



Pêches et Océans  
Canada

Fisheries and Oceans  
Canada

# Characterization of the sea floor for benthic ecology: what does it means for benthic ecologists.

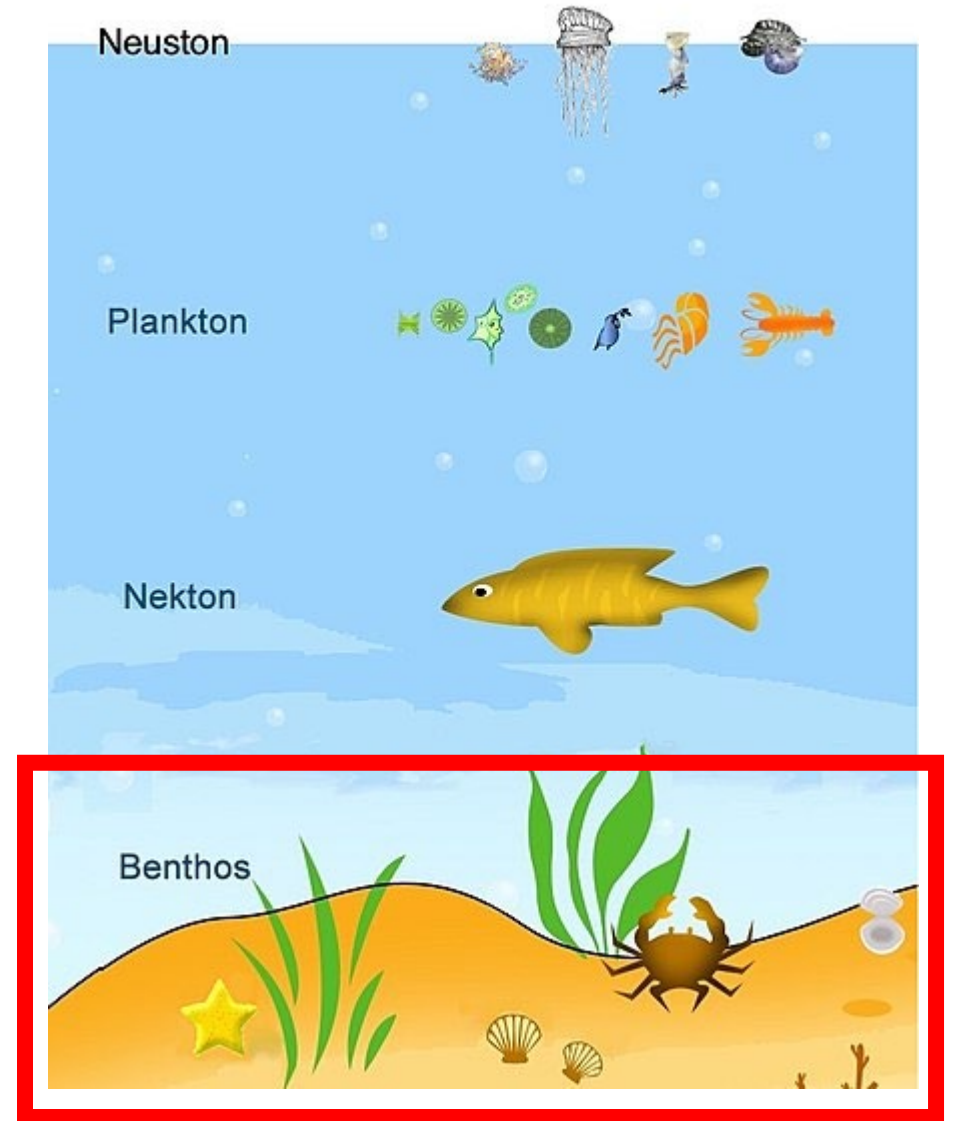
[filippo.ferrario@dfo-mpo.gc.ca](mailto:filippo.ferrario@dfo-mpo.gc.ca)

Filippo Ferrario, Jillian Shao, Kathleen MacGregor,  
Chris Mckindsey, Yanick Gendreau



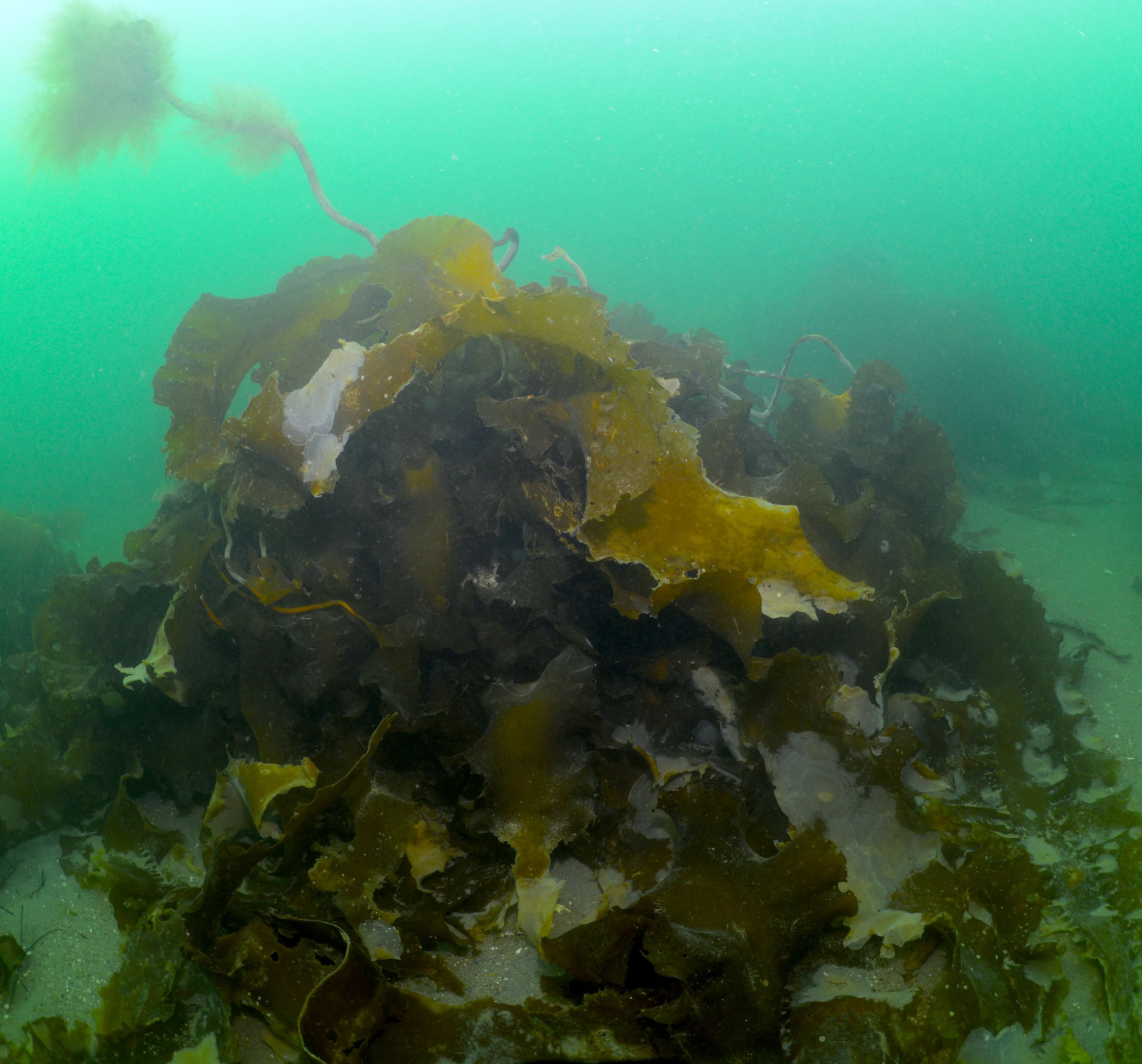
# What do we mean with **Benthos**?

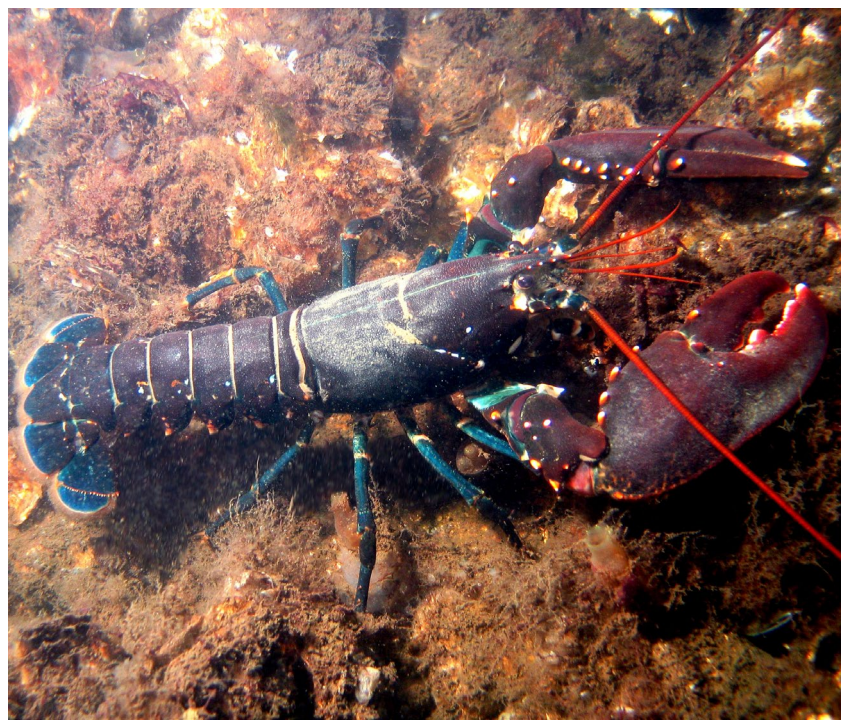
The community of organisms that live on, in, or near the bottom (of a sea, lake...)





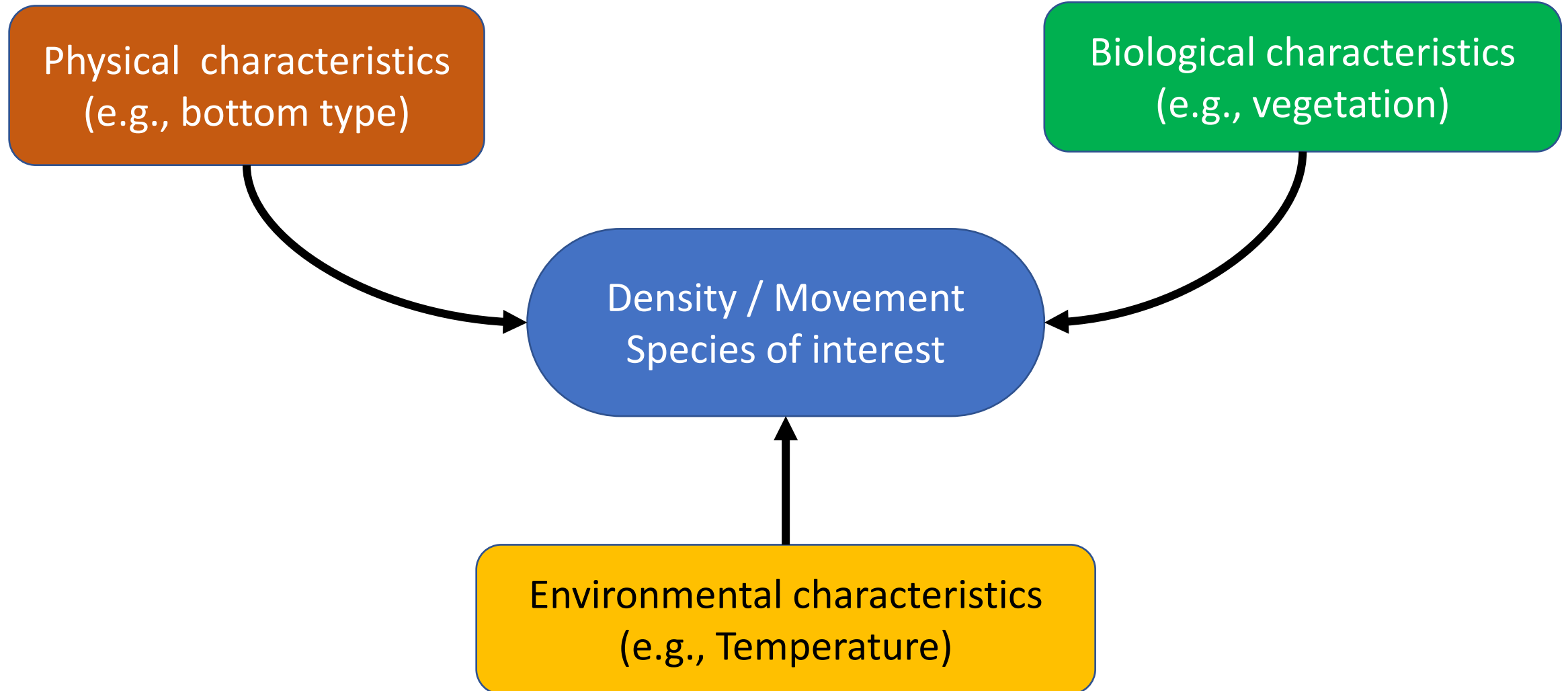






# Studying species distribution and Habitat use

# Studying species distribution and Habitat use





# Studying species distribution and Habitat use

Physical characteristics  
(e.g., bottom type)

Biological characteristics  
(e.g., vegetation)



A spatial issue



Large (potentially)



Movement capabilities



Small

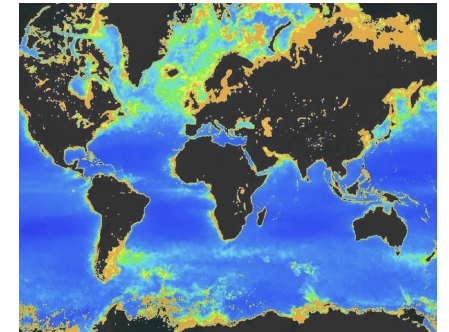
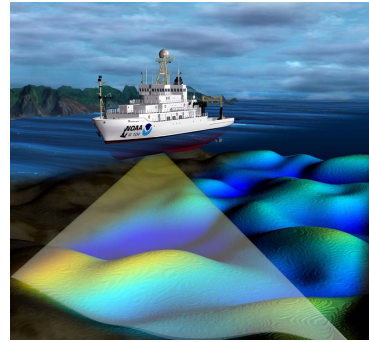
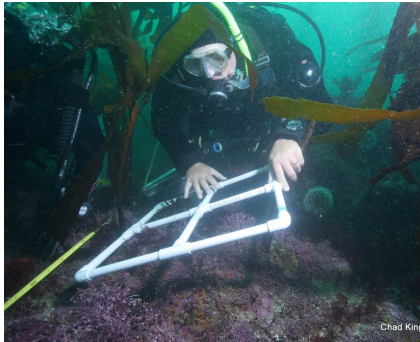


