



BSAI Crab Plan Team Modeling Workshop REPORT

January 14 & 15, 2025

NPFMC Offices, Anchorage, AK

Hybrid Meeting

Committee Members in attendance:

Katie Palof, **Co-Chair** (ADF&G-Juneau)

Mike Litzow, **Co-Chair** (AFSC-Kodiak)

Anita Kroska, **Coordinator** (NPFMC)

André Punt (Univ. of Washington)

Cody Szuwalski (AFSC-Seattle)

Tyler Jackson (ADF&G-Kodiak)

William Stockhausen (AFSC-Seattle)

Members absent: Ben Daly (ADF&G-Kodiak), Brian Garber-Yonts (AFSC-Seattle), Erin Fedewa (AFSC-Kodiak), Ethan Nichols (ADF&G-Dutch Harbor), Ginny Eckert (UAF/CFOS-Juneau), William Bechtol (UAF-Homer), *Vacant, quantitative expert*

Modeling Workshop

Assessment authors, some members of the CPT, and others interested in crab modeling met during a 2-day workshop prior to the May CPT meeting. The agenda for this meeting included a range of topics but focused on GMACS updates and implementation for new stocks, guidelines for diagnostics, and other ongoing research questions within the crab assessment framework.

GMACS

General Model for Assessing Crustacean Stocks (GMACS) updates and ongoing improvements to the framework were discussed during this meeting. These included implementing a more consistent framework for version control updates on GitHub, reviewing changes made to GMACS in the last year, and assessing the current status of the GMACS to-do list.

The GMACS Project is an umbrella GitHub organization for repositories related to GMACS (<https://github.com/GMACS-project>). Within the Project website, the repository for the latest version of the GMACS ADMB code (https://github.com/GMACS-project/GMACS_tpl-cpp_code) now hosts a GMACS to-do list in the “issues” tab. This provides a centralized place to keep track of changes that need to be made to the code or output. The Project also now hosts a repo (https://github.com/GMACS-project/GMACS_Models) that includes recent versions of GMACS models for most stocks that use GMACS to facilitate version control and simplify testing when updates are made to the base GMACS code. While the contents of these repos existed previously,

Buck (William Stockhausen) established a more streamlined workflow that adapts to the current needs of GMACS users.

During the meeting, edits to the GMACS code occurred. These included: adjusting the OFL calculations to include multiple directed fleets (for NSRKC) and revisions to how size composition data is aggregated - including auto tail compression and how effective sample sizes are calculated in this process, as well as some general cleanup of the code. A new platform-independent approach to building the GMACS executable based on CMake was also introduced, simplifying builds on both Windows and OSX machines. The most recent version of the GMACS code and input files can be found in the repositories listed above.

The group of GMACS users and developers also discussed transitioning GMACS from ADMB to RTMB in the near future. This is something that Buck and Grant Adams (AFSC - Seattle) are working on, and they informed the group of an internal NOAA workshop in March that would be an introduction to RTMB. The group expects to have updates on this multi-year transition at May CPT.

Spatio-temporal indices

Emily Ryznar (NMFS - Kodiak), Caitlin Stern (ADF&G - Juneau), and Jon Richar (NMFS - Kodiak) presented initial work on comparing VAST and sdmTMB for constructing model-based indices of survey data. Bering Sea Tanner crab, St. Matthew Island blue king crab (SMBKC), and Norton Sound red king crab (NSRKC) were used as example species/stocks. The goal was to compare the best sdmTMB model with the best VAST model for each stock, similar to what has been done for groundfish.

The decision points included the number of knots in the models, the spatiotemporal random field estimation and the observation model family. The consensus with the group was that current assessments assume independence in the survey from year to year, leading to temporal IID being the most appropriate random field estimation for use in stock assessment. The discussion included the importance of the variance co-variance matrix as a tool to determine the appropriateness of the models. The importance of taking into account “island effects” for SMBKC was also discussed: this should be included in the sdmTMB model since it is currently in the VAST one.

