DRAFT Report of Stock Assessment Author Review of Essential Fish Habitat (EFH) Components 1 and 7 for the 2022 EFH 5-Year Review

November 2021

This draft report was prepared ahead of the November 2021 Joint Groundfish Plan Team meeting. It explains the stock assessment author review process of essential fish habitat (EFH) component 1 (EFH descriptions and identification) and component 7 (prey species) documents. The stock assessment authors did species or species complex-specific reviews of:

- Current EFH text and tables in the Fishery Management Plans,
- Maps from the 2017 EFH 5-Year Review to compare to the new species distribution model maps,
- Draft species distribution model ensemble methods sections, and
- New species distribution models in draft species results chapters, which include text, model results, and maps.

This draft report summarizes the communications between stock assessment authors and EFH analysts receiving and responding to comments, questions, and critiques. This draft report details the changes made to the component 1 information based on the stock assessment author review. This is a work in progress and a final version the NMFS will present to the North Pacific Fishery Management Council's Scientific and Statistical Committee February 2022

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1. INTRODUCTION

This report details the comprehensive and iterative process that NMFS used to review the essential fish habitat (EFH) descriptions and identification for the 2022 EFH 5-Year Review. Since the 2017 EFH 5-Year Review, NMFS has worked to improve the EFH descriptions and identification in the eastern Bering Sea (EBS), Aleutian Islands (AI), and Gulf of Alaska (GOA). This document describes EFH components 1 and 7, discusses the new information developed for EFH component 1, and the review of components 1 and 7 by stock assessment authors (hereafter stock authors or SAs) at this stage of the iterative EFH 5-Year Review process.

1.1 Essential Fish Habitat Overview

Essential fish habitat (EFH) is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (50 CFR 600.10). The EFH Final Rule requires that the National Marine Fisheries Service (NMFS) and Fishery Management Councils (Councils) describe and identify EFH for managed species, minimize to the extent practicable the adverse effects of fishing and other anthropogenic activities on EFH, and identify actions to encourage the conservation and enhancement of EFH. As part of this mandate, EFH text descriptions and maps are necessary for each life stage of species in a Fishery Management Plan (FMP) (EFH component 1, descriptions and identification) (50 CFR 600.815) with an overarching consideration that the science related to this effort meets the standards of best available science (NMFS National Standard 2 – Scientific Information 50 CFR 600.315).

The North Pacific Fishery Management Council (Council) described EFH for its FMPs in 1999 with an environmental assessment that also outlined human-induced effects on EFH. In 2000, a legal challenge of the EFH provisions nation-wide resulted in a reevaluation of EFH information by all Councils. In 2005, the Alaska Region and Council completed a more comprehensive EFH description and effects analysis in an environmental impact statement (EIS).

Councils and NMFS are required to review the ten EFH components of FMPs and revise or amend EFH components based on available information at least every 5 years (50 CFR 600.815(a)(10)). The six Council FMPs are:

- Groundfish of the Bering Sea and Aleutian Islands Management Area (BSAI FMP)
- Groundfish of the Gulf of Alaska (GOA FMP)
- Bering Sea/Aleutian Islands King and Tanner Crabs (Crab FMP)
- Scallop Fishery off Alaska (Scallop FMP)
- Salmon Fisheries in the EEZ off Alaska (Salmon FMP)
- Fish Resources of the Arctic (Arctic FMP)

The Council conducted its first 5-Year Review and updated its EFH information for all six FMPs in 2010 (77 FR 66564, 11/06/2012). Updates included several species descriptions, where these earlier descriptions of EFH in Alaska were identified by the Council as the distribution of species life stages and maps based on survey results and observed catch. The Council concluded its second EFH 5-Year Review in 2017 and updated EFH information for five FMPs (83 FR 31340, 7/05/2018, Simpson et al. 2017).

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For the 2022 Review, NMFS and the Council are evaluating the EFH components in the Council's FMPs. NMFS has prioritized the seven EFH components in bold for a comprehensive review:

1. **EFH descriptions and identification**
2. **Fishing activities that may adversely affect EFH**
3. Non-MSA fishing activities that may adversely affect EFH
4. **Non-fishing activities that may adversely affect EFH**
5. Cumulative impacts analysis
6. **EFH conservation and enhancement recommendations**
7. **Prey species list and locations**
8. Habitat Areas of Particular Concern (HAPC) identification
9. **Research and information needs**
10. **Review EFH every 5 years.**

A comprehensive review of each of the seven EFH components prioritized by NMFS and the Council will be presented to the Council in a summary report at the conclusion of the review in October 2022(T). If the Council chooses to update its FMPs based on the report, FMP amendments will be prepared along with the appropriate analytical documents through the normal Council process.

1.2 Component 1 EFH Descriptions and Identification

Component 1 descriptions and identification of EFH consists of written summaries, tables, and maps in the FMPs or appendices. The EFH regulations provide an approach to organize the information necessary to describe and identify EFH (50 CFR 600.815(a)(1)(iii)). When designating EFH, the Council should strive to describe and identify EFH information in the FMPs 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.

1.2.1 2017 EFH 5-Year Review

A new approach to develop stock-specific habitat information for EFH component 1 was developed for the 2017 EFH 5-Year Review that used species distribution models (SDM) to describe and map the habitat-related distribution and abundance for individual species in the Council's FMPs, including many species of groundfish in the BSAI and GOA FMPs and crabs in the Crab FMP, where data existed for egg, larval, juvenile, and adult life history stages in four seasons. SDM results were provided as text and maps that described and identified the attributes and location of EFH. The SDM EFH approach of the 2017 Review is discussed in detail in the 2017 EFH Summary Report (Simpson et al. 2017), three NOAA Technical Memos. (Laman et al. 2017, Turner et al. 2017, Rooney et al. 2018), and a peer-reviewed publication (Laman et al. 2018). New information was also reviewed for the Salmon FMP that included quantitative

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model-based maps (Echave et al. 2012) and for the Arctic FMP that included maps of species distribution from surveys (Simpson et al. 2017).

As an outcome of the 2017 Review, the Council adopted SDMs to describe and identify EFH (Laman et al. 2018) and updated EFH information levels and maps for species life history stages (Simpson et al 2017). EFH maps for North Pacific Council managed species are available on the Alaska and National EFH Mappers. The SDM developed during the 2017 Review resulted in more quantitative, precise descriptions and identification of EFH in the Council's FMPs, and met the recommendations in the MSA to use the best available scientific information to define EFH.

1.2.2 2022 EFH 5-Year Review

The Alaska EFH Research Plan was revised following the 2017 EFH Review (Sigler et al. 2017). The revised plan provided two-specific research objectives to advance EFH information for Alaska in the intervening 5 years leading up to the 2022 EFH Review:

1. Develop EFH Level 1 (distribution) or Level 2 (habitat-related densities or abundance) for life stages and areas where missing.
2. Raise EFH information from Level 1 or Level 2 to Level 3 (habitat-related growth, reproduction, or survival rates (i.e., vital rates)).

NMFS AKR and AFSC funded several studies to accomplish Alaska EFH Research Plan research objectives. New research and new or revised *EFH Level 2 and 3* information from four in-progress studies will be available to the Council and NMFS for the 2022 EFH Review—

Laman et al. (*in prep*) is developing new SDM EFH information and maps using new and existing data and modernized SDM methods (e.g., ensemble models) for life stages of groundfish and crabs in the Bering Sea, Aleutian Islands, and Gulf of Alaska, advancing the SDM approach 2017 EFH Review (*new EFH Levels 2 and 3*).

Marsh et al. (*in prep*) is developing new SDM EFH information and maps for life history stages of Arctic cod (Boreogadus saida), saffron cod (*Eleginus gracilis*), and snow crab (*Chionoecetes opilio*), presenting Arctic SDM EFH maps for the first time (*new EFH Levels 2 and 3*).

Copeman et al. (*in prep*) is a multi-year, integrated study with field, lab, and SDM components that is measuring and mapping habitat-related vital rates for juvenile walleye pollock (*Gadus chalcogrammus*) in the Gulf of Alaska (*new EFH Level 3*).

Shotwell et al. (*in prep*) is a novel application of biophysical individual-based models (IBM) to describe and map EFH for groundfish pelagic early life history stages with case studies of sablefish (*Anoplopoma fimbria*) and Pacific cod (*Gadus macrocephalus*) in the Gulf of Alaska (*new EFH Levels 2 and 3*).

This body of work is innovative and inclusive of many contributors who are developing new habitat-related distribution, abundance, and vital rates for Council managed species in the GOA, Bering Sea, AI, and Arctic.

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The Laman et al. (*in prep*) study was funded by NMFS AKR and AFSC to advance the SDM EFH approach of the 2017 Review, using a modernized SDM ensemble approach with updated new and existing data sources and life history information that has become available since the 2017 Review for species in the BSAI and GOA Groundfish and Crab FMPs. This study has assessed the forecasting accuracy of the 2017 SDM approach for describing EFH (Laman et al. 2018), refined the modeling approach, and updated the data sources. EFH in this present work is represented as life stage-specific and spatially-explicit population percentiles predicted from an ensemble of best-performing constituent SDMs modeling groundfish and crab species across up to three life stages per species in the Aleutian Islands, EBS, and Gulf of Alaska. To achieve this, the EFH analyst –

- expanded the SDM approach from the 2017 5-year EFH Review to include up to five constituent SDMs (three SDMs were assessed in 2017 and a single SDM selected *a priori* was applied to each species life stage) in an ensemble and refined our methodology by modeling numerical abundance instead of transformed catch-per-unit-effort (CPUE) and by using the lowest cross-validated root mean square error (RMSE) to identify the best fitting models;
- incorporated new sources of response data and demonstrated this for the settled early juvenile life stage in the GOA (e.g., nearshore survey data, Grüss et al. 2021 - AFSC Nearshore Fish Atlas updated in 2019);
- updated several independent predictor variables (e.g., survey-dependent bottom temperature observations);
- enhanced existing data sets (both response and predictor variables) with recent survey results (von Szalay and Raring 2018 - summer bottom trawl surveys 1993–2019); and
- extended EFH to include a critical ontogenetic habitat transition by separately accounting for, and when possible modeling, groundfish settled early juvenile life stages.

In general, SDMs were revised for species where maturity schedules or life stage definitions were recently updated. This study is also one of the first to map EFH Level 3 (habitat-related vital rates), demonstrating an approach for a subset of species in all three regions modeled.

These four studies contribute new EFH component 1 information for the 2022 Review and modernize the species distribution model (SDM) EFH approach from the 2017 Review and extensions and will provide—

- **New EFH Level 2 and 3** descriptions and maps for life stages of groundfish in the Gulf of Alaska, Bering Sea, and Aleutian Islands for the GOA and BSAI FMPs.
- **New EFH Level 2** descriptions and maps for crabs in the Bering Sea and Aleutian Islands for the Crab FMP.
- **New EFH Level 2 and 3** descriptions and maps for pelagic early life history stages of sablefish and Pacific cod in the Gulf of Alaska, including eggs, larvae, and pelagic juveniles for the GOA FMP.
- **New EFH Level 2 and 3** descriptions and maps for Arctic cod, saffron cod, and snow crab life history stages for the Arctic FMP.

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The 2022 EFH 5-Year Review is an iterative review process. During the course of the 2022 Review to date, the studies contributing new information for EFH component 1 have been reviewed by the SSC, Plan Teams, and stakeholders. Authors have incorporated feedback from each of these meetings into the work products for component 1. The SSC in June 2020 and the Joint Groundfish Plan Teams (JGPTs) in September 2020 provided input regarding study methods, progress to date, and planned research products to support the new EFH component 1 information for the 2022 Review (Pirtle et al. 2020)[1]. The 2022 EFH 5-Year Review Plan was presented to the SSC in April 2021, when the Laman et al. (*in prep*) study took the opportunity to respond to the SSC and Plan Team input received in 2020 with an update on methods and revised draft results examples. The 2022 EFH 5-Year Review Plan was also presented to the Crab Plan Team Meeting in May 2021 and included draft SDM ensemble results examples for crabs. As the Council process is public, materials provided for review to the Council bodies have also been available to the public and valuable public testimony was received at each meeting.

NMFS then conducted an iterative SA review of the new SDM ensemble draft methods, results, and EFH maps (Laman et al. *in prep*). The details of this process are discussed in Chapter 2 and the results are discussed in Chapter 3 of this Report.

Additionally, EFH component 2, fishing activities that may adversely affect EFH, will use the EFH maps generated under component 1. The SSC will review this information at the February 2022 meeting when the fishing effects analysis planned for the 2022 Review will also be presented. SAs will also review and conduct an analysis to assess the effects of fishing on EFH for their stocks once the Fishing Effects Model has been run with the new SDM ensemble EFH maps for EFH component 2 (Spring 2022).

In addition to supporting our EFH mandates, the new species-specific habitat information presented for the 2022 EFH 5-Year Review can be extended to stock assessment and other ecosystem-based fisheries management (EBFM) efforts for our region. The Ecosystem and Socioeconomic Profiles (ESP) in the Stock Assessment and Fishery Evaluation (SAFE) Reports include species distribution models (SDMs) developed for EFH component 1 in the 2017 EFH 5-Year Review (Laman et al. 2018) and GOAIERP (Pirtle et al. 2019) (e.g., GOA walleye pollock (Shotwell et al. 2019)). Recent studies have also applied these SDMs to develop stock-specific indicators for the ESPs (Shotwell et al. *in review*), and to test hypotheses about groundfish recruitment processes in the Gulf of Alaska (Goldstein et al. 2020), and spatial-temporal stock structure in the Bering Sea under future climate scenarios (Rooper et al. 2021) and through new dynamic SDMs (Barnes et al. *in prep*). Several milestones of the Alaska EBFM Roadmap Implementation Plan (NMFS 2018)[2] reference actions related to habitat science and EFH. In these examples, information and SDMs developed for EFH are extended in a meaningful context to further support fishery and ecosystem management in our region.

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[1] Discussion Paper on Advancing Essential Fish Habitat Descriptions and Maps for the 2022 5-Year Review: https://www.npfmc.org/efh-distribution/

[2] Alaska EBFM Roadmap Implementation Plan

1.3 EFH Component 7 Prey Species

FMPs should list the major prey species for the species in the fishery management unit and discuss the location of prey species habitat (EFH component 7; 50 CFR 600.815(a)(7)). For the 2022 EFH Review, SAs had the opportunity to review and recommend updates to the prey species information text and tables for the managed species' life history stages in the FMPs. A goal for the next EFH 5-Year Review is to identify and evaluate data gaps so new information can be developed to include descriptions and maps of key attributes of prey species distribution and habitat types for the Gulf of Alaska and Bering Sea and Aleutian Islands groundfish and crabs.

2. STOCK AUTHOR REVIEW PROCESS FOR EFH COMPONENTS 1 AND 7

Review by SAs and stock experts is a critical element of the iterative EFH 5-Year Review process and serves to strengthen the evaluation. SA recommendations in their review are based on new information and the guidance of National Standard 2 and the EFH Final Rule to describe EFH based on the best scientific information available at the highest level of detail possible (50 CFR 600.815(a)(1)(iii)(B)). This report is for the SA review of information for EFH components 1 and 7.

For the 2017 Review, each SA was asked to review current FMP EFH component 1 information for each species or species complex for which they have responsibility. SAs were asked to review and update, if appropriate, EFH text descriptions, EFH levels, habitat association tables, habitat-related life history information that also included prey of EFH species (component 7), and the list of literature. SAs were provided with the new SDM maps developed for the 2017 Review and compared the new maps to the old maps from the 2010 EFH Review. Following the SA review of EFH components 1 and 7, SAs were provided output from the Fishing Effects model and asked to evaluate the effects of fishing on their stocks following a method developed during the 2017 Review for EFH component 2 fishing activities that may adversely affect EFH. This information was summarized and presented to the Plan Teams and the Council.

The 2022 Review provided an opportunity to improve on the process of the 2017 Review of EFH component 1 and 7 review by the SAs. NMFS started the SA Review with a workshop in January 2021 and will conclude the process by presenting the SA review report to the SSC in February 2022. Improvements to the process in this (2022) cycle included reaching agreement with SAs regarding the timing of the document review period (achieved in the January 2021 workshop) and access to both Methods and preliminary Results in their review. This chapter details the SA review timeline and the SA review methods. The results of the SA review are in Chapter 3.

2.1 Stock Author Review Process Timeline

This section provides a detailed timeline of the SA review of components 1 and 7.

