3D Seabed Imaging — developing the next generation of monitoring

Martin Sayer

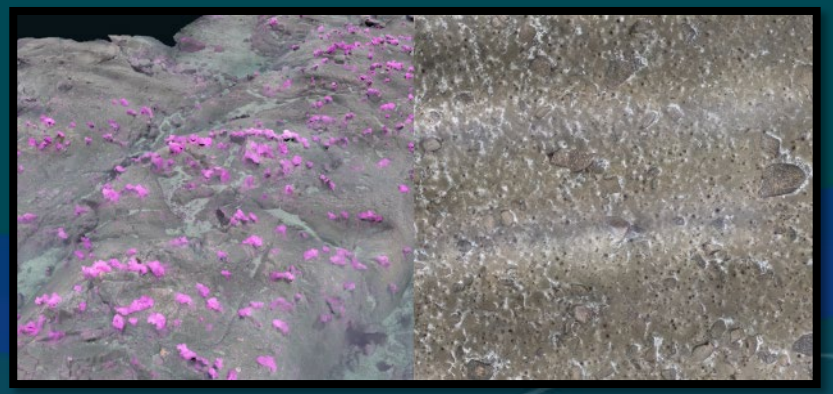
TRITONIA
providing underwater clarity

FHF Project Number: 910484
Start Date: 01.10.2025 End Date: 01.03.2028
Rikard Albrigtsen, DNV Aquaculture and Ocean Health AS (formerly Åkerblå Group AS)

CONTEXT

- Environmental monitoring of aquaculture is evolving
- New knowledge around vulnerable species and seabed impacts is creating new monitoring requirements
- FHF has funded three projects exploring future monitoring methods
- **3D Seabed Imaging is one of them**

Can we make seabed environmental monitoring more spatial, quantitative and repeatable?



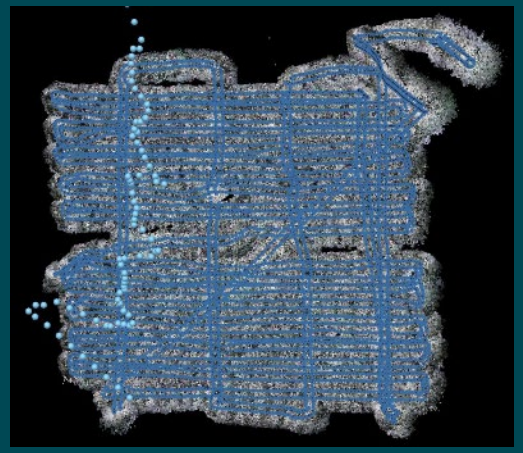
What makes Georeferenced 3D photogrammetry (G3DP) different?

Georeferencing turns imagery into a repeatable spatial measurement

ACCURATE AND PRECISE SEABED GEOREFERENCING

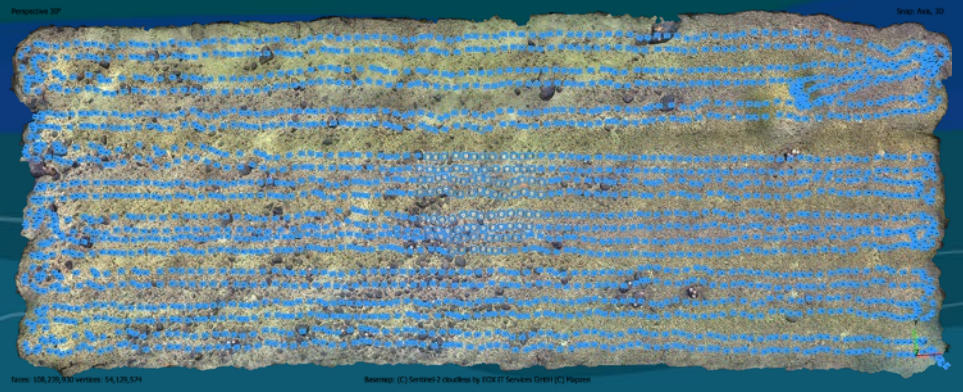
Autonomous surveying

Precise positioning enables automated survey patterns, terrain following and consistent coverage



Optimised 3D recontruction

Precise positioning supports image overlap and reconstruction

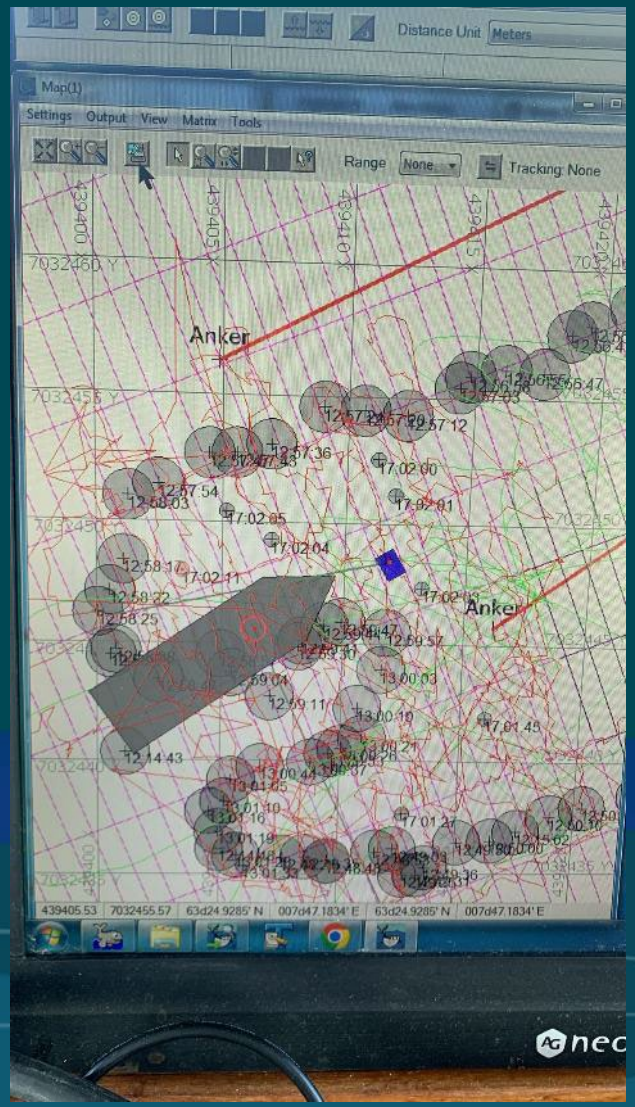


Repeatable monitoring

Return to the same seabed and identify and measure change or recovery

CASE STUDY 1

Mapping soft corals – Norway, April 2026



Modified ROV

Battery-powered time-lapse photography
Additional lighting (video lights)

