ENVIRONMENTAL DEFENSE FUND

Finding the ways that work

Creative Approaches & Emerging Tools for Stock Assessments

Post-Workshop Report

September 2021

Event Summary

On the evening of September 15th, 2021, US time--the morning of September 16th, 2021, Japan time-- Environmental Defense Fund hosted a workshop designed to share information on emerging technologies and other creative solutions for fishery dependent data collection. Titled Creative Approaches and Emerging Tools for Stock Assessments, the event brought together experts from the United States and Japan to discuss the rationale and status of the pathbreaking Fishery Reform Act, as well as data poor assessment methodologies and new technologies like AI-assisted cameras to facilitate collection of data for stock assessment purposes. The event was attended by nearly 60 scientists from national and prefectural research institutions, technology and fishery data industry members, and leaders from the United States and Japan, including representatives from the Environmental Defense Fund (EDF), the National Oceanic and Atmospheric Administration (NOAA), and the Fisheries Research and Education Agency of Japan (FRA).

Background

The 2018 Fisheries Reform Act, which went into force in December 2020, calls for 80% of Japan's catch to be managed with TACs by 2024 when the Act will be fully implemented. It also requires a significant increase in the number of scientifically assessed species from roughly 100 currently to 200 over that same time period. Partly in response to this new legislation, Japanese scientists at the Fisheries Research and Education Agency of Japan (FRA) hope to employ cutting-edge tools like AI to increase the efficiency and reduce the manpower required in collection of fishery dependent data. At the same time, the fishing industry, including processing companies, would like to introduce automatic sorting machines, to help meet a drastic reduction in available manpower. FRA hopes to collect detailed biological data on landed fish by supporting the introduction of automatic sorting machines equipped with AI technology. Deployment of such technologies could also be an important component of Japan's drive to develop smart fisheries where technology enhances efficiency, value, and production through integrated collection and synthesis of a wide variety of data streams including oceanographic, market, catch, and other information.

