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Alaska Essential Fish Habitat Research Plan

A Research Plan for the National Marine Fisheries Service's Alaska Fisheries Science Center and Alaska Regional Office

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Alaska Essential Fish Habitat Research Plan

A Research Plan for the National Marine Fisheries Service's Alaska Fisheries Science Center and Alaska Regional Office

by
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Introduction

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) mandates NOAA to identify habitats essential for managed species and conserve habitats from adverse effects on those habitats. These habitats are termed "Essential Fish Habitat" or EFH, and are defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity". Further, the MSFCMA requires federal agencies to consult with the National Marine Fisheries Service (NMFS) when their actions may adversely affect EFH. These consultations occur for both fishing and non-fishing activities.[1] The recently revised National Standard 1 guidelines add several provisions to facilitate the incorporation of ecosystem-based fisheries management into federal fisheries management. National Standard 2 of the MSFCMA requires NMFS to conserve and manage fishery resources based upon the best available scientific information. To meet these mandates, NOAA's research must identify habitats that contribute most to the survival, growth, and productivity of managed fish species and determine science-based measures to best manage and conserve these habitats from adverse effects of human activities.

The approach for identifying EFH is described in the NMFS EFH regulations (Appendix 1). The regulations require that, at a minimum, distributional data (level 1 information) be used in the identification of EFH. This level 1 information is based on presence/absence data of the species or life stages in specific habitats used. Where possible, data sets and information on habitat-related densities of species (level 2), growth, reproduction and survival within habitats (level 3) and production rates by habitat (level 4) should be used to identify EFH. In Alaska, information for most commercial fish and crab species currently is level 1 or level 2, depending on the species and life stage, and no level 3 or level 4 information has been described. EFH research is conducted in part to elevate the EFH level for the studied species. While striving for level 4 information, the current goal of this research plan is level 3 information (see research objective 2, listed below).

Previous EFH Research Plans (AFSC 2006, Sigler et al. 2012) for Alaska have guided research to meet EFH mandates in Alaska since 2005. This document revises and supersedes these earlier plans, and similar to previous plans, is expected to guide the next several years of EFH research. Revisions of the EFH research plan (Sigler et al. 2012, this document) are timed to match required EFH 5-year reviews; the North Pacific Fishery Management Council (Council) and

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[1] NOAA Fisheries recommends measures to conserve EFH resulting from fishing and non-fishing activities. EFH measures conserve sensitive habitats and features necessary to fish for spawning, breeding, feeding, or growth to maturity. For fishing activities (such as trawling and fixed gears), recommendations may include gear restrictions, time and area closures, and gear modifications. For non-fishing activities (such as oil and gas exploration and development, port and harbor expansions, mining, and roadway construction), recommendations may include measures such as in-water work timing windows, alternative site selection, onshore disposal of dredge spoils, and methods to avoid, remove and remediate impacts from accidental discharge of oil.

NMFS are required by EFH regulations to review the EFH components within each fishery management plan (FMP) every 5 years. The objectives of these reviews are to evaluate and synthesize new information on habitat, determine whether changes to the FMPs are warranted, and present this evaluation in a summary report to the Council. These reviews summarize the status of EFH research, which then provides a basis for determining future research directions (i.e., this revised research plan).

The 2015 EFH review demonstrated a large advance in EFH information, in particular by substantially refining EFH maps for fish and crab species (Fisheries Leadership and Sustainability Forum 2016). The refinement occurred through an analysis to determine the environmental influences on species distributions and used this information to refine the EFH maps. These maps provide EFH Level 2 information (habitat-related densities) for the adult life stage for many FMP species and EFH Level 1 information (habitat distribution) for the juvenile life stages of some FMP species. These maps also provide a solid foundation for the next 5 years of EFH research.

Long-term Research Goals and 5-Year Research Objectives

A set of five long-term EFH research goals have guided EFH research in Alaska since 2005 (Appendix 2). These long-term goals have been consistent since 2005 with only minor modifications. We will continue to use these five long-term EFH goals as broad guidelines for EFH research in this update of the EFH research plan. Briefly these are as follows: 1) characterize habitat utilization and productivity; 2) assess habitat sensitivity and recovery; 3) validate and improve fishing impacts model; 4) map the seafloor; and 5) assess coastal habitats facing development.

Here we describe specific EFH research objectives to be accomplished in the next 5 years; that is, by the next EFH update. These objectives are more focused than the five long-term research goals and describe specific tasks to accomplish in the next 5 years. There are two research objectives for the next 5 years:

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

Objective 1: Develop EFH Level 1 Maps

Distribution information has not been fully developed for juvenile life stages of fish and crab species listed in the Gulf of Alaska, Bering Sea, and Aleutian Islands FMPs, as well as juvenile and adult life stages of fish and crab species listed in the Arctic FMP. The purpose of the first EFH research objective is to develop these maps where information is available for analysis, but this information has not yet been analyzed. One area with information available is settlement stage juveniles in the Gulf of Alaska, Bering Sea, and Aleutian Islands. Currently, many juvenile stage maps have been developed; this analysis would separate settlement and later stage juveniles (i.e., separate the juvenile stages based on length into early (settlement) and late juveniles, where practical (e.g., Pacific cod)).[2] Likewise, information is available for early life stages and adults of fish and crab species in the northern Bering, Chukchi and Beaufort seas, but has not been analyzed. The goal is to analyze all of these data sets to develop EFH Level 1 maps.

