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# Assessment of Haddock in NAFO Division 5Z

by

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## ABSTRACT

In 1985, about 3500 t (45% of total) was landed in Canada compared to about 1500 t (14%) in 1984. 1985 was the first full calendar year in which the international boundary on Georges Bank, established by the International Court of Justice, was implemented. The majority of the Canadian catch was comprised of 2-year-old haddock, the 1983 year-class. Research surveys indicate that the 1985 year-class is better than average. The results of sequential population analysis suggest that fishing mortality on this stock has been relatively high in recent years, ranging from 0.3 to 0.5 for ages 3 to 8. The biomass is at the lowest level observed since 1963, continuing a declining trend from the late 1970's.



## RÉSUMÉ

En 1985, environ 3 500 t (45 % du total) ont été débarqués au Canada comparativement à environ 1 500 t (14 %) en 1984. 1985 a été la première année civile complète au cours de laquelle on a appliqué la décision de la Cour internationale de justice concernant la frontière internationale du Banc Georges. Les prises canadiennes étaient constituées majoritairement d'aiglefin de 2 ans, la classe d'âge de 1983. Les relevés de recherche indiquent que la classe d'âge 1985 est supérieure à la moyenne. Les résultats de l'analyse séquentielle de population laissent entendre que la mortalité par pêche dans ce stock a été relativement élevée au cours des dernières années, variant de 0,3 à 0,5 pour les âges 3 à 8. La biomasse est à son plus bas niveau depuis 1963, tendance à la baisse qui se poursuit depuis la fin des années 70.

## INTRODUCTION

Total landings of the Georges Bank haddock fishery have fluctuated greatly since the 1920's with the highest level of exploitation (150,000 t) occurring in 1965. The average catch between 1956 and 1986 was about 34,000 t. Recent stock assessments (Anon. MS 1986, Waiwood and Neilson MS 1985) have indicated a low and declining stock abundance.

## PATTERN OF EXPLOITATION

Total annual catches for this stock peaked in the mid-1960's when Canadian, USA and foreign fleets landed over 100,000 t annually (maximum 150362 t, 1965). Catches declined rapidly thereafter and in 1972-1976 remained between 4300-5700 t (Table 1, Fig. 1). Since 1977, fishing has been conducted by only Canada and the USA. Total landings showed an initial increase followed by a decline over the period 1976 to 1984. The total catch in 1985 (7757 t) was about 24% lower than in 1984.

Historically, the Canadian fishing effort has been concentrated on the northeast peak of Georges Bank on the Canadian side of the ICJ line. Since 1963, Canadian landings of 5Z haddock have averaged about 24% of the total (range 10-46%). In 1985, Canadians landed 3485 t or 45% of the total catch, representing a 2.4-fold increase over the previous year. This was the highest catch since 1981 but only about a quarter of the level during 1964-1967.

The majority of the Canadian catch has been taken during June to September (Table 2). However, during 1977-1982, significant catch was taken in the first quarter due to presence of TC 5 vessels. In 1985, landings in June were relatively less, and those in September-October were relatively more important than in recent years.

Since 1981, Canadian otter trawlers (TC 4 and 5) have taken 3 to 4 times the catch of longliners with the exception of 1984 when longliners caught about 26% more than otter trawlers (Table 3; Fig. 2). Subsequent to 1978, the relative contribution of the side trawlers has declined and no significant catch has been reported by this gear since 1983. During 1968 to 1982, TC 4 and 5 vessels have taken the highest portion of the Canadian stern otter trawl catch. However since 1983, TC 2 and 3 vessels have increased their contribution to the landings from .85 to 4.5 times the TC 4 and 5 catch (Table 4).

The USA catch in 1985 (4272 t) was about 50% lower than in 1984 and the lowest since 1976 (data provided by W. Overholtz, NMFS) . Catches in the first quarter of 1985 were both relatively and absolutely lower than in recent years (Table 5). The USA catch is taken, almost exclusively, by TC 3 and TC 4 otter trawlers.

A further account of the history of the NAFO Divsion 5Z haddock fishery is given in Waiwood and Neilson (MS 1984).

## AGE COMPOSITION OF CATCH

During 1985, 26 samples were collected from the Canadian commercial fishery (Table 6). The samples were well distributed with respect to the landed weight. The samples were used to calculate statistics at age (Table 7, 8) according to the method described by Gavaris and Gavaris (1983). The coefficients of variation for ages 3 and older are relatively high for this stock, an indication of low sampling levels and a poor relationship between length and age. The length-weight relationship, weight (kg) = 0.0000158 length$^{2.91612}$ (cm), derived from Canadian fishery samples (Waiwood and Neilson 1985), was used in these calculations.

## STOCK ABUNDANCE INDICES

### Research Vessel Surveys

Groundfish surveys in the Georges Bank/Gulf of Maine area include: spring and fall surveys conducted by NMFS since 1968 and 1963 respectively, and summer surveys (NMFS), conducted in 1963-1965, 1969, and 1977-1980. A new time series was initiated by the Department of Fisheries and Oceans, Canada, in spring 1986. All surveys are of the stratified random design (Fig. 3 and 4). The USA surveys have used a Yankee 36 trawl except for the spring survey (1973-1981) when a modified Yankee 41 was used. In 1985, Norwegian otter doors were replaced by Portuguese BMB (poly valent) doors in all the USA surveys. In the Canadian survey, a Western IIA trawl is used.

Trends in mean catch per tow (Fig. 5; Table 9) from the USA spring and fall surveys are in close agreement and indicate an increase in abundance during the mid- to late 1970's and a decline subsequently to 1968-1974 levels. The increase in fall 1985 is the result of an apparently well represented 1985 year-class - supported also by the 1986 Canadian spring survey (Table 9). The two 1985 USA surveys and the 1986 Canadian survey also suggest a stronger than average 1983 year-class.

The total abundance by strata in the USA fall survey is given in Table 10. Over the time series, a relatively consistent pattern can be seen with stratum 16 (NE central Georges Bank) being most important for 1-yr-old haddock followed by stratum 23 (Cape Cod to Georges Bank). For ages 2 and 3, stratum 29, the large stratum to the northwest of Georges Bank is the most influential to the overall estimate followed by stratum 17 (SE edge of Georges). For 4+ haddock, stratum 24 (between Georges Bank and Cape Cod) is most important. Hence, the larger strata generally have the highest abundance weighting although there are differences with age.

When the concentration of haddock is considered (Table 10), the smaller narrow strata around the edge of Georges Bank show the highest densities. This is generally true for ages 1 to 3 with the exception of stratum 16 (age 1) which, in addition to strata 22 and 21 has the highest numbers per mi$^2$. Older fish tend to be more evenly distributed although the same "edge effect" can be seen for strata 18, 17 and 22. This is in general agreement with Overholtz (1982) who demonstrated that, for large year-classes of haddock, which tended to concentrate at ages 1-3 on the Northeast Peak while older fish tended to move off the bank into the deeper waters to the northwest.

Commercial Fishery

Catch and effort statistics by month, for the Canadian fishery, were derived from Table 5 of NAFO (ICNAF) Statistical Bulletins for 1966-83. Data for 1984 and 1985 were obtained from the Department of Fisheries and Oceans, Canada. Due to previous observations regarding systematic bias caused by truncation of this type of data (Gavaris and Sinclair 1985), all observations where either the catch was less than 10 t or the effort was less than 10 hr were excluded from a multiplicative analysis (Gavaris 1980).

Examination of residuals from a preliminary unweighted analysis resulted in the exclusion of one observation: OTB2-3, March, 1966. There did not appear to be any annual trends in either month or gear residuals. The residuals also showed that observations with lower catch and effort were more variable; therefore a weighted analysis was applied. An iterative procedure described in Judge et al. (1980) was used to estimate the weights based on the partitioning of residuals along a ln (catch x effort) scale. The analysis of variance from the weighted regression (Table 11) indicates that about 61% of the variation was explained by the model. The coefficients for gears follow an intuitive pattern with larger vessels associated with greater power.

The results of the analysis are presented in Table 12 in both the ln scale and transformed back to the linear scale. Abundance trends in the linear scale (Fig 6) indicate a decline from 1966-72 followed by a marginal increase to 1976. Catch rates doubled in 1977 due to the recruitment of the strong 1975 year-class and remained high until 1982. The increase in catch rate in 1985 was probably due to the recruitment of the 1983 year-class.

## SEQUENTIAL POPULATION ANALYSIS

Sequential population analysis, assuming a natural mortality of 0.2, was conducted using the catch at age and weight at age for 1963-85 (Table 13, 14). Based on examination of a preliminary fishing mortality matrix, it was assumed that ages 3 and older were fully recruited. For calibration, results of the autumn survey were compared to the sequential population analysis for the subsequent age in the next year. It was observed that the mean and standard error were approximately proportionately related; therefore, a logarithmic transformation was applied in order to stabilize variances (Fig. 7). Assuming a partial recruitment of 0.5 for age 2 in 1985, the following model was examined:

$$\ln SPA(3+) - \ln RV(2+) = \ln k + \varepsilon$$

The sum of squares of residuals was minimized with a fully recruited fishing mortality of 0.5 in 1985 (Table 15). The residuals did not indicate any strong trends (Fig. 8). Examination of the relationship

$$\ln SPA(3) - \ln RV(2) = \ln k + \varepsilon$$

supported the use of a partial recruitment of 0.5 at age 2 in 1985 (Fig. 9) since the 1986 observation had a small residual.

The relationships

$$\ln SPA(2) - \ln RV(1) = \ln k + \varepsilon$$

and

$$\ln SPA(1) = \ln(a + b\ RV(0)) + \varepsilon$$

were examined to establish the strengths of the 1983, 1984 and 1985 year-classes (Fig. 10, 11). The latter relationship was used for age 1 versus age 0 because of indications that an additive constant was necessary, i.e. on the linear scale the relationship did not pass through the origin (Fig. 12). The residual for the 1983 year-class was positive in one relationship and negative in the other, supporting the use of a partial recruitment value of 0.5 for age 2 in 1985. Both relationships suggested that the 1984 year-class was small, in the order of 400-500 thousand fish. Applying a partial recruitment of $5 \times 10^{-7}$ for age 1 in 1985 resulted in a value of 441 thousand fish (about half way between the two estimates) for the 1984 year-class. The 1985 year-class was predicted from the SPA age 1 versus RV age 0 relationship at 63 million.

Calibration with a catch rate index was not used due to concern about interpretation of the 1985 catch rates when fishing patterns changed.

The analysis indicated that the stock abundance and biomass are at the lowest since 1963 (Table 16). The stock had reached similar low levels in the early 1970's during a period of high exploitation. Few older fish remain now and the majority of the population is accounted for by the 1983 and 1985 year-classes.

Weighted fully recruited fishing mortality has been high in recent years. The age specific exploitation pattern in 1985 was markedly different for Canada and USA. Partial fishing mortalities are:

| Age | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9+ |
|---|---|---|---|---|---|---|---|---|---|
| Canada | 0.0 | 0.21 | 0.25 | 0.22 | 0.1 | 0.1 | 0.02 | 0.03 | 0.05 |
| USA | 0.0 | 0.04 | 0.25 | 0.28 | 0.4 | 0.4 | 0.48 | 0.47 | 0.45 |

This indicates that partial recruitment to the Canadian fishery peaks at age 3 and decreases rapidly at higher ages. In the 1985 US fishery haddock apparently were not fully recruited until age 5 or older and few age 2 haddock were landed. This partial recruitment pattern for the US fishery differs from past observations; however, it should be recognized that in 1985 the exploitation pattern probably changed due to implementation of the international boundary. This disparate availability pattern for the Canadian and US fisheries coincides with observations of spatial distribution by age from research vessel survey data. It appears therefore that haddock may be available to the Canadian fishery at a younger age than to the US fishery.

## ACKNOWLEDGMENT

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Table 1. Nominal catches (t) of haddock from Georges Bank, NAFO Division 5Z, for 1956-1985[1]. (--- no fishing activity, - no TAC).

| Year | USA | (%) | Canada | (%) | USSR | (%) | Spain | (%) | Others | (%) | Total | TAC ICNAF | TAC[8] Canada | TAC US |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1956 | 51144 | (100) | --- | | --- | | --- | | --- | | 51144 | - | | |
| 1957 | 48561 | (100) | --- | | --- | | --- | | --- | | 48561 | - | | |
| 1958 | 37322 | (100) | --- | | --- | | --- | | --- | | 37322 | - | | |
| 1959 | 36051 | (100) | --- | | --- | | --- | | --- | | 36051 | - | | |
| 1960 | 40800 | (100) | 77 | (<1) | --- | | --- | | --- | | 40877 | - | | |
| 1961 | 46384 | (99) | 266 | (1) | --- | | --- | | --- | | 46650 | - | | |
| 1962 | 49409 | (91) | 3461 | (6) | 1134 | (2) | --- | | --- | | 54004 | - | | |
| 1963 | 44150 | (80) | 8379 | (15) | 2317 | (4) | --- | | --- | | 54846 | - | | |
| 1964 | 46512 | (73) | 11625 | (18) | 5483 | (9) | 2 | (<1) | 464 | (1) | 64086 | - | | |
| 1965 | 52823 | (35) | 14889 | (10) | 81882 | (54) | 10 | (<1) | 758 | (<1) | 150362 | - | | |
| 1966 | 52918 | (44) | 18292 | (15) | 48409 | (40) | 1111 | (1) | 544 | (<1) | 121274 | - | | |
| 1967 | 34728 | (67) | 13040 | (25) | 2316 | (5) | 1355 | (3) | 30 | (<1) | 51469 | - | | |
| 1968 | 25469 | (62) | 9223 | (23) | 1397 | (3) | 3014 | (7) | 1318 | (4) | 40421 | - | | |
| 1969 | 16456 | (74) | 3990 | (18) | 66 | (<1) | 1201 | (5) | 470 | (2) | 22183 | - | | |
| 1970 | 8415 | (74) | 1978 | (18) | 103 | (1) | 782 | (7) | 7 | (<1) | 11285 | 12000 | | |
| 1971 | 7306 | (67) | 1630 | (15) | 374 | (3) | 1310 | (12) | 242 | (2) | 10862 | 12000 | | |
| 1972 | 3869 | (67) | 609 | (11) | 137 | (2) | 1098 | (19) | 20 | (<1) | 5733 | 6000 | | |
| 1973 | 2777 | (52) | 1563 | (29) | 602 | (11) | 386 | (7) | 3 | (<1) | 5331 | 6000 | | |
| 1974 | 2396 | (56) | 462 | (11) | 109 | (3) | 764 | (18) | 559 | (13) | 4290[3] | - | | |
| 1975 | 3989 | (74) | 1358 | (25) | 8 | (<1) | 61 | (1) | 4 | (<1) | 5420 | 6000 | | |
| 1976 | 2904 | (67) | 1361 | (31) | 4 | (<1) | 46 | (1) | 9 | (<1) | 4324 | 6000 | | |
| 1977 | 7934 | (73) | 2909 | (27) | --- | | --- | | --- | | 10843[4] | - | 12600 | 10500 |
| 1978 | 12160 | (54) | 10179 | (46) | --- | | --- | | --- | | 22339[5] | - | 12600 | 19000[7] |
| 1979 | 14279 | (73) | 5182 | (27) | --- | | --- | | --- | | 19461 | - | 39000 | 22100[7] |
| 1980 | 17470 | (63) | 10101 | (37) | --- | | --- | | --- | | 27571[6] | - | 32500 | 22900[7] |
| 1981 | 19245 | (77) | 5659 | (23) | --- | | --- | | 3 | (<1) | 24907 | - | 32500 | 22900[7] |
| 1982 | 12622 | (72) | 4931 | (28) | --- | | --- | | --- | | 17553 | - | 32500 | - |
| 1983 | 8680 | (73) | 3212 | (27) | --- | | --- | | --- | | 11892 | - | 28000 | - |
| 1984[2] | 8806 | (86) | 1463 | (14) | --- | | --- | | --- | | 10269 | - | 20000 | - |
| 1985[2] | 4272 | (55) | 3485 | (45) | --- | | --- | | --- | | 7757 | - | 5100 | |

[1]Data Sources: 1956-78 ICNAF; 1979-83 NAFO; 1984-85 NMFS and DFO.
[2]Provisional.
[3-6]Corresponding values corrected for discards are: [3]6190, [4]20531, [5]26281, [6]51084.
[7]Does not represent calendar year and does not always include Canadian allocation. Values for 1977 and 1978 are for Subarea 5. Values for 1979-81 include recreational fishery.
[8]Includes 5Y.

