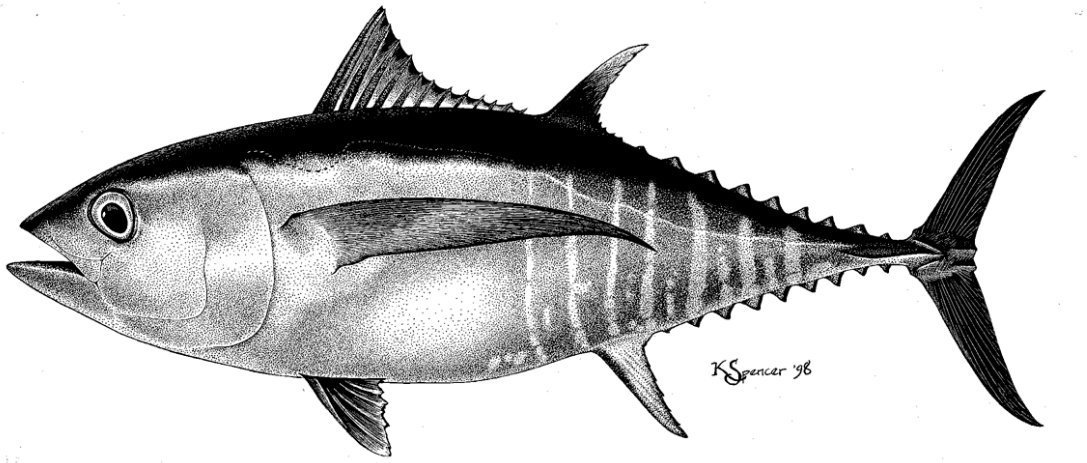
STATUS OF BIGEYE TUNA IN THE EASTERN PACIFIC OCEAN IN 2015

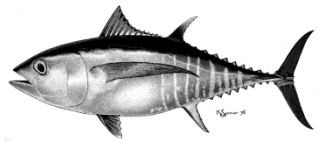
January 1975 – December 2015



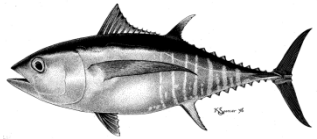
7th Meeting of the IATTC Scientific Advisory Meeting

La Jolla, California (USA), 9-15 May 2016

Outline



- Full stock assessment (base case model)
  - Fishery data updates
  - Model assumptions
  - Results (recruitment, biomass, fishing mortality)
  - Model diagnostics
  - Stock status (base case)
- Sensitivity analyses
- Summary conclusions
- Future directions



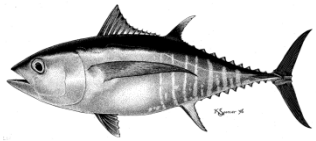
New or updated data

- Surface fisheries
  - Catch, CPUE and size-frequency data updated to include new data for 2015 and revised data for earlier years
- Longline fisheries
  - New or updated longline catch data: China (2014), Chinese Taipei (2012-2014), Japan (2013-2014), Korea (2006, 2014), US (2013-2014), French Polynesia (2013-2014), Vanuatu (2007-2014) and other nations (2013-2015)
  - 2015 longline catch data available from monthly reports: China, Chinese Taipei, Japan and Korea
  - **New or updated CPUE data available for Japan (1975-2015)**
  - **New size-frequency for Japan (1975-2014)**

Changes in BET JPN LL size-composition data

Residual pattern (revisited)

Fishery data



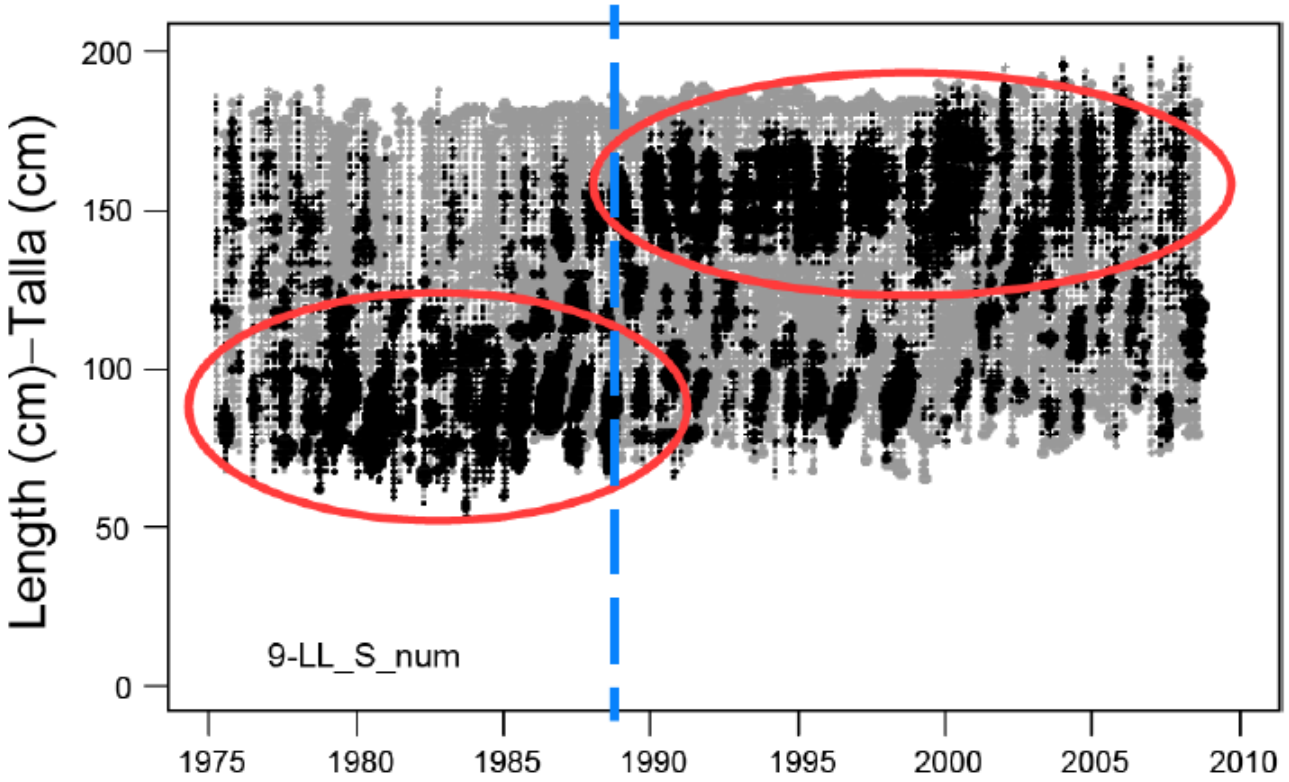


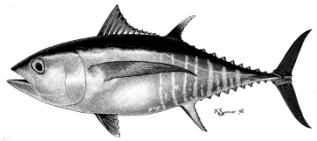
FIGURE 1. Pearson residual plots for the model fit to the length-composition data for the Southern longline fishery assumed in the base-case assessment in Aires-da-Silva and Maunder (2009). The gray and black circles represent observations that are lower and higher, respectively, than the model predictions. The sizes of the circles are proportional to the absolute values of the residual. The ovals identify clusters of prominent residual patterns. The dashed vertical line indicates where the residual pattern seems to change. From Aires-da-Silva *et al.* (2010).

See Doc BET-01-05
of BET External Review

Changes in BET JPN LL size-composition data

"Back to the raw data"

Fishery data



- See docs SAC-07-03d and SAC-07-04a

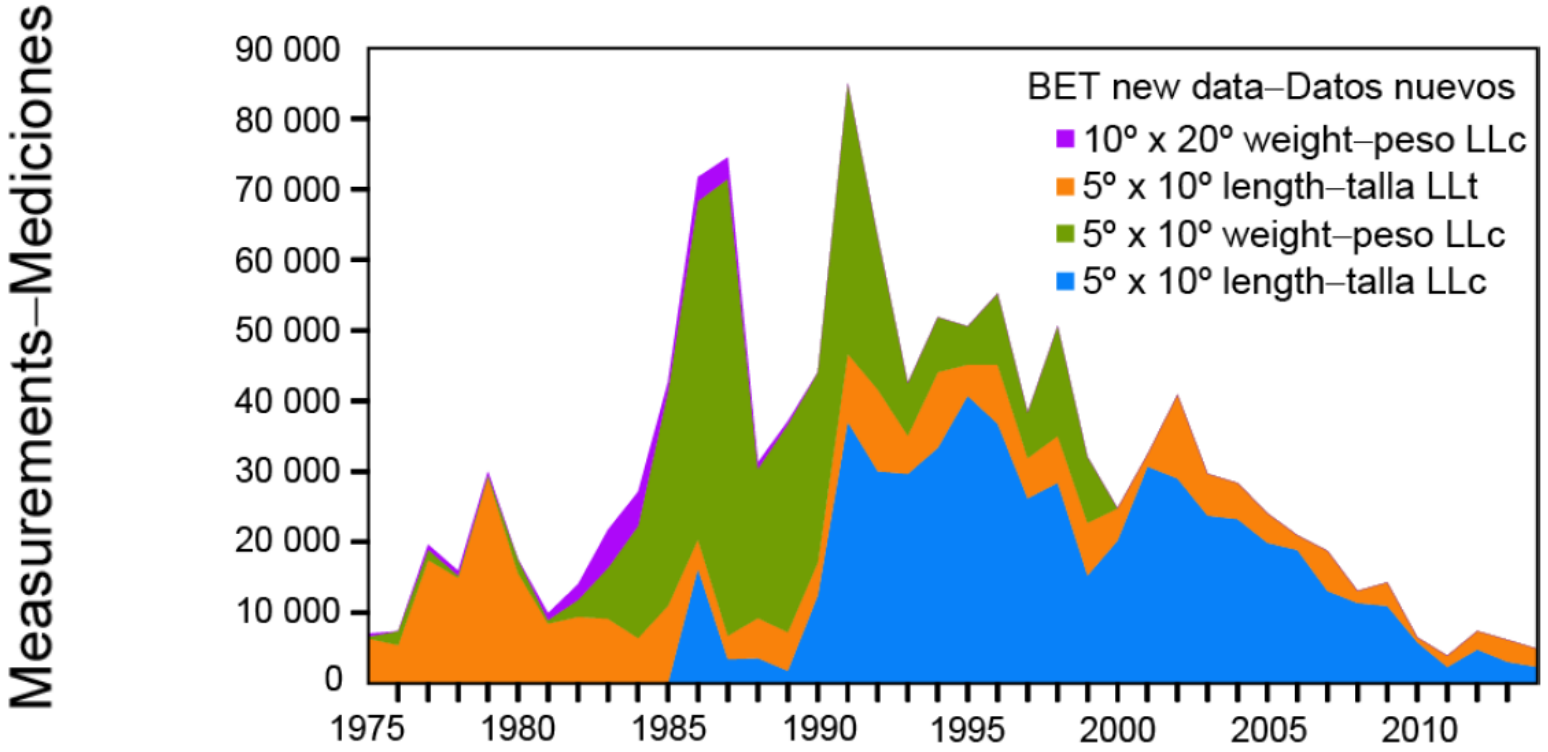
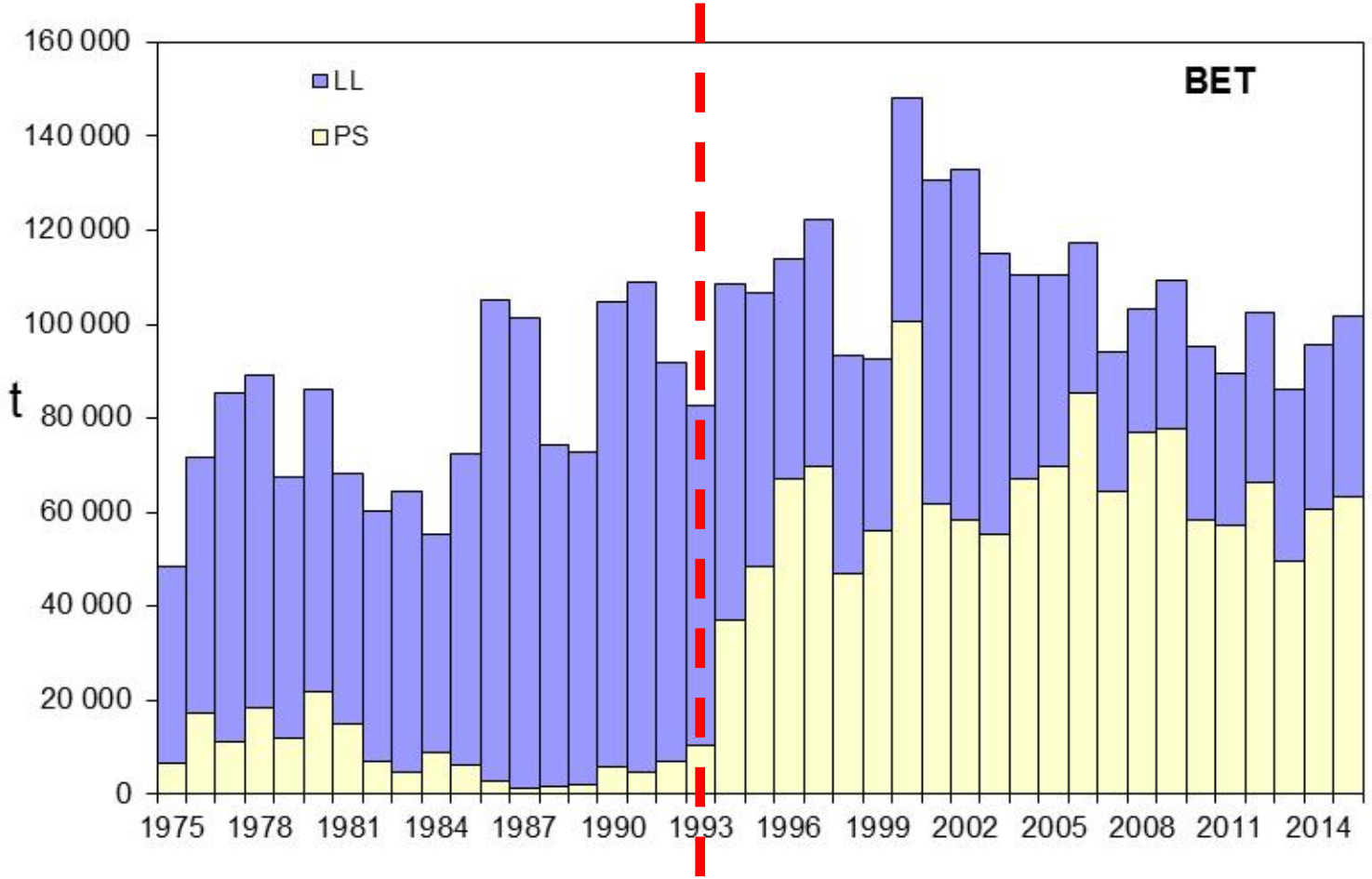


FIGURE 3. Number of size measurements of fish from the EPO during the stock assessment period (1975-2014), by species (yellowfin (YFT), top panel; bigeye (BET), bottom panel), type of vessel (LLc: commercial longline vessel; LLt: longline training vessel), spatial resolution (10° x 20° or 5° x 10°), and measurement type (weight: gilled-and-gutted weight; length: fork length).

Total catches

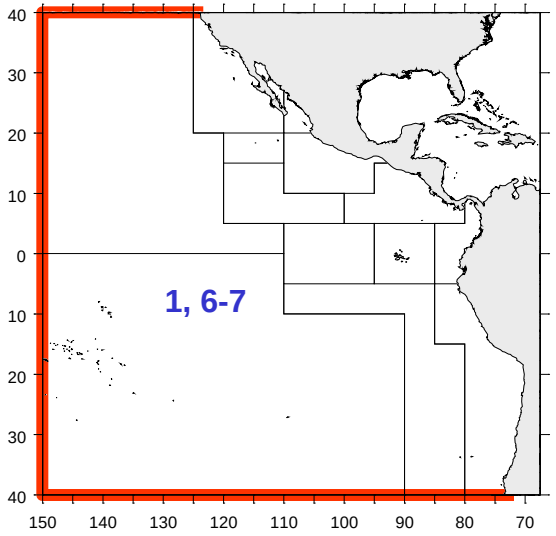


Expansion of FAD fishery

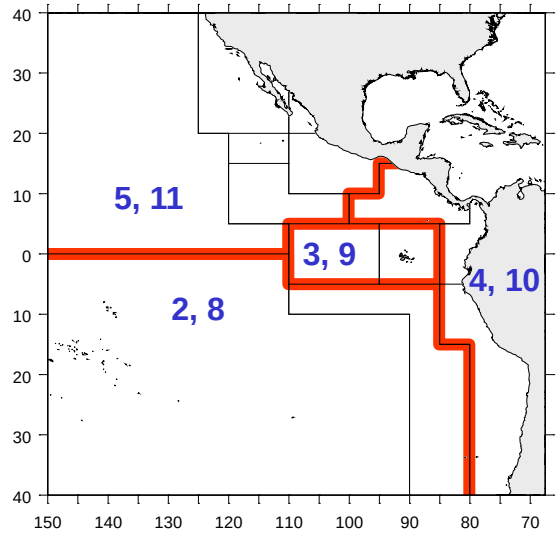
BET fishery definitions

19 fisheries

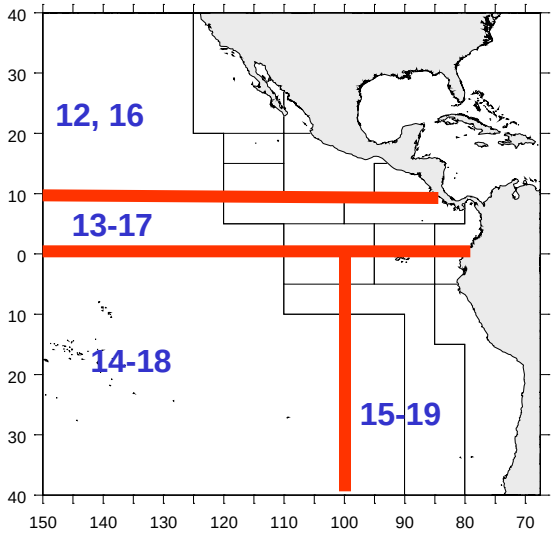
Early OBJ (1)
Early & Late DEL&NOA (6, 7)



Recent OBJ (2-5)
Discards (8-11)



LL N (12, 20)
LL C (13, 21)
LL S (14, 22)
LL I (15, 23)



GEAR TYPE: PS, LP, LL

PS set type (OBJ, NOA and DOL)

Time period

The IATTC sampling areas

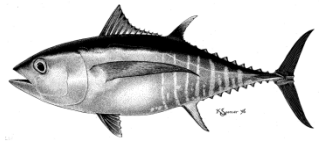
DEL – sets on dolphins

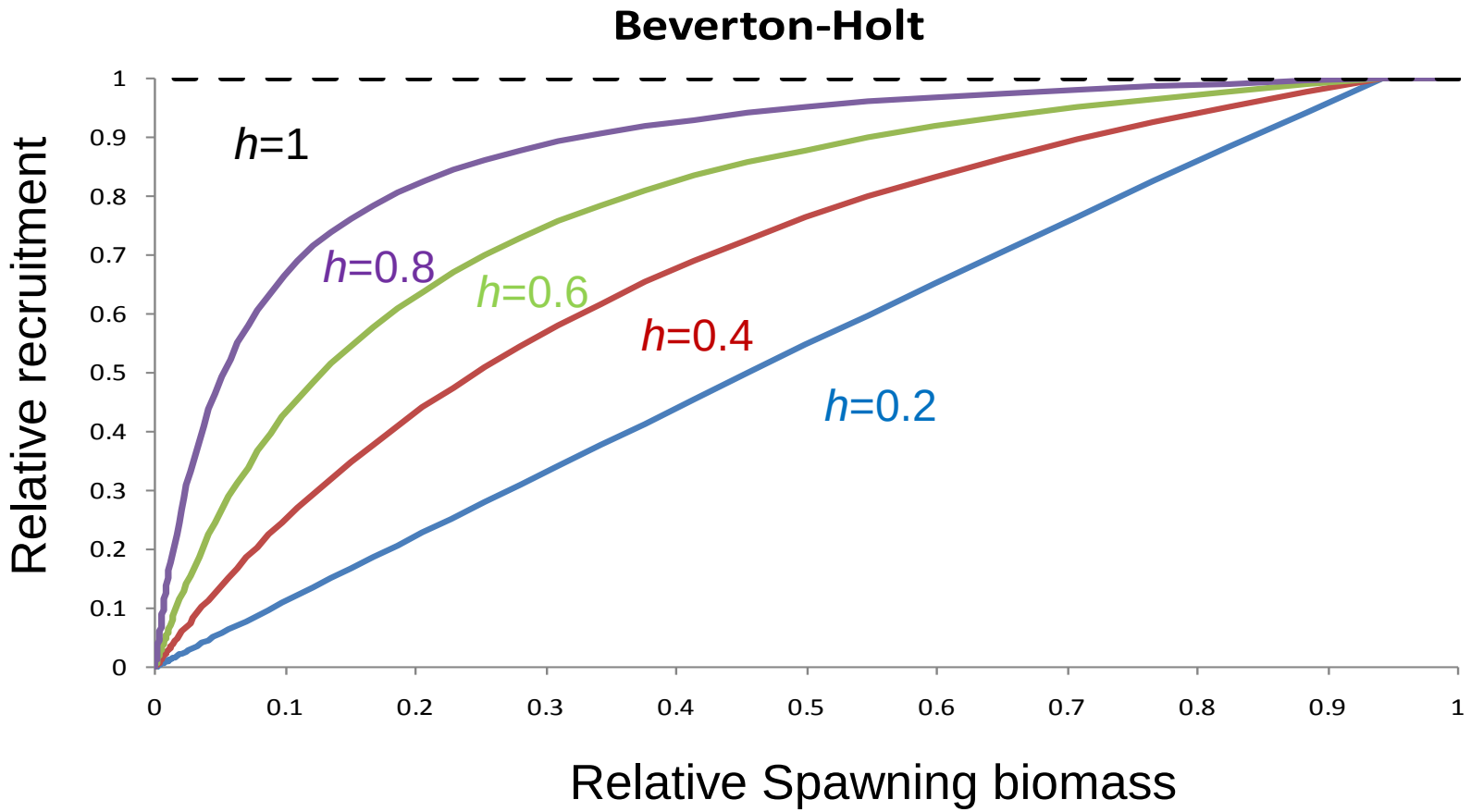
NOA – sets on unassociated fish

OBJ – sets on floating objects

LL – longline sets

Stock-recruitment relationship





- Base case assumes no S-R relationship (h = 1)
- Sensitivity analysis with h = 0.75 (**Appendix B**)

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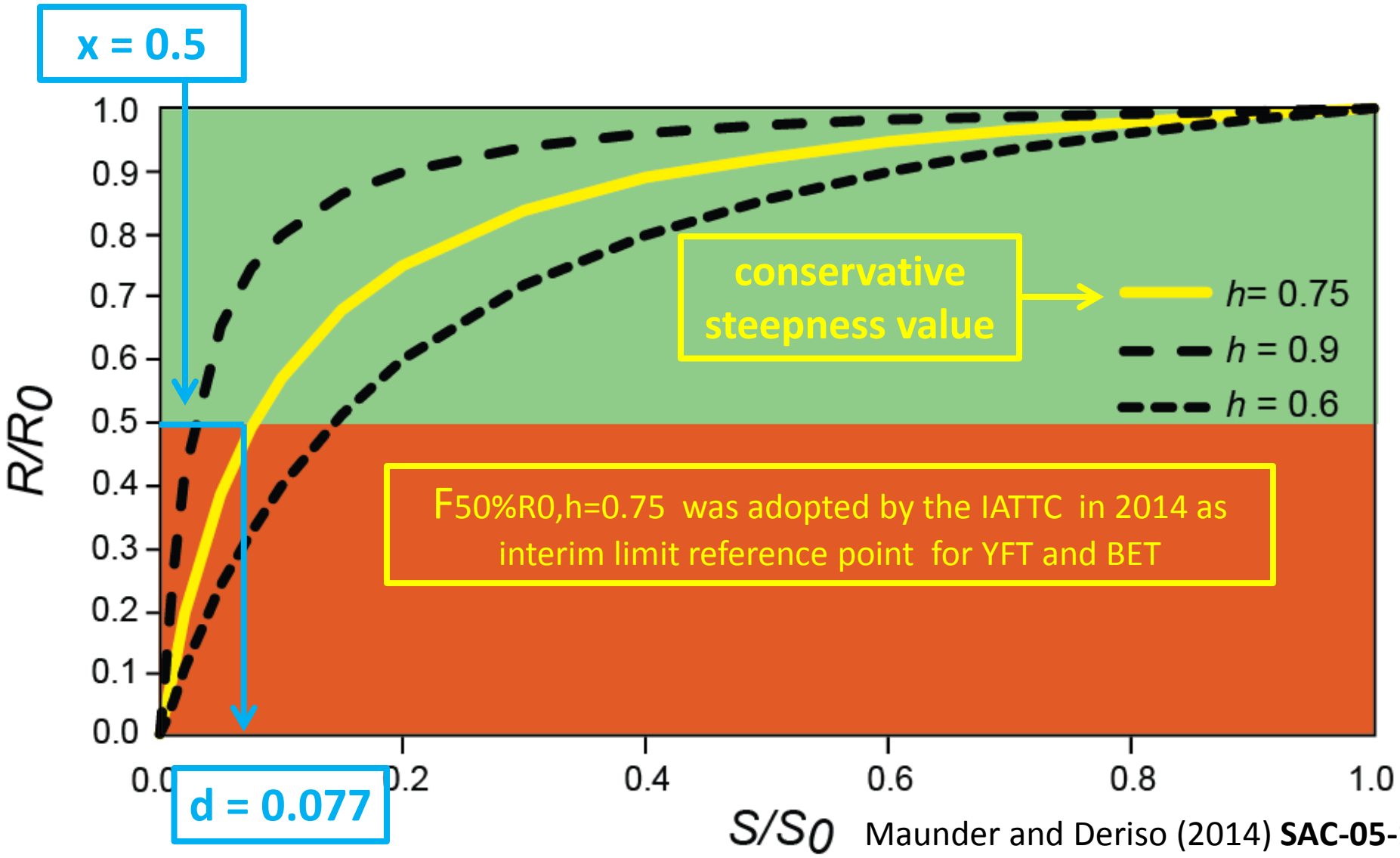
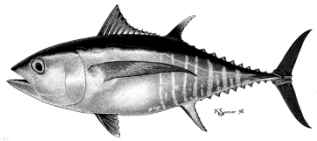
Limit reference point: IATTC



