

# SC21-SA-WP-02

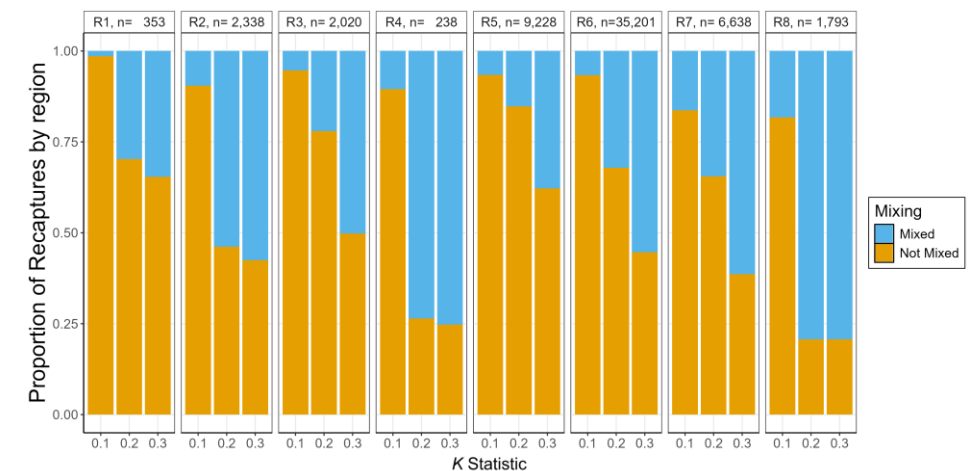
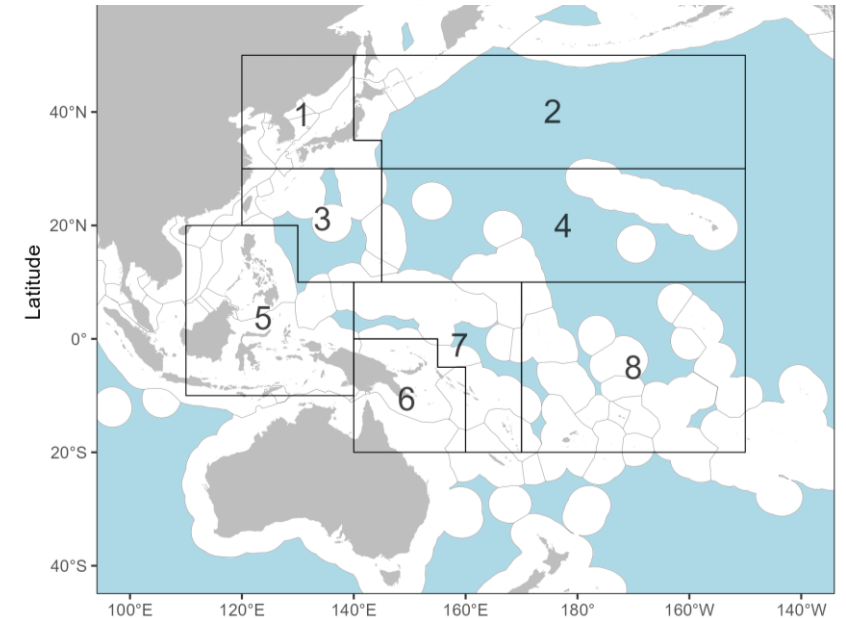
## skipjack stock assessment



SCIENTIFIC COMMITTEE  
TWENTY-FIRST REGULAR SESSION  
Nuku'alofa, Tonga  
13–21 August 2025

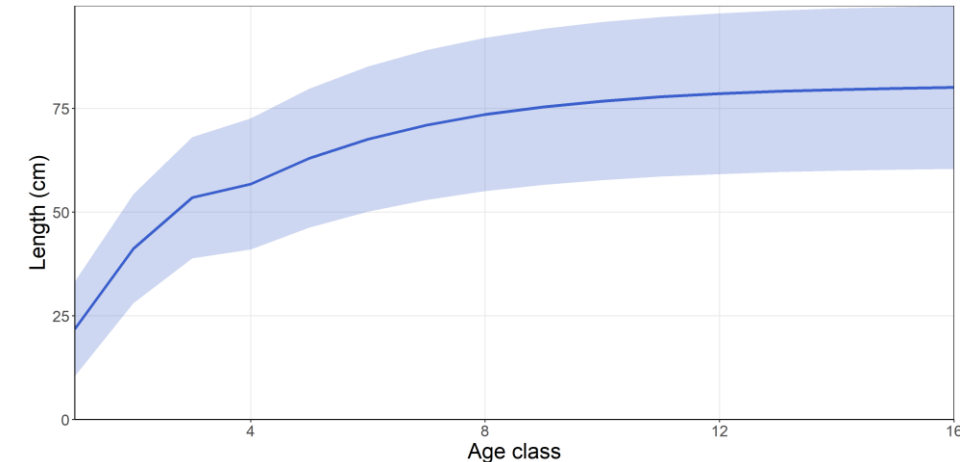
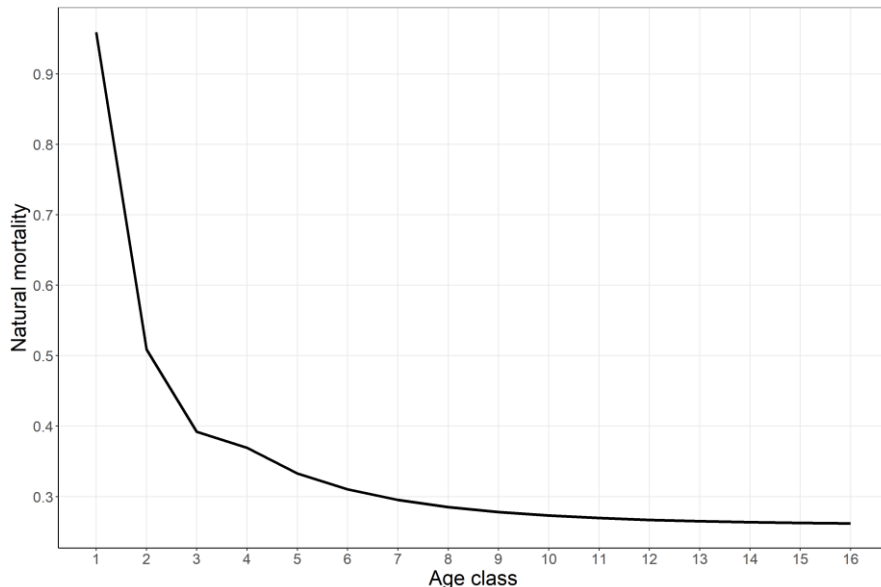
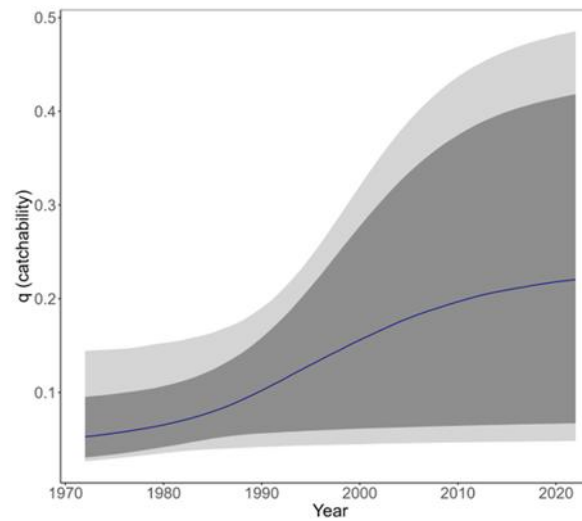
# Structure

- **Catch-conditioned, quarterly time-step, 1972-2024**
- **8-region spatial structure** (slight change in R5)
- **32 extraction fisheries:**
  - PH and ID PS fisheries split (conflict in length data)
- **10 index fisheries:**
  - JPPL in regions 1-4 , 7 & 8
  - PS in regions 5-8
  - Geostatistical CPUE standardisation (sdmTMB)
- **Length compositions**
- **Tagging data:** tag mixing informed by IKAMOANA simulations
  - Dissimilarity (untagged vs. tagged population)  $K$  statistic 0.1 (longer mixing; 8.3% included), 0.2 (moderate; 31%), and 0.3 (shorter mixing; 53.2%)



# Key changes

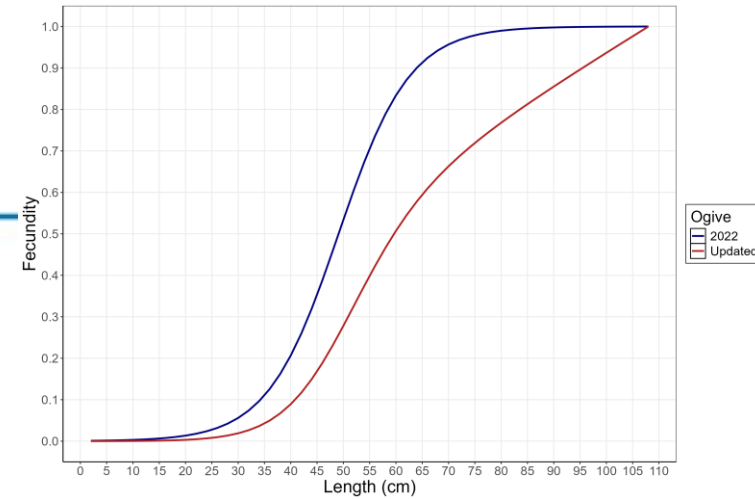
- Model ensemble with uncertainty estimation (Monte Carlo)
- SSAP tagging data excluded
- Change in reporting rate (RR) groupings, only estimate RR where tagging data is adequate



- Lorenzen  $M$
- Orthogonal polynomial recruitment (OPR)
- Effort creep applied to JPPL
- Growth:  $L1$  and  $L2$  estimated,  $k$  fixed, VB offsets – ages 2 & 3 qtrs

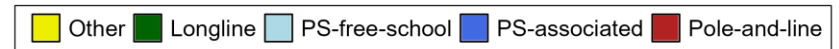
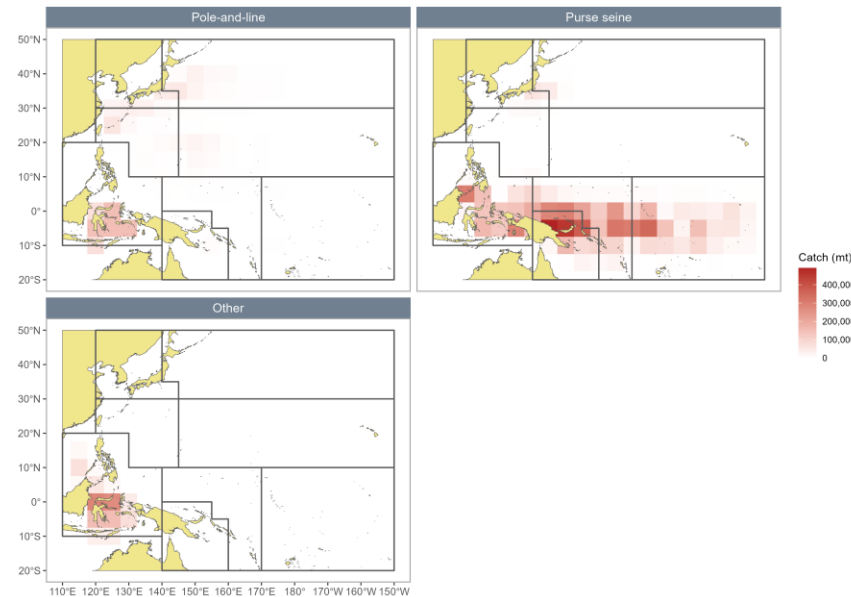
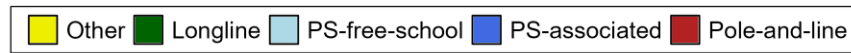
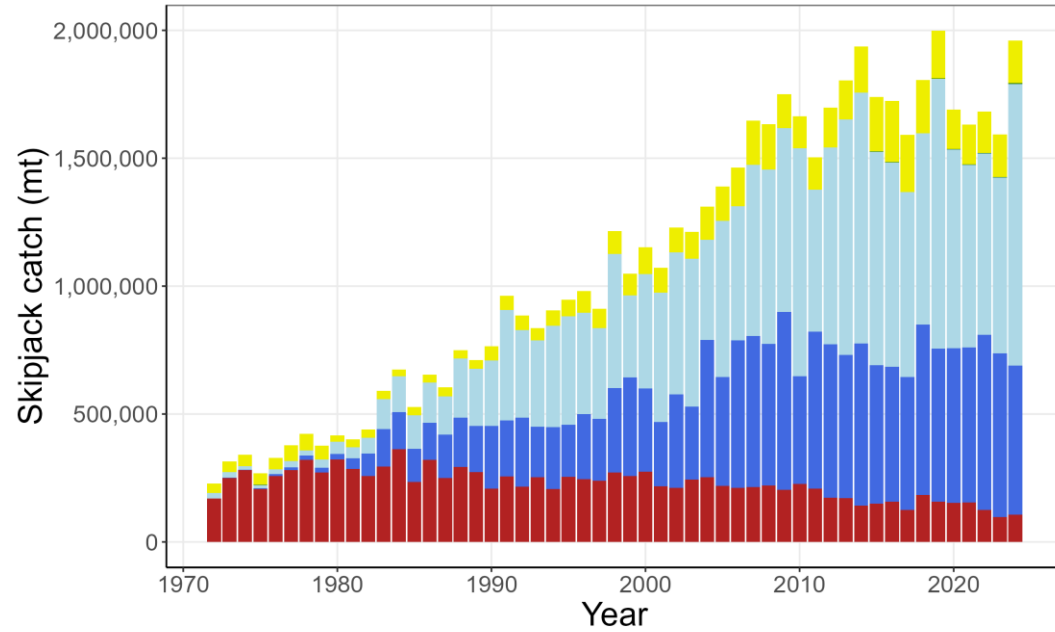
# Minor changes

- LL length data aggregated to single time-step (Q3 2000)
- Dirichlet Multinomial (DM) groupings from 3 to 4 (PL and PS separated)
  - DM-4: PL, PS, LL, ID/PH/VN-MISC
- Length-based selectivity
- Updated tag seeding and tagger effects
- Updated fecundity (Ashida, 2020)
- LL asymptotic selectivity relaxed for older fish
- Initial population: lightly exploited (2% of  $M$ )

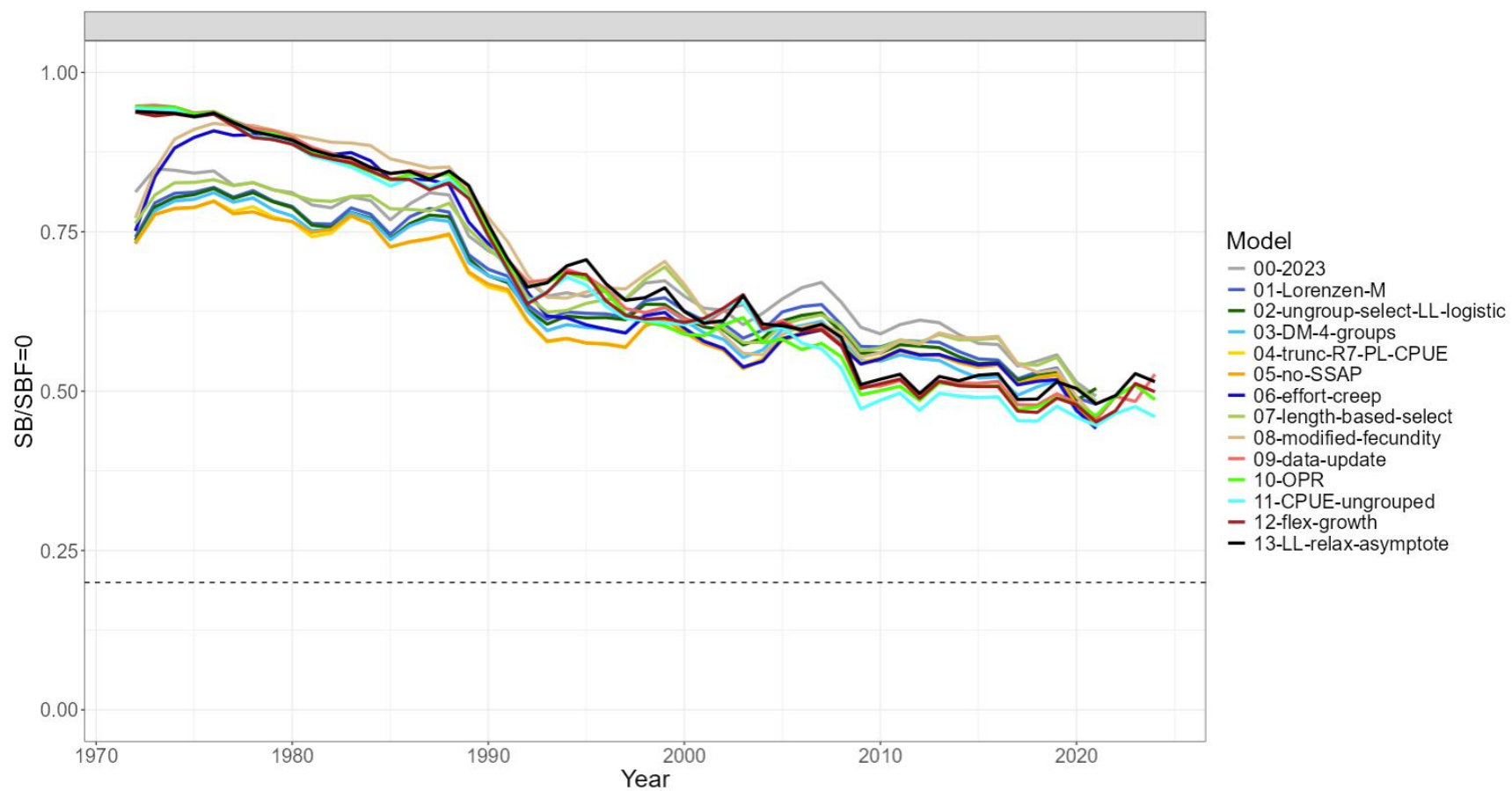


- CPUE indices:
  - selectivity and likelihood ungrouped
  - Time-varying CVs
- Region 5 (WPEA) tag returns grouped (uncertainty in fishery allocation)
- Growth: VB offsets for ages 2 and 3 quarters

