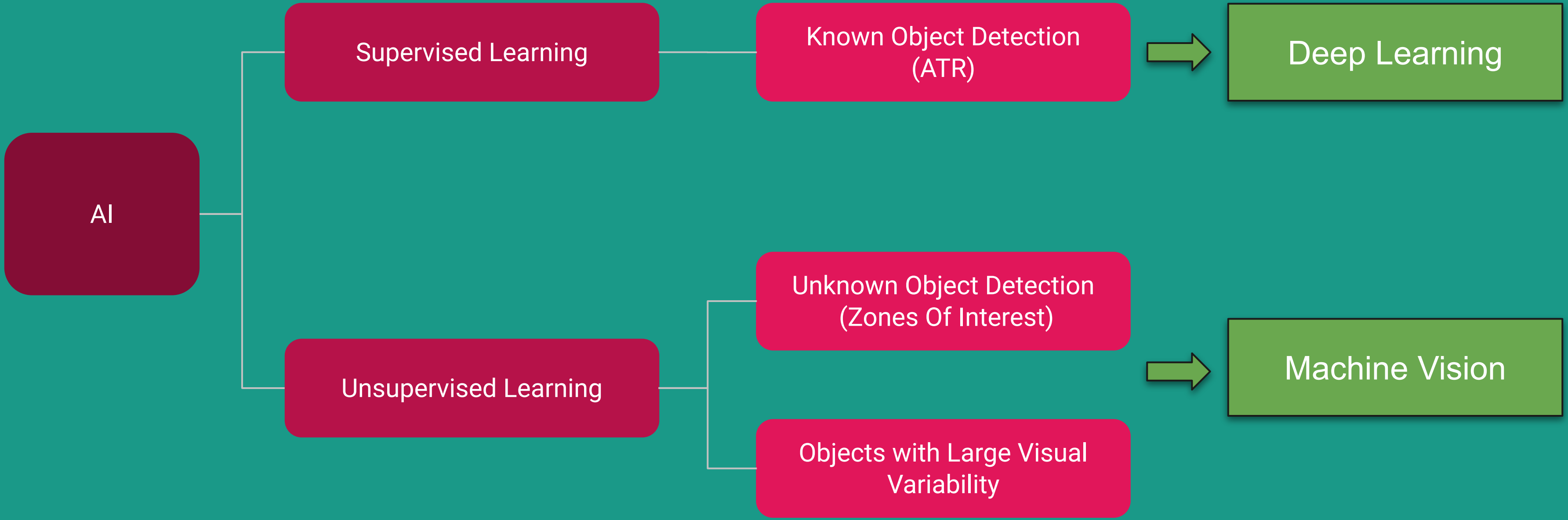
CIDCO

Automating marine inventories using artificial intelligence

AI @ CIDCO

- Artificial Intelligence
  - Ghost Gear Detection
  - Marine Species Inventories
  - Underwater Archaeology
  - Habitat Characterization