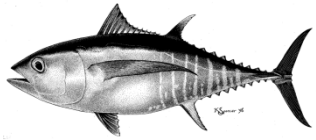
Maunder and Deriso (2014) **SAC-05-14**

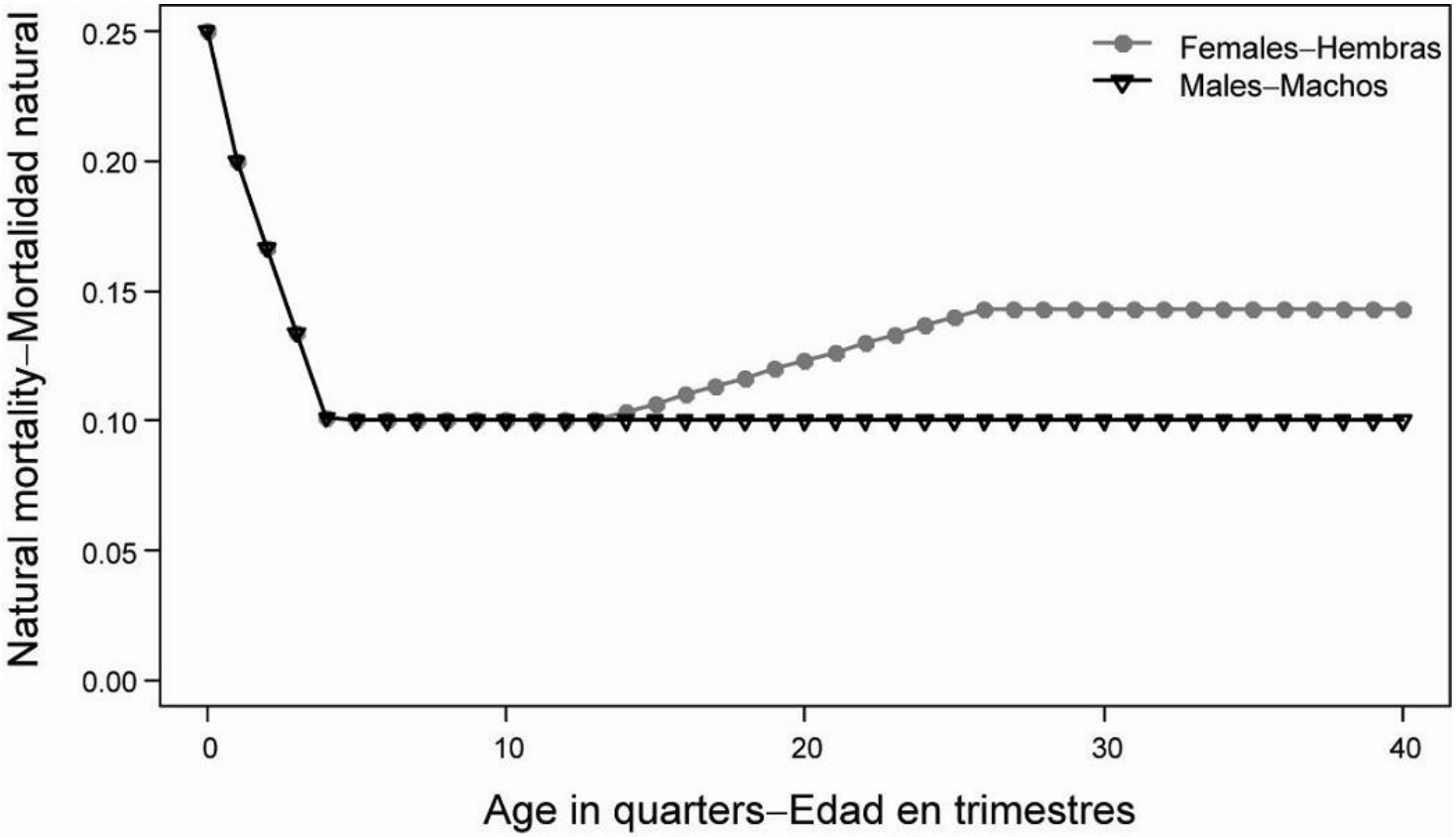
BET stock structure



- Minimal net movement of fish between the EPO and WCPO
- Single stock of bigeye in EPO
- Pacific-wide collaborative assessment with SPC and sensitivity analysis extending the western boundary of stock to 170°E
- See SPC Pacific-wide assessment and CPUE analysis

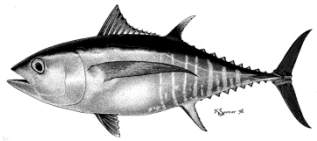
Natural mortality (*M*)





- Sensitivity analysis
  - Juvenile *M* (**Appendix E**)
  - Adult *M* (**Appendix F**)

Growth modeling



- New growth curve estimated externally, L_2 and variance of length-at-age fixed

Fisheries Research 163 (2015) 119–126

Contents lists available at ScienceDirect

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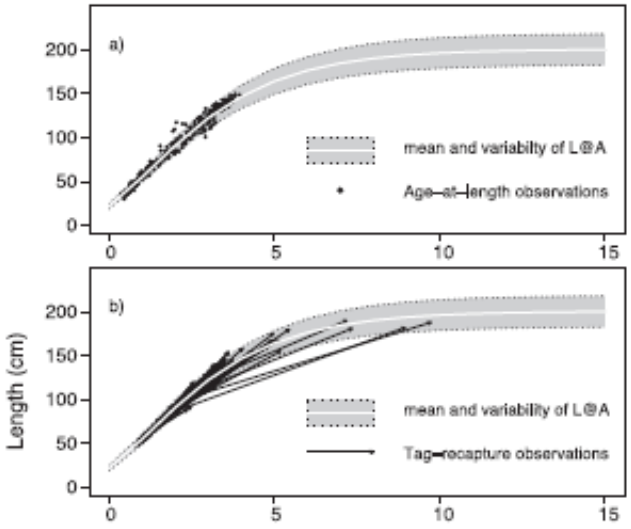
journal homepage: www.elsevier.com/locate/fishres

Improved growth estimates from integrated analysis of direct aging and tag–recapture data: An illustration with bigeye tuna (*Thunnus obesus*) of the eastern Pacific Ocean with implications for management

Alexandre M. Aires-da-Silva*, Mark N. Maunder, Kurt M. Schaefer, Daniel W. Fuller

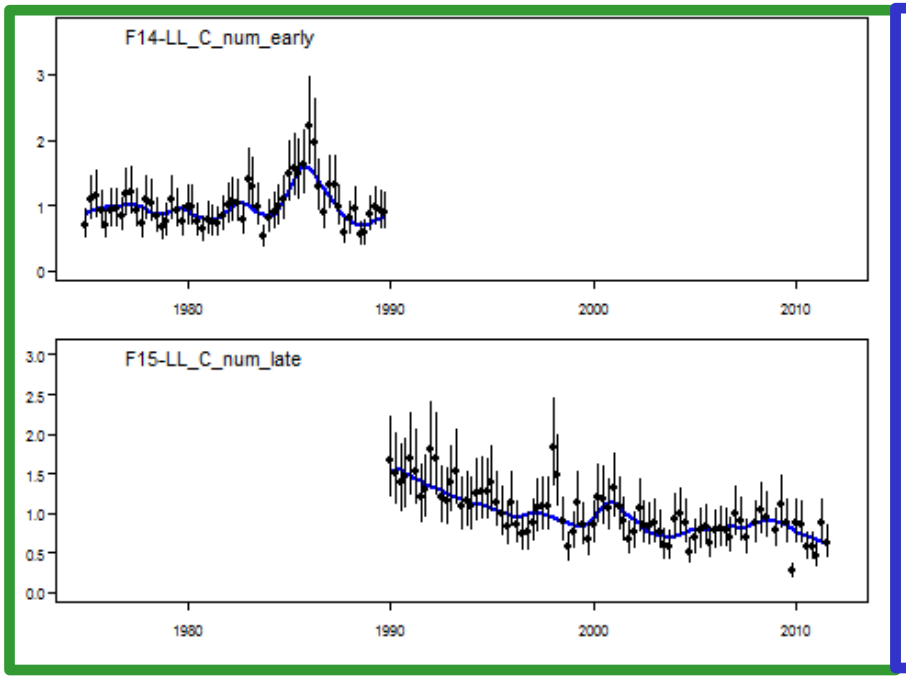
Inter-American Tropical Tuna Commission, 8901 La Jolla Shores Drive, La Jolla, CA 92037-1508, United States

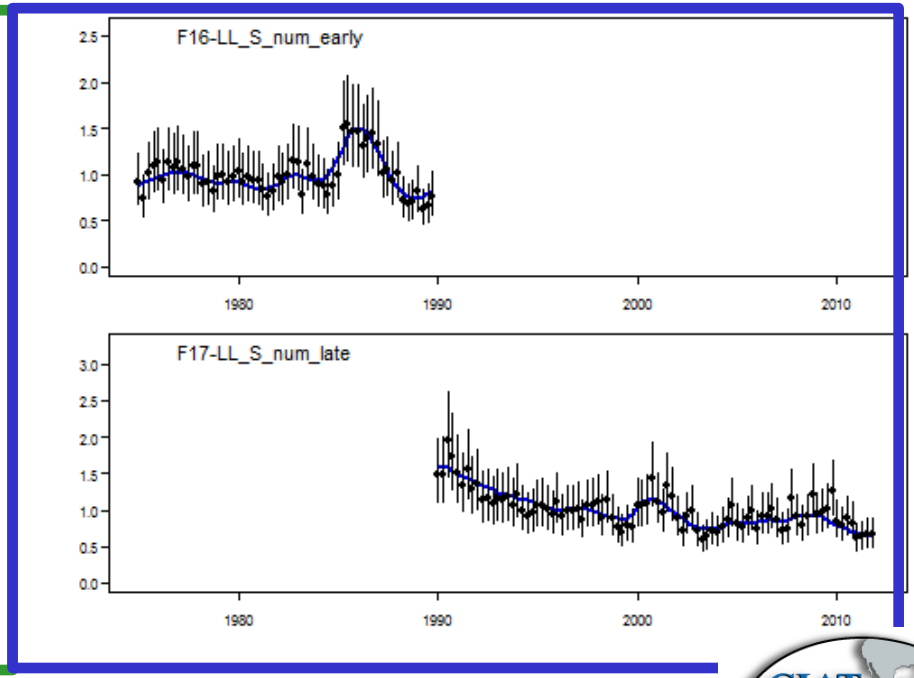


- Sensitivity analysis to lower L_2 values (**Appendix D**)

Catchability

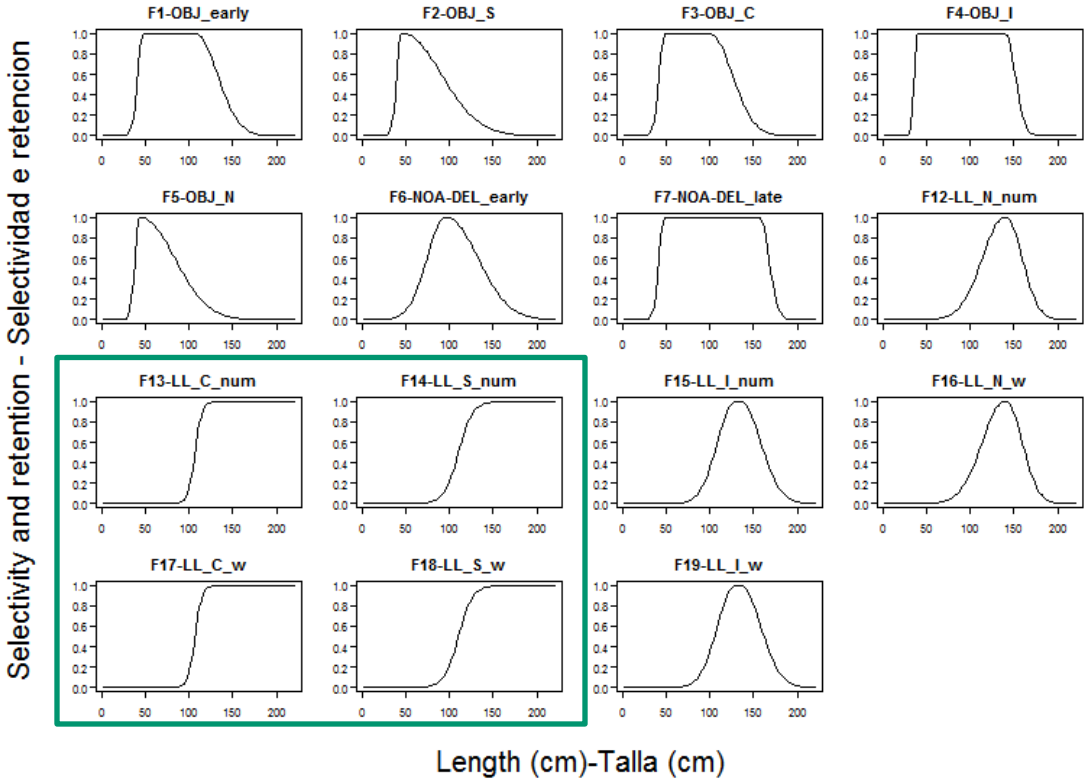
- Drop use of two time blocks for LL fisheries
- One single historic period of Q for all LL fisheries (1975-2015)





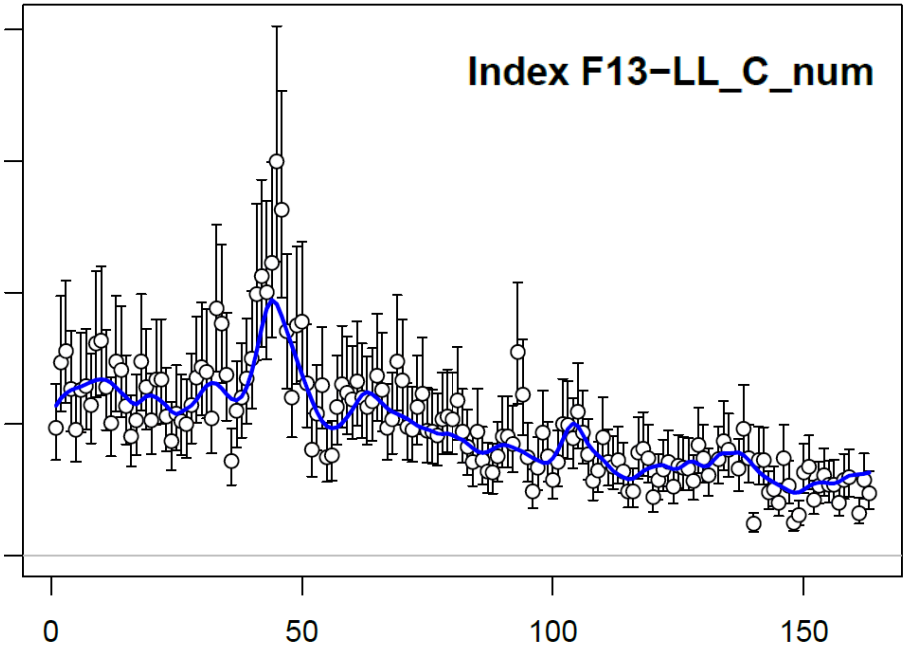
Selectivity

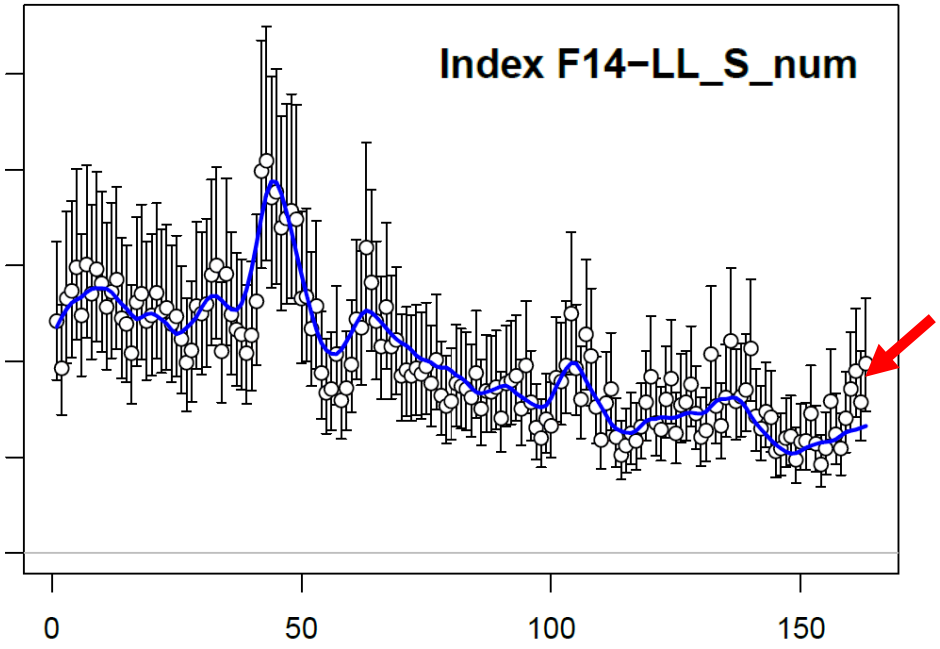
- Drop use of two time blocks for LL fisheries
- Asymptotic selectivities (LL-C, LL-S), dome-shape (LL-N, LL-I)
- Dome-shape selectivity for all surface fisheries



Data weighting (CPUE)

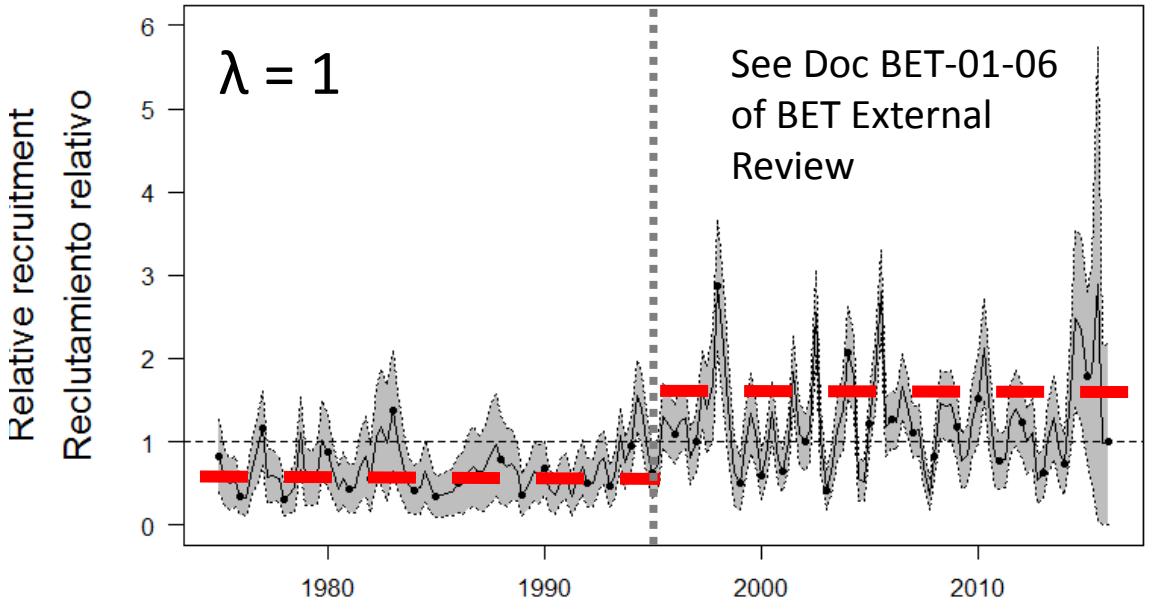
- Fit to Central and Southern LL CPUE series (CV=0.15)
- No fit to purse-seine CPUE





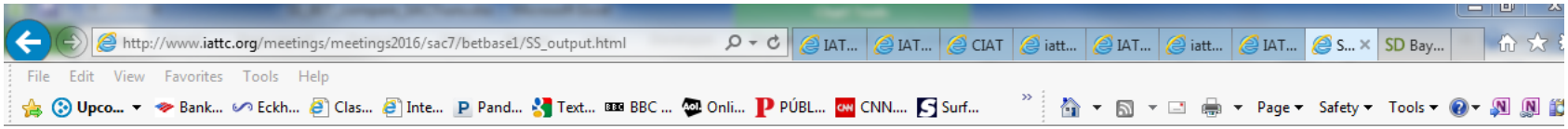
Data weighting (composition)

- Attempt to upweight the size composition data for all fisheries (λ = 1)



- Maintaining weighting of size composition data for all fisheries as in SAC6 base case (λ = 0.05)
- Do sensitivity runs with alternative weighting (**Appendix B**)

New SS output report



Home | Bio | Sel | Timeseries | RecDev | S-R | Catch | SPR | Index | Numbers | CompDat | LenComp | A@LComp | Yield | Data

EPO Bigeye Tuna 2016 Base Case Assessment

The assessment was conducted using Stock Synthesis (SS). These web pages provide information created automatically by the R4SS program. They also provide the SS output files and files used to run the stock assessment. The information contained in these web pages and files, or any content derived from them, should not be publically redistributed without the permission of the IATTC.

IATTC bigeye tuna stock assessment document

The SS output is also available as a pdf

SS model files in zip archive

SS output files in zip archive

SS version: SS-V3.23b-safe-win64;_11/05/2011;_Stock_Synthesis_by_Richard_Methot_(NOAA)_using_ADMB_10

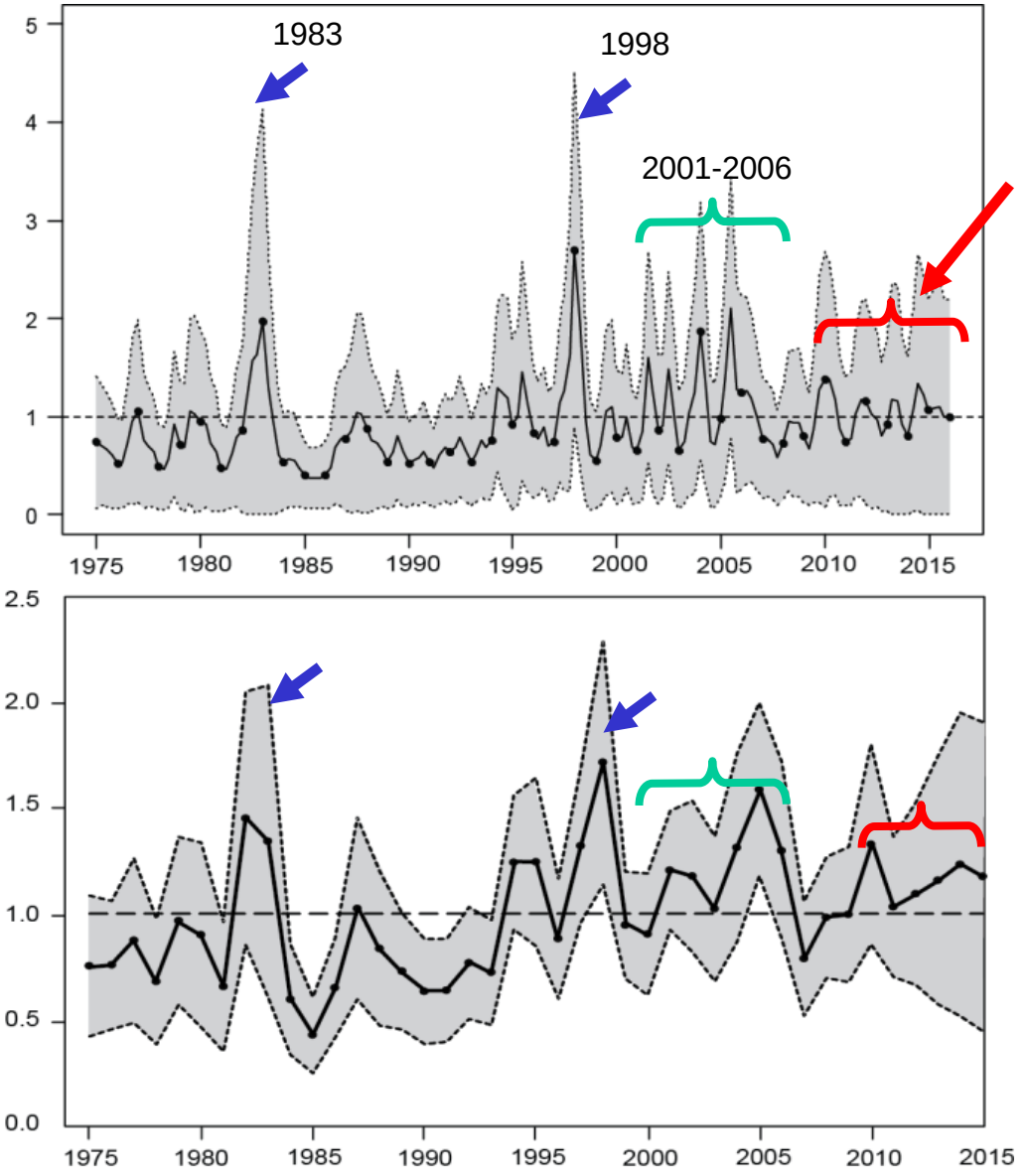
Starting time of model: Thu Apr 14 15:28:23 2016

Warnings (from file warnings.sso):

```
 Early recdev biasadj is >2 times ratio of rmse to sigmaR
 Early recdev biasadj is >2 times ratio of rmse to sigmaR
 N warnings: 2
Number_of_active_parameters_on_or_near_bounds: 0
```

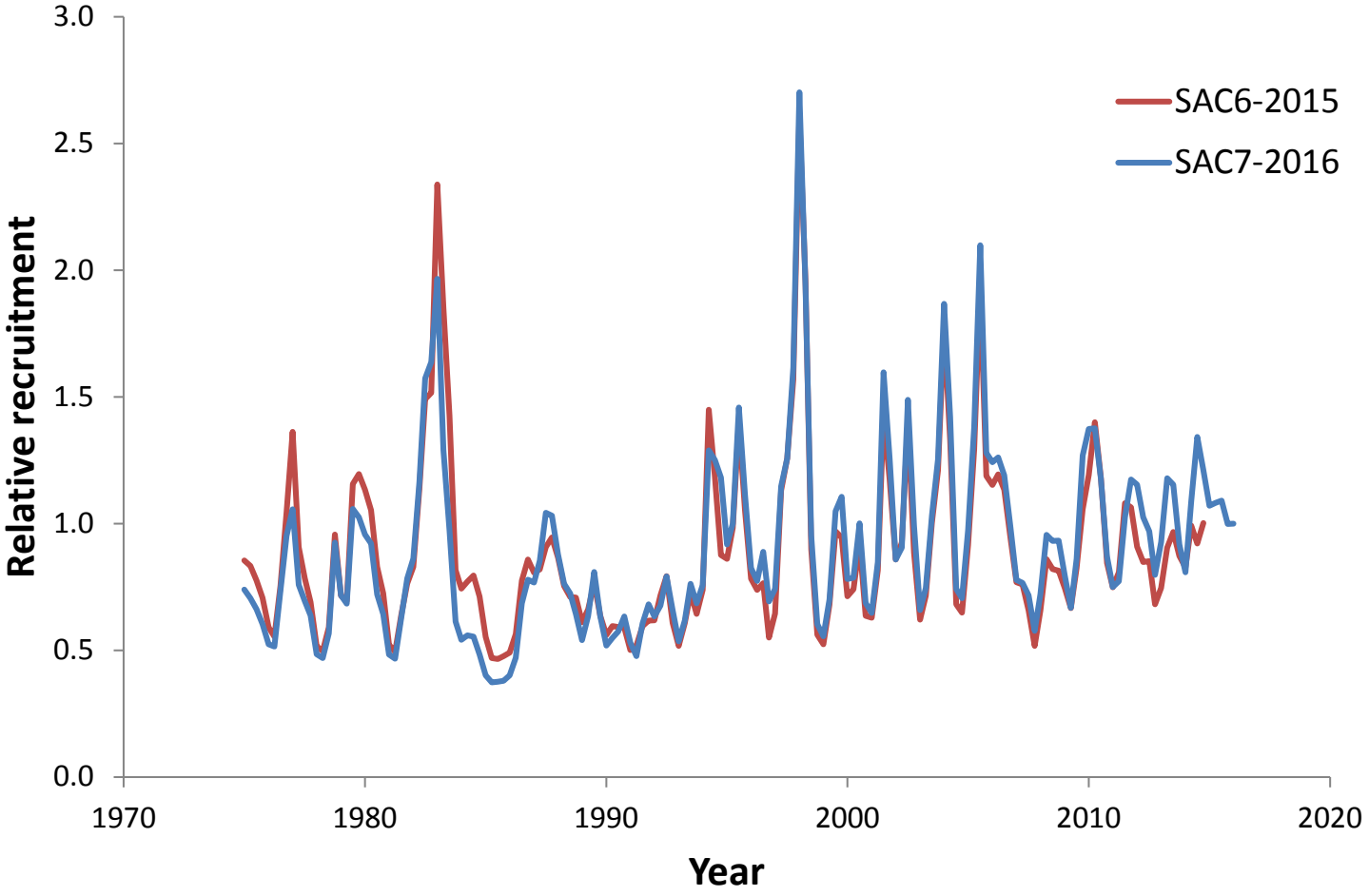
Recruitment

Results (base case)



