

NOT TO BE CITED WITHOUT PRIOR
REFERENCE TO THE SECRETARIAT

Northwest Atlantic



Fisheries Organization

Serial No. N5132

NAFO SCR Doc. 05/46

SCIENTIFIC COUNCIL MEETING – JUNE 2005

Roughhead Grenadier NAFO Subareas 2 and 3 Age Disaggregate Data (1992-2003)

by

F. González¹ and H. Murua²

¹ Instituto Español de Oceanografía

² AZTI TECNALIA, Herrera Kaia, Portualde z/g, 20110 Pasaia, Basque Country (Spain)

fernando.gonzalez@vi.ieo.es

hmurua@pas.azti.es

Abstract

The aim of this document is to compile all available information for the stock of roughhead grenadier in NAFO Subareas 2 and 3 which in turn will allow carry out an age disaggregate assessment in the future.

This document present the catch at age matrix as well as mean weights and lengths by age of roughhead grenadier in NAFO Subareas 2 and 3 between 1992 and 2003, resulting of applying the Spanish ALK available to the national catches length distributions.

We have also transformed the Spanish 3NO survey length distributions in age distributions applying a mix ALK (3M survey and catches ALK).

Introduction

The roughhead grenadier (*Macrourus berglax* Lacépède, 1802) is an abundant and widespread fish species in the north Atlantic and is usually found both on the shelf and on the continental slope (Scott and Scott, 1988; Savvatimsky, 1994). It is predominant in depths ranging from 400 to 1 200 m, although they may inhabit depths between 200-2 000 m (Snelgrove and Haedrich, 1985; de Cardenas *et al.*, 1996). It has, however, been found in depths up to 2 700 m (Wheeler, 1969).

The fishery for roughhead grenadier is unregulated as it has been mainly taken as by-catch in Greenland halibut fishery. However, roughhead grenadier is becoming an important commercial fish in NAFO Regulatory Area and reliable information is needed for its assessment. Catches of roughhead grenadier increased sharply from 1989 (333 tons) to 1990 (3 244 tons), since then total catches has been about 4 000 tons and increased 7 200 tons in 1998 remaining at this level in 1999. The catches decreased to about 4 000 tons in 2003 (NAFO, 2004).

With the catches of roughhead grenadier increasing in the most recent years, rising to historic maximum levels, it has been recognised that reliable information is needed to properly monitor and assess the status of this “new” resource. This is even more important as the collapse of traditional groundfish fisheries and the decrease in the abundance of other fish resources of the area continue.

The aim of this document is to compile all the available information for the stock of roughhead grenadier in NAFO Subareas 2 and 3. As well the objective is to prepare the necessary inputs (catch-at-age matrix, mean weight and length by age, maturity ogive, etc.) that allow us to carry out an analytic assessment in the future.

Materials, Methods and Results

Total catch numbers by age and year with their mean weights and length by age

The revised catch history by country for this stock from 1991 to 2003 is presented in Table 1.

Roughhead length frequencies by sex from the Spanish, Portuguese (R. Alpoim personal communication) and Russian (K. Gorchinsky, personal communication) trawl catches in Div. 3LMNO are available for different years. The Spanish and Portuguese length frequencies measured the length as preanal fin lengths (AFL) while the Russian ones are estimated as total lengths. The latter were converted to AFL using the Total Length/AFL relationship presented by Murua and Motos (1997). Table 2 shows the length distributions available by country and year.

The age structure of roughhead grenadier was estimated from otolith readings of specimens captured in NAFO Div.3LMN. Validation of age estimates derived from otolith reading was presented by Rodríguez Marín *et al.* (2002). Table 2 shows the years when ALK information were available, it should be mentioned that only Age Length Key (ALK) by sex of the Spanish catches were available.

Parameter values of the length-weight relationship by sex for roughhead grenadier, from the catches were available for Portugal (Alpoim, 2004) and Spain. In the Spanish case, there is available a constant value which were applied to both sexes and all years. In the Russian case we used the Portugal parameters. Table 3 shows the values of the parameters of the length-weight relationship in the form $W = a * AFL^b$.

The way to calculate the total catches length distribution by country was the following. For each country, when there was length frequencies by sex and Division, these frequencies were raised to the catches of the Divisions and after, all Divisions were added to have the each country total catch length distribution by sex and year (Tables 4, 5 and 6).

Only 1999, 2000, 2002 and 2003 Spanish catches ALK were available, for the years where ALK information were not available we apply a combined ALK by sex based on all the available data. The process to convert the total catches length distributions by sex and country in age distributions was the following. The Spanish ALK by sex and year was apply to the respective total length distribution by sex, year and country and then both sexes were added to have the age distributions by country and year. In this process mean weight and mean length by age, year and country were also calculated and presents in Tables 7, 8 and 9.

