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Update of the Status of the Northwest Atlantic

Mackerel Stock for 1985


By

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## Summary

An assessment update for 1985 suggests that the Northwest Atlantic mackerel stock is continuing its expansion which began in 1981. Nominal catch rose from 39,000 mt in 1984 to 57,000 mt in 1985 and the USA domestic fishery harvested 6,700 mt, the eighth increase in a row. Current information suggests that the 1981, 1982 and 1984 year classes are all above average in strength and contributing heavily to the fishery. Present stock size from VPA is approximately 1.5 million mt and the spawning stock is about 1.3 million tons. Catch projections under an $F_{0.1}$ management strategy produce an expected catch of 285-334 thousand mt depending on recruitment assumptions used. A 1986 catch of 50-60 thousand mt will produce an increase in spawning stock in 1987, even under a conservative projection of recruitment from the 1983 and 1984 year classes.

NOMINAL CATCH

Nominal catches of Atlantic mackerel rose 44% in 1985, increasing from 39,445 mt in 1984 to 56,997 mt (Table 1). After a period of stable landings (1978-1983) catches have increased in the last two years. The increase is due primarily to joint venture catches by countries other than the US and Canada, including GDR (19%) and the Netherlands (26%) who accounted for 26,010 mt; 46% of the total. Overall landings from the mackerel stock are still small compared to the aggregate international catches that occurred from 1969-1976 in the Mid-Atlantic area, but all available information indicates that landings will continue to increase in the future, contingent on interest, specific management and regulation.

The USA commercial catch has increased in every year since 1977 and accounted for about 12% of the total catch in 1985 (Table 1). USA commercial landings were 6,697 mt in 1985, a 13% increase over 1984. The estimated Canadian catch of 16,590 mt for 1985 is similar to the amount landed the previous year (Table 1). The Northeast Fisheries Center continued to conduct a cooperative research fishery with Poland in 1985 resulting in a total of 6,200 mt.

CONTRIBUTION OF RECENT YEAR CLASSES

The 1981 and 1982 year classes comprised the bulk of the landings in 1984, accounting for 27% and 44% (in numbers), respectively, of the SA 5-6 total (Table 2). In addition, the 1974 (8%) and 1978 (5%) year classes contributed significantly to the catch in this area. Catches in the Canadian fishery, SA 2-4, followed similar trends, with the 1981 cohort accounting for 29% and the 1982, 45% (Table 2). Recruitment of the 1982 year class contributed heavily to 1984 landings, but the fishery was also very dependent on the 1981 year class (Table 3). The 1980 year class provided a major share

of the landings (numbers) in 1981, but in recent years catches from this cohort have been much reduced, suggesting that it is smaller than previous estimates had indicated (Anderson 1985) (Table 3).

SURVEY AND STANDARDIZED CPUE

Catch-per-tow indices for mackerel from the spring NEFC survey increased slightly for 1985 (Table 4). The spring 1985 value of 0.89 is the second highest observed in the 1968-1985 series. The autumn survey does not appear to be quite as useful for following trends in this species (Table 4).

The standardized US catch-per-day index dropped to an aberrantly low value of 0.27 in 1984 (Table 5). This index is based on catches in the US floating trap fishery and has until recently been useful for standardizing catches from the other gear categories. In two of the last three years (1982, 1984) the US catch-per-day index has been low relative to observed stock increases as indicated by spring NEFC survey and VPA results. This is probably because the catch from floating traps is highly dependent on distribution and short-term environmental phenomena. Also recent changes in regulations for other species caught in traps may have modified effort by this gear type. To remedy the situation a predictive regression between USA otter trawl (ton class 51-150) CPUE and US standardized catch-per-tow was used to predict the 1984 US CPUE (Table 6). A value of 0.71 was predicted and used to estimate a starting F for the VPA (Anderson 1985).

VPA RESULTS

Fishing mortality for ages 3 and older was estimated to be 0.043, a large percentage drop from 1983 (Table 7). This occurred because the catch was dominated by age 2 and 3 fish in 1984. Recall that the age 2 and 3 catch (numbers) accounted for 44% and 27%, respectively, of the total. The projected catch of 57,000 mt in 1985 generated an F of approximately 0.065, a

very low value when compared to $F_{0.1}$ for mackerel (F=0.29) under current conditions (Anderson 1985).

The 1981, 1982, and 1984 year classes appear to be relatively strong. The 1984 year class will enter the fishery in 1986, thus three large year classes will contribute to the catch.

Total stock biomass (ages 1 and older) reached 1.5 million mt at the beginning of 1985, continuing a steady increase that began in 1981 (Table 7). Spawning stock biomass has also risen steadily since 1981, reaching 1.3 million mt at the beginning of 1985.

Some uncertainty exists when recruitment in the most recent years is estimated from regressions of survey catch-per-tow and VPA stock size. Therefore, high and low options for age 1 and 2 recruitment from the 1984 and 1983 year classes, respectively, were used in catch forecasts for 1986-1987 (Table 8).

