SKIPJACK TUNA IN THE EASTERN PACIFIC OCEAN, 2021: INTERIM ASSESSMENT

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1st External Review of IATTC staff's stock assessment of skipjack tuna in the eastern Pacific Ocean
07-10 November 2022 – La Jolla CA, USA

Outline

- Motivation
- Stock assessment
  - Data
  - Reference model assumptions
  - Sensitivity analyses
- Results
  - Reference model
  - Sensitivity analyses
  - Stock status
- Future research

Motivation

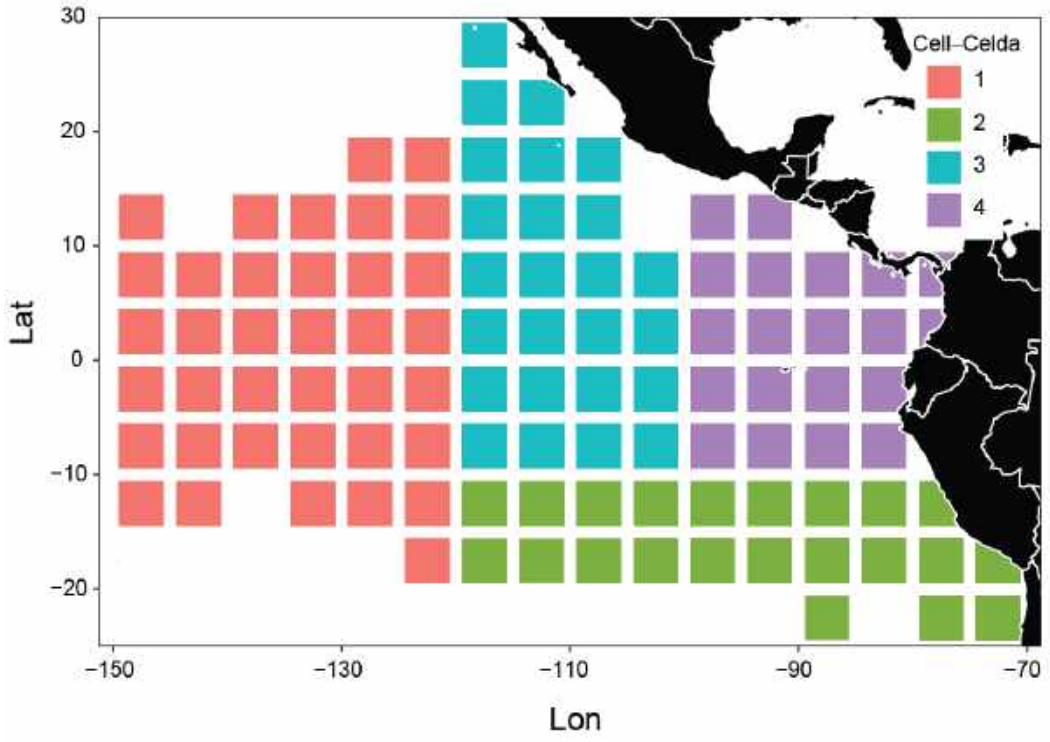
- No reliable assessment for SKJ
  - Unknown if purse seine index is proportional to abundance
  - Unknown if purse seine selectivity is dome shape
  - No reliable aging data
- SPC uses longline data for skipjack
  - Provides estimates of dome shape selectivity
  - Possible index of abundance
- Echosounder buoy index
- Can do assessment without absolute age
  - New tagging data to estimate growth

Data

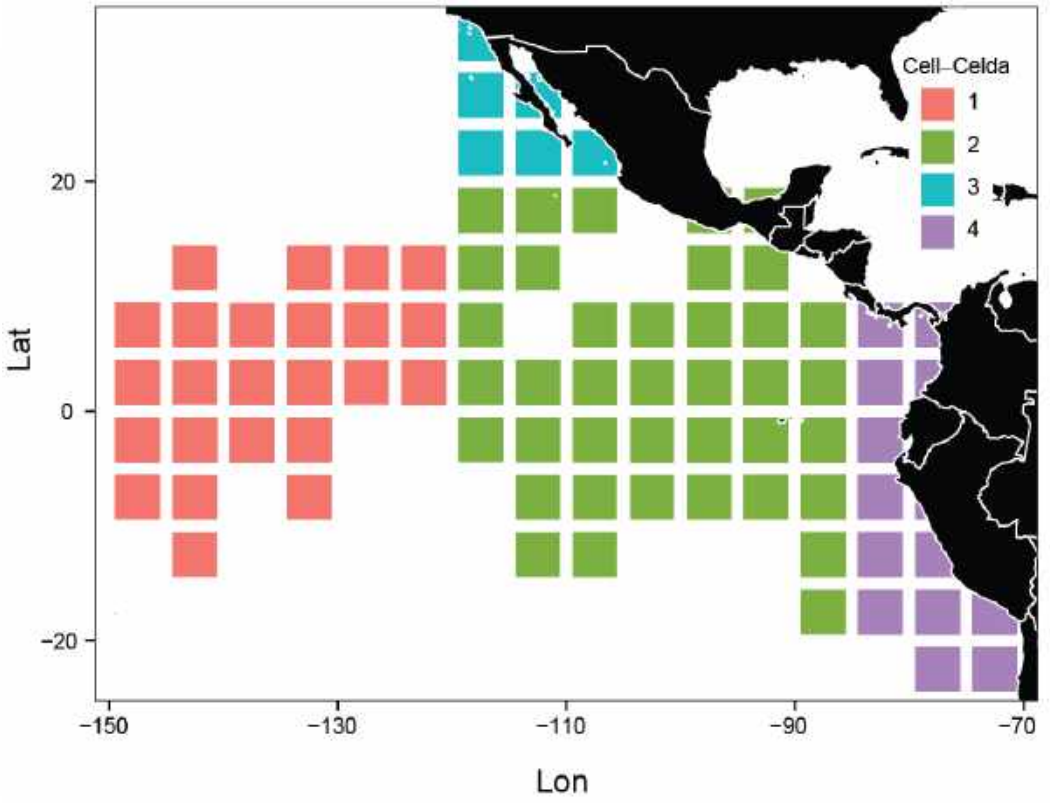
- Catch
  - Assumed known precisely
- Length composition
- Indices of abundance
  - Longline catch in numbers per hook
  - Echosounder buoy index
  - OBJ standardized catch per set (not used in reference model)
  - OBJ standardized catch per set (not used in reference model)

Fishery definitions

OBJ



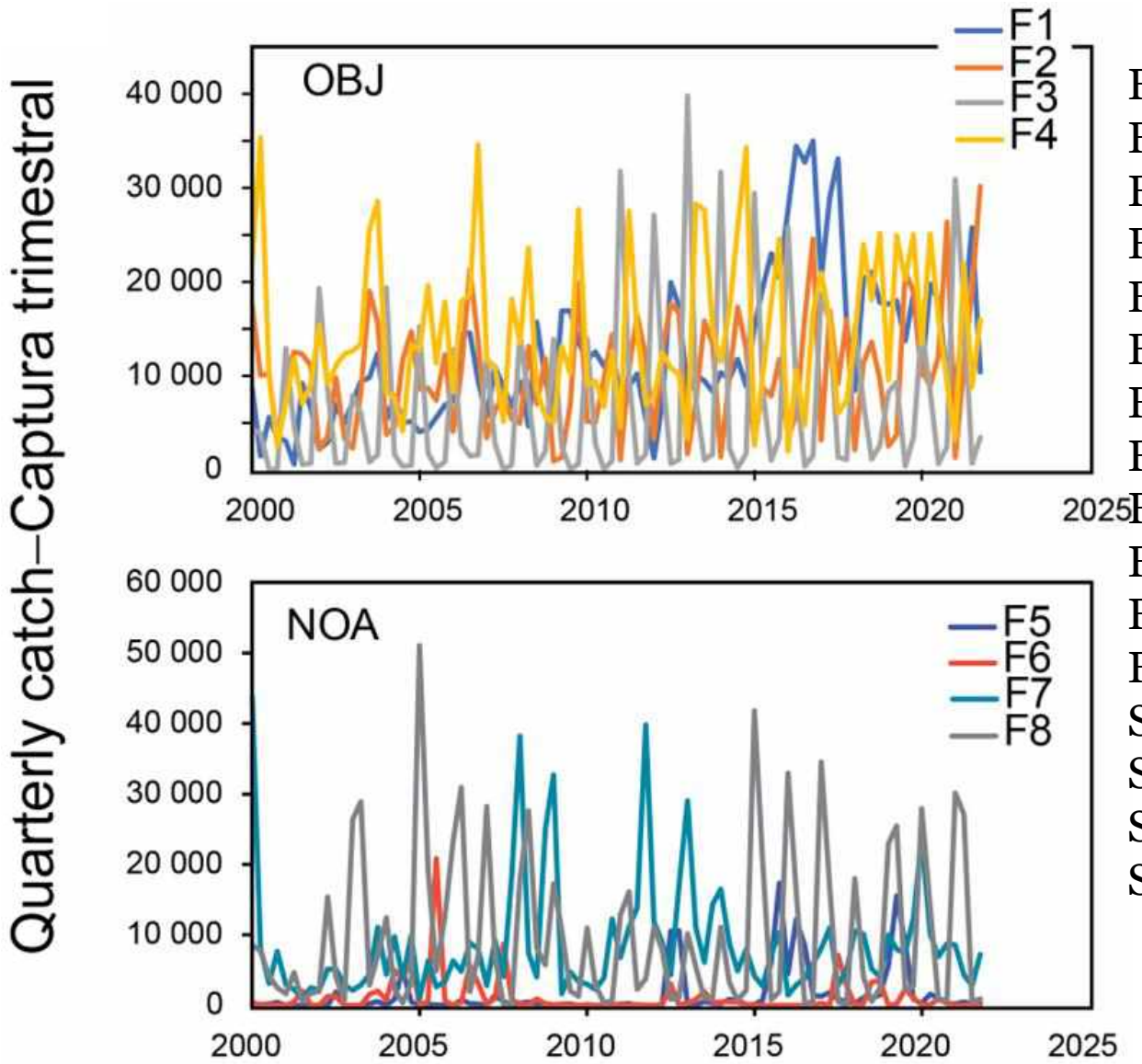
NOA



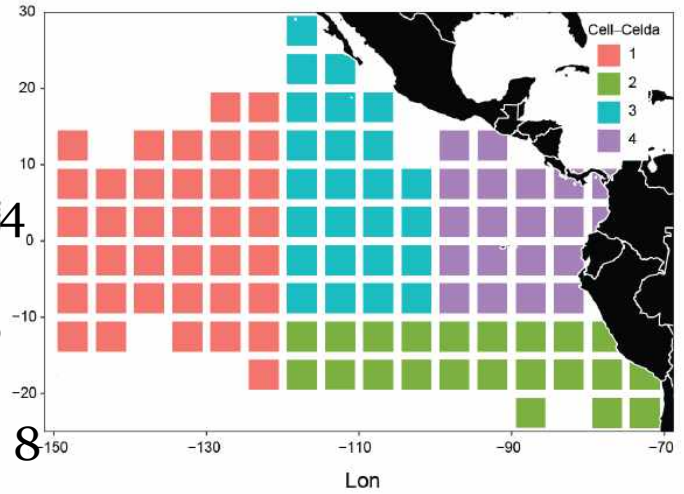
DEL – North and south of the equator

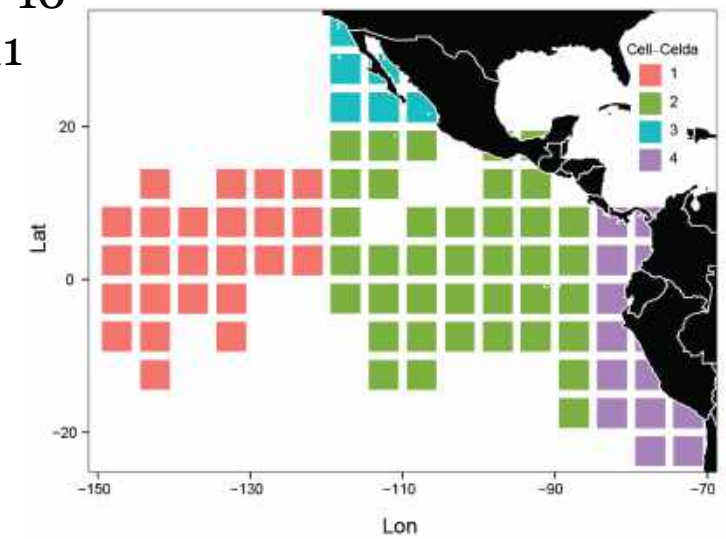
LL – Whole EPO

Catch

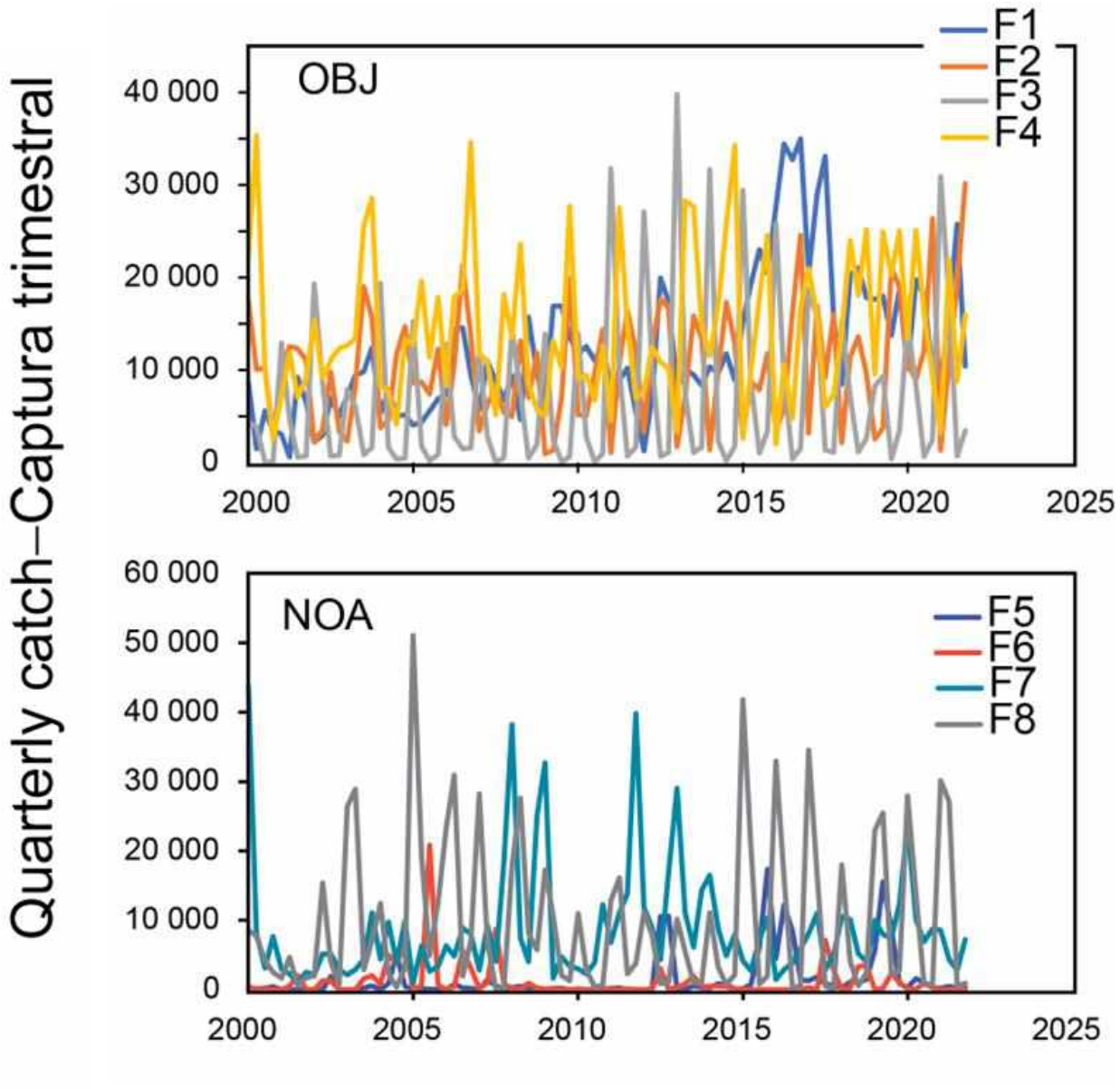


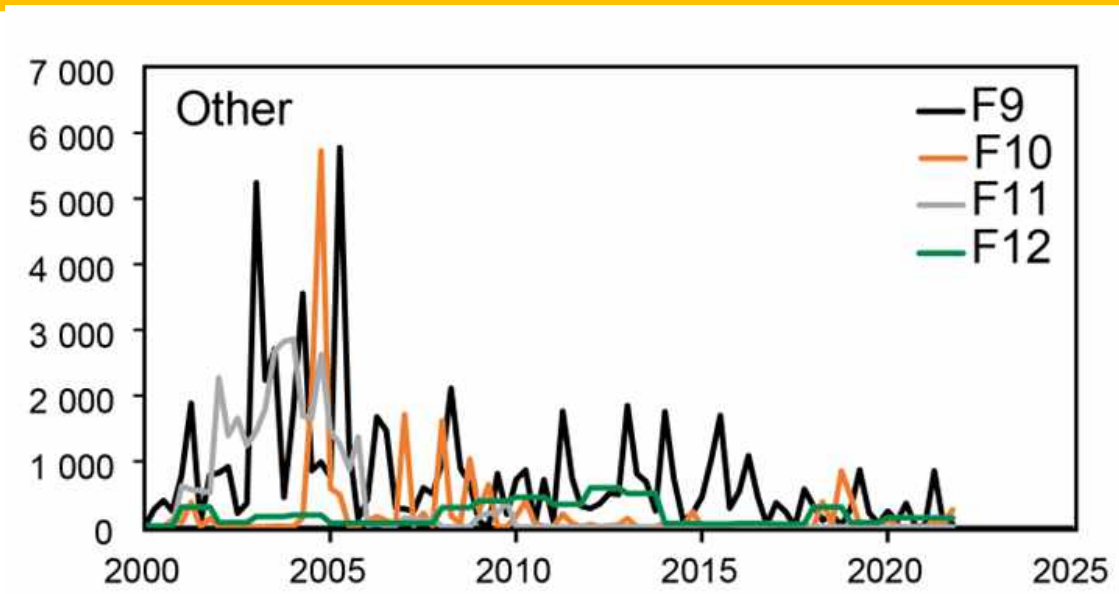
F1-OBJ_OS # 1
F2-OBJ_Nth # 2
F3-OBJ_Sth # 3
F4-OBJ_Coast # 4
F5-NOA_OS # 5
F6-NOA_Nth # 6
F7-NOA_Cnt # 7
F8-NOA_Coast # 8
F9-DEL_Nth # 9
F10-DEL_Sth # 10
F11-DISsmall #11
F12-LL # 12
S1-OBJ # 13
S2-NOA # 14
S3-ECHO # 15
S4-LL # 16





