

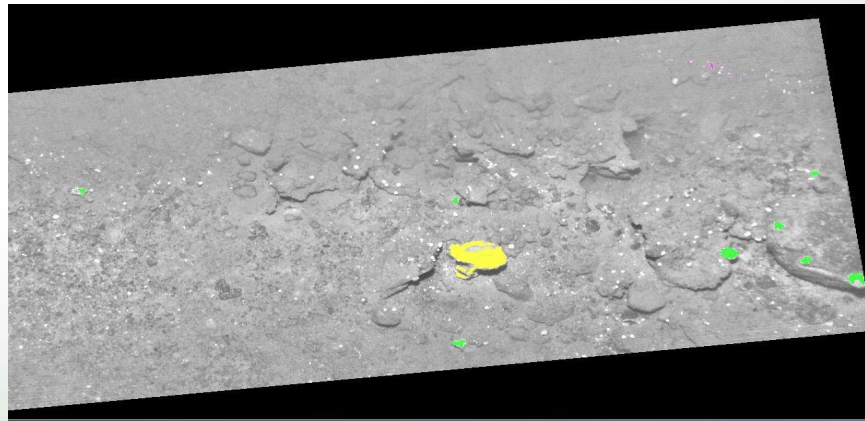
Seabed mapping project for Lundin Norway AS



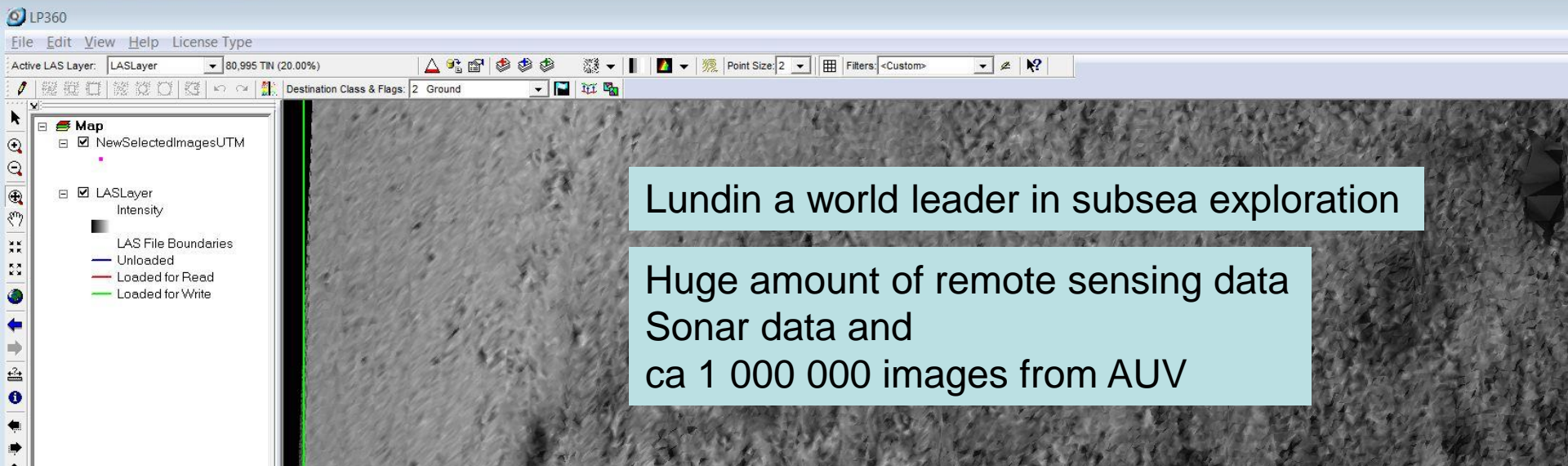
“Lundin sees the information that is gained through the extensive seabed mapping as relevant to the whole E&P value chain.



It provides us with detailed information about local and regional variations in the seabed environment, natural leakage of hydrocarbons from seabed, potential geohazards, and suitability of sea bottom for future seabed installations.”

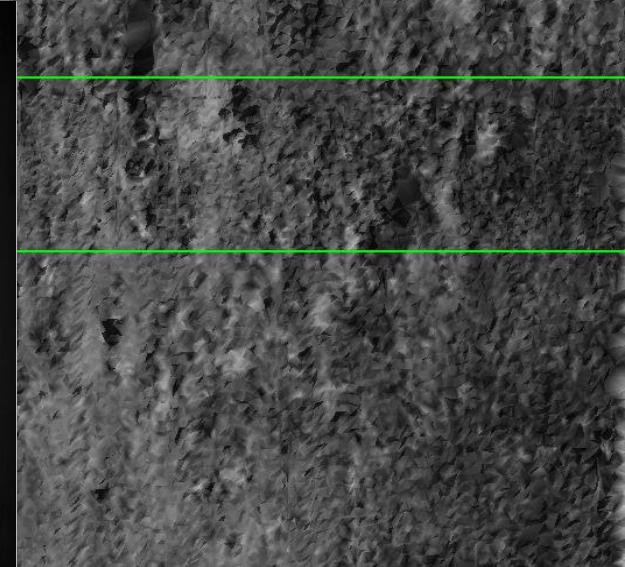
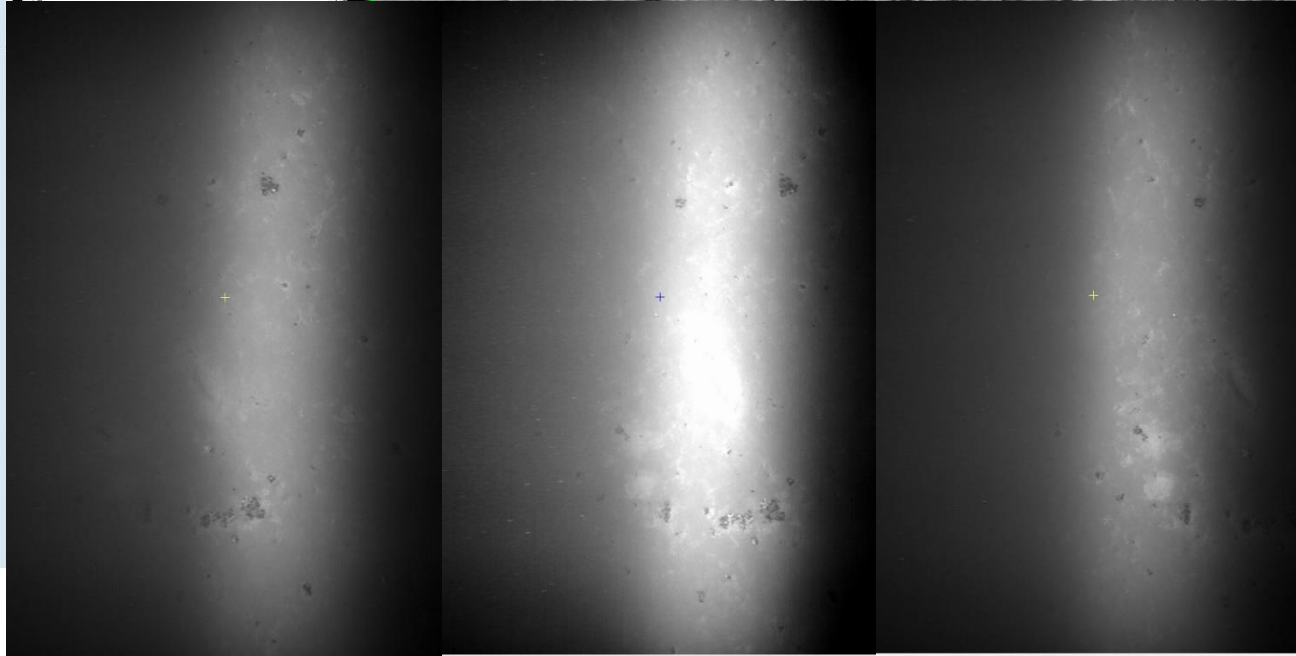


