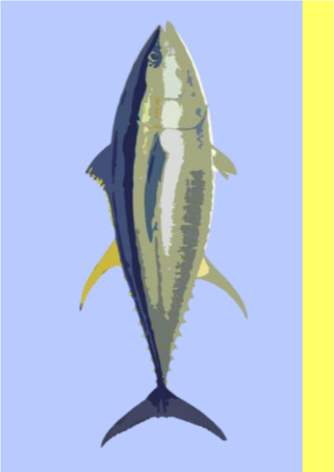
// NOAA Spatial Assessment Modeling Workshop - Wellington
March 5-7, 2023

Spatial stock assessment simulation experiment

Yellowfin tuna

ICES SS Team



FRANCISCO IZQUIERDO, GIANCARLO M. CORREA, MARTA COUSIDO, MARIA GRAZIA PENNINO & SANTIAGO CERVIÑO

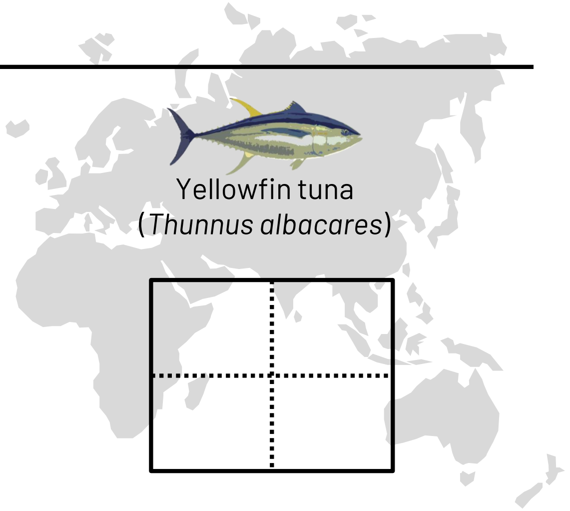
Team SS ICES

NOAA DATASETS

STOCK SYNTHESIS

1 Area
Stock assessment model

4 Areas
Spatial stock assessment model



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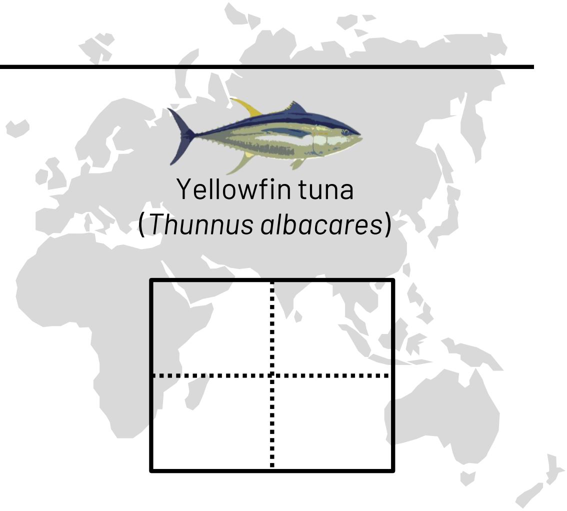


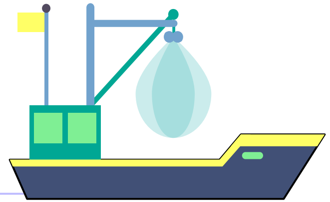
Pseudoyear vs **Year**

Fine-scale model configuration with all provided data (**0 to 28+ pseudoyears**, k seasonal dev., M each quarter ...)

Simplified model with parameter inputs that we would have in a real case (**0 to 7+ years**, k base, M at age ...)

Modeling approach

1. Data exploration
2. CPUE standardization
3. SS Parametrization
4. Final models & diagnostics
5. 100 assessment comparisons
6. Conclusions



2. CPUE standardization

Fishing and species distribution are dynamic processess correlated along space and time, so an autoregressive CPUE model may be adequate to take into account this spatiotemporal dependence structure

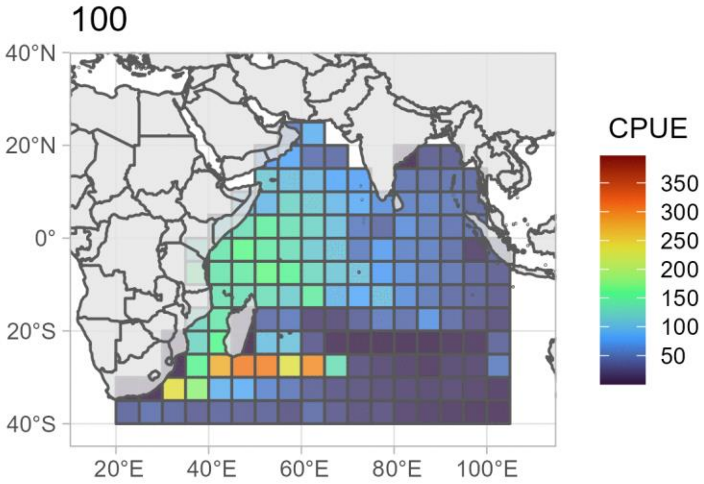
Besag spatiotemporal model via INLA

$$Z_{st} \sim \text{Gamma}\ (\mu_{st}, \phi)$$

$$\log(\mu_{st}) = \alpha + U_{st} + g(t)\ ;\ U_{st} = W_{st} + \rho\ U_{st\ -1},$$

$$W_{st} \sim N(0, \Sigma)\ \&\ g\ \text{RW2}$$

We construct a **spatial correlation** matrix (neighbour locations) and we add a **temporal AR1** process interaction



2. CPUE standardization

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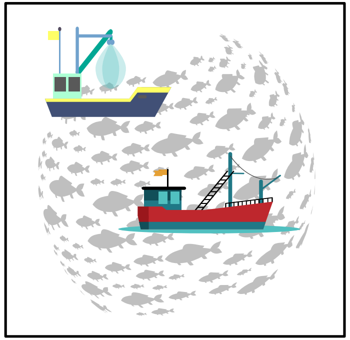
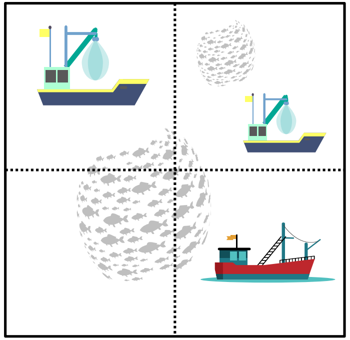
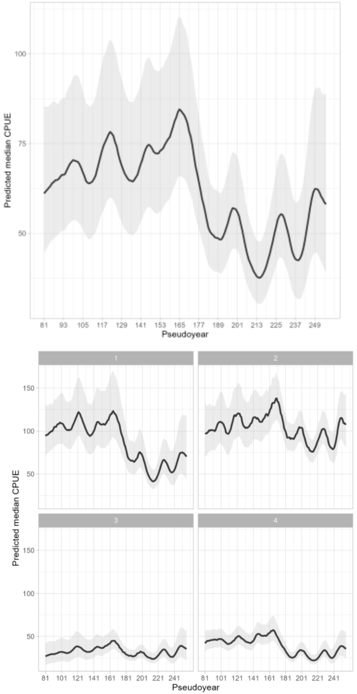


4 AREAS MODEL



CPUE st



Prediction step

Condition: the sum of the **4 area** CPUE indices values must result in the total **1 area** CPUE index

- We sum predicted values by grid cells what provides a **scaled** areal CPUE index
- This allowed us to set constant catchability Q parameters

3. SS Parametrization

Pseudoyear

Biology: Values each pseudoyear as provided in the experiment

Spawner-recruit: All parameter fixed unless R0

Growth: All parameter fixed as provided.