Manual piloting

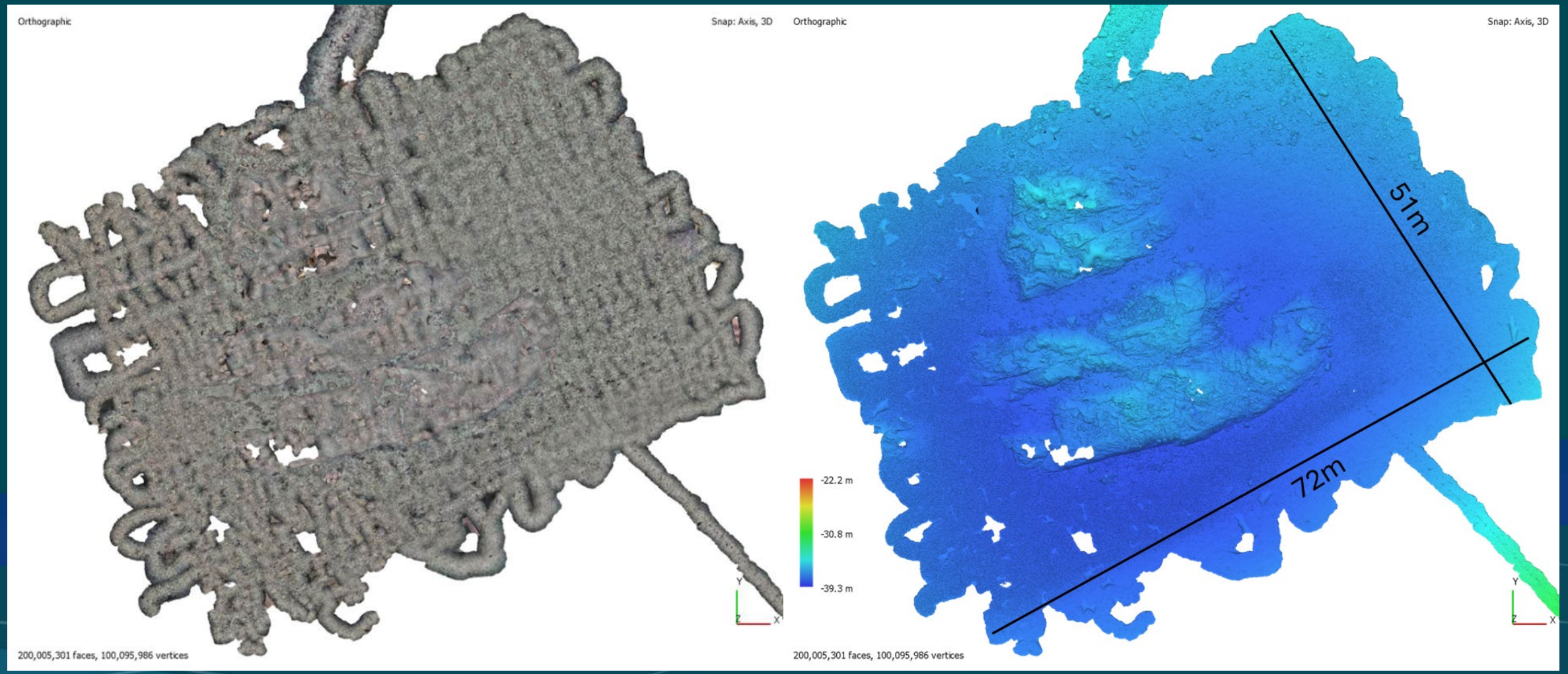
Pilot following prescribed survey plan (lawnmower pattern)
Manual altitude adjustment

