# Assessment of Pollock (Pollachuis Virens) in Divisions 4VWX and Subdivision 5Zc

by

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## Abstract

With the definition of the new international boundary (1984), a need was recognized to re-examine the management unit definition for the pollock stock on the Scotian Shelf and the Gulf of Maine (divs. 4VWX and Subarea 5). A review of the relevant data concerning this was undertaken (see appendix 1). As a result of this review, advice was provided for pollock in divs. 4VWX and Subdiv. 5Zc.

The 1988 catch for pollock fell almost 3000 t below that of 1987 to 43016 t, the drop being the result of a 3500 t decrease in Canadian landings while foreign landings increased a small amount. The centering of the pollock fishery in Div. 4V rather than Div. 4W during 1985-1987 has continued in 1988. Research indices indicate a relatively high mature stock biomass with a lower abundance of young fish. No above average year-classes have been observed in the population since 1982. Commercial catch rates have been highly variable since 1982 and have remained so through 1988. Only RV numbers at age were used to calibrate the cohort analysis using age by age non-linear least squares to estimate fishing mortality. The F for 1988 was .31. Catch projections indicate that if a catch of 43,000 t is taken in 1989 this would result in an $F_{0.1}$ catch of 34,000 t in 1990. Application of the 50% rule would give a catch of 38,000 t.



## Résumé

Suité à l'adoption d'une nouvelle frontière internationale, on a éprouvé le besoin de revoir la définition de la zone de gestion du stock de goberge de la plate-forme néo-écossaise et du golfe du Maine (divisions 4VWX et sous-zone 5). On a donc examiné les données pertinentes à ce sujet (voir l'annexe 1) et, conséquemment, formulé des conseils au sujet de la goberge des divisions 4WX et de la sous-division 5Zc.

Les prises de goberge de 1988 sont tombées à 43 016 t, ce qui représente une baisse de près de 3 000 t par rapport à 1987. Cette chute s'explique par une diminution de 3 500 t des débarquements canadiens et une légère augmentation des débarquements étrangers. Comme cela s'était produit de 1985 à 1987, la pêche de la goberge a continué d'être concentrée dans la division 4V, plutôt que dans la division 4W, en 1988. Les indices provenant de la recherche révèlent l'existence d'une biomasse relativement forte de goberge parvenue à maturité et une plus faible abondance de jeunes poissons. On n'a pas observé de classe d'âge supérieure à la moyenne depuis 1982. Les taux de prises commerciales, très irréguliers depuis 1982, ont continué de l'être en 1988. On s'est servi uniquement des chiffres selon l'âge provenant des relevés des navires de recherche pour étalonner l'analyse par cohorte, utilisant l'étalonnage âge par âge sur une échelle non linéaire par la méthode des moindres carrés pour estimer la mortalité par pêche. En 1988, F était de 0,31. Les projections révèlent qu'à raison de 43 000 t de prises en 1989, les prises au niveau $F_{0.1}$ seraient de 34 000 t en 1990. En appliquant la règle de 50 % on obtiendrait des prises de 38 000 t.

## Introduction

### Management Unit

In 1973 ICNAF established the management unit for pollock to include the entire Division 4VWX and Subarea 5 region. A single management unit was accepted at that time because only one major spawning ground (Jeffery's Ledge in Div. 5Y) had been identified (Steele 1963). With the extension of jurisdiction (1977) both Canada and the USA assumed management responsibility for the stocks within their respective zones. In 1984 the International Court of Justice defined a new international boundary which created a need to review the management unit definition for pollock to reflect our current understanding of the stock structure. This was based on egg and larval distributions, analysis of meristic and morphometric parameters, fishery distributions and recent tagging studies (see Appendix I). From the accumulated evidence it was concluded that although it is not possible to draw geographic boundaries which separate the distribution areas of pollock, this did not imply complete mixing throughout the species range. With regard to the USA/Canada boundary it would appear that there is not enough movement to USA waters to seriously prejudice the long-term benefits that Canada could expect from unilateral management within the Canadian zone. Therefore for 1989 a new management unit for pollock in divs. 4VWX and Subdiv. 5Zc was established.

### Description of the Fishery

Preliminary estimates of nominal catch for 1988 indicate a decrease from 46,098 t to 43,016 in 1988 (Table 1, Fig. 1). Canadian landings have consistently accounted for the largest share of the landings. Catches by foreign fleets have been primarily incidental with the major share taken by the USSR and Cuban trawlers fishing for silver hake and other groundfish or by the USA fishing on the Northeast peak of Georges Bank. With the definition of the new international boundary, the ICJ line (Fig 2) in 1984, no USA catches have been reported. Since the extension of jurisdiction in 1977, catches by foreign vessels have generally averaged less than 2000 t.

The pollock fishery is centered in Div. 4X and Subdiv. 5Zc with slightly over one-third of the total being taken in divs. 4VW. Within divs. 4VW there has been shift in the fishery from Div. 4W to Div. 4V during 1984-88. Div. 4V landings have increased from about 5000 t in 1984 to an average of 13,000 t for the 1985-1988 period (Table 2; Fig. 3).

Catches by Canadian vessels are taken mainly by large offshore trawlers (with mobile gear greater than 100 ft.) in divs. 4VW and by smaller vessels inshore using both mobile and fixed gear in Div. 4X and Subdiv. 5Zc.

Seasonal breakdowns (Table 3) indicate a year round fishery although with a bias toward summer and early fall in Div. 4X and Subdiv. 5Zc. The Canadian catch is broken down by gear, area, and season in Table 4. There was a significant decrease in the divs. 4VW tonnage class 4 and over (TC 4+) otter trawler catch as well as that of the fixed gear catch in Div. 4X and Subdiv. 5Zc. Nominal catch of the inshore trawler fleet TC 1-3 increased slightly while the large trawler (TC 4+) catch in Div. 4X and Subdiv. 5Zc remained high as in 1987. The increase over the low landings reported in the early 1980s may be attributable to the offshore fleet sector choosing to fish their previously underutilized enterprise allocations (unconfirmed industry report).

Small mesh landings by the USSR (Table 3) show a substantial increase from 314 t in 1987 to 1054 t in 1988. Possibly, higher pollock concentrations were available due to the earlier start of the USSR silver hake fishery.

The Canadian allocation of 43,000 t was not taken during the 1988 fishery. The shortfall amounted to 1,282 t. A description of the fishery and associated catch is presented in Table 5. For 1988, mobile gear and fixed gear <65 ft. were divided into two categories; a) mobile and fixed gear <45 ft. and b) mobile and fixed gear 45-65 ft. Seasonal quotas and trip limits were introduced in 1986 for mobile gear <65 ft. in order to extend the fishery to the end of the year. Seasonal quotas are applied to the mobile gear <45 ft. to allow a larger portion of the catch to be taken during the summer months when they are less subject to weather conditions.

The mobile gear sector >100 ft. and 65-100 ft. had a combined shortfall of 2979 t, while other gear sectors overran their quotas by small amounts. For vessels on seasonal quotas, most of the catch was taken during the Jan-Aug period with little quota left for the remainder of the year. For the small dragger fleet in Southwest Nova Scotia, the 1989 management plan has combined the quota for divs. 4X and 5Z cod and haddock and divs. 4VWX and Subdiv. 5Zc pollock into a single combined quota. The fishery is only limited by the aggregate total, even though individual quotas comprising the total may be overrun. By removing the landing restrictions from individual species, the 1989 management plan hopes to address the problems of misreporting by species and area, although it may lead to discarding of species like pollock as more valuable species are preferentially kept. To date, this plan has resulted in the entire quota being taken in the first half of the year, as the regulation of number of trips per month was not implemented until April.

Distribution maps of catch per unit effort as recorded from the International Observer Program on Canadian vessels in 1980-88 are shown in Fig. 4. These maps show a shift from predominantly a Div. 4X and Subdiv. 5Zc fishery in 1980 to an almost entirely Subdiv. 4Vs fishery in 1986. In 1987 and 1988, the distribution of fishing effort was more extensive than in the 1983-86 period consistent with the increased catch by large otter trawlers in Div. 4X and Subdiv. 5Zc.

## Catch at age

The catch at age prior to 1988 was taken from Annand et al. (1988). Sampling for 1988 is shown in Table 6. Seasonal age length keys for TC 4+ otter trawlers by area (4VW, 4X+5) and annual keys for both small trawlers TC 1-3 and fixed gears for the entire area (4VWX+5) were generated. Length-weight parameters were obtained from analysis of 1988 summer groundfish survey collections. Input data for generating the eight keys used for the Canadian catch at age is given in Table 7. These keys accounted for 41,718 t or 97% of the entire catch, the difference consisting of foreign by-catch. The age composition of the small mesh (foreign after 1976) catch was based on proportions and weights at age from the Canadian July RV survey. The combined total catch at age reflects the total landings (43,016 t of pollock in divs. 4VWX and Subdiv. 5Zc).

Because of the new management unit, the historical catch at age (1974-1984) was adjusted for USA landings taken in the Canadian zone, i.e. the northeast peak of Georges Bank. USA catches in that area were relatively low with a significant portion (60%) (Pers. Comm. R. Mayo

NMFS, from fisheries interviews) taken on the Canadian side. These landings are given in Table 8. The age composition was assumed to be similar to the Canadian catch at age during those years and the catch at age was adjusted to reflect these increased landings.

The total catch at age is given in Table 9, along with the Canadian catch at age and the small mesh and foreign catch-at-age matrices. The 1988 total catch at age was dominated by the 1981-84 year-classes which accounted for 78% of the catch numbers and 72% of the catch biomass (Table 10). The 1982 or 1983 year-classes were strongest in all components of the catch at age with the exception of the large otter trawlers in Div. 4X where the four year old 1984 year-class was stronger. The 1979 year-class at age nine was 7% of the catch at age which is the highest observed since 1970. As in last year's assessment, (Annand et al., 1988), we again see a substantial difference in the age composition of the large trawler catch between divs. 4VW and Div. 4X and Subdiv. 5Zc (Fig. 5). Mean weights-at-age for all components of the catch at age are given in Table 11. No significant trends were observed; weight at age was similar to that observed in recent years.

## Abundance Indices

### Commercial Catch Rates

A Canadian catch rate series (CPUE) for stern OTB's for divs. 4VWX and Subdiv. 5Zc (April-November; Table 12, Fig. 6) was estimated for 1974-1988. The April-November time period avoids increases in availability due to spawning aggregations (December-March) which could cause high CPUE which are not indicative of stock size. Trip limits imposed by government and industry since 1983 may also have an impact on the catch rate series. Catch rates increased from the early 1970's to the 1980's and have been highly variable through 1988. The catch rate trend does not appear to be consistent with observations of incoming good recruitment (ie., 1979-1982 year classes) and its effect on fishable biomass in subsequent years. This index of abundance was not considered representative for the stock, so the commercial catch rate series was not used for calibration purposes.

A catch rate series (April-November) 1982-88 was also calculated from the International Observer Program (IOP) data (Table 13). This series was consistently higher than the other, however except for the 1985 point the trends were similar. The IOP catch rate series is too short to be used for calibration purposes, but it may become useful as the time series is extended.

### Research Surveys

Three vessels have been involved in the summer stratified random surveys of the Scotian Shelf (Fig. 7) since 1970. After analyses of comparative fishing experiments, pollock catches were found to be the same between the different research vessels and hence no conversion factors were applied. The estimated total numbers at age from these surveys for Strata 40-95 are in Table 14 and ages 4-9 abundance are plotted in Fig. 8. The surveys indicate an increase in the age 4-9 abundance from the early 80's with the 1987 and 1988 numbers among the highest observed. The 1988 numbers indicate a relatively high mature stock abundance, but a lower abundance of younger fish. This corresponds well with the passage through the population of the large 1979-82 year-classes. At the moment no incoming year-classes look

above average, although the 1984 year-class appeared above average as 3 year olds. Since the early 80's, mean numbers per tow by Strata (Table 15) indicate an increase in abundance in divs. 4VW, notably the Gully and inshore Div. 4W, with abundance in Div. 4X remaining relatively constant. This increase of abundance could be due to the appearance of strong and above average year-classes during the 1979-82 period. The mean weight per standard tow is given in Table 16.

