2028 Essential Fish Habitat (EFH) 5-Year Review Plan

Jodi Pirtle, National Marine Fisheries Service, Alaska Region
Anita Kroska, North Pacific Fishery Management Council

Scientific and Statistical Committee, February 3 2026

Council Action

- SSC review and provide input regarding the focus and scope of the 2028 EFH 5-year Review plan.

D2 EFH 5-year Review Action Memo and Council Motion, December 2025
D3 2028 EFH 5-year Review Plan Discussion Paper - chapter 3, pg. 22; appendix A, pg. 26.

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Plan Overview Outline

1. EFH in the Council process
2. 2028 EFH 5-year Review plan

SSC eAgenda: D3 EFH 5-year Review

Documents:

- 2028 EFH 5-year Review Plan (review)

- 2023 EFH 5-year Review Final Summary Report (reference)

EFH Introduction

- The Magnuson-Stevens Fishery Conservation and Management Act (MSA) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity".

- The MSA (303(a)(7)) requires that fishery management plans (FMPs) describe and identify EFH, minimize to the extent practicable adverse effects on EFH caused by fishing, and identify other actions to encourage the conservation and enhancement of EFH.

- NMFS published guidelines to implement the MSA's EFH provisions in Federal regulations at 50 CFR 600 Subpart J - Essential Fish Habitat and Subpart K - EFH Coordination, Consultations, and Recommendations.

- Federal regulations require that each FMP contains the ten EFH components.

2028 EFH 5-year Review Plan [Discussion Paper](#) - chapter 1, pg. 1.

EFH 5-Year Review

- Federal regulations require Fishery Management Councils review and revise EFH components at least every five years, and amend EFH provisions in the FMPs, as warranted, based on available information (50 CFR 600.815(a)(10)).

- The EFH 5-year review is a mechanism to ensure that NOAA Fisheries and Fishery Management Councils incorporate the best science available for EFH into fishery management.

- 2005 (EFH EIS), 2010 Review, 2017 Review, 2023 Review

- The proposed plan for the 2028 EFH 5-year Review is based on direction received from the Council during the 2023 EFH 5-year Review and reflects current priorities of the Council and NMFS.

2023 EFH Review Outcomes

Amended five of six Council FMPs:

Added or revised the EFH text descriptions and maps:

- For 41 species or complexes in the BSAI FMP
- For 46 species or complexes in the GOA FMP
- For all five species in the Crab FMP
- For all three species in the Arctic FMP
- All with new and revised EFH text descriptions and species distribution model (SDM) based EFH maps of Level 1, 2, or 3 information.

Replaced the distribution maps with the EFH maps:

- For all five species in the Salmon FMP

Revised the FMP sections with updated information for EFH fishing effects, non-fishing effects, prey species, and research and information needs.

2023 EFH 5-year Review Final Summary Report - section 1.4, pg. 12.

2023 EFH Review Documents for Reference

- Synthesis Report of Model-Based EFH Descriptions and Maps (Pirtle et al. 2025)

- SDM EFH Regional Reports for the BSAI, GOA, Crab, and Arctic FMPs (Harris et al. 2022, Laman et al. 2022, Pirtle et al. 2023, Marsh et al. 2021)

- SDM EFH Ensemble Manuscript in Journal of Applied Ecology (Harris et al. 2024)

- 2022 EFH Fishing Effects Evaluation (Zaleski et al. 2024)

- EFH Non-fishing Impacts Report (Limpinsel et al. 2023)

- Alaska EFH Research Plan (4th edition) (Pirtle et al. 2024)

- 2023 EFH 5-year Final Review Summary Report (Pirtle et al. 2025)

2028 EFH Review Roadmap

NMFS and the Council have prioritized the five EFH components in bold:

1. **Description and identification of EFH** (*Next*)
2. **Fishing activities that may adversely affect EFH** (*Next*)
3. Non-MSA fishing activities that may adversely affect EFH
4. Non-fishing activities that may adversely affect EFH
5. Cumulative impacts analysis
6. **Conservation and enhancement**
7. **Prey species list and habitat locations**
8. Identification of habitat areas of particular concern
9. Research and Information needs
10. **Review and revision of EFH components of FMPs**

This information will be presented to the Council in a Summary Report in 2028 (T). If the Council chooses to update its FMPs, FMP amendments will be prepared along with the appropriate analytical documents through the regular Council process.

2028 EFH 5-year Review Plan Discussion Paper - chapter 2, pg. 6; appendix A, pg. 26.

Component 6. EFH Conservation and Enhancement Recommendations

- FMPs must identify actions to encourage the conservation and enhancement of EFH, including recommended options to avoid, minimize, or compensate for adverse impacts (50 CFR 600.815(a)(6)).

- Habitat conservation and enhancement recommendations address fishing and non-fishing threats to EFH and HAPCs.

- The Council has taken several actions to minimize potential adverse impacts to EFH from fishing activities (EFH conservation measures, section 7.1).

2028 EFH 5-year Review Plan Discussion Paper - section 2.6, pg. 16;
2023 EFH 5-year Review Final Summary Report - section 7.1, pg. 79.
EFH Non-fishing Impacts Report (Limpinsel et al. 2023)

2028 EFH Review Plan

- Review the results of the EFH fishing effects evaluation.

- Review existing habitat conservation and enhancement measures.

- The Council may choose to recommend priorities for additional habitat conservation measures.

Figure 1. Areas with habitat restrictions in the Aleutian Islands (NPFMC).

2028 EFH 5-year Review Plan Discussion Paper - section 2.6, pg. 16.

Component 7. Prey Species List and Habitat Locations

Figure 2. Capelin (Seafood Watch).

- EFH regulations (50 CFR 600.815(a)(7)):

- "Loss of prey may be an adverse effect on EFH and managed species because the presence of prey makes waters and substrate function as feeding habitat, and the definition of EFH includes waters and substrate necessary to fish for feeding. (. . .)

- (. . .) FMPs should list the major prey species for the species in the fishery management unit and discuss the location of prey species' habitat."

2028 EFH 5-year Review Plan Discussion Paper - section 2.7, pg. 17.

2028 EFH Review Plan

- Review prey species information in the FMPs and determine if updates are warranted.

- Studies funded during the 2023 Review will have results for the 2028 Review, such as SDM maps of prey habitat available for the first time.

- Present new SDM maps of habitat-related distribution and abundance for a subset of EFH species' prey for the BSAI and GOA FMPs.

2028 EFH 5-year Review Plan Discussion Paper - section 2.7.2, pg. 18.

Component 8. HAPC Identification

- EFH regulations (50 CFR 600.815(a)(8)): "FMPs should identify specific types or areas of habitat within EFH as habitat areas of particular concern [HAPC]. . ."

- HAPCs are areas within EFH that are rare and are either ecologically important, sensitive to disturbance, or may be stressed.

- HAPC are a site specific management tool for federally managed species that may require additional protection from adverse fishing effects.

- The Council may choose to identify priorities for HAPC consideration and request proposals for specific sites for HAPC inclusion.

- The Council can request conservation and enhancement proposals and open the HAPC process at any time, if the need and information are available.

2028 EFH 5-year Review Plan Discussion Paper - section 2.8, pg. 19.
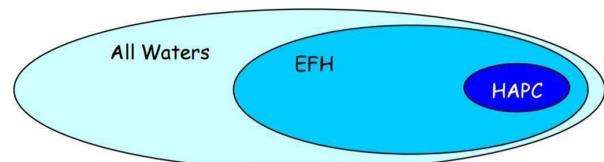
Component 9. Research and Information Needs

- FMPs should identify recommendations for research that the Council and NMFS view as necessary to improve descriptions and identification of EFH, evaluate impacts to EFH, and develop EFH conservation and enhancement measures (50 CFR 600.815(a)(9)).

- The NMFS Alaska EFH Research Plan is revised following an EFH 5-year review to guide research development for the next and future EFH reviews.

- For 2028 EFH 5-year Review, we will identify recommendations that are necessary to fill gaps in EFH knowledge and determine whether updates to the FMPs are warranted.

- We anticipate that the NMFS Alaska EFH Research Plan will maintain status quo, in its fourth edition since 2006.

2028 EFH 5-year Review Plan Discussion Paper - section 2.9, pg. 20.

Component 10. EFH 5-Year Reviews

- Federal regulations require Fishery Management Councils review and revise EFH components at least every five years, and amend EFH provisions in the FMPs, as warranted, based on available information (50 CFR 600.815(a)(10)).

- Council will receive a Summary Report representing the 2028 EFH 5-year Review. Appropriate analysis will follow if the Council recommends to amend the FMPs with new information.

2028 EFH 5-year Review Plan Discussion Paper - section 2.10, pg. 21.

2028 EFH Review Timeline

SSC Reviews Overall Plan and Methods for C1 Maps and C2 FE Analysis

Feb 2026

SSC Reviews Draft C1 Maps, Draft C2 FE Analysis, and FE Evaluation Methods

Feb-Mar 2027 (T)

Plan Teams and SSC Review C2 FE Evaluations, and SSC Reviews other EFH analysis

Sep/Oct 2027 (T)

Dec 2025

Mar 2026

Mar-Jun 2027 (T)

TBD 2028/29

Launch 2028 EFH 5-year Review Plan with Council and (postponed from June 2025)

Ecosystem Committee Informational Presentation

Stock Assessment Author Workshop and Review of C1 Maps and C2 FE Evaluations

2028 EFH 5-year Review Summary Report to Council

2028 EFH 5-year Review Plan Discussion Paper - appendix B, pg. 30.

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Council Action

- Review the 2028 EFH 5-year Review Plan Discussion Paper.

- Provide direction regarding the focus and scope of the review.

- Staff are seeking input on the following:

  - Component 1: EFH descriptions and identification (*Next*)
  - Component 2: Fishing activities that may adversely affect EFH (*Next*)
  - Component 6: EFH conservation and enhancement measures
  - Component 7: Prey species list and locations
  - Component 9: Research and information needs
  - Component 10: Review and revision of EFH components of FMPs.

- Additionally, the Council may choose to initiate the HAPC process by identifying specific priorities for HAPC consideration, pending information and need identified from this EFH 5-year Review, or at any time (Component 8).

D3 EFH 5-year Review Action Memo, February 2026
2028 EFH 5-year Review Plan Discussion Paper - chapter 3, pg. 22; appendix A, pg. 26.

Component 1. EFH Description and Identification - Proposed Methods

Mallarie Yeager, National Marine Fisheries Service, Alaska Region
Mason Smith, National Marine Fisheries Service, Alaska Region
Jodi Pirtle, National Marine Fisheries Service, Alaska Region

Scientific and Statistical Committee, February 3 2026

Component 1. EFH Description and Identification

- EFH component 1 description and identification is FMP text, tables, and maps.

- EFH component 1 requires individual species maps for the fishery management unit of the FMP (50 CFR 600.805(b)), where some or all portions of the species' geographic range is mapped (50 CFR 600.815(a)(1)(iii)(1)).

- The EFH regulations provide an approach to organize the information necessary to describe and identify EFH. When designating EFH, the Council should strive to describe and identify EFH information at the highest level possible (50 CFR 600.815(a)(1)(iii)(B))—

  - Level 1: Distribution data are available for some or all portions of the geographic range of the species.
  - Level 2: Habitat-related densities or relative abundance of the species are available.
  - Level 3: Growth, reproduction, or survival rates within habitats are available.
  - Level 4: Production rates by habitat are available. *[Not available at this time]*

2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 1.2, pg. 3.

Alaska EFH Maps

- Species distribution models (SDMs) apply data to produce a map based on the relationship between species occurrences and environmental variables.