Recruits: Recruitment settlements in each pseudoyear

Year

Natural mortality (M) summed across seasons for each age. **Maturity** values averaged across seasons for each age

All parameter fixed unless R0

All parameter fixed as provided unless the **single k value** (0.45) used

Recruitment **settlements** tried in different months of the year (1,4,7 and 10)

3. SS Parametrization

1 Area — Modeling steps

01 Input data

Input Catch, LFD (N25)

Assumption 1: standardized CPUE

02 Selectivity

Selex at length (year)

Selex at age (pseudoyear)

All fleets DN unless LL (logistic)

03 Recruitment deviations

Recdevs advanced options

suggested from SS

Main period starting in 1970

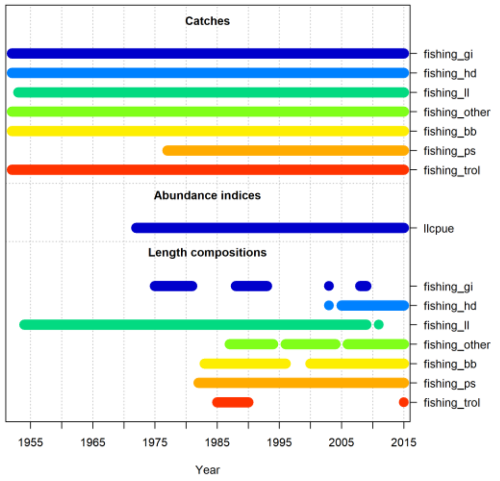
04 Tagging

Estimating reporting rate only for PS

Fixed parameters from report:

Init. tag loss (10%) & Tag loss chronic (3%)

Assumption 2: Mixing latency period (3)



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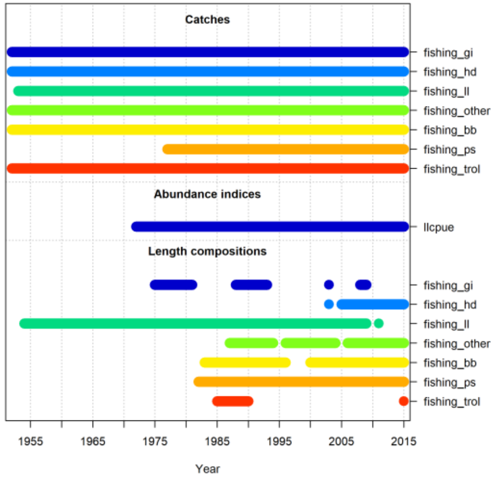

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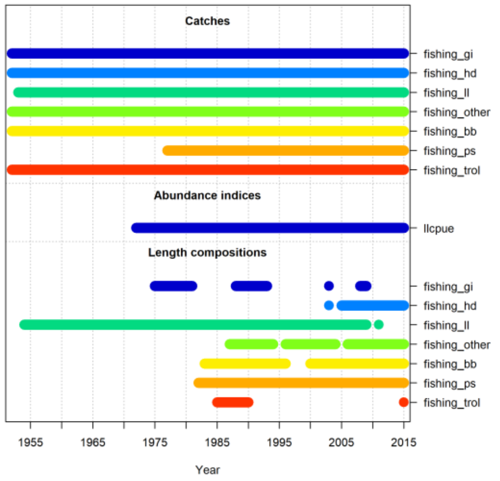

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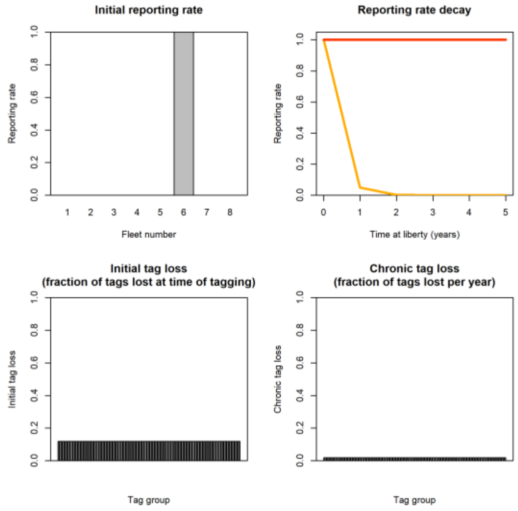

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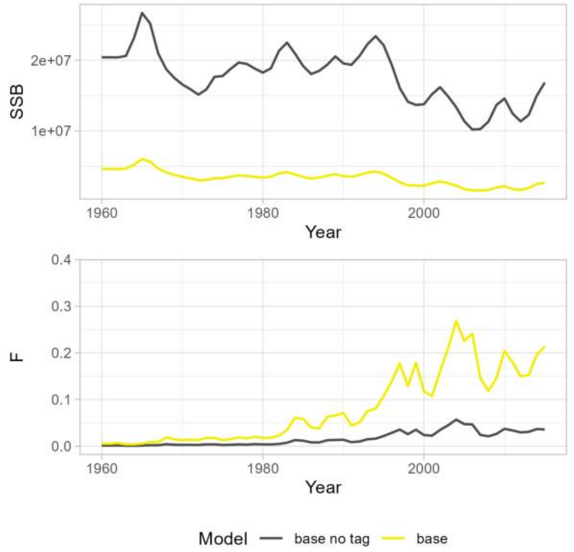

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4 Areas **Modeling steps**

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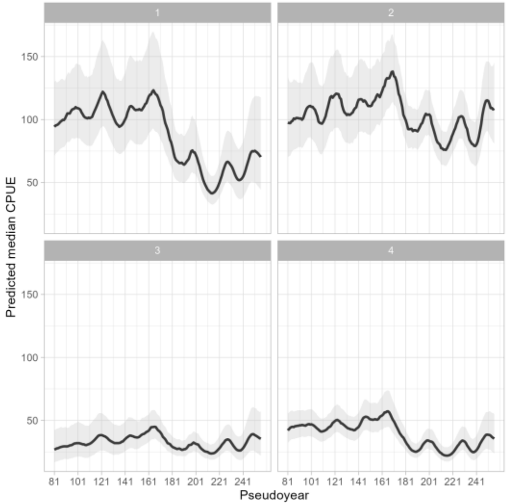
03 **Recruitment settlements**

