# How Long Is A Fish?

## Estimating the Length of Tarakihi Using Machine Learning

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# Policy Background & Driver of AI development

In 2018, the commercial fishing industry and Te Ohu Kaimoana agreed that immediate action was needed to reduce fish mortality and rebuild the East Coast Tarakihi stock in New Zealand in a manner that reflected the history of the fishery and the complex management and research approach required.

Industry developed a management plan in response to the stock assessment to facilitate the rebuilding of the stock. Part of the Strategy is the reporting of sub-minimum legal size (MLS) catches. Reporting indicates areas and times of high sub-MLS abundance.

The idea is to avoid these areas where possible and use move-on rules to reduce small tarakihi catch.

This project is addressing this by designing a model that will be able to collect data efficiently and accurately on sub-MLS tarakihi in a way that does not significantly impact current operations on fishing vessels.

# The Requirement

- To demonstrate how machine learning and AI development can be used to advance fisheries management and monitoring in New Zealand

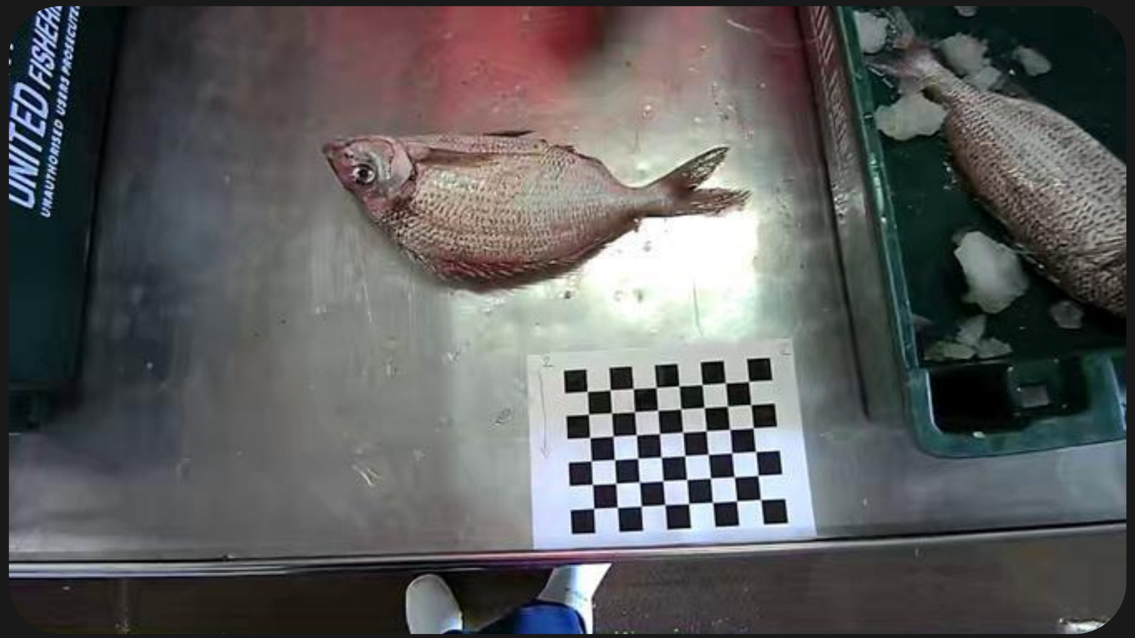
- Provide for improved data utilisation and incorporation of technology to support future management

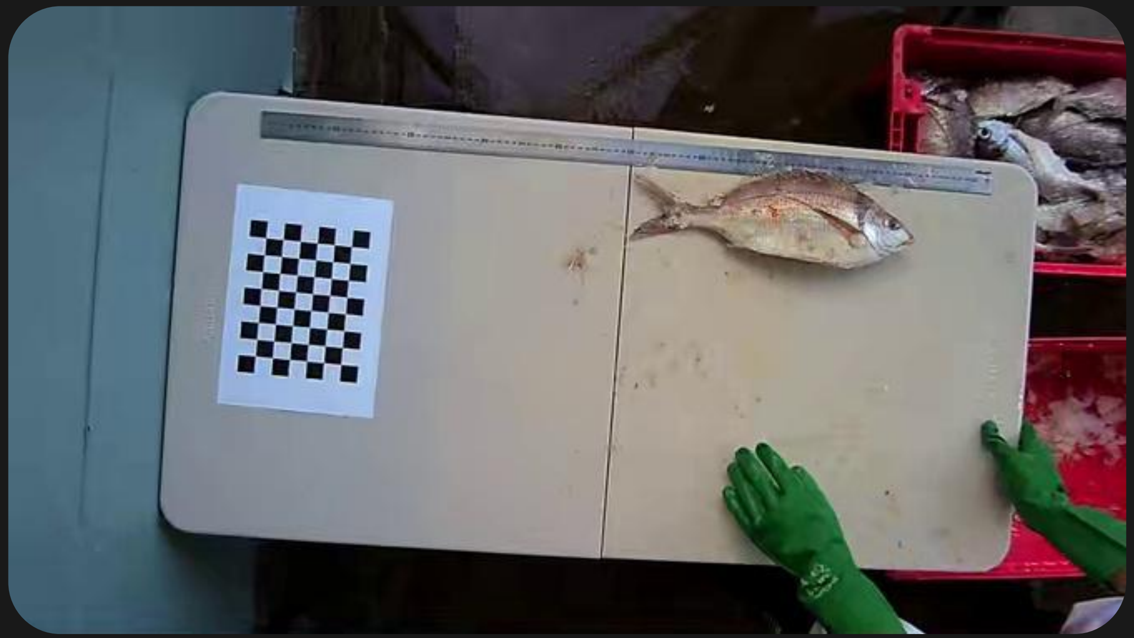
- Currently measuring sub-legals is a manual task and can be time consuming, and while EM has provided 3rd party validation of sub-legal encounters, there is still a time-lag between fishing & reporting

