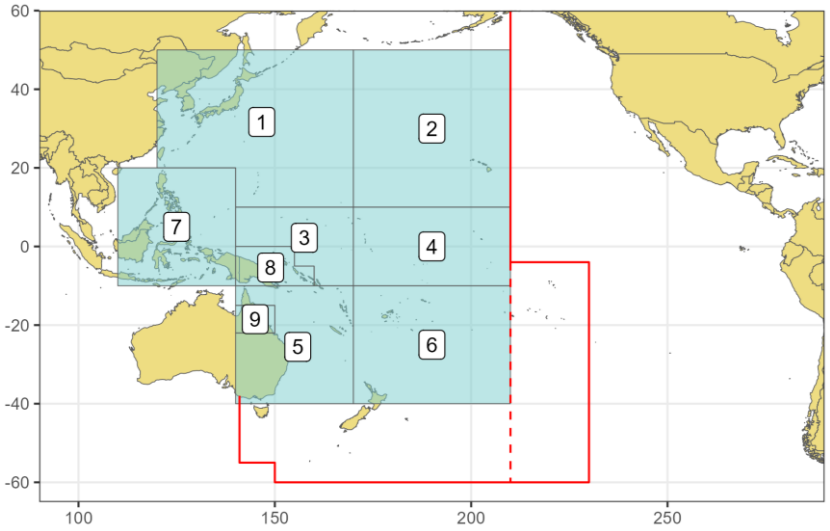
Updates to the Operating Models for Bigeye Tuna in the WCPO

WCPFC-SC22-2026-MI-WP-01

SPC-OFP

BET OMs based on 2023 stock assessment



SC21 recommended the BET OMs be based on the 2023 assessment and identified 8 areas to consider to expand the initial OM grid.

Noting it may not be possible to address all of them in the short-term.

Uncertainty	Priority	Timing
Growth	High	Short (preferably by 2026)
Natural mortality	High	Short (preferably by 2026)
Movement dynamics	High	Short (preferably by 2026)
Hyperstability in CPUE	High	Short (preferably by 2026)
Variability in recruitment	High	Short (preferably by 2026)
Spatial structure	High	Long
Uncertainty in domestic catch level	High	Long
Effect of climate change	High	Long

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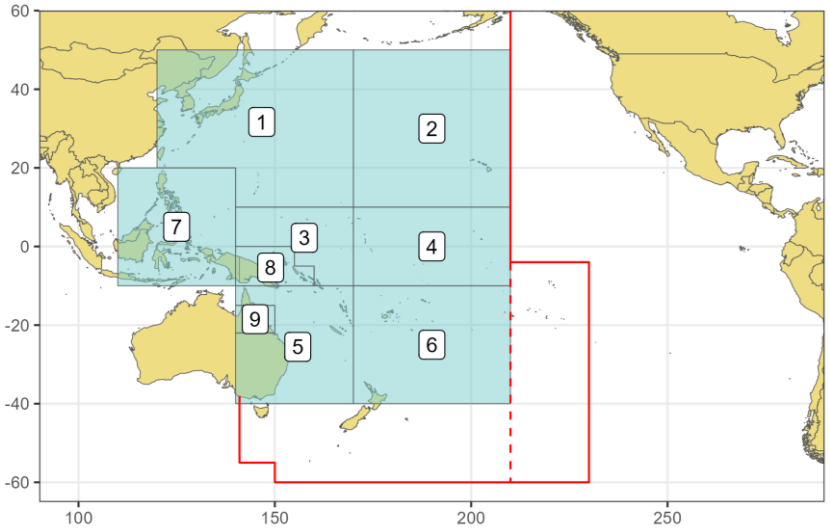

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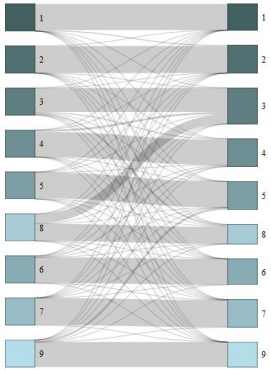
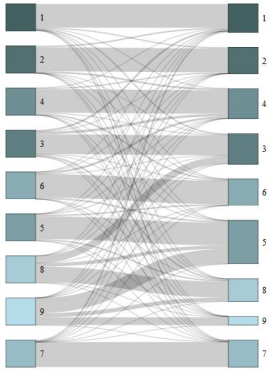
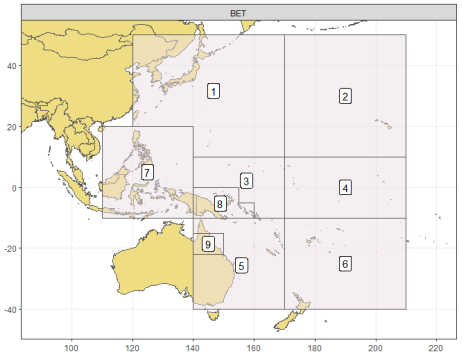
Not addressed so far



MFCL



SEAPODYM



Movement dynamics

- Fits using Seapodym movement unsuccessful

Spatial structure

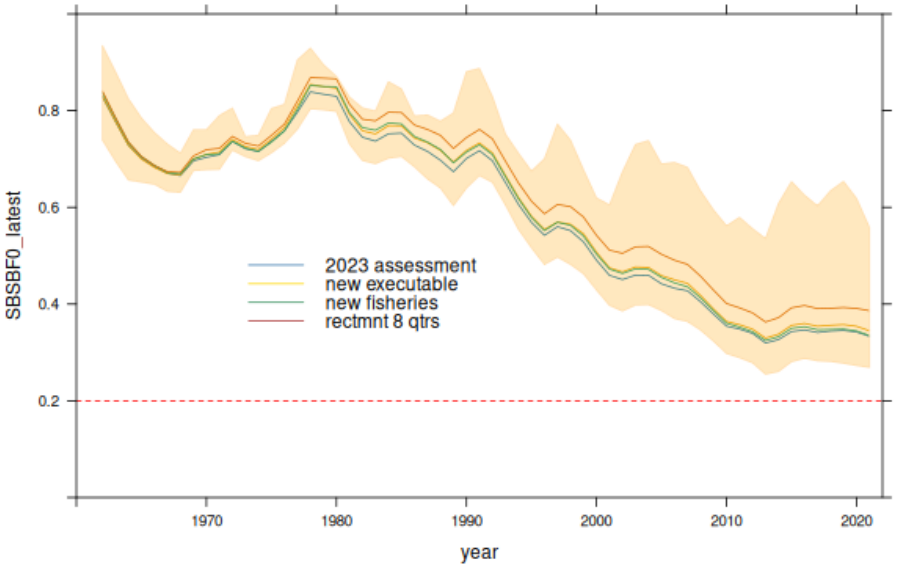
- Insufficient time to fully explore alternative spatial structures and fishery definitions
- Recruitment distribution potentially impacted by movement and spatial structure.

