

ADVANCING ESSENTIAL FISH HABITAT DESCRIPTIONS AND MAPS FOR THE 2022 5-YEAR REVIEW



NED LAMAN¹, JODI PIRTLE², JIM THORSON³

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- ¹ Groundfish Assessment Program (GAP), Alaska Fisheries Science Center (AFSC), Seattle, WA
- ² Habitat Conservation Division (HCD), NMFS Alaska Region, Juneau, AK
- ³ Habitat and Ecological Processes Research (HEPR) Program, AFSC, Seattle, WA

CONTRIBUTORS / AFFILIATIONS

Cheryl Barnes^{1,2,3}, Christina Conrath⁴, Louise Copeman^{5,6}, Alison Deary⁷, Matt Eagleton⁸, Georgina Gibson⁹, Gretchen Harrington¹, Jeremy Harris¹⁰, Tom Hurst⁵, Ben Laurel⁵, Jennifer Marsh^{1,11}, Franz Mueter¹¹, Chris Rooper¹², S. Kalei Shotwell¹³, William Stockhausen¹⁴

¹ Habitat Conservation Division (HCD), NMFS Alaska Region, Juneau, AK

² Habitat and Ecological Processes Research (HEPR) Program, AFSC, Seattle, WA

³ University of Washington, Seattle, WA

⁴ Groundfish Assessment Program (GAP), Alaska Fisheries Science Center (AFSC), Kodiak, AK

⁵ Fisheries Behavioral Ecology Program, AFSC, Newport, OR

⁶ Oregon State University (OSU), Newport, OR

⁷ Recruitment Processes Program, AFSC, Seattle, WA

⁸ HCD, NMFS Alaska Region, Anchorage, AK

⁹ University of Alaska Fairbanks, Fairbanks, AK

¹⁰ GAP, AFSC, Seattle, WA

¹¹ University of Alaska Fairbanks, Juneau, AK

¹² Department of Fisheries and Oceans, Nanaimo, BC, Canada

¹³ Resource Ecology and Fisheries Management (REFM), AFSC, Juneau, AK

¹⁴ REFM, AFSC, Seattle, WA



OUTLINE

Research

Advancing EFH for North Pacific Species in Alaska (*Laman et al.*)

First Arctic Model-based EFH (*Marsh et al.*)

Juvenile Walleye Pollock Thermal Habitat (*Laurel et al.*)

Individual-based Models to Advance EFH (*Shotwell et al.*)

Discussion Topics

How to Construct EFH from SDM

Skill Testing and Model Selection

Mapping EFH Level 3 Information

Individual-based Models and EFH



ADVANCING EFH FOR NORTH PACIFIC SPECIES IN ALASKA (*LAMAN et al.*)

Since the 2017 EFH Review:

- 5 bottom trawl survey years added
- Improved GOA bathymetry
- Introduced nearshore data and early juvenile life stage – None to Level 2
- Updated maturity schedules and redefined life stages
- Modeling refinements – None and Level 1 to Level 2
- Skill testing and model selection
- Habitat-linked growth potential – Level 3



UPDATING EFH MAPS (*LAMAN et al.*)

Changes in the areal extent of EFH were species-specific and largely attributable to life stage redefinitions or to modeling refinements

Groundfishes:

EFH Area:

Change attributed to:

