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**Scientific Advisory Committee (SAC)**
**Workshop on Stock Assessment of Selected Species of Elasmobranchs in the GFCM area**
Brussels (Belgium), 12 -16 December 2011

# Considerations on the EU project - Fish/2004/03-41: Status of ray populations in the Mediterranean Sea and advice for sustainable exploitation of the stocks

2006-2008

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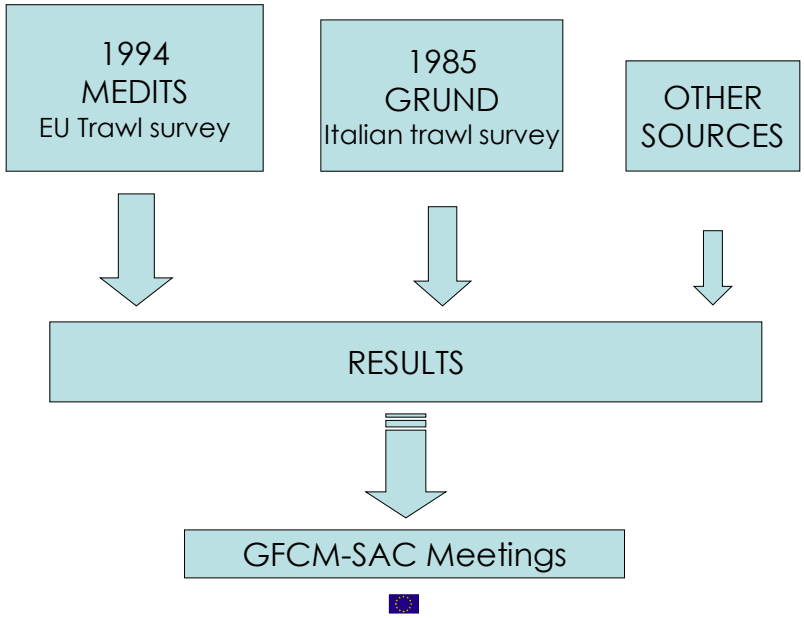
## The main goals of the project

• Building a network of fishery scientists with the aim to analyse the datasets proceeding from different sources and **update the biology, dynamics and exploitation status** of skates by using a common methodology.

• Performing a "synchronic" (the most recent and common dataset) analysis to get the most recent **picture of the status of the resources** in the different Geographical Sub-Areas.

• Performing a "diachronic" (the longest available time-series) comparison of the skate populations amongst the GFCM-GSAs in order to **study any temporal change** in the overall pattern.

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## SPECIFIC TASKS AND SUB-TASKS

The data gathered from different sources were organized by GSA in a single database.

A common methodology was defined in order to figure out, for each GSA, skate abundance indexes.

Length structures for each GSA, **if available**, have been provided as well as the sex of the specimens, biological data on maturity, growth, etc.

| TASK | Arguments | Data requested |
|---|---|---|
| TASK1 | • Unique data-base is needed<br>• **time-space distribution features**<br>• **stock status** | • Raw data by tow (ta,tb,tc files)<br>• **Georeferenced data of catches in number and weight by tow and survey**<br>• **Length Frequencies Distribution when available** |
| TASK2 | • **changes in the status of the populations and in the patterns of distribution** | • **Georeferenced data of catches in number and weight by tow and survey** |

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# TASK 1 – Synchronic Analysis

The aim of this task is to figure out, on the basis of the most recent and common trawl data (MEDITS), the complex **spatial distribution features** (i.e. different size and depth) in the investigated area of the Mediterranean.

The results have been used to estimate the **stock status** and to analyse **pattern of distribution** and the actual **abundance indices** per GSA.

## TASK 2 – Diachronic Analysis

The results derived from all the data base gathered in the investigated time period and in each GSA have been analysed in order to point out any **changes in the status of the skate populations and in the patterns of distribution.**

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## Expected RESULTS

- Estimation of biological and population main parameters for the species according to the data availability
- Definition of temporal trend of skate species in different studied area (GSA) in order to understand possible changes in distribution, abundance and mean sizes
- Definition of the "status" of these resources in the Mediterranean waters (Reference Points)

