Transforming Science into Business

JOINT RESEARCH CENTRE
STECF - Scientific, Technical and Economic Committee for Fisheries

www.azti.es

Management strategy evaluation for the Bay of Biscay anchovy long term management plan definition

Sánchez, S., Ibaibarriaga, L., Uriarte, A., Andrés, M. Prellezo, R., Jardim, E., Roel, B., Pawlowsky, L., Lehuta, S. and Abaunza, P.
ssanchez@azti.es

1 Bay of Biscay anchovy

Bay of Biscay anchovy

azti tecnalia

Biology

- Short lived species → highly dependent on incoming recruitments
- Spawning: spring
- Maturity: full at age 1
- Recruitment: age 1

Research surveys

<u>Direct surveys in spring (May):</u>

- DEPM
- Acoustic survey

<u>Autumn (September-October):</u>

- Acoustic for estimating recruitment

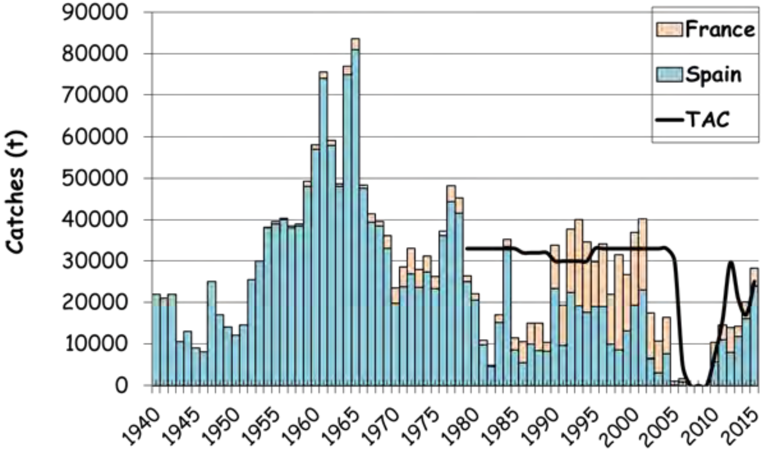
Fleets

<u>Spain (mainly spring-summer):</u>

- purse-seiners

<u>France (mainly summer-autumn):</u>

- pelagic trawlers
- purse-seiners



Long term management plan development and revision

Technical work from several STECF meetings

- STECF 2008. 29th Plenary Meeting Report of the Scientific, Technical and Economic Committee for Fisheries (PLEN-08-03). JRC, scientific and technical report, ISBN 978-92-79-10940-9.
- STECF 2009. 30th Plenary Meeting Report of the Scientific, Technical and Economic Committee for Fisheries (PLEN-09-01). JRC, scientific and technical report, ISBN 978-92-79-12424-2.
- STECF 2013. Advice on the Harvest Control Rule and Evaluation of the Anchovy Plan COM(2009) 399 Final (STECF-13-24). Publications Office of the European Union, Luxembourg, EUR 26326 EN, JRC 86109, 71 pp.
- STECF. 2014. Evaluation/scoping of Management plans - Data analysis for support of the impact assessment for the management plan of Bay of Biscay anchovy (COM(2009)399 final). (STECF-14-05). Publications Office of the European Union, Luxembourg, EUR 26611 EN, JRC 89792, 128 pp.

2 Simulation framework

FLBEIA framework was used to test the performance of different management strategies by means of simulation