DISCUSSION

The results of stock projections under these two options indicate that the stock is in good condition even under the conservative recruitment option (Table 9; Figure 1). Under current levels of fishing mortality catches will continue to be low relative to those that would result from fishing at the $F_{0.1}$ level. The $F_{0.1}$ catch in 1986 would be 285,000 mt under the low recruitment option (Table 9). It is important to consider the uncertainty associated with the stock projections in Table 9. Anderson (1985) estimated an $F_{0.1}$ equilibrium catch of 134,000 mt for the Northwest Atlantic mackerel stock. Since recruitment is highly variable, this strategy, which represents the long-term average with good and bad year classes, should be considered against a strict adherence to $F_{0.1}$ projected catches, which are as large as the catches that were taken in several years preceding the collapse of the inter-

national fishery in the mid-1970's. Future recruitment may not approach the present situation with three large year classes in the fishery. Interspecific interactions and short-term environmental changes probably play an important role in regulating this stock, but at present these phenomena are not well understood. A conservative strategy, therefore, would insure that relatively large catches could be sustained over the long term.

## REFERENCES

Anderson, E. D. 1985. Status of the Northwest Atlantic Mackerel Stock-1984. Woods Hole Laboratory Reference Document No. 85-03, 46 pp.

Table 1.  Mackerel catch (mt) from NAFO SA 2-6 during 1960-1985.

| Year | US Commercial | US Recreational | Canada | Other Countries | Commercial Total | Grand Total |
|------|-----------|--------------|--------|-----------------|------------------|-------------|
| 1960 | 1,396 | 2,478 | 5,957 | - | 7,353 | 9,831 |
| 1961 | 1,361 | 3,022 | 5,459 | 11 | 6,831 | 9,853 |
| 1962 | 938 | 3,565 | 6,801 | 175 | 7,914 | 11,479 |
| 1963 | 1,320 | 3,981 | 6,363 | 1,299 | 8,982 | 12,963 |
| 1964 | 1,644 | 4,343 | 10,786 | 801 | 13,231 | 17,574 |
| 1965 | 1,998 | 4,292 | 11,185 | 2,945 | 16,128 | 20,420 |
| 1966 | 2,724 | 4,535 | 11,577 | 7,951 | 22,252 | 26,787 |
| 1967 | 3,891 | 4,498 | 11,181 | 19,047 | 34,119 | 38,617 |
| 1968 | 3,929 | 7,781 | 11,134 | 65,747 | 80,810 | 88,591 |
| 1969 | 4,364 | 13,050 | 13,257 | 114,189 | 131,810 | 144,860 |
| 1970 | 4,049 | 16,039 | 15,710 | 210,864 | 230,623 | 246,662 |
| 1971 | 2,406 | 16,426 | 14,942 | 355,892 | 373,240 | 389,666 |
| 1972 | 2,006 | 15,588 | 16,254 | 391,464 | 409,724 | 425,312 |
| 1973 | 1,336 | 10,723 | 21,619 | 396,759 | 419,714 | 430,437 |
| 1974 | 1,042 | 7,640 | 16,701 | 321,837 | 339,580 | 347,220 |
| 1975 | 1,974 | 5,190 | 13,544 | 271,719 | 287,237 | 292,427 |
| 1976 | 2,712 | 4,202 | 15,746 | 223,275 | 241,733 | 245,935 |
| 1977 | 1,377 | 522 | 20,362 | 56,067 | 77,806 | 78,328 |
| 1978 | 1,605 | 6,571 | 25,429 | 841 | 27,875 | 34,446 |
| 1979 | 1,990 | 3,723 | 30,244 | 440 | 32,674 | 36,397 |
| 1980 | 2,683 | 2,381 | 22,136 | 566 | 25,385 | 27,766 |
| 1981 | 2,941 | 5,052 | 19,294 | 5,361[1] | 27,596 | 32,648 |
| 1982 | 3,330 | 1,131 | 16,379 | 6,647[2] | 26,356 | 27,487 |
| 1983 | 3,805 | 3,000 | 19,785 | 5,955[3] | 29,545 | 32,545 |
| 1984 | 5,954 | 1,451 | 16,995 | 15,045[4] | 37,994 | 39,445 |
| 1985[5] | 6,697 | 1,500 | 16,590 | 32,210[6] | 55,497 | 56,997 |

[1]Includes 3,979 mt taken by Poland.

[2]Includes 4,364 mt taken by Poland in a research fishery conducted with the NEFC.

[3]Includes 4,341 mt taken by Poland in a research fishery conducted with the NEFC.

[4]Includes 5,531 mt taken by Poland in a research fishery conducted with the NEFC.

[5]Estimated.

[6]Includes 6,200 mt taken by Poland in a research fishery conducted with the NEFC.

Table 2. Age composition (thousands of fish) of the 1984 mackerel catch from NAFO SA 2-6.