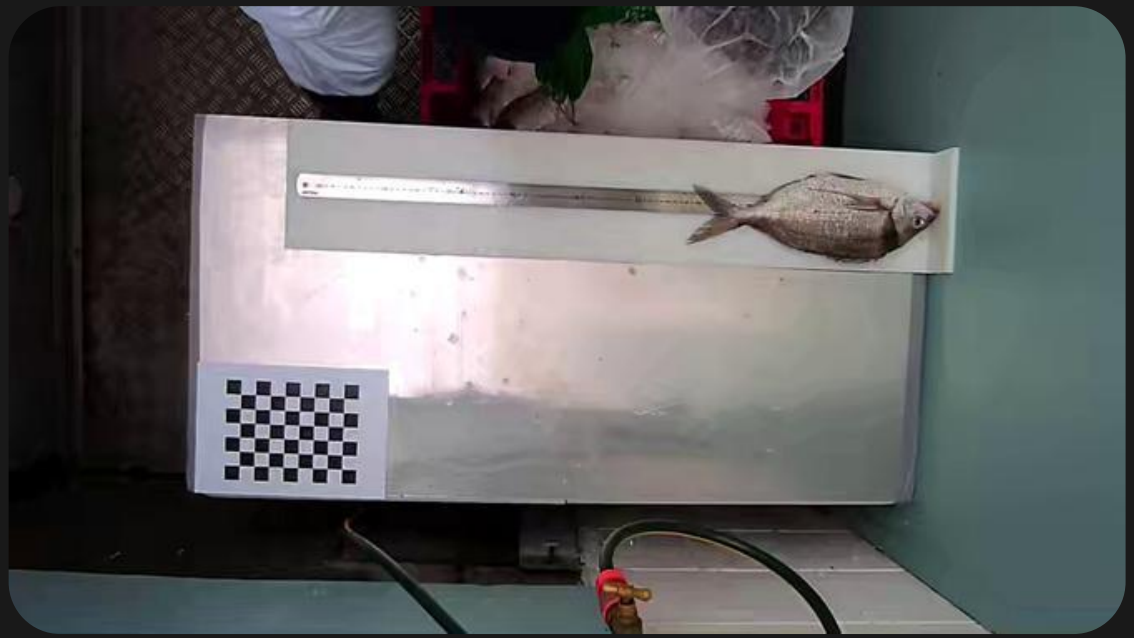
**What was our performance metric?**

· demonstration of the ability to determine absolute average differences between true and predicted lengths in mm


# The 3 Factory Visits







## Free Camera approach

+ A variety of camera angles
- Inconsistent scale factor
- Multiple individuals in the scene

## Fixed Camera

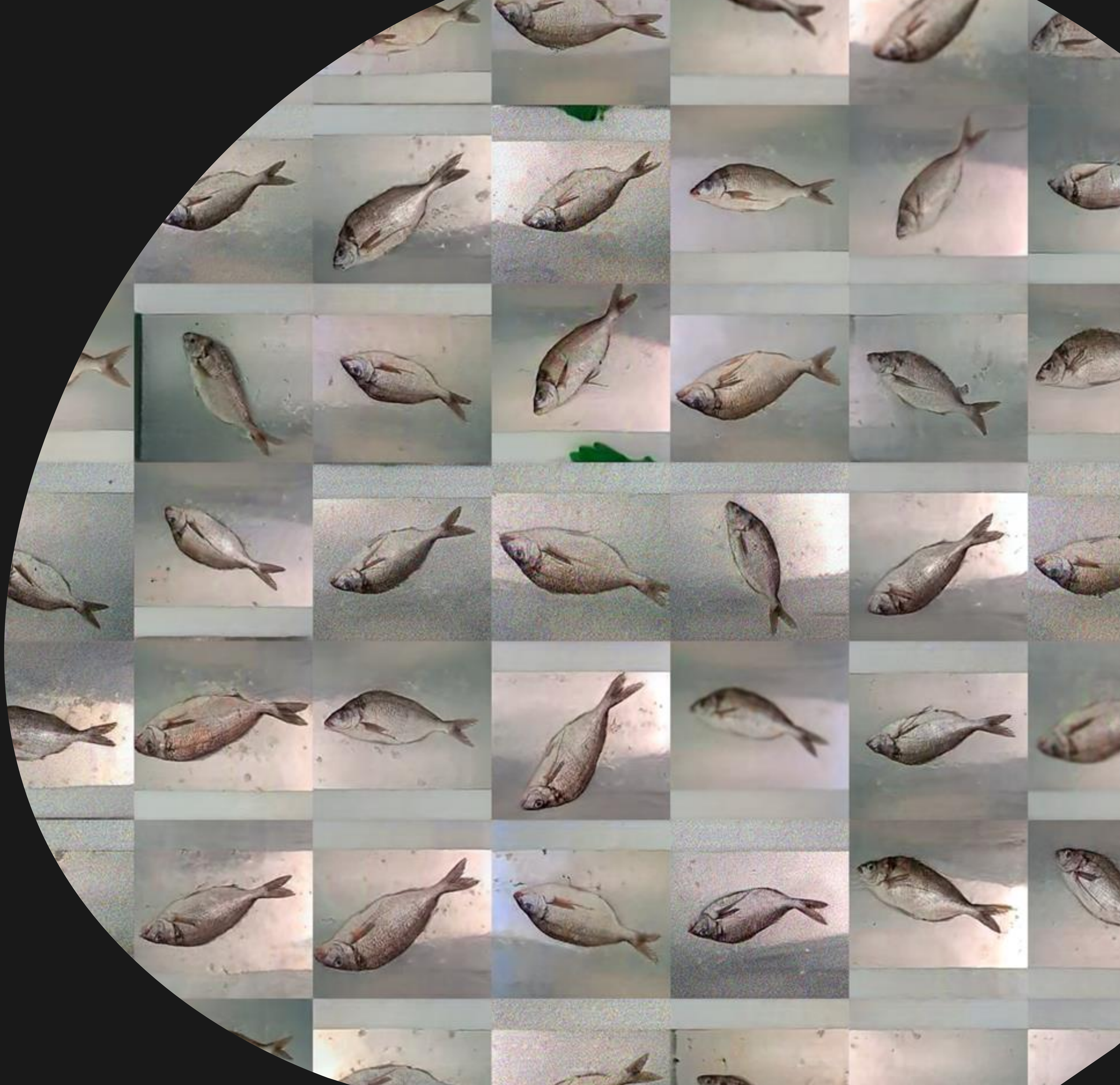
+ Consistent scene is easily cropped
+ Scale factor mostly consistent
- Limited observation angle