- EFH maps based on single species distribution models (SDMs) were established in the 2017 Review.

- SDM ensemble EFH maps from the 2023 Review improved skill and reduced methods bias in mapping EFH

- EFH is the upper 95% of the spatial domain of occupied habitat.

- Core EFH area (CEA) is the upper 50% of the area of occupied habitat applied to the EFH Component 2 fishing effects analysis.
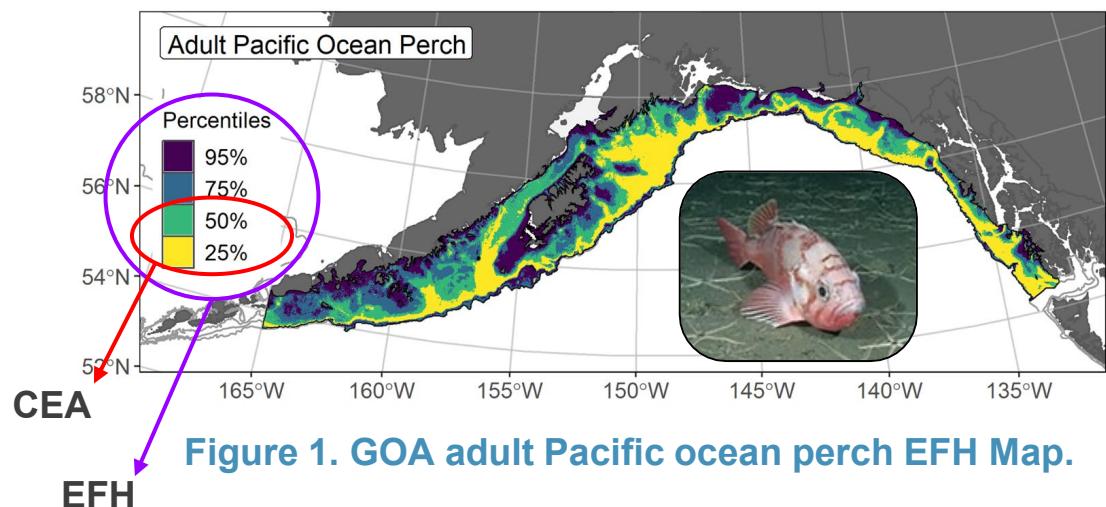
Figure 1. GOA adult Pacific ocean perch EFH Map.

Component 1. 2028 EFH Review Plan

The 2028 Review will apply the 2023 Review SDM ensemble with new and revised species data and environmental data to map EFH.

- New Level 2 EFH maps will be developed for the following:

    - A subset of groundfish species by life history stage in the BSAI and GOA FMPs: sablefish, pollock, Pacific cod, Pacific ocean perch, and arrowtooth flounder.

    - All five crab species in the Crab FMP, by sex and maturity stage, which was a research recommendation from the 2023 Review.

- New and revised Level 3 EFH maps will be developed for species with temperature-dependent vital rates.

We will also develop new spatio-temporal SDMs (STMs) to explore changes in EFH over time, as recommended by the SSC during the 2023 Review.

2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 1.2.2, pg. 5.

Component 1. 2028 EFH Review Plan

At **this meeting** staff are seeking SSC input on—

- Updates to the ensemble SDM EFH maps
  - New data and updated covariate methods; and
- New STM EFH methods, results and application
- Overall scope of Component 1

At a **subsequent** SSC meeting, we seek input on—

- Component 1 final methods, bridging analyses, and draft results

2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 1, pg. 1.

Component 1. Methods and Draft Results Outline

- Model Input Data
  - Species Data (dependent vars)
    - **New survey years** (2020-2025)
    - **New BSAI crab life history stages**
  - Environmental Data (independent vars)
    - **New updates to majority of covariates**
    - Bridging of new or updated covariates
- Ensemble SDMs
  - Methods consistent with 2023 EFH Review
  - Workflow of proposed results
- **STMs (*New method*)**
  - Model structure and method
  - Draft results and application

Species Data

Environmental Data

Model Development

Model Results
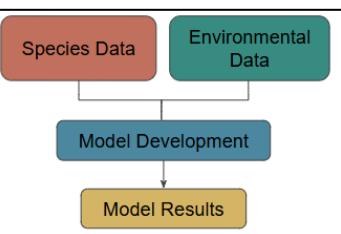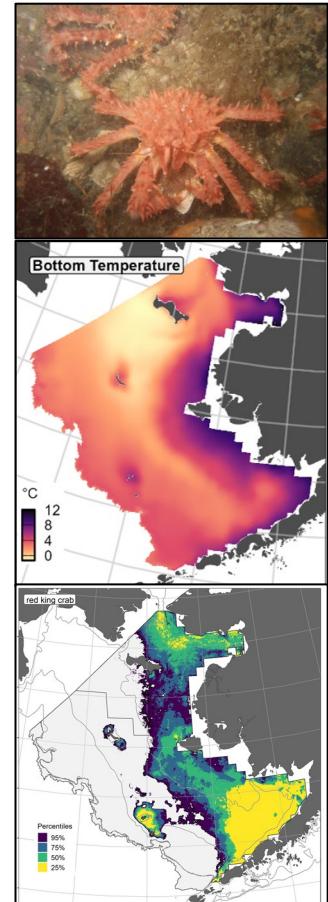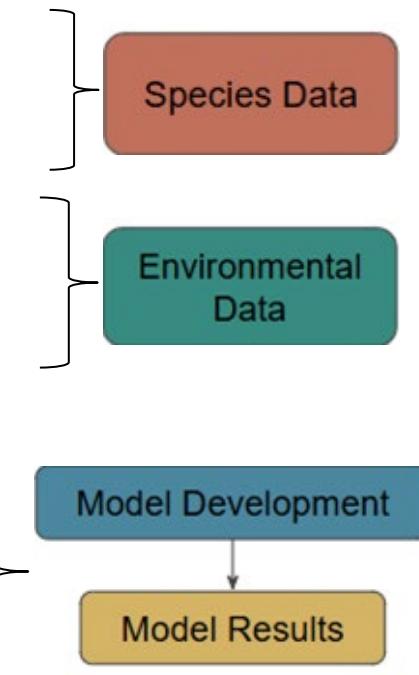
2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 2, pg. 9.

Species Data (Dependent Variables)

- **Survey**: AFSC RACE-GAP summer bottom trawl survey
- **Years**:
  - GOA: 1993 - 2025
  - EBS: 1982 - 2025
    - propose change to 1993 - 2025
  - AI: 1982 - 2025
    - propose change to 1994 - 2025

- **Species**
  - Level 2 EFH:
    - BSAI/GOA Groundfish: Settled early juvenile, subadult and adult
      - Sablefish
      - Walleye pollock
      - Pacific cod
      - Pacific ocean perch
      - Arrowtooth flounder
    - BSAI Crab: Sex (M/F) and maturity life stage
      - Red king crab
      - Blue king crab
      - Golden king crab
      - Tanner crab
      - Snow crab
  - Level 3 EFH:
    - BSAI Groundfish: Settled early juvenile
      - Walleye pollock
      - Pacific cod
    - GOA Groundfish: Settled early juvenile
      - Sablefish
      - Walleye pollock
      - Pacific cod
    - BSAI Crab: juvenile
      - Tanner crab
      - Snow crab

Species Data

Environmental Data

Model Development

Model Results
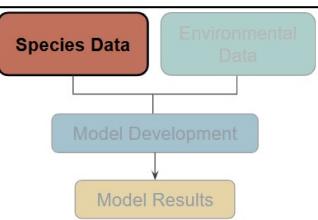
2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 2.2, pg. 10.

Environmental Data (Independent Variables)

- Geographic and Physical

  - Location: geographic coordinates (Latitude/Longitude)

  - Terrain: **bathymetry**, slope, aspect (eastness/northness), curvature, and bathymetric position index

  - Substrate: sediment grain size (phi) and rockiness

- Oceanographic

  - MOM6-NEP products: **summer bottom temperature**, summer bottom current (eastings and northings), summer bottom current variability (eastings and northings), cold pool extent

  - Hydrodynamics: Maximum tidal speed

- Biological

  - SFI SDMs: **structure-forming invertebrates**
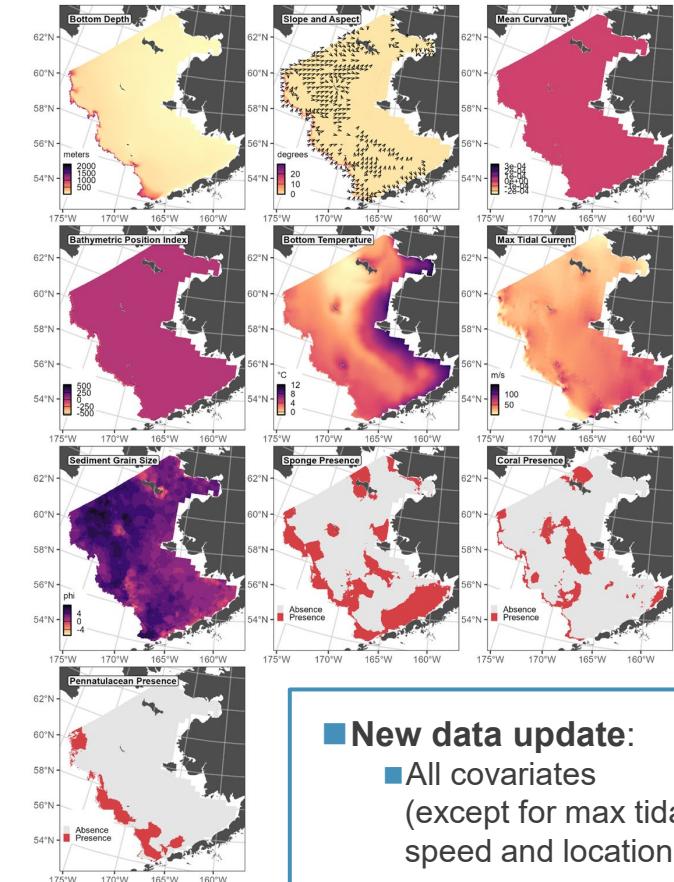
- **New data update**:
  - All covariates (except for max tidal speed and location)
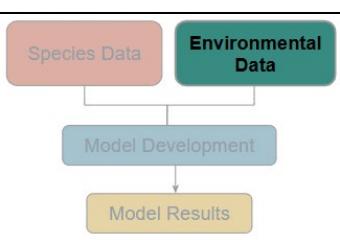

2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 2.3, pg. 14.

