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# Status of the Cod Stock in Divisions 3Pn 4RS

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## Abstract

Catches declined in the early 1970's but have increased substantially in recent years. The catch composition in 1979 indicated a modal length of 52 cm. with the bulk of the fishery being on 1972, 73, and 74 year-classes within the population. An appropriate terminal F was obtained from the relationship of cohort biomass to standard CPUE. Using the cohort biomass obtained and an estimate of recruitment, the projected catch in 1981 fishing at $F_{0.1}$ would be approximately 76,000 t.

## Résumé

Les prises ont diminué au début des années 1970, mais ont augmenté de façon marquée en ces dernières années. La composition des prises en 1979 montre une longueur modale de 52 cm, la pêche prélevant surtout les classes de 1972, 73 et 74 à même la population. Un F terminal approprié a été obtenu à partir de la relation entre la biomasse des cohortes et les prises par unité d'effort normalisées. Utilisant la biomasse des cohortes ainsi obtenue et une estimation du recrutement, on établit à environ 76,000 t les prévisions de capture pour 1981, à un taux de pêche de $F_{0.1}$.

Nominal catches

Catches in Subdivisions 3Pn and Divisions 4RS peaked at 106,000 t in 1970 with a subsequent decline to approximately 60,000 t in 1975. Since that time catches have increased to a high of 78,350 t in 1978. Recent catches and TAC's were ('000 t):

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|---|---|
| TAC | - | - | 55 | 55 | 75 | 75 | 75 |
| Catch | 66 | 60 | 77 | 74 | 78 | 90* | |

* preliminary

Catch compositions

Catch compositions at age were determined for the commercial fishery in 1979. Sampling data were available from Canada (N) and France as obtained by the Commercial Sampling and Foreign Cooperative Research units, respectively, of Department of Fisheries and Oceans. Table 1 indicates the catch by Canada (N) in 3Pn 4RS by month and gear. The sampling data available from Canada (N) and France is shown in Tables 2 and 3 while age compositions for Canada (N) are seen in Tables 4 and 5. Table 6 indicates the total age composition for 3Pn 4RS

for the estimated landing of 89,697 t. The age composition for France was obtained using sampling data indicated in Table 3 while that for Canada (M) was obtained using the age composition for Canada (N) OT. The Canada (Q) age composition was derived from the combined age compositions of Can(N), France and Can (M) The total per mille length and age compositions for the commercial fishery in 1979 are shown in Figure 1. The modal length was 52 cm., with the majority of the fishery occuring on 5-7 year old fish.

The per mille age composition from a research survey trip in 3Pn 4RS in 1979 is shown in Figure 2 while length and age compositions for a similar survey in 1980 are shown in Figure 3. There is an indication from the 1980 survey data that the 1977 year class (3 year-olds) show some promise.

Partial selection

The partial selection at age values were derived from the ratio of the percent commercial age compositions to the percent survey age compositions for 1979 (Table 7) and from an average of $F^S$ over the years 1974-76 from a cohort run (Table 8). The latter were considered a better approximation of the present fishery.

Yield per recruit

Estimates of yield per recruit (Table 9 ) were obtained using average weight at age data from the commercial fishery in 1979 and an estimate of partial selection in 1979 (Table 8).

From the yield per recruit curve (Fig. 4) estimates of $F_{0.1}$ and $F_{max}$ were 0.237 and 0.451 respectively.

Fishing mortality

Using catch at age data from 1973-79 and average weight and partial selection values as shown in Table 9, the cohort was run over a series of Terminal F's. Catch-at-age data for 1978, as used in the 1979 assessments, were updated to the new catch of 78,348 t. From regressions of standard catch per unit effort (Table 10)

against biomass (ages 4+) at a range of terminal Fs for 1979, it was found that the relationship over the period 1973-79 providing the highest $r^2$ was at terminal F=0.39, although the $r^2$ values were very similar for a wide range of $F_t$. There was a poor correlation of total F against effort over the same range of terminal Fs. The results of a cohort run at $F_t$=0.39 are shown in Table II and this F was chosen as the F in 1979.

Survey Data

Stratified random surveys have been conducted in 3Pn4RS in January-February in each of 1978, 79 and 80. The results of these surveys, indicating biomass estimates in the strata fished, are shown in Table 12. In Table 13 are shown the mean number at age caught per tow from the same surveys. It would appear that there are at least five strong year classes within the population which has remained stable over the survey period.

Recruitment

Estimates of relative strengths of year-classes 1969-76 were derived from research vessel surveys. In years in which surveys were conducted, the catch rate at age over the series was calculated. The catch rate at age for each year-class was adjusted to a percentage of the highest value at that age. The geometric mean of the values for each year-class gave an index of relative strengths of year-classes.

The relative strengths of year-classes 1969-76 from research vessel surveys were compared to the number of 4 year olds of the same year-classes from the cohort run (Table 14). The strengths of the 1975 and 76 year-classes were predicted from the correlation obtained by regressing survey abundance on cohort age 4 numbers (1969-74). The geometric mean of the 1969-76 cohort year-class abundance was approximately 107 million. Because survey results indicated that the 1979 year class was above average in abundance its predicted size at age 4 in 1981 was arbitrarily set at 150 million.

Projections

Catch projections were obtained for 1980 and 81 using the population number at age from the cohort at $F_t$=0.39 (Table 11). The mean weight stage and partial selection values used are shown in Table 15. Recruitment at age 4 in 1979, 80 and 81 were approximately 151, 136 and 150 millions respectively. The projections, as shown in Tables 16-18, were made assuming a TAC in 1980 and fishing at $F_{0.1}$ in 1981. The estimated catch in 1981 fishing at $F_{0.1}$=0.24 is 7600 t.

Table 1. Cod landings (metric tons) by Can(N) in Subdivision 3Pn and Divisions 4R and 4S by month and gear.

| Division | Month | OT | Trap | GN | LT | HL | Other | Total |
|---|---|---|---|---|---|---|---|---|
| 3Pn | Jan. | 100 | | | 342 | 3 | | 445 |
| | Feb. | 736 | | | 1126 | 9 | | 1871 |
| | Mar. | 1187 | | | 1869 | 1 | | 3057 |
| | Apr. | 239 | | | 1142 | 2 | 31 | 1414 |
| | May | 55 | | | 336 | 3 | 3 | 397 |
| | June | 11 | 20 | 44 | 416 | 25 | 11 | 527 |
| | July | 38 | 5 | 6 | 352 | 22 | 69 | 492 |
| | Aug. | 41 | | | 109 | 16 | 51 | 217 |
| | Sept. | 27 | | | 162 | 13 | 8 | 210 |
| | Oct. | 3 | | 1 | 368 | 9 | 5 | 386 |
| | Nov. | 23 | | | 777 | 4 | 3 | 807 |
| | Dec. | 6 | | | 277 | 9 | | 292 |
| | Total | 2466 | 25 | 51 | 7276 | 116 | 181 | 10,115 |
| 4R | Jan. | 4871 | | 1 | 43 | 3 | | 4918 |
| | Feb. | 929 | | | 112 | 2 | | 1043 |
| | Mar. | 568 | | | 125 | 2 | 18 | 713 |
| | Apr. | 665 | | 308 | 308 | 31 | 94 | 1406 |
| | May | 1451 | 33 | 2197 | 440 | 345 | 35 | 4501 |
| | June | 1949 | 1807 | 2865 | 944 | 478 | 39 | 8082 |
| | July | 1913 | 819 | 3442 | 627 | 865 | 68 | 7734 |
| | Aug. | 1190 | 165 | 1744 | 1594 | 833 | 16 | 5542 |
| | Sept. | 170 | | 340 | 411 | 330 | 13 | 1264 |
| | Oct. | 205 | | 237 | 210 | 143 | 17 | 812 |
| | Nov. | 93 | | 87 | 181 | 18 | 8 | 387 |
| | Dec. | 38 | | 69 | 27 | 3 | | 137 |
| | Total | 14,042 | 2824 | 11,290 | 5022 | 3053 | 308 | 36,539 |
| 4S | Jan. | 3 | | | | | | |
| | Feb. | 32 | | | | | | |
| | Mar. | 9 | | | | | | |
| | Apr. | 3 | | | | | | |
| | Total | 47 | | | | | | 47 |

