Comments from 2017 flatfish CIE Review

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September 2017

Bering Sea and Aleutian Islands Kamchatka flounder

Bering Sea and Aleutian Islands Kamchatka flounder Terms of Reference

Evaluate stock assessment approach to model the Kamchatka flounder resource using three spatially distinct trawl surveys to provide reliable estimates of productivity, stock status, and statistical uncertainty for management advice.

Evaluate likelihood profile approach to estimate natural mortality rate (and suggest/provide alternatives?).

Evaluate how survey catchability estimates are derived based on assumptions about relative stock distributions.

Evaluation of the modeling approach

- The science reviewed represents the best information available with some limitations of the data.
- The modelling approach uses advanced statistical methods that are close to state of the art.
- The survey data are of high quality, fishery data are limited in scale and lack age information.
- Main limitation is the absence of age composition data for the fishery resulting in more uncertain fishery selectivity estimates since it relies on the length compositions alone.
- Uncertainty in the fishery selectivity will have a direct bearing on the calculation of reference points.

Evaluation of the modeling approach (continued)

- Estimated stock biomass shows a continuous upward trend over the assessment period .
- This trend not reflected in individual survey biomass data.
- There are systematic residuals in the fitted survey values.

Estimation of M by likelihood profiling

- Total mortality, Z, can be a good indicator of the magnitude of M when M is low. Plotting log numbers from the survey against age for each cohort and calculating the slope might provide an adequate measure of the magnitude of M.

- Two reviewers suggest to assume that M is size-dependent and use the Lorenzen (1996) equation as the basis for a prior. The assessment reliability can be checked by model runs at 0.08, 0.11 using the size-dependent natural mortality schedule. The important thing is to test reliability of management advice by considering alternatives.

Estimation of M by likelihood profiling (continued)

- Evaulation of M seems irrelevant, because there are other uncertainties in the assessment that are likely to have significantly more impact on the management metrics than the choice of M over a reasonable range.

- If likelihood profiling provides a conclusive answer as to which choice is optimal, then it should be possible for the model to estimate M appropriately within the minimization procedure. If the model fails to converge under these conditions, then it suggests likelihood gradient is insufficient to support such a decision.

Estimation of catchability

- If possible, develop and use priors for the three survey q's, or at least consider likely lower and upper bounds on q based on survey attributes and different life stages and behaviors of Kamchatka flounder.

- Catchability and natural mortality parameters are correlated. Fixing M based on profiling over q and then profiling q over the chosen value of M seems to be a circular argument. If indeed there is a distinct minimum in the likelihood, then the parameters should be estimable within the model.

2017 Flatfish CIE Review Arrowtooth Flounder

Ingrid Spies

September 2017 Plan Team Meeting

CIE Terms of Reference

- Evaluation of the ability of the stock assessment model for arrowtooth flounder, combined with the available data, to provide parameter estimates to assess the current status of arrowtooth flounder in the Bering Sea and Aleutian Islands.
- Evaluation of the strengths and weaknesses in the stock assessment model for arrowtooth flounder.
- Evaluation of the assumption that male natural mortality is higher than female in arrowtooth flounder.
- Recommendations for further improvements to the assessment model.

Pros

- The model is able to make use of both biomass, age and length composition data in a unified framework.
- There is also a fairly well established statistical framework in which to estimate the parameters.
- The model is supported by comprehensive survey biomass estimates which should provide high quality estimates of biomass trends.

Main points

- Fewer parameters.
- More age data.
- Explore male/female natural mortality.
- Issues with integrating 3 surveys.
- Temperature relationship on EBS shelf catchability - significant?
- "The main weakness of the assessment in terms of assessing stock status is in understanding the stock dynamics immediately preceding the assessment period."

Reduce parameters

- The model is data rich but there is relatively little contrast in the data→ danger of over-fitting data and poor predictive power.
- Consolidate male and female selectivity curves were possible.
- Consider the gamma distribution.
- Model fully selected *F* as a time series. (Fishing mortality or selectivity → good predictor for next year).