Hyper-stability in CPUE

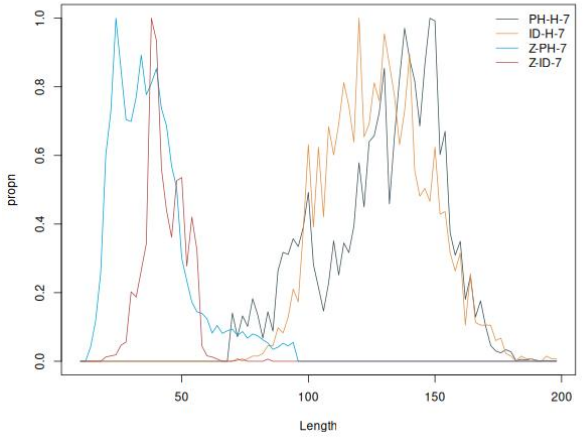
- OMs based on a catch conditioned assessment

Climate change scenarios

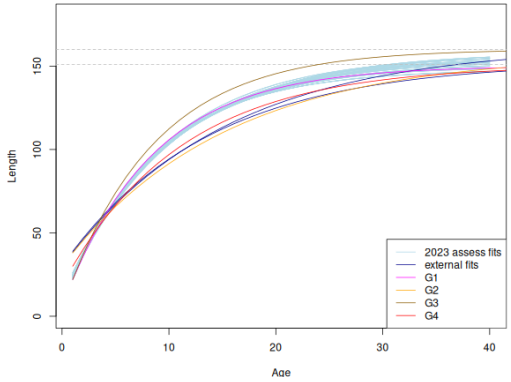
Initial OM setup

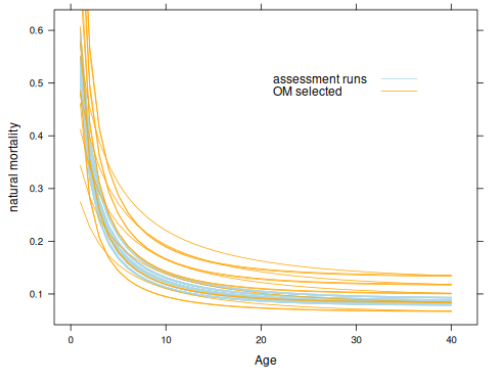


1. New MFCL executable
2. New fishery structure (20°N)
    1. 3 split LL fisheries
        1. Selectivity mirrored
    2. 1 split domestic (ID-PH HL)
        1. Selectivity free
3. Input catch in numbers to weight
4. Fix recruitment for last 8 qtrs



Growth and natural mortality





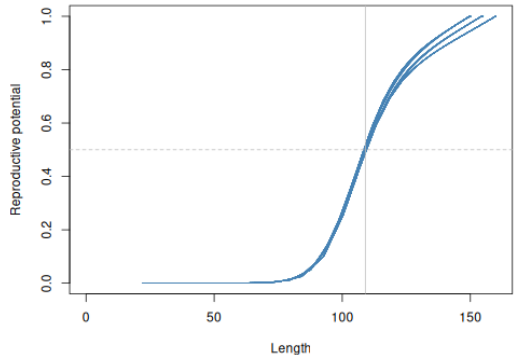
2023 stock assessment
External fits

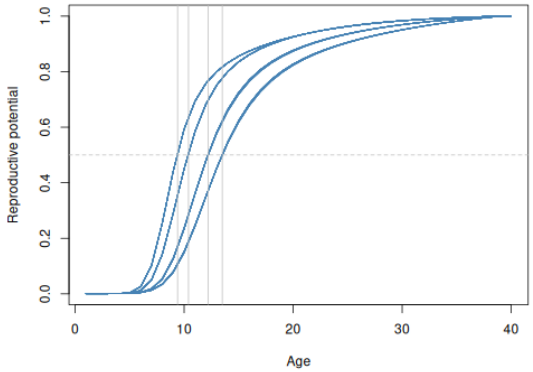
OM Growth
2023 stock assessment
External fits
Temperate samples (Hasegawa et al)
Alternative intermediate k

Average natural mortality at age set to assumed value (0.1 – 0.2)

Lorenzen inverse relationship with growth retained.

Reproductive potential



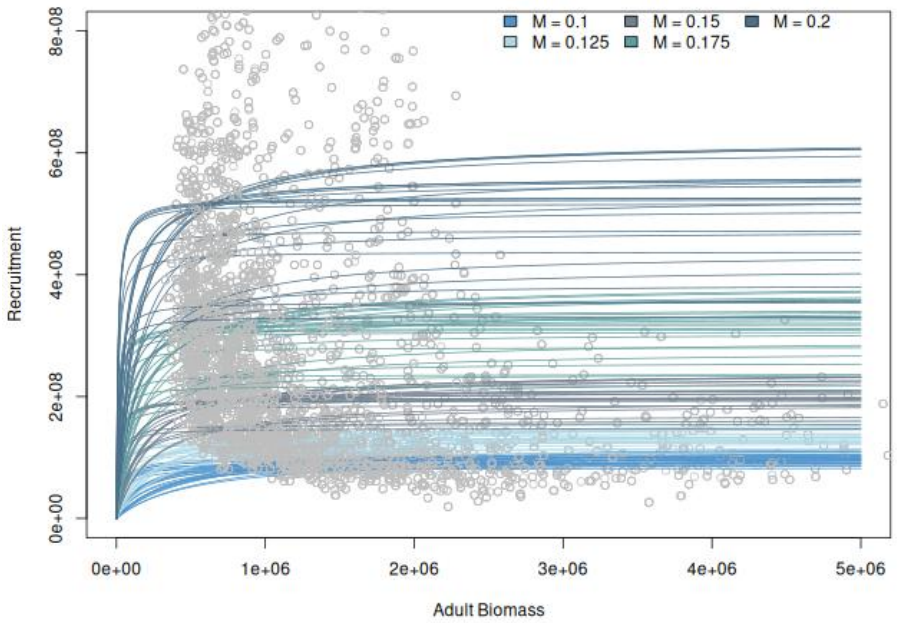


Reproductive potential at age the product of maturity, fecundity and sex ratio (propn female)

Values at age determined from length-based ogive for each growth model

50% maturity occurring around 110cm and between ages 2.5 and 3.5 years of age, approximately

Recruitment



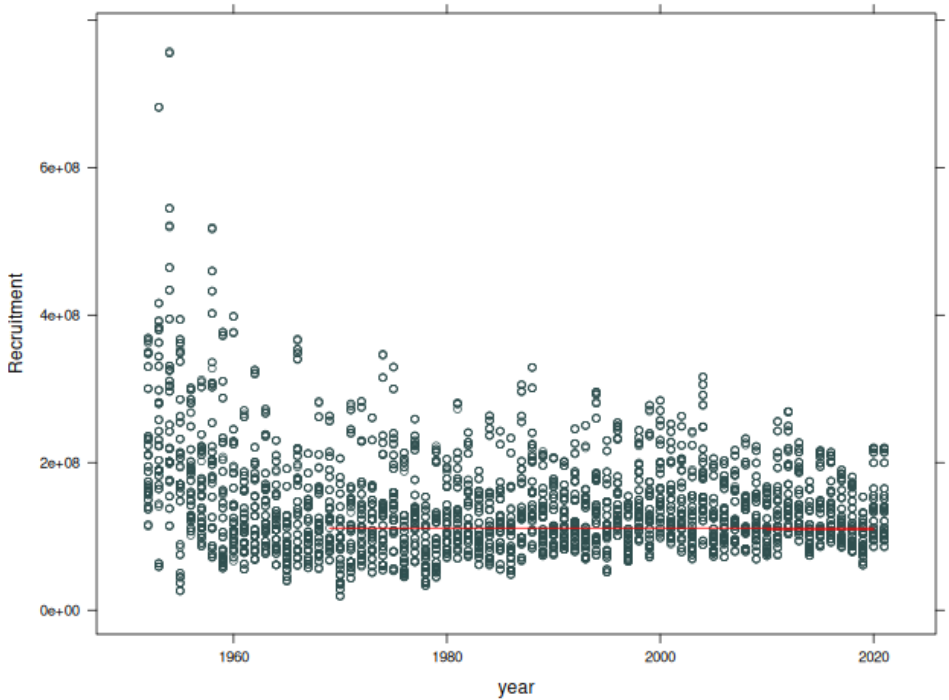
Three levels of steepness:

