Climate Ecosystem & Fisheries Initiative (CEFI)

ACLIM phase 2 → 3

Kirstin Holsman

CCTF Nov. 1, 2023

Government, industry and community decision makers urgently need robust information on future ocean conditions, how to prepare and what actions to take to reduce risks and adapt.

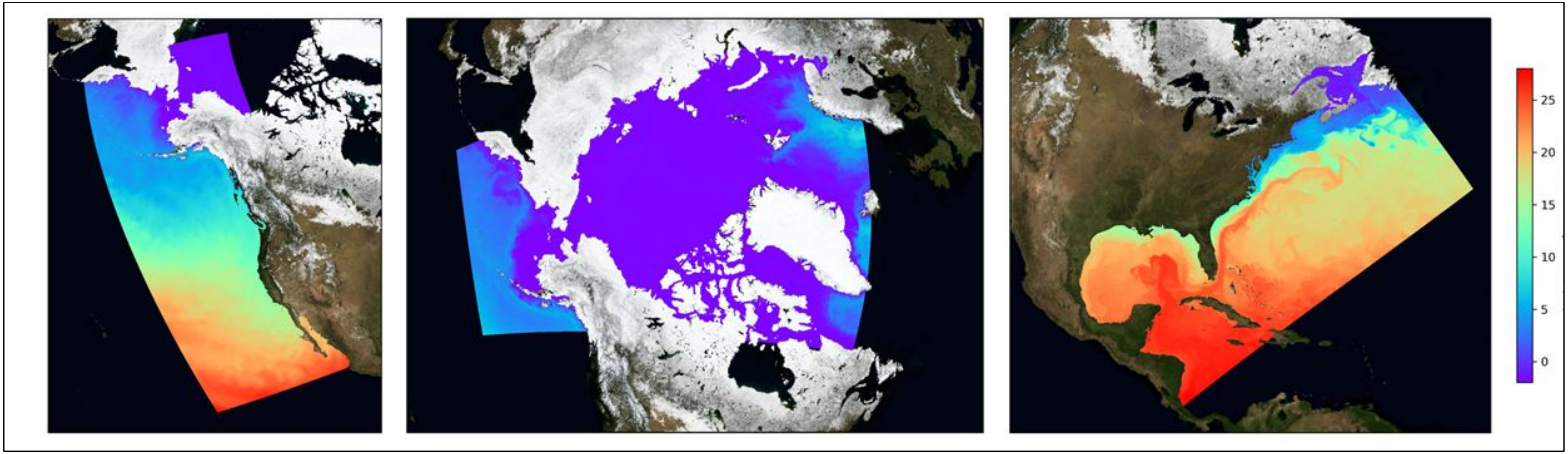
CEFI will provide decision makers with the information and capacity needed to assess risks, identify adaptation strategies and take action.

CEFI MOM6 High-Res Regional Oceanographic model grids

E. Pacific

Arctic

W. Atlantic



CEFI Decision Support System

Regional Ocean Modeling
(produce hindcasts, forecasts, predictions)

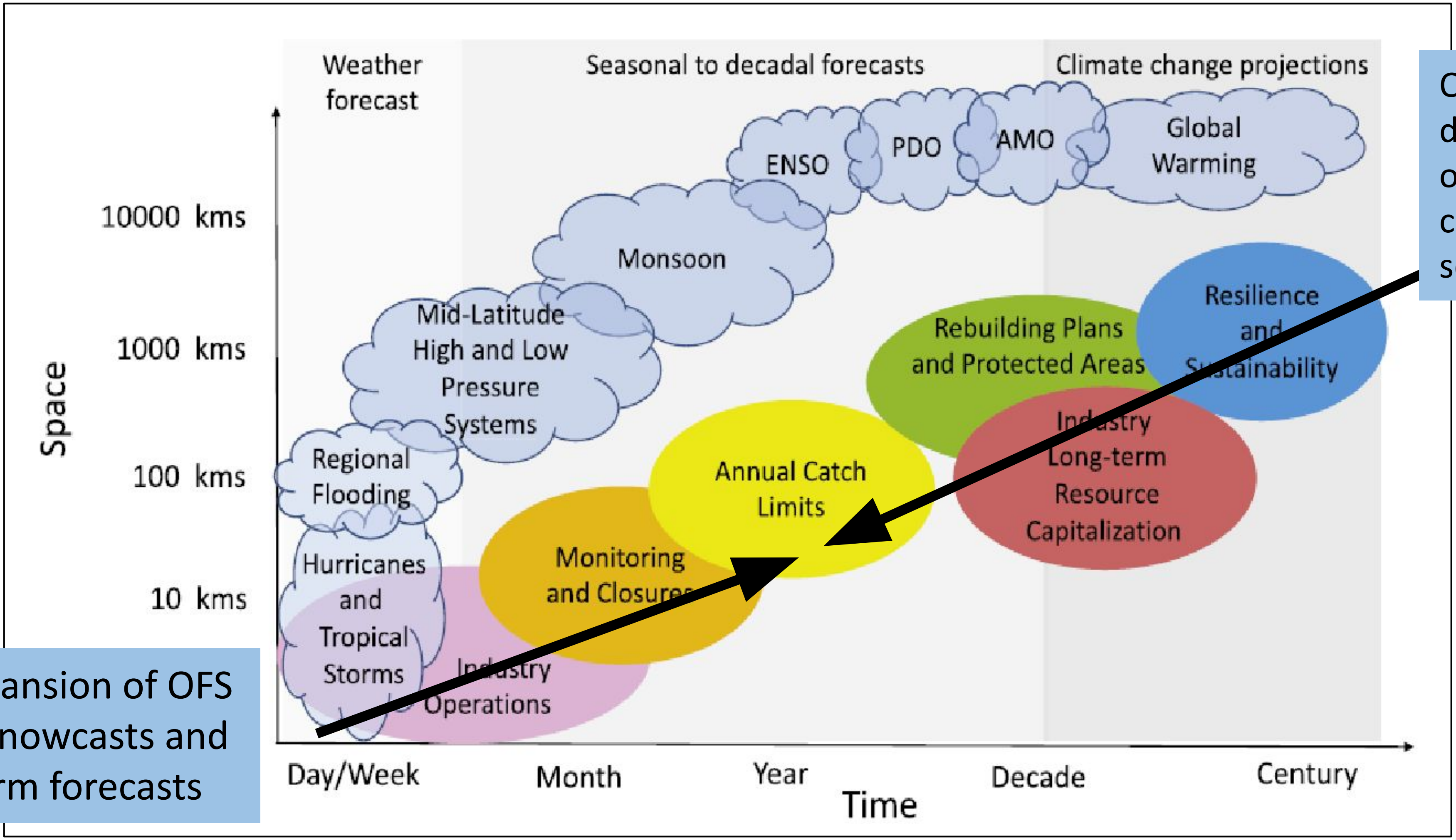
Information Hub
(serve model output in standardized format)

Decision Support Teams
(produce tools and advice for climate-ready resource management)

Decision Makers
(use tools and advice for resilience & adaptation)

Targeted Research and Observations Supporting All Elements

Ocean Predictions & Projections across Management Time Horizons



OAR-led regional deployment of MOM6 ocean physics + BGC configurations for seasonal to decadal

NOS-led expansion of OFS systems for nowcasts and shorter-term forecasts

"Work to Ensure" the following deliverables are met

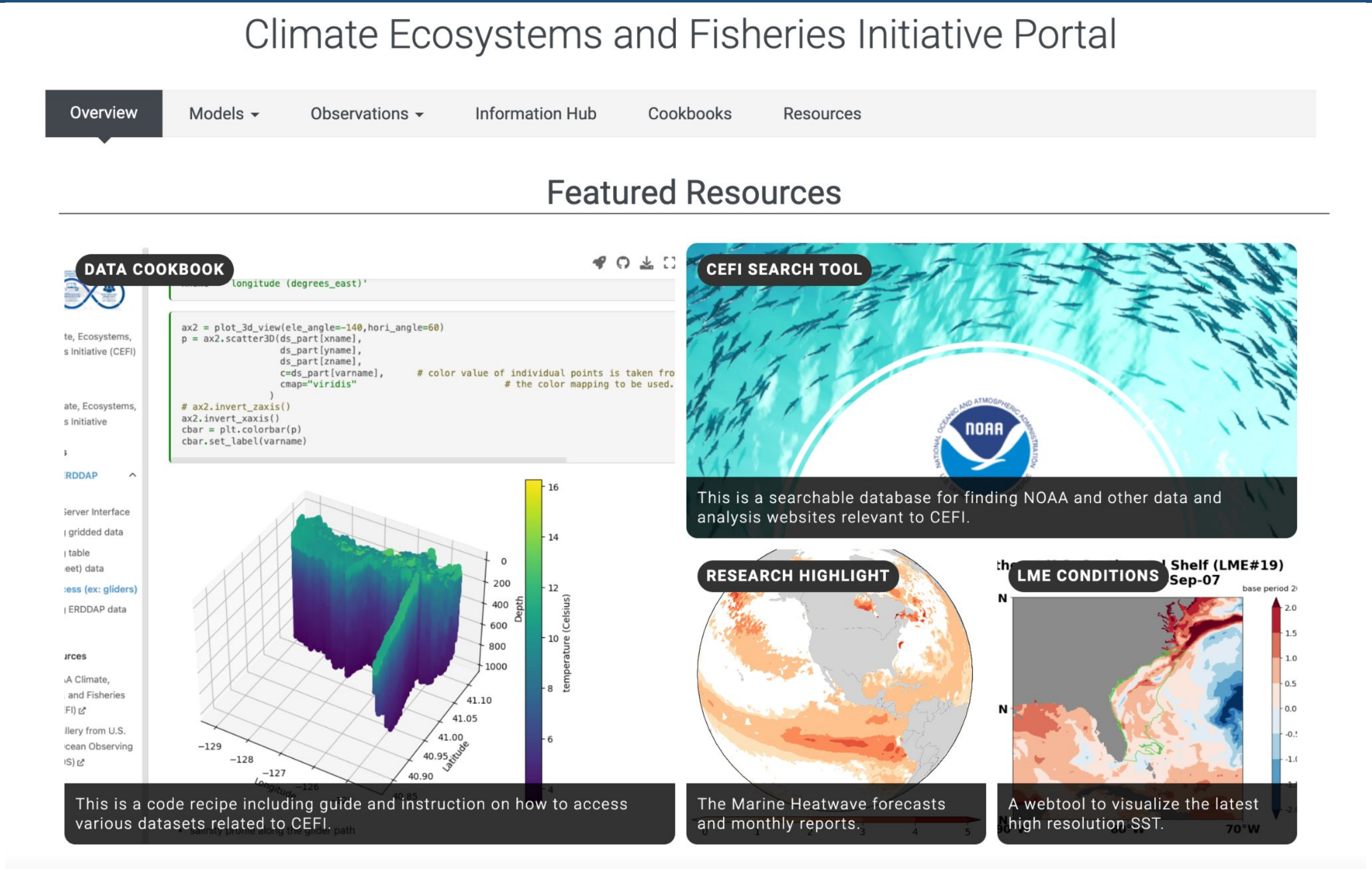
Year	East Coast	West Coast and Arctic	Great Lakes, Pacific Islands
FY23	Retrospective Ocean Simulation	Initial Configurations	
FY24	Multidecadal projections and retrospective seasonal predictions	Retrospective Ocean Simulations	Initial configurations
FY25	Retrospective multi-annual predictions	Multidecadal projections and retrospective seasonal predictions	Retrospective Ocean Simulation
FY26	Seasonal outlooks commence	Retrospective multi-annual predictions	Multidecadal projections and retrospective seasonal predictions
FY27	Continue seasonal outlooks, multi-annual outlooks commence	Begin regular seasonal and multi-annual outlook updates	Retrospective multi-annual predictions

Portal Component FY24 Annual Work Plan

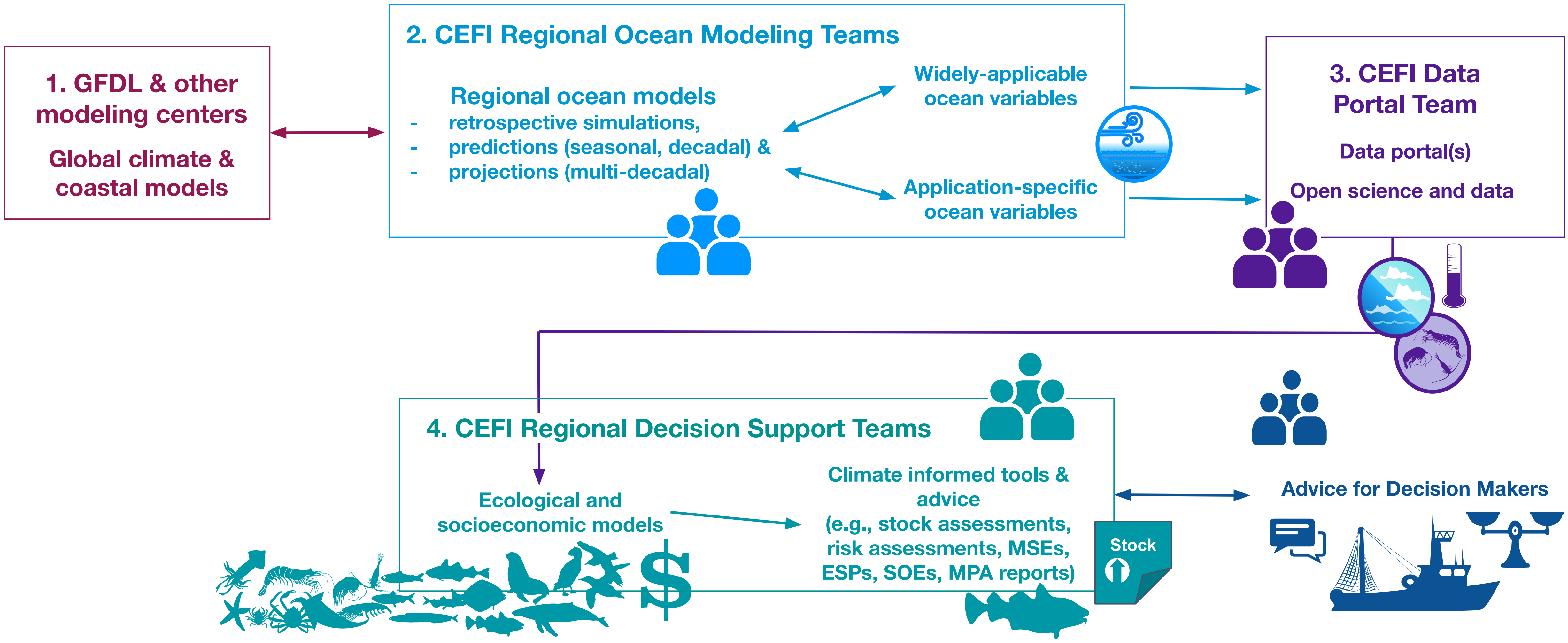
FY23 Achievements:

Prototype Portal Structure

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



Decision Support Component Workflow



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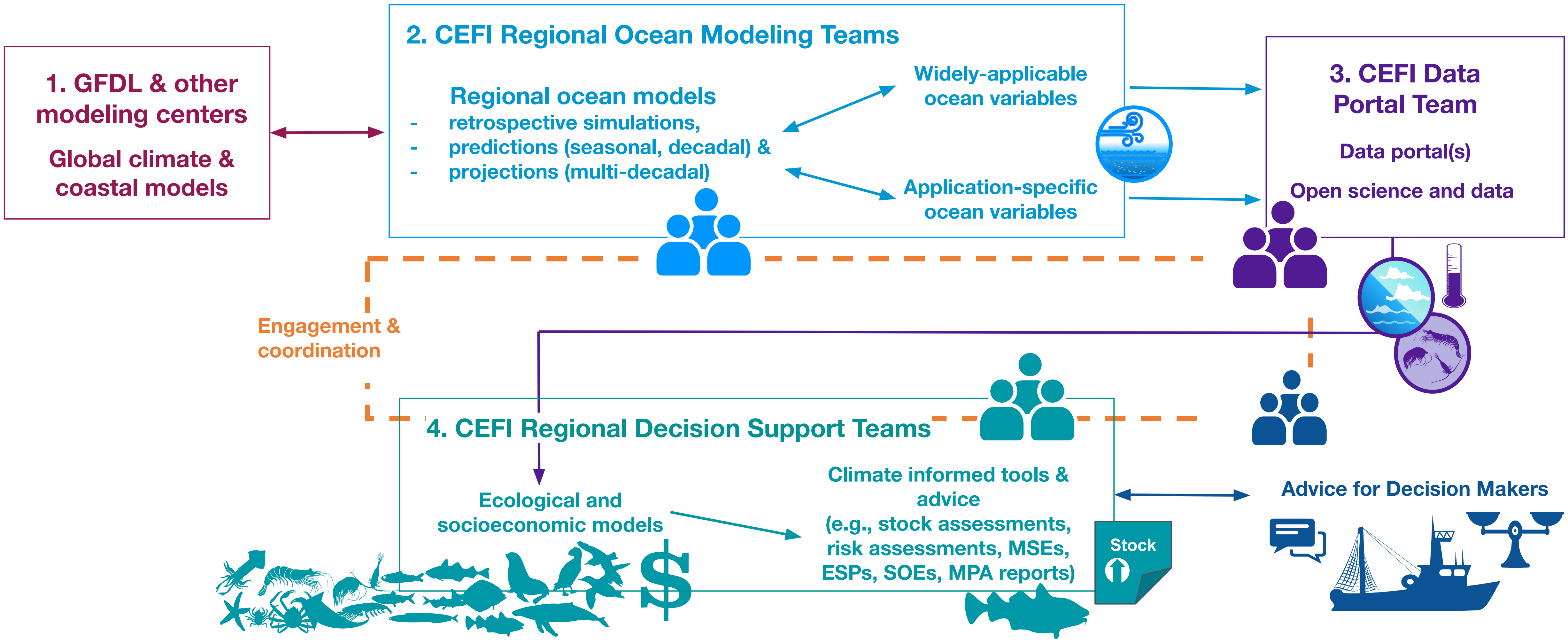

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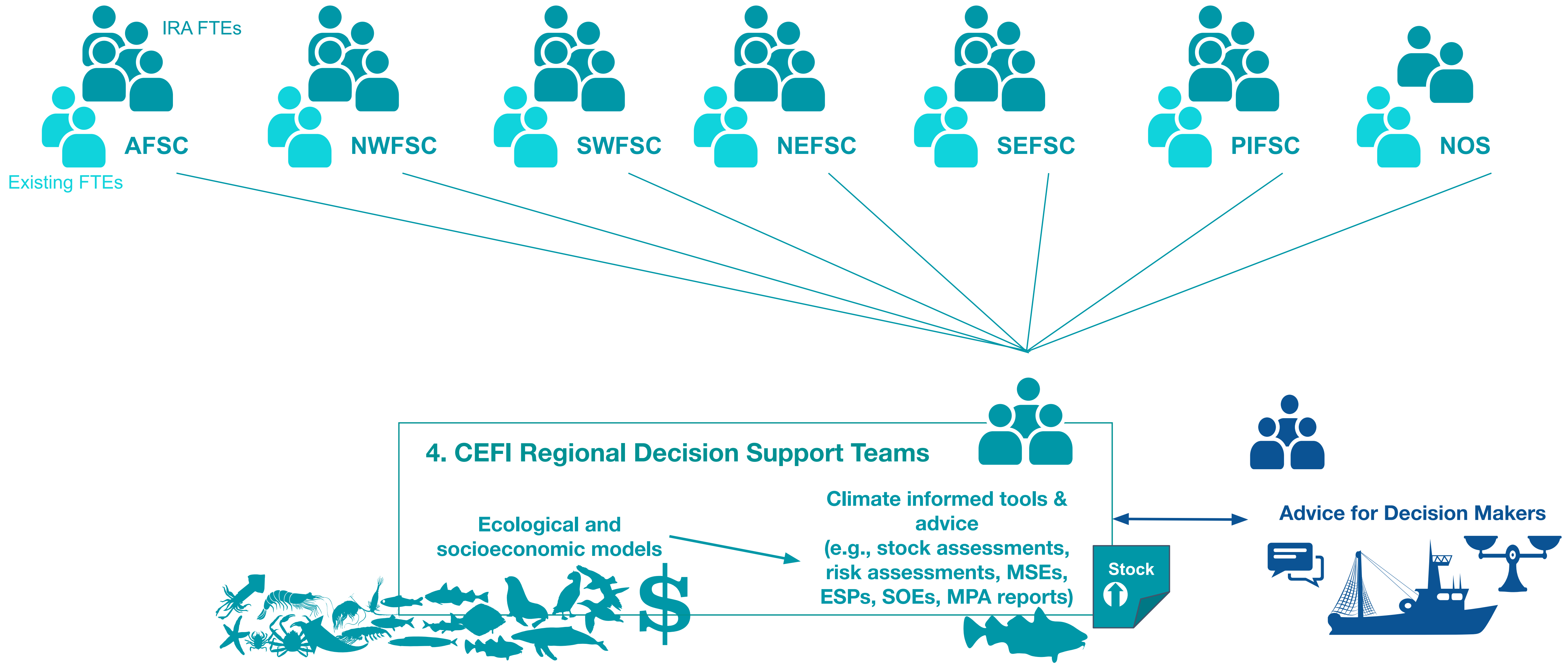

