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Abundance and Distribution of Elasmobranchs in NAFO Regulatory Area (Divisions 3MNO)  
(Elasmobranch Fisheries – Oral)

by

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### Abstract

Recently, the importance of elasmobranch fisheries has increased in the NAFO area due to the collapse of some important stocks like cod or American plaice; species like thorny skate are now one of the main resources in the NAFO Regulatory Area, especially in the Grand Bank. Nevertheless, in Flemish Cap (NAFO Div 3M), despite the weakness of the main stocks, elasmobranchs carry on being a resource without direct fishing that is mainly fished as by-catch.

Since 1988 a bottom trawl survey was carried out by the European Community in Flemish Cap waters. Furthermore, since 1995, another trawl survey was also carried out in the Regulatory Area of the Grand Bank (NAFO, Div. 3NO); the goal of these surveys is collecting data for the assessment of the main species but these surveys are also an important source of information on biology and population dynamics of other fish species like elasmobranchs.

The aim of this work is to show the present status and the recent changes in biomass of the main elasmobranch species in the areas covered by these surveys, with focus on their relative abundance, their spatial distribution and their size distribution. We have found out that thorny skate, that is the most important elasmobranchs in NAFO area, is widely distributed in both sampling areas without signs of stocks differentiation.

### Introduction

Flemish Cap is a underwater plateau centred at about 47° N and 45° W with minimum water depths of 125 m. Flemish Cap is separated from the Grand Bank of Newfoundland to the West by the Flemish Pass, a region with minimum depth of about 1 100 m. Historically, the fishery in this area was directed towards cod and American plaice but these fisheries collapsed in the 1990s and were replaced by shrimp and redfish that are now the main target species.

As a result of an increasing in fishing effort towards non-regulated species added to the decline in the traditional groundfish resources in the area of the Grand Bank, in recent years the catches of non-traditional resources in the NAFO area have been increasingly important (Durán *et al.*, 1997; Junquera and Paz, 1998).

The elasmobranchs have slow growth and late sexual maturation, very low egg production and long reproductive cycles. These attributes result in very low intrinsic rates of increases (Smith *et al.*, 1998) and very low resilience to fishing mortality (Hoening and Gruber, 1990). Because of their low population resilience, most

elasmobranchs only withstand modest levels of fishing without depletion and stock collapse (Camhi *et al.*, 1998; Musick, 1999a). Thus, they are highly susceptible to over-exploitation.

### Material and Methods

Data used in this study come from two different surveys: the UE summer bottom trawl surveys for NAFO Div. 3M (Flemish-Cap survey) and the Spanish spring bottom trawl surveys in NAFO Div. 3NO. The sampling area of both surveys is showed in Fig. 1.

The EU-Flemish Cap survey has been carried out since 1988 with the aim of evaluate the main commercial species in the area (Vázquez, 2002). The stratified random sampling, that usually has 120 hauls, follows the NAFO specifications as described by Doubleday (1981). The sampling area spreads out until 720 m covering an area of 10 555 square miles. Table 1 (upper panel) shows a short description of some survey features: the vessel used in this survey was always the *R/V Cornide de Saavedra* except for the years 1989 and 1990 when it was not available, but the gear characteristics were the same through all the years. The number of valid tows, depth range and time of survey for every year are also indicated.

Since 1995 the Spanish spring bottom trawl survey was performed in the NAFO Regulatory Area (Div. 3NO). The stratified-random sampling method of set selection was used. The area and strata covered by the surveys were based on the stratification charts and tables in Bishop (1994). The surveys, which covered offshore areas on the Grand Bank, were conducted following the same procedures and the same vessel and gear (Paz, *et al.*, 1995,1996,1997,1999, 2000 and Durán *et al.*, 1998). Surveys characteristics are described in Table 1 (lower panel), the first survey, in 1995, just covered until 684 m depth with 77 valid tows, but in the last four years the maximum depth reached 1400 m with near 120 valid tows. Due to big differences in the area covered in the first three surveys these were excluded from this analysis.

### Results and Discussion

The presence of elasmobranchs in both surveys areas is quite different. Meanwhile elasmobranchs in Flemish-Cap just represent about a 1.5% on total catch, ranging among 0.5 and 3.0% along the time series, elasmobranchs catch reached the 16% in the Div. 3NO surveys in 1997 and the medium catch in all the series was about 12% (Fig. 2).

In Table 2 we can see the elasmobranch species recorded in both surveys. The number of species is larger in the sampled area of Div. 3NO where 15 different species were classified, meanwhile in the Flemish-Cap survey just 9 species were found. This result can be explained since the Div. 3NO surveys cover a deeper area, 1400 m, against the 730 m in Flemish-Cap surveys. All species found in the Flemish-Cap surveys are also presented in the Div. 3NO surveys except white skate with 14 individuals recorded in Flemish-Cap.

The relative importance of these elasmobranchs is different in both areas (Fig. 3). The main species caught in both surveys is thorny skate, with 64% of total elasmobranchs catch in Flemish-Cap and 78% in Div. 3NO. Spinetail skate is the second species in Flemish-Cap with a 31%, meanwhile in the Div. 3NO survey represents only the 1% of total elasmobranchs. However, in the Div. 3NO survey the second specie in abundance is black dogfish with an 18% of total elasmobranchs, although this species hardly appears in Flemish-Cap (0.9%). The percentage of all others species is almost the same in both surveys (4% in Flemish-Cap and 3.5% in Div. 3NO surveys).

Table 3 shows the catch of all elasmobranchs by species and year in both surveys. The annual catch of elasmobranchs in Flemish-Cap fluctuates between 178 kg in the year 2000 and 623 kg in 1993, with a total catch in all the surveys of 5 532 kg. During the Div. 3NO survey in the last four years the annual catch oscillates among 14 291 kg in the year 1998 and 28 119 in 2000, with a total catch in all the series (1995-2001) of 101 404 kg. This big difference among the total catch in both areas, could be explained by the increase in the Div. 3NO surveyed depth that allows the high presence of species like black dogfish, mainly distributed in deeper waters. Nevertheless, as we have shown before (Fig. 3) the main species in both areas is the thorny skate that mainly occurs in shallower waters.

### Thorny skate

*Amblyraja radiata* is the most abundant elasmobranch in both areas studied and it is the only one that has a directed fishery in the Div. 3NO area. The skate fishery in the Grand Bank and the Scotian Shelf within Canadian waters is regulated since 1994, through quota control (Simon and Frank, 1996), but the fishery in the Regulatory Area is currently unregulated. Since 1996, part of the Spanish fleet formerly targeting exclusively on Greenland halibut, started to undertake occasionally the skate fishery on the southern Grand Bank Regulatory Area in shallow waters. The estimated catches of thorny skate by the Spanish fleet in NAFO Div. 3N in 1999 were 4 700 tons. (Junquera *et al.*, 2000) and increased to about 10 700 tons in 2000.

The biomass estimated by sweep area method in both surveys is presented in Fig. 4; the trend in Flemish Cap peaks in the years 1991-1994 with values higher than 2 500 tons. Nevertheless, since 1996 sweep area biomass never reached 1 500 tons and its lower value was 900 tons in the year 2000. In the Div. 3NO spring survey just the last four years were included in the calculus of sweep area biomass. The values estimated for this area oscillate approximately between 100 000 tons in 1998 and 200 000 tons in 2000.

Total catch, total numbers, number of hauls with presence, mean weight and depth distribution for thorny skate by year and area are showed in Table 4. The hauls with thorny skate presence in Flemish Cap are about a half, meanwhile in the Div. 3NO survey thorny skate appears in near all the hauls. In both surveys and every year the minimum and maximum depth with records of thorny skate matches the hauls depth range, which suggests that the thorny skate has a wide depth tolerance and its distribution could exceed the survey maximum depth. In Flemish-Cap, mean weight ranges between 1.4 kg in 2001 and 1.9 kg in 1991 and in the Div. 3NO survey, in the last four years mean weight oscillates between 1.1 kg and 1.5 kg, clearly lower than Flemish-Cap values.

Length-weight relationship for both surveys by year is presented in Table 5. The sampling of the last three years let us establish the length-weight relationship by sex (Fig. 5).

The length distributions of thorny skate in Flemish-Cap (1988-2001) and in the Div. 3NO survey (1998-2001) are shown in Fig. 6. In Flemish-Cap the length range in the catches is mainly between 10 and 85 cm, without any clear mode. In the Div. 3NO survey the length range is approximately between 12 and 90 cm, with a mode of 34 cm in 1998, 43 cm in 1999 and about 50 cm in 2000 and 2001. Both sexes appeared equally represented in the catches of both surveys. In the last three years the length distribution in the Div. 3NO survey shows a higher proportion of small skates than in Flemish-Cap. This large proportion of small fish explained that mean weight in Flemish-Cap is larger than Div. 3NO mean weight.

The distribution of thorny skate catches in Flemish-Cap surveys and Div. 3NO surveys are presented in Fig. 7. Thorny skate in Flemish-Cap is widely distributed, although we can see that during the more abundant years (1991-1994), skate mainly occurs northwards at about 400 m depth. In the Div. 3NO survey the thorny skate also is widely distributed, although mainly occurs at shallower waters, specially bounding the EEZ in the limit between Div. 3N and 3O. High concentrations of thorny skate also were observed in depth water in the East slope.

### Black Dogfish

*Centroscyllium fabricii* is a deep species that usually occurs beyond 500 m in the NAFO area (Durán *et al.*, 1999). Black dogfish rarely occurs in Flemish-Cap, where only was recorded in six years of all the series (Table 6). In the Div. 3NO survey that reached 1400 m deep, black dogfish is more abundant. In the last four years total catch oscillated between 2 202 kg in 1999 and 5 876 kg in 2000.

The length distributions of black dogfish in the spring Div. 3NO surveys are shown in Fig. 9. The length range in the catches is mainly between 40 and 80 cm in the last four years. Males are larger and more abundant than females. Length-weight relationship for the spring Div. 3NO surveys by sex from 1997 to 2001 is presented in Table 7.

Black dogfish in the Div. 3NO survey appears in just a few hauls (22-28) usually in the deepest strata beyond 1000 m and around all the area surveyed (Fig. 10).

### Spinetail ray

*Bathyraja spinicauda* is a species not very abundant in both areas. In the Div. 3NO survey the catches oscillated from 214 kg in 2000 to 504 kg in 1999 (Table 8). In the Flemish-Cap survey the catches ranged among 265 kg in 1998 and 42 kg in 2000. It is a large species with mean weight that oscillates between 2 454 g in 2000 and 8 291 g in 1988. Length-weight relationship for Flemish-Cap surveys from 1990 to 2001 is presented in Table 9.

