Drivers of dynamics of small pelagic fish resources
International Symposium, Victoria (Canada), March 6-11, 2017
Session 5: Future challenges for ecosystem-based management of highly variable fish populations

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Managing the Bay of Biscay anchovy:

fishery requirements vs. sustainability given recruitment uncertainty

Uriarte, A., Sánchez, S., Ibaibarriaga, L., Abaunza, P., Andrés, M., Duhamel, E., Guyader, O., Lehuta, S., Jardim, E., Leonardi, S., Prellezo, R., and Roel, B.

1- Background

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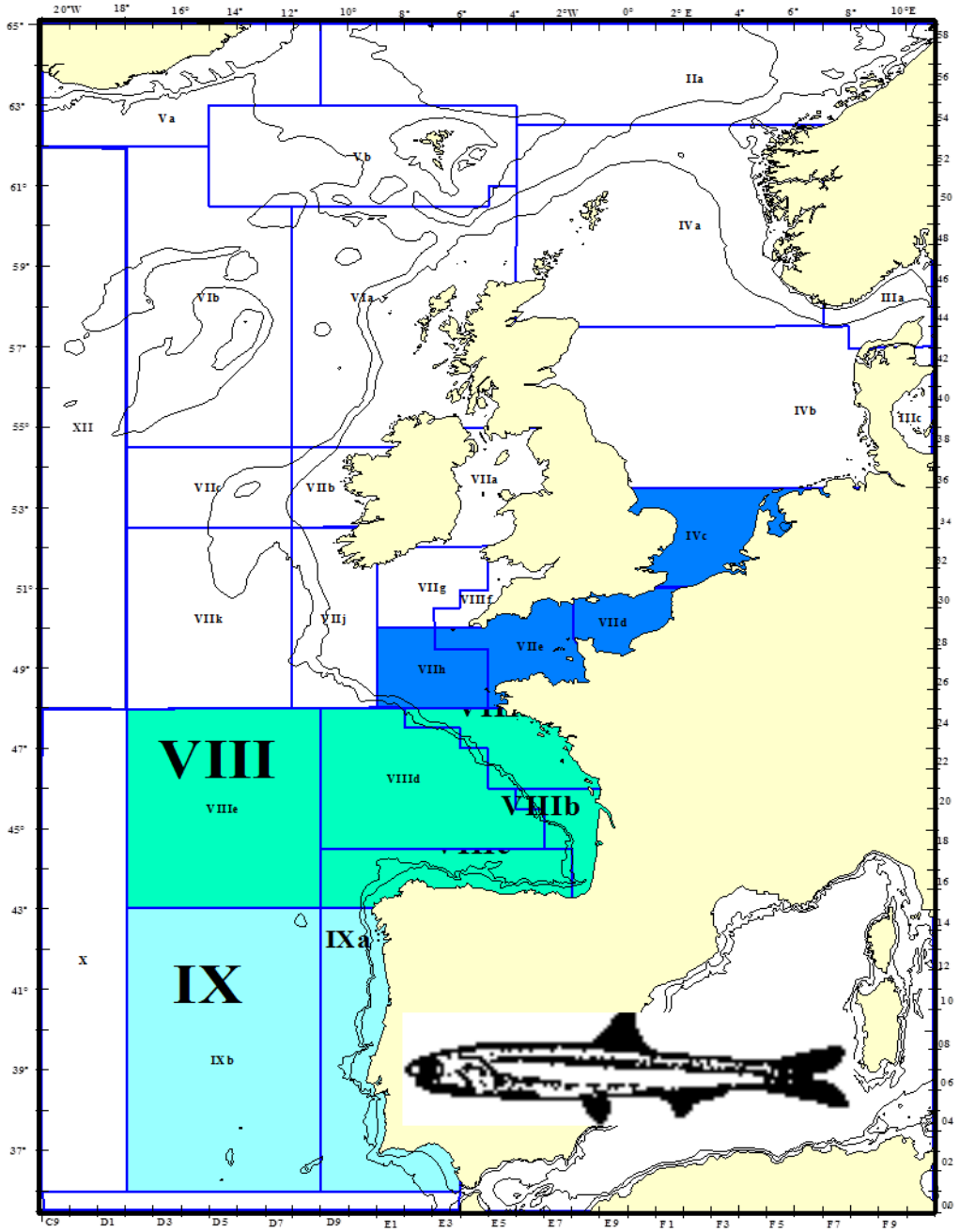
1. The anchovy

- Small pelagic species
- Short-lived (3-5 years)
- Fast turn-over
- Sustained by age 1 recruits
- Mature at age 1
- Spawning in spring
- High and variable M (M1<M2)
- Major predators on juveniles and adults are: tunidae, hake, monkfish, and demersal fishes, big mackerel, horse mackerel and jack mackerel



2. The fishery

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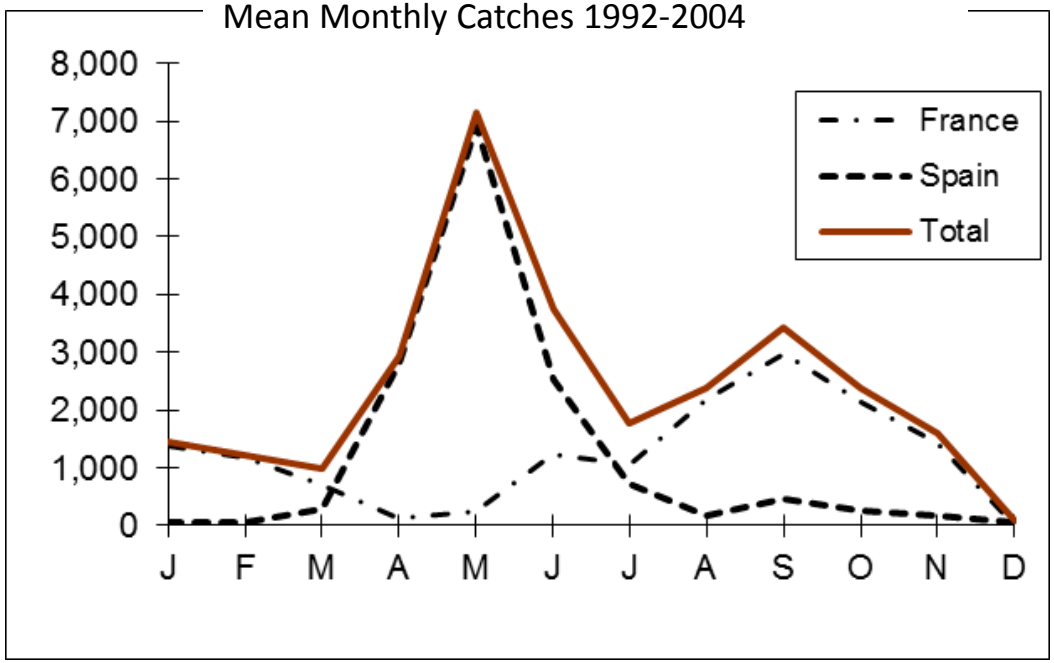
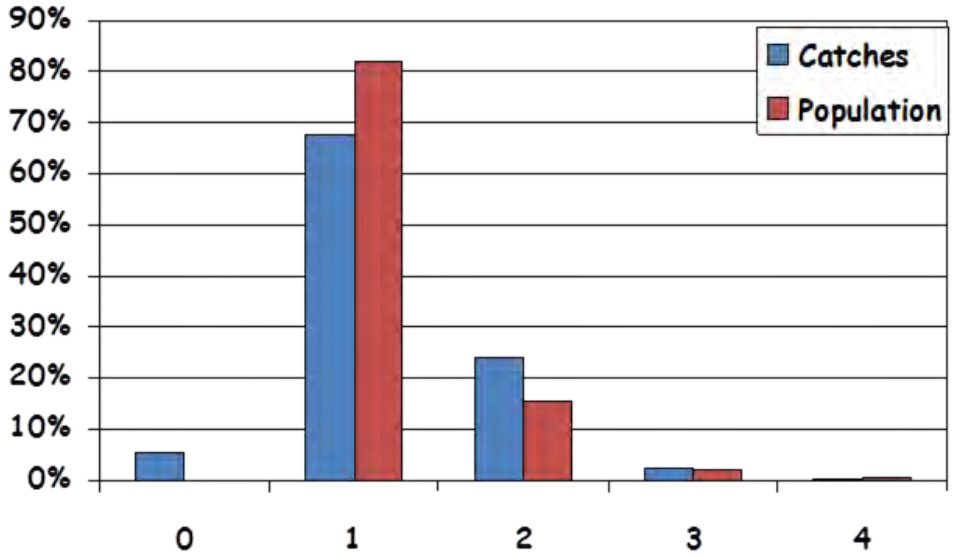
Spanish fleet:

purse seines (~150 licences)