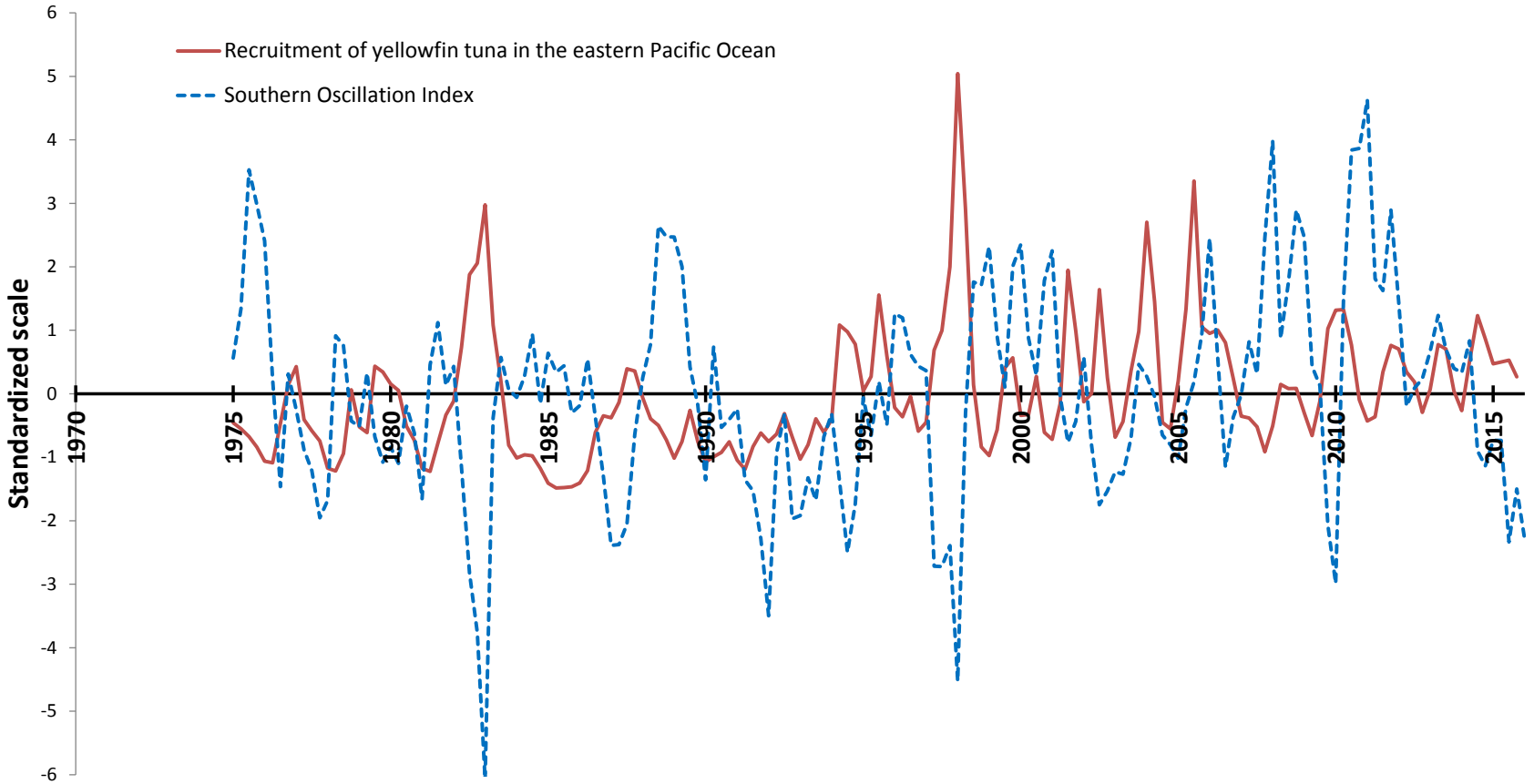
Recruitment – comparisons with previous assessment

Results (base case)



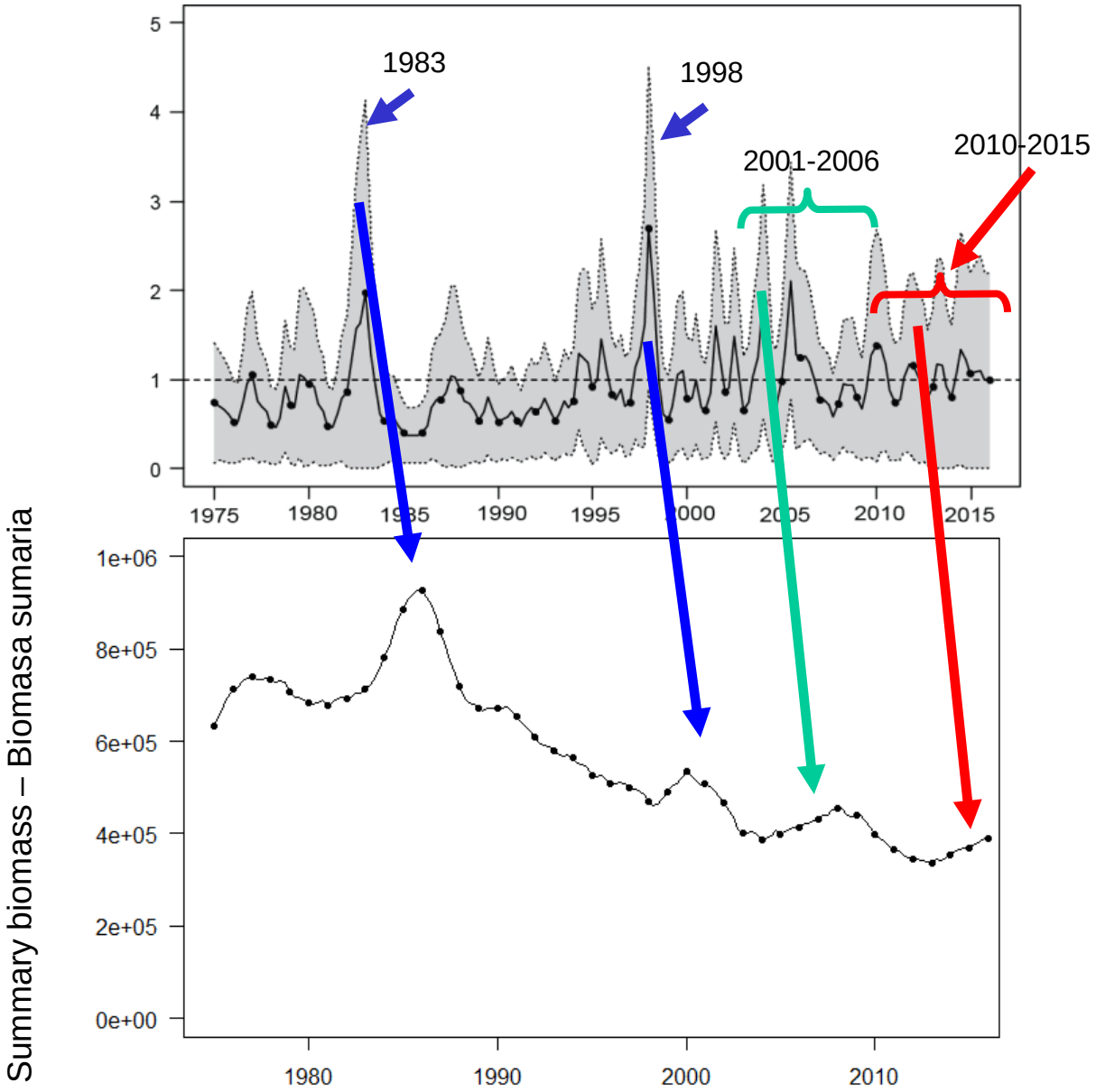
Recruitment and environment

Results
(base case)



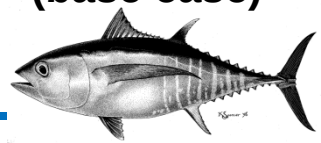
Summary biomass

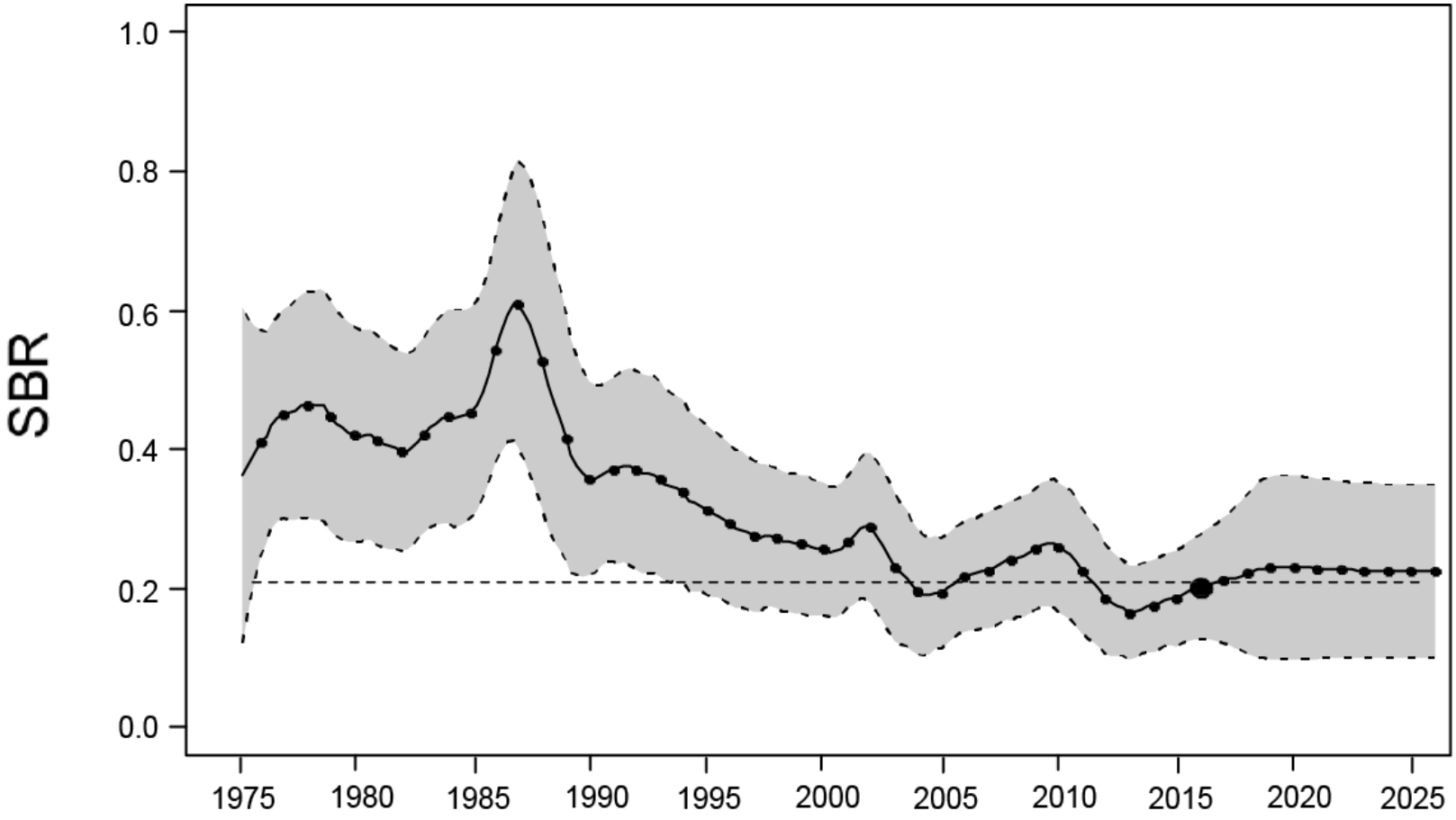
Results (base case)



Spawning Biomass Ratio (SBR)

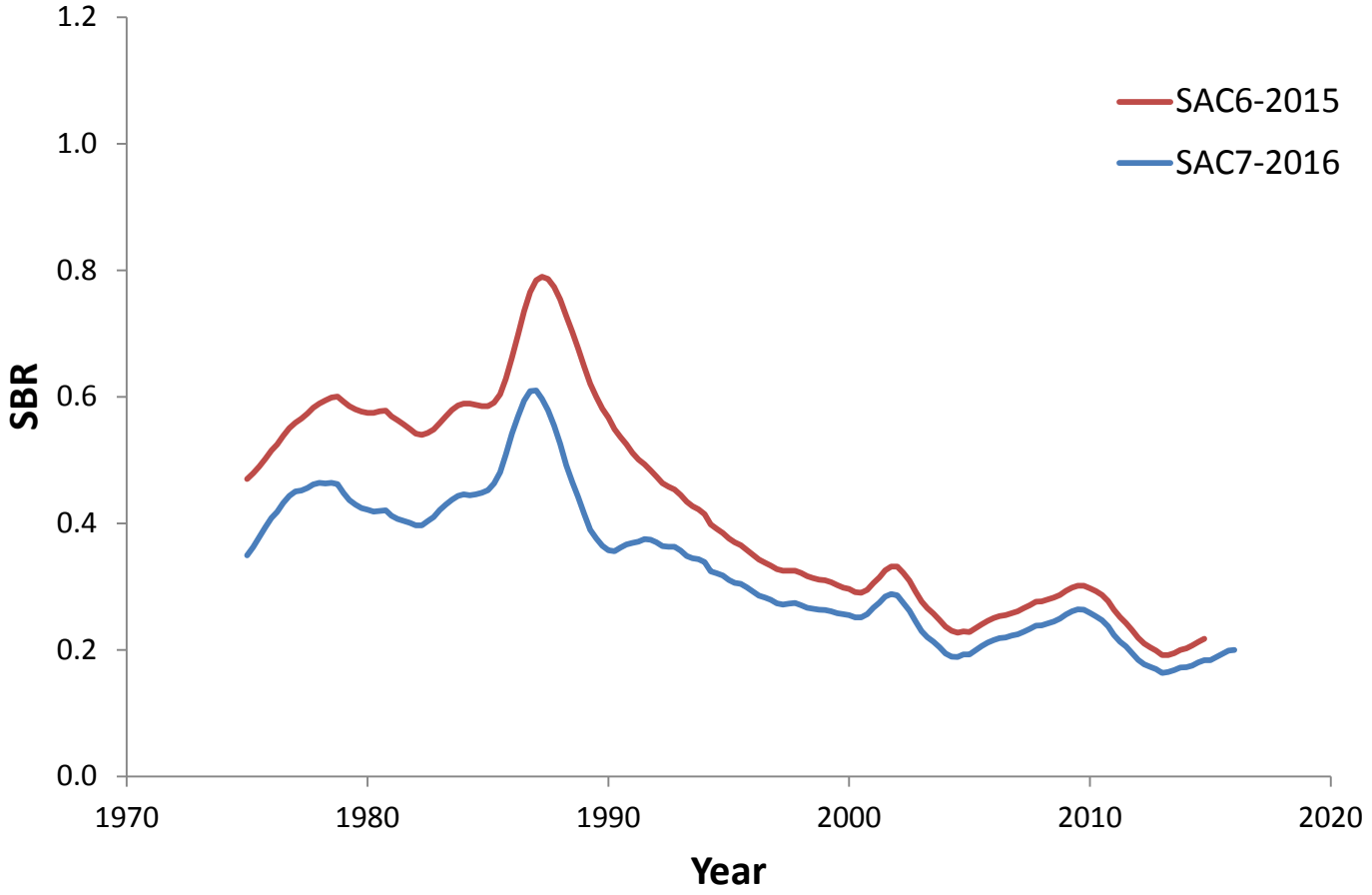
Stock status (base case)





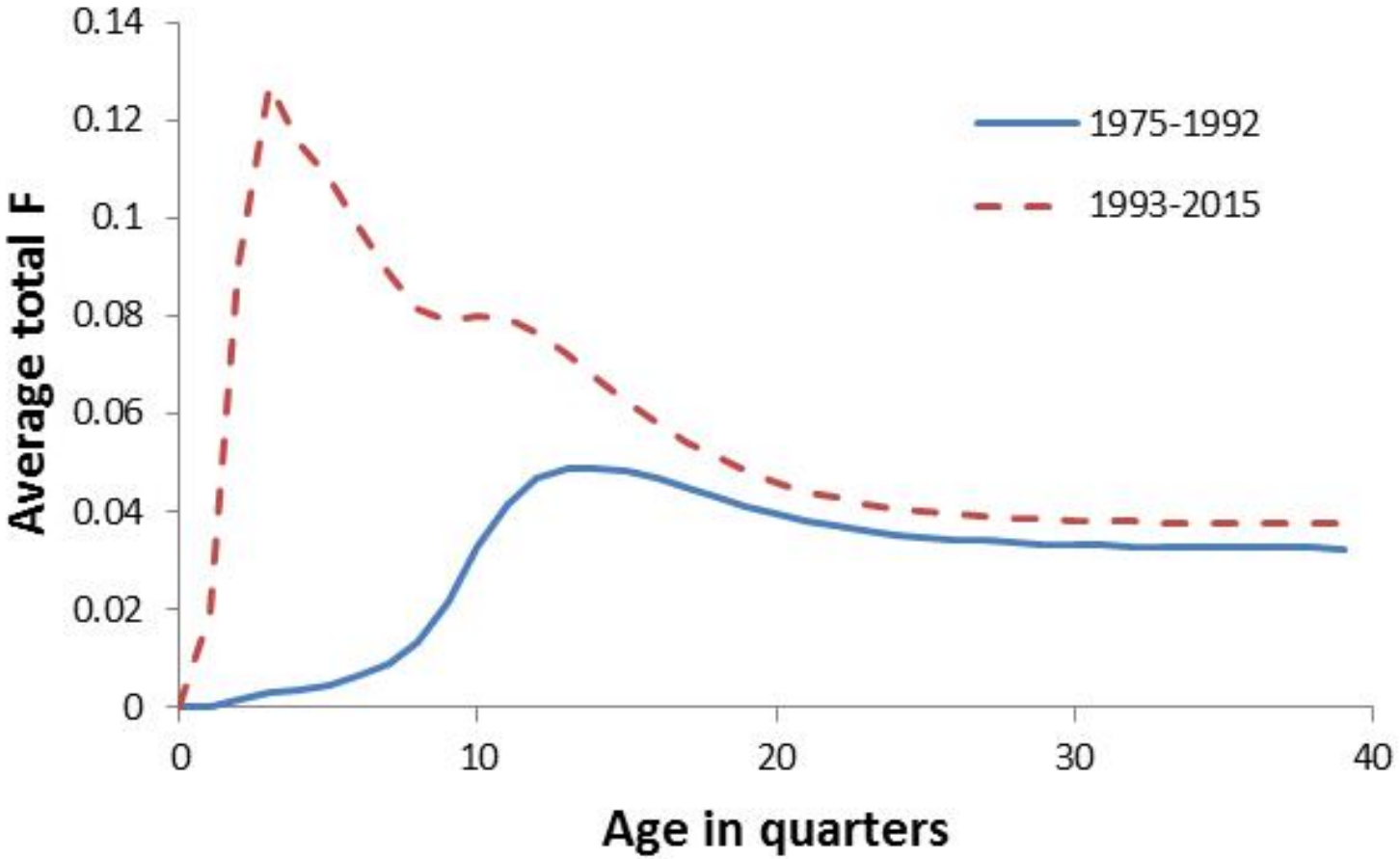
SBR – comparisons with previous assessment

Results (base case)



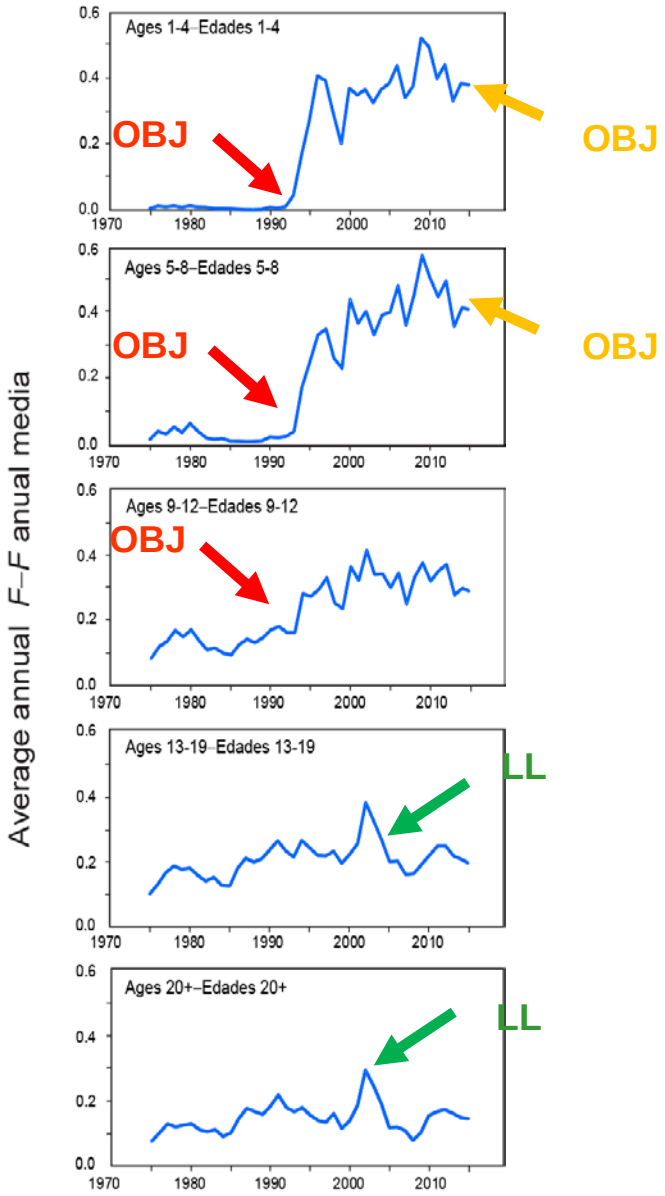
Age-specific fishing mortality

Results
(base case)



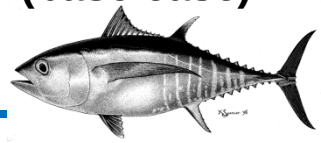
Fishing mortality (F)

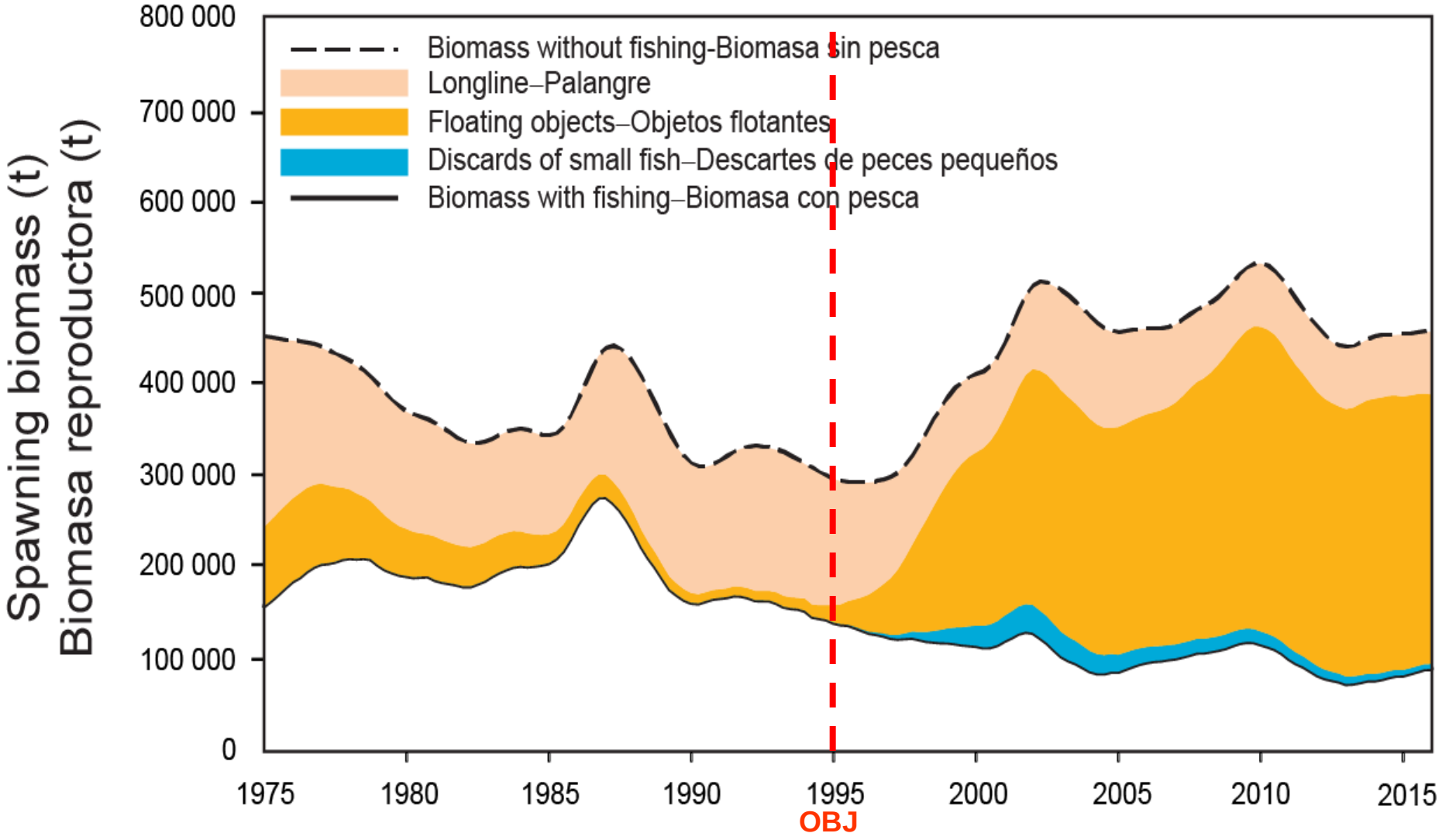
Results (base case)