## Estimation of Parameters

### Partial Recruitment

Partial recruitment was estimated for the 1979-1987 period from the ratio of F's at younger ages to fully recruited F's. The input PR and $F_t$ were from last year's assessment. It was assumed that ages 7-11 were fully recruited. The F's on the younger ages were divided by the 7+ average fully recruited F weighted by population numbers within each year. The annual PR vectors were then averaged across years and the resulting PR vector was adjusted so that the fully recruited mean was equal to 1. The input PR used in an initial ADAPT run is given below:

| AGE | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| PR 1988 | .013 | .167 | .433 | .712 | .907 | 1 | 1 | 1 | 1 | 1 |

The partial recruitment used in the final ADAPT run was calculated using the fishing mortality matrix resulting from the initial ADAPT run. It was estimated for the 1977-1985 period in order to include the dominant year classes that have passed through the pollock fishery in recent years. This PR vector indicated slightly lower recruitment for all non-fully recruited ages and is given below:

| AGE | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| PR 1988 | .012 | .163 | .411 | .670 | .851 | 1 | 1 | 1 | 1 | 1 |

### Yield Per Recruit

Yield per recruit analysis for pollock was reviewed and the Thompson and Bell Yield per Recruit model used to calculate $F_{0.1}$ values.

Because the calculations are sensitive to the oldest age group included, the maximum age included in the analysis was the commonly observed maximum age in the commercial catch, ie. age 16. In order to obtain comparable results between stocks, the first age group was taken as age 1. Using the 1977-85 average PR and 1980-88 mean weights at age (Table 17) gave an $F_{0.1}$ value of .24 and a yield/recruit value at $F_{0.1}$ of .98. The previous $F_{0.1}$ value determined for pollock in past assessments using ages 2-11 was .28. The observed difference is due to increasing the maximum age included in the analysis from age 11 to age 16. Because haddock, pollock and american plaice stocks all have $F_{0.1}$ values between .23 and .27, it was decided that a value of $F_{0.1}$ = .25 be used for these stocks in doing projections.

## SPA Calibration

Modifications to the adaptive framework formulation used in last year's assessment were investigated because of the change in the input parameters under the new management unit. Consequently, estimates of population size were obtained with a formulation of the adaptive framework using the research survey index and including ages 4-9, rather than using both the research survey ages 6-8 and age aggregrated CPUE as in last year's assessment. Cohort analysis of ages 2-11 from 1974 to 1988 was calibrated using ADAPT, an implementation of the adaptive framework of Gavaris (1988) (listing Appendix 2). Natural mortality was assumed constant at .2 for all ages and years. The RV numbers at ages 4-9 were used to estimate fishing mortality at ages 6-9. The F's for ages 2-5 and age 10 were based on the weighted average F of ages 7-9 and the final PR given above. The F on the oldest age group (age 11) was calculated as the weighted mean F for ages 7, 8 and 9.

Initially, the size of the 1983 year class was estimated to be higher than the large 79 year class, based on one or two survey points. There is no other indication from the fishery that the 1983 year class was above average - thus the age 4 RV observation in 1987 and the age 4 and 5 RV observation in 1988 were given zero weight in the residual matrix. This resulted in population estimates more consistent with average recruitment. Standard errors were available for the RV series, but proved unusable, even though CV's (Table 18) were reasonable. Instead, log transformations were used in order to try and stabilize variance. The diagnostics from initial runs indicated that intercepts were not necessary between RV and SPA numbers. The ADAPT summary table is given in Table 19. The estimated numbers and estimated slopes in 1988 were significant for all ages (Table 20). Diagnostics plots (Fig. 9) of the residuals (Table 21) were reviewed. Fishing mortality for fully recruited ages in 1988 varied between .25 and .52, with an average fully recruited F of .31. The fishing mortality matrix, beginning of year population numbers and mean population biomass are given in tables 22, 23 and 24.

## Assessment Results

The 1979 (78 million) and the 1982 (64 million) year classes at age 2 are the largest observed in the 1974-88 period (Figure 10). While the 1980, 1981, 1983 and 1984 year classes are all above the long-term average of 30 million fish, the 1985 and 1986 year classes are relatively weak.

Mid-year biomass for ages 2 and older has increased since 1983 reflecting the strong 1979-82 year classes and is currently at a relatively high level (Figure 11). Population numbers, ages 4-9, have increased since 1982 and are presently at about their maximum (Figure 12).

Fully recruited fishing mortalities have been flucuating with a decreasing trend toward $F_{0.1}$ (0.25) for almost the entire time series (Figure 13).

In general, recruitment of strong year classes has occured every 3-4 years since the mid 1970's. Flucuations in age 4-9 stock size reflect the interaction of recruitment and fishing mortality. Population numbers ages 4-9 peaked in 1979 in response to the 1975 year class at age 4 while the decline in stock size between 1979 and 1982 reflects increased fishing mortality rates associated with elevated effort during this period. Abundance (ages 4-9) increased substantially in 1983 and peaked in 1986 following recruitment of the strong 1979 and 1982 year classes. Since 1982, landings have remained relatively constant (35,000 - 40,000 t) while fishing mortality declined from over .5 to about .3. Given the relatively stable catches throughout most of the 1980's, fishing mortality has generally flucuated inversely with stock size. However, the sharp apparent decline in F in 1984 is likely due to variation in the catch at age. Abundance has remained high since the mid-1980's due to continued recruitment of strong year classes at 3-4 year intervals. Fully recruited fishing mortalities have been over $F_{0.1}$ since 1974.

Prognosis

Catch projections to 1990 used the 1989 beginning of year population numbers, average weights from 1986-88 and a PR derived from fishing mortalities in the period 1977-85, assuming full recruitment at age 7. The 1988 and 1989 year classes at age 2 were set equal to the geometric mean of the 1974-86 year classes of 30 million. Input data are given below.

| Age | 1989 Population (000's) | Weight at age (kg) | PR |
|---|---|---|---|
| 2 | 30000 | .80 | .012 |
| 3 | 24470 | 1.35 | .163 |
| 4 | 11478 | 1.96 | .411 |
| 5 | 16937 | 2.55 | .670 |
| 6 | 12855 | 3.14 | .851 |
| 7 | 13751 | 3.61 | 1 |
| 8 | 5701 | 4.15 | 1 |
| 9 | 2913 | 4.87 | 1 |
| 10 | 1650 | 5.88 | 1 |
| 11 | 106 | 6.78 | 1 |

The results (Table 25) indicate that a catch of 43,000 t in 1989 will result in a terminal fishing mortality of 0.31 and an $F_{0.1}$ = .25 catch in 1990 of 34,200 tons. Application of the 50% rule would set the target F for 1989 to be 0.28, which would imply a catch of 38,000 tons in 1989.

References

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Table 1a. Pollock landings (t round fresh) by country for divs. 4VWX and Subdiv. 5Zc, 1974-1977.

| Year | Canada | Fed Rep Germany | German Dem Rep | Japan | Spain | USSR | United Kingdom | U.S.A. | Other | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1974 | 24975 | 149 | - | 40 | 1500 | 2301 | 47 | 435 | 14 | 29461 |
| 1975 | 26548 | 236 | 95 | - | 708 | 2004 | - | 403 | 124 | 30118 |
| 1976 | 23565 | 994 | 24 | - | 303 | 1466 | - | 443 | 385 | 27180 |
| 1977 | 24653 | 368 | - | 1 | - | 182 | - | 325 | 53 | 25582 |

Table 1b. Pollock landings (t round fresh) by country for divs. 4VWX and Subdiv. 5ZC, 1978-1988.

| Year | Canada | Japan | France St. Pierre & Mainland | | Cuba | USSR | USA | Other | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1978 | 26801 | 110 | 15 | 18 | 141 | 502 | 451 | - | 28038 |
| 1979 | 29967 | 19 | 8 | 15 | 50 | 1025 | 391 | 7 | 31482 |
| 1980 | 35986 | 81 | 19 | 80 | 32 | 950 | 443 | - | 37591 |
| 1981 | 40270 | 15 | 17 | 73 | - | 358 | 918 | - | 41651 |
| 1982 | 38029 | 3 | 30 | 14 | 84 | 297 | 840 | - | 39297 |
| 1983** | 32749 | 6 | 22 | | 261 | 226 | 1324 | - | 34588 |
| 1984 | 33465 | 1 | 46 | | 123 | 97 | 1691 | 1 | 35424 |
| 1985 | 43300 | 17 | 77 | | 66 | 336 | - | - | 43796 |
| 1986* | 42975 | 51 | - | | 136 | 564 | - | - | 43726 |
| 1987* | 45308 | 84 | 50 | | 342 | 314 | - | - | 46098 |
| 1988* | 41718 | 1 | - | | 243 | 1054 | - | - | 43016 |

* -Provisional catch statistics
** -From 1983 on, French catches are combined

Table 2. Pollock landings (t, round fresh) for divs. 4VWX and Subdiv. 5Zc, 1974-1988.

| Year | 4V | 4W | 4X | 5Y | 5Z | Total 4VW | Total 4X+5 | Total |
|---|---|---|---|---|---|---|---|---|
| 1974 | 307 | 4740 | 19731 | 680 | 4003 | 5047 | 24414 | 29461 |
| 1975 | 799 | 5697 | 17977 | 420 | 5225 | 6496 | 23622 | 30118 |
| 1976 | 1102 | 3424 | 19164 | 57 | 3433 | 4526 | 22654 | 27180 |
| 1977 | 1347 | 6082 | 14381 | 237 | 3535 | 7429 | 18153 | 25582 |
| 1978 | 2931 | 4910 | 14997 | 341 | 4859 | 7841 | 20197 | 28038 |
| 1979 | 4877 | 4963 | 18219 | 573 | 2850 | 9840 | 21642 | 31482 |
| 1980 | 3893 | 7511 | 20110 | 530 | 5547 | 11404 | 26187 | 37591 |
| 1981 | 2316 | 15678 | 18689 | 713 | 4255 | 17994 | 23657 | 41651 |
| 1982 | 2939 | 9373 | 20771 | 926 | 5288 | 12312 | 26985 | 39297 |
| 1983 | 5491 | 5787 | 17603 | 1079 | 4628 | 11278 | 23310 | 34588 |
| 1984 | 5474 | 6043 | 18926 | 2091 | 2890 | 11517 | 23907 | 35424 |
| 1985 | 12085 | 3262 | 26685 | 853 | 911 | 15347 | 28449 | 43796 |
| 1986** | 14945 | 2998 | 22885 | 636 | 1511 | 17943 | 25032 | 43726* |
| 1987** | 12710 | 3762 | 25609 | 1127 | 2096 | 16864* | 28832 | 46098* |
| 1988** | 11759 | 3061 | 24143 | 352 | 2403 | 16118* | 26898 | 43016* |

* - includes catch where division is unknown.
** - Data from DFO Statistics Branch, provisional data for countries other than Canada.

Table 3. Pollock landings (t round fresh) by season and country for NAFO divs. 4VWX and Subdiv. 5Zc.