January 2021: NMFS AKR and AFSC EFH analysts and senior stock assessment scientists convened a summit of SAs with the following goals—

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1. Inform SAs of the 2022 EFH 5-Year Review process, tools in development to provide new EFH component 1 (descriptions and identification) and component 7 (prey species) information for their stocks, and their role.
2. Reach a shared understanding and agreement on what is required of SAs for EFH components 1 and 7 of the 2022 EFH 5-Year Review and their evaluation process.
3. Establish a timeline for SA review that accommodates their annual stock assessment cycle.
4. Discuss the connections between EFH components 1 and 7 research and stock assessment.
5. Identify opportunities to strengthen our work products to support shared management needs.

Outcomes of this meeting include the presentation of the goals listed above, discussions about how to achieve the goals, and co-development of an approach and timeline for the 2022 Review SA review of these two EFH components. Agreement was reached on the timeline to coordinate review of EFH results with existing stock assessment workload (review window from May - September 2021). Agreement was also reached on the content of the review which (an extensive expert peer review of the new component 1 information).

April 2021: A paper describing the 2022 EFH 5-Year Review Plan was presented to the SSC and Council. The paper described the ten EFH components, work related to the components and the FMPs, and what types of new information will be included in the EFH 5-Year Review summary report. The SSC highlighted the importance of SA review in their minutes from April 2021: "*The SSC considers consultation with assessment authors to be a critical link in evaluating model configuration and output, and was pleased to hear the EFH team was involving assessment authors early in the EFH review process.*"

May 2021: The 2022 EFH 5-Year Review Plan was presented to the Crab Plan Team in May 2021, which included SDM ensemble methods and preliminary results for crabs. The presentation also introduced the opportunity for the Crab Plan Team members to participate in the review process as stock experts, in partnership with the SAs. All species except for Tanner crab ended up having at least two reviewers to offer edits, updates, and suggestions. This SA-stock expert partnership was new for this review and offered more opportunities for feedback. The Crab Plan Team requested that the crab SAs and experts receive the EFH components 1 and 7 review materials first to accommodate the timing of the crab stock assessments. The EFH analyst team agreed and provided crab SDM EFH results chapters for SA review in May 2021.

May to September 2021: The agreed upon SA author review period was from May to September 1. New EFH component 1 information was provided to the SAs for their review, revisions, and recommendations.

In May, we provided all SAs with

- excerpts of the current FMP text, tables, and literature for their species,
- the 2017 EFH maps for comparison with the new EFH maps, and
- the draft SDM ensemble EFH methods sections.

From May through July, we provided each SA and stock expert with complete drafts of their species results chapters to review, as each chapter was complete and the model results were available.

We received comments back on nearly all of the chapters we sent out for review by the agreed upon deadline of September 1.

This approach allowed for a comprehensive and meaningful expert peer review, which greatly improved this body of work for the 2022 Review and the process overall.

September 2021: The JGPT meeting was an opportunity for the EFH component 1 analysts to circle back with the SAs following their review of the present EFH component 1 information in the FMPs and the new SDM ensemble EFH descriptions and maps. At this meeting, the EFH analysts summarized the SA reviews received as well as the analysis team's responses to concerns and questions from the SAs.

EFH analysts communicated at the meeting that they would be following up with ALL SAs who expressed concern over model performance in their reviews to further communicate the updated model performance metrics, revised results for their species, and to address other concerns if needed.

EFH analysts communicated at the meeting that they would revise the SDM ensemble EFH methods and species results chapters and share those with all of the SAs should they be interested in seeing the chapter revisions prior to the SSC February Meeting when the full set of revised methods, results, and comparisons with 2017 would be shared with the SSC and stakeholders.

October 2021: The SSC reviewed the JPT September Meeting report, which included the JPT's report on the EFH presentation. The SSC provided additional guidance on component 1 that NMFS is in the process of incorporating into this report and into the materials for the SSC in February.

November 2021: The JGPT meeting is an opportunity to have a conversation with the Joint Groundfish Plan Team and share the final stages of the EFH components 1 and 7 review by the SAs prior to the next stage of the 2022 Review process with the SSC in February 2022.

2.2 Stock Author Review Methods

We provided each SA the current FMP text and 2017 maps, the tables from the FMP, SDM ensemble methods, and the new draft SDM technical memo chapters and resulting maps. We provided a detailed instruction and guidance document for this review to SAs at the beginning of the review period. The SAs had an opportunity to review information for EFH components 1 and 7 between May and September 1, 2021. The SAs either reviewed documents through a Google Drive folder system or email. As a note on process, some SAs found emailed documents easier or more accessible than the Google Drive system.

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We provided instructions to the authors as follows for each of the documents under review:

Current FMP Text and 2017 Maps

- Update necessary information for life history, habitat, and prey components, as well as supporting literature that is relevant to management, including research in development.
- Compare the new EFH maps provided in the new draft species results chapters to the 2017 EFH maps and offer comments or input.

FMP Tables

- Review the FMP tables for your species and provide any suggested species-specific changes to those summary tables.

NEW SDM EFH Introduction, Methods, and Results Chapters & Maps

- Review the new component 1 information, including study Introduction and Methods, new SDM results, SDM abundance and uncertainty maps, and EFH percentiles maps provided as preliminary, species-specific results chapters. An outcome of this SA review will be the production of NOAA Technical Memoranda by RACE-GAP survey region (i.e., Aleutian Islands, Bering Sea, and Gulf of Alaska) incorporating SA revisions and suggestions as appropriate. Final methods for the new models with example results will be provided to the SSC by February 2022.
    - Our approach to develop the 2022 SDM ensemble EFH maps (prepared as a discussion paper and report for the SSC)[3, 4] was supported by the SSC (refer to SSC minutes from June 2020 and April 2021)[5, 6].
- Use any new information in the new draft species results chapters to inform recommendations to the FMP text and tables that could be useful in advancing EFH information levels for those species. New EFH information levels available for the 2022 Review include Level 2 and Level 3:
    - Level 2 EFH maps are the top 95% of numerical abundance predictions where the encounter rates were > 5% from an habitat-based ensemble developed for each species life history stage modeled for the 2022 Review.
        - Within the EFH map area are the shapes of the percentiles corresponding to the top 25% (EFH hot spots), top 50% (core EFH area), and top 75% (principal EFH area) of habitat-related, ensemble-predicted numerical abundance.
    - Level 3 EFH maps will be developed for a small set of species. Level 3 EFH maps of habitat-related vital rates (e.g., temperature-dependent growth potential) may be used to further interpret the Level 2 EFH maps of habitat-related abundance.

[3] Pirtle et al. 2020 to SSC (June 2020)
[4] NMFS 2021 to SSC (April 2021)
[5] SSC Minutes June 2020
[6] SSC Minutes April 2021

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- Additional guidance provided: new EFH maps were developed for the 2022 Review for demersal groundfish (early juvenile, subadult, and adult) and crab species (all life stages combined) where possible in the summer season. New EFH maps were not developed for the other seasons (fall, winter, spring) or for pelagic early life history stages (pelagic juvenile, larvae, egg) during this EFH 5-Year Review.
    - The 2022 5-Year Review has produced 25 new EFH maps for species/regions that did not have maps in 2017.
    - An exception is that new IBM-based EFH maps are in development for pelagic early life history stages of GOA Pacific cod and sablefish (Shotwell et al. *in prep*).

2.3 Analysis of Stock Author Input

Once SAs and stock experts had completed their reviews of the documents listed in Section 2.2 above, they were asked to inform the analysts and to provide any additional input either through a shared document or via email. We recorded the comments received, as well as our responses to those comments. The summary of this back-and-forth communication forms the body of Chapter 3.

Overall, we are very appreciative of the engagement by the SAs and stock experts in their reviews, and, in particular, when additional communication was required to address their concerns. Some SAs and stock experts raised concerns in their reviews. These concerns included model performance and sources of data, both the data included in the analyses and data with the potential to be included in future analyses. The EFH analysts engaged with the SAs in further communications to address these concerns. Due to the timing of events this fall (i.e., the SA review deadline was September 1, 2021 and the September JGPT meeting was held the week of September 20, 2021), much of our (EFH analysis team) communication with SAs has taken place between the September JGPT meeting week and the present (November 1, 2021 at the time of this writing).

We responded to SAs and stock experts who communicated concern about the SDMs or EFH maps either through collaboration and replies in shared documents, through emails, or in conversations between reviewers and analysts. As indicated above, we have saved those communications for future reference and summarize the outcomes in this Report. **When additional communication was necessary, we contacted the SA(s), providing them with revised model fit metrics, methods, and revised results for their species along with a request for a conversation or an email response that their concern had or had not been met.** In all cases, when the SA was able to respond, a positive resolution was reached. In some cases, the SA has not yet been able to respond at the time that this document is being drafted (November 1, 2021).

All of the SA authors who expressed concern over model fit/performance or confidence in EFH maps in their review of the draft methods and results were contacted by the EFH analysis team. In a limited number of cases (i.e., GOA Atka mackerel, Pacific sleeper sharks, GOA Other Rockfish), EFH analysts worked closely with the reviewing SAs to address their concerns with these species in the 2022 EFH Review. For GOA Atka mackerel, ensemble constituent SDMs

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were examined and the ensemble was revised and re-run. Pacific sleeper shark in Alaska and two species in the GOA Other Rockfish Stock Complex (darkblotched and yellowtail rockfish) did not have EFH maps in 2017. Due to concerns raised by the SA about SDM fits and data adequacy for these species, they were removed from consideration for the 2022 EFH Review. However, the EFH regulations require FMPs to include EFH description and identification for all fish species in the fishery management unit, even when there is limited data. The EFH analysis will work with SAs to develop EFH information for these species for the next 5 year review.

The EFH analysis team believes that this iterative process, and SA engagement in it, has strengthened the results to be presented in the 2022 EFH 5-Year Review.

3. STOCK AUTHOR REVIEW RESULTS

There were 30 SAs that reviewed the draft Introduction and Methods sections for the three study regions surveyed by the RACE-GAP bottom trawl team: GOA, EBS, and AI. They reviewed 125 draft species or species/stock complex chapters containing preliminary results during this round of the EFH 5-Year Review, with separate chapters for species in different regions (Table A.1 in Appendix A). Nearly every species or species complex had at least one SA review their information, though some species had two or more and there was overlap for some species with similar concerns across multiple regions. From their work, we tallied 443 basic edits, 126 clarifying questions, 189 constructive critiques, and 98 revisions provided to expand existing text (Tables A.2 - A.5 in Appendix A). We provide full tables with tallies for the species and regions in Appendix A.

Most SAs provided edits and comments on the new draft species results chapters, though the existing text and maps from FMPs had some engagement in many species reviewed as well (Table A.6 in Appendix A). The edits and comments to the new draft species results chapters will be incorporated in the three regional NOAA Technical Memorandum reports that are in preparation. Of the 60 unique species that made up the species and species/stock complexes in the EBS, AI, and GOA, models were re-run for 27. Some were re-run for the species across all regions and some model re-runs were limited to specific life history stages and regions. Some were re-run as a result of SA comments while others were a result of internal review. More information on model reruns will be included in the final SA Review Report. All new results were sent to SAs during the review process.

Of the information edited or updated in the existing FMP text documents, most of the focus was on component 1 descriptions and identification. In the next EFH 5-Year Review, a greater focus on updating component 7 prey species will make this SA and species expert review stronger. In particular, a goal will be updating existing Habitat and Biological Associations information in the FMPs and providing a separate prey species summary table for component 7.

Below we report the comments provided by SAs and stock experts and the responses from the analysts. A short list of common comments across species (section 3.1) will be followed by the full lists of regional and species-specific recommendations (sections 3.2 - 3.4).

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3.1 Summary of common recommendations across regions and species

This section has summarized versions of common concerns that were raised by several SAs and stock experts across different species. The EFH analysts address these repeated concerns with some common language before responding with species-specific answers. Species-specific responses and details were communicated with the SAs and are summarized in the following sections.

Designating EFH

- SA concern: How does NMFS and the Council designate what is 'essential' fish habitat?
    - General response: Essential Fish Habitat is designated based on the definition in the MSA: "Essential fish habitat (EFH) means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." For the purpose of interpreting the definition of essential fish habitat, NMFS published regulations further specifying that: "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle (50 CFR 600.10).

      Federal regulations at 50 CFR 600.815(a)(1) provide more detailed guidance on designating EFH for each species managed under an FMP. The regulations require that each FMP must describe and identify EFH for each life stage of the managed species. FMPs must identify the specific geographic location or extent of habitats described as EFH. FMPs must include maps of the geographic locations of EFH or the geographic boundaries within which EFH for each species and life stage is found.

      The Council designated EFH for the species under its FMPs with the 2005 EFH EIS (NMFS 2005). Since then, the Council, SSC, and NMFS have further refined how EFH is designated in the North Pacific with each 5 year review. Details on the current EFH designations are provided in the summary report for the last EFH 5-Year Review (Simpson et al 2017). Any changes to how the Council designates EFH based on this current review will be described in the summary report for this 5-Year Review.

- SA concern: Bering Sea crab SAs expressed concerns about the nexus between describing EFH regionally for a species that is managed on smaller, regional scales by stock (e.g., Bristol Bay red king crab).
    - General response: We welcome the interest of crab scientists to work with EFH analysts to assist in refining the crab EFH designations in the future. Our goal is to keep refining EFH information for species with each EFH 5-Year Review as the science and data available progresses over time. Note that in this 5-Year Review cycle, we will have new SDM EFH maps for snow crab in the Arctic

management area that combines the Chukchi and Beaufort Seas as well as new EFH maps for golden king crab in the Aleutian Islands and Bering Sea and for red king crab in the Aleutian Islands.

The EFH regulations specify that EFH must be designated and mapped by species (50 CFR 600.815(a)(1)(i).

Model Performance

- SA concern: Stock Assessment (SA) authors were concerned about apparent low ensemble fits in the first drafts of our results where we reported the single metric Spearman's R-squared.
    - General response: Thanks to SA review, we recognized that the single metric we reported was flawed and we have pivoted to reporting 3 traditional metrics (Spearman's rank correlation coefficient (***ρ*** or rho), area under the receiver-operator curve (AUC), and deviance explained based on the Poisson distribution (PDE)) which will provide a more comprehensive view of where the model performs well and where it does not. Due to concerns raised in some SA reviews of ensemble performance and identified by the EFH analyst team's own assessment of the draft results, the single performance metric presented in the preliminary results reviewed by SAs (Spearman's rank correlation squared, a.k.a. Spearman's R-squared) was re-evaluated and a set of three traditional fit metrics was presented at this meeting to replace the single, draft metric. The three metrics presented provide a more comprehensive evaluation of where the ensemble performs well and where it does not. Spearman's rho indicates how well the ensemble distinguishes between locations of high and low abundance, AUC indicates the ensemble's ability to discriminate between presence and absence locations, and the PDE provides a measure of how good of a job the ensemble does explaining deviance. Examples of the revised model performance metrics were presented to the JGPT in September 2021.
    - Performance metric rubric (now included in the revised methods):

      ρ (rho): <0.20 (poor), 0.21 – 0.40 (fair), 0.41 – 0.60 (good), 0.61 – 0.99 (excellent)

      AUC: <0.70 (poor), 0.71 – 0.90 (good), 0.90 – 0.99 (excellent)

      PDE: <0.20 (poor), 0.21 – 0.40 (fair), 0.41 – 0.60 (good), 0.61 – 0.99 (excellent)
- Details of communication between SAs and EFH analysts regarding model fit can be found in sections 3.2 (BSAI Groundfish), 3.3 (GOA Groundfish), and 3.4 (BSAI Crab).

Survey Data Use/Omission

- SA concern: Several SA authors communicated concern about relatively low numbers of catches used to describe EFH for some species. In some cases (e.g., shortraker rockfish, sablefish, shortspine thornyhead, ATF, and a few others), SAs communicated their suppositions that to augmenting RACE-GAP bottom trawl survey data from other sources

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(e.g., longline survey data, fishery-dependent data, or optical survey data) could provide more comprehensive and defensible EFH descriptions. In other cases, SAs communicated that using a low number of incidences to describe EFH over a large area could be cause for concern or for low confidence in the EFH extent described.