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| GSA | official name | short name | institutions | Hauls |
|---|---|---|---|---|
| 1 | Northern Alboran Sea | Alboran | **IEO** | 452 |
| 5 | Balearic Islands | Balearic | **IEO** | 398 |
| 6 | Northern Spain | Spain | **IEO** | 530 |
| 7 | Gulf of Lions | France | **IFREMER** | 823 |
| 8 | Corse | Corse | **IFREMER** | 248 |
| 9 | Ligurian and North Tyrrhenian Sea | N Tyrrhenian | **UniGE ARPAT CIBM UniRO** | 1733 |
| 10 | South and Central Tyrrhenian Sea | S Tyrrhenian | **COIPSA CnrME** | 958 |
| 11 | Sardinia | Sardinia | **UniCA** | 838 |
| 15 | Malta | Malta | **MCFS** | 193 |
| 16 | South of Sicily | S Sicily | **CnrMA** | 754 |
| 17 | Northern Adriatic Sea | N Adriatic | **UniBO** | 1164 |
| 18 | Southern Adriatic Sea | S Adriatic | **LBMB** | 1176 |
| 19 | Western Jonian Sea | W Jonian | **UniBA** | 724 |
| 20 | Eastern Jonian Sea | E Jonian | **NCMR** | 491 |
| 22 | Aegean Sea | Aegean | **NCMR** | 883 |
| 23 | Crete | Crete | **NCMR** | 410 |
| 25 | Cyprus | Cyprus | **CYP** | 38 |
| | | | **total =** | **11813** |

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GFCM Geographical Sub Areas

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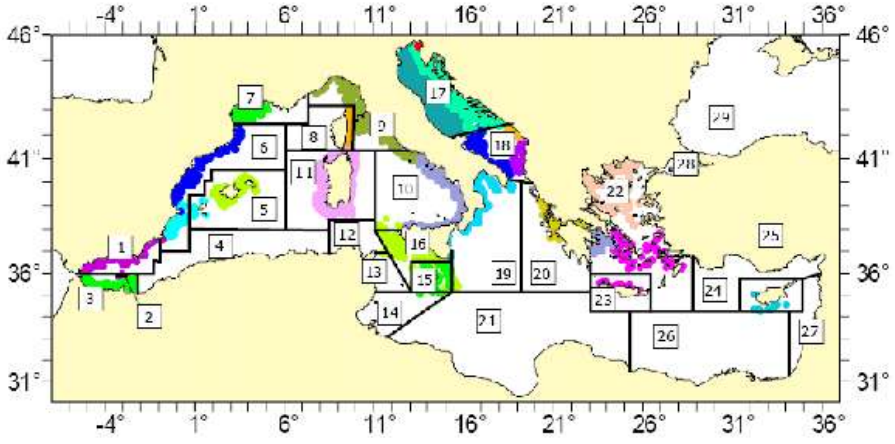
## Medits tows

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## Skate species collected

| | file code | Medits code | species name | common name |
|---|---|---|---|---|
| 1 | RBA | RAJA BAT | Dipturus batis (Linnaeus, 1758) | Skate |
| 2 | ROX | RAJA OXY | Dipturus oxyrinchus (Linnaeus, 1758) | Longnose skate |
| 3 | RCI | RAJA CIR | Leucoraja circularis (Couch, 1838) | Sandy ray |
| 4 | RFU | RAJA FUL | Leucoraja fullonica (Linnaeus, 1758) | Shagreen ray |
| 5 | RME | RAJA MEL | Leucoraja melitensis (Clark, 1926) | Maltese ray |
| 6 | RAS | RAJA AST | Raja asterias Delaroche, 1809 | Starry ray |
| 7 | RBR | RAJA BRA | Raja brachyura Lafont, 1873 | Blonde ray |
| 8 | RCL | RAJA CLA | Raja clavata Linnaeus, 1758 | Thorback ray |
| 9 | RMI | RAJA MIR | Raja miraletus Linnaeus, 1758 | Brown ray |
| 10 | RNA | RAJA NAE | Leucoraja naevus (Mueller and Henle, 1841) | Cuckoo ray |
| 11 | RPO | RAJA POL | Raja polystigma Regan, 1923 | Speckled ray |
| 12 | RRA | RAJA RDA | Raja radula Delaroche, 1809 | Rough ray |
| 13 | RRO | RAJA RON | Raja rondeleti | Rondelet's ray |
| 14 | RUN | RAJA UND | Raja undulata Lacépède, 1802 | Undulated ray |
| 15 | RAL | RAJA ALB | Rostroraja alba Lacépède, 1803 | White skate |
| 16 | RXX | RAJA SPP | Raja sp. | Not identified rays |