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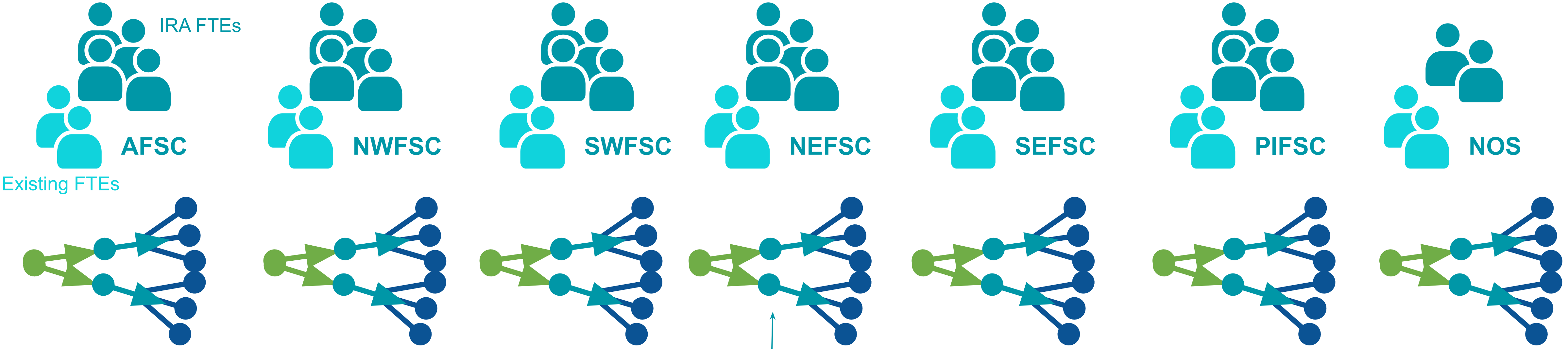

2-3 operational climate-integrated advice products anticipated per region by 2026

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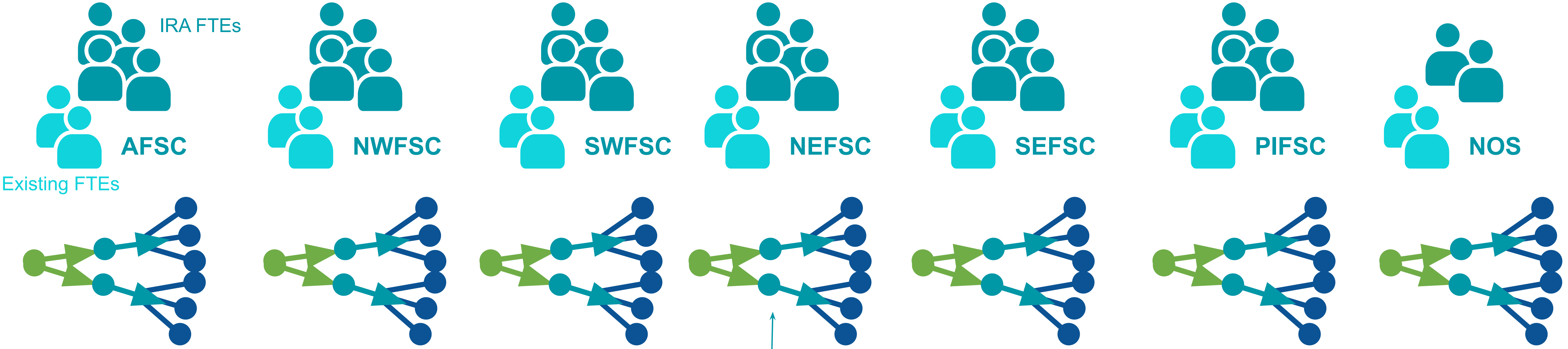

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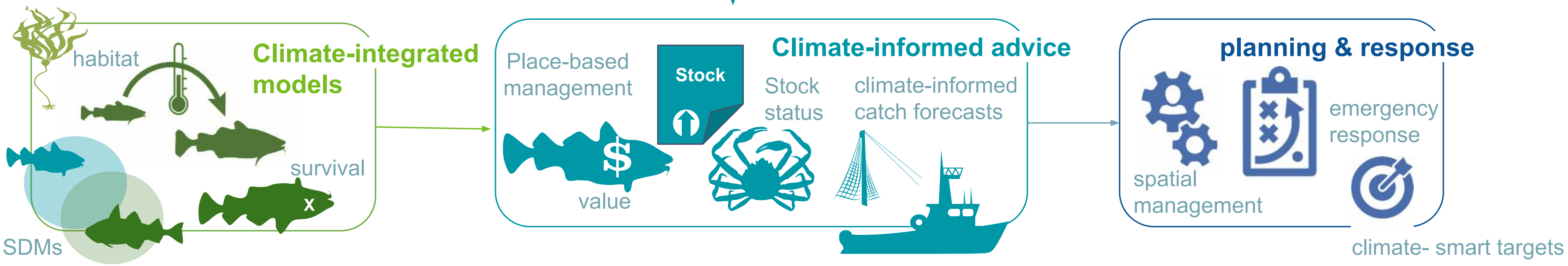
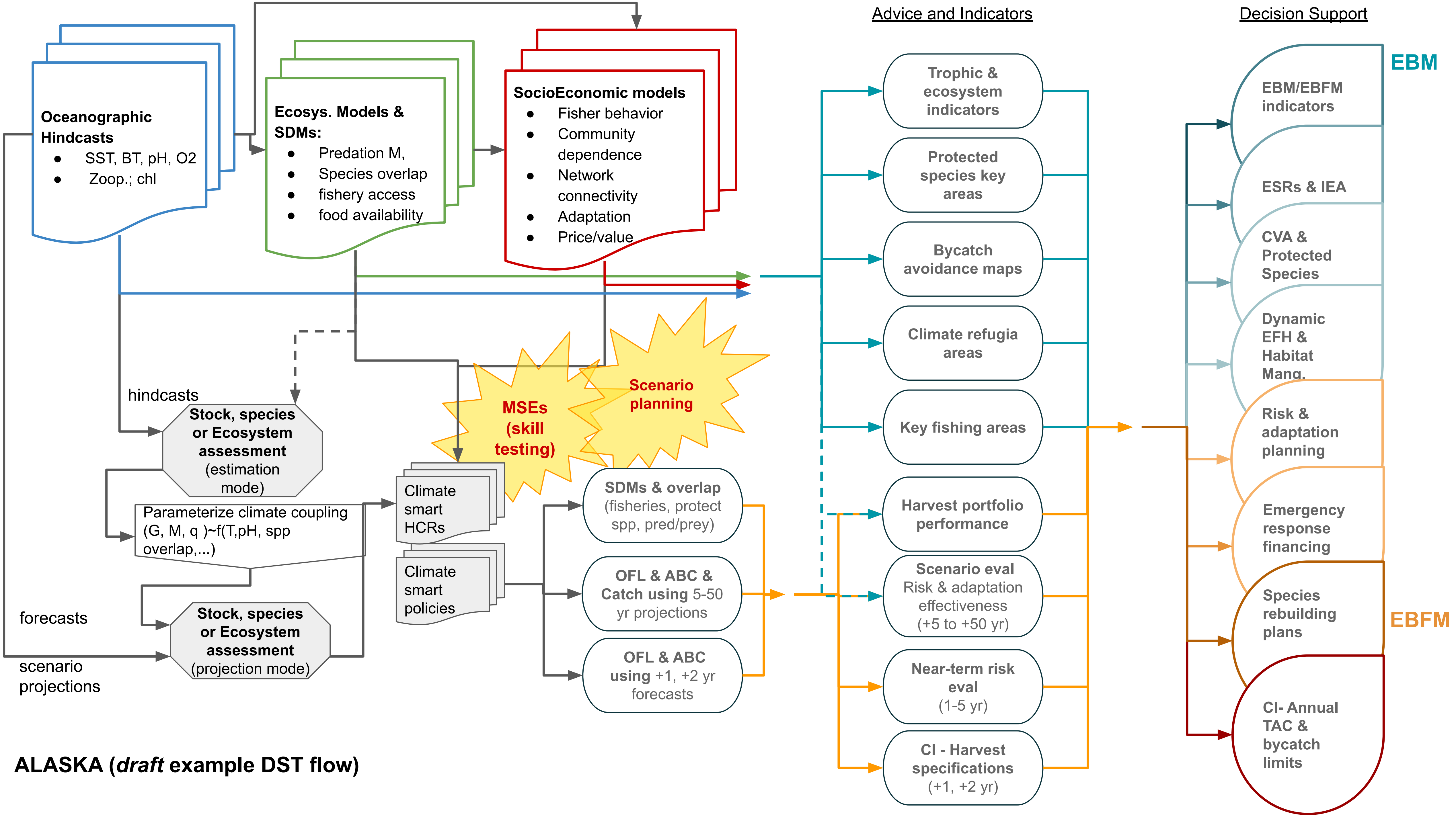
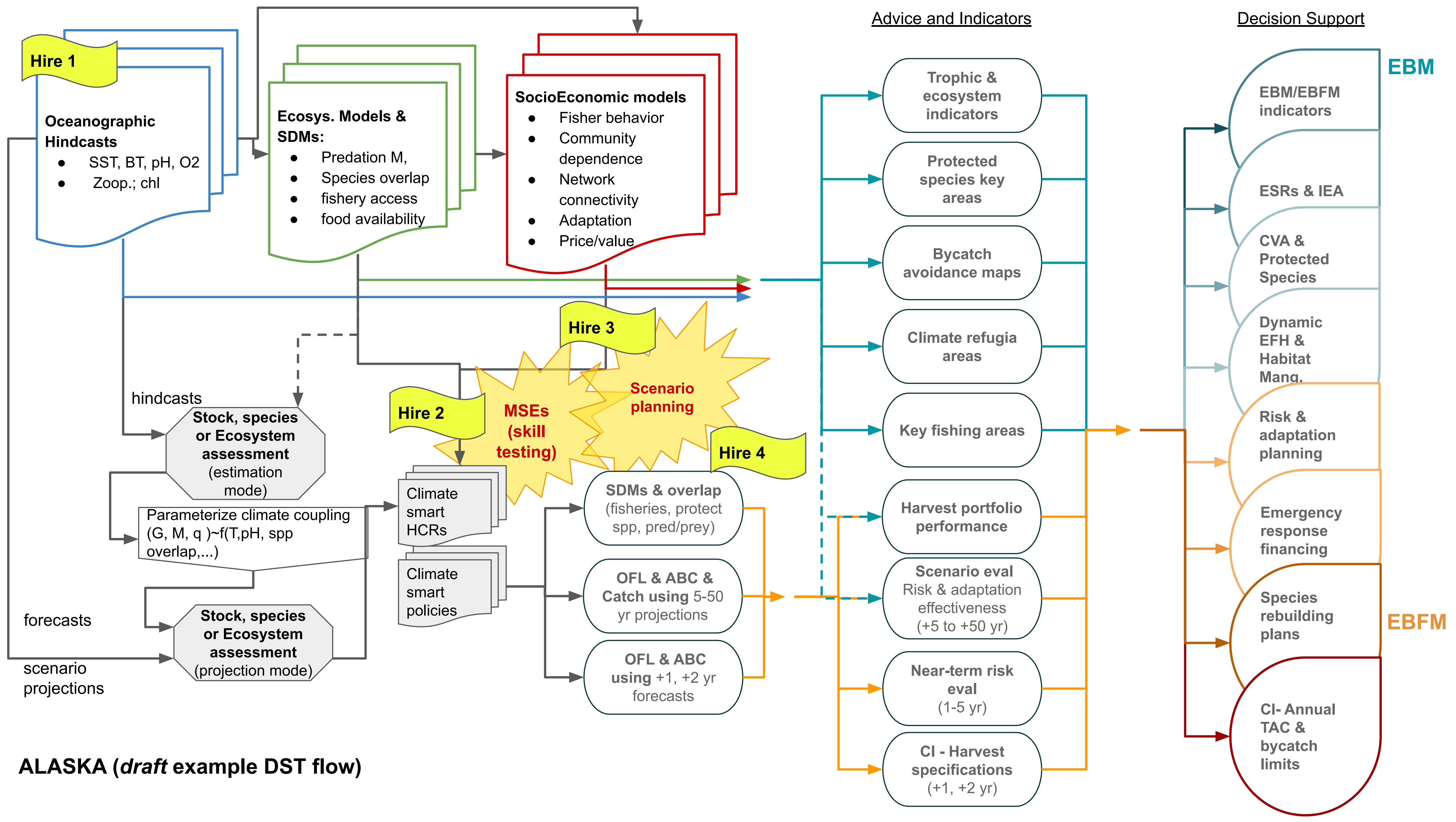




ALASKA (*draft* example DST flow)


Advice and Indicators
Decision Support
Hire 1
Oceanographic Hindcasts
SST, BT, pH, O2
Zoop.; chl
Ecosys. Models & SDMs:
Predation M,
Species overlap
fishery access
food availability
SocioEconomic models
Fisher behavior
Community dependence
Network connectivity
Adaptation
Price/value
Trophic & ecosystem indicators
Protected species key areas
Bycatch avoidance maps
Climate refugia areas
Key fishing areas
Harvest portfolio performance
Scenario eval
Risk & adaptation effectiveness (+5 to +50 yr)
Near-term risk eval (1-5 yr)
CI - Harvest specifications (+1, +2 yr)
EBM
EBM/EBFM indicators
ESRs & IEA
CVA & Protected Species
Dynamic EFH & Habitat Mang.
Risk & adaptation planning
Emergency response financing
Species rebuilding plans
CI- Annual TAC & bycatch limits
EBFM
Hire 3
Scenario planning
Hire 2
MSEs (skill testing)
Hire 4
hindcasts
Stock, species or Ecosystem assessment (estimation mode)
Parameterize climate coupling (G, M, q)~f(T,pH, spp overlap,...)
Climate smart HCRs
Climate smart policies
SDMs & overlap (fisheries, protect spp, pred/prey)
OFL & ABC & Catch using 5-50 yr projections
OFL & ABC using +1, +2 yr forecasts
forecasts
Stock, species or Ecosystem assessment (projection mode)
scenario projections
ALASKA (draft example DST flow)

ACLIM phase 2 → 3

Kirstin Holsman
CAFA group update
Sep 27, 2023

ACLIM Team

Lead PIs: Anne Hollowed, Kirstin Holsman, Jon Reum, Andre Punt, Kerim Aydin, Al Hermann, Cody Szuwalski, Sarah Wise

Active Co-Pis & Collaborators

Wei Cheng
Jim Ianelli
Kelly Kearney
Elizabeth McHuron
Daren Pilcher
Ingrid Spies
Paul Spencer
Jeremy Sterling
William Stockhausen
Ellen Yasumiishi
Steve Barbeaux
Cheryl Barnes
Andy Whitehouse
Maurice Goodman

Mike Dalton
Jennifer Bigman
Martin Dorn
Ed Farley
Elliott Hazen
Mike Jacox
David Kimmel
Stan Kotwicki
Ben Laurel
Carey McGilliard
M. Mooney-Seus
Maxime Olmos
Kalei Shotwell
Elizabeth Siddon

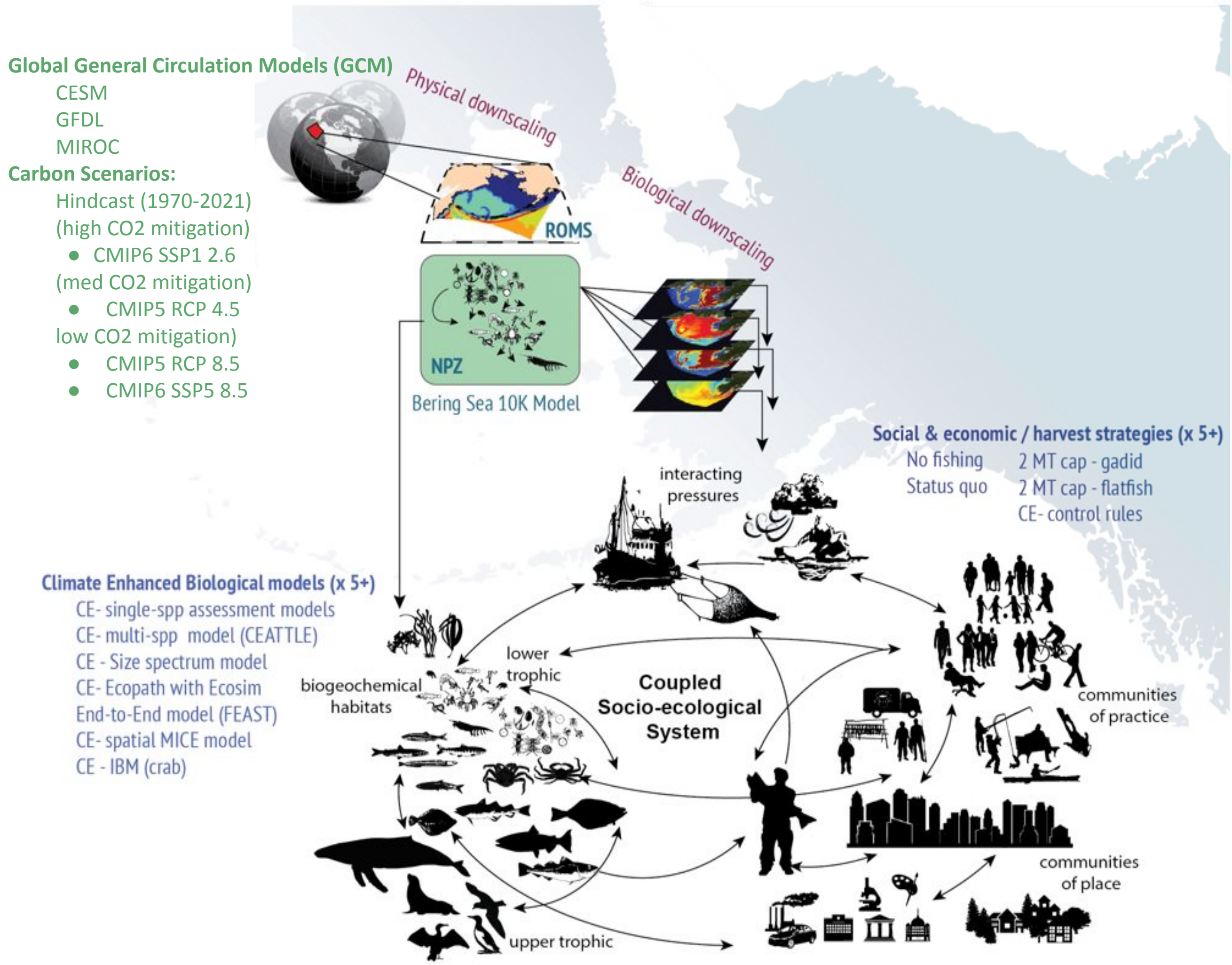
Ivonne Ortiz
Lauren Rogers
Phyllis Stabeno
Peggy Sullivan
Roland Schweitzer
Jessica Reynolds
Matthieu Veron
Genoa Sullaway
Andrea Havron

Diana Evans
Cathleen Vestfals
Rolf Ream
Chris Rooper
Libby Logerwell
Enrique Curchister
Charlie Stock
Franz Mueter
Thomas Hurst
James Thorson
Trond Kristiansen

Supporting climate resilience through climate-informed Ecosystem Based Management advice

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

The Alaska Climate Integrated Modeling Project



Hollowed et al. 2020. https://doi.org/10.3389/fmars.2019.00775

Goal: To address climate information needs with best available science & tools

What to expect?

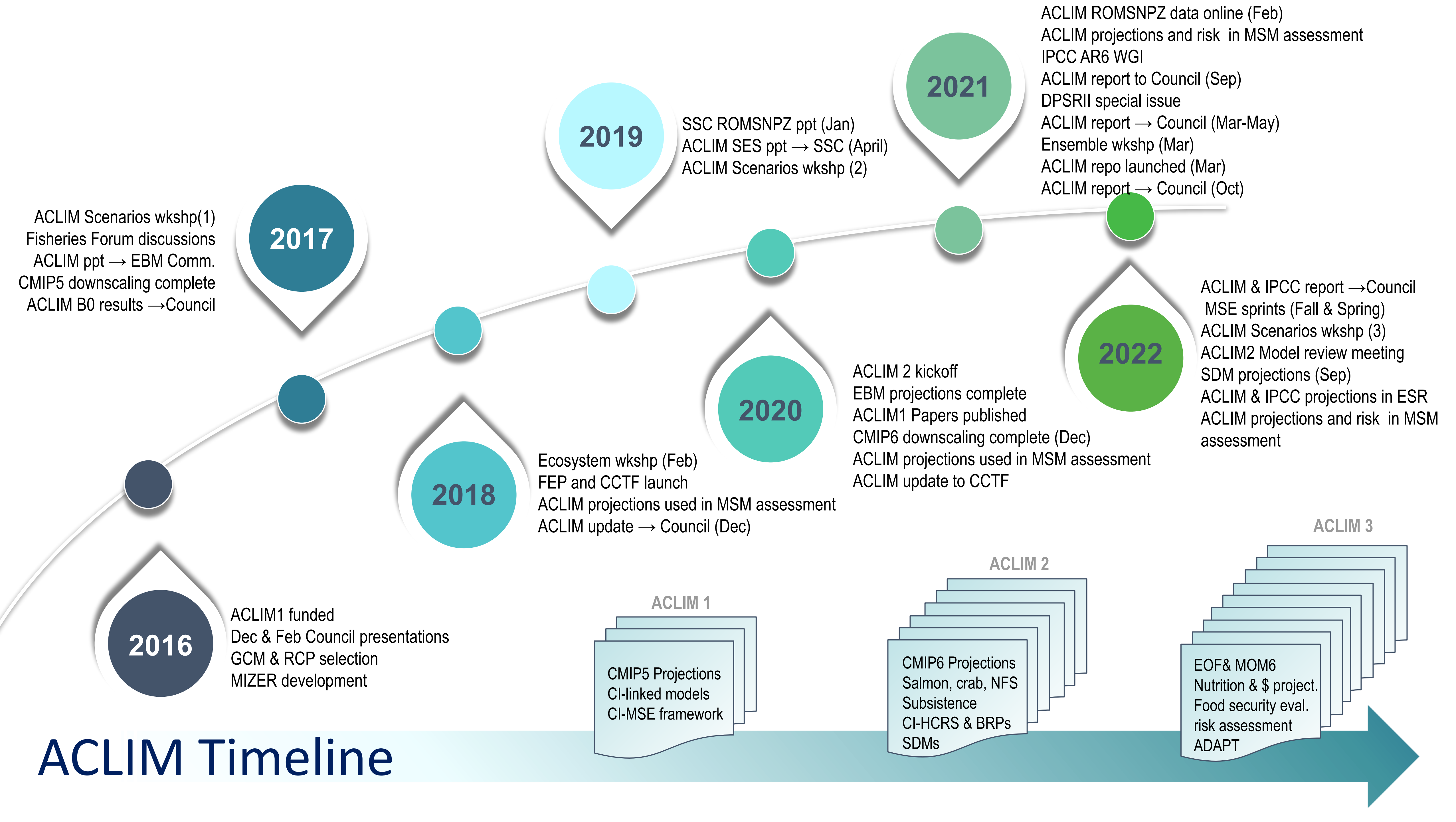
- Project physical and ecological conditions under levels of climate change (levels of global carbon mitigation)
- Characterize uncertainty

What can be done?

