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Aser Mata

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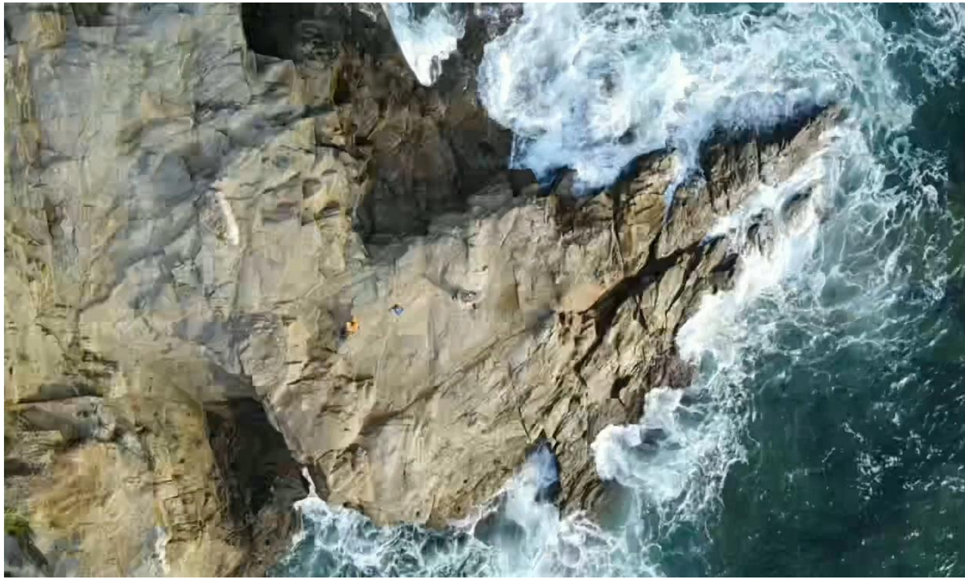
Mapping wild Pacific oysters with drones and Deep Learning



Pacific Oysters

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Ecological Informatics
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Drone imagery and deep learning for mapping the density of wild Pacific oysters to manage their expansion into protected areas

Aser Mata [a], David Moffat [a], Sílvia Almeida [b], Marko Radeta [b c d], William Jay [a], Nigel Mortimer [e], Katie Awty-Carroll [f 1], Oliver R. Thomas [a g], Vanda Brotas [h], Steve Groom [a]

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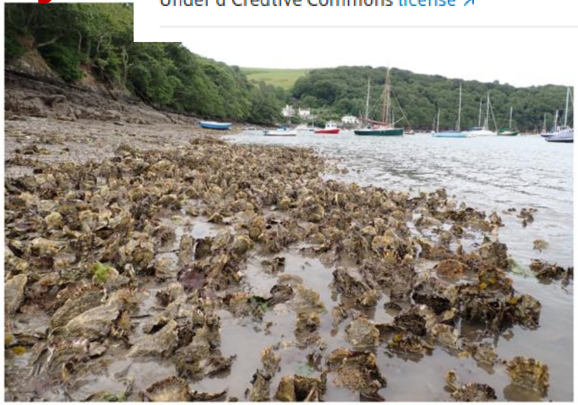
Can we apply EO and AI to tackle this issue?



