Progress Summary of WG NSAM 2025-01&02

Libin Dai

15th SSC PS meeting

01-05 September 2025

Year	Month-day	Meeting	Track name	Key progress and main changes
2024	June 27-29	WG NSAM 2024-01	Nanaimo→Shanghai	• Decide to prioritize the development of SS • Develop and test a list of model scenarios a. Time-varying q for JPN early CPUE b. Approximate Gompertz in SS c. Age-specific survey index • Develop a list of priority items
2024	August 02	WG NSAM 2024-02	Shanghai	• Test model runs in terms of steepness, CPUE residual, and fit to size data
2024	August 26-29	SSC PS13	Shanghai→Step 1-3	• Try to estimate growth and selectivity parameters within the model
2024	October 17	WG NSAM 2024-03	Step 3→ Step 4-8	• Update standardized CPUE, catch and length composition through 2023 • Add 2024 JPN survey
2024	December 11-13&16	SSC PS14	Step 8→Step 9-16	• Nonlinear CPUE and random walk q • Undivided CT CPUE • Asymptotic selectivity • Downweight commercial CPUE • Reduce age class and refine growth curve
2025	May 28	WG NSAM 2025-01	Step 16	• Review the modeling work made in 2024 • Transition of modeling work to new experts
2025	July 11-13	WG NSAM 2025-02	Step 16→Step 17→ Step 18-21	• Improve annual model and check biological plausibility • Introduce and improve seasonal model and test some additional scenarios regarding: a. Influence of commercial CPUE b. Steepness (fixed vs. estimated) c. Post-spawning natural mortality d. Starting year (1980 vs. 1994) e. Change in selectivity and growth • Add 2024 catch

WG NSAM meetings in 2025

➢ WG NSAM01 (May 28, 2025)

Kick-off meeting

- Introduced the background of the WG and reviewed progress made in 2024.
- Reviewed the Step16 SS model developed by Dr. Larry Jacobson.
- Dr. Quang Huynh provided feedback on an earlier model (Step7) and offered suggestions.
- Established a timeline and work plan for meetings and deliverables in 2025.

➢ WG NSAM02 (July 11-13, 2025)

Technical meeting

- Examined the structure of the Step16 model and its variant (Step17).
- Introduced and reviewed the seasonal model (Step18).
- Developed and discussed additional case scenarios (Step19–21).
- Introduced the Japanese survey.
- Summarized candidate case scenarios for potential use as base case(s) in future work.

Meeting arrangement for WG NSAM02

Day 1
Agenda Item 1-4
- ✓ Opening of the Meeting
- ✓ Adoption of Agenda
- ✓ Overview of development progress of new stock assessment models for Pacific saury
- ✓ **Stock Synthesis 3**

Day 2-3
Agenda Item 4-9
- ✓ **Stock Synthesis 3**
- ✓ State-space age-structured model
- ✓ Data gaps and needs for Pacific saury stock assessment
- ✓ Other matters
- ✓ Workload till SSC PS13 and PS14
- ✓ Close of the Meeting

Day 1	
Hybrid section	In-person section
9:00-12:00	13:30-17:00

Day 2	
Hybrid section	In-person section
9:00-12:00	13:30-17:00

Day 3	
Hybrid section	In-person section
9:00-12:00	13:30-17:00

WG NSAM02 Day-1

- Revisit and improve annual models (Step 16-17 models)
- Introduce seasonal model from revised annual model (Step 18 models)
- Diagnostics of Step 18 models

WG NSAM02 Day-1

- Revisit and improve annual models (Step 16-17 models)
- Introduce seasonal model from revised annual model (Step 18 models)
- Diagnostics of Step 18 models

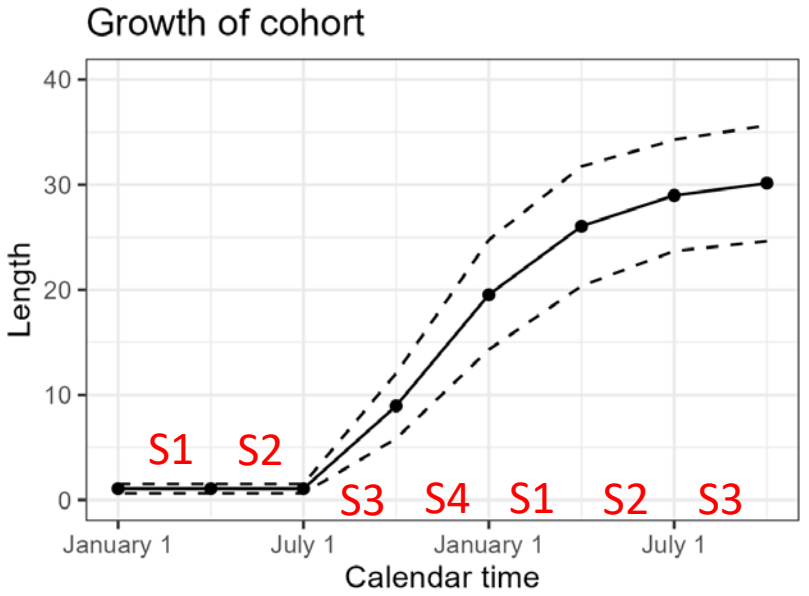
Step 16 model

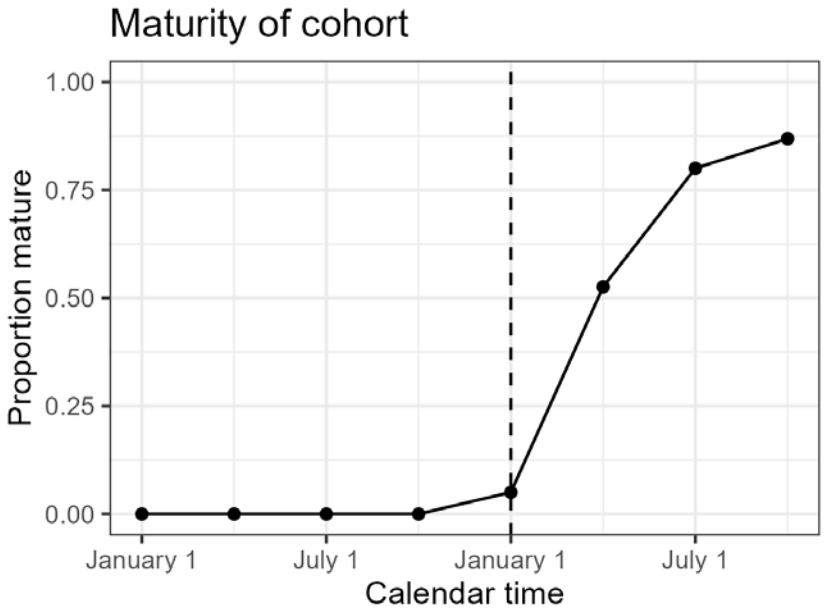
Cohort life span

- Annual model with seasonal sub-structure, **but age & growth are not independent of calendar time**
- Age-0 cohort appears in age structure in Season 3, advances to age 1 on January 1st

- One discrete spawning event per year
- Spawning occurs in February (Season 1) → **a cohort spawns only once per lifetime** (~5 percent of cohort, proportion in bottom right figure, dashed line)

- The spawning component is a small fraction of total biomass (≈0.07)





Step 16 model

Fishery dynamics

- Fishery operates in the second half of the year
- **Age 0 is specified to be invulnerable**
- Cohort spawns before any vulnerability to fishing → **Fishing has little to no impact** on spawning potential ratio

Lifespan of cohort:

Year 1 Age 0				Year 2 Age 1			
Season 1	Season 2	Season 3	Season 4	Season 1	Season 2	Season 3	Season 4
Does not exist in age structure	Does not exist in age structure	Settlement, mean length = 1 cm (Month 7)		Spawning, ~5 % of cohort (Month 2)		Full vulnerability to fishery	- Full vulnerability to fishery

Step 17 models

Major updates

- Allow fishery vulnerability at age-0 (ageselex option 0 instead of 10), partial age-0 vulnerability informed by length comp and selectivity-at-length
- Re-weight multinomial likelihoods for size composition with McAllister-Ianelli method
- Updated seasonal catches from 2023 data update (some catches in season 2. In Step 16, annual catches were evenly divided between seasons 3 and 4)

Step 17a: Change aggregation of size data

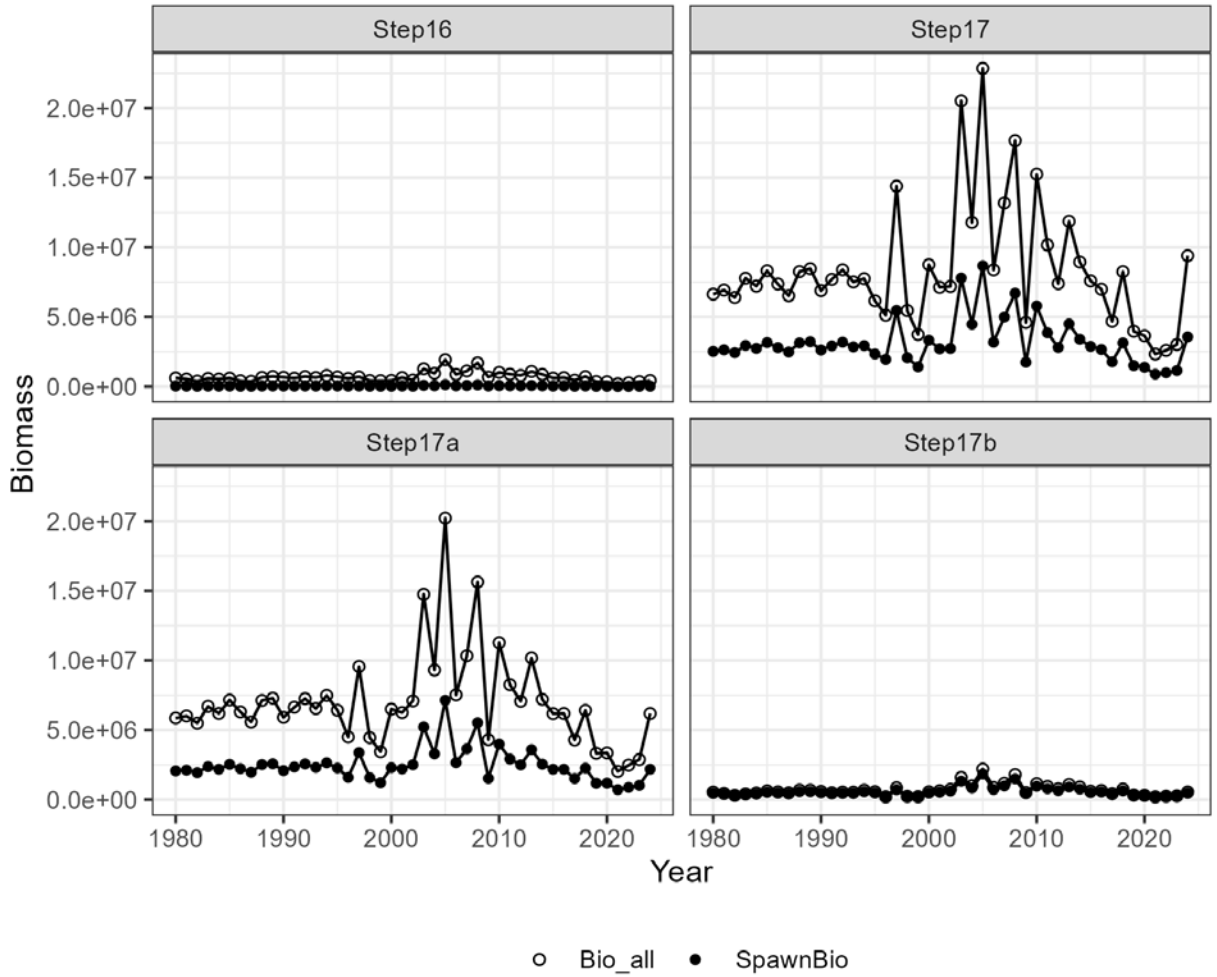
- SS3 can fit size composition data by month but difficult to visually compare fits
- Step 17 with size composition aggregated by season

Step 17b: Change maturity and spawning dynamics

- Step 17a with 2 spawning events per cohort
- With annual model, spawn timing must occur between July 1 – December 31
- Specify spawn timing = 12.999 (December 31st)
- Proportion mature is 0.30 at age 0, 1 at age 1 (Table 4, NPFC-2021-SSC PS07-WP03).

Step 17 models

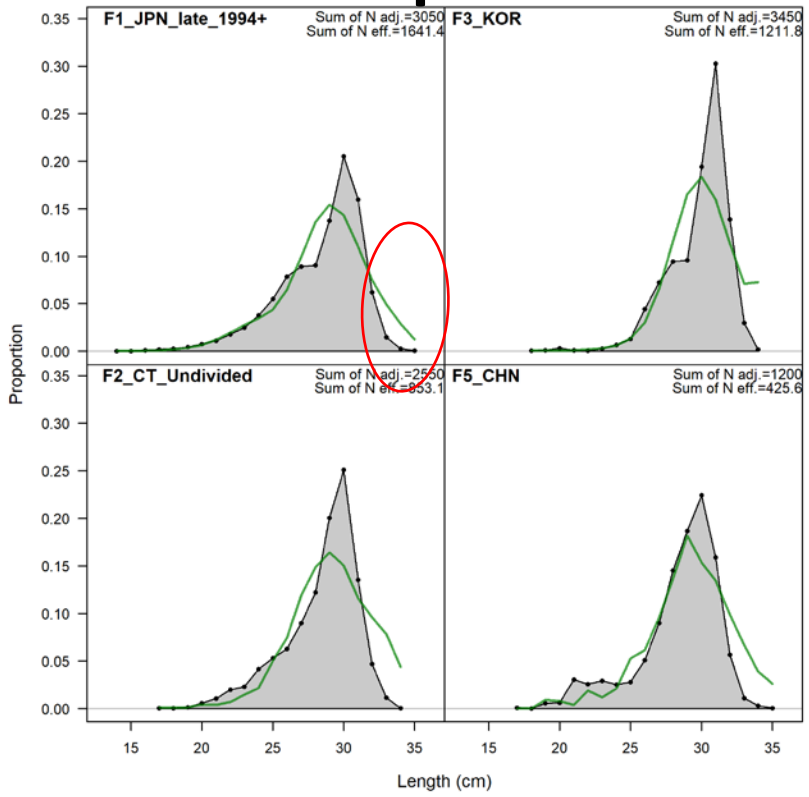
- Stock size is very sensitive to model structure
- Changes in age-0 selectivity and maturity/spawning dynamics results in larger spawning/total biomass ratio
- However, there is a mis-match between spawn timing, occurring at the end of the cohort lifetime (end of calendar year) instead of middle of the calendar year
- A seasonal model is needed to replicate the protracted spawning behaviour of the species