\+ Dipturus nidarosiensis

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| species name | MEDITS | | GRUND | |
|---|---|---|---|---|
| | Number of specimens | Biological data | Number of specimens | Biological data |
| Dipturus batis (Linnaeus, 1758) | 1 | | 6 | 6 |
| Dipturus oxyrinchus (Linnaeus, 1758) | 3538 | 426 | 1913 | 412 |
| Leucoraja circularis (Couch, 1838) | 109 | 25 | 151 | 60 |
| Leucoraja fullonica (Linnaeus, 1758) | 44 | 7 | 17 | 12 |
| Leucoraja melitensis (Clark, 1926) | 313 | 6 | 238 | 206 |
| Raja asterias Delaroche, 1809 | 1751 | 449 | 1014 | 281 |
| Raja brachyura Lafont, 1873 | 535 | 228 | 399 | 47 |
| Raja clavata Linnaeus, 1758 | 12586 | 9274 | 8370 | 3844 |
| Raja miraletus Linnaeus, 1758 | 5419 | 1292 | 8291 | 4852 |
| Leucoraja naevus (Mueller and Henle, 1841) | 304 | 56 | 479 | |
| Raja polystigma Regan, 1923 | 3719 | 433 | 4172 | 1133 |
| Raja radula Delaroche, 1809 | 193 | 41 | 49 | 3 |
| Raja rondeleti | 4 | | | |
| Raja undulata Lacépède, 1802 | 38 | 3 | 1 | 1 |
| Rostroraja alba Lacépède, 1803 | 45 | 4 | 40 | 30 |
| Raja sp. | 453 | 12 | 1763 | 36 |
| **TOTAL** | **29052** | **12256** | **26903** | **10923** |

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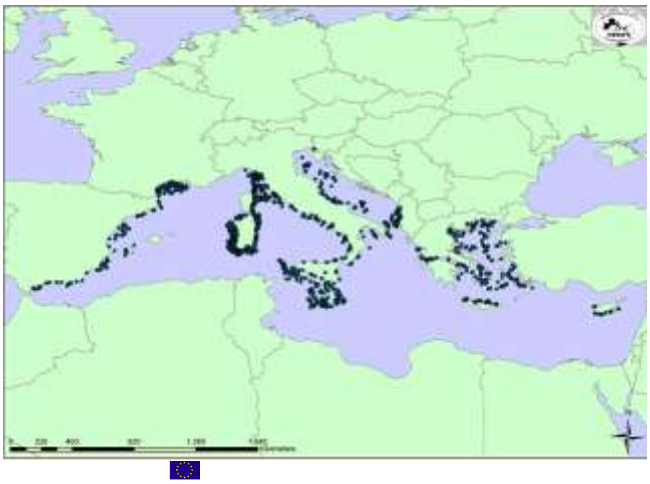
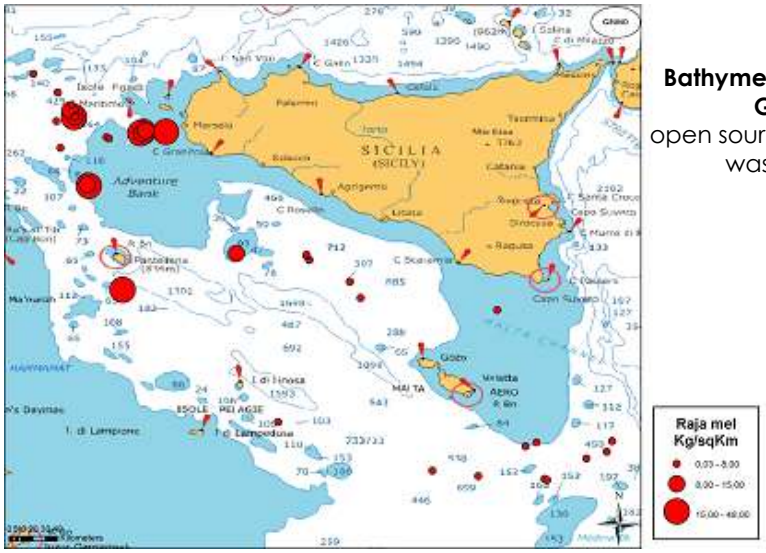
Two kinds of maps have been produced:

**Georeferenced** maps (data are linked to latitude and longitude UTM WGS84);
**Bathymetrical** maps (based on coastal line and depths).

