

SAC GFCM Sub-Committee on Stock Assessment

| | | | | | |
|-------------------------------------|--|--|-------------|--------------|-------------------|
| Date* | 5 | October | 2009 | Code* | PIL0609Bel |
| Authors* | Bellido, J.M.1*, Quintanilla, L.2, Torres, P2., Giráldez, A.2, Ceruso, C.1, Alemany, F.3, Iglesias, M.3 | | | | |
| Affiliation* | 1 Instituto Español de Oceanografía. Centro Oceanográfico de Murcia. C/ Varadero 1. San Pedro del Pinatar. 30740. Murcia. Spain. | | | | |
| Species Scientific name* | 1 | <i>Sardina pilchardus</i> - <i>PIL</i> Source: GFCM Priority Species | | | |
| | 2 | Source: - | | | |
| | 3 | Source: - | | | |
| Geographical area* | Western Mediterranean (FAO Subarea 37.1.) | | | | |
| Geographical Sub-Area (GSA)* | 06 - Northern Spain | | | | |
| Combination of GSAs | 1 | | | | |
| | 2 | | | | |
| | 3 | | | | |

SAC GFCM - Sub-Committee on Stock Assessment (SCSA)

Assessment form

Sheet #0

Basic data on the assessment

Code: PIL0609Bel

| | | | | | |
|-------|---|-----|------|----------|---|
| Date* | 5 | Oct | 2009 | Authors* | Bellido, J.M.1*, Quintanilla, L.2, Torres, P2., Giráldez, A.2, Ceruso, C.1, Alemany, F.3, Iglesias, M.3 |
|-------|---|-----|------|----------|---|

| | | | |
|--------------------------|--------------------------|----------------------|------------------|
| Species Scientific name* | Sardina pilchardus - PIL | Species common name* | Sardine, Sardina |
|--------------------------|--------------------------|----------------------|------------------|

Data Source

| | | | |
|------|---------------------|-----------------|-----------|
| GSA* | 06 - Northern Spain | Period of time* | 1994-2008 |
|------|---------------------|-----------------|-----------|

Description of the analysis

| | | | |
|-----------------------|--|----------------|--|
| Type of data* | Landings, Length and biological samplings. Tuning from Purse seiners | Data source* | Official Statistics, IEO Sampling Network, Acoustic Survey |
| Method of assessment* | XSA - Extended Survivor Analysis | Software used* | VPA Suite. Lowestoft. 1995 |

Sheets filled out

| B | P1 | P2a | P2b | G | A1 | A2 | A3 | Y | Other | D | Z | C |
|---|----|-----|-----|-----|----|----|----|-----|-------|---|---|---|
| 1 | 1 | 1 | 1 | --- | 1 | 1 | 1 | --- | 1 | 1 | 1 | 1 |

Comments, bibliography, etc.

Fishery assessment by VPA methods of the Spanish sardine stock GSA06 is reported. VPA Lowestoft software suite was used and XSA was the assessment method. A separable VPA was also run as exploratory analysis for both stocks. Stochastic short term projections were also produced.

Comments, bibliography, etc.**Bibliography (Published papers and books):**

Abella A., Caddy J.F., Serena F. (1997) Declining natural mortality with age and fisheries on juveniles: a Mediterranean demersal fishery yield paradigm illustrated for *Merluccius merluccius*. *Aquatic Living Resources* 10: 257–269.

Caddy, J.F. (1991). Death rates and time intervals: Is there an alternative to the constant natural mortality axiom? *Rev. Fish Bio./ Fisheries*, 1: 109-13 8.

De Oliveira, J.A.A., Uriante, A., and Roel, B., 2005. Potential improvements in the management of Bay of Biscay anchovy by incorporating environmental indices as recruitment predictors. *Fisheries Research*, 75: 2-14.

Freon, P. and Misund, O.A., 1999. Dynamics of Pelagic Fish Distribution and Behaviour: Effects on Fisheries and Stock Assessment. Fishing News Books, UK, 348 pp.

Hilborn, R. and Walters C.J., 1992. quantitative Fisheries Stock Assessment; Choice, Dynamics and Uncertainty. New York: Chapman and Hall, 570 pp.

Leonard, J. and Maynou, F., 2003. Fish Stock Assessment in the Mediterranean: state of the art. *Scientia Marina*, 67: 37-49.

Patterson, K., 1992. Fisheries for small pelagic species: an empirical approach to management targets. *Review in Fish Biology and Fisheries*, 2: 321-338.

Ramon M.M and Castro, J.A., 1997. Genetic variation in natural stocks of *Sardina pilchardus* (Sardines) from the western Mediterranean Sea. *Heredity*, 78: 520-528.

Sheperd, J.G., 1999. Extended Survivors Analysis: An improved method for the analysis of catch-at-age data and abundance indices. *Journal of Marine Science*, 56: 584-591.

Bibliography (Technical Reports and grey literature):

Darby, C.D. and Flatman, S., 1994. Virtual Population Analysis, version 3.1 (Windows/DOS) user guide. Information Technology Series 1. CEFAS, Lowestoft, UK.

Reports from the SCSA and SAC of the General Fisheries Commission for the Mediterranean (GFCM), available at http://www.fao.org/fi/body/rfb/GFCM/gfcm_home.htm and/or <ftp://cucafera.icm.csic.es/pub/scsa/>

Reports from the Assessment Working Groups of the International Council for the Exploration of the Seas (ICES), particularly the small pelagics assessment working group WGMHSA. Available at www.ices.dk

Reports from the SGMED Working Groups on the Mediterranean of the Scientific, Technical and Economic Committee for Fisheries (STECF). Available at <http://fishnet.jrc.it/web/stecf>.

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Assessment form

Sheet B
Biology of the species

Code: PIL0609Bel

Biology

| | | | | | | |
|---|-----|-----|------|--------------|---------------------|----------------|
| Somatic magnitude measured (LH, LC, etc)* | | | | Total Length | Units* | 1/2 centimeter |
| Sex | Fem | Mal | Both | Unsexed | | |
| Maximum size observed | | | 22 | | Reproduction season | Oct-Mar |
| Size at first maturity | | | 13.3 | | Reproduction areas | All the coast |
| Recruitment size | | | 10 | | Nursery areas | Bays |

Parameters used (state units and information sources)

| | | Units | Sex | | | |
|----------------------------|----------------|--------------------|--------|-------------------------|---------|---------|
| | | | female | male | both | unsexed |
| Growth model | L [∞] | cm | | | 22.9489 | |
| | K | year ⁻¹ | | | 0.2506 | |
| | t ₀ | year | | | -2.9262 | |
| | Data source | Otoliths | | | | |
| Length weight relationship | a | | | | 0.0052 | |
| | b | | | | 3.14 | |
| M | | | | M vector (see comments) | | |
| sex ratio (mal/fem) | | 44/56 | | | | |

Comments

ALK 2004-2008, combined ALK for 1994-2003. Length Distributions 1994-2008.