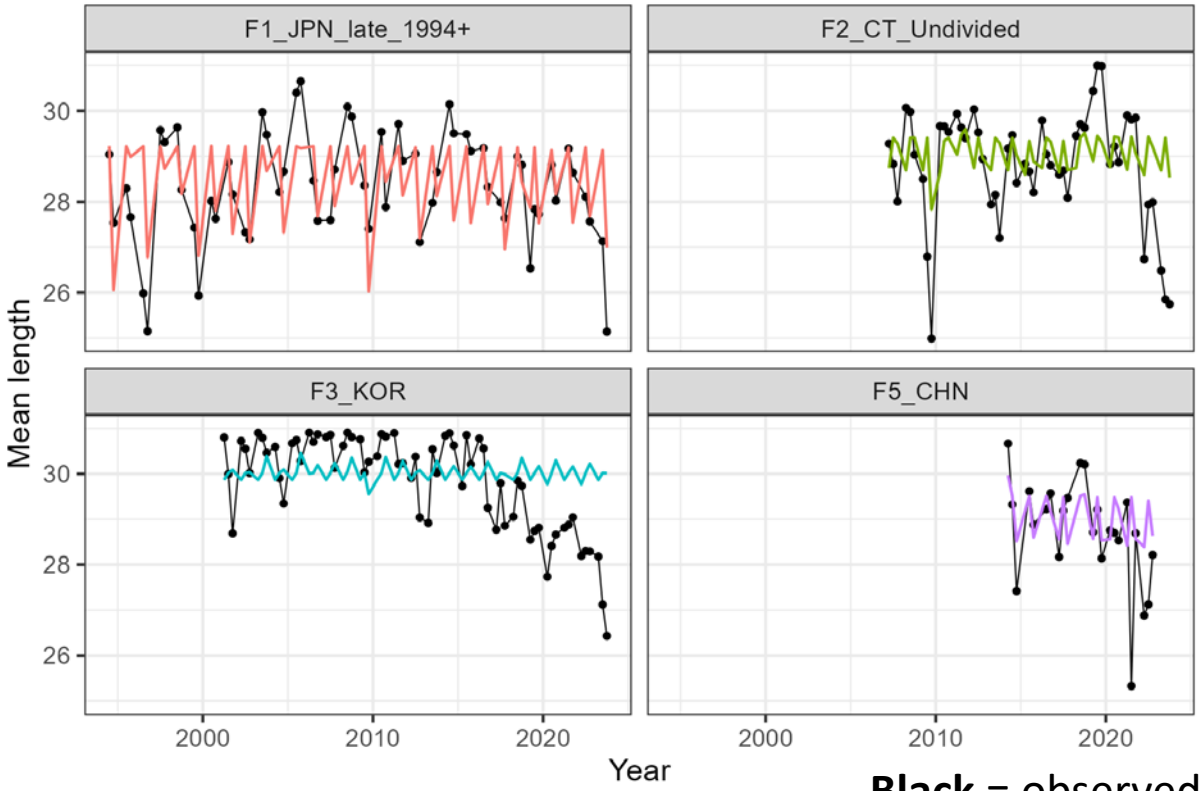


Step 17 models

- Step 17b still has poor fit to size composition. With asymptotic selectivity, model predicts more post-spawning fish than observed
- Model appears insufficiently flexible to model variability in size composition

Step 17b





Black = observed

Colour = predicted

WG NSAM02 Day-1

- Revisit and improve annual models (Step 16-17 models)
- Introduce seasonal model from revised annual model (Step 18 models)
- Diagnostics of Step 18 models

Step 18 models

Structural features of seasonal models

- Seasons are independent time steps, with conversion to year/season after model fit

- Seasonal model removes relationship between growth of cohort and calendar time
- Growth is measured in time since settlement of seasonal cohort in the age structure

- Spawning can occur multiple times per calendar year (not possible with annual model), may be better representation of protracted spawning of Pacific saury
- Seasonality in recruitment can be modeled in SS3, i.e., no recruitment in season 3
- Stock-recruit relationship & equilibrium quantities related to seasonal recruitment

Seasonal model

Lifespan of cohorts (Step 18)

	Year 1				Year 2				Year 3			
	Season 1	Season 2	Season 3	Season 4	Season 1	Season 2	Season 3	Season 4	Season 1	Season 2	Season 3	Season 4
Season 1 cohort	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 7 (plus group)	Age 7 (plus group)	Age 7 (plus group)	Age 7 (plus group)
Season 2 cohort		Age 0	Age 1	Age 2	…	…						
Season 3 cohort												
Season 4 cohort				Age 0	Age 1	Age 2	…	…				

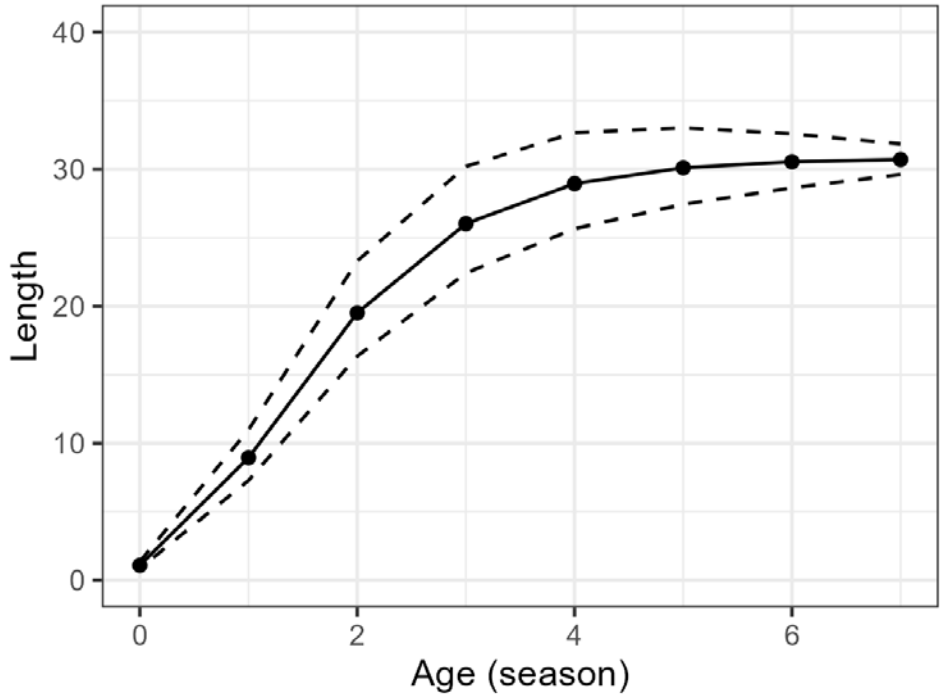
- Recruitment in seasons 1, 2, and 4, lifespan of each cohort is 8 seasons (dark green)
- Compared to annual model, fishery and survey dynamics unchanged with respect to calendar time
- Growth is calculated with respect to age since settlement (appearance in age structure), not related to calendar year

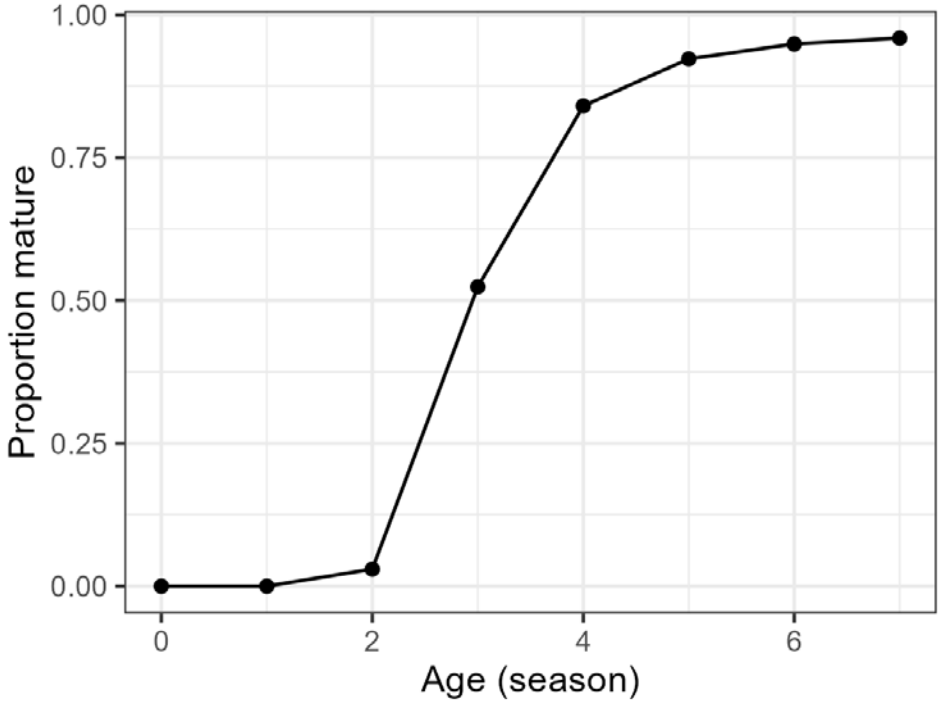
- Maturity is predicted from ogive (length-based values converted to age-based values)
- Cohort spawns approximately 6 times with proportions according to ogive (model predicts zero recruitment in season 3)

Seasonal model

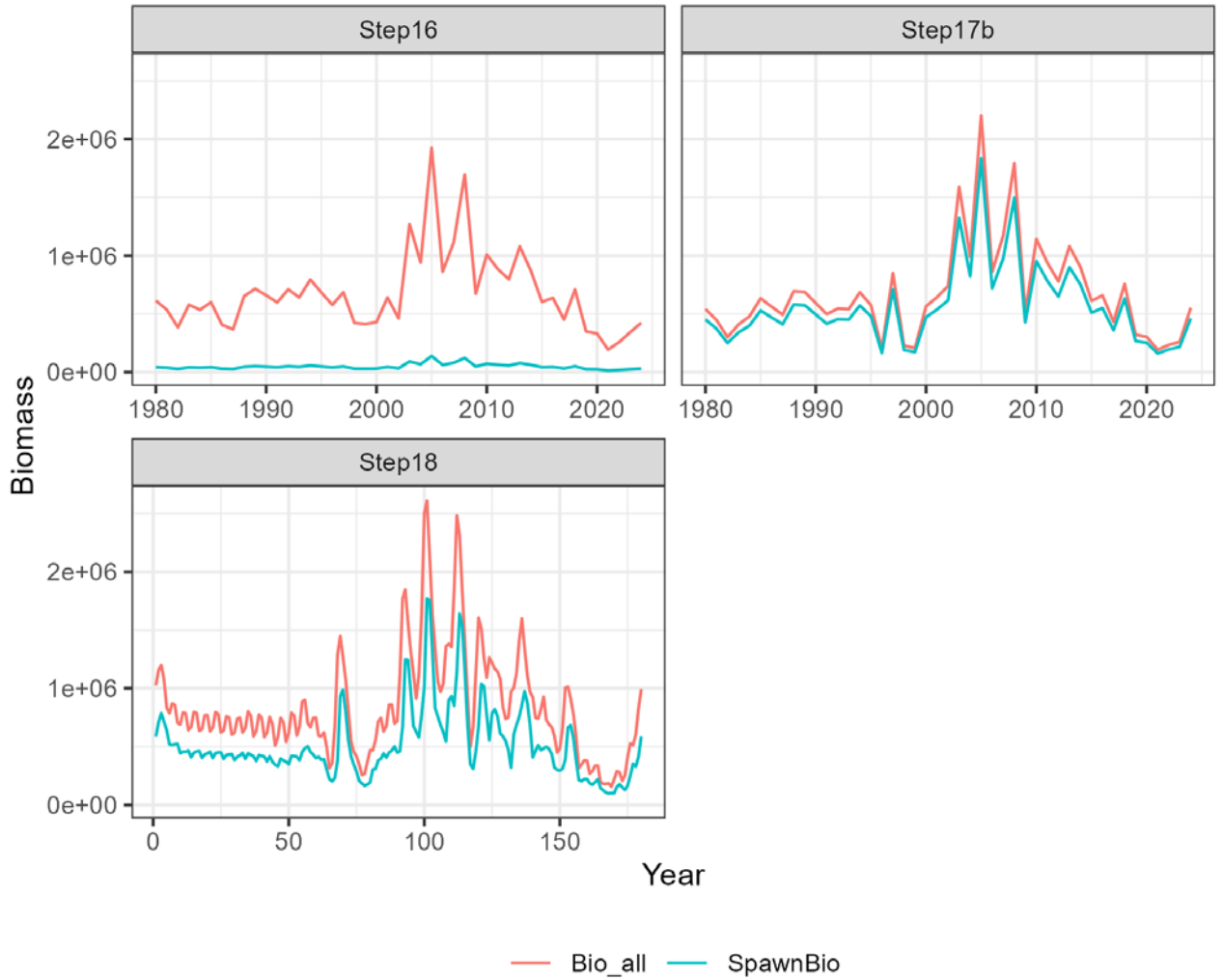
Lifespan of cohorts (Step 18)

	Year 1				Year 2				Year 3			
	Season 1	Season 2	Season 3	Season 4	Season 1	Season 2	Season 3	Season 4	Season 1	Season 2	Season 3	Season 4
Season 1 cohort	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 7 (plus group)	Age 7 (plus group)	Age 7 (plus group)	Age 7 (plus group)
Season 2 cohort		Age 0	Age 1	Age 2	…	…						
Season 3 cohort												
Season 4 cohort				Age 0	Age 1	Age 2	…	…				



