



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center
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DATE: May 5, 2021
MEMORANDUM FOR: AFSC GAP, SAP, SSMA, MESA, ABL, HEPR
FROM: Lewis Barnett, Cecilia O'Leary, Jason Conner, James Thorson
SUBJECT: **Terms of reference for model-based abundance and distribution estimates in support of 2021 stock assessment and fishery evaluation reports**

Purpose

Provide model-based estimates of abundance, distribution or age composition from AFSC Groundfish Assessment Program (GAP) bottom trawl survey data to stock assessment authors and other requestors on a similar timeline as their equivalent design-based estimates. Such estimates can be included within stock assessment models or related analyses and reports (such as stock assessment and fishery evaluation, or SAFE reports), and may be subject to review by the relevant North Pacific Fishery Management Council Plan Team and Scientific and Statistical Committee (SSC). This planning document provides an outline of the process for development and delivery of model-based index products and serves as the Terms of Reference (TOR) for these products.

Background

GAP began developing model-based estimates of abundance, distribution, and age composition in 2019. Spatiotemporal generalized linear mixed-effect models (GLMMs), as implemented using the Vector Autoregressive Spatio-Temporal (VAST) framework was selected as the primary tool for index development given that 1) this approach has been reviewed and approved for use in groundfish stock assessments in neighboring regions (by the Pacific Fishery Management Council SSC for use in NWFSC stock assessments), and 2) there is a large body of peer-reviewed journal articles demonstrating the utility and features of the framework. GAP seeks to continue to provide indices using this framework, with a vision to expand the tools and methods used to produce model-based indices from survey data in future years.

Species Requests

- Use the tracking Google Sheet (see Resources) to request products. Products requested for the current assessment year are summarized by species, region and type of data product in Table 1.
- Prioritize each request by:
 - High - will be used in SAFE or published report
 - Medium - will be included in preliminary models
 - Low - of interest only to assessment author
- Optional step: include any desired settings if different from initial model settings (specified in Table 2)

Model-based Index Products

- Abundance indices, age compositions, or area occupied and center-of-gravity (for Ecosystem and Socioeconomic Profiles, ESPs). Each will be made available as a hindcast (model fitted to data prior to the current assessment year) and as a production version (model fitted to data including the current assessment year).
- Standard documentation of methods, by region
- Standard model diagnostics

Index Development Process

- Hindcast
 - Coordinate software versions, data extraction, computing resources
 - Use tracking Google Sheet (see Resources) to document settings
 - Run model at initial reference settings
 - Discuss initial results with requestor
 - Explore up to two alternate settings as needed or requested, while documenting any changes
 - Freeze code for version of product accepted by requestor
- Production
 - Once data QA/QC is completed, fit model using accepted settings and deliver outputs

Timeline

- February 8, 2021 - Planning meeting with program leads
- March 1, 2021 - Species requests/prioritizations submitted
- March 15, 2021 - TOR finalized
- April 1, 2021 - Crab hindcasts completed
- May 1, 2021 - Groundfish hindcasts completed
- August 25, 2021 - Model-based estimates for EBS crabs completed
- September 25, 2021 - Model-based estimates for NBS crabs completed
- September 30, 2021- Model-based estimates for groundfishes completed (NBS may take longer)

Resources

- [Project Requests and Tracking by Region/Species](#)
- [Project Google Drive](#)

Table 1. Model-based indices requested by assessment authors. Priority is based on intended usage: High - will be used in SAFE or published report; Medium - will be included in preliminary models; Low - of interest only to the author. Products include abundance indices (Abundance), age compositions (Age comps), or area occupied and center-of-gravity (for ESP).

