

2022 Essential Fish Habitat 5-Year Review Plan

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Abstract: This planning document describes progress to-date and plans for the 2022 essential fish habitat (EFH) 5-year Review, following the Council’s EFH Roadmap. The paper describes the ten EFH components, ongoing work related to the components and the Council FMPs, and what types of new information will be included in the EFH 5-year Review summary report that will be prepared and presented to the Council, tentatively in June 2022. The proposed approach is based on direction received from the Council during the 2017 EFH 5-year Review and an initial presentation in April 2019. Staff are seeking input from the Council and SSC on advances to this approach for the 2022 Review, and whether the Council is interested in prioritizing any additional components or identifying HAPC areas of priority.

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1 Introduction

The 1996 provisions to the Sustainable Fisheries Act require regional Fishery Management Councils (Councils) to describe and identify EFH for all fisheries and to minimize to the extent practicable the adverse effects of fishing on EFH. The Magnuson-Stevens Fishery Conservation and Management Act (MSA) defines EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity”. Federal agencies that authorize, fund, or undertake actions that may adversely affect EFH must consult with NMFS and NMFS must provide conservation recommendations to Federal and state agencies regarding actions that would adversely affect EFH. Councils also have the authority to comment on Federal or state agency actions that would adversely affect the habitat, including EFH, of managed species.

Additionally, section 303(a)(7) of the MSA requires that Fishery Management Plans (FMP) describe and identify EFH based on the guidelines established by the Secretary under section 305(b)(1)(A) of the MSA, minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat.

NMFS published guidelines to implement the MSA’s EFH provisions in Federal regulations at 50 CFR 600 Subpart J - Essential Fish Habitat and Subpart K - EFH Coordination, Consultations, and Recommendations. Federal regulations require that each FMP contains the following 10 EFH components:

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.

To guide the review of EFH every 5 years, Federal regulations at [50 CFR 600.815\(a\)\(10\)](#) state:

Councils and NMFS should periodically review the EFH provisions of FMPs and revise or amend EFH provisions as warranted based on available information. FMPs should outline the procedures the Council will follow to review and update EFH information. The review of information should include, but not be limited to, evaluating published scientific literature and unpublished scientific reports; soliciting information from interested parties; and searching for previously unavailable or inaccessible data. Council should report on their review of EFH information as part of the Annual Stock Assessment and Fishery Evaluation (SAFE) report prepared pursuant to §600.315(e). A complete review of all EFH information should be conducted as recommended by the Secretary, but at least once every 5 years.

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). 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 revised species descriptions, changed the HAPC process to coincide with each EFH 5-year Review, and revised EFH research priorities. EFH descriptions consist of quantitative maps and text descriptions. 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). The 2017 Review introduced new data and species distribution models (SDMs) to describe and map EFH (Laman et al. 2017, Turner et al. 2017, Rooney et al. 2018), developed a new Fishing Effects model, and significantly updated the evaluation of non-fishing effects on EFH (Limpinsel et al. 2017). The SDMs developed for the 2017 Review allowed Level 2 descriptions (habitat-related density or abundance) for some life stages of some species in the BSAI and GOA FMPs. Most descriptions, however, remained Level 1 descriptions (distribution), although several previously undescribed life stages of targeted species were described at Level 1 in the 2017 Review.

This document describes the progress made and plans for the 2022 EFH 5-year Review following the Council’s EFH Roadmap. As with the previous reviews, the 2022 EFH 5-year Review will evaluate the EFH components in the six Council FMPs with respect to new information. The objective of the EFH 5-year Review is to evaluate and synthesize new information for each component, and determine whether changes to the FMPs are warranted.

2 Plan for Review and Revision of EFH FMP Components

For the 2022 Review, NMFS and the Council are evaluating the EFH components in the Council’s FMPs. NMFS has prioritized the six 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.

The following sections describe each component and discuss the plan for review. **This information will be presented to the Council in a summary report at the conclusion of the review in June 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.

2.1 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 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.

2.1.1 2017 EFH 5-year Review

A new approach to develop stock-specific habitat information for EFH component 1 was presented 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. SDMs were developed for many species of groundfish and crabs in the Bering Sea, Aleutian Islands, and Gulf of Alaska, 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 NMFS 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 model-based maps (Echave et al. 2012) and for the Arctic FMP that included maps of species distribution from surveys (Simpson et al. 2017).

For the 2017 Review, each stock assessment author was asked to review current FMP EFH component 1 information for each species or species complex for which they have responsibility. Stock authors 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. Stock authors were provided with the new SDM results, text and maps developed for the 2017 Review and compared the new maps to the old maps from the 2010 EFH Review. Finally, stock authors 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 presented to the Plan Teams and the Council.

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.

2.1.2 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, building on 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*).

In addition to supporting EFH mandates, this new species-specific habitat information can be extended to stock assessment (e.g., Ecosystem and Socioeconomic Profiles (ESP); Shotwell et al. 2019, Shotwell et al. *In review*) and other ecosystem-based fisheries management (EBFM) efforts for our region (e.g., Goldstein et al. 2020, Rooper et al. 2020). These stand-alone studies function as a package to provide new information for the 2022 EFH Review, which advances the 2017 SDM EFH approach using best available science and new techniques to advance EFH information for North Pacific Council managed species. All four studies, including data, methods, and preliminary results examples, were reported in a Discussion Paper¹ (Pirtle et al. 2020) that was presented to the Council's Scientific and Statistical Committee (SSC) in June 2020.