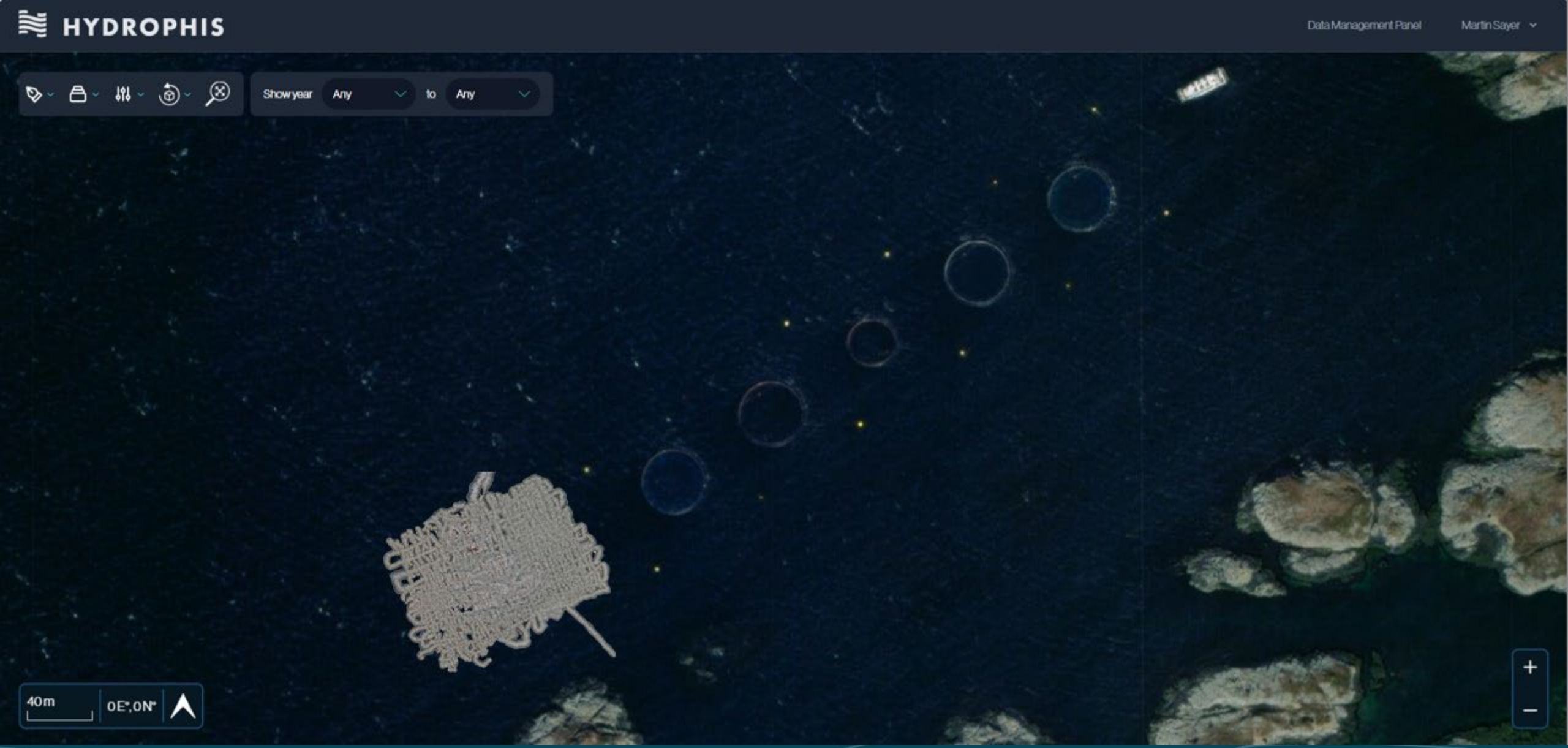
Cauliflower corals

Drifa glomerata
Sensitive seabed habitat / Protected Marine Feature

CASE STUDY 1

Quantifying vulnerable habitat