Spinetail ray is found in the deepest strata usually beyond 400 m, although in 1990 appears in shallower waters (Fig. 8).

### Other elasmobranch

Table 10 shows a summary for other elasmobranchs much less abundant found in both surveys. Species like chimeras only appeared in the Div. 3NO survey, never in the Flemish-Cap survey series.

## **Conclusions**

The information recorded of elasmobranch species in the summer Flemish-Cap surveys and spring Div. 3NO surveys are limited because the elasmobranchs aren't target species in both surveys and the sampling area covers only partially the depth range for the main elasmobranchs. Just for thorny skate, that is the more abundant elasmobranchs, we have got enough information. The geographic distribution of thorny skate in the Div. 3NO surveys, that appears at more than 1 300 m in the nose of the Grand Bank, indicates that Flemish Pass with 1 100 m depth would not be an impediment to move between Grand Bank and Flemish-Cap. The size distribution in both areas support this suggestion; both distributions are quite similar except in Div. 3NO where the small individuals are relatively more abundant than in Flemish-Cap, given that the sampling area in Div. 3NO survey covers shallower waters than the Flemish Cap survey.

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Table 1.- Description of the research surveys involved in this study.

**A.- UE summer bottom trawl surveys for NAFO Div. 3M**

| Year | Period    | Depth strata(m) | Vessel                  | Valid tows |
|------|-----------|-----------------|-------------------------|------------|
| 1988 | July      | 120 - 730       | R/V Cornide de Saavedra | 115        |
| 1989 | July      | 120 - 730       | R/V Cryos               | 116        |
| 1990 | July-Aug  | 120 - 730       | R/V Ignat Pavlyuchenkov | 113        |
| 1991 | June-July | 120 - 730       | R/V Cornide de Saavedra | 117        |
| 1992 | July      | 120 - 730       | R/V Cornide de Saavedra | 117        |
| 1993 | June-July | 120 - 730       | R/V Cornide de Saavedra | 101        |
| 1994 | July      | 120 - 730       | R/V Cornide de Saavedra | 116        |
| 1995 | July      | 120 - 730       | R/V Cornide de Saavedra | 121        |
| 1996 | July      | 120 - 730       | R/V Cornide de Saavedra | 117        |
| 1997 | July      | 120 - 730       | R/V Cornide de Saavedra | 117        |
| 1998 | July      | 120 - 730       | R/V Cornide de Saavedra | 119        |
| 1999 | July      | 120 - 730       | R/V Cornide de Saavedra | 117        |
| 2000 | July      | 120 - 730       | R/V Cornide de Saavedra | 120        |
| 2001 | July      | 120 - 730       | R/V Cornide de Saavedra | 120        |

**B.- Spanish spring bottom trawl surveys for NAFO Div. 3NO**

| Year | Period    | Depth strata(m) | Vessel               | Valid tows |
|------|-----------|-----------------|----------------------|------------|
| 1995 | May       | 42 - 684        | C/V Playa de Mendiña | 77         |
| 1996 | May       | 41 - 1135       | C/V Playa de Mendiña | 112        |
| 1997 | April-May | 42 - 1263       | C/V Playa de Mendiña | 128        |
| 1998 | May       | 56 - 1390       | C/V Playa de Mendiña | 124        |
| 1999 | May       | 41 - 1381       | C/V Playa de Mendiña | 114        |
| 2000 | May       | 42 - 1401       | C/V Playa de Mendiña | 118        |
| 2001 | May       | 40 - 1343       | C/V Playa de Mendiña | 121        |

Table 2. List of elasmobranch species caught in the EU summer surveys in Div. 3M: 1988-01 (A) and the Spanish spring bottom trawl surveys in NAFO Div. 3NO: 1995-01 (B).

(A)

| <b>order</b>  | <b>family</b> | <b>genus</b>          | <b>specie</b>     | <b>common name</b> |
|---------------|---------------|-----------------------|-------------------|--------------------|
| ESQUALIFORMES | Squalidae     | <i>Squalus</i>        | <i>acanthias</i>  | spiny dogfish      |
| ESQUALIFORMES | Dalatiidae    | <i>Centroscyllium</i> | <i>fabricii</i>   | black dogfish      |
| ESQUALIFORMES | Dalatiidae    | <i>Etmopterus</i>     | <i>princeps</i>   | greatlaternshark   |
| RAJIFORMES    | Rajidae       | <i>Amblyraja</i>      | <i>radiata</i>    | thorny skate       |
| RAJIFORMES    | Rajidae       | <i>Bathyraja</i>      | <i>spinicauda</i> | spinetail ray      |
| RAJIFORMES    | Rajidae       | <i>Malacoraja</i>     | <i>senta</i>      | smooth skate       |
| RAJIFORMES    | Rajidae       | <i>Dipturus</i>       | <i>lintea</i>     | white skate        |
| RAJIFORMES    | Rajidae       | <i>Amblyraja</i>      | <i>hyperborea</i> | arctic skate       |
| RAJIFORMES    | Rajidae       | <i>Rajella</i>        | <i>fyllae</i>     | round skate        |

(B)

| <b>order</b>     | <b>family</b>    | <b>genus</b>          | <b>specie</b>     | <b>common name</b>      |
|------------------|------------------|-----------------------|-------------------|-------------------------|
| ESQUALIFORMES    | Squalidae        | <i>Squalus</i>        | <i>acanthias</i>  | spiny dogfish           |
| ESQUALIFORMES    | Squalidae        | <i>Squalus</i>        | <i>cubensis</i>   | Cuban dogfish           |
| ESQUALIFORMES    | Dalatiidae       | <i>Centroscyllium</i> | <i>fabricii</i>   | black dodfish           |
| ESQUALIFORMES    | Dalatiidae       | <i>Centroscymnus</i>  | <i>coelolepis</i> | Portuguese dogfish      |
| ESQUALIFORMES    | Dalatiidae       | <i>Etmopterus</i>     | <i>princeps</i>   | greatlaternshark        |
| CARCHARINIFORMES | Scyliorhinidae   | <i>Apristurus</i>     | spp               | catshark                |
| RAJIFORMES       | Rajidae          | <i>Amblyraja</i>      | <i>radiata</i>    | thorny skate            |
| RAJIFORMES       | Rajidae          | <i>Bathyraja</i>      | <i>spinicauda</i> | spinetail ray           |
| RAJIFORMES       | Rajidae          | <i>Malacoraja</i>     | <i>senta</i>      | smooth skate            |
| RAJIFORMES       | Rajidae          | <i>Amblyraja</i>      | <i>hyperborea</i> | arctic skate            |
| RAJIFORMES       | Rajidae          | <i>Rajella</i>        | <i>fyllae</i>     | round skate             |
| CHIMAERIFORMES   | Chimaeridae      | <i>Hydrolagus</i>     | <i>affinis</i>    | smalled eyed rabbitfish |
| CHIMAERIFORMES   | Chimaeridae      | <i>Chimaera</i>       | <i>monstrosa</i>  | rabbit fish             |
| CHIMAERIFORMES   | Rhinochimaeridae | <i>Harriotta</i>      | <i>raleighana</i> | narrownose rabbitfish   |
| CHIMAERIFORMES   | Rhinochimaeridae | <i>Rhinochimaera</i>  | <i>atlantica</i>  | spearnose rabbitfish    |

Table 3. Catch (kg) of the elasmobranch species by year. EU summer surveys Div. 3M: 1988-01 (A) and the Spanish spring bottom trawl surveys in NAFO Div. 3NO: 1995-01 (B).

(A)

|                                | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | total |
|--------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-------|
| <i>Squalus acanthias</i>       | 2    | 0    | 0    | 2    | 1    | 2    | 2    | 0    | 2    | 3    | 4    | 2    | 7    | 0    | 27    |
| <i>Etmopterus princeps</i>     | 5    | 0    | 0    | 1    | 10   | 0    | 4    | 3    | 0    | 0    | 0    | 0    | 0    | 0    | 23    |
| <i>Centroscyllium fabricii</i> | 0    | 0    | 31   | 1    | 0    | 0    | 4    | 0    | 0    | 1    | 8    | 0    | 0    | 2    | 47    |
| <i>Bathyraja spinicauda</i>    | 265  | 103  | 160  | 144  | 167  | 152  | 128  | 68   | 116  | 85   | 63   | 92   | 42   | 126  | 1711  |
| <i>Amblyraja radiata</i>       | 264  | 166  | 224  | 419  | 351  | 453  | 332  | 270  | 176  | 173  | 222  | 128  | 125  | 202  | 3505  |
| <i>Malacoraja senta</i>        | 14   | 0    | 0    | 15   | 22   | 5    | 3    | 7    | 5    | 4    | 3    | 2    | 4    | 7    | 91    |
| <i>Dipturus lineata</i>        | 0    | 0    | 0    | 0    | 2    | 9    | 4    | 0    | 0    | 2    | 0    | 0    | 0    | 0    | 17    |
| <i>Amblyraja hyperborea</i>    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 2    | 0    | 6    | 8     |
| <i>Rajella fyllae</i>          | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 0    | 0    | 0    | 1    | 0    | 0    | 2    | 4     |
| <i>Rajiidae</i>                | 64   | 31   | 4    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 99    |
| <b>total</b>                   | 614  | 299  | 419  | 582  | 553  | 623  | 477  | 348  | 298  | 268  | 302  | 227  | 178  | 344  | 5532  |

(B)

|                                 | 1995 | 1996 | 1997  | 1998  | 1999  | 2000  | 2001  | total         |
|---------------------------------|------|------|-------|-------|-------|-------|-------|---------------|
| <i>Squalus acanthias</i>        |      |      |       |       |       | 45    | 16    | <b>60</b>     |
| <i>Centroscyllium fabricii</i>  |      | 61   | 3339  | 2980  | 2202  | 5886  | 3746  | <b>18213</b>  |
| <i>Squalus cubensis</i>         |      |      |       |       |       | 2     |       | <b>2</b>      |
| <i>Centroscymnus coelolepis</i> |      |      |       |       |       | 12    | 30    | <b>43</b>     |
| <i>Etmopterus princeps</i>      |      |      |       |       |       |       | <1    | <b>&lt;1</b>  |
| <i>Apristurus</i> spp           |      |      |       |       |       | 152   | 218   | <b>370</b>    |
| <i>Amblyraja radiata</i>        | 2081 | 7978 | 6418  | 10955 | 14922 | 20627 | 14904 | <b>77886</b>  |
| <i>Bathyraja spinicauda</i>     |      |      | 1     | 228   | 504   | 214   | 258   | <b>1204</b>   |
| <i>Amblyraja hyperborea</i>     |      |      |       |       |       | 482   | 177   | <b>659</b>    |
| <i>Rajiidae</i>                 |      |      | 281   |       | 1138  | 187   | 142   | <b>1748</b>   |
| <i>Hydrolagus affinis</i>       |      |      |       | 39    | 17    | 79    | 62    | <b>197</b>    |
| <i>Chimaera monstrosa</i>       |      | 31   | 26    |       |       |       |       | <b>58</b>     |
| <i>Harriotta raleighana</i>     |      |      |       |       |       | 434   | 441   | <b>875</b>    |
| <i>Rhinochimaera atlantica</i>  |      |      |       |       | 90    |       |       | <b>90</b>     |
| <b>total</b>                    | 2081 | 8070 | 10065 | 14291 | 18782 | 28119 | 19995 | <b>101404</b> |



Table 4. Summary of thorny skate. (A) EU summer surveys Div. 3M and (B) the Spanish spring bottom trawl surveys in NAFO Div. 3NO: 1995-01.