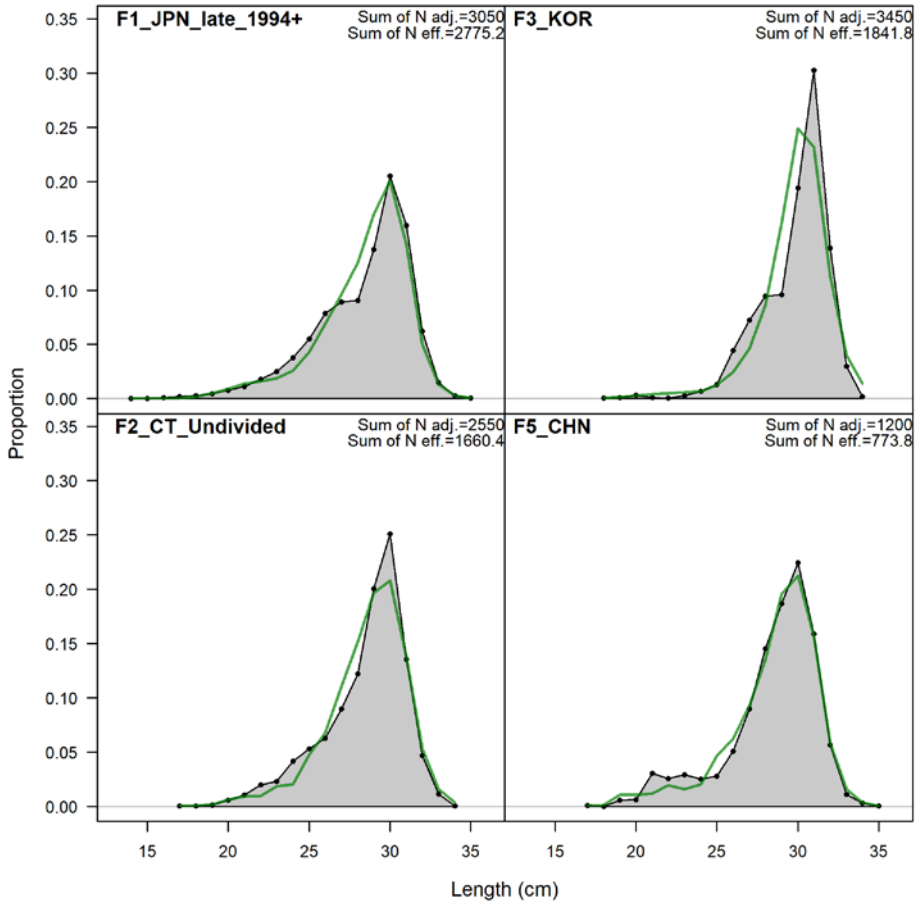


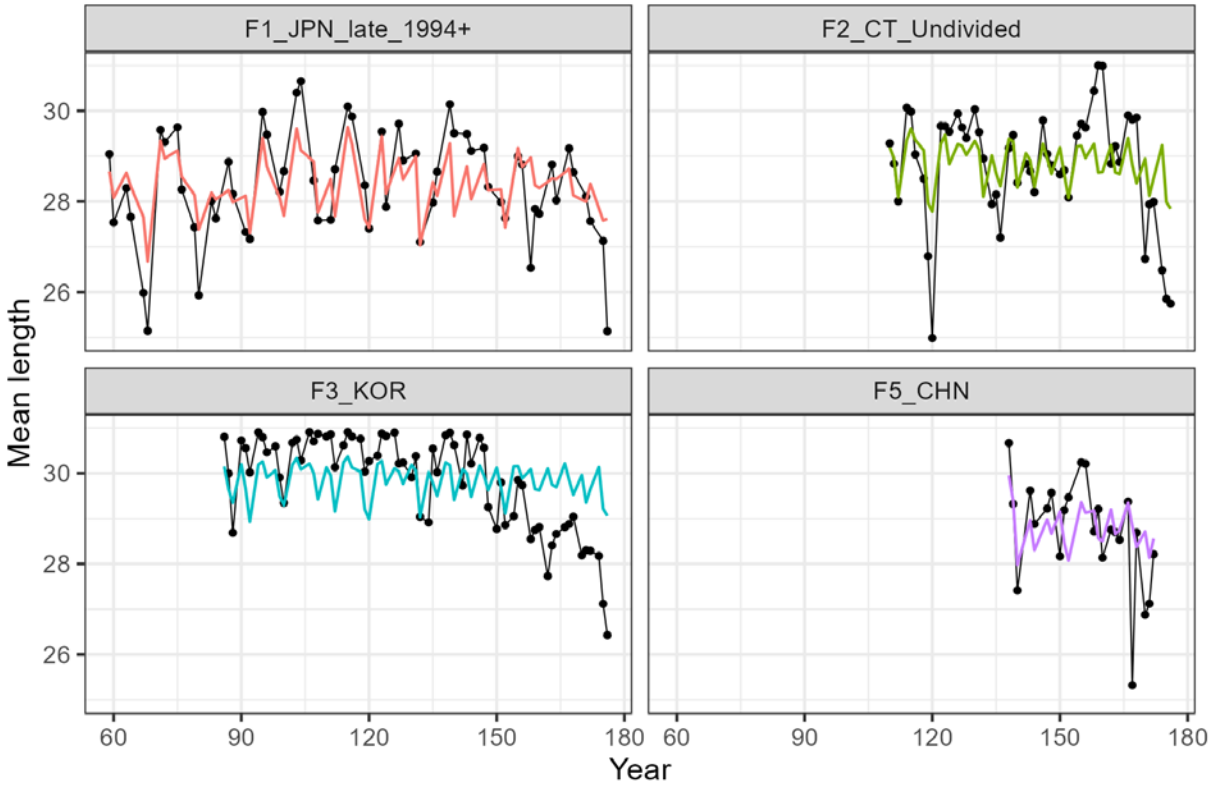
Biomass comparison



Step 18 models

- Seasonal model improves fit to size composition





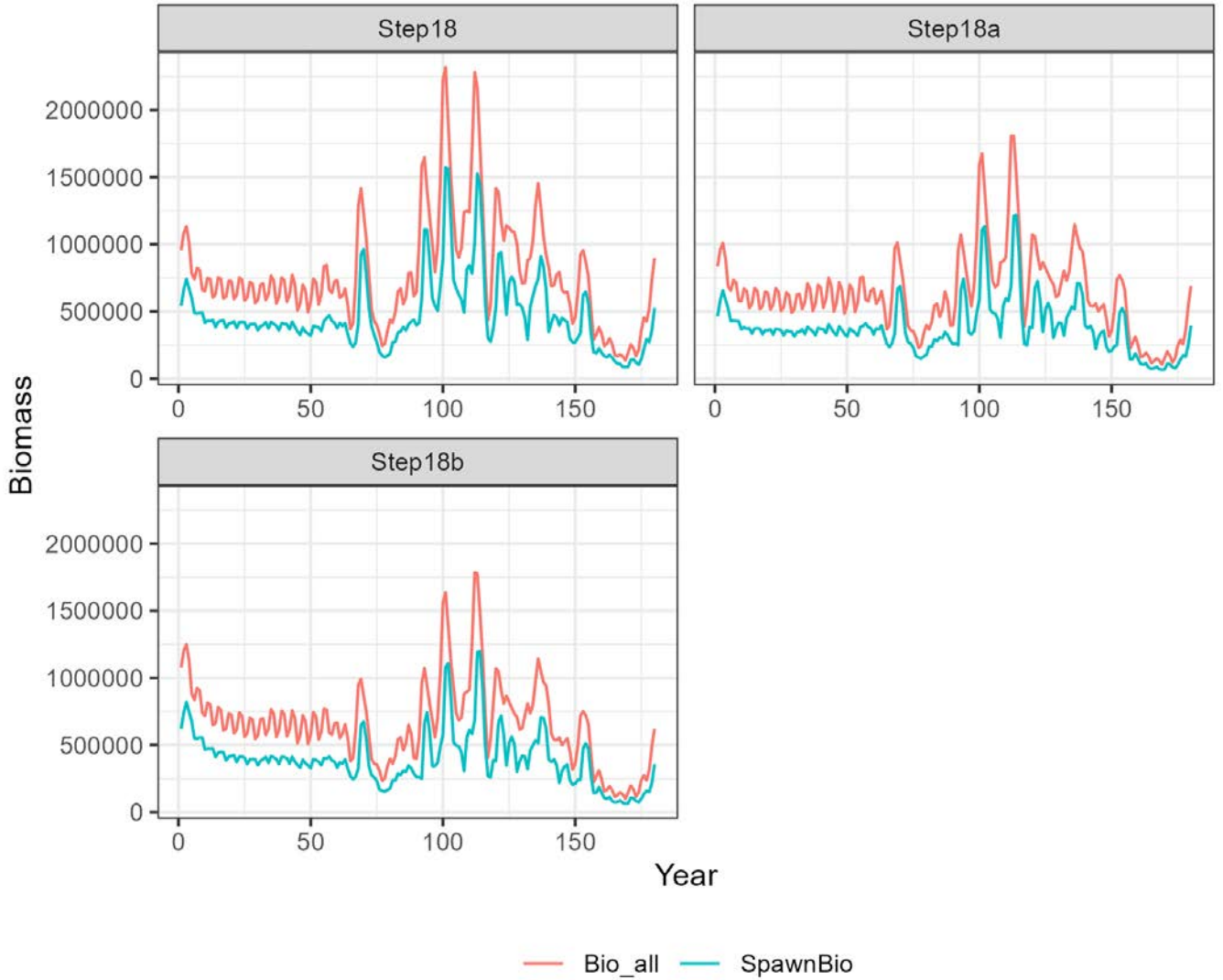
Step 18 models

Step18a: Fix hyperstability parameter = 0

- CPUE of Late JPN, KOR, RUS, CHN, are representative of stock trends
- Random walk of Early JPN, CT catchability remains

Step18b: Estimate steepness

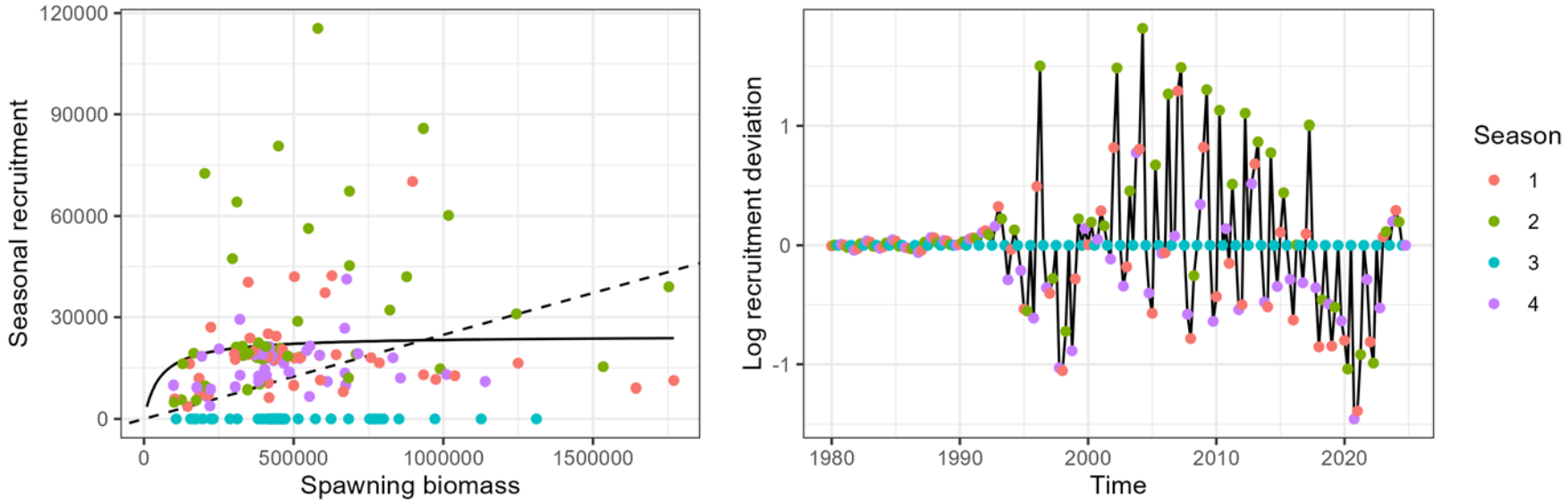
Step 18 models



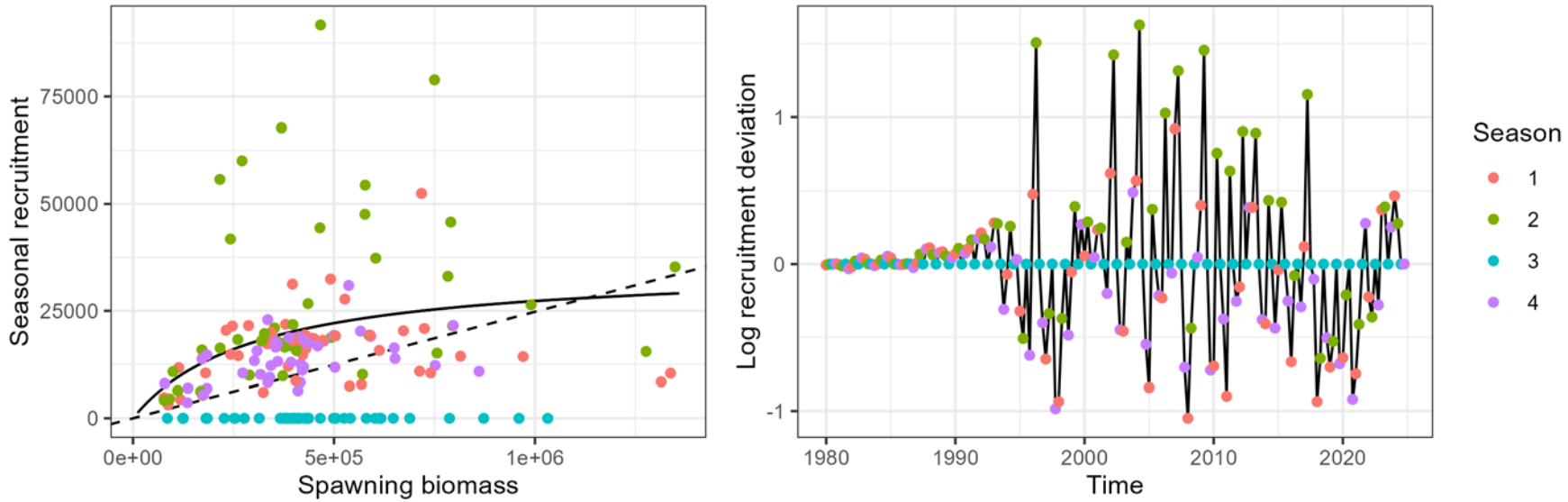
Step 18 stock-recruit relationship

- Residual trend in recruitment deviations with estimated steepness is somewhat improved
- The steepness estimate in Step18b is 0.54 (compared to 0.82 in all other models)

Step18:



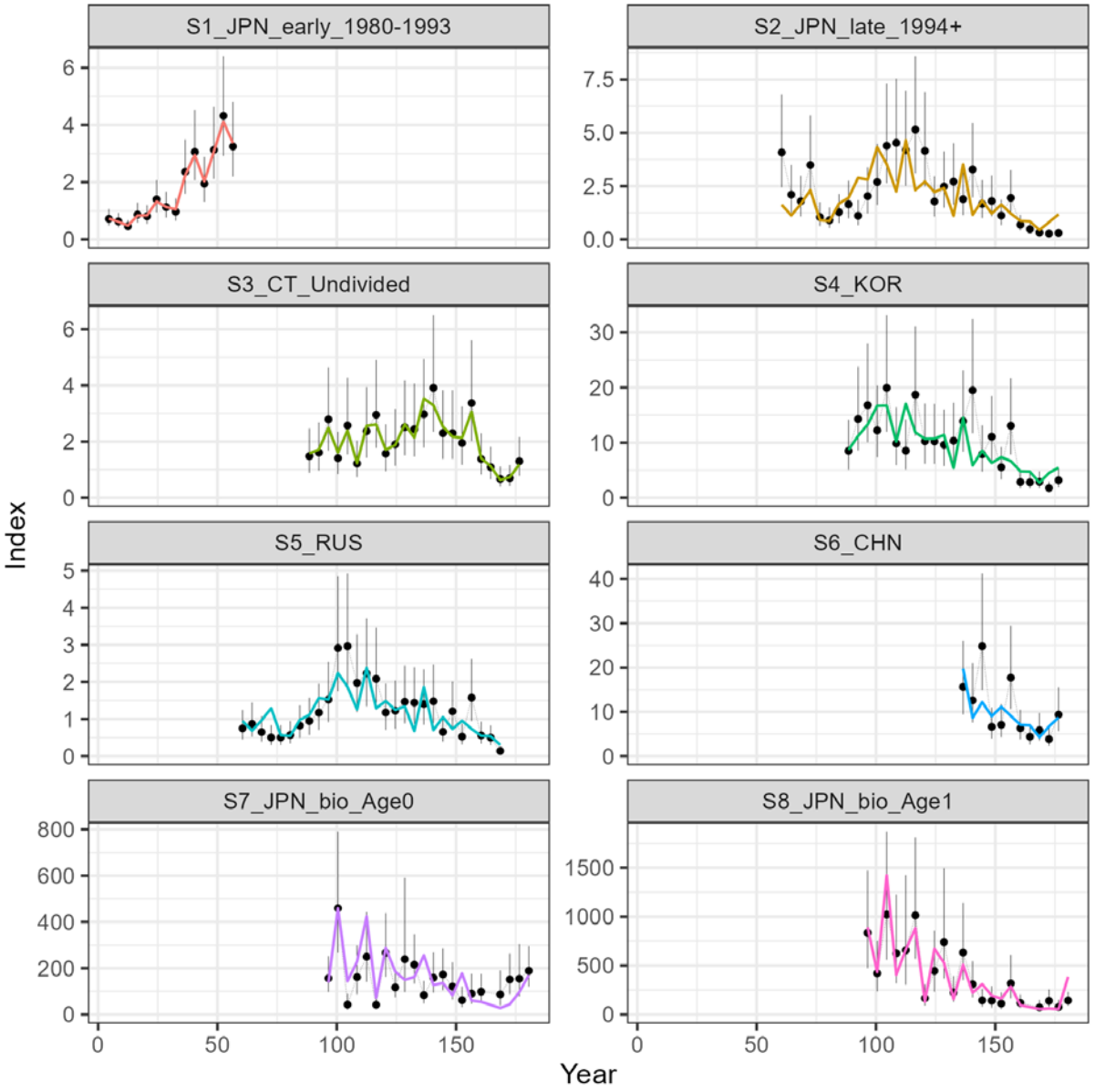
Step18b:

