NOAA
Changing Ecosystems and Fisheries Initiative (CEFI)
Summit Report

May 7–9, 2024
NOAA Southwest Fisheries Science Center, La Jolla, CA

Edited by Grace Roskar, Grace Groover, Jay Peterson, and Roger Griffis

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

NOAA Technical Memorandum NMFS-F/SPO-258
August 2025

NOAA Changing Ecosystems and Fisheries Initiative (CEFI) Summit Report

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Atmosphere and NOAA Administrator

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Recommended Citation:
Roskar, G., G. Groover, J. Peterson, and R. Griffis (Editors). 2025. NOAA Changing Ecosystems and Fisheries (CEFI) Summit Report. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/SPO-258, 64 p. [avail. at https://doi.org/10.25923/emmt-8g45]

This report is available online at these locations:

https://doi.org/10.25923/emmt-8g45

https://spo.nmfs.noaa.gov/tech-memos/

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Acronyms

ACLIM	Alaska Climate Integrated Modeling Project
ACT	Alaska CEFI/Climate Team
AFSC	Alaska Fisheries Science Center
AK	Alaska
AKRO	Alaska Regional Office
AOML	Atlantic Oceanographic and Meteorological Laboratory
ASMFC	Atlantic States Marine Fisheries Commission
BGC	Biogeochemical
BOEM	Bureau of Ocean Energy Management
CEATTLE	Climate-enhanced Age-based with Temperature-specific Trophic Linkages
CEFI	Changing Ecosystems and Fisheries Initiative
CIOFS	Cook Inlet Operational Forecast System
CMIP6	Coupled Model Intercomparison Project Phase 6
COBALT	Carbon, Ocean Biogeochemistry and Lower Trophics
CPO	Climate Program Office
CO-OPS	Center for Operational Oceanographic Products and Services
CVA	Climate Vulnerability Assessment
DST	Decision Support Team
EBFM	Ecosystem-based fishery management
EBM	Ecosystem-based management
EBS	Eastern Bering Sea
EDA	Essential Data Acquisition
ENSO	El Nino Southern Oscillation
ESP	Ecosystem and Socioeconomic Profile
ESR	Ecosystem Status Report
FATE	Fisheries and the Environment
FMP	Fishery Management Plan
FSC	Fisheries Science Center
FTE	Full-time equivalent
FVCOM	Finite Volume Community Ocean Model
GAM	Generalized additive model
GARFO	Greater Atlantic Regional Fisheries Office
GC5	Groundfish, Climate Change, and Communities in the California Current project
GFDL	Geophysical Fluid Dynamics Laboratory
GL	Great Lakes
GLERL	Great Lakes Environmental Research Laboratory
GLOBEC	Global Ocean Ecosystems Dynamics
GOA	Gulf of Alaska
GoACLIM	Gulf of Alaska Climate Integrated Modeling Project
GOMO	Global Ocean Monitoring and Observing
HABs	Harmful algal blooms
HMS	Highly migratory species
HPC	High performance computing
IEA	Integrated Ecosystem Assessment
IOOS	U.S. Integrated Ocean Observing System
IRA	Inflation Reduction Act
LMR	Living marine resource(s)
LO	Line Office
LTL	Lower trophic level
MAFMC	Mid-Atlantic Fisheries Management Council
mCDR	Marine carbon dioxide removal
MML	Marine Mammal Laboratory
MOM6	Modular Ocean Model 6
MSE	Management Strategy Evaluation
NARW	North Atlantic Right Whales
NASA	National Aeronautics and Space Administration
NCCOS	National Centers for Coastal Ocean Science
NCEI	National Centers for Environmental Information
NCLIM	Northeast Climate Integrated Modeling Project
NCSS	NOAA Fisheries Climate Science Strategy
NE	Northeast

NEFMC	New England Fishery Management Council
NEFSC	Northeast Fisheries Science Center
NESDIS	National Environmental Satellite, Data, and Information Service
NGO	Non-governmental organization
NICAT	NMFS Interoffice Climate Action Team
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NODD	NOAA Open Data Dissemination
NOPP	National Oceanographic Partnership Program
NORT	National Observations and Research Team
NOS	National Ocean Service
NPFMC	North Pacific Fishery Management Council
NSF	National Science Foundation
NW	Northwest
NWFSC	Northwest Fisheries Science Center
OAA	Office of the Assistant Administrator
OAP	Ocean Acidification Program
OAQ	Office of Aquaculture
OAR	Office of Oceanic and Atmospheric Research
OHC	Office of Habitat Conservation
ONMS	Office of National Marine Sanctuaries
OPR	Office of Protected Resources
OSF	Office of Sustainable Fisheries
OST	Office of Science and Technology
PACE	Plankton, Aerosol, Cloud, ocean Ecosystem
PFMC	Pacific Fishery Management Council
PIFSC	Pacific Islands Fishery Science Center
PIRO	Pacific Islands Regional Office
PMEL	Pacific Marine Environmental Laboratory
PR	Protected resources
PSL	Physical Sciences Laboratory
RAP	Regional Action Plans
REFM	Resource Ecology and Fisheries Management
RO	Regional Office
ROMS	Regional Ocean Modeling System
ROMSNPZ	Regional ocean modeling System with Nutrients, Phytoplankton and Zooplankton
SAFE	Stock Assessment and Fishery Evaluation report
SAFMC	South Atlantic Fishery Management Council
SE	Southeast
SEFSC	Southeast Fisheries Science Center
SERO	Southeast Regional Office
SOE	State of the Ecosystem
SPEAR	Seamless System for Prediction and Earth System Research
SSC	Scientific and Statistical Committee
SSS	Sea surface salinity
SST	Sea surface temperature
SW	Southwest
SWFSC	Southwest Fisheries Science Center
USGS	United States Geological Survey
WCOFS	West Coast Operational Forecast System
WCR	West Coast Region
WHAM	Woods Hole Assessment Model

Acknowledgements

Thank you to the many people who helped plan and implement the CEFI Summit. Thank you especially to the organizing committee, session leads, and panelists for stimulating such valuable discussions. Many thanks to Kristen Koch and the NMFS Southwest Fisheries Science Center for hosting the Summit. Special thanks to the Center facilities staff and Dawn Graham for her tireless efforts to ensure that participants were well fed and caffeinated and that the logistics ran smoothly. Additional thanks to the many people who helped facilitate discussions and lead breakout sessions. Thank you to all the participants who provided their time, energy, and input for a successful Summit.

Executive Summary

Ocean and coastal decision-makers are facing numerous challenges to prepare for and respond to major changes in climate and ocean conditions, including marine heat waves and other extreme events. There is much at risk, from fish stocks and other vital marine resources to the thousands of businesses and coastal communities that depend on them and help drive the nation's blue economy. Decision-makers urgently need information on what is changing, what is coming, what is at risk, and how to respond to ensure the productivity and sustainability of fisheries, protected resources, coastal communities, and the ecosystems they depend on. The NOAA Changing Ecosystems and Fisheries Initiative (CEFI) was established to address these needs by building a nation-wide operational system to provide decision-makers with early warnings, forecasts, and strategies to safeguard the nation's valuable marine resources and the businesses, communities, and economies that depend on them.

CEFI is a cross-NOAA effort to build the nation-wide, operational Decision Support System (System) needed to reduce impacts, increase resilience, and help marine resources and resource users adapt to changing ocean conditions. The CEFI System addresses four core requirements for effective decision-making: (1) robust early warnings, forecasts, and projections of ocean and Great Lakes conditions; (2) capacity to operationally assess risks, evaluate options, and provide robust advice for adapting to changing conditions; (3) decision-maker capability to incorporate this information into decision-making to reduce risks and increase the resilience of resources and the people that depend on them; and (4) continuous validation and innovation through dedicated observations and research. By combining existing capabilities, developments from pilot projects, and new investments, CEFI is efficiently and effectively beginning to build the end-to-end System needed for climate-informed decision-making.

An inaugural CEFI Summit was held May 7–9, 2024, in La Jolla, California at the NMFS Southwest Fisheries Science Center (SWFSC). The Summit included over 150 in-person and virtual participants from four NOAA Line Offices, spanning 32 different offices and programs across all six regions, and several external NOAA partners. The Summit brought together members of the CEFI community to affirm the initiative's goals and objectives, review and prioritize expected products, discuss workflows, strengthen critical collaborations, identify engagement strategies for partners and decision-makers, and increase the system-wide coordination of the CEFI System.

The Summit began with input from representatives from NMFS and partner organizations on the needs and approaches for build-out of the CEFI System. The panelists emphasized engaging end users and stakeholders early and often and focusing on products to inform decisions on a 2–5-year time frame, which would foster both immediate operational changes and positioning for future resilience. The panel also noted the need to provide clear explanations of risk and uncertainty in forecasts, projections, and other products to assist users in assessing risks and options.

Following the introductory panel, the leads of each of the 4 major components of the CEFI System (Regional Ocean Modeling, Regional Decision Support Teams (DSTs), Data Portal and

Information Hub, and Observations and Research) gave overviews of the structure, goals, key needs, and current status of each component as summarized below:

- The Regional Ocean Modeling leads stressed the need for high-performance computing resources and sufficient observations to run and validate models and a clear sense of initial applications to ensure that the modeling products are fit to task.
- The Data Portal and Information Hub component highlighted their engagement with other CEFI components to better understand the types of users who will be accessing the portal and user needs.
- The Regional DSTs presented their current focus of ensuring that each region has the information and logistical support needed to start work while the Modular Ocean Models (MOM6) are being developed and that there is collaboration across regions and components to develop nationally integrated yet regionally specific solutions. Each DST is developing a list of potential CEFI projects to prioritize for completion by 2026. These regional projects include efforts by the National Ocean Service (NOS) Team to apply MOM6 ocean outlooks and other products to specific issues and users on smaller geographic scales such as National Marine Sanctuaries.
- The Observations and Research Team component focused on how they can directly advance the needs of the Modeling and DSTs, using regional models as tools to help prioritize observational needs.

The first day of the Summit closed with another expert panel providing reflections and perspectives on the needs and challenges to building out the CEFI system. The panel stressed the need for assessing and prioritizing focus on regions and resources most impacted by climate change. The panel also noted that data management and transfer will be key in making the outputs and products accessible and effective for end users.

On the second day, attendees met in regional groups to identify and prioritize “demonstration projects” and deliverables to help meet key decision-maker needs over the next 2–3 years. The groups also discussed ways to strengthen engagement and codevelopment of projects with target users. The subsequent breakout groups were by CEFI System components, where the groups further discussed the input on possible projects and deliverables to assess what might be doable and impactful with existing resources and key next steps to advance each component of the System. Some of the findings included the following:

- The Regional Ocean Modeling Team formalized regional roles and identified opportunities for national coordination.
- The Data Portal Team met with the DSTs to better understand the component’s needs and then reviewed possible products, datasets, and information to host on the data portal, as well as key users’ priorities and existing resources to leverage and learn from.
- The DST breakout group discussed cross-regional challenges, solutions, and needs. The group discussed existing processes and partnerships that could be utilized at either a regional or a national level and how to make progress while the updated MOM6 models are being developed.

- The Observations and Research Team discussed how to further engage with collaborators to identify (1) priority data needs and (2) strategies to leverage available resources to address the needs, both in specific regions and across the national CEFI System.

The final session of the Summit focused on key next steps to begin building out the System in each region and nation-wide. Next steps varied by region or component, but the following three overall steps were identified as key steps for success:

1. Communication for awareness, input, and support
2. Engagement with target audiences and users
3. Demonstration of the CEFI System products through implementing initial demonstration projects

The final session of the Summit included a panel of leaders reflecting on key steps for successful implementation of the CEFI System. The panel expressed enthusiasm for the System and provided input on defining and reaching success. The panelists offered a number of findings and recommendations including the following:

- CEFI should continue to be user-centric and product-focused, connecting with stakeholders and communities early and often to ensure that products fit their needs.
- The strength of the CEFI System is that it supports the three pillars of NOAA, science, service, and stewardship, and provides an opportunity for strategic thinking and application of modeling and observations.
- A whole-process view will be needed to successfully develop and maintain an integrated System with continuous improvement and innovation, as CEFI works across a variety of scales, regions, and governments.

NMFS Chief Scientist Cisco Werner closed out the Summit by thanking participants for their hard work, input, and support for the development of the CEFI System, reminding the group that climate-driven impacts on marine ecosystems are inevitable and calling on all to work together to help safeguard the nation's valuable marine resources and the many communities that depend on them in a changing climate.

Foreword

Climate change is rapidly transforming the nation's oceans, coastal, and Great Lakes ecosystems, putting valuable natural resources and the many people, communities, and businesses that depend on them at risk. Decision-makers urgently need information on what is changing, what is coming, what is at risk, and how to respond to promote resilience and adaptation. Action is needed now to effectively prepare for and respond to the major changes underway in ocean and Great Lakes ecosystems.

The NOAA Changing Ecosystems and Fisheries Initiative (CEFI) is an important and timely response to provide decision-makers with the information they need to respond to extreme events such as marine heat waves, identify the best management strategies for fisheries, aquaculture, and protected species, and help increase the resilience and adaptation of resource dependent coastal communities. CEFI will build an operational system to provide this information and support climate-ready decision-making.

From the initial planning for CEFI in 2019 to the announcement of the historic $40 million investment in CEFI in June 2023,[1] the architects and builders of the CEFI System have been immersed in planning its structure, function, and construction. The inaugural CEFI Summit brought together over 200 leaders, builders, and users of the CEFI System to identify critical steps, requirements, and relationships needed for a successful build out of the cross-NOAA system. This report summarizes the many valuable discussions, strategies, and recommendations from this important gathering that helped launch the implementation of the CEFI System.

- Cisco Werner and Michelle McClure

Cisco Werner, Ph.D.
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Director of Scientific Programs and
Chief Science Officer
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Co-chair, CEFI Executive Committee
Director, Pacific Marine Environmental Laboratory
NOAA Office of Oceanic and Atmospheric
Research

[1] NMFS. 2023. Inflation Reduction Act: A Historic Investment in America's Climate Resilience. [Available at https://www.fisheries.noaa.gov/feature-story/inflation-reduction-act-historic-investment-americas-climate-resilience; accessed 15 October 2024]

Introduction[2]

The Grand Challenge

Ocean and Great Lakes ecosystems are undergoing major changes. Droughts, floods, warming oceans, loss of sea ice, rising seas, extreme events, and ocean acidification are having significant impacts on these systems, the important products and services they provide, and the many people, businesses, communities, and economies that depend on them.

There is much at risk from valuable natural resources such as fish stocks, protected species, and habitats to significant economic activity (e.g., $370 billion and 1.8 million jobs from fisheries), the burgeoning aquaculture industry, tourism, and other sectors that support thousands of businesses and coastal communities. In many areas, the cultural heritage associated with these ecosystems is also threatened, and there will be disproportionate effects on some sectors and communities.

Preparing for and responding to these changes require a shift from existing assumptions of relatively stationary environmental conditions to forward-looking approaches that can incorporate expected changes in future conditions, assess risks, and evaluate the best ways to promote resilience and adaptation to a changing world. Climate-informed data and advice are needed across multiple timescales to respond effectively, including near-term timescales to respond to immediate conditions and extreme events, as well as information on longer-term seasonal and multidecadal time frames to make fundamental decisions about how to manage fisheries and protected species and areas.

Action is urgently needed to effectively respond to current and future changes in marine and Great Lakes ecosystems. The grand challenge is to identify ways to sustainably manage natural resources and support resource-dependent communities in the face of significant changes in these ecosystems. The nation currently lacks an operational system to provide decision-makers the information they need for rapid responses and longer-term adaptation to rapidly changing systems. The Changing Ecosystems and Fisheries Initiative (CEFI) was established to increase the production of information and tools for effective marine resource management and community adaptation with changing oceans.

What is CEFI?

CEFI is a cross-National Oceanic and Atmospheric Administration (NOAA) effort to build the nation-wide operational ocean modeling and Decision Support System (System; Figure 1) needed to reduce impacts, increase resilience, and help marine resources and resource users adapt to changing ocean conditions. The end-to-end System will provide decision-makers with the actionable information and capacity they need to prepare for and respond to changing

[2] This Introduction is based on the Opening Remarks to the Summit by Dr. Cisco Werner, Chief Science Advisor and Director of Scientific Programs, NMFS. The slide presentation is available on the NOAA internal network at https://drive.google.com/file/d/1TsQJJuj8G7r2vgxwLE4JnTpdyRtH9X8x/view. For external access, please contact the editors of this document.

conditions today, the next year, and for decades to come. The CEFI System addresses four core requirements for climate-ready decision-making for marine resources:

1. Robust forecasts and projections of ocean and Great Lakes conditions for use in developing climate-informed advice
2. Operational capability to assess risks, evaluate options, and provide robust advice on adapting to changing conditions
3. Decision-maker capability to use climate-informed advice to reduce risks and increase the resilience of resources and the people that depend on them
4. Continuous validation and innovation through observations and research

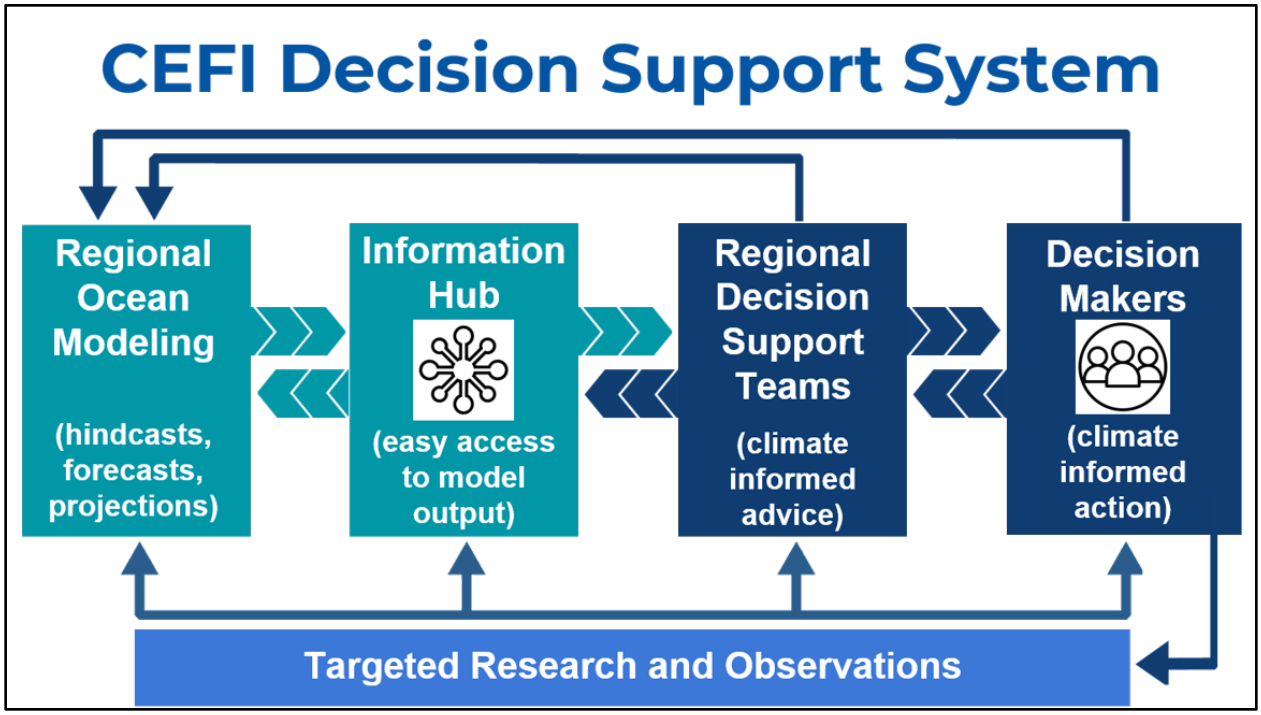

Figure 1: The major components of the CEFI Decision Support System. The end-to-end system is designed for innovation and feedback to ensure continuous improvement in meeting decision-maker needs.