Environmental Data: Bathymetry

- **Source data** - Combined digital terrain models (DTMs)
    - EBS - GEBCO 2024, Zimmerman and Prescott 2018, Prescott and Zimmerman 2015 (Norton sound)
    - GOA - Zimmerman et al. 2019
    - AI - Zimmerman et al. 2013, Zimmerman and Prescott 2021
- **Mosaic approach** - Overlapping DTMs were prioritized by AFSC bottom trawl depth validations
- **Resolution** - 100 m x 100 m aggregated to 1 km x 1 km
- Used to calculate all other terrain variables

Thanks to Dr. Sean Rohan for the analysis
https://github.com/alaska-groundfish-efh/efhbathy
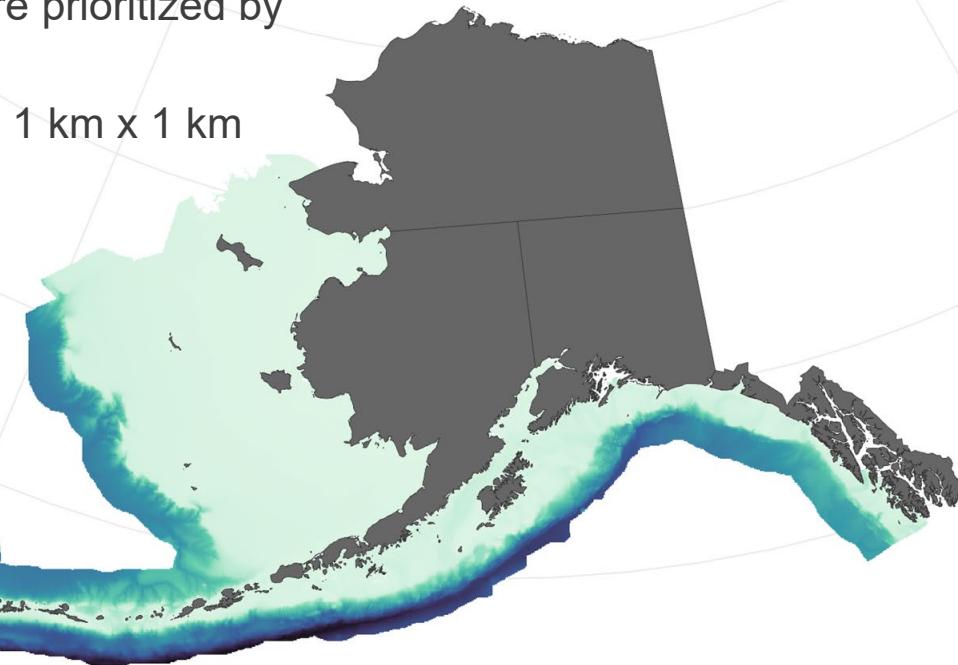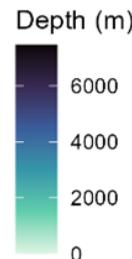
Depth (m)
6000
4000
2000
0

Species Data | Environmental Data
Model Development
Model Results

2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 2.3.2, pg. 17.
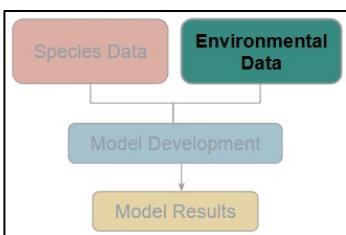
Environmental Data: Bridging Bathymetry

Overall:
2028 bathymetry update shows improved accuracy across all regions and *almost* all depth profiles

See slide 69 for MRE table

Depth difference maps
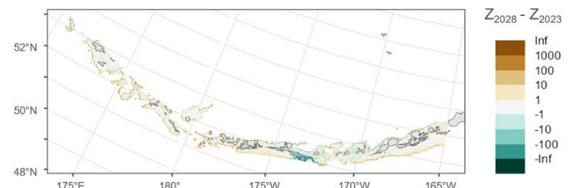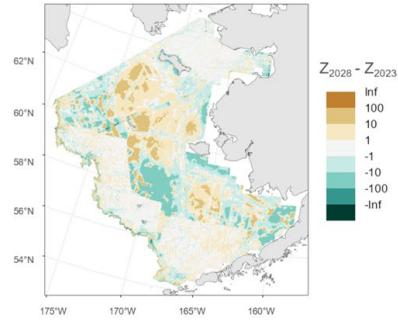
Model validation against observed depth
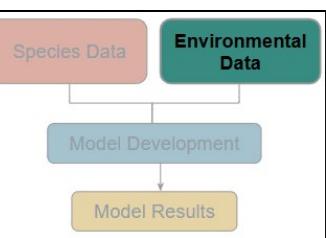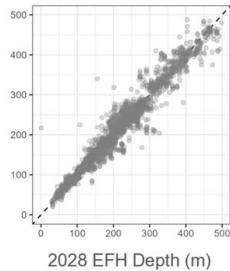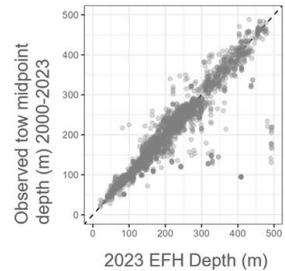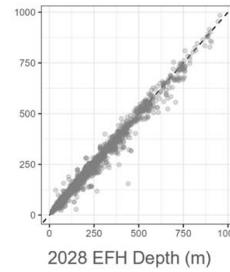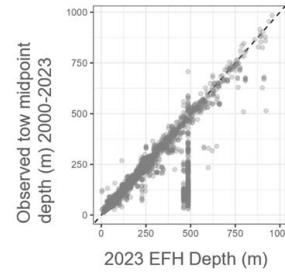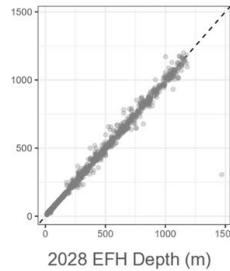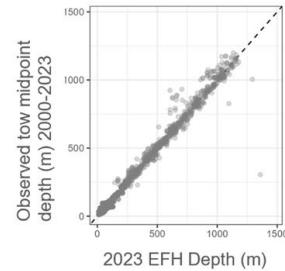
2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 2.3.2, pg. 17.

Environmental Data: Structure-Forming Invertebrates

- 2017 and 2023 EFH Review SFI maps (Rooper et al., 2014, 2016, 2017)

  - RACE GAP bottom trawl survey

- 2028 EFH Review: **Combined gear SDM**

  - AK Coral and Sponge Initiative camera data and RACE GAP bottom trawl survey

  - AKCSI report: Conrath et al 2025

- Presence-absence maps across three taxa groups:

  - Sponge, Corals, and Pennatulaceans
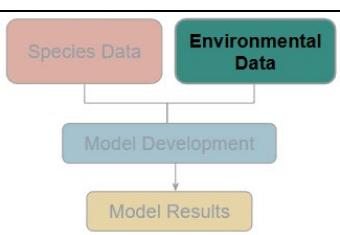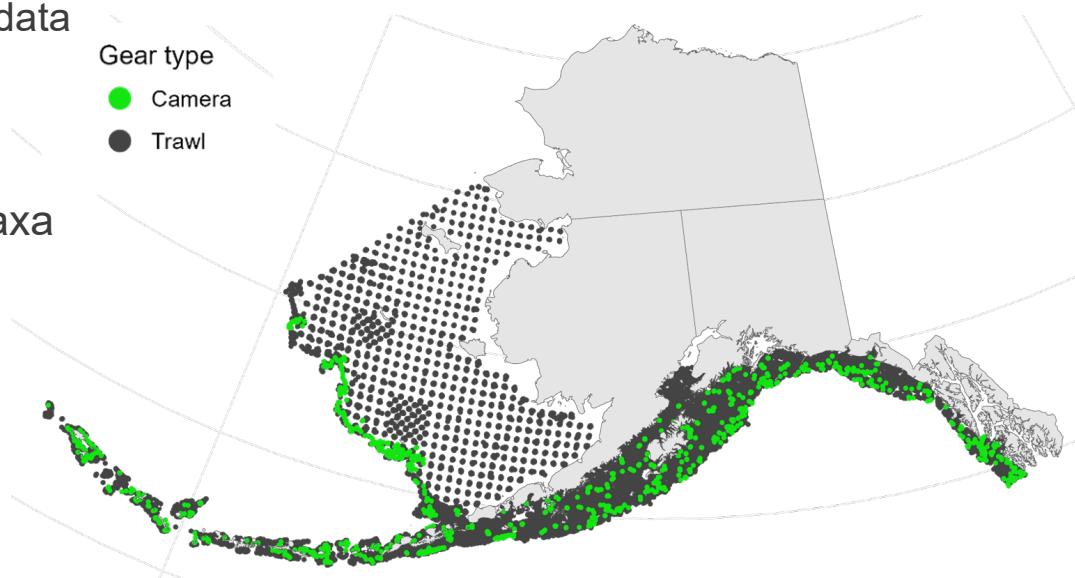
Gear type
- Camera
- Trawl

2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 2.3.8, pg. 28.

Environmental Data: Structure-Forming Invertebrates

- Model Framework: GAMM using sdmTMB
  - Spatial model using a SPDE mesh
  - Binomial distribution (logit link)

Sponge

Probability of occurance

- 0.75
- 0.50
- 0.25

Thresholds based on ROC

Sponge

Presence/Absence
- 1
- 0
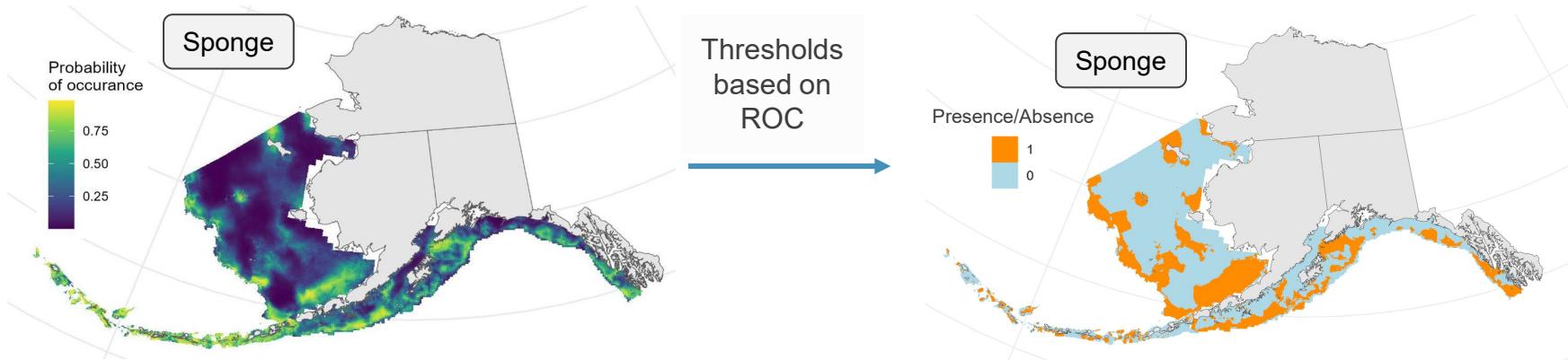
$$\text{logit}(p_i) = \beta_0 + \beta_1(\text{Gear}) + f_1(\text{depth}_i) + f_2(\text{temp}_i) + f_3(\text{phi}_i) + f_4(*\text{rockiness}_i) + f_5(\text{mean current}_i)$$

fixed factor

smooth terms

* rockiness: GOA and AI
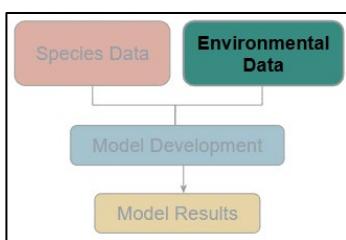
Species Data Environmental Data

Model Development

Model Results

2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 2.3.8, pg. 28.

