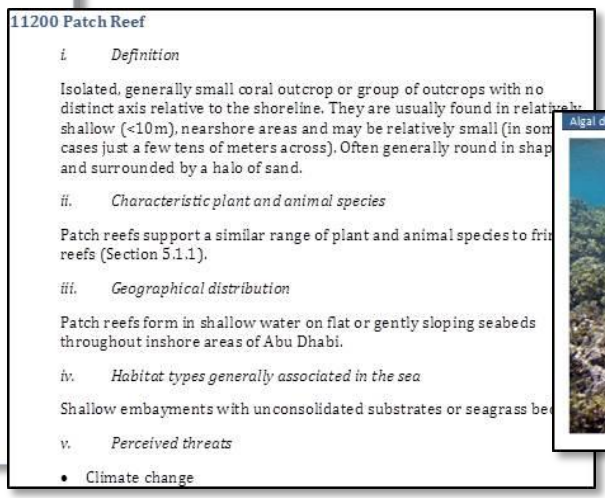
D4.1a, D6.1a

MARINE CLASSIFICATION DOSSIER

EAD Project No: PCD – FH/EISOMS/47/2012
Proteus Project No: PN12/MYD/001
Date: 3rd June 2013 (DRAFT)
Prepared by: R. Zimmerman
Contributor(s): M. Bidd (EOMAP)
E. Palmer (Navtec)
Reviewed by: D. Critchley
Approved by:

This report has been prepared for Environment Agency Abu Dhabi in accordance with the terms and conditions of appointment for Ecological Classification and Landuse Mapping from Satellite Imagery (Baseline Project); Contract Ref PCD – FH/EISOMS/47/2012 dated 17/01/2013. Proteus FZC cannot accept any responsibility for any use of or reliance on the contents of this report by any third party.

D4.1a, D6.1a 20130603_EAD_Satellite_Baseline_Marine_Classification_Dossier_v0.3 Page 1 of 37



11200 Patch Reef

i. Definition

Isolated, generally small coral outcrop or group of outcrops with no distinct axis relative to the shoreline. They are usually found in relatively shallow (<10m), nearshore areas and may be relatively small (in some cases just a few tens of meters across). Often generally round in shape and surrounded by a halo of sand.

ii. Characteristic plant and animal species

Patch reefs support a similar range of plant and animal species to fringing reefs (Section 5.1.1).

iii. Geographical distribution

Patch reefs form in shallow water on flat or gently sloping seabeds throughout inshore areas of Abu Dhabi.

iv. Habitat types generally associated in the sea

Shallow embayments with unconsolidated substrates or seagrass bed

v. Perceived threats

- Climate change

- Originally produced for EAD in 2009
- Not designed for satellite application
- Adapted and refined to suit this project

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Applying CMRECS - Density

CMRECS "Other Modifier"	Definition
Dense Cover	>75% live cover
Moderate Cover	25% - 75% live cover
Sparse Cover	<25% live cover

- CMRECS used to guide the rules for marine classification.
- e.g. category "Seagrass" will be classified when Seagrass is the dominant species over 25% or more of an area.
- Less than 25% of plant cover will mean classification as the underlying substrate.

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Density - Example

Seagrass

“Sparse” Cover

(insufficient seagrass, so classed as “Unconsolidated bottom”)

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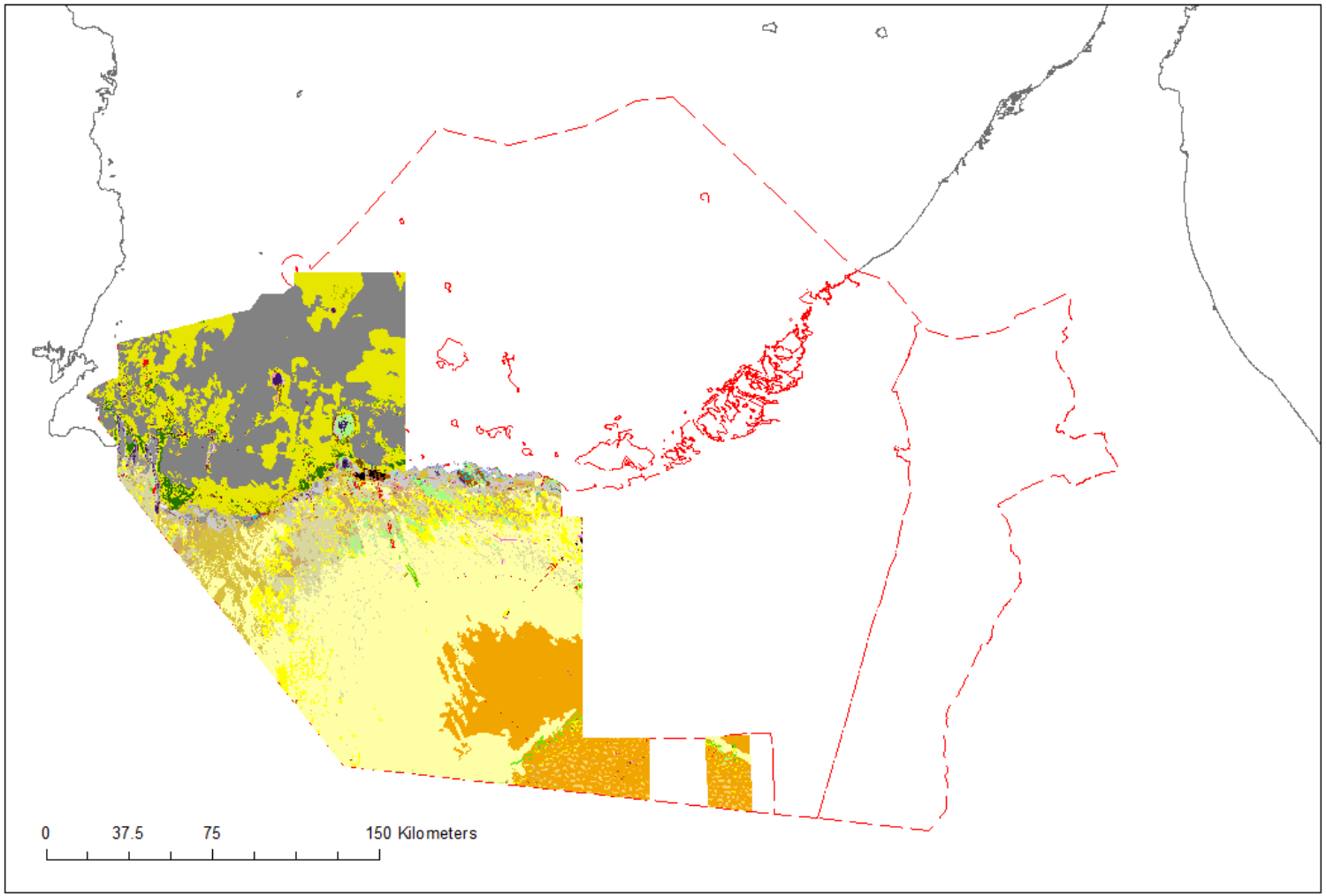
Progress