Mainly in spring





Population and catches sustained by recruitment at age 1

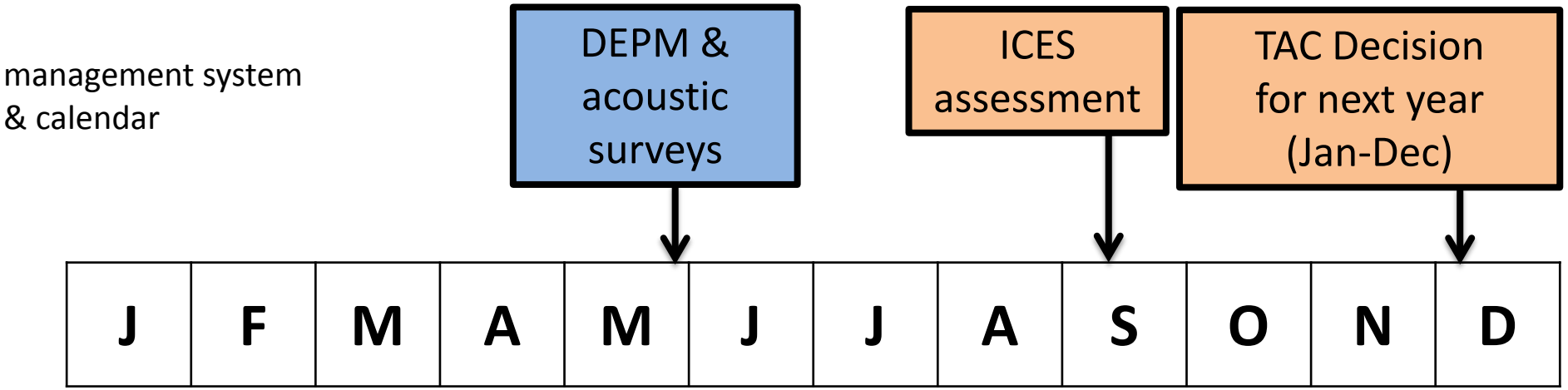
French fleet:

pelagic trawlers (~50 vessels) + purse seines (~27, but mainly on sardine)

Mainly in Second half of the year

2. Historical development

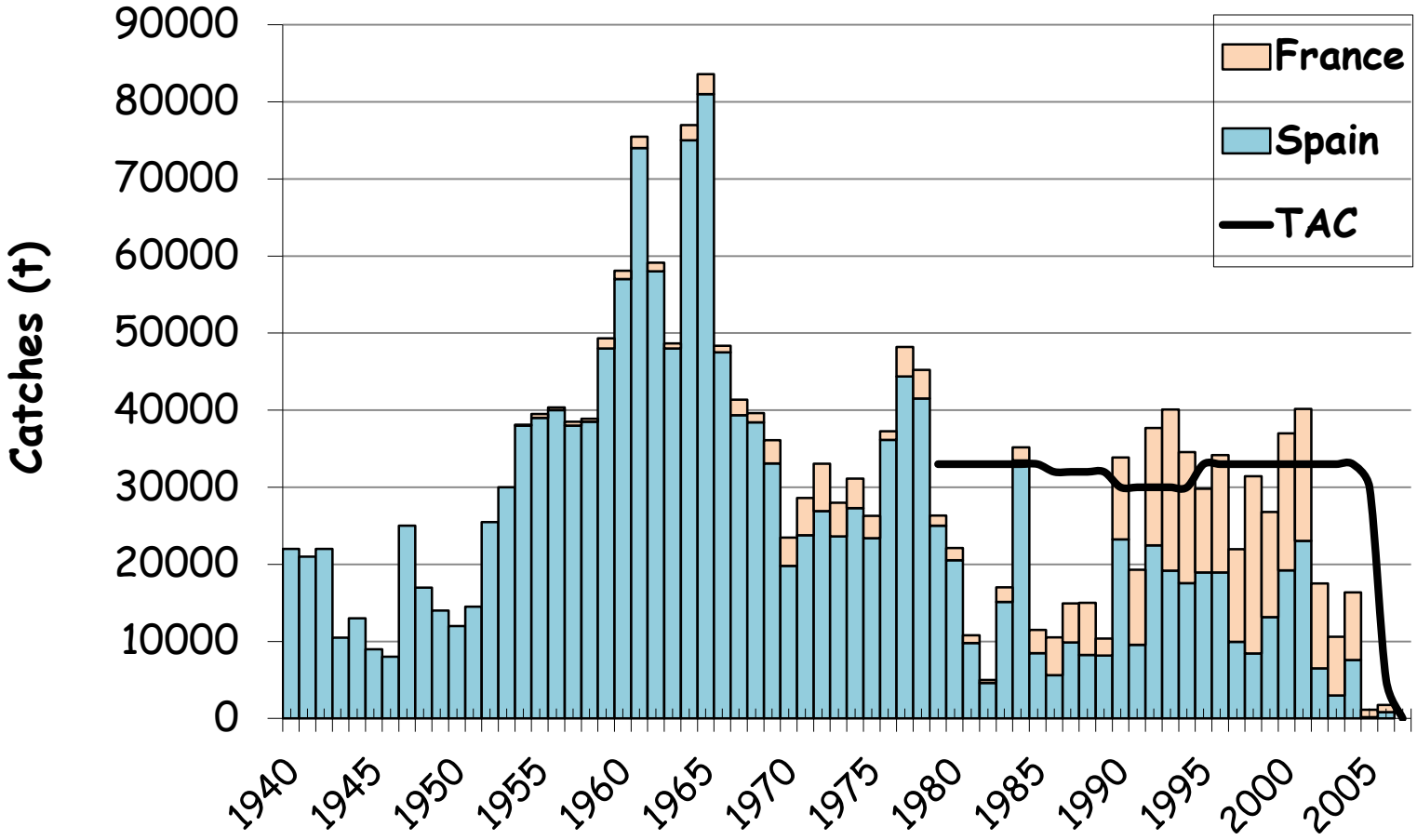
ICES Provision of advice 2001-2004



- Catch advice provided for Y+1 with unknown recruits at age 1 (~60% of catches unknown)
- ICES precautionary approach (PA) strategy: two phase approach for advice
  - I. Initial TAC advice based on poor recruit assumption to start the year (January)
  - II. Revised TAC advice (in June) after recruit estimates from May surveys
- Caveats: most of the catches (60%) in 1st half of the year governed under PA
  - Unbalanced PA affection by countries (Spain 87%; France 33% during 1st half of the year)
  - PA approach → precautionary but suboptimal exploitation strategy due to the unknown recruits

The advice was not followed / Fixed TAC around 30 to 33 000 t

2. Historical development of the fishery



The fishery crashed in 2005 due to successive failures of recruitments leading the stock below B_{lim} (21 000 t)