Seabed mapping project for Lundin Norway AS

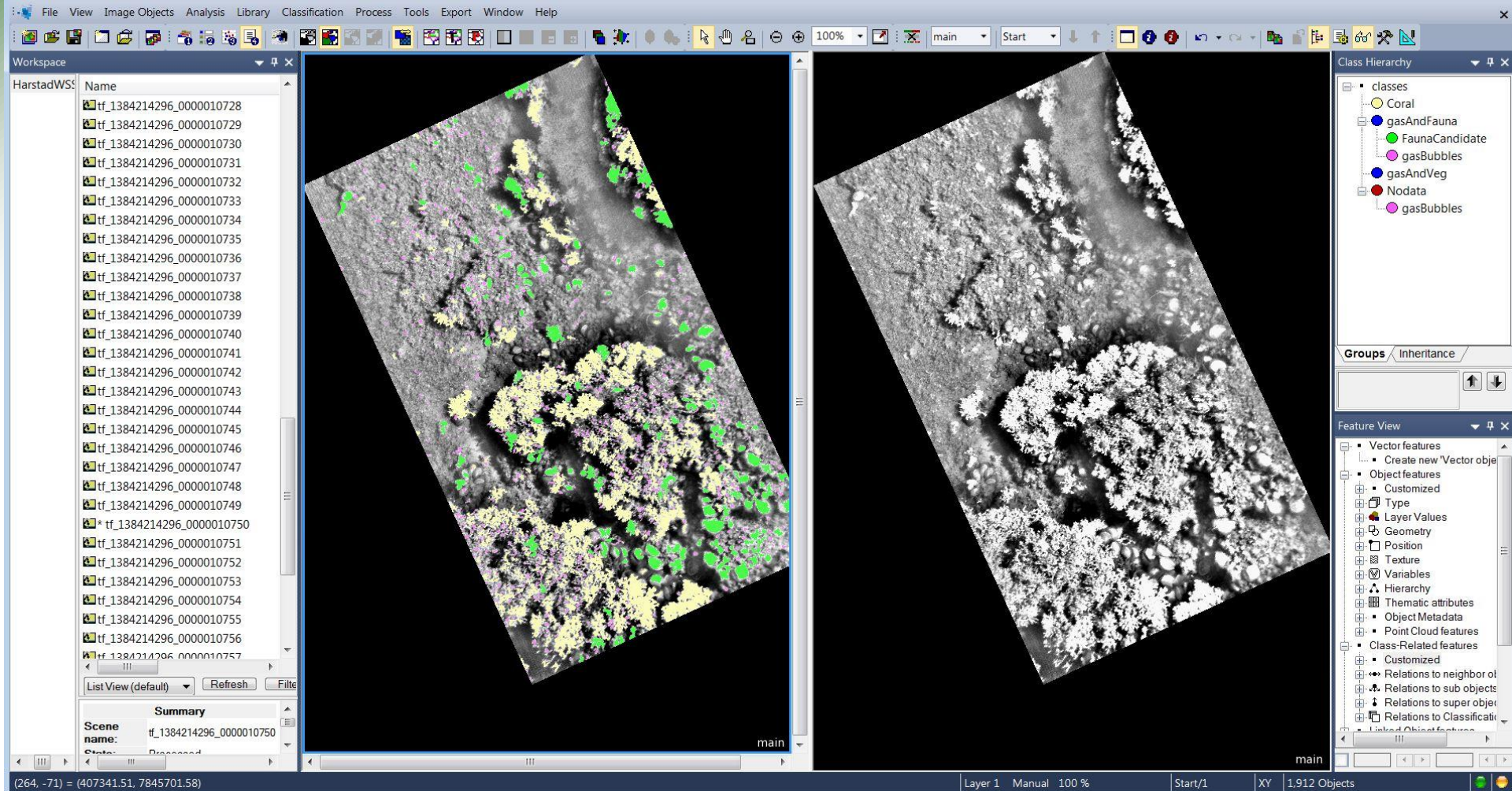


Lundin a world leader in subsea exploration

Huge amount of remote sensing data
Sonar data and
ca 1 000 000 images from AUV

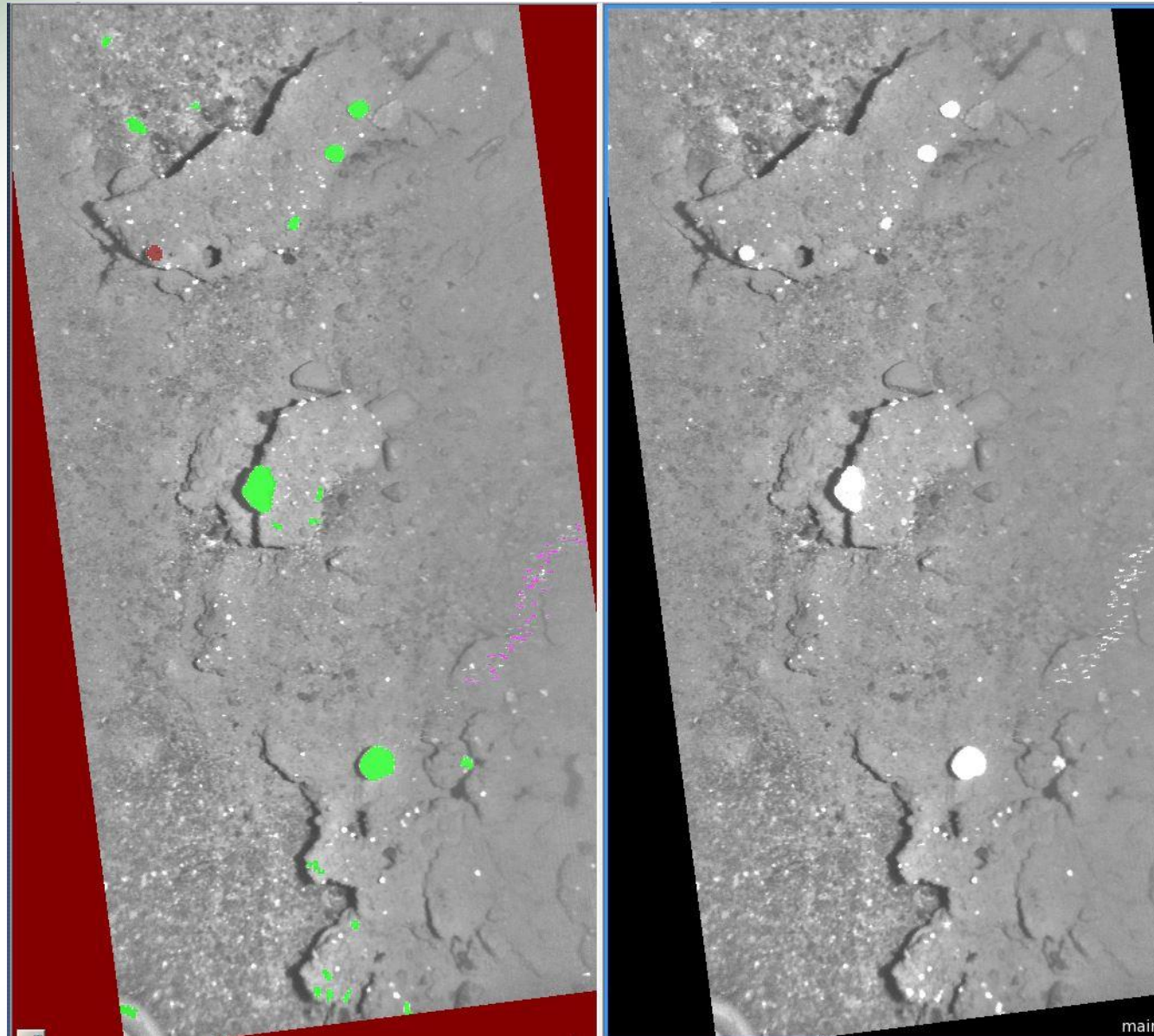


Environmental analysis of images from the seabed

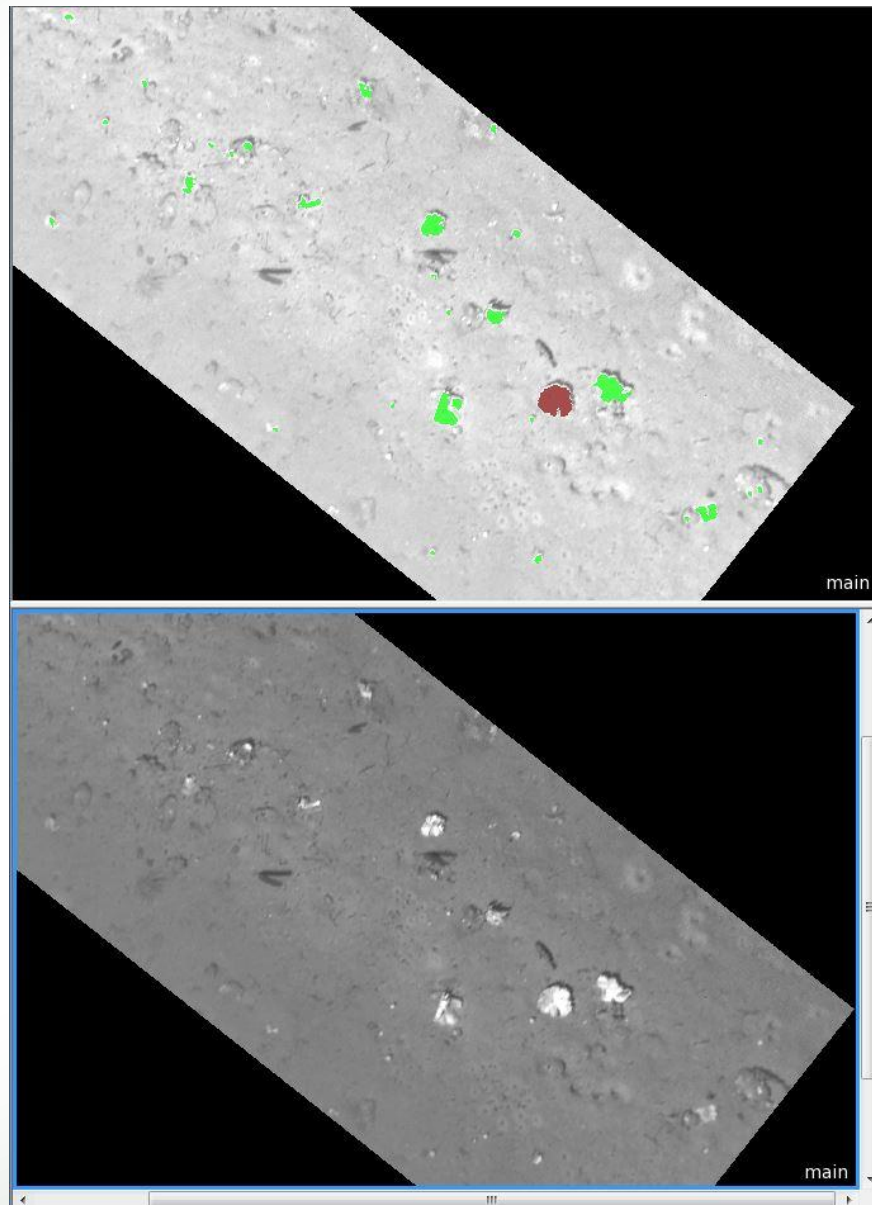


What species will be affected by operational activities

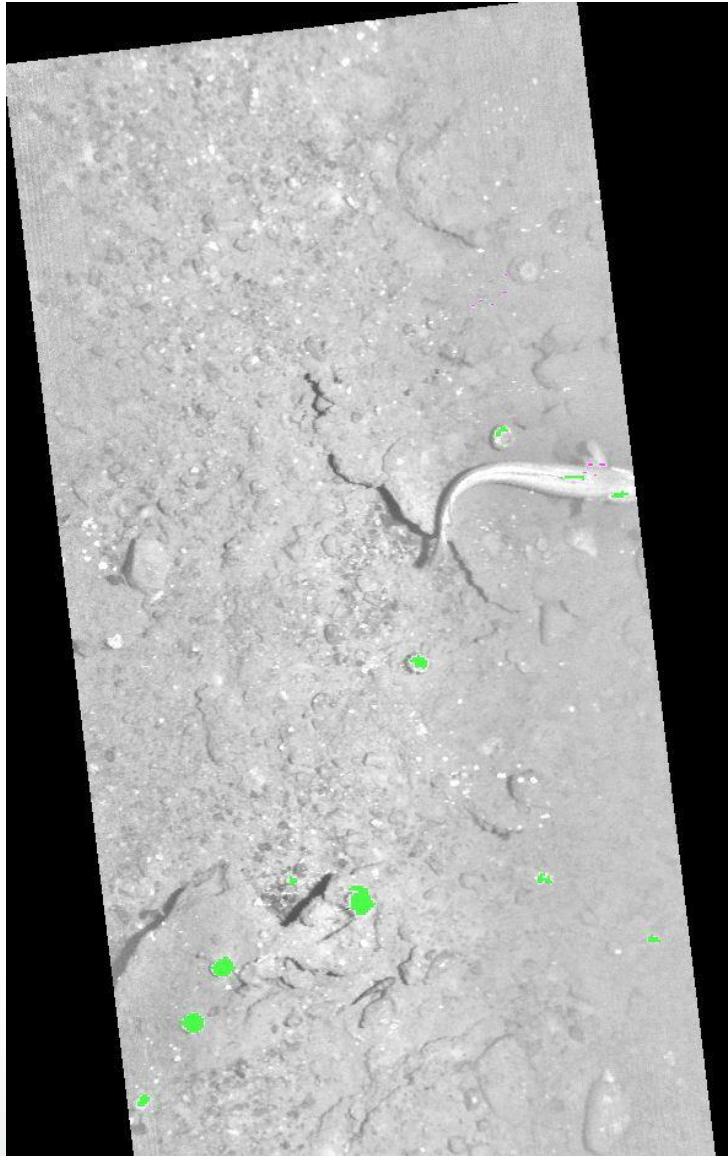
Hydrocarbones and fauna



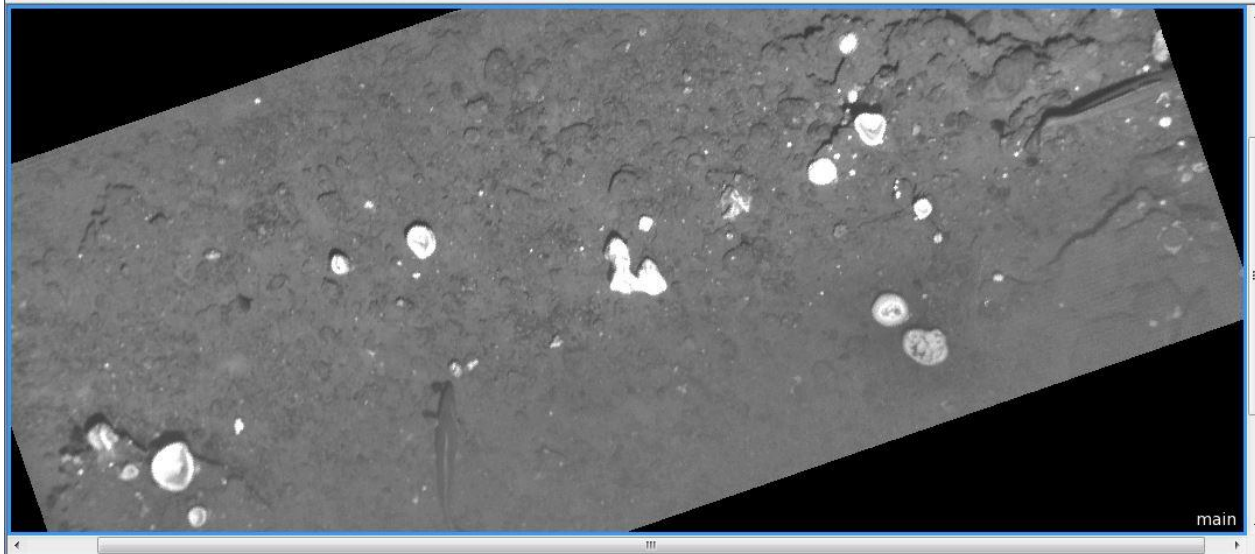
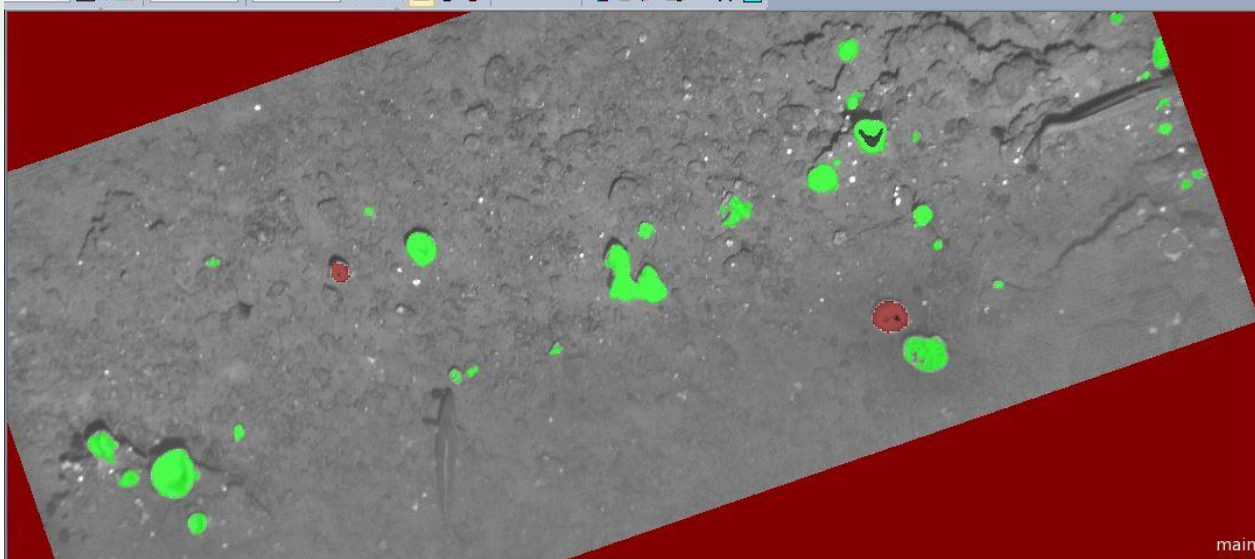
Anemones