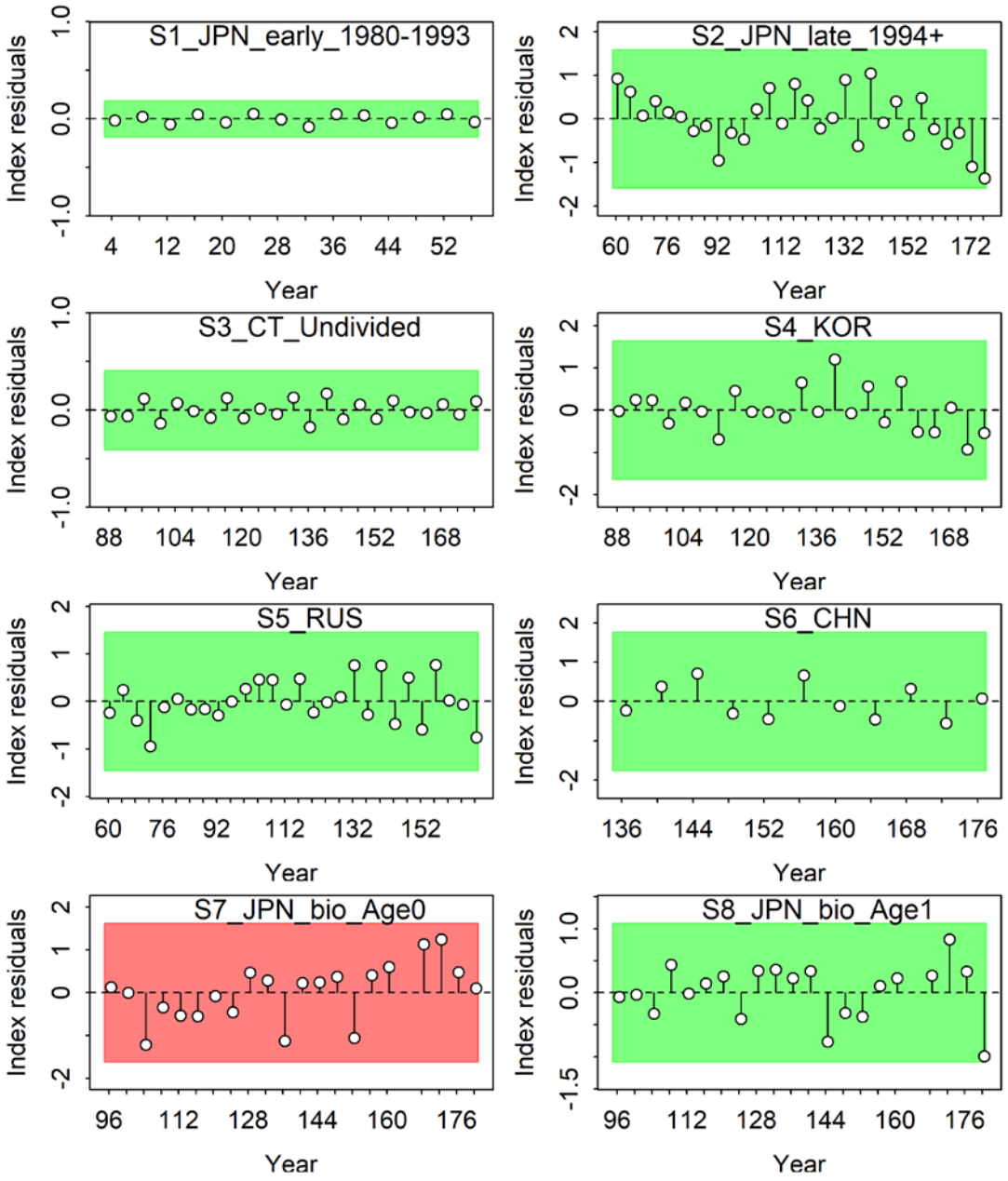


WG NSAM02 Day-1

- Revisit and improve annual models (Step 16-17 models)
- Introduce seasonal model from revised annual model (Step 18 models)
- Diagnostics of Step 18 models

Step18 fit to indices



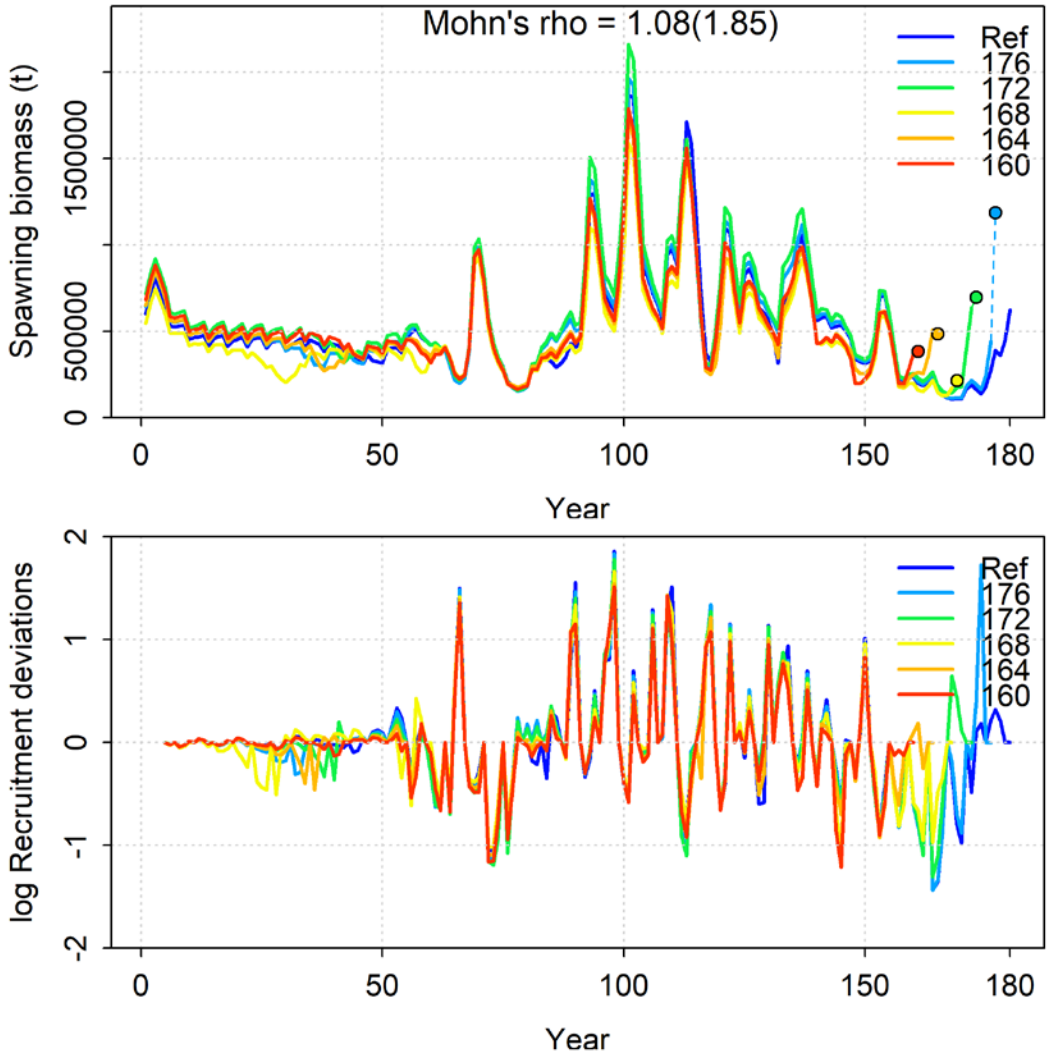


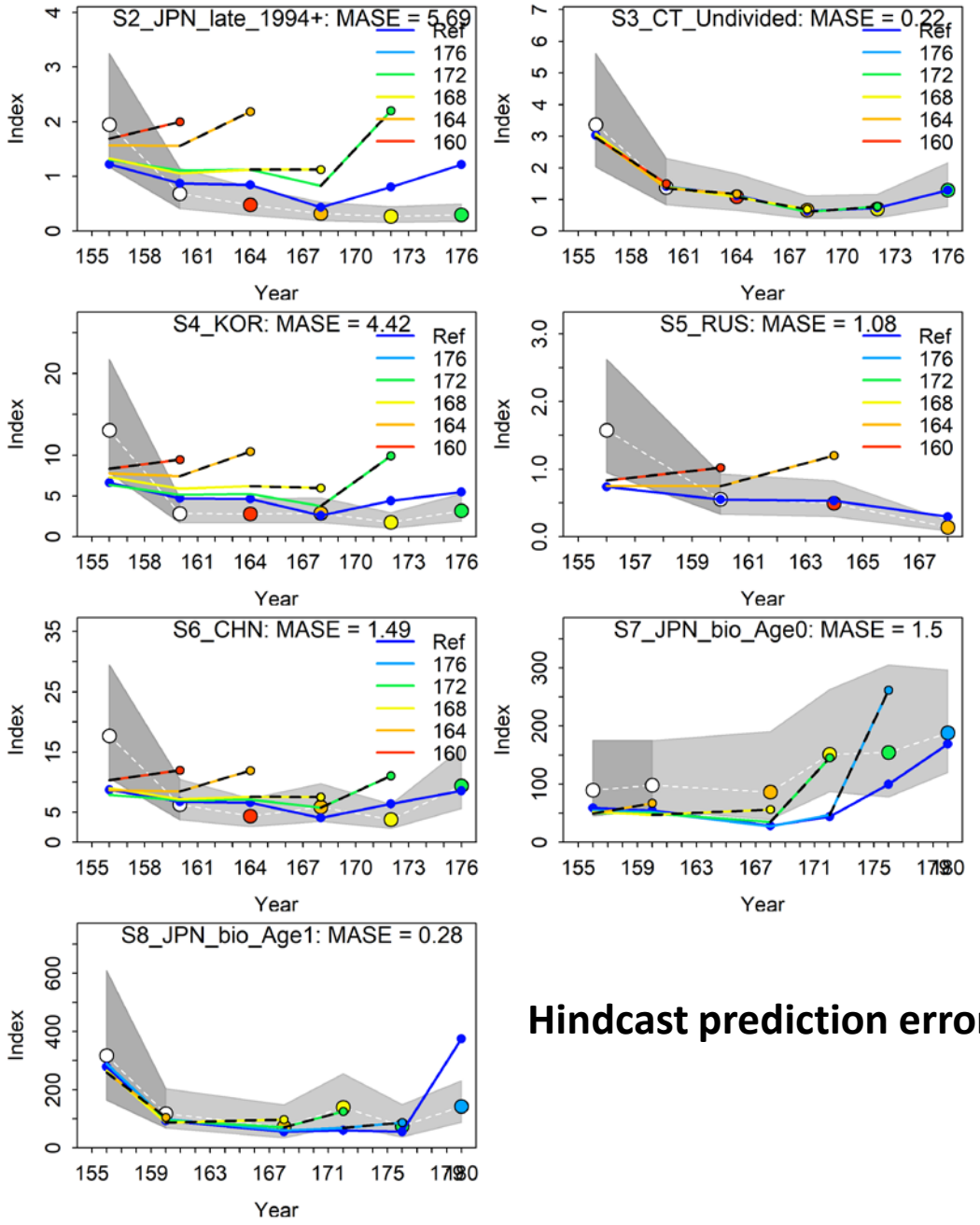
Step 18 models

- Retrospective peel by calendar year (intervals of 4 seasonal time steps)

- Top figure: Positive Mohn's rho with divergence at end of SSB time series: unfished stock size (R0) is consistently estimated but terminal year recruitment is not.
- Bottom figure: Inconsistent recruitment deviations in retrospective figure suggests that they should not be estimated in the last calendar year. Or we need to improve the fit to the age-0 JPN index

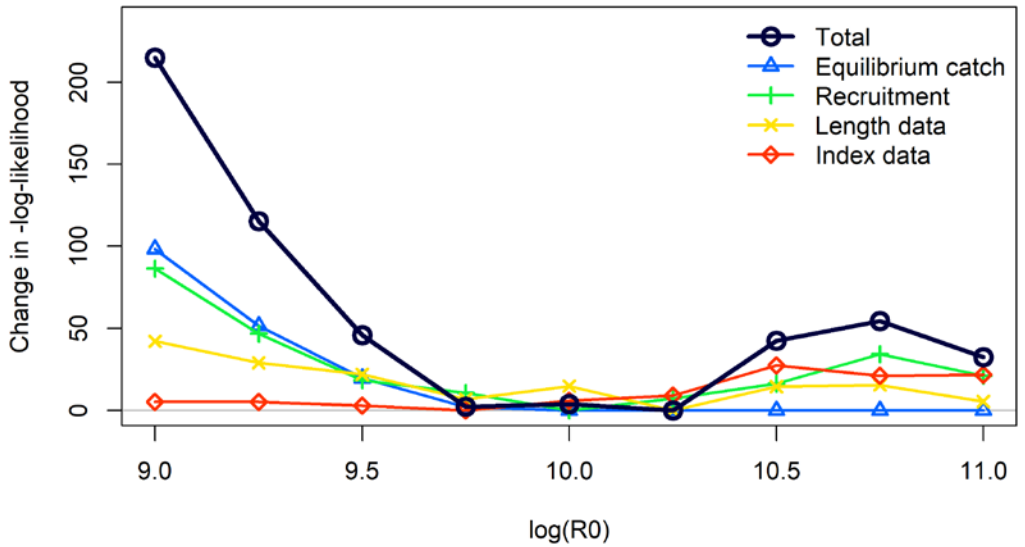
- Due to short lifespan, model likely cannot forecast more than one year
- Current model structure cannot be used for forecasting. Good forecast skill dependent on fit to age-0 survey index

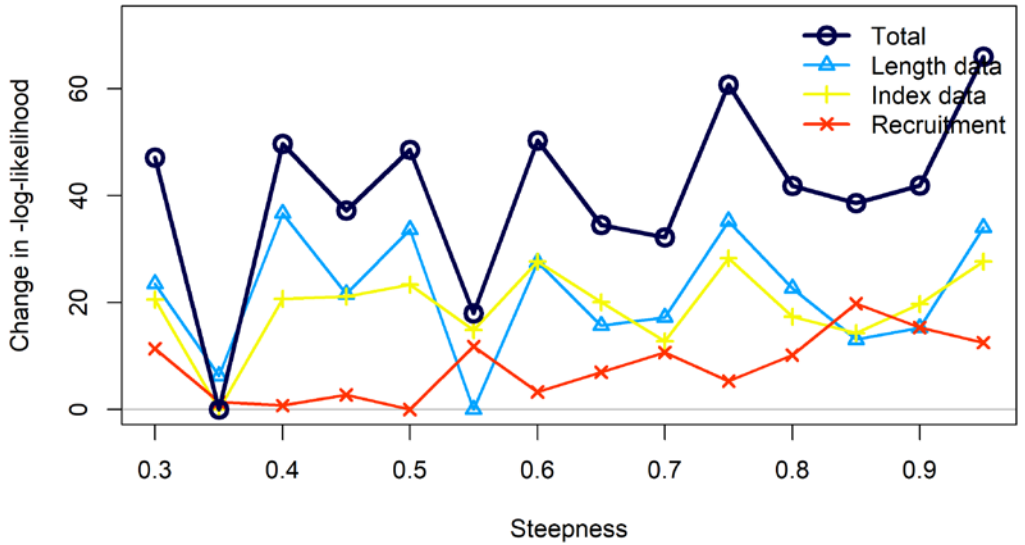




Hindcast prediction error

Profile

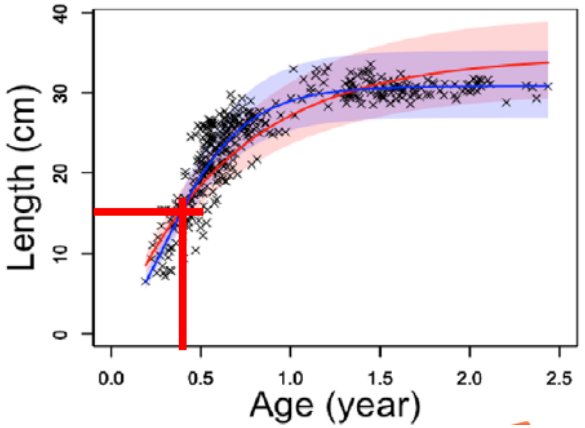




WG NSAM02 Day-2

Step 19:

