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# Separable VPA and trends in the instantaneous rates of fishing mortality, population abundance and spawning stock biomass for the Northwest Atlantic mackerel (*Scomber scombrus* L.) between 1968 and 2008

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## ACKNOWLEDGEMENTS

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**Table 1**. Total catch at age (thousands of fish) for the Northwest Atlantic mackerel in NAFO Subareas 2-6, 1968-2008[1].

| | AGE (yr) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+ |
| 1968 | **161 471** | 64 836 | 64 121 | 41 546 | 15 614 | 7 229 | 1 036 | 1 773 | 10 959 | 145 |
| 1969 | 8 743 | **269 708** | 165 912 | 66 385 | 5 968 | 3 247 | 2 317 | 3 227 | 2 333 | 11 087 |
| 1970 | 198 612 | 55 421 | **530 567** | 164 929 | 28 229 | 7 114 | 5 407 | 10 298 | 10 415 | 7 693 |
| 1971 | 77 391 | 297 082 | 128 064 | **572 914** | 206 472 | 35 284 | 9 759 | 4 195 | 5 033 | 17 452 |
| 1972 | 22 100 | 85 737 | 257 402 | 184 113 | **397 180** | 88 659 | 25 433 | 4 221 | 8 349 | 11 266 |
| 1973 | 165 837 | 292 274 | 289 345 | 237 706 | 198 547 | **207 008** | 34 859 | 12 219 | 4 468 | 6 105 |
| 1974 | 101 295 | 257 437 | 281 116 | 110 641 | 122 184 | 119 573 | **117 926** | 28 237 | 7 473 | 4 395 |
| 1975 | **382 600** | 447 003 | 121 875 | 108 090 | 63 018 | 72 515 | 55 318 | **52 954** | 13 017 | 3 664 |
| 1976 | 13 383 | **364 589** | 286 700 | 91 452 | 56 454 | 29 326 | 43 078 | 36 683 | **24 236** | 15 410 |
| 1977 | 2 093 | 27 893 | **103 824** | 55 417 | 12 461 | 10 222 | 5 701 | 6 481 | 3 912 | **4 415** |
| 1978 | 100 | 200 | 4 700 | **17 400** | 13 300 | 8 400 | 4 700 | 2 200 | 4 500 | 7 300 |
| 1979 | 400 | 600 | 1 300 | 7 100 | **18 600** | 13 100 | 6 200 | 2 600 | 2 200 | 6 500 |
| 1980 | 1 200 | 10 900 | 3 312 | 1 926 | 6 900 | **13 800** | 7 596 | 3 384 | 2 208 | 5 200 |
| 1981 | 16 100 | 7 100 | 9 200 | 1 400 | 2 000 | 6 100 | **11 700** | 4 900 | 2 500 | 3 500 |
| 1982 | 3 700 | 11 800 | 2 700 | 9 100 | 1 200 | 1 900 | 3 400 | **8 400** | 2 900 | 5 100 |
| 1983 | **2 200** | 15 300 | 6 500 | 1 900 | 7 000 | 700 | 1 200 | 5 500 | **10 200** | 6 500 |
| 1984 | 500 | **40 400** | 27 200 | 3 200 | 1 200 | 4 600 | 600 | 700 | 3 400 | **14 000** |
| 1985 | 3 105 | 1 558 | **122 995** | 32 539 | 2 900 | 955 | 3 952 | 420 | 737 | 14 871 |
| 1986 | 1 289 | 12 715 | 6 708 | **100 901** | 25 394 | 2 104 | 696 | 3 184 | 215 | 6 088 |
| 1987 | 4 168 | 14 588 | 14 622 | 7 705 | **110 118** | 17 794 | 2 511 | 363 | 2 107 | 3 531 |
| 1988 | 1 005 | 13 009 | 10 274 | 9 955 | 11 680 | **106 775** | 23 039 | 2 628 | 1 189 | 5 552 |
| 1989 | **3 932** | 17 163 | 11 033 | 7 320 | 7 077 | 2 352 | **88 629** | 4 977 | 925 | 2 252 |
| 1990 | 1 950 | **20 881** | 32 129 | 7 952 | 6 422 | 4 318 | 800 | **54 213** | 2 604 | 1 200 |
| 1991 | 1 413 | 14 610 | **56 390** | 24 626 | 6 460 | 3 900 | 3 300 | 1 000 | **27 300** | 1 200 |
| 1992 | 733 | 6 751 | 5 292 | **25 694** | 15 380 | 2 070 | 1 554 | 1 269 | 1 339 | **16 748** |
| 1993 | 1 519 | 9 205 | 11 311 | 6 171 | **16 535** | 8 949 | 1 918 | 814 | 1 116 | 8 442 |
| 1994 | 1 991 | 1 778 | 12 711 | 14 415 | 5 489 | **19 728** | 6 687 | 1 084 | 307 | 4 106 |
| 1995 | 18 516 | 20 653 | 2 732 | 9 544 | 8 203 | 3 231 | **10 261** | 3 226 | 307 | 921 |
| 1996 | 7 685 | 34 972 | 25 797 | 1 945 | 12 745 | 9 866 | 2 553 | **10 219** | 2 309 | 1 484 |
| 1997 | **6 902** | 21 987 | 23 401 | 11 115 | 1 076 | 8 523 | 6 801 | 2 781 | **7 227** | 1 872 |
| 1998 | 2 308 | **29 849** | 19 107 | 16 691 | 8 719 | 1 155 | 5 881 | 4 141 | 985 | **2 405** |
| 1999 | 1 738 | 6 715 | **23 877** | 14 191 | 9 205 | 4 805 | 1 450 | 2 908 | 2 023 | 1 274 |
| 2000 | **26 104** | 9 592 | 6 178 | **10 302** | 4 373 | 3 303 | 702 | 54 | 229 | 376 |
| 2001 | 9 084 | **76 911** | 23 792 | 7 512 | **9 859** | 2 384 | 2 068 | 716 | 168 | 331 |
| 2002 | 9 945 | 12 354 | **120 036** | 14 246 | 5 259 | **9 714** | 3 107 | 808 | 187 | 78 |
| 2003 | 10 212 | 23 947 | 26 542 | **121 931** | 13 985 | 5 018 | **4 861** | 261 | 5 | 0 |
| 2004 | **37 551** | 77 904 | 22 340 | 25 202 | **121 086** | 9 058 | 2 828 | **881** | 225 | 0 |
| 2005 | 18 652 | **101 050** | 63 245 | 12 859 | 9 410 | **70 156** | 2 164 | 3 243 | **80** | 45 |
| 2006 | **24 721** | 22 212 | **129 188** | 44 706 | 10 632 | 8 499 | **39 205** | 1 007 | 142 | **43** |
| 2007 | 2 186 | **52 804** | 39 401 | **64 204** | 13 947 | 2 167 | 1 668 | **6 531** | 151 | 6 |
| 2008 | 18 346 | 19 611 | **54 873** | 13 883 | **18 530** | 2 874 | 522 | 334 | **1 245** | 27 |

[1] US data include commercial discards for 1989-2008 and recreational landings (chartered vessels) for 2005-2008; Canadian data do not include discards and recreational landings; bold and underlined figures represent dominant year-classes

**Table 2**. Total catch at age (%) for the Northwest Atlantic mackerel in NAFO Subareas 2-6, 1968-2008[1].

| | AGE (yr) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+ |
| 1968 | **43.79** | 17.58 | 17.39 | 11.27 | 4.23 | 1.96 | 0.28 | 0.48 | 2.97 | 0.04 |
| 1969 | 1.62 | **50.05** | 30.79 | 12.32 | 1.11 | 0.60 | 0.43 | 0.60 | 0.43 | 2.06 |
| 1970 | 19.50 | 5.44 | **52.08** | 16.19 | 2.77 | 0.70 | 0.53 | 1.01 | 1.02 | 0.76 |
| 1971 | 5.72 | 21.95 | 9.46 | **42.32** | 15.25 | 2.61 | 0.72 | 0.31 | 0.37 | 1.29 |
| 1972 | 2.04 | 7.91 | 23.74 | 16.98 | **36.62** | 8.18 | 2.35 | 0.39 | 0.77 | 1.04 |
| 1973 | 11.45 | 20.18 | 19.98 | 16.41 | 13.71 | **14.29** | 2.41 | 0.84 | 0.31 | 0.42 |
| 1974 | 8.81 | 22.38 | 24.44 | 9.62 | 10.62 | 10.40 | **10.25** | 2.45 | 0.65 | 0.38 |
| 1975 | **28.98** | 33.86 | 9.23 | 8.19 | 4.77 | 5.49 | 4.19 | **4.01** | 0.99 | 0.28 |
| 1976 | 1.39 | **37.93** | 29.82 | 9.51 | 5.87 | 3.05 | 4.48 | 3.82 | **2.52** | 1.60 |
| 1977 | 0.90 | 12.00 | **44.67** | 23.84 | 5.36 | 4.40 | 2.45 | 2.79 | 1.68 | **1.90** |
| 1978 | 0.16 | 0.32 | 7.48 | **27.71** | 21.18 | 13.38 | 7.48 | 3.50 | 7.17 | 11.62 |
| 1979 | 0.68 | 1.02 | 2.22 | 12.12 | **31.74** | 22.35 | 10.58 | 4.44 | 3.75 | 11.09 |
| 1980 | 2.13 | 19.32 | 5.87 | 3.41 | 12.23 | **24.46** | 13.46 | 6.00 | 3.91 | 9.22 |
| 1981 | 24.96 | 11.01 | 14.26 | 2.17 | 3.10 | 9.46 | **18.14** | 7.60 | 3.88 | 5.43 |
| 1982 | 7.37 | 23.51 | 5.38 | 18.13 | 2.39 | 3.78 | 6.77 | **16.73** | 5.78 | 10.16 |
| 1983 | **3.86** | 26.84 | 11.40 | 3.33 | 12.28 | 1.23 | 2.11 | 9.65 | **17.89** | 11.40 |
| 1984 | 0.52 | **42.17** | 28.39 | 3.34 | 1.25 | 4.80 | 0.63 | 0.73 | 3.55 | **14.61** |
| 1985 | 1.69 | 0.85 | **66.83** | 17.68 | 1.58 | 0.52 | 2.15 | 0.23 | 0.40 | 8.08 |
| 1986 | 0.81 | 7.98 | 4.21 | **63.34** | 15.94 | 1.32 | 0.44 | 2.00 | 0.13 | 3.82 |
| 1987 | 2.35 | 8.22 | 8.24 | 4.34 | **62.04** | 10.02 | 1.41 | 0.20 | 1.19 | 1.99 |
| 1988 | 0.54 | 7.03 | 5.55 | 5.38 | 6.31 | **57.68** | 12.45 | 1.42 | 0.64 | 3.00 |
| 1989 | **2.70** | 11.78 | 7.57 | 5.03 | 4.86 | 1.61 | **60.85** | 3.42 | 0.64 | 1.55 |
| 1990 | 1.47 | **15.76** | 24.25 | 6.00 | 4.85 | 3.26 | 0.60 | **40.93** | 1.97 | 0.91 |
| 1991 | 1.01 | 10.42 | **40.22** | 17.56 | 4.61 | 2.78 | 2.35 | 0.71 | **19.47** | 0.86 |
| 1992 | 0.95 | 8.79 | 6.89 | **33.44** | 20.02 | 2.69 | 2.02 | 1.65 | 1.74 | **21.80** |
| 1993 | 2.30 | 13.95 | 17.14 | 9.35 | **25.06** | 13.56 | 2.91 | 1.23 | 1.69 | 12.79 |
| 1994 | 2.92 | 2.60 | 18.61 | 21.11 | 8.04 | **28.89** | 9.79 | 1.59 | 0.45 | 6.01 |
| 1995 | 23.86 | 26.62 | 3.52 | 12.30 | 10.57 | 4.16 | **13.22** | 4.16 | 0.40 | 1.19 |
| 1996 | 7.01 | 31.92 | 23.54 | 1.78 | 11.63 | 9.00 | 2.33 | **9.33** | 2.11 | 1.35 |
| 1997 | **7.53** | 23.98 | 25.52 | 12.12 | 1.17 | 9.30 | 7.42 | 3.03 | **7.88** | 2.04 |
| 1998 | 2.53 | **32.71** | 20.94 | 18.29 | 9.56 | 1.27 | 6.45 | 4.54 | 1.08 | **2.64** |
| 1999 | 2.55 | 9.85 | **35.02** | 20.81 | 13.50 | 7.05 | 2.13 | 4.26 | 2.97 | 1.87 |
| 2000 | **42.64** | 15.67 | 10.09 | **16.83** | 7.14 | 5.40 | 1.15 | 0.09 | 0.37 | 0.61 |
| 2001 | 6.84 | 57.90 | 17.91 | 5.66 | **7.42** | 1.80 | 1.56 | 0.54 | 0.13 | 0.25 |
| 2002 | 5.66 | 7.03 | 68.31 | 8.11 | 2.99 | **5.53** | 1.77 | 0.46 | 0.11 | 0.04 |
| 2003 | 4.94 | 11.58 | 12.84 | 58.97 | 6.76 | 2.43 | **2.35** | 0.13 | 0.00 | 0.00 |
| 2004 | **12.64** | 26.22 | 7.52 | 8.48 | 40.76 | 3.05 | 0.95 | **0.30** | 0.08 | 0.00 |
| 2005 | 6.64 | **35.97** | 22.51 | 4.58 | 3.35 | 24.98 | 0.77 | 1.15 | **0.03** | 0.02 |
| 2006 | **8.82** | 7.92 | **46.08** | 15.95 | 3.79 | 3.03 | 13.98 | 0.36 | 0.05 | **0.02** |
| 2007 | 1.19 | **28.84** | 21.52 | **35.07** | 7.62 | 1.18 | 0.91 | 3.57 | 0.08 | 0.00 |
| 2008 | 14.09 | 15.06 | **42.13** | 10.66 | **14.23** | 2.21 | 0.40 | 0.26 | 0.96 | 0.02 |

[1] US data include commercial discards for 1989-2008 and recreational landings (chartered vessels) for 2005-2008; Canadian data do not include discards and recreational landings; bold and underlined figures represent dominant year-classes

**Table 3**. Mean weight at age (kg) for the Northwest Atlantic mackerel in NAFO Subareas 2-6, 1968-2008[1].

| | AGE (yr) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+ |
| 1968 | **0.148** | 0.241 | 0.335 | 0.425 | 0.506 | 0.576 | 0.634 | 0.683 | 0.722 | 0.753 |
| 1969 | 0.131 | **0.214** | 0.300 | 0.382 | 0.456 | 0.520 | 0.574 | 0.618 | 0.654 | 0.683 |
| 1970 | 0.107 | 0.179 | **0.253** | 0.324 | 0.389 | 0.444 | 0.491 | 0.530 | 0.562 | 0.595 |
| 1971 | 0.110 | 0.181 | 0.256 | **0.327** | 0.391 | 0.446 | 0.494 | 0.532 | 0.564 | 0.598 |
| 1972 | 0.123 | 0.210 | 0.300 | 0.386 | **0.464** | 0.533 | 0.590 | 0.638 | 0.677 | 0.725 |
| 1973 | 0.113 | 0.189 | 0.269 | 0.345 | 0.414 | **0.473** | 0.524 | 0.565 | 0.600 | 0.634 |
| 1974 | 0.111 | 0.190 | 0.273 | 0.352 | 0.425 | 0.487 | **0.541** | 0.585 | 0.621 | 0.654 |
| 1975 | **0.104** | 0.176 | 0.252 | 0.326 | 0.393 | 0.451 | 0.500 | **0.540** | 0.573 | 0.605 |
| 1976 | 0.097 | **0.168** | 0.244 | 0.316 | 0.382 | 0.440 | 0.489 | 0.530 | **0.563** | 0.592 |
| 1977 | 0.114 | 0.198 | **0.288** | 0.375 | 0.454 | 0.524 | 0.582 | 0.631 | 0.671 | **0.707** |
| 1978 | 0.192 | 0.285 | 0.425 | **0.463** | 0.509 | 0.582 | 0.625 | 0.659 | 0.673 | 0.713 |
| 1979 | 0.190 | 0.272 | 0.531 | 0.567 | **0.579** | 0.603 | 0.652 | 0.714 | 0.752 | 0.803 |
| 1980 | 0.146 | 0.376 | 0.541 | 0.600 | 0.617 | **0.635** | 0.670 | 0.706 | 0.769 | 0.777 |
| 1981 | 0.114 | 0.315 | 0.523 | 0.577 | 0.643 | 0.660 | **0.674** | 0.707 | 0.723 | 0.768 |
| 1982 | 0.152 | 0.340 | 0.541 | 0.606 | 0.666 | 0.743 | 0.737 | **0.722** | 0.719 | 0.775 |
| 1983 | **0.098** | 0.257 | 0.479 | 0.593 | 0.628 | 0.659 | 0.712 | 0.709 | **0.705** | 0.730 |
| 1984 | 0.098 | **0.162** | 0.338 | 0.525 | 0.625 | 0.657 | 0.696 | 0.715 | 0.705 | **0.716** |
| 1985 | 0.122 | 0.304 | **0.301** | 0.451 | 0.577 | 0.711 | 0.727 | 0.743 | 0.814 | 0.791 |
| 1986 | 0.103 | 0.258 | 0.391 | **0.394** | 0.483 | 0.621 | 0.740 | 0.743 | 0.820 | 0.770 |
| 1987 | 0.140 | 0.231 | 0.336 | 0.427 | **0.434** | 0.535 | 0.520 | 0.746 | 0.753 | 0.792 |
| 1988 | 0.112 | 0.232 | 0.355 | 0.426 | 0.473 | **0.506** | 0.601 | 0.697 | 0.759 | 0.775 |
| 1989 | **0.142** | 0.282 | 0.384 | 0.431 | 0.506 | 0.536 | **0.560** | 0.697 | 0.776 | 0.839 |
| 1990 | 0.133 | **0.222** | 0.334 | 0.449 | 0.487 | 0.527 | 0.609 | **0.570** | 0.644 | 0.774 |
| 1991 | 0.186 | 0.287 | **0.399** | 0.462 | 0.543 | 0.596 | 0.616 | 0.688 | **0.686** | 0.793 |
| 1992 | 0.180 | 0.269 | 0.375 | **0.419** | 0.476 | 0.520 | 0.575 | 0.627 | 0.640 | **0.653** |
| 1993 | 0.185 | 0.269 | 0.350 | 0.435 | **0.477** | 0.534 | 0.594 | 0.643 | 0.682 | 0.706 |
| 1994 | 0.158 | 0.231 | 0.315 | 0.396 | 0.486 | **0.519** | 0.591 | 0.643 | 0.701 | 0.675 |
| 1995 | 0.158 | 0.262 | 0.339 | 0.415 | 0.469 | 0.539 | **0.556** | 0.612 | 0.689 | 0.718 |
| 1996 | 0.191 | 0.246 | 0.352 | 0.474 | 0.481 | 0.550 | 0.585 | **0.644** | 0.690 | 0.770 |
| 1997 | **0.199** | 0.301 | 0.382 | 0.451 | 0.546 | 0.532 | 0.570 | 0.609 | **0.658** | 0.709 |
| 1998 | 0.147 | **0.250** | 0.373 | 0.482 | 0.535 | 0.560 | 0.592 | 0.604 | 0.656 | **0.684** |
| 1999 | 0.166 | 0.263 | **0.391** | 0.459 | 0.529 | 0.581 | 0.611 | 0.618 | 0.681 | 0.705 |
| 2000 | **0.199** | 0.230 | 0.321 | **0.442** | 0.530 | 0.585 | 0.614 | 0.674 | 0.693 | 0.747 |
| 2001 | 0.135 | 0.261 | 0.359 | 0.401 | **0.506** | 0.580 | 0.649 | 0.628 | 0.662 | 0.616 |
| 2002 | 0.138 | 0.220 | 0.344 | 0.430 | 0.471 | **0.563** | 0.599 | 0.645 | 0.708 | 0.693 |
| 2003 | 0.126 | 0.229 | 0.308 | 0.435 | 0.517 | 0.573 | **0.635** | 0.642 | 0.626 | 0.679 |
| 2004 | **0.171** | 0.224 | 0.341 | 0.387 | 0.479 | 0.500 | 0.606 | **0.695** | 0.545 | 0.679 |
| 2005 | 0.110 | **0.235** | 0.338 | 0.394 | 0.446 | 0.547 | 0.614 | 0.636 | **0.708** | 0.665 |
| 2006 | **0.181** | 0.249 | **0.304** | 0.387 | 0.419 | 0.451 | 0.537 | 0.567 | 0.465 | **0.521** |
| 2007 | 0.133 | **0.248** | 0.356 | **0.427** | 0.509 | 0.564 | 0.576 | 0.644 | 0.641 | 0.695 |
| 2008 | 0.140 | 0.227 | **0.346** | 0.418 | **0.481** | 0.500 | 0.613 | 0.526 | 0.662 | 0.689 |

