NOAA FISHERIES

Tools and Approaches for Climate-Informed Fisheries Management

Jay Peterson[1], Wendy Morrison[2], Melissa Karp[1] and Roger Griffis[1]

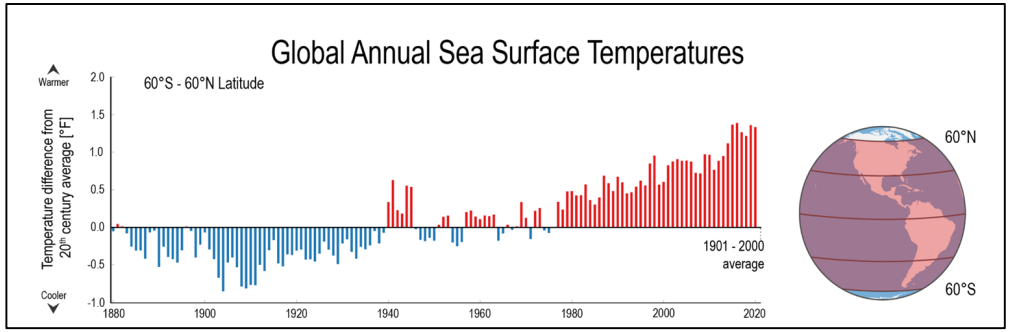
[1]NMFS Office of Science and Technology

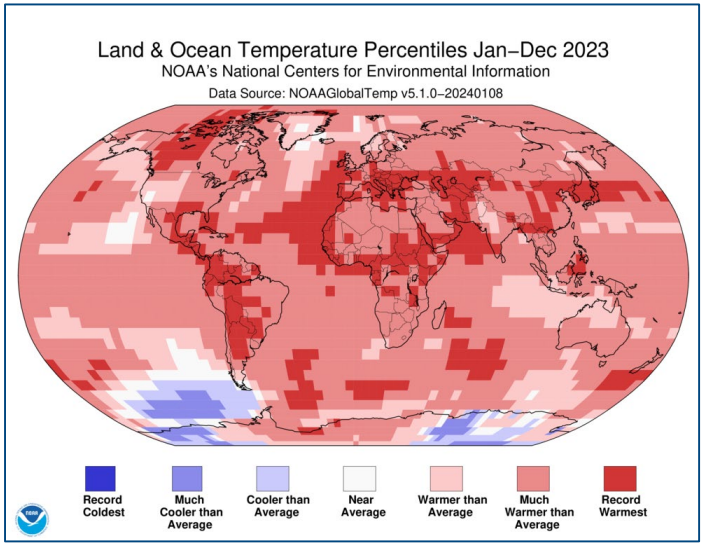
[2]NMFS Office of Sustainable Fisheries

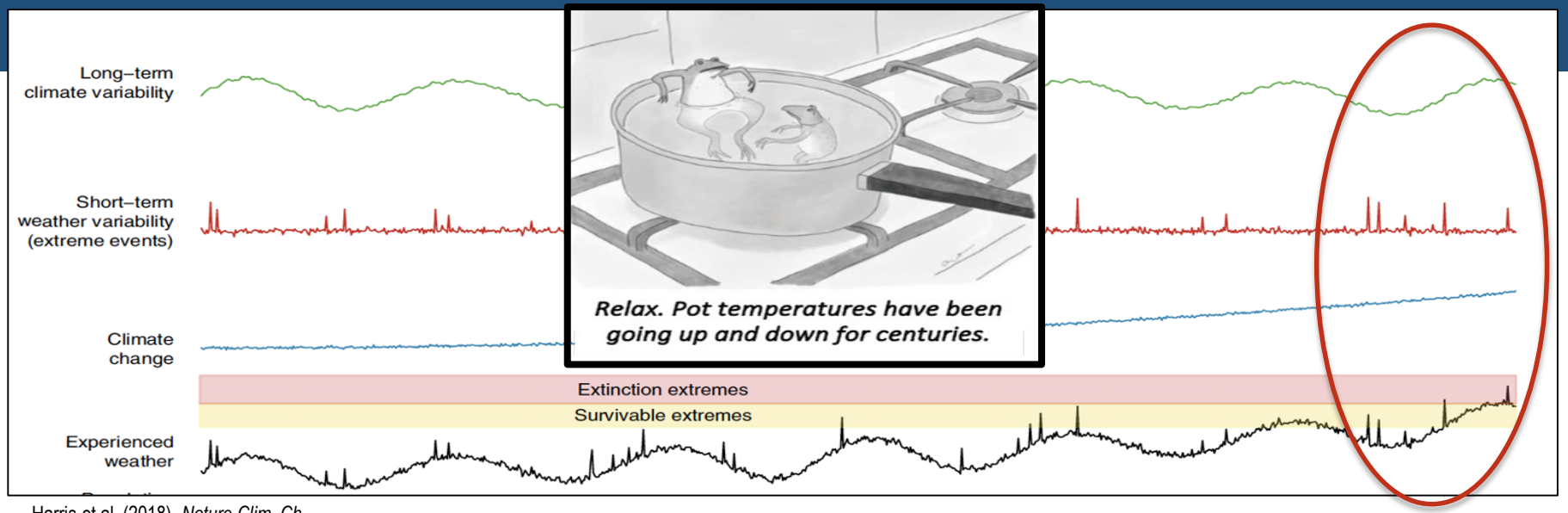
New Council Member Training October 29, 2024

Outline

- Background & Useful Strategies
- Tools and Resources
- Management Approaches
  - Reactive
  - Proactive
- Key Takeaways

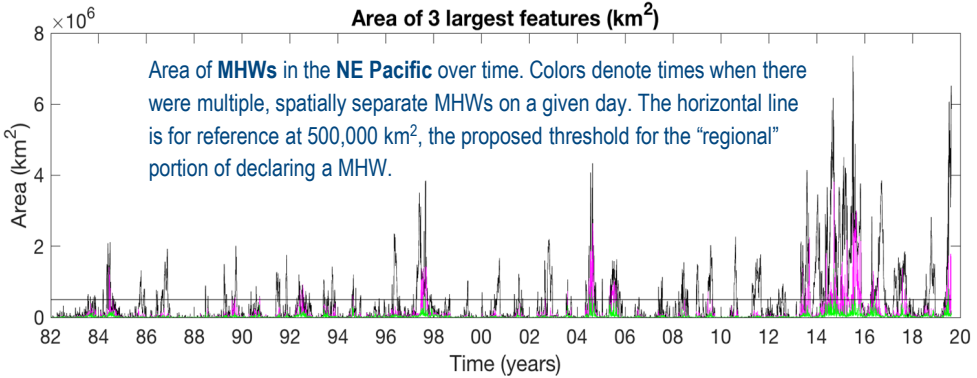






Harris et al. (2018), *Nature Clim. Ch.*

Interacting (evolving) conditions: long-term, short-term, non-stationary (climate), extreme events