- Evaluate effectiveness of adaptation actions including those supported by fisheries management

Scenarios form the basis for comparative simulations & Management Strategy Evaluations

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


ACLIM Timeline
2016
ACLIM1 funded
Dec & Feb Council presentations
GCM & RCP selection
MIZER development
2017
ACLIM Scenarios wkshp(1)
Fisheries Forum discussions
ACLIM ppt → EBM Comm.
CMIP5 downscaling complete
ACLIM B0 results →Council
2018
Ecosystem wkshp (Feb)
FEP and CCTF launch
ACLIM projections used in MSM assessment
ACLIM update → Council (Dec)
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IPCC AR6 WGI
ACLIM report to Council (Sep)
DPSRII special issue
ACLIM report → Council (Mar-May)
Ensemble wkshp (Mar)
ACLIM repo launched (Mar)
ACLIM report → Council (Oct)
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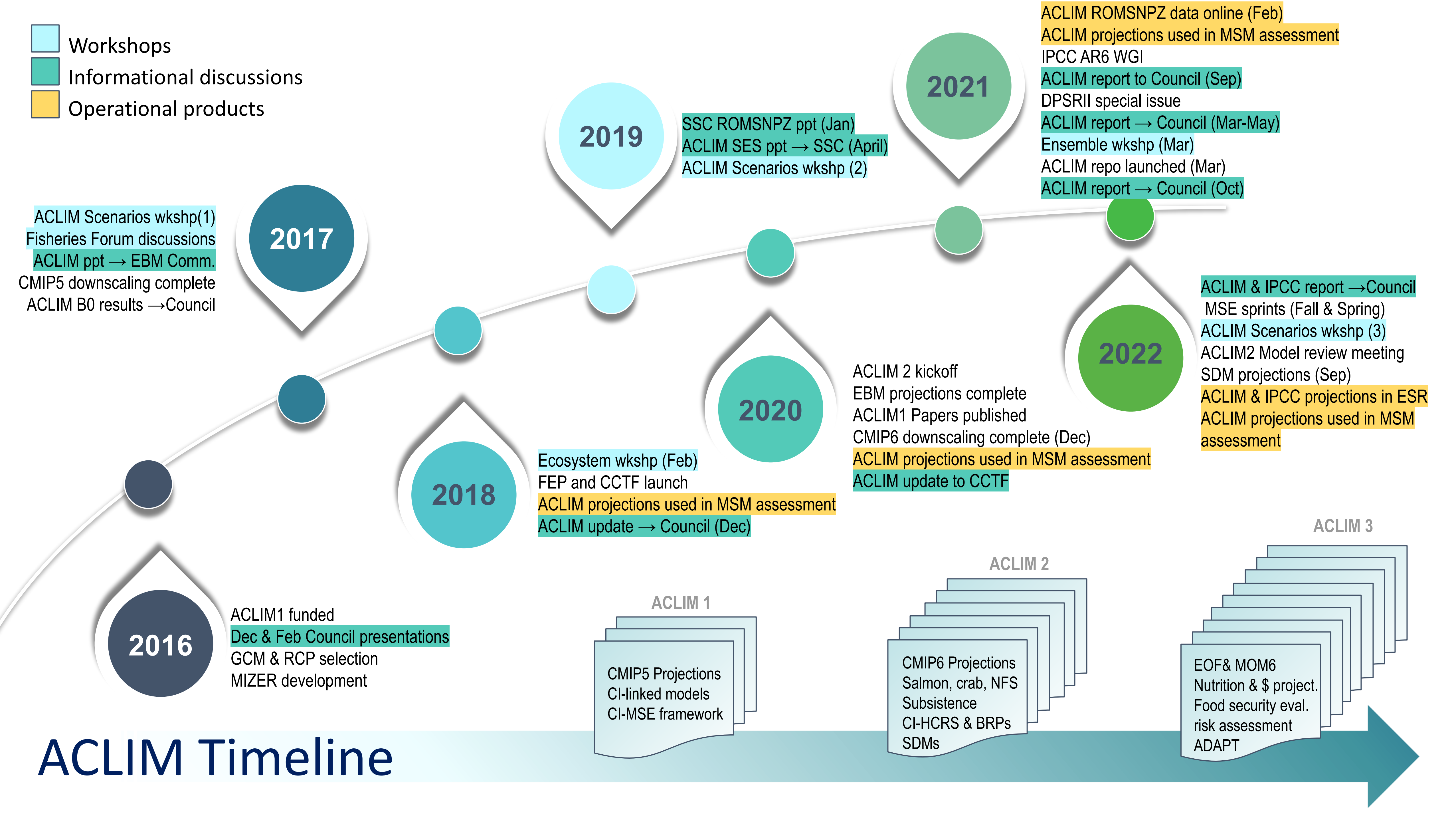
CI-linked models
CI-MSE framework
ACLIM 2
CMIP6 Projections
Salmon, crab, NFS
Subsistence
CI-HCRS & BRPs
SDMs
ACLIM 3
EOF& MOM6
Nutrition & $ project.
Food security eval.
risk assessment
ADAPT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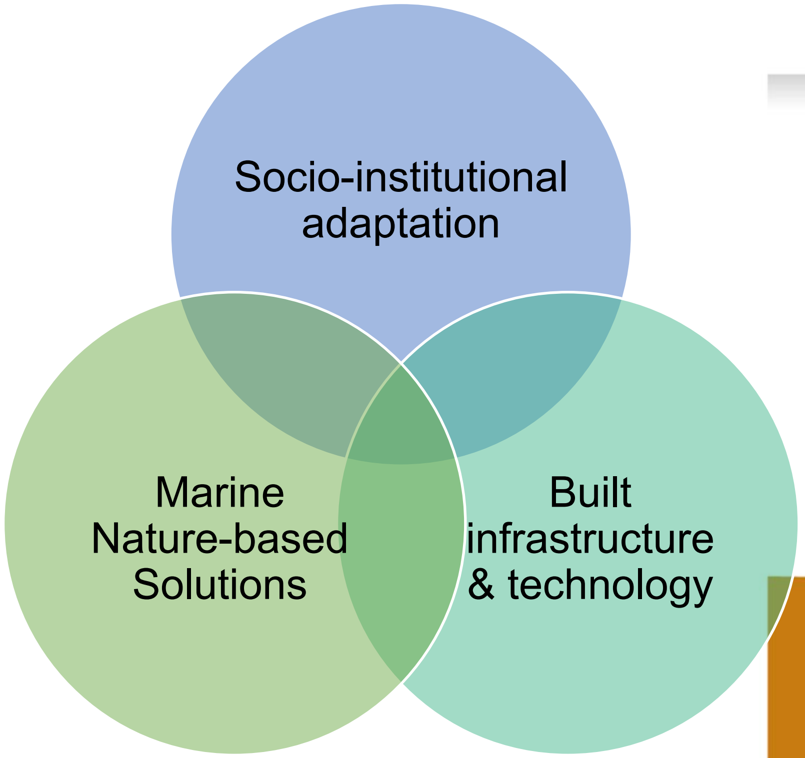
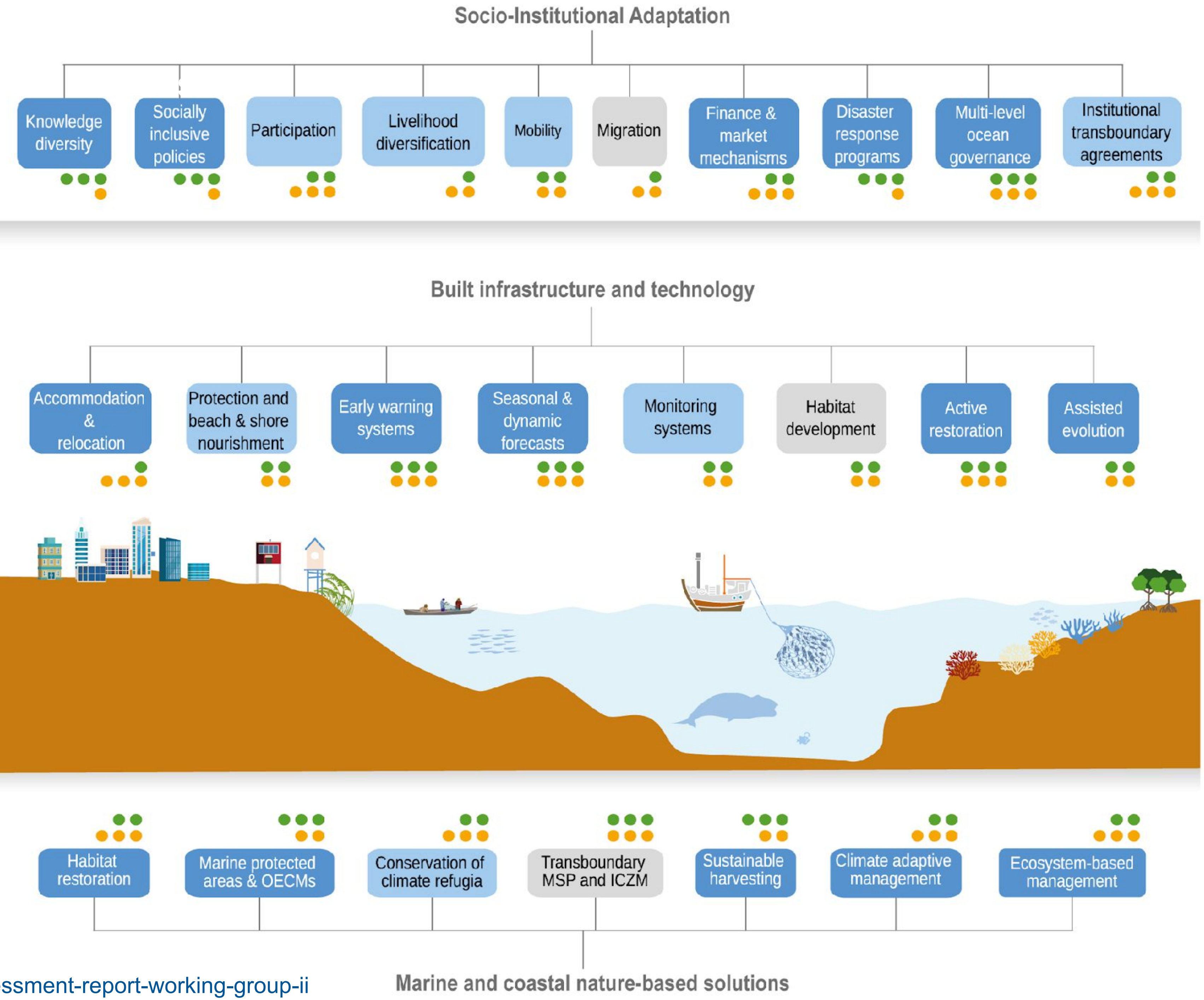
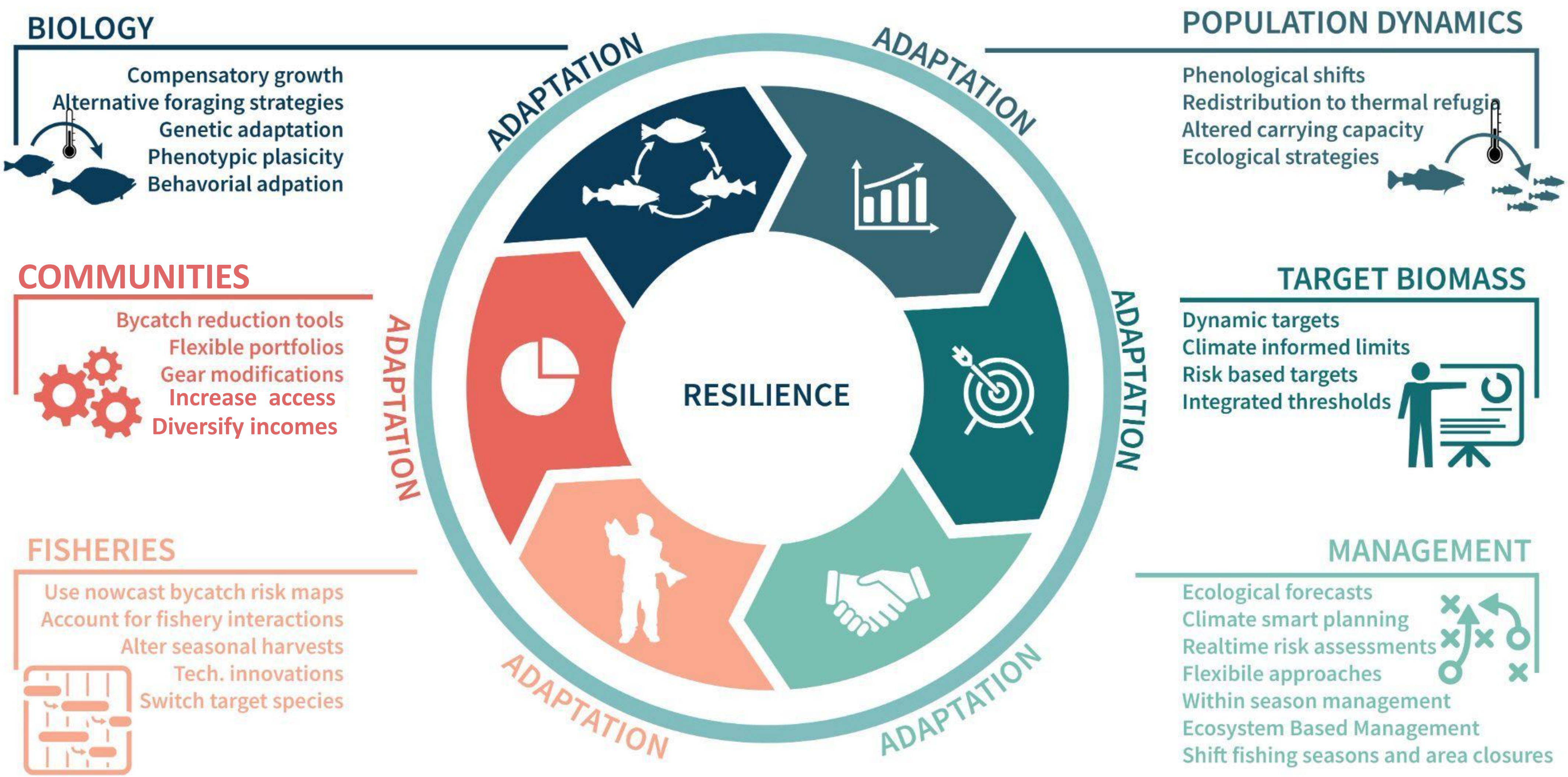
ACLIM Timeline

Adaptation (IPCC WGII)



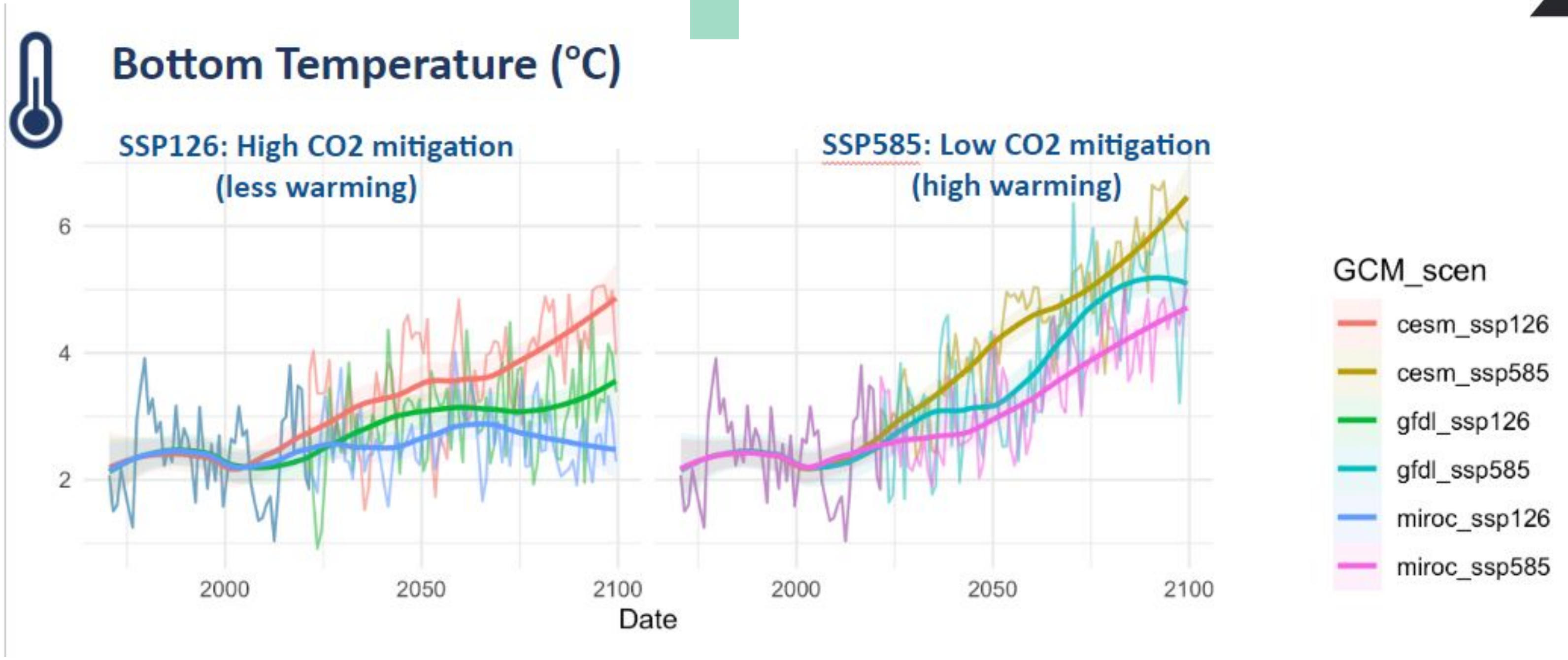


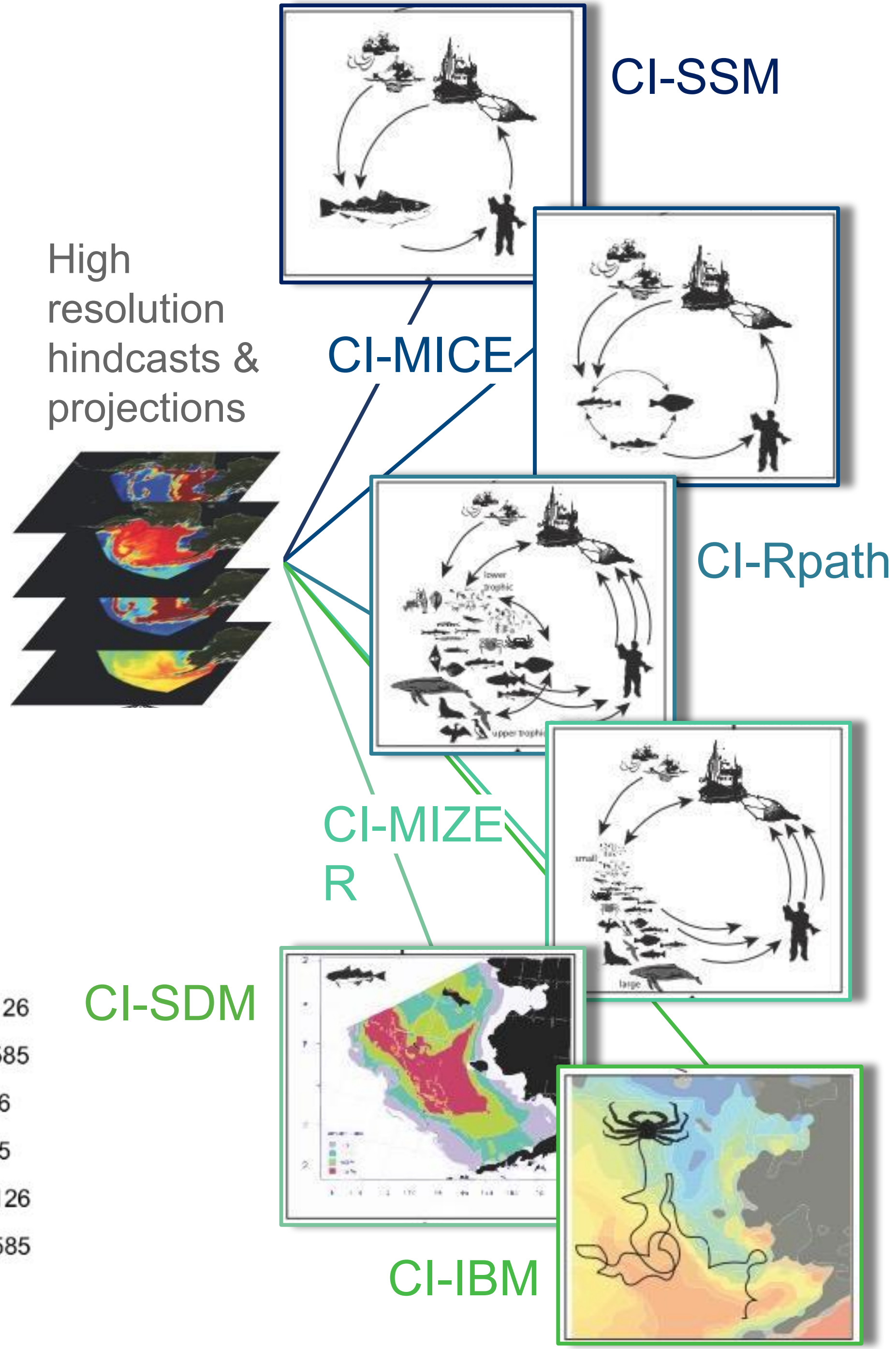
Chp3: www.ipcc.ch/report/sixth-assessment-report-working-group-ii



Holsman et al. in prep.

