

## Alternative HCRs





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ACLIM and GOA CLIM Teams CEFI - Alaska ICES/PICES S-CCME/ SICCME





#### Outline for today's talk



- b) Setting the stage for discussion
  - i) B0, B\_target; considerations for session 2
  - ii) Cap effects; considerations for session 3
  - iii) Evaluating HCRs, considerations for session 1
- c) SSC Discussion questions / feedback
  - i) Simulation evaluation criteria
  - ii) First phase HCRs
  - iii) First phase focal species





#### **AFSC Integrated Climate Modeling Projects**



#### **ACLIM3 Team**



Supporting productive
fisheries & resilient
communities through
climate-informed Ecosystem
Based Management advice

Kirstin Holsman, Sarah Wise, Andre Punt, Albert Hermann, Cheryl Barnes, Cody Szuwalski, Kerim Aydin, Kelly Kearney, Anne Hollowed, Alberto Rovellini, Andrea Havron, Andy Whitehouse, Anna Amalka Sulc, Carey McGilliard, Catherine Moncrieff, Darren Pilcher, Diana Stram, Ed Farley, Elizabeth McHuron, Elizabeth Siddon, Ellen Yasumiishi, Grant Adams, Ingrid Spies, Ivonne Ortiz, James Ianelli, James Thorson, Jean Lee, Jennifer Bigman, Jeremy Sterling, Jodi Pirtle, Jonathan Reum, Kalei Shotwell, Kate Haapala, Kelly Kearney, Lorenzo Ciannelli, Mabel Baldwin-Schaeffer, Maggie Mooney-Seus, Martin Dorn, Maurice Goodman, Meaghan Bryan, Melissa Haltuch, Melissa Parks, Michael Litzow, Mike Dalton, Molly Graham, Patricia Pinto da Silva, Paul Spencer, Sarah Stone, Serena Fitka, Steve Barbeaux, Trond Kristiansen, Wei Cheng, William Stockhausen, Lia Domke, Anne Beaudreau, Justin Hansen, Angela Abolhassani, Matt Callahan, Brett Holycross





#### GOA-CLIM 2 Team



Supporting productive
fisheries & resilient
communities through
climate-informed Ecosystem
Based Management advice

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#### ACLIM & GOACLIM Overviews in eAgenda



ORIGINAL RESEARCH published: 14 January 2020



#### Integrated Modeling to Evaluate Climate Change Impacts on Coupled Social-Ecological Systems in Alaska

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Haum J.C., Spannor P., Spisie I.,
Stochbauson G. And Wilderburn TK.
(2020) Integrated Modeling
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Ferret Mr. Soi. 6175.

The Alaska Climate Integrated Modeling (ACLIM) project represents a comprehensive, multi-year, interdisciplinary effort to characterize and project climate-driven changes to the eastern Bering Sea (EBS) ecosystem, from physics to fishing communities. Results from the ACLIM project are being used to understand how different regional fisheries management approaches can help promote adaptation to climate-driven changes to sustain fish and shellfish populations and to inform managers and fishery dependent communities of the risks associated with different future climate scenarios. The project relies on iterative communications and outreaches with managers and fishery-dependent communities that have informed the selection of fishing scenarios. This iterative approach ensures that the research team focuses on policy relevant scenarios that explore realistic adaptation ontions for managers and communities. Within each iterative cycle, the interdisciplinary research team continues to improve: methods for downscaling climate models, climate-enhanced biological models, socio-economic modeling, and management strategy evaluation (MSE) within a common analytical framework. The evolving nature of the ACLIM framework ensures improved understanding of system responses and feedbacks are considered within the projections and that the fishing scenarios continue to reflect the management objectives of the regional fisheries management bodies. The multi-model approach used for projection of biological responses, facilitates the quantification of the relative contributions of climate forcing scenario, fishing scenario, parameter, and structural uncertainty with and between models. Ensemble means and variance within and hotwoon models inform risk assessments under different future scenarios. The first phase of projections of climate conditions to the end of the 21st century is complete,

dai: 10.3389/lmars.2019.00775 ph8

January 2020 | Volume 6 | Article 775



#### Gulf of Alaska Climate Integrated Modeling (GOA-CLIM) Project

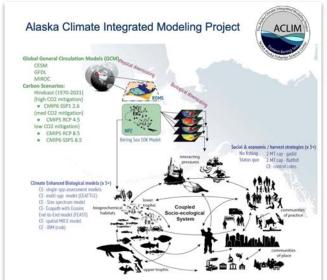
Meaghan Bryan<sup>1</sup>, Carey McGilliard<sup>1</sup>, Alberto Rovellini<sup>2</sup>, Bia Dias<sup>1</sup>, Bridget Ferriss<sup>1</sup>, Szymon Surma<sup>3</sup>, Kerim Aydin<sup>1</sup>, Grant Adams<sup>1</sup>, Cheryl Barnes<sup>4</sup>, Chang Seung<sup>1</sup>, Andre Punt<sup>2</sup>, Martin Dorn<sup>2</sup>

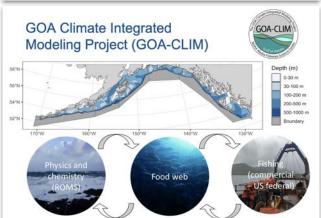
- 1 NOAA Fisheries, Alaska Fisheries Science Center
- <sup>2</sup> University of Washington, School for Aquatic and Fisheries Science
- 3 University of British Columbia, Institute for Ocean and Fisheries
- 4 Oregon State University, College of Agricultural Sciences

The Gulf of Alaska Climate Integrated Modeling (GOA-CLIM) project is an integrated research program that is closely aligned with the Alaska Climate Integrated Modeling (ACLIM) project. This is a multiphase project where the first phase focused on (1) the development, calibration, and skill testing of an end-to-end Atlantis model for the GOA. (2) development of two Ecopath with Ecosam models splitting the GOA into eastern and western portions, (3) refinement of other multispecies models (e.g., Ecastelle, (4) synthesizing datasets for the ensemble of models, (5) linking continuous Regional Ocean Modeling System (ROMS) simulations from the present to 2100 to ecosystem and stock assessment models, and (6) evaluating the performance of management strategies under different environmental scenarios (e.g., system level optimum yield). The main goals of the current phase, phase two, are to refine the ensemble of environment coupled models (e.g., refine modeling of top predators, refine the fleet structure in Atlantis) and develop a multispecies size spectrum model to include in the ensemble. The ensemble of regional economic models to assess the impacts of environmental scenarios and fisheries management measures on GOA communities.

The purpose of this document is to provide a brief description of the ensemble of component models that have been developed or are under development, along with highlights of their model assumptions. The models include Atlantis, Ecopath with Ecosim/Rpath, Receatle (as a multi-species model and as an extended single-species stock assessment model), a bioeconomics community impact model infaced to Receatle, and a multipacies size spectrum model. Though Recentle has utility as a production assessment model in single-species form, the use of all of the GOA-CLIM models for projecting under environmental and harvest scenarios is intended for exploring long-term outcomes and corresponding uncertainty.