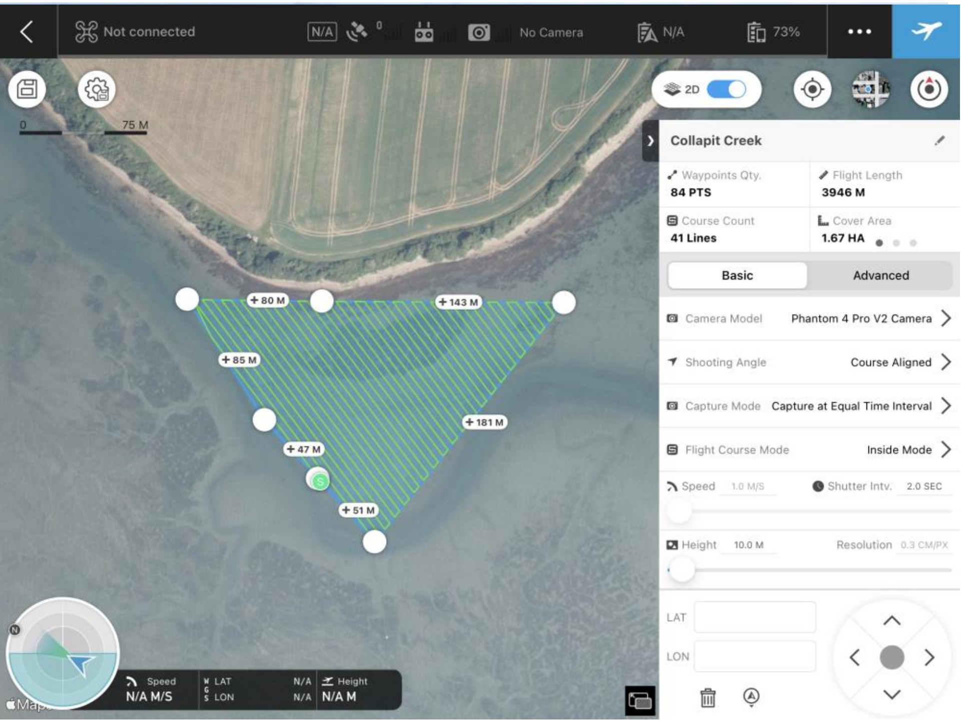
Understanding the problem: Pacific oysters are quite large!

-Pacific oysters are an intertidal species with adult specimen (~ 20 months) of typical lengths of **8 – 15 cm** (commonly, 20 cm or larger).

-Their shape and color can be leveraged for their detection.

-Selection of an **adequate pixel size** is key.