Ensemble of models help identify structural uncertainties and characterize confidence in projections





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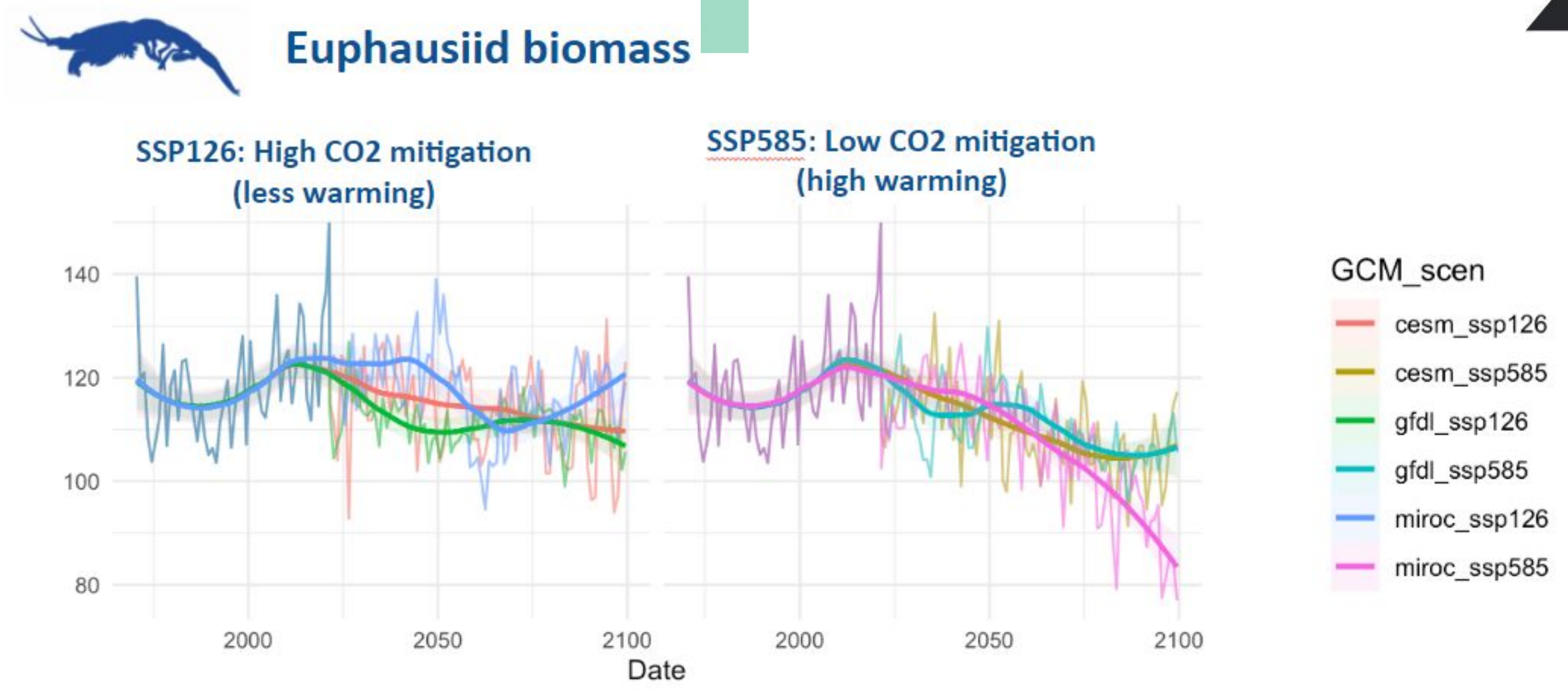
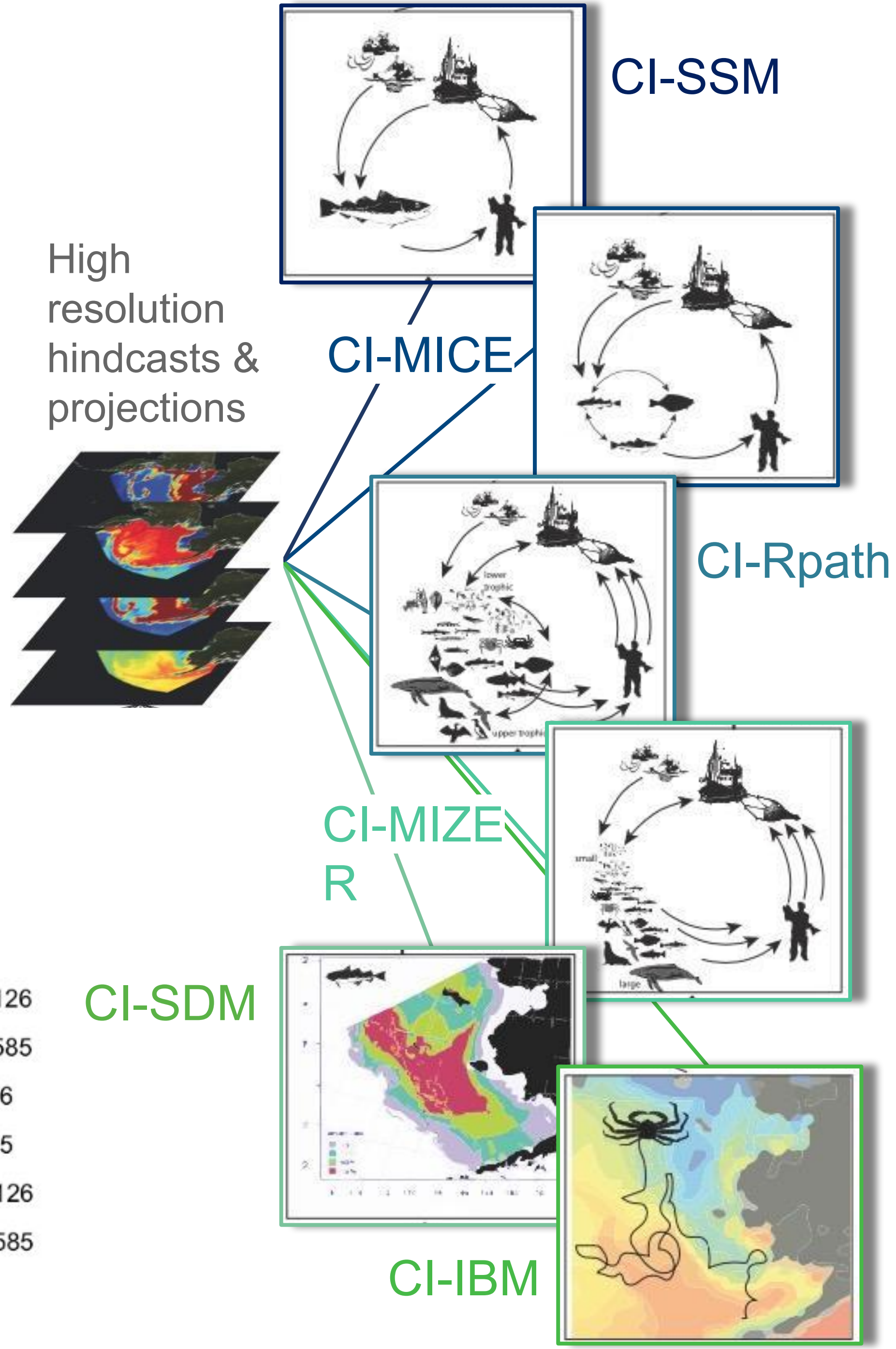
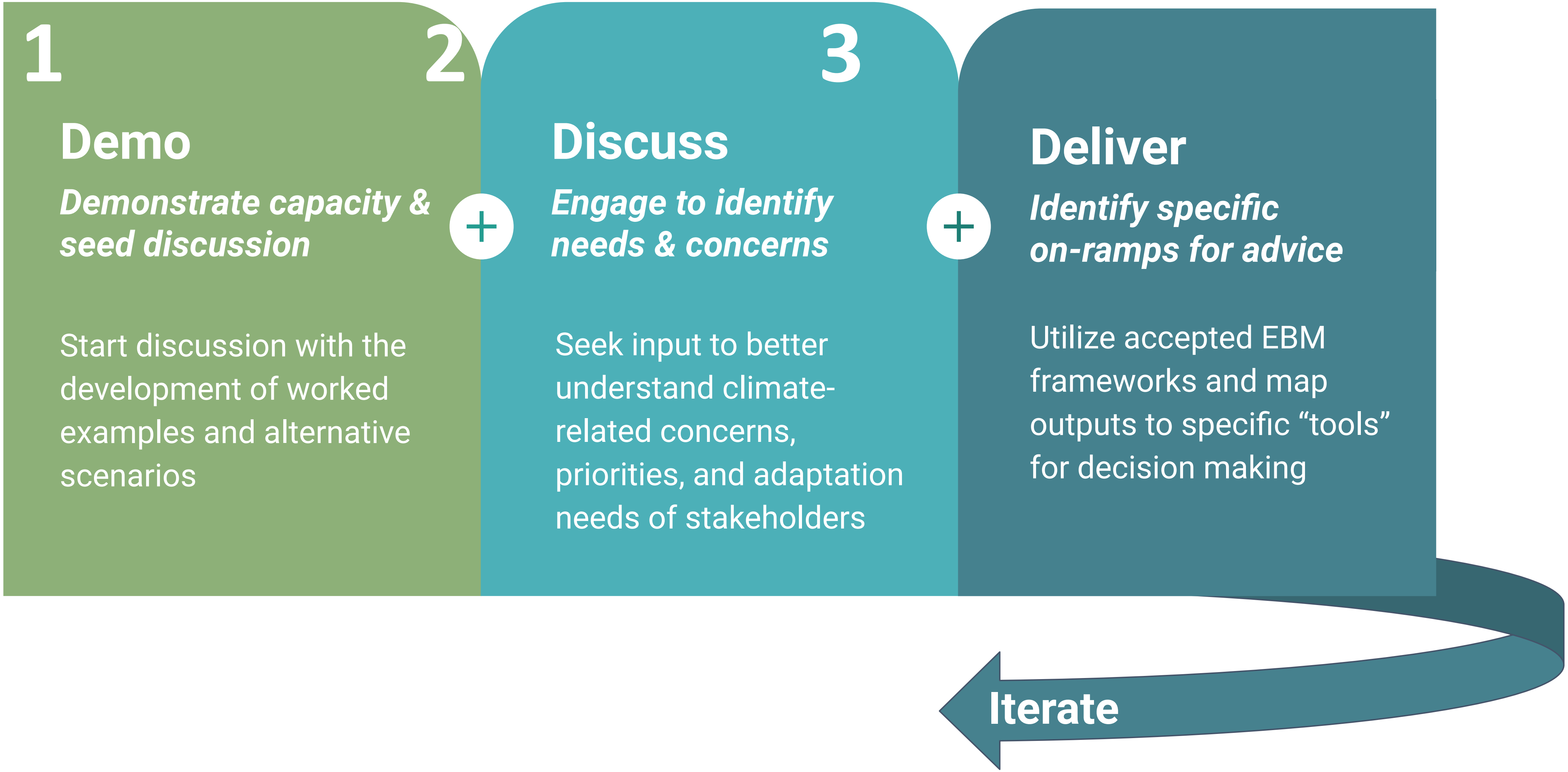
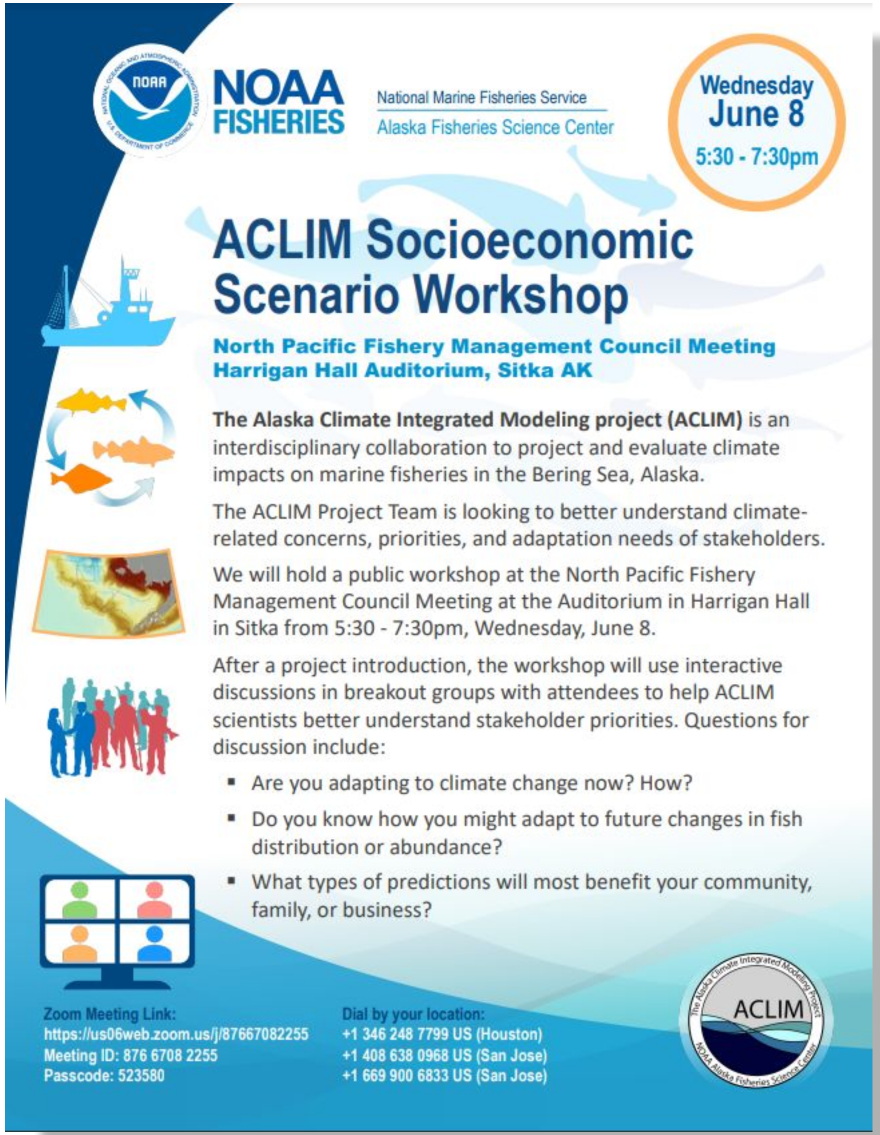




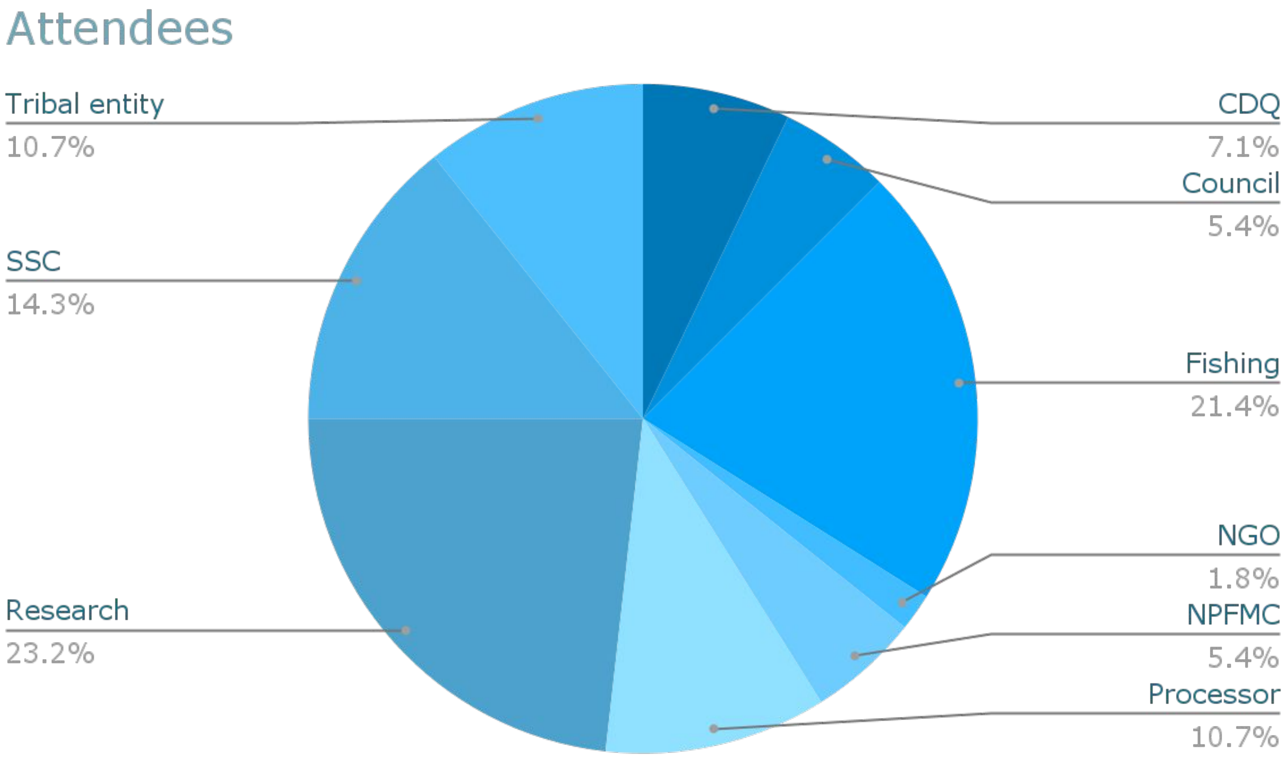


Hollowed et al. (submitted) Selecting climate linked decision relevant and adaptation informing community level scenarios for ecosystems through constituent engagement : A case study for the eastern Bering Sea. ICES JMS

June 2022 ACLIM Scenarios workshop (3)



8 Remote
48 In Person



Hollowed et al. (submitted) ICES JMS

ACLIM2 Workshop Emergent themes

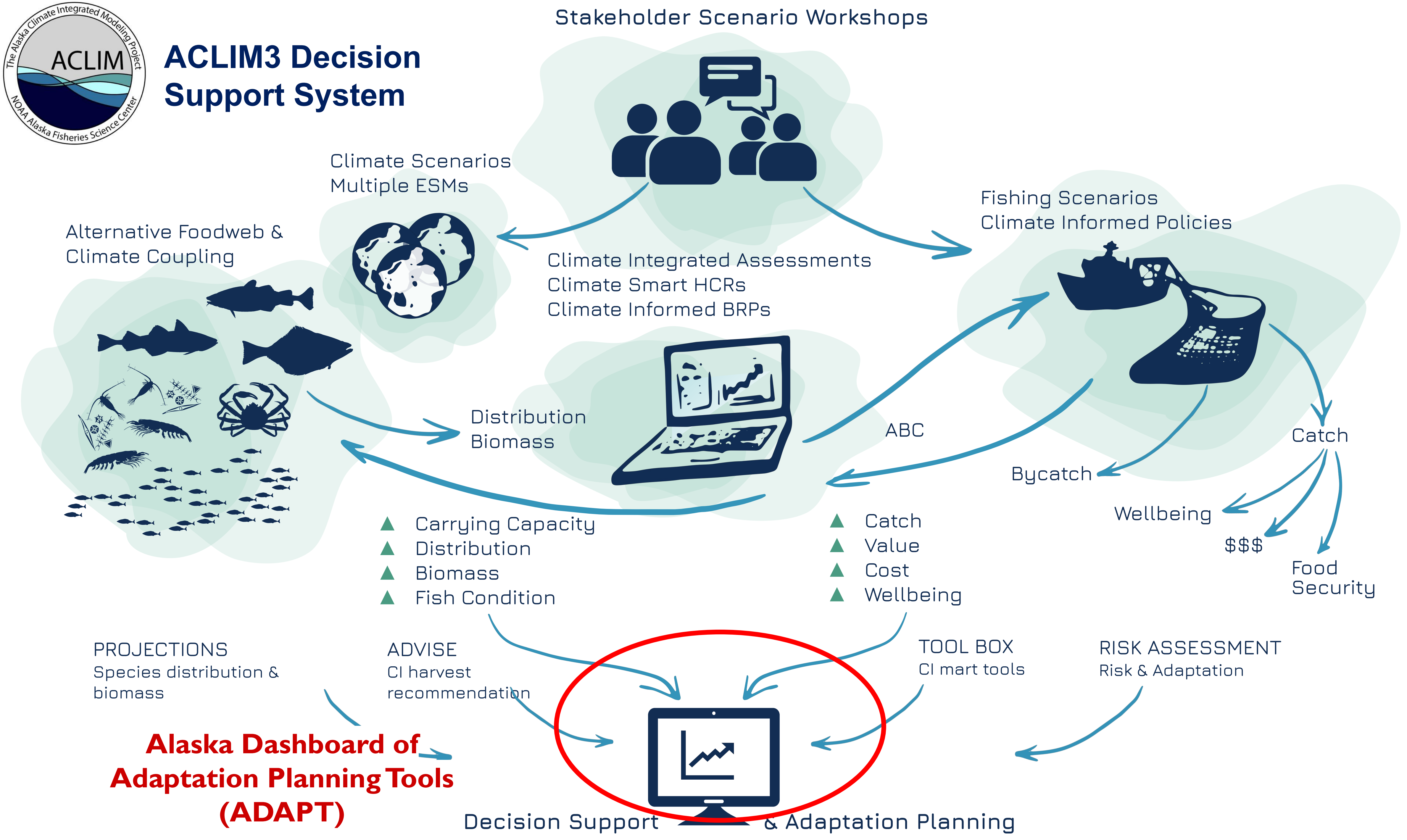
- Issue: Management lags climate impacts
- Issue: Avoidance of bycatch increasingly challenging
- Issue: Over-reliance on single target spp (catch shares)