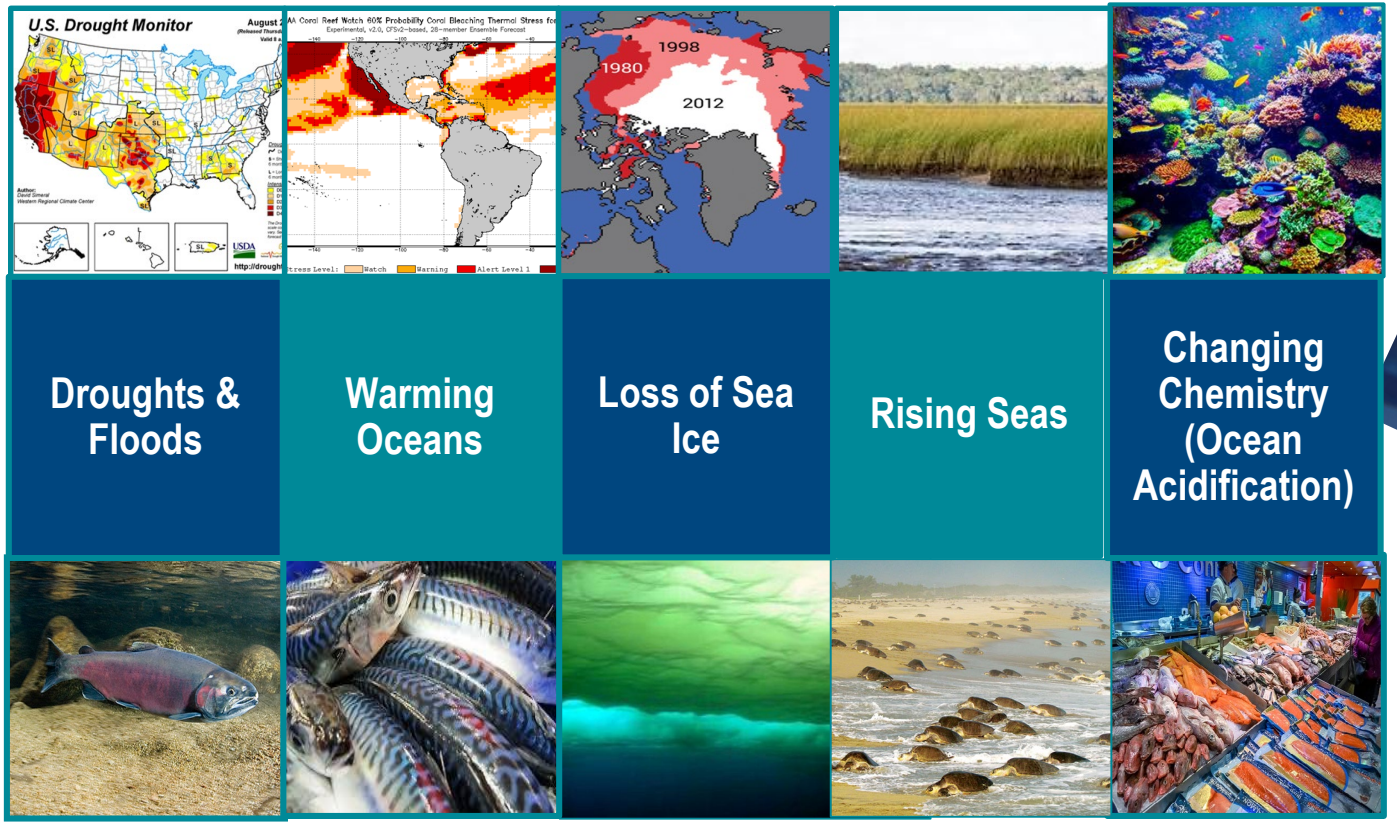


(A. Leising and S. Bograd)

Ocean conditions are changing

Extreme Events

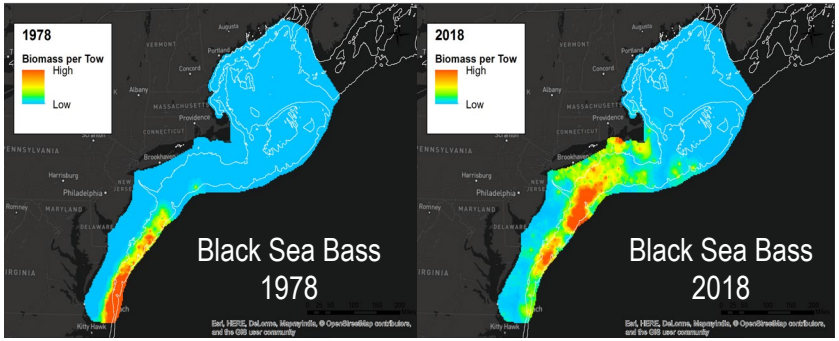
Long term change



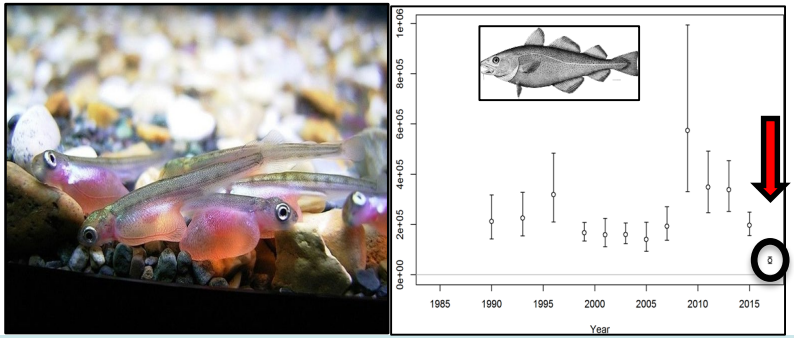
Growing Challenges for Effective Resource Management

Changing Habitats

Shifting Distributions



Changing Abundance



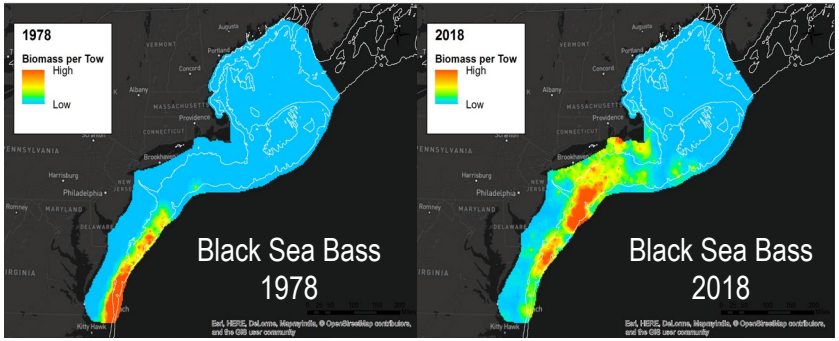
Changing Interactions

Fisheries Management Issues

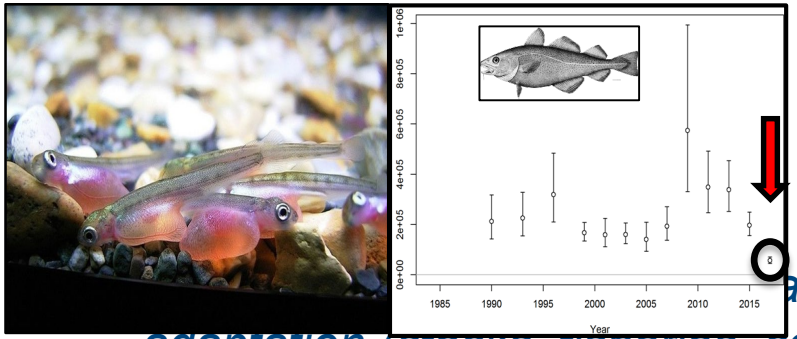
Changing Habitats

- *Impacts on essential fish habitats and protected areas?*

Shifting Distributions



Changing Abundance



Changing Interactions

adaptation (stocks, fisheries, communities)?

There is much at risk

Marine Resources

1.7 Million Jobs

$350+ Billion in economic activity

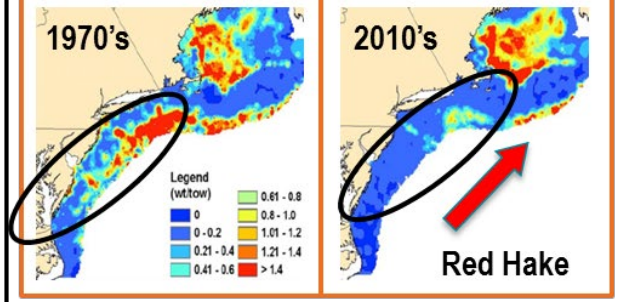
Tourism & Recreation

Fishing Communities

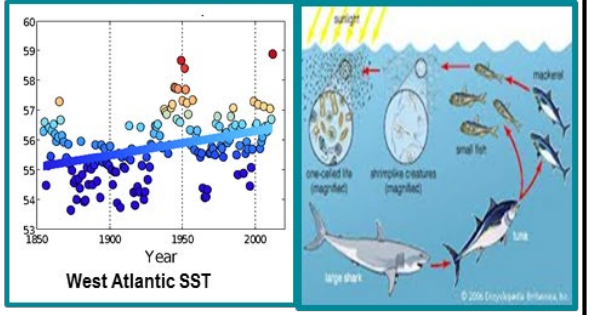
Cultural Heritage

High Demand for Information and Action

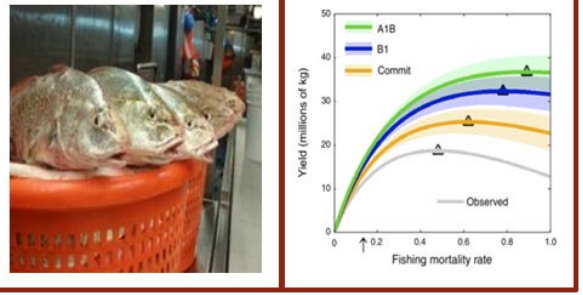
WHAT IS CHANGING?