Medium



# Studying species distribution and Habitat use: Scale matters

Habitat Map detail / resolution



10 m

100 m

1 km

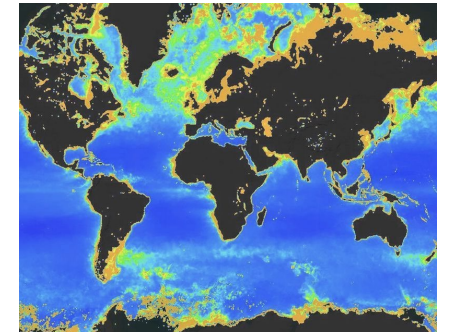
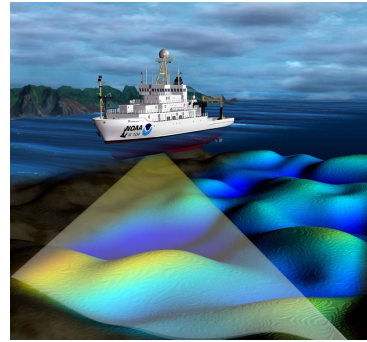
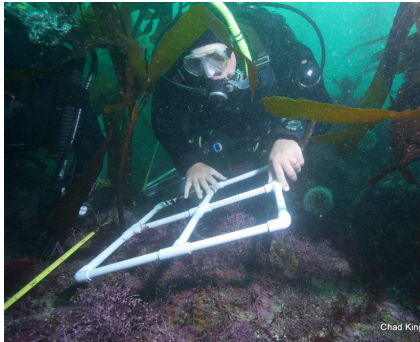
100 km

Scale of movement / of maps



# Studying species distribution and Habitat use: Scale matters

Habitat Map detail / resolution



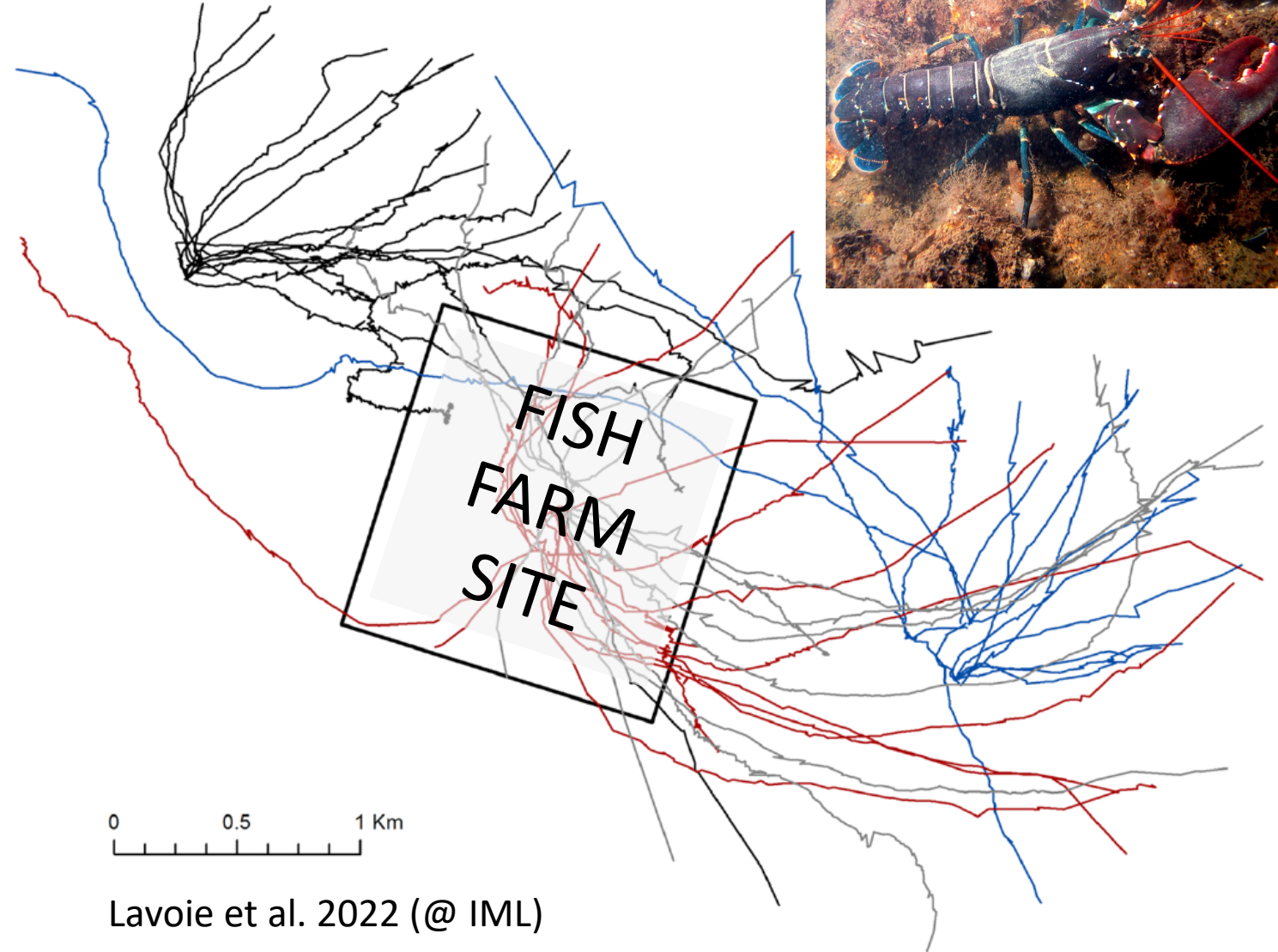
**? MAP AVAILABILITY ?**

# Availability of maps at relevant Scales

Medium Scale

Lobster tracks

Available Habitat Type:  
**In vs Out**  
the farm

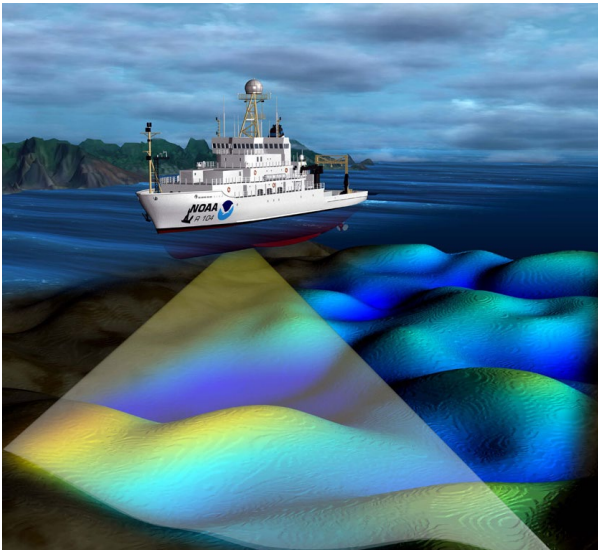


Lavoie et al. 2022 (@ IML)

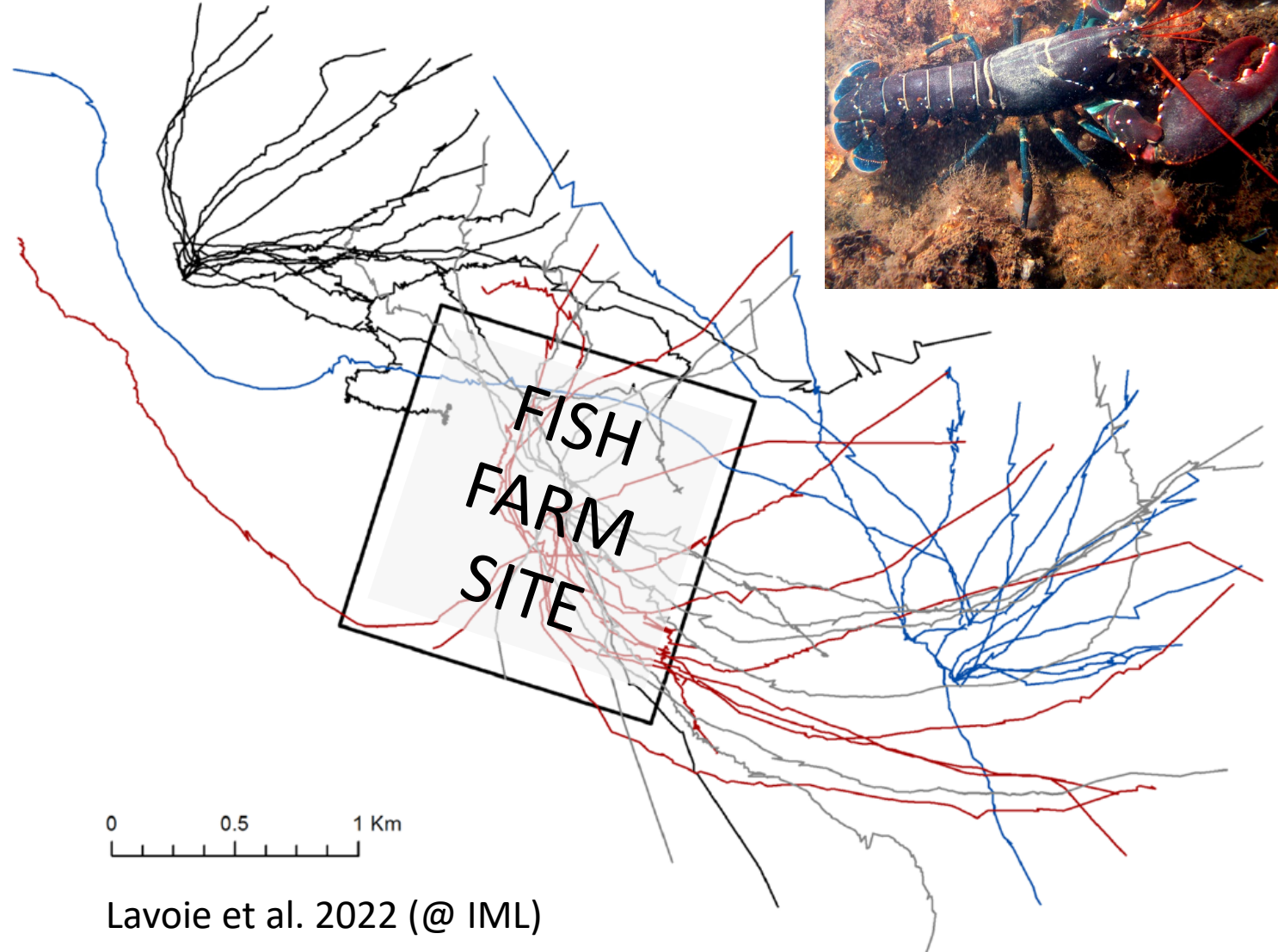
# Availability of maps at relevant Scales

## Medium Scale

- Desired habitat characteristic :**
- Sea floor (e.g., Depth, Slope, Substrate Classification, ...)