Table 2. Monthly and quarterly breakdown of Canadian haddock catches in 5Z for 1968-1985.

| | MONTH | | | | | | | | | | | | QUARTER | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEPT | OCT | NOV | DEC | 1 | 2 | 3 | 4 | TOTAL |
| 1968 | 337 | 510 | 990 | 2337 | 760 | 352 | 693 | 1240 | 941 | 904 | 120 | 139 | 1837 | 3449 | 2874 | 1163 | 9323 |
| 1969 | 106 | 73 | 6 | 291 | 587 | 691 | 559 | 607 | 553 | 364 | 119 | 34 | 185 | 1569 | 1719 | 517 | 3990 |
| 1970 | 10 | 105 | 0 | 1 | 576 | 345 | 104 | 456 | 241 | 103 | 25 | 12 | 115 | 922 | 801 | 140 | 1978 |
| 1971 | 0 | 9 | 2 | 0 | 400 | 153 | 283 | 279 | 97 | 246 | 140 | 21 | 11 | 553 | 659 | 407 | 1630 |
| 1972 | 0 | 118 | 2 | 0 | 4 | 112 | 87 | 116 | 91 | 70 | 9 | 0 | 120 | 116 | 294 | 79 | 609 |
| 1973 | 4 | 10 | 0 | 0 | 0 | 183 | 198 | 569 | 339 | 233 | 23 | 4 | 14 | 183 | 1106 | 260 | 1563 |
| 1974 | 19 | 0 | 1 | 0 | 0 | 57 | 64 | 52 | 96 | 60 | 93 | 20 | 20 | 57 | 212 | 173 | 462 |
| 1975 | 5 | 14 | 0 | 0 | 0 | 167 | 257 | 482 | 104 | 167 | 117 | 45 | 19 | 167 | 843 | 329 | 1358 |
| 1976 | 0 | 8 | 61 | 68 | 61 | 595 | 152 | 188 | 186 | 26 | 9 | 7 | 69 | 724 | 526 | 42 | 1361 |
| 1977 | 102 | 176 | 6 | 0 | 23 | 519 | 1098 | 836 | 12 | 58 | 56 | 23 | 284 | 524 | 1946 | 137 | 2909 |
| 1978 | 103 | 932 | 44 | 21 | 22 | 319 | 407 | 86 | 640 | 5605 | 2000 | 0 | 1079 | 362 | 1133 | 7605 | 10179 |
| 1979 | 125 | 898 | 398 | 175 | 69 | 1393 | 905 | 395 | 488 | 261 | 53 | 22 | 1421 | 1637 | 1788 | 336 | 5182 |
| 1980 | 39 | 134 | 13 | 33 | 225 | 2957 | 2299 | 963 | 1419 | 1739 | 103 | 177 | 186 | 3215 | 4681 | 2019 | 1010 |
| 1981 | 38 | 482 | 568 | 4 | 254 | 1354 | 1242 | 727 | 292 | 82 | 378 | 238 | 1088 | 1612 | 2261 | 698 | 5659 |
| 1982 | 131 | 309 | 1 | 12 | 45 | 1118 | 767 | 684 | 582 | 838 | 400 | 44 | 441 | 1175 | 2033 | 1282 | 493 |
| 1983 | 31 | 67 | 28 | 46 | 60 | 1288 | 386 | 489 | 527 | 194 | 90 | 6 | 126 | 1394 | 1402 | 290 | 3212 |
| 1984[1] | 3 | 5 | 80 | 89 | 73 | 433 | 218 | 255 | 212 | 70 | 25 | 0 | 88 | 595 | 685 | 95 | 1463 |
| 1985[1] | 1 | 11 | 33 | 99 | 26 | 354 | 392 | 1103 | 718 | 594 | 61 | 93 | 45 | 479 | 2213 | 749 | 3485 |

[1]Provisional

Table 3. Nominal catches[1] (t) of haddock caught by Canadian (Maritimes) and Quebec) fishing vessels in NAFO Division 5Z during 1968-1985. Numbers in parenthesis indicate number of samples taken by DFO samplers.

| | GEAR | | | |
|---|---|---|---|---|
| YEAR | OTTER TRAWL | LONGLINE | OTHER | TOTAL |
| 1968 | 9170(8) | 111 | 11 | 9292 |
| 1969 | 3955(2) | 22 | 13 | 3990 |
| 1970 | 1900(5) | 76 | 2 | 1978 |
| 1971 | 1475(1) | 154 | 1 | 1630 |
| 1972 | 411 | 198 | 0 | 609 |
| 1973 | 1461(3) | 102 | 0 | 1563 |
| 1974 | 374(5) | 87 | 1 | 462 |
| 1975 | 1247(1) | 111 | 0 | 1358 |
| 1976 | 1185(9) | 154 | 15 | 1354 |
| 1977 | 2814(11) | 94 | 1 | 2909 |
| 1978 | 9716(27) | 171 | 292 | 10179 |
| 1979 | 4907(17) | 274 | 1 | 5182 |
| 1980 | 9510(25) | 590 | 1 | 10101 |
| 1981 | 4644(17) | 1015(2) | 0 | 5659 |
| 1982 | 4222(17) | 709 | 0 | 4931 |
| 1983 | 2396(8) | 813 | 3 | 3212 |
| 1984 | 624 | 838(3) | 1 | 1463 |
| 1985 | 2817(17) | 626(9) | 42 | 3485 |

[1]Excludes catches by TC 1 vessels except for 1983 longliners (27 t). Provisional.

Table 4. Nominal catches (t) of haddock caught by Canadian (Maritimes) otter trawlers in NAFO Division 5Z during 1968-1985

| | SIDE OTTER TRAWLERS T.C. | | | | STERN OTTER TRAWLERS T.C. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| YEAR | 2 | 3 | 4 | 5 | 2 | 3 | 4 | 5 | TOTAL |
| 1968 | 0 | 176 | 3463 | 0 | 1165 | 0 | 580 | 3876 | 9170 |
| 1969 | 1 | 8 | 792 | 0 | 0 | 1 | 225 | 2928 | 3955 |
| 1970 | 0 | 25 | 553 | 0 | 2 | 0 | 134 | 1186 | 1900 |
| 1971 | 0 | 0 | 494 | 0 | 0 | 0 | 16 | 965 | 1475 |
| 1972 | 0 | 0 | 0 | 0 | 0 | 0 | 148 | 263 | 411 |
| 1973 | 0 | 25 | 609 | 0 | 0 | 0 | 61 | 766 | 1451 |
| 1974 | 0 | 0 | 26 | 0 | 0 | 6 | 8 | 334 | 374 |
| 1975 | 0 | 0 | 223 | 0 | 0 | 1 | 60 | 963 | 1247 |
| 1976 | 0 | 1 | 192 | 23 | 0 | 0 | 61 | 908 | 1185 |
| 1977 | 5 | 47 | 358 | 0 | 91 | 243 | 18 | 2052 | 2814 |
| 1978 | 69 | 17 | 2485 | 0 | 238 | 822 | 351 | 5734 | 9716 |
| 1979 | 12 | 116 | 1573 | 0 | 135 | 855 | 651 | 1565 | 4907 |
| 1980 | 9 | 16 | 1426 | 1 | 354 | 365 | 1016 | 6323 | 9510 |
| 1981 | 4 | 87 | 389 | 0 | 448 | 484 | 884 | 2348 | 4644 |
| 1982 | 1 | 25 | 90 | 0 | 190 | 297 | 250 | 3359 | 4212 |
| 1983 | 16 | 89 | 0 | 0 | 618 | 432 | 107 | 1134 | 2396 |
| 1984 | 0 | 5 | 0 | 0 | 181 | 269 | 21 | 148 | 624 |
| 1985 | 0 | 72 | 0 | 0 | 840 | 1402 | 155 | 348 | 2817 |

Table 5. Monthly and quarterly breakdown of USA catches in 5Z and 5nk, from 1968 to 1985

| | MONTH | | | | | | | | | | | | | QUARTER | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | UK | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | 1 | 2 | 3 | 4 | TOTAL |
| 1968 | 0 | 1680 | 1756 | 3023 | 2381 | 2499 | 2750 | 2696 | 2261 | 2372 | 1971 | 1376 | 704 | 6459 | 7630 | 7329 | 4051 | 25469 |
| 1969 | 0 | 990 | 909 | 1617 | 2422 | 1688 | 2329 | 1357 | 1466 | 1392 | 1119 | 630 | 537 | 3516 | 6439 | 4215 | 2286 | 16456 |
| 1970 | 0 | 480 | 419 | 409 | 634 | 1230 | 1328 | 1090 | 822 | 747 | 803 | 245 | 208 | 1308 | 3192 | 2659 | 1256 | 8415 |
| 1971 | 0 | 305 | 476 | 640 | 719 | 1148 | 1075 | 670 | 546 | 556 | 543 | 401 | 227 | 1421 | 2942 | 1772 | 1171 | 7306 |
| 1972 | 0 | 246 | 308 | 273 | 282 | 632 | 561 | 382 | 371 | 236 | 262 | 158 | 158 | 827 | 1475 | 989 | 578 | 3869 |
| 1973 | 0 | 180 | 165 | 136 | 179 | 338 | 537 | 329 | 269 | 134 | 253 | 129 | 128 | 481 | 1054 | 732 | 510 | 2777 |
| 1974 | 0 | 190 | 130 | 138 | 212 | 298 | 327 | 349 | 197 | 125 | 155 | 98 | 177 | 458 | 837 | 671 | 430 | 2396 |
| 1975 | 20 | 237 | 201 | 142 | 234 | 569 | 849 | 316 | 351 | 359 | 295 | 236 | 180 | 580 | 1652 | 1026 | 711 | 3989 |
| 1976 | 18 | 187 | 226 | 224 | 277 | 534 | 350 | 132 | 167 | 221 | 166 | 238 | 164 | 637 | 1161 | 520 | 568 | 2904 |
| 1977 | 50 | 237 | 369 | 361 | 382 | 743 | 902 | 1017 | 829 | 572 | 773 | 955 | 744 | 967 | 2027 | 2418 | 2472 | 7934 |
| 1978 | 53 | 535 | 735 | 675 | 977 | 1313 | 2061 | 1249 | 1287 | 973 | 1140 | 914 | 248 | 1945 | 4351 | 3509 | 2302 | 12160 |
| 1979 | 61 | 757 | 637 | 777 | 1355 | 1844 | 1748 | 1553 | 1485 | 1170 | 1081 | 1284 | 527 | 2171 | 4947 | 4208 | 2892 | 14279 |
| 1980 | 84 | 1006 | 1393 | 1130 | 1705 | 2319 | 1583 | 2060 | 1554 | 1769 | 977 | 1045 | 845 | 3529 | 5607 | 5383 | 2867 | 17470 |
| 1981 | 68 | 1190 | 2373 | 1436 | 1528 | 2650 | 2586 | 1976 | 1635 | 1273 | 1006 | 774 | 750 | 4999 | 6764 | 4884 | 2530 | 19245 |
| 1982 | 25 | 829 | 1163 | 752 | 772 | 1416 | 2416 | 1624 | 693 | 1047 | 707 | 725 | 453 | 2744 | 4604 | 3364 | 1885 | 12622 |
| 1983 | 30 | 869 | 1075 | 387 | 759 | 864 | 1674 | 737 | 590 | 511 | 341 | 484 | 359 | 2331 | 3297 | 1838 | 1184 | 8680 |
| 1984 | 0 | 832 | 1157 | 583 | 599 | 1105 | 1570 | 735 | 747 | 523 | 412 | 271 | 272 | 2572 | 3274 | 2005 | 954 | 8806 |
| 1985[1] | 0 | 262 | 281 | 367 | 534 | 681 | 710 | 443 | 349 | 226 | 170 | 134 | 115 | 910 | 1925 | 1018 | 419 | 4272 |

[1]1985 Data provided by W. Overholtz (NMFS)

Table 6. A total of 26 samples were collected from the Canadian commercial haddock fishery in NAFO Division 5Z during 1985. Length frequencies were applied to the weight indicated. The braces represent the manner in which statistics were pooled. The number in brackets shows the number of age interpretations available for the age length key which was applied at that stage.

| Gear | Month | Number measured | Weight (t) |
|---|---|---|---|
| OT | Jan. | - | 1 |
| | Feb. | - | 4 |
| | June | 1443 | 295 — 300(219) |
| | July | 152 | 301 |
| | Aug. | 1214 | 955 |
| | Sept. | 805 | 634 |
| | Oct. | 200 | 531 |
| | Nov. | 116 | 35 |
| | Dec. | - | 61 — 96 — 2517(281) |
| LL | Feb. | - | 7 |
| | Mar. | - | 33 |
| | Apr. | 228 | 97 |
| | May | - | 25 — 162 |
| | June | - | 58 |
| | July | 215 | 78 — 136 |
| | Aug. | 939 | 139 |
| | Sept. | 395 | 71 |
| | Oct. | - | 62 |
| | Nov. | - | 25 |
| | Dec. | - | 31 — 189 — 626(298) |
| Misc. | | | 142 — 3485 |

Table 7. Age compositions (000's) for components of the 5Z haddock fishery in 1985.

| Age | a | b | c | d | e | f | g |
|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - |
| 2 | 4 | 65 | 1912 | - | 42 | 199 | 82 |
| 3 | 12 | 40 | 249 | 20 | 98 | 105 | 43 |
| 4 | 17 | 28 | 69 | 11 | 69 | 22 | 9 |
| 5 | 24 | 27 | 38 | 46 | 76 | 72 | 30 |
| 6 | 20 | 13 | 22 | 29 | 52 | 27 | 11 |
| 7 | 56 | 14 | 17 | 117 | 355 | 68 | 28 |
| 8 | 17 | 3 | 2 | 18 | 31 | 14 | 6 |
| 9+ | 44 | 8 | 8 | 50 | 63 | - | - |

a. Can. LL Jan.-Dec.
b. Can. OT Jan.-June
c. Can. OT July-Dec.
*d. USA Jan.-Mar.
*e. USA Apr.-June
*f. USA July-Sept.
*g. USA Oct.-Dec. (based on July-Sept. samples)

*Overholtz (pers. comm.)