Atlantis is a deterministic ecosystem simulation model that comprises physical, food web, and fishery submodels. The GOA Atlantis model spans the GOA shelf from 170W (MMES ares 61) to Northern BC,
using 109 depth-stratified spatial polygons. The physical sub-model is forced using temperature, salinity,
and currents output from ROMS for the Northeast Pacific, available for the historical period,
(1980-2020) and as three CO; emission scenarios through 2100. The food web sub-model captures 78
functional groups, including age-structured fish populations representing the FMP groundfish stocks and
stock complexes, as well as key predators such as Steller sea lions and seabirds. Model functional groups
are connected via trophic interactions, and recruitment of fish populations follow Beverton-Holt stockrecruit relationships. The fishery sub-model allows modeling species-specific fishing mortality, either as
fixed rates or as determined dynamically by harvest control rules. Various harvest control rule forms can
be reproduced, including the ramped fishing mortality (status quo) control rules used for GOA
groundfish, as well as alternative formulations. A notable Fature is the ability to model the Optimium
Yield cap on FMP groundfish removals, allowing users to evaluate different cap values and species
prioritization schemes when resealing harvest specifications if aggregate projected cache exceeds the cap.







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



















#### What to expect?

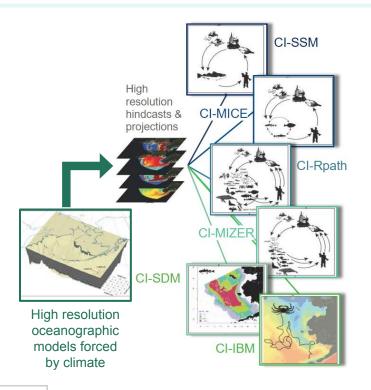
- Project physical and ecological conditions under alternative levels of global carbon mitigation
- Characterize uncertainty

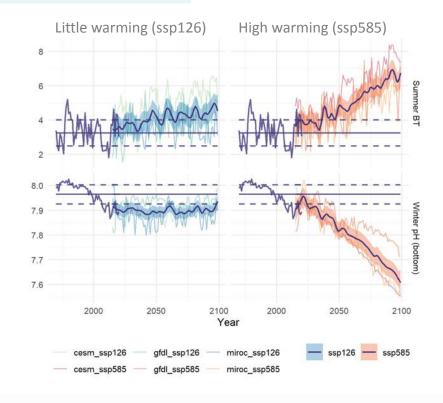
#### What can be done?

 Evaluate effectiveness of adaptation actions including those supported by fisheries management

Scenarios form the basis for comparative simulations & Management Strategy Evaluations

## **CLIM Models & Simulations**



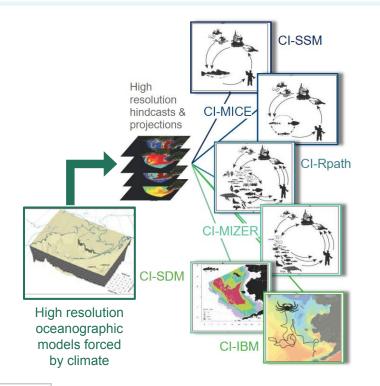




#### **Supporting Publications**

Goodman et al. (2024), Punt et al. (2023), Szuwalski et al. (2023), Olmos et al. (2023), McHuron et al. (2024), Barnes et al. (2022), Thorson et al. (2021), Whitehouse et al. (2021), Kearney et al (2020), Pilcher et al. (2022), Hollowed et al. (2020).

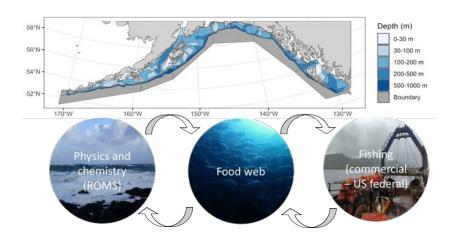
## **CLIM Models & Simulations**





A. Rovellini

**GOA-CLIM Atlantis** 

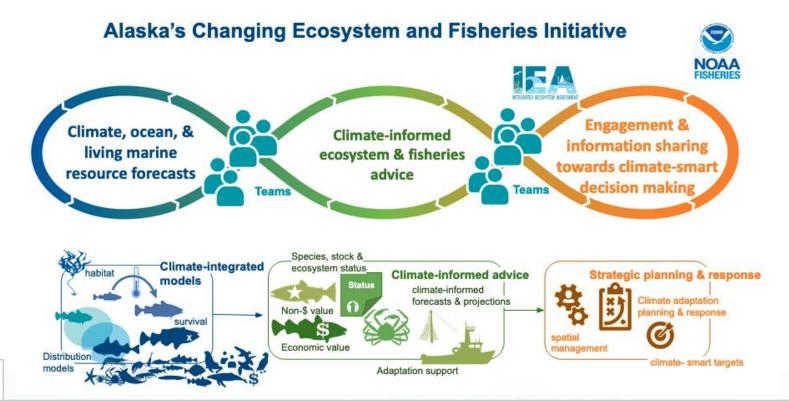




#### **Supporting Publications**

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## Strategic foresight & predictions

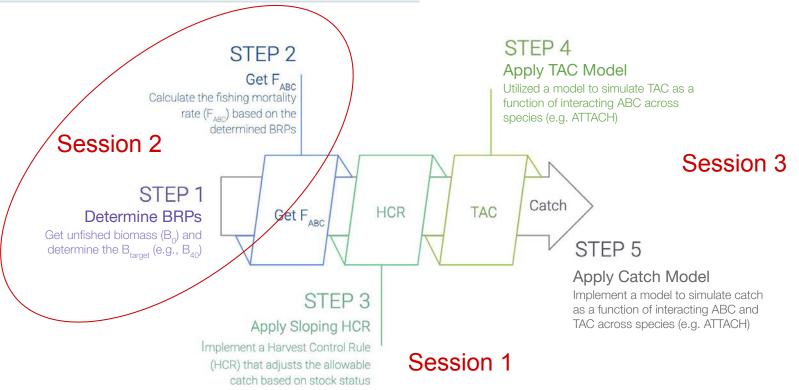








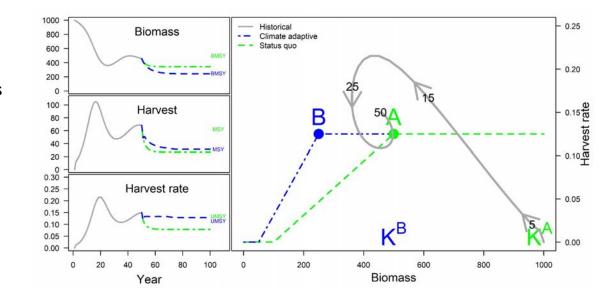
## HCR simulation process





#### Adapting reference points to reflect changes in productivity

- MSA directs reference points to reflect current and probable future environmental conditions
- Changing reference points for stocks undergoing climate-related productivity shifts can result in counter-intuitive management actions:
  - Declining stocks could be fished harder
  - Flourishing stocks could be fished more conservatively



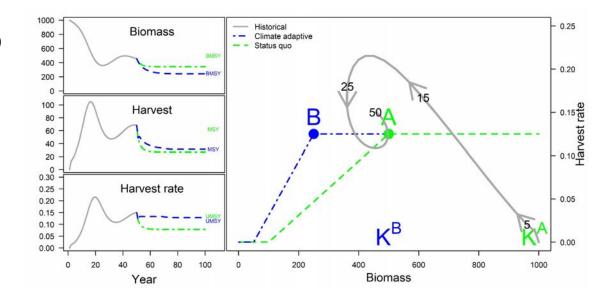




### How might this arise?

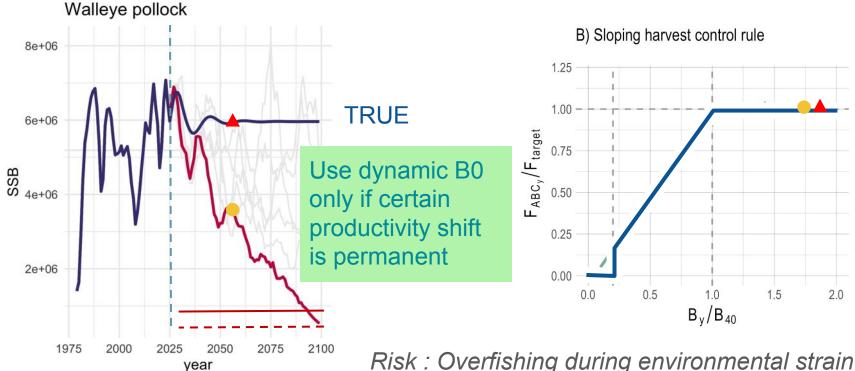
#### Proceed with caution....