  - General response: SAs raised concerns in their reviews of particular species about the efficacy and value of including sources of data in addition to the RACE-GAP summer bottom trawl survey data used in our analyses. The RACE-GAP surveys collect data from locations in the study areas where the bottom trawl can be successfully deployed. Areas that are untrawlable or out of range of the RACE-GAP samplers (e.g., too deep) are underrepresented in the data we analyzed. In addition, seasonality is not represented in the RACE-GAP summer survey data. For species that reside in these areas not successfully trawled by the RACE-GAP survey (e.g., sablefish or shortraker rockfish), this lack of sampling is a concern when describing EFH. SAs and others communicated that there are other data, from both fishery-independent and fishery-dependent sources, which could augment the RACE-GAP summer trawl survey data and potentially improve the accuracy of species distribution modeling to support EFH descriptions. Combining data from disparate data sources is not a trivial analytical effort and was beyond the scope of the present EFH project. Our response to requests from SAs to include additional data at this time have been to highlight in text where we/they believe additional data could be helpful to more comprehensively describe species distribution and abundance, and to strongly recommend that research effort be expended in the next 5-year EFH Review to combine relevant data sets to model species distributions and describe EFH. SAs were invited to participate in the anticipation of this effort by submitting proposals to begin establishing methodology for combining disparate data sets for the species in question.

Life History

- SA concern: Some life history specifics (e.g., length at 50% maturity) were identified as needing updates during the SA review.
  - General response: The EFH analysis team was pleased to collaborate with SA subject experts and receive updated life history information. When an update was recommended, we integrated the updated life history information into new model runs of the SDMs and EFH maps.

3.2 Recommendations for BSAI Groundfish Species

This section has summarized conversations between SAs and EFH analysts regarding EBS or AI groundfish species. These comments and responses were either recorded through the shared Google folder system within the documents provided or captured through conversational follow-up emails after SAs had a chance to finish their initial review and look over any updates to the new draft species result chapters such as model fit metrics (as discussed in section 3.1 common recommendations).

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A description of the recommendations, comments, or constructive critiques that are tallied in the summary table (Table A.2 in Appendix A) is provided below for each individual species or species complex for which EFH is defined in the BSAI Groundfish FMP. Species that were reviewed with edits that are reflected in Table A.2, including references added, revisions provided, clarifying questions asked, etc., but did not include SA comments reported here are:

- ***Alaska plaice***
- ***Blackspotted/Rougheye rockfish complex***
- ***Flathead sole-Bering flounder complex***
- ***Northern rockfish***
- ***Octopuses***
- ***Pacific ocean perch***

Recommendations and responses:

Arrowtooth flounder
Comments for BSAI arrowtooth flounder were:

- We now use only data starting from 1992 in the BSAI arrowtooth flounder assessment. The survey crew did not have moderate confidence levels for arrowtooth flounder identification until 1992 in the EBS bottom trawl survey and so we do not use data from the earlier surveys. Given the large number of years over which the EFH model covers, this may not be a concern, but if the distribution of samples was really different in those earlier years this might cause some issues as the model might be showing locations where there were Kamchatka flounder instead of arrowtooth.
    - Response: This is a typo in citing the data analysis set date range and has been corrected. We are analyzing Kamchatka and arrowtooth flounder separately from 1992-2019 for this EFH review. We are not using data prior to 1992 in these analyses for these two species.
- Adult arrowtooth are commonly caught on the longline survey and the IPHC survey. It might be worth including in a future update since the slope bottom trawl survey might not happen for a while.
    - Response: It would be interesting to include other data sources for many species, but will likely be the focus of data poor species in the next review and may be less of an issue for data rich species like arrowtooth flounder.
- There seems to be a low number of data points for several decades of surveys for Aleutian Island early juvenile arrowtooth flounder. These maps might be misleading for this life stage.
    - Response: In the next EFH Review we would like to expand the combined survey data approach taken for GOA early juveniles (i.e., incorporating additional data sources) to the EBS and AI regions and a goal is to develop the methods to do that within the ensemble framework.

EFH analysts communication summary:

- EFH analysts addressed remaining concerns in species chapter revision as the SA indicated in previous communication that there was not an immediate concern or need for additional discussion.

Atka mackerel

Comments for BSAI Atka mackerel were:

- The results are not meaningful given the lack of data and lack of fit in the models.
    - Response: We realized, thanks to this review and others, that our application of the Spearman's R-squared was flawed and that providing a single metric for an ensemble of multiple models was insufficient to comprehensively describe ensemble performance. In the revisions of the Methods and Results under development for all regions modeled (EBS, AI, and GOA), we have replaced the Spearman's R-squared with model performance metrics rho, AUC, and deviance to provide a more comprehensive view of model performance. See section 3.1 common recommendations for more.
- There is a general concern for these maps and the GOA Atka mackerel maps when it comes to extrapolating results from very few observations.
    - Response: We are recommending that a working group should be formed to revisit and potentially revise scientific guidance for any thresholds applied in EFH mapping and the fishing effects analysis and to provide this guidance to the SSC ahead of the 2027 5-year EFH Review. The current SSC guidance used for the 2017 and 2022 EFH 5-Year Reviews was that N > 50 species occurrences was a sufficient threshold for developing an SDM EFH map (e.g., Laman et al. 2017).

Further communication:

- EFH analysts contacted the lead SA to let them know that the model performance metrics for this species had been updated and that a plan was in process to investigate improving the Atka mackerel ensemble models by e.g., removing a model constituent. The SA was invited to have a conversation.
- EFH analysts contacted the SA again to share a document with the updated model performance metrics and results for all regions (AI, EBS, GOA), suggested an alternative EFH map for GOA adult Atka mackerel based on a revised ensemble, and provided a response to the larger concerns shared (above) in the review.

EFH analysts communication summary:

- As a follow up, EFH analysts asked for confirmation that their efforts were an improvement that helped address the SA's concerns to the extent possible as offered by the EFH analysts at this time. The SA was also informed that the revised Atka mackerel EFH NOAA Technical Memo chapters (AI, EBS, and GOA) and the final version of this report with detailed comments/responses would be shared with them when available before the February 2022 SSC meeting. The SA was invited to have a conversation and, if unavailable to meet, requested to let the EFH analysts know if the information provided has helped address their concerns.

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- Note: See GOA Atka mackerel for the comments/responses from the follow-up communication between the EFH analysts and the SA, upon sharing the revised Atka mackerel results for all regions.

Greenland turbot & Kamchatka flounder
Comments for BSAI Greenland turbot were:

- The R-squared values are fairly low for Greenland turbot and Kamchatka flounder life history stages. Is there a standard for what constitutes a reasonable model fit/R-squared value for these types of models?
    - Response: We are pivoting from the single metric of Spearman's R-squared to a tripartite view of model performance utilizing rho, AUC, and deviance to provide a more comprehensive view of model performance. For example, for Greenland turbot and Kamchatka flounder, using the 3 metric approach, the models are all "good" performers though they would've been classified as "fair" under the previous Spearman's R-squared rubric we presented in the first draft of results.
- How is "total deviance" calculated?
    - Response: "Total deviance" was a confusing term. It is the percent contribution of the covariate to the deviance explained by the ensemble. A more appropriate term would be "explained deviance" or "deviance explained by the ensemble". These revisions were incorporated into the draft species results chapters.

Further communication:

- EFH analysts shared the updated model performance methods and results for the EBS Greenland turbot and Kamchatka flounder due to concerns raised about model fit in the review of these species.

EFH analysts communication summary:

- As a follow up, EFH analysts asked for confirmation that their efforts were an improvement that helped address the SA's concerns to the extent possible as offered by the EFH analysts at this time. The SA was also informed that our detailed responses to all of their comments would be provided in a summary report of the SA Review of EFH component 1 and that the revised species EFH NOAA Technical Memo chapters would be shared with them when available before the February 2022 SSC meeting.
    - (*Awaiting SA response*)

Northern rock sole
Comments for BSAI northern rock sole were:

- A concern is that only data from 1996 onward were used because that is when northern and southern rock sole were identified separately. The Bering Sea is nearly all northern rock sole, not southern rock sole. The stock assessment includes data prior to 1996.
    - Response: Most of the rock sole in EBS are northern rock sole. There have been around 50 catches from the shelf of southern rock sole since 1996. These few

catches were insufficient to parameterize an SDM for southern rock sole EFH at this time. We have established a stanza of confident discrimination between these two species and are modeling northern rock sole since 1996 on this basis.

- Further SA comment: If EFH changed significantly, that would be interesting to explore whether northern rock sole habitat has changed over time as a separate issue from whether there were enough southern rock sole to change the EFH maps.
- Response: We attempted to model all southern rock sole catches as a single life stage in the EBS, but, even combined, there were insufficient catches (n<50) to parameterize an SDM.
- Note: AI southern rock sole are part of the other flatfish stock complex.

Further communication:

- The EBS and AI are thought to have few southern rock sole. The 2017 documents note that 95% of rock sole in the EBS are northerns. The stock assessment uses all the data, not just 1996 onward, so this is a disconnect between the SAFE and EFH.
    - Response: We acknowledge that there is a disconnect between the SAFE data set and the EFH data set where northern rock sole are concerned, but we are cautious combining multiple species into a single data set unless doing so to intentionally map a species complex. Modeling northern rock sole for EFH since 1996 offers more confidence of field distinctions being made between the two species and provides a high number of years included in the analyses (1996-2019) to mitigate concerns. However, it would be interesting to compare combined northern and southern rock sole SDM maps (1982-1995) to northern rock sole SDM maps (1996-2019) at some future date. For future consideration, we may look at the frequency of northern and southern rock sole catches in the EBS through time to determine if we could align our data set with the SAFE data set in the future.
- The SA noted some potential problems with length-based stage categories for GOA species (section 3.3). BSAI northern rock sole have also exhibited changes in growth over time. They noted that the length-based categories may introduce some effects that may need to be addressed in the next round of EFH.
    - Response: We are recommending that future EFH descriptions try to account for subregional growth and size-at-age differences for applicable species

EFH analysts communication summary:

- EFH analysts addressed remaining concerns in species chapter revision as the SA indicated in previous communication that there was not an immediate concern or need for additional discussion.

Other flatfish stock complex

The BSAI other flatfish stock complex is made up of the following species:

- ***Butter sole***
- ***Deepsea sole***

- ***Dover sole***
- ***Longhead dab***
- ***Rex sole***
- ***Sakhalin sole***
- ***Southern rock sole***
- ***Starry flounder***

Comments for the BSAI other flatfish stock complex were:

Dover sole

- Analyst note: SA comments about subregional growth differences for GOA Dover sole and GOA rex sole may affect EBS Dover sole.

Southern rock sole

- Could an error in the Aleutian Island subadult southern rock sole model be from an extreme covariate value, essentially extrapolating beyond the observed range?
    - Response: Due to an error in the length at maturity, the southern rock sole chapter was rerun. The problematic area is no longer present in the ensemble. This original problem appears to have been caused by the maxnet model, which was eliminated from the ensemble during the second run.

EFH analysts communication summary:

- EFH analysts addressed remaining concerns in species chapter revision as the SA indicated in previous communication that there was not an immediate concern or need for additional discussion.

Other rockfish stock complex

The other rockfish stock complex is made up of the following species for each region:

- *Dark rockfish*
- ***Dusky rockfish***
- ***Harlequin rockfish***
- ***Shortspine thornyhead rockfish***

In the EBS, only shortspine thornyhead rockfish merited an SDM and EFH map to represent the other rockfish stock complex. This is because, of the rockfishes that could contribute to EFH for the EBS other rockfish stock complex, only shortspine thornyhead was caught in sufficient prevalence (>50 catches) in RACE-GAP summer bottom trawl surveys (1982-2019) to parameterize a species distribution model (SDM). Dark, dusky, harlequin, and shortspine thornyhead rockfish represented the other rockfish stock complex in the AI, but dark rockfish did not have sufficient data for an SDM and EFH map. That said, the species-specific chapter detailing the shortspine thornyhead SDM EFH suffices as the proxy for the other rockfish stock complex in the BSAI at this time. Comments and notes for the other rockfish stock complex were therefore focused on shortspine thornyhead rockfish.

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- The EBS shortspine thornyhead rockfish SA addressed two common concerns: incorporation of the longline survey data and model fit.
    - Response: EFH analysts let them know that their suggestion to add longline survey data to the EFH mapping effort for slope species would be included in the future recommendations and that a "data caveat" statement would be added to the revised species results chapters indicating that including data from this additional survey may improve the SDM EFH descriptions and maps for these species. Model fit concerns were addressed in further communication between the SA and EFH analysts (see below).
- It might be helpful to state that shortspine thornyhead rockfish are not sampled on the EBS shelf and therefore haven't been sampled since 2016. I included this same comment in Fig 1 and 4 since it lists all surveys and the full 1982-2019 time series.
    - Response: There have been samples collected on the EBS slope survey from the EBS shelf in waters around 200 m deep which are also sampled on the EBS shelf survey (i.e., shortspine thornyheads could occur in shelf survey catches even though they haven't yet). However, the EBS shortspine thornyhead rockfish chapter will explicitly state that the slope survey hasn't happened since 2016 so technically only one more survey's worth of shortspine thornyhead rockfish presence data were added when the new SDM methods added 5 more years of survey data.

Further communication:

- EFH analysts shared the updated model performance methods and results for all of the SA's species in the BSAI and GOA FMPs (i.e., concern over model fit for the BSAI species).
- The SA raised concerns about the use of the EBS shelf survey for EBS shortspine thornyhead maps despite that species being rarely present in the survey. They offered, "While I acknowledge that zeros are data, it may be helpful for readers to know that results are dependent on the EBS slope survey that ended in 2016."
    - Response: There is now text in the chapter that emphasizes the point raised about shortspine thornyhead rockfish only being collected on slope surveys and most recently in 2016 (the most recent slope survey). While assessments focus on positive catches, this effort was interested in positive and zero catches to understand not only where species are, but where they are not. There is also text added to highlight our recommendation to include other data sources in the future (e.g., fishery dependent data or longline survey data). Adding these data in the future should provide better temporal coverage of shortspine thornyheads, and better spatial coverage of the other rockfishes in this stock complex.
- Other statements provided through correspondence with the SA included: Given that EFH is an iterative process, it would be helpful to see how EFH estimates have changed over time.
    - Response: We will be providing more detailed comparisons to the 2017 EFH SDMs at a later stage of this EFH 5-Year Review and we provided the extant

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(2017) maps in the FMPs for the most recent SA Review. Previous maps (for example from the 5-Year Review from 2010) are available as part of the public record, though were not included in the documents folders provided the SAs.

EFH analysts communication summary:

- As a follow up, EFH analysts asked for confirmation that their efforts were an improvement that helped address the SA's concerns to the extent possible as offered by the EFH analysts at this time. The SA was also informed that our detailed responses to all of their comments would be provided in this report and that the revised species EFH NOAA Technical Memo chapters would be shared with them when available before the February 2022 SSC meeting.
    - SA responded that their concerns about poor model fits for both stocks were satisfied through analyst communication. They offered, "Although I understand its challenges, I'm happy to hear this team will consider using the longline survey data for slope species in the future."

Pacific cod

Comments for BSAI Pacific cod were:

- What and where is the schedule of "poor", "good", "fair", and "excellent" fit when referencing Spearman's r-squared results
    - Response: This question is partly addressed by the comment on use of R-squared in section 3.1 above. With the three metrics used in the new methods, the rubric is:

      rho: <0.20 (poor), 0.21 – 0.40 (fair), 0.41 – 0.60 (good), 0.61 – 0.99 (excellent)

      AUC: <0.70 (poor), 0.71 – 0.90 (good), 0.90 – 0.99 (excellent)

      PDE: <0.20 (poor), 0.21 – 0.40 (fair), 0.41 – 0.60 (good), 0.61 – 0.99 (excellent)
    - Further response: This detail now also appears in the revised Methods sections being prepared for the NOAA Technical Memos.
- The definition of "growth potential" as used in the draft species result chapter is unfamiliar. As defined, it sounded more like population growth rate than "growth potential".
    - Response: This is a novel definition of "growth potential" where the population growth potential is considered since it is the spatially mapped product of ensemble-predicted abundance and temperature-dependent growth. It could be considered a type of population growth rate as well. As a result of this SA clarifying question, the section referring to "growth potential" was rewritten to indicate that the outcome is the result of the multiplication of growth rate and abundance rasters and that, given the definition of "growth potential", it was important to point out that for population growth potential to be high, high potential growth rates and high predicted abundance must coincide.

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Further communication:

- EFH analysts shared the updated model performance methods and results for BSAI Pacific cod (i.e., concern over model fit).