Recdevs same than 1A
First, we estimated recruitment in all areas (no time-varying)



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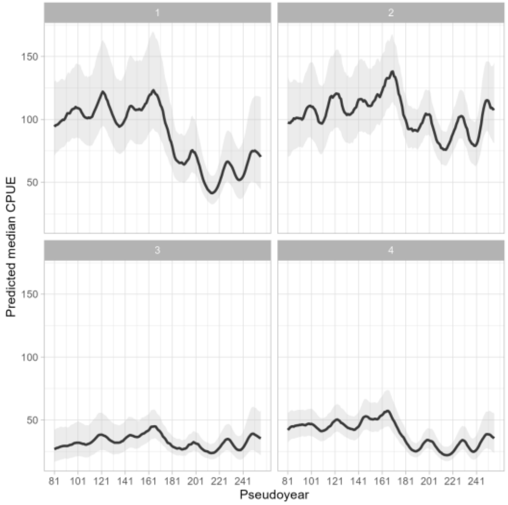

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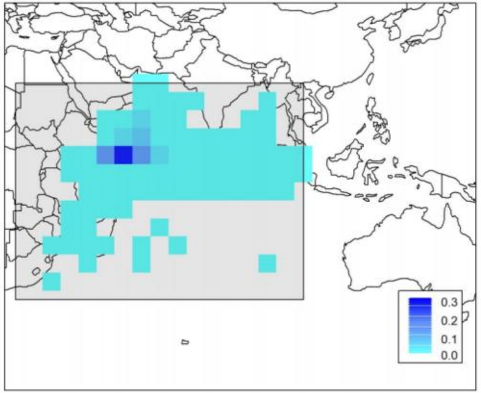

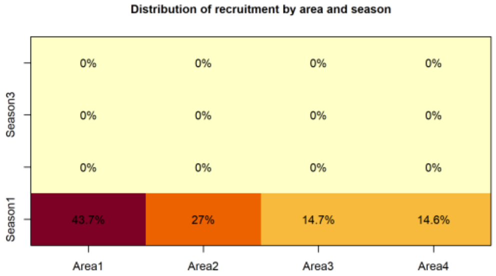

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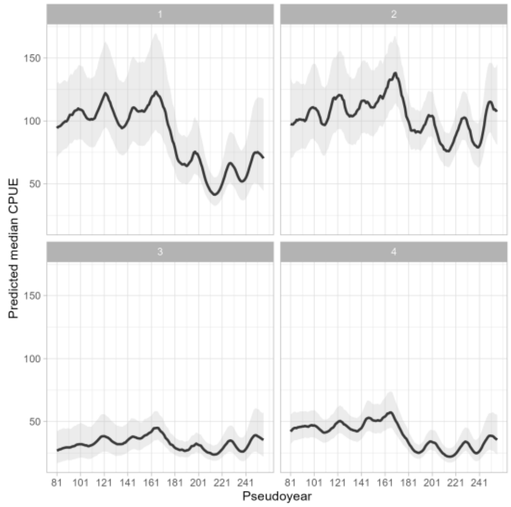

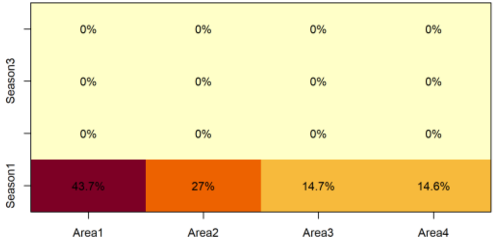

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04 **Tagging**

Once recruitment in all areas, include tag (same settings than 1A)

05 **Movement**

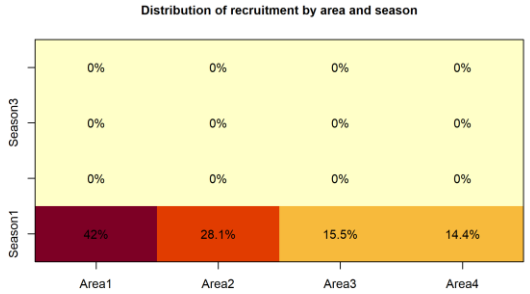
Define movement. Different options tested (no difference).

Assumption 4: areas 3-4 similar in terms of CPUE,and Chl.a maps

06 **Recruitment settlements**

Assumption 5: recruitment apportionment by area may not be constant along time

Assumption 6: there is no recruitment in area 3, based on articles and Chl.a maps



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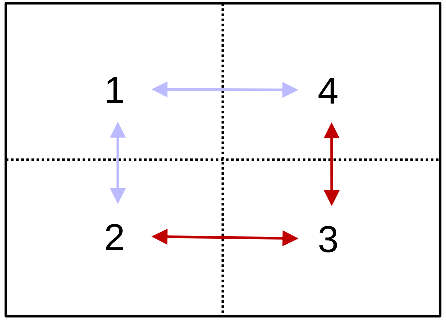

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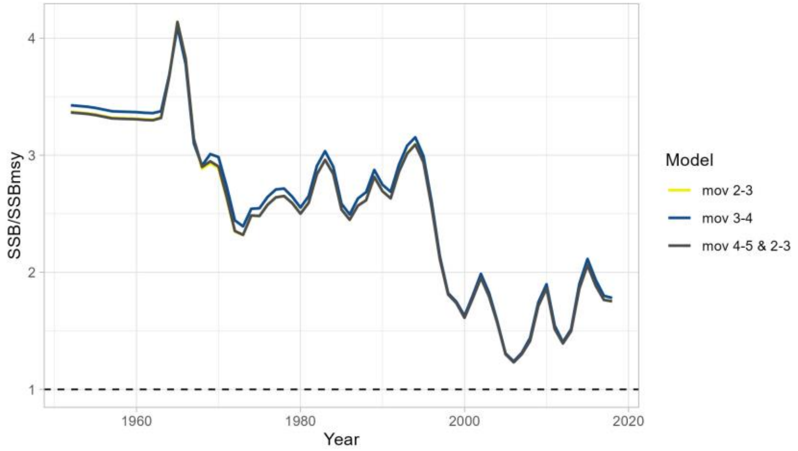