As an opportunity to strengthen this work, SSC provided input regarding study methods, progress to date, and planned research products to support new EFH component 1 information for the 2022 EFH Review, which Laman et al. (*In prep*) and the other contributing EFH component 1 studies have taken into account to update their approach (response as sub-bullets)—

- **SSC requested** justification for selection of the final models using RMSE (root mean square error) or other skill testing metrics.
 - Response: Methods now describe how RMSE is used as an indicator of the best-performing model and model elimination steps are clear.

¹ Pirtle, J.L., E.A. Laman, J.T. Thorson. 2020. Discussion Paper on Advancing Essential Fish Habitat Descriptions and Maps for the 2022 5-year Review. <https://www.npfmc.org/efh-distribution/>.

- **SSC recommended** consideration of error distributions that are better suited to over-dispersed data (e.g., negative binomial).
 - Response: To address overdispersion of data, a negative binomial model is now included among ensemble constituents, along with Generalized Additive Models (GAM) and MaxEnt.
- **SSC recommended** that analysts define thresholds for excluding or denoting areas where uncertainty is high (e.g., ratio of estimated response to uncertainty).
 - Response: Species distribution model (SDM) prediction uncertainty (coefficient of variation (CV)) will be mapped and areas of high uncertainty will be compared with the SDM prediction maps.
- **SSC suggested** consideration of ensemble methods that weight EFH prediction across candidate SDMs with similar out-of-sample predictive performance (weighting based on out-of-sample predictive skill may be the most applicable).
 - Response: Out of sample skill testing is used to select the best performing models and relative RMSE weighting for model constituent inclusion in the ensemble.
- **SSC supported** continued exploration of alternative SDM approaches across species, regions, and life stages (e.g., presence-absence GAM (paGAM), hurdle GAM, GAM, and MaxEnt).
 - Response:
 - A negative binomial model has been added to address overdispersion.
 - An ensemble method is now applied and skill tested with the constituent models.
- **SSC supported** the following: Response variable of numerical abundance with area swept (effort) as an offset in the SDM; Out-of-sample skill testing for arbitrating among candidate SDMs; Cross-validation through repeated sampling of testing and training datasets; Use of the complementary log-log (cloglog) link to relate abundance to occurrence, which facilitates skill testing; Use of RMSE for skill testing.
 - Response:
 - All of these supported methods are utilized in the Laman et al. (*In prep*) SDM EFH approach for the 2022 EFH 5-year Review and SSC's support is appreciated.
 - In addition to facilitating skill-testing among models by standardizing model units, use of the cloglog link places formerly Level 1 (distribution) models using occurrence data (paGAM and MaxEnt) in units of Level 2 (abundance).
- **SSC supported** continued exploration of static and dynamic predictor covariates.
 - Response:
 - ROMS covariates have been updated for the Bering Sea and will be updated for the Gulf of Alaska, *pending access to requested ROMS 2018 data*.
 - Developing a covariate to describe trawlable/untrawlable areas has been considered. The EFH research community is exploring how to address untrawlable areas for a subsequent EFH 5-year Review.

- **SSC supported** research permitting description of Level 3 EFH.
 - Response: All four studies contributing new EFH component 1 information for the 2022 Review describe and identify Level 3 EFH for a subset of species in the Gulf of Alaska, Bering Sea, Aleutian Islands, and Arctic: Copeman et al. *In prep* (Gulf of Alaska); Laman et al. *In prep* (Gulf of Alaska, Bering Sea, Aleutian Islands); Marsh et al. *In prep* (Arctic); Shotwell et al. *In prep* (Gulf of Alaska).

- **SSC encouraged** expanded efforts to include additional sources of information to describe and define EFH.
 - Response: Studies have considered expanding approaches to include additional sources of information to describe and identify EFH for the 2022 Review. Given the timeline of the four contributing studies, most expanded efforts under consideration are best applied as new EFH component 1 information for a subsequent EFH 5-year Review (e.g., additional SDM covariates, data types, and surveys; untrawlable and other habitat areas currently underrepresented by the survey data that is included in the majority of the SDMs).

- **SSC encouraged** consideration of EFH in timeblocks and **discussed** the need to move to a more dynamic definition of EFH given recent and rapid changes observed in the environment and species distributions.
 - Response: EFH is currently described and identified for North Pacific Council managed species as habitat-related species distribution and abundance, using SDM with survey data from the 1980s through 2014 (2017 Review) and through 2019 (2022 Review). NMFS Office of Sustainable Fisheries funded a separate study to develop dynamic SDM for species in the Bering Sea (e.g., at 1, 3, 5, 10, and 15-year timeblocks) to explore and map EFH at more dynamic temporal scales (Barnes et al. *In prep*). This dynamic SDM approach may be another informative approach to describe and map EFH, given recent and rapid changes observed in the environment and species distributions. In a future EFH 5-year Review, Barnes et al. (*In prep*) can potentially compliment the SDM EFH approach that Laman et al. (*In prep*) has advanced for the 2022 EFH Review. Laman et al. (*In prep*) builds on the SDM EFH approach of the 2017 EFH Review (Laman et al. 2018) with new data and refined methods.

