# Climate work plan overview and Alternative Harvest Control Rule discussion paper

Diana Stram, NPFMC
Kirstin Holsman, AFSC

SSC June, 2026

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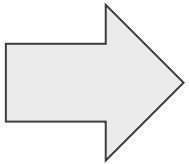
2026

# Outline of presentation

Climate work plan

4 Initial Elements



Development of Alternative Harvest Control Rules (HCR)

# Climate Work Plan overview

Climate work plan

- Development of work plan
- Overview of 4 elements
- Spreadsheet tracking tool
- Coordination with CEFI
- Current Council focus on Element 4

# NPFMC Dec. 2024 Motion

D-1 Climate Change Task Force Report
Council Motion
December 8, 2024

The Council acknowledges the final recommendations of the Climate Change Task Force (CCTF) that was established by the Bering Sea FEP and appreciates the extensive contributions of the Task Force members. The Council establishes a climate resilience workplan as recommended by the CCTF, with efforts guided by the principles outlined in the CCTF Key Element 1 (to expand existing inclusive processes, collaborations, and partnerships that facilitate inclusion of multiple knowledge systems in climate planning), and Key Element 2 (to consider management tools and options focused on the inclusion of existing and emergent climate information). The Council requests staff format the workplan, including timeframes, with the intent that it guides near-term actions for enhanced climate resilient management in the GOA and the BSAI. As an initial step, the work plan contains the following items as recommended by the CCTF; additional longer-term items and priority actions may be considered in the future. The Council anticipates that output from the NOAA Climate, Ecosystems and Fisheries Initiative (CEFI) will provide invaluable contributions to these work plan items.

- **Incorporate climate forecast linked management advice (2.1).** Use climate and ecosystem forecasts to improve management advice through assessments and supportive documents:
  a. Incorporate forecasts of climate and ecosystem conditions (+1-2 yrs) in the harvest projections and specifications processes, including through the assessment of maximum allowable catch, ABC and overfishing limit, OFL; as well as climate, ecosystem, and socioeconomic sections of Ecosystem Status Reports (ESRs), and Ecosystem and Socio-economic Profiles (ESPs) that are used in the Risk Tables (i.e., for ABC) and in the context of informing the TAC-setting process.
  b. Include climate forecast information and vulnerability assessments in management advice to inform Risk Tables and discussions around ABC or TAC. Climate information on risk could be communicated via updates and expanded climate risk sections of the Annual Community Engagement and Participation Overviews (ACEPOs), through an appendix to ESRs, or as a standalone report or assessment.
  c. Consider climate-forecast linked spatial management measures (e.g., via climate specific species distribution models) to inform apportionments.

- **Incorporate climate-driven interactions and cascading impacts through use of ecosystem indicators and models (2.2).** Develop and use ecological indicators and multi-species, multi-fleet, or ecosystem models that quantify uncertainty, interactions, and risk across multiple fisheries or species. As part of this effort risk table discussions can be aligned around climate buffers/risks.

- **Consider and incorporate dynamic management tools to increase in-season adaptation capacity (2.4).** Examples of these kinds of tools include:
  a. Using nowcasts (daily; weekly) and forecasts (<2 years) to inform spatial in-season and annual management actions
  b. Increase in-season flexibility and responsiveness in harvest measures through incorporation of real-time observations from a broader suite of observations and information

- **Review tier systems, consider climate-informed biomass targets and limits and climate-robust or forecast-informed harvest control rules (2.5)**

## Climate Workplan

1. Incorporate climate **forecast** linked management advice
2. Incorporate climate-driven interactions and cascading impacts through use of **ecosystem indicators and models**
3. Consider and incorporate **dynamic management** tools to increase in-season adaptation capacity
4. Review tier systems, consider **climate-informed biomass targets** and limits and climate-robust or **forecast-informed HCRs**

# Climate work plan

## Climate work plan adopted by the Council December 2024

- Spreadsheet tracking tool developed by staff
- Tracks combined efforts of CEFI, AFSC, AKRO and Council
- Initial summary focused on 2025-2026
- Items planned but not yet started (‘potential’) not included until they move into the ‘new/in development’ phase
- Current Council focus on Element 4 (HCR work)

## Four initial Elements:

A. Incorporate climate-forecast linked management advice
B. Incorporate climate-driven interactions and cascading impacts through use of ecosystem indicators and models
C. Consider and incorporate dynamic management tools to increase in-season adaptation capacity
D. Review tier systems, consider climate-informed biomass targets and limits and climate-robust or forecast-informed harvest control rules

# Work plan tracking tool

| | Key Element | Council Product * | Product Detail* | New, existing, modified | Relevant FMPs | Lead responsibility: Council staff/ RO/AFSC |
|---|---|---|---|---|---|---|
| **Element B: Incorporate climate-driven interactions and cascading impacts through use of ecosystem indicators and models** | | | | | | |
| B.6 | **Link to groundfish, crab, and marine mammal SDMs to MOM6 hindcasts and forecasts for EBS** | EBS ESR | Develop climate informed SDMs and management trajectories based on MOM6 linked assessment models for groundfish and crab - provide contribution to the ESR | Modification to existing | BSAI Crab, BSAI Groundfish | Lead: AFSC, Partners: AKRO, NPFMC |
| B.7 | **Link to ice seal SDMs to MOM6 hindcasts and forecasts for EBS** | EBS ESR (noteworthy or index) | Develop climate informed SDMs and management trajectories based on MOM6 linked assessment models for marine mammals | New/ in development | BSAI Crab, BSAI Groundfish | Lead: AFSC, Partners: AKRO, NPFMC |
| B.8 | **Coordination through SDM 6 month meetings and workshops** | SDM and EFH updates | Coordination through SDM 6 mo meetings and workshops to facilitate cross pollination & tie into deliverables, reports and the dashboard | Existing/ operational | GOA Groundfish, GOA Crab, BSAI Crab, BSAI Groundfish | Lead: AFSC, Partners: AKRO, NPFMC |
| **Element C: Consider and incorporate dynamic management tools to increase in-season adaptation capacity** | | | | | | |
| C.1 | **ACL in-season management authority** | Regulatory impact review (RIR) | Analysis of modifying in-season management authority | New/ in development | BSAI Groundfish, GOA Groundfish | Co-leads NPFMC, AKRO |
| C.2 | **Stock Assessment Prioritization** | ongoing discussions with NPFMC (PT, SSC) | Within typical stock assessment review process, across all stocks as needed | Modification to existing | BSAI Groundfish, GOA Groundfish | Lead: AFSC, Partners: NPFMC |
| **Element D: Review tier systems, consider climate-informed biomass targets and limits and climate-robust or forecast-informed harvest control rules** | | | | | | |
| D.1 | | Presentation on Tier systems and flexibility within FMPs cor Groundfish and Crab FMPs | Presentation at SSC workshop | Completed | BSAI Groundfish, BSAI Crab, GOA Groundfish | Lead: NPFMC, Partners AFSC |
| D.2 | **Alternative Harvest Control Rule (HCRs) considerations** | SSC Workshop on HCRs | SSC Workshop June 2025: https://meetings.npfmc.org/Meeting/Details/3093 | Completed | BSAI Groundfish, BSAI Crab, GOA Groundfish, GOA Crab | Lead: NPFMC |

| | Key Element | Council Product * | Product Detail* | New, existing, modified | Relevant FMPs | Lead responsibility: Council staff/ RO/AFSC |
|---|---|---|---|---|---|---|
| **Element A: Incorporate climate forecast linked management advice** | | | | | | |
| A.1 | **Create Science Brief; CEFI 1 pager** | Climate Science Brief | Summarize new CEFI products, highlight new climate relevant information for the assessment season | Modification to existing | BSAI Groundfish | Lead: AFSC, Partners: NPFMC |
| A.4 | **Generate MOM6 indices (hindcast + forecast) for annual assessment cycle products** | ESR EBS, Risk tables in stock assessments | Indices of cold pool, BT, SST, etc. | Modification to existing | BSAI Groundfish, BSAI Crab | Lead: AFSC, Partners: NPFMC |
| A.5 | | ESR AI, Risk tables in stock assessments | Indices of cold pool, BT, SST, etc. | New/ in development | BSAI Groundfish, BSAI Crab | Lead: AFSC, Partners: NPFMC |
| A.6 | | ESR GOA, Risk tables in stock assessments | Indices of cold pool, BT, SST, etc. | New/ in development | GOA Groundfish | Lead: AFSC, Partners: NPFMC |
| A.7 | | ESPs for BSAI stock assessments | Indices of cold pool, BT, SST, etc. | New/ in development | BSAI Groundfish, BSAI Crab | Lead: AFSC, Partners: NPFMC |

## 3.0 Details from each 2025-2026 listed Element

**Element A**

*A.1) Climate Science Brief (plus CEFI 1 pager)*

A summary of new Changing Ecosystem and Fisheries Initiative (CEFI) products that highlights new climate-relevant information for the assessment season. The Climate Report is delivered annually and informs the groundfish and crab assessment cycles. A pilot version of the report was presented through the Fall 2024 assessment cycle (no report was generated in 2025 due to the government shutdown).