| Age | SA 2-4 Total[1] | SA 5-6 | | | | SA 2-6 Total |
| | | US (Comm) | US (Rec)[2] | Other Countries | Total | |
|---|---|---|---|---|---|---|
| 1 | 12.0 | 227.4 | 52.1 | 201.1 | 480.6 | 492.6 |
| 2 | 16,286.0 | 5,512.8 | 2,835.1 | 13,620.3 | 21,968.2 | 38,254.2 |
| 3 | 10,513.0 | 3,340.7 | 1,989.0 | 8,799.0 | 14,128.7 | 24,641.7 |
| 4 | 1,122.0 | 482.9 | 150.2 | 1,225.7 | 1,858.8 | 2,980.8 |
| 5 | 407.0 | 79.9 | 19.1 | 276.6 | 375.6 | 782.6 |
| 6 | 1,207.0 | 654.5 | 117.7 | 2,237.3 | 3,009.5 | 4,216.5 |
| 7 | 152.0 | 48.6 | 9.8 | 219.3 | 277.7 | 429.7 |
| 8 | 317.0 | 30.8 | 3.6 | 134.0 | 168.4 | 485.4 |
| 9 | 1,442.0 | 222.6 | 39.8 | 1,056.4 | 1,318.8 | 2,760.8 |
| 10 | 3,131.0 | 642.1 | 124.4 | 3,334.1 | 4,100.6 | 7,231.6 |
| 11 | 1,348.0 | 194.4 | 43.9 | 1,250.8 | 1,489.1 | 2,837.1 |
| 12 | 164.0 | 99.7 | 20.1 | 493.1 | 612.9 | 776.9 |
| 13 | 110.0 | 58.7 | 13.3 | 336.4 | 408.4 | 518.4 |
| 14+ | 128.0 | 225.4 | 45.2 | 1,209.1 | 1,479.7 | 1,607.7 |
| Total | 36,339.0 | 11,820.5 | 5,463.3 | 34,393.2 | 51,672.0 | 88,016.0 |
| Weight (mt) | 16995 | 5954 | 1451 | 15045 | 22450 | 39445 |

[1]Based on Canadian data.

[2]Percent age composition assumed same as SA 2-6 Total.

Table 3. Mackerel commercial and recreational catch at age (millions of fish) from NAFO SA 2-6 during 1962-84.

| Year | Age | | | | | | | | | | | | | | | Total | Weight[1] | Mean age |
|------|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|------|-------|-----------|----------|
|      | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14+ | | | |
| 1962 | -   | 16.1  | 2.8   | 15.2  | 3.8   | 1.2   | 1.6  | 1.4  | 0.8  | 0.4  | 0.1  | 0.3 | -   | -   | -   | 43.7    | 11.5  | 2.8 |
| 1963 | -   | 1.1   | 4.2   | 1.3   | 26.3  | 6.0   | 0.3  | 0.2  | 0.2  | 0.2  | 0.1  | 0.1 | -   | -   | -   | 40.0    | 13.0  | 4.1 |
| 1964 | -   | 12.9  | 7.0   | 4.1   | 4.0   | 19.4  | 4.1  | 3.9  | 0.7  | 0.8  | 0.2  | -   | -   | -   | -   | 57.1    | 17.6  | 3.8 |
| 1965 | -   | 9.0   | 3.6   | 2.9   | 4.0   | 5.2   | 19.5 | 4.2  | 4.0  | 0.7  | -    | -   | -   | -   | -   | 53.1    | 20.4  | 4.7 |
| 1966 | -   | 24.0  | 11.5  | 5.3   | 2.6   | 4.7   | 7.9  | 21.8 | 0.5  | 0.2  | -    | -   | -   | -   | -   | 78.5    | 26.8  | 3.9 |
| 1967 | 1.8 | 0.8   | 26.7  | 19.8  | 3.5   | 3.3   | 5.1  | 6.1  | 32.3 | 0.3  |      |     | -   | -   | -   | 99.7    | 38.6  | 4.8 |
| 1968 | 1.1 | 141.4 | 61.5  | 59.3  | 38.1  | 14.3  | 6.6  | 0.7  | 1.0  | 6.1  | 0.1  | -   | -   | -   | -   | 330.2   | 88.6  | 2.3 |
| 1969 | 4.0 | 7.1   | 262.1 | 160.7 | 65.8  | 5.7   | 3.0  | 2.0  | 3.1  | 2.2  | 8.3  | -   | -   | -   | -   | 524.0   | 144.9 | 2.8 |
| 1970 | 4.8 | 193.5 | 54.5  | 522.1 | 162.9 | 27.6  | 7.0  | 5.3  | 9.9  | 10.0 | 3.8  | 2.8 | -   | -   | -   | 1,004.2 | 246.7 | 3.0 |
| 1971 | 2.4 | 74.6  | 294.2 | 127.4 | 558.9 | 203.5 | 34.6 | 8.9  | 3.6  | 4.3  | 8.1  | 7.2 | -   | -   | -   | 1,327.7 | 389.7 | 3.6 |
| 1972 | 3.6 | 22.1  | 85.7  | 256.2 | 182.6 | 390.4 | 87.3 | 24.0 | 4.2  | 8.2  | 3.8  | 5.6 | -   | -   | -   | 1,073.7 | 425.3 | 4.2 |
| 1973 | 4.0 | 161.8 | 283.2 | 285.1 | 233.6 | 192.4 | 197.2| 31.2 | 11.0 | 4.1  | 3.8  | 1.6 | -   | -   | -   | 1,409.0 | 430.4 | 3.6 |
| 1974 | 2.0 | 95.9  | 242.2 | 264.4 | 101.5 | 114.3 | 111.8| 108.3| 25.7 | 6.4  | 2.5  | 0.8 | -   | -   | -   | 1,075.8 | 347.2 | 3.8 |
| 1975 | 3.7 | 373.7 | 431.4 | 113.7 | 100.8 | 58.6  | 67.8 | 51.9 | 50.5 | 12.5 | 2.3  | 1.0 | -   | -   | -   | 1,267.9 | 292.4 | 2.8 |
| 1976 | -   | 12.5  | 353.5 | 272.5 | 85.7  | 52.4  | 27.3 | 40.5 | 34.6 | 22.6 | 13.4 | 1.4 | -   | -   | -   | 916.4   | 245.9 | 3.5 |
| 1977 | -   | 2.0   | 27.0  | 101.0 | 54.0  | 12.0  | 9.9  | 5.6  | 6.3  | 3.8  | 3.6  | 0.3 | 0.3 | -   | -   | 225.8   | 78.3  | 3.8 |
| 1978 | -   | 0.1   | 0.2   | 4.7   | 17.4  | 13.3  | 8.4  | 4.7  | 2.2  | 4.5  | 1.5  | 4.6 | 0.6 | 0.6 | -   | 62.8    | 34.4  | 5.9 |
| 1979 | -   | 0.4   | 0.6   | 1.3   | 7.1   | 18.6  | 13.1 | 6.2  | 2.6  | 2.2  | 2.3  | 0.7 | 1.9 | 0.6 | 1.0 | 58.6    | 36.4  | 6.2 |
| 1980 | -   | 1.2   | 10.9  | 1.0   | 1.0   | 6.9   | 13.8 | 4.7  | 2.0  | 1.0  | 1.0  | 1.6 | 0.5 | 1.3 | 0.8 | 47.7    | 27.8  | 5.6 |
| 1981 | +   | 10.4  | 4.8   | 8.7   | 2.0   | 2.8   | 7.9  | 13.1 | 5.6  | 2.7  | 0.9  | 0.4 | 0.4 | 0.7 | 0.8 | 61.2    | 32.6  | 5.1 |
| 1982 | +   | 3.6   | 9.9   | 2.7   | 8.4   | 1.2   | 2.7  | 4.4  | 8.1  | 2.6  | 1.3  | 0.6 | 0.3 | 0.7 | 1.3 | 47.8    | 27.5  | 5.4 |
| 1983 | -   | 2.2   | 15.5  | 6.3   | 2.0   | 7.7   | 0.7  | 1.8  | 5.5  | 11.6 | 5.0  | 1.0 | 0.4 | 0.2 | 0.8 | 60.7    | 32.5  | 5.7 |
| 1984 | -   | 0.5   | 38.3  | 24.6  | 3.0   | 0.8   | 4.2  | 0.4  | 0.5  | 2.8  | 7.2  | 2.8 | 0.8 | 0.5 | 1.6 | 88.0    | 39.4  | 3.5 |