- **SSC encouraged** consideration of whether co-mapping or directly incorporating vital rates (for L3) within SDM is the best approach, while highlighting that it ultimately depends upon the underlying assumptions and questions.
 - Response: All four studies that describe and identify EFH Level 3 for the 2022 Review use a *raster product approach*, where raster-1 is the SDM prediction of habitat-related abundance, raster-2 is temperature-dependent growth rate (or, another temperature-dependent vital rate), and the resulting product of the two rasters is an EFH Level 3 map (e.g., juvenile walleye pollock in the Gulf of Alaska; Copeman et al. *In prep*). These EFH Level 3 maps can be used to further interpret the EFH Level 2 maps, e.g., to consider corresponding areas of high growth and habitat-related abundance.

- **SSC noted** the immense progress in EFH modeling and hopes that these analyses will be considered in stock assessments and analyses supporting stock assessments, particularly habitat suitability and how it may pertain to recruitment and spawning locations. At a minimum, these efforts should be able to contribute to the stock assessment process and ongoing EBFM efforts, including through the ESPs.

Work in progress by the four studies developing new EFH component 1 information was also presented to a joint meeting of the GOA and BSAI Groundfish Plan Teams in September 2020 and to the stock assessment authors in January 2021 to plan and coordinate the stock author review of EFH component 1 for the 2022 Review. As in the 2017 Review, new EFH component 1 information will be provided to the stock assessment authors in Spring 2021 for their review and recommendations for updates. Stock assessment author recommendations will be based on this 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\(a\)\(1\)\(iii\)\(B\)](#)).

For the 2022 EFH Review, the studies contributing new EFH component 1 information for the 2022 Review modernize the SDM EFH approach of the 2017 Review 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 FMP and BSAI FMP.
- New EFH Level 2 and 3 descriptions and maps for life stages of 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.

This body of work is innovative and inclusive of many contributors that are developing new habitat-related distribution, abundance, and vital rates for North Pacific Council managed species in the Gulf of Alaska, Bering Sea, Aleutian Islands, and Arctic. This work has potential to update the EFH descriptions and maps through new and best available science, leading to new and revised EFH Level 2 and for the first time Level 3. NMFS looks forward to sharing this completed body of work with the stock authors, Plan Teams, and Council in the next stages of the 2022 EFH 5-year Review. Questions about the review of EFH component 1 can be directed to Jodi Pirtle (Jodi.Pirtle@noaa.gov).

2.2 Fishing Activities that may affect EFH

During the 2017 EFH 5-year review cycle, the Council requested updates to methods to assess fishing effects on EFH. This request resulted in the development of the Fishing Effects (FE) model to replace the Long-term Effects Index (LEI) model developed for the 2005 EFH EIS. The FE is operationally similar to the LEI; however, the FE model includes substantial analytical improvements including being cast in a discrete-time framework, allowing sub-annual (monthly) tracking of fishing impacts and habitat disturbance, and utilizing the VMS-enabled Catch-In-Areas (CIA) database for spatially explicit analysis of fishing activities. The FE model also incorporates an extensive global literature review (Grabowski et al. 2014) to estimate the habitat susceptibility and recovery dynamics of 26 unique habitat features and incorporates impact and recovery rates to predict habitat reduction and recovery over time. The FE model was reviewed and approved for use by the SSC in April 2016, and the Council approved a three-tiered method to evaluate whether there are adverse effects of fishing on EFH (NPFMC 2016). This analysis considers impacts of commercial fishing first at the population level, then uses objective criteria to determine whether additional analysis is warranted to evaluate if habitat impacts caused by fishing are adverse and more than minimal or not temporary. In April 2017, the SSC and Council concurred with species-specific EFH fishing effects reviews conducted by stock assessment authors that no stocks needed mitigation review, and that the effects of fishing on the EFH of fisheries species managed by the Council are minimal and temporary (NPFMC 2017).

At the conclusion of the 2017 EFH 5-year Review, the SSC provided several recommendations related to the FE model. These included continuing to refine FE model parameters, examining the potential benefits of gear modifications, requesting sensitivity analyses and the release of species-specific “core EFH area” (CEA) maps, and more explicit consideration of corals and other living structure in the model. Since that time, development and use of the FE has continued and many of the SSC recommendations have been addressed through these efforts—

- In 2019, the authors of the FE model published “A seascape scale habitat model to support management of fishing impacts on benthic ecosystems” (Smeltz et al 2019).
- New England Fishery Management Council implemented the FE model as their primary fishing impacts analysis tool (NEFMC 2019).
- Output from the FE model has been included as an indicator (habitat disturbed) in the Council’s Ecosystem Status Reports since 2017, providing yearly FE output updates.
- A sensitivity analysis is now available as a standard FE output.
- CEA maps will be available to the public.
- Updated gear descriptions may be available for longline (Welsford et al. 2014) and pot gears (Doherty et al. 2017).
- Finally, the Alaska Deep Sea Coral and Sponge Initiative (science plan available in April 2021) funded by the Deep-Sea Coral Research and Technology program is taking place in Alaska from 2020 – 2023 and includes several funded proposals, which may provide new information on coral and sponge susceptibility to fishing gears and potential for recovery from impacts; however, any updates from this initiative will not be available for the 2022 Review.