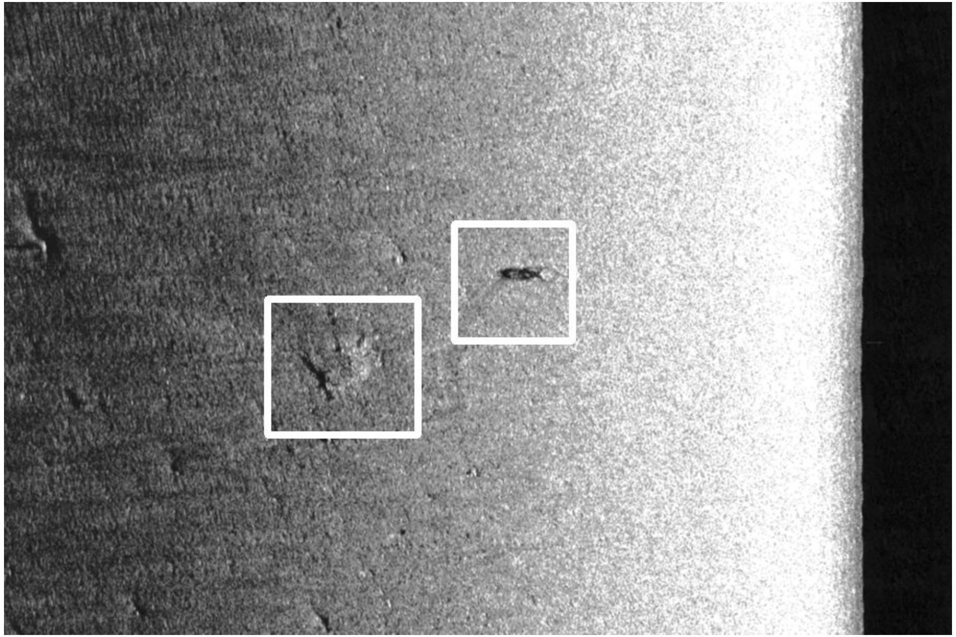
AI methods for object detection



Underwater Object Detection

Detecting Ghost Gear

1st Generation: Detecting odd shapes

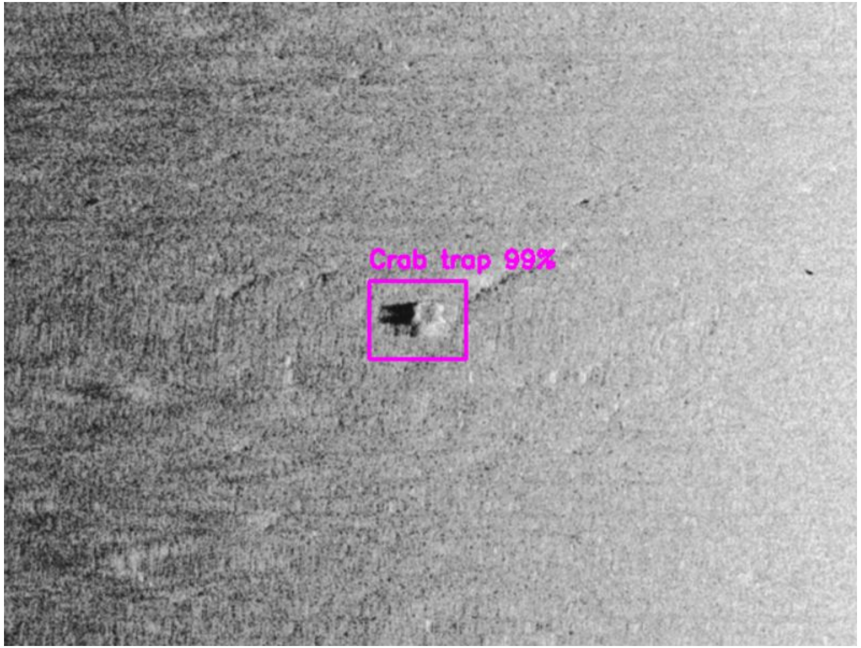


Nets, long lines and historical traps do not have a regular shape that can be properly turned into a visual signature.

Machine vision algorithms such as (Morissette & Gautier, 2020) address this issue.

2nd Generation: Deep Learning Signatures

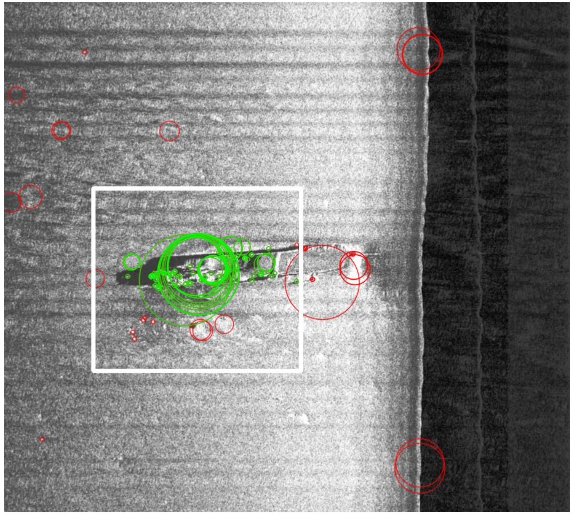
Modern crab pots are easily recognisable and have a well–defined geometry that can be exploited through deep learning methods such as (Jocher & AI,2022)

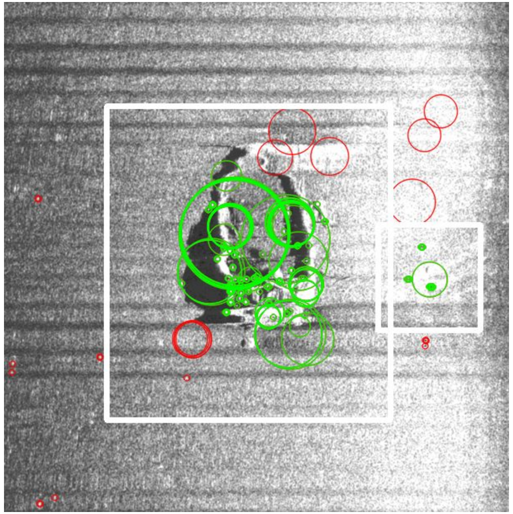


Underwater Object Detection

Underwater Archaeology

Finding Shipwrecks





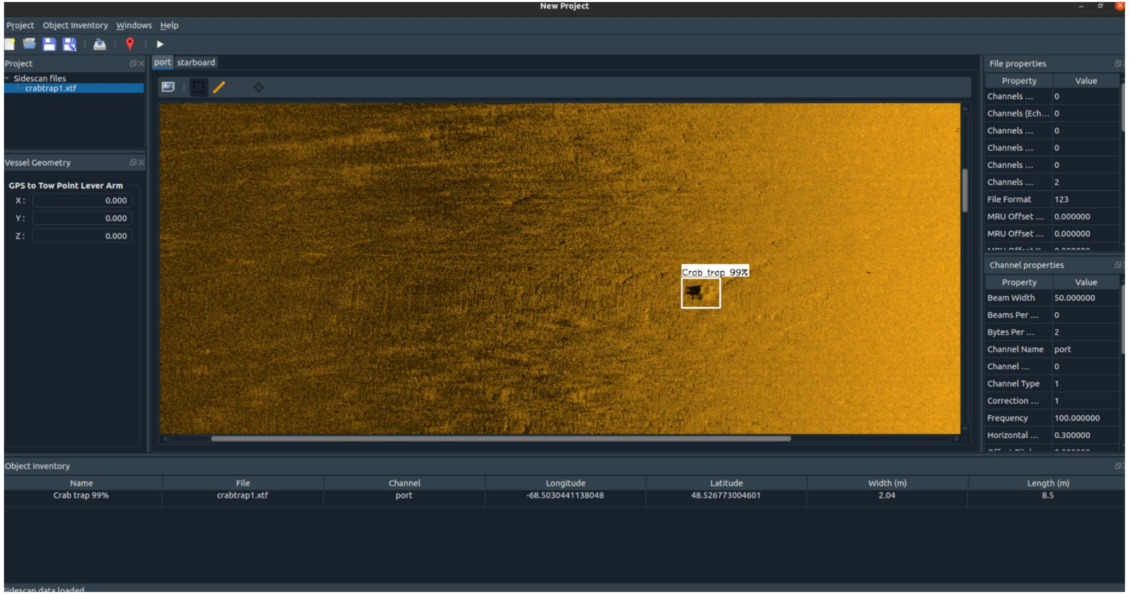
Clusters of visual features left by shipwrecks in sidescan sonar imagery can be identified using machine vision algorithms such as (Morissette & Gautier, 2020).