Table 2. Cod length and age sampling data by gear and month for Divisions 3Pn 4R obtained by Can(N) in 1979.

| Division | Gear | Month | No. of samples | No. measured | No. aged |
|---|---|---|---|---|---|
| 3Pn | LT | March | 4 | 1545 | 491 |
| | | April | 1 | 1245 | |
| 4R | OT | Jan. | 13 | 6625 | 599 |
| | | March | 3 | 1586 | |
| | | May | 1 | 575 | 137 |
| | | June | 1 | 402 | |
| | GN | May | 8 | 3570 | 386 |
| | | June | 4 | 1380 | 693 |
| | | July | 3 | 1168 | |
| | Trap | June | 2 | 1154 | |
| | | July | 3 | 1334 | |

Table 3. Cod length and age sampling by gear and month for Division 4R from France as obtained by the Foreign Cooperative research unit.

| Gear | Month | No. of Samples | No. Meas. | No. Aged |
|---|---|---|---|---|
| OT | Jan. | 20 | 3646 | |
| | Feb. | 54 | 11696 | 611 |
| | Mar. | 19 | 5098 | |
| | Apr. | 93 | 22464 | 807 |
| | May | 38 | 9105 | |

Table 4 . Age compositions for cod in Subdivision 3Pn in 1979 from Can(N) landings.

| Age | OT | Inshore gears | Total 3Pn |
|---|---|---|---|
| 2 | | | |
| 3 | | 5 | 5 |
| 4 | 56 | 401 | 457 |
| 5 | 412 | 2114 | 2526 |
| 6 | 537 | 1176 | 1713 |
| 7 | 576 | 691 | 1267 |
| 8 | 201 | 225 | 426 |
| 9 | 50 | 116 | 166 |
| 10 | 7 | 54 | 61 |
| 11 | 7 | 42 | 49 |
| 12 | 3 | 27 | 30 |
| 13 | | 7 | 7 |
| 14 | 2 | 2 | 4 |
| 15 | | 12 | 12 |
| 16 | | 5 | 5 |
| 17 | | 2 | 2 |
| 18 | | | |
| 19 | | | |
| 20 | | | |
| 21 | | 2 | 2 |
| Total | 1851 | 4881 | 6732 |
| Ave. Wt. | 1.43 | 1.53 | 1.50 |
| Landings | 2647 | 7468 | 10,115 |

Table 5. Age compositions for cod in Divisions 4R and 4S in 1979 from Can(N) landings.

| Age | OT | Trap | GN | Other | Total |
|---|---|---|---|---|---|
| 3 | | 6 | | 2 | 8 |
| 4 | 918 | 471 | 15 | 406 | 1810 |
| 5 | 3694 | 1381 | 175 | 1518 | 6768 |
| 6 | 3207 | 480 | 678 | 1262 | 5627 |
| 7 | 2546 | 175 | 1447 | 1205 | 5373 |
| 8 | 728 | 48 | 977 | 507 | 2260 |
| 9 | 194 | 3 | 334 | 154 | 685 |
| 10 | 36 | 3 | 231 | 78 | 348 |
| 11 | 47 | | 108 | 45 | 200 |
| 12 | 13 | | 76 | 26 | 115 |
| 13 | 1 | | 40 | 12 | 53 |
| 14 | 5 | | 26 | 9 | 40 |
| 15 | | | 6 | 2 | 8 |
| 16 | | | 5 | 1 | 6 |
| 17 | | | 1 | | 1 |
| 18 | | | | | |
| 19 | | | | | |
| 20 | | | 1 | | 1 |
| Total | 11,389 | 2567 | 4120 | 5227 | 23,303 |
| Ave. Wt. | 1.26 | 1.10 | 2.74 | 1.55 | 1.57 |
| Landings | 14,350 | 2824 | 11,290 | 8122 | 36,586 |

Table 6. Age compositions for cod in Divisions 3Pn 4RS in 1979.

| Age | Can(N) | France | Can(M) | Can(Q) | Total |
|---|---|---|---|---|---|
| 3 | 13 | 25 | | 11 | 49 |
| 4 | 2267 | 897 | 253 | 1024 | 4441 |
| 5 | 9294 | 2992 | 1067 | 4004 | 17,357 |
| 6 | 7340 | 3120 | 972 | 3428 | 14,860 |
| 7 | 6640 | 3369 | 811 | 3244 | 14,064 |
| 8 | 2686 | 948 | 241 | 1162 | 5037 |
| 9 | 851 | 257 | 63 | 351 | 1522 |
| 10 | 409 | 114 | 11 | 160 | 694 |
| 11 | 249 | 140 | 14 | 121 | 524 |
| 12 | 145 | 65 | 4 | 64 | 278 |
| 13 | 60 | 37 | | 29 | 126 |
| 14 | 44 | 25 | 2 | 22 | 93 |
| 15 | 20 | 4 | | 7 | 31 |
| 16 | 11 | 4 | | 4 | 19 |
| 17 | 3 | | | 1 | 4 |
| 18 | | | | | |
| 19 | | | | | |
| 20 | 1 | | | | 1 |
| 21 | 2 | | | | 2 |
| Total | 30,035 | 11,997 | 3438 | 13,632 | 59,102 |
| Ave. Wt. | 1.55 | 1.49 | 1.28 | 1.52 | 1.52 |
| Landings | 46,701 | 17,875 | 4400 | 20,721 | 89,697 |

Table 7. Estimation of partial selection at age for cod in 3Pn 4Rs

| Age | Survey | Comm. | % Survey | % Comm. | Comm / Survey | Partial Selection |
|---|---|---|---|---|---|---|
| 3 | 4484 | 49 | 5.76 | .08 | .0139 | .007 |
| 4 | 15425 | 4441 | 19.80 | 7.52 | .3798 | .190 |
| 5 | 22781 | 17357 | 29.24 | 29.39 | 1.0051 | .503 |
| 6 | 15204 | 14860 | 19.52 | 25.17 | 1.2894 | .645 |
| 7 | 11249 | 14064 | 14.44 | 23.82 | 1.6496 | .825 |
| 8 | 4969 | 5037 | 6.38 | 8.53 | 1.3370 | .668 |
| 9 | 1003 | 1522 | 1.29 | 2.58 | 2.000 | 1.000 |
| 10 | 554 | 694 | .71 | 1.18 | 1.6620 | .831 |
| 11 | 1153 | 524 | 1.48 | .89 | .6014 | .301 |
| 12 | 395 | 278 | .51 | .47 | .9216 | .461 |
| 13 | 300 | 126 | .39 | .21 | .5385 | .269 |
| 14 | 192 | 93 | .25 | .16 | .6400 | .320 |
| 15 | 108 | 31 | .14 | .05 | .3571 | .179 |
| 16 | 71 | 19 | .09 | .03 | .3333 | .167 |
| 17 | 15 | 4 | .02 | .01 | .5000 | .250 |