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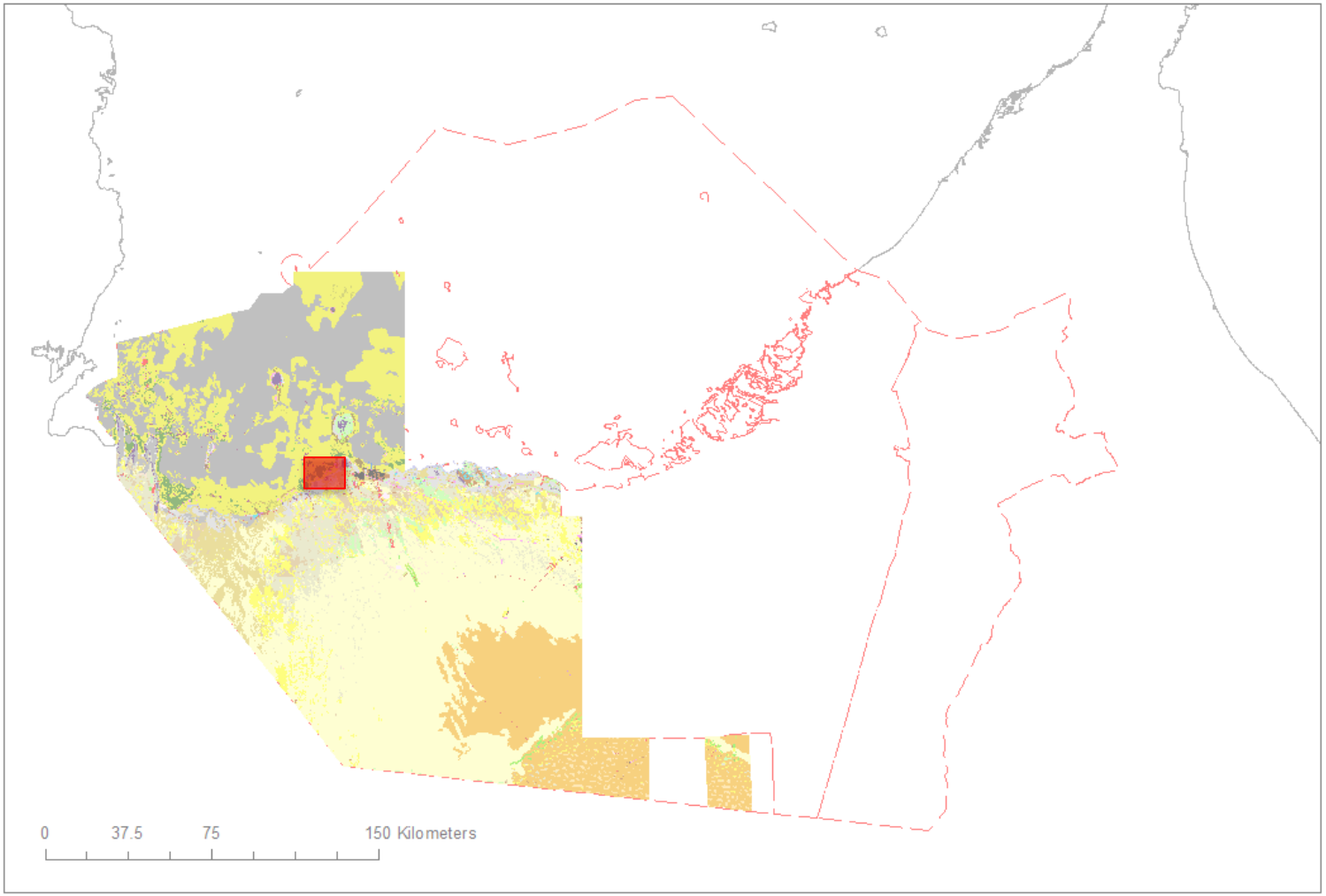
Focus



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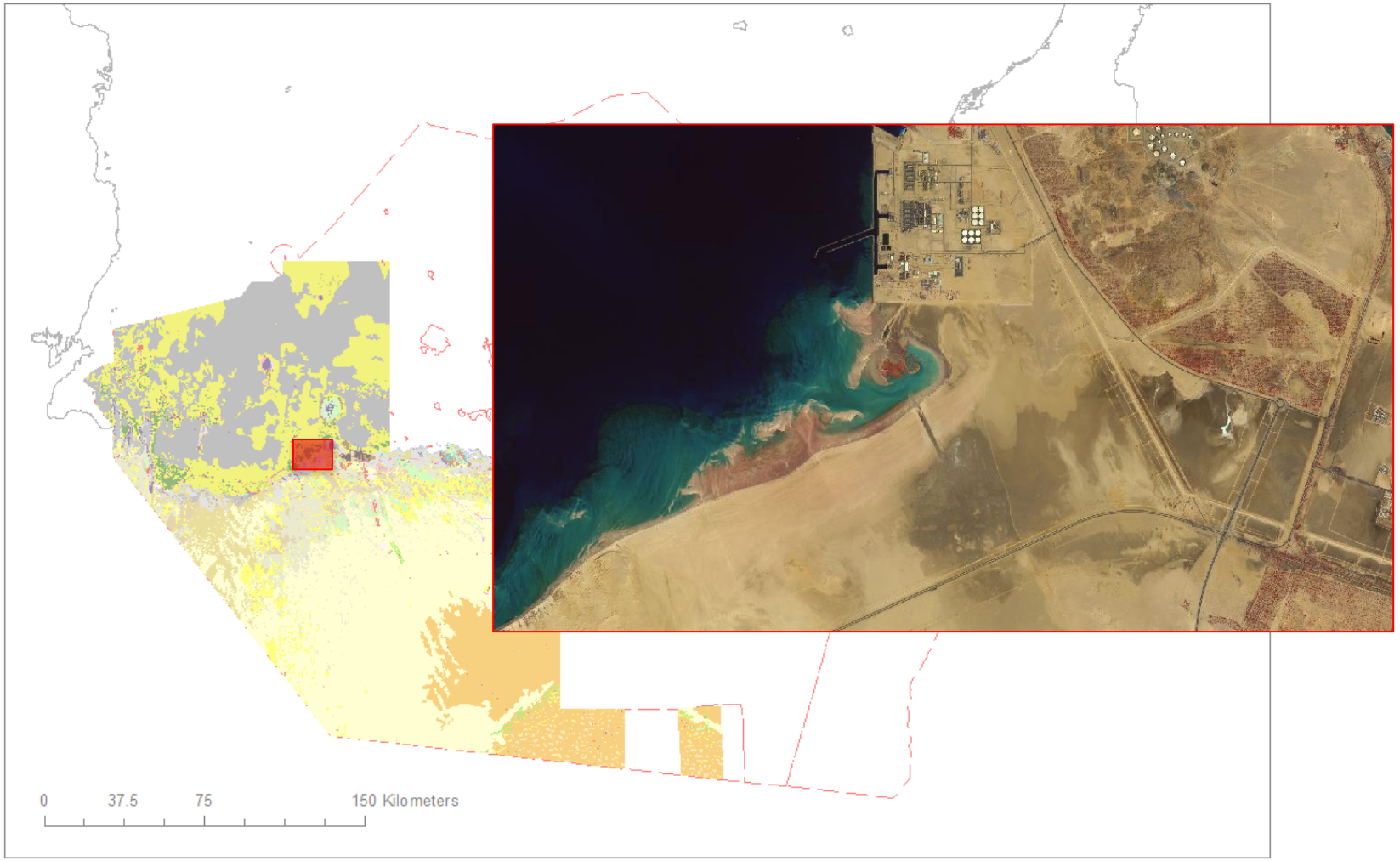