Environmental Data: MOM6-NEP bottom temperature

- **Source**: MOM6-NEP (Drenkard et al., 2025)
  - Raw gridded monthly hindcast data
  - NOAA NMFS CEFI Portal
- **Resolution:** ~ 10 km grid, 52 vertical layers
  - **Interpolation**: IDW to a 1km x 1 km res.
- **Temporal scope**: Annual summer mean (June - August) across 33 years (1993 - 2025)
- **Other MOM6 covariates:**
  - Bottom current and variability (*In progress*)
 - Cold pool extent (*Done - for STMs*)
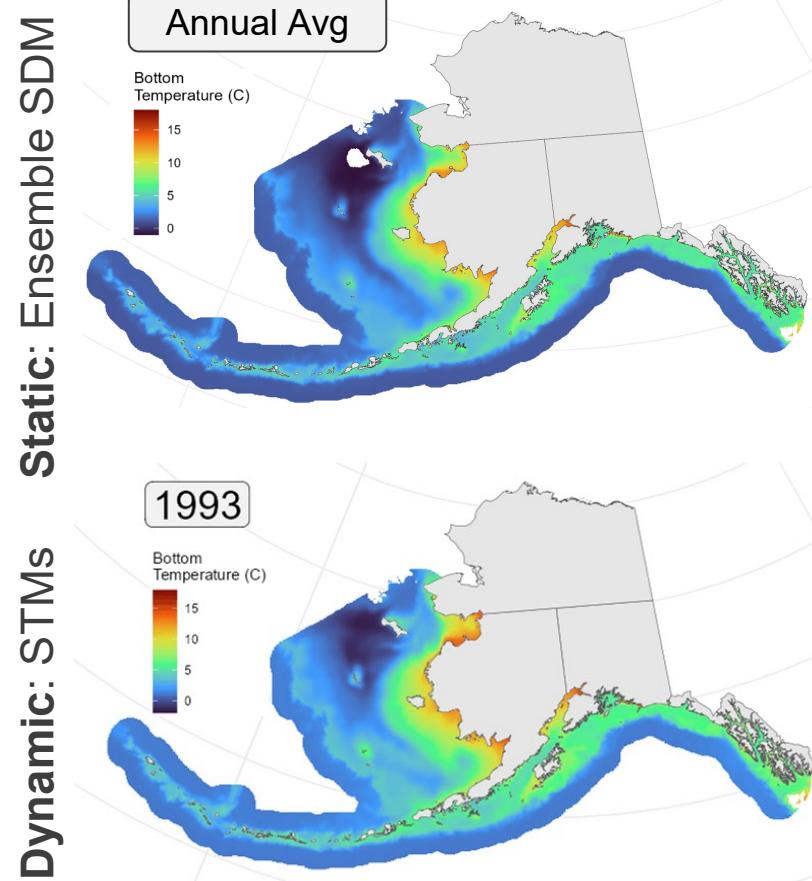
2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 2.3.4, pg. 20.
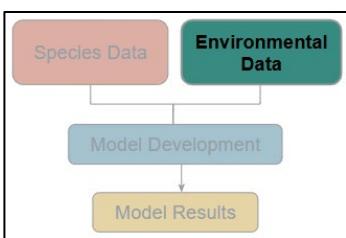
Environmental Data: Bridging Bottom Temperature

2028 EFH bottom temp.
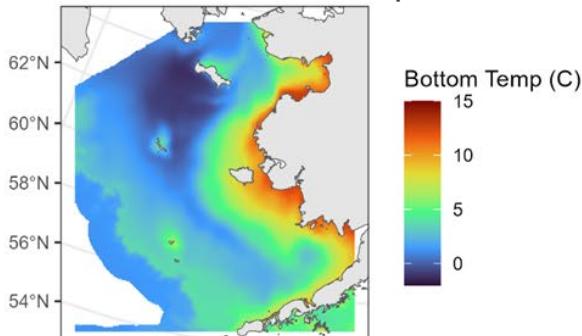

MOM6-NEP (1993 - 2019)

2023 EFH bottom temp.
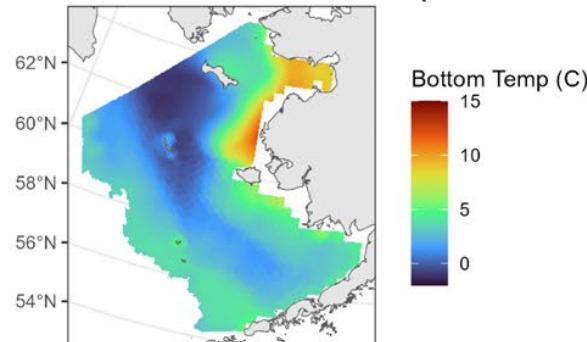
Survey Station (1992 - 2019)

Difference (2028 - 2023)
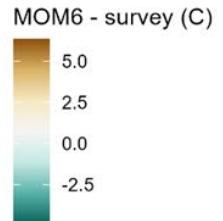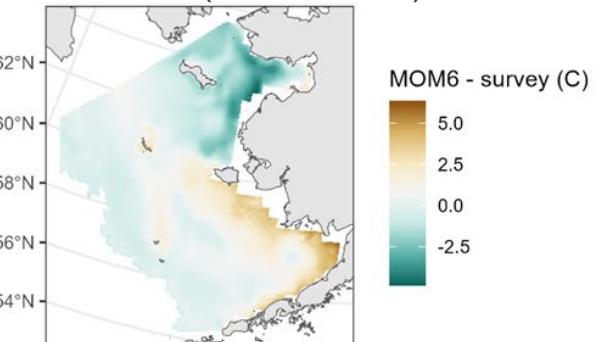
- **Spatial Comparisons**
  - Broad agreement - both maps capture major patterns (e.g., cool waters in the Northern Bering Sea)
  - Localized divergences - MOM6 predicts:
    - Warmer temperatures (brown) in coastal Bristol Bay and along the inner shelf
   - Cooler temperatures (blue-green) in Northern Bering Sea and Norton Sound
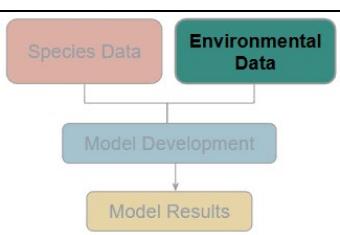
2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 2.3.4, pg. 20.

# Component 1. Methods and Draft Results Outline

- Model Input Data
  - Species Data (dependent vars)
    - **New survey years** (2020-2025)
    - **New BSAI crab life history stages**
  - Environmental Data (independent vars)
    - **New updates to majority of covariates**
    - Bridging of new or updated covariates
- **Ensemble SDMs**
  - Methods consistent with 2023 EFH Review
  - Workflow of proposed results
- **STMs (*New method*)**
 - Model structure and method
  - Draft results and application

2028 EFH 5-year Review Description and Maps Methods [Discussion Paper](#) - section 2, pg. 9.

Ensemble SDMs

GAM$_P$ (Poisson, effort offset, log link)	**GAM$_{nb}$** (Neg. binomial, offset, log link)	***h*GAM** (Binomial/Poisson, offset, cloglog/log link)	***pa*GAM** (Binomial, offset, cloglog link)	**MaxEnt** (Poisson Process, cloglog link)
Abundance Check	Abundance Check	Abundance Check	Abundance Check	Abundance Check
10-fold CV	10-fold CV	10-fold CV	10-fold CV	10-fold CV

1 Model Selected (RMSE) → Weighting (1/RMSE^2)

Final Ensemble

Final Skill Test
(RMSE, rho, AUC, PDE)

https://github.com/noaa-akro/alaska-efh-ensemble-sdm

Species Data
Environmental Data
Model Development
Model Results
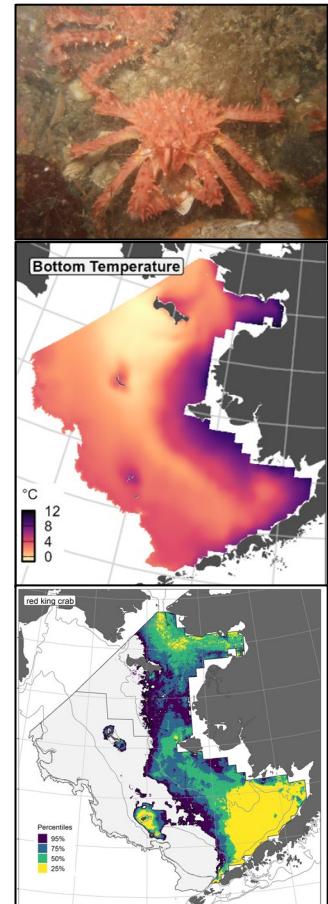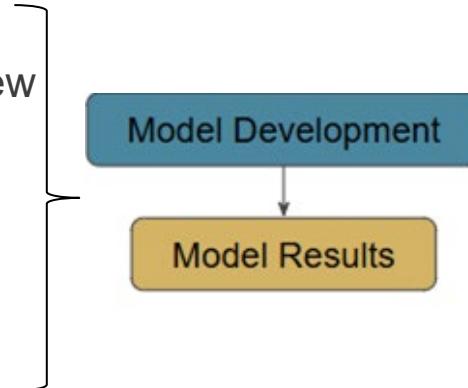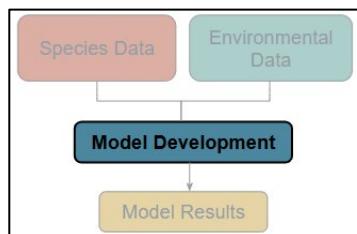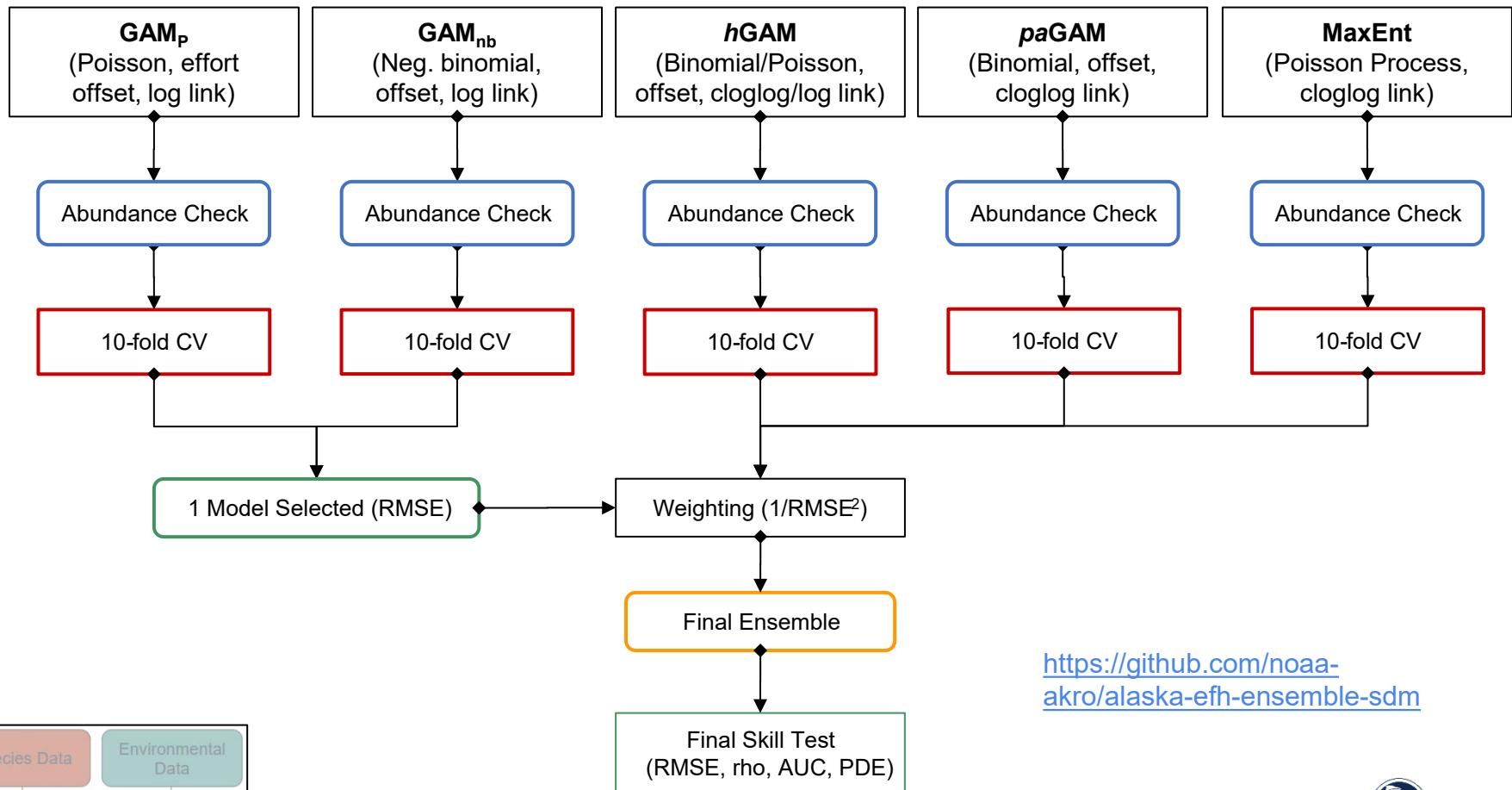
2028 EFH 5-year Review Description and Maps Methods Discussion Paper - sec. 2.4, pg. 33.

