



## **Climate and Fisheries Initiative**

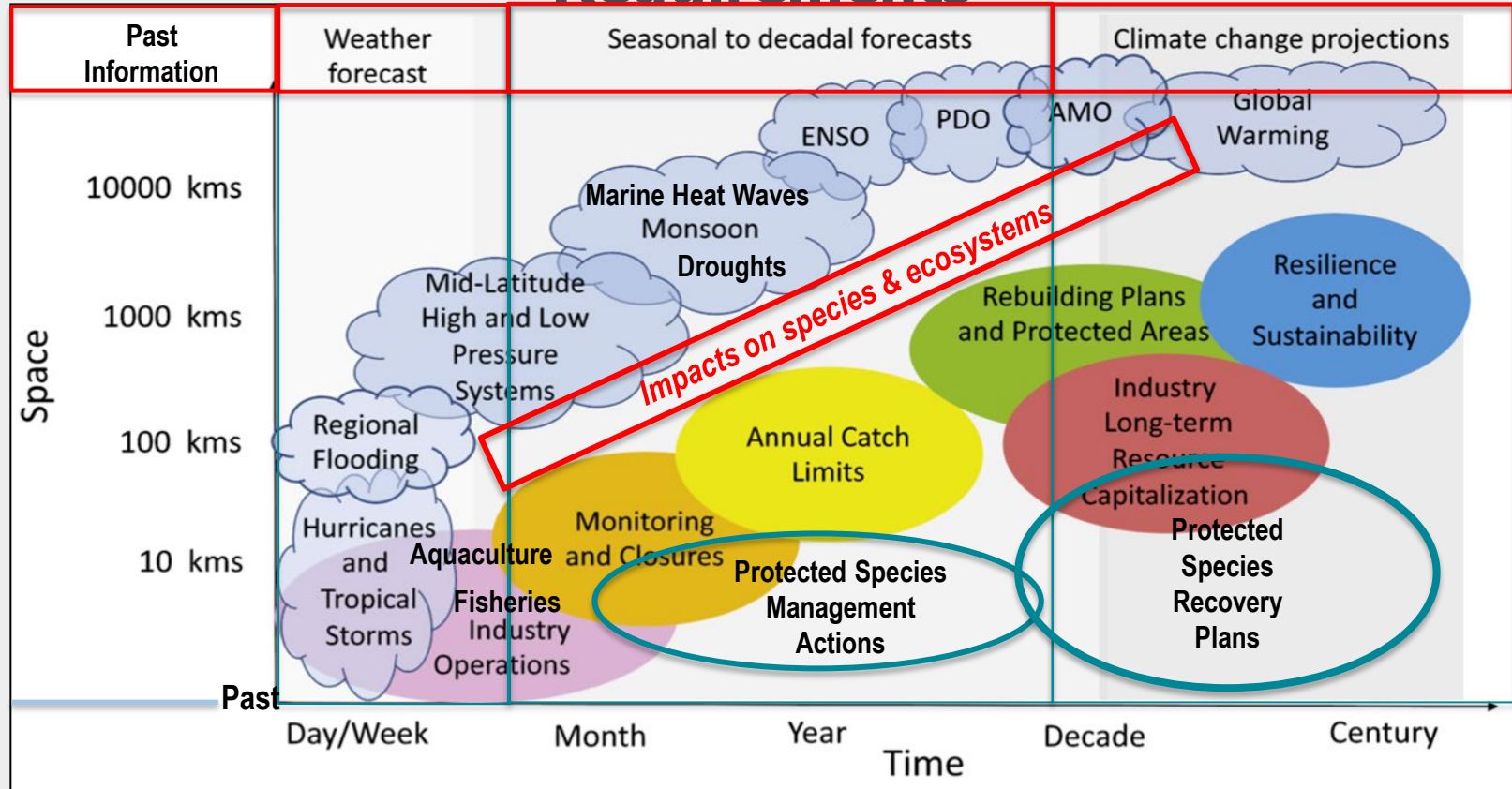
Status of U.S. efforts to understand the impacts of climate change on fisheries to inform long term, medium and near term decision making