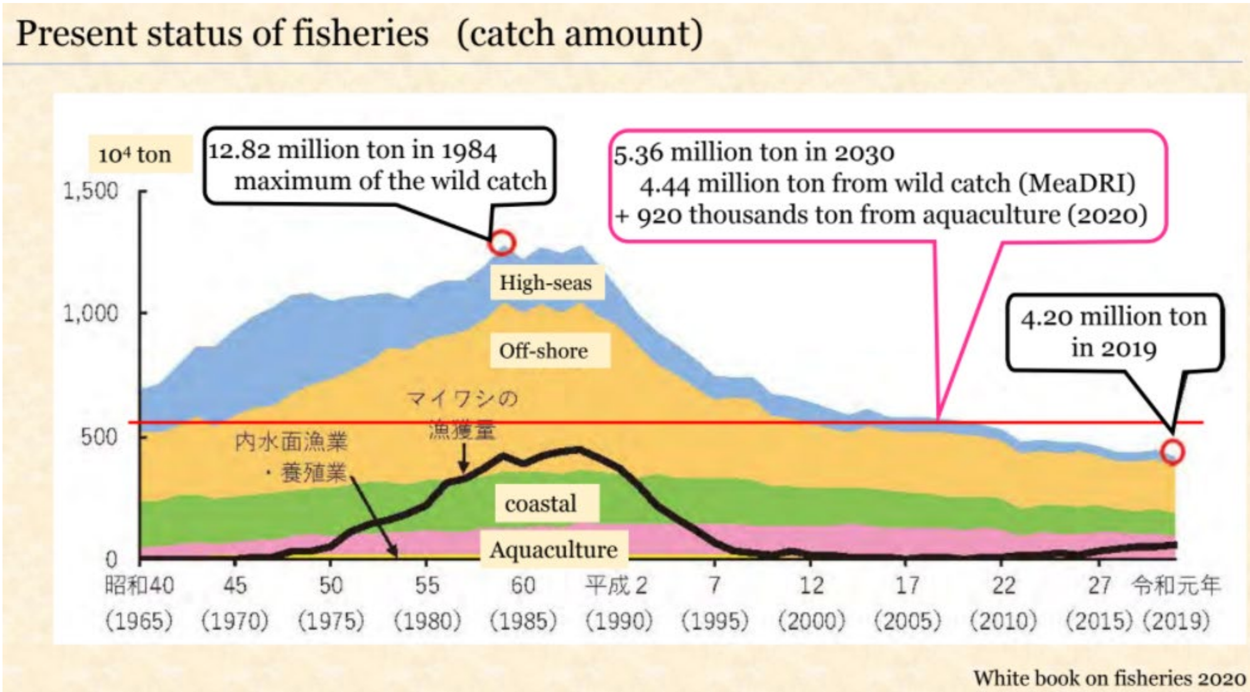
Goals

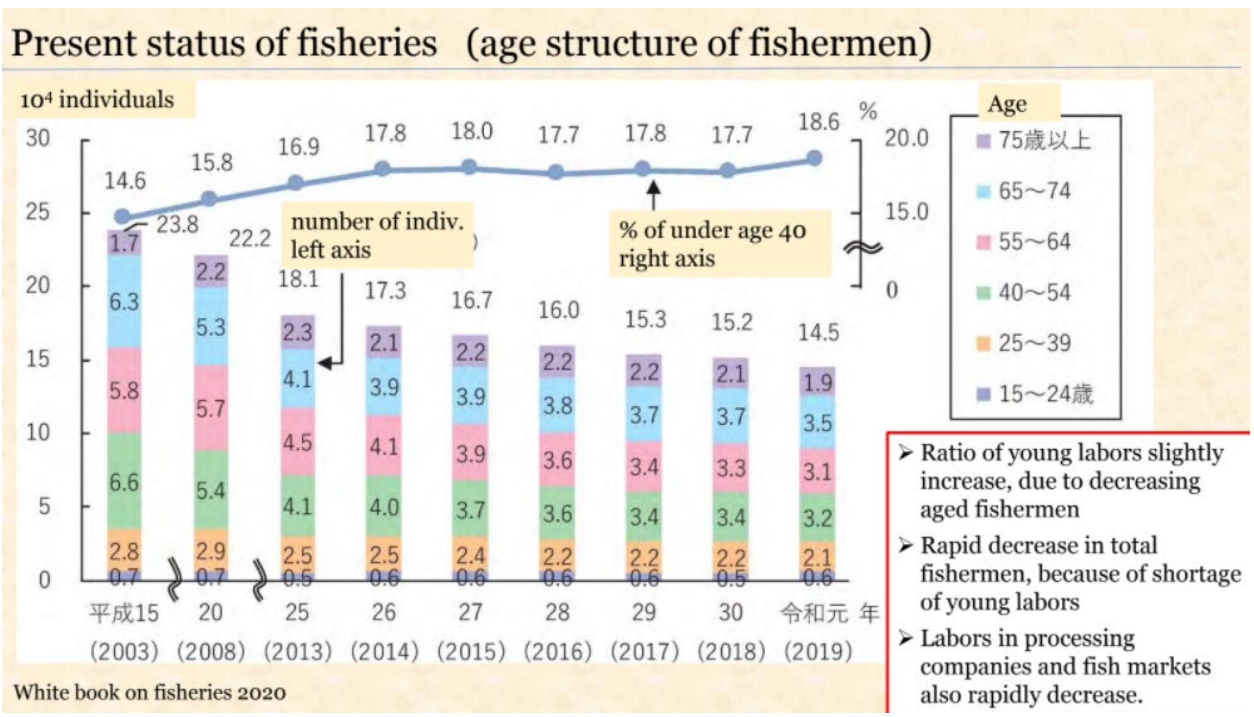
- Share knowledge of tools/ideas that will allow the FRA to enhance data collection for stock assessments
- Create lasting connections between Japanese and US/international fisheries scientists and tech experts
- Identify potential opportunities for collaboration
- Identify points for further clarification and/or future workshops

Speaker Overview

Mr. Shems Jud, Director, Japan Fisheries & Oceans, Environmental Defense Fund, opened the event and welcomed participants. He briefly described the background and problem statement, highlighting the focus on emerging tools like AI to create data streams that could feed into stock assessments.