Spatiotemporal Models (STMs)

- **New in 2028 EFH Review**

- **Method: sdmTMB**
  - Static and Dynamic covariates
  - tweedie distribution, log link, & effort offset
  - Spatial effects
  - Spatiotemporal effects
  - Spatially-varying coefficient (SVC)

$$\log(\mu_{s,t}) = \boxed{f_1(D_{s,t})} + \boxed{f_n(X_{s,t})} + \boxed{\log(k)_{s,t}} + \boxed{\omega_{s,t}} + \boxed{\epsilon_{s,t}} + \boxed{(P_t \cdot \gamma_s)}$$

Static   Dynamic   Effort   Spatial   Spatiotemporal AR(1)   SVC

Species Data — Environmental Data

Model Development

Model Results
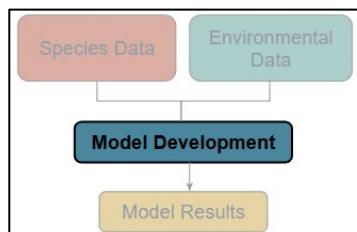
2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 2.5, pg. 37.

STMs: Draft Results (EBS Adult Pacific cod)

- Developed on high occurring species in EBS bottom trawls (Smith et al. *in review*)
  - **For 2028 Review**: all regions + species/life history stages in our subset
- Draft output: EFH expansion, contraction, and shifts through time
- Supplemental to ensemble: greater temporal accuracy

Static (2023 Review)
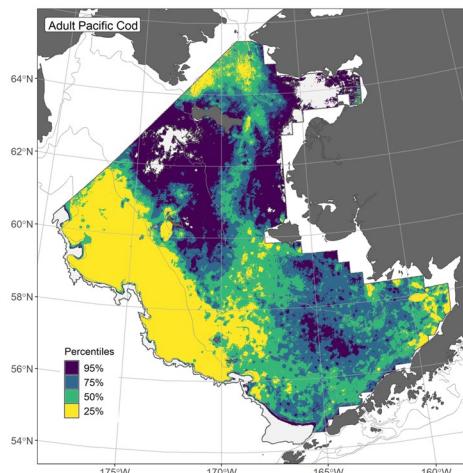
Spatiotemporal (2028 Review)
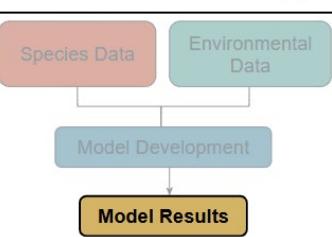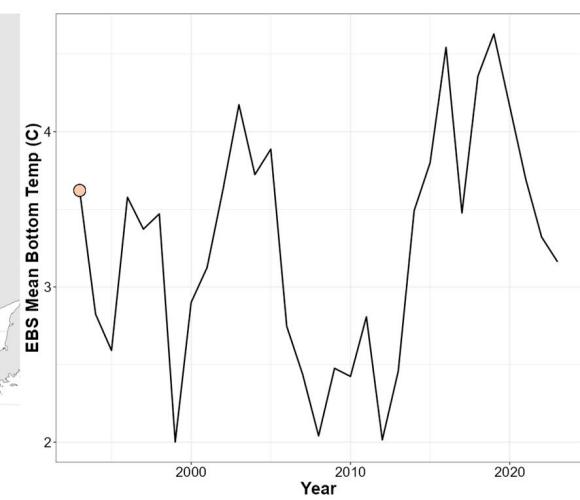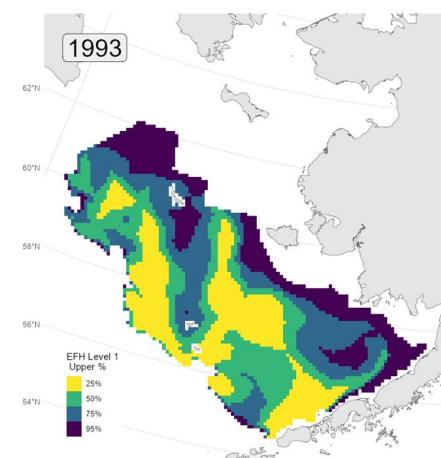
2028 EFH 5-year Review Description and Maps Methods [Discussion Paper] - section 3.2, pg. 48.

Component 1. 2028 EFH Review Plan

At **this meeting** staff are seeking SSC input on—

- Updates to the ensemble SDM EFH maps
    - New data and updated covariate methods; and
- New STM EFH methods, results and application
- Overall scope of Component 1

2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 1, pg. 1.

36

Component 2. EFH Fishing Effects Evaluation

EFH component 2 - Fishing activities that may adversely affect EFH

- EFH regulations (50 CFR 600.815(a)(2)):

- *(i) Evaluation*: Each FMP must contain an evaluation of the potential adverse effects of fishing on EFH designated under the FMP.

- *(ii) Minimizing adverse effects*: Each FMP must minimize to the extent practicable adverse effects from fishing on EFH. Councils must act to prevent, mitigate, or minimize any adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely affects EFH in a manner that is more than minimal and not temporary in nature, based on the evaluation.

2028 EFH 5-year Review Plan Discussion Paper - section 2.2, pg. 11.

Component 2. 2028 EFH Review Plan

The following analytical updates and process milestones are planned for the
2028 Review EFH FE evaluation:

- Incorporate NMFS Catch In Areas (CIA) Database updates, including additional
  years of fishing effort data from January 2021 forward, and provide a retrospective
  bridging analysis.

- Update the fishing effects (FE) model data inputs, including gear parameters,
  geological and biological benthic habitat features, and recovery and susceptibility
  rates.

- Run the FE model for the full BSAI and GOA domain and overlay results on CEAs
  from the updated ensemble SDM EFH maps for the subset of species in the BSAI
  and GOA Groundfish FMPS, and all crab species in the Crab FMP.

- Complete the EFH FE evaluation based on this new information. Stock assessment
  authors will conduct the individual species evaluations.

2028 EFH 5-year Review Plan Discussion Paper - section 2.2.2, pg. 13.

Component 2. 2028 EFH Review Plan

At **this meeting** staff are seeking SSC input on—

- Newly available data resources for FE model inputs;
- Bridging analyses for changes in model outputs due to CIA database updates, gear parameter table updates, and any other updates proposed; and
- Overall scope of Component 2

At a **subsequent** SSC meeting, we seek input on—

- Final FE model methods, bridging analyses, and model run results
- Methods for stock author evaluation of adverse FE

2028 EFH 5-year Review Plan Discussion Paper - section 4, pg. 20.

Fishing Effects (FE) Model

Fishing Module

- Integrates track lines of fishing events (fishing effort) with corresponding fishing gear parameters

- Product = swept area and bottom contact area
 - These are used on their own for other management decisions

swept area

bottom contact area

Gear parameters are the dimensions and combinations of vessel-specific gear components.

Fishing tracks are collected via satellite through the Vessel Monitoring System (VMS).

gear parameters (widths) x fishing track (lengths) = swept area (total area fished)

swept area x contact adjustment = bottom contact area (seafloor contacted)

The Fishing Module can be used on its own, separate from the Habitat Module, for fishery management decisions.

D3 EFH 5-year Review Fishing Effects Methods - section 2, pg. 6.

FE Model

Habitat Module

- Integrates results from the Fishing Module with the susceptibility and recovery time of an area

- Sediment types correlate with common habitat features used in the FE model

D3 EFH 5-year Review Fishing Effects Methods - section 2, pg. 6.
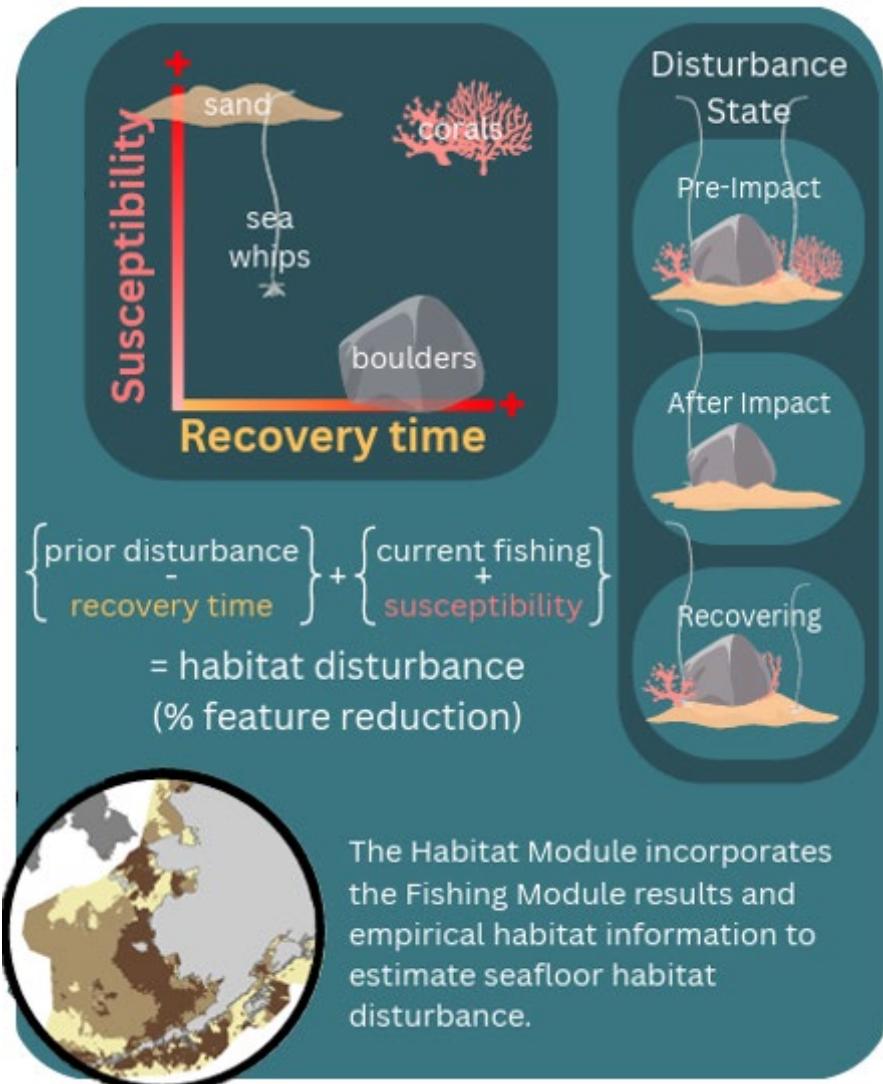
FE Model