For each year the available national catch age distributions were added and they were risen to the SC total catch estimate of that year to get the total catch numbers by age and year as well as the associated mean weights and length by age. These results are presented in Table 10 and Fig. 1 and 2.

Flemish Cap Survey Ages Abundance Indices

The new Flemish Cap transformed survey series by age is presented in Murua and González, 2005.

Spanish 3NO Survey Ages Abundance Indices

The Spanish 3NO Survey length abundance indices between 1997 and 2004 (González-Troncoso, 2005) were transformed in age abundances applying the Flemish Cap ALKs for lengths between 0 and 24 cm and the Spanish commercial catches ALKs for lengths bigger than 24 cm. In 1997 and 1998 the 1999 Spanish commercial ALK was applied and in 2001 the 2002 one. The reason of applying a mix ALK was that Flemish Cap survey only cover the shallowest part of the bank (up to 700 m) while the roughhead grenadiers is distributed well beyond up to 2000 m (Murua and De Cárdenas, in press). We have chosen to use the survey ALK for lengths <24 cm to avoid the bias in the transformation due to the partial selection of individuals smaller than that length in the commercial ALK. The total abundance by age and year and MNPT of the Spanish 3NO Survey is presented in Table 11.

Maturity Ogive

Information about maturity was available from Russia (K. Gorchinsky, pers. com.) and Spain (Murua, 2003). The Russia information is based on macroscopical staging and is available by length, sex and year (1996-2004) while the Spanish was estimated microscopically for females only by length and age based upon samples collected between 1998-2000 in Flemish Cap and Flemish Pass.

References

- ALPOIM, R. and J. VARGAS. 2004. Length-weight relationships of the Portuguese commercial catches in NAFO, 1998-2003. *NAFO SCR Doc.*, No. 40, Serial No. N4991, 9 p.
- DE CARDENAS, E., J. M. CASAS, R. ALPOIM, and H. MURUA. 1996. Preliminary Results of the european Long-line Survey in the NAFO Regulatory Area. *NAFO SCR Doc.*, No. 34 Serial No N2709, 6 p.
- GONZALEZ-TRONCOSO, D, X. PAZ, and F. GONZÁLEZ. 2005. Results for the Roughead grenadier from the Spanish Surveys conducted in the NAFO Regulatory Area in Divisions 3NO, 1997-2004. *NAFO SCR Doc.*, No. 28, Serial No. N5114, 18 p.
- MURUA, H., and L. MOTOS. 1997. Reproductive biology of roughhead grenadier, *Macrurus berglax* in NAFO Divisions 3MNL. *NAFO SCR Doc.*, No. 20
- MURUA, H. 2003. Population structure, growth and reproduction of roughhead grenadier on the Flemish Cap and Flemish Pass. *J. Fish Biol.*, **63**: 356–373.
- MURUA, H., and F GONZÁLEZ. 2004. A review on roughhead grenadier (*Macrourus berglax*) biology and population structure on Flemish Cap (NAFO Division 3M) 1991-2003 based upon EU Flemish Cap bottom survey Data. *NAFO SCR Doc.*, No. 14 Serial No N4961, 19 p.
- RODRÍGUEZ-MARÍN, E., M. RUIZ, and A. SARASUA. 2002. Validation of roughhead grenadier (*Macrourus berglax*) otolith reading. *J. Appl. Ichthyology*, **18**: 70-80.
- SAVVATIMSKY P.I. 1994. Age Structure of of Roughhead Grenadier (*Macrourus berglax*) in the Northwest Atlantic, 1985. *NAFO Sci. Coun. Studies*, **20**: 53-64.
- SCOTT, W. B., and M. G. SCOTT. 1988. Atlantic fishes of Canada. *Can Bull. Fish. Aquat. Sci.*, **219**, 731 p.
- SNELGROVE, P. V. R., and R. L. HAEDRICH. 1985. Structure of the deep demersal fish-fauna off Newfoundland. *Mar. Ecol. Prog. Ser.*, **27**: 99-107
- WHEELER, A. 1969. The fishes of the British Isles and Northwest Europe: Anacanthini (p. 255.259). MacMillan and Co. Ltd., London England, 613 p.

Table 1. Recent nominal catches (t.) for roughhead grenadier in Subarea 2+3.

