

METHOD OF INCORPORATING UNCERTAINTY IN SIZE COMPOSITION OF CATCHES OF EAST ATLANTIC BLUEFIN TUNA IN ASSESSMENTS

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SUMMARY

The methods used by the 1992 SCRS to examine uncertainty in size composition of catches of large bluefin in the Mediterranean fisheries are expanded for use in VPA simulation.

RESUME

La méthode utilisée par le SCRS en 1992 pour examiner le degré d'incertitude de la composition de tailles des prises de grand thon rouge dans les pêcheries Méditerranéennes est étendue aux simulations par VPA.

RESUMEN

Los métodos utilizados por el SCRS en 1992 para examinar incertidumbres en la composición por tallas de las capturas de atún rojo grande en las pesquerías mediterráneas se amplían para utilizarlos en simulaciones VPA.

Introduction

A large proportion of the catches and size composition of Mediterranean fisheries are not well known (Anon. 1993). In 1992 the SCRS estimated that size composition was not available for 40-60% of the catches by those fisheries since the mid 1970's and higher fractions were poorly known in earlier years. To conduct age structured population analyses, size composition must be estimated, and therefore the SCRS has used observed size compositions from other fisheries for the fisheries for which size data are not available. The substitutions used in adding new data to the catch at size data base and other changes to that base are documented for each assessment (Miyake and Kebe 1993).

In 1992 the SCRS conducted one sensitivity analysis to examine the sensitivity of VPA estimates of stock size to alternative substitutions for several Mediterranean Sea fisheries. The approach was to apply an alternative age composition to the estimated yield of the fisheries for which size composition was poorly known. That analysis was restricted to one alternative, because of the limited time available. The estimates of absolute fishing mortality rate of ages 10+ were roughly half those of the base case assessment, and the patterns of F relative to 1980 in ages 5-9 and 10+ differed from the base case.

The purpose of this paper is to document more fully (1) the fisheries for which alternative age compositions were estimated and (2) the observed age compositions of fisheries used in the original and alternative substitutions by the SCRS. Other systems for examining this uncertainty are discussed.

Methods

The 1992 SCRS estimated alternative age compositions for five groups of East Atlantic and Mediterranean fisheries. Those fisheries were (1) Mediterranean small fish fisheries for which French purse seine size composition was generally in calculating the base catch at size, (2) a group of high seas longline fisheries in the east Atlantic for which Japanese longline east Atlantic size composition are generally used for substituting, (3) a group of high seas longline fisheries in the Mediterranean Sea for which Japanese longline Mediterranean size composition are generally used for substituting, (4) a group of Mediterranean Sea large fish fisheries primarily by African nations for which Spanish trap size compositions have usually be substituted, and (5) some Italian large fish fisheries for which Spanish trap size compositions have usually be substituted. The age compositions substitutions were: (1) Spanish Bay of Biscay baitboat was used as the alternative for the Mediterranean small fish fisheries, (2) and (3) east Atlantic Spanish large fish age composition was used as the alternative age composition for both the east Atlantic and Mediterranean high seas longline fisheries, and (4) and (5) the Japanese longline Mediterranean age composition was used as the alternative age composition for the other Mediterranean large fish fisheries.

Estimated total annual yield for ages 1+ was calculated from the original age composition for each group of fisheries, and the alternative age composition was calculated from the age 1+ average weight and age composition from the fishery used for

substitution. In a few instances there was no age composition available from the fishery used for the revised age composition, in those cases the original catch at age was retained.

Results

Tables 1 to 6 show the annual 1+ yield of the fisheries in the east Atlantic and Mediterranean Sea for which alternative age compositions were calculated. Table 7 shows total catches for each fishery group for which revised catches at age were calculated and total age 1+ catches for each area. The east Atlantic fisheries represented from less than 1% to more than 20% of the east Atlantic total yield and were generally in the 5-10% range in the 1970's and were often lower than that in the 1980's. The estimated 1+ yields for the Mediterranean fisheries for which alternative catches at age were calculated were from 30-70% of the Mediterranean total yields. Yields of the Mediterranean small fish fisheries for which size composition data was generally not available was above 1500 mt since 1971 and above 3000 mt since 1980.

Figure 1 shows the SCRS base annual age composition of the French small fish purse seine fishery which was used as substitution for several small fish fisheries and the alternative age composition from the Spanish Bay of Biscay bait boat fishery.

Figure 2 shows the SCRS base annual age composition of Italian large fish fisheries compared with the alternative age composition for those catches derived by using the age compositions from the Japanese longline fishery in the Mediterranean.

Figure 3 shows the SCRS base annual age composition of Mediterranean large fish fisheries which are usually sized with Spanish east Atlantic (near Gibraltar) trap age composition and the alternative age composition calculated by applying the Japanese longline east Atlantic age composition.

Figure 4 shows the age composition from the total SCRS base catch at age and the alternative catch at age, while the total catches at age are shown in Tables 8 and 9.

Discussion

The uncertainty about the catch at age has several components - uncertainty about the total catch, uncertainty about the size composition of the catch and uncertainty about the conversion from size to age. The sensitivity trial by the 1992 SCRS addressed only one of those components. Turner and Restrepo (1992) showed that uncertainty in the catch (CV's to 10%) and the age composition contributed up to 30% of the perceived range in estimates of absolute stock size of small and medium west Atlantic bluefin, but had less effect on the range of estimates for large fish. For small and medium west Atlantic bluefin decreases in the perceived range of estimates of relative stock sizes of up to 75% were of calculated. The substantial uncertainty about the estimated catches of east Atlantic - Mediterranean bluefin was not addressed by the 1992 SCRS; the SCRS should consider examining the affects of that uncertainty on the estimates of abundance.