EFH analysts communication summary:

- As a follow up, EFH analysts asked for confirmation that their efforts were an improvement that helped address the SA's concerns to the extent possible as offered by the EFH analysts at this time. The SA was also informed that our detailed responses to all of their comments would be provided in the final version of this summary report and that the revised species EFH NOAA Technical Memo chapters would be shared with them when available before the February 2022 SSC meeting.
    - (*Awaiting SA response*)

Pacific sleeper shark

Comments for Pacific sleeper shark were:

- Only the slope survey has consistent catches in the EBS, and it's a small component of the species distribution. Also, the fishery distribution is much larger than that observed in survey data. For a more accurate distribution model, fishery data and surveys with higher catchability needs to be included for this species.
    - Response: After more conversations with the SA, the outcome is a shared agreement that Pacific sleeper shark EFH maps will not advance this cycle with an understanding that research should take place to include longline survey data in future EFH mapping efforts for this species. The SA will update the FMP text description. (Note: Pacific sleeper sharks did not have an EFH map in 2017.)
- The slope and shelf surveys are different gears, different catchabilities, and inconsistent time series.
    - Response: There is a future need to better equate the slope and shelf effort to more validly combine the two surveys. The methods for the SDM models describe combining distinct surveys (EBS shelf, EBS slope, and northern Bering Sea (NBS)) and also clarify that the surveys are jointly referred to as the EBS RACE-GAP bottom trawl survey in the EFH Review documents.

Further communication:

- EFH analysts shared the updated model performance methods and results for EBS Pacific sleeper sharks due to concerns raised about model performance in the review of these species. We also discussed options for this species where an EFH map had not been advanced in 2017 and future research recommendations.

EFH analysts communication summary:

- As a follow up, EFH analysts asked for confirmation that their efforts were an improvement that helped address the SA's concerns to the extent possible as offered by the EFH analysts at this time. The SA was also informed that our detailed responses to all of their comments would be provided in the final version of this summary report and that

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the revised species EFH NOAA Technical Memo chapters would be shared with them when available before the February 2022 SSC meeting.

- The SA appreciated the shared updates and found them helpful for understanding model performance more comprehensively for these species in the BSAI as well as the GOA.
- There was agreement that Pacific sleeper shark EFH maps would not be developed in any region for this EFH 5-Year Review. Pacific sleeper sharks also did not have an EFH map in 2017.
- The SA and EFH analysts recommend that research should take place to include longline survey data in future EFH mapping efforts for shark species.
- See also the GOA sharks summary (section 3.3).

Sablefish

Comments for BSAI sablefish were:

- The main concern was the lack of incorporation of the longline survey data. This concern was repeated for GOA sablefish in section 3.3. Sablefish, particularly adults, are not consistently surveyed by the trawl gear due to depth, habitat, and potentially tow speed limitations. The longline survey is designed explicitly to survey sablefish abundance. It seems like the inclusion of longline survey data would be necessary to adequately identify EFH for sablefish using SDMs.
    - Response: The addition of longline data is an appropriate inclusion for the next EFH review. We anticipate that in the next review trawl data could be combined with longline and pot data to give a more accurate picture of sablefish in Alaska. The inclusion of different data sources was a common concern across species (see section 3.1 for common recommendations and response).
- Consistency in summary descriptions across chapters would be useful not just to ensure consistent message, but also to reduce workload for authors and reviewers.
    - Response: We are taking the SA's advice and converging summary descriptions for sablefish (and other species) where possible. However, there are some regional concerns in many cases so that introductory paragraphs will require some customization.
- Some caveats to using the trawl survey data, particularly in the BSAI regions, are warranted. Mainly, the trawl gear does not always survey adult sablefish habitat (i.e., depths>500m) and adult sablefish might be able to outswim the gear.
    - Response: Caveats affecting confidence in EFH descriptions based on RACE bottom trawl survey data will be incorporated into our results chapters where appropriate as will taking note of any future recommendations to improve the models or outcomes. Also note that the Bering slope surveys which sample prime sablefish habitat are included in the present SDMs, ensemble, and EFH maps.
- The SA raised concerns about model fit and asked a clarifying question about the consistency of ranking model results for all regions.

- Response: The new model fit metrics should provide a more comprehensive view of model performance. This should help build confidence in the modeling approach with the given data, but will not mitigate the need for additional data indicated by comments about incorporating longline survey data. We have addressed consistently reporting model performance metrics among regional authors for the revised species results chapters and provided the revisions to the SA. See section 3.1 for the new performance metric rubric. This has also been addressed through better coordination among the writing team.

- It would be good to note the lack of genetic structure, wide distribution, and large scale movement capabilities along with management as a single resource in Alaska. Much of this is noted in the AI chapter, but not elsewhere. Mainly, I think it is important to identify that sablefish are widely distributed and so the EFH is really a large-scale issue not a regional issue.
    - Response: This is partly addressed through better coordination and the text has been altered to accommodate the suggested revisions. Note: EFH is described and mapped for targeted species (not stocks) in the fishery management units corresponding to the Fishery Management Plans (50 CFR 600.805(b)). There are regional introductions because the BSAI and GOA groundfish FMPs are regional.

EFH analysts communication summary:

- EFH analysts contacted the lead SA to share a document with the updated model performance results for all regions (AI, EBS, GOA), and provided responses to the larger concerns shared (above) in the review. EFH analysts asked for confirmation that their efforts were an improvement that helped address the SA's concerns to the extent possible as offered by the EFH analysts at this time. The SA was also informed that the revised sablefish EFH NOAA Technical Memo chapters (AI, EBS, and GOA) and the final version of this report with detailed comments/responses would be shared with them when available before the February 2022 SSC meeting. The SA was invited to have a conversation and, if unavailable to meet, requested to let the EFH analysts know if the information provided has helped address their concerns.
    - (*Awaiting SA response*)

Shortraker rockfish

Comments for BSAI shortraker rockfish were:

- In future iterations of the BSAI shortraker stock assessment, we plan to include the AFSC longline and potentially the IPHC longline survey data as additional indices in the random effects model since the longline surveys consistently catch shortraker in the AI. So in future versions of EFH models and maps can they include this data? Perhaps this data source is useful to mention here?
    - Response: We are including future recommendations in the results sections of the new NOAA Technical Memo chapters and will mention the intention for BSAI shortraker rockfish to include AFSC/IPHC longline survey data if possible. Incorporating other surveys into EFH models is a request for other species as well (see section 3.1 common recommendations and analyst responses).

EFH analysts communication summary:

- EFH analysts addressed remaining concerns in species chapter revision as the SA indicated in previous communication that there was not an immediate concern or need for additional discussion.

Skate complex
The BSAI skate complex is made up of the following species:

- ***Alaska skate***
- ***Aleutian skate***
- ***Bering skate***
- ***Big skate***
- *Leopard skate*
- ***Mud skate***
- ***Whiteblotched skate***

There was not sufficient data for a leopard skate SDM, though there are likely sufficient numbers to include the leopard skate in an ensemble map in the future. Comments for the rest of the BSAI skate complex were:

- The sections on the aggregate habitat modeling for skates were confusing due to the use of the term "other skates". In each area, "other skates" has a specific meaning from a management perspective (in the BSAI it is all species except Alaska skate; in the GOA it is all skates except for big and longnose skates). It is confusing to use "other skates" in a different context and the SA recommended just calling it the skate complex.
    - Response: Make certain that the region-specific members of "the skate complex" are listed in the introductory paragraph or a table and, once defined in the introductory paragraph, take SA's advice to use "skate complex" in the results sections to refer to the composite.

EFH analysts communication summary:

- EFH analysts contacted the SA and confirmed the species lists for the "skate complex" combined species maps are correct. Any other remaining concerns were addressed.

Walleye pollock
Comments for BSAI walleye pollock were:

- There is need for clarity on figure captions for the new maps in the draft species results chapter with phrases like, "top 10%", and which data is used.
    - Response: The figure caption language was reworded to more clearly describe what is top 10% and what is the remaining 90%. This will be a global change to the presence figures across all regions. E.g., "Distribution of settled early juvenile walleye pollock catches (N = 9,367) in 1982–2019 AFSC RACE-GAP summer bottom trawl surveys of the EBS shelf, slope, and NBS with the 50 m, 100 m, and 200 m isobaths indicated. Each circle on the map indicates where this species life stage was present in trawl catches; filled red circles indicate individual catches

with numerical abundance in the top 10% of all catches observed and open orange circles indicate catches with lower abundance."

EFH analysts communication summary:

- EFH analysts addressed remaining concerns in species chapter revision as the SA indicated in previous communication that there was not an immediate concern or need for additional discussion.

Yellowfin sole
Comments for BSAI yellowfin sole were:

- Rather than qualitative "good" or "excellent" consider expressing correlation quantitatively, such as "strongly positive".
    - Response: Since this quantity was the square of the Spearman's correlation coefficient stating the direction of the correlation is not indicated which is why we used a qualitative descriptor. Model performance is being measured by three fit metrics in the revised methods, so refer to the section 3.1 common recommendations for the performance metric rubric.
- The SA asked a clarifying question: Does "95% of locations" in the EFH figure caption refer to probability?
    - Response: No, this is the upper 95% of locations based on abundance predictions reduced by 5% encounter probability.

EFH analysts communication summary:

- EFH analysts addressed remaining concerns in species chapter revision as the SA indicated in previous communication that there was not an immediate concern or need for additional discussion.

3.3 Recommendations for GOA Groundfish Species

This section has summarized conversations between SAs and EFH analysts regarding GOA groundfish species. These comments and responses were either recorded through the shared Google folder system within the documents provided or captured through conversational follow-up emails after SAs had a chance to finish their initial review and look over any updates to the new draft species results chapters such as model fit metrics (as discussed in section 3.1 common recommendations).

A description of the recommendations, comments, or constructive critiques that are tallied in the summary table (Table A.2 in Appendix A) is provided below for each individual species or species complex for which EFH is defined in the GOA Groundfish FMP. Species that were reviewed with edits that are reflected in Table A.2, including references added, revisions provided, clarifying questions asked, etc., but did not include comments reported here are:

- ***Northern rockfish***
- ***Octopuses***
- ***Pacific cod***

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Recommendations and responses:

Arrowtooth flounder

Comments and suggestions for GOA arrowtooth flounder were:

- Edits provided for the EFH text descriptions in the FMP and the Habitat and Biological Associations Table.
- Clarifying question: what surveys were used?
    - Response: The surveys of mixed gear type are described in detail in the SDM methods section. Arrowtooth flounder early juvenile occurrence data used in the SDM were from the RACE GAP summer bottom trawl survey, ADFG small mesh bottom trawl survey, and nearshore bottom trawl surveys in the updated Nearshore Fish Atlas database. If helpful, we can report the surveys where the species' early juvenile data contributed to the SDM in the results sections.
- The AFSC longline survey and IPHC survey catch arrowtooth flounder with annual sampling in the GOA. Perhaps this information could be included in the next update?
- Response: This is a common concern raised across species (see section 3.1 common recommendations section for more). We will work on adding combined survey data to the SDM Ensembles for the next 5-Year Review. We will include a data caveat statement in the species results section to indicate that this additional survey data would likely improve the EFH maps for this species in the GOA.

EFH analysts communication summary:

- EFH analysts addressed remaining concerns in species chapter revision as the SA indicated in previous communication that there was not an immediate concern or need for additional discussion.

Atka mackerel

Comments and suggestions for GOA Atka mackerel were:

- Edits provided for the EFH text descriptions in the FMP and substantial updates were provided to the Literature Cited section.
- In reference to length-based life stage breaks: Female maturity-at-length and were determined for GOA Atka mackerel (McDermott and Lowe 1997). The age at 50% maturity is 3.6 years and the length at 50% maturity is 38.2 cm.
    - Response: Atka mackerel were re-run in all regions because we switched the subadult break from a reference where the value was based on the central and eastern Aleutians, to McDermott and Lowe (1997). This outcome came from the SA review.
- The SA addressed concerns of the model results. These concerns were also reflected with the BSAI Atka mackerel and discussion between the SA and analysts covered all regions.
    - Response: We are revisiting how model performance is reported and will revise this for the revised species chapters to provide a more comprehensive picture.

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(See also section 3.1 common recommendations and the BSAI Atka mackerel summary in section 3.2.)

- Note: See the EFH analysts further communication and summary for GOA Atka mackerel below for more information relating to model fit.

- Is there a threshold for the amount of data needed for running the models? This question was in reference to concern for low sample size for mapping subadult GOA Atka mackerel.
    - Response: The current threshold for inclusion in an SDM for EFH mapping is >50 hauls with individual occurrences (carried over from the SDM EFH approach from the 2017 5-Year Review). This concern was addressed through direct contact and discussion (see below in the EFH analysts further communication and summary for GOA Atka mackerel for more).
- In reference to the adult encounter probabilities map in the draft species results chapter: Recent survey data shows about a 25% chance of encounter (hauls with catch) in the Shumagin area since 2009 and the percent hauls with catch in the Chirikof and Kodiak areas are even less; the probabilities in the eastern GOA in this map are way more optimistic than the recent survey data. Why?
    - Response: In the EFH working group, we are tackling a lot of the same issues having to do with model fits, limited data sets, and how to assess the results. We will be working to achieve consensus around these issues and your comments will help us to focus our discussions and next steps.

Further communication:

- EFH analysts contacted the lead SA to let them know that the model performance metrics for this species had been updated and that a plan was in process to investigate improving the Atka mackerel ensemble models by e.g., removing a model constituent. The SA was invited to have a conversation.
- EFH analysts contacted the SA to share a document with the updated model performance results for all regions (AI, EBS, GOA), suggested an alternative EFH map for GOA adult Atka mackerel, and provided a detailed response to the larger concerns shared (above) in the review.
- EFH analysts provided the updated model performance metrics for Atka mackerel in all three regions, including the revised GOA adult ensemble with one constituent removed from the ensemble first draft. They included the following: in the revisions of the Methods and Results under development for all regions modeled (AI, EBS, and GOA), we have replaced the Spearman's r-squared with the more traditional Spearman's rank correlation coefficient (rho) and have added the area under the receiver-operator curve (AUC) as well as the deviance explained by the ensemble under the Poisson distribution (PDE). These three fit metrics interpreted together allow a more comprehensive interpretation of where the ensemble performs well and where it does not. Spearman's rho indicates how well the ensemble distinguishes between locations of high and low abundance, AUC indicates the ensemble's ability to discriminate between presence and

absence locations, and the PDE provides a measure of how good of a job the ensemble does explaining deviance.

    - SA response was positive.

- EFH analysts responded to concerns raised for the subadult SDM ensemble EFH map: that an N of 87 for subadults was not sufficient. They offered: We understand your concern. While 87 hauls with occurrences is a relatively low number, the overall ensemble performance for this life stage is decent (rho = 0.15 (poor), AUC = 0.91 (excellent), and PDE = 0.41 (good)), and the ensemble is doing very well discriminating between locations of presence and absence in the RACE GAP summer bottom-trawl survey area (i.e., AUC). SSC guidance for the 2017 EFH 5-Year Review was that N > 50 species occurrences was a sufficient threshold for developing an SDM EFH map (e.g., Laman et al. 2017). We have applied this species occurrence threshold to all species life stages modeled for the 2022 EFH 5-Year Review. Our approach to develop the 2022 SDM ensemble EFH maps was supported by the SSC.
    - SA response, raised continued concerns over sample size, while expressing understanding around use of the occurrence threshold.
        - EFH analyst response: Thank you for clearly explaining your concerns about describing subadult Atka mackerel EFH in the GOA (and for this species in general in the AI and EBS). We feel that it is important to provide this description as a first step to describing some portion of the EFH for this life stage and species in this region (e.g., EFH Level 1 "Distribution data are available for some or all portions of the geographic range of the species" (50 CFR 600.815(a)(1)(iii)(1)). We also agree that it is important to communicate concerns and caveats about model outcomes that are difficult to explain ecologically (i.e., in the revised species results chapters) and to start a conversation to determine how to continue to improve the EFH descriptions and maps for this species and others in the next EFH 5-Year Review.
        - EFH analyst follow-up: We are recommending that an expert working group should be formed to revisit and potentially revise scientific guidance for any thresholds applied in EFH mapping, the fishing effects model, and the fishing effects analysis of the EFH maps, and to provide this guidance to the SSC ahead of the 2027 5-year EFH Review. Please let us know if you have an interest in participating.
            - SA responded with interest in participating in the working group.
- The SA indicated disagreement that anywhere a species has ever been observed over the whole time period is relevant to EFH designations. They agreed that exploration of EFH over time and space is very important and it would be an interesting area of research to explore EFH over different time blocks representing different environmental conditions, and also regulations in place over the time series.
    - EFH analyst response: They explained the use of survey catch from 1993–2019 to model and map EFH is intended to map the long term distribution of the stock over a range of environmental conditions. We agree that this is a good area of

research to explore. We will add this to the future recommendations. They provided the following information: SSC noted (June 2020; April 2021) that EFH mapped at more temporally dynamic scales may be helpful to include in future EFH mapping efforts to identify potential species range shifts in fishery management areas under climate change. We agree and have a NMFS Office of Sustainable Fisheries funded project underway that develops methods to map and forecast EFH using dynamic environmental covariates and compares this approach to map and forecast EFH using the current static and long term approach (Barnes, Thorson, Pirtle, Rooper, Laman, Aydin, Holsman, Essington in preparation). In addition, this research need was included in the AFSC Regional Action Plans for Climate Science 2.0 for the EBS and GOA. Thank you for your input which will strengthen our approach to SDM EFH mapping for future EFH 5-Year Reviews. We hope that research will progress to be able to support these ideas.