Biological sampling 2004-2008 for Maturity at age and Weight-Length relationships.

Natural Mortality value (M) - Following the recommendation from the Workshop on Mediterranean Stock Assessment Standardization (SG-ECA/RST/MED 09-01), a vector (declining value of M with age) instead of a constant value was used. The vector was estimated using the ProdBiom method (Abella et al., 1997) based on Caddy (1991).

| | |
|-----|------|
| Age | M |
| 0 | 1.20 |
| 1 | 0.46 |
| 2 | 0.34 |
| 3 | 0.29 |
| 4 | 0.26 |
| 5+ | 0.25 |

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Assessment form

Sheet P1

General information about the fishery

Code: PIL0609Bel

| | | | |
|--|---|-----------|-----------|
| Data source* | Official Statistics, IEO Sampling Network, Acoustic | Year (s)* | 2000-2008 |
| Data aggregation (by year, average figures between years, etc.)* | By year 2000-2008 | | |

Fleet and catches (please state units)

| | Country | GSA | Fleet Segment | Fishing Gear Class | Group of Target Species | Species |
|---------------------|---------|-----|--------------------------------|--------------------|-------------------------------|---------|
| Operational Unit 1* | ESP | 06 | G - Purse Seine (6-12 metres) | 02 - Seine Nets | 31 - Small gregarious pelagic | PIL |
| Operational Unit 2 | ESP | 06 | H - Purse Seine (12-24 metres) | 02 - Seine Nets | 31 - Small gregarious pelagic | PIL |
| Operational Unit 3 | ESP | 06 | F - Trawl (>24 metres) | 02 - Seine Nets | 31 - Small gregarious pelagic | PIL |
| Operational Unit 4 | | | | | | |
| Operational Unit 5 | | | | | | |

| Operational Units* | Fleet (n° of boats)* | Kilos or Tons | Catch (species assessed) | Other species caught | Discards (species assessed) | Discards (other species caught) | Effort units |
|----------------------|----------------------|---------------|--------------------------|----------------------|-----------------------------|---------------------------------|--------------|
| ESP 06 G 02 31 - PIL | 5 | Tons | 14123 | | | | |
| ESP 06 H 02 31 - PIL | 111 | Tons | | | | | |
| ESP 06 F 02 31 - PIL | 14 | Tons | | | | | |
| | | | | | | | |
| Total | 130 | | 14123 | | | | |

| | |
|--------------------|----------|
| Legal minimum size | 11 cm TL |
|--------------------|----------|

Comments

The catch (landings) is not split by Fleet segments. It comprises 14123 Tons in 2008 for the three Operational Units. Although landings are not still separated by Fleet segments we can provide a segmentation of the pelagic fleet in GSA06, with number of boats for every fleet segment:

The Fleet Segment Purse Seine (6-12 metres) comprises 5 boats in GSA06 in 2008

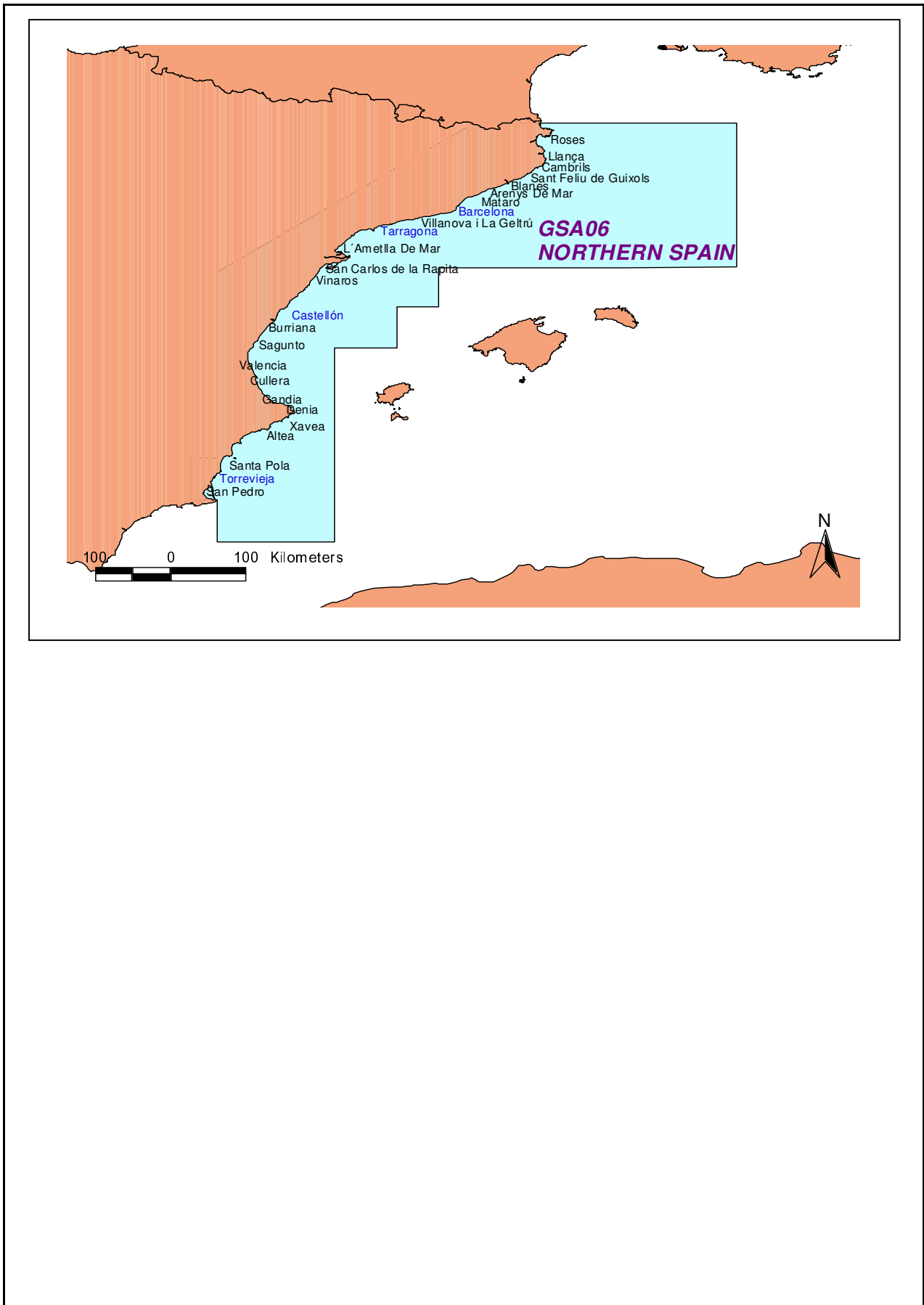
The Fleet Segment Purse Seine (12-24 metres) comprises 111 boats in GSA06 in 2008

The Fleet Segment Purse Seine (greater than 24 metres) comprises 14 boats in GSA06 in 2008

Then, and because that landing aggregation, we prefer to fill pages P2a and P2b considering the three fleet segments as an unique pelagic fleet. We aim to split landings by Fleet segment in a near future.