**Georeferenced maps**
**ArcGis**
software was used



## Bathymetrical distributions




**Bathymetrical maps**
**GMT**
open source software was used

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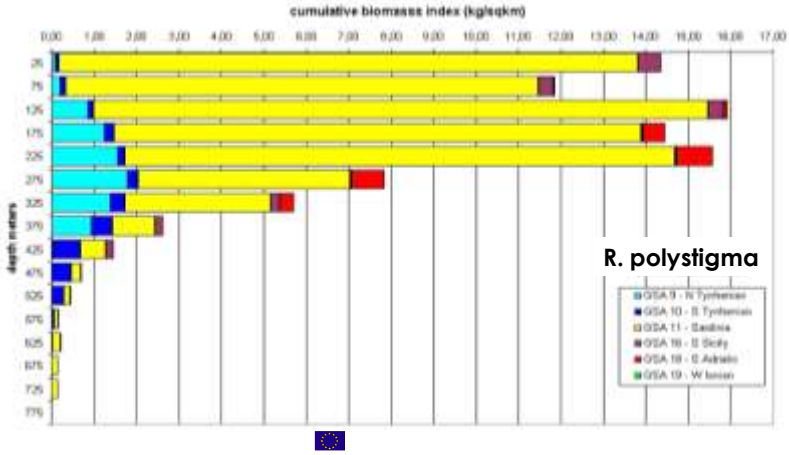
## Bathymetrical distributions

Bathymetrical distribution of abundance of all species was analysed on a GSA basis and 50 m depth intervals form 25 (0-50) m down to 775 (750-800) m. The results were smoothed by means of a running average among 3 depth intervals.



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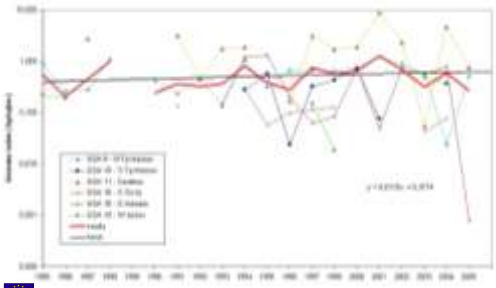
## Temporal trends

| YEAR | GSA 9 | GSA 10 | GSA 11 | GSA 16 | GSA 18 | GSA 19 | mean value |
|---|---|---|---|---|---|---|---|
| 1985 | 0,871 | 0,000 | 0,000 | | | 0,217 | 0,556 |
| 1986 | 0,250 | 0,000 | 0,000 | | | 0,189 | 0,201 |
| 1987 | 0,279 | 0,000 | 2,750 | | | | 0,448 |
| 1988 | 1,075 | | 0,000 | | | | 0,981 |
| 1989 | | | 0,000 | | | | 0,000 |
| 1990 | 0,412 | 0,000 | 0,000 | | 0,000 | 0,000 | 0,240 |
| 1991 | 0,233 | 0,000 | 3,149 | | 0,132 | 0,000 | 0,360 |
| 1992 | 0,446 | 0,000 | 0,445 | | 0,000 | 0,000 | 0,321 |
| 1993 | 0,131 | 0,000 | 1,737 | | 0,147 | 0,000 | 0,363 |
| 1994 | 1,019 | 0,278 | 1,843 | 0,294 | 1,189 | | 0,789 |
| 1995 | 0,308 | 0,563 | 0,000 | 0,056 | 1,282 | 0,000 | 0,378 |
| 1996 | 0,651 | 0,023 | 0,167 | 0,098 | 0,203 | 0,000 | 0,276 |
| 1997 | 0,657 | 0,323 | 3,107 | 0,113 | 0,062 | 0,147 | 0,748 |
| 1998 | 0,636 | 0,422 | 1,686 | 0,125 | 0,084 | 0,018 | 0,554 |
| 2000 | 0,746 | 0,704 | 1,896 | 0,000 | 0,747 | 0,000 | 0,644 |
| 2001 | 1,194 | 0,075 | 8,752 | 0,000 | 0,049 | 0,000 | 1,273 |
| 2002 | 0,881 | 0,000 | 2,292 | 0,000 | 0,736 | 0,000 | 0,669 |
| 2003 | 0,565 | 0,000 | 0,054 | 0,043 | 0,558 | 0,480 | 0,314 |
| 2004 | 0,024 | 0,356 | 4,670 | 0,076 | 0,774 | 0,355 | 0,580 |
| 2005 | 0,503 | 0,000 | 0,740 | | 0,001 | 0,000 | 0,263 |