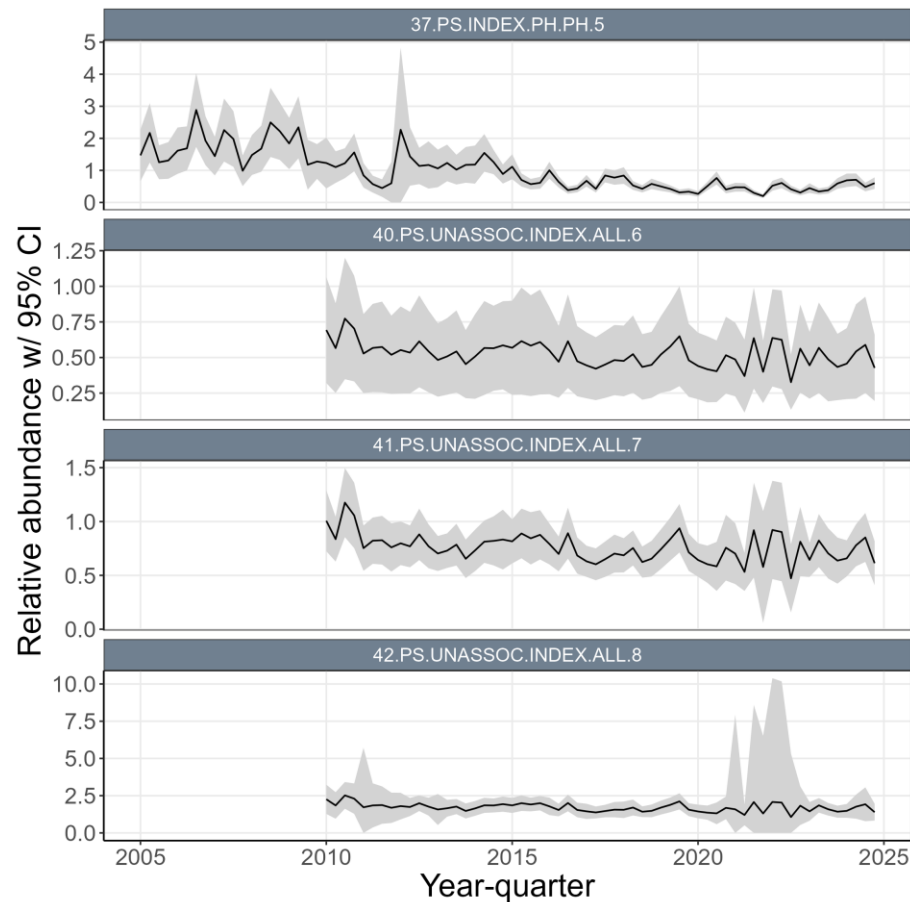
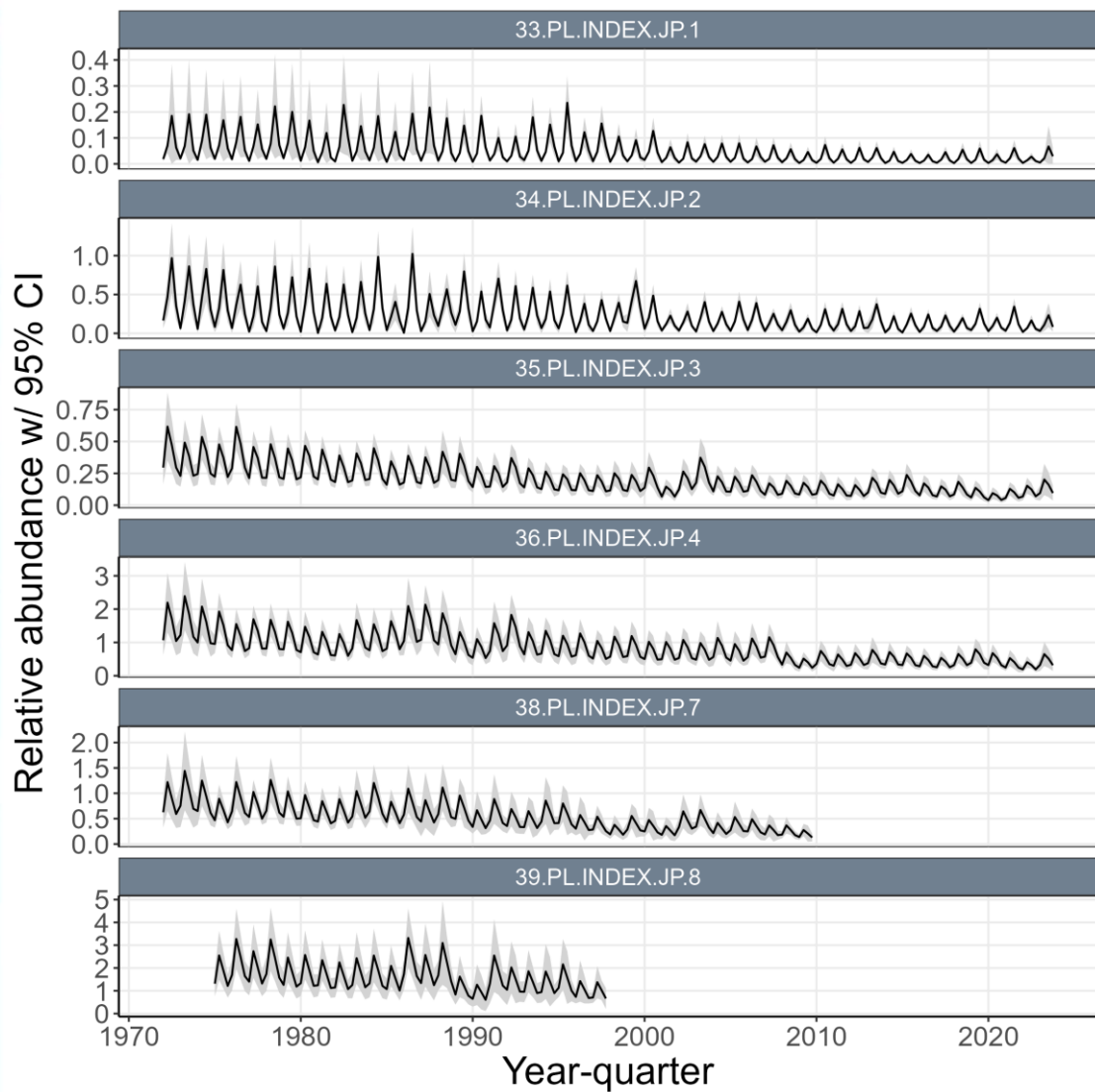
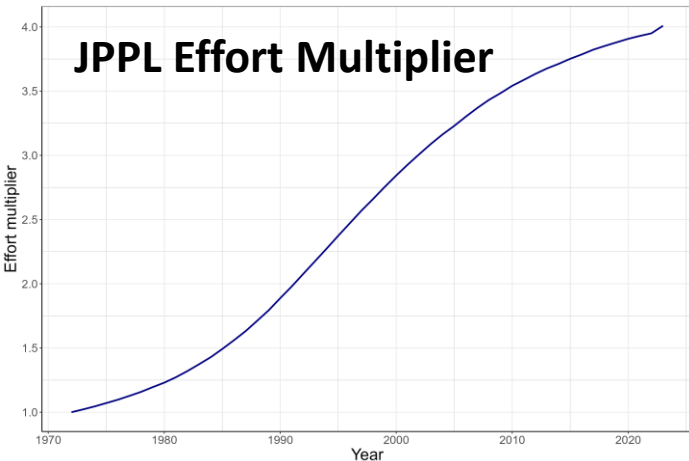
# Catch



# Stepwise

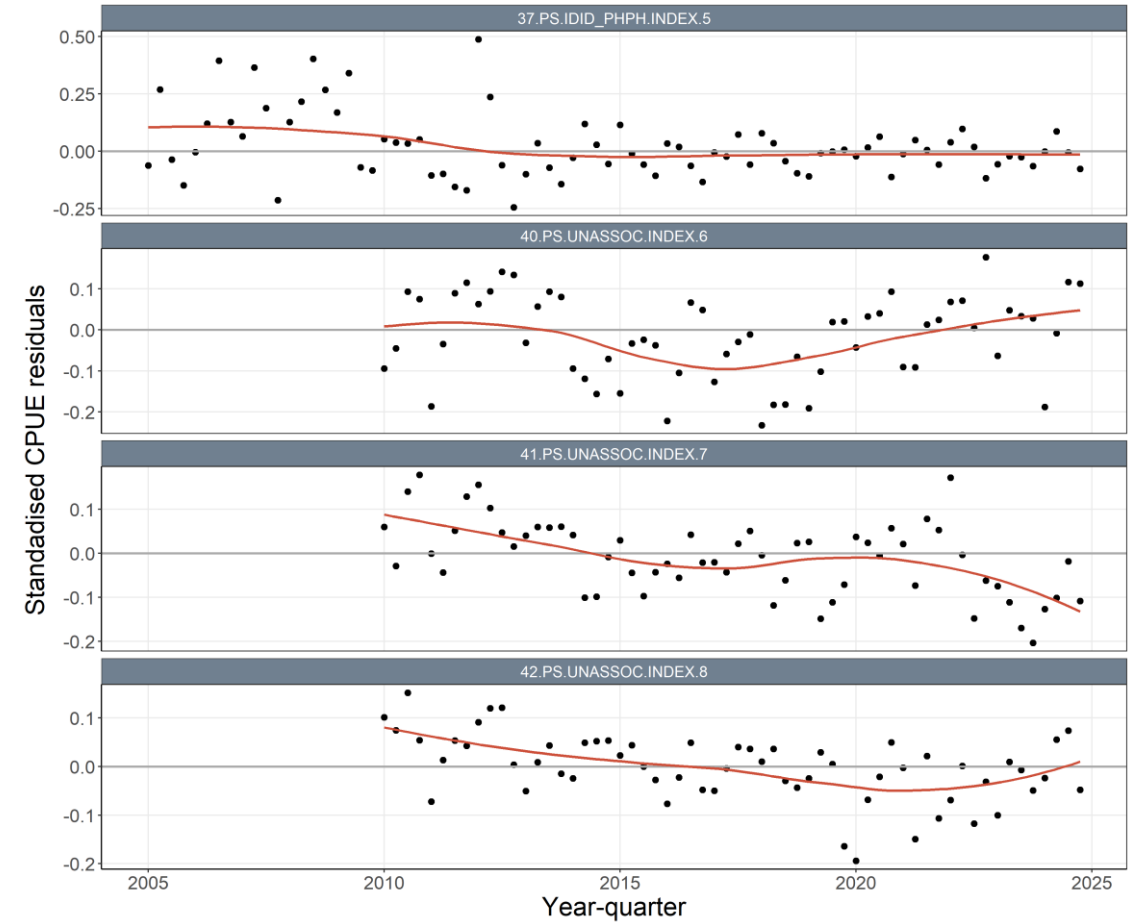
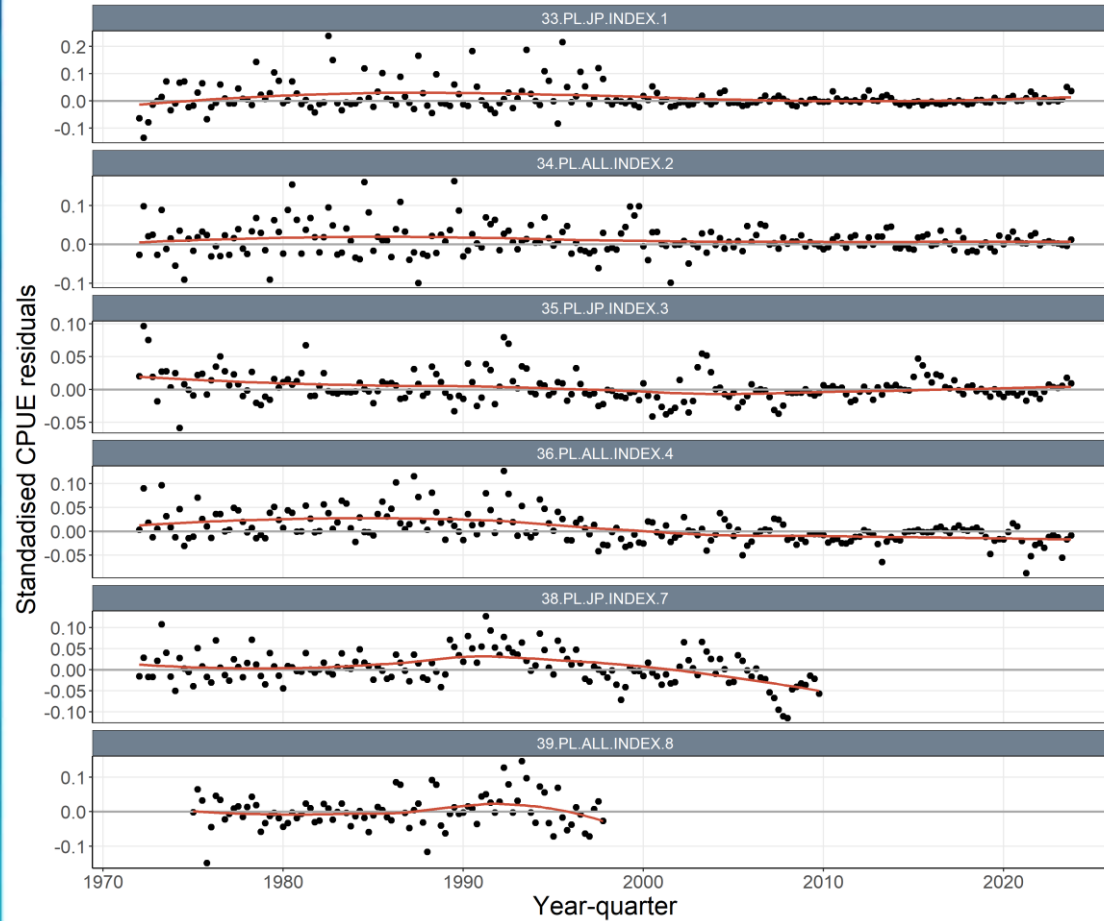