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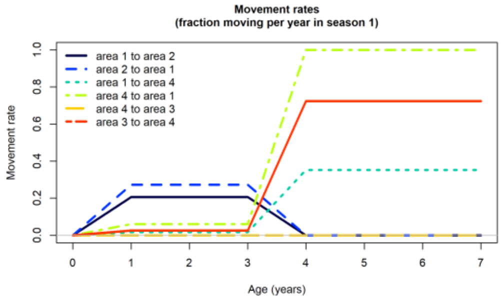
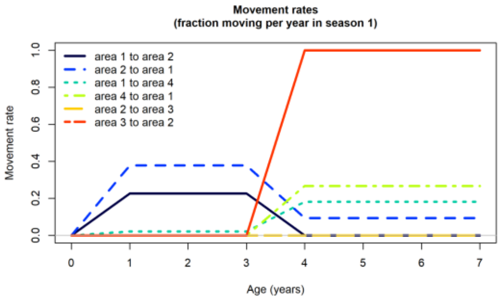


4-3



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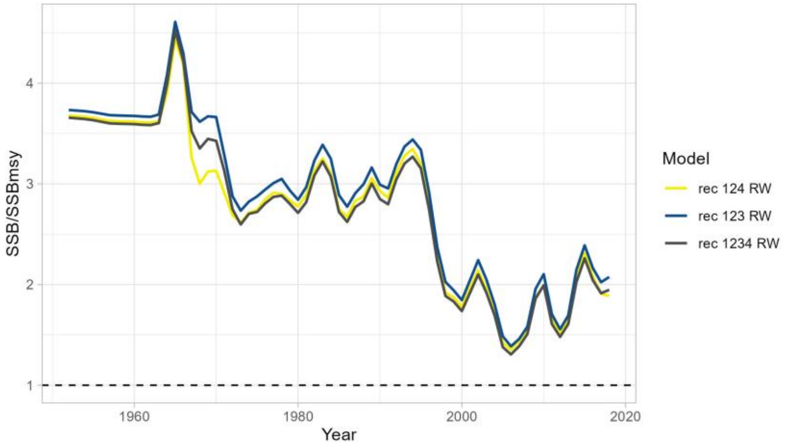

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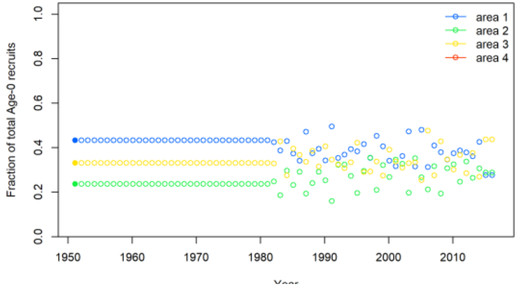
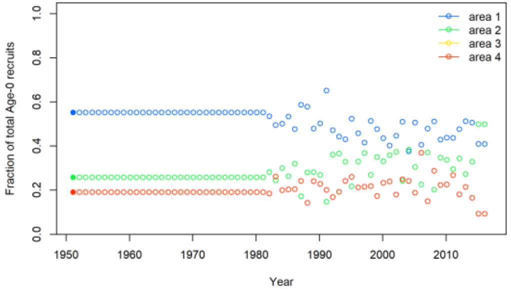


1,2,3

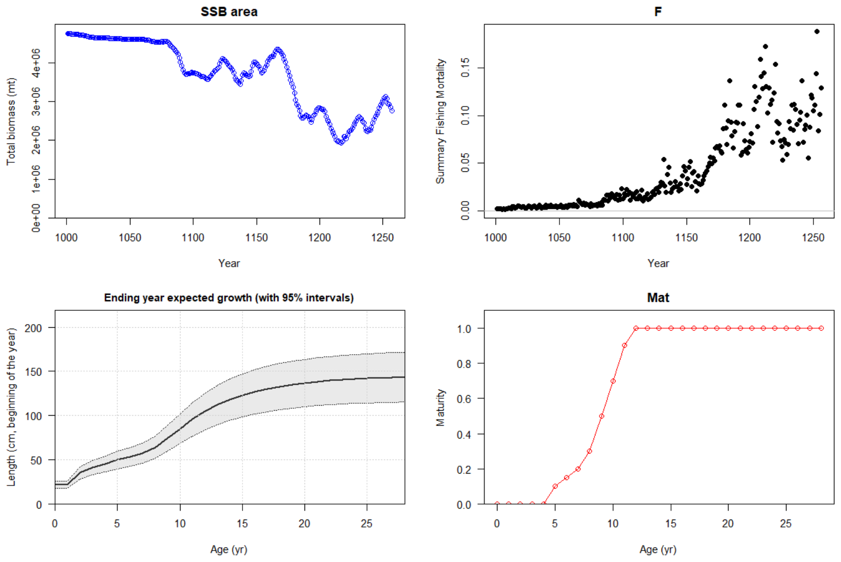


1,2,4

4. Final models and diagnostics

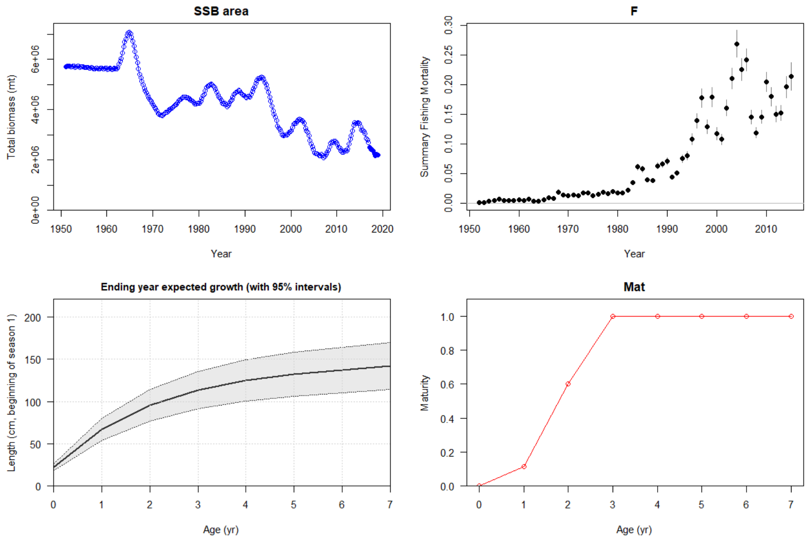
1 Area

Pseudoyear



Fine-scale model configuration (biology, growth, etc.). Recruitment each pseudoyear

Year



Simpler model configuration (biology, growth, etc.).Recruitment in each season of the year

4. Final models and diagnostics

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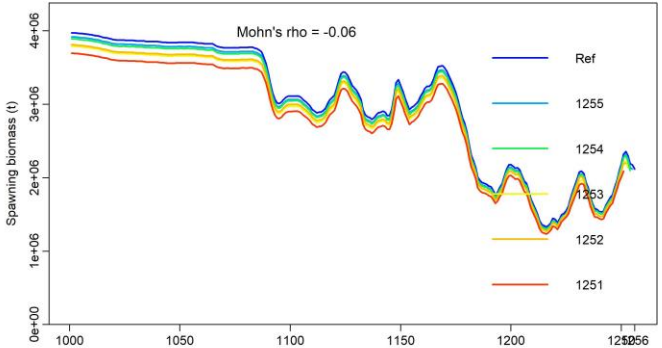