Integrating surveys

- EBS is a contiguous area and species are distributed in EBS and slope. Investigate ways of inter-calibrating survey biomass estimates.
- Consider a separate assessment for the Aleutian Islands (requires assumption about the relative contribution to the total biomass).
- Investigate contribution of scaling values used to derive the swept area to overall uncertainty.
- The choice of biomass based proportionality seems reasonable given similarity of survey gears, but if selectivities are estimated to be different between surveys this assumption should be reviewed.

Integrating surveys

- In the 2016 assessment survey catchability is set proportionate to the average annual biomass caught, and the sum of the catchabilities are constrained to 1.0.
- Examine whether this assumption is valid.
- Survey index = absolute or relative index of abundance?

More age data

- Increase the number of aged specimens (samples are available), especially from the fishery.

Male/Female natural mortality

- Arrowtooth males grow more slowly than females so should have higher M than similarly aged females (profiling supports this theory).
- Is difference in M is due to gender or body size?
- If the latter, then modeling M by size might be simpler and would account for differential survival by size rather than assuming a fixed value for all ages. Consider Lorenzen (1996) method.

Male/female natural mortality

- Natural mortality and survey catchability are fixed (both affect the scale of the biomass estimates and can bias other parameters).
- Try M fixed but survey catchability estimated freely.
- Determine whether differences in male/female M could be replicated through differences in selectivity.
- M differences could be an arbitrary weighting factor which potentially could obscure other important stock dynamics.

Selectivity

- Consider modeling selectivity by size rather than age and combining sexes.
- Internal consistency of cohort information in the raw data (both length and age) seems to be undervalued in the accepted assessments which suggest more stable recruitment than the raw data. Use of age-based rather than length-based selectivities alleviates the problem in some developmental models.

Understanding historical stock dynamics

- Current stock status is comparatively robust to different model settings.
- There is evidence that the historic fishery length distributions are similar to current ones.
- If SSB was historically low it would have been due to a period of poor recruitment rather than high *F*.
- So biomass reference points in relation to average recruitment may not be appropriate.

Temperature

- The temperature effect on BSAI shelf catchability is ‘unconvincingly good’.
- One way to assess this would be to bootstrap across the temperature index, examine the influence on stock dynamics and the significance of the effect.
- Unless the effect is very strong, there is a danger of over-fitting the data and the need for these additional parameters needs rigorous evaluation.

Sex ratio

- Examine the risks taken by making specific assumptions about the cause of the skewed sex ratio.
- An investigation of spatial separation of the sexes might be useful to see if the surveys are representative of the population and to judge the appropriateness of the new selectivity curves.
- Second, the assumption of a 50% sex ratio at recruitment should be tested. It could interact with selectivity.

Weighting

- There is little choice but to implement some arbitrary weighting, but it the sensitivity should be evaluated.