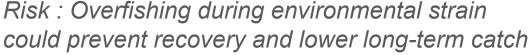
- If using a climate informed target (B0 based on climate trajectory)
- If truncating recruitment time series data to reflect recent lower productivity
- If adopting a long-term higher mortality in recent years as set M
- If re-estimating B0/B40 each year





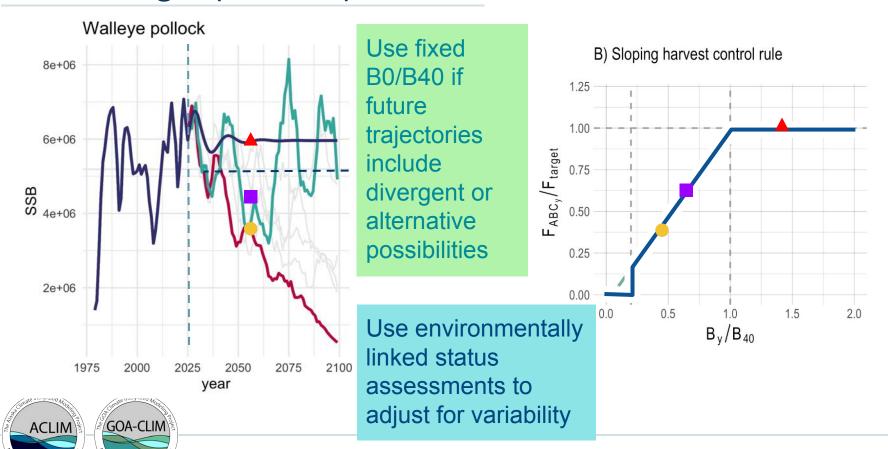
## If using a environmentally-linked B0 (dynamic B0)



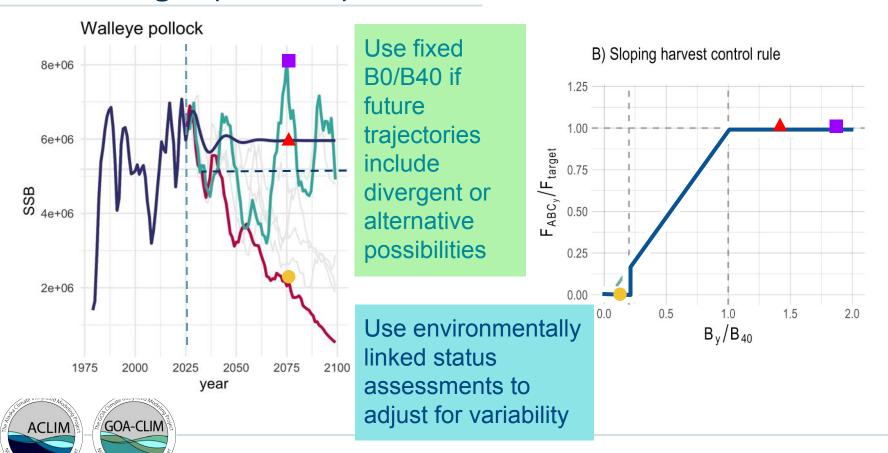




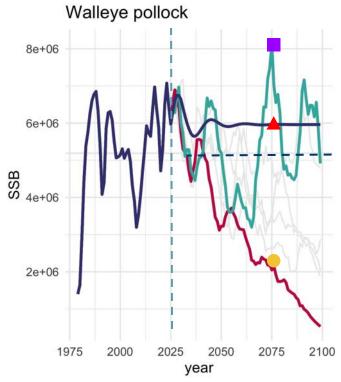
## Fixed target (fixed B0) + Env. enhanced status



## Fixed target (fixed B0) + Env. enhanced status



## Options for "hybrid" approach



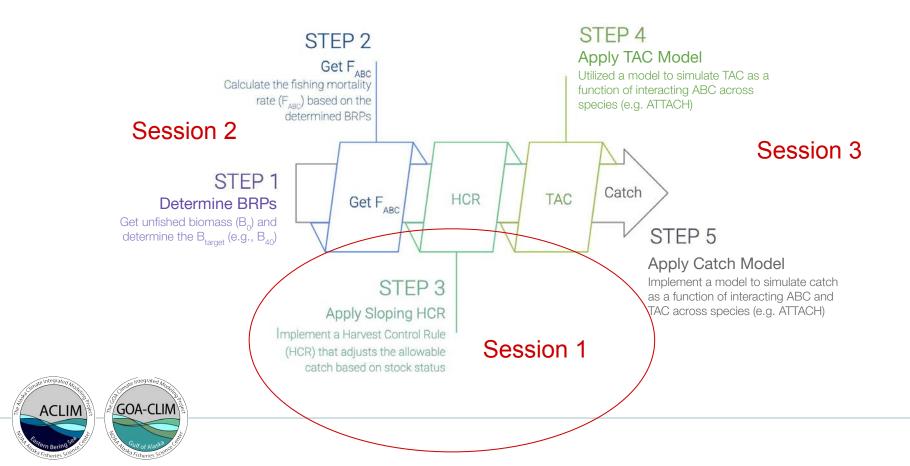
- (1) Set targets based on fixed productivity potential
  - (a) Historical reference period (historical B<sub>0</sub>)
  - (b) Persistence (constant environment) model based B<sub>0</sub>

- (2) Set status based on dynamic or environmentally informed status
  - (a) Use environmentally linked model to estimate current status
  - (b) Use base M + additional M\_env blocks (sensu Barbeaux et al. and Spies et al. 2024, Holsman et al. 2024)



## M

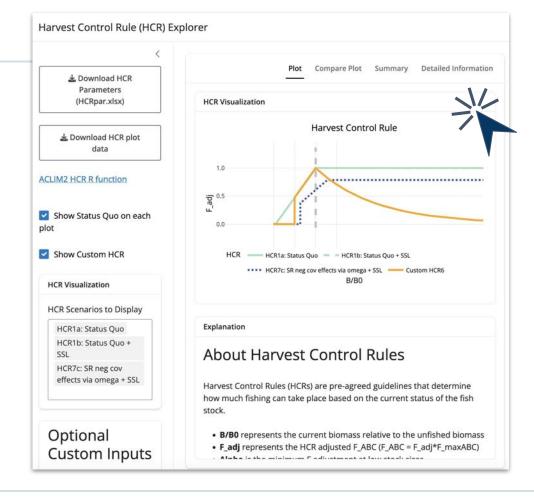
## HCR simulation process



## Interactive HCR explorer tool

https://kholsman.shinyapps.io/HCRshiny/

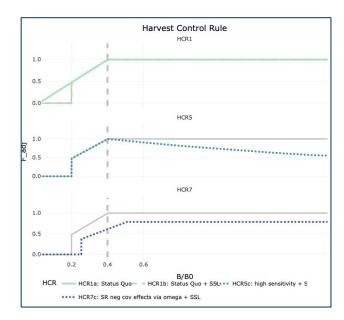
Are there alternative HCRs that can perform better than status quo under alternative future scenarios?