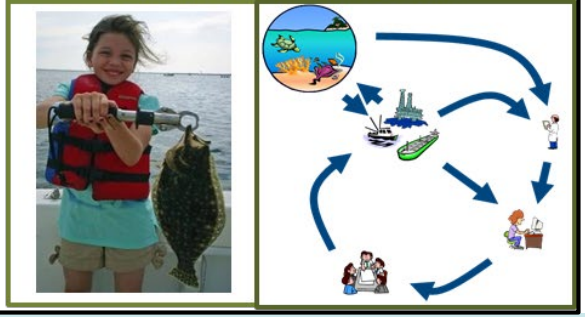
WHY IS IT CHANGING?



HOW WILL IT CHANGE?

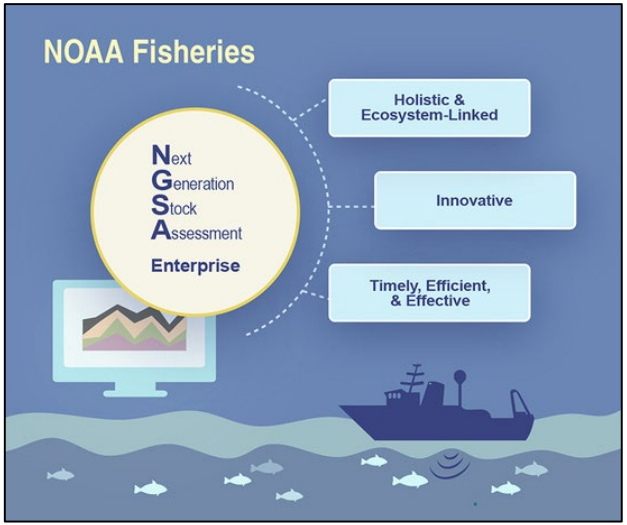


HOW TO RESPOND?



NOAA Fisheries Strategic Plans

Next Generation Stock Assessment Improvement Plan

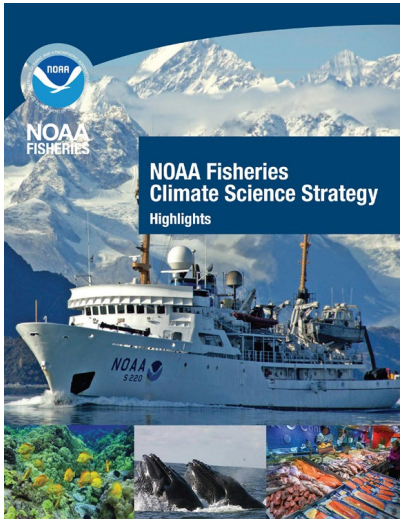


Climate Science Strategy

Increase the:

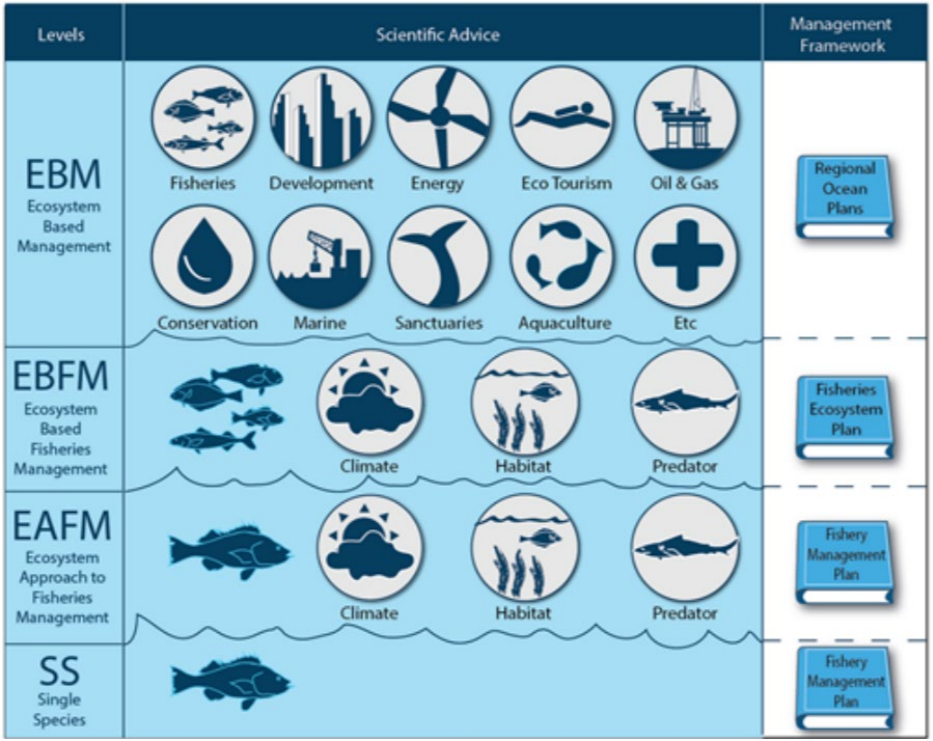
- production
- delivery
- use

of climate-related info



Ecosystem Based Fisheries Management (EBFM)

- Holistic approach to fisheries management
- Considers multiple ecosystem components
- Climate-informed
- Goals:
  - Reduce risks
  - Better decisions
  - Effective management



Dolan et al 2015

https://www.fisheries.noaa.gov/national/ecosystems/ecosystem-based-fisheries-management

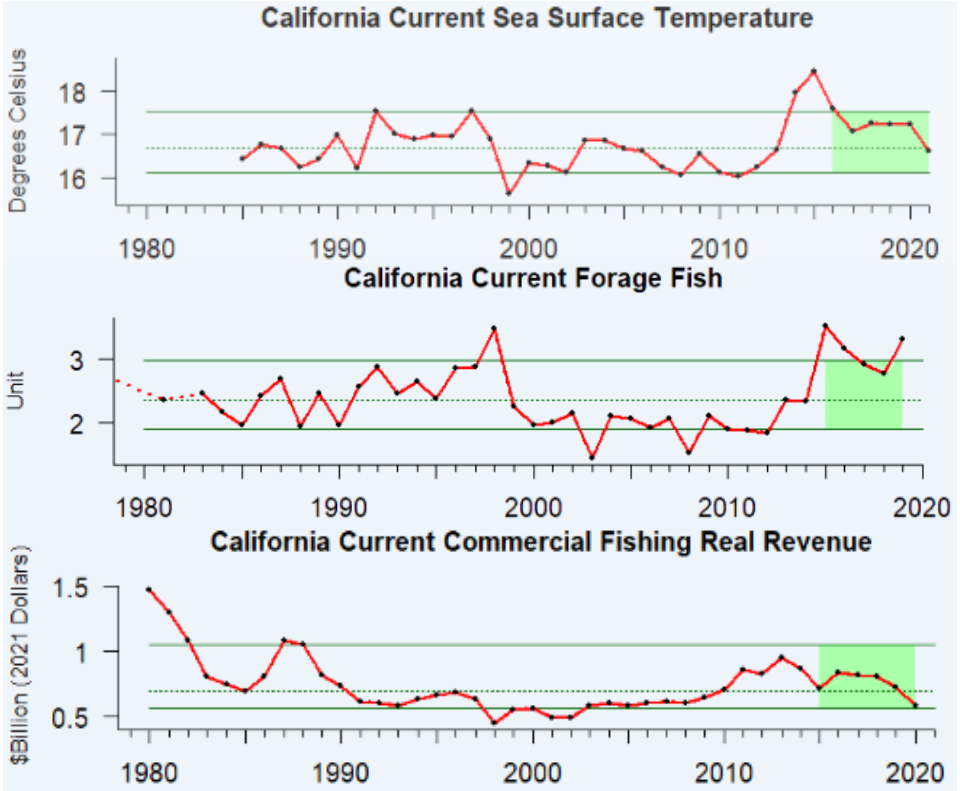
What are we doing about it?

Resources & Tools

Ecosystem Status Reports (ESRs) - What is changing?

