



The Fate of Fisheries in a Climate Changed World

Post-Workshop Report

July 2021

Event Summary

The Fate of Fisheries in a Climate Changed World was a virtual two-day workshop planned and hosted by the Environmental Defense Fund's oceans team. The event brought together experts from the United States and Japan for a discussion on the impacts of climate change on fisheries and marine ecology. This impact was examined through scientific, sociological, and economic lenses, with the ultimate focus of increasing resiliency of fisheries to climate change with better science and adaptive management.

This workshop was held on the evenings of July 20th and July 21st ET (mornings of July 21st and July 22nd JST). The event was attended by nearly 80 scientists and leaders from the United States and Japan. This included representatives from Environmental Defense Fund (EDF), the National Oceanic and Atmospheric Administration (NOAA), the Fisheries Research and Education Agency of Japan (FRA) and Fisheries Agency, Japan (FAJ).

Goals and Organizing Themes

The primary, overarching goal in hosting this event was to promote international collaboration between scientists in the United States and Japan. There is growing recognition of the significant challenge that climate change poses to the health and stability of fisheries worldwide, and that this challenge will only intensify as the effects of a changing climate become more pronounced. While some countries are beginning to emphasize climate resiliency in fisheries management, climate impact is still a relatively new and evolving phenomenon that most countries are not yet considering when designing management plans. It is clear that implementation of these practices at a much larger scale will be necessary to ensure a sound future for global fisheries.

It is also deliberate that this workshop took place between the United States and Japan, two major fishing powers with large EEZs and significant economic reliance on fisheries. Given the vastness of the areas they govern and the longitudinal stretch from tropical to subarctic (arctic for US), climate impacts will be unavoidable and possibly severe. It will be critical to better understand coming changes, identify data gaps, and collaborate in order to mitigate some of those impacts. The experts in the US and Japan are also well poised to provide leadership in this space that other countries can look to as they struggle with similar issues. In addition, Japanese lawmakers recently passed the farsighted Fishery Reform Act, which will increase the percentage of catch managed with science-based catch limits and will expand stock assessments to cover all

commercial stocks. Therefore, it is particularly important for Japanese scientists to communicate with one another and work with U.S.-based organizations to ensure that this reform legislation is implemented fully and in a climate-resilient manner.

The overarching objectives for this workshop were therefore 1) to promote a common understanding of climate change-related challenges faced by fisheries in the Pacific Ocean, and 2) to catalyze knowledge sharing and conversation between scientists from the US and Japan so that this understanding can become more advanced, nuanced, and collaborative.

Under these broader objectives, the workshop sought specifically to foster discussion around 1) creating more effective climate forecasts to better equip fisheries for change, 2) identifying and closing key data gaps that are relevant for better management, 3) identifying communities of practice where international collaboration would be beneficial (i.e., pooling data from the U.S. and Japan to facilitate large scale modeling, which can then be utilized by each country in tandem with locally relevant inputs), and 4) creating new connections or deepening existing professional relationships among scientists in the two countries to set the stage for future partnerships. With these goals in mind, the workshop was designed to maximize interaction among its participants; each day consisted of speaker presentations followed by opportunities to ask questions and concluded with a longer Q&A and discussion section.

Speaker Overview

Day 1

Leader Remarks

The event opened with a series of introductory remarks from various leaders from the organizations in attendance. Dr. Eric Schwaab, EDF's Senior VP of Ecosystems and Oceans, kicked off the conference by reminding everyone of just how important the ocean is as a source of income and nutrients—especially in the Pacific, which is home to some of the world's highest volume fisheries and most powerful fishing nations. Dr. Schwaab emphasized that while fisheries worldwide need to adapt to climate change, this will look different in different places, and that there are key questions scientists must answer to make sure local management is effective. He noted: ***“To me, this is the main objective of this workshop. How are fisheries in the Pacific changing? What additional stressors may be coming? What data do we need to understand these questions? How can we collaborate across borders to deepen our scientific understanding and ultimately manage changing fisheries more effectively?”***

Dr. Schwaab was followed by Dr. Francisco Werner, the Director of Scientific Programs and Chief Science Advisor at NOAA Fisheries. Dr. Werner noted that climate impacts on productivity, recruitment, survivorship, and species movements are now occurring even more rapidly than predicted. In addition, socioeconomic impacts on fishing communities are beginning to occur with greater frequency. He noted that the number, rate, and magnitude of such impacts will likely increase over time. These challenges make it difficult for NOAA to fulfill its mandate for sustainable fisheries and conservation of protected species. In order to reduce risk and increase resilience, he highlighted the recently launched Climate and Fisheries Initiative¹ which will provide new investments and new partnerships, and drive innovation by producing critical data that ultimately fosters better management. He concluded by emphasizing the importance of international partnerships and collaboration which will be critical to solving this problem: ***“The challenges ahead of us are much larger than any one organization or any one nation can undertake. The importance of this workshop is coming together to jointly take the necessary steps in addressing the climate change challenge that affects us all.”***