Questions

BSAI Flathead sole

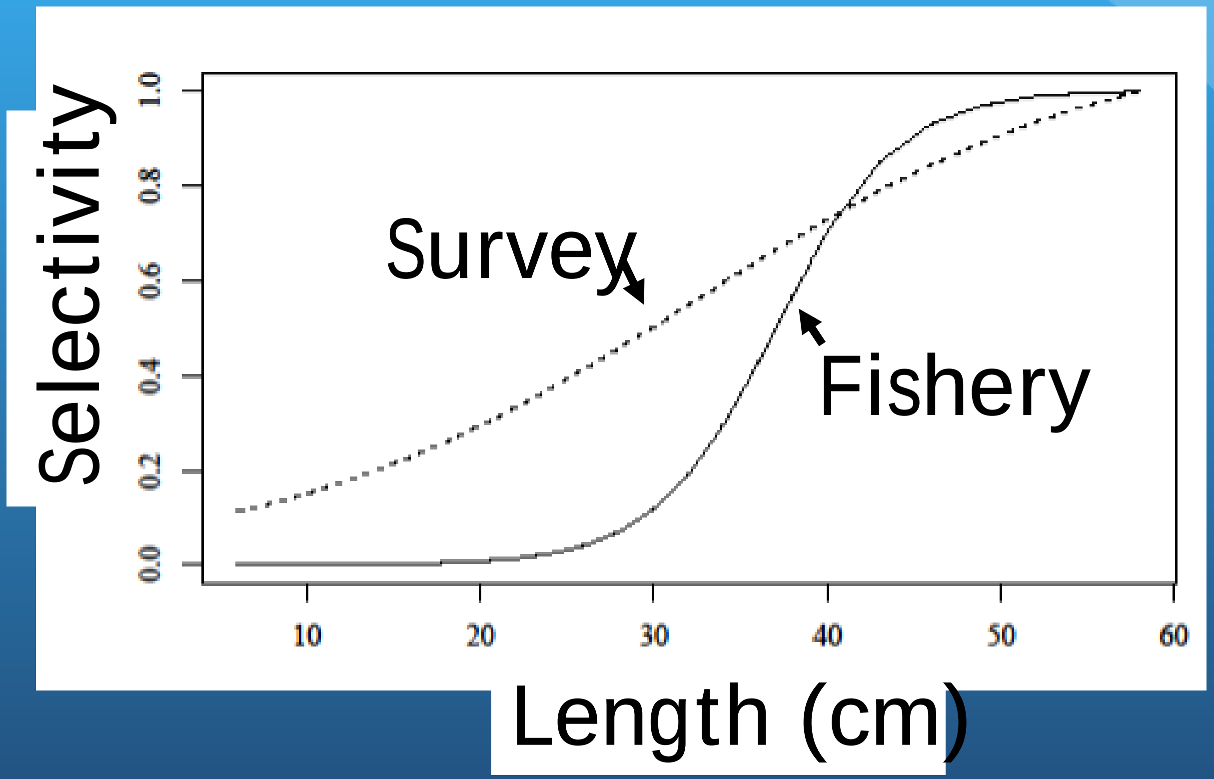
Bering Sea and Aleutian Islands Flathead sole Terms of Reference

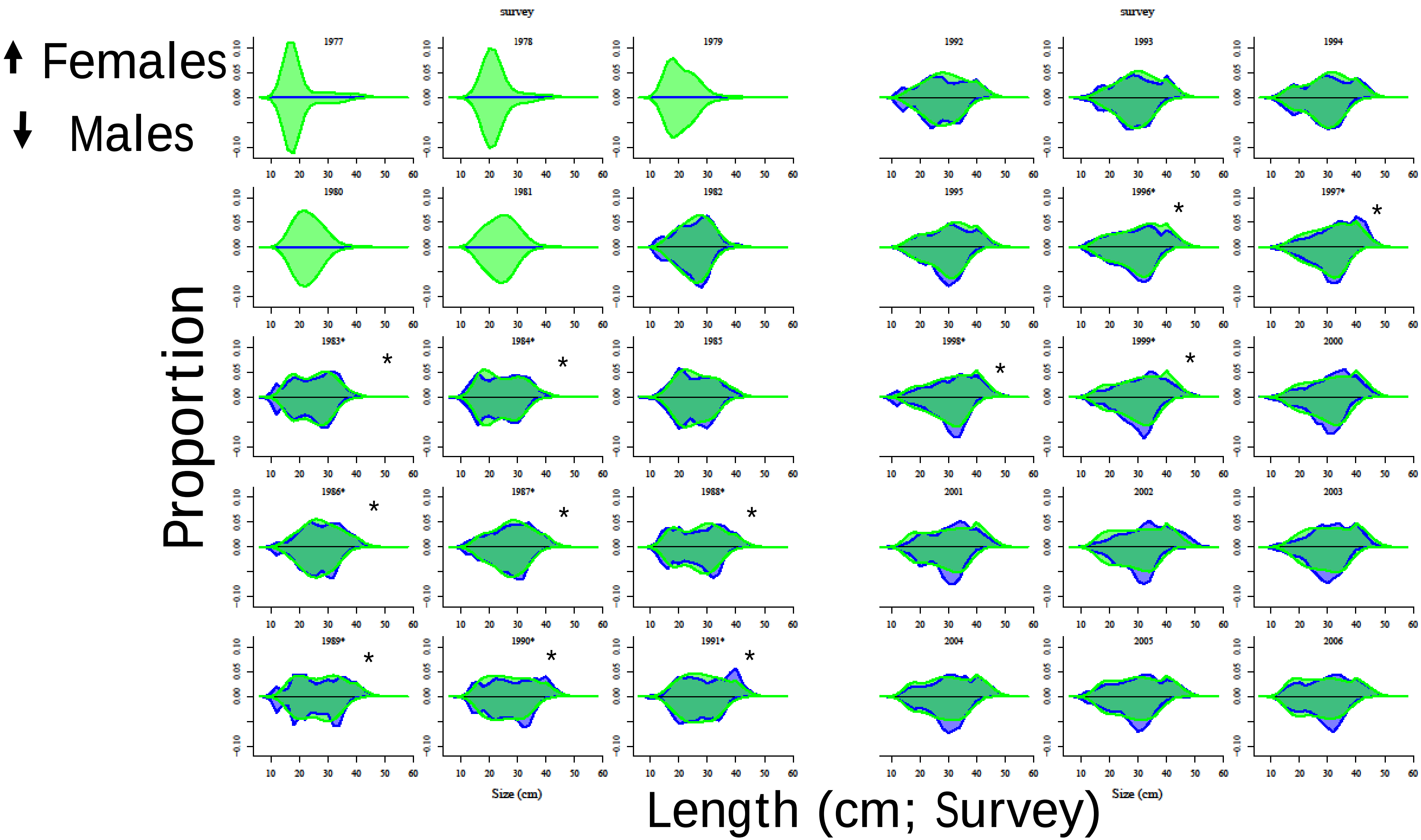
- Evaluation of the ability of the stock assessment model for flathead sole, with the available data, to provide parameter estimates to assess the current status of flathead sole in the Bering Sea and Aleutian Islands
- Evaluation of the strengths and weaknesses in the stock assessment model for BSAI flathead sole
- Evaluation of alternatives to the current length-based survey selectivity curves used in the assessment
- Potential evaluation of an equivalent BSAI flathead sole assessment model in Stock Synthesis