2- 1st management plan: Management under recruitment uncertainty

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3. First management plan: the process

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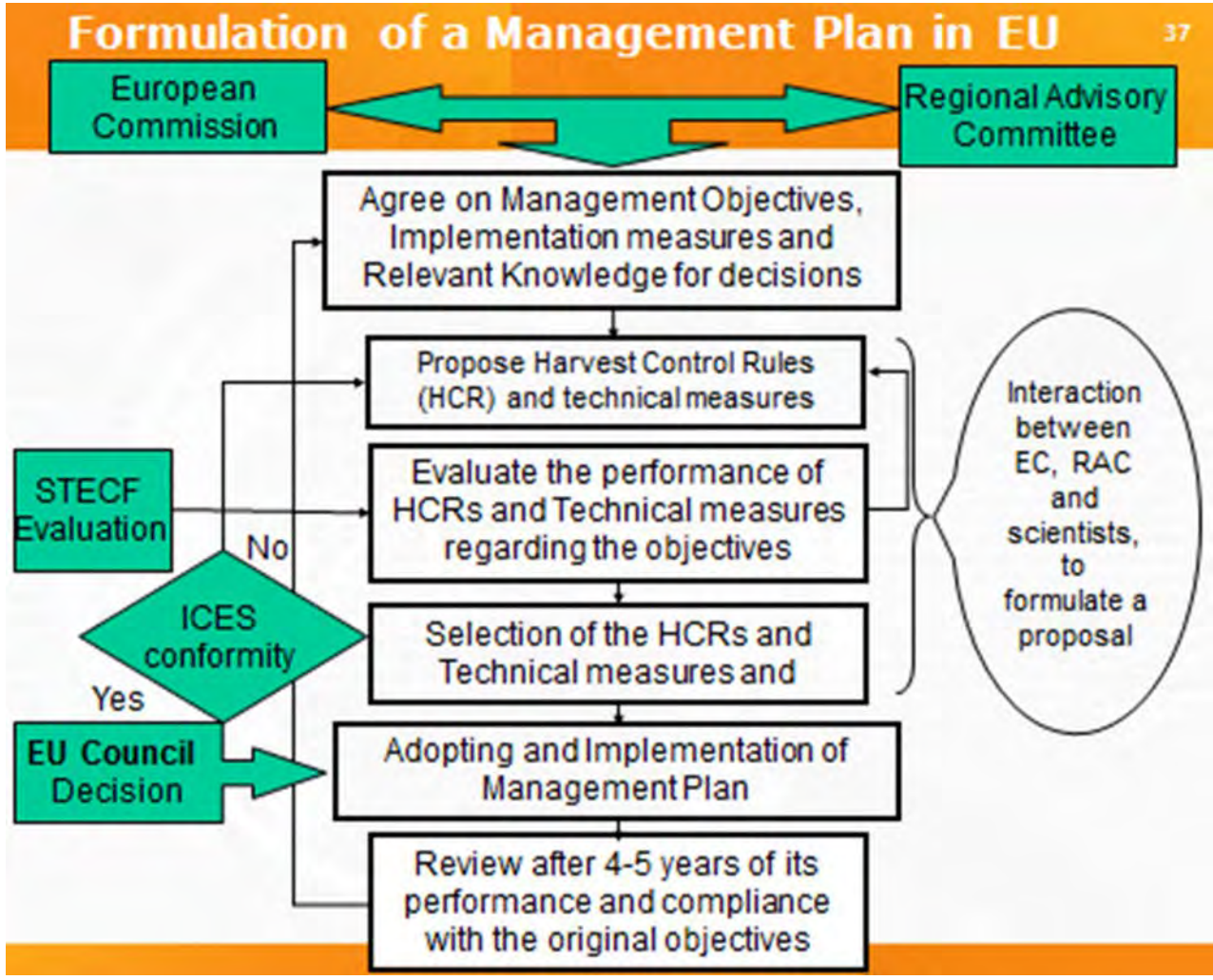
- 2006/2007 First initiatives through SWW. RAC
  - Sustainability of the resource / sustainability of the fleets / cohabitation of fleets

- 2008: The European Commission launched the process

  EC set objectives:
  - **to ensure the exploitation of the stock at high yields consistent with maximum sustainable yield (MSY);**
  - **to guarantee the stability of the fishery, as far as possible, and with a low risk of stock collapse.**

  Basis: STECF works in 2008 with scientists of AZTI, IEO, IFREMER, CEFAS, universities,…

- Iterative consultation process with managers and stakeholders 2008/2009

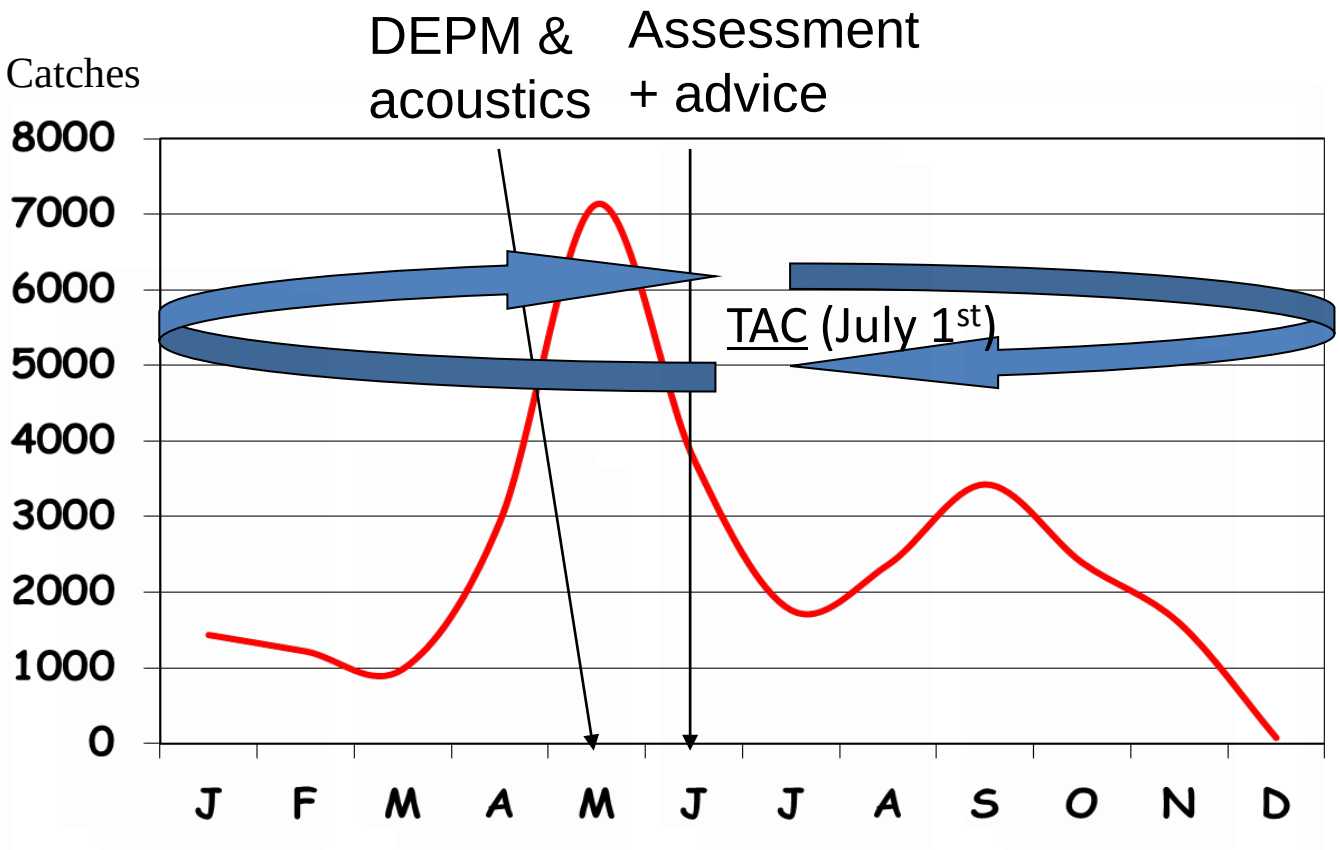


3. First management plan approach:

close coupling of monitoring + advice with management

New management calendar:
Set TACs July (*Y*) - June (*Y+1*). according to the biomass levels estimates from May surveys year ***y***.