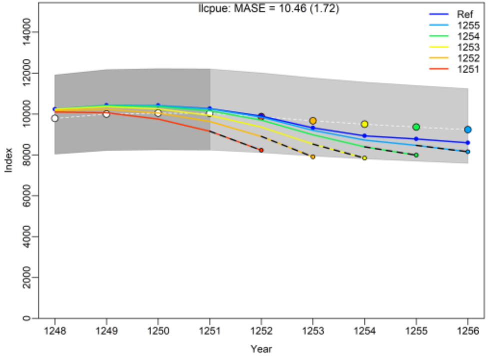

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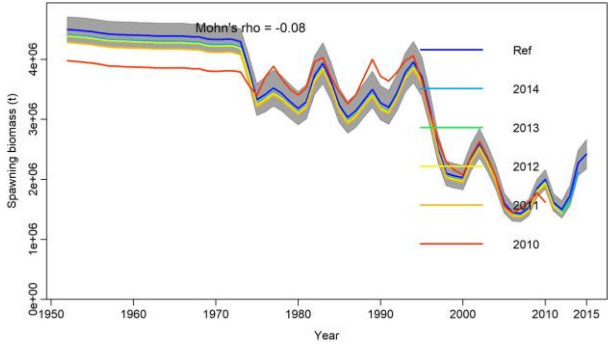

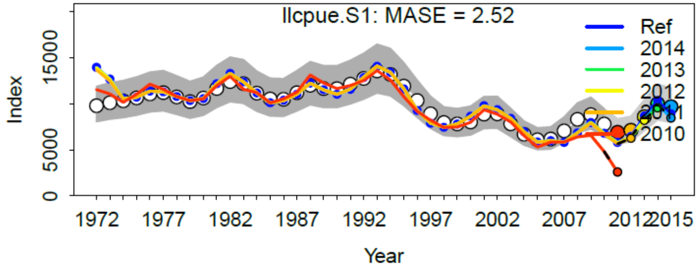

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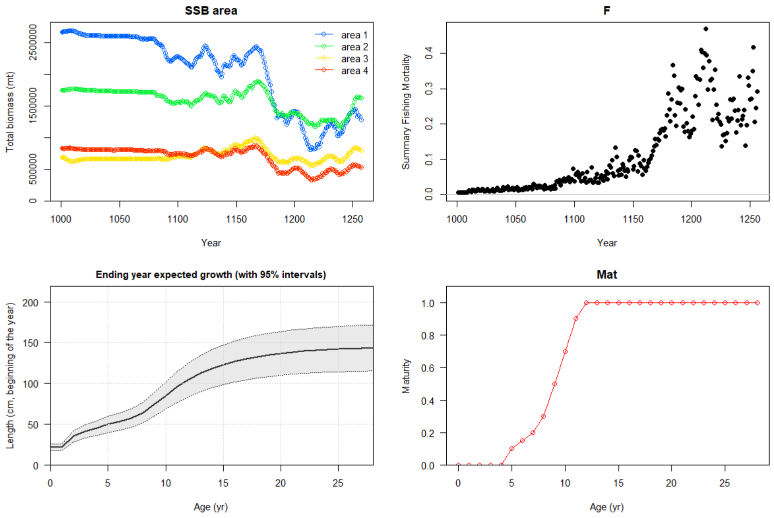
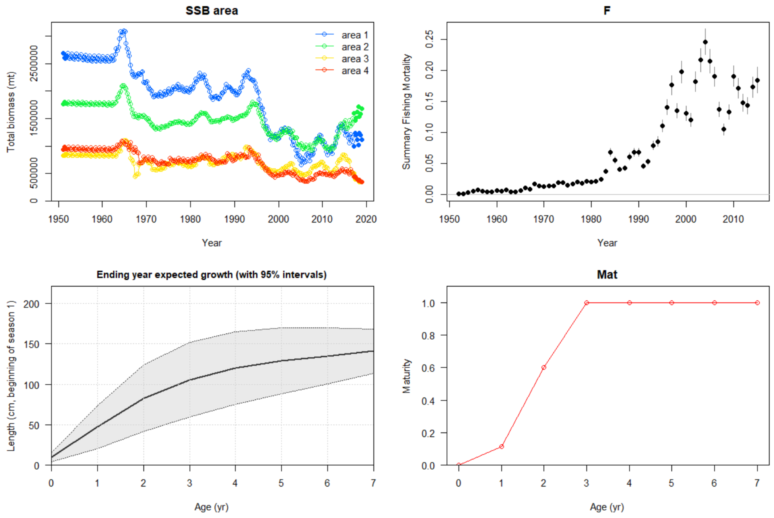


Fine-scale model configuration (biology, growth, etc.). Recruitment settlements RW (areas 1,2,4) in each pseudoyear

Year

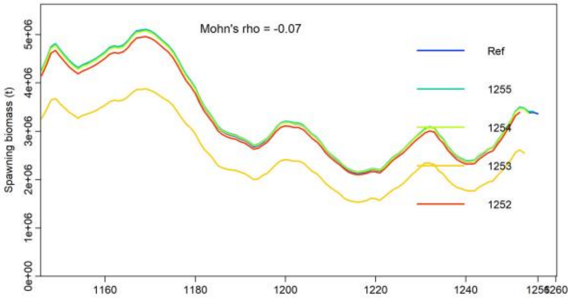


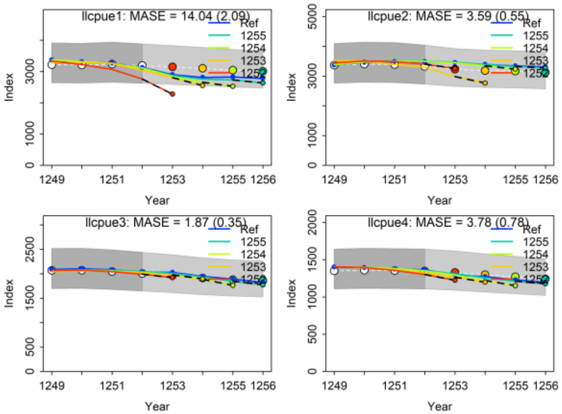
Simpler model configuration (biology, growth, etc.).Recruitment settlements RW areas (1,2,4) in the first season of each year