CEFI grew out of many efforts, including the Global Ocean Ecosystems Dynamics (GLOBEC) project,[3] the Fisheries and the Environment Program (FATE),[4] Integrated Ecosystem

[3] NOAA. 2017. Global Ocean Ecosystems Dynamics (GLOBEC) project. [Available at https://coastalscience.noaa.gov/project/global-ocean-ecosystems-dynamics-globec-northeast-pacific: accessed 16 October 2024.]
[4] NOAA. 2017. Fisheries and the Environment Program (FATE). [Available at https://www.st.nmfs.noaa.gov/fate/: accessed 16 October 2024.]

Assessments (IEA),[5] the NOAA Fisheries Climate Science Strategy (NCSS),[6] and the Agency's efforts toward ecosystem-based fisheries management (EBFM).[7] The culmination of many efforts since 2015 resulted in the official implementation of the Initiative in 2023, as shown in the timeline in Figure 2.

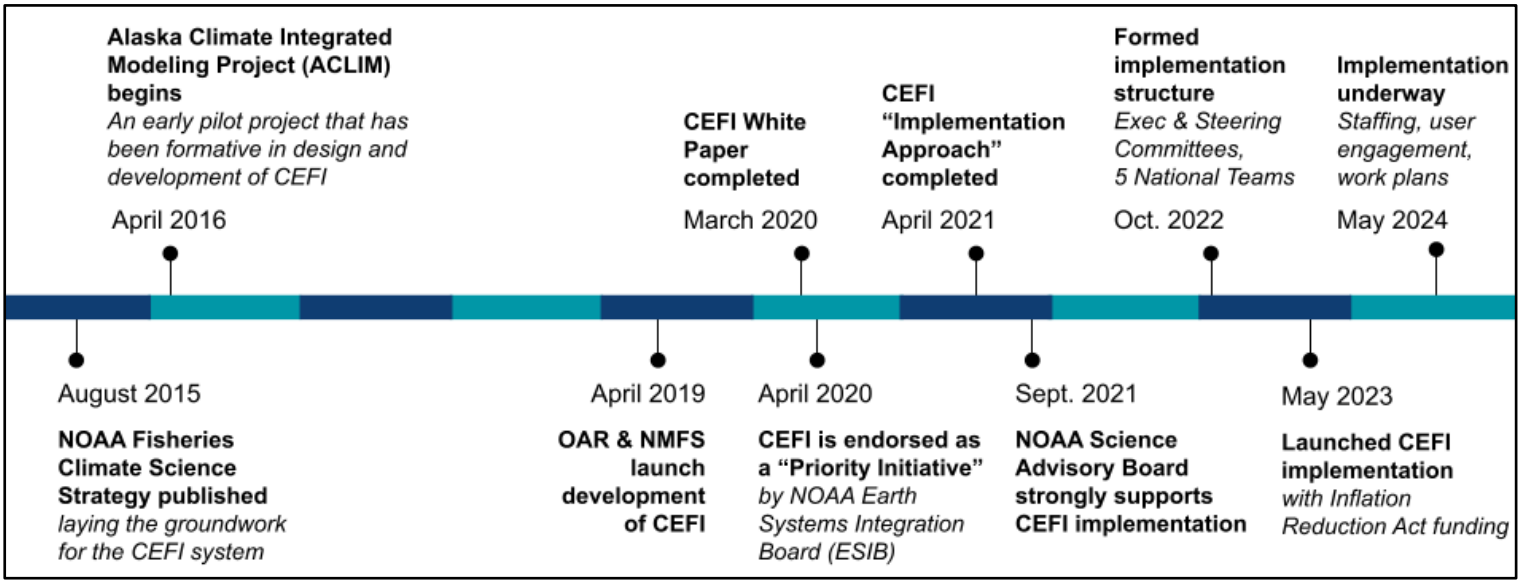

Figure 2: A timeline of the development of CEFI.

Additionally, input and engagement from multiple sources have been critical to shaping the CEFI System, including gathering perspectives on needs from scientists, managers, partners, and stakeholders since 2015. Since 2019, there has been cross-NOAA input and leadership, and in 2021, the Science Advisory Board[8] to NOAA provided input on the implementation approach for CEFI[9] and general support for the initiative. In 2021, public input[10] was solicited on "...how to make fisheries, protected resources, and aquaculture more resilient to climate change," and in 2022, valuable insight was gained from the Proceedings of the 7th Meeting of

[5] NOAA. 2024. Integrated Ecosystem Assessment (IEA). [Available at https://www.integratedecosystemassessment.noaa.gov/: accessed 16 October 2024.]
[6] NOAA. 2015. NOAA Fisheries Climate Science Strategy (NCSS). [Available at https://www.fisheries.noaa.gov/national/climate/noaa-fisheries-climate-science-strategy: accessed 16 October 2024.]
[7] NOAA. 2024. Ecosystem-based fisheries management (EBFM). [Available at https://www.fisheries.noaa.gov/national/ecosystems/ecosystem-based-fisheries-management: accessed 16 October 2024.]
[8] NOAA. 2024. Science Advisory Board. [Available at https://sab.noaa.gov/: accessed 16 October 2024.]
[9] NOAA. 2021. Implementation approach for CEFI. [Available at https://sab.noaa.gov/wp-content/uploads/2021/09/CWG-Review-of-Climate-and-Fisheries-Initiative-Implementation-Approach_09-17-21_Final.pdf: accessed 16 October 2024.]
[10] NOAA Fisheries. 2021. Synthesis of Public Comments to NOAA on Executive Order 14008. [Available at https://spo.nmfs.noaa.gov/sites/default/files/TMSPO218.pdf: accessed 16 October 2024.]

the Scientific Coordination Subcommittee of the Regional Fishery Management Councils, which was focused on "Adapting Fishery Management to Changing Ecosystems."[11]

Since the formation of the CEFI structure in 2022, there has been engagement with resource managers and science partners across NMFS programs (fisheries, protected resources, habitat, aquaculture) and National Ocean Service (NOS) Office of National Marine Sanctuaries. Nearly a decade of planning, strategizing, and developing has resulted in the strong integration of cross-NOAA efforts as part of CEFI and ensured strong connections between CEFI and existing NOAA programs and capacities. CEFI is also a key part of NOAA's Building a Climate-Ready Nation Strategic Plan,[12] contributing to all of its strategic goals.

CEFI is a timely, efficient, and effective way to address the nation's requirements for climate-ready resource management and community adaptation. By combining existing capabilities and new investments from the Inflation Reduction Act (IRA),[13] CEFI will build the modeling and Decision Support System needed in each region to provide decision-makers with the climate-informed advice they need to reduce risks, accelerate adaptation, and increase resilience of the nation's valuable living marine resources and resource-dependent communities.

Summit Goals and Objectives

The first CEFI Summit was held May 7–9, 2024, in La Jolla, California at NMFS Southwest Fisheries Science Center (SWFSC). The purpose of the CEFI Summit was to bring together members of the CEFI community to review expected products, discuss workflows, and increase system-wide coordination to effectively build out the CEFI System over the next three years. The objectives of the Summit were to:

1. Affirm CEFI purpose, goals, and implementation teams across components and regions.
2. Review and prioritize requirements, expected products, workflows, timelines, and performance metrics for all CEFI System components.
3. Strengthen critical collaborations and identify strategies for effective engagement with partners and target decision-makers (internal and external).

The expected outcomes of the Summit were:

1. Increased understanding of the CEFI System purpose, structure, and function.

[11] NPFMC. 2023. Adapting Fishery Management to Changing Ecosystems. [Available at https://static1.squarespace.com/static/56c65ea3f2b77e3a78d3441e/t/646cddadcb0f2d31ca95072f/1684856256361/SCS7-Proceedings.pdf: accessed 16 October 2024.]
[12] NOAA. 2022. Building a Climate-Ready Nation Strategic Plan. [Available at https://www.noaa.gov/sites/default/files/2022-06/NOAA_FY2226_Strategic_Plan_ExecutiveSummary.pdf: accessed 16 October 2024.]
[13] NOAA. 2024. Biden-Harris Administration, NOAA Announced $147.5 Million to Transform NOAA Data Collection and Analysis. [Available at https://www.fisheries.noaa.gov/media-release/biden-harris-administration-noaa-announced-1475-million-transform-noaa-data-collection: accessed 16 October 2024.]

2. Identification and prioritization of key requirements, products, timelines, and workflows across CEFI System components (e.g., modeling data products, Decision Support Team (DST) products, derived/advice products, and applications).
3. Determination of key issues/needs to build out the System components.
4. Development of key targets and metrics to measure/track successful implementation over the next three years.
5. Identification of key engagement strategies with partners and clients.

Summit Attendees

The Summit was attended by 129 in-person participants and over 50 virtual participants. Plenary sessions of the Summit were also available via livestream for NOAA employees, and over 80 viewers watched some or all of the livestream over the 2.5 days.

Four NOAA Line Offices (LOs) were represented at the Summit, with attendees from the Office of Oceanic and Atmospheric Research (OAR), NOS, the National Environmental Satellite, Data, and Information Service (NESDIS), and the National Marine Fisheries Service (NMFS). Thirty-two different offices and programs within OAR, NOS, NESDIS, and NMFS were represented (Figure 3). The interdisciplinary nature of CEFI and the need for system-wide coordination warranted the gathering of the key CEFI regional and national teams as well as several partners and ”users” or ”clients” of the CEFI system. Several key partners external to NOAA were also invited to participate in the Summit due to their expertise and were asked to provide constructive input, feedback, and their perspectives on the key issues CEFI aims to address and what a successful CEFI system would look like.

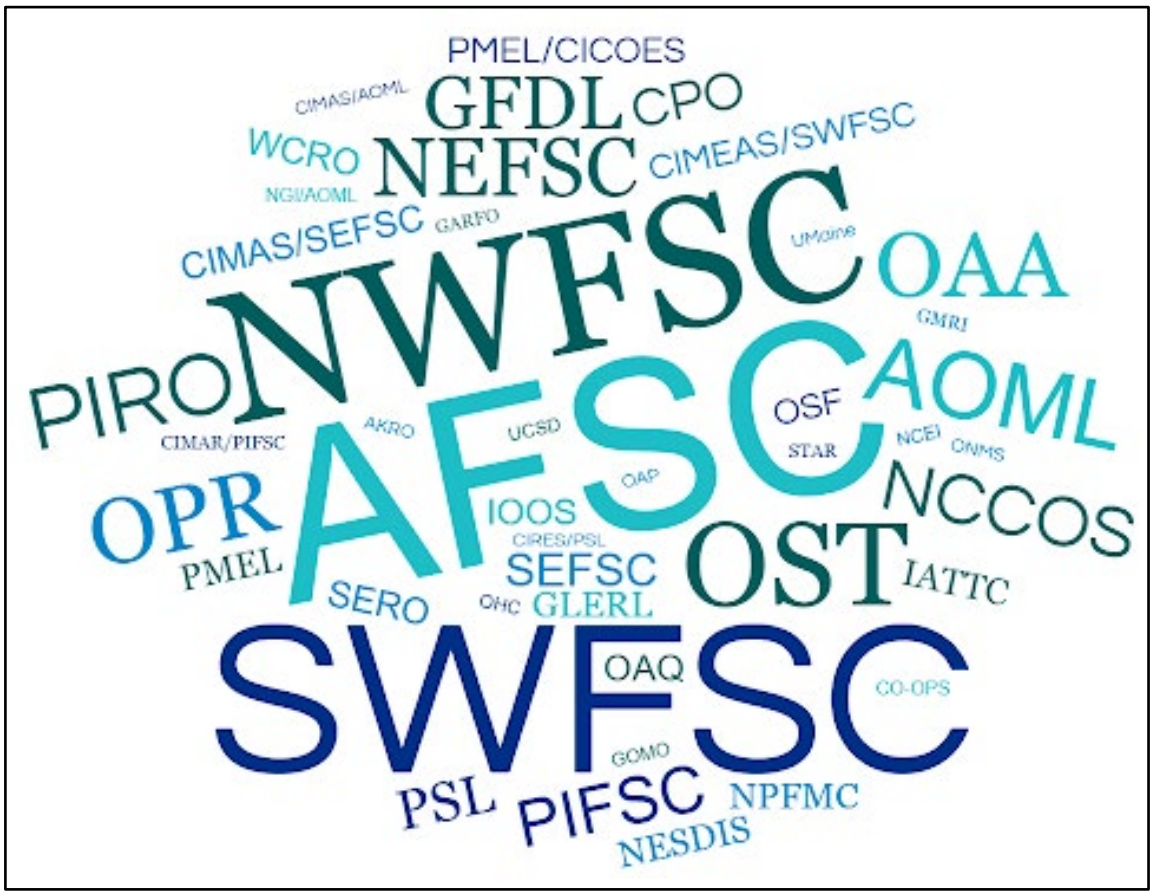

Figure 3: A “word cloud” of NOAA offices that were in attendance at the CEFI Summit. The larger the word or phrase, the more participants from that office were in attendance.

Summit Summary - *Session 1*

Panel 1: Perspectives on Needs and Build-Out of the CEFI System

CEFI is an end-to-end system, compelling engagement with potential users and collaborators early and often. To that end, a variety of experts, representing several offices and end users with which CEFI Teams will be working, were invited to kick off the Summit with a panel discussion (panelists' biographies are provided in Appendix C). They were invited to share their perspectives on the needs, approaches, and build-out of the CEFI Decision Support System. Panelists were asked to comment on key issues or needs that CEFI needs to address, as well as what a successful CEFI System would look like for them.

Beth Turner
NOAA Science Advisory Board, Ecosystem Science and Management Working Group

CEFI builds on the foundation of other programs in NOAA, like the GLOBEC program. CEFI now is the source of much pride and relief that NOAA has made it to this level in its work. Here are six key points to keep in mind as the System is built out:

1. **Know your audience.** Know the intended users and their challenges, including decisions, timescales, and needs. Operational delivery will need to be at a narrow enough scale to be useful but broad enough to encompass climate effects. Communicate levels of engagement explicitly so that any outside observers (or future partners) can see the efforts being made to incorporate user feedback.
2. **Make it easy to use.** Use plain language and translate results so that all users, not just specialists, are able to input data and access results in a straightforward process. Build trust by being transparent about the difference your audience's input makes.
3. **Do not fear uncertainty.** Managers deal with uncertainty all the time, so information does not have to be 100 percent certain to be useful to them. Be explicit about the levels of uncertainty when communicating information rather than holding back out of fear.
4. **Do not focus only on temperature.** Climate impacts a range of things, so it can be easy to focus only on temperature. It is important to take a multiple-stressor approach to data to ensure that other useful areas are taken into account.
5. **Remember that you are working with people.** It can be easy to become occupied only by the science part of this endeavor, but people will be involved every step of the way, with varying priorities and interpretations. Decision-makers may not be able to take your best advice due to their own constraints. NOAA Headquarters Office of Sustainable Fisheries (OSF) may have questions or requirements that feel inconvenient, and they may not be able to provide the resources desired. However, they are working on behalf of the programs. Remember to treat everyone with respect, being responsive and understanding when communicating.
6. **This is a long-term effort.** There will be setbacks and challenges, but the CEFI community is smart enough to adapt and keep moving forward. This effort is important,

needed, and enormously difficult. Take pride in where the initiative has already been and appreciate that this would never have been possible before now.

Kelly Denit
Office of Sustainable Fisheries, NMFS

CEFI is an awesome opportunity to address needs within the fisheries communities. It is encouraging to remember that this system is not being developed from scratch but is instead building on what NOAA has achieved over the years.

1. **Understand managers' roles.** Managers need to make a lot of difficult decisions which will have significant impacts on communities. It is fundamental to maintain connections between the users and the different levels of DSTs throughout development and implementation.
2. **Consider broad utility when deciding products.** Given limited resources, it is important to think about which products and delivery mechanisms will serve the most end users at once. CEFI can provide utility in multiple areas.
3. **Communicate about stakeholders.** It is important to hear from decision-makers about their stakeholders to build buy-in throughout the process. CEFI needs to be clear on what it wants to achieve and on what that looks like for decision-makers.
4. **Emphasize social and economic components.** Including social and economic components when working with political bodies helps them to make decisions by demonstrating impacts on communities to whom they are responsible.
5. **Consider cross-regional concerns.** CEFI has a regional structure, but some decision-makers have stocks and priorities that move between regions. How are the decision support structure and products being handled for those cross-regional concerns, for example, migratory species experiencing different variables than stationary ecosystems?

Kim Damon-Randall
Office of Protected Resources, NMFS

CEFI has a great deal of potential for connecting to climate challenges facing protected resources and their managers. There are several past and ongoing efforts that could contribute to CEFI work, including Climate Smart conservation training through the Office of Protected Resources (OPR), Office of Science and Technology (OST) scenario planning exercises for species recovery, and IRA-funded projects to advance adaptation and resilience of species to climate-related changes. Three areas for CEFI to focus on as it develops are:

1. **Incorporate protected species science into management.** There is a tremendous need for the ecosystem component to be accounted for in management to develop climate-ready protected species. OPR has a list of potential products for CEFI to consider.
2. **Emphasize the ecosystem component.** The existing ecosystem-based management (EBM) process needs to be incorporated into the development of CEFI.

3. **Continue aligning scientific products.** It is important to continue integrating management needs into CEFI and to ensure that scientific products are being developed to address those needs in parallel to other scientific efforts.

Kathy Mills
Gulf of Maine Research Institute

1. **Highlight relevance of CEFI to non-management arenas.** Many areas outside of Fisheries Management could benefit from CEFI, including the work outlined in the Fisheries Strategic Plan, fishing communities, the seafood sector, individuals asking if they need to adjust locations, communities concerned about infrastructure investments, and communities looking for place-specific adaptation information and options.
2. **Develop a modeling framework that enables communities to assess adaptation options.** Consider on-the-ground support to integrate information into decision processes of business leaders, community groups, and non-governmental organizations (NGOs) with different backgrounds and needs.
3. **Know your users.** CEFI has the potential to transform how we approach climate issues and needs for decades, so it needs to lay the foundation for that by engaging a broad base of collaborators. CEFI needs to consider how to design and communicate the system so that its value and use are clear, even to non-scientists.
4. **CEFI needs champions.** In order for this to be implemented, there will need to be buy-in from within NOAA, industry, communities, public organizations, and groups who can engage in the political arena and ensure the program's longevity.

Bill Tweit
Washington Department of Fish and Game; North Pacific Fisheries Management Council

This panel has outlined clear foundational characteristics of trust, simplicity, ease of use and access, knowing your users, and the importance of communication.

1. **History.** It is important to remember that CEFI today owes a great deal to NOAA leaders and scientists who were able to keep climate change research, discussion, and planning going through several administrations. They also developed many of the seminal partnerships and inter-agency efforts that form an invaluable part of CEFI's foundation.
2. **Indigenous partnerships.** CEFI should specifically consider indigenous partnerships. The North Pacific Fishery Management Council (NPFMC) had a workshop where a Tribal elder stood up at the end and shared that he now understood the science that the agency and Councils could bring to him and his people, and he reminded NPFMC to also consider indigenous knowledge. CEFI could benefit from considering the same.
3. **Communication.** It is important for CEFI to communicate to its stakeholders and partners what its role is and what it has to offer. This will help in advocating for CEFI's resources but also serve as a reminder for decision-makers who might get overwhelmed by their situations and forget that CEFI is here to help.
4. **Success for CEFI.** Climate change challenges can cause communities to fracture as they have to adapt, becoming combative for resources and opportunities. A success for

CEFI would be to encourage stakeholder communities to consider a shared approach to the future. Another success would be to provide decision-makers with increased comfort with their decision-making process in an increasingly chaotic world, despite higher levels of uncertainty. CEFI can provide stakeholders with the ability to push for decisions rather than having to wait for more data that may arrive too late.