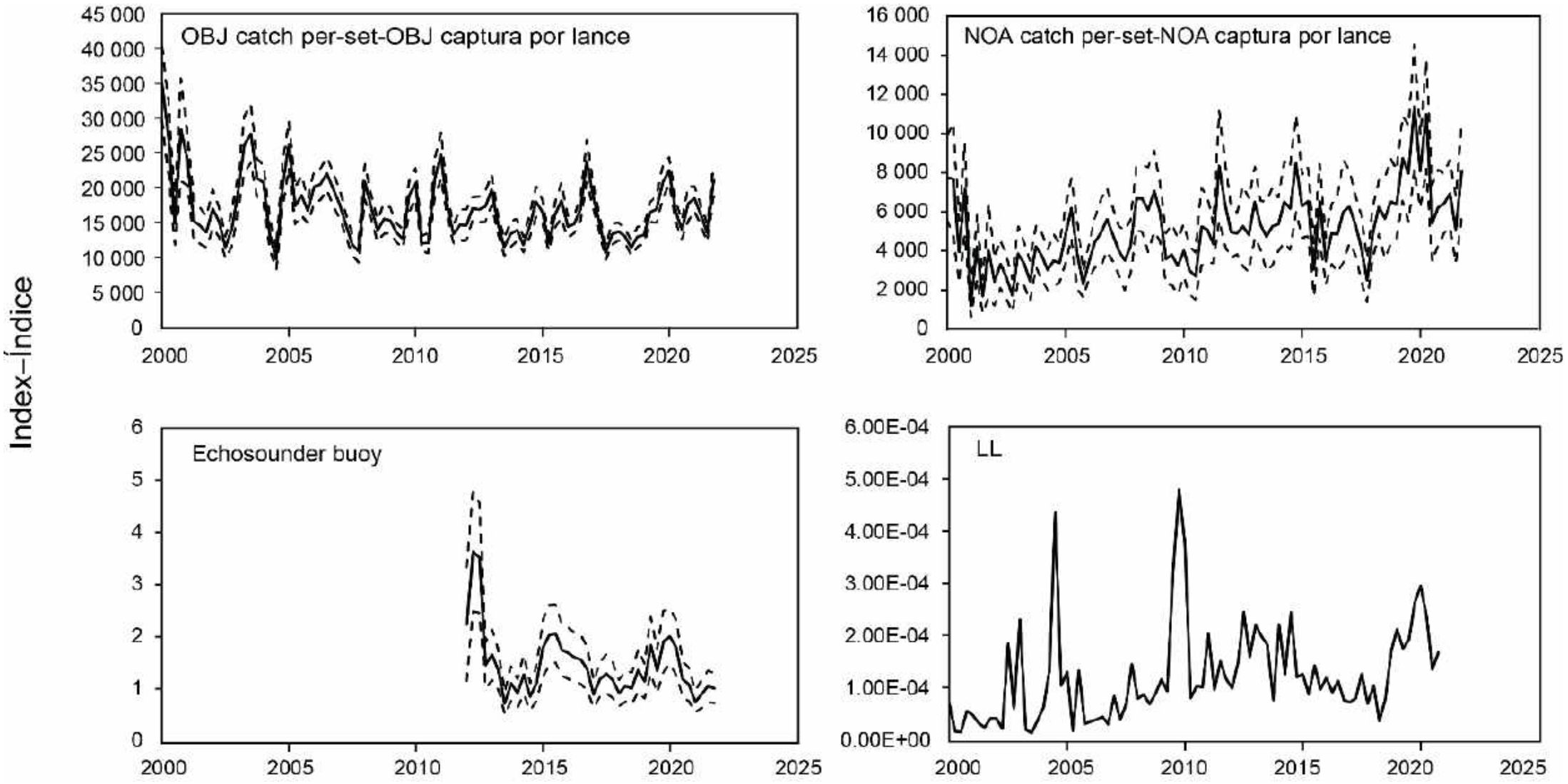
Catch



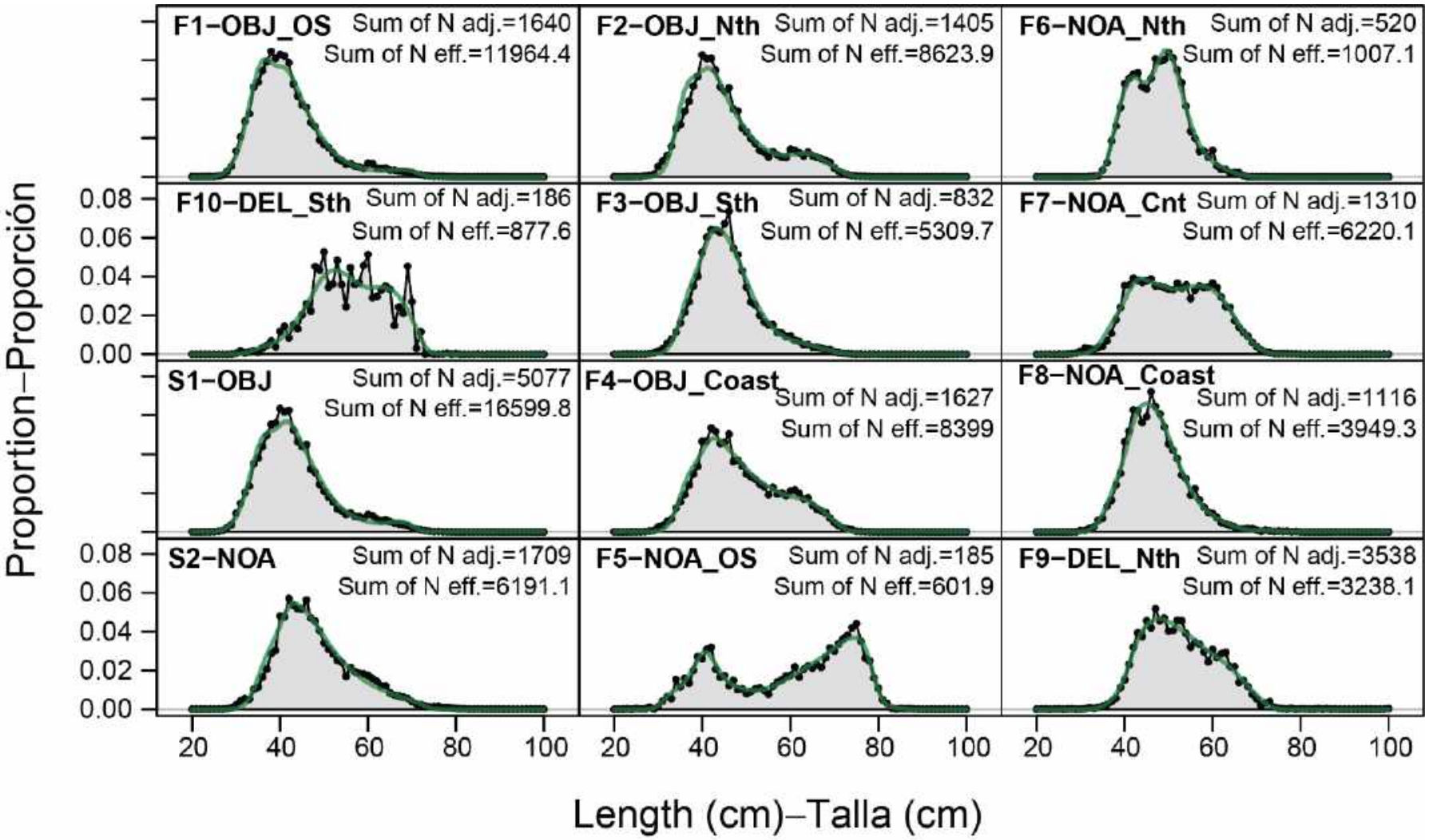


F9-DEL_Nth
F10-DEL_Sth
F11-DISsmall
F12-LL

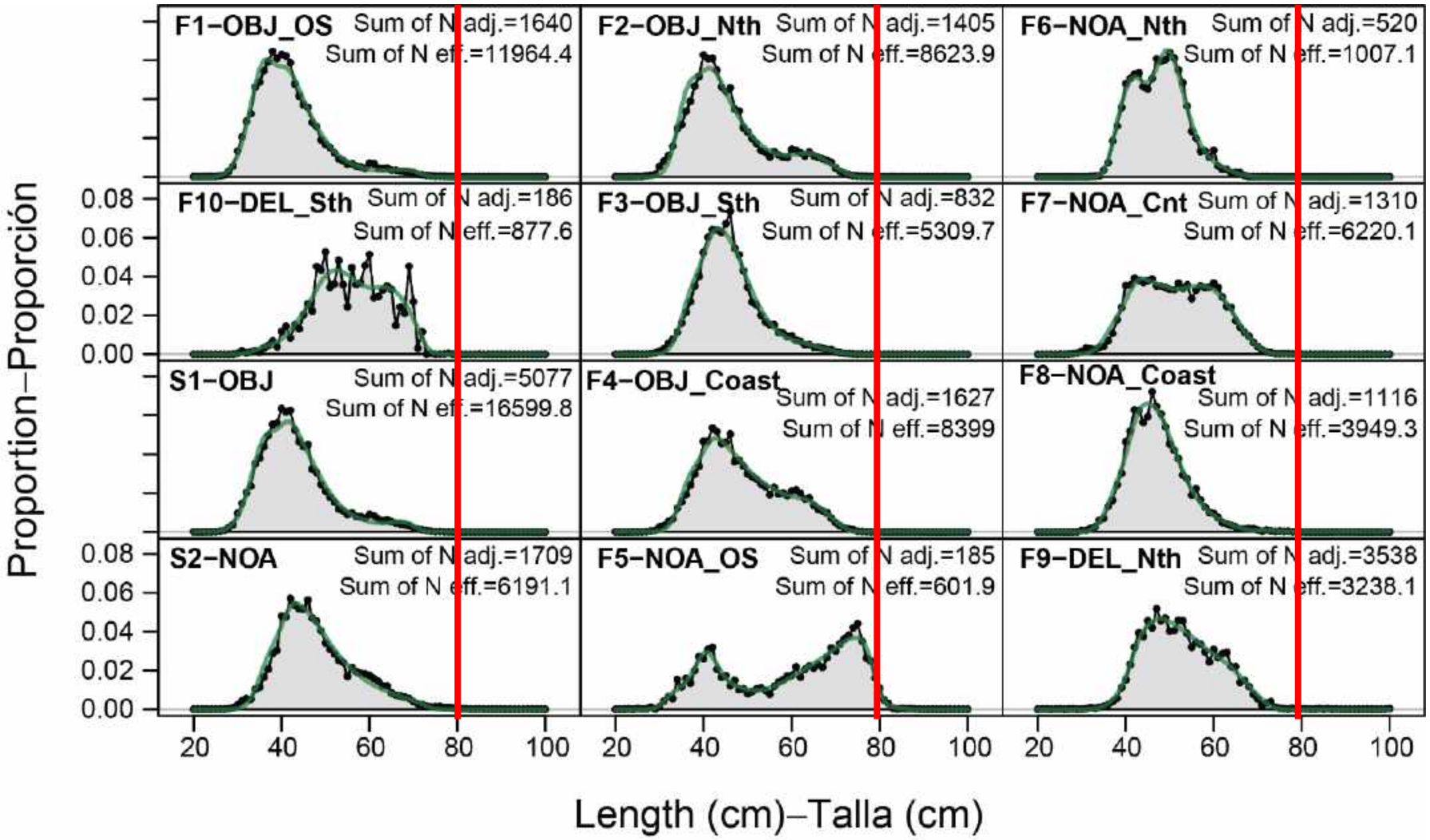
Indices of abundance

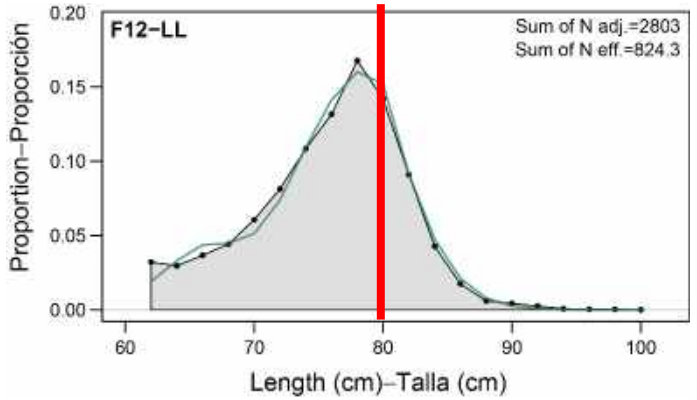


Composition data



Composition data

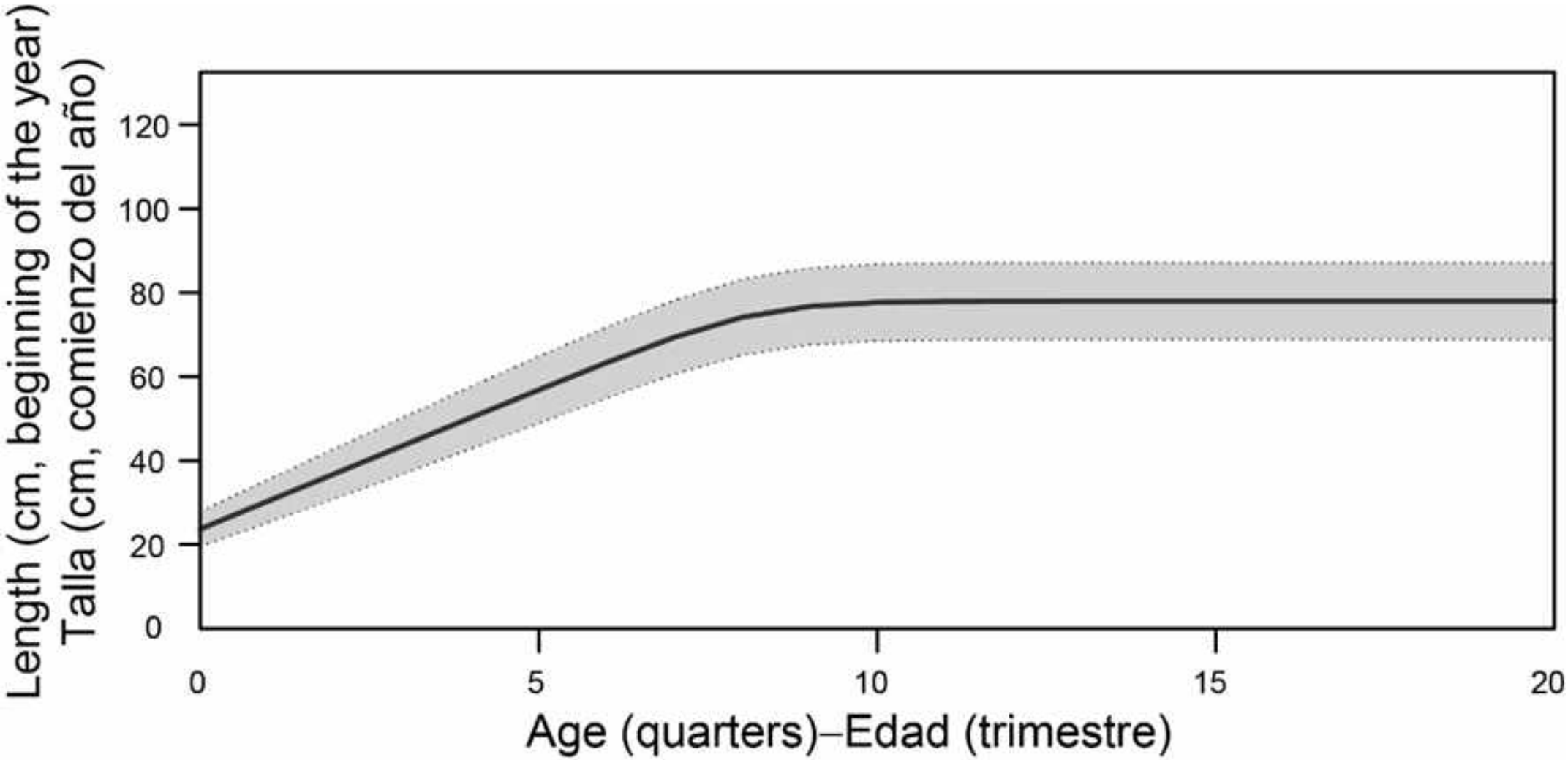




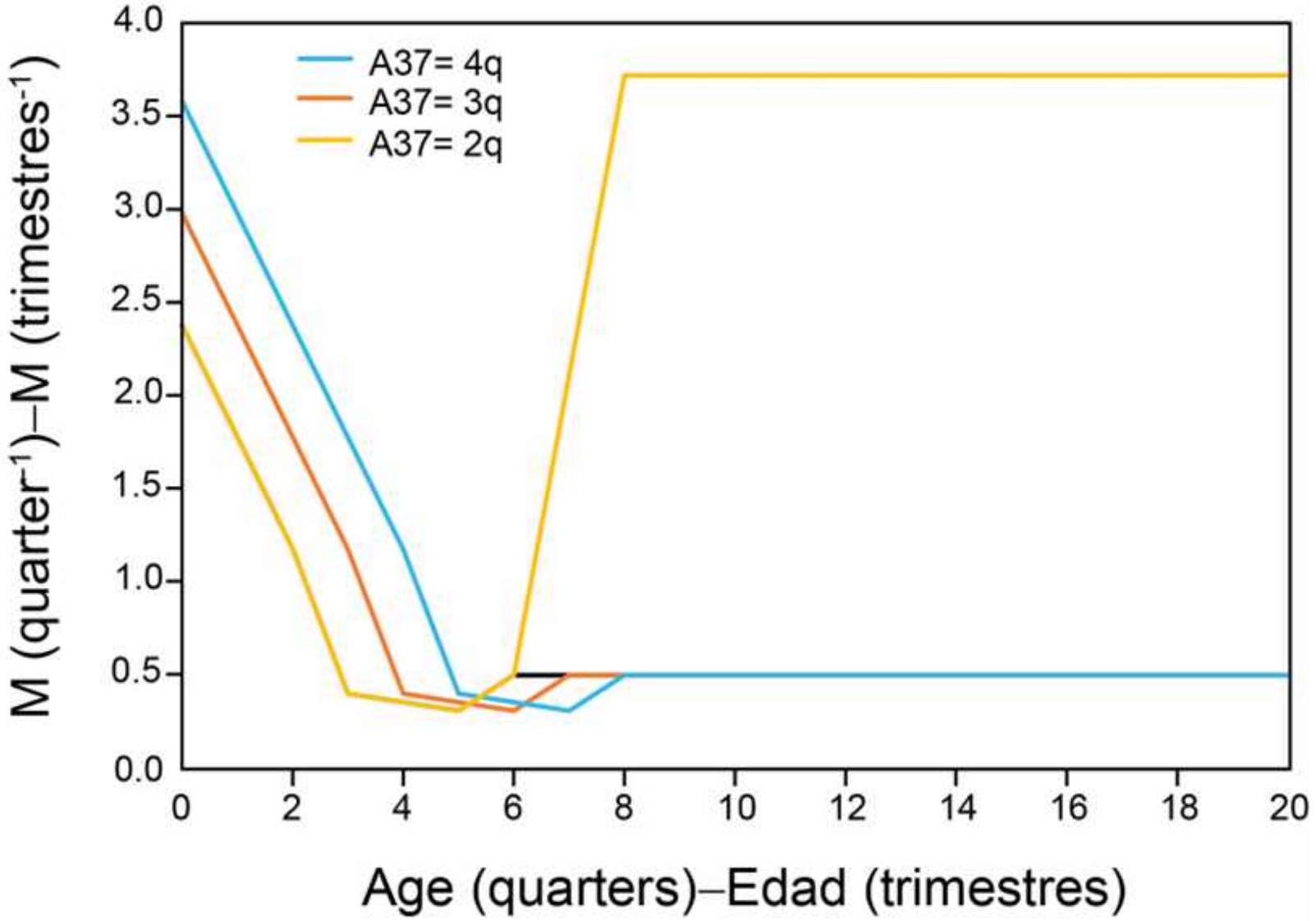
Reference model assumptions

- Single stock in the whole EPO
- Quarterly time step
- Longline selectivity is asymptotic, purse-seine selectivity is dome-shaped, modelled with splines
- Natural mortality based on Hampton (2000) and constant after a length of 65 cm.
- The asymptotic length is 78 cm.
- The age at 37 cm is 2 quarters.
- The CV of the length at age is a linear function of length and for age zero fish is 0.09 and for age 20 quarters is 0.06.
- Recruitment is independent of stock size
- Recruitment standard deviation of 0.6.
- Uses the longline and the echosounder buoy-based indices of relative
- Length compositions for the purse-seine OBJ index are used for the echosounder buoy index
- Index CVs average 0.2
- Length composition data OBJ/NOA = No. Wells; DEL =0.1 x No. Wells; LL = 0.1 x No fish

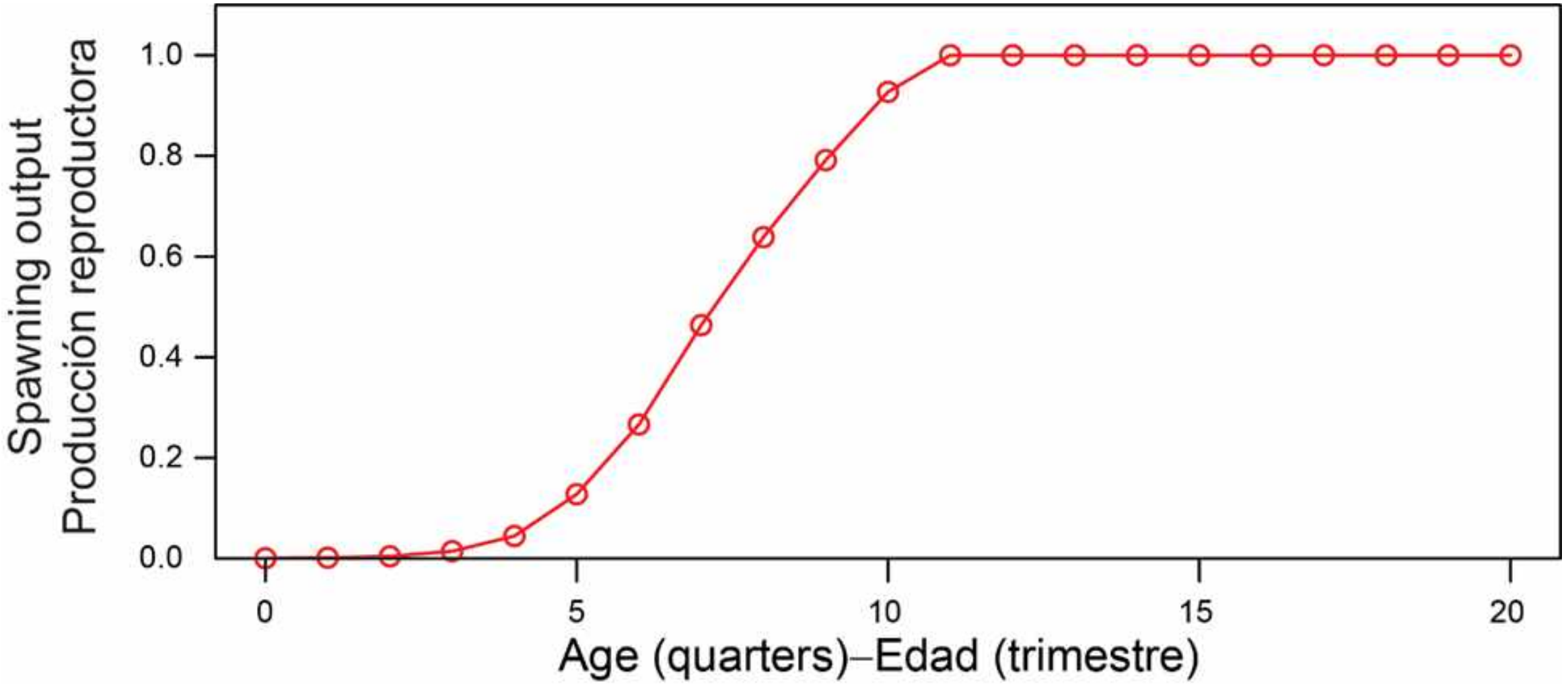
Growth


Length (cm, beginning of the year)