[1]Thousands of mt.

Table 4. Stratified mean catch (kg) per tow of mackerel
from NMFS, NEFC bottom trawl surveys in the
spring (offshore strata 1-25, 61-76, and inshore
strata 1-66) and autumn (offshore strata 1-42, 49,
and inshore strata 1-14, 45-66).

| Year | Spring | Autumn |
|------|--------|--------|
| 1963 | - | .02 |
| 1964 | - | .01 |
| 1965 | - | .04 |
| 1966 | - | .04 |
| 1967 | - | .17 |
| 1968 | 1.62 | .11 |
| 1969 | .03 | .21 |
| 1970 | .85 | .05 |
| 1971 | .86 | .04 |
| 1972 | .59 | .11 |
| 1973 | .37 | .05 |
| 1974 | .37 | .02 |
| 1975 | .16 | .01 |
| 1976 | .16 | .04 |
| 1977 | .06 | .04 |
| 1978 | .17 | .11 |
| 1979 | .09 | .07 |
| 1980 | .13 | .06 |
| 1981 | .64 | .03 |
| 1982 | .33 | .15 |
| 1983 | .13 | .03 |
| 1984 | .83 | .08 |
| 1985 | .89 | |

Table 5. Mackerel catch per standardized US day fished in NAFO SA 5-6.

| Year | Catch per day (mt) |
|------|--------------------|
| 1964 | .43 |
| 1965 | .49 |
| 1966 | .84 |
| 1967 | 1.75 |
| 1968 | 2.80 |
| 1969 | 1.92 |
| 1970 | 2.07 |
| 1971 | 1.29 |
| 1972 | .84 |
| 1973 | .53 |
| 1974 | .17 |
| 1975 | .53 |
| 1976 | .59 |
| 1977 | .52 |
| 1978 | .48 |
| 1979 | .69 |
| 1980 | 1.42 |
| 1981 | 1.19 |
| 1982 | .86[1] |
| 1983 | 1.08 |
| 1984 | 0.27 |

[1]Predicted.

Table 6. Data used in estimating fishing mortality (F) in 1984 for the NAFO SA 2-6 mackerel fishery. Catch per day, international catch, fishing effort, and F values apply to age 4 and older fish.