Aim of management plan:
Develop Harvest Control Rules (robust to uncertainties) to set max TACs keeping risk low [P(SSB(Y+1) < Blim) < 0.05]



Surveyed estimates (*y*) accounts for about 67% managed catches and 10- 40% managed population (y+1)

Major sources of uncertainties: *i)* assessment uncertainties of biomass in year *y*

ii) Recruitment uncertainty (age 1 in year *y+1*, 1st half) →SSB(*y+1*)

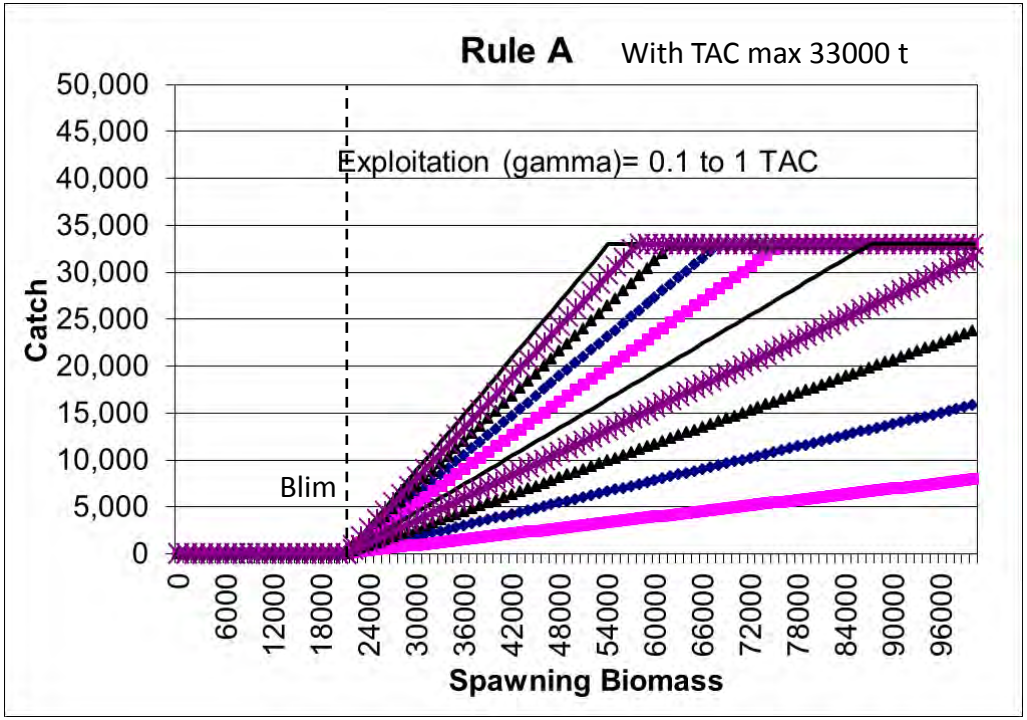
iii) Others: process errors and model miss-specification

3. First management plan:

formulation of Harvest Control Rules & stakeholders' input

Rule A:

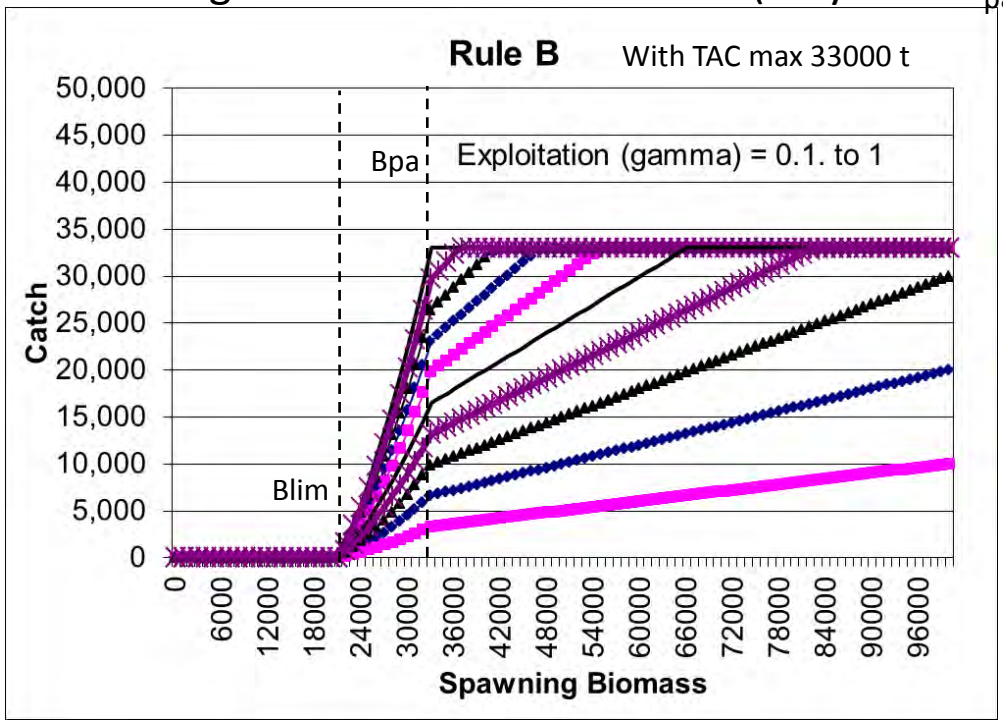
Harvesting a constant fraction of B in excess of B_{lim}



$$TAC_y = \begin{cases} 0 & \text{if } S\hat{S}B_{y-1} \le B_{\lim} \\ \gamma(S\hat{S}B_{y-1} - B_{\lim}) & \text{if } S\hat{S}B_{y-1} > B_{\lim} \end{cases}$$

Rule B:

Harvesting a constant fraction of SSB (only if B> B_{pa})



$$TAC_y = \begin{cases} 0 & \text{if } S\hat{S}B_{y-1} \le B_{lim} \\ \gamma \dfrac{(S\hat{S}B_{y-1} - B_{lim})}{(B_{pa} - B_{lim})} S\hat{S}B_{y-1} & \text{if } B_{lim} < S\hat{S}B_{y-1} < B_{pa} \\ \gamma\, S\hat{S}B_{y-1} & \text{if } S\hat{S}B_{y-1} \ge B_{pa} \end{cases}$$

Stakeholders' variants: **TAC constraints**:

With and without a maximum TAC (33 000 t)

With and without a minimum TAC (7 000 t)

(stakeholders' minimum economic viable TAC

if TAC<TAC_{min} then close the fishery)

3. First management plan: evaluations

- Scientific work - simulations:
  - following MSE approach
  - Using FLBEIA framework (http://flbeia.azti.es/)

- Work carried out within STECF:
  - 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.

