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Distribution and Abundance of Cod on the Flemish Cap  
in January 1981 and Mortality in 1980

by

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INTRODUCTION

The numerical analysis of a fish stock is facilitated by data from research vessel cruises. Besides providing estimates of trends in abundance which are independent of data from the commercial fisheries, estimates of total mortality at age and of recruitment patterns can be derived.

MATERIALS AND METHODS

One hundred and forty-two positions on the Flemish Cap were selected at random according to the stratification scheme proposed by Wells (1977) and subsequently fished during January 1981 (Fig. 1). Depths fished ranged from 127-703 m.

For each net, the entire catch of cod was weighed in baskets and each individual cod was measured at sea. Detailed examination of 589 cod was done at sea and 136 cod were frozen at sea and examined in detail in the laboratory. From the interpretation of ages from the otoliths of these 725 cod, an age-length key was constructed. The otoliths of two cod were crystallized and ages from these could not be determined. Abundance and biomass estimates were made as usual by adjusting the arithmetic average catch per 30-minute tow in each stratum to the area of the stratum and summing the abundance estimates of all strata.

Two further estimates of abundance were made. As both involved logarithmic transformation, the catch per 30-minute tow was increased by one fish.

In one method, log transformation A, the  $\log(\text{catch} + 1)$  values were averaged for each stratum. The average logarithmic  $(\text{catch} + 1)$  per set values for each stratum were weighted by the area of the stratum and the average logarithmic  $(\text{catch} + 1)$  value for all of the strata computed. For the other method, log transformation B, the  $\log(\text{catch} + 1)$  values were averaged for each stratum. The exponential of the average  $\log(\text{catch} + 1)$  value for each stratum was derived and the value of 1 subtracted from it. This arithmetic value was adjusted to the area of the stratum. The sum of the abundance estimates for individual strata provides an estimate of abundance for the whole area.

## RESULTS

Details of the sampling are given in Table 1. Most cod were taken in depths less than 200 fath. The average weight of a specimen tended to increase with depth. The sampling intensity was, within the limits of integral numbers of tows, constant.

The frequency of cod by fork length shown in Fig. 2 is apportioned by age groups as derived from the age-length key. It is clear that the 1977 year-class is dominant numerically. The 1978 year-class is well represented. The 1979 year-class is conspicuously absent although a few specimens of the 1980 year-class were present. The estimated abundance by year-class is shown in Table 2.

Estimates of total mortality were derived for 1978-1980 by comparing arithmetic estimates of abundance at age for the years 1978-81 (Table 3). It would appear that the total mortality in 1980 was about 0.6-0.75.

Estimates of abundance by means of logarithmic transformation A show a smaller range of variation than the arithmetic estimates (Table 4). No estimates of variation were available for the abundance estimates from the logarithmic transformation B.

The frequencies of the numbers of cod caught per tow on the Flemish Cap tend to be skewed to the right (Wells, MS 1981). Logarithmic transformations are therefore probably appropriate. If so, there are implications with respect to trends in abundance and to mortality estimates. For example, assuming the same age distribution is applicable for all three estimates, the total mortality on ages 4 and older in 1980 would be as follows:

|                           |        |
|---------------------------|--------|
| from arithmetic           | - 0.66 |
| from log transformation A | - 0.90 |
| from log transformation B | - 0.95 |

## REFERENCES

- WELLS, R. MS 1977. Stratification scheme and age composition of cod catches taken on the Flemish Cap, 2-15 February 1977, by R/V A. T. *Cameron*. ICNAF Res. Doc. 77/VI/29, Serial No. 5054.
- WELLS, R. MS 1981. The number of research vessel tows on the Flemish Cap is never enough. NAFO SCR Doc. 81/II/15, Serial No. N279.

Table 1. Number of tows per stratum and by depth zone completed on the Flemish Cap in January 1980, by R. V. Gadus Atlantica. Sampling intensity is the number of tows per 350 square nautical miles.