# Fishery data – CPUE trends





# Fishery data – CPUE residuals



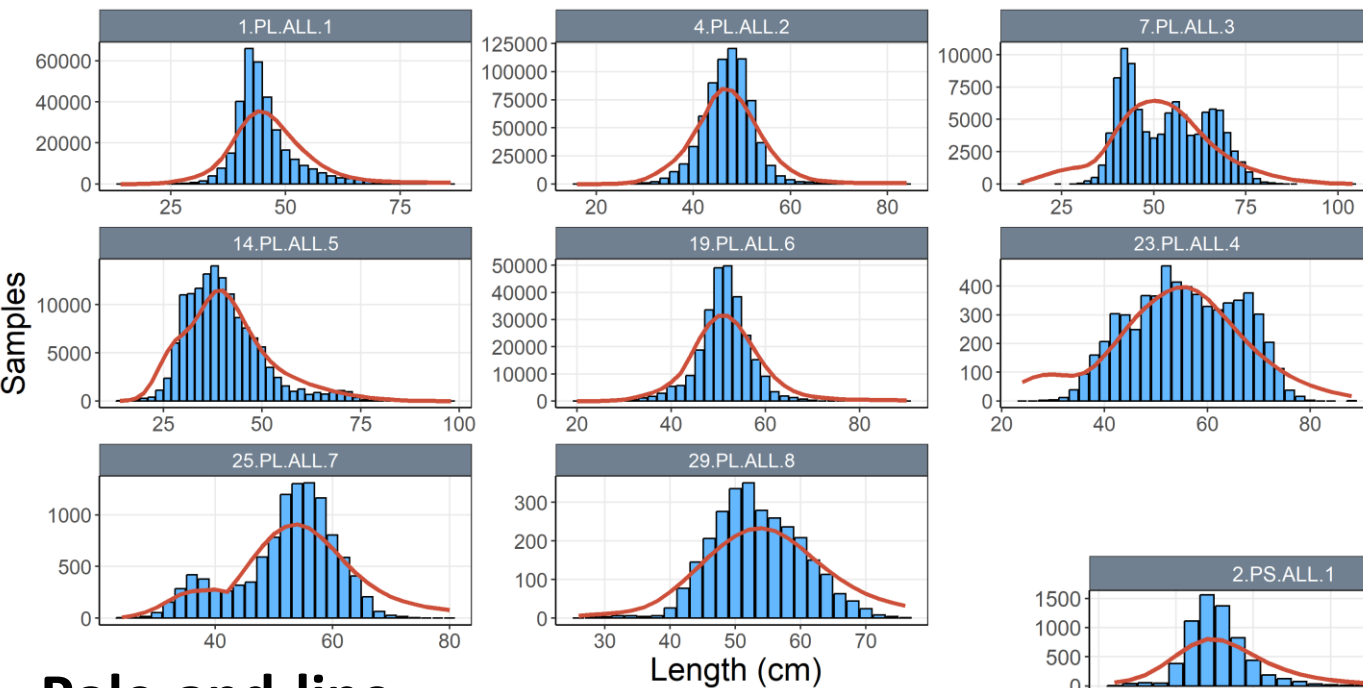


# Fishery data – length data (extraction fisheries)

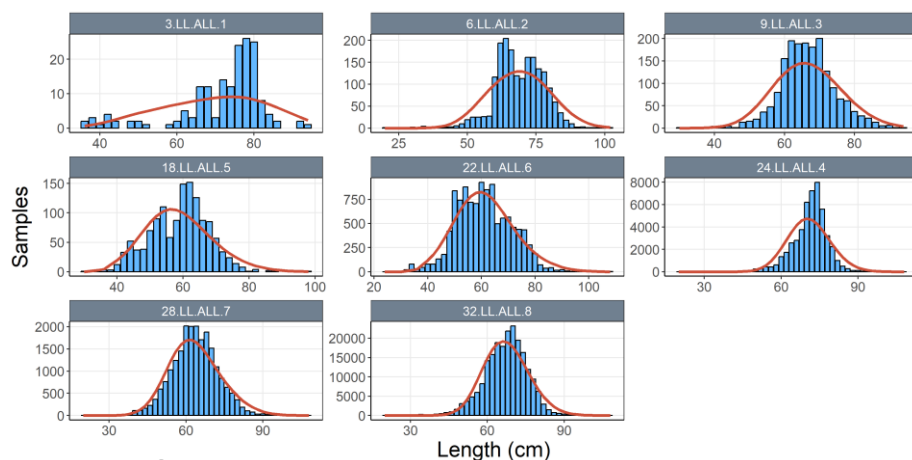


Pacific  
Community  
Communauté  
du Pacifique

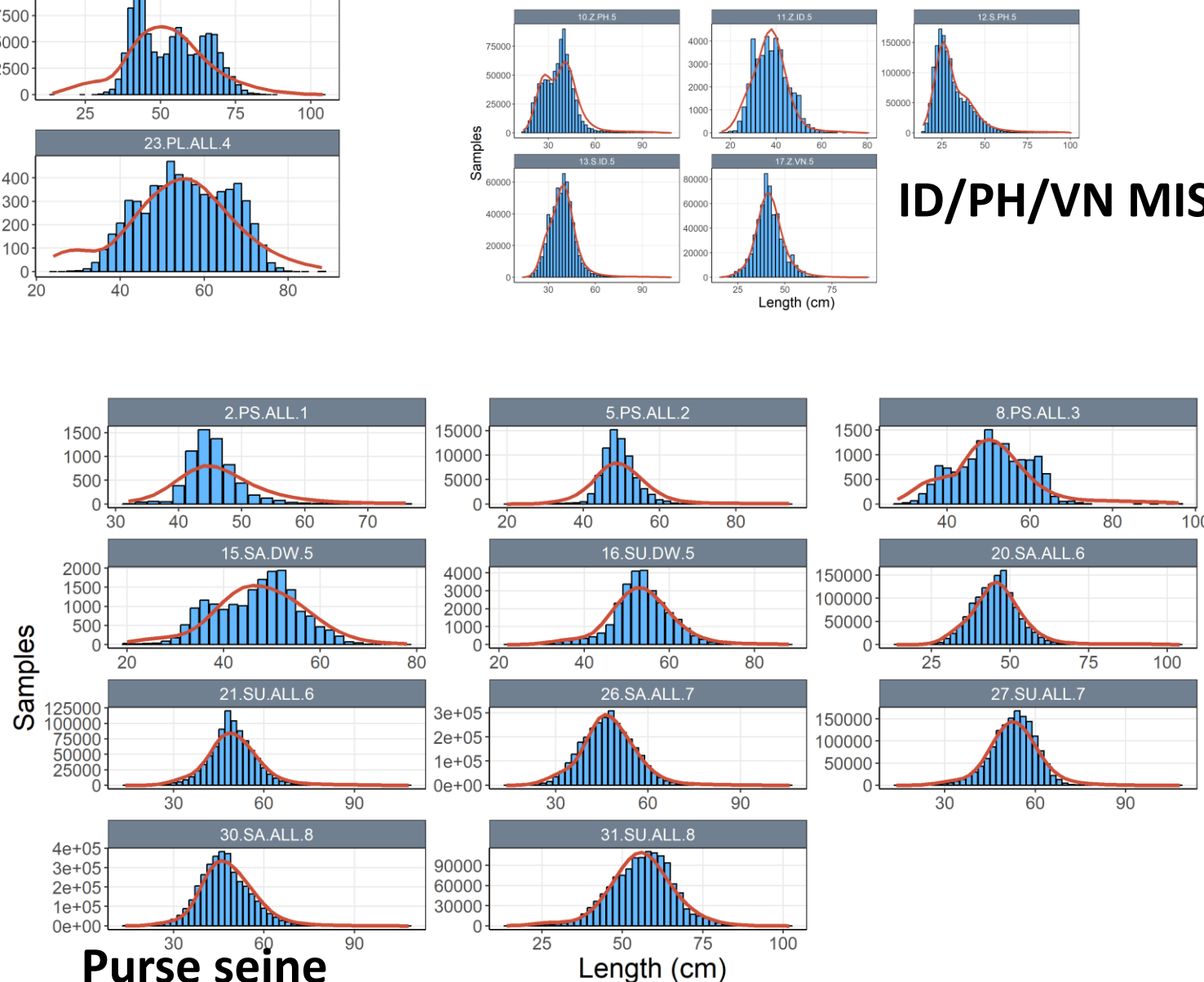
ID/PH/VN MISC



**Pole-and-line**

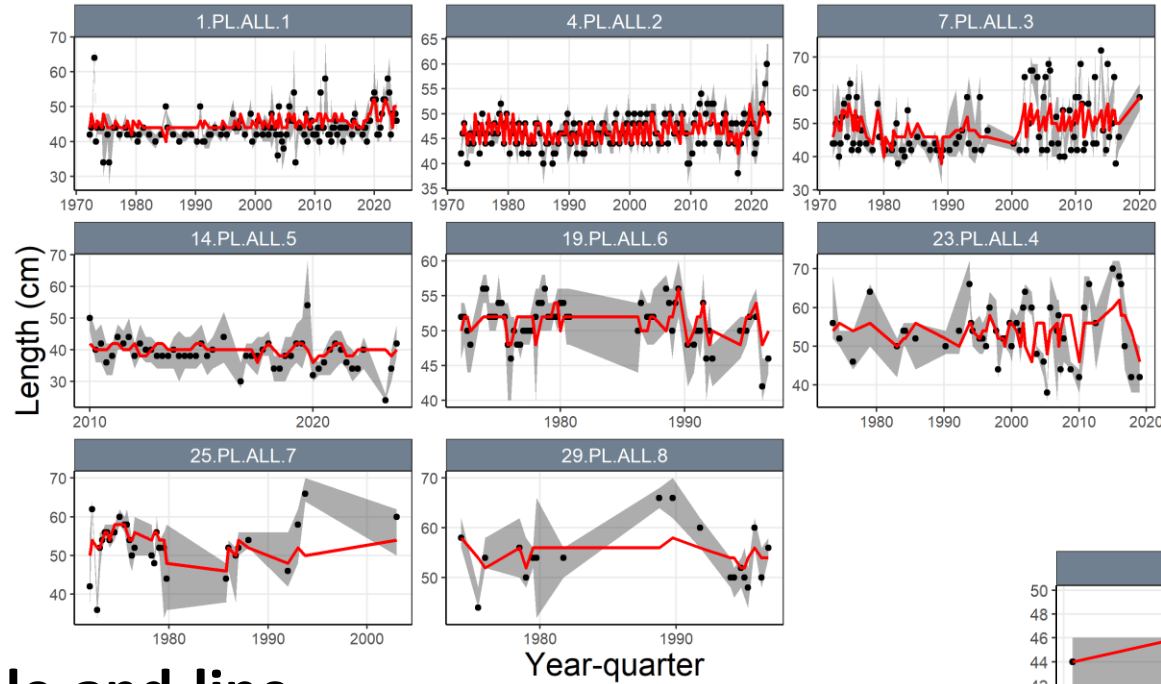


**Longline**

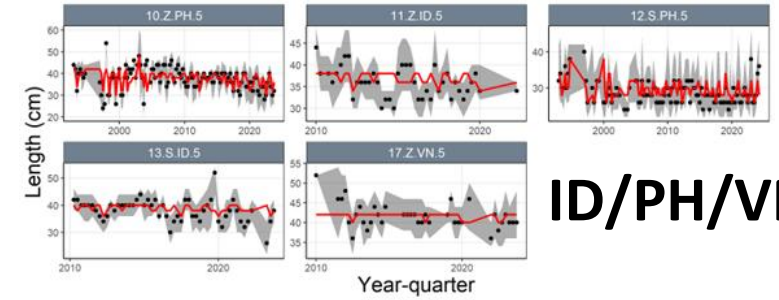


**Purse seine**

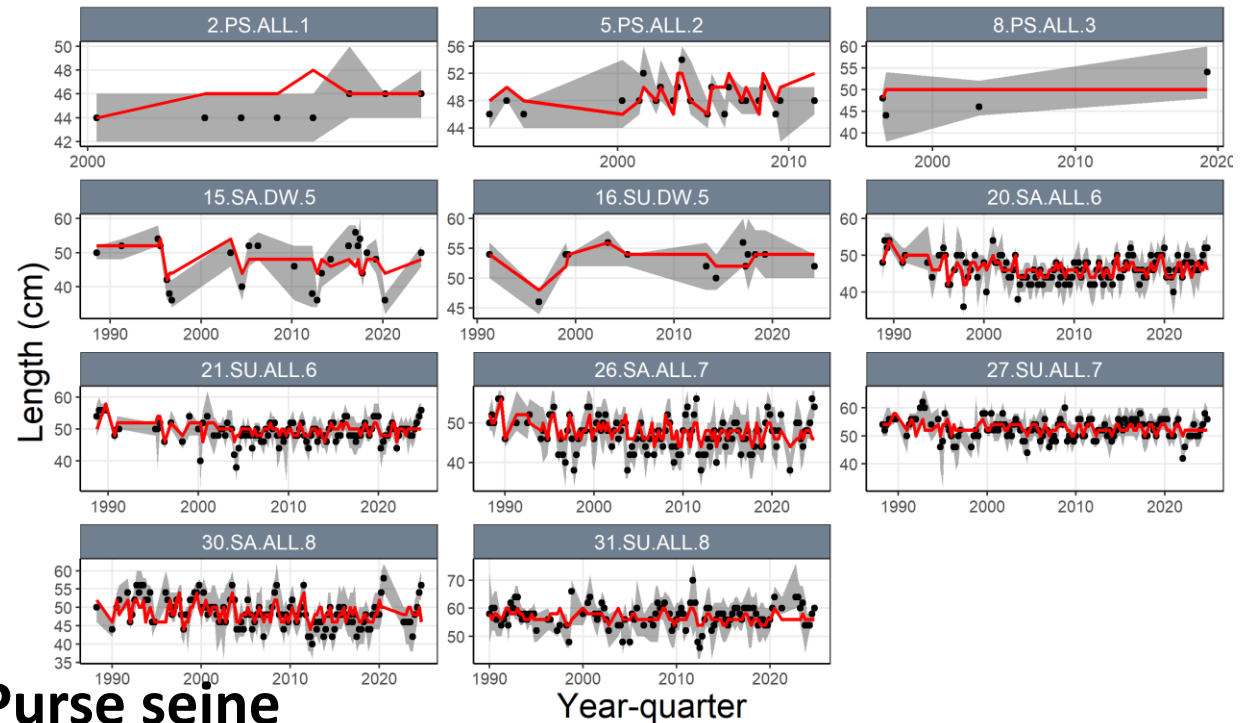
# Fishery data – length data (extraction fisheries)



**Pole-and-line**



**ID/PH/VN MISC**



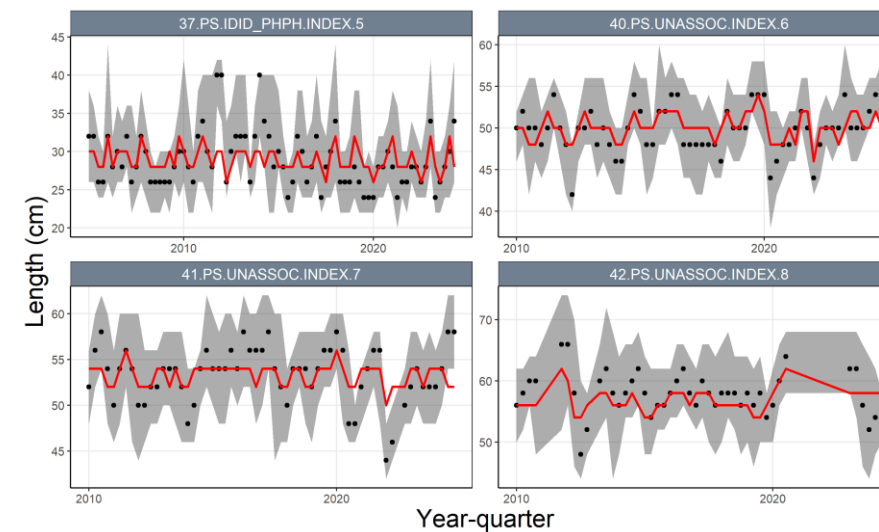
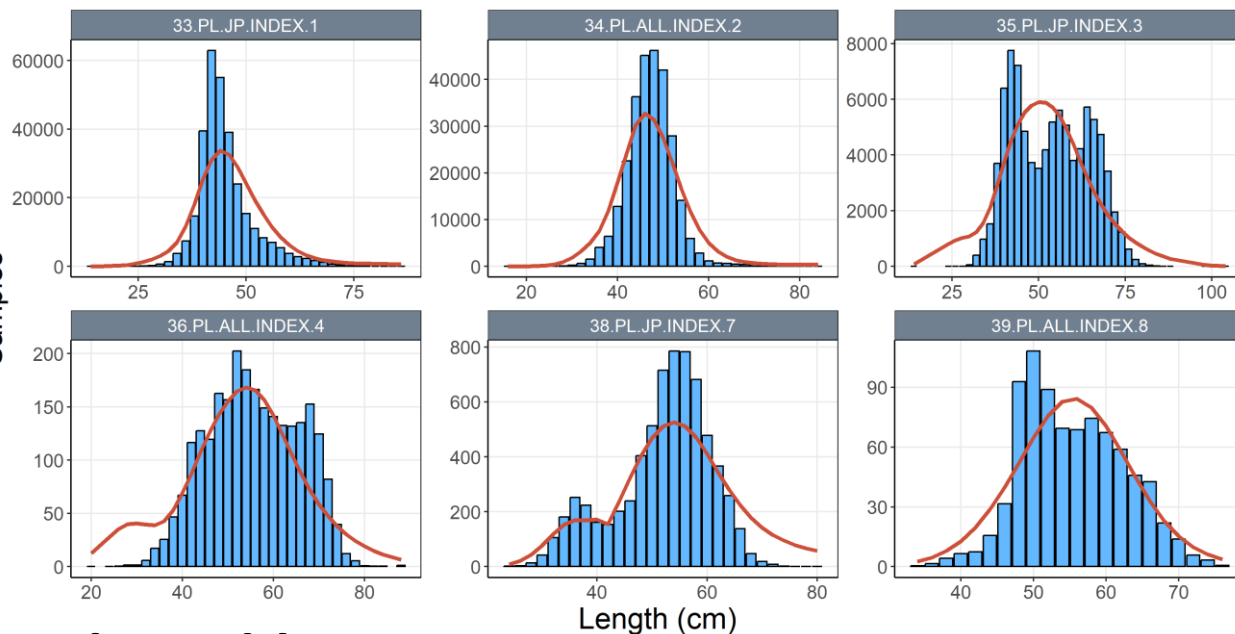
**Purse seine**

# Fishery data – length data (CPUE indices)



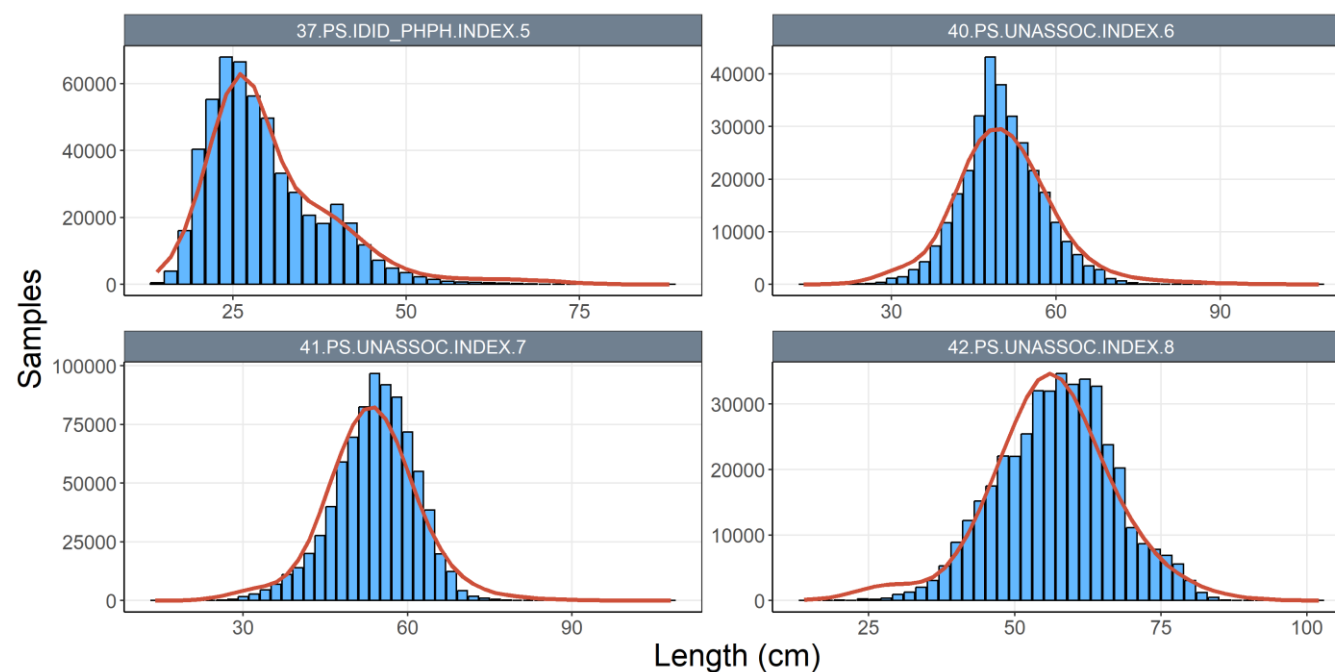
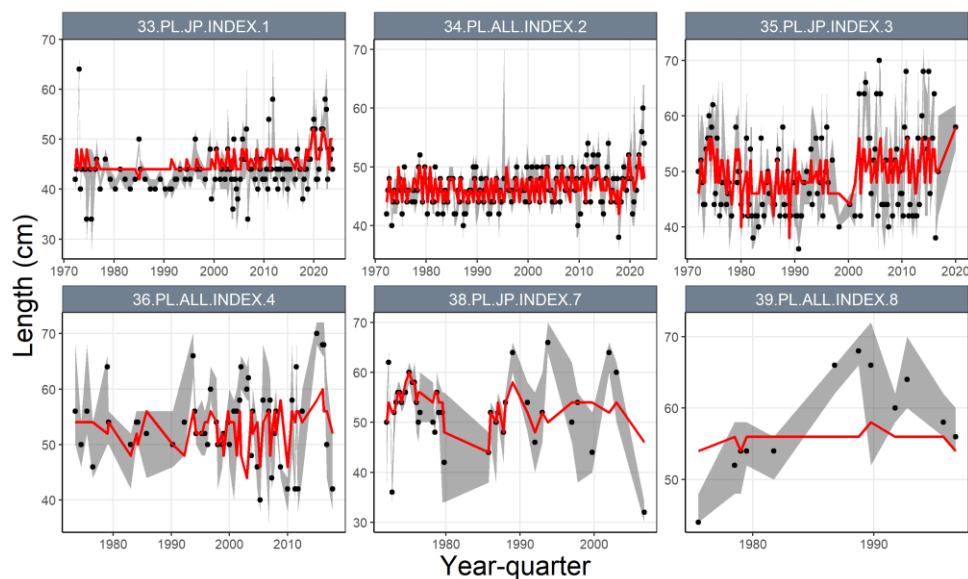
Pacific  
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du Pacifique