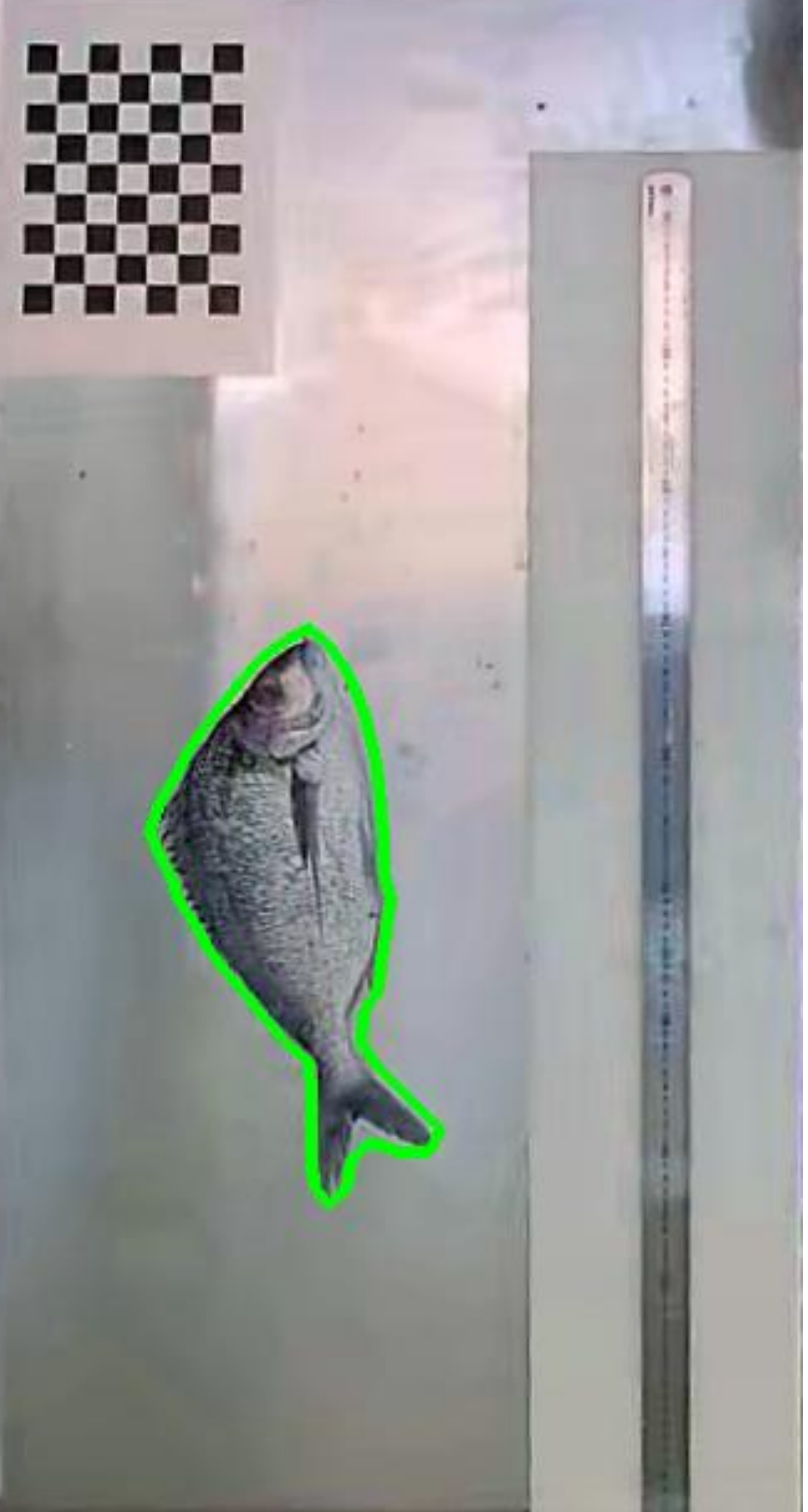
## Fixed Camera & Metallic surface

+ Surface is more similar to fishing vessels

# Synthetic Image Generation

Images from the third factory visit were cropped and used to train a StyleGANs model to create synthetic images of tarakihi.