Fishery impact

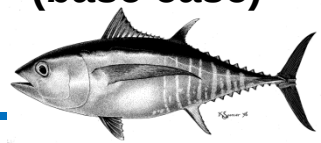
Results
(base case)

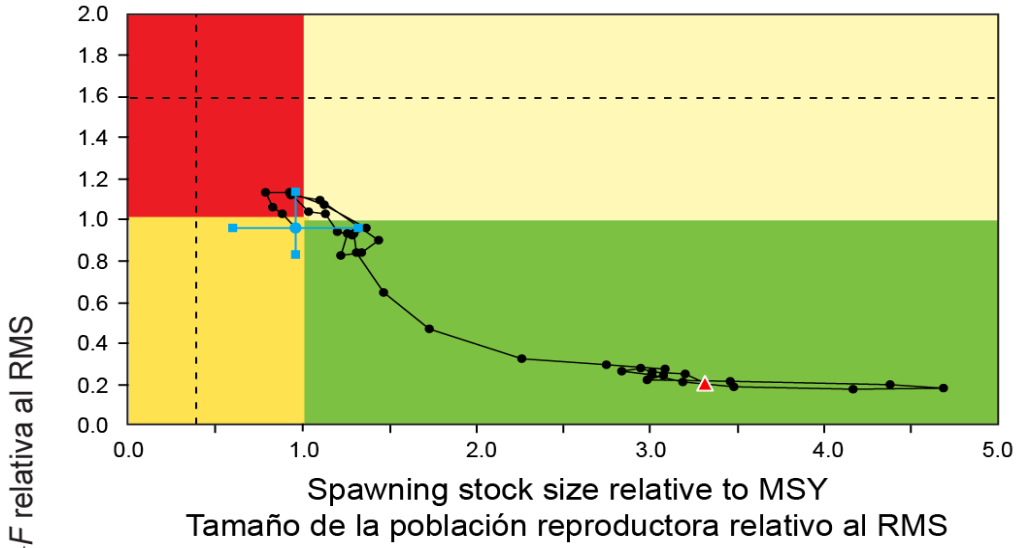


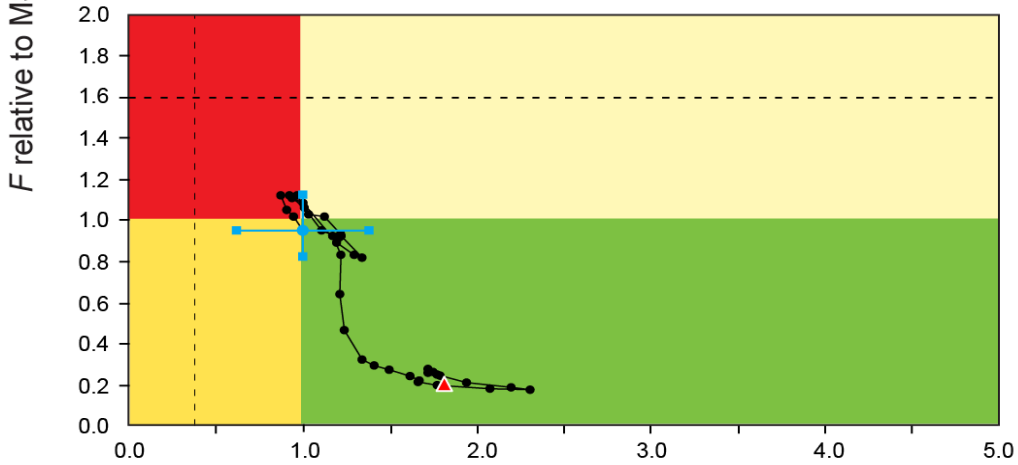


Target and Limit Kobe plot

Stock status (base case)







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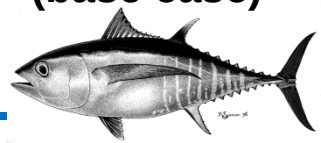
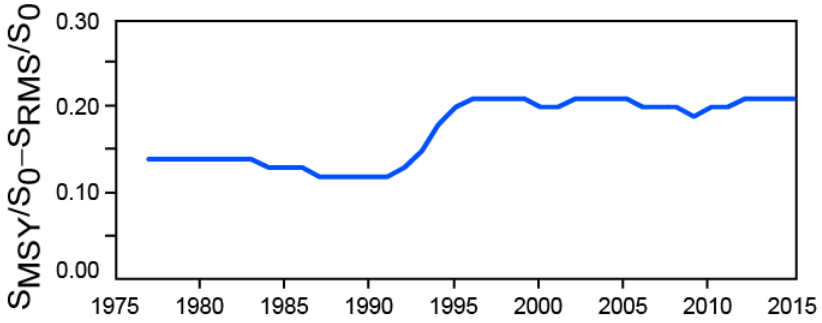
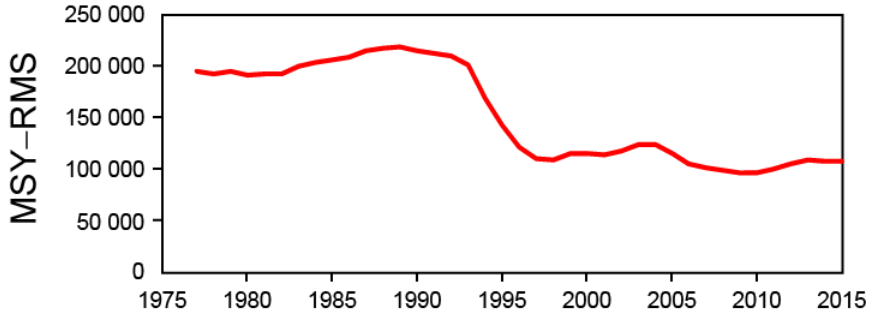
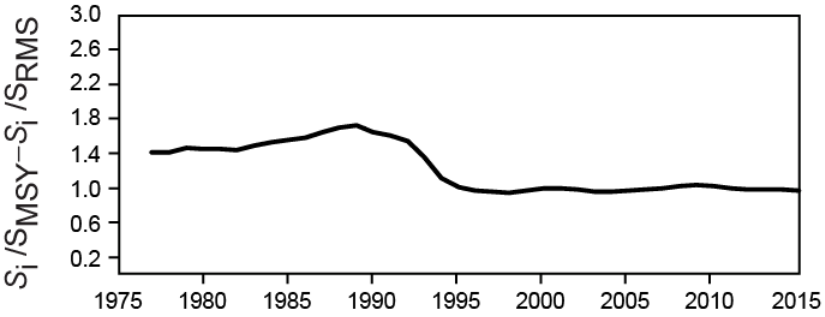
Time varying indicators

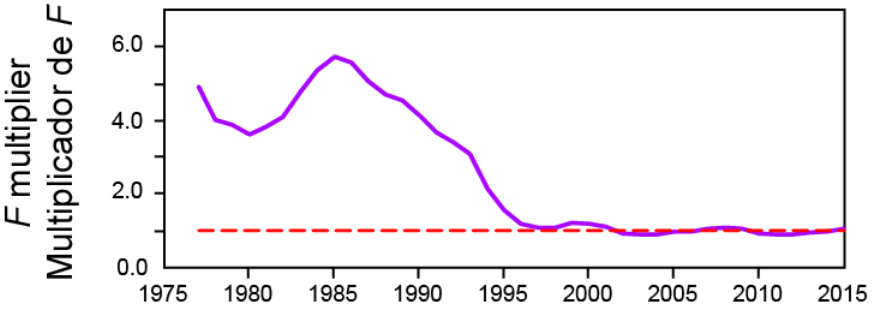
Stock status (base case)



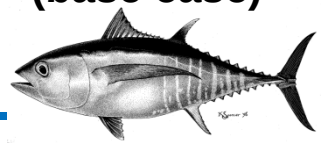








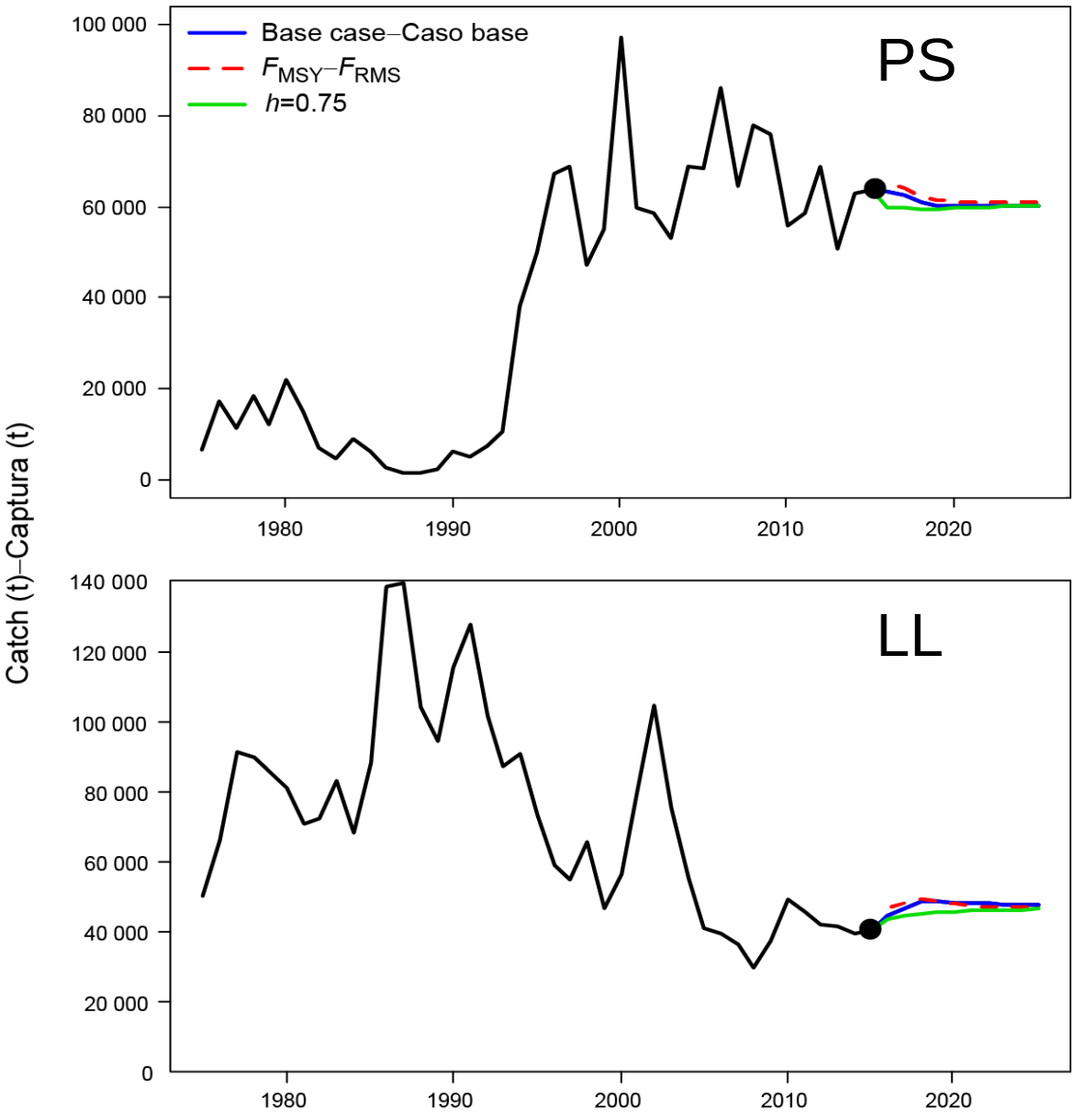
Management quantities

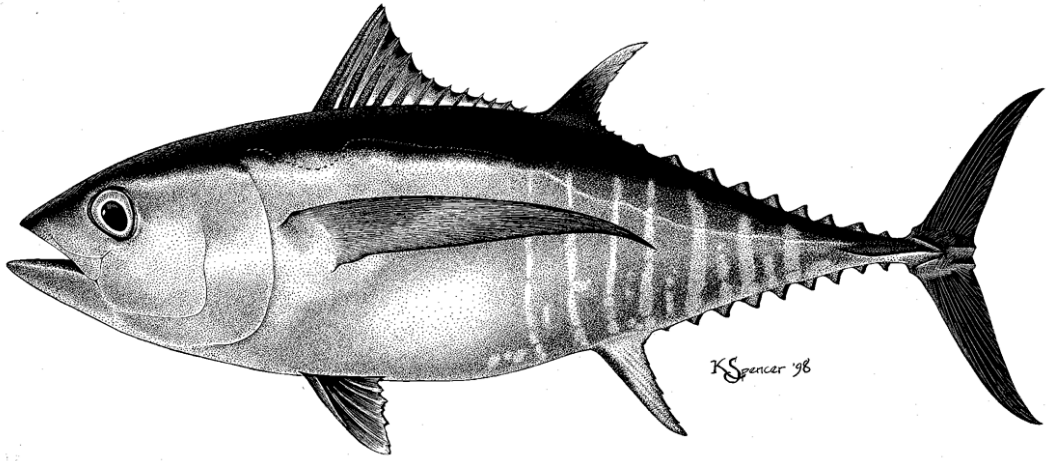


	Base case- Caso base
MSY-RMS	107,864
B_{MSY}- B_{RMS}	389,211
S_{MSY}- S_{RMS}	95,101
B_{MSY}/B_0- B_{RMS}/B_0	0.26
S_{MSY}/S_0- S_{RMS}/S_0	0.21
C_{recent}/MSY- C_{recent}/RMS	0.97
B_{recent}/B_{MSY}- B_{recent}/B_{RMS}	1.00
S_{recent}/S_{MSY}-S_{recent}/S_{RMS}	0.96
F multiplier- Multiplicador de *F*	1.05

CIAT
IATTC

Projected catches – *Status quo* (F_{cur})

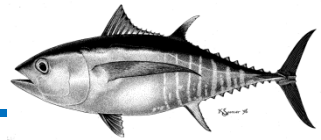




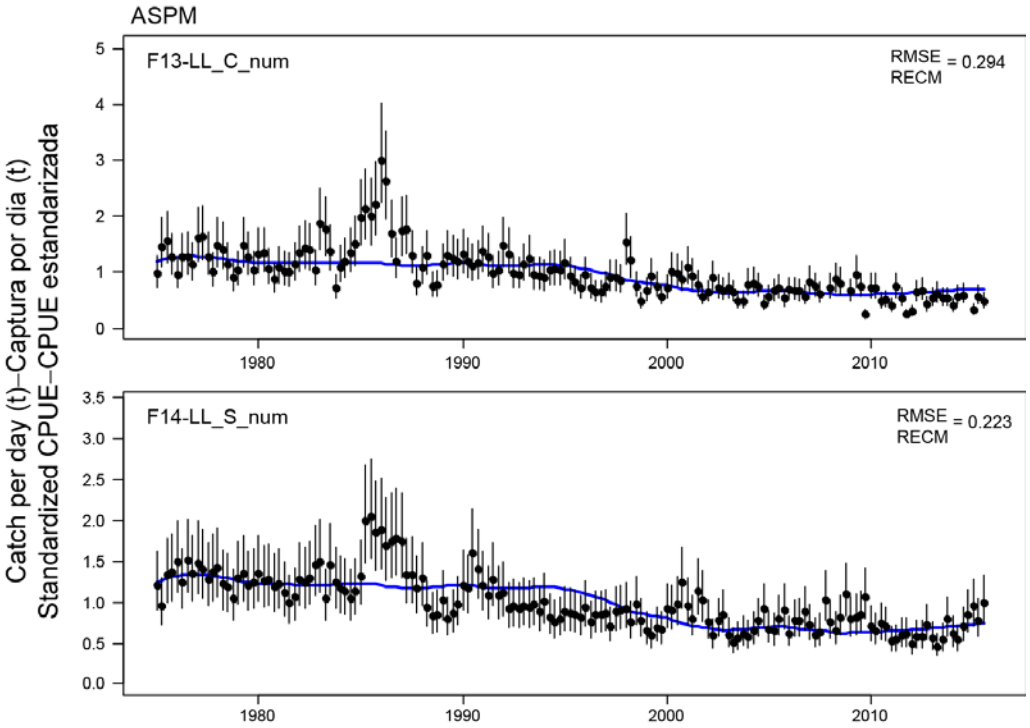
Diagnostics

- Age-structured production model (ASPM) diagnostic

ASPM diagnostic
no recruitment deviates



- Can catch alone explain the trends in CPUE
  - General decline over time with OBJ expansion,
  - Model unable to fit major fluctuations in abundance cause by recruitment



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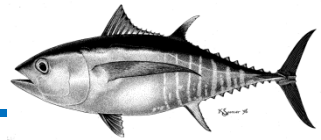
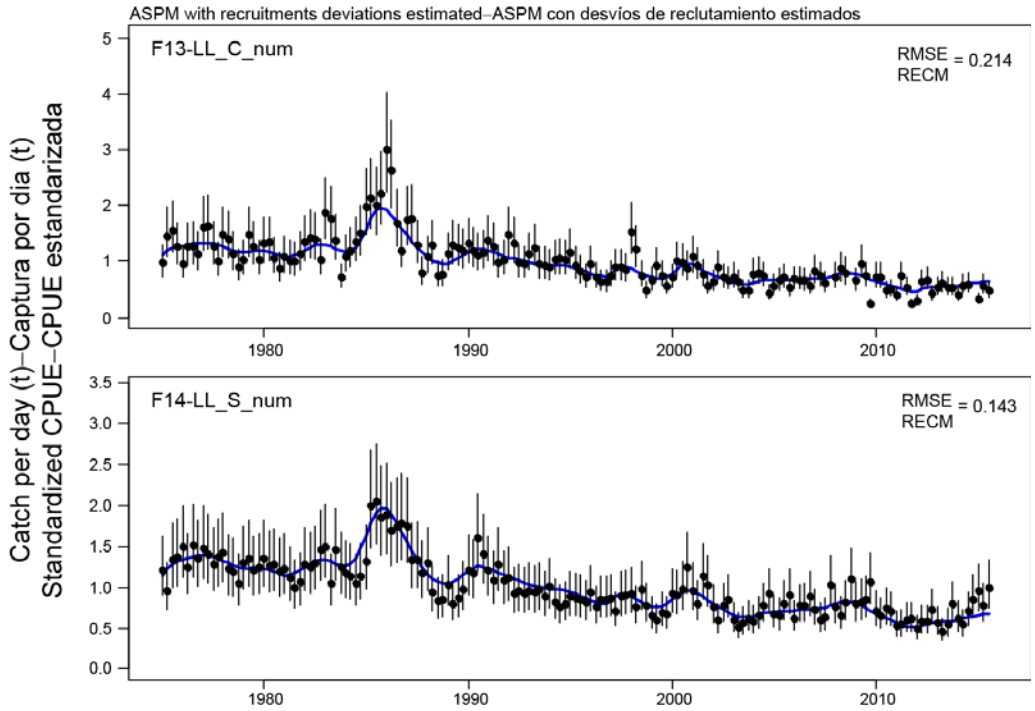
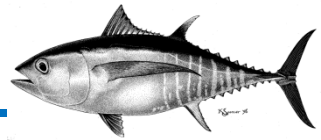
ASPM diagnostic with recruitment deviates estimated



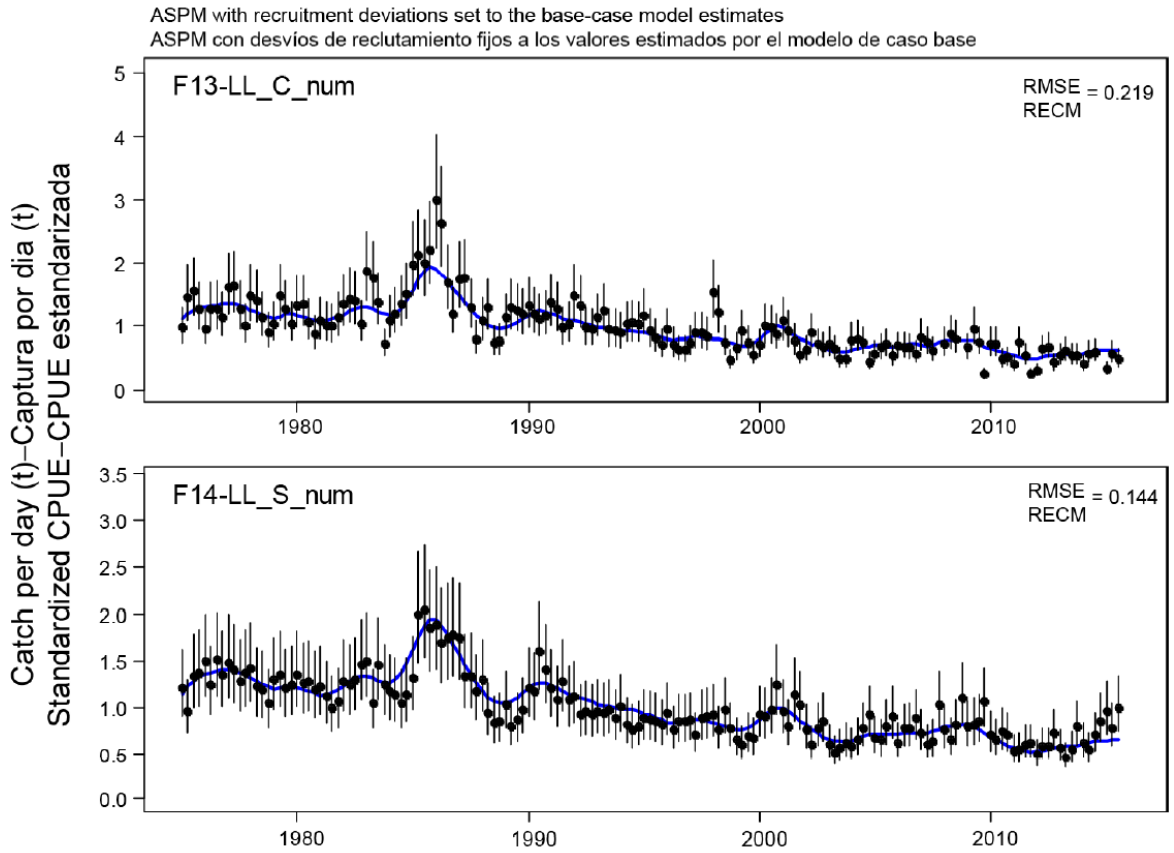
- Model able to fit major fluctuations in abundance caused by recruitment



ASPM diagnostic with recruitment deviates fixed

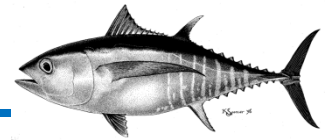


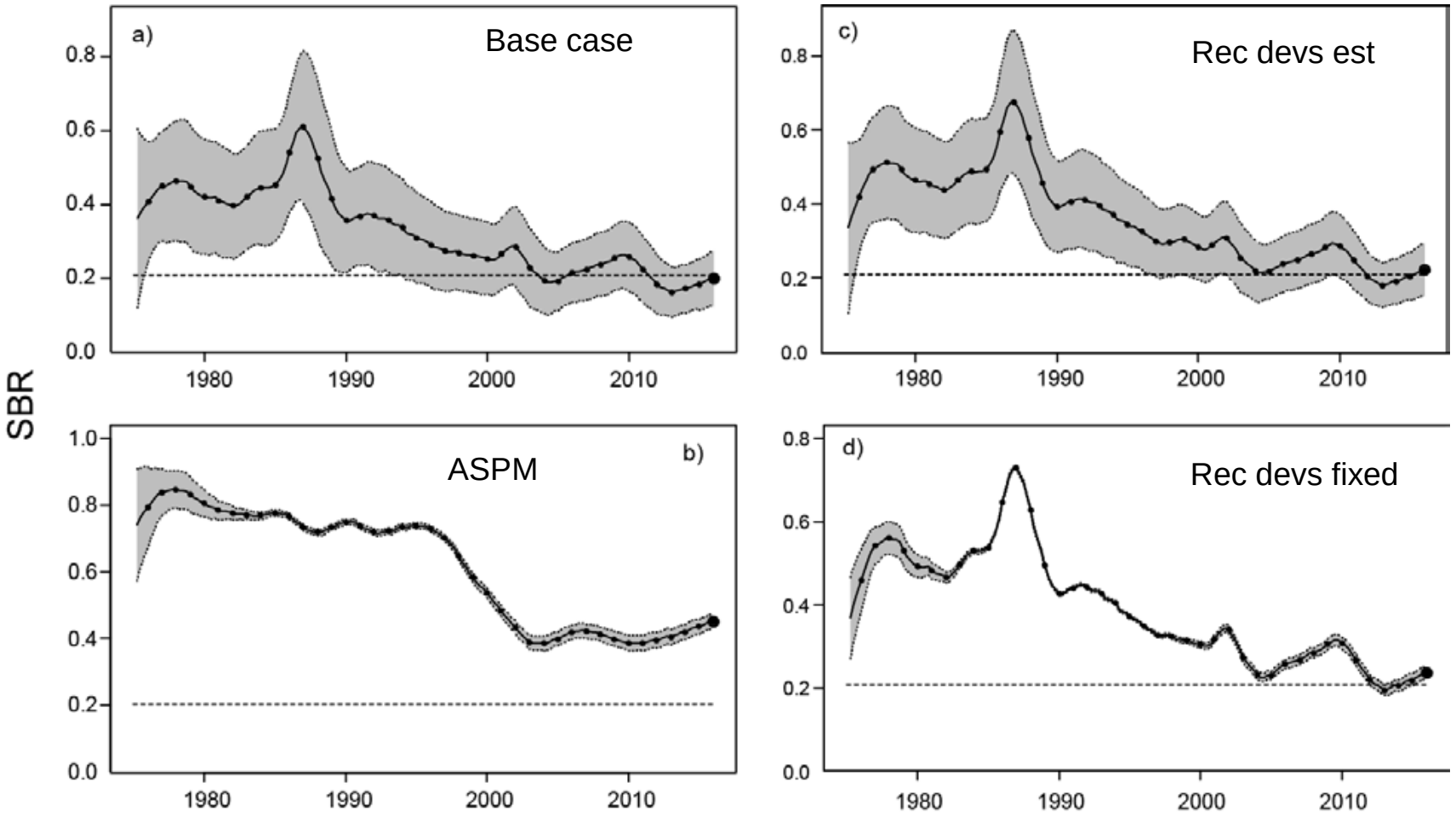
- Model able to fit major fluctuations in abundance caused by recruitment
- The composition data are having little influence on absolute abundance and relative trends