The sdmTMB framework includes options for a “sanity check”, model diagnostics, and predictive skill diagnostics that allow for increased ease of use for users and also provide diagnostics that reviewers (i.e., the CPT and SSC) can use to determine the appropriateness of model choices.

Tanner crab models included models fit on abundance, biomass, all males, mature females, and immature females, also fit separately for pre-1982 and post-1982. Models were fit using data from the entire EBS and then predicted for the entire EBS as well as Tanner east and west stocks. A range of model families and random fields were examined. The best sdmTMB model for Tanner crab depended on the data inputs. Overall, the delta-gamma using 50 knots had the best overall predictive skill and was similar to the design-based survey estimates post-1982. There was

discussion on which bias corrections were being used in sdmTMB and VAST. The authors looked for feedback on if there should be specific model frameworks for time period or sex-maturity category and how to balance model diagnostics versus visual fits to observations.

St. Matthew blue king crab models were examined and are needed since the corner stations are likely not going to be sampled in the future, and a model-based index would allow for the same data set to be used throughout time. The best models for SMBKC were the Tweedie using 90 knots with a random walk, although discussion centered around whether the random walk was appropriate for data that would be inputted into a stock assessment. Discussion also focused around ensuring that the model considers the island effect, which the current VAST model does. The compared VAST model was IID, not RW so it was not a similar comparison.

The group discussed what the decision criteria should be to decide between sdmTMB or VAST, especially if they produce similar results. There was discussion on how they have different functionality, but folks appear to be moving to sdmTMB for ease of use and run time. There was discussion on using IID for assessments due to issues with temporal correlations in the RW and AR1 models making each survey non-independent.

NSRKC models were still under development and there were questions on if or how the three different surveys time series (historic NOAA trawl, ADF&G trawl, and NBS trawl survey) should or could be combined. With minimal time overlap it is important to determine if selectivity is the same. There was concern that the lack of good spatial overlap among the three surveys would be limited to a combined survey index. More work is expected on this stock in the future.

Discussion centered around what the CPT would want to see in the vetting of indices before they would be accepted into the assessment models. Besides reviewing model-based indices on their own, similar to this presentation, it would be good to put these indices into the model and see if they make a difference in model results. If they do make a difference, can we explain those differences, and do they make sense for the modeled population? It came up in discussion that survey modernization work is currently running spatio-temporal models on crab data, and it would be good to get a presentation from that group on their model based indice runs, hopefully during the next CPT meeting.

This presentation to the modeling workshop group was intended as an initial look at this work, any indices considered for use in assessment models would be vetted by the entire CPT.

Data updates

The Kodiak NOAA fisheries group reminded assessment authors (e-mails went out in the fall) of the new direct access method to access survey data and the R package - *crabpack* - to process this data. They requested that assessment authors and data users attempt to access the data and use *crabpack* to ensure they were getting similar results to older methods (AKFIN Answers). The modeling workshop participants spent some time troubleshooting access to the data - specifically accessing Oracle using the *crabpack* interface. Mike Litzow requested that authors

prioritize running data comparisons in the next month after the modeling workshop. The status of this data access transition will be reviewed at the May CPT meeting.

The members of the modeling workshop were informed of updates to data delivery and data time series for catch time series from ADF&G, and the associated R package for this data processing - *BSAIcrabR* - written by Tyler Jackson. The goal of this work was to have a standardized catch time series and R workflow for processing these. This work began in 2020/21 but stalled out due to data clarity issues pre-rationalization. It was resurrected after some catch data discrepancies were found last fall. Current goals are to incorporate an updated time series of catch for the May proposed models for the big three stocks. Tyler Jackson is the ADF&G point of contact for this data at this time.

Research topics

AIGKC sdmTMB CPUE models

Tyler Jackson presented some preliminary work on CPUE standardization models using sdmTMB to incorporate spatial variables into the CPUE standardization process. The models presented are similar to the current CPUE standardization but performed using sdmTMB. Tyler was seeking feedback on the setup and parameterization of these models before bringing them forward for use in the assessment model process. The goal would be to work on these models prior to the September plan team meeting when proposed models would be discussed for AIGKC. Modeling workshop participants encouraged him to present work towards these at the May CPT meeting, even though they would not be used for specification setting this cycle.