- Goal: expand “ability for mobility”
- Goal: stabilize profits & reduce catch volatility
- Method: Investments in infrastructure or technology, fuel efficiency, business risk profile
- Method: Invest in alternative products (e.g., boutique products)

- Equity: Evaluate factors impacting communities (food, availability, risk of access)
- Equity: Reduce barriers to entry (new / alternative fisheries)

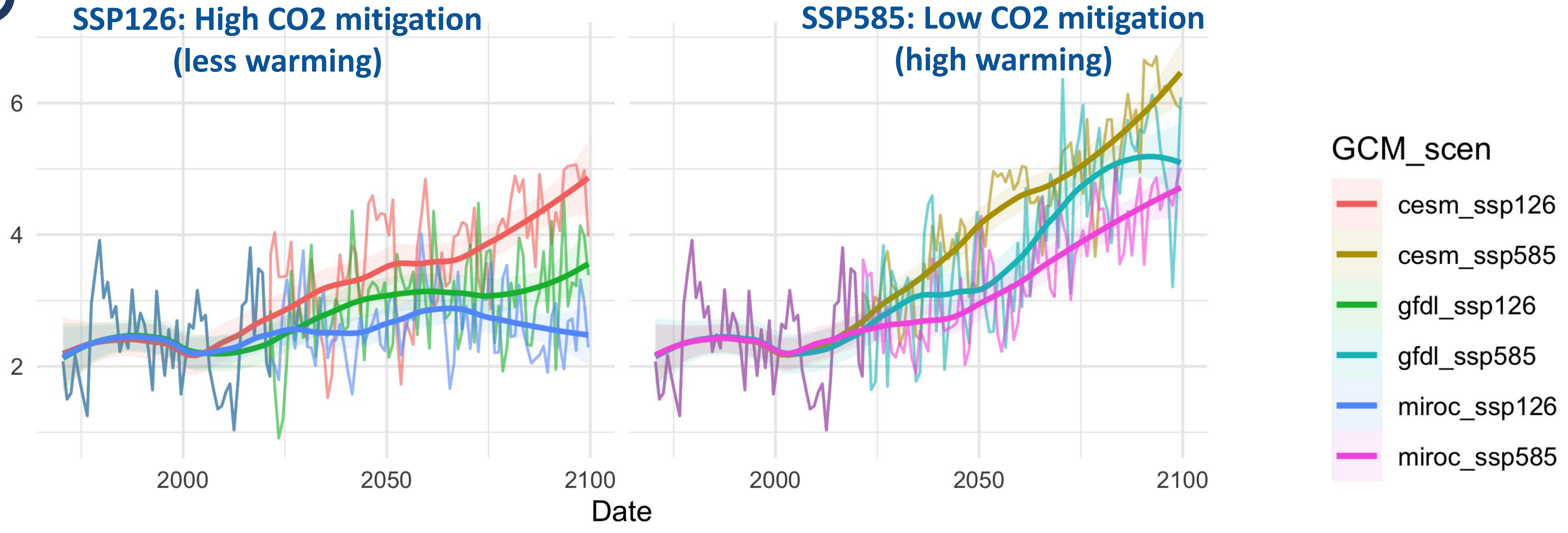
Hollowed et al. (submitted) Selecting climate linked decision relevant and adaptation informing community level scenarios for ecosystems through constituent engagement : A case study for the eastern Bering Sea. ICES JMS

ACLIM3 Decision Support System



Increased warming expected in the EBS

Bottom Temperature (°C)



ACLIM CMIP6 Shiny tool: kkh2022.shinyapps.io/ACLIM2_indices

ACLIM Online

ACLIM Github Repo: https://github.com/kholsman/ACLIM2

ACLIM CMIP6 Shiny tool: kkh2022.shinyapps.io/ACLIM2_indices

Bering10KROMSNPZ web-based data (CMIP5):

- THREDDS: Catalog listing where data and metadata can be accessed and/or downloaded
- Live Action Server: An interactive web interface with plotting and mapping capabilities, primarily for data exploration (though some limited download can be achieved from here)
- ERDDAP: Web interface to access and download tabular data. Note that only a small subset of the model output (primarily Level 3 indices) is able to be formatted for access through this interface.

BERING10K Data & Info portals

Learn More:
https://beringnpz.github.io/roms-bering-sea/B10K-dataset-docs/

Explore the Data:
https://github.com/kholsman/ACLIM2

roms-bering-sea   Posts   About   Literature

The Bering10K ROMS configuration

The Bering10K ROMS configuration, including associated biological modules (research conducted through the University of Washington, CICOES)

GitHub

The Bering10K dataset

3 minute read

Numerous Bering 10K ROMS model simulations have been run to date, including hindcasts of the past few decades, long-term forecasts under CMIP5 and CMIP6 emissions scenarios, and seasonal retropective forecasts. Data and metadata related to these simulations are held in a number of locations. This page serves as a centralized hub for this data and metadata.

The model

Model source code is available on GitHub: beringnpz/roms-bering-sea

The documentation

A few guides for working with the Bering10K output dataset can be found

- The Bering10K Dataset documentation: A pdf describing the dataset, including:

Getting Started with Bering10K Level 2 & 3 indices

K. Holsman and K. Aydin (Tutorial), A. Hermann, K. Kearney, W. Cheng, I. Ortiz (Bering10K)

The ACLIM Repository github.com/kholsman/ACLIM2 is maintained by Kirstin Holsman, Alaska Fisheries Science Center, NOAA Fisheries, Seattle WA. Multiple programs and projects have supported the production and sharing of the suite of Bering10K hindcasts and projections. *Last updated: Mar 10, 2021*

1. Overview

This repository contains R code and Rdata files for working with netcdf-format data generated from the downscaled ROMSNPZ modeling of the ROMSNPZ Bering Sea Ocean Modeling team; Drs. Hermann, Cheng, Kearney, Pilcher,Ortiz, and Aydin. The code and R resources described in this tutorial are publicly available through the ACLIM2 github repository maintained by Kirstin Holsman as part of NOAA's ACLIM project for the Bering Sea. *See Hollowed et al. 2020 for more information about the ACLIM project.*

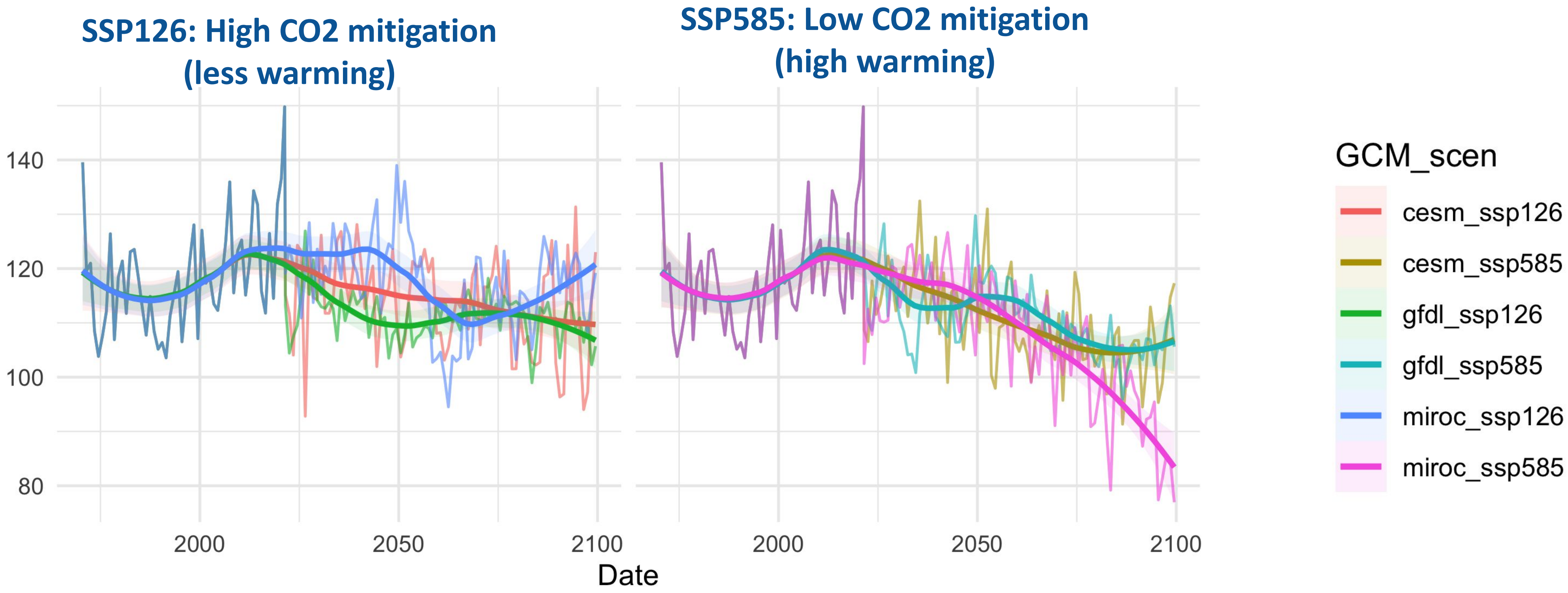
1.1. Resources

We **strongly recommend** reviewing the following documentation before using the data in order to understand the origin of the indices and their present level of skill and validation, which varies considerably across indices and in space and time:

- **The Bering10K Dataset documentation (pdf)**: A pdf describing the dataset, including full model descriptions, inputs for specific results, and a tutorial for working directly with the ROMS native grid (Level 1 outputs).
- **Bering10K Simulaton Variables (xlsx)**: A spreadsheet listing all simulations and the archived output variables associated with each, updated periodically as new simulations are run or new variables are made available.
- A collection of Bering10K ROMSNPZ model documentation (including the above files) is maintained by Kelly Kearney and will be regularly updated with new documentation and publications.

Decreases in zooplankton expected

Euphausiid biomass



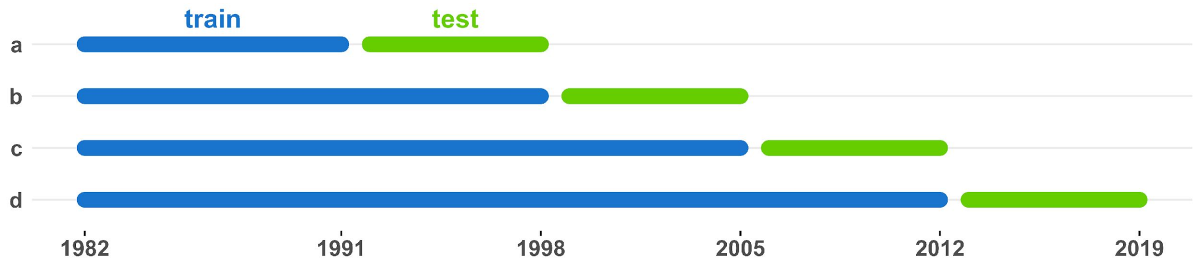
ACLIM CMIP6 Shiny tool: kkh2022.shinyapps.io/ACLIM2_indices

Species distribution models (Delta-Lognormal GAMMs)

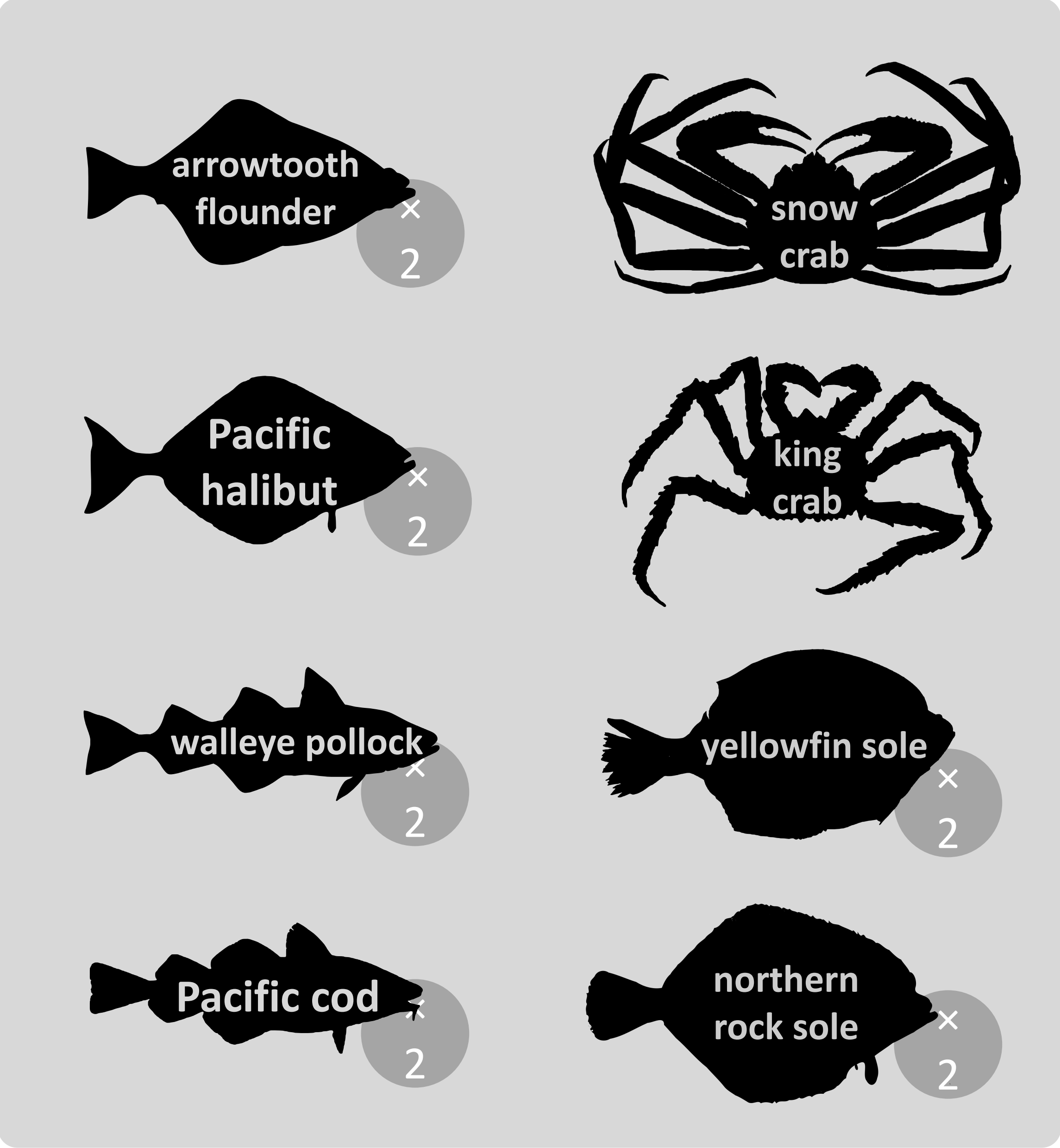
Candidate model terms (Bering10K hindcast):

- Temperature (bottom 5m, k = 3)
- Oxygen (bottom 5m, k = 3)
- pH (bottom 5m, k = 3)
- Depth (k = 3)
- Log sediment grain size (*φ,* k = 3)
- Cold pool (0C/2C – spatially varying, k = 10)

Environmental covariates selected via time-series cross validation,
i.e. based on forward predictive skill



+ spatial autocorrelation
+ annual random intercepts (lognormal model only)



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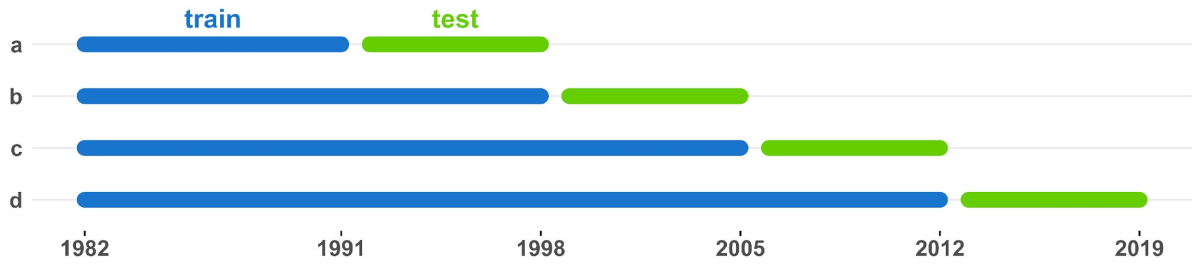
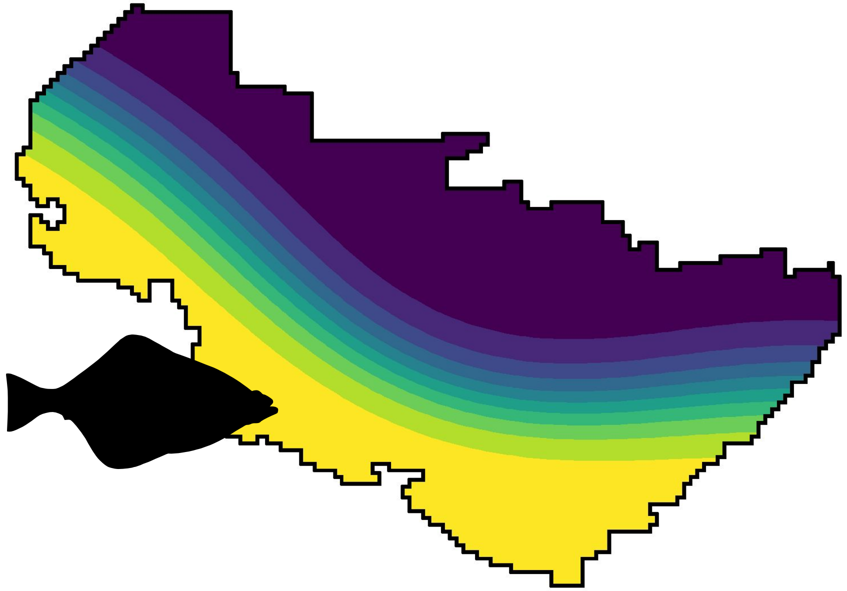
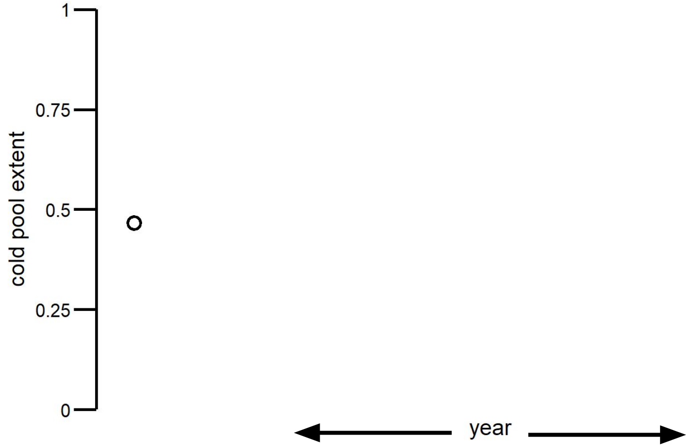


+ spatial autocorrelation
+ annual random intercepts (lognormal model only)

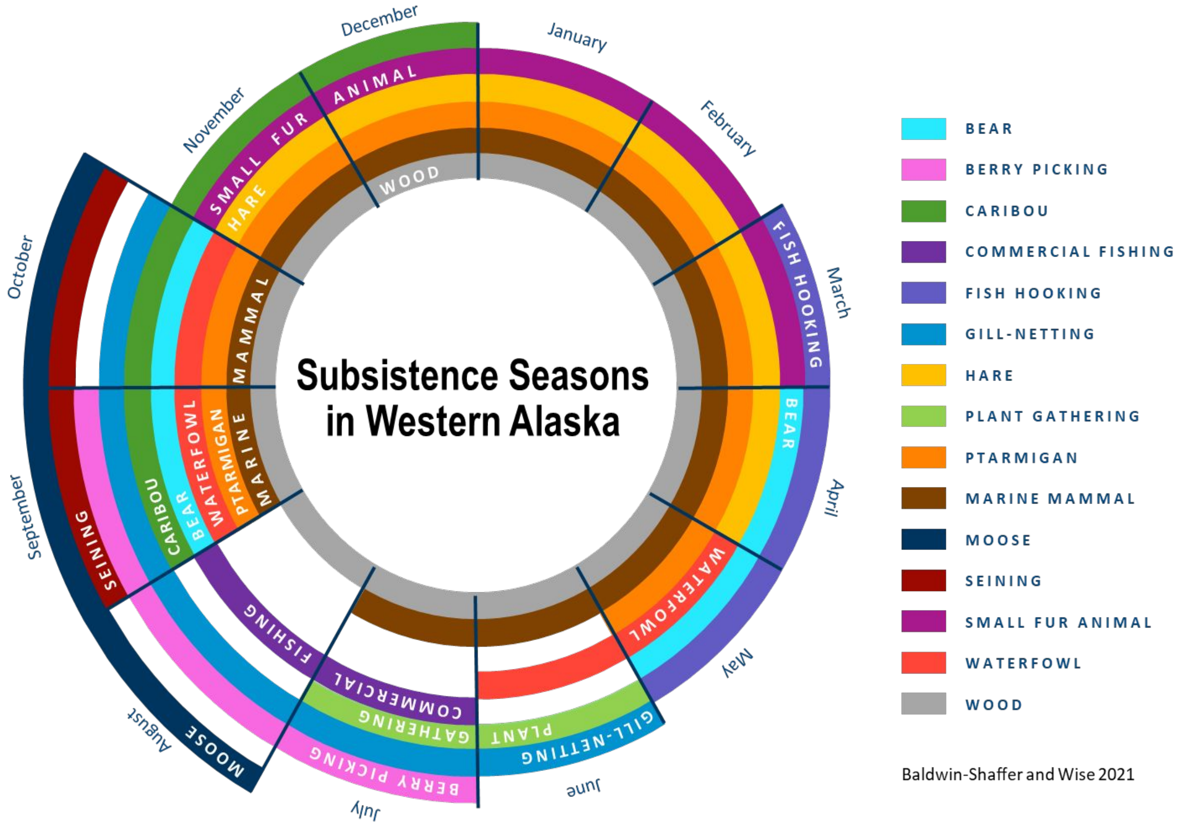
Local responses to non-local environmental conditions can be modeled with spatially-varying coefficients