As described above, the 1992 the SCRS used a simple approach for examining the effects of uncertainty in size composition of some catches by substituting different age compositions from sampled fisheries and creating one alternative catch at age. Another approach might be to create multiple different catches at age by using randomly selected alternative age compositions for each unsampled fishery, and to use those multiple catches at age in a Monte Carlo simulation incorporation various sources of uncertainty.

If the SCRS is to conduct this type of sensitivity analysis in the future, a more detailed approach might be warranted. For some of the fisheries for which alternative catches at age were calculated there were some years in which size samples were available; for instance there were size samples for Italian large fish fisheries in 1987-1989. Undoubtedly there were fisheries for which alternative catches at age were not estimated, but for which size sample substitutions were necessary in some years.

Literature Cited

- Anonymous 1993. Report for the Biennial period 1992-93. Part I (1992). Int. Comm. Conserv. Atl. Tunas, 375 p.
- Miyake, P.M. and P. Kebe. 1993. Bluefin data substitution and raising made for 1992. Int. Comm. Conserv. Atl. Tunas, Col. Vol. Sci. Pap. 50(1): 239-241.
- Turner, S.C. and V.R. Restrepo. 1992. Sensitivity of bluefin tuna virtual population analysis and projections to uncertainty in inputs. Int. Comm. Conserv. Atl. Tunas, Col. Vol. Sci. Pap. 39(3): 793-802

Table 1. Annual age 1+ yields (mt) of east Atlantic small fish fisheries for which alternative age compositions were estimated. After each nation and gear is given its ICCAT code in ().

| | | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 |
|--------------|-----------------|-----|-----|-----|-----|-----|------|-----|-----|----|-----|-----|-----|
| Morocco (16) | surface (11) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Morocco (16) | purse seine (6) | 412 | 30 | 541 | 517 | 599 | 2664 | 336 | 672 | 37 | 209 | 157 | 107 |
| total | | 412 | 30 | 541 | 517 | 599 | 2664 | 336 | 672 | 37 | 209 | 157 | 107 |
| | | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | | |
| Morocco (16) | surface (11) | 0 | 85 | 44 | 0 | 0 | 0 | 198 | 146 | 53 | 28 | | |
| Morocco (16) | purse seine (6) | 609 | 190 | 128 | 83 | 5 | 0 | 0 | 0 | 7 | 3 | | |
| total | | 609 | 275 | 172 | 83 | 5 | 0 | 198 | 146 | 60 | 31 | | |

Table 2. Annual age 1+ yields (mt) of Mediterranean small fish fisheries for which alternative age compositions were estimated. After each nation and gear is given its ICCAT code in ().

| | | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 |
|-------------------------|---------------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Italy (11) | purse seine - smalls (26) | 0 | 465 | 89 | 111 | 0 | 0 | 566 | 45 | 119 | 380 | 950 | 950 |
| Italy-Ligurian Sea (91) | purse seine - smalls (26) | 0 | 0 | 1581 | 1312 | 2814 | 2008 | 4644 | 1151 | 2337 | 430 | 1666 | 2817 |
| Morocco (16) | surface (11) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Turkey (24) | purse seine (6) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Yugoslavia (26) | purse seine (6) | 71 | 306 | 188 | 213 | 301 | 147 | 533 | 900 | 1004 | 722 | 545 | 353 |
| Tunisia (23) | purse seine (6) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 21 | 115 | 139 | 98 |
| total | | 71 | 771 | 1858 | 1636 | 3115 | 2155 | 5743 | 2107 | 3481 | 1647 | 3300 | 4218 |
| | | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | | |
| Italy (11) | purse seine - smalls (26) | 956 | 956 | 1821 | 699 | 1343 | 1410 | 1418 | 1437 | 1910 | 1926 | | |
| Italy-Ligurian Sea (91) | purse seine - smalls (26) | 3814 | 2014 | 948 | 2356 | 2234 | 497 | 383 | 379 | 105 | 0 | | |
| Morocco (16) | surface (11) | 0 | 0 | 4 | 12 | 1 | 0 | 43 | 9 | 6 | 0 | | |
| Turkey (24) | purse seine (6) | 0 | 0 | 0 | 0 | 1421 | 847 | 1442 | 2761 | 2036 | 2036 | | |
| Yugoslavia (26) | purse seine (6) | 456 | 1165 | 720 | 1041 | 762 | 618 | 1459 | 537 | 898 | 0 | | |
| Tunisia (23) | purse seine (6) | 108 | 111 | 103 | 128 | 110 | 141 | 148 | 90 | 109 | 1034 | | |
| total | | 5334 | 4246 | 3596 | 4236 | 5871 | 3513 | 4893 | 5213 | 5064 | 4996 | | |

Table 3. Annual age 1+ yields (mt) of east Atlantic high seas longline fisheries for which alternative age compositions were estimated. After each nation and gear is given its ICCAT code in ().

| | | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 |
|-----------------------------|----------------|----|----|----|----|----|----|----|----|----|----|----|----|
| China - Taiwan (5) | longline (1-4) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Panama (28) | longline (1-4) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Not Elsewhere Reported (73) | longline (1-4) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| total | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | | |
| China - Taiwan (5) | longline (1-4) | 0 | 2 | 0 | 0 | 2 | 10 | 14 | 0 | 52 | 6 | | |
| Panama (28) | longline (1-4) | 0 | 0 | 19 | 29 | 12 | 5 | 0 | 0 | 0 | 0 | | |
| Not Elsewhere Reported (73) | longline (1-4) | 0 | 0 | 5 | 4 | 5 | 0 | 0 | 6 | 7 | 2 | | |
| total | | 0 | 2 | 24 | 33 | 19 | 15 | 14 | 6 | 59 | 8 | | |

Table 4. Annual age 1+ yields (mt) of Mediterranean high seas longline fisheries for which alternative age compositions were estimated. After each nation and gear is given its ICCAT code in ().

| | | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 |
|-----------------------------|----------------|----|----|----|----|-----|-----|-----|-----|-----|-----|----|----|
| Panama (28) | longline (1-4) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 |
| Not Elsewhere Reported (73) | longline (1-4) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| total | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 |
| | | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | | |
| Panama (28) | longline (1-4) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Not Elsewhere Reported (73) | longline (1-4) | 2 | 0 | 22 | 87 | 199 | 370 | 636 | 384 | 104 | 881 | | |
| total | | 2 | 0 | 22 | 87 | 199 | 370 | 636 | 384 | 104 | 881 | | |

Table 5. Annual age 1+ yields (mt) of Mediterranean large fish fisheries (excluding Italy) for which alternative age compositions were estimated. After each nation and gear is given its ICCAT code in ().

| | | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 |
|--------------|---------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|------------|-----------|------------|
| Morocco (16) | trap (10) | 0 | 37 | 36 | 1 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Greece (10) | handline (19) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tunisia (23) | handline (19) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 27 | 1 |
| Tunisia (23) | trap (10) | 127 | 115 | 29 | 18 | 49 | 49 | 30 | 60 | 60 | 79 | 15 | 47 |
| other | trap (10) | 20 | 3 | 14 | 4 | 10 | 4 | 4 | 7 | 7 | 41 | 32 | 60 |
| total | | 147 | 155 | 79 | 23 | 66 | 53 | 34 | 67 | 67 | 138 | 74 | 108 |
| | | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | | |
| Morocco (16) | trap (10) | 0 | 0 | 0 | 0 | 0 | 138 | 86 | 284 | 685 | 22 | | |
| Greece (10) | handline (19) | 0 | 0 | 0 | 11 | 130 | 98 | 119 | 141 | 154 | 84 | | |
| Tunisia (23) | handline (19) | 2 | 13 | 60 | 78 | 22 | 34 | 57 | 70 | 42 | 49 | | |
| Tunisia (23) | trap (10) | 110 | 109 | 79 | 81 | 130 | 82 | 97 | 90 | 99 | 106 | | |
| other | trap (10) | 108 | 61 | 65 | 94 | 106 | 241 | 290 | 430 | 176 | 141 | | |
| total | | 220 | 183 | 204 | 264 | 388 | 593 | 649 | 1015 | 1156 | 402 | | |

Table 6. Annual age 1+ yields (mt) of Italian large fish fisheries for which alternative age compositions were estimated. After each nation and gear is given its ICCAT code in ().

| | | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 |
|---------------------------|-----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Italy (11) | handline (19) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Italy - Ligurian Sea (92) | purse seine - big fish (25) | 1194 | 835 | 1013 | 1217 | 3100 | 4141 | 4094 | 4152 | 2087 | 2838 | 3339 | 1699 |
| Italy - Ligurian Sea (92) | handline (19) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Italy - Ligurian Sea (92) | trap (10) | 954 | 1037 | 830 | 364 | 734 | 708 | 646 | 694 | 209 | 193 | 151 | 207 |
| total | | 2148 | 1872 | 1843 | 1581 | 3834 | 4849 | 4740 | 4846 | 2296 | 3031 | 3490 | 1906 |
| | | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | | |
| Italy (11) | handline (19) | 0 | 0 | 11 | 10 | 9 | 10 | 9 | 9 | 11 | 9 | | |
| Italy - Ligurian Sea (92) | purse seine - big fish (25) | 2180 | 2541 | 3559 | 1442 | 1075 | 553 | 332 | 447 | 465 | 455 | | |
| Italy - Ligurian Sea (92) | handline (19) | 0 | 0 | 14 | 12 | 0 | 0 | 0 | 0 | 0 | 13 | | |
| Italy - Ligurian Sea (92) | trap (10) | 154 | 282 | 325 | 301 | 455 | 308 | 352 | 327 | 245 | 370 | | |
| total | | 2334 | 2823 | 3909 | 1765 | 1539 | 871 | 693 | 783 | 721 | 847 | | |

Table 7. Annual age 1+ yields (mt) in the east Atlantic and Mediterranean Sea for all fisheries and for fisheries for which revised catches at age were estimated.