[1] Bold and underlined figures represent dominant year-classes

**Table 4**. Catch biomass at age (metric tons) for the Northwest Atlantic mackerel in NAFO Subareas 2-6, 1968-2008[1].

| | AGE (yr) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+ |
| 1968 | **23 898** | 15 625 | 21 480 | 17 657 | 7 901 | 4 164 | 657 | 1 211 | 7 912 | 109 |
| 1969 | 1 145 | **57 718** | 49 774 | 25 359 | 2 721 | 1 688 | 1 330 | 1 994 | 1 526 | 7 572 |
| 1970 | 21 252 | 9 920 | **134 234** | 53 437 | 10 981 | 3 158 | 2 655 | 5 458 | 5 853 | 4 575 |
| 1971 | 8 513 | 53 772 | 32 784 | **187 343** | 80 731 | 15 736 | 4 821 | 2 232 | 2 838 | 10 432 |
| 1972 | 2 718 | 18 005 | 77 221 | 71 068 | **184 292** | 47 255 | 15 006 | 2 693 | 5 652 | 8 164 |
| 1973 | 18 740 | 55 240 | 77 834 | 82 009 | 82 199 | **97 915** | 18 266 | 6 904 | 2 681 | 3 872 |
| 1974 | 11 244 | 48 913 | 76 745 | 38 945 | 51 928 | 58 232 | **63 798** | 16 519 | 4 641 | 2 872 |
| 1975 | **39 790** | 78 672 | 30 713 | 35 237 | 24 766 | 32 704 | 27 659 | **28 595** | 7 459 | 2 218 |
| 1976 | 1 298 | **61 251** | 69 955 | 28 899 | 21 566 | 12 903 | 21 065 | 19 442 | **13 645** | 9 122 |
| 1977 | 239 | 5 523 | **29 901** | 20 781 | 5 657 | 5 356 | 3 318 | 4 089 | 2 625 | **3 121** |
| 1978 | 19 | 57 | 1 998 | **8 056** | 6 770 | 4 889 | 2 938 | 1 450 | 3 029 | 5 205 |
| 1979 | 76 | 163 | 690 | 4 026 | **10 769** | 7 899 | 4 042 | 1 856 | 1 654 | 5 220 |
| 1980 | 175 | 4 098 | 1 791 | 1 156 | 4 257 | **8 763** | 5 091 | 2 390 | 1 698 | 4 040 |
| 1981 | 1 835 | 2 237 | 4 812 | 808 | 1 286 | 4 026 | **7 886** | 3 464 | 1 808 | 2 688 |
| 1982 | 562 | 4 012 | 1 461 | 5 515 | 799 | 1 412 | 2 506 | **6 065** | 2 085 | 3 953 |
| 1983 | **216** | 3 932 | 3 114 | 1 127 | 4 396 | 461 | 854 | 3 900 | **7 191** | 4 745 |
| 1984 | 49 | **6 545** | 9 194 | 1 680 | 750 | 3 022 | 418 | 501 | 2 397 | **10 024** |
| 1985 | 377 | 473 | **36 972** | 14 680 | 1 672 | 679 | 2 874 | 312 | 600 | 11 770 |
| 1986 | 132 | 3 284 | 2 621 | **39 789** | 12 262 | 1 306 | 516 | 2 366 | 176 | 4 691 |
| 1987 | 584 | 3 372 | 4 920 | 3 294 | **47 836** | 9 521 | 1 306 | 271 | 1 586 | 2 796 |
| 1988 | 113 | 3 012 | 3 652 | 4 243 | 5 529 | **54 032** | 13 841 | 1 833 | 903 | 4 304 |
| 1989 | **559** | 4 833 | 4 233 | 3 153 | 3 578 | 1 260 | **49 630** | 3 469 | 718 | 1 888 |
| 1990 | 259 | **4 630** | 10 730 | 3 569 | 3 127 | 2 275 | 487 | **30 896** | 1 677 | 929 |
| 1991 | 264 | 4 199 | **22 479** | 11 369 | 3 506 | 2 324 | 2 033 | 688 | **18 728** | 952 |
| 1992 | 132 | 1 818 | 1 987 | **10 761** | 7 316 | 1 075 | 894 | 795 | 857 | **10 940** |
| 1993 | 281 | 2 480 | 3 956 | 2 682 | **7 881** | 4 775 | 1 140 | 523 | 761 | 5 961 |
| 1994 | 315 | 410 | 4 005 | 5 711 | 2 670 | **10 239** | 3 951 | 697 | 216 | 2 773 |
| 1995 | 2 933 | 5 403 | 926 | 3 962 | 3 846 | 1 741 | **5 706** | 1 974 | 211 | 661 |
| 1996 | 1 470 | 8 591 | 9 083 | 921 | 6 129 | 5 427 | 1 494 | **6 580** | 1 593 | 1 142 |
| 1997 | **1 375** | 6 610 | 8 930 | 5 013 | 588 | 4 534 | 3 880 | 1 694 | **4 756** | 1 327 |
| 1998 | 338 | **7 452** | 7 134 | 8 045 | 4 667 | 647 | 3 480 | 2 503 | 647 | **1 646** |
| 1999 | 289 | 1 768 | **9 340** | 6 510 | 4 866 | 2 792 | 886 | 1 798 | 1 377 | 898 |
| 2000 | **5 202** | 2 206 | 1 985 | **4 558** | 2 320 | 1 934 | 431 | 37 | 159 | 281 |
| 2001 | 1 228 | 20 074 | 8 530 | 3 014 | **4 987** | 1 382 | 1 342 | 450 | 111 | 204 |
| 2002 | 1 374 | 2 723 | 41 274 | 6 122 | 2 476 | **5 467** | 1 861 | 522 | 133 | 54 |
| 2003 | 1 289 | 5 477 | 8 162 | 53 003 | 7 229 | 2 873 | **3 089** | 167 | 3 | 0 |
| 2004 | **6 433** | 17 475 | 7 623 | 9 750 | 58 030 | 4 531 | 1 714 | **612** | 122 | 0 |
| 2005 | 2 050 | **23 750** | 21 396 | 5 063 | 4 198 | 38 357 | 1 328 | 2 062 | **57** | 30 |
| 2006 | **4 481** | 5 540 | **39 315** | 17 301 | 4 452 | 3 831 | 21 054 | 571 | 66 | **22** |
| 2007 | 291 | **13 087** | 14 014 | **27 420** | 7 100 | 1 222 | 960 | 4 205 | 97 | 4 |
| 2008 | 2 570 | 4 444 | **18 989** | 5 803 | **8 906** | 1 437 | 320 | 176 | 824 | 19 |

[1] Bold and underlined figures represent dominant year-classes

**Table 5**. Total catch biomass[1] (metric tons) and total catch (metric tons) by country for the Northwest Atlantic mackerel in NAFO Subareas 2-6, 1968-2008.

| YEAR | CATCH BIOMASS | CATCH (metric tons) | | | |
|---|---|---|---|---|---|
| | (metric tons) | Canada | US[2] | Foreign (US waters) | TOTAL |
| 1968 | 100 614 | 20 819 | 3 929 | 65 747 | 90 495 |
| 1969 | 150 828 | 17 364 | 4 364 | 114 189 | 135 917 |
| 1970 | 251 523 | 19 959 | 4 049 | 210 864 | 234 872 |
| 1971 | 399 202 | 24 496 | 2 406 | 355 892 | 382 794 |
| 1972 | 432 073 | 22 360 | 2 006 | 391 464 | 415 830 |
| 1973 | 445 659 | 38 514 | 1 336 | 396 759 | 436 609 |
| 1974 | 373 836 | 44 655 | 1 042 | 321 837 | 367 534 |
| 1975 | 307 814 | 36 258 | 1 974 | 271 719 | 309 951 |
| 1976 | 259 146 | 33 065 | 2 712 | 223 275 | 259 052 |
| 1977 | 80 611 | 22 765 | 1 377 | 56 067 | 80 209 |
| 1978 | 34 409 | 25 899 | 1 605 | 841 | 28 345 |
| 1979 | 36 397 | 30 612 | 1 990 | 440 | 33 042 |
| 1980 | 33 460 | 22 296 | 2 683 | 566 | 25 545 |
| 1981 | 30 849 | 19 294 | 6 151 | 5 361 | 30 806 |
| 1982 | 28 369 | 16 380 | 4 521 | 6 647 | 27 548 |
| 1983 | 29 935 | 19 797 | 6 807 | 5 955 | 32 559 |
| 1984 | 34 579 | 17 320 | 8 273 | 15 045 | 40 638 |
| 1985 | 70 409 | 29 855 | 9 345 | 32 409 | 71 609 |
| 1986 | 67 143 | 30 325 | 13 860 | 26 507 | 70 692 |
| 1987 | 75 485 | 27 488 | 16 342 | 36 564 | 80 394 |
| 1988 | 91 461 | 24 060 | 15 574 | 42 858 | 82 492 |
| 1989 | 73 321 | 20 795 | 16 503 | 36 823 | 74 121 |
| 1990 | 58 578 | 19 190 | 33 955 | 30 678 | 83 823 |
| 1991 | 66 542 | 24 914 | 30 625 | 15 714 | 71 253 |
| 1992 | 36 575 | 24 307 | 13 216 | 0 | 37 523 |
| 1993 | 30 440 | 26 158 | 5 601 | 0 | 31 759 |
| 1994 | 30 987 | 20 564 | 11 341 | 0 | 31 905 |
| 1995 | 27 363 | 17 706 | 9 748 | 0 | 27 454 |
| 1996 | 42 430 | 20 394 | 19 487 | 0 | 39 881 |
| 1997 | 38 707 | 21 309 | 17 196 | 0 | 38 505 |
| 1998 | 36 558 | 19 334 | 15 268 | 0 | 34 602 |
| 1999 | 30 525 | 16 561 | 13 615 | 0 | 30 176 |
| 2000 | 19 111 | 13 383 | 7 208 | 0 | 20 591 |
| 2001 | 41 322 | 23 950 | 14 546 | 0 | 38 497 |
| 2002 | 62 005 | 34 309 | 27 860 | 0 | 62 169 |
| 2003 | 81 291 | 44 475 | 35 243 | 0 | 79 718 |
| 2004 | 106 290 | 53 365 | 57 020 | 0 | 110 385 |
| 2005 | 98 291 | 54 279 | 43 774 | 0 | 98 053 |
| 2006 | 96 632 | 53 649 | 58 359 | 0 | 112 008 |
| 2007 | 68 402 | 53 016 | 26 518 | 0 | 79 534 |
| 2008 | 43 487 | 28 245 | 22 798 | 0 | 51 043 |

[1] From Table 4
[2] Commercial discards and recreational landings (chartered vessels) included

**Table 6**. Mean proportion of maturity at age for the Northwest Atlantic mackerel in NAFO Subareas 3-4, 1968-2008[1].

| | AGE (yr) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+ |
| 1968 | 0.288 | 0.495 | 0.705 | 0.853 | 0.934 | 0.972 | 0.988 | 0.995 | 0.998 | 0.999 |
| 1969 | 0.288 | 0.495 | 0.705 | 0.853 | 0.934 | 0.972 | 0.988 | 0.995 | 0.998 | 0.999 |
| 1970 | 0.288 | 0.495 | 0.705 | 0.853 | 0.934 | 0.972 | 0.988 | 0.995 | 0.998 | 0.999 |
| 1971 | 0.288 | 0.495 | 0.705 | 0.853 | 0.934 | 0.972 | 0.988 | 0.995 | 0.998 | 0.999 |
| 1972 | 0.288 | 0.495 | 0.705 | 0.853 | 0.934 | 0.972 | 0.988 | 0.995 | 0.998 | 0.999 |
| 1973 | 0.288 | 0.495 | 0.705 | 0.853 | 0.934 | 0.972 | 0.988 | 0.995 | 0.998 | 0.999 |
| 1974 | 0.288 | 0.495 | 0.705 | 0.853 | 0.934 | 0.972 | 0.988 | 0.995 | 0.998 | 0.999 |
| 1975 | 0.163 | 0.857 | 0.995 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1976 | 0.204 | 0.785 | 0.981 | 0.999 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1977 | 0.049 | 0.841 | 0.998 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1978 | 0.429 | 0.907 | 0.992 | 0.999 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1979 | 0.368 | 0.593 | 0.785 | 0.902 | 0.958 | 0.983 | 0.993 | 0.997 | 0.999 | 1.000 |
| 1980 | 0.231 | 0.972 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1981 | 0.123 | 0.984 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1982 | 0.015 | 0.995 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1983 | 0.378 | 0.654 | 0.854 | 0.948 | 0.983 | 0.994 | 0.998 | 0.999 | 1.000 | 1.000 |
| 1984 | 0.010 | 0.503 | 0.990 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1985 | 0.402 | 0.879 | 0.988 | 0.999 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1986 | 0.422 | 0.847 | 0.974 | 0.996 | 0.999 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1987 | 0.442 | 0.815 | 0.961 | 0.993 | 0.999 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1988 | 0.395 | 0.904 | 0.980 | 0.996 | 0.999 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1989 | 0.349 | 0.992 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1990 | 0.283 | 0.937 | 0.998 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1991 | 0.216 | 0.881 | 0.995 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1992 | 0.229 | 0.807 | 0.977 | 0.997 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1993 | 0.212 | 0.771 | 0.973 | 0.997 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1994 | 0.172 | 0.801 | 0.979 | 0.998 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1995 | 0.242 | 0.733 | 0.959 | 0.995 | 0.999 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1996 | 0.195 | 0.736 | 0.970 | 0.997 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1997 | 0.132 | 0.830 | 0.985 | 0.999 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1998 | 0.068 | 0.925 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1999 | 0.117 | 0.766 | 0.988 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 2000 | 0.459 | 0.908 | 0.991 | 0.999 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 2001 | 0.430 | 0.929 | 0.996 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 2002 | 0.306 | 0.949 | 0.999 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 2003 | 0.241 | 0.953 | 0.999 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 2004 | 0.138 | 0.855 | 0.995 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 2005 | 0.088 | 0.624 | 0.966 | 0.998 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 2006 | 0.251 | 0.845 | 0.989 | 0.999 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 2007 | 0.081 | 0.922 | 0.999 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 2008 | 0.209 | 0.790 | 0.982 | 0.999 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |

[1] From Canadian samples collected in June and July; data in 1974 used for 1968-1973

**Table 7**. Separable VPA (SVPA) for the Northwest Atlantic mackerel: Sum of squared residuals (SSQ) for different terminal fishing mortality (Ft) and selectivity (St) values.

| TERMINAL FISHING MORTALITY (Ft) | TERMINAL SELECTIVITY (St) | | |
|---|---|---|---|
| | 0.75 | 1.00 | 1.25 |
| 0.10 | 166.38 | 164.54 | 163.11 |
| 0.20 | 160.61 | 157.25 | 154.69 |
| 0.30 | 157.91 | 153.85 | 150.81 |
| 0.40 | 156.30 | 151.82 | 148.49 |
| 0.50 | 155.24 | 150.46 | 146.95* |

* Lowest value; outputs from this SVPA were used to start a traditional VPA

**Table 8**. Separable VPA (SVPA) for six New England groundfish/flatfish stocks: Sum of squared residuals (SSQ) for different terminal fishing mortality (Ft) and selectivity (St) values.

Georges Bank Haddock

| | St | | |
|---|---|---|---|
| Ft | 0.75 | 1 | 1.25 |
| 0.10 | 809.0 | 806.1 | 805.98* |
| 0.20 | 817.0 | 814.4 | 814.1 |
| 0.30 | 824.3 | 821.8 | 821.1 |
| 0.40 | 830.9 | 828.2 | 827.3 |
| 0.50 | 836.7 | 834.0 | 832.8 |

Georges Bank Cod

| | St | | |
|---|---|---|---|
| Ft | 0.75 | 1 | 1.25 |
| 0.10 | 85.3 | 89.0 | 92.4 |
| 0.20 | 76.5 | 78.8 | 80.7 |
| 0.30 | 72.1 | 73.6 | 74.9 |
| 0.40 | 69.3 | 70.3 | 71.2 |
| 0.50 | 67.27* | 68.0 | 68.6 |

Gulf of Maine Cod

| | St | | |
|---|---|---|---|
| Ft | 0.75 | 1 | 1.25 |
| 0.10 | 1096.4 | 1119.2 | 1135.3 |
| 0.20 | 1042.8 | 1056.9 | 1066.4 |
| 0.30 | 1007.8 | 1017.8 | 1024.5 |
| 0.40 | 982.0 | 989.7 | 994.9 |
| 0.50 | 961.9* | 968.1 | 972.2 |

Georges Bank YTF

| | St | | |
|---|---|---|---|
| Ft | 0.75 | 1 | 1.25 |
| 0.10 | 100.2 | 117.9 | 125.7 |
| 0.20 | 99.9 | 107.3 | 112.9 |
| 0.30 | 96.1 | 102.1 | 106.4 |
| 0.40 | 93.6 | 98.7 | 102.4 |
| 0.50 | 91.83* | 96.4 | 99.6 |

SNEMA YTF[1]

| | St | | |
|---|---|---|---|
| Ft | 0.75 | 1 | 1.25 |
| 0.10 | 184.4 | 199.1 | 208.5 |
| 0.20 | 178.9 | 190.3 | 197.5 |
| 0.30 | 176.0 | 185.8 | 191.9 |
| 0.40 | 174.0 | 183.0 | 188.4 |
| 0.50 | 172.68* | 181.0 | 185.9 |

GOMCC YTF[2]

| | St | | |
|---|---|---|---|
| Ft | 0.75 | 1 | 1.25 |
| 0.10 | 73.1 | 77.4 | 80.7 |
| 0.20 | 68.1 | 71.4 | 73.6 |
| 0.30 | 65.5 | 68.4 | 70.1 |
| 0.40 | 64.0 | 66.4 | 68.0 |
| 0.50 | 62.87* | 65.0 | 66.5 |

* Lowest values; outputs from these SVPA were used to start traditional VPAs

[1] South New England and Maine yellowtail flounder

[2] Gulf of Maine and Cape Cod yellowtail flounder

**Table 9**. Traditional VPA: Recruits at age 1 (thousands of fish), fishing mortality (average ages 3-5) and spawning stock biomass (metric tons) calculated from the outputs of a Separable VPA (SVPA) with **Ft=0.50** and **St=1.25**.

NORTHWEST ATLANTIC MACKEREL
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| YEAR | RECRUITS AGE 1 (thousands of fish) | FISHING MORTALITY (average ages 3-5) | SPAWNING STOCK BIOMASS (metric tons) |
|---|---|---|---|
| 1968 | 4 964 383 | 0.327 | 651 327 |
| 1969 | 1 893 608 | 0.198 | 931 000 |
| 1970 | 2 261 357 | 0.226 | 1 077 340 |
| 1971 | 1 199 317 | 0.371 | 1 235 249 |
| 1972 | 1 336 130 | 0.357 | 1 315 682 |
| 1973 | 1 064 366 | 0.543 | 998 062 |
| 1974 | 1 514 764 | 0.579 | 762 317 |
| 1975 | 1 461 885 | 0.592 | 626 858 |
| 1976 | 201 302 | 0.811 | 463 295 |
| 1977 | 38 778 | 0.324 | 290 210 |
| 1978 | 24 638 | 0.100 | 271 422 |
| 1979 | 148 469 | 0.102 | 248 086 |
| 1980 | 41 448 | 0.174 | 244 954 |
| 1981 | 101 595 | 0.155 | 199 289 |
| 1982 | 417 340 | 0.178 | 191 801 |
| 1983 | 1 916 736 | 0.172 | 246 900 |
| 1984 | 85 387 | 0.127 | 304 133 |
| 1985 | 129 435 | 0.158 | 557 060 |
| 1986 | 97 699 | 0.174 | 519 437 |
| 1987 | 98 244 | 0.232 | 413 843 |
| 1988 | 256 695 | 0.405 | 343 998 |
| 1989 | 418 017 | 0.287 | 303 511 |
| 1990 | 96 307 | 0.334 | 252 305 |
| 1991 | 165 360 | 0.354 | 244 934 |
| 1992 | 147 725 | 0.219 | 184 510 |
| 1993 | 25 406 | 0.173 | 173 467 |
| 1994 | 138 247 | 0.232 | 145 755 |
| 1995 | 181 819 | 0.209 | 124 358 |
| 1996 | 129 339 | 0.385 | 124 588 |
| 1997 | 182 612 | 0.347 | 113 561 |
| 1998 | 90 237 | 0.549 | 105 652 |
| 1999 | 156 374 | 0.569 | 89 915 |
| 2000 | 1 254 978 | 0.262 | 196 928 |
| 2001 | 176 344 | 0.318 | 327 978 |
| 2002 | 140 739 | 0.264 | 342 691 |
| 2003 | 361 323 | 0.421 | 316 383 |
| 2004 | 621 930 | 0.557 | 274 434 |
| 2005 | 187 967 | 0.537 | 232 800 |
| 2006 | 360 159 | 0.960 | 207 527 |
| 2007 | 95 755 | 0.796 | 173 349 |
| 2008 | 494 404 | 0.480 | 133 957 |

**Table 10**. Traditional VPA: Mohn's Rho statistic for recruits (age 1), population abundance, and fishing mortality (average ages 3-5) calculated from the outputs of a Separable VPA (SVPA) with **Ft=0.50** and **St=1.25**.

| TERMINAL YEAR | RECRUITS AGE 1 | POPULATION ABUNDANCE | FISHING MORTALITY (3-5) |
|---|---|---|---|
| 2003 | -0.370 | -0.261 | 0.374 |
| 2004 | 0.703 | 0.422 | -0.084 |
| 2005 | 0.874 | 0.265 | -0.146 |
| 2006 | -0.050 | 0.135 | -0.443 |
| 2007 | -0.535 | 0.141 | -0.396 |
| AVERAGE: | 0.125 | 0.140 | -0.139 |
| TOTAL | 0.623 | 0.701 | -0.695 |

**Table 11**. Input data for the yield per recruit (YPR) and projection (AGEPRO[1]) analyses. Recruits at age 1 for all year-classes (n=41) and selectivity data (partial recruitment) are from a traditional VPA started with the outputs of a Separable VPA (SVPA) with **Ft=0.50** and **St=1.25**.

| AGE | SELECTIVITY [2] | NATURAL MORTALITY | STOCK WEIGHT [3] | CATCH WEIGHT [4] | SPAWNING STOCK WEIGHT | FRACTION MATURE [5] |
|---|---|---|---|---|---|---|
| 1 | 0.1142 | 0.2 | 0.118 | 0.147 | 0.118 | 0.154 |
| 2 | 0.4893 | 0.2 | 0.184 | 0.237 | 0.184 | 0.807 |
| 3 | 0.8968 | 0.2 | 0.283 | 0.337 | 0.283 | 0.986 |
| 4 | 1.0000 | 0.2 | 0.364 | 0.403 | 0.364 | 0.999 |
| 5 | 0.9935 | 0.2 | 0.435 | 0.467 | 0.435 | 1.000 |
| 6 | 1.0000 | 0.2 | 0.492 | 0.512 | 0.492 | 1.000 |
| 7 | 0.9822 | 0.2 | 0.557 | 0.589 | 0.557 | 1.000 |
| 8 | 1.0000 | 0.2 | 0.603 | 0.613 | 0.603 | 1.000 |
| 9 | 0.9646 | 0.2 | 0.619 | 0.604 | 0.619 | 1.000 |
| 10 | 0.9646 | 0.2 | 0.650 | 0.650 | 0.650 | 1.000 |

[1] Recruit model = empirical CDF; harvest strategy = F at 40%

[2] From Fs (3-5), average 2004-2008

[3] Rivard's method (NOAA Fisheries Toolbox 2009a), average 2004-2008

[4] Average 2004-2008

[5] Canadian data, average 2004-2008

**Table 12.** Yield per recruit analysis (YPR) results (F at 40% as a proxy of $F_{msy}$). Selectivity data (partial recruitment) used in this analysis are from a traditional VPA started with the outputs of a Separable VPA (SVPA) with **Ft=0.50** and **St=1.25**.

| | PARAMETERS | | | | | | |
|---|---|---|---|---|---|---|---|
| | F | Y/R | SSB/R | TB/R | Mean Age | Mean Gen. Time | Expected Spawnings |
| F-0 | 0 | 0 | 1.752 | 2.067 | 5.517 | 8.146 | 3.075 |
| F-0.1 | 0.259 | 0.162 | 0.616 | 0.892 | 2.994 | 4.725 | 1.567 |
| F-Max | 0.812 | 0.187 | 0.232 | 0.473 | 2.028 | 3.083 | 0.699 |
| F at 40% | 0.215 | 0.153 | 0.701 | 0.982 | 3.194 | 5.035 | 1.724 |

**Table 13.** Biological reference points: MSY and $B_{msy}$ as deterministic points estimated by the YPR analysis; msy and $B_{msy}$ were also estimated from stochastic bootstrapped projections (AGEPRO). Recruits and selectivity data (partial recruitment) used in YPR and AGEPRO are from a traditional VPA started with the outputs of a Separable VPA (SVPA) with **Ft=0.50** and **St=1.25**.

| RECRUITS | Analytical | | Stochastic | | F (3-5) $_{2008}$ / Fmsy | SSB $_{2008}$ / Bmsy | |
|---|---|---|---|---|---|---|---|
| (average 1968-2008) | msy (t) | $B_{msy}$ (t) | msy (t) | $B_{msy}$ (t) | Analytical | Analytical | Stochastic |
| 601 918 | 92 232 | 421 830 | 84 025 | 384 258 | 2.100 | 0.318 | 0.349 |

**Table 14**. Additional Separable VPAs (SVPA) for the Northwest Atlantic mackerel: Sum of squared residuals (SSQ) for different terminal fishing mortality (Ft) and selectivity (St) values.

| TERMINAL FISHING MORTALITY (Ft) | TERMINAL SELECTIVITY (St) | | |
|---|---|---|---|
| | 0.75 | 1.00 | 1.25 |
| 0.60 | 154.49 | 149.49 | 145.85 |
| 0.70 | 153.94 | 148.77 | 145.03 |
| 0.80 | 153.52 | 148.21 | 144.39* |
| 0.90 | 153.20 | 147.78 | 143.89* |
| 1.00 | 152.96 | 147.43 | 143.13* |

* Lowest values; outputs from these SVPAs were used to start traditional VPAs

**Table 15**. Traditional VPAs: Recruits at age 1 (thousands of fish), fishing mortality (average ages 3-5) and spawning stock biomass (metric tons) calculated from the outputs of three Separable VPAs (SVPA) with **Ft=0.80, 0.90**, and **1.00** and **St=1.25**.

