



Tier 4 and 5 assessment considerations

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Background and motivation

- The **2015 Sept PT** meeting gave a framework for Tier 5 assessments, but needs are different and approaches diverged.
- The **2020 Nov BSAI PT** “*recommended ... to consider issues with the Tier 5 model process for stocks with variable ... survey observations. Specifically, the manner in which biomass estimates of 0 are handled (i.e., currently ignored)...*”

Goals

- Collate and summarize the range of Tier 4/5 approaches currently used
- Identify areas for improvement in the assessment process
- Get feedback and guidance on how to progress
- Examine uncertainty calculations given multiple surveys/species
- Survey reduction effect and P^* approach potential

Approach used

- We designed and sent out a questionnaire for T 4/5 AFSC authors, inquiring about:
 - Details of approach used
 - Software files (.tpl)
- 20 respondents
- Primary discrepancies found:
 - Model software & zeroes approach
 - Combining estimates if > 1 index (survey/species)
 - Order of grouping in stock complexes

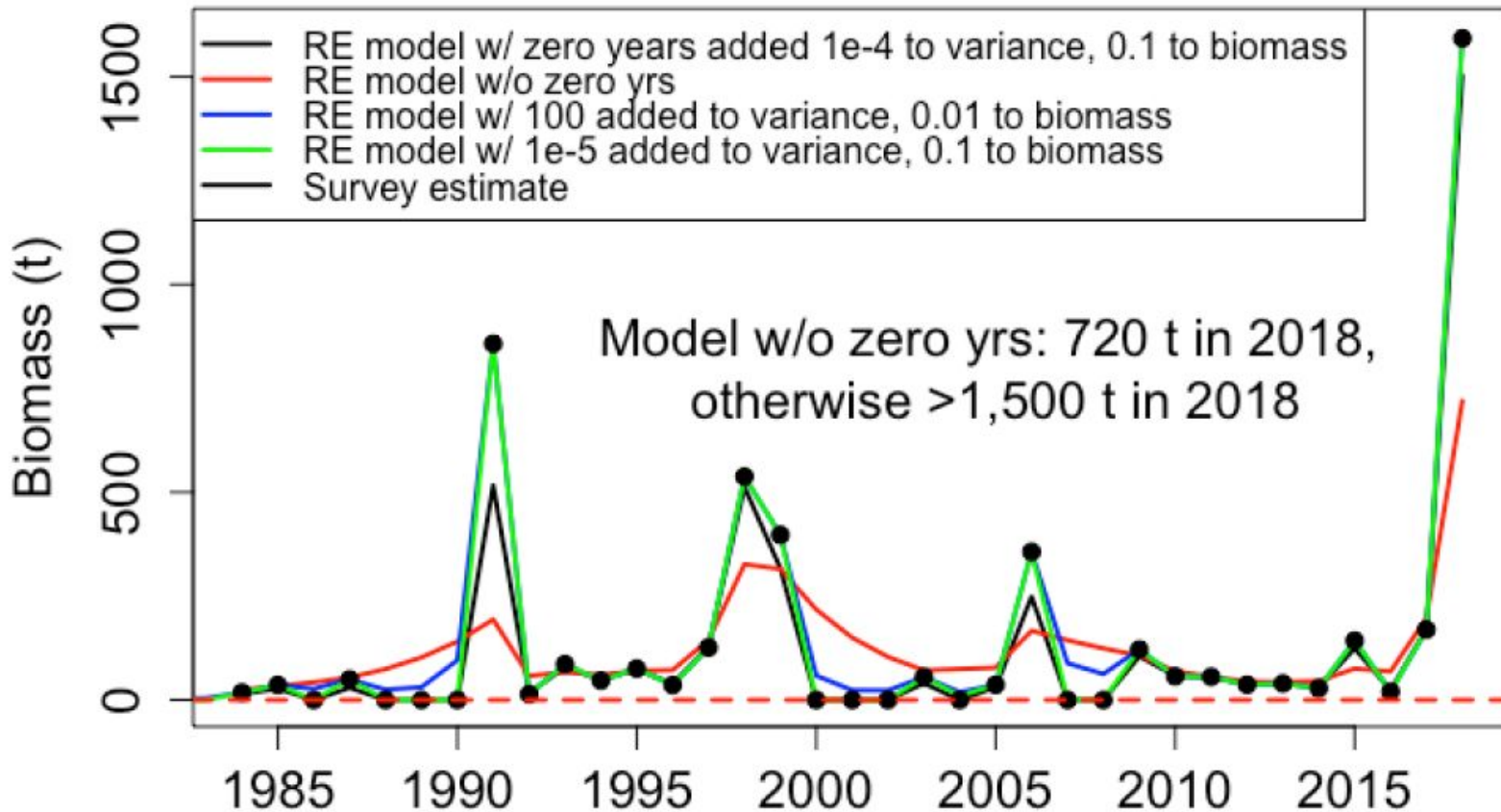
Model Software

1. **RE** model developed/tested (2012-2013)
 - Accepts a single biomass time series
2. **REM** modification (2015)
 - >1 index, user discretion pooled process errors
 - For GOA rockfish and spiny dogfish
3. **REMA** began in 2017, still in development
 - Additional survey index data (Hulson et al. 2021)
 - GOA Shortraker and shortspine thornyhead

Zeroes Approach

- Spies et al. (2018) found about **double the terminal biomass** depending if the zeroes were ignored or a small constant was added
- Most authors reported either no zeroes, or that they were removed from the data
- Zero filtering depends on the model:
 - RE does not accept zeroes, so must filter out externally
 - REM/REMA has option for user to remove zeroes or fit (by adding small constant and setting SD)
- This equates no observation with no survey

Importance of dealing with zeroes



Spies et al. (2018) BSAI other rockfish found large influence of adding small constants to estimated biomass

Combining Estimates - model runs

Multi-area, single species

Two approaches are used across assessments

1. Fit each index in separate RE run ($n=3$)
2. Fit multiple indices in same REM run ($n=5$)

Combining Estimates - model runs

Multi-area, complexes

Four approaches are used across assessments

1. Grouped by natural mortality (M-groups; $n=3$)
2. Lumped due to low biomass or small sample sizes ($n=4$)
3. Lumped due to species ID issues ($n=3$)
4. All species estimated separately ($n=2$)