Samples

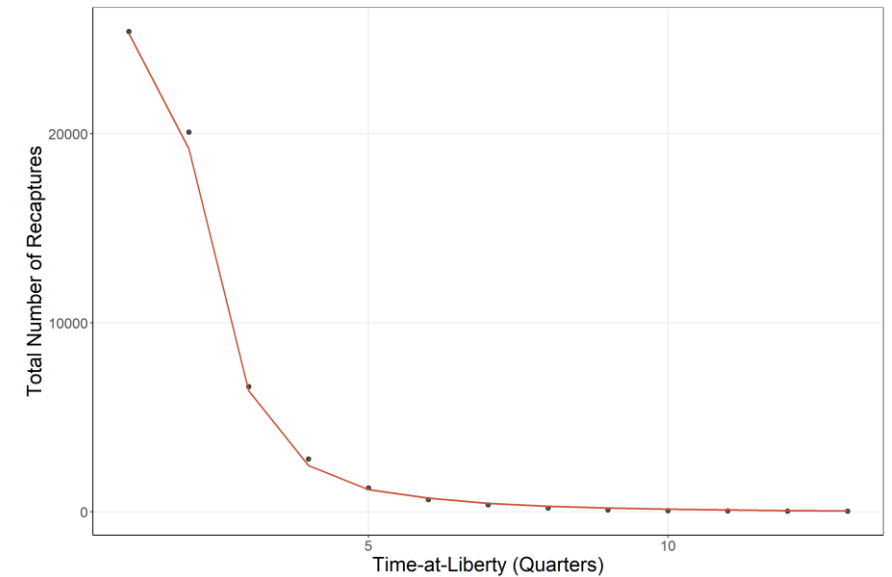
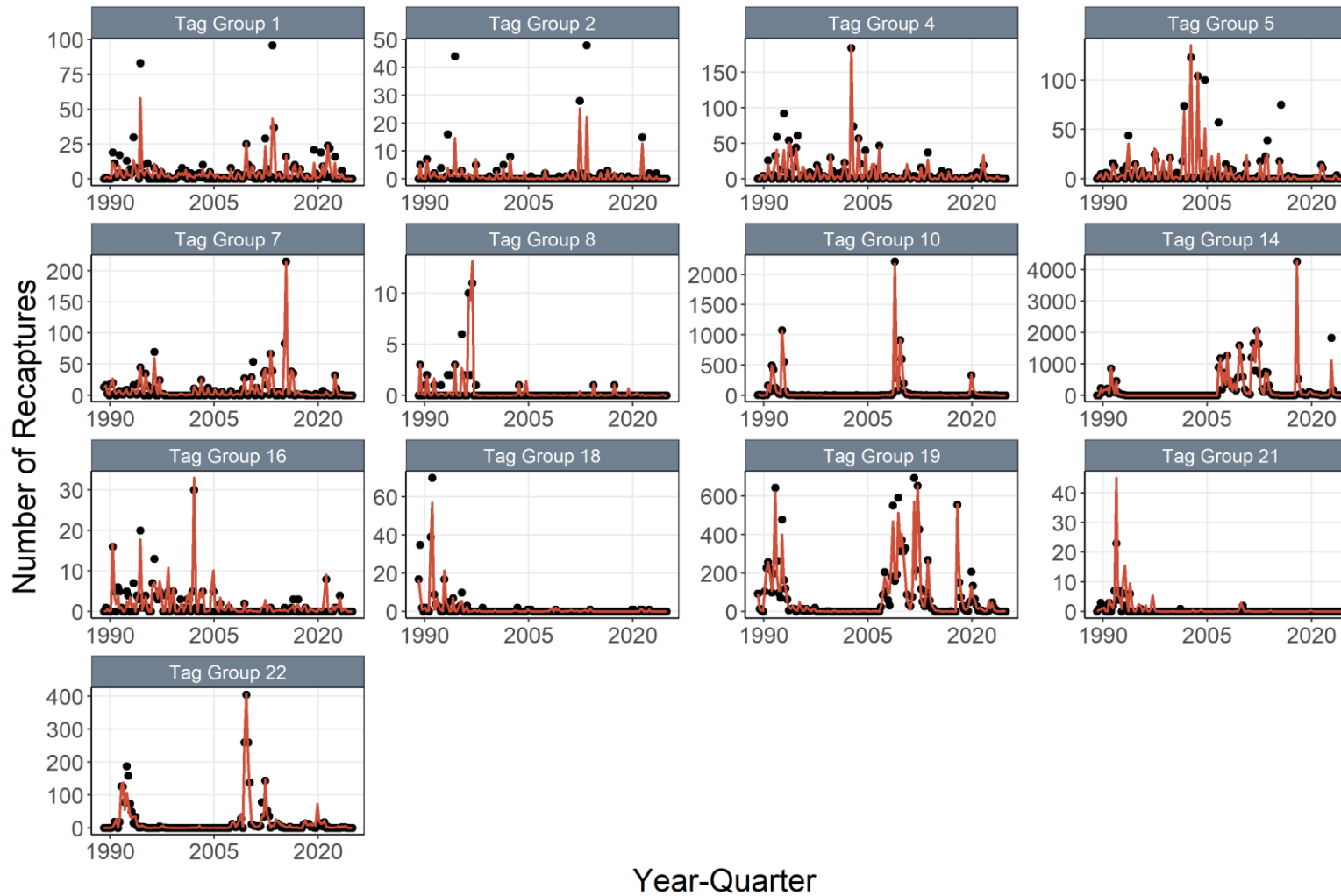


Purse seine

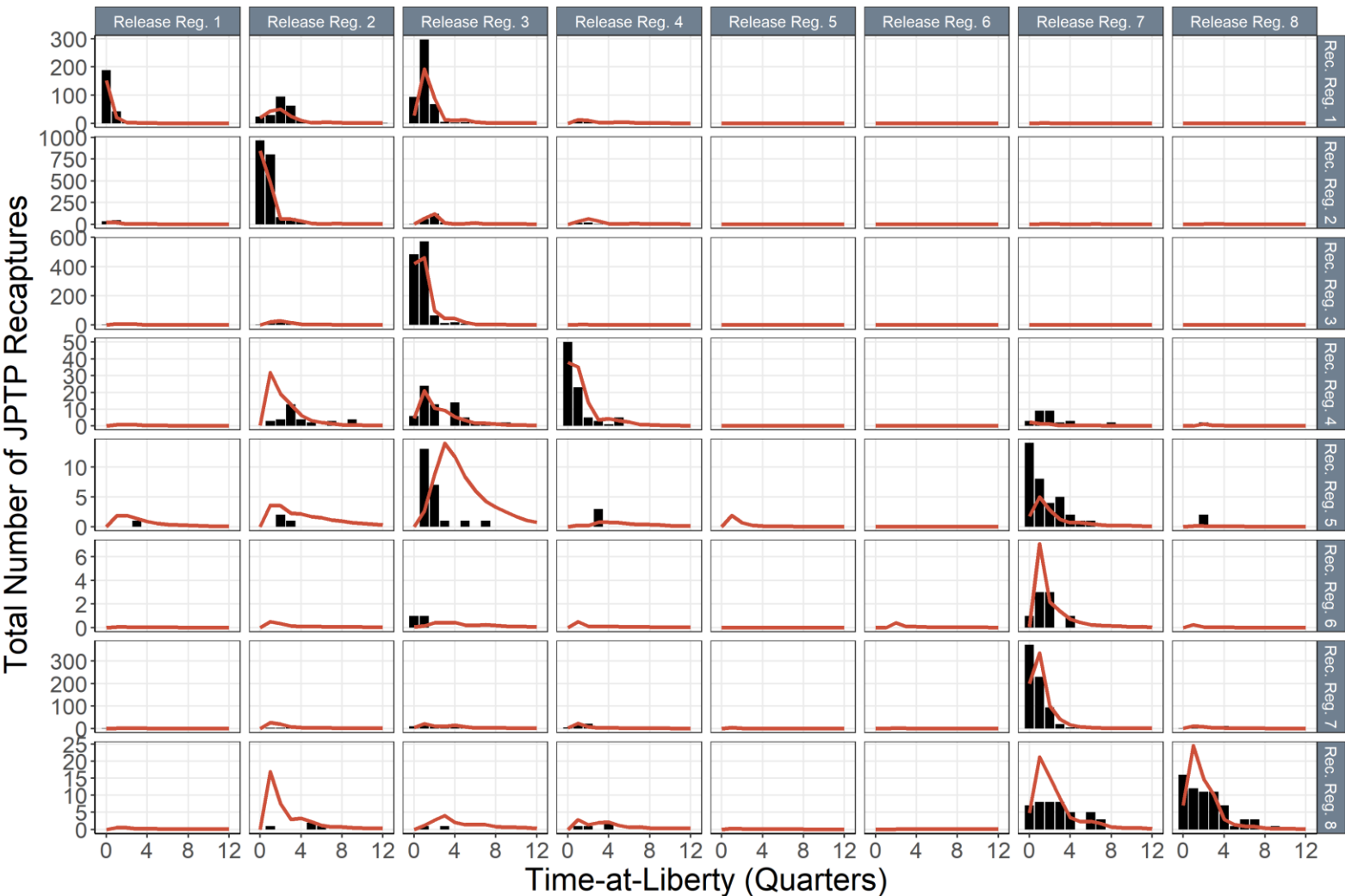
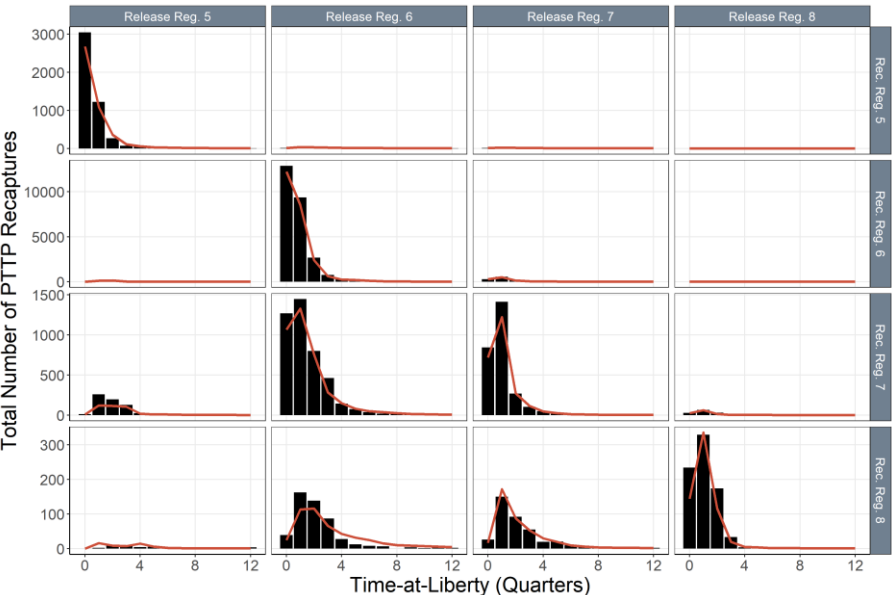
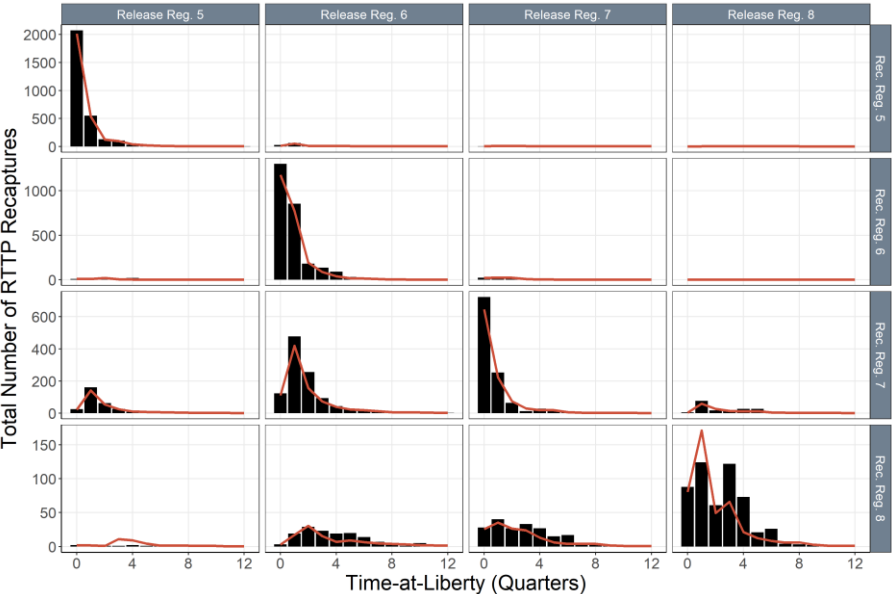
Pole-and-line



# Fishery data – tagging data



# Fishery data – tagging data



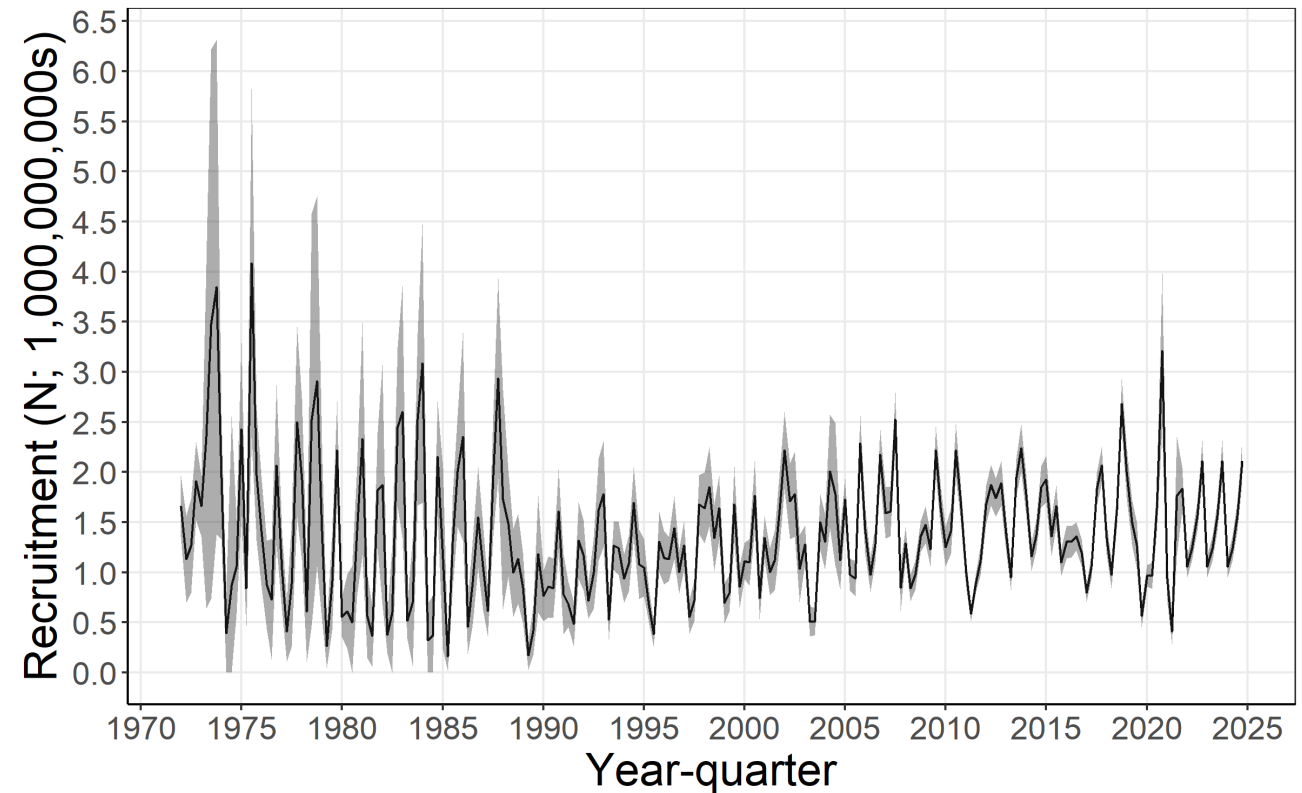
## Diagnostics

Max gradient =  $5.9\text{e-}05$

No parameters on bounds, 38 movement  
parms. near lower bounds (bound = 0)

Correlation of parameters: (99.9% not  
correlated), 9 correlations from selectivity  
spline nodes

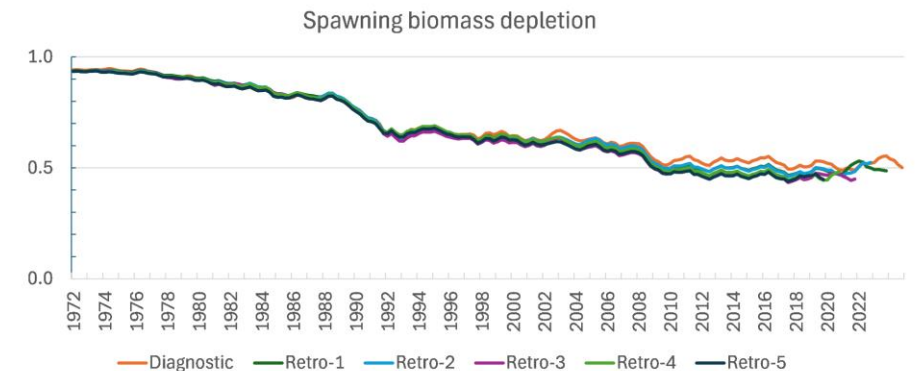
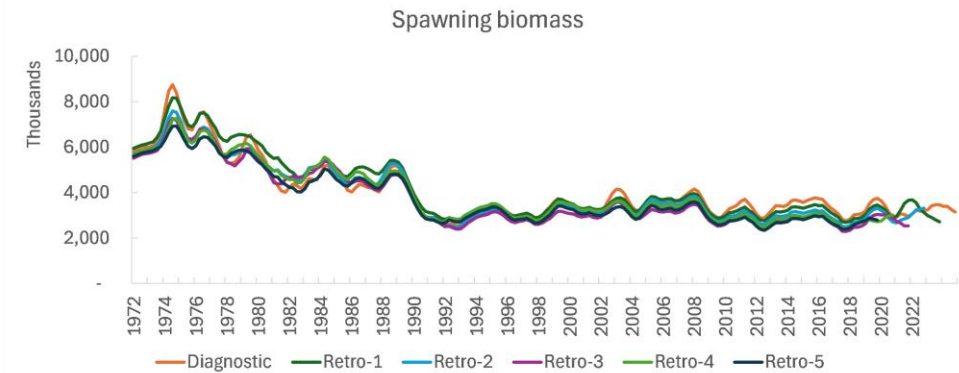
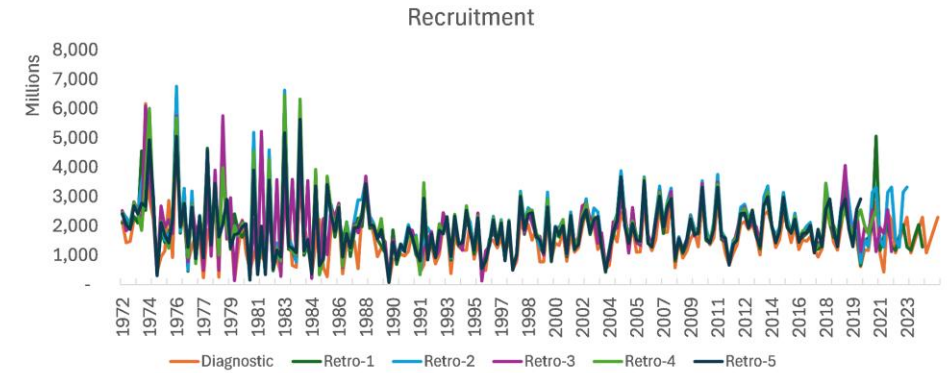
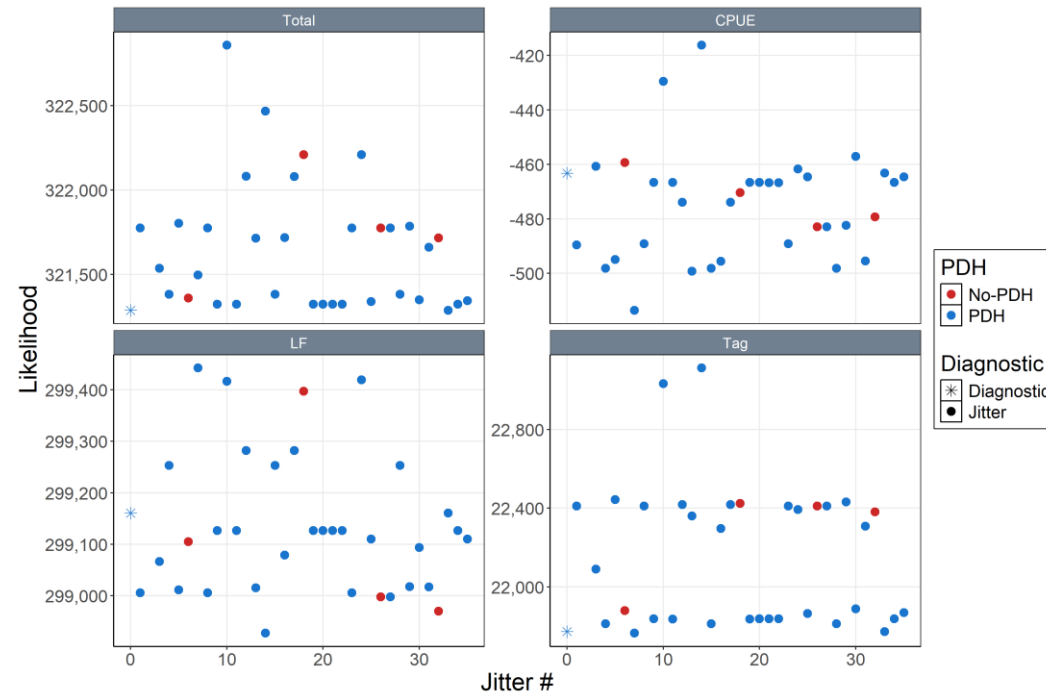
Stable recruitment trend