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 ^a | 2000 | 2001 | 2002 | 2003 ^d |
|------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|------|-----------------|-------------------|------|------|------|-------------------|
| Canada | 215 | 595 | 345 | 79 | 84 | | 240 | 39 | 108 | 201 | 164 | 244 | 182 |
| EU-ESP | | 4125 ^b | 2054 ^b | 1720 ^b | 2502 ^b | 3090 ^b | 3738 | 6050 | 5704 | 3948 | 2562 | 2588 | 3097 |
| EU-PRT | 4053 ^b | 2000 ^b | 1969 ^b | 2223 ^b | 1402 ^b | 784 ^b | 762 | 1089 | 1299 | 396 | 241 | 438 | 461 |
| Russia | | | | | | | | 92 ^c | 49 | 211 | 150 | 228 | 116 |
| Japan | | | | | | | | | | | | 120 | 5 |
| Estonia | | | | | | | | | | 1 | | 25 | 93 |
| Lithuania | | | | | | | | | | 1 | | | |
| Norway | | | | | | | | | | | | | 30 |
| Others | | 5 | 27 | 2 | | 4 | | | | | | | |
| TOTAL | 4268 | 6725 | 4395 | 4023 | 3982 | 4135 | 4740 | 7270 | 7160 | 4767 | 3117 | 3657 | 3984 |

^a Provisional.

^b First reported as roundnose grenadier.

^c Reported as roundnose grenadier in STATLANT 21A.

^d In 2003, STACFIS could not precisely estimate the catch.

Table 2 Roughhead grenadier data of catches length distributions and ALK available in the period 1992-2003.

| Country | Data | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|----------|-------------|----------------|------|------|------|------|------|------|------|------|------|------|------|
| Spain | Length Dis. | X ¹ | X | X | X | X | X | X | X | X | X | X | X |
| Portugal | Length Dis. | X ¹ | | | X | X | X | X | X | X | X | X | X |
| Russia | Length Dis. | | | | | | | X | X | X | X | X | X |
| Spain | ALK | | | | | | | | X | X | | X | X |

¹ Sex Combined.

Table 3. Length-weight relationship parameters by years and country as well as the value of R^2 .

| Year | Sex | Portugal | | |
|------|-------|----------|--------|--------|
| | | a | b | R^2 |
| 1998 | F | 0,3457 | 2,7070 | 0,9947 |
| | M | 0,4407 | 2,6036 | 0,9934 |
| | Total | 0,3510 | 2,6959 | 0,9949 |
| 1999 | F | 0,2505 | 2,8735 | 0,9977 |
| | M | 0,1374 | 3,0938 | 0,9966 |
| | Total | 0,2137 | 2,9229 | 0,9975 |
| 2000 | F | 0,1757 | 2,9816 | 0,9933 |
| | M | 0,1368 | 3,0894 | 0,9958 |
| | Total | 0,1752 | 2,9822 | 0,9962 |
| 2001 | F | 0,1747 | 2,9563 | 0,9975 |
| | M | 0,1037 | 3,1441 | 0,9903 |
| | Total | 0,1514 | 3,0005 | 0,9974 |
| 2002 | F | 0,3364 | 2,7548 | 0,9936 |
| | M | 0,4964 | 2,5873 | 0,9952 |
| | Total | 0,3409 | 2,7480 | 0,9941 |
| 2003 | F | 0,6888 | 2,5123 | 0,9946 |
| | M | 0,6794 | 2,4713 | 0,9950 |
| | Total | 0,6148 | 2,5461 | 0,9943 |
| All | Both | Spain | | |
| | | a | b | |
| | | 0,1139 | 2,8921 | |

Table 5 (cont.). Roughhead grenadier Portugal Div. 3LMNO total catches length distributions by sex and year.