FLBEIA by AZTI

http://flbeia.azti.es/

email: flbeia@azti.es

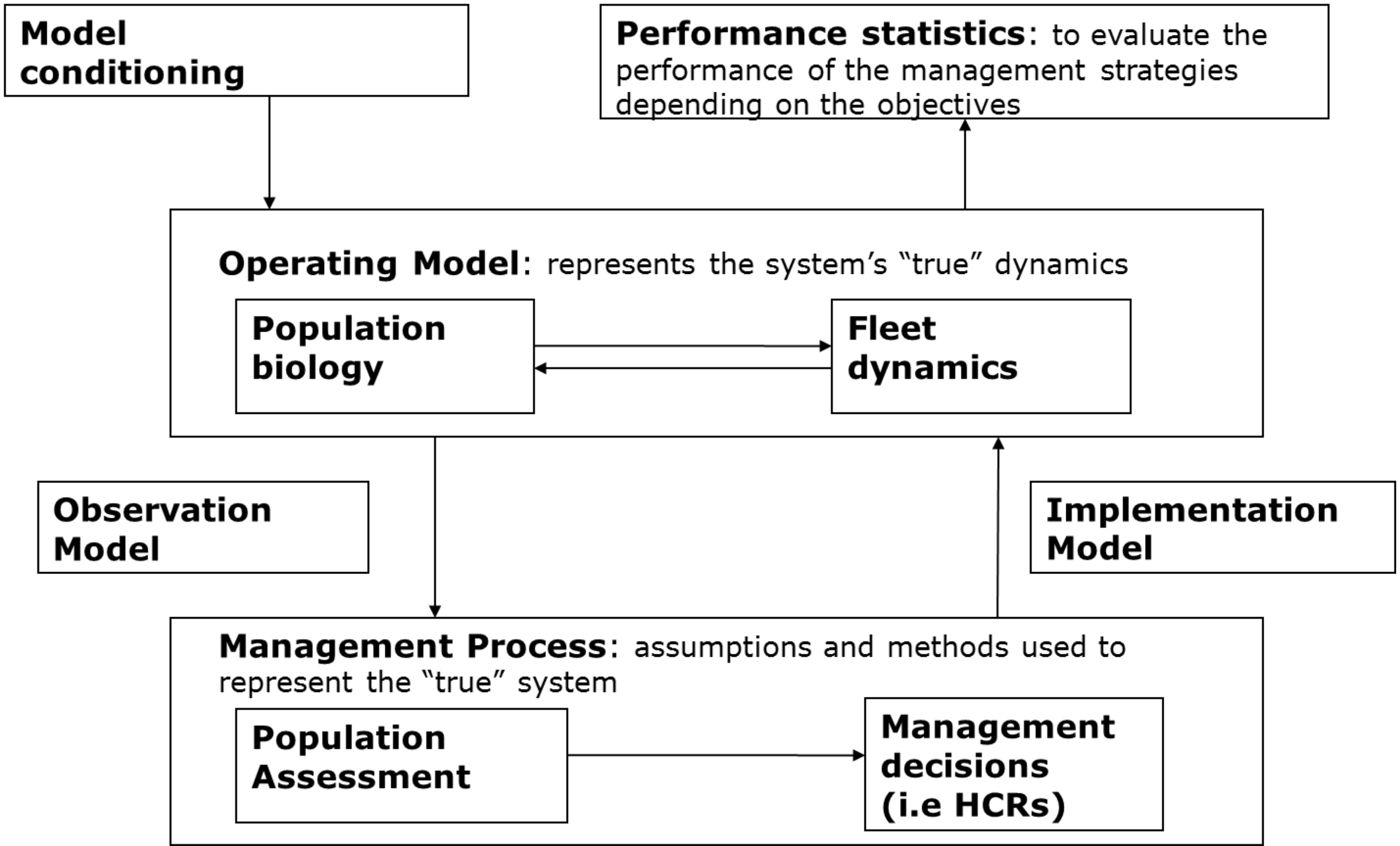
Why FLBEIA?

- Allows bio-economic impact assessment of fisheries management strategies
- Follows the MSE approach
- Flexible (permits adding extra functions if necessary)
- Allows seasonal steps

Reference:

García, D., S. Sánchez, R. Prellezo, A. Urtizberea and M. Andrés, submitted. FLBEIA: A simulation model to conduct Bio-Economic evaluation of fisheries management strategies. SoftwareX.

Simulation framework



Biological Operating Model

Age classes: 0 - 3+
Seasons: 2 (half-year basis)

Survival Equation (Pope approach)

Recruitment

- Ricker stock-recruitment (SR) model
- Quadratic-hockey stick SR model
- Persistent low recruitment
- Beverton and Holt SR model (not density dependent)
- 3 successive years with low recruitment

Fleets: INT

Selectivity by semester

Catch Equation

Cobb Douglas

$$C_{st,f,m} = q_{st,f,m} \cdot (E_f \cdot \gamma_{f,m})^{\alpha_{st,f,m}} \cdot B_{st}^{\beta_{st,f,m}}$$

Derivation of catch at age

$$C_{a,f,m} = \frac{C_{f,m}}{\sum_a s_{a,f,m} \cdot B_a} \cdot s_{a,f,m} \cdot B_a$$

No effort data available → effort dynamics not simulated

TAC share: sensitivity

TAC split into semesters:

- Based on historical values (60% Jan-Jun / 40% Jul-Dec)
- Alternative allocations based on different quota assignments by country

PRICES

Different by semester:

- 1st: modelled by inverse demand function considering a linear relationship in the log scale between landing and prices
- 2nd: fixed price (avg. 2010-2013)

ECONOMIC EVALUATION

Price function:

By semester for anchovy and fixed price for the rest of the species

Effort:

Anchovy: all necessary to catch each country quotas

Rest of the species: catches corresponding to remaining effort

Costs by fleet:

assumed constant and different for each fleet (FR and SP)