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| YEAR | RECRUITS AGE 1 (thousands of fish) | | | FISHING MORTALITY (average ages 3-5) | | | SPAWNING STOCK BIOMASS (metric tons) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Ft=0.80 | Ft=0.90 | Ft=1.00 | Ft=0.80 | Ft=0.90 | Ft=1.00 | Ft=0.80 | Ft=0.90 | Ft=1.00 |
| 1968 | 4 969 971 | 4 971 415 | 4 972 711 | 0.324 | 0.323 | 0.323 | 654 756 | 655 593 | 656 329 |
| 1969 | 1 895 906 | 1 896 505 | 1 897 044 | 0.197 | 0.197 | 0.196 | 934 498 | 935 357 | 936 118 |
| 1970 | 2 266 454 | 2 267 768 | 2 268 945 | 0.226 | 0.225 | 0.225 | 1 080 090 | 1 080 780 | 1 081 394 |
| 1971 | 1 203 092 | 1 204 050 | 1 204 904 | 0.369 | 0.369 | 0.369 | 1 239 126 | 1 240 099 | 1 240 965 |
| 1972 | 1 341 345 | 1 342 661 | 1 343 832 | 0.356 | 0.356 | 0.356 | 1 320 080 | 1 321 198 | 1 322 195 |
| 1973 | 1 070 721 | 1 072 323 | 1 073 750 | 0.540 | 0.540 | 0.539 | 1 002 449 | 1 003 568 | 1 004 565 |
| 1974 | 1 526 555 | 1 529 521 | 1 532 160 | 0.574 | 0.572 | 0.571 | 767 530 | 768 859 | 770 047 |
| 1975 | 1 477 844 | 1 481 849 | 1 485 407 | 0.583 | 0.581 | 0.579 | 633 611 | 635 326 | 636 857 |
| 1976 | 205 616 | 206 695 | 207 651 | 0.790 | 0.784 | 0.780 | 471 611 | 473 719 | 475 599 |
| 1977 | 39 679 | 39 904 | 40 103 | 0.312 | 0.309 | 0.307 | 300 529 | 303 137 | 305 460 |
| 1978 | 25 189 | 25 326 | 25 447 | 0.096 | 0.095 | 0.094 | 284 225 | 287 457 | 290 334 |
| 1979 | 151 431 | 152 166 | 152 817 | 0.098 | 0.097 | 0.097 | 260 692 | 263 865 | 266 687 |
| 1980 | 42 077 | 42 234 | 42 373 | 0.169 | 0.168 | 0.167 | 257 313 | 260 418 | 263 176 |
| 1981 | 102 933 | 103 266 | 103 562 | 0.150 | 0.149 | 0.148 | 209 460 | 212 013 | 214 281 |
| 1982 | 422 816 | 424 178 | 425 383 | 0.173 | 0.172 | 0.171 | 202 420 | 205 082 | 207 450 |
| 1983 | 1 934 432 | 1 938 821 | 1 942 703 | 0.167 | 0.166 | 0.165 | 254 491 | 256 386 | 258 069 |
| 1984 | 86 076 | 86 247 | 86 398 | 0.124 | 0.123 | 0.123 | 311 261 | 313 036 | 314 608 |
| 1985 | 130 590 | 130 875 | 131 127 | 0.155 | 0.154 | 0.153 | 566 443 | 568 775 | 570 840 |
| 1986 | 98 389 | 98 559 | 98 709 | 0.171 | 0.170 | 0.170 | 528 343 | 530 553 | 532 510 |
| 1987 | 98 890 | 99 049 | 99 189 | 0.229 | 0.228 | 0.228 | 420 487 | 422 135 | 423 593 |
| 1988 | 258 075 | 258 414 | 258 712 | 0.399 | 0.398 | 0.396 | 349 808 | 351 248 | 352 524 |
| 1989 | 419 885 | 420 344 | 420 747 | 0.283 | 0.282 | 0.281 | 309 308 | 310 745 | 312 015 |
| 1990 | 96 637 | 96 719 | 96 791 | 0.329 | 0.328 | 0.327 | 257 164 | 258 368 | 259 432 |
| 1991 | 165 743 | 165 838 | 165 921 | 0.349 | 0.348 | 0.347 | 249 044 | 250 062 | 250 960 |
| 1992 | 148 044 | 148 122 | 148 191 | 0.217 | 0.216 | 0.216 | 187 023 | 187 643 | 188 190 |
| 1993 | 25 460 | 25 473 | 25 485 | 0.172 | 0.172 | 0.172 | 175 971 | 176 588 | 177 132 |
| 1994 | 138 413 | 138 454 | 138 490 | 0.231 | 0.231 | 0.230 | 148 026 | 148 585 | 149 079 |
| 1995 | 181 819 | 181 819 | 181 819 | 0.208 | 0.208 | 0.208 | 125 498 | 125 777 | 126 024 |
| 1996 | 129 338 | 129 338 | 129 338 | 0.383 | 0.383 | 0.383 | 125 466 | 125 681 | 125 871 |
| 1997 | 182 606 | 182 606 | 182 607 | 0.346 | 0.346 | 0.346 | 114 106 | 114 241 | 114 359 |
| 1998 | 90 180 | 90 170 | 90 163 | 0.548 | 0.547 | 0.547 | 105 966 | 106 043 | 106 113 |
| 1999 | 156 262 | 156 242 | 156 226 | 0.569 | 0.569 | 0.569 | 90 079 | 90 121 | 90 158 |
| 2000 | 1 252 712 | 1 252 331 | 1 252 039 | 0.262 | 0.262 | 0.262 | 196 842 | 196 841 | 196 844 |
| 2001 | 175 817 | 175 734 | 175 672 | 0.318 | 0.319 | 0.319 | 327 501 | 327 425 | 327 368 |
| 2002 | 139 791 | 139 629 | 139 504 | 0.265 | 0.265 | 0.265 | 342 032 | 341 924 | 341 843 |
| 2003 | 355 007 | 353 895 | 353 032 | 0.422 | 0.422 | 0.422 | 315 335 | 315 157 | 315 022 |
| 2004 | 591 574 | 586 065 | 581 725 | 0.561 | 0.562 | 0.563 | 271 880 | 271 434 | 271 087 |
| 2005 | 166 780 | 162 876 | 159 777 | 0.549 | 0.552 | 0.553 | 226 780 | 225 706 | 224 866 |
| 2006 | 284 173 | 270 074 | 258 818 | 1.031 | 1.045 | 1.055 | 192 317 | 189 550 | 187 363 |
| 2007 | 68 034 | 62 975 | 58 940 | 0.992 | 1.039 | 1.080 | 144 704 | 139 452 | 135 286 |
| 2008 | 281 411 | 245 198 | 217 071 | 0.755 | 0.846 | 0.937 | 93 531 | 86 204 | 80 404 |

**Table 16**. Traditional VPA: Mohn's Rho statistic for recruits (age 1), population abundance, and fishing mortality (average ages 3-5) calculated from the outputs of a Separable VPA (SVPA) with **Ft=0.90** and **St-1.25**.

| TERMINAL YEAR | RECRUITS AGE 1 | POPULATION ABUNDANCE | FISHING MORTALITY (3-5) |
|---|---|---|---|
| 2003 | -0.691 | -0.544 | 1.303 |
| 2004 | -0.128 | -0.179 | 0.554 |
| 2005 | 0.064 | -0.196 | 0.476 |
| 2006 | -0.362 | -0.183 | -0.120 |
| 2007 | -0.652 | -0.061 | -0.192 |
| AVERAGE | -0.354 | -0.233 | 0.404 |
| TOTAL | -1.769 | -1.163 | 2.021 |

**Table 17**. Input data for the yield per recruit (YPR) and projection (AGEPRO[1]) analyses. Recruits at age 1 for all year-classes (n=47) and selectivity data (partial recruitment) are from a traditional VPA started with the outputs of a Separable VPA (SVPA) with **Ft=0.90** and **St=1.25**.

| AGE | SELECTIVITY [2] | NATURAL MORTALITY | STOCK WEIGHT [3] | CATCH WEIGHT [4] | SPAWNING STOCK WEIGHT | FRACTION MATURE [5] |
|---|---|---|---|---|---|---|
| 1 | 0.1297 | 0.2 | 0.118 | 0.147 | 0.118 | 0.154 |
| 2 | 0.5017 | 0.2 | 0.184 | 0.237 | 0.184 | 0.807 |
| 3 | 0.9013 | 0.2 | 0.283 | 0.337 | 0.283 | 0.986 |
| 4 | 0.9981 | 0.2 | 0.364 | 0.403 | 0.364 | 0.999 |
| 5 | 0.9895 | 0.2 | 0.435 | 0.467 | 0.435 | 1.000 |
| 6 | 1.0000 | 0.2 | 0.492 | 0.512 | 0.492 | 1.000 |
| 7 | 0.9816 | 0.2 | 0.557 | 0.589 | 0.557 | 1.000 |
| 8 | 1.0000 | 0.2 | 0.603 | 0.613 | 0.603 | 1.000 |
| 9 | 0.9598 | 0.2 | 0.619 | 0.604 | 0.619 | 1.000 |
| 10 | 0.9598 | 0.2 | 0.650 | 0.650 | 0.650 | 1.000 |

[1] Recruit model = empirical CDF; harvest strategy = F at 40%

[2] From Fs (3-5), average 2004-2008

[3] Rivard's method (NOAA Fisheries Toolbox 2009a), average 2004-2008

[4] Average 2004-2008

[5] Canadian data, average 2004-2008

**Table 18.** Yield per recruit analysis (YPR) results (F at 40% as a proxy of $F_{msy}$). Selectivity data (partial recruitment) used in this analysis are from a traditional VPA started with the outputs of a Separable VPA (SVPA) with **Ft=0.90** and **St=1.25**.

| | PARAMETERS | | | | | | |
|---|---|---|---|---|---|---|---|
| | F | Y/R | SSB/R | TB/R | Mean Age | Mean Gen. Time | Expected Spawnings |
| F-0 | 0 | 0 | 1.752 | 2.067 | 5.517 | 8.146 | 3.075 |
| F-0.1 | 0.258 | 0.162 | 0.613 | 0.888 | 2.994 | 4.734 | 1.559 |
| F-Max | 0.787 | 0.186 | 0.233 | 0.474 | 2.036 | 3.110 | 0.701 |
| F at 40% | 0.213 | 0.153 | 0.701 | 0.981 | 3.200 | 5.052 | 1.720 |

**Table 19.** Biological reference points: MSY and $B_{msy}$ as deterministic points estimated by the YPR analysis; msy and $B_{msy}$ were also estimated from stochastic bootstrapped projections (AGEPRO). Recruits and selectivity data (partial recruitment) used in YPR and AGEPRO are from a traditional VPA started with the outputs of a Separable VPA (SVPA) with **Ft=0.90** and **St=1.25**.

| RECRUITS | Analytical | | Stochastic | | $F_{(3-5)\ 2008}$ / Fmsy | $SSB_{\ 2008}$ / Bmsy | |
|---|---|---|---|---|---|---|---|
| (average 1968-2008) | msy (t) | $B_{msy}$ (t) | msy (t) | $B_{msy}$ (t) | Analytical | Analytical | Stochastic |
| 594 042 | 90 734 | 416 346 | 82 520 | 378 629 | 3.979 | 0.207 | 0.228 |

**Table 20.** Biological reference points: MSY and $B_{msy}$ as deterministic points estimated by the YPR analysis; msy and $B_{msy}$ were also estimated from stochastic bootstrapped projections (AGEPRO). Recruits and selectivity data (partial recruitment) used in YPR and AGEPRO are from an **Iterative Cohort model** (J.-J. Maguire, comm. pers.).

| RECRUITS | Analytical | | Stochastic | | $F_{(3-5)\ 2008}$ / Fmsy | $SSB_{\ 2008}$ / Bmsy | |
|---|---|---|---|---|---|---|---|
| (average 1968-2008) | msy (t) | $B_{msy}$ (t) | msy (t) | $B_{msy}$ (t) | Analytical | Analytical | Stochastic |
| 636 440 | 107 183 | 309 482 | 100 750 | 291 029 | 2.315 | 0.314 | 0.333 |

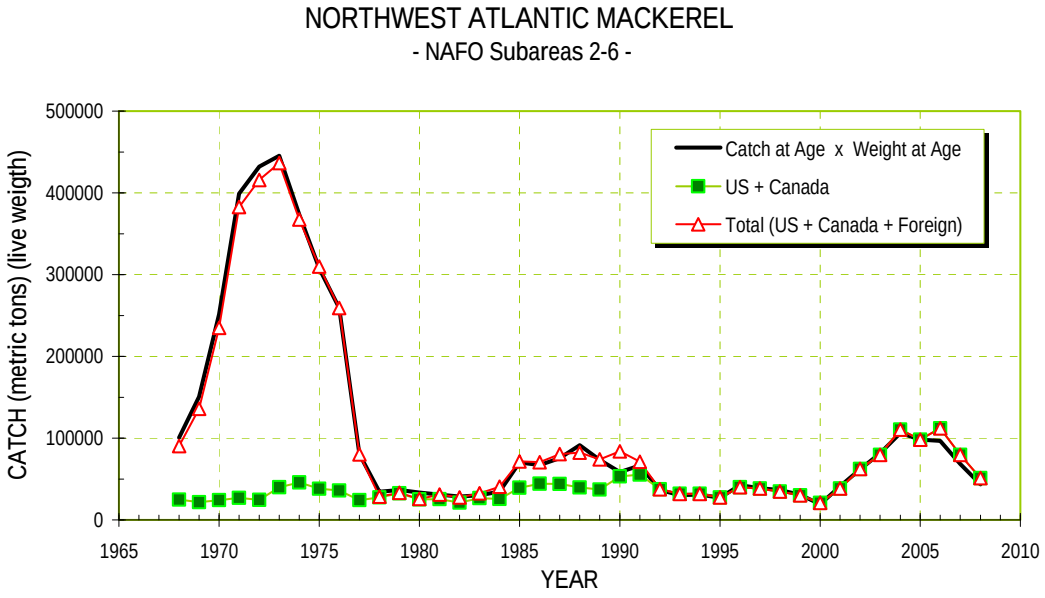


**Figure 1**. Total catch (metric tons) of Atlantic mackerel in NAFO Subareas 2-6, 1968-2008.

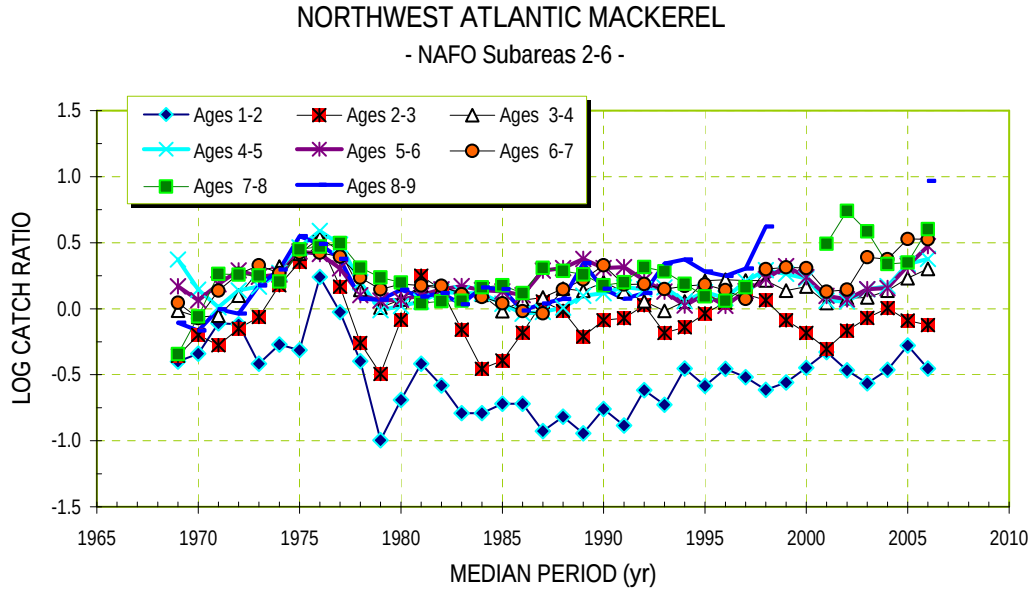


**Figure 2**. Mortality signal in catch data: Log of catch ratio (3 year running average) between successive age groups.

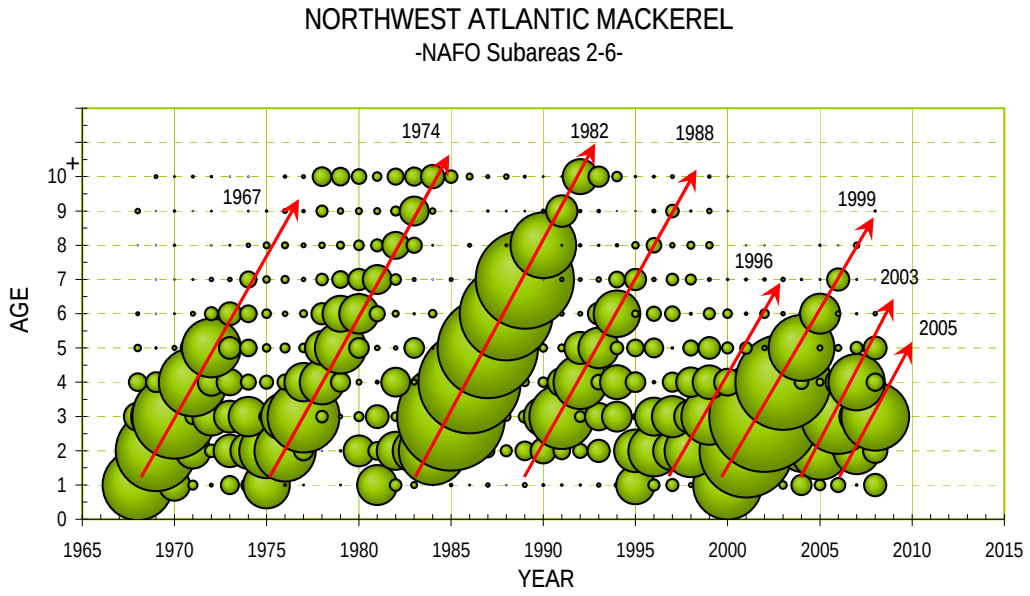


**Figure 3**. Catch at age (%) for the 1968-2008 period (size represents width of bubbles; the year-classes that have dominated the fishery over several years are indicated; the $10^{+}$ age group represents all fish older than 10 years old).

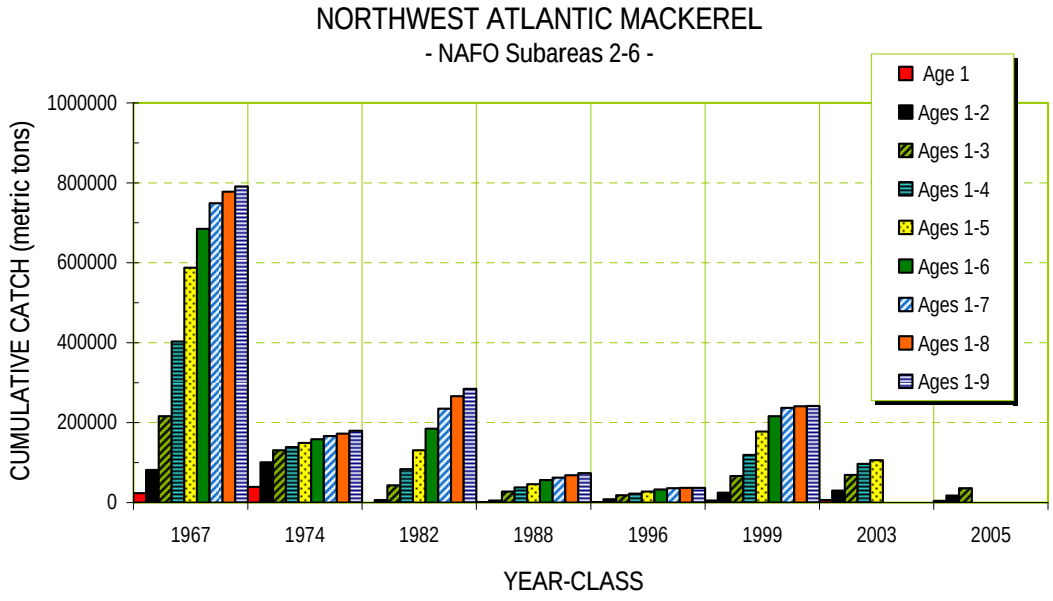


**Figure 4**. Cumulative catch at age (metric tons) for the year-classes that have dominated the fishery over several years since the end of the 1960s.

