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


ssanchez@azti.es
Bay of Biscay anchovy
Bay of Biscay anchovy

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

**Research surveys**
Direct surveys in spring (May):
- DEPM
- Acoustic survey
Autumn (September-October):
- Acoustic for estimating recruitment

**Fleets**
Spain (mainly spring-summer):
- purse-seiners
France (mainly summer-autumn):
- pelagic trawlers
- purse-seiners
Present Work

Long term management plan development and revision

Technical work from several STECF meetings

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

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:

http://flbeia.azti.es/
email: flbeia@azti.es
Simulation framework

Model conditioning

Performance statistics: to evaluate the performance of the management strategies depending on the objectives

Operating Model: represents the system’s "true" dynamics

Population biology

Fleet dynamics

Observation Model

Implementation Model

Management Process: assumptions and methods used to represent the "true" system

Population Assessment

Management decisions (i.e., HCRs)
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

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

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 \rightarrow 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

Fleet Operating 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 $\Rightarrow$ catch = TAC
Management Procedure

CALENDAR CHANGE BASIS

DEPM & acoustic surveys

Juveniles acoustic survey

assessment

assessment

Motivation to use half-year steps in the modelling

TAC July-June

TAC January-December
### HARVEST CONTROL RULES

<table>
<thead>
<tr>
<th>Rationale</th>
<th>Gamma</th>
<th>Trigger points</th>
<th>TACmin</th>
<th>TACmax</th>
<th>Calendar</th>
<th>Rule names</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fraction above ( B_{lim} )</td>
<td>([0,0.1, ..., 1])</td>
<td>( B_{lim} )</td>
<td>Yes / No</td>
<td>Yes / No</td>
<td>Jan-Dec</td>
<td>Rule A</td>
<td>STECF 2008</td>
</tr>
<tr>
<td>Fraction of SSB</td>
<td>([0,0.1, ..., 1])</td>
<td>( B_{lim}, B_{pa} )</td>
<td>Yes / No</td>
<td>Yes / No</td>
<td>Jan-Dec</td>
<td>Rule B, Rule E</td>
<td>STECF 2008</td>
</tr>
<tr>
<td>Constant risk</td>
<td>0.766</td>
<td>26 500</td>
<td></td>
<td></td>
<td>Jan-Dec</td>
<td>Rule C</td>
<td>STECF 2008</td>
</tr>
<tr>
<td>Fraction of SSB (discontinuous)</td>
<td>([0,0.1, ..., 1])</td>
<td>( B_{lim}, B_{pa} )</td>
<td>Yes</td>
<td>Yes / No</td>
<td>July-June / Jan-Dec</td>
<td>G0</td>
<td>STECF 2013, 2014</td>
</tr>
<tr>
<td>Fraction of SSB (general, continuous)</td>
<td>([0,0.1, ..., 1])</td>
<td>( B_{trig1}=24 \text{ kt} ) ( B_{trig2}=24/33 \text{ kt} ) ( B_{trig3} \text{ for TAC}_{\text{max}} )</td>
<td>Yes: 7 kt</td>
<td>Yes: 33/25 kt</td>
<td>July-June / Jan-Dec</td>
<td>G1: ( B_{trig2}=33, \text{TAC}<em>{\text{max}}=33 ) ( G2: B</em>{trig2}=33, \text{TAC}<em>{\text{max}}=25 ) ( G3: B</em>{trig2}=24, \text{TAC}<em>{\text{max}}=33 ) ( G4: B</em>{trig2}=24, \text{TAC}_{\text{max}}=25 )</td>
<td>STECF 2013, 2014</td>
</tr>
</tbody>
</table>

- 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 $B_{lim}$ and $B_{pa}$

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
Summary statistics

- Median SSB, median SSB in the last year of the projection
- **Probability of SSB being under** $B_{\text{lim}}$, probability of SSB being under $B_{\text{lim}}$ at least once in the projection period
- Number of years with SSB being under $B_{\text{lim}}$, number of years necessary to get SSB above $B_{\text{lim}}$
- **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
<table>
<thead>
<tr>
<th></th>
<th>STECF 2008</th>
<th>STECF 2013/14</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conditioning</strong></td>
<td>Half-year BBM assessment (Ibaibarriaga <em>et al.</em> 2008) + SICA (Uriarte <em>et al.</em> 2006)</td>
<td>BBM (Ibaibarriaga <em>et al.</em>, 2011)</td>
</tr>
<tr>
<td><strong>Biological OM</strong></td>
<td>Ages 0-2$^+$ &amp; 0-3$^+$ Recruitment:</td>
<td>Ages 0-2$^+$ Recruitment:</td>
</tr>
<tr>
<td></td>
<td>- Ricker</td>
<td>- Ricker</td>
</tr>
<tr>
<td></td>
<td>- Beverton-Holt</td>
<td>- Sensitivity to 3 successive years of poor recruitment</td>
</tr>
<tr>
<td></td>
<td>- Segmented Regression</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Quadratic Hockey Stick</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Persistent low</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Historical variability</td>
<td></td>
</tr>
<tr>
<td><strong>Observation model</strong></td>
<td>Observation and assessment error (cv 25% + sensitivity analysis)</td>
<td>Observation and assessment error (cv 25%) + sensitivity to 15% as assessment predicts</td>
</tr>
<tr>
<td><strong>MP management</strong></td>
<td>Discontinuous rules</td>
<td>Continuous rules</td>
</tr>
<tr>
<td><strong>Implementation model</strong></td>
<td>TAC July-June</td>
<td>TAC July-June &amp; TAC Jan-Dec Sensitivity to error in assumed % by semester</td>
</tr>
<tr>
<td><strong>Simulations</strong></td>
<td>10 years 100 iterations</td>
<td>20 years 500 iterations</td>
</tr>
</tbody>
</table>
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** $B_{\text{lim}}$ and of closure

→ **JD reduces the time of stock recovery** from below $B_{\text{lim}}$

→ **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 (γ=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

- **Little effect** on biological risk of different quota shares among countries and when not density dependent SRR
- **Slightly lower** 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
→ 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
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)

• ...