**Mean density** (kg/sqkm) of ***R. asterias*** for each available year and GSA. The trends have been plotted on a logarithmic scale



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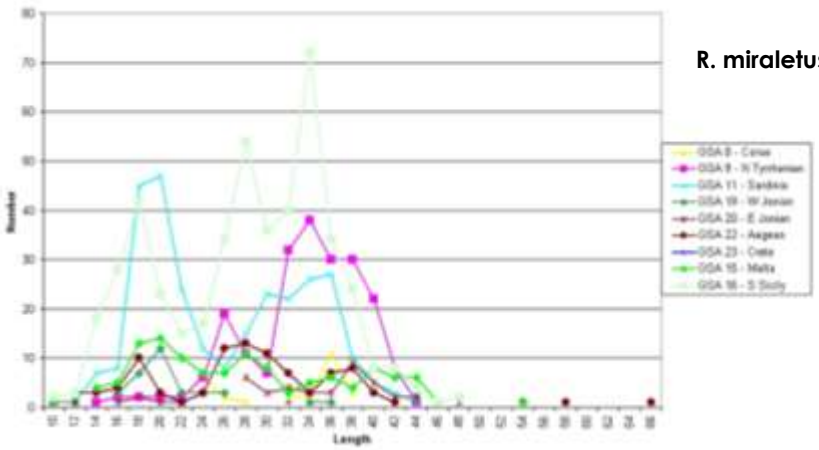
## Length frequency distributions

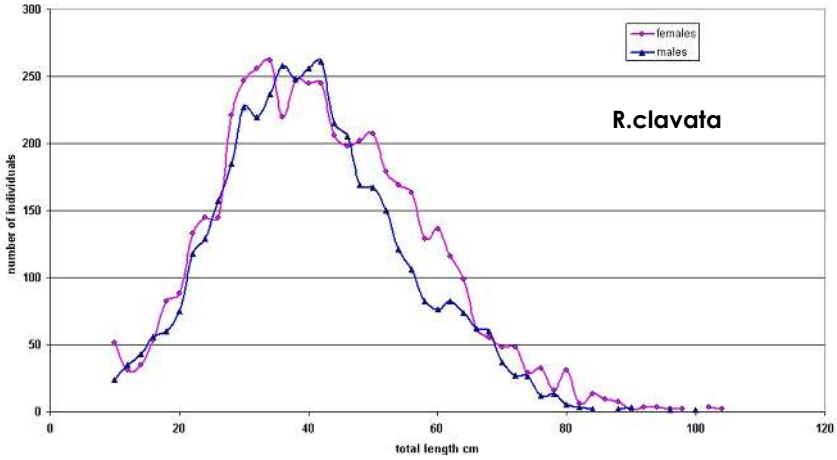
Since most protocols of the survey did not include a systematic recording of the size structure of the skate species, the available data derive only from some GSAs where, for various reasons, this information has been recorded.




**R. miraletus**

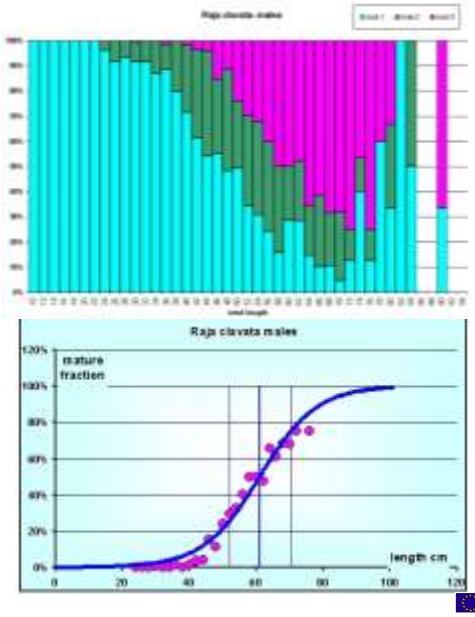
## Biological data

The analyses by species were performed by relating sizes, sexes, ages and depth. Sexual maturity stages, were available, were plotted as proportion by size and maturity sigmoids were also plotted