Pacific oysters

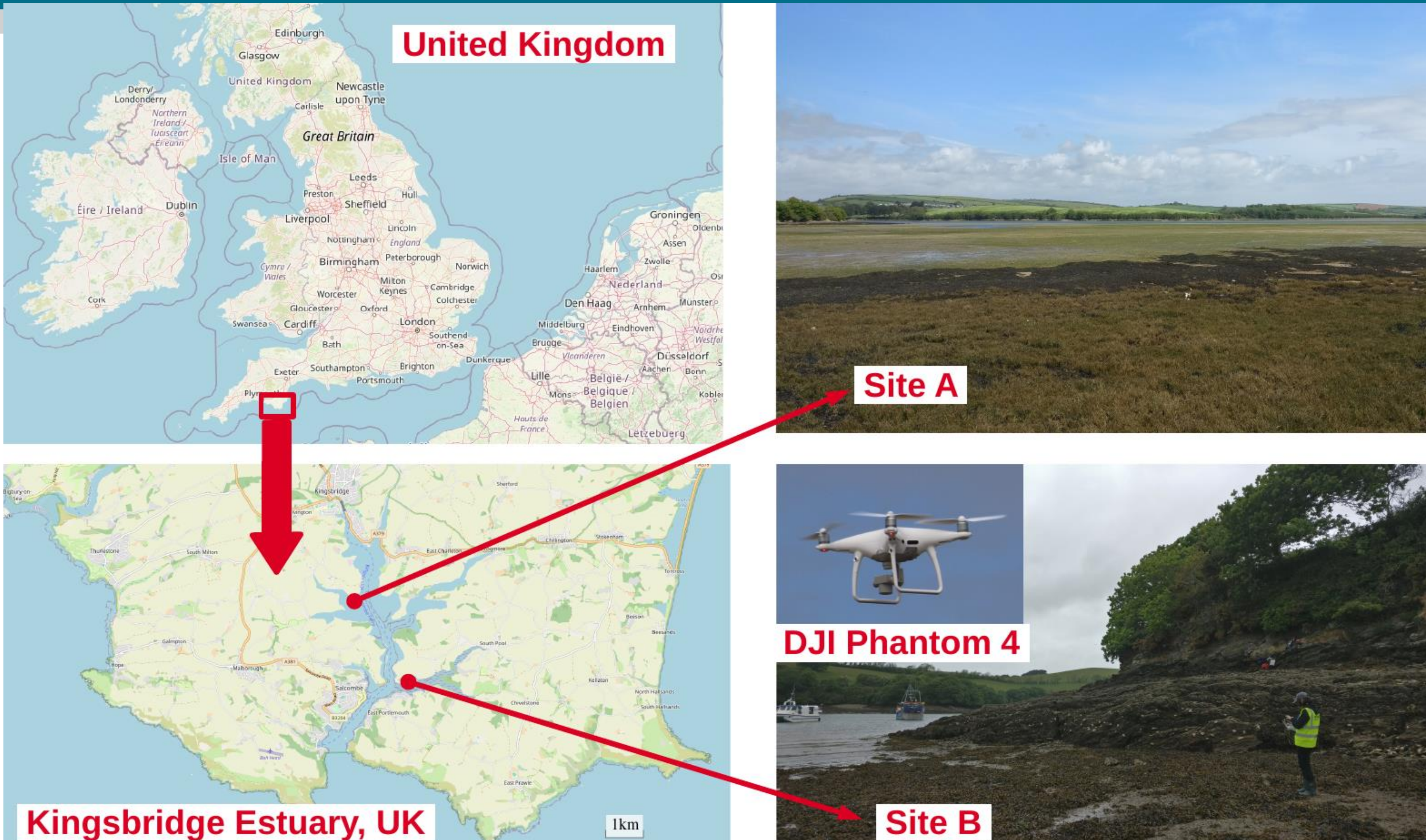


-Our approach identifies Pacific oysters using **medium size object detection** (50–300 pixels, Gong et al. 2022).

-Hence, we recommend a **resolution of at least 0.5 cm per pixel** to be able to correctly detect Pacific oysters.

-The pixel size depends on **flight altitude** and **camera parameters** (calculated via mission planning software).

Sites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Vlaanderen
Düsseldorf
Dunkerque
Lille
België / Belgique / Belgien
Aachen
Bonn
Mons
Hauts-de-France
Letzebuerg
Site A
DJI Phantom 4
Kingsbridge Estuary, UK
1km
Site B

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Mudflats: Collapit Creek

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Rocky Shore: Scoble Point

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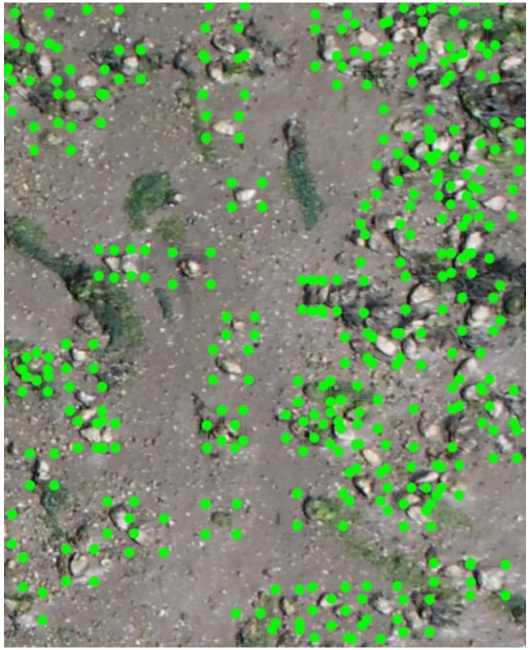
Data Annotation, Validation and Training Dataset



-To create the validation and training datasets, **subsets** were manually selected to ensure **all terrain types** were captured (mud, rocks, and sand) and configurations (dense and sparse population and include oysters that were clearly visible or partially covered by mud…).

-Approx. 4000 Pacific oysters tagged at the mudflat (Site A)

-Approx. 3000 at the rocky shore (Site B).

-Data split into **70% training, and 30% validation**.

-Data augmentation was used to increase the size of the training

-Four models were compared:

-FRCNN **-YOLOv5s**
-YOLOv5m **-TPH-YOLO**

Augmentation	Minimum	Maximum
Flip	-	-
Crop	0	10%
Contrast Shift	-25%	+50%
Translation	-20%	20%
Rotation	-90°	+90°