4. Final models and diagnostics

4 Areas

Pseudoyear





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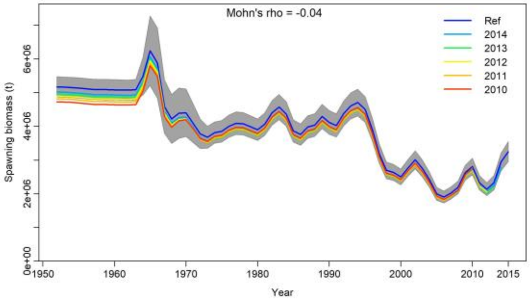
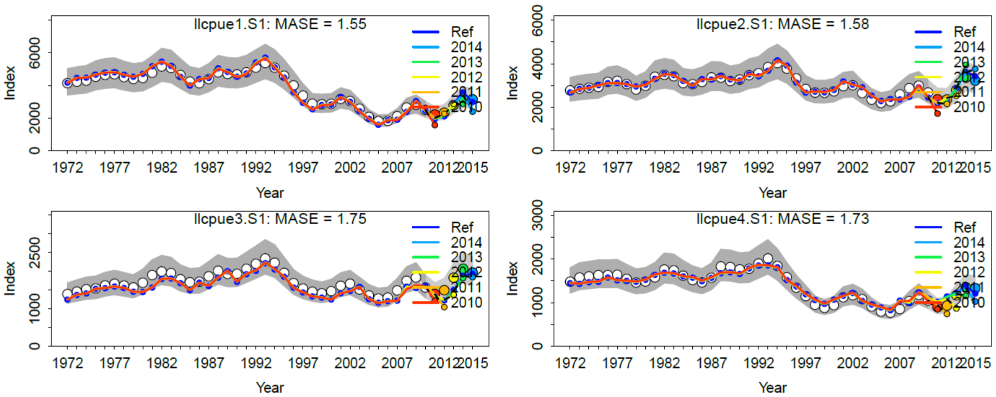




5. 100 Assessment comparisons

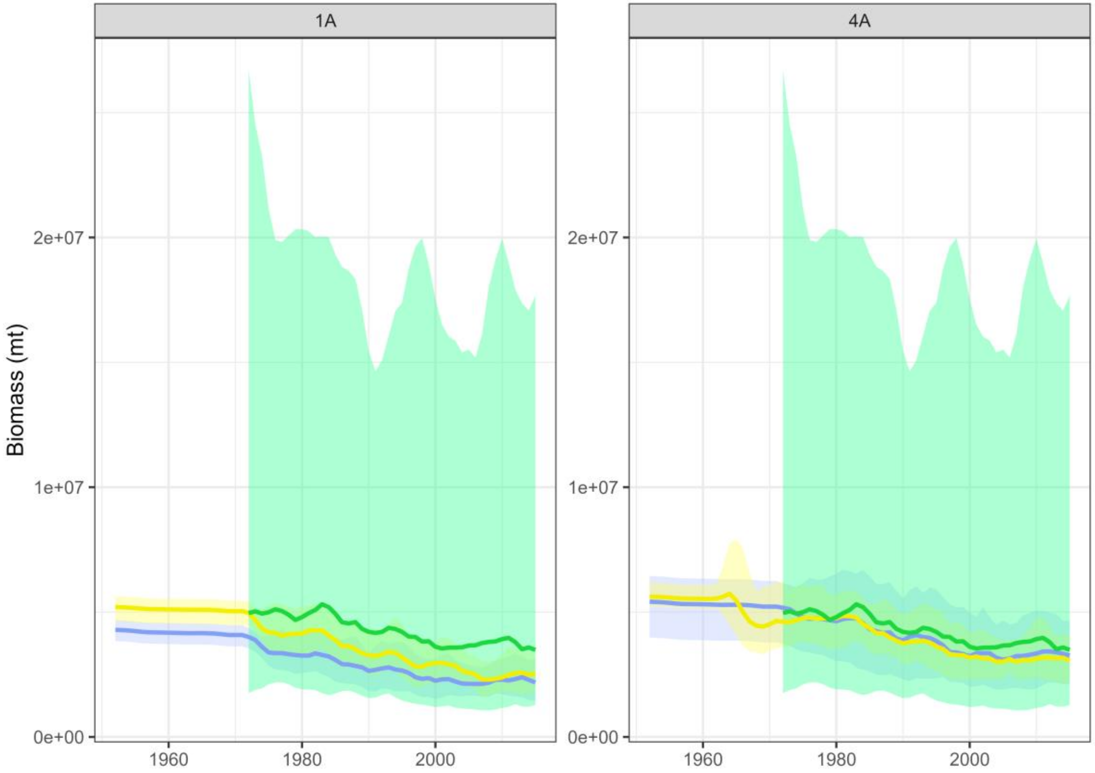
Pseudoyear

vs

Year

vs

SPiCT



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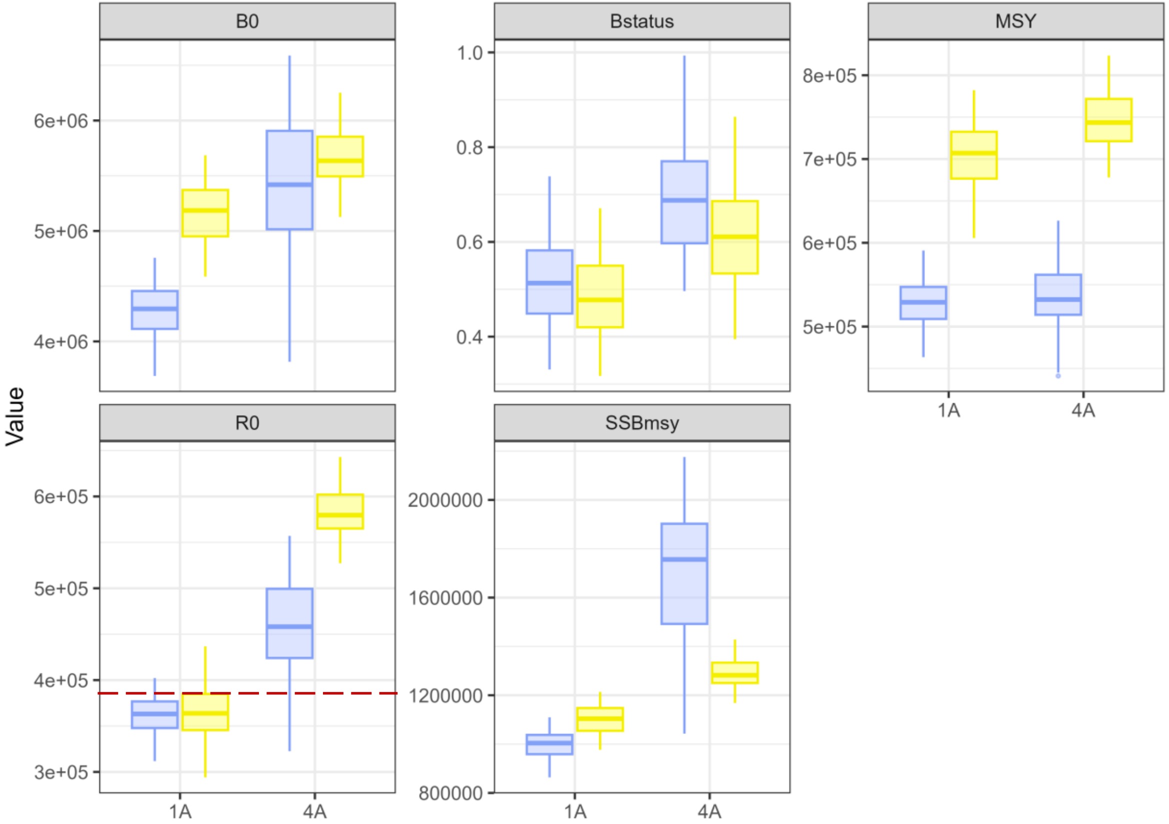