Anne B. Hollowed  
Alaska Fisheries Science Center  
July 2021

# Growing Challenges for Effective Resource Management

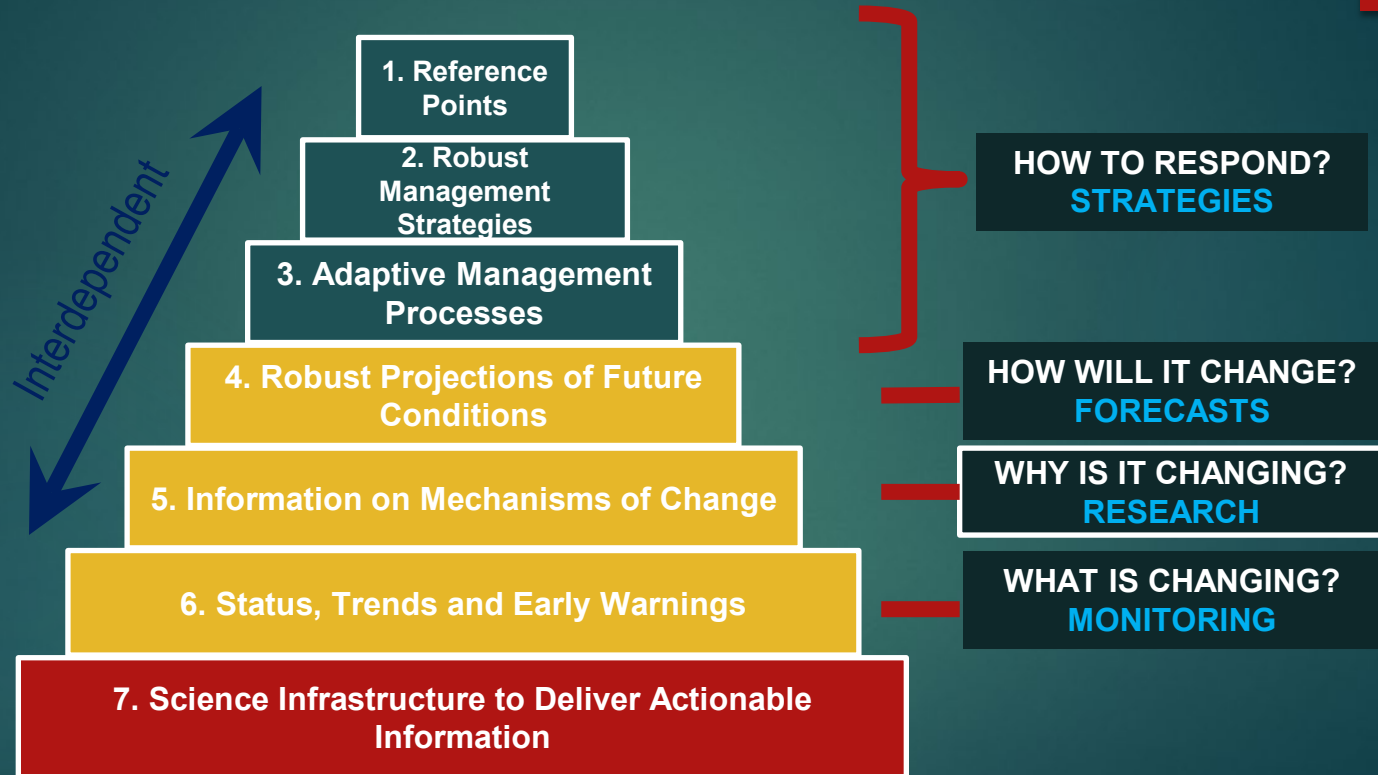


# 2019 Assessment: NMFS Climate Information Requirements



# NOAA Fisheries Climate Science Strategy

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





**NOAA  
FISHERIES**

**Northwest Fisheries  
Science Center**

**Southwest Fisheries  
Science Center**

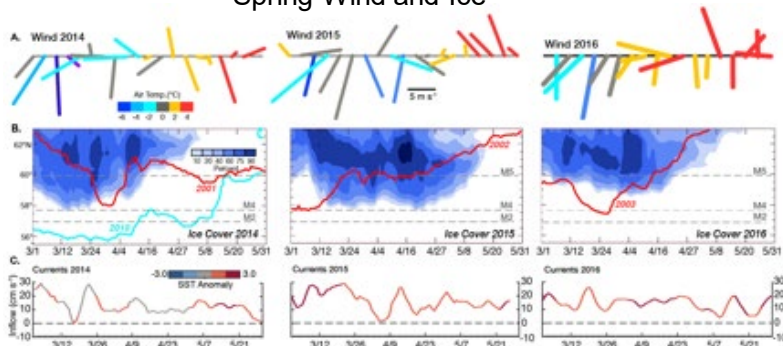
# Level 6: West Coast Integrated Ecosystem Assessment