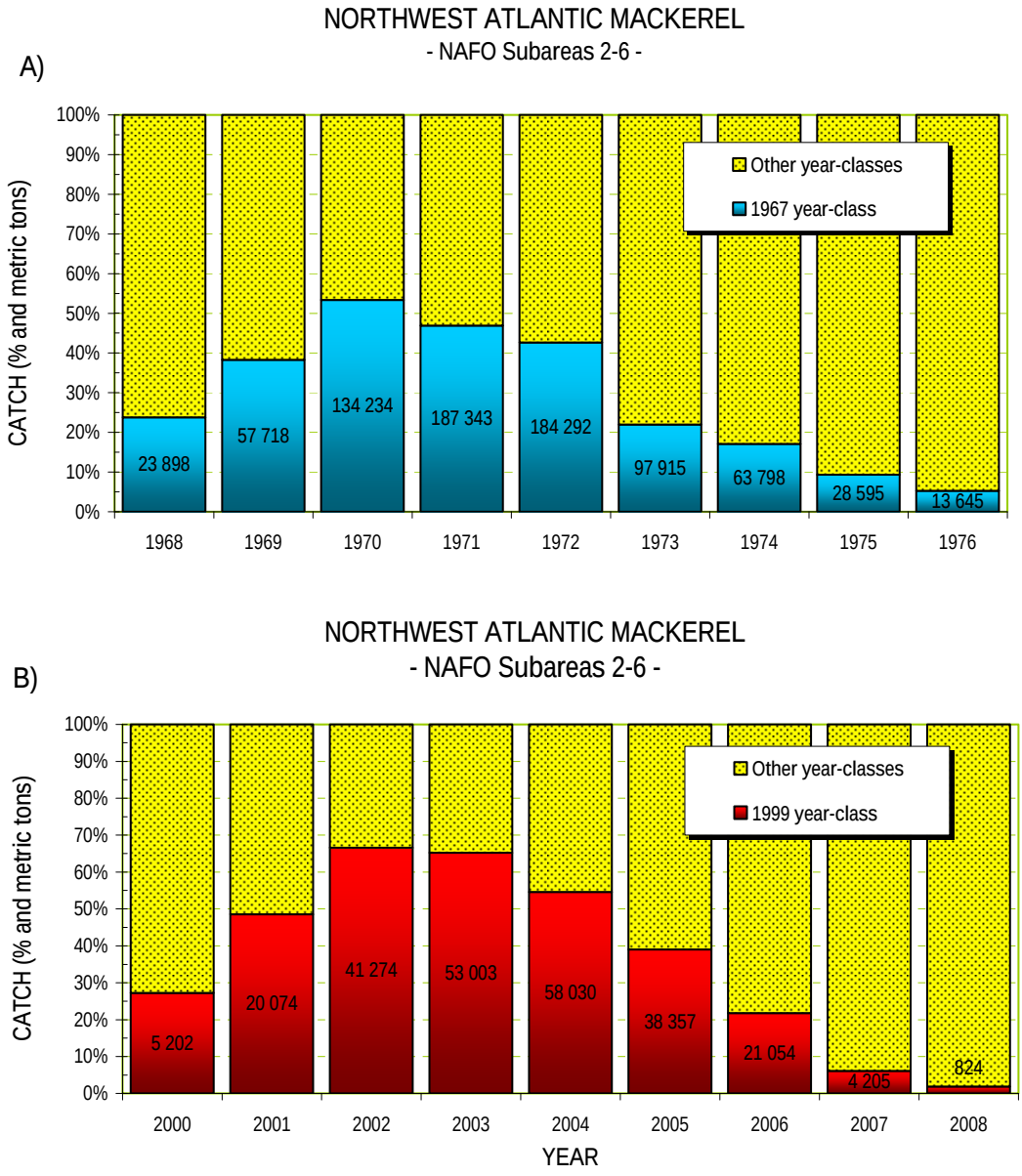


**Figure 5**. Annual catch (% and metric tons) attributed to the dominant 1967 (A) and 1999 (B) year-classes between 1968 and 1976 and 2000 and 2006, respectively.

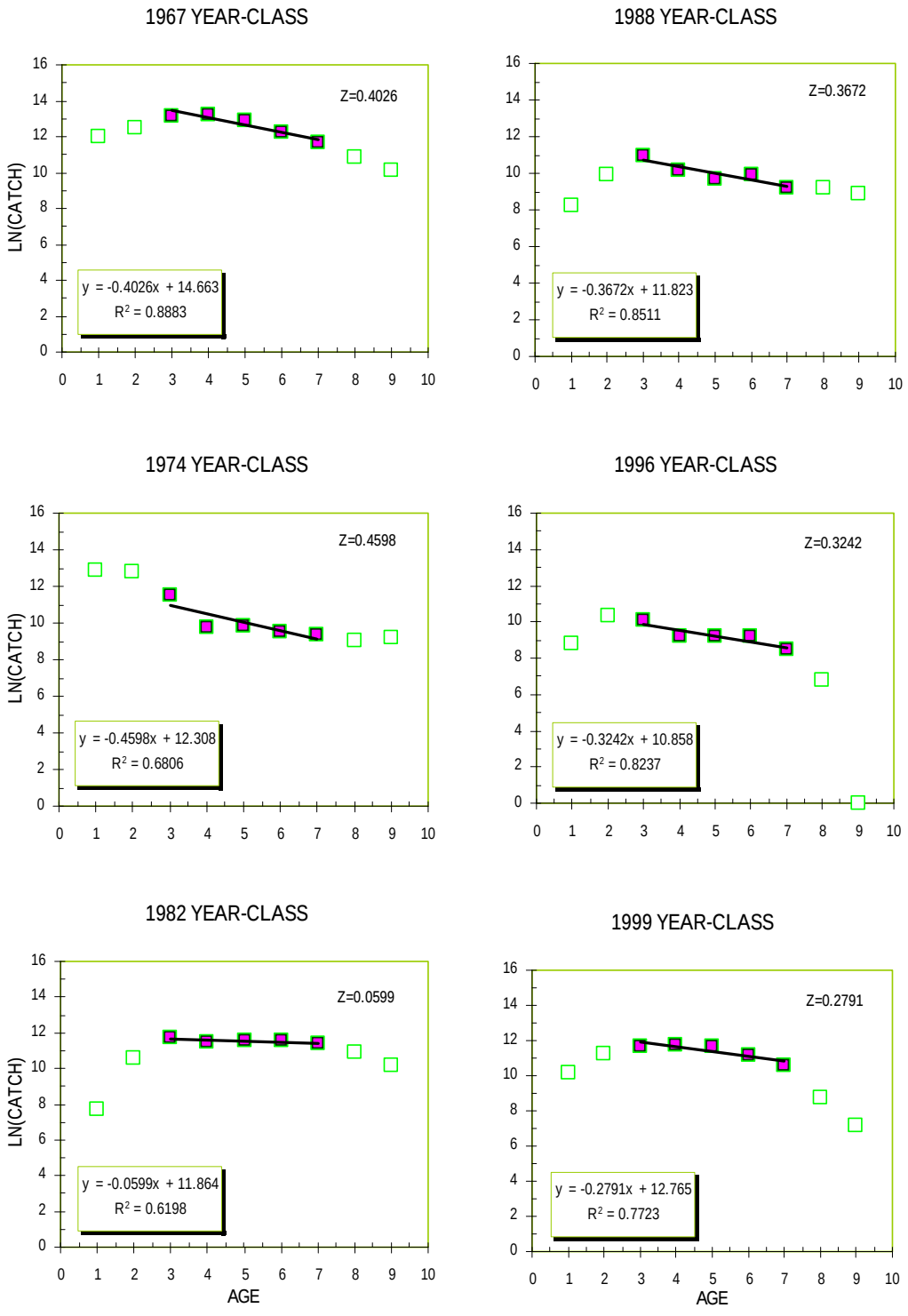


**Figure 6**. Catch at age curves for the Northwest Atlantic mackerel year-classes that have dominated the fishery over several years since the end of the 1960s.

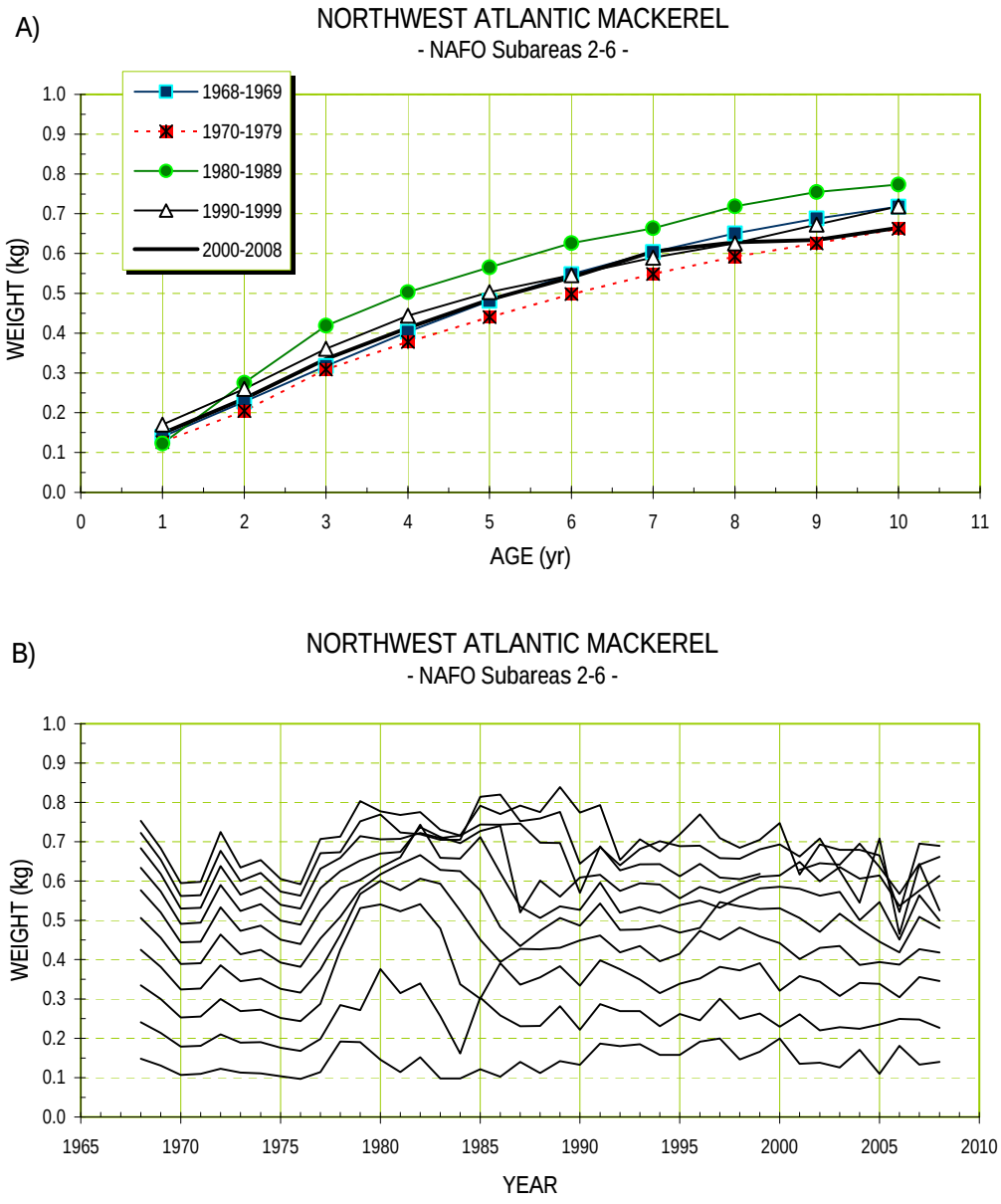


**Figure 7**. Mean weight (kg) at age of the Northwest Atlantic mackerel by group of years (A) and age group (B).

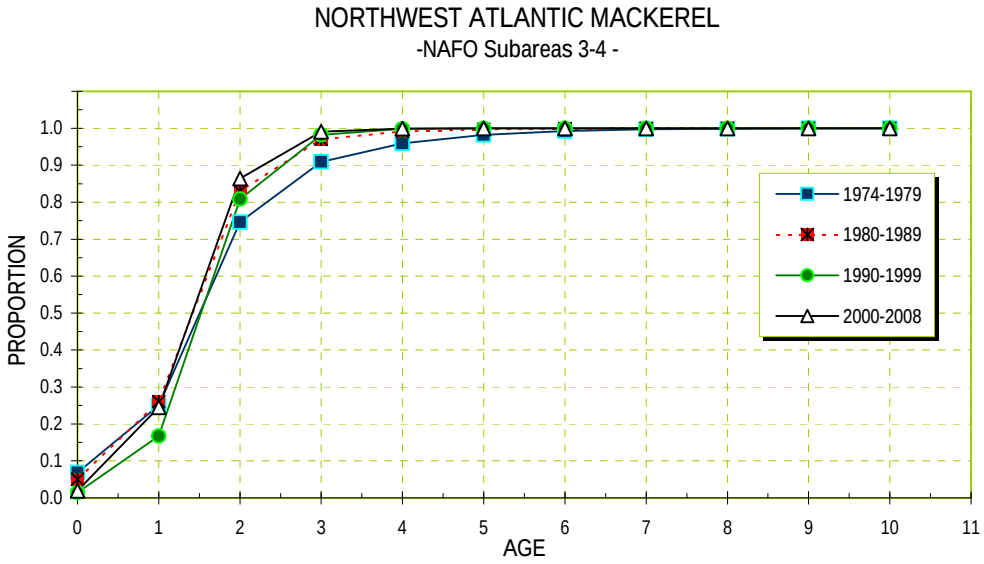


**Figure 8**. Mean proportion of maturity at age of the Northwest Atlantic mackerel by group of years (from Canadian samples collected in June and July; data not available before 1974).

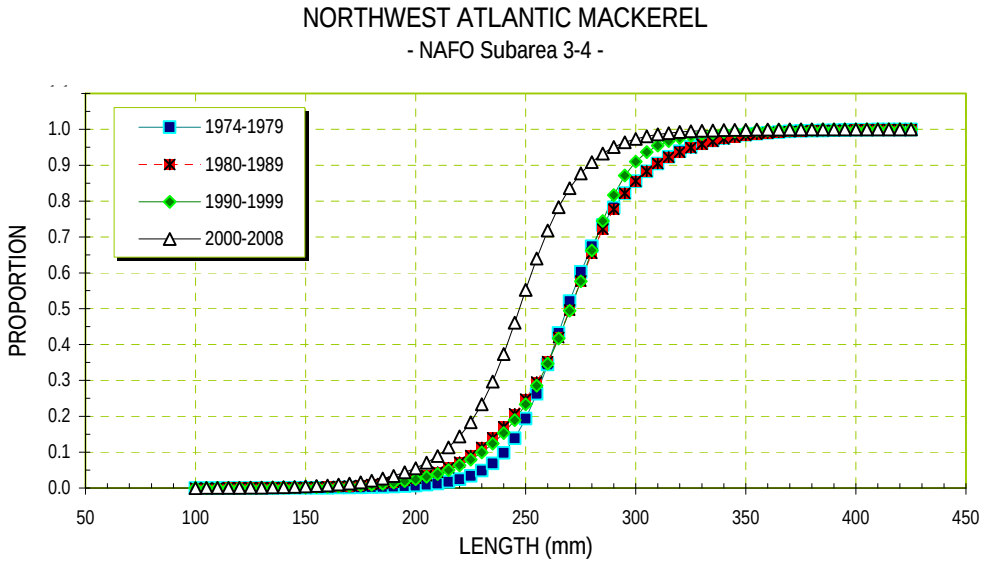


**Figure 9**. Mean proportion of maturity at length (mm) of the Northwest Atlantic mackerel by group of years (from Canadian samples collected in June and July; data not available before 1974).

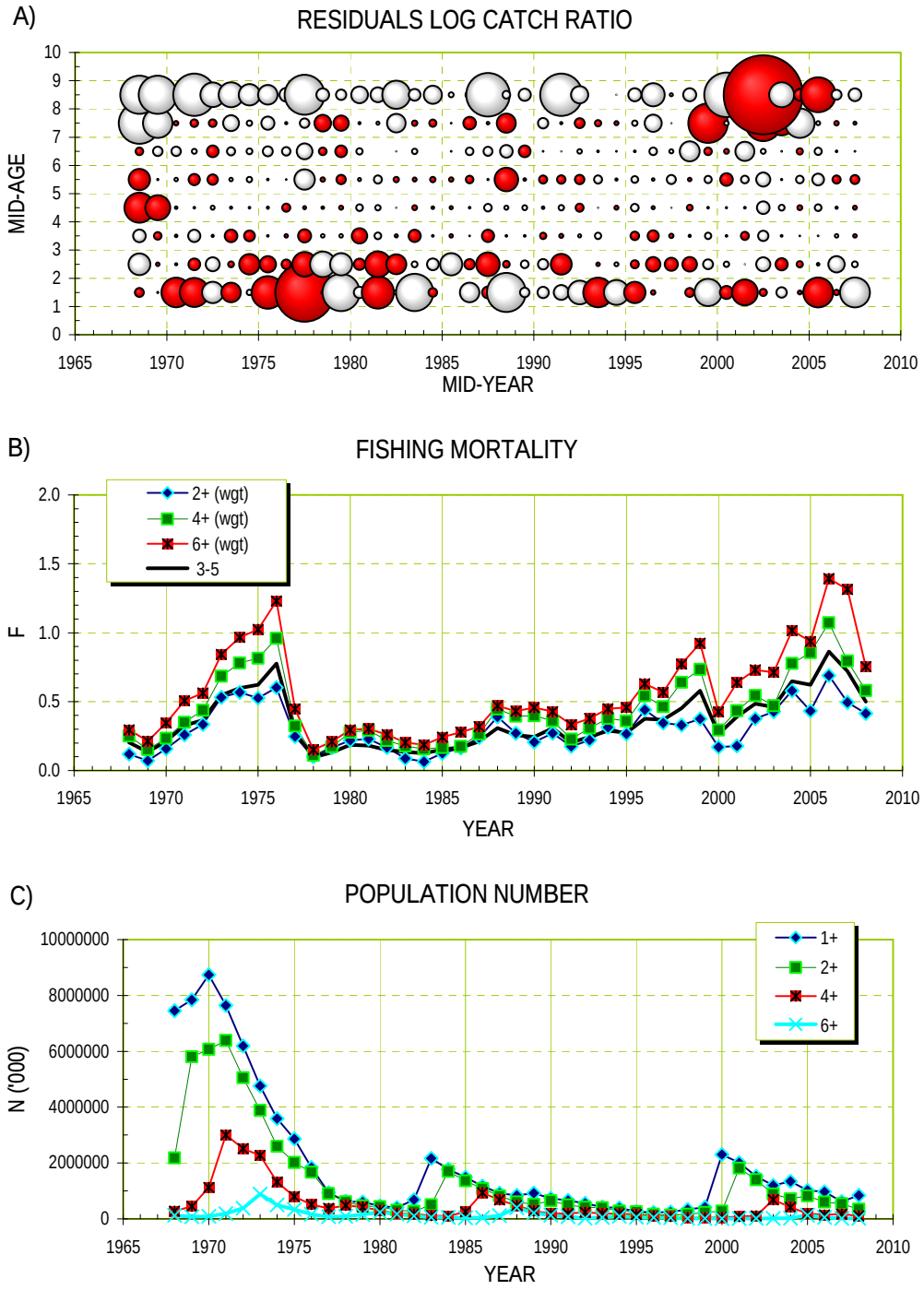


**Figure 10**. Separable VPA (SVPA) analysis for **Ft=0.50** and **St=1.25**: A) log of catch ratio residuals; B) fishing mortality (F) (weighted by abundance); and C) population abundance (thousands of fish).

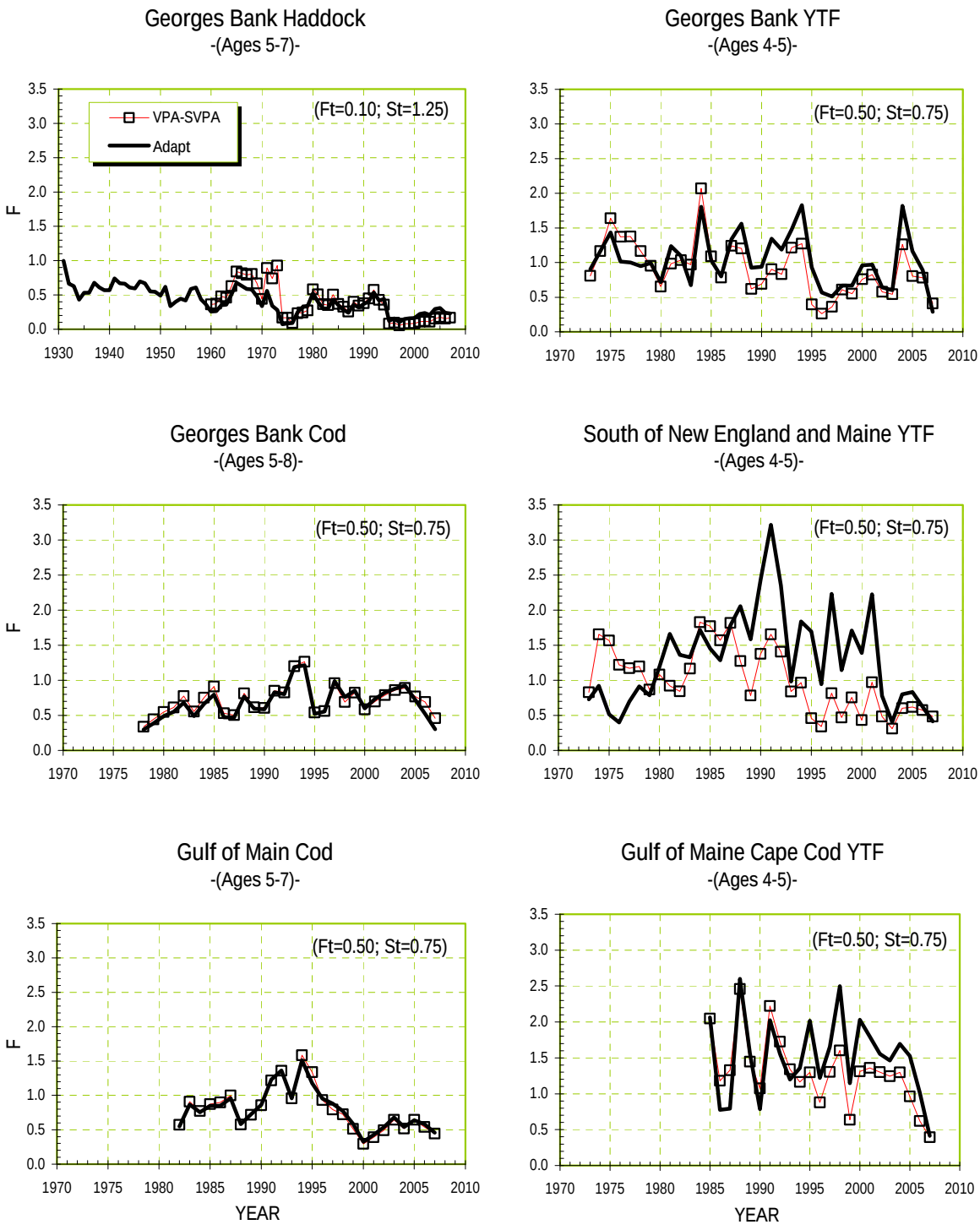


**Figure 11**. Fishing mortalities (F) calculated for six New England groundfish/flatfish stocks. **Adapt**: Current assessment (see references) conducted with at least one index of abundance. **VPA-SVPA**: Traditional VPA started with the outputs of a separable VPA (SVPA) with the catch at age as the only input (**Ft** and **St** were chosen based on the lowest sum of squared residuals).