Crust and gas



Sponges - Geodia



Coral and mussels

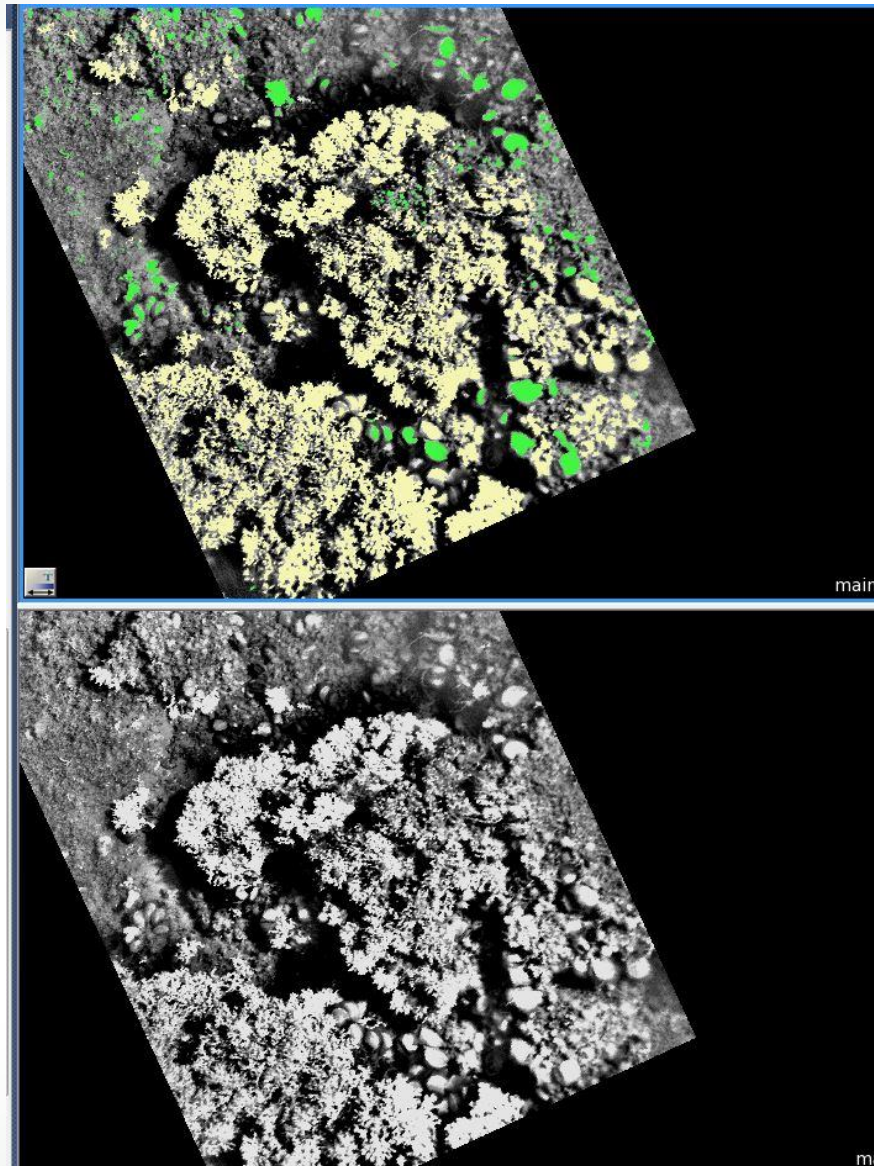
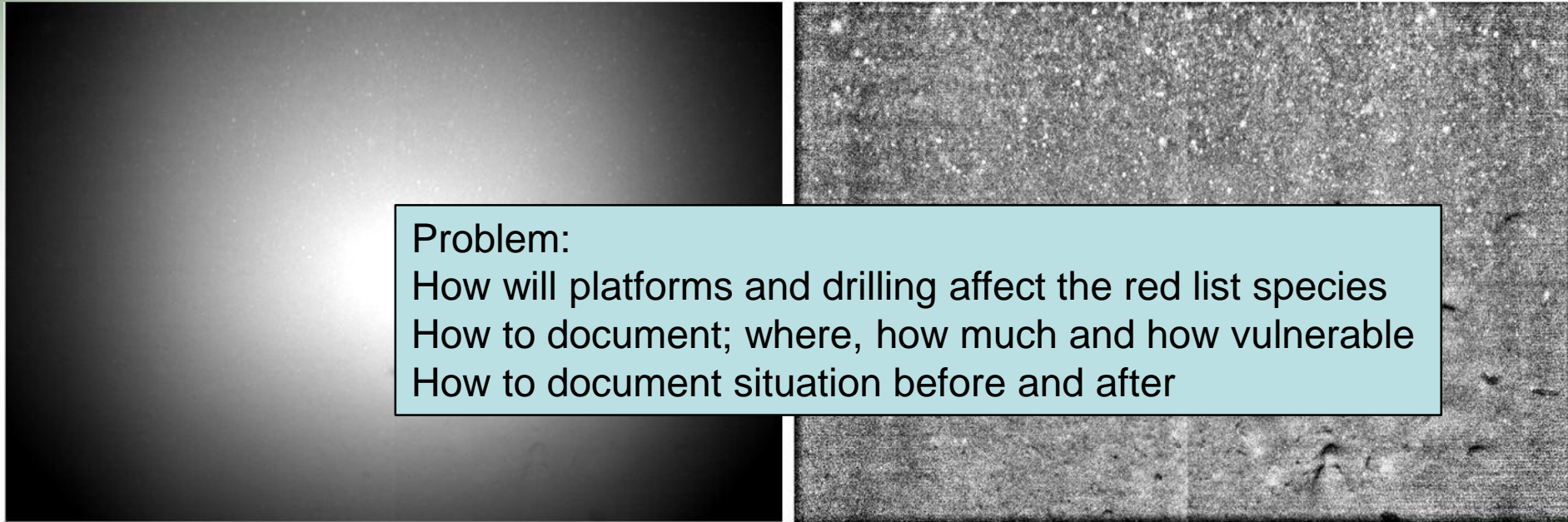


Image Light Compensation is important



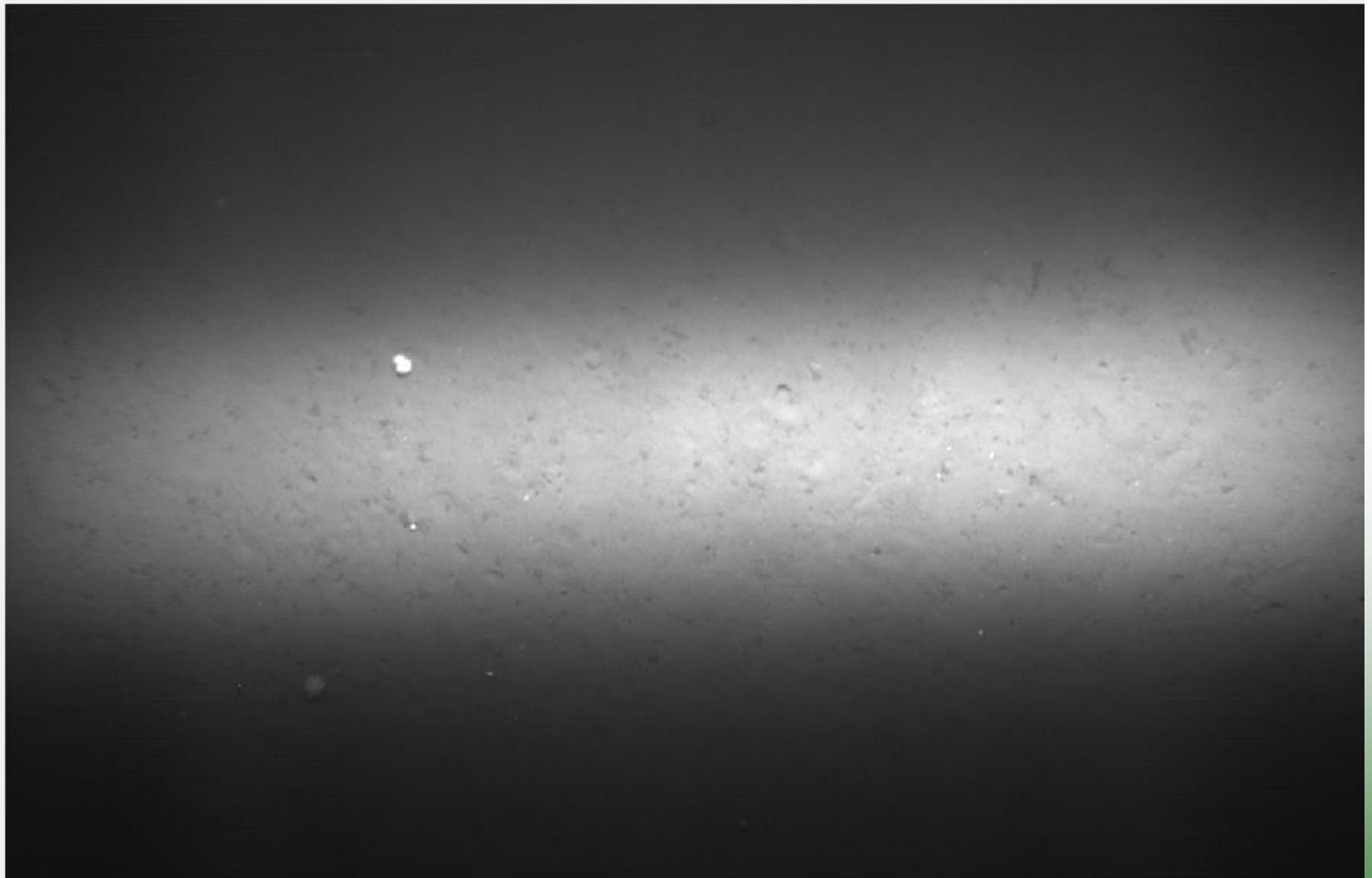
Problem:

How will platforms and drilling affect the red list species
How to document; where, how much and how vulnerable
How to document situation before and after

120, 16 bit

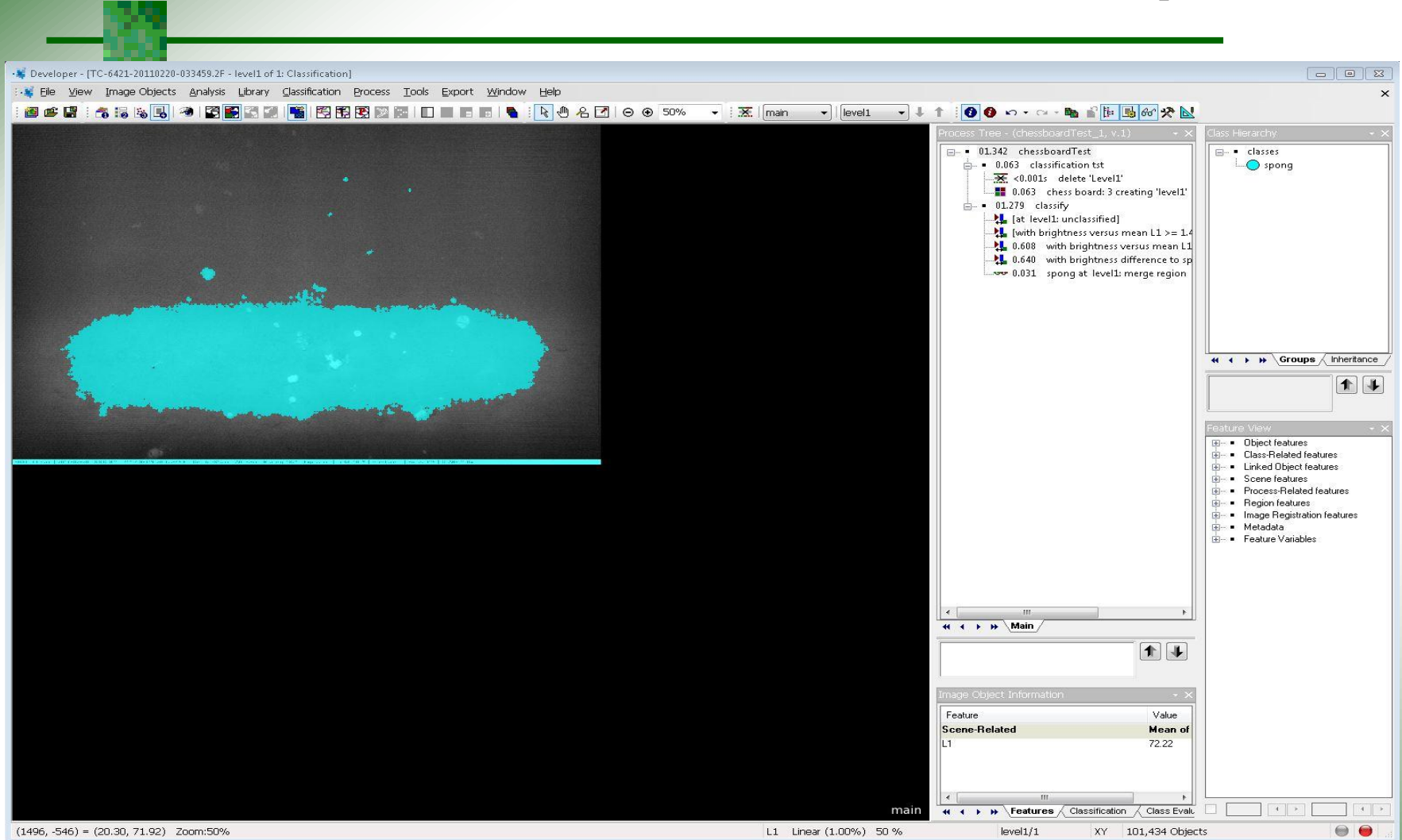
120, 16 bit enhanced

Artificial light a challenge



The light is strong in the centre
Less light to the sides

Automatic machine classification impossible



Objects to be classified will be different in the centre than to the sides. In this example the image became one light object ...not very useful