Talla (cm, comienzo del año)
0
20
40
60
80
100
120
0
5
10
15
20
Age (quarters)–Edad (trimestre)

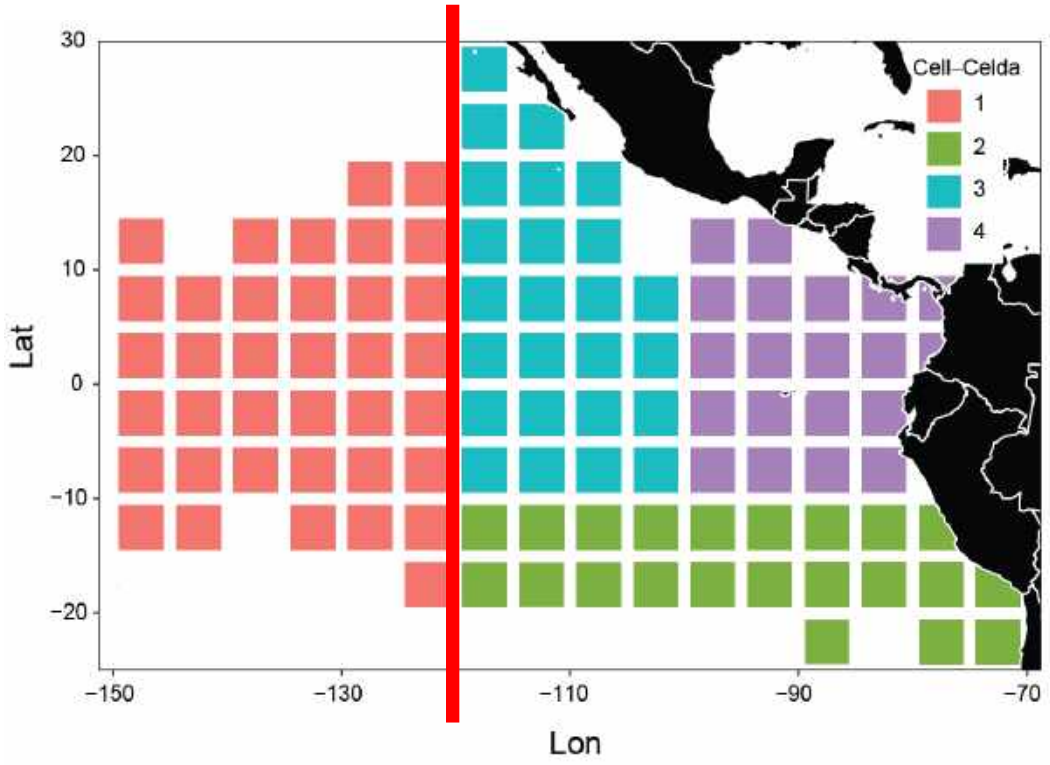
Composition data

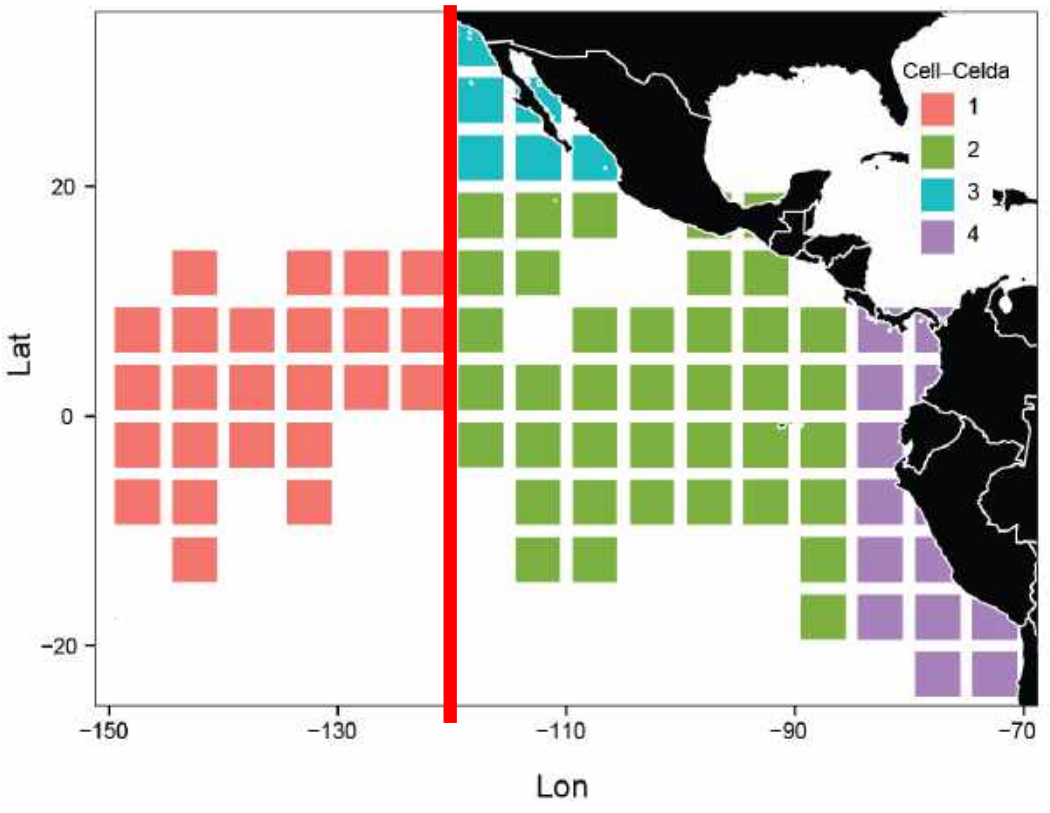


Reproductive output: Maturity x batch fecundity

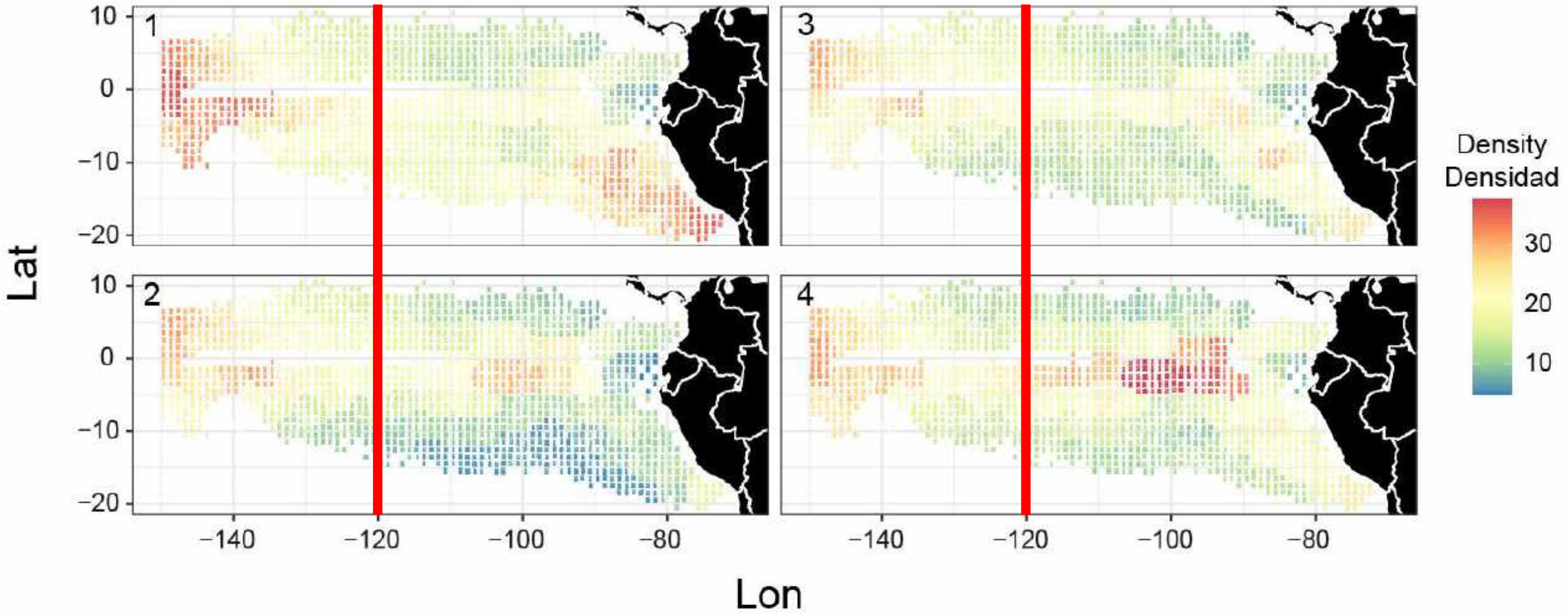


Fishery definitions: Possible stock structure





Indices of abundance: OBJ catch-per-set



Sensitivity analyses

a) Lower asymptotic length. The asymptotic length is set at 73 cm.

b) Higher asymptotic length. The asymptotic length is set at 83 cm.

c) Lower variation of length at age. The CV for variation at the asymptotic length is fixed at 0.05.

d) Higher variation of length at age. The CV for variation at the asymptotic length is fixed at 0.07.

e) Including the improved estimates of catch for 2020 and 2021.

f) Excluding the echosounder buoy index of abundance.

g) No longline index of abundance.

h) Inclusion of the purse-seine OBJ catch-per-set index.

i) Inclusion of the purse seine NOA catch-per-set index.

j) NOA asymptotic selectivity.

k) OBJ asymptotic selectivity.

l) Eastern assessment: east of -120

m) High natural mortality for old fish.

n) High fishing mortality for old individuals. The asymptotic length is fixed at 70 cm.

