SMARTFISH H2020

Innovation for sustainable fisheries

CatchMonitor

AUTOMATED BY-CATCH QUANTIFICATION

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CatchMonitor

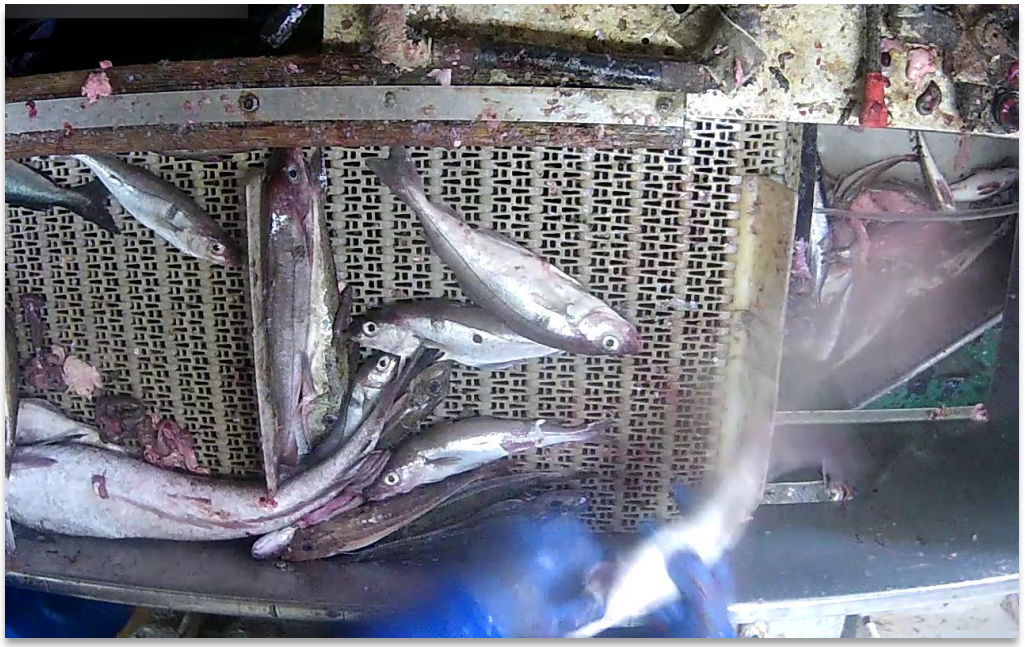
- CatchMonitor is part of SMARTFISH, funded by EU Horizon 2020
- CatchMonitor built on prior work funded by Marine Scotland from 2014

Overview

CatchMonitor

- CatchMonitor is an automated by-catch quantification system
- Process surveillance footage of on-board conveyor belts
- Uses state of the art computer vision and AI to quantify by-catch in the video footage

CatchMonitor: what it does



- Surveillance footage as input

CatchMonitor: what it does

- Spreadsheet listing discards as output
  - Species of each fish
  - The time in the video when it was discarded

Discard	Time	Species
1	0:02:38.224810	Saithe
2	0:02:40.468198	Herring
3	0:02:41.325964	Saithe
4	0:02:41.589892	Saithe
5	0:02:43.305423	Haddock
6	0:02:49.573712	Saithe
7	0:02:49.573712	Norway pout
8	0:02:50.365496	Argentines

CatchMonitor: status

- A working prototype has been developed
- We have evaluated its performance in comparison to expert observers from Cefas and Marine Scotland Science

Requirements

CatchMonitor: requirements

- CatchMonitor was developed with a view to minimizing the impact on the work practices of existing fishing vessels
- Development of CatchMonitor has suggested requirements for deployment
  - Camera
  - Calibration
  - Non-work area at discard end of conveyor belt
  - Maintenance: cleaning