Meredith Moore

Director of the Fish Conservation Program, Ocean Conservancy

CEFI provides a much-needed bridge between science and management. It will be important to see the rapid scaling up of these capabilities and the implementation of on-the-water management.

1. **Climate is changing faster than communities are adapting.** Speed and engagement are paramount to CEFI addressing this challenge.
2. **Action cannot wait for perfection.** Managers tend to wait for uncertainty to be low enough for them to make a confident decision. CEFI can provide them with the tools to help them understand how and why, moving them out of inaction.
3. **Communicate both the risk level and opportunities for reduction.** This helps build more informed decisions and provides the opportunity to outline the risk of inaction.
4. **Involve managers in DSTs from the beginning.** Also include advisory panels or ecosystems subcommittees of the Councils for the greatest impact.
5. **Integrate CEFI into existing processes like IEA teams, Regional Action Plans (RAPs), and so on.** It is critically important to leverage success from previous related efforts.
6. **Avoid accidentally moving in the direction of maladaptation.** Communicate that there are multiple factors that could influence stocks and recognize which ones are not covered by CEFI. Consider how to identify those areas of uncertainty and risk.
7. **Evaluate reference points and regime shifts.** These need to be better characterized for well-informed management.
8. **Consider Congress an audience.** Council members will want to advocate for CEFI with Congress but will need demonstrable value to do so. Aim to deliver work before December of 2025 in order to help that case.
9. **Consider fishermen an audience.** Ensure that fishermen understand the benefits of CEFI and how to utilize them. They need to understand what changes are happening but also know when a population is doing well and they can fish more.

Audience Q&A

1. What can CEFI anticipate, forestall, or prepare for legal concerns regarding regulatory decisions?
    - Understand that there is a possibility that even the best decisions could result in being sued and lay out the process as clearly as possible. Incorporate decision-makers early and often into the process and outline the uncertainty, risks, and rationale as clearly as possible to provide context for the decision.

2. How do we avoid potentially creating new silos of information and entrain experience and expertise to those who are not aware of the climate influences of their products?
    - Communicate continuously and build on existing integrative mechanisms and examples of success. Consider both formal and informal networking with a designated coordinator and information conduit connecting teams and disciplines.
3. Are there certain timescales that matter most from a management perspective?
    - In the short term, it is important to communicate early and often that there is a roadmap to success and to encourage feedback from end users.
    - Different decisions have different timescales, so it depends on which decision is being informed. The 2–5-year time frame is a good sweet spot for immediate operations as well as for positioning for future resilience.
4. The easiest variable to deliver by 2025 is temperature, but there are many other important variables. What are some helpful ways to package physical uncertainties (beyond just temperature) so that they are useful for management?
    - It would be helpful to identify strengths and how to capitalize on them for lower uncertainty, then use that information as a starting point for how to move from a scientific arena to a decision-making arena.
    - Quantitative explanations of uncertainty can be helpful, but qualitative descriptors are often the base of management organization and decision-making.

CEFI System Components

Goals, status, and next steps

Following opening remarks and panel discussion on Summit Day 1, there were presentations on each of the 4 major components of the CEFI System: (1) Regional Ocean Modeling, (2) Regional DSTs, (3) Data Portal and Information Hub, and (4) Observations and Research. The purpose of these presentations was to provide information on the purpose, structure, current status, build-out plans for each component, and any specific goals for the Summit. The presentations were given by the National Team leads for each component. Below is a synopsis of the presentations and subsequent discussions.

Regional Ocean Modeling[14]

The goal of the Regional Ocean Modeling component of CEFI is to produce a nationwide ocean modeling system that provides robust regional ocean outlooks at multiple timescales in support of climate-informed advice for living marine resource management. This climate-informed modeling and advice is a key component of the operational CEFI Decision Support System. For each of the five regions (i.e., foundational model configurations) spanning the U.S. coastal waters and the Great Lakes, the teams will produce four products: (1) a “Coast-wide” high-

[14] The slide presentation is available on the NOAA internal network at https://drive.google.com/file/d/18rPj4yIh9h_uZ6ouY5JEu6ZiRSNt0dDn/view. If access is needed, please reach out to the editors of this document.

resolution physical and biogeochemical hindcast of conditions over the last 30 years (updated yearly), (2) seasonal outlooks extending to 12 months (updated quarterly), (3) decadal outlooks extending to 10 years (updated annually), and (4) next century climate change projections (updated every 5–6 years). The intended timeline for these deliverables is below (Figure 4).

Year	East Coast	West Coast and Arctic	Great Lakes, Pacific Islands
FY23	Initial hindcast	Initial Configuration	
FY24	Hindcast update, retrospective seasonal predictions	Initial hindcast	Initial configuration
FY25	Hindcast update, retrospective decadal predictions, initial climate change projections	Hindcast update, retrospective seasonal predictions, initial climate change projections	Initial hindcast
FY26	Hindcast update, expanded projections, seasonal outlooks reliably delivered	Hindcast update, expanded projections, retrospective decadal predictions	Hindcast update, retrospective seasonal predictions, initial climate change projections
FY27	All products reliably delivered	Hindcast update, seasonal outlooks reliably delivered	Hindcast update, expanded projections, retrospective decadal predictions
FY28	All products reliably delivered	All products reliably delivered	Hindcast update, seasonal outlooks reliably delivered
FY29	All products reliably delivered	All products reliably delivered	All products reliably delivered

Figure 4: Timeline of the expected delivery of MOM6 products by region.

Regional Ocean Modeling Teams consisting of ocean modelers from OAR and NMFS, in collaboration with NOS and external partners, will work with regional Modular Ocean Model 6 (MOM6) code developers to utilize global models, global climate predictions (e.g., Seamless System for Prediction and Earth System Research (SPEAR)) and projections (e.g., Coupled Model Intercomparison Project Phase 6 (CMIP6)) to produce hindcasts, seasonal forecasts, decadal predictions, and multi-decadal projections. They will then provide this information to the CEFI DSTs via the CEFI Data Portal. This workflow is visualized in the diagram below (Figure 5).

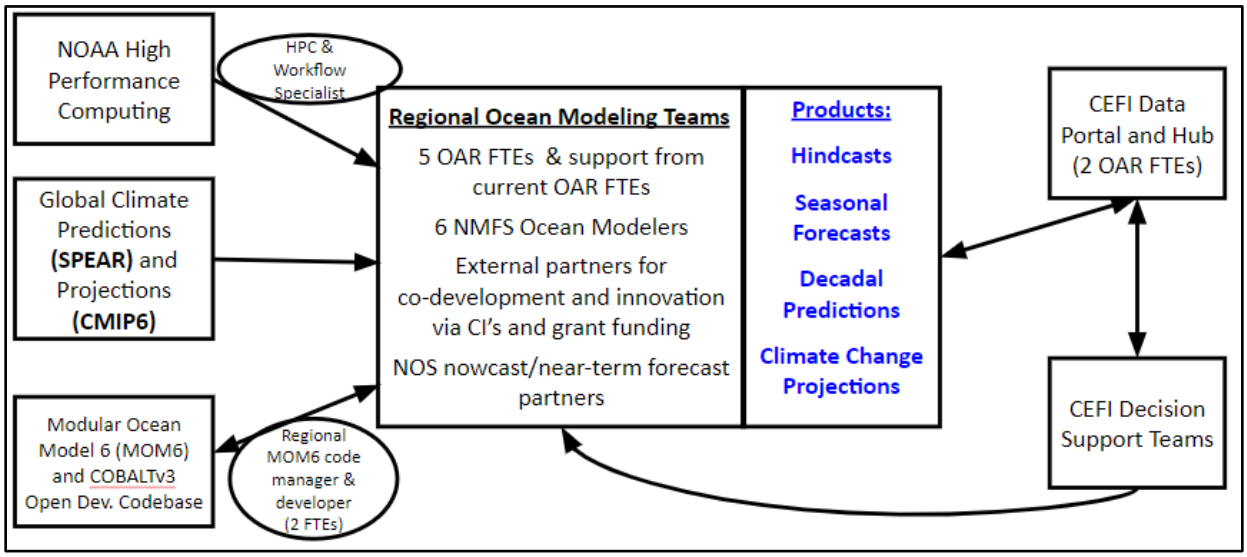

Figure 5: Workflow diagram of the Regional Ocean Modeling component.

The Regional Ocean Modeling Teams have already delivered hindcasts for the Northwest Atlantic and West Coast surface and bottom temperature fluctuations and El Nino Southern Oscillation (ENSO) teleconnections (MOM6 vs. Global Ocean Reanalysis and Simulations (GLORYS) reanalysis), and CEFI synergies are already at work in the Bering Sea. Seasonal and decadal outlooks have made progress, as has climate change projections, which have built on existing resources in each of those areas. Design and evaluation have also started on next-generation regional ocean projections for living marine resource (LMR) management in a changing climate. These developments contribute to other NOAA mission priorities, for example, the regional MOM6 infrastructure supporting multiple National Oceanographic Partnership Program (NOPP)-funded marine carbon dioxide removal (mCDR) projects. Developing model products concurrently with their applications presents unique challenges that the Team is addressing by consistent communication with other component teams. This also helps them to navigate a balance between the advantages of model consistency across regions with the advantages afforded by regional tailoring.

Goals for the Summit/Key questions and needs to be addressed:

- As clear a sense for the initial applications as possible to ensure that the modeling products are fit to task
- Priority fisheries/ecosystem-critical model evaluation metrics and the datasets to test against
- Further progress toward protocol consensus for CEFI modeling products and reliable data delivery
- Strengthened integration across CEFI components and NOAA LOs

Audience Q&A:

- Is a multi-model ensemble approach going to be used?

        - Multi-decadal projections will be built with an ensemble of models that best capture the global scale uncertainty. For seasonal and decadal projections, multi-model ensembles could be integrated but are less critical.
    - Are the timescales of the regional ocean modeling outlooks focused on climate change in general, or are they a suite of products (e.g., sea ice, etc.)?
        - The ocean prediction models writ large are over those same timescales. However, some insight into critical parameters is needed; we need to focus on the questions that the models need to help answer. (i.e., specific context the models would be applied toward).
    - If hindcasts are coming out yearly but seasonal forecasts are quarterly, would hindcasts be downscaled?
        - The hindcasts will be updated every three months, but we need to determine if that includes all aspects of hindcast or just some.
    - How will the need for communication regarding uncertainty be incorporated into modeling, visualizations, and so on?
        - Visualizing uncertainty is critical. The modeling team has been working with the Data Portal Team to consider ways to visualize uncertainty within the data portal.
    - Regarding the Great Lakes, what kind of process needs to be embedded in the Carbon, Ocean Biogeochemistry and Lower Trophics (COBALT)/biogeochemical models?
        - The biggest deficiency for Great Lakes is that the benthic model is relatively simple. The model needs to be strategically augmented for the Great Lakes due to the shallow depths, and it needs to match fisheries critical features.

Data Portal and Information Hub[15]

The goal of the Data Portal and Information Hub component is to build and service a portal that can manage, store, and provide access to the information provided by the Regional Ocean Modeling Teams and other data sources. This is critical for handling the large amounts of model output (forecasts, projections) that enable easy access by experts across a range of fields, from fisheries to coastal communities and other ocean uses (e.g., wind energy, aquaculture). It will also serve relevant datasets, including reanalyses, and provide web-based systems for analyzing and visualizing the data.

The data portal will post-process and disseminate regional MOM6 output, enabling analysis, visualization, and downloading of ocean variables, derived variables, indices, and “cookbook” (tutorials on how to obtain and use data) examples of how to access, visualize, or analyze data. It will also link to other data sources, including NOS model output and data, reanalyses at 8 km resolution, and relevant, prioritized observations. The Information Hub will show where to find CEFI-relevant data or information in other places.

[15] The slide presentation is available on the NOAA internal network at https://drive.google.com/file/d/11XUz1flFJcl6MUJS_ovMfpNCR7MkdtTC/view. If access is needed, please reach out to the editors of this document.

The flow chart below (Figure 6) shows the data flow through the portal. The system enables MOM6 output (and other data) to be served through a NOAA-based system housed at the Physical Sciences Laboratory (PSL; on-premises). A second pathway is being tested for storing/accessing the data via the cloud. The model and data through either source can then be processed via cookbooks (scripts/code), visualized on the portal, accessed via Open-source Project for a Network Data Access Protocol (OPeNDAP), or downloaded.

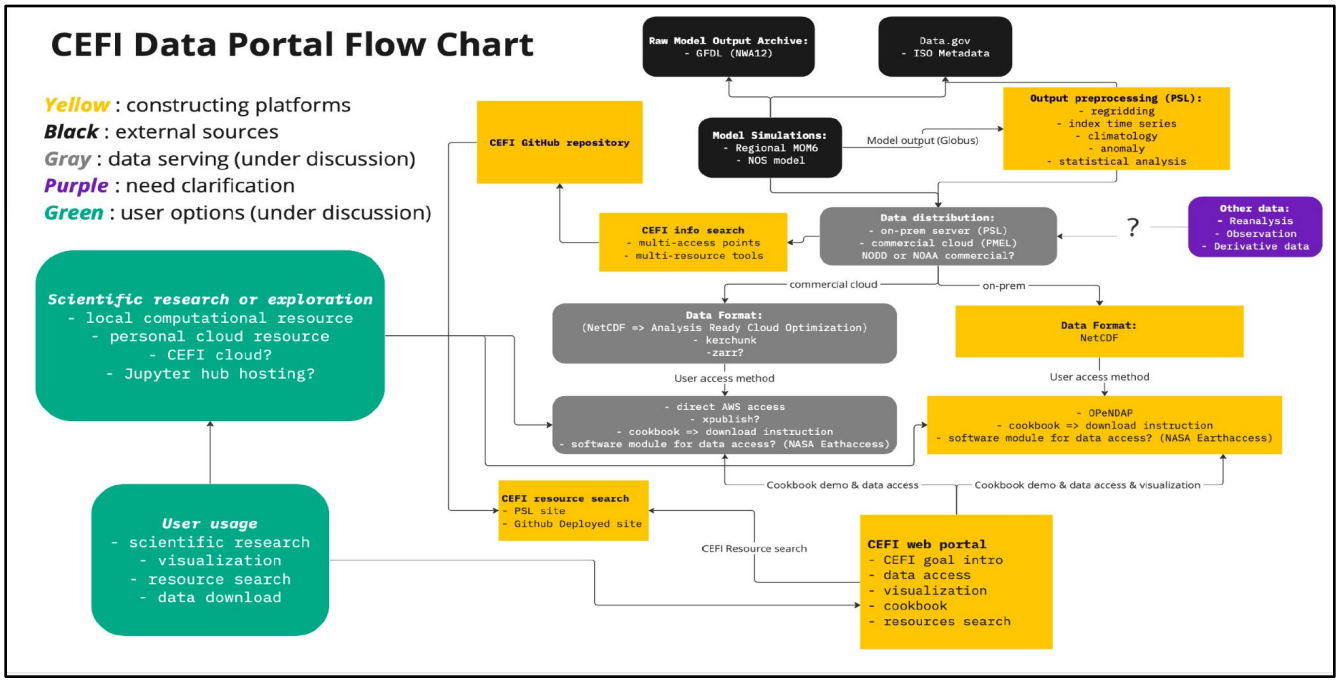

Figure 6: Workflow diagram of the Data Portal component.

The CEFI Data Portal[16] currently has a landing page with general CEFI information, with several pull-down menus enabling analyzing and visualizing MOM6 fields and observations. Select MOM6 output can be visualized from Northwest Atlantic simulations for historical simulations (hindcasts) and re-forecasts (forecasts of past periods). Select observational datasets are also available for comparison on the data portal, including three high resolution sea surface temperature data sets and daily/monthly maps and time series for large marine ecosystems, and reanalysis with a combination of model fields and observations.

The information hub (linked in the data portal) contains a searchable database (currently containing ~130 websites) for finding NOAA and other data and analysis websites relevant to CEFI. There is also a GitHub repository describing those sites. Users can request that sites be added by filling out a form. There are also several “cookbooks” available.

Goals for the Summit/Key questions and needs to be addressed:

- *Goals:*

[16] NOAA. 2024. CEFI Data Portal. [Available at https://psl.noaa.gov/cefi_portal/: accessed 16 October 2024.]

    - More in-depth understanding of the types of users and their needs
    - Establish cross-CEFI working relationships
    - Obtain additional websites to include in the information hub
    - Discussion of cloud methods for serving data: output and structure

- *Key questions and needs to be addressed:*
    - Who will use the portal, and what are their needs?
    - How will model output and CEFI-relevant data be used?
    - How will users access the data?
        - Cloud vs. NOAA computer
        - NOAA Open Data Dissemination (NODD) vs. purchased cloud (enables cloud computing)
        - Download, OPeNDAP, cloud (applications and access)
    - What additional information should be served?
        - Physical/biogeochemical data, reanalyses?
        - Fishery data, output from fishery models? Or should this be under the purview of DSTs?
        - NOS model output?
    - How to prioritize (given computer/human resources), for example, high, medium, low?
    - How to best co-develop and share code?
    - What can we learn from other portals and cloud-based applications?
        - For example, VEDA,[17] PecAN,[18] Earth Access[19]
    - Useful methods to display ensemble forecast information
    - Would creating a survey help to address these and other questions?

Audience Q&A:

- Will the data portal support non-NOAA data and observations?
    - First, we need to prioritize what is critical for us to serve through this portal and what should remain outside or elsewhere for us to point to.
- Follow on: Priority should be given to output from the NOAA MOM6 simulations and then NOAA data. Some observations, such as high-resolution sea surface temperature (SST) or reanalysis datasets will likely be served.
- Will the model outputs be bias-corrected?
    - Certain outputs would have basic processing, but considering bias corrections is something to be discussed with the Regional Ocean Modeling Team as a next step. The data portal could provide standard bias correction guidance. The SST and bottom temperature fields, which are currently provided, have been bias-corrected.

[17] NASA. 2022. NASA's Visualization, Exploration, and Data Analysis (VEDA) Project. [Available at https://www.earthdata.nasa.gov/esds/veda: accessed 16 October 2024.]
[18] University of Illinois. 2012. Predictive Ecosystem Analyzer (PEcAn). [Available at https://pecanproject.github.io/: accessed 16 October 2024.]
[19] NASA. 2024. NASA's earthaccess Python library. [Available at https://www.earthdata.nasa.gov/learn/blog/earthaccess: accessed 16 October 2024.]

- What from the NOS model output will be hosted on the CEFI data portal?
    - The next step is to discuss with NOS about the best way to do this (i.e., does the data portal simply point/link to NOS models, or does CEFI ingest the outputs from the regional model configurations?)
- Who is the audience of the data portal?
    - The goal is for the data portal to be user-friendly for all or possibly have tutorials available for how to use it. However, a discussion needs to be had with the DSTs on how to make the data portal more useful and if any usability testing is needed. Follow on: The highest priority should be data access and products for the regional application teams. Often, once more complex products are developed, it can be relatively straightforward to make them more general.
- Has there been any coordination with Tribal coordinating bodies, state fish/wildlife/natural resource agencies?
    - The focus has largely been on ocean applications because that is what is available so far from the Atlantic domain. However, we certainly hope to serve Great Lakes information on the data portal.
- Has there been any thought of capturing metadata for specific model runs or specific versions so that users are aware of the version used?
    - The code will be in the GitHub repository, but the data portal team can work with the Regional Ocean Modeling Team to create a naming system for metadata (e.g., timestamp, version number, etc.)

Regional Decision Support Teams[20]

Goal of the Regional DST Component:

- Provide operational support to produce the climate-related information and advice needed by decision-makers for effective resource management (fisheries, protected species, protected areas), industry planning, and community adaptation.
- The teams work with the existing science enterprise in each region and other internal and external partners to provide a historical context of climate impacts on living marine resources, early warnings of ocean change, and long-term projections of future ecosystem conditions (e.g., future species distributions and abundance), risk assessments, and actionable advice for climate-ready fisheries management, protected species conservation, protected area management, and community adaptation.