Landing Ports are shown in the attached Figure. Sampling ports are highlighted in blue. Tuning data from acoustic survey ECOMED and Commercial Fleet off Barcelona, Tarragona, Castellón and Torrevieja from 1994 to 2008.

Comments



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Assessment form

Sheet P2a
Fishery by Operational Unit

Code: PIL0609Bel

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| | | | |
|--------------|---|-----------|----------------------|
| Data source* | Official Statistics, IEO Sampling Network | OpUnit 1* | ESP 06 G 02 31 - PIL |
|--------------|---|-----------|----------------------|

Time series

| Year* | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|-----------------|---------|----------|----------|----------|---------|----------|
| Catch | 35618 t | 32274 t | 36142 t | 36972 t | 30275 t | 18762 t |
| Minimum size | 7.5 cm | 9.5 cm | 6 cm | 9 cm | 9 cm | 8 cm |
| Average size Lc | 16.6 cm | 16.66 cm | 16.78 cm | 16.72 cm | 16.9 cm | 16.56 cm |
| Maximum size | 20 cm | 19.5 cm | 20 cm | 20 cm | 20.5 cm | 20.5 cm |
| Fleet | | 223 | | 207 | 179 | 157 |

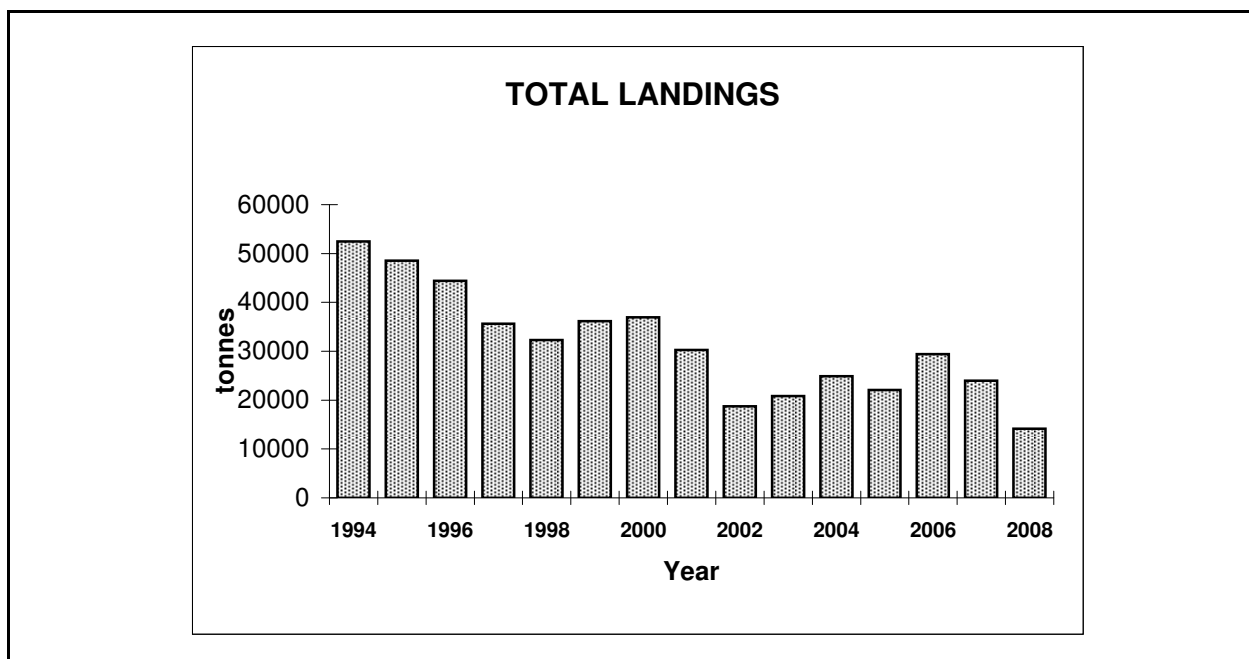
| Year | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|-----------------|----------|----------|----------|----------|----------|---------|
| Catch | 20817 t | 24874 t | 22081 t | 29381 t | 23984 t | 14123 t |
| Minimum size | 6.5 cm | 6.5 cm | 9 cm | 9 cm | 9.5 cm | 9.0 cm |
| Average size Lc | 16.84 cm | 17.02 cm | 16.87 cm | 16.08 cm | 17.81 cm | 16.9 cm |
| Maximum size | 22 cm | 23.5 cm | 22.5 cm | 22.5 cm | 22.5 cm | 22.0 cm |
| Fleet | 161 | 155 | 147 | 139 | 132 | 132 |