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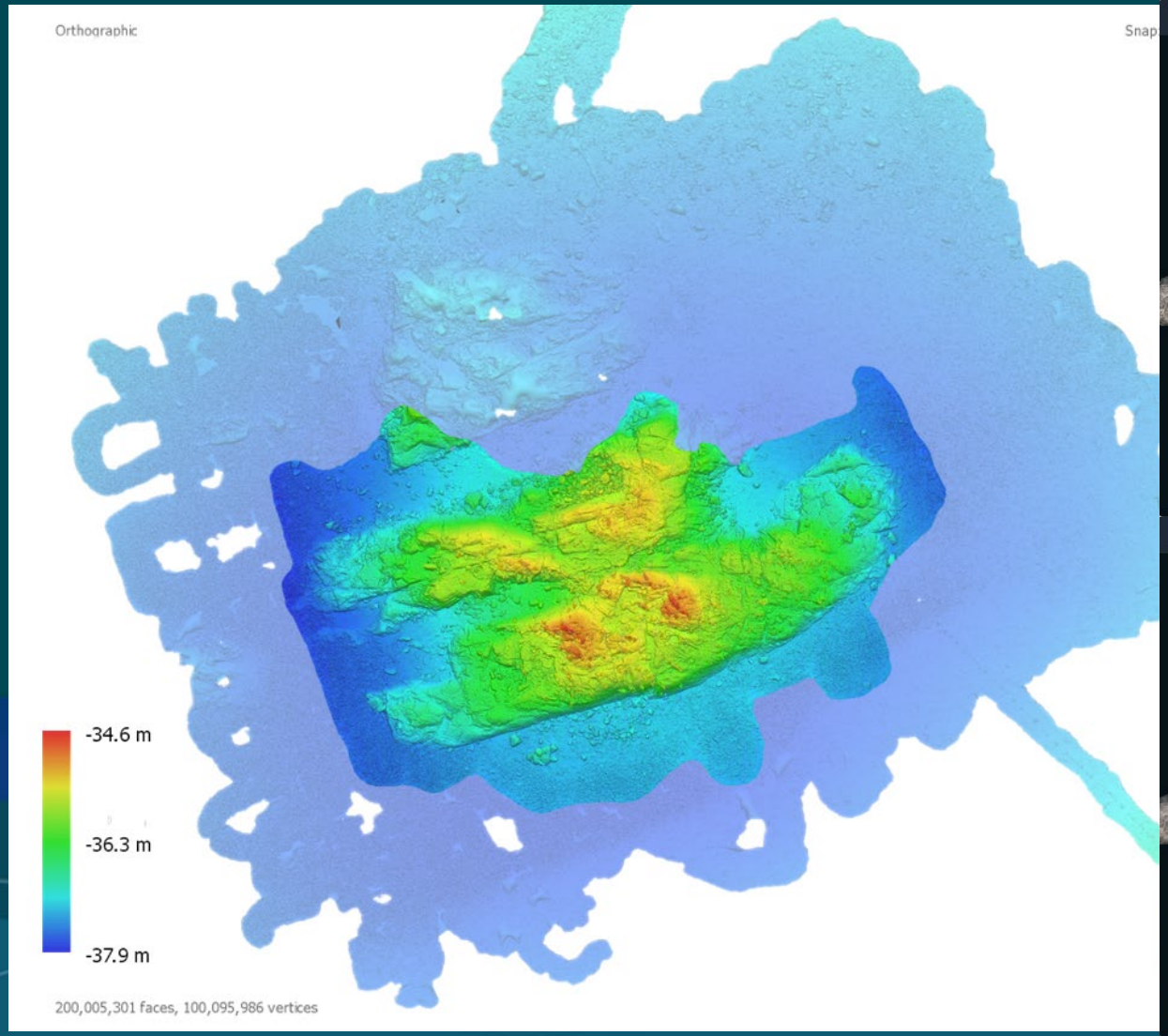
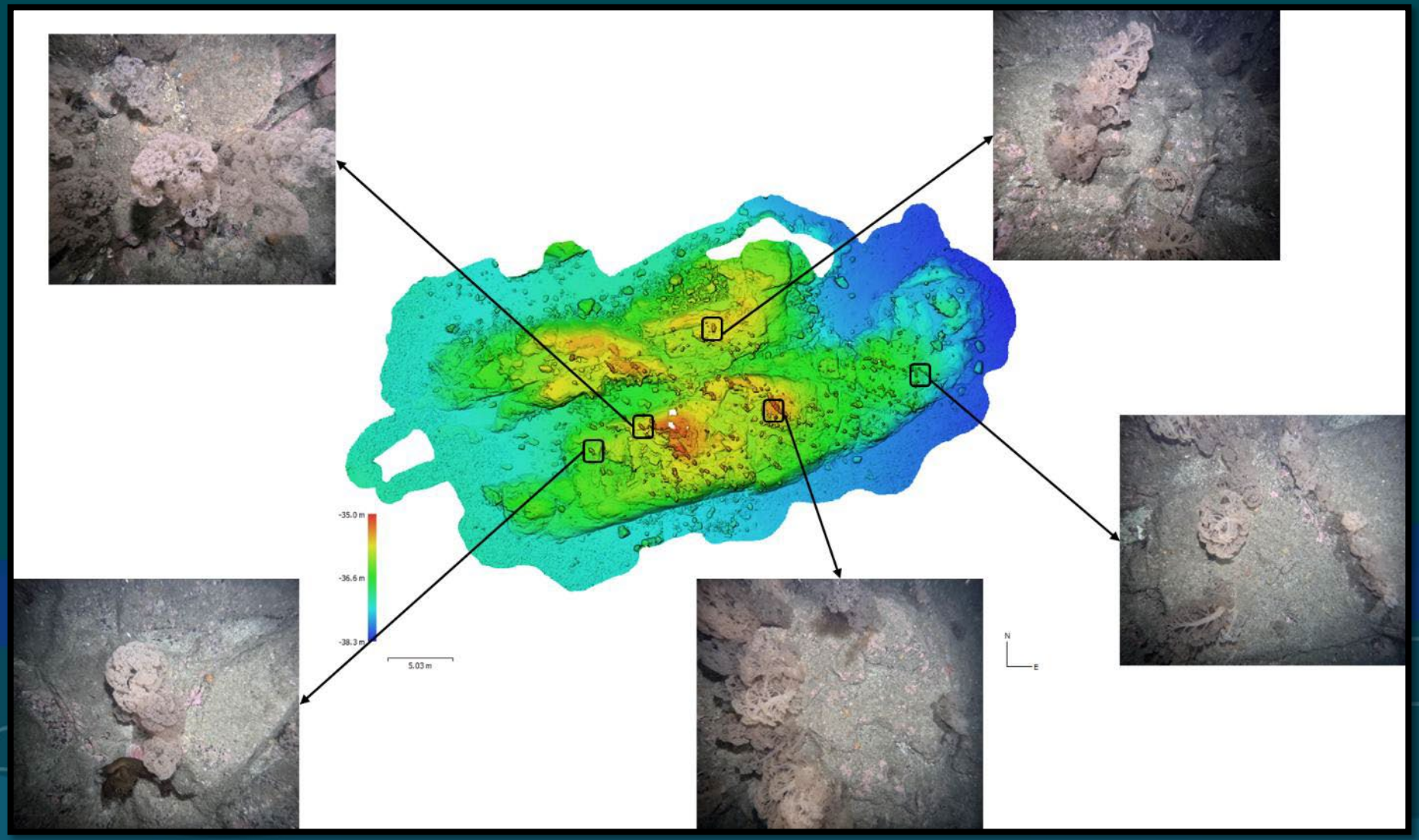
CASE STUDY 1