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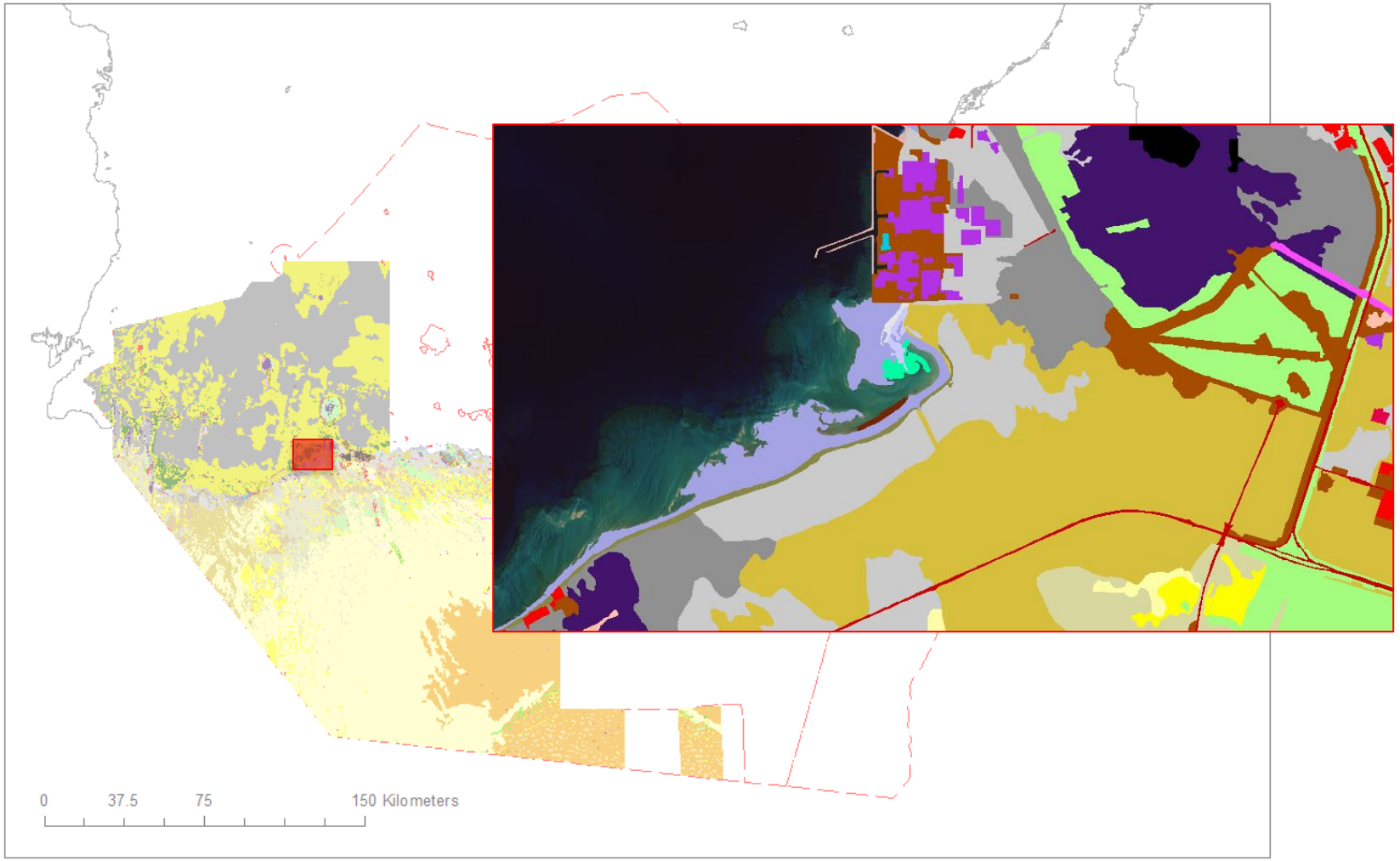

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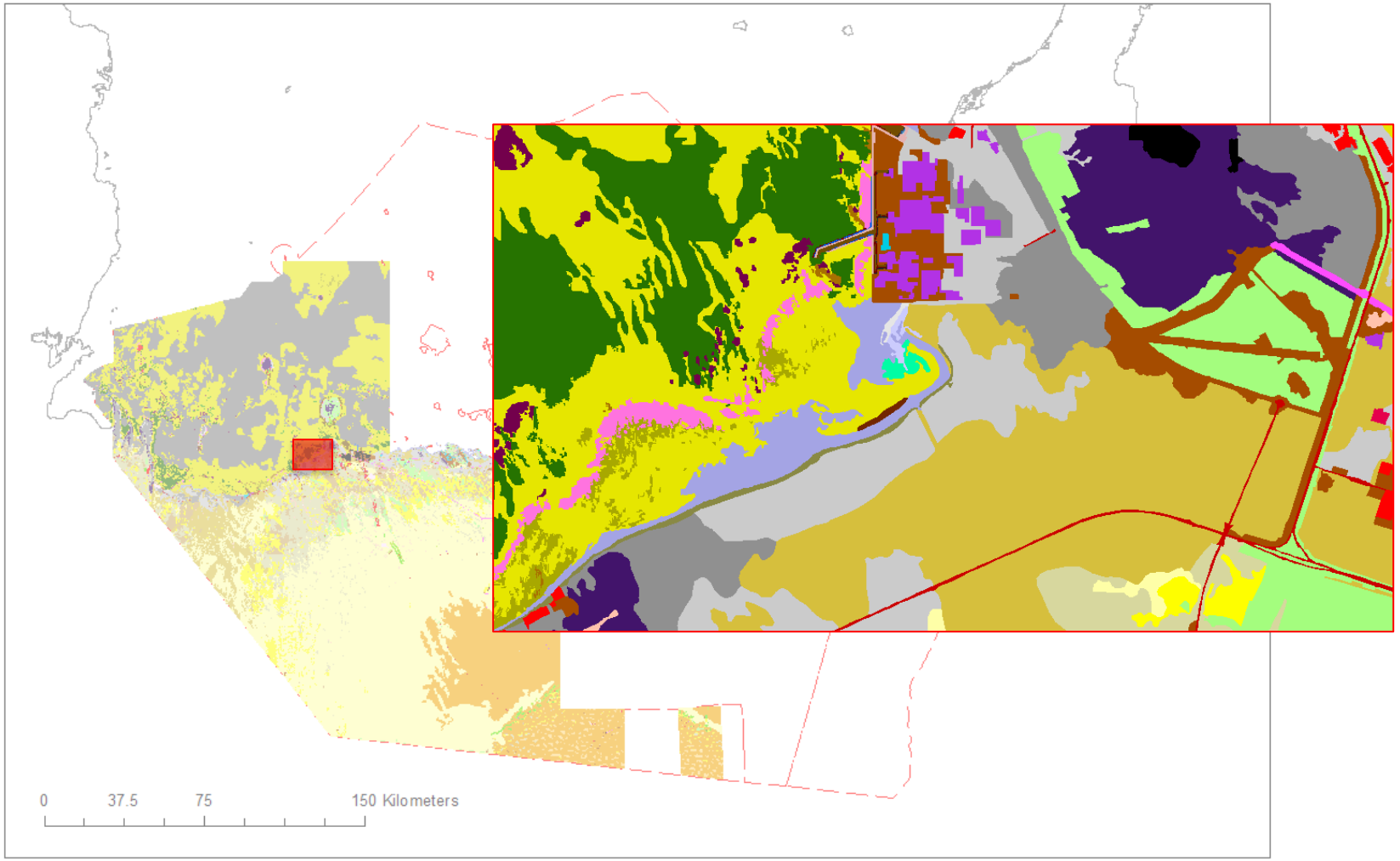