No feedback between economic and biological model

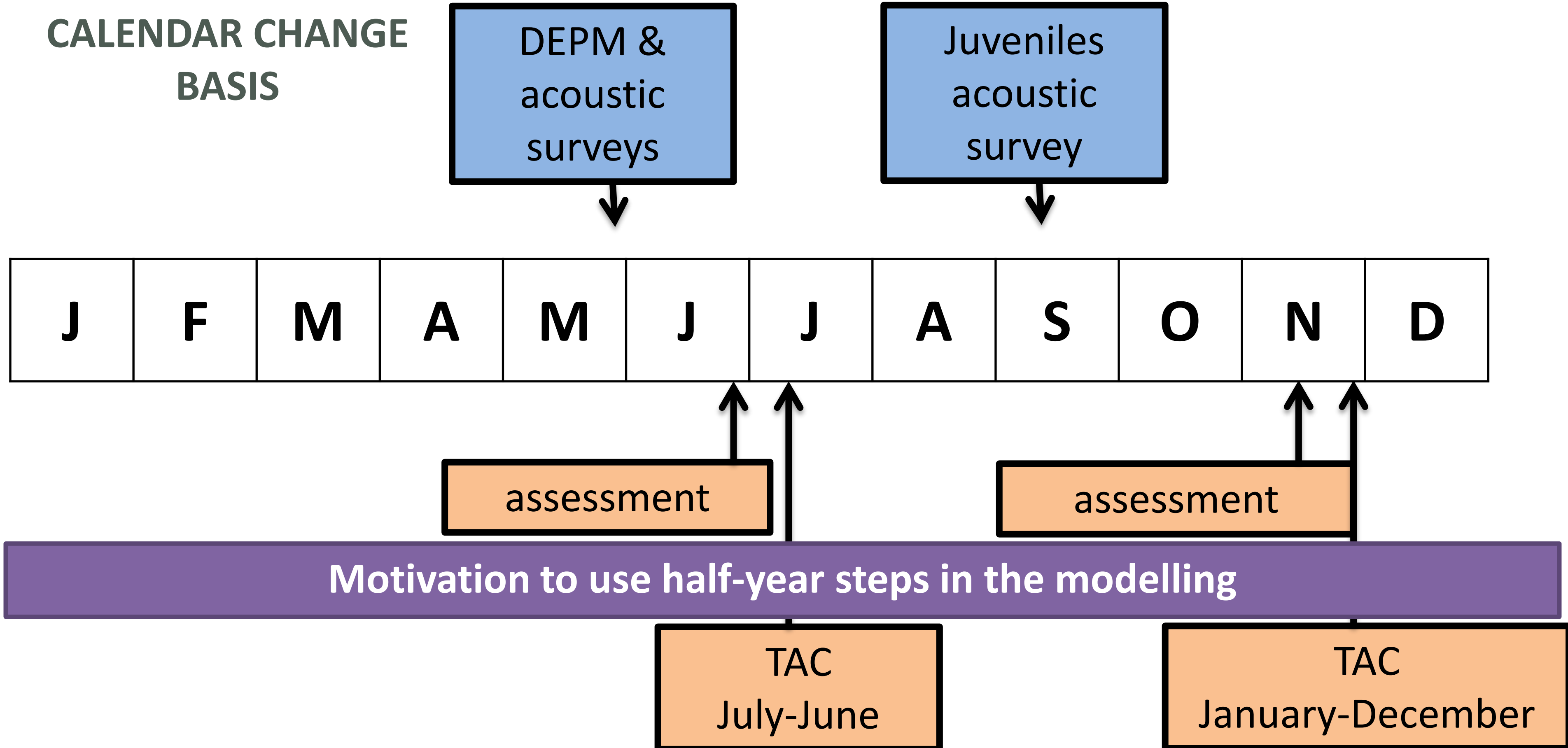
OBSERVATION, ASSESSMENT AND IMPLEMENTATION

Annual management (no TAC revision):

- 2 calendars: July-June and January-December
- Observation error for research survey indices
- No assessment error (no explicit, but included in the observation error)
- No implementation error → `catch = TAC`