# Image **Segmentation**

✔

1) Inferences are defined by an arbitrary number of points

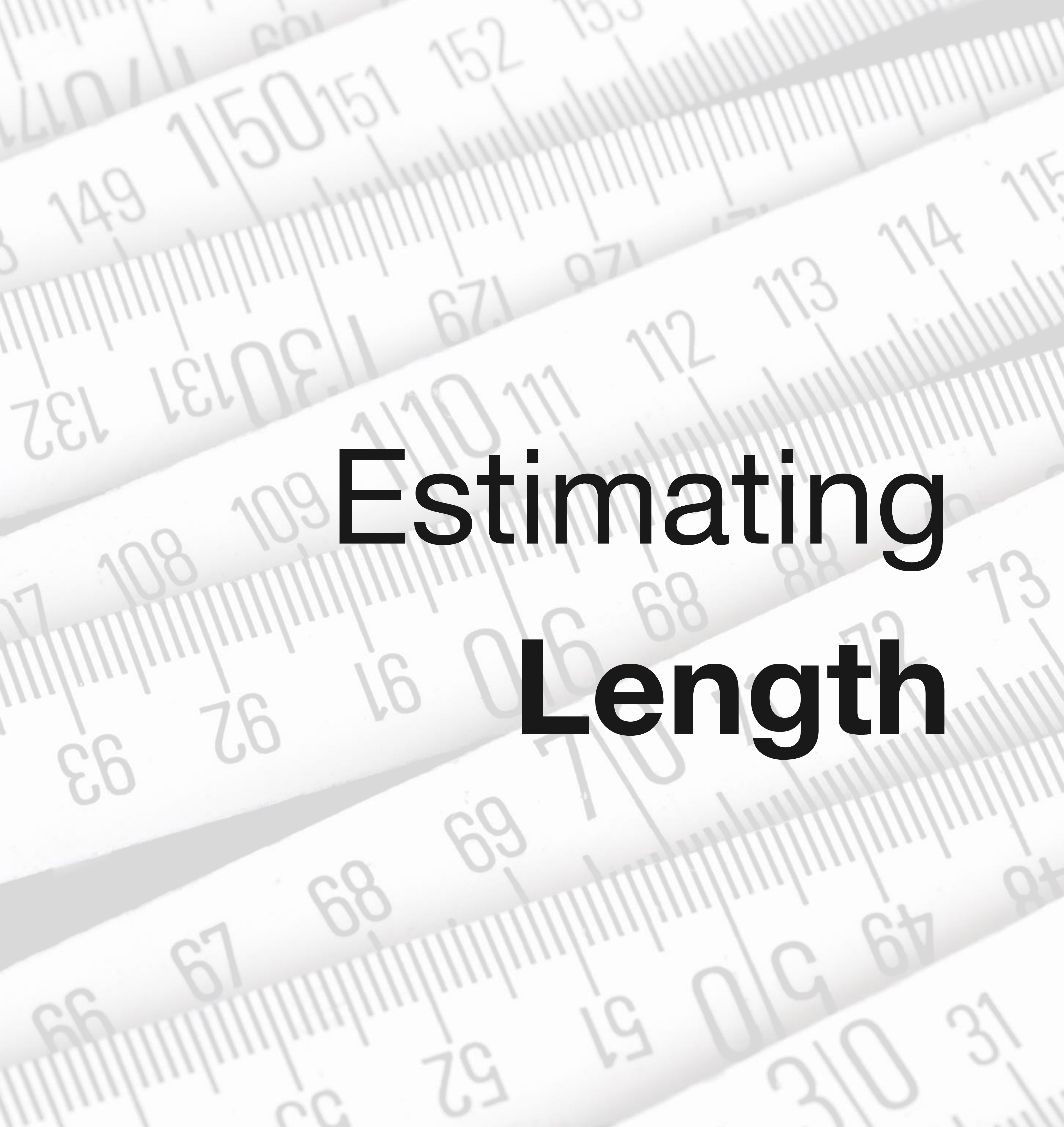
2) Geometric properties of the inference may be found

3) Easy transition to instance segmentation

✖

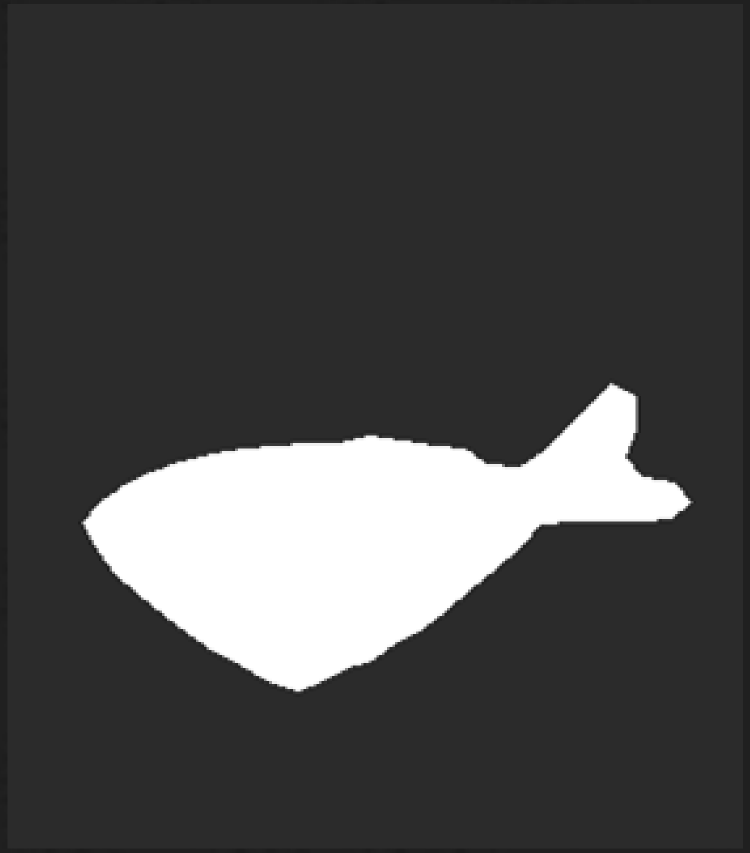
4) Greater number of points required for training