Next was Mr. Takashi Koya, the Director-General of the Fishery Agency of Japan. Like Dr. Werner, Mr. Koya noted changes in distribution, shifts in spawning areas, poor recruitment and other issues driven by changes in currents, water temperature, and other climate driven factors. He went on to highlight the impacts on fishermen and fishing communities as fishing grounds become more distant for example, or as biomass for certain stocks begins to decline. Mr. Koya highlighted the potential for science to help us understand future impacts enabling a smart management response that will foster resilience. He closed by reiterating the value on international collaboration and the opportunity for the workshop to be a fruitful beginning to a discussion of this important issue. Mr. Koya stated: ***“In order to efficiently and sustainably use resources that are affected by environmental changes, we must first establish the scientific resources necessary for research and study, and to confirm the impact of environmental changes on marine resources. This is a difficult task, but in the future, it will be beneficial to study the mechanisms of environmental changes, forecast possible future changes, and think of what kind of management can be considered based on these findings.”***

The keynote remarks were given by Dr. Manuel Barange, the Director of the Fisheries and Agriculture Division at FAO in Rome. Dr. Barange spoke about how the primary cause of inaction isn't due to an absence of science: ***“Actions are risky and are considered carefully. Often, inaction is the result of the complexity facing the decision-maker, not so much the lack of knowledge itself.”*** While Dr. Barange

¹ <https://www.fisheries.noaa.gov/topic/climate-change#noaa-climate-and-fisheries-initiative>

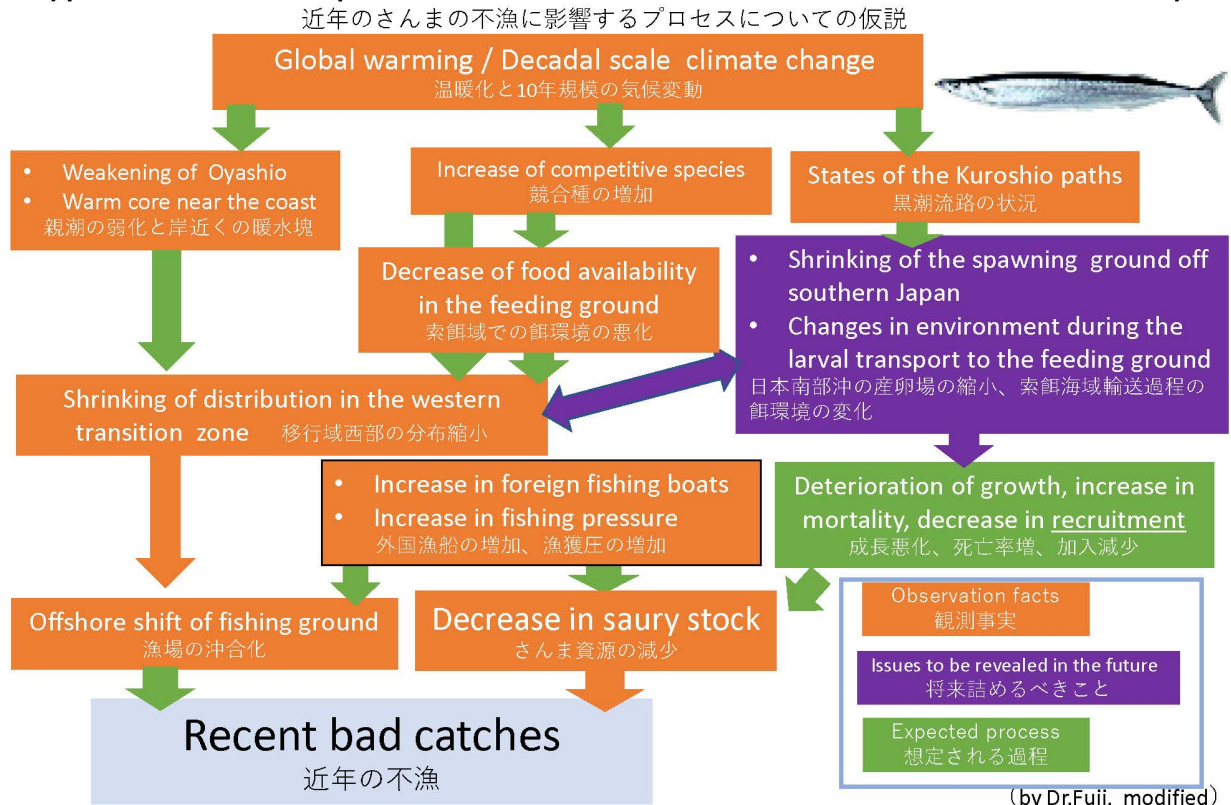
called for more accurate science to inform decision-making, he emphasized that action cannot be contingent solely upon knowledge because, by nature, knowledge within the ever-evolving field of climate change will never be fully complete. Dr. Barange also emphasized the importance of maximizing opportunities in adaptive management: ***“The impacts of climate change and fisheries are not a zero-sum game. This is not about minimizing damages or maintaining the status quo. It is also about maximizing opportunities ... We cannot do much to convince a species not to change its distribution. But we can do a lot in terms of maximizing our response.”*** Ultimately, Dr. Barange emphasized that we are moving into a phase of fisheries management in which managing for change must become the status quo instead of managing for stability, which has always been the goal in the past.