- 0.65
- 0.80
- 0.95

Recruitment scales with natural mortality

SRR fitted with low penalty weighting

Uncertainty in projections



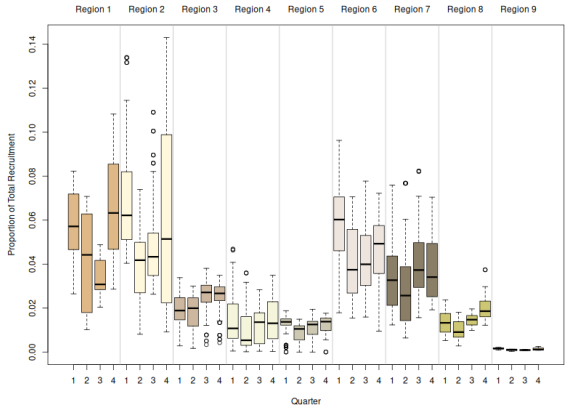
Effort creep and recruitment variability provide additional uncertainty into the projections.

Effort creep assumed at 1% LL & 2 % PS per annum.

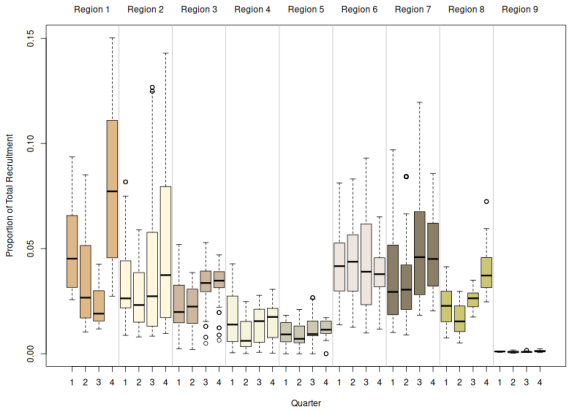
Short (2010:2021) and long-term (1952:2021) recruitment show very similar average levels
Less variable in short-term

Recruitment

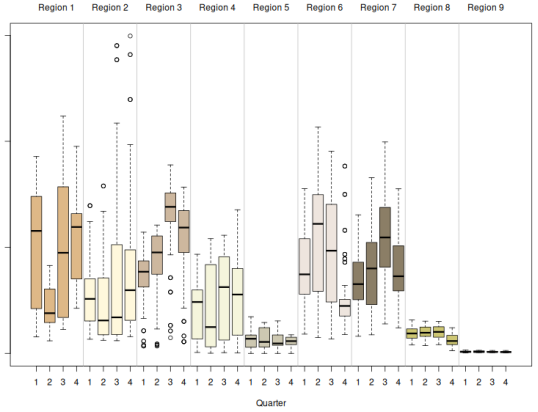
Spatial distribution of recruitment appears to be changing over time
Increased recruitment in tropical regions in recent years
Likely linked to spatial structure – should be further investigated in future evals



1952:2020

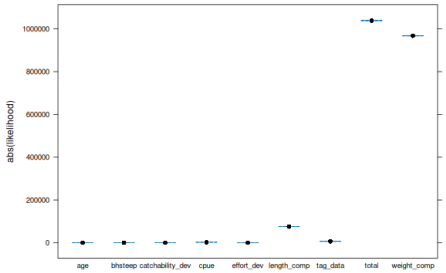


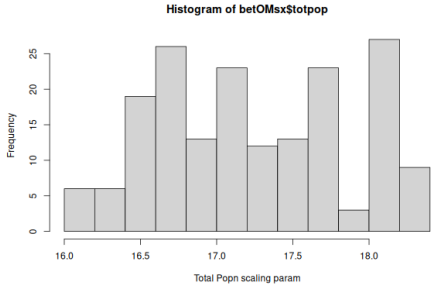
1980:2020

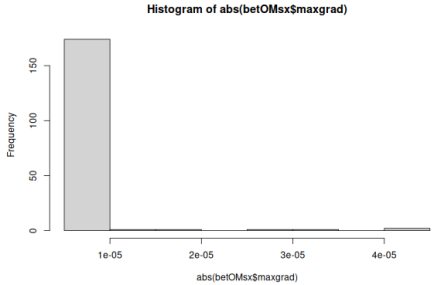


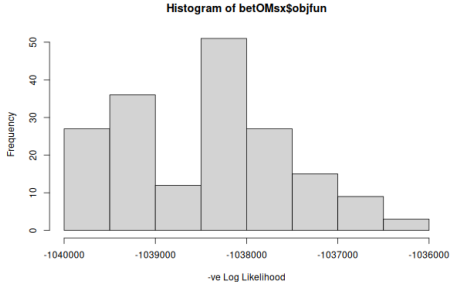
2010:2020

OM diagnostics





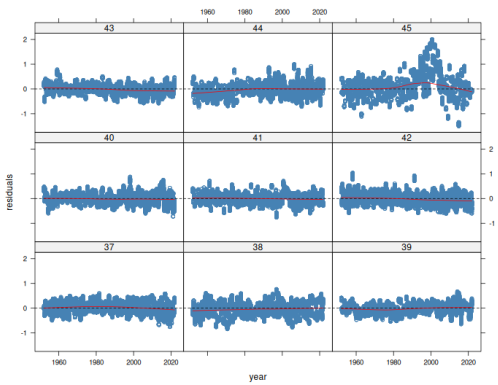


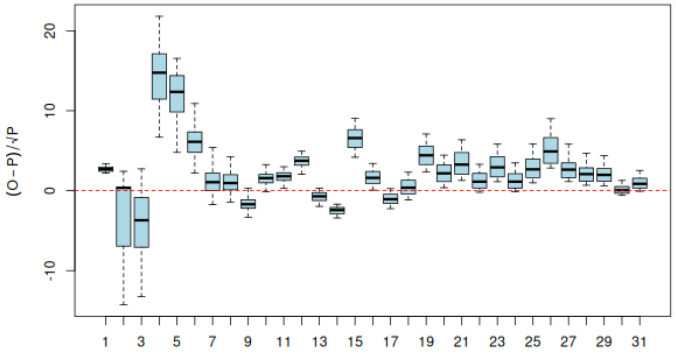


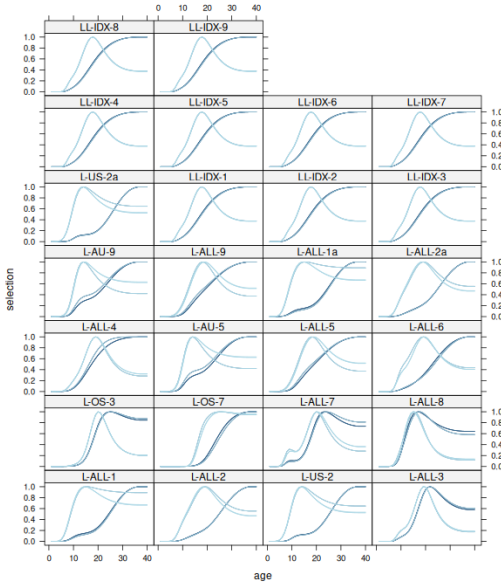
Consistent performance across the grid in terms of:

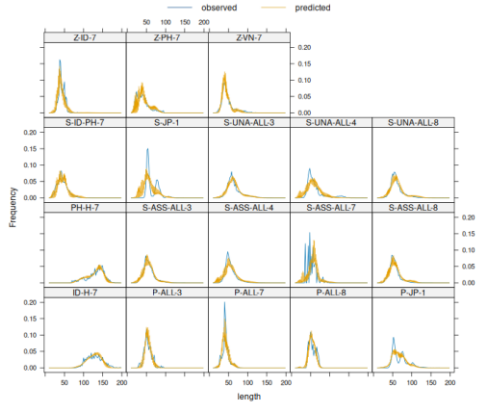
- Maximum gradient
- Total population scaling
- Objective function
- Likelihood contributions

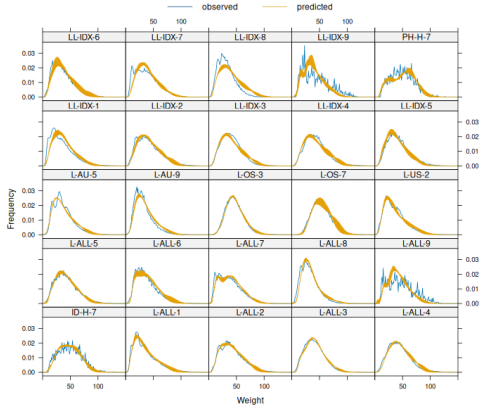
OM diagnostics





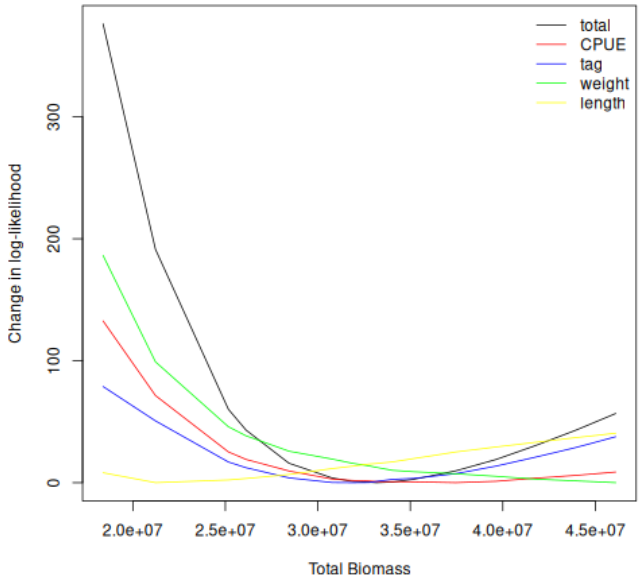


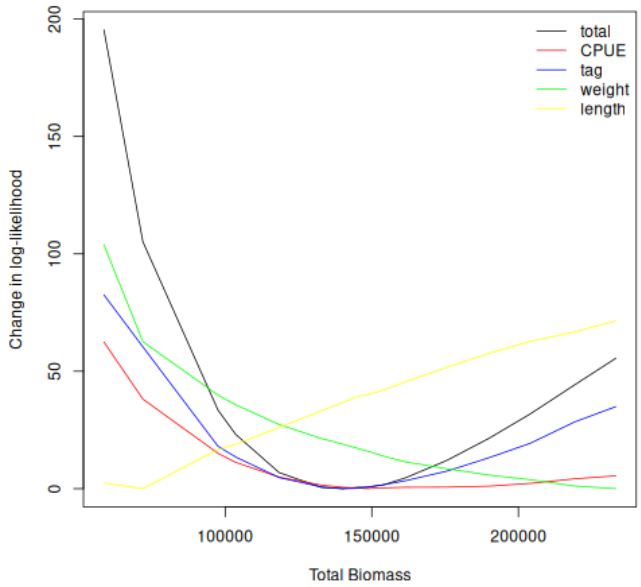




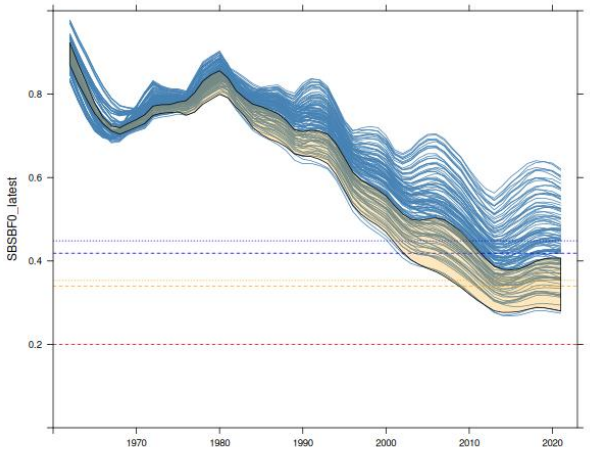
OM diagnostics

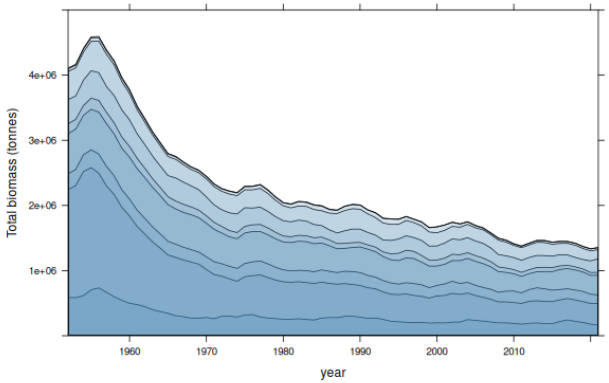
Likelihood profiles consistent with 2023 assessment outcomes:
Length and weight data conflict