Objective 2: Raise EFH Level from Level 1 or Level 2 to Level 3

Habitat-related densities are available for the juvenile and adult life stages of most species listed in the Gulf of Alaska, Bering Sea, and Aleutian Islands FMPs. The next step is to incorporate habitat-related growth, survival, and reproductive rates into the EFH maps. In some cases, this incorporation also is possible for Level 1 species. There are two pathways for doing so. First, growth, survival, or reproductive rates are available for several species (Table 1). This information often was collected during laboratory studies (e.g., growth response to temperature of four gadid species [Laurel et al., 2016]). In these cases, analysis methods similar to those applied for the Level 1 and Level 2 maps could be applied to create Level 3 maps (Appendix 3). Second, additional laboratory and/or field studies could be conducted and this new information used to create Level 3 EFH maps. The performance objective for the number of species with Level 3 information examined through new studies after 5 years is 8-10 (assuming 2-3 years to conduct a study, 2-3 related species examined in each study and 1-2 studies conducted simultaneously).

Next 5-year EFH Plan (in ~2022)

Another large advance for the 2016 EFH update was the revision of the fishing effects model. The revised fishing effects model includes much more sediment information (250,000 vs. 2,000 sediment points) compared to the decade-old original model and adds recent recovery rate information. The revised fishing effects model provides estimates of the percent of EFH impacted by fishing based on Level 2 EFH information. A next step is to update the fishing effects model with Level 3 information. It is anticipated that sufficient Level 3 information will not become available until the 2022 EFH research plan revision.

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[2] Use the presence only (MaxEnt) approach to analyze nearshore fish survey, ADFG small mesh survey, and small size fish from bottom trawl survey in combination.

Research Approach

Integrated Proposals

To accomplish Objective 2, the primary research approach is to build integrated lab, field, and modeling studies, with the purpose of mapping, for example, the growth potential of the studied fish and crab species (Level 3 EFH). As for previous EFH research plans, studies that estimate functional relationships will be conducted (e.g., response of fish growth rate to a range of temperatures; Laurel et al. 2016). The difference for this research plan is that the functional response will be incorporated into a model and EFH Level 3 information mapped. The study components (lab and/or field components and the modeling) will be explicitly tied together, explained in the proposal, and then reported. Verification of EFH Level 3 maps should be conducted to confirm that results determined in the laboratory also occur in the field (*sensu* Rooper et al. 2016 for confirmation of EFH Level 2 maps). The addition of verification also differs from the approach of most previous EFH research. The expectation is that the lab and/or field research, modeling, and if completed, verification, will be reported together in a peer-reviewed publication.

Modeling

Currently species distribution models exist for EFH Level 1 and Level 2 information. To date, the Level 1 models have been presence-only maximum entropy or MaxEnt models (Phillips et al. 2006) and the Level 2 models have been based on generalized additive models (GAMs) predicting relative abundance (Wood 2006). These modeling approaches use different data sets, but both can be regional in scale and extended as Level 3 information is available (Appendix 3). These models are currently curated by Jodi Pirtle and Chris Rooper and we anticipate their roles will continue. They are constructing and parameterizing models and habitat metrics, as well as currently tracking life history stages and species where models can be developed or refined. These models can develop or refine EFH by constructing and parameterizing habitat metrics for a particular history life stage. For projects that collect new Level 3 information, project PIs will collaborate with the EFH model developers to incorporate project data into the regional models. PIs will be expected to consult with the modeler beforehand and describe the plan for incorporating data into the model in their proposal.

Reporting New EFH Information

The new EFH information will be integrated into the stock assessment process. Currently new habitat information is incorporated into the stock assessment process every 5 years with the EFH update. Going forward, this information will be provided to stock assessment authors as available through existing web locations. Most of the modeling is automated to the point that annual or biennial updates may become relatively simple. New models will be run as new data becomes available (including both the results of new field and lab studies as well as new density information and updated bathymetry (e.g., Zimmermann et al. 2013). In addition, the newly revamped Stock Profile and Ecosystem Considerations (SPEC) section of the Stock Assessment and Fishery Evaluation Reports (SAFE) allows for inclusion of EFH information in the stock assessment process (Shotwell et al. 2016). Relevant text descriptions and maps can be provided to the stock authors to be included within the SPEC framework.

The EFH information for Alaska will be provided in three web locations: the EFH mapper maintained by NOAA Fisheries Headquarters Office, the EFH maps archived by the Alaska Ocean Observing System (AOOS), and an Alaska Regional Office EFH web site which is the source web location for text and map descriptions and is maintained by Steve Lewis, NMFS Alaska Regional Office.