Combining Estimates - Complexes

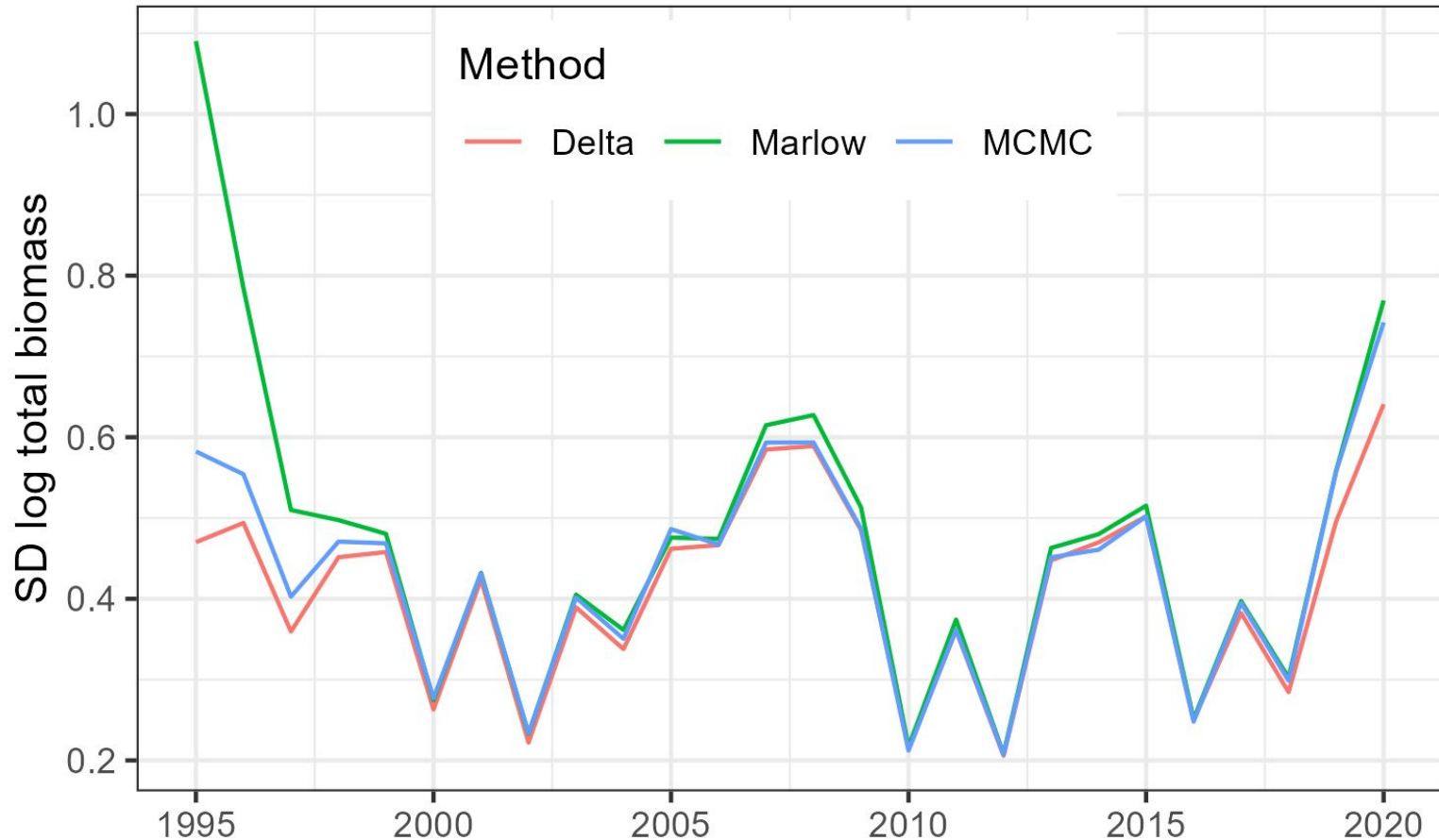
Workflow A	Workflow B*
<p>Step 1: <i>Calculate M-group biomass/variances using haul-level data</i></p> <p>Step 2: Run RE model for each group</p> <p>Step 3: <i>Calculate a weighted-average of M</i></p> <p>Step 4: repeat Steps 1 and 2 for full complex</p> <p>Step 5. <i>Calculate complex ABCs and OFLs using the weighted-average M and complex biomass</i></p>	<p>Step 1: <i>Sum species-level GAP estimates to get M-group biomass/variances</i></p> <p>Step 2: Run RE model for each group</p> <p>Step 3: Calculate M-group ABCs and OFLs for each M-group</p> <p>Step 4: <i>Calculate complex ABCs and OFLs summing M-group ABCs and OFLs</i></p>

*Most common workflow

Combining Estimates - Uncertainty

- Total biomass requires summing lognormal indices, resulting in an unknown distribution
- Thus, uncertainty must be approximated, e.g.:
 - Marlow (1967); used by REM
 - Delta method (via ADMB)
 - Posterior samples via MCMC integration
 - Summation of the individual confidence intervals (presumably used by splitters)
- **It is unclear which method is best, and whether the total biomass is approximately lognormal**
- So we tested this with BSAI other rockfish non-SST