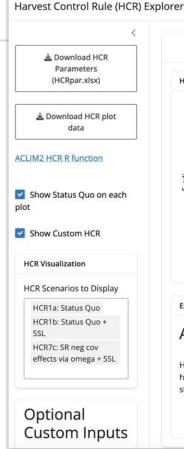


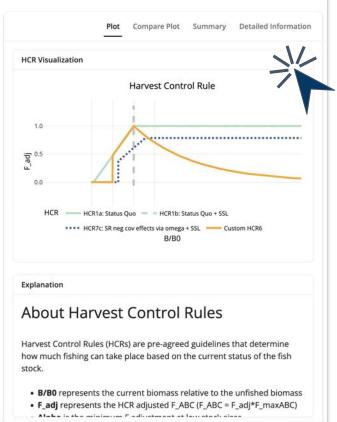


## Interactive HCR explorer tool

#### https://kholsman.shinyapps.io/HCRshiny/



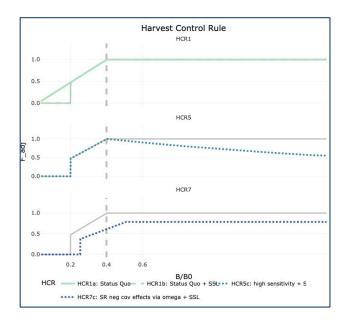


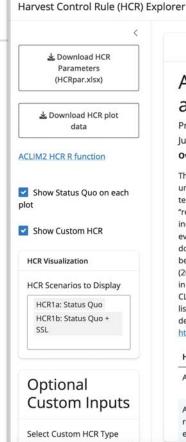


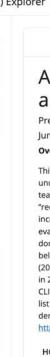


## Interactive HCR explorer tool

#### https://kholsman.shinyapps.io/HCRshiny/







Compare Plot

Detailed Information

#### ACLIM and GOA-CLIM alternative HCR set



Prepared by: Kirstin Holsman (kirstin.holsman at noaa.gov) June 2025

#### Overview

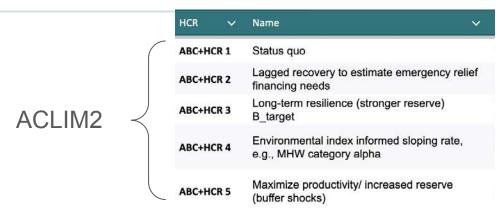
This document serves as an white paper outlining the current set of HCRs under consideration for simulation testing by the ACLIM and GOACLIM teams. This document is informational only and HCRs outlined here are not "recommended HCRs", rather alternative formulations being evaluated for increased performance through coordinated modeling in 2025. Any evaluation of HCRs to be implemented for management purposes would be done by the NPFM Council through the established Council process. The set below builds on previous modeling efforts. During ACLIM phase 2 (2019-2022), modelers evaluated a suite of Harvest Control Scenarios (1-5), in 2025 during phase 3 of the ACLIM project and in collaboration with GOA-CLIM phase 2 we added a number of additional HCRs to the set. Below is a list of those standardized harvest control rules and the equations used to derive the curves. An interactive version of these HCRs is available on line at https://kholsman.shinyapps.io/HCRshiny/

HCR	Goal
ABC+HCR 1: Status quo	This HCR is the baseline sloping harvest control rule used for groundfish in
ABC+HCR 2: Lagged recovery to estimate emergency relief financing	Simulations with this HCR will mimic economic-driven fishery closures and delayed recovery in order to estimate





#### **HCR Scenarios**



ICES Journal of Marine Science, 2024, Vol. 82, Issue 1, fsae034 https://doi.org/10.1093/icesims/fsae034 ; accepted: 21 February 2024 Advance access publication date: 29 March 2024

Stories from the front lines

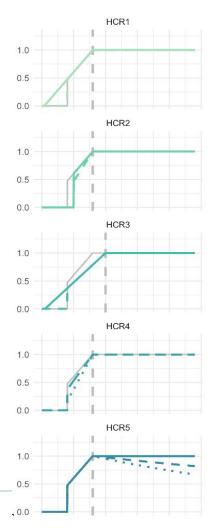


## Development of climate informed management scenarios for fisheries in the eastern Bering Sea

Anne Babcock Hollowed <sup>1,\*</sup>, Kirstin K. Holsman <sup>2</sup>, Sarah P. Wise<sup>2</sup>, Alan C. Haynie <sup>3</sup>, Wei. Cheng<sup>4,5</sup>, Diana C. K. Evans<sup>6</sup>, Albert J. Hermann<sup>4,5</sup>, James N. Ianelli<sup>2</sup>, Kelly A. Kearney <sup>2</sup>, Andre E. Punt<sup>1</sup>, Jonathan C. P. Reum <sup>2</sup>, Diana L. Stram<sup>6</sup>, Cody S. Szuwalski<sup>2</sup>

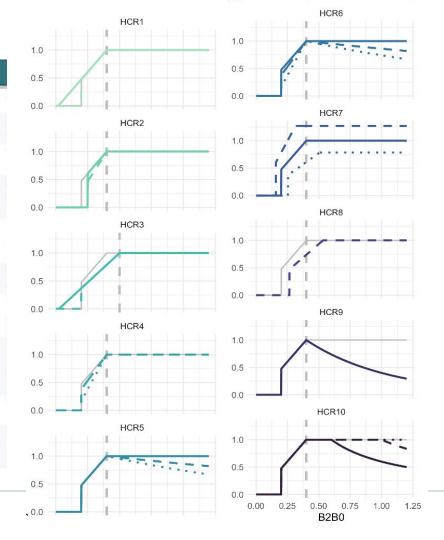
Hollowed et al. (2025) https://doi.org/10.1093/icesjms/fsae034





#### **HCR Scenarios**

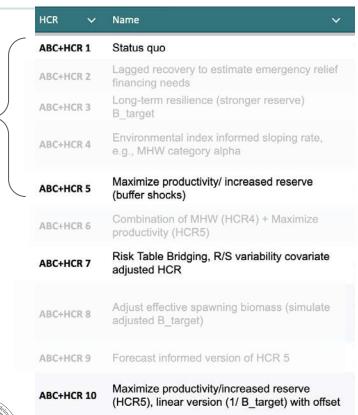
HCR V Name ABC+HCR 1 Status quo Lagged recovery to estimate emergency relief ABC+HCR 2 financing needs Long-term resilience (stronger reserve) ABC+HCR 3 ACLIM2 B target Environmental index informed sloping rate, ABC+HCR 4 e.g., MHW category alpha Maximize productivity/ increased reserve ABC+HCR 5 (buffer shocks) Combination of MHW (HCR4) + Maximize ABC+HCR 6 productivity (HCR5) Risk Table Bridging, R/S variability covariate ABC+HCR 7 adjusted HCR Adjust effective spawning biomass (simulate **ABC+HCR 8** adjusted B target) ABC+HCR 9 Forecast informed version of HCR 5 Maximize productivity/increased reserve ABC+HCR 10 (HCR5), linear version (1/B target) with offset