Table 8. Estimation of partial selection at age for cod in 3Pn 4RS based on cohort Average Fs (ages 7-9) for the period 1974-76.

| Age | 1974 | 1975 | 1976 | Ave. 74-76 | P.S. |
|---|---|---|---|---|---|
| 4 | .068 | .066 | .044 | .059 | .059 |
| 5 | .379 | .284 | .529 | .397 | .397 |
| 6 | .569 | .803 | .864 | .745 | .745 |
| 7 | .936 | .781 | .939 | .885 | .885 |
| 8 | 1.162 | .833 | 1.020 | 1.005 | 1.000 |
| 9 | .934 | 1.395 | 1.007 | 1.112 | 1.000 |
| 10 | 1.263 | .747 | 1.576 | 1.195 | 1.000 |
| 11 | .789 | .781 | 1.759 | 1.110 | 1.000 |
| 12 | | | | | |
| 13 | | | | | |
| 14 | | | | | |
| 15 | | | | | |
| Ave $F_{7-9}$ | .45 | .42 | .36 | | |

Table 9. Partial selection and average weight at age data from 1979 used in estimation of yield per recruit.

| Age | Average Weight | P.S. |
|---|---|---|
| 4 | .55 | .059 |
| 5 | .89 | .397 |
| 6 | 1.32 | .745 |
| 7 | 1.78 | .885 |
| 8 | 2.41 | 1.000 |
| 9 | 3.15 | 1.000 |
| 10 | 3.57 | 1.000 |
| 11 | 3.79 | 1.000 |
| 12 | 4.51 | 1.000 |
| 13 | 5.23 | 1.000 |
| 14 | 4.74 | 1.000 |
| 15 | 5.43 | 1.000 |

YIELD PER RECRUIT ANALYSIS

| | FISHING MORTALITY | CATCH (NUMBER) | YIELD (KG) | AVG. WEIGHT (KG) | YIELD PER UNIT EFFORT |
|---|---|---|---|---|---|
| | 0.1000 | 0.224 | 0.535 | 2.392 | 1.000 |
| | 0.2000 | 0.349 | 0.741 | 2.122 | 0.693 |
| F0.1 --- | 0.2371 | 0.382 | 0.779 | 2.038 | 0.614 |
| | 0.3000 | 0.427 | 0.816 | 1.911 | 0.508 |
| | 0.4000 | 0.480 | 0.838 | 1.746 | 0.392 |
| FMAX --- | 0.4508 | 0.501 | 0.840 | 1.676 | 0.348 |
| | 0.5000 | 0.519 | 0.839 | 1.617 | 0.313 |
| | 0.6000 | 0.549 | 0.831 | 1.515 | 0.259 |
| | 0.7000 | 0.572 | 0.820 | 1.433 | 0.219 |
| | 0.8000 | 0.592 | 0.809 | 1.366 | 0.189 |
| | 0.9000 | 0.609 | 0.798 | 1.311 | 0.166 |
| | 1.0000 | 0.623 | 0.788 | 1.264 | 0.147 |
| | 1.1000 | 0.636 | 0.778 | 1.224 | 0.132 |
| | 1.2000 | 0.647 | 0.770 | 1.190 | 0.120 |
| | 1.3000 | 0.657 | 0.762 | 1.160 | 0.109 |
| | 1.4000 | 0.666 | 0.754 | 1.133 | 0.101 |
| | 1.5000 | 0.674 | 0.748 | 1.110 | 0.093 |

Table 10. Relationship of cohort biomass with standard CPUE from cohort runs at a range of Terminal F's.

| Year | .33 | .35 | .37 | .39 | .41 | .43 | .45 | .47 | CPUE |
|---|---|---|---|---|---|---|---|---|---|
| 1973 | 322,146 | 321,039 | 320,052 | 319,167 | 318,370 | 317,648 | 316,990 | 316,390 | .911 |
| 1974 | 310,457 | 308,733 | 307,197 | 305,820 | 304,578 | 303,454 | 302,431 | 301,496 | 1.016 |
| 1975 | 296,574 | 293,417 | 290,604 | 288,082 | 285,808 | 283,749 | 281,875 | 280,163 | .864 |
| 1976 | 335,498 | 328,739 | 322,716 | 317,316 | 312,448 | 308,037 | 304,023 | 300,356 | .946 |
| 1977 | 373,989 | 362,709 | 352,656 | 343,642 | 335,515 | 328,151 | 321,449 | 315,323 | 1.023 |
| 1978 | 453,945 | 434,987 | 418,089 | 402,935 | 389,268 | 376,882 | 365,605 | 355,296 | 1.033 |
| 1979 | 578,454 | 548,243 | 521,311 | 497,151 | 475,359 | 455,605 | 437,616 | 421,167 | 1.276 |
| Predicted Biomass 1979 | 524,527 | 497,974 | 474,306 | 453,082 | 433,942 | 416,596 | 400,804 | 386,549 | |
| r | .6780 | .6811 | .6836 | .6851 | .6849 | .6824 | .6763 | .6662 | |
| m | 566,051 | 503,607 | 447,947 | 398,032 | 353,015 | 312,214 | 275,070 | 241,585 | |
| b | -197,754 | -144,628 | -97,274 | -54,807 | -16,505 | 18,211 | 49,815 | 78,287 | |
| t | 1.8447 | 1.8605 | 1.8732 | 1.8808 | | 1.867 | 1.8362 | 1.7867 | |
| dF | 4 | 4 | 4 | 4 | | 4 | 4 | 4 | |

Table 11.

COD 3PN4RS 1973-79

NATURAL MORTALITY= 0.20

PARTIAL RECRUITMENT MULTIPLIER

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0590 | 0.3970 | 0.7450 | 0.8850 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |

ASSUMED FISHING MORTALITY FOR LAST AGES

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.2700 | 0.4500 | 0.4100 | 0.5200 | 0.2900 | 0.2600 | 0.3900 |

ESTIMATED POPULATION

| AGE \ YEAR | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 |
|---|---|---|---|---|---|---|---|
| 4 | 53301. | 55456. | 107253. | 141419. | 115071. | 166113. | 215323. |
| 5 | 81875. | 35655. | 44072. | 85166. | 113989. | 91370. | 133166. |
| 6 | 37539. | 48518. | 24558. | 32120. | 56405. | 84014. | 64710. |
| 7 | 39778. | 21636. | 29284. | 14274. | 19448. | 32318. | 52858. |
| 8 | 17321. | 27577. | 11061. | 15789. | 8271. | 8998. | 17098. |
| 9 | 9676. | 11290. | 12637. | 5987. | 7618. | 4164. | 5166. |
| 10 | 3905. | 5989. | 5713. | 5091. | 3078. | 3485. | 2356. |
| 11 | 1100. | 2556. | 2440. | 3187. | 1830. | 1661. | 1779. |
| 12 | 479. | 624. | 1455. | 1260. | 1056. | 945. | 944. |
| 13 | 815. | 341. | 264. | 404. | 489. | 600. | 428. |
| 14 | 182. | 650. | 146. | 158. | 154. | 246. | 316. |
| 15 | 23. | 121. | 489. | 73. | 48. | 82. | 105. |