| Year | US std. catch per day (mt) | International catch (thousands of mt) | Fishing effort[1] (thousands of days) | $\overline{F}_{4-14+}$[2] |
|------|------|------|------|------|
| 1964 | .33 | 13.7 | 41.0 | .088 |
| 1965 | .43 | 17.8 | 41.6 | .097 |
| 1966 | .62 | 19.7 | 31.9 | .098 |
| 1967 | 1.24 | 27.4 | 22.0 | .153 |
| 1968 | 1.04 | 32.9 | 31.6 | .198 |
| 1969 | .52 | 39.5 | 75.5 | .182 |
| 1970 | .70 | 83.9 | 119.2 | .221 |
| 1971 | .98 | 295.6 | 301.9 | .383 |
| 1972 | .65 | 327.5 | 506.2 | .378 |
| 1973 | .35 | 281.7 | 811.8 | .429 |
| 1974 | (.33)[3] | 218.3 | 653.6 | .444 |
| 1975 | .27 | 148.9 | 553.6 | .465 |
| 1976 | .28 | 118.8 | 418.3 | .528 |
| 1977 | .29 | 43.6 | 150.3 | .186 |
| 1978 | .36 | 32.7 | 92.1 | .085 |
| 1979 | .64 | 35.5 | 55.0 | .087 |
| 1980 | .54 | 22.9 | 42.7 | .066 |
| 1981 | .31 | 25.4 | 83.0 | .093 |
| 1982 | .51 | 22.1 | 43.1 | .072 |
| 1983 | .53 | 25.3 | 48.1 | .095 |
| 1984 | .71[4] | 17.7 | 24.9 | .071[5] |

[1] Expressed as equivalent US standardized days fished.

[2] Weighted mean fishing mortality for ages 4 and older obtained from virtual population analysis assuming a mean F of 0.105 at ages 4 and older in 1983.

[3] Actual value of 0.11 replaced by 0.33 [see Anderson (1982) for explanation].

[4] Predicted from regression of USA otter trawl (TC 51-150) catch per day on US Std. catch per day. USCPUE = .334 + .034 OTCPUE $r$ = .693.

[5] Predicted from regression of fishing effort (f) on F for 1964-83: F = .0121 $f^{.5508}$.

**Table 7.** Fishing mortality (F) and stock size (millions) by age and year for mackerel in NAFO SA 2-6 derived from VPA (M=0.20).

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### FISHING MORTALITY

| AGE | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.032 | 0.007 | 0.074 | 0.036 | 0.034 | 0.000 | 0.031 | 0.004 | 0.093 | 0.073 | 0.018 | 0.178 |
| 2 | 0.011 | 0.017 | 0.053 | 0.026 | 0.059 | 0.048 | 0.044 | 0.073 | 0.038 | 0.205 | 0.112 | 0.343 |
| 3 | 0.041 | 0.006 | 0.021 | 0.028 | 0.049 | 0.136 | 0.143 | 0.134 | 0.203 | 0.118 | 0.277 | 0.650 |
| 4 | 0.141 | 0.093 | 0.024 | 0.026 | 0.032 | 0.042 | 0.415 | 0.233 | 0.230 | 0.349 | 0.244 | 0.437 |
| 5 | 0.042 | 0.345 | 0.092 | 0.040 | 0.038 | 0.051 | 0.238 | 0.099 | 0.145 | 0.498 | 0.437 | 0.443 |
| 6 | 0.085 | 0.020 | 0.421 | 0.126 | 0.078 | 0.052 | 0.137 | 0.072 | 0.170 | 0.272 | 0.413 | 0.416 |
| 7 | 0.068 | 0.014 | 0.375 | 1.445 | 0.203 | 0.079 | 0.009 | 0.056 | 0.174 | 0.339 | 0.307 | 0.254 |
| 8 | 0.144 | 0.012 | 0.060 | 0.032 | 0.316 | 0.319 | 0.017 | 0.051 | 0.425 | 0.172 | 0.265 | 0.225 |
| 9 | 0.185 | 0.048 | 0.043 | 0.079 | 0.084 | 0.318 | 0.172 | 0.046 | 0.228 | 0.331 | 0.726 | 0.447 |
| 10 | 0.050 | 0.064 | 0.063 | 0.000 | 0.000 | 0.000 | 0.166 | 0.372 | 0.185 | 0.291 | 0.347 | 0.920 |
| 11 | 0.053 | 0.044 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.206 | 0.274 | 0.334 | 0.470 |
| 12 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 13 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 14+ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| MEAN F | 0.053 | 0.064 | 0.063 | 0.079 | 0.084 | 0.143 | 0.166 | 0.159 | 0.206 | 0.274 | 0.336 | 0.470 |
| REC AGE | 3+ | 3+ | 3+ | 3+ | 3+ | 3+ | 3+ | 3+ | 3+ | 3+ | 3+ | 3+ |