# Diagnostics

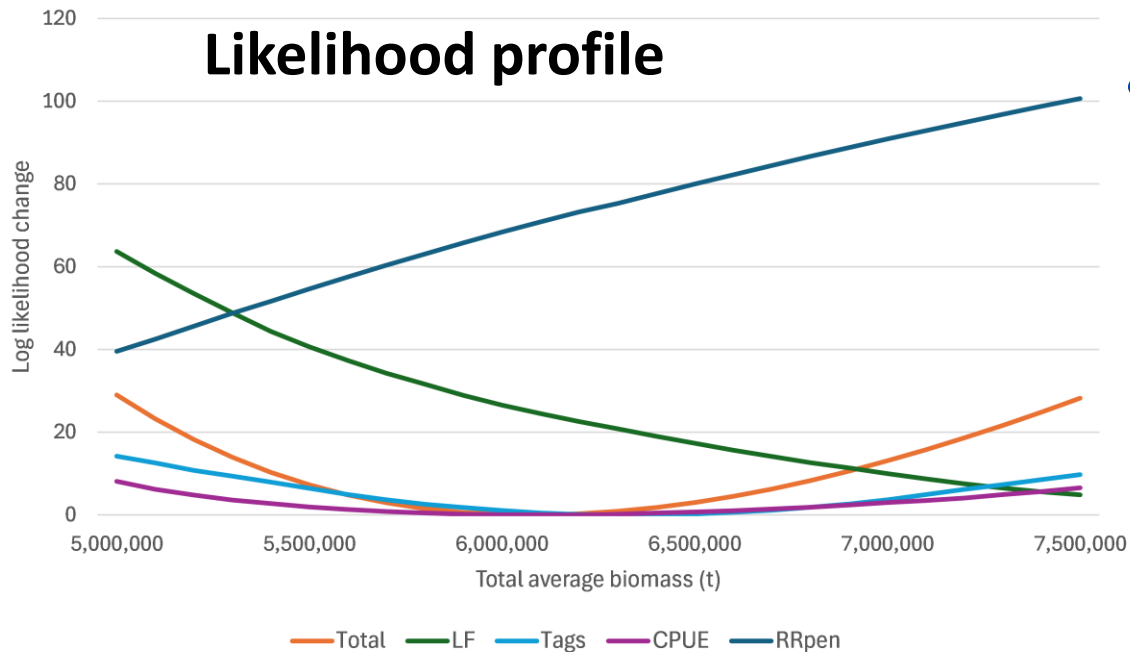
- Jitter analysis
- Retrospectives





# Diagnostics

- Likelihood profile (LP)  
conflict between LF with CPUE and tag data



- LP by fishery  
CPUE: PL-R4  
conflict with  
PL-R2 & PL-R8
- LF: PS-SA-R6  
and PS-SU-R7  
conflict with  
the others

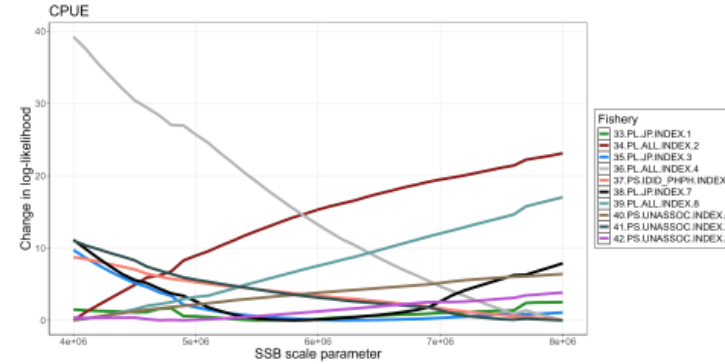
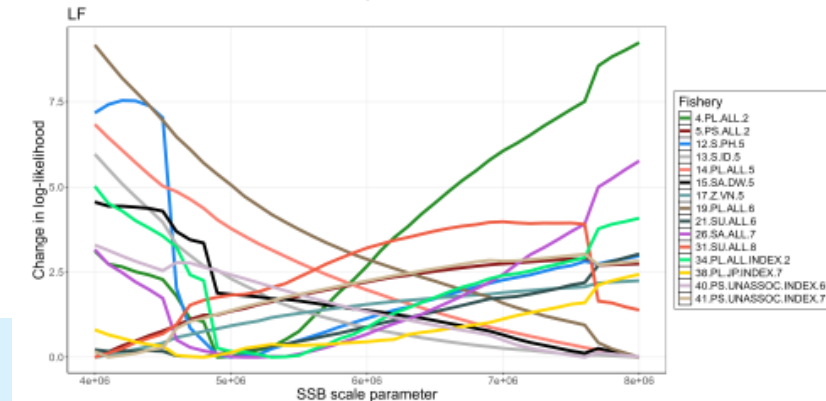
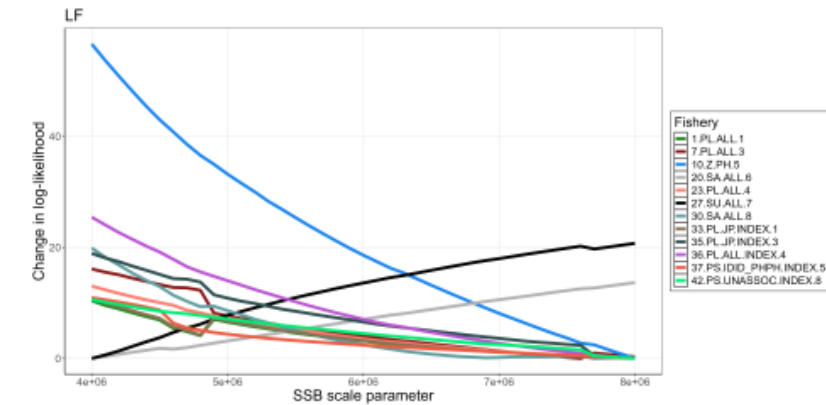
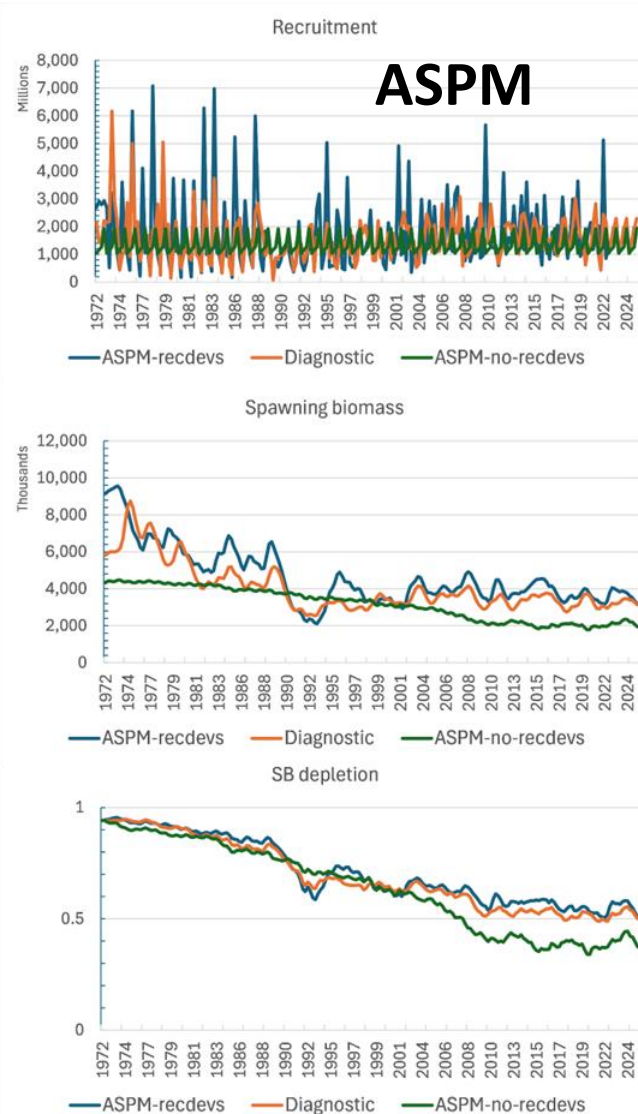


Figure 63: Likelihood profiles by fishery for CPUE indices.

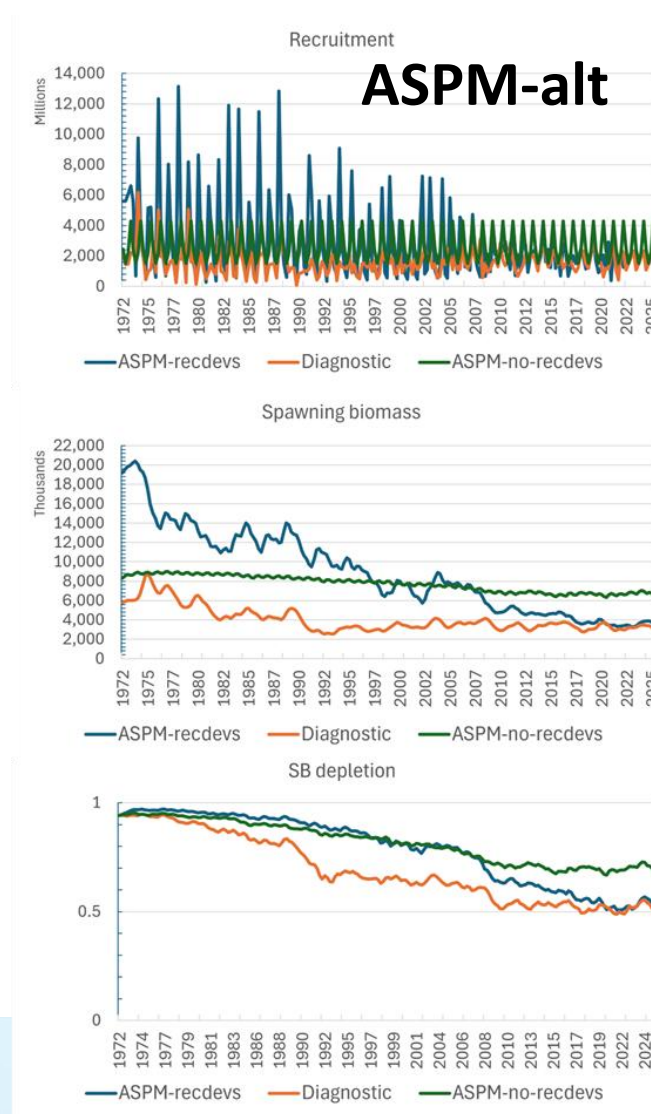


# Diagnostics



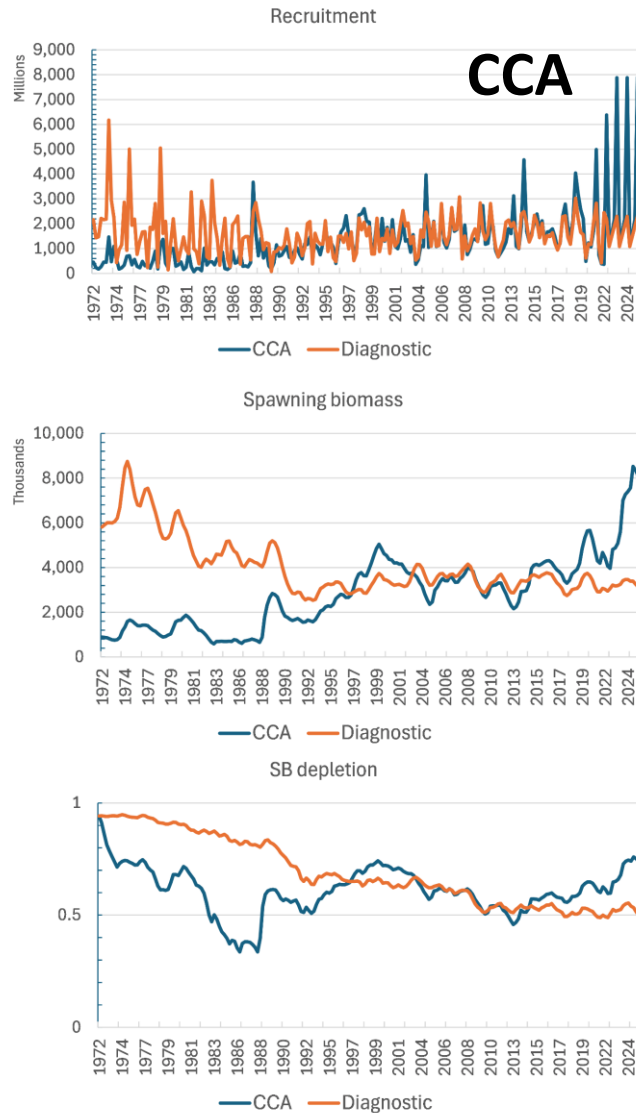
- Age-structured production model (ASPM; remove length data)

Consistency indicates CPUE and tagging data inform scale and trends



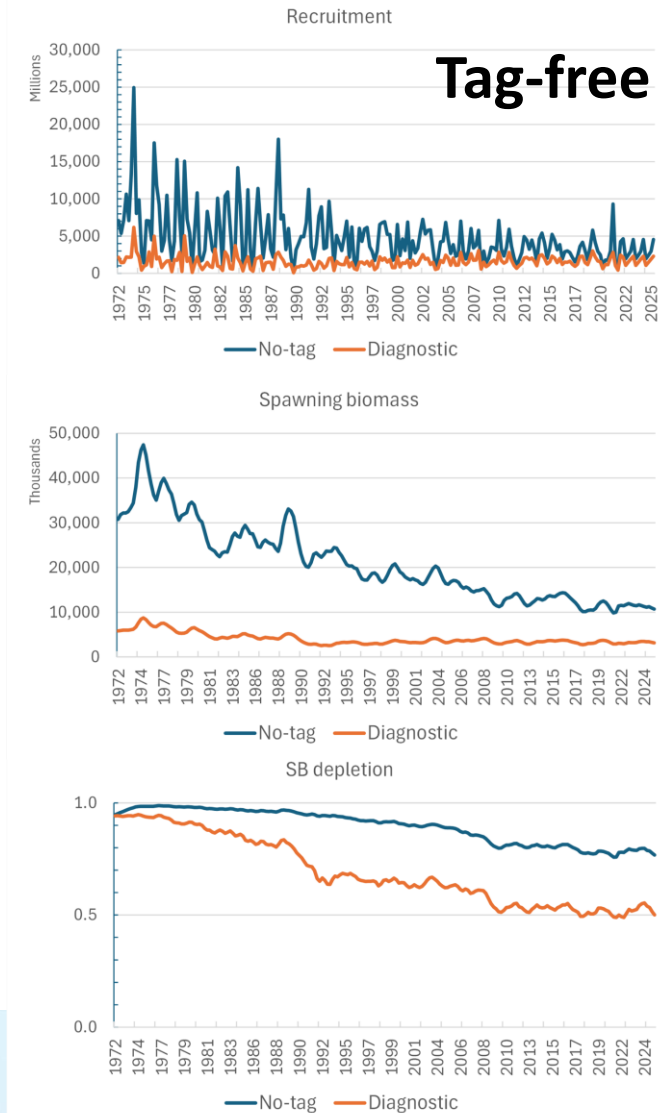
- ASPM-alt:  
Alternate run with tag data removed

# Diagnostics



- Catch-curve analysis (CCA; CPUE removed)