| | east Atlantic | | | | | | | | | | | | |
|--|-------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|-------------|--------------|--|
| | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | |
| French purse seine substituted fisheries | 412 | 30 | 541 | 517 | 599 | 2664 | 336 | 672 | 37 | 209 | 157 | 107 | |
| Japanese longline substituted fisheries | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Spanish trap substitutions, except Italy | 315 | 70 | 135 | 1 | 8 | 0 | 0 | 247 | 0 | 0 | 7 | 79 | |
| substituted fisheries sub total | 727 | 100 | 676 | 518 | 607 | 2664 | 336 | 919 | 37 | 209 | 164 | 186 | |
| area total | 6108 | 4902 | 4882 | 4966 | 6670 | 12679 | 6234 | 7481 | 6463 | 5113 | 3994 | 3549 | |
| | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | | | |
| French purse seine substituted fisheries | 609 | 275 | 172 | 83 | 5 | 0 | 198 | 146 | 60 | 31 | | | |
| Japanese longline substituted fisheries | 0 | 2 | 24 | 33 | 19 | 15 | 14 | 6 | 59 | 8 | | | |
| Spanish trap substitutions, except Italy | 433 | 104 | 0 | 0 | 0 | 132 | 37 | 301 | 209 | 738 | | | |
| substituted fisheries sub total | 1042 | 381 | 196 | 116 | 24 | 147 | 249 | 453 | 328 | 777 | | | |
| area total | 7481 | 7813 | 7243 | 4938 | 4438 | 4248 | 6802 | 5366 | 5595 | 5368 | | | |
| | Mediterranean Sea | | | | | | | | | | | | |
| | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | |
| French purse seine substituted fisheries | 71 | 771 | 1858 | 1636 | 3115 | 2155 | 5743 | 2107 | 3481 | 1647 | 3300 | 4218 | |
| Japanese longline substituted fisheries | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Spanish trap substitutions, except Italy | 147 | 155 | 79 | 23 | 66 | 53 | 34 | 67 | 67 | 138 | 74 | 108 | |
| Spanish trap substitutions, Italy | 2148 | 1872 | 1843 | 1581 | 3834 | 4849 | 4740 | 4846 | 2296 | 3031 | 3490 | 1906 | |
| substituted fisheries sub total | 2366 | 2798 | 3780 | 3240 | 7015 | 7057 | 10517 | 7024 | 5844 | 4816 | 6864 | 6232 | |
| area total | 4703 | 6137 | 5668 | 5886 | 12633 | 11154 | 16665 | 11500 | 8518 | 7238 | 9683 | 10187 | |
| | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | | | |
| French purse seine substituted fisheries | 5334 | 4246 | 3596 | 4236 | 5871 | 3513 | 4893 | 5213 | 5064 | 4996 | | | |
| Japanese longline substituted fisheries | 2 | 0 | 22 | 87 | 199 | 370 | 636 | 384 | 104 | 881 | | | |
| Spanish trap substitutions, except Italy | 220 | 183 | 204 | 264 | 388 | 593 | 649 | 1015 | 1156 | 402 | | | |
| Spanish trap substitutions, Italy | 2334 | 2823 | 3909 | 1765 | 1539 | 871 | 693 | 783 | 721 | 847 | | | |
| substituted fisheries sub total | 7890 | 7252 | 7731 | 6352 | 7997 | 5347 | 6871 | 7395 | 7045 | 7126 | | | |
| area total | 16526 | 13246 | 18734 | 19288 | 16137 | 13480 | 17090 | 16094 | 15531 | 14981 | | | |

Table 8. 1992 SCRS base catch at age for east Atlantic and Mediterranean bluefin. The SCRS combined ages 10+ into a plus group.

