Deep Learning Video Analysis to Support Trawl Fishery Sustainability

Moses Lurbur[1*], Katherine C. Wilson[2], Noëlle Yochum[3]

1. **University of Washington**, Seattle, WA
2. Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, Seattle, WA
3. Trident Seafoods, Seattle, WA
* mlurbur@cs.washington.edu

Introduction

Video data collected during fishing plays an important role in bycatch reduction research, providing insights into how fish escape from fishing gear. We developed object detection models that can help reduce the time required to review and annotate fishing footage in the high-volume Alaskan pollock (*Gadus chalcogrammus*) fishery. We also explored the feasibility of automating two video review tasks: detecting the presence of infrequent bycaught salmon (*Oncorhynchus spp.*) and tracking individual salmon in videos.

Methods

- Manually annotated over 17,000 images
- Trained YOLOv8 models on 20% of annotations
- Combined models with our presence prediction algorithm to identify salmon
- Tuned and evaluated multi-object tracking algorithms using the Higher Order Tracking Accuracy (HOTA) metric

Results

- Salmon mean average precision (mAP): 84%
- Pollock mAP: 88%
- 99% of salmon presence detected
- HOTA scores on salmon videos:
  - BoT-SORT tracker: 58.5
  - IOU tracker: 54.3
  - ByteTrack tracker: 51.6

(The current best HOTA score for the standardized MOT17 tracking dataset is 65.8)

Conclusions

Our deep learning models are accurate at detecting infrequent species in challenging computer vision scenarios with high rates of occlusion and variable lighting. However, accuracy declines in footage containing species that were not present in training data, such as herring (*Clupea spp.*). Our results show that well-trained object detection models have the potential to accelerate the process of manual video review. Using our salmon presence prediction algorithm to filter out false positives and predict frames containing salmon, we detected over 99% of all instances of salmon presence. From our analysis, we found that object tracking remains a challenging task in trawl videos. Basic trackers outperform more advanced state-of-the-art trackers in our tests.

Our custom object detection models **meet or exceed the performance of humans**. The high detection accuracy of infrequent species creates new data-collection opportunities, including **semi-automated video review and annotation**, and the collection of individual movement patterns using **multi-object object tracking**.