Speakers

The presentations of Day 1 considered important questions we need to answer to address the challenges resulting from climate change. Key questions included: What do countries most urgently need to know about how climate change is affecting fisheries and what can today’s science tell us? What is the current state of science, and where is it headed? Where are critical data gaps, and how can they be filled?

The speaker series was kicked off by Dr. Kaoru Nakata, the Executive Director at Japan Fisheries and Education Research Agency. Dr. Nakata used the declining chum salmon catch in Japan to illustrate the importance of understanding the mechanisms through which regional climate change is linked to poor catches. Scientists have hypothesized which mechanisms might be chiefly responsible (is it a matter of recruitment failure or distribution changes?), and Dr. Nakata focused on what types of data science will be needed to answer these questions. Below is a slide presented by Dr. Nakata that illustrates how large-scale global warming trickles down into more specific local effects that fisheries managers must understand in order to take proper action.

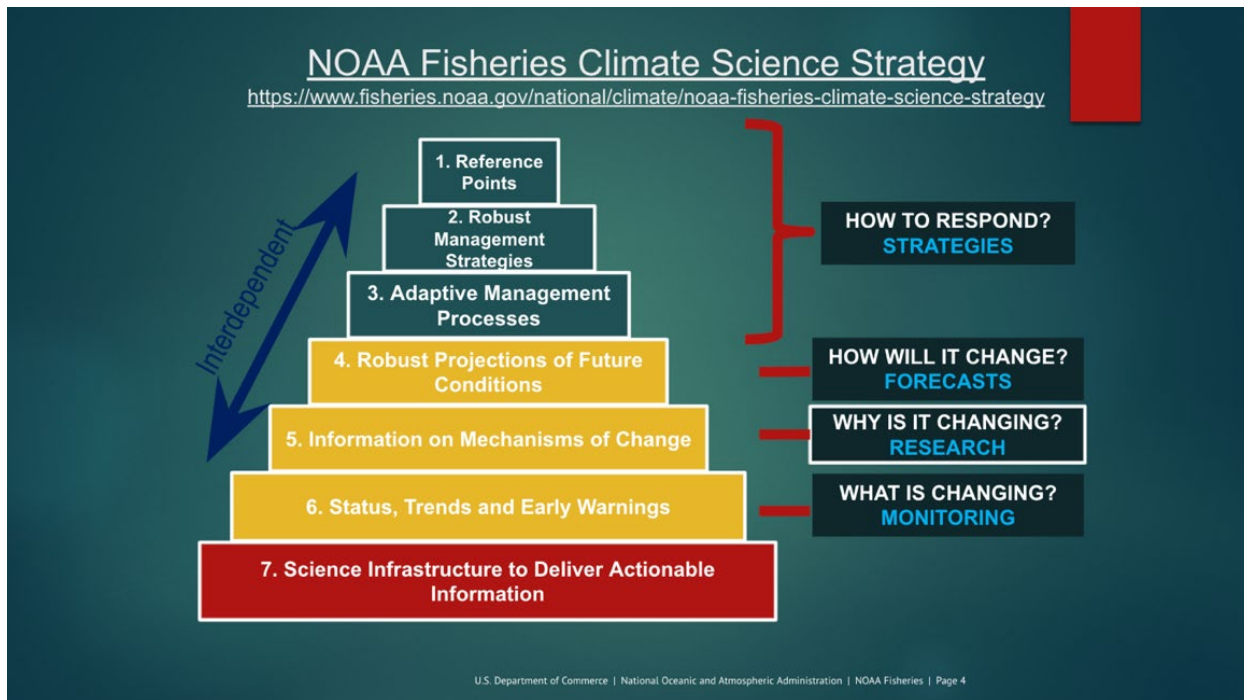
Hypothesis on the processes for the recent bad catch for Pacific saury