Management Procedure

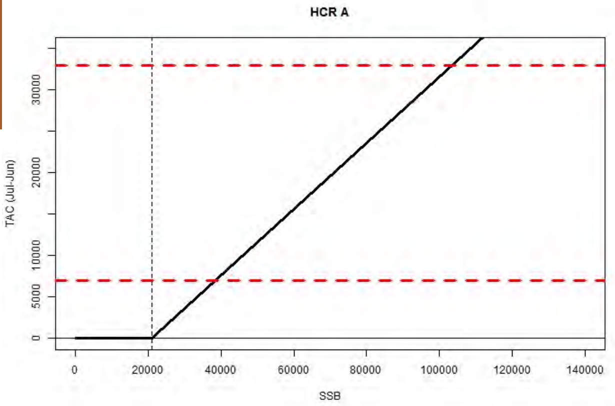
CALENDAR CHANGE BASIS



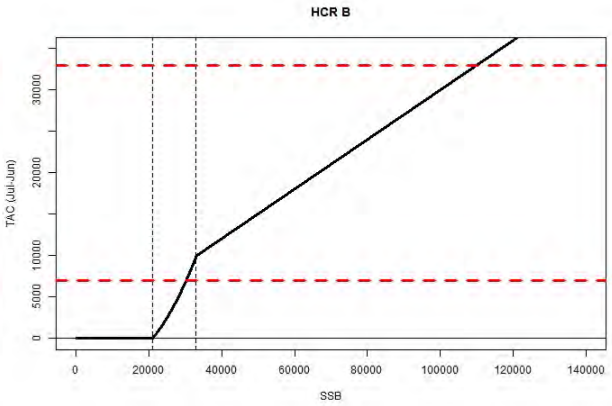
HARVEST CONTROL RULES

Rationale	Gamma	Trigger points	TACmin	TACmax	Calendar	Rule names	Reference
Fraction above B_{lim}	0,0.1, …, 1	B_{lim}	Yes / No	Yes / No	Jan-Dec	Rule A	STECF 2008
Fraction of SSB	0,0.1, …, 1	B_{lim}, B_{pa}	Yes / No	Yes / No	Jan-Dec	Rule B, Rule E	STECF 2008
Constant risk	0.766	26 500			Jan-Dec	Rule C	STECF 2008
Fraction of SSB (discontinuous)	0,0.1, …, 1	B_{lim}, B_{pa}	Yes	Yes / No	July-June /Jan-Dec	G0	STECF 2013, 2014
Fraction of SSB (general, continuous)	0,0.1, …, 1	B_{trig1}=24 kt B_{trig2}=24/33 kt B_{trig3} for TAC_{max}	Yes: 7 kt	Yes: 33/25 kt	July-June /Jan-Dec	G1: B_{trig2}=33, TAC_{max}=33 G2: B_{trig2}=33, TAC_{max}=25 G3: B_{trig2}=24, TAC_{max}=33 G4: B_{trig2}=24, TAC_{max}=25	STECF 2013, 2014

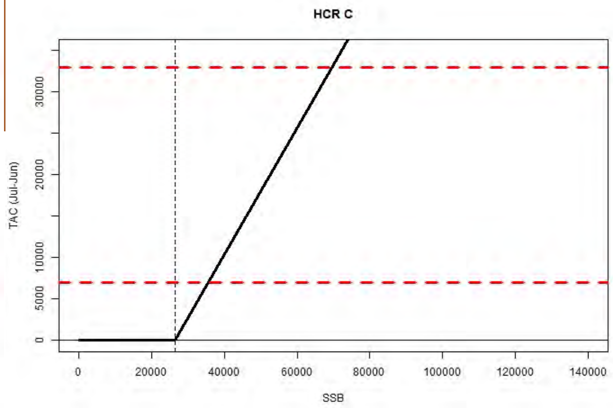
- Jul-Jun: SSB = latest SSB observed
- Jan-Dec: SSB = expected SSB during management period



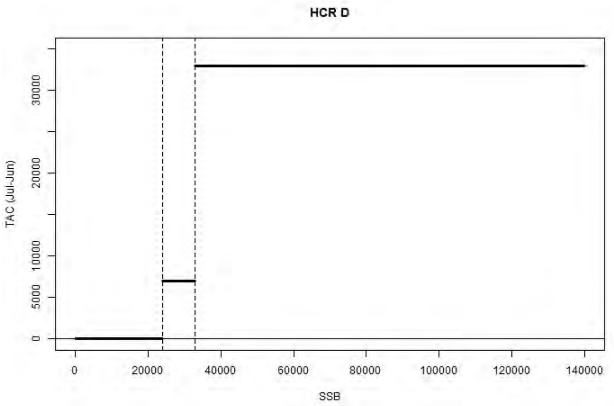
Escapement: catch fraction above B_{lim}



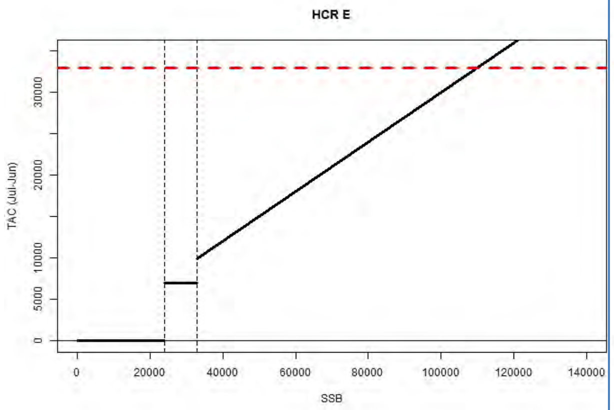
Catch fraction of SSB decrease between Blim and Bpa