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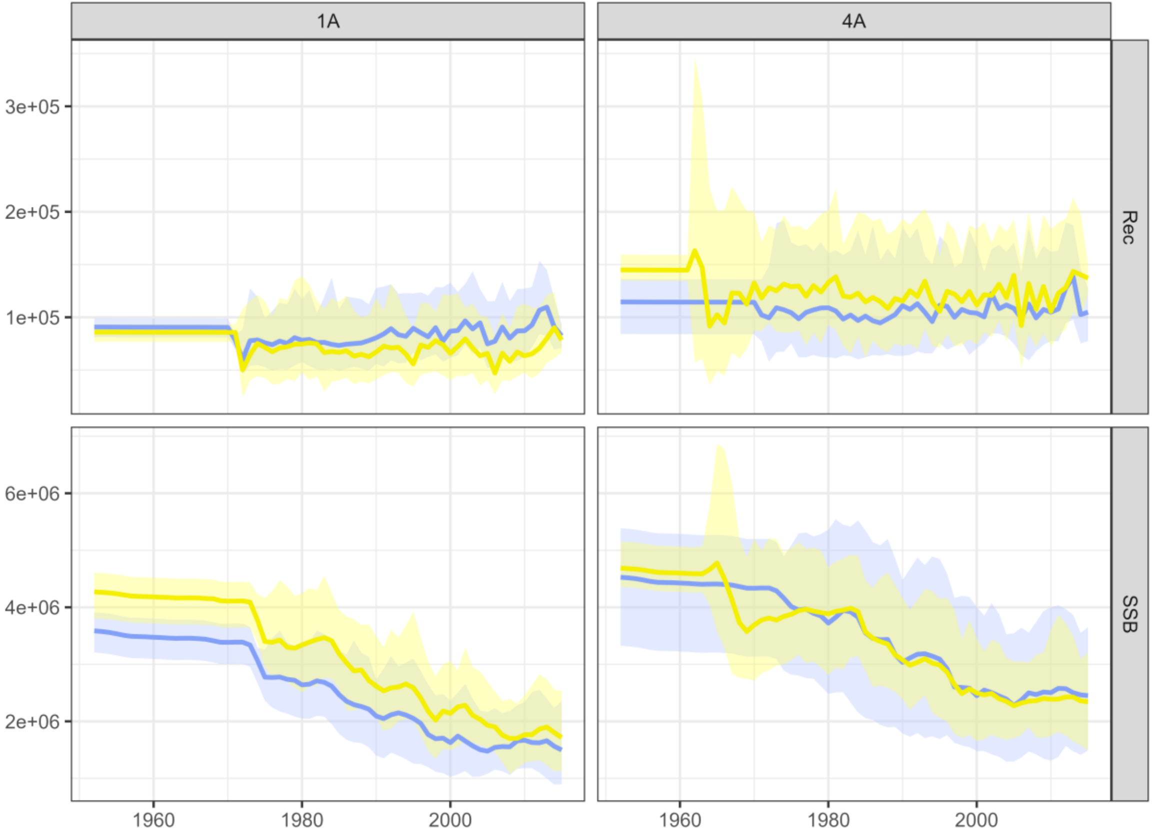

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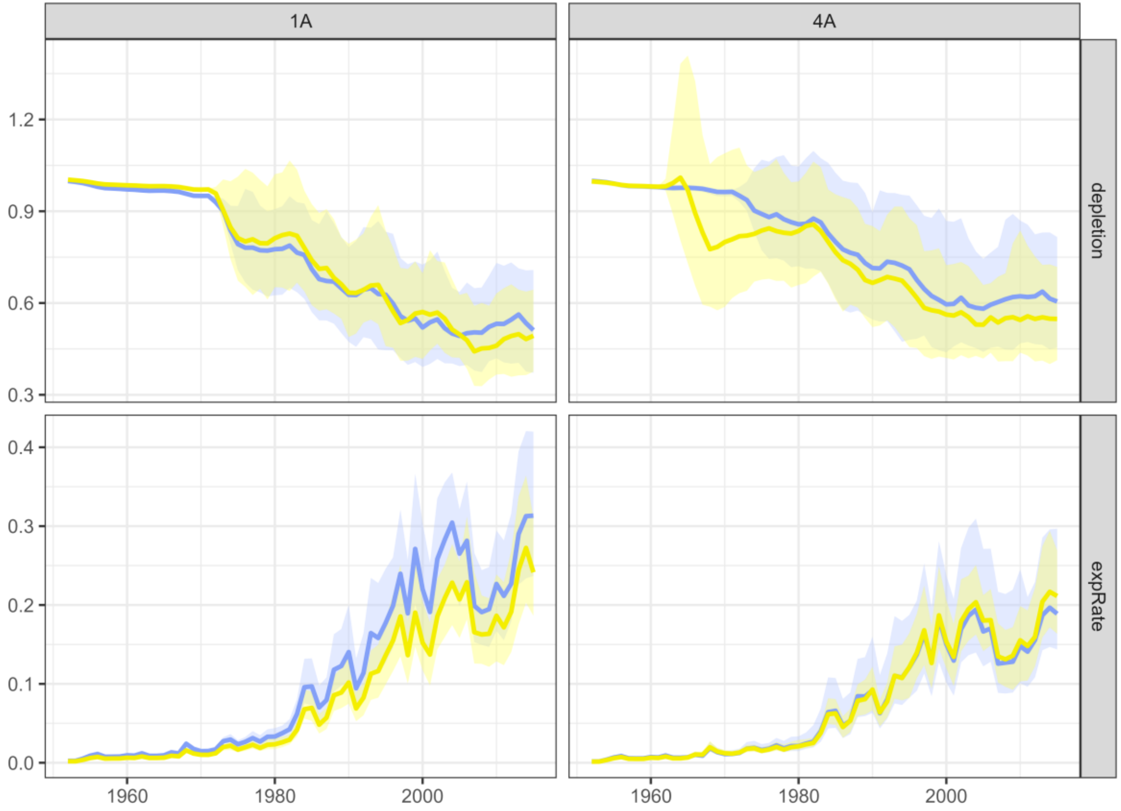
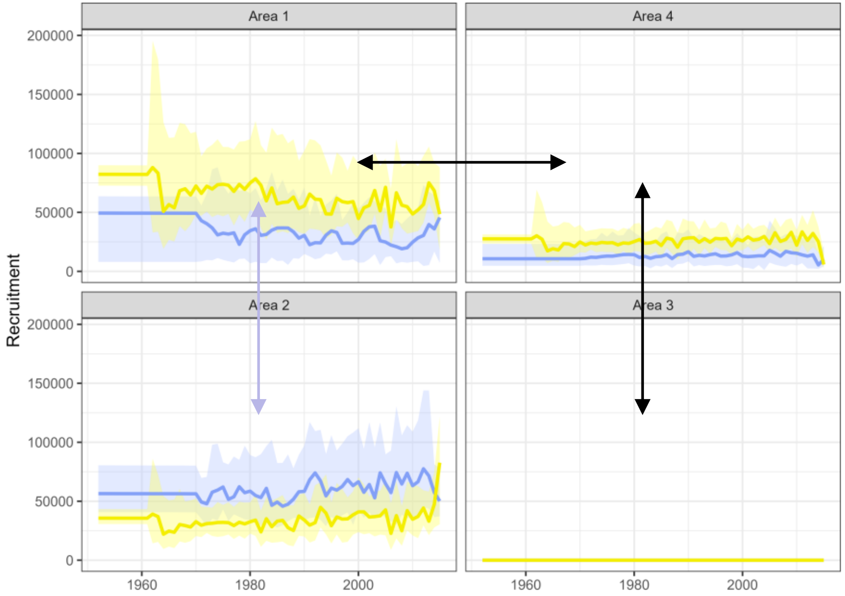