3. First management plan: evaluations

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- Rules A & B were tested over a 10 years projections
  - For a range of harvest rates from 0 to 1 (0.1 steps)
  - With and without TAC max at 33 000 t
  - With and without TAC min at 7 000 t (below which the fishery is closed)
  - For different quota allocations between Spain and France of the TAC: from the 50:50 recent historical ratio) to 90:10 (official) and other variants

- Evaluation of rules A & B for the following performance indicators
  - Sustainability of the population: mean SSB, risk [$P(SSB(Y+1) < B_{lim}) < 0.05$],…
  - Fishery performance: mean catch, variability of catch (SD), probability of closures,…
  - Socio-economic performance: TAC value, gross and net revenue , wage (as social indicator),…

- Testing robustness to uncertainties in
  - Population dynamics models: two stage or full age structured models
  - Stock recruitment relationships: Ricker or Quadratic Hockey stick SRR
  - Persistent low recruitment scenario

3. Evaluation of HCRs for TAC constrains

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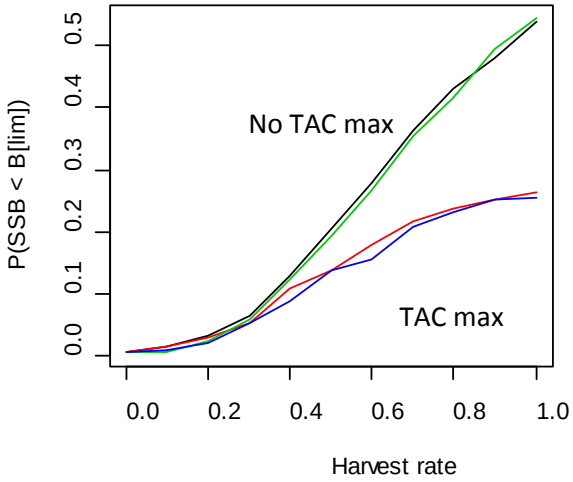
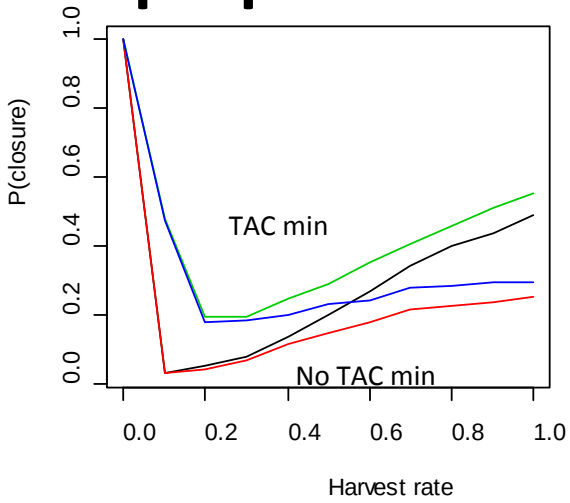
Case Rule B: harvesting a constant proportion biomass (Ricker)



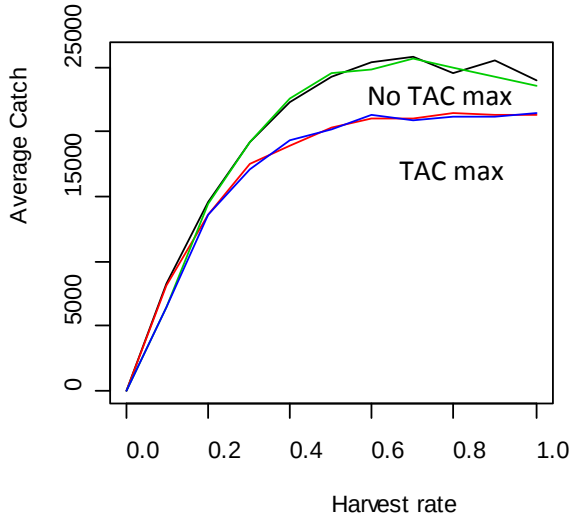


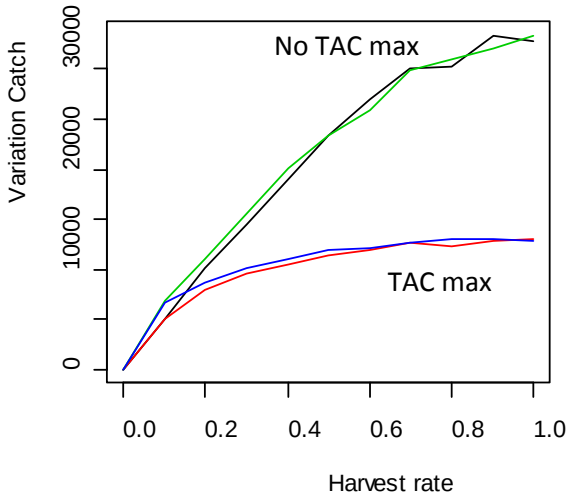
TAC_{max}

i) reduces mean catch

ii) **stabilizes catches**

iii) reduce risks





TAC_{min}

i) **increases the probability of closure**

ii) very little reduction of catches and increases variability

iii) does not alter the risks

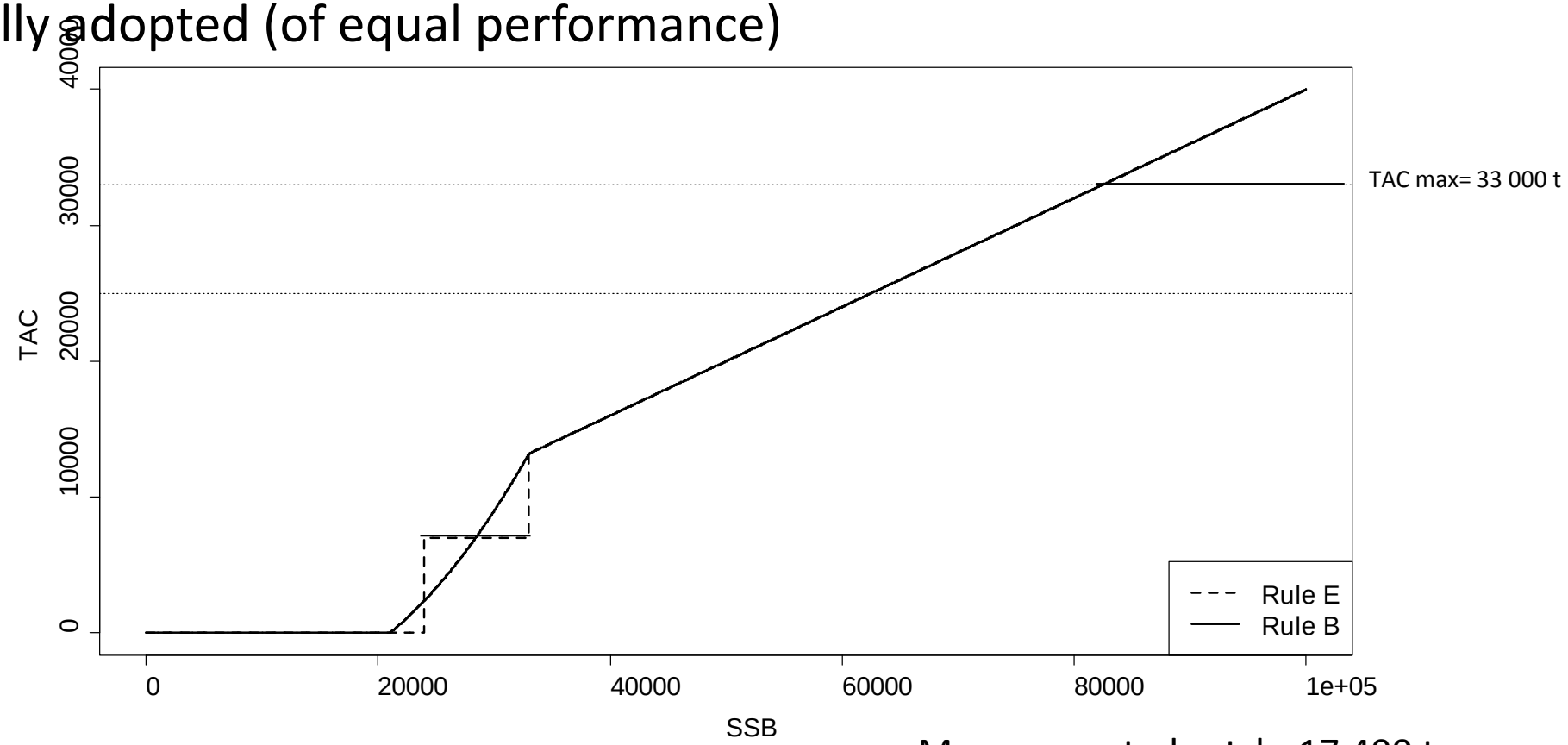
Similar effects of TAC_{max} and TAC_{min} on Rule A