- Various processes relevant to the climate change have acted
気候変動と関係する様々な現象が作用

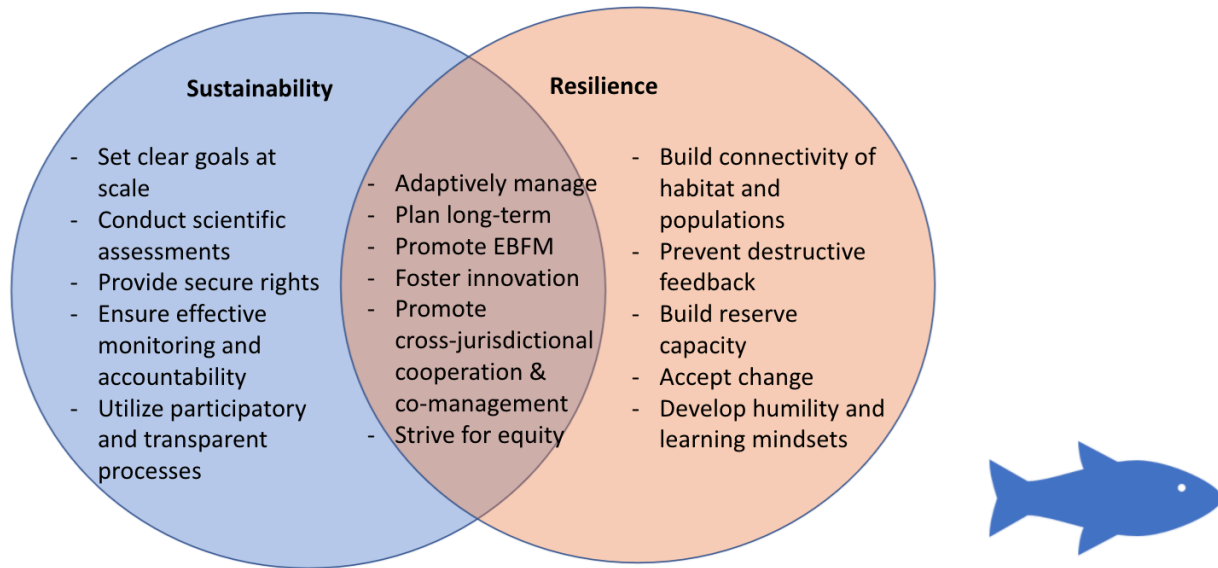
Dr. Anne Hollowed of NOAA's Alaska Fisheries Science Center was the next presenter and spoke about the importance of creating a "decision support system" that uses the results of physical modeling to inform management strategies. Dr. Hollowed discussed how a foundation of scientific modeling and observation can lead to more effective responses at the management level. Specifically, Dr. Hollowed spoke about NOAA's Climate and Fisheries Initiative (CFI), a cross NOAA operational modeling and decision support system that would provide state-of-the-art forecasts and ecosystem projections. This will directly contribute to the management and strategy levels of NOAA's 7-level scheme shown below taken from the NOAA Fisheries Climate Science Strategy² (refer to the illustration below).

² <https://www.fisheries.noaa.gov/national/climate/noaa-fisheries-climate-science-strategy>



The final speaker of Day 1 was Dr. Kristin Kleisner, the Senior Director of Oceans Science at EDF. Dr. Kleisner gave a brief history of EDF’s sustainable fisheries efforts, highlighting the main principle that improving fisheries management in different socio-ecological and political contexts requires different kinds of scientific work. Dr. Kleisner then gave a working definition of resilience as: ***“The capacity of socio-ecological systems to recover, adapt, or transform constructively to support human and natural well-being as climate change and other stressors interact unpredictably over time.”*** Dr. Kleisner used the Venn Diagram below to demonstrate how sustainability and resilience are distinct but overlapping principles, and what a fishery that is both sustainable and resilient might look like. Dr. Kleisner detailed 5 climate resilience pathways that EDF strives for with fisheries reform: ***1) Establish & promote effective management and governance, 2) Plan ahead for change, 3) Enhance cooperation across borders, 4) Improve ecosystem & institutional health, and 5) Uphold principles of fairness and equity.*** Finally, the presentation concluded with a case study on the Humboldt Current ecosystem, which combines many of these pathways through the development of a comprehensive system for ocean observation, prediction, and early warning (“SAPO”). Dr. Kleisner noted specifically that collecting data at appropriate scales is key for determining relevant information for a given time and place.