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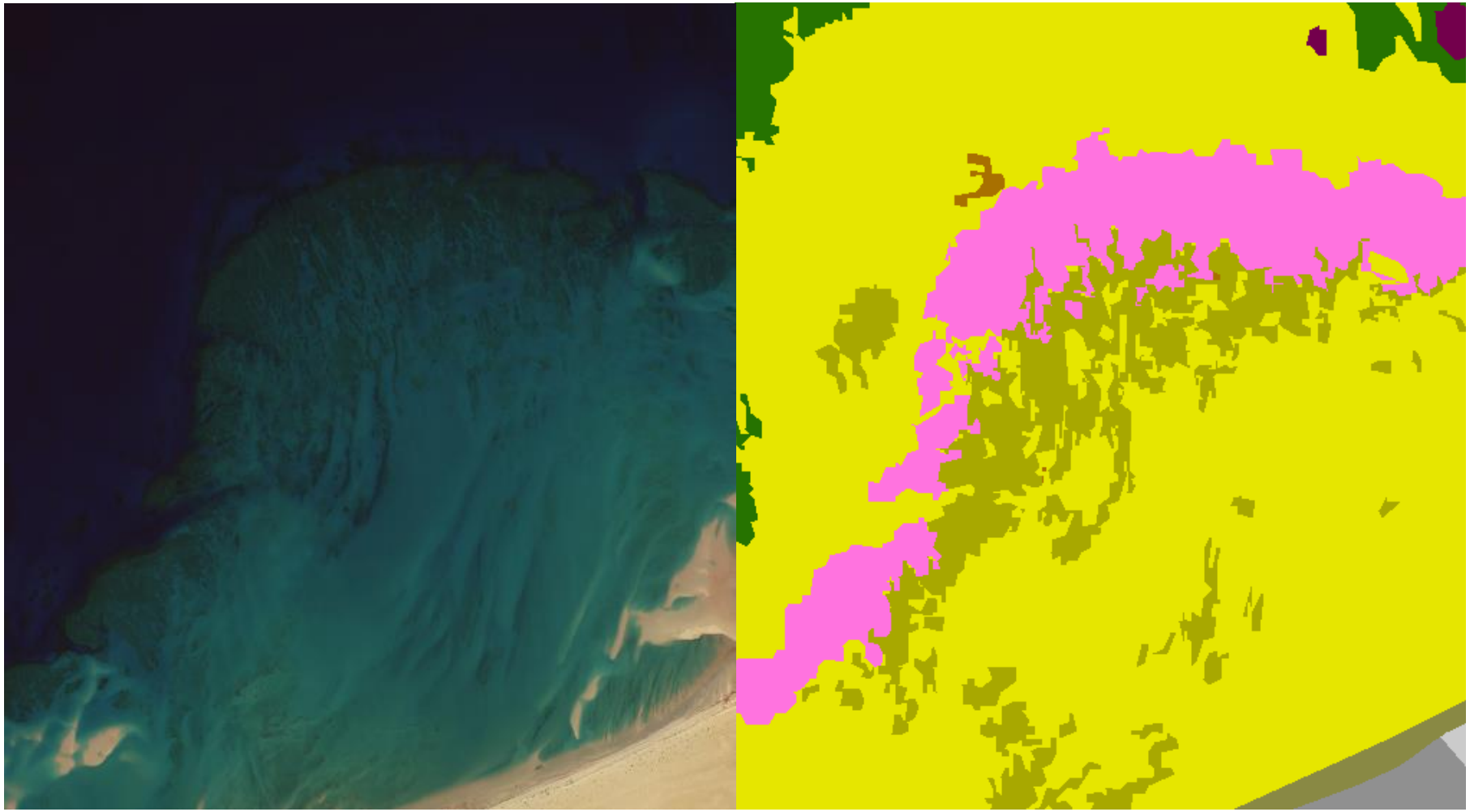
Marine Examples