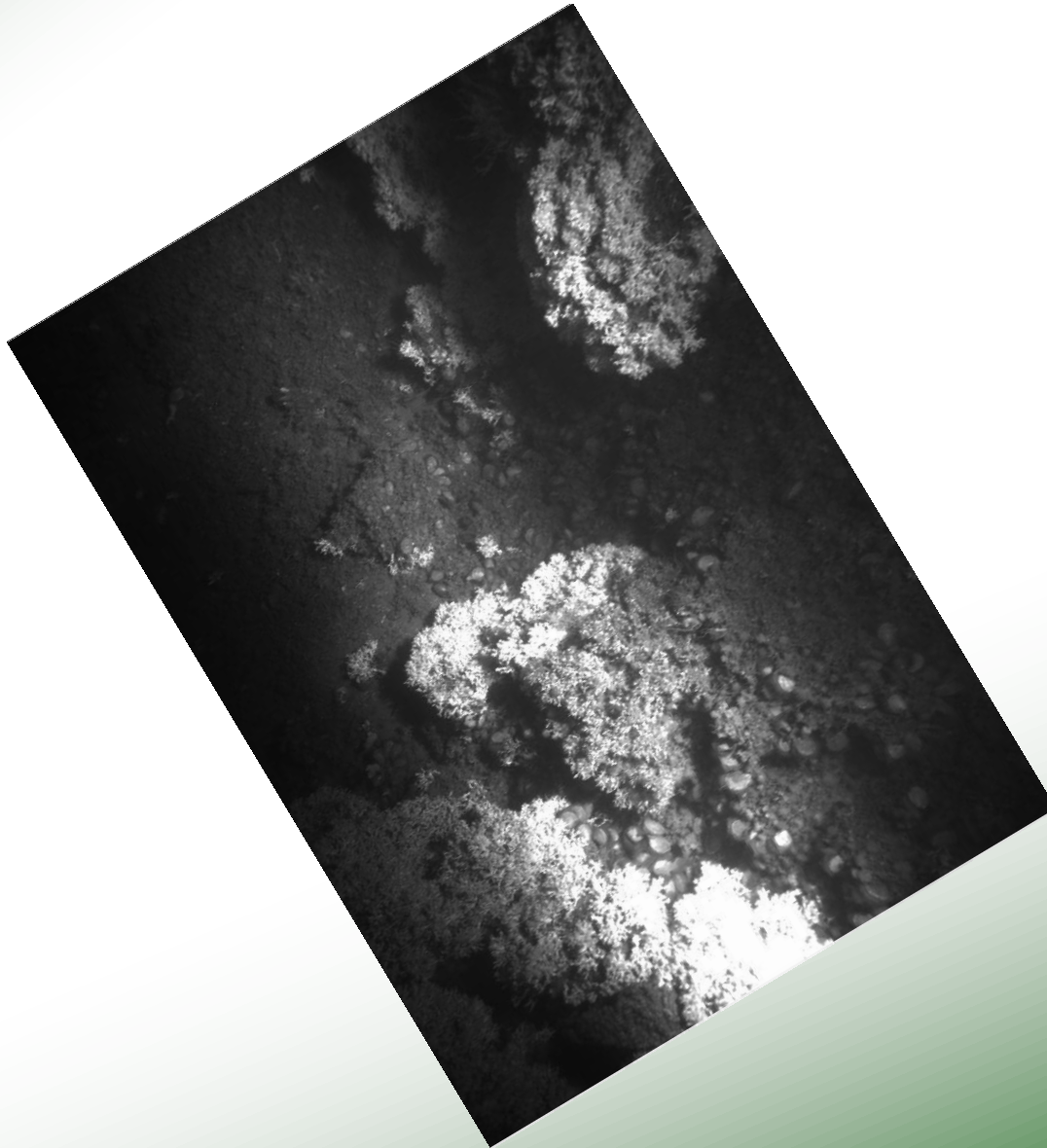
How we solved the problem



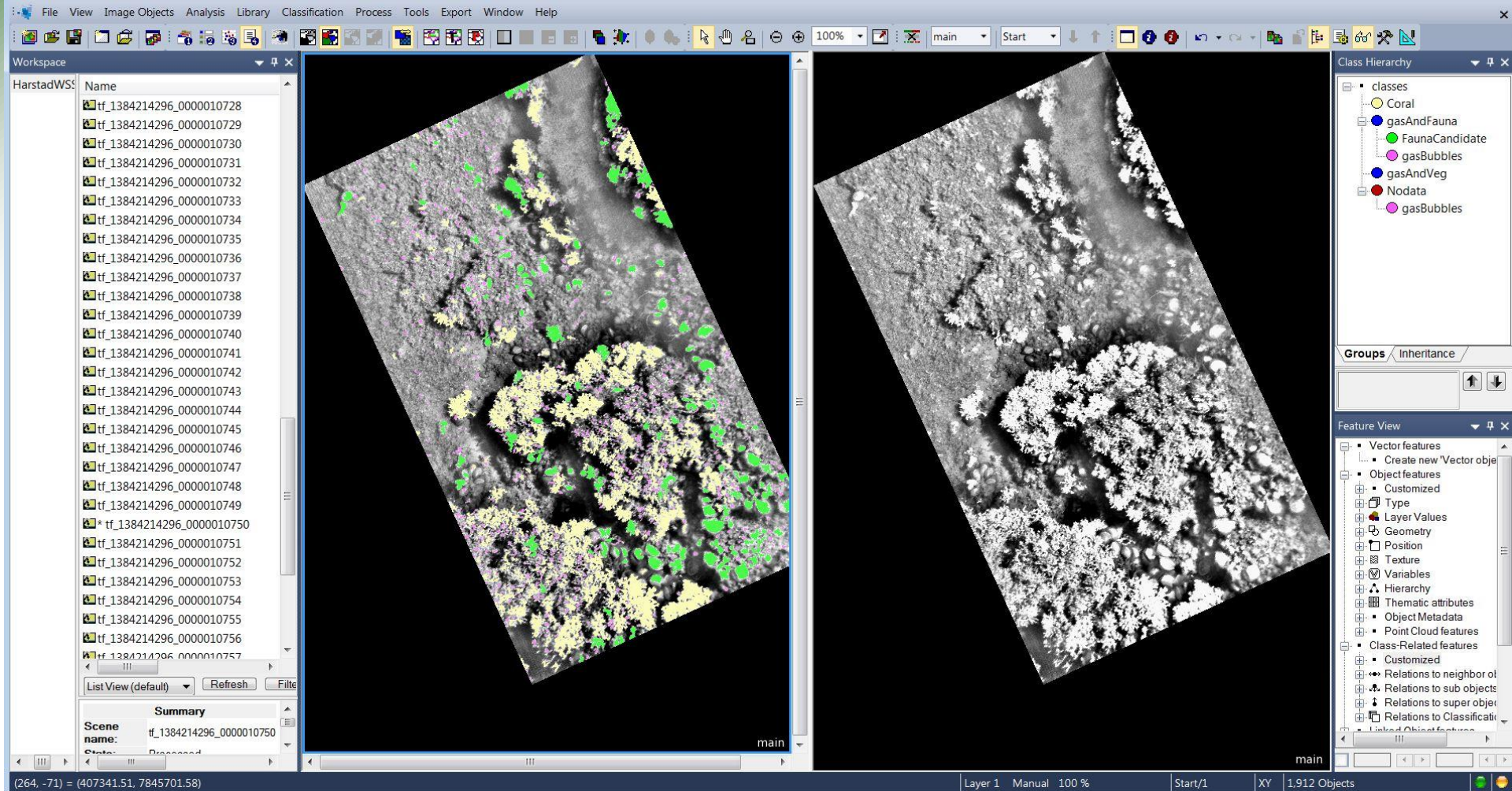
- No standard software in the market could handle the images
- TerraNor developed Image Light Compensation ILC software
- Solution: TerraNor ILC
 - GPU processing with **CUDA/OpenCL**
 - Automatic batch processing
 - High speed for 1 000 000 images
 - Compensation, orthorectification and new image format included
- Software process:
 - Different light conditions and distance to seabed
 - Perfect result without user interaction (no time for that)
 - Automatic orthorectification based on DEM or Distance to seabed
 - Standard image format out for use in other software (PCI, eCognition, ESRI)
 - eCognition Developer used to classify objects