KNOWN CATCHES

| AGE \ YEAR | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 |
|---|---|---|---|---|---|---|---|
| 4 | 8824. | 1471. | 2924. | 1984. | 3141. | 3134. | 4441. |
| 5 | 20463. | 5121. | 4380. | 14724. | 10292. | 11159. | 17357. |
| 6 | 10055. | 11537. | 6446. | 7570. | 15321. | 17601. | 14860. |
| 7 | 5515. | 7353. | 9048. | 3775. | 7653. | 10346. | 14064. |
| 8 | 3196. | 10987. | 3392. | 5867. | 2882. | 2432. | 5037. |
| 9 | 2137. | 3902. | 5808. | 2016. | 3041. | 1164. | 1522. |
| 10 | 709. | 2722. | 1647. | 2584. | 949. | 1188. | 694. |
| 11 | 306. | 704. | 815. | 1717. | 612. | 460. | 524. |
| 12 | 56. | 273. | 870. | 600. | 292. | 382. | 278. |
| 13 | 19. | 147. | 64. | 196. | 171. | 194. | 126. |
| 14 | 31. | 48. | 52. | 90. | 49. | 106. | 93. |
| 15 | 5. | 40. | 150. | 27. | 11. | 17. | 31. |

Table 11 (cont'd)

ESTIMATE FISHING MORTALITY

| AGE | YEAR 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 |
|---|---|---|---|---|---|---|---|
| 4 | 0.2021 | 0.0298 | 0.0306 | 0.0156 | 0.0306 | 0.0211 | 0.0 |
| 5 | 0.3233 | 0.1728 | 0.1163 | 0.2120 | 0.1051 | 0.1450 | 0.0 |
| 6 | 0.3510 | 0.3049 | 0.3426 | 0.3017 | 0.3569 | 0.2634 | 0.0 |
| 7 | 0.1663 | 0.4709 | 0.4177 | 0.3457 | 0.5707 | 0.4367 | 0.0 |
| 8 | 0.2281 | 0.5804 | 0.4139 | 0.5288 | 0.4863 | 0.3548 | 0.0 |
| 9 | 0.2798 | 0.4812 | 0.7092 | 0.4655 | 0.5819 | 0.3696 | 0.0 |
| 10 | 0.2240 | 0.6978 | 0.3837 | 0.8231 | 0.4167 | 0.4727 | 0.0 |
| 11 | 0.3673 | 0.3630 | 0.4606 | 0.9050 | 0.4614 | 0.3654 | 0.0 |
| 12 | 0.1384 | 0.6608 | 1.0806 | 0.7467 | 0.3649 | 0.5923 | 0.0 |
| 13 | 0.0261 | 0.6462 | 0.3121 | 0.7670 | 0.4885 | 0.4422 | 0.0 |
| 14 | 0.2087 | 0.0851 | 0.4983 | 0.9922 | 0.4341 | 0.6479 | 0.0 |
| 15 | 0.2700 | 0.4500 | 0.4100 | 0.5200 | 0.2900 | 0.2600 | 0.3900 |

TOTAL F AGES 6 TO 12

| 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 |
|---|---|---|---|---|---|---|
| 0.2500 | 0.4315 | 0.4391 | 0.4203 | 0.4274 | 0.3197 | |

POPULATION WTS AND NOS

| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 |
|---|---|---|---|---|---|---|---|
| WT | 319167. | 305820. | 288082. | 317316. | 343642. | 402935. | 497151. |
| NO | 245995. | 210412. | 239373. | 304927. | 327455. | 393994. | 494249. |

POPULATION WTS AND NOS AGE 6 TO 15

| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 |
|---|---|---|---|---|---|---|---|
| WT | 216983. | 243586. | 189868. | 163738. | 178903. | 230253. | 260206. |
| NO | 110819. | 119302. | 88047. | 78343. | 98396. | 136511. | 145760. |

Table 12. Cod biomass estimates (Metric tons) from research cruises in 3Pn4Rs

| Strata | Depth | Gadus 4 1978 | Gadus 16 1979 | Gadus 31 1980 | |
|---|---|---|---|---|---|
| 301 | 51-100 | | | | |
| 2 | " " | 8880 | 1073 | 3036 | |
| 3 | 101-150 | 2459 | 96 | 2786 | 3Pn |
| 4 | 151-200 | 127 | 108 | 639 | |
| 5 | 201+ | 271 | 170 | 508 | |
| 820 | 51-100 | 5162 | 4022 | 103645 | |
| 1 | " " | 59500 | 2943 | 5082 | |
| 2 | " " | 59876 | 37986 | 224 | |
| 3 | " " | 8356 | 283 | 29 | |
| 4 | " " | | 2 | 2 | |
| 811 | 101-150 | 8195 | 3686 | 20412 | |
| 2 | " " | 16047 | 7435 | 882 | 4R |
| 3 | " " | 7459 | 541 | 1575 | |
| 801 | 151-200 | 127 | 1299 | 126 | |
| 809 | " " | 3512 | 4524 | 1924 | |
| 810 | " " | 1811 | 583 | 8889 | |
| 802 | 201+ | 1863 | 646 | 10523 | |
| 833 | 50 | 124 | | 0 | |
| 4 | " | >1 | | >1 | |
| 825 | 51-100 | 433 | | 49 | |
| 6 | | | | 0 | |
| 7 | " " | 127 | | 9 | |
| 8 | " " | 200 | | 85 | |
| 9 | " " | 294 | 14399 | 18 | |
| 30 | " " | 210 | | 60 | |
| 1 | " " | 3 | | 1 | 4S |
| 2 | " " | | | 21 | |
| 814 | 101-150 | 535 | | 95 | |
| 5 | " " | 1007 | 1276 | 1109 | |
| 6 | " " | 1160 | 5899 | 1195 | |
| 7 | " " | | | 88 | |
| 8 | " " | 140 | | 986 | |
| 9 | " " | 312 | 2655 | 79 | |
| 805 | 151-200 | | | 273 | |
| 6 | " " | 299 | | 163 | |
| 7 | " " | 856 | 278 | 180 | |
| 8 | " " | 5171 | 4557 | 8844 | |
| 803 | 201+ | 1594 | | 18567 | |
| 4 | " | 515 | | 1035 | |
| 3Pn | | 11737 | 1447 | 6969 | |
| 4R | | 171908 | 63950 | 153313 | |
| 4S | | 12980 | 30511 | 32857 | |
| Total | | 196625 | | 193139 | |

Table 13. Cod mean catch (No.) per tow from survey cruises in 3Pn 4Rs

| | 4R | | | 4S | | | 3Pn | | |
|---|---|---|---|---|---|---|---|---|---|
| Age | 1978 | 1979 | 1980 | 1978 | 1979 | 1980 | 1978 | 1979 | 1980 |
| 1 | | .08 | | .33 | .03 | | | | |
| 2 | .14 | 5.32 | 3.52 | 2.82 | .91 | .68 | | | .29 |
| 3 | 5.05 | 3.58 | 27.62 | 7.55 | 5.35 | 8.80 | .63 | | .08 |
| 4 | 41.03 | 13.41 | 45.73 | 8.40 | 17.33 | 4.53 | 3.25 | .10 | .22 |
| 5 | 68.04 | 27.46 | 90.32 | 1.57 | 18.17 | 2.50 | 5.68 | 1.08 | 3.05 |
| 6 | 85.37 | 21.34 | 69.52 | 1.62 | 9.13 | 2.04 | 16.42 | 1.40 | 5.00 |
| 7 | 24.07 | 16.59 | 32.48 | .63 | 5.92 | 1.78 | 8.40 | 1.34 | 3.52 |
| 8 | 8.10 | 7.18 | 16.86 | .26 | 2.73 | 1.49 | 3.53 | .71 | 3.11 |
| 9 | 3.06 | 1.46 | 6.55 | .14 | .52 | .71 | 1.63 | .22 | 1.98 |
| 10 | 4.74 | .78 | .92 | .18 | .32 | .19 | 2.18 | .10 | .80 |
| 11 | 1.56 | 1.63 | .87 | .08 | .65 | .15 | .86 | .26 | .43 |
| 11+ | 3.17 | 1.63 | 2.06 | .12 | .46 | .42 | 1.60 | .39 | 1.30 |
| Total | 244.33 | 100.47 | 296.47 | 23.70 | 61.58 | 23.29 | 44.19 | 5.61 | 19.77 |