## Size of first maturity




Raja clavata

## Size of first maturity (cm)

| | | from MEDITS data | | | from GRUND data | | |
|---|---|---|---|---|---|---|---|
| | | L25% | L50% | L75% | L25% | L50% | L75% |
| Raja clavata | females | 66,7 | **85,2** | 103,6 | 80,3 | **82,3** | 84,4 |
| | males | 51,9 | **61,2** | 70,5 | 55,4 | **60,8** | 66,2 |
| Raja miraletus | females | 35,6 | **38,5** | 41,3 | 31,8 | **40,1** | 48,5 |
| | males | 35,5 | **40,7** | 45,9 | 34,7 | **36,1** | 37,4 |
| Raja asterias | females | 56,9 | **62,3** | 67,6 | | | |
| | males | 47,3 | **52,5** | 57,7 | | | |
| Dipturus oxyrinchus | females | 104,4 | **104,4** | 104,4 | | | |
| | males | 75,7 | **83,2** | 90,6 | | | |
| Raja polystigma | females | 45,4 | **48,5** | 51,5 | | | |
| | males | 42,4 | **44,3** | 46,2 | | | |



Lc=20 | knife-edge length at first capture for all species set to 20 cm

| M estimates | Raja asterias | Raja asterias | Raja clavata | Raja clavata | Raja miraletus | Raja miraletus | Raja asterias | Raja clavata |
|---|---|---|---|---|---|---|---|---|
| method | females | males | females | males | females | males | mean lSm | mean lSm |
| Pauly | 0,56 | 0,68 | 0,19 | 0,21 | 0,33 | 0,30 | 0,57 | 0,20 |

| Z estimates | | Raja asterias | Raja asterias | Raja clavata | Raja clavata | Raja miraletus | Raja miraletus | Raja brachyura | Raja brachyura |
|---|---|---|---|---|---|---|---|---|---|
| source | method | females | males | females | males | females | males | females | males |
| medits | LCCC | 0,62 | 0,97 | 0,53 | 0,65 | 0,51 | 0,95 | 0,53 | 0,62 |
| medits | BEH | 0,67 | 0,81 | 0,32 | 0,34 | 0,81 | 0,79 | 1,039 | 0,969 |
| grund | LCCC | 0,78 | 0,66 | 0,35 | 0,32 | 0,88 | 0,67 | | |
| grund | BEH | 0,88 | 0,62 | 0,318 | 0,314 | 0,818 | 0,654 | | |

LCCC = Length Converted Catch Curve
BEH = Beverton & Holt equation

Production models

| source | method | species | $B_0$ | $Z_{MSY}$ | MSP | notes |
|---|---|---|---|---|---|---|
| gr + med | fit by GSA | Raja asterias | 2,86 | 0,70 | 2,38 | 13 different GSA |
| gr + med | fit by GSA | Raja clavata | 12,40 | 0,66 | 6,97 | 14 different GSA |
| gr + med | fit by GSA | Raja clavata | 7,04 | 0,30 | 2,13 | 5 GSA central Mediterranean |
| grund | fit by year | Raja clavata | 7,43 | 0,39 | 2,89 | GSA-9 and GSA-16 |
| medits | fit by year | Raja clavata | 17,04 | 0,99 | 16,94 | GSA-20, GSA-22 and GSA-23 |

$B_0$ Virgin stock biomass
$Z_{MSY}$ Total mortality corresponding to MSP
MSP Maximum Biological Production

| REFERENCE POINTS | Raja asterias | Raja clavata | Raja miraletus | notes |
|---|---|---|---|---|
| $F_{max}$ | 0,42 | 0,13 | 0,28 | from Yield per recruit |
| $F_{0.1\,SSB_0}$ | 0,20 | 0,11 | 0,25 | from Yield per recruit |
| $F_{MSP}$ | 0,21 | 0,10 | | from Production models |
| $Z_{MSP}$ | 0,75 | 0,30 | | from Production models |

Yield per recruit models were used for a preliminary assessment of the current status of exploitation of the species in the different areas. The level of F in each area was calculated by subtracting the value of M derived from the Pauly's empirical equation to the Z

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## Preliminary assessment based on Yield/Recruit and reproduction-based reference points

It was also estimated the surviving fraction of the **Spawning Stock Biomass** as the rate between the value of the current **Spawning Biomass** and the same value regarding the unfished (**virgin**) stock (**SSBc/SSBv**). For this rate, a level of **0.3** was considered as a limit: fishing levels that allows the Spawning Stock Biomass to be above this value is assumed will ensure the self-renewal of the stock.