Open Sourcing SSS & Deep Learning Tools

CIDCO has open-sourced its sidescan data processing tool under MIT license as the OpenSidescan application.

The current version features CIDCO's shipwreck detector.

The next release will feature deep-learning features such as ONNX models for arbitrary object detection.



Underwater Object Detection

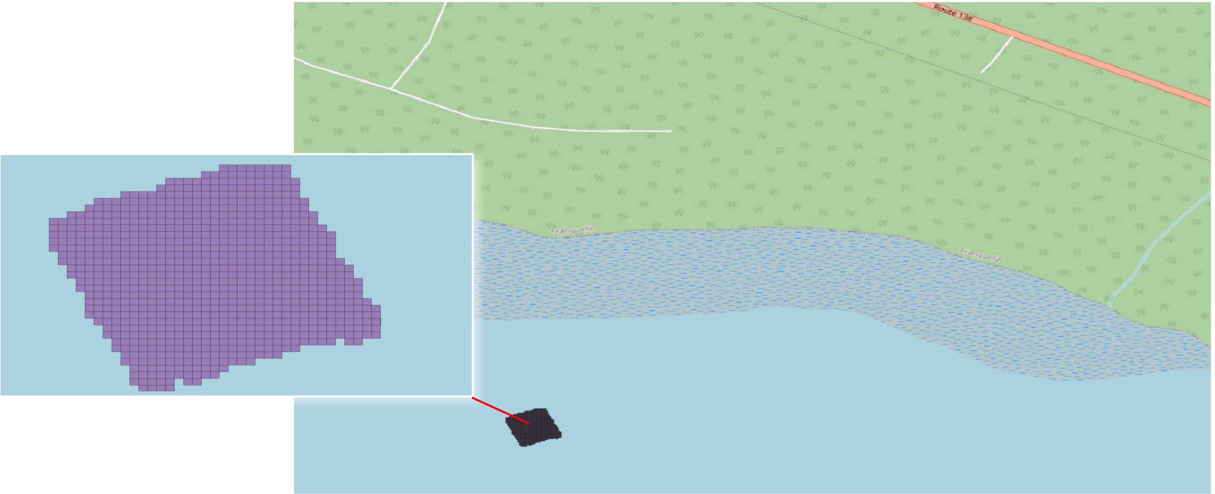
Marine Species Inventories