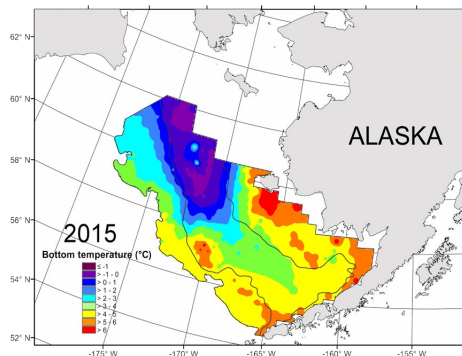
# Level 5: Understanding

## Unexpected finding: Young pollock survival better than expected during 2014-2016 warm phase

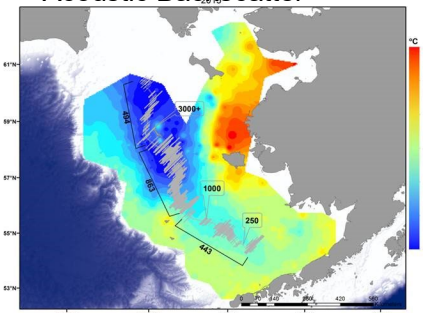
Spring Wind and Ice



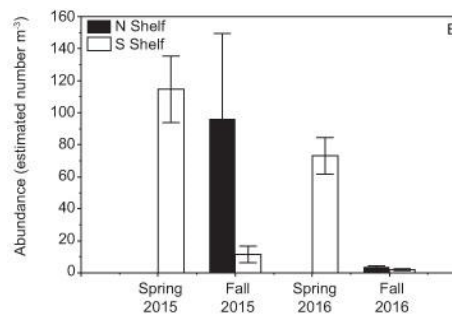
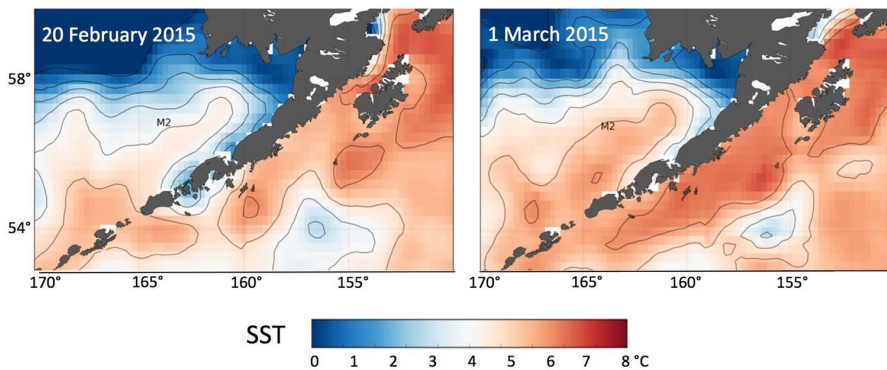
Summer Bottom temp



2015 Spring Juvenile Pollock Acoustic Backscatter



Warm blob extension from Gulf of Alaska



In FY15, S&T provided supplemental funds for an emergency survey to assess emergent warm year stanza in EBS. These conclusions are based in part on that effort.

Duffy-Anderson JT, et. al. PLoS ONE 12(6): e0178955. <https://doi.org/10.1371/journal.pone.0178955>

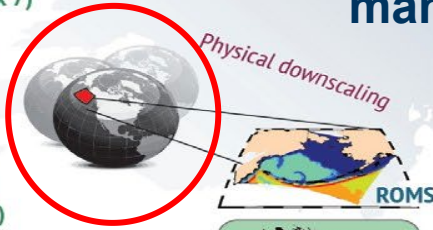
## Climate scenarios

### Global Climate Models (x 7)

ECHO-G  
MIROC3.2 med res.  
CGCM3-t47  
CCSM4-NCAR-PO  
MIROCESM-C-PO  
GFDL-ESM2M\*-PO  
GFDL-ESM2M\*-PON

### Projection Scenarios (x3)

AR4 A1B  
AR5 RCP 4.5  
AR5 RCP 8.5



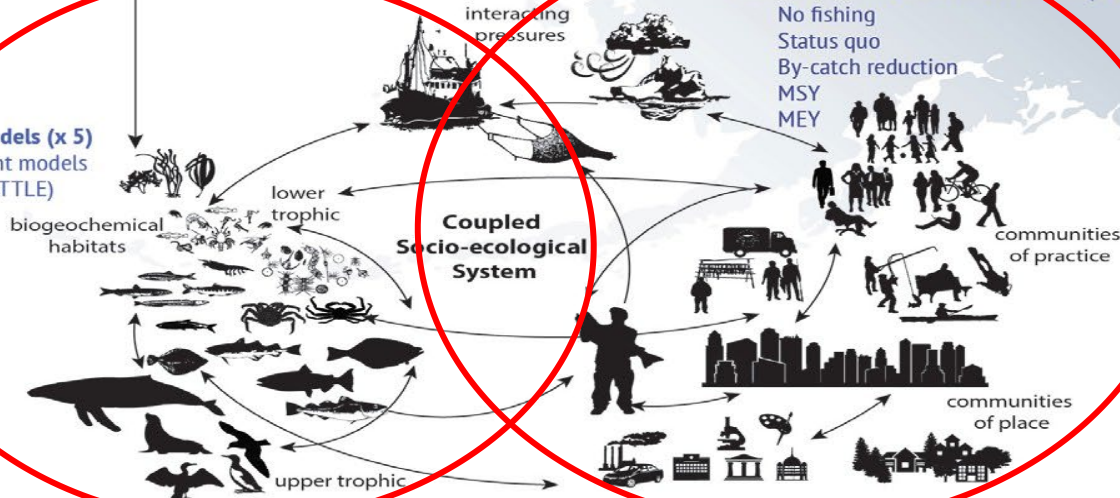
Bering Sea 10K Model

## Ocean scenarios

## Ecosystem and stock scenarios

### Climate Enhanced Biological models (x 5)

CE- single species assessment models  
CE- multispecies model (CEATTLE)  
CE- Size spectrum model  
CE- Ecopath with Ecosim  
End-to-End model (FEAST)