Selectivity

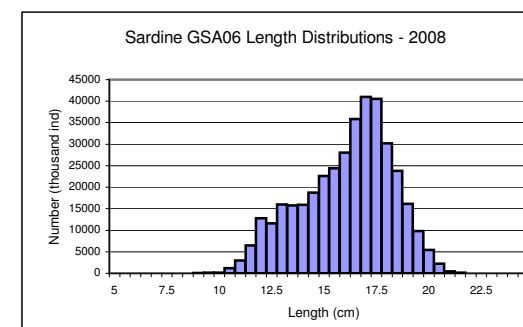
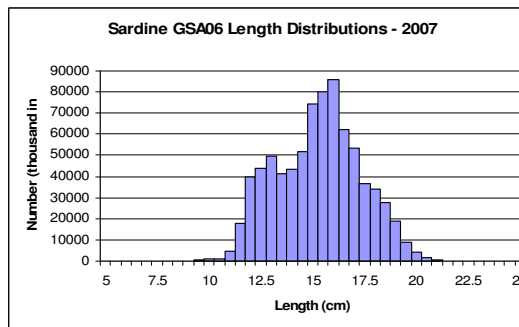
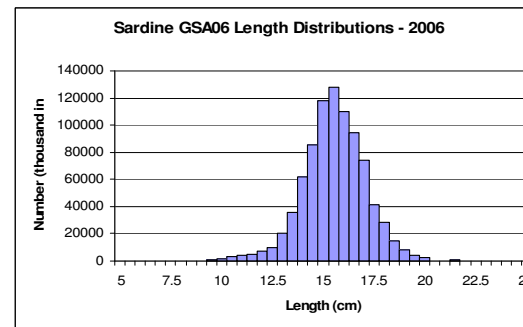
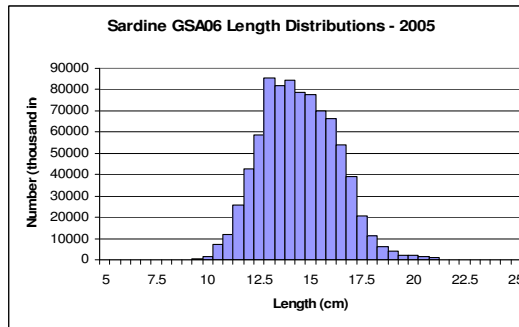
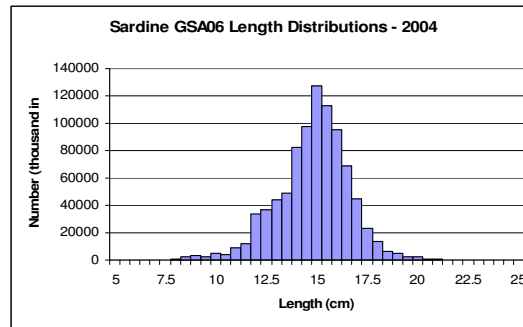
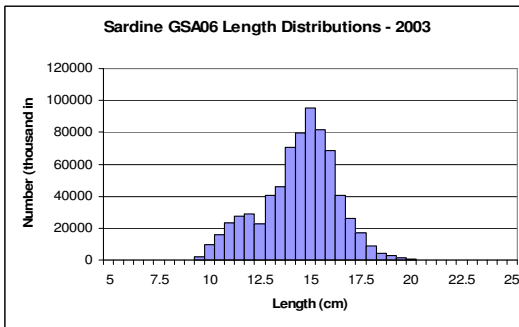
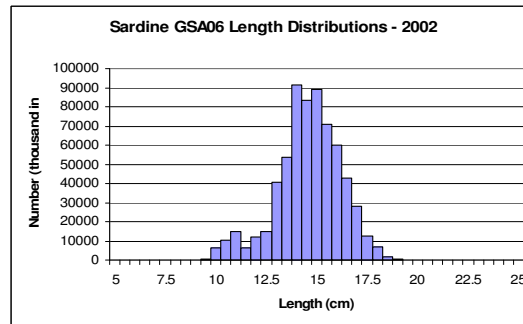
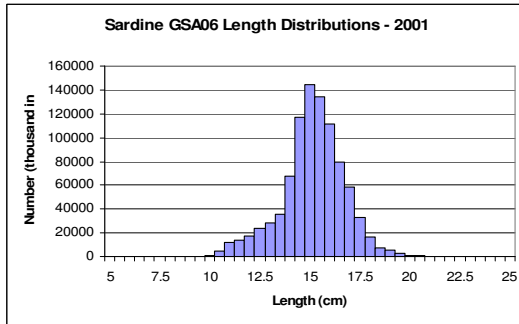
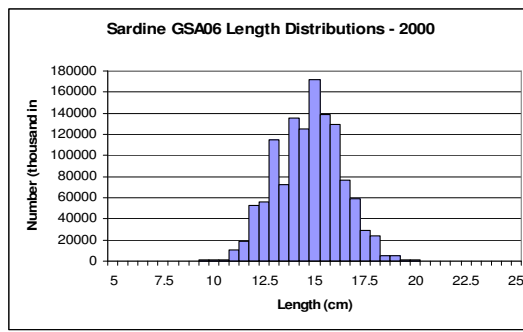
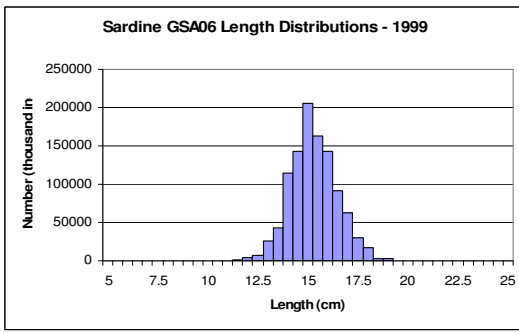
Remarks

| | | |
|------------------|--|--|
| L25 | | |
| L50 | | |
| L75 | | |
| Selection factor | | |
| | | |

Structure by size or age



Structure by size or age



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Assessment form

Sheet P2a
Fishery by Operational Unit

Code: PIL0609Bel

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| | | | |
|--------------|--|-----------|----------------------|
| Data source* | | OpUnit 2* | ESP 06 H 02 31 - PIL |
|--------------|--|-----------|----------------------|

Time series

| | | | | | | |
|-----------------|--|--|--|--|--|--|
| Year* | | | | | | |
| Catch | | | | | | |
| Minimum size | | | | | | |
| Average size Lc | | | | | | |
| Maximum size | | | | | | |
| Fleet | | | | | | |

| | | | | | | |
|-----------------|--|--|--|--|--|--|
| Year | | | | | | |
| Catch | | | | | | |
| Minimum size | | | | | | |
| Average size Lc | | | | | | |
| Maximum size | | | | | | |
| Fleet | | | | | | |

Selectivity

Remarks

| | | |
|------------------|--|--|
| L25 | | |
| L50 | | |
| L75 | | |
| Selection factor | | |
| | | |

Structure by size or age

SAC GFCM - Sub-Committee on Stock Assessment (SCSA)

Assessment form

Sheet P2b
Fishery by Operational Unit

Code: PIL0609Bel

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| | | | |
|--------------|---|-----------|----------------------|
| Data source* | Official Statistics, IEO Sampling Network | OpUnit 1* | ESP 06 G 02 31 - PIL |
|--------------|---|-----------|----------------------|

Regulations in force and degree of observance of regulations

Fishing license: fully observed
Minimum landing size 11cm: not fully observed (Some landings under minimum size in some specific ports).
No fishing allowed on weekend. Time at sea 12 hours per day and 5 days a week: fully observed
Several technical measures regulations (gear and mesh size, engine, GRT, etc...): not fully observed
Temporary fishing closure (two months, variable along the time series): fully observed.