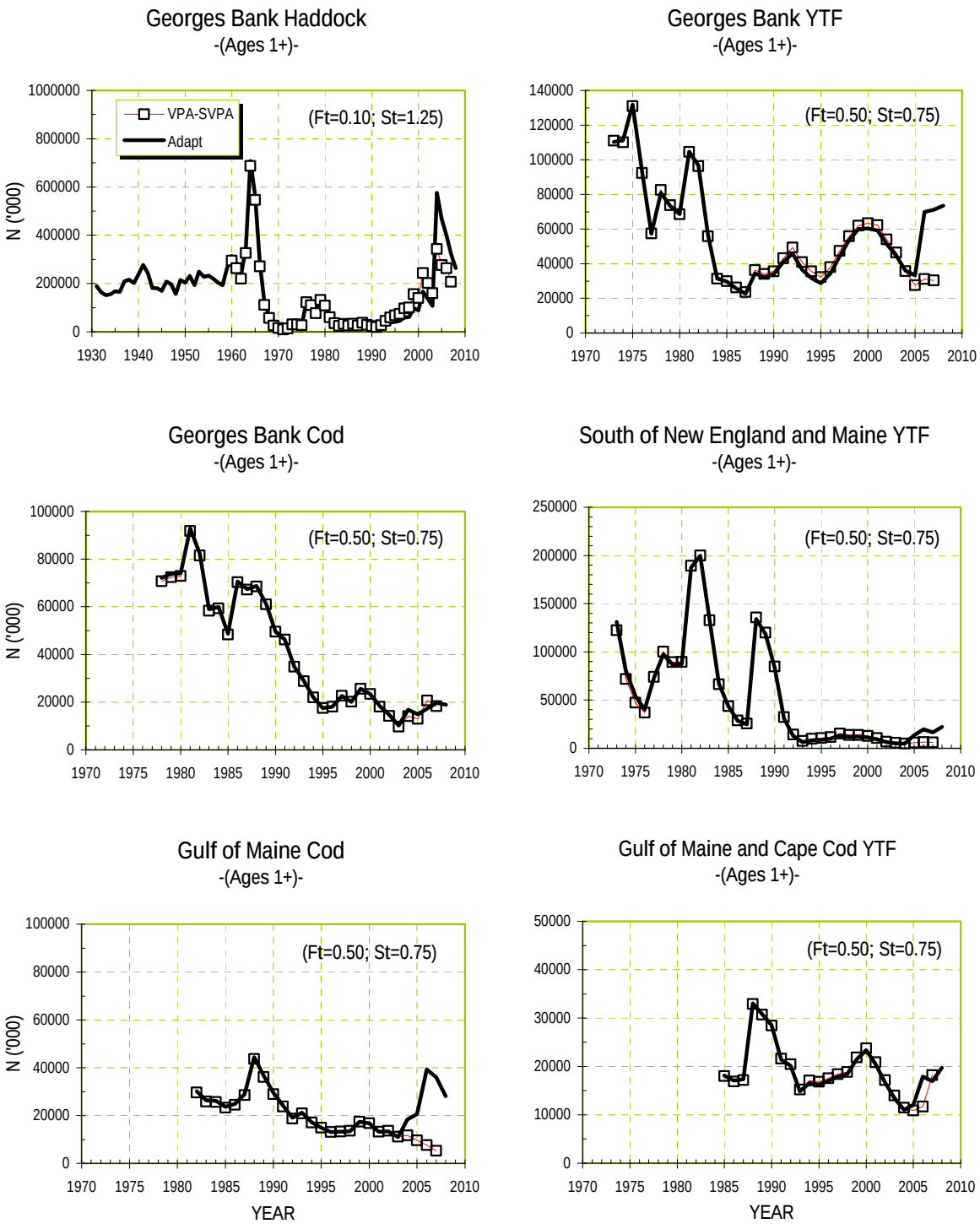


**Figure 12**. Population number (thousands of fish) calculated for six New England groundfish/flatfish stocks. **Adapt**: Current assessment (see references) conducted with at least one index of abundance. **VPA-SVPA**: Traditional VPA started with the outputs of a Separable VPA (SVPA) with the catch at age as the only input (**Ft** and **St** were chosen based on the lowest sum of squared residuals).

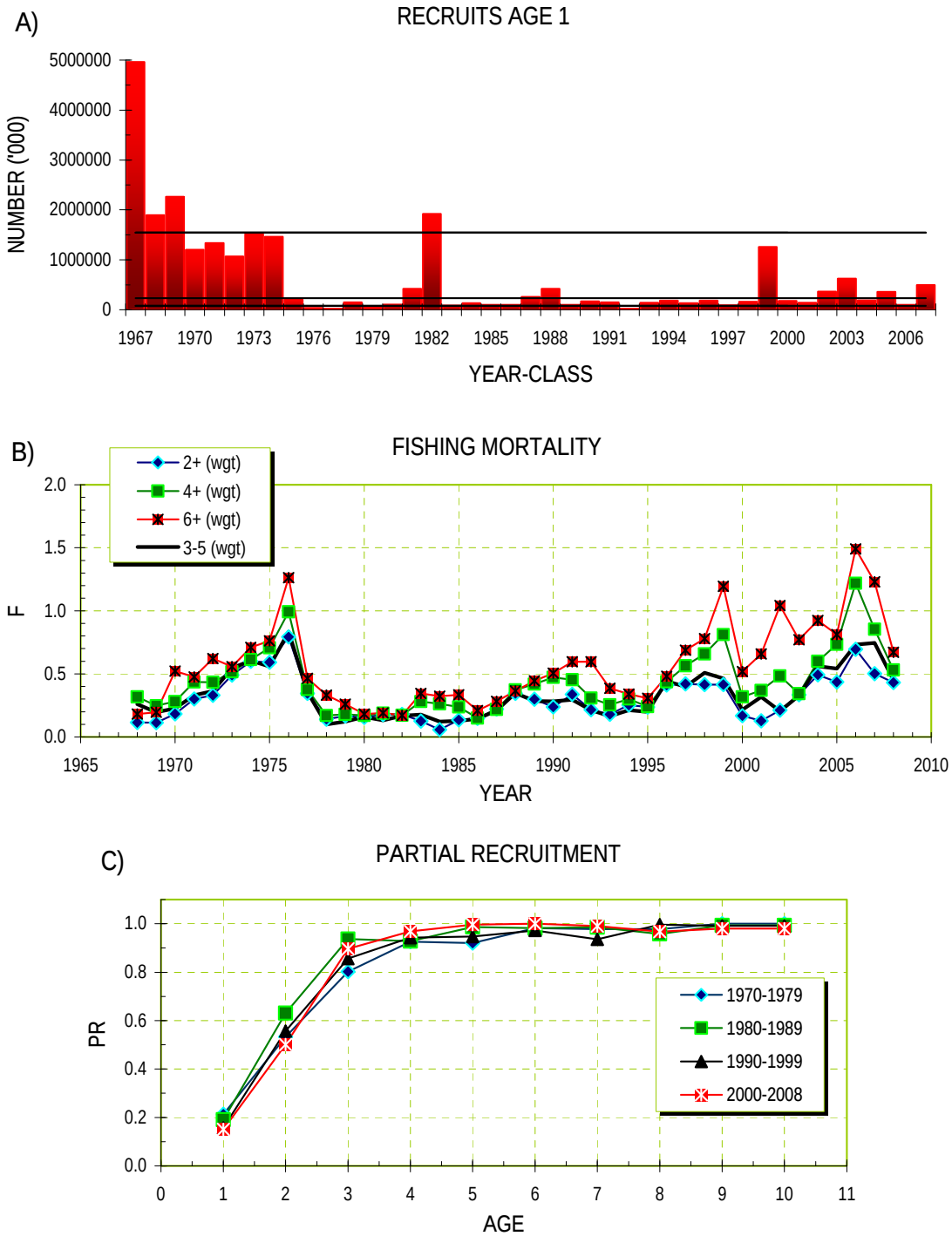


**Figure 13**. Traditional VPA: A) Recruits at age 1 (thousands of fish); B) fishing mortality (weighted by abundance); and C) partial recruitment (from fishing mortalities) for the Northwest Atlantic mackerel. The horizontal lines in A) represent three levels of recruitment: low, average and high. The VPA was started from the outputs of a Separable VPA (SVPA) with **Ft=0.50** and **St=1.25**.

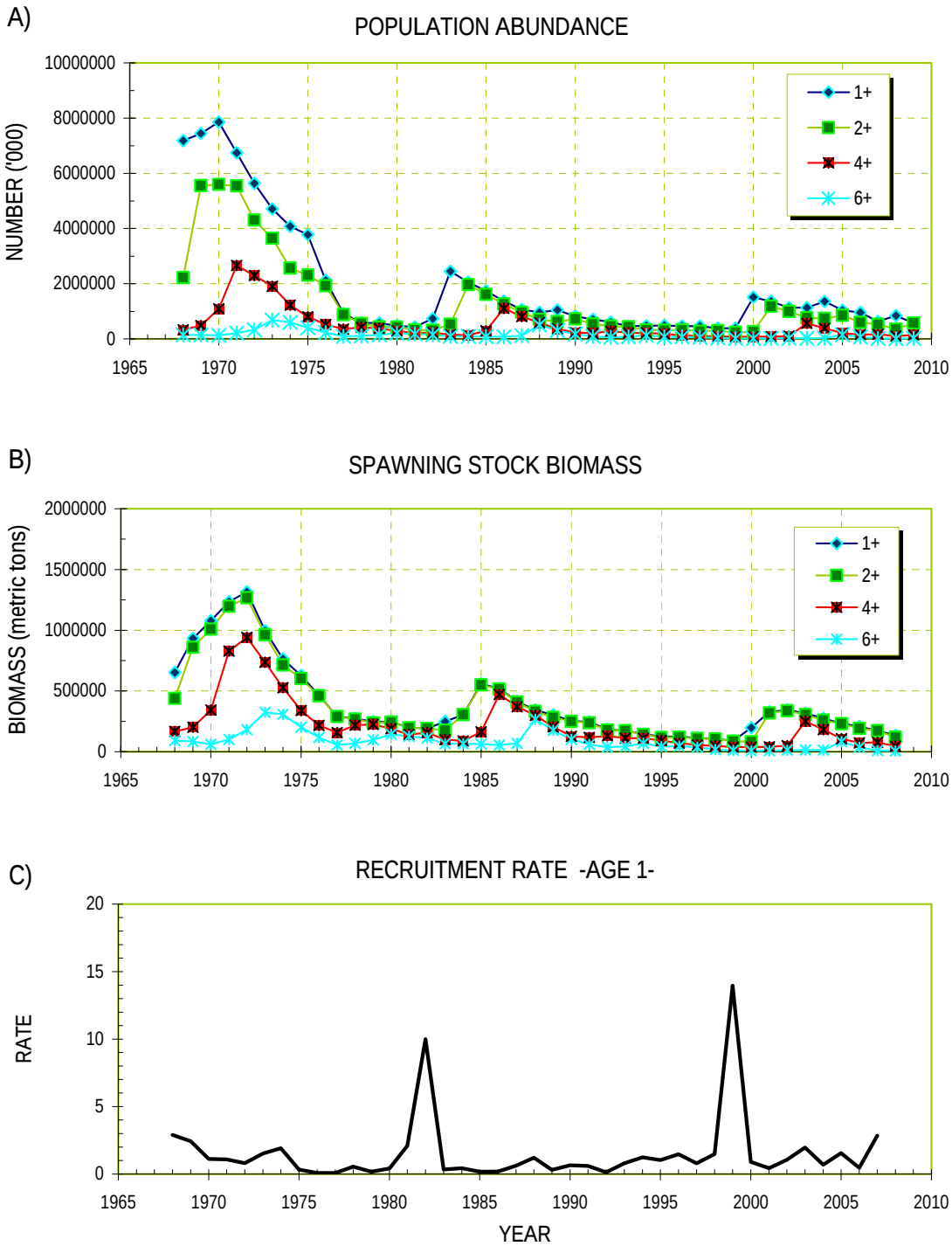


**Figure 14**. Traditional VPA: A) Population abundance (thousands of fish); B) spawning stock biomass (metric tons); and C) recruitment rate at age 1 for the Northwest Atlantic mackerel. The VPA was started from the outputs of a Separable VPA (SVPA) with **Ft=0.50** and **St=1.25**.

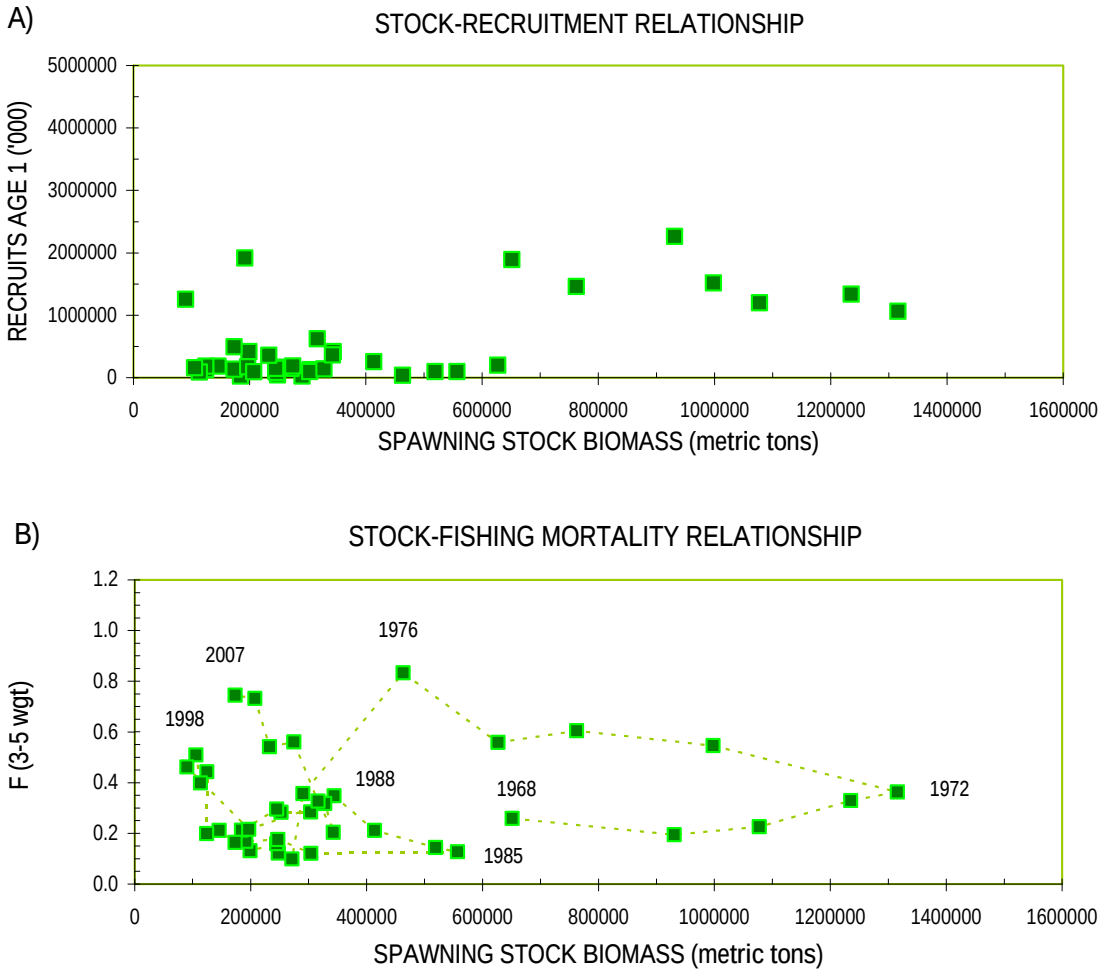


**Figure 15**. Traditional VPA: A) Stock-recruitment relationship; and B) stock-fishing mortality relationship for the Northwest Atlantic mackerel (some years are indicated). The VPA was started from the outputs of a Separable VPA (SVPA) with **Ft=0.50** and St=**1.25**.

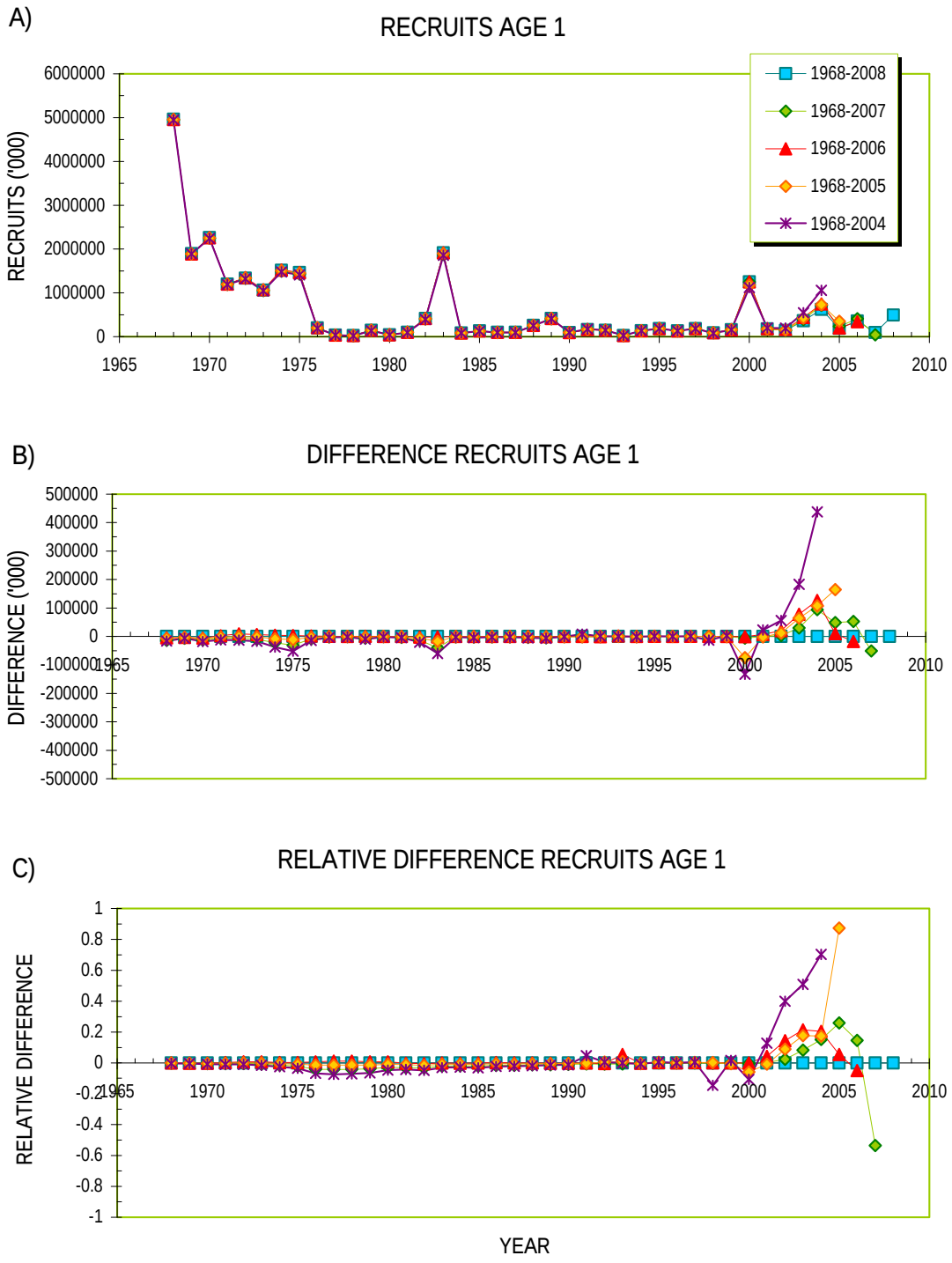


**Figure 16.** Traditional VPA: A) Retrospective analysis of age 1 recruitment; B) difference; and (C) relative difference to the terminal year (Mohn's Rho statistic: Average = 0.125; total = 0.623). The VPA was started from the outputs of a Separable VPA (SVPA) with **Ft=0.50** and **St=1.25**.