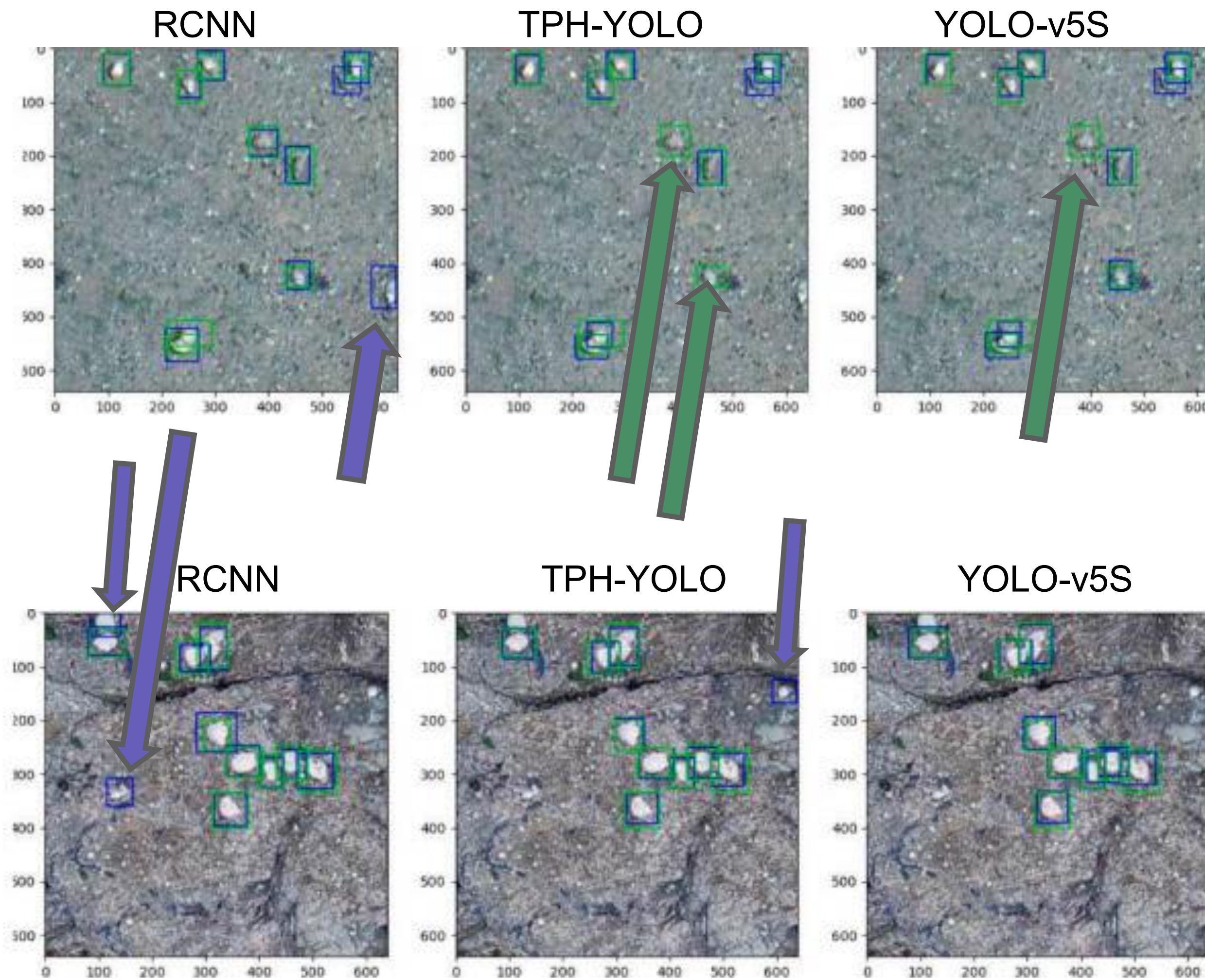
DL Model	Ground Truth	Number Detected	True Positives	False Negatives	False Positives	Precision	Recall
			Both Sites				
FRCNN	1829	2191	**1650**	**179**	541	0.753	**0.902**
TPH-YOLOv5	1829	1594	1257	572	337	0.789	0.687
YOLOv5s	1829	1709	1508	321	**201**	**0.882**	0.824
YOLOv5m	1829	1751	1446	383	305	0.826	0.791
			Collapit Mudflat (Site A)				
FRCNN	1025	1225	**916**	**109**	309	0.748	**0.894**
TPH-YOLOv5	1025	796	699	326	**97**	**0.878**	0.682
YOLOv5s	1025	935	821	204	114	**0.878**	0.801
YOLOv5m	1025	970	784	241	186	0.808	0.765
			Scoble Point Rocky Shore (Site B)				
FRCNN	804	966	**734**	**70**	232	0.760	**0.913**
TPH-YOLOv5	804	798	558	246	240	0.699	0.694
YOLOv5s	804	774	687	117	**87**	**0.888**	0.854
YOLOv5m	804	781	662	142	119	0.848	0.823

Table 2: Validation results from the four models, for each Site (A and B).