During the 2022 EFH Review, the FE model will be run using updated fishing effort data. To investigate the potential relationships between fishing effects and stock production, stock assessment authors will examine trends in life history parameters and the amount of disturbed habitat in the CEA, identified as the upper 50th percentile of the cumulative distribution of ensemble predicted habitat-related abundance from the SDM EFH maps (i.e., Laman et al. *In prep*), for each species using the 2017 FE assessment methodology (NPFMC 2016). Coordination with AFSC BSAI and GOA Plan Team chairs on a review timeline was initiated in March 2021. Questions about the review of EFH component 2 can be directed to John V. Olson (John.V.Olson@noaa.gov).

2.3 Non-MSA Fishing Activities that may affect EFH

The EFH review considers any fishing activities that are not managed under the MSA that may affect EFH. The effects of non-Magnuson-Stevens Act fishing activities are covered within the discussion of fishing effects on habitat in the 2005 EFH EIS. Non-MSA fishing activities include State-parallel fisheries, State-water fisheries, recreational fisheries, and halibut fisheries managed under the Northern Pacific Halibut Act of 1982. The types of gear used by the non-MSA fisheries in Alaska are discussed in detail in the 2005 EFH EIS, as well as their distribution. Although new data exist to evaluate other non-MSA fishing impacts, at this time, **we are not planning to analyze these changes or new information regarding the impacts of these activities on EFH in the 2022 Review.**

2.4 Non-fishing activities that may affect EFH

NMFS habitat biologists use the *Impacts to Essential Fish Habitat from Non-Fishing Activities Report* in Alaska² (Limpinsel et al. 2017) as a reference, along with information from other sources, when reviewing proposed actions for potential impacts to EFH and when considering possible ways to avoid or minimize adverse effects. Federal and State of Alaska action agencies also use this report as a reference when preparing the EFH Assessments they provide to NMFS as a part of EFH consultations. The purpose of this report is to mitigate and reduce impacts to EFH and support NOAA Fisheries sustainable fisheries management efforts.

The 2022 EFH Review builds upon previous versions: Analysis presents HCD's current understanding of how anthropogenic influences impact EFH (termed non-fishing impacts in MSA). All sections of the report will be updated with current references and research that improve understating of EFH, impacts to EFH or support NMFS's EFH conservation recommendations. Some sections of the report will be completely rewritten (e.g., Climate Change, Mining), others simply modified. Several sections will be added in this review (Hydropower, Aquaculture, Vessel Scuttles). The review team is HCD subject matter experts working in chapter groups to review, write, and edit these updates. **The final version is expected to be complete by the end of 2021 and will be included with the 2022 Summary Report for this 5-year Review.** If you have questions about the review of EFH component 4, send inquiries to Charlene Felkley (Charlene.Felkley@noaa.gov).

2.5 Cumulative impacts analysis

To the extent practicable, FMPs should analyze how cumulative impacts of fishing and non-fishing activities influence the function of EFH on an ecosystem or watershed scale. The cumulative impacts of fishing activities are evaluated in the Supplemental Information Report (SIR) to the Alaska Groundfish Fisheries Programmatic Environmental Impact Statement completed each year. For fishing impacts to EFH, the FE model allows for an assessment of cumulative effects from fishing activities. Output from the FE model has been included as an indicator (habitat disturbed) in the Council's Ecosystem Status Reports since 2017, providing yearly FE output updates. For non-fishing impacts, the revised and updated *Impacts to Essential Fish Habitat from Non-Fishing Activities in Alaska* provides cumulative information on the impacts to EFH from non-fishing activities. At this time, **we are not planning to conduct a new stand-alone cumulative impact analysis in the 2022 EFH Review.**

2.6 EFH Conservation and Enhancement recommendations

FMPs must identify actions to encourage the conservation and enhancement of EFH, including recommended options to avoid, minimize, or compensate for adverse impacts. The annual Supplemental Information Reports³ for the groundfish fisheries detail all of the Council's actions since 2008 to conserve EFH from fishing effects. **For the 2022 EFH 5-Year Review**, new information will be available from the Fishing Effects model to understand fishing effects on EFH. **The Council may wish to identify additional recommendations to minimize effects from fishing when it reviews the summary report in June 2022.** Questions about the review of this EFH component can be directed to John V. Olson (John.V.Olson@noaa.gov).

² Impacts to Essential Fish Habitat from Non-fishing Activities in Alaska (Limpinsel et al. 2017). Available at: <https://www.fisheries.noaa.gov/resource/document/impacts-essential-fish-habitat-non-fishing-activities-alaska>

³ The Supplemental Information Reports are available at <https://www.fisheries.noaa.gov/resource/document/alaska-groundfish-harvest-specifications-environmental-impact-statement-eis>

For the 2022 EFH 5-Year Review, NMFS is revising the EFH conservation recommendations for non-fishing activities in the non-fishing report under EFH component 4. If you have questions about the review of this EFH component, send inquiries to Doug Limpinsel (Doug.limpinsel@noaa.gov).

2.7 Prey species

The definition of EFH includes waters and substrate necessary to fish for feeding. A loss of prey may be an adverse effect on EFH and managed species because the presence of prey makes waters and substrate function as feeding habitat. Actions that reduce the availability of a major prey species or their habitat may be considered adverse effects on EFH. Therefore, it is necessary to know what habitats the prey of EFH species are utilizing. 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\(a\)\(7\)](#)). Adverse effects on prey species and their habitats may result from fishing and non-fishing activities.