    - SA response was positive.

EFH analysts communication summary:

- As a follow up, EFH analysts asked for confirmation that the SA's concerns were addressed to the extent possible as offered by the EFH analysts at this time. The SA was also informed that the revised Atka mackerel EFH NOAA Technical Memo chapters (AI, EBS, and GOA) and the final version of this report with detailed comments/responses would be shared with them when available before the February 2022 SSC meeting. The SA was invited to have a conversation and, if unavailable to meet, requested to let the EFH analysts know if the information provided has helped address their concerns.
    - Overall SA response (all regions): The SA offered appreciation for addressing concerns, improving EFH maps, and revising the Atka mackerel results chapters. They offered, "The new information and revisions provide much needed clarification and help in the interpretation of results from this update." They will have more comments for future updates and/or future research but approve this draft for the 2022 5-Year Review.
    - Note: See also BSAI Atka mackerel for the comments/responses from the follow-up communication between the EFH analysts and the SA, upon sharing the revised Atka mackerel results for the BSAI.

Blackspotted/Rougheye rockfish complex

Comments and suggestions for GOA blackspotted/rougheye rockfish were:

- The AFSC longline survey has a high encounter rate of rougheye and blackspotted rockfish and may be a useful data set in this context.
    - Response: The SA was assured their suggestion to add longline survey data to the EFH mapping effort for slope species would be included in the future recommendations and that a "data caveat" statement would be added to the revised species results chapters indicating that including additional data sources may improve the SDM EFH descriptions and maps for these species. See section 3.1 common recommendations for more.

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Further Communication:

- EFH analysts shared the updated model performance methods and results with the SA for all of their species in the BSAI and GOA FMPs (i.e., concern over model fit for the BSAI species).
- Other statements provided through correspondence with the SA included: Given that EFH is an iterative process, it would be helpful to see how EFH estimates have changed over time.
    - Response: We will be providing more detailed comparisons to the 2017 EFH SDMs at a later stage of this EFH 5-Year Review and we provided the extant (2017) maps in the FMPs for the most recent SA Review.

EFH analysts communication summary:

- As a follow up, EFH analysts asked for confirmation that their efforts were an improvement that helped address the SA's concerns to the extent possible as offered by the EFH analysts at this time. The SA was also informed that our detailed responses to all of their comments would be provided in this report and that the revised species EFH NOAA Technical Memo chapters would be shared with them when available before the February 2022 SSC meeting.
    - SA responded that their concerns about poor model fits for both stocks were satisfied through analyst communication. They offered, "Although I understand its challenges, I'm happy to hear this team will consider using the longline survey data for slope species in the future."

Deepwater flatfish complex

The GOA deepwater flatfish complex is made up of the following species:

- *Deepsea sole*
- ***Dover sole***
- *Greenland turbot*

Neither deepsea sole nor Greenland turbot presented sufficient data for SDMs. If possible they should have an EFH text description, which is a requirement of the MSA EFH Regulations. If information is not available, the Dover sole EFH text description can be used as a proxy. Comments for the GOA deepwater flatfish complex were therefore limited to Dover sole:

- The analysis shows the subadults' top 10% are offshore at the deepest depths, however the SA noted it looked suspect. Dover sole appear to have cohort-specific changes in maximum size/growth rates over time. The oldest cohorts have small size-at-age. They move ontogenetically, so the old fish are offshore as well. There is also smaller size-at-age in the eastern GOA as compared to the rest of the GOA. The length-stage definitions may therefore need to be revisited. The 2020 September Groundfish Plan Team documents presented research models addressing this.
    - Response: We are recommending based on SA comments that future EFH descriptions and maps try to account for subregional growth and size-at-age differences for applicable species, if possible.

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- Note: The SA raised that a similar problem may be happening for mapping rex sole. See the GOA rex sole section for more.

- The SA raised concerns similar to other species about model fit.
    - Response: See section 3.1 common recommendations on model fit. Specific to Dover sole, the revised model performance metrics were shared with the SA, and they were informed they will be provided with the revised methods and species results chapters when available.

Further communication:

- EFH analysts shared the updated model performance methods and results for GOA Dover sole (i.e., concern over model fit) and the future recommendation to address temporal and subregional growth differences for this species in a future EFH 5-Year Review.

EFH analysts communication summary:

- As a follow up, EFH analysts asked for confirmation that their efforts were an improvement that helped address the SA's concerns to the extent possible as offered by the EFH analysts at this time. The SA was also informed that our detailed responses to all of their comments would be provided in the final version of this summary report and that the revised species EFH NOAA Technical Memo chapters would be shared with them when available before the February 2022 SSC meeting.
    - (*Awaiting SA response*)

Dusky rockfish

Comments for GOA dusky rockfish were:

- The SA raised concerns similar to other species that GOA dusky rockfish may not be fit for these analyses given the sparsity of data and gaps in life history knowledge.
    - Response: While we won't be able to address data and life history gaps in this EFH 5-Year Review, we recommend that efforts be made to include additional survey data for this species, if possible, in the next EFH Review. See section 3.1 common recommendations on survey data use for more.
- The SA also raised concerns similar to other species about model fit.
    - Response: See section 3.1 common recommendations section on model fit. Specific to dusky rockfish, the revised model performance metrics were shared with the SA, and they were informed they will be provided with the revised methods and species results chapters when available.

Further communication

- EFH analysts shared the updated model performance methods and results for GOA dusky rockfish and the future recommendation to address survey data availability for this species in a future EFH 5-Year Review.
    - SA response: We will communicate future revisions of the 2022 GOA dusky rockfish EFH to the other author now working on this stock.

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        - EFH analysts responded by sending a document to the new SA with GOA dusky rockfish information in order to share what is planned to help address concerns raised by the first SA in this EFH 5-Year Review and asked for questions or comments.

- In response to reaching out to the second SA for dusky rockfish, analysts were able to have more discussions and opportunities to answer the following questions:
    - Why are fishery catches excluded from these analyses, particularly for species that are poorly represented by the survey.
        - EFH analyst response: Fishery observer data were used to model/map Fall/Winter/Spring in 2017 using a single presence-only MaxEnt model due to the nature of those data and the SDM approach to EFH at the time. In the present study, we focused our limited resources on updating the SDM approach and developed the ensemble methods that we are now using; demonstrating these to make new summer maps using the RACE GAP survey data. We will be recommending the development of methods to include other data sources (see section 3.1 common recommendations for more).
    - Have these EFH outputs been passed by the fleets/industry/stakeholders?
        - EFH analyst response: We agree that the fleet/industry/stakeholders have valuable insights and information that could be brought to bear to describe and map EFH. Our methods and draft results examples have been made available to the public through the SSC and Plan Team meetings at earlier stages of the Council's EFH 5-Year Review, which is an iterative review process. The updated methods and complete set of results for species in all regions will be available as NOAA Technical Memos in the near future and accompanied by a Discussion Paper with further comparative analysis and in depth examples provided for the subsequent stages of the Council process, including the February 2022 SSC meeting.
    - The second SA raised similar questions on model fit and the performance metric rubric, and sample size.
        - EFH analyst response: The SA was provided with information specific to dusky rockfish and an explanation of the performance metric rubric described in section 3.1 (common recommendations) on model fit (above). A recommendation that may come from this EFH 5-Year Review will be to revisit the previously established guidelines to describe and map EFH using SDMs and the related Fishing Effects model analysis and develop an objective set of potentially revised scientific guidelines ahead of the next EFH 5-Year Review. The SSC approved a minimum sample size of >50 species occurrences (e.g., hauls where the species was present) during the 2017 EFH 5-Year Review to support SDM-based EFH descriptions. The recommended guidelines research would examine whether this or another sampling adequacy cut off would be appropriate.

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- Carrying on concerns with sample size, is it appropriate to use a survey that poorly samples a species as the vehicle for determining EFH?
    - EFH analyst response: This is a fair question that can be answered with more research. We invite SAs and other researchers to submit proposals for research that would help to illuminate and answer questions of this nature. Note that EFH designations in the FMPs have two parts: the EFH text descriptions, meant to provide the best possible comprehensive overview of what is understood to be the EFH of each species, and the EFH maps, which identify the geographic locations of EFH for a species within the fishery management units of the FMPs. The MSA EFH regs provide that EFH can be defined based on ". . . some or all portions of the geographic range of the species." (50 CFR 600.815 (a)(1)(i)(iii)(1)), and so we start there and refine this with each 5-Year Review.

EFH analysts communication summary:

- As a follow up, EFH analysts asked for confirmation that their efforts were an improvement that helped address the SA's concerns to the extent possible as offered by the EFH analysts at this time. The SA was also informed that our detailed responses to all of their comments would be provided in the final version of this summary report and that the revised species EFH NOAA Technical Memo chapters would be shared with them when available before the February 2022 SSC meeting.
    - (*Awaiting additional SA response*)

Flathead sole

Comments and suggestions for GOA flathead sole were:

- Edits provided for the EFH text descriptions in the FMP with helpful editorial revisions and reference changes.
- The SA asked a clarifying question for EFH areas reported in the new draft species results chapter for subadult and adult flathead sole to understand if they were reached by multiplying relative weight by area then summing.
    - Response: It would be incorrect to interpret the ensemble area as a weighted average of the constituent areas. The ensemble abundance was calculated as a weighted average of the constituents, and then we recalculated the EFH map and area from that abundance. We will revisit how this step is described in the methods to see if we can state this more clearly.
- The SA also asked some clarifying questions regarding the new SDM maps which led to making caption described more clearly. For example, the SA asked what, "top 10% of overall abundance" had referred to in Figure 1: "Does this just mean the top 10% of observed catches? Or catches in the top 10% of predicted EFH?"
    - Response: That refers to the RACE GAP hauls in the top 10% of those with survey catches. We will clarify that in the caption for the early juveniles with combined surveys.

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EFH analysts communication summary:

- EFH analysts addressed remaining concerns in species chapter revision as the SA indicated in previous communication that there was not an immediate concern or need for additional discussion.

Other rockfish complex - Demersal sub-group
The other rockfish complex - demersal sub-group is made up of the following species:

- *Canary rockfish*
- *China rockfish*
- *Copper rockfish*
- ***Quillback rockfish***
- ***Rosethorn rockfish***
- *Tiger rockfish*
- ***Yelloweye rockfish***

Of the demersal sub-group other rockfish complex species, quillback rockfish, rosethorn rockfish, and yelloweye rockfish were the only ones with sufficient data for SDMs. Comments for those three species were:

Quillback and rosethorn rockfish

- Currently quillback or rosethorn rockfish are not mapped out for the GOA Southeast Outside (SEO) management area but, looking at ADF&G ROV data, their abundance is higher in the SEO than what the map is showing. The distinction is likely due to the fact that the ROV surveys are conducted closer to shore than what the bottom trawl survey can cover.
    - Response: The use of ROV survey data would make aid the maps and incorporation of additional data sources is a future recommendation for development. See section 3.1 common recommendations for more.

Yelloweye rockfish

- In regard specifically to yelloweye rockfish, ADF&G can provide additional data in regard to subadult presence locations from the Southeast Alaska (SEAK) ROV surveys from the SEO ADF&G management areas in the future. Additional data can be provided in regard to adult yelloweye presence locations from ADF&G.
- A question: why isn't juvenile habitat included in EFH designations and is it due to the size being too small to obtain in trawl surveys? ADF&G also documents juvenile locations in SEO SEAK ROV surveys.
- It would be helpful to see where the bottom trawl survey was conducted in relation to the documented presence points. Yelloweye rockfish abundance/presence may be higher in SEO than what the SDM map shows. This is a similar observation to the quillback and rosethorn rockfish maps.

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Complex chapter

- We (ADF&G) hope that the SSC considers including this updated EFH designation data for DSR (yelloweye, quillback, and rosethorn rockfish) for the future. They appear to be much more well defined than previous maps.
- Response: We will add a data caveat statement to the chapters about species availability to the RACE GAP survey. We will also make a future research recommendation to develop methods to combine survey data in the SDM ensemble framework to map EFH when helpful for certain species and life stages. The GOA DSR species EFH maps would be more comprehensive if the ADFG ROV survey data was also included.

EFH analysts communication summary:

- EFH analysts addressed remaining concerns in species chapter revision as the SA indicated in previous communication that there was not an immediate concern or need for additional discussion. We also thank ADF&G staff for review of new and current EFH information for the GOA demersal rockfish complex and providing helpful input.

Other rockfish complex - Slope sub-group

The other rockfish complex - slope sub-group is made up of the following species:

- *Aurora rockfish*
- *Blackgilled rockfish*
- *Boccacio rockfish*
- *Chilipepper rockfish*
- *Darkblotched rockfish*
- ***Greenstriped rockfish***
- ***Harlequin rockfish***
- ***Pygmy rockfish***
- ***Redbanded rockfish***
- ***Redstripe rockfish***
- ***Sharpchin rockfish***
- *Shortbelly rockfish*
- ***Silvergray rockfish***
- *Splitnose rockfish*
- *Stripetail rockfish*
- *Vermilion rockfish*
- *Yellowmouth rockfish*
- *Yellowtail rockfish*

Of the slope subgroup other rockfish complex species, greenstriped, harlequin, pygmy, redbanded, redstripe, rosethorn, sharpchin, and silvergray rockfish had sufficient data for SDMs. Originally darkblotched and yellowtail rockfish were also included and reviewed, but were removed on SA's advice due to too little data. Comments for the seven remaining rockfish were:

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Greenstriped rockfish

- There was a consistent concern across Other rockfish complex - slope subgroup species over low spearman's rho square values reported.
    - Response: This comment was included in each of the individual species chapters so, while we report it for greenstriped rockfish, the response is true for all species. We have revised our methods to assess and report model performance more comprehensively. We shared the updated methods and performance results for the GOA OR with you when we met to discuss a parth ahead on 09/28/21 given your concerns over the GOA OR and GOA sharks draft results (*discussion outcome reported below*).
- This is a pretty rare species in all surveys and fishery data. That said, it is pretty consistent, in small numbers, in the longline survey each year. The adult EFH map may be representative, but data are so sparse it is hard to judge. Looking at the IPHC data, it strongly suggests that this species is more southern and the GOA is the very extent of it's range, supporting these results.
    - Response: It is helpful when the SA can provide some ecological context for what the resulting SDM EFH maps are showing us (or not). It is also good to know that longline survey data may also be helpful for this species and other GOA OR complex species, which we will include as a future recommendation. We discuss the use of other data sources in section 3.1 common recommendations.

Harlequin rockfish

- Important point: harlequin rockfish not only associate with high relief habitat, but have high affinity, which really impacts survey catchability.
- Clarifying question: why did the 2017 EFH maps include spring, but not the new SDM maps?
    - Response: In 2017 they modeled summer with RACE GAP bottom trawl survey data (single SDM) and other seasons using fishery observer data with a single presence-only model. We were funded to advance the 2017 EFH maps by advancing the SDM methods using an ensemble approach and new data for the summer season. The other seasonal maps may also benefit from additional data sources if available in the combined survey data approach we would like to develop for the next EFH 5-Year Review. The other seasonal maps should be updated sometime.
- These maps seem reasonable, there are some model issues with such low model results and the high affinity for untrawlable habitat that need to be dealt with.
    - Response: We will include a data caveat statement in the species results chapters for harlequin rockfish and other species with similar behavior. Additional presence-absence data from underwater images would be a helpful addition to the SDM ensemble framework for species that associate with untrawlable habitat, if possible, in future mapping efforts. Research will be required from this recommendation to develop the combined survey data methods for the ensembles.