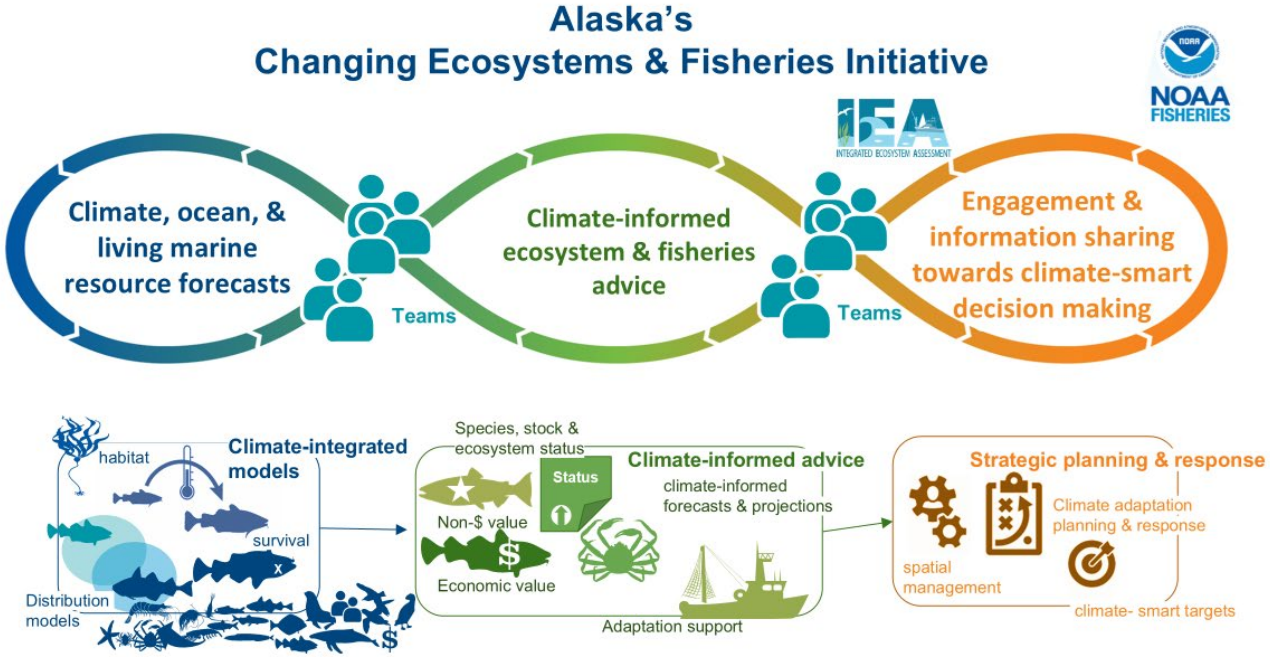
*A.4, A.5, A.6, A.7) MOM6-derived indices for ESRs and ESPs:*

Alaska regionally-tailored indices of cold pool, bottom temperature, sea surface temperature, mixed layer depth, Ocean Acidification (OA) and Aragonite Saturation rate, and additional variables are being generated from MOM6 hindcasts and forecasts and being provided publicly for use in various decision support tools including the EBS, AI, and GOA ESRs and to the ESPs in EBS and GOA SAFE chapters to support the annual assessment cycle.

# Work Plan lists actions by AFSC/CEFI, AKRO and Council actions

As products are available they will be incorporated into the Council process (via assessments, ESRs, analyses, etc)

Council and RO staff also included in CEFI overall as well as Alaska Climate Team (ACT) to coordinate and communicate activities



# Harvest Control Rules (HCR): treatment of risk and uncertainty

# HCR discussion paper: Outline of presentation

Harvest Control Rules (HCR) discussion paper

- Overview of HCRs (general)
- NPFMC Groundfish Assessment Tier system and OFL/ABC HCRs
- NPFMC BSAI Crab Assessment Tier system and OFL/ABCs HCRs
- How risk and/or uncertainty considered in NPFMC:
  - Stock Assessments
  - ABC-setting
  - TAC-setting
- Alternative HCRs under development
- SSC considerations re scalability and moving forward

# Considerations of Risk and Uncertainty

Council consideration of treatment of risk and uncertainty in harvest specifications for BSAI/GOA Groundfish and BSAI crab stocks for potential improvements.

recommend

Overfishing Limit (OFL)
Acceptable Biological Catch (ABC)

SSC

Total Allowable Catch (TAC)

Council (groundfish)
State of Alaska (crab)

## Uncertainty

Relative lack of information or confidence in the reliability of that information

## Risk

Considering the likelihood of an adverse event and the severity of the consequences

# General sloping HCR (Fig 1)

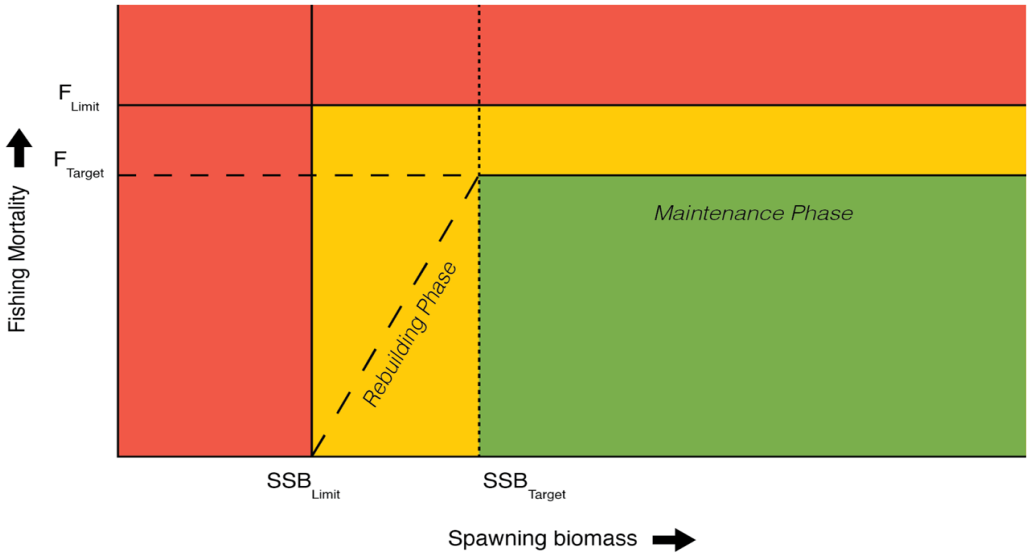
## Concepts

HCR: guideline for how much fishing can take place based upon an estimate of stock status

Spawning stock biomass (SSB): Best estimate of sexually mature biomass capable of reproducing
$SSB_{LIMIT}$ $SSB_{TARGET}$

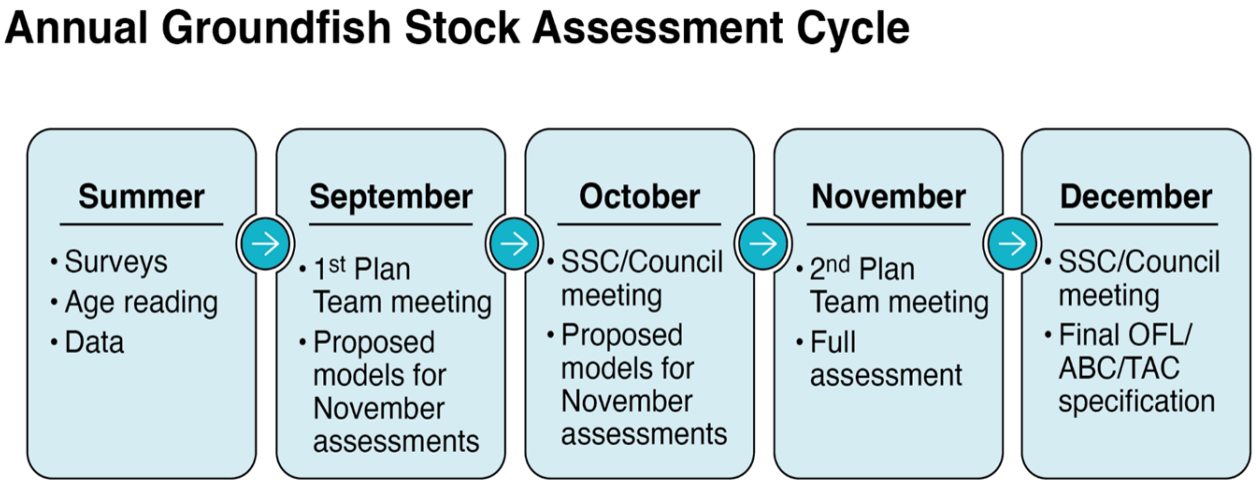
Fishing mortality rate (F): rate applied to SSB to determine catch. $F_{LIMIT}$ $F_{TARGET}$