11,100: Fringing Reef & 13,020: Algal Bed



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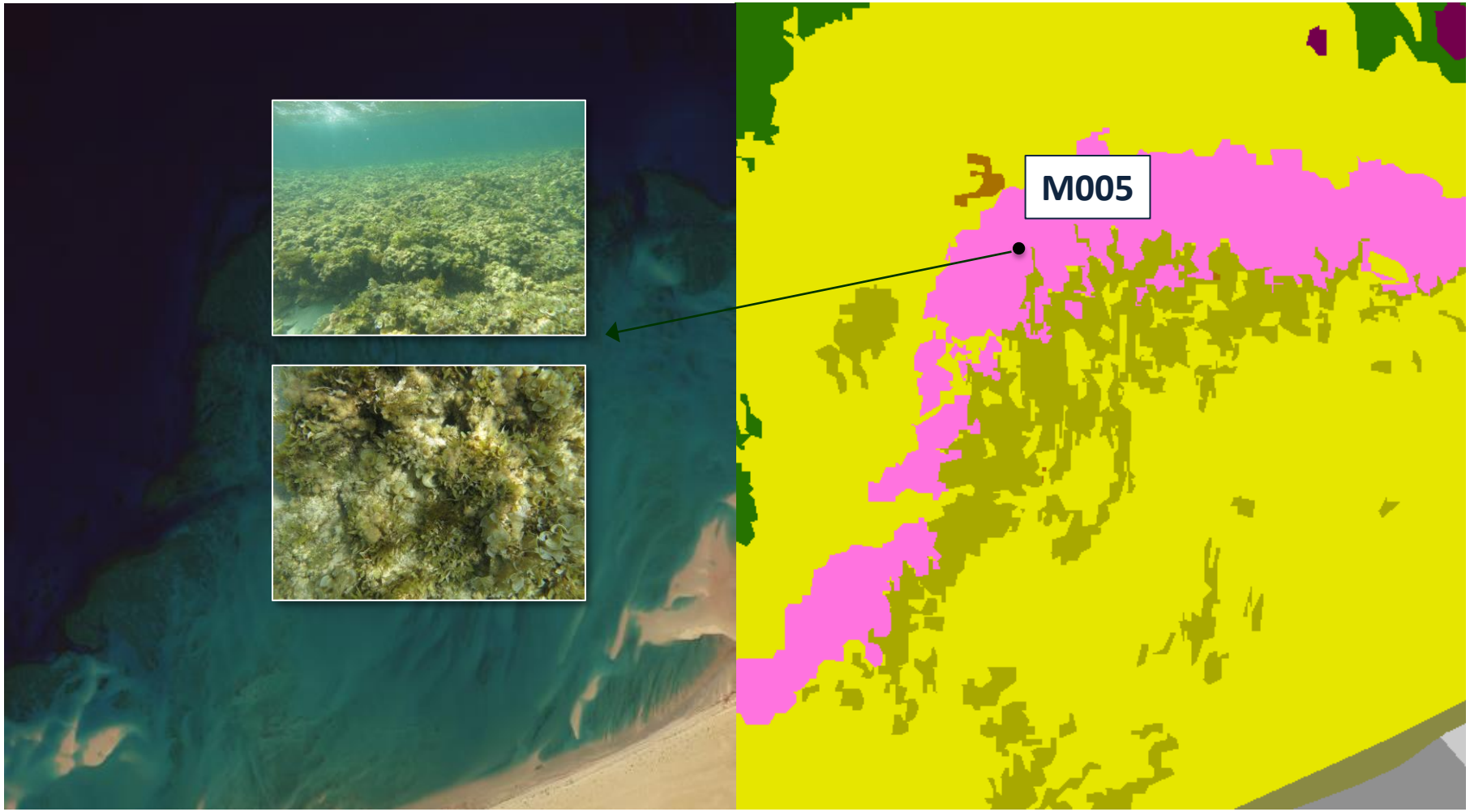

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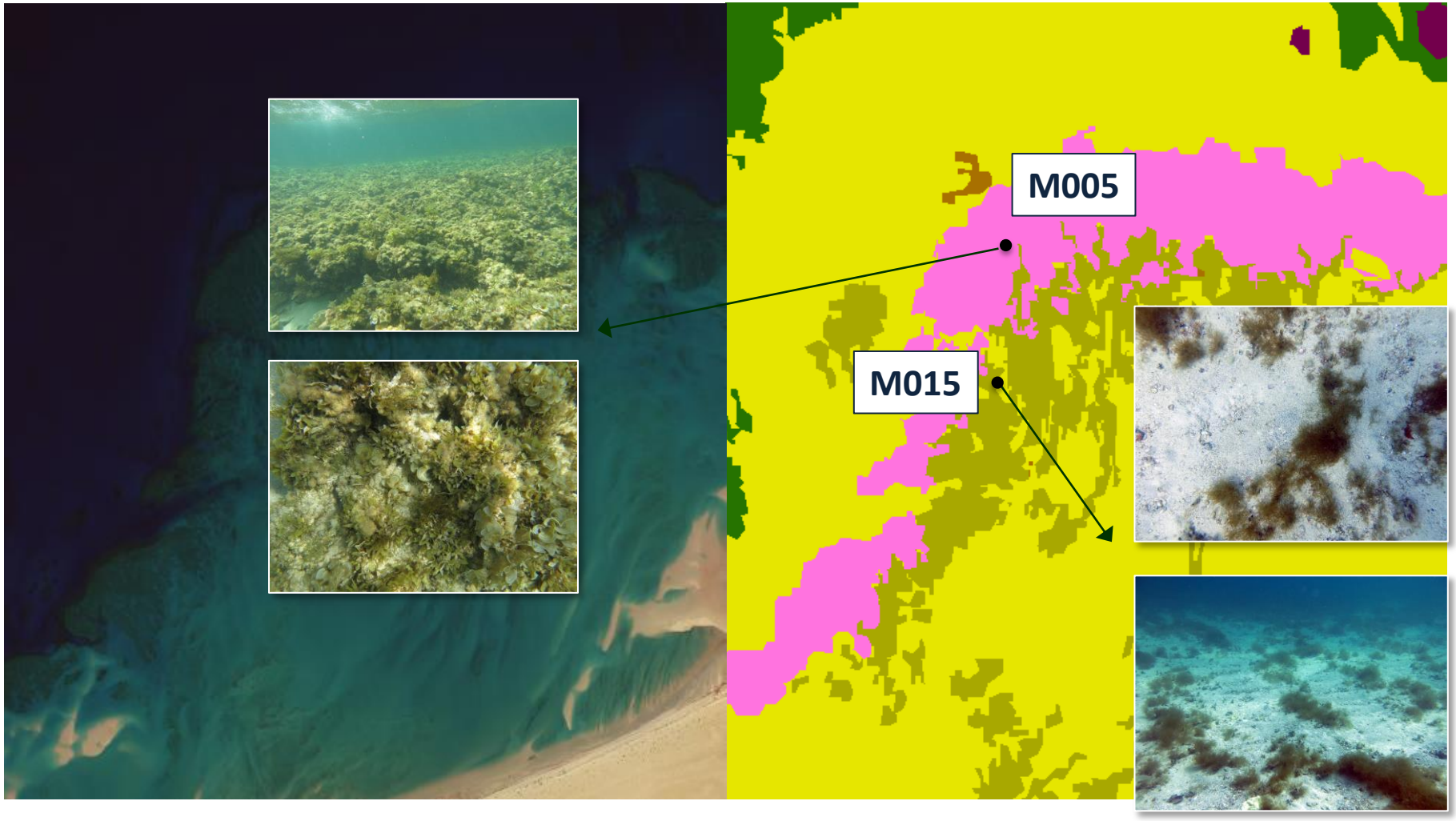