Brief Review of BSAI flathead sole assessment

- Age- and sex-structured population dynamics model
- 1 length-based survey selectivity curve for both sexes: problematic because model estimates shallow and not-totally-believable curve
- 1 length-based fishery selectivity curve for both sexes
- Residual patterns for survey and fishery length comps are worrisome and indicate that the model is consistently missing something
- Residual patterns were not solved by updating growth estimates in 2016 assessment

From the 2016 assessment

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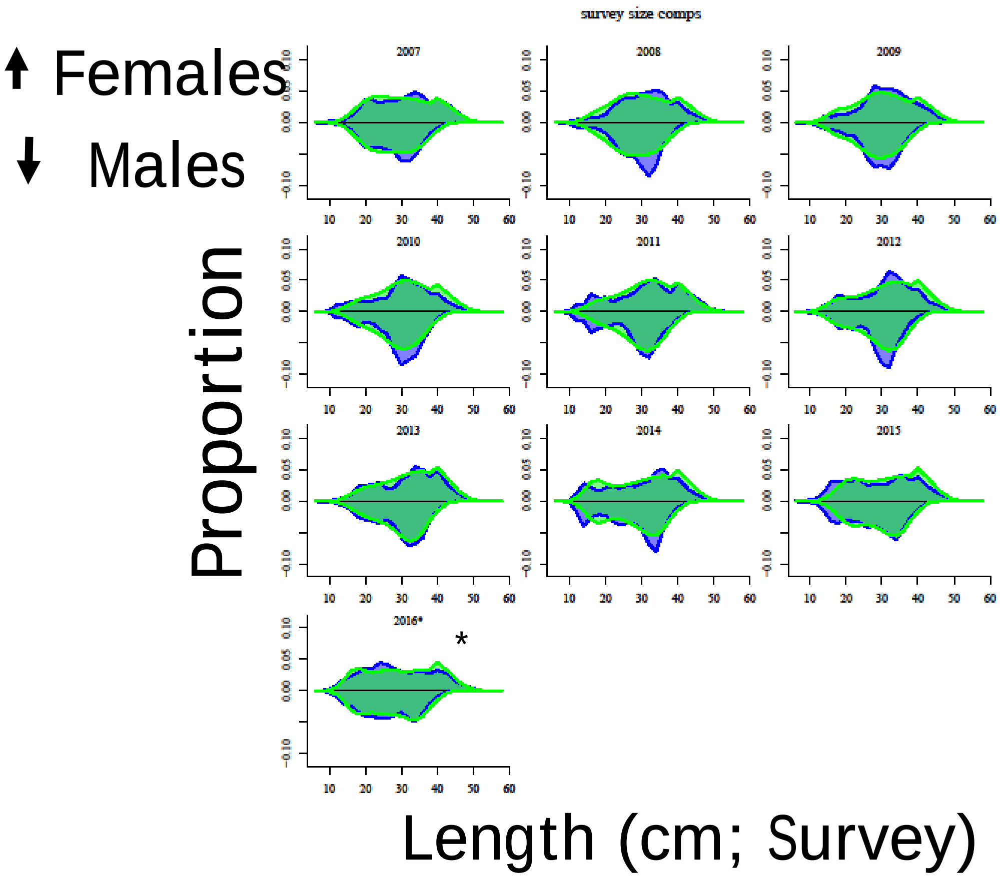
Size (cm)
Size (cm)
Length (cm; Survey)