(A)

|             | <b>Total catch (kg)</b> | <b>Total numbers</b> | <b>Hauls</b> | <b>Mean weight (g)</b> | <b>Min depth (m)</b> | <b>Mean depth (m)</b> | <b>Max depth (m)</b> |
|-------------|-------------------------|----------------------|--------------|------------------------|----------------------|-----------------------|----------------------|
| <b>1988</b> | 264                     | 148                  | 62           | 1781                   | 156                  | 359                   | 711                  |
| <b>1989</b> | 166                     | 101                  | 46           | 1637                   | 171                  | 381                   | 655                  |
| <b>1990</b> | 224                     | 114                  | 52           | 1972                   | 127                  | 373                   | 674                  |
| <b>1991</b> | 419                     | 212                  | 80           | 1978                   | 130                  | 385                   | 701                  |
| <b>1992</b> | 351                     | 179                  | 74           | 1958                   | 141                  | 365                   | 708                  |
| <b>1993</b> | 453                     | 258                  | 69           | 1757                   | 149                  | 373                   | 738                  |
| <b>1994</b> | 332                     | 213                  | 68           | 1558                   | 144                  | 386                   | 713                  |
| <b>1995</b> | 270                     | 146                  | 72           | 1847                   | 127                  | 370                   | 665                  |
| <b>1996</b> | 176                     | 106                  | 48           | 1663                   | 161                  | 362                   | 685                  |
| <b>1997</b> | 173                     | 106                  | 54           | 1631                   | 175                  | 379                   | 679                  |
| <b>1998</b> | 222                     | 128                  | 62           | 1732                   | 143                  | 403                   | 677                  |
| <b>1999</b> | 128                     | 83                   | 52           | 1547                   | 140                  | 400                   | 716                  |
| <b>2000</b> | 125                     | 80                   | 52           | 1566                   | 143                  | 373                   | 680                  |
| <b>2001</b> | 202                     | 143                  | 74           | 1411                   | 132                  | 394                   | 712                  |

(B)

|             | <b>Total Catch (kg)</b> | <b>Total numbers</b> | <b>Hauls</b> | <b>Mean weight (g)</b> | <b>Min depth (m)</b> | <b>Mean depth (m)</b> | <b>Max depth (m)</b> |
|-------------|-------------------------|----------------------|--------------|------------------------|----------------------|-----------------------|----------------------|
| <b>1995</b> | 2081                    | -                    | 65           | -                      | 42                   | 124                   | 684                  |
| <b>1996</b> | 7978                    | -                    | 102          | -                      | 43                   | 268                   | 1066                 |
| <b>1997</b> | 6418                    | -                    | 123          | -                      | 42                   | 363                   | 1255                 |
| <b>1998</b> | 10955                   | 9277                 | 115          | 1181                   | 42                   | 419                   | 1339                 |
| <b>1999</b> | 14922                   | 9855                 | 93           | 1514                   | 41                   | 362                   | 1340                 |
| <b>2000</b> | 20627                   | 18801                | 97           | 1097                   | 42                   | 361                   | 1314                 |
| <b>2001</b> | 14904                   | 11737                | 104          | 1270                   | 40                   | 370                   | 1299                 |

Table 5. Thorny skate length-weight parameters.

|             | <b>Flemish</b> |          |          | <b>3NO</b> |          |          |
|-------------|----------------|----------|----------|------------|----------|----------|
|             | <b>N</b>       | <b>a</b> | <b>b</b> | <b>N</b>   | <b>a</b> | <b>b</b> |
| <b>1990</b> | 12             | 0.0011   | 3.54     |            |          |          |
| <b>1993</b> | 17             | 0.0028   | 3.30     |            |          |          |
| <b>1994</b> | 109            | 0.0051   | 3.18     |            |          |          |
| <b>1995</b> | 63             | 0.0021   | 3.40     |            |          |          |
| <b>1996</b> | 66             | 0.0059   | 3.15     |            |          |          |
| <b>1997</b> | 66             | 0.0142   | 2.92     | 220        | 0,0090   | 3,03     |
| <b>1998</b> | 110            | 0.0133   | 2.94     | 156        | 0,0112   | 2,97     |
| <b>1999</b> | 124            | 0.0078   | 3.07     | 86         | 0,0293   | 2,74     |
| <b>2000</b> | 90             | 0.0110   | 2.99     | 443        | 0,0349   | 2,69     |
| <b>2001</b> | 218            | 0.0083   | 3.06     | 1324       | 0,0080   | 3,05     |

Table 6. Summary of black dogfish in the (A) EU summer surveys Div. 3M and (B) the Spanish spring bottom trawl surveys in NAFO Div. 3NO.

(A)

|             | <b>Total Catch<br/>(kg)</b> | <b>Total numbers</b> | <b>Hauls</b> | <b>Mean weight<br/>(g)</b> | <b>Min depth<br/>(m)</b> | <b>Mean depth<br/>(m)</b> | <b>Max depth<br/>(m)</b> |
|-------------|-----------------------------|----------------------|--------------|----------------------------|--------------------------|---------------------------|--------------------------|
| <b>1990</b> | 31                          | 34                   | 2            | 907                        | 665                      | 633                       | 674                      |
| <b>1991</b> | 1                           | 1                    | 1            | 940                        | 263                      | 263                       | 263                      |
| <b>1994</b> | 4                           | 5                    | 1            | 794                        | 713                      | 713                       | 713                      |
| <b>1997</b> | 1                           | 1                    | 1            | 745                        | 719                      | 719                       | 719                      |
| <b>1998</b> | 8                           | 8                    | 2            | 1055                       | 655                      | 677                       | 685                      |
| <b>2001</b> | 2                           | 3                    | 2            | 713                        | 614                      | 647                       | 714                      |

(B)

|             | <b>Total Catch<br/>(kg)</b> | <b>Total numbers</b> | <b>Hauls</b> | <b>Mean weight<br/>(g)</b> | <b>Min depth<br/>(m)</b> | <b>Mean depth<br/>(m)</b> | <b>Max depth<br/>(m)</b> |
|-------------|-----------------------------|----------------------|--------------|----------------------------|--------------------------|---------------------------|--------------------------|
| <b>1996</b> | 61                          | -                    | 5            | -                          | 719                      | 887                       | 1006                     |
| <b>1997</b> | 3339                        | -                    | 21           | -                          | 318                      | 1088                      | 1255                     |
| <b>1998</b> | 2980                        | 2508                 | 22           | 1188                       | 697                      | 1131                      | 1354                     |
| <b>1999</b> | 2202                        | 2033                 | 24           | 1083                       | 810                      | 1151                      | 1340                     |
| <b>2000</b> | 5886                        | 5407                 | 28           | 1089                       | 289                      | 1139                      | 1401                     |
| <b>2001</b> | 3746                        | 3236                 | 28           | 1158                       | 699                      | 1142                      | 1343                     |

Table 7. Black dogfish size-weight parameters in the Spanish spring bottom trawl surveys in NAFO Div. 3NO.

|             | <b>N</b> | <b>a</b> | <b>b</b> |
|-------------|----------|----------|----------|
| <b>1997</b> | 166      | 0,0034   | 3,08     |
| <b>1999</b> | 212      | 0,0044   | 3,02     |
| <b>2000</b> | 683      | 0,0028   | 3,13     |
| <b>2001</b> | 735      | 0,0021   | 3,21     |

|             | <b>Males</b> |          |                      | <b>Females</b> |          |                      |
|-------------|--------------|----------|----------------------|----------------|----------|----------------------|
|             | <b>a</b>     | <b>b</b> | <b>r<sup>2</sup></b> | <b>a</b>       | <b>b</b> | <b>r<sup>2</sup></b> |
| <b>1997</b> | 0,0073       | 2,88     | 0,96                 | 0,0011         | 3,37     | 0,96                 |
| <b>1999</b> | 0,0146       | 2,72     | 0,89                 | 0,0018         | 3,25     | 0,92                 |
| <b>2000</b> | 0,0041       | 3,04     | 0,93                 | 0,0023         | 3,19     | 0,95                 |
| <b>2001</b> | 0,0044       | 3,02     | 0,94                 | 0,0016         | 3,28     | 0,96                 |

Table 8. Spinetail skate summary. (A) EU summer surveys Div. 3M and (B) the Spanish spring bottom trawl surveys in NAFO Div. 3NO.