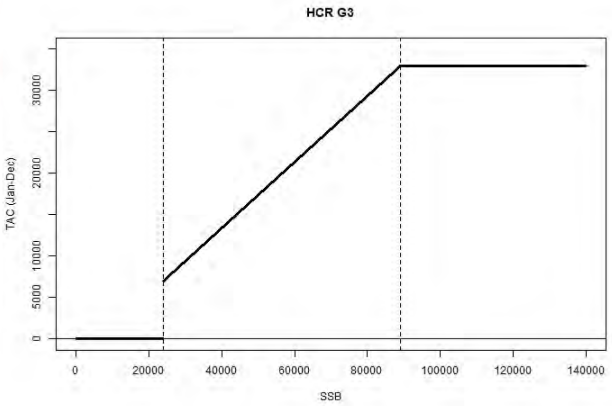
Constant risk of 0.15



Stakeholders proposal: tiered approach



Accepted: mixture approach



Revision: avoidance of discontinuities and calendar change

Model conditioning

Results of most recent assessment available

Historical catches

Natural mortality and maturity (fixed values)

Uncertainty

- starting population (selected chains from CBBM)
- recruitment predictions
- observation error of the indices

Markov Chain Monte Carlo

Summary statistics

- Median SSB, median SSB in the last year of the projection
- **Probability of SSB being under B_{lim}**, probability of SSB being under B_{lim} at least once in the projection period
- Number of years with SSB being under B_{lim}, number of years necessary to get SSB above B_{lim}
- **Probability of fishery closure**, probability of fishery closure at least once
- Number of years with closure
- **Average catch**
- **Average standard deviation of the catches**
- **Discounted present value of the landings**
- **…**

3 Simulations

STECF: LTMP evaluations

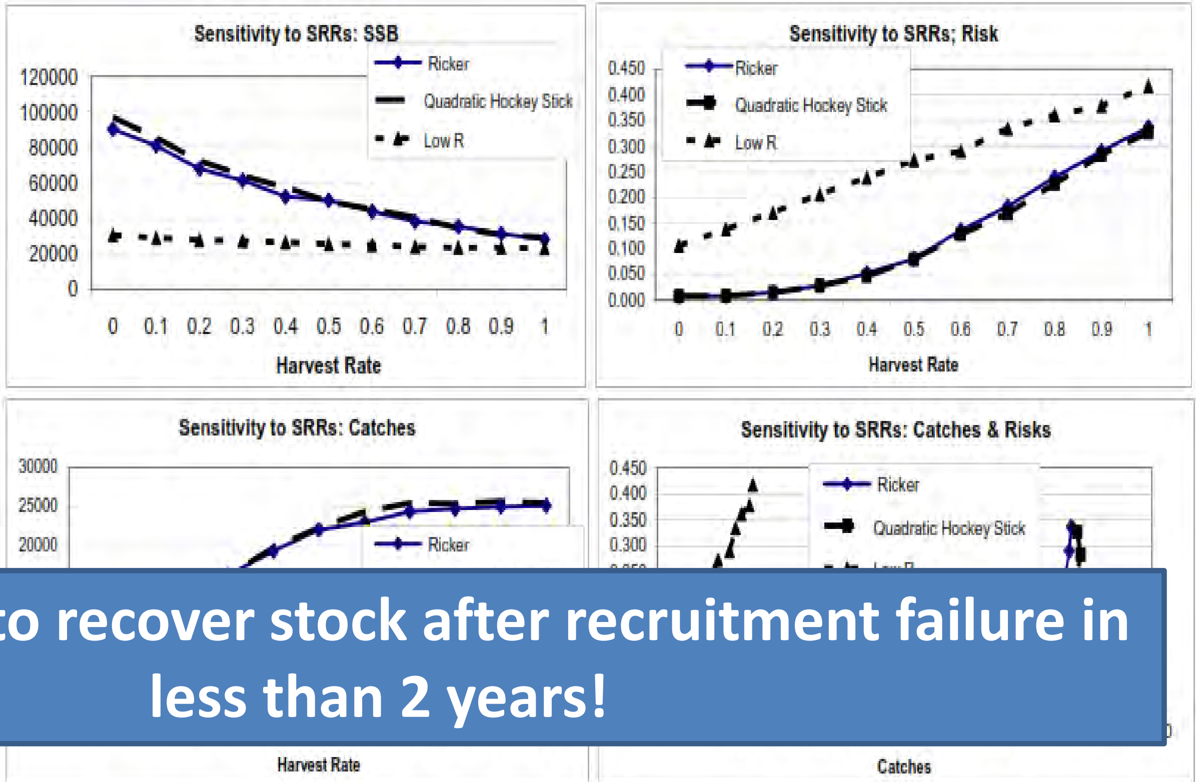
	STECF 2008	STECF 2013/14
Conditioning	Half-year BBM assessment (Ibaibarriaga *et al*. 2008) + SICA (Uriarte *et al*., 2006)	BBM (Ibaibarriaga *et al*., 2011)
Biological OM	Ages 0-2+ & 0-3+ Recruitment: - Ricker - Beverton-Holt - Segmented Regression - Quadratic Hockey Stick - Persistent low - Historical variability	Ages 0-2+ Recruitment: - Ricker - Sensitivity to 3 successive years of poor recruitment
Observation model	Observation and assessment error (cv 25% + sensitivity analysis)	Observation and assessment error (cv 25%) + sensitivity to 15% as assessment predicts)
MP management	Discontinuous rules	Continuous rules
Implementation model	$TAC_{July\text{-}June}$	$TAC_{July\text{-}June}$ & $TAC_{Jan\text{-}Dec}$ Sensitivity to error in assumed % by semester
Simulations	10 years 100 iterations	20 years 500 iterations