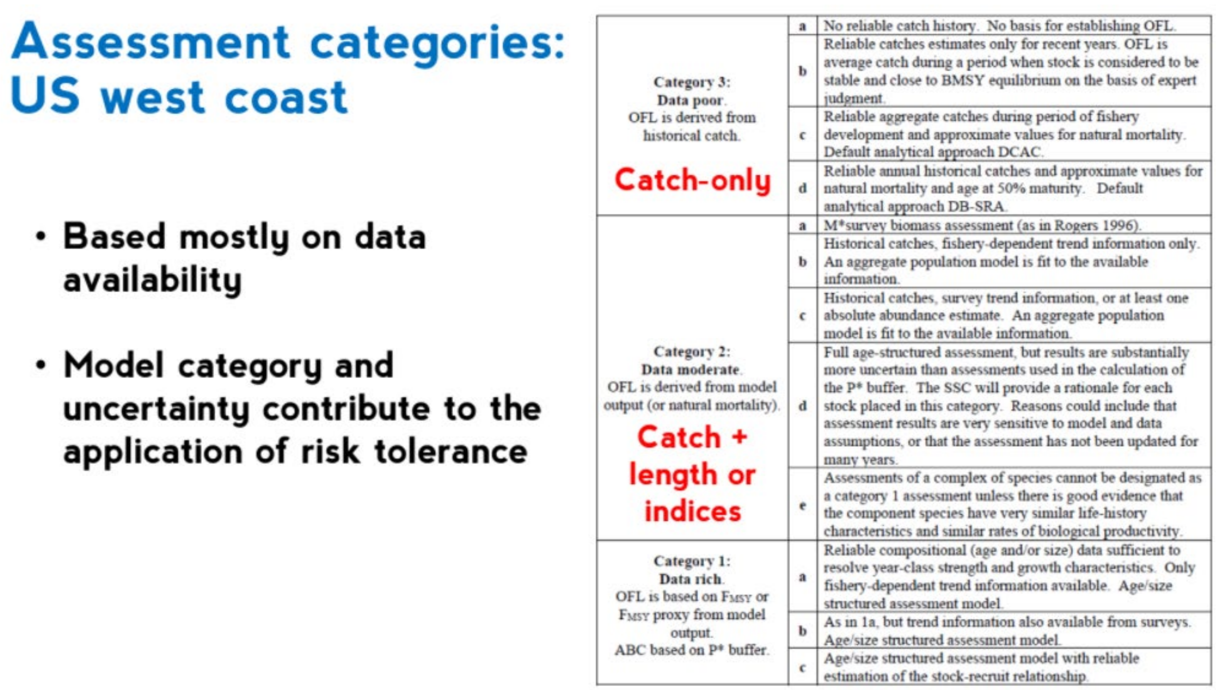
Mr. Jud then invited **Dr. Yoshioki Oozeki**, Senior Adviser, Japan Fisheries and Education Research Agency, to provide a more detailed description of the Fisheries Reform Act, the responsibilities of the FRA, and how new technologies fit into their goals. Dr. Oozeki provided a presentation titled **Needs of innovative image analyses in Fisheries Research —in relation to the recent fisheries measures.** In it he noted the compounding issues of declining catch over time and the aging of the fleet as key factors motivating the reform.





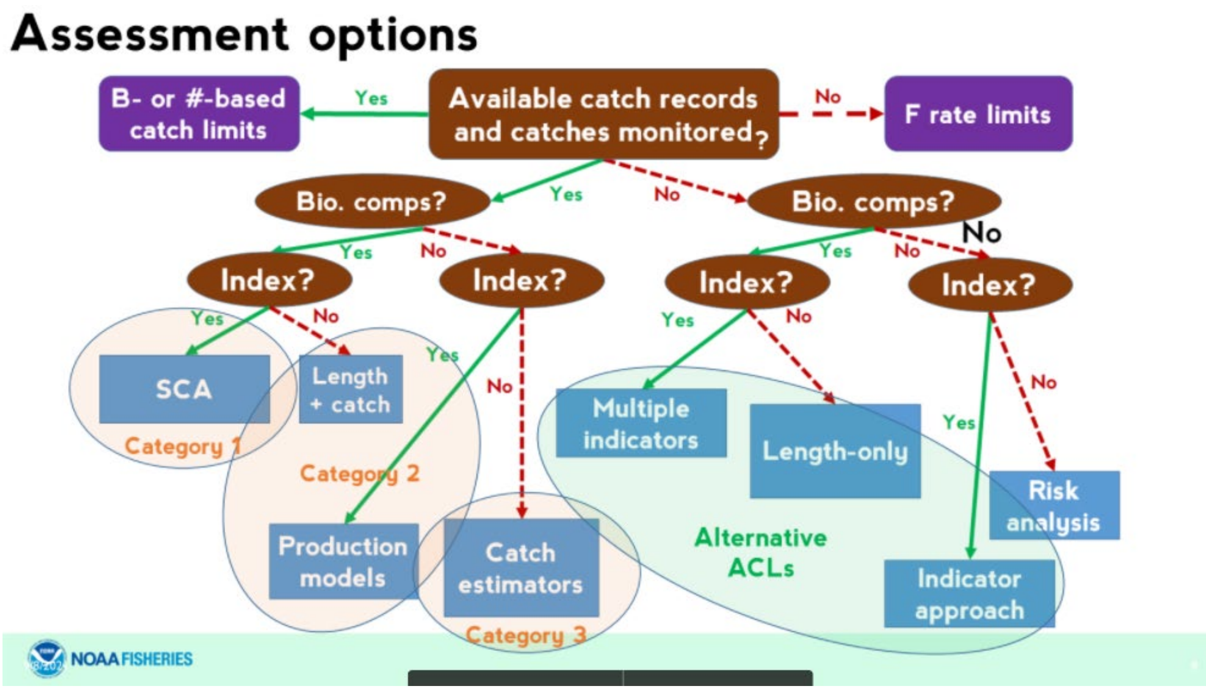
He noted the need for enhanced data collection, including through the use of ICT technologies, to support stock assessments, harvest control rules, and ultimately specific management measures that will be needed to improve catch, value, and efficiency in Japanese fisheries. Dr. Oozeki reinforced that meeting the specific mandate of 200 assessments nationwide by 2024 will likely require the deployment of automated systems capable of collecting species and size/weight data in near-real time. Dr. Oozeki reminded the audience of some of the challenges facing FRA and JFA as they work to implement the reform including the sheer number of ports, fishermen, and gear types in use in Japan, the diversity in operational scale between coastal and large-scale vessels, and the compounding effects of climate driven events like marine heat waves and red tides. He concluded noting that those challenges are significant and cannot be solved solely through adoption of new technology, but they may be impossible to solve without new technology.