## HCR



# Groundfish Tier System and current OFL and ABC control rules (Section 2.3)

# Groundfish Stock Assessment cycle (Fig 2)

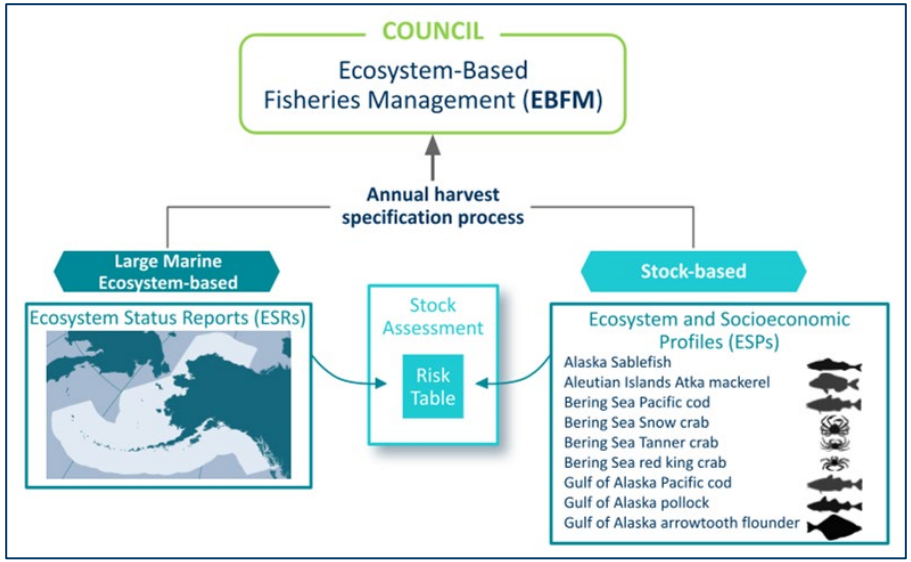



Annual assessment review and recommendations process for BSAI and GOA groundfish

# Ecosystem Status Reports (ESRs) & Ecosystem and Socioeconomic Profiles (ESPs)

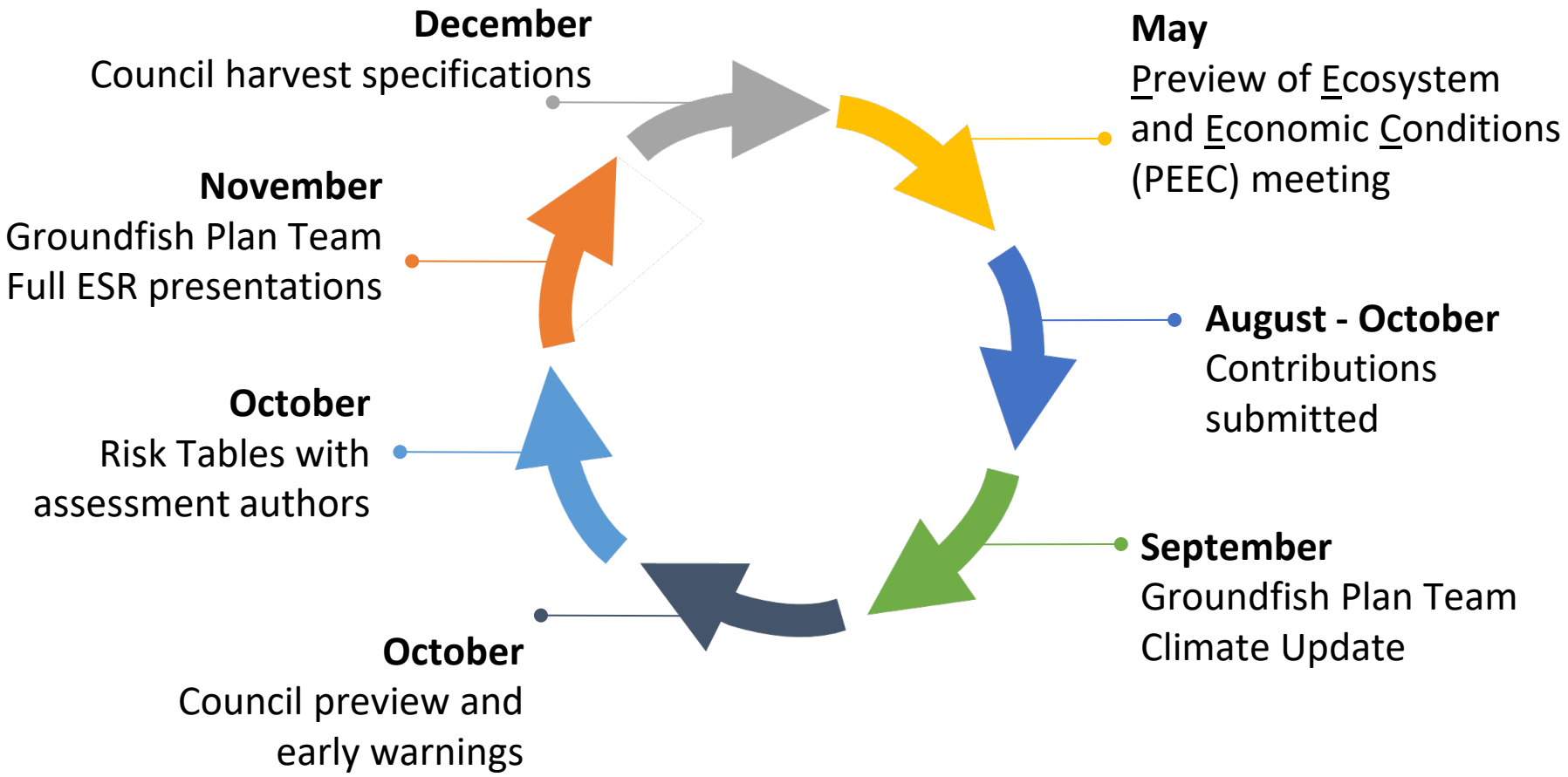
Both ESRs and ESPs allow for incorporating ecosystem information into management decisions. They inform the SSC's ABC and OFL recommendations, as well as final TAC determination.

- ESRs provide Large Marine Ecosystem scale status and trends
- ESRs provide contextual assessments that reflect ecosystem components ranging from physical oceanography up through the food web

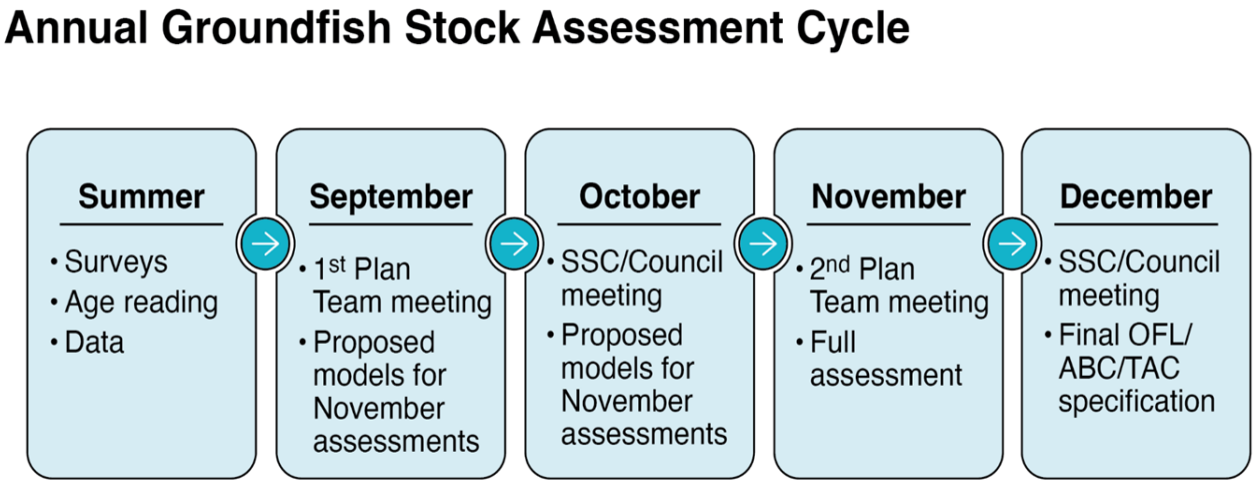



- ESPs are stock-specific and appended to stock assessments
- ESPs identify key ecosystem and socioeconomic indicators relevant to the stock assessment model