Request for Proposals

1. The request for proposals (RFP) will call for 2- to 3-year integrated proposals, as well as 1-year independent proposals (as before). Funding some 1-year proposals will maintain some flexibility in priority-setting (annual emphasis areas) and creativity from PIs. The integrated proposals can last no longer than 3 years.
2. The proportion of funds allocated to each proposal type will be two-thirds of the total for integrated proposals and one-third for independent proposals. For planning purposes, the amounts allocated to each category will assume $350,000 annually available for EFH projects, which is about the average amount spent the last few years. This new approach will have a staggered start for funding of integrated proposals: for FY 2018, one-third of funds will be allocated to integrated proposals, which will increase to two-thirds of funds for integrated proposals for FY 2019. In FY 2020, two-thirds of funds will support integrated proposals and one-third for independent proposals, anticipating that the third year of each integrated proposals will require only a small amount of funding (i.e., one-third of funding always will go toward individual proposals). Staggering the start will allow integrated proposal(s) to start each year, as seen in the following figure.

Year				
2018	2019	2020	2021	2022
Project A				
	Project B			
		Project C		

3. Retain tool of annual emphasis areas to maintain flexibility in research direction.
4. Each integrated proposal:
    a. Must provide deliverables for each year. These annual deliverables must be clearly stated in the proposal.
    b. Must demonstrate satisfactory progress each year to continue to receive funding. Progress will be described in annual status reports (as before). The HEPR Team will review these annual status reports to determine progress and to determine whether or not funding should continue.
    c. At the PIs choosing, integrated proposals may (but are not required to) describe what research would be completed if only one year of funding is available. For example, three integrated proposals may be submitted but funding sufficient only for one of the three. In this case, the other two could qualify for one-year funding. To also compete for one-year funding, briefly describe (one-page limit) the one-year project.

Plan Writing and Review

The writing team consisted of Mike Sigler (HEPR), Chris Rooper (RACE), Tom Helser (REFM, HEPR team), Bob Stone (ABL), Matthew Eagleton (AKRO, EFH coordinator), John Olson (AKRO, fishing effects), Jodi Pirtle (AKRO), and Samantha Simpson (AKRO). Each division of the AFSC which has conducted EFH research was represented on the writing team as well as the Alaska Regional Office. Draft plans were reviewed by the HEPR Team in February 2017. The new approach for writing EFH proposals was presented to interested AFSC staff in February 2017. Draft plans were communicated at the December 2016 Council meetings and the December 2016 AFSC Board of Directors meeting.

The review was based on the group's EFH research and stock assessment experience, the 2012 EFH research plan and two recent documents: 1) the AFSC science plan, which identified a habitat-related research priority[3] (AFSC 2016); 2) the North Pacific Fishery Management Council and NOAA Fisheries Alaska Region 5-year EFH review (NPFMC 2016). During 2006-2016, NOAA Fisheries spent about $5 M on 91 EFH projects in Alaska resulting in 74 scientific publications (NPFMC 2016).

[3] Forecast direct and indirect effects of climate change on fish, crab, and marine mammal species, their habitats, and the associated communities which rely on these resources.

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Table 1. -- Growth, survival, or reproductive rates are available for several species. EFH Level 3 maps can be created from this information. This table lists some examples.

Species name	Source
Arctic cod, saffron cod, Pacific cod, walleye pollock (growth)	Laurel et al. 2016
Yellowfin sole, northern rock sole, Alaska plaice (growth)	Matta et al. 2010, Black et al. 2013, Matta and Helser 2016
Pacific ocean perch (growth, bioenergetics)	Rooper et al. 2012, Van der Sleen et al. 2016
Rockfish (maturity)	Conrath et al. 2013
Many species (bioenergetics)	Heintz et al. 2013, Farley et al. 2016, Moss et al. 2016

Appendix 1. Definitions of EFH Levels

See 50 CFR § 600.815 (2002), Contents of Fishery Management Plans, 67 FR 2376
https://alaskafisheries.noaa.gov/sites/default/files/finalrules/efhfr.pdf

Level	Definition	Information necessary to describe and identify EFH
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.
2	Habitat-related densities of the species are available	At this level, quantitative data (i.e., density or relative abundance) are available for the habitats occupied by a species or life stage. Because the efficiency of sampling methods is often affected by habitat characteristics, strict quality assurance criteria should be used to ensure that density estimates are comparable among methods and habitats. Density data should reflect habitat utilization, and the degree that a habitat is utilized is assumed to be indicative of habitat value. When assessing habitat value on the basis of fish densities in this manner, temporal changes in habitat availability and utilization should be considered.
3	Growth, reproduction, or survival rates within habitats are available	At this level, data are available on habitat-related growth, reproduction, and/or survival by life stage. The habitats contributing the most to productivity should be those that support the highest growth, reproduction, and survival of the species (or life stage).
4	Production rates by habitat are available	At this level, data are available that directly relate the production rates of a species or life stage to habitat type, quantity, quality, and location. Essential habitats are those necessary to maintain fish production consistent with a sustainable fishery and the managed species' contribution to a healthy ecosystem.