Following Dr. Oozeki, **Dr. Jason M. Cope,** Northwest Fisheries Science Center, NOAA Fisheries, provided a presentation entitled **Stock assessments options to support fisheries management, with examples from the United States.** In it he described the 2007 revisions to the Magnuson-Stevens Act requiring assessments for all species "in the fishery" by 2011. On the West Coast, which has several hundred species under management, this created a data and assessment crunch as many species did not have adequate data available for traditional stock assessments and the number of stock assessment experts remained steady despite the increased demand for assessments.



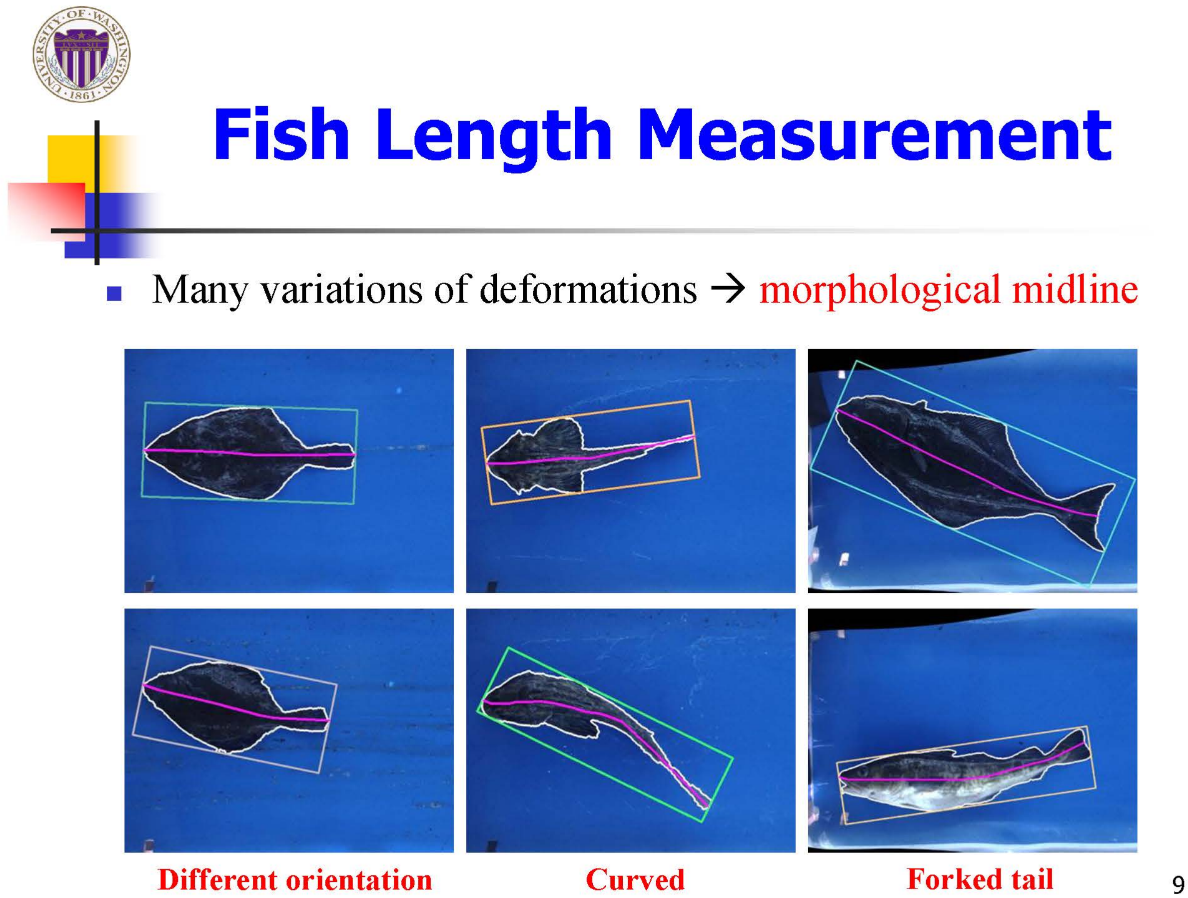
Category 3: **Data poor**. OFL is derived from historical catch. Catch-only	a	No reliable catch history. No basis for establishing OFL.
	b	Reliable catches estimates only for recent years. OFL is average catch during a period when stock is considered to be stable and close to BMSY equilibrium on the basis of expert judgment.
	c	Reliable aggregate catches during period of fishery development and approximate values for natural mortality. Default analytical approach DCAC.
	d	Reliable annual historical catches and approximate values for natural mortality and age at 50% maturity. Default analytical approach DB-SRA.
Category 2: **Data moderate**. OFL is derived from model output (or natural mortality). Catch + length or indices	a	M*survey biomass assessment (as in Rogers 1996).
	b	Historical catches, fishery-dependent trend information only. An aggregate population model is fit to the available information.
	c	Historical catches, survey trend information, or at least one absolute abundance estimate. An aggregate population model is fit to the available information.
	d	Full age-structured assessment, but results are substantially more uncertain than assessments used in the calculation of the P* buffer. The SSC will provide a rationale for each stock placed in this category. Reasons could include that assessment results are very sensitive to model and data assumptions, or that the assessment has not been updated for many years.
	e	Assessments of a complex of species cannot be designated as a category 1 assessment unless there is good evidence that the component species have very similar life-history characteristics and similar rates of biological productivity.
Category 1: **Data rich**. OFL is based on F_{MSY} or F_{MSY} proxy from model output. ABC based on P* buffer.	a	Reliable compositional (age and/or size) data sufficient to resolve year-class strength and growth characteristics. Only fishery-dependent trend information available. Age/size structured assessment model.
	b	As in 1a, but trend information also available from surveys. Age/size structured assessment model.
	c	Age/size structured assessment model with reliable estimation of the stock-recruit relationship.

NOAA adopted a multi-tiered approach, largely based on data availability, along corresponding uncertainty buffers that reduced allowed catch relative to scientific uncertainty.



While not a technological approach to stock assessment and data collection, relying on a variety of different assessment methodologies corresponding to data availability, enabled the US West Coast to meet a rigorous increase in the required number of stock assessments in a short amount of time.