Model Product

- Estimate of cumulative habitat disturbance

D3 EFH 5-year Review Fishing Effects Methods - section 2, pg. 6.
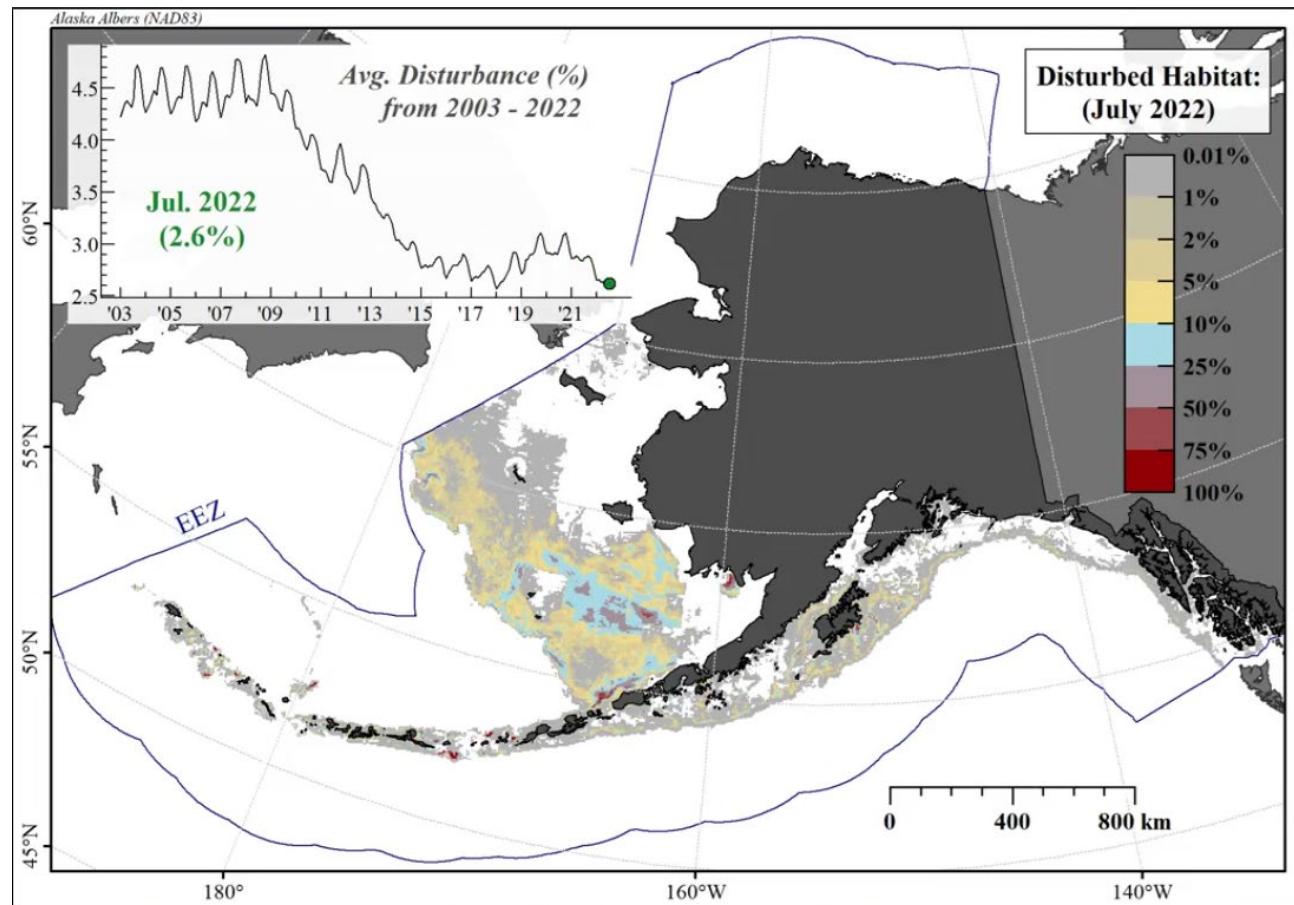
FE Evaluation Workflow

FE evaluation is a multi-step process:

1. **Review and update model inputs**
   a. **WE ARE HERE**
2. FAST Lab will run the FE model
3. Overlay FE model results with updated SDMs (C1 work products)
4. Stock author evaluation process
   a. Effects determinations
5. Report findings and conclusions to Plan Teams and Council bodies
   a. Opportunity for elevating species for mitigation measures

D3 EFH 5-year Review Fishing Effects Methods - section 2, pg. 7.

Step 1: Review and update FE model inputs with newly available data and information

↓

Step 2: Run the FE model

↓

Step 3: Overlay FE model results with updated SDM CEAs and calculate estimates of habitat disturbance for each area

↓

Step 4: Provide stock authors with species-specific results and launch the stock author evaluation for adverse FE to EFH

↓

Step 5: Report FE model results and stock author conclusions to the Plan Teams and Council bodies

FE Evaluation Workflow: Step 1

Model Input Parameter:

- Fishing Module:
  - Fishing Effort *
  - Gear Parameter Table *
- Habitat Module:
  - Habitat Categorization
  - Susceptibility and Recovery
- Bridging Analyses *

D3 EFH 5-year Review Fishing Effects Methods - section 2.1, pg. 7-14.

Step 1: Review and update FE model inputs with newly available data and information

Step 2: Run the FE model

Step 3: Overlay FE model results with updated SDM CEAs and calculate estimates of habitat disturbance for each area

Step 4: Provide stock authors with species-specific results and launch the stock author evaluation for adverse FE to EFH

Step 5: Report FE model results and stock author conclusions to the Plan Teams and Council bodies

FE Evaluation Workflow: Step 1

Fishing Module Input

Fishing Effort:

Spatial data from the NMFS AKRO Catch-In-Areas database is collected from VMS on board fishing vessels.

The VMS records GPS locations in 30-minute intervals while a ship is at sea providing a continuous path of where that vessel has traveled.

Proposed Updates

- Add additional fishing data:
  - AKRO rebuilt CIA system
  - Through Dec 2025* and will include any data into 2026 if timing and availability align

Additional Analysis

- Bridging analysis

D3 EFH 5-year Review Fishing Effects Methods - section 2.1.1, pg. 8; section 2.2.1, pg. 14.

FE Evaluation Workflow: Step 1

Fishing Module Input

Gear Parameter Table: provides the input parameters relating to the fishing gears used in the FE model

Parameters include:
- Nominal width
- Contact adjustment

Proposed Updates

- Gear Innovation Initiative
  - Led by FAST Lab
  - Update metrics (e.g., nominal widths, bottom contact) for participating fleets, where available

- NMFS internal review
  - For completeness and consistency

Additional Analysis
- Bridging analysis

D3 EFH 5-year Review Fishing Effects Methods - section 2.1.2, pg. 9; section 2.2.2, pg. 14.

FE Evaluation Workflow: Step 1

Habitat Module Input

Habitat Categorization:

Common habitat features correlate to combinations of seafloor sediments and depths (6 categories)

Resource: sediment data derived largely from the dbSEABED system

Proposed Updates

- Include new sediment observations
  - recently updated dbSEABED system sediment data (link to PDF for Jenkins et al. 2025)

D3 EFH 5-year Review Fishing Effects Methods - section 2.1.3, pg. 11.
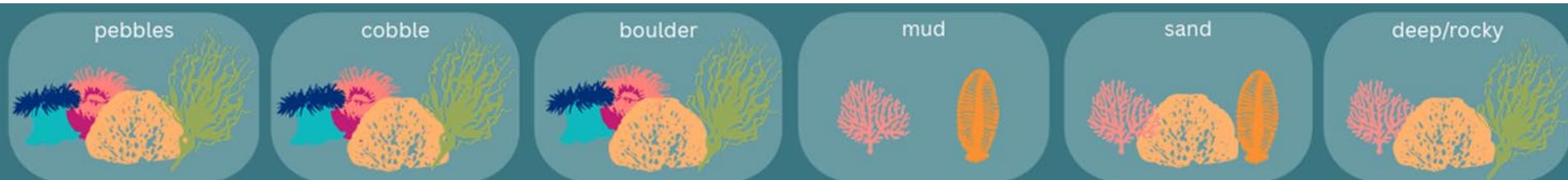
FE Evaluation Workflow: Step 1

Habitat Module Input

Susceptibility and Recovery:

Susceptibility = the proportion of habitat impacted by fishing gear (i.e., transitions from "undisturbed" to "disturbed")

Recovery = the rate at which a habitat transitions from "disturbed" to "undisturbed", based on both the underlying habitat

Proposed Updates

- Review rates and update as warranted
  - Fishing Gear Effects on Marine Habitats

D3 EFH 5-year Review Fishing Effects Methods - section 2.1.4, pg. 12.
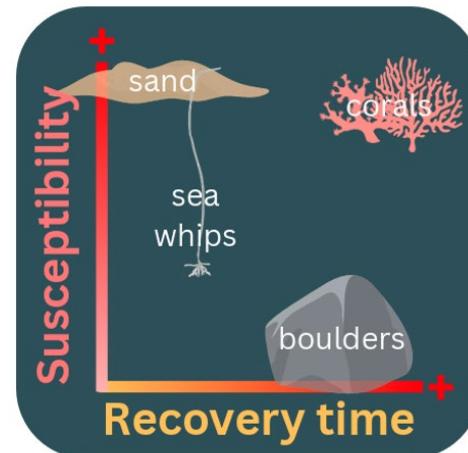
FE Evaluation Workflow: Step 2

- The FE model run for the full BSAI and GOA domain with primary output = **estimate of the amount of disturbed habitat in each grid cell for each month**

  - 5 km x 5 km grid cells
  - Monthly time steps
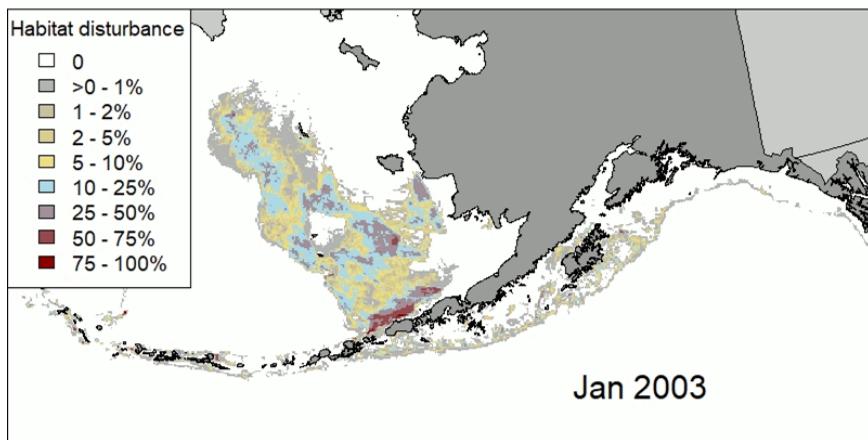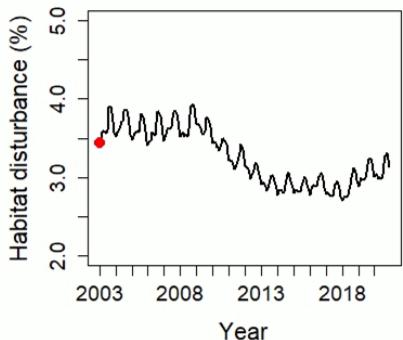
Jan 2003

D3 EFH 5-year Review Fishing Effects Methods - section 2, pg. 6.