Provide trends in a variety of indicators

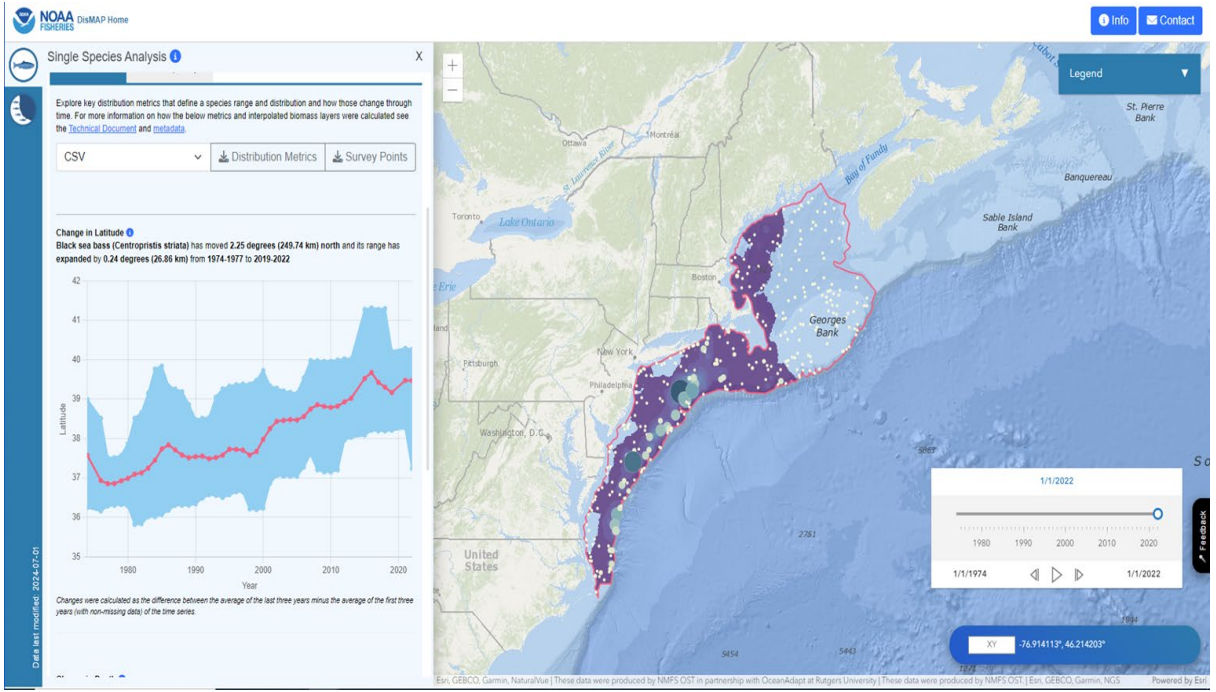
- physical (e.g., temperature)
- chemical (e.g., oxygen)
- biological (e.g., forage, predators)
- Socio-economic (e.g., landings, market diversity)



https://www.integratedecosystemassessment.noaa.gov/Ecosystem-Status-Reports
https://ecowatch.noaa.gov/

Understanding Shifting Distributions – DisMAP portal

- Nationwide portal (2022)
- Distributions and analysis tools for 400+ species of marine fish and invertebrate species in U.S. marine waters.
- User-friendly tool to help in climate-ready decision making.



https://apps-st.fisheries.noaa.gov/dismap/DisMAP.html

Understanding Vulnerability – Climate Vulnerability Analyses

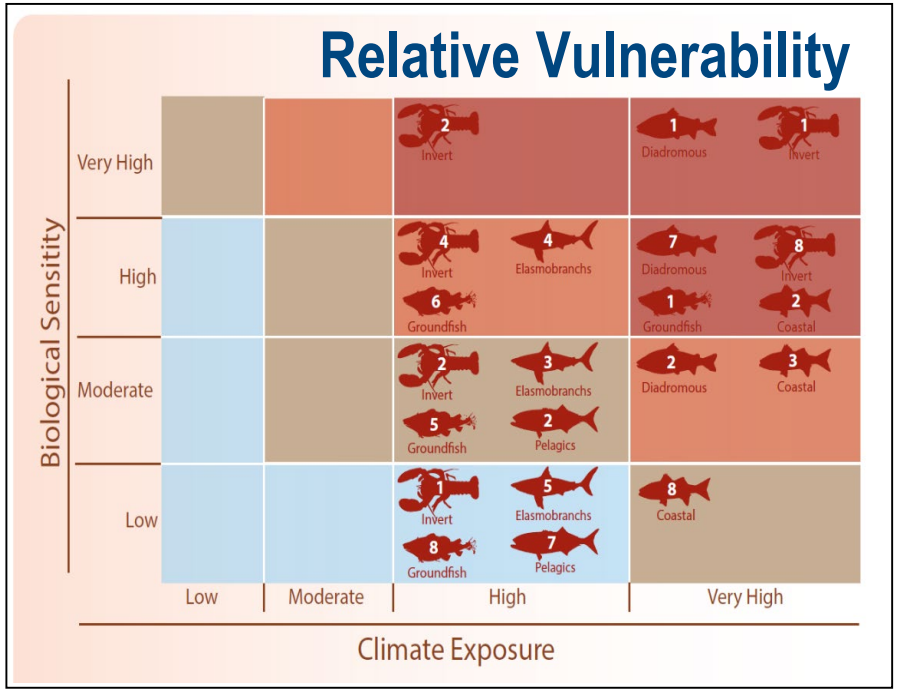
Fish Stocks

Fishing Communities

MAINE COAST FISHERMEN'S ASSOCIATION

Protected Species

Habitats



Online Tool - https://www.fisheries.noaa.gov/data-tools/climate-vulnerability-assessment-tool

Evaluating Risks - MAFMC Example

- Management elements with associated management objectives
  - ecological
  - economic
  - social
- Indicators for each element
- Annual updates on the status and risk of not meeting management objectives.

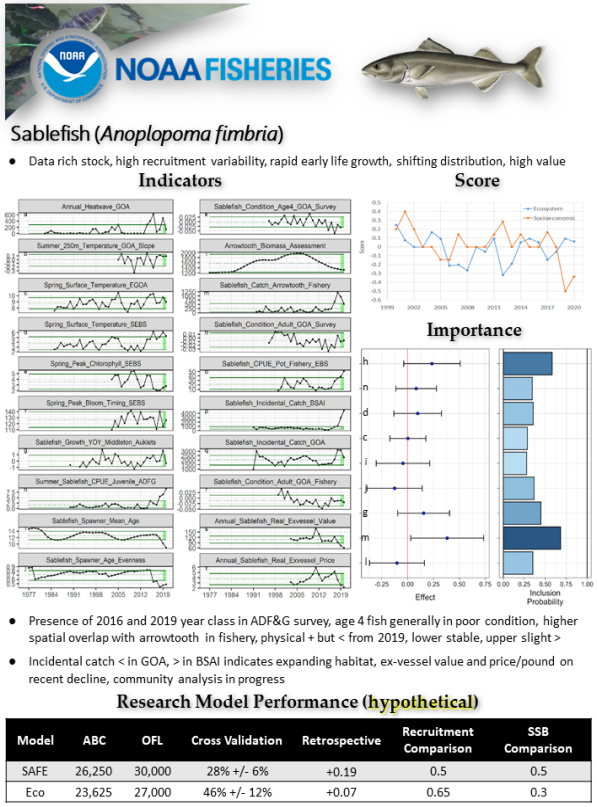
Species	Assess	Fstatus	Bstatus	FW1Pred	FW1Prey	FW2Prey
Ocean Quahog	l	l	l	l	l	l
Surfclam	l	l	l	l	l	l
Summer flounder	l	l	lm	l	l	l
Scup	l	l	l	l	l	l
Black sea bass	l	l	l	l	l	l
Atl. mackerel	l	h	h	l	l	l
Chub mackerel	h	lm	lm	l	l	l
Butterfish	l	l	lm	l	l	l
Longfin squid	lm	lm	lm	l	l	lm
Shortfin squid	lm	lm	lm	l	l	lm
Golden tilefish	l	l	lm	l	l	l
Blueline tilefish	h	h	mh	l	l	l
Bluefish	l	l	h	l	l	l
Spiny dogfish	lm	l	lm	l	l	l
Monkfish	h	lm	lm	l	l	l
Unmanaged forage	na	na	na	l	lm	lm
Deepsea corals	na	na	na	l	l	l