Pygmy rockfish

- The SA commented they would prefer all life stages combined into a single SDM for pygmy rockfish over the other considered method using a length-based break between subadult and adult life stages.
    - Response: We have revised the SDM ensemble to combine the subadult and adult life stages.
- With the poor model fits and the extreme data-limited it's hard to gauge how reasonable the EFH map is. Pygmy rockfish do not show up in the longline survey and are limited in the fishery, but the fishery data is mostly in NMFS area 630, which appears to agree with this map. I would be hesitant to advance this one.
    - Response: The revised ensemble combining both life stages (subadults and adults) is poor at distinguishing between locations with high and low abundance, excellent at discriminating between locations of presence and absence from the RACE GAP summer survey data, and fair at explaining deviance. (Qualitative values refer to the performance metric rubric as shown in section 3.1 common recommendations.) Revised ensemble performance for this species is fair and adding additional species survey data sources to future mapping efforts will be recommended as a possible improvement.

Redbanded rockfish

- Add a few sentences about how the survey catches both subadult and adults, and mention the frequency of catch. This is one of the better sampled species, relatively speaking. This species is really a longline species, with good sampling on both the IPHC and AFSC longline surveys. One common concern with a lot of these is that the catchability/susceptibility of a species to the survey gear is not discussed.
    - Response: We will add data caveat statements where appropriate to the revised species chapters based on your input. If you were able to provide us with a table of survey catchability values that would be very helpful, thank you.
- The SA advised a follow-up to the phrase, "should be used with some caution" for this and the other species in this complex. The follow-up should have a few sentences addressing the concerns about the data, catchability, etc.
    - Response: We are now being more comprehensive about adding data caveat statements to the revised species chapters and future recs for developing methods to combine survey data in the SDM ensembles well.
- The SA voiced concern about lack of data with this species as well.
    - Response: EFH Regulations for EFH Level 1 "Distribution data are available for some or all portions of the geographic range of the species." (50 CFR 600.815(a)(1)(iii)(1)). We provided the SA with revised ensemble results and, while the currently revised ensemble performance for this species is good, adding additional species survey data sources to future mapping efforts will be recommended. We also feel that it is important to include data caveat statements

in the results chapters and we will include a future recommendation to develop methods to combine survey data in the SDM ensemble framework.

Redstripe rockfish

- The adult map is supported by fishery data, however, the fishery data does not have sizes, so it is impossible to gauge sub-adults. I would guess that the sub-adult map is not quite accurate.
    - Response: Thanks for connecting the SDM ensemble EFH maps to your understanding of the fishery data. We provided model results from the revised ensembles (summer season) for both life stages (subadults and adult). Although currently ensemble performance for this species is good, following similar suggestions from the other species in this complex, we will recommend adding additional species survey data sources to future mapping efforts.

Sharpchin rockfish

- The SA asked a similar question about seasonal data, specifically data used for a spring map, that was also asked for harlequin rockfish.
    - Response: The other seasonal maps from 2017 (not summer) used fishery observer data. It is outside the scope of this study to update the other seasonal maps. However, the maps for the other seasons should be updated at some point and included in the effort to combine additional survey data to the extent possible in the SDM ensemble framework.
- This species is rarely caught by hook and line gears, so the bottom trawl survey is likely the best survey for this species. The model fits are poor, but on the scale of Other rockfish, not bad.
    - Response: Thanks for connecting the SDM ensemble EFH maps to your understanding of the ecology of this species and the fishery data, which is very helpful. Overall, ensemble performance for this species is good. The analysts supplied the SA with new ensemble performance metrics for review.

Silvergray rockfish

- The SA offered this species is also a good species to be represented with AFSC longline survey data. They noted silvergray rockfish are not a huge fishery bycatch species, but their distribution seems to match the adult map.
    - Response: This is a good candidate for adding longline survey data to future mapping efforts. We will add a data caveat for this species.

Complex Chapter

- The only caveat that has not been addressed in the complex chapter is that the trawl survey can't sample untrawlable habitat, which is primary habitat for one of the primary species in the complex (harlequin rockfish).

- Response: We have included data caveat statements in the revised species results chapters where needed e.g., for harlequin. Additional presence-absence data from underwater images would be a helpful addition to the SDM ensemble framework for species that associate with untrawlable habitat, if possible, in future mapping efforts. Research will be required from this recommendation to develop the combined survey data methods for the ensembles.

- Should the EFH text descriptions have references?
    - Response: Something will need to be provided more clearly this time in the FMP species complex chapters for the EFH sections. References are usually provided in the Life History sections.

Further communication:

- EFH analysts shared the updated model performance methods and results for the GOA other rockfish complex member species due to SA concerns raised about model performance in the review of these species. We also discussed options for species of concern where an EFH map had not been advanced in 2017, data caveats to report, and future research recommendations.
    - EFH analyst and SA shared response:
        - Updated model performance metrics were shared and discussed for GOA other rockfish complex, which was helpful and appreciated by theSA in understanding model performance more comprehensively for these species.
        - There was agreement that EFH maps for darkblotched and yellowtail rockfishes would not be developed for this EFH 5-Year Review. These species members of the complex also did not have an EFH map in 2017.
        - The SA and EFH analysts recommend that research should take place to include data from the longline surveys and underwater images from uncrawlable habitats in future EFH mapping efforts for these rockfish species.

EFH analysts communication summary:

- As a follow up, EFH analysts asked for confirmation that their efforts were an improvement that helped address the SA's concerns to the extent possible as offered by the EFH analysts at this time. The SA was also informed that our detailed responses to all of their comments would be provided in the final version of this summary report and that the revised species EFH NOAA Technical Memo chapters would be shared with them when available before the February 2022 SSC meeting.
    - Proceed based on agreements from further communication.

Pacific ocean perch

Comments for GOA Pacific ocean perch were:

- These maps may lead to a bit of over-confidence in what we actually know about distribution, in particular for the subadult/juvenile life stages. The SA wanted to make

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sure we identify and are aware of places where it might be overstating confidence in the models.

- Response: We agree with identifying loci where we may be overstating confidence in our model output and carrying that forward for future improvement.

EFH analysts communication summary:

- EFH analysts addressed remaining concerns in species chapter revision as the SA indicated in previous communication that there was not an immediate concern or need for additional discussion.

Rex sole

Comments for GOA rex sole were:

- Similar to notes for Dover sole size-at-age comment, rex sole may need to be revisited: there are a lot of subadults in the Eastern GOA where fish have smaller size-at-age. The stock assessment is actually a 2-area assessment with growth estimated separately by area for this reason.
    - Response: Thanks for pointing out these regional and temporal growth differences (i.e., rex sole, Dover sole, and possibly northern rock sole). We recommend that this be addressed in the next 5-Year Review cycle, if possible, as there is not time to dig into this well in the current cycle and it was not flagged as a concern in 2017. We invite the SA to participate in working through a revised approach for this species and Dover sole.

Further communication

- EFH analysts shared the updated model performance methods and results for GOA rex sole (although fit concerns were not raised in their review of this species) and the future recommendation to address temporal and subregional growth differences for this species in a future EFH 5-Year Review.
- EFH analysts note: We are recommending based on SA comments that future EFH descriptions and maps try to account for subregional growth and size-at-age differences for applicable species, if possible.

EFH analysts communication summary:

- EFH analysts asked for confirmation that their efforts were an improvement that helped address the SA's concerns to the extent possible as offered by the EFH analysts at this time. The SA was also informed that our detailed responses to all of their comments would be provided in the final version of this summary report and that the revised species EFH NOAA Technical Memo chapters would be shared with them when available before the February 2022 SSC meeting.
    - (*Awaiting SA response*)

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Sablefish

Comments for GOA sablefish were:

- The SA echoed comments and concerns between BSAI and GOA sablefish. See the BSAI responses to general sablefish comments (section 3.2).
- The main concern was the lack of incorporation of the longline survey data. Sablefish, particularly adults, are not consistently surveyed by the trawl gear due to depth, habitat, and potentially tow speed limitations. The longline survey is designed explicitly to survey sablefish abundance. It seems like the inclusion of longline survey data would be necessary to adequately identify EFH for sablefish using SDMs.
    - Response: There are several efforts in the works for combining disparate survey data into single species distribution models so we anticipate that in the next review trawl data could be combined with longline and pot data to give a more accurate picture of sablefish in Alaska. The inclusion of different data sources was a common concern across species (see section 3.1 for common recommendations and response).
- It might be worth some consideration of whether the trawl data is reliable enough for sablefish and/or the optics created by not incorporating the longline survey data.
    - Response: We will add a survey data caveat statement to the sablefish SDM ensemble results chapters. We will include as a future recommendation from the 2022 EFH 5-Year Review that longline survey data be included if possible in future SDM ensemble EFH mapping efforts for this species. Research will be required to develop methods to combine survey data sets in the SDM ensemble framework.
- Caveats about the use of trawl data to define EFH is warranted, especially since trawl gear does not necessarily consistently survey common habitat/depths of adult sablefish and it would also be good to mention potential use of longline survey data in the future
    - Response: I will add this data caveat statement and a footnote indicating the future recommendation for research to develop methods for a combined survey data approach for certain species within the new SDM ensemble framework that we are putting forth this year. Your review and others are emphasizing how important using more than just the RACE GAP bottom trawl survey data is to more comprehensively map EFH for slope and untrawlable habitat species.
- The SA asked a clarifying question about the early juvenile stage mixed gear SDM methods. They noted that other sablefish chapters do not use other gears and also emphasized the use of longline survey data.
    - Response: The regional methods were revised and shared with the SA. The sablefish early juvenile SDMs were presence-only (MaxEnt) models that combined RACE GAP bottom trawl, ADFG small mesh bottom trawl, Auke Bay Laboratory Nearshore Fish Atlas, holdings from small mesh nearshore trawls, beach and purse seines, and the MESA sablefish tagging program jigging catch locations. To combine survey data well to map EFH we need to develop combined survey/gear methods to be applied within the SDM ensemble

framework (e.g., with GAMs) that is new in the 2022 EFH Review for the subadult

- The SA asked a clarifying question about the consistency of ranking model results for all regions.
    - Response: We have addressed consistently reporting model performance metrics among regional authors for the revised species results chapters and provided the revisions to the SA. See section 3.1 for the new performance metric rubric.

EFH analysts communication summary:

- EFH analysts contacted the lead SA to share a document with the updated model performance results for all regions (AI, EBS, GOA), and provided responses to the larger concerns shared (above) in the review. EFH analysts asked for confirmation that their efforts were an improvement that helped address the SA's concerns to the extent possible as offered by the EFH analysts at this time. The SA was also informed that the revised Sablefish EFH NOAA Technical Memo chapters (AI, EBS, and GOA) and the final version of this report with detailed comments/responses would be shared with them when available before the February 2022 SSC meeting. The SA was invited to have a conversation and, if unavailable to meet, requested to let the EFH analysts know if the information provided has helped address their concerns.
    - (*Awaiting SA response*)

Shallow water flatfish complex

The shallow water flatfish complex is made of the following species:

- ***Alaska plaice***
- ***Butter sole***
- ***English sole***
- ***Northern rock sole***
- ***Southern rock sole***
- *Sand sole*
- ***Starry flounder***
- ***Yellowfin sole***

Additional "other flatfish" species are also included in this complex:

- ***Pacific sanddab***
- ***Petrale sole***
- ***Slender sole***

Not all species had comments that were substantial for reporting here or concerns raised are responded to for the entire complex, like model fit. Sand sole did not have 2017 documents to review or a new draft species results chapter. Comments for the shallow water flatfish complex were summarized for English sole, northern rock sole, and the overall complex:

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English sole

- In reference to life stage breaks, the study used to delineate stages focused on yellowfin sole and northern rock sole in the Bering Sea. Did you assume English sole and yellowfin sole had similar length stratification regarding subadults and adults?
    - Response: Yes, this is the best information that we could find to set length-based life history breaks for this species and clearly report that studies of similar species are being used as proxies until better life history information is available for this species. Similarly, we used a study of yellowfin sole, Alaska plaice, and flathead sole for distinguishing between subadults and adults as a proxy for English sole. We will clarify in these sections that this study of other flatfish species in Alaska is used as a proxy.

Northern rock sole

- Which models in the ensemble were applied to the mixed survey data, like the early juvenile life stage?
    - Response: The GOA early juvenile models are presence-only MaxEnt models, which we use as an approach to combine survey data and gear types for the GOA early juvenile life stage only in the study. We developed the SDM ensemble framework (MaxEnt and 4 types of GAMs) for the 2022 EFH 5-Year Review, which is an improvement over the single model approach of the 2017 Review. Combining survey data and gear types in the ensembles is beyond what we can accomplish with time and staff capacity now. We realize, thanks to your review and others, that combining survey data in the ensembles is needed for certain species and life stages and recommend research to develop this for the next EFH 5-Year Review.
- How representative is northern rock sole distribution prior to 1996 if northern and southern rock sole were separately identified consistently until 1996? Did you run models starting in 1996 to see if this impacted the model results? These questions apply to southern rock sole as well.
    - Response: Northern and southern rock sole were modeled separately (for all regions) using RACE GAP survey data from 1996-2019. These two species are combined in a presence-only model of the settled early juvenile life stages in the GOA, where earlier years sampled by the nearshore surveys are included.

Complex chapter

- Overall the SA raised questions for each of the species regarding model fit and sample size, and discussed the inclusion of some of the species in mapping.
    - Response: The revised model performance methods and results were shared with the SA with an explanation similar to what is reported in section 3.1 above. The EFH analyst shared, “Using the expanded approach to assess model performance, the results for GOA shallow water flatfish overall ensemble performance for each species life stage is considered ‘good’ for most and none are considered ‘poor’.”

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Further communication:

- EFH analysts shared the updated model performance methods and results for the GOA shallow water flatfish stock complex species due to concerns raised about model fit in the review of these species. Clarification was provided on the first survey year applied (1996) to model subadult and adult northern and southern rock soles as individual species in the GOA (and other regions).

EFH analysts communication summary:

- EFH analysts asked for confirmation that their efforts were an improvement that helped address the SA's concerns to the extent possible as offered by the EFH analysts at this time. The SA was also informed that our detailed responses to all of their comments would be provided in the final version of this summary report and that the revised species EFH NOAA Technical Memo chapters would be shared with them when available before the February 2022 SSC meeting.
    - (*Awaiting SA response*)

Shark complex
The GOA shark complex includes:

- ***Pacific sleeper shark***
- ***Spiny dogfish***
- *Salmon shark*
- *Other sharks*

Only Pacific sleeper shark and spiny dogfish were common enough in catches to support SDMs, so comments on the GOA shark complex are limited to those species.

Pacific sleeper shark

- The survey data applied to develop the SDM ensemble is inadequate to represent this species. It does not accurately represent the true distribution of the species, only the survey distribution, from one survey. It would be a misrepresentation of the species distribution to put this in an official EFH for the species.
    - Response: Through discussions with the SA and EFH analysts, there was agreement that Pacific sleeper shark EFH maps would not be developed for this EFH 5-Year Review.
    - SA note: It might be interesting to look at the spatial distribution of the lengths. While the survey is very poor for this species and not adequate for this type of modelling, the length data are useful.
- If this gets put forward, the SA suggested adding notes to the effect that this survey is ineffective for this species and specify other surveys that may provide more representative data. The SA suggested to change the wording from "with some caution" to "as a minimally informed SDM only showing a slice of the habitat used by the species" to hit the point home. The SA did not recommend putting this model forward.

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- Response: The model results were low values. Model fit concerns were partially addressed with the new metrics (see section 3.1 common recommendations), and through communication with the SA, Pacific sleeper shark EFH maps will not be developed for this 5-Year Review.

Spiny dogfish

- The SA offered edits including updating references and resources.
- The SA raised concerns about the model fit and noted it makes sense that the sub-adult dogfish would be the best fitting model because the trawl survey tends to get smaller dogfish.
    - Response: We are revisiting how we assess and report model performance and supplied the SA with new model metrics (see section 3.1 common recommendations).
- Making the phrase, "with some caution" more direct reiterate that this model is informed only by a survey that has poor catchability for this species and that other surveys may be more informative.
    - Response: Spiny dogfish results will be reported with a data caveat about use of bottom trawl survey data alone. There was more discussion summarized below.
- It makes sense that there would be some hotspots shown in the EFH maps, but not that there are none in the rest of the GOA.
    - Response: This is a good point. Currently, the ensemble model of predicted habitat-related abundance is an EFH Level 2 model and map. These models and maps are still in development, and we plan to find ways to improve in the future (e.g., add other surveys if possible in a GAM framework), and see offering some species/life stage maps as a helpful place to start. Here is the definition of EFH Level 1: "Distribution data are available for some or all portions of the geographic range of the species. At this level, only distribution data are available to describe the geographic range of a species (or life stage). Distribution data may be derived from systematic presence/absence sampling and/or may include information on species and life stages collected opportunistically. In the event that distribution data are available only for portions of the geographic area occupied by a particular life stage of a species, habitat use can be inferred on the basis of distributions among habitats where the species has been found and on information about its habitat requirements and behavior. Habitat use may also be inferred, if appropriate, based on information on a similar species or another life stage." Do you support putting forth EFH maps for the sharks as a place to begin in this 5-year EFH Review?
        - SA response: This is a place to start for Level 1 subadult spiny dogfish, and maybe for adults if the appropriate caveats are included in the text. For Pacific sleepers sharks, the data does not support it yet.