| Stratum | Depth Range (FM) | Number of Tows | Area of Stratum | Sampling Intensity | Average Number per tow | Average Weight per tow | Average Weight per specimen |
|---------|------------------|----------------|-----------------|--------------------|------------------------|------------------------|-----------------------------|
| 1       | 70-80            | 5              | 341.8           | 5.1                | 33.40                  | 32.90                  | 0.99                        |
| 2       | 80-100           | 11             | 837.9           | 4.6                | 89.55                  | 126.67                 | 1.41                        |
| 3       | 100-140          | 8              | 627.8           | 4.5                | 29.88                  | 26.74                  | 0.89                        |
| 4       | 100-140          | 5              | 347.8           | 5.0                | 37.40                  | 65.56                  | 1.75                        |
| 5       | 100-140          | 9              | 703.4           | 4.5                | 171.11                 | 253.38                 | 1.48                        |
| 6       | 100-140          | 7              | 496.1           | 4.9                | 29.29                  | 41.73                  | 1.42                        |
| 7       | 140-200          | 11             | 821.8           | 4.7                | 9.91                   | 16.33                  | 1.65                        |
| 8       | 140-200          | 9              | 646.1           | 4.9                | 65.11                  | 56.06                  | 0.86                        |
| 9       | 140-200          | 4              | 314.3           | 4.5                | 45.75                  | 85.75                  | 1.87                        |
| 10      | 140-200          | 13             | 951.3           | 4.8                | 23.69                  | 64.69                  | 2.73                        |
| 11      | 140-200          | 11             | 806.1           | 4.8                | 19.00                  | 39.95                  | 2.10                        |
| 12      | 200-300          | 9              | 670.4           | 4.7                | 1.78                   | 6.13                   | 3.44                        |
| 13      | 200-300          | 3              | 248.6           | 4.2                | 0                      | 0                      | 0                           |
| 14      | 200-300          | 8              | 602.0           | 4.7                | 1.75                   | 6.25                   | 3.57                        |
| 15      | 200-300          | 9              | 665.7           | 4.7                | 3.33                   | 15.64                  | 4.70                        |
| 16      | 300-400          | 9              | 634.1           | 5.0                | 0                      | 0                      | 0                           |
| 17      | 300-400          | 3              | 215.7           | 4.9                | 0                      | 0                      | 0                           |
| 18      | 300-400          | 3              | 209.7           | 5.0                | 0                      | 0                      | 0                           |
| 19      | 300-400          | 5              | 413.9           | 4.2                | 0                      | 0                      | 0                           |
| Total   | 70-400           | 142            | 10554.5         | 4.7                | 33.65                  | 50.89                  | 1.51                        |
| 1-2     | 70-100           | 16             | 1179.7          | 4.8                | 72.00                  | 97.37                  | 1.35                        |
| 3-6     | 100-140          | 29             | 2175.1          | 4.7                | 74.86                  | 107.39                 | 1.43                        |
| 7-11    | 140-200          | 48             | 3539.6          | 4.8                | 29.06                  | 48.08                  | 1.65                        |
| 12-15   | 200-300          | 29             | 2186.7          | 4.6                | 2.07                   | 8.48                   | 4.10                        |
| 16-19   | 300-400          | 20             | 1473.4          | 4.8                | 0                      | 0                      | 0                           |
| Total   | 70-400           | 142            | 10554.5         | 4.7                | 33.65                  | 50.89                  | 1.51                        |

Table 2. Estimated numbers and weights at age of cod on the Flemish Cap, January, 1981.

| Age   | Number<br>(000's) | Average<br>Length | Number<br>of<br>Specimens<br>Aged | Average<br>Weight | Biomass<br>(tons) |
|-------|-------------------|-------------------|-----------------------------------|-------------------|-------------------|
| 1     | 32                | 13.00             | 5                                 | .018              | 1                 |
| 2     | 0                 | -                 | 0                                 | -                 | 0                 |
| 3     | 5173              | 37.53             | 127                               | .482              | 2493              |
| 4     | 15479             | 48.08             | 164                               | 1.054             | 16315             |
| 5     | 975               | 52.24             | 21                                | 1.382             | 1347              |
| 6     | 2109              | 62.50             | 97                                | 2.450             | 5167              |
| 7     | 1040              | 66.44             | 63                                | 3.007             | 3127              |
| 8     | 2067              | 75.73             | 227                               | 4.749             | 9816              |
| 9     | 102               | 80.91             | 12                                | 6.065             | 619               |
| 10    | 23                | 99.74             | 4                                 | 10.932            | 251               |
| 11    | 6                 | 91.00             | 1                                 | 7.990             | 48                |
| 12    | 0                 | -                 | 0                                 | -                 | 0                 |
| 13    | 12                | 112.00            | 2                                 | 15.595            | 187               |
| Total | 27018             | 50.32             | 723                               | 1.457             | 39371             |



Table 3. Estimates of abundance and total mortality of cod on the Flemish Cap from Canadian research vessel surveys in 1978-81.