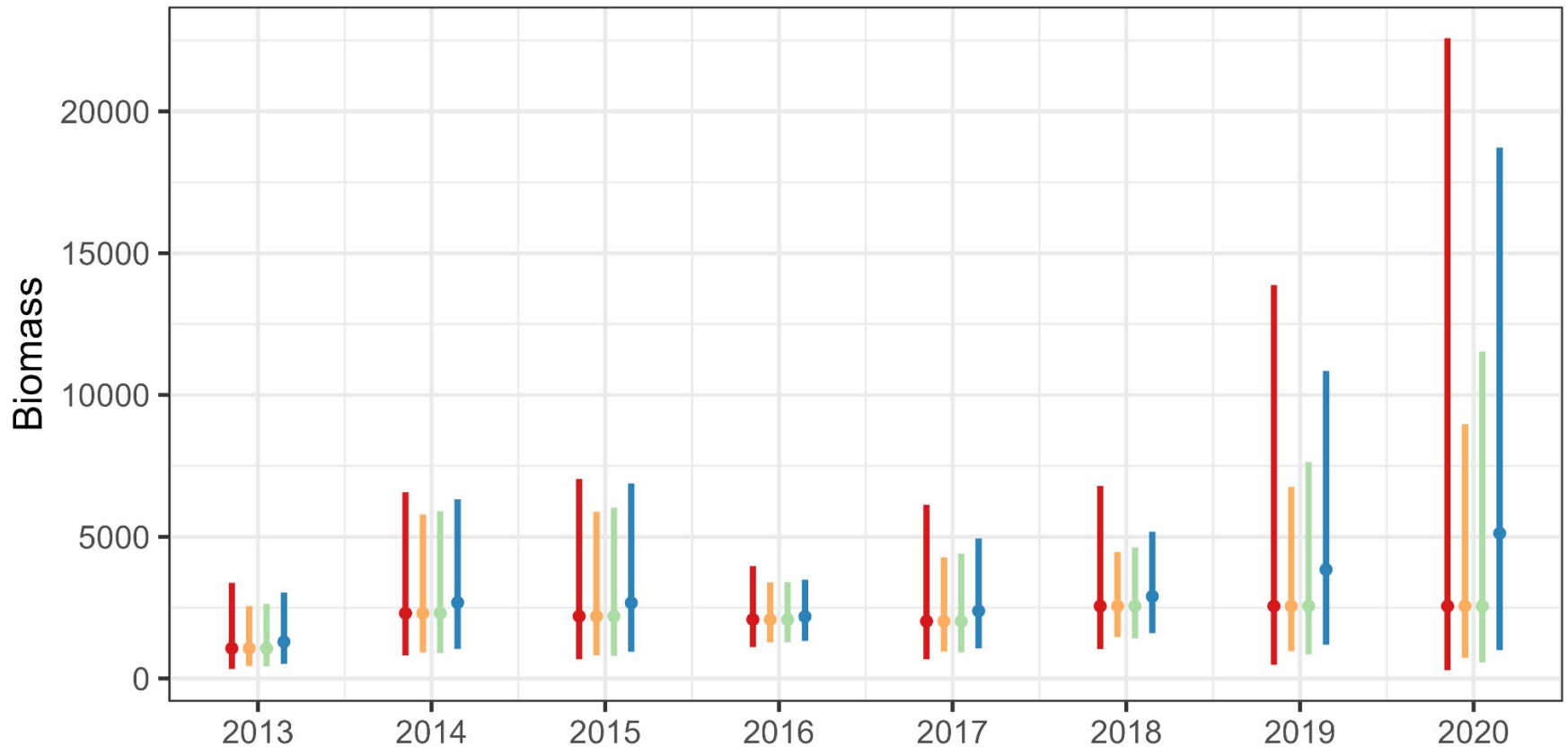
Issue of uncertainty of summed time series