Climate Ready Management and Communities

in the context of remote Alaska communities experiencing the direct effects of climate change



Baldwin-Shaffer and Wise 2021

Some social effects

- Disrupted sharing networks/social networks
- Disrupted knowledge sharing
- Reduced confidence in management
- Shifts in target species
- Shifts in subsistence calendar
- Increased food insecurity
- Increased reliance on family networks.
- Increased uncertainty

Salmon

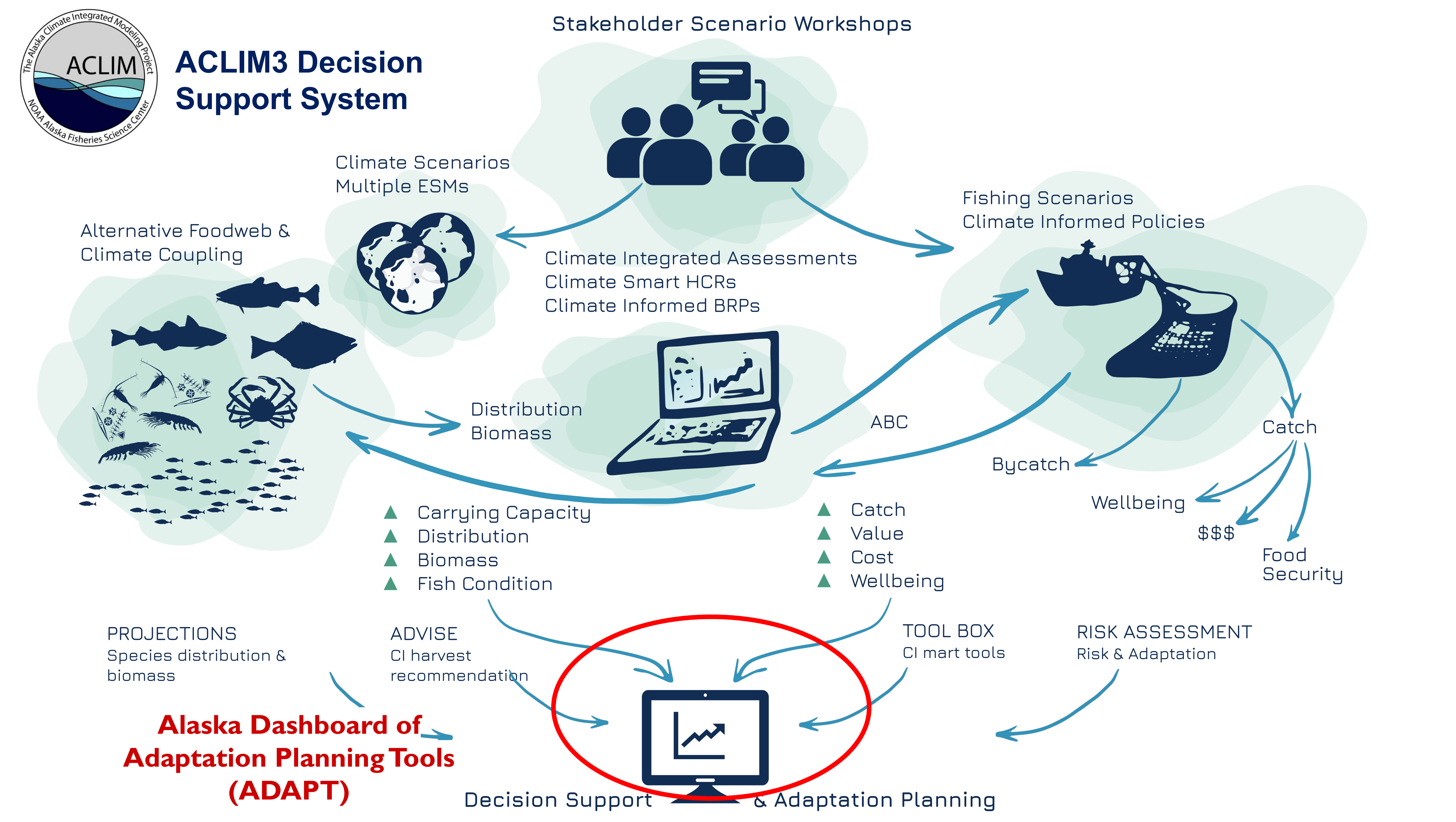
Identify candidate ROMS/NPZ indicators for Yukon River Chinook salmon survival based on scientific and traditional knowledge.

H1: Ocean temperatures during the 1st and 2nd year at sea impacts growth & survival.

Spring 2023 trip to Lower Yukon LTK:
Good for salmon returns: Strong north winds, high river water, ice break up but not thaw, & yellow butterflies. (wish list indicators)

Produce recruitment projections under different climate & emission scenarios at various lags

YRFDA and Yasumiishi et al. in prep.
Draft results, please do not copy or distribute without permission of the author



ACLIM
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NOAA Alaska Fisheries Science Center
ACLIM3 Decision Support System
Stakeholder Scenario Workshops
Climate Scenarios
Multiple ESMs
Alternative Foodweb &
Climate Coupling
Fishing Scenarios
Climate Informed Policies
Climate Integrated Assessments
Climate Smart HCRs
Climate Informed BRPs
Distribution
Biomass
ABC
Catch
Bycatch
Wellbeing
$$$
Food
Security
Carrying Capacity
Distribution
Biomass
Fish Condition
Catch
Value
Cost
Wellbeing
PROJECTIONS
Species distribution &
biomass
ADVISE
CI harvest
recommendation
TOOL BOX
CI mart tools
RISK ASSESSMENT
Risk & Adaptation
Alaska Dashboard of
Adaptation Planning Tools
(ADAPT)
Decision Support & Adaptation Planning

Key elements of climate ready advice

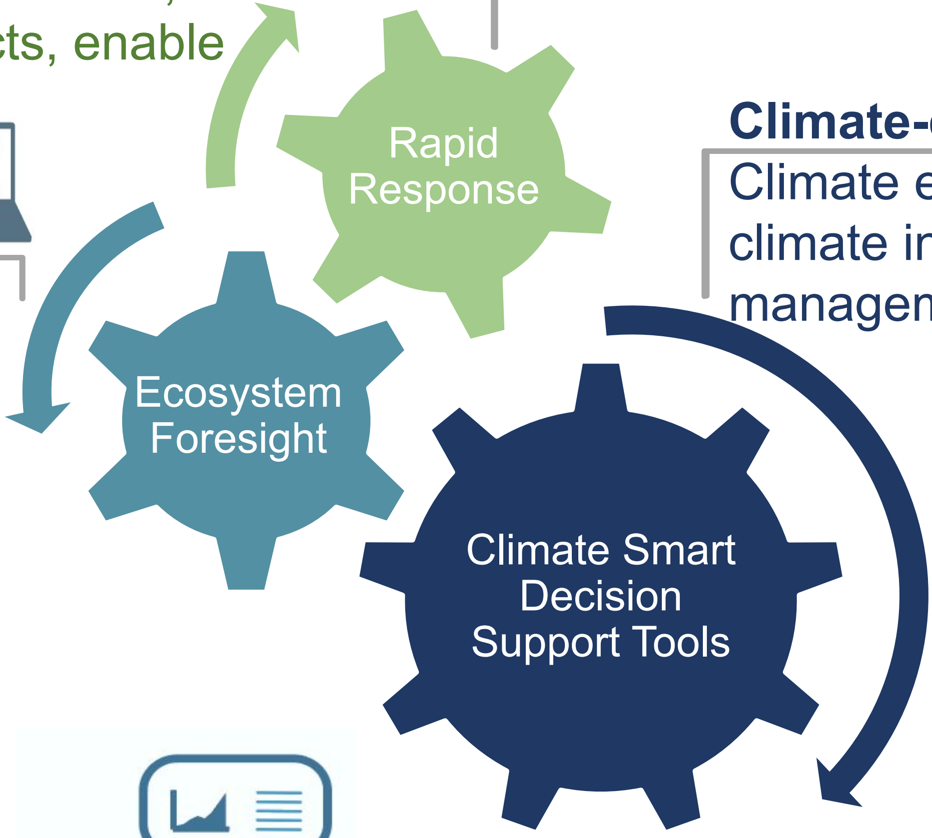
Holsman et al. in prep

Rapid response
Plan & predict, near-real time alerts, emergency aid, triage impacts, enable individual adaptation

e.g., Emergency relief

Ecosystem foresight

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



Climate-driven decision support tools
Climate enhanced stock assessments, climate informed advice & tools, dynamic management

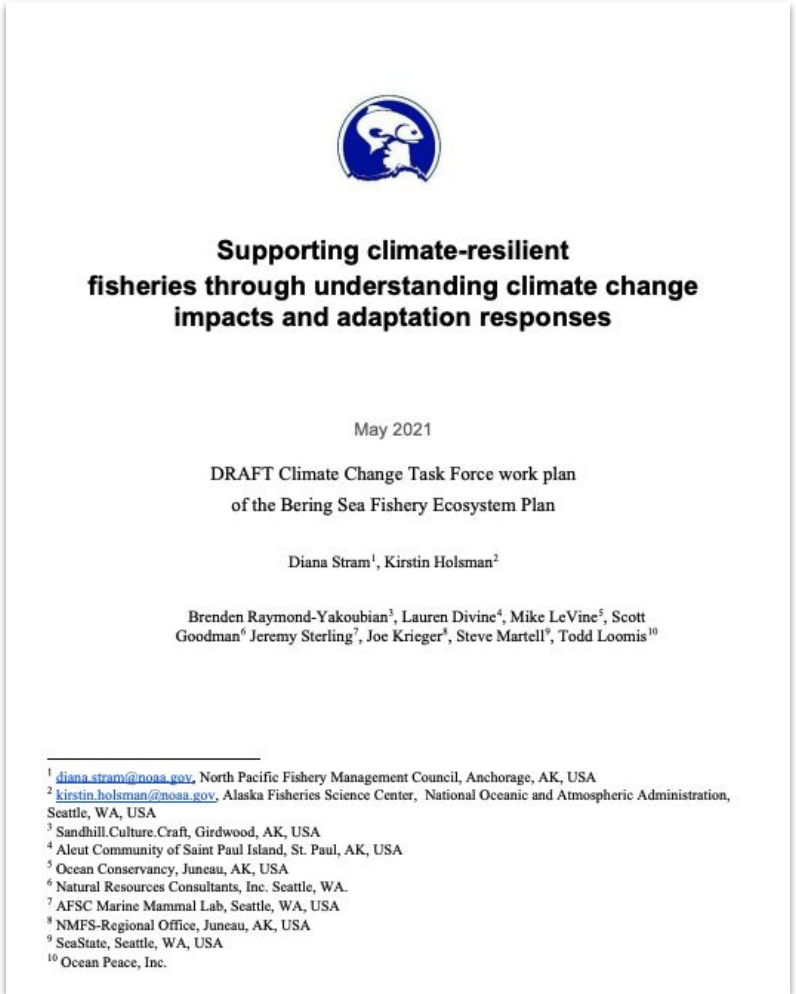
e.g., Risk assessment & probability of increase or decrease

Coordinated science & advice

Inter- & intra-agency coordination, national strategies aligned with regional priorities, efficient information sharing, reduced redundancy

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

Provide tools and approaches to support climate informed management decisions



Supporting climate-resilient fisheries through understanding climate change impacts and adaptation responses

May 2021

DRAFT Climate Change Task Force work plan of the Bering Sea Fishery Ecosystem Plan

Diana Stram[1], Kirstin Holsman[2]

Brenden Raymond-Yakoubian[3], Lauren Divine[4], Mike LeVine[5], Scott Goodman[6] Jeremy Sterling[7], Joe Krieger[8], Steve Martell[9], Todd Loomis[10]

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[4] Aleut Community of Saint Paul Island, St. Paul, AK, USA
[5] Ocean Conservancy, Juneau, AK, USA
[6] Natural Resources Consultants, Inc. Seattle, WA.
[7] AFSC Marine Mammal Lab, Seattle, WA, USA
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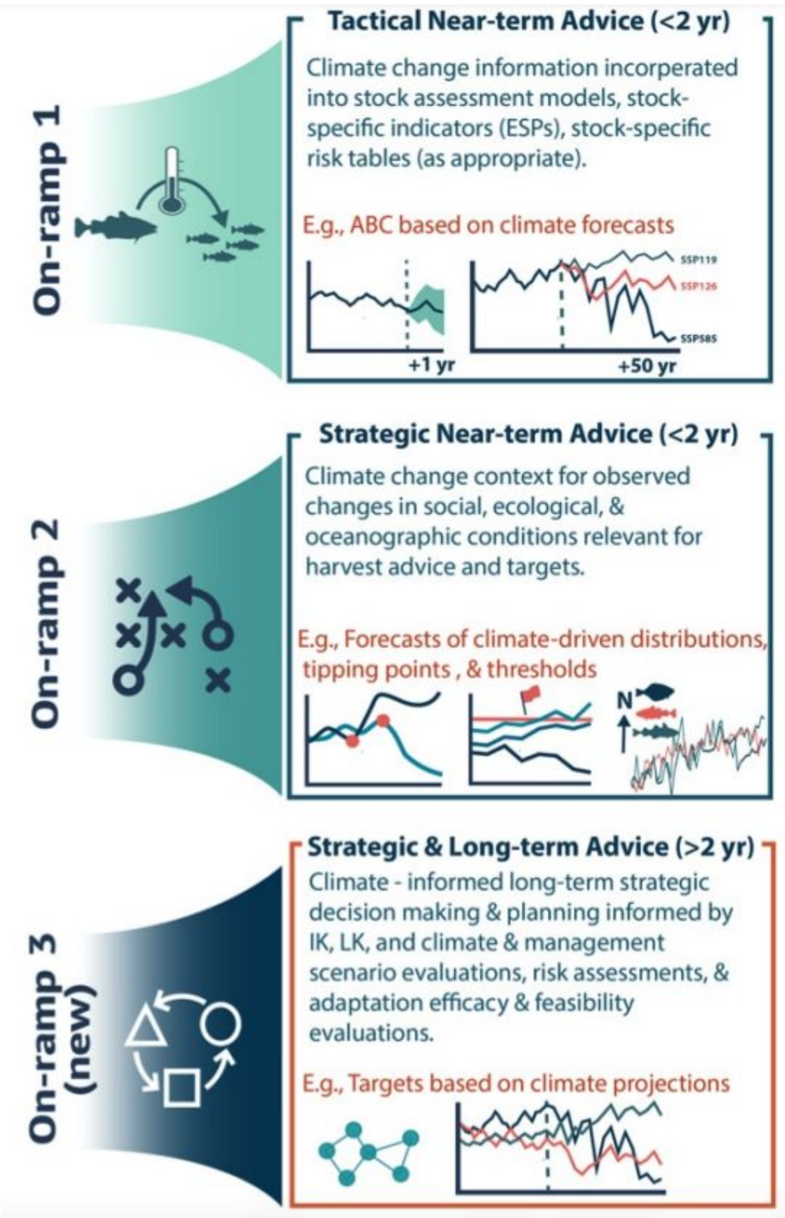
[9] SeaState, Seattle, WA, USA
[10] Ocean Peace, Inc.

https://www.npfmc.org/climatechangetaskforce/
Stram et al. 2021

Climate information on ramps for fisheries management



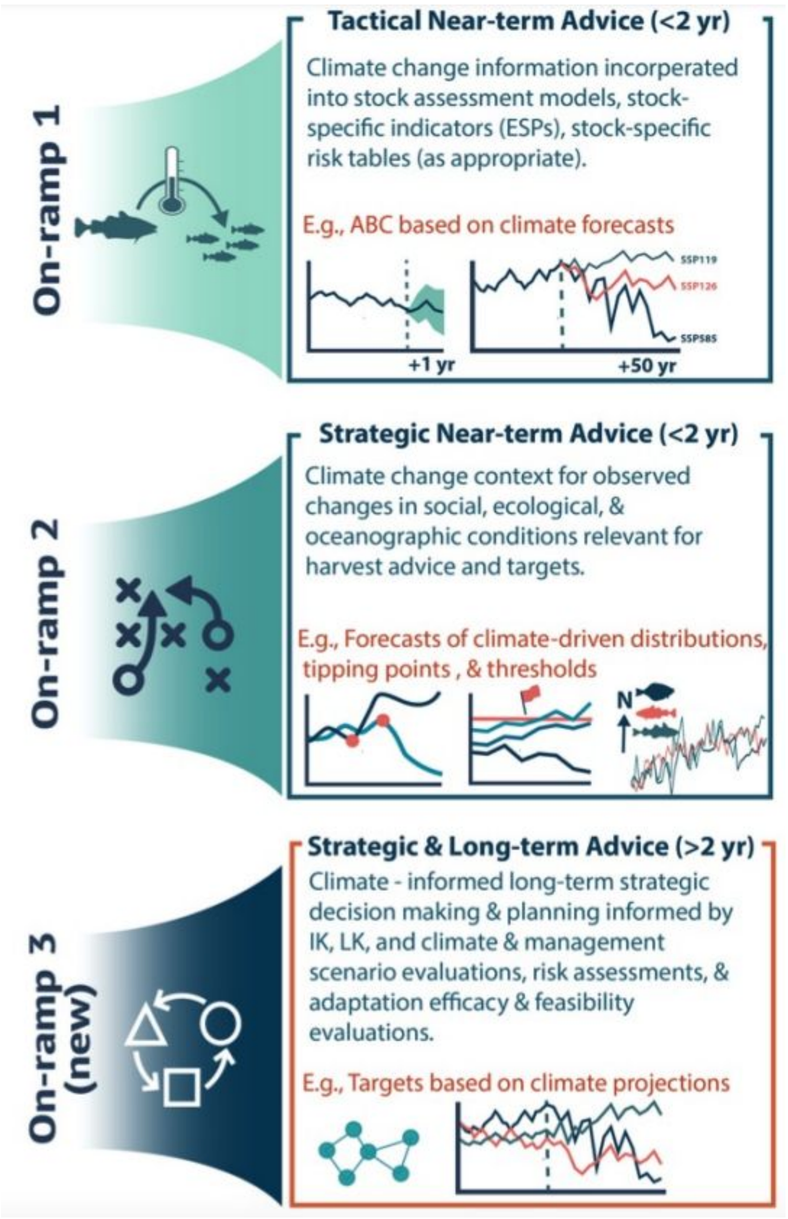
Provide tools and approaches to support climate informed management decisions