Table 8. Mean number (000's) caught at age in the 1985 commercial fishery for haddock in NAFO Division 5Z. The average weight (kg) and average length (cm) at age are included.

| CANADA |

| AGE | AVERAGE WEIGHT | AVERAGE LENGTH | CATCH MEAN | CATCH STD ERR | CATCH CV |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | 0.981 | 43.764 | 2005 | 61.368 | 0.031 |
| 3 | 1.306 | 48.118 | 305 | 57.445 | 0.188 |
| 4 | 2.127 | 56.690 | 115 | 19.546 | 0.170 |
| 5 | 2.224 | 57.303 | 90 | 11.712 | 0.130 |
| 6 | 3.008 | 64.063 | 56 | 7.992 | 0.143 |
| 7 | 3.351 | 66.768 | 88 | 8.326 | 0.094 |
| 8 | 3.277 | 66.056 | 22 | 4.671 | 0.209 |
| 9 | 3.778 | 69.459 | 18 | 3.831 | 0.211 |
| 10 | 4.033 | 71.088 | 17 | 3.637 | 0.218 |
| 11 | 3.718 | 68.941 | 23 | 4.651 | 0.200 |
| 12 | 5.087 | 77.334 | 2 | 0.817 | 0.511 |
| 13 | 4.320 | 73.047 | 2 | 1.384 | 0.731 |
| 14 | 5.808 | 81.000 | | 0.001 | 0.009 |
| 15 | | | | | |
| 16 | 5.808 | 81.000 | | 0.289 | 1.026 |

| USA | (Overholtz , pers. com.)

| AGE | AVERAGE WEIGHT | AVERAGE LENGTH | CATCH |
|---|---|---|---|
| 1 | | | |
| 2 | 1.161 | 48.129 | 323 |
| 3 | 1.249 | 49.384 | 266 |
| 4 | 1.730 | 55.642 | 110 |
| 5 | 2.485 | 62.862 | 223 |
| 6 | 2.822 | 65.734 | 120 |
| 7 | 2.992 | 67.270 | 566 |
| 8 | 3.633 | 71.845 | 68 |
| 9 | 3.806 | 72.989 | 31 |
| 10 | 4.272 | 75.546 | 46 |
| 11 | 3.535 | 72.114 | 16 |
| 12 | 3.867 | 72.990 | 2 |
| 13 | 3.569 | 72.500 | 14 |
| 14 | 4.168 | 76.500 | 5 |

| TOTAL |

| AGE | AVERAGE WEIGHT | AVERAGE LENGTH | CATCH |
|---|---|---|---|
| 1 | | | |
| 2 | 1.006 | 44.370 | 2328 |
| 3 | 1.279 | 48.707 | 571 |
| 4 | 1.933 | 56.177 | 225 |
| 5 | 2.410 | 61.264 | 313 |
| 6 | 2.881 | 65.204 | 176 |
| 7 | 3.041 | 67.203 | 656 |
| 8 | 3.544 | 70.417 | 91 |
| 9 | 3.796 | 71.699 | 50 |
| 10 | 4.208 | 74.355 | 63 |
| 11 | 3.644 | 70.215 | 39 |
| 12 | 5.440 | 80.782 | 4 |
| 13 | 3.608 | 72.565 | 16 |
| 14 | 4.199 | 76.586 | 6 |
| 15 | | | |
| 16 | 5.808 | 81.000 | |

Table 9. Stratified mean catch per tow at age (numbers) for haddock in NEFC offshore spring and autumn[1] bottom trawl surveys on Georges Bank 1963-1984 (modified from Clark et al. 1982 and Overholtz et al. 1983) and DFO spring survey 1986.

| Year | Age 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Totals 0+ | 1+ | 2+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spring (NEFC)[2] | | | | | | | | | | | | | |
| 1968 | - | 0.27 | 1.90 | 0.31 | 0.47 | 4.51 | 1.13 | 0.17 | 0.30 | 0.23 | - | 9.29 | 9.02 |
| 1969 | - | 0.00 | 0.05 | 0.39 | 0.17 | 0.28 | 2.84 | 0.69 | 0.19 | 0.31 | - | 4.85 | 4.85 |
| 1970 | - | 0.45 | 0.17 | 0.00 | 0.22 | 0.31 | 0.31 | 1.34 | 0.66 | 0.57 | - | 4.03 | 3.58 |
| 1971 | - | 0.00 | 0.78 | 0.17 | 0.00 | 0.08 | 0.08 | 0.06 | 0.55 | 0.15 | - | 1.87 | 1.87 |
| 1972 | - | 2.70 | 0.06 | 0.41 | 0.08 | 0.02 | 0.03 | 0.09 | 0.02 | 0.87 | - | 4.28 | 1.58 |
| 1973 | - | 20.59 | 3.25 | 0.00 | 0.36 | 0.06 | 0.00 | 0.12 | 0.01 | 0.86 | - | 25.25 | 4.66 |
| 1974 | - | 1.43 | 8.92 | 1.92 | 0.00 | 0.16 | 0.00 | 0.01 | 0.07 | 0.25 | - | 12.76 | 11.33 |
| 1975 | - | 0.63 | 0.65 | 2.23 | 0.42 | 0.00 | 0.09 | 0.06 | 0.01 | 0.10 | - | 4.19 | 3.56 |
| 1976 | - | 54.22 | 0.20 | 0.40 | 0.62 | 0.29 | 0.00 | 0.03 | 0.00 | 0.07 | - | 55.83 | 1.61 |
| 1977 | - | 0.41 | 22.42 | 0.28 | 0.82 | 0.40 | 0.30 | 0.00 | 0.03 | 0.08 | - | 24.74 | 24.33 |
| 1978 | - | 0.05 | 0.65 | 10.69 | 0.24 | 0.63 | 0.55 | 0.11 | 0.04 | 0.07 | - | 13.03 | 12.98 |
| 1979 | - | 24.24 | 1.06 | 0.76 | 3.83 | 0.22 | 0.11 | 0.25 | 0.04 | 0.03 | - | 30.54 | 6.30 |
| 1980 | - | 3.49 | 31.34 | 0.34 | 0.70 | 3.27 | 0.45 | 0.25 | 0.31 | 0.16 | - | 40.31 | 36.82 |
| 1981 | - | 2.70 | 2.69 | 15.95 | 1.79 | 0.62 | 1.46 | 0.20 | 0.09 | 0.04 | - | 25.53 | 22.83 |
| 1982 | - | 0.62 | 1.25 | 0.77 | 3.33 | 0.34 | 0.23 | 0.50 | 0.00 | 0.00 | - | 7.04 | 6.42 |
| 1983 | - | 0.29 | 0.37 | 0.39 | 0.15 | 1.62 | 0.01 | 0.03 | 0.78 | 0.12 | - | 3.76 | 3.47 |
| 1984 | - | 1.40 | 0.79 | 0.43 | 0.42 | 0.39 | 0.48 | 0.05 | 0.03 | 0.20 | - | 4.19 | 2.79 |
| 1985[3] | - | 0.00 | 4.96 | 0.76 | 0.40 | 0.87 | 0.34 | 1.17 | 0.10 | 0.25 | - | 8.85 | 8.85 |
| Spring (DFO) | | | | | | | | | | | | | |
| 1986 | - | 3.37 | 0.18 | 4.93 | 0.88 | 0.15 | 0.25 | 0.25 | 0.27 | 0.34 | - | 10.62 | 7.25 |
| Autumn (NEFC) | | | | | | | | | | | | | |
| 1963 | 56.33 | 17.04 | 6.19 | 4.57 | 5.60 | 3.99 | 1.37 | 1.13 | 0.79 | 0.31 | 97.32 | 40.99 | 23.95 |
| 1964 | 1.59 | 75.75 | 42.78 | 3.91 | 1.20 | 2.56 | 1.05 | 0.46 | 0.17 | 0.22 | 129.69 | 128.10 | 53.35 |
| 1965 | 0.22 | 6.82 | 51.94 | 6.51 | 0.72 | 0.54 | 0.61 | 0.54 | 0.17 | 0.18 | 68.25 | 68.03 | 61.21 |
| 1966 | 4.12 | 0.64 | 1.94 | 12.34 | 2.25 | 0.35 | 0.33 | 0.22 | 0.08 | 0.05 | 22.32 | 18.20 | 17.56 |
| 1967 | 0.02 | 4.51 | 0.24 | 0.67 | 4.54 | 1.09 | 0.33 | 0.14 | 0.22 | 0.12 | 11.88 | 11.86 | 7.35 |
| 1968 | 0.06 | 0.04 | 0.64 | 0.09 | 0.22 | 2.59 | 0.85 | 0.18 | 0.11 | 0.26 | 5.04 | 4.98 | 4.94 |
| 1969 | 0.26 | 0.02 | 0.00 | 0.19 | 0.09 | 0.11 | 1.02 | 0.34 | 0.06 | 0.18 | 2.27 | 2.01 | 1.99 |
| 1970 | 0.03 | 2.77 | 0.14 | 0.01 | 0.19 | 0.18 | 0.34 | 0.92 | 0.32 | 0.27 | 5.17 | 5.14 | 2.37 |
| 1971 | 1.63 | 0.00 | 0.21 | 0.05 | 0.01 | 0.15 | 0.02 | 0.06 | 0.50 | 0.19 | 2.82 | 1.19 | 1.19 |
| 1972 | 4.53 | 1.69 | 0.00 | 0.35 | 0.06 | 0.00 | 0.06 | 0.04 | 0.02 | 0.87 | 7.62 | 3.09 | 1.40 |
| 1973 | 2.17 | 6.04 | 1.08 | 0.00 | 0.13 | 0.03 | 0.00 | 0.05 | 0.01 | 0.48 | 9.99 | 7.82 | 1.78 |
| 1974 | 0.50 | 1.19 | 0.66 | 0.21 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.15 | 2.72 | 2.22 | 1.03 |
| 1975 | 15.76 | 0.42 | 0.48 | 3.26 | 0.62 | 0.00 | 0.02 | 0.00 | 0.01 | 0.20 | 20.77 | 5.01 | 4.59 |
| 1976 | 2.90 | 43.07 | 0.35 | 0.36 | 0.55 | 0.20 | 0.00 | 0.03 | 0.07 | 0.17 | 47.70 | 44.80 | 1.73 |
| 1977 | 0.11 | 1.75 | 15.33 | 0.46 | 0.47 | 0.52 | 0.28 | 0.03 | 0.01 | 0.07 | 19.03 | 18.92 | 17.17 |
| 1978 | 10.82 | 0.69 | 0.85 | 7.59 | 0.15 | 0.21 | 0.37 | 0.01 | 0.00 | 0.01 | 20.70 | 9.88 | 9.19 |
| 1979 | 1.08 | 37.29 | 0.03 | 0.74 | 3.12 | 0.21 | 0.23 | 0.04 | 0.01 | 0.00 | 42.75 | 41.67 | 4.38 |
| 1980 | 9.56 | 2.22 | 10.41 | 0.37 | 0.25 | 1.39 | 0.39 | 0.38 | 0.07 | 0.05 | 24.99 | 15.43 | 13.21 |
| 1981 | 0.31 | 5.02 | 1.70 | 3.03 | 0.17 | 0.34 | 0.43 | 0.00 | 0.00 | 0.01 | 11.01 | 10.70 | 5.68 |
| 1982 | 0.89 | 0.00 | 0.74 | 0.32 | 1.27 | 0.13 | 0.07 | 0.19 | 0.01 | 0.05 | 3.67 | 2.78 | 2.78 |
| 1983 | 3.89 | 0.16 | 0.14 | 0.18 | 0.20 | 0.63 | 0.08 | 0.00 | 0.07 | 0.01 | 5.36 | 1.47 | 1.31 |
| 1984 | 0.02 | 2.23 | 0.59 | 0.16 | 0.19 | 0.04 | 0.30 | 0.00 | 0.00 | 0.08 | 3.61 | 3.59 | 1.36 |
| 1985[3] | 11.35 | 0.65 | 1.53 | 0.22 | 0.05 | 0.10 | 0.01 | 0.17 | 0.00 | 0.05 | 14.19 | 2.84 | 2.19 |

[1]Strata 13-25, 29, and 30 (see Fig. 3).
[2]Surveys for 1968-72 and 1982-85 used a "36 Yankee" trawl and surveys for 1973-81 used a "41 Yankee" trawl. No adjustments made to data to account for differences.
[3]From Anon. MS, 1986.