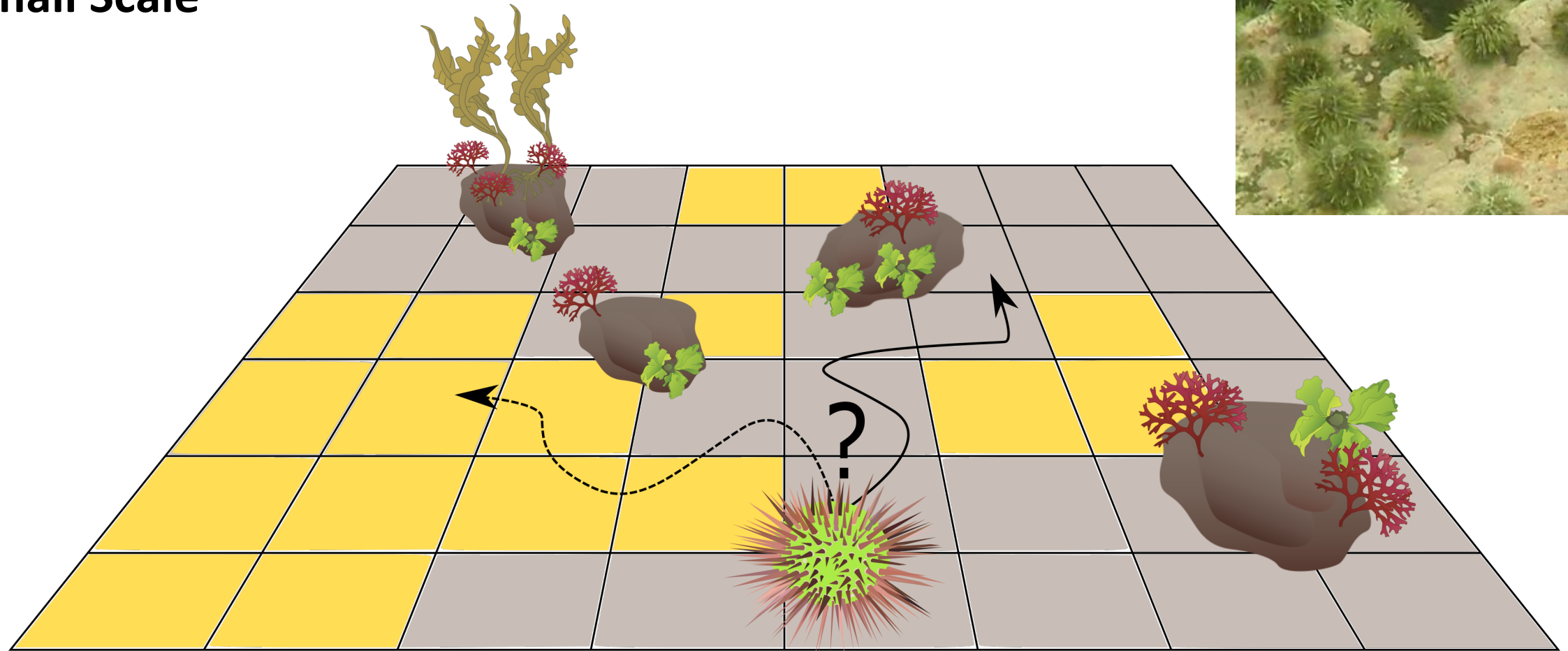


Lobster tracks



# Green sea urchin's habitat use in heterogeneous habitats

## Small Scale



# Spatial point patterns analysis

Distribution as proxy for movement





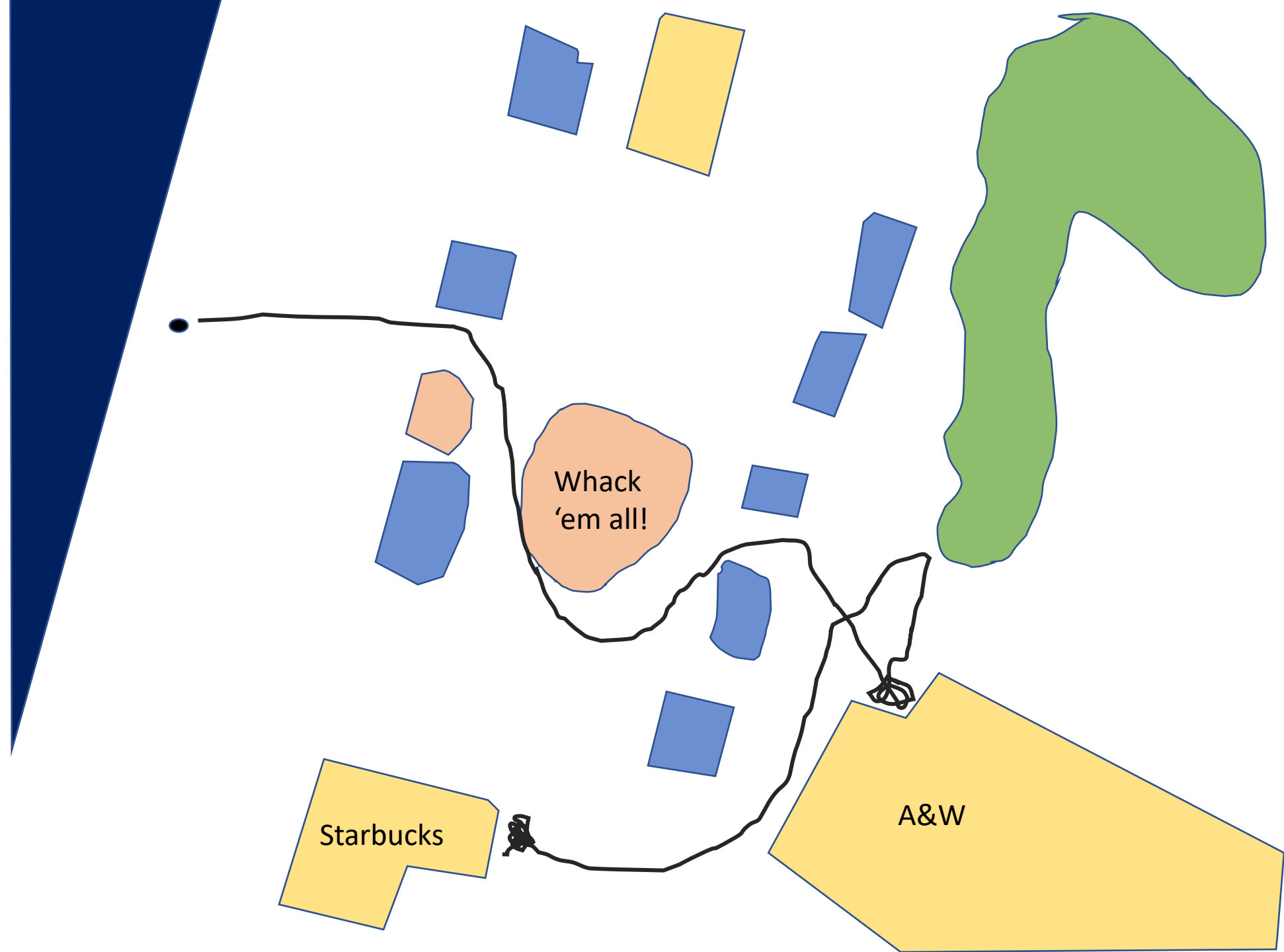
Spatial point patterns analysis

Distribution as proxy for movement



Acoustic  
Telemetry

Movement  
tracks related to  
landscape

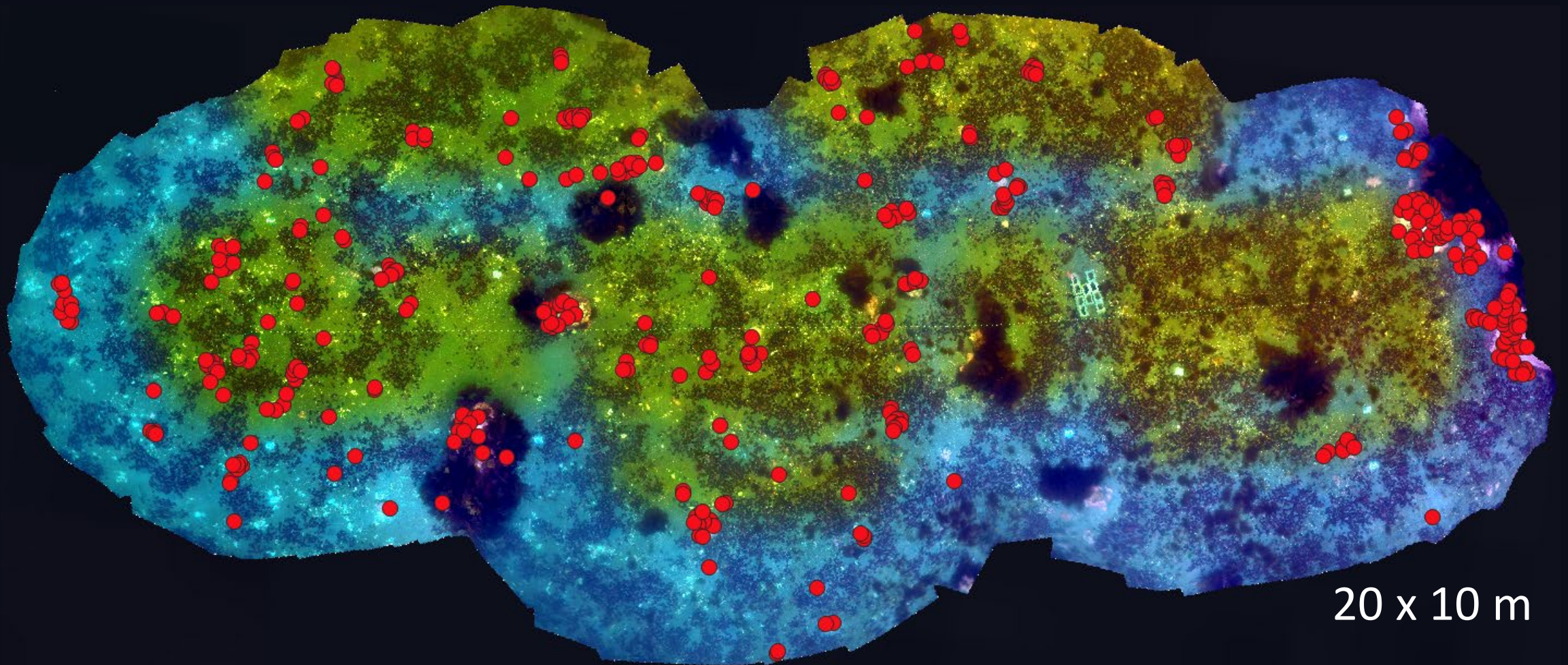


# Underwater photomosaics



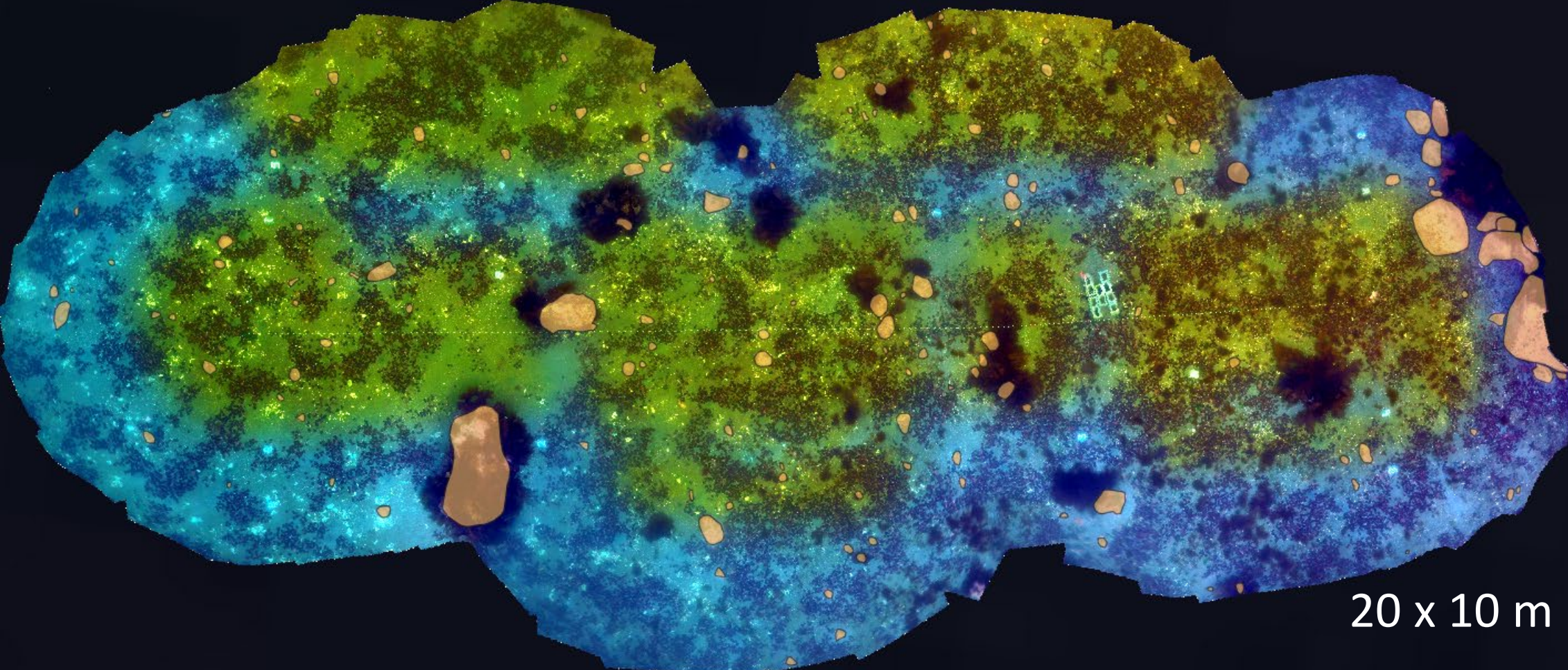