OM results





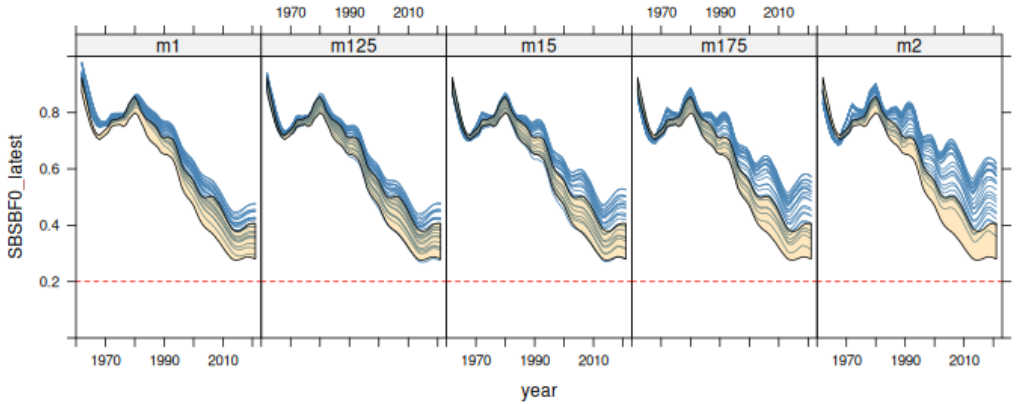
Initial OM results

Some overlap with 2023 assessment outcomes

Less depleted with higher M assumptions

M=0.2 may be too high

Additional runs conducted to explore options for a more depleted stock



OM results – additional runs

Axis	Initial	Levels M+tmix	tau	Options						
Growth	4			G1	G2	G3	G4			
Natural Mortality	5					0.1	0.125	0.15	0.175	0.2
Steepness	3			0.65	0.8	0.95				
Tag mixing (qtrs)	2			1	2	3				
Tau	-			1						
Growth		4		G1	G2	G3	G4			
Natural Mortality		7		0.05	0.075	0.1	0.125	0.15	0.175	0.2
Steepness		3		0.65	0.8	0.95				
Tag mixing (qtrs)		3		1	2	3				
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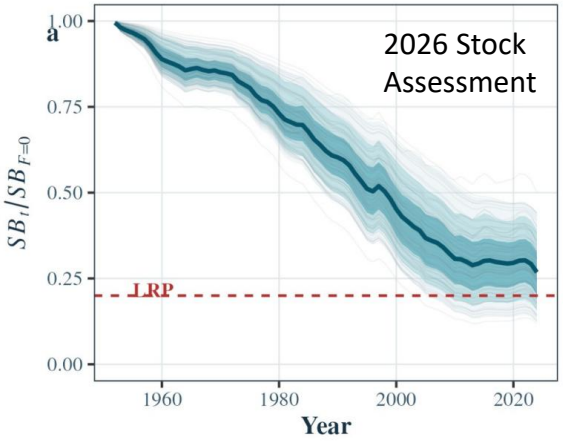
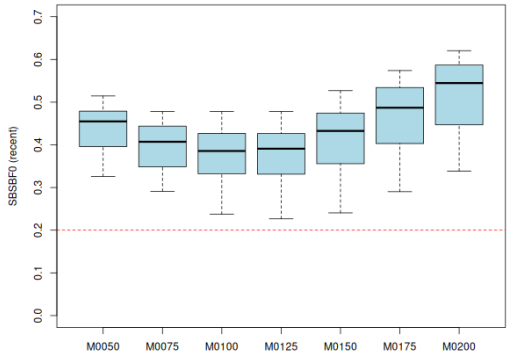
Tau			1		2					

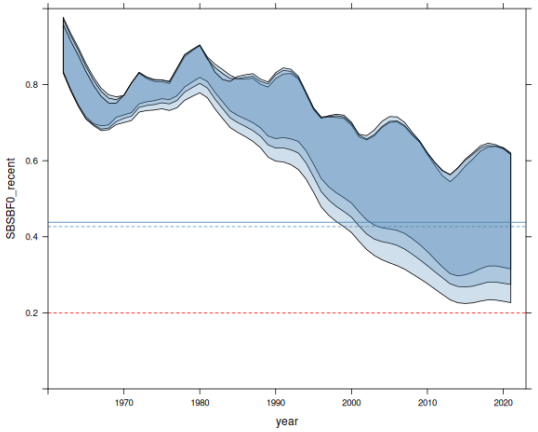
120 models
480 OMs

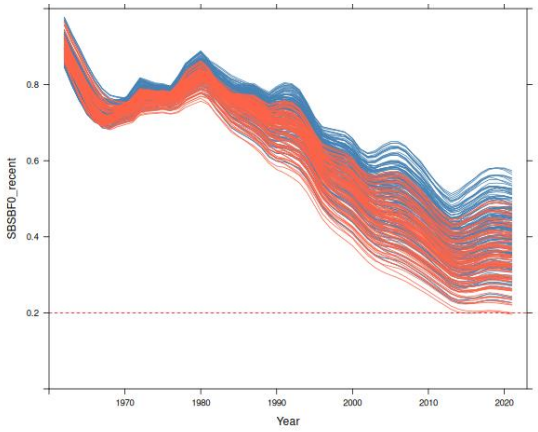
252 models

108 models









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Tau			1		2					

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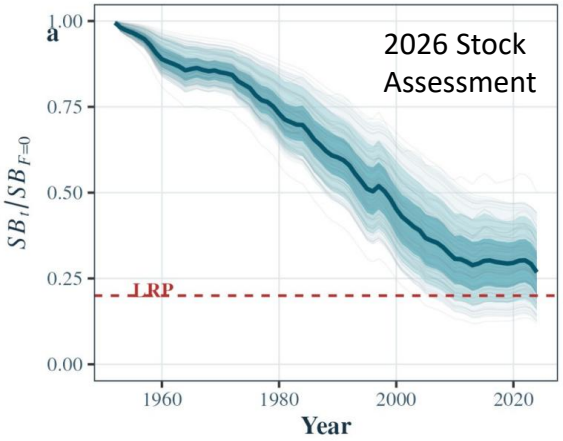
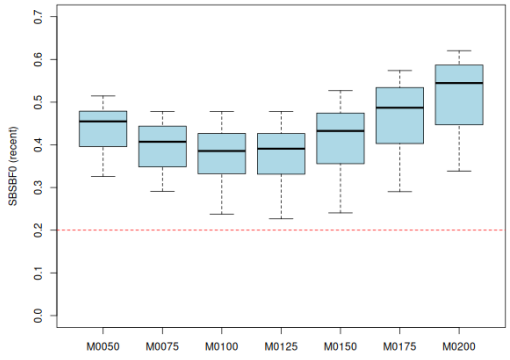
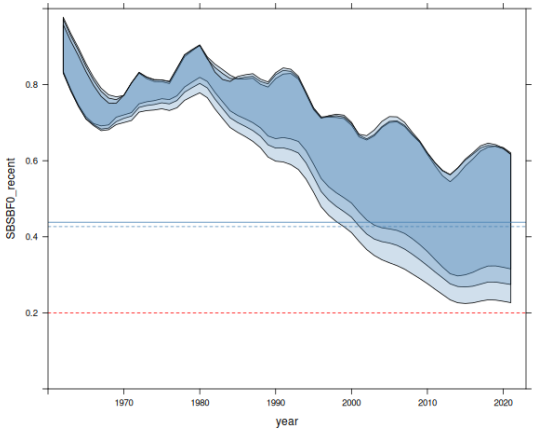
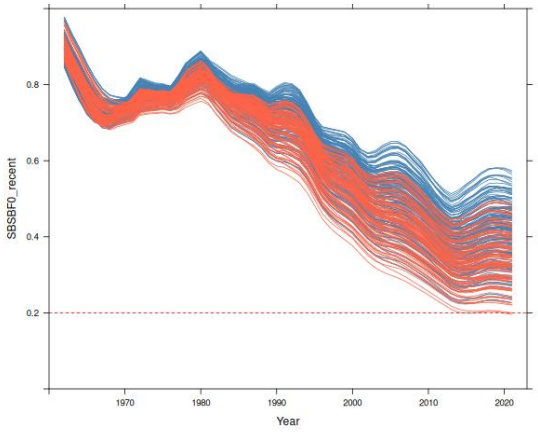
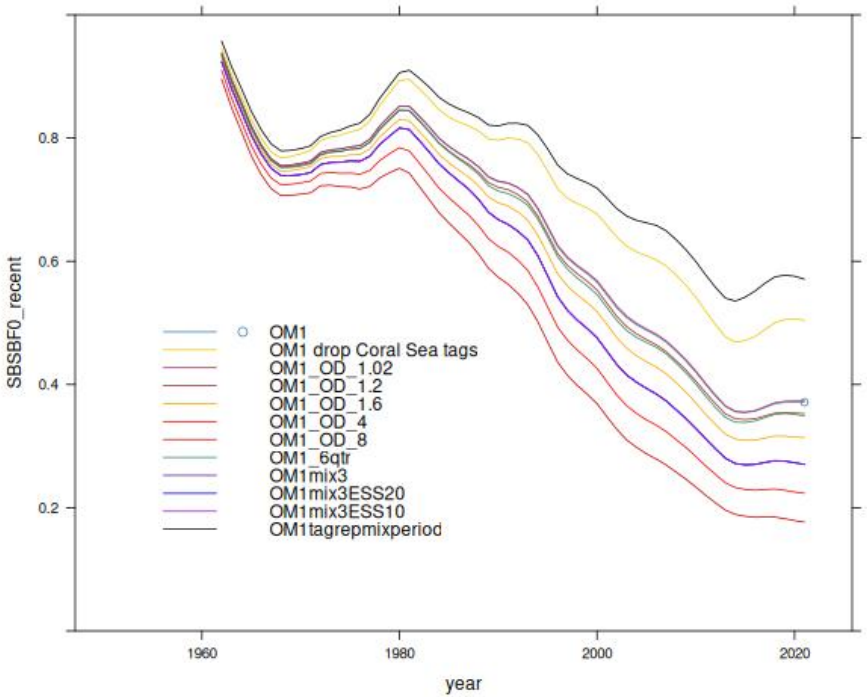