Climate information on ramps for fisheries management

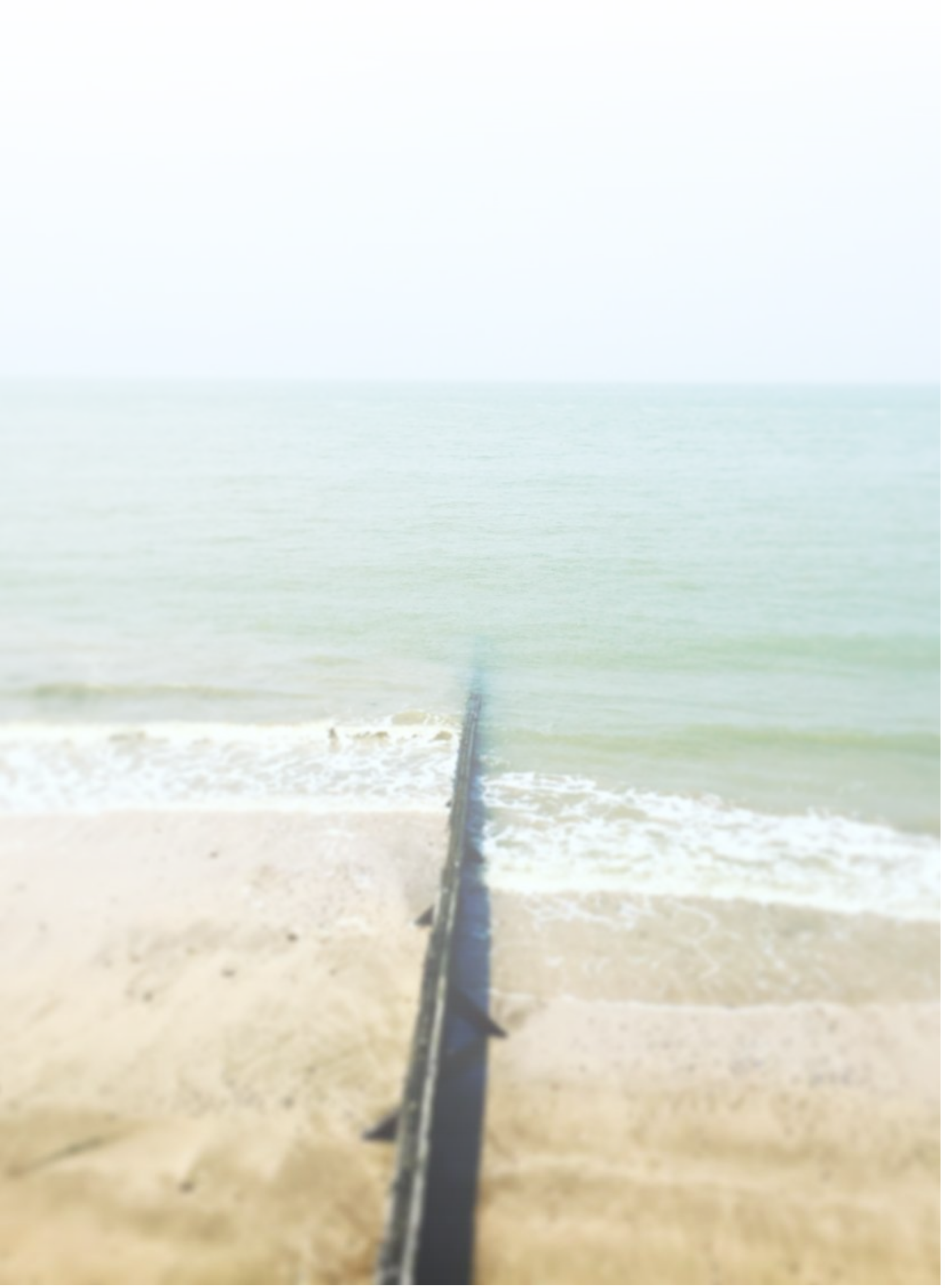
Climate informed annual* stock assessments & advice

Climate information in near-term management targets

Climate information in long-term management targets and design



https://www.npfmc.org/climatechangetaskforce/



ACLIM support

- ACLIM 1.0 funding:
  - Fisheries & the Environment (FATE)
  - Stock Assessment Analytical Methods (SAAM)
  - Climate Regimes & Ecosystem Productivity (CREP)
  - Economic and Human Dimensions Program, AFSC, OAR
  - NMFS Economics and Human Dimensions Program
  - NOAA Integrated Ecosystem Assessment Program (IEA)
  - NOAA Research Transition Acceleration Program (RTAP)
  - Alaska Fisheries Science Center
- ACLIM 2.0 funding:
  - NOAA's Coastal and Ocean Climate Applications (COCA) Climate and Fisheries Program
  - NOAA Integrated Ecosystem Assessment Program (IEA)
  - Alaska Fisheries Science Center

Collaboration support:

MAPP Bering Seasons & FATE EFH

- NPRB & BSIERP Team
- GOA-CLIM Team
- AFSC REEM, REFM, RACE
- ICES PICES Strategic Initiative on climate change and marine ecosystems (SICCME/S-CCME)
- NPFMC Climate change task force, the Ecosystem Committee of the NPFMC

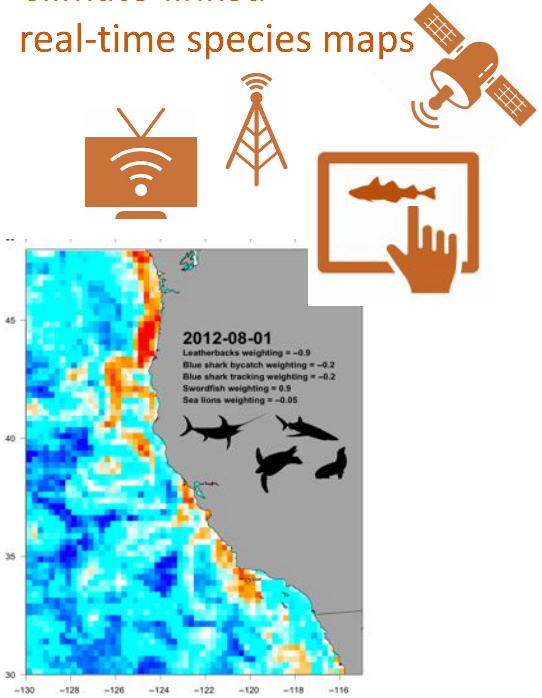
Questions?

Climate smart decision support tools

Adapt in real-time
(incremental adaptation)

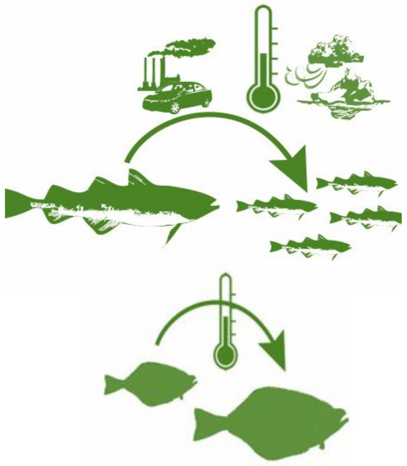
Minimize impacts through prep & planning
(transformational adaptation)

Climate-linked real-time species maps



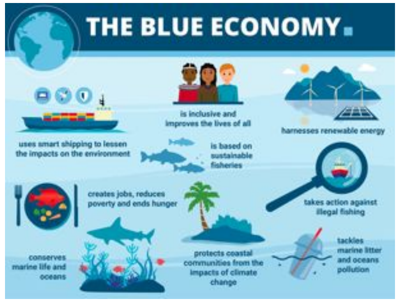
Hazen et al. 2019
https://advances.sciencemag.org/content/4/5/eaar3001

Climate-enhanced stock Assessment models



Hollowed et al. 2020 (ACLIM)
Holsman et al. 2022 (EBS)
Adams et al. 2022 (GOA)

Climate smart long-term strategies



www.blueeconomyconference.go.ke

Santos et al. 2020.
https://www.nature.com/articles/s41893-020-0513-x

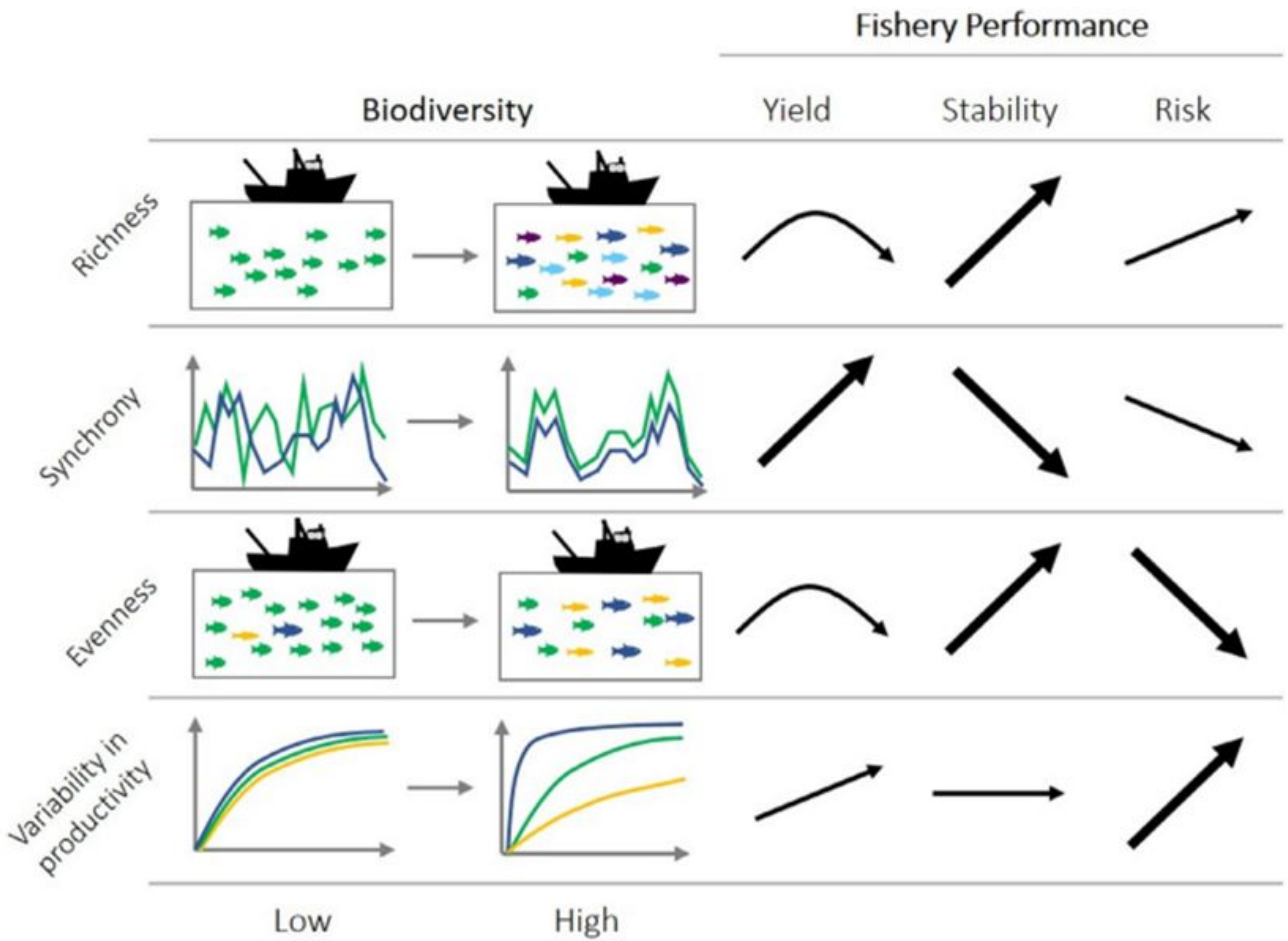


FIGURE 3 Illustrative synthesis of relationships between dimensions of biodiversity and fisheries performance under the base case simulations (see Figure 1 and Figure S1). These relationships are further influenced by harvest intensity and management control (see Figure 2). Arrows indicate the direction, approximate shape, and magnitude (arrow weight) of the relationship between increasing biodiversity (x axis) and fishery performance (y axis)

Moore et al. Conservation risks and portfolio effects in mixed-stock fisheries. DOI: 10.1111/faf.12567

ACLIM Publications

1. (submitted) Hollowed et al. (submitted) Selecting climate linked decision relevant and adaptation informing community level scenarios for ecosystems through constituent engagement : A case study for the eastern Bering Sea. ICES JMS
2. (in review) Punt et al. Capturing Uncertainty when Modelling Environmental Drivers of Fish Populations, with an Illustrative Application to Pacific Cod in the Eastern Bering Sea. Fisheries Research
3. (in press) Hermann et al. Applications of biophysical modeling to Pacific high-latitude ecosystems. Oceanography
4. (2023) Szuwalksi et al. Szuwalski et al. 2023, Unintended consequences of climate-adaptive fisheries management targets. Fish and Fisheries. https://doi.org/10.1111/faf.12737
5. (2022) Hollowed, A. B., A. C. Haynie, A. J. Hermann, K. K. Holsman, A. E. Punt, C. S. Szuwalski. Implications of climate change on the Bering Sea and other cold water systems. Introduction to the special issue of Deep-Sea Research Part II: Topical Studies in Oceanography.
6. (2021) Hermann, A. J., Kearney, K., Cheng, W., Pilcher, D., Aydin, K., Holsman, K. K., & Hollowed, A. B.. Coupled modes of projected regional change in the Bering Sea from a dynamically downscaling model under CMIP6 forcing. Deep-Sea Research Part II: Topical Studies in Oceanography, 194 (Dec), 104974. https://doi.org/10.1016/j.dsr2.2021.104974
7. (2021) Cheng, W., Hermann, A. J., Hollowed, A. B., Holsman, K. K., Kearney, K. A., Pilcher, D. J., Stock, C. A., & Aydin, K. Y.. Eastern Bering Sea shelf environmental and lower trophic level responses to climate forcing: Results of dynamical downscaling from CMIP6. Deep-Sea Research Part II: Topical Studies in Oceanography, 193, 104975. https://doi.org/10.1016/j.dsr2.2021.104975
8. (in revision) Torre, M. , W. T. Stockhausen, A. J. Hermann, W. Cheng, R. Foy, C. Stawitz, K. Holsman, C. Szuwalski, A. B. Hollowed. (In Review). Early life stage connectivity for snow crab, Chionoecetes opilio, in the eastern Bering Sea: evaluating the effects of temperature-dependent intermolt duration and vertical migration. Deep Sea Research II.
9. (2021) Punt, A., M G Dalton, W Cheng, A Hermann, K Holsman, T Hurst, J Ianelli, K Kearney, C McGilliard, D Pilcher, M Véron. Evaluating the impact of climate and demographic variation on future prospects for fish stocks: An application for northern rock sole in Alaska. Deep Sea Research Part II: Topical Studies in Oceanography 189–190:104951.
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11. (2020) Holsman, K.K., A. Haynie, A. Hollowed, J. Reum, K. Aydin, A. Hermann, W. Cheng, A. Faig, J. Ianelli, K. Kearney, A. Punt. (2020) Ecosystem-based fisheries management forestalls climate-driven collapse. Nature Communications. DOI:10.1038/s41467-020-18300-3
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15. (2020) Hollowed, A. B., K. K. Holsman, A. C. Haynie, A. J. Hermann, A. E. Punt, K. Aydin, J. N. Ianelli, S. Kasperski, W. Cheng, A. Faig, K. A. Kearney, J. C. P. Reum, P. Spencer, I. Spies, W. Stockhausen, C. S. Szuwalski, G. A. Whitehouse, and T. K. Wilderbuer. 2020. Integrated Modeling to Evaluate Climate Change Impacts on Coupled Social-Ecological Systems in Alaska. Frontiers in Marine Science 6. https://doi.org/10.3389/fmars.2019.00775
16. (2019) Holsman, KK, EL Hazen, A Haynie, S Gourguet, A Hollowed, S Bograd, JF Samhouri, K Aydin, Toward climate-resiliency in fisheries management. ICES Journal of Marine Science. 10.1093/icesjms/fsz031
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18. (2019) Reum, J., JL Blanchard, KK Holsman, K Aydin, AE Punt. Species-specific ontogenetic diet shifts attenuate trophic cascades and lengthen food chains in exploited ecosystems. Okios DOI: 10.1111/oik.05630
19. (2019) Reum, J., K. Holsman, KK, Aydin, J. Blanchard, S. Jennings. Energetically relevant predator to prey body mass ratios and their relationship with predator body size. Ecology and Evolution (9):201–211 DOI: 10.1002/ece3.4715

ACLIM2 Objectives

Objective 1. Evaluate changes in ocean conditions and Net Primary Production (NPP) in the NBS

Objective 2. Understand historical and future changes to benthic-pelagic coupling and food web dynamics in the NBS.

Objective 3. Evaluate impacts of changes in temperature, ocean acidification, and oxygen depletion on habitat quality and species distributions and how these changes may impact food web structure.

Objective 4. Evaluate the foraging and reproductive responses of northern fur seals to a changing Bering Sea climate under different fishery management scenarios

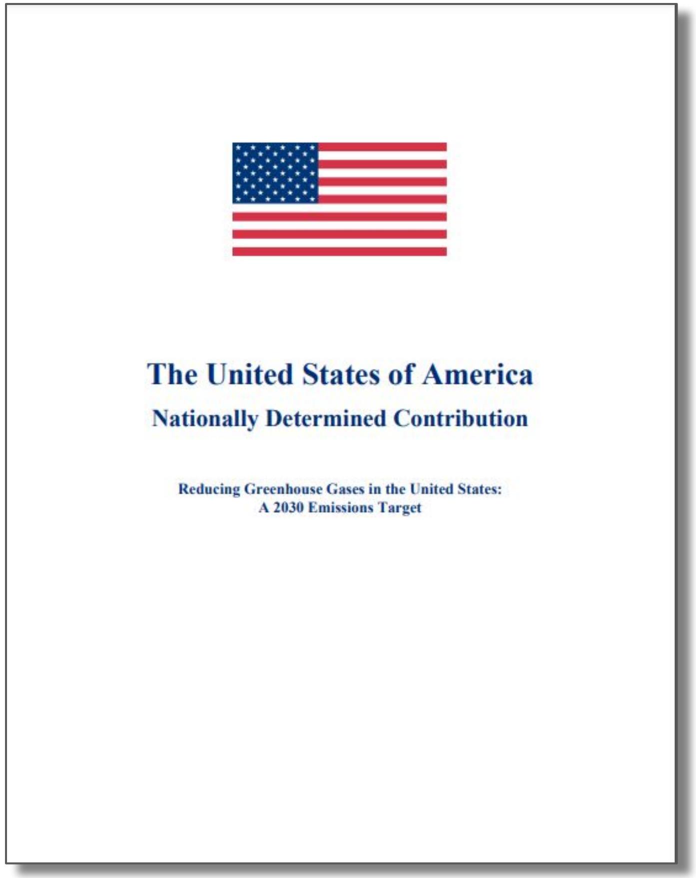
Objective 5. Evaluate how fishing fleets and human communities will be impacted by future climate change and test potential adaptive responses, tools, and policies using management strategy evaluations

Objective 6. Continue to incorporate multiple knowledge sources and perspectives in the development and evaluation of climate-informed marine management in the EBS

WG 1: Ensemble modeling group	WG 2: Climate downscaling and ocean modeling	WG 3: Spatial Modeling group	WG 4 / 5: HCRS, Social-econ, modeling	WG 6: Food web models	WG 7: Ecophysiology, energetics, IBMs	WG 8: Marine Mammals	WG 9: Indicators for ESRs and ESP

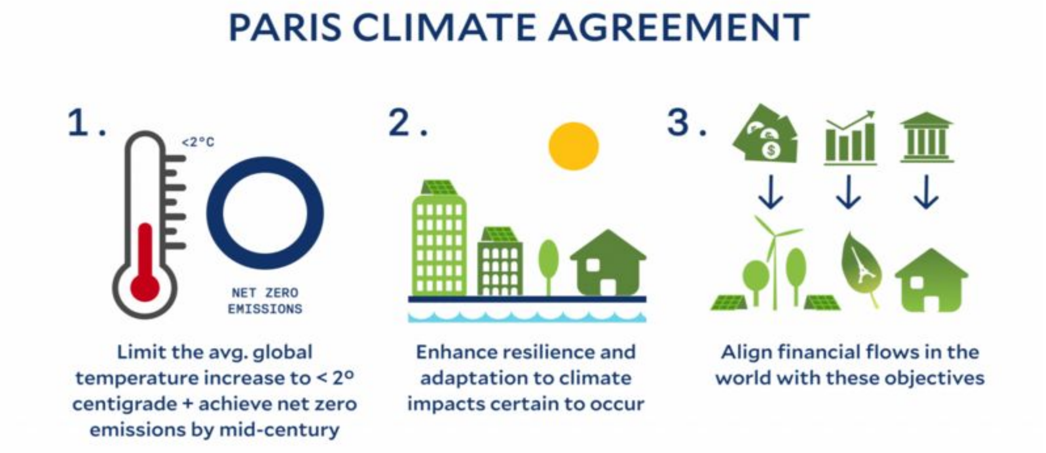
Nationally Determined Contributions (NDCs)

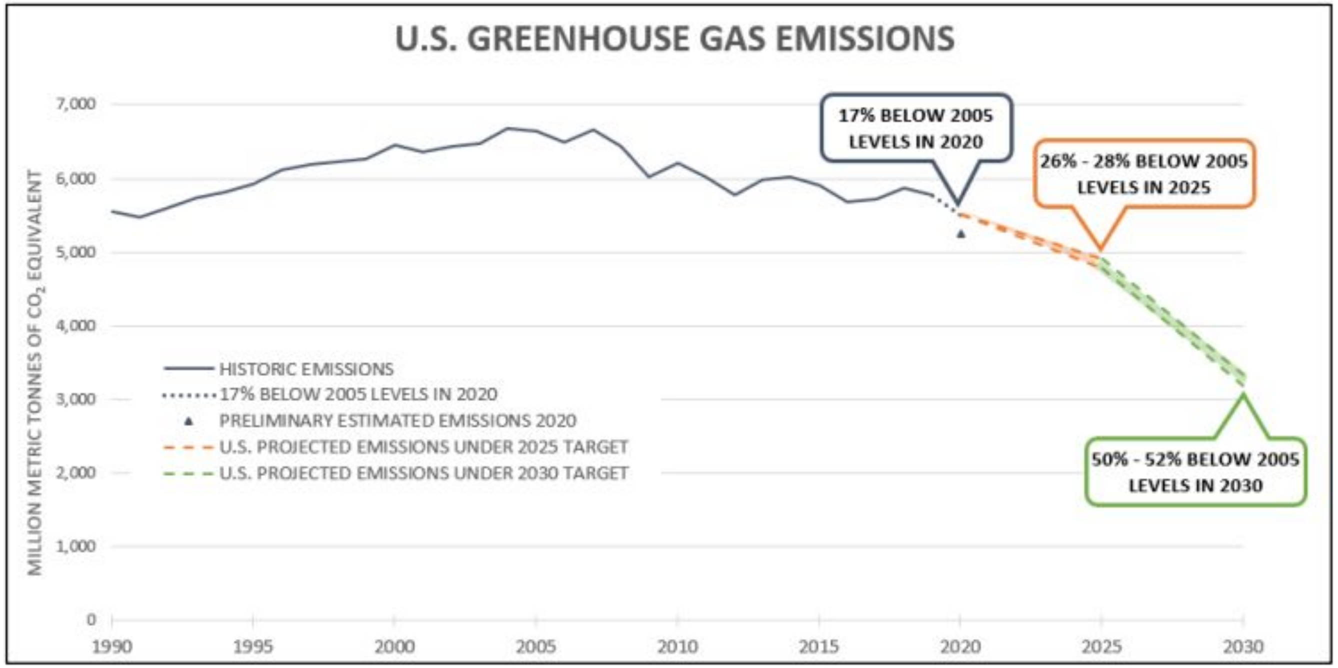
https://unfccc.int/ndc-information/nationally-determined-contributions-ndcs