Each FMP for groundfish in the Gulf of Alaska and the Bering Sea and Aleutian Islands management area includes text on prey species for each life history stage of EFH species. The FMPs also contain tables of the major prey species consumed by FMP species life stages, yet this information does not include the habitat associations of prey species.

For the 2022 EFH 5-year Review, stock assessment authors will have the opportunity to review and recommend updates to the prey species life history information and tables in the FMPs. Improving prey habitat information in the FMPs will allow NMFS to make better informed habitat conservation recommendations in EFH consultations. EFH prey information in the FMPs can be categorized as—

- Nearshore: the species utilizes the nearshore marine environment during a key part of its life cycle (e.g., spawning, rearing); and
- Offshore: the species' entire life cycle takes place in the offshore marine environment.

Nearshore prey species habitat is the focus of the 2022 EFH Review. The nearshore marine environment in Alaska is known as some of the most productive fisheries habitat in North America (Arimitsu and Piatt 2008, Limpinsel et al. 2017) and is nursery habitat for many FMP species (e.g., gadids, Abookire et al. 2007; flatfishes, Hurst 2016; sablefish Coutré et al. 2015; crabs, Loher and Armstrong 2000; and Pacific salmon, Miller et al. 2016). The productivity of this habitat and the proximity to human development make nearshore prey habitat the most likely to be affected through direct impacts from human activities (Johnson et al. 2012, Limpinsel et al. 2017).

We will also lay the framework for how prey information as an EFH component can be used by Federal and State of Alaska action agencies to develop EFH Assessments for proposed actions that may adversely affect EFH, and by NMFS to provide Conservation Recommendations in EFH Consultations for these actions. Prey information can be incorporated into EFH consultations by answering the following questions—

- What are the EFH species in an action area?
 - The FMPs provide this information as text descriptions and maps (EFH component 1).
- What are the EFH species' prey?
 - Each FMP provides life history and habitat information text with detailed prey information and species-specific tables with prey and habitat descriptions (EFH component 1 and 7). EFH species prey information in the FMPs can be reviewed and revised during the 2022 EFH Review or a future EFH 5-year Review based on best

available science, which would improve the quality of EFH component 7 available to support NMFS Conservation Recommendations and EFH Consultations.

- What prey species are in the action area?
 - Prey species for a given life history stage of EFH species present in an action area under review for EFH Consultation can be identified by literature review and existing databases. The AFSC Nearshore Fish Atlas (Johnson et al. 2012, Grüss et al. 2021) and NMFS *ShoreZone* (ShoreZone.org) databases provide information on prey location and habitat types in the nearshore environment off Alaska. Additional prey species distribution data from ADFG and other sources can also be used.
 - SDM (species distribution models) can be developed to describe and map prey species habitat comprehensively for EFH component 7, similar to the SDM for EFH component 1 (Laman et al. 2018, Pirtle et al. 2020). Grüss et al. (2021) developed an SDM approach at fine spatial scales (10s to 100s of meters), using North Pacific Council FMP species and the recently updated Nearshore Fish Atlas and *ShoreZone* databases, which demonstrates a practical approach to describe and map nearshore prey species habitat for EFH component 7. The SDM approach by Grüss et al. (2021) can be extended to additional species and areas for a future EFH 5-year Review.
 - As a potential future application of eDNA (environmental DNA), water samples collected in the field can be analyzed to account for prey species present and absent in an action area, where species biomarkers are available. Standard protocols and Alaska species biomarkers are currently being developed and tested for Alaska species.

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 FMPs. In order to improve nearshore habitat information for the next EFH 5-year Review, NMFS will include a near term objective in the revision to the Alaska EFH Research Plan following the 2022 EFH Review, of which improving nearshore prey habitat information will be included (EFH component 9). If you have questions about the review of EFH component 7, send inquiries to Molly Zaleski (Molly.Zaleski@noaa.gov).

2.8 Habitat Areas of Particular Concern (HAPC)

FMPs should identify specific types or areas of habitat within EFH as Habitat Areas of Particular Concern (HAPC) based on one or more of the following considerations: importance of ecological function, habitat sensitivity to human-induced degradation, whether development activities are or will be stressing the habitat, and rarity of the habitat. In 2010, the Council outlined its HAPC evaluation criteria⁴ and determined that as part of its HAPC process, areas nominated for inclusion must meet at least two of the four considerations, one of which must be the rarity consideration. If the Council chooses to identify a specific habitat type for HAPC consideration, they will solicit nominations from the public. Nominations are reviewed by the SSC and other Council advisory bodies. If an area is designated as HAPC, the Council can determine whether additional management measures should be recommended for that area. The Council identified HAPCs for seamounts and coral at Bowers Ridge and other areas in the Aleutian Islands and the GOA in 2006, which also included a prohibition on fishing in the areas with bottom contact or mobile bottom contact gear, depending on the area. In 2014, the Council identified six known areas of skate egg concentration in the Bering Sea as HAPC, and included a request to NMFS to monitor the areas for changes in egg density or other potential effects of fishing. In February 2020, the Council's Ecosystem Committee received a report from AFSC researchers of the research conducted on skate

⁴ https://www.npfmc.org/wp-content/PDFdocuments/conservation_issues/HAPC/HAPC_eval_210.pdf

nursery areas over the last 17 years and concluded, based on the information provided, that updates to the skate egg concentration HAPCs are not warranted at this time.

