IPHC Scientific Review Board Meeting

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Overview

We met on 21-22 June 2016 to review the data and model development completed during 2016 and to provide strategic guidance for the upcoming 2016 stock assessment and management process.

Spatio-Temporal Survey (STS) modeling of the IPHC survey: a model-based survey index of abundance and biomass

We are very pleased to see the application of a statistical spatio-temporal model (INLA: integrated nested Laplace approximation; details at http://www.r-inla.org/) to the extensive IPHC survey data. The STS model makes better use of the available data in computing survey abundance indices coastwide and by regulatory area, and because of its Bayesian structure, forces one to be honest about uncertainties.

We also see this as an improved approach over the simple regulatory-area mean estimate for interpolating missing station values. For example, the Strait of Georgia predicted values more closely resemble nearby Area 2A observations than either the overall 2B mean or values closer to the more distant 2C survey. Although these missing values are filled in, they don't contribute that much to overall regulatory area or coast-wide means because their prediction uncertainty is high—the regulatory-area means are a weighted combination of station means, where the weights are higher for more certain stations and lower for more uncertain stations such as those based only on predictions.

In response to specific IPHC staff questions, we SRB recommend:

1. Using the new STS model rather than *ad hoc* adjustment factors to predict survey CPUE at missing survey stations (due to incomplete coverage of bottom area, failed sets, etc.). The model-predicted values better propagate the uncertainty arising from filling in the missing values;
2. Generating predicted STS model values at missing locales by station rather than by station bottom depth because the latter will involve uncertainties associated with depth effects that are not well-understood at this time;
3. Using the new STS model coast-wide and regulatory-area abundance indices for the 2016 assessment and apportionment. The STS model is more consistent with the original survey design and intent of apportionment, compared to the more *ad hoc* adjustment factors and post-smoothing survey time series via the Kalman Filter.

SRB research recommendations

1. Explore some classical metrics of spatial patterning, such as the Negative Binomial *k* or Moran's *I*, to summarize patchiness of halibut abundance. These may be useful later to simulate survey observations for the MSE;

2. Explore biogeographical definitions of halibut habitat and then compute STS biomass indices for each since this type of classification is more realistic biologically than arbitrary regulatory-areas;
3. Consider the feasibility/utility of coding the STS model via Template Model Builder. The automatic differentiation capability of TMB could allow evaluation of anisotropy (i.e., that the spatial correlation is not the same in all directions) as well as the benefits of applying the STS model across the entire survey range rather than by regulatory-area.
4. Consider expanding the mesh size somewhat to make the current INLA model more computationally efficient.
5. Compare versions of the model fit to O32 Pacific halibut versus all sizes.
6. Consider including a covariate on depth, which may reduce sensitivity to the isotropy assumption (i.e., that the spatial correlation is the same in all directions).

Biological and Ecosystem Science Program

The proposed ecosystem work, which includes genetic methods for sexing fish, temperature-dependent sex determination, skipped spawning, partial migration, and growth experiments all are interesting and fit squarely into Pasteur's Quadrant (Stokes 1977) in which an important applied problem motivates a search for fundamental understanding. The key will be for the staff to explore synergies between this work and more traditional stock assessment and MSE modeling. The potential here is enormous, but there is also the potential for the two work streams to become isolated.

Our specific concern relative to the growth studies is understanding how changes in diet and variable food availability (as observed from stomach content data) may impact Pacific halibut growth in the wild.

Stock assessment modeling for 2016

IPHC staff described progress toward fishery-based estimates of sex ratios in the catch - we are especially encouraged that this work has been popular (particularly in 2B).

Staff presented the development of a spatial model, which results in 21 fishing fleets. With staff, we discussed complexities and trade-offs of assuming fixed movements between areas and regional recruitment patterns. The tagging data are aggregated over sex and this is an apparent limitation since the survey suggests old males are relatively abundant in the GOA and females appear to moving from area 3 down to area 2. It might be worthwhile to propose hypothetical recruitment-by-area scenarios, and then compute the biomass spatial distribution at equilibrium, contrasting results based on (for example):

i. average weight-at-age for all areas vs area-specific weight-at-age;
ii. fishing vs no fishing;
iii. alternative movement rates among areas.

A spatial yield per recruit analysis could be derived each of the above scenarios given the biomass spatial distribution.

Subjective weighting is a common problem in ensemble modeling and IPHC staff have made progress exploring more objective ways of evaluating relative model performance. We encourage further exploration of methods for objectively weighting models based on both retrospective performance (i.e., comparing historical model estimates over time) and prospective performance (comparing model ability to predict new data).

We recommend that IPHC staff begin developing a series of data benchmarks that acceptable stock assessment models need to capture. Inevitably, there will be differences between model predictions and observations; the key is to determine the particular observations that must be captured by a model (e.g., juvenile catch in the Bering Sea or the downstream effects of direct exploitation) as opposed to observations that are probably less important (e.g., early 20th century removals). The goal may not necessarily be to make the best possible halibut model but to make the one that is the best for addressing current (i.e., stock assessment) and future (i.e., MSE) management issues.

Halibut fishery MSE

In our June 2015 report, we recommended that MSAB move forward under the original charge of making progress on evaluating management procedures for the halibut fishery. We were encouraged by the progress over 2016. Although most of the progress was organizational and more related to objectives, these provide the clarity of purpose and focus needed for progress by the science team.

Work-plans

The work-plans all show high potential for synergy. We particularly encourage IPHC staff to further integrate the proposed ecosystem work into the stock assessment model, perhaps in the short term by helping to develop growth models based on environmental factors. A clear link might also include specific advice on how the PDO is presently applied and how that might be refined based on some of the growth studies underway and planned.

Citations

Stokes, D. 1997. *Pasteur's Quadrant. Basic Science and Technological Change.* Brookings Institution Press, Washington, DC