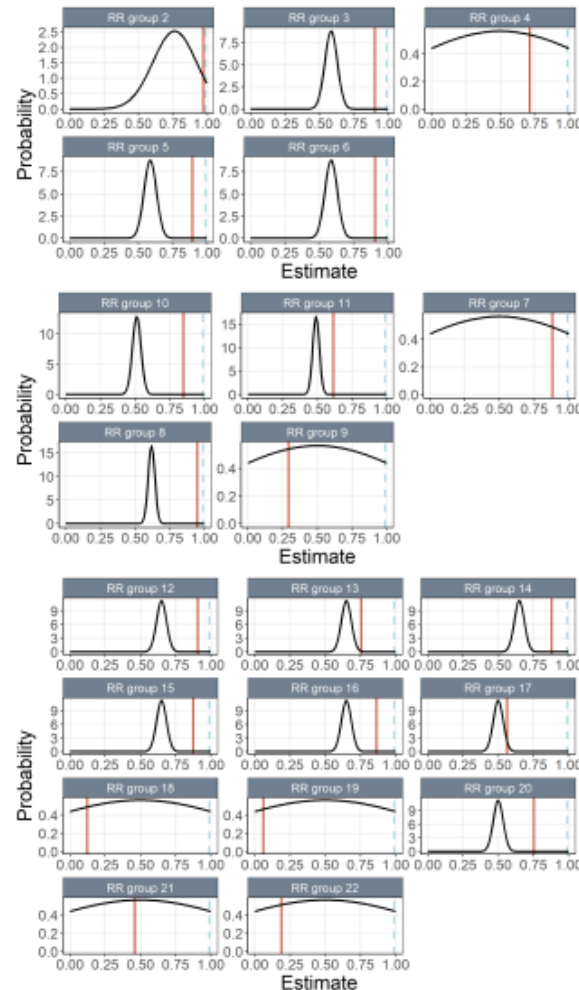
Inconsistency indicates CPUE inform trends, lengths inform short-term variability (high recruitment in later years)



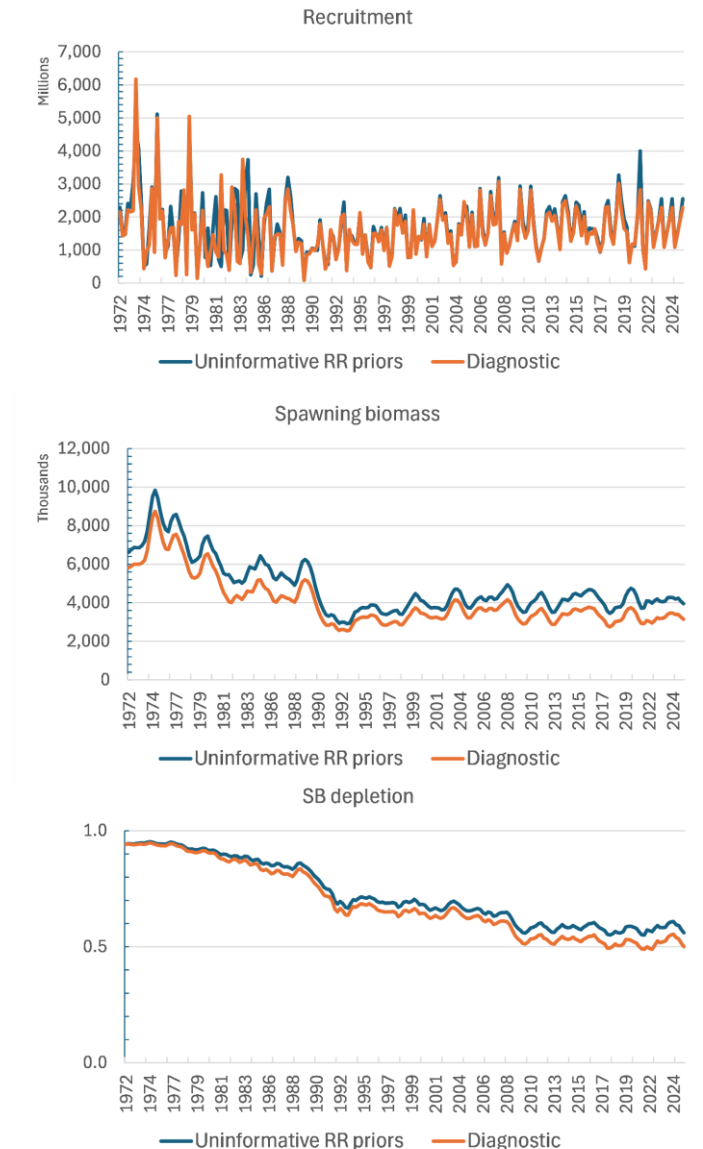
- Tag-free model  
Difference in scale indicates tags largely moderate population scale

# Sensitivities

- Diagnostic case reporting rate priors



- Uninformative priors on RR priors
- Difference in scale  
SB and SB depletion

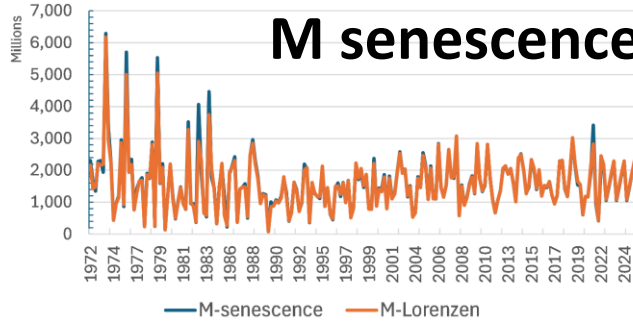




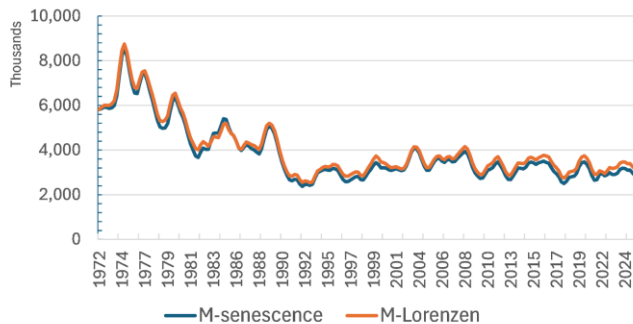
# Sensitivities

Recruitment

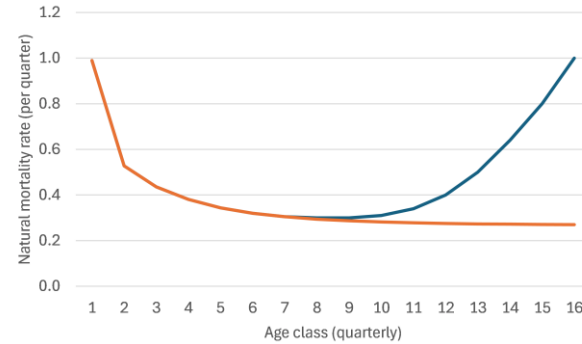
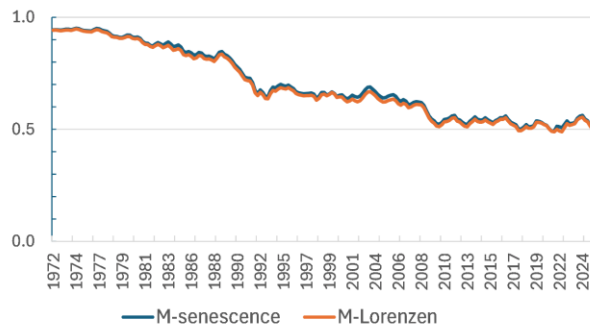
## M senescence



Spawning biomass



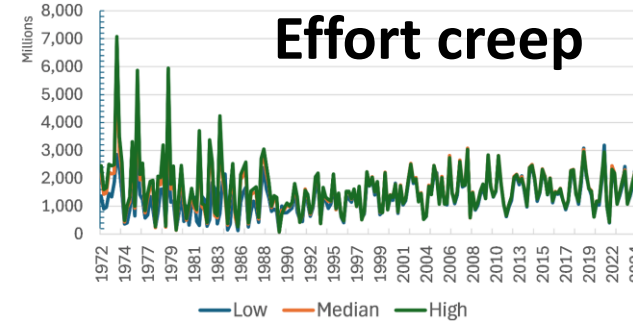
SB depletion



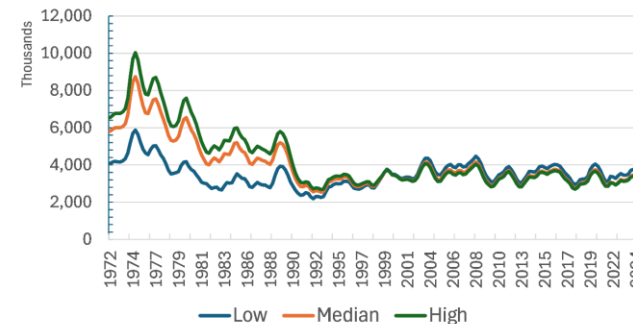
- M senescence  
Very little effect  
on the key model  
outputs

Recruitment

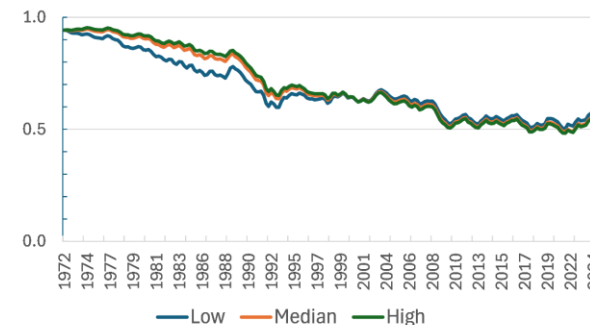
## Effort creep



Spawning biomass



SB depletion



- Effort creep  
10%, median, &  
90%

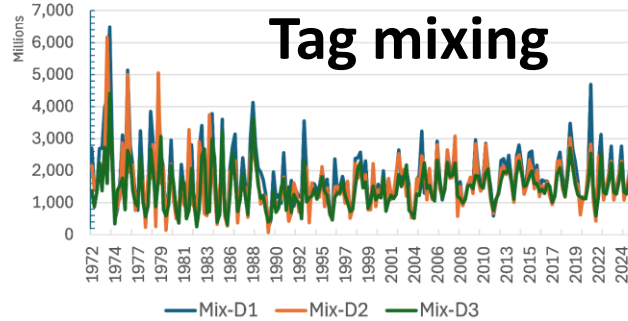
Moderate  
effects on early  
years of model  
outputs

Influential on  
recruitment

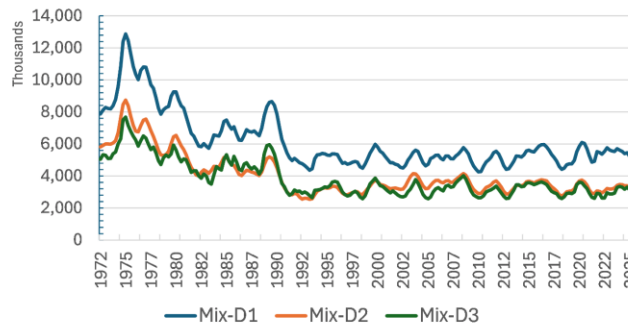
# Sensitivities

Recruitment

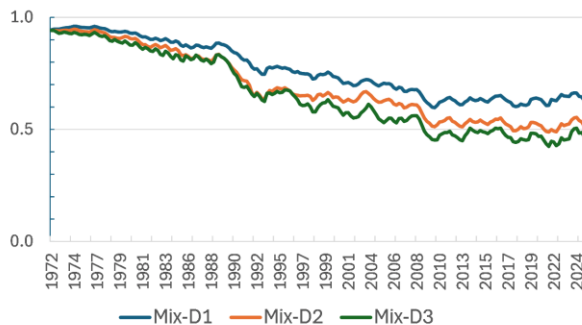
## Tag mixing



Spawning biomass



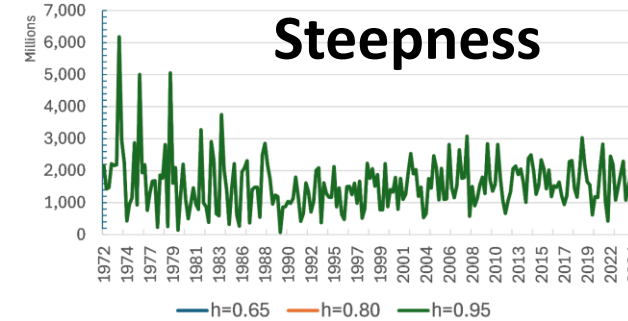
SB depletion



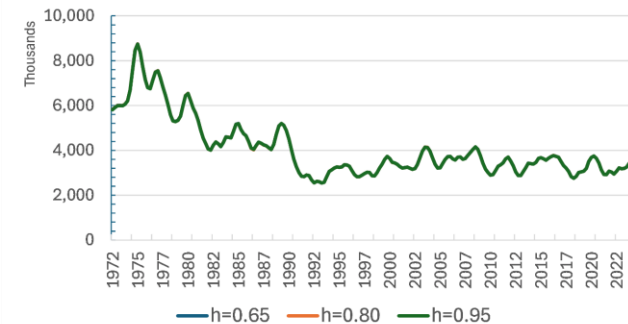
- Tag mixing
  - Dissimilarity
  - $K=0.1, 0.2, 0.3$
  - Highly influential on the key model outputs

Recruitment

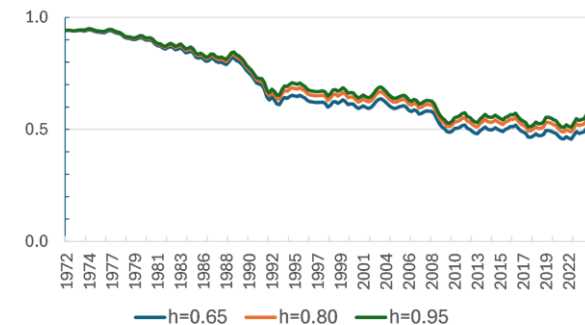
## Steepness



Spawning biomass



SB depletion

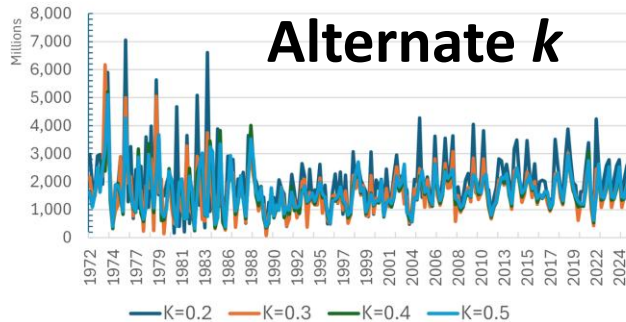


- Steepness
  - 0.65, 0.8, 0.95
  - Impacts MSY

# Sensitivities

Recruitment

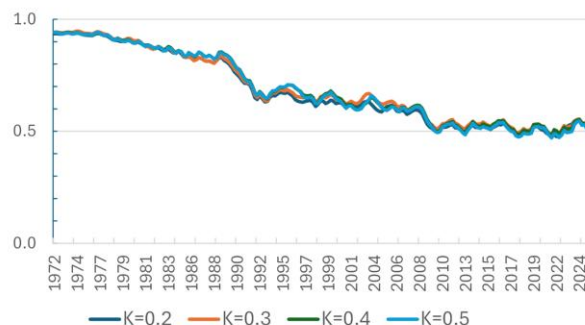
## Alternate $k$



Spawning biomass



SB depletion

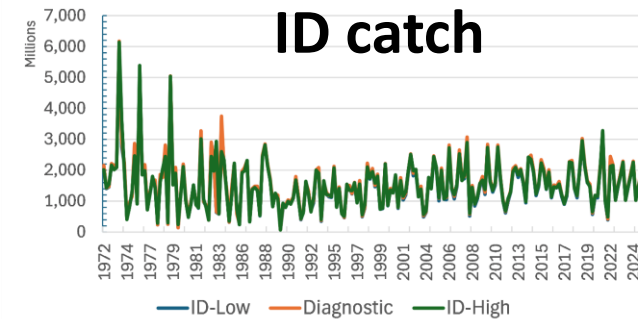


- Alternate  $k$   
Not highly influential

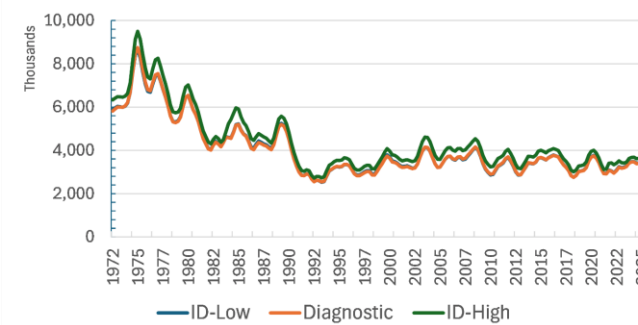
Potential interactions with other uncertainties