Sensitivity analyses

a) Lower asymptotic length. The asymptotic length is set at 73 cm.

b) Higher asymptotic length. The asymptotic length is set at 83 cm.

c) Lower variation of length-at-age. The CV for variation at the asymptotic length is fixed at 0.05.

d) Higher variation of length-at-age. The CV for variation at the asymptotic length is fixed at 0.07.

e) Including the improved estimates of catch for 2020 and 2021.

f) Excluding the echosounder buoy index of abundance. The echosounder buoy index of abundance and the associated length-composition data are excluded from the model and the associated selectivity not estimated.

g) No longline index of abundance. The longline index of abundance and its associated length-composition data are excluded from the model. The selectivity of the longline fishery is fixed at that estimated by the reference case.

h) Inclusion of the purse-seine OBJ catch-per-set index. The index of abundance based on the OBJ catch-per-set is included in the model. The associated length-composition data is already included in the model for the echosounder index and the selectivity is shared between these two “surveys”.

i) Inclusion of the purse-seine NOA catch-per-set index. The index of abundance based on the NOA catch-per-set and associated length-composition data is included in the model and the selectivity estimated.

j) NOA asymptotic selectivity. The offshore NOA fishery is constrained to have asymptotic selectivity and the asymptotic length is equal to the mode of the length distribution for this fishery (75 cm). The longline index of abundance and its associated length-composition data are excluded from the model. The selectivity of the longline fishery is fixed at that estimated by the reference case. The NOA catch-per-set index of abundance and composition data are used.

Sensitivity analyses

k) OBJ asymptotic selectivity. The coastal OBJ fishery is constrained to have asymptotic selectivity and the asymptotic length is equal to the mode of the length distribution for this fishery (65 cm). The longline index of abundance and its associated length-composition data are excluded from the model. The DEL and NOA length-composition data are excluded from the analysis. The selectivity of the longline, DEL, and NOA fisheries are fixed at that estimated by model p. The OBJ catch-per-set index of abundance is used.

l) Eastern assessment. The assessment is conducted for the EPO area east of -120°W. This involves setting the catch in the offshore fisheries (F1 and F5) to zero, not using their length-composition data, and not estimating their selectivities. The ECHO index is from data mainly west of -120°W and therefore it is not used. The OBJ index and its composition data are used instead, but are adjusted to appropriately represent the area east of -120°W. The longline index and composition data are recalculated for the areas east of -120°W. The longline catch is not adjusted because it is small.

m) High natural mortality for old fish. The constant natural mortality after 65 cm assumption is replaced with the higher natural mortality for 75 cm fish as estimated by Hampton (2000), a linear trend between 65 cm and 75 cm, and natural mortality after size 75 cm is assumed to be at this level. Several analyses are carried out: 1) including or 2) excluding the longline data and 3) not constraining the purse-seine fisheries to be dome-shaped (with and without higher *M* for the old fish).

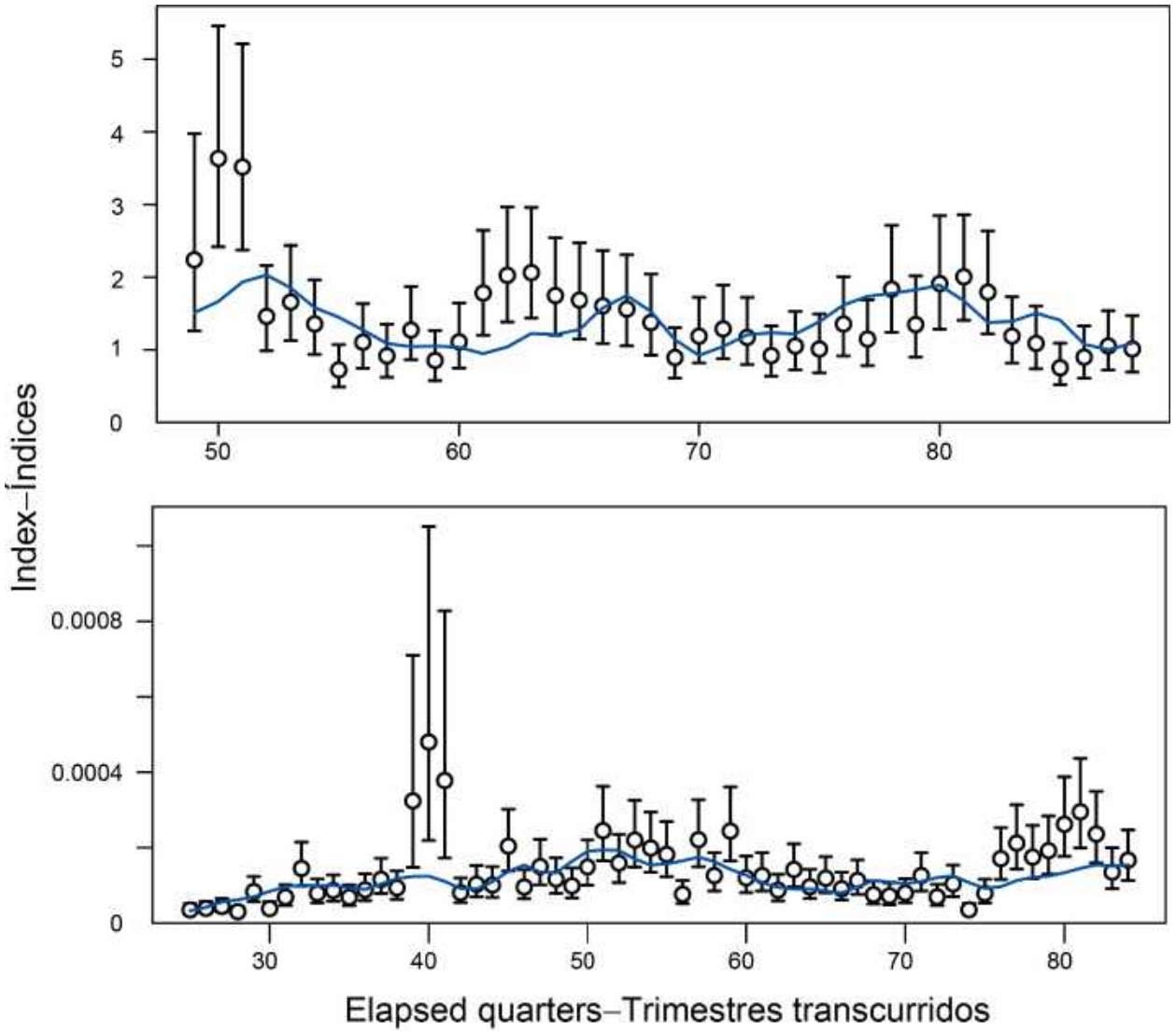
n) High fishing mortality for old individuals. The selectivity curve for the offshore NOA fishery (F5) is constrained to be constant after the asymptotic length. The longline index and composition data are still fit in the model.

o) Rapid reduction in growth rate for older individuals. The asymptotic length is fixed at 70 cm. Several analyses are carried out: 1) including or 2) excluding the longline data, 3) not constraining the purse-seine fisheries to be dome-shaped, and 4) making the offshore NOA fishery (F5) to have constant selectivity after the asymptotic size.

Reference model: Fit to indices of abundance

Echosounder buoys

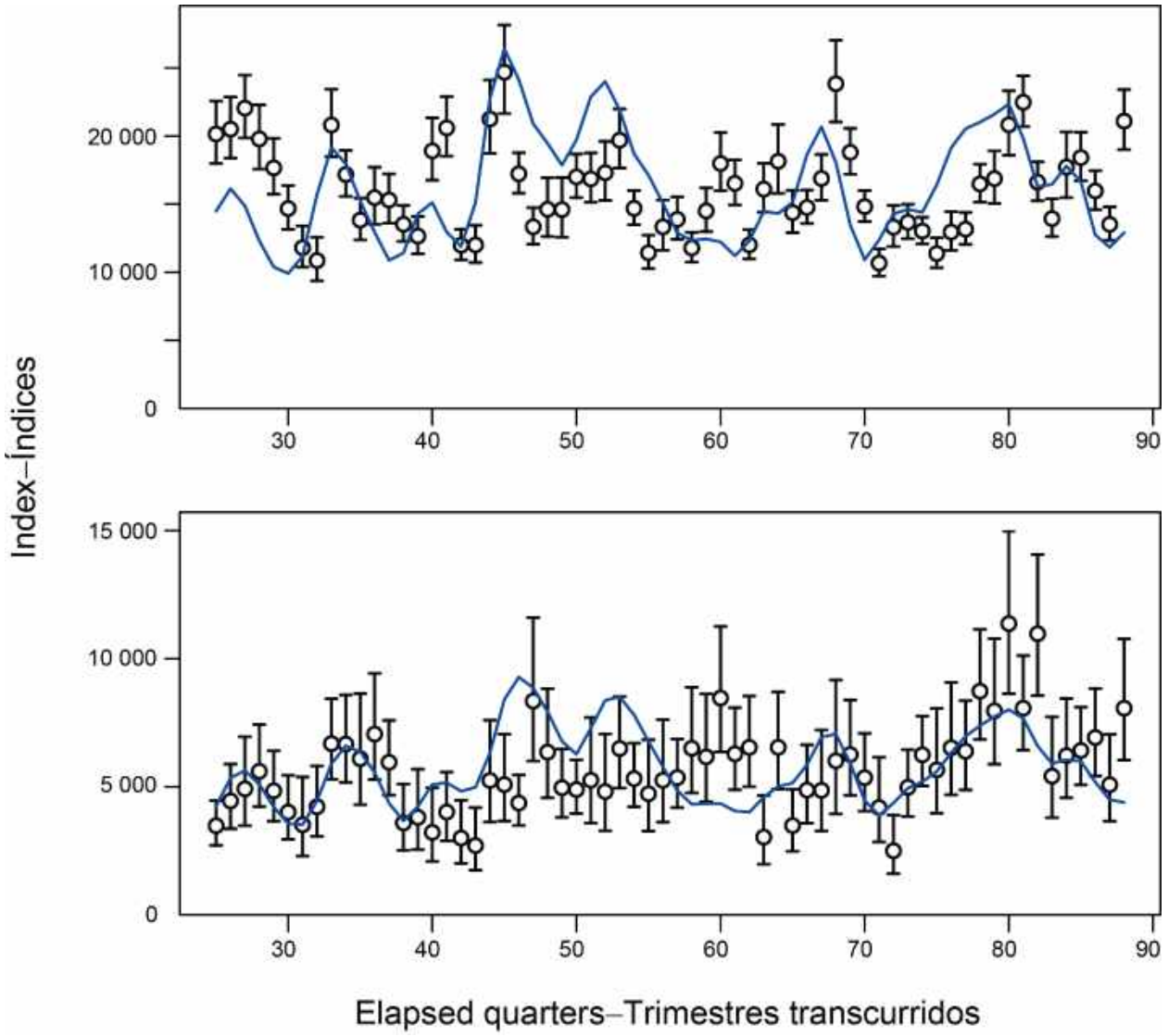
Longline



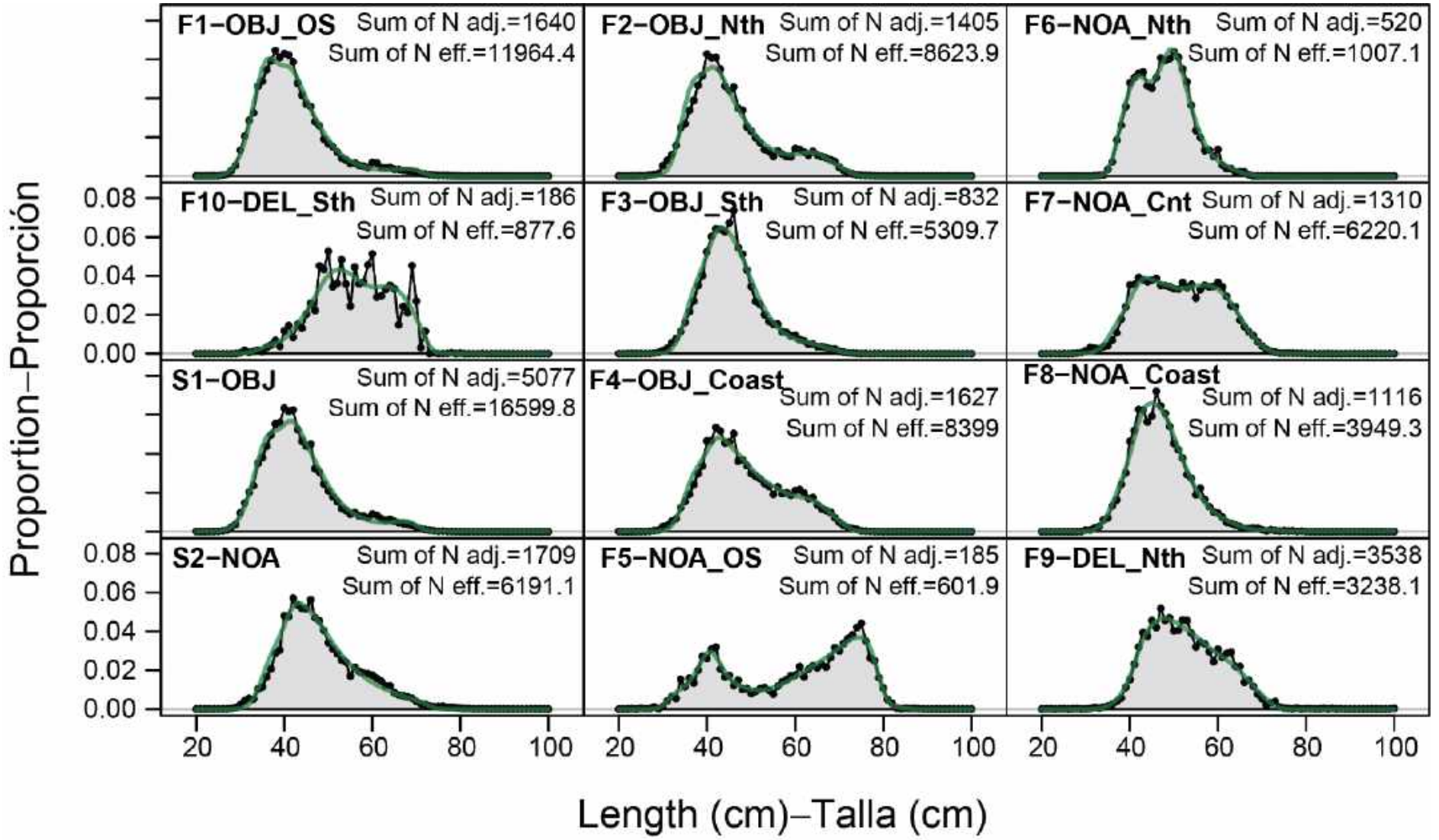
Reference model: Fit to indices of abundance