Accompanying species

The most important are:
Anchovy (*Engraulis encrasicolus*)
Mediterranean Horse Mackerel (*Trachurus mediterraneus*)
Other Horse Mackerels (*Trachurus trachurus* and *Tachurus picturatus*)
Mackerel (*Scomber scombrus*)
Chub Mackerel (*Scomber japonicus*)
Round sardinella (*Sardinella aurita*)
Bogue (*Boops boops*)

SAC GFCM - Sub-Committee on Stock Assessment (SCSA)

Assessment form

Sheet G
Indirect methods. Global model

Code: PIL0609Bel

Analysis #*

Page 1 /

Data source* Gear*

Model characteristic

| | | | |
|----------------|----------------------|------------------------|----------------------|
| Type of model* | <input type="text"/> | Fitting criterion | <input type="text"/> |
| Software | <input type="text"/> | Bibliographical source | <input type="text"/> |

Data

| | | | | | | | |
|--------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Year | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Catch | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Effort | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| CPUE | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> |

| | | | | | | | |
|--------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Year | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Catch | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Effort | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| CPUE | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> |

Adjustment

RMS

Results

| | | | |
|------------------|----------------------|----------------------|----------------------|
| Carryng capacity | <input type="text"/> | a | <input type="text"/> |
| Growth rate | <input type="text"/> | b | <input type="text"/> |
| Catchability | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| MSY | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| EMSY | <input type="text"/> | TACMSY | <input type="text"/> |
| E0.1 | <input type="text"/> | TAC0.1 | <input type="text"/> |
| Ecurrent | <input type="text"/> | <input type="text"/> | <input type="text"/> |

Comments

SAC GFCM - Sub-Committee on Stock Assessment (SCSA)

Assessment form

Sheet A1
Indirect methods: VPA, LCA

Code: PIL0609Bel

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Sex* Both

Analysis # * XSA

Time series

| Data | Size | Age |
|---------------|------|-----|
| (mark with X) | X | X |

| Model | Cohorts | Pseudocohorts |
|---------------|---------|---------------|
| (mark with X) | X | |

| | | | |
|-----------------------|---------------------|---------------|------------------------|
| Equation used | VPA | Tuning method | XSA |
| # of gears | Purse seiners | Software | VPA95. Lowestoft suite |
| F _{terminal} | Not relevant to XSA | | |

Population results (please state units)

| | Sizes | Ages | | Amount | Biomass |
|----------|-------------|------|--------------------|--------------------|---------|
| Minimum | 9 | 0 | Recruitment | 1945 millions | |
| Average | See page 2a | | Average population | See comments below | |
| Maximum | 22 | 5+ | Virgin population | | |
| Critical | | | Turnover | | |
| | | | | | |
| | | | | | |

Average mortality

| | Total | Gear | | | | |
|----------------|--------------|------|--|--|--|--|
| F ₁ | Fbar=0.87 | | | | | |
| F ₂ | | | | | | |
| Z | See Comments | | | | | |

(F1 and F2 represent different possible calculations. Please state them)

Comments

Reference F is Fbar1-3 (average of ages 1 to 3 are considered the reference ages). Following the SG-ECA/RST/MED 09-01 recommendation, a vector instead of a constant value was used. The vector was estimated using the ProdBiom method (Abella et al., 1997) based on Caddy (1991).

| Age | 0 | 1 | 2 | 3 | 4 | 5+ |
|-----|------|------|------|------|------|------|
| F | 0.10 | 0.42 | 1.07 | 1.12 | 0.81 | 0.81 |
| M | 1.20 | 0.46 | 0.34 | 0.29 | 0.26 | 0.25 |

Separable VPA results show no unusual pattern of Log catchability residuals and no particular conflicts between ages. XSA main settings were Fbar 1-3; Age 2 for q stock-size independent and age 3 for q independent of age. Landings decrease in 2008, reaching up 14123 t, which represents the lowest landings of the assessed time series. Fishing mortality is at a moderate-high level (F08=0.87), showing a rather plane pattern from 2002 onwards. Recruitment in 2008 (R08=1945 millions) is similar to 2007 (2077 millions) following a decreasing trend from 2003 onwards. The trend of the recruitments is so important as they can affect seriously to the stock health. Both Total Biomass(TB=68031 t) and Spawning Stock Biomass (SSB=42605 t) in 2008 are also the lowest of the time series. See also figures in page VPA

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Assessment form

Sheet A1
Indirect methods: VPA, LCA

Code: PIL0609Bel

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Sex*

Analysis # *

Time series

| Data | Size | Age |
|---------------|--------------------------|--------------------------|
| (mark with X) | <input type="checkbox"/> | <input type="checkbox"/> |

| Model | Cohorts | Pseudocohorts |
|---------------|--------------------------|--------------------------|
| (mark with X) | <input type="checkbox"/> | <input type="checkbox"/> |

| | | | |
|-----------------------|----------------------|--------------|----------------------|
| Equation used | <input type="text"/> | Tunig method | <input type="text"/> |
| # of gears | <input type="text"/> | Software | <input type="text"/> |
| F _{terminal} | <input type="text"/> | | |

Population results (please state units)

| | Sizes | Ages | | Amount | Biomass |
|----------|----------------------|----------------------|--------------------|----------------------|----------------------|
| Minimum | <input type="text"/> | <input type="text"/> | Recruitment | <input type="text"/> | <input type="text"/> |
| Average | <input type="text"/> | <input type="text"/> | Average population | <input type="text"/> | <input type="text"/> |
| Maximum | <input type="text"/> | <input type="text"/> | Virgin population | <input type="text"/> | <input type="text"/> |
| Critical | <input type="text"/> | <input type="text"/> | Turnover | <input type="text"/> | <input type="text"/> |
| | <input type="text"/> | <input type="text"/> | | <input type="text"/> | <input type="text"/> |
| | <input type="text"/> | <input type="text"/> | | <input type="text"/> | <input type="text"/> |

Average mortality

| | Total | Gear | | | | | |
|----------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| F ₁ | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| F ₂ | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Z | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> |

(F1 and F2 represent different possible calculations. Please state them)