TACmax=NA, TACmin=NA ; **TACmax=33000 t , TACmin=NA**

TACmax=NA, TACmin=7000 t; **TACmax=33000 t, TACmin=7000 t**

3. Selection of a final HCR

- EC decision: Rule B with TAC_{max} 33 000 t & harvest rate 0.3 (risk~0.05/0.06)
  - Fishermen preferred harvest rate 0.4 (but the risk was about 0.09)
- A variant (rule E) selected by fishermen with a step TAC_{min} at 7 000 t was finally adopted (of equal performance)



$$TAC_y = \begin{cases} 0, & \text{si } \widehat{SSB}_{y-1} \leq 24000 \\ 7000, & \text{si } 24000 \leq \widehat{SSB}_{y-1} \leq 33000 \\ \min\left(0.3 \cdot \widehat{SSB}_{y-1}, 33000\right), & \text{si } \widehat{SSB}_{y-1} \geq 33000 \end{cases}$$

Mean expected catch: 17 400 t
Risk of falling bellow B_{lim}: around 0.05
Fishery closure risk: 0.11

3- 2nd management plan: Management informed on recruitment

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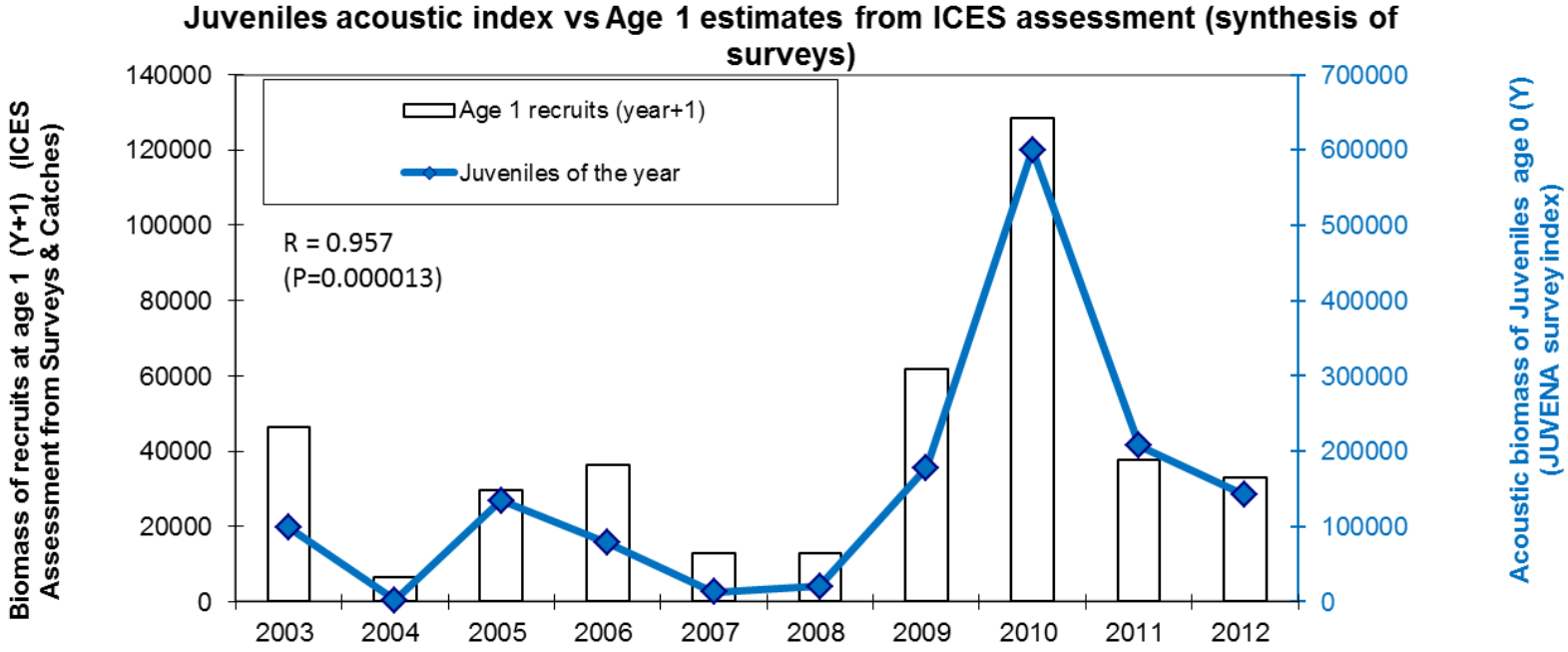
4. Second management plan:

Reasons for the review

- **Review (in 2014 requested after 4 years of application)**
- **ICES benchmark (ICES CM 2013/ACOM:46).**
  - **Changes in population dynamics (Natural Mortality) and in Assessment Model**
  - **Revision of inputs (DEPM revision) and…**
- **Inclusion of an acoustic survey on juveniles (age 0) in autumn: JUVENA**



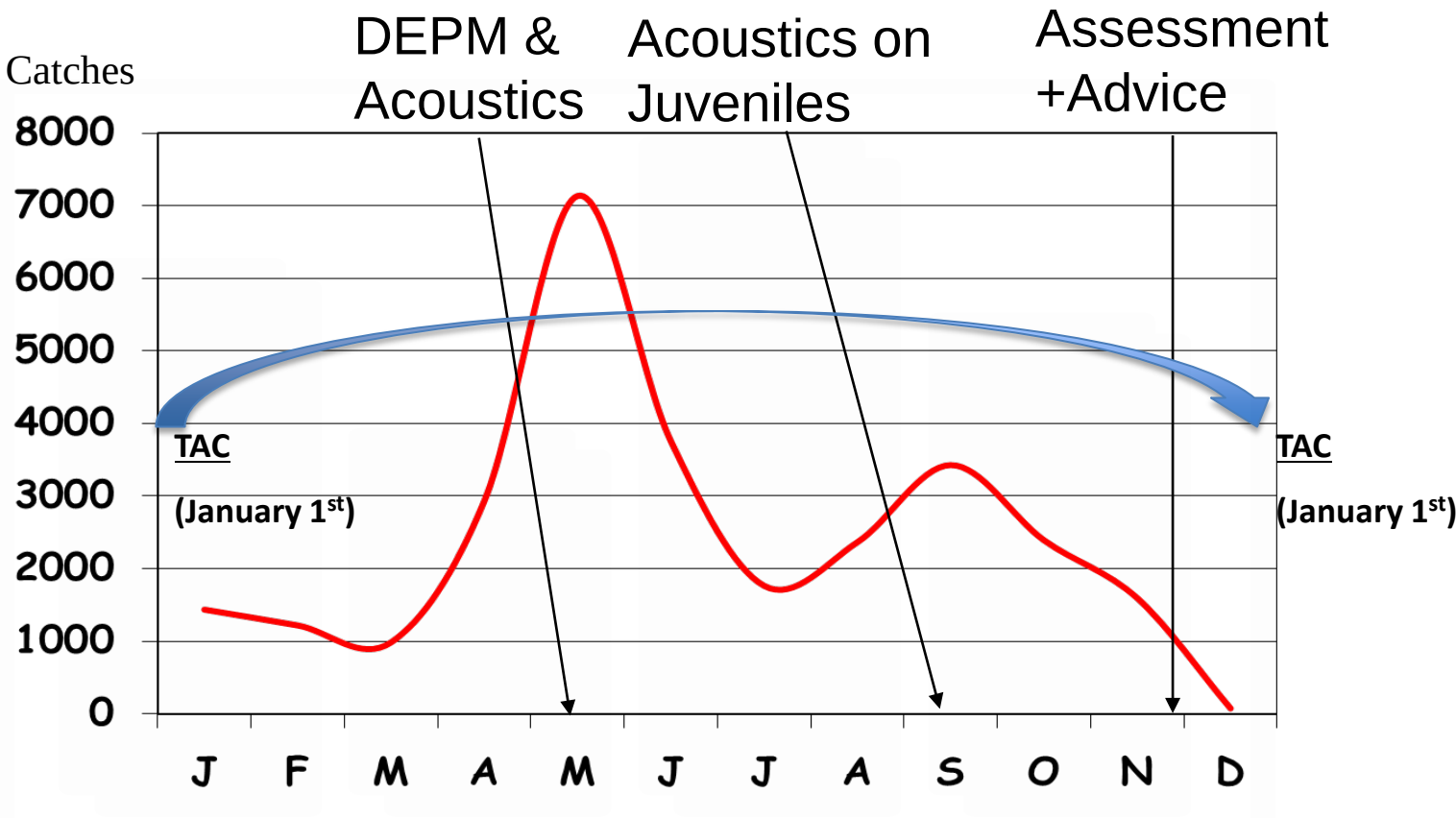
Boyra et al. 2013: ICES Journal of Marine Science, 70: 1354–1368.