| LENGTH GROUP | 2000 | | | | 2001 | | | | 2002 | | | | 2003 | | | | |
|------------------------|---------------------|--------|---|--------|---------------------|--------|---|--------|---------------------|--------|----|--------|---------------------|--------|-----|---------|-----|
| | Total Catches 3LMNO | | | Total | Total Catches 3LMNO | | | Total | Total Catches 3LMNO | | | Total | Total Catches 3LMNO | | | Total | |
| | M | F | I | | M | F | I | | M | F | I | | M | F | I | | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 0 | 18 | 712 | 226 | 0 | 938 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 196 | 22 | 0 | 218 | 168 | 304 | 0 | 472 |
| 6 | 100 | 135 | 0 | 235 | 16 | 10 | 0 | 26 | 164 | 137 | 0 | 301 | 1292 | 980 | 0 | 2272 | |
| 7 | 2395 | 1251 | 0 | 3646 | 990 | 462 | 0 | 1452 | 754 | 1215 | 0 | 1969 | 8797 | 6080 | 0 | 14876 | |
| 8 | 15729 | 9703 | 0 | 25432 | 5136 | 3808 | 0 | 8944 | 6093 | 3281 | 0 | 9374 | 8491 | 10003 | 0 | 18494 | |
| 9 | 47907 | 43456 | 0 | 91363 | 25220 | 16752 | 0 | 41971 | 24677 | 13411 | 0 | 38088 | 30681 | 17333 | 0 | 48014 | |
| 10 | 93241 | 79081 | 0 | 172323 | 60586 | 44863 | 0 | 105449 | 66618 | 44107 | 0 | 110725 | 73691 | 54901 | 0 | 128592 | |
| 11 | 91332 | 73673 | 0 | 165006 | 59803 | 47007 | 0 | 106810 | 84360 | 64331 | 0 | 148691 | 97275 | 63301 | 0 | 160576 | |
| 12 | 108591 | 89240 | 0 | 197831 | 59082 | 48970 | 0 | 108052 | 99444 | 85999 | 0 | 185444 | 114688 | 104929 | 0 | 219617 | |
| 13 | 73838 | 70430 | 0 | 144269 | 46475 | 43748 | 0 | 90223 | 71906 | 63964 | 0 | 135870 | 77288 | 73044 | 0 | 150332 | |
| 14 | 42768 | 39454 | 0 | 82222 | 29493 | 30522 | 0 | 60015 | 45010 | 48837 | 0 | 93847 | 47146 | 50340 | 0 | 97485 | |
| 15 | 19335 | 17930 | 0 | 37264 | 14823 | 14713 | 0 | 29536 | 39352 | 31652 | 0 | 71004 | 31705 | 31936 | 0 | 63641 | |
| 16 | 6378 | 9612 | 0 | 15990 | 6055 | 8790 | 0 | 14845 | 22870 | 23762 | 0 | 46632 | 23555 | 26159 | 0 | 49714 | |
| 17 | 5210 | 8644 | 0 | 13854 | 3066 | 6522 | 0 | 9588 | 10357 | 15375 | 0 | 25733 | 12328 | 15553 | 0 | 27881 | |
| 18 | 1607 | 8670 | 0 | 10278 | 477 | 5921 | 0 | 6398 | 5590 | 8833 | 0 | 14422 | 4567 | 12784 | 0 | 17351 | |
| 19 | 60 | 6198 | 0 | 6258 | 0 | 4916 | 0 | 4916 | 2574 | 7876 | 0 | 10449 | 1604 | 6947 | 0 | 8551 | |
| 20 | 0 | 5361 | 0 | 5361 | 0 | 3816 | 0 | 3816 | 1669 | 6021 | 0 | 7690 | 2581 | 6348 | 0 | 8930 | |
| 21 | 0 | 6707 | 0 | 6707 | 0 | 3475 | 0 | 3475 | 1494 | 5057 | 0 | 6551 | 1406 | 6470 | 0 | 7876 | |
| 22 | 0 | 3607 | 0 | 3607 | 0 | 3782 | 0 | 3782 | 489 | 4800 | 0 | 5290 | 127 | 5252 | 0 | 5378 | |
| 23 | 0 | 4256 | 0 | 4256 | 0 | 3635 | 0 | 3635 | 237 | 5175 | 0 | 5412 | 190 | 4195 | 0 | 4385 | |
| 24 | 0 | 3004 | 0 | 3004 | 0 | 2767 | 0 | 2767 | 156 | 2849 | 0 | 3005 | 190 | 3422 | 0 | 3612 | |
| 25 | 0 | 1561 | 0 | 1561 | 0 | 1601 | 0 | 1601 | 100 | 2364 | 0 | 2464 | 365 | 2480 | 0 | 2845 | |
| 26 | 0 | 931 | 0 | 931 | 0 | 1568 | 0 | 1568 | 0 | 1519 | 0 | 1519 | 127 | 1261 | 0 | 1387 | |
| 27 | 0 | 677 | 0 | 677 | 0 | 855 | 0 | 855 | 10 | 1158 | 0 | 1168 | 147 | 1254 | 0 | 1401 | |
| 28 | 0 | 915 | 0 | 915 | 0 | 887 | 0 | 887 | 0 | 1018 | 0 | 1018 | 0 | 525 | 0 | 525 | |
| 29 | 0 | 745 | 0 | 745 | 0 | 548 | 0 | 548 | 12 | 248 | 0 | 260 | 0 | 90 | 0 | 90 | |
| 30 | 0 | 592 | 0 | 592 | 0 | 595 | 0 | 595 | 0 | 141 | 0 | 141 | 0 | 105 | 0 | 105 | |
| 31 | 0 | 747 | 0 | 747 | 0 | 262 | 0 | 262 | 0 | 104 | 0 | 104 | 0 | 0 | 0 | 0 | |
| 32 | 0 | 248 | 0 | 248 | 0 | 68 | 0 | 68 | 0 | 16 | 0 | 16 | 0 | 0 | 0 | 0 | |
| 33 | 0 | 219 | 0 | 219 | 0 | 22 | 0 | 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 9 | 0 | 0 | 0 | 0 | |
| 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 36 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 39 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TOTAL | 508491 | 487047 | 0 | 995538 | 311223 | 300896 | 0 | 612119 | 484134 | 443301 | 0 | 927435 | 539117 | 506223 | 0 | 1045340 | |
| Total Catches SC (ton) | | | | 396 | | | | 242 | | | | 438 | | | | 487 | |
| Number Samples | | | | 104 | | | | 154 | | | | 180 | | | | 117 | |