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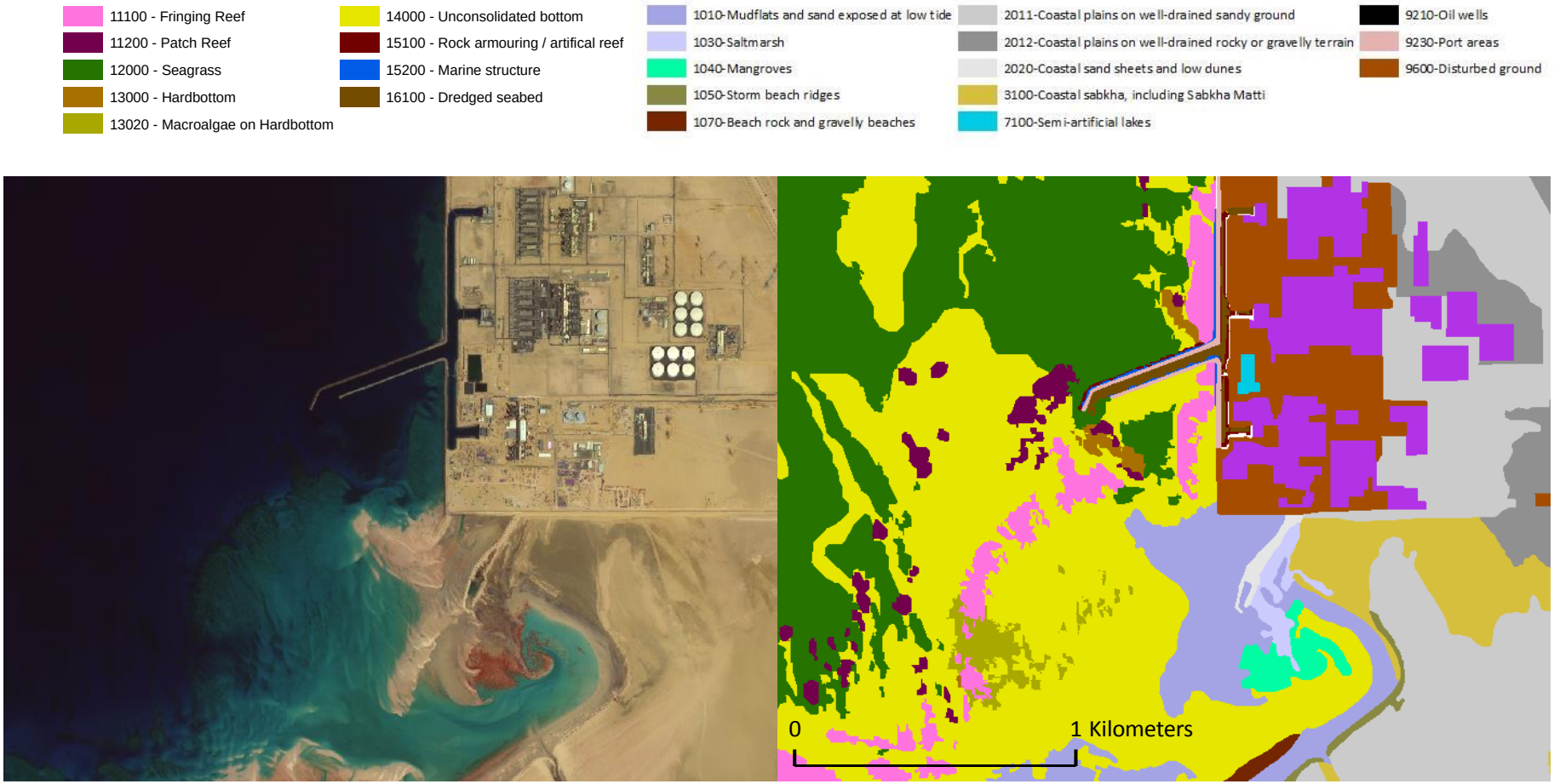
Coastal Example



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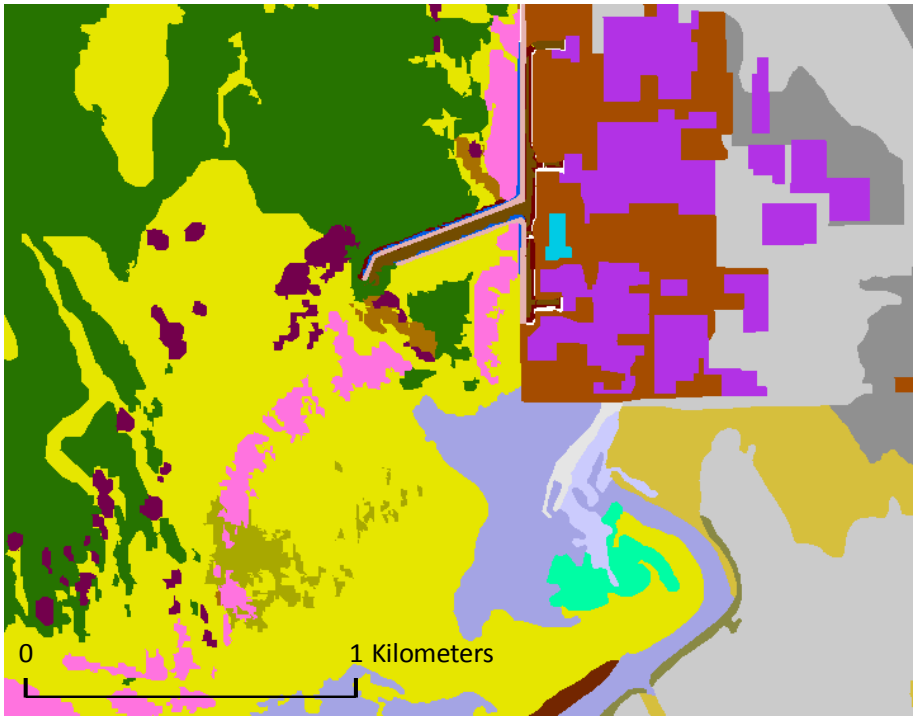
Coastal Example - Field Verification – Survey Point No. 223

Habitat 1050: Storm Beach Ridge

Characteristics: Parallel with the high water mark; 20%+ vegetation; hummocky



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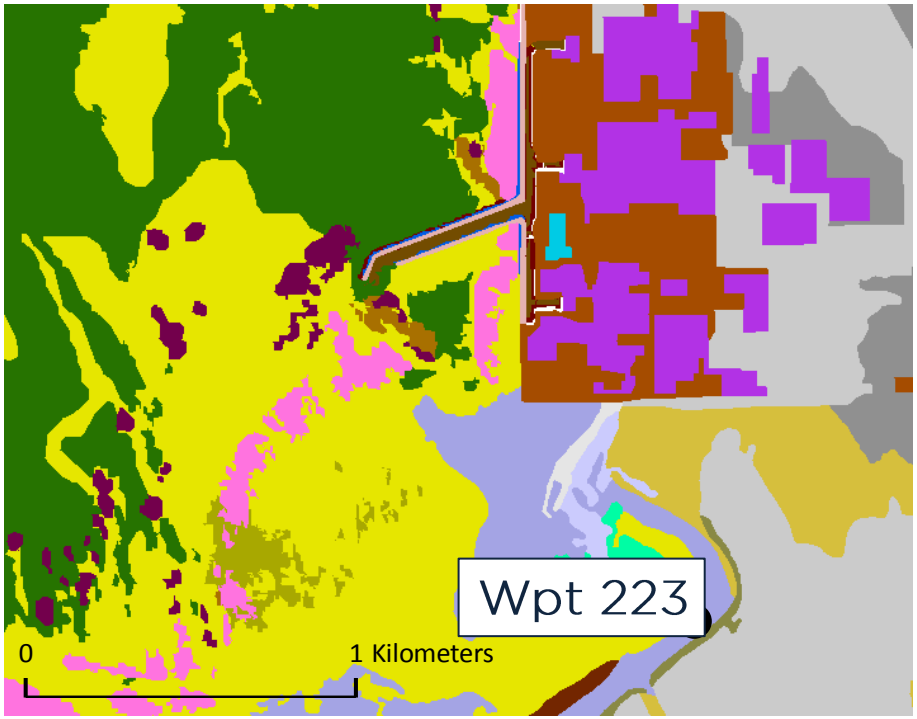