(A)

|             | <b>Total catch<br/>(kg)</b> | <b>Total numbers</b> | <b>Hauls</b> | <b>Mean weight<br/>(g)</b> | <b>Min depth<br/>(m)</b> | <b>Mean depth<br/>(m)</b> | <b>Max depth<br/>(m)</b> |
|-------------|-----------------------------|----------------------|--------------|----------------------------|--------------------------|---------------------------|--------------------------|
| <b>1988</b> | 265                         | 32                   | 25           | 8291                       | 229                      | 425                       | 712                      |
| <b>1989</b> | 103                         | 28                   | 16           | 3668                       | 178                      | 454                       | 699                      |
| <b>1990</b> | 160                         | 41                   | 26           | 3895                       | 161                      | 342                       | 647                      |
| <b>1991</b> | 144                         | 32                   | 21           | 4492                       | 301                      | 508                       | 709                      |
| <b>1992</b> | 167                         | 26                   | 15           | 6382                       | 354                      | 469                       | 717                      |
| <b>1993</b> | 152                         | 42                   | 22           | 3620                       | 149                      | 458                       | 651                      |
| <b>1994</b> | 128                         | 23                   | 18           | 5518                       | 299                      | 471                       | 713                      |
| <b>1995</b> | 68                          | 20                   | 15           | 3383                       | 258                      | 482                       | 720                      |
| <b>1996</b> | 116                         | 24                   | 17           | 4826                       | 316                      | 463                       | 687                      |
| <b>1997</b> | 85                          | 15                   | 13           | 5665                       | 319                      | 479                       | 719                      |
| <b>1998</b> | 63                          | 14                   | 11           | 4488                       | 301                      | 477                       | 614                      |
| <b>1999</b> | 92                          | 24                   | 18           | 3847                       | 332                      | 517                       | 714                      |
| <b>2000</b> | 42                          | 17                   | 17           | 2454                       | 281                      | 422                       | 631                      |
| <b>2001</b> | 126                         | 27                   | 18           | 4677                       | 282                      | 444                       | 702                      |

(B)

|             | <b>Total Catch<br/>(kg)</b> | <b>Total numbers</b> | <b>Hauls</b> | <b>Mean weight<br/>(g)</b> | <b>Min depth<br/>(m)</b> | <b>Mean depth<br/>(m)</b> | <b>Max depth<br/>(m)</b> |
|-------------|-----------------------------|----------------------|--------------|----------------------------|--------------------------|---------------------------|--------------------------|
| <b>1997</b> | 1                           | -                    | 1            | -                          | 318                      | 318                       | 318                      |
| <b>1998</b> | 228                         | -                    | 13           | -                          | 660                      | 971                       | 1354                     |
| <b>1999</b> | 504                         | -                    | 24           | -                          | 548                      | 1063                      | 1340                     |
| <b>2000</b> | 214                         | -                    | 21           | -                          | 531                      | 925                       | 1391                     |
| <b>2001</b> | 258                         | -                    | 19           | -                          | 558                      | 1069                      | 1335                     |

Table 9. Spinetail skate size-weight parameters in the EU summer surveys Div. 3M.

|              | <b>N</b> | <b>a</b> | <b>b</b> |
|--------------|----------|----------|----------|
| <b>1990</b>  | 6        | 0.0062   | 3.03     |
| <b>1993</b>  | 13       | 0.0046   | 3.05     |
| <b>1994</b>  | 19       | 0.0050   | 3.04     |
| <b>1995</b>  | 17       | 0.0058   | 3.00     |
| <b>1996</b>  | 17       | 0.0033   | 3.13     |
| <b>1997</b>  | 4        | 0.0028   | 3.16     |
| <b>1998</b>  | 14       | 0.0024   | 3.19     |
| <b>1999</b>  | 36       | 0.0090   | 2.87     |
| <b>2000</b>  | 20       | 0.0027   | 3.16     |
| <b>2001</b>  | 36       | 0.0034   | 3.13     |
| <b>total</b> | 182      | 0.0042   | 3.07     |

Table 10. Other elasmobranch sampling summary in the EU summer surveys Div. 3M: 1988-01 (A) and the Spanish spring bottom trawl surveys in NAFO Div. 3NO: 1995-01 (B).

(A)

| specie                          |      | Total catch<br>(kg) | Total<br>numbers | Hauls | Mean weight<br>(kg) | Min depth<br>(m) | Mean depth<br>(m) | Max depth<br>(m) |
|---------------------------------|------|---------------------|------------------|-------|---------------------|------------------|-------------------|------------------|
| <i>Squalus<br/>acanthias</i>    | 1988 | 2.45                | 1                | 1     | 2450                | 249              | 249               | 249              |
|                                 | 1991 | 1.75                | 1                | 1     | 1750                | 259              | 259               | 259              |
|                                 | 1992 | 1.38                | 1                | 1     | 1380                | 431              | 431               | 431              |
|                                 | 1993 | 1.96                | 1                | 1     | 1955                | 246              | 246               | 246              |
|                                 | 1994 | 1.93                | 1                | 1     | 1930                | 279              | 279               | 279              |
|                                 | 1996 | 1.50                | 1                | 1     | 1500                | 237              | 237               | 237              |
|                                 | 1997 | 3.33                | 2                | 2     | 1663                | 264              | 370               | 476              |
|                                 | 1998 | 4.11                | 2                | 2     | 2055                | 270              | 289               | 307              |
|                                 | 1999 | 2.20                | 1                | 1     | 2200                | 276              | 276               | 276              |
|                                 | 2000 | 7.02                | 4                | 4     | 1754                | 243              | 321               | 408              |
| <i>Etmopterus<br/>princeps</i>  | 1988 | 4.70                | 4                | 1     | 1175                | 653              | 653               | 653              |
|                                 | 1991 | 1.47                | 3                | 1     | 490                 | 681              | 681               | 681              |
|                                 | 1992 | 9.75                | 13               | 1     | 750                 | 717              | 717               | 717              |
|                                 | 1994 | 4.00                | 4                | 1     | 1000                | 691              | 691               | 691              |
|                                 | 1995 | 3.12                | 1                | 1     | 3120                | 697              | 697               | 697              |
| <i>Malacoraja<br/>senta</i>     | 1988 | 13.86               | 28               | 17    | 495                 | 166              | 262               | 468              |
|                                 | 1991 | 15.19               | 11               | 8     | 1381                | 195              | 304               | 709              |
|                                 | 1992 | 21.99               | 6                | 6     | 3665                | 269              | 398               | 497              |
|                                 | 1993 | 5.40                | 8                | 5     | 674                 | 246              | 435               | 612              |
|                                 | 1994 | 3.01                | 3                | 3     | 1003                | 176              | 225               | 286              |
|                                 | 1995 | 7.18                | 5                | 5     | 1436                | 182              | 280               | 337              |
|                                 | 1996 | 5.23                | 4                | 3     | 1308                | 165              | 234               | 269              |
|                                 | 1997 | 4.46                | 4                | 4     | 1115                | 175              | 246               | 326              |
|                                 | 1998 | 3.05                | 3                | 3     | 1015                | 168              | 261               | 323              |
|                                 | 1999 | 1.98                | 2                | 2     | 990                 | 243              | 261               | 280              |
|                                 | 2000 | 4.12                | 6                | 6     | 686                 | 213              | 290               | 321              |
| 2001                            | 6.61 | 6                   | 5                | 1178  | 245                 | 366              | 706               |                  |
| <i>Dipturus<br/>lincea</i>      | 1992 | 1.90                | 1                | 1     | 1900                | 717              | 717               | 717              |
|                                 | 1993 | 9.36                | 7                | 3     | 1337                | 646              | 686               | 738              |
|                                 | 1994 | 3.94                | 4                | 4     | 985                 | 286              | 340               | 441              |
|                                 | 1997 | 1.55                | 2                | 2     | 775                 | 679              | 699               | 719              |
| <i>Amblyraja<br/>hyperborea</i> | 1999 | 2.10                | 1                | 1     | 2100                | 628              | 628               | 628              |
|                                 | 2001 | 5.60                | 1                | 1     | 5600                | 707              | 707               | 707              |
| <i>Rajella<br/>fyllae</i>       | 1994 | 0.65                | 1                | 1     | 650                 | 442              | 442               | 442              |
|                                 | 1998 | 1.11                | 2                | 2     | 555                 | 386              | 548               | 709              |
|                                 | 2000 | 0.31                | 1                | 1     | 310                 | 511              | 511               | 511              |
|                                 | 2001 | 1.53                | 4                | 3     | 381                 | 469              | 478               | 485              |

(B)

| specie                          |      | Total catch<br>(kg) | Total<br>numbers | Hauls | Mean weight<br>(kg) | Min depth<br>(m) | Mean depth<br>(m) | Max depth<br>(m) |
|---------------------------------|------|---------------------|------------------|-------|---------------------|------------------|-------------------|------------------|
| <i>Apristurus<br/>spp</i>       | 2000 | 152                 | 97               | 12    | 1567                | 864              | 1187              | 1401             |
|                                 | 2001 | 218                 | -                | 20    | -                   | 682              | 1167              | 1343             |
| <i>Amblyraja<br/>hyperborea</i> | 2000 | 482                 | -                | 14    | -                   | 920              | 1186              | 1401             |
|                                 | 2001 | 177                 | -                | 18    | -                   | 840              | 1218              | 1343             |
| <i>Harriota<br/>raleighana</i>  | 2000 | 434                 | -                | 20    | -                   | 373              | 1143              | 1401             |
|                                 | 2001 | 441                 | -                | 22    | -                   | 831              | 1158              | 1343             |

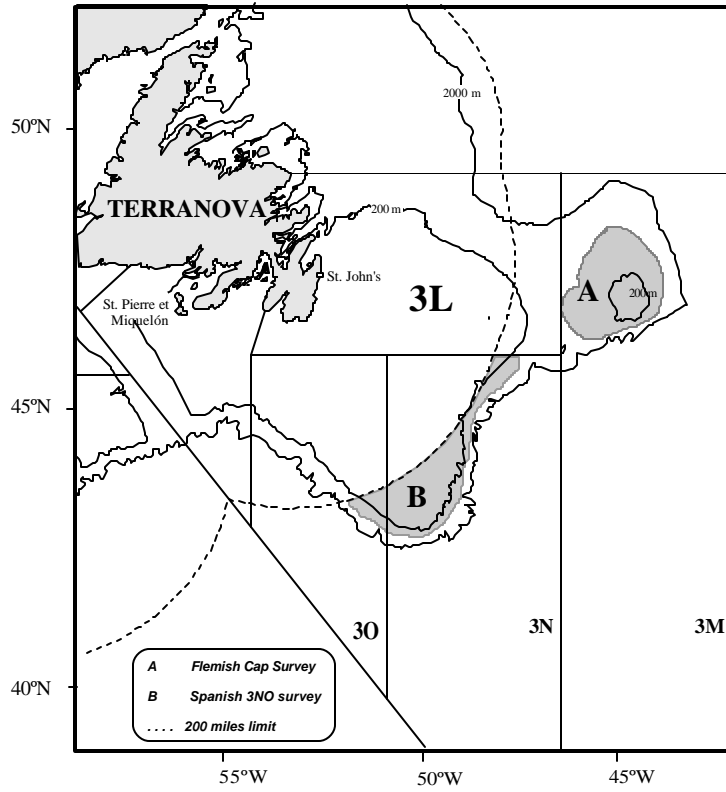


Fig. 1. Maps showing the study areas. Depths in m.