Original image coral

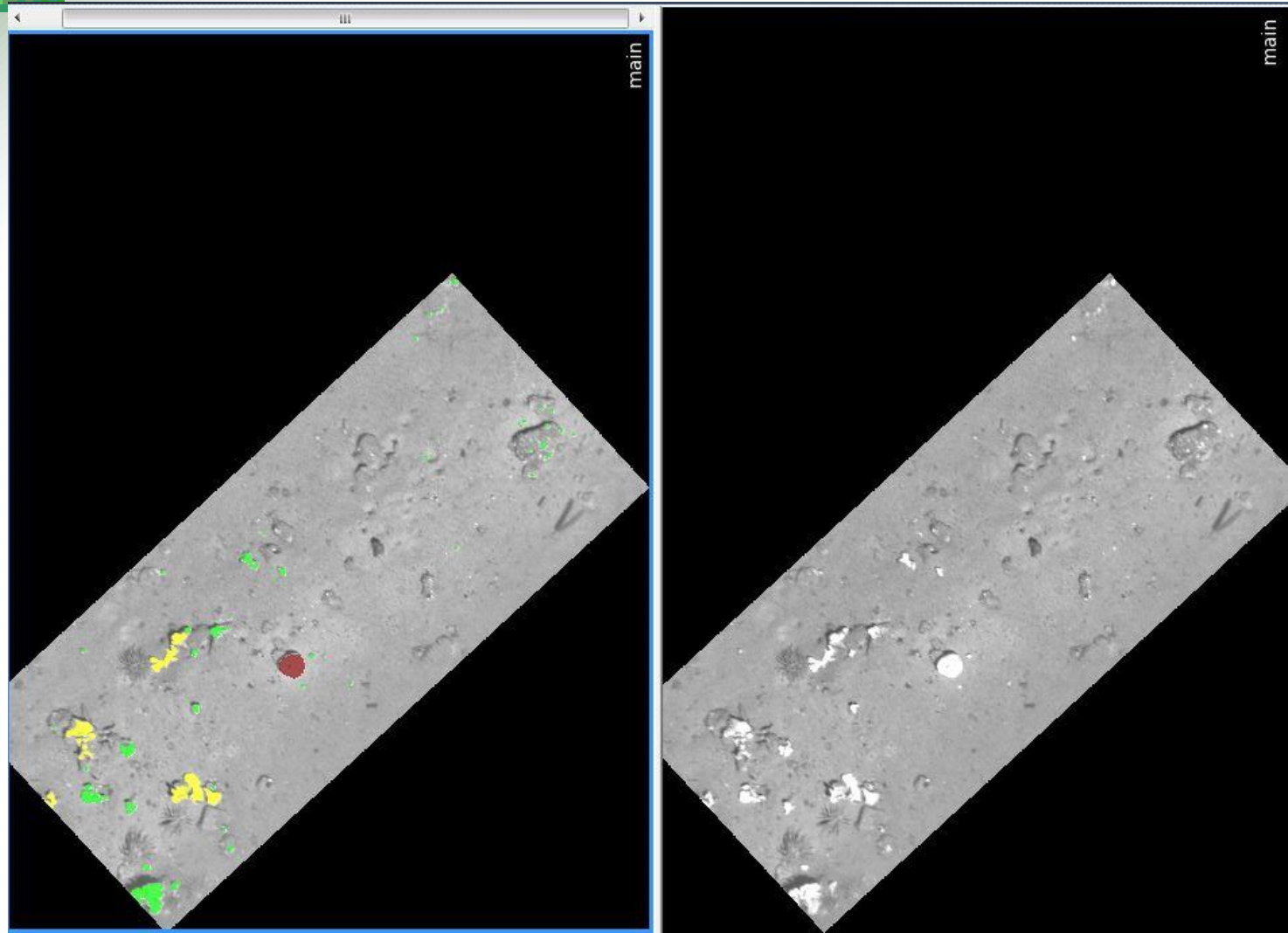


Compensated and classified image



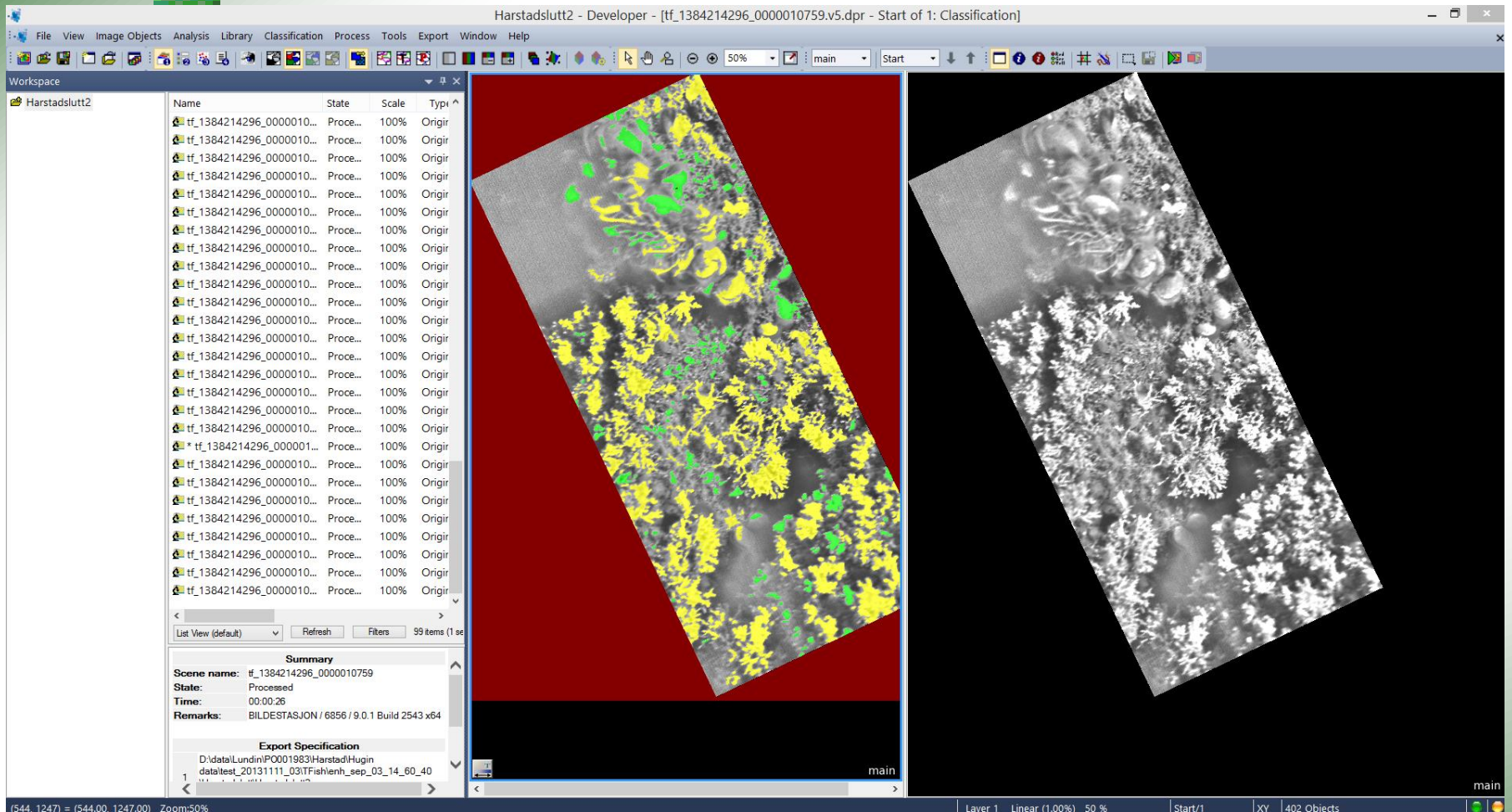
eCognition developer workspace

Anemone and feather + wrong classification



You cannot win them all...

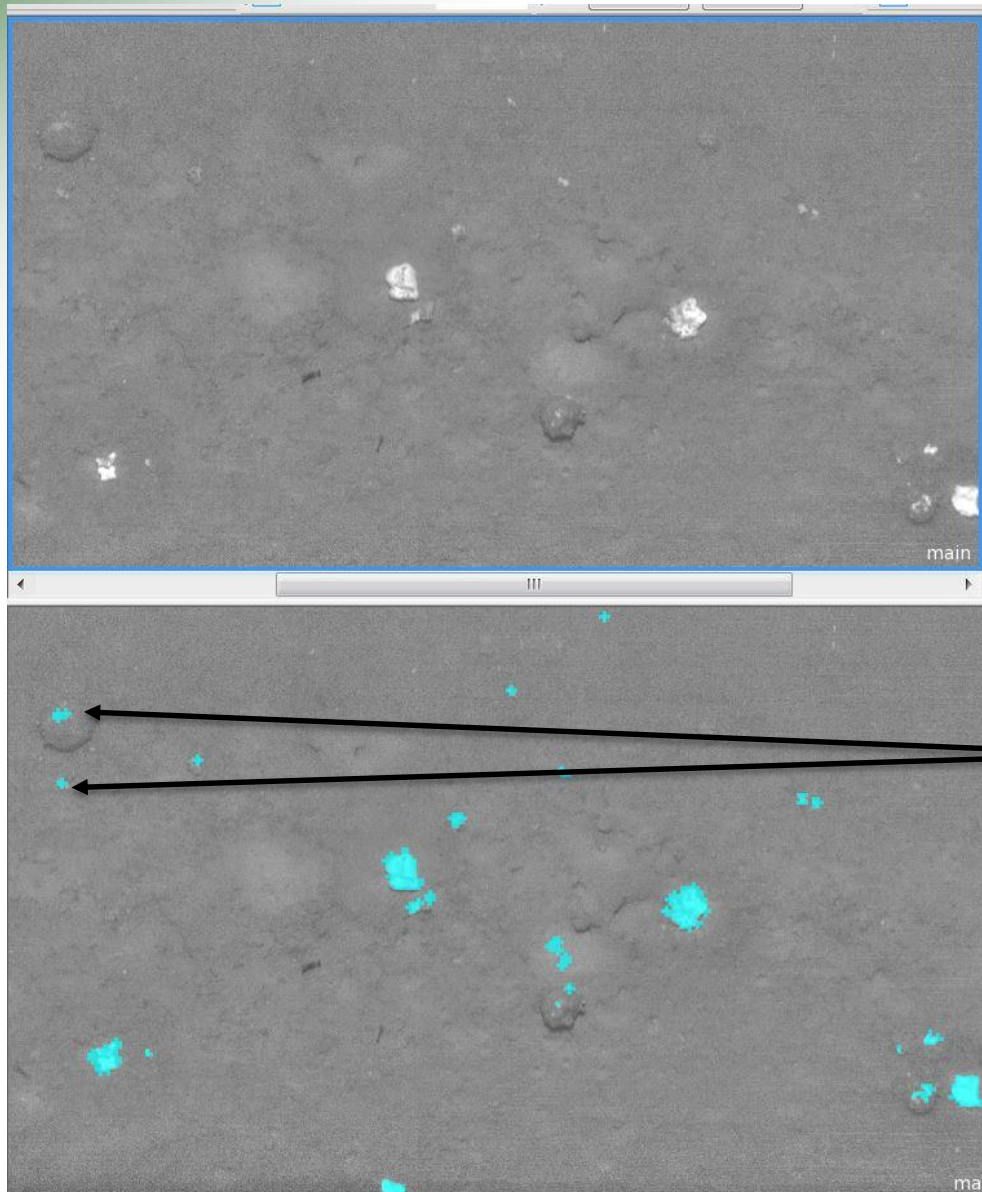
Workspace in eCognition



With images in geotiff format we can analyze images in batch in Trimble eCognition classification software.

Together with Lundin staff, TerraNor developed the rulesets.

Sponges



Notice the classified objects
that are difficult to see manually

Production line

The screenshot displays the eCognition Developer software interface. The main window is titled "ffi_sponges - Developer - [6420.v23.dpr - level1 of 1: Pixels]". The interface includes a menu bar (File, View, Image Objects, Analysis, Library, Classification, Process, Tools, Export, Window, Help) and a toolbar. The workspace is divided into several panels:

- Workspace:** A list of objects with columns for Name, State, Scale, and Type. The list includes objects 6420 through 6427.
- Main View:** A large image view showing a grayscale image of a sponge. Below it, a smaller view shows the same image with colored overlays (red, green, blue, yellow) representing different object classes.
- Process Tree:** A hierarchical view of the processing steps. The tree shows a sequence of operations: Segmentations, delete 'Level1', delete 'SamplesLevel', disconnect all samples, Merge similar objects, unclassified with difference mean brightness to whole scene, [5x: with brightness versus mean L1 <= 1.15 at Level1: spectra], at Level1: copy creating 'SamplesLevel' below, Classify shadows, unclassified with Brightness <= 14500 at Level1: shadow, Manual classification, train classifier, at SamplesLevel: unclassified, Fish, mud, rock, shadow, sponge, TryGaz at SamplesLevel: classified, apply machine learning to all maps, Fish, mud, rock, TryGaz at Level1: unclassified, unclassified at Level1: classifier: apply.
- Class Hierarchy:** A tree view showing the classification hierarchy. The classes are: Fish, mud, rock, shadow, sponge, and TryGaz.
- Feature View:** A table showing the features used for classification. The features are: Object features, Class-Related features, Linked Object features, Scene features, Process-Related features, Region features, Image Registration features, Metadata, and Feature Variables.
- Image Object Information:** A table showing the values for various features. The features are: Object features, Customized, area_length, brightness versus mean L1, length_width, rel border to area, Relational Feature 2, Layer Values, Mean, Brightness, Layer 1, L1, Layer Values, Standard deviation, L1.

The status bar at the bottom shows the coordinates (368, -8) = (475657.63, 7979742.61), Zoom: 50%, Dist: 4.92 Meters, L1 Linear (1.00%) 50 %, level1/1, XY 132,040 Objects.