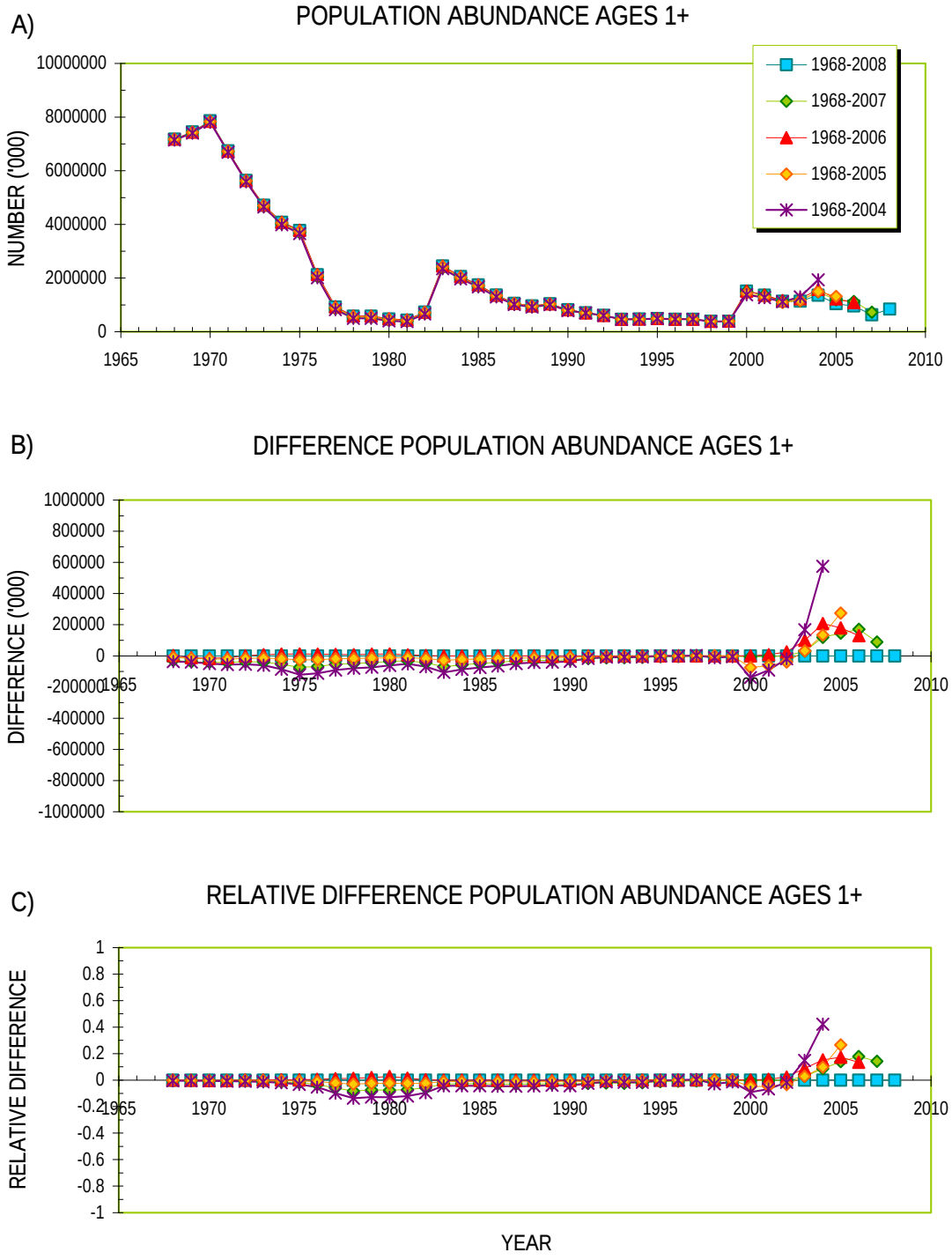


**Figure 17.** Traditional VPA: A) Retrospective analysis of population abundance ages $1^{+}$; B) difference; and C) relative difference to the terminal year (Mohn's Rho statistic: Average = 0.140; total = 0.701). The VPA was started from the outputs of a Separable VPA (SVPA) with **Ft=0.50** and **St=1.25**.

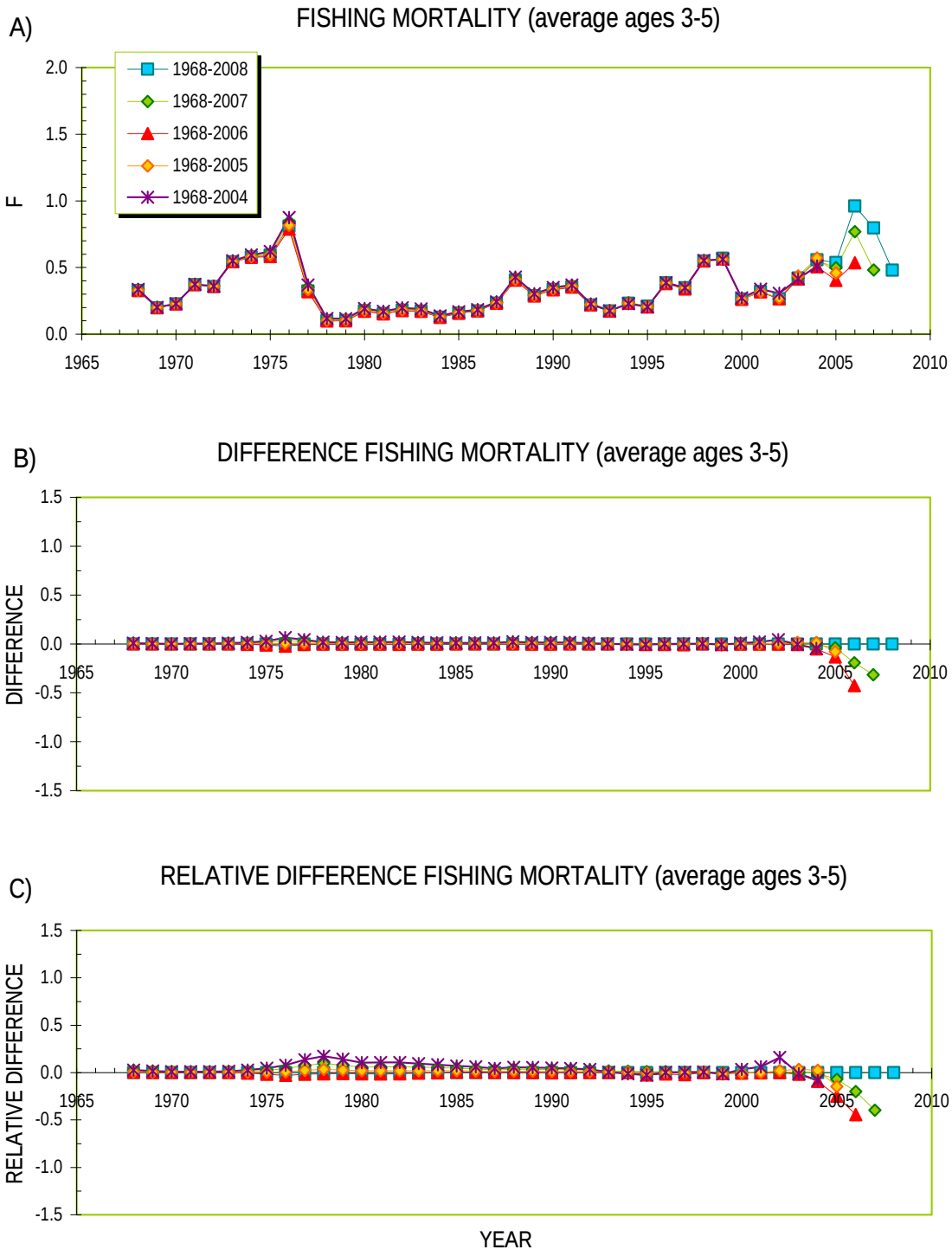


**Figure 18.** Traditional VPA: A) Retrospective analysis of fishing mortality (average ages 3-5); B) difference; and C) relative difference to the terminal year (Mohn's Rho: Average = -0.139; total = -0.695). The VPA was started from the outputs of a Separable VPA (SVPA) with **Ft=0.50** and **St=1.25**).

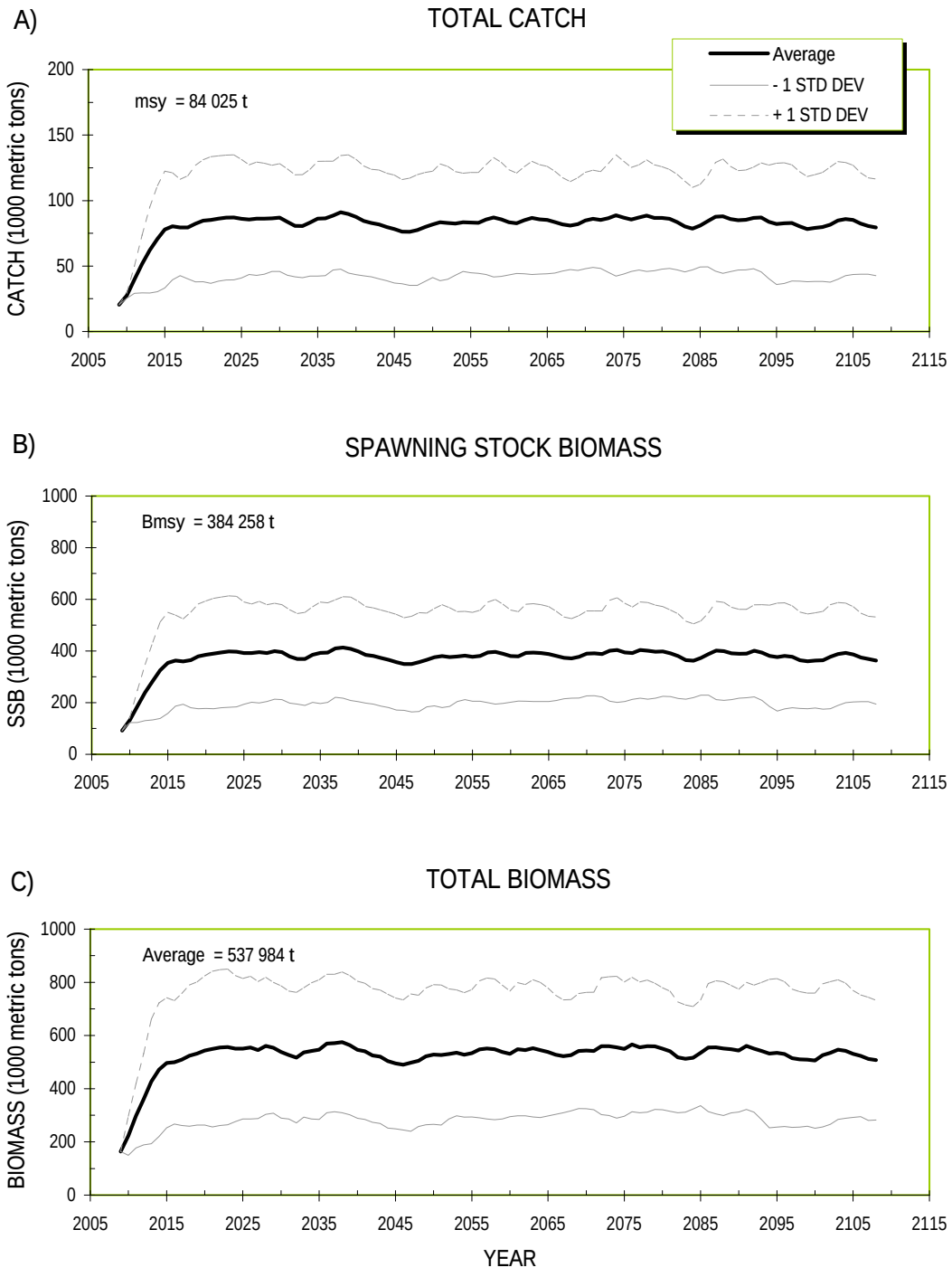


**Figure 19**. Stochastic bootstrapped projections (AGEPRO) of: A) total catch (thousands of metric tons); B) spawning stock biomass (thousands of metric tons); and C) total biomass (thousands of metric tons) with F at 40% as the harvest strategy. MSY and $B_{msy}$ in A) and B) are calculated as the averages of the 2020-2108 period. Data used in this analysis are from a traditional VPA started with the outputs of a Separable VPA (SVPA) with **Ft=0.50** and **St=1.25**.

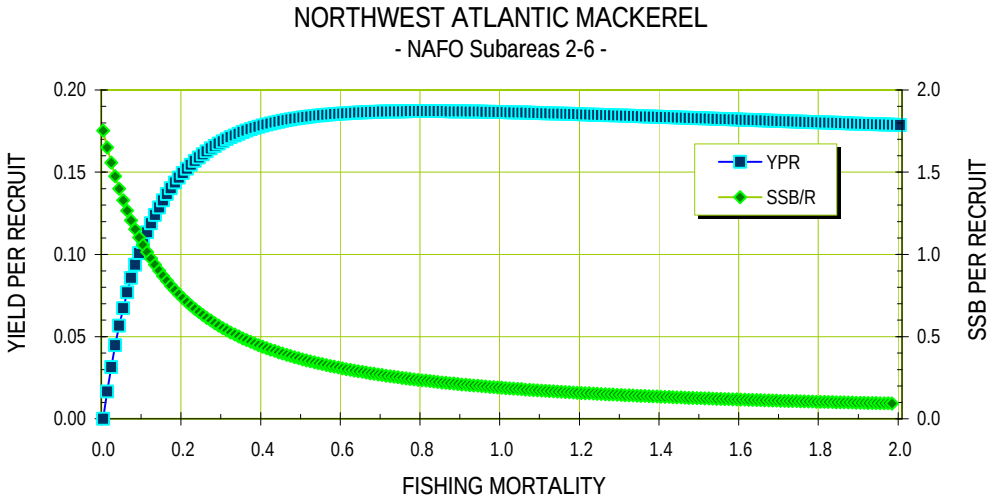


**Figure 20**. Yield- and spawning stock biomass per-recruit analyses for the Northwest Atlantic mackerel ($F_{0.1}$ = 0.259, $F_{max}$ = 0.812 and $F_{40\%}$ = 0.214). Data used in these analyses are from a traditional VPA started with the outputs of a Separable VPA (SVPA) with **Ft=0.50** and **St=1.25**.

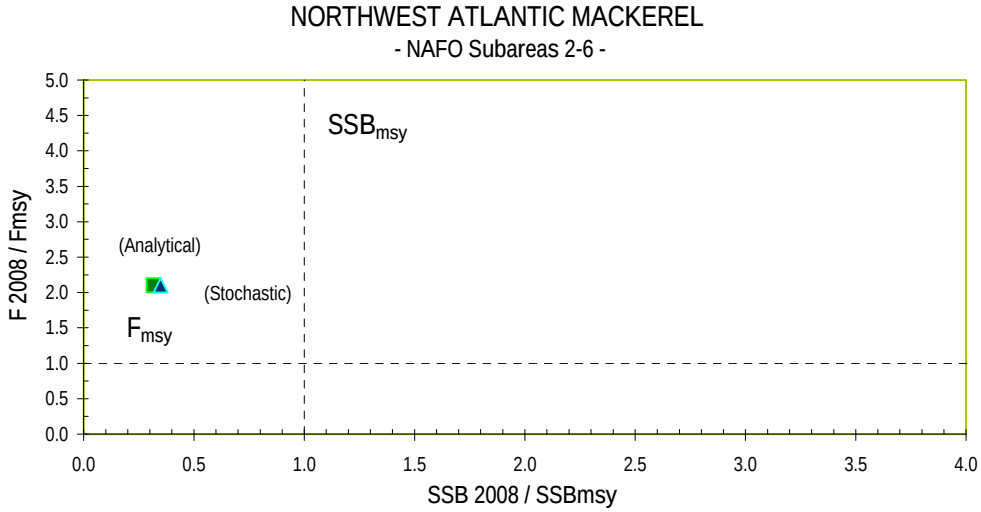


**Figure 21**. Status of 2008 fishing mortality (F) and spawning stock biomass (SSB) of the Northwest Atlantic mackerel to $F_{msy}$ and $SSB_{msy}$. Data used in this analysis are from a traditional VPA started with the outputs of a Separable VPA (SVPA) with **Ft=0.50** and **St=1.25**.

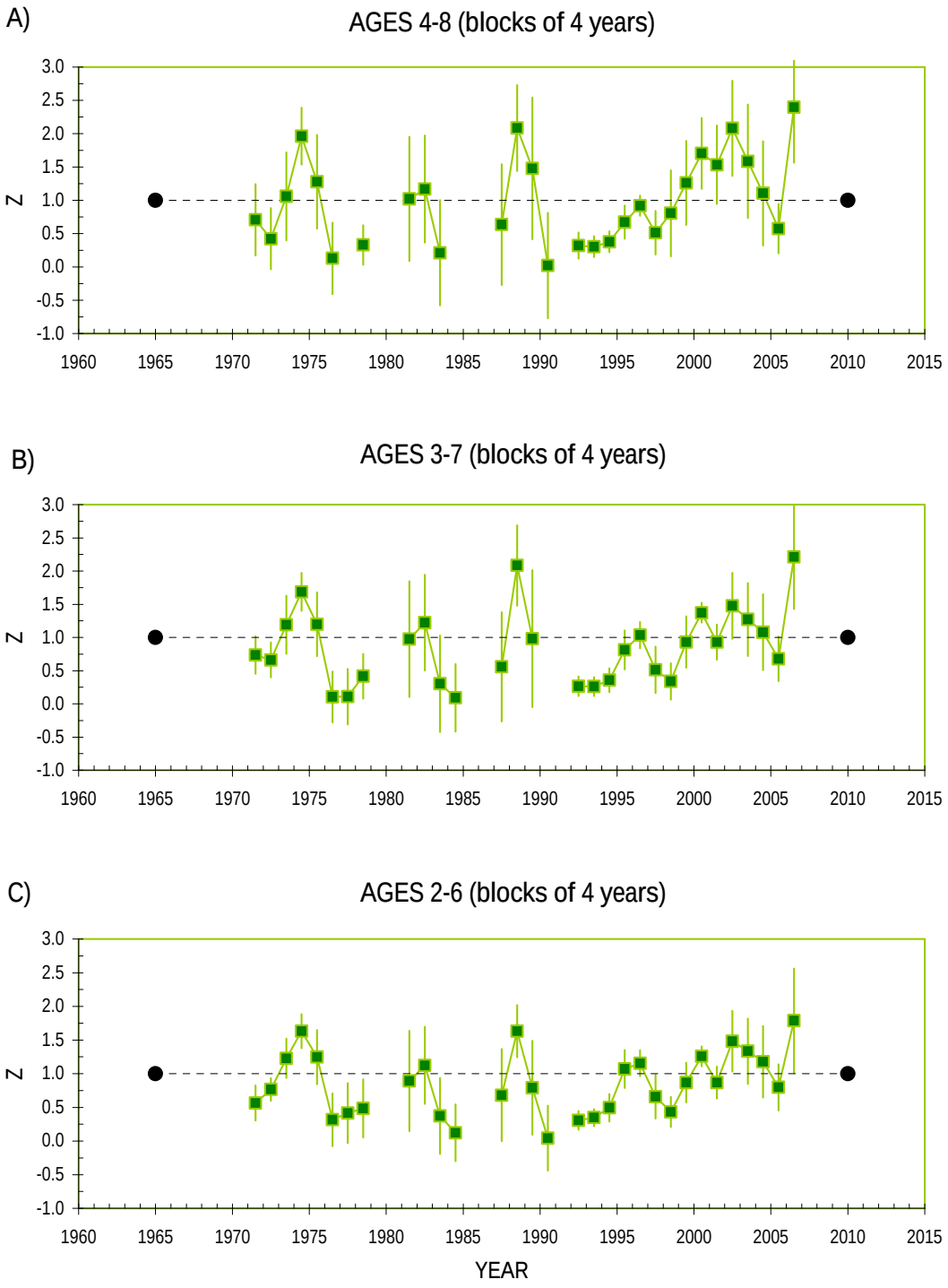


**Figure 22**. Estimates of instantaneous rate of total mortality (Z) derived from the NEFSC spring research vessels bottom trawl surveys and fit according to the Sinclair's method (Sinclair 1998) for blocks of 4 years and different groups of ages: A) ages 4 to 8; B) ages 3 to 7; and C) ages 2 to 6. The horizontal lines represent Z = 1.0.

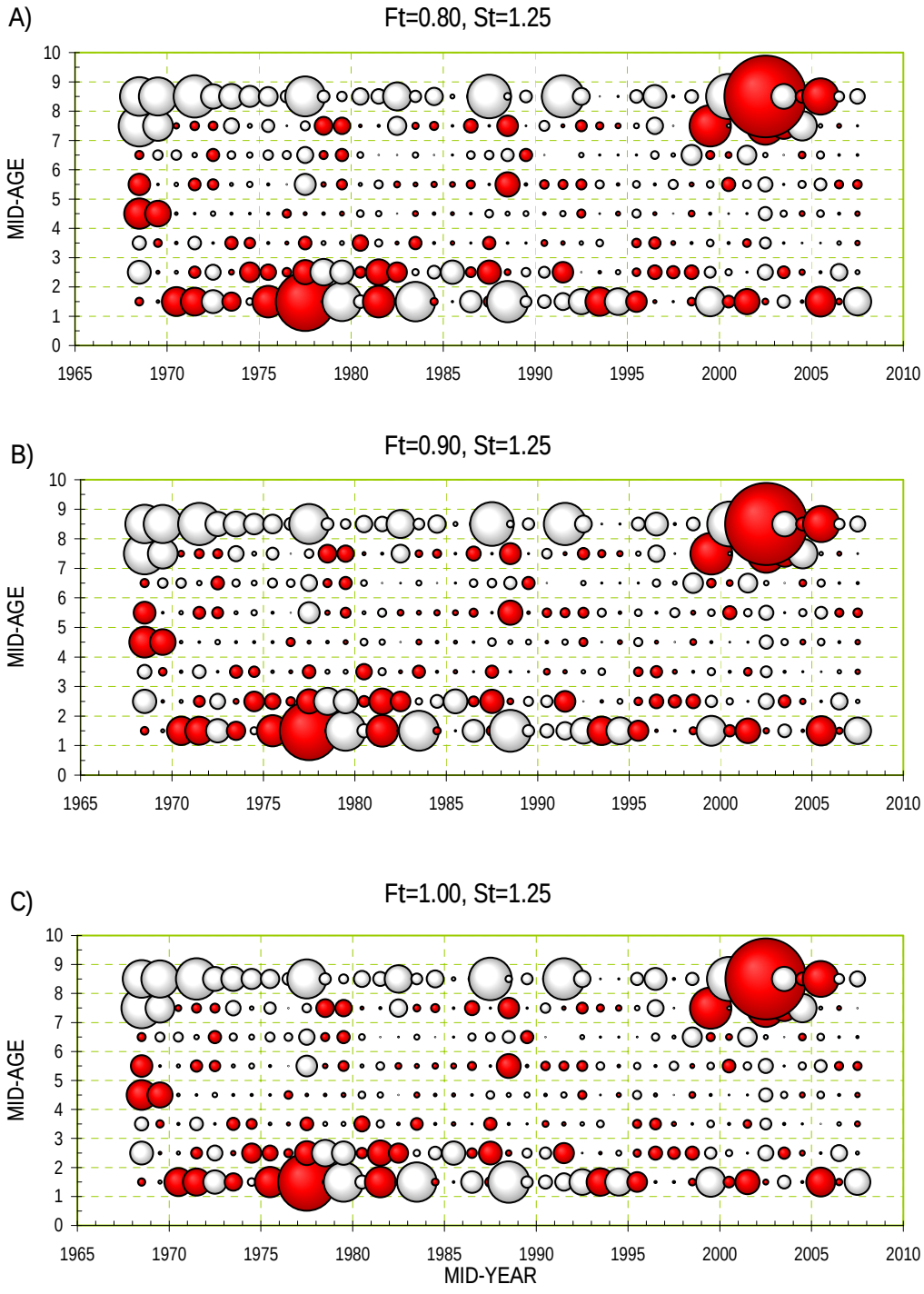


**Figure 23**. Separable VPA (SVPA) analysis: Log of catch ratio residuals for **Ft=0.80, 0.90**, and **1.00** and **St=1.25**.