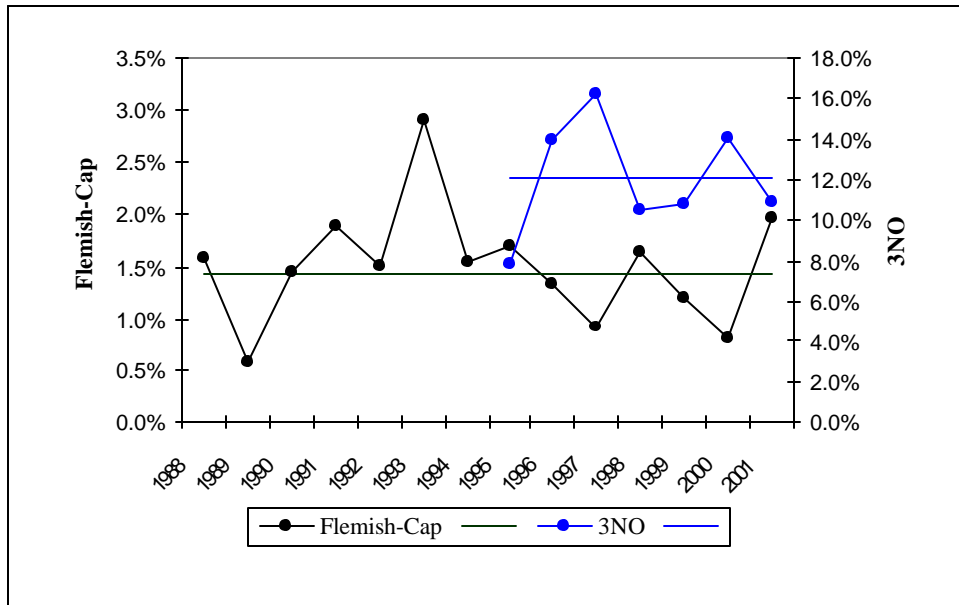
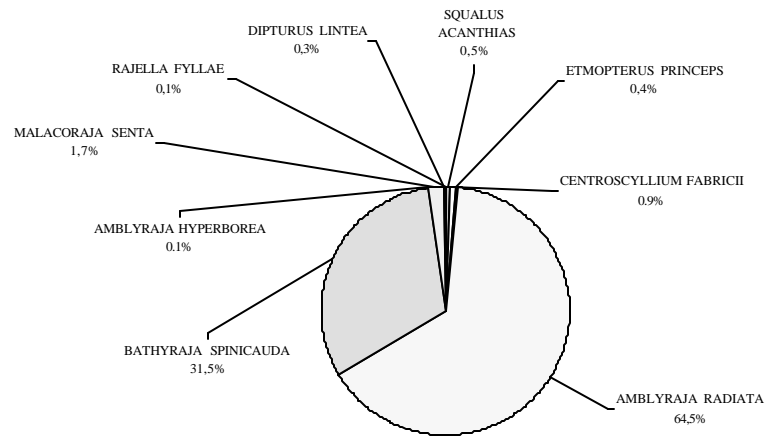


Fig. 2. Year elasmobranch proportions related with total catch.

(A)



(B)

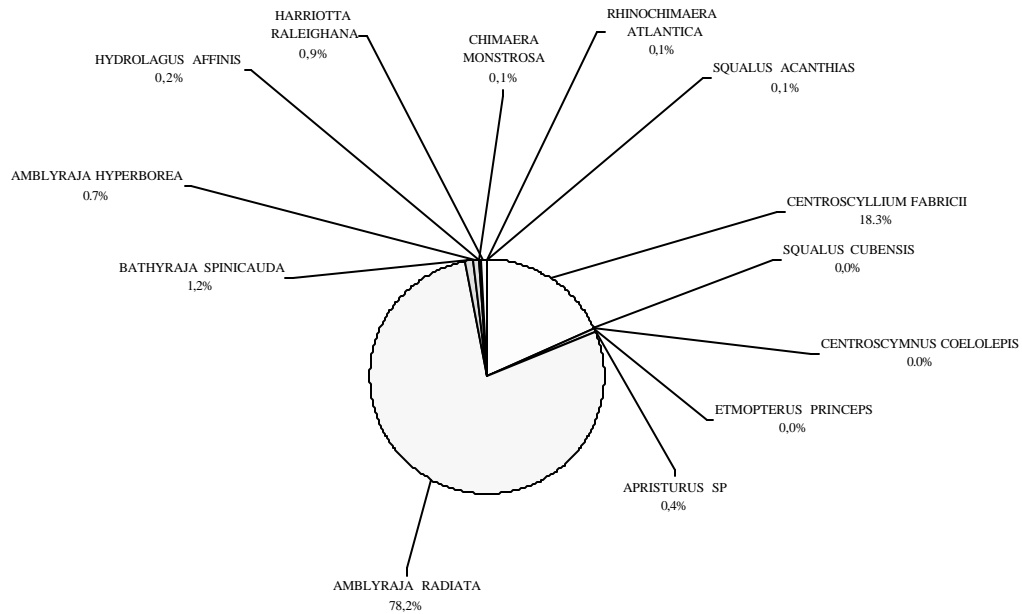
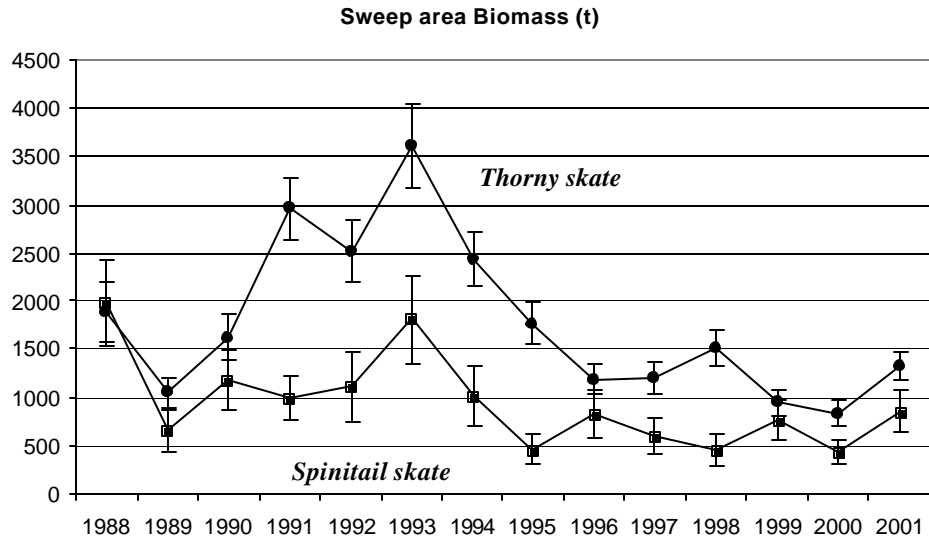


Fig. 3. Elasmobranch proportions (in weight) in the EU summer surveys in Div. 3M, (A) and the Spanish spring bottom trawl surveys in NAFO Div. 3NO (B).

(A)



(B)

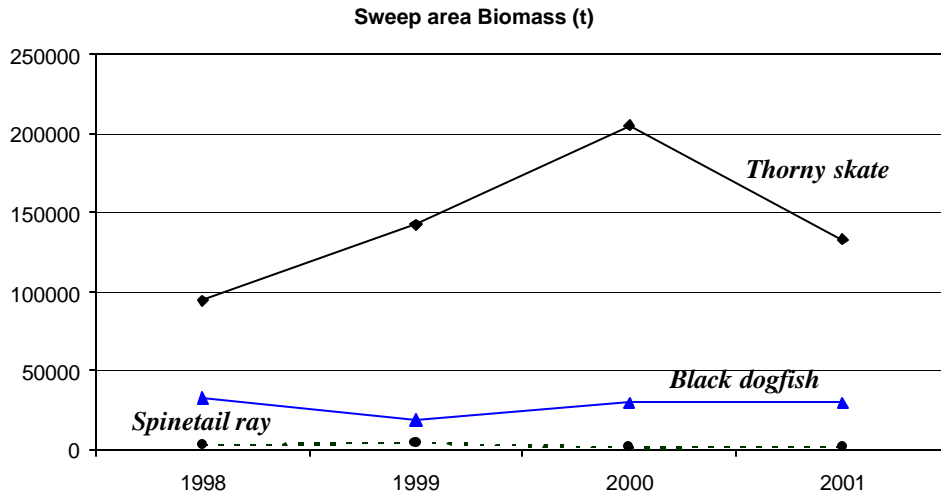


Fig. 4. Biomass indexes (tons) in the EU summer surveys in Div. 3M: 1988-01 (A) and the Spanish spring bottom trawl surveys in NAFO Div. 3NO: 1998-01 (B).

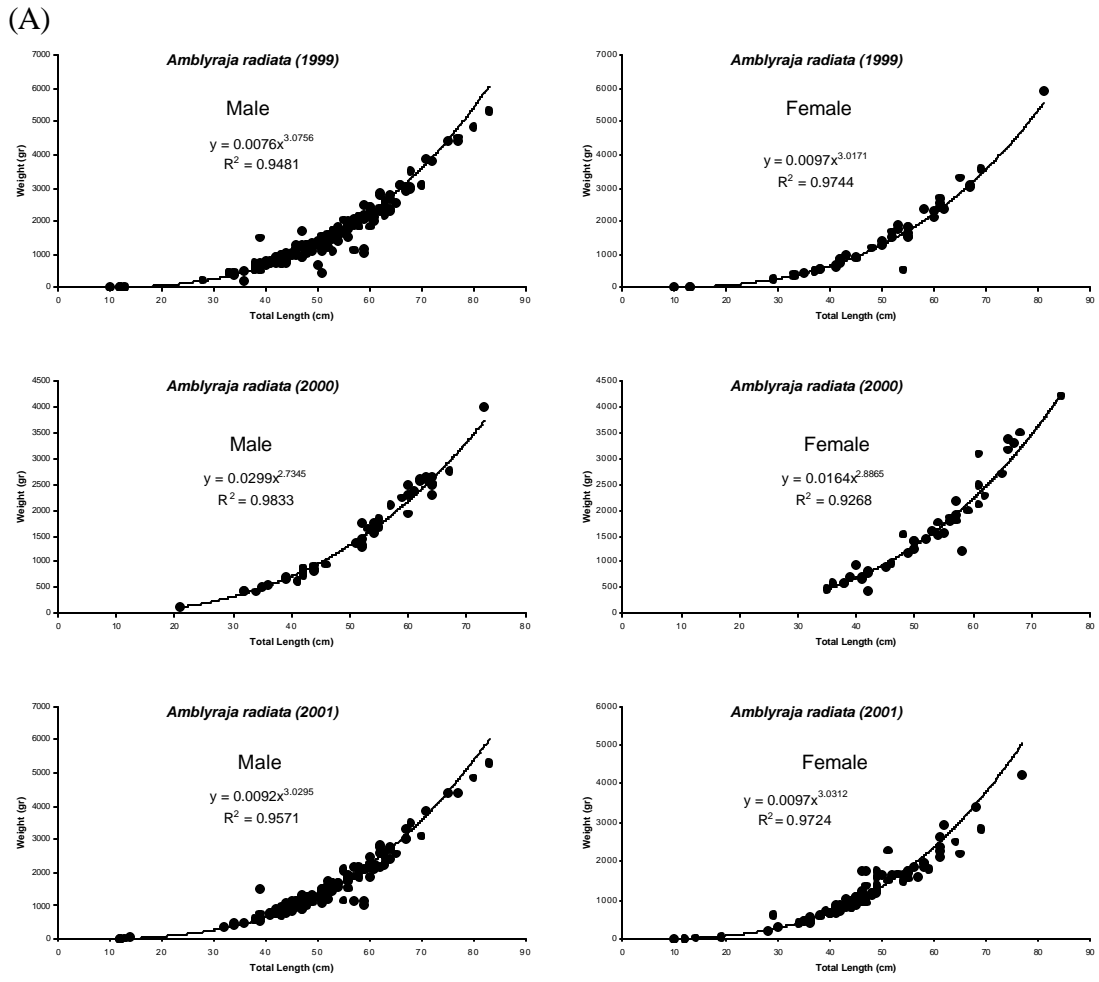


Fig. 5a. Thorny skate length-weight relationship by sex in the UE summer bottom trawl surveys.