# Estimating **Length**

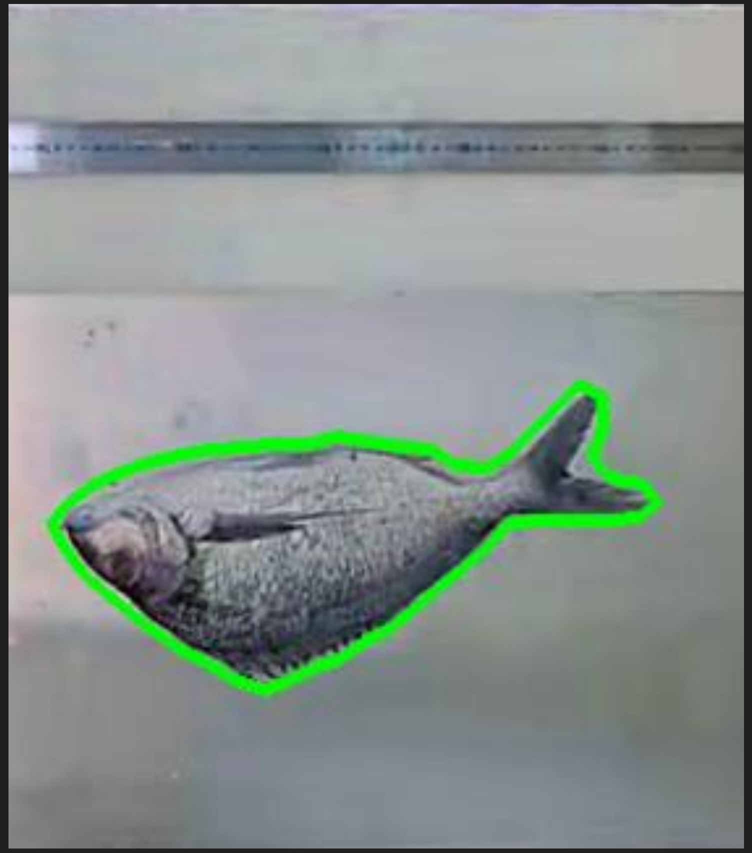


1. Estimating pixel Length from an image
2. Converting the length to millimetres
3. Selecting the best length from a series of images