Recruitment

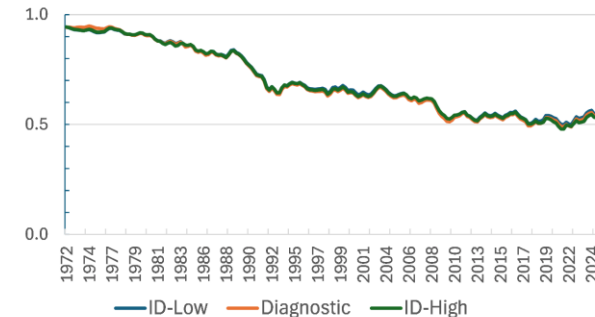
## ID catch



Spawning biomass



SB depletion

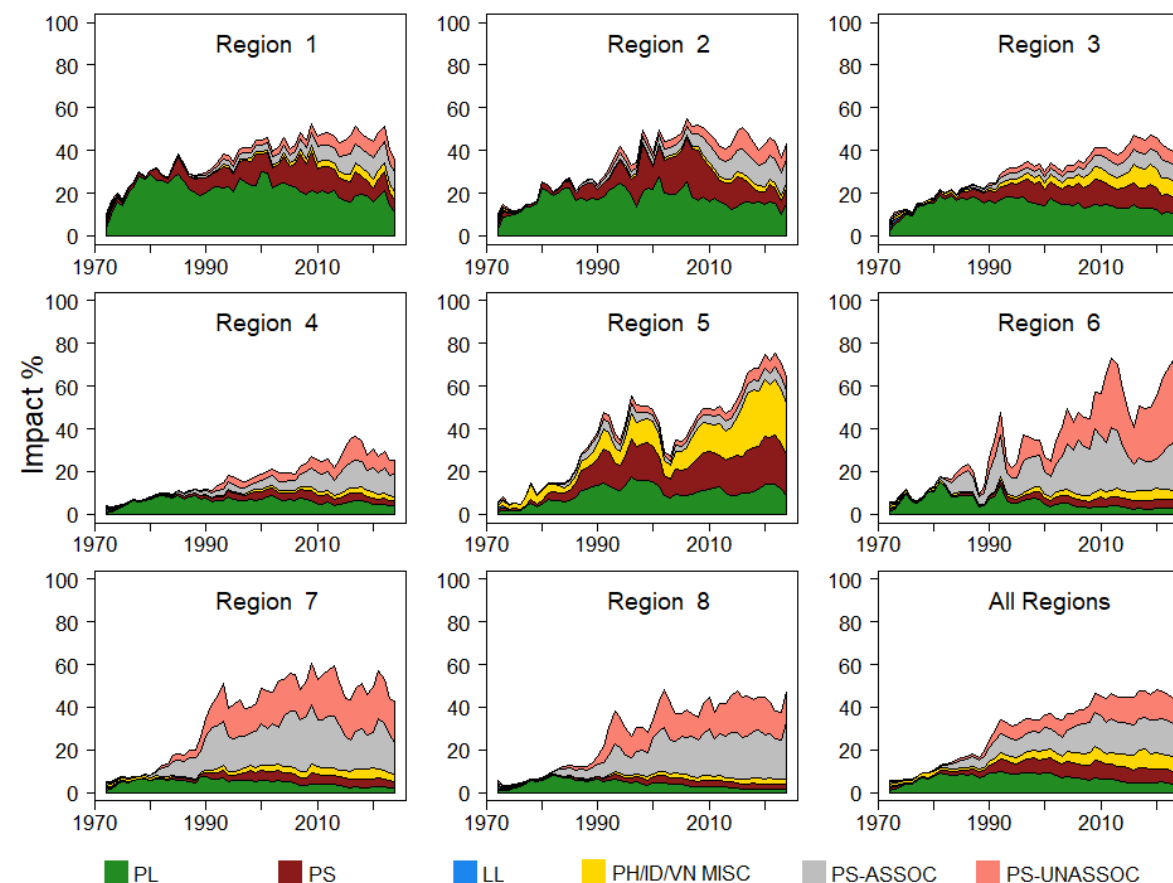


- ID catch  
uncertainty  $\pm 20\%$

Very little effect on the key model outputs

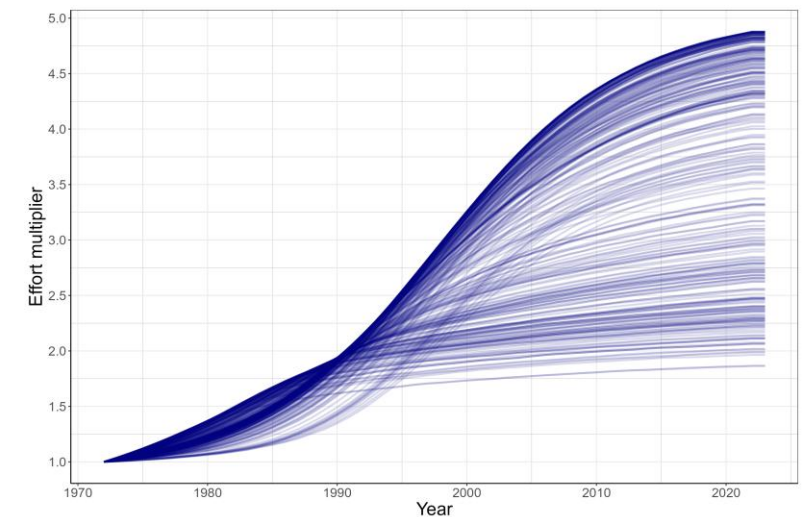
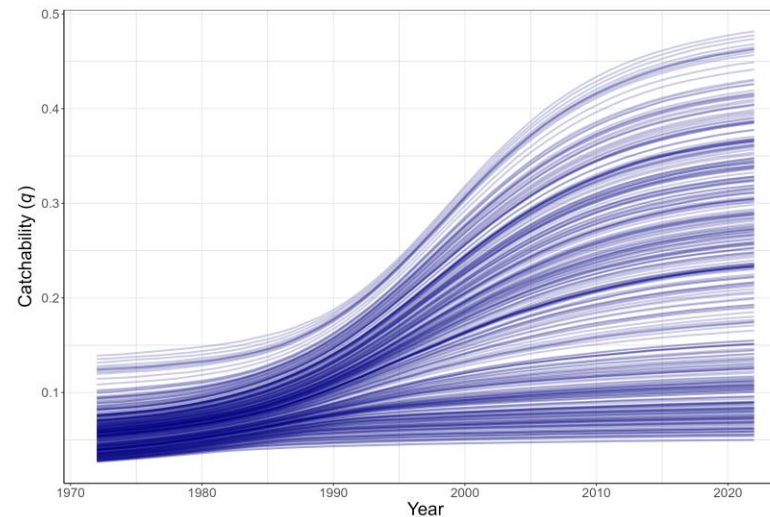
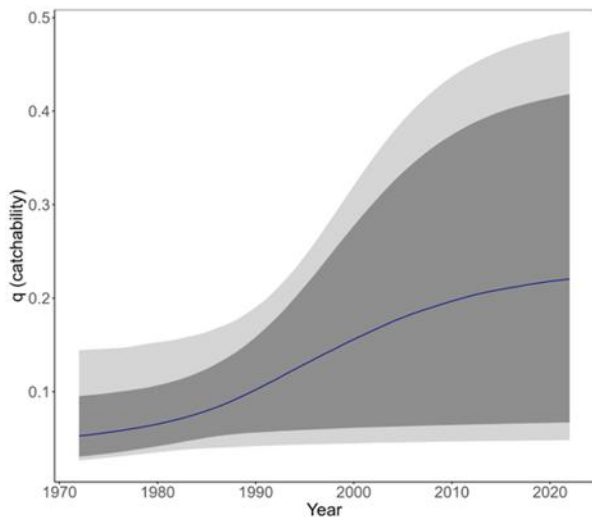
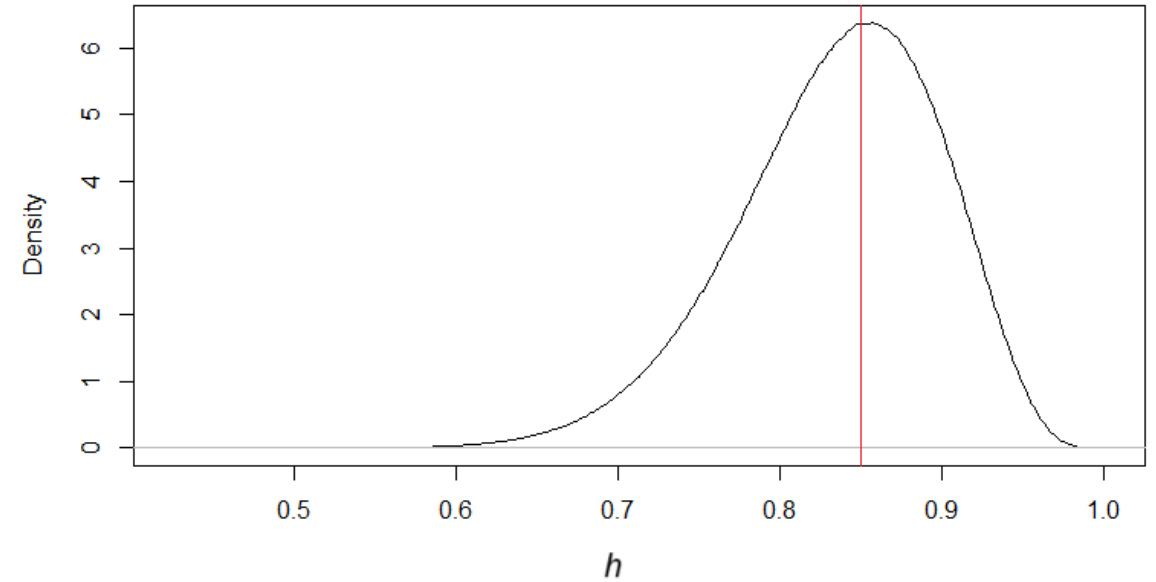


# Fishery impacts



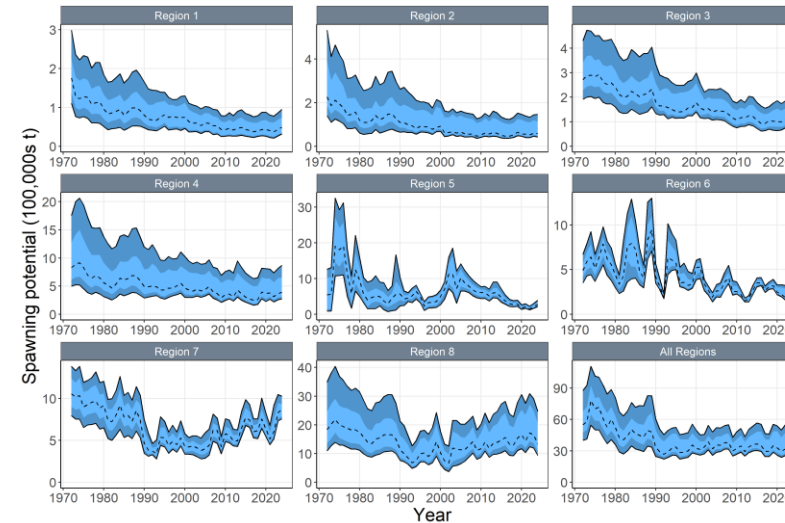
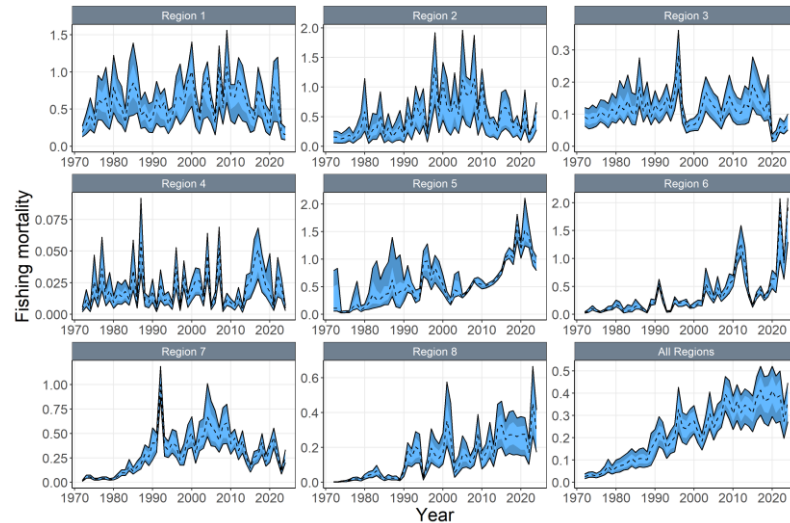
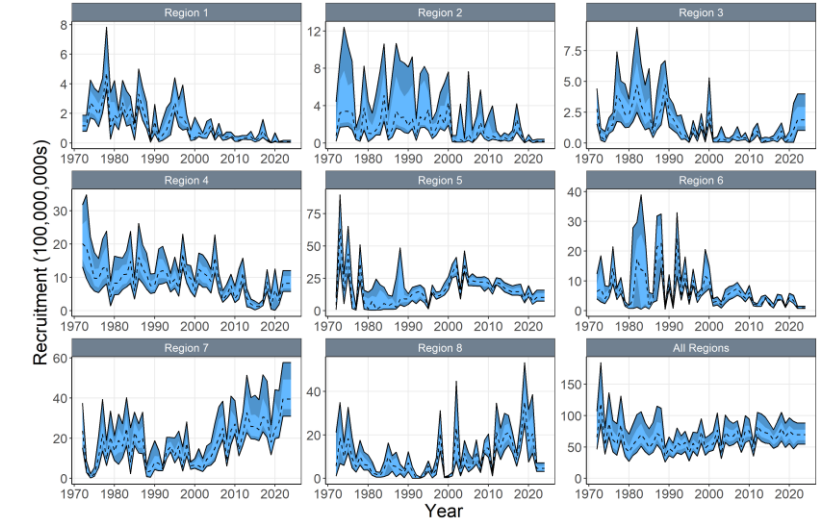
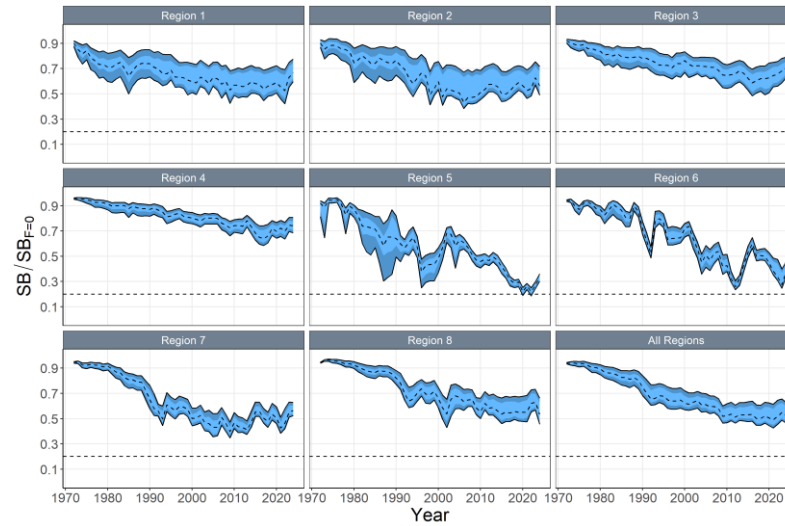
# Model ensemble

- 271 of 300 converged
- Steepness distribution
- Effort creep multiplier distribution of trajectories
- Mixing periods dissimilarity  $K= 0.1, 0.2, 0.3$
- Growth  $k$  as  $U[0.2,0.4]$



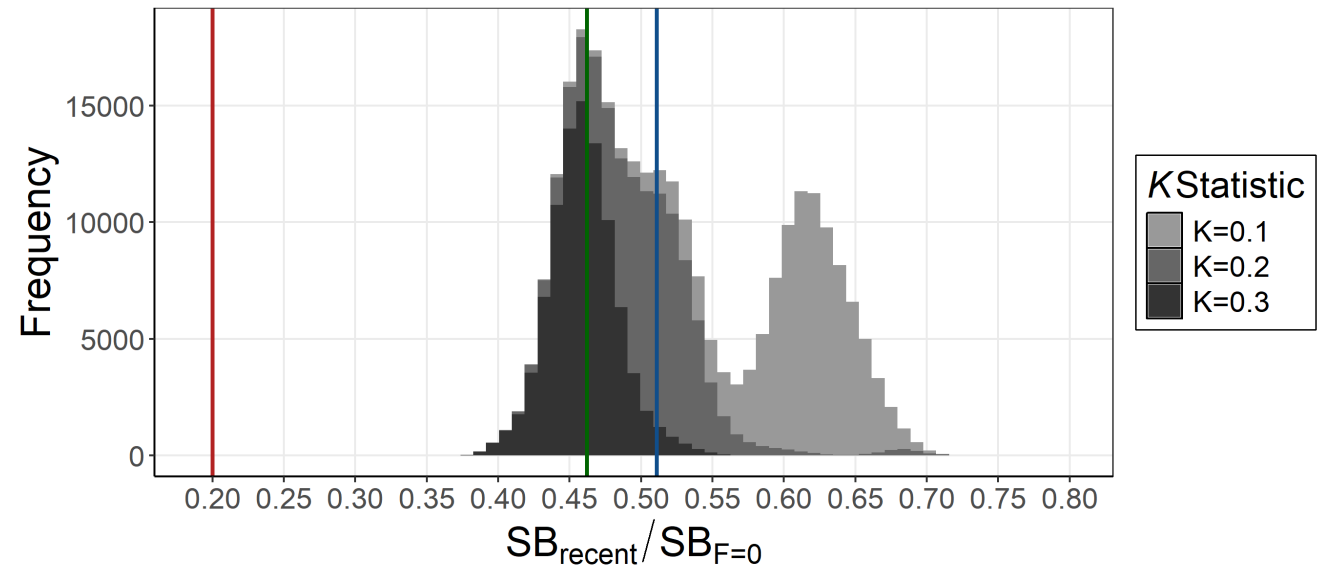
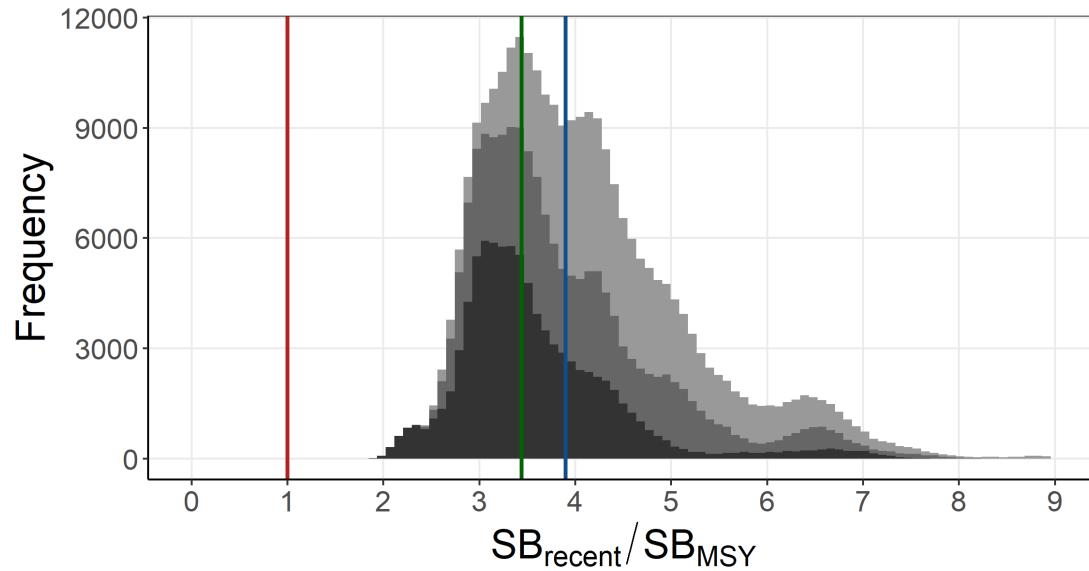
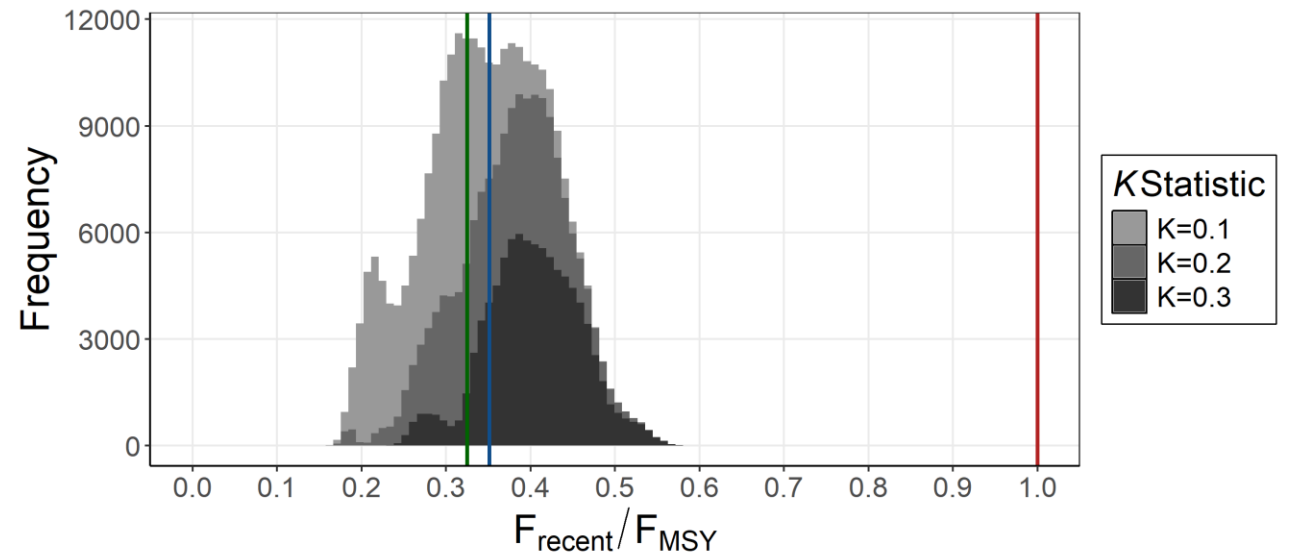
# Model ensemble