Table 9. Roughhead grenadier Russia Div. 3LMNO total catches ages distributions, mean weight and mean length by year and age.

| Abundance | | | | | | | | | | | | |
|------------|------|------|------|------|------|------|--------|--------|--------|--------|--------|--------|
| Age | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
| 1 | | | | | | | 47 | 104098 | 66 | 376 | 303 | 521 |
| 2 | | | | | | | 2083 | 20670 | 2539 | 1638 | 505 | 2564 |
| 3 | | | | | | | 6074 | 2538 | 12771 | 6223 | 2475 | 4635 |
| 4 | | | | | | | 5976 | 1482 | 18881 | 9842 | 5166 | 7260 |
| 5 | | | | | | | 8586 | 2972 | 30804 | 22704 | 12977 | 6755 |
| 6 | | | | | | | 18754 | 5209 | 51974 | 50364 | 37014 | 14336 |
| 7 | | | | | | | 22571 | 7520 | 34699 | 50706 | 35812 | 27374 |
| 8 | | | | | | | 20384 | 7853 | 35760 | 41194 | 34633 | 30342 |
| 9 | | | | | | | 12317 | 4972 | 34253 | 24006 | 25896 | 16753 |
| 10 | | | | | | | 6845 | 2917 | 16417 | 10906 | 16288 | 8508 |
| 11 | | | | | | | 4759 | 2418 | 8388 | 5317 | 16610 | 4601 |
| 12 | | | | | | | 3721 | 1512 | 7646 | 3717 | 13960 | 4269 |
| 13 | | | | | | | 2616 | 1796 | 5035 | 2600 | 8580 | 2011 |
| 14 | | | | | | | 2011 | 1199 | 4637 | 1834 | 5698 | 1659 |
| 15 | | | | | | | 1176 | 516 | 2577 | 1087 | 3665 | 1521 |
| 16 | | | | | | | 837 | 292 | 1199 | 637 | 2841 | 1862 |
| 17 | | | | | | | 640 | 173 | 530 | 437 | 2969 | 828 |
| 18 | | | | | | | 626 | 231 | 432 | 277 | 1730 | 160 |
| 19 | | | | | | | 514 | 138 | 621 | 169 | 718 | 201 |
| 20 | | | | | | | 410 | 193 | 310 | 115 | 304 | 69 |
| 21 | | | | | | | 243 | 109 | 238 | 60 | 278 | |
| 22 | | | | | | | 116 | 59 | 128 | 33 | 30 | 5 |
| 23 | | | | | | | 68 | 47 | 53 | 19 | 88 | |
| 24 | | | | | | | 36 | 9 | 17 | 3 | 10 | |
| Total ages | | | | | | | 121408 | 168920 | 269975 | 234264 | 228552 | 136234 |

| Mean Weight (gr) | | | | | | | | | | | | |
|------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Age | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
| 1 | | | | | | | 30 | 10 | 13 | 13 | 15 | 38 |
| 2 | | | | | | | 107 | 51 | 115 | 85 | 72 | 98 |
| 3 | | | | | | | 155 | 139 | 164 | 138 | 162 | 184 |
| 4 | | | | | | | 225 | 260 | 225 | 210 | 258 | 286 |
| 5 | | | | | | | 330 | 373 | 329 | 325 | 371 | 383 |
| 6 | | | | | | | 435 | 493 | 430 | 418 | 492 | 493 |
| 7 | | | | | | | 523 | 652 | 568 | 522 | 591 | 571 |
| 8 | | | | | | | 630 | 831 | 724 | 661 | 741 | 777 |
| 9 | | | | | | | 798 | 1075 | 956 | 857 | 928 | 877 |
| 10 | | | | | | | 971 | 1260 | 1160 | 1035 | 1141 | 1126 |
| 11 | | | | | | | 1190 | 1593 | 1507 | 1325 | 1288 | 1582 |
| 12 | | | | | | | 1421 | 1945 | 1752 | 1610 | 1536 | 1807 |
| 13 | | | | | | | 1725 | 2324 | 2183 | 1996 | 1778 | 2308 |
| 14 | | | | | | | 2112 | 2608 | 2674 | 2478 | 2311 | 2643 |
| 15 | | | | | | | 2583 | 3343 | 3060 | 2950 | 2497 | 3057 |
| 16 | | | | | | | 2998 | 3625 | 3676 | 3296 | 3042 | 3199 |
| 17 | | | | | | | 3458 | 4169 | 3987 | 3729 | 3602 | 3672 |
| 18 | | | | | | | 3873 | 4684 | 4808 | 4204 | 4065 | 4363 |
| 19 | | | | | | | 4160 | 4858 | 5327 | 4801 | 4544 | 4255 |
| 20 | | | | | | | 4695 | 6056 | 6407 | 5725 | 5387 | 4056 |
| 21 | | | | | | | 4838 | 6335 | 7273 | 5936 | 5030 | |
| 22 | | | | | | | 5375 | 6921 | 7040 | 6232 | 6293 | 5404 |
| 23 | | | | | | | 5333 | 7258 | 9292 | 6295 | 4883 | |
| 24 | | | | | | | 6692 | 9573 | 9350 | 6689 | 6677 | |