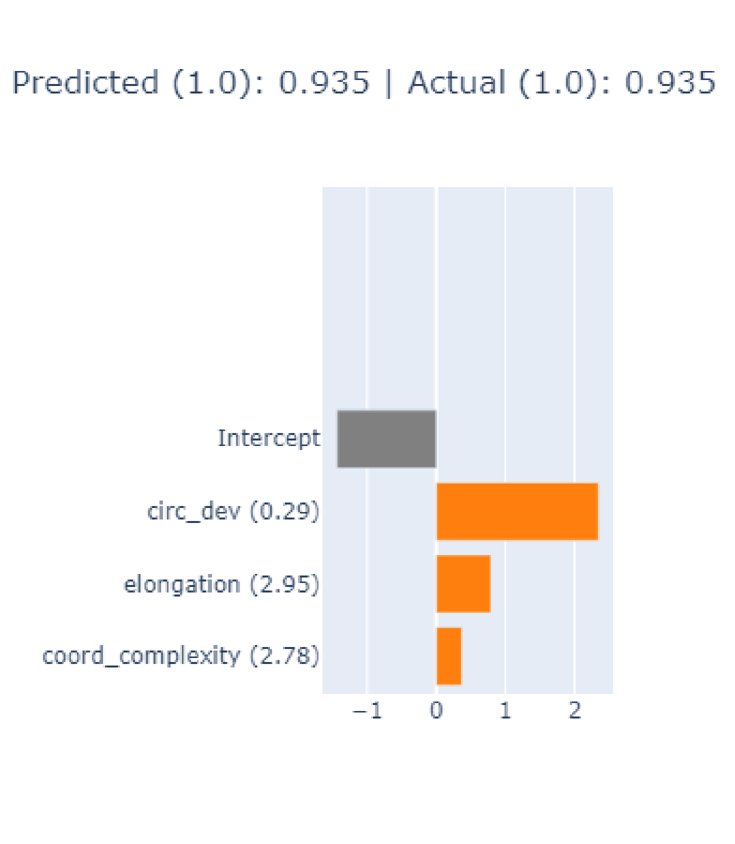
# Pixel Length



An inference is made by the algorithm



Contours of inferred objects are found



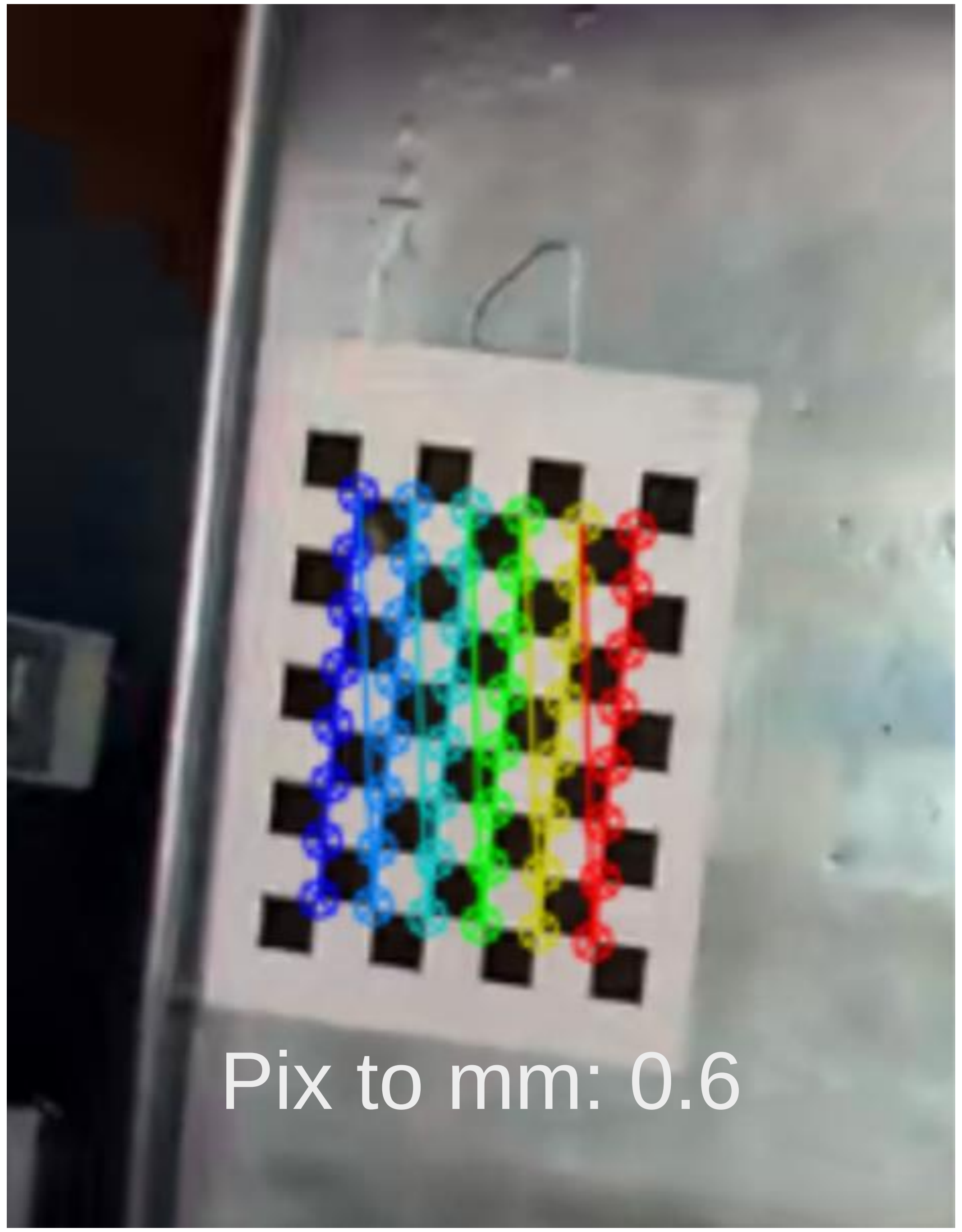

Geometric properties are evaluated to determine which contours are discarded

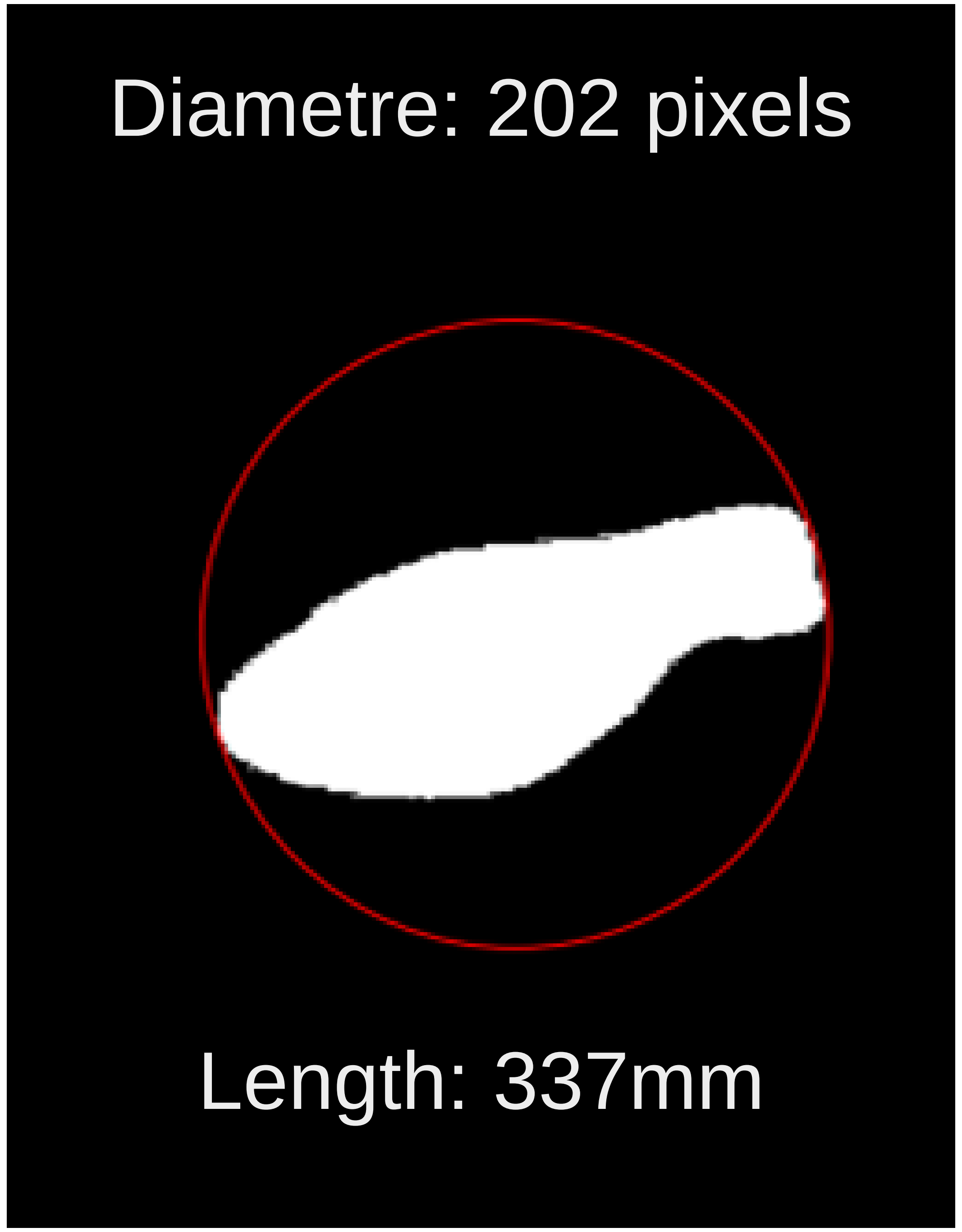
A minimum enclosing circle is applied, the diameter of this is the pixel length

# Pixel to **Millimetre** Conversion

The calibration pattern is used to find the pixel to millimetre ratio

This is applied to the pixel length from the minimum enclosing circle