CatchMonitor requirements: camera

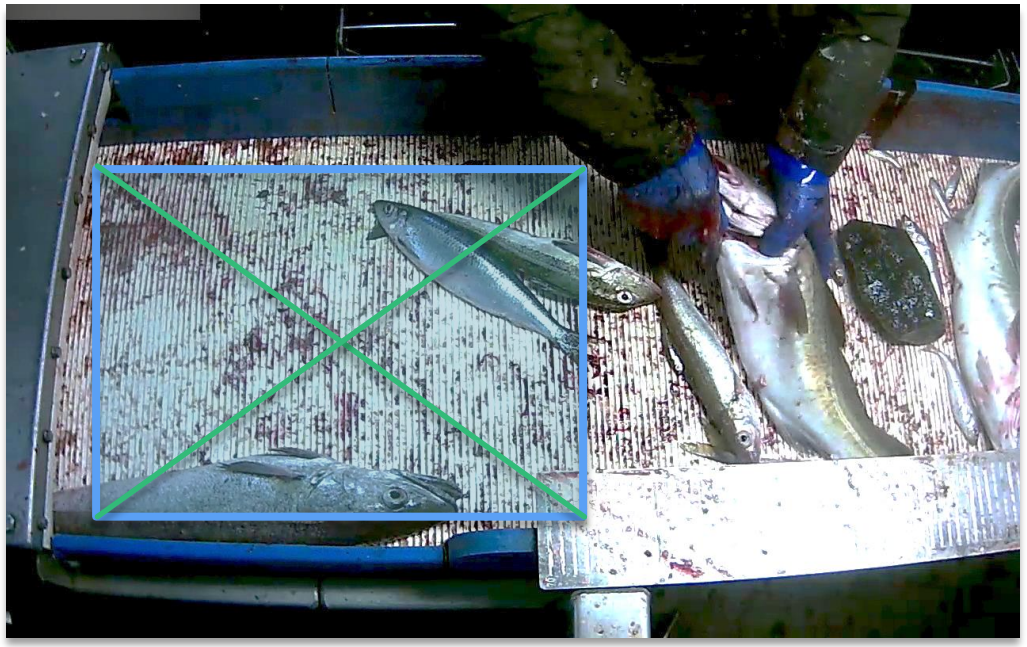
- Dome covered surveillance camera over the discard chute end of the conveyor belt
- HD camera; 720p resolution or better
- Frame rate of at least 25 frames per second (similar to TV)

CatchMonitor requirements: calibration

- Calibration setup
  - Performed once at installation
  - Performed if the camera is changed

CatchMonitor requirements: non-work area

- Ideally the last 50-75cm of the belt adjacent to the discard chute should not be a work area
  - To prevent working fishers from obscuring the cameras' view of the belt



CatchMonitor requirements: non-work area

- An obscured view of the discard end of the belt hampers the performance of our system

CatchMonitor requirements: maintenance

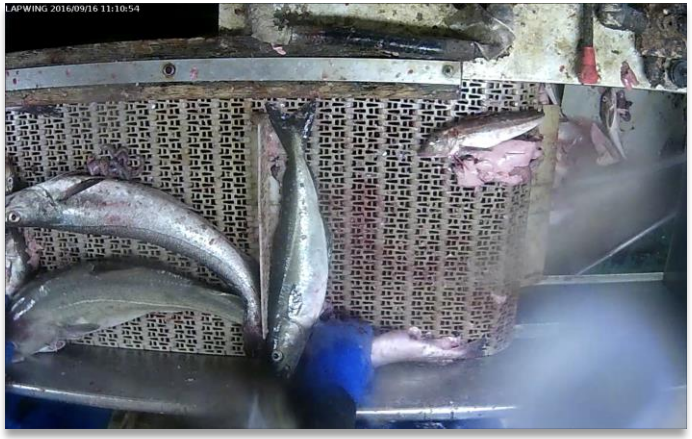
- The dome covering the camera will need regular cleaning
- The fish gutting process can throw spatter onto the dome
- Spatter on the dome obscures the view and significantly degrades performance