Step 1: Review and update FE model inputs with newly available data and information

Step 2: Run the FE model

Step 3: Overlay FE model results with updated SDM CEAs and calculate estimates of habitat disturbance for each area

Step 4: Provide stock authors with species-specific results and launch the stock author evaluation for adverse FE to EFH

Step 5: Report FE model results and stock author conclusions to the Plan Teams and Council bodies

FE Evaluation Workflow: Step 3

- Overlay FE model results with updated ensemble SDM EFH maps

  - Species: subset of groundfish species in BSAI and GOA Groundfish FMPs and all crab species in BSAI Crab FMP

  - Overlay with core EFH area (CEA)

GOA Adult Pacific ocean perch EFH
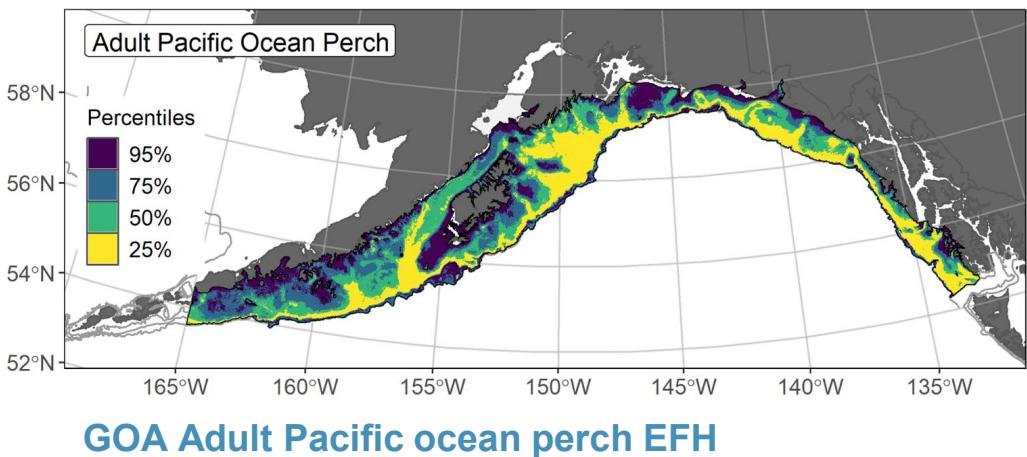
D3 EFH 5-year Review Fishing Effects Methods - section 2.3, pg. 14.

Step 1: Review and update FE model inputs with newly available data and information

Step 2: Run the FE model

Step 3: Overlay FE model results with updated SDM CEAs and calculate estimates of habitat disturbance for each area

Step 4: Provide stock authors with species-specific results and launch the stock author evaluation for adverse FE to EFH

Step 5: Report FE model results and stock author conclusions to the Plan Teams and Council bodies

Council Action

At **this meeting** staff are seeking SSC input on—

2028 EFH Review Plan

- Focus and scope of the overall plan

Component 1

- Planned updates to the ensemble SDM EFH maps
  - New data and updated covariate methods
- New STM EFH methods, results, and application
- Overall scope of Component 1

Component 2

- Newly available data resources for FE model inputs
  - Model output bridging analyses accounting for updates to CIA database, gear parameter table, and other updates proposed
- Overall scope of Component 2

2028 EFH 5-year Review Plan Discussion Paper - section 4, pg. 20.

THANK YOU

Jodi Pirtle

Anita Kroska

Mallarie Yeager

Mason Smith

Molly Zaleski

Scott Smeltz

Felipe Restrepo

Environmental Data: Bridging Bathymetry

Overall:
2028 bathymetry update shows improved accuracy across all regions and *almost* all depth profiles

- bold numbers: MRE value is best by that depth bin/region

Depth Bin	EBS		GOA		AI	
	2028 MRE	2023 MRE	2028 MRE	2023 MRE	2028 MRE	2023 MRE
0-50	**0.076**	0.142	**0.096**	0.133	**0.126**	0.132
50-100	**0.017**	0.116	**0.044**	0.083	**0.050**	0.062
100-200	**0.008**	0.020	**0.033**	0.085	**0.044**	0.060
200-300	**0.034**	0.047	**0.031**	0.074	0.316	**0.065**
300-400	**0.049**	0.057	**0.050**	0.092	**0.061**	0.065
400-500	**0.030**	0.032	**0.036**	0.041	0.046	**0.033**
500-600	**0.025**	0.025	**0.044**	0.064	-	-
600-700	0.034	**0.029**	**0.040**	0.075	-	-
700-800	**0.028**	0.036	**0.025**	0.036	-	-
800-900	**0.025**	0.049	**0.026**	0.035	-	-
900-1000	**0.019**	0.035	**0.016**	0.019	-	-
1000-1200	**0.023**	0.041	-	-	-	-
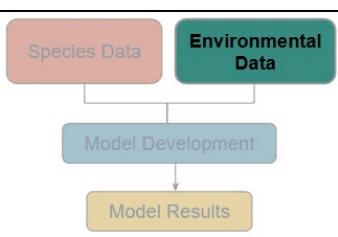
Species Data / Environmental Data → Model Development → Model Results

2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 2.3.2, pg. 17.

Environmental Data: Bridging SFI

- Area under the receiver-operator-characteristics curve (AUC)

  - 5-fold cross validation

  - Bold number indicated better performing model

- Overall the combined gear models had better or the same AUC compared to the trawl only models

Taxa	EBS		GOA		AI	
	combined (camera + trawl)	trawl only	combined (camera + trawl)	trawl only	combined (camera + trawl)	trawl only
Coral	**0.97**	0.95	**0.91**	0.83	**0.78**	0.72
Sponge	**0.84**	0.84	**0.80**	0.80	**0.72**	0.72
Pennatulaceans	**0.94**	0.93	**0.80**	0.75	**0.88**	0.81
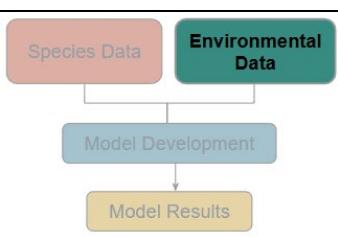
2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 2.3.8.1, pg. 29.

Environmental Data: Structure-Forming Invertebrates
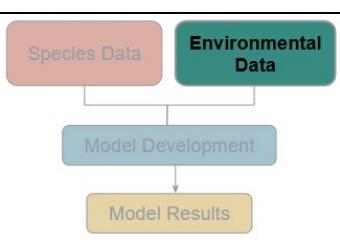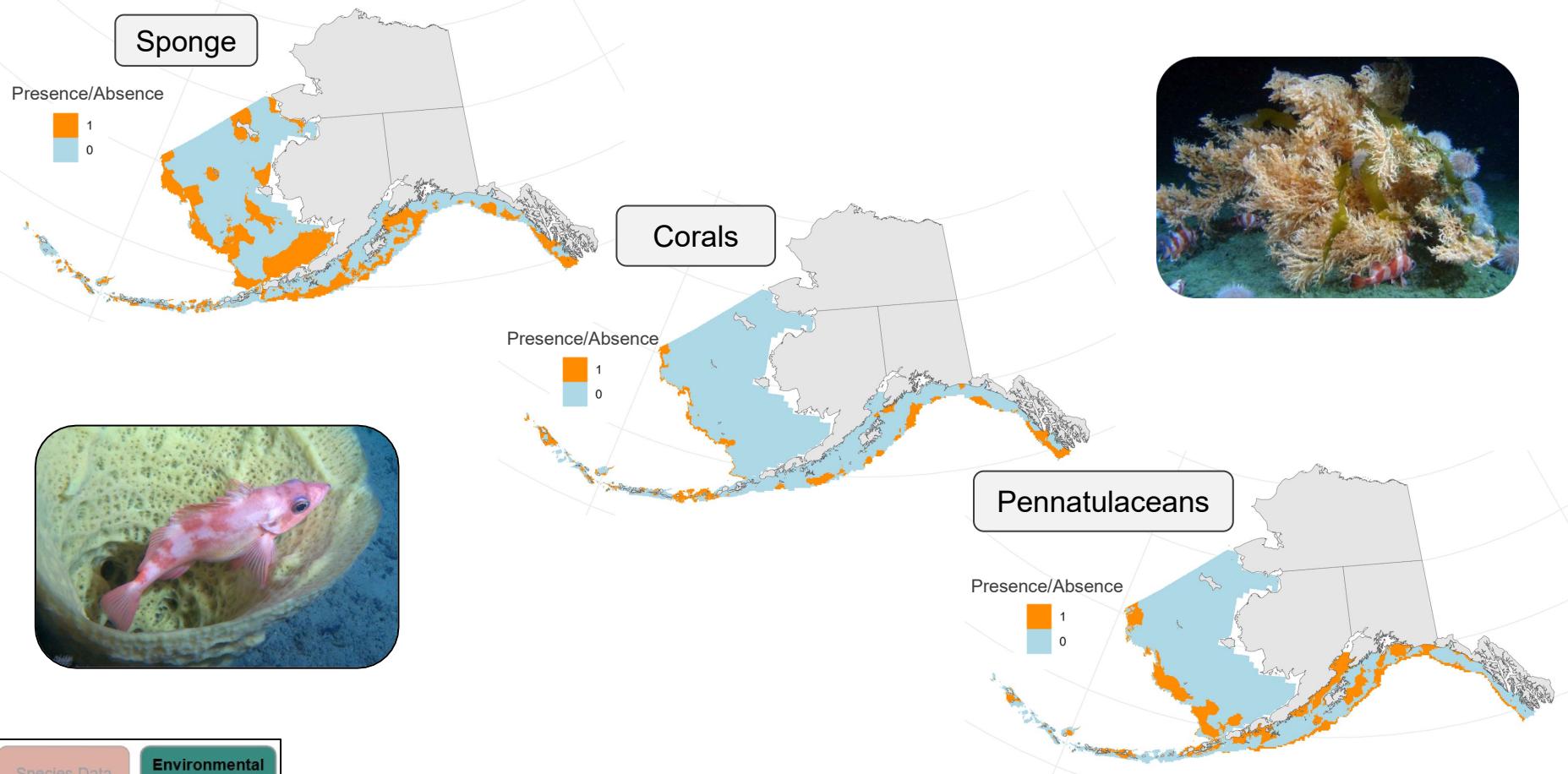
Sponge

Presence/Absence
- 1
- 0

Corals

Presence/Absence
- 1
- 0

Pennatulaceans

Presence/Absence
- 1
- 0

Species Data | **Environmental Data**

Model Development

Model Results

Predicting EFH

- Occupied habitat: probability under a Poisson distribution of encountering one or more fish at location: $P(x > 0) = 1 - e^{-\lambda}$

- Level 2 EFH = the upper 95% area of occupied habitat
  - Subareas: upper 75% (principal), 50% (core), and 25% (hotspot)

- Level 3 EFH = (occupied habitat) * (temperature-dependent vital rates)
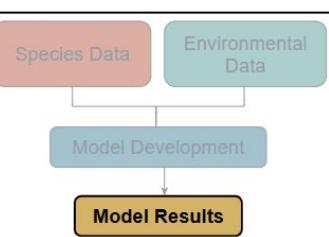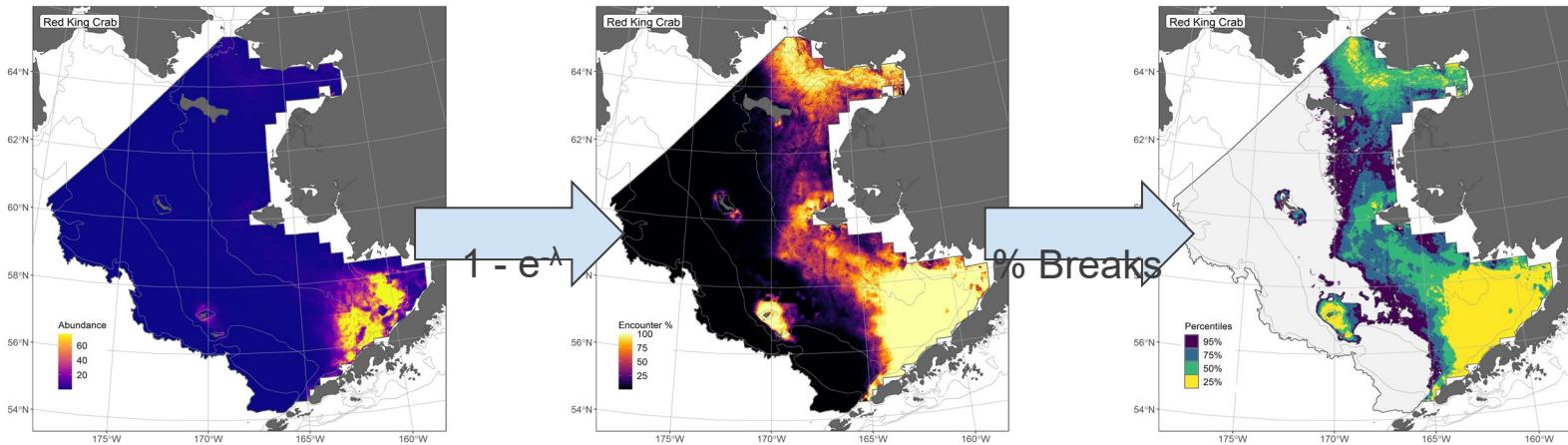
2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 2.4, pg. 36.