Sustainable management + Resilience = Climate readiness



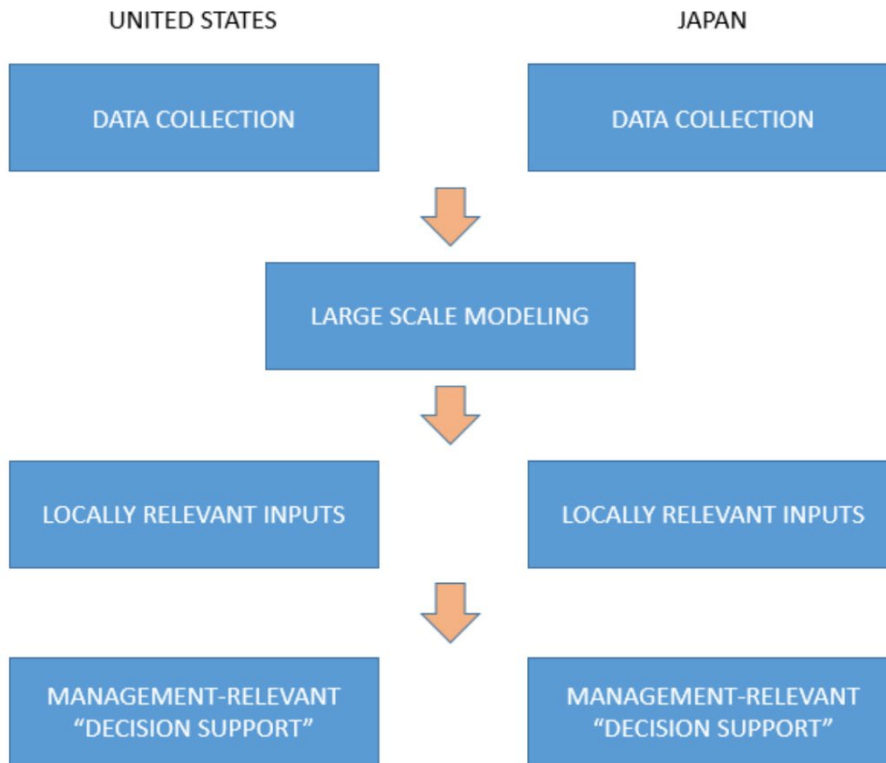
Former FRA Director Masanori Miyahara concluded the session by leading a discussion about the presentations. He noted the similarities between them and tied them together by highlighting the importance of foundational science but also the need to translate that science into actionable information for fisheries management.

Day 2

The second day of the workshop built off the themes of the first day and focused more on how countries can improve science and how models can be made more temporally and spatially relevant to fisheries managers. It also focused on how scientific uncertainty, which is inevitable in this field, could be handled through multi-lateral collaboration.

The session was kicked off by Dr. John Mimikakis, who conducted a brief overview of the concepts discussed the previous day. Dr. Mimikakis focused especially on drawing parallels between speakers. As an exercise, he turned Dr. Hollowed's slides upside down and noticed many similarities between Dr. Hollowed's and Dr. Nakata's logic. He concluded that both scientists' approaches 1) started with data collection and subsequent modelling or analysis to produce predictions about large-scale impacts, 2) then downscale the results or combine them with locally relevant information (such as economic or social information about a given region) which then aids in the drafting of 3) locally-relevant management advice. (These steps also resemble EDF's "FISHE"

process, a step-by-step procedure that enables data-limited fisheries to develop plans for becoming climate-resilient.) Highlighting similarities and patterns among ideas of different speakers draws attention to important opportunities for collaboration between the U.S. and Japan (as illustrated below).