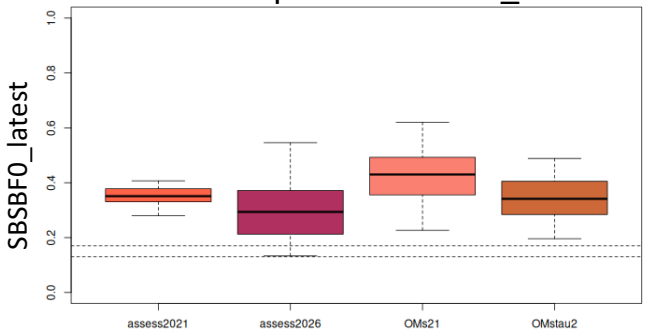
Sensitivity



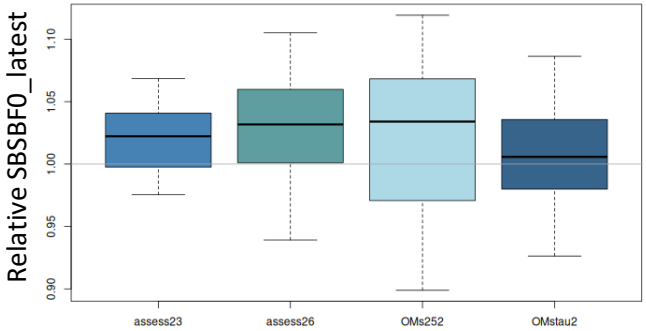
One off sensitivity runs on OM1
Mostly looking at tag settings
Very wide spread of outcomes

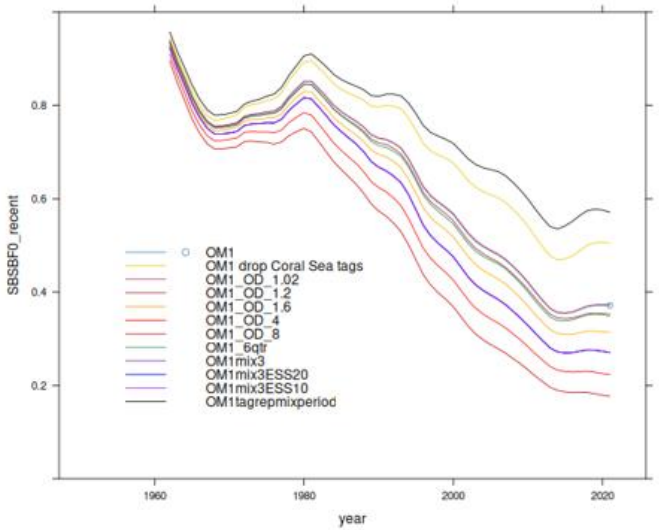
OM results – additional runs

Terminal depletion SBSBF0_latest



Terminal depletion relative to 2012-15

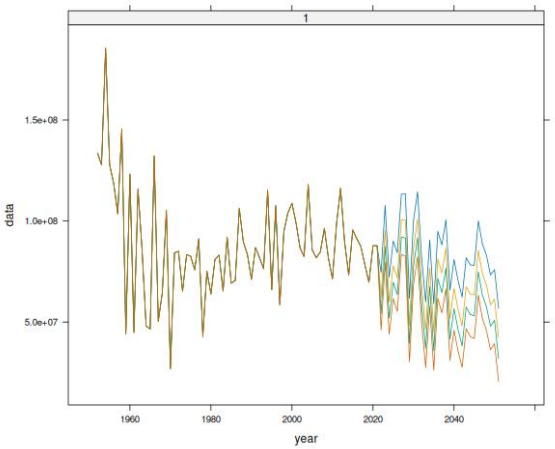




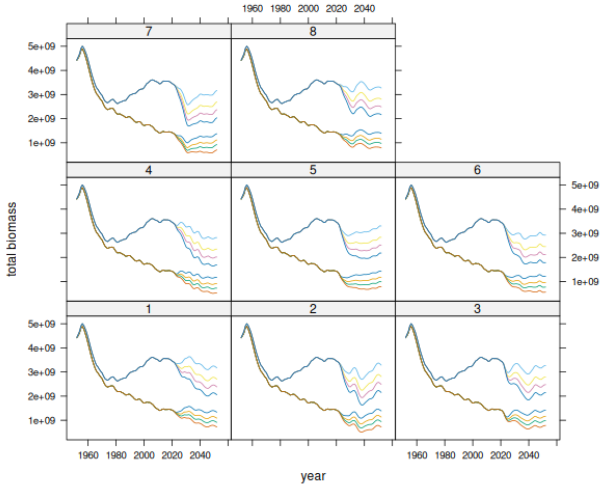
OM results – low recruitment scenario

Reduced recruitment scenarios:
Recruitment residuals modified to generate 30%, 50%, reduction in recruitment