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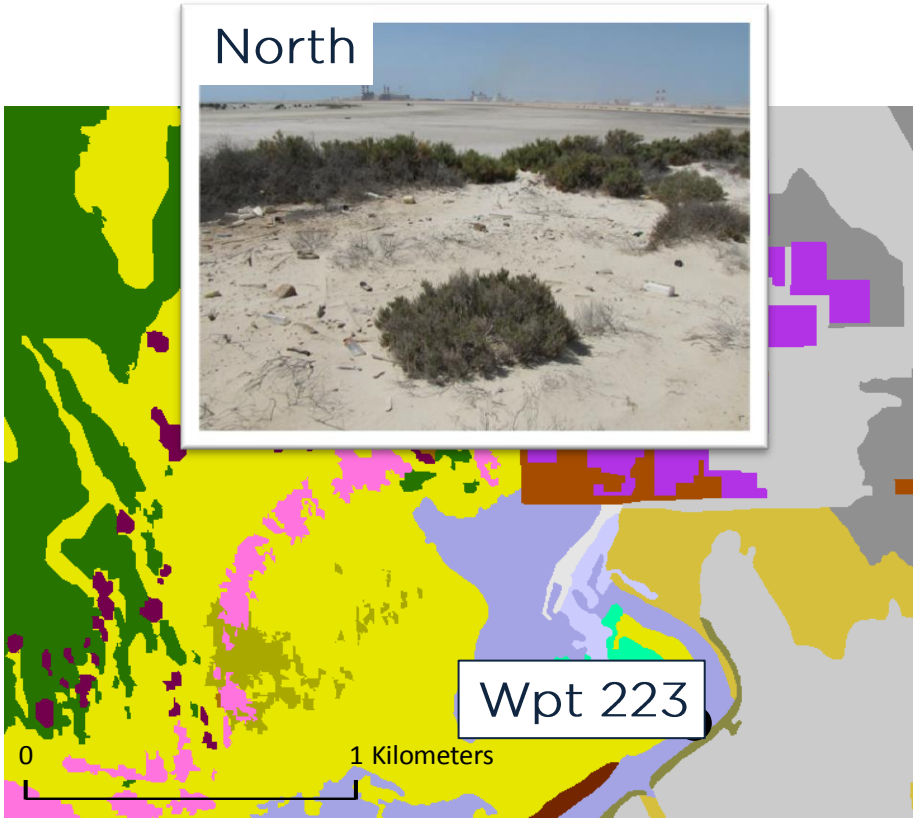

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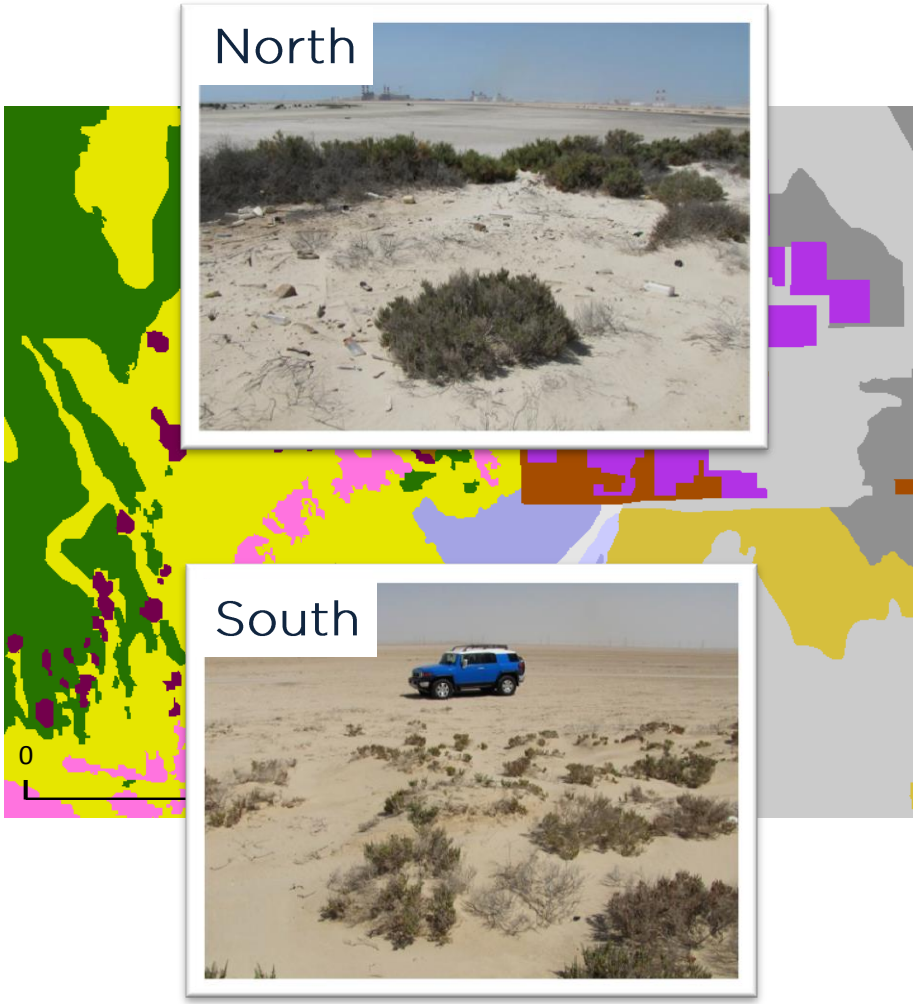