Appendix 2. Core EFH Research Priorities

EFH Research Priorities

A set of five core EFH research goals have guided EFH research in Alaska since 2005 (AFSC 2006, Sigler et al. 2012). These core goals have been consistent since 2005 with only minor modifications. We will continue to use these five core EFH goals as broad guidelines for EFH research in this current update of the EFH research plan. These priorities support objectives of the AFSC Strategic Science Plan (AFSC 2016), including Theme 2 (Understand and forecast effects of climate change on marine ecosystems) and foci 2.5 (Forecast direct and indirect effects of climate change on fish, crab, and marine mammal species, their habitats, and the associated communities which rely on these resources). The five EFH research priorities are as follows:

Characterize Habitat Utilization and Productivity; Increase the Level of Information Available to Describe and Identify EFH; Apply Information from EFH Studies at Regional Scales – This priority focuses on understanding the relationship between habitat type, patterns of use by species, and differences between habitats in productivity of managed species. Our approach is to support integrated research projects that combine measurements of habitat characteristics, habitat utilization, and habitat productivity in one study, and also combine laboratory experiments, controlled field manipulations, and field observations. Our approach also includes conducting studies that support refining the description and identification of EFH in FMPs.

Assess Sensitivity, Impact, and Recovery of Disturbed Benthic Habitat – Habitat-forming biota such as corals and sponges often are sensitive to human activity and may take many years to recover from disturbance. Some managed fish and shellfish species use this habitat for protection and camouflage. Estimates of habitat impacts, sensitivity, and recovery, in both areal extent and temporal rates, are necessary to understand the effects of human activities. Recovery rates are defined as the rate of change of impacted habitat back to undisturbed habitat following disturbance. Sensitivity is defined as the susceptibility of habitat to degradation. Habitat may be affected by fishing and studies of sensitivity to and recovery from these effects are a priority. In addition, coastal areas often are affected by non-fishing impacts. Recovery and monitoring studies of impacted coastal areas, such as marine ports, are needed to determine if these sites have returned to their pre-utilization state following facility closure or development. Recovery rate studies remain as a high priority for habitat research.

Validate and Improve Habitat Impacts Model – A habitat impacts model has been used to estimate effects of fishing in Alaska, but the parameter estimates were not well resolved and had a high degree of uncertainty. Model validation remains a priority because the habitat impacts model played a key role in evaluating the effects of fishing and deciding on measures to conserve and protect habitat areas from fishing gear impacts (i.e., closure areas).

Map the Seafloor – Information characterizing fish habitat and utilization in Alaska is limited to coarse-scale depth and habitat information (e.g., nautical charts) and utilization information from AFSC surveys for the adult stage of commercially important species. Missing are fine-scale depth and habitat information, as well as juvenile stage information, especially nearshore. Seafloor mapping is costly and time-consuming. The research approach is to support low-cost mapping efforts with existing sampling platforms (e.g., trawl survey vessels, NOAA vessels) to reduce costs, as well as reanalysis of existing data.

Assess Coastal and Marine Habitats Facing Development – Characterization of coastal habitats susceptible to disturbance from non-fishing activities is a priority. These non-fishing activities include oil and gas development, logging, mining, urbanization, and contaminants. The research approach includes coastal habitat mapping (ShoreZone), as well as field surveys of a representative subset of the mapped habitats to measure fish and shellfish utilization. Priority coastal habitats for study are those utilized by managed fish and shellfish species and facing development pressure.

Appendix 3. Example of Level 3 Mapping

Growth Potential Estimated for Juvenile Pacific Ocean Perch in the Gulf of Alaska

Currently species distribution models exist for EFH Level 1 and Level 2 information (Fig. 1). To date, the Level 1 models have been presence-only maximum entropy or MaxEnt models (Phillips et al. 2006) and the Level 2 models have been based on generalized additive models (GAMs) predicting relative abundance (Wood 2006). These modeling approaches use different data sets, but both can be regional in scale and extended as Level 3 information is available and in possibly Level 4 information.

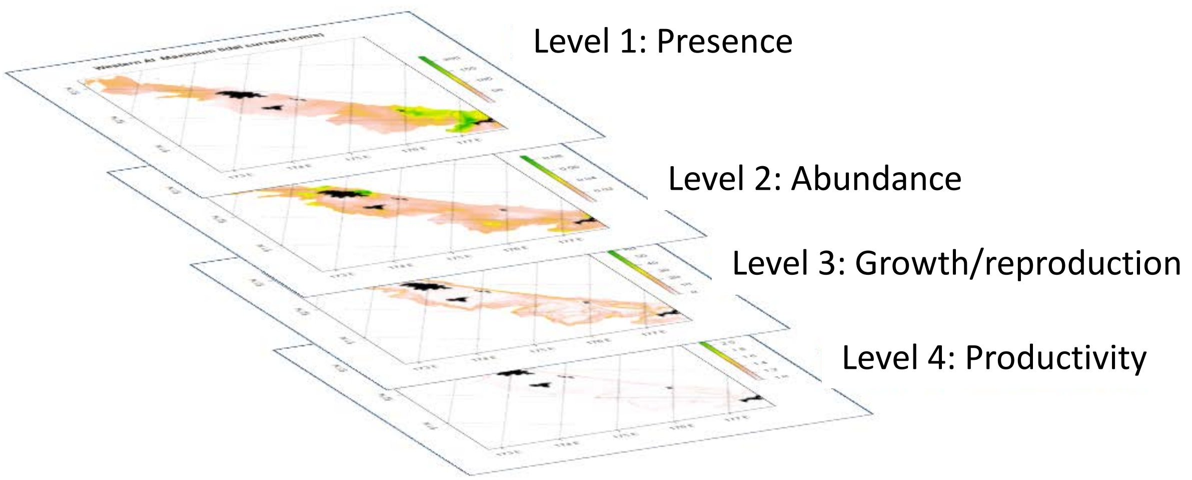

Figure 1. -- Examples of maps of Levels 1, 2, 3, and 4 information.