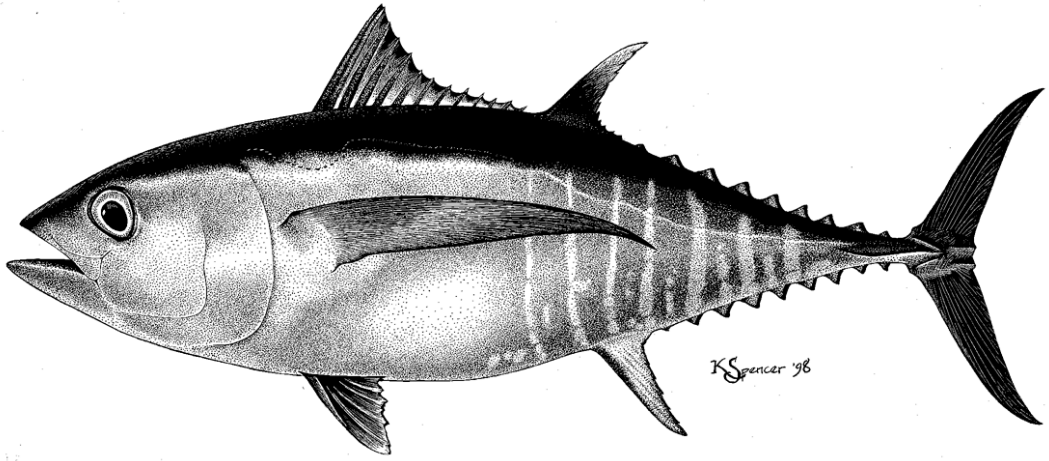


ASPM diagnostic

SBR comparisons (uncertainty)

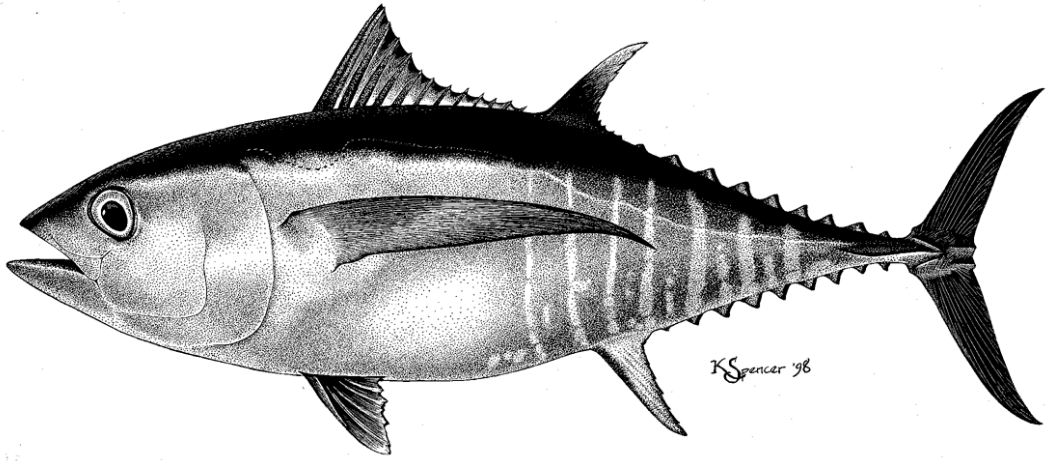






Sensitivity analyses

- Steepness of SR relationship (Appendix B)
- Weighting assigned to the size-composition data (Appendix C)
- Lower values of average size of oldest fish (L_2) (Appendix D)
- Higher rates of juvenile *M* (Appendix E)
- Lower and higher rates of adult *M* (Appendix F)



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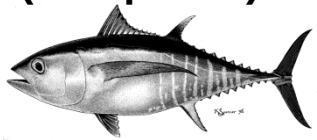
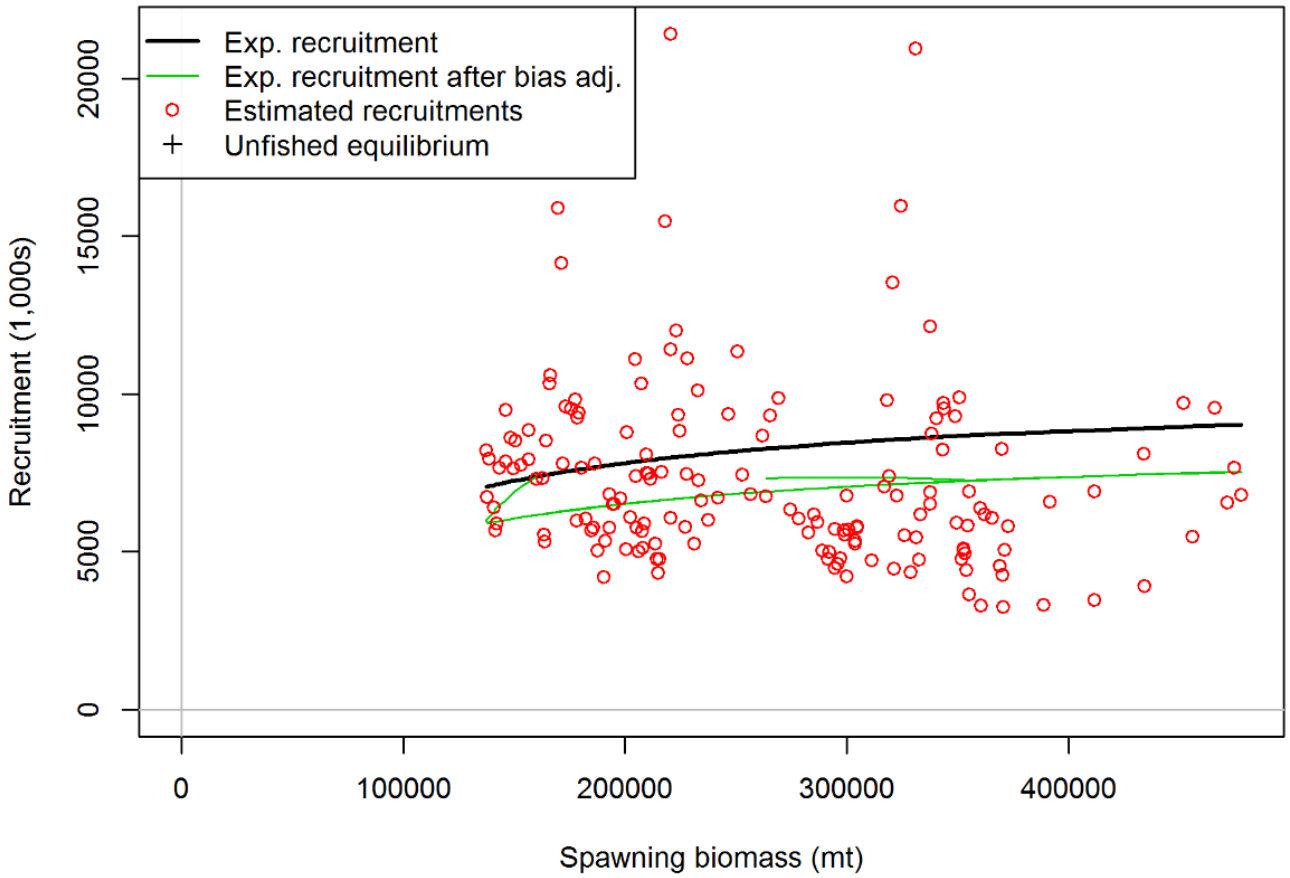
Spawner-recruitment curve

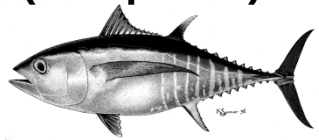
Sensitivities (Steepness)

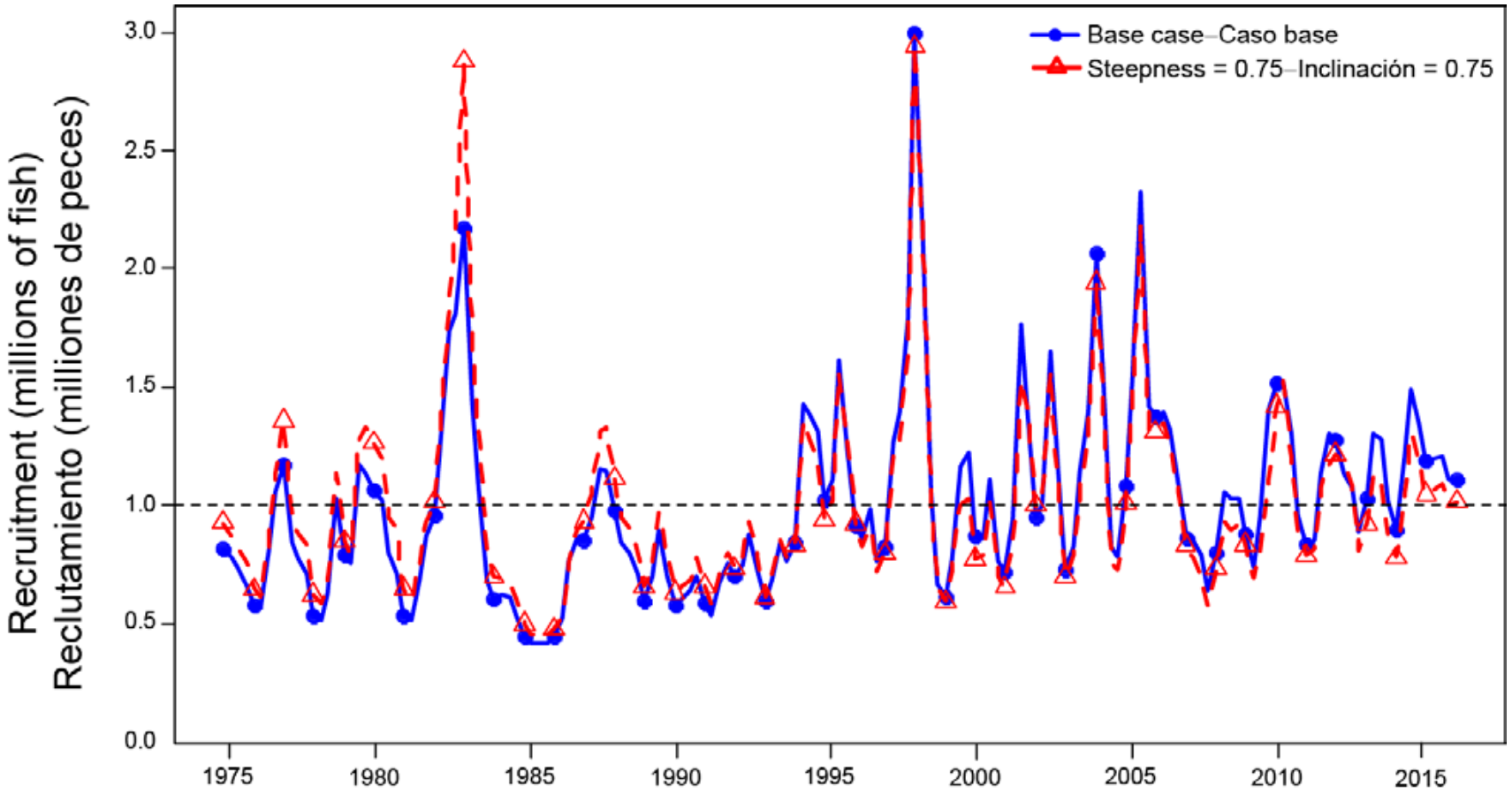




Recruitment

Sensitivities (Steepness)





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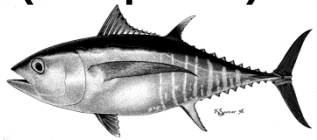
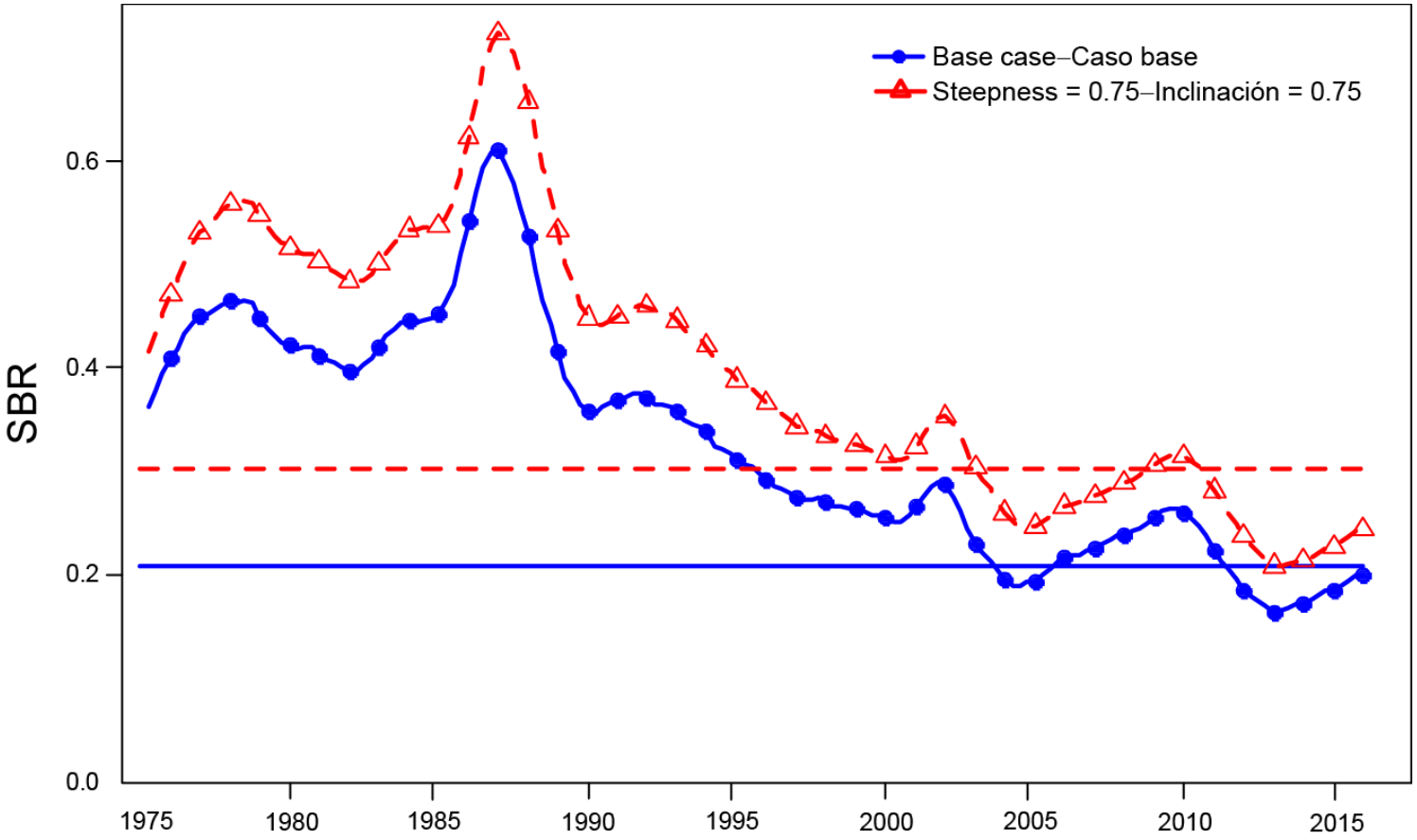
Spawning biomass ratio

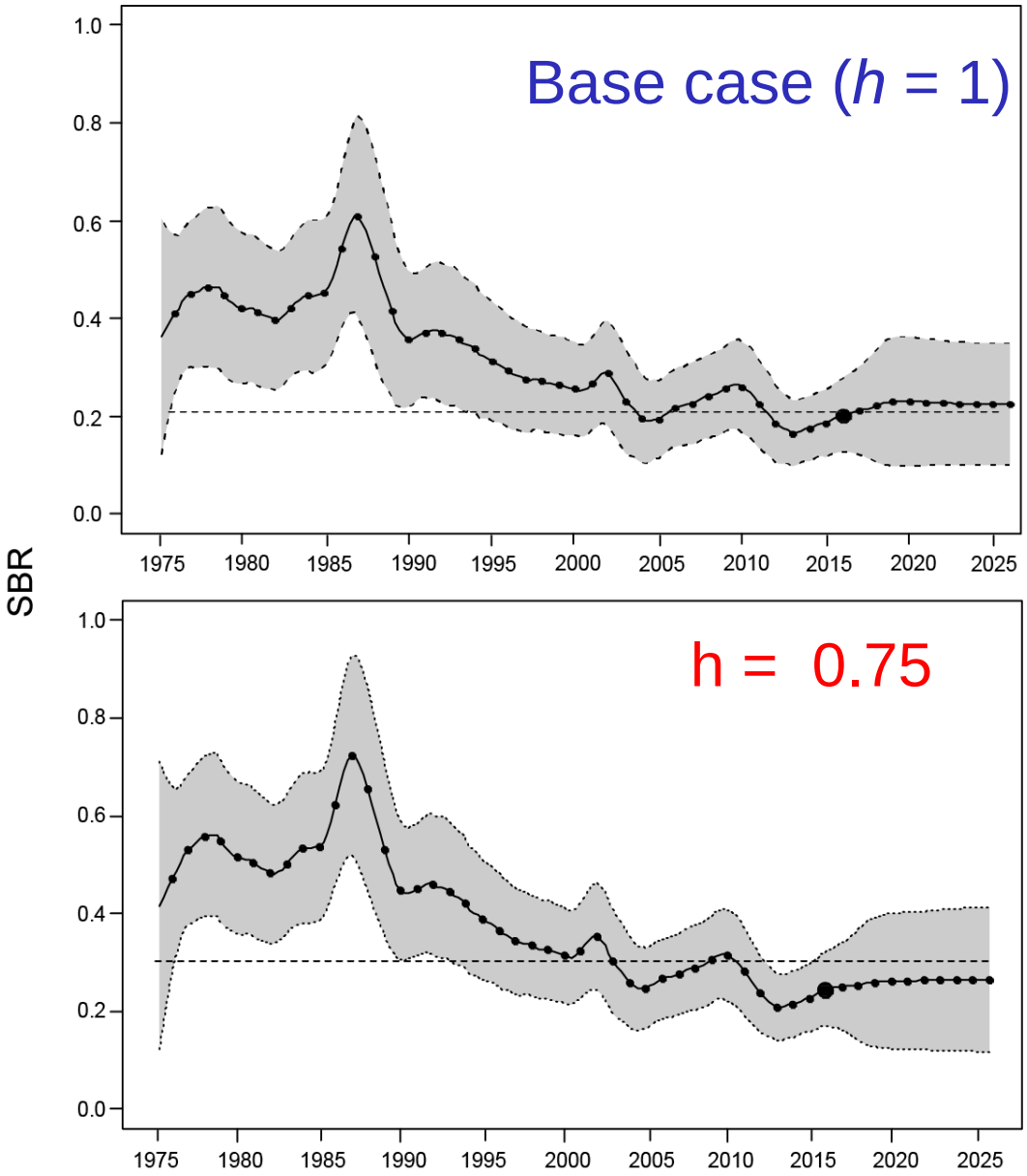
Sensitivities (Steepness)





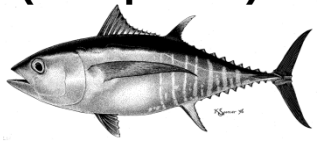
Spawning Biomass Ratio (SBR)

Sensitivities (Steepness)



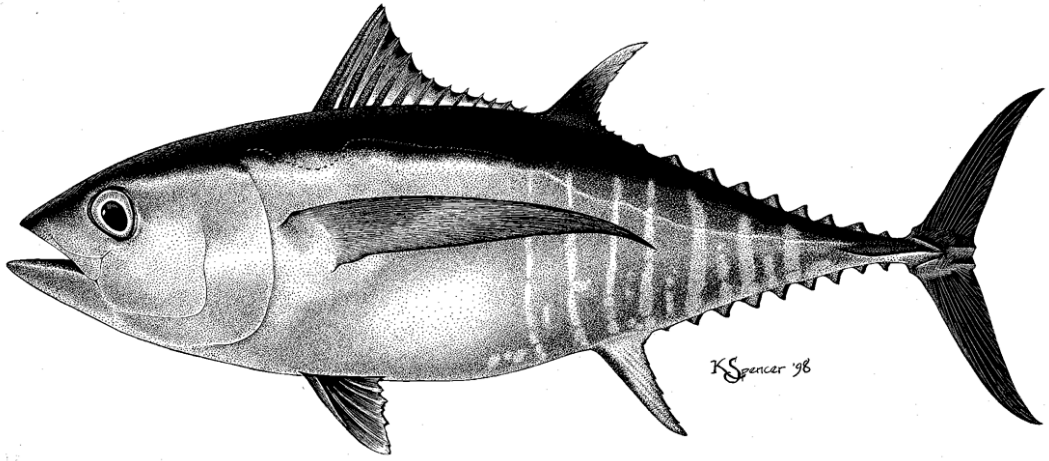
Management quantities

Sensitivities (Steepness)



	Base case-Caso base	h = 0.75
MSY-RMS	107,864	107,595
B_{MSY}- B_{RMS}	389,211	726,606
S_{MSY}- S_{RMS}	95,101	200,215
B_{MSY}/B_0- B_{RMS}/B_0	0.26	0.34
S_{MSY}/S_0- S_{RMS}/S_0	0.21	0.30
C_{recent}/MSY- C_{recent}/RMS	0.97	0.97
B_{recent}/B_{MSY}- B_{recent}/B_{RMS}	1.00	0.83
S_{recent}/S_{MSY}-S_{recent}/S_{RMS}	0.96	0.81
F multiplier-Multiplicador de F	1.05	0.91

- Lower h
  - More **pessimistic** stock status



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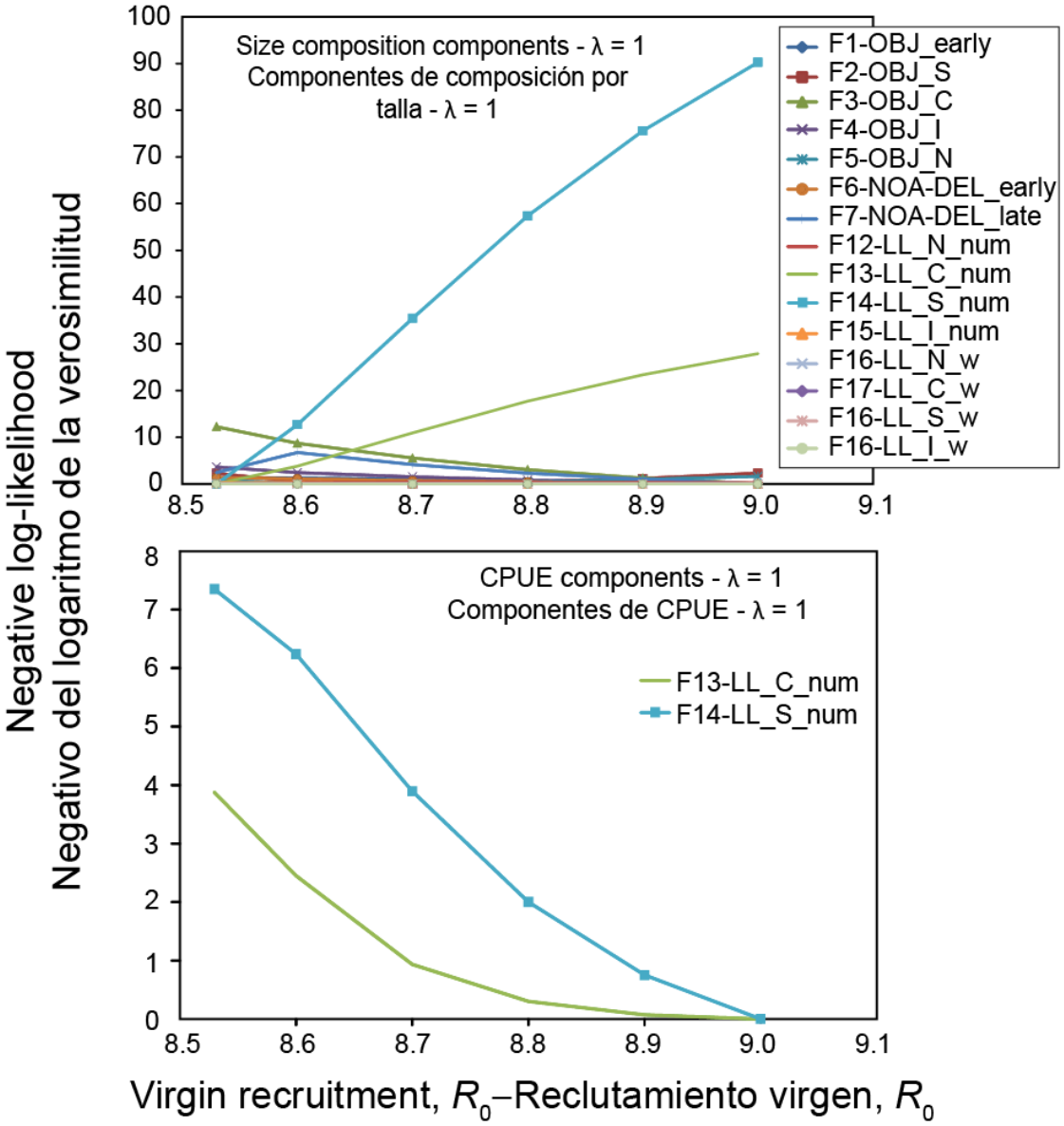
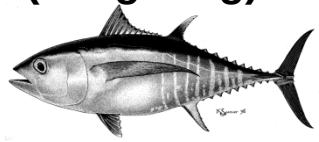
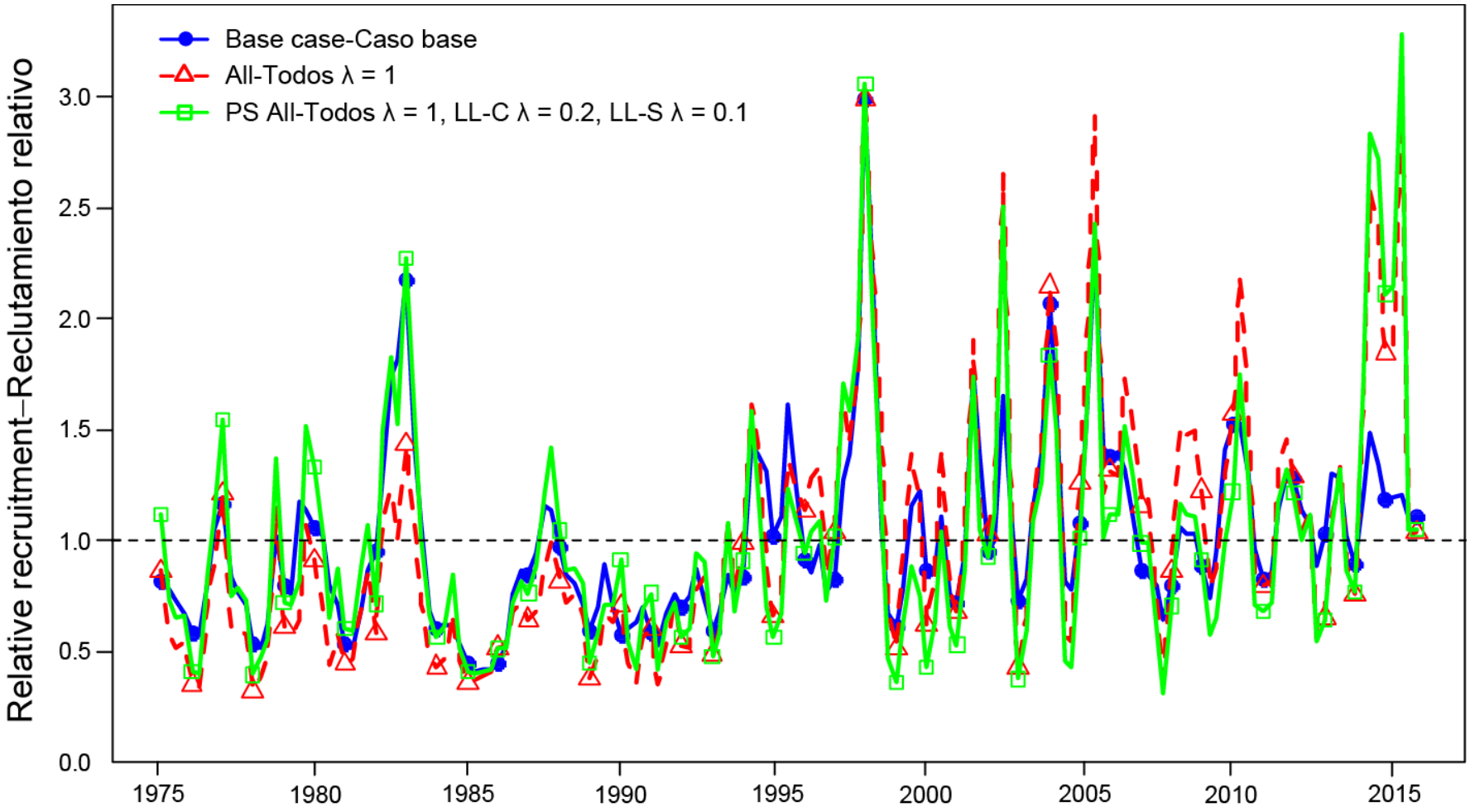
R_0 profile