[20] The slide presentation is available on the NOAA internal network at https://drive.google.com/file/d/1cBY4y5rRTOPlIgb_TgZadqc4LW8Obf41/view. For external access, please contact the editors of this document.

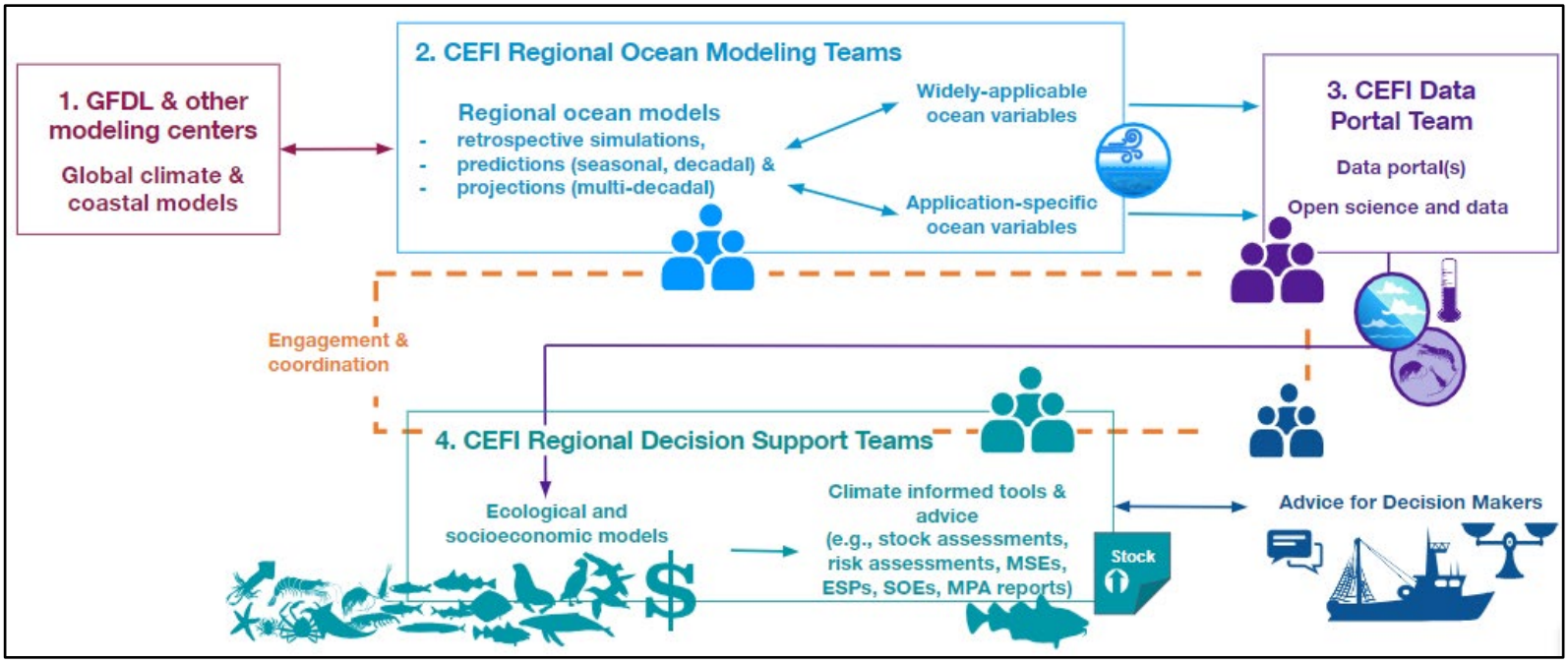

Figure 7: Workflow diagram showing how the Regional DSTs work with the Regional Ocean Modeling Team and Data Portal Team to incorporate ocean models into ecological and socioeconomic models to produce climate-informed tools and advice.

How will this be achieved?

- The DSTs will work with OAR and NMFS regional ocean modelers to incorporate relevant oceanographic information into decision support products and tools (Figure 7; e.g., stock assessments, management strategy evaluations, and risk assessments) and disseminate through appropriate channels (e.g., council initiatives, state of the ecosystem reports, real-time web tools).
    - High resolution oceanographic model (MOM6) grids will be used to produce high resolution hindcasts, seasonal to annual forecasts, decadal predictions, and century-scale projections (e.g., sea ice, water temp, pH, winds, currents, zooplankton), which DSTs will use to match the scale of these outlooks to decision-support tools and advice (Figure 8).
- The DSTs and modular groups will use observations, reanalysis products, and regional ocean models as input to stock assessments, ecological and socioeconomic models, risk assessments, scenario planning, and management strategy evaluations developed specifically for regional needs and applications.
- Figure 9 outlines the full process for the delivery of decision support tools and advice.

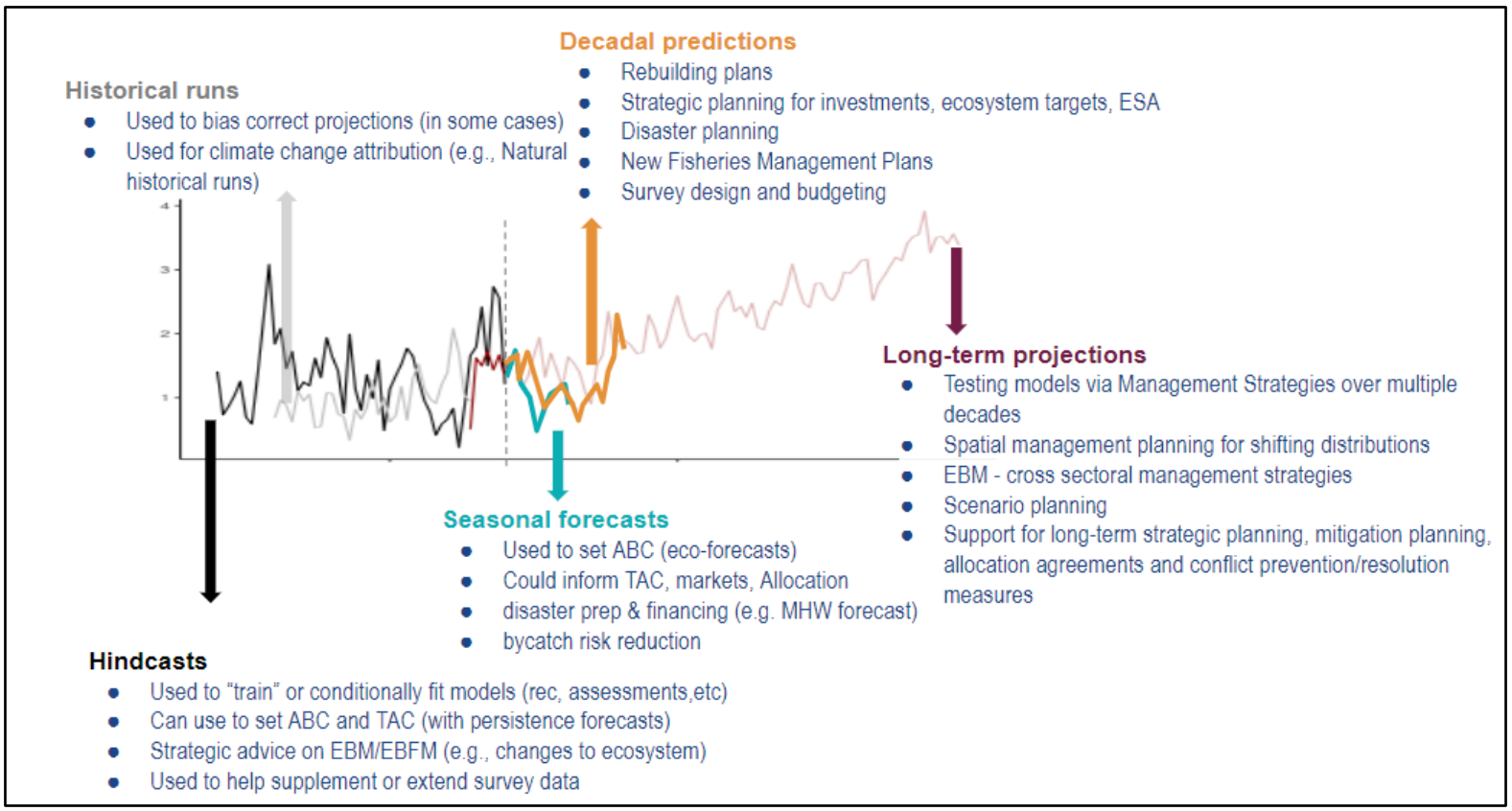

Figure 8: Ocean modeling outlooks matched to the scale of decision support tools in which they are utilized.

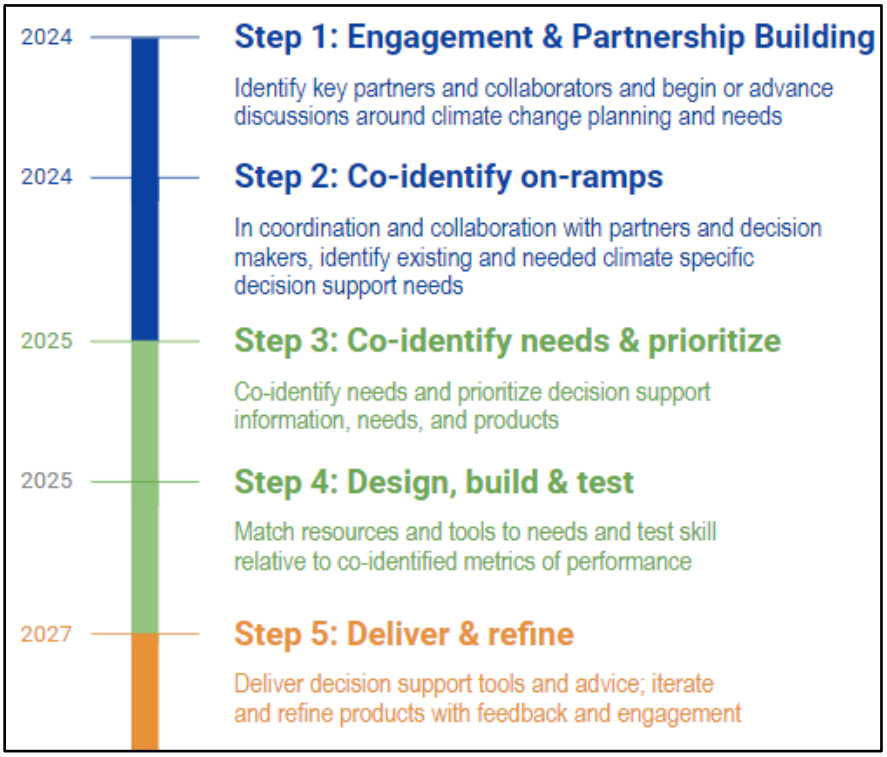

Figure 9: Each step in the full process for the delivery of decision support tools and advice.

Products/deliverables:

- A variety of operational climate-integrated advice products are anticipated in each region by 2027. The products will vary among regions based on the region's needs and priorities. Examples of products and deliverables include:
    - Climate-informed stock assessment models
    - Climate-informed management strategy evaluations
    - Climate-informed species distribution models
    - Climate-informed ecological models
    - Ecosystem and socio-economic profiles
    - Risk assessments
    - Ecosystem reports
    - Scenario planning
    - Vulnerability assessments

Current status/progress to date:

- Interdisciplinary modeling projects in four regions have been implemented as pilot projects for CEFI (Appendix E): the Alaska Climate Integrated Modeling project (ACLIM), the Gulf of Alaska Climate Integrated Modeling Project (GoACLIM), the Northeast Climate Integrated Modeling Project (NCLIM), and the Future Seas Project (U.S. West Coast). These pilot projects serve as part of the existing foundation for the development of the CEFI Decision Support System.

- Hiring of IRA-funded DST members is underway at all NMFS Science Centers (FSCs) to build capacity for a core DST to integrate with the existing science enterprise at each FSC.
- Each DST is developing a list of potential CEFI projects to prioritize for completion by the end of 2026 to demonstrate the utility of the CEFI System.

Goals for the Summit/Key questions and needs to be addressed:

- Goals for the Summit:
    - Help each region feel that they have the information and logistical support needed to get started now (bridge until MOM6 available)
    - Compare notes across regions, connect the dots among CEFI components and DSTs, and discuss progress and solutions to remaining roadblocks
    - Leave with a clear (regionally tailored) stepwise plan for targeted engagement through product delivery
- Key questions to be addressed:
    - How do we get started now while we wait for MOM6 products to be in hand?
        - Do deliverables have to use the MOM6 output in the near-term? If not, can we build tools that can be enhanced by model output and how? For example, using bottom temperature observations, model-based, replicating as close as possible to existing indices (cold pool).
        - What are additional key indices (beyond bottom temperature and cold pool) to replicate?
        - Engagement is key but with whom and how?
        - Communication of assumptions, uncertainty, and potential shared solutions.
        - We mentioned a few key audiences; what existing or future climate advice users are missed?
    - Where does CEFI end, where do our EBM/EBFM research partners begin, and how do we best maintain those links going forward?
        - How can we best collaborate with IEA partners to leverage both programs?
        - How do we maintain and build collaborations through CEFI in a way that allows for visibility/transparency?
    - What would a fully successful CEFI Decision Support look like in 10 yrs?
        - What is the feedback process that gets us toward this ideal?
        - What is the process for the integrated approach to be skillful enough to be used?
        - Hindcasts? Seasonal to annual forecasts? Decadal predictions? Projections?

Audience Q&A:

- What is the capacity of regional DSTs to assist with the uptake (e.g., basic training sessions, tutorials) of new decision-making tools?

    - This is a key challenge and opportunity with engagement. The challenge is not to overwhelm the users. The discussion could start with learning how much capacity decision-makers have to start learning these tools and determine what is needed in terms of process and not just the product.
- How does adaptation and other blue economy sectors fall into the DSTs?
    - DSTs could provide information to facilitate decision-making tools for adaptation and can also provide advice for individuals on how to respond. Adaptation planning is already happening in some regions, and DSTs may be able to help provide the information needed for such planning efforts (e.g., planning for different port infrastructure based on projected climate changes, etc.)

Observations and Research[21]

The goal of the Observations and Research component is to help guide improvements to the backbone of ocean observations and scientific research that are needed to support the Modeling (both ocean modeling and ecosystem modeling) and Decision Support components of CEFI. The identification of critical needs can help focus observation and research efforts and advance the implementation of plans to address these gaps by NOAA and non-NOAA partners. Needs will likely include observations that enhance the ability to regularly assess model performance.

The first steps necessary to achieve the goals are a synthesis of targeted research and observation needs across the CEFI regional groups, identifying common and unique needs. This synthesis of key needs can then be shared with communities of observationalists (e.g., NOAA survey teams, NOAA's Global Ocean Monitoring and Observing program, the NOAA Climate Program Office, the Integrated Ocean Observing community). A clear statement by CEFI regarding the data needed to support the developing CEFI System may help justify future research and observational efforts by providing a pipeline through which the value chain of those data can be demonstrated. The CEFI community can act as a coordinated community of data users with an established system in which these data act to improve and assess model performance and decision-relevant information. Engaging in regular, strategic discussions about the observational and research needs of the CEFI system, both within NOAA and with external partners, may help develop programmatic level support for addressing these needs in the future.

One concern of the goal to improve observation and research efforts relevant to CEFI is the potential boundless nature of climate and ecosystem information. We recognize that scientific understanding of the impact of natural and anthropogenic processes on the structure and function of marine ecosystems remains incomplete, and arguments can be made that any new insight into the dynamics of marine systems could improve the scientific capacity to describe the future state of the ecosystem. To avoid developing a scope that is unwieldy and vague, the

[21] The slide presentation is available on the NOAA internal network at https://drive.google.com/file/d/1oWn__jcbFM2oONgr8NWatSzNVoTm9N_U/view. For external access, please contact the editors of this document.

efforts of the Observations and Research component need to be narrowly focused on issues that directly advance the needs of the Modeling and DSTs. These might include enhancing data streams to evaluate model performance, improving data for forecast initialization, understanding of key processes linking CEFI model output to decision needs, and assessing data on community concerns.

Engagement between the developing Regional Ocean Modeling and the Observations and Research components will be valuable, as the region models can act as tools to help prioritize observational needs. For example, model experiments can identify the regions, parameters, or periods in time for which increased observations may have a disproportionate impact on assessment of model performance. As regional models are developed and analyzed, the Ocean Modeling teams may be able to provide feedback on the observations that may have the greatest impact on model assessment and improved model performance (perhaps in a manner similar to Observing System Simulation Experiments).

Goals for the Summit/Key questions and needs to be addressed:

- *Goals:*
    - Trigger CEFI regional teams and components to continue internal discussions on priorities for targeted observations and research and then share those thoughts with the Observations and Research Team
    - Consider strategies to engage observational groups (which ones? how?) and ways to foster a sense of community between CEFI teams and those making observations (and observational products)
    - Take away some “lessons learned” regarding observations and research from the CEFI pilot projects
    - Learn how we might influence the activities (and outyear budgets) or other programs
- *Key questions:*
    - How can the CEFI system distinguish its observational and research needs from broader ocean and climate monitoring efforts?
    - How can we motivate collaborators and transition from a mode of “observing to improve understanding” to “observing to advance the CEFI mission?”
    - What insight can be gleaned from CEFI pilot projects?
    - How do we walk the line between managing CEFI-relevant data streams and taking on too much in terms of data management tasks?

Audience Q&A:

- How can CEFI engage with other agencies to think creatively about achieving observations and research goals with other sources of funding?
    - The Observations and Research team is considering a workshop to bring partners and agencies together to explain CEFI, create a curated list of needs, and discuss how to leverage resources.
- What is the capacity of the ocean modeling system to leverage observations for forecast initializations?

    - For the Northwest Atlantic, which indirectly included observations, the detailed initialization was most powerful in the first month, and then the value declined. Having a good quality hindcast that performed reasonably well in capturing the data was very important for forecasting beyond 2–3 months in the future.

Panel 2: Perspectives on Needs and Build-Out of the CEFI System (Day 1 Reflections)

Panelists were asked to provide reflections on Day 1 of the CEFI Summit, including their perspectives on the needs and build-out of the CEFI System.

V. "Ram" Ramaswamy
Geophysical Fluid Dynamics Laboratory, NOAA Office of Oceanic and Atmospheric Research

- There have been some spectacular modeling advances, including integrated earth systems modeling, in the last five years. The open model development and GitHub system for MOM6 is revolutionary.
- It is important to emphasize the ability of users and decision-making teams to understand what the modelers are doing and what the models reflect is happening in the environment.
- CEFI needs to be nimble in the face of rapidly changing variables. Factors can be impacted by more than just temperature. There may also be region-specific uncertainties driven by different factors.
- Data management, transfer, archiving, and storage are extremely important. Data need to be easily available and transferable.
- CEFI could gather input from other data users (e.g., civil engineers.)
- CEFI needs to be sure to document its success stories, as this provides examples of its impact on its users.

Jason Link
Senior Scientist for Ecosystem Management, NMFS

- **Forced flexibility.** Snow crabs in Alaska crashed in population. This was despite significant resources present to track influencing factors on their population. The system in place was too rigid, as are others, so flexibility needs to be emphasized. CEFI may need to force information into onramps in order to get climate forecasts into the system and implement warnings or predictions.
- **Reduced reductionism.** NOAA is mandated to manage 2,876 living marine resources. With this quantity, we will not be able to provide a detailed mechanistic process for each; we will need to use a systems approach. We will need to triage risk assessments and prioritizations accordingly.