### Socio-economic / harvest scenarios (x 5)

No fishing  
Status quo  
By-catch reduction  
MSY  
MEY

## Fishery and Management scenarios

# What are the best management options?

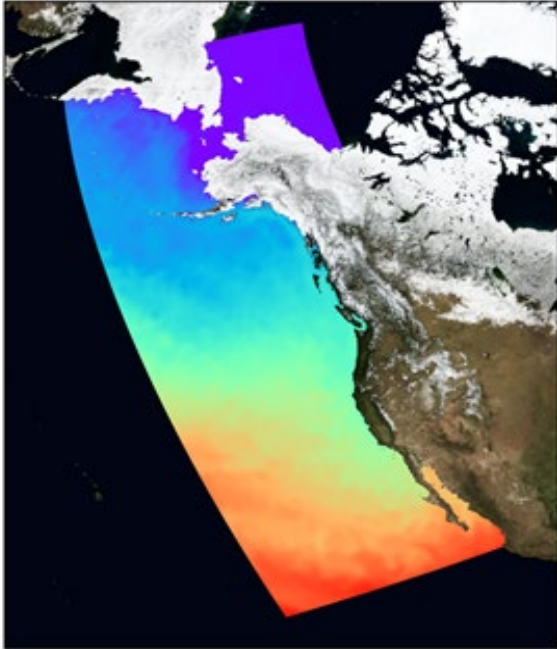
## ACLIM

### Alaska Climate Integrated Modeling Project

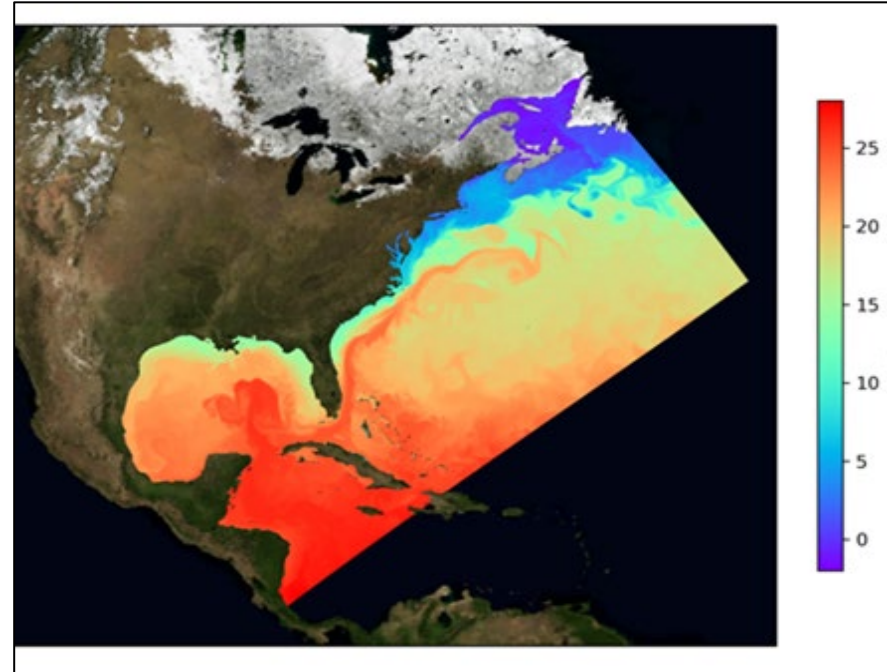
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Kerim Aydin (AFSC, REEM/REFM)  
Trond Kristiansen (IMR, Norway)  
Al Hermann (UW JISAO/PMEL)  
Wei Cheng (UW JISAO/PMEL)  
André Punt (UW SAFS)  
Jonathan Reum (UW SAFS)  
Amanda Faig (UW SAFS)

RTAP: Research Transition Acceleration Program  
COCA Competition 8 and IEA

COCA: Pilot Integrated long-term projection studies  
MAPP: Short - term forecast skill assessments



**Bering Sea  
Northwest Atlantic  
California Current  
Gulf of Alaska**



Modeling Analysis Predictions and Projections (MAPP) <https://cpo.noaa.gov/Meet-the-Divisions/Earth-System-Science-and-Modeling/MAPP>

Coastal and Ocean Climate Applications (COCA)

<https://cpo.noaa.gov/Meet-the-Divisions/Climate-and-Societal-Interactions/The-Adaptation-Sciences-Program/COCA/About-COCA>



# Level 1-4 NOAA Climate and Fisheries Initiative (CFI)

- 
- *Cross-NOAA effort (NMFS, OAR, NOS, NWS, NESDIS)*
  - *Build a operational ocean modeling and decision support system*
  - *Provide state-of-the-art ocean forecasts and projections*
  - *Provide climate-informed ecosystem projections, risk assessments and management strategies*
  - *Reduce impacts and increase resilience of LMRs and communities.*

# What will CFI do?

## CFI will:

- *Build an operational ocean modeling and decision support system to*
- *Provide NMFS and other decision-makers with state-of-the-art ocean forecasts, risk assessments and management options that*
- *Enable climate-informed LMR management.*

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Integrated, nation-wide operational system that delivers:

- Ocean forecasts and projections
- Ecosystem projections
- Stock projections
- Risk Assessments
- Adaptation Options
- Strategy Evaluations
- Management capacity

# CFI End-to-End Ocean Modeling and Decision Support System

▶ Advancing Ocean, Ecosystem, and Climate Understanding

▶ Operational Ocean, Climate, and Ecosystem Prediction Systems

▶ Climate Ready Decision Making

1

2

3



## SCIENCE AND DEVELOPMENT

*Drives Innovation and Skill*



## OPERATIONS AND INFRASTRUCTURE

*Drives Dissemination and Decision Support*



## EXTENSION AND ENGAGEMENT

*Drives Service Delivery and Knowledge Transfer*



Targeted Research that Fuels Innovation



Enhanced Observations



National Community of Practice



Enhanced Ocean Modeling Capabilities



Regional Ocean Modeling and Prediction



CFI Information Hub



Fisheries and Climate Decision Support Systems



Ecosystem Foresight

(FACSS)



