Species Recognition Pilot Project
Update for GEMPAC meeting on January 21, 2021
Summary for PFMC March 2021 Meeting

Partners: Environmental Defense Fund (EDF), FV Cape Windy (Paul Kujala), Saltwater Inc. (SWI), the EM Innovation (EMI) Team of the Alaska Fisheries Science Center (AFSC)

Background:
EDF has been working with Mr. Paul Kujala, owner/operator of FV Cape Windy (Warrenton, OR) for the last year to develop and test an EM system that minimizes the deck sorting burden on crewmembers while enabling the collection of required discard information needed for catch accounting/compliance required by the Trawl IFQ program. For Paul and many other 'coastal' trawlers who operate on the continental shelf, after sorting the marketable catch, there is often a significant amount of smaller, unmarketable fish (mostly flatfish species and no high value/concern species) which they discard.

Figure 1 Installation of camera chute aboard the Cape Windy (photo credit Justin Smith)

Current EM discarding rules for the exempted fishing permits (EFP) require separate totes for each species, estimating total weight, and showing to the camera before discard. Although this method is likely to ensure accurate catch accounting of the discard, it results in time consuming and sometimes unsafe processing by the crew such that after five years of the EFP, almost no 'coastal' trawlers wish to adopt EM. EDF's goal is to apply automated technologies, including artificial intelligence (AI), to minimize sorting time while still meeting the need for species identification and weights for catch accounting, thereby increasing EM uptake by the trawl sector.

Methods:

During fall 2020, the partners installed a specialized camera chute onto the end of a conveyor belt used to discard fish. The camera chute – designed by AFSC EMI researchers - improves image quality through controlled lighting and calibration to allow accurate length measurements. A SWI camera was installed in the chute and linked to an approved EM system (deck view camera, computer in wheelhouse w/ monitor and removable hard drive). Each catch was lifted onto and sorted from the conveyor belt. Discards dropped from the end of the belt and slid through the camera chute.

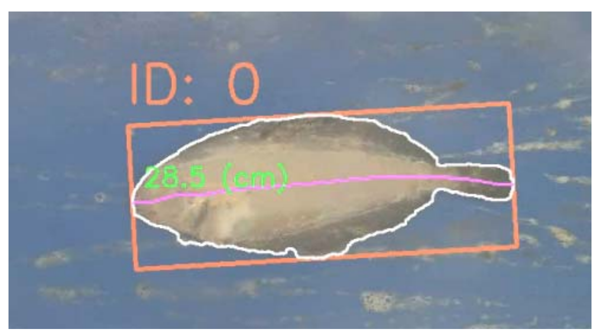

Figure 2- Rex sole detected and measured by AI.

Since this was not an EFP participating vessel, an at-sea observer used standard sampling procedures to estimate all discards for compliance purposes. Hard drives were mailed to SWI, who annotated time, location, and species for each animal in the videos. Videos and annotations were then sent to EMI team members at the University of Washington's (UW) Information Processing Lab. At UW, researchers trained and improved the automated species identification algorithm, and tested results against SWI reviewer counts and observer discard estimates.

Figure 3 Back deck view of haul sorting, October 2020. (Credit SWI)

Results:
The Cape Windy took three trips once camera chute was installed. Due to challenges with fish sticking to the belt surface and/or sticking together on early trips, the third trip yielded the best results for image and length detection. Eleven species groups, representing 98% of fish and crabs, had enough images to train the species model. The total number annotated of these groups was 3,458 (Table 1, TP+FN), with an average AI precision rate of 88%. Species counts, comparing detections (AI analysis), annotations (human review by SWI), and observer discard estimates, showed relative similarity across species overall (Figure 4). Some variation was seen by haul, notably in hauls 6, 8, and 9 where observer counts where higher overall (Figure 5). Persistence of this difference across species within hauls may point toward artifacts in estimating the observer's sample proportion as a possible cause.