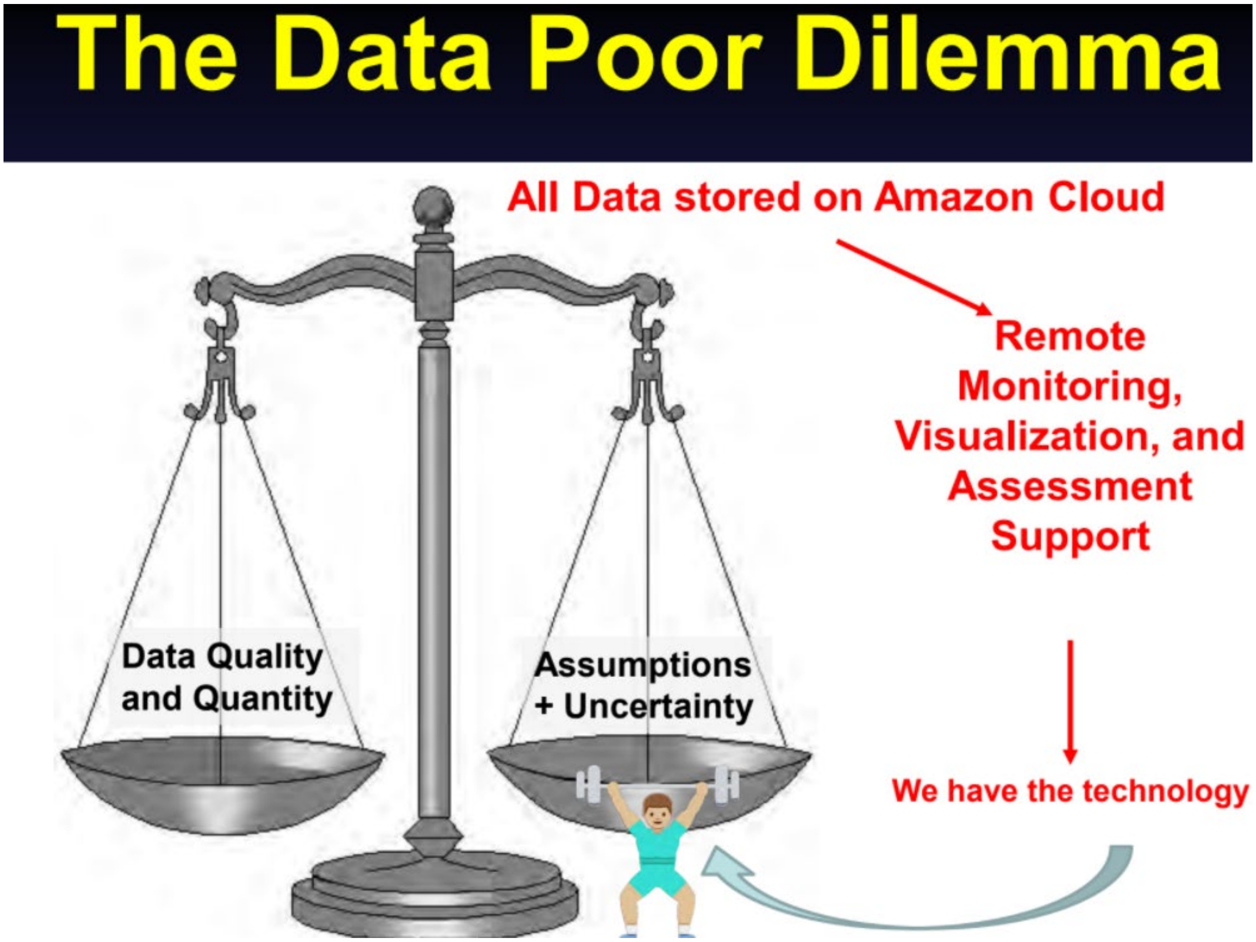
Dr. Jenq-Neng Hwang from the Department of Electrical & Computer Engineering at the University of Washington followed Dr. Cope with a presentation titled **Electronic Visual Monitoring of Fisheries for Smart Ocean.** In that presentation Dr. Hwang highlighted the value of fisheries globally and noted the importance of careful management for long-term sustainability. He catalogued several areas where emerging technologies can assist with management objectives including “no touch sampling” using stereo cameras, vessel-based reporting using AI assisted cameras, satellite and cell transmission for near real-time data, and more. He then focused on the use of cameras and machine learning for species ID and size estimation.