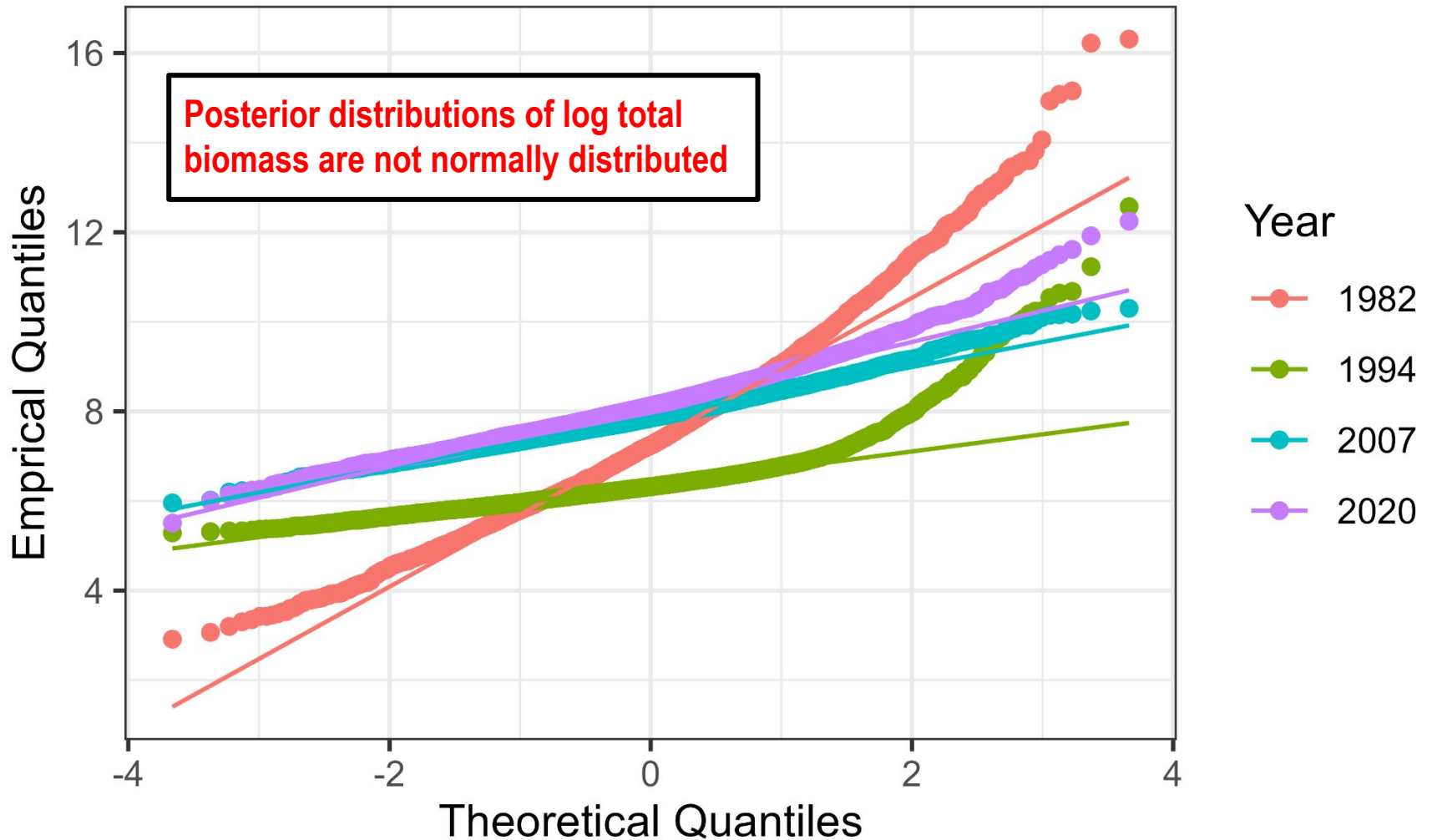
BSAI other rockfish non-SST

Issue of uncertainty of summed time series

Method Additive Delta Marlow MCMC



Issue of uncertainty of summed time series



Combining Estimates - Uncertainty

- Approximations differ; unclear which is preferred
- Our brief tests suggests this issue is likely common
- **The sum of lognormal random variables is not lognormal!**
- Assumed in:
 - Tier 4/5 models with >1 area or >1 species
 - Tier 3 models that sum design-based indices
 - Presumably our design-based estimators themselves

Important take homes at this point

1. The RE model has evolved for individual stocks
2. Zeroes are generally ignored, may be unclear what the software does internally
3. Important differences exist in combining >1 indices (mainly with order)
4. Approaches for complexes differ considerably
5. The uncertainty of combined lognormal estimates is a challenge; REM uses Marlow method.

Plan moving forward

1. Create a consensus version of the RE model code for all Tier 4/5 assessments to use
 - a. Based on REM which has several advantages
 - b. Documented and version-controlled online
2. Encourage consistent approach to zeroes
 - a. Explore alternative statistical approaches, e.g., delta-models
 - b. Recommend that SAFEs note filtering of zeroes

Plan moving forward

3. Explorations of the preferred method for grouping multivariate models
 - a. Interacts w/ methods for zeroes
 - b. Provide empirical basis for a best practices protocol
4. Explore complex workflows for input variances, and M approaches
5. Further tests of lognormal issue
 - a. How prevalent it is?
 - b. If T3 indices are not lognormal, how does that affect management advice?

Plan Team Feedback

A more consistent, transparent, and reproducible approach across groundfish Tier 4/5 and crab Tier 4 assessments would streamline the assessment process, benefit current and future authors, and make reviews more productive and helpful.

- 1. Does the PT support the Plan Moving Forward?**
- 2. Does the PT request additional analyses?**

Questions/Comments?