4 Results

Results: sensitivity to recruitment

Comparison of the performance of a harvest rule consisting on harvesting a constant proportion above an escapement SSB level for the different SR models selected for the analysis

- → not sensitive to the use of either the Ricker or the Quadratic Hockey Stick SR models.
- → high sensitivity to a persistently low recruitment scenario (risks always >1

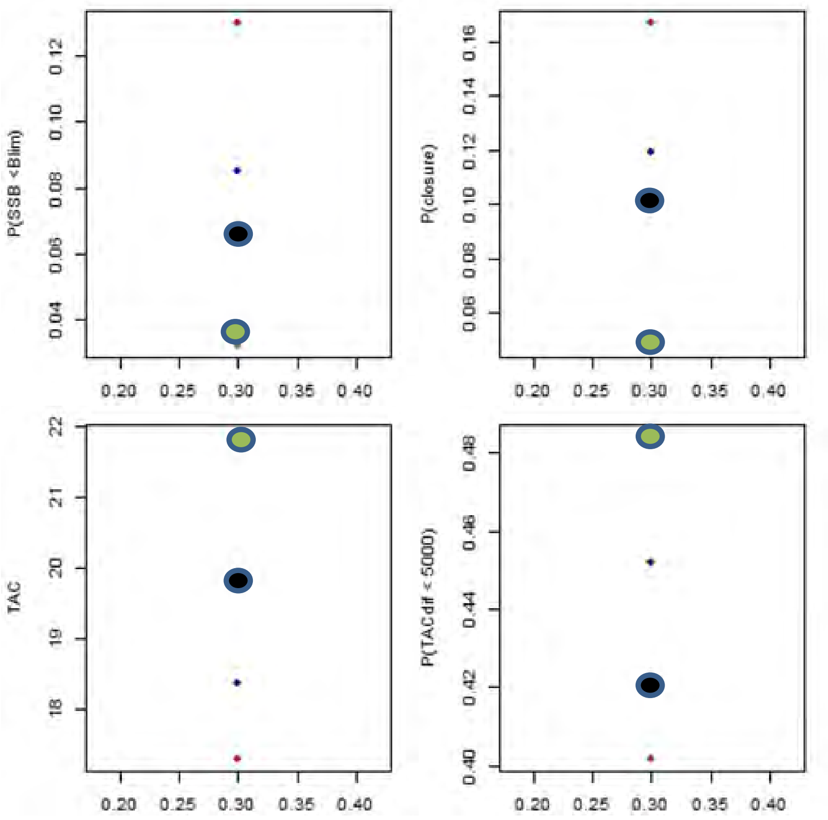


All rules able to recover stock after recruitment failure in less than 2 years!

Results: sensitivity to management calendar

Comparison of the performance of the Original Rule (G0) when applied from January to December (JD)

- → JD halves the risk of being below B_{lim} and of closure
- → JD reduces the time of stock recovery from below B_{lim}
- → JD results in higher catches (by 2000t) and larger inter-annual stability up to 0.48