| Mean Length (cm) | | | | | | | | | | | | |
|------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Age | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
| 1 | | | | | | | 5.1 | 3.6 | 4.1 | 4.1 | 3.4 | 4.9 |
| 2 | | | | | | | 8.2 | 6.5 | 8.8 | 8.1 | 6.9 | 7.2 |
| 3 | | | | | | | 9.5 | 9.1 | 9.9 | 9.6 | 9.3 | 9.3 |
| 4 | | | | | | | 10.9 | 11.3 | 11.0 | 11.1 | 11.1 | 11.2 |
| 5 | | | | | | | 12.6 | 12.7 | 12.4 | 12.8 | 12.7 | 12.6 |
| 6 | | | | | | | 14.0 | 14.0 | 13.6 | 13.9 | 14.2 | 13.9 |
| 7 | | | | | | | 15.0 | 15.4 | 14.9 | 15.0 | 15.2 | 14.9 |
| 8 | | | | | | | 16.1 | 16.7 | 16.1 | 16.1 | 16.5 | 16.6 |
| 9 | | | | | | | 17.6 | 18.2 | 17.7 | 17.6 | 17.9 | 17.6 |
| 10 | | | | | | | 18.9 | 19.2 | 18.8 | 18.7 | 19.2 | 19.3 |
| 11 | | | | | | | 20.4 | 20.8 | 20.6 | 20.3 | 20.1 | 21.8 |
| 12 | | | | | | | 21.7 | 22.4 | 21.7 | 21.7 | 21.4 | 22.9 |
| 13 | | | | | | | 23.2 | 23.9 | 23.4 | 23.4 | 22.5 | 25.3 |
| 14 | | | | | | | 25.0 | 24.8 | 25.0 | 25.2 | 24.9 | 26.7 |
| 15 | | | | | | | 26.9 | 27.2 | 26.3 | 26.8 | 25.5 | 28.3 |
| 16 | | | | | | | 28.3 | 27.9 | 27.8 | 27.8 | 27.2 | 28.7 |
| 17 | | | | | | | 29.9 | 29.3 | 28.8 | 29.0 | 29.0 | 30.4 |
| 18 | | | | | | | 31.2 | 30.6 | 30.7 | 30.2 | 30.2 | 32.6 |
| 19 | | | | | | | 32.1 | 31.0 | 31.7 | 31.6 | 31.5 | 32.2 |
| 20 | | | | | | | 33.6 | 33.5 | 33.8 | 33.6 | 33.6 | 31.6 |
| 21 | | | | | | | 34.0 | 34.0 | 35.3 | 34.1 | 32.7 | |
| 22 | | | | | | | 35.3 | 35.1 | 34.9 | 34.6 | 35.5 | 35.5 |
| 23 | | | | | | | 35.1 | 35.7 | 38.3 | 34.7 | 32.3 | |
| 24 | | | | | | | 38.3 | 39.3 | 38.4 | 35.5 | 36.3 | |

Table 11. Spanish 3NO survey total abundance and mean numbers per tow by age and year