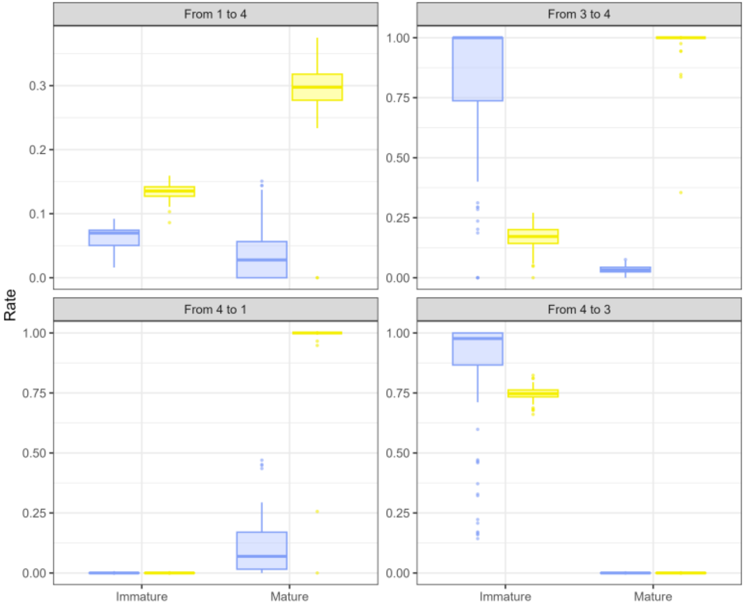
5. 100 Assessment comparisons

MODEL	CV_SSB	CV_Rec	CV_expRate	Conv. rate
1A_25_PY	0.1377	0.1552	0.1250	0.95
1A_25_Y	0.1262	0.2002	0.1152	0.83
4A_25_PY	0.1989	0.2016	0.2057	0.7
4A_25_Y	0.1403	0.2222	0.1302	0.99

5. 100 Assessment comparisons

Pseudoyear vs **Year**





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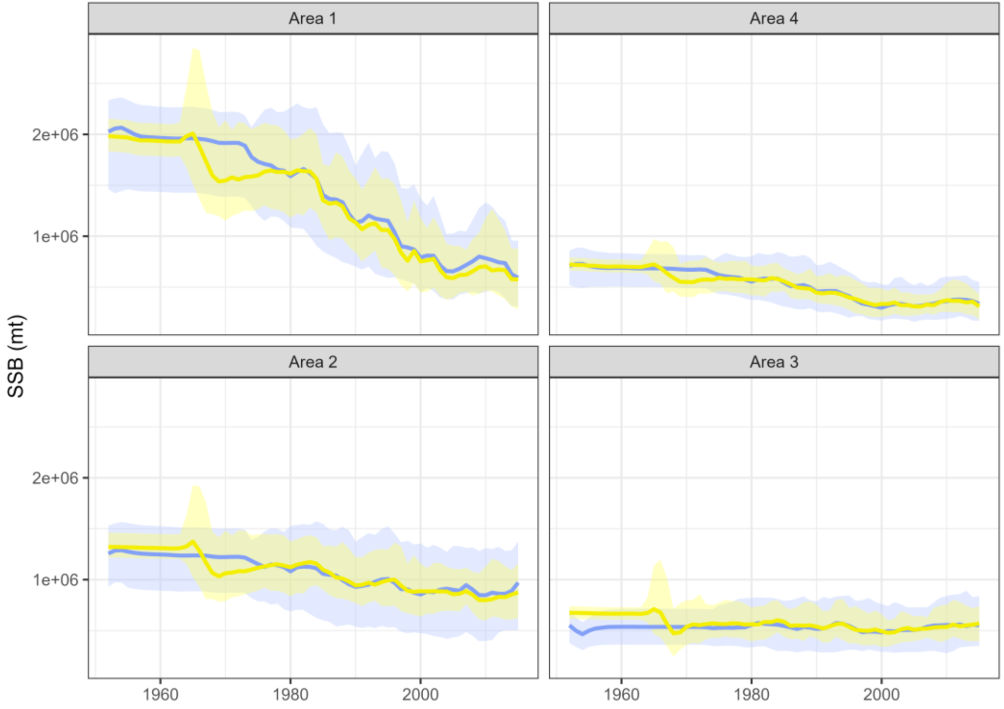

6. Conclusions

- ✓ Importance of standardizing the CPUE to take into account the spatiotemporal structure and make catchability parameters comparable among areas
- ✓ Need for studies in order to configure the spatial movement and recruitment areas
- ✓ In general terms, there were no large differences between the fine-scale configuration (pseudoyear) and the simplified configuration (year), so the decision must be based on the species available information
- ✓ Importance of a spatially explicit model for management
- ✓ Balance between model complexity and computational costs
- ✓ Identification of informative data for movement and recruitment

THANKS!

Do you have any questions?

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https://github.com/FranIzquierdo/NOAA-YFT-workshop-IEO-team
https://github.com/gmoroncorrea/SpatialStockAssessment_SpanishGroup
https://github.com/aaronmberger-nwfsc/Spatial-Assessment-Modeling-Workshop