Method

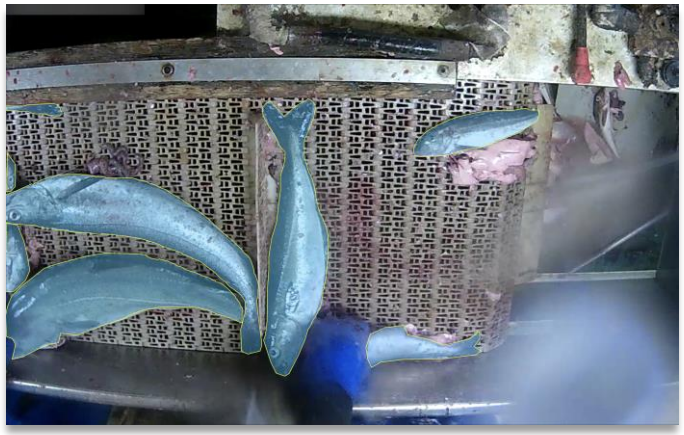
IN A NUTSHELL

Catchmonitor: method

- Fish are detected and their outlines estimated



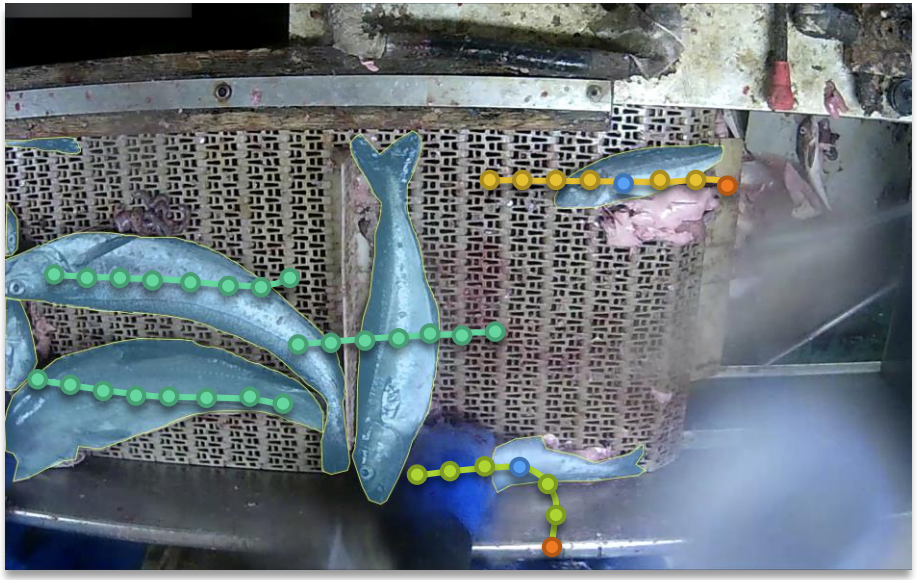
Segmentation



Aside: CatchMonitor - Annotation Tool

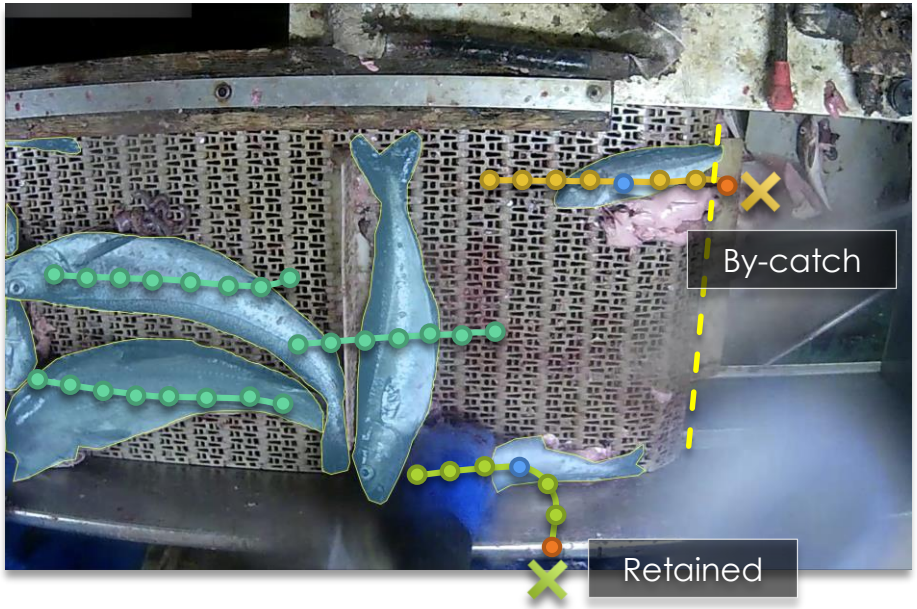
CatchMonitor: method

- Motion of fish tracked throughout the video



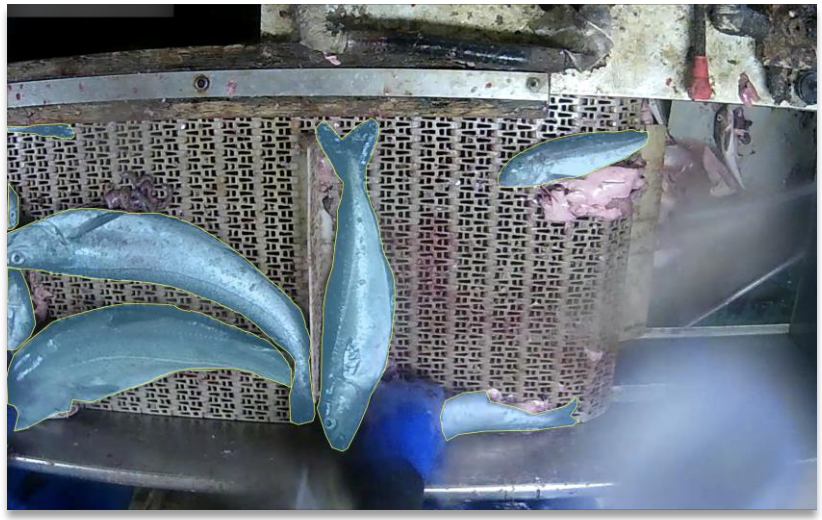
CatchMonitor: method

- Fish that cross over into the discard chute region (dashed yellow line) are counted as by-catch