Data rich imagery

Green sea urchin



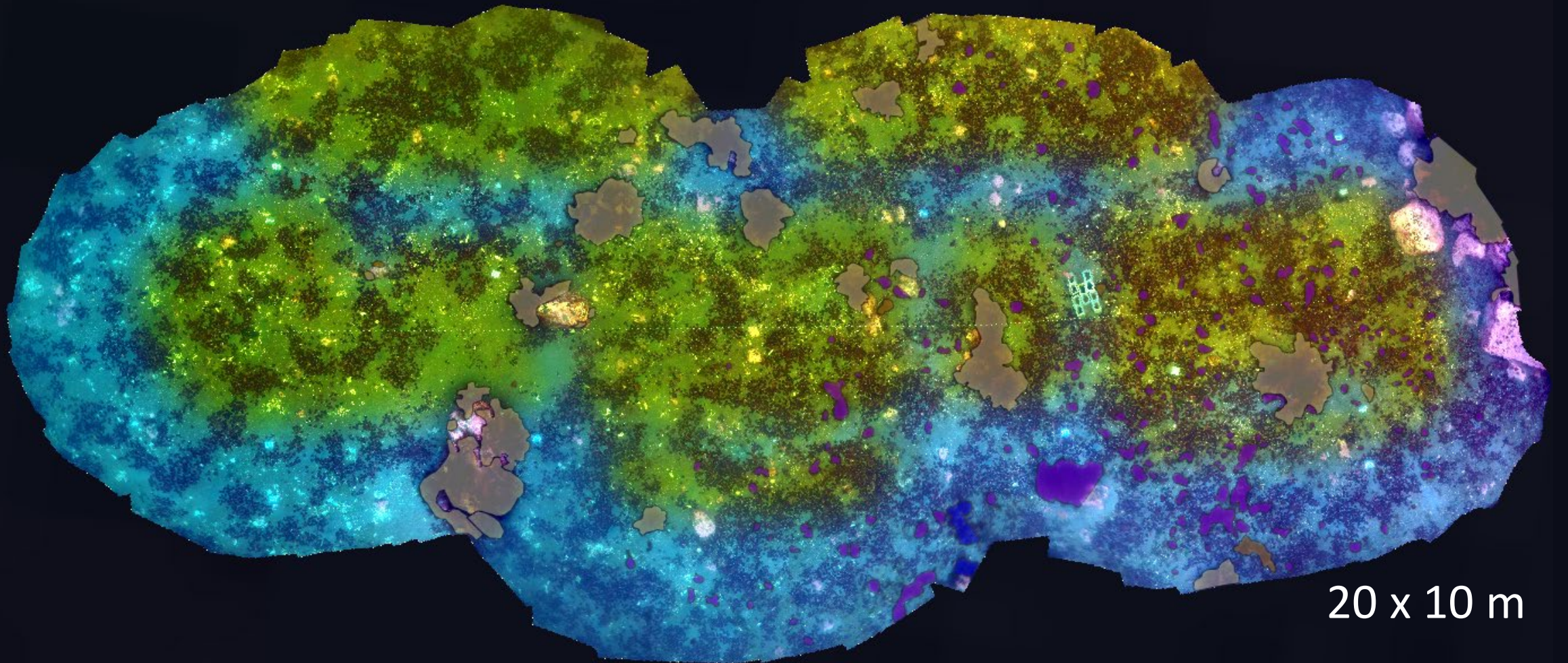
Data rich imagery

Rocks



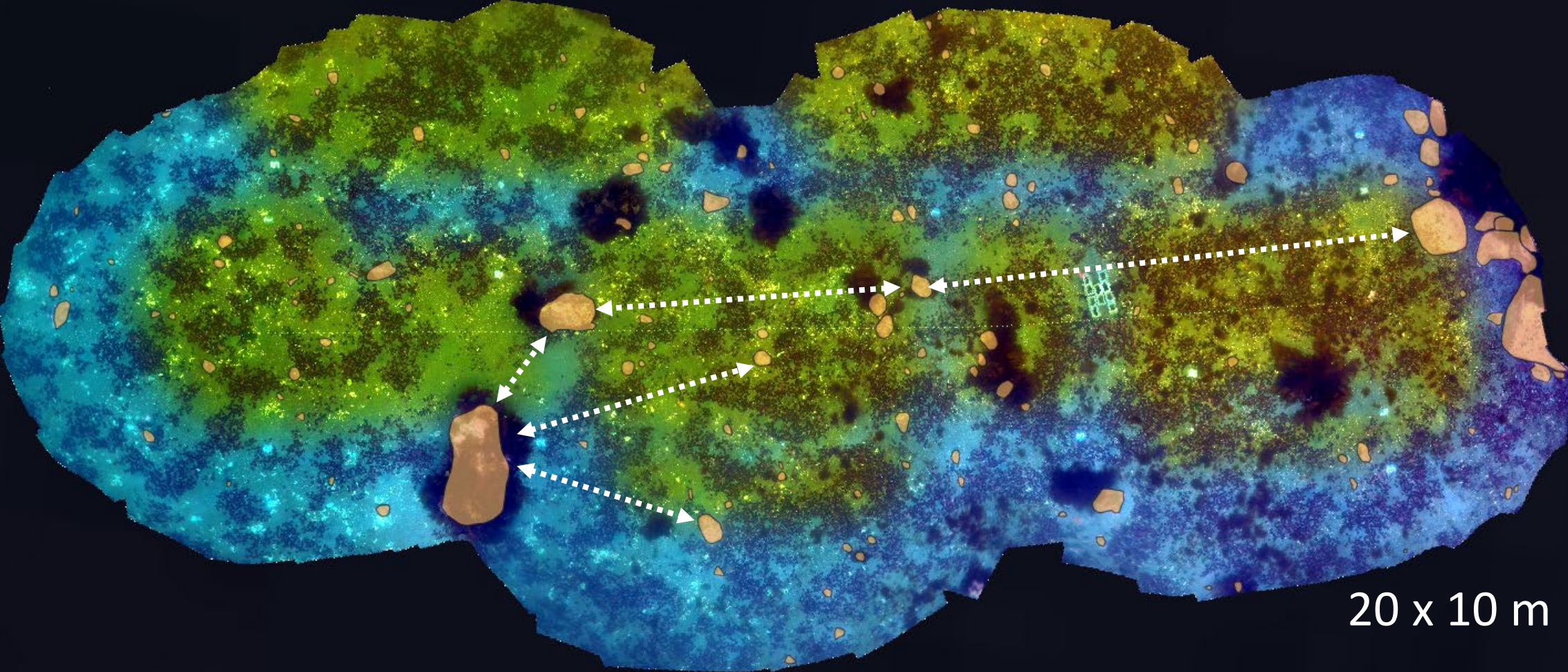
Data rich imagery

Macroalgae



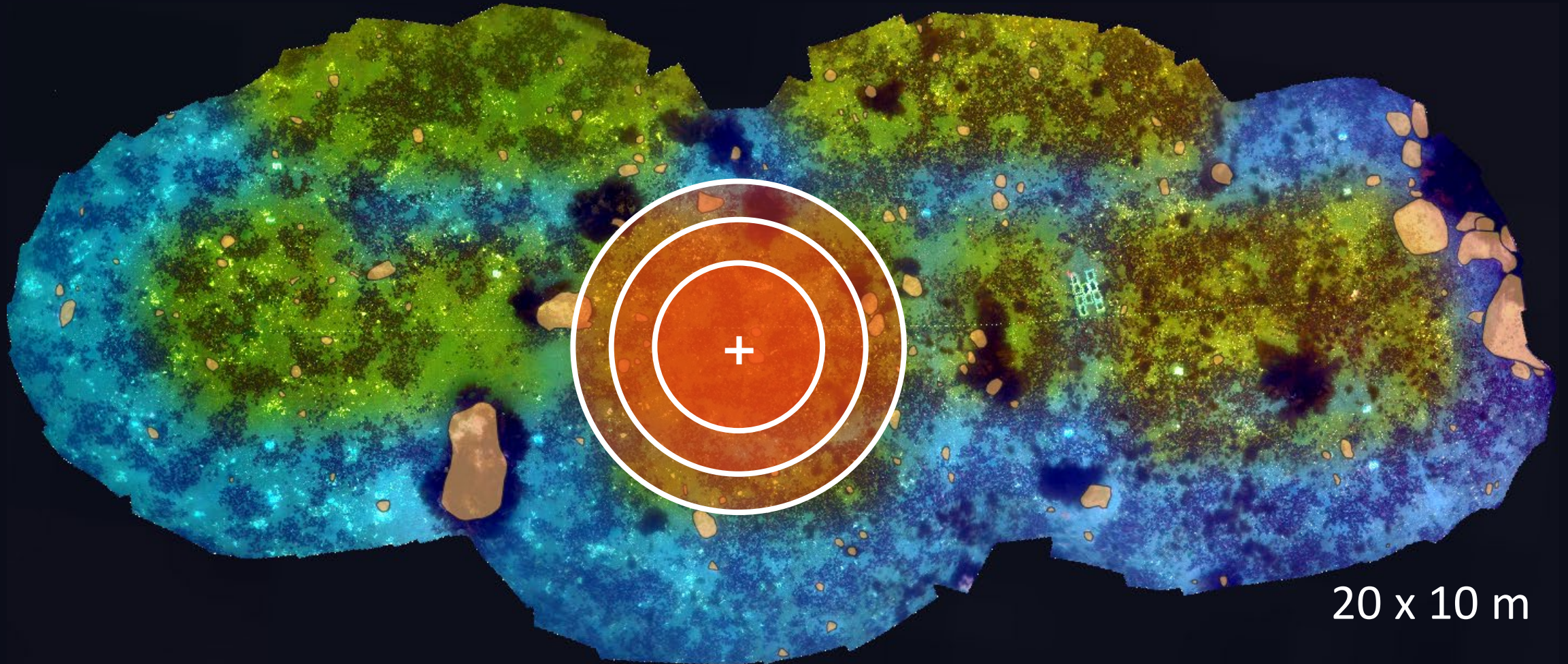
Data rich imagery

Distances



Data rich imagery

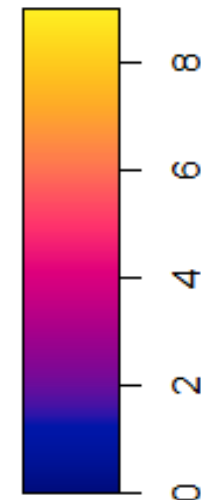
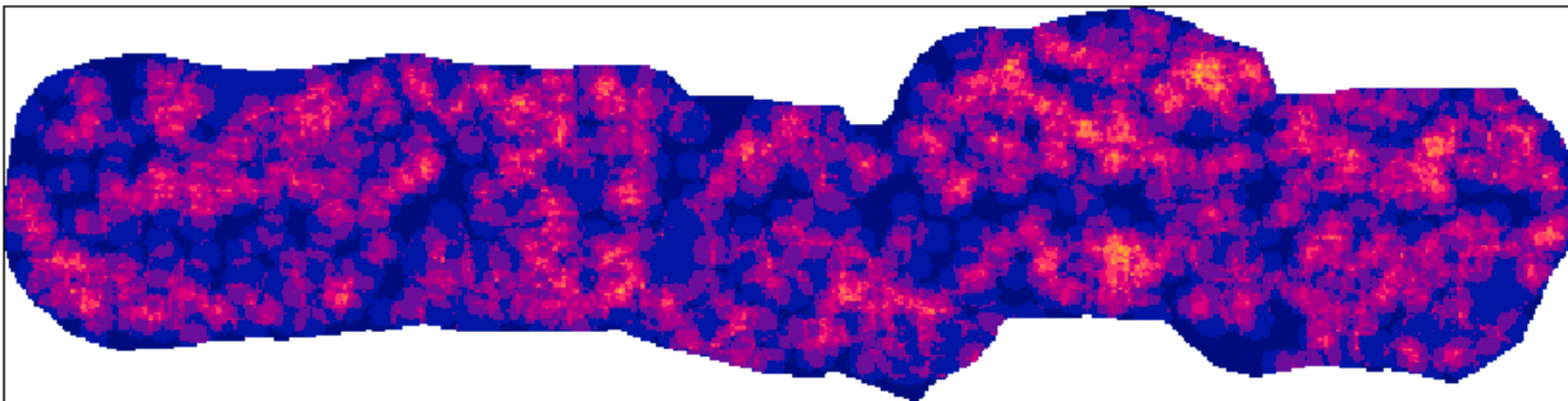
Other spatial metrics (e.g., buffers)



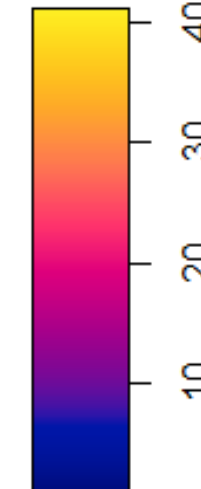
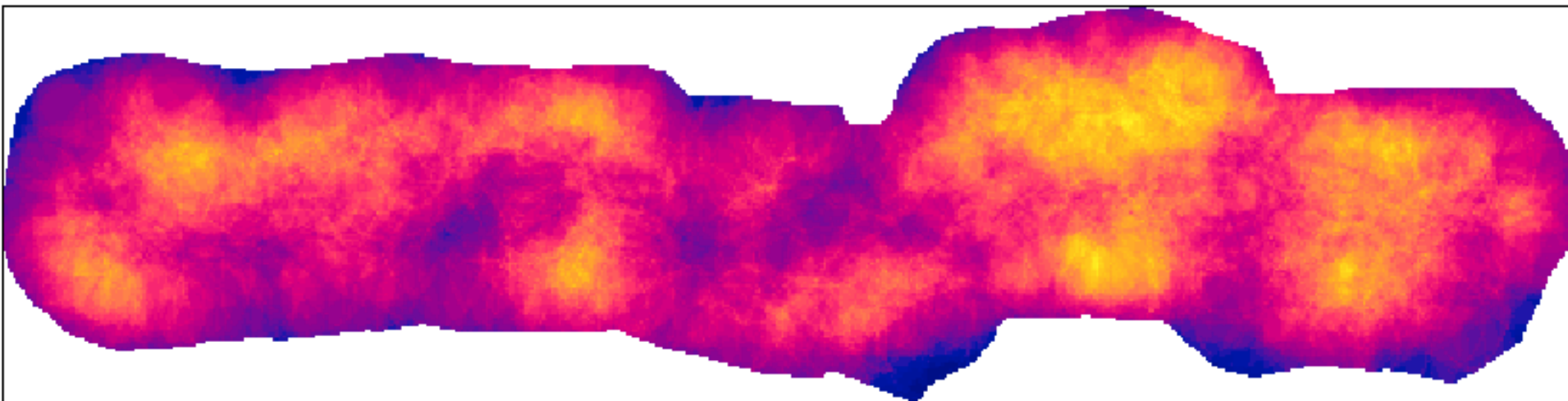