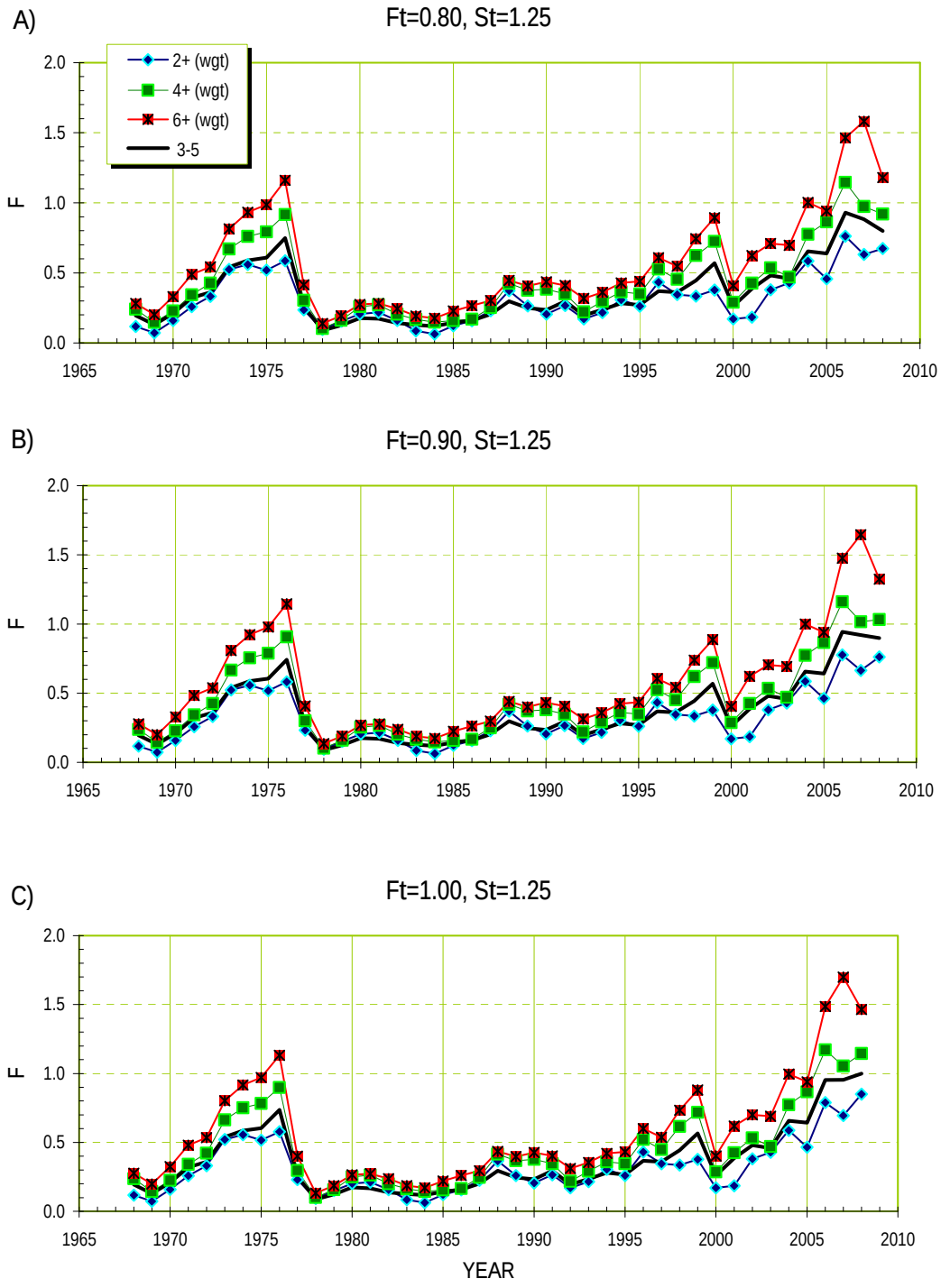


**Figure 24**. Separable VPA (SVPA) analysis: Fishing mortality for **Ft=0.80, 0.90**, and **1.00** and **St=1.25**.

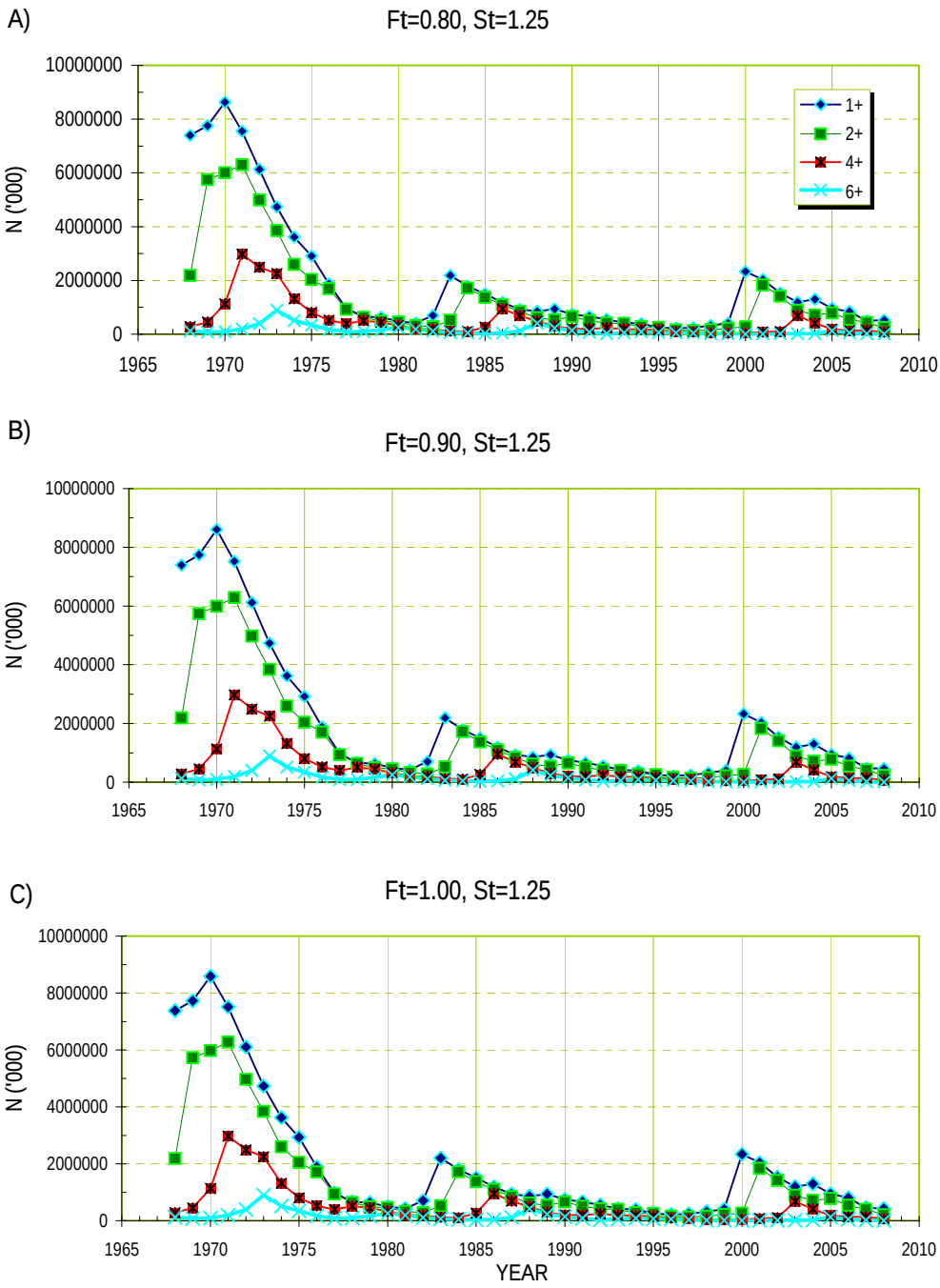


**Figure 25**. Separable VPA (SVPA) analysis: Population abundance (thousands of fish) for **Ft=0.80, 0.90**, and **1.00** and **St=1.25**.

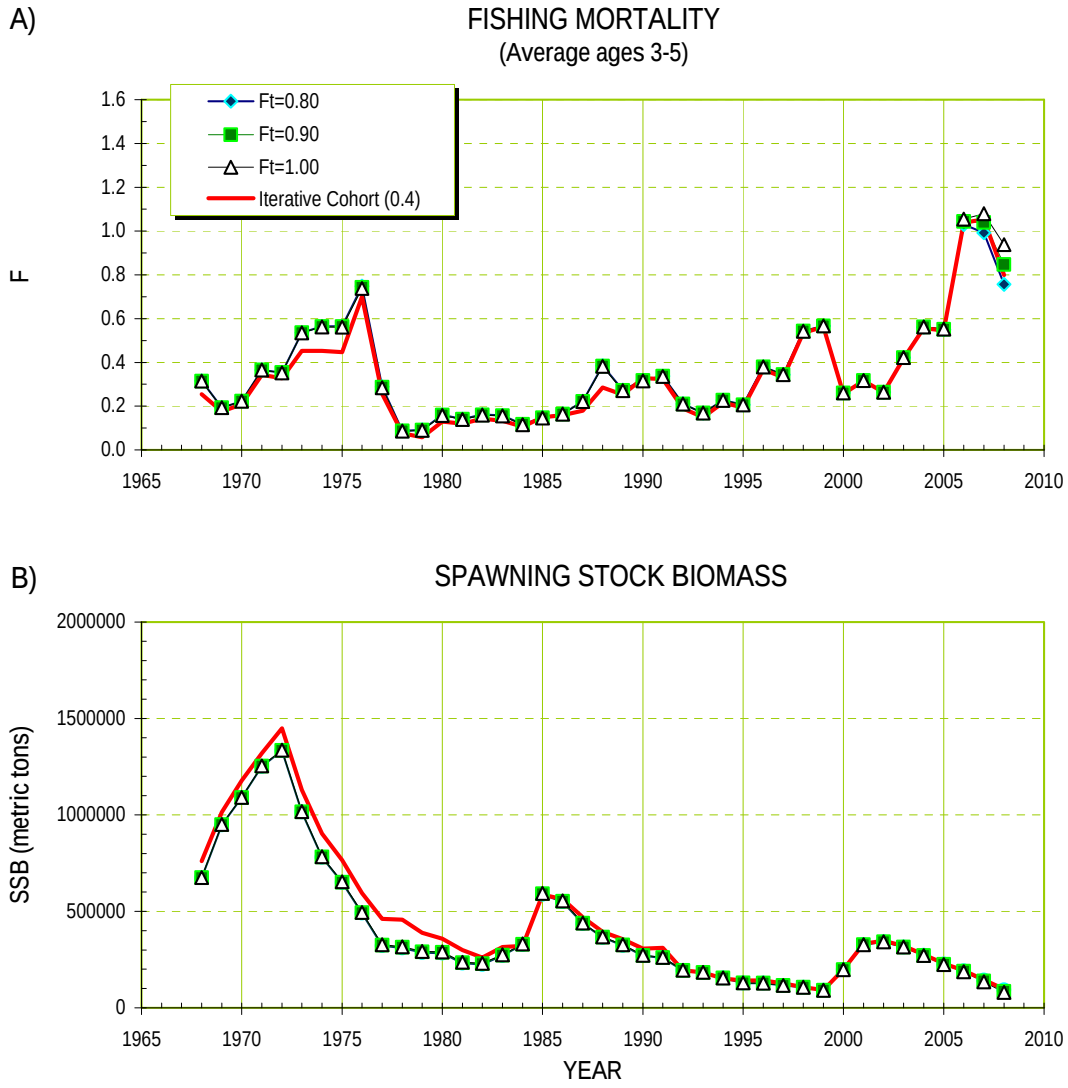


**Figure 26**. Fishing mortality (average ages 3-5) and spawning stock biomass (metric tons) calculated from traditional VPA and iterative cohort (J.-J. Maguire, comm. pers.). Traditional VPA was started from the outputs of a Separable VPA (SVPA) with **Ft=0.90** and **St=1.25**, and the iterative cohort with initial **F** of **0.4**.

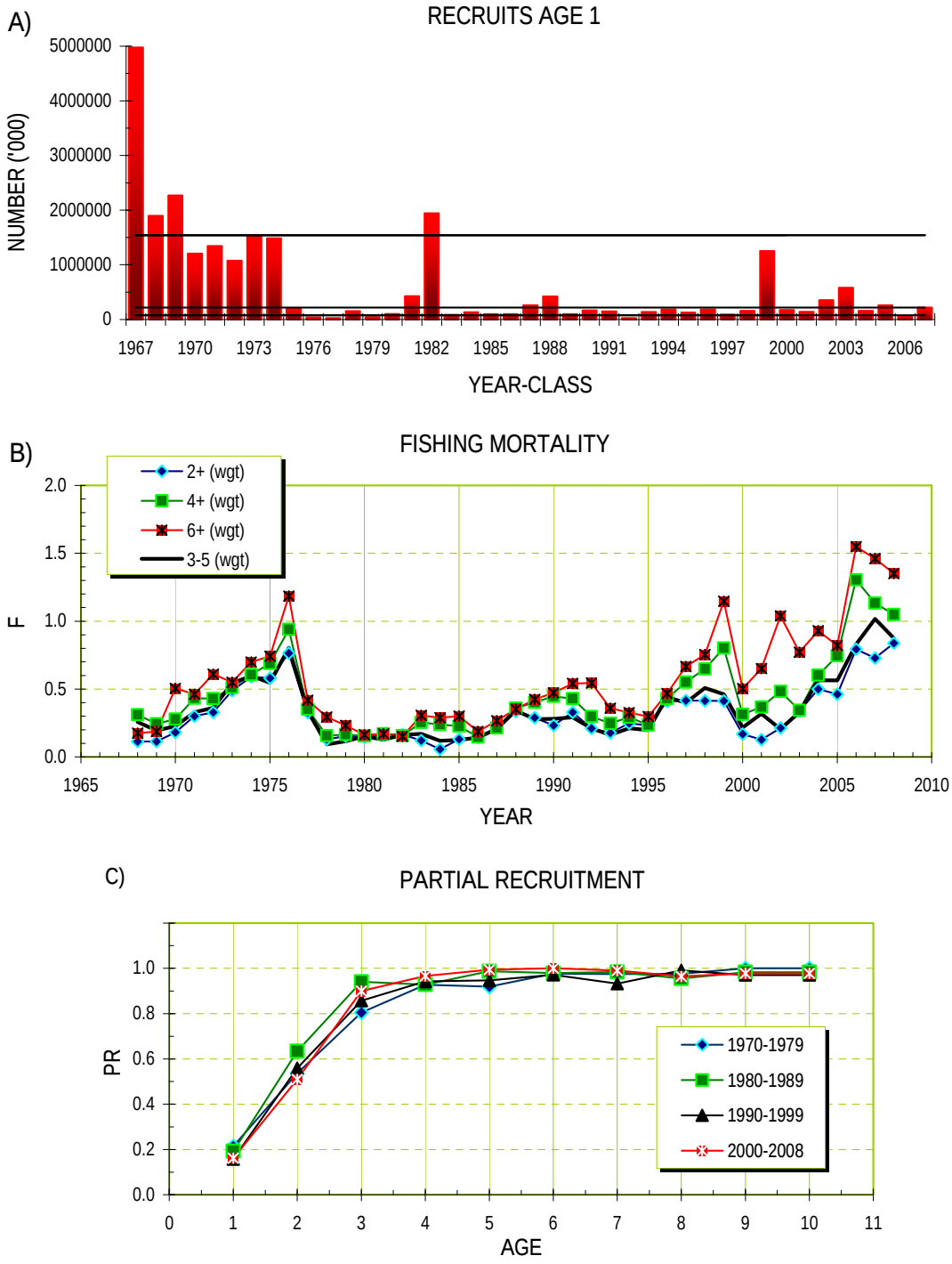


**Figure 27**. Traditional VPA: A) Recruits at age 1 (thousands of fish); B) fishing mortality (weighted by abundance); and partial recruitment (from fishing mortalities) for the Northwest Atlantic mackerel. The horizontal lines in A) represent three levels of recruitment: low, average and high. The VPA was started from the outputs of a Separable VPA (SVPA) with **Ft=0.90** and **St=1.25**.

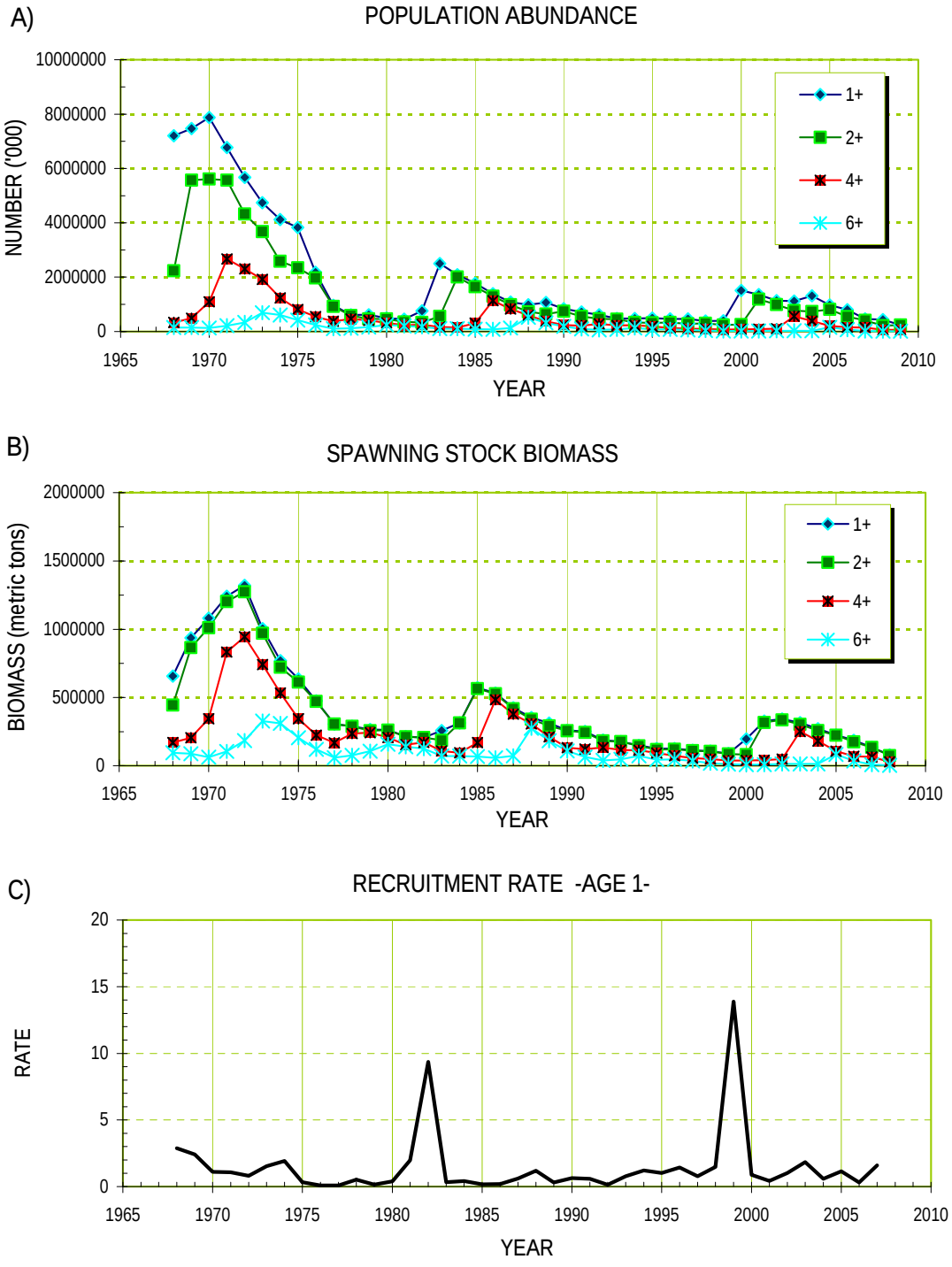


**Figure 28**. Traditional VPA: A) Population abundance (thousands of fish); B) spawning stock biomass (metric tons); and C) recruitment rate at age 1 for the Northwest Atlantic mackerel. The VPA was started from the outputs of a Separable VPA (SVPA) with **Ft=0.90** and **St=1.25**.