Risk to achieving Optimum Yield.
Low, Medium, High

Example from MAFMC Risk Assessment: https://www.mafmc.org/s/d_MAB_RiskAssess_2022update.pdf

Understanding Changes - Ecosystem and Socioeconomic Profiles (ESPs)

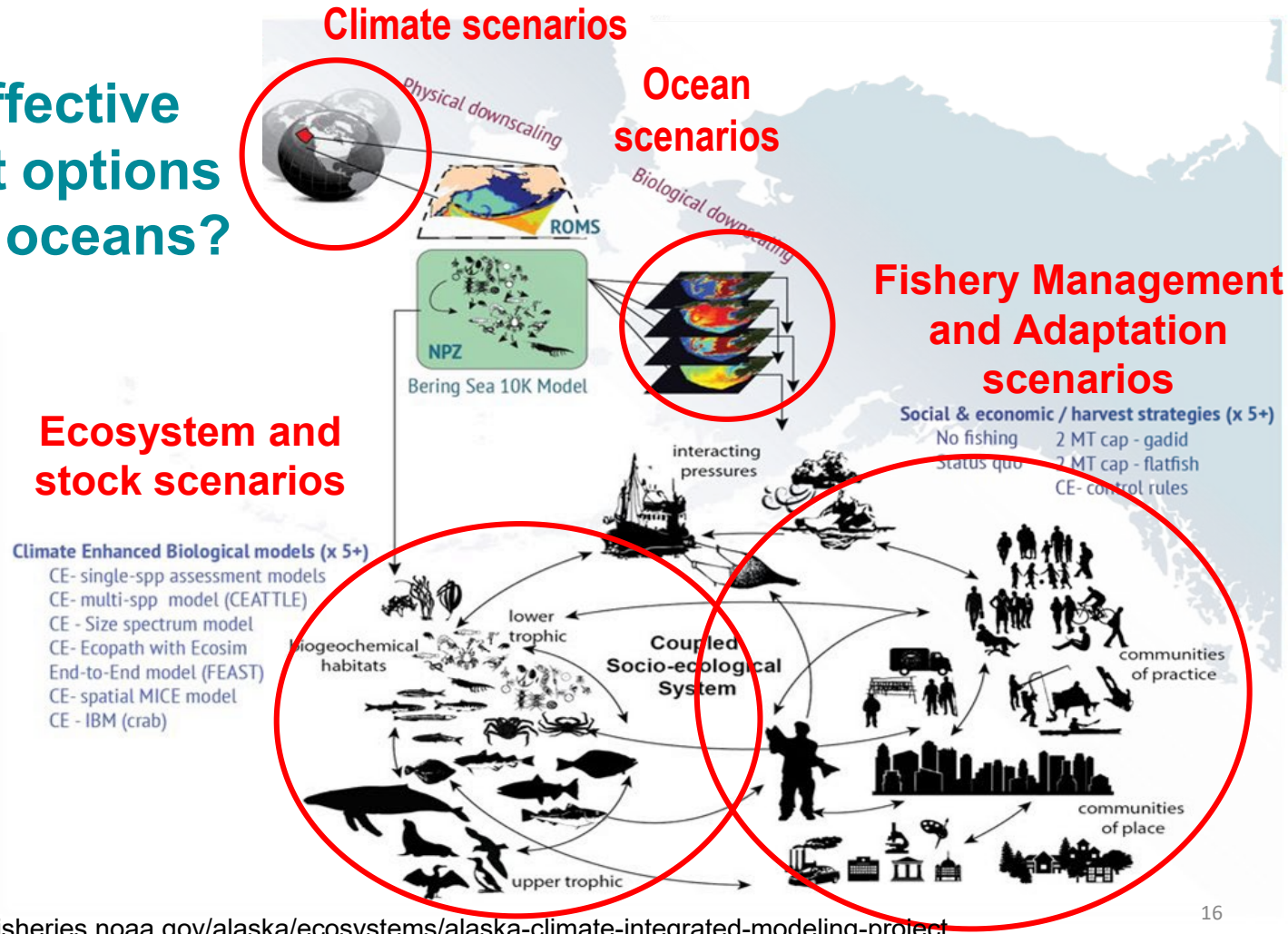
- Stock-specific ecosystem and socioeconomic info.
- Routine use in Alaska and NE, one completed in Pacific Islands.
- Working to expand nationally! Development and Pilots in other regions.



Model	ABC	OFL	Cross Validation	Retrospective	Recruitment Comparison	SSB Comparison
SAFE	26,250	30,000	28% +/- 6%	+0.19	0.5	0.5
Eco	23,625	27,000	46% +/- 12%	+0.07	0.65	0.3

ESP: https://www.afsc.noaa.gov/REFM/Docs/[YEAR]/GOAsablefish.pdf, Contact: Kalei.Shotwell@noaa.gov

What are effective management options for changing oceans?

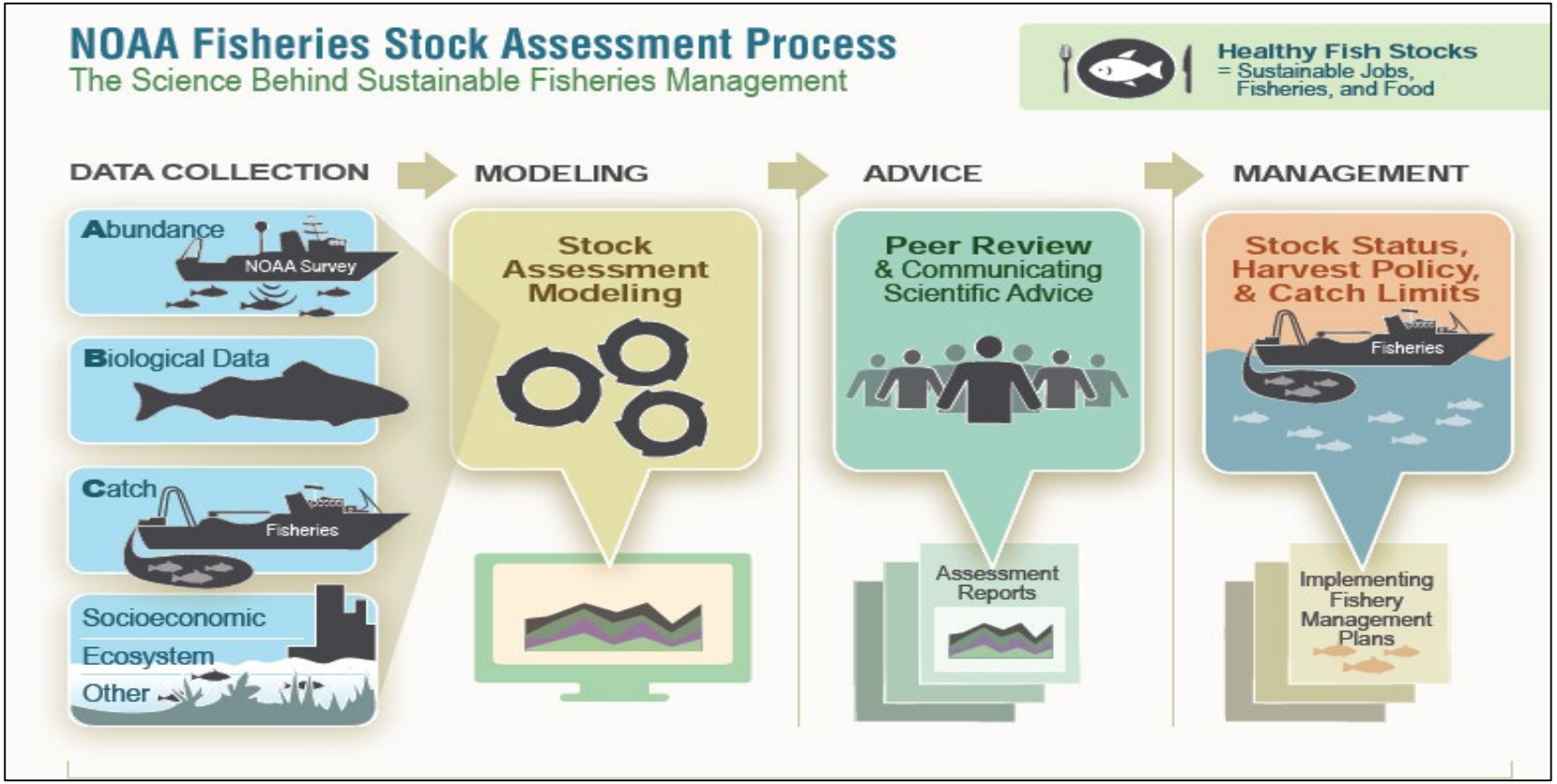


ACLIM: https://www.fisheries.noaa.gov/alaska/ecosystems/alaska-climate-integrated-modeling-project

Management Approaches

Link et al. 2019 ICES

How to incorporate climate information?