Example : Number of rock patches within buffer of

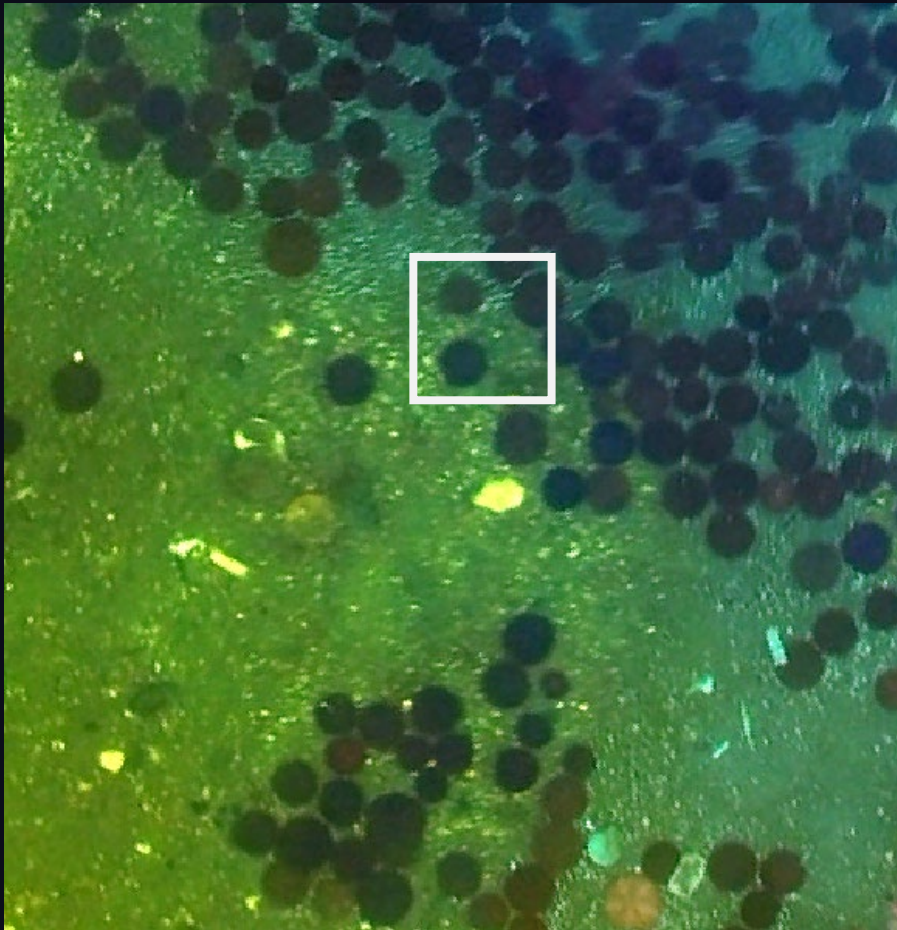
0.5 m



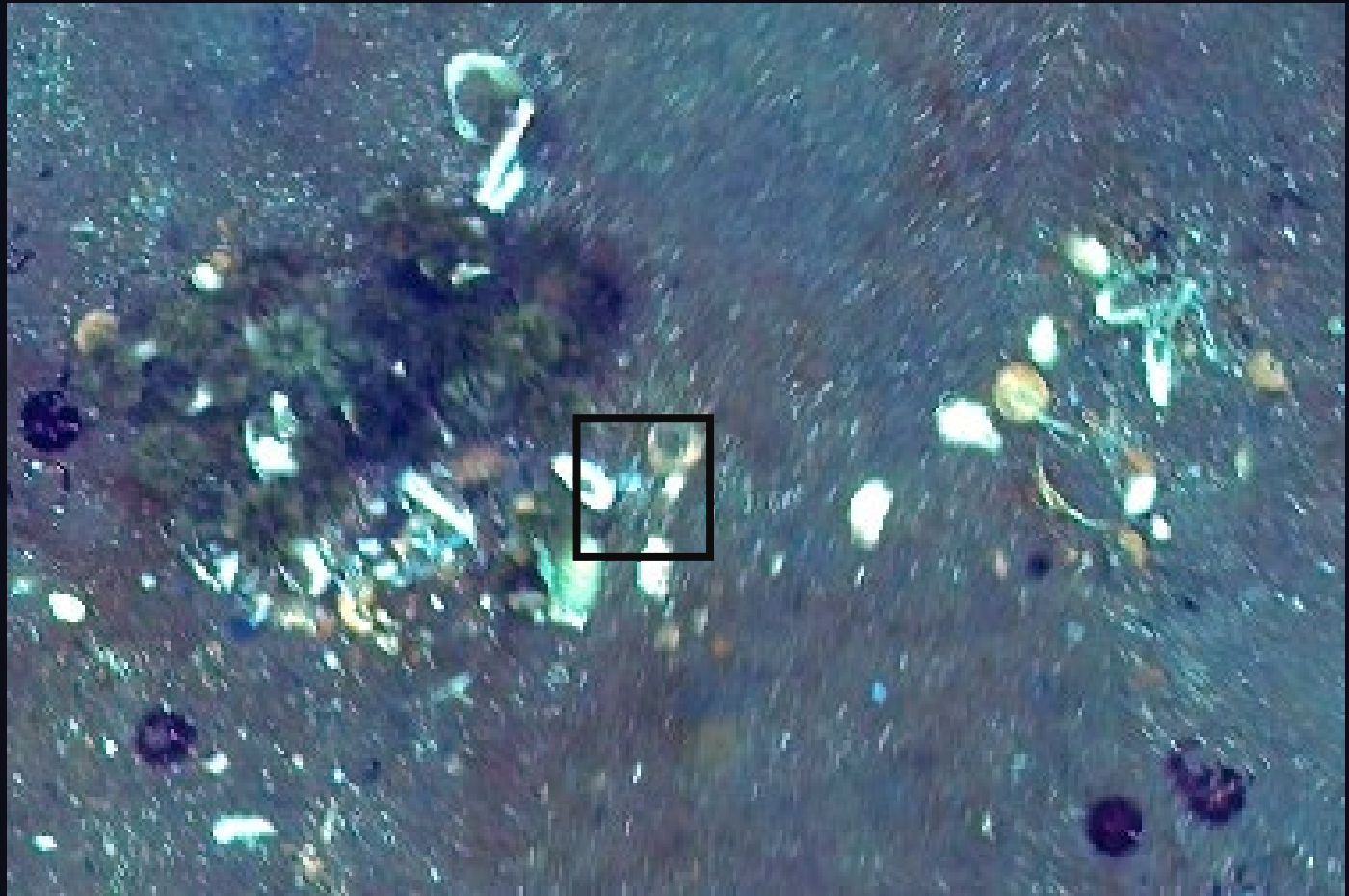
2.0 m



## Predictor variables

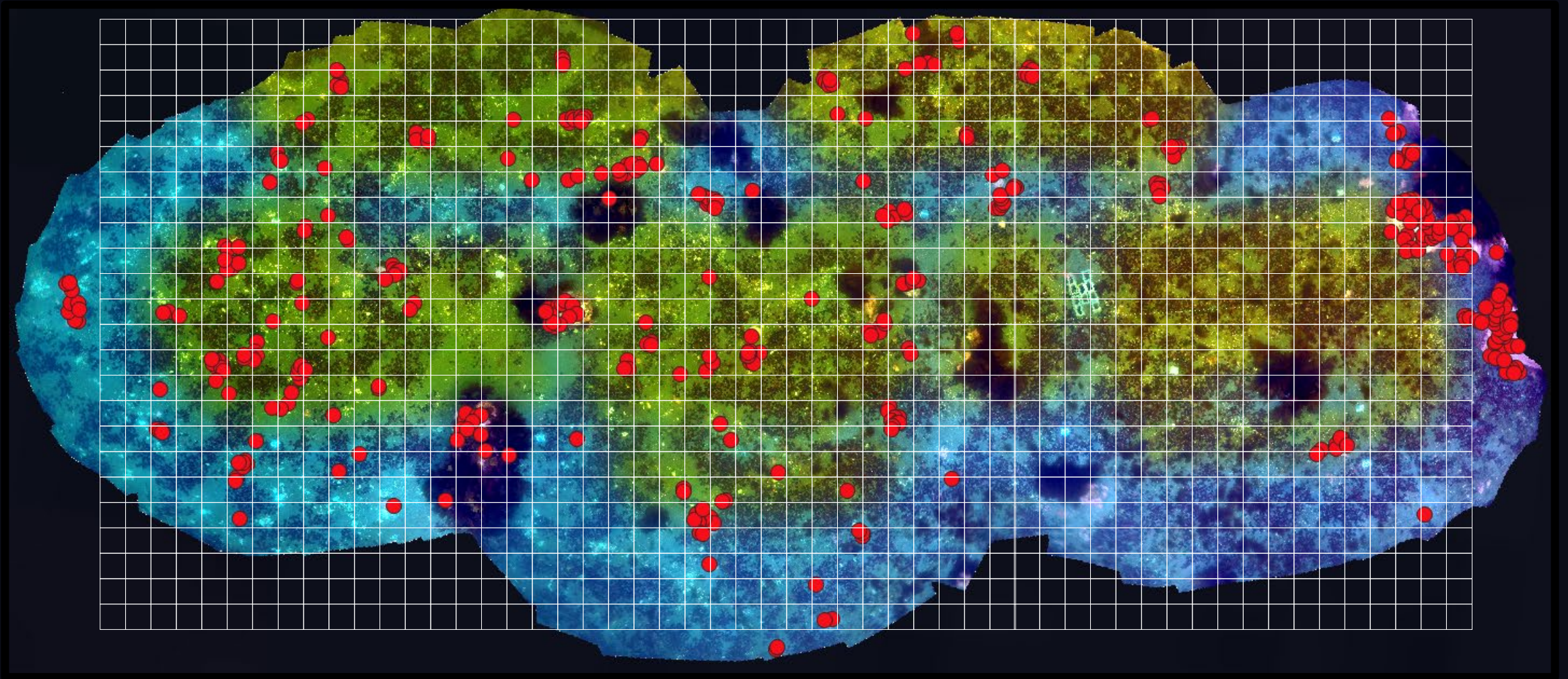


Sand dollars  
density (biotic)



Dead shells  
density (abiotic)

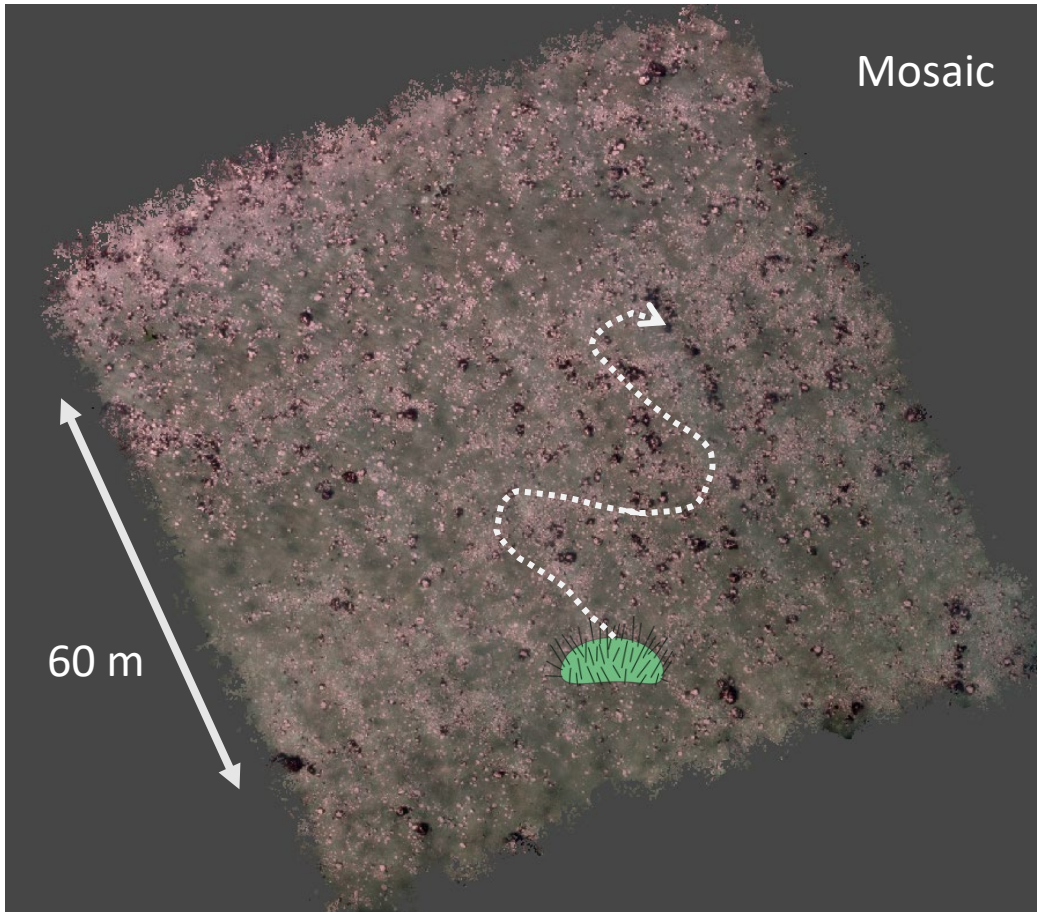
Features in a mosaic converted in rasters of variables (densities; % covers)



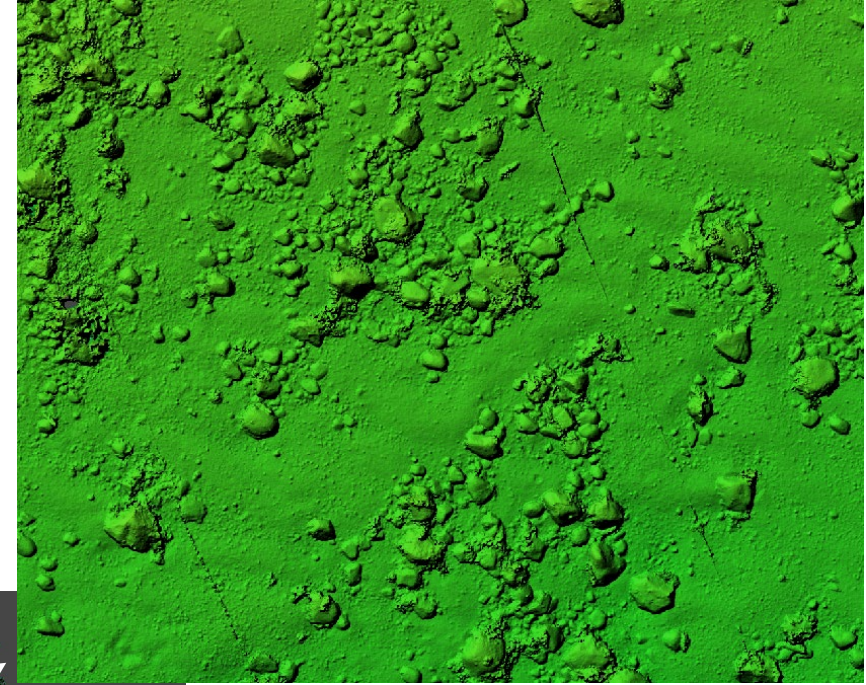
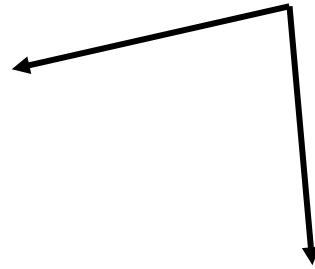
Green sea urchin points → density per pixel

# Benthic invertebrates habitat use ... Acoustic telemetry

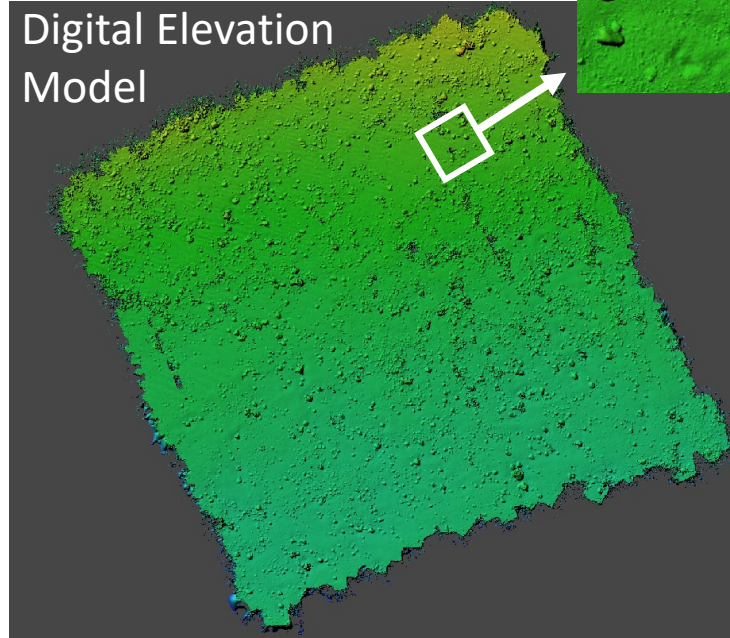
Combine acoustic telemetry with habitat mapping from photomosaicing