- Change timing of JPN survey to season 3. Change age 0 selectivity to capture Season 4 of previous year, Season 1 cohort of this year (> 15 cm)
- Add 2024 catch from NPFC-2025-SSC PS15-WP01



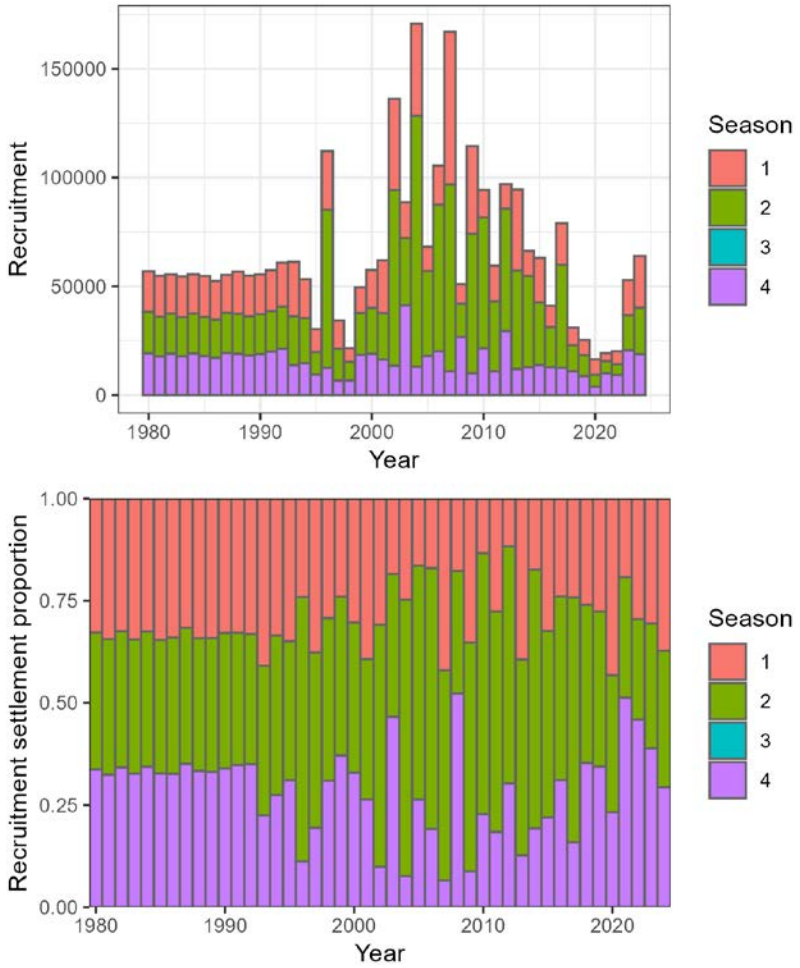
- Step 19a: Exclude early-JPN and CT CPUE
- Step 19b: Exclude all CPUE
- Step 19c: Seasonal M for post-spawning mortality
- Step 20: Start year in 1994

JPN survey (Annual age 0) ↓ Annular ring formation ↓ JPN survey (Annual age 1) ↓

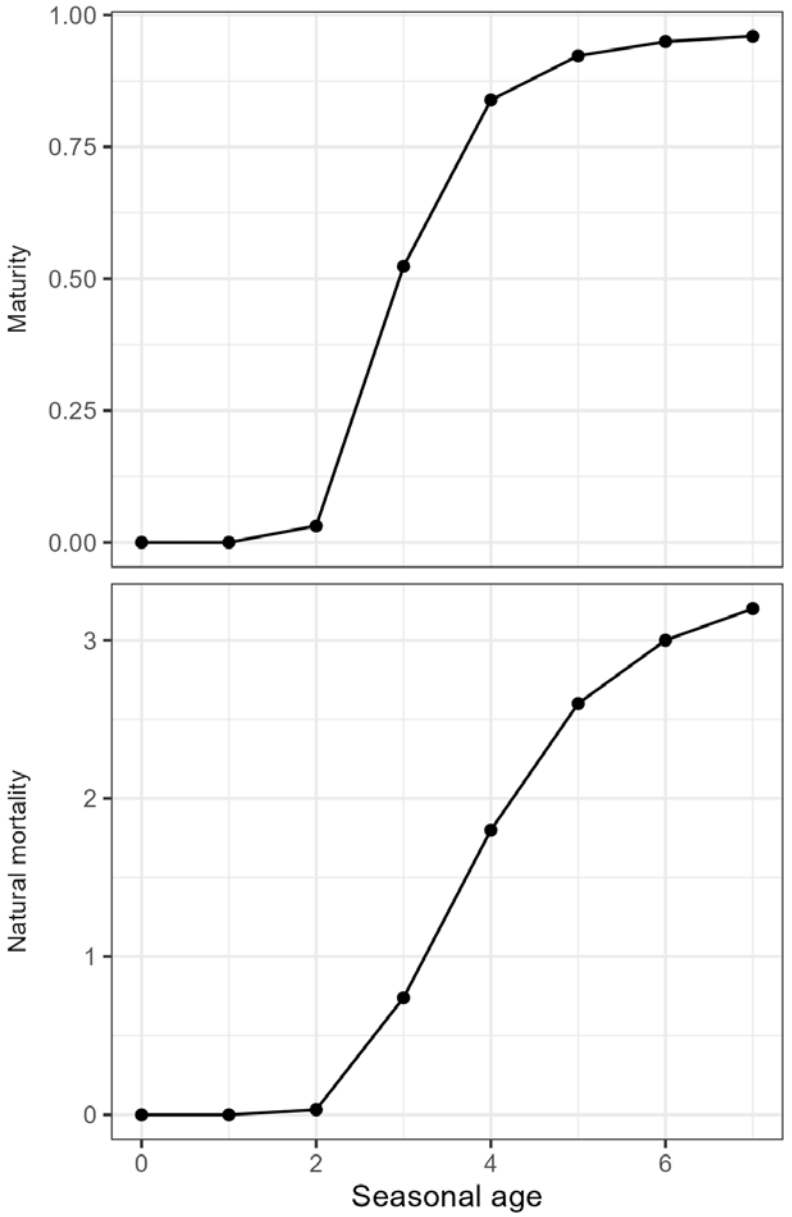
	Year 1	Year 2				Year 3				Year 4
	Season 4	Season 1	Season 2	Season 3	Season 4	Season 1	Season 2	Season 3	Season 4	Season 1
Season 4 cohort	Seasonal Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	**Age 7**	Age 7 (plus group)	Age 7 (plus group)
Season 1 cohort		Age 0	Age 1	Age 2	**Age 3**	Age 4	Age 5	Age 6	Age 7	Age 7 (plus group)
Season 2 cohort			Age 0	Age 1	Age 2	**Age 3**	…			
Season 3 cohort										

WG NSAM02 Day-2

Figures: proportion of recruitment settlement by calendar year,
****not cohort year ****

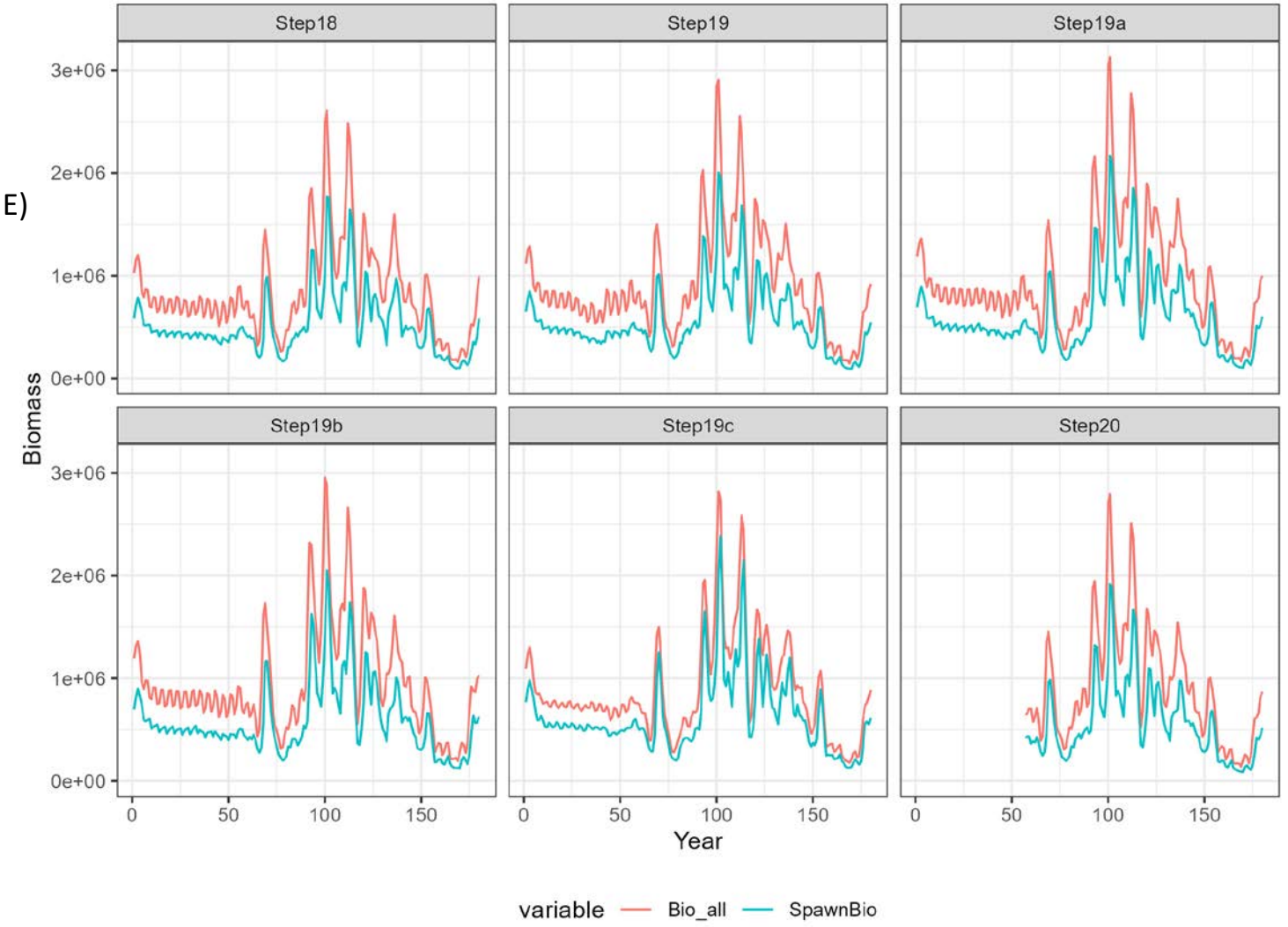


Seasonal M for post-spawning mortality

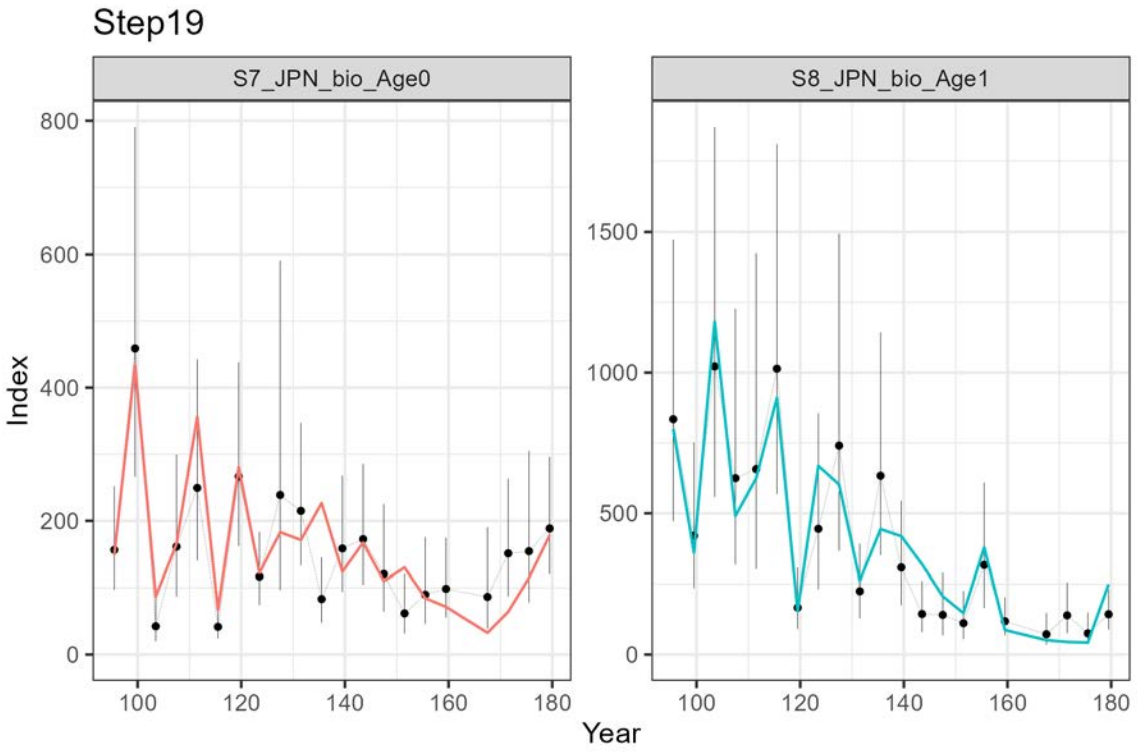


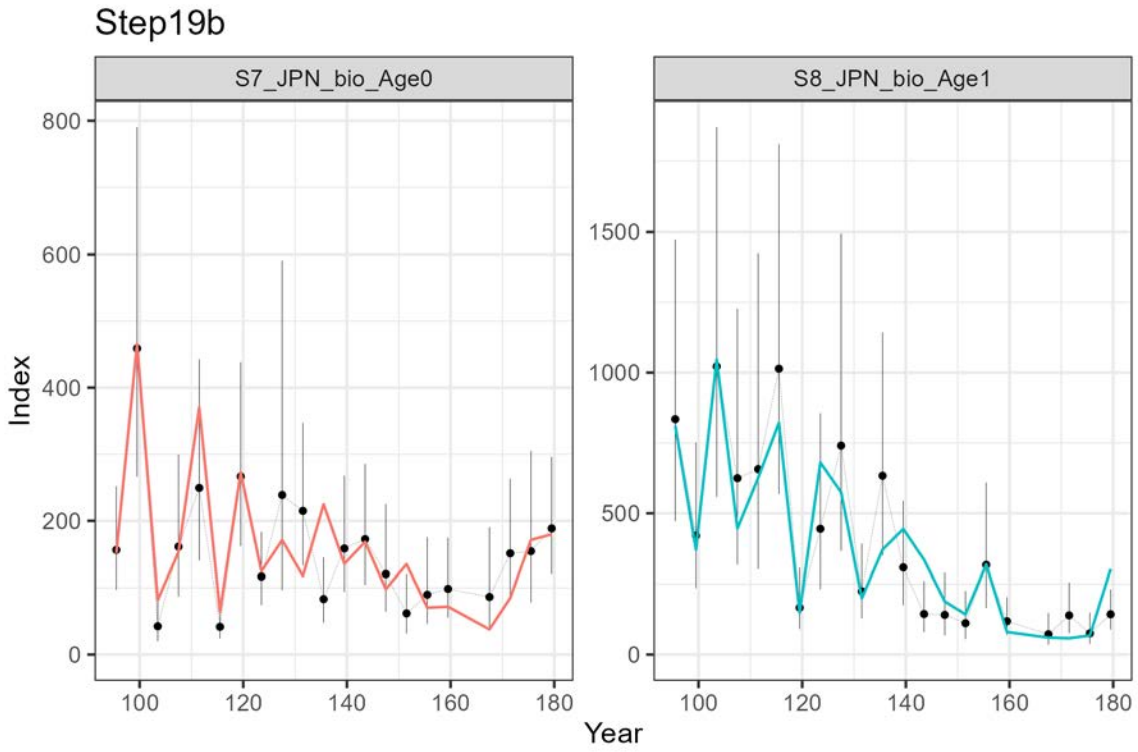
WG NSAM02 Day-2

Step 19: Change timing/sel JPN survey, add 2024 catch (all CPUE)
Step 19a: Exclude early-JPN and CT CPUE
Step 19b: Exclude all CPUE
Step 19c: Seasonal M for post-spawning mortality (all CPUE)
Step 20: Start year in 1994 (all CPUE)