| AGE | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.043 | 0.227 | 0.037 | 0.037 | 0.003 | 0.002 | 0.030 | 0.098 | 0.003 | 0.001 | 0.001 |
| 2 | 0.437 | 0.439 | 0.349 | 0.106 | 0.005 | 0.023 | 0.061 | 0.140 | 0.127 | 0.016 | 0.023 |
| 3 | 0.425 | 0.378 | 0.353 | 0.158 | 0.024 | 0.037 | 0.053 | 0.063 | 0.127 | 0.111 | 0.031 |
| 4 | 0.509 | 0.520 | 0.548 | 0.178 | 0.037 | 0.046 | 0.036 | 0.142 | 0.080 | 0.131 | 0.071 |
| 5 | 0.399 | 0.430 | 0.567 | 0.134 | 0.046 | 0.050 | 0.037 | 0.136 | 0.118 | 0.098 | 0.071 |
| 6 | 0.503 | 0.439 | 0.692 | 0.173 | 0.131 | 0.089 | 0.048 | 0.086 | 0.187 | 0.094 | 0.071 |
| 7 | 0.424 | 0.444 | 0.515 | 0.270 | 0.133 | 0.135 | 0.042 | 0.058 | 0.063 | 0.184 | 0.071 |
| 8 | 0.342 | 0.358 | 0.632 | 0.137 | 0.176 | 0.101 | 0.059 | 0.064 | 0.046 | 0.105 | 0.071 |
| 9 | 0.197 | 0.278 | 0.269 | 0.133 | 0.137 | 0.246 | 0.051 | 0.105 | 0.038 | 0.087 | 0.071 |
| 10 | 0.343 | 0.101 | 0.542 | 0.062 | 0.071 | 0.096 | 0.187 | 0.060 | 0.067 | 0.075 | 0.071 |
| 11 | 0.493 | 0.436 | 0.082 | 0.020 | 0.105 | 0.043 | 0.090 | 0.106 | 0.051 | 0.048 | 0.071 |
| 12 | 0.000 | 0.000 | 0.000 | 0.023 | 0.051 | 0.058 | 0.039 | 0.029 | 0.106 | 0.044 | 0.071 |
| 13 | 0.000 | 0.000 | 0.000 | 0.000 | 0.058 | 0.046 | 0.031 | 0.070 | 0.065 | 0.098 | 0.071 |
| 14+ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.046 | 0.031 | 0.070 | 0.065 | 0.098 | 0.043 |
| MEAN F | 0.493 | 0.436 | 0.534 | 0.160 | 0.050 | 0.044 | 0.051 | 0.070 | 0.065 | 0.098 | 0.043 |
| REC AGE | 3+ | 3+ | 3+ | 3+ | 3+ | 3+ | 3+ | 3+ | 3+ | 3+ | 3+ |

### STOCK SIZE

| AGE | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 340.4 | 182.5 | 199.9 | 281.7 | 793.3 | 1919.3 | 3160.9 | 1967.1 | 2341.2 | 1168.5 | 1330.4 | 1092.5 |
| 2 | 200.6 | 270.7 | 148.6 | 152.0 | 222.5 | 627.9 | 1585.4 | 4097.9 | 1603.8 | 1742.6 | 869.5 | 1069.1 |
| 3 | 413.6 | 227.1 | 217.9 | 113.3 | 121.3 | 171.8 | 490.1 | 1242.6 | 3118.5 | 1263.3 | 1161.7 | 651.8 |
| 4 | 31.7 | 324.9 | 185.1 | 174.7 | 91.8 | 94.5 | 122.8 | 347.8 | 872.4 | 2083.2 | 919.6 | 720.7 |
| 5 | 22.2 | 22.4 | 242.3 | 148.0 | 139.5 | 72.9 | 74.2 | 66.4 | 225.3 | 367.8 | 1203.7 | 388.4 |
| 6 | 21.6 | 17.1 | 13.1 | 100.9 | 116.5 | 110.6 | 56.7 | 47.9 | 49.2 | 139.8 | 282.6 | 635.4 |
| 7 | 23.5 | 16.3 | 13.7 | 7.0 | 130.5 | 80.3 | 85.4 | 40.3 | 36.3 | 34.0 | 99.7 | 133.0 |
| 8 | 6.6 | 18.0 | 13.1 | 7.7 | 2.0 | 87.2 | 66.8 | 69.3 | 31.3 | 23.1 | 19.8 | 60.1 |
| 9 | 2.6 | 4.7 | 14.6 | 10.1 | 2.7 | 1.2 | 42.5 | 53.8 | 54.0 | 16.8 | 17.3 | 12.5 |
| 10 | 2.3 | 1.8 | 3.6 | 0.0 | 0.0 | 0.0 | 0.7 | 29.3 | 42.6 | 35.2 | 9.9 | 6.9 |
| 11 | 6.4 | 1.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 16.5 | 31.0 | 21.5 | 4.7 |
| 12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 13 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 14+ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOT NOS | 1159.4 | 1087.6 | 1051.9 | 1077.5 | 1620.2 | 3173.1 | 7683.5 | 7962.6 | 8391.2 | 7127.3 | 5955.8 | 4994.4 |
| UGHTUNOS | 250.8 | 286.0 | 309.8 | 318.7 | 377.9 | 567.4 | 1130.3 | 1544.7 | 1891.5 | 1919.2 | 1693.1 | 1443.9 |
| SPWN NOS | 670.8 | 769.7 | 777.7 | 719.9 | 715.6 | 939.8 | 1731.9 | 3944.5 | 5248.1 | 5087.4 | 4180.5 | 3367.4 |
| UGHTUNOS | 192.6 | 344.5 | 277.4 | 270.2 | 282.0 | 327.7 | 494.6 | 993.2 | 1324.8 | 1632.8 | 1464.6 | 1244.4 |