Table 10. Percent numbers per stratum and density for haddock ages 1 to 4+ from U.S. fall survey[1]

AGE 1

| STRAT. | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1982 | 1983 | 1984 | 1985 | MEAN | DEN-SITY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | 0.6 | 31.1 | 5.5 | 0 | 0 | 0 | 0.4 | 0 | 3.4 | 0.1 | 0.7 | 0 | 0 | 0 | 15.6 | 3.8 | 31 |
| 14 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 10 |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 7.8 | 25.5 | 51.2 | 91.9 | 6.1 | 31.7 | 77.7 | 11.2 | 30.5 | 10 | 10.1 | 0 | 8.7 | 19.6 | 70 | 30.1 | 2048 |
| 17 | 3.4 | 12.5 | 0.3 | 3.9 | 0 | 1.9 | 0.7 | 1.2 | 2.7 | 0.5 | 25 | 0 | 59.1 | 41.4 | 2.4 | 10.3 | 731 |
| 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.4 | 0.8 | 0 | 1.5 | 0 | 0.3 | 0.3 | 726 |
| 19 | 83.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14.4 | 0 | 0 | 0 | 0 | 0 | 0 | 6.5 | 132 |
| 20 | 0 | 0 | 0 | 0 | 0 | 7.5 | 0 | 0 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 1.6 | 17 |
| 21 | 0.2 | 19.7 | 0.1 | 0.2 | 0.9 | 0 | 17.7 | 5.6 | 5.9 | 0.2 | 2.5 | 0 | 16.8 | 5.1 | 1.2 | 5.1 | 2556 |
| 22 | 0.6 | 0 | 0.3 | 0 | 0 | 9.1 | 0.1 | 3.6 | 0.3 | 78.2 | 15 | 0 | 3.2 | 0.6 | 0 | 7.4 | 8717 |
| 23 | 2.5 | 8 | 31.6 | 3.7 | 55.1 | 29 | 2.7 | 53.2 | 20.2 | 0.6 | 8.5 | 0 | 0 | 33.4 | 10 | 17.2 | 616 |
| 24 | 0.6 | 0 | 4 | 0.3 | 29.1 | 4.5 | 0.6 | 7.8 | 4.4 | 5.6 | 8 | 0 | 0 | 0 | 0.3 | 4.4 | 164 |
| 25 | 0.3 | 0 | 0.6 | 0 | 1.2 | 0 | 0 | 13.9 | 0.1 | 0 | 2 | 0 | 0 | 0 | 0.2 | 1.2 | 111 |
| 29 | 0 | 3.2 | 6.4 | 0 | 6.9 | 16.3 | 0.1 | 2.6 | 0.4 | 2.3 | 27.3 | 0 | 10.7 | 0 | 0 | 5.1 | 76 |
| 30 | 0 | 0 | 0 | 0 | 0.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

AGE 2

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.1 | 0 | 0 | 0 | 1.6 | 0 | 0 | 0 | 0.1 | 1 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 1.4 | 13.3 | 0 | 37.7 | 28.1 | 4.5 | 41.6 | 8.4 | 6.7 | 0 | 3.5 | 2.3 | 0 | 4.1 | 7.4 | 10.6 | 120 |
| 17 | 6.6 | 7.9 | 0 | 9.2 | 3.8 | 12.1 | 0.2 | 1.3 | 34.3 | 0 | 11.8 | 27.2 | 72.3 | 13.6 | 13.8 | 14.3 | 940 |
| 18 | 2.1 | 0 | 0 | 0.6 | 0.5 | 0 | 1.5 | 0 | 1.8 | 19.6 | 0.1 | 4.8 | 5.3 | 0 | 12.2 | 3.2 | 221 |
| 19 | 51.1 | 49.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0.4 | 0 | 1 | 0 | 0 | 0 | 0 | 6.8 | 15 |
| 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | 2.7 | 2.6 | 0 | 0 | 18.2 | 0 | 30.5 | 59.2 | 1.3 | 0 | 2.5 | 1 | 5.1 | 1.2 | 16.8 | 9.4 | 3135 |
| 22 | 12.1 | 2.8 | 0 | 0.5 | 5.4 | 2 | 0.2 | 9.5 | 1.7 | 0 | 7.5 | 0 | 0 | 0.5 | 0.6 | 2.8 | 684 |
| 23 | 7.6 | 1.1 | 0 | 45.2 | 0.8 | 4.6 | 1.7 | 3.6 | 2.1 | 0 | 0 | 1.7 | 0 | 13.4 | 1.9 | 5.6 | 167 |
| 24 | 10 | 0 | 0 | 5.3 | 8 | 8.1 | 7 | 8.9 | 21.8 | 0 | 7.6 | 43.7 | 0 | 0 | 0.9 | 8.1 | 146 |
| 25 | 1.2 | 4.8 | 0 | 1.4 | 5 | 0 | 0 | 1 | 0 | 0 | 0.1 | 0.1 | 0 | 0 | 0 | 0.9 | 75 |
| 29 | 5.2 | 17.7 | 0 | 0 | 29.9 | 29.6 | 13.3 | 8 | 28.5 | 80.4 | 65.7 | 17.6 | 17.4 | 67.2 | 46.5 | 28.5 | 414 |
| 30 | 0 | 0 | 0 | 0 | 0.4 | 39.1 | 4 | 0.1 | 1 | 0 | 0.2 | 0 | 0 | 0 | 0 | 3 | 53 |

AGE 3

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.3 | 0 | 0 | 0 | 0.1 | 0 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 0 | 13.2 | 10.8 | 0 | 4.1 | 0.9 | 22.6 | 1.5 | 6.8 | 10.4 | 3.2 | 5.6 | 0 | 5.6 | 0.7 | 5.7 | 37 |
| 17 | 8.9 | 8.8 | 14.2 | 0 | 1.4 | 7.3 | 0 | 3.1 | 25.4 | 0 | 10.4 | 40.3 | 52.8 | 14.8 | 20.4 | 13.8 | 987 |
| 18 | 8.5 | 0 | 1.1 | 0 | 1.4 | 0.5 | 2.8 | 0 | 3.5 | 5.8 | 0.3 | 9.5 | 12.7 | 2.6 | 15.3 | 4.3 | 350 |
| 19 | 26.8 | 26.5 | 0 | 0 | 0 | 0 | 0 | 0.2 | 1.6 | 0 | 2 | 0 | 0 | 0 | 0 | 3.8 | 8 |
| 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | 5.2 | 0 | 0 | 0 | 11.2 | 0 | 30.6 | 39.3 | 3.1 | 4.7 | 2.2 | 1.8 | 7.9 | 0 | 5.3 | 7.4 | 198 |
| 22 | 5.6 | 0 | 0.5 | 0 | 13.8 | 2.3 | 0.2 | 2.4 | 3.8 | 9.9 | 6.2 | 1.3 | 4.1 | 0.5 | 3 | 3.6 | 156 |
| 23 | 25 | 4.9 | 29.7 | 0 | 2.9 | 0.1 | 4.8 | 5 | 0.4 | 1.4 | 0.4 | 0 | 0 | 0 | 6.2 | 5.4 | 28 |
| 24 | 0 | 0 | 9.2 | 0 | 19.5 | 1.3 | 11.6 | 13.8 | 21.4 | 6.5 | 15.3 | 21.3 | 0 | 0 | 9 | 8.6 | 108 |
| 25 | 0 | 7.1 | 2.9 | 0 | 18.2 | 0 | 0 | 1.7 | 0 | 0 | 0.1 | 1.2 | 0 | 0 | 0 | 2.1 | 22 |
| 29 | 20 | 39.5 | 26.8 | 0 | 27.4 | 20.5 | 20.7 | 32.4 | 29.2 | 55.6 | 59.5 | 16.6 | 22.6 | 76.4 | 35.3 | 32.2 | 179 |
| 30 | 0 | 0 | 4.9 | 0 | 0 | 67.1 | 6.5 | 0.7 | 4.7 | 5.6 | 0.5 | 1.1 | 0 | 0 | 4.6 | 6.4 | 576 |

Table 10. ( con't )

AGE 4+

| STRAT. | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1982 | 1983 | 1984 | 1985 | MEAN | DEN-SITY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | 0.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 1 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 1.7 | 5.4 | 1.6 | 4.2 | 0 | 1.7 | 0 | 0.7 | 1.8 | 6 | 1.8 | 16.1 | 1.7 | 2 | 0 | 3 | 35 |
| 17 | 1.8 | 3.8 | 7.2 | 2.3 | 0 | 4.9 | 0 | 2.6 | 1.8 | 0 | 12.6 | 24.6 | 10.6 | 11.7 | 18.1 | 6.8 | 484 |
| 18 | 3.8 | 0.6 | 0.2 | 0 | 0 | 1.5 | 2.7 | 0 | 3.3 | 1.7 | 2.4 | 15.5 | 4.5 | 7.8 | 8.4 | 3.5 | 558 |
| 19 | 37.4 | 8.6 | 0 | 0 | 0 | 0 | 0 | 0.8 | 0.2 | 0 | 5 | 0 | 0 | 0 | 0 | 3.5 | 56 |
| 20 | 0 | 0 | 0 | 21 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.4 | 0 | 0 | 0 | 0 | 1.4 | 21 |
| 21 | 5.9 | 1.2 | 0 | 0 | 0 | 0 | 9.9 | 12.5 | 3.1 | 4.5 | 0.4 | 0.5 | 1.8 | 0 | 0.1 | 2.7 | 206 |
| 22 | 10.7 | 5 | 6.1 | 9.5 | 33.7 | 4.5 | 3.2 | 2 | 4.3 | 11.3 | 1.2 | 13.8 | 7 | 1.9 | 4.3 | 7.9 | 416 |
| 23 | 6.5 | 0.6 | 19.5 | 28.3 | 0 | 0.1 | 9.3 | 6.3 | 0.5 | 0.9 | 2.1 | 0 | 0 | 0 | 2.8 | 5.1 | 117 |
| 24 | 24.9 | 24.5 | 29.5 | 6.6 | 62.2 | 4.1 | 36 | 17.1 | 27.2 | 11.4 | 34 | 19.7 | 22.9 | 9.7 | 23.5 | 23.5 | 216 |
| 25 | 0 | 21.3 | 2 | 1.2 | 4.1 | 0 | 0 | 0.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 85 |
| 29 | 6.4 | 25.6 | 29.2 | 24.4 | 0 | 11.8 | 30.4 | 54.3 | 40.5 | 52.1 | 30.3 | 5 | 50.3 | 65.1 | 25 | 30 | 254 |
| 30 | 0 | 3.4 | 4.7 | 2.5 | 0 | 71.4 | 8.5 | 2.9 | 17.2 | 12 | 9.8 | 4.8 | 1.1 | 1.7 | 17.8 | 10.5 | 393 |

[1]Data provided by NMFS (contact T. Azarovitz)

Table 11. Analysis of variance and coefficients from the regression of ln catch rate for haddock in NAFO Division 5Z using data from 1966-85.

*regression of multiplicative model*

*multiple r..... 0.780*
*multiple r squared..... 0.608*

*analysis of variance*

| *source of variation* | *df* | *sums of squares* | *mean squares* | *f-value* |
|---|---|---|---|---|
| *intercept* | *1* | *3.058e2* | *3.058e2* | |
| *regression* | *34* | *5.911e1* | *1.739e0* | *13.711* |
| *type 1* | *4* | *8.107e0* | *2.027e0* | *15.984* |
| *type 2* | *11* | *1.379e1* | *1.253e0* | *9.885* |
| *type 3* | *19* | *3.564e1* | *1.876e0* | *14.795* |
| *residuals* | *300* | *3.804e1* | *1.268e⁻1* | |
| *total* | *335* | *4.030e2* | | |

| Country/Gear | | ln Power |
|---|---|---|
| CAN-M | OTB2-2 | -0.033 |
| CAN-M | OTB1-4 | 0.000 |
| CAN-M | OTB2-4 | 0.181 |
| CAN-M | OTB2-3 | 0.218 |
| CAN-M | OTB2-5 | 0.371 |

| Month | ln Power |
|---|---|
| Nov. | -0.516 |
| Dec. | -0.407 |
| Sept. | -0.330 |
| July | -0.325 |
| Aug. | -0.295 |
| Oct. | -0.202 |
| June | -0.189 |
| May | -0.183 |
| Jan. | 0.000 |
| Feb. | 0.058 |
| Mar. | 0.327 |
| Apr. | 0.358 |

Table 12. Catch rate index for haddock in NAFO Division 5Z, standardized to CAN-M OTB2-5 and June. The standardized effort index was calculated using the mean catch rate and catch.

| | predicted catch rate | | | | | |
|---|---|---|---|---|---|---|
| | ln transform | | retransformed | | | |
| year | mean | s.e. | mean | s.e. | catch | effort |
| 1966 | -0.8602 | 0.0111 | 0.448 | 0.047 | 121274 | 270488 |
| 1967 | -0.9179 | 0.0069 | 0.424 | 0.035 | 51469 | 121354 |
| 1968 | -1.1019 | 0.0068 | 0.353 | 0.029 | 40421 | 114558 |
| 1969 | -1.2064 | 0.0086 | 0.318 | 0.029 | 22183 | 69855 |
| 1970 | -1.1666 | 0.0121 | 0.330 | 0.036 | 11285 | 34209 |
| 1971 | -1.3385 | 0.0159 | 0.277 | 0.035 | 10862 | 39178 |
| 1972 | -1.6999 | 0.0510 | 0.190 | 0.042 | 5733 | 30208 |
| 1973 | -1.2451 | 0.0186 | 0.304 | 0.041 | 5331 | 17538 |
| 1974 | -0.9703 | 0.2883 | 0.349 | 0.175 | 4290 | 12275 |
| 1975 | -1.0655 | 0.0259 | 0.362 | 0.058 | 5420 | 14955 |
| 1976 | -1.1195 | 0.0182 | 0.345 | 0.046 | 4324 | 12543 |
| 1977 | -0.4865 | 0.0153 | 0.650 | 0.080 | 10843 | 16678 |
| 1978 | -0.1531 | 0.0097 | 0.910 | 0.090 | 22339 | 24551 |
| 1979 | -0.4259 | 0.0075 | 0.693 | 0.060 | 19461 | 28062 |
| 1980 | -0.4457 | 0.0065 | 0.680 | 0.055 | 27571 | 40531 |
| 1981 | -0.3520 | 0.0078 | 0.747 | 0.066 | 24907 | 33364 |
| 1982 | -0.8144 | 0.0141 | 0.469 | 0.055 | 17563 | 37474 |
| 1983 | -0.9411 | 0.0181 | 0.412 | 0.055 | 11892 | 28860 |
| 1984 | -0.9322 | 0.0331 | 0.413 | 0.075 | 10269 | 24888 |
| 1985 | -0.6526 | 0.0147 | 0.551 | 0.067 | 7757 | 14083 |

Table 13. Catch numbers at age from the commercial fishery for haddock in NAFO Division 5Z.

CATCH AT AGE (000) 17/ 9/86

| | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2910 | 10101 | 9601 | 114 | 1150 | 8 | 2 | 46 | 0 | 156 | 2560 | 46 | 192 | 144 |
| 2 | 4047 | 15935 | 125818 | 6843 | 168 | 2994 | 11 | 158 | 1375 | 2 | 2057 | 4320 | 1034 | 473 |
| 3 | 7418 | 4554 | 44496 | 100810 | 2891 | 709 | 1698 | 16 | 223 | 450 | 3 | 657 | 1864 | 550 |
| 4 | 11152 | 4776 | 5356 | 19167 | 20667 | 1921 | 448 | 570 | 40 | 81 | 386 | 2 | 375 | 880 |
| 5 | 8198 | 8722 | 4391 | 2768 | 10338 | 14519 | 654 | 186 | 289 | 32 | 53 | 70 | 4 | 216 |
| 6 | 2205 | 5794 | 6690 | 2591 | 1209 | 3499 | 5954 | 214 | 246 | 120 | 30 | 2 | 42 | 1 |
| 7 | 1405 | 2082 | 3772 | 2332 | 993 | 677 | 1574 | 2308 | 285 | 78 | 77 | 2 | 4 | 23 |
| 8 | 721 | 1028 | 1094 | 1268 | 917 | 453 | 225 | 746 | 1469 | 66 | 15 | 53 | 4 | 4 |
| 9 | 1096 | 1332 | 1366 | 867 | 698 | 842 | 570 | 464 | 928 | 1236 | 447 | 249 | 88 | 112 |

| | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 8 | 0 | 78 | 0 | 0 | 0 |
| 2 | 19585 | 761 | 26 | 31000 | 1661 | 1424 | 87 | 94 | 2328 |
| 3 | 187 | 14395 | 1726 | 347 | 9550 | 1634 | 748 | 335 | 571 |
| 4 | 680 | 305 | 7169 | 975 | 754 | 2895 | 709 | 722 | 225 |
| 5 | 515 | 567 | 525 | 6054 | 699 | 335 | 1923 | 367 | 313 |
| 6 | 357 | 517 | 410 | 594 | 2278 | 645 | 267 | 1532 | 176 |
| 7 | 4 | 139 | 315 | 546 | 308 | 1387 | 222 | 199 | 656 |
| 8 | 39 | 14 | 96 | 153 | 139 | 130 | 875 | 325 | 91 |
| 9 | 111 | 67 | 46 | 81 | 80 | 119 | 96 | 456 | 177 |

1963-80 Overholtz (MS 1983)

1981-84 data source, W. Overholtz

Table 14. Average weight at age of haddock caught in the commercial fishery in NAFO Division 5Z.