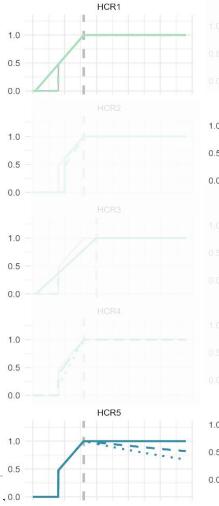


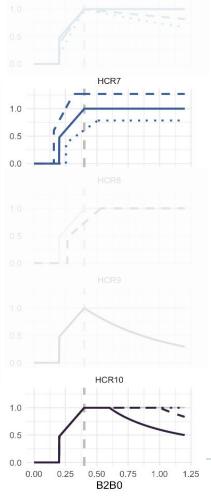


#### **HCR Scenarios**

ACLIM2









## HCR 1: Status quo (Tier 3)

#### HCR

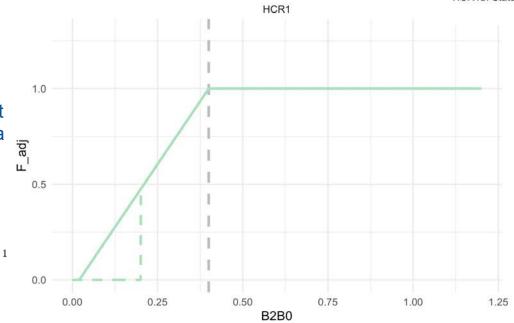
— HCR1a: Status Quo

HCR1b: Status Quo + SSL

#### **Simulation Goal:**

This HCR is the baseline sloping harvest control rule used for groundfish in Alaska

$$F_{ABC_{max}} = \left[ \begin{array}{c} F_{ABC} & \frac{B_y}{B_{target}} > 1 \\ F_{ABC}((\frac{B_y}{B_{target}} - \alpha)/(1 - \alpha)) & \frac{B_{lim}}{B_{target}} \leq \frac{B_y}{B_{target}} < 1 \\ 0 & \frac{B_y}{B_{target}} \leq \frac{B_{lim}}{B_{target}} \end{array} \right]$$



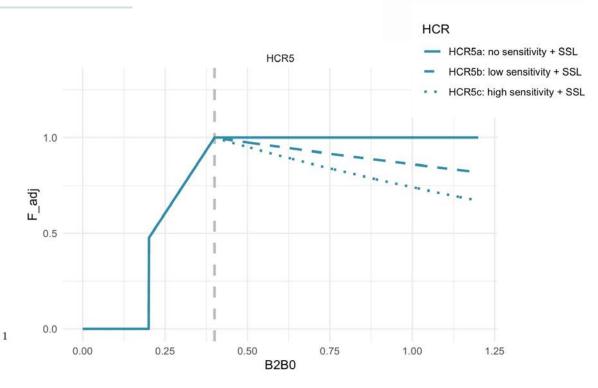


### HCR 5: Maximize productivity/ increased reserve (buffer shocks)

#### **Simulation Goal:**

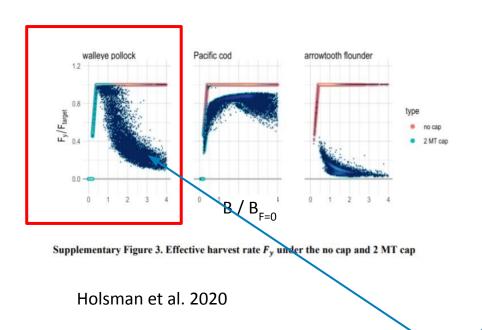
HCR 5 is designed to maximize ecosystem and spawning biomass productivity by increasing reserves, creating a buffer against environmental shocks, and enhancing long-term sustainability

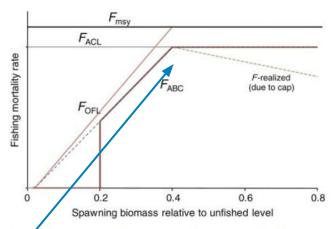
$$F_{ABC_{max}} = \left[ \begin{array}{cc} F_{ABC} \; e^{(-\gamma(\frac{B_y}{B_{target}}-1))} & \frac{B_y}{B_{target}} > 1 \\ F_{ABC}((\frac{B_y}{B_{target}}-\alpha)/(1-\alpha)) & \frac{B_{lim}}{B_{target}} \leq \frac{B_y}{B_{target}} < 1 \\ 0 & \frac{B_y}{B_{target}} < \frac{B_{lim}}{B_{target}} < \frac{B_{lim}}{$$





#### Apply effective pollock HCR cap-like effect





**Figure 4.** Schematic of harvest control rule currently affecting ABC or annual catch limit (ACL) for Alaska groundfish species like pollock (thick line). Note that this schematic indicates that  $B_{msy}$  is 40% of the unfished expected spawning biomass.

Ianelli et al. 2011

### Effect of the 2 mt Cap on pollock

Hollowed et al. (2025) Development of climate informed management scenarios for fisheries in the eastern Bering Sea . ICES Journal of Marine Science, Volume 82, Issue 1, January 2025, fsae034, <a href="https://doi.org/10.1093/icesims/fsae034">https://doi.org/10.1093/icesims/fsae034</a>

## HCR 7: Risk TableBridging via R/S variability covariate adjusted HCR

#### HCR

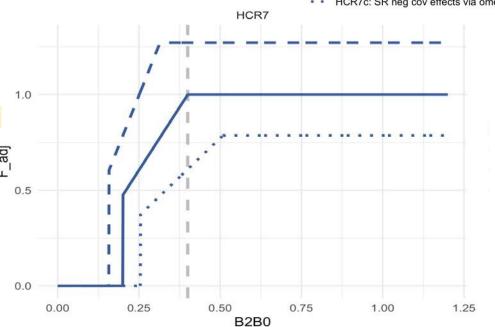
- HCR7a: max productivity (SQ) + SSL
- HCR7b: SR pos cov effects via omega + SSL
- HCR7c: SR neg cov effects via omega + SSL

#### **Simulation Goal:**

This HCR provides a way to transition from qualitative risk tables to a more explicit, analytical approach for species whose productivity is known to vary with environmental conditions.

$$F_{ABC_{max}} = \left[ \begin{array}{c} F_{ABC} \; e^{(\omega_1 * \mathbf{x}_\mathbf{y})} \\ F_{ABC}((\frac{B_y}{\hat{B}_{target}} - \alpha)/(1 - \alpha)) \; e^{(\omega_1 * \mathbf{x}_\mathbf{y})} \\ 0 \end{array} \right. \quad \frac{\frac{B_y}{\hat{B}_{target}}}{\frac{B_y}{\hat{B}_{target}}} \leq \frac{B_y}{\hat{B}_{target}} < 1$$

$$\hat{B}_{lim} = B_{lim} e^{(-\omega_3*\mathbf{x_y})} \qquad \hat{B}_{target} = B_{target} e^{(-\omega_2*\mathbf{x_y})}$$