The Council linked its nomination process for HAPC with the EFH review schedule. **For this review, the Council may wish to identify areas of priority for HAPC and request proposals for specific sites for HAPC inclusion.** The Council's HAPC process is described here: https://www.npfmc.org/wp-content/PDFdocuments/conservation_issues/HAPC/hapc_process092010.pdf

2.9 Research and Information needs

FMPs should identify recommendations for research efforts that the Council and NMFS view as necessary to improve descriptions and identification of EFH, identification of threats to EFH, and development of EFH conservation and enhancement measures. During each EFH 5-year Review, NMFS identifies gaps in knowledge and recommends research activities to fill those gaps in a 5 year research plan. These become EFH research priorities identified in the FMPs.

In 2008, the NMFS Science Board recognized the need to improve habitat science. They identified goals, including supplementing stock assessments with ecosystem considerations, improving the descriptions of EFH, and reducing habitat uncertainty. To address these goals scientists and fishery managers developed the Habitat Assessment Improvement Plan (HAIP) in 2010. Progress towards these HAIP 2010 goals, as well as updated recommendations for how to integrate EFH and EBFM were later published by a national team ([Peters et al. 2018](#)), and the completed Alaska Habitat Assessment Prioritization also provides priority for Alaska stocks ([McConnaughey et al. 2017](#)).

The 2017 Alaska EFH Research Plan (Sigler et al. 2017) describes the five long-term research goals:

- characterize habitat utilization and productivity,
- assess habitat sensitivity and recovery,
- validate and improve fishing impacts model,
- map the seafloor, and
- assess coastal habitats facing development.

The 2017 Alaska EFH Research Plan also identifies two research objectives:

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

Objective 2 also calls for fishery researchers to collaborate with model developers to incorporate new and existing data into regional models, which may be funded as multi-year studies. New data continue to be collected and new modeling techniques may make use of those new data to produce more precise descriptions of EFH. NMFS has funded several projects since the 2017 Review to address these objectives and provide data for the updates to EFH information levels in Component 1 for the 2022 EFH 5-year Review.

Figure 1 shows the number of research projects NMFS has funded by research goal, from 2005 through 2021.

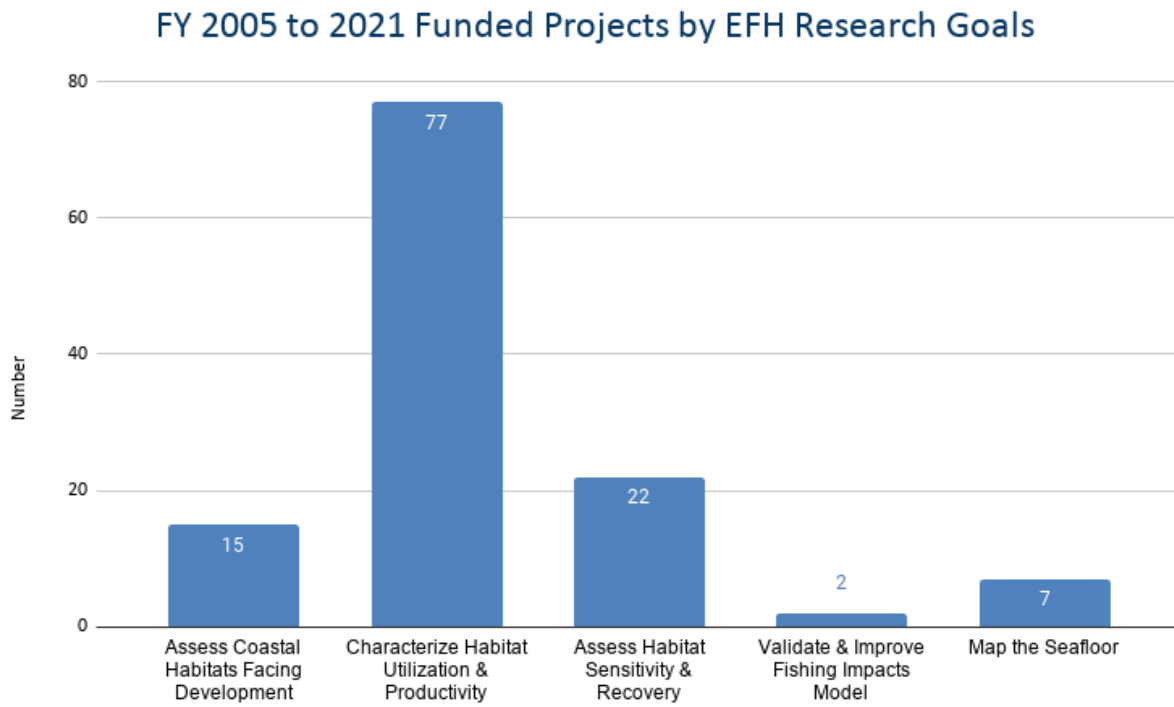


Figure 1. Summary of EFH research projects NMFS has funded by EFH Research Goal, 2005 to 2021.

Table 1 lists the EFH research projects NMFS has funded since the 2017 EFH Review.