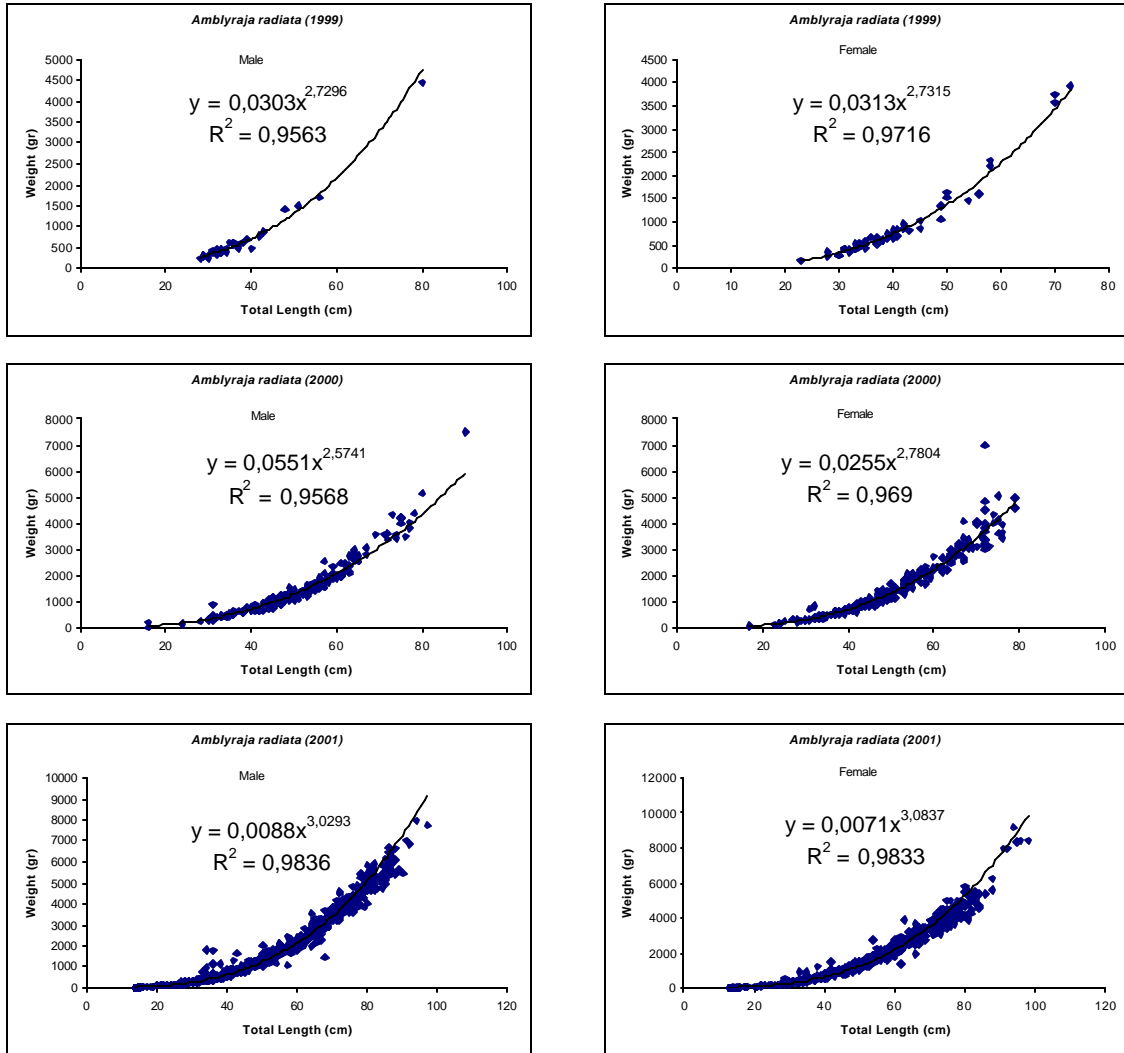


Fig. 5b. Thorny skate length-weight relationship by sex. Spanish spring bottom trawl surveys in Div. 3NO.

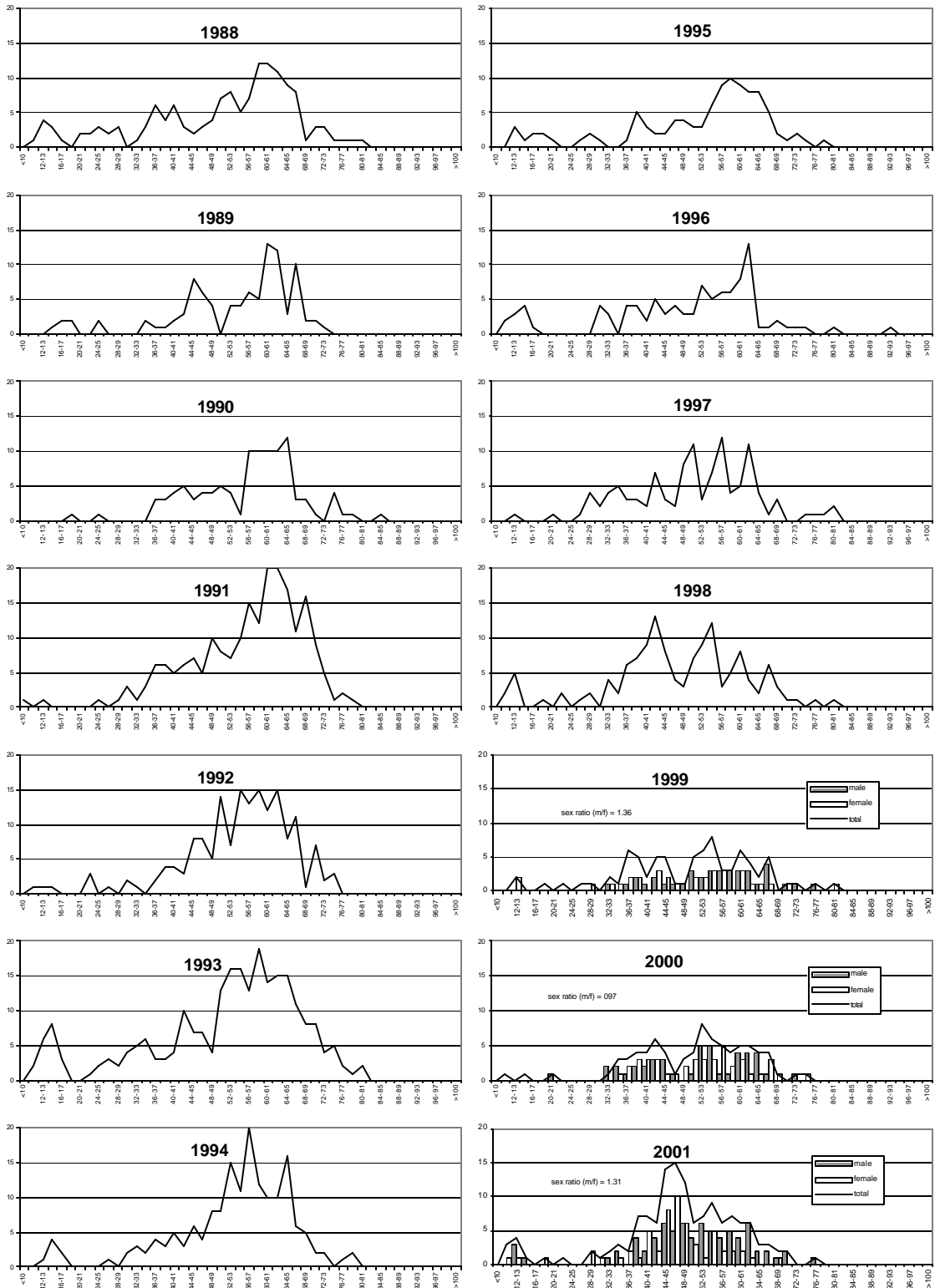


Fig. 6a. Length distribution of thorny skate in the UE summer bottom trawl surveys: 1988-2001. (absolute frequencies).