The United States of America

Nationally Determined Contribution

Reducing Greenhouse Gases in the United States:
A 2030 Emissions Target



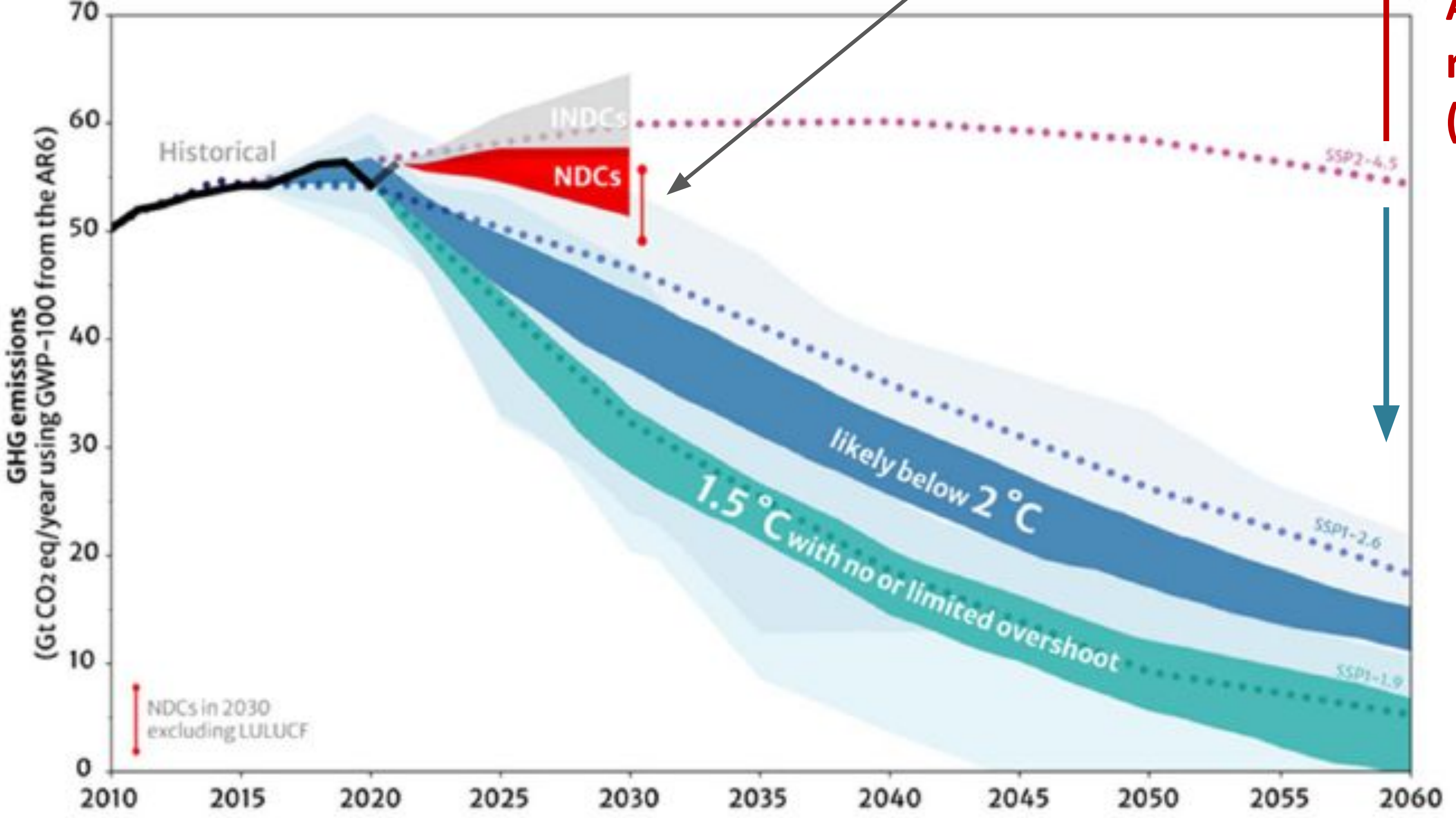


United States Historic Emissions and Projected Emissions Under 2030 Target

Graphic: https://sustainability.yale.edu/explainers/yale-experts-explain-paris-climate-agreement

UNFCC 2022 NDC Synthesis report

Updated revised NDCs



ACLIM finds higher risk above this (SSP585, RCP8.5)

ACLIM finds lower risk below this (SSP126)

https://unfccc.int/ndc-synthesis-report-2022

Multispecies assessment

2022 Climate-enhanced multi-species Stock Assessment for walleye pollock, Pacific cod, and arrowtooth flounder in the South Eastern Bering Sea

Kirstin K. Holsman, Jim Ianelli, Kerim Aydin, Grant Adams, Kelly Kearney, Kalei Shotwell, Grant Thompson, and Ingrid Spies

kirstin.holsman@noaa.gov *November 2022*
Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA,
7600 Sand Point Way N.E., Seattle, Washington 98115

Summary of assessment results for 2022:

Biomass

- At 6.8 million tons, the 2022 SEBS pollock spawning biomass from the multispecies model is above the long-term (1979-2015) average of 4.9 million tons and represents a 31% change from 2021 and 35% change from 2020 spawning biomass levels. Similarly, the downward trend in total biomass observed in the past few years has continued through 2022, with recent declines placing the total 2022 biomass (23 million t) above the 1979-2015 average of 15.4 million tons. However it is important to note that because there was no Alaska Fisheries Science Center summer bottom trawl survey in 2020, estimates of, and differences relative to the 2020 biomass should be interpreted cautiously.
- The 2022 SEBS Pacific cod female spawning biomass has declined -10% since 2021 and -26% since 2020. 2022 estimates are approximately -17% below the 1979-2015 average. Total biomass in the SEBS has declined -45% since 2016, and at approximately 758 thousand tons, is 26% below the long-term 1979-2015 average of 1 million tons. These patterns are driven in part by continued low survey indices in 2021 and warm bottom temperatures that have induced northward redistribution of the P. cod stock (Spies et al. 2020, Stevenson et al. 2019). This assessment does not include Northern Bering Sea survey data collected in 2017, 2018, and 2019.
- Arrowtooth total and spawning biomass estimates are 48% and 65% greater than the long-term 1979-2015 average (respectively), and trends suggest relatively stable biomass since 2012.
- The multispecies model estimates of a 31% and -10% change in spawning biomass (SSB) between 2021 and 2022 for pollock and Pacific cod (respectively) agree with CEATTLE single species model patterns of decline (25% and -10%, respectively). Both models predict an increase (slightly) in spawning biomass for arrowtooth flounder relative to 2021.

Recruitment

- While pollock age 1 recruitment estimates for this year are 35% above the 1979-2015 average, estimated recruitment has decreased (slightly) in 2022 relative to 2021(note that the most recent estimates have the highest uncertainty).

Probability of near-term (+ 1-2 yr) biomass decline or increase:

- Relative to 2022 levels, the model projects SSB of pollock will increase in 2023 (projected based on 2022 catch) followed by an increase in SSB in 2024 (projected with F_{ABC}). For Pacific cod the model projects a decline in SSB in both 2023 and 2024.
- Ensemble projections using climate-enhanced recruitment models and projected future warming scenarios (including high carbon mitigation (ssp126), low carbon mitigation (ssp585), as well as persistence scenarios and assuming 2022 catch for 2023 and F_{ABC} for 2024) estimate a 95% chance that pollock ... of 2022 SSB

Use climate informed model to characterize risk in +1 & +2 years

... ojections esti- ... f 2022 SSB in

... ojections esti- mate a 95% chance that arrowtooth SSB will be between 92 and 130% of 2022 SSB in 2023 and will be between 87 and 117% of 2022 SSB levels in 2024.

Probability of long-term (2032, 2050, 2080) biomass decline or increase under high mitigation (low warming) scenarios:

Note that projections assume no adaptation by the species, fishery, or fishery management.

- Ensemble projections using climate-enhanced recruitment models and projected future warming sce- ... will be between ... 71-75% of 2022

Use climate informed model to characterize risk in 10 + years with low warming

... projections esti- ... between 69-74%

- Ensemble projections using climate-enhanced recruitment models based on long-term projections estimate a 95% chance that arrowtooth SSB will be between 76-100% of 2022 SSB in 2032, between 81-92% of 2022 SSB levels in 2050, and between 76-90% of 2022 SSB levels in 2080.

Probability of long-term (2032, 2050, 2080) biomass decline or increase under low carbon mitigation scenarios (high warming):

Note that projections assume no adaptation by the species, fishery, or fishery management.

... e warming sce- ... will be between ... between 48 and

Use climate informed model to characterize risk in 10 + years with high warming

... projections esti- ... 2032, between 61 and 75% of 2022 SSB levels in 2050, and between 36 and 48% of 2022 SSB levels in 2080.

https://apps-afsc.fisheries.noaa.gov/Plan_Team/2022/EBSmultispp.pdf

Research topics

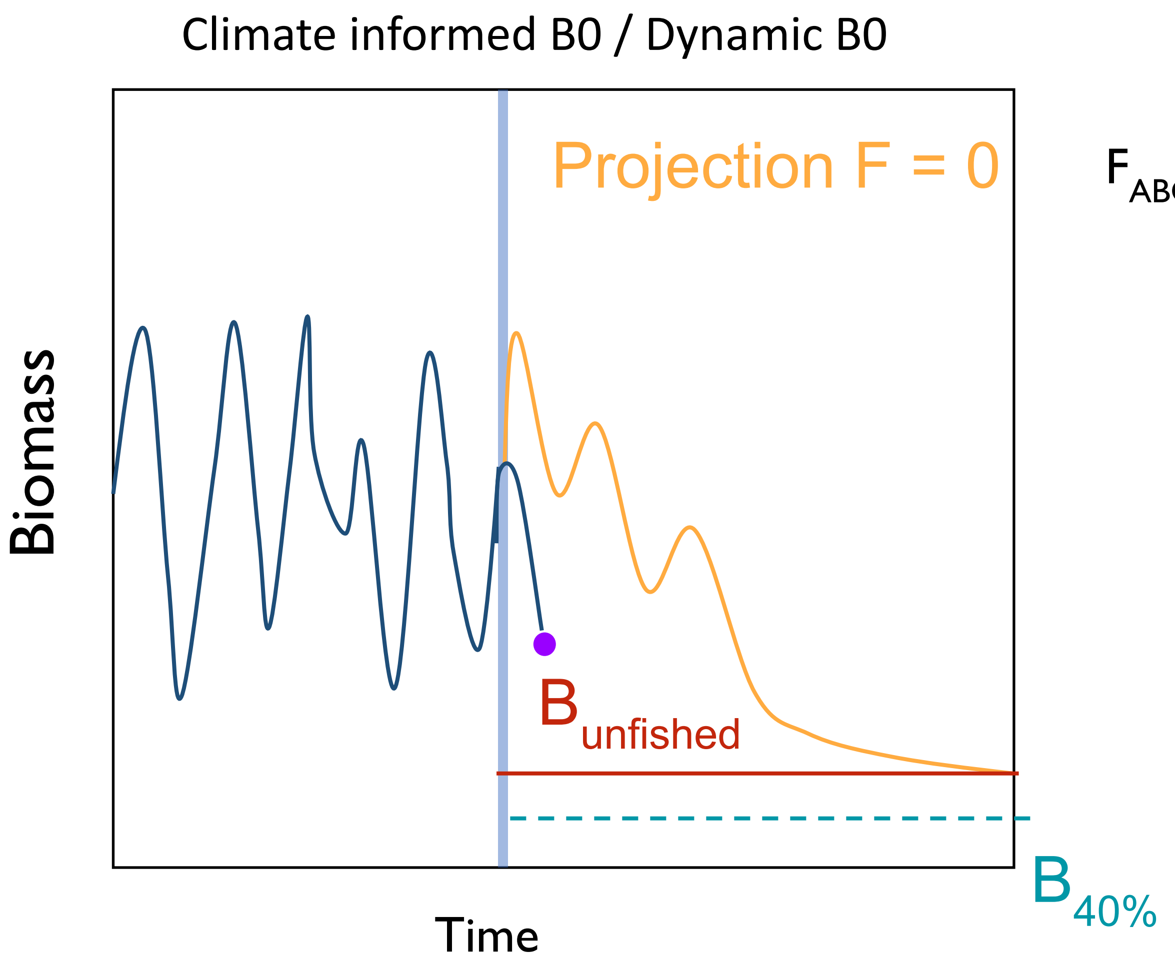
- Climate informed or climate naive targets?

  → Use Climate Naive (see Cody's paper)
- Climate informed or climate naive models for ABC?

  → testing presently, use CI - Models
- Eval performance of Climate Enhanced HCRs

  → testing presently, use CI - Models
- Eval. potential emergency responses
- Eval effect of climate driven distributions on pop-dynamics,catch, & bycatch
- Eval skill of ecosystem forecasts to "foresight"
- Consider inclusive evaluation metrics
- Consider lags in markets to climate shocks

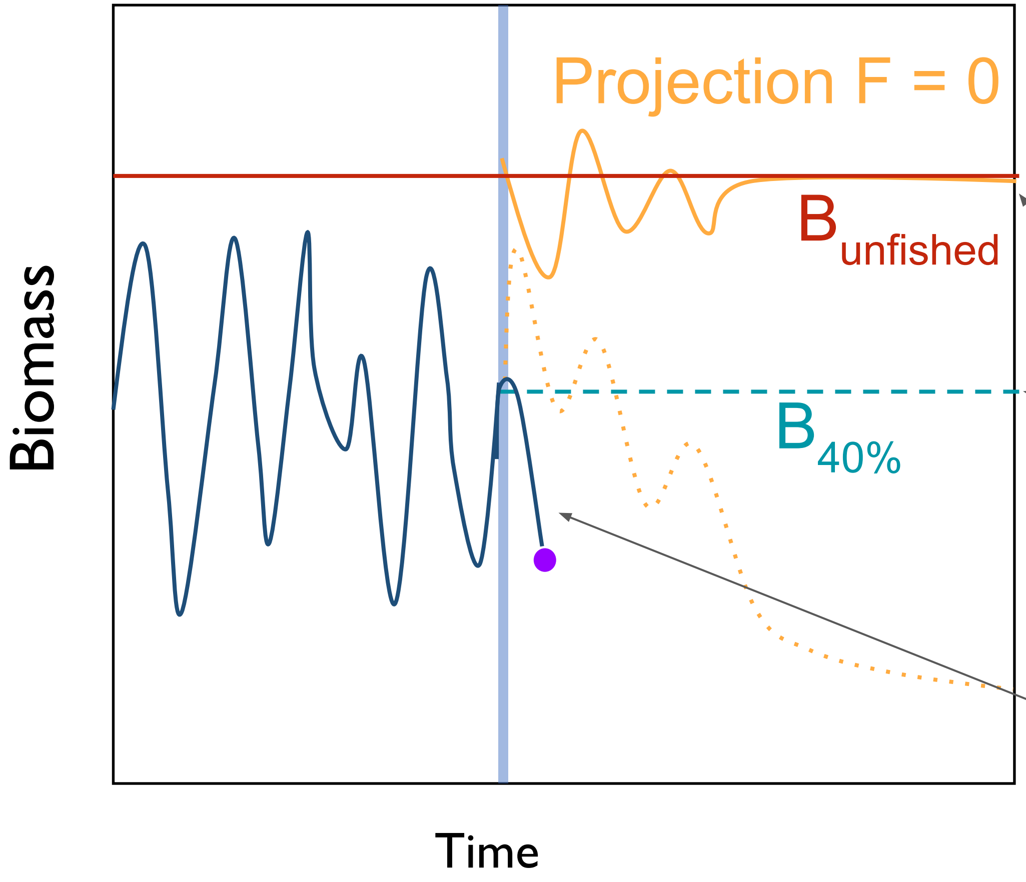
First: Set Target / reference points



$F_{ABC} = 1.0 * F_{ACL}$

ACLIM :"hybrid" climate- naive target, & climate informed status

Climate naive B0 + climate informed By



$F_{ABC} = 1.0 * F_{ACL}$

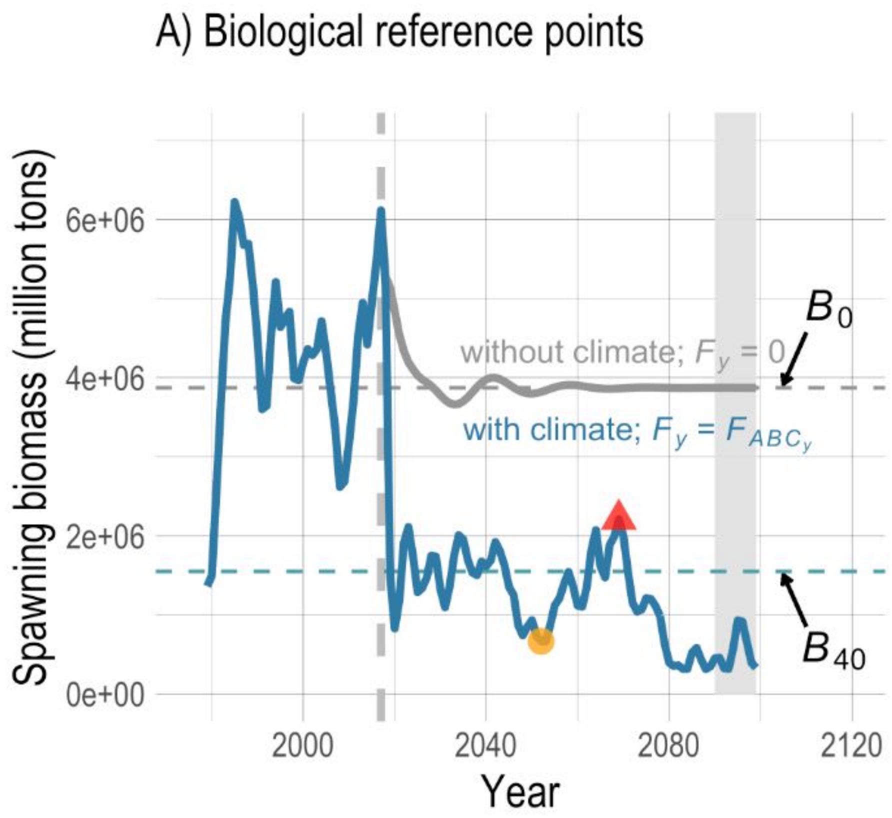
$F_{ABC} = 0.7 * F_{ACL}$

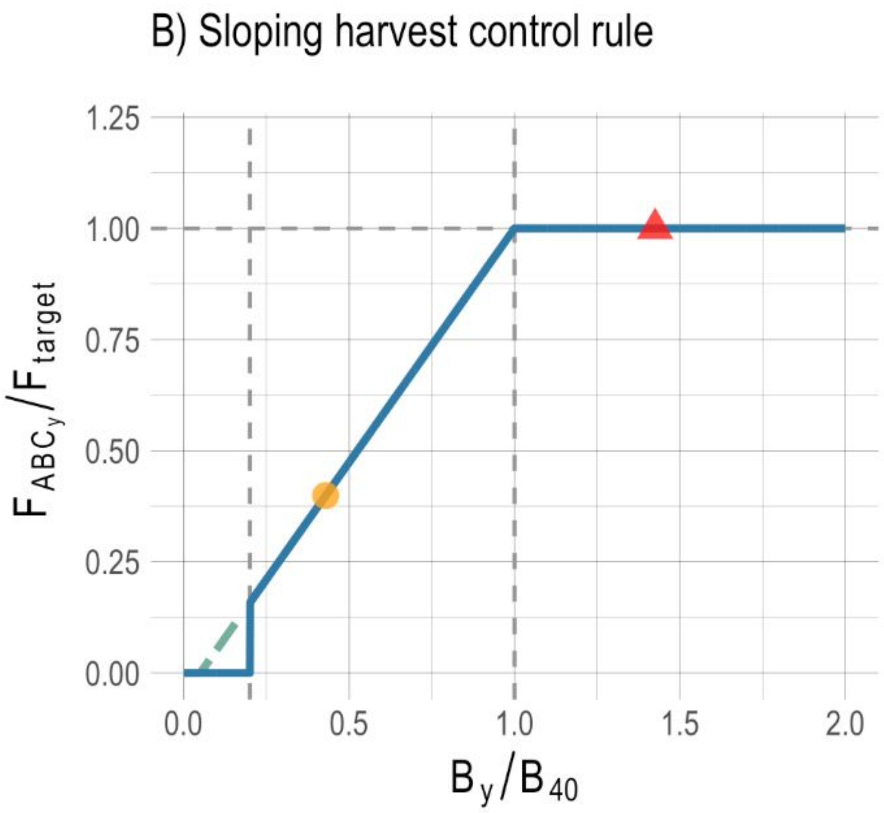
Climate naive model to set $B_{unfished}$ & $B_{40\%}$

Climate informed model to get B_y / $B_{40\%}$

Solution?

Set B40 using climate naive models (or historical $B_{unfished}$), eval. current B:B40 using climate informed models





Holsman, K.K., Haynie, A.C., Hollowed, A.B. et al. Ecosystem-based fisheries management forestalls climate-driven collapse. Nat Commun 11, 4579 (2020). https://doi.org/10.1038/s41467-020-18300-3