OBJ catch-per-set

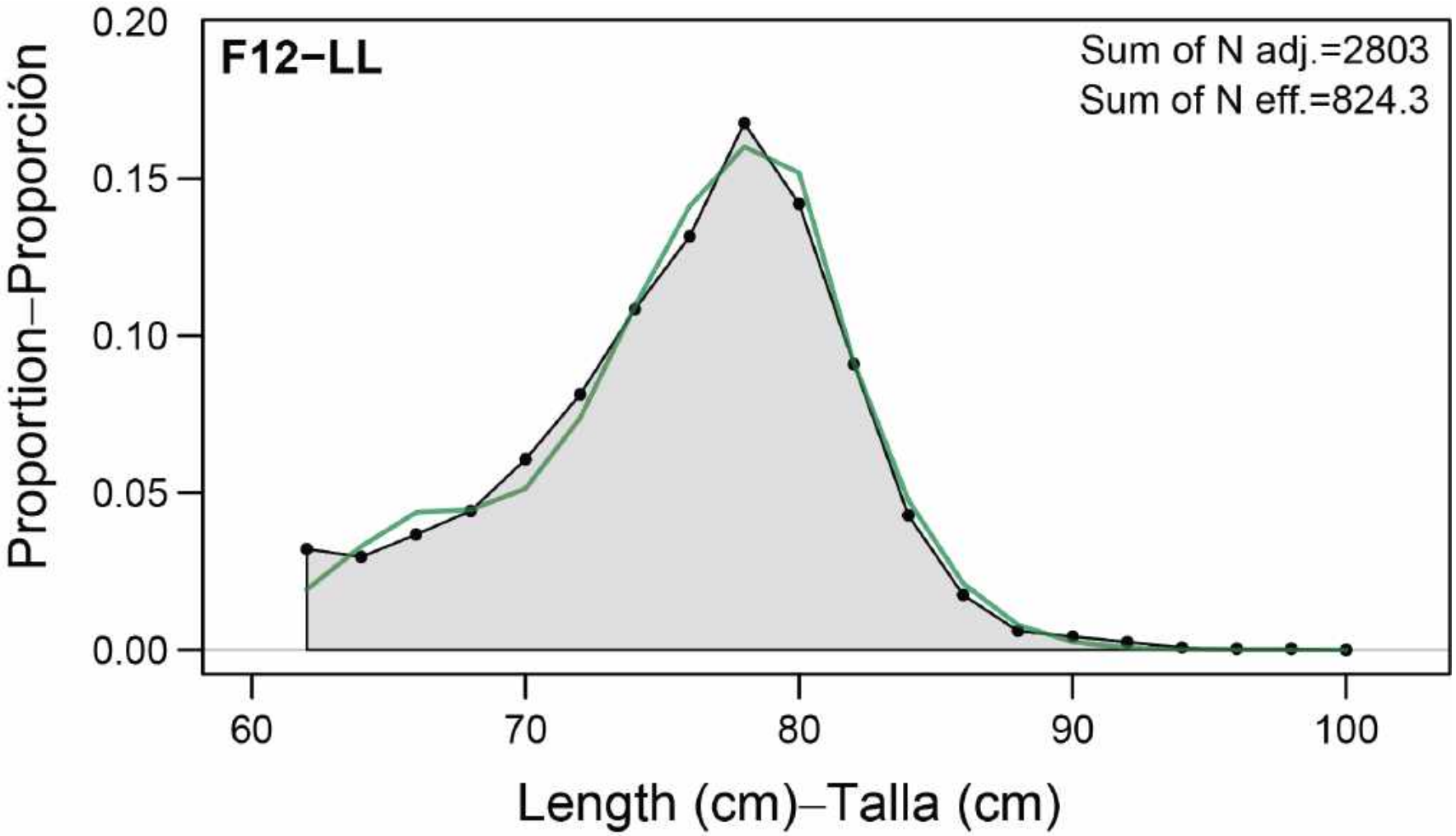
NOA catch-per-set



Reference model: Fit to length composition



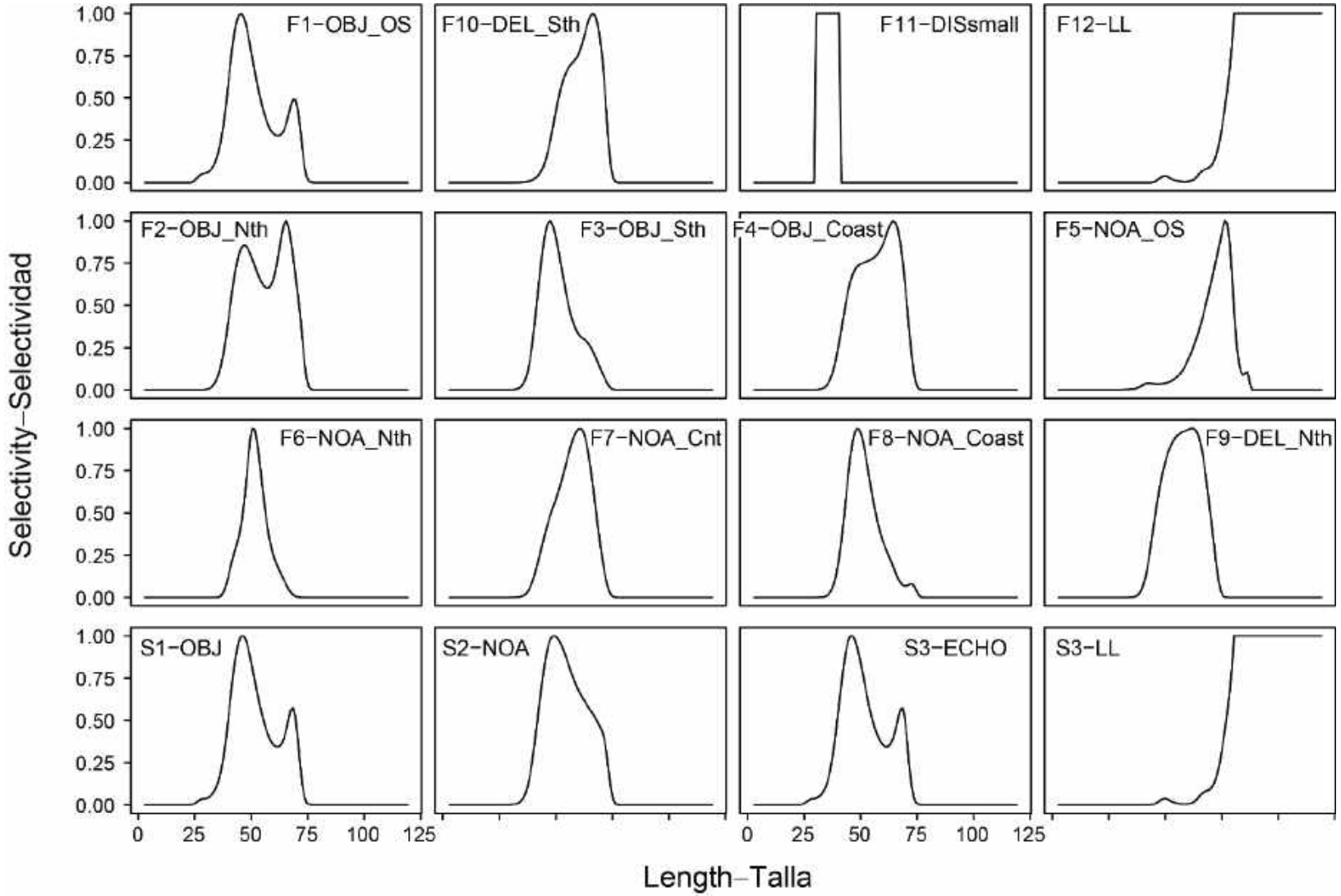
Reference model: Fit to length composition



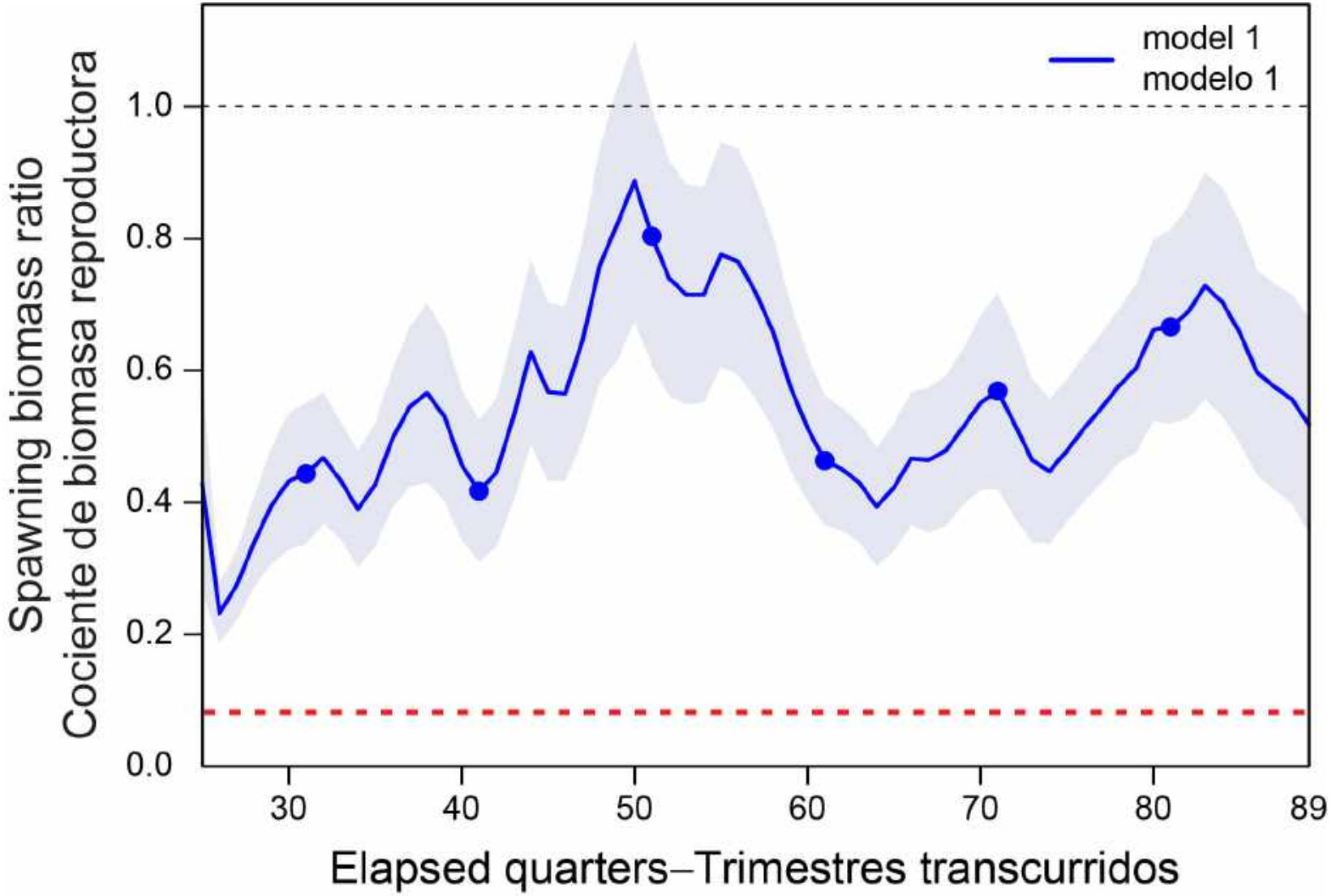
Residuals

- See html output

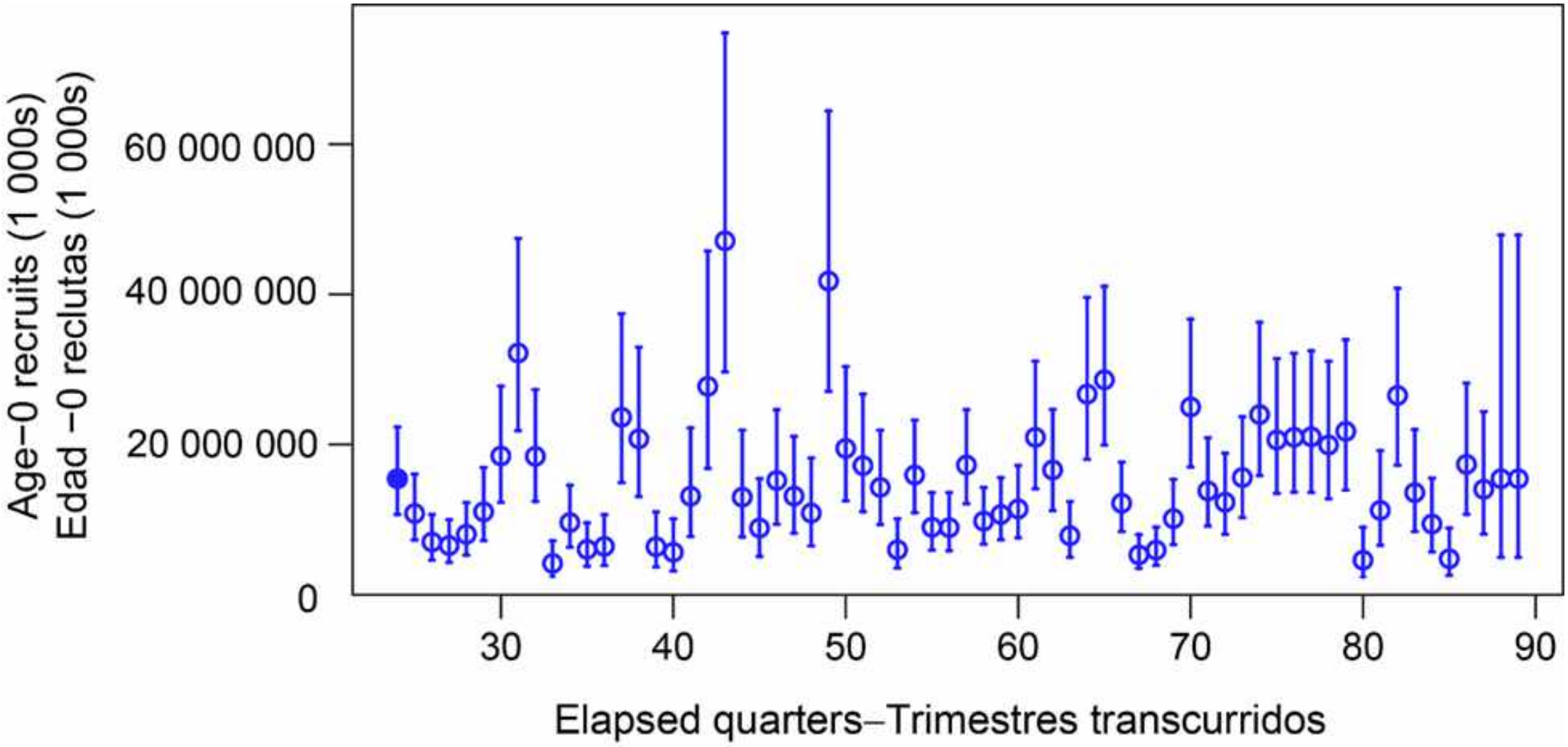
Reference model: Fit to indices of abundance



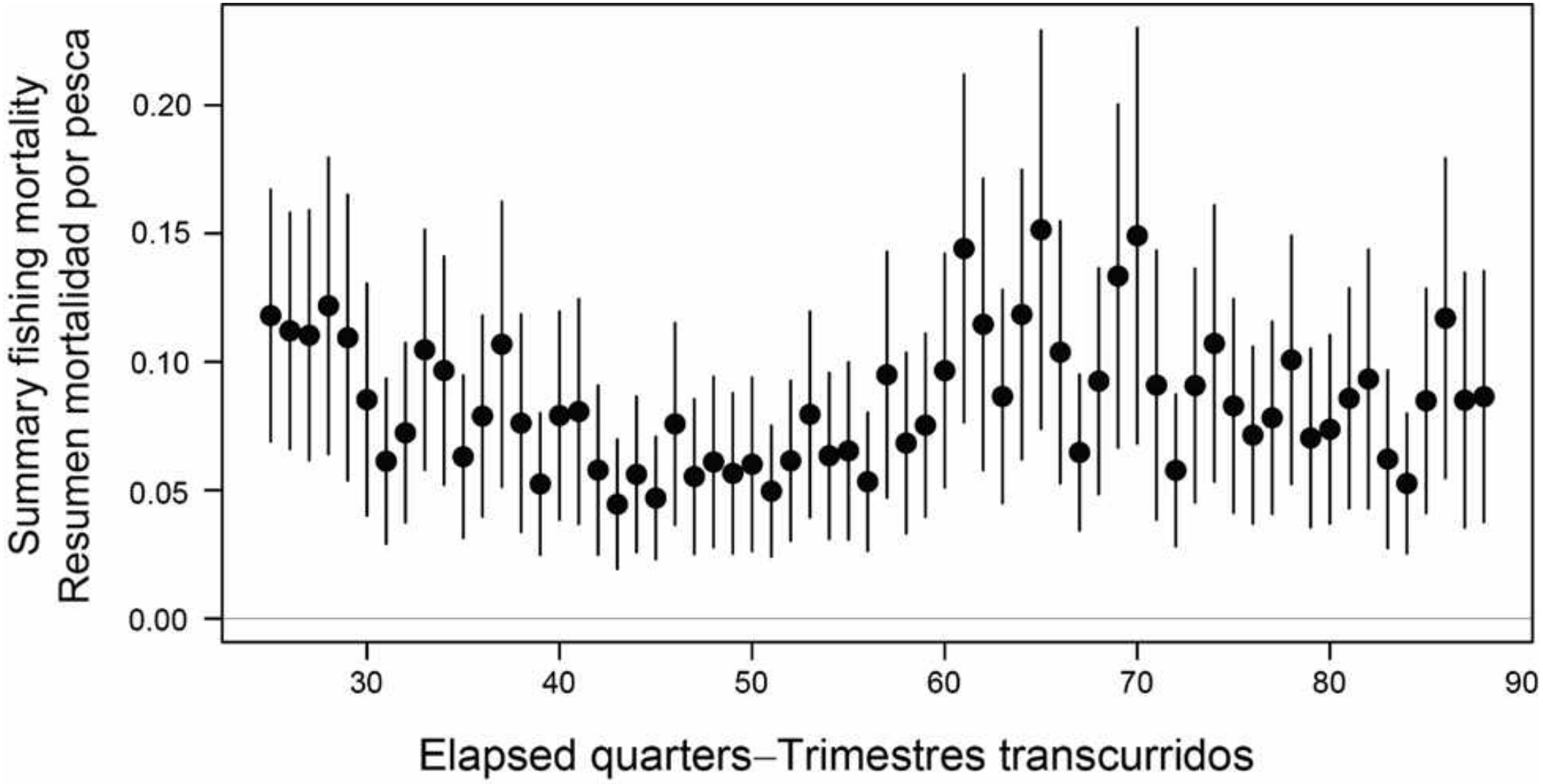
Reference model: Spawning biomass ratio (SBR)