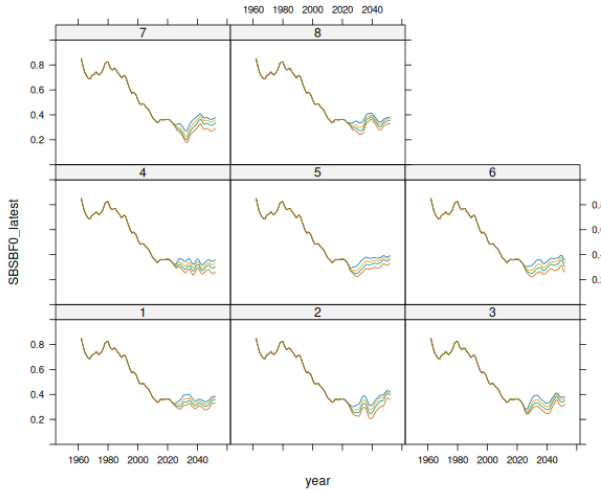
Recruitment



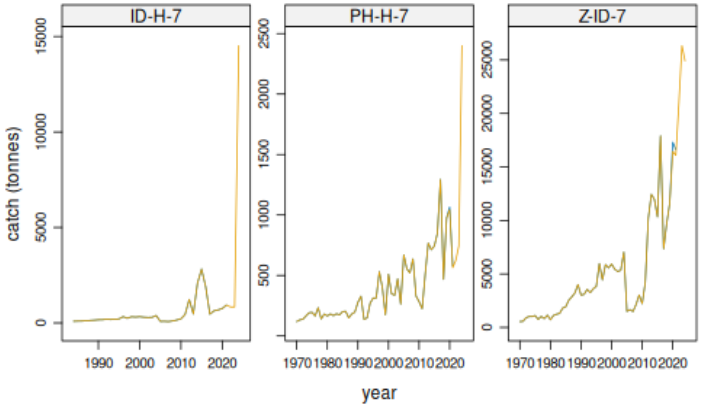
Biomass



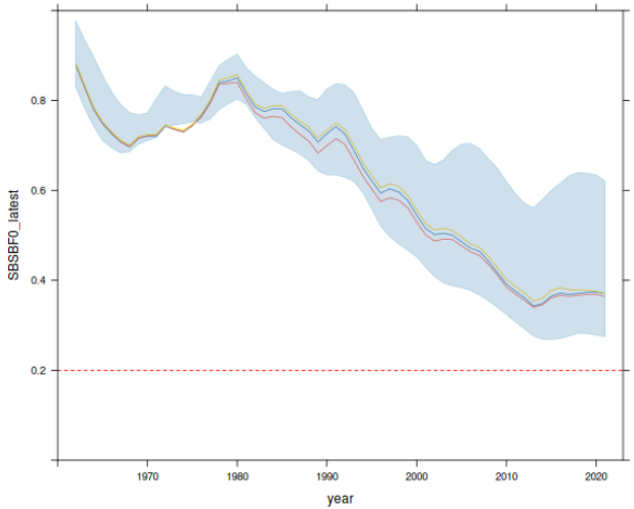
Depletion

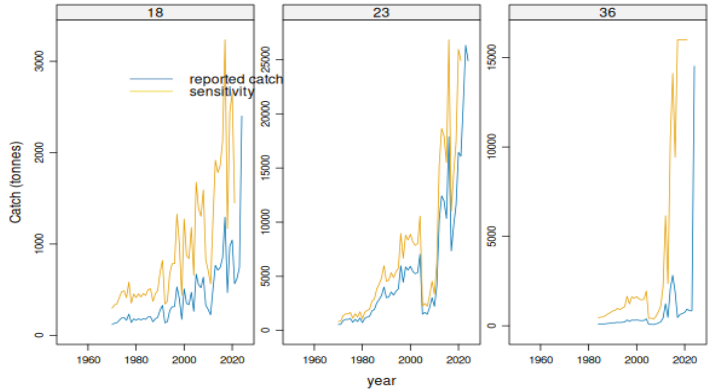


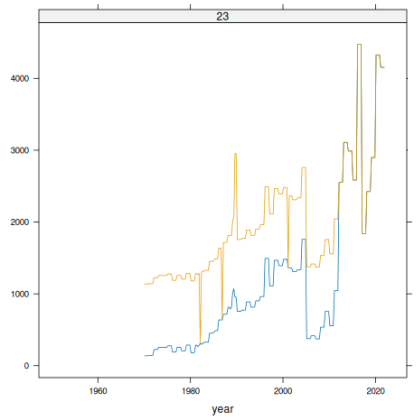
Uncertainty in domestic catches



Historical catches inflated for domestic fisheries in region







Bigeye tuna: OM grid

Axis	Levels			Options						
	Initial	M+tmix	tau							
Growth	4			G1	G2	G3	G4			
Natural Mortality	5					0.1	0.125	0.15	0.175	0.2
Steepness	3			0.65	0.8	0.95				
Tag mixing (qtrs)	2			1	2	3				
Tau	-			1						
Growth		4		G1	G2	G3	G4			
Natural Mortality		7		0.05	0.075	0.1	0.125	0.15	0.175	0.2
Steepness		3		0.65	0.8	0.95				
Tag mixing (qtrs)		3		1	2	3				
Tau		-		1						
Growth			4	G1	G2	G3	G4			
Natural Mortality			3			0.1	0.125	0.15		
Steepness			3	0.65	0.8	0.95				
Tag mixing (qtrs)			3	1	2	3				
Tau			1		2					