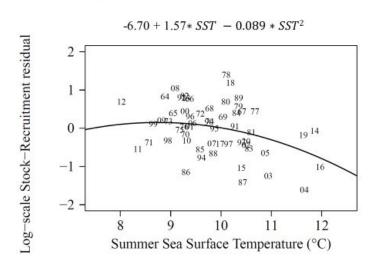




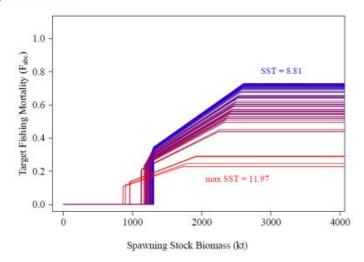


## Spencer et al. in prep

#### Effect of temperature on recruitment



## How would the harvest control rule change with temperature?





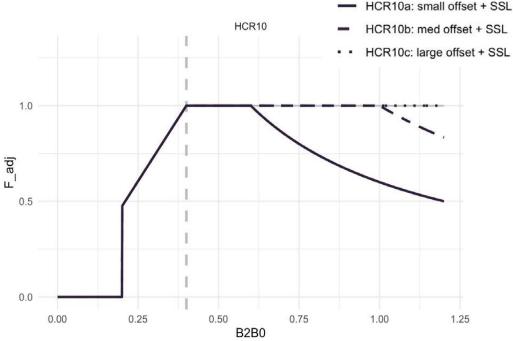
# HCR 10: Maximize productivity/increased reserve; linear version (1/ B\_target) with offset

#### **Simulation Goal:**

This HCR builds on HCR 5 by applying a proportional reduction in fishing mortality based on biomass levels, further enhancing stock and environmental productivity through strengthening the buffer against environmental shocks.

$$F_{ABC_{max}} = \begin{bmatrix} F_{ABC}/(\frac{B_y}{B_{target}}\frac{1}{(1+\gamma)}) \\ F_{ABC} \\ F_{ABC}((\frac{B_y}{B_{target}} - \alpha)/(1-\alpha)) \\ 0 \end{bmatrix}$$

$$\begin{array}{l} \frac{B_y}{B_{target}} > (1+\gamma) \\ 1 < \frac{B_y}{B_{target}} < (1+\gamma) \\ \frac{B_{tim}}{B_{target}} \leq \frac{B_y}{B_{target}} < 1 \\ \frac{B_y}{B_{target}} < \frac{B_{tim}}{B_{target}} \end{array}$$