Size composition components - λ = 1
Componentes de composición por talla - λ = 1
F1-OBJ_early
F2-OBJ_S
F3-OBJ_C
F4-OBJ_I
F5-OBJ_N
F6-NOA-DEL_early
F7-NOA-DEL_late
F12-LL_N_num
F13-LL_C_num
F14-LL_S_num
F15-LL_I_num
F16-LL_N_w
F17-LL_C_w
F16-LL_S_w
F16-LL_I_w
CPUE components - λ = 1
Componentes de CPUE - λ = 1
F13-LL_C_num
F14-LL_S_num
Negative log-likelihood
Negativo del logaritmo de la verosimilitud
Virgin recruitment, R_0–Reclutamiento virgen, R_0

Recruitment

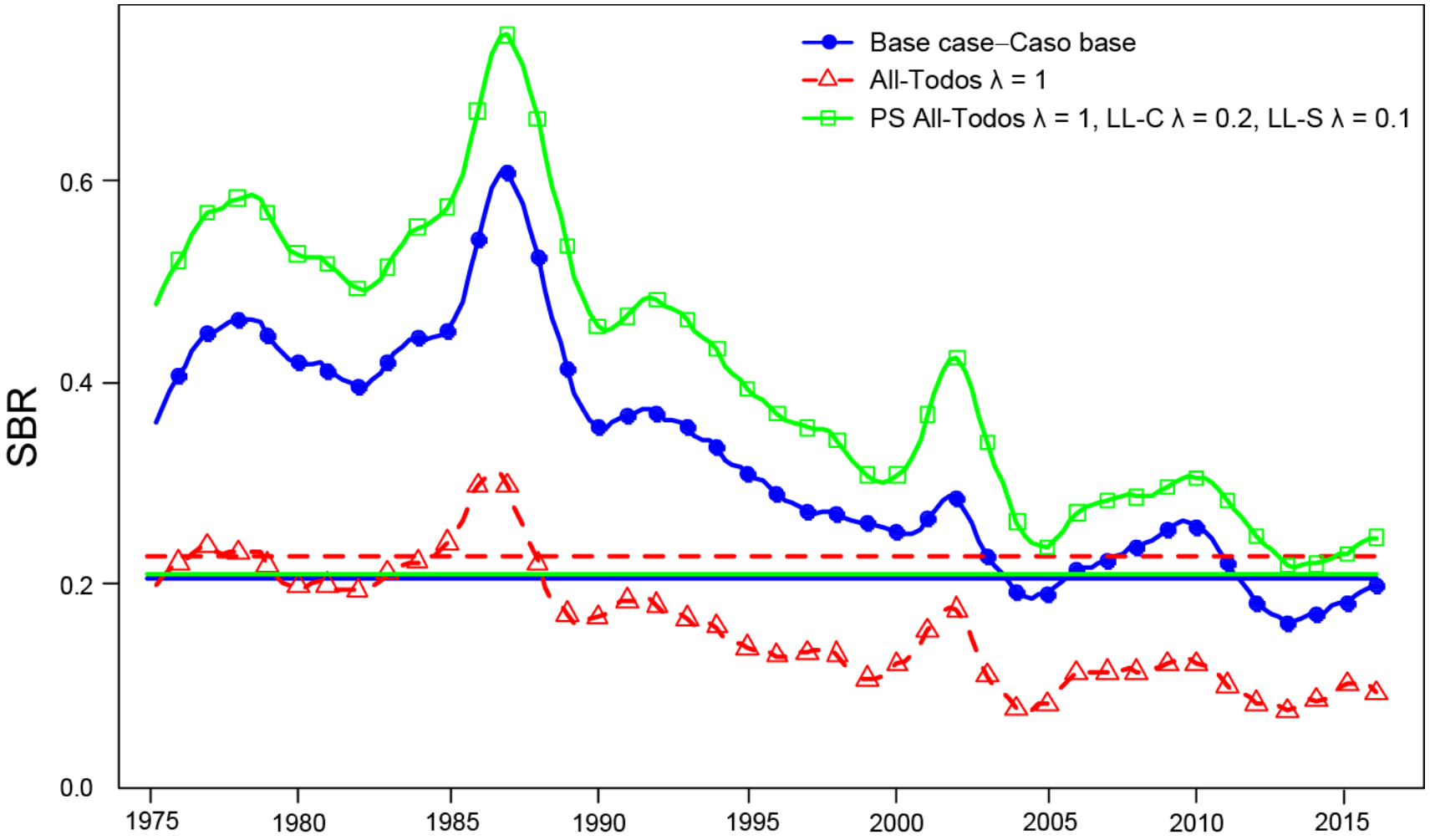
Sensitivities (Weighting)





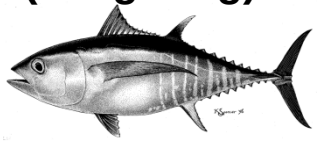
Spawning biomass ratio

Sensitivities (Weighting)



Management quantities

Sensitivities (Weighting)



	Base case-Caso base	λ = 1	F13: λ = 0.2 F14: λ = 0.1 Others/Otros: λ = 1
MSY-RMS	107,864	95,544	114,954
B_{MSY}- B_{RMS}	389,211	340,276	456,082
S_{MSY}- S_{RMS}	95,101	82,911	115,464
B_{MSY}/B_0- B_{RMS}/B_0	0.26	0.29	0.26
S_{MSY}/S_0- S_{RMS}/S_0	0.21	0.23	0.21
C_{recent}/MSY- C_{recent}/RMS	0.97	1.09	0.91
B_{recent}/B_{MSY}- B_{recent}/B_{RMS}	1.00	0.59	1.35
S_{recent}/S_{MSY}-S_{recent}/S_{RMS}	0.96	0.41	1.16
F multiplier-Multiplicador de *F*	1.05	0.57	1.30

- Unweighting size composition data of LL fisheries
  - More **pessimistic** stock status
  - Strong “two-stage” recruitment pattern

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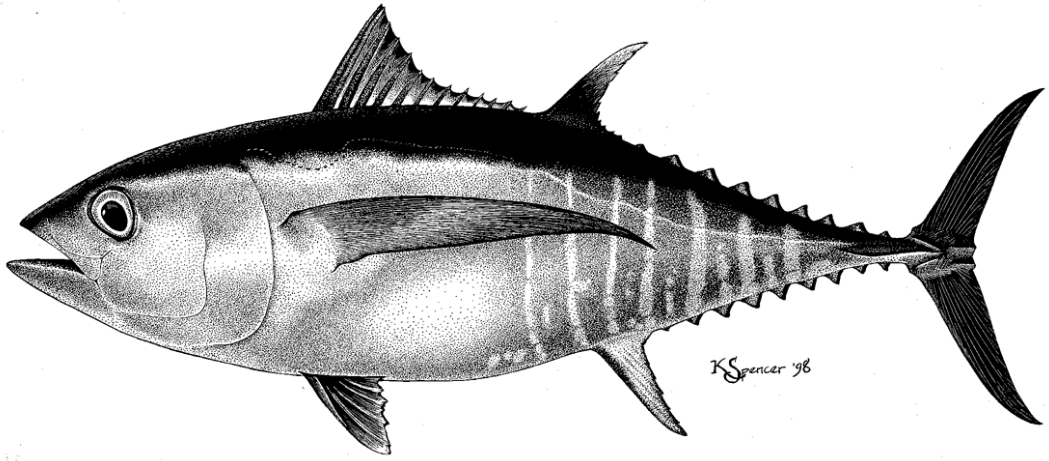

Sensitivity analyses

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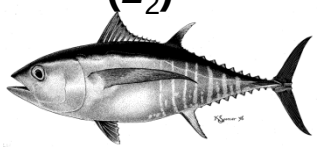
Average size of oldest fish (L_2)?

Sensitivities (L_2)



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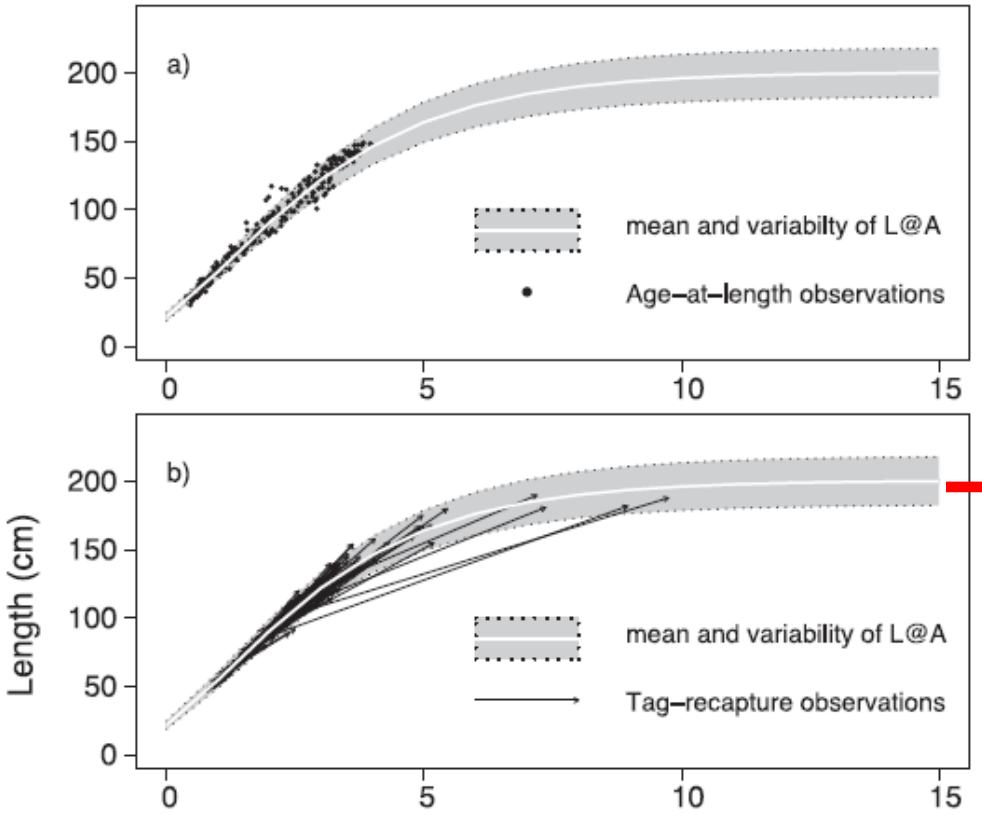
Improved growth estimates from integrated analysis of direct aging and tag–recapture data: An illustration with bigeye tuna (*Thunnus obesus*) of the eastern Pacific Ocean with implications for management

Alexandre M. Aires-da-Silva*, Mark N. Maunder, Kurt M. Schaefer, Daniel W. Fuller

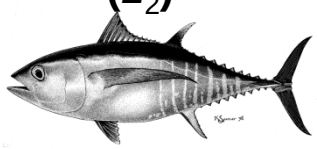
Inter-American Tropical Tuna Commission, 8901 La Jolla Shores Drive, La Jolla, CA 92037-1508, United States

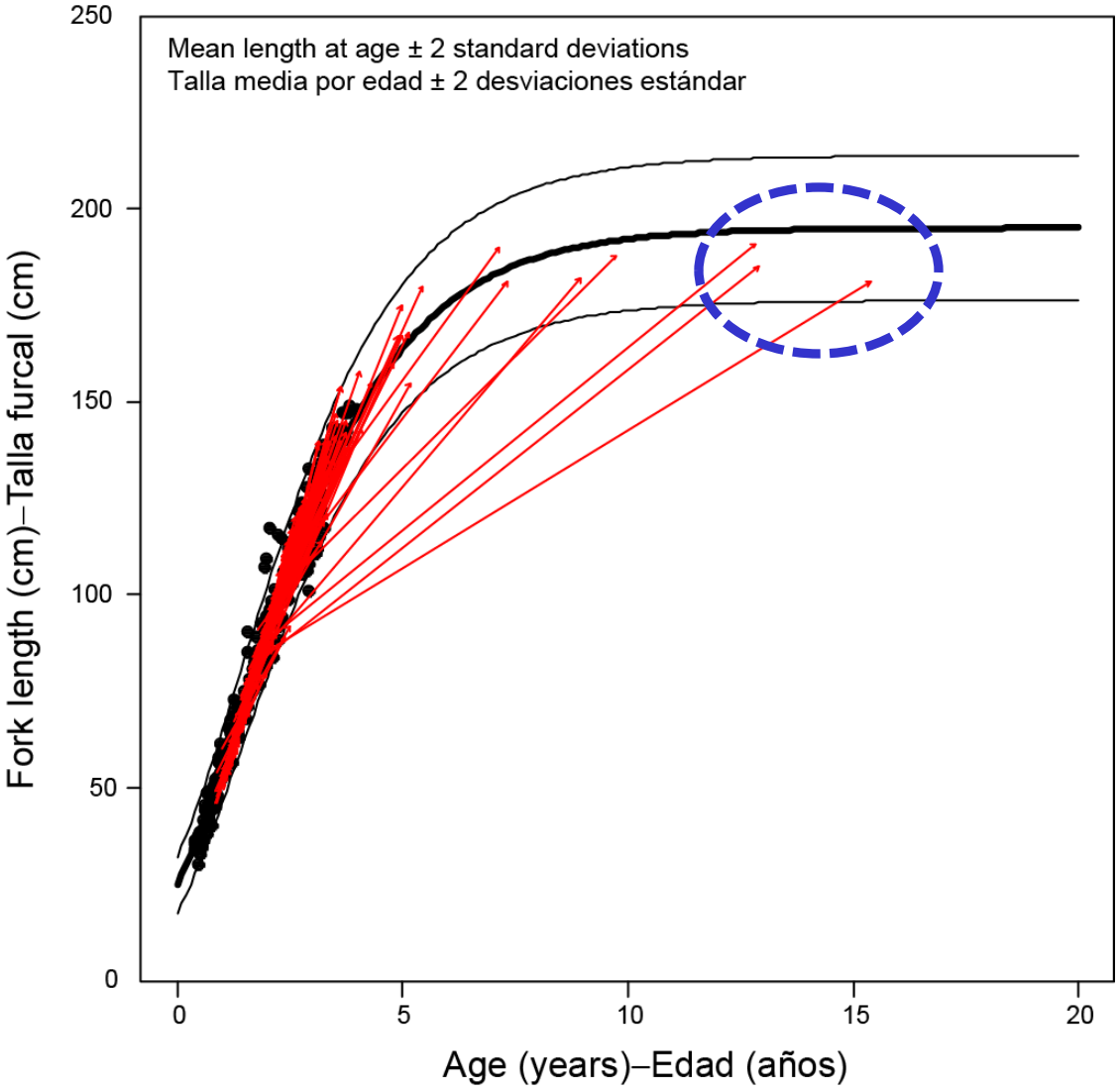


L_2 = 196 cm

Average size of oldest fish (L_2)?

Sensitivities (L_2)

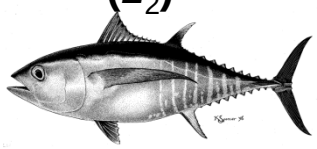


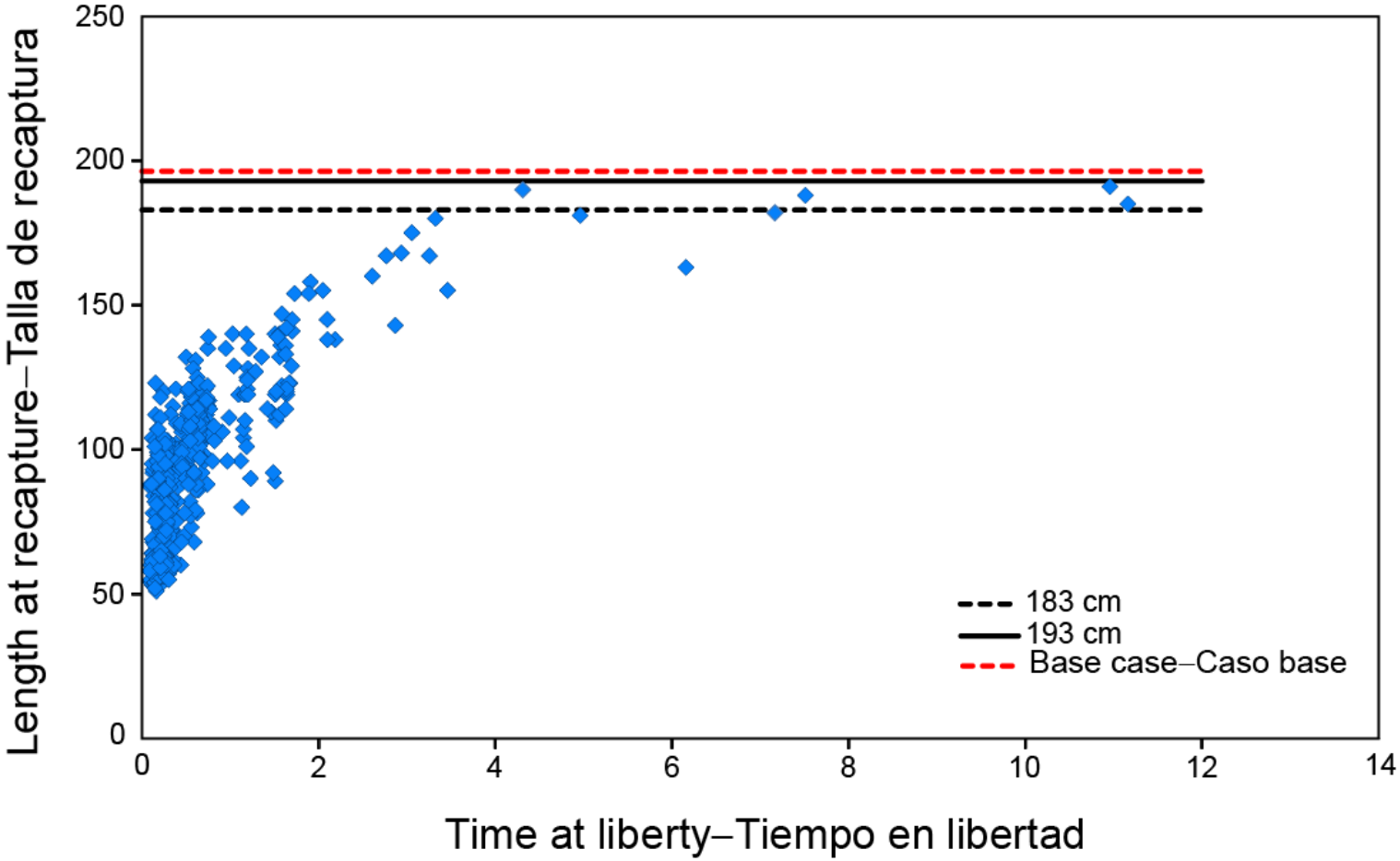


→ L_2 = 193 cm

Average size of oldest fish (L_2)?

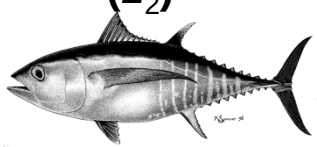
Sensitivities (L_2)

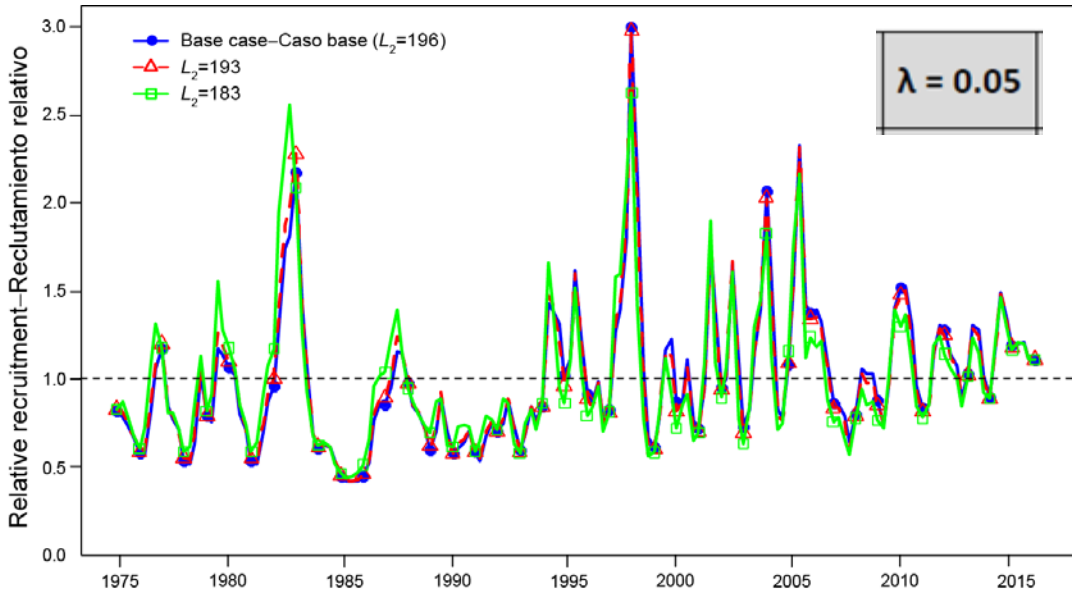


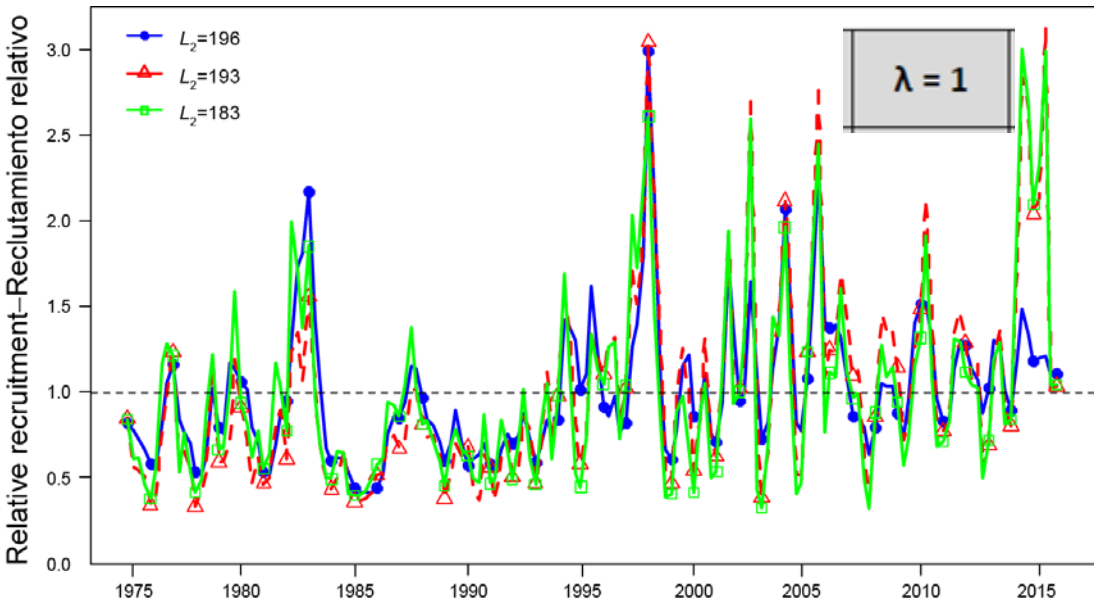


Recruitment

Sensitivities (L_2)