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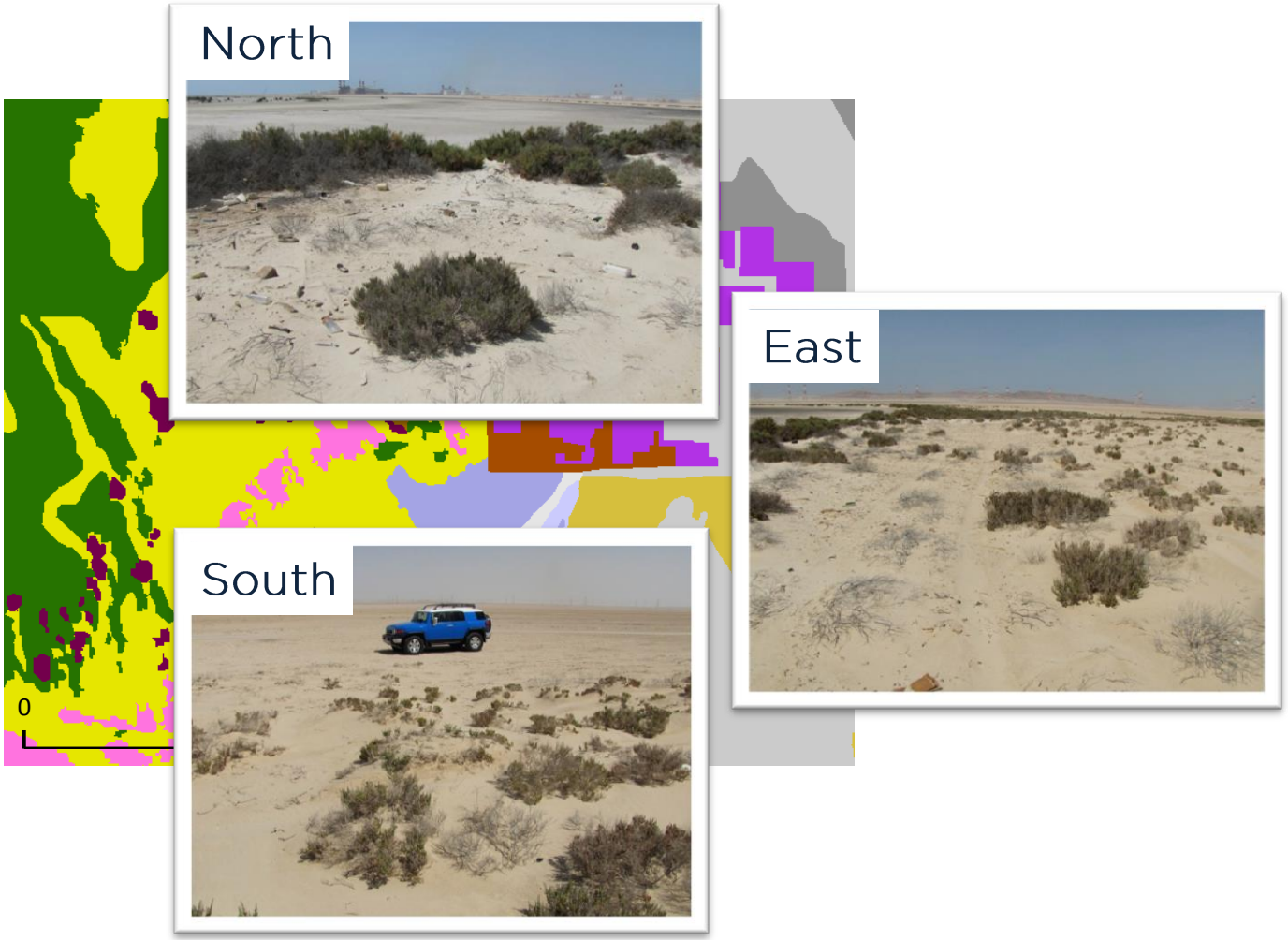

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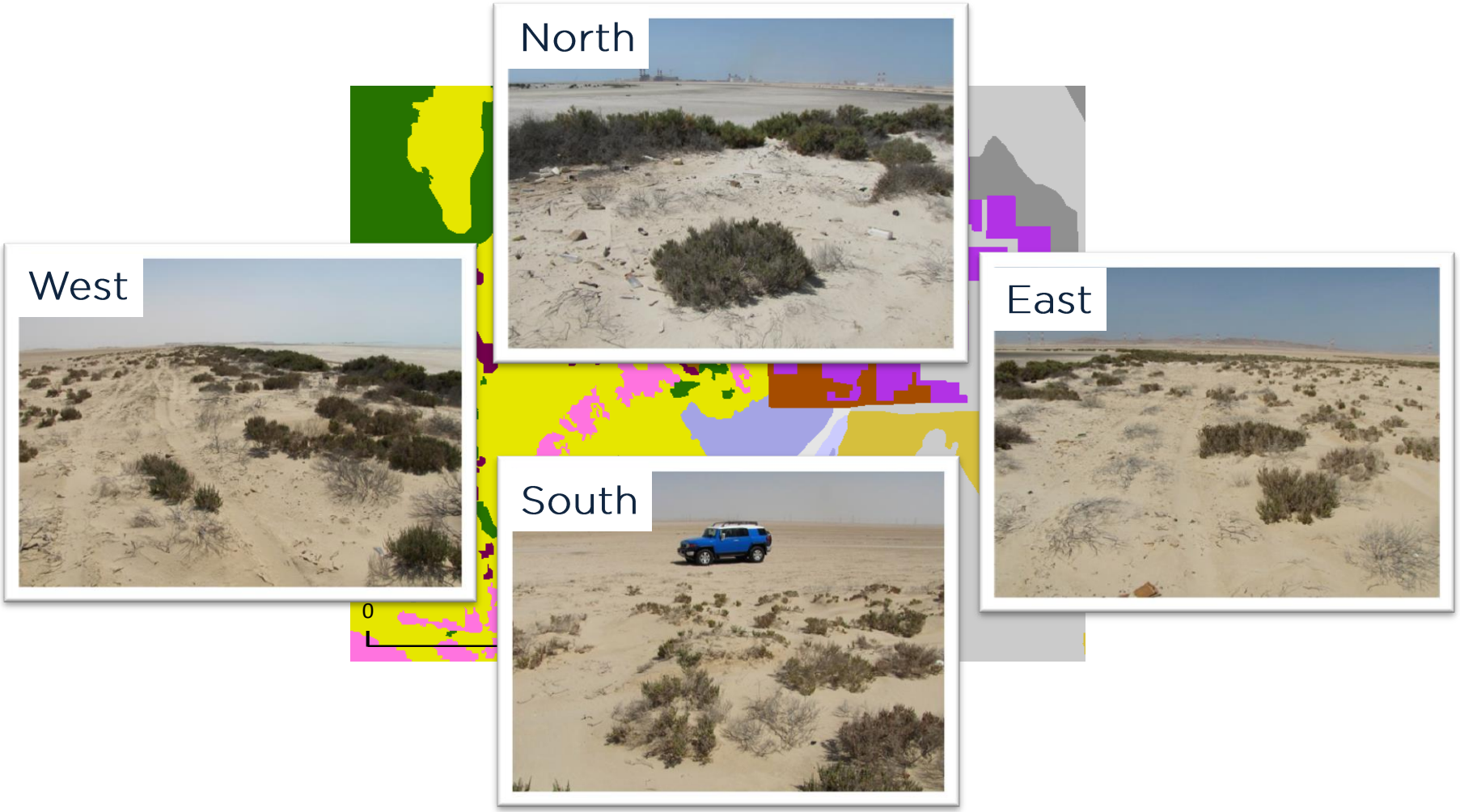

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Outputs: Data and Products

Outputs: Tools for Planning & Guidance

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Outputs: Tools for Planning & Guidance

Decision Making

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Outputs: Tools for Planning & Guidance

Conservation Planning

Decision Making

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Outputs: Tools for Planning & Guidance

Legislation

Conservation Planning

Decision Making

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Outputs: Tools for Planning & Guidance

- Sustainable Development
- Legislation
- Conservation Planning
- Decision Making

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Summary

Consistent

Detailed

Objective

Cost Effective

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Questions?

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