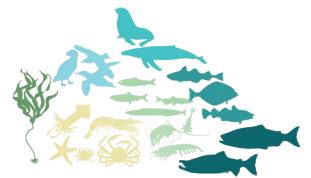


**HCR** 

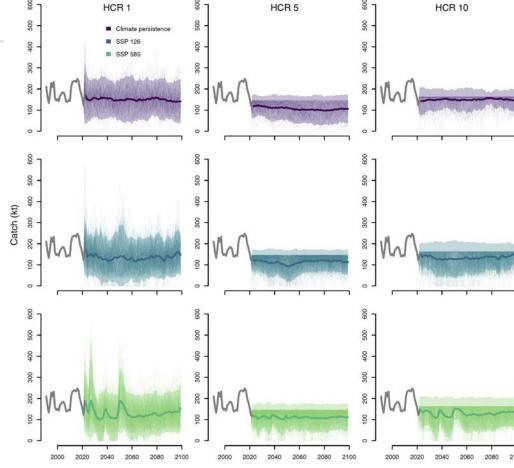


## Rpath() example

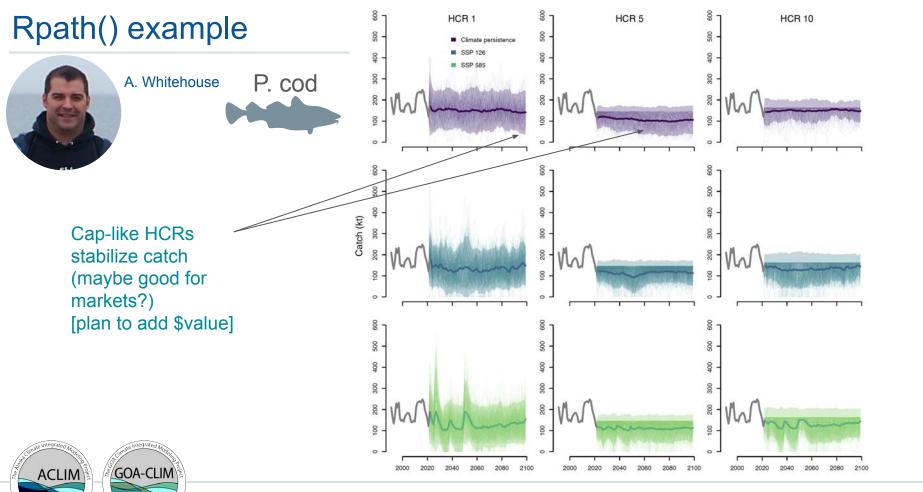


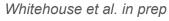


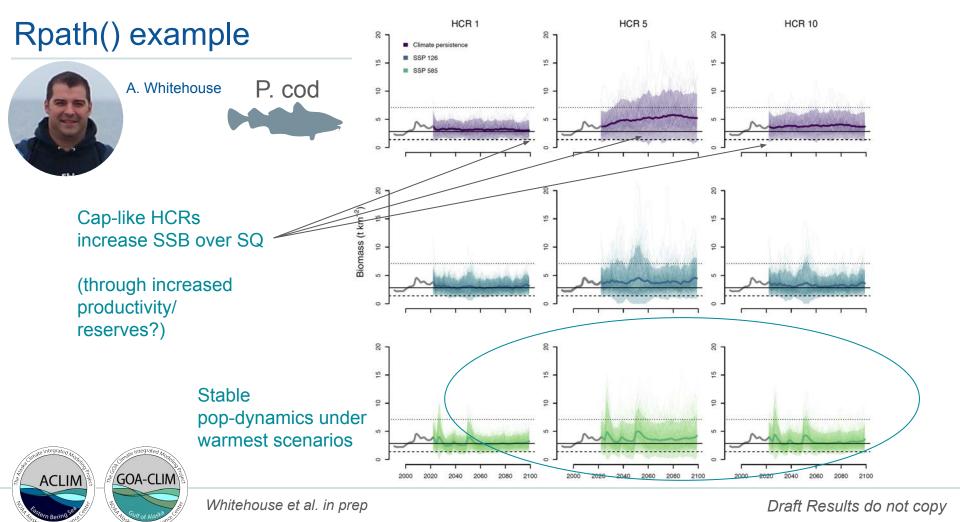
EBS Food web model

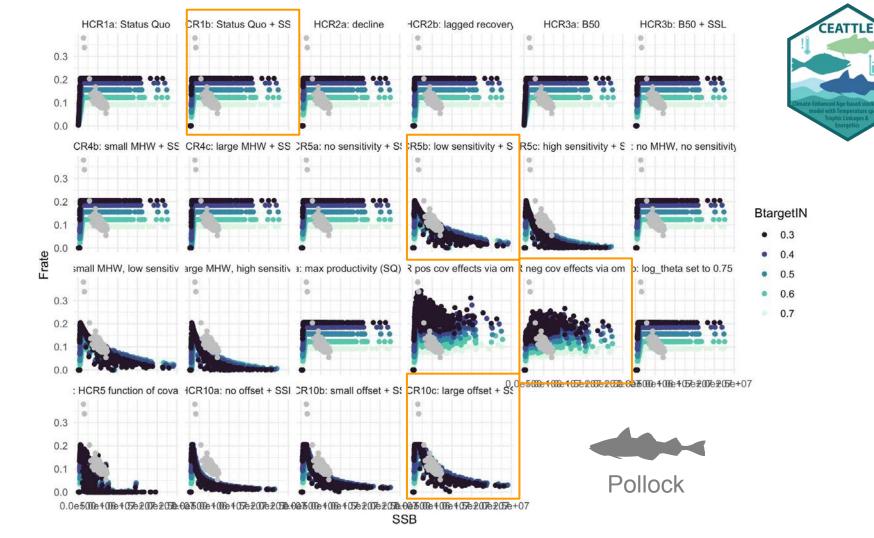


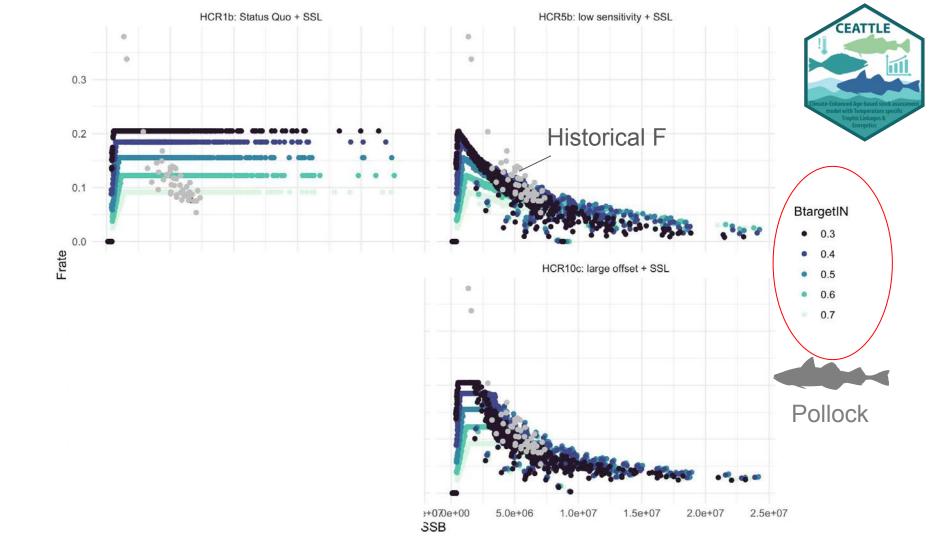












# CEATTLE example (SSB)

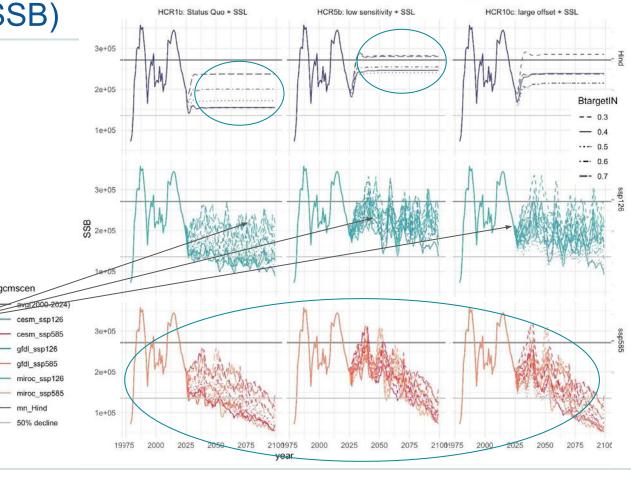




Cap-like HCRs reduce differences across Btarget

Cap-like HCRs increase SSB (through increased productivity/ reserves?)

> **Environmental** dynamics >> HCRs

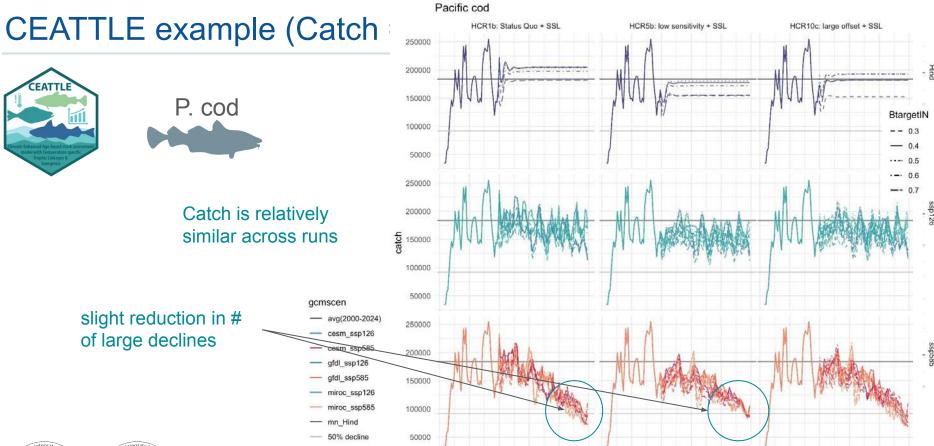


Pacific cod



gcmscen

gfdl\_ssp126 qfdl ssp585



vear



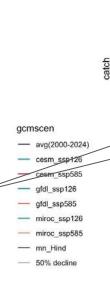
## CEATTLE example (Catch



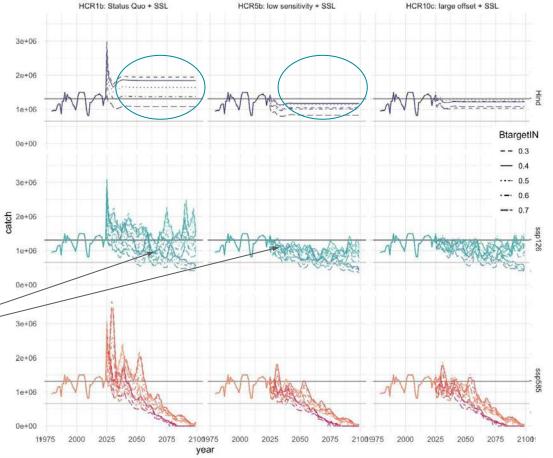


Cap-like HCRs reduce differences across Btarget

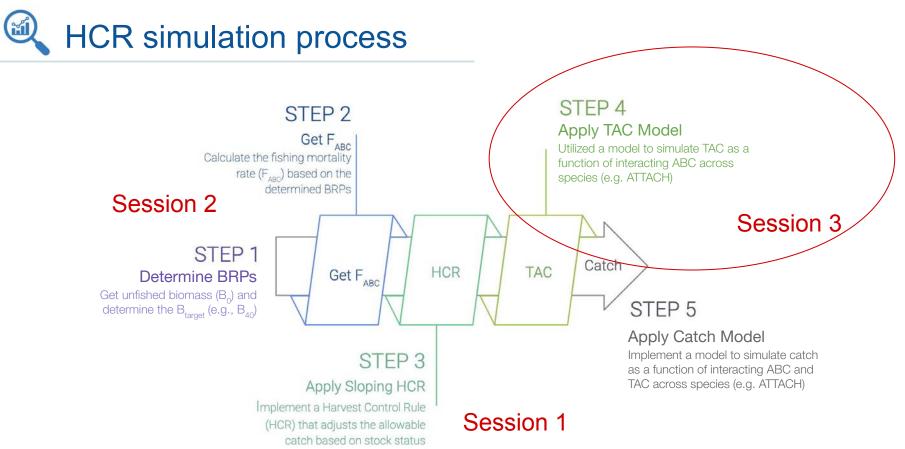
Cap-like HCRs stabilize catch (maybe good for markets?) [plan to add \$value]