WEIGHT AT AGE (KG) 17/ 9/86

| | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.57 | 0.50 | 0.58 | 0.58 | 0.66 | 0.59 | 0.52 | 0.71 | 0.60 | 0.62 | 0.60 | 0.72 | 0.62 | 0.60 | 0.60 | 0.60 |
| 2 | 0.87 | 0.83 | 0.69 | 0.73 | 0.70 | 0.81 | 0.78 | 1.27 | 1.03 | 1.03 | 1.03 | 1.06 | 0.98 | 0.99 | 1.07 | 0.94 |
| 3 | 1.18 | 1.12 | 1.03 | 0.89 | 0.95 | 1.05 | 1.10 | 1.22 | 1.31 | 1.74 | 1.58 | 1.82 | 1.63 | 1.39 | 1.44 | 1.50 |
| 4 | 1.47 | 1.43 | 1.35 | 1.26 | 1.18 | 1.32 | 1.69 | 1.93 | 1.74 | 2.04 | 2.13 | 2.32 | 2.21 | 1.99 | 2.17 | 2.04 |
| 5 | 1.68 | 1.64 | 1.67 | 1.70 | 1.42 | 1.57 | 1.75 | 2.19 | 2.39 | 2.42 | 2.41 | 2.83 | 2.20 | 2.66 | 2.73 | 2.79 |
| 6 | 2.15 | 2.01 | 1.99 | 2.07 | 2.05 | 2.10 | 1.99 | 2.39 | 2.81 | 2.92 | 3.29 | 3.76 | 2.94 | 2.63 | 3.21 | 3.19 |
| 7 | 2.35 | 2.40 | 2.26 | 2.28 | 2.31 | 2.32 | 2.52 | 2.58 | 2.92 | 3.06 | 3.42 | 4.05 | 4.00 | 3.69 | 4.15 | 3.37 |
| 8 | 3.04 | 2.64 | 2.66 | 2.87 | 2.66 | 2.62 | 2.99 | 3.23 | 3.10 | 3.44 | 3.86 | 3.92 | 4.05 | 4.67 | 4.00 | 3.61 |
| 9 | 3.10 | 2.97 | 3.11 | 3.18 | 3.10 | 2.86 | 3.63 | 3.75 | 3.72 | 3.66 | 3.94 | 4.26 | 4.33 | 4.94 | 4.99 | 5.11 |

| | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|
| 1 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 |
| 2 | 1.00 | 0.72 | 0.91 | 0.92 | 1.00 | 0.86 | 1.00 |
| 3 | 1.28 | 1.20 | 1.24 | 1.41 | 1.43 | 1.31 | 1.27 |
| 4 | 2.02 | 1.93 | 1.80 | 1.94 | 1.94 | 1.74 | 1.92 |
| 5 | 2.51 | 2.30 | 2.40 | 2.44 | 2.31 | 2.17 | 2.40 |
| 6 | 3.14 | 2.94 | 2.80 | 2.83 | 2.80 | 2.67 | 2.87 |
| 7 | 3.78 | 3.86 | 3.73 | 3.35 | 3.38 | 2.98 | 3.03 |
| 8 | 3.79 | 4.13 | 4.44 | 4.00 | 3.59 | 3.39 | 3.54 |
| 9 | 4.87 | 4.83 | 4.04 | 3.73 | 3.89 | 3.62 | 3.93 |

1963-79 from Clark et al. (1982)

1980-84 Overholtz (pers. comm.)

Table 15. Ages 3+ numbers from cohort analysis conducted at various 1985 fully recruited fishing mortality levels between 0.4 and 0.6 along with the corresponding 2+ numbers from the previous fall survey and the residuals from the model fit. Labels for years used in figures 8, 9, 10, 11, and 12 are indicated in the leftmost column.

| | | | 0.40 | | 0.50 | | 0.55 | | 0.60 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | SPA YEAR | SURVEY | SPA | RES. | SPA | RES. | SPA | RES. | SPA | RES. |
| M | 1964 | 23.95 | 97541 | -0.228 | 97541 | -0.201 | 97541 | -0.189 | 97541 | -0.179 |
| L | 1965 | 52.35 | 163737 | -0.492 | 163737 | -0.465 | 163737 | -0.453 | 163737 | -0.443 |
| K | 1966 | 61.21 | 265264 | -0.166 | 265264 | -0.138 | 265264 | -0.127 | 265264 | -0.117 |
| J | 1967 | 17.56 | 107867 | 0.183 | 107867 | 0.210 | 107867 | 0.222 | 107867 | 0.232 |
| I | 1968 | 7.35 | 56531 | 0.407 | 56531 | 0.435 | 56531 | 0.447 | 56531 | 0.457 |
| H | 1969 | 4.94 | 30169 | 0.177 | 30169 | 0.205 | 30169 | 0.216 | 30169 | 0.226 |
| G | 1970 | 1.99 | 15364 | 0.411 | 15364 | 0.439 | 15364 | 0.450 | 15364 | 0.461 |
| F | 1971 | 2.37 | 9408 | -0.254 | 9408 | -0.226 | 9408 | -0.215 | 9408 | -0.204 |
| E | 1972 | 1.19 | 6621 | 0.084 | 6621 | 0.111 | 6621 | 0.123 | 6621 | 0.133 |
| D | 1973 | 1.40 | 3509 | -0.714 | 3509 | -0.686 | 3509 | -0.675 | 3509 | -0.664 |
| C | 1974 | 1.78 | 5928 | -0.430 | 5928 | -0.402 | 5928 | -0.390 | 5928 | -0.380 |
| B | 1975 | 1.03 | 10908 | 0.727 | 10908 | 0.755 | 10908 | 0.767 | 10908 | 0.777 |
| A | 1976 | 4.59 | 13169 | -0.579 | 13169 | -0.551 | 13169 | -0.539 | 13169 | -0.529 |
| 7 | 1977 | 1.73 | 14308 | 0.480 | 14308 | 0.508 | 14308 | 0.519 | 14308 | 0.529 |
| 8 | 1978 | 17.17 | 61276 | -0.360 | 61276 | -0.333 | 61276 | -0.321 | 61276 | -0.311 |
| 9 | 1979 | 9.19 | 44231 | -0.061 | 44231 | -0.034 | 44231 | -0.022 | 44231 | -0.012 |
| 0 | 1980 | 4.38 | 30570 | 0.310 | 30436 | 0.334 | 30387 | 0.344 | 30347 | 0.352 |
| 1 | 1981 | 13.31 | 42702 | -0.467 | 41798 | -0.460 | 41471 | -0.457 | 41200 | -0.453 |
| 2 | 1982 | 5.68 | 26843 | -0.080 | 25929 | -0.086 | 25598 | -0.088 | 25324 | -0.088 |
| 3 | 1983 | 2.78 | 18546 | 0.265 | 17544 | 0.237 | 17181 | 0.228 | 16880 | 0.221 |
| 4 | 1984 | 1.31 | 11591 | 0.548 | 10621 | 0.488 | 10271 | 0.466 | 9979 | 0.447 |
| 5 | 1985 | 1.36 | 7344 | 0.054 | 6143 | -0.097 | 5709 | -0.159 | 5349 | -0.214 |
| 6 | 1986 | 2.19 | 13497 | 0.186 | 10424 | -0.045 | 9310 | -0.146 | 8384 | -0.241 |
| | INTERCEPT: | | 8.54 | | 8.51 | | 8.50 | | 8.49 | |
| | SSR: | | 3.44 | | 3.32 | | 3.33 | | 3.36 | |

Table 16. Results from sequential population analysis for haddock in NAFO Division 5Z. A fishing mortality of 0.5 was used for 1985. The weighted fishing mortality for ages 3 to 8 is indicated.

POPULATION NUMBERS (000) 11/12/86

| | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 188457 | 467459 | 32524 | 4109 | 11524 | 435 | 996 | 4768 | 384 | 8550 | 19207 | 10733 | 8220 |
| 2 | 32109 | 151662 | 373583 | 17941 | 3261 | 8395 | 349 | 813 | 3862 | 314 | 6859 | 13409 | 8746 |
| 3 | 32526 | 22627 | 109752 | 192019 | 8497 | 2518 | 4164 | 276 | 523 | 1918 | 255 | 3755 | 7070 |
| 4 | 45500 | 19918 | 14405 | 49596 | 65995 | 4341 | 1420 | 1873 | 211 | 226 | 1163 | 206 | 2480 |
| 5 | 28695 | 27161 | 11986 | 6547 | 23263 | 35332 | 1816 | 757 | 1017 | 137 | 112 | 603 | 167 |
| 6 | 8783 | 16075 | 14346 | 5840 | 3183 | 9692 | 15790 | 895 | 452 | 571 | 83 | 44 | 430 |
| 7 | 5045 | 5196 | 7919 | 5692 | 2437 | 1512 | 4769 | 7541 | 539 | 147 | 359 | 41 | 34 |
| 8 | 3054 | 2859 | 2370 | 3070 | 2550 | 1097 | 626 | 2480 | 4085 | 184 | 50 | 224 | 32 |
| 9 | 4642 | 3704 | 2960 | 2099 | 1941 | 2039 | 1585 | 1543 | 2581 | 3437 | 1486 | 1055 | 695 |
| 1+ | 348811 | 716662 | 569845 | 287314 | 122652 | 65360 | 31514 | 20945 | 13654 | 15485 | 29575 | 30070 | 27874 |
| 2+ | 160354 | 249203 | 537321 | 283205 | 111128 | 64925 | 30518 | 16177 | 13271 | 6935 | 10268 | 19337 | 19654 |
| 3+ | 128245 | 97541 | 163737 | 265264 | 107867 | 56531 | 30169 | 15364 | 9408 | 6621 | 3509 | 5928 | 10908 |

| | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 103391 | 13974 | 5509 | 78811 | 8606 | 6547 | 1896 | 2496 | 14124 | 441 |
| 2 | 6556 | 84519 | 11441 | 4510 | 64525 | 7039 | 5360 | 1452 | 2043 | 11564 |
| 3 | 6225 | 4940 | 51477 | 8678 | 3669 | 24779 | 4260 | 3100 | 1134 | 1588 |
| 4 | 4101 | 4599 | 3875 | 29121 | 5543 | 2690 | 11646 | 2010 | 1861 | 626 |
| 5 | 1691 | 2562 | 3150 | 2897 | 17355 | 3656 | 1520 | 6915 | 1033 | 870 |
| 6 | 133 | 1189 | 1631 | 2066 | 1897 | 8731 | 2361 | 941 | 3921 | 489 |
| 7 | 314 | 108 | 650 | 868 | 1321 | 1015 | 5087 | 1349 | 529 | 1524 |
| 8 | 24 | 237 | 85 | 407 | 425 | 587 | 552 | 2910 | 904 | 253 |
| 9 | 679 | 673 | 406 | 195 | 225 | 339 | 502 | 318 | 1268 | 492 |
| 1+ | 123116 | 112800 | 78225 | 127552 | 103567 | 55384 | 33185 | 21521 | 26789 | 18149 |
| 2+ | 19725 | 98827 | 72716 | 48741 | 94961 | 48837 | 31289 | 19025 | 12665 | 17707 |
| 3+ | 13169 | 14308 | 61276 | 44231 | 30436 | 41798 | 25929 | 17544 | 10621 | 6143 |

MEAN POPULATION BIOMASS (T) 11/12/86

| | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 96535 | 209384 | 14218 | 2128 | 6519 | 230 | 469 | 3053 | 209 | 4738 | 9661 | 6986 | 4561 |
| 2 | 23570 | 107551 | 188235 | 9225 | 2011 | 4887 | 242 | 835 | 2861 | 292 | 5306 | 10498 | 7266 |
| 3 | 30337 | 20393 | 78005 | 105019 | 5879 | 2013 | 3154 | 295 | 464 | 2626 | 363 | 5593 | 8886 |
| 4 | 52252 | 22333 | 13906 | 43827 | 57912 | 3825 | 1781 | 2705 | 298 | 332 | 1816 | 432 | 4553 |
| 5 | 36589 | 32925 | 14275 | 8199 | 22009 | 38094 | 2278 | 1295 | 1848 | 261 | 175 | 1449 | 529 |
| 6 | 14692 | 23154 | 18630 | 8060 | 4603 | 14577 | 22212 | 1678 | 763 | 1335 | 196 | 146 | 1086 |
| 7 | 9045 | 8640 | 11565 | 8922 | 3878 | 2331 | 6822 | 14545 | 964 | 275 | 980 | 146 | 116 |
| 8 | 7306 | 5428 | 4157 | 6065 | 4878 | 1978 | 1346 | 6024 | 9168 | 454 | 145 | 693 | 108 |
| 9 | 11325 | 7912 | 6069 | 4595 | 4329 | 4014 | 4138 | 4350 | 6504 | 9048 | 4403 | 3536 | 2540 |
| 1+ | 281670 | 437722 | 348961 | 196040 | 112016 | 71949 | 44442 | 34780 | 23418 | 19380 | 23066 | 29479 | 29445 |
| 2+ | 185116 | 228337 | 334743 | 193913 | 105497 | 71718 | 43973 | 31727 | 23210 | 14642 | 13386 | 22491 | 24883 |
| 3+ | 161545 | 120786 | 146508 | 184688 | 103486 | 66831 | 43730 | 30892 | 20348 | 14330 | 8078 | 11993 | 17617 |

| | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 56183 | 7599 | 2996 | 42858 | 4678 | 3560 | 1008 | 1357 | 7681 | 240 |
| 2 | 5653 | 71303 | 9396 | 4075 | 29901 | 5036 | 3797 | 1300 | 1553 | 9275 |
| 3 | 7466 | 6316 | 58865 | 8952 | 3785 | 21568 | 4223 | 3472 | 1120 | 1451 |
| 4 | 6510 | 8309 | 6859 | 45920 | 8752 | 3690 | 17607 | 2810 | 2268 | 864 |
| 5 | 3791 | 5628 | 7170 | 5928 | 28873 | 7107 | 2947 | 12191 | 1554 | 1504 |
| 6 | 316 | 2865 | 3859 | 5230 | 4147 | 18889 | 5116 | 2003 | 7317 | 1610 |
| 7 | 1010 | 399 | 1749 | 2346 | 3493 | 2837 | 13058 | 3757 | 1115 | 3982 |
| 8 | 93 | 780 | 253 | 1213 | 1264 | 2051 | 1739 | 7856 | 2203 | 642 |
| 9 | 2766 | 2769 | 1712 | 747 | 782 | 1079 | 1474 | 931 | 3301 | 1391 |
| 1+ | 83788 | 105969 | 92859 | 117269 | 85674 | 65818 | 50970 | 35679 | 28113 | 20361 |
| 2+ | 27605 | 98370 | 89863 | 74411 | 80996 | 62257 | 49962 | 34322 | 20433 | 20121 |
| 3+ | 21952 | 27067 | 80467 | 70336 | 51095 | 57222 | 46164 | 33022 | 18879 | 10846 |

Table 16 (cont'd.)