Females
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survey size comps
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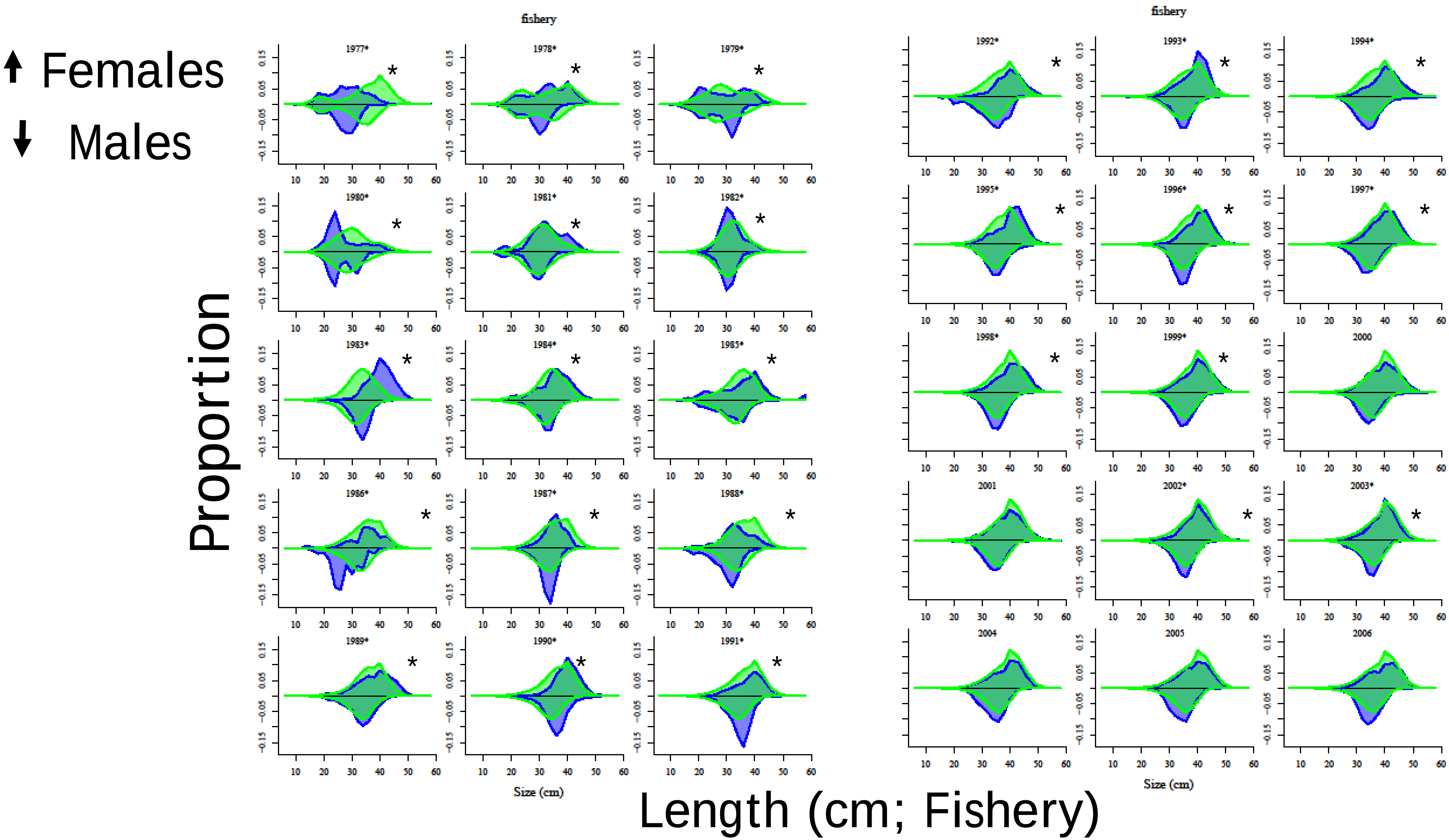
Length (cm; Survey)