| Analysis type | Age Group | Abundance |       |       |      | Total mortality |      |      |
|---------------|-----------|-----------|-------|-------|------|-----------------|------|------|
|               |           | 1978      | 1979  | 1980  | 1981 | 1978            | 1979 | 1980 |
| Arithmetic    | 4+        | 74395     | 19868 | 12240 | -    | 1.65            | 0.70 | 0.66 |
|               | 5+        | 58856     | 14258 | 9863  | 6334 | 1.90            | 0.73 | 0.61 |
|               | 6+        | 13185     | 8823  | 6873  | 5359 | 1.83            | 0.76 | 0.75 |
|               | 7+        | -         | 2118  | 4136  | 3250 | -               | -    | -    |

Table 4. Trends in abundance of cod on the Flemish Cap from Canadian research vessel surveys in winter 1978-81. The 95% confidence limits are also shown.

| Year | Estimate | Arithmetic | Relative variation | Logarithmic Transformation A | Relative variation | Logarithmic Transformation B |
|------|----------|------------|--------------------|------------------------------|--------------------|------------------------------|
| 1978 | Lower    | 82.92      | 0.83               | 39.21                        | 0.85               | 73.44                        |
|      | Mean     | 99.94      | 1.00               | 46.17                        | 1.00               |                              |
|      | Upper    | 116.95     | 1.17               | 54.34                        | 1.18               |                              |
| 1979 | Lower    | 21.19      | 0.66               | 9.49                         | 0.79               | 18.65                        |
|      | Mean     | 32.33      | 1.00               | 12.07                        | 1.00               |                              |
|      | Upper    | 43.47      | 1.34               | 15.29                        | 1.27               |                              |
| 1980 | Lower    | 3.44       | 0.08               | 6.76                         | 0.81               | 16.25                        |
|      | Mean     | 41.33      | 1.00               | 8.31                         | 1.00               |                              |
|      | Upper    | 79.21      | 1.92               | 10.16                        | 1.22               |                              |
| 1981 | Lower    | 8.98       | 0.26               | 4.19                         | 0.78               | 9.97                         |
|      | Mean     | 34.10      | 1.00               | 5.40                         | 1.00               |                              |
|      | Upper    | 59.22      | 1.74               | 6.90                         | 1.28               |                              |