Green Boxes: Ground Truth

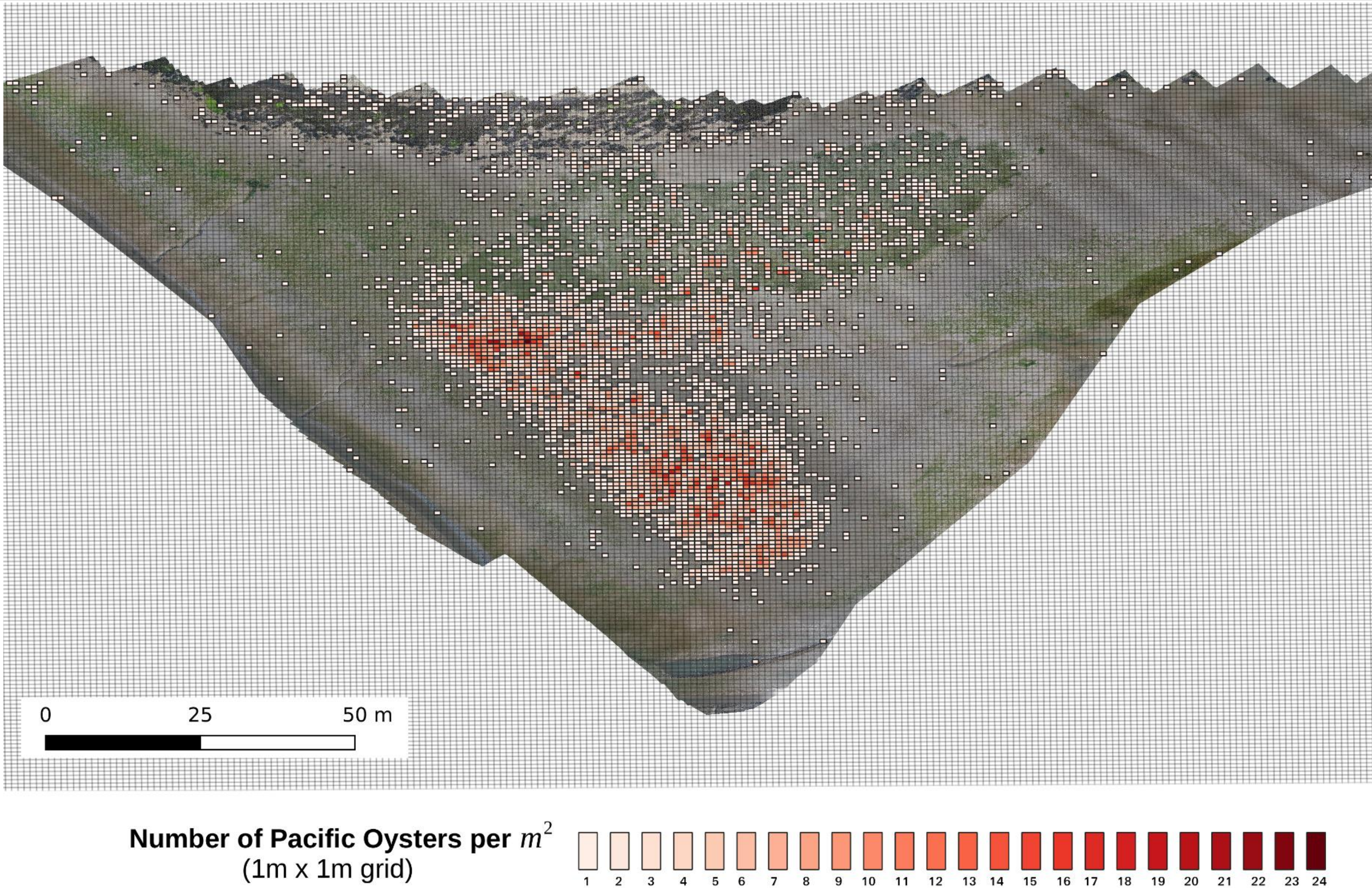
Blue boxes: Detection raised by the model