Underwater photos



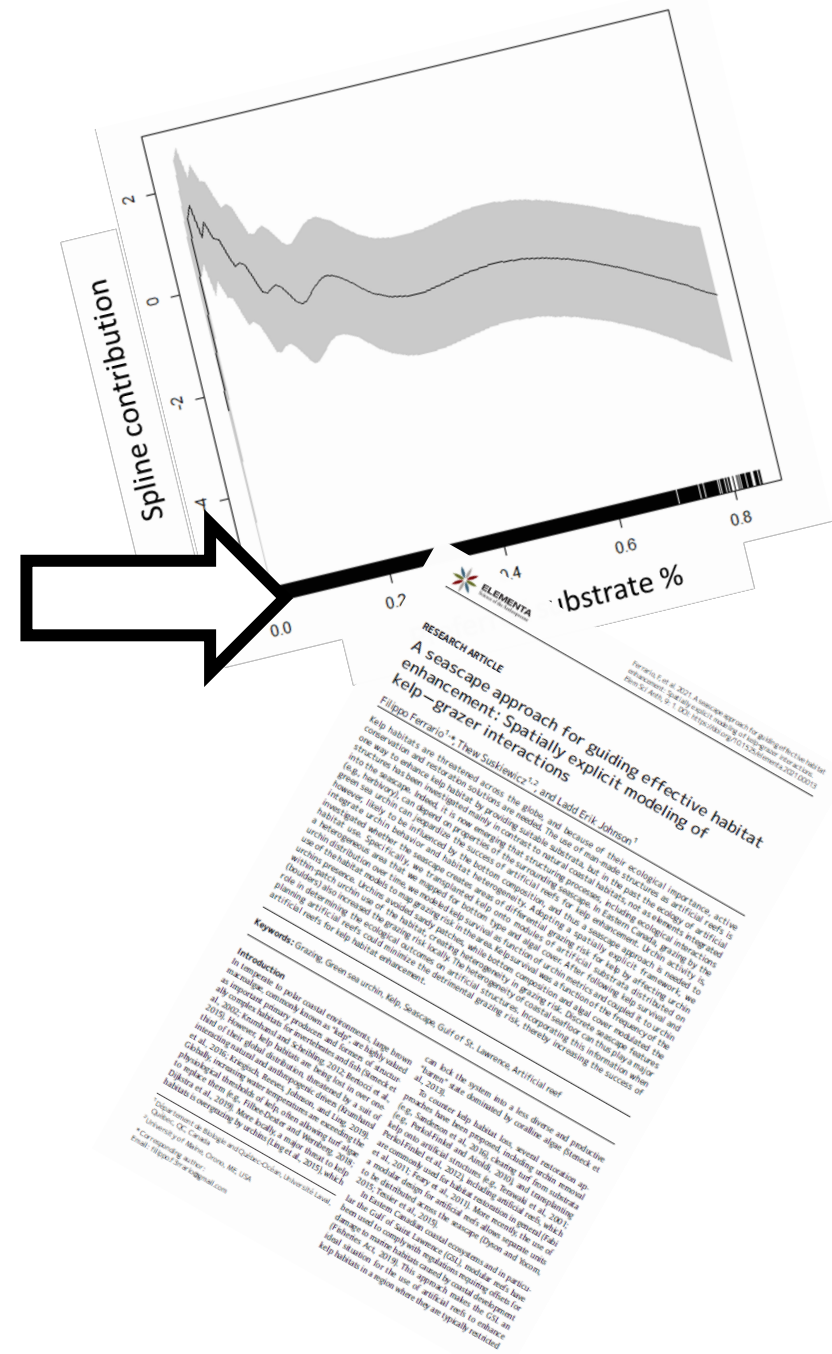
Digital Elevation Model



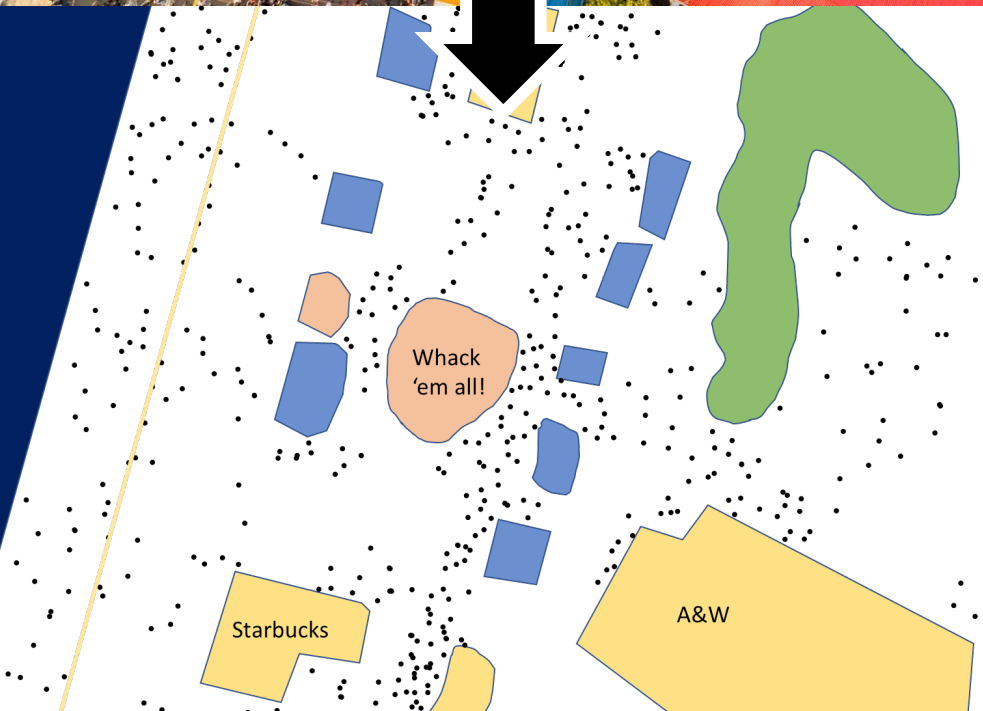
Structural complexity



# Data Extraction



# Data Extraction



# Data Extraction

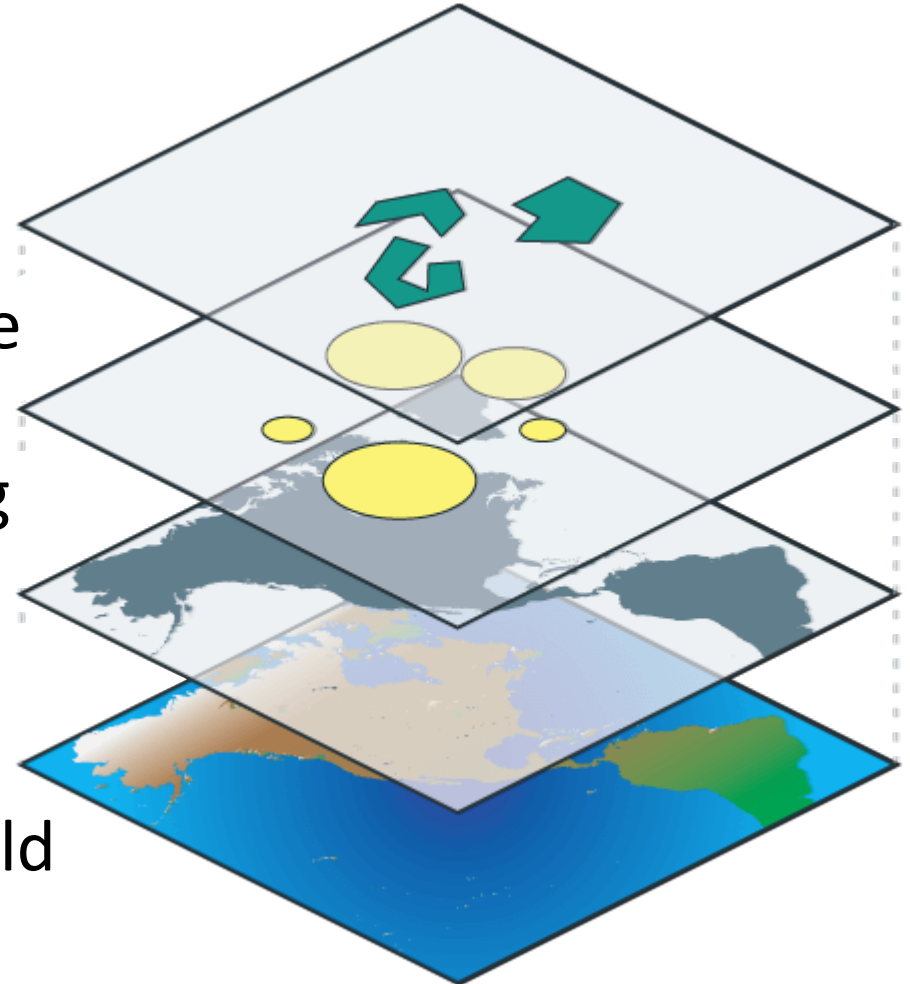


Species

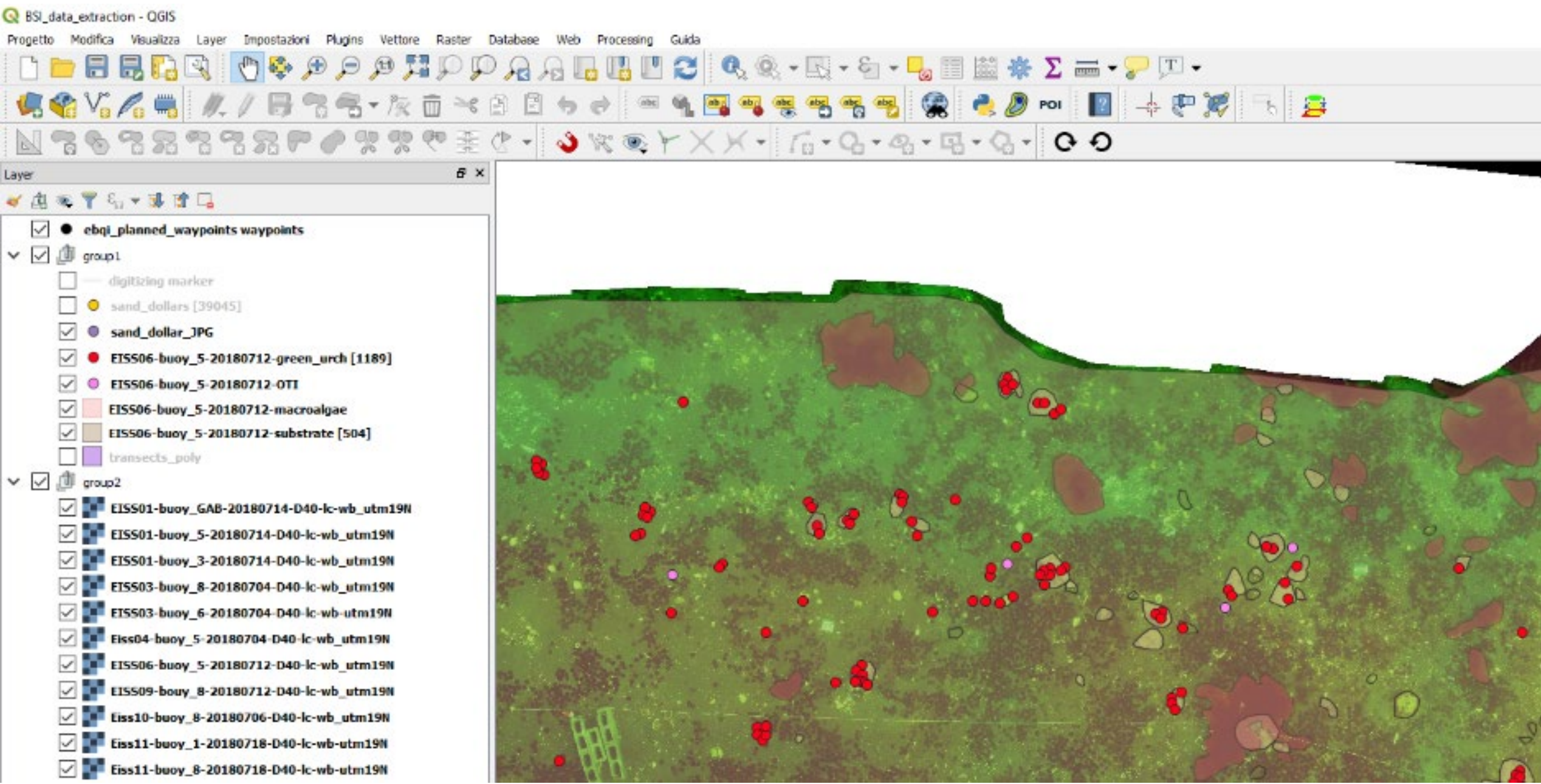
Substrate

Sampling  
area

Real world



# DATA EXTRACTION Manual in a GIS environment



The image shows a screenshot of the QGIS desktop environment. The title bar reads "BSI\_data\_extraction - QGIS". The menu bar includes "Progetto", "Modifica", "Visualizza", "Layer", "Impostazioni", "Plugins", "Vettore", "Raster", "Database", "Web", "Processing", and "Guida". The toolbar contains various icons for navigation, editing, and analysis. The "Layer" panel on the left lists the following layers:

- ebqi\_planned\_waypoints waypoints
- group1
  - digitizing marker
  - sand\_dollars [39045]
  - sand\_dollar\_JPG
  - EISS06-buoy\_5-20180712-green\_urch [1189]
  - EISS06-buoy\_5-20180712-OTT
  - EISS06-buoy\_5-20180712-macroalgae
  - EISS06-buoy\_5-20180712-substrate [504]
  - transects\_poly
- group2
  - EISS01-buoy\_GAB-20180714-D40-lc-wb\_utm19N
  - EISS01-buoy\_5-20180714-D40-lc-wb\_utm19N
  - EISS01-buoy\_3-20180714-D40-lc-wb\_utm19N
  - EISS03-buoy\_8-20180704-D40-lc-wb\_utm19N
  - EISS03-buoy\_6-20180704-D40-lc-wb\_utm19N
  - EISS04-buoy\_5-20180704-D40-lc-wb\_utm19N
  - EISS06-buoy\_5-20180712-D40-lc-wb\_utm19N
  - EISS09-buoy\_8-20180712-D40-lc-wb\_utm19N
  - EISS10-buoy\_8-20180706-D40-lc-wb\_utm19N
  - EISS11-buoy\_1-20180718-D40-lc-wb\_utm19N
  - EISS11-buoy\_8-20180718-D40-lc-wb\_utm19N

The main map area displays a satellite-style background with several data layers overlaid. Red dots represent planned waypoints, and various colored polygons represent different substrate types and macroalgae. The map shows a coastal area with a greenish-brown background and several brownish patches.