| yr | age | | | | | | | | | | | | | | | total |
|----|---------|---------|---------|--------|--------|--------|--------|-------|--------|--------|-------|-------|-------|-------|--------|----------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
| 70 | 131720. | 76236. | 26881. | 16343. | 9845. | 8218. | 4541. | 3548. | 5576. | 6245. | 6585. | 4098. | 2254. | 2088. | 3499. | 307677. |
| 71 | 10520. | 88642. | 53182. | 14685. | 12400. | 3652. | 4472. | 9690. | 5633. | 1615. | 1418. | 1222. | 1841. | 2779. | 9352. | 221103. |
| 72 | 116582. | 148602. | 77235. | 11361. | 8283. | 7084. | 4239. | 2295. | 3291. | 1053. | 1108. | 1332. | 2168. | 2569. | 7267. | 394469. |
| 73 | 142935. | 66886. | 83721. | 6267. | 3312. | 3313. | 6745. | 7906. | 8518. | 1667. | 1495. | 1608. | 2022. | 2268. | 7550. | 346213. |
| 74 | 187116. | 130117. | 57043. | 63076. | 7324. | 4814. | 2896. | 4389. | 10578. | 5013. | 3659. | 4533. | 6265. | 5708. | 14270. | 506801. |
| 75 | 696772. | 289275. | 34844. | 19900. | 6046. | 4371. | 3204. | 3338. | 5371. | 5126. | 5576. | 7527. | 9870. | 7950. | 18077. | 1117247. |
| 76 | 96880. | 188237. | 281023. | 39694. | 20426. | 5059. | 3176. | 2030. | 3794. | 2588. | 3520. | 4005. | 6842. | 5094. | 17079. | 679447. |
| 77 | 217547. | 289458. | 45386. | 64050. | 2332. | 5261. | 3982. | 2461. | 2498. | 3117. | 3654. | 3278. | 4289. | 4420. | 17444. | 669177. |
| 78 | 151716. | 194104. | 152611. | 19182. | 5168. | 1548. | 2874. | 1798. | 1225. | 3421. | 2015. | 2292. | 3146. | 2586. | 13312. | 556998. |
| 79 | 75632. | 33969. | 101914. | 50033. | 7012. | 2414. | 2292. | 3938. | 3660. | 3564. | 2521. | 1525. | 2433. | 2944. | 9809. | 303660. |
| 80 | 111411. | 164497. | 124018. | 30599. | 9120. | 4642. | 3076. | 2275. | 2376. | 3411. | 3916. | 3159. | 3350. | 3145. | 7482. | 476477. |
| 81 | 149771. | 339495. | 111215. | 13008. | 14863. | 5658. | 3833. | 4560. | 3408. | 3031. | 3897. | 3198. | 2597. | 1265. | 3667. | 663466. |
| 82 | 700457. | 226063. | 191497. | 23556. | 5343. | 3283. | 5213. | 8957. | 5172. | 4973. | 6484. | 6879. | 5920. | 8473. | 6176. | 1208446. |
| 83 | 706900. | 169904. | 121271. | 24955. | 12521. | 3359. | 9861. | 5867. | 4501. | 13937. | 5692. | 4411. | 5779. | 4307. | 5630. | 1098895. |
| 84 | 172844. | 643018. | 48832. | 36450. | 19562. | 10176. | 6222. | 6632. | 10309. | 11553. | 8635. | 7855. | 8235. | 3723. | 6653. | 1000699. |
| 85 | 216811. | 358919. | 316508. | 31823. | 13308. | 9016. | 4126. | 3619. | 3857. | 5731. | 6950. | 6015. | 5257. | 3975. | 5650. | 991565. |
| 86 | 624402. | 273767. | 167405. | 74982. | 8279. | 5681. | 2753. | 2024. | 3017. | 3493. | 4557. | 5493. | 4995. | 3940. | 4309. | 1189097. |
| 87 | 259574. | 445346. | 109512. | 30336. | 9773. | 7725. | 8295. | 4025. | 3467. | 5256. | 4207. | 3904. | 3539. | 2797. | 3985. | 901741. |
| 88 | 817094. | 170042. | 249682. | 29438. | 9467. | 10091. | 10875. | 5992. | 5155. | 7899. | 6505. | 5485. | 5234. | 3787. | 5980. | 1342726. |
| 89 | 461927. | 421252. | 89294. | 64371. | 37760. | 6686. | 11789. | 6702. | 4578. | 5364. | 4356. | 3428. | 3737. | 2430. | 4162. | 1127836. |
| 90 | 528783. | 368008. | 209215. | 57102. | 27267. | 7926. | 6556. | 9121. | 10210. | 9146. | 3618. | 1666. | 2821. | 1530. | 3175. | 1246144. |
| 91 | 307468. | 415924. | 146599. | 38370. | 18673. | 6316. | 3924. | 5103. | 10313. | 13826. | 8635. | 2248. | 1898. | 841. | 4078. | 984216. |

Table 9. 1992 SCRS alternative catch at age for east Atlantic and Mediterranean bluefin. The SCRS combined ages 10+ into a plus group.

| yr | age | | | | | | | | | | | | | | | total |
|----|----------|---------|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|----------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
| 70 | 132018. | 77592. | 27391. | 16782. | 10140. | 8397. | 4842. | 4048. | 7112. | 8417. | 7921. | 4834. | 3164. | 2627. | 4288. | 319574. |
| 71 | 11481. | 103914. | 57702. | 18824. | 16884. | 4815. | 4754. | 9802. | 5819. | 1937. | 1792. | 1502. | 2170. | 3093. | 10290. | 254781. |
| 72 | 117932. | 188555. | 81798. | 14850. | 14717. | 12339. | 6290. | 3498. | 3583. | 2523. | 1800. | 2162. | 3264. | 3138. | 5762. | 462211. |
| 73 | 142689. | 84861. | 89473. | 7532. | 4570. | 5081. | 9396. | 11288. | 11100. | 3640. | 2428. | 2468. | 3473. | 2748. | 6689. | 387436. |
| 74 | 189525. | 223324. | 117340. | 77434. | 10905. | 5102. | 1419. | 5183. | 11041. | 10353. | 5540. | 6931. | 10727. | 7673. | 12469. | 694968. |
| 75 | 727882. | 392008. | 52032. | 30028. | 6174. | 2939. | 1379. | 3635. | 5385. | 9468. | 7576. | 9425. | 11876. | 10177. | 16949. | 1286932. |
| 76 | 105515. | 439681. | 352534. | 54936. | 32587. | 8538. | 2397. | 2536. | 4096. | 4575. | 7450. | 5860. | 8020. | 4940. | 16470. | 1050135. |
| 77 | 229000. | 393068. | 68714. | 74148. | 2967. | 4027. | 3244. | 5965. | 6276. | 7229. | 6241. | 4085. | 3952. | 4882. | 15357. | 829153. |
| 78 | 357874. | 272590. | 168729. | 40148. | 11102. | 3087. | 2627. | 3158. | 1111. | 2911. | 1675. | 3555. | 5031. | 2288. | 14715. | 890601. |
| 79 | 97057. | 50662. | 122611. | 68410. | 10351. | 6155. | 10243. | 16917. | 8946. | 4076. | 2390. | 1546. | 1698. | 1836. | 7178. | 410075. |
| 80 | 224297. | 228551. | 152706. | 36443. | 16188. | 10668. | 7402. | 5203. | 8061. | 5990. | 5096. | 3541. | 3533. | 2636. | 5017. | 715332. |
| 81 | 573173. | 484331. | 125380. | 17107. | 15796. | 6907. | 5075. | 7192. | 4057. | 3905. | 4719. | 4581. | 2953. | 1450. | 3679. | 1260307. |
| 82 | 865931. | 403554. | 227214. | 37126. | 13118. | 8179. | 10525. | 11845. | 6378. | 5568. | 6773. | 7186. | 6064. | 9992. | 11966. | 1631419. |
| 83 | 1290749. | 250583. | 128914. | 27771. | 13048. | 3891. | 10329. | 6363. | 5284. | 16421. | 7194. | 6304. | 7359. | 5770. | 7537. | 1787518. |
| 84 | 228350. | 837671. | 73147. | 32403. | 18029. | 10131. | 6833. | 8800. | 16065. | 17091. | 13988. | 10272. | 9946. | 4312. | 7156. | 1294195. |
| 85 | 263278. | 539167. | 385500. | 42732. | 15034. | 10293. | 5190. | 4435. | 4812. | 7272. | 8790. | 7367. | 7282. | 5504. | 7841. | 1314495. |
| 86 | 1245764. | 419429. | 183853. | 88956. | 10446. | 6334. | 2747. | 2282. | 3466. | 5057. | 6109. | 6399. | 6200. | 4449. | 4939. | 1996432. |
| 87 | 373228. | 667122. | 115259. | 35130. | 11620. | 9384. | 8336. | 3906. | 3438. | 5429. | 4744. | 4646. | 4845. | 4197. | 6154. | 1257436. |
| 88 | 1403362. | 291064. | 264368. | 31712. | 11548. | 11120. | 11198. | 6259. | 5913. | 8974. | 8615. | 6856. | 7662. | 5680. | 8863. | 2083194. |
| 89 | 872732. | 635769. | 105009. | 69881. | 38874. | 7616. | 12616. | 7405. | 5014. | 5409. | 4912. | 3550. | 4076. | 3159. | 6069. | 1782091. |
| 90 | 724117. | 486032. | 265240. | 68243. | 41965. | 9582. | 6049. | 9411. | 10743. | 11495. | 6081. | 2979. | 3798. | 2206. | 4382. | 1652324. |
| 91 | 519141. | 622598. | 160215. | 52275. | 25519. | 9068. | 5603. | 6120. | 11775. | 15079. | 9431. | 2560. | 2222. | 1016. | 4941. | 1447562. |