WG NSAM02 Day-2

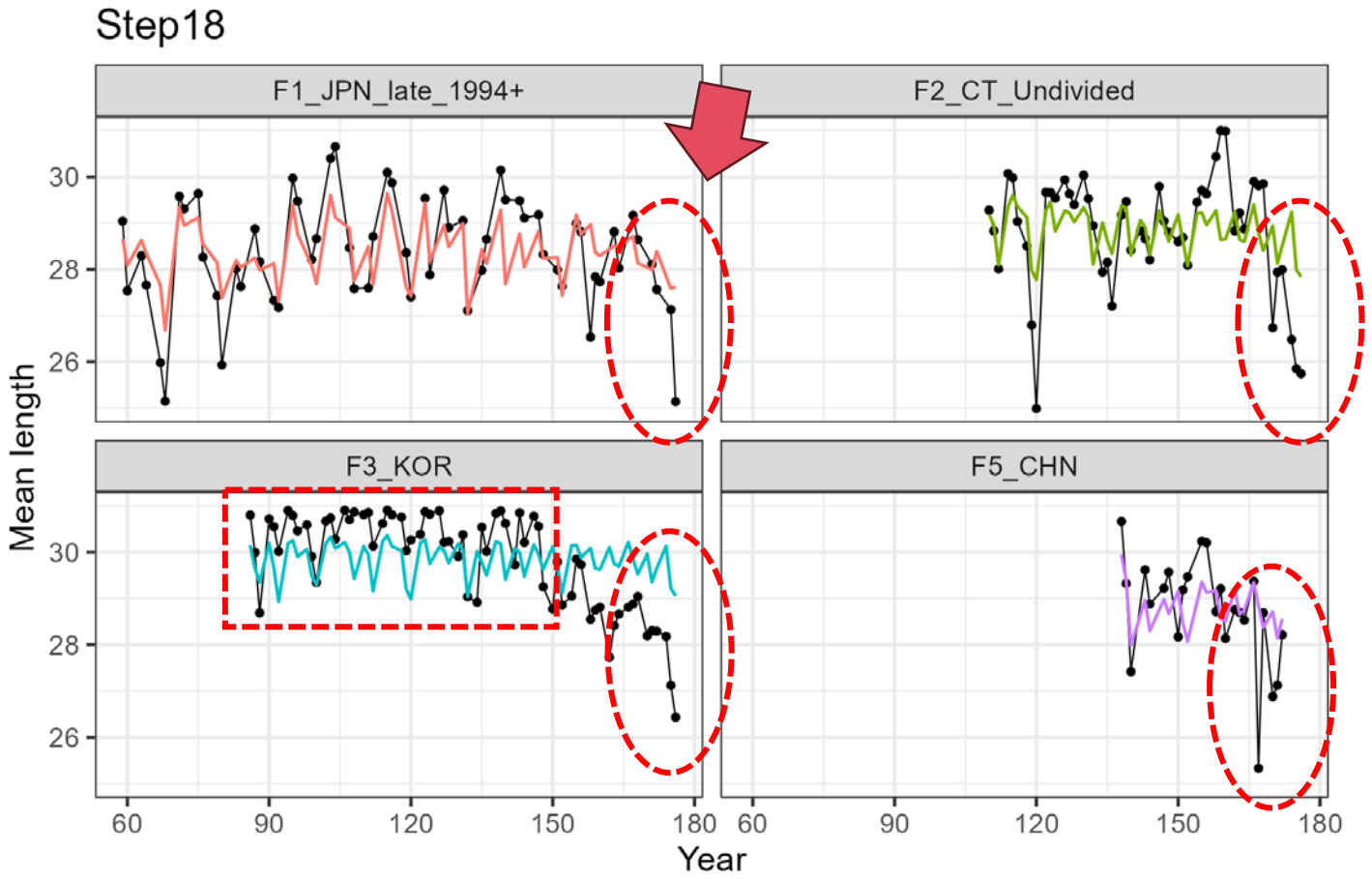




Step 19: Change timing/sel JPN survey, add 2024 catch (all CPUE)
Step 19a: Exclude early-JPN and CT CPUE
Step 19b: Exclude all CPUE
Step 19c: Seasonal M for post-spawning mortality (all CPUE)
Step 20: Start year in 1994 (all CPUE)

WG NSAM02 Day-2

- How to explain the reduction of body size?



Step 19: Change timing/sel JPN survey, add 2024 catch (all CPUE)
Step 19a: Exclude early-JPN and CT CPUE
Step 19b: Exclude all CPUE
Step 19c: Seasonal M for post-spawning mortality (all CPUE)
Step 20: Start year in 1994 (all CPUE)

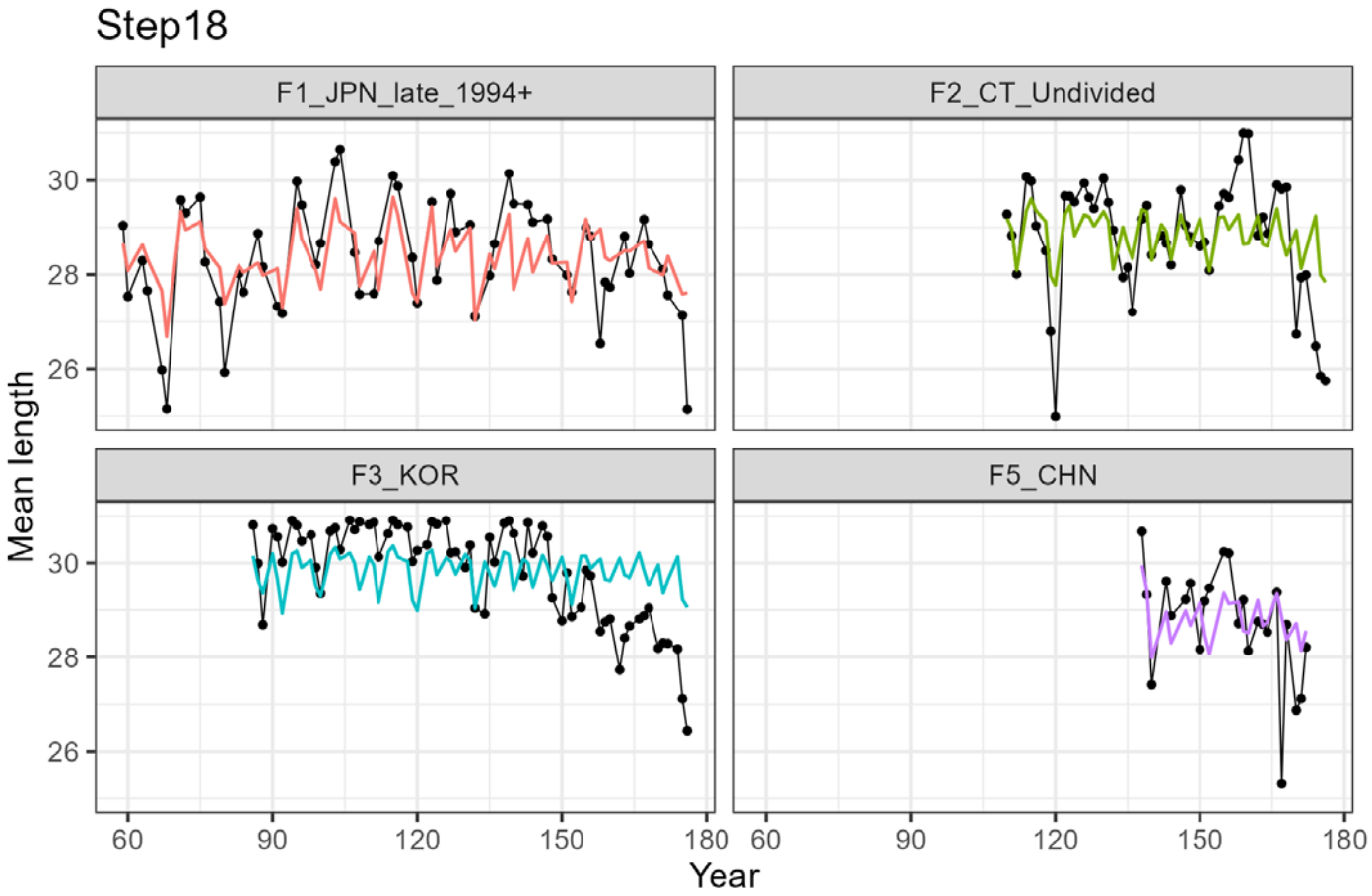
WG NSAM02 Day-3

Additional sensitivity cases:

- Distribution shift: Change from logistic to dome shaped selectivity (time block) to explain population shift to NE Pacific (fishery and survey escapement)

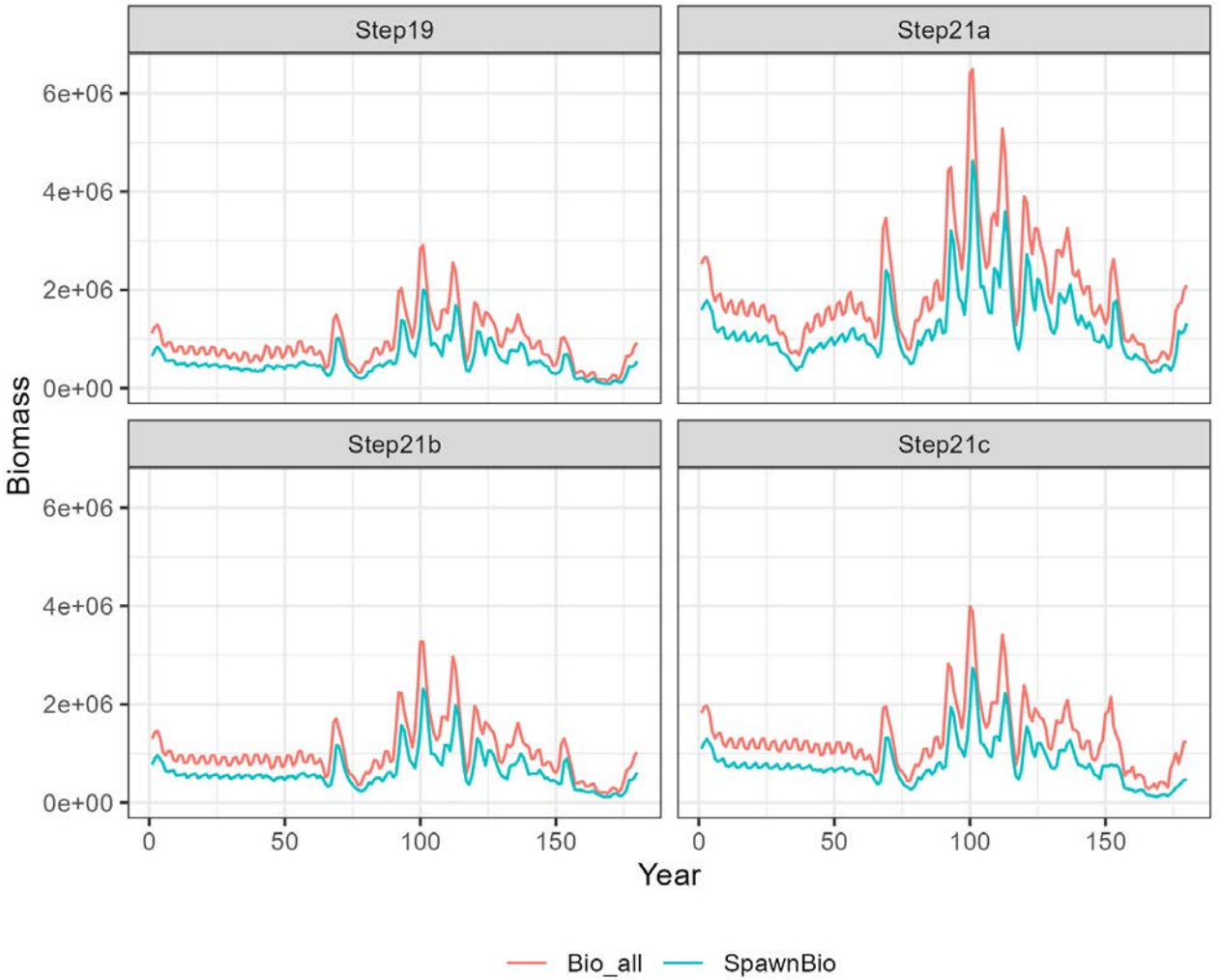
- Depletion of large fish: Change in selectivity, but remains logistic

- Reduction in body size: Time-varying growth (need annual length-age data by seasonal age)

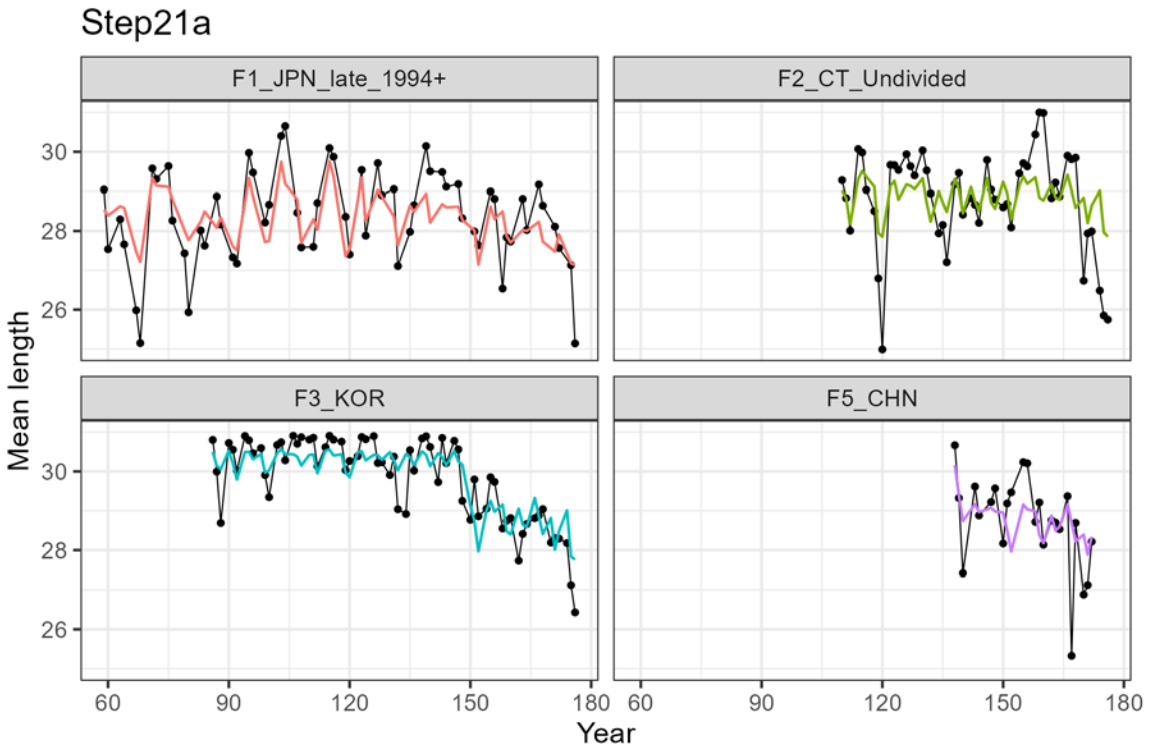


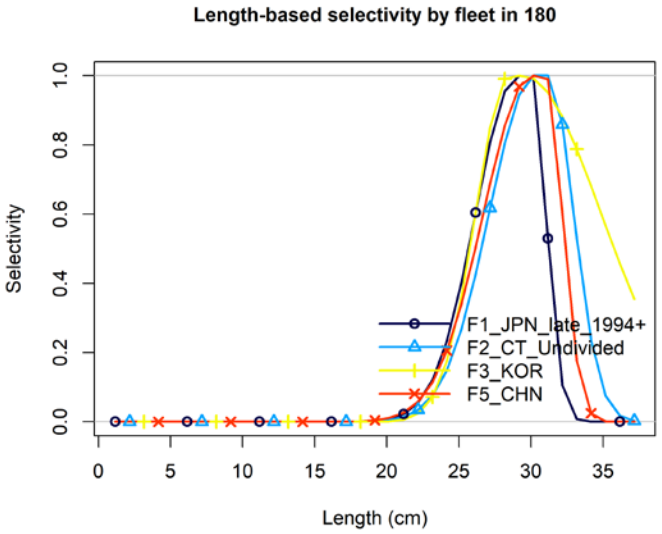
- Step 19: Change timing/sel JPN survey, add 2024 catch (all CPUE)
- Step 21a: Distribution hypothesis: Change in selectivity (new sel is dome)
- Step 21b: Targeting hypothesis: Change in selectivity (new sel is logistic)
- Step 21c: Change in growth