Rule set in eCognition and Workspace for batch processing

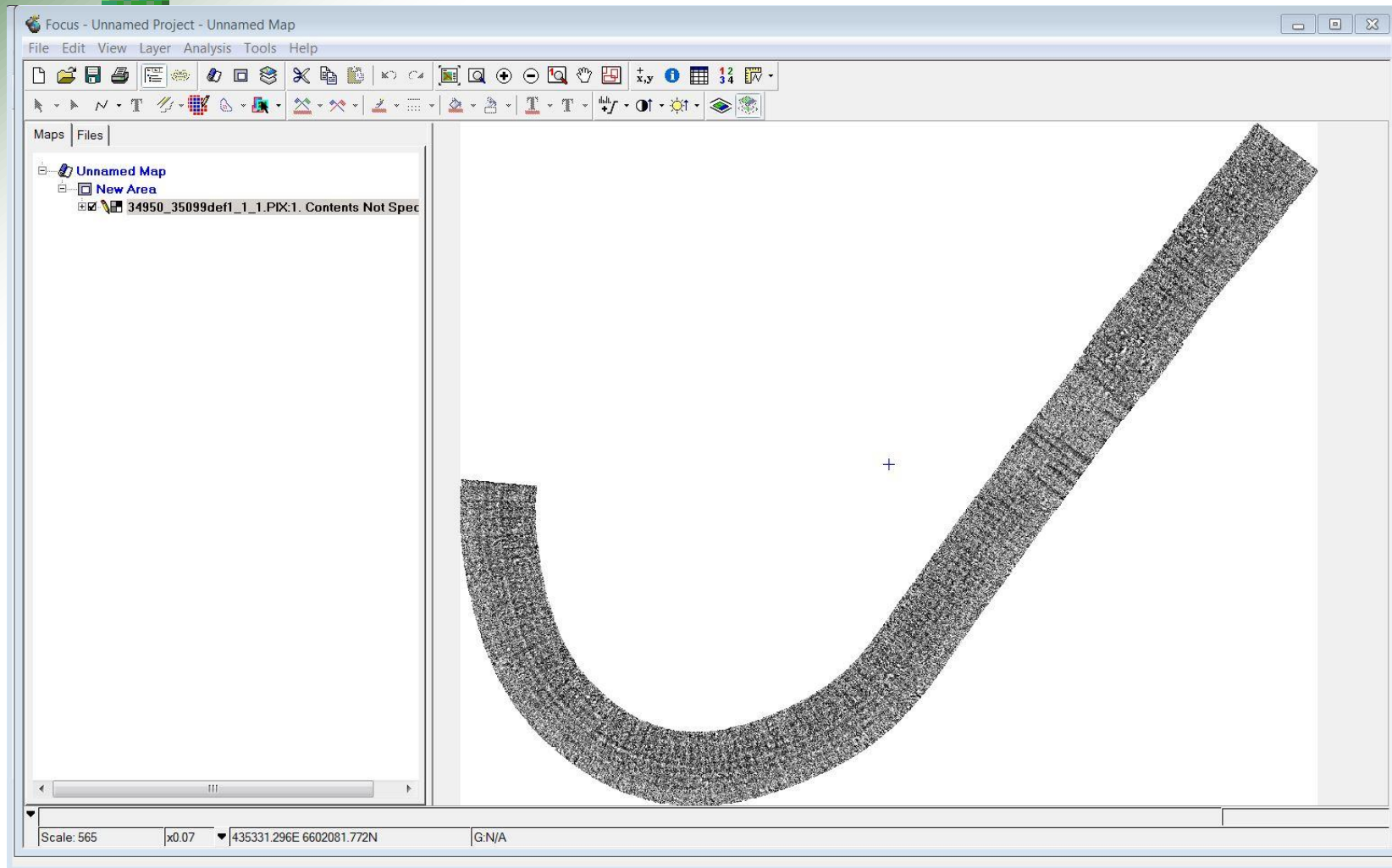
Classification of 50 000 single images



We classified:
Crust
Gas
Corall
Anemone
Sponge

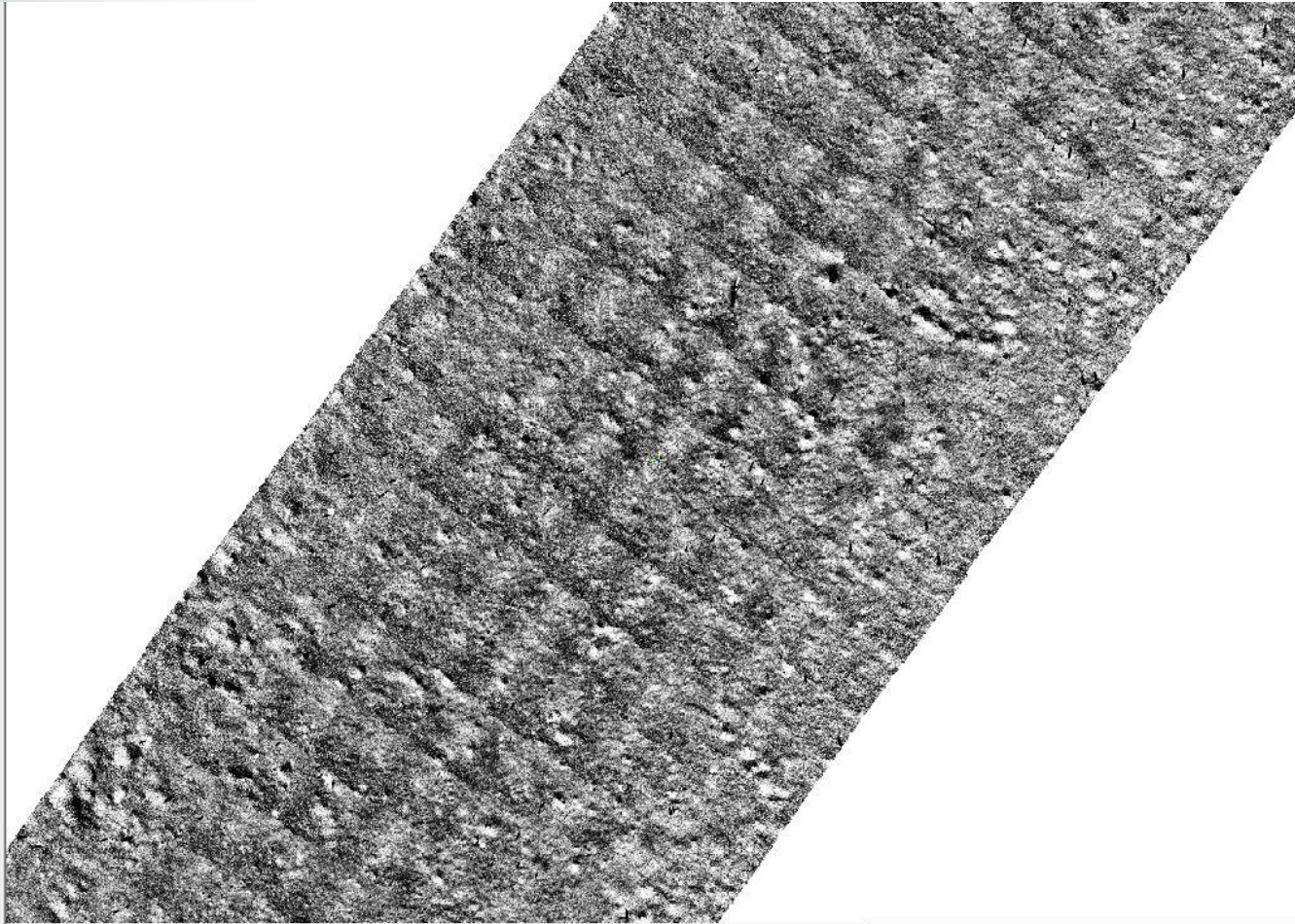
All images with red list species were found.
Images without red list species did not show any classification.
False classification was not a problem.

Orthorectified images can be mosaicked

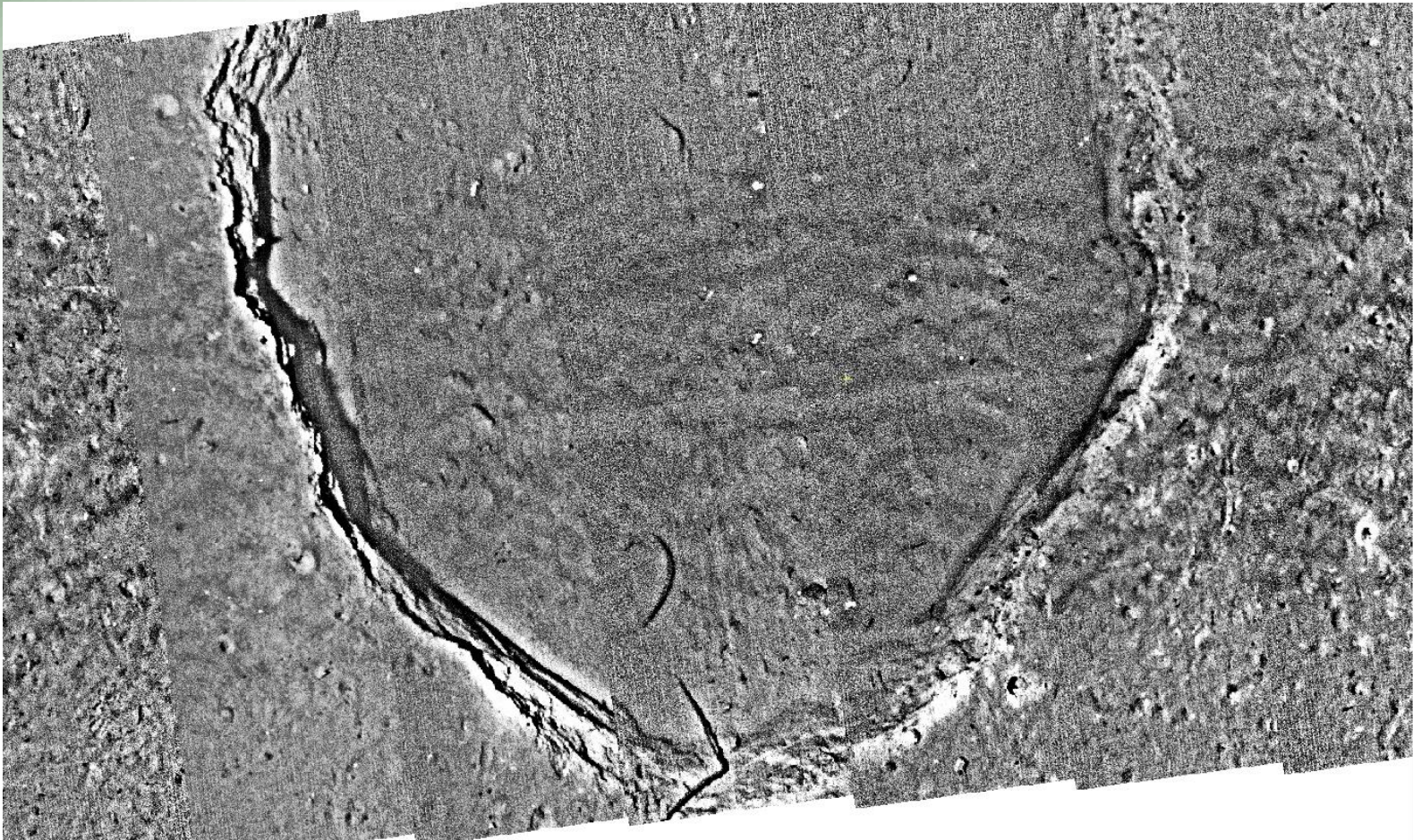


PCI Geomatica software was used to mosaic images
with 150 images in each mosaick
All done in one large batch process using EASI. (Python possible)

Mosaic zoom in



Color adjusted and geo oriented



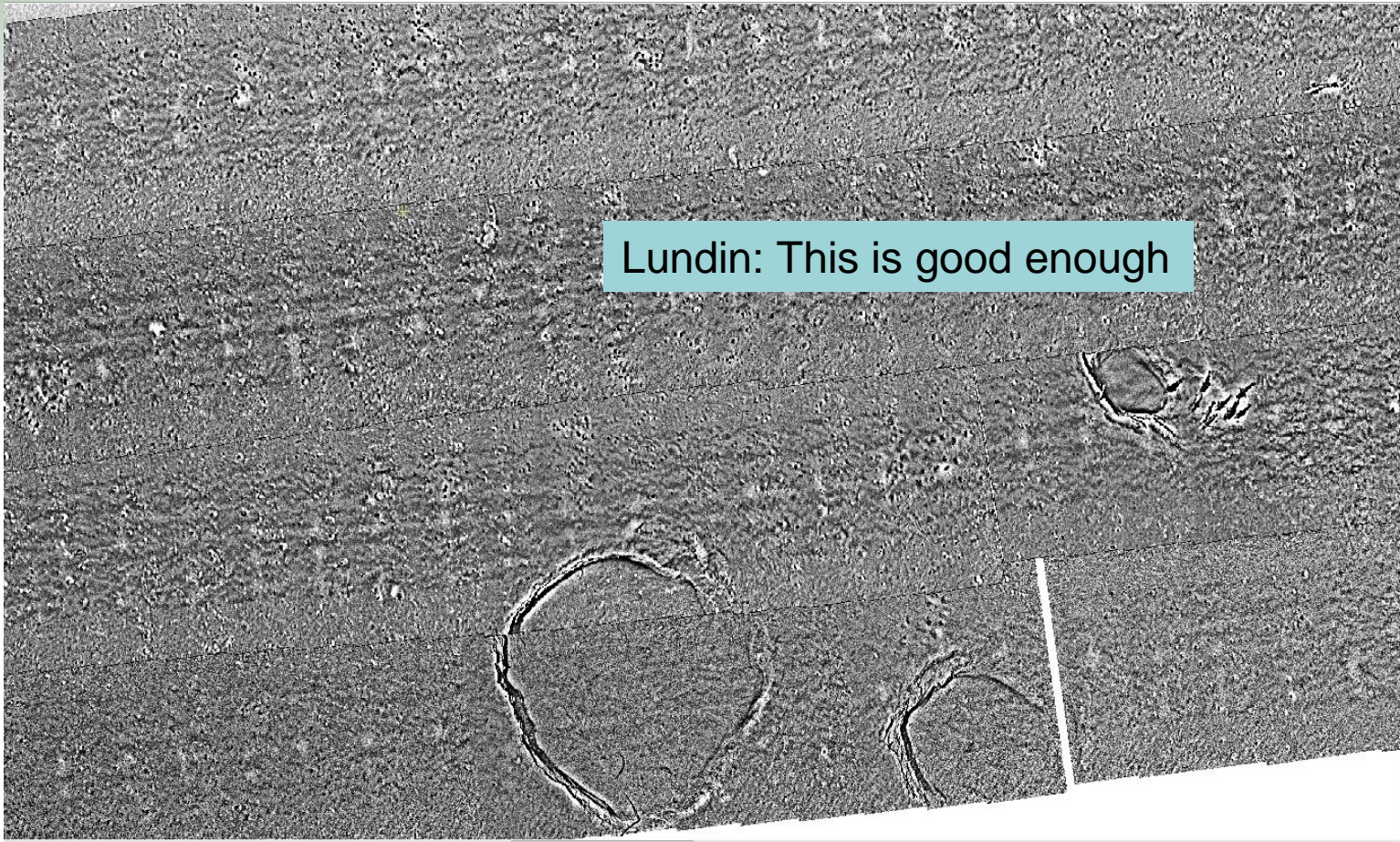
Each image normally 7*5 m.

With overlap and masking: 6.5*3m

Resolution = 0.006m (6mm)

Lack of DEM makes the result 'good enough'

Mosaic several flight lines



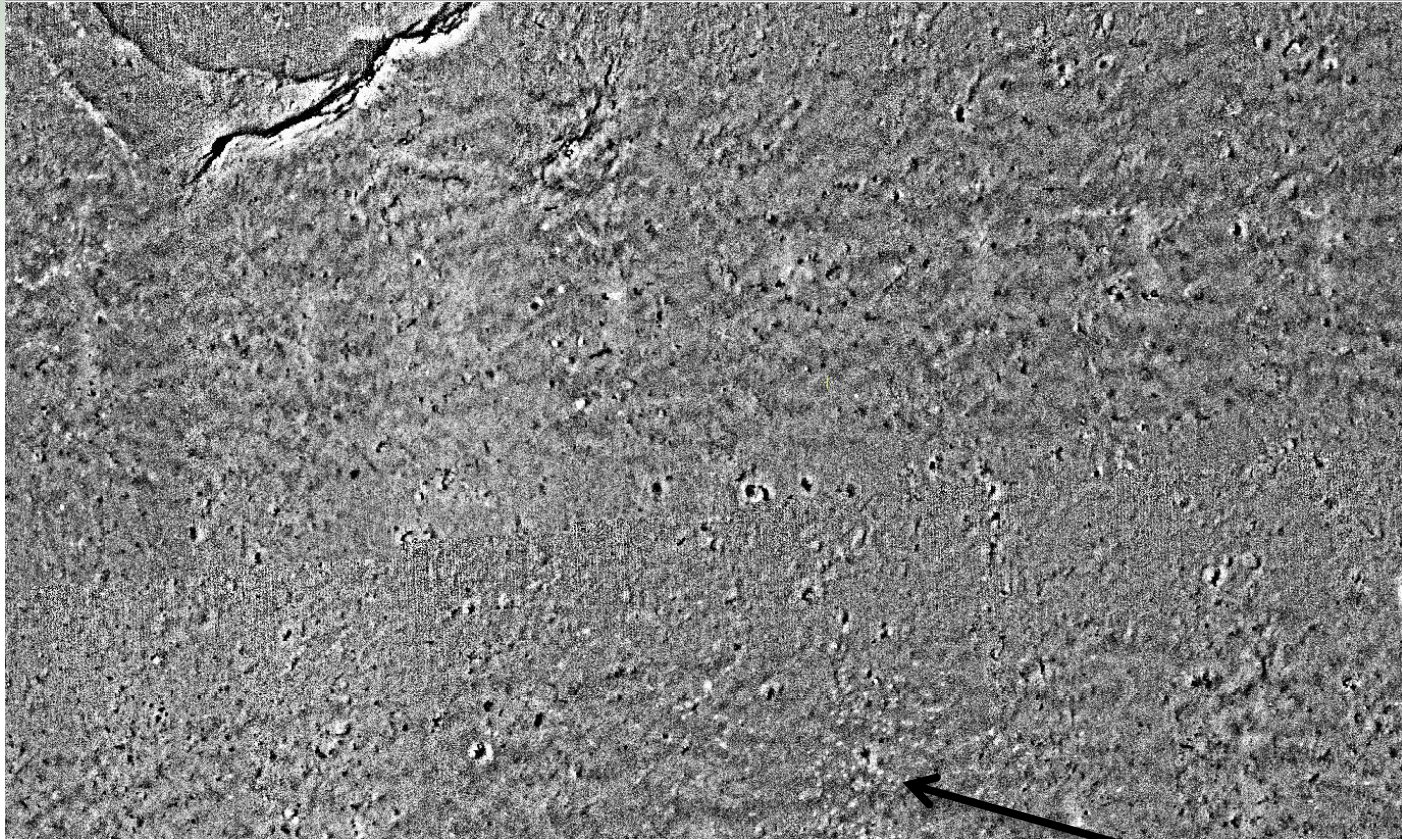
Several flight lines can be merged to one image.