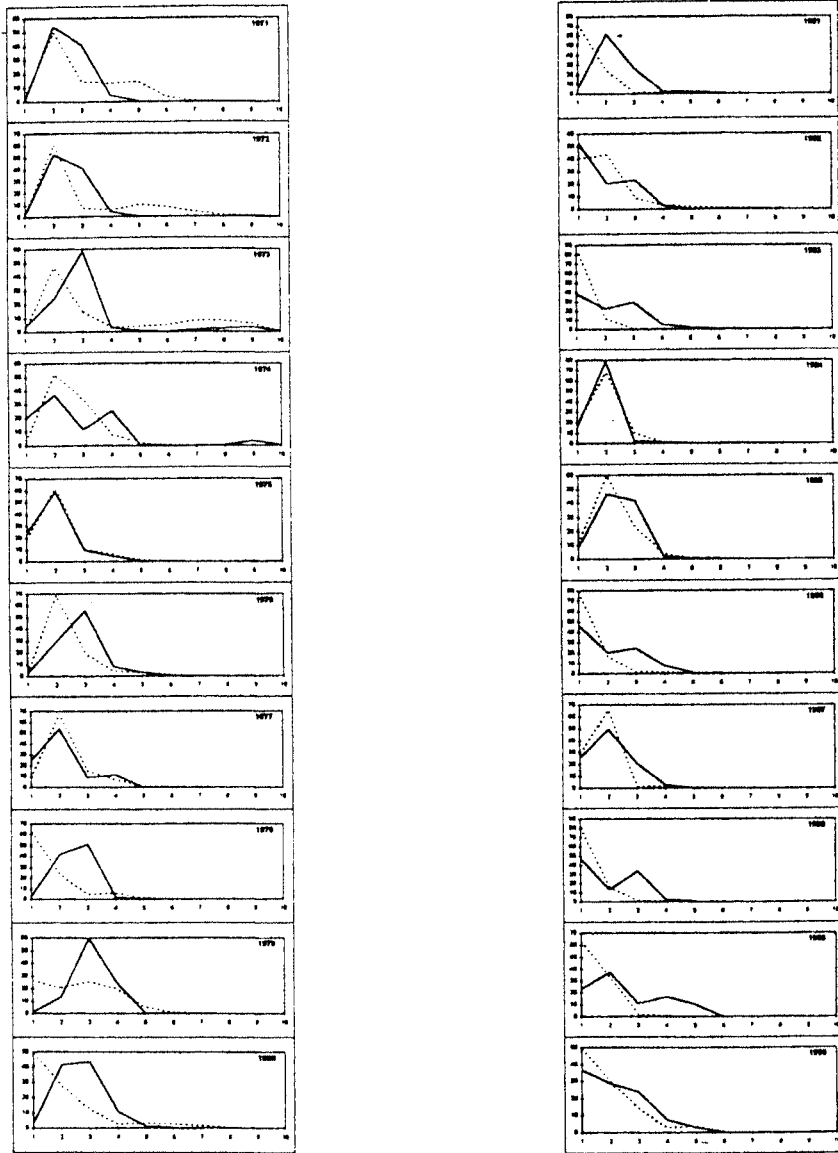


Figure 1. Proportions of 1971-1990 catch (x axis, in number of fish) by age (y axis) for small fish fisheries, which are usually sized with french purse seine size composition, from the 1992 SCRS base catch at age (solid line) and the alternative catch at age from the Spanish east Atlantic baitboat fishery (dashed line).