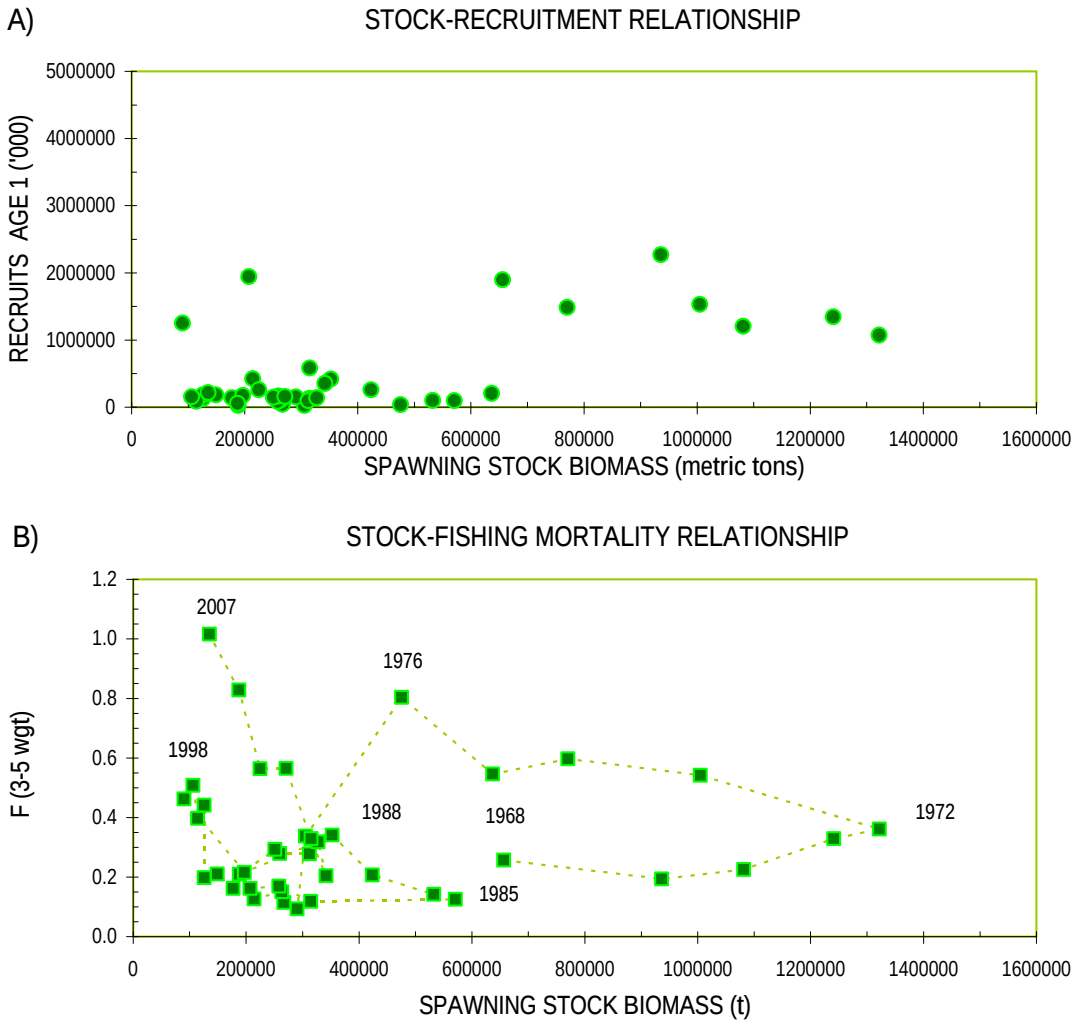


**Figure 29**. Traditional VPA: A) Stock-recruitment relationship; and B) and stock-fishing mortality relationship for the Northwest Atlantic mackerel (some years are indicated). The VPA was started from the outputs of a Separable VPA (SVPA) with **Ft=0.90** and St=**1.25**.

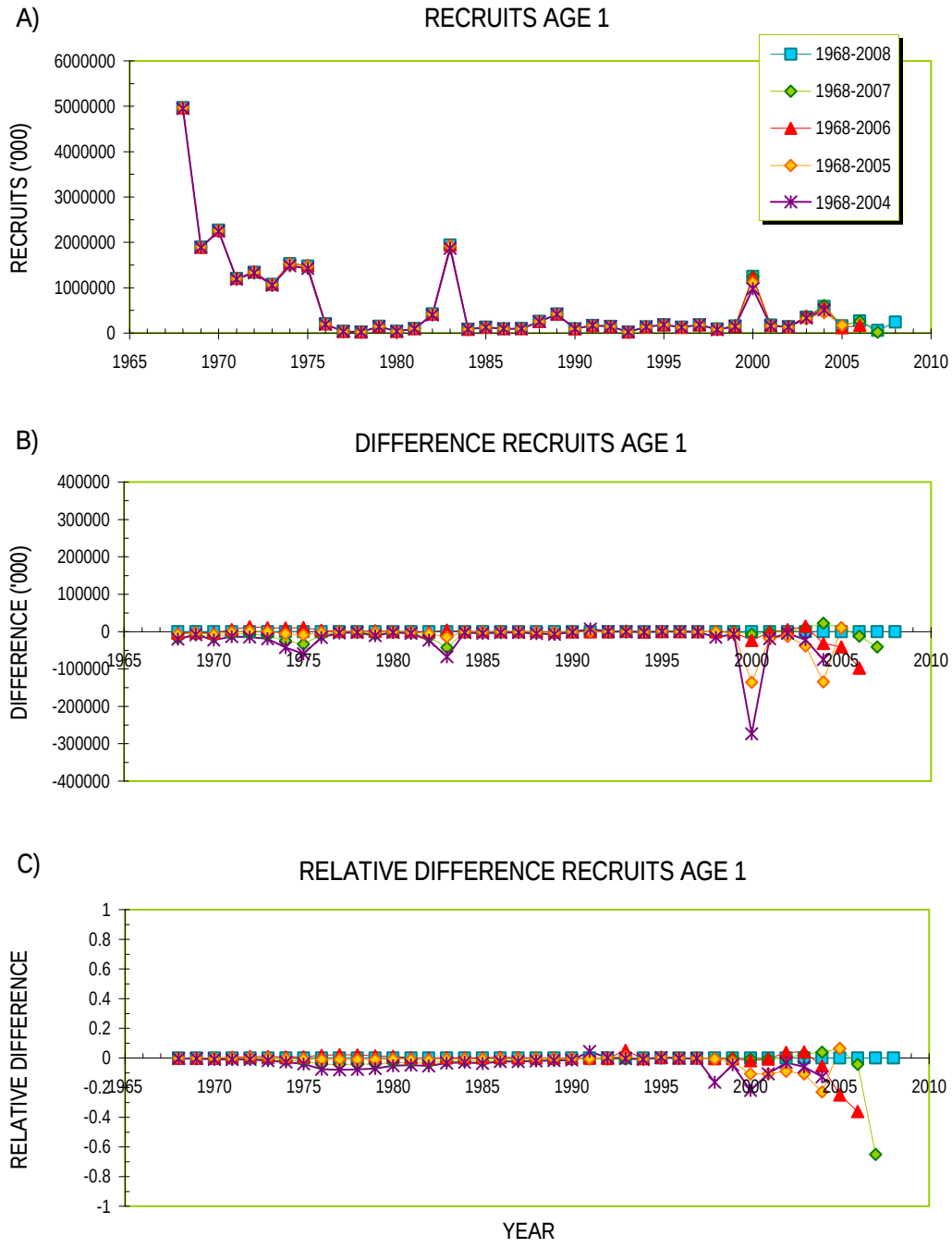


**Figure 30.** Traditional VPA: A) Retrospective analysis of age 1 recruitment; B) difference; and (C) relative difference to the terminal year (Mohn's Rho statistic: Average = -0.354; total = -1.769). The VPA was started from the outputs of a Separable VPA (SVPA) with **Ft=0.90** and **St=1.25**.

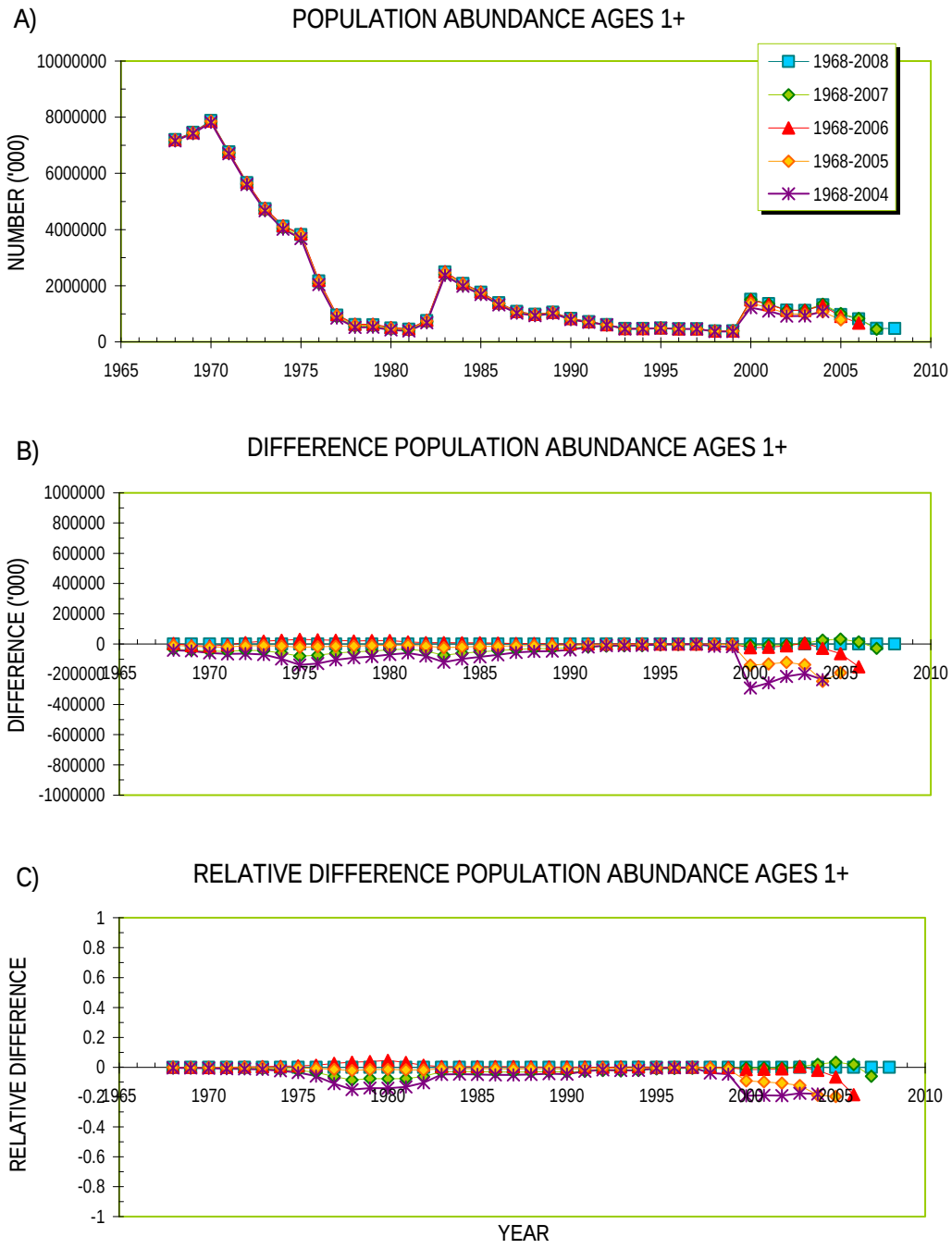


**Figure 31.** Traditional VPA: A) Retrospective analysis of population abundance ages $1^{+}$; B) difference; and C) relative difference to the terminal year (Mohn's Rho statistic: Average = -0.233; total = -1.163). The VPA was started from the outputs of a Separable VPA (SVPA) with **Ft=0.90** and **St=1.25**.

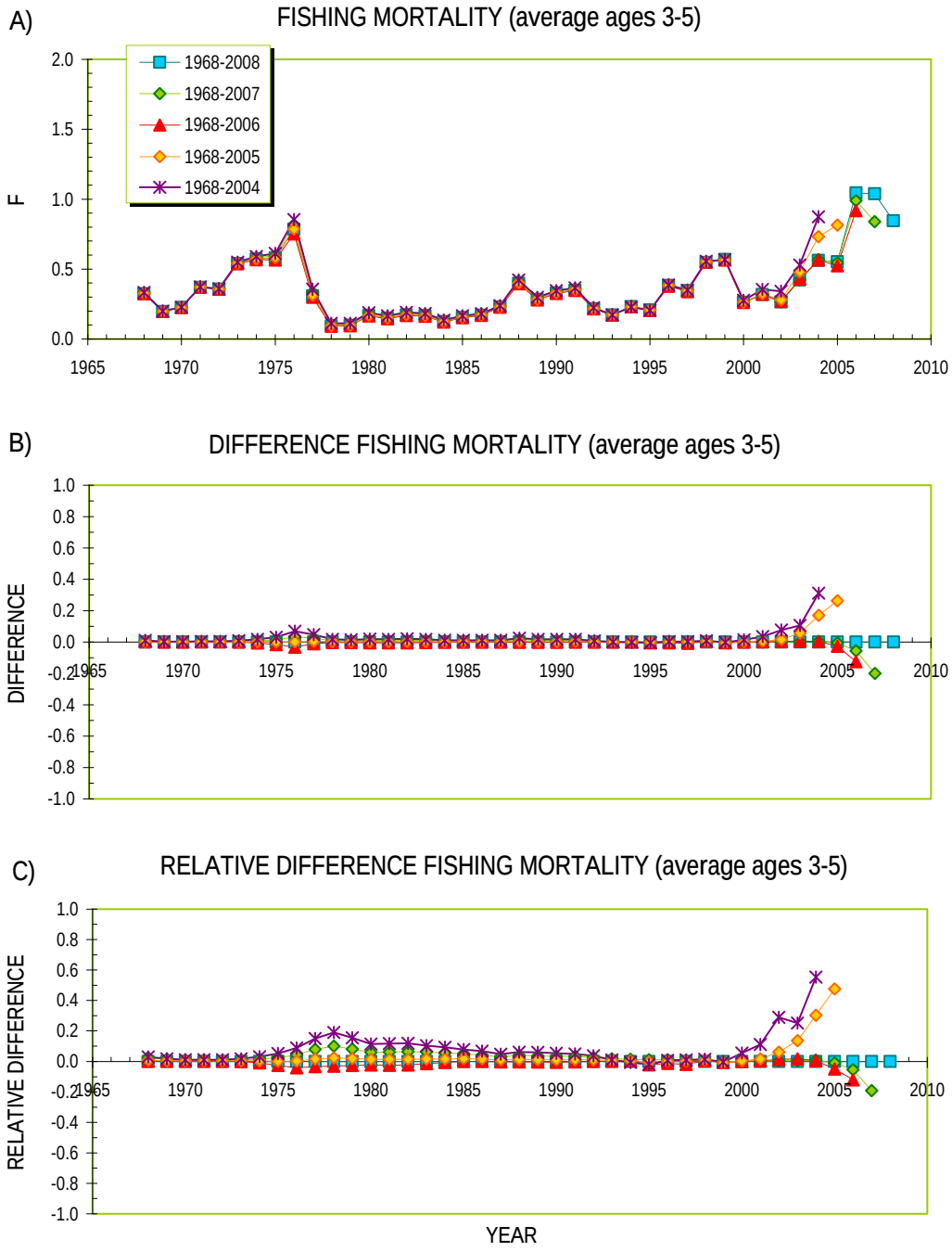


**Figure 32.** Traditional VPA: A) Retrospective analysis of fishing mortality (average ages 3-5); B) difference; and C) relative difference to the terminal year (Mohn's Rho statistic: Average = 0.404; total = 2.021). The VPA was started from the outputs of a Separable VPA (SVPA) with **Ft=0.90** and **St=1.25**).

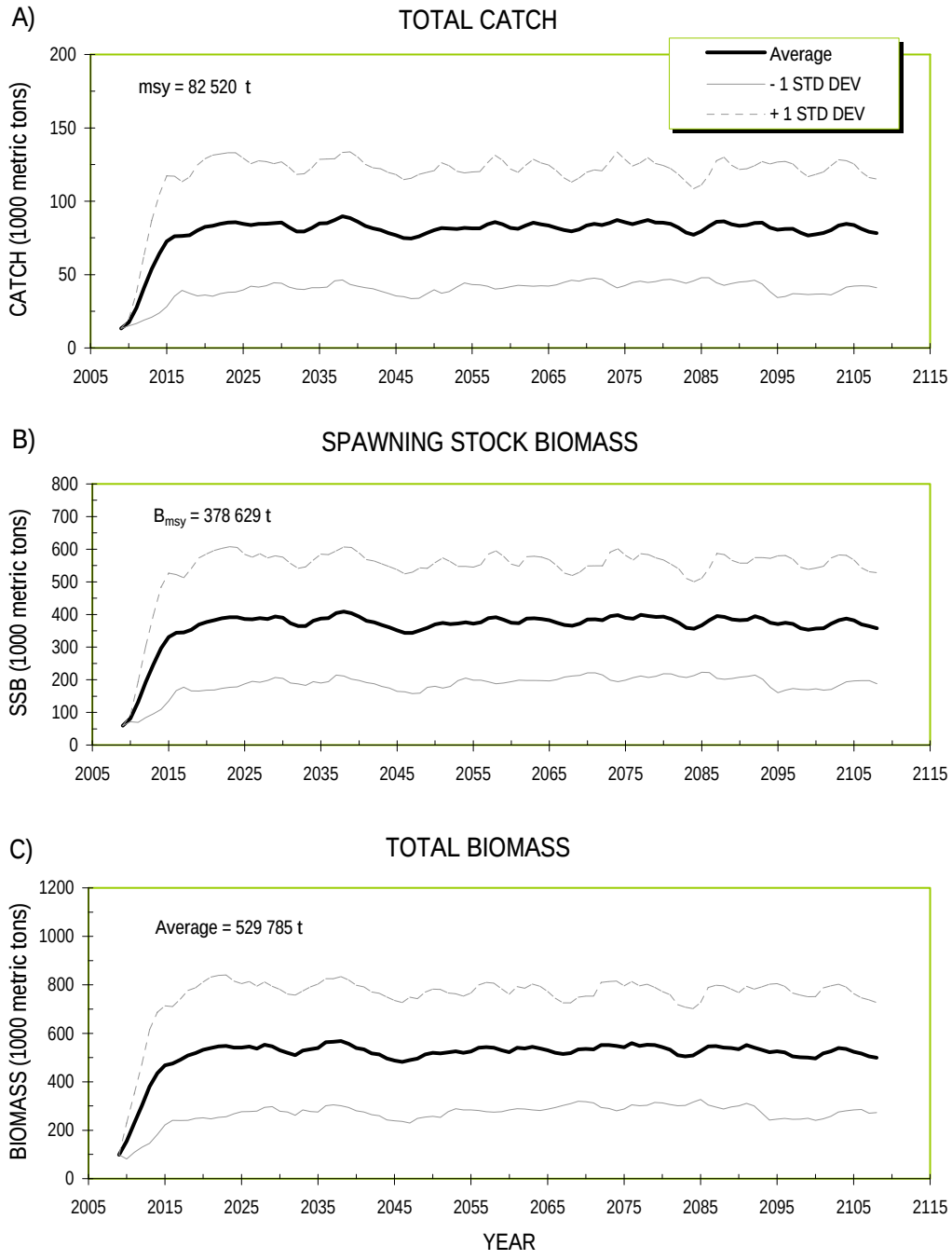


**Figure 33**. Stochastic bootstrapped projections (AGEPRO) of: A) total catch (thousands of metric tons); B) spawning stock biomass (thousands of metric tons); and C) total biomass (thousands of metric tons) with F at 40% as the harvest strategy. MSY and $B_{msy}$ in A) and B) are calculated as the averages of the 2020-2108 period. Data used in this analysis are from the outputs of a Separable VPA (SVPA) with **Ft=0.90** and **St=1.25**.

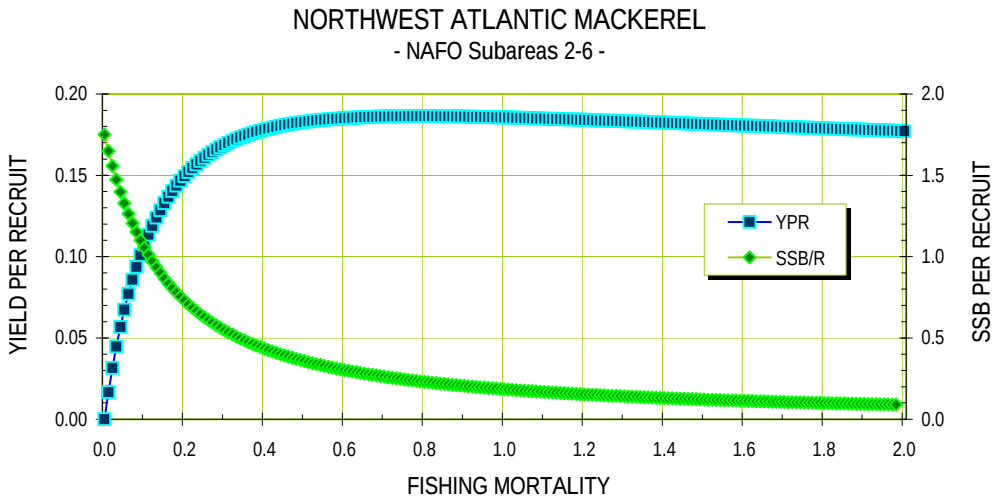


**Figure 34**. Yield- and spawning stock biomass per-recruit analyses for the Northwest Atlantic mackerel ($F_{0.1}$ = 0.258, $F_{max}$ = 0.787 and $F_{40\%}$ = 0.213). Data used in these analyses are from a traditional VPA started with the outputs of a Separable VPA (SVPA) with **Ft=0.90** and **St=1.25**.

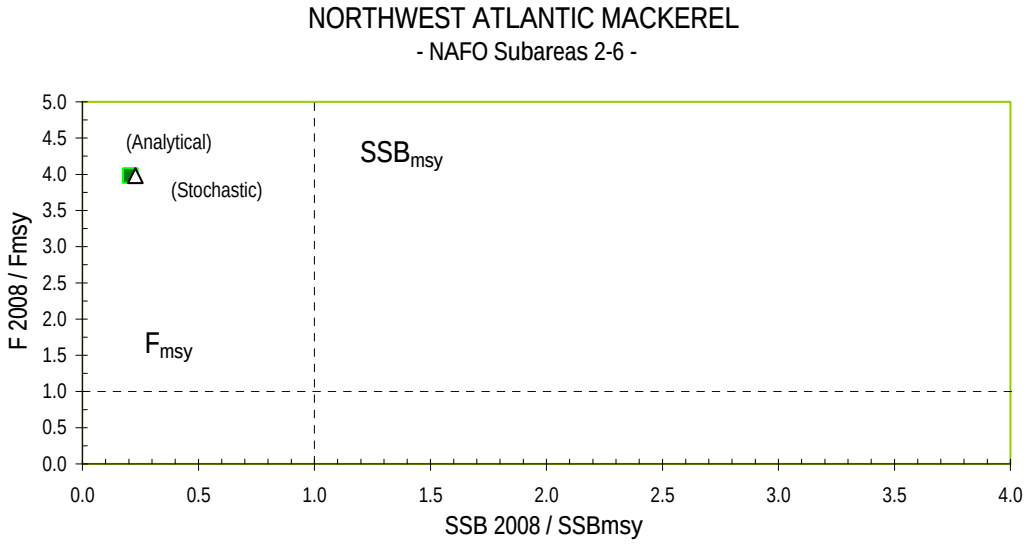


**Figure 35**. Status of 2008 fishing mortality (F) and spawning stock biomass (SSB) of the Northwest Atlantic mackerel to $F_{msy}$ and $SSB_{msy}$. Data used in this analysis are from a traditional VPA started with the outputs of a Separable VPA (SVPA) with **Ft=0.90** and **St=1.25**.