Table 1 EFH Research projects funded by NMFS from 2017 through 2020

Year	Project Title	Principal Investigators
2017/18/19	Optimal overwintering thermal habitat of juvenile walleye pollock (<i>Gadus chalcogrammus</i>) from the Gulf of Alaska (Copemen et al. <i>In prep</i>)	Laurel, Heintz, Copeman, Hurst, Pirtle, Gibson
2017	A pilot study for assessing deep-sea corals and sponges as nurseries for fish larvae in the western Gulf of Alaska	Rooper, Wilborn, Goddard
2017	Using habitat characteristics and prey abundance to predict distribution, abundance, and condition of groundfish in the Gulf of Alaska	Ressler, Simonson, Rooper, Punt
2017/18/19	Essential fish habitat of flatfish early life stages in the Chukchi Sea	Cooper, Logerwell, Heintz, Ianelli
2017	Juvenile flatfish habitat in the northern Bering Sea	Yeung, Cooper, Copeman, Matta, Yang
2018/19	Developing a novel approach to estimate habitat-related survival rates for early life history stages using individual-based models (Showell et al. <i>In prep</i>)	Shotwell, Stockhausen, Gibson, Deary, Pirtle, Rooper
2018/19	A unified nearshore catch database to refine juvenile EFH models and maps for Alaska (Grüss et al. 2021)	Lindeberg, Pirtle, Neff
2018	Is nearshore habitat essential to overwintering YOY Pacific cod?	Kastelle, Helser, Litzow, Laurel
2018	Spatial variation in early juvenile flatfish growth and condition in relation to thermal phases in the eastern Bering Sea Shelf	Yeung, Copeman, Matta, Rooper, Yang
2018	Age effects on thermal habitat requirements on commercial flatfishes	Hurst, Copeman
2019/20/21	Advancing EFH species distribution modeling descriptions and methods for the North Pacific Fishery Management Plan species (Laman et al. <i>In prep</i>)	Laman, Pirtle, Rooper, Hurst, Conrath
2019/20	Model-based essential fish habitat descriptions for Fish Resources of the Arctic Management Area (Marsh et al. <i>In prep</i>)	Pirtle, Marsh <i>*note, this project is funded by BOEM.</i>
2019	Spatial variation in early juvenile flatfish growth and condition in relation to habitat quality the Bering Sea	Yeung, Copeman, Matta, Pirtle, Yang
2019	Modeling nearshore fish habitats using Alaska as a regional case study. (Grüss et al. 2021)	Pirtle, Thorson, Lindeberg
2019	Dynamic models inform species responses to climate change in high latitude systems (Barnes et al. <i>In prep</i>)	Barnes, Thorson, Aydin, Pirtle, Holsman, Rooper
2020	Evaluating seasonal habitat use and movements by juvenile age-1+ Pacific cod in the Gulf of Alaska	Rooney, Laurel, Holsman
2020	Nearshore essential habitats of juvenile flatfish in the eastern and northern Bering Sea.	Yeung, Copeman, Matta, Pirtle, Spies
2020/21	Condition indicators for Pacific Cod and Walleye Pollock from the eastern Bering Sea	Hoff, Hachn, Helser, Britt, Rooper, Boldt
2020	Using drones to update and enhance essential fish habitat eelgrass/substrate maps	Miller

Year	Project Title	Principal Investigators
2020	Pilot project using eDNA metabarcoding to improve nearshore consultations and EFH maps and descriptions.	Maselko, Lunsford, Larson, Olson, Pochardt, MacLean, Hoffman
2020	Spatio-temporal environmental covariates to refine salmon EFH within the Bering and Chukchi seas of the U.S. EEZ.	Yasumiishi, Cunningham, Pirtle, Thorson
2021	Defining essential habitats for juvenile FMP crab species (<i>Chionoecetes</i> spp.): the importance of bottom temperature and diatom flux in defining juvenile crab abundance and condition across a warming Bering Sea	Copeman, Cooper, Eisner, Murphy, Andrew
2021	Acoustic and image-based habitat classification in the Gulf of Alaska using machine learning	Williams, Rooper
2021	Developing a submersible eDNA autosampler: a DNA “net” that can be deployed remotely with no selectivity bias	Larson, Neumann, Pochardt, Maselko, Olson, Levi, Selker, Udell

Plan for the next Alaska EFH Research Plan

HEPR plans to lead a process to develop a new Alaska EFH Research Plan that will guide research and development during 2023-2027. HEPR envisions inviting two participants from the AKRO and four from the AFSC (including the HEPR lead), where participants will be identified in 2021 based upon input from AFSC and AKRO. The research plan will be drafted in 2022 with the intent of providing a draft plan by Oct. 2022 (for potential feedback from council bodies during the 2022 EFH Review), and published as a Tech. Memo in 2023. Previous EFH Research Plans have consistently had the same five core research goals (see Fig. 1), and have differed primarily by providing additional “emphasis areas” and also in how Research Proposals are solicited and funded. For example, the current Alaska EFH Research Plan lists as emphasis areas (1) providing Level-1 and 2 maps for species and stages that are not currently mapped, and (2) providing Level-3 maps for species using process research information where available. The most recent Alaska EFH Research Plan also introduced a new process to submit, review, and fund multi-year proposals that conduct field- and laboratory-based process research and then synthesize these to provide EFH mapping products (termed “multi-year proposals”).