Environmentally Informed Stock Assessments

Model term	Factors	Example Species
Catchability	Temperature-dependent	
Catch	Temperature-dependent assignment	
Productivity/ Recruitment	Environmental indicators	
Growth	Time-varying with PDO regime	
Mortality	Harmful algal bloom indicator	

Table credit: Kristin Marshall

Management Challenges

- Many historical approaches are based on scientific assumptions that are no longer valid
- Updating science is not enough, we also need to update management to be more adaptable

Adapting Fisheries Management – Need Two - Pronged Approach

- Reactive Management
- Proactive Management

https://www.fisheries.noaa.gov/resource/document/review-potential-approaches-managing-marine-fisheries-changing-climate

Reactive - Adjusting Catch Limits to account for Uncertainty (Risk Tables)

Table 1. Risk classification table for assessment, population dynamics, and environmental/ecosystem considerations.

	Assessment-related considerations	Population dynamics considerations	Environmental/ecosystem considerations
Level 1: Normal	Typical to moderately increased uncertainty; minor unresolved issues in assessment.	Stock trends are typical for the stock; recent recruitment is within normal range.	No apparent environmental/ecosystem concerns.
Level 2: Substantially increased concerns	Substantially increased assessment uncertainty or unresolved issues.	Stock trends are unusual; abundance increasing or decreasing faster than has been seen recently, or recruitment pattern is atypical.	Some indicators showing an adverse signals but the pattern is not consistent across all indicators.
Level 3: Major Concern	Major problems with the stock assessment; very poor fits to data; high level of uncertainty; strong retrospective bias.	Stock trends are highly unusual; very rapid changes in stock abundance, or highly atypical recruitment patterns.	Multiple indicators showing consistent adverse signals a) across the same trophic level, and/or b) up or down trophic levels (i.e., predators and prey of stock)
Level 4: Extreme concern	Severe problems with the stock assessment; severe retrospective bias. Assessment considered unreliable.	Stock trends are unprecedented. More rapid changes in stock abundance than have ever been seen previously, or a very long stretch of poor recruitment compared to previous patterns.	Extreme anomalies in multiple ecosystem indicators that are highly likely to impact the stock. Potential for cascading effects on other ecosystem components.

Dorn and Zador, 2020

Reactive - Adjusting Catch Limits to account for Uncertainty (Risk Tables)

"In summary, while there are clearly positive signs of strong incoming recruitment, concerns exist regarding the lack of older fish contributing to spawning biomass, the uncertainty surrounding the estimates of the strength of the 2014, 2016, and 2017 year classes, and ambiguity related to how existing environmental conditions may affect the success of these year classes in the future. ***These concerns warrant additional caution when recommending the 2021 and 2022 ABCs****."*

Table. Risk table summary.

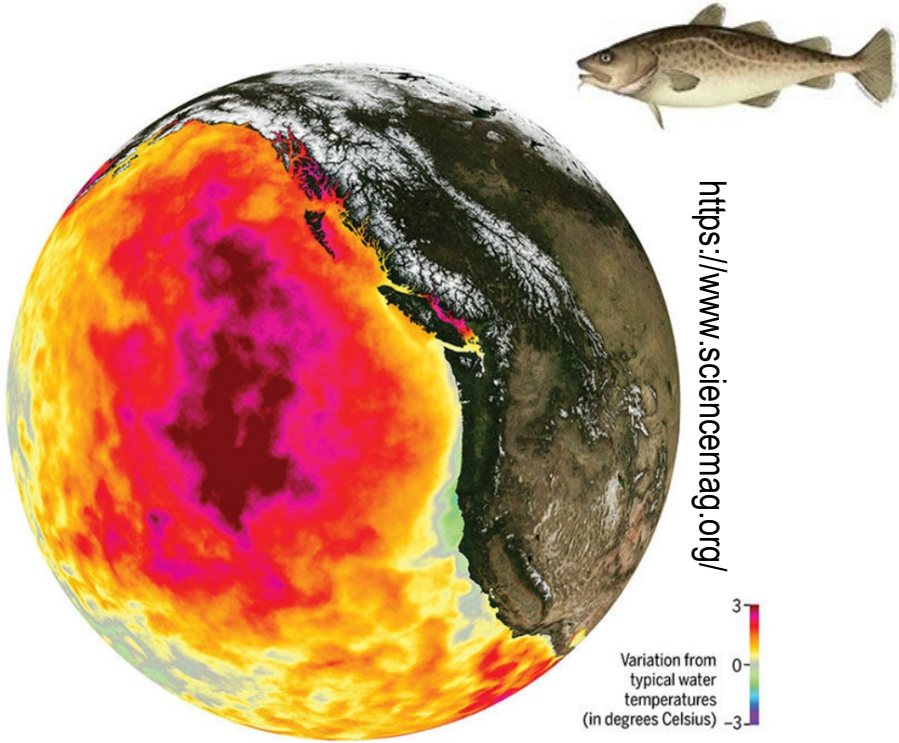
Assessment Related Considerations	Population Dynamics Considerations	Environmental and Ecosystem Considerations	Fishery Performance Considerations
Level 3: Major concern	Level 3: Major concern	Level 2: Substantially increased concern	Level 3: Major concern

2020 Sablefish of Alaska stock assessment

Dorn and Zador, 2020

Reactive - Adjusting Catch Limits as Abundances Change

- Marine heatwave anomaly coincided with reduction in Gulf of Alaska Pacific Cod biomass
- Management responded with severe cuts to catch limits and declared the 2018 fishery a fishery disaster
- Emphasizes the importance of observational data to facilitate reactive management response

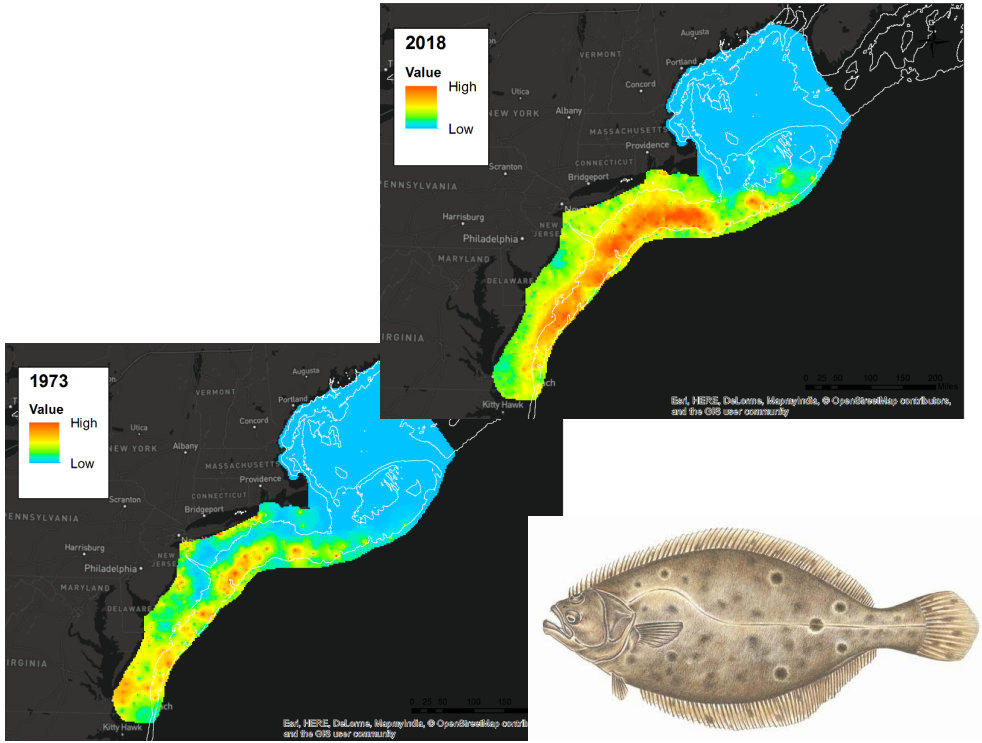


By early 2015, the unusually warm water known as The Blob covered a vast swath of the Pacific Ocean.
GENTEMANN, C., *ET AL. GEOPHYSICAL RESEARCH LETTERS* 44.1, 312, (2017)

https://www.frontiersin.org/articles/10.3389/fmars.2020.00703/full

Reactive - Adjusting Fishing Allocations as Distributions Change

- Summer Flounder have extended their range north
- New rule revises percent allocations for quota greater than 9.55 mill lb
- Management needs to balance historical use with new fishing opportunities