- Trajectories
  - SB depletion
  - $F$
  - SB
  - Recruitment



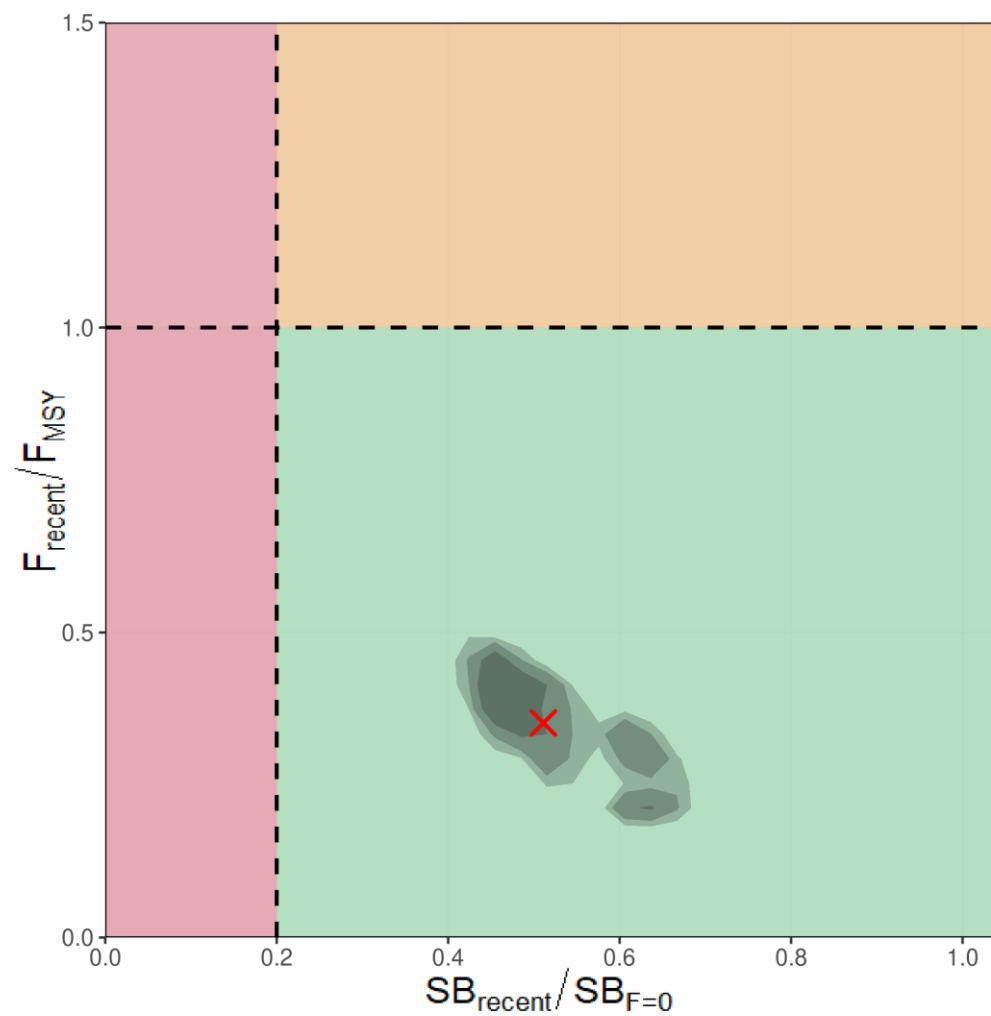
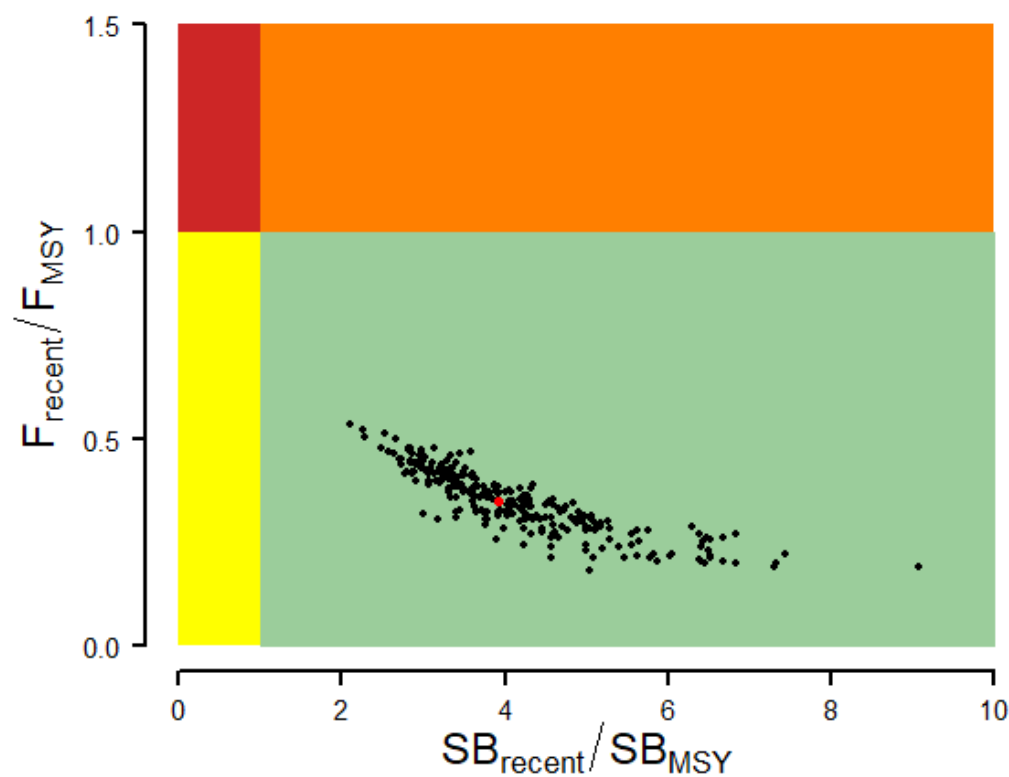
# Model ensemble

- Monte Carlo approach
  - bootstrap 1000 random samples using ensemble (271 models) means and standard deviations

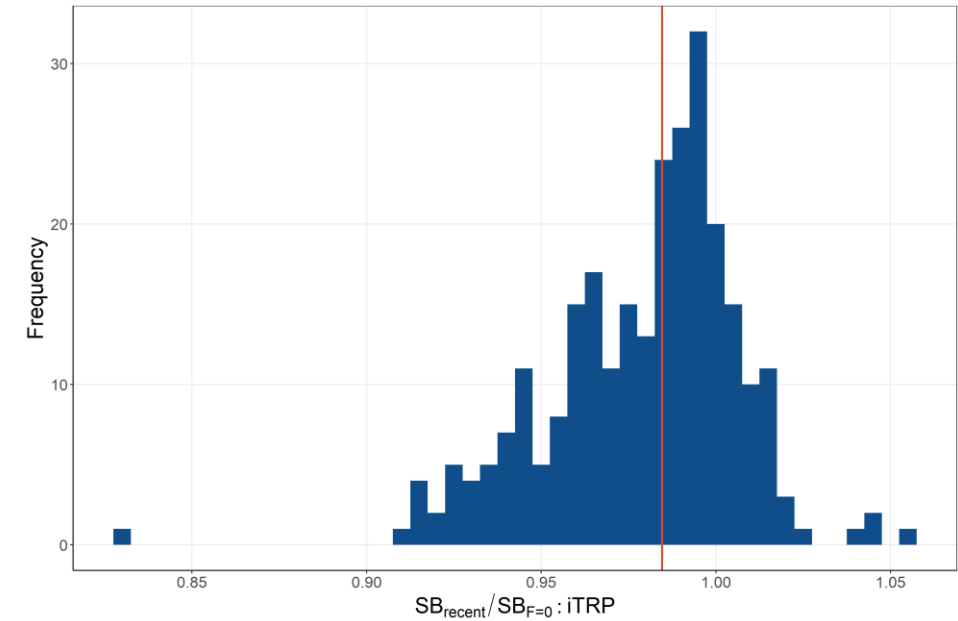
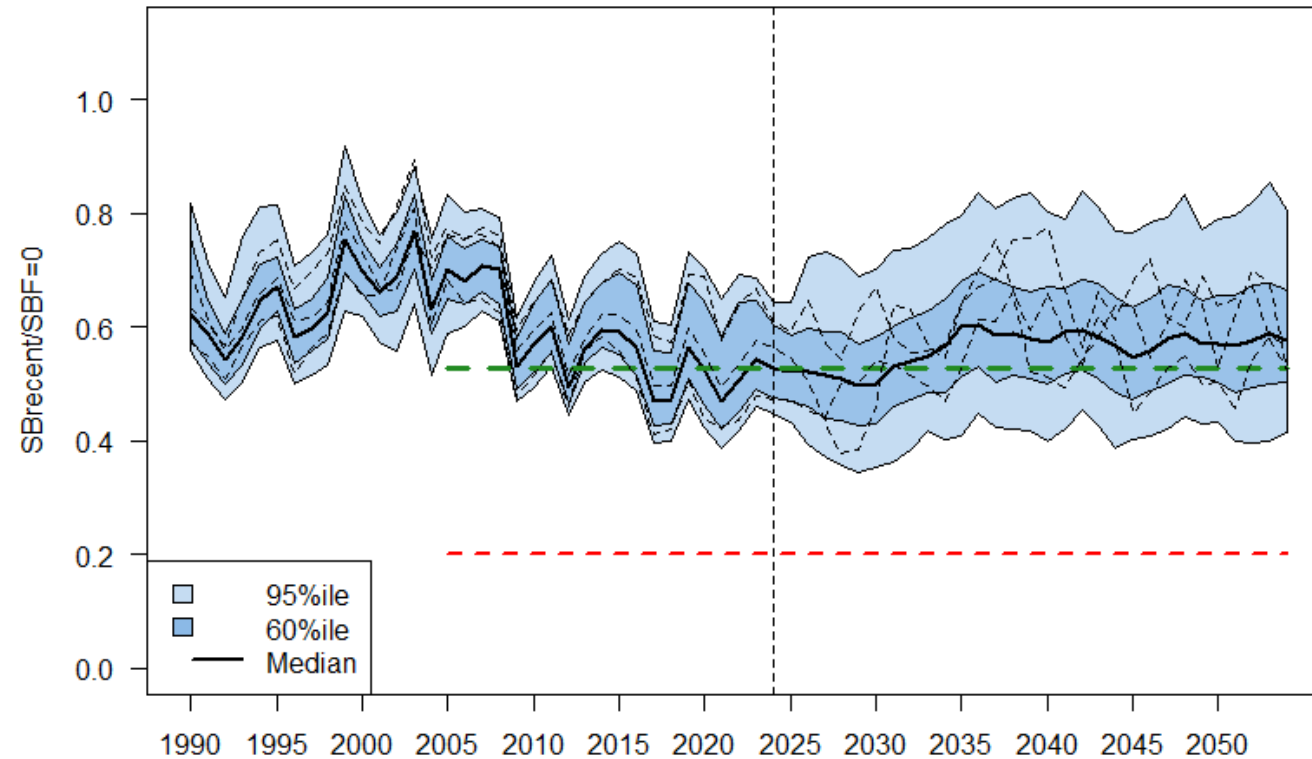


Blue line: median, Green line: mode

# Majuro and Kobe plots



# Projections and iTRP





# Management quantities

	Mean	Median	Min	10%	90%	Max
$F_{MSY}$	0.28	0.28	0.22	0.25	0.32	0.37
$f_{mult}$	3.01	2.85	1.88	2.25	4.12	5.42
$F_{recent}/F_{MSY}$	0.35	0.35	0.18	0.24	0.44	0.53
$MSY$	2,506,046	2,374,800	1,819,600	2,090,400	3,200,800	4,204,000
$SB_{latest}$	3,715,913	3,365,822	2,320,595	2,747,472	5,231,863	5,801,571
$SB_{recent}$	3,681,316	3,248,438	2,337,134	2,641,802	5,337,579	6,023,691
$SB_{F=0}$	6,844,279	6,466,725	5,102,043	5,753,337	8,444,739	9,440,668
$SB_{latest}/SB_{F=0}$	0.54	0.53	0.42	0.46	0.62	0.82
$SB_{latest}/SB_{MSY}$	4.17	3.91	2.24	3.07	5.62	8.92
$SB_{MSY}$	924,241	893,900	399,400	624,900	1,232,000	1,908,000
$SB_{MSY}/SB_{F=0}$	0.13	0.14	0.07	0.10	0.16	0.20
$SB_{recent}/SB_{F=0}$	0.53	0.51	0.40	0.45	0.63	0.68
$SB_{recent}/SB_{MSY}$	4.11	3.91	2.14	2.98	5.60	8.92
$Y_{F_{recent}}$	440,394	438,000	362,400	398,500	486,800	562,600
$20\%SB_{F=0}$	1,368,856	1,293,345	1,020,409	1,150,667	1,688,948	1,888,134
$SB_{recent}/SB_{F=0}: iTRP$	0.98	0.98	0.83	0.94	1.01	1.05
Including estimation uncertainty						
$F_{recent}/F_{MSY}$	0.35	0.35	0.16	0.24	0.45	0.59
$SB_{recent}/SB_{F=0}$	0.53	0.51	0.37	0.45	0.63	0.74
$SB_{recent}/SB_{MSY}$	4.11	3.90	1.92	2.95	5.61	10.73

- Median – 0.35  
 $F_{recent}/F_{MSY}$  (0.35 with estimation uncertainty)
  - Zero risk >  $F_{recent}/F_{MSY}$
- Median – 0.51  
 $SB_{recent}/SB_{F=0}$  (0.51 with estimation uncertainty)
  - Zero risk < 0.20  
 $SB_{recent}/SB_{F=0}$
- Median – 0.98  
 $SB_{recent}/SB_{F=0}: iTRP$

The stock is not overfished and overfishing is not occurring



# Recommendations

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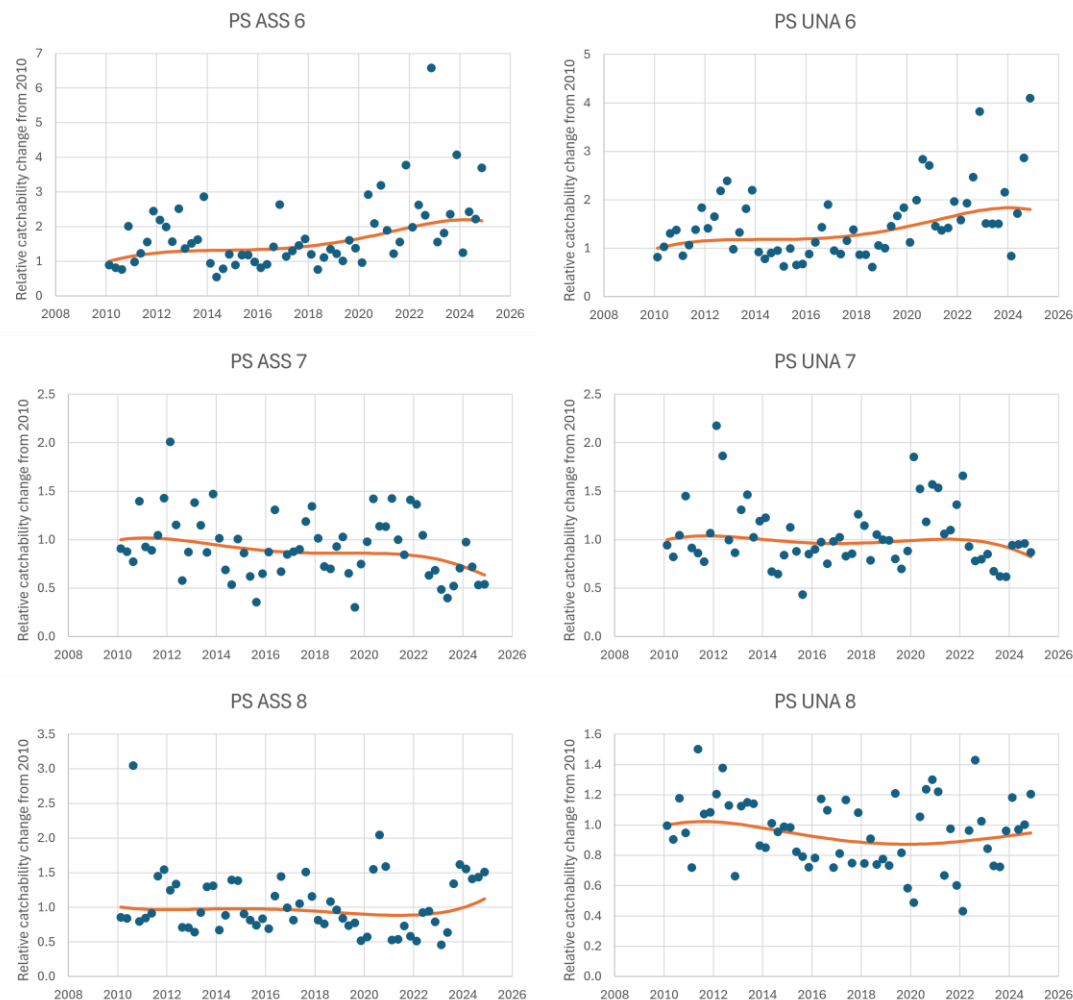
- Develop better information on growth and age structure (i.e., epigenetics)
- Develop better information on metapopulation, especially linkage between east Asian waters and WCPO
- Develop better information on tag mixing
  - Model tags as release conditioned in SEAPODYM
  - External tagging analysis
- Improve reporting rate priors
- Resolve data conflict (LF with CPUE and tag data) by improved filtering (collaboration between observer and port sampling programmes of CCMs)

# Questions

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# Catchability – PS



# MSY