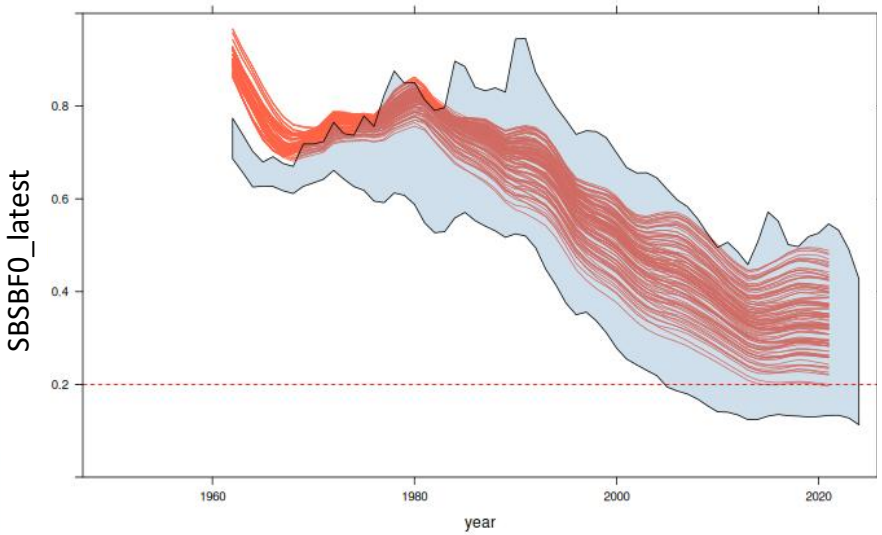
Initial grid: 120 models

Additional M values: 252 models

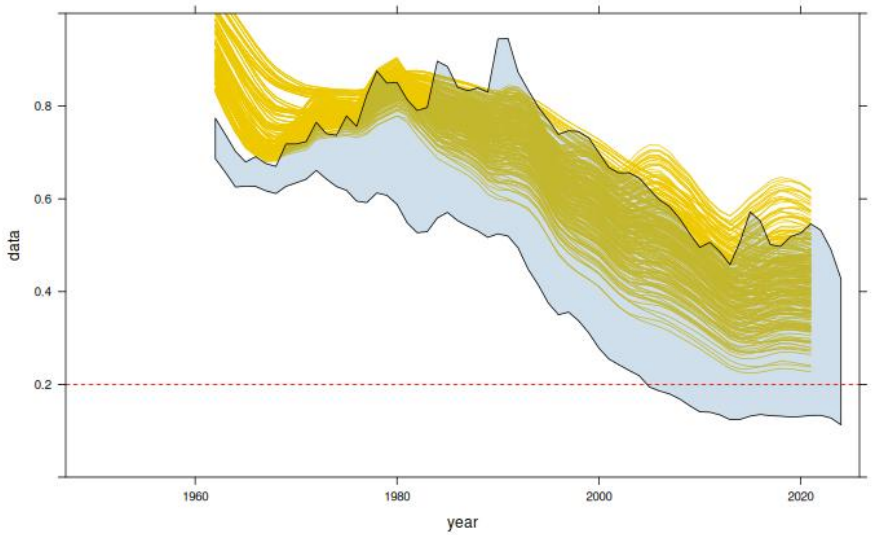
Tau2 grid: 108 models

Bigeye tuna OMs

Tau2 OMs (108)

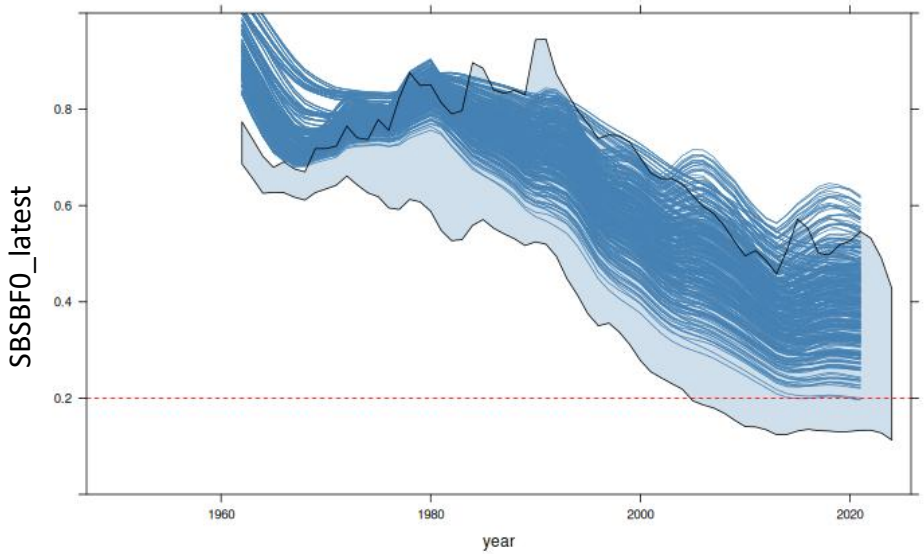


Tau1 OMs (252)



Bigeye tuna OMs

Combined OMs (108 + 252)

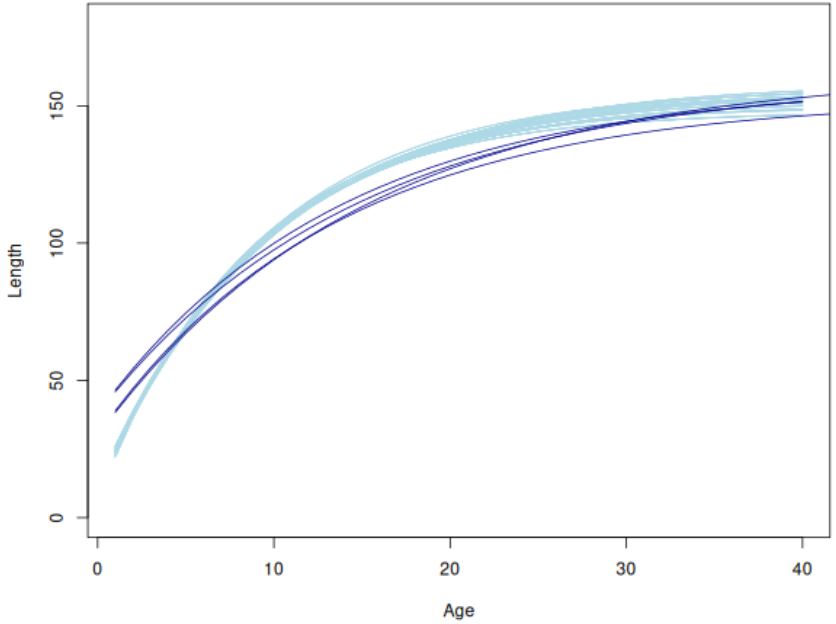


WCPFC Bigeye Tuna Operating Models

We invite to:

- Note that the reference set of OMs reflects the most important sources of uncertainty and plausible states of nature for WCPO bigeye tuna
- Agree the reference set of OMs as the basis for testing of candidate MPs for bigeye tuna
- Note that work will continue in the longer-term to further develop the OMs and this can be managed through an agreed monitoring strategy.

Growth and natural mortality

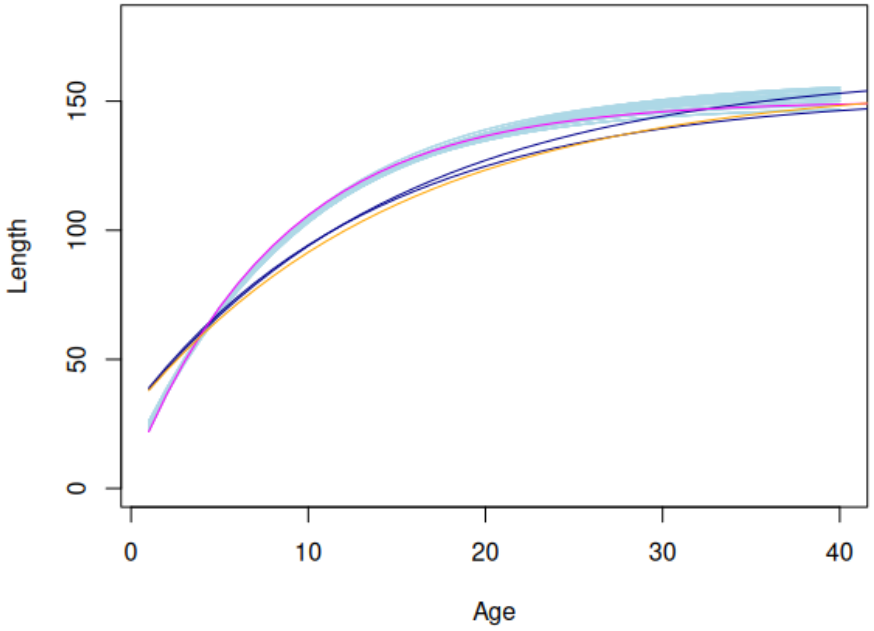


2023 stock assessment

External fits

- Farley et al 2017
- SPC ageing work

Growth and natural mortality



2023 stock assessment
External fits

OM growth
2023 stock assessment
External fits