Females
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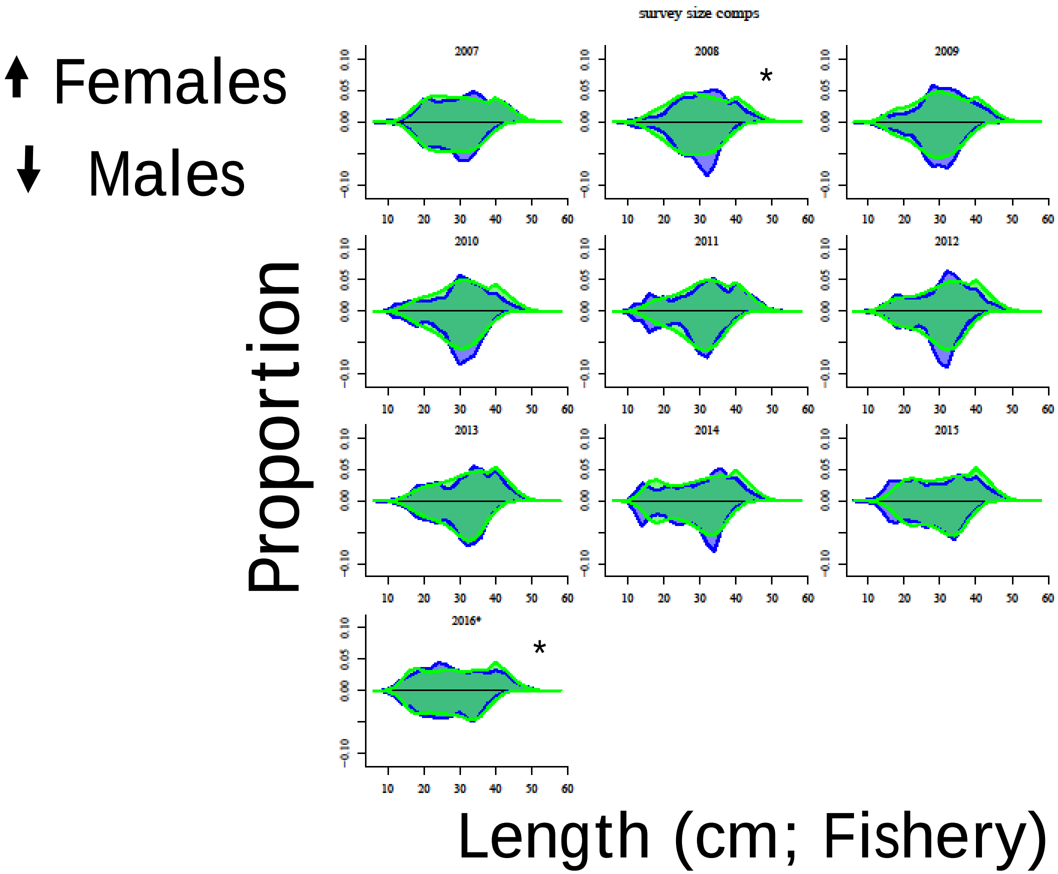
Size (cm)
Length (cm; Fishery)