Increasing Capacity for Climate Ready Decisions



Rapid Response



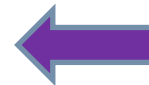
Climate Smart Decision Support Tools



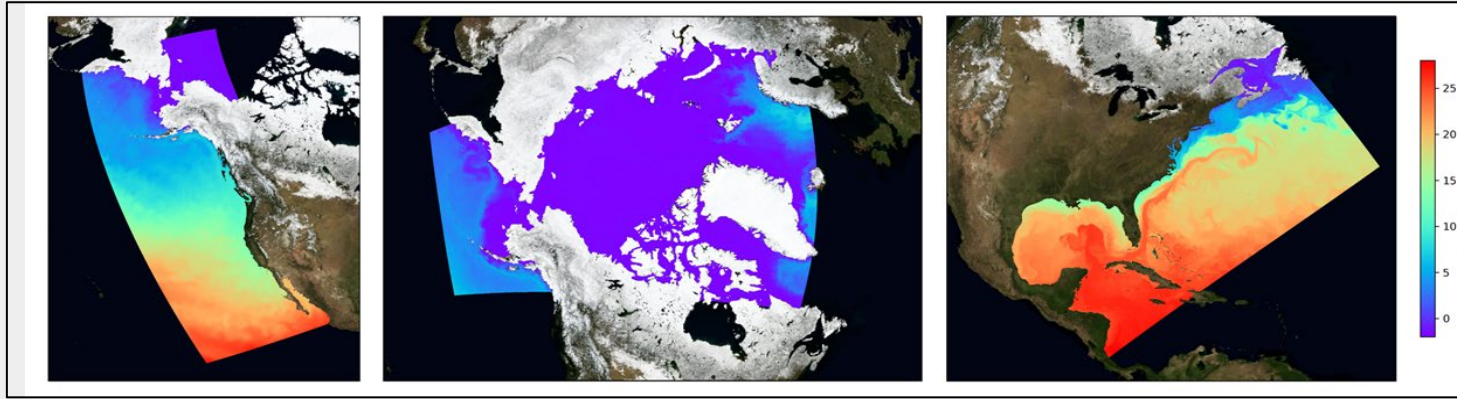
Improve Surveys and Research



Coordinated Science and Advice



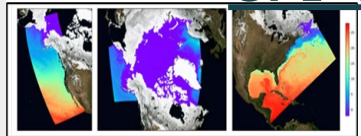
# National Ocean Prediction System fueled by NOAA High Performance Computing



Prototype MOM6 coast-wide domains for seasons to decades (Great Lakes, Pacific Islands in progress)

- Builds on NOAA ocean forecast (NOS) and Prediction Systems (OAR/GFDL)
- Regional Ocean Modeling Teams customize products for NMFS uses
- Holistic ocean/BGC predictions, expandable to earth system as needed
- NOAA HPC powers predictions spanning the range of ocean futures
- Robust dissemination through CFI Information Hub & national data stds

# CFI Ocean Modeling and Decision Support System



**Fisheries and Climate Decision Support System**

**1 Ecosystem foresight**  
Social-ecological system forecasts & projections, tipping points & early warnings

**2 Rapid response**  
Plan & predict, near-realtime alerts, emergency aid, triage impacts, enable individual adaptation

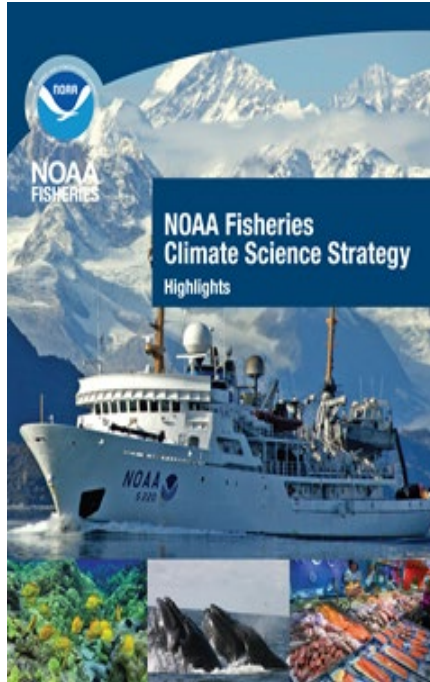
**3 Climate smart decision support tools**  
Climate enhanced stock assessments, climate informed advice & tools, dynamic management

**4 Effective monitoring & research**  
Improved research & climate-ready survey design, increased speed of response

**5 Coordinated science & advice**  
Inter- & intra-agency coordination, national strategies aligned with regional priorities, efficient information sharing, reduced redundancy