**Canada (Maritimes & Newfoundland)**

| | 4VW | | | | 4X+5 | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Jan-Apr | May-Aug | Sept-Dec | Total | Jan-Apr | May-Aug | Sept-Dec | Total |
| 1974 | 713 | 1257 | 807 | 2777 | 1643 | 11738 | 8817 | 22198 |
| 1975 | 1223 | 1005 | 1854 | 4082 | 1836 | 9866 | 10764 | 22466 |
| 1976 | 425 | 845 | 1186 | 2456 | 2078 | 12167 | 6864 | 21109 |
| 1977 | 931 | 1428 | 4748 | 7107 | 6010 | 5880 | 5656 | 17546 |
| 1978 | 3875 | 2696 | 510 | 7081 | 5835 | 7484 | 6401 | 19720 |
| 1979 | 1406 | 5477 | 1927 | 8810 | 4558 | 10023 | 6576 | 21157 |
| 1980 | 2493 | 4301 | 3633 | 10427 | 6353 | 13188 | 6018 | 25559 |
| 1981 | 4056 | 2437 | 11055 | 17548 | 5792 | 7170 | 9760 | 22722 |
| 1982 | 3030 | 4082 | 4774 | 11886 | 3096 | 14664 | 8383 | 26143 |
| 1983 | 2029 | 7099 | 1644 | 10772 | 4879 | 14212 | 2886 | 21977 |
| 1984 | 2288 | 4744 | 4217 | 11249 | 2820 | 13900 | 5496 | 22216 |
| 1985 | 3861 | 5031 | 5959 | 14851 | 6589 | 15673 | 6187 | 28449 |
| 1986* | 5503 | 8035 | 4403 | 17941 | 5840 | 14163 | 5031 | 25034 |
| 1987* | 6182 | 5511 | 4780 | 16473 | 5771 | 16477 | 6587 | 28835 |
| 1988* | 4587 | 5635 | 4597 | 14819 | 3754 | 15720 | 7425 | 26899 |

* - Data from DFO Statistics Branch

**USSR**

| | 4VW | | | | | 4X+5 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Jan-Apr | May-Aug | Sept-Oct | UK Mon. | Total | Jan-Apr | May-Aug | Sept-Dec | UK Mon. | Total |
| 1974 | 194 | 903 | 628 | - | 1725 | 11 | 512 | 53 | - | 576 |
| 1975 | 471 | 981 | 221 | - | 1673 | 58 | 149 | 124 | - | 331 |
| 1976 | 555 | 488 | 291 | - | 1334 | 10 | 58 | 64 | - | 132 |
| 1977 | 17 | 82 | - | - | 99 | 39 | 44 | - | - | 83 |
| 1978 | 9 | 459 | 8 | - | 476 | - | 26 | - | - | 26 |
| 1979 | 4 | 928 | - | - | 932 | 6 | 87 | - | - | 93 |
| 1980 | 122 | 715 | - | - | 837 | - | 113 | - | - | 113 |
| 1981 | 45 | 311 | - | - | 356 | 2 | - | - | - | 2 |
| 1982 | - | 297 | - | - | 297 | - | - | - | - | - |
| 1983 | 16 | 204 | - | - | 220 | - | 6 | - | - | 6 |
| 1984 | - | 97 | - | - | 97 | - | - | - | - | - |
| 1985 | - | 336 | - | - | 336 | - | - | - | - | - |
| 1986*** | - | 564 | - | - | 564 | - | - | - | - | - |
| 1987*** | - | 314 | - | - | 314 | - | - | - | - | - |
| 1988*** | 79 | 400 | 379 | 196 | 1054 | - | - | - | - | - |

*** - Provisional data from NAFO Circular letters

Table 3. (Continued)

**Other Foreign Countries**

| | 4VW | | | | | 4X+5 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Jan-Apr | May-Aug | Sept-Oct | UK Mon. | Total | Jan-Apr | May-Aug | Sept-Dec | UK Mon. | Total |
| 1974 | 176 | 196 | 173 | - | 545 | 746 | 605 | 289 | - | 1640 |
| 1975 | 421 | 57 | 263 | - | 741 | 145 | 253 | 427 | - | 825 |
| 1976 | 254 | 318 | 162 | 2 | 736 | 288 | 237 | 888 | - | 1413 |
| 1977 | 10 | 194 | 19 | - | 223 | 168 | 304 | 52 | - | 524 |
| 1978 | 36 | 153 | 95 | - | 284 | 200 | 111 | 140 | - | 451 |
| 1979 | 22 | 22 | 54 | - | 98 | 118 | 136 | 138 | - | 392 |
| 1980 | 101 | 38 | 1 | - | 140 | 272 | 128 | 115 | - | 515 |
| 1981 | 90 | - | - | - | 90 | 410 | 269 | 254 | - | 933 |
| 1982 | 23 | 106 | - | - | 129 | 365 | 221 | 256 | - | 842 |
| 1983 | 18 | 268 | - | - | 286 | 358 | 497 | 472 | - | 1327 |
| 1984 | 87 | 83 | 1 | - | 171 | 387 | 528 | 776 | - | 1691 |
| 1985 | 82 | 70 | 8 | - | 160 | - | - | - | - | - |
| 1986*** | 157 | 10 | 20 | - | 187 | - | - | - | - | - |
| 1987*** | - | - | 39 | 437 | 476 | - | - | - | - | - |
| 1988*** | 3 | 241 | - | - | 244 | - | - | - | - | - |

*** - Provisional data from NAFO Circular Letters & NMFS data tapes.

Table 4. Nominal landings of pollock in NAFO divs. 4VW and 4X and Subdiv. 5Zc for Canadian (Maritimes, Quebec, and Newfoundland). Data for 1986-1988 are provisional.

**OTB 1, 2 (TC 4+)**

| Year | 4VW | | | | 4X+5 | | | |
|---|---|---|---|---|---|---|---|---|
| | Jan-Apr | May-Aug | Sept-Dec | Total | Jan-Apr | May-Aug | Sept-Dec | Total |
| 1970 | 1523 | 212 | 138 | 1873 | 686 | 1865 | 1581 | 4132 |
| 71 | 629 | 63 | 208 | 900 | 919 | 3473 | 2073 | 6465 |
| 72 | 417 | 90 | 545 | 1052 | 1461 | 5800 | 4138 | 11399 |
| 73 | 726 | 276 | 2173 | 3175 | 3259 | 4227 | 3239 | 10725 |
| 74 | 707 | 1113 | 628 | 2448 | 1057 | 6350 | 5964 | 13371 |
| 75 | 1222 | 926 | 1776 | 3924 | 1042 | 5699 | 5361 | 12102 |
| 76 | 424 | 737 | 1081 | 2242 | 877 | 5418 | 2746 | 9041 |
| 77 | 912 | 1358 | 4545 | 6815 | 4846 | 1522 | 2661 | 9029 |
| 78 | 3558 | 2107 | 377 | 6042 | 4676 | 3383 | 2411 | 10470 |
| 79 | 1368 | 5194 | 1715 | 8277 | 3487 | 3421 | 1004 | 7912 |
| 1980 | 2448 | 3949 | 3412 | 9809 | 4321 | 3409 | 2411 | 10141 |
| 81 | 3980 | 1382 | 9017 | 14379 | 4280 | 558 | 4956 | 9794 |
| 82 | 2919 | 3084 | 4123 | 10126 | 1628 | 3917 | 3665 | 9210 |
| 83 | 1879 | 6144 | 1032 | 9055 | 2890 | 2652 | 396 | 5938 |
| 84 | 2155 | 3416 | 3559 | 9130 | 729 | 1633 | 564 | 2926 |
| 85 | 3628 | 4339 | 5502 | 13469 | 581 | 835 | 879 | 2295 |
| 86 | 4861 | 6499 | 3957 | 15317 | 1326 | 939 | 235 | 2500 |
| 87 | 5609 | 4178 | 3998 | 13785 | 2435 | 2518 | 2408 | 7361 |
| 88 | 3951 | 3588 | 4244 | 11783 | 755 | 3301 | 2951 | 7007 |

Table 4. (Continued)

**OTB 1, 2 (TC 1-3)**

| Year | 4VW | | | | 4X+5 | | | |
|---|---|---|---|---|---|---|---|---|
| | Jan-Apr | May-Aug | Sept-Dec | Total | Jan-Apr | May-Aug | Sept-Dec | Total |
| 1970 | 8 | 0 | 0 | 8 | 336 | 2042 | 483 | 2861 |
| 71 | 4 | 0 | 0 | 4 | 245 | 1708 | 717 | 2670 |
| 72 | 0 | 9 | 1 | 10 | 537 | 2035 | 902 | 3474 |
| 73 | 0 | 0 | 2 | 2 | 1922 | 6762 | 618 | 9302 |
| 74 | 0 | 39 | 40 | 79 | 562 | 3398 | 591 | 4551 |
| 75 | 0 | 0 | 0 | 0 | 745 | 2610 | 836 | 4191 |
| 76 | 0 | 0 | 0 | 0 | 1039 | 2844 | 715 | 4598 |
| 77 | 0 | 2 | 0 | 2 | 896 | 2224 | 808 | 3928 |
| 78 | 9 | 23 | 2 | 34 | 955 | 2187 | 961 | 4103 |
| 79 | 0 | 8 | 2 | 10 | 869 | 4043 | 1170 | 6082 |
| 1980 | 2 | 137 | 18 | 157 | 1523 | 4033 | 823 | 6379 |
| 81 | 32 | 302 | 44 | 378 | 957 | 3178 | 1547 | 5682 |
| 82 | 58 | 220 | 93 | 371 | 713 | 4775 | 1734 | 7222 |
| 83 | 84 | 155 | 23 | 262 | 1403 | 6829 | 855 | 9087 |
| 84 | 119 | 598 | 252 | 969 | 1847 | 8492 | 3015 | 13354 |
| 85 | 197 | 151 | 89 | 437 | 5408 | 8564 | 1386 | 15358 |
| 86 | 379 | 804 | 44 | 1227 | 3797 | 4801 | 594 | 9192 |
| 87 | 504 | 311 | 73 | 888 | 2747 | 5859 | 483 | 9089 |
| 88 | 556 | 708 | 13 | 1277 | 2739 | 6196 | 244 | 9179 |

Table 4. (Continued)

**GN LL and Other Gears (TC 1-6)**

| Year | 4VW | | | | 4X+5 | | | |
|---|---|---|---|---|---|---|---|---|
| | Jan-Apr | May-Aug | Sept-Dec | Total | Jan-Apr | May-Aug | Sept-Dec | Total |
| 1970 | 0 | 46 | 224 | 270 | 53 | 893 | 663 | 1609 |
| 71 | 0 | 118 | 72 | 190 | 5 | 979 | 544 | 1528 |
| 72 | 0 | 137 | 170 | 307 | 8 | 927 | 845 | 1780 |
| 73 | 6 | 101 | 139 | 246 | 9 | 2196 | 1335 | 3540 |
| 74 | 6 | 105 | 139 | 250 | 24 | 1990 | 2262 | 4276 |
| 75 | 1 | 79 | 78 | 158 | 49 | 1557 | 4567 | 6173 |
| 76 | 1 | 108 | 105 | 214 | 162 | 3908 | 3403 | 7473 |
| 77 | 19 | 68 | 203 | 290 | 268 | 2134 | 2188 | 4590 |
| 78 | 308 | 566 | 131 | 1005 | 204 | 1914 | 3029 | 5147 |
| 79 | 38 | 275 | 210 | 523 | 202 | 2559 | 4402 | 7163 |
| 1980 | 43 | 215 | 203 | 461 | 509 | 5746 | 2784 | 9039 |
| 81 | 44 | 753 | 1994 | 2791 | 555 | 3434 | 3257 | 7246 |
| 82 | 53 | 778 | 558 | 1389 | 755 | 5972 | 2984 | 9711 |
| 83 | 66 | 800 | 589 | 1455 | 586 | 4731 | 1635 | 6952 |
| 84 | 14 | 730 | 406 | 1150 | 244 | 3775 | 1917 | 5936 |
| 85 | 36 | 541 | 368 | 945 | 600 | 6274 | 3922 | 10796 |
| 86 | 264 | 732 | 403 | 1399 | 716 | 8422 | 4202 | 13340 |
| 87 | 69 | 1022 | 709 | 1800 | 589 | 8100 | 3696 | 12385 |
| 88 | 80 | 1339 | 340 | 1759 | 260 | 6223 | 4230 | 10713 |

Table 5. Description of the pollock fishery in 4VWX5 and its regulations 1974-1988.