# How are Ecosystem Status Reports used in fisheries management

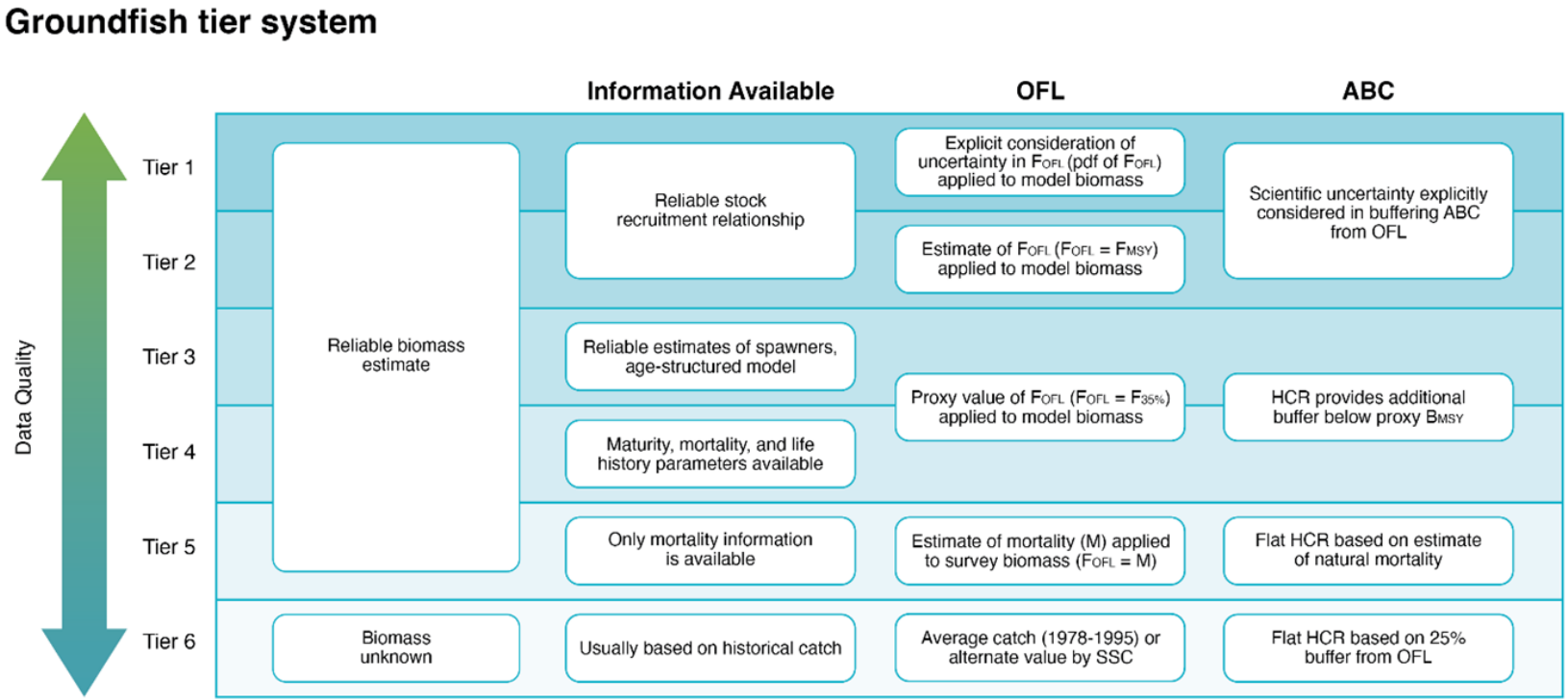


# Groundfish Stock Assessment cycle (Fig 2)




Annual assessment review and recommendations process for BSAI and GOA groundfish

# Groundfish Tier System (Fig 3)

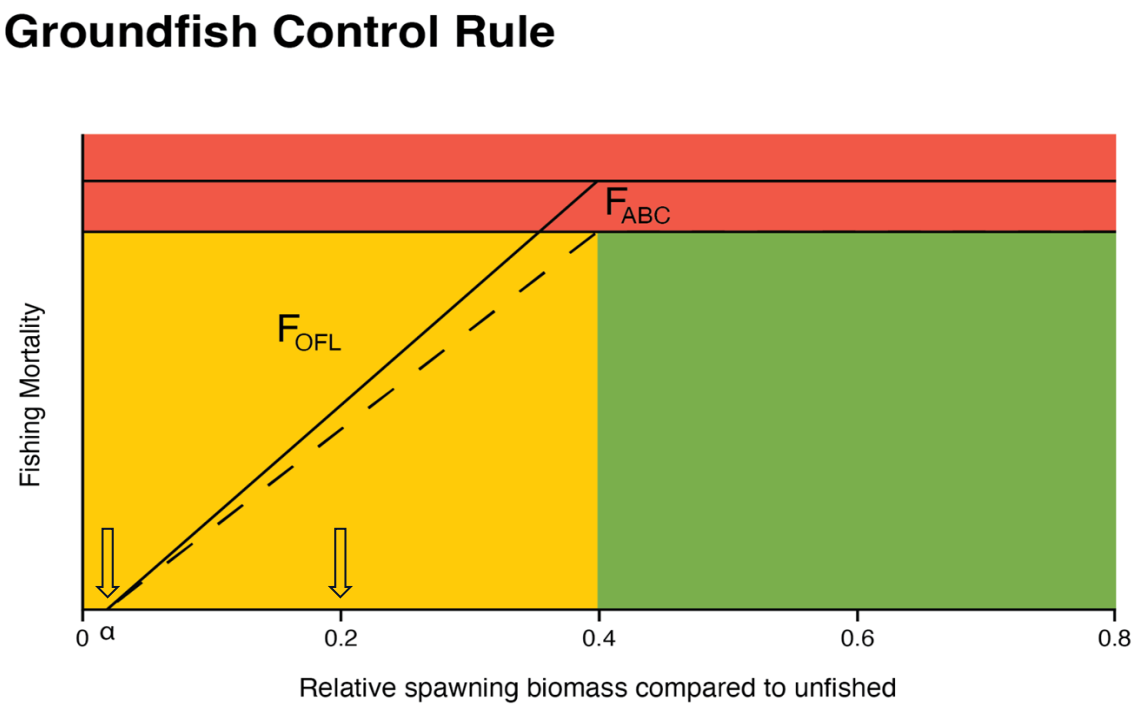


# BSAI and GOA stocks by Tiers (Tables 1 and 2)

| Stock BSAI | Assessment Region | Tier |
|---|---|---|
| Pollock | BS | 3 |
| | AI | 3 |
| | Bogoslof | 5 |
| Pacific cod | BS | 3 |
| | AI | 3 |
| Sablefish | BSAI/GOA | 3 |
| Yellowfin sole | BSAI | 1 |
| Greenland turbot | BSAI | 3 |
| Arrowtooth flounder | BSAI | 3 |
| Kamchatka flounder | BSAI | 3 |
| Northern rock sole | BSAI | 1 |
| Flathead sole | BSAI | 3 |
| Alaska plaice | BSAI | 3 |
| Other flatfish | BSAI | 5 |
| Pacific Ocean perch | BSAI | 3 |
| Northern rockfish | BSAI | 3 |
| Blackspotted/Rougheye rockfish | BSAI | 3 |
| Shortraker rockfish | BSAI | 5 |
| Other rockfish | BSAI | 5 |
| Atka mackerel | BSAI | 3 |
| Skates | BSAI | 3,5[1] |
| Sharks | BSAI | 6 |
| Octopuses | BSAI | 6 |

| Stock GOA | Assessment Region | Tier |
|---|---|---|
| Pollock | W/C/WYAK | 3 |
| | SEO | 5 |
| Pacific cod | GOA | 3 |
| Sablefish | BSAI/GOA | 3 |
| Shallow-Water flatfish | GOA | 3,5[1] |
| Deep-Water flatfish | GOA | 3,6 [2] |
| Rex sole | GOA | 3 |
| Arrowtooth flounder | GOA | 3 |
| Flathead sole | GOA | 3 |
| Pacific Ocean perch | GOA | 3 |
| Northern rockfish | GOA | 3 |
| Shortraker rockfish | GOA | 5 |
| Dusky rockfish | GOA | 3 |
| Rougheye and Blackspotted rockfish | GOA | 3 |
| Demersal Shelf rockfish | W/C/WYAK | 6 |
| | SEO | 5,6[3] |
| Thornyhead rockfish | GOA | 5 |
| Other rockfish | GOA | 4,5,6[4] |
| Atka mackerel | GOA | 6 |
| Big Skate | GOA | 5 |
| Longnose Skate | GOA | 5 |
| Other Skates | GOA | 5 |
| Sharks | GOA | 5,6 [5] |
| Octopuses | GOA | 6 |

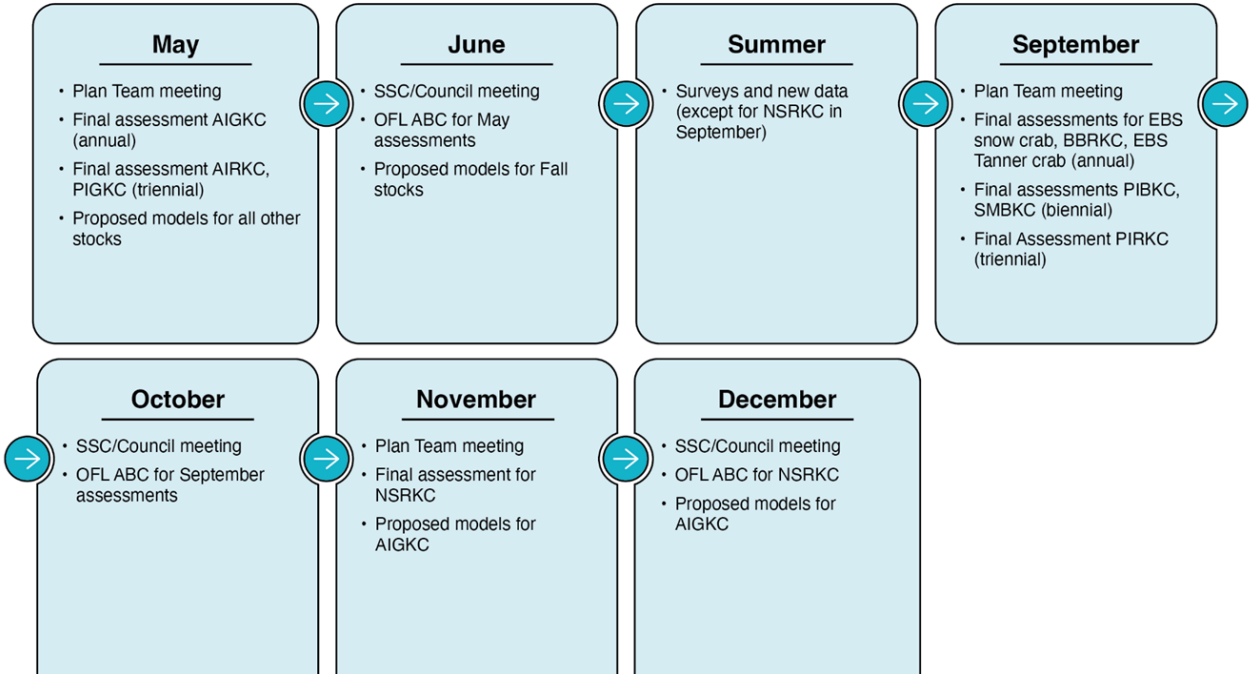
# Groundfish OFL and ABC HCRs (Fig 4)



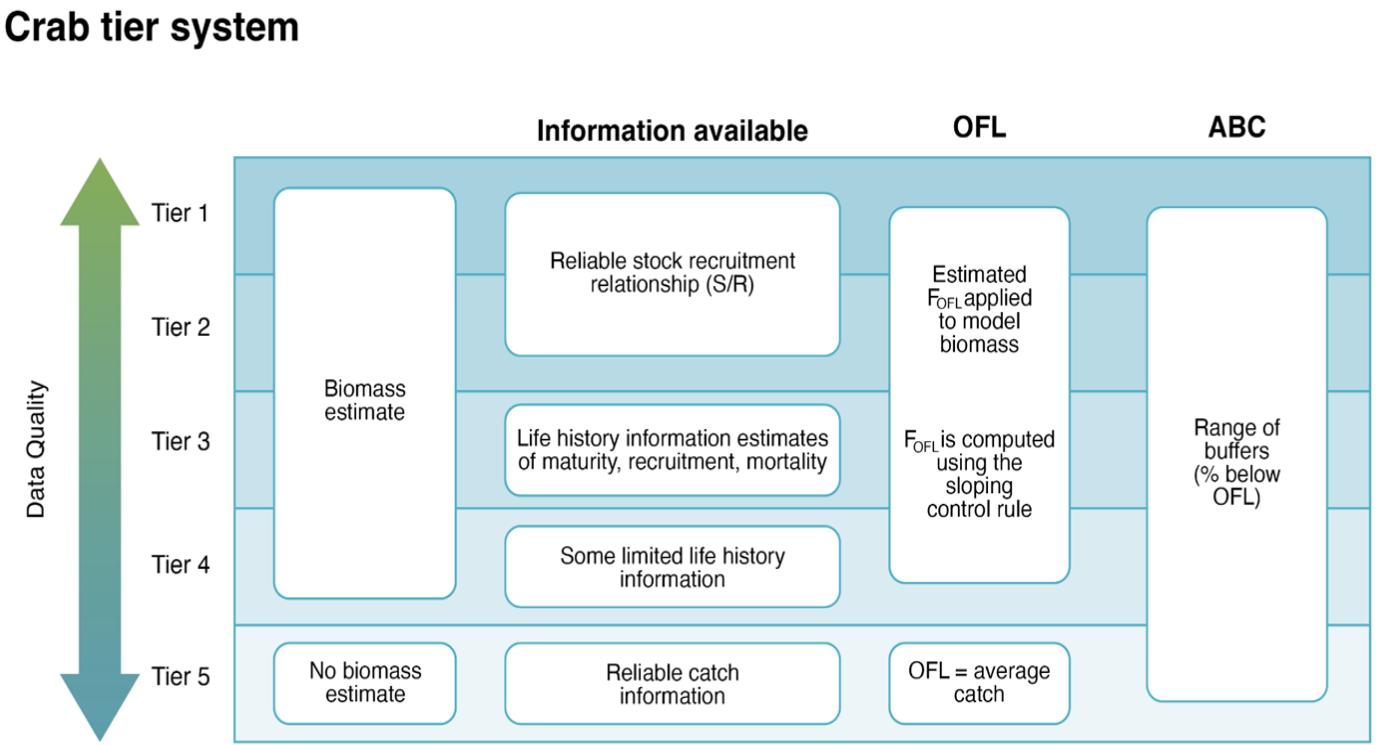
# BSAI Crab Tier System and current OFL and ABC control rules (Section 2.4)