Comments

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Assessment form

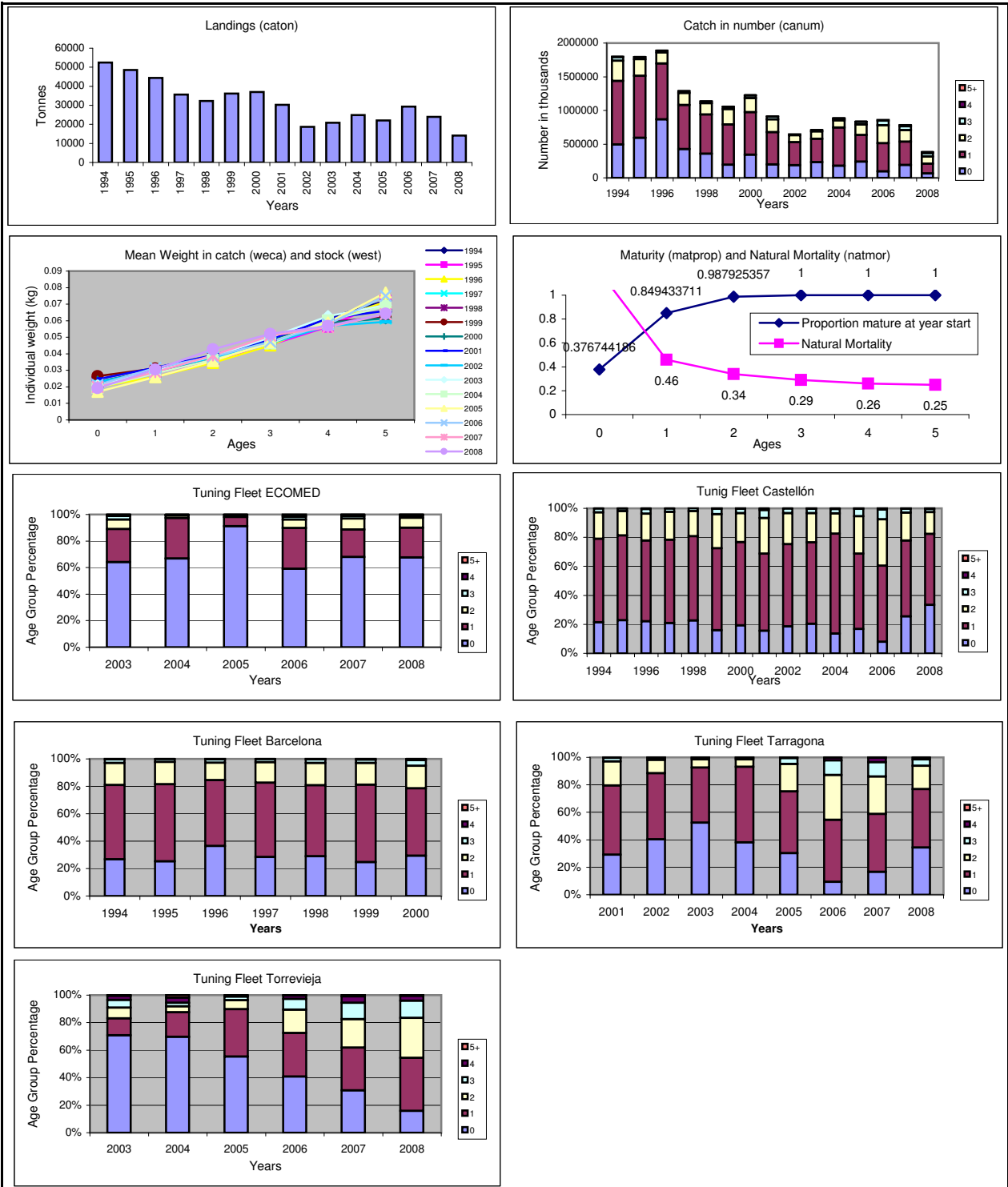
Sheet A2
Indirect methods: data

Code: PIL0609Bel

| | | | | | |
|------|------|-------|---------------|--------------|-----|
| Sex* | Both | Gear* | Purse seiners | Analysis # * | XSA |
|------|------|-------|---------------|--------------|-----|

| | |
|------|--------------------|
| Data | Input data for XSA |
|------|--------------------|