Thanks to Jim Ianelli and Paul Spencer for previous feedback and editorial comments

Effects of survey reductions

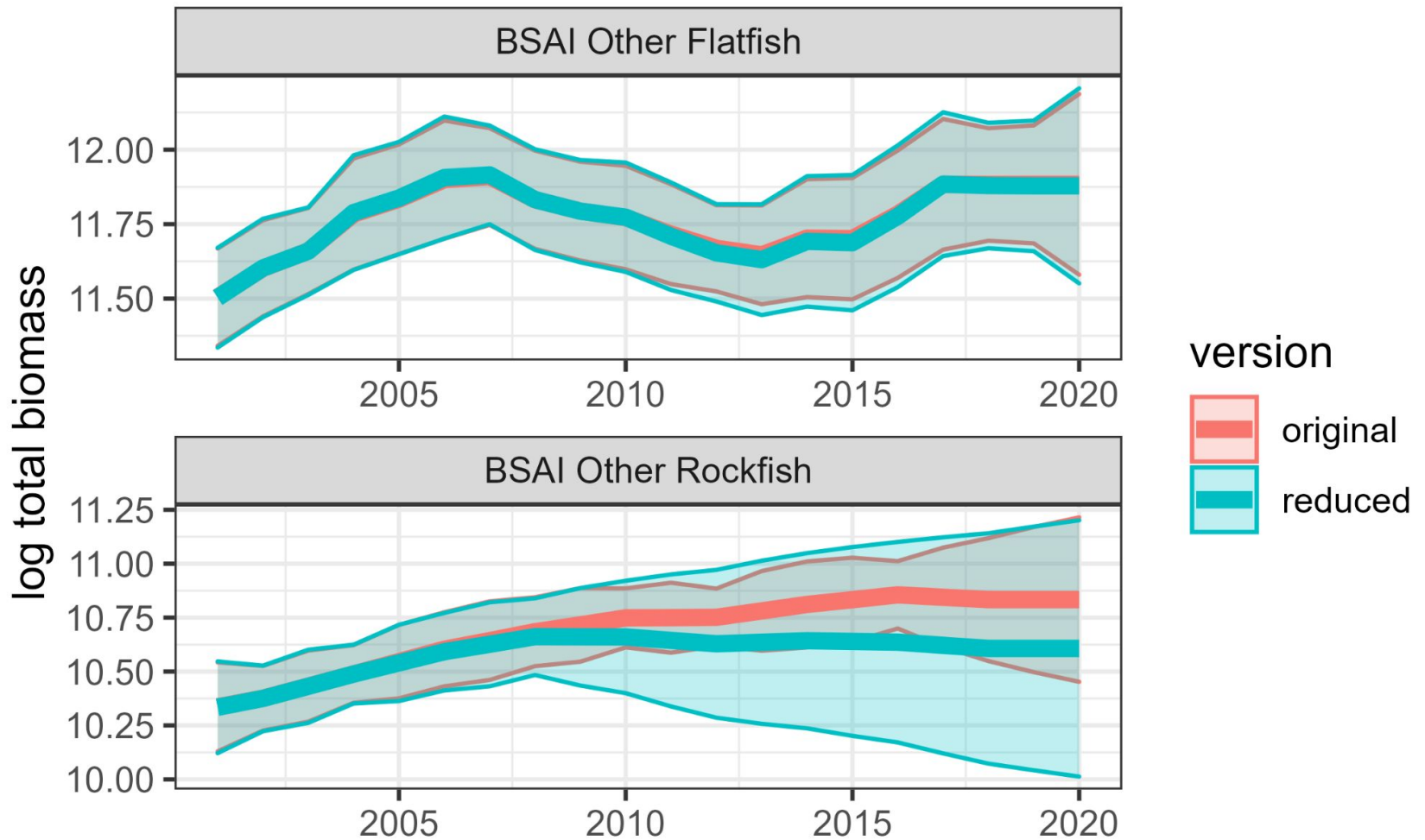
- Survey reductions lead to increased uncertainty in estimated biomass
- The current approach does not account for this
- Other councils and the crab plan team incorporate the P^* approach, specifying a larger buffer with increasing uncertainty
- Is this something the GPT would want to consider?