EBS adult sablefish

↓↓

Life stages redefined, Poisson model

GOA subadult Pacific cod

↓↓

Poisson model, updated covariates

GOA adult Pacific cod

↓

Poisson model

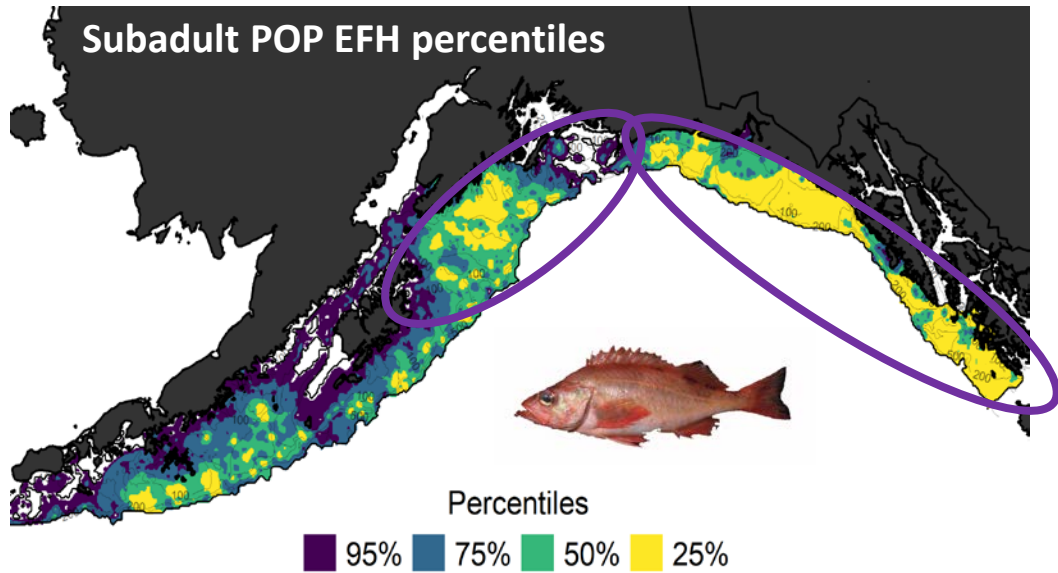
GOA subadult POP

↑↑↑

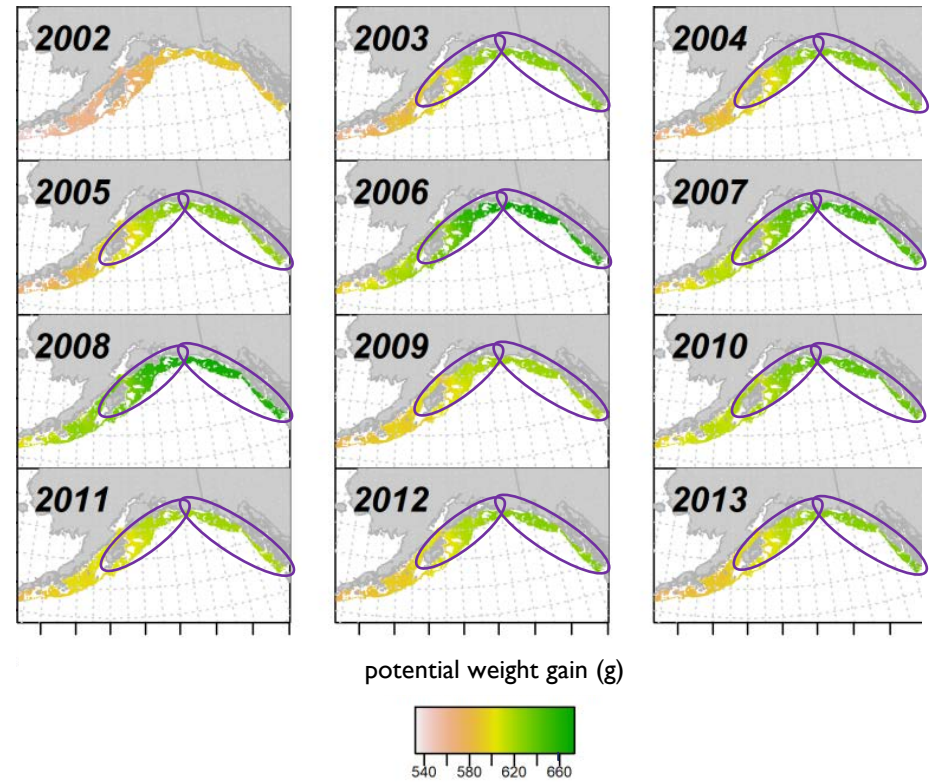
Contrasting models – skill testing



LEVEL 3 EFH: CO-MAPPING TO LINK SDM PREDICTIONS WITH VITAL RATES FOR EFH MAPS (*LAMAN et al.*)



Areas with the top 25% of SDM-predicted abundance (“hot spots”) roughly correspond to areas of perennially higher growth potential