FISHING MORTALITY 11/12/86

| | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.017 | 0.024 | 0.395 | 0.031 | 0.117 | 0.021 | 0.002 | 0.011 | 0.000 | 0.020 | 0.159 | 0.005 | 0.026 | 0.002 | 0.000 | 0.000 |
| 2 | 0.150 | 0.123 | 0.466 | 0.547 | 0.059 | 0.501 | 0.035 | 0.242 | 0.500 | 0.007 | 0.403 | 0.440 | 0.140 | 0.083 | 0.296 | 0.076 |
| 3 | 0.290 | 0.252 | 0.594 | 0.868 | 0.472 | 0.373 | 0.599 | 0.066 | 0.637 | 0.300 | 0.013 | 0.215 | 0.344 | 0.103 | 0.043 | 0.370 |
| 4 | 0.316 | 0.308 | 0.529 | 0.557 | 0.425 | 0.671 | 0.429 | 0.410 | 0.235 | 0.503 | 0.457 | 0.011 | 0.183 | 0.271 | 0.178 | 0.091 |
| 5 | 0.379 | 0.438 | 0.519 | 0.580 | 0.676 | 0.605 | 0.508 | 0.317 | 0.377 | 0.299 | 0.739 | 0.137 | 0.027 | 0.152 | 0.251 | 0.222 |
| 6 | 0.325 | 0.508 | 0.724 | 0.674 | 0.544 | 0.509 | 0.539 | 0.307 | 0.922 | 0.264 | 0.510 | 0.052 | 0.114 | 0.008 | 0.403 | 0.431 |
| 7 | 0.368 | 0.585 | 0.747 | 0.603 | 0.598 | 0.683 | 0.454 | 0.413 | 0.878 | 0.882 | 0.270 | 0.056 | 0.139 | 0.084 | 0.042 | 0.269 |
| 8 | 0.300 | 0.500 | 0.700 | 0.600 | 0.500 | 0.600 | 0.500 | 0.400 | 0.500 | 0.500 | 0.400 | 0.300 | 0.150 | 0.200 | 0.200 | 0.200 |
| 9 | 0.300 | 0.500 | 0.700 | 0.600 | 0.500 | 0.600 | 0.500 | 0.400 | 0.500 | 0.500 | 0.400 | 0.300 | 0.150 | 0.200 | 0.200 | 0.200 |
| | 0.326 | 0.388 | 0.604 | 0.789 | 0.493 | 0.585 | 0.525 | 0.391 | 0.542 | 0.346 | 0.384 | 0.198 | 0.289 | 0.163 | 0.163 | 0.340 |

| | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|
| 1 | 0.000 | 0.001 | 0.000 | 0.047 | 0.000 | 0.000 | 0.000 |
| 2 | 0.006 | 0.757 | 0.302 | 0.348 | 0.067 | 0.052 | 0.250 |
| 3 | 0.248 | 0.110 | 0.555 | 0.551 | 0.310 | 0.395 | 0.500 |
| 4 | 0.318 | 0.216 | 0.371 | 0.321 | 0.494 | 0.560 | 0.500 |
| 5 | 0.224 | 0.487 | 0.238 | 0.279 | 0.367 | 0.518 | 0.500 |
| 6 | 0.248 | 0.425 | 0.340 | 0.360 | 0.376 | 0.565 | 0.500 |
| 7 | 0.513 | 0.611 | 0.409 | 0.359 | 0.201 | 0.537 | 0.500 |
| 8 | 0.300 | 0.500 | 0.300 | 0.300 | 0.400 | 0.500 | 0.500 |
| 9 | 0.300 | 0.500 | 0.300 | 0.300 | 0.400 | 0.500 | 0.500 |
| | 0.298 | 0.393 | 0.463 | 0.368 | 0.365 | 0.531 | 0.500 |

PARTIAL RECRUITMENT 11/12/86

| | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.05 | 0.06 | 0.65 | 0.04 | 0.24 | 0.04 | 0.00 | 0.03 | 0.00 | 0.06 | 0.41 | 0.02 | 0.09 | 0.01 | 0.00 | 0.00 |
| 2 | 0.46 | 0.32 | 0.77 | 0.69 | 0.12 | 0.86 | 0.07 | 0.62 | 0.92 | 0.02 | 1.05 | 2.23 | 0.48 | 0.51 | 1.83 | 0.22 |
| 3 | 0.89 | 0.65 | 0.98 | 1.10 | 0.96 | 0.64 | 1.14 | 0.17 | 1.18 | 0.87 | 0.03 | 1.09 | 1.19 | 0.63 | 0.26 | 1.07 |
| 4 | 0.97 | 0.79 | 0.88 | 0.71 | 0.86 | 1.15 | 0.82 | 1.05 | 0.43 | 1.45 | 1.19 | 0.05 | 0.63 | 1.64 | 1.10 | 0.26 |
| 5 | 1.16 | 1.13 | 0.86 | 0.74 | 1.37 | 1.04 | 0.97 | 0.81 | 0.70 | 0.86 | 1.92 | 0.69 | 0.09 | 0.93 | 1.55 | 0.64 |
| 6 | 1.00 | 1.31 | 1.20 | 0.85 | 1.10 | 0.87 | 1.03 | 0.78 | 1.70 | 0.76 | 1.33 | 0.26 | 0.39 | 0.05 | 2.49 | 1.33 |
| 7 | 1.13 | 1.51 | 1.24 | 0.76 | 1.21 | 1.17 | 0.86 | 1.06 | 1.62 | 2.55 | 0.70 | 0.28 | 0.48 | 0.52 | 0.26 | 0.76 |
| 8 | 0.92 | 1.29 | 1.16 | 0.76 | 1.01 | 1.03 | 0.95 | 1.02 | 0.92 | 1.44 | 1.04 | 1.52 | 0.52 | 1.22 | 1.24 | 0.58 |
| 9 | 0.92 | 1.29 | 1.16 | 0.76 | 1.01 | 1.03 | 0.95 | 1.02 | 0.92 | 1.44 | 1.04 | 1.52 | 0.52 | 1.22 | 1.24 | 0.58 |

| | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|
| 1 | 0.00 | 0.00 | 0.00 | 0.13 | 0.00 | 0.00 | 0.00 |
| 2 | 0.02 | 1.93 | 0.65 | 0.94 | 0.18 | 0.10 | 0.50 |
| 3 | 0.83 | 0.28 | 1.20 | 1.50 | 0.85 | 0.74 | 1.00 |
| 4 | 1.07 | 0.55 | 0.80 | 0.87 | 1.36 | 1.06 | 1.00 |
| 5 | 0.75 | 1.24 | 0.51 | 0.76 | 1.01 | 0.98 | 1.00 |
| 6 | 0.83 | 1.08 | 0.74 | 0.98 | 1.03 | 1.07 | 1.00 |
| 7 | 1.72 | 1.55 | 0.88 | 0.97 | 0.55 | 1.01 | 1.00 |
| 8 | 1.01 | 1.27 | 0.65 | 0.82 | 1.10 | 0.94 | 1.00 |
| 9 | 1.01 | 1.27 | 0.65 | 0.82 | 1.10 | 0.94 | 1.00 |

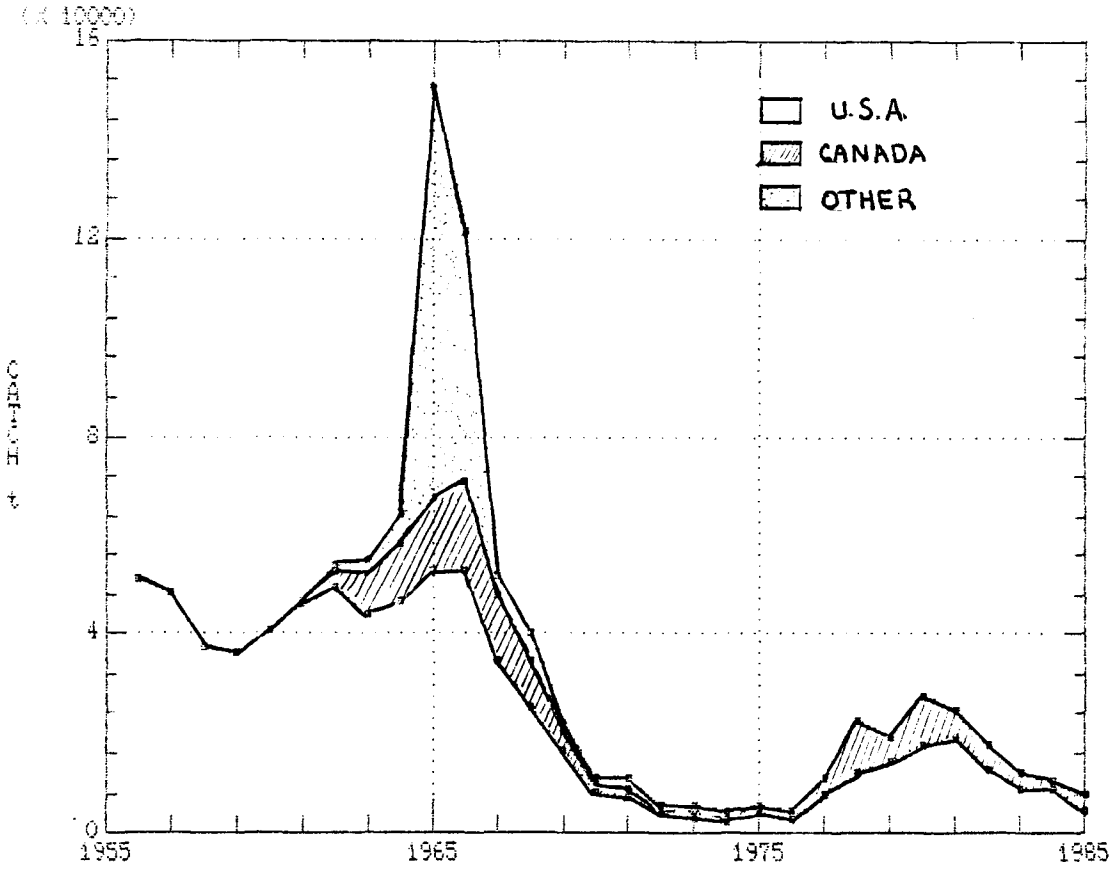



Figure 1. Annual landings of haddock in 5Ze, 5Zw and 5nk by country.

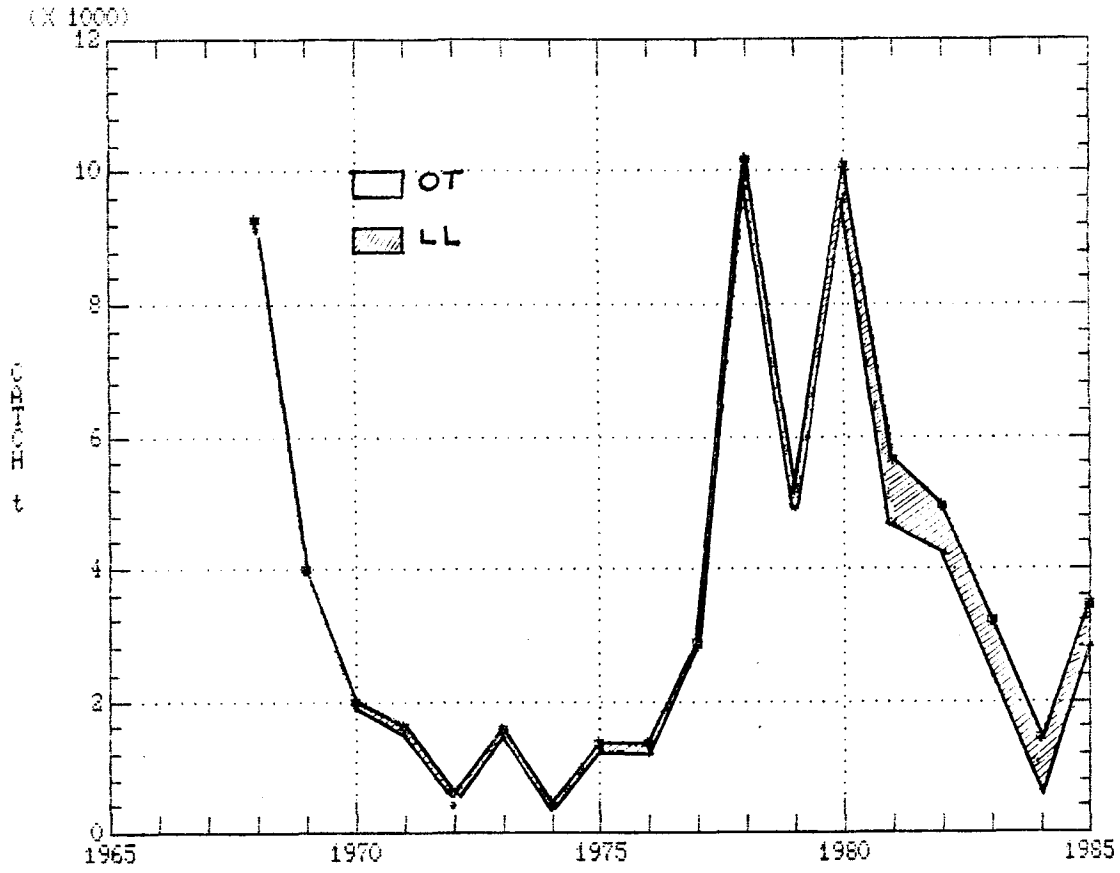



Figure 2. Canadian catch of 5Ze haddock by gear and year.
OT - otter trawl; LL - longline.