Reactive - Adjusting Fishing Practices as Interactions Change

- Dungeness crab fishery delayed and overlapped with northern migration of gray and humpback whales
- High number of whales entangled in crab lines
- Management exploring changes in gear and timing of season

Proactive – Add Future Flexibility

Link et al. 2019 ICES

Proactive – Scenario Planning Tool

- Identifies options to reduce risks and meet goals under multiple likely futures
- Identify actions for adaptability
- Prepares for future reactive management

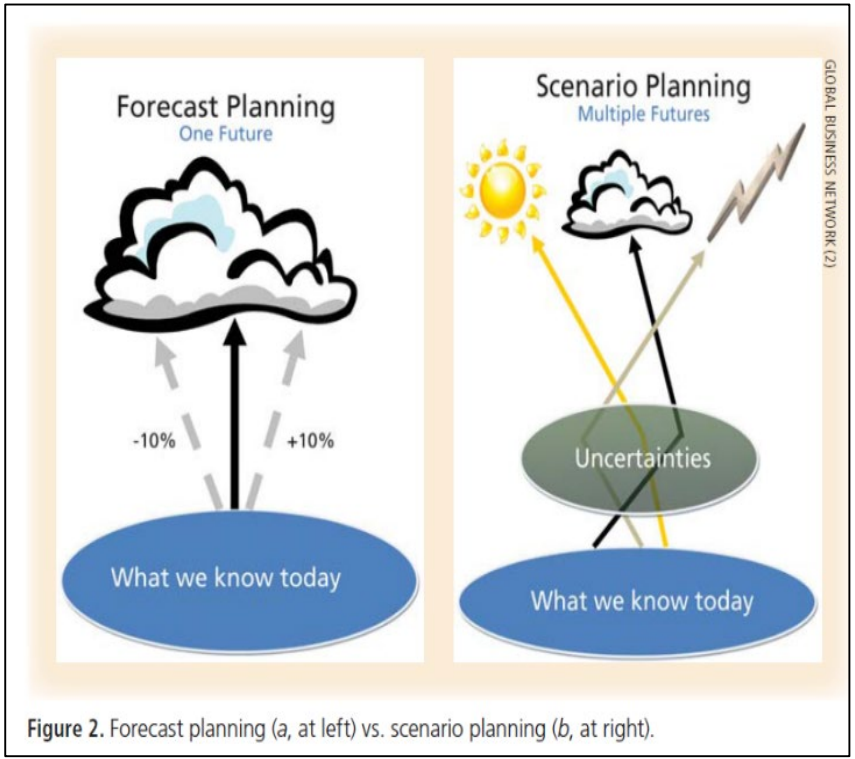


Figure 2. Forecast planning (*a*, at left) vs. scenario planning (*b*, at right).

Weeks et al. 2011, Park Science

Benefits from Scenario Planning

1. *Flexibility to react quickly to a changing world*
2. *More robust decisions and plans*
3. *Innovative ideas*
4. *Early and broad risk identification*
5. *Alignment towards a common vision*

Source: Scenario Insight

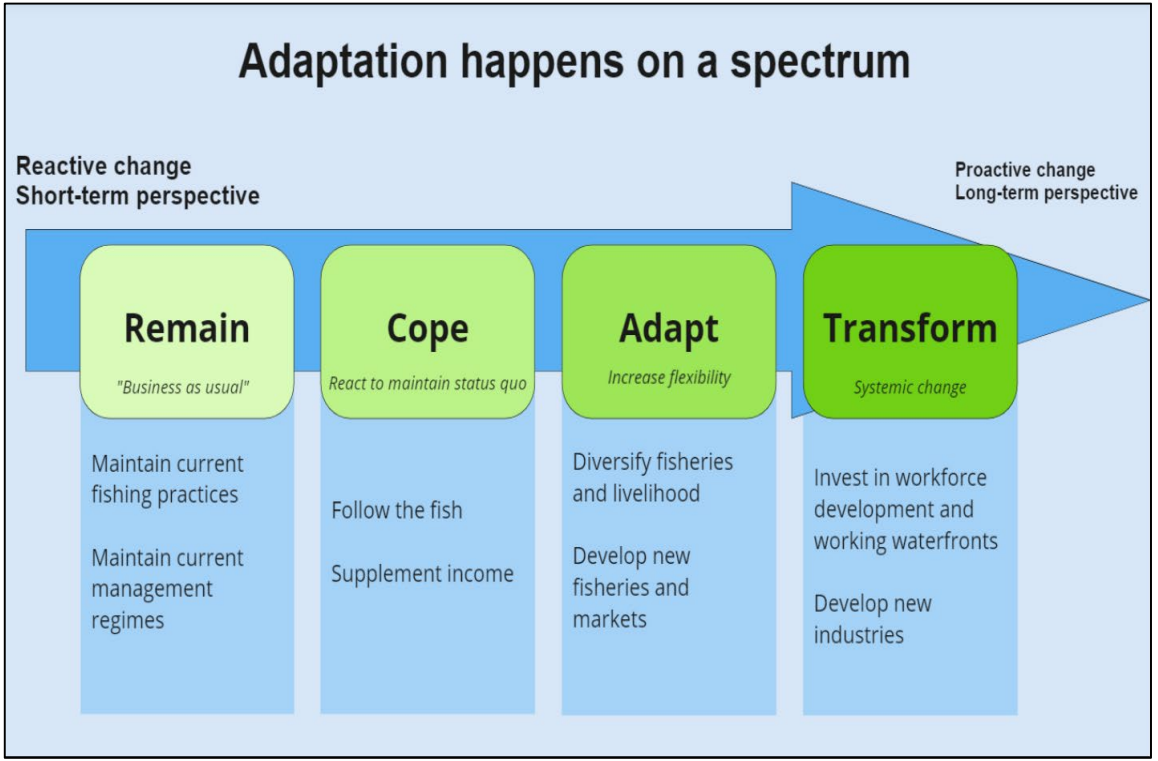
Proactive – Increase Resilience of Stocks, Ecosystems

- Protect old females (BOFFs).
- Protect key habitats or species.
- Evaluate Council risk policies (more and less risk).

Review of Fishery Management Approaches to Changing Climate - https://www.fisheries.noaa.gov/resource/document/review-potential-approaches-managing-marine-fisheries-changing-climate

Proactive – Increase Resilience of Communities & Businesses

- Identify risks
- Diversify catch
- Consider supply chains
- Engage communities
- Plan for adaptation



Source image: Marysia Szymkowiak (NMFS AFSC)

Unique Opportunity – Inflation Reduction Act (IRA) Funding

+ $349 million to advance Climate-Ready Fisheries:
  - Expand and Modernize Stock Assessments
  - Climate Ecosystems and Fisheries Initiative (CEFI)
  - Focus on specific challenges including North Atlantic Right Whale, Red Snapper, Pacific Salmon, Protected Resources recovery.
+ $784 million for hatcheries and habitat conservation

https://www.fisheries.noaa.gov/national/climate/helping-america-prepare-and-respond-climate-change-under-inflation-reduction-act
https://www.fisheries.noaa.gov/topic/climate-change/climate,-ecosystems,-and-fisheries

Climate, Ecosystems and Fisheries Initiative (CEFI)

$40M effort building capacity to better:

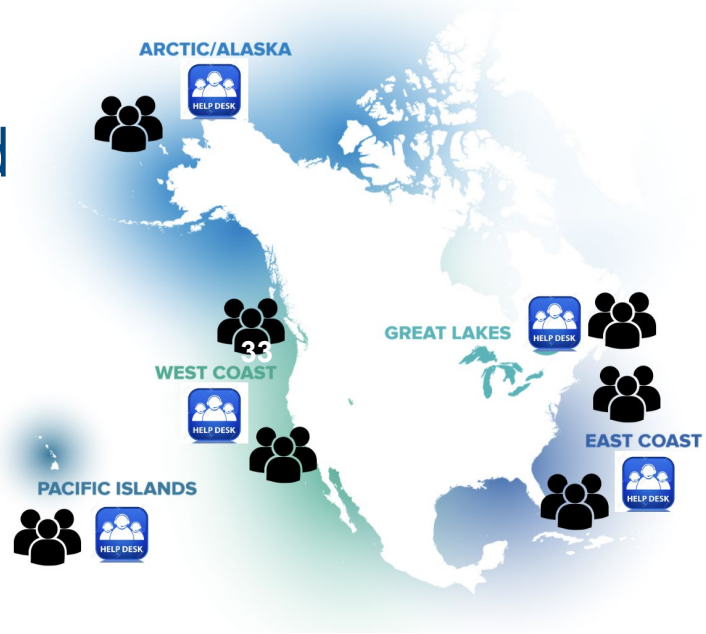
- assess risks
- evaluate options
- inform decisions

for effective resource management and community adaptation.