Complex chapter

- The SA asked a clarifying question that there was no text to review for the GOA shark complex from 2017.
    - Response: The GOA FMP has sparse text for the shark complex (and no individual species at all) to indicate that there is no EFH text description. There are also no EFH maps for GOA sharks and there was not enough data to make an SDM in 2017 so no EFH model and map were attempted. Now, there are more data, so an EFH model and map were attempted for both spiny dogfish and Pacific sleeper sharks. Working with the SA, we are in agreement that the spiny dogfish maps and text description should be developed for the 2022 EFH 5-Year Review.

Further communication:

- EFH analysts shared the updated model performance methods and results for the GOA shark complex species due to concerns raised about model performance in the review of these species. We also discussed options for species where an EFH map had not been advanced in 2017, data caveats to report, and future research recommendations.

EFH analysts communication summary:

- EFH analysts asked for confirmation that their efforts were an improvement that helped address the SA's concerns to the extent possible as offered by the EFH analysts at this time. The SA was also informed that our detailed responses to all of their comments would be provided in the final version of this summary report and that the revised species EFH NOAA Technical Memo chapters would be shared with them when available before the February 2022 SSC meeting.
    - EFH analyst and SA shared response:
        - Updated model performance metrics were shared and discussed for GOA sharks, which was helpful and appreciated by the SA in understanding model performance more comprehensively for these species.
        - There was agreement that spiny dogfish EFH maps will be developed for this EFH 5-Year Review for both subadults and adults in the GOA and the EFH text description will also be updated with current information by the SA. Spiny dogfish results will be reported with a data caveat about use of bottom trawl survey data alone.
        - There was agreement that Pacific sleeper shark EFH maps would not be developed for this EFH 5-Year Review. Pacific sleeper sharks also did not have an EFH map in 2017.
        - The SA and EFH analysts recommend that research should take place to include longline survey data in future EFH mapping efforts for shark species.
- EFH analysts do not need to develop a GOA Sharks Complex EFH map, as spiny dogfish are the only species mapped in this complex (see our new, proposed methods for mapping stock complexes as a proxy for unmapped member species).

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Shortraker rockfish
Comments for GOA shortraker rockfish were:

- The suggestion would be to add the use of the longline survey in the future. The SA added they would not expect the inclusion of that data to change the model results.
    - Response: We agree it would be very helpful to include the longline survey data in the SDM and this is a commonly requested data source to include for several species. We are sorting out how to include information from additional surveys as well as untrawlable habitat. See section 3.1 common recommendations for more.

EFH analysts communication summary:

- EFH analysts addressed remaining concerns in species chapter revision as the SA indicated in previous communication that there was not an immediate concern or need for additional discussion.

Skate stock complex
The GOA skate complex is made up of the following species:

- ***Alaska skate***
- ***Aleutian skate***
- ***Bering skate***
- ***Big skate***
- ***Longnose skate***
- *Whiteblotched skate*

There was not sufficient data for an individual whiteblotched skate SDM ensemble EFH map, Comments for the of the GOA skate stock complex were:

- Similar to the comment made for BSAI skates, the sections on the aggregate habitat modeling for skates were confusing due to the use of the term "other skates". In each area, "other skates" has a specific meaning from a management perspective. The SA recommended calling it the skate complex.
    - Response: We received confirmation from the SA that the species lists for the "skate complex" combined species maps are correct. See also the BSAI skate stock complex discussion.

EFH analysts communication summary:

- EFH analysts contacted the SA and confirmed the species lists for the "skate complex" combined species maps are correct. There were extensive editorial suggestions provided to the SDM Chapter, which will be addressed upon revision. Any other remaining concerns were addressed.

Thornyhead complex
The GOA thornyhead complex includes:

- ***Longspine thornyhead rockfish***
- ***Shortspine thornyhead rockfish***

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There was not sufficient data for a GOA longspine thornyhead individual species SDM ensemble EFH map. Comments for the complex and shortspine thornyhead rockfish were:

- Why was the longline survey data not used to assist with this analysis? The longline survey is now used in the random effects model, in addition to the trawl survey, to estimate the biomass of shortspine thornyhead.It also is more consistent in sampling this species.
    - Response: It would be very helpful to include the longline survey data in the SDM and we are tracking for which species this is requested. See section 3.1 common recommendations for more of the EFH analysts' response.

EFH analysts communication summary:

- EFH analysts addressed remaining concerns in species chapter revision as the SA indicated in previous communication that there was not an immediate concern or need for additional discussion.

Walleye pollock

Comments for GOA walleye pollock were:

- The SA offered edits and recommendations for updating the life history section.
- The methods for the new models only describe nearshore mixed gear-type surveys, which are mostly beach seines. The SA asked for clarification of which survey this is.
    - Response: The surveys were updated NMFS Auke Bay Laboratory Nearshore Fish Atlas beach seine and nearshore trawl data, and the ADF&G small mesh trawl survey. We also used RACE GAP bottom trawl survey data from hauls where this life stage was caught. In reference to the juvenile pollock mixed survey mapping, a paper used mixed nearshore only survey data from the updated Nearshore Fish Atlas to make some finer resolution and very nearshore SDM maps for pollock in SEAK and PWS (Grüss et al. 2021). Although this is not part of what is being put forward for the 2022 EFH Review, we hope that their approach will be a helpful starting place to mapping EFH for species and life stages in the nearshore (using combined survey data of mixed gear types) to be paired with the fishery management unit wide EFH maps in a future EFH 5-Year Review.
- The SA asked the relevance of lab results to pollock habitat in reference to the EFH Level 3 habitat-related vital rate methods/results.
    - Response: We will add a caveat sentence about the lab studies, however they are a helpful contribution and a good place to begin assessing these relationships with respect to EFH Level 3 information (habitat-related vital rates) and others.
- The SA also had several clarifying questions in regards to growth, temperature, and lipid accumulation data used for the EFH Level 3 habitat-related vital rate methods/results. They noted some relationships looked odd.
    - Response: A one size fits all approach to fitting the SDM ensembles is easiest with so many species life stages and limited staff capacity and time. However, we

are considering that in some cases a species specific approach might be warranted to get under the hood of some of the models and make adjustments to possibly improve the overall result.

EFH analysts communication summary:

- EFH analysts addressed remaining concerns in species chapter revision as the SA indicated in previous communication that there was not an immediate concern or need for additional discussion.

3.4 Recommendations for BSAI Crab Species

This section has summarized conversations between SAs and EFH analysts regarding BSAI crab species. These comments and responses were either recorded through the shared Google folder system within the documents provided or captured through conversational follow-up emails after SAs had a chance to finish their initial review and look over any updates to the new draft species results chapters such as model fit metrics (as discussed in section 3.1 common recommendations).

A description of the recommendations, comments, or constructive critiques that are tallied in the summary table (Table A.2 in Appendix A) is provided below for each individual species or species complex for which EFH is defined in the BSAI Crab FMP.

Recommendations and responses:

Blue king crab
Comments for EBS blue king crab were:

- Could the EFH maps be provided in more detail by stock? For example: around St. Matt's and Pribilof Islands in greater detail could inform the ESP/ stock assessment process.
    - Response: We map EFH for targeted species (not stocks) in the fishery management units corresponding to the Fishery Management Plans (50 CFR 600.805(b)).
- If an encounter probability of 50% means blue king crab are caught once out of every 2 years at a station, then this is probably overestimating in a lot of areas.
    - Response: We agree that the SDM approach and use of encounter probability presently overpredicts the likely area of EFH for blue king crab especially with regard to predicting EFH in areas historically without any blue king crab occurrence. There are a number of avenues to be pursued in improving this result (e.g., using a cumulative frequency distribution instead of an encounter probability to shape the distribution of predictions, exploring additional covariates like salinity that may help structure populations, and spatio-temporal modeling in place of GAMs or Maxent) that we can explore.

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EFH analysts communication summary:

- EFH analysts addressed remaining concerns in species chapter revision as the SA indicated in previous communication that there was not an immediate concern or need for additional discussion.

Golden king crab
Comments for BSAI golden king crab were:

- The SA asked a clarifying question about the weighting given to individual models in the ensemble model analysis.
    - Response: This was a lesson in document access for SAs from different agencies and something we will be sure to provide all information, including the SDM methods section, to all SAs and stock experts in the future. We provided the model methodology to the SA and they appreciated the information on the ensemble methods and weighting approaches.
- The SA identified difficulty in assessing golden king crab populations noting the lack of fishery-independent surveys for this stock. Also, the AI trawl survey is not able to trawl in golden king crab habitat. They noted there are other data streams including observer sample pots in the fishery and a pot survey in the eastern portion of the grounds.
    - Response: Thank you for suggesting a supplemental source of data to include. We would like to develop methods to combine survey data sources and gear types in the SDM ensemble framework for the next EFH 5-Year Review, if possible. AI GKC would be a good candidate for a combined species survey data approach. We also address different data sources in section 3.1 common recommendations.

EFH analysts communication summary:

- EFH analysts addressed remaining concerns in species chapter revision as the SA indicated in previous communication that there was not an immediate concern or need for additional discussion.

Red king crab
Comments for BSAI red king crab were:

- SAs offered several edits updating existing EFH descriptions and adding new references in the FMP.
- Like snow crab, it might be useful to parse juvenile and mature crab out at some point in the future.
    - Response: We will be exploring separately modeling immature/mature crabs in the EBS in the next EFH 5-Year Review using the crab maturity data stored in Kodiak. We will include the suggestion to utilize Kodiak Lab crab maturity data as a future recommendation.
- Multiple red king crab SAs and stock experts raised questions about the differences for stocks compared to the regional differences mapped for EFH. Topics included potential

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differences in biology; differences in habitat conditions, needs, or preferences; differences in survey efforts between the EBS and NBS

- Response: We are not specifically addressing those differences in this work because we map EFH for targeted species (not stocks) in the fishery management units corresponding to the Fishery Management Plans (50 CFR 600.805(b)). This is why EFH is mapped for red king crab as a species and not separately by subarea stocks such as Norton Sound red king crabs. There is potential to improve the BSAI red king crab EFH descriptions and maps in the next EFH 5-Year Review, such as working on getting more species presence-absence data for red king crab in Norton Sound to the extent possible and improving the environmental covariates applied to the models.
- Response: A future recommendation will be to address survey effort differences with weighting the stations to standardize effort.

Further communication:

- Why is Norton Sound only important habitat in summer when there are summer and winter (extending into spring in some years) fisheries, and some tracking data?
    - Response: Observer data from commercial fishery catches of red king crab in fall, winter, and spring commercial fisheries were applied when the 2017 EFH maps (currently in the FMP) were developed using the species distribution modeling approach of the 2017 EFH 5-Year Review. Observer data available at that time from catches on the middle shelf near Bristol Bay and around the Pribilof Islands and were applied to the seasonal models (other than summer). See the NOAA Technical Memo 357 (Laman et al. 2017, Fig. 152) for the seasonal fishery observer data maps. Although we did not revise the seasonal maps (other than summer) for the 2022 EFH 5-Year Review in the present study, it is possible that the other seasonal maps will be revised in a future EFH 5-Year Review when additional data, if available, could be applied to the models to improve the BSAI red king crab EFH maps, including inside Norton Sound. We suggest that a research priority for the next EFH 5-Year Review be developing an approach to combine data from different surveys and gear types in the SDM ensemble framework if possible to potentially improve the EFH maps for crabs.
        - SA response: There is existing data on red king crab winter distribution at the scale of ADF&G statistical harvest area for retained legal male crab, and potentially additional observer data for other crab categories and seasons. There was confusion over the need to wait for the next review for seasonal maps.
            - Response: Similar concerns have been raised for crabs by other reviewers and the EFH analysts have been working to address those concerns to the extent that is possible at this time. The species distribution modeling (SDM) EFH study for the 2022 EFH 5-Year Review was funded to update the 2017 SDM methods with a new SDM ensemble approach and revise the summer EFH maps for groundfish and crabs in the GOA and BSAI to advance EFH

information levels from none to Level 1 (distribution) and from Level 1 to Level 2 (density or abundance) and to add Level 3 (habitat-related vital rates) for the first time to demonstrate a Level 3 approach for a small set of species, as were the priorities of the Alaska EFH Research Plan recommended from the 2017 EFH 5-Year Review. As the EFH 5-Year Review process is iterative, there is an opportunity to keep improving each time.

- Further response: The seasonal maps (other than summer) from the 2017 EFH 5-Year Review were developed using fishery observer data and, due to the nature of those data, modeled using presence-only (MaxEnt) models (i.e., not presence-absence GAMs). We agree that there is a need to update the other seasonal maps for crabs when possible. To do this well, we have realized that a combined survey data approach is needed to include multiple data sources in the SDM ensemble framework for certain species and seasons. Thanks to your input and that of other stock authors/experts in this review, we have identified that developing this combined survey data approach within the SDM ensemble framework should be recommended as one of the research priorities for the next EFH 5-Year Review.

EFH analysts communication summary:

- EFH analysts addressed remaining concerns in species chapter revision as the SA indicated in previous communication that there was not an immediate concern or need for additional discussion.

Snow crab

Comments for EBS snow crab were:

- There are many small snow crab up north (NBS) and it's unclear if they come south, grow enough to be impacted by the EBS fishery, or contribute to the population dynamics of the EBS, given the prevailing currents. As such, it's a little hard to designate what is 'essential' habitat.
    - Response: We designate Essential Fish Habitat based on the definition in the MSA EFH provisions, "Essential fish habitat (EFH) means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." See section 3.1 common recommendations for more information on the definition. We welcome the interest of crab scientists to work with EFH analysts to assist in refining the crab EFH designations in the future. Our goal is to keep refining EFH information for species with each EFH 5-Year Review as the science and data available progresses over time.
    - Further response: In this 5-Year Review we will have new SDM EFH maps for snow crab in the Arctic management area that combines the Chukchi and Beaufort seas.

- Bottom temperature would likely shake out as much more important if snow crab was split by life stage: the juveniles are stenothermic, but there is an ontogenetic migration in which older mature crab end up in warmer, deeper waters. Given the ontogenetic migration observed, it might make sense to separately model snow crab life stages.
    - Response: We will be exploring separately modeling immature and mature crabs in the EBS in the next EFH 5-Year Review using the crab maturity data stored in Kodiak.

EFH analysts communication summary:

- EFH analysts addressed remaining concerns in species chapter revision as the SA indicated in previous communication that there was not an immediate concern or need for additional discussion.

Tanner crab

Comments for EBS Tanner crab were:

- The EFH map indicates "core" habitat in eastern Norton Sound but the map of survey catches does not show any Tanner caught close to the area in question. Is this a consequence of what one might call "extrapolation" by the SDM?
    - Response: This is an example of the SDM extrapolating Tanner abundance into eastern Norton Sound. Given the habitat covariates underlying the ensemble SDM, I interpret this to indicate that conditions are favorable for Tanner's to be found in that part of Norton Sound whether they appeared there in the survey data or not.
    - Note: The SA noted Tanner crab were caught in Norton Sound in 1985 and 1988. However, no NBS data prior to 2010 were included in the SDMs.
- The designation of EFH for Tanner crab in eastern Norton Sound is somewhat problematic and probably revolves on the meaning of “essential” in EFH. The EFH maps were based on surveys in the NBS starting in 2010. None of these surveys found Tanner crab in Norton Sound, so the designation of EFH in eastern Norton Sound must be based strictly on habitat characteristics.
    - Response: We are aware of this concern and are developing a strategy to recommend scientific guidance for mapping EFH under the MSA EFH Regulations before the next EFH 5-Year Review. See section 3.1 common recommendations for more information.

EFH analysts communication summary:

- EFH analysts addressed remaining concerns in species chapter revision as the SA indicated in previous communication that there was not an immediate concern or need for additional discussion.