CatchMonitor: method

- Images of fish identified as by-catch are extracted



CatchMonitor: method

- Individuals are classified according to species

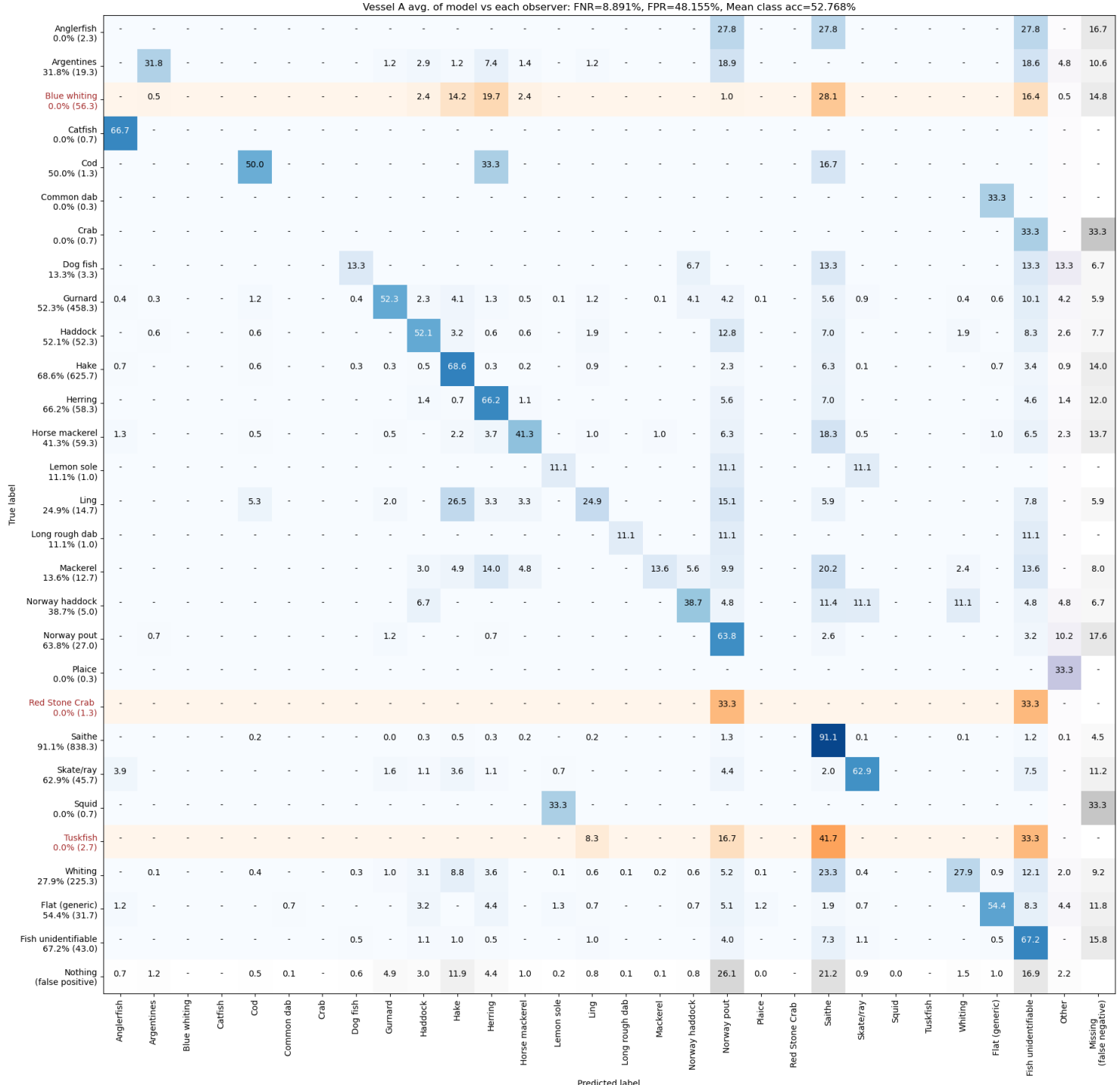
Performance

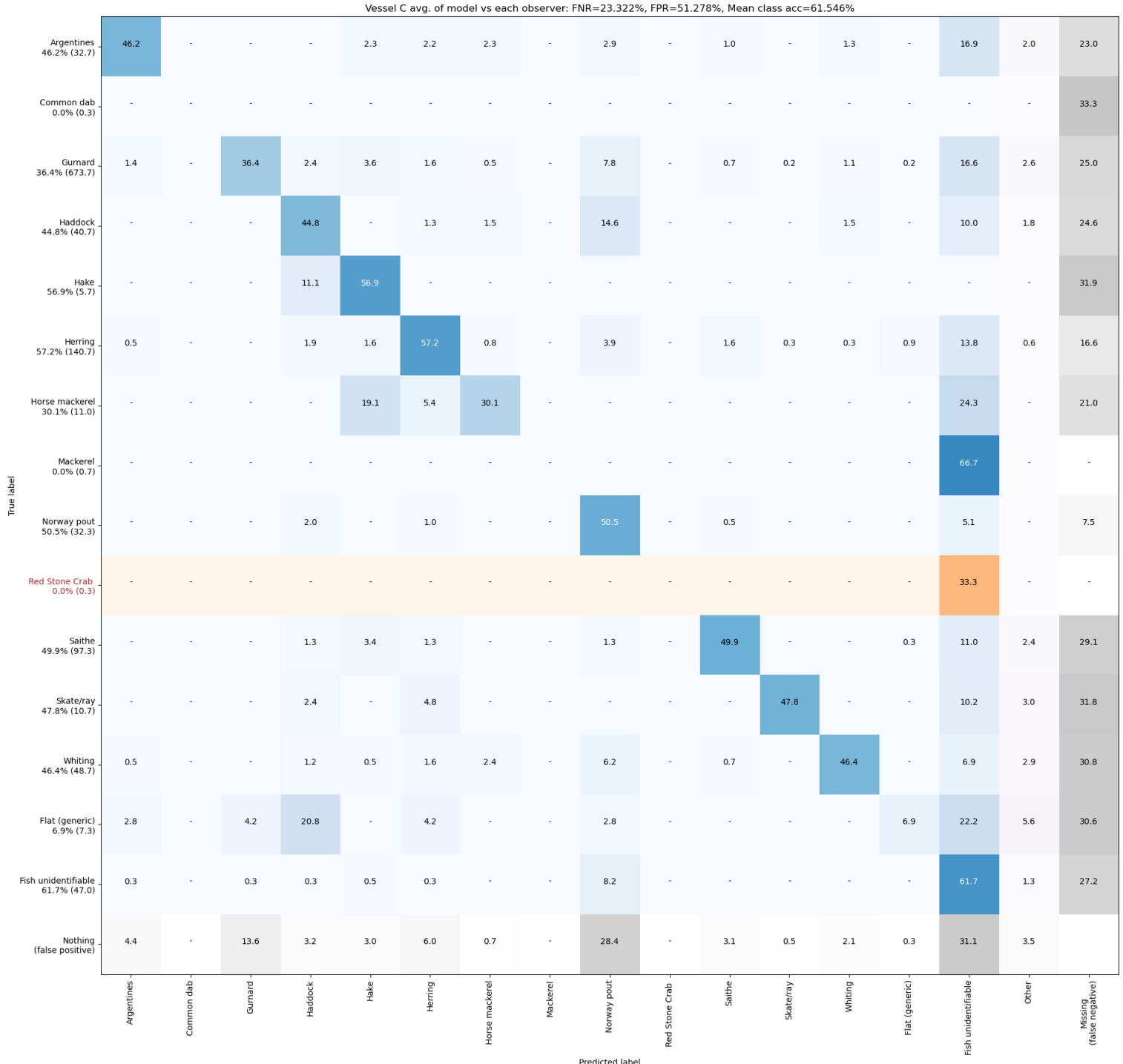
Confusion matrices

- Shows the proportion of samples of each species (e.g. haddock) that the model predicts as each other species (including e.g. haddock)
  - E.g. Of all the haddock in the data
    - 52.1% were successfully predicted as Haddock
    - 12.8% were mis-identified as Norway Pout, 7% as Saithe, etc.