| | 3Pn 4RS |
|---|---|
| 1978 | 93.08 |
| 1979 | 72.27 |
| 1980 | 89.95 |

Table 14. Recruitment estimates 3Pn4RS

| Yr.Cl | Abundance Survey | Age 4 Cohort |
|---|---|---|
| 1969 | 8.75 | 53301 |
| 1970 | 8.79 | 55456 |
| 1971 | 22.56 | 107253 |
| 1972 | 25.83 | 141419 |
| 1973 | 15.17 | 115071 |
| 1974 | 29.14 | 166113 |
| 1975 | 27.44 | 215323 (Est 150819) |
| 1976 | 24.33 | ( 135593) |
| 1977 | 93.27 | |
| | | 107265 (Geometric mean 1969-76) |

Survey abundance vs. cohort age 1969-74

| | |
|---|---|
| r | .964 |
| slope | 4896 |
| int. | 16473 |

Table 15. Data used in catch projections

| Age | Numbers |
|---|---|
| 4 | 150819 |
| 5 | 133166 |
| 6 | 64710 |
| 7 | 52858 |
| 8 | 17098 |
| 9 | 5166 |
| 10 | 2356 |
| 11 | 1799 |
| 12 | 944 |
| 13 | 428 |
| 14 | 316 |
| 15 | 105 |

| Age | Mean Weight (Gm) | Proportion Recruited |
|---|---|---|
| 4 | 550.00 | .059 |
| 5 | 890.00 | .397 |
| 6 | 1320.00 | .745 |
| 7 | 1780.00 | .885 |
| 8 | 2410.00 | 1.000 |
| 9 | 3150.00 | 1.000 |
| 10 | 3570.00 | 1.000 |
| 11 | 3790.00 | 1.000 |
| 12 | 4510.00 | 1.000 |
| 13 | 5230.00 | 1.000 |
| 14 | 4740.00 | 1.000 |
| 15 | 5430.00 | 1.000 |

Natural mortality rate is .200

CATCH PROJECTION FOR 1979 USING POPULATION ESTIMATES FROM COHORT WITH TERMINAL F OF .390

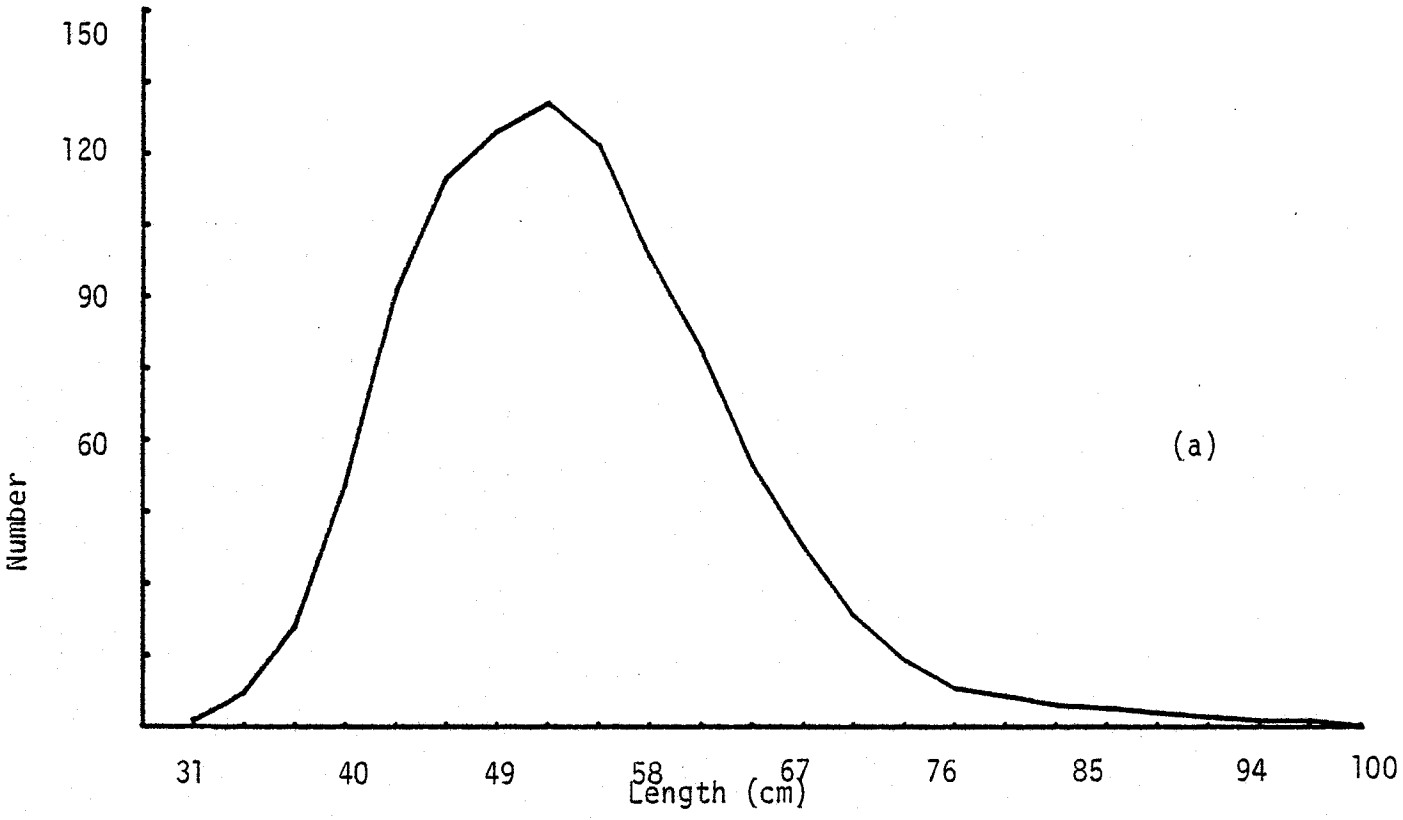
| AGE | POPULATION NUMBERS (000S) | POPULATION WEIGHT (MT) | FISHING MORTALITY | CATCH NUMBERS (000S) | CATCH WEIGHT (MT) | RESIDUAL NUMBERS (000S) | RESIDUAL WEIGHT (MT) |
|---|---|---|---|---|---|---|---|
| 4 | 150819. | 82950. | .023 | 3111. | 1711. | 120671. | 66369. |
| 5 | 133166. | 118518. | .155 | 17357. | 15448. | 93388. | 83116. |
| 6 | 64710. | 85417. | .291 | 14860. | 19615. | 39621. | 52300. |
| 7 | 52858. | 94087. | .345 | 14064. | 25034. | 30645. | 54548. |
| 8 | 17098. | 41206. | .390 | 5037. | 12139. | 9478. | 22842. |
| 9 | 5166. | 16273. | .390 | 1522. | 4794. | 2864. | 9021. |
| 10 | 2356. | 8411. | .390 | 694. | 2478. | 1306. | 4662. |
| 11 | 1779. | 6742. | .390 | 524. | 1986. | 986. | 3738. |
| 12 | 944. | 4257. | .390 | 278. | 1254. | 523. | 2360. |
| 13 | 428. | 2238. | .390 | 126. | 659. | 237. | 1241. |
| 14 | 316. | 1498. | .390 | 93. | 441. | 175. | 830. |
| 15 | 105. | 570. | .390 | 31. | 168. | 58. | 316. |
| TOTAL | 429745. | 462169. | | 57697. | 85728. | 299953. | 301342. |