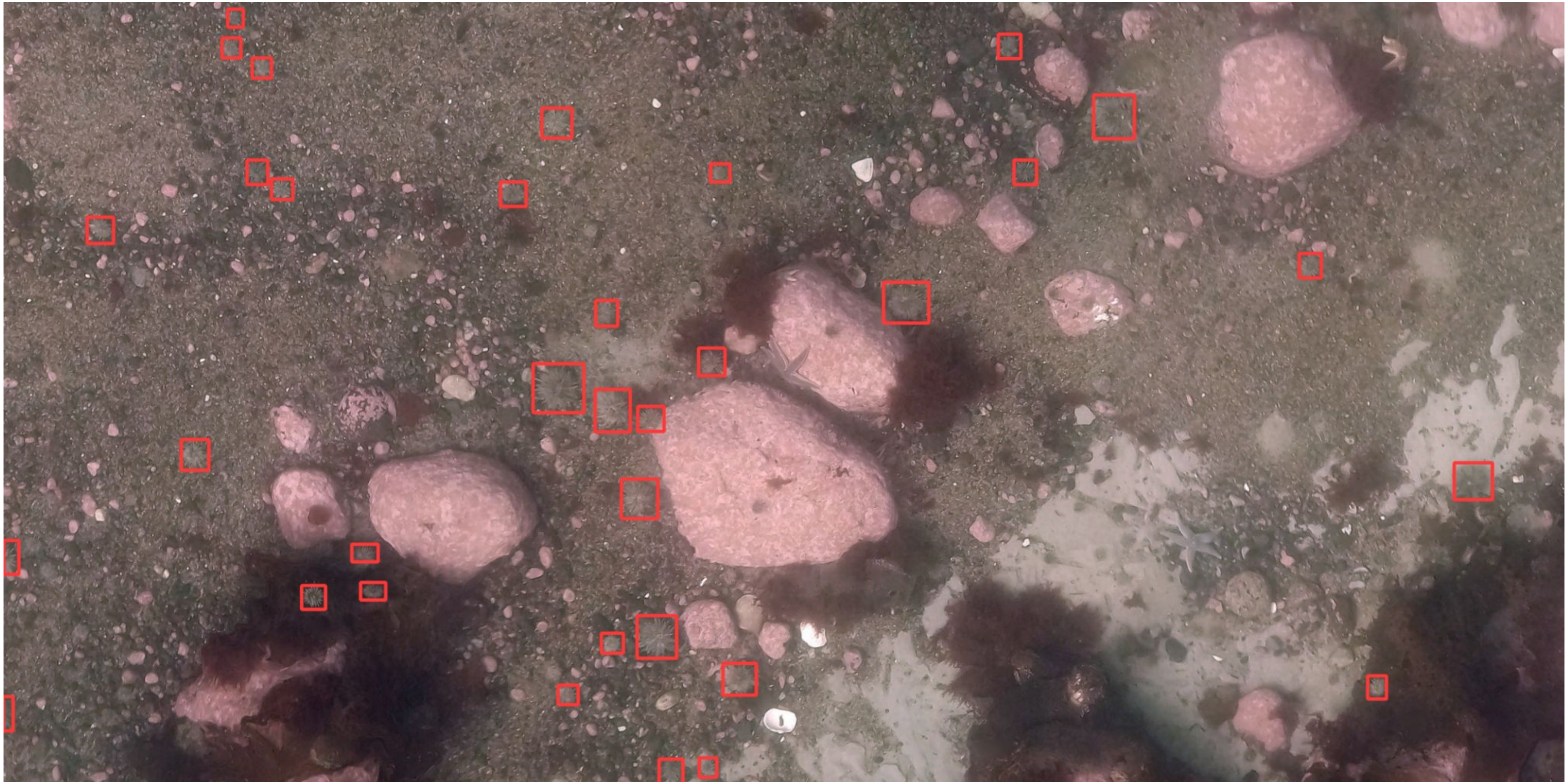
Automated Marine Species Inventories

Godbout’s urchins

831 orthomosaics
6.858m^2 per zone
5699m^2 in total
Detection in 3 minutes

5668 Urchins Detected

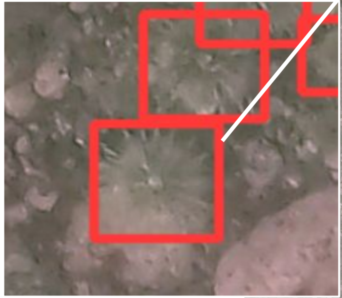


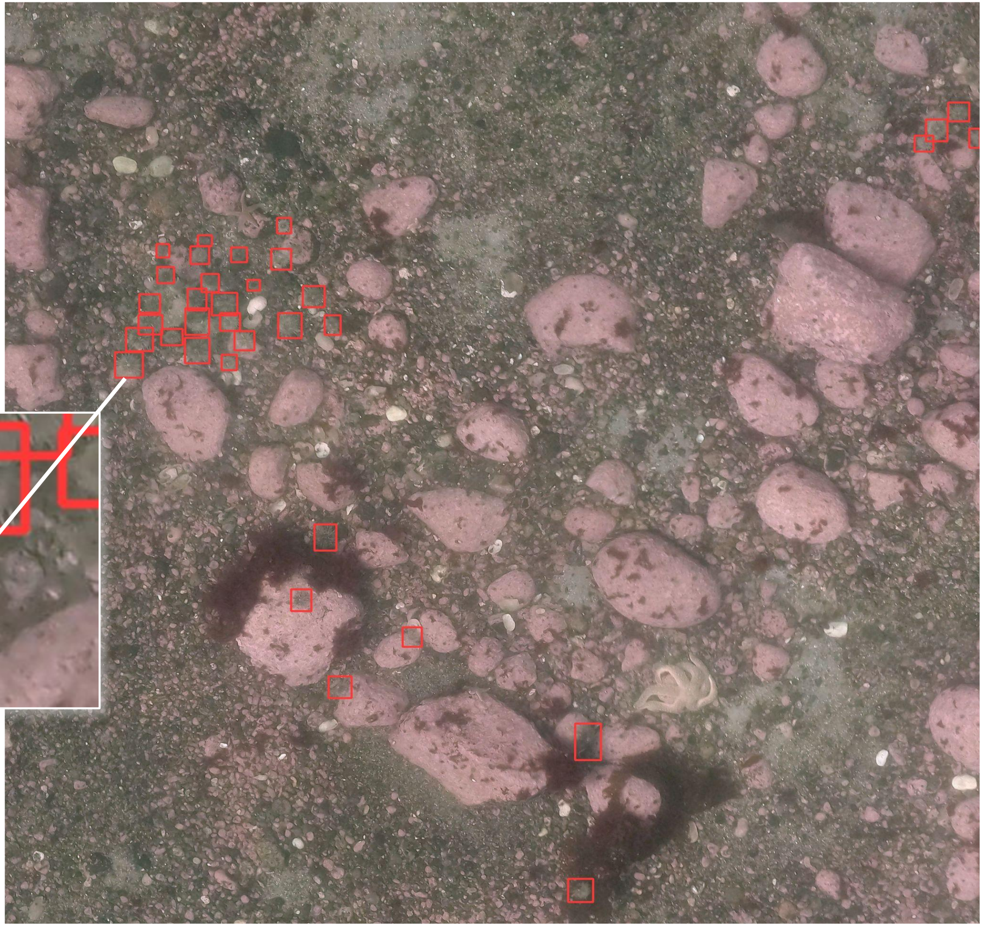


Results

Once trained, the AI can detect more urchins than the ***average*** human eye and alleviate issues due to contrast, illumination and turbidity.