| AGE | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1729.6 | 2019.2 | 376.3 | 60.7 | 32.9 | 240.2 | 44.8 | 123.0 | 1348.4 | 2249.7 | 750.0 | 1130.0 |
| 2 | 748.7 | 1329.6 | 1316.7 | 296.6 | 47.9 | 26.9 | 203.2 | 35.6 | 91.3 | 1102.4 | 1037.8 | 613.4 |
| 3 | 621.0 | 373.8 | 701.7 | 740.7 | 218.7 | 39.0 | 21.5 | 156.6 | 24.8 | 65.9 | 888.7 | 1406.4 |
| 4 | 270.2 | 272.0 | 222.0 | 330.6 | 331.9 | 174.7 | 30.8 | 16.7 | 120.4 | 17.9 | 48.2 | 705.4 |
| 5 | 380.4 | 136.8 | 132.4 | 105.0 | 222.1 | 419.9 | 136.7 | 24.3 | 11.9 | 91.0 | 12.9 | 36.8 |
| 6 | 309.4 | 209.1 | 59.6 | 61.3 | 75.2 | 169.8 | 327.0 | 105.7 | 17.4 | 8.4 | 47.3 | 9.8 |
| 7 | 343.3 | 154.2 | 110.4 | 24.4 | 41.5 | 54.0 | 127.2 | 255.3 | 79.4 | 11.8 | 6.4 | 31.5 |
| 8 | 97.2 | 183.9 | 78.9 | 54.1 | 15.0 | 29.7 | 38.4 | 99.9 | 197.2 | 61.0 | 8.0 | 4.9 |
| 9 | 39.3 | 56.5 | 105.2 | 33.7 | 38.6 | 18.3 | 22.0 | 29.8 | 76.7 | 134.2 | 45.0 | 6.1 |
| 10 | 6.3 | 26.4 | 35.0 | 65.8 | 24.1 | 27.5 | 6.4 | 17.1 | 22.0 | 60.5 | 115.0 | 14.3 |
| 11 | 2.2 | 3.1 | 19.5 | 14.7 | 50.7 | 18.4 | 20.5 | 4.4 | 13.2 | 16.8 | 45.0 | 88.3 |
| 12 | 0.0 | 0.0 | 0.0 | 14.7 | 13.4 | 37.3 | 14.4 | 15.3 | 3.2 | 10.3 | 12.9 | 14.3 |
| 13 | 0.0 | 0.0 | 0.0 | 0.0 | 11.8 | 10.4 | 28.9 | 11.4 | 12.2 | 2.4 | 8.0 | 9.8 |
| 14+ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 17.4 | 17.8 | 13.0 | 22.6 | 9.5 | 42.1 | 39.2 |
| TOT NOS | 4336.0 | 4785.7 | 3158.0 | 1824.8 | 1323.4 | 1283.6 | 1037.8 | 908.1 | 2040.7 | 3801.9 | 3908.5 | 4250.4 |
| UGHTUNOS | 1174.0 | 1054.3 | 843.3 | 394.5 | 383.5 | 609.5 | 350.3 | 403.4 | 372.9 | 725.6 | 1298.3 | 1807.9 |
| SPWN NOS | 2452.1 | 2101.6 | 2123.3 | 1415.8 | 1266.7 | 1022.0 | 893.3 | 747.3 | 646.7 | 1061.8 | 2229.4 | 2813.7 |
| UGHTUNOS | 941.7 | 745.0 | 690.6 | 562.4 | 373.4 | 371.4 | 322.2 | 467.1 | 413.6 | 439.7 | 906.9 | 1320.9 |

Table 8. Input data for forecasts of catch in 1985-86 and stock in 1986-87 of mackerel in NAFO SA 2-6.

| Age | Stock size in 1985 (millions) | Exploitation pattern | Mean weight of the catch (kg) | Mean weight of stock on 1 Jan. (kg) | Maturity ogive |
|-----|------|------|-------|-------|------|
| 1 | 500,1500 | 0.06 | 0.125 | 0.090 | 0.00 |
| 2 | 200,800 | 0.33 | 0.299 | 0.252 | 0.50 |
| 3 | 1486.4 | 0.47 | 0.510 | 0.435 | 1.00 |
| 4 | 705.4 | 0.78 | 0.600 | 0.534 | 1.00 |
| 5 | 36.8 | 1.17 | 0.647 | 0.596 | 1.00 |
| 6 | 9.8 | 1.44 | 0.701 | 0.655 | 1.00 |
| 7 | 51.5 | 1.44 | 0.725 | 0.687 | 1.00 |
| 8 | 4.9 | 1.28 | 0.716 | 0.690 | 1.00 |
| 9 | 6.1 | 1.33 | 0.712 | 0.693 | 1.00 |
| 10 | 34.3 | 1.20 | 0.734 | 0.719 | 1.00 |
| 11 | 88.3 | 1.00 | 0.763 | 0.752 | 1.00 |
| 12 | 34.3 | 1.00 | 0.782 | 0.773 | 1.00 |
| 13 | 9.8 | 1.00 | 0.771 | 0.767 | 1.00 |
| 14+ | 39.2 | 1.00 | 0.817 | 0.812 | 1.00 |

Table 9. Projected catch of mackerel in 1986 in NAFO SA 2-6 and accompanying fishing mortality ($\overline{F}$ 3+) with spawning stock biomass (SSB) in 1987 along with percent change from 1986 SSB. These forecasts assume a 1985 catch of 57,000 mt and recruitment of 250 and 500 million fish (Option 1) for the 1983 and 1984 year classes at age 1 respectively, or 1000 and 1500 million fish (Option 2) for the 1983 and 1984 year classes respectively.