| Year | Fleet | Initial Allocation (t) | Final Allocation (t) | Reported Catch (t) | Percent Taken (%) | Dates (Closures (cl) Trip Limits (tl) Bycatch (bc) | Remarks |
|---|---|---|---|---|---|---|---|
| 1974 | All vessels-Canadian | 34.0K | 34.0K | - | - | --- | Directed fishery |
| | All vessels-foreign | 21.0K | 21.0K | - | - | | 65% Can; 23% USA; 12% DWF |
| | Total 4VWX+5 | 55.0K | 55.0K | 38.0K | 69 | | |
| 1975 | All vessels-Canadian | 33.5K | 33.5K | - | - | --- | Directed fishery |
| | All vessels-foreign | 21.5K | 21.5K | - | - | | 67% Can; 23% USA; 10% DWF |
| | Total 4VWX+5 | 55.0K | 55.0K | 39.0K | 71 | | |
| 1976 | All vessels-Canadian | 33.5K | 33.5K | - | - | --- | Directed fishery |
| | All vessels-foreign | 21.5K | 21.5K | - | - | | 63% Can; 29% USA; 8% DWF |
| | Total 4VWX+5 | 55.0K | 55.0K | 38.0K | 69 | | |
| 1977 | All vessels-Canadian | 20.975K | 20.975K | - | - | --- | 200 mile limit imposed |
| | All vessels-foreign | 9.025K | 9.025K | - | - | | Directed fishery |
| | Total 4VWX+5 | 30.0K | 30.0K | 38.0K | 127 | | 65% Can; 34% USA; 1% DWF |
| 1978 | All vessels-Canadian | 20.975K | 20.975K | - | - | --- | Directed fishery |
| | All vessels-foreign | 9.025K | 9.025K | - | - | | 60% Can; 40% USA; <1% DWF |
| | Total 4VWX+5 | 30.0K | 30.0K | 45.0K | 150 | | |
| 1979 | All vessels-Canadian | 22.32K | 22.32K | - | - | --- | Directed fishery |
| | All vessels-foreign | 7.68K | 7.68K | - | - | | 65% Can; 34% USA; <1% DWF |
| | Total 4VWX+5 | 30.0K | 30.0K | 47.0K | 156 | | Treaty signed* |
| 1980 | All vessels-Canadian | 22.32K | 29.76K | - | - | | Directed fishery |
| | FG | 5.0K | 4.76K | 9.342K | 196 | | 65% Can; 34% USA; <1% DWF |
| | MG<125' | 3.81K | 9.0K | 8.278K | 92 | cl 18/08-9/10;cl 09/11-31/12 | Allocations based on |
| | MG>.25'(1/1-14/10) | 11.91K | 12.10K | 18.375K | 115 | cl 31/03- ? ;cl 12/07-15/10 | treaty 74.4% Can, 24.6% |
| | MG>125'(15/10-31/12) | 1.6K | 3.90K | | | cl 16/11-31/12 | Foreign |
| | All vessels-USA | 7.68K | 10.24K | 18.3K | 179 | | |
| | All vessels-foreign | - | - | 0.2K | - | | |
| | Total 4VWX+5 | 30.0K | 40.0K | 55.0K | 137 | | |
| 1981 | All vessels-Canadian | 29.76K | 40.16K | - | - | | Directed fishery |
| | FG | 8.76K | 9.3K** | 9.8K | 105 | | 69% Can; 30% USA; <1% DWF |
| | MG<125' | 7.0K | 8.5K | 7.2K | 84 | | Allocation based on |
| | MG>125'(1/1-14/10) | 10.5K | 18.9K | 23.8K | 106 | cl 15/04-15/10 | treaty |
| | MG>125'(15/10-31/12) | 3.5K | 3.5K | | | | |
| | Reserve | - | 5.0K** | | | | |
| | All vessels-USA | 10.24K | 13.84K | 18.0K | 130 | | |
| | All vessels-foreign | - | - | 0.5K | - | | |
| | Total 4VWX+5 | 40.0K | 54.0K | 59.0K | 109 | | |

* Treaty signed 29 March; was not ratified although allocation made accordingly; 74.4% Canada, 25.6% USA.
** Reserve assigned to fixed gear near end of year to give final allocation of 9.3K

Table 5. (Continued)

| Year | Fleet | Initial Allocation (t) | Final Allocation (t) | Reported Catch (t) | Percent Taken (%) | Dates (Closures (cl) Trip Limits (tl) Bycatch (bc) | Remarks |
|---|---|---|---|---|---|---|---|
| 1982 | All vessels-Canadian | 43.0K | 43.0K | - | - | | Directed fishery |
| | FG | 10.5K | 11.5K | 10.9K | 95 | | 69% Can; 30% USA; <1% DWF |
| | MG>100' | 24.0K | 22.0K | 19.0K | 86 | | Vessels greater than 65'- |
| | MG 65'-100' | 0.5K | 0.5K | 0.22K | 44 | | sector management-company |
| | MG<65' | 8.0K | 9.0K | 8.3K | 92 | cl 8/10-13/11 | quotas |
| | All vessels-USA | 12.0K | 12.0K | 14.3K | 119 | | |
| | All vessels-foreign | - | - | 0.4K | - | | |
| | Total 4VWX+5 | 55.0K | 55.0K | 53.0K | 96 | | |
| 1983 | All vessels-Canadian | 40.0K | 42.0K | - | - | | Directed fishery |
| | FG | 9.6K | 10.69K | 8.2K | 77 | | 70% Can; 30% USA; <1% DWF |
| | MG>100' | 22.4K | 21.4K | 14.8K | 69 | | (Dec) Companies |
| | MG 65'-100' | 0.25K | 0.28K | 0.23K | 82 | cl 30/07 | discouraged fishing for |
| | MG<65' | 7.75K | 9.63K | 9.5K | 99 | | pollock because of low |
| | All vessels-USA | 5.0K | 10.0K | 14.0K | 140 | | market value; 20,000 lb |
| | All vessels-foreign | - | - | 0.5K | - | | limit except if sold |
| | Total 4VWX+5 | 45.0K | 52.0K | 47.0K | 90 | | fresh. |
| 1984 | All vessels-Canadian | 42.4K | 42.4K | - | - | | Directed fishery |
| | FG | 10.17K | 8.97K | 7.0K | 78 | | 65% Can; 35% USA; <1% DWF |
| | MG>100' | 23.75K | 19.45K | 12.0K | 62 | | Trip limits set by |
| | MG 65'-100' | 0.27K | 0.77K | 0.65K | 84 | | companies (IOP) vary from |
| | MG <65' | 8.21K | 13.21K | 13.8K | 104 | Ent. Alloc. Pierce Fishery | 20,000-200,000 lb |
| | All vessels-USA | 10.6K | 10.6K | 17.7K | 167 | cl 17/10;4X cl 22/05-01/06; | |
| | All vessels-foreign | - | - | 0.3K | - | cl 30/06-02/09 | |
| | Total 4VWX+5 | 53.0K | 53.0K | 51.0K | 96 | | |
| 1985 | All vessels-Canadian | 42.4K | 42.4K | - | - | | Directed fishery |
| | FG | 10.17K | 8.37K | 11.63K | 139 | <65' cl 16/11-28/11 | No U.S. or foreign alloc. |
| | MG>100' | 23.75K | 17.35K | 15.8K | 91 | | Trip limits (IOP) imposed |
| | MG 65'-100' | 0.27K | 0.47K | 0.42K | 89 | | by companies vary from |
| | MG<65' | 8.21K | 16.21K | 15.14K | 93 | 27/07-20% bc; 13/08-10% bc; | 30-125,000 lbs |
| | Total 4VWX+5 | 42.4K | 42.4K | 42.9K | 101 | 30/08-35% bc; 16/11-10% bc. | |
| | All vessels-USA | - | - | 19.3K | - | | |
| | All vessels-foreign | - | - | 0.5K | - | | |
| 1986 | All vessels-Canadian | 40.0K | 40.0K | - | - | | Directed fishery |
| | FG | 11.0K | 11.4K | 14.4K | 126 | Class A-03/10-1500kg tl 10% | No U.S. or foreign alloc. |
| | MG>100' | 20.0K | 18.8K | 18.1K* | 96 | bc to 31/12 | Trip limits imposed by |
| | MG 65'-100' | 0.25K | 0.25K | 0.38K | 152 | cl 13/09 | companies 15-100,000 lbs |
| | MG<65' | 8.75K** | 9.55K | 10.1K | 106 | 28/03-4500kg tl; 8/04-0kg tl | |
| | Total 4VWX+5 | 40.0K | 40.0K | 43.0K | 108 | 10% bc; 28/04-13600 tl; | |
| | All vessels-USA | - | - | 24.0K | - | 8/05-22500kg tl; 14/06- | |
| | All vessels-foreign | - | - | 0.8K | - | 4500kg tl; 23/06-1500kg tl; | |
| | | | | | | 18/07-1500kg tl or 10% bc; | |
| | | | | | | 26/08-0kg tl 10% bc; 1/09- | |
| | | | | | | 1000kg tl or 10% bc; 20/09- | |
| | | | | | | 0kg tl 10% bc to 31/12 | |

* 1.7K Newfoundland 16.2 Scotia Fundy

** Jan-Apr 1.3K; May-Aug 5.65K; Sept-Dec 1.8K - changed mid year - Jan-Apr 2.97K; May-Aug 5.26K; Sept-Dec 1.31K

Table 5. (Continued)