# Crab Assessment and Review/Recommendations Cycle (Fig 6)

## Annual Crab Stock Assessment Cycle

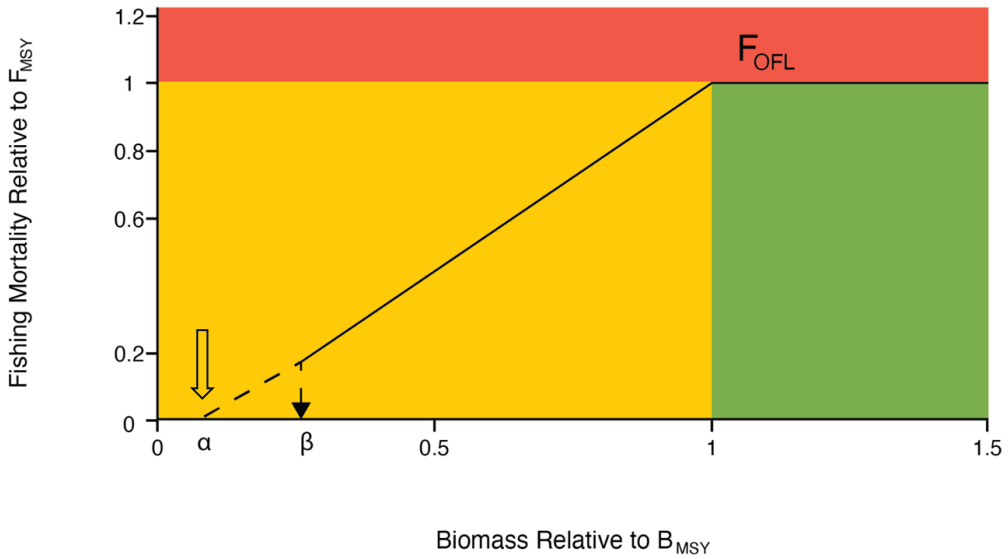


# Crab Tier System (Fig 5)



# Crab OFL HCR

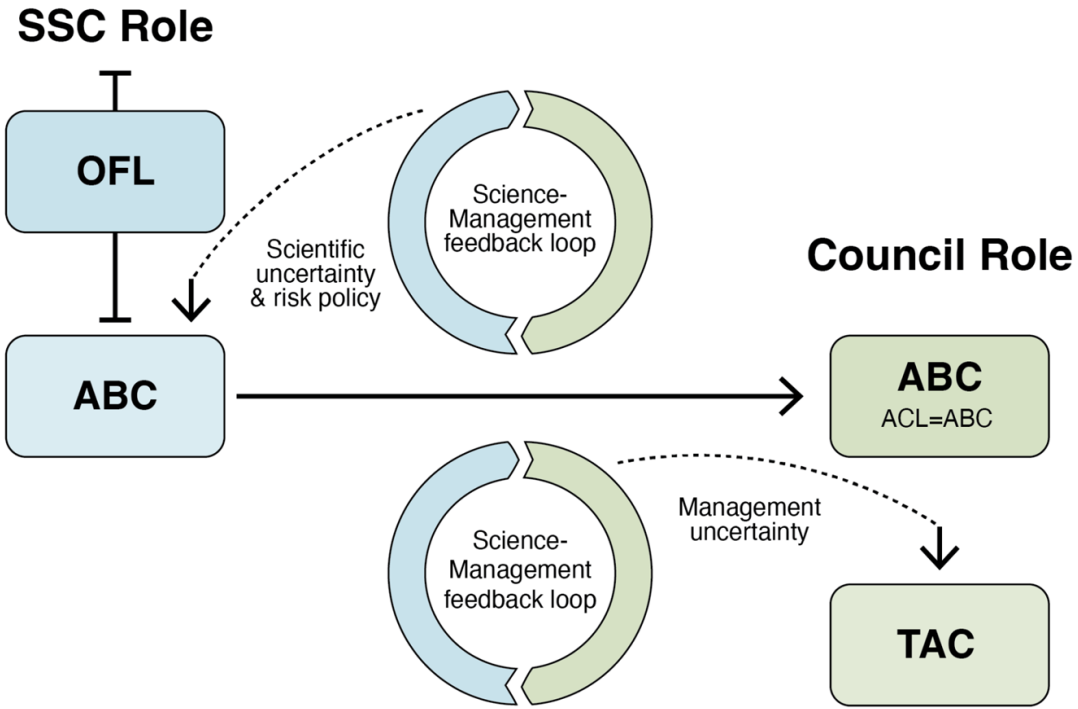
## Crab control rule



# Risk and Uncertainty: Assessment, ABC-setting, TAC-setting, Alternative HCRs (Section 3)

# Science and policy in addressing risk and uncertainty

Scientific uncertainty: uncertainty in OFL




Management uncertainty: uncertainty in ability to constrain catch to ACL (= ABC)

# Assessment changes that can impact ABC (Section 3.1)

- Model structure modifications:
  - Approaches reviewed at least Sept/Oct to Nov/Dec before adoption
- Biological reference points/new or revised data:
  - New data, revised time-series, selectivity changes
  - No change to model structure but can impact biological reference points
  - Not always reviewed in Sep/Oct prior to incorporation
- Tier level changes
  - Proposed changes reviewed at least Sept/Oct to Nov/Dec before adoption

Table 3 page 16

| Stock | Proposed change/ rationale | Change in resulting maxABC | Time frame from proposal to adoption for use in specifications |
|---|---|---|---|
| EBS Pollock | Change Tier 1 to Tier 3, lack of data at low stock sizes results in uncertain Stock-Recruit relationship (SRR) | -1,666,000 t | Discussion paper reviewed in September/October 2024; Tier level change by SSC in December 2024 |
| BSAI Yellowfin sole | Change Tier 1 to Tier 3,lack of data at low stock sizes results in uncertain SRR | Not yet available | Discussion paper September/October 2025; change pending 2026 assessment cycle |
| AI Pacific cod | Change from Tier 5 to Tier 3; approved age-structured model | -3,134 | Multiple years in development and 2024 approval of age-structured model |
| BSAI Atka mackerel | Estimate of $F_{OFL}$ and $F_{ABC}$ 25% higher relative to previous year due to changes in the fishery selectivity | +10,290 t | Assessments in 2021 relative to 2020 |
| Various | Revised Tier 3 proxies, age-(or sex) specific schedules updated. E.g., selectivity, weight-age, and maturity | Varies | Generally proposed in September, if approved by SSC, will be included for December meeting |

# ABC setting [Groundfish] Section 3.2

Tier specific HCR = maximum permissible ABC (maxABC )

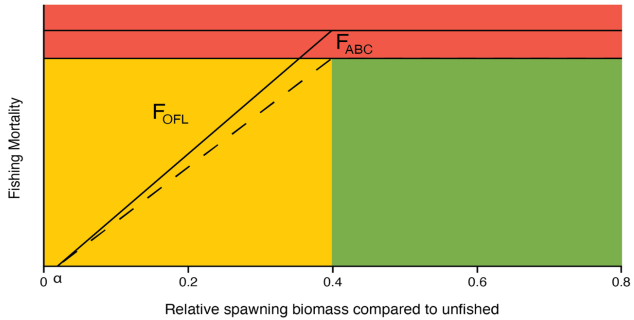
maxABC is the upper bound on ABC but the SSC may recommend an ABC below the maxABC
No flexibility to recommend ABC >maxABC

Process in general:
Assessment author develops a recommendation for ABC<maxABC
Review by Plan Team and subsequent recommendation
Final recommendation by SSC

Reduction per FMP and NS1 Guidelines is based upon “whether conditions exist that warrant setting ABC at a value lower than the maximum permissible value” and accounts for “any other scientific uncertainty”

Reductions from maxABC have been documented recently through the use of risk tables

**Groundfish Control Rule**



# Risk tables: Scientific uncertainty not directly captured in the stock assessments

## Categories of concern

1. Assessment-related considerations
2. Population dynamics considerations
3. Ecosystem considerations
4. Fishery-related stock considerations

- Risk table categories describe scientific uncertainty not directly captured in the stock assessments
- Ranked 1-3 based on relative level of concern
  - Normal (1)
  - Increased concern (2)
  - Extreme concern (3)

- Can be used to document recommendations of ABC<maxABC

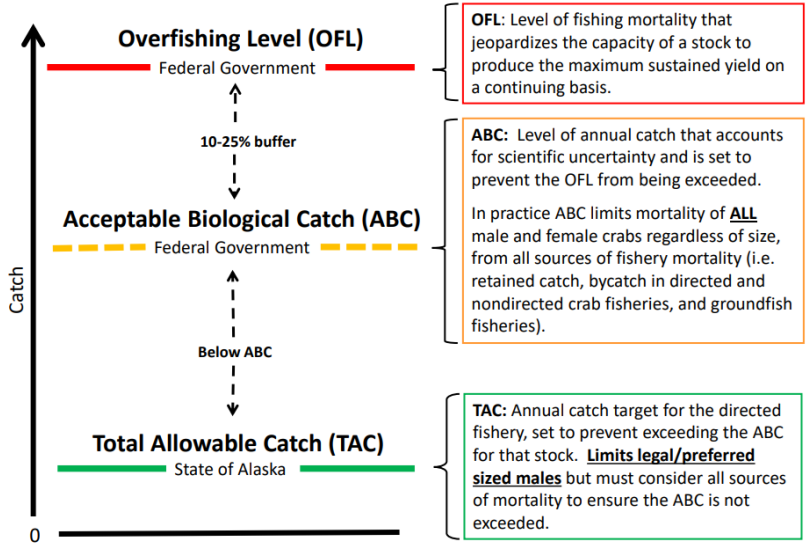
Table 6, pg 22

# Table 6: ABC<maxABC 2018-2024

Note categories and scoring levels have changed between 2018-2022

| Stock | Assessment Year(s) | Risk Table Scores > 1 | SSC reduction from maxABC |
|---|---|---|---|
| EBS Pollock | 2018 | P-2, E-2 | 30% |
| | 2019 | P-2, E-2, F-2 | 43% |
| | 2020 | E-2, F-2 | 30% |
| | 2021 | A-2, E-2, F-2 | 11% |
| | 2022 | A-2 | 43% |
| | 2023 | E-2 | 18% |
| EBS Pacific cod | 2019 | E-2 | 3% |
| AI Pacific cod | 2023 | P-2, E-2 | 10% |
| AK Sablefish | 2018 | A-2, P-4, E-2 | 45% |
| | 2019 | A-2, P-3, E-2, F-3 | 50% |
| | 2020 | A-3, P-3, E-2, F-3 | 44% |
| BSAI Yellowfin sole | 2021 | P-2, E-2 | 24% |
| BSAI Greenland turbot | 2024 | A-3, P-2, E-2 | 25% |
| BSAI Northern rock sole | 2022 | A-3 | 23% |
| | 2023 | rollover | 23% |
| BSAI Blackspotted / Rougheye rockfish | 2022 | A-3, P-2, F-2 | 11% |
| | 2023 | rollover | 11% |
| BSAI Sharks | 2022 | A-3, P-2 | 13% |
| | 2023-2024 | rollover | 13% |
| GOA Pollock | 2023 | A-2 | 18% |
| GOA Pacific cod | 2018 | NA* | 14% |
| | 2019 | A-2, P-2, E-2 | NA** |
| GOA Dusky Rockfish | 2020 | A-2 | 24% |
| | 2021 | Rollover of stair-step | 24% |
| GOA Rougheye/Blackspotted rockfish | 2023 | A-2, P-2 | 20% |
| | 2024 | NA*** | 10% |
| GOA Demersal shelf rockfish | 2021 | A-2, P-2, F-2 | 22% |
| | 2022 | A-2, P-2, F-2 | 15% |