Quantifying vulnerable habitat



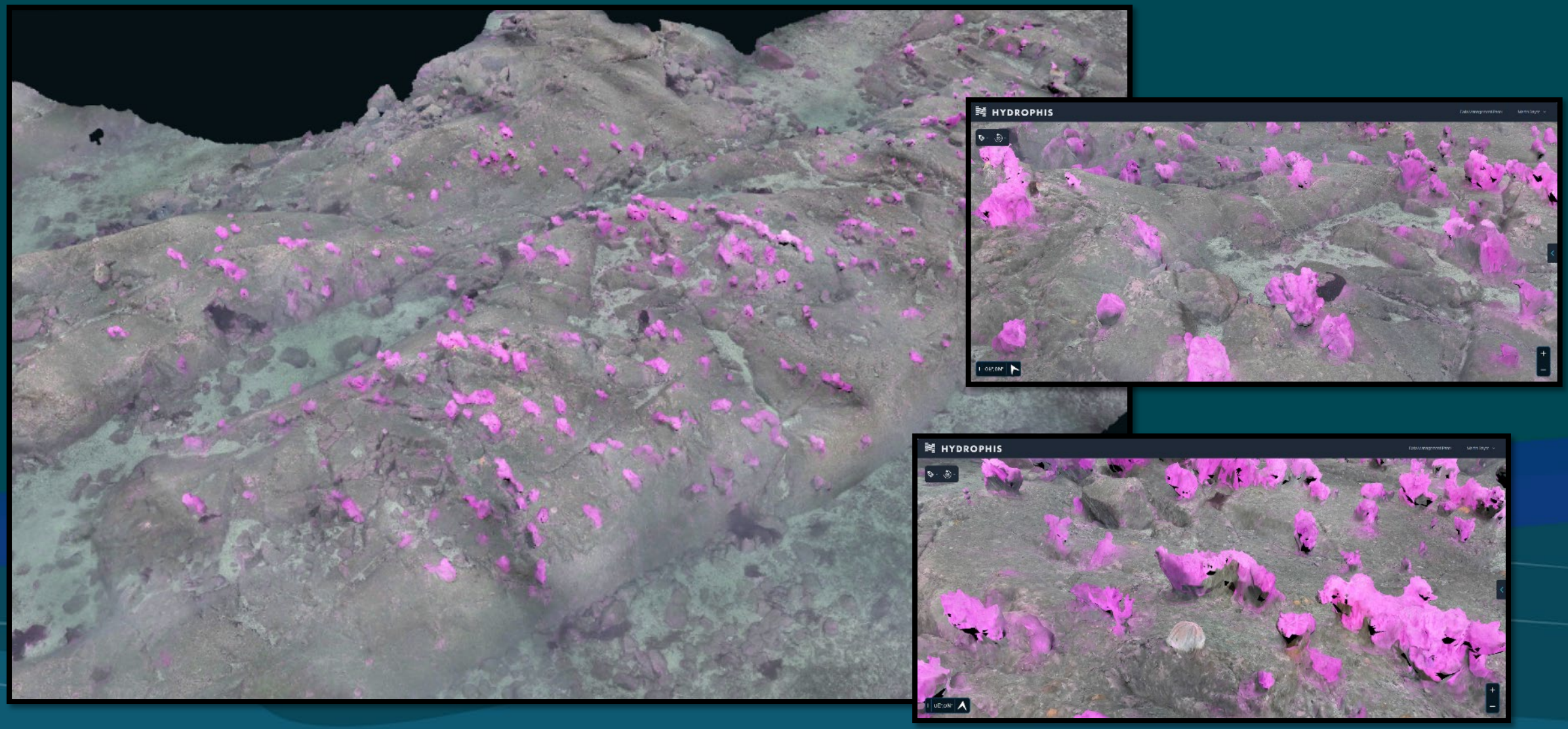
CASE STUDY 1

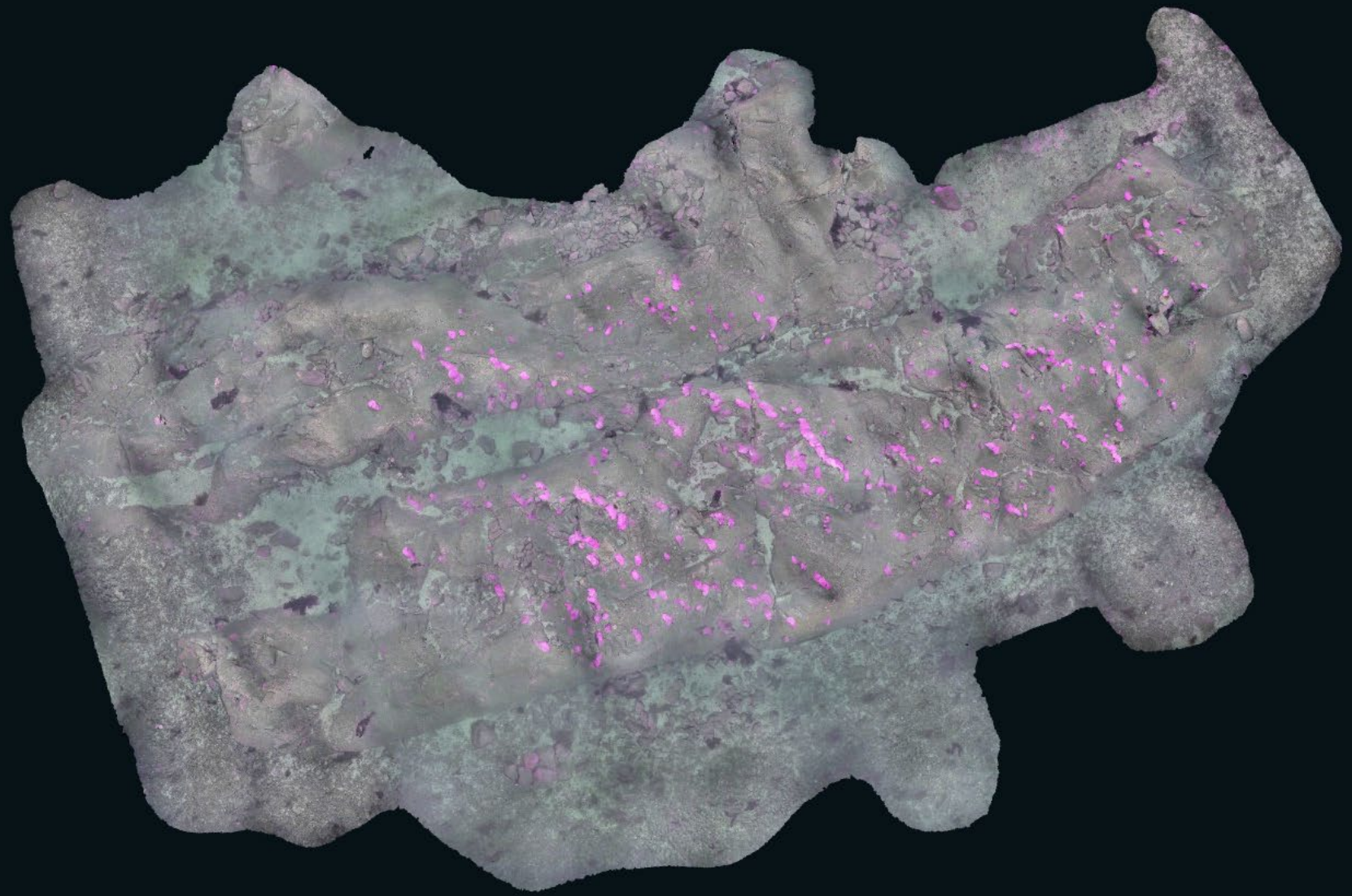
Quantifying vulnerable habitat



CASE STUDY 1

Quantifying vulnerable habitat





7.787 E°, 63.415 N°

CASE STUDY 1

Quantifying vulnerable habitat

High-resolution, georeferenced datasets provide new evidence about vulnerable habitats and species

Change / impact / recovery

Potential measurements:

- *coral abundance*
- *density*
- *distribution*
- *occupied area*
- *colony size / volume*
- *change through time*

REPEAT SURVEYS SEPTEMBER 2026

CASE STUDY 2

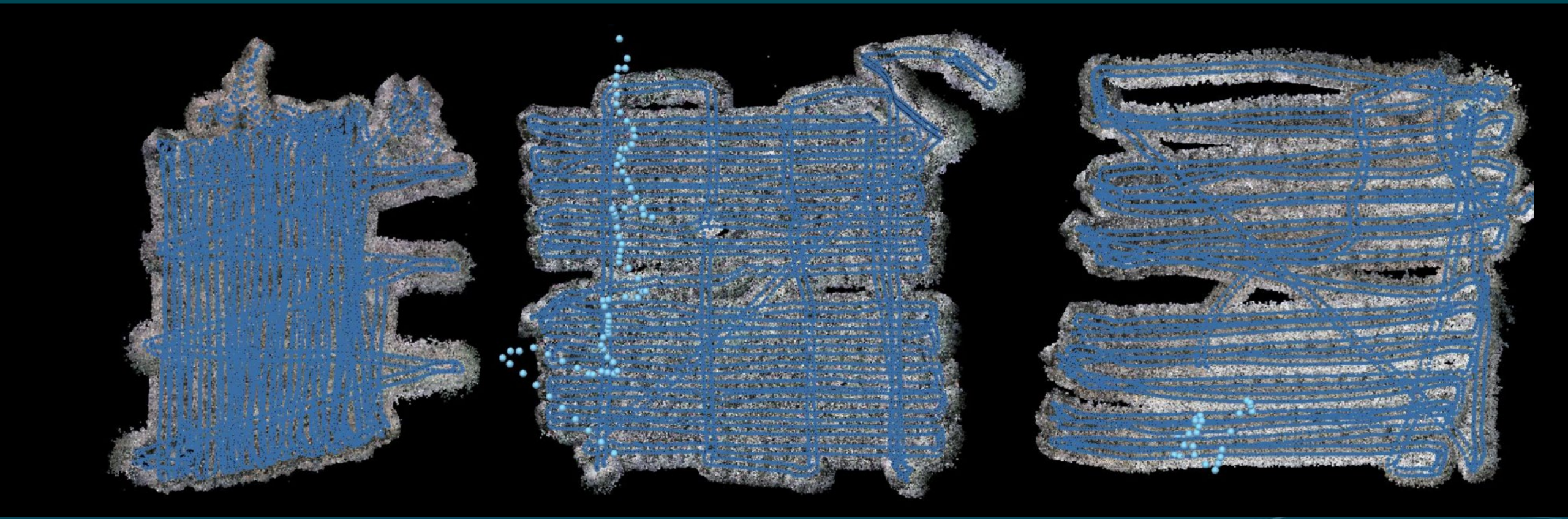
Scotland: 100% visual,100% autonomous – June / July 2026

Redacted images of fish farm survey maps of a site in Scotland that is the base for the FHF experiments
Images highlighted:

- that the site has hard, soft and mixed sediment types
- some of the traditional surveying failed where there was hard substrate seabed
- a revised survey design based on a nominal eight survey areas (two north of site, two south, two east, two west) where all sites are surveyed using ROVS employing autonomous navigation