Speakers

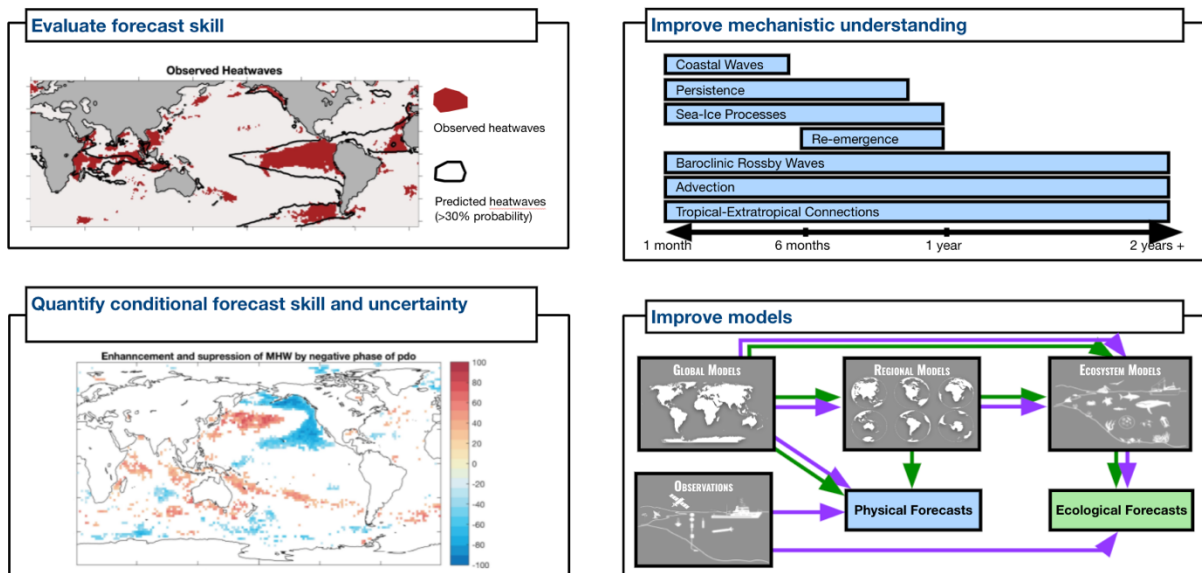
The next speaker of Day 2 was Dr. Kirstin Holsman, a Research Fishery Biologist with the NOAA Alaska Fisheries Science Center. She spoke about the challenges to implementing adaption, including shifting baselines and uncertainty around climate change hazards, the long time-horizons of adaption outcomes, the difficulty in assessing attribution of results, and addressing counterfactual scenarios. These concerns can be addressed, in part, though repeated engagement with a fisheries council (or similar management body) in which a participatory approach is emphasized. Dr. Holsman talked about this participation in the context of the Alaska Climate Integrated Modeling Project (ACLIM³), an effort that connects research on global climate and socioeconomic projections with regional circulation and biological models, among other components. Dr. Holsman emphasized that combining species-specific management with ecosystem-

³ <https://www.fisheries.noaa.gov/alaska/ecosystems/alaska-climate-integrated-modeling-project>

based measures is highly important for resilience by stabilizing catch and forestalling declines.

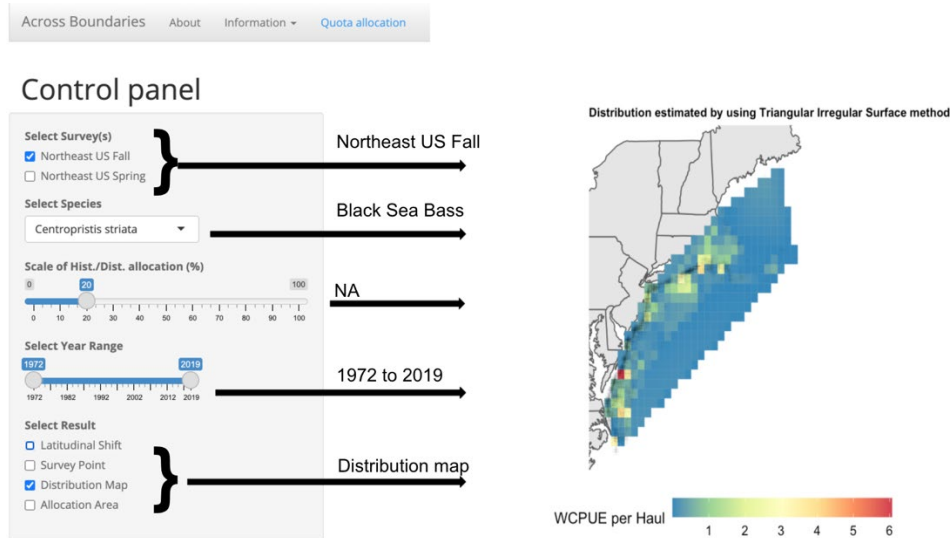
Following Dr. Holsman was Dr. Mike Jacox, a Physical Oceanographer at the NOAA Southwest Fisheries Science Center & the Earth System Research Laboratory. Dr. Jacox focused his talk on marine heat waves—periods where the ocean is unusually warm—and how scientists can improve forecasts for when and where these heat waves will happen. Dr. Jacox presented a suite of models and projections that can be linked together to produce physical or ecological forecasts. Scientists have also come to a better understanding of physical processes that generate predictability for marine ecosystems. Dr. Jacox emphasized the importance of understanding what these processes are, their time scales, and where they are active, and how we can represent these pieces in our models (and great improvement in forecasts skill have already been made!). Overall, there are multiple pathways for improving accuracy in predicting extremes (as summarized by the visual below).