CATCH PROJECTION FOR 1980 USING POPULATION ESTIMATES FROM COHORT WITH TERMINAL F OF .390

| AGE | POPULATION NUMBERS (000S) | POPULATION WEIGHT (MT) | FISHING MORTALITY | CATCH NUMBERS (000S) | CATCH WEIGHT (MT) | RESIDUAL NUMBERS (000S) | RESIDUAL WEIGHT (MT) |
|---|---|---|---|---|---|---|---|
| 4 | 135593. | 74576. | .016 | 2010. | 1106. | 109199. | 60059. |
| 5 | 120671. | 107397. | .111 | 11506. | 10241. | 88422. | 78696. |
| 6 | 93388. | 123273. | .208 | 15964. | 21072. | 62089. | 81958. |
| 7 | 39621. | 70526. | .247 | 7901. | 14063. | 25331. | 45090. |
| 8 | 30645. | 73854. | .279 | 6803. | 16396. | 18973. | 45724. |
| 9 | 9478. | 29855. | .279 | 2104. | 6628. | 5868. | 18484. |
| 10 | 2864. | 10223. | .279 | 636. | 2270. | 1773. | 6329. |
| 11 | 1306. | 4950. | .279 | 290. | 1099. | 809. | 3064. |
| 12 | 986. | 4448. | .279 | 219. | 987. | 611. | 2754. |
| 13 | 523. | 2737. | .279 | 116. | 608. | 324. | 1694. |
| 14 | 237. | 1125. | .279 | 53. | 250. | 147. | 696. |
| 15 | 233. | 1267. | .279 | 52. | 281. | 144. | 785. |
| TOTAL | 435546. | 504230. | | 47654. | 75000. | 313690. | 345333. |

CATCH PROJECTION FOR 1981 USING POPULATION ESTIMATES FROM COHORT WITH TERMINAL F OF .390

| AGE | POPULATION NUMBERS (000S) | POPULATION WEIGHT (MT) | FISHING MORTALITY | CATCH NUMBERS (000S) | CATCH WEIGHT (MT) | RESIDUAL NUMBERS (000S) | RESIDUAL WEIGHT (MT) |
|---|---|---|---|---|---|---|---|
| 4 | 150000. | 82500. | .014 | 1912. | 1052. | 121083. | 66596. |
| 5 | 109199. | 97187. | .095 | 9009. | 8018. | 81279. | 72338. |
| 6 | 88422. | 116718. | .179 | 13160. | 17372. | 60541. | 79914. |
| 7 | 62089. | 110519. | .212 | 10807. | 19236. | 41107. | 73170. |
| 8 | 25331. | 61049. | .240 | 4918. | 11853. | 16314. | 39318. |
| 9 | 18973. | 59764. | .240 | 3684. | 11604. | 12219. | 38490. |
| 10 | 5868. | 20949. | .240 | 1139. | 4067. | 3779. | 13492. |
| 11 | 1773. | 6719. | .240 | 344. | 1305. | 1142. | 4328. |
| 12 | 809. | 3647. | .240 | 157. | 708. | 521. | 2349. |
| 13 | 611. | 3193. | .240 | 119. | 620. | 393. | 2056. |
| 14 | 324. | 1536. | .240 | 63. | 298. | 209. | 989. |
| 15 | 291. | 1582. | .240 | 57. | 307. | 188. | 1019. |
| TOTAL | 463690. | 565361. | | 45369. | 76440. | 338775. | 394058. |



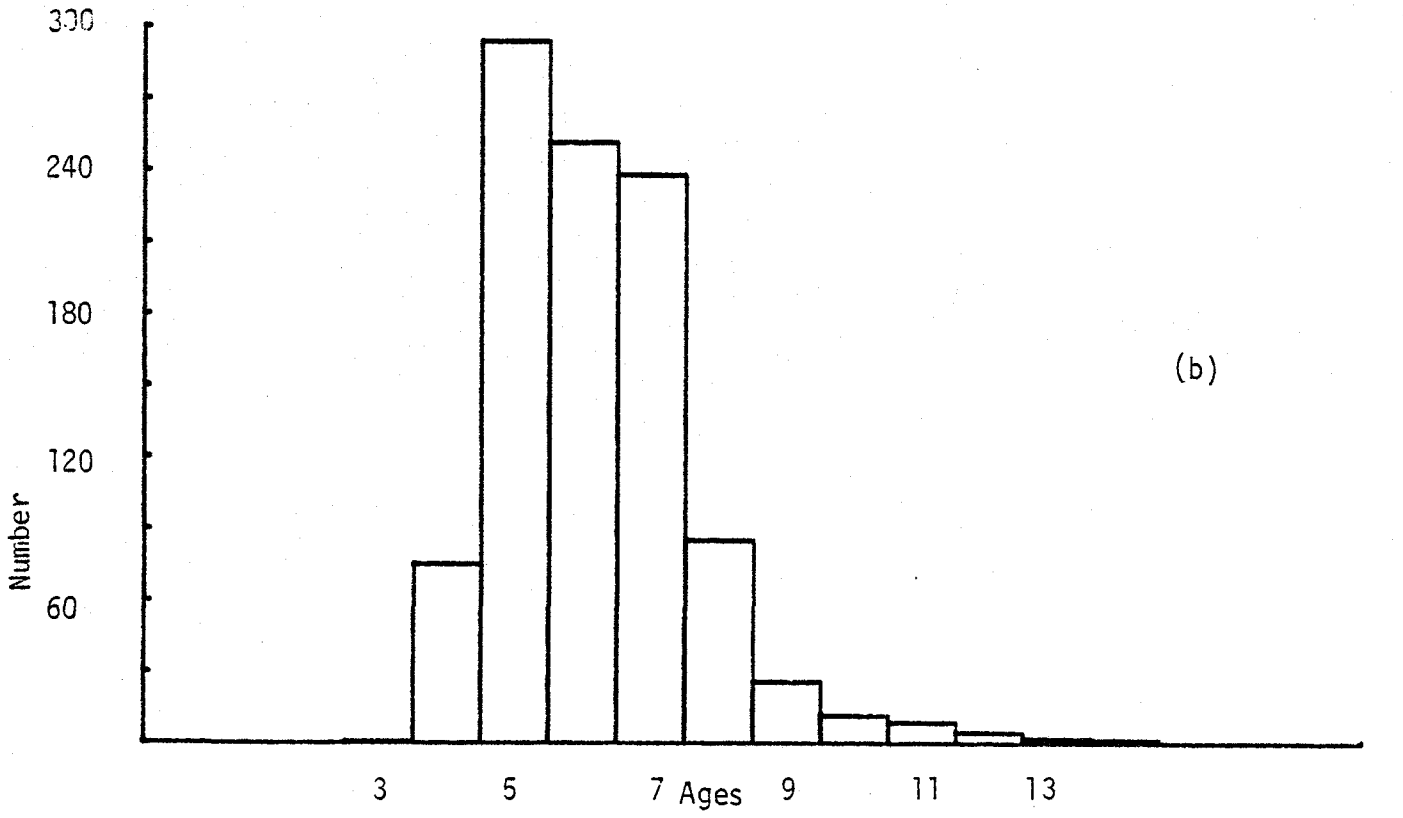




Fig. 1. Per mille length (a) and age compositions (b) from the commercial fishery in 3Pn 4RS in 1979.