| Spanish 3NO Survey Total Abundance | | | | | | | | |
|---|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Edad | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
| 1 | 0 | 5165 | 5438 | 11545 | 67228 | 325985 | 529797 | 511040 |
| 2 | 32481 | 156218 | 982698 | 902686 | 532368 | 648260 | 2184155 | 606283 |
| 3 | 141816 | 965738 | 1955847 | 1579722 | 748942 | 496842 | 1552355 | 3414010 |
| 4 | 220962 | 1518901 | 3200880 | 839747 | 655183 | 309680 | 1071563 | 2060154 |
| 5 | 322711 | 1063589 | 3380992 | 6176255 | 2104780 | 755159 | 1176158 | 2047164 |
| 6 | 1060652 | 1625224 | 2196379 | 4854350 | 3352016 | 1393211 | 1840783 | 2546145 |
| 7 | 2034967 | 2648325 | 1896552 | 2264971 | 3347877 | 1843908 | 3427229 | 2549054 |
| 8 | 696115 | 3691333 | 1840944 | 1510625 | 1960709 | 1454321 | 3420153 | 3361223 |
| 9 | 698216 | 1296299 | 849876 | 1472413 | 1316343 | 1011123 | 1511756 | 3754385 |
| 10 | 387456 | 1130638 | 345851 | 1324369 | 1432969 | 1006692 | 1058672 | 3193367 |
| 11 | 522924 | 484043 | 208830 | 237202 | 359326 | 518317 | 885167 | 1441700 |
| 12 | 491170 | 629574 | 141245 | 289124 | 134303 | 679038 | 399211 | 829087 |
| 13 | 256042 | 636745 | 106606 | 155790 | 98888 | 166503 | 266659 | 491326 |
| 14 | 88802 | 306068 | 103961 | 253670 | 66946 | 139673 | 137612 | 256698 |
| 15 | 61218 | 256735 | 84223 | 144054 | 58647 | 94770 | 154609 | 96287 |
| 16 | 36815 | 83717 | 30922 | 88211 | 54347 | 145589 | 151930 | 85891 |
| 17 | 17475 | 55386 | 20814 | 41454 | 68832 | 134222 | 97853 | 39520 |
| 18 | 25523 | 83711 | 26515 | 38650 | 54681 | 78120 | 19093 | 29615 |
| 19 | 19643 | 69006 | 18018 | 50319 | 34288 | 58443 | 25086 | 7274 |
| 20 | 12816 | 47903 | 16783 | 25896 | 16017 | 15827 | 13895 | 1914 |
| 21 | 8795 | 25795 | 11017 | 17761 | 14776 | 15540 | 0 | 1914 |
| 22 | 4572 | 13835 | 3661 | 7003 | 3765 | 7023 | 4435 | 1914 |
| 23 | 5406 | 11338 | 2301 | 6583 | 5331 | 5231 | 0 | 0 |
| 24 | 0 | 2404 | 1179 | 1184 | 3760 | 2913 | 0 | 0 |

| Spanish 3NO Survey Mean Numbers Per Town | | | | | | | | |
|---|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Edad | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
| 1 | 0.000 | 0.005 | 0.006 | 0.012 | 0.069 | 0.358 | 0.572 | 0.542 |
| 2 | 0.037 | 0.159 | 1.022 | 0.913 | 0.548 | 0.712 | 2.356 | 0.643 |
| 3 | 0.162 | 0.984 | 2.034 | 1.598 | 0.771 | 0.546 | 1.675 | 3.620 |
| 4 | 0.252 | 1.547 | 3.328 | 0.849 | 0.675 | 0.340 | 1.156 | 2.184 |
| 5 | 0.368 | 1.083 | 3.515 | 6.247 | 2.167 | 0.830 | 1.269 | 2.171 |
| 6 | 1.210 | 1.655 | 2.284 | 4.910 | 3.451 | 1.531 | 1.986 | 2.700 |
| 7 | 2.321 | 2.697 | 1.972 | 2.291 | 3.447 | 2.027 | 3.697 | 2.703 |
| 8 | 0.794 | 3.760 | 1.914 | 1.528 | 2.019 | 1.598 | 3.689 | 3.564 |
| 9 | 0.796 | 1.320 | 0.884 | 1.489 | 1.355 | 1.111 | 1.631 | 3.981 |
| 10 | 0.442 | 1.152 | 0.360 | 1.340 | 1.475 | 1.106 | 1.142 | 3.386 |
| 11 | 0.597 | 0.493 | 0.217 | 0.240 | 0.370 | 0.570 | 0.955 | 1.529 |
| 12 | 0.560 | 0.641 | 0.147 | 0.292 | 0.138 | 0.746 | 0.431 | 0.879 |
| 13 | 0.292 | 0.649 | 0.111 | 0.158 | 0.102 | 0.183 | 0.288 | 0.521 |
| 14 | 0.101 | 0.312 | 0.108 | 0.257 | 0.069 | 0.154 | 0.148 | 0.272 |
| 15 | 0.070 | 0.261 | 0.088 | 0.146 | 0.060 | 0.104 | 0.167 | 0.102 |
| 16 | 0.042 | 0.085 | 0.032 | 0.089 | 0.056 | 0.160 | 0.164 | 0.091 |
| 17 | 0.020 | 0.056 | 0.022 | 0.042 | 0.071 | 0.148 | 0.106 | 0.042 |
| 18 | 0.029 | 0.085 | 0.028 | 0.039 | 0.056 | 0.086 | 0.021 | 0.031 |
| 19 | 0.022 | 0.070 | 0.019 | 0.051 | 0.035 | 0.064 | 0.027 | 0.008 |
| 20 | 0.015 | 0.049 | 0.017 | 0.026 | 0.016 | 0.017 | 0.015 | 0.002 |
| 21 | 0.010 | 0.026 | 0.011 | 0.018 | 0.015 | 0.017 | 0.000 | 0.002 |
| 22 | 0.005 | 0.014 | 0.004 | 0.007 | 0.004 | 0.008 | 0.005 | 0.002 |
| 23 | 0.006 | 0.012 | 0.002 | 0.007 | 0.005 | 0.006 | 0.000 | 0.000 |
| 24 | 0.000 | 0.002 | 0.001 | 0.001 | 0.004 | 0.003 | 0.000 | 0.000 |