CASE STUDY 2

Scotland: 100% visual,100% autonomous – June / July 2026



‘Lawn-mower’ navigation with cross passes for ground-truthing and geometric fidelity

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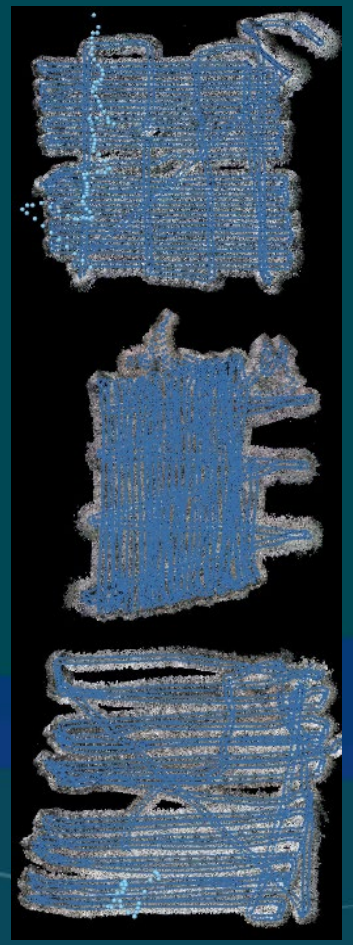


A fully autonomous visual environmental survey

100% visual

ROV imagery as the environmental survey dataset

100% autonomous navigation

Automated survey pattern, terrain following and altitude control

VIDEO

VIDEO


HYDROPHIS
Data Management Panel
Martin Sayer
0E°,0N°


HYDROPHIS
Data Management Panel
Martin Sayer
0E°,0N°

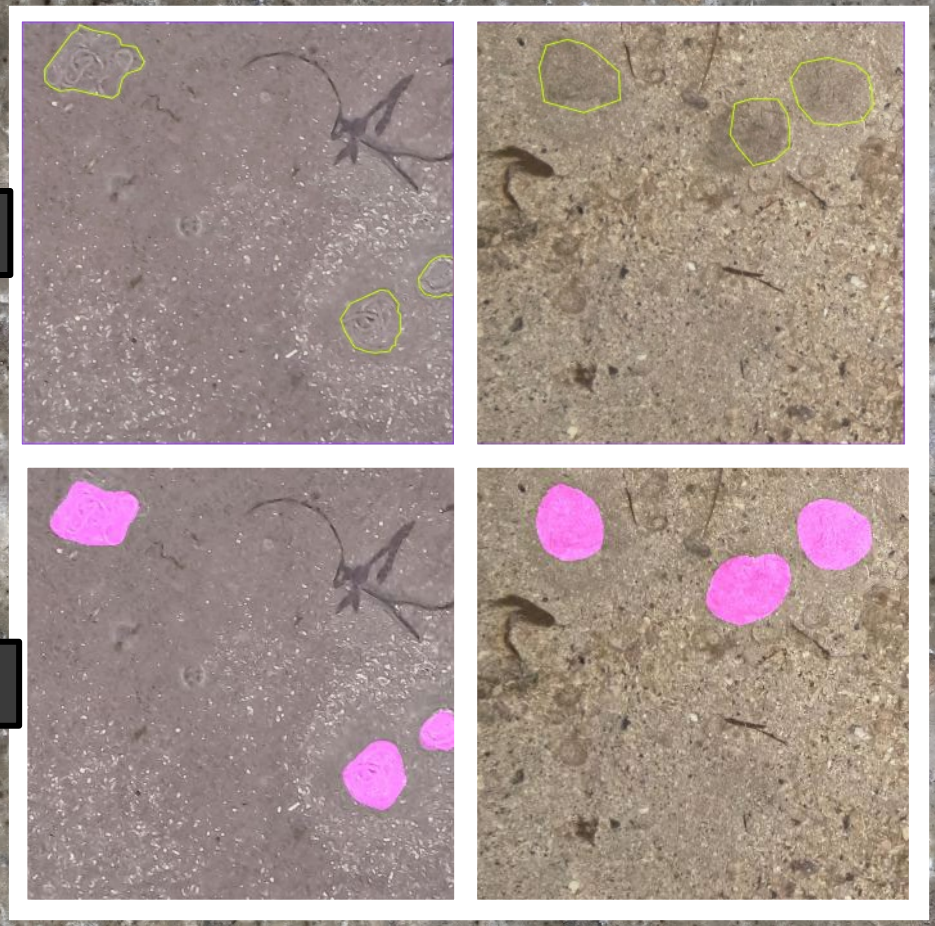

108.122 m

IMPACTS: Area of impact / changes in area with changes in farmed biomass
Microbathymetry – Digital Elevation Modelling over time / farm biomass