Rick Methot
Senior Scientist for Stock Assessments, NMFS

- It often takes an observations and research approach to set references to stock productivity, rather than an ecosystem or biological one. "Control rules" are a system for

translating observations into catch levels that would maintain stock availability. These rules can be improved by climate information, reducing historical bias.
- The most helpful projections would be 1–3-year projections of stock productivity. Even qualitative (e.g., higher or lower than average) would be useful. Two to 10-year projections would be even more useful.
- One particular challenge fisheries face from whole climate changes is the timescale of changing reference points relative to tracking reference points. Models exist for this, but MOM6 has more calibration. When MOM6 is applied, the manpower that has gone into previous models will provide a correlation-based link with previous skill testing.
- CEFI needs to prioritize fish stocks most impacted by climate changes for climate-enhanced stock assessments.

Mark Monaco
Senior Scientist, National Centers for Coastal Ocean Science, National Ocean Service

- There are far more potential users (and benefactors) of CEFI available for engagement (e.g., Office of National Marine Sanctuaries (ONMS), National Estuarine Research Reserves, coastal resilience). Specifically, CEFI should engage with the U.S. Integrated Ocean Observing System (IOOS) Regional Associations.
- It is important to highlight interim success stories as well as end-state success stories.
- Two potential challenges are in bridging the ocean-basin scale from shelf to estuaries and managing cloud computing for models and data.

Audience Q&A

1. It is helpful to remember the timeline of development. By having systems in place now using non-MOM6 outputs, we will be ready to input MOM6 data when they are ready.
2. CEFI will need to not just promise and provide predictions but will need to consider responses to those predictions. For instance, if the snow crab crash had been predicted with 100% certainty, a response could have been “let us harvest all of them now because they will crash next year anyway.” How can CEFI use tools to address that possibility?
    - CEFI can bring socio-economic and governance considerations to projections, helping to extend control rules to a longer-term view.
    - Feedback from decision-makers to modelers can help the modelers be aware of things like this and provide a greater qualitative understanding of such decisions.
    - Any prediction information, even minimally, is better than no information. Communicate these predictions and projections in terms of timescales and impact on human/economic/coastal communities or protected resources.
3. Where is CEFI’s greatest opportunity to show value by the end of Fiscal Year (FY) 26?
    - The cross-disciplinarity of research investigations will produce more integrated advancements and provide new observations to spark new thinking.
    - The delivery of MOM6 data portals and the timelines associated with them will provide concrete evidence of success, especially if they can be paired with a gap analysis and demonstrations of areas of potential improvement.
    - Provide a measure of how many models have had climate forecasts utilized.

4. How does CEFI accommodate for the fact that changes are increasing and accelerating? If historic data are no longer reliable (e.g., stocks move to places they have not been before), how can CEFI expand in response?
    - This challenge emphasizes the need to rethink reference points and time frames, as well as rethinking the governance system's current rules.
5. How important is it to develop predictive systems versus the best predictive information or improved modeling? Is it more important to provide information that can be used to make decisions, or is it more important to understand every little process to get to our ability to talk about what a species is going to be doing?
    - AI is a possible disruptor to the current modeling systems and to MOM6, so it should be considered. However, AI builds on past data, which is becoming less predictive of the future. Being able to predict the ocean system will inform how the fish respond to changes in that system.
    - It is more important to have good predicted information to pass on than have predictive models be perfect.
6. CEFI needs to have initiative-wide success stories, and each region needs to have its own success story and be able to highlight wins in that region. This will inspire champions outside the agency to advocate for CEFI, citing benefits to their region.
7. What would constitute a "CEFI win?"
    - In the past, serial receivers of information were considered the end of the process. Now, however, they are integrated from the very beginning. The win at this time would be everyone having a common understanding of what CEFI is building and what it will look like.

Summit Summary: *Session 2*

Regional Breakout Groups

Status, plans, and next steps

On the second day of the Summit, participants divided up into breakout groups to discuss the build-out of the CEFI System in each region and discuss prospective projects/products to complete in the next few years to demonstrate the utility of the CEFI System. Each of the regional breakout groups was asked to identify the following:

- Current status: review proposed regional DST structure, process, and existing work
- What is useful and achievable: review prospective demonstration projects/products, how they connect to user needs, and how to complete them (e.g., plans, workflows, partnerships)
- What are the key challenges, opportunities, and next steps?

For each of the regional teams, a brief synopsis of key points and findings is listed below.

Northeast (NE)[22]

Over 20 participants from the Northeast Fisheries Science Center (NEFSC), Greater Atlantic Regional Fisheries Office (GARFO), highly migratory species (HMS), Geophysical Fluid Dynamics Laboratory (GFDL), NOS National Centers for Coastal Ocean Science (NCCOS), IOOS, Gulf of Maine Research Institute (GMRI), and the University of Maine were present in person, and a few individuals were online. Vincent Saba facilitated the session.

Current status

- Draft list of over 30 key deliverables
- Identified end-users (draft list completed)
- New hires: ecosystem modeler, spatial modeler, ocean modeler, social scientist

What is useful and achievable?

- Draft list of over 30 key deliverables:
    - Climate-informed stock assessments, Ecosystem and Socioeconomic Profiles (ESPs), end-to-end ecosystem model, State of the Ecosystem (SOE) Reporting (MOM6 products), vulnerability/adaptation for fishing communities, risk assessments, extreme events, protected species models, Atlantic HMS - PRiSM, Atlantic HMS Climate Vulnerability Assessment (CVA), Apex predators, Management Strategy Evaluation (MSEs), modeling assistance for proposed Hudson Canyon National Marine Sanctuary
- Key next steps:
    - Complete CEFI hire onboarding: work plan for new hires
    - Identify all end users and engage
        - Council meetings (August 15–16, 2024, Joint Council Meeting)
        - Onboard Council and GARFO staff on NE DST
    - Engagement: Organize a regional users meeting (NE, SE, and HMS)
    - Identify tactical vs. strategic products
    - Identify short-term wins (from spreadsheet)
    - Update climate webpage for NE
    - External funding: tracking CEFI progress
    - Deeper dive into MOM6 hindcasts and explore detailed utility for NE

Questions, suggestions, challenges, and opportunities for moving forward

- Challenges
    - Uncertain if management will incorporate ocean forecasts into decisions due to uncertainty in skill.
    - Very few management decisions rely on observed ocean data (e.g., temperature). Need targeted research based on ocean observations and possibly the MOM6 hindcasts.

[22] The slide presentation is available on the NOAA internal network at https://drive.google.com/file/d/1JAlrRwkIi9t2GBiVd8o52Ds0y4kJjKZh/view. For external access, please contact the editors of this document.

- Opportunities
    - Southeast Fisheries Science Center (SEFSC) linkages
        - Black sea bass, HMS, right whales, other transboundary stocks
    - Direct connection between social systems
        - Community vulnerability assessments
        - Make that connection to CVA
    - North Atlantic Right Whales (NARW)
        - Lower trophic level (LTL) with generalized additive model (GAM) for habitat projections
    - Revising vulnerability assessment
        - HMS, Mid-Atlantic, and New England are all interested in revamping.
        - Stock area vs. species scale: need for stock level vulnerability information (and maybe even splitting up unit stocks).
        - Update from qualitative to quantitative. Improve the timescale to be more dynamic.
        - Opportunity to ask South Atlantic Fishery Management Council (SAFMC), Mid-Atlantic Fishery Management Council (MAFMC), and New England Fishery Management Council (NEFMC) whether they could all be using the same tools, including Atlantic States Marine Fisheries Commission (ASMFC)?
    - Demonstrating value
        - Evaluate improved performance by using the Woods Hole Assessment Model (WHAM) and climate covariates

West Coast[23]

The West Coast regional breakout session was attended by ~40 participants, of which ~5 attended virtually. NOAA participants represented NMFS (Northwest Fisheries Science Center (NWFSC), SWFSC, West Coast Regional Office (WCRO), OST), OAR (PSL, GFDL, Pacific Marine Environmental Laboratory (PMEL), Climate Program Office (CPO)), and NOS (IOOS, NCCOS). Two additional participants represented the Inter-American Tropical Tuna Commission (IATTC), while two more attendees from Scripps represented the regional IOOS associations and the Fisheries and Marine Ecosystem Model Intercomparison Project (FishMIP).

The session was facilitated by Mike Jacox (SWFSC) and Chris Harvey (NWFSC). The session included (1) an introductory presentation and discussion about West Coast CEFI's progress, current status, and plans; (2) two breakout groups, covering forecast and long-term projection timescales, to discuss details of how CEFI applications would be carried out from end to end; and (3) a plenary summary of the breakout groups and discussion of next steps.

[23] The slide presentation is available on the NOAA internal network at https://drive.google.com/file/d/12RmizipHG6SVosxH_i4Wp9zUv-F3_ZGo/view. For external access, please contact the editors of this document.

Current status

- The West Coast has a strong foundation of climate-ecosystems-fisheries work spanning all time scales (Future Seas, Groundfish, Climate Change, and Communities in the California Current project (GC5), Dynamic Ocean Management, Ecosystem Status Reports, etc.). CEFI will build on the existing science/results/frameworks to operationalize regional decision support.
- Ocean modeling status:
    - NOS has a high-resolution operational ocean forecast system (West Coast Operational Forecast System (WCOFS)) spanning the West Coast of the continental U.S. and providing short-term information (nowcast → 72-hour forecast)
    - MOM6 hindcast is mature with a manuscript describing the baseline simulation nearing completion. Seasonal forecast development is underway. OAR (GFDL, PSL) is leading these efforts.
- New DST hires at NWFSC and SWFSC (some complete, some planned or in progress)
    - Northwest (NW): 2 permanent, 3 terms
    - Southwest (SW): 4 terms
- Scoping of potential West Coast CEFI applications has begun (see below).

What is useful and achievable?

- There is a large suite of potential decision support project ideas (n = 28) compiled by NWFSC and SWFSC, building from existing science and partner engagement processes, and spanning key domains associated with partner (e.g., West Coast Region (WCR), Pacific Fishery Management Council (PFMC), ONMS) needs:
    - Tactical ↔ Strategic
    - Fish ↔ PR ↔ Habitat ↔ Economies ↔ People
    - Stock ↔ Multispecies ↔ FMPs ↔ Ecosystem
    - Fishing ↔ Species Recovery ↔ Wind
- Several projects were selected for further discussion during breakout sessions. These projects were not meant to be the actual projects that will be pursued but were representative of several types of applications in order to facilitate discussion about workflow.
    - Protected resources risk mitigation
    - Climate-enhanced stock assessment
    - MSE for climate-ready harvest control rule
- WCR provided initial feedback on these 28 project ideas (done on very short notice and will be iterative). In summary,
    - 8 project ideas identified as priorities for new resources
    - 6 not supported in the current form but has room for discussion
    - 14 no comment/partially funded outside CEFI
- Additional partner engagement is being pursued, for example, with the PFMC (through the Ecosystem Working Group (EWG), Ecosystem Status Reports, and other venues) and with other stakeholders (e.g., ONMS, Bureau of Ocean Energy Management (BOEM), States) through project-specific venues.

Some key takeaways were summarized following the breakout session:

- A leading priority is narrowing to a feasible selection of applications. This ongoing process seems daunting but is doable based on decision support need and feasibility (e.g., mature science, alignment with CEFI DST expertise, NMFS and stakeholder interest, and capacity)
- "Researchers want to research" → We must be careful to distinguish applications that are ready to be operationalized as CEFI ocean models come online from those that are promising but require further research.
- The role/scope of the data portal should be clarified. Specifically, how much bespoke post-processing of ocean model output should happen on the data portal vs. being handled by the region?
- Plans were discussed for communication post-Summit:
    - Within/across NWFSC and SWFSC, communications are well established and can rely largely on existing channels.
    - Targeted discussions with WCR and the council can also leverage existing meetings/groups (CCIEA, WCR Climate Team, EWG).
    - NOS is ready to engage on DST schedule (but not currently West-Coast focused for CEFI).
    - Additional existing fora offer opportunities for coordination (e.g., National Stock Assessment Forum, West Coast Groundfish Meetings).
    - A desire has been expressed for a national community of practice for DST members, especially those who are new(er) to NOAA.

Southeast (SE)[24]

The SE regional breakout group was facilitated by Mandy Karnauskas and included 35 attendees (29 in person and 6 virtual). The largest representations were from SEFSC (n = 7) and the Atlantic Oceanographic and Meteorological Laboratory (AOML) (n = 8). Additionally, attendees included individuals from the Southeast Regional Office (SERO), PMEL, NCCOS, OST, OSF, Office of Aquaculture (OAQ), and National Centers for Environmental Information (NCEI) offices, as well as one external member (Meredith Moore) from the Ocean Conservancy.

The SE regional breakout presentation included presentations on (1) the region's current structure, processes, workflows, and modes of collaboration (presentation;[25] delivered by Mandy Karnauskas and Ana Vaz) and (2) the current statuses of the Northwest Atlantic high resolution regional downscaled MOM6 models (i.e., the GFDL-ESM4 and MOM6-NWA12 ocean

[24] The slide presentation is available on the NOAA internal network at https://drive.google.com/file/d/1-xwglB4tqZaDYKh7uEuRG8L52NHnI1fJ/view. For external access, please contact the editors of this document.
[25] The slide presentation is available on the NOAA internal network at https://docs.google.com/presentation/d/1zZgdXrarSED-959MiJD54HkvccQQXQ3-pnQcax9uycl.

models) by Fabian Gomez. The majority of the breakout session time and discussion was dedicated to reviewing and considering demonstration projects (presentation[26]).

Current status

- Long history of working across LOs with IEA; CEFI builds on existing capacity, partnerships, and projects.
- 20+ demonstration projects include many existing efforts that could be enhanced by CEFI.
- Aspiring projects to meet emerging questions from managers (e.g., *where have all the coastal pelagics gone?*).
- Number of informal working groups making progress; still working on hires and formal DSTs.
- AOML has a pilot down-scaled MOM6 ocean model (NWA12) with long-term physical projections.

What is useful and achievable?

- Use Ecosystem Status Reports (ESRs) to start communicating climate issues and impacts to managers
- Important to focus on frameworks/applications that can be translated for other questions/species
    - Use MSEs and scenario planning for developing harvest strategies that are robust to climate change.
    - Focus on region-specific issues like coral health, harmful algal blooms (HABs), coastal pelagics, and sargassum.
    - Address the unique challenges and opportunities in the SE region, including the diverse ongoing and aspiring projects.
- Forage species (shrimp, menhaden) that are the best candidates for tactical advice
    - "Shrimp Futures" integrate climate-enhanced information on environmental drivers, storms, and infrastructure.
- Reduce uncertainty in stock assessment projections by using nowcasts/short-term forecasts of recruitment based on physical variables.
- Use the GoM-CLIM Ecospace Model to project climate "winners and losers;" workflow developed to integrate MOM6 outputs as environmental drivers in ecosystem models.

Questions, suggestions, challenges, and opportunities for moving forward

- Challenges
    - Biological: Tropical ecosystems and diverse fisheries. The lack of data and too much complexity make it difficult to focus on deterministic links. Instead, focus on managing through uncertainty.
    - Management: SE covers three regions and HMS. How do we distribute projects

[26] The slide presentation is available on the NOAA internal network at https://docs.google.com/presentation/d/1lZNS_IypRcXHBGb_rB50P-3u0mcS8k4NxtlXm3lOO50.

across regions and across NOAA priorities (fish, protected resources, habitats)?
    - Trade-off between investing in predictive modeling vs. data collection to tell us what is going on right now.
- What is needed?
    - Collaborations across agencies both during and after CEFI
    - Basic data collection for physical models and biology/ecology
        - For example, the need for consistent surveys in the North and South as species move

Alaska (AK)[27]

The session was facilitated by Kirstin Holsman and Kris Holderied and had 29 people participate through a combination of in-person and virtual (remote) means.

Current status

- Current operational products that include climate change information:
    - AK: IEA, Resource Ecology and Fisheries Management (REFM), Alaska Fisheries Science Center (AFSC), and ESRs have been supporting operational climate decision support tools and advice developed during recent research projects including:
        - Regional ocean modeling system with nutrients, phytoplankton, and zooplankton (ROMSNPZ) bi-annually updated hindcasts and 9-month forecasts (Eastern Bering Sea (EBS)).
        - ESR cold pool indices based on Bering10K ROMSNPZ.
        - ESR pH indices based on Bering10K ROMSNPZ.
        - Climate-enhanced multispecies stock assessment model (e.g. CEATTLE) with climate linked growth, mortality, and recruitment and ensemble projections at +2, +10, and + 50 years under high and low warming.
        - ESR for EBS includes CEATTLE prey consumed, consumption demand, and predation/mortality indices since 2016.
        - ESR for the Gulf of Alaska (GOA) includes CEATTLE prey consumed, consumption demand, and predation/mortality indices since 2018.
- Global climate models and information have been used for two species attribution studies to relate recent collapses to climate change.
    - The recent crab rebuilding plan includes climate attribution of recent crab collapse.
    - Cod collapse in the GOA.
- 82+ AFSC potential projects have been identified as possible candidates for support with CEFI, of which ~25 are at readiness level (RL) 7 or above. NOS has additionally identified 10 potential projects. The Marine Mammal Laboratory (MML) has an additional 11 identified.

[27] The slide presentation is available on the NOAA internal network at https://drive.google.com/file/d/1wLG1wPntRna2iof_OrsaSB-SgpEYP4R0. For external access, please contact the editors of this document.

    - These do not include on-going scoping discussions that have identified multiple additional co-management and food security and sovereignty projects, Alaska Regional Office (AKRO) potential projects, nor lists being generated by external partners.
    - Engagement and collaboration for project prioritization beginning with existing networks and partnerships and building out is slated for May and June 2024.
    - June 2024 Climate Scenarios Workshop is expected to identify key needs and priorities to inform the project list.
- Discussions during the breakout sessions identified a key need to evaluate multiple questions around recent collapses of Chinook and Chum salmon populations (as well as concomitant record high returns of Bristol Bay sockeye salmon). The Alaska CEFI/Climate Team (ACT) is still scoping existing products at AFSC that could be enhanced with MOM6 output.
- Two permanent NMFS hires are complete: OAR bridge (Kearney) multispecies MSE stock assessment coordinator) and marine mammal/protected species coordinator (Liz McHuron); 1 remaining permanent hire is pending (offered).
- NOS/NCCOS: 24-year Cook Inlet hindcast was completed using the Cook Inlet Operational Forecast System (CIOFS) model configuration, with a performance evaluation report. FY24: test alternate freshwater forcing for resource management needs and implement trajectory tools.
- Two NOS CEFI full-time equivalents (FTEs), one AK oceanographer (Holderied). Five contractors are being hired for national support.

What is useful and achievable?

- Identify key questions that will focus efforts within CEFI (cannot do everything)
- Improve how we more routinely bridge management needs (within/across LOs)
- Need to leverage cross-NOAA capacity to more effectively accomplish CEFI goals
- Build on pilot projects and relationships that already exist and identify synergies between existing efforts
- Establish processes for identifying use cases, figuring out the ocean parameters needed to answer the questions, and identifying the ability of the model to produce the needed parameters.
- Communicate with NPFMC on CEFI immediately, explaining how existing regional efforts fit into the CEFI structure and that it is a national program
- Partnering: For example, NOS/NCCOS Cook Inlet efforts to develop and validate CEFI-relevant ocean model products (hindcasts, visualization tools) with regional partners

Questions, suggestions, challenges, and opportunities for moving forward

- Challenges
    - Communication gaps: Need to improve communication on multiple levels between modelers and decision support product developers; with Councils and other management groups to identify priority needs and refine advice services; with communities, and so on.
    - Collaboration: How do we use CEFI to work together effectively on emerging

topics that cross NOAA LO missions, nearshore/shelf domains, and across regions (i.e., salmon, aquaculture, HABs)?