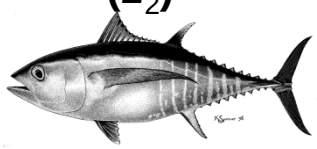


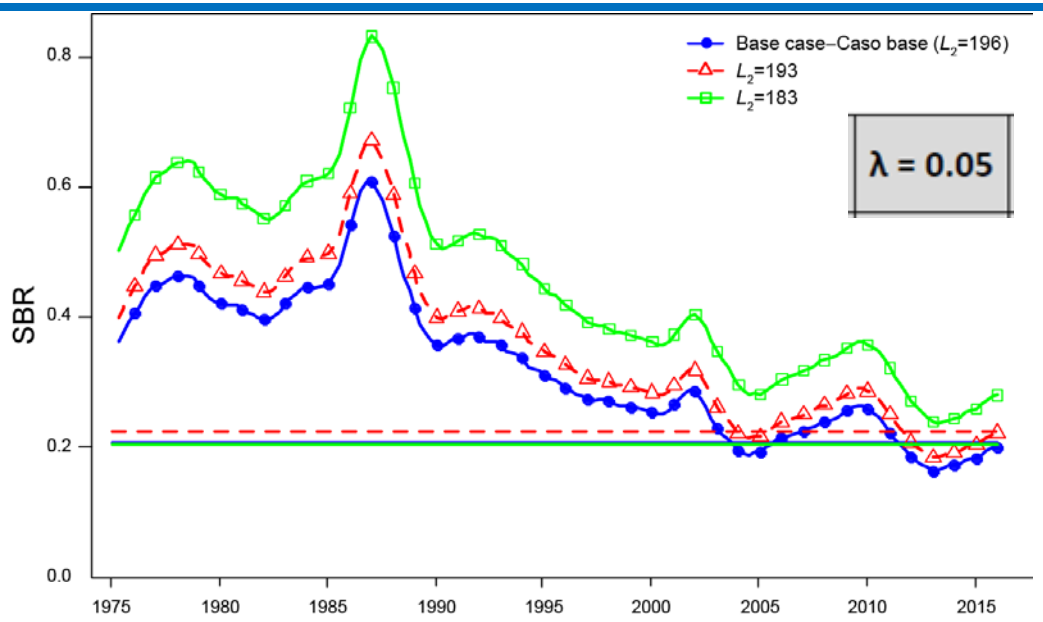


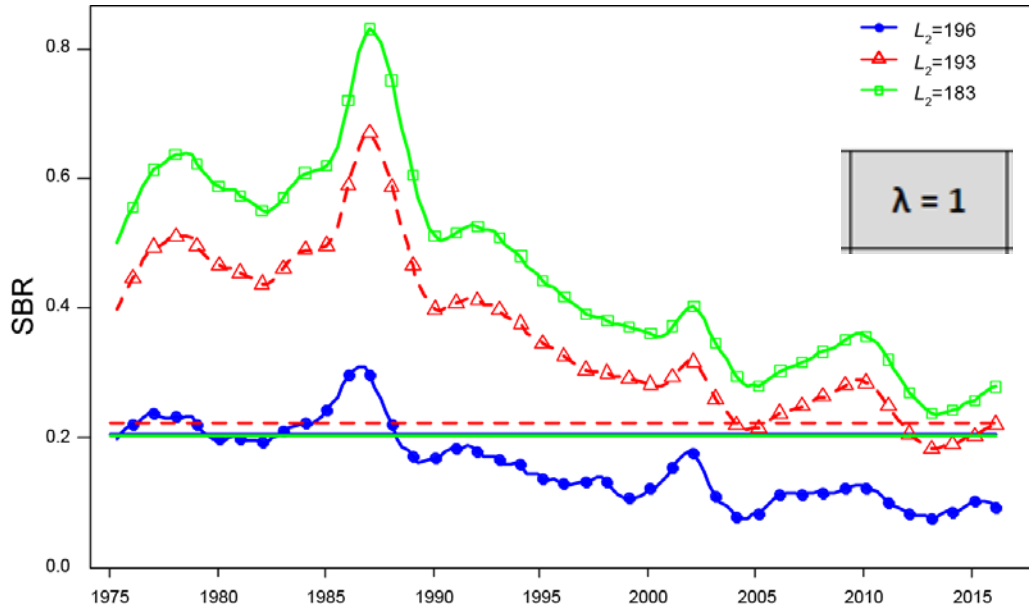


Spawning biomass ratio

Sensitivities (L_2)

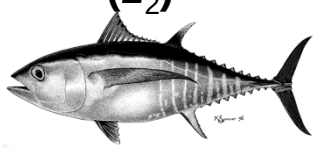






Management quantities

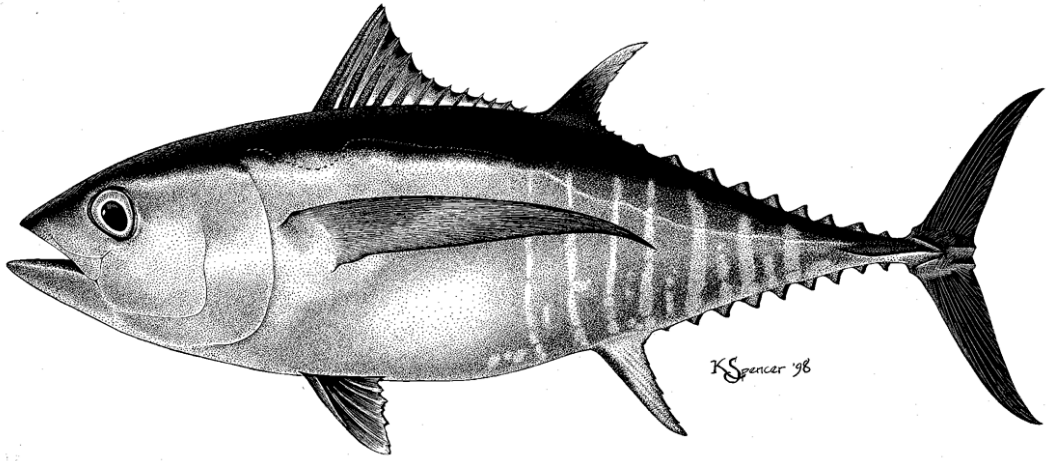
Sensitivities (L_2)



	Base case-Caso base	λ = 0.05	λ = 0.05	λ = 1	λ = 1	λ = 1
L_2	196	193	183	196	193	183
MSY-RMS	107,864	110,115	120,434	95,544	100,872	107,620
B_{MSY}- B_{RMS}	389,211	399,907	432,280	340,276	352,365	382,856
S_{MSY}- S_{RMS}	95,101	94,726	90,508	82,911	81,834	79,086
B_{MSY}/B_0- B_{RMS}/B_0	0.26	0.26	0.25	0.29	0.29	0.27
S_{MSY}/S_0- S_{RMS}/S_0	0.21	0.21	0.19	0.23	0.22	0.2
C_{recent}/MSY- C_{recent}/RMS	0.97	0.95	0.87	1.09	1.03	0.97
B_{recent}/B_{MSY}- B_{recent}/B_{RMS}	1.00	1.11	1.39	0.59	0.77	1.29
S_{recent}/S_{MSY}-S_{recent}/S_{RMS}	0.96	1.08	1.45	0.41	0.53	1.06
F multiplier-Multiplicador de *F*	1.05	1.16	1.53	0.57	0.69	1.16

- Lower L_2
  - More **optimistic** stock status
  - Improves “two-stage” recruitment pattern

CIAT IATTC



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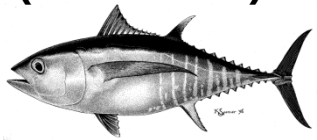
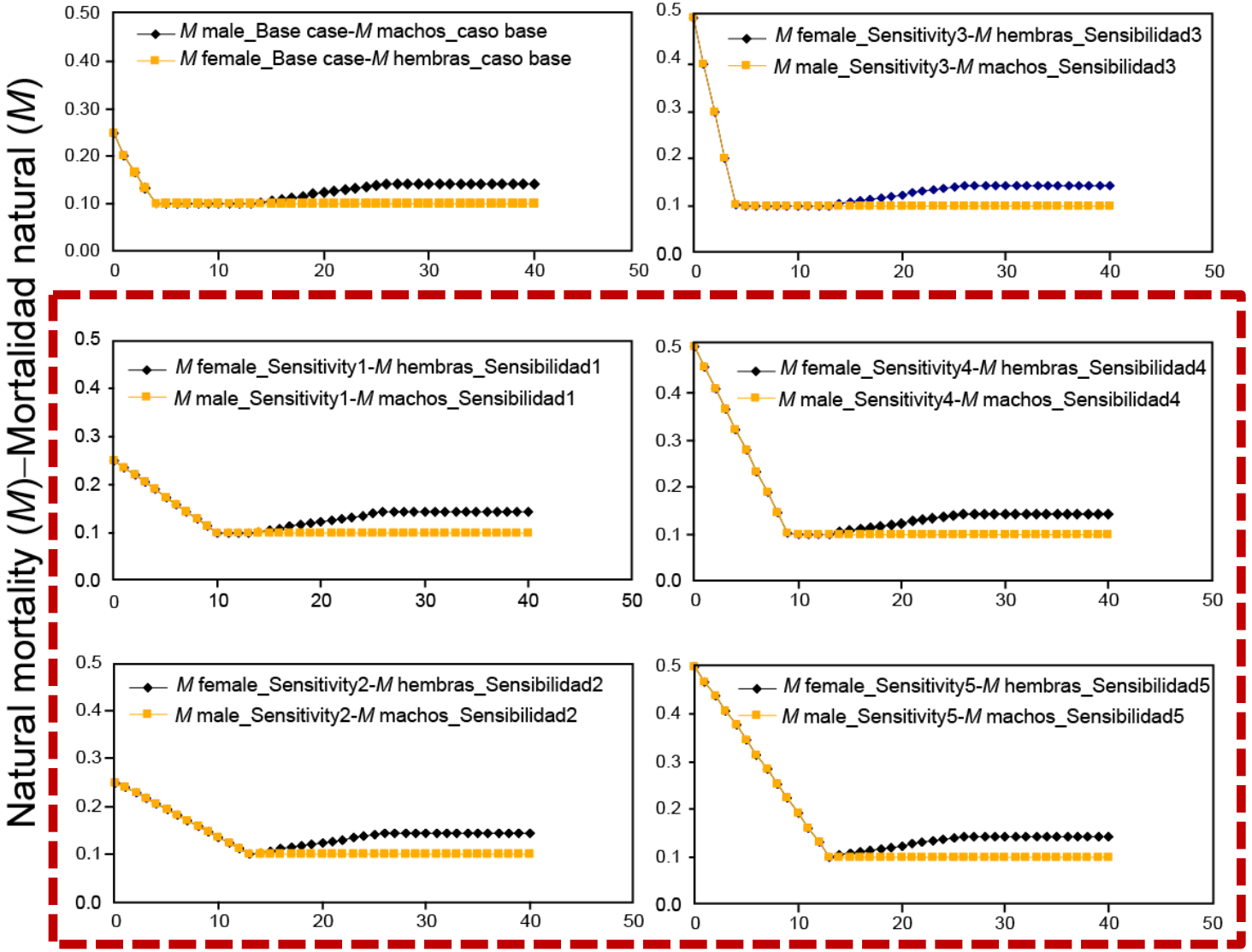
Juvenile *M* schedules

Sensitivities (Juvenile *M*)





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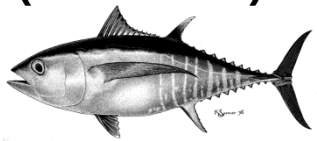
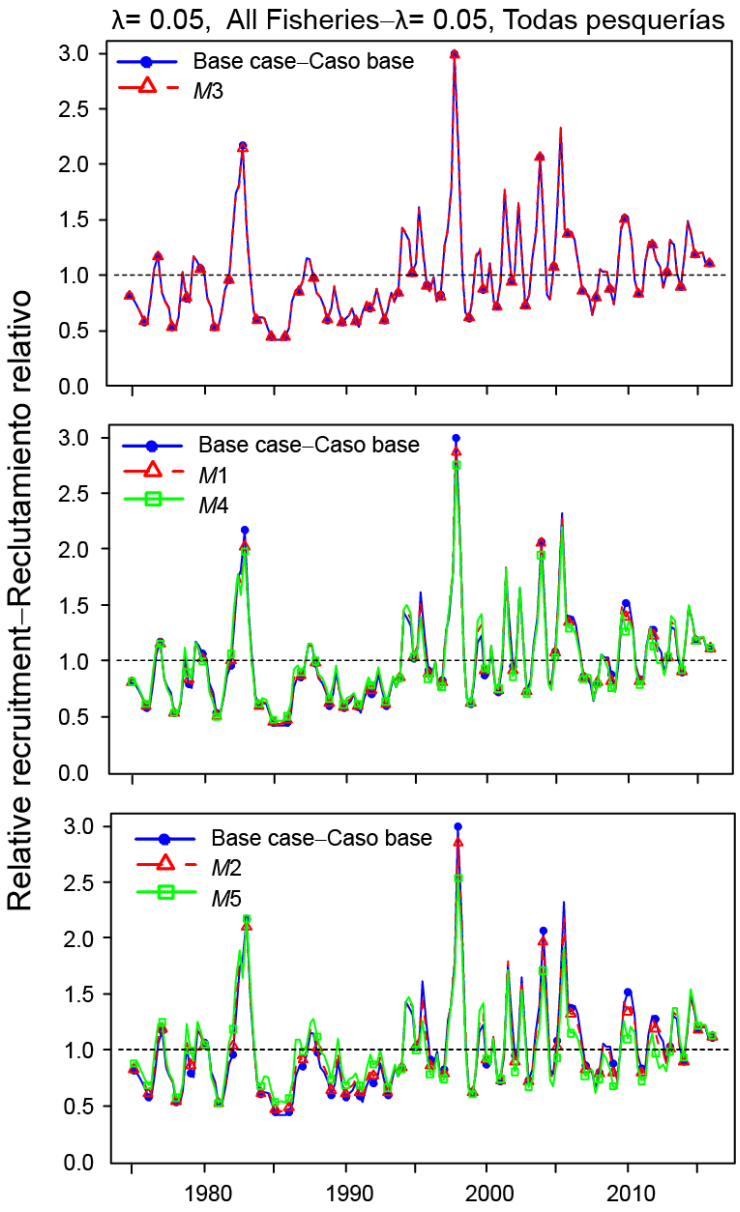
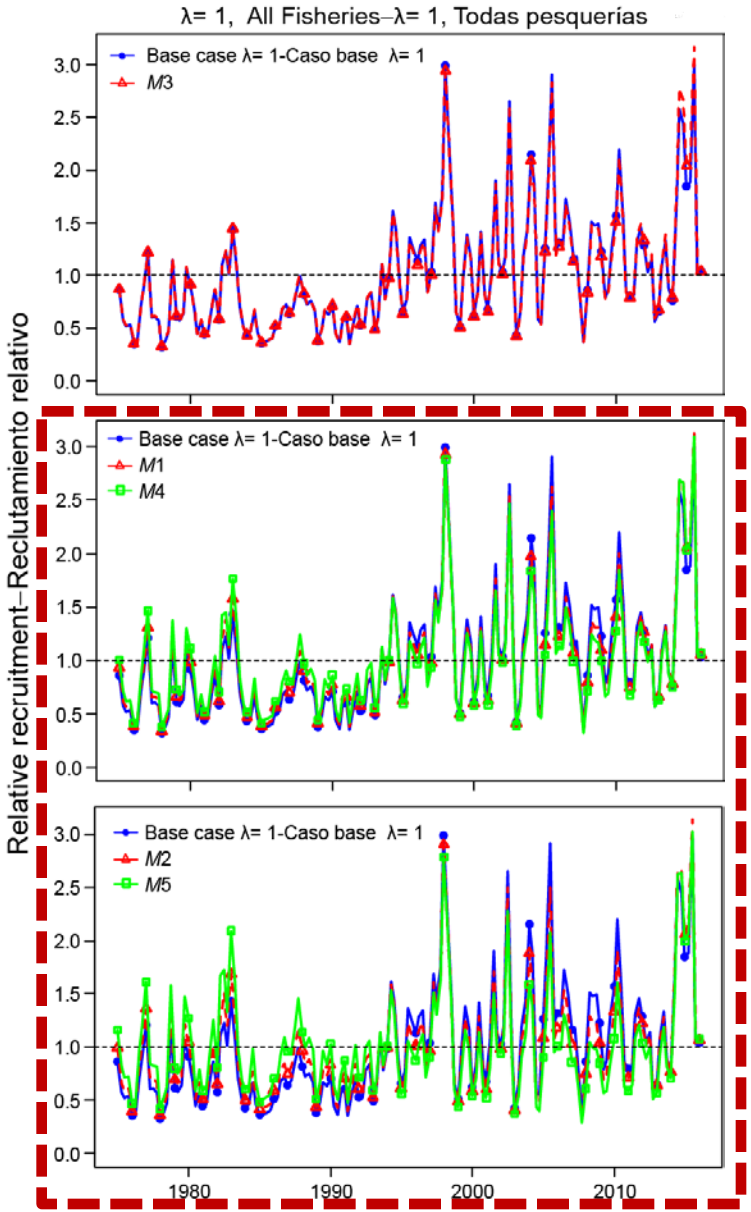
Recruitment

Sensitivities (Juvenile *M*)

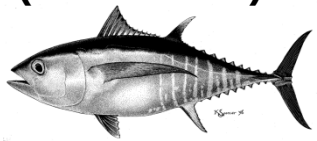


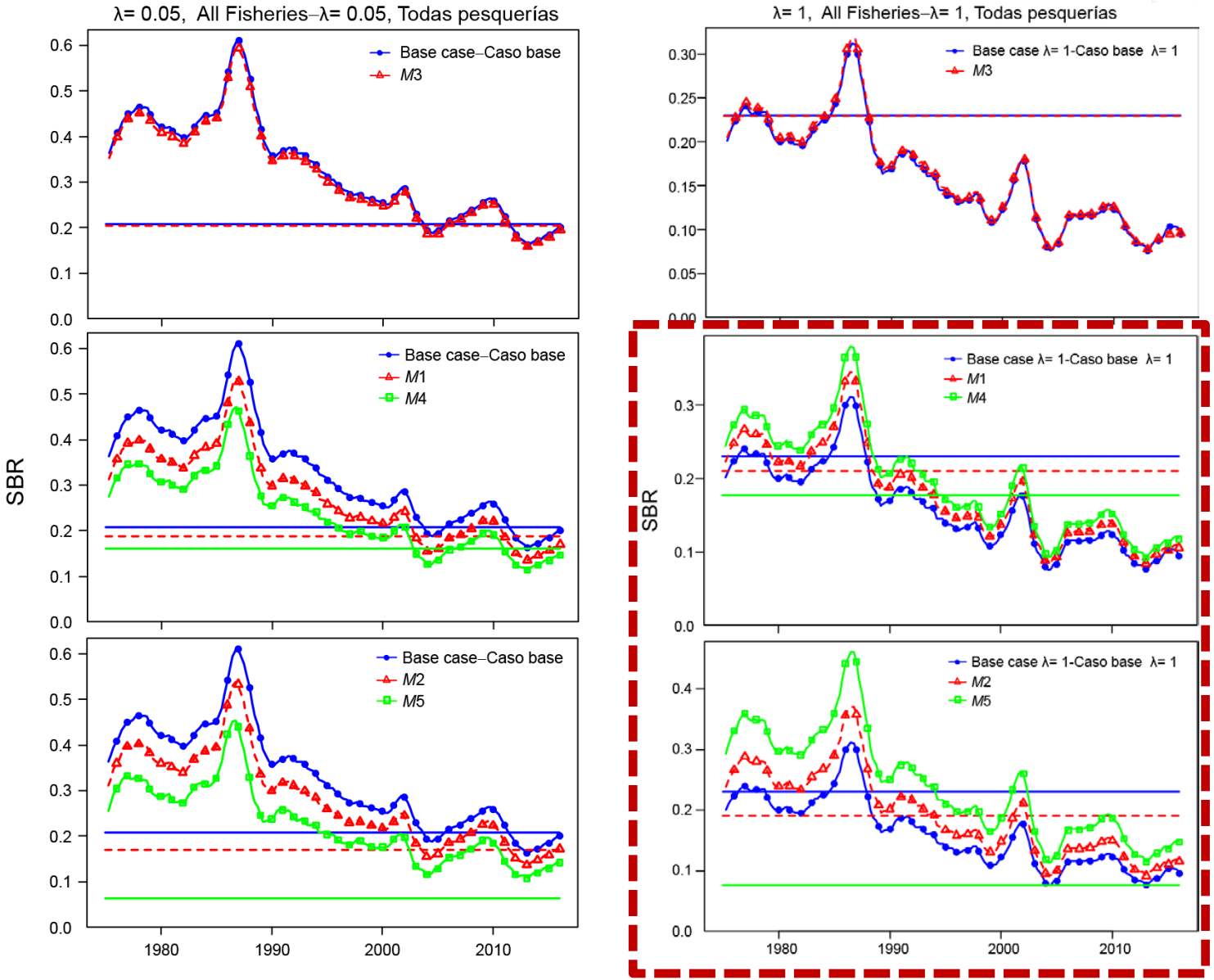




Spawning biomass ratio

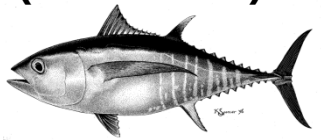
Sensitivities (Juvenile *M*)





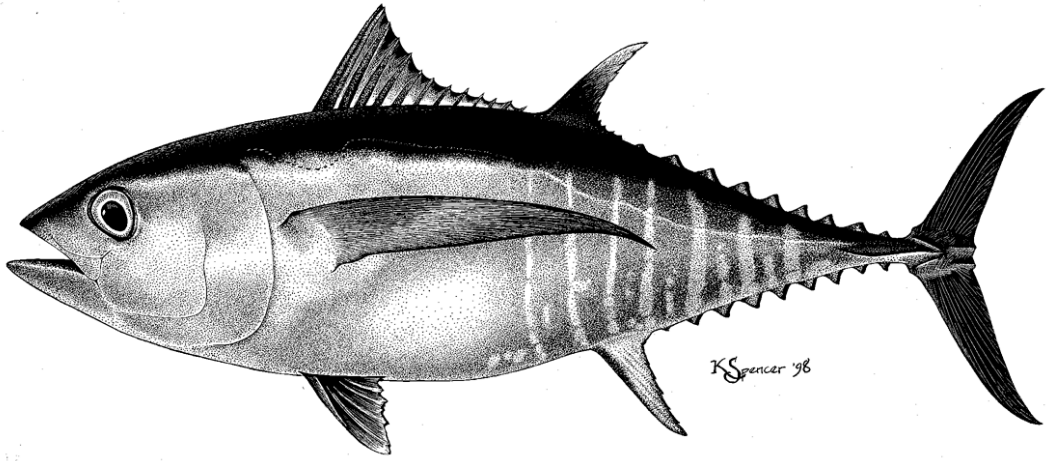
Management quantities

Sensitivities (Juvenile *M*)



λ = 0.05, all fisheries—todas pesquerías	M_0 = 0.25	M_0 = 0.5	M_0 = 0.25	M_0 = 0.5	M_0 = 0.25	M_0 = 0.5
Age (quarters) Edad (trimestres)	**5**	**5**	**10**	**10**	**13**	**13**
MSY-RMS	107,864	107,692	108,830	111,450	112,312	126,262
B_{MSY}- B_{RMS}	389,211	374,742	326,723	281,092	305,120	211,981
S_{MSY}- S_{RMS}	95,101	90,427	71,794	52,902	60,632	16,596
B_{MSY}/B_0- B_{RMS}/B_0	0.26	0.26	0.26	0.26	0.25	0.22
S_{MSY}/S_0- S_{RMS}/S_0	0.21	0.21	0.19	0.16	0.17	0.064
C_{recent}/MSY- C_{recent}/RMS	0.97	0.97	0.96	0.94	0.93	0.83
B_{recent}/B_{MSY}- B_{recent}/B_{RMS}	1.00	0.99	0.97	1.00	1.06	1.55
S_{recent}/S_{MSY}-S_{recent}/S_{RMS}	0.96	0.95	0.9	0.91	1.01	2.22
F multiplier- Multiplicador de *F*	1.05	1.04	1.01	1.03	1.11	1.77
λ = 1, all fisheries—todas pesquerías	**M_0 = 0.25**	**M_0 = 0.5**	**M_0 = 0.25**	**M_0 = 0.5**	**M_0 = 0.25**	**M_0 = 0.5**
Age (quarters) Edad (trimestres)	**5**	**5**	**10**	**10**	**13**	**13**
MSY-RMS	95,544	102,822	105,136	109,484	107,477	126,703
B_{MSY}- B_{RMS}	340,276	345,811	319,633	286,226	301,285	225,595
S_{MSY}- S_{RMS}	82,911	82,195	70,235	54,692	60,012	19,854
B_{MSY}/B_0- B_{RMS}/B_0	0.29	0.3	0.29	0.28	0.28	0.23
S_{MSY}/S_0- S_{RMS}/S_0	0.23	0.23	0.21	0.18	0.19	0.076
C_{recent}/MSY- C_{recent}/RMS	1.09	1.01	0.99	0.95	0.97	0.82
B_{recent}/B_{MSY}- B_{recent}/B_{RMS}	0.59	0.66	0.81	1.03	0.94	1.88
S_{recent}/S_{MSY}-S_{recent}/S_{RMS}	0.41	0.42	0.51	0.66	0.6	1.93
F multiplier- Multiplicador de *F*	0.57	0.59	0.68	0.84	0.78	1.7

- Higher *juvenile M*
  - More **optimistic** stock status
  - Only extreme cases improves “two-stage” recruitment pattern, not biologically reasonable

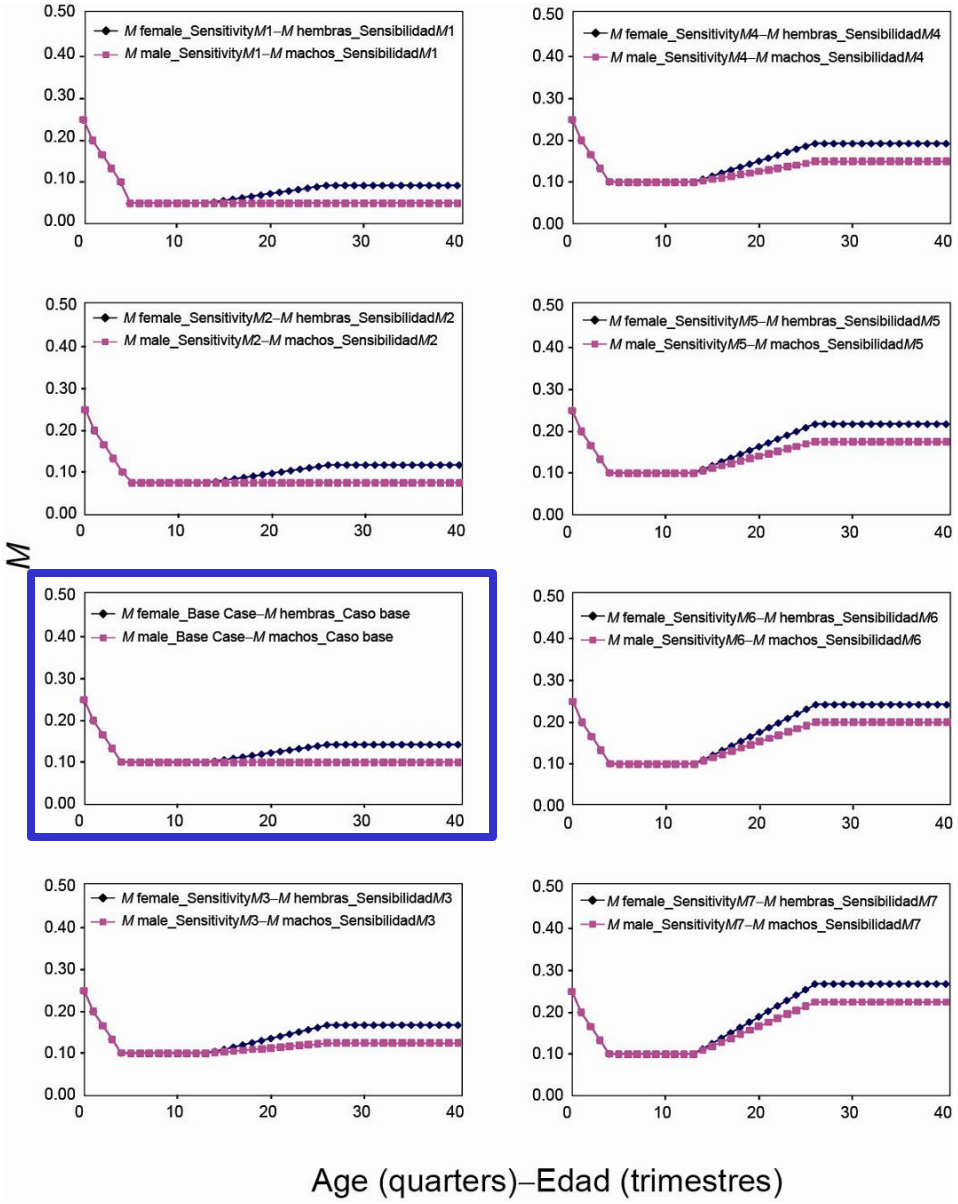


Sensitivity analyses

- Steepness of SR relationship (Appendix B)
- Weighting assigned to the size-composition data (Appendix C)
- Lower values of average size of oldest fish (L_2) (Appendix D)
- Higher rates of juvenile *M* (Appendix E)
- Lower and higher rates of adult *M* (Appendix F)