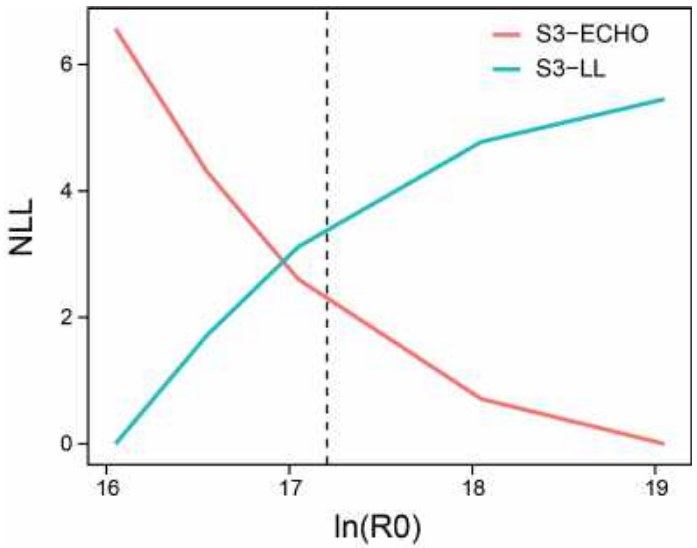
Reference model: Recruitment

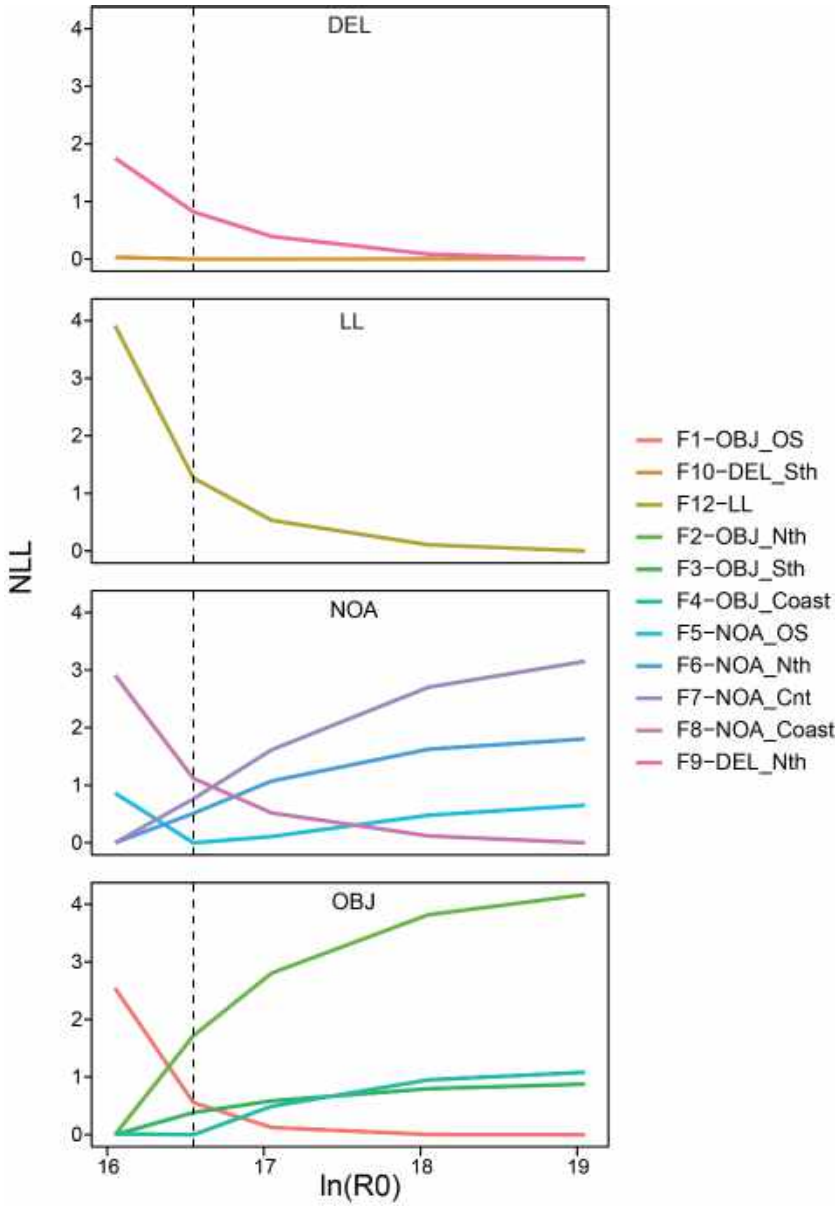


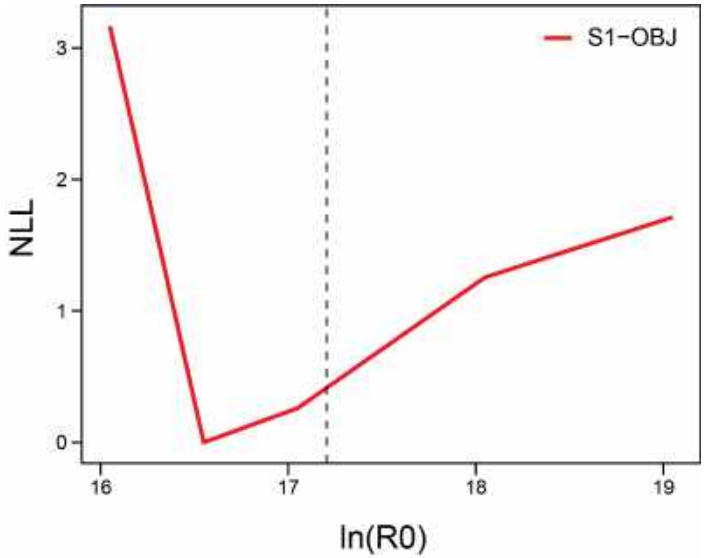
Reference model: Proxy fishing mortality (2+)



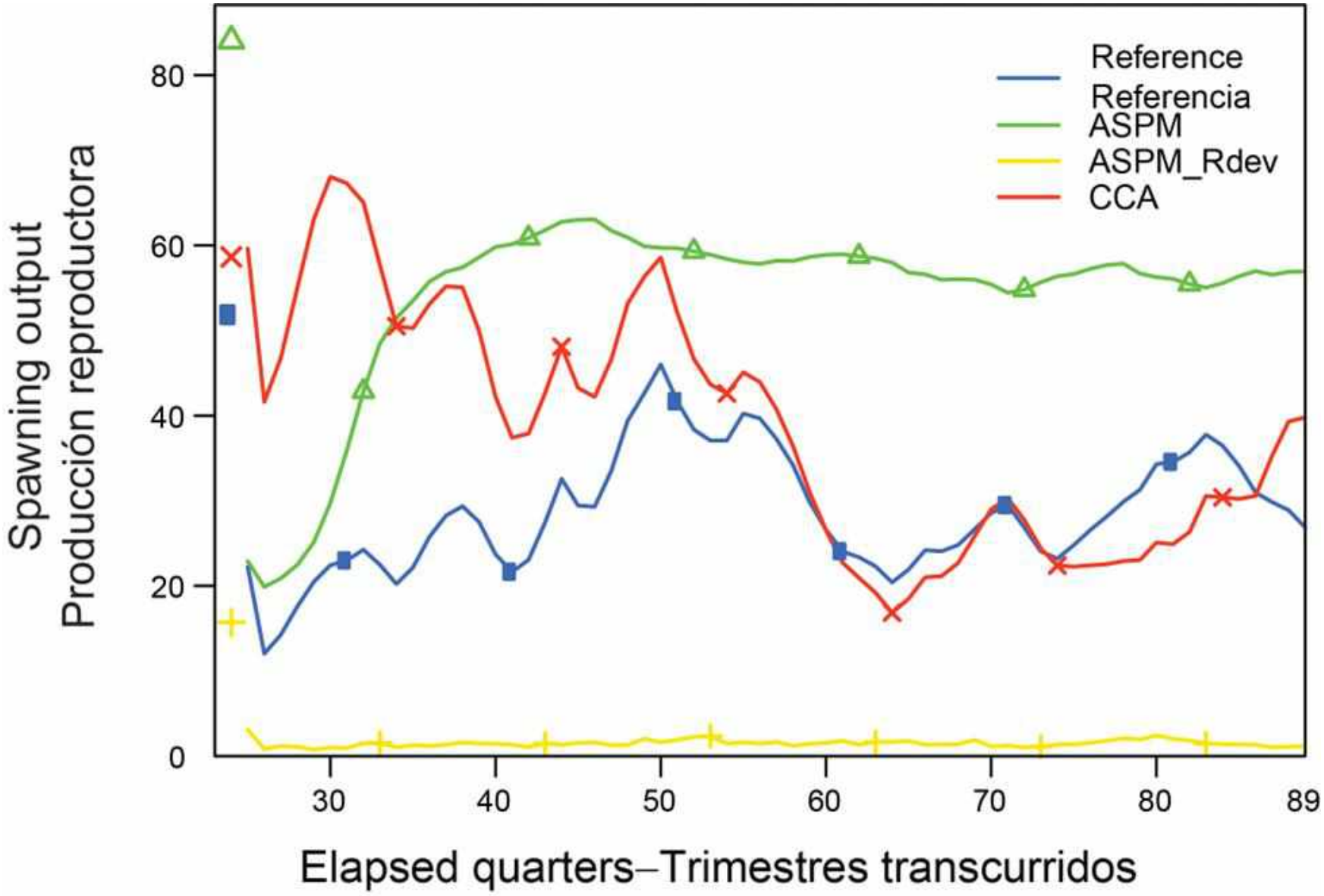
Reference model: R0 likelihood profile



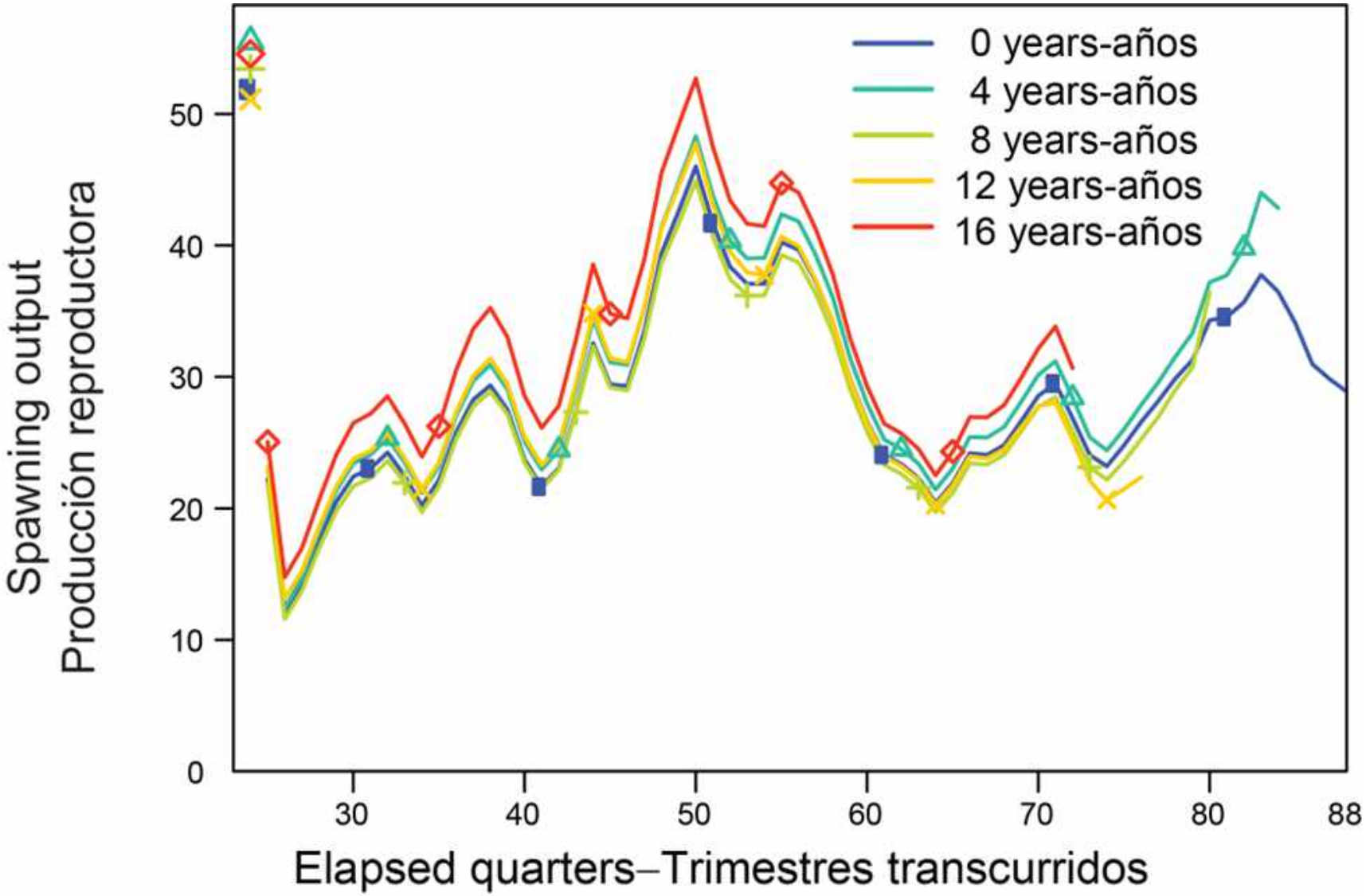




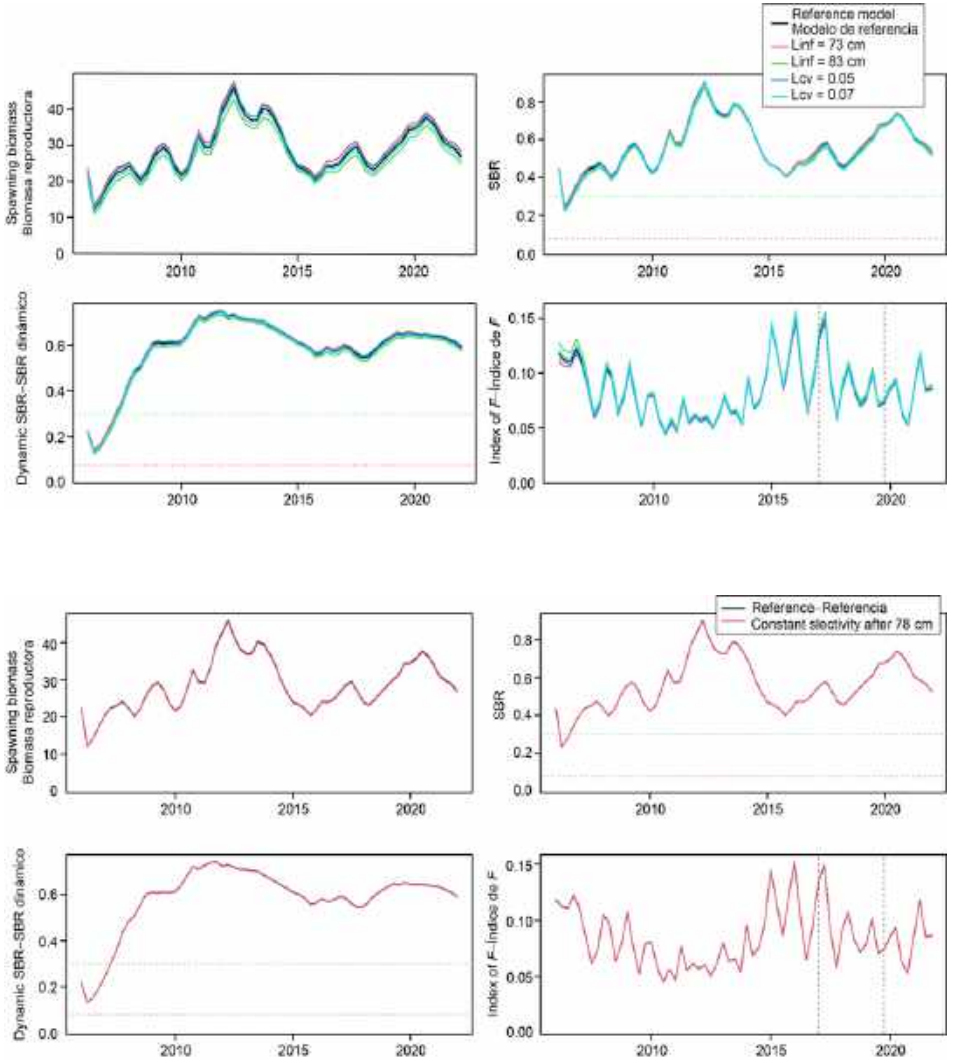
Reference model: ASPM and Catch-curve analysis