- Needs
    - Mechanisms to enhance routine communication and leverage existing forums as possible
    - Routine integration of observations from multiple sources for model calibration/validation
    - Clarify CEFI data portal services and other model output data services (IOOS Regional Associations?)
    - Frame products in response to community needs/concerns to support adaptation

Pacific Islands[28]

The Pacific Islands break-out session included 14 in-person participants and 11 remote participants (joining from Hawaii and American Samoa).

Current status

- Key efforts being built upon regarding CEFI pilots or others:
    - Examples: EBFM efforts (e.g., EBFM workshop with Councils, Pacific Islands Regional Office (PIRO)/Pacific Islands Fishery Science Center (PIFSC)), Stock Assessment and Fishery Evaluation (SAFE) reports, Hawaii Integrated Ecosystem Assessment, regional ocean modeling system (ROMS) modeling (University of Hawaii), socio-cultural monitoring, and so on.
- Engagement with decision-makers/stakeholders
    - We have had some interactions back-and-forth with the Regional Office (RO) on priorities (and some general discussion with the Council)
- Engagement with other partners
    - Particularly with University of Hawaii laboratories (physical and biogeochemical (BGC) modeling; impacts on coral and human communities)
- Staffing capacity**:** PIFSC CEFI positions (4) in place and PIRO liaison with the Council to be hired
- Initial discussion between the Science Center and RO: Development of targeted questions and discussions on overlap with CEFI and refinement of goals:
    - Future distributions
    - Climate change impacts on health, distribution, and extinction risk of protected species
    - Climate influence on essential fish habitat (designation, revision, and threats to current areas)
    - As part of the processes, include indigenous knowledge
    - Effects on Pacific Island human communities (e.g., resource use, cultural connections, etc.)

[28] The slide presentation is available on the NOAA internal network at https://drive.google.com/file/d/1G65NMU0zGppHBHSXhrMuFyOAgj9aBBpK. For external access, please contact the editors of this document.

    - Improved understanding on how to support the industry and seafood sector in the face of climate change (e.g., trip distance, price and freshness of fish, fishing pressure)

What is useful and achievable?

- Four demonstration projects under development/consideration (that address RO needs to varying extents):
    - MOM6 downscaling: foundation for continued progress but will get started with other resources
    - Central North Pacific Ecosystem Modeling: changes in ecological production (at two spatial scales)
    - Modeling catch rates using ensemble-boosted regression trees: changes in distribution of species/fleet interactions
    - Social and human dimensions: assessing priorities for human communities and modeling of the economic consequences of climate change on the fleet
- <u>Some key points for our region</u>:
    - We can make some immediate progress (using existing ROMS simulations and global models).
    - Relationships across domains (land, nearshore, and oceanic) are important to resolve.
    - We need to continue to engage with our staff and territorial partners.

Questions, suggestions, challenges, and opportunities for moving forward

- Challenges:
    - Jurisdiction is big. We are inherently missing a large swath of the Pacific Islands Region at the onset of CEFI.
    - Unique biogeophysical setting of the Hawaiian islands: coastal process, indigenous communities, and management landscape (i.e., most economically important fisheries are high seas).
    - Human dimensions: knowing the specific question that is most pressing for local communities and having the data to drive engagement.
    - Management needs to include non-CEFI efforts, such as sea level rise, coastal erosion, and so forth.
- Opportunities:
    - Leveraging existing science and management efforts and relationships, increased community awareness, changing conditions, and overall collective motivation to understand climate impacts marine and human communities.
- Questions:
    - Strong emphasis on the communication of CEFI products and efforts during yesterday's discussion. Will this be on the regions to take this on (including funding), or will there be national coordination?

Great Lakes[29]

The session was facilitated by Joe Langan, and 10 people participated through a combination of in-person and virtual (remote) means. Background information was presented on the major drivers of change and how resources are managed. Much of the focus of change in the region has historically been on invasive species. However, the region is also experiencing issues similar to the other CEFI regions. Management of resources is done through lake-specific committees that are composed of state/provincial/Tribal entities. The DST for the GL is composed of modelers and a stakeholder engagement specialist. Meetings with regional partners/managers to inform them about CEFI and understand management needs are ongoing and a priority.

Current status

- History of successful "as needed" collaborations between NOAA and other agencies
- Preliminary DST assembled modelers and a stakeholder engagement specialist
    - Building out extended team
- Two NOAA FTEs hired
- MOM6 GL implementation in "engineering phase:" Running 5 disconnected lakes now but working on hydraulic control for Niagara falls and water flowing out of the system via St. Lawrence Seaway
- Developing products in parallel to MOM6 work using existing modeling platforms
- Prioritizing engagement with regional partners/managers to engage them in CEFI and understand their greatest needs
    - Meetings ongoing

What is useful and achievable?

- MOM6 implementation for the Great Lakes and comparisons to existing Finite Volume Community Ocean Model (FVCOM) configurations
- Climate-informed projections of future ecosystem conditions
    - Ecosystem models (Atlantis)
    - Projections of habitat suitability or productivity for fish populations of interest
- Identifying regional product priorities with engaged partners and what capacity is needed
- Example: "Plug in" climate projections to United States Geological Survey (USGS) Coregonine Restoration Framework
- Develop regional/binational awareness of CEFI

Questions, suggestions, challenges, and opportunities for moving forward

- Challenges
    - Unique modeling (MOM6) challenges in Great Lakes
    - Freshwater dynamics are different: vertical mixing, ice, river inflows and outflows
    - Five connected lakes with realistic water levels and flow velocities
    - Importing benthic ecosystem capabilities for use with MOM6/COBALT (mussels)

[29] The slide presentation is available on the NOAA internal network at https://drive.google.com/file/d/12WLrcaHORh7Oq2fiCSHl0_kMlR01W7iA. For external access, please contact the editors of this document.

    - Consistent collaboration with regional partners is essential to identify needs and produce products
    - Lack of observations: biological and physical
- Opportunities
    - Leverage the capacity and funding of other agencies
    - Regional collaboration already a successful model to tap into
- Questions
    - What are the on-ramps for uptake into management?

Component Breakout Groups

Status, plans, and next steps

In the afternoon of Day 2 of the Summit, participants divided again into breakout groups for the 4 components of the CEFI System: regional ocean modeling, DSTs, data portal, and research and observations. The purpose of the working session was to identify the most important activities per component to achieve over the next three years and the best approach for success. Each of the component breakout groups were asked to discuss:

- Current status of the component, including the structure, process, and existing work
- Key issues, questions, suggestions, and opportunities
- Updates and next steps for build-out (~1-year outlook)

For each of the component teams, a brief synopsis of key points and findings is listed below.

Regional Ocean Modeling[30]

The regional ocean modeling breakout group was led by Charlie Stock (Geophysical Fluid Dynamics Laboratory, OAR), and the discussion of the near-term issues and opportunities that were discussed focused on two main themes: (1) coordination and capacity-building and (2) technical aspects of the component.

Coordination and capacity building:

- Formalizing Regional Ocean Modeling Teams and roles
    - Establish coordinating lead(s)
    - Basic coverage across all regions, waiting on co-development partner news
    - Data portal liaison/contributions
    - FSC (and NCCOS) modelers/liaisons
    - Establishing responsibilities by product
    - Entrainment of NOS nowcast/forecast and estuarine experts through initial high priority case studies or recently funded projects
- National coordination (e.g., consistent protocols for model products)
- Useful and achievable

[30] The slide presentation is available on the NOAA internal network at https://drive.google.com/file/d/1bstO0GKPsToraPgefuOPphpMPww7a_mo. For external access, please contact the editors of this document.

Technical aspects:

- Diagnostics: What do we need to add for high priority applications?
- GitHub and the co-development processes: building the plane as we fly it
- A pathway to reliable delivery
- High performance computing (HPC) onboarding and resources (we are already using more than we have)

In terms of the build-out plan and key next steps over the next year, the deliverables vary by region in accordance with published timelines (Figure 4) and remain achievable if it is accepted that the models must be useful but not perfect. An important point made was that the more the Regional Ocean Modeling Teams know about the specific applications that the models will be used in, the better the teams can ensure that models meet application needs. This will require ongoing communication with the regional DSTs to discuss applications and needs and is also contingent on the availability of HPC resources.

Data Portal and Information Hub[31]

The data portal breakout group was led by Mike Alexander (Physical Sciences Laboratory, OAR). The Data Portal team first met with the decision support component breakout group to better understand their needs. The rest of the breakout session for the Data Portal team focused on discussing the variety of possible products, datasets, and information to host on the data portal and/or information hub and priorities for the data portal depending on key users and existing resources to leverage and learn from. A summary of the main points of discussion from the breakout session is below.

- Is the data portal intended to be the main way that regional ocean modeling data are served to the DSTs?
    - This is still to be determined and will not be the same for all regions. There might be standardized data outputs available across regions. Other caveats include offline model runs (these would need to be uploaded to the data portal), and some products might be shared when final rather than in raw data form.
- Training sessions and tutorials for users of the data hosted on the portal would be helpful.
- To inform what would be the most useful parameters, outputs, scales, and datasets to host on the data portal for the DSTs, a ”wish list” should be started as a key next step. It was also discussed that it would be helpful for the regional DSTs to identify the top priority products that could be served by the data portal.
- Metadata and other information would be helpful to have for datasets on the data portal.
- A working group could be established to develop cookbooks for analyses.
- Bias-corrected outputs would be helpful to provide on the data portal.

[31] The slide presentation is available on the NOAA internal network at https://drive.google.com/file/d/1Qr8EBsM3u5lbw7bEPyN8pOzMw7nciaz4. For external access, please contact the editors of this document.

- Further discussion should be had on when to serve MOM6 outputs (e.g., beta runs, when a paper is submitted, when a paper is published, etc.)
- Learning from existing data portals efforts such as IOOS data is advantageous to learn best practices.
- Target users of the data portal include:
    - Scientists (internal to NOAA, academia, developers)
    - Ecosystem modelers
    - Stock assessors
    - Resource managers (federal, state, Councils, etc.)
    - Tribal entities
    - General public

Regional Decision Support Teams[32]

The decision support team breakout group brought together teams from across all six regions to discuss challenges, solutions, needs, and to learn from each other. The discussion was led by Kirstin Holsman (AFSC, NMFS) and Vince Saba (NEFSC, NMFS). A summary of the rich cross-regional discussion is below.

Engagement with partners and users is key for CEFI

- Partners should be involved from the onset and throughout the whole process. Partners are the key to building relationships for product lines.
- Existing processes and frameworks should be leveraged (e.g., IEA program, EBFM, ESRs, ESPs). Given the overlap between many groups involved in each of these and CEFI, working toward sharing capacity would be helpful.
- Existing national-level NOAA working groups or teams can also be utilized for cross-regional needs. For example, the NMFS Interoffice Climate Action Team (NICAT) has representatives from each of the NMFS Headquarters offices (e.g., OSF, Habitat, Aquaculture, OPR) and has gathered information from ROs regarding science needs and feedback to provide information to the DSTs.
- Communication is also key to engagement with partners and users of CEFI. Personal stories and concrete examples are important for sharing impacts and improving uptake.

How to get started now while waiting for MOM6 products to be in hand?

- DSTs could start with engagement and partnership-building.
- DSTs can also start with products that use historical observations or other models, and the MOM6 data can be substituted in when ready.
- Even early products from MOM6 hindcasts can help start the validation process.

Next steps for DSTs

- The National DST can help coordinate the formation of cross-regional thematic teams

[32] The slide presentation is available on the NOAA internal network at https://drive.google.com/file/d/1Ff8D2Bt1LSXGzESA8ktP8aru74H-6nuU. For external access, please contact the editors of this document.

(e.g., form a group of all of the CEFI regional social science modelers) and collation of existing teams (e.g., MSE working group, national ecosystem modeling working group) to work with regional DSTs.
- DSTs should coordinate with the Data Portal Team to communicate the needs hosted and accessible on the data portal.
- DSTs should track the status of engagement with partners toward completing the project scoping phase and identifying prioritized projects.

Observations and Research[33]

The observations and research breakout group consisted of about a dozen people and was led by Ryan Rykaczewski (PIFSC, NMFS). The group discussed how to identify key research and observation needs, recognizing that these gaps will be regionally specific. The CEFI System presents an opportunity to highlight the "value chain" of marine ecosystem observations. That is, the development of the CEFI System will be the framework that connects ocean observations and research with the decision tools used to improve ecosystem management. A summary of the main points of discussion from the breakout session is below.

Key issues, questions, suggestions, and opportunities

- The observations and research team needs to work with modeling teams to conduct sensitivity experiments to identify key needs. Observing System Simulation Experiments and Observing System Experiments may be efforts pursued collaboratively with modelers with the goal of developing an optimal coastal observing backbone, providing key data for model assessment and initialization.
- It is easier to discuss the needs for validation of physical and biogeochemical models, but the needs for ecological models must be considered as well. This can be done via process studies and fundamental research (e.g., ecological thresholds and tipping points).
- It is critical to show the use cases of observational systems and their products; we need to show potential returns on investment in the CEFI framework.
    - One example that was shared of a similar effort to recognize the value of observations and research to the broader effort was National Aeronautics and Space Administration's (NASA's) Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) program, which is supporting research on ecosystem dynamics so that the value of PACE data is better recognized.
- There was recognition that ocean color is the only synoptic observation of the food web. The utility of such products should be emphasized to NESDIS colleagues.
- While new research and observations may be more exciting, the group also sees a need for a data-management framework that can streamline the flow of observations between

[33] The slide presentation is available on the NOAA internal network at https://drive.google.com/file/d/1cHy02VFb7AoTZklEiD_uKYUrjtN2G7Lx. For external access, please contact the editors of this document.

observational systems and modelers. This may be more than the Observational and Research Team is able to address.

Updates and next steps for build-out (~1-year outlook):

- Receive and digest feedback from regional groups on prioritized observations and research gaps. This includes modeling groups (e.g., what observations are needed and can sensitivity analyses be conducted) for model validation, improvement, and for process understanding.
- Achievable next steps (in order):
    - A common need identified in discussions is reliable satellite data that can be compared against model output. A priority is ocean color data in coastal waters of sufficient length to assess interannual-to-decadal scale variability in phytoplankton concentration. The Observations and Research Team should advocate for:
        - Production satellite data products (e.g., anomalies of sea surface salinity (SSS), sea surface temperature (SST), chlorophyll concentration, etc.) on horizontal grids that match CEFI regional models, facilitating comparisons.
        - For model assessment such as (a) case-2 water product for chlorophyll concentration in coastal waters and (b) sensor-agnostic, long-term chlorophyll record.
- Hold a workshop with representatives from CEFI teams, IOOS, Global Ocean Monitoring and Observing (GOMO), Ocean Acidification Program (OAP), Essential Data Acquisition (EDA), and Strategic Initiatives to discuss what the groups need and what can be done to move CEFI forward (e.g., types, frequency, location). This can help build a culture of cooperation around CEFI and the "need to know" urgency, and this is the "science on a mission" opportunity of ecosystem and fisheries research.
    - Preceding a workshop: work with regional teams to review observational priorities to attempt to focus the discussion on some common needs (while still appreciating that details and other parameters will be region-specific).
    - Consider limiting the workshop to about 20 participants, emphasizing the requirements for improvement of the CEFI system rather than for ocean and climate monitoring more broadly.

Recommendations

The breakout group sessions resulted in rich discussions that allowed the regional teams and component teams to dive deeper into specific goals, challenges, and approaches. General recommendations for a successful build-out of the CEFI system are outlined below, followed by recommendations for each component of CEFI.

General recommendations

- **Strengthen the collaborative mindset.** The scale of collaboration required by CEFI is unprecedented within NOAA and requires multiple NOAA LOs working together not only

within the planning process, producing climate-informed models, products, and advice but also on efforts to show the utility of CEFI and the need for sustained funding in regular appropriations and budget initiatives. The power of CEFI lies in the aspect that the serial receivers of information (e.g., fishery management Councils, managers, decision-makers) come in at the end of other processes, whereas with CEFI they are included at the beginning, and feedback loops exist at every step of the system. As such, having proponents of CEFI at every step in the process, internal and external to the agency, with a unified voice that speaks to the benefits of CEFI is paramount to the success and sustainment of the initiative.

- **Information does not need to be perfect to be usable, but be honest and open about uncertainties.** As many participants pointed out, any predictive information is better than no information at all. Uncertainties with predictions will exist, but being honest about the uncertainties and communicating them in an explicit way that users will understand are necessary. It was also noted that while quantitative explanations of uncertainty are useful, managers often operate with qualitative descriptors (e.g., tiers, bins, etc.), and uncertainty can be described in these ways as well. Visualizing uncertainty is also critical, and the modeling and Data Portal Teams will continue to work together on ways to visualize uncertainty.
- **Areas of greatest need should be considered at every step.** The impacts of climate change on marine ecosystems will vary across regions, sectors, and communities. The NOAA CEFI System is designed and needed to provide forward looking information to a broad range of decision-makers and the general public. Considerations of areas in greatest need should be incorporated into the processes, products, and advice pathways of CEFI based on engagement and codevelopment with target sectors and communities.
- **Document success stories.** Each region should have a success story that can serve as a key example in demonstrating the utility and importance of CEFI. These success stories can be leveraged by “champions” outside of NOAA that can show how CEFI was helpful and why it is important to sustain.
- **Be specific on who will be the users of the information**. While communicating the purpose and impacts of CEFI, it will be advantageous to communicate with specific examples of decision-makers and stakeholders, rather than using those generic terms. For example, “mariculture farms in Alaska” is a more compelling way to communicate who will be using a specific product or line of advice than referring to them as “stakeholders.”

Regional Ocean Modeling

- Regional Ocean Modeling Teams should work with the DSTs to understand the critical parameters needed for the models and the specific context the models would be applied toward.

Data Portal and Information Hub

- It will be necessary to prioritize what data, products, and resources are critical to serve through the data portal versus what should remain external or achieved via other sources.
- The Data Portal Team should work with the DSTs to discuss and determine how to make the portal user-friendly and useful for the correct audiences.
- The Data Portal Team should work with the Regional Ocean Modeling Teams to discuss and determine how to visualize and communicate uncertainty.
- The Data Portal Team should work with NOS in the near future regarding their model outputs and if and how they will be hosted on the CEFI Data Portal.
- The Data Portal and information hub should provide standard bias correction guidance.
- The Data Portal Team and Regional Ocean Modeling Teams should jointly develop a naming system for metadata on the data portal (e.g., timestamp, version number, etc.)
- Once the data portal is publicly available and the users are better understood, tutorials on how to use the data as a form of outreach were recommended.
- To communicate uncertainties, a user-friendly option could include having a question mark icon (“?”) that users can click that explains how projections versus predictions works or other useful explanations.

Regional DSTs

- DSTs can continue modeling efforts and set up the systems and product lines to be ready for MOM6 outputs when they are available in the region.
- Coordinating the review of DST tools and products by the SSCs of the Regional Fishery Management Councils, among and/or across regions, is recommended to assist with the review and uptake of DST-provided scientific advice in the management process.
- Engagement with users of DST-produced tools will be necessary to understand if users have the capacity and knowledge to put the tools to use and absorb the information. If not, basic training and/or tutorials with new decision-making tools may be needed.
- Topical teams across DSTs should be formed, consisting of key DST positions from across the regions (e.g., Social Science Modeling Topical Team, Climate-Enhanced Stock Assessment Topical Team, etc.) to act as a community of practice and discuss key challenges or issues.

Observations and Research

- CEFI’s National Observations and Research Team (NORT) should develop a list of specific research and observation needs and use it to communicate with other offices and programs in NOAA that fund research to leverage funding opportunities and obtain much-needed data.
- Various sources of data already being collected by NOAA should be leveraged for CEFI, for example, physical observation data collected during fishery-independent surveys and data collected by the IRA-funded Strategic Initiatives. Processes to obtain and use these data may need to be formalized.

- Engagement with agencies outside of NOAA (e.g., IOOS regional associations, NASA, National Science Foundation (NSF), etc.). will be important to leverage funding and data collection efforts. An interagency workshop would be useful to communicate and educate external partner agencies about CEFI and discuss how to leverage each other's efforts.