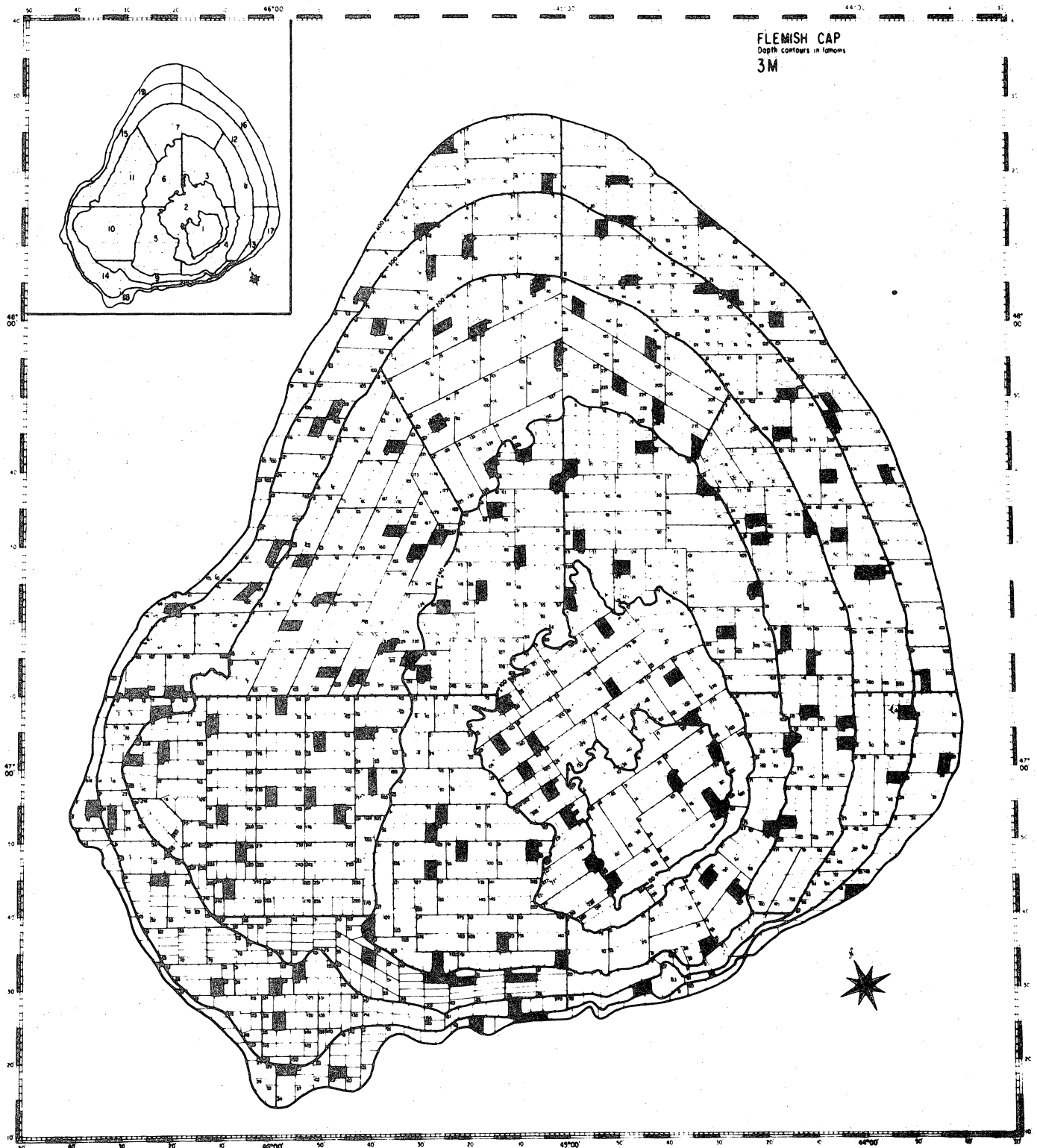


Fig. 1. Map of the Flemish Cap showing portions fished in January 1981.

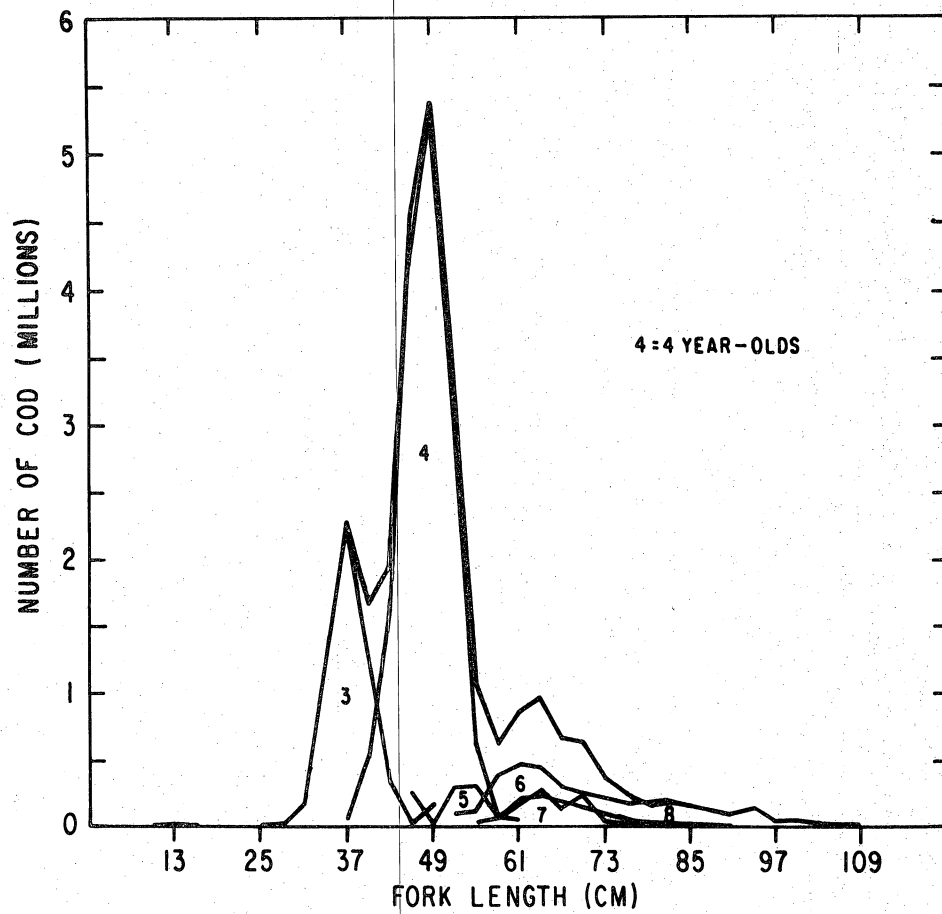


Fig. 2. Length frequency of cod on the Flemish Cap in January 1981 by age and in total.