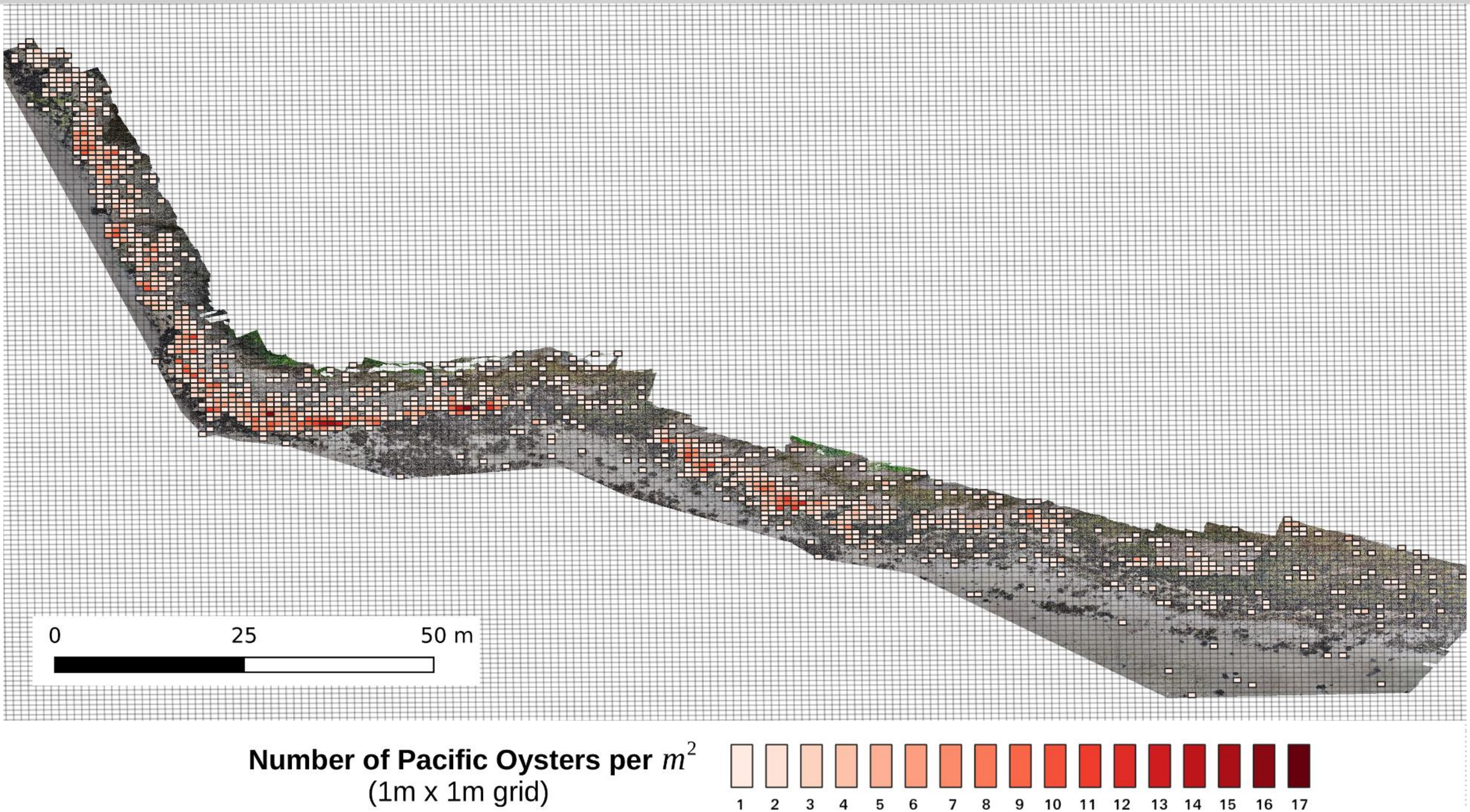
Only Blue -> **False Positive**
Only Green -> **False Negative**
Both Colors **-> True Positive**



True Positive (TP): A Pacific oyster successfully detected.