The mapping of growth potential for juvenile Pacific ocean perch (POP; *Sebastes alutus*) is an example of Level 3 information. Previous EFH research on juvenile POP in Alaska showed that this species is strongly associated with rocky habitats at depths from 85 to 245 m along mostly the continental shelf (Fig. 2). Deep-sea corals and sponges are often found in these nursery habitats. Densities of juvenile POP were predicted to be highest in the eastern and central Gulf of Alaska.

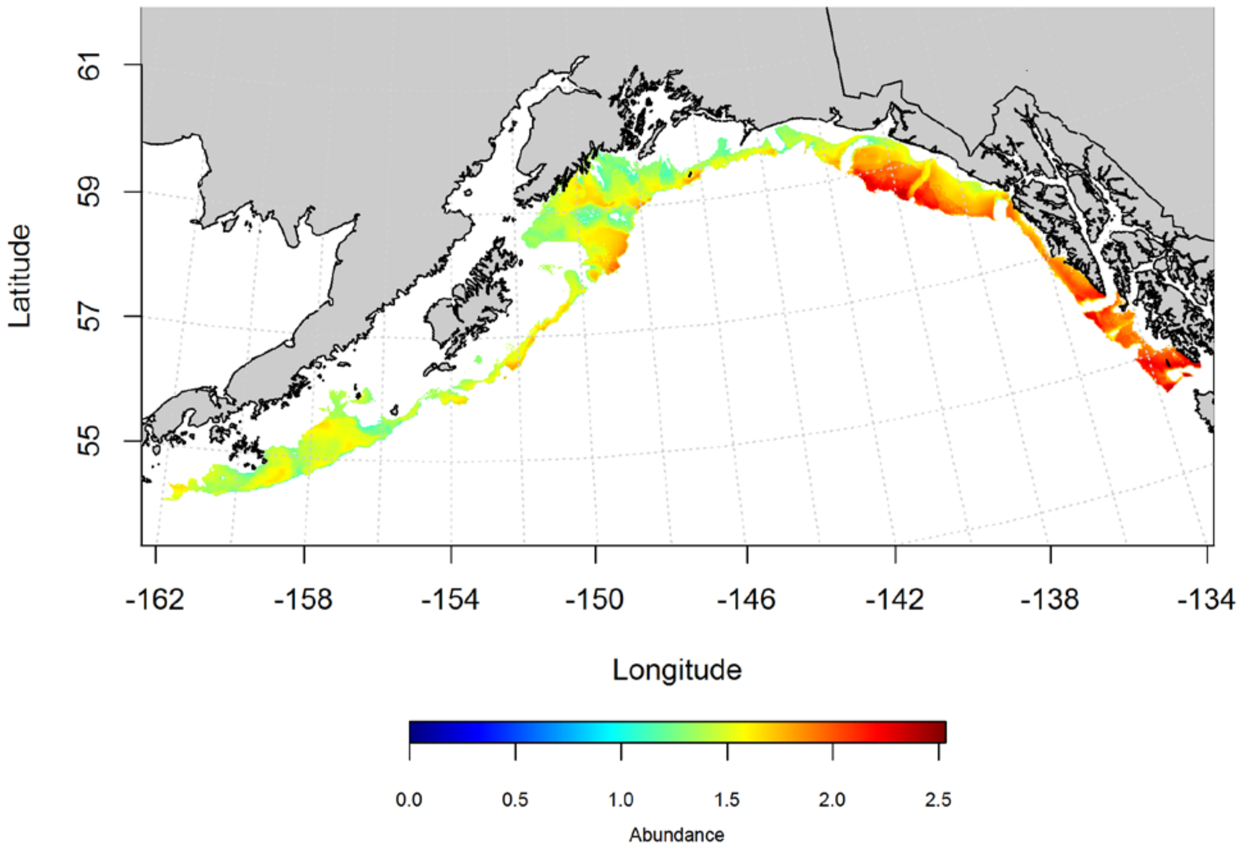

Figure 2. -- Predicted 4th root transformed catch-per-unit-of-effort of juvenile Pacific ocean perch (< 250 mm) in the Gulf of Alaska. The predictions were based on two-stage generalized additive models fit to bottom trawl survey catches from 1991 to 2014.

Based on the predicted distribution of juvenile POP abundance, EFH for juvenile POP habitat was widely distributed around the Gulf of Alaska near the continental shelf break (Fig. 3). Many of the shallow banks on the shelf (such as Portlock Bank, Albatross Bank, and Sanak Bank) as well as most of the shelf in the eastern Gulf of Alaska were predicted to be important habitats for juvenile POP.