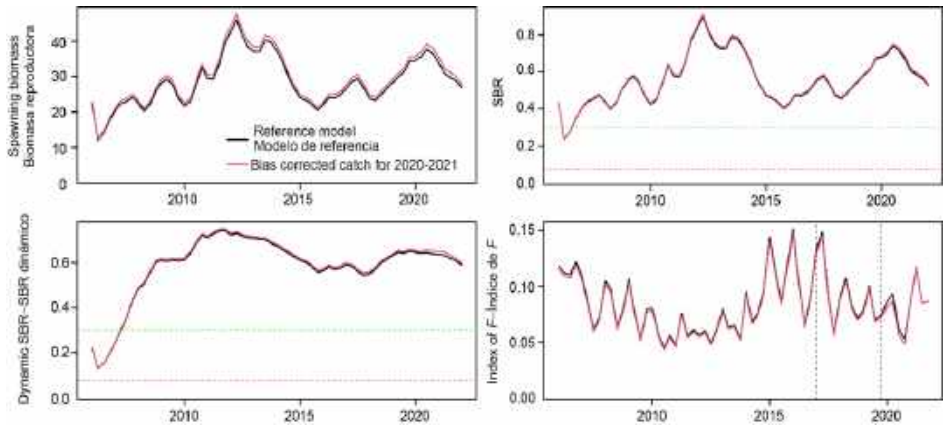


Reference model: Retrospective analysis

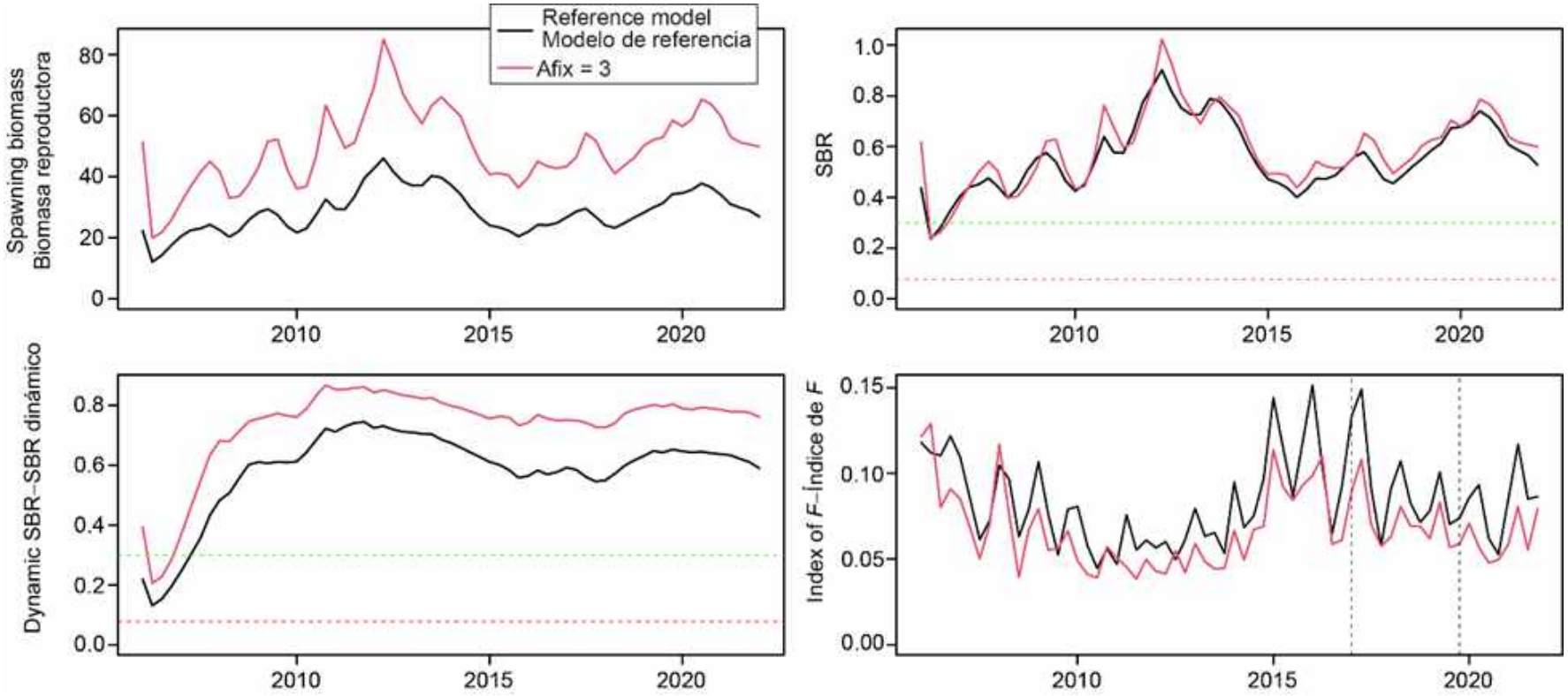


Sensitivity analysis: not sensitive

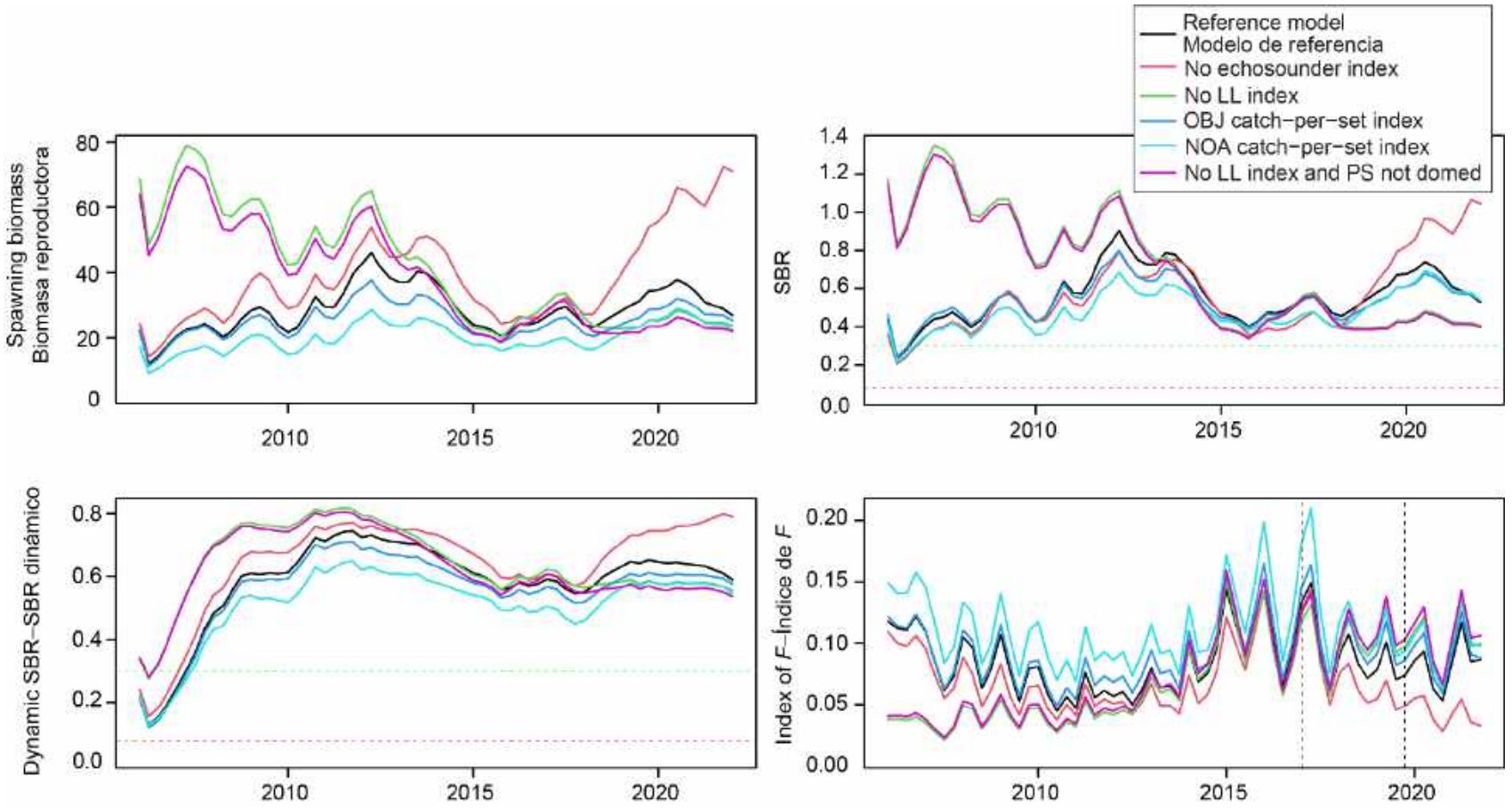




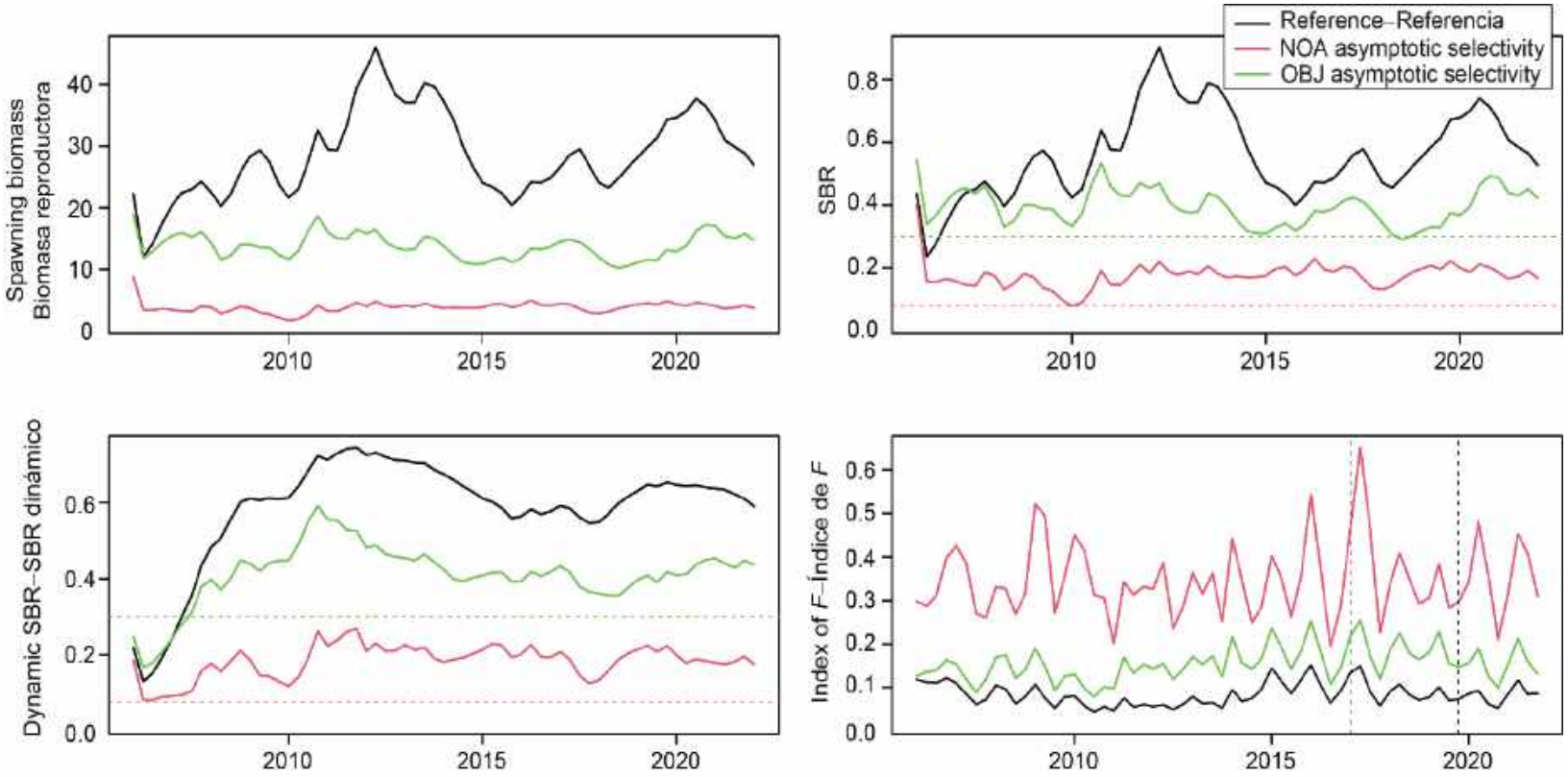
Sensitivity analysis: Age at 37 cm



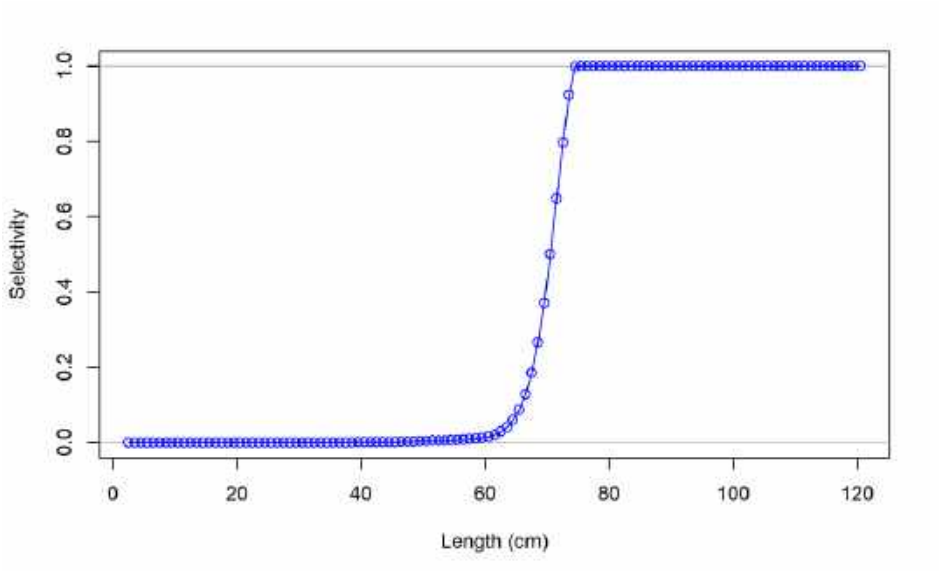
Sensitivity analysis: Data

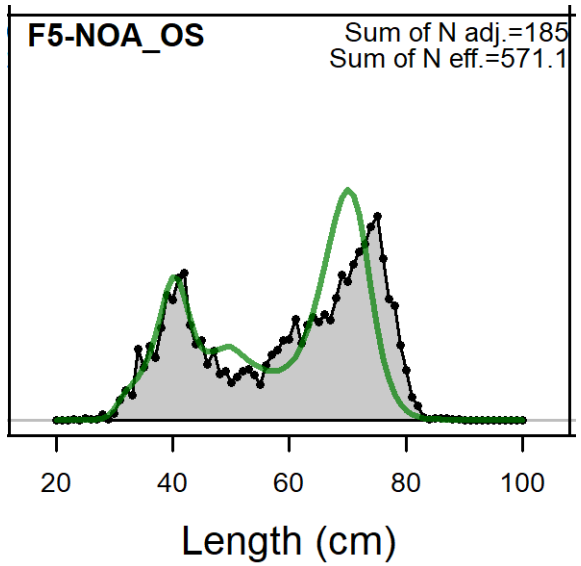


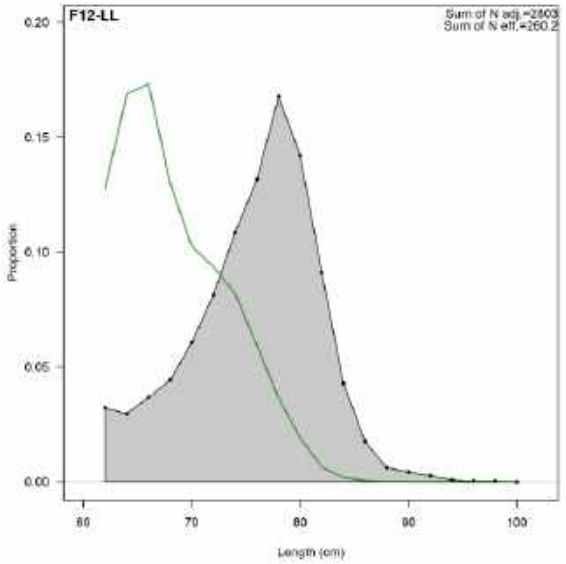
Sensitivity analysis: Asymptotic selectivity