Region	Stock/Species	Priority	Requestor Name	Recipient Program	Analyst	Product
EBS & NBS	pollock	High	Jim Ianelli	SSMA	Caitlin Allen-Akselrud	Abundance
EBS & NBS	pollock	High	Jim Ianelli	SSMA	Caitlin Allen-Akselrud	Age comps
EBS & NBS	Pacific cod	High	Grant Thompson	SSMA	Jason Conner	Abundance
EBS & NBS	Pacific cod	High	Grant Thompson	SSMA	Jason Conner	Age comps
EBS & NBS	Pacific cod	High	Kalei Shotwell	SSMA	Jason Conner	ESP
EBS & NBS	pollock	Medium	Kalei Shotwell	SSMA	Caitlin Allen-Akselrud	ESP
EBS	Yellowfin sole	Medium	Ingrid Spies	SSMA	Emily Markowitz	Abundance
EBS	Yellowfin sole	Medium	Ingrid Spies	SSMA	Emily Markowitz	Age comps
BS	Bristol Bay red king crab	High	Erin Fedewa	SAP	Jon Richar	ESP
BS	Snow crab	Medium	Erin Fedewa	SAP	Jon Richar	ESP
BS	Bairdi crab	Medium/High	William Stockhausen	SSMA	Jon Richar	Abundance
BS	Snow crab	Medium/High	Cody Szuwalski	SSMA	Jon Richar	Abundance
BS	Bristol Bay red king crab	High	Jie Zheng	ADFG	Jon Richar	Abundance
BS	Norton Sound red king crab	Medium/High	Hamachan Hamazaki	ADFG	Jon Richar	Abundance
GOA	northern rockfish	High	Ben Williams	MESA	Madison Hall	Abundance
GOA	POP	High	Pete Hulson	MESA	Madison Hall	Abundance
GOA	Pacific cod	High	Kalei Shotwell	SSMA	Zack Oyafuso	ESP
GOA	pollock	High	Kalei Shotwell	SSMA	Zack Oyafuso	ESP
GOA	arrowtooth	Low	Kalei Shotwell	SSMA	Paul von Szalay	Abundance
GOA	arrowtooth	Low	Kalei Shotwell	SSMA	Paul von Szalay	ESP
GOA	pollock	High	Martin Dorn	SSMA	Paul von Szalay	Abundance
GOA	dusky rockfish	High	Kari Fenske	MESA	Cecilia O'Leary	Abundance
GOA	northern rock sole	Medium	Meaghan Bryan	SSMA	Cecilia O'Leary	Abundance
GOA	southern rock sole	Medium	Meaghan Bryan	SSMA	Cecilia O'Leary	Abundance
GOA	rock sole unid.	Medium	Meaghan Bryan	SSMA	Cecilia O'Leary	Abundance
GOA	flathead sole	Low	Cole Monnahan	SSMA	Cecilia O'Leary	Abundance

Table 2. Initial model settings used to generate model-based indices. Versions of software and key dependencies: VAST 3.6.1; .cpp VAST_v12_0_0; Matrix 1.2.18, TMB 1.7.18.

Initial model setting	Suggested alternative setting (if needed)
purpose = "index2" in make_settings()	NA
knots = 750 in make_settings()	knots = 1000
delta-gamma observation model: ObsModel = c(2,1) in make_settings()	option 2: Tweedie ObsModel = c(10,2) option 3: delta-lognormal ObsModel = c(1,1)
knot_method = 'grid' in fit_model()	knot_method = 'samples' if necessary to aid convergence or for comparison to a previous model fit.
fine_scale = TRUE in make_settings()	NA
bias.correct = TRUE in make_settings()	NA
spatiotemporal fields: "IID" default settings for FieldConfig in make_settings()	model spatiotemporal components (epsilon) as a first-order autoregressive process "AR1" (required for extremely unbalanced data) or "0" (if necessary to aid convergence)
anisotropy is on (use_anisotropy = TRUE) in make_settings()	anisotropy off (use_anisotropy = FALSE) if necessary to aid convergence
no vessel effects, catchability or density covariates in fit_model()	may include covariates in cases where their incorporation has been previously demonstrated to improve model fit (e.g., a spatially varying response to cold-pool extent when generating abundance indices combining the EBS and NBS)