# Regional FACSS



**Increased:**

- Science Capacity**
- Climate-Ready Management**
- Resilience and Adaptation**

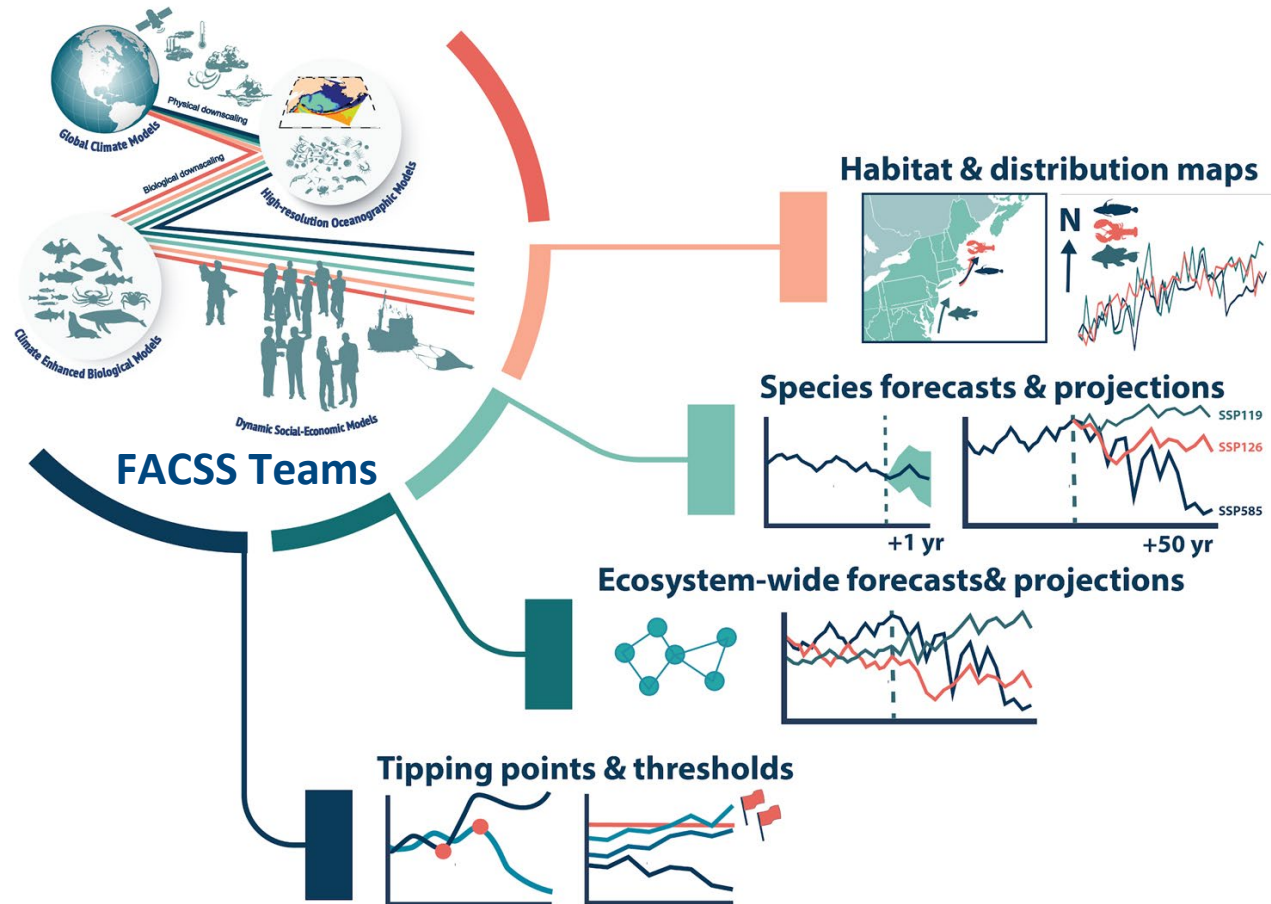
<https://www.fisheries.noaa.gov/topic/climate>