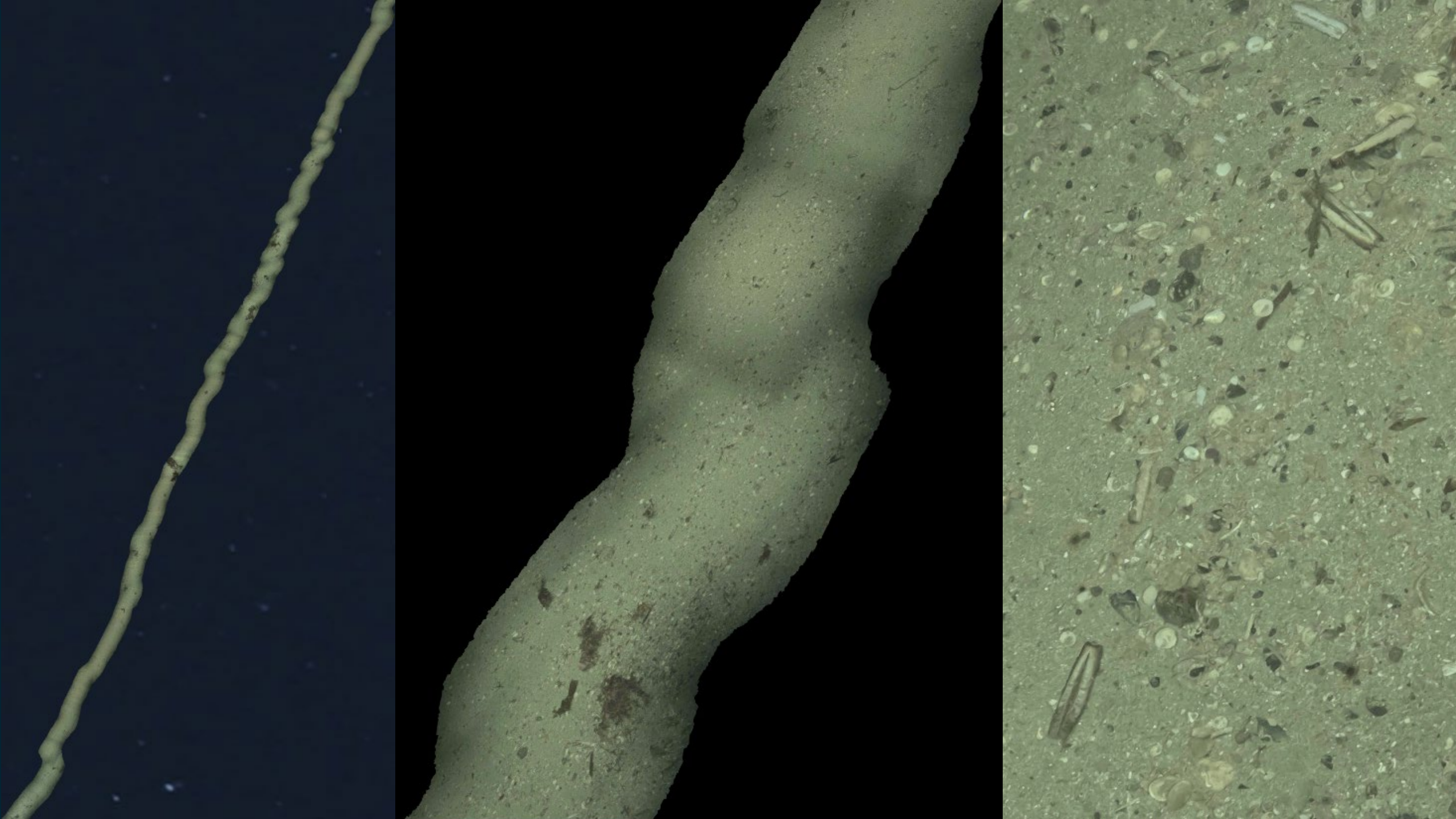
Beggiatoa microbial mats on the seabed may be linked to the organic matter enrichment

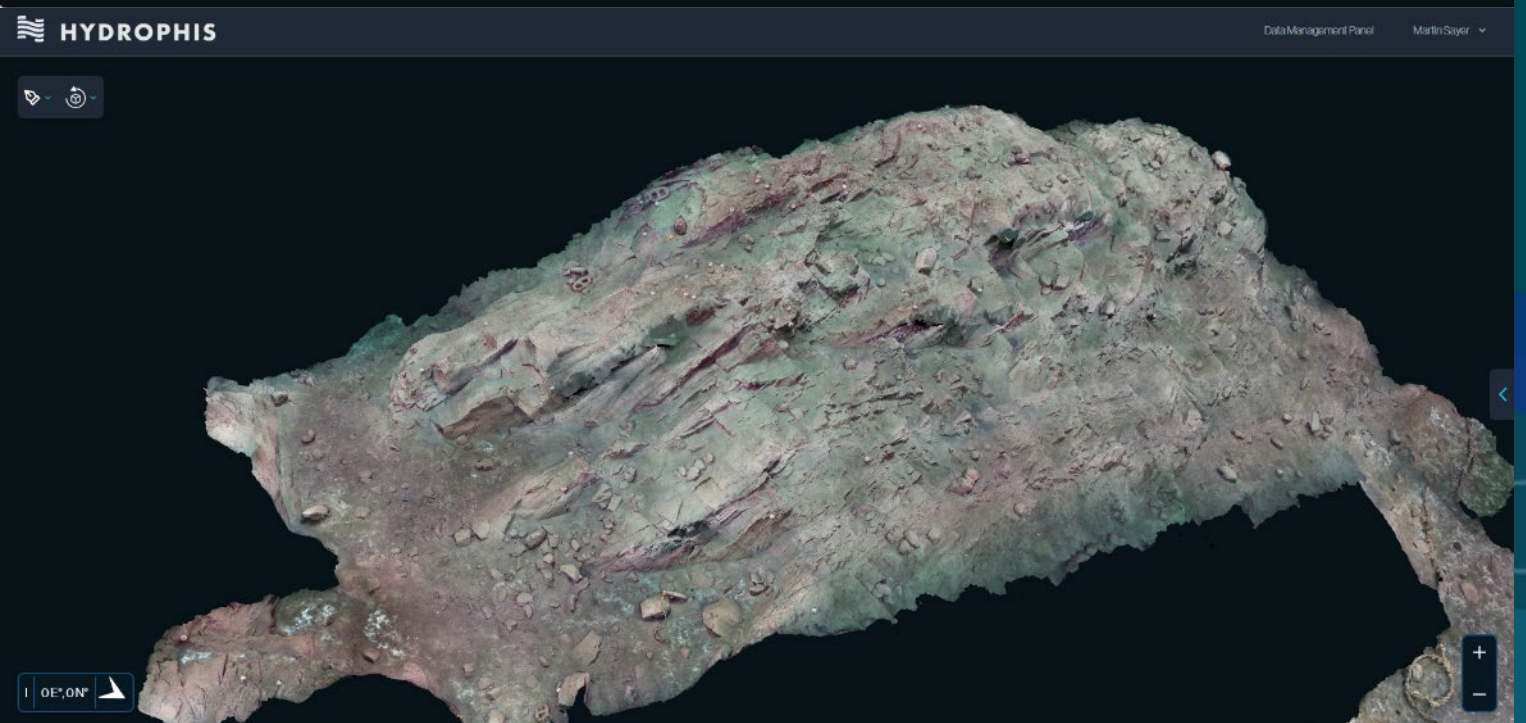
Ground truth →

ML predicted →



ML-based detection and quantification of biogenic structures in 3D imagery, and their spatial distribution: possible additional indicators of benthic condition? (Pezzola 2021)





ROV Piloting:

manual = 3x duration of automated to ensure 100% cover

Image pre-processing:

Both employ ML-assisted pre-processing and image cataloguing (2x faster than manual; more consistent exports)

Auto v manual processing:

manual processing = 3x duration of automated caused mostly through manual sorting and removal of duplicate data

Autonomy and georeferencing

from surveying to repeatable monitoring

Precise positioning
↓
Automated survey pattern
↓
Consistent coverage
↓
Repeatable acquisition
↓
Comparable datasets
↓
Measure change