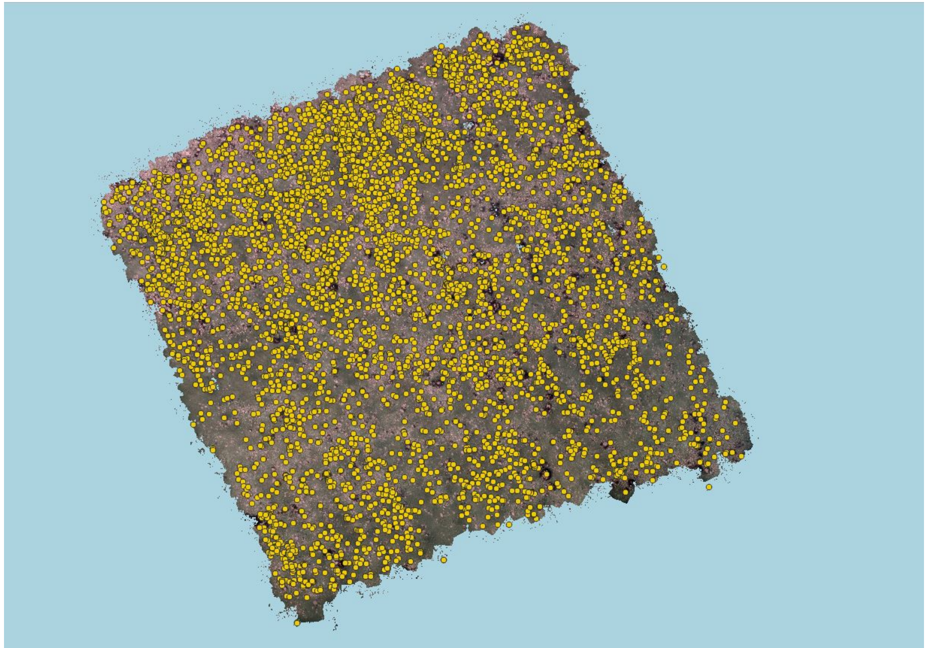
Can you spot them all?





Spatial distribution

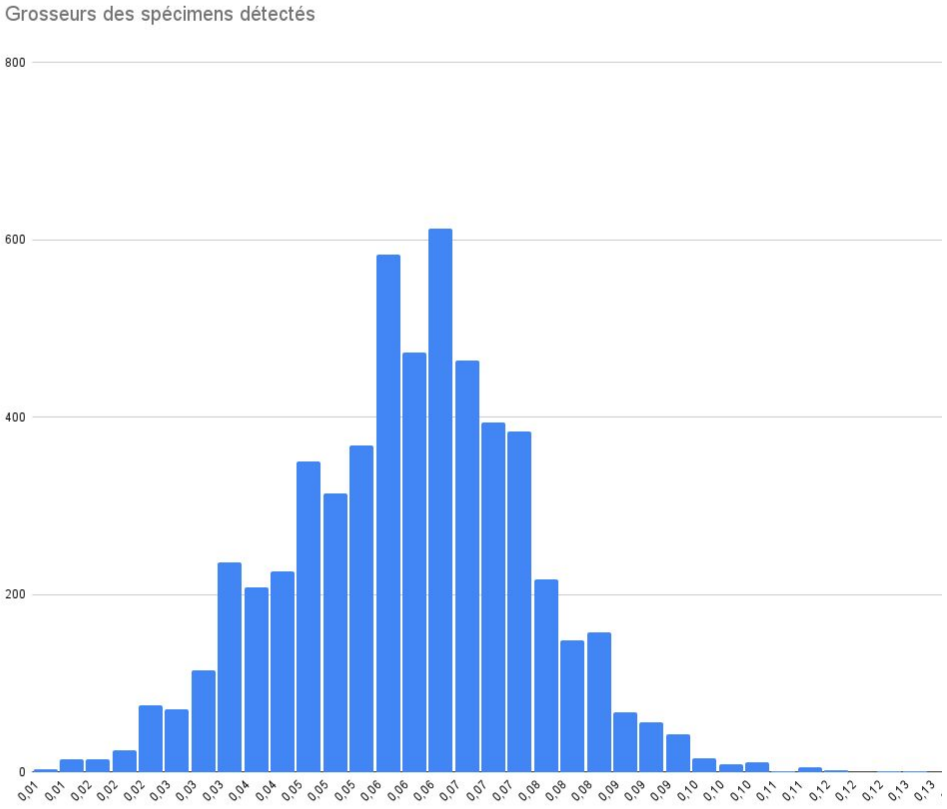
The spatial distribution of detected urchins’ positions and sizes can be readily exported as a SHP file for further analysis.