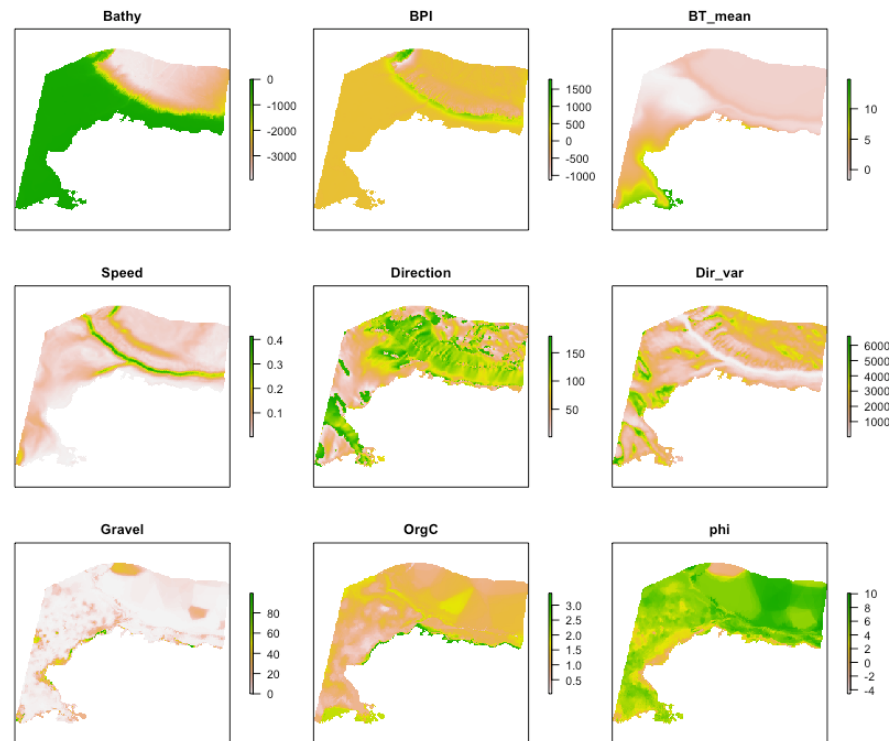


Temperature-dependent subadult POP summer growth

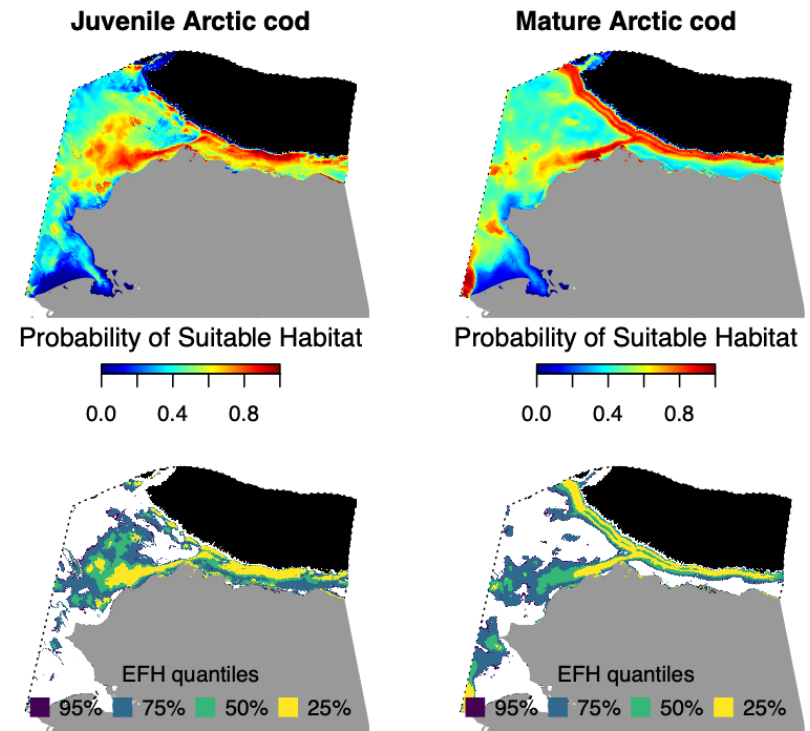


FIRST U.S. ARCTIC MODEL-BASED EFH (MARSH *et al.*)