Walleye pollock





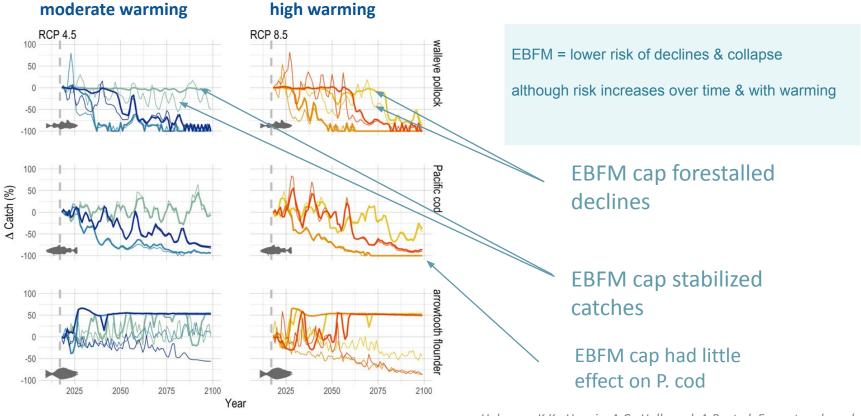






Assumes climate effects on recruitment, growth, & mortality





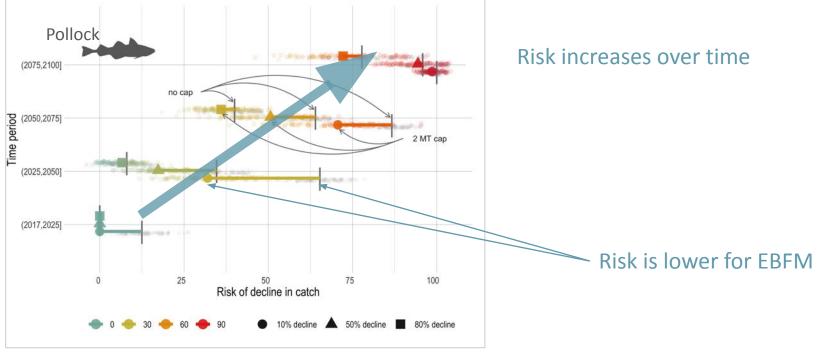
CESM rcp85

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

#### CEATTLE: EBFM vs non-EBFM cap

Assumes climate effects on recruitment, growth, & mortality





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



- What HCRs are of interest?
- What species should we focus on first (e.g., highest productivity spp?)
- What are some performance criteria to include in our evaluations?

#### Performance criteria

- → %time below B20
- $\blacksquare$  Number of F = 0, closures
- Diversity of age classes (sensu
- lanelli et al.)
- Total Catch
- ☐ Total \$ Yield
- Stability of Catch over time
- Mean age
- ☐ R/S or other product. indices
- → Mean trophic level

Hollowed et al.

Alaska Integrated Climate Modeling

#### TABLE 6 | Suite of candidate performance indicators for ACLIM.

Name	Derivation	Purpose
Core species abundance	Mean and variance for time block	Sustainable fishing index
Core species recruitment	Mean and variance for time block	Sustainable fishing index
Core species average size and age at maturity	Mean and variance for time block	Sustainable fishing index
Core species exploitation	Annual time trend F/F <sub>MSY</sub>	Sustainable fishing index
Core species crab status	Annual time trend reproductive potential vs. target reproductive potential.	Sustainable fishing index
Core species crab catch	Mean and variance for time block	Sustainable fishing index
Centroid of distribution for core species	Annual time trend	Index distribution
Euphausiid biomass	Mean and variance for time block	Ecosystem stability index
Motile epifauna biomass	Mean and variance for time block	Trophic structure index
Benthic forager biomass	Mean and variance for time block	Trophic structure index
Pelagic forager biomass	Mean and variance for time block	Trophic structure index
Apex predator biomass	Mean and variance for time block	Trophic structure index
Species diversity index	Alpha and beta diversity indices	Ecosystem stability index
Mean trophic level of the catch	Mean and variance for time block	Ecosystem Based Fishery Management inde
Number of fishery closures by core species	Average for time block	Fishery efficiency index
Core species and fleet CPUE	Annual time trend of CPUE by species and fleet	Fishery catchability index
Fishing effort by fleet	Annual time trend of fishing effort	Fisheries participation and employment
Core species first-wholesale revenue index	Annual time trend	Economic index
Core species percent TAC utilization	Percentage of total allowable catch landed	Management index
Fleet species diversity index	Annual measure of diversity of target species revenues	Measure of fishery portfolio by sector
Fleet revenue variability	Coefficient of variations of fisheries revenue by sector	Financial risk index



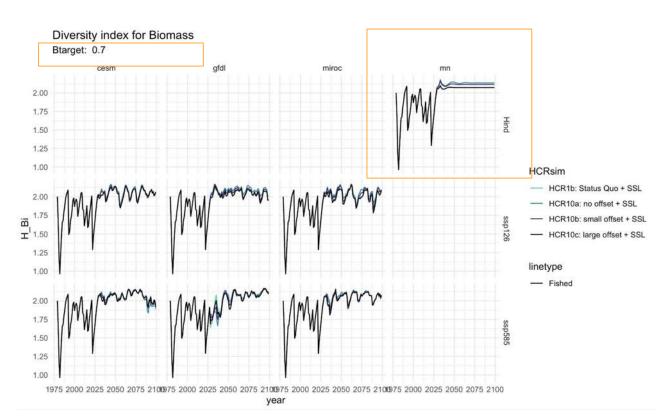
### **CEATTLE** example





Status Quo HCR1 is sensitive to B\_target

Diversity Index is lower when B\_target is higher



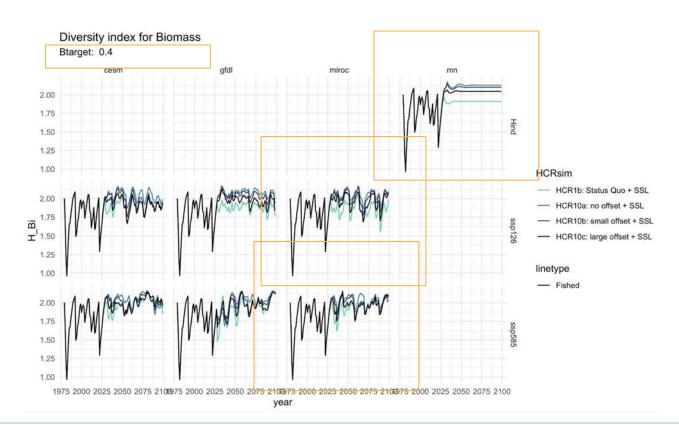


### **CEATTLE** example



Pollock

Environmental variability (productivity pulses) reduces that difference for HCR1







- What HCRs are of interest?
- What species should we focus on first (e.g., highest productivity spp?)
- What are some performance criteria to include in our evaluations?

# Questions? GOA-CLIM ACLIM Thanks!

#### ACLIM Publications (direct & indirect) 1 of 2

- (in review) Punt et al. Identifying and reducing climate uncertainty in fisheries management reference points. Fisheries Research
- (in review) Stone et al. Socioeconomic risk of coastal Alaskan fishing communities to climate-driven changes in Pacific cod distributions. ICES Journal of Marine Science
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  (2022) Punt, A.E., et al., Szuwalski, C.S. 2022. A framework for assessing harvest strategy choice when considering multiple interacting fisheries and a changing environment: The example of
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- (2022) Szuwalski, C.S.. Estimating time-variation in confounded processes in population dynamics modeling: a case study for snow crab in the eastern Bering Sea. Fisheries Research. 251: 106298.
- (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

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- (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
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