Summit Summary: *Session 3*

Looking forward: key approaches to success[34]

The final session of the CEFI Summit focused on affirming what CEFI is trying to achieve, the key steps required for success, and other opportunities to increase system-wide coordination. Roger Griffis, Climate Change Coordinator for NMFS Office of Science and Technology, reminded the group of the need that CEFI will fulfill—a transformed science enterprise to deliver information and advice to decision-makers that focuses on what is changing, what future changes may be, what the risks are, and the best options for action and response. The core customers of CEFI were also reiterated: resource managers, in the areas of fisheries, protected species, protected areas, habitat, and aquaculture; affected communities; and other ocean use sectors (e.g., offshore wind energy).

The audience was also reminded of the strong foundation CEFI is being built on, and the strong capabilities that exist nationwide. There have been historic advances in the climate-ocean modeling system already that have provided robust outlooks across time and spatial scales, interdisciplinary pilot projects in four regions (ACLIM, GoACLIM, NCLIM, Future Seas; Appendix E), and advances in information and approaches to climate-informed decision-making and adaptation nation-wide and internationally. This strong foundation also means that there is much to build on.

Discussions over the 2.5-day Summit resulted in numerous next steps that could be taken at the regional and national levels, by the different regional teams, component teams, coordination teams, and users and partners of CEFI, but can be categorized into three main categories:

- *Communication*: for awareness, support, and input
- *Engagement*: with target audiences and users
- *Demonstration*: finalize and implement projects to demonstrate utility of the CEFI System, products, and services

Moving forward, there are clear opportunities to advance implementation of the CEFI System, including expanding collaborations within NOAA such as efforts by protected resources funded projects,[35] the projects being undertaken by the regional fishery management councils to

[34] The slide presentation is available on the NOAA internal network at https://drive.google.com/file/d/1XZ-F_fsN4o0CPxcegWFwCtI4J-SEhpef. For external access, please contact the editors of this document.
[35] NOAA Fisheries. 2024. Data Modernization Efforts for NOAA Fisheries. [Available at https://www.fisheries.noaa.gov/science-data/data-modernization-efforts-noaa-fisheries: accessed 16 October 2024.]

advance climate-informed fisheries management,[36] and other investments in observations, data management, and social sciences.[37]

This session also included reflections on what success for CEFI would look like, which were summarized into several key undertakings for the CEFI community to embark on:

- Shared sense of destiny
- Shared commitment to climate-informed decision-making
- Climate-informed decision-making
- Delivery of useful information and advice for climate-informed decision-making
- Demonstration of the utility of climate-informed advice
- Collaborative development of climate-informed advice
- Effective communication and engagement
- Collaboration and integration
- Strong partnerships and trust

To close out this last session of the Summit, another set of panelists was invited to provide their perspectives on what excites them about CEFI, questions or concerns they have, and their ideas on key next steps for success. A summary of the panelists' remarks is below.

Panel 3: Discussion on Looking Forward and Key Approaches to Success

Panelists with a variety of experiences engaging with CEFI were asked to provide reflections on directions, approaches, and key next steps to a successful build-out of the CEFI System based on the Summit.

Jon Hare
Northeast Fisheries Science Center, NMFS

- As CEFI moves forward, we need to remember to **celebrate our wins**.
- The scale of collaboration required to implement CEFI is unprecedented within NOAA. The initiative aims to build a new type of system that others will want to participate in or replicate in their own organizations. To do this, we need to **continue to strengthen our collaborative mindset**.
- CEFI needs to remain **pragmatic**. The short timeline means that we need to focus on demonstrating value now, opening opportunities to offer more value in the future.

[36]NOAA Fisheries. 2024. Biden-Harris Administration Awards $20 Million for Regional Fishery Management Council Projects as Part of Investing In America Agenda. [Available at https://www.fisheries.noaa.gov/media-release/biden-harris-administration-awards-20-million-regional-fishery-management-council: accessed 16 October 2024.]
[37] NOAA Fisheries. 2024. Essential Data Acquisition Efforts Under the Inflation Reduction Act. [Available at https://www.fisheries.noaa.gov/science-data/essential-data-acquisition-efforts-under-inflation-reduction-act: accessed 16 October 2024.]

- This Summit has outlined the importance of **being user-centric and product-focused**, working with users early and often to design and provide products that are highly impactful to them. Those products and impacts will demonstrate CEFI's value.
- CEFI interacts with a range of stakeholders and communities. It is important to **build and maintain those connections**. Those communities are constituents of policymakers, and if they see benefits, they will inform their policymakers, who will then advocate for CEFI.
- In order to succeed, CEFI needs to maintain a **perseverance mindset**, reframing challenges as opportunities to do things with CEFI that have never been done before.

Liz Drenkard
Geophysical Fluid Dynamics Laboratory, NOAA Office of Oceanic and Atmospheric Research

- CEFI provides a **valuable observations push**. Data gathered as part of the initiative can also help validate and refine other models outside of the regional MOM6 models.
- In order to meet the 2025 deadline that has been discussed at the Summit, CEFI will need **good branding** to advocate effectively for funding. Language and messaging need to be consistent across a wide, cross-regional initiative.
- CEFI needs to be mindful and **engage a variety of voices** when gathering input at every stage of the process.
- CEFI provides exciting **opportunities for modelers to engage strategically**. Modelers can often be siloed, so this is a good reminder of the value of their work to their users.

John Cortinas
NOAA Office of Oceanic and Atmospheric Research

- The level of engagement and enthusiasm at this Summit speaks highly of NOAA's capabilities and ability to come together across the agency.
- NOAA LOs typically operate independently when developing budget requests and meeting with Congress. CEFI demonstrates the value of cross-LO integration, and that should carry out to developing budget initiatives or meetings on the Hill.

Holden Harris
Southeast Fisheries Science Center, NMFS

- CEFI fulfills NOAA's three pillars of **science, service, and stewardship.** At the same time, the goals of CEFI are unprecedented and ambitious, and this has fostered incredible **collaboration** and palpable **excitement**.
- The CEFI model is relatively top-down. I have concerns that we have been given the directive and resources to build a tool, and after that we have been asked to develop questions and find uses for these down-scaled ocean models.
- Success will look different in different regions. A key question I have asked coming here and through this workshop is: **what is a CEFI success?**
- My interpretation of success is that CEFI delivers **climate and ecosystem information used to inform management decisions.**

- The timeline of CEFI is a challenge. The next step is to identify achievable projects (many of them already under way) and accelerate their implementation. They are very exciting opportunities, and we can make progress on **operationalizing EBM and EBFM**.

Kim Damon-Randall
Office of Protected Resources, NMFS

- Consideration and integration of management needs are important, so a key step is to engage managers early and often.
- Information does not need to be perfect to have utility for managers. It is important for managers to be able to define or explain the levels of uncertainty within that information.
    - The term “advice” sounds very speculative. Managers rely on the best available information to implement laws, which is more than just giving advice.
- Communication and collaboration between regions are paramount to success.
- Demonstrated success of short-term CEFI products can help garner additional funding.
- It is important to consider critical issues such as protected resources, essential fish habitats, and aquaculture when considering CEFI’s engagement and benefits.

Heather Welch
Southwest Fisheries Science Center, NMFS

Below is a series of 5 steps to translate from physics to fisheries management. Typically, individuals work on single steps, so integration is needed to create a whole-process view of the timeline. It will also be important to keep in mind that there will be steps after management uptake in order to continue “winning” and providing deliverables.

1. **Environmental Information Creation.** Observing and modeling environmental information. If this builds on previous efforts, like using pre-existing satellite or in-situ observations, the time to completion can be shortened.
    a. Example: Develop MOM6 modeling capabilities.
2. **Ecological/Socio-economic Information Creation.** Translating environmental data into ecological and socio-economic modeling.
    a. Example: Develop species distribution models.
3. **Management Advice Creation.** Managers will need to help identify which information they need and which they have the capacity to implement, as not all management onramps have equal capacity for information uptake.
    a. Example: Translate the species distribution models into a management trigger for when to close a fishery area.
4. **Operationalization.** Deliver that management advice at a regular frequency.
5. **Management Uptake.** Deliver the advice to managers and incorporate consulting it into the decision-making framework.

Sean Corson
National Centers for Coastal Ocean Science, National Ocean Service

- CEFI will allow for an **enhanced state of readiness**, having an operationalized system that addresses the recurring questions that emerge in the world of ecosystems and fisheries management.
- CEFI is uniquely positioned to **address 3D habitats across space and time** to produce practical results. This is a new area of work, but CEFI is accelerating it.
- One challenge that CEFI will need to address is that it **works across landscape and seascape scales, spanning local, state, federal, and Tribal governments**. Administrative and institutional systems are not designed for that kind of integration, but those intersections will be where CEFI can be most effective. This will require grace, humility, objectivity, and both philosophical and tactical approaches.
- **CEFI's messaging should focus on people**, using terminology the public will understand. We should use examples; rather than in terms of "decision-makers" or "stakeholders," say "mariculture farms in Alaska." It is easier to understand and more compelling.
    - Above all, we are civil servants. Our job is to deliver information to the whole public, so we need to remember our diverse usership when communicating.

Audience Q&A

1. What would a future for CEFI look like without further funding going forward?
    - This is a major challenge, but there are ways to mitigate it. Some of these are already ongoing projects within LOs, so those should be continued. There are opportunities to look at base funding in the FSCs to see if more support could be provided. It will be important to communicate that the current investment is for speed and efficiency. In order to deliver more thoroughly at short deadlines, more investment will be needed. A key question will be to examine whether the current speed and investment levels are sustainable, or if there are areas where cutting back will be necessary.
    - Regardless of whether the funding is sustained, the cross-LO collaboration from this initiative is still highly beneficial for all of NOAA.
2. Who are you including in meetings when advocating for or communicating about CEFI? Those not in the room will not share the sense of understanding that we experienced at this Summit. It is important to know who you are talking to, who you wish was there, and who your skeptical audience members will be. Attendees at this Summit have shown their willingness to engage with their audiences, and several have offered to be ambassadors for CEFI.
3. What connectivity has happened with mCDR?
    - The relationship with CEFI and mCDR is not yet explicit, but there are overlapping scientists working in these areas, especially marine spatial planning and modeling work. The International Council for the Exploration of the Sea (ICES) workshop this fall is an opportunity for greater connectivity. The NCCOS spatial team has been having conversations about mCDR's resolution needs, and MOM6 has greater resolution. So, how can we get to the resolutions and timescales needed for marine spatial planning?

4. It is important to consider what touchpoints with federal agencies we have not discussed yet. What can we do for different agencies, and how can they contribute? Should they be partners in going to Congress to present the importance of this work?
5. How do we balance the messaging around uncertainty?
    - By focusing on what CEFI *can* tell users, that is, we cannot predict that a crab crash will happen next year, but we can tell you that the frequency of instances that cause crab crashes will increase.
    - It is important to set expectations ahead of time, so users understand that it might be cold when we said it would be warm, but that in the long term the outlook will be aligned and consistent.
6. CEFI should put together an inventory of existing pilot projects and regional prospective projects.

Next Steps and Closing Remarks

Key next steps

While the themes of the post-Summit actions can be categorized into communication, engagement, and demonstration, participants identified a core set of more specific next steps for each of these efforts. These next steps are summarized below, and the brackets following each action indicate to which theme of action (i.e., communication, engagement, demonstration) the step corresponds.

- The DSTs will engage with the users/partners at ROs and finalize the priority list of key demonstration projects to demonstrate the utility of the CEFI system and products. *[Engagement, Demonstration]*
    - These lists will be used to keep an inventory of projects, including the CEFI pilot projects, and can be continuously updated.

- Topical teams across DSTs will be formed, consisting of key DST positions from across the regions (e.g., Social Science Modeling Topical Team, Climate-Enhanced Stock Assessment Topical Team, etc.) to share lessons learned, present progress updates, and discuss key challenges or issues. *[Engagement, Communication]*

- Success stories in each region will be highlighted as they evolve, from a combination of dissemination methods (e.g., announcements to users such as Regional Fishery Management Councils, communications stories to be posted on the CEFI webpage, etc.). *[Engagement, Communication]*

- The NOAA LOs involved in CEFI will develop a joint engagement strategy for Congressional outreach and to form budget initiatives. *[Engagement, Communication]*

- To leverage the unprecedented funding that the IRA has provided NOAA to work toward climate-readiness and increase the impact of the funds to the greatest extent possible, CEFI teams, where appropriate, will engage with other IRA-funded initiatives, such as

the investments for advanced technologies under the EDA component,[38] the projects for modernizing protected species management that connect to CEFI,[39] and the projects being undertaken by the Regional Fishery Management Councils for climate-ready fisheries management.[40] *[Engagement, Demonstration]*

Engagement strategies

Engagement with partners, stakeholders, and users of CEFI is multifaceted, nuanced, and necessary. National-level communication about the CEFI System will need to be tailored to regionally relevant scales, and both internal and external communication still need to happen about what CEFI is and the unique scale of the initiative (i.e., the fact that it is a cross-LO investment that will make more clear the opportunities to invest or leverage other resources). It will also be essential to garner support from key "champions" (e.g., certain stakeholders, Council members) who will be able to communicate with their audiences and constituents how the CEFI demonstration projects are important and useful.

Below are initial lists of various internal and external groups that CEFI should connect with to communicate its products and value and gather interest, support, and feedback.

- Internal
    - NMFS
        - ROs
        - OSF
        - OPR
        - OAQ
    - ONMS
    - Office of Coastal Management
    - National Estuarine Research Reserves
    - U.S. Integrated Ocean Observing System
    - NOAA Climate Program Office
    - NESDIS STAR
    - NCEI
    - BGC Argo Program
    - NMFS EDA groups
        - Integrated West Coast Pelagics Survey

[38] NOAA Fisheries. 2024. Essential Data Acquisition Efforts Under the Inflation Reduction Act. [Available at: https://www.fisheries.noaa.gov/science-data/essential-data-acquisition-efforts-under-inflation-reduction-act: accessed 16 October 2024.]
[39] NOAA Fisheries. 2024. Data Modernization Efforts Under the Inflation Reduction Act. [Available at: https://www.fisheries.noaa.gov/science-data/data-modernization-efforts-under-inflation-reduction-act: accessed 16 October 2024.]
[40] NOAA Fisheries. 2024. Biden-Harris Administration Awards $20 Million for Regional Fishery Management Council Projects as Part of Investing In America Agenda. [Available at: https://www.fisheries.noaa.gov/media-release/biden-harris-administration-awards-20-million-regional-fishery-management-council: accessed 16 October 2024.]

        - Advanced Technology Strategic Initiatives (e.g., Active Acoustics, Passive Acoustics, Remote Sensing, Optics, ‘Omics, Social Science, Uncrewed Systems)
    - Other programs, for example, IEA program, OAP, GOMO Program
- External
    - Congress
    - Other federal government agencies (e.g., NASA, NSF, Department of the Interior, the State Department)
    - Regional Fishery Management Councils
    - Tribes
    - IOOS Regional Associations
    - International bilateral meetings
    - ICES
    - North Pacific Marine Science Organization (PICES)
    - State fishery management
    - U.S. delegation to Food and Agriculture Organization of the United Nations (FAO) meetings
    - Sustainability, Predictability, and Resilience of Marine Ecosystems Program (SUPREME)
    - Department of Fisheries and Oceans Canada
    - U.S. Climate Variability and Predictability (CLIVAR) working groups
    - Constituents/communities in the regions

Closing Remarks

In the final session of the Summit, participants were asked a series of questions (Figure 10) to reflect on the CEFI Summit, open questions that still need to be resolved, and what they were most excited about. Attendees noted that this Summit emphasized the importance of CEFI’s work and its potential impact as an innovative way to approach climate change in marine ecosystems. They highlighted the collaborative nature of the initiative, emphasizing the necessity of the end-to-end approach as well as coordinating on region-specific needs with the users in those areas. They recognized that the next year and a half would be key in establishing the foundational teams and garnering buy-in from external partners as well as internal NOAA leaders. That support would be a key facilitator to the integration CEFI aims to build, making sure the research, models, and decision support fits the needs of CEFI’s end users. As the initiative progresses, there will be more technical questions around specific products and implementation, but regions are already finding solutions to many of those questions as they meet internally and with partners.

Cisco Werner concluded the Summit by stressing that climate change in our marine ecosystems is inevitable but that the difficult part is determining the specifics of ”the inevitable,” hence the vital purpose of CEFI. The Summit closed with a shared enthusiasm and optimism for the integration and acceleration of CEFI.

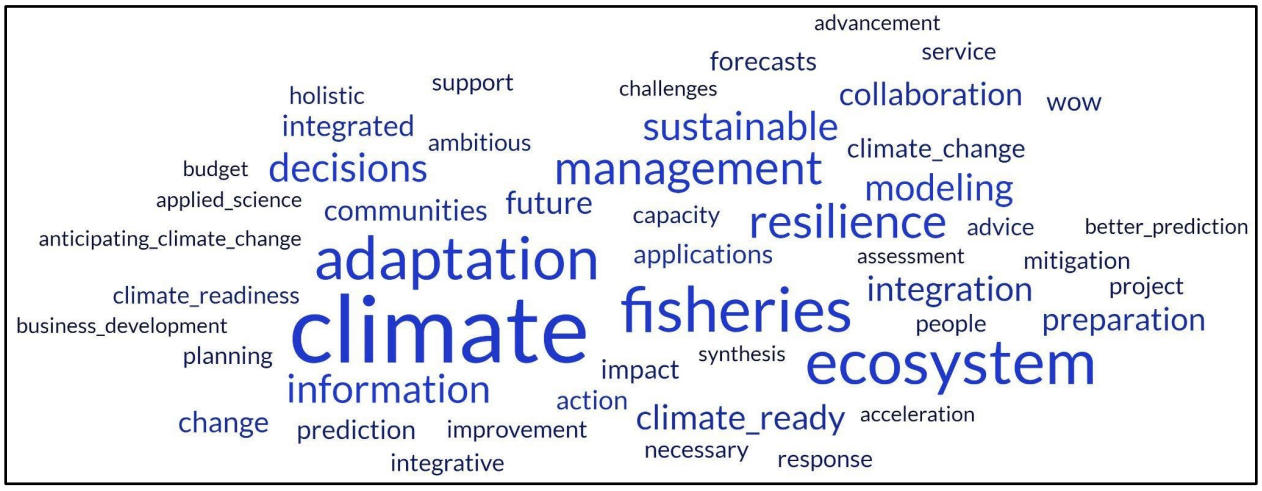

Figure 10: This word cloud is an example of participants' answers to one of the reflection questions asked of Summit participants: "*What 1 to 3 words would you use to describe CEFI?"*

Thank you!

For more information

Visit the CEFI webpage

https://www.fisheries.noaa.gov/topic/climate-change/climate,-ecosystems,-and-fisheries

Visit the CEFI Data Portal

https://psl.noaa.gov/cefi_portal/

Contact Information:

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Regional Decision Support Team Leads:

Northeast:
- Vince Saba (vincent.saba@noaa.gov)
- Scott Large (scott.large@noaa.gov)
- Bethany Williams (bethany.williams@noaa.gov)

West Coast:
- NW: Jameal Samhouri (jameal.samhouri@noaa.gov)
- SW: Mike Jacox (michael.jacox@noaa.gov)

Southeast: Mandy Karnauskas (mandy.karnauskas@noaa.gov)

Alaska: Kirstin Holsman (kirstin.holsman@noaa.gov)

Pacific Islands: Ryan Rykaczewski (ryan.rykaczewski@noaa.gov)

Great Lakes: Joe Langan (joseph.langan@noaa.gov)

Regional Ocean Modeling:

Charlie Stock (charles.stock@noaa.gov)

Data Portal and Information Hub:

Chia-Wei Hsu (chia-wei.hsu@noaa.gov)

Observations and Research:

Ryan Rykaczewski (ryan.rykaczewski@noaa.gov)

Appendices

A. Summit Agenda

CEFI Summit Agenda

May 7-9 2024 | La Jolla, CA

NOAA Southwest Fisheries Science Center

Day 1: *Tuesday, May 7, 2024*

9:00 **Meeting Start** [livestreamed]

9:10 **Opening Remarks (25 min)** [livestreamed]
Set vision, goal, and purpose of the workshop. Provide context for CEFI, including structure and current status.