# Polygons

- Substrate & Seaweeds
- Position, size & shape



# Points

- Animal species
- Only position



Points

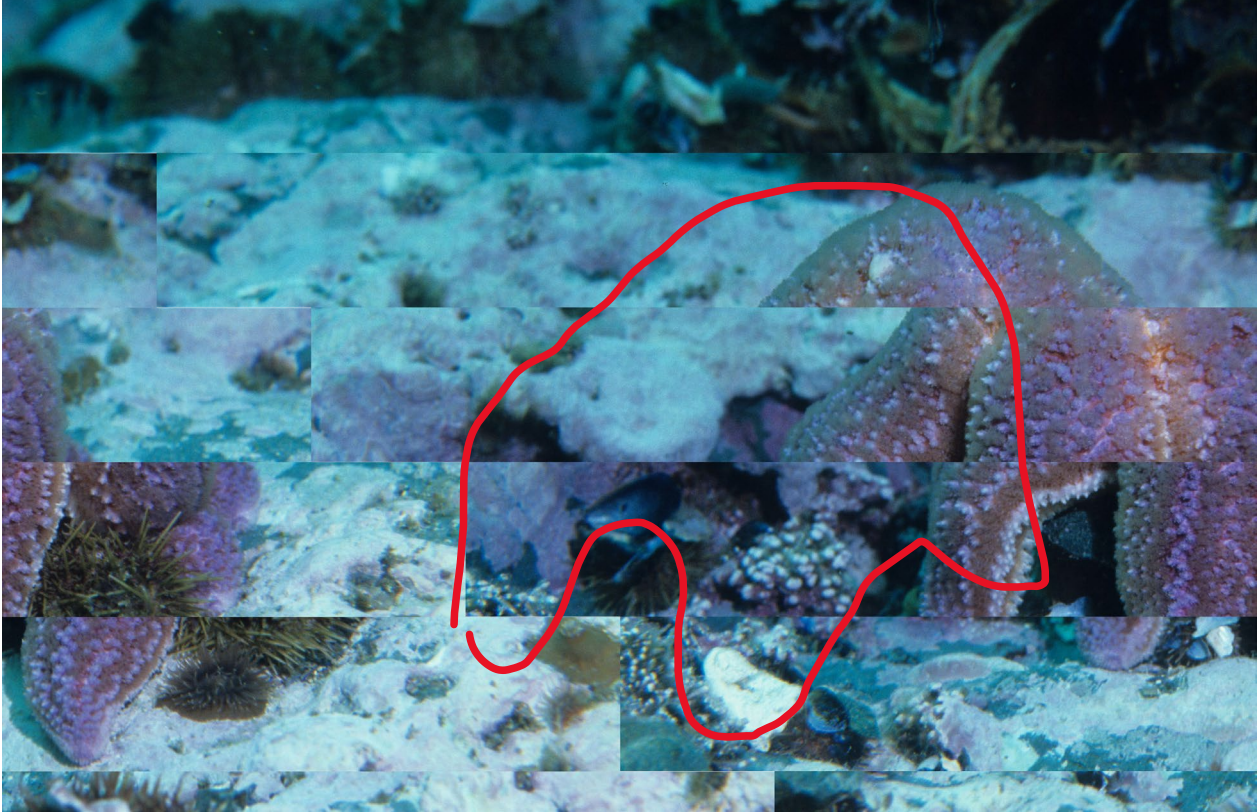


Polygons



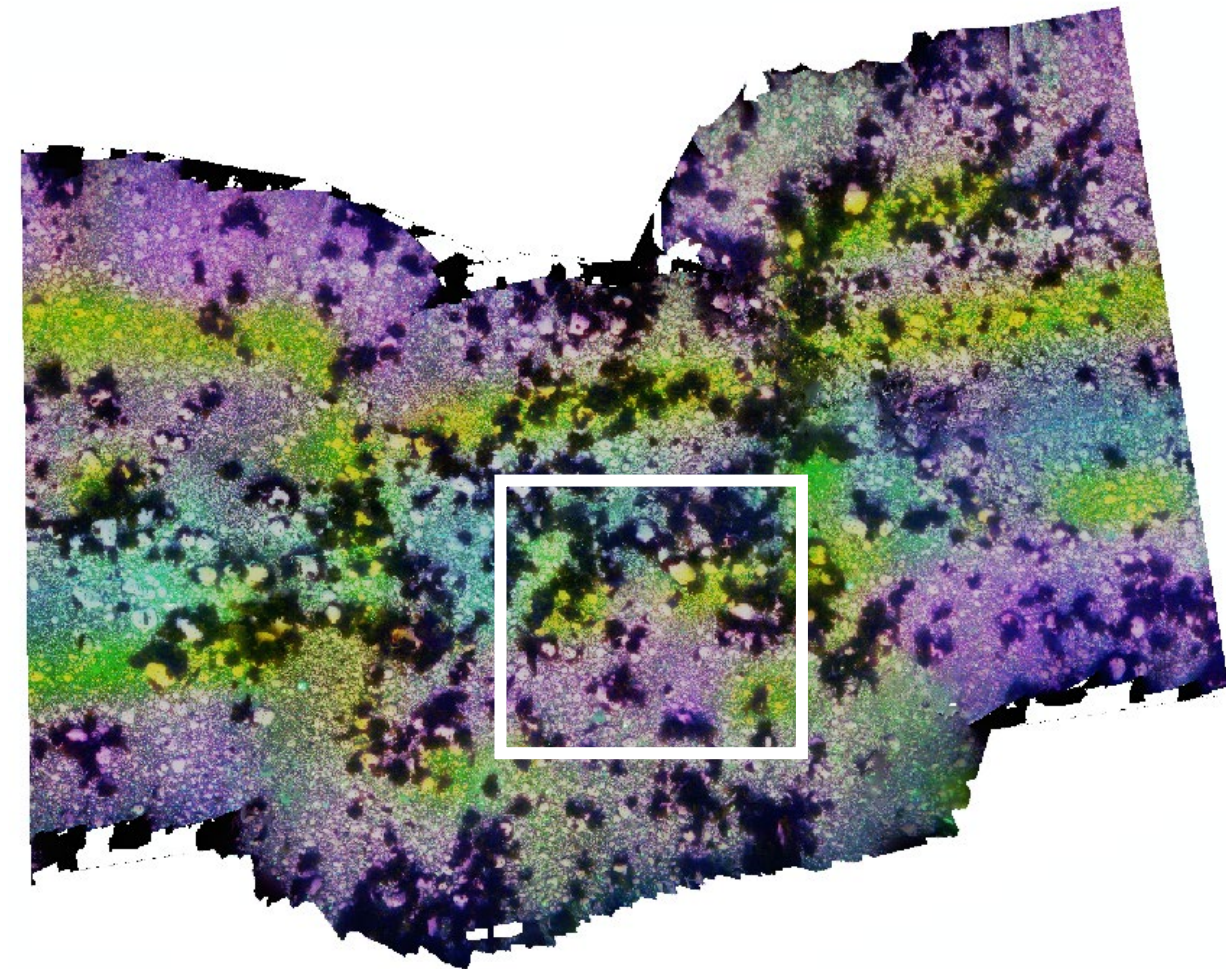
**Animals are not points!**

Polygon => Shape => Behavior (e.g., feeding), Size,...

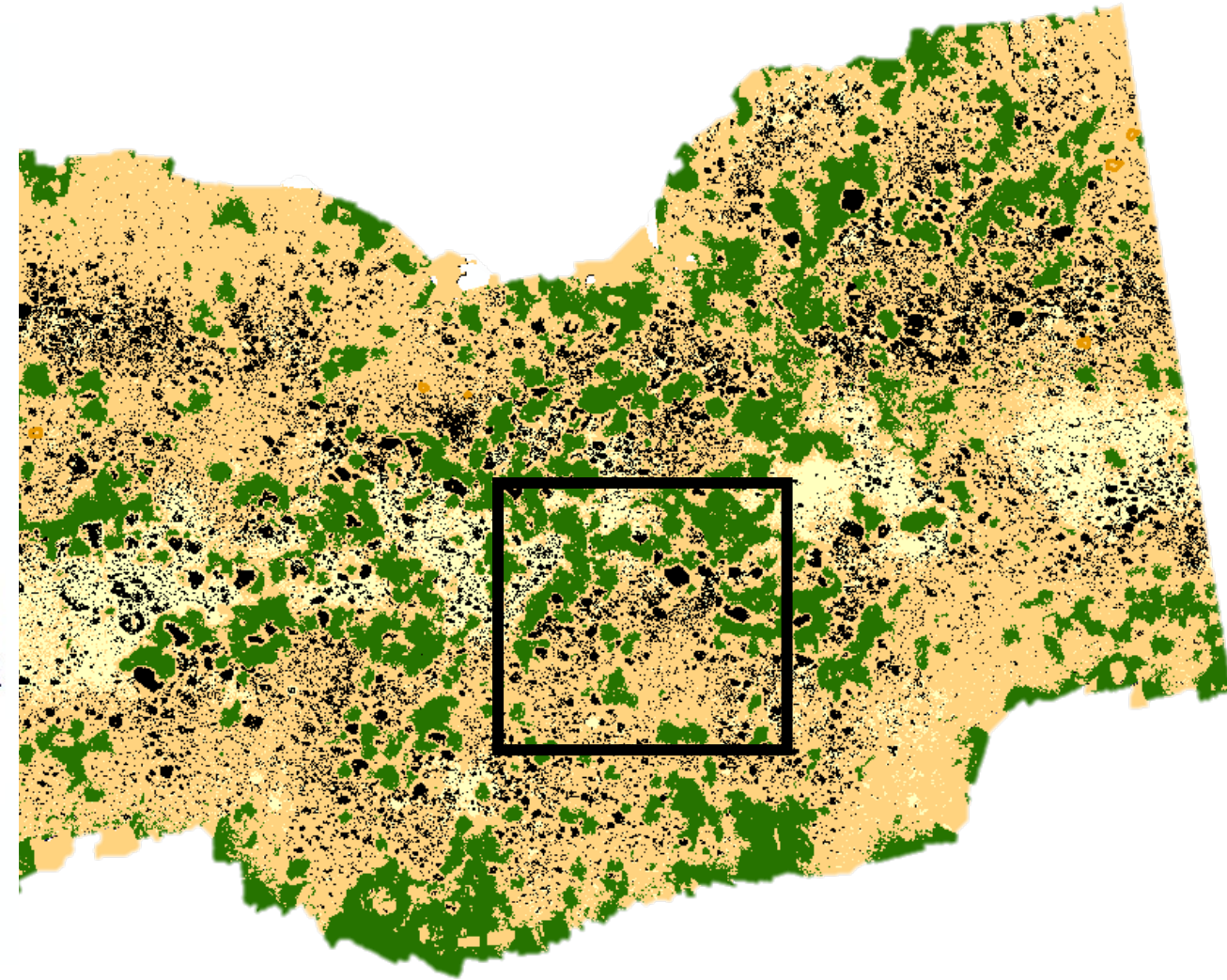


# Moving towards computer vision & Machine Learning

Pixel Classification  
supervised - Maximum likelihood



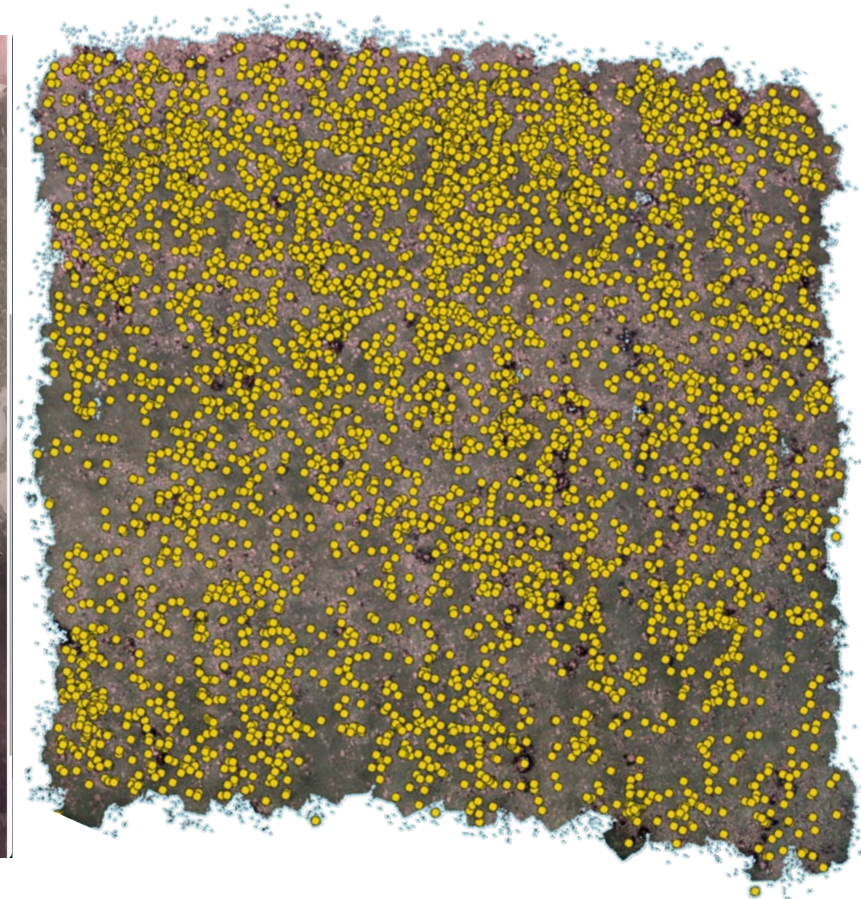
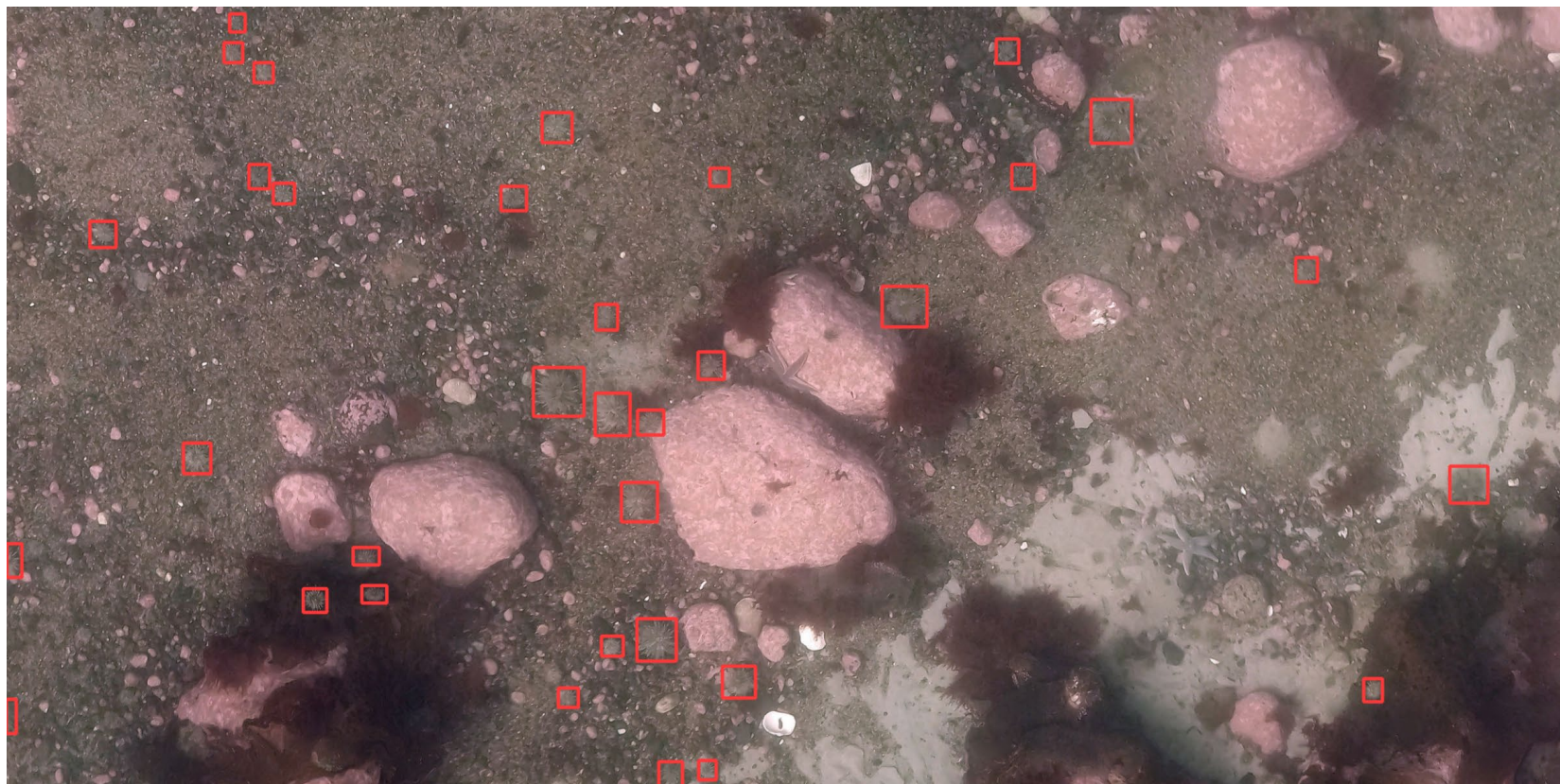
ArcMap - PCI Geomatica – Ecognition