survey size comps
Females
Males
Proportion
Length (cm; Fishery)
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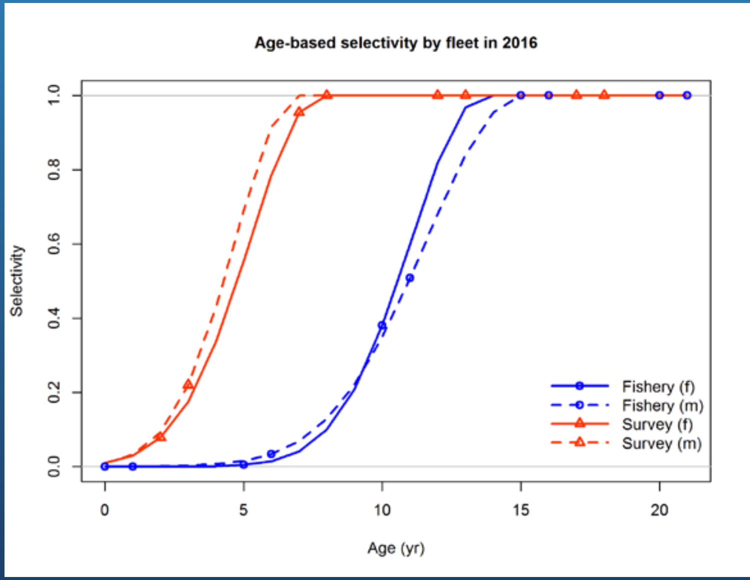
SS Model + Alternative Runs for CIE Review

- SS model constructed to match previous model
- Changed survey selectivity to be age-based, recruitment deviations for 21 years prior to model/data start
- Improved fits to data and improved survey selectivity



- Ongoing work to figure out how to improve fits to length and age comps, particularly for the fishery

Ability of the model to provide parameter estimates to assess current status

- “Adoption of the 2016 base case model or variants with different survey selectivity fits would not likely result in different stock status determination or management advice.”

- “Model runs show a sharp decline in fishing mortality in the late 1970s associated with a strong increase in stock biomass. Subsequently, the fishing mortality stabilizes at a low level and stock biomass reaches a peak in the early 1990s followed by a gradual decline. Superficially, the precipitous decline in fishing mortality looks unrealistic and may well be an artifact of the model”

Model strengths

- Biomass, age and length composition data used in a unified framework.
- Well established statistical framework in which to estimate the parameters.
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Model weaknesses

- Age residual patterns suggested some rather complex selectivity curves would be required to randomise the residuals
- Retrospective pattern exists
- Fishing occurs before the start of the model and therefore there is uncertainty in initial conditions

Ideas

- Perhaps take a closer look at incorporating more AI data: recruitments in recent years may be important
- Separate Am80 fishery component into separate selectivity?
- Do a separate AI assessment (right now signal swamped by EBS shelf survey)?
- Incorporate slope data for better info on older/larger fish?
- Model fishery selectivity as an autocorrelated time series
- Estimate q and M

Alternatives to current length-based survey selectivity

Note: I implemented age-based survey and fishery selectivity as alternative SS models + some alternative models for fishery selex. Residual patterns remained for all of these alternatives.

- Age-based selectivity used age data directly and avoided "cohort smearing" that occurs with length-based selex
- Age residual patterns suggested some rather complex selectivity curves would be required to randomise the residuals (survey and fishery)
- Unaccounted sex difference in natural mortality?
- Remove length data: differences in growth rate and characterizing variance in length-at-age may be a cause of problems

Evaluation of alternative model in Stock Synthesis

- The assessment authors have successfully implemented a flathead sole 2016- equivalent assessment in SS.
- The equivalent assessment has the same features and outcomes as the 2016 assessment and SS can provide a useful framework for exploring alternative selectivity models.

Potential next steps

- Present transition to stock synthesis model to BSAI Plan Team in 2018
- Take a closer look at the length and age data and assumptions used in constructing length and age comps
- Investigate methods for including time-varying fishery selectivity
- Investigate catchability and natural mortality
- Take a look at including length and age comps from pelagic trawl (30% of catches in some years) which are not currently included in the assessment
- VAST models to improve biomass index and for accounting for temperature-catchability relationship
- Can any additional data be added to inform initial state of the fishery?