Arctic SDM-based EFH descriptions and maps for Arctic cod, saffron cod, and snow crab



SDM covariates

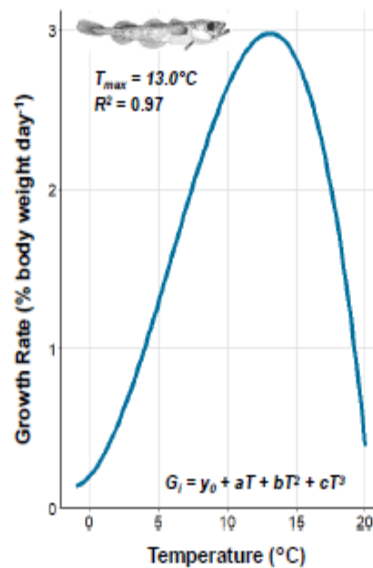


SDM maps and SDM-based EFH maps

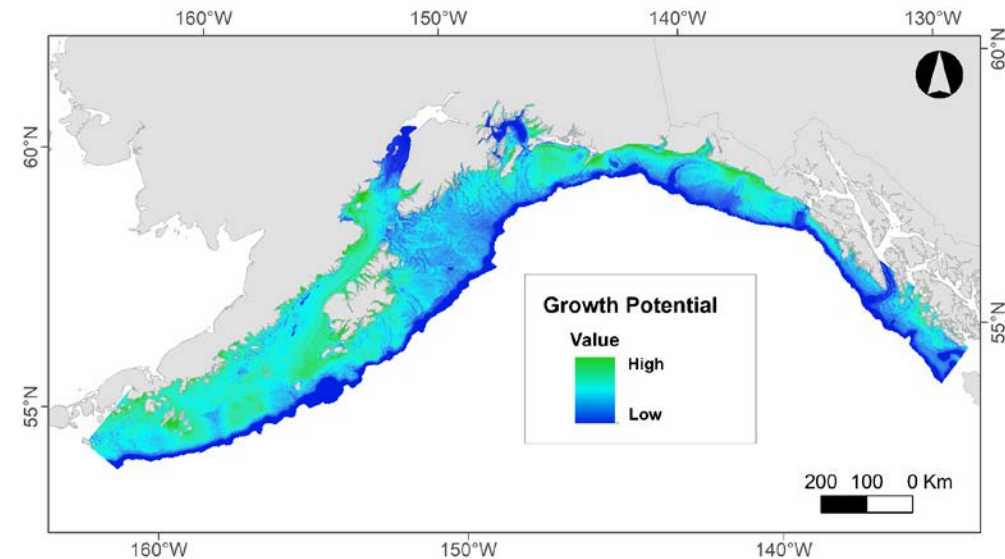
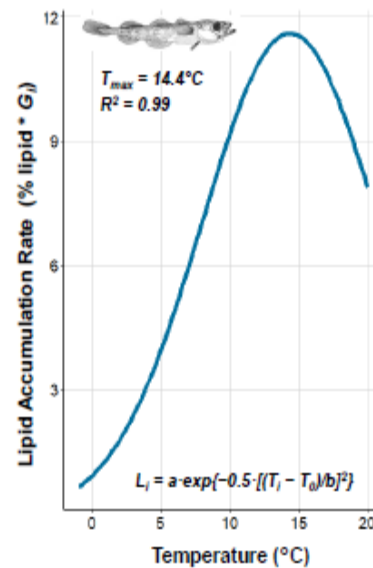


LEVEL 3 EFH: THERMAL HABITAT FOR JUVENILE WALLEYE POLLOCK (LAUREL *et al.*)

- Early juvenile stage pollock (40-120 mm)
- Laboratory studies identified temperature-dependent growth and lipid accumulation (condition) rates for summer and winter
- Map is the *product* of summer growth rate and an SDM



Vital rates as $f(\text{temperature})$



Habitat-related growth potential



INDIVIDUAL-BASED MODELS (IBM) TO ADVANCE EFH (*SHOTWELL et al.*)

EFH Level 1: Initial IBM run will create the presence/absence map – life stage trajectory of survivors (**Fig. 1**).