Data



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Assessment form

Sheet A3

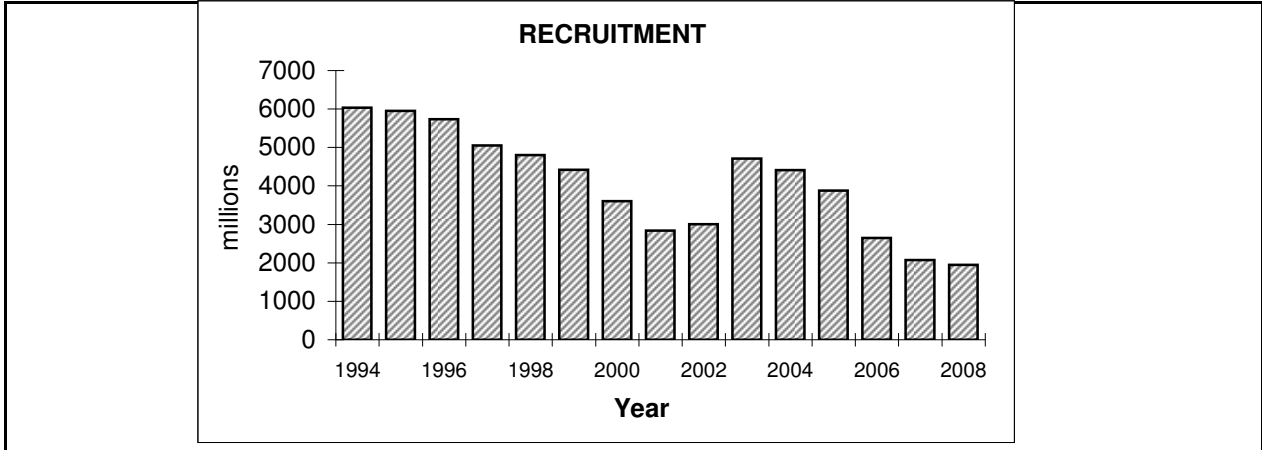
Indirect methods: VPA results

Code: PIL0609Bel

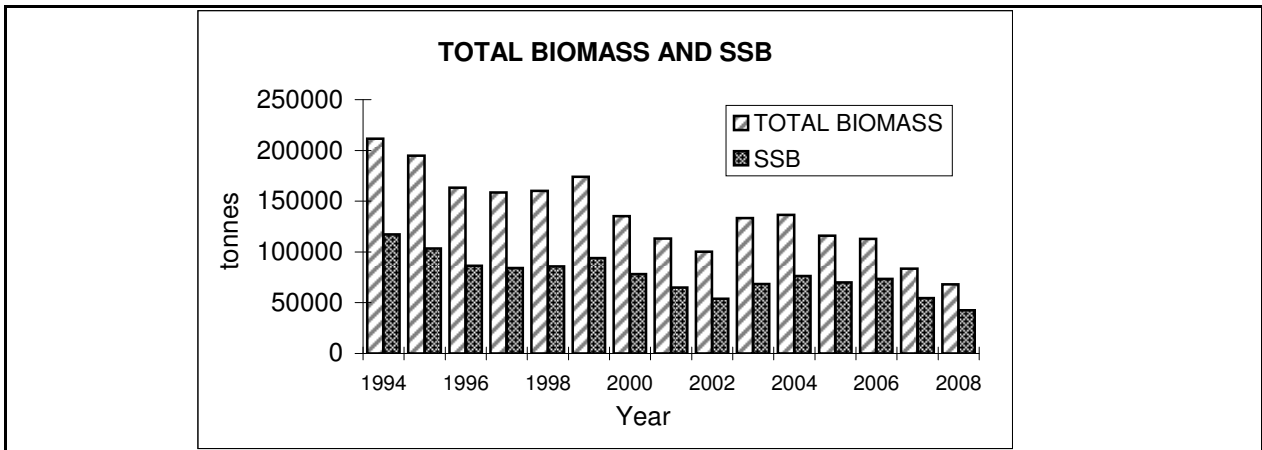
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| | | | | | |
|------|------|-------|---------------|-------------|-----|
| Sex* | Both | Gear* | Purse Seiners | Analysis #* | XSA |
|------|------|-------|---------------|-------------|-----|

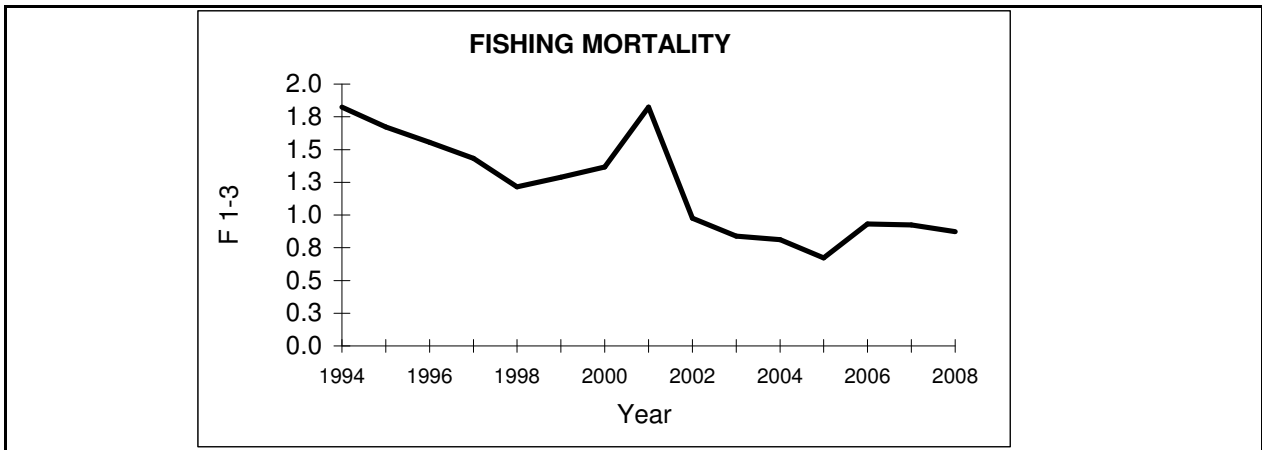
Population in figures



Population in biomass



Fishing mortality rates



| | |
|--|----------------------------------|
| SAC GFCM - Sub-Committee on Stock Assessment (SCSA) | |
| Assessment form | Sheet Y Indirect methods: Y/R |

| | |
|--|---|
| Sex <input style="width: 50px;" type="text"/> | Code: PIL0609Bel |
| | Analysis # <input style="width: 50px;" type="text"/> |

| | | | |
|-------------------|--|-----------------|--|
| # of gears | | Software | |
|-------------------|--|-----------------|--|

Parameters used

| | |
|-----------------|--|
| Vector F | |
| Vector M | |
| Vector N | |
| | |
| | |

Model characteristics

Results

| | Total | Gear | | | |
|-------------|-------|------|--|--|--|
| | | | | | |
| Current YR | | | | | |
| Maximum Y/R | | | | | |
| Y/R 0.1 | | | | | |
| F_{max} | | | | | |
| $F_{0.1}$ | | | | | |
| Current B/R | | | | | |
| Maximum B/R | | | | | |
| B/R 0.1 | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Comments

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Assessment form

Sheet other

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Other assessment methods

Short Terms Deterministic Projections for three years (2009 to 2011).

MFDP software (Multi-Fleet Deterministic Projections).

Table below shows the management options from the short term catch prediction. Assuming statu quo F (Fbar06-08=0.91) and the recruitment is similar to the recruitment observed in 2008 (Rlow=1945 millions). We realise this option is more conservative but the most realistic and robust as recruitment has been continuously decreasing from 2003 onwards reaching their lowest value in 2008. Landings are predicted to be close to 16211 t in 2009 and 14994 t in 2010. Total biomass will remain more or less stable with a slight decrease: 68650 t in 2009, 66245 t in 2010 and 65373 t in 2011. SSB will decrease from 41900 t to 38779 t from 2009 to 2011.

Hence this exploitation pattern of maintaining F statu quo 2009-11 with scenarios of low recruitment rates, will produce a slight loss and continuing decreasing trend which could prompt a decline of the fishery.

In this situation it is particularly important to pay special attention to recruitment levels as they could prompt sudden increases or drops in a near future.