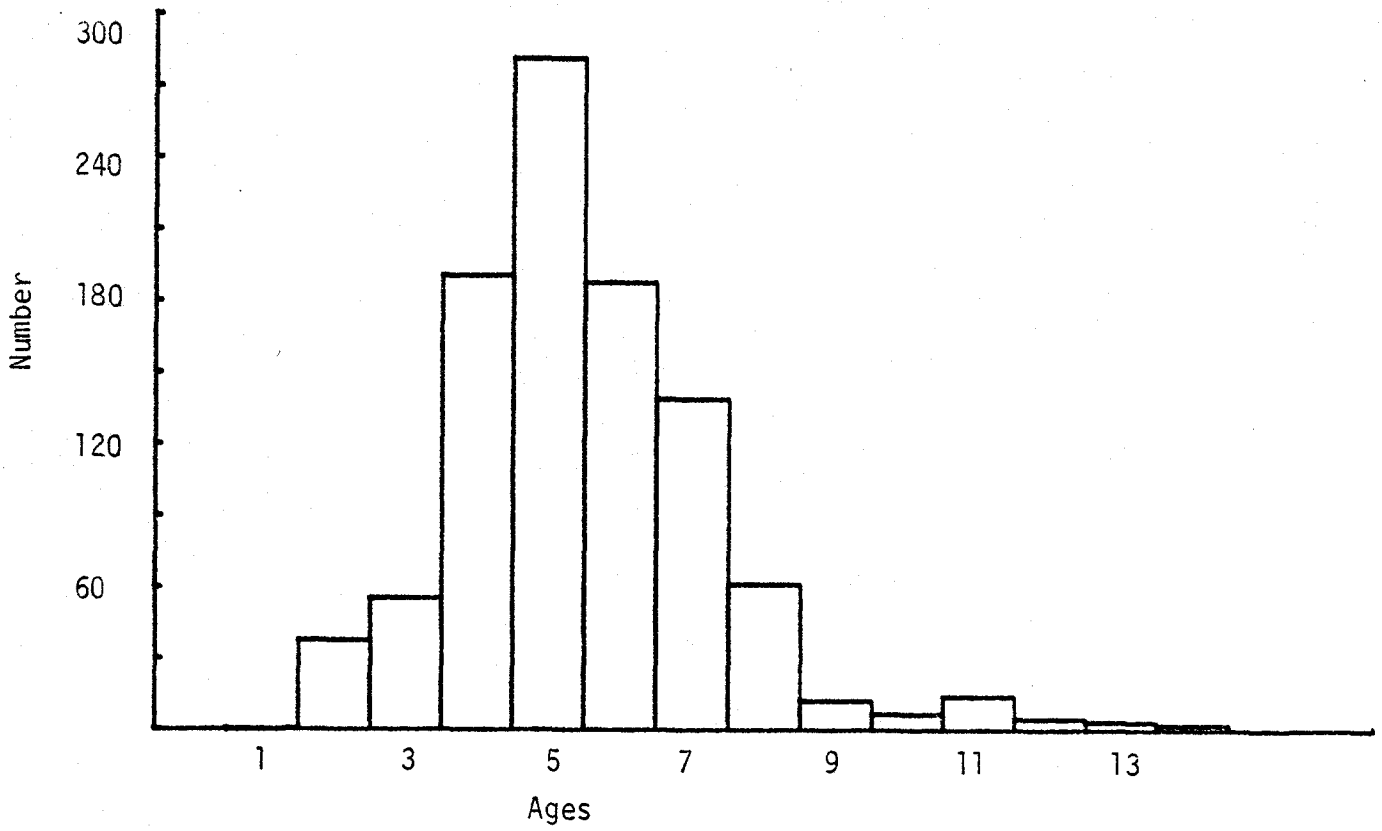
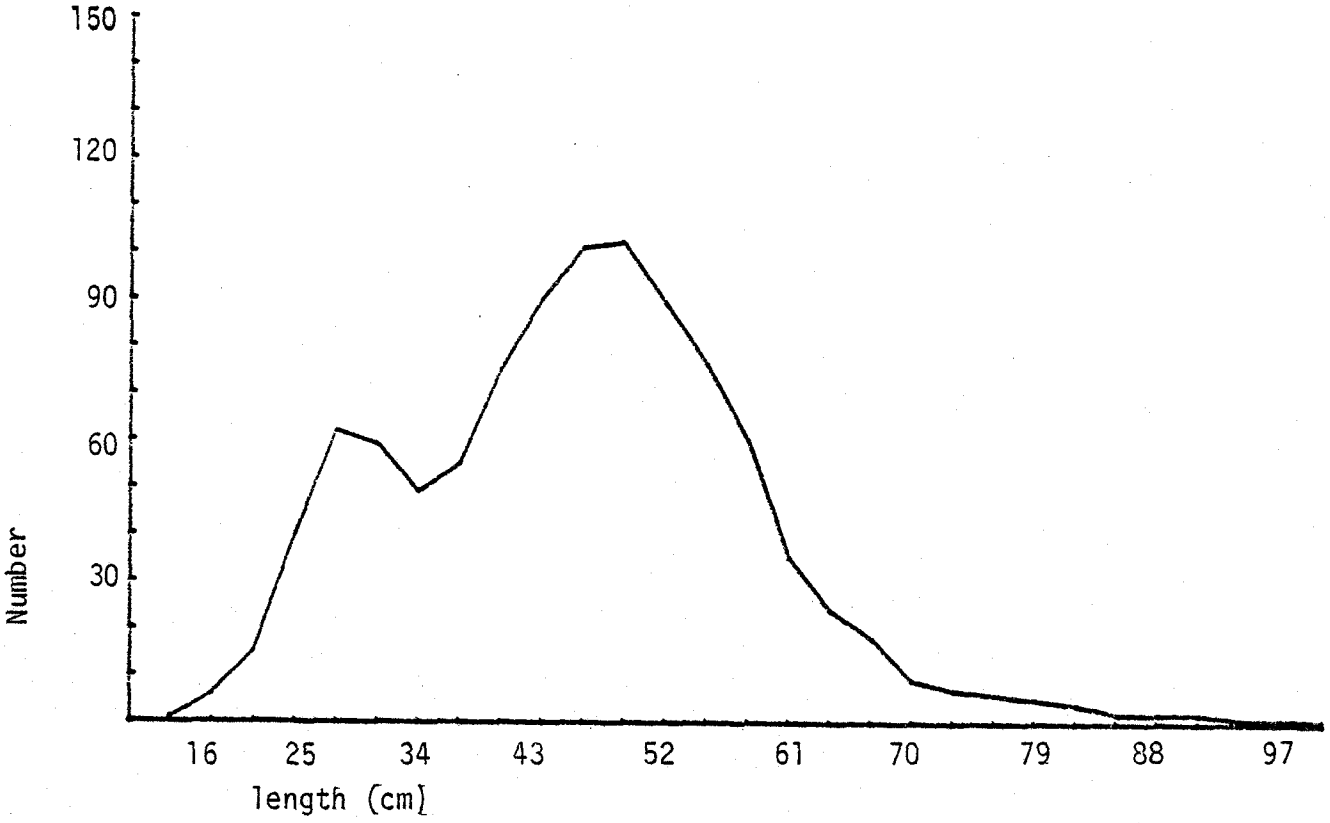



Fig. 2. Per mille age composition from a research survey in 3Pn 4Rs - January 1979