Pathways to progress in predicting extremes



The next speaker was Dr. Rod Fujita, the Senior Director of Research and Development of EDF’s Oceans Program, who presented on a tool that provides a scientific basis for decisions about allocation of shifting fish stocks (a topic generally thought of as a political issue). Dr. Fujita’s project aims to reduce conflict among stakeholders and the overfishing that can result from those conflicts. Using retrospective analysis to reconstruct distribution of past stocks and test different allocation formulas, different weights can be placed on different factors (i.e., historical catch, biomass shift). Social

and economic impacts that would have resulted from each scheme can then be measured and the benefits can be optimized. This project primarily focuses on black sea bass and summer flounder in the U.S. East Coast. These alternative allocation policies can increase transparency, reduce negotiation and transaction costs, and reduce uncertainty about future allocations. The tool could look something like the following:



Finally, Dr. Hiroshi Kuroda (Leader of Subarctic Area Research Group, Fisheries Resources Institute, FRA) and Dr. Shiroh Yonezaki (Deputy Director, Socio-Ecological Systems Division, Fisheries Resources Institute, FRA) gave a joint two-part presentation on the weakened state of the Oyashio current. Dr. Kuroda spoke the Oyashio and its relationship to the subarctic gyre in the North Pacific. He emphasized the need to understand decadal cooling of Sea Surface Temperatures (SSTs) in terms of regionality and seasonality, and as an unconventional rather than a conventional change. Dr. Yonezaki spoke about how the weakened current has led to changes in fisheries resources. Specifically, he detailed the decrease in the catch of Japanese flying squid and the change in Pacific saury distribution affected by the Oyashio, and discussed the future work that must be done around these topics (e.g., including the monitoring of responses of fish stocks to climate change, implementation of stock assessments considering uncertainty, and multi-species management to ensure that fishing is sustainable).

Discussion Section and Q&A

Participants were asked to consider several key questions to trigger discussion and to recommend actions after the conclusion of the workshop. Questions were posed to the group (presenters were specifically asked to give answers) and responses were recorded on a virtual whiteboard application called Miro so that all participants could clearly see the arc of the discussion.

The first question, posed during the discussion session at the end of Day 2 of the workshop, was: ***“What are the most urgent needs to deal with climate-related fisheries challenges?”*** Dr. Holsman answered building teams that can help predict and communicate climate change and risks (which include multiple stakeholder perspectives to ensure that decision making is equitable). This sustained collaborative teamwork is what allows steady change to occur at a rapid pace. Dr. Jacox answered that better understanding of physical changes and ecological responses will be necessary to extrapolate data in order to make predictions for conditions under novel climate scenarios. Dr. Fujita shared his belief that tactical adaptive management advice is the most urgent need—even if all the information is not yet gathered, developing plans and acting now is crucial since stocks are already depleting and conflicts arising. Dr. Kuroda answered that a better understanding of changes across various time scales is necessary to increase predictive accuracy in the future. Finally, Dr. Yonezaki noted that improving the communication of complex phenomena to stakeholders (i.e. simplifying and being able to explain stock shifts such that the information is accessible and clear to more communities) is the most urgent need—this will allow more fishers to become involved in action.

Another question posed to the group was: ***“What are the opportunities for international collaboration to overcome barriers and meet needs?”*** Attendee Dr. Stephen Bograd of NOAA mentioned the U.N. Decade of Ocean Science as a venue for facilitating collaboration. There are several programs, including the NOAA-sponsored SUPREME (focused on ecosystem predictability) and SMARTNET (an ICES-PICES joint effort). Dr. Bograd believes these programs may be avenues for ramping up dialogue between countries. Dr. Kirstin Holsman also mentioned the ICES-PICES strategic initiative on climate change and marine ecosystems, whose goal is to coordinate integrated modeling from climate to management activities. (<https://meetings.pices.int/members/sections/S-CCME>) Finally, Dr. Ryan Rykaczewski mentioned the U.S. and Japan are already big contributors to global oceanographic programs (such as biogeochemical ARGO) that aim to collect data from across the world.