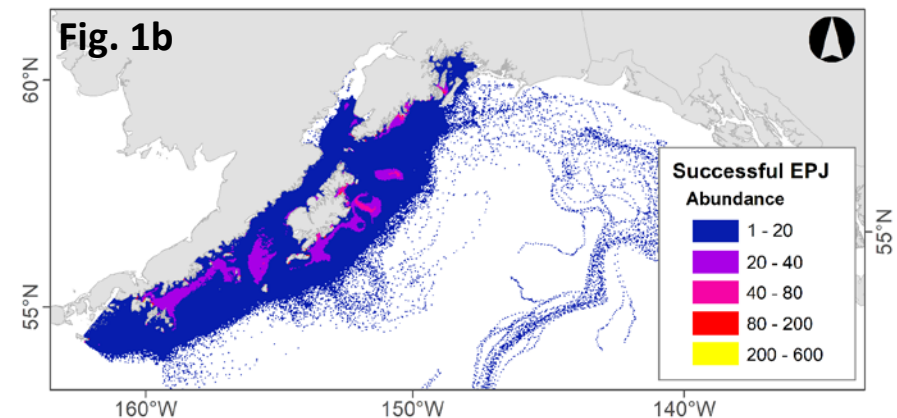
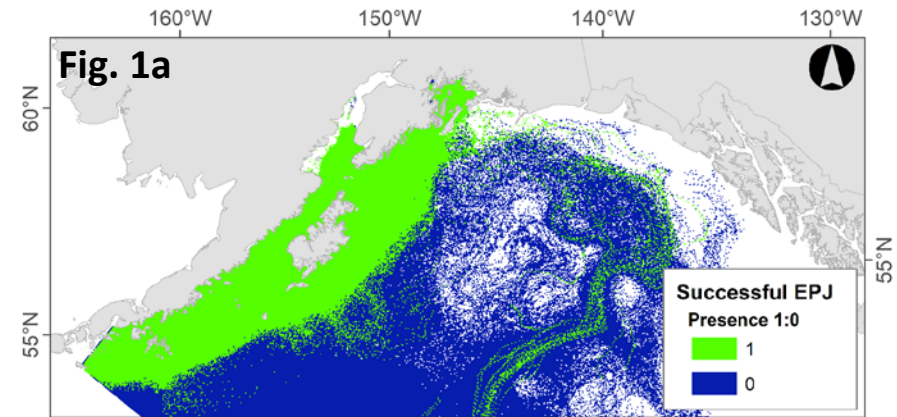
EFH Level 2: Model trajectories are post-processed with spatially-explicit spawning biomass information to create the relative abundance map.



EFH Level 3: Trajectories are further post-processed with vital rates to create maps of habitat-related survival and growth potential.



IBMs for Alaska Sablefish and GOA Pacific cod



Pacific cod successful epipelagic juveniles



DISCUSSION TOPICS

- 1) How to Construct EFH from SDM
- 2) Skill Testing and Model Selection
- 3) Mapping EFH Level 3 information
- 4) Individual-based models and EFH