Simple models and historical biases in crab

Cody Szuwalski shared work on two papers he was hoping for assessment author/modeling workshop group participant feedback on. These papers covered crab assessments over all species in the BSAI and model processes over time. Cody was looking for assessment author feedback and collaboration on these papers.

Using side-by-side haul data to estimate NMFS EBS survey catchability for Tanner crab

Buck Stockhausen presented updates on work on using the BSFRF side-by-side haul data to inform survey catchability, which expands on their current use as either a survey data set in the stock assessment models or informing priors on catchability in these models. This analysis is important to inform stock assessments on the proportional differences in abundance between the number of crab that survey catches in its gear and what is actually on the bottom. Buck provided an overview of work on both a haul specific comparison and a survey-specific comparison of this data. While the survey/study area level analysis doesn't utilize the side-by-side nature of the hauls, the haul specific analysis contributes noise and variability that may be too large for estimation of catchability.

The best model to estimate survey-level catchability was Model 3 for both male and female Tanner crab. Model 3 is a Tweedie model that fits size dependent catchability with the year variability as a random effects. This model allows for extension to non-study years and has the

best AIC and adjusted R^2 values. The resulting model exhibited a dome shape for males, prompting discussion as to the validity of that shape.

The haul-level catchability, which utilizes the paired haul nature of the sampling and allows for the incorporation of environmental covariates, resulted in more complex model options. A couple of approaches were presented based on Somerton et al. 2013 and Kotwicki et al. 2017. Haul level analysis added a layer of complexity especially when side-by-side hauls had large differences, raising questions as to whether these differences were simply random or were the result of small-scale spatial patchiness and, in either case, what the appropriate statistical distribution would be for the catch ratios. Buck presented some of the better models for males and females, but these models lacked the ability to explain a large amount of the variability.

Next steps for this work include incorporation of results from the best models into the Tanner crab analysis and performing a similar analysis with the BBRKC and snow crab data sets. The CPT would be presented with models used in the stock assessment during the typical CPT meeting process so that the entire CPT would be able to review these and their utilization in the stock assessment process.

Assessment model guideline topics

Jittering and MCMC

At a request from the SSC, the group worked towards some standard practices for jittering and MCMC runs to determine model convergence and fit. The group did not reach good consensus on guidelines and will revisit this in May with the entire CPT. The group discussed performing jittering to first ensure model convergence at the MLE, and secondarily to determine the distribution of management quantities. The default jitter level in GMACS is 0.10 sd; however, the participants discussed what this means as far as variability for all model parameters and suggested the authors do a smaller subset at a wider level of variability.

For diagnostics of jittering results the discussion covered presenting the distribution of the likelihood (to ensure the MLE model), distribution of the management quantities, and encouraged likelihood profiling for models at the MLE.

One-step ahead (OSA) residuals

At the suggestion of the SSC, assessment authors are encouraged to bring forward OSA residuals in assessment diagnostics for size composition residuals. The modeling workshop discussed a recent seminar in Andre's lab by Cole Monnahan on OSA and their use in other stock assessments. Authors are encouraged to explore OSA residuals and GMACS users talked about adding code to produce these residuals within the GMACS output eventually.

New business

Upcoming CPT meeting dates and locations:

- May 12 - 15, 2025: Virtual
- Sept. 8 - 12, 2025: Seattle, WA (AFSC)

Others in attendance: **indicates virtual*

Caitlin Stern
Grant Adams
Madi Heller Shipley
Jonathan Richar*
Danielle Mercurief*
Serine Reeves*
Hamachan Hamazaki
Rachel Alinsunurin*
Emily Ryznar*
Linda Kozak*
Mateo Paz-Soldan*
Jared Weems*

Cory Lescher*
Meghan Korte*
Shannon Hennessey*