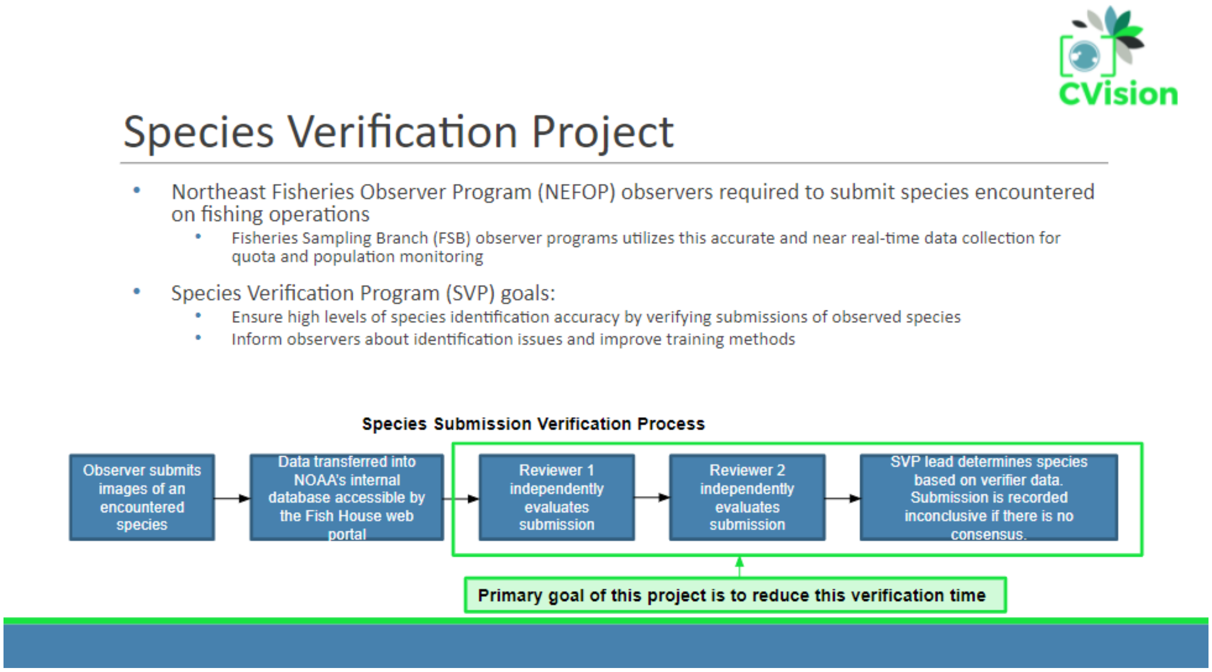
Dr. Hwang shared some of the common problems encountered – fish of a very similar appearance, lightning/glare/shadows, overlapping fish, and curvature – as well as solutions. He concluded by noting that every fishing boat has the potential to be an IoT hub gathering catch, oceanographic, weather, and other information. That big fishery data can be powerful for conservation and for profitability, and represents a major step toward smart fisheries and oceans.

Following Dr. Hwang, **Dr. Todd Gedamke** of MER Consultants shared a presentation on **Developing smart scales and data solutions for small scale fisheries.** Dr. Gedamke began his presentation by describing traditional approaches to stock assessment including the assumptions they rely on, and the trade-offs often required between data availability, value of the fishery, uncertainty, and cost of further data collection. He noted that for many data-poor or unassessed species, especially in small-scale fisheries, traditional stock assessment approaches are unlikely to ever be a viable or cost-effective option. He then described a unique approach that he has pioneered in the Caribbean using a smart tablet coupled with a scale to automatically capture species ID and weight. This provides a method of rapid identification and capture of key biological information to enhance stock assessment capability for a number of fisheries that due to their size and value might otherwise not be properly assessed.

Dr. Gedamke concluded by noting that we now have the technology to overcome the traditional tradeoffs between data availability and uncertainty through solutions like this one that are fast, portable, and inexpensive.