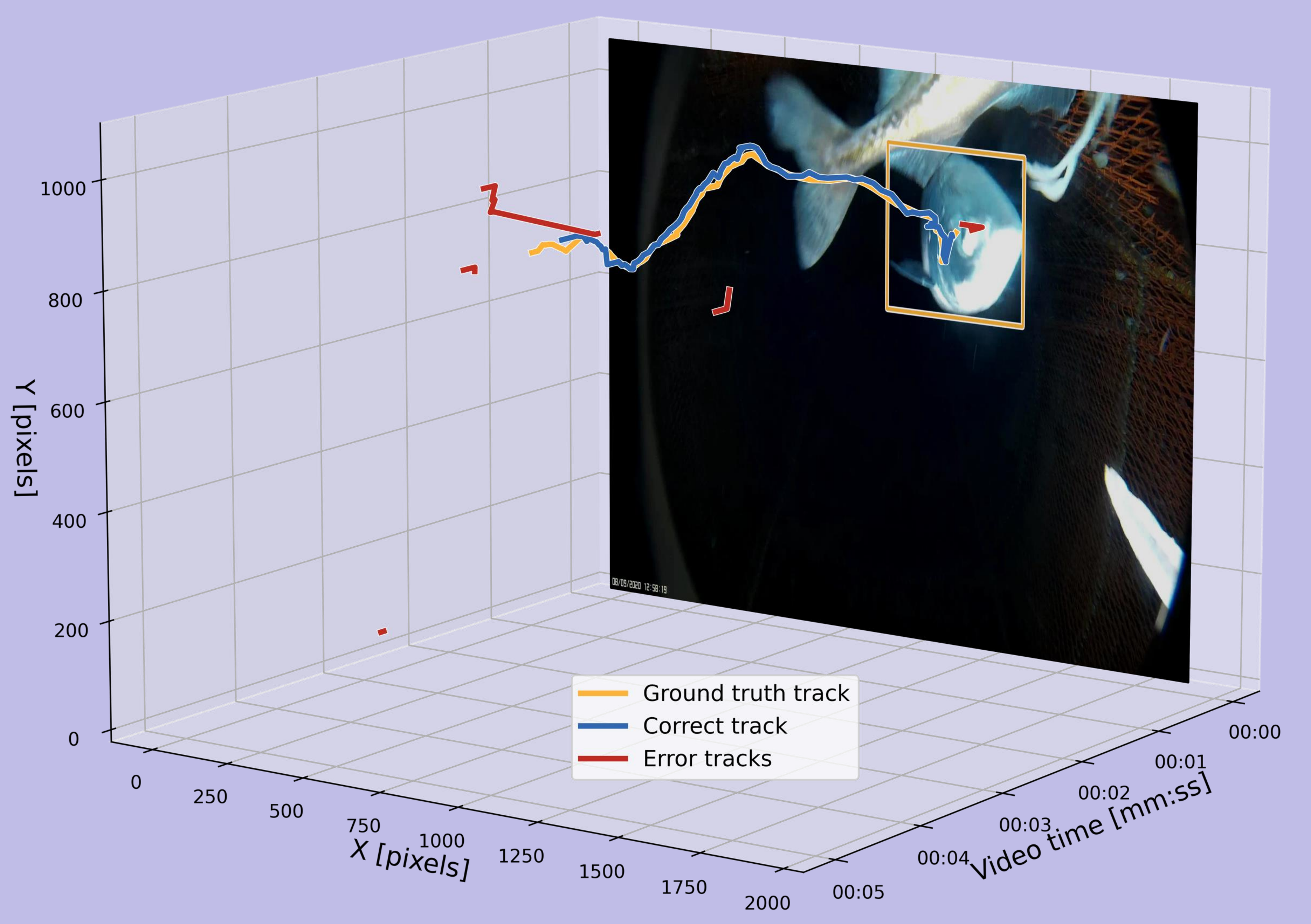

Figure 1. Salmon tracking results for a basic centroid tracker. Predicted track centroids are plotted as a salmon moves aft in a trawl net. The correct predicted track is shown in blue, false positive tracks are in red. Initial salmon position and the ground truth track is shown in yellow.

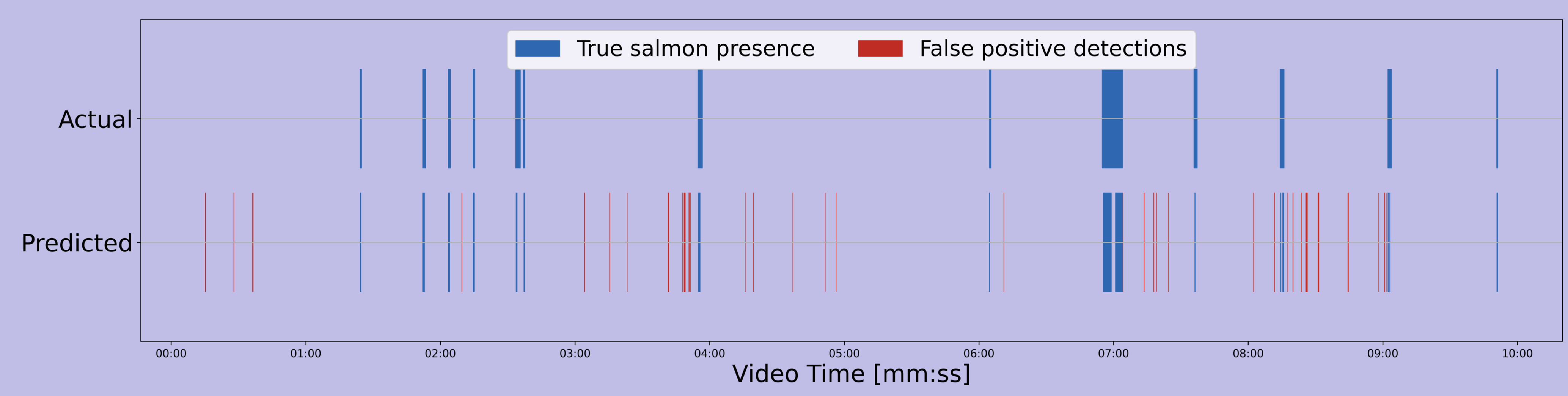

Figure 2. Predicted and actual salmon presence during 10 minutes of an Alaskan pollock trawl. Our salmon presence algorithm processes object detection results to filter out false positives and predict frames where salmon are likely to be present.