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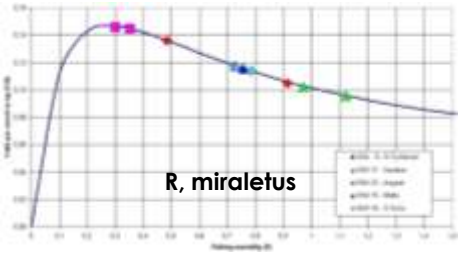
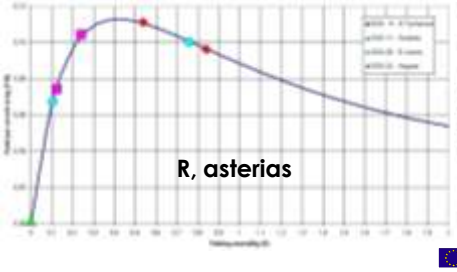
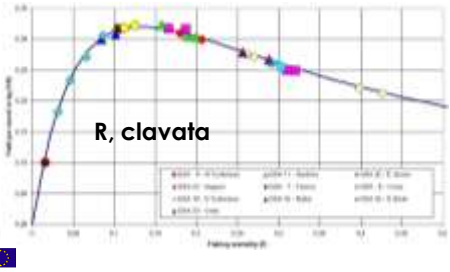
## Preliminary assessment based on Yield/Recruit and reproduction-based reference points




The general situation of growth overfishing for the species in different areas



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## Preliminary assessments using a variant of Production Models

The assessment of the state of the fisheries by using a **Composite Model** was performed for ***R. asterias*** and ***R. clavata***.

The assessment was done using the **instantaneous annual total mortality rate Z** as a direct index of effort and standardized kg/km2/catch per hour towing as an abundance index. The approach allowed comparing the current total mortality rate of each single GSA to the **Z** at Maximum Biological Production (**ZMBP**).

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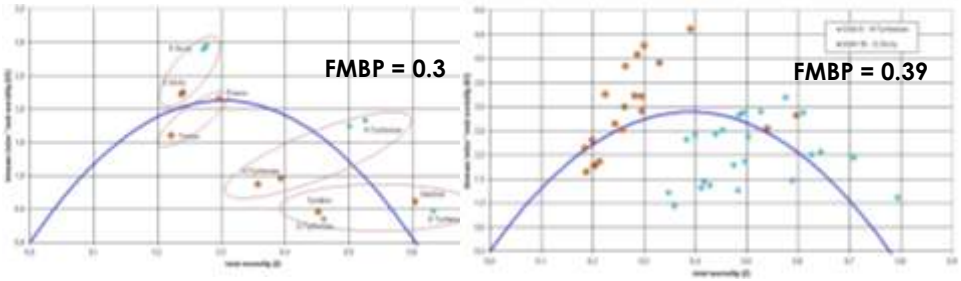
## Preliminary assessments using a variant of Production Models

The equilibrium model of **Schaefer** allowed the estimation of the **F** corresponding to the Maximum Biological Production (**MBP**), considering an average value of Z by sex for each GSA

Grund in **blu** e Medits in **rosso** Grund



## Conclusions

In agreement with Die and Caddy (1997), the ZMBP reference point can be considered precautionary because it corresponds to a lower exploitation rate than the Z at Maximum Sustainable Yield derived from a traditional production model and almost always to those derived from yield per recruit analyses

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## Proposals


MEDITS COORDINATION (Data Collection Programme)
Protocol FOR using MEDITS raw data on elasmobranchs

**First step** should be to build an archive for raw data to define and analyse the time series

**Second step** could be to utilize a variety of statistical methods (e.g. Generalized Linear Models, hierarchical Bayes methods, meta-analytic methods, delta-gamma models and others)