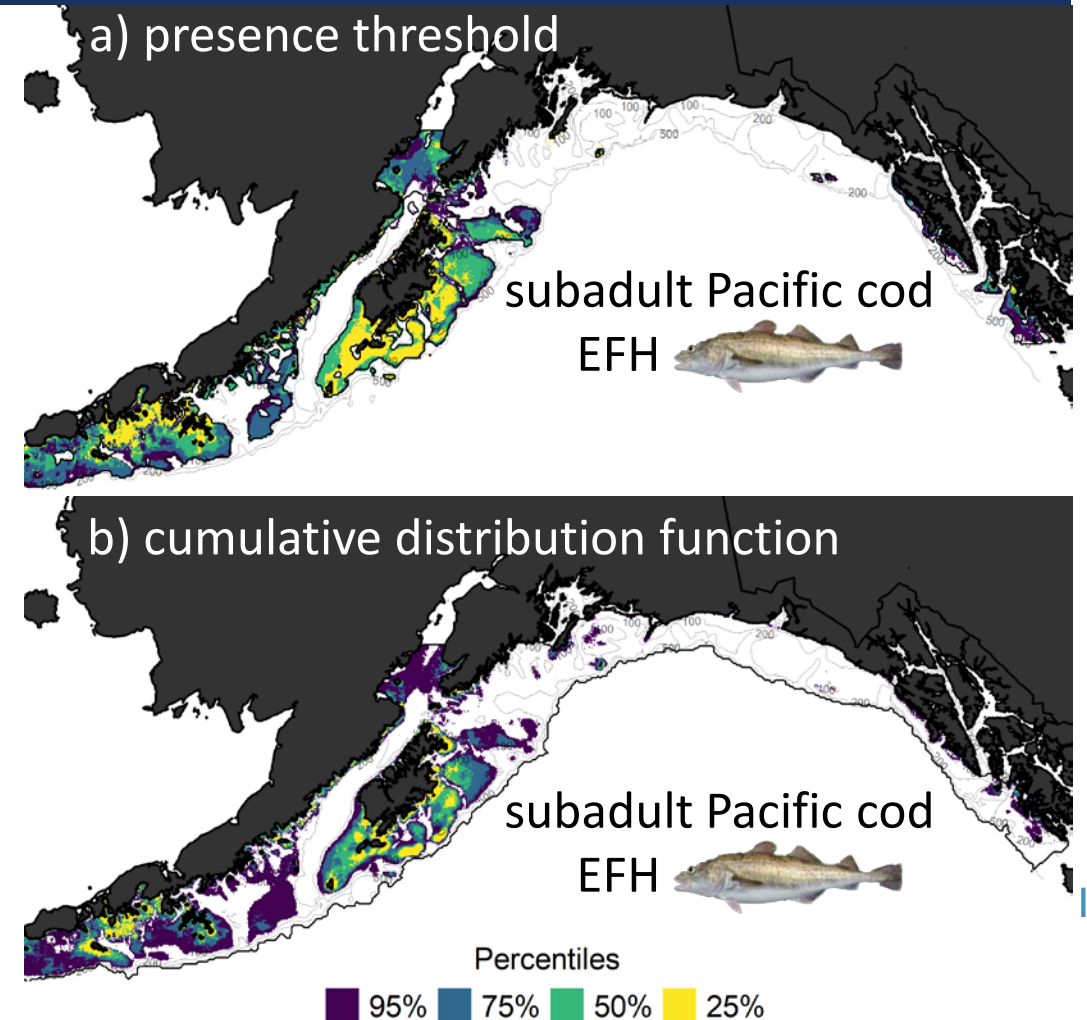
1) HOW TO CONSTRUCT EFH FROM SDM

Currently:

- Minimum threshold for presence values \leq minimum abundance or probability considered absent (2017 Review and Laman *et al.* 2020)

Recommended:

- Cumulative distribution function (2022 5-year EFH Review)



2) SKILL TESTING AND MODEL SELECTION

2017 Review (*a priori* assignment)

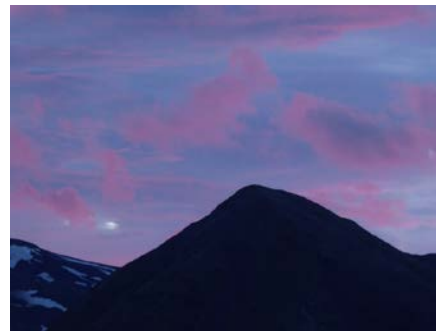
- Maxent
- hGAM
- GAM

2020 Laman *et al.* (skill testing)

- Maxent
- hGAM
- GAM
- paGAM

2022 Review (skill testing)

- Maxent
- hGAM
- GAM
- paGAM
- Negative binomial
- quasi-Poisson
- Ensemble



2 (cont'd) EVALUATING MODEL PERFORMANCE (“SKILL TESTING”)

Root-mean-square-error

$$RMSE = \sqrt{\frac{\sum_i^{20} \sum_j^{n_i} (y_{ij} - x_{ij})^2}{\sum_i^{20} n_i}}$$