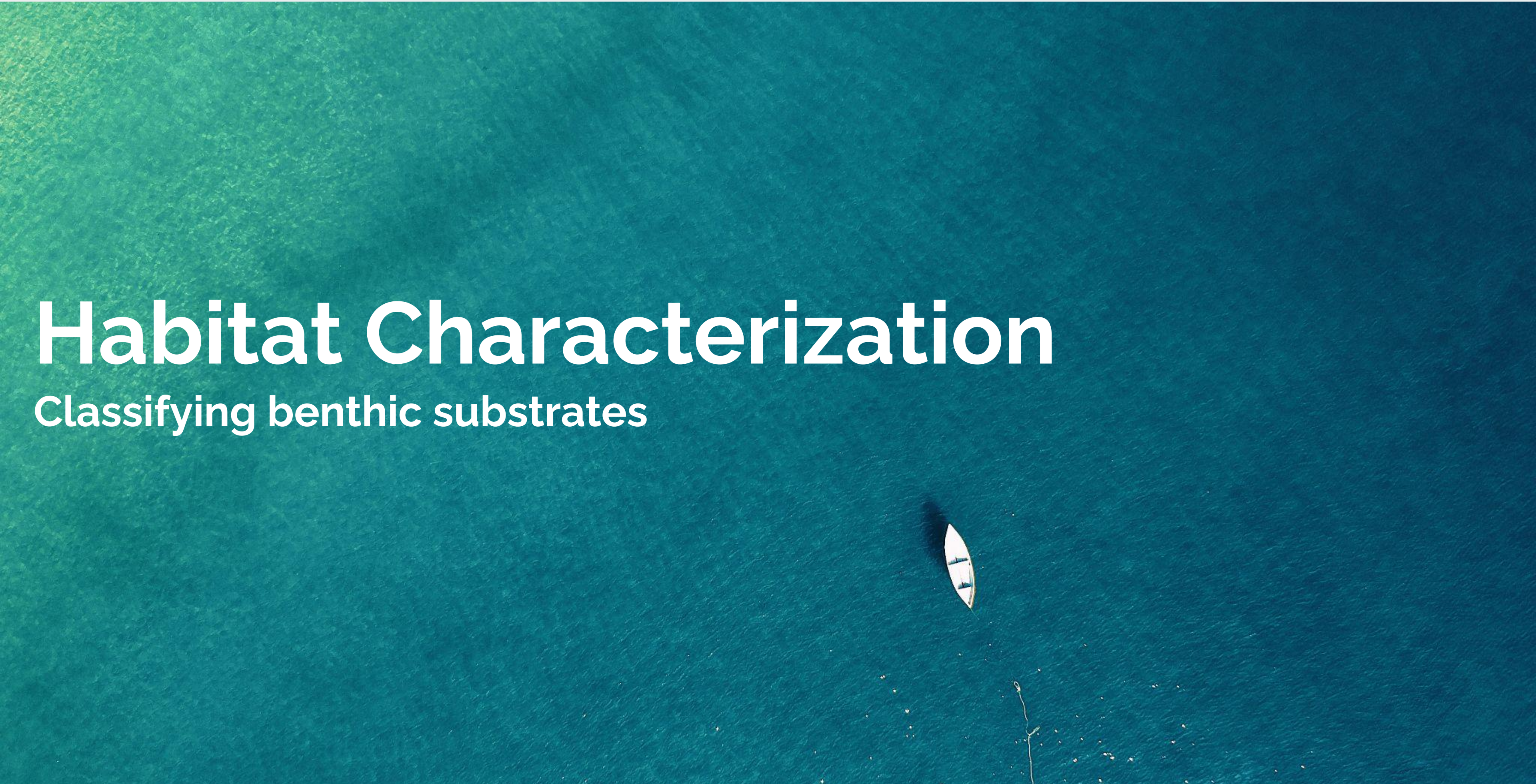


Size

“the shell of the green urchin can reach a diameter of 100 millimeters, with an average between 50 and 60 millimeters”

-DFO-MPO

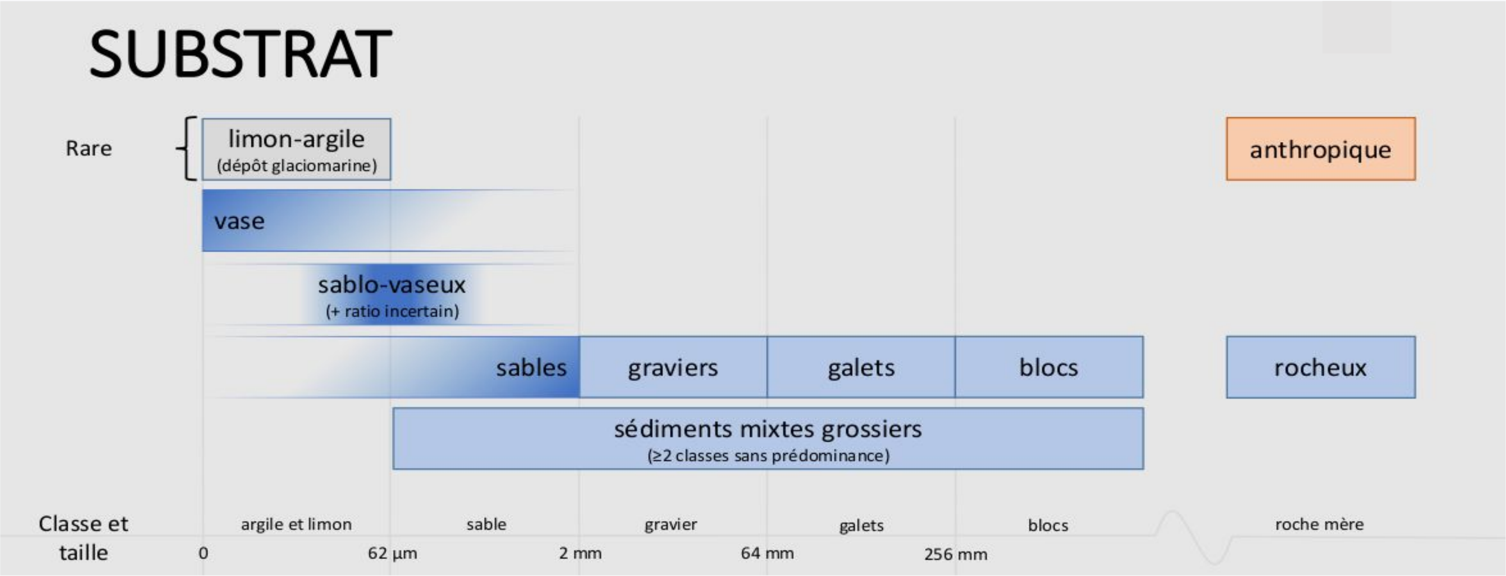




Habitat Characterization

Classifying benthic substrates

Caractérisation des substrats marins



Ground Truth Stations

1000 DFO Ground Truthing Stations

Process

Using supervised learning makes it possible to classify benthic habitats using proxy variables derived from seafloor geometry.