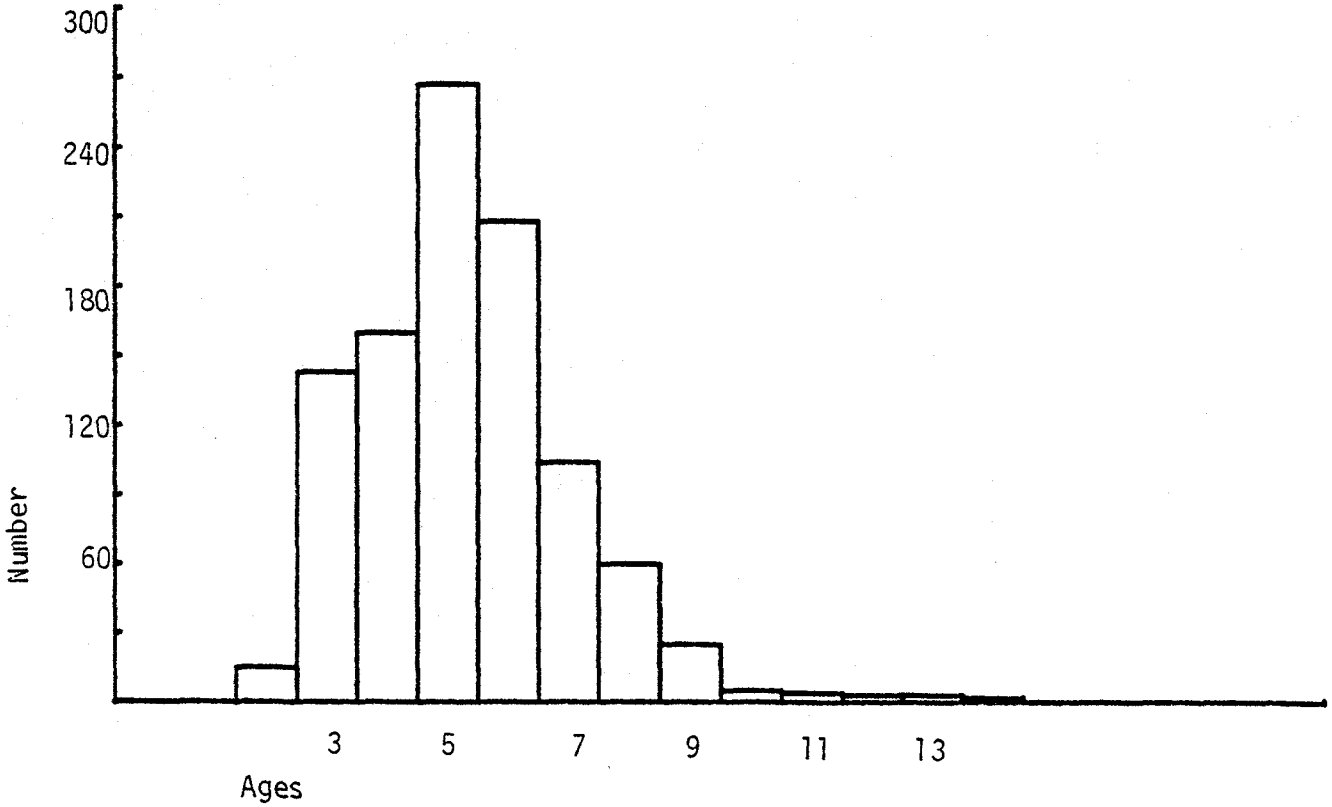




Fig. 3. Per mille length (a) and age composition (b) from a research survey in 3Pn4Rs -January-February 1980

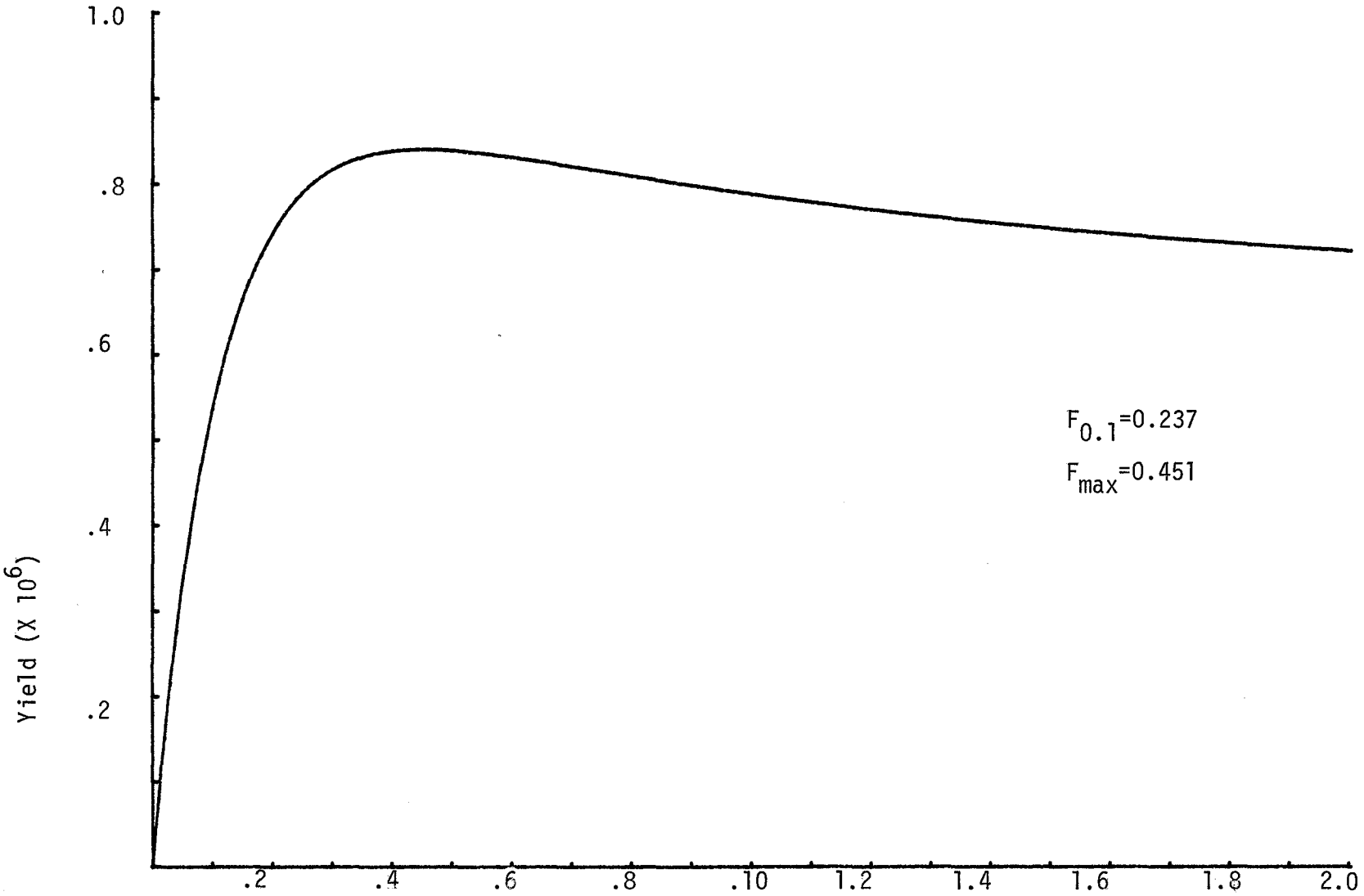



Fig. 4. Yield per recruit curve-3Pn 4RS cod-from 1979 commercial and research catch-at-age data.