# FACSS Teams Provide Core Products & Services

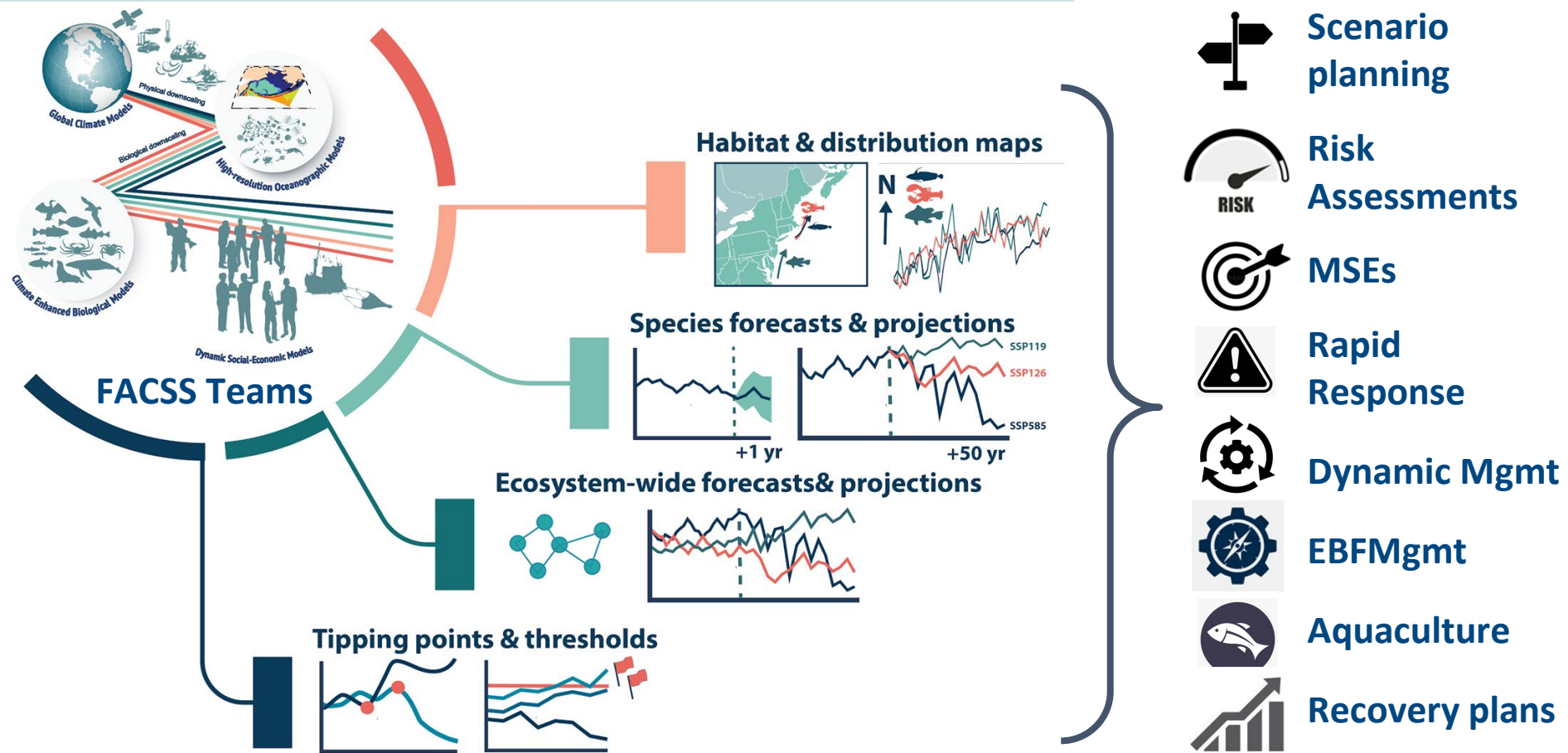


## FACSS Teams:

- Expert Teams at each SCenter
- Work with existing programs
- Catalyze efforts
- Dedicated products
- Operational delivery
- Customized services
- NMFS-wide support
- NOAA-wide services

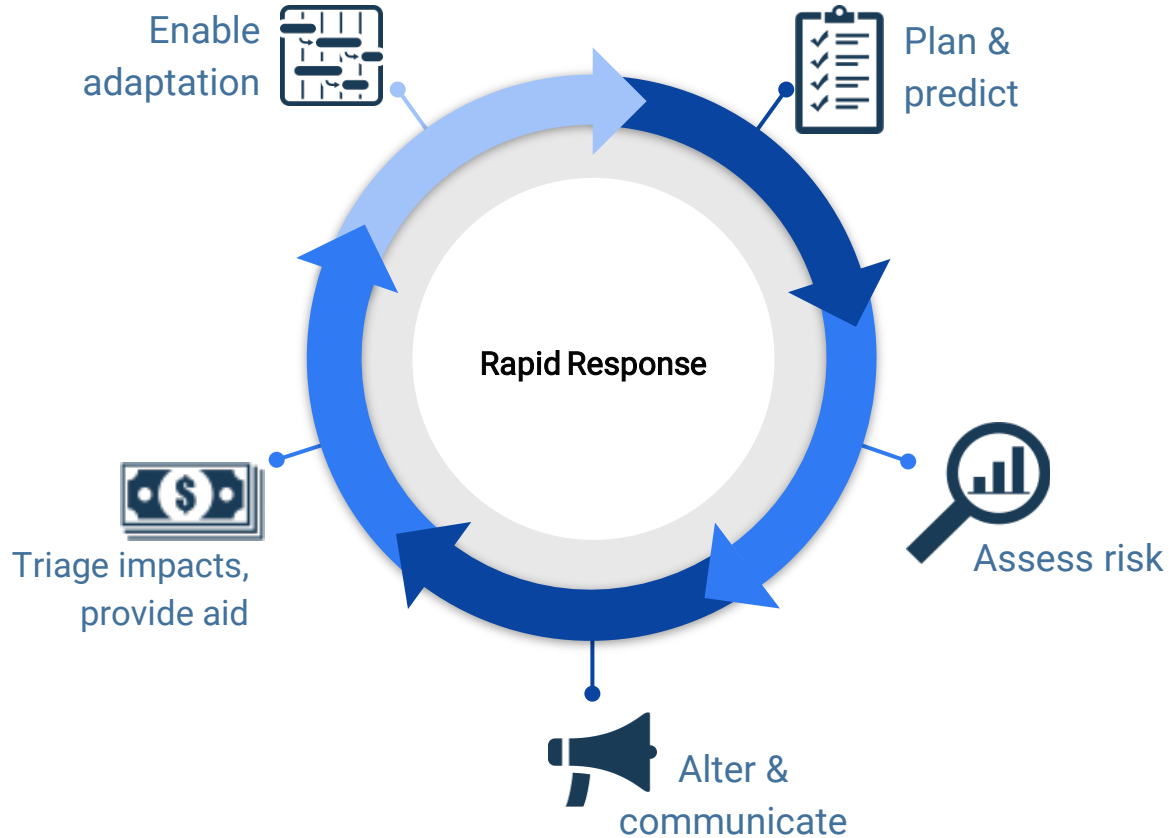


# FACSS Enable Climate-Informed Management





# Improve Rapid Responses



1

## Ecosystem foresight

*Social-ecological system forecasts & projections, tipping points & early warnings*