| 2009 | | | | | | | | | |
|---------|-------|-------|------|----------|-------|---------|-------|--|--|
| Biomass | SSB | FMult | FBar | Landings | | | | | |
| 68651 | 41935 | | 1 | 0.9103 | 16211 | | | | |
| | | | | | | | | | |
| 2010 | | | | | | 2011 | | | |
| Biomass | SSB | FMult | FBar | Landings | | Biomass | SSB | | |
| 66245 | 39648 | | 0 | 0 | 0 | 79918 | 52994 | | |
| . | 39648 | | 0.1 | 0.091 | 2000 | 77919 | 51032 | | |
| . | 39648 | | 0.2 | 0.1821 | 3863 | 76071 | 49219 | | |
| . | 39648 | | 0.3 | 0.2731 | 5600 | 74359 | 47542 | | |
| . | 39648 | | 0.4 | 0.3641 | 7222 | 72774 | 45990 | | |
| . | 39648 | | 0.5 | 0.4552 | 8737 | 71303 | 44553 | | |
| . | 39648 | | 0.6 | 0.5462 | 10155 | 69938 | 43221 | | |
| . | 39648 | | 0.7 | 0.6372 | 11483 | 68671 | 41985 | | |
| . | 39648 | | 0.8 | 0.7282 | 12728 | 67492 | 40837 | | |
| . | 39648 | | 0.9 | 0.8193 | 13896 | 66395 | 39771 | | |
| . | 39648 | | 1 | 0.9103 | 14994 | 65373 | 38779 | | |
| . | 39648 | | 1.1 | 1.0013 | 16028 | 64421 | 37855 | | |
| . | 39648 | | 1.2 | 1.0924 | 17001 | 63531 | 36995 | | |
| . | 39648 | | 1.3 | 1.1834 | 17919 | 62700 | 36192 | | |
| . | 39648 | | 1.4 | 1.2744 | 18785 | 61923 | 35442 | | |
| . | 39648 | | 1.5 | 1.3655 | 19605 | 61196 | 34742 | | |
| . | 39648 | | 1.6 | 1.4565 | 20380 | 60513 | 34087 | | |
| . | 39648 | | 1.7 | 1.5475 | 21115 | 59873 | 33473 | | |
| . | 39648 | | 1.8 | 1.6385 | 21812 | 59272 | 32898 | | |
| . | 39648 | | 1.9 | 1.7296 | 22475 | 58707 | 32358 | | |
| . | 39648 | | 2 | 1.8206 | 23105 | 58174 | 31850 | | |

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Assessment form

Sheet D
Diagnosis

Code: PIL0609Bel

Indicators and reference points

| Criterion | Current value | Units | Reference Point | Trend | Comments |
|-----------|---------------|-------|-----------------|-------|---------------------------------|
| B | | | | | Not Reference Point defined yet |
| SSB | | | | | Not Reference Point defined yet |
| F | | | | | Not Reference Point defined yet |
| Y | | | | | Not Reference Point defined yet |
| CPUE | | | | | Not Reference Point defined yet |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Stock Status* Use one (or both) of the following two systems for the stock assessment status description

| | | |
|-----------------------|--------------------------|--|
| Unidimensional | <input type="checkbox"/> | ? - (or blank) Not known or uncertain. Not much information is available to make a judgment; |
| | <input type="checkbox"/> | U - Underexploited, undeveloped or new fishery. Believed to have a significant potential for expansion in total production; |
| | <input type="checkbox"/> | M - Moderately exploited, exploited with a low level of fishing effort. Believed to have some limited potential for expansion in total production; |
| | <input type="checkbox"/> | F - Fully exploited. The fishery is operating at or close to an optimal yield level, with no expected room for further expansion; |
| | <input type="checkbox"/> | O - Overexploited. The fishery is being exploited at above a level which is believed to be sustainable in the long term, with no potential room for further expansion and a higher risk of stock depletion/collapse; |
| | <input type="checkbox"/> | D - Depleted. Catches are well below historical levels, irrespective of the amount of fishing effort exerted; |
| | <input type="checkbox"/> | R - Recovering. Catches are again increasing after having been depleted or a collapse from a previous; |

| | | | | | | |
|----------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Bidimensional | Exploitation rate | | Stock abundance | | | |
| | <input type="checkbox"/> | No or low fishing | <input type="checkbox"/> | Virgin or high abundance | <input type="checkbox"/> | Depleted |
| | <input type="checkbox"/> | Moderate fishing | <input type="checkbox"/> | Intermediate abundance | <input type="checkbox"/> | Uncertain / Not assessed |
| | <input type="checkbox"/> | High fishing mortality | <input type="checkbox"/> | Low abundance | | |
| | <input type="checkbox"/> | Uncertain / Not assessed | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

Comments

No reference points for sardine can be suggested at this point. Further research is aimed to produce Reference Points and Harvest Control Rules for the sardine GSA06 fishery.

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Assessment form

Sheet Z

Objectives and recommendations

Code: PIL0609Bel

Management advice and recommendations*

Regarding suggestion for management options, this fishery is considered overexploited. Although the exploitation rate (fishing mortality) is at a moderate level, the stock abundance in 2008 remains at low levels (the lowest of the time series 1994-2008) and continues the decreasing trend observed from 2004 onwards. Unless the recruitment levels increase in the near future, this fishery will be being exploited at above a level which is believed to be sustainable in the long term, with no potential room for further expansion and a higher risk of stock depletion/collapse.

Advice for scientific research*

No reference points for sardine can be suggested at this point. Further research is aimed to produce Reference Points and Harvest Control Rules for the sardine GSA06 fishery.

Comments*

Conclusions - Assessment:

Landings in 2008 were 14123 t, showing a decrease from that of previous years 2007 (23984 t in 2007 and 29381 t in 2006). The time series shows an irregular pattern but a continuous decreasing trend with the lowest landings of the assessed time series in 2008.

Fishing mortality is at a moderate-high level ($F_{08}=0.87$), showing a rather plane pattern from 2002 onwards.

Recruitment in 2008 ($R_{08}=1945$ millions) decreases slightly from that of 2007 (2077 millions) and reaches the lowest value of the assessed time series. It continues the decreasing trend observed from 2003 onwards. The trend of the recruitments is so important as they can affect seriously to the stock health.

Both Total Biomass in 2008 ($TB=68031$ t) and Spawning Stock Biomass in 2008 ($SSB=42605$ t) also show a decreasing trend and the lowest levels of the assessed time series.

Conclusions – Catch Forecasting

Assuming Statu quo F ($F_{bar06-08}=0.91$) and conservative recruitment levels (the lowest of the assessed time series $R_{low}=1945$ millions):

- Landings are predicted to be close to 16211 t in 2009 and 14994 t in 2010
- Total biomass will remain more or less stable with a slight decrease: 68650 t in 2009, 66245 t in 2010 and 65373 t in 2011.
- SSB will decrease from 41900 t to 38779 t from 2009 to 2011.

Hence this exploitation pattern to maintain F statu quo 2009-11 will produce a slight gain in 2009 followed by a small decrease in 2010. So no important shifts are expected by maintaining this statu quo pattern.

In this situation it is particularly important to pay special attention to recruitment levels as they could prompt sudden increases or drops in a near future.

Conclusions - Management considerations:

This fishery is considered overexploited. Unless the recruitment levels increase in the near future, this fishery will be being exploited at above a level which is believed to be sustainable in the long term, with no potential room for further expansion and a higher risk of stock depletion/collapse.

Further work:

- Reference points.
- Harvest Control Rules.