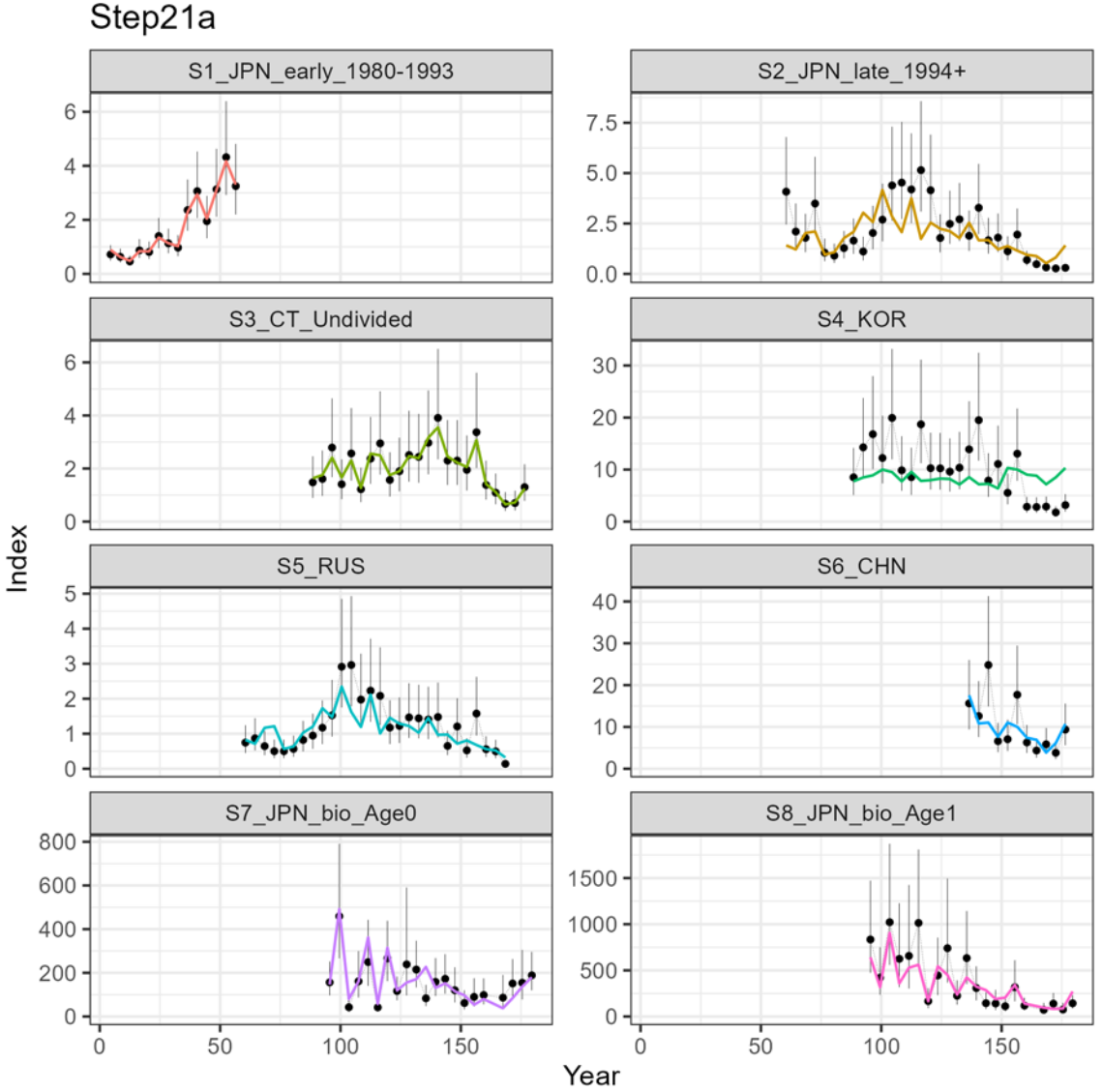
WG NSAM02 Day-3



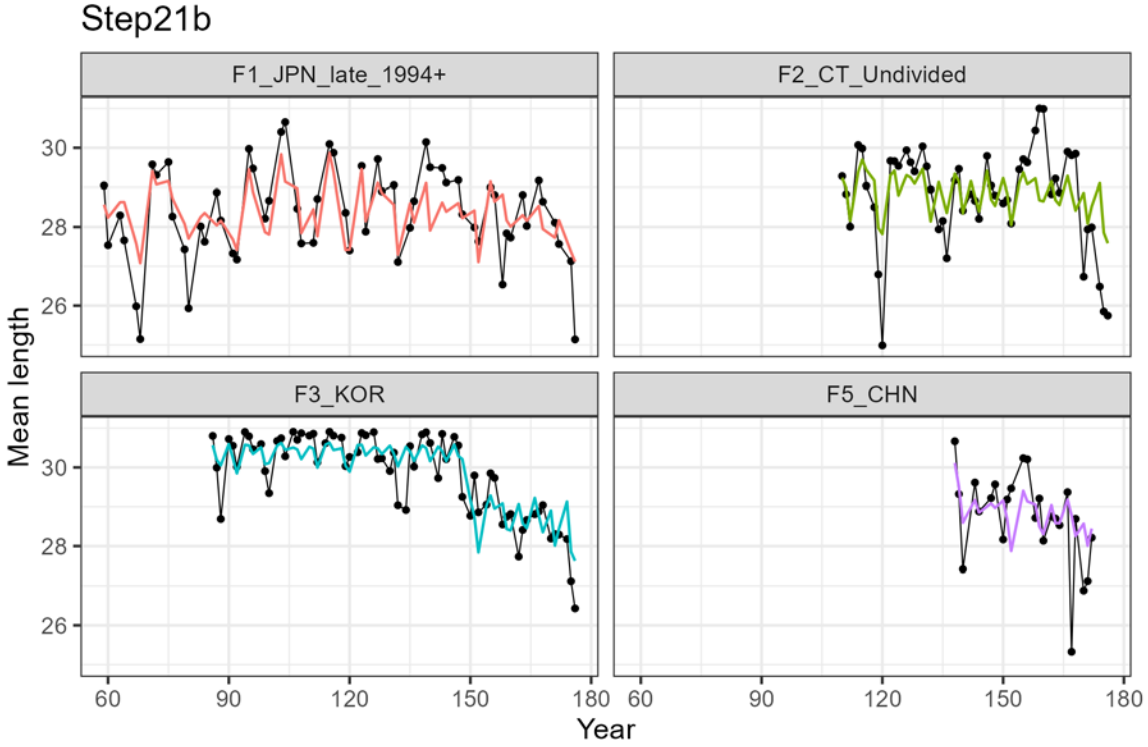
- Step 19: Change timing/sel JPN survey, add 2024 catch (all CPUE)
- Step 21a: Distribution hypothesis: change in selectivity (new sel is dome)
- Step 21b: Change in selectivity (new sel is logistic)
- Step 21c: Change in growth

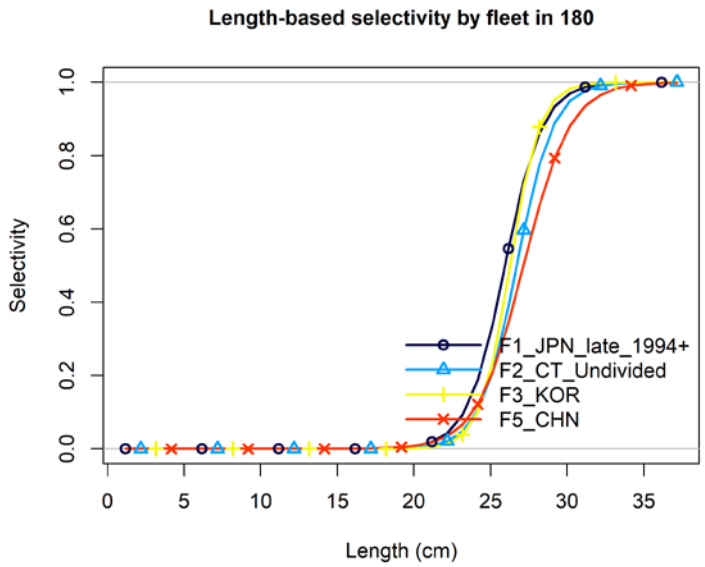


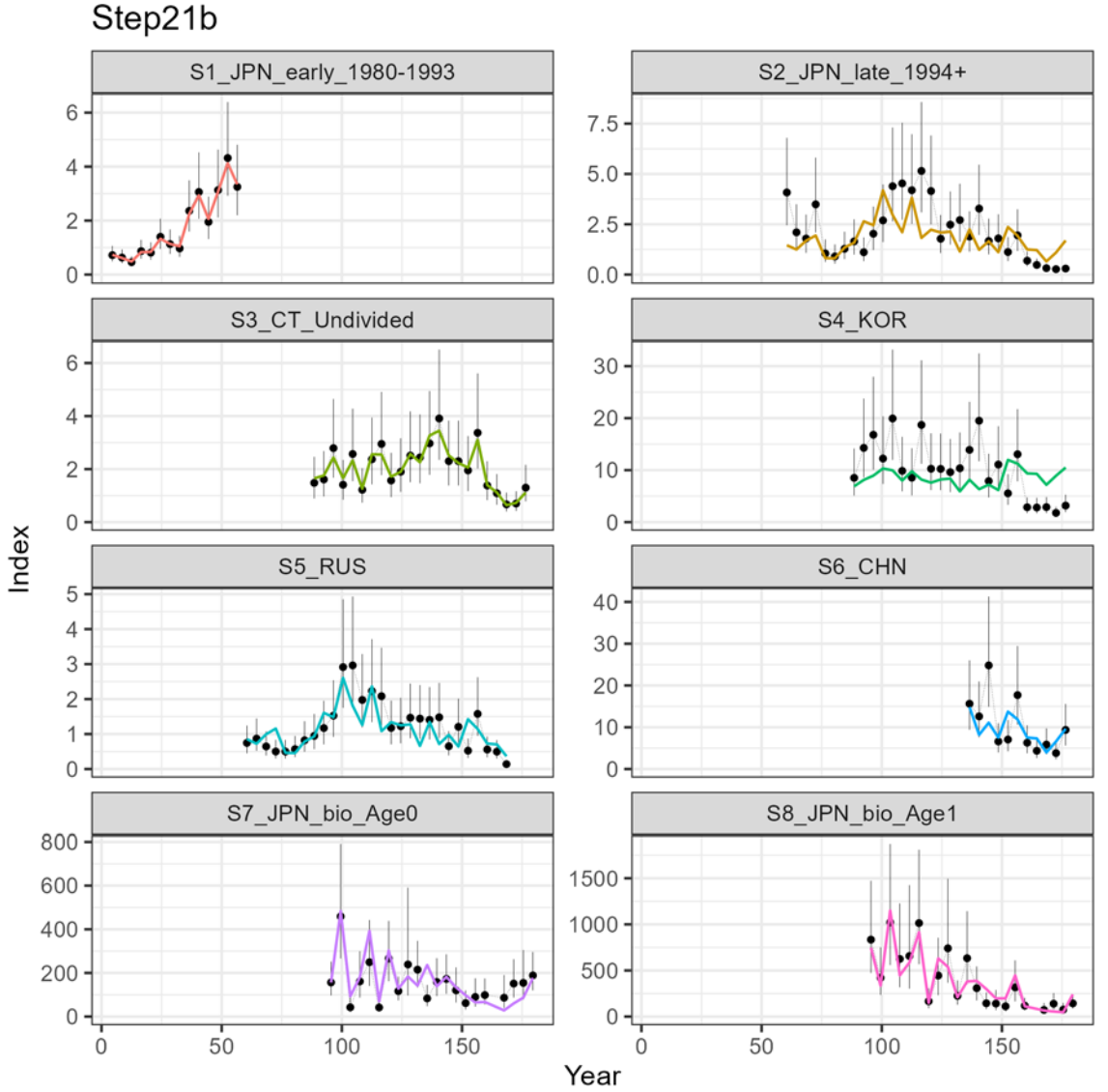




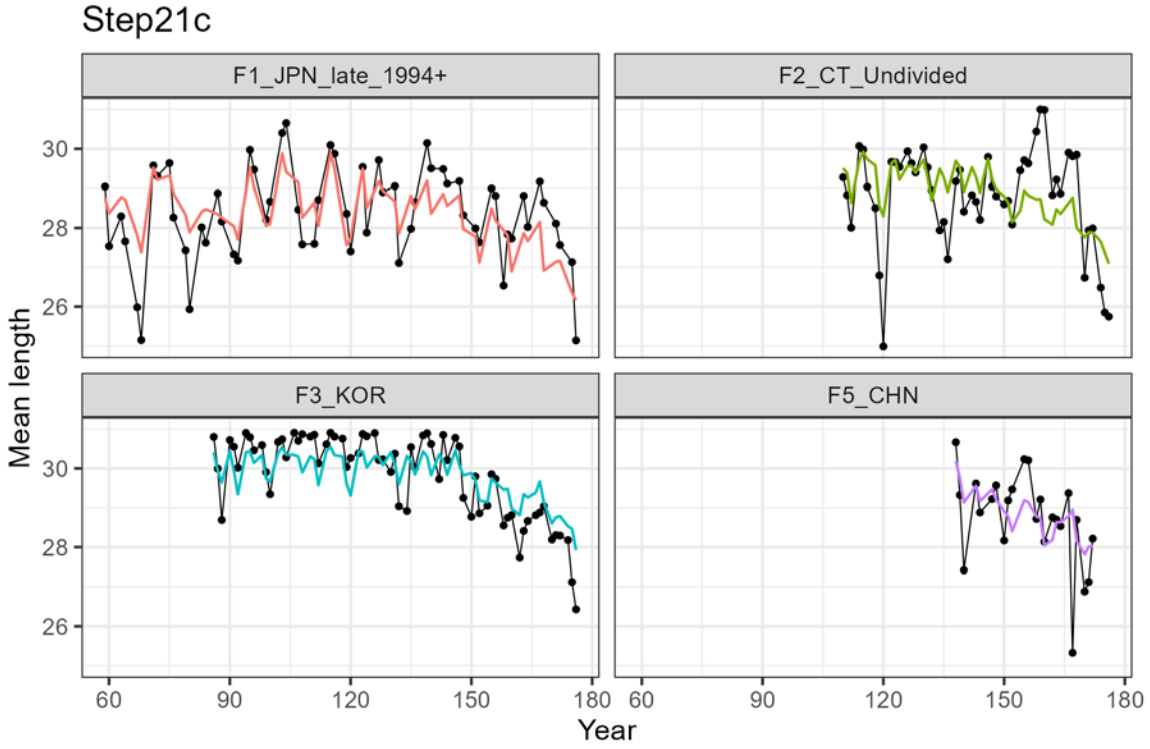
Step 21a: Distribution hypothesis: change in selectivity (new sel is dome)

