SEA STATE INC

Project Proposal

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EXECUTIVE SUMMARY

Objective

To review and modify the existing AD Model Builder Code for the Age-structured model for Alaska herring stocks (version 0.1 Jan 2015). The over-arching objectives are: to improve numerical stability, ease of use, general flexibility for alternative structural assumptions, and estimation of observation and process error variance to better quantify uncertainty.

Goals

The objective function for the existing Age-structured model for Alaska herring stocks is based on a simple weighted least-squares estimator with user specified weights for 4 separate residual components. The goals of this proposal include parametrizing the model to include observation error and process error components, include options for exploring time-varying parameters, improve numerical stability through parameter transformations, develop a log-likelihoods for data components and penalized likelihoods for structural components, and smoothing functions for compositional information.

Solution

The existing model code is written in ADMB and is fairly well documented. Proposed modifications would build on the existing code. Input data file and control files would also have to be modified to accommodate additional flexibility and alternative structural assumptions for time-varying parameters. Any proposed structural changes to the model would have to be approved and documentation of the new changes would be provided.

Project Narrative

Normally software development or modifications would involve creating a full design document. This document would clearly specify the needs and requirements of the assessment model. For the purposes of this proposal, I'm providing a bulleted list of "a-la-carte" items that could potentially be added/modified to the existing code. You may pic and choose only a few items, or all items. Note however, that some items, (i.e., the development of a simulation model) are required for model testing.

The following list describes the general modifications to the model that would be necessary to achieve the aforementioned Goals and Objectives.

- Improve numerical stability. Estimated parameters in the current Stika model span nearly 7 orders of magnitude; this has the potential to create numerical instability in the quasi-newton search routine. Where possible (i.e., positive parameters), parameters should be estimated on a log-scale. Annual recruitment estimates and initial age-structure result in (n*m-1) scaling parameters, where n is the number of years and m is the number of ageclasses; this can be reduced to just 2 scaling parameters, and a series of deviates around average recruitment for the initial age-class and average recruitment for the time series. This transformation would also prevent estimates of recruitment from going negative.

- Develop a maximum likelihood approach using a penalized likelihood components for structural assumptions. The existing code is based on a weighted least-squares estimator where observation error components are weighted by a user defined multiplier, rather than a more appropriate weighting using inverse variance. This modification would allow the user to specify the actual standard deviations in observation and process errors, and even allow for estimation using Bayesian methods, or Random-effects. In cases where observation error estimates are available, these can also be incorporated directly into the code.
- Addition of time-variating parameters. Currently, the existing model implements time-varying parameters in natural mortality (2 blocks), maturity and selectivity (only 1 block implemented in each). An alternative approach to the blocking method is to use smooth functions that are continuous and differentiable (i.e., bicubic spline or random walk) where the knots are treated as estimable variables using a penalized likelihood approach. This can allow for additional flexibility that corresponds to gradual, or abrupt, changes in selectivity, or natural mortality, given environmental change or changes in management regimes.
- Command line options for simulation testing and retrospective analysis. Self-testing, or simulation testing, is a critical tool to ensure the model is capable of estimating known parameter values using simulated data. Command line options are implemented at run time (e.g., “model.exe -sim 0”, or “model.exe -sim 1234”) and inform the model to simulate data, then estimate model parameters. It’s common to include “-sim 0” where 0 is a flag that corresponds to simulating data with no error to ensure the exact solution can be obtained. This ensures that the model and likelihood functions are internally consistent and correct. Using “-sim 1234” where 1234 represents a random number seed would add observation and process errors to the simulated data that are repeatable across machines. These simulation experiments are critical for assessing potential biases in key policy parameters. The “-retro n_peel_years” is a simplification for automating retrospective analyses where n_peel_years is the number of retrospective years to examine.
- Documentation of model changes. Provide technical documentation for the proposed additions and structural modifications to the Age-structured model for Alaska herring stocks. This additional documentation would serve as material for peer review along with the model code.
- Workshop, training & collaboration. Ideally it would be nice to collaborate with department staff who intend on using the model for conducting routine assessments. The objective here is to have a feedback process where assessment scientist would have the opportunity to provide input on necessary changes that they would like to see, as well as, and opportunity to provide staff training via small working group in a workshop format.
- R-scripts & other source code. Scripts for generating and summarizing model output for retrospective analysis, simulations, likelihood profiles etc. will be necessary to develop in concert with the assessment model code to ensure output is correct.

BUDGET

Budget Narrative

The following table provides an estimate of the programming hours, unit price $125 per hour, and estimated cost for bullet items described in the Project Narrative. Improving numerical stability is estimated to take roughly 10-hours to implement and test. Developing a MLE approach for parameter estimation will involve the addition of code and modifications to the current control file to allow for optional estimation of observation error and process error variance. Estimated time for implementing and testing is estimated a 40 hours. Addition of optional smooth and block-style time-varying parameters is estimated to take 40 hours to implement and test. The addition of command line options for simulation testing and conveniently conducing retrospective analysis will take roughly 20 hours. Training and collaboration: an estimate of 40 hours is budgeted for this item and would cover time spent working with assessment authors on feedback and a 2-3 day workshop on using the revised Age-structure model and implementing new features. Additional R-scrips and C++ templates will be developed in parallel with additions to the Age-structured model and is estimated to add and additional 20 hours of programming. Travel costs, air roundtrip Seattle to Juneau, hotel and per diem estimated at $2000 (air $800, daily per-diem $200 *6 days).

Description	Quantity (hours)	Unit Price	Cost
Improving numerical stablility	10	$ 125	$ 1,250
Maximum likelihood approach	40	$ 125	$ 5,000
Time-varying parameters	40	$ 125	$ 5,000
Command line options (-sim & -retro)	20	$ 125	$ 2,500
Technical documentation	20	$ 125	$ 2,500
Training & collaboration	40	$ 125	$ 5,000
R-scripts & other source code.	20	$ 125	$ 2,500
Indirect	**190**	**20%**	**$ 4,750**
Travel			$ 2,000
Total			**$ 30,500**