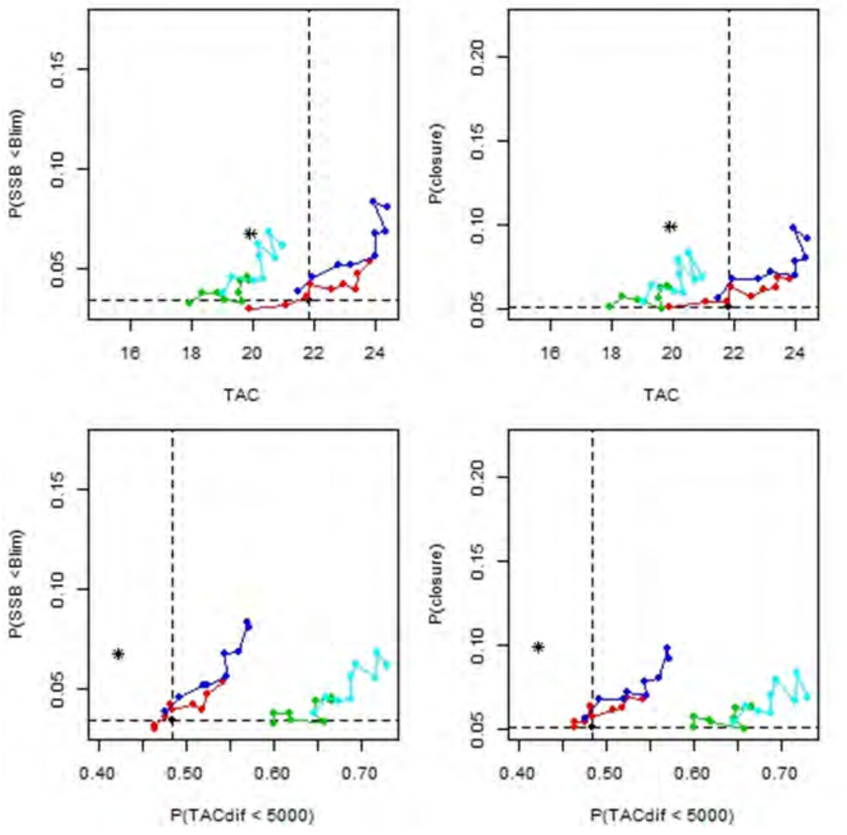
Black : **July-June calendar,**
Green: **January-December calendar,**
Red : **July-June with Ricker and low recruitment,**
Blue : **January-December with Ricker and low recruitment.**

Results: sensitivity to TAC constraints

Comparison of the performance of all Harvest control Rules from January to December

→ G1(JD) gives higher and more stable catches than G0 (JD) and lower levels of risks than 0.05 (for gamma between 0.35 and 0.65).

→ G0 January to December results in lower risks than G0 for July to June (*)



G0: initially adopted HCR (ɣ=0.3, TACmax=33000 t), * JJ calendar;
G1: TACmax=33000 t; G2: TACmax=25000 t;
G3 : TACmax=33000 t ; G4: TACmax=25000 t