Seafloor geometry data
(MBES, lidar, etc)

Training data
from ground truthing data

Artificial Intelligence

Feature Engineering

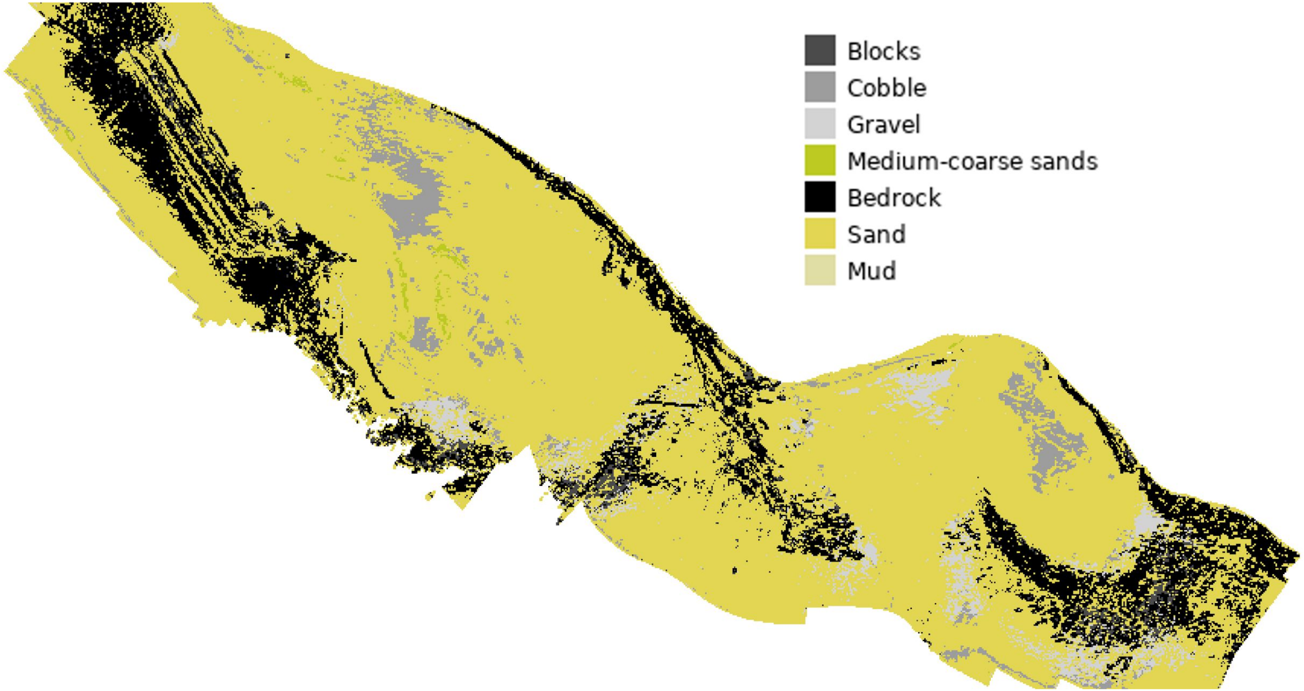
We enrich bathymetric surface data with **geomorphometric features**

covariance	Sum	$\lambda_1 + \lambda_2 + \lambda_3$
	Omnivariance	$(\lambda_1 \cdot \lambda_2 \cdot \lambda_3)^{\frac{1}{3}}$
	Eigenentropy	$-\sum_{i=1}^{3} \lambda_i \cdot \ln(\lambda_i)$
	Anisotropy	$(\lambda_1 - \lambda_3)/\lambda_1$
	Planarity	$(\lambda_2 - \lambda_3)/\lambda_1$
	Linearity	$(\lambda_1 - \lambda_2)/\lambda_1$
	Surface Variation	$\lambda_3/(\lambda_1 + \lambda_2 + \lambda_3)$
	Sphericity	λ_3/λ_1
	Verticality	$1 - \lvert\langle[0\,0\,1], \mathbf{e}_3\rangle\rvert$
moment	1^{st} order, 1^{st} axis	$\sum_{i \in \mathcal{P}} \langle \mathbf{p}_i - \mathbf{p}, \mathbf{e}_1 \rangle$
	1^{st} order, 2^{nd} axis	$\sum_{i \in \mathcal{P}} \langle \mathbf{p}_i - \mathbf{p}, \mathbf{e}_2 \rangle$
	2^{nd} order, 1^{st} axis	$\sum_{i \in \mathcal{P}} \langle \mathbf{p}_i - \mathbf{p}, \mathbf{e}_1 \rangle^2$
	2^{nd} order, 2^{nd} axis	$\sum_{i \in \mathcal{P}} \langle \mathbf{p}_i - \mathbf{p}, \mathbf{e}_2 \rangle^2$
height	Vertical range	$z_{\text{max}} - z_{\text{min}}$
	Height below	$z - z_{\text{min}}$
	Height above	$z_{\text{max}} - z$