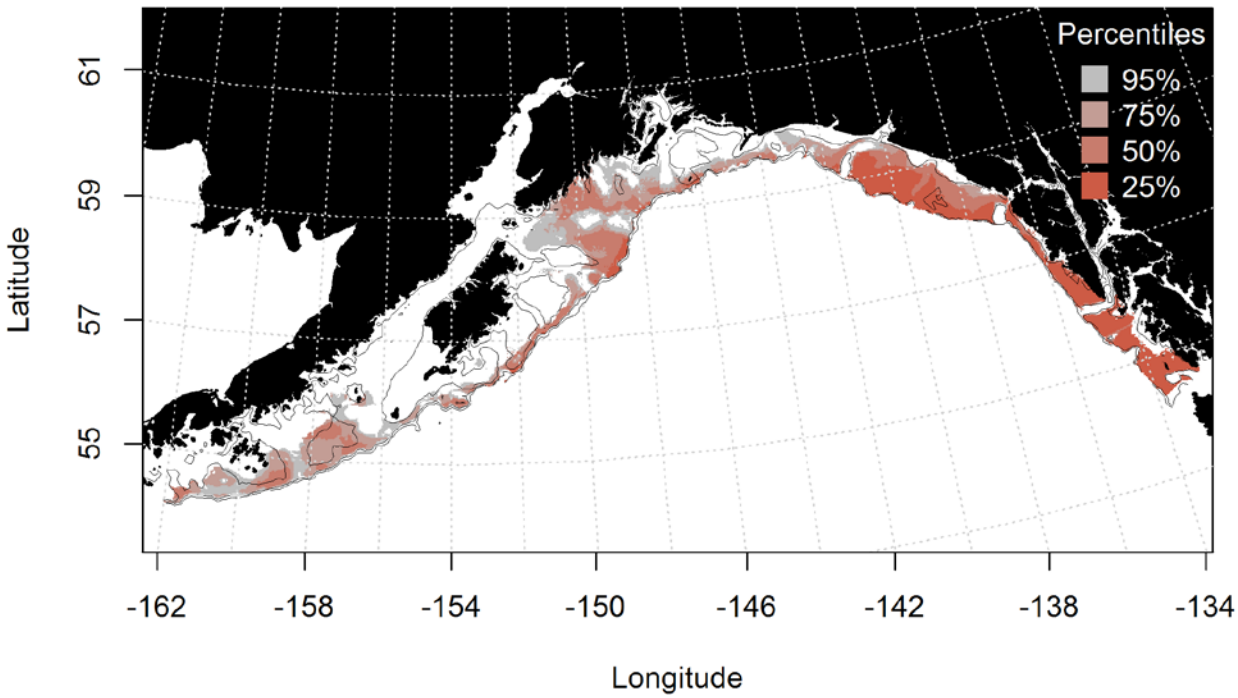

Figure 3. -- Essential fish habitat map for juvenile Pacific ocean perch (< 250 mm) in the Gulf of Alaska based on predictions from two-stage generalized additive models fit to bottom trawl survey catches from 1991 to 2014. Percentages indicate quantiles of predicted abundance (i.e., 25% indicates the top 25% of predicted juvenile POP abundance occurs within this color shade).

In 2012 a Wisconsin bioenergetics model (Hewett and Johnson 1992, Harvey 2005) was parameterized for juvenile POP (Rooper et al. 2012). The model used diet, energetics and growth data from field data and laboratory analyses collected during a series of EFH-funded studies in the eastern Aleutian Islands from 2003 to 2008 (Rooper et al. 2007, Boldt and Rooper 2009). This bioenergetics model predicted growth potential for juvenile POP given daily consumption (predicted from the field and laboratory data using a consumption model; Elliot and Persson 1978, Rooper and Haldorson 2000). The bioenergetics model was driven by monthly mean temperatures derived from relationships between satellite-derived sea-surface temperature (SST) and bottom trawl survey data. The model also incorporated the duration of the growing season inferred from continuous plankton recorder data from the central Gulf of Alaska (Batten and Mackas 2009). The model was run for 1982-2010 and growth predicted by the bioenergetics model was found to accurately predict growth measured in the field in the 2003-2008 Aleutian Islands EFH projects. Full details of the bioenergetics model and growth predictions are found in Rooper et al. (2012).

One of the outputs of the juvenile POP bioenergetics model was a spatially explicit calculation of growth potential for the Gulf of Alaska. This model in combination with the maps produced in

2015 (Fig. 4) can be used to estimate the growth potential in juvenile POP essential fish habitat (i.e., EFH Level 3). Averaged across all years (1987-2010), growth potential for juvenile POP in the Gulf of Alaska was highest in the eastern Gulf of Alaska (where water temperatures are generally higher in the summer) and lowest westward of Kodiak. This spatial pattern was consistent across most individual years (Fig. 5), but the temporal pattern across years was highly variable. For example, growth potential was almost uniformly higher in the 2002, 2003, and 2008 across the entire Gulf of Alaska, while growth potential was uniformly low in 2001 and 2009. The interannual variability is a combination of the interplay between the duration of the spring and summer zooplankton bloom and the water temperature during that bloom. For example, in 2005, there was an extremely short duration for the zooplankton bloom, yet water temperatures in the spring were the highest in the time series (Rooper et al. 2012). This resulted in about average growth potential for the year. In contrast, 2002 and 2003 had two of the longest durations of the zooplankton bloom and about average water temperatures, which resulted in 2 years of very high growth potential across the Gulf of Alaska.