Session Outcomes and Next Steps

The Fate of Fisheries in a Climate Changed World workshop was a key first step in U.S.-Japan collaboration. The workshop brought together scientists and academics from a wide range of backgrounds in an important dialogue around building climate resilient fisheries. Each presentation gave attendees a unique perspective on some facet of the complex issue at hand, whether it was a detailed account of how the weak Oyashio Current contributed to a decrease in annual Japanese flying squid catch (S. Yonezaki) or a formula that provides a scientific basis for allocation decisions in cases

of stock distribution shifts (R. Fujita). Taken as a whole, the eight presentations (in addition to keynote and welcoming/concluding remarks) painted a nuanced picture of the problems and potential solutions for climate resilient management. Dissemination of knowledge among scientists was achieved both by the content shared in the presentations themselves and the discussion that cropped up among participants in the chat and during the Q&A sections. The ongoing partnerships among JFA, FRA, EDF, and NOAA were strengthened, and continued engagement between scientists at these organizations is expected.

In that vein, several specific next steps were discussed. One recommendation was to develop working groups of scientists comprised of NOAA Fisheries, FRA, JFA, and EDF staff to coordinate on key subject areas of interest. Another recommendation was to hold periodic scientific workshops focused on this topic and expand participation to include scientists from key countries such as China. After all, the work of fisheries management, especially in an era of rapidly changing ocean conditions, is necessarily transboundary and international. Workshop organizers intend to follow-up on both recommendations in coming months.

Agenda

Day 1:

Introductory Addresses

- **Dr. Eric Schwaab**, Senior Vice President of Ecosystems and Oceans, Environmental Defense Fund
 - *Welcome Address*
- **Dr. Francisco Werner**, Director of Scientific Programs and Chief Science Advisor, NOAA Fisheries
 - *Leader statement*
- **Mr. Takashi Koya**, Director-General, Fishery Agency, Japan
 - *Leader statement*
- **Dr. Manuel Barange**, Director of Fisheries and Aquaculture Policy, FAO
 - *Keynote Speech*

Presentations

- **Dr. Kaoru Nakata**, Executive Director, Japan Fisheries and Education Research Agency
 - *“Urgent challenges Japan faces in understanding the impact climate change is having on fisheries”*
- **Dr. Anne Hollowed**, Senior Scientist, NOAA Alaska Fisheries Science Center
 - *“Status of U.S. efforts to understand the impacts of climate change on fisheries to inform long term, medium and near term decision making”*
- **Dr. Kristin Kleisner**, Senior Director of Oceans Science, Environmental Defense Fund
 - *“Creating Climate Resilient Fisheries”*

General Discussion

- **Mr. Masanori Miyahara**, Former President, Japan Fisheries Research and Education Agency
 - *Discussion facilitated by Mr. Miyahara*

Day 2:

Introductory Addresses

- **Dr. John Mimikakis**, Vice President of the Oceans Program, Environmental Defense Fund
 - *Brief overview of topics from day 1*

Presentations

- **Dr. Kirstin Holsman**, Research Fishery Biologist, NOAA Alaska Fisheries Science Center
 - *“Understanding long-term scenarios for fisheries: efforts to improve modeling and advice”*
- **Dr. Mike Jacox**, Physical Oceanographer, NOAA Southwest Fisheries Science Center & Earth System Research Laboratory
 - *“Anticipating medium-term climate shocks: efforts to improve forecasts of marine heatwaves”*
- **Dr. Rod Fujita**, Senior Director of Research and Development of Oceans Program, Environmental Defense Fund
 - *“Adaptive allocation of shifting fish stocks”*

- **Dr. Hiroshi Kuroda**, Leader of Subarctic Area Research Group, Marine Environment Division, Fisheries Stock Assessment Center, Fisheries Resources Institute, Japan Fisheries and Education Research Agency
 - *“A very weak state of the Oyashio in recent years: Its relationships with the subarctic gyre in the North Pacific”*
- **Dr. Shiroh Yonezaki**, Deputy Director, Socio-Ecological Systems Division, Fisheries Stock Assessment Center, Fisheries Resource Institute, Japan Fisheries and Education Research Agency
 - *“A very weak state of the Oyashio in recent years: Changes in the distribution of fisheries resources and fishing ground”*

Closing Remarks

- **Dr. Ichiro Nakayama**, President, Japan Fisheries Research and Education Agency