Absolut orientation is difficult.

AUV orientation is not good enough for exact merging of lines

Along one line images fit well together

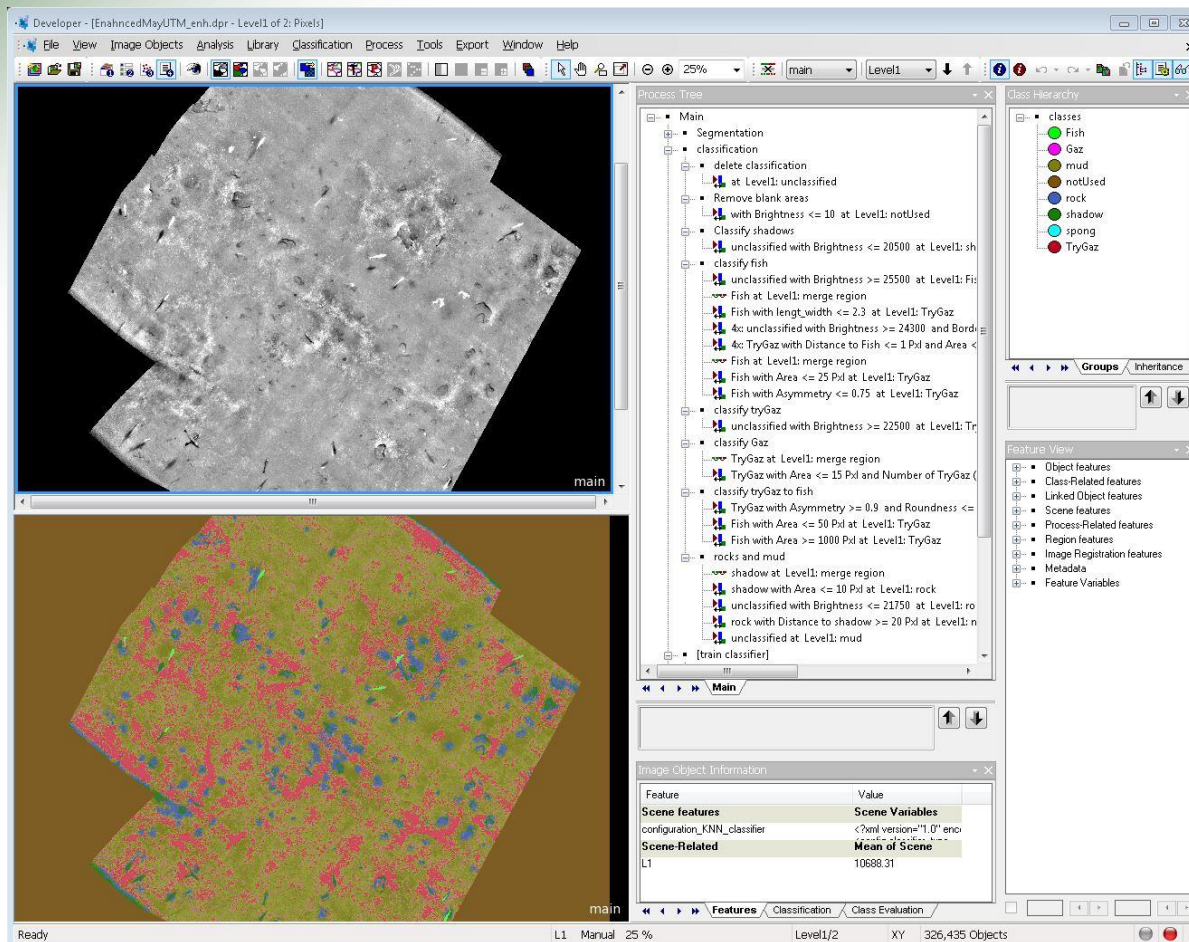
Seabed has little variation



You have to know what to look for

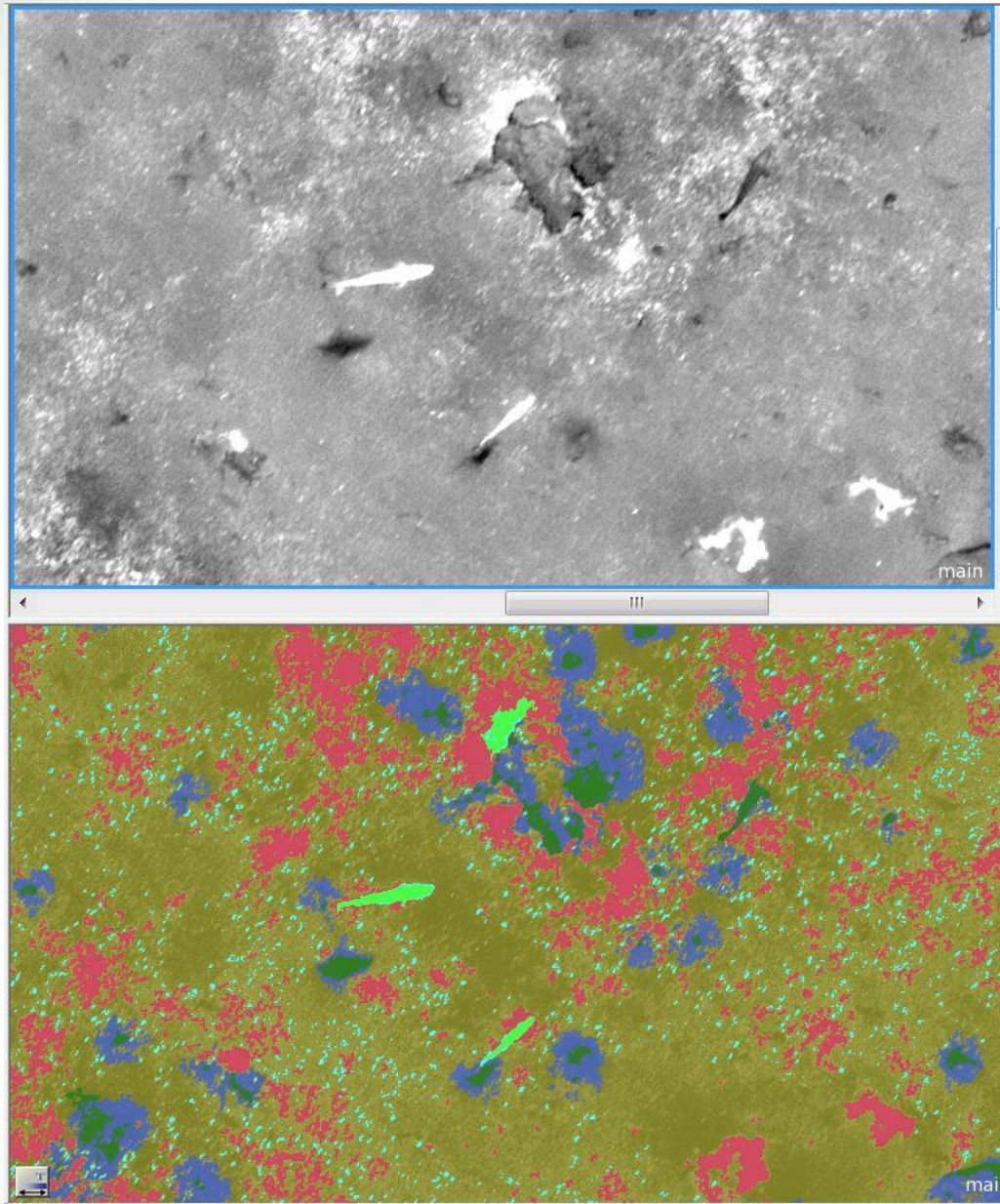
Gas

Large overlap between some images made it possible to use UAV software



It requires use of TerraNor Image Light Compensation, ILC, software

Classification seabed with eCognition



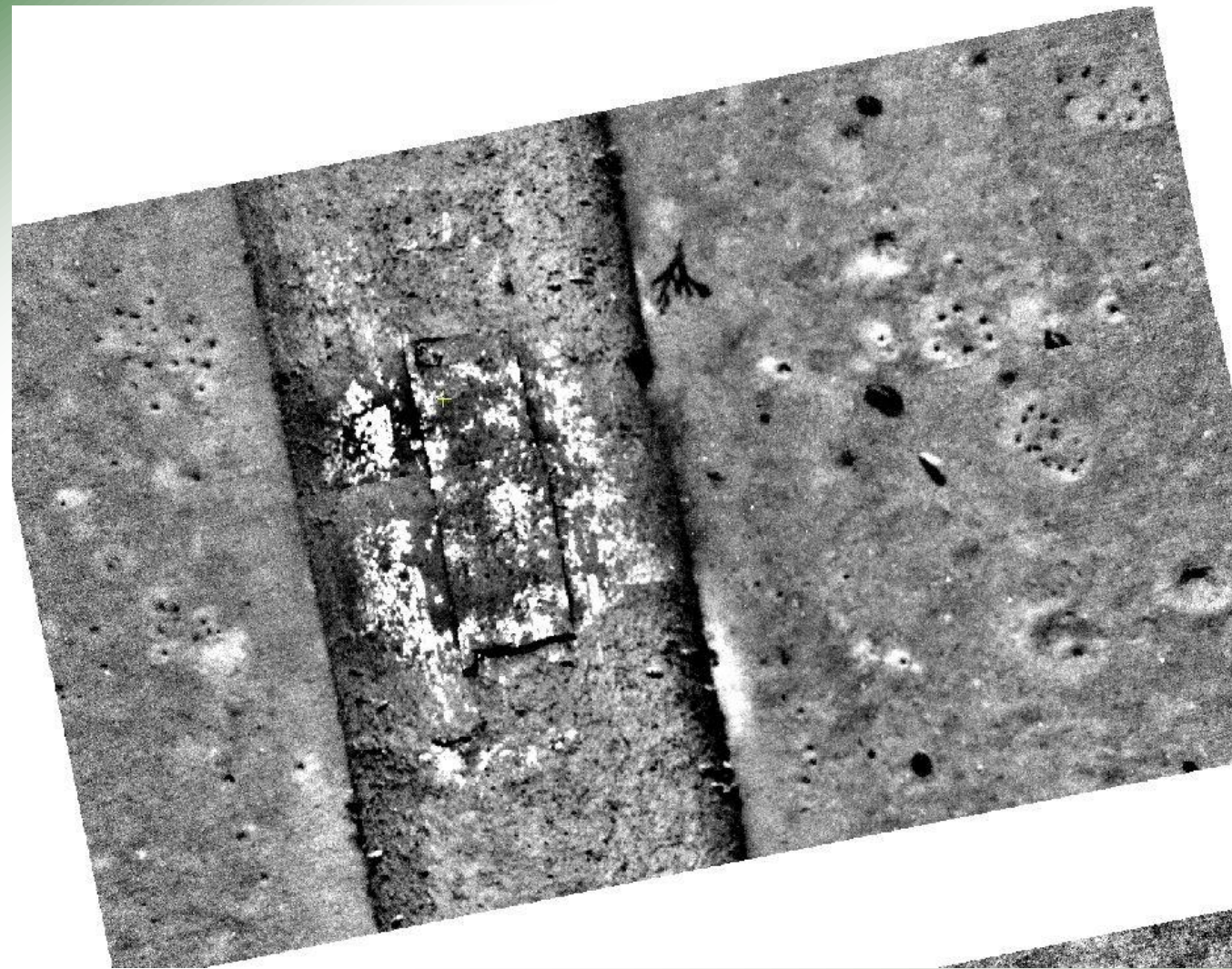
Next step: use of DEM

- Pipelines
 - Constructions
 - Fisheries
 - Mining
-
- They all want better accuracy and to be able to fit images together