9:35 **Panel Discussion: Perspectives on Needs and Build-out of the CEFI System** [livestreamed]
Hear perspectives on needs, approaches and buildout of the CEFI Decision Support System to help inform Day 2 breakout sessions

- Panelists:
  - Bill Tweit (WA Dept. of Fish and Game; North Pacific Fisheries Management Council)
  - Meredith Moore (Ocean Conservancy Fisheries Program)
  - Kelly Denit (NMFS Office of Sustainable Fisheries)
  - Kim Damon-Randall (NMFS Office of Protected Resources)
  - Kathy Mills (Gulf of Maine Research Institute)
  - Beth Turner (NOAA Science Advisory Board, Ecosystem Science and Management Working Group)

10:45 ***Break***

11:00 **Introduce component overview sessions** [livestreamed]

11:05 **CEFI Regional Ocean Modeling Component** [livestreamed]
Slides: https://drive.google.com/open?id=18rPj4yIh9h_uZ6ouY5JEu6ZiRSNt0dDn
Provide information on the goal, plan and status of this component of the CEFI System; identify points of discussion for the next couple days, and have a mini working session on the component.

11:50 ***Lunch***

1:00 **CEFI Data Portal Component** [livestreamed]
Slides: https://drive.google.com/open?id=11XUz1flFJcl6MUJS_ovMfpNCR7MkdtTC
Provide information on the goal, plan and status of this component of the CEFI System; identify points of discussion for the next couple days, and have a mini working session on the component.

1:45 CEFI Regional Decision Support Teams [livestreamed]
Slides: https://drive.google.com/open?id=1cBY4y5rRTOPIlgb_TgZadqc4LW8Obf41
Set shared context for this component, help identify points of discussion for the next couple days, and have a mini working session on the component.

2:45 Break

3:00 Observations & Research [livestreamed]
Slides: https://drive.google.com/open?id=1oWn__jcbFM2oONgr8NWatSzNVoTm9N_U
Provide information on the goal, plan and status of this component of the CEFI System; identify points of discussion for the next couple days, and have a mini working session on the component.

3:45 Day 1 Recap and Discussion [livestreamed]
Summarize the day's sessions and provide time for additional feedback and discussion

- Invited Perspectives Discussion
    - V. 'Ram' Ramaswamy (Director, OAR Geophysical Fluid Dynamics Laboratory)
    - Jason Link (Senior Scientist - Ecosystems, NMFS)
    - Rick Methot (Senior Scientist - Stock Assessments, NMFS)
    - Mark Monaco (Senior Scientist - Ecosystems, NOS/NCCOS)

4:50 Meeting Close

5:00 Adjourn

Day 2: *Wednesday, May 8, 2024*

9:00 Meeting Open (15 min) [livestreamed]
Recap Day 1 conversations and review Day 2 agenda, including announcements about materials and breakout session locations.

9:15 Break

9:30 Breakout Session 1: CEFI Regional Teams
Working session to identify (1) the most useful and achievable demonstration projects over the next 3 years and (2) the best approach to get there

- Alaska
- Great Lakes
- Northeast
- Pacific Islands
- Southeast
- West Coast

11:45 Lunch

1:00 Breakout Session 2: CEFI System Components

Working session to identify (1) the most important activities over the next 3 years and (2) the best approach to get there

- Regional Ocean Modeling
- Data Portal
- Regional Decision Support Teams
- Observations & Research

2:30 Break

3:00 Report Out from Breakout Sessions [livestreamed]
Celebrate the wins of the integrative breakout sessions, bring the group back together as a whole, and identify if anything additional needs to be addressed in the final day of the workshop

- Regional Ocean Modeling: https://drive.google.com/open?id=1bstO0GKPsToraPgefuOPphpMPww7a_mo
- Data Portal: https://drive.google.com/open?id=1Qr8EBsM3u5lbw7bEPyN8pOzMw7nciaz4
- Decision Support Teams: https://drive.google.com/open?id=1Ff8D2Bt1LSXGzESA8ktP8aru74H-6nuU
- Observations & Research: https://drive.google.com/open?id=1cHy02VFb7AoTZklEiD_uKYUrjtN2G7Lx

- Alaska: https://drive.google.com/open?id=1wLG1wPntRna2iof_OrsaSB-SgpEYP4R0
- Great Lakes: https://drive.google.com/open?id=12WLrcaHORh7Oq2fiCSHl0_kMlR01W7iA
- Northeast: https://drive.google.com/open?id=1JAlrRwkIi9t2GBiVd8o52Ds0y4kJjKZh
- Pacific Islands: https://drive.google.com/open?id=1G65NMU0zGppHBHSXhrMuFyOAgj9aBBpK
- Southeast: https://drive.google.com/open?id=1-xwglB4tqZaDYKh7uEuRG8L52NHnI1fJ
- West Coast: https://drive.google.com/open?id=12RmizipHG6SVosxH_i4Wp9zUv-F3_ZGo

4:45 Day 2 Recap [livestreamed]
Close out meeting on the same page and prepare for the next day

5:00 Adjourn

Day 3: *Thursday, May 9, 2024*

9:00 Meeting Open [livestreamed]

9:15 Looking Forward: Review 3-year Plan & key next steps [livestreamed]
Slides: https://drive.google.com/open?id=1XZ-F_fsN4o0CPxcegWFwCtI4J-SEhpef
Bring the breakout session discussions into a cross-CEFI presentation around the next 3 years.

10:00 Break

10:30 Looking Forward: Key approaches for success [livestreamed]

Opportunity for input/discussion on next steps and key approaches to building out the CEFI System

- Panelists:
    - Jon Hare (NMFS/NEFSC)
    - Liz Drenkard (OAR/GFDL)
    - John Cortinas (OAR)
    - Holden Harris (NMFS/SEFSC)
    - Kim Damon-Randall (NMFS/OPR)
    - Heather Welch (NMFS/SWFSC)
    - Sean Corson (NOS/NCCOS)

11:45 Meeting Close [livestreamed]

12:00 Adjourn

B. CEFI Summit Attendees

Participants of the CEFI Summit attended either in person or virtually, and are listed in alphabetical order by last name below. Asterisks (*) indicate participants that served as speakers and/or panelists.

*Mike Alexander, OAR PSL
Peter Alsip, OAR GLERL
Clarissa Anderson, Scripps Institution of Oceanography
Kerim Aydin, NMFS AFSC
Molly Baringer, OAR AOML
Lewis Barnett, NMFS
Dan Barrie, OAR CPO
Eric Bayler, NESDIS
Karen Beatty, NMFS OPR
Stephanie Bennett, NMFS PIRO
Shannon Bettridge, NMFS OPR
Mary Bhuthimethee, NMFS OST
Mathew Biddle, NOS IOOS
Jennifer Bigman, NMFS OST
Steven Bograd, NMFS SWFSC
Meaghan Bryan, NMFS AFSC
Joe Caracappa, NMFS NEFSC
Hingling Chan, NMFS PIFSC
Wei Cheng, OAR PMEL
Kristine Cherry, NMFS OAQ
Michelle Chow, NMFS PIRO
Allison Cluett, NMFS SWFSC
Bret Collier, OAR GLERL
*Sean Corson, NOS NCCOS
*John Cortinas, OAR
Dan Crear, Inter-American Tropical Tuna Commission
Lisa Crozier, NMFS NWFSC
Jennifer Cudney, NMFS OSF
*Kim Damon-Randall, NMFS OPR
*Kelly Denit, NMFS OSF
*David Detlor, NMFS OST
Dori Dick, NMFS OPR
*Liz Drenkard, OAR GFDL
Dmitry Dukhovskoy, OAR PSL
Megan Feddern, NMFS NWFSC
Erin Fedewa, NMFS AFSC
Mike Ford, NESDIS
Travis Ford, NMFS GARFO
Robert Foy, NMFS AFSC
Sarah Gaichas, NMFS NEFSC
Jason Gasper, NMFS AKRO
Steve Gittings, NOS ONMS
Dwight Gledhill, OAR OAP
Fabian Gomez, Northern Gulf Institute
Karla Gore, NMFS SERO
Jamison Gove, NMFS PIFSC
*Roger Griffis, NMFS OST
Grace Groover, OAR
Richard Hall, NMFS PIRO
Robert Hallberg, OAR GFDL
Melissa Haltuch, NMFS AFSC
Sean Hanser, NMFS PIRO
*Jon Hare, NMFS NEFSC
Abigail Harley, NMFS AFSC
*Holden Harris, NMFS SEFSC
Chris Harvey, NMFS NWFSC
Tim Haverland, NMFS OST
Elliott Hazen, NMFS SWFSC
Al Hermann, OAR PMEL/Cooperative Institute for Climate, Ocean, and Ecosystem Studies
Kevin Hill, NMFS SWFSC
Pat Hogan, NESDIS
*Kris Holderied, NMFS NCCOS
Anne Hollowed, retired, NMFS AFSC
Eli Holmes, NMFS NWFSC
*Kirstin Holsman, NMFS AFSC
*Evan Howell, NMFS OST
Chia-Wei Hsu, OAR PSL/Cooperative Institute for Research in Environmental Sciences
Mary Hunsicker, NMFS NWFSC
Jim Ianelli, NMFS AFSC
*Mike Jacox, NMFS SWFSC
Jasmin John, OAR AOML
Isaac Kaplan, NMFS NWFSC
*Mandy Karnauskas, NMFS SEFSC
Melissa Karp, NMFS OST
Kelly Kearney, NMFS AFSC
Chris Kelble, OAR AOML
Lisa Kerr, University of Maine
Dongmin Kim, OAR AOML
*Kristen Koch, NMFS SWFSC
Lindsey Kraatz, NMFS OAA
*Joe Langan, OAR GLERL
Scott Large, NMFS NEFSC
Kirsten Larsen, NESDIS NCEI
Deborah Lee, OAR GLERL

Sang-Ki Lee, OAR AOML
Kirsten Leong, NMFS PIFSC
Nerea Lezama-Ochoa, NMFS SWFSC
Josh Lindsay, NMFS WCRO
Jason Link, NMFS OAA
Doug Lipton, NMFS OAA
Charles Littnan, NMFS PIFSC
Tyler Loughran, NMFS OSF
Sandy Lucas, OAR GOMO
Ian Lundgren, NMFS OHC
Patrick Lynch, NMFS OST
Sarah Malloy, NMFS PIRO
Kristin Marshall, NMFS NWFSC
Catherine Marzin, NMFS OPR
Dax Matthews, NMFS PIFSC/Cooperative Institute for Marine and Atmospheric Research
Cami McCandless, NMFS NEFSC
*Michelle McClure, OAR PMEL
Carey McGilliard, NMFS AFSC
Liz McHuron, NMFS AFSC
Rick Methot, NMFS NWFSC
Tim Miller, NMFS NEFSC
*Kathy Mills, Gulf of Maine Research Institute
Mark Monaco, NOS NCCOS
*Meredith Moore, Ocean Conservancy
Kiera Morrill, NMFS NEFSC
Theresa Morrison, OAR GFDL
Wendy Morrison, NMFS OSF
Hassan Moustahfid, NOS IOOS
Barbara Muhling, NMFS SWFSC/Cooperative Institute for Marine Ecosystems and Climate
Roldan Muñoz, NMFS SEFSC
Gabrielle Negrete-Garcia, OAR GFDL
Stephanie Oakes, NMFS OST
Erica Ombres, NMFS OA
Dan Pendleton, NMFS NEFSC
Kaipo Perez, NMFS PIRO
Jay Peterson, NMFS OST
Colleen Petrik, Scripps Institution of Oceanography
Jason Philibotte, NMFS PIRO
Clay Porch, NMFS SEFSC
Mercedes Pozo, NMFS SWFSC
John Quinlan, NMFS SEFSC
V Ramaswamy, OAR GFDL
Sam Rauch, NMFS OAA
Ken Riley, NMFS OAQ
Grace Roskar, NMFS OST
Andrew Ross, OAR GFDL
Ed Rutherford, OAR GLERL
James Ruzicka, NMFS PIFSC
*Ryan Rykaczewski, NMFS PIFSC
*Vince Saba, NMFS NEFSC
Skylar Sagarese, NMFS SEFSC
Sarah Salois, NMFS NEFSC
Jameal Samhouri, NMFS NWFSC
Roland Schweitzer, OAR PMEL
Virginia Selz, OAR CPO
Kalei Shotwell, NMFS AFSC
Elizabeth Siddon, NMFS AFSC
Derrick Snowden, NOS IOOS
Cameron Speir, NMFS SWFSC
Phyllis Stabeno, OAR PMEL
Christine Stawitz, NMFS OST
Jeremy Sterling, NMFS AFSC
*Charles Stock, OAR GFDL
Diana Stram, North Pacific Fishery Management Council
Justin Suca, NMFS PIFSC
Marysia Szymkowiak, NMFS AFSC
Kate Taylor, NMFS PIRO
Yi-Cheng Teng, OAR GFDL
Desiree Tommasi, NMFS SWFSC/Cooperative Institute for Marine Ecosystems and Climate
Howard Townsend, NMFS OST
Brittany Troast, OAR CIMAS/AOML
*Beth Turner, retired, NOAA Science Advisory Board
*Bill Tweit, Washington Department of Fish and Game; North Pacific Fisheries Management Council
Ryan Vandermeulen, NMFS OST
Ana Vaz, NMFS SEFSC
John Walter, NMFS SEFSC
Jia Wang, OAR GLERL
Eric Ward, NMFS NWFSC
Lauren Waters, NMFS SERO
George Watters, NMFS SWFSC
Robert Webb, OAR PSL
*Heather Welch, NMFS SWFSC
*Cisco Werner, NMFS OAA
Kevin Werner, NMFS NWFSC
Chuck Wheeler, NMFS PIRO
Robert Wildermuth, NMFS SWFSC
Bethany Williams, NOS NCCOS
Sarah Wise, NMFS AFSC
Phoebe Woodworth-Jefcoats, NMFS PIFSC
Stephanie Zador, NMFS AFSC
AJ Zhang, NOS CO-OPS

C. Panelist Biographies

Sean Corson

National Centers for Coastal Ocean Science, National Ocean Service

Sean Corson is the Director for the National Centers for Coastal Ocean Science, an office that focuses on ecosystem science, ecological monitoring and forecasts, coastal pollutants, climate adaptation, and social science. He represents the National Ocean Service on the CEFI Executive Committee. NOS is standing up a Climate Ecosystem Decision Support Team to produce marine protected area condition reports and climate vulnerability assessments in an operational format, and develop ocean model hindcasts to inform predictions of climate-related changes in species distributions and support coastal communities and the local economies that depend on them.

John Cortinas

NOAA Office of Oceanic and Atmospheric Research

John V. Cortinas, Jr., Ph.D, is the new Deputy Assistant Administrator for Science with NOAA's Office of Oceanic and Atmospheric Research. John joins the NOAA Research leadership team with a wealth of experience and more than 30 years of dedicated service to NOAA and its Cooperative Institutes, most recently as director of NOAA's Atlantic Oceanographic and Meteorological Laboratory in Miami, Florida.

Kim Damon-Randall

NMFS Office of Protected Resources

Kim Damon-Randall is the director of NMFS Office of Protected Resources. Ms. Damon-Randall has extensive experience in the conservation, recovery, and management of protected species. She has worked on issues ranging from responding to petitions to list species under the Endangered Species Act to designating critical habitat. She has coordinated focused outreach efforts to raise awareness about threats to endangered species through initiatives such as the International Year of the Salmon and Species in the Spotlight campaigns.

Kelly Denit

NMFS Office of Sustainable Fisheries

Kelly Denit is the Director of NMFS' Office of Sustainable Fisheries. Ms. Denit joined the Office of Sustainable Fisheries in 2011. Most recently, she served as the Chief of the Domestic Fisheries Division providing national policy direction and performance oversight to ensure the continued sustainable management of our nation's fisheries. Ms. Denit earned a B.S. in Ecology from Yale University and an M.S. in Biological Oceanography from the University of Miami. She also completed NOAA's Leadership Competencies Development Program in 2014.

Liz Drenkard

Geophysical Fluid Dynamics Laboratory, NOAA Office of Oceanic and Atmospheric Research

Liz is a research oceanographer with NOAA's Geophysical Fluid Dynamics Laboratory and has been leading development of the regional MOM6 Northeast Pacific model.

Jon Hare

NMFS Northeast Fisheries Science Center

Jon is the Northeast Fisheries Science Center Director and has been working to bring climate information into fisheries management for a long time. CEFI is built on hard work by a large number of people over decades and CEFI is our best chance in a generation to take a grand leap forward.

Holden Harris

NMFS Southeast Fisheries Science Center

Holden Harris is a marine systems ecologist with the Southeast Fisheries Science Center. His research integrates ocean model projections and other climate information into decision-support tools, including ecosystem models, management strategy evaluations, and ecosystem status reports.

Kathy Mills

Gulf of Maine Research Institute

As a senior research scientist at the Gulf of Maine Research Institute in Portland, Maine, Kathy studies marine ecosystem changes and fish-ecosystem-fishery relationships with a focus on the Northeast U.S.. Specifically, her research investigates (1) how physical and ecosystem conditions are changing; (2) how these changes affect fish populations, biological communities, and marine fisheries; and (3) how fisheries and fishing communities can effectively respond through adaptation measures or resilience planning. Much of her work (and a connection to CEFI) is grounded in using population and distribution models to project climate-driven species changes and then to translate this information to community scales as a basis for discussion and planning for climate adaptation.

Meredith Moore

Ocean Conservancy

Meredith Moore is the director of the Fish Conservation Program at Ocean Conservancy. Her work focuses on ensuring that U.S. fisheries are sustainable, resilient, and equitably managed. She is a member of the Marine Fisheries Advisory Committee and has a Master's degree in Astronomy from the University of Maryland and a Bachelor’s degree in Physics from the University of Georgia.

Beth Turner

NOAA Science Advisory Board, Ecosystem Science and Management Working Group

Beth Turner retired from NOAA in 2020. She managed the US GLOBEC program and the Southeast Bering Sea Carrying Capacity project until those programs ended, and then went on to manage other research programs designed to develop predictive capacity around issues such as hypoxia, shoreline modifications, Ocean Acidification and Harmful Algal Blooms. She currently serves on the Ecosystem Science and Management Working Group of the NOAA Science Advisory Board.

Bill Tweit

Washington Department of Fish and Game; North Pacific Fisheries Management Council

Bill Tweit is the Vice Chair of the North Pacific Fishery Management Council, and the chair of the Council's Ecosystem Committee. The North Pacific Council has been steadily transitioning towards Ecosystem Based Fishery Management, and in recent years the primary emphasis of this effort has been to develop EBFM approaches that can help the Council be prepared for the predicted and unpredicted impacts of climate change.

Heather Welch

NMFS Southwest Fisheries Science Center

Heather Welch is a Research Biologist at the Southwest Fisheries Science Center and a member of the CEFI West Coast decision support team. Her research focuses on understanding and planning for climate impacts on marine biodiversity and fisheries, and she has led the development of tools like EcoCast and TOTAL to help mitigate risk to protected species.

D. CEFI Fact Sheet:

https://drive.google.com/file/d/1slOOFqe_8BXx2PGEwZcA7vmOfs2JSsli/view?usp=sharing

E. CEFI Pilot Project Fact Sheet:

https://drive.google.com/file/d/1yA09ZfHObeHIVvasjGoHLe0VBqojExJz/view?usp=sharing