The results presented here is a compilation of a variety of studies, with data and modeling from different areas and regions. As such, there are a number of sources of potential error. For example, the energetics values for POP were taken from only the far western Gulf of Alaska and were applied across the entire region. Predictions of EFH are based on data from the entire region, but there is some unexplained variability associated with the models of distribution. It is important that research on EFH provides adequate estimates of the error associated with predictions and seeks to address data gaps that may limit the regional application of study results.

These analyses show an example of integrating field and laboratory studies to determine vital rates (in this case potential for growth) and distribution models and maps to elevate EFH to Level 3 information for a species. Mapping growth potential to EFH distribution shows habitats and regions that potentially have more value in terms of productivity and are thus potentially more essential as fish habitat. This type of exercise could be done for other groundfish species in Alaska where there is some information from the laboratory or field to link through a model, vital rates (growth, survival, fecundity, etc.) to variables that can be measured on a broad scale. The new generation of regional ocean models (ROMS) for the North Pacific can potentially provide large-scale variables to explore and model Level 3 EFH processes on a Large Marine Ecosystem scale. Ideally, these Level 3 EFH descriptions would provide estimates of associated error that can be used to gauge confidence in the results.

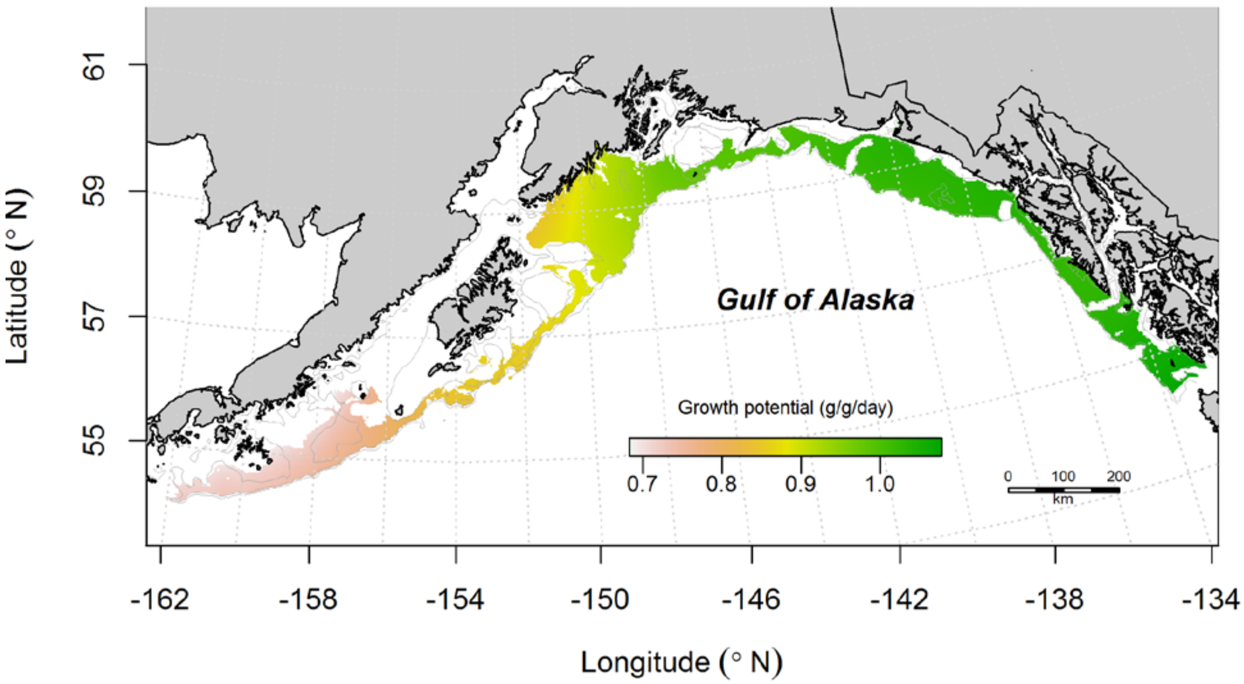

Figure 4. -- Map of predicted growth potential for juvenile Pacific ocean perch (< 250 mm) in the Gulf of Alaska within the boundaries of the defined EFH (Fig. 2). Growth potential (g/g body weight/day) was estimated using a bioenergetics model (Rooper et al. 2012) and averaged across 1987-2010.