# ABC setting Crab (Fig 10, Table 4)




| Crab Stock | Tier | ABC Buffer by year | | | | |
|---|---|---|---|---|---|---|
| | | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 |
| EBS Snow Crab | 3 | 25% | 25% | 50% | 65% | 40% |
| Bristol Bay Red King Crab | 3 | 20% | 20% | 20% | 20% | 20% |
| EBS Tanner Crab | 3 | 20% | 20% | 20% | 20% | 20% |
| Pribilof Islands red king crab | 4 | 25% | 25% | 25% | 25% | 25% |
| Pribilof Islands blue king crab | 4 | 25% | 25% | 25% | 25% | 25% |
| St. Matthew blue king crab | 4 | 25% | 25% | 25% | 25% | 25% |
| Norton Sound red king crab | 4 | 40% | 40% | 30% | 30% | 30% |
| Aleutian Islands golden king crab | 3 | 30% | 25% | 25% | 25% | 25% |
| Pribilof Islands golden king crab | 5 | 25% | 25% | 25% | 25% | 25% |
| Western Aleutian Islands red king crab | 5 | 75% | 75% | 75% | 75% | 75% |

# Risk Table development for crab (Table 7)

| Crab Stock | Tier | Risk Table/Year | Risk Table Score | | | |
|---|---|---|---|---|---|---|
| | | | Assessment | Population dynamics | Ecosystem | Fishery |
| EBS Snow Crab | 3 | Y 2025 | 2 | 2 | 1 | 1 |
| Bristol Bay Red King Crab | 3 | Y 2025 | 1 | 2 | 2 | 1 |
| EBS Tanner Crab | 3 | Y 2025 | 2 | 1 | 1 | 1 |
| Pribilof Islands red king crab | 4 | Y 2025 | 2 | 2 | 1 | 1 |
| Pribilof Islands blue king crab | 4 | Y 2025 | 1 | 1 | 1 | 1 |
| St. Matthew blue king crab | 4 | N | | | | |
| Norton Sound red king crab | 4 | N | | | | |
| Aleutian Islands golden king crab | 3 | Y 2025 | 1 | 2 | 1 | 2 |
| Pribilof Islands golden king crab | 5 | N | | | | |
| Western Aleutian Islands red king crab | 5 | N | | | | |

# TAC setting

## Groundfish

- Annually recommends final harvest specifications to the Secretary of Commerce
- SUM of the recommended TACs must fall within the Optimum Yield (OY) range by FMP (specified in FMPs and implementing regs):
  - BSAI = 1.4 – 2.0 million mt
  - GOA 116,000 – 800,000 mt
- TAC must be set = or < ABC.
- The Council retains broad latitude to recommend TAC below ABC on an annual basis, consistent with the Groundfish FMPs and implementing regulations
  - drawing on socioeconomic information and concerns not addressed in the ABC-setting process provided the sum of the TACs is within the ranges specified in the respective FMPs

## BSAI Crab

- State of Alaska as a Category 2 measure under the Crab FMP (framework management measures)

# Benefits and Drawback across 3 approaches (Table 8)

| Approach | Benefits | Drawbacks | Timing |
|---|---|---|---|
| **Assessment changes** | Highly targeted; can address stock-specific dynamics; scientific peer review provides quality control | Less transparent to the public; extended development time; changes within scientific purview, not direct Council action | Depends upon scope and scientific concurrence on modifications; can be done within two meetings of Plan Teams and SSC; sometimes may take multiple iterations of changes to eventually get approved (e.g., AI Pacific cod model and resulting Tier level change) |
| **ABC changes from maxABC** | Can be done within an assessment cycle drawing on information within the assessment (e.g., where recruitment estimates are modified) or with the use of risk table scoring and justifications for out of assessment model uncertainties | Qualitative; scoring and resulting reductions may be inconsistent across assessments; it is not possible to recommend an ABC above the maxABC | Modified by the SSC during their annual stock assessment review and ABC recommendations |
| **TAC adjustments** | Flexible and responsive on annual timescales; can draw on a broad range of information; no FMP amendment needed but sum of TACs must fall within the OY range by FMP. | Does not create lasting structural change; ad hoc; may lack analytical basis; subject to annual political dynamics; and structure (e.g., use of HCRs and risk tables) | Modified within a Council meeting cycle without additional analysis |

# Considerations for revising treatment of risk and uncertainty

Status quo

- Framework in place for many years
- BRP and ABC can change within individual assessments in response to:
  - New information
  - Shifts in information availability and Tiers
  - Changes in spatial distributions that may influence availability and/or catchability
  - Changes in selectivity and catchability (critical to assessment):
    - Gear changes
    - Time-area-gear regs influencing selectivity
    - Other factors impacting harvest practices (PSC caps, Discard mortality regs etc)

Concerns regarding population impacts to fish and crab under future environmental conditions lead to consideration of more adaptive HCRs

# Stock specific issues (Table 10)- Case studies under Appendix 5

| Key Issues | Stocks |
|---|---|
| Recruitment variability, especially irregular large recruitment events | Sablefish, rockfish, pollock, |
| Increased natural mortality: elevated or event driven | GOA cod, AI cod, EBS snow crab |
| Prolonged recruitment failure | Greenland turbot |
| Environmental sensitivity of year-class strength | BSAI/GOA Pollock, Bristol Bay red king crab |
| Long-lived, slow recovery, declining productivity despite large biomass levels | BSAI/GOA Pacific ocean perch |

# SSC Considerations

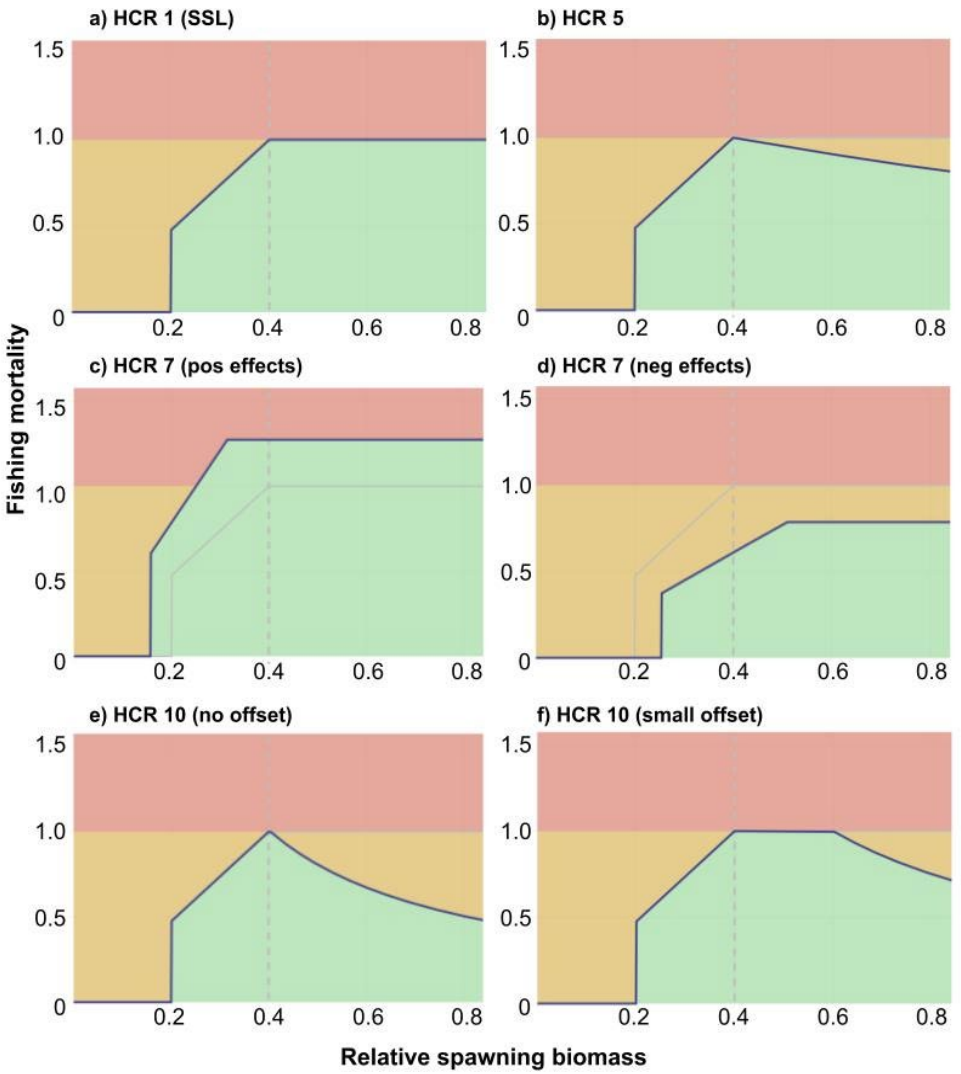
## Scalability of analysis (staff suggestions at end)

- **FMPs (Groundfish, Crab)**
- **Performance metrics: process for development**
- **Tiers**
- **Stocks**

Draft timeline and milestone (Section 4.7) as an example pending Council decisions in June

# Modified HCRS (Table 9, Fig 11)

| HCR | GOAL |
|---|---|
| **Status Quo (HCR #1)** | Automatic rebuilding below target stock size (Status Quo baseline sloping CR used for BSAI and GOA Groundfish) |
| **Lower fishing mortality at high stock size (HCR #5)** | Maximize ecosystem biomass and SSB (intent to increase reserves, buffer against environmental shocks, and enhance long-term sustainability with lower fishing mortality) |
| **Lower fishing mortality at high stock size (HCR #10)** | Similar objectives as with HCR 5 (intent to provide increased buffering against environmental shocks through proportional reductions in fishing mortality) |
| **Dynamic HCRs that respond to time-varying stock productivity (HCR #7)** | Transition from qualitative risk tables to an explicit analytical approach in which recommended harvest rates respond to estimated temporal changes in stock productivity (obtained from population models with time-varying parameters, linkages with environmental covariates or other methods) |