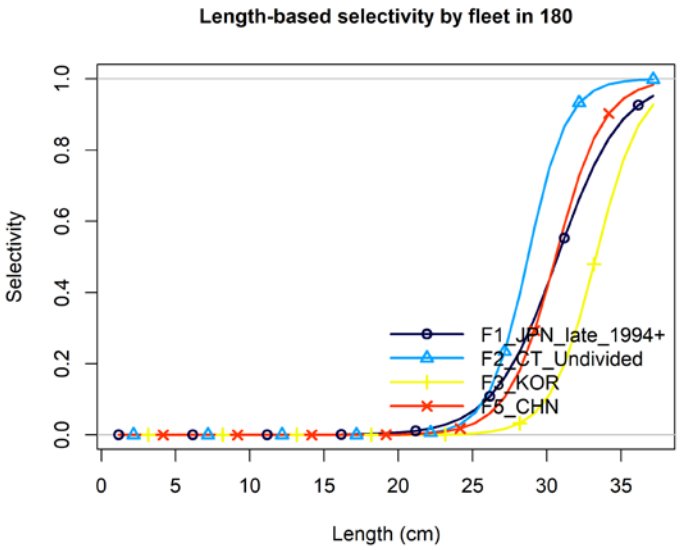


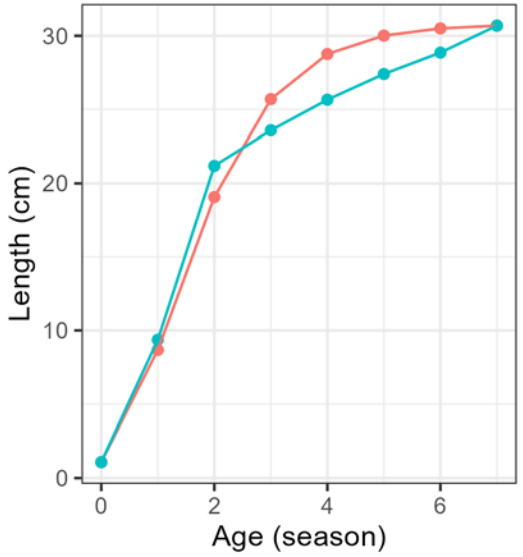


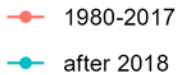


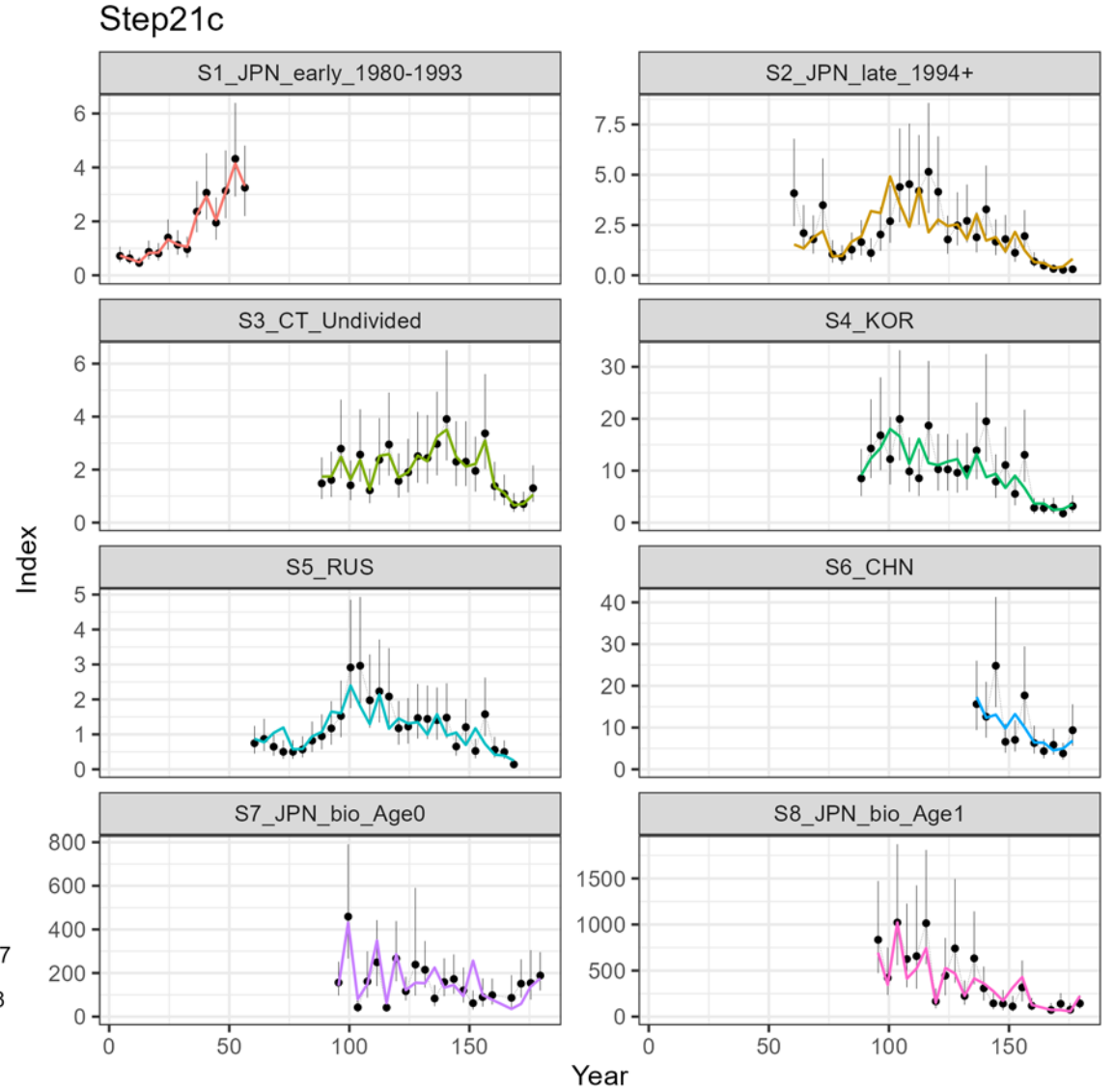
Step 21b: Fishery targeting: Change in selectivity (new sel is logistic)



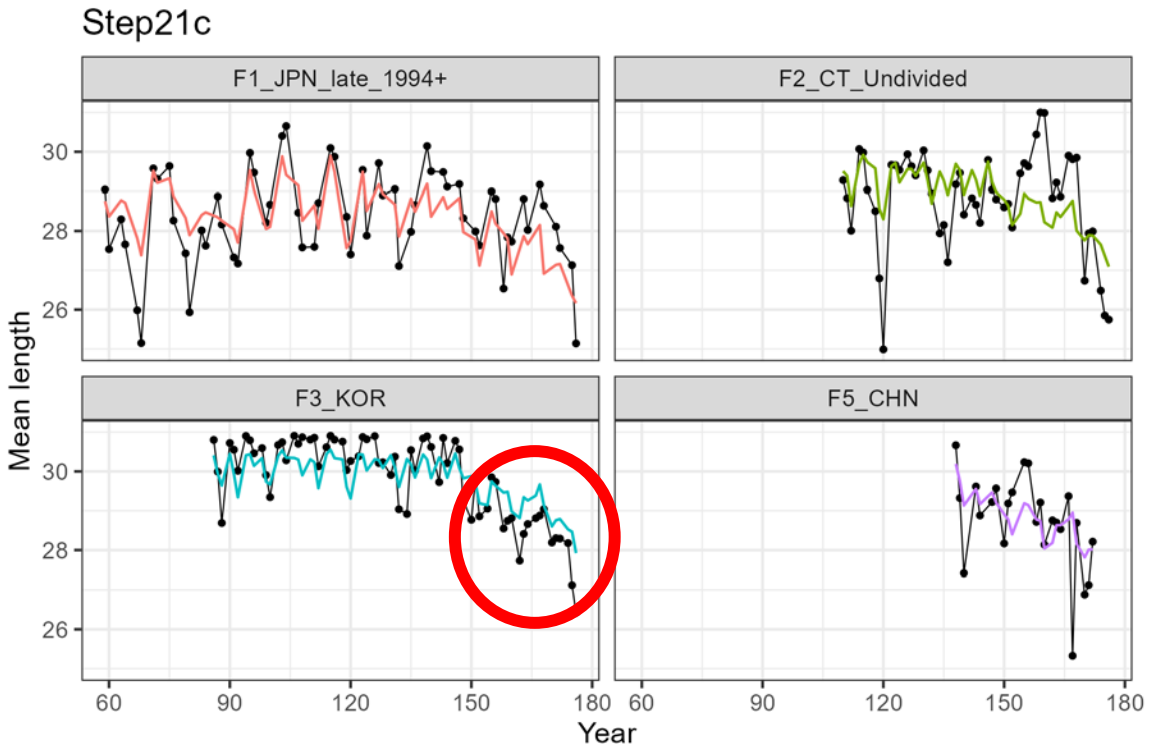


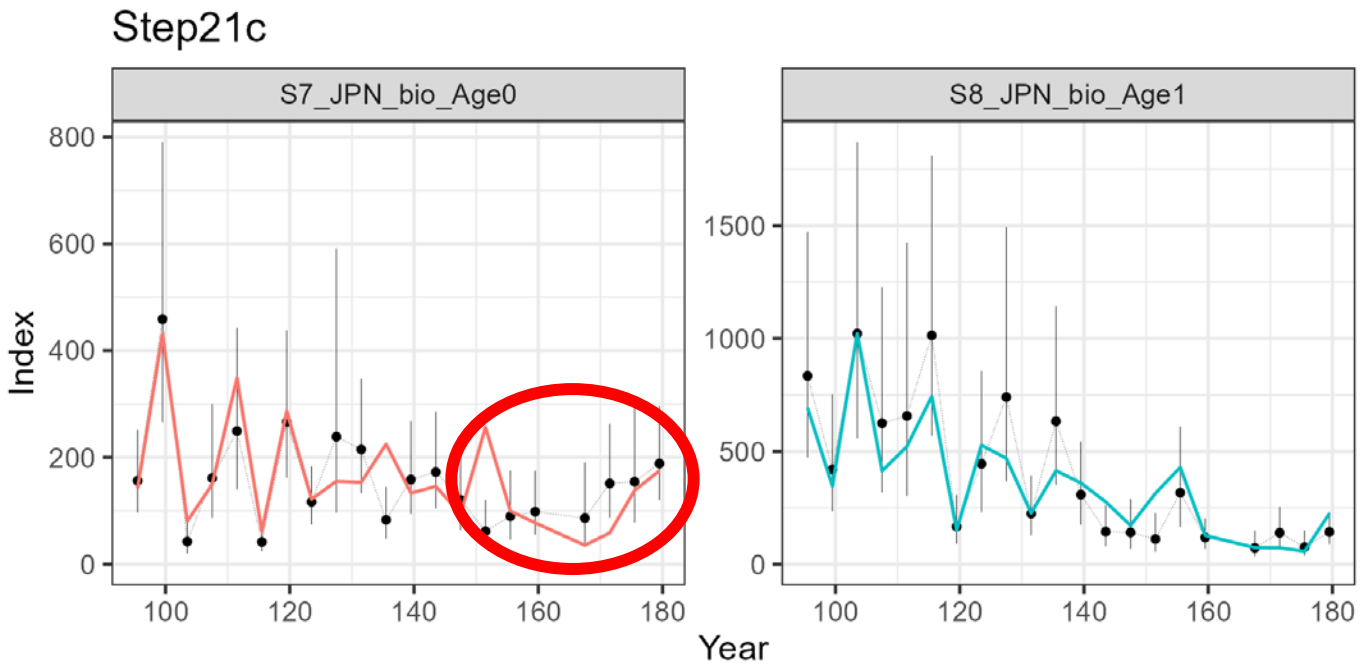






Step 21c: Change in growth





Stock depletion alone cannot explain decrease in mean size.
Due to increasing age-0 index, the model sees increasing recruitment

Summary

- The seasonal SS models are able to model the fishery and population dynamics of Pacific saury more plausibly than annual models.
- The model primarily estimated stock size from the Japanese survey.
- Model diagnostics (retro analysis, hindcasting) indicated the model can not be used for projection at this stage. However, improved fit the Japanese survey in recent years might solve these problems.
- Several hypotheses were developed to explain the trend of fishery mean size during recent years, and it will be important to decide which are most likely.
- The base and sensitivity scenarios will likely be revision of models presented at the WG NSAM02 meeting, based on diagnostic results and biological plausibility.

Some key model specifications for Step-19 and other options for future candidate cases

Model specification	**Step-19**	**Other options**	**Comments and Decisions**
Data	Length comps only	Conditional age-at-length/ALK	Confirmed with KOR on size comps sampling/data issue
Starting year	1980	1994	
Time step	Seasonal	annual	Seasonal model is prioritized
Spatial considerations	None	Fleets as areas	divide CT or JPN fleets by season (easiest) see NPFC-2024-SSC PS14-WP13 (Future work)
Fleet structure	All CPUE	1. Exclude JPN-early and CT 2. Exclude all CPUE	Explore Seasonal CPUE indices (include both Member-specific CPUE and joint CPUE, be careful about specification on selectivity when using joint CPUE)
Survey indices and selectivity	Age-specific indices with age-based selectivity	Age-aggregated indices with size-based selectivity	Need to incorporate survey size comps and check VAST estimates
Fishery Selectivity	Asymptotic selectivity for fisheries	1. Change from logistic to dome-shaped selectivity (time-block)	

		2. Time-varying logistic selectivity	
Catchability	non-linear q	Check the plausibility of q estimate for survey index	Failed to estimate one exponent for all CPUE
Variance weighting (size comps)	McAllister-Ianelli method	Fishery length comps downweighted	Need to incorporate survey size comps
Natural mortality	Constant	Seasonal M for post-spawning mortality	
Growth	Approximate Gompertz	Explore time-varying growth	Need to confirm with biologists about seasonal pattern and mean size at age over time
Maturity	Length logistic inflection ~ 26 cm		update with suggestions by Japan (Dr. Fuji)
Steepness	Fixed (0.82)	Estimated with MCMC	

Date	Meeting	Objective
July 11-13	WG NSAM 2025-02	• Review and update intersessional modeling work • Identify key uncertainties in assessment • Check diagnostic analysis results and biological plausibility • Establish preliminary candidate case scenarios
Sept. 01-05	SSC PS15	• Report the modeling progress from WG NSAM 2025-02 • Obtain the latest fishery, CPUE (Member-specifc CPUE and joint CPUE) and survey data (include size comps) from Members • Check ALKs and VAST estimates • Confirmation with biologists (growth, maturity, spawning timing, etc.)
TBD (2 days in Nov.?)	WG NSAM 2025-03	• Update model specification for all case scenarios • **Identify base and sensitivity cases based on diagnostic analysis results and biological plausibility** • **Draft a stock assessment report and make recommendations for review by the SSC PS** • Try to incorporate environmental covariate in key population/fishery processes (low priority)
Dec. 11-14	SSC PS16	• Review the first stock assessment report of age-structured models • Compare the assessment results of SS and BSSPM

Acknowledgements

- External experts (Dr. Larry Jacobson and Dr. Quang Huynh)
- SWG NSAM
- Biologists
- Secretariat

Thank you!