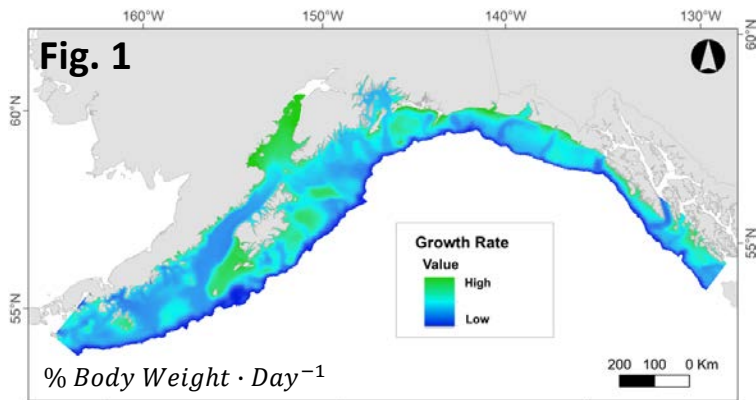
where

y_{ij} is the predicted numerical abundance,
 x_{ij} is the observed numerical abundance at trawl
station j in cross validation fold i , and
 n_i is the number of trawl stations sampled in the
 i th fold

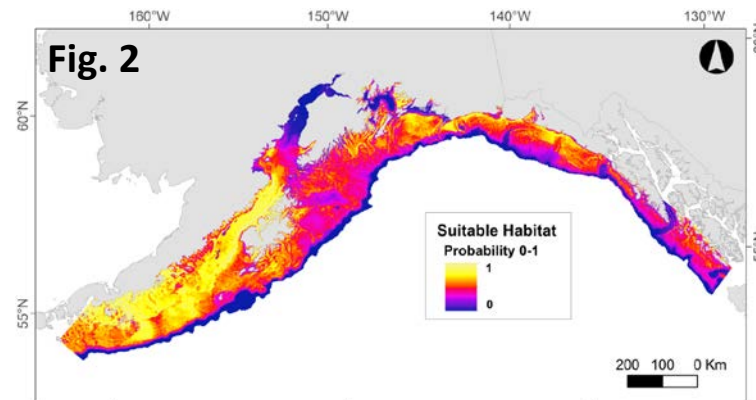


3) INTEGRATING VITAL RATES AND SDM TO MAP EFH LEVEL 3

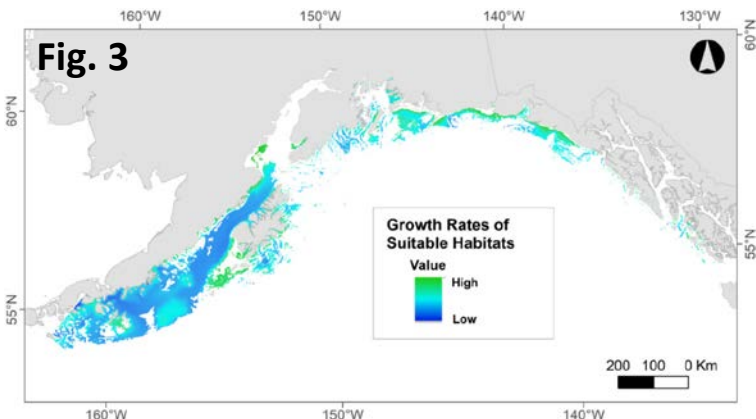
Early Juvenile Walleye Pollock (40-120 mm)



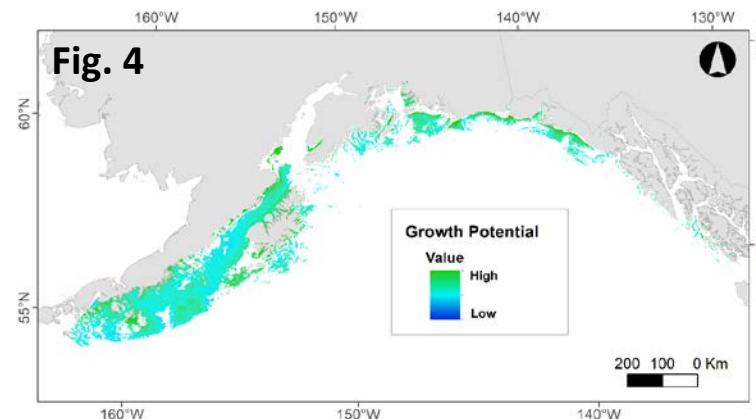
Temperature-dependent growth rate



Early juvenile pollock habitat suitability



Growth rates of suitable habitat (co-mapping)