# Stock specific issues (Table 10)

| Key Issues | Stocks | Potential HCR approaches |
|---|---|---|
| Recruitment variability, especially irregular large recruitment events | Sablefish, rockfish, pollock, | HCR5 or 10, sablefish HCRs under MSE |
| Increased natural mortality: elevated or event driven | GOA cod, AI cod, EBS snow crab | HCR with environmental covariates (HCR7), HCR5 or 10? |
| Prolonged recruitment failure | Greenland turbot | HCR7 |
| Environmental sensitivity of year-class strength | BSAI/GOA Pollock, Bristol Bay red king crab | HCR with environmental covariates (HCR7), HCR5 or 10? |
| Long-lived, slow recovery, declining productivity despite large biomass levels | BSAI/GOA Pacific ocean perch | Dynamic HCRs that adjusts reference points to reflect trends in stock productivity (variant of HCR 7) |

# Bookended climate complexity in Sablefish vs CLIM methodology

**Sablefish ('simple' climate)**

- 'Quasi-climate' scenarios simulated via alternative future recruitment scenarios (cyclical, recruitment crash)
- No explicit climate linkages included in simulations
- Spatial model includes simple 'climate movement' scenario (poleward distributional shift)
- Goal was to explore 'climate robust' HCRs, especially to extreme events (recruitment crashes, redistribution across management units)
- Climate is implicit in the simulation modeling, not explicit as in ACLIM simulations

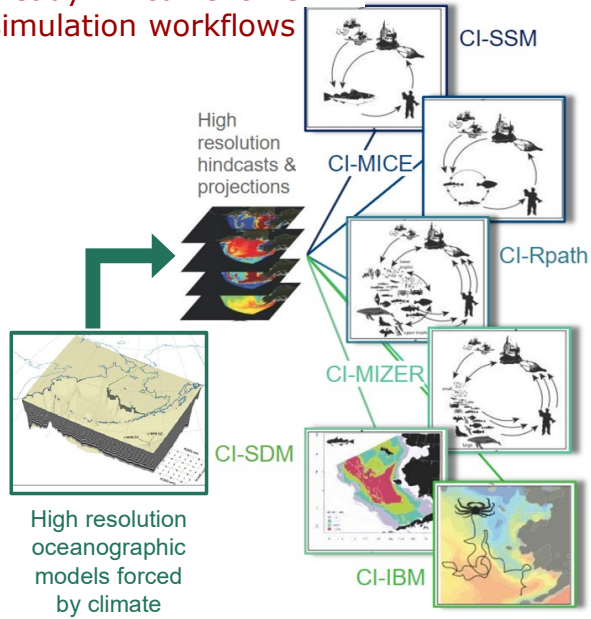
**CLIM examples (more complex climate)**

- Regionally tailored climate scenarios (based on globally standardized projections) provide plausible bounds on future environmental conditions
- Alternative hypotheses regarding environmental drivers of growth, recruitment, mortality, distribution & productivity are specifically incorporated into simulations and contrasts
- Structural uncertainty is represented and quantified through alternative model formulations
- Performance is measured against multiple Ecosystem Based Management metrics (from ecological to social & economic)
- Simulations quantify alternative HCR robustness to: (a) Structural Uncertainty; (b) Process Uncertainty(climate & ecosystem) ; (c) Observation Uncertainty; (d) Management Implementation Uncertainty

# e.g., ACLIM3 (HCR Round 2) Ecological Models*

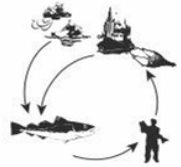
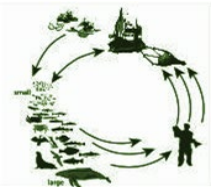
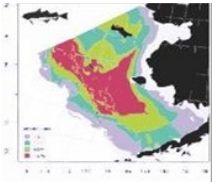
| Category | Model type | Model description | TS | Target species | Climate coupling | ROMSNPZ covariates | Refs/ Lead |
|---|---|---|---|---|---|---|---|
| Stock assessment | CI-SSM | Climate-integrated single-species stock asessment model | annual | Northern rock sole; Pacific cod, RKC, Snow crab | Growth; Recruitment | pH &, BT (recruitment), SST (growth) | Punt et al. 2021, 2023, 2024a,b, 2025; Ianelli et al. in prep |
| Stock assessment | CI-MICE | Multi species assessment model/ non-spatial but includes SDMs for predation exposure; annual | annual | ATF, Pollock, P. cod, *optional: halibut, NFS* | Growth; Recruitment; M (predation) | Seasonal averages for BT, SST, wind, large Zoop., +... | Spencer et al 2016, Spencer et al. in prep.; Holsman et al. 2016, 2020, 2024 |
| Stock assessment | CI-SR | Climate linked recruitment models | annual | Snow, tanner, and red king crab | Recruitment | AO, sea ice, BT | Szuwalski et al. 2020 |
| Food-web | CI-MIZER | Climate integrated size-spectrum foodweb model (MIZER) includes fully resolves the size structure of populations; non-spatial; weekly | weekly | 7 species, 3 functional groups | Growth & M (non predation) ~f(Temp); lower trophic levels forced by NPZ | BT, SST | Reum et al. 2019, 2020 |
| Food-web | CI-RPATH | Rpath ecosystem model; multiple species and functional groups, several of which are divided further according to life history stage; non-spatial; monthly | monthly | 72 biological groups | Lower trophic levels linked to NPZ output; climate mediated energetics | Phytoplankton production, euphausiid production, benthos, BT, SST | Whitehouse et al. 2021, Whitehouse & Aydin 2025 |
| Spatial | CI-SDM | Climate integrated spatial distribution model for juvenile and adult fish and crab | seasonal | Pollock, P. cod, ATF, YFS, NRS, snow crab, RKC, P. halibut | Distribution ~f(env. conditions) | BT, SST, salinity, pH, O2, … (multiple covariates) | Goodman et al. 2024; Barnes et al. 2022; Stone et al. 2025 |
| Spatial | CI-HS | Groundfish and crab habitat suitablity maps for juvenile and adult stocks | seasonal | Pollock, P. cod, ATF, YFS, NRS, snow crab, RKC, P. halibut; N Fur Seals | Spawning or adult habitat suitability ~f(env. conditions) | BT, SST, salinity, pH, O2, … (multiple covariates) | Kristiansen et al. in prep; Bigman et al. 2023; McHuron et al. 2024 |
| Social/ Economic | Conceptual models | Co-development of conceptual models of climate, ecosystem, and subsistence species dynamics and accessibility | variable | Multiple subsistence species | Multiple complex climate and ecosystem linkages | Sea ice, phytoplankton, SST, O2, + | Multiple collaborations underway |
| Social/ Economic | CI-spatial catch | Spatial effort and catch model | seasonal | Pollock, select A80 species, P. cod | effort and catch~f(env. conditions)+ non-env drivers (biomass, distance from port, etc). | Cold pool, BT, wind, sea ice | In prep |

**Pollock, P. cod, arrowtooth & N. Rock sole** dynamics are most "ready" in current ACLIM simulation workflows

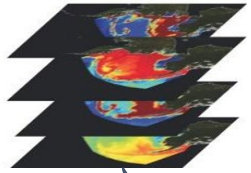


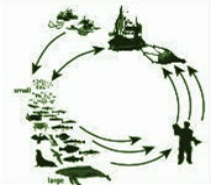
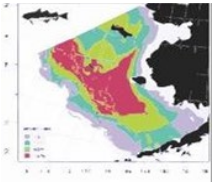

**Non-exhaustive list; additional species, social, economic, and conceptual models in progress for GOACLIM and ACLIM3 for HCR & other EBM evaluations; list subject to change*

# e.g., Summary of ACLIM3 HCR Round 2 Models*

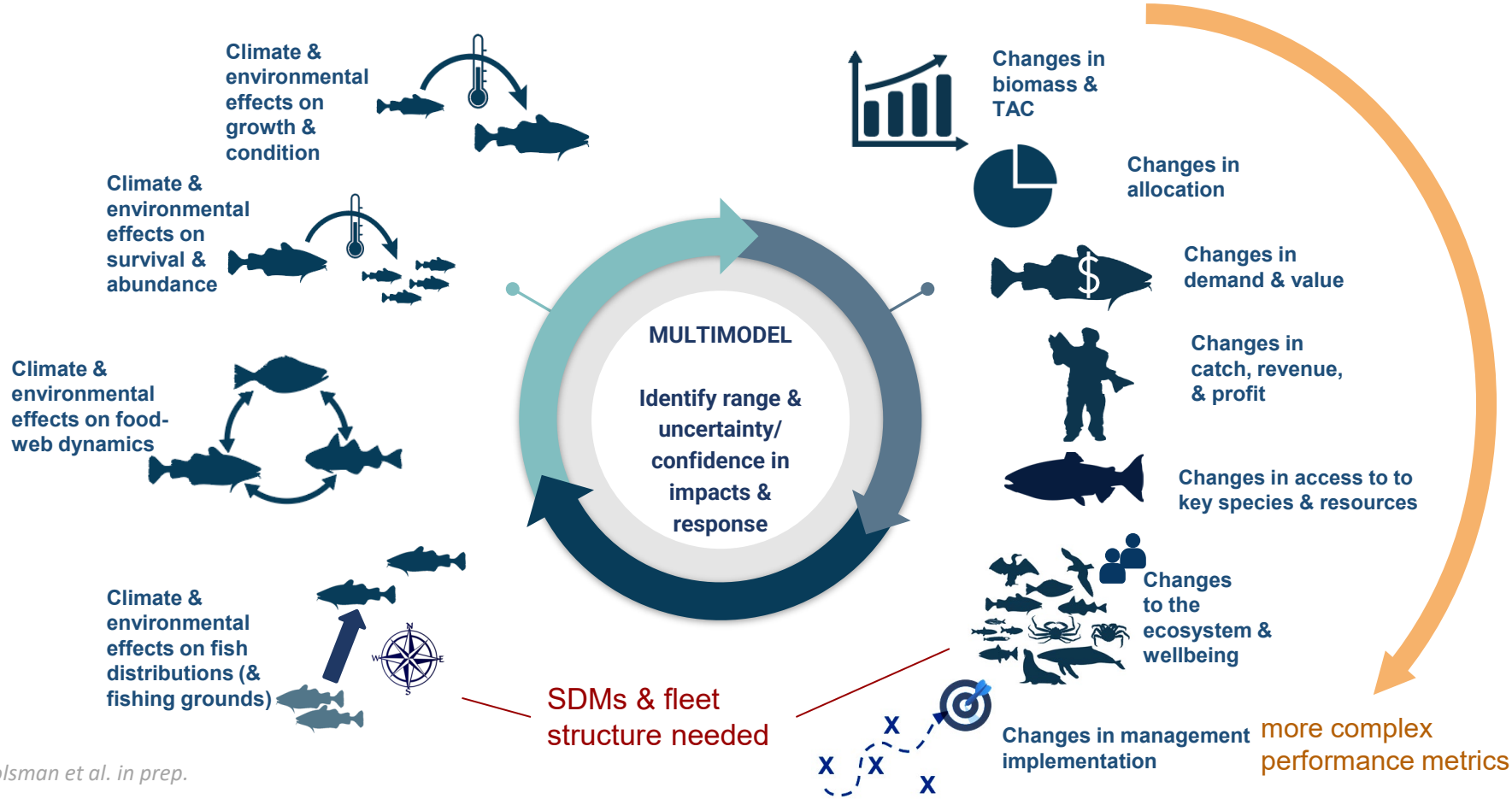
| | CI-SSM | CI-MICE | CI-Rpath | CI-MIZER | CI-SDM |
|---|---|---|---|---|---|
| |  |  |  |  |  |
| Pollock | ✓ | ✓ | ✓ | ✓ | ✓ |
| Arrowtooth flounder | | ✓ | ✓ | ✓ | ✓ |
| Pacific cod | | ✓ | ✓ | ✓ | ✓ |
| Northern rock sole | ✓ | | ✓ | ✓ | ✓ |