Consistency
Less dependence on individual ROV pilots

Coverage
Efficient acquisition of larger areas

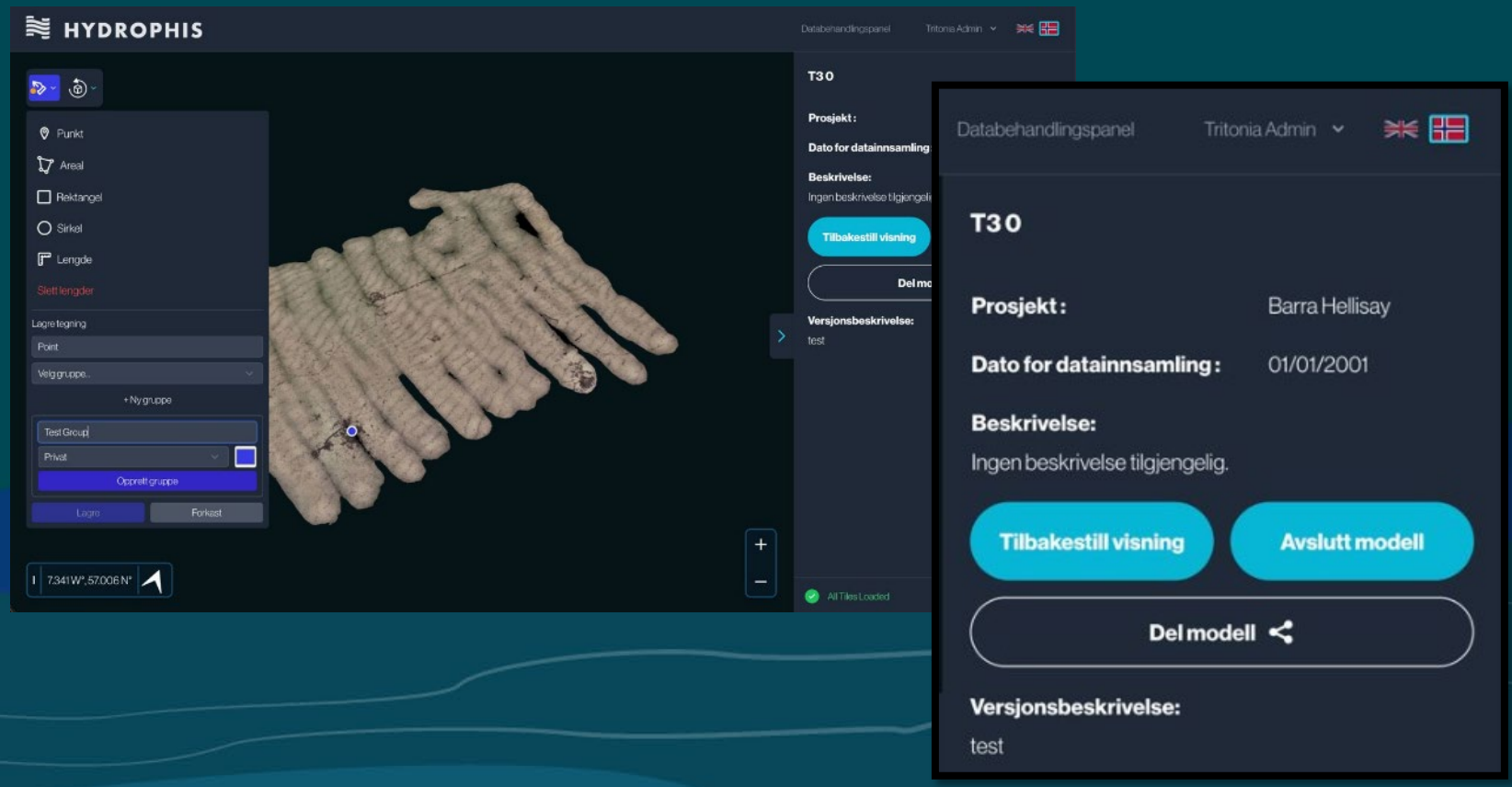
Repeatability
Return to the same spatially defined survey

HYDROPHIS

Spatial data | 3D models | orthomosaics | classification | change detection

G3DP generates the spatial data. ***Hydrophis*** makes them accessible, comparable and useful over time

- G3DP
- MBES
- ROV imagery
- Species observations
- Environmental data



What could this mean for any revision of NS 9410?

G3DP has the potential to provide new levels of spatial evidence

Today	Potential future
Discrete samples	Spatially continuous imaging
Point observations	Georeferenced seabed record
Primarily sediment-focused	Sediment + habitat + epifauna
Condition assessment	Condition **and change detection**
Survey → report	Survey → reusable digital dataset

Regulatory consideration:
Norwegian national-security requirements concerning detailed seabed information need to be accommodated within any high-resolution monitoring methodology

What could this mean for any revision of NS 9410?

FHF Project Number: 910484

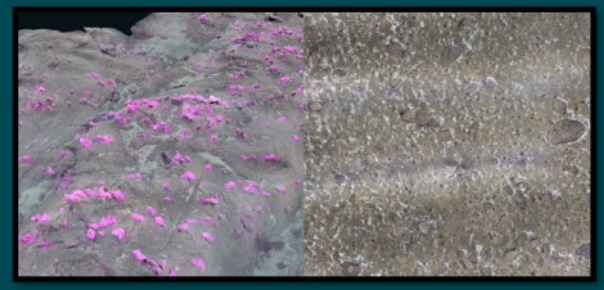
Accuracy
Can we measure what we claim to measure?

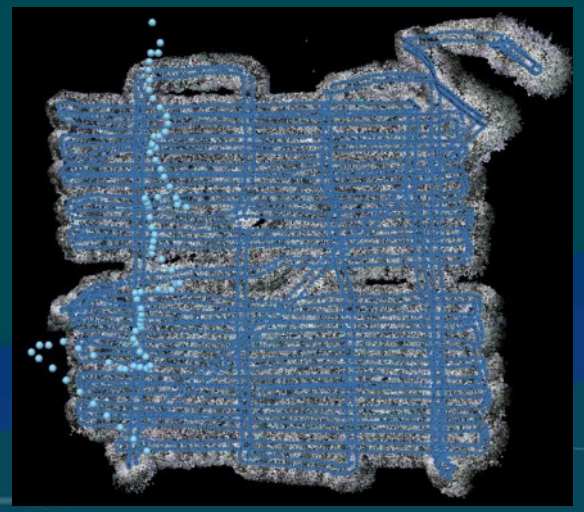
Repeatability
Can the same area be surveyed consistently?

Detection
Can we reliably identify relevant organisms / habitats?

Change
Can differences between surveys be quantified?

Regulatory confidence
Can the outputs be independently verified and audited?





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From documenting the seabed to measuring it

G3DP provides the ability to acquire accurately georeferenced seabed data, repeat the surveys, quantify what is seen and increasingly automate the analysis.

G3DP works, but can these capabilities be validated and incorporated into future environmental monitoring standards?

Questions?