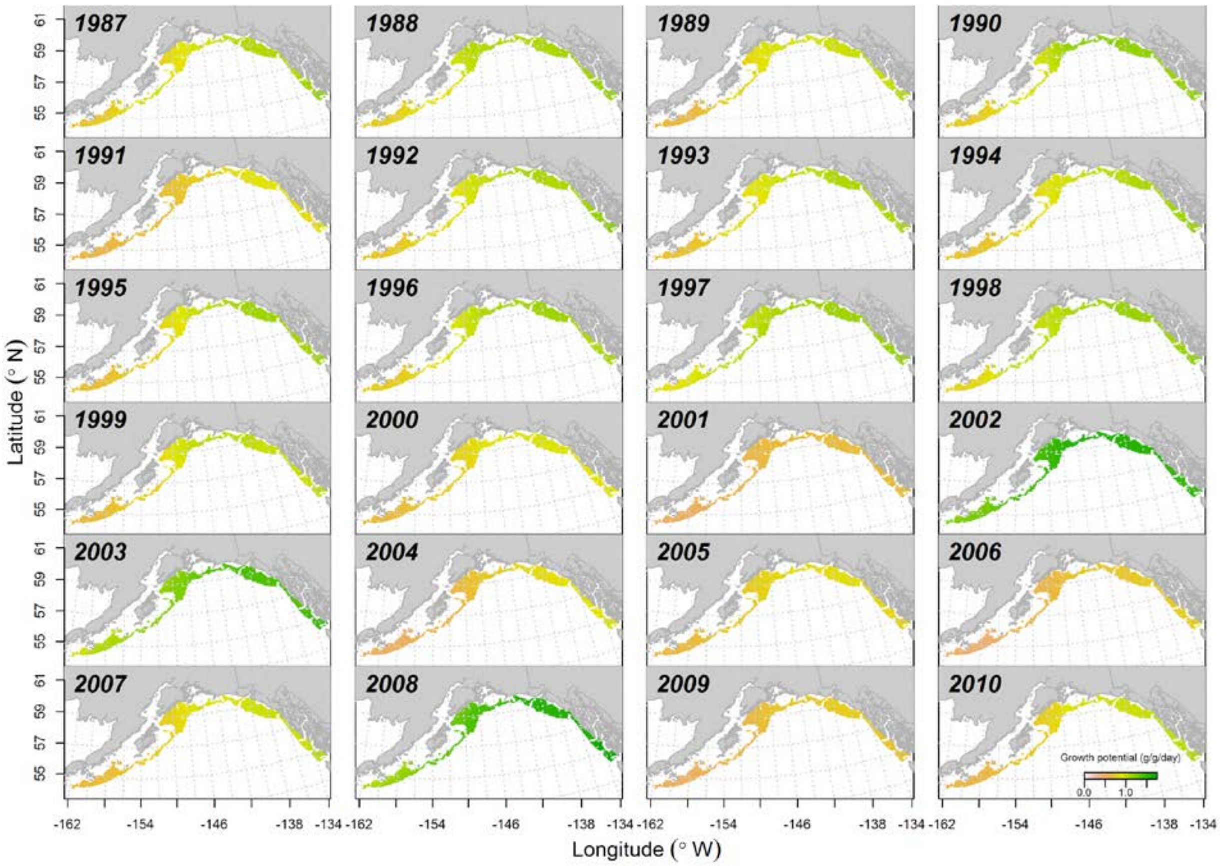

Figure 5. -- Map of summer predicted growth potential for juvenile Pacific ocean perch (< 250 mm) in the Gulf of Alaska within the boundaries of the defined EFH (Fig. 2). Growth potential (g/g body weight/day) was estimated using a bioenergetics model (Rooper et al. 2012) for 1987-2010.

Appendix 4. Template for Proposals

Write complete proposals that provide sufficient information for the review panel to judge your proposal.

Study duration (years) (circle one): 1 2 3

If multi-year, you may (but are not required to) describe what research would be completed if only one year of funding is available. To also compete for one-year funding, briefly describe (one-page limit) the one-year project. Indicate (yes/no) whether you also are competing for one-year funding.

Title

Principal Investigators:

Research Priority:

Justification:

Project Description:

Required Resources: Provide details of, for example, travel, rent (charters), equipment, and supplies (fuel)

Expected Products: List the milestones to be achieved each year, the products to be delivered upon completion, and when the milestones and products will be completed. Product descriptions should include the method of dissemination (e.g., refereed publication).

References:

Budget

Title

Object Class	Description	Amount ($)
1100	Direct Labor: Funds will not be approved for labor or benefits.	
1150	Overtime and hazard pay	
1200	Benefits: Funds will not be approved for labor or benefits.	
2100	Travel	

2200	Transportation	
2300	Rents (vessel charter)	
2400	Printing	
2500	Contracts: List name or type of contractor	
2600	Supplies and Materials: Itemize large items, group small stuff	
3100	Equipment: Itemize large items, group small stuff	
4100	Grants	
	Total	

Appendix 5. Form for Annual Report of Project Status

Essential Fish Habitat Project Status Report

Reporting date:

Project number:

Title:

PIs:

Funding year:

Funding amount:

Status: Complete   Incomplete, on schedule   Incomplete, behind schedule

Planned completion date if incomplete:

Reporting: Have the project results been reported? If yes, state where the results were reported and attach an electronic copy of the report.

Results: What is the most important result of the study?