| Year | Fleet | Initial Allocation (t) | Final Allocation (t) | Reported Catch (t) | Percent Taken (%) | Dates (closures (cl) Trip Limits (tl) Bycatch (bc) | Remarks |
|---|---|---|---|---|---|---|---|
| 1987 | All vessels-Canadian | 44.5K | 44.5K | - | - | | Directed fishery |
| | FG<65' | 11.825K | 11.825K | 14.096K | 119 | 20/11-1500kg tl | |
| | MG>100' | 21.5K | 21.5K | 20.959K | 97 | | |
| | MG 65'-100' | 0.27K | 0.468K | 0.479K | 102 | cl 24/03-31/03 | |
| | MG<65' (Jan 1-Apr 30) | 2.93K | 2.962K | 2.959K | 100 | 1/01-9000kg tl; 03/02-9000kg tl; 20/02-4500kg tl; 12/03-0kg tl 10% bc | |
| | MG<65' (May 1-Aug 31) | 5.175K | 6.252K | 6.234K | 100 | 01/05-9000kg tl; 01/06-7000kg tl; 11/06-4500kg tl; 19/06-1500kg tl; 26/06-0kg tl 10% bc | |
| | MG<65' (Sept 1-Dec 31) | 1.3K | 0.562K | 0.512K | 91 | 01/09-900kg tl; 03/10-0kg tl 10% bc | |
| | 3PS | 1.5K* | 0.931K | 0.178K | 19 | | |
| | Total 4VWX+5+3PS | 44.5K | 44.5K | 45.417K | 102 | | |
| | All vessels-USA | - | - | 20.25K | - | | |
| | All vessels-foreign | - | - | 0.790K | - | | |
| 1988* | All vessels-Canadian | 48.4K | - | - | - | | Directed fishery |
| | FG<45' | 11.525K | 11.325K | 11.500K | 102 | | |
| | FG 45'-64' | 0.3K | 0.671K | 0.485K | 72 | 16/07-1500kg tl 10% bc (revoked September 20) | |
| | MG>100' | 21.5K | 21.885K | 19.048K | 87 | | |
| | MG 65'-100' | 0.275K | 0.219K | 0.077K | 35 | | |
| | MG 45'-64' (Jan 1-Apr 30) | 1.75K | 1.75K | 2.2K | 126 | 19/03-4500 kg tl | |
| | MG 45'-64' (May 1-Aug 31) | 3.1K | 2.8K | 3.374K | 121 | 06/05-9000kg tl 10% bc; 01/06-4500kg tl 10% bc; 01/07-9000kg tl 10% bc | |
| | MG 45'-64' (Sept 1-Dec 31) | 0.79K | 0.79K | 0.144K | 18 | 01/08-4500kg tl 10% bc; 06/08-0kg tl 10% bc | |
| | MG<45' (Jan 1-Apr 30) | 1.165K | 1.165K | 1.118K | 96 | 19/03-6800kg tl | |
| | MG<45' (May 1-Aug 31) | 2.07K | 1.87K | 3.229K | 173 | 01/05-9000kg tl 10% bc; 23/07-6800kg tl 10% bc; 28/07-1000kg tl 10% bc | |
| | MG<45' (Sept 1-Dec 31) | 0.525K | 0.525K | 0.135K | 26 | 06/08-0kg tl 10% bc | |
| | Total 3Ps | 5.4K | 5.4K | 1.400K | 26 | | |
| | Total 4VWX+5 | 43.0K | 43.0K | 41.310K | 96 | | |
| | All vessels-foreign | - | - | 1.3K | - | | |
| 1989 | All vessels-Canadian | 48.4K | - | - | - | | Note: During March, the inshore SW Nova dragger fishery was opened by borrowing from summer and fall quotas. Per trip limits on combined cod, haddock and pollock were imposed; 25,000 lbs for vessels 45'-64', and 20,000 lbs for <45'. |
| | FG<45' | 12.07K | - | 0.062K | 1 | | |
| | FG 45'-64' | 0.315K | - | 0.021K | 7 | | |
| | MG>100' | 20.5K | - | 3.450K | 17 | | |
| | MG 65'-100' | 0.275K | - | 0.440K | 16 | | |
| | MG 45'-64' (Jan 1-Apr 30) | 1.830K | - | 2.156K | 118 | 01/01-9000kg tl; 26/01-11300kg tl; 01/03 10% bc; 09/03-11300 kg tl; 16/03-0kg tl, 0 bc; 22/03-11300kg tl | |
| | MG 45'-100' (May 1-Aug 31) | 3.250K | - | 0.0K | 0 | | |
| | MG 45'-100' (Sept. 1-Dec 31) | 0.825K | - | 0.0K | 0 | | |
| | MG<45' (Jan. 1-Apr 30) | 1.220K | - | 1.586K | 130 | 01/01-6800kg tl; 26/01-9000kg tl; 22/02 10% bc; 23/02-9000kg tl; 01/03 10% bc; 09/03 9000kg tl; 16/03 0 tl 0 bc; 22/03-1500 kg tl 10% bc; 28/03-9000 kg tl | |
| | MG<45' (May 1-Aug 31) | 2.165K | - | 0.0K | 0 | | |
| | MG<45' (Sept 1-Dec 31) | 0.550K | - | 0.0K | 0 | | |
| | Total 3Ps | 5.4K | - | 0.645K | 12 | | |
| | Total 4VWX+5 | 43.0K | - | 6.360K | 19 | | |
| | All vessels-foreign | | | - | | | |

* - 3Ps 1.5K; Aug. 15-Sept. 20, MG <65'

Table 6. Canadian commercial samples available for pollock in divs. 4VW and in Div. 4X and Subdiv. 5Zc by gear and season.

**4VW**

| | OTB 4+ | | | | OTB TC, 1-3 | | | | GN | | | | LL & Others | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Jan-Apr | May-Aug | Sept-Dec | Total | Jan-Apr | May-Aug | Sept-Dec | Total | Jan-Apr | May-Aug | Sept-Dec | Total | Jan-Apr | May-Aug | Sept-Dec | Total |
| 1988 | 21 | 13 | 14 | 48 | 2 | 2 | 0 | 4 | - | 1 | 2 | 3 | - | 1 | - | - |

**4X + 5**

| | OTB 4+ | | | | OTB TC, 1-3 | | | | GN | | | | LL & Others | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Jan-Apr | May-Aug | Sept-Dec | Total | Jan-Apr | May-Aug | Sept-Dec | Total | Jan-Apr | May-Aug | Sept-Dec | Total | Jan-Apr | May-Aug | Sept-Dec | Total |
| 1988 | 1 | 7 | 6 | 14 | 15 | 11 | 2 | 28 | - | 9 | 7 | 16 | - | 4 | - | 4 |

Table 7. Grouping of catch by gears and time period for estimation of removals-at-age. OTB trawls are primarily stern bottom trawls, but there are some side trawls; GN are gillnets, LL are longlines, and Others are primarily inshore fisheries.

| Year | Period Class | Tonnage | Gears | No. of Samples | Area | Number Aged | Number Measured | Catch (t) | Weight-Length Relationship a | b | Cruise | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | Jan-Dec | TC 1-6 | GN, LL, Other | 24 | 4VWX+5 | 583 | 5183 | 12472 | 0.0138 | 2.95257 | Needler 105/106 | July 1988 |
| | Jan-Dec | TC 1-3 | OTB | 32 | 4VWX+5 | 951 | 7577 | 10456 | 0.0138 | 2.95257 | Needler 105/106 | July 1988 |
| | Jan-Apr | TC 4+ | OTB | 21 | 4VW | 480 | 4953 | 3951 | 0.0172 | 2.88603 | Needler 105/106 | July 1988 |
| | May-Aug | TC 4+ | OTB | 13 | 4VW | 301 | 3020 | 3588 | 0.0172 | 2.88603 | Needler 105/106 | July 1988 |
| | Sept-Dec | TC 4+ | OTB | 14 | 4VW | 303 | 3149 | 4244 | 0.0172 | 2.88603 | Needler 105/106 | July 1988 |
| | Jan-Apr | TC 4+ | OTB | 1 | 4X+5 | 37 | 259 | 755 | 0.0138 | 2.95257 | Needler 105/106 | July 1988 |
| | May-Aug | TC 4+ | OTB | 7 | 4X+5 | 111 | 1656 | 3301 | 0.0138 | 2.95257 | Needler 105/106 | July 1988 |
| | Sept-Dec | TC 4+ | OTB | 6 | 4X+5 | 173 | 1300 | 2951 | 0.0138 | 2.95257 | Needler 105/106 | July 1988 |

Table 8. USA catches on Canadian side of ICJ line (1974-1984).

| Year | 5Zj | 5Zm | Total | 60% |
|---|---|---|---|---|
| 1974 | 572 | 77 | 649 | 389 |
| 75 | 477 | 112 | 589 | 353 |
| 76 | 479 | 121 | 600 | 360 |
| 77 | 315 | 213 | 528 | 317 |
| 78 | 437 | 308 | 745 | 447 |
| 79 | 523 | 130 | 653 | 391 |
| 1980 | 551 | 187 | 738 | 442 |
| 81 | 1200 | 331 | 1531 | 919 |
| 82 | 1239 | 163 | 1402 | 841 |
| 83 | 2027 | 180 | 2207 | 1324 |
| 84 | 2660 | 159 | 2819 | 1691 |

Table 9. Catch at age (in thousands).

**TOTAL CATCH AT AGE**

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 2 | 197 | 175 | 178 | 36 | 23 | 98 | 171 | 105 | 145 | 67 | 23 | 50 | 6 | 11 | 28 |
| 3 | 5603 | 1058 | 1361 | 1476 | 835 | 2763 | 291 | 1338 | 3738 | 1988 | 722 | 551 | 348 | 486 | 661 |
| 4 | 2662 | 4023 | 1974 | 2873 | 3119 | 5786 | 1864 | 679 | 1585 | 9453 | 3501 | 2197 | 2912 | 2318 | 2561 |
| 5 | 2356 | 2090 | 3649 | 1785 | 3084 | 3482 | 5306 | 2087 | 563 | 1252 | 7178 | 4146 | 3572 | 4990 | 3307 |
| 6 | 1088 | 1904 | 1089 | 2181 | 1276 | 1705 | 3169 | 4048 | 1872 | 243 | 641 | 6229 | 3622 | 3541 | 3451 |
| 7 | 317 | 835 | 1089 | 732 | 1167 | 528 | 1075 | 2444 | 2304 | 526 | 95 | 1109 | 3334 | 2397 | 1900 |
| 8 | 164 | 196 | 207 | 417 | 257 | 249 | 277 | 722 | 1074 | 849 | 223 | 129 | 316 | 1701 | 1203 |
| 9 | 80 | 55 | 36 | 108 | 143 | 47 | 168 | 215 | 400 | 434 | 215 | 139 | 82 | 176 | 1013 |
| 10 | 83 | 57 | 14 | 19 | 17 | 15 | 32 | 148 | 176 | 166 | 93 | 230 | 122 | 37 | 43 |
| 11 | 74 | 35 | 18 | 25 | 19 | 14 | 9 | 31 | 87 | 52 | 19 | 82 | 178 | 46 | 17 |
| 12 | 40 | 31 | 49 | 80 | 18 | 0 | 2 | 24 | 24 | 58 | 22 | 58 | 117 | 100 | 97 |

**CANADIAN CATCH AT AGE**

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 2 | 182 | 165 | 124 | 36 | 23 | 97 | 126 | 41 | 129 | 52 | 21 | 24 | 4 | 8 | 27 |
| 3 | 4709 | 973 | 1189 | 1415 | 773 | 2717 | 241 | 1303 | 3440 | 1786 | 685 | 477 | 317 | 428 | 618 |
| 4 | 2327 | 3521 | 1712 | 2818 | 3019 | 5510 | 1712 | 657 | 1550 | 8951 | 3322 | 2179 | 2868 | 2231 | 2493 |
| 5 | 2092 | 1828 | 3123 | 1737 | 2971 | 3298 | 4975 | 1997 | 551 | 1200 | 6805 | 4126 | 3519 | 4859 | 3235 |
| 6 | 939 | 1639 | 925 | 2101 | 1202 | 1624 | 3076 | 3929 | 1832 | 228 | 608 | 6178 | 3575 | 3489 | 3345 |
| 7 | 269 | 785 | 986 | 701 | 1123 | 489 | 1035 | 2377 | 2245 | 503 | 87 | 1102 | 3291 | 2372 | 1784 |
| 8 | 142 | 130 | 191 | 390 | 242 | 245 | 266 | 696 | 1044 | 801 | 205 | 126 | 298 | 1672 | 1146 |
| 9 | 63 | 44 | 34 | 89 | 132 | 46 | 163 | 202 | 381 | 412 | 197 | 134 | 82 | 175 | 991 |
| 10 | 50 | 55 | 12 | 19 | 17 | 15 | 32 | 145 | 168 | 157 | 85 | 221 | 113 | 35 | 43 |
| 11 | 32 | 34 | 16 | 25 | 19 | 14 | 9 | 30 | 85 | 48 | 17 | 78 | 165 | 44 | 17 |
| 12 | 10 | 30 | 41 | 79 | 18 | 0 | 2 | 23 | 22 | 56 | 20 | 57 | 113 | 95 | 93 |

**FOREIGN CATCH AT AGE**

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 12 | 8 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 291 | 67 | 121 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 162 | 228 | 160 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 152 | 87 | 237 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 77 | 78 | 64 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 20 | 23 | 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 9 | 4 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 6 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 3 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 3 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 1 | 1 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**SMALL MESH GEAR CATCH AT AGE**

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 35 | 0 | 0 | 0 | 43 | 63 | 13 | 13 | 1 | 26 | 2 | 3 | 1 |
| 3 | 528 | 6 | 33 | 43 | 49 | 11 | 47 | 5 | 222 | 131 | 2 | 74 | 31 | 58 | 43 |
| 4 | 136 | 229 | 77 | 18 | 49 | 204 | 131 | 7 | 1 | 144 | 10 | 18 | 44 | 87 | 68 |
| 5 | 79 | 151 | 242 | 25 | 62 | 141 | 271 | 44 | 0 | 4 | 26 | 20 | 53 | 131 | 72 |
| 6 | 57 | 166 | 86 | 53 | 54 | 60 | 56 | 29 | 0 | 6 | 2 | 51 | 47 | 52 | 106 |
| 7 | 24 | 17 | 46 | 22 | 25 | 33 | 28 | 12 | 10 | 3 | 4 | 7 | 43 | 25 | 116 |
| 8 | 10 | 60 | 0 | 22 | 11 | 1 | 8 | 10 | 7 | 16 | 8 | 3 | 18 | 29 | 57 |
| 9 | 10 | 9 | 0 | 18 | 9 | 0 | 3 | 8 | 11 | 6 | 8 | 5 | 0 | 1 | 22 |
| 10 | 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 3 | 4 | 9 | 9 | 2 | 0 |
| 11 | 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 4 | 13 | 2 | 0 |
| 12 | 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 1 | 4 | 5 | 4 |

Table 10. Total percent catch at age and total percent biomass at age for 4VWX5 pollock (1974-1988).