Confusion matrices

- Row = true species
- Column = predicted species
- Strong performance indicated by dark band (high values) along top-left to bottom-right diagonal
  - This indicates that the model successfully identified e.g. haddock as haddock
- High values off-diagonal indicate that species was mis-identified
- Extra column to right to indicate false negatives (uncounted discards)
- Extra row at bottom to indicate false positives (over-predicted discards)
- We will also summarise the performance of the algorithm in the context of inter-reviewer variability


Vessel A avg. of model vs each observer: FNR=8.891%, FPR=48.155%, Mean class acc=52.768%
True label
Predicted label
Anglerfish 0.0% (2.3)
Argentines 31.8% (19.3)
Blue whiting 0.0% (56.3)
Catfish 0.0% (0.7)
Cod 50.0% (1.3)
Common dab 0.0% (0.3)
Crab 0.0% (0.7)
Dog fish 13.3% (3.3)
Gurnard 52.3% (458.3)
Haddock 52.1% (52.3)
Hake 68.6% (625.7)
Herring 66.2% (58.3)
Horse mackerel 41.3% (59.3)
Lemon sole 11.1% (1.0)
Ling 24.9% (14.7)
Long rough dab 11.1% (1.0)
Mackerel 13.6% (12.7)
Norway haddock 38.7% (5.0)
Norway pout 63.8% (27.0)
Plaice 0.0% (0.3)
Red Stone Crab 0.0% (1.3)
Saithe 91.1% (838.3)
Skate/ray 62.9% (45.7)
Squid 0.0% (0.7)
Tuskfish 0.0% (2.7)
Whiting 27.9% (225.3)
Flat (generic) 54.4% (31.7)
Fish unidentifiable 67.2% (43.0)
Nothing (false positive)
Anglerfish
Argentines
Blue whiting
Catfish
Cod
Common dab
Crab
Dog fish
Gurnard
Haddock
Hake
Herring
Horse mackerel
Lemon sole
Ling
Long rough dab
Mackerel
Norway haddock
Norway pout
Plaice
Red Stone Crab
Saithe
Skate/ray
Squid
Tuskfish
Whiting
Flat (generic)
Fish unidentifiable
Other
Missing (false negative)


Vessel C avg. of model vs each observer: FNR=23.322%, FPR=51.278%, Mean class acc=61.546%
True label
Predicted label
Argentines 46.2% (32.7)
Common dab 0.0% (0.3)
Gurnard 36.4% (673.7)
Haddock 44.8% (40.7)
Hake 56.9% (5.7)
Herring 57.2% (140.7)
Horse mackerel 30.1% (11.0)
Mackerel 0.0% (0.7)
Norway pout 50.5% (32.3)
Red Stone Crab 0.0% (0.3)
Saithe 49.9% (97.3)
Skate/ray 47.8% (10.7)
Whiting 46.4% (48.7)
Flat (generic) 6.9% (7.3)
Fish unidentifiable 61.7% (47.0)
Nothing (false positive)
Argentines
Common dab
Gurnard
Haddock
Hake
Herring
Horse mackerel
Mackerel
Norway pout
Red Stone Crab
Saithe
Skate/ray
Whiting
Flat (generic)
Fish unidentifiable
Other
Missing (false negative)

Comparison with observers

- The average count accuracy by vessel for each reviewer (human and algorithm).

	Reviewer				
Vessel	Reviewer 4	Reviewer 5	Reviewer 6	Reviewer Average	Algorithm
Vessel A	83.35%	79.61%	72.73%	78.56%	56.76%
Vessel B	71.02%	75.74%	61.09%	69.28%	63.83%
Vessel C	77.28%	65.29%	71.24%	71.27%	63.97%
Vessel D	64.14%	61.91%	33.80%	53.28%	63.65%
Mean	73.95%	70.64%	59.72%	68.10%	62.05%

Demo video

HTTPS://WWW.YOUTUBE.COM/WATCH?V=OLU_CZAYTKK

Catchmonitor: summary

- CatchMonitor is a working prototype
- Automatically quantifies by-catch from surveillance videos captured on-board fishing trawlers
- Testing has shown inter-reviewer variability in count accuracies across each vessel were high and the algorithm count accuracy was typically close to the lowest individual count accuracy of the reviewers. Therefore, the performance of the algorithm is more or less equal to the lower ability end of “expert” human reviewers.
- With additional training data and further development we expect to reach accuracy sufficient for industrial application

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Thank you!

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