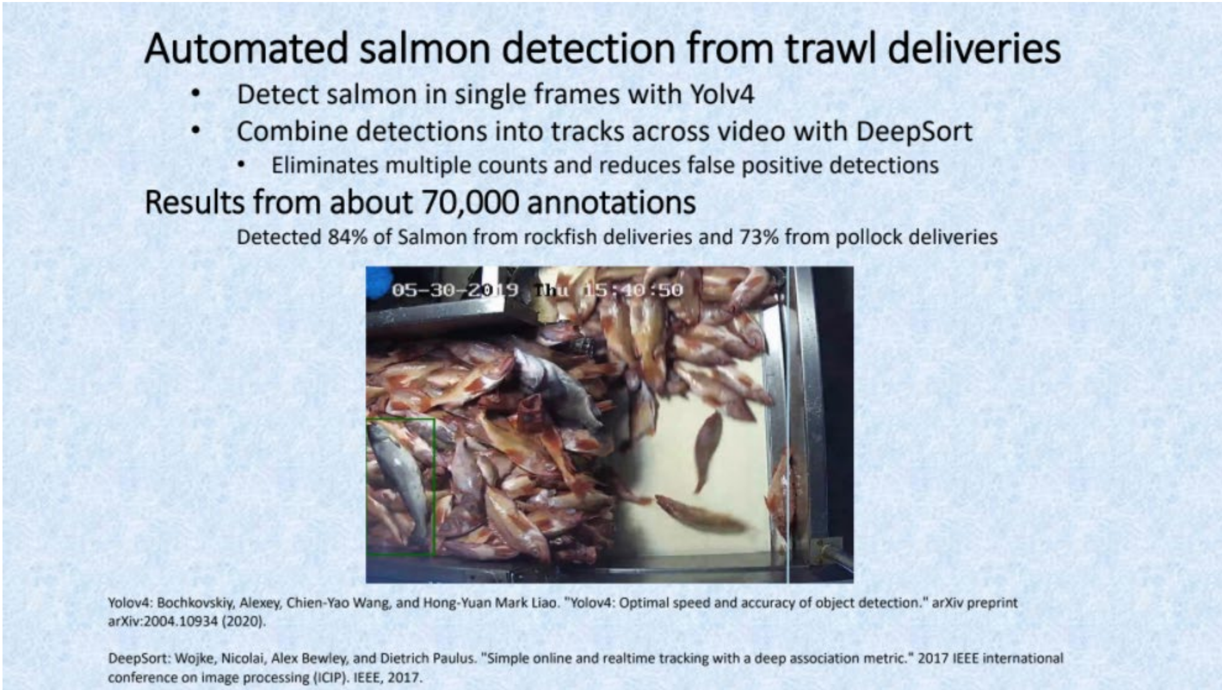


Ben Woodward of CVision AI provided the next presentation on **Automated Fish Analysis in the Northeast Groundfish Fishery: Building a Library for Image Processing and Machine Learning to Support Electronic Monitoring Programs.** Mr. Woodward began by noting some of the common challenges in implementation of EM systems including high costs of human review to ascertain information such as species ID and size. He described a project on the East Coast of the United States aimed at demonstrating the significant efficiencies that can be realized through adoption of AI solutions. The primary goal is to minimize the cost and human labor required to verify species encountered in fishing operations.



He described the algorithm pipeline/decision matrix and how the system works. He then described the process for refining algorithm performance and assessing results. Overall, the algorithm is able to accurately identify species with a high degree of confidence showing great promise for significant efficiencies that could be incorporated into current data collection processes.

Dr. Craig Rose of FishNext Research, the last presenter of the workshop, offered a presentation on **The Alaska Fisheries Electronic Monitoring Innovation (EMI) Project: Developing Automated Methods to Monitor Fisheries—Validating bycatch reports from processing plants.** In his presentation, Dr. Rose described four different components of the Alaska EMI project. First, monitoring longline catches as they come aboard for species ID and size. Next, monitoring discard on trawl vessels for species and size composition. Third, monitoring crew locations and activities to enhance EM functionality. And finally, plant-based cameras to capture and identify rare/sensitive species. Dr. Rose spent the bulk of his talk describing the plant-based application of smart cameras to ensure accurate accounting of rare and hard to monitor species like salmon and crab that often make up less than 1% of the overall catch.



Through this research Dr. Rose identified several important lessons that may be applicable in other plant-based applications of cameras and AI. Specifically, the need for well-placed cameras and use of proper lighting to minimize both glare and shadows; training of personnel working in the plant to ensure they don't obstruct camera views and understand how to clean and maintain the equipment; the understanding that different primary delivery species may require retraining or recalibrating the algorithm; and the importance of a digital record of AI images to enable human review at a later time if necessary.

Conclusion and next steps

Individually, each presentation in this workshop provided important insights into cutting-edge research and ideas for fisheries data collection. There is no doubt that cameras coupled with AI enable cost-effective and less labor-intensive ways to gather data for assessment purposes. Likewise, data-poor assessment methodologies may have an important role to play as Japan seeks to radically increase the number of scientifically-assessed stocks. Collectively, we hope that the presentations and discussion also helped to chart a course for adoption of technologies that will lead us closer to a smart fisheries future. However, while that future may now be in sight, we still have a number of steps to take before it is a reality. Holistic data systems that can seamlessly integrate data from multiple sources while serving multiple functions (e.g. data collection for assessments, catch/compliance data for management, market, location data for fishing efficiency/profitability etc.) is an important next step on that path. To that end, one of the issues that was discussed briefly but not directly addressed in this meeting was the potential value and incentives for fishermen and processors to install cameras, AI, and other ICT systems on vessels and in plants. Identifying and providing direct or indirect benefit to industry stakeholders will ease uptake and allow adoption of such solutions at scale. Relatedly, synthesis of data collected through such systems with the ER reporting system currently envisioned for TAC and other management compliance could add tremendous value and reduce duplication. EDF, in conjunction with a number of other stakeholders and partners, is currently in the process of designing a future workshop that will focus on some of these critical issues. That workshop is expected to occur in spring 2022.

Thanks to all of the speakers and participants. You made this workshop a success. We hope for your continued support and interest in the future.