**Third step** regards necessarily modeling aspects related to the management of fish stocks

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# Proposals

## Data Base documentation **EXAMPLE**:

### MEDITS data format (use also for other sources)

**the following sheets hold:**

**Hauls** = ALL the Medits tows from 1994 to 2010 = files TA

**Catches** = elasmobranchs only

**LF** = recorded elasmobranchs only

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# Proposals

## HAULS

| Country | Area | Year | date | Haul code | Lat | Long | Depth | Towed area |
|---|---|---|---|---|---|---|---|---|
| es | 111a | 1994 | 30-lug-1995 | 96 | 43,87833 | 9,95833 | 30 | 0,07 |
| es | 112a | 1994 | 30-lug-1995 | 97 | 43,89417 | 10,13750 | 15 | 0,07 |
| es | 113a | 1994 | 30-lug-1995 | 98 | 43,70417 | 10,21167 | 15 | 0,07 |
| es | 113a | 1994 | 30-lug-1995 | 99 | 43,65333 | 10,16083 | 28 | 0,07 |
| es | 113a | 1994 | 23-lug-1995 | 100 | 43,60500 | 10,11333 | 42 | 0,07 |
| fr | 121a | 1994 | 2-lug-1995 | 101 | 43,50667 | 10,23917 | 34 | 0,07 |
| fr | 121b | 1994 | 2-lug-1995 | 102 | 43,24750 | 10,46167 | 20 | 0,07 |
| fr | 121b | 1994 | 20-lug-1995 | 103 | 42,96667 | 10,46167 | 31 | 0,07 |
| fr | 121b | 1994 | 30-lug-1995 | 104 | 43,84417 | 9,91333 | 56 | 0,08 |
| it | 132a | 1994 | 2-lug-1995 | 105 | 43,24750 | 10,25333 | 74 | 0,08 |
| it | 132b | 1994 | 20-lug-1995 | 106 | 42,96667 | 10,45667 | 55 | 0,08 |
| it | 132c | 1994 | 4-lug-1995 | 107 | 42,99750 | 9,98500 | 94 | 0,08 |
| it | 132d | 1994 | 20-lug-1995 | 108 | 43,06583 | 9,86083 | 90 | 0,08 |
| it | 133a | 1994 | 23-lug-1995 | 109 | 43,76583 | 9,92500 | 109 | 0,08 |

GENERAL FISHERIES COMMISSION FOR THE MEDITERRANEAN

COMMISSION GÉNÉRALE DES PÊCHES POUR LA MÉDITERRANÉE

Scientific Advisory Committee (SAC)

# Proposals

## CATCHES

| Country | Area | Year | Haul code | Species | Kg | Num | Kg/Km$^2$ | Num/Km$^2$ |
|---|---|---|---|---|---|---|---|---|
| it | 211 | 1994 | 8 | Raja asterias | 0,1 | 1 | | |
| it | 281 | 1994 | 74 | Raja radula | 0,35 | 1 | | |
| it | 211 | 1995 | 73 | Raja asterias | 1,1 | 2 | | |
| it | 211 | 1995 | 86 | Raja asterias | 1,38 | 1 | | |
| it | 227 | 1995 | 33 | Raja clavata | 1,16 | 1 | | |
| it | 250 | 1996 | 103 | Raja miraletus | 1,7 | 7 | | |
| it | 251 | 1996 | 104 | Raja miraletus | 0,02 | 1 | | |
| it | 211 | 1997 | 61 | Raja asterias | 3,059 | 4 | | |
| it | 211 | 1997 | 82 | Raja asterias | 1,54 | 1 | | |
| it | 228 | 1997 | 21 | Raja clavata | 0,05 | 1 | | |
| it | 229 | 1997 | 61 | Raja clavata | 2,764 | 3 | | |
| it | 254 | 1997 | 106 | Raja miraletus | 2,75 | 9 | | |

GENERAL FISHERIES COMMISSION FOR THE MEDITERRANEAN

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# Proposals

## LF

| Country | Area | Year | Haul code | Species | Length | Num | Sex | Maturity |
|---|---|---|---|---|---|---|---|---|
| es | 111a | 1994 | 96 | RAJA MIR | 13 | 1 | m | |
| es | 112a | 1994 | 97 | RAJA MIR | 19 | 1 | m | |
| es | 113a | 1994 | 98 | RAJA MIR | 26 | 1 | f | |
| es | 113a | 1994 | 99 | RAJA MIR | 28 | 6 | f | |
| es | 113a | 1994 | 100 | RAJA MIR | 30 | 3 | f | |
| fr | 121a | 1994 | 101 | RAJA MIR | 31 | 1 | m | |
| fr | 121b | 1994 | 102 | RAJA MIR | 32 | 1 | m | |
| fr | 121b | 1994 | 103 | RAJA MIR | 35 | 1 | m | |
| fr | 121b | 1994 | 104 | RAJA CLA | 36 | 2 | f | |
| it | 132a | 1994 | 105 | RAJA CLA | 37 | 2 | f | |
| it | 132b | 1994 | 106 | RAJA CLA | 40 | 3 | f | |
| it | 132c | 1994 | 107 | RAJA CLA | 41 | 2 | m | |
| it | 132d | 1994 | 108 | RAJA CLA | 42 | 1 | m | |
| it | 133a | 1994 | 109 | RAJA CLA | 45 | 1 | m | |