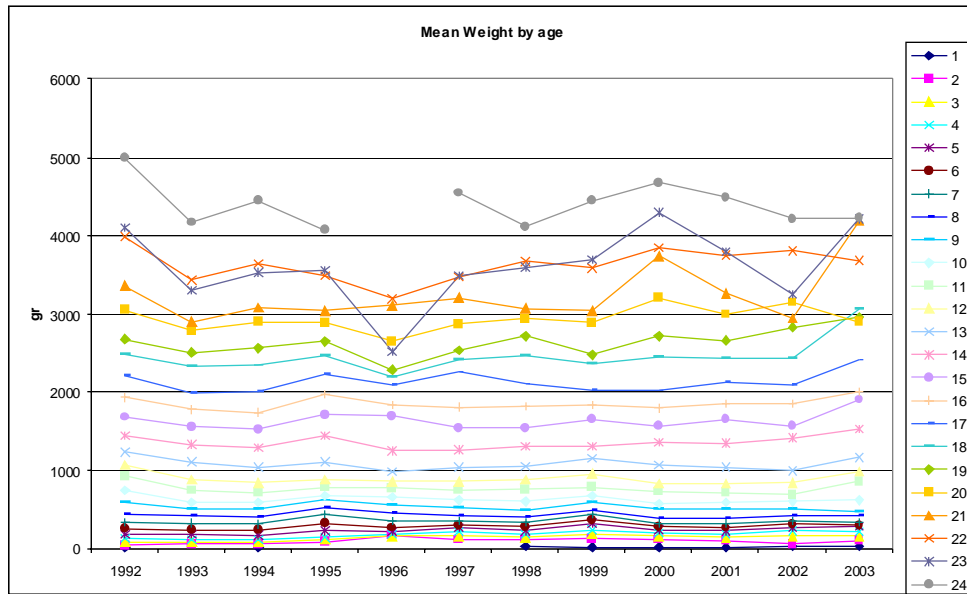


Fig. 1. Roughhead grenadier catches mean weight by age

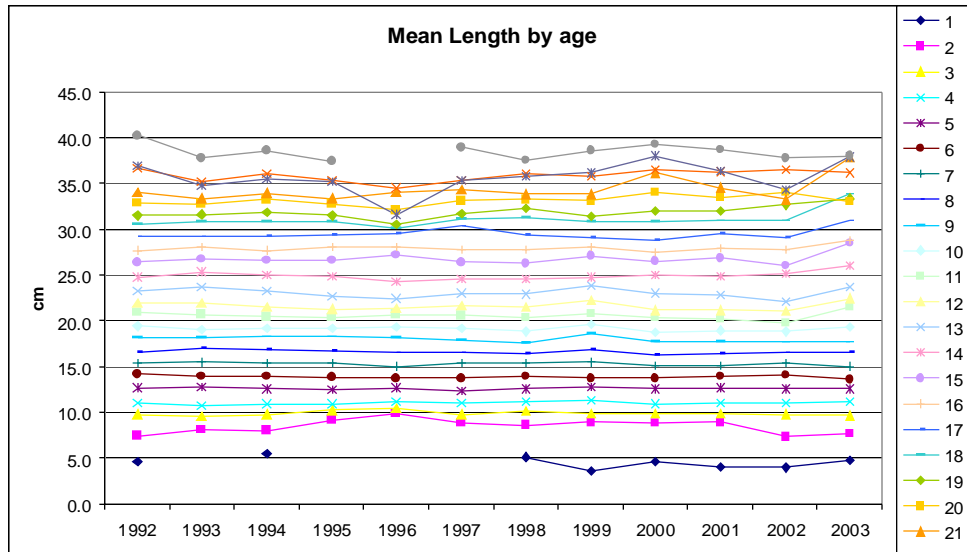


Fig. 2. Roughhead grenadier catches mean length by age.