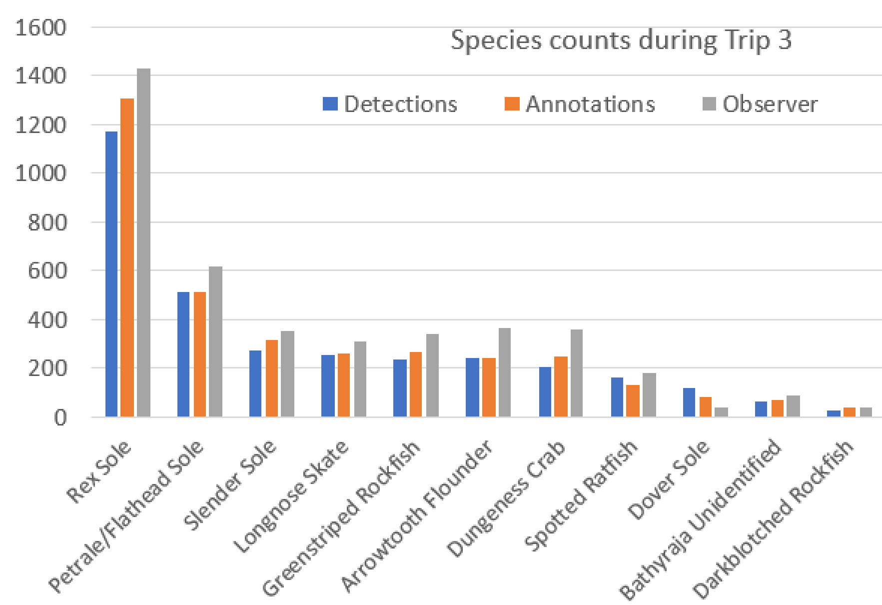

Figure 4 Total count comparisons by source for Trip 3. Detections (from automated analysis of the video), Annotations (numbers resulting from human annotated review), and Observer discard estimates.

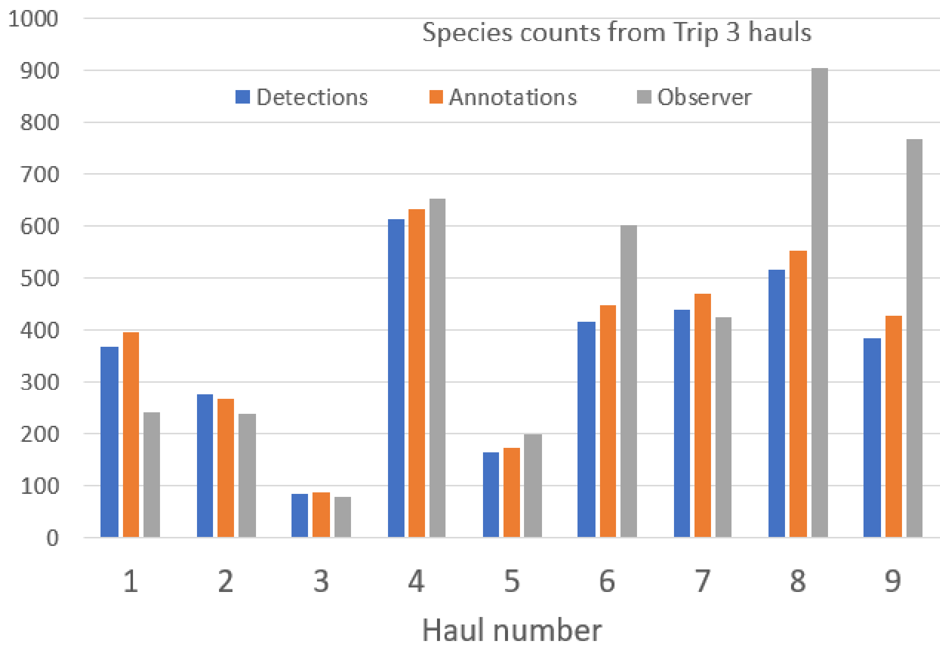

Figure 5 Haul count comparisons by source for Trip 3. Detections (from automated analysis of the video), Annotations (numbers resulting from human annotated review), and Observer discard estimates.

Measured fish lengths were converted to weights, using length-weight formulas for each species calculated from NMFS survey data. Some species like skates are hard for the algorithm to discern head/tail from side/side, but for the most part total length (TL) measurements are being consistently acquired.

Summary:

Results from this fall are showing great promise for automated species identification and transforming lengths to weights for catch accounting and compliance. The partners intend to continue collecting data on more fishing trips this year, making improvements to the chute for better data quality. We are also hoping to create some 'known' images by running some fish through the chute a second time once they have been identified by the observer. This will greatly improve the training data set for important species like petrale sole and flathead sole, which have not yet been differentiated in annotations or by the model.

We look forward to sharing additional results with NOAA Fisheries staff in the WCGOP and the WCR who are helping to develop and implement the Groundfish EM program, so that it may be incorporated into the future regulatory program and shared with other vessels who wish to use it.

Project Contacts

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(The AFSC EMI project is managed by the Pacific States Marine Fisheries Commission)

Table 1 Trip performance statistics for image analyses. [True Positive - Same species detected by both AI analysis and annotation, False Positive – Fish detected by AI, but not by annotation, False Negative – Fish not detected by AI, but annotated as present, Precision = TP / (TP+FP) is the proportion of IA detections that matched annotations, and Recall = TP/ (TP+FN), the proportion of annotations that were detected by AI.]

Category	**True Positive**	**False Positive**	**False Negative**	**Precision**	**Recall**
Total	2848	414	610	87%	82%
Rex Sole	1093	79	211	93%	84%
Petrale/Flathead Sole	440	71	71	86%	86%
Slender Sole	233	38	83	86%	74%
Longnose Skate	231	21	27	92%	90%
Greenstriped Rockfish	212	23	51	90%	81%
Arrowtooth Flounder	201	38	38	84%	84%
Dungeness Crab	184	22	61	89%	75%
Spotted Ratfish	109	52	21	68%	84%
Dover Sole	62	59	22	51%	74%
Bathyraja Unidentified	55	11	12	83%	82%
Darkblotched Rockfish	28	0	13	100%	68%