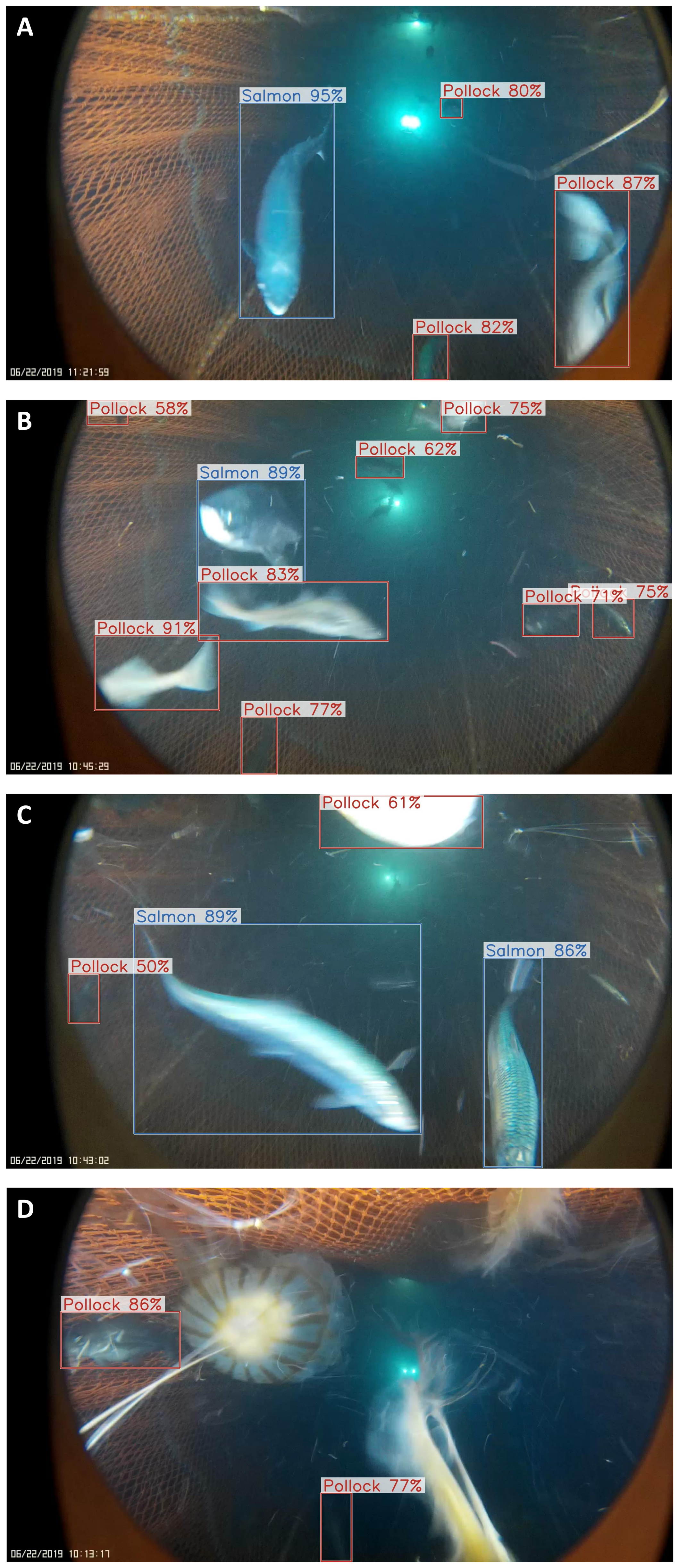

Figure 3. Examples of object detection results from pollock trawl footage. Bounding boxes are labeled with the predicted species name and the model's detection confidence score. A and B show true positive salmon and pollock detections. C shows two herring incorrectly identified as salmon. D shows accurate detection despite the presence of large jellyfish.

Take a picture to view videos of salmon tracking and detection

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