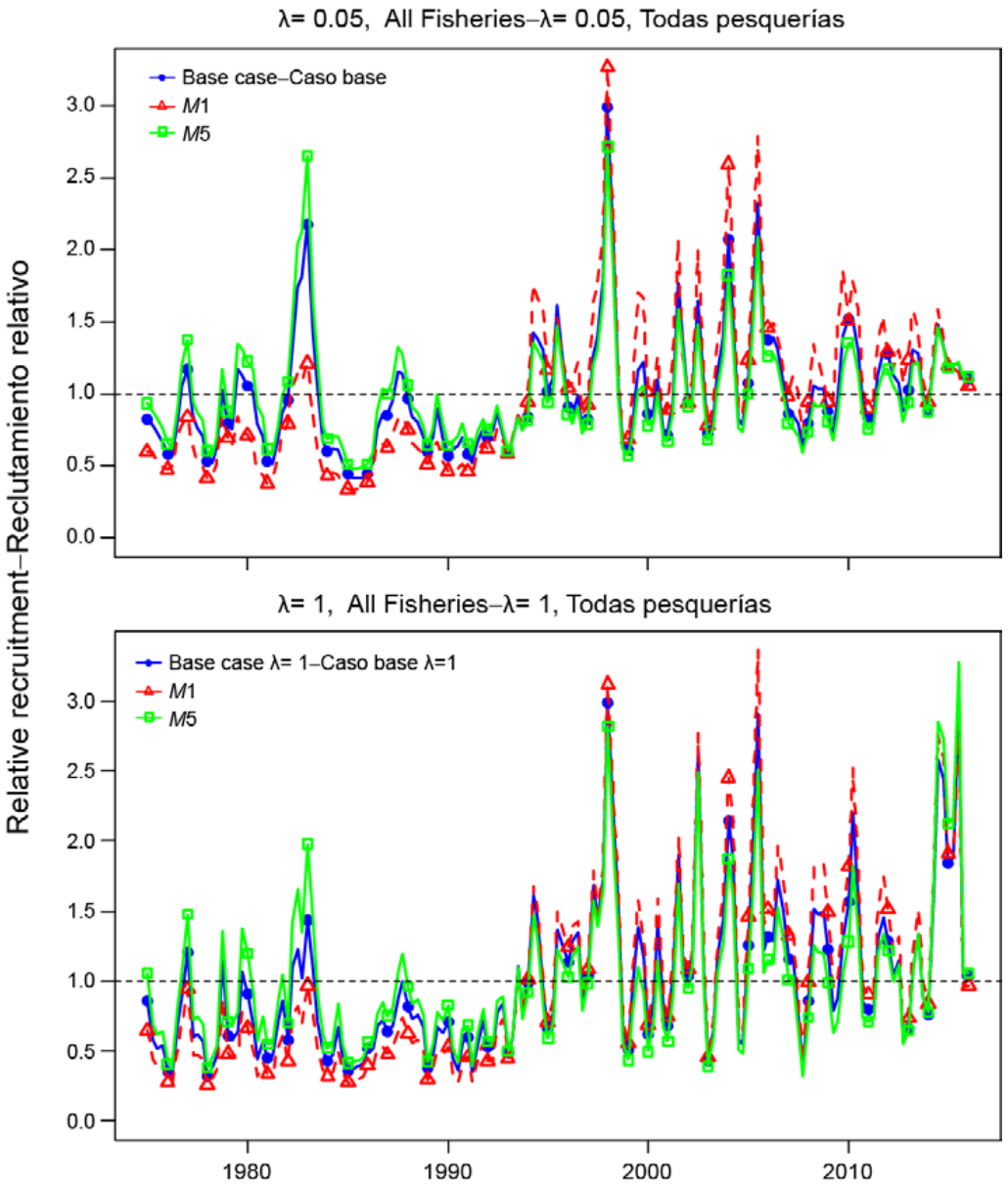
Adult *M* schedules

Sensitivities (Adult *M*)



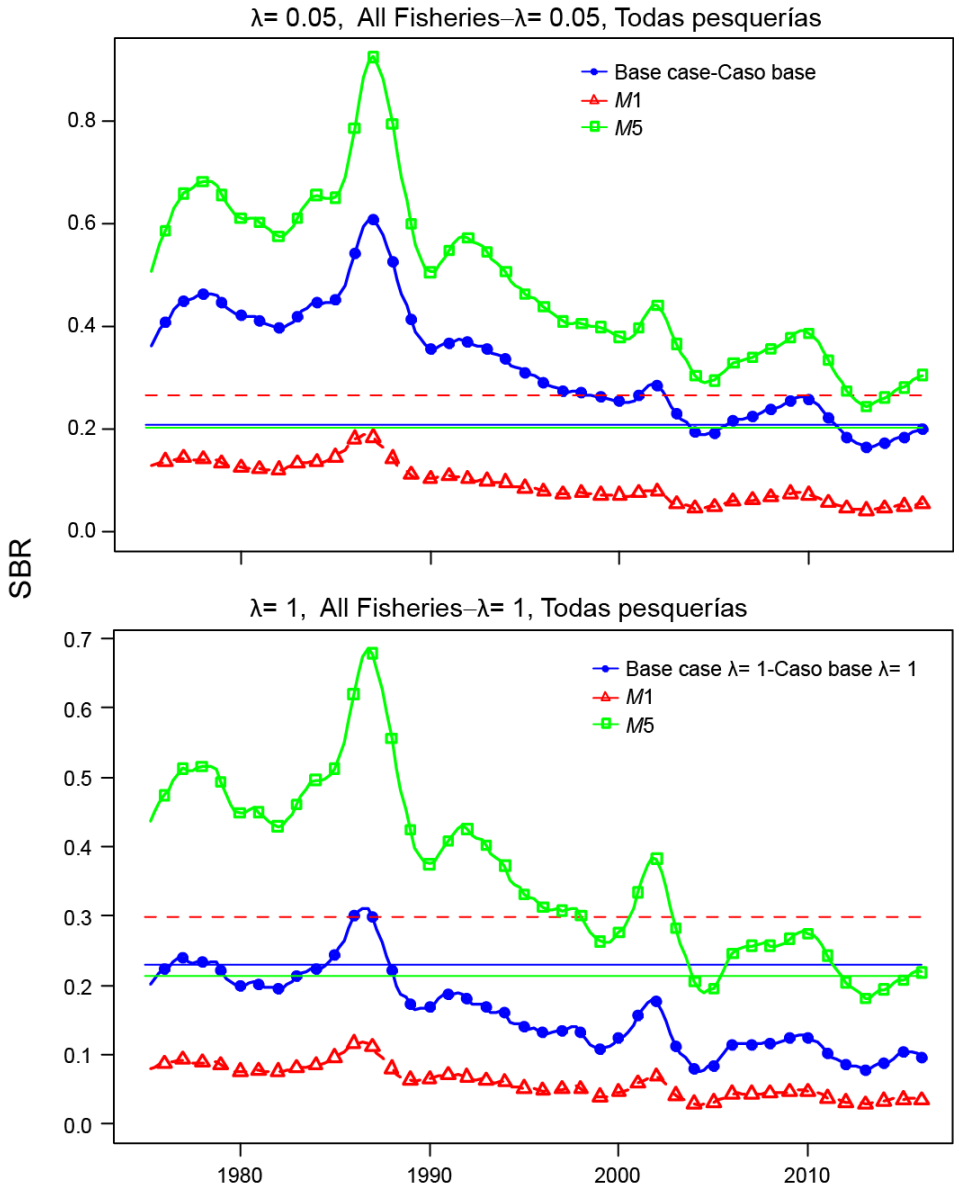
Recruitment

Sensitivities (Adult *M*)



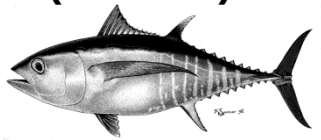
Spawning biomass ratio

Sensitivities (Adult *M*)



Management quantities

Sensitivities (Adult *M*)



λ = 0.05, all fisheries—todas pesquerías	*M*ad-sens1	*M*ad-sens2	Base case Caso base	*M*ad-sens3	*M*ad-sens4	*M*ad-sens5	*M*ad-sens6	*M*ad-sens7
MSY-RMS	123,379	105,537	107,864	114,673	121,037	126,395	130,515	134,010
B_{MSY}- B_{RMS}	565,617	425,993	389,211	406,529	416,454	421,992	424,606	426,046
S_{MSY}- S_{RMS}	169,233	115,829	95,101	97,768	97,168	96,336	94,607	92,750
B_{MSY}/B_0- B_{RMS}/B_0	0.28	0.27	0.26	0.26	0.26	0.26	0.26	0.27
S_{MSY}/S_0- S_{RMS}/S_0	0.27	0.23	0.21	0.21	0.2	0.2	0.2	0.2
C_{recent}/MSY- C_{recent}/RMS	0.84	0.99	0.97	0.91	0.86	0.82	0.8	0.78
B_{recent}/B_{MSY}- B_{recent}/B_{RMS}	0.31	0.58	1.00	1.21	1.35	1.44	1.5	1.55
S_{recent}/S_{MSY}-S_{recent}/S_{RMS}	0.2	0.47	0.96	1.22	1.39	1.5	1.58	1.63
F multiplier-Multiplicador de *F*	0.4	0.64	1.05	1.29	1.48	1.62	1.72	1.81
λ = 1, all fisheries—todas pesquerías	***M*ad-sens1**	***M*ad-sens2**	**λ = 1**	***M*ad-sens3**	***M*ad-sens4**	***M*ad-sens5**	***M*ad-sens6**	***M*ad-sens7**
MSY-RMS	133,834	111,103	95,544	100,851	102,766	108,296	115,942	122,755
B_{MSY}- B_{RMS}	663,082	454,769	340,276	338,034	337,600	350,831	371,995	388,208
S_{MSY}- S_{RMS}	205,439	126,585	82,911	78,926	76,612	78,414	81,777	83,760
B_{MSY}/B_0- B_{RMS}/B_0	0.3	0.3	0.29	0.29	0.29	0.28	0.28	0.28
S_{MSY}/S_0- S_{RMS}/S_0	0.3	0.26	0.23	0.22	0.22	0.21	0.21	0.21
C_{recent}/MSY- C_{recent}/RMS	0.78	0.94	1.09	1.03	1.01	0.96	0.9	0.85
B_{recent}/B_{MSY}- B_{recent}/B_{RMS}	0.21	0.39	0.59	0.83	1.03	1.24	1.43	1.56
S_{recent}/S_{MSY}-S_{recent}/S_{RMS}	0.11	0.22	0.41	0.59	0.8	1.02	1.22	1.36
F multiplier-Multiplicador de *F*	0.27	0.4	0.57	0.73	0.91	1.12	1.34	1.52

- Higher adult *M*
  - More **optimistic** stock status
  - Only extreme cases improves “two-stage” recruitment pattern, not biologically reasonable

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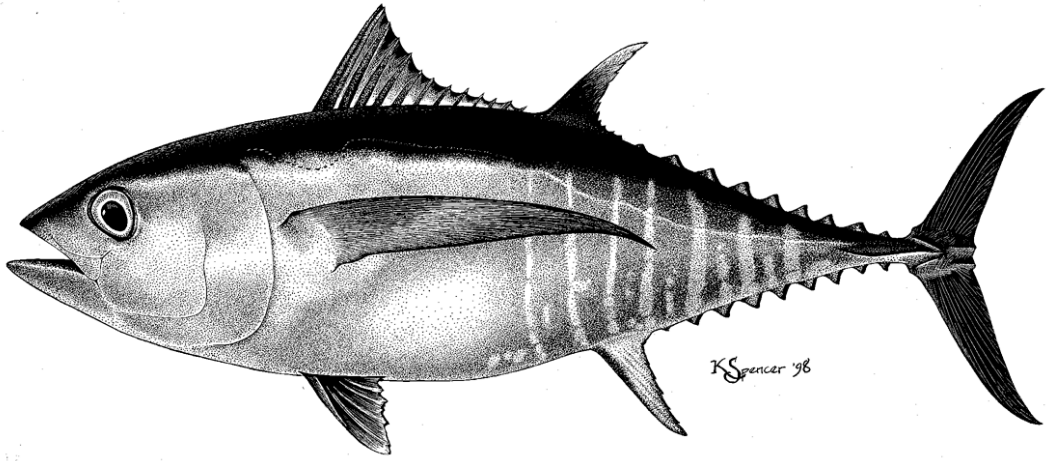
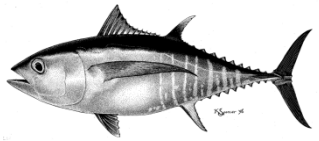
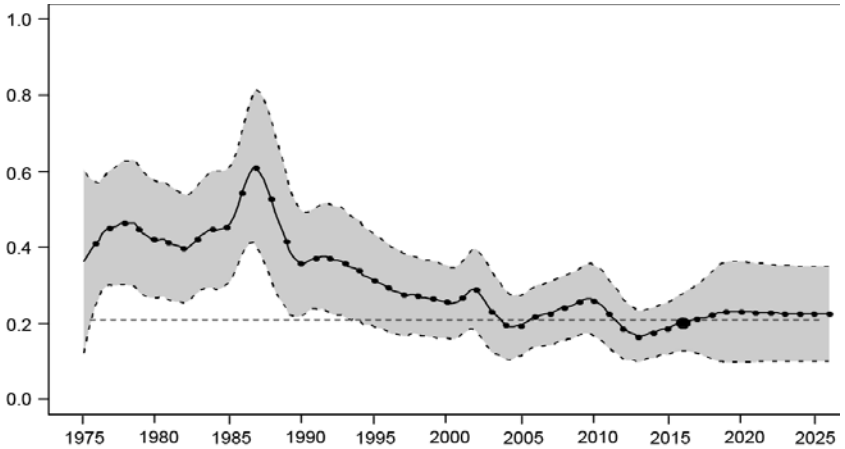


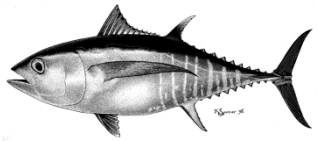
Summary

Summary: key results



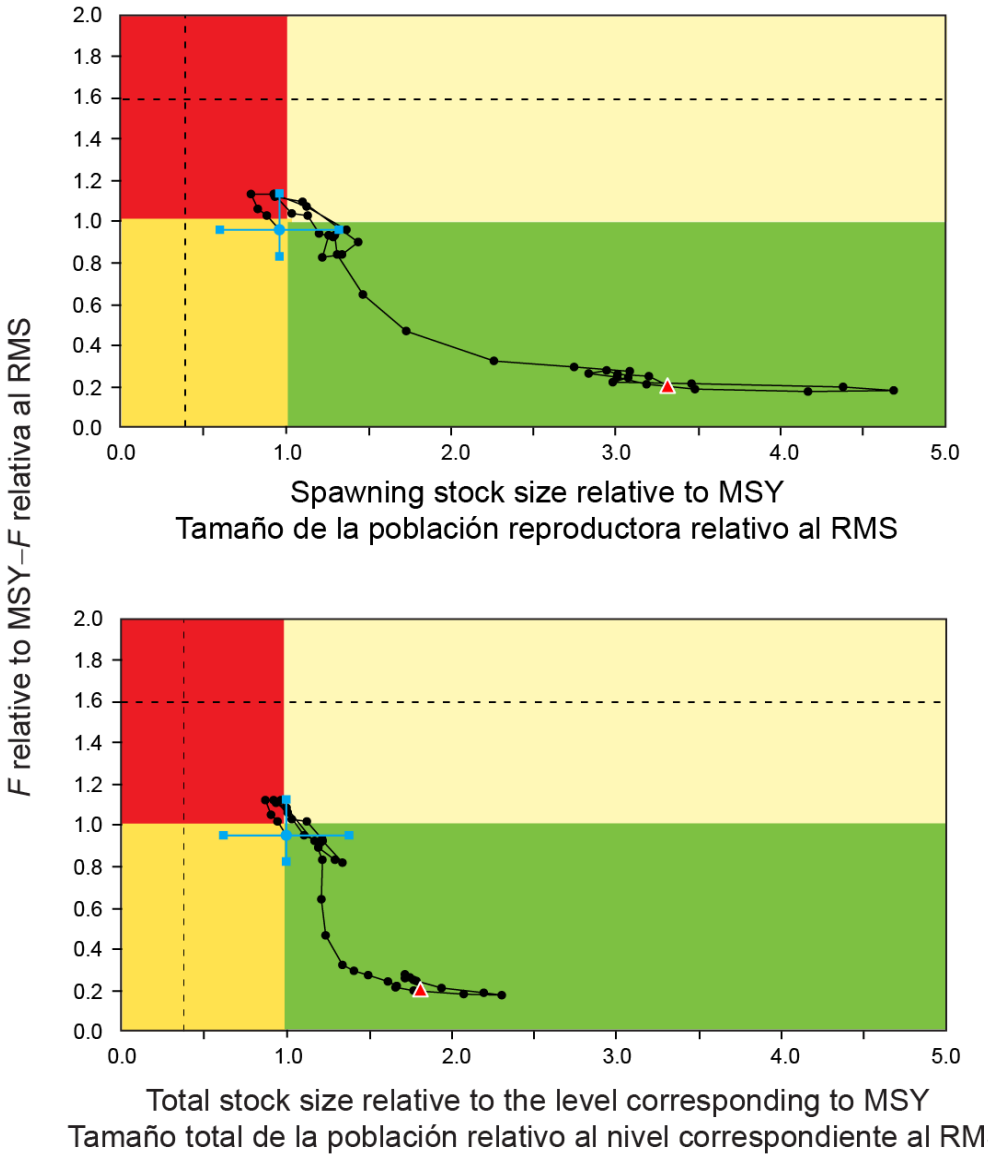
- Population decline observed since the early 1990s ceased around 2005 following IATTC conservation resolutions
- The recent decline since 2010 may be related to series of below average recruitments coinciding with strong La Nina events (since 2007)
- The recent improvement since 2012 is driven by a recent increase in the longline CPUE data
- At current fishing mortality levels, and average recruitment, SBR is predicted to stabilize slightly above SBR at MSY

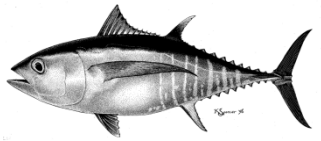




Summary: key results (cont.)

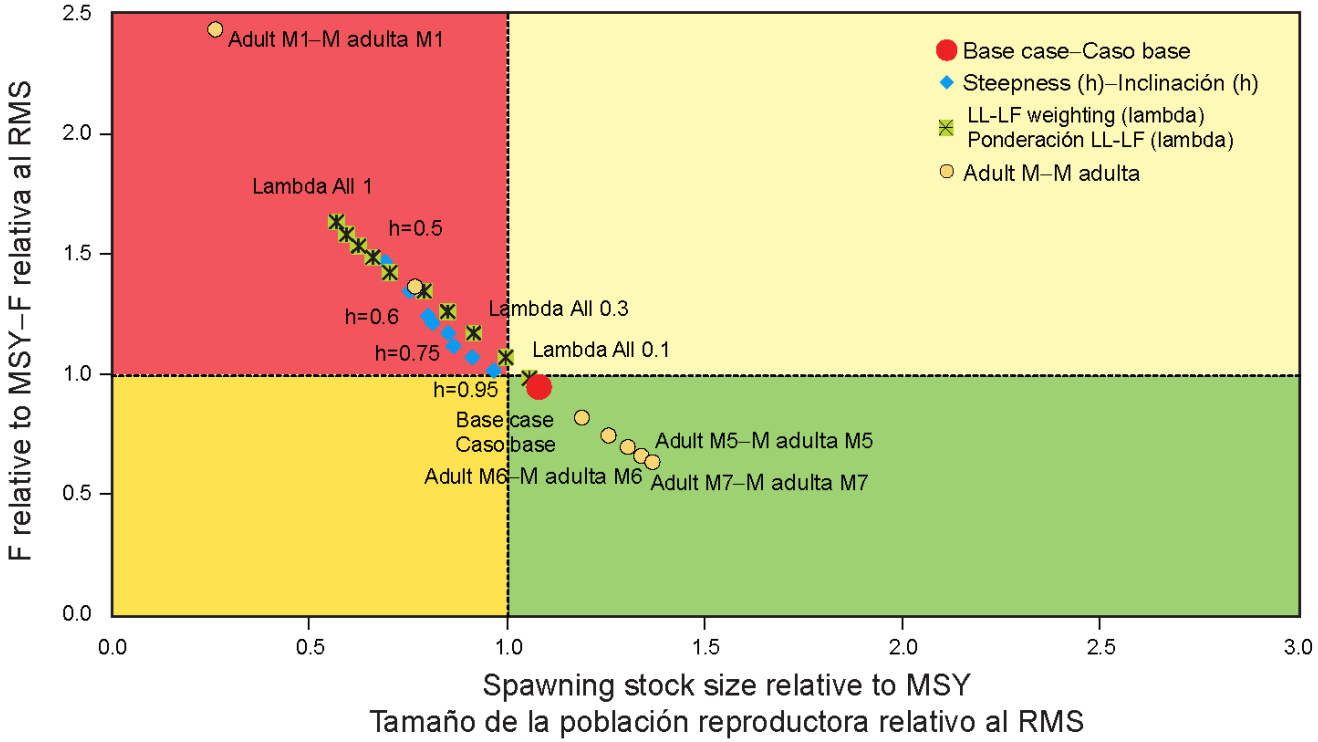
- The recent levels of spawning biomass are estimated to be slightly below the MSY level ($S_{recent} < S_{MSY}$), overfished
- The recent fishing mortality rates are estimated to be below the level corresponding to MSY ($F_{recent} < F_{MSY}$), overfishing not taking place
- But the recent estimates are uncertain (low precision)
- Proposed limit reference points of 0.38 S_{MSY} and 1.6 F_{MSY} have not been exceeded



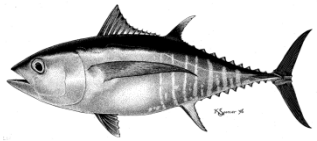


Summary: key results (cont.)

- However, these interpretations are highly sensitive about the following assumptions:
  - Steepness of stock-recruitment relationship
  - Average size of the oldest fish (L_2)
  - Natural mortality levels
  - Weighting assigned to the size composition data



Plausible Sensitivities and Uncertainties



- Results are more **pessimistic** with:
  - The inclusion of a stock-recruitment relationship
  - Lower rates of adult natural mortality (*M*)
  - Higher L_2 (but it may be lower from tagging data)
  - Up-weighting the size composition data (LL in particular)

- Results are more **optimistic** with:
  - Higher rates of adult natural mortality (*M*)
  - Lower L_2 (likely under the tag-recapture data)

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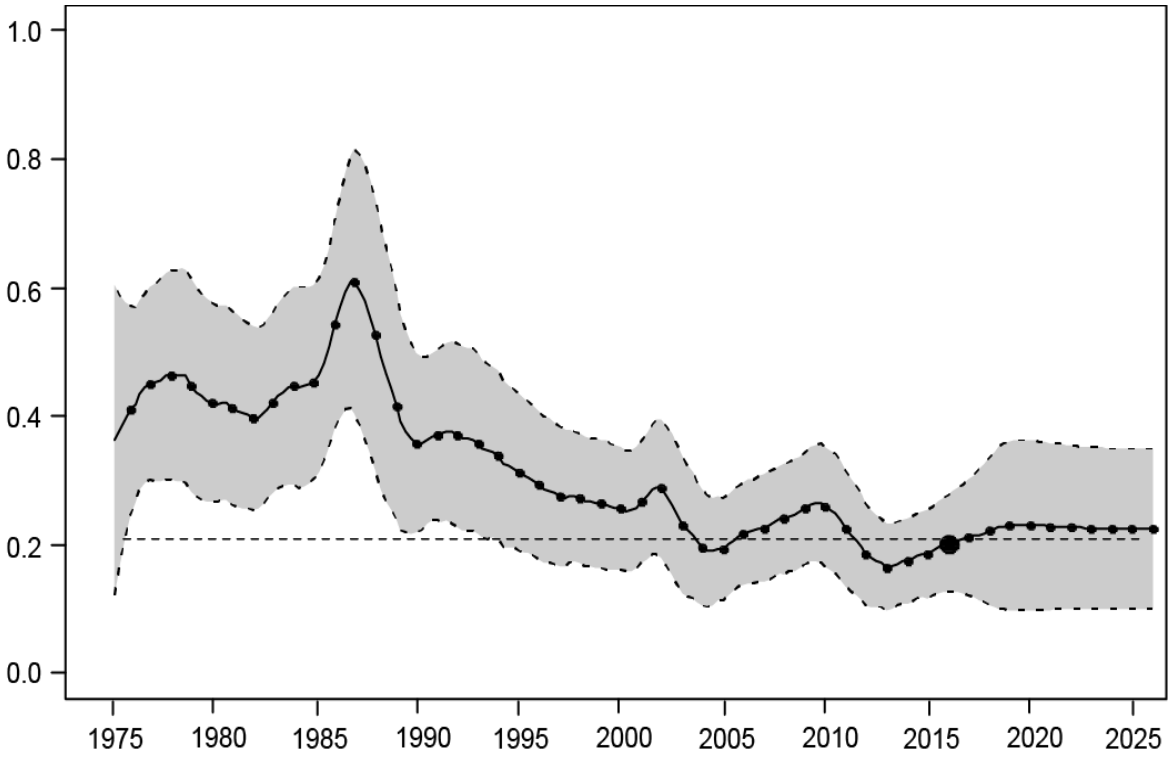
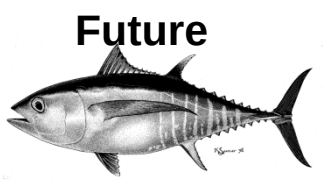
What is robust

- Relative trend
- Lower biomass compared to historic levels



Future work



- Investigate sources of model misspecification
  - Average length of oldest bigeye (L_2)
  - Natural mortality (M)
  - Formulation of more flexible growth curve
  - Weighting of different data sets
  - Fishery definitions
  - Stock structure (collaboration with SPC staff on PW assessment)

Questions?