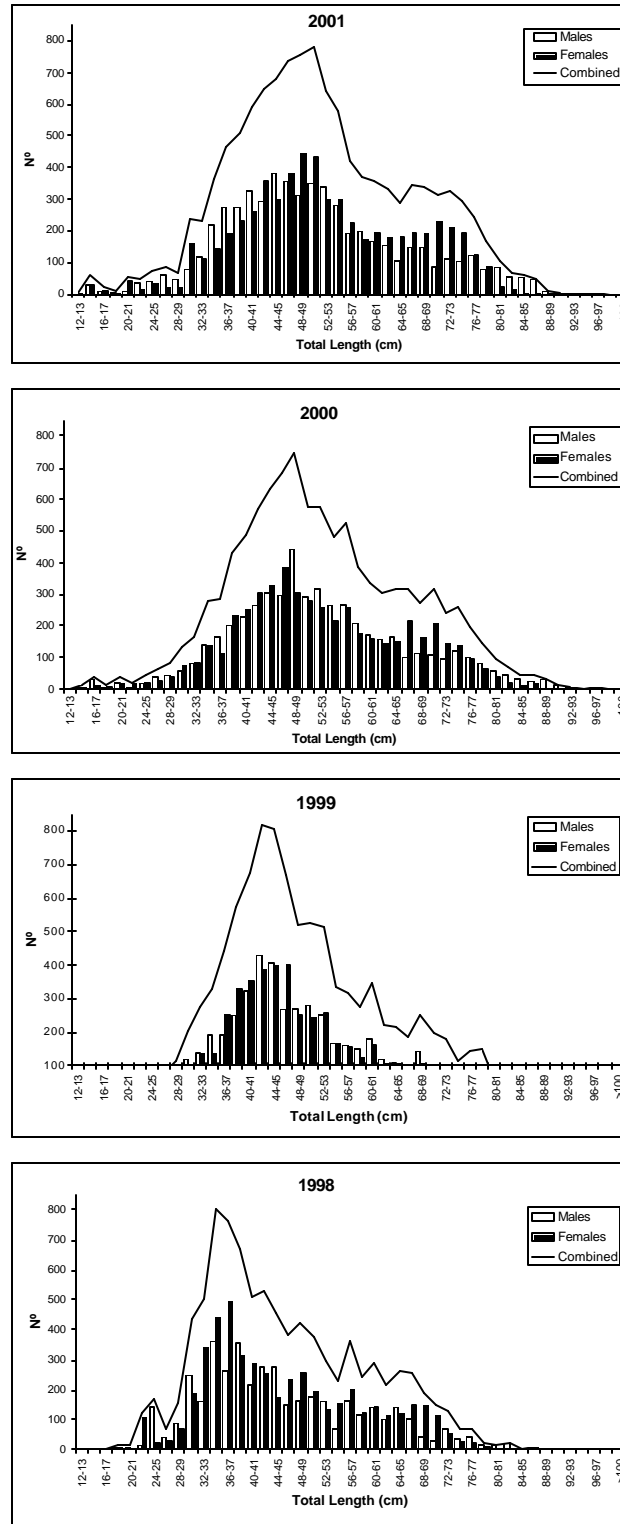


Fig. 6b. Length distribution of thorny skate. Spanish spring bottom trawl surveys: 1998-2001.

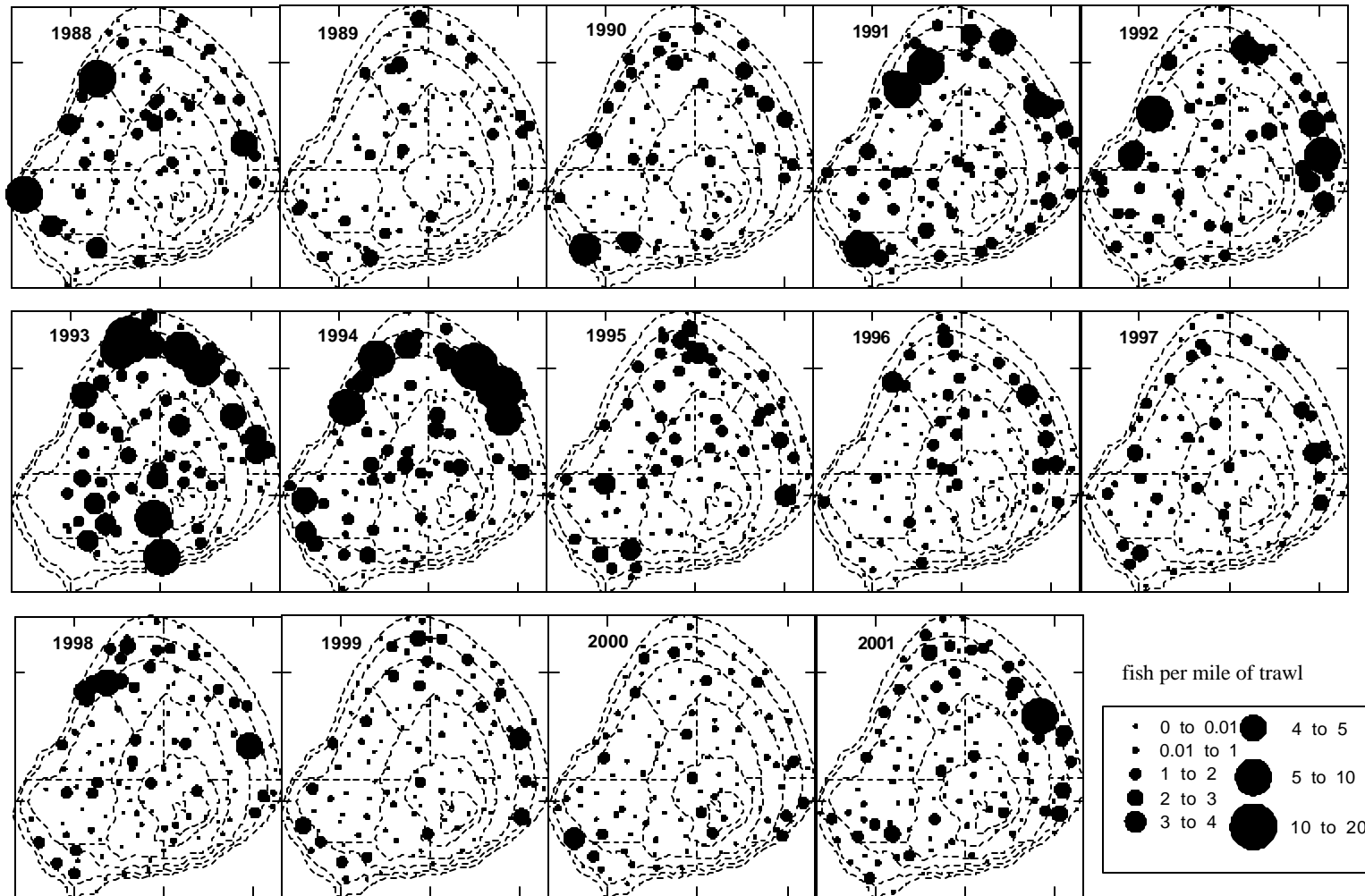


Fig. 7a. Thorny skate spatial distribution in the UE summer bottom trawl surveys: 1988-2001.

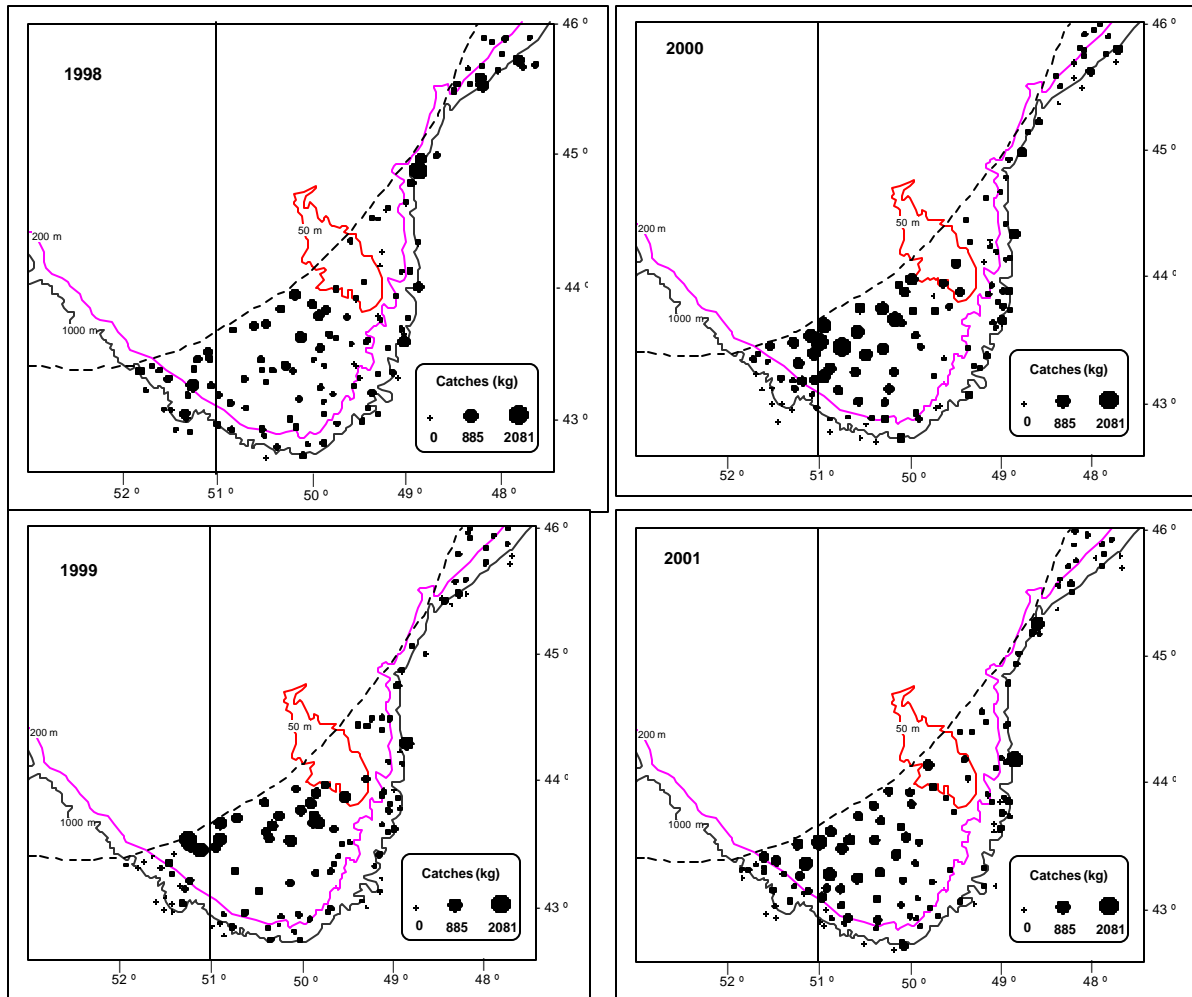


Fig. 7b. Catch distribution of thorny skate performed during Spanish spring bottom trawl. Surveys in NAFO Div. 3NO: 1998 – 2001. Symbols represent catch in weight (Kg) per tow (Root Square scale).