4. Second Management Plan:

Coupling monitoring + advice to management

New Management Calendar: January – December (*Y+1*). according to the adult and recruits levels estimates in May and autumn surveys of year ***y***.

Aim of Management Plan: Develop Harvest Control Rules (robust to uncertainties) to set max TACs keeping risk low [$P(SSB(Y+1) < B_{lim}) < 0.05$]



Surveyed estimates (*y*) accounts for 98% managed catches & 100 % managed population (Y+1)

Sources of Biological risks: *i)* survey uncertainties of biomass and recruits_0 in year *y*
ii) Others: Process errors and model miss specification

4- Re-evaluation of the LTMP: STECF 2013/14

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Several alternative HCR were evaluated (avoiding discontinuities) for two levels of TAC_{max} and management calendar, continuous rules, setting TACs as a linear function of the expected SSB in the management year Y+1.

Work carried out within STECF:

- 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.

4- Re-evaluation of the LTMP: STECF 2013/14

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Conclusions:

- Reducing TAC_{max} from 33 000 t to 25 000 t:
  - reduces risks in 1-2%
  - provides more stability in catches (around 15%)
  - but reduces expected catches between 2000 y 4000 t by year (the higher the exploitation rate, the higher the reduction)
- Informed management on recruitment with a TAC January to December:
  - reduces the risks of falling below B_{lim} around 40%, with similar probabilities of fishery closures
  - provides slightly higher mean catches (~5%)
  - and more stability in the catches (~12%)

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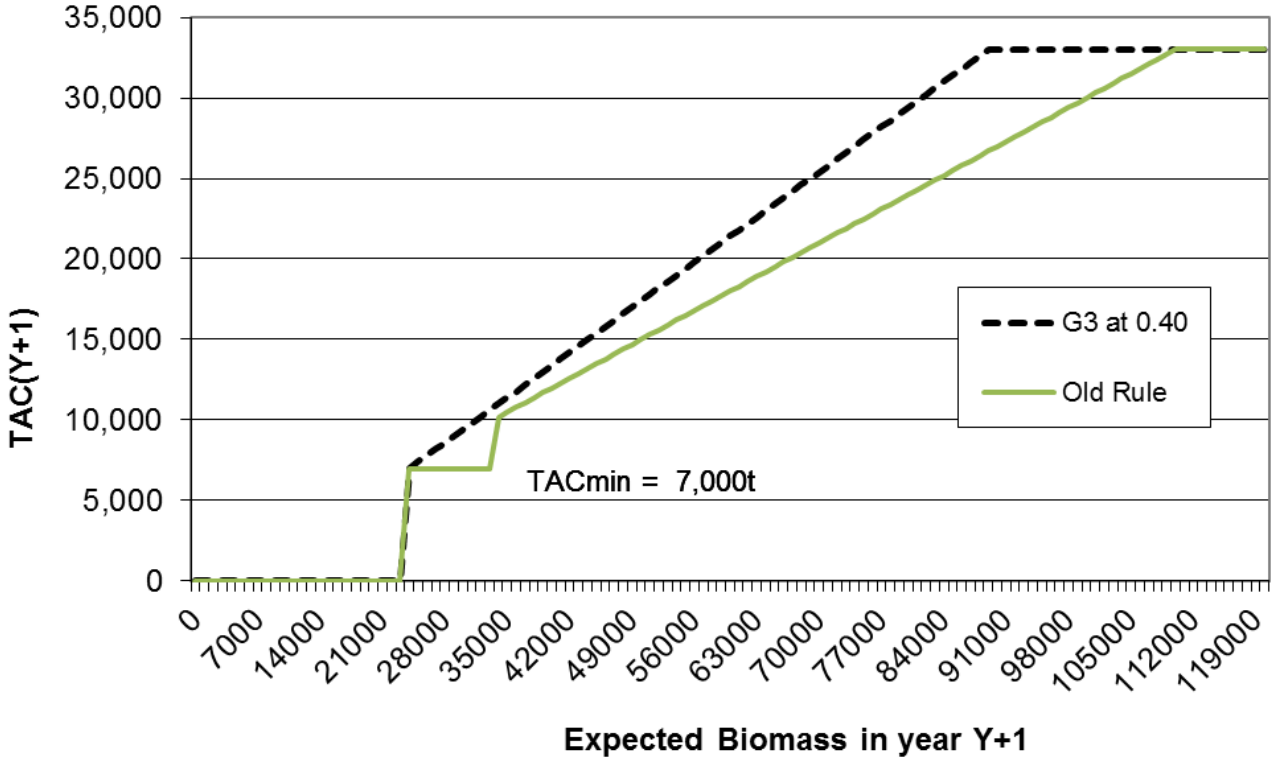
Rule adopted in 2016

- New rule (G3)

$$TAC = \begin{cases} 0 & \text{si } \widehat{SSB}_{y+1} \leq 24000 \\ -2600 + 0.40 \cdot \widehat{SSB}_{y+1} & \text{si } 24000 < \widehat{SSB}_{y+1} \leq 89000 \\ 33000 & si\ \widehat{SSB}_{y+1} > 89000 \end{cases}$$