# Moving towards computer vision & Machine Learning

Collaboration with CIDCO

Machine Learning model to identify Sea Urchins on photomosaics



# Moving towards computer vision & Machine Learning

ML model for individuals

Species

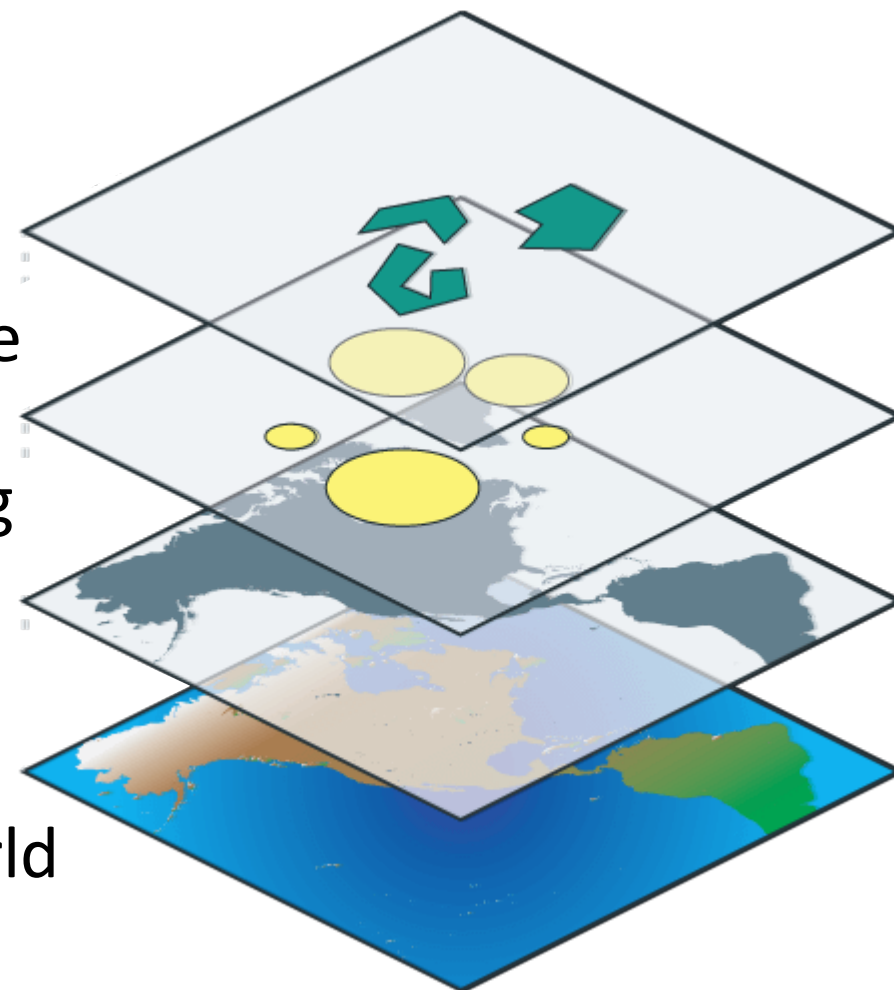
ML model for substrate

Substrate

Sampling area

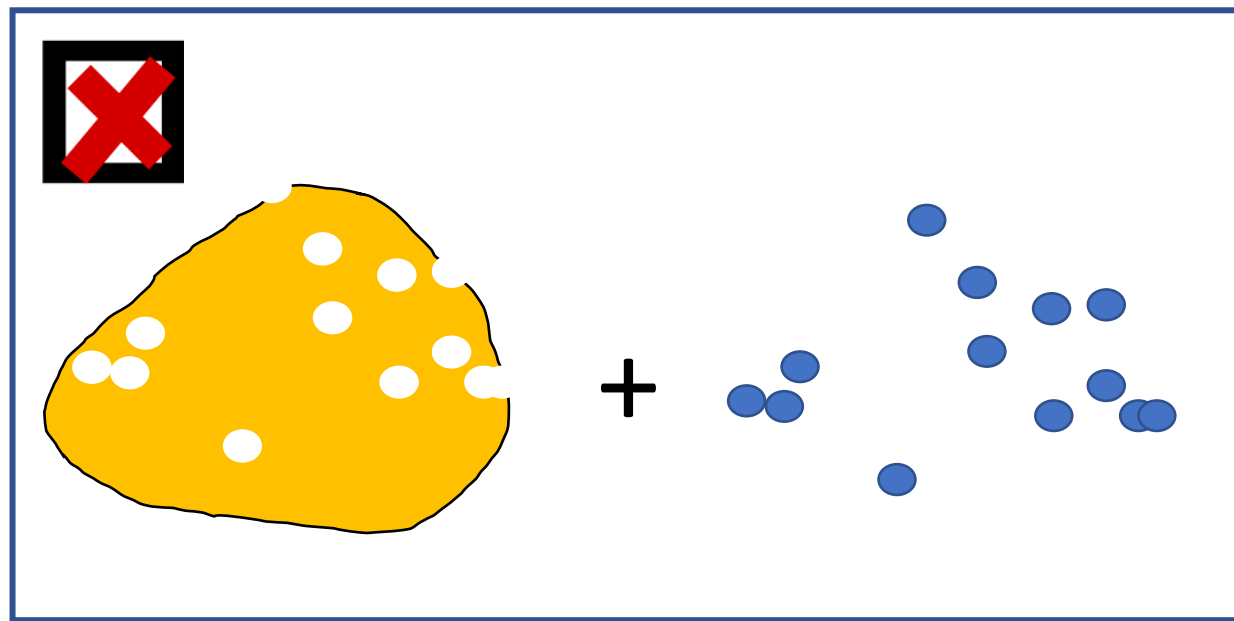
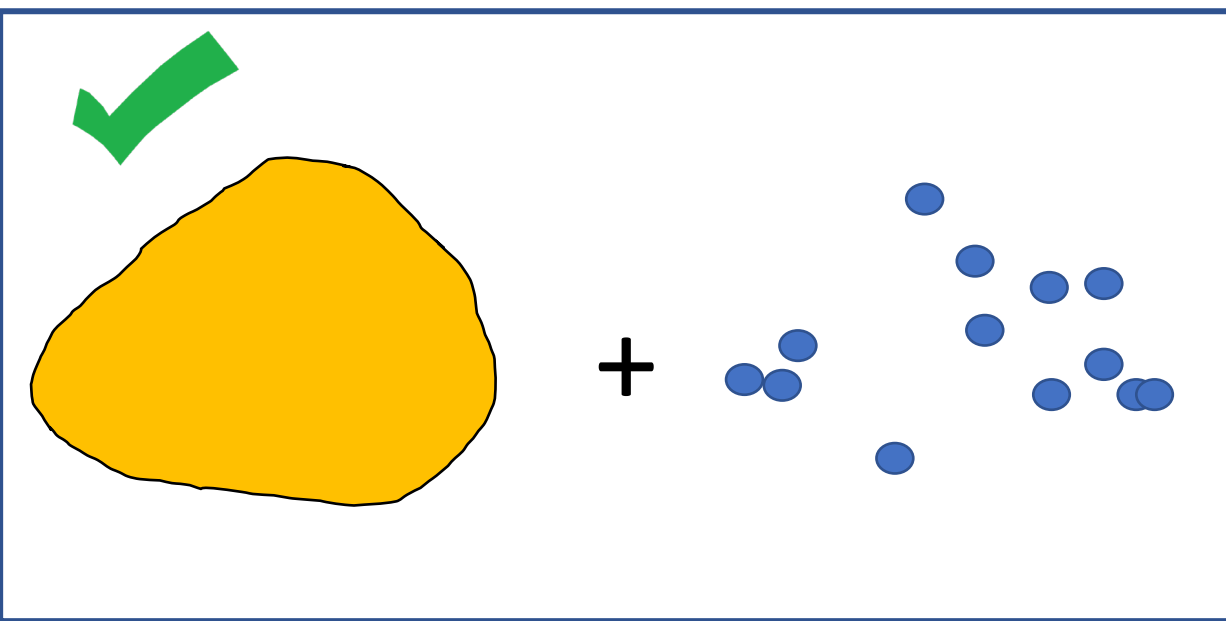
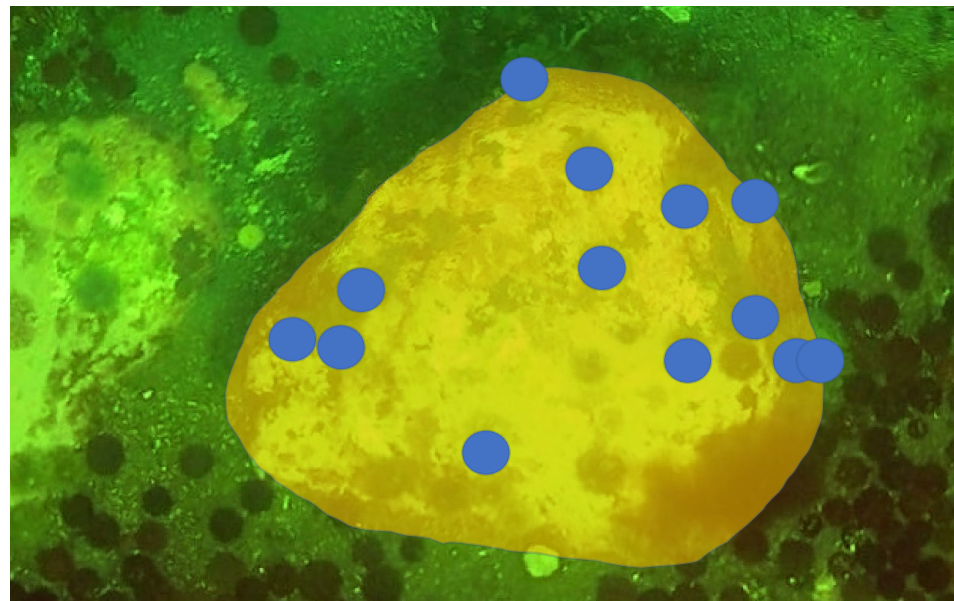
Real world

A desired approach that  
preserve overlay of layers



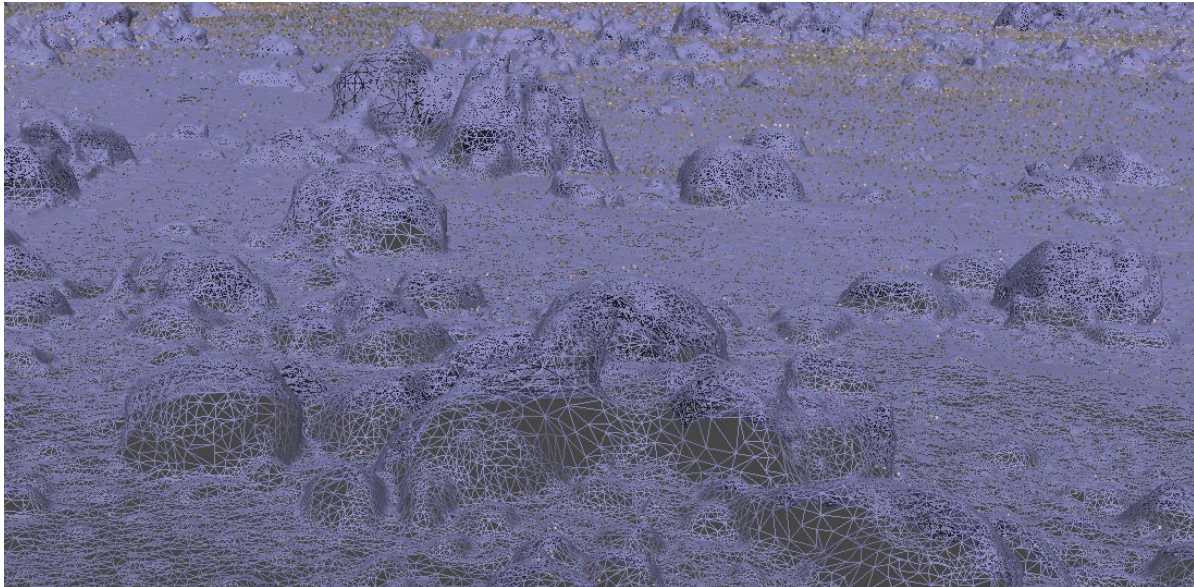
# Moving towards computer vision & Machine Learning

A desired approach that  
preserve overlay of layers



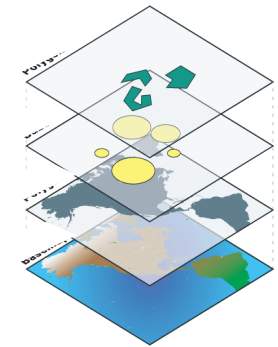
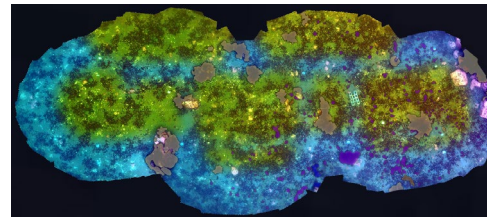
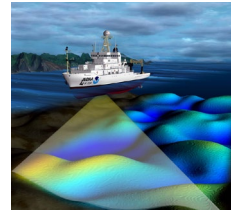



CV/ML to combine 2D and 3D ?



# Characterization of the sea floor **NEEDS** for benthic ecology

- Scale and Map availability
- Substrate type @ medium scale  
? Multibeam Classification
- Small scale: Image data extraction





Mapping &  
Image analysis

Me

You experts

# Contact us!

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Institute Maurice Lamontagne

Small and Medium scale Sea Floor Characterization needed