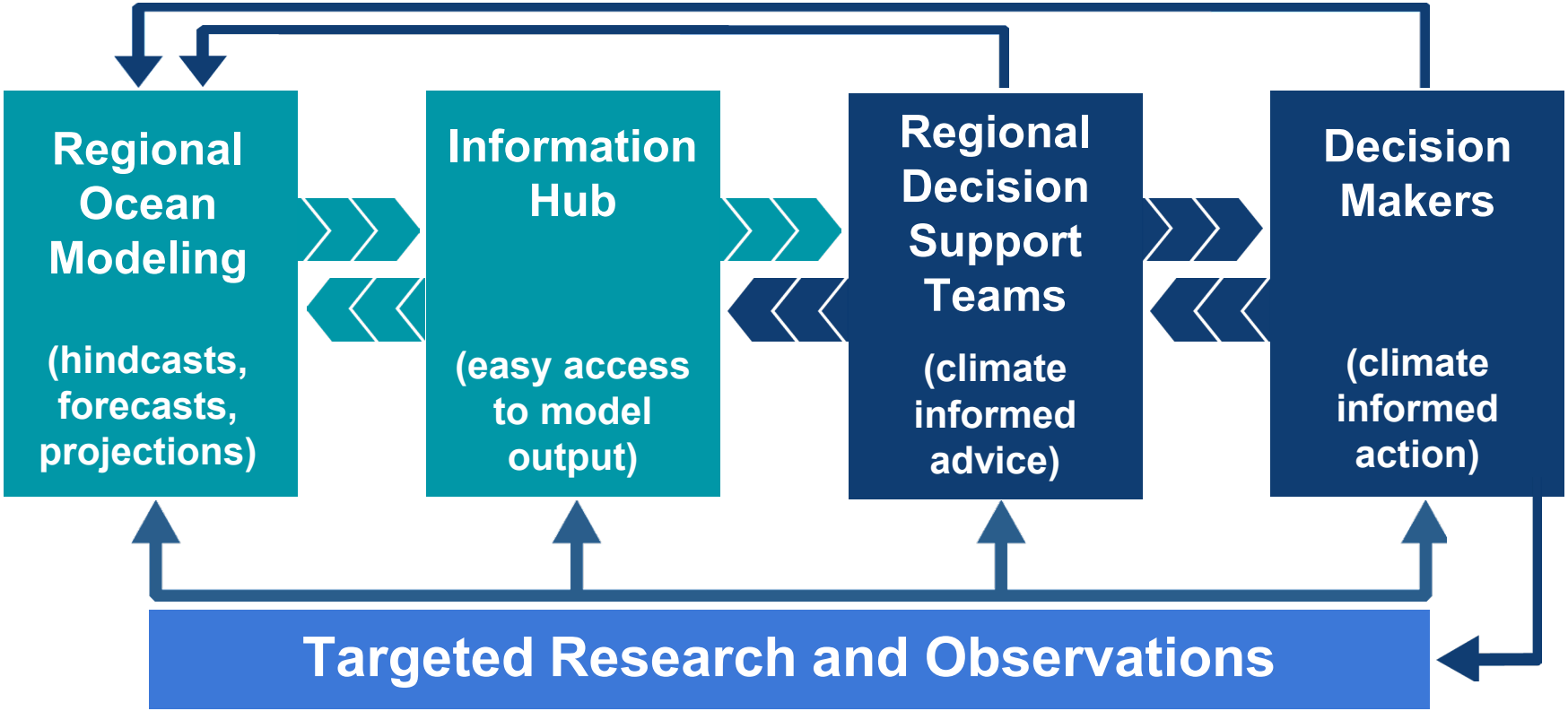
Regional Ocean Modeling Teams

Regional Decision Support Teams

CEFI Regional Teams

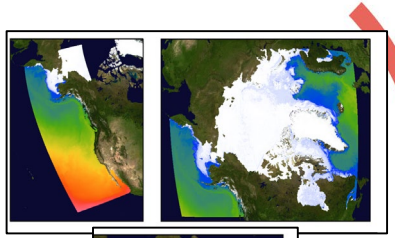


CEFI Decision Support System

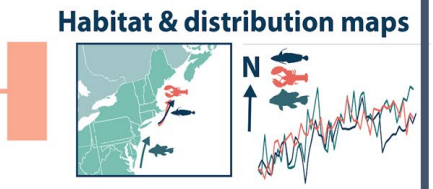


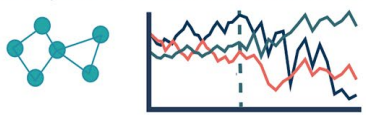
CEFI Decision Support System

Regional Ocean Modeling Outlooks



Regional Decision Support Team Products





Advice Pathways

- Stock Assessmts
- Socio-Econ Assessmts
- Ecosystem Assessmts
- Risk Assessmts
- Scenario Planning [35]
- Strategy Evaluations

Regional Applications

- Rapid responses
- Fisheries strategies
- Recovery plans
- Community adaptation Strategies

Key Take-aways (1)

- Changing climate and ocean conditions are impacting fisheries, fisheries management & fishing communities.
- There are a number of tools available to help track change, assess risks and identify effective management strategies.
- NOAA is working to increase the production, delivery and use of ecosystem and climate information in fisheries management.

Key Take-aways (2)

- Decision makers need to be ***both proactive and reactive***
- We can expect the need for reactive responses to increase in the future
- There are proactive things we can do now to improve our reactive responses in the future (e.g. **Scenario planning)**

For more information (1)

- NOAA Fisheries Climate Science Strategy and Regional Action Plans - https://www.fisheries.noaa.gov/national/climate/noaa-fisheries-climate-science-strategy
- Next Generation Stock Assessments - https://spo.nmfs.noaa.gov/sites/default/files/TMSPO183.pdf
- Accounting for shifting distributions and changing productivity in Fisheries Management - https://spo.nmfs.noaa.gov/sites/default/files/TMSPO188.pdf
- Integrated Ecosystem Assessments - https://www.integratedecosystemassessment.noaa.gov/
- NOAA Climate, Ecosystems and Fisheries Initiative (CEFI) - https://www.fisheries.noaa.gov/topic/climate-change#noaa-climate-and-fisheries-initiative
- NMFS EBFM Policy and Road Map - https://www.fisheries.noaa.gov/national/ecosystems/ecosystem-based-fisheries-management

For more information (2)

- Review of Fishery Management Approaches to Changing Climate - https://www.fisheries.noaa.gov/resource/document/review-potential-approaches-managing-marine-fisheries-changing-climate
- East Coast Scenario Planning https://www.mafmc.org/climate-change-scenario-planning
- Scenario Planning for Fisheries Managers - https://www.fisheries.noaa.gov/resource/document/scenario-planning-introduction-fishery-managers
- Proposed Business Rules to Incorporate Climate-Induced Changes in Fisheries Management https://academic.oup.com/icesjms/article/78/10/3562/6425783
- Linking Knowledge and Action for Climate-Ready Fisheries: Emerging Best Practices Across the U.S. https://www.sciencedirect.com/science/article/pii/S0308597X23002919

Thank you!

Questions?

Jay Peterson - jay.peterson@noaa.gov
Wendy Morrison - wendy.morrison@noaa.gov
Melissa Karp - melissa.karp@noaa.gov
Roger Griffis - roger.b.griffis@noaa.gov