Given funding limitations at AFSC and AKRO, we envision leading some discussion to potentially revise the five core research areas, as well as providing new “emphasis areas.” If the SSC is interested, the HEPR lead and other authors could present a draft research plan to the SSC in late 2022. These revisions to core and emphasis areas may include:

- an emphasis on improving information available for Level 1-3 EFH descriptions and maps for nearshore habitats (see section 2.7);
- an emphasis on combining Levels 1-3 maps to estimate habitat-specific productivity (Level-4 maps) or recently published proxies for this Level-4 EFH information.
- an emphasis upon developing maps of distribution, density, demographics, or productivity (i.e., EFH Levels 1-4) that reflect changes in environmental and biological processes that regulate these, but which are rapidly changing given anthropogenic climate change.
- an emphasis on developing maps for forage fish distribution, density, or abundance that could be used in the next five-year update (see section 2.7), similar to how the 2017 EFH Review involved developing species distribution models for use in component 1.

However, these and other potential revisions will be discussed and drafted only after the authorship has been identified by HEPR. We also envision continuing the process for multi-year proposals, which have generally been successful in linking process research and EFH mapping activities. If you have questions about the review of EFH component 9, send inquiries to Jim Thorson (James.Thorson@noaa.gov).

2.10 Review EFH components every 5 years

Councils and NMFS should *periodically review the EFH provisions of FMPs and revise or amend EFH provisions as warranted based on available information*. The review of information should include, but not be limited to: evaluating published scientific literature and unpublished scientific reports, soliciting information from interested parties, and searching for previously unavailable or inaccessible data. At the conclusion of the EFH Review, a summary report is prepared that describes the review process and the results of review for all EFH components the Council elects to review and potentially revise. **The summary report represents the EFH review and meets the requirements for review outlined in MSA.** If, after reviewing the summary report, the Council chooses to update any EFH components in its FMPs, FMP amendments will be prepared along with the appropriate analytical documents.

3 Council action

The proposed approach for the 2022 EFH Review is based on direction received from the Council during the 2017 EFH Review and the initial approach and draft timeline presented in April 2019. Here, we have broadly identified which of the EFH components the Council may wish to update. Staff are seeking input from the Council and SSC on specific components currently prioritized for review and revision:

- Develop and present new data, methods, SDM, maps, and habitat information (component 1);
- Run Fishing Effects model with updated fishing data and new maps (component 2);
- Provide updated EFH conservation recommendations and analysis for non-fishing impacts to EFH (component 4 and 6);
- Provide refined prey habitat information in the groundfish FMPs (component 7);
- Update research priorities and information needs (component 9).

Additionally, the Council may wish to identify priorities for HAPC consideration and request proposals for specific sites for HAPC inclusion.

4 Timeline

To complete the EFH 5-year Review summary report for Council review in 2022, and any potential FMP amendments that may result, the following general timeline is being followed:

Month/ Year	Primary audience	Major milestones in the EFH 5-Year Review Process
April 2019	Council	NMFS presented the 2022 EFH 5-Year Review Proposed Approach to the Ecosystem Committee and Council (B2 EFH 2022 5 Year Review Approach)
April 2020	Council (<i>canceled</i>)	Review proposed approach and identify EFH components for potential revision (EFH 5-year review workplan)
June 2020	SSC	NMFS presented a progress report on SDM approach and provided an opportunity to engage, inform, and receive input from the SSC at this stage of the 2022 EFH 5-year Review (D3 EFH Discussion Paper on Advancing EFH Descriptions and Maps for the 2022 5-year Review)
September 2020	Groundfish Plan Teams	NMFS presented a progress report on the SDM approach and provided an opportunity to engage, inform, and receive input from the groundfish plan teams at this stage of the 2022 EFH 5-year Review. (EFH presentation - Advancing EFH Habitat Descriptions and Maps for the 2022 5-year Review)
January 2021	Stock Assessment Authors	NMFS met with groundfish and crab stock assessment authors to explain the tools in development to provide new EFH information for their stocks for components 1 and 7 and their role in reviewing this new information.
April 2021	Council, SSC	NMFS presents the planning document for the 2022 EFH 5-year Review
<i>Mar-Aug 2021</i>	<i>Assessment authors</i>	<i>Review information from models, recommend changes to EFH descriptions in the FMPs, if necessary</i>
<i>September 2021</i>	<i>Groundfish and Crab Plan Teams</i>	NMFS will present a progress report on the EFH component 1 SDM outputs and the component 2 Fishing Effects model results
<i>January 2022</i>	<i>Stock Assessment Authors</i>	NMFS will meet with groundfish and crab stock assessment authors to conclude the stock assessment author review for EFH components 1, 2, and 7
<i>up to March 2022</i>	<i>HCD, NPFMC staff, AFSC</i>	<i>Develop summary report with updates to identified EFH components</i>
<i>June 2022</i>	<i>Council</i>	<i>Review summary report with proposed updates to EFH components and develop alternatives to amend the FMPs, if appropriate</i>
<i>June-Nov 2022</i>	<i>NPFMC staff, HCD, AFSC</i>	<i>NEPA analyses for potential FMP amendments</i>
<i>October (T) 2022</i>	<i>Council</i>	<i>Review Initial Review Draft of EFH FMP amendment analysis</i>
<i>December (T) 2022</i>	<i>Council</i>	<i>Review Final Review Draft of EFH FMP amendment analysis</i>

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