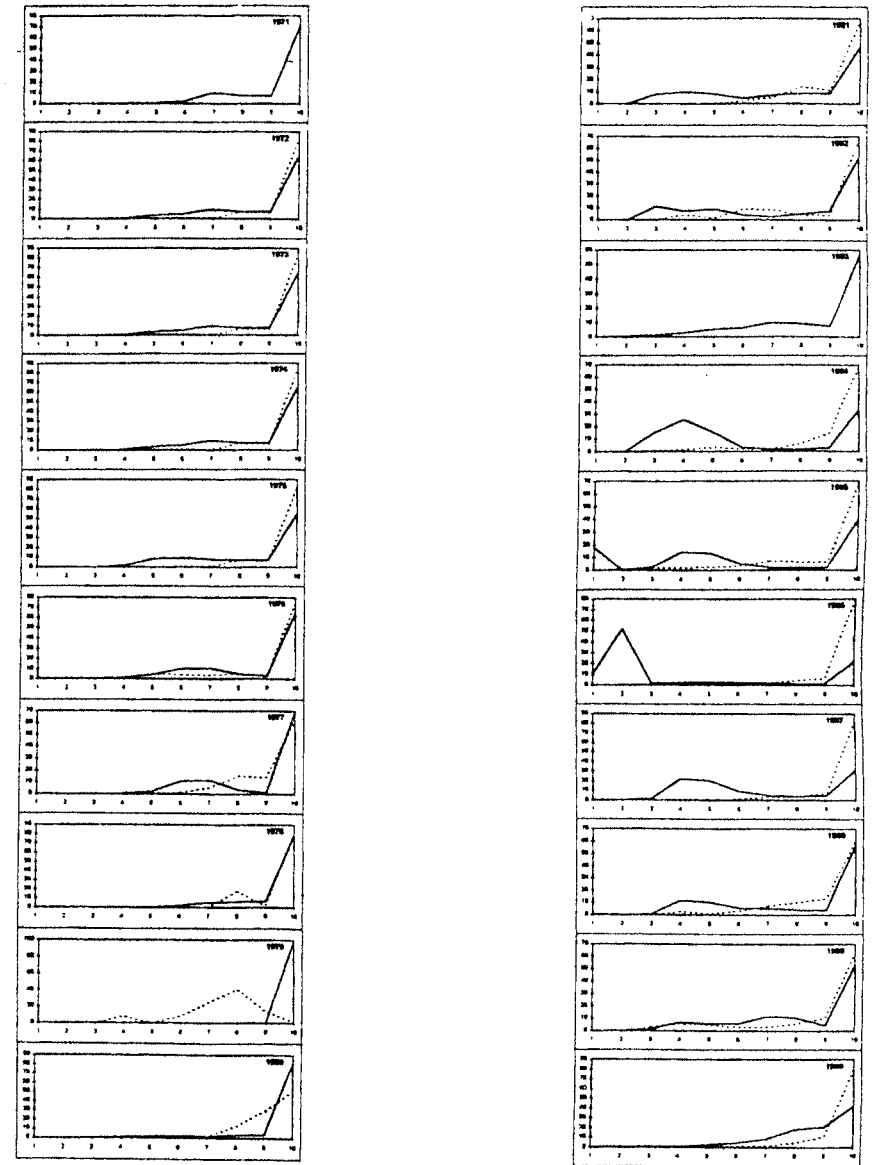


Figure 2. Proportions of 1971-1990 catch (x axis, in number of fish) by age (y axis) for Italian large fish fisheries, which are usually sized with Spanish large fish fishery size composition, from the 1992 SCRS base catch at age (solid line) and the alternative catch at age from the Japanese longline fishery in the Mediterranean Sea (dashed line).