False Positive (FP): An incorrect detection, no Pacific oyster exists, but one is predicted (example: a misclassified rock)


0
25
50 m
Number of Pacific Oysters per m^2
(1m x 1m grid)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24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16
17

Conclusions

+ This study presents a workflow for mapping emerged wild Pacific oysters using aerial drones and Deep Learning.

+ We report metrics of each model with precision scores up to 88% (YOLOv5s) with only a marginal 1% difference across the two sites.

+ Output of the model can be visualised on an UTM projected grid map to efficiently assess the number of Pacific oysters per square meter for management purposes and time series.

+ This provides a cost-effective monitoring solution while can also provide data over complex terrain that in many cases is otherwise unreachable via “walk-over” surveys.

+ **Great opportunities for habitat mapping and similar approaches can be applied to detect birds or vegetation.**

Additional information

Thank you

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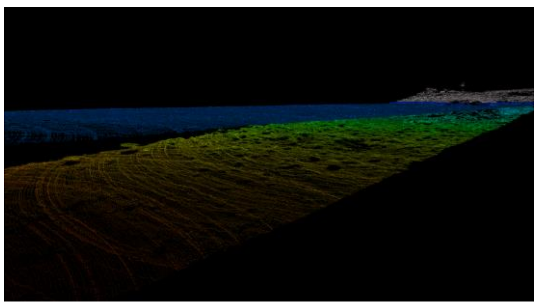
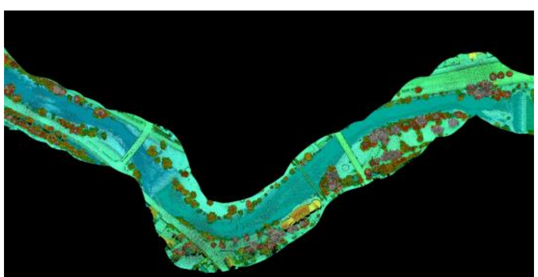
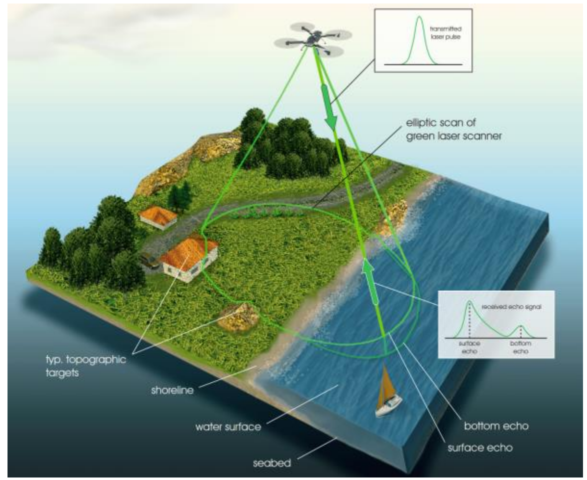
A remotely piloted aerial Green LiDAR for mapping bathymetry of shallow waters and boundary land







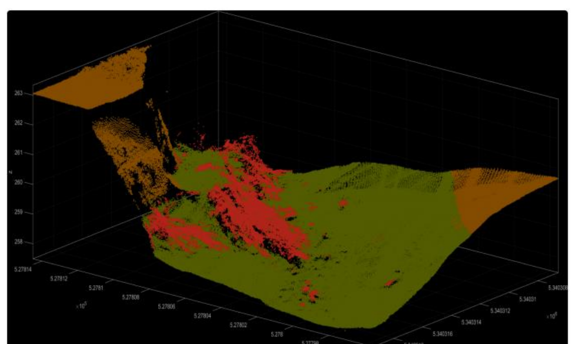


Figure 4: 3D point cloud of submerged bunch of willow tree branches coloured by class ID (red).

-A **£1M** project funded by NERC

-A green LiDAR for **bathymetry**.

-Estimated penetration depth of nominally **2 Secchi disks**.

-Looking for collaborative projects to and open new novel research paths.

-Potential to capture 3D model of Kelp or other submerge vegetation and apply AI for better biomass estimations.

-**Sensor** expected to arrive before end of summer **2025**.

-**Benchmarking** and testing: **2026**.