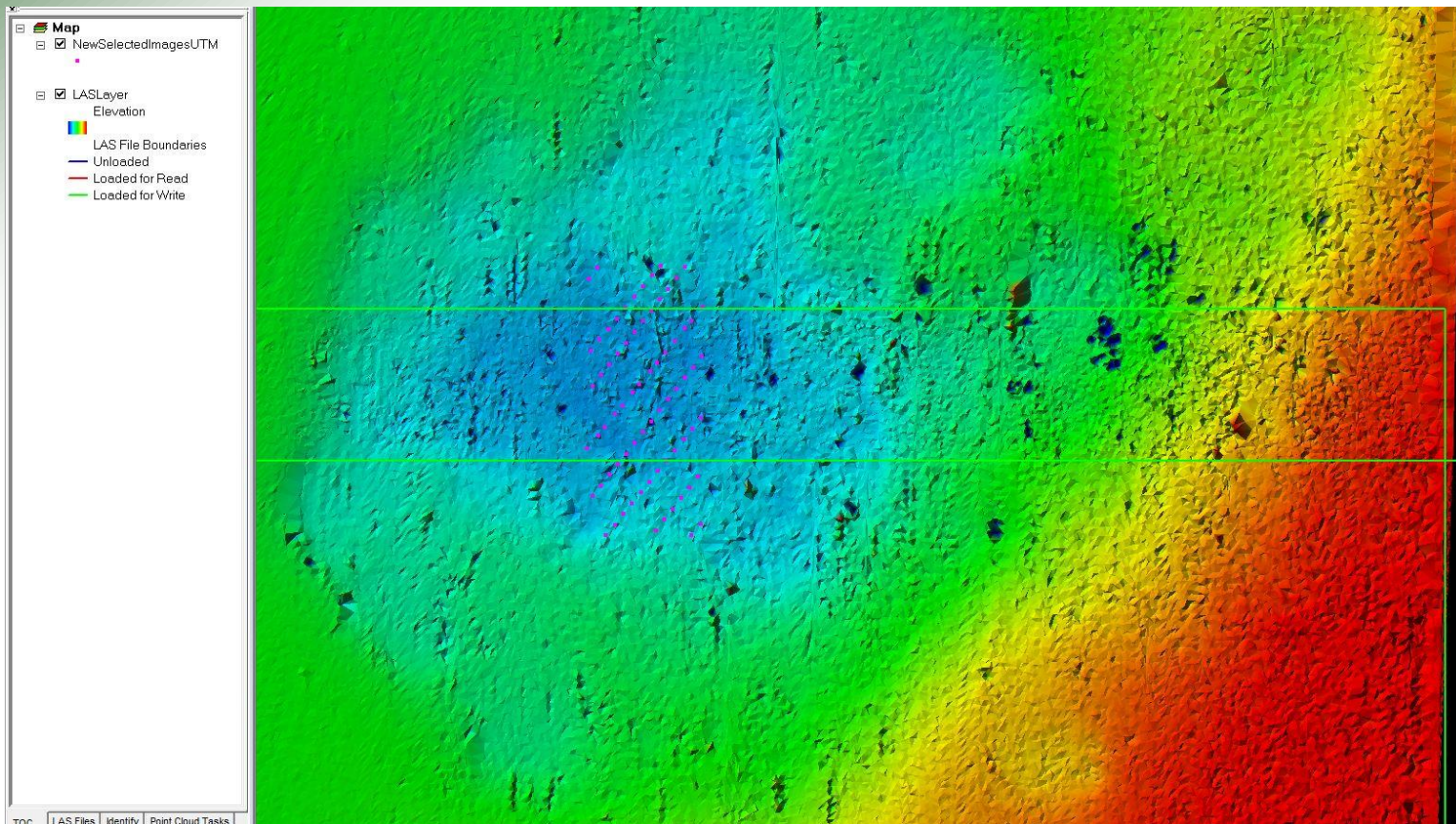
Original image pipeline



Same image compensated and geo-corrected

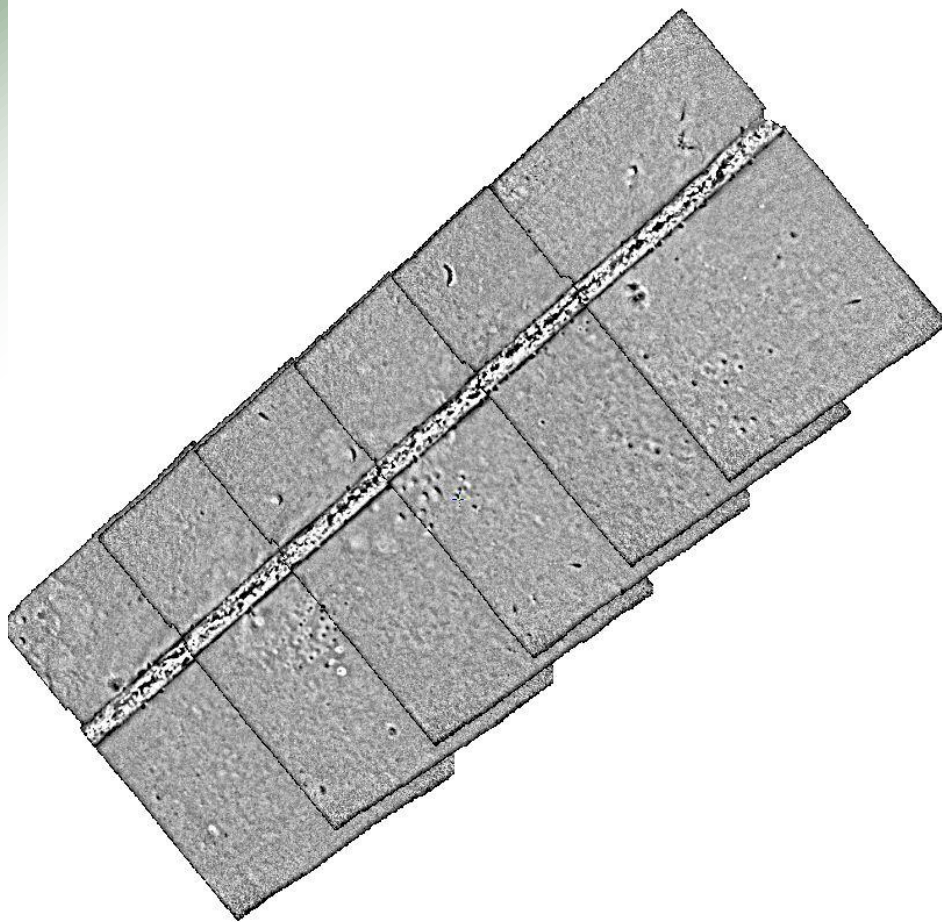


Mapping seabed using sonar



Hugin AUV from Kongsberg Maritime has built in sonar.
Images can be linked to the DEM and orthorectification will be better

Pipeline images and DEM



Notice that the images are wider at one side. This is due to correction using DEM. GPU processing makes this fast.

Data from DOF Subsea

We used DEM + images captured on the same trip. The fit between images is good. The DEM is 20 cm and the images are 0.6 cm, so there is a small misalignment.

Another next step: color

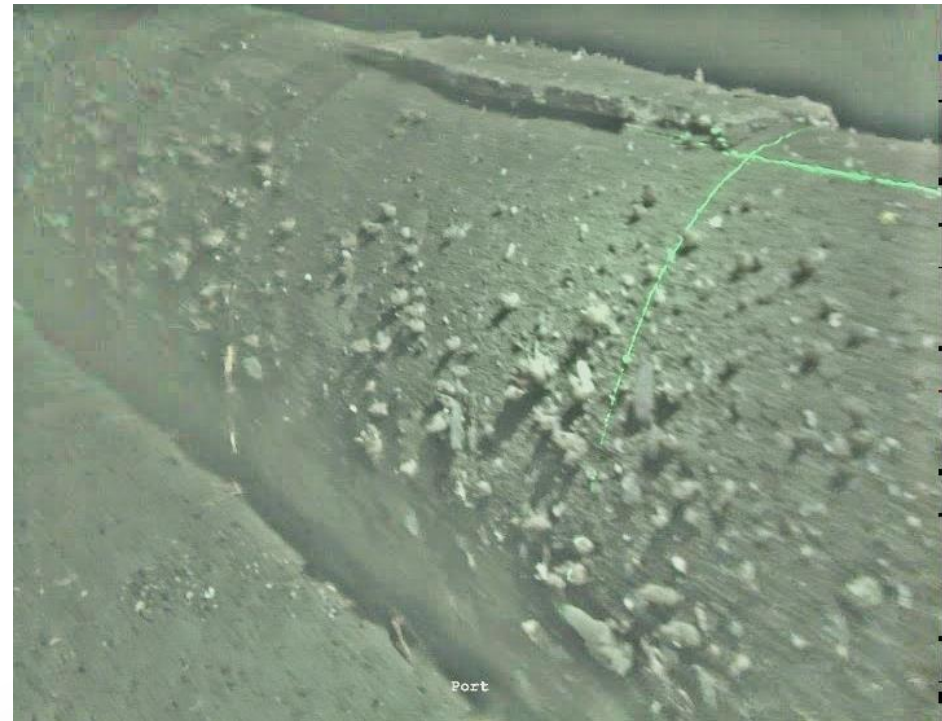


- Underwater imagery is sensible for light
- Different colors will be reduced different over same distance
- Use of Image Light Compensation ILC will still work

Colour images from video



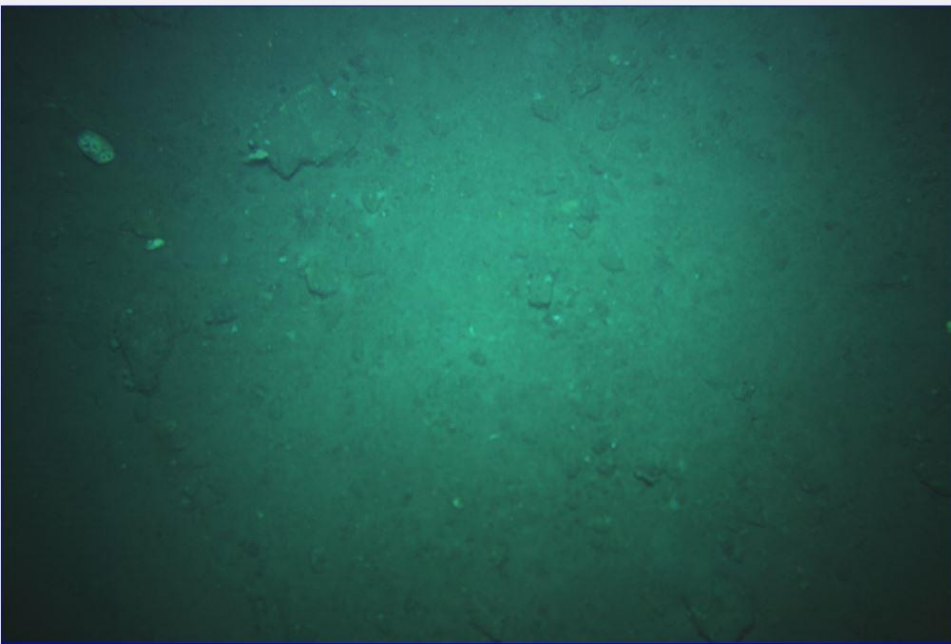
Original



Compensated

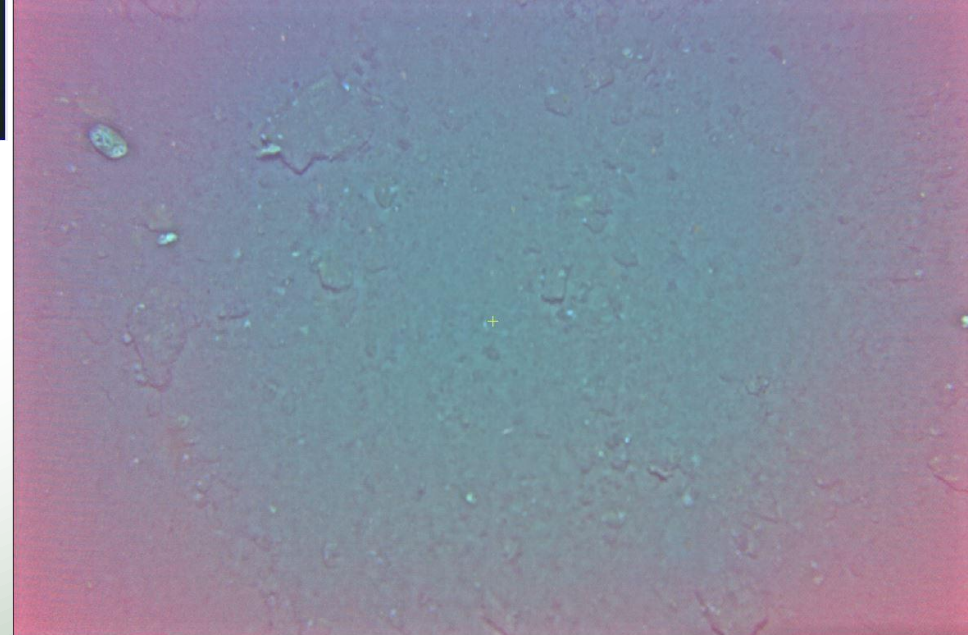
Example color image from video
DOF Subsea

Color image from new camera



Original image

Compensated image



As expected different colors act differently. Red is compensated too much in the dark areas.

Distance from camera to seabed is important.

We will finish this part of the project with better source images.

How can we help you?



- Needs
- Requirements
- Time
- Sample data
- Eval project

- We can solve your problems!