PERCENT TOTAL CATCH AT AGE

(A)

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 2 | 2 | 2 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 44 | 10 | 14 | 15 | 8 | 19 | 2 | 11 | 31 | 13 | 6 | 4 | 2 | 3 | 5 |
| 4 | 21 | 38 | 20 | 30 | 31 | 39 | 15 | 6 | 13 | 63 | 27 | 15 | 20 | 15 | 18 |
| 5 | 19 | 20 | 38 | 18 | 31 | 24 | 43 | 18 | 5 | 8 | 56 | 28 | 24 | 32 | 23 |
| 6 | 9 | 18 | 11 | 22 | 13 | 12 | 26 | 34 | 16 | 2 | 5 | 42 | 25 | 22 | 24 |
| 7 | 3 | 8 | 11 | 8 | 12 | 4 | 9 | 21 | 19 | 3 | 1 | 7 | 23 | 15 | 13 |
| 8 | 1 | 2 | 2 | 4 | 3 | 2 | 2 | 6 | 9 | 6 | 2 | 1 | 2 | 11 | 8 |
| 9 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 7 |
| 10 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 1 | 0 | 0 |
| 11 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 12 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |

PERCENT BIOMASS AT AGE

(B)

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 26 | 4 | 6 | 6 | 4 | 10 | 1 | 6 | 12 | 7 | 3 | 2 | 1 | 1 | 2 |
| 4 | 18 | 26 | 14 | 17 | 20 | 29 | 10 | 4 | 11 | 46 | 24 | 10 | 13 | 10 | 11 |
| 5 | 24 | 21 | 38 | 17 | 29 | 29 | 39 | 15 | 5 | 11 | 54 | 26 | 21 | 27 | 20 |
| 6 | 15 | 24 | 15 | 30 | 18 | 18 | 29 | 33 | 20 | 3 | 7 | 45 | 27 | 23 | 26 |
| 7 | 5 | 14 | 19 | 13 | 19 | 7 | 12 | 25 | 26 | 7 | 1 | 9 | 28 | 19 | 15 |
| 8 | 3 | 4 | 4 | 9 | 6 | 4 | 4 | 10 | 14 | 12 | 4 | 1 | 3 | 15 | 12 |
| 9 | 2 | 1 | 1 | 3 | 4 | 1 | 3 | 4 | 6 | 7 | 4 | 2 | 1 | 2 | 10 |
| 10 | 2 | 1 | 0 | 1 | 0 | 0 | 1 | 3 | 3 | 3 | 2 | 3 | 2 | 1 | 1 |
| 11 | 2 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 2 | 1 | 0 | 1 | 2 | 1 | 0 |
| 12 | 1 | 1 | 2 | 4 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |

Table 11. Mean weights at age.

TOTAL WEIGHT AT AGE

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.19 | 0.00 | 0.00 | 0.00 | 0.63 | 0.36 | 0.00 | 0.10 | 0.00 | 0.00 |
| 2 | 0.82 | 0.86 | 0.59 | 0.79 | 1.14 | 0.77 | 1.03 | 0.80 | 0.75 | 0.76 | 1.42 | 0.65 | 0.66 | 0.61 | 1.14 |
| 3 | 1.38 | 1.26 | 1.21 | 1.10 | 1.23 | 1.18 | 1.68 | 1.74 | 1.22 | 1.25 | 1.68 | 1.40 | 1.34 | 1.30 | 1.40 |
| 4 | 1.94 | 1.95 | 1.92 | 1.52 | 1.80 | 1.55 | 2.08 | 2.53 | 2.69 | 1.67 | 2.36 | 1.95 | 2.02 | 1.95 | 1.91 |
| 5 | 3.00 | 3.06 | 2.81 | 2.48 | 2.60 | 2.62 | 2.77 | 2.91 | 3.51 | 3.13 | 2.67 | 2.73 | 2.52 | 2.49 | 2.64 |
| 6 | 4.09 | 3.81 | 3.71 | 3.50 | 3.90 | 3.40 | 3.46 | 3.34 | 4.18 | 4.12 | 3.84 | 3.12 | 3.29 | 2.94 | 3.20 |
| 7 | 5.08 | 5.06 | 4.67 | 4.52 | 4.59 | 4.34 | 4.12 | 4.32 | 4.45 | 4.83 | 5.40 | 3.42 | 3.61 | 3.71 | 3.50 |
| 8 | 6.16 | 6.52 | 5.64 | 5.47 | 6.02 | 5.55 | 5.58 | 5.92 | 5.19 | 5.07 | 5.96 | 4.39 | 4.18 | 4.04 | 4.23 |
| 9 | 6.68 | 7.49 | 7.02 | 6.62 | 6.91 | 6.61 | 6.50 | 6.92 | 6.19 | 5.83 | 5.90 | 6.10 | 5.66 | 4.55 | 4.41 |
| 10 | 7.39 | 7.49 | 7.80 | 7.25 | 7.37 | 7.14 | 9.07 | 7.77 | 7.63 | 6.49 | 6.32 | 5.86 | 6.09 | 6.29 | 5.26 |
| 11 | 8.58 | 8.22 | 8.76 | 10.02 | 8.38 | 8.79 | 8.40 | 7.54 | 8.00 | 7.98 | 7.66 | 6.18 | 6.11 | 6.20 | 8.03 |
| 12 | 10.03 | 9.59 | 9.11 | 11.30 | 10.03 | 0.00 | 11.64 | 9.22 | 8.64 | 8.72 | 8.64 | 7.54 | 6.63 | 7.53 | 8.46 |

CANADIAN WEIGHT AT AGE

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.19 | 0.00 | 0.00 | 0.00 | 0.63 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | 0.83 | 0.86 | 0.63 | 0.79 | 1.14 | 0.77 | 1.12 | 1.01 | 0.76 | 0.84 | 1.46 | 0.94 | 0.83 | 0.72 | 1.17 |
| 3 | 1.43 | 1.27 | 1.23 | 1.11 | 1.26 | 1.18 | 1.77 | 1.74 | 1.24 | 1.25 | 1.68 | 1.52 | 1.39 | 1.37 | 1.46 |
| 4 | 1.98 | 1.99 | 1.94 | 1.52 | 1.81 | 1.54 | 2.10 | 2.54 | 2.70 | 1.67 | 2.36 | 1.96 | 2.02 | 1.97 | 1.92 |
| 5 | 3.02 | 3.10 | 2.80 | 2.48 | 2.59 | 2.63 | 2.80 | 2.91 | 3.51 | 3.13 | 2.67 | 2.74 | 2.52 | 2.51 | 2.64 |
| 6 | 4.05 | 3.87 | 3.73 | 3.49 | 3.88 | 3.38 | 3.47 | 3.34 | 4.18 | 4.11 | 3.84 | 3.12 | 3.29 | 2.95 | 3.22 |
| 7 | 5.03 | 5.07 | 4.65 | 4.50 | 4.59 | 4.33 | 4.14 | 4.32 | 4.45 | 4.83 | 5.41 | 3.43 | 3.61 | 3.72 | 3.51 |
| 8 | 6.06 | 6.51 | 5.62 | 5.45 | 6.00 | 5.54 | 5.56 | 5.93 | 5.19 | 5.08 | 5.97 | 4.39 | 4.20 | 4.04 | 4.23 |
| 9 | 6.62 | 7.47 | 7.04 | 6.55 | 6.84 | 6.61 | 6.51 | 6.90 | 6.12 | 5.84 | 5.90 | 6.13 | 5.66 | 4.55 | 4.41 |
| 10 | 7.22 | 7.69 | 7.71 | 7.25 | 7.37 | 7.14 | 9.07 | 7.77 | 7.64 | 6.48 | 6.34 | 5.89 | 6.09 | 6.32 | 5.26 |
| 11 | 8.12 | 8.47 | 8.67 | 10.02 | 8.38 | 8.79 | 8.40 | 7.54 | 8.00 | 8.00 | 7.69 | 6.19 | 6.11 | 6.26 | 8.03 |
| 12 | 9.36 | 9.89 | 9.19 | 11.30 | 10.03 | 0.00 | 11.64 | 9.22 | 8.65 | 8.72 | 8.76 | 7.56 | 6.86 | 7.62 | 8.52 |

FOREIGN WEIGHT AT AGE

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | 0.59 | 0.84 | 0.63 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3 | 1.24 | 1.13 | 1.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 4 | 1.81 | 1.68 | 1.88 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5 | 2.89 | 2.32 | 2.83 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 6 | 3.97 | 3.25 | 3.52 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 7 | 5.23 | 4.33 | 4.83 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 8 | 6.70 | 5.13 | 5.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 9 | 6.72 | 5.13 | 6.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 10 | 7.00 | 0.00 | 8.26 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 11 | 8.43 | 0.00 | 9.46 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 12 | 13.00 | 0.00 | 8.68 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

SMALL MESH GEAR WEIGHT AT AGE

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.36 | 0.00 | 0.10 | 0.00 | 0.00 |
| 2 | 0.00 | 0.00 | 0.42 | 0.00 | 0.00 | 0.00 | 0.77 | 0.66 | 0.62 | 0.43 | 0.48 | 0.37 | 0.32 | 0.32 | 0.26 |
| 3 | 1.02 | 1.11 | 0.92 | 0.74 | 0.83 | 1.23 | 1.25 | 1.52 | 0.84 | 1.15 | 1.29 | 0.62 | 0.87 | 0.79 | 0.50 |
| 4 | 1.47 | 1.74 | 1.45 | 1.65 | 1.66 | 1.81 | 1.86 | 1.74 | 2.15 | 1.28 | 2.50 | 1.39 | 1.68 | 1.40 | 1.22 |
| 5 | 2.71 | 3.04 | 2.94 | 2.80 | 2.88 | 2.49 | 2.19 | 2.96 | 0.00 | 2.52 | 2.82 | 2.35 | 2.48 | 1.92 | 2.39 |
| 6 | 4.90 | 3.47 | 3.68 | 3.90 | 4.32 | 3.93 | 2.72 | 3.63 | 3.54 | 4.38 | 3.77 | 2.92 | 3.24 | 2.65 | 2.70 |
| 7 | 5.50 | 5.62 | 5.13 | 4.99 | 4.45 | 4.48 | 3.14 | 4.28 | 4.97 | 4.62 | 4.97 | 3.04 | 3.20 | 2.94 | 3.36 |
| 8 | 7.01 | 6.64 | 0.00 | 5.90 | 6.45 | 5.98 | 6.32 | 5.41 | 6.90 | 4.85 | 5.60 | 4.29 | 3.85 | 3.61 | 4.33 |
| 9 | 7.01 | 8.00 | 0.00 | 6.92 | 8.01 | 0.00 | 6.37 | 7.36 | 8.82 | 5.03 | 5.87 | 5.40 | 0.00 | 4.78 | 4.30 |
| 10 | 7.73 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 8.87 | 7.43 | 7.08 | 5.96 | 5.35 | 6.14 | 5.74 | 0.00 |
| 11 | 8.99 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 7.61 | 7.25 | 5.94 | 6.04 | 4.84 | 0.00 |
| 12 | 10.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 8.50 | 8.39 | 6.19 | 6.46 | 0.00 | 5.96 | 7.04 |

Table 12. Commercial catch rates (t/hr) for pollock (main species) in divs. 4VWX and Subarea 5.