# Length Estimation From Video

### Lengths paired to an individual

Lengths over multiple frames are paired with an individual based on their location in the image

These are stored for later finding the individuals length

### Observed length grouping

Lengths within 10 mm of the median length are stored for each individual

Consistent observations greater than 10mm are used to calculate a new median

### Unrestricted upper limit to lengths

Stored lengths are allowed to increase not decrease.

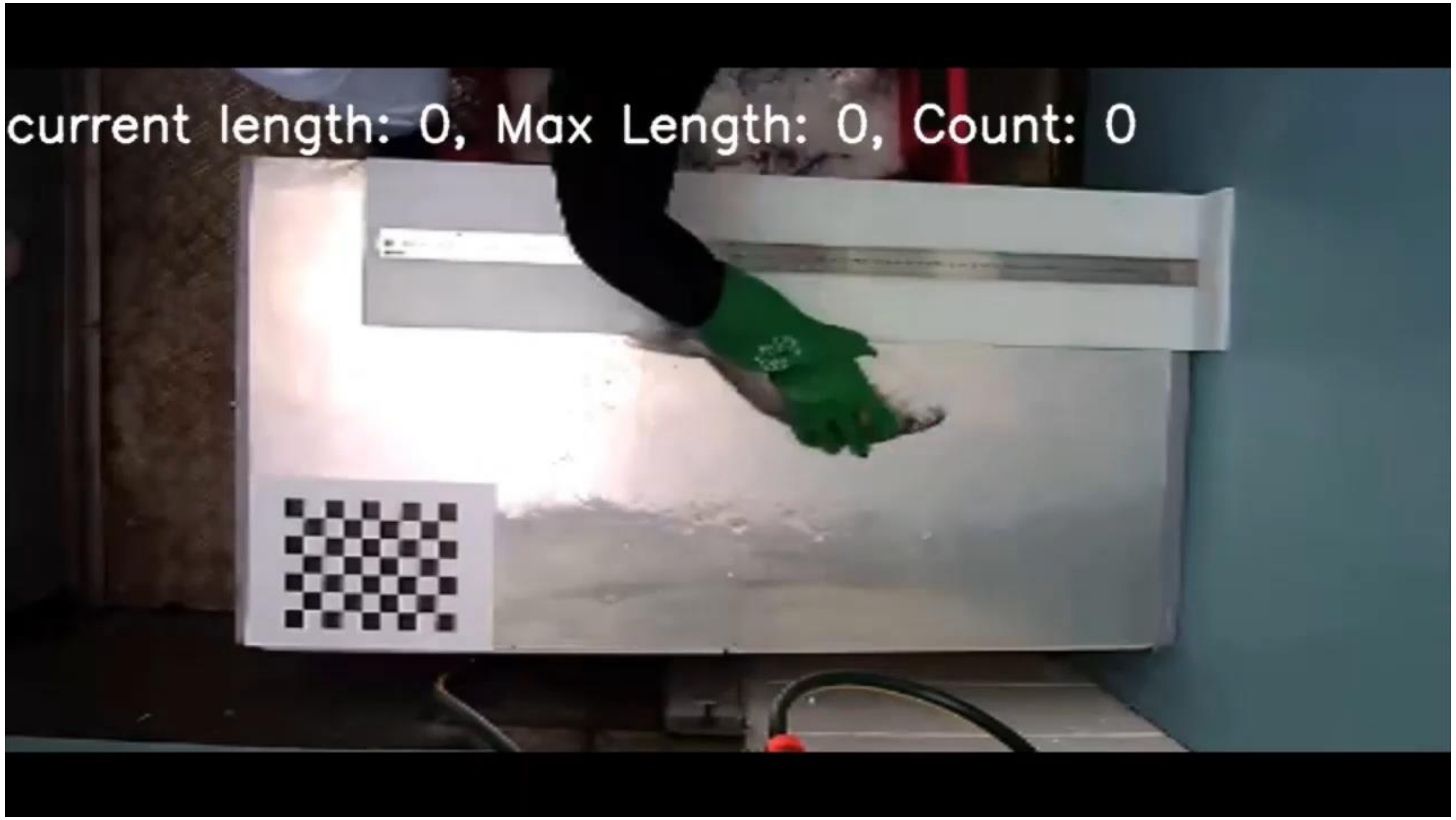
This reduced the use of partially visible fish being included in length estimates