# Climate linkages vary with model



| | CI-SSM | CI-MICE | CI-Rpath | CI-MIZER | CI-SDM |
|---|---|---|---|---|---|
| |  |  |  |  |  |
| Plankton & Benthos forcing | | ✓ | ✓ | ✓ | ✓ |
| Temperature-dependent processes | | ✓ | | ✓ | ✓ |
| Environmental S-R relationship | ✓ | ✓ | | | |
| Environmental Growth relationship | ✓ | ✓ | ✓ | | |

# ACLIM3 HCR performance metric approach:
# Modeling the management cycle to help inform effective response




*Holsman et al. in prep.*

# Goals and Objectives (pg 28-29) - Council/AP considerations

## Overarching goal (draft)

- Increased resilience for long-term sustainability of fish and crab stocks

## Objectives (draft)

- Sustainable biomass for groundfish and crab stocks
- Prevent overfishing
- Transition from use of risk tables to analytical approach (species whose productivity known to vary with environmental conditions)
- Increased buffering against environmental shocks
- Socio-economic sustainability
- Community-level objectives (to be defined)
- Transparency in the ABC –setting process

# Once objectives defined – performance metrics developed (e.g. Appx 3)

## Key decision points

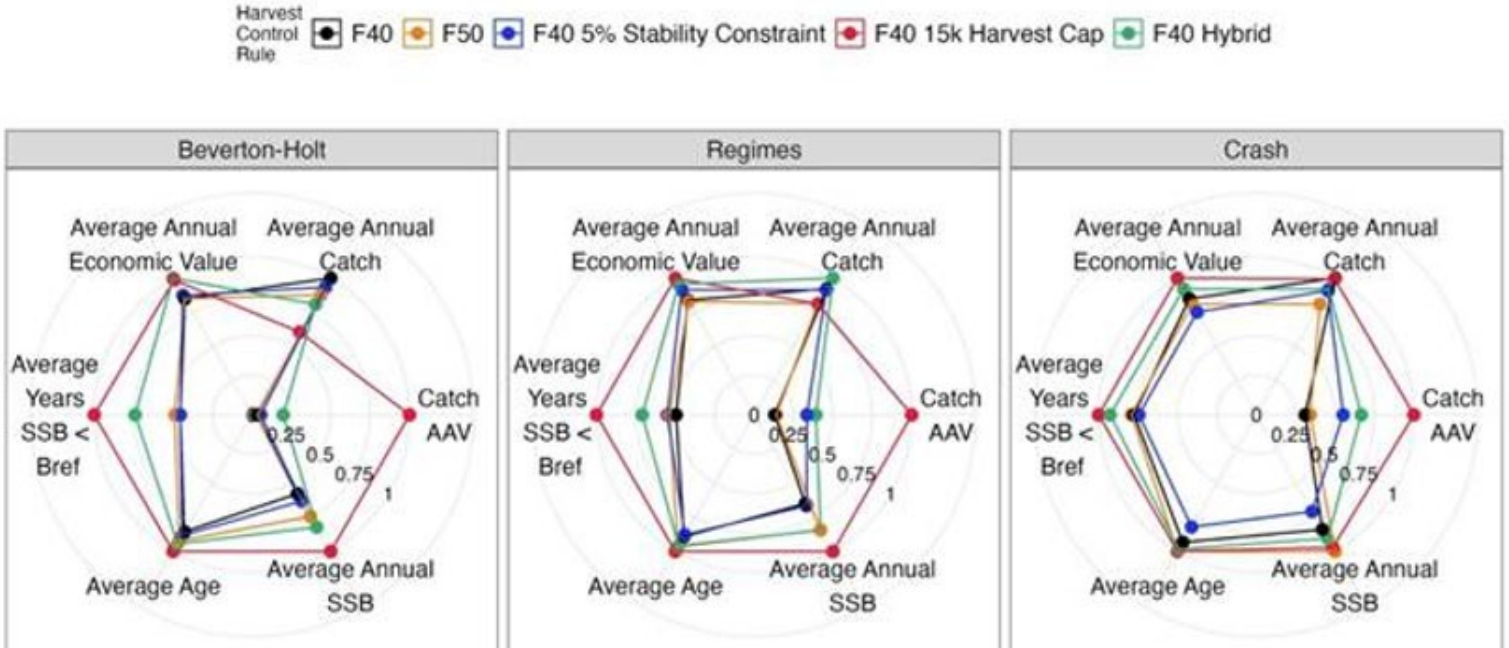
- Priority management objectives identified
- Objectives stated in clear and specific manner
- Time frame over which performance metrics are calculated

Table A3.1
page 46

| Category | Description | Quantity of interest | Case study metrics |
|---|---|---|---|
| Status | Maintain biomass above biomass limit/ Minimize the chance of being overfished | Biomass (B) and Blimit | $P(B > 0.4B_{MSY}) \geq 0.95$[a]<br>$P(B > 0.25B_0)$[b]<br>$P(RSB < 20\%) < 0.05$[c]<br>$P(SSB < 7.7\%SSB_0) < 0.10$[d] |
| | Maintain spawning stock size above target reference points | Biomass and Btarget | $P(B_{2052} > B_{targ}) = 0.5$[a]<br>$P(B > 0.4B_0)$[b]<br>$P(RSB < 36\%) < 0.50$ |
| | Maintain stock within the green zone of Kobe plot | Biomass and Blimit and Fishing mortality (F) and Flimit | $P(SSB \geq SSB_{MSY} \& F < F_{MSY}) \geq 0.6$[d] |
| Yield | Maintain average/ median/minimum catch | Catch | P(Catch > min(Catch) > 0.5[b]<br>Average catch last five projection years[b]<br>Average catch by fishery for various time frames[d] |
| | Maximize catch | Catch | Total catch<br>P(Catch > min viable catch)[a] |
| | Minimize catch variability over time | Variation in catch | Median across replicates of average absolute annual change in landed catch[a]<br>P(AAV < 0.15)[b] |
| | | Variation in output or input control (e.g., ABC or FABC) | P(Change in TCEY > 15%) |
| Stability | Maintain age structure or size structure | Age<br>Size (length or weight) | Change in mean age or size |
| Societal | Maximize long term profitability | Size (length or weight)<br>Revenue | Mean size of directed fishery[b]<br>Mean revenue (by fishery or region)[e] |
| | Maintain employment | Regional employment (number of jobs) | Mean percent change in the number of jobs[e] |
| | Maintain or minimize change in nutritional value | Size at age and nutrition metrics | Change in nutritional value of overall fishery[e] |

# Example performance metrics from sablefish MSE (appx 4; 4.7.1 pgs 52-59)

5 HCRs, 6 performance metrics shown in radar plot (Figure A4.4)



# Stocks and models that are currently developed for Fall 2026 vs 2027-2028

## Fall 2026

Brief status update and forward looking ACLIM and GOA-CLIM HCR analysis plan briefing to PTs

As appropriate, preliminary findings (workable examples) from Bering Sea ACLIM Phase 2 HCR simulations

- Pollock
- Pacific cod
- *Arrowtooth*
- *Northern rock sole*

Alaska sablefish (MSE results)

## Fall 2027-2028

- Iterative discussions of results from more complete CLIMs performance metric evaluations (including EBM metrics, and when ready, social/econ metrics)

- CLIMs model syntheses to date, including quantification of sensitivity and uncertainty/confidence in HCR performance under future scenarios

# SSC Considerations

## Scalability of analysis (staff suggestions)

- **FMPs (Groundfish, Crab):** Focus on Groundfish
- **Performance metrics:** Begin with biological and fisheries metrics
- **Tiers:** Tier 3 examples
- **Stocks:** 2(or 3) candidate to start
  - P. cod and pollock
  - sablefish

*representative of differing responses to climate change and model formulation (e.g., simple sablefish responses, more complex environmental linkages etc)*

Draft timeline and milestone (Section 4.7) as an example pending Council decisions in June

# Additional considerations

- Development of triggers to move to an alternative HCR: eg new science, new info, retrospective concerns when to adopt change in BRP and rate at which incorporate updated info into HCRs
  - Iterative process for feedback
- Stock by stock basis
- No double counting (in assessment, risk tables, and alt. HCRs)
- Thought examples
  - New forecast for region
  - Consistent High Risk Table score
  - Newest set of climate scenarios/ implications (CMIP7)
  - Species moving into region
  - Species / stocks moving out of historical survey area

# Thank you!

**Council HCR webpage:** https://www.npfmc.org/hcr-project-overview/

# Figure A4.2 HCRs considered in Sablefish MSE as compared to Tier 3 ABC HCR