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canadian OTB-2 (TC5) CPUE (t/Hr) | | | | | | | | | | | | | | | |
| April-November | .66 | .70 | .57 | .78 | .89 | 1.09 | .94 | 1.01 | 1.32 | 1.05 | 1.33 | .96 | 1.26 | .94 | .906 |

Table 13. International Observer Program catch rates (t/hr) for pollock (main species) in divs. 4VWX and Subarea 5.

| | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|
| Canadian OTB-2 (TC5) CPUE (t/hr) | | | | | | | |
| April-November | 1.95 | 1.42 | 2.05 | 2.37 | 1.75 | 1.06 | 1.15 |

Table 14. Stratified total numbers at age (x $10^{-3}$) in Canadian summer trawl surveys (strata 40 - 95).

| | Year | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
| 1 | 30 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 49 | 29 | 0 | 426 | 148 | 30 | 186 | 0 | 86 |
| 2 | 7613 | 3106 | 82 | 1649 | 165 | 37 | 122 | 1108 | 29 | 0 | 4842 | 673 | 832 | 504 | 1989 | 6281 | 2571 | 2503 | 122 |
| 3 | 1866 | 2573 | 55 | 2021 | 3381 | 77 | 928 | 3266 | 610 | 458 | 5299 | 744 | 11816 | 3882 | 966 | 19321 | 2769 | 10352 | 2360 |
| 4 | 1132 | 713 | 618 | 9100 | 842 | 1375 | 2826 | 4177 | 2526 | 2631 | 14011 | 215 | 1129 | 7214 | 2965 | 14886 | 4065 | 15574 | 4622 |
| 5 | 825 | 165 | 1361 | 3442 | 1098 | 1182 | 5251 | 8604 | 3927 | 3305 | 22026 | 2147 | 502 | 830 | 8508 | 14291 | 4249 | 24663 | 9081 |
| 6 | 748 | 76 | 595 | 363 | 514 | 1587 | 1315 | 5998 | 1458 | 2401 | 5572 | 2143 | 1556 | 203 | 1297 | 11399 | 5807 | 9678 | 8090 |
| 7 | 502 | 115 | 157 | 220 | 548 | 252 | 2264 | 779 | 1365 | 986 | 3032 | 1492 | 1070 | 383 | 892 | 1693 | 4237 | 7021 | 7605 |
| 8 | 275 | 46 | 288 | 206 | 308 | 389 | 836 | 1308 | 424 | 710 | 872 | 1028 | 628 | 1113 | 1934 | 471 | 297 | 5715 | 4209 |
| 9 | 106 | 31 | 209 | 252 | 233 | 151 | 182 | 458 | 198 | 44 | 327 | 461 | 553 | 703 | 2919 | 854 | 45 | 220 | 2442 |
| 10 | 0 | 74 | 100 | 10 | 151 | 35 | 188 | 219 | 91 | 154 | 173 | 321 | 306 | 239 | 1811 | 1323 | 430 | 481 | 169 |
| 11 | 148 | 0 | 52 | 75 | 313 | 40 | 62 | 129 | 0 | 0 | 0 | 121 | 50 | 250 | 301 | 463 | 571 | 372 | 178 |
| 12+ | 28 | 0 | 111 | 48 | 131 | 0 | 203 | 49 | 98 | 0 | 0 | 54 | 208 | 86 | 662 | 428 | 365 | 1464 | 674 |
| UK | 0 | 0 | 17 | 59 | 0 | 0 | 45 | 15 | 71 | 97 | 122 | 195 | 143 | 116 | 186 | 15 | 31 | 119 | 0 |
| TOTAL | 13302 | 6899 | 3645 | 17444 | 7713 | 5125 | 14224 | 26110 | 10797 | 10824 | 56326 | 9621 | 18794 | 15949 | 24577 | 71455 | 25622 | 78164 | 39638 |
| 4+ | 3765 | 1220 | 3491 | 13715 | 4137 | 5010 | 13128 | 21721 | 10087 | 10232 | 46013 | 7981 | 6004 | 11021 | 21289 | 45808 | 20066 | 65189 | 37069 |
| 5+ | 2633 | 507 | 2873 | 4615 | 3295 | 3636 | 10302 | 17543 | 7561 | 7601 | 32002 | 7766 | 4874 | 3806 | 18324 | 30922 | 16001 | 49615 | 32447 |
| 6+ | 1808 | 342 | 1511 | 1174 | 2198 | 2454 | 5050 | 8940 | 3634 | 4295 | 9976 | 5619 | 4373 | 2976 | 9815 | 16631 | 11753 | 24952 | 23366 |

Table 15. Mean numbers/tow for 4VWX + 5 Pollock in Canadian summer bottom trawl surveys [1]

YEAR

| Stratum | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | All | Divn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.26 | 0.41 | 45.11 | 0.34 | 2.43 | |
| 41 | 0.00 | 3.94 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.31 | 0.00 | 0.00 | 1.40 | 0.65 | 1.30 | 0.29 | 1.03 | 0.21 | 37.43 | 9.14 | 2.93 | 4Vn |
| 42 | 0.32 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.34 | 0.00 | 0.16 | 0.33 | 0.06 | |
| 43 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.21 | 0.18 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | |
| 44 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.26 | 0.83 | 0.34 | 0.00 | 0.08 | |
| 45 | 0.00 | 0.00 | 0.19 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 18.03 | 0.17 | 5.85 | 0.00 | 1.28 | |
| 46 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.97 | 16.47 | 0.00 | 3.09 | 0.69 | 0.00 | 0.97 | 1.19 | |
| 47 | 0.00 | 0.00 | 0.00 | 0.37 | 0.00 | 0.44 | 0.00 | 0.00 | 0.00 | 0.61 | 0.00 | 0.00 | 0.51 | 0.26 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 4Vs |
| 48 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| 49 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.08 | 0.00 | 0.00 | 0.00 | 0.00 | 5.35 | 0.00 | 0.52 | 0.00 | 0.00 | 0.55 | |
| 50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.36 | 0.00 | 0.00 | 0.00 | 1.56 | 0.00 | 15.10 | 1.09 | 0.00 | 0.00 | 0.00 | 0.34 | 0.34 | 0.00 | 0.99 | |
| 51 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 | 0.49 | 3.13 | 25.93 | 0.00 | 2.92 | 571.50 | 0.00 | 0.00 | 96.76 | 0.73 | 133.02 | 22.13 | 45.11 | |
| 52 | 0.00 | 1.14 | 0.46 | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 | 0.49 | 3.60 | 0.00 | 0.00 | 5.05 | 3.60 | 113.75 | 6.69 | 60.03 | 0.34 | 0.55 | 10.33 | |
| 53 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.34 | 0.00 | 0.58 | 0.07 | |
| 54 | 0.00 | 0.00 | 0.34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.39 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.05 | 0.00 | 0.00 | 0.00 | 0.09 | |
| 55 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.29 | 1.42 | 0.26 | 0.00 | 0.00 | 0.13 | 0.12 | 0.00 | 0.12 | |
| 56 | 0.39 | 0.27 | 0.00 | 0.18 | 0.00 | 0.00 | 0.00 | 0.34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.16 | 2.97 | 1.94 | 0.17 | 0.70 | 4.73 | 0.62 | |
| 57 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.49 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | |
| 58 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.27 | 0.00 | 0.00 | 0.44 | 0.00 | 1.03 | 0.20 | |
| 59 | 0.76 | 0.44 | 0.00 | 0.58 | 0.00 | 0.00 | 0.20 | 0.63 | 0.24 | 0.00 | 0.00 | 0.00 | 0.00 | 0.58 | 17.06 | 2.34 | 10.47 | 3.28 | 9.43 | 2.42 | 4W |
| 60 | 75.99 | 0.00 | 0.83 | 4.12 | 0.00 | 5.07 | 0.00 | 0.97 | 14.72 | 1.45 | 353.50 | 0.97 | 6.55 | 29.17 | 36.66 | 12.40 | 8.92 | 337.21 | 7.87 | 47.18 | |
| 61 | 0.00 | 0.00 | 0.00 | 0.51 | 0.00 | 20.26 | 0.00 | 2.78 | 0.00 | 0.00 | 0.00 | 0.00 | 2.76 | 1.46 | 1.61 | 5.06 | 3.78 | 11.67 | 3.28 | 2.80 | |
| 62 | 0.00 | 0.65 | 0.00 | 0.00 | 5.10 | 2.73 | 0.23 | 0.00 | 3.82 | 1.22 | 55.19 | 6.87 | 0.78 | 0.00 | 1.29 | 48.10 | 14.78 | 3.98 | 5.48 | 7.91 | |
| 63 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.31 | 6.13 | 1.17 | 0.00 | 3.89 | 0.51 | 5.41 | 0.23 | 4.86 | 0.00 | 1.46 | 1.72 | 4.46 | 0.55 | 1.77 | |
| 64 | 0.00 | 0.00 | 0.19 | 0.00 | 0.00 | 0.00 | 0.32 | 1.79 | 3.52 | 0.97 | 0.00 | 0.00 | 0.00 | 41.22 | 0.62 | 2.96 | 0.28 | 4.57 | 1.58 | 3.05 | |
| 65 | 0.19 | 14.00 | 0.00 | 0.00 | 20.85 | 1.17 | 2.33 | 1.95 | 0.41 | 0.21 | 0.00 | 0.85 | 0.15 | 0.51 | 1.29 | 2.72 | 0.19 | 5.65 | 1.67 | 2.85 | |
| 66 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.24 | 0.39 | 0.55 | 0.00 | 0.22 | |
| 70 | 2.19 | 3.46 | 0.38 | 27.47 | 2.43 | 0.49 | 96.62 | 18.47 | 74.79 | 9.30 | 1.09 | 16.40 | 0.00 | 42.41 | 6.56 | 60.82 | 19.56 | 72.06 | 74.27 | 27.83 | |
| 71 | 0.00 | 0.00 | 0.00 | 0.55 | 0.00 | 0.00 | 0.00 | 6.35 | 3.04 | 0.00 | 4.86 | 1.37 | 0.00 | 0.97 | 1.63 | 27.79 | 4.63 | 108.57 | 6.85 | 8.77 | |
| 72 | 2.06 | 22.75 | 0.82 | 1.09 | 2.57 | 0.00 | 2.13 | 1.74 | 0.46 | 0.34 | 16.42 | 5.83 | 0.49 | 5.47 | 1.75 | 377.22 | 6.18 | 3.60 | 8.51 | 24.18 | |
| 73 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 | 0.00 | 0.00 | 0.38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.49 | 2.13 | 0.51 | 0.00 | 0.21 | |
| 74 | 0.00 | 0.24 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.88 | 0.55 | 0.00 | 0.16 | |
| 75 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.51 | 0.00 | 1.03 | 0.00 | 0.00 | 0.08 | |
| 76 | 1.09 | 0.49 | 0.00 | 9.24 | 5.72 | 7.70 | 2.19 | 20.79 | 1.75 | 0.00 | 1.17 | 0.00 | 0.00 | 6.03 | 50.95 | 0.00 | 26.74 | 1.35 | 35.97 | 9.01 | |
| 77 | 0.00 | 0.00 | 0.44 | 1.84 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.58 | 0.00 | 0.00 | 0.00 | 1.03 | 0.00 | 0.00 | 0.00 | 23.50 | 0.00 | 1.44 | |
| 78 | 1.46 | 2.43 | 0.88 | 0.97 | 0.00 | 1.09 | 0.00 | 0.00 | 1.75 | 1.29 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.89 | 0.36 | 0.00 | 4.12 | 0.96 | |
| 80 | 0.49 | 0.52 | 0.19 | 0.31 | 0.00 | 0.00 | 0.23 | 34.81 | 0.55 | 0.00 | 0.97 | 0.18 | 0.51 | 1.46 | 0.00 | 1.84 | 2.60 | 11.74 | 0.22 | 2.98 | |
| 81 | 0.00 | 2.92 | 0.00 | 6.00 | 1.30 | 0.00 | 0.29 | 0.00 | 2.11 | 0.00 | 1.82 | 1.46 | 1.80 | 2.73 | 0.26 | 0.46 | 8.14 | 0.51 | 2.36 | 1.69 | 4X |
| 82 | 0.49 | 0.46 | 0.46 | 0.00 | 0.00 | 0.00 | 0.32 | 0.73 | 1.07 | 13.64 | 1.35 | 4.04 | 1.41 | 1.00 | 0.88 | 0.49 | 1.03 | 4.25 | 3.62 | 1.85 | |
| 83 | 0.00 | 0.00 | 2.43 | 0.00 | 0.00 | 0.00 | 1.95 | 0.49 | 0.00 | 0.58 | 0.78 | 0.00 | 0.52 | 0.51 | 1.54 | 0.49 | 0.00 | 1.64 | 1.03 | 0.63 | |
| 84 | 0.00 | 0.55 | 1.25 | 1.78 | 1.34 | 1.58 | 21.52 | 2.38 | 0.49 | 9.82 | 0.25 | 16.54 | 0.26 | 0.00 | 3.43 | 3.56 | 2.40 | 4.72 | 11.75 | 4.40 | |
| 85 | 23.72 | 0.00 | 7.00 | 83.38 | 2.17 | 0.00 | 1.99 | 127.10 | 1.59 | 19.79 | 21.61 | 3.57 | 58.78 | 1.70 | 23.70 | 13.35 | 46.03 | 14.24 | 127.16 | 30.36 | |
| 90 | 9.85 | 0.00 | 0.00 | 0.34 | 3.98 | 1.19 | 8.17 | 0.78 | 8.61 | 3.28 | 1.35 | 15.75 | 2.60 | 8.20 | 0.00 | 67.91 | 2.94 | 0.23 | 1.98 | 7.22 | |
| 91 | 0.00 | 0.38 | 25.14 | 5.10 | 1.13 | 0.65 | 2.52 | 1.53 | 0.00 | 46.01 | 1.92 | 0.53 | 0.60 | 1.88 | 3.09 | 4.55 | 26.08 | 64.80 | 3.65 | 9.98 | |
| 92 | 0.32 | 0.00 | 4.37 | 1.63 | 3.19 | 2.02 | 2.10 | 3.68 | 2.27 | 0.00 | 0.00 | 0.29 | 11.08 | 1.03 | 0.36 | 0.65 | 6.32 | 3.47 | 5.93 | 2.56 | |
| 93 | 0.00 | 0.00 | 0.00 | 1.54 | 0.00 | 0.46 | 0.58 | 1.16 | 0.00 | 0.69 | 1.32 | 0.00 | 4.25 | 1.94 | 0.00 | 46.94 | 0.65 | 4.12 | 0.00 | 3.54 | |
| 94 | 0.00 | 0.00 | 0.00 | 0.00 | 0.42 | 0.46 | 2.17 | 0.00 | 0.00 | 1.03 | 0.51 | 0.00 | 0.00 | 0.00 | 0.55 | 0.49 | 0.00 | 0.00 | 0.00 | 0.30 | |
| 95 | 0.00 | 0.00 | 2.02 | 0.15 | 1.54 | 0.70 | 0.00 | 0.00 | 0.00 | 1.06 | 1.21 | 2.92 | 0.00 | 0.67 | 0.00 | 0.92 | 0.00 | 0.00 | 0.00 | 0.59 | |