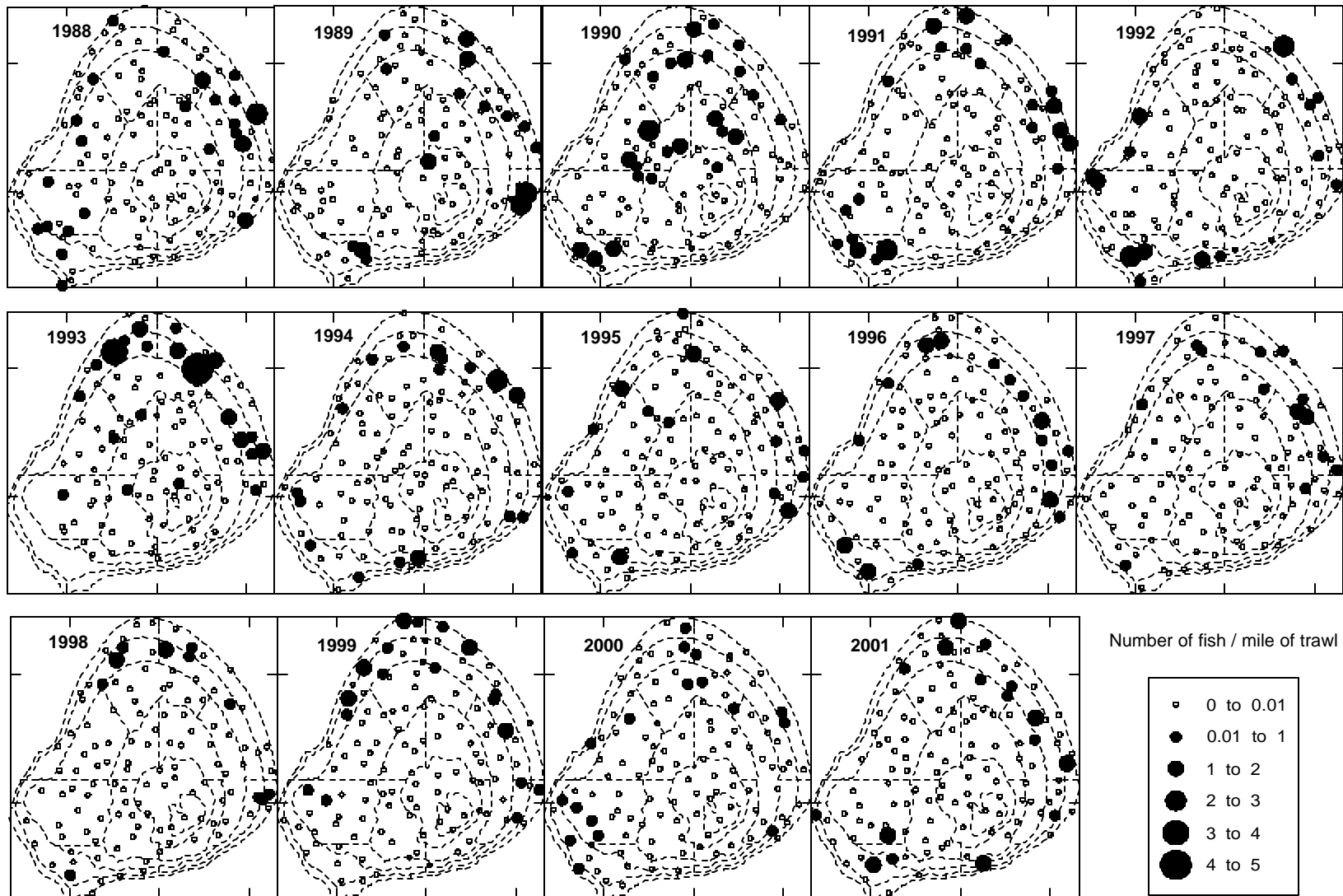


Fig. 8. Spinetail skate spatial distribution in the UE summer bottom trawl surveys: 1988-2001.

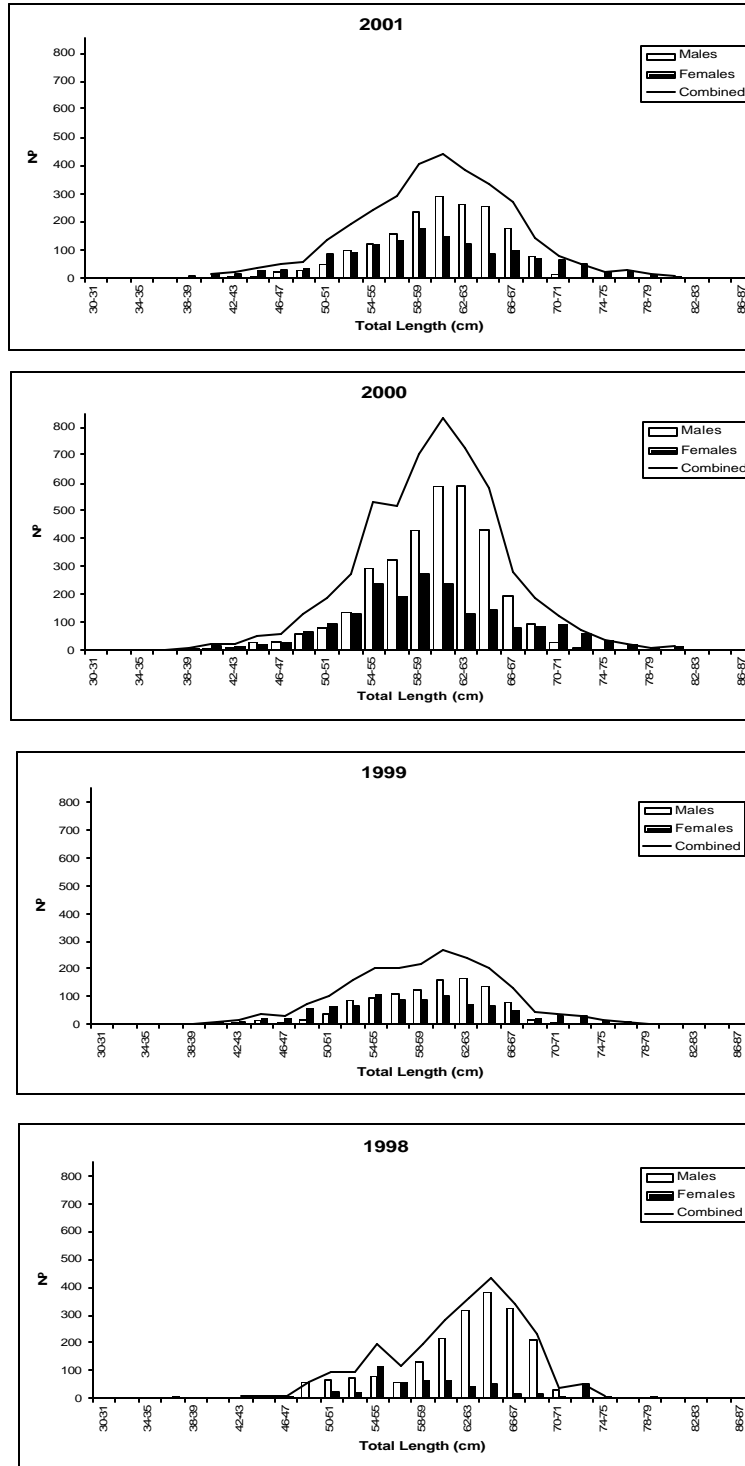


Fig. 9. Length distribution of black dogfish. Spanish spring bottom trawl surveys: 1998-2001.

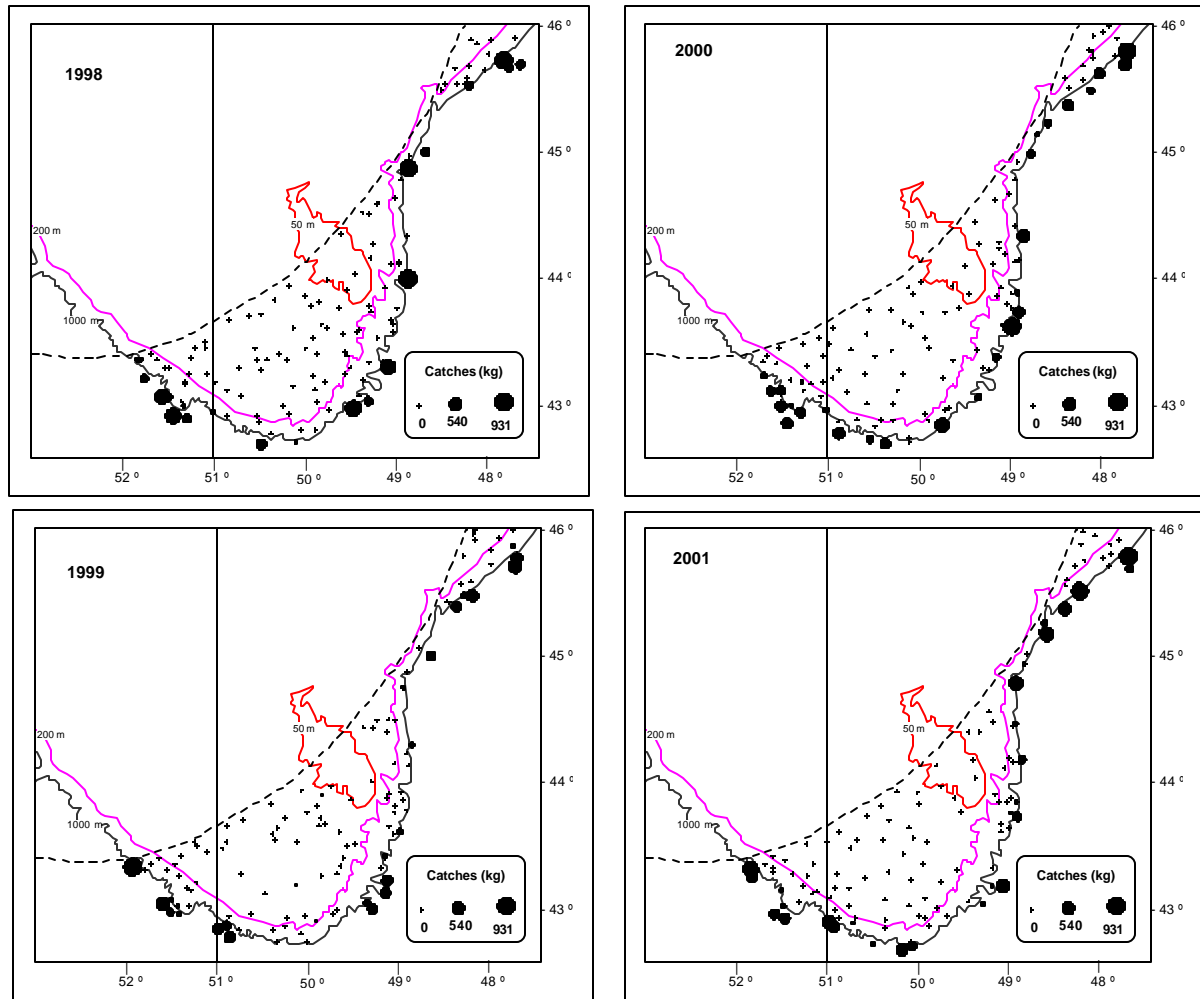


Fig. 10. Catch distribution of black dogfish performed during Spanish spring bottom trawl surveys in NAFO Div. 3NO: 1998-2001. Symbols represent catch in weight (Kg) per tow (Root Square scale).