2

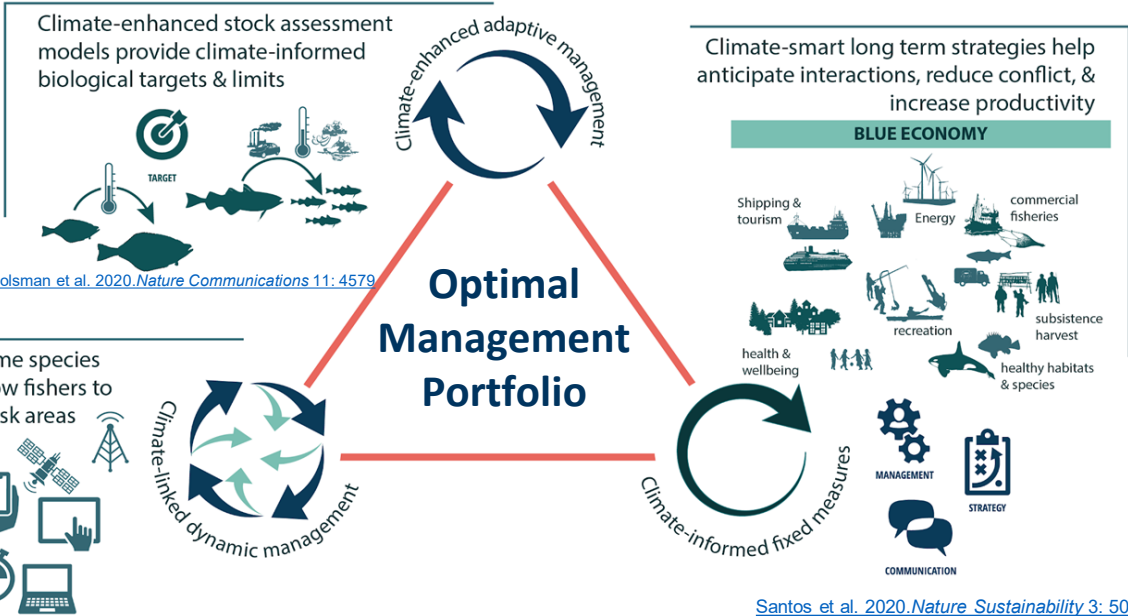
## Rapid response

*Plan & predict, near-realtime alerts, emergency aid, triage impacts, enable individual adaptation*



- **Planning**
- **Preparation**
- **Triage**
- **Action**

# Tailored Adaptation Approaches



Holsman et al. 2020. *Nature Communications* 11: 4579

Hazen et al. 2018. *Science Advances*. 4(5) eaar3001

Santos et al. 2020. *Nature Sustainability* 3: 505-516

1

**Ecosystem foresight**

*Social-ecological system forecasts & projections, tipping points & early warnings*

2

**Rapid response**

*Plan & predict, near-realtime alerts, emergency aid, triage impacts, enable individual adaptation*

3

**Climate smart decision support tools**

*Climate enhanced stock assessments, climate informed advice & tools, dynamic management*

## Performance Testing



# Summary: CFI is a foundation of Climate Ready NMFS

- **ONE-NOAA** *nation-wide system implemented regionally.*
- **RELIABLE** *delivery of ocean forecasts and projections needed by NMFS and other ocean users.*
- **OPERATIONAL** *capability to turn ocean forecasts into climate-informed management advice.*
- **CONTINUOUS** *innovation and validation through observations, research & end-to-end feedback.*
- **ROBUST NMFS** *capability to deliver climate-informed advice.*
- **INCREASED** *management capability to use climate-informed advice to reduce risks and increase resilience.*



# CFI Steering Committee

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## Co-chairs

Wayne Higgins (OAR)

David Detlor (NMFS)

## Members

John Cortinas (OAR)

Libby Jewett (OAR)

Debbie Lee (OAR)

Michelle McClure (OAR)

V Ramaswamy (OAR)

Robin Webb (OAR)

Robert Foy (NMFS)

Jon Hare (NMFS)

Catherine Marzin (NMFS)

Kevin Werner (NMFS)

Jenni Wallace (NMFS)

John Murphy (NWS)

Keelin Kuipers (NOS)

Jeff Privette (NESDIS)

# CFI Implementation Team

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## Co-chairs

Anne Hollowed (NMFS)

Charles Stock (OAR)

Desiree Tommasi (NMFS)

Michael Jacox (NMFS & OAR)

## Members

Kirsten Larsen (NESDIS)

Roger Griffis (NMFS)

Kirstin Holsman (NMFS)

Aijun Zhang (NOS)

Hassan Moustahfid (NOS)

Kris Holderied (NOS)

Arun Kumar (NWS)

Avichal Mehra (NWS)

Dan Barrie (OAR)

Mike Alexander (OAR)

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# Questions?

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## Climate and Fisheries Initiative

Implementation Approach