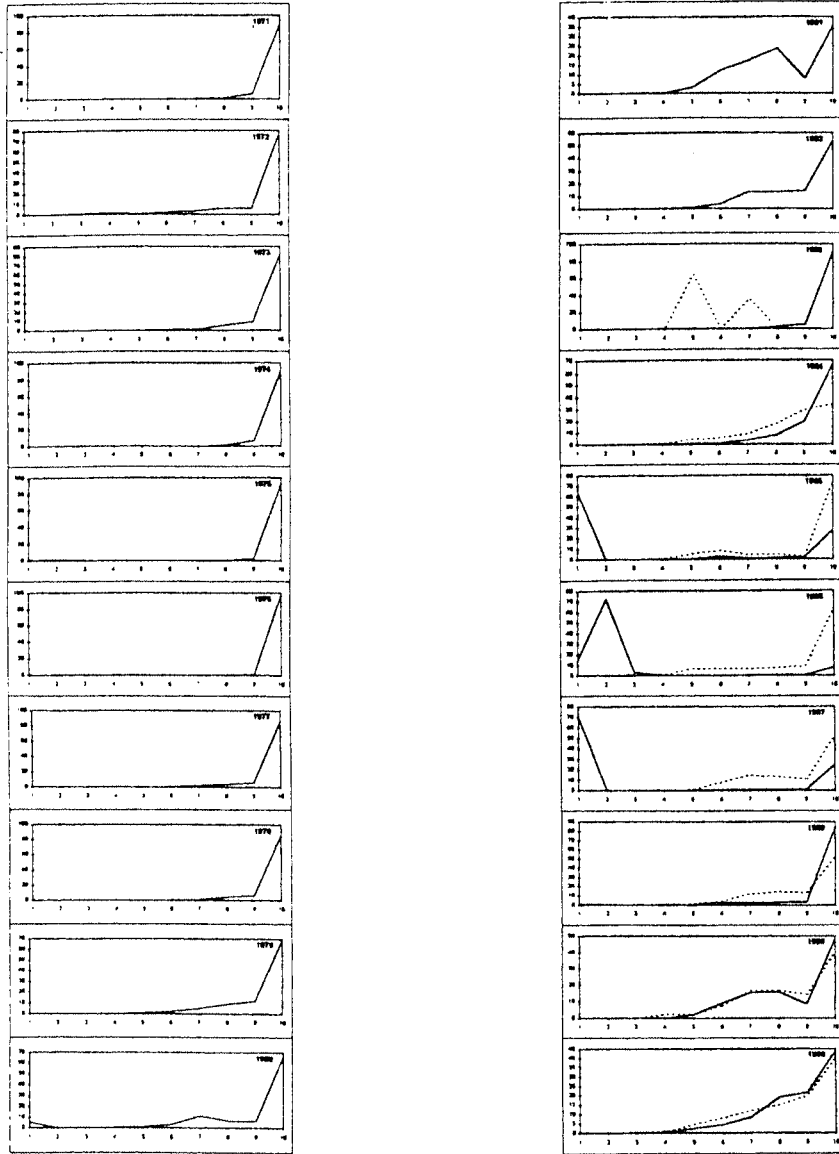


Figure 3. Proportions of 1971-1990 catch (x axis, in number of fish) by age (y axis, ages 1-10+) for Mediterranean Sea large fish fisheries, which are usually sized with Spanish east Atlantic trap size composition, from the 1992 SCRS base catch at age (solid line) and the alternative catch at age from the Japanese longline east Atlantic fishery (dashed line).

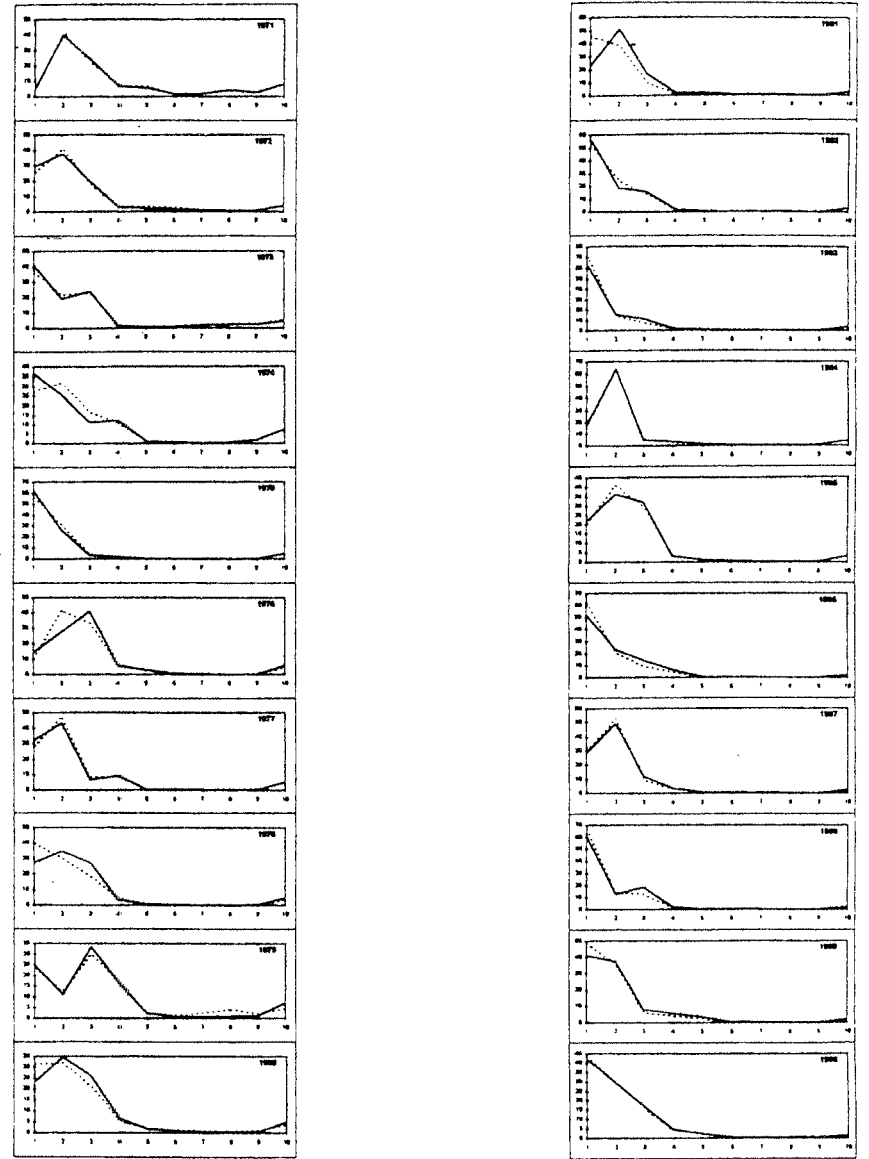


Figure 4. Proportions of 1971-1990 catch (x axis, in number of fish) by age (y axis, ages 1-10+) for the 1992 SCRS base catch at age (east Atlantic and Mediterranean Sea combined) and the alternative catch at age.