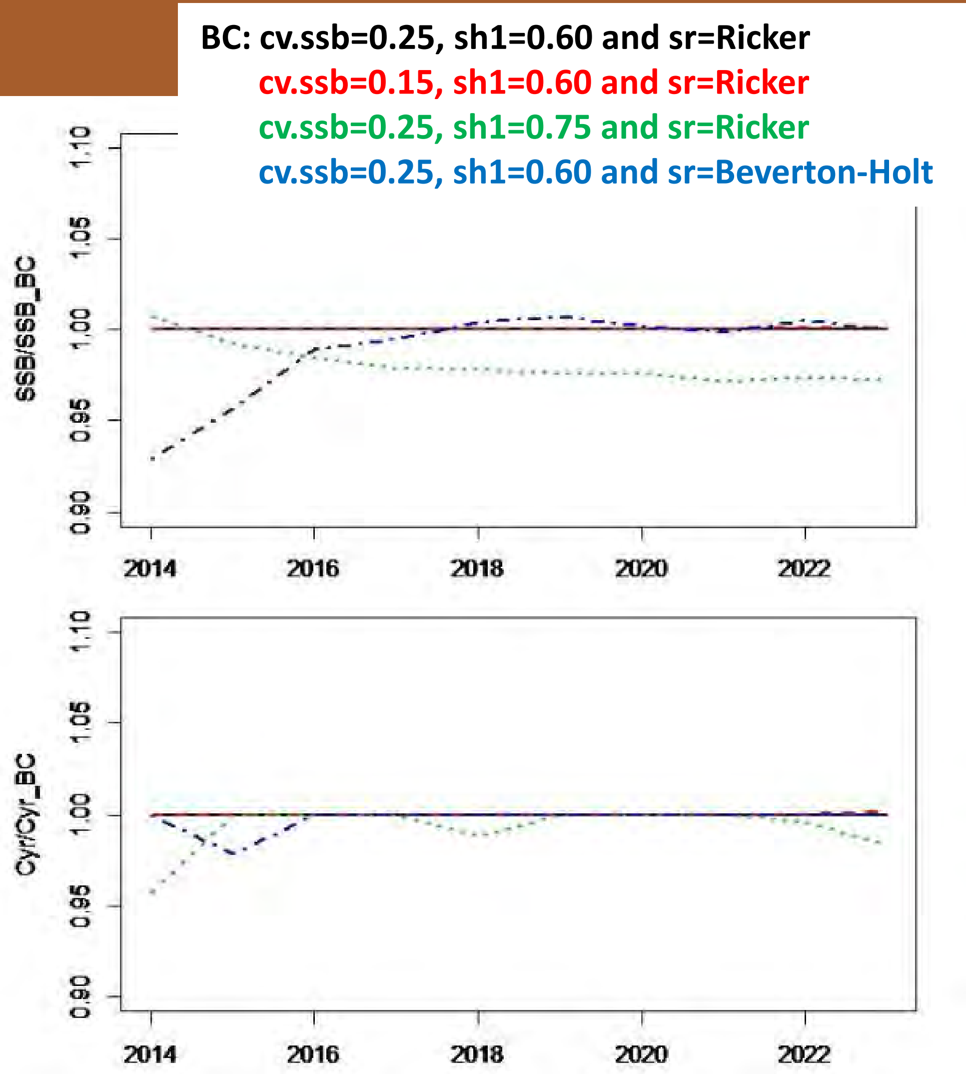
Results: sensitivity

Sensitivity to observation error, share by countries and the stock-recruitment relationship

→ <u>Little effect</u> on biological risk of different quota shares among countries and when not density dependent SRR

→ <u>Slightly lower</u> biomasses and catches given actual country shares and agreement in place (difs. < 5%)

→ Limited sensitivity to a lower CV, in line with current assessment output



Results: economic analysis

→ Confirmation of catch thresholds proposed by stakeholders

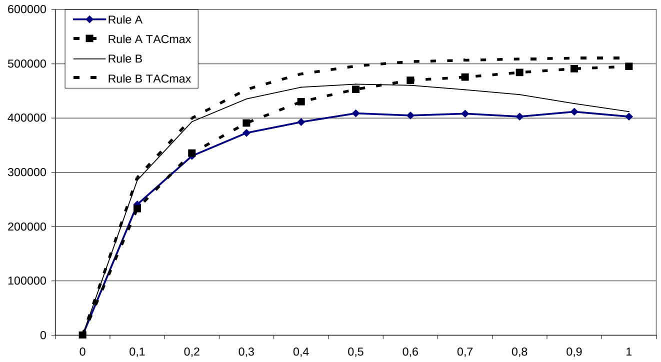
- Maximum value of a TAC at 32 000 t
- Minimum viable TAC for sustainable fishery 7 000 t

→ Economic performance always improve with TAC max

→ International economic results does not depend on TAC share by countries

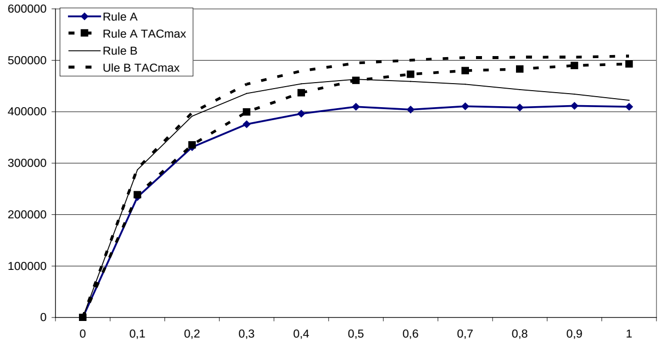
Allocation key 50% each country

International Gross Iincome from anchovy for a Constant allocation of TAC between countries 50% for each (Average Historical mean 1992-2004)



Official: 90% Spain-10% France

International Gross income from anchovy for an allocation rule 90% Spain and 10% France (according to the relative stability principle)



5 Conclusions and future work

Conclusions

Simulation framework

- FLBEIA, under MSE framework, adequate tool for evaluating the alternative HCRs
- Need to consider half-yearly steps (despite the difficulties):
  - due to changing calendars; and
  - to simulate the different fishing patterns of the fisheries by semesters
- Sensitivity analysis to different uncertainties were carried out

Management strategies

- If 3 years of low recruitment → rules able to recover the stock in less than 2 years; but if persisting low recruitment long time → risks always >10%
- Economic analysis confirmed the logic of maximum TAC around 33 000 t as suggested by stakeholders
- January – December calendar reduces biological risks and the probability of fishery closure for a management informed on recruits entering the population in the management year, whereas maximum TAC stabilizes catches and reduces risks.

Future work

- Include the assessment explicitly in the Management Procedure
- Introduce the effort dynamics → full feedback between biological and economic models
  - However, difficult to obtain economic information with enough resolution
- Model both fleets separately (France and Spain), including the different metiers (pelagic trawlers and purse-seiners)
- …

Sonia Sánchez *Researcher*
Marine Research Division
T. +34 667 174 481
IP Videoconferencing: 150.241.234.121
Herrera Kaia, Portualdea z/g E-20110 Pasaia, Gipuzkoa.
Mail: ssanchez@azti.es

FLBEIA by AZTI