| | Catch (000's mt) 1986 | F 3+ 1986 | Spawning stock (000's mt) 1987 | % change in spawning stock from 1986 |
|---|---|---|---|---|
| (Option 1) | 50.0 | .045 | 1,296 | +5.0 |
| 1983=250 | 60.0 | .055 | 1,286 | +4.5 |
| 1984=500 | 70.0 | .065 | 1,276 | +3.7 |
| (million) | 80.0 | .075 | 1,266 | +2.8 |
| | 90.0 | .084 | 1,258 | +2.2 |
| | 100.0 | .094 | 1,248 | +1.4 |
| | 120.0 | .113 | 1,231 | +0.0 |
| | 140.0 | .133 | 1,212 | -1.5 |
| | 160.0 | .153 | 1,194 | -3.0 |
| | 180.0 | .174 | 1,176 | -4.5 |
| | 200.0 | .194 | 1,158 | -5.9 |
| | 220.0 | .215 | 1,140 | -7.4 |
| | 260.0 | .260 | 1,104 | -10.3 |
| | 285.0 | .290[1] | 1,079 | -12.3 |

| | Catch (000's mt) 1986 | F 3+ 1986 | Spawning stock (000's mt) 1987 | % change in spawning stock from 1986 |
|---|---|---|---|---|
| (Option 2) | 57.0 | .045 | 1,790 | +15.3 |
| 1983=1000 | 70.0 | .055 | 1,779 | +15.1 |
| 1984=1500 | 82.0 | .065 | 1,767 | +14.3 |
| (million) | 94.0 | .075 | 1,757 | +13.6 |
| | 105.0 | .084 | 1,746 | +12.9 |
| | 117.0 | .094 | 1,734 | +12.2 |
| | 139.0 | .113 | 1,723 | +11.4 |
| | 163.0 | .133 | 1,691 | + 9.4 |
| | 186.0 | .153 | 1,669 | + 8.0 |
| | 210.0 | .174 | 1,646 | + 6.5 |
| | 232.0 | .194 | 1,625 | + 5.1 |
| | 255.0 | .215 | 1,604 | + 3.8 |
| | 303.0 | .260 | 1,558 | + 0.8 |
| | 334.0 | .290 | 1,529 | - 1.0 |

[1]F0.1 (Anderson 1985).
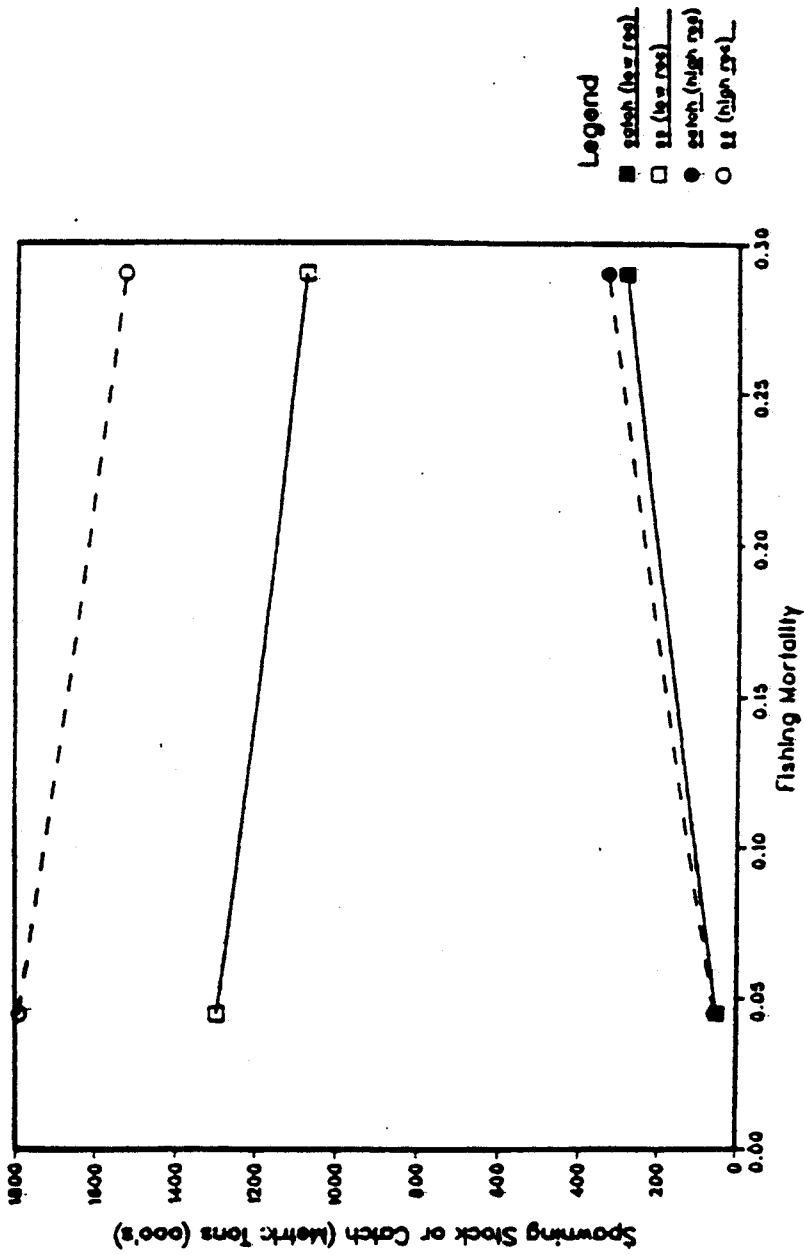
Figure 1. Projected catches of mackerel in 1986 in NAFO SA 2-6 with spawning stock in 1987 under two options of recruitment. Option 1 (low) assumes 250 and 500 million fish for the 1983 and 1984 year classes respectively and option 2 (high) assumes 1000 and 1500 million fish for the 1983 and 1984 year class respectively.