Both rules resulted in the same risk levels



4- Conclusion

1. Current status of the fishery & stock
2. The consultative process and stakeholder inputs

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5. Current state: fishery

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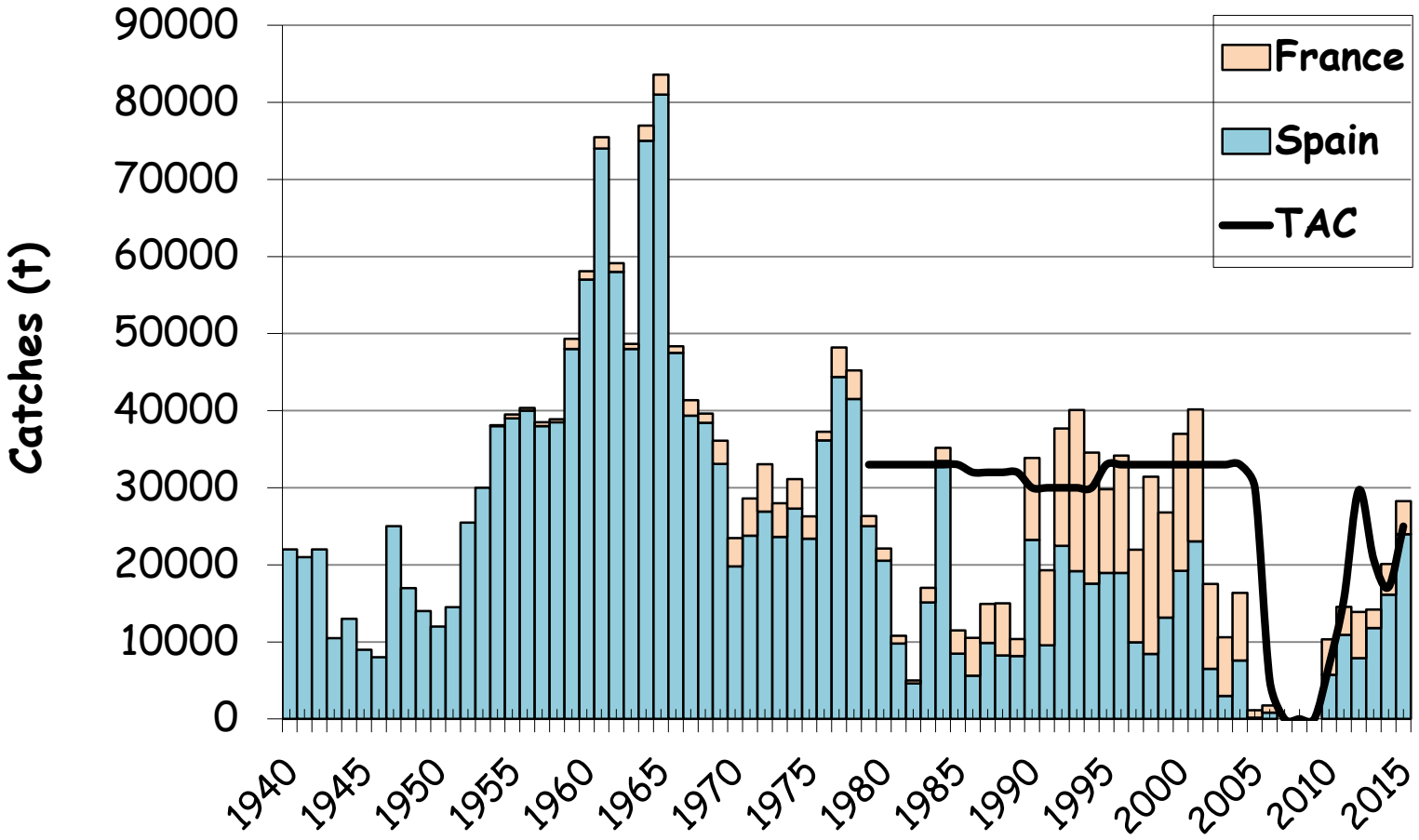

5. Current state of stock

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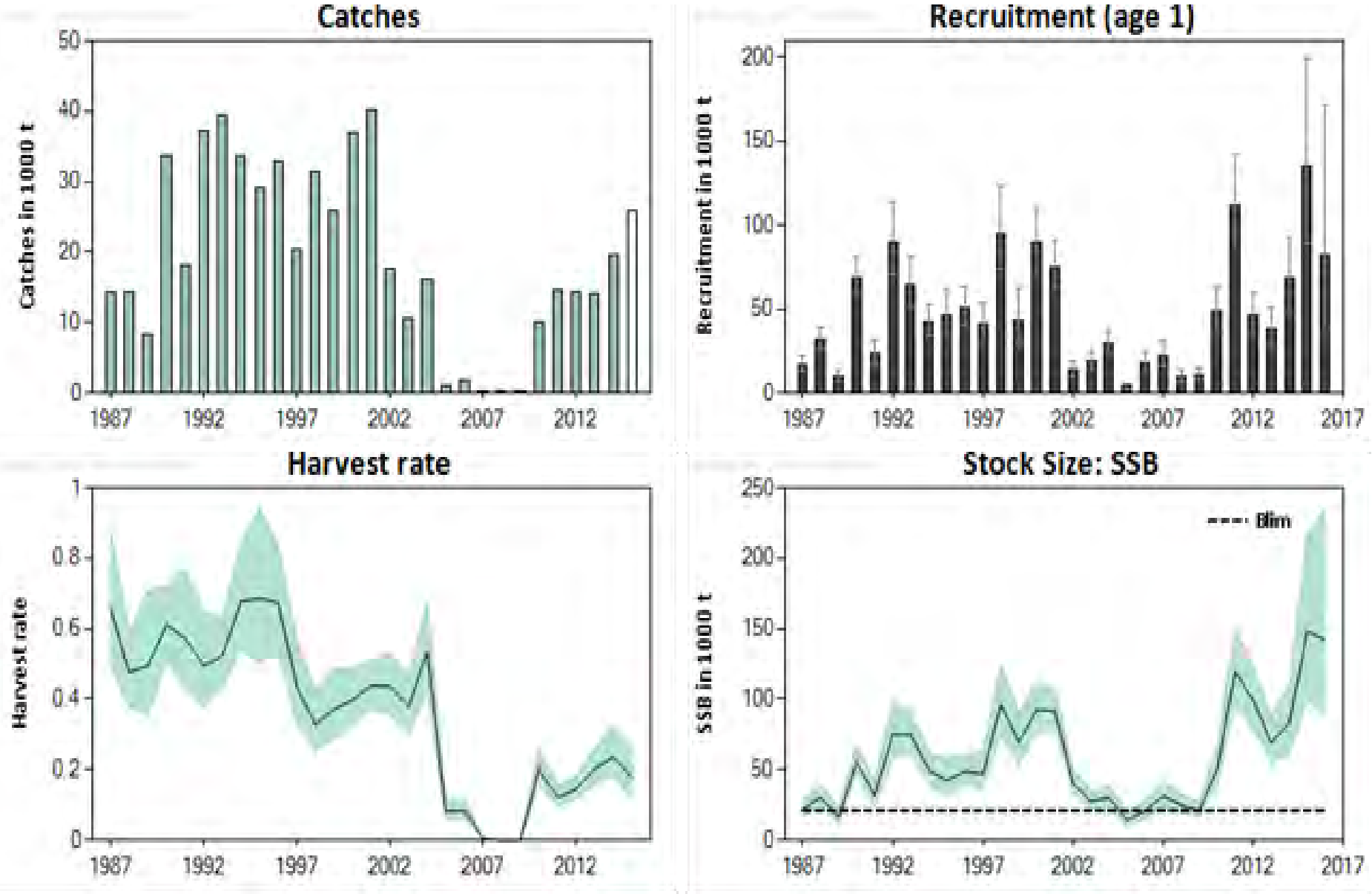

4. Discussion: final considerations

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- **For a short living species**
  - Recruitment uncertainty is the key element affecting management
  - Direct monitoring of adult biomass and juveniles (recruits) are key inputs for reducing uncertainty in assessment and advice
  - Variability is unavoidable, but some stability may arise from moderate exploitation and with the concept of TAC_{max}
- **Both biological and economic assessment of HCR are relevant**
- **Consultation with stakeholders iteratively throughout the process**
  - Benefits the scientific work in better definition of HCRs and of performance indicators by addressing matters of concern to stakeholders
  - Encourages compliance of the fishermen with the LTMP
- **No direct ecosystem consideration was assessed while testing HCRs**
  - TAC_{max} additionally allows diverging surplus production to other populations (i.e. predators)

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Thank you for your attention!

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