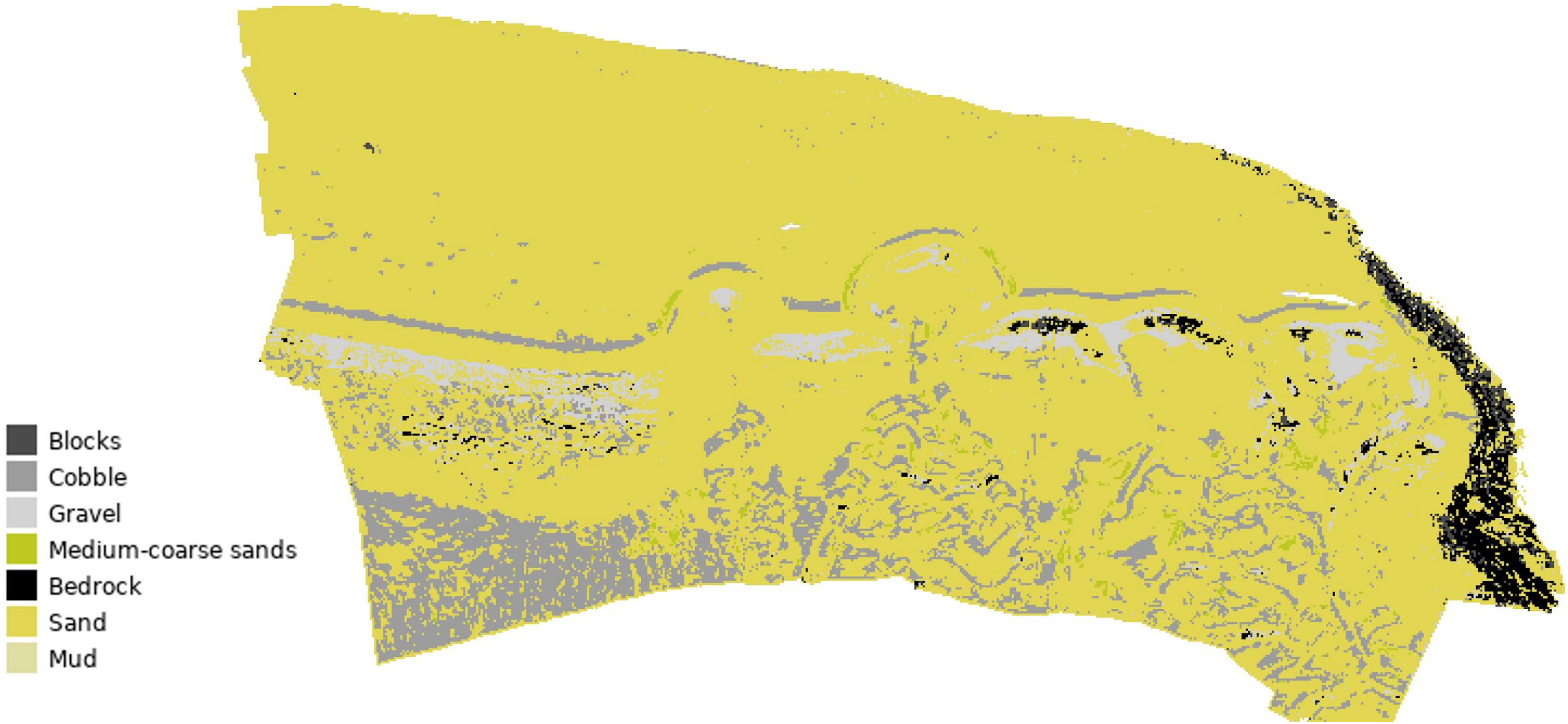
Hackel, 2016

Benchmark results

Algorithm	Average Accuracy (over all classes)
K Nearest-Neighbors	91% (Danger: Overfitting)
Gradient Boosted Trees	90%
Support Vector Machines	83%
Naive Bayes	31%



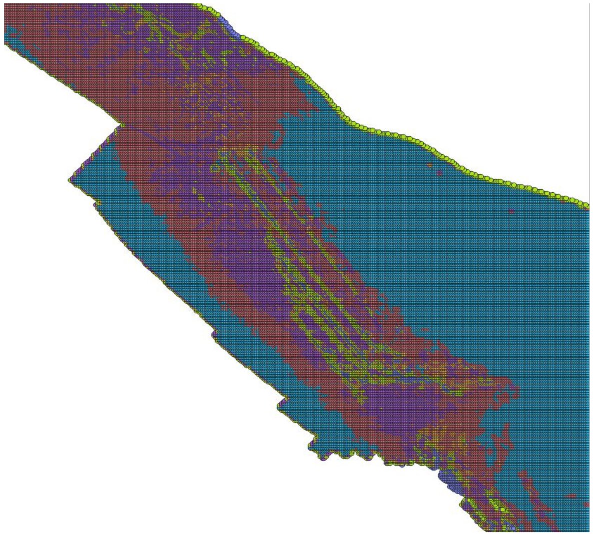
Baie-des-Anglais, Côte Nord, QC, Canada



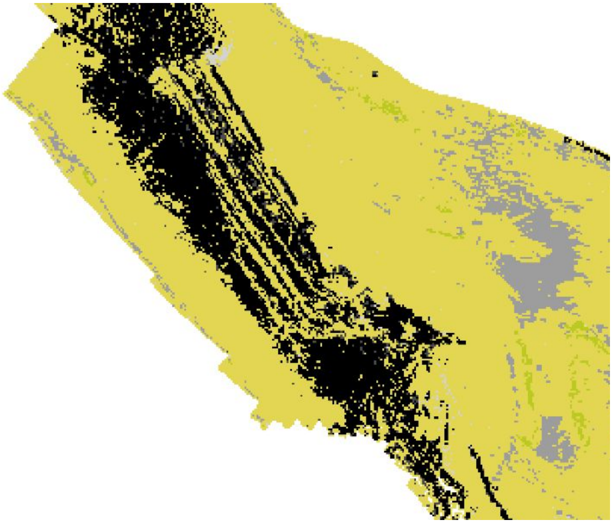
Franquelin, North Shore, QC, Canada

Unsupervised Characterization

Processus Non-supervisé (sans vérité terrain)



Procédé Supervisé (avec vérité terrain)

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