Effects of survey reductions

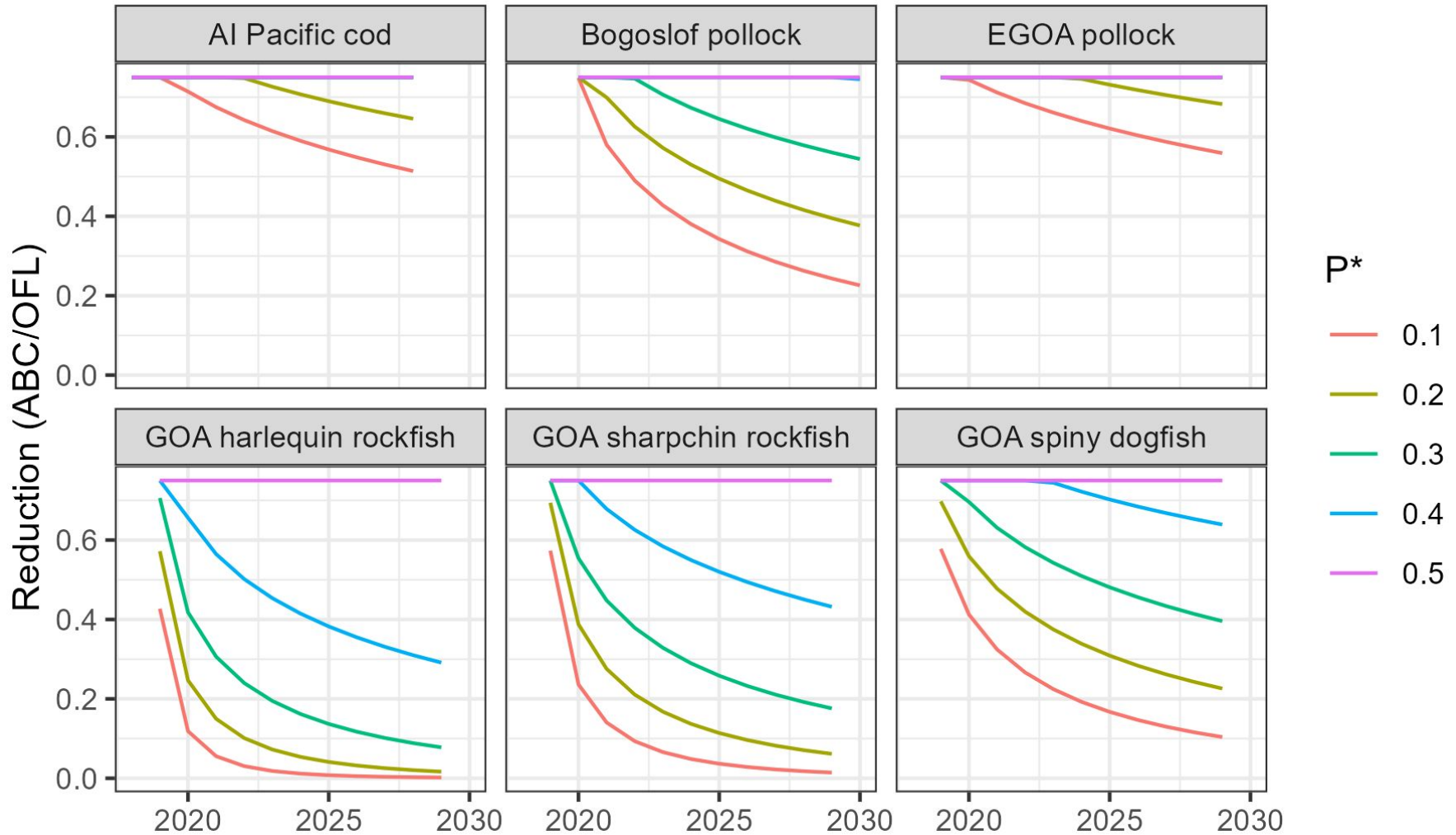
We performed two experiments.

1. **Case studies** w/ two BSAI complexes if the last 3 BS slope surveys didn't happen (2010, 2012, 2016)
 - a. The slope survey is not expected to continue
 - b. May represent near-term situation
2. **Forward projections** for a set of stocks presuming no new surveys under different P^* levels.
 - a. Brackets one extreme
 - b. Not covered here

Effects of survey reductions: case studies



Effects of survey reductions: projections



Effects of survey reductions

- The effect will depend heavily on the stock and which surveys are dropped or reduced
- If the BS slope is discontinued, at least BSAI other rockfish will be affected
- Further investigations could be coordinated w/ RACE under a range of reduction scenarios
- **Is this something the GPT would want to consider?**