Stock status: NOA asymptotic

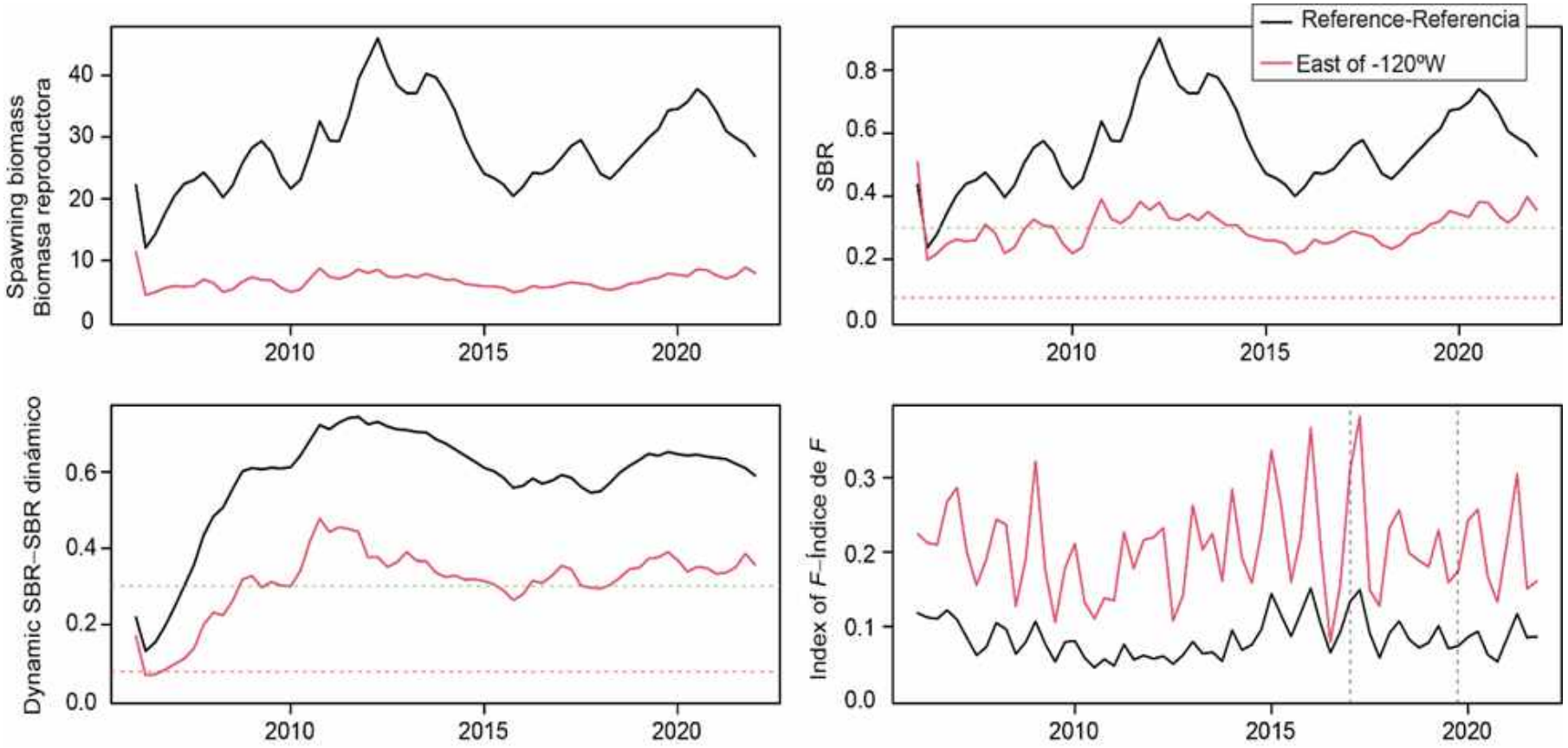




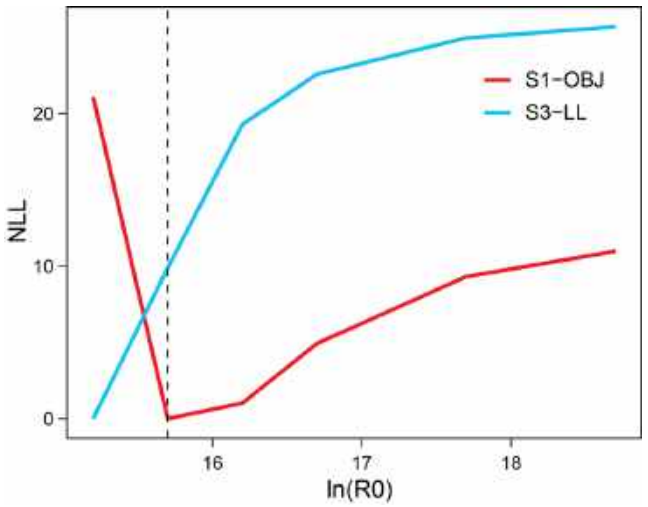


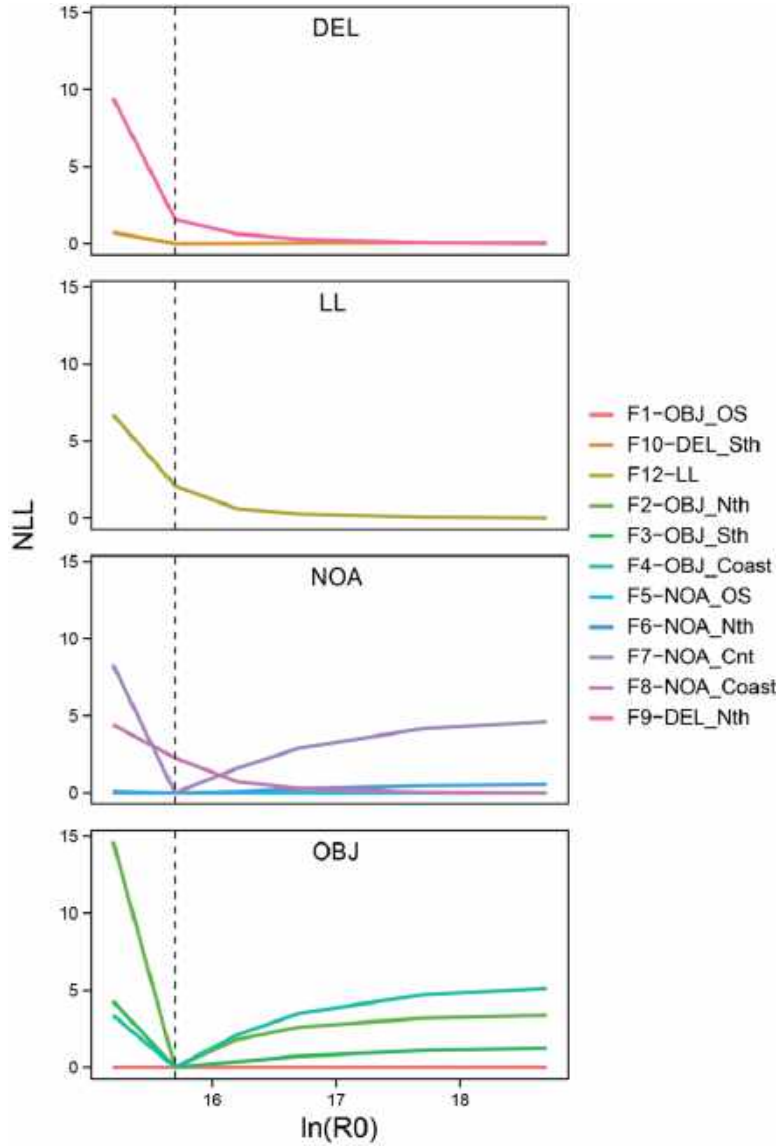
N parameters are on or within 1% of min-max bound: 10; check results, variance may be suspect

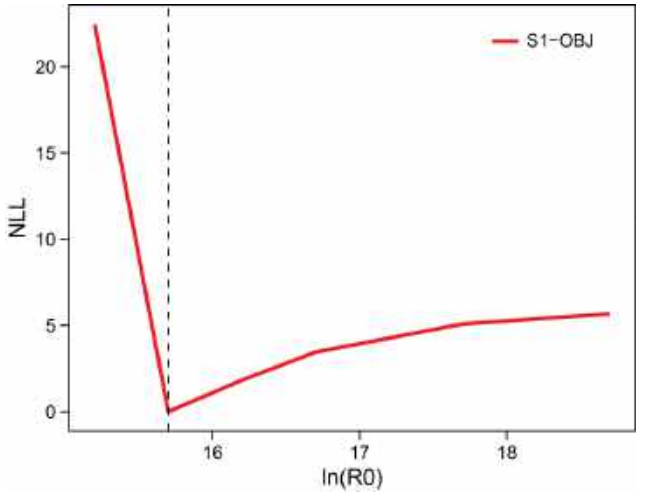
Sensitivity analysis: East model



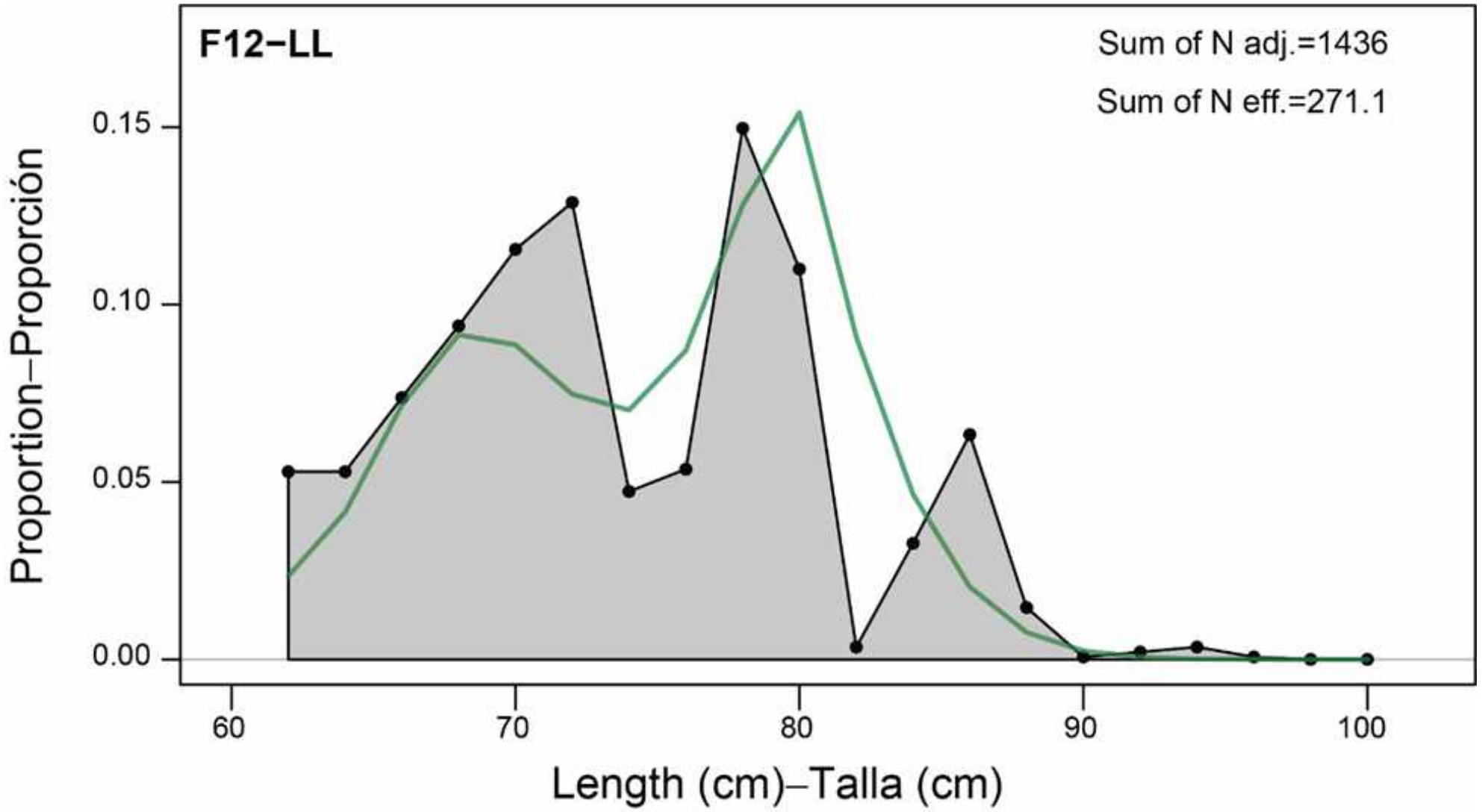
East model: R0 likelihood profile







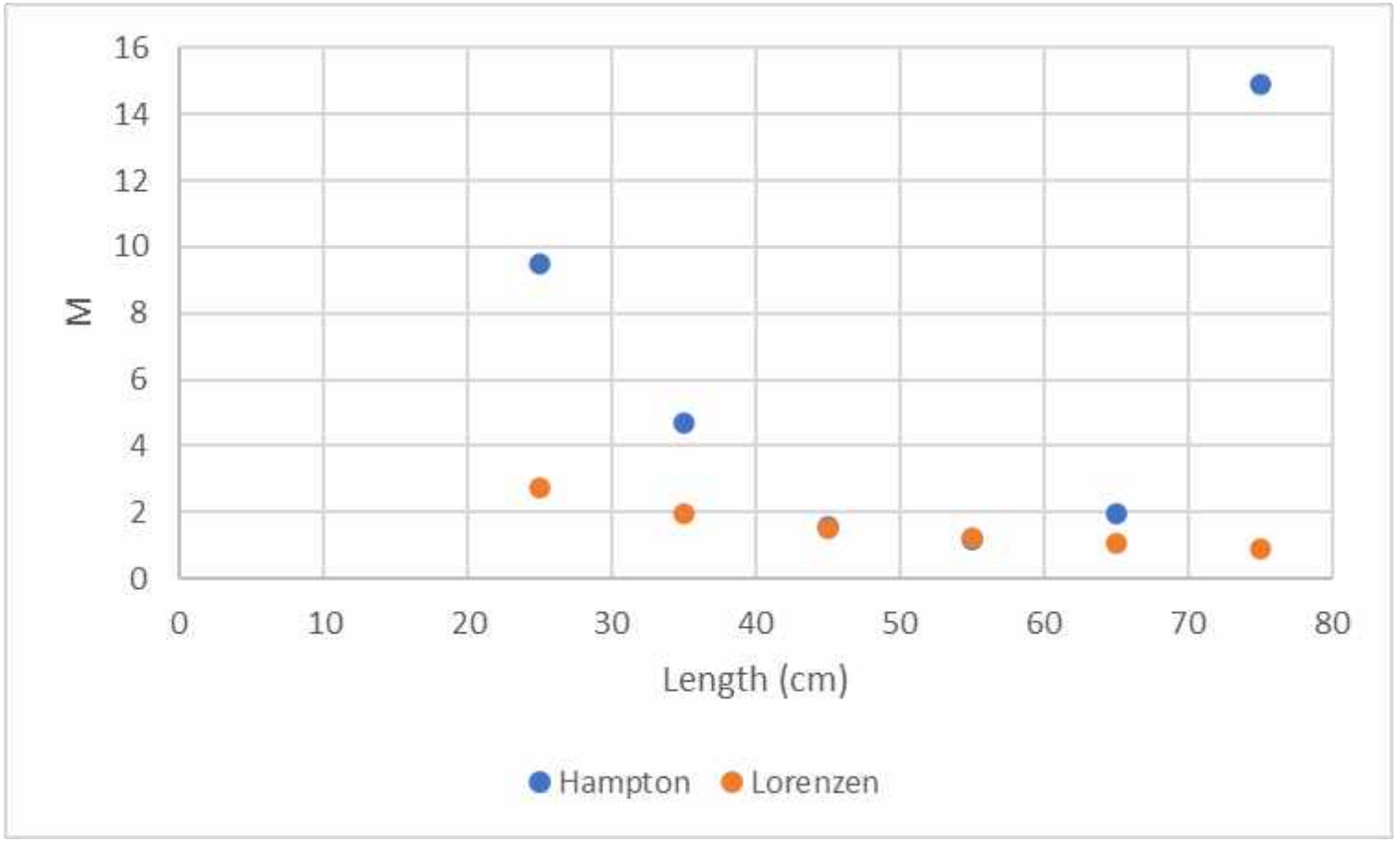
East model: LL length composition



Lorenzen M

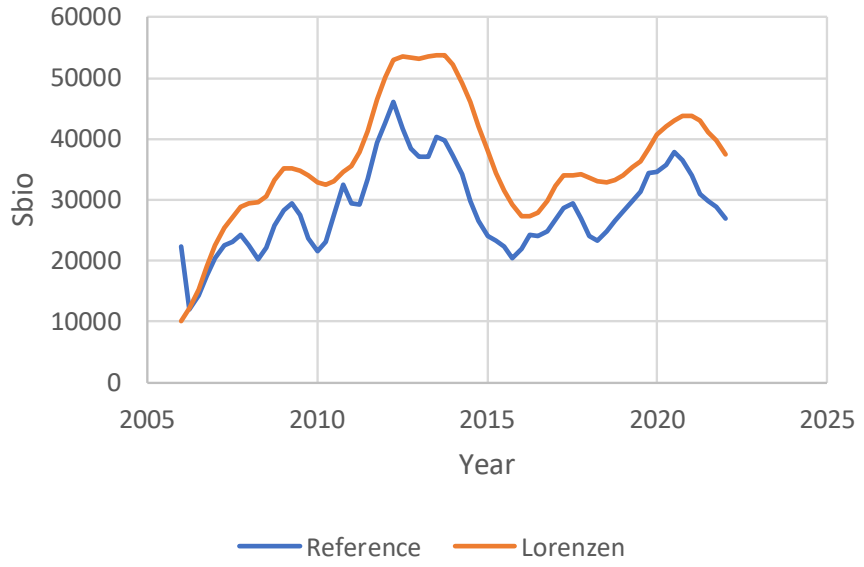
Lorenzen et al. (2022)

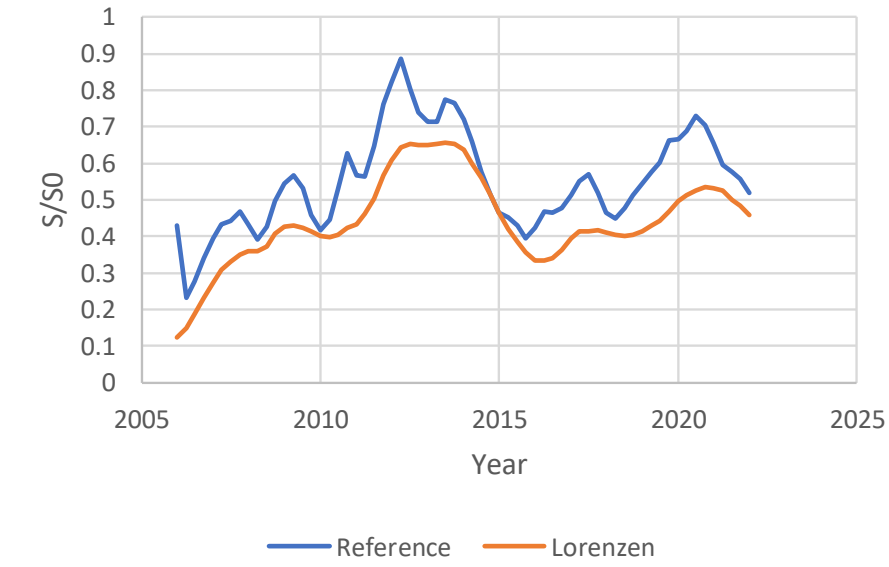
M proportional to L^{-1}



Lorenzen M

	Reference	Lorenzen	Dif
TOTAL	2627.61	2582.88	44.73
Catch	1.13E-12	7.50E-13	3.81E-13
Equil_catch	0	0	0
Survey	16.4001	22.3968	-5.9967
Length_cor	2504.53	2459.32	45.21
SizeFreq	110.886	106.385	4.501
Recruitmer	-4.2243	-5.24289	1.01859
InitEQ_Reg	0	0	0
Forecast_R	0.007739	0.010383	-0.00264
Parm_prior	0	0	0
Parm_softb	0.012726	0.01004	0.002686





F1-OBJ_OS	F2-OBJ_Ntl	F3-OBJ_Sth	F4-OBJ_Coa	F5-NOA_OS	F6-NOA_Nt	F7-NOA_Cr	F8-NOA_Cc	F9-DEL_Ntl	F10-DEL_St	F11-DISsma	F12-LL	S1-OBJ	S2-NOA	S3-ECHO	S3-LL
3.18	10.443	2.616	6.046	3.831	-0.831	5.365	4.273	-1.01	0.374	0	0	10.343	-46.692	0	0

Summary

- An assessment for skipjack was developed
- Longline data and an echosounder buoy-based index of abundance were included
- The assessment is like those used to provide management advice for bigeye and yellowfin
- The length composition data from the longline fishery suggest that the purse seine fisheries have dome-shape selectivities
- Sensitives to the assumptions were conducted
- The conclusion that the skipjack stock is healthy is generally robust to data usage and model assumptions
- Exceptions are models that assume asymptotic selectivity for the unassociated fishery

Future research

- Benchmark assessment in 2024
- Analyze tagging data and integrate it into assessment and management advice (SAC-13-08)
- Improve model
  - Investigations on stock structure and further evaluation of the eastern model
  - Refine the fishery definitions to remove bimodal and other undesirable length-composition distributions and selectivities
  - Investigate alternative selectivity patterns to avoid bimodal and other undesirable selectivity patterns
  - Consider the possibility of changes in selectivity as indicated by the catch curve analysis
  - Adjusting the length-composition data for shrinkage
  - Using the offshore OBJ length-composition data for the echosounder buoy index of abundance
  - Improve the estimates of age-specific natural mortality using the tagging data and other available information
  - Spatio-temporal modelling of the longline CPUE and composition data

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Questions