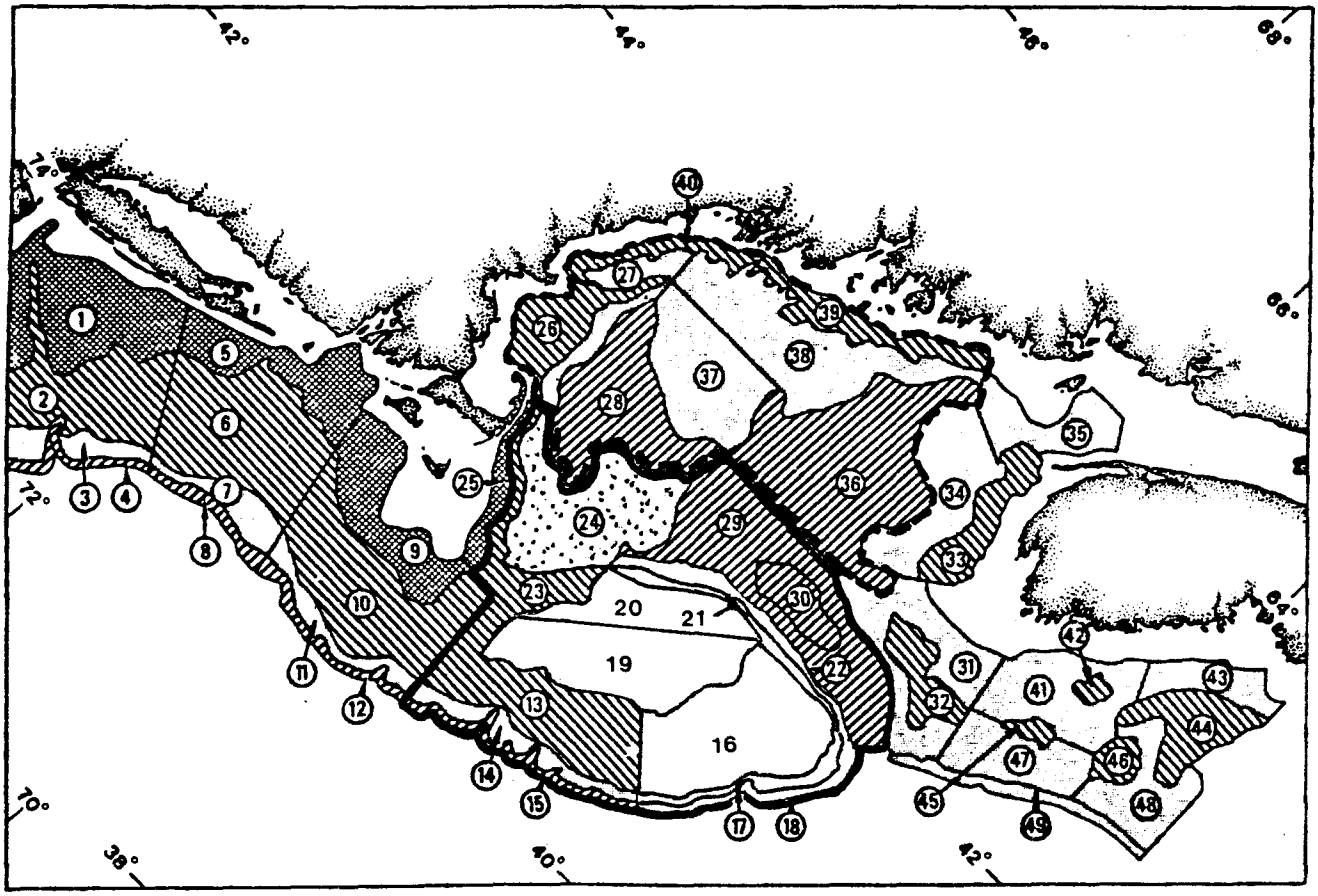



Figure 3. Stratification scheme used for bottom-trawl surveys of Georges Bank. The area outlined includes strata covered by the U.S. groundfish surveys.

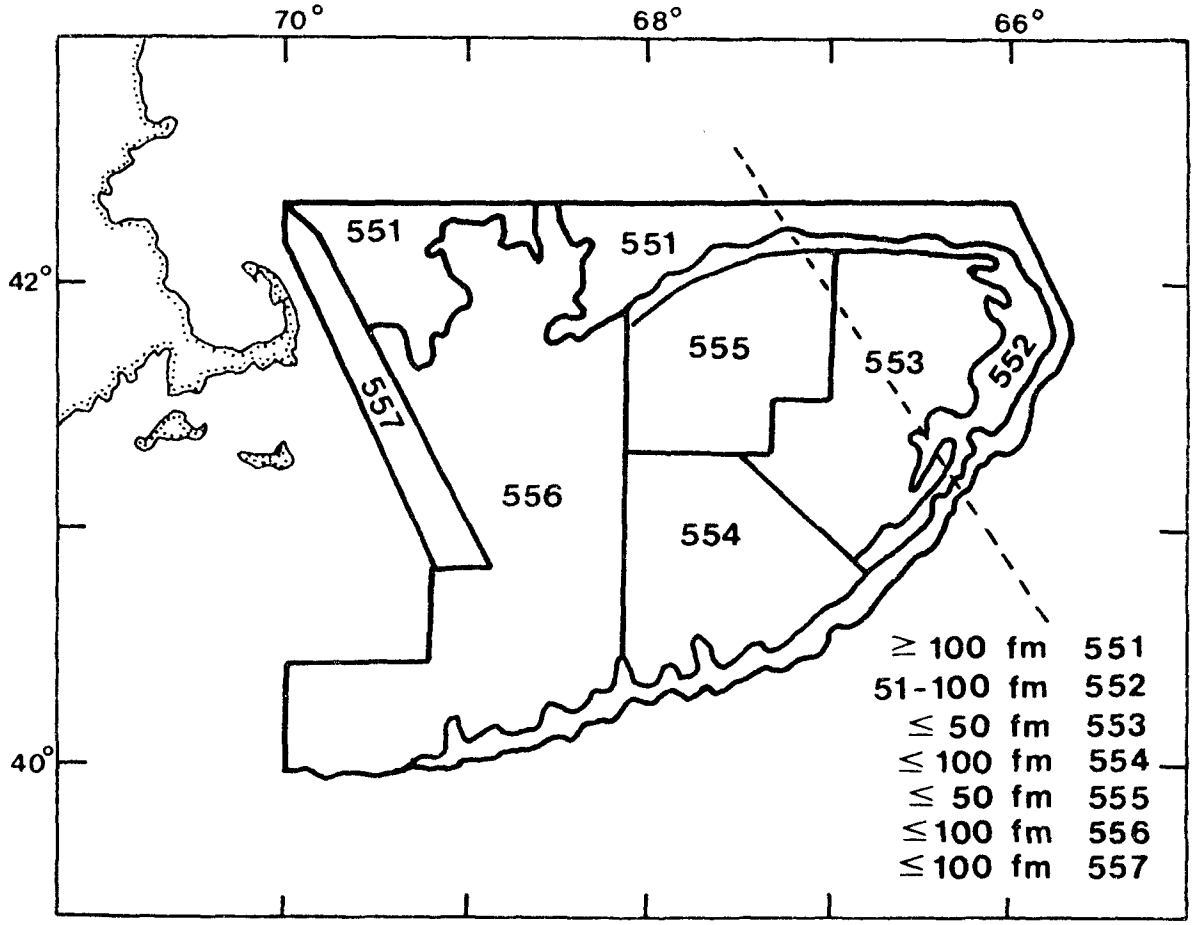



Figure 4. Stratification scheme used for Canadian spring survey (1986).

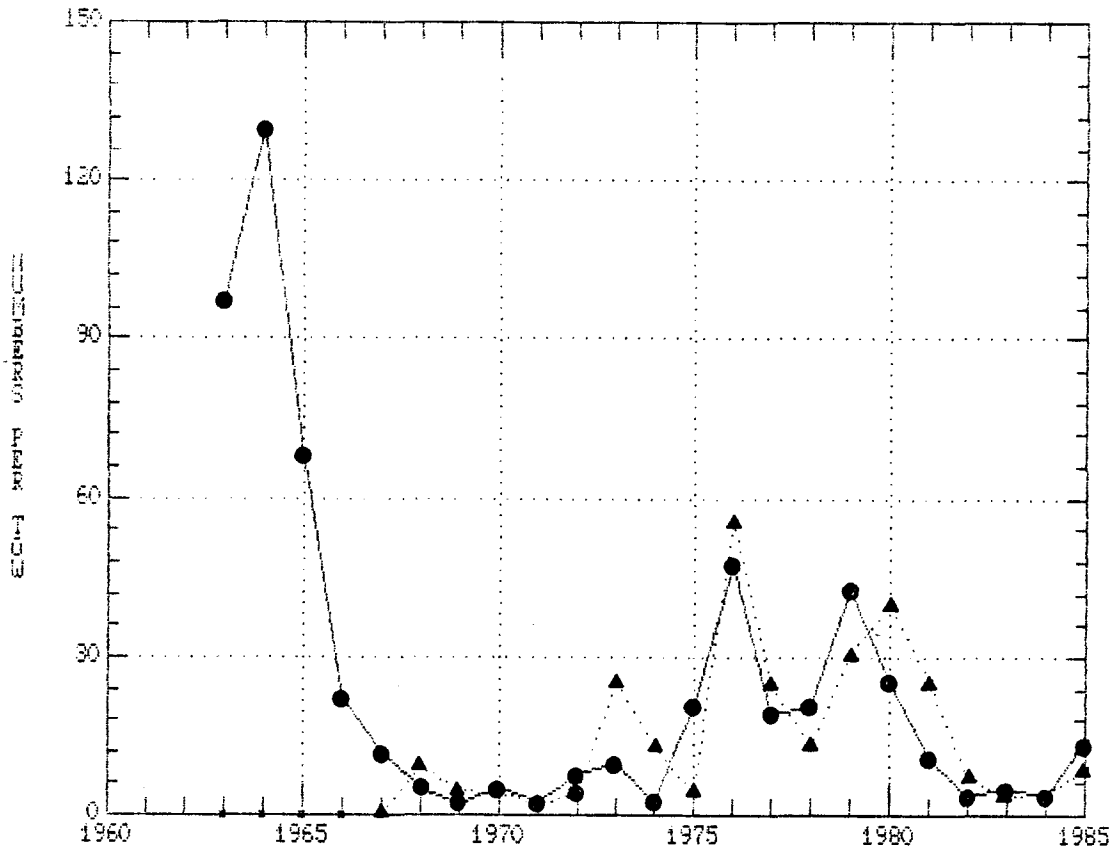



Figure 5. Mean numbers per tow for spring and fall U.S. research vessel surveys (1963-1985). ● - fall; ▲ - spring.

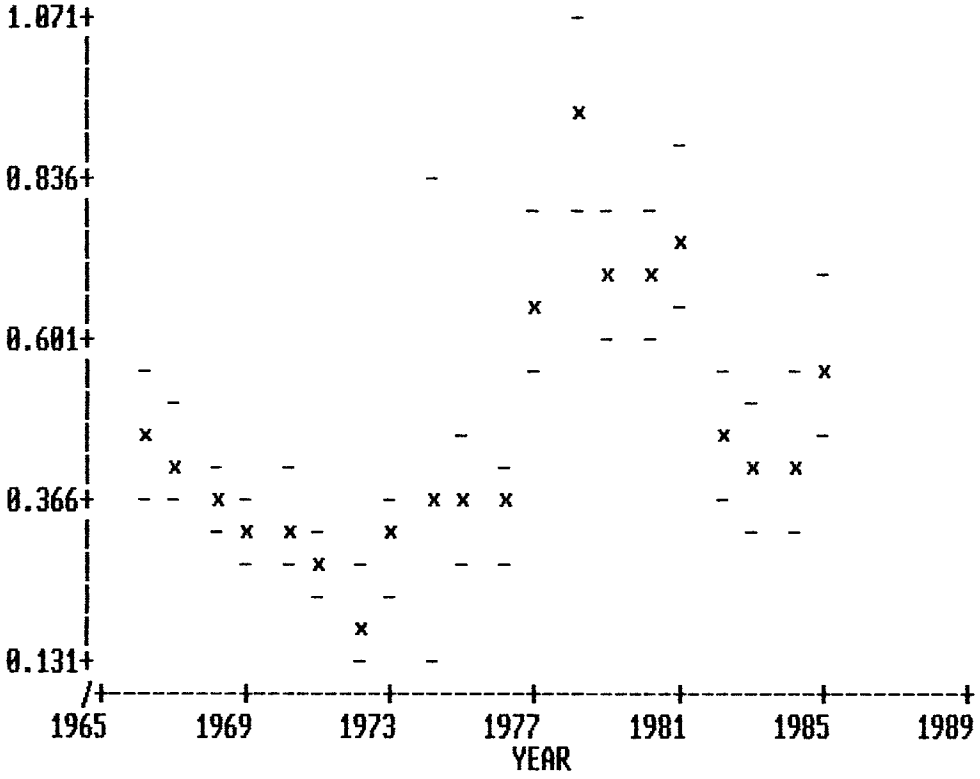



Figure 6. Catch rate index with approximate 90% confidence intervals for haddock in NAFO Division 5Z.