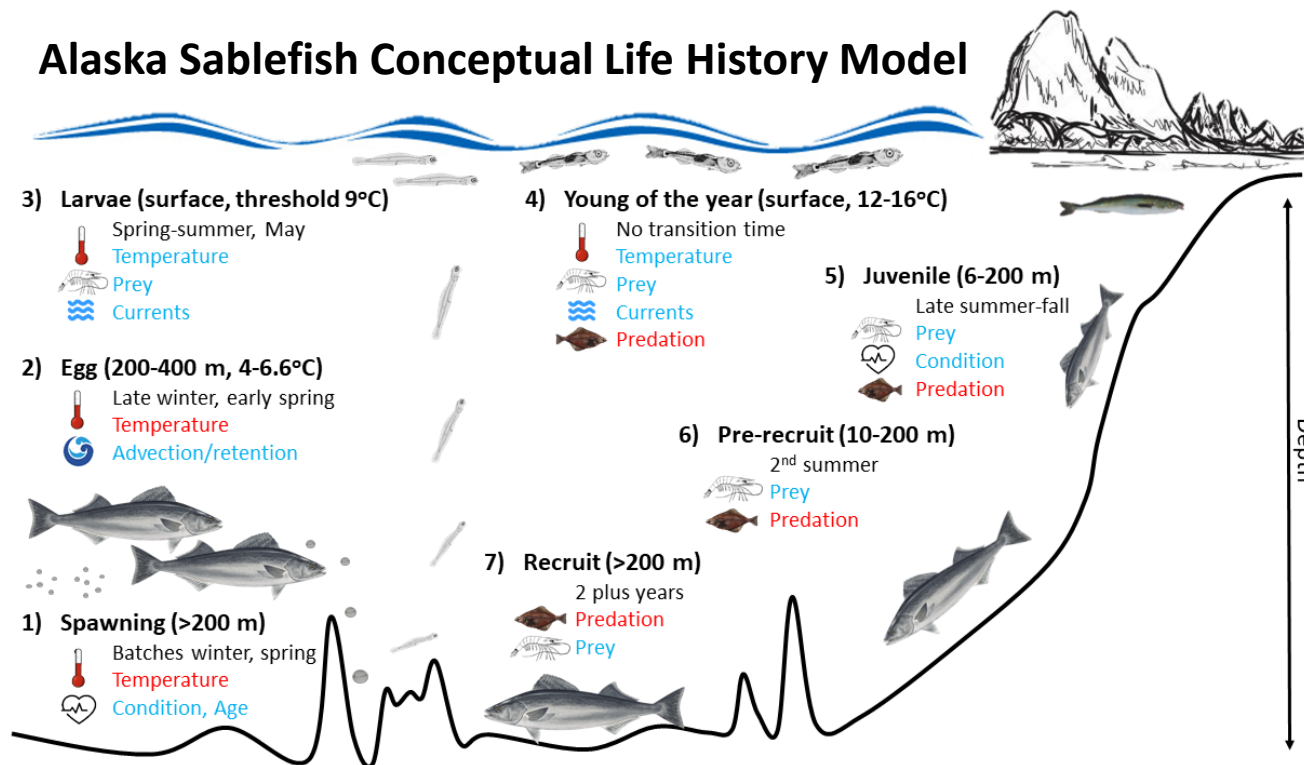


Habitat-related growth potential (product)



4) INDIVIDUAL-BASED MODELS (IBM) TO DESCRIBE AND MAP EFH

Alaska Sablefish Conceptual Life History Model



How do we use survey data and IBMs to inform EFH?

- 2017 Review – survey data in pelagic early life stage SDMs (EFH Level 1)
- 2022 Review – survey data and process studies inform IBMs (EFH Level 1, 2, and 3)
- Future Directions



THANK YOU



NED LAMAN

NED.LAMAN@NOAA.GOV

206-526-4832

JODI PIRTLE

JODI.PIRTLE@NOAA.GOV

907-586-7006