STMs: Response and Covariates

- **Method: sdmTMB**
    - Static and Dynamic covariates
    - tweedie distribution, log link, & effort offset
    - Spatial effects
    - Spatiotemporal effects
   - Spatially-varying coefficient (SVC)

$$\log(\mu_{s,t}) = \boxed{f_1(D_{s,t})} + \boxed{f_n(X_{s,t})} + \boxed{\log(k)_{s,t}} + \omega_{s,t} + \epsilon_{s,t} + (P_t \cdot \gamma_s)$$

Static   Dynamic   Effort

Species Data   Environmental Data

Model Development

Model Results
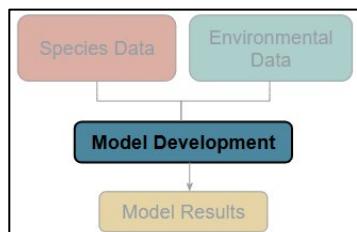
2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 2.5, pg. 37.

STMs: Spatial and Spatiotemporal Fields

SPDE

Spatial Effect
- 1.0
- 0.5
- 0.0
- -0.5
- -1.0
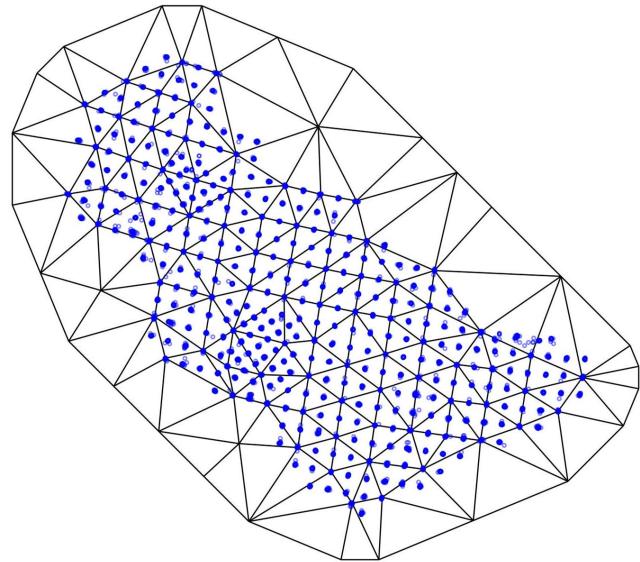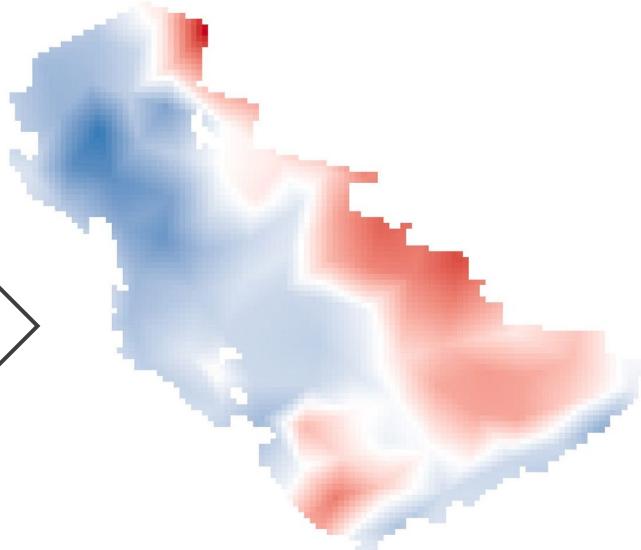
$$\log(\mu_{s,t}) \; = \; f_1(D_{s,t}) \; + \; f_n(X_{s,t}) \; + \; \log(k)_{s,t} \; + \; \boxed{\omega_{s,t}} \; + \; \boxed{\epsilon_{s,t}} \; + \; (P_t \cdot \gamma_s)$$

Spatial   Spatiotemporal AR(1)
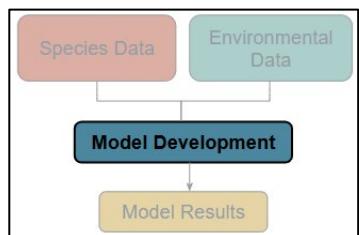
Species Data   Environmental Data

Model Development

Model Results

2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 2.5, pg. 37.

STMs: Spatially-Varying Coefficient (SVC)

- **Cold Pool Extent (km²)**
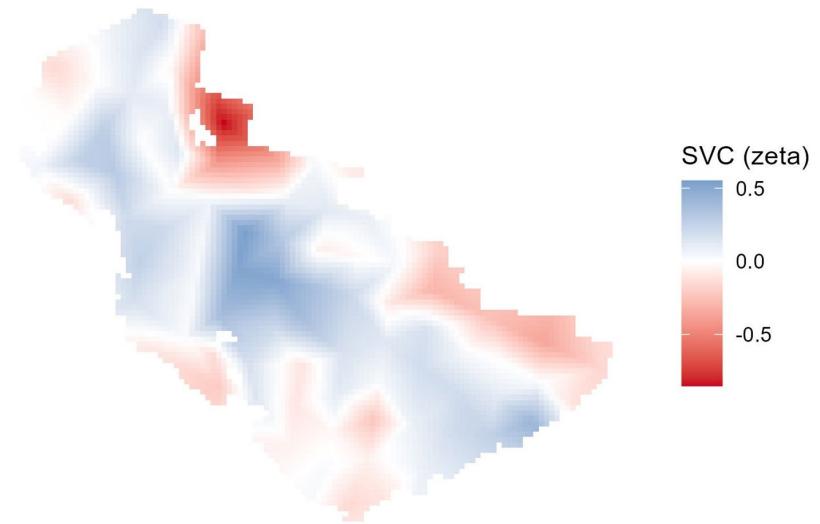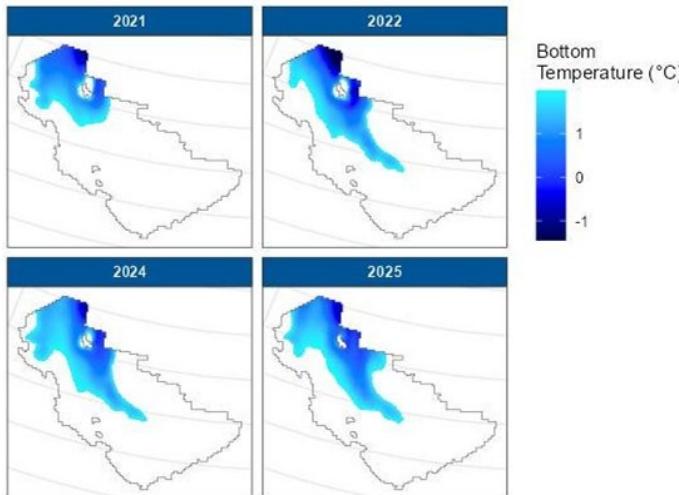
$$\log(\mu_{s,t}) = f_1(D_{s,t}) + f_n(X_{s,t}) + \log(k)_{s,t} + \omega_{s,t} + \epsilon_{s,t} + \boxed{(P_t \cdot \gamma_s)}$$

SVC
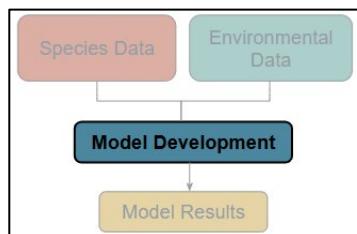
2028 EFH 5-year Review Description and Maps Methods Discussion Paper - section 2.5, pg. 37.

Fishing Effects (FE) Model Resources

- Peer-review published report on the FE model: Smeltz et al. (2019)

- Infographic presented during the June 2025 meeting r.e., pelagic trawl

  - 4 page infographic that explains the modules and applications of the model including and outside of the EFH 5-year reviews

  - Linked under agenda item C3 in the eAgenda

D3 EFH 5-year Review Fishing Effects Methods - section 1.3, page 5 has documents incorporated by reference for more resources

# Proposed: Incorporate Coral and Sponge SDMs

Habitat Module Input

Research in development:

- Incorporate coral and sponge SDMs to better characterize distribution of long-lived organisms
- Methods may not be ready for the 2028 EFH Review work plan timeline
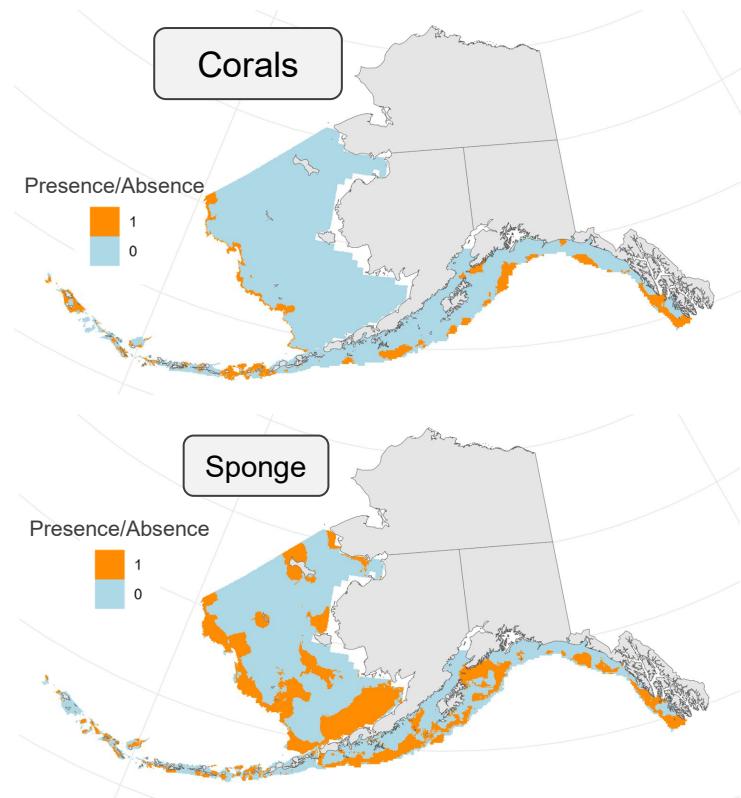
SDMs in preparation for C1 (slides 36-38)

D3 EFH 5-year Review Fishing Effects Methods - section 2.1.3, pg. 11.

FE Evaluation Workflow: Step 3

- Overlay FE model results with updated ensemble SDM EFH maps:

  Example of results - GOA adult Pacific ocean perch time series and map