4. CLOSING SUMMARY

The review process of EFH components 1 and 7 for the 2022 EFH 5-Year Review was successful as a way to engage with SAs and stock experts, gain insights into new information, build on existing documents, modify methodology for the new draft species results chapters to be implemented in NOAA Technical Memos, and participate in constructive conversations. We are carrying forward reviewer comments and concerns that we couldn't address in this Review as future directions for research to be addressed in the next 5-year EFH Review. We will present Future Recommendations regarding SA concerns about data sources, modeling, the conceptual framework, and process and communication, to the SSC in February 2022. Through this iterative review process, and the SA engagement in it, the EFH descriptions, maps, and model results have been strengthened for the 2022 EFH 5-Year Review.

5. PREPARERS AND PERSONS CONSULTED

NMFS Alaska Fisheries Science Center

- Ned Laman, RACE GAP, EFH Component 1 SDM Project Lead Principal Investigator
- Jeremy Harris, RACE GAP, EFH Component 1 SDM Project, Contractor (Lynker)
- Jim Thorson, HEPR, EFH Program Lead

NMFS Alaska Region

- Jodi Pirtle, HCD, EFH Component 1 Descriptions and Identification Lead; EFH Component 1 SDM Project Principal Investigator
- Molly Zaleski, HCD, EFH Component 7 Prey Species Lead
- Gretchen Harrington, HCD, Assistant Regional Administrator

Stock Authors and Experts

- Refer to Table A.1 in Appendix A for the full list of SAs and stock experts who reviewed species information documents for this EFH 5-Year Review.

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APPENDIX A. Summary Tables for the Draft Report of Stock Assessment Author Review of Essential Fish Habitat (EFH) Components 1 and 7 of the 2022 EFH 5-Year Review

Contents

A.1 Overview

This appendix contains information on the SAs and stock experts that reviewed species EFH component 1 and component 7 information (section A.2, Table A.1).

Appendix A also provides species-specific information on edits provided by SAs (section A.4). There are regional tables with tallied information for which species or species complex information was reviewed, edited, or updated (Tables A.2 – A.5).

The last table provides a simple overview of which sections were edited within the available documents for review: existing FMP text or tables, current EFH maps, or new SDM tech memo text and maps (Tables A.6). The phrases used to collect review results in Table A.6 match or are similar to language used in the 2017 EFH 5-Year Review Summary Report, sections 4.3, 5.3, and 6.3.[1]

A.2 Stock Assessment Authors and Experts

Below is a list of the 30 SAs and stock experts that participated in the review of FMP documents and new draft species results chapters for the 2022 5-Year Review (Table A.1). The species or species complexes, with species within the complexes listed parenthetically, are divided by the regions each SA reviewed.

Table A.1. Stock assessment authors and experts by region (EBS, AI, and/or GOA) and species or species complexes.

Name	Affiliation	Region	Species
Steve Barbeaux	NOAA	AI	Walleye pollock
		GOA	Pacific cod
Bill Bechtol	University of Alaska Homer	EBS	Red king crab
Meaghan Bryan	NOAA	EBS	Greenland turbot, Kamchatka flounder
		AI	Greenland turbot, Kamchatka flounder
		GOA	Shallow water flatfish complex (Alaska plaice, butter sole, English sole, northern rock sole, Pacific sanddab, petrale sole, sand sole, slender sole, southern rock sole, starry flounder, yellowfin sole)

[1] 2017 EFH 5-Year Review Summary Report

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Name	Affiliation	Region	Species
Ben Daly	ADF&G	EBS	Golden king crab, red king crab
		AI	Golden king crab, red king crab
Martin Dorn	NOAA	GOA	Walleye pollock
Katy Echave	NOAA	GOA	Shortraker rockfish, Thornyhead complex (longspine thornyhead rockfish, shortspine thornyhead rockfish)
Kari Fenske	NOAA	GOA	Dusky rockfish
Jennifer Gardner	ADF&G	EBS	Snow crab
Dan Goethel	NOAA	EBS	Sablefish
		AI	Sablefish
		GOA	Sablefish
Pete Hulson	NOAA	GOA	Pacific ocean perch
Jim Ianelli	NOAA	EBS	Walleye pollock
Chris Long	ADF&G	EBS	Blue king crab
Sandra Lowe	NOAA	EBS	Atka mackerel
		AI	Atka mackerel
		GOA	Atka mackerel
Carey McGilliard	NOAA	EBS	Northern rock sole
		AI	Northern rock sole
		GOA	Deepwater flatfish complex (Dover sole), Rex sole
Cole Monnahan	NOAA	EBS	Flathead sole-Bering flounder complex (Bering flounder, flathead sole), Other flatfish complex (butter sole, deepsea sole, Dover sole, longhead dab, rex sole, Sakhalin sole, starry flounder)
		AI	Flathead sole-Bering founder complex (flathead sole), Other flatfish complex (Dover sole, rex sole, southern rock sole)
		GOA	Flathead sole
Olav Ormseth	NOAA	EBS	Alaska plaice, Octopuses (giant octopus), Skate complex (Alaska skate, Aleutian skate, Bering skate, big skate, mud skate, whiteblotched skate)
		AI	Octopuses (giant octopus), Skate complex (Alaska skate, Aleutian skate, Bering skate, mud skate)
		GOA	Octopuses (giant octopus), Skate complex (Alaska skate, Aleutian skate, Bering skate, mud skate)

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Name	Affiliation	Region	Species
Katie Palof	ADF&G	EBS	Blue king crab
Kalei Shotwell	NOAA	EBS	Arrowtooth flounder, shortraker rockfish
		AI	Arrowtooth flounder, shortraker rockfish
		GOA	Arrowtooth flounder
Shareef Siddeek	ADF&G	EBS	Golden king crab
		AI	Golden king crab
Paul Spencer	NOAA	EBS	Blackspotted/Rougheye complex (blackspotted rockfish, rougheye rockfish), northern rockfish, Pacific ocean perch
		AI	Blackspotted/Rougheye complex (blackspotted rockfish, rougheye rockfish), northern rockfish, Pacific ocean perch
Ingrid Spies	NOAA	EBS	Yellowfin sole
		AI	Pacific cod
Buck Stockhausen	NOAA	EBS	Blue king crab, Tanner crab
Jane Sullivan	NOAA	EBS	Other rockfish complex (shortspine thornyhead rockfish)
		AI	Other rockfish complex (dusky rockfish, harlequin rockfish, shortspine thornyhead rockfish)
		GOA	Blackspotted/Rougheye complex (blackspotted rockfish, rougheye rockfish)
Cody Szuwalski	NOAA	EBS	Red king crab, Snow crab
Grant Thompson	NOAA	EBS	Pacific cod
Cindy Tribuzio	NOAA	EBS	Pacific sleeper shark
		GOA	Other rockfish complex - Demersal subgroup (quillback rockfish, rosethorn rockfish, yelloweye rockfish), Other rockfish complex - Slope subgroup (darkblotched rockfish, greenstriped rockfish, harlequin rockfish, pygmy rockfish, redbanded rockfish, redstripe rockfish, sharpchin rockfish, silvergray rockfish, yellowtail rockfish), Shark complex
Miranda Westphal	ADF&G	EBS	Golden king crab
		AI	Golden king crab

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Name	Affiliation	Region	Species
Ben Williams	NOAA	GOA	Dusky rockfish, northern rockfish
Kellii Wood	ADF&G	GOA	Other Rockfish complex - Demersal subgroup (quillback rockfish, rosethorn rockfish, yelloweye rockfish)
Leah Zacher	ADF&G	EBS	Red king crab

A.3 Summary of Stock Assessment Author Feedback

EFH analysts received edits, questions, comments, and updated information through the SA review process. Feedback was collected and quantified once SAs would inform the analysts they had completed their review, and further feedback was tracked and tallied through resulting conversations of any questions, comments, or critiques that required more discussion. Below are tables with two sets of tracking feedback: type of feedback (Tables A.2 – A.5) and sections of the provided EFH documents reviewed (Table A.6).

Table A.2. A tallied list of the SA input received for the EBS groundfish species and species complexes. 'Basic edits' include grammar or word choices, sentence structure, and other simple editorial changes that will be adopted in updating existing FMP text or th e new SDM tech memo chapters. 'Clarifying questions' were questions a SA raised and was provided with an answer from the EFH analysts. Many clarifying questions did not warrant summarizing in this report. 'Constructive critiques' included comments that required further conversation and explanation, and were often summarized in this report as a record of how the EFH analysts were able to implement change through SA discussions. 'Revisions' represented expansions to the text within the FMP or the new SDM tech memo chapters that went beyond 'Basic edits'. They don't include changes the EFH analysts may have made to the text as a result of SA conversations from 'Constructive critiques'.

EBS Species or Species Complexes	Basic edits	Clarifying questions	Constructive critiques	Revisions provided
Alaska plaice				
Arrowtooth flounder	3		4	
Atka mackerel	9		7	
Flathead-Bering flounder complex	5			
Bering flounder				
Flathead sole	1		2	
Blackspotted/Rougheye complex	7			5
Blackspotted rockfish	3			
Rougheye rockfish	3			
Greenland turbot		2	1	
Kamchatka flounder		1		
Northern rock sole		4	2	

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EBS Species or Species Complexes	Basic edits	Clarifying questions	Constructive critiques	Revisions provided
Northern rockfish	5			6
Octopuses (giant octopus)	1			
Other flatfish complex				
Butter sole				
Deepsea sole	1		1	
Dover sole	2			
Longhead dab		1		
Rex sole				
Sakhalin sole	2			
Starry flounder				
Other rockfish complex *Shortspine thornyhead as proxy				
Pacific cod				
Pacific ocean perch				
Pacific sleeper shark				
Sablefish				
Shortraker rockfish				
Skate complex	18		1	1
Alaska skate				
Aleutian skate				
Bering skate				
Big skate				
Mud skate				
Whiteblotched skate				
Walleye pollock	34	2	1	
Yellowfin sole	7	3	2	1

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Table A.3. A tallied list of the SA input received for the AI groundfish species and species complexes. 'Basic edits' include grammar or word choices, sentence structure, and other simple editorial changes that will be adopted in updating existing FMP text or the new SDM tech memo chapters. 'Clarifying questions' were questions a SA raised and was provided with an answer from the EFH analysts. Many clarifying questions did not warrant summarizing in this report. 'Constructive critiques' included comments that required further conversation and explanation, and were often summarized in this report as a record of how the EFH analysts were able to implement change through SA discussions. 'Revisions' represented expansions to the text within the FMP or the new SDM tech memo chapters that went beyond 'Basic edits'. They don't include changes the EFH analysts may have made to the text as a result of SA conversations from 'Constructive critiques'.

Stocks	**Basic edits**	**Clarifying questions**	**Constructive critiques**	**Revisions provided**
Arrowtooth flounder	7	2	4	
Atka mackerel	12		4	
Blackspotted/Rougheye complex	6			
Blackspotted rockfish	3			
Rougheye rockfish	3			
Flathead sole	4			
Greenland turbot		2	1	
Kamchatka flounder		1		
Northern rock sole	2	4	2	
Northern rockfish	5			9
Octopuses (giant octopus)	1			
Other flatfish complex	1			
Dover sole	3			
Rex sole	3			
Southern rock sole	2	1		
Other rockfish complex *Shortspine thornyhead as proxy	1	1	2	2
Dusky rockfish	7			2
Harlequin rockfish	8			1
Pacific cod	18	2	2	2
Pacific ocean perch	7			2
Sablefish	26	5	10	7
Shortraker rockfish	7	1	2	
Skate complex	10	1	1	1
Alaska skate				
Aleutian skate				
Bering skate				
Mud skate				
Whiteblotched skate				
Walleye pollock	29	2		1

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Table A.4. A tallied list of the SA input received for the GOA groundfish species and species complexes. 'Basic edits' include grammar or word choices, sentence structure, and other simple editorial changes that will be adopted in updating existing FMP text or the new SDM tech memo chapters. 'Clarifying questions' were questions a SA raised and was provided with an answer from the EFH analysts. Many clarifying questions did not warrant summarizing in this report. 'Constructive critiques' included comments that required further conversation and explanation, and were often summarized in this report as a record of how the EFH analysts were able to implement change through SA discussions. 'Revisions' represented expansions to the text within the FMP or the new SDM tech memo chapters that went beyond 'Basic edits'. They don't include changes the EFH analysts may have made to the text as a result of SA conversations from 'Constructive critiques'.

Stocks	**Basic edits**	**Clarifying questions**	**Constructive critiques**	**Revisions provided**
Arrowtooth flounder	6	1	2	1
Atka mackerel	5		8	4
Blackspotted/rougheye rockfish complex	2	1	2	
Deepwater flatfish complex *Dover sole as proxy	1	1	8	
Dusky rockfish		7	5	
Flathead sole	6	4	2	
Northern rockfish	6			
Octopuses (giant octopus)	1			
Other rockfish complex (2017 FMP Documents)	1	1		
Other rockfish complex - Demersal sub-group				
Quillback rockfish		2	2	
Rosethorn rockfish		2	2	
Yelloweye rockfish		3	3	
Other rockfish complex - Slope sub-group	7		2	1
Darkblotched rockfish		2	2	
Greenstriped rockfish			3	2
Harlequin rockfish		1	4	1
Pygmy rockfish		2	2	
Redbanded rockfish		1	5	2
Redstripe rockfish			5	2
Sharpchin rockfish		1	3	1
Silvergray rockfish	1		3	1

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Stocks	Basic edits	Clarifying questions	Constructive critiques	Revisions provided
Yellowtail rockfish		1	2	1
Pacific cod	12			1
Pacific ocean perch	1	2	1	
Rex sole	1	1	2	1
Sablefish	4	8	15	4
Shallow water flatfish complex	2			
Alaska plaice		1	1	
Butter sole				
English sole		2		
Northern rock sole		3		
Pacific sanddab				
Petrale sole				
Slender sole				
Southern rock sole		1		1
Starry flounder				
Yellowfin sole		2	2	1
Shark Complex	4	1	1	
Pacific sleeper shark	2	1	6	
Spiny dogfish	2	1	7	1
Shortraker rockfish			1	
Skate complex	15	1	1	2
Alaska skate				
Aleutian skate				
Bering skate				
Big skate				
Longnose skate				
Thornyhead complex			1	
Longspine thornyhead				
Shortspine thornyhead				
Walleye pollock	2	2	4	1

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Table A.5. A tallied list of the SA input received for the EBS and AI crab species. 'Basic edits' include grammar or word choices, sentence structure, and other simple editorial changes that will be adopted in updating existing FMP text or the new SDM tech memo chapters. 'Clarifying questions' were questions a SA raised and was provided with an answer from the EFH analysts. Many clarifying questions did not warrant summarizing in this report. 'Constructive critiques' included comments that required further conversation and explanation, and were often summarized in this report as a record of how the EFH analysts were able to implement change through SA discussions. 'Revisions' represented expansions to the text within the FMP or the new SDM tech memo chapters that went beyond 'Basic edits'. They don't include changes the EFH analysts may have made to the text as a result of SA conversations from 'Constructive critiques'.

Region	Stocks	Basic edits	Clarifying questions	Constructive critiques	Revisions provided
EBS	Blue king crab	7	3	3	5
	Golden king crab	6	3		2
	Red king crab	7	4	1	5
	Snow crab		2	1	
	Tanner crab	15	4	2	4
AI	Golden king crab	14	2		3
	Red king crab	2			1

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Table A.6. Total edits provided by SAs for different sections of review documents in the 2022 EFH 5-Year Review of components 1 and 7. The phrases used to collect review results match or are similar to language used in the 2017 EFH 5-Year Review Summary Report, sections 4.3, 5.3, and 6.3. The existing FMP documents are represented by "Expanded on existing description", "Updates to life history", "Updates to general distribution", "Notes to 2017 maps", and "Updates to habitat association table". Edits to the new SDM tech memo chapters are represented with "Updates to tech memo text", and "Updates to literature" reflects any new citations or research the SAs offered for existing or new documents. It's important to note that not all species and species complexes included in the 2022 EFH 5-Year Review had habitat association tables or maps from the 2017 Review. The top row of the table shows the total number of species and species complexes in each FMP and region for comparison.

Sections and topics edited	**EBS**		**AI**		**GOA**	**TOTAL**
	Groundfish	**Crabs**	**Groundfish**	**Crabs**	**Groundfish**	
Total # Species and Complexes	**37**	**5**	**29**	**2**	**52**	**125**
Expanded on existing description	5	3	4	1	3	**16**
Updates to life history	14	4	11	1	7	**37**
Updates to general distribution	8	4	7	1	5	**25**
Notes to 2017 maps	5	2	4	1	2	**14**
Updates to habitat association table	3	1	2	1	2	**9**
Updates to tech memo text	21	5	19	2	30	**77**
Updates to literature	13	5	13	2	11	**44**

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