### Final recorded length

A final length is calculated as the median of all stored lengths

A line per fish is outputted to a CSV file at the end of processing the video

# RESULTS




**7.523**

Absolute average difference, in millimetres, between predicted and true lengths after a linear adjustment.

**11.254**

Absolute average difference, in millimetres, with no adjustment

**0.9523**

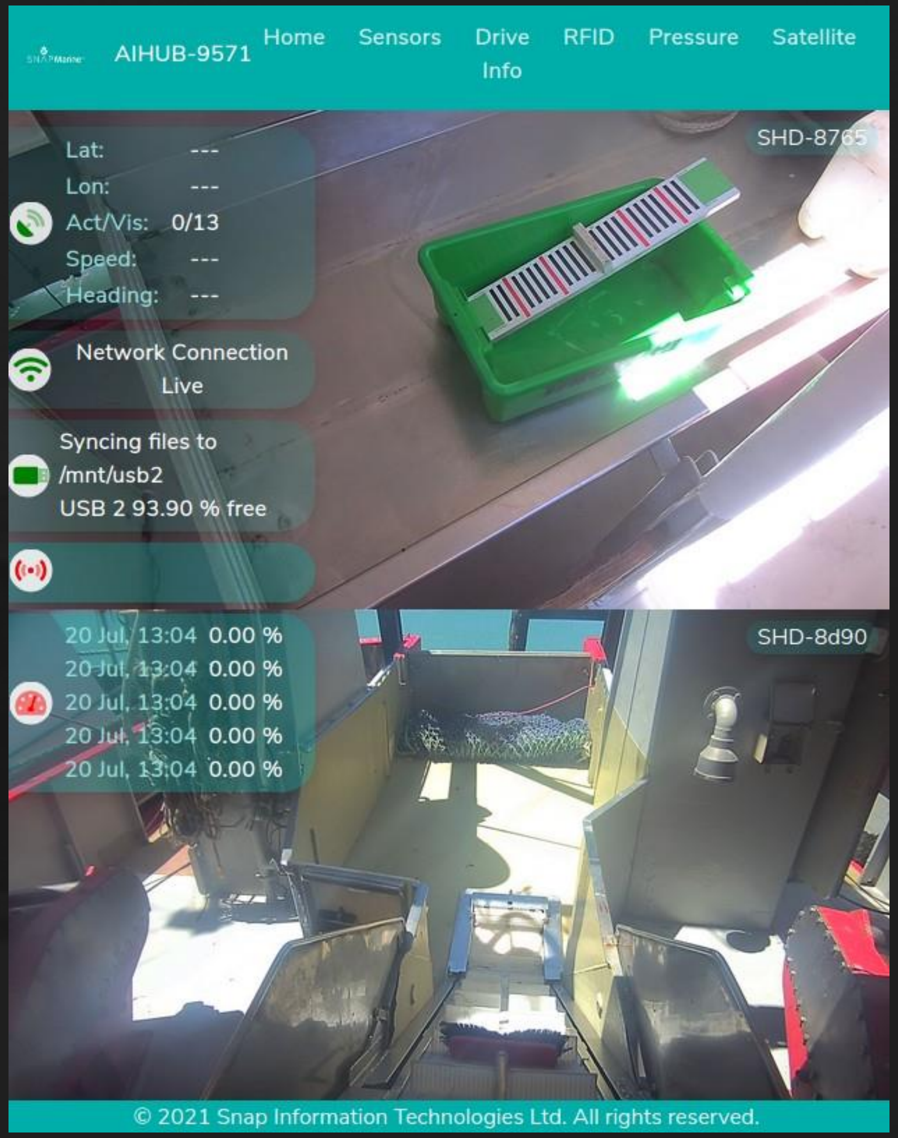
R^2 value for the adjusted length predictions

# **Ongoing** Work

The methods and models developed in this research are being run on video footage from inshore vessels.

Conditions on vessel vary from one another and from the factory conditions in which the initial training set of tarahiki images where captured.

This requires training the model for varying conditions and determining how close it can come to an absolute average inferred mm length of within 1cm of the ground truth length.

# Ongoing Work & Phase III

Add key point detection to the model to better estimate fork length

Exploring methods for pose estimation, using keypoint detection,  to identify curvature

Are there tweaks to the operational conditions that would lend themselves to better model performance and is this something that industry could accommodate OR is there any space in the accuracy measurement for reduced model performance with the introduction of a secondary validation (video review)

Testing model on edge

# Thank you!

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