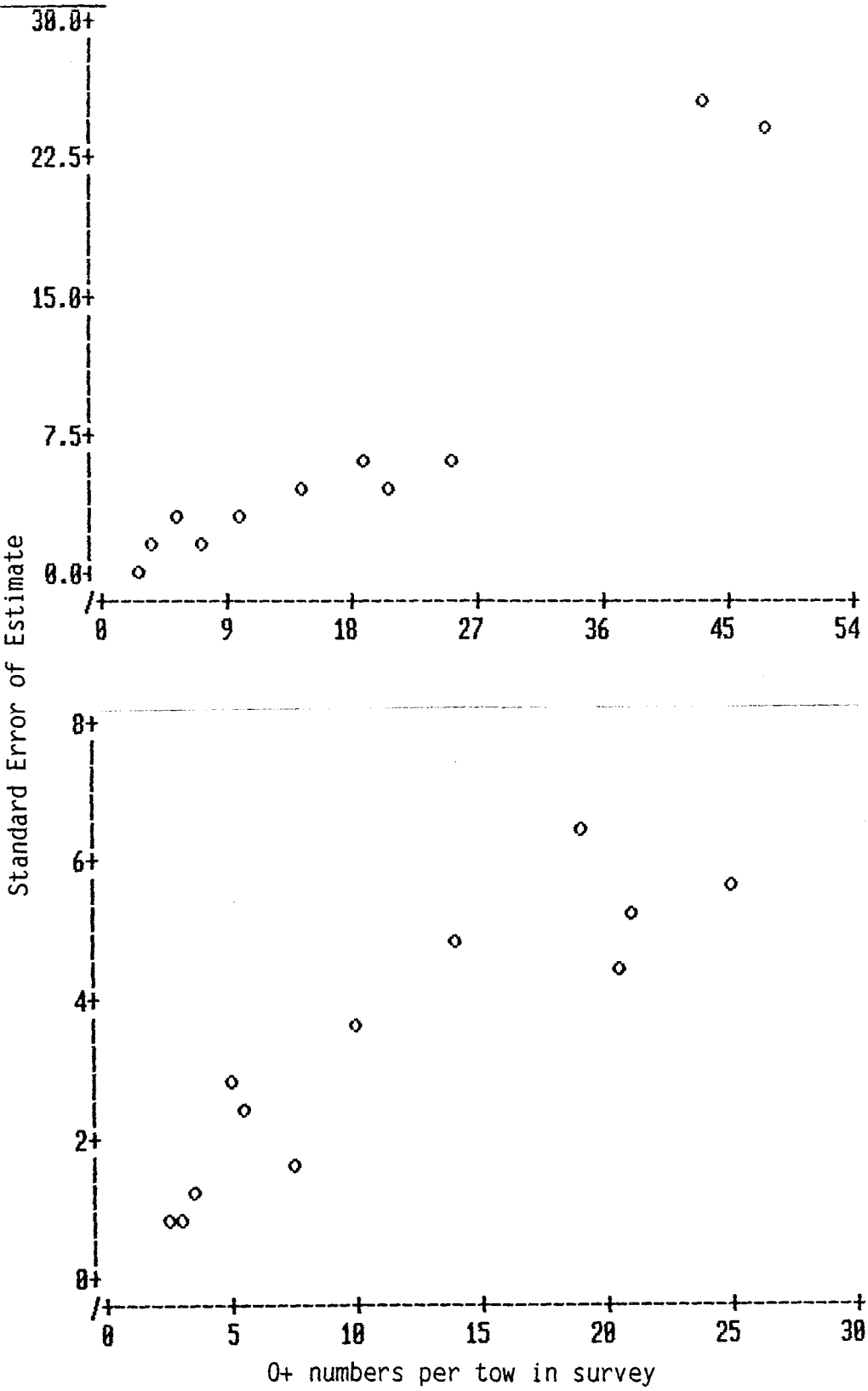
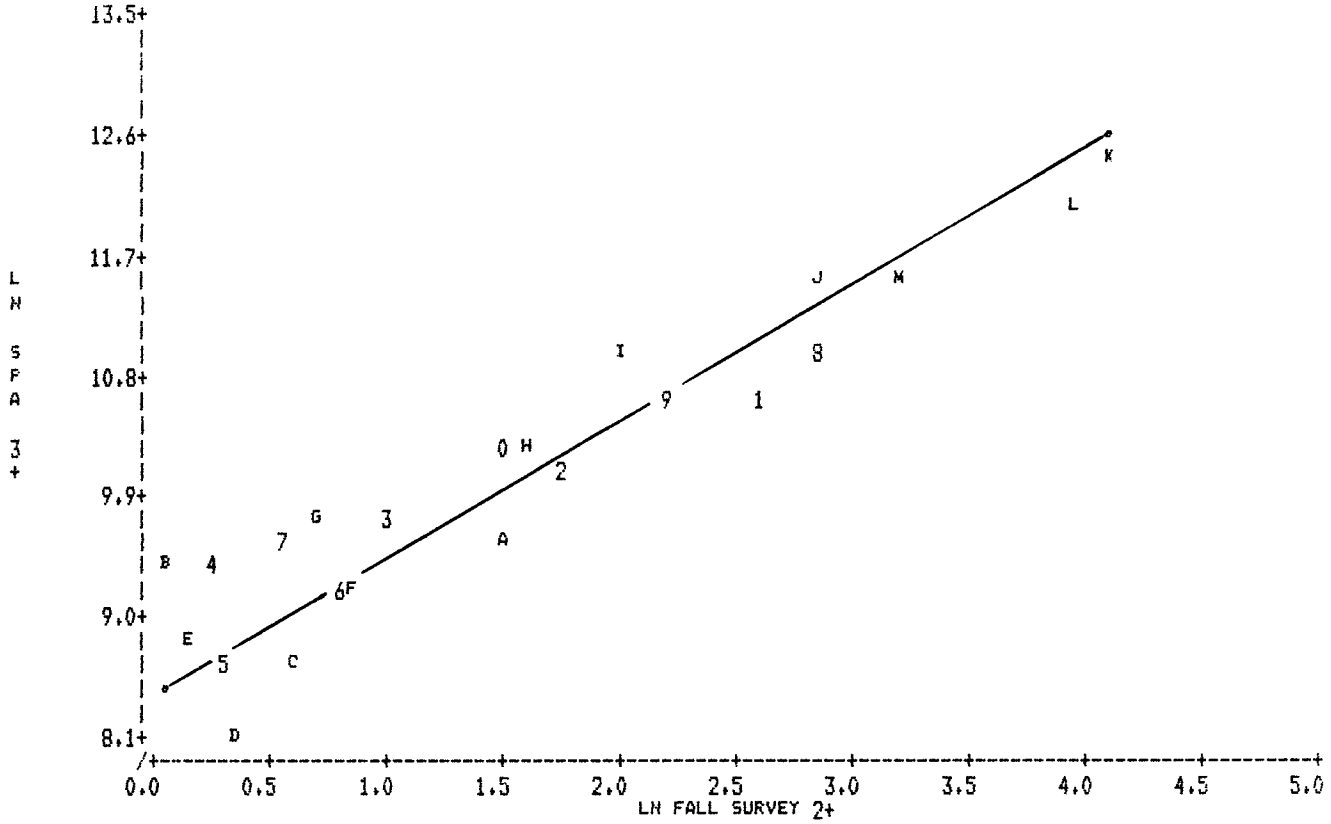



Figure 7. Relationship of NMFS fall survey 0+ numbers per tow (x axis) vs. SE of estimate. Upper panel includes all points; lower panel excludes two points on extreme right.



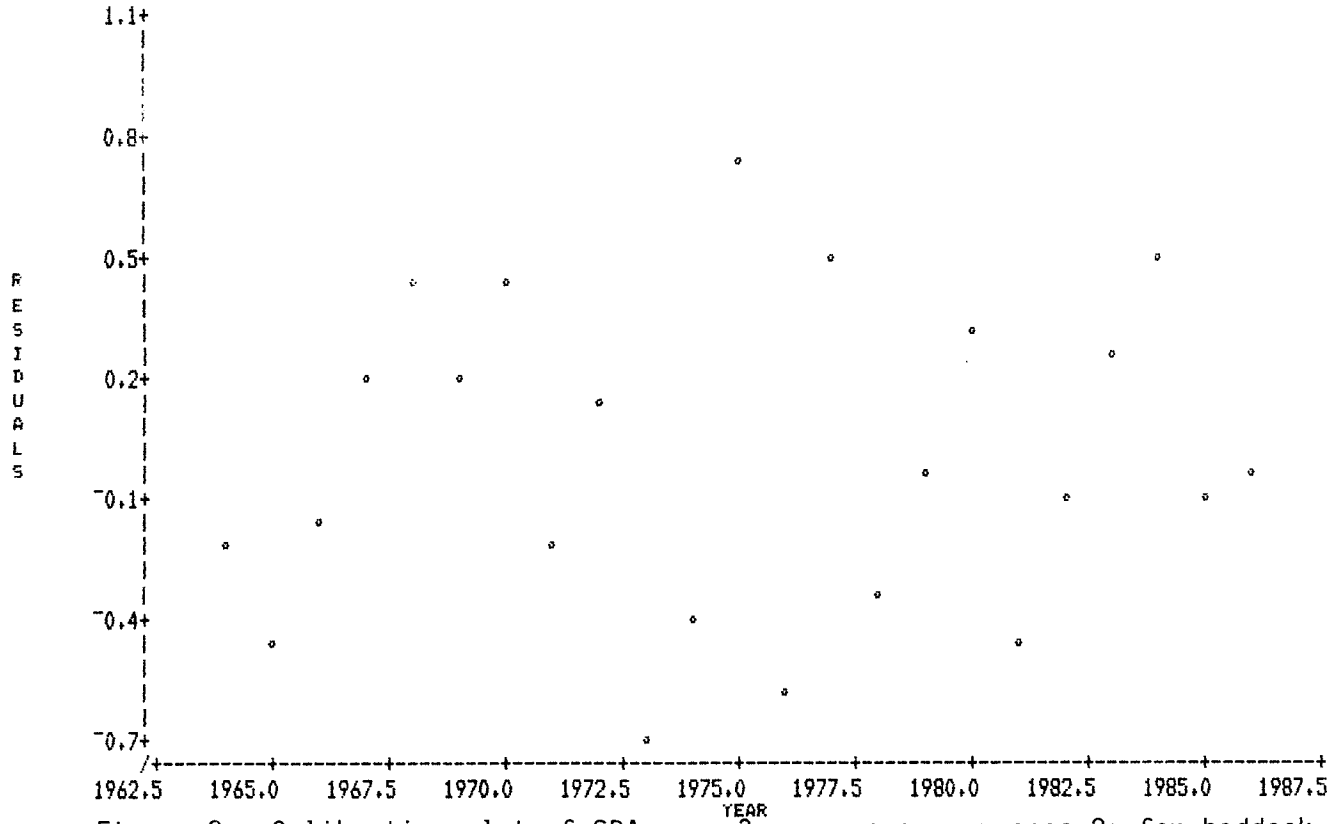




Figure 8. Calibration plot of SPA ages 3+ versus survey ages 2+ for haddock in NAFO Division 5Z. Time series of residuals is shown.

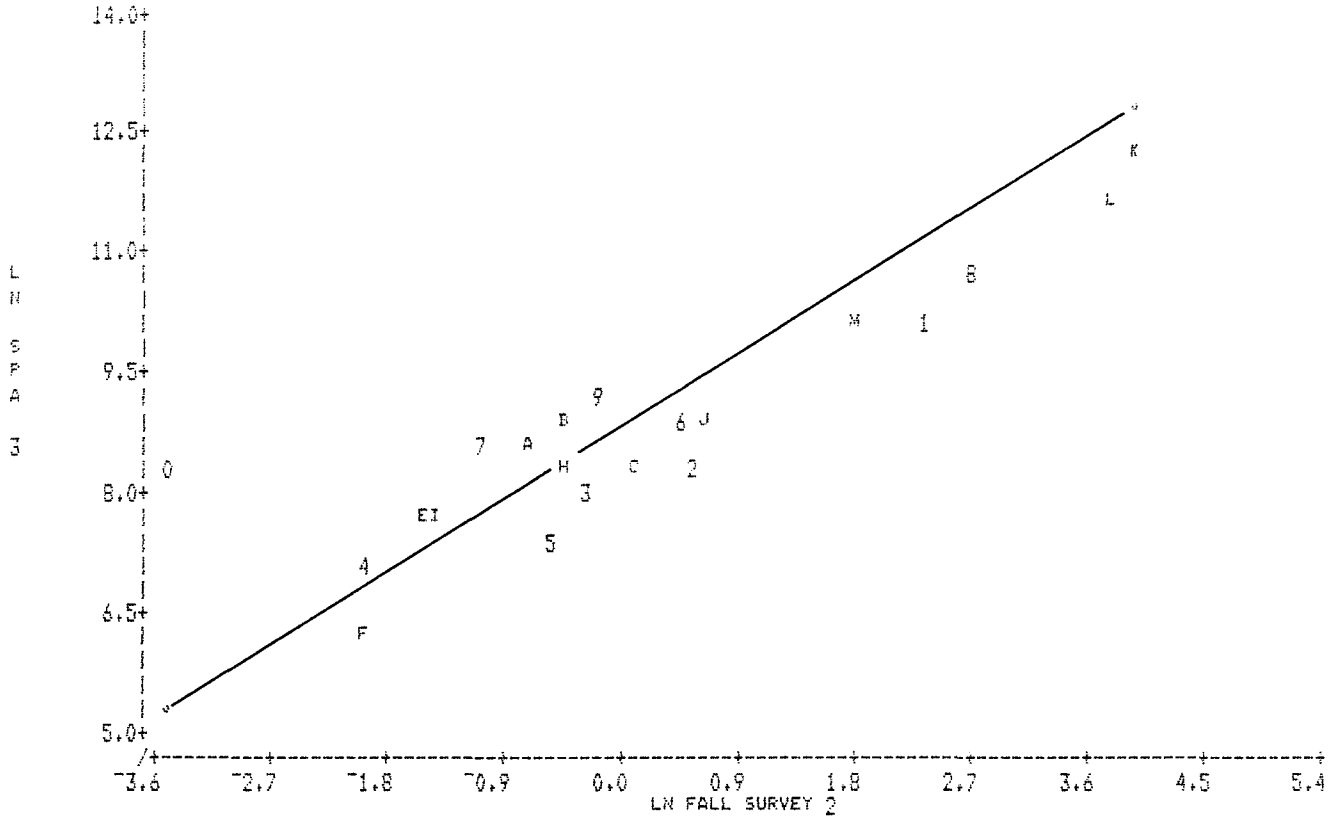



Figure 9. Calibration plot of SPA age 3 versus survey age 2 for haddock in NAFO Division 5Z.

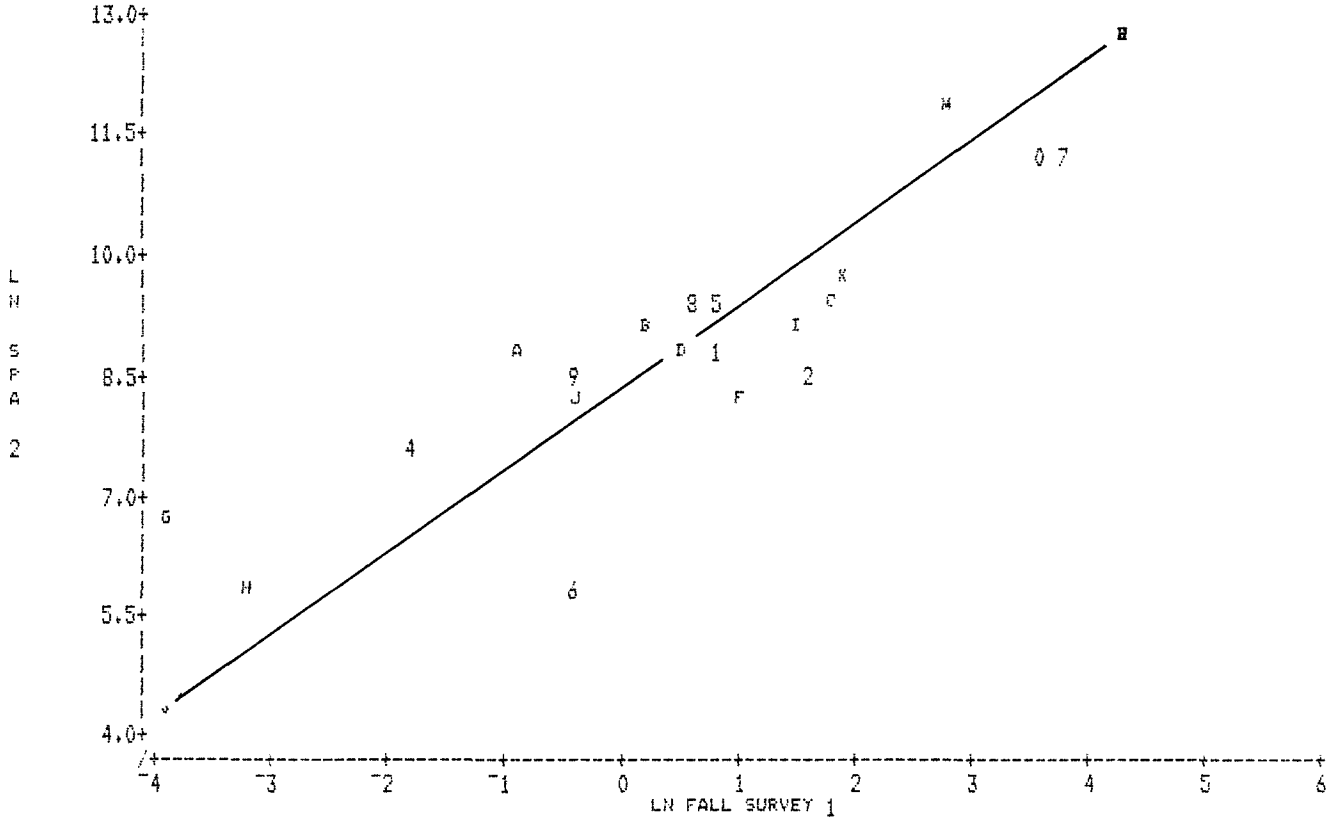



Figure 10. Calibration plot of SPA age 2 versus survey age 1 for haddock in NAFO Division 5Z.