[1] Survey vessels: 1970 - 1981 A. T. Cameron
1982 Lady Hammond
1983 - 1988 Alfred Needler

Table 16. Stratified mean weights-per-standard-tow in Canadian summer trawl surveys (strata 40 - 95).

| | Year | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
| 1 | 0.001 | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | 0.013 | 0.012 | 0.001 | 0.009 | 0.000 | 0.004 |
| 2 | 1.054 | 0.343 | 0.012 | 0.181 | 0.020 | 0.003 | 0.016 | 0.178 | 0.006 | 0.000 | 0.873 | 0.105 | 0.117 | 0.053 | 0.261 | 0.613 | 0.288 | 0.198 | 0.017 |
| 3 | 0.520 | 0.558 | 0.011 | 0.604 | 0.828 | 0.021 | 0.335 | 0.916 | 0.141 | 0.136 | 1.568 | 0.312 | 2.311 | 1.157 | 0.353 | 4.571 | 0.764 | 1.797 | 0.536 |
| 4 | 0.683 | 0.368 | 0.330 | 4.805 | 0.307 | 0.587 | 1.560 | 2.092 | 1.337 | 1.332 | 6.232 | 0.123 | 0.658 | 2.658 | 1.746 | 6.103 | 1.804 | 5.569 | 2.062 |
| 5 | 0.691 | 0.122 | 1.143 | 2.364 | 0.794 | 0.870 | 3.848 | 5.892 | 2.847 | 2.413 | 11.693 | 1.577 | 0.363 | 0.631 | 6.193 | 8.517 | 2.806 | 12.415 | 6.205 |
| 6 | 0.853 | 0.075 | 0.720 | 0.376 | 0.547 | 1.449 | 1.238 | 5.062 | 1.544 | 2.339 | 3.939 | 1.950 | 1.606 | 0.185 | 1.398 | 8.826 | 5.156 | 6.661 | 6.556 |
| 7 | 0.747 | 0.134 | 0.215 | 0.278 | 0.701 | 0.320 | 2.710 | 0.882 | 1.613 | 1.219 | 2.655 | 1.604 | 1.205 | 0.404 | 1.094 | 1.503 | 4.126 | 6.282 | 7.072 |
| 8 | 0.475 | 0.066 | 0.426 | 0.303 | 0.444 | 0.615 | 1.111 | 1.765 | 0.681 | 1.121 | 1.294 | 1.314 | 0.875 | 1.241 | 2.620 | 0.535 | 0.339 | 5.478 | 4.616 |
| 9 | 0.207 | 0.048 | 0.347 | 0.385 | 0.389 | 0.287 | 0.303 | 0.762 | 0.356 | 0.072 | 0.530 | 0.753 | 0.917 | 0.879 | 4.271 | 1.187 | 0.065 | 0.301 | 2.854 |
| 10 | 0.000 | 0.104 | 0.160 | 0.022 | 0.281 | 0.075 | 0.385 | 0.407 | 0.138 | 0.288 | 0.284 | 0.637 | 0.490 | 0.382 | 2.901 | 1.715 | 0.646 | 0.729 | 0.272 |
| 11 | 0.330 | 0.000 | 0.097 | 0.158 | 0.648 | 0.094 | 0.121 | 0.238 | 0.000 | 0.000 | 0.000 | 0.218 | 0.094 | 0.433 | 0.545 | 0.777 | 0.819 | 0.494 | 0.305 |
| 12+ | 0.059 | 0.000 | 0.210 | 0.144 | 0.314 | 0.000 | 0.434 | 0.099 | 0.225 | 0.000 | 0.000 | 0.088 | 0.401 | 0.163 | 1.324 | 0.776 | 0.574 | 2.587 | 1.281 |
| UK | 0.000 | 0.000 | 0.005 | 0.085 | 0.000 | 0.000 | 0.109 | 0.033 | 0.160 | 0.235 | 0.275 | 0.496 | 0.344 | 0.246 | 0.472 | 0.027 | 0.065 | 0.242 | 0.000 |
| TOTAL | 5.619 | 1.818 | 3.676 | 9.705 | 5.274 | 4.320 | 12.169 | 18.326 | 9.047 | 9.155 | 29.342 | 9.177 | 9.381 | 8.444 | 23.187 | 35.152 | 17.460 | 42.753 | 31.780 |
| 4+ | 4.043 | 0.917 | 3.649 | 8.835 | 4.425 | 4.297 | 11.708 | 17.199 | 8.741 | 8.784 | 26.626 | 8.263 | 6.609 | 6.976 | 22.090 | 29.939 | 16.335 | 40.516 | 31.223 |
| 5+ | 3.360 | 0.550 | 3.318 | 4.030 | 4.119 | 3.709 | 10.149 | 15.106 | 7.404 | 7.452 | 20.394 | 8.140 | 5.951 | 4.318 | 20.344 | 23.837 | 14.531 | 34.947 | 29.161 |
| 6+ | 2.669 | 0.428 | 2.175 | 1.666 | 3.325 | 2.840 | 6.301 | 9.214 | 4.557 | 5.039 | 8.701 | 6.563 | 5.587 | 3.687 | 14.151 | 15.320 | 11.725 | 22.533 | 22.955 |

Table 17. Input parameters and yield per recruit analysis for pollock in divs. 4VWX and Subdiv. 5Zc.

SUMMARY:

| AGE | WEIGHT-AT-AGE | PARTIAL RECRUITMENT |
|---|---|---|
| 1 | .400 | .000 |
| 2 | .869 | .012 |
| 3 | 1.445 | .163 |
| 4 | 2.130 | .411 |
| 5 | 2.820 | .670 |
| 6 | 3.499 | .851 |
| 7 | 4.150 | 1.000 |
| 8 | 4.951 | 1.000 |
| 9 | 5.784 | 1.000 |
| 10 | 6.755 | 1.000 |
| 11 | 7.346 | 1.000 |
| 12 | 8.453 | 1.000 |
| 13 | 8.900 | 1.000 |
| 14 | 9.500 | 1.000 |
| 15 | 9.900 | 1.000 |
| 16 | 9.980 | 1.000 |

NATURAL MORTALITY RATE : 0.2
F0.1 COMPUTED AS .2377 AT Y/R OF .9767
FMAX COMPUTED AS .6850 AT Y/R OF 1.0944

| | FISHING MORTALITY | CATCH (NUMBER) | YIELD (KG) | AVG. WEIGHT (KG) | YIELD PER UNIT EFFORT |
|---|---|---|---|---|---|
| | .1000 | .157 | .676 | 4.315 | 1.645 |
| | .2000 | .242 | .928 | 3.829 | 1.130 |
| F0.1--- | .2377 | .265 | .977 | 3.682 | 1.000 |
| | .3000 | .296 | 1.028 | 3.473 | .834 |
| | .4000 | .333 | 1.070 | 3.211 | .651 |
| | .5000 | .361 | 1.087 | 3.012 | .529 |
| | .6000 | .382 | 1.093 | 2.858 | .443 |
| FMAX--- | .6850 | .398 | 1.094 | 2.752 | .389 |
| | .7000 | .400 | 1.094 | 2.735 | .380 |
| | .8000 | .415 | 1.093 | 2.634 | .332 |
| | .9000 | .428 | 1.090 | 2.549 | .295 |
| | 1.0000 | .439 | 1.086 | 2.476 | .264 |
| | 1.1000 | .448 | 1.082 | 2.413 | .239 |
| | 1.2000 | .457 | 1.078 | 2.358 | .219 |
| | 1.3000 | .465 | 1.073 | 2.309 | .201 |
| | 1.4000 | .472 | 1.069 | 2.265 | .186 |
| | 1.5000 | .479 | 1.065 | 2.225 | .173 |

Table 18. Survey coefficients of variation (C.V.'s) 1974-1988.

| Age | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 1.051 | .508 | .452 | .720 | .704 | .418 | .440 | .548 | .709 | .468 | .386 | .788 | .356 | .682 | .282 |
| 5 | .470 | .452 | .552 | .852 | .651 | .354 | .414 | .579 | .656 | .557 | .359 | .565 | .233 | .618 | .403 |
| 6 | .502 | .390 | .646 | .747 | .416 | .340 | .422 | .357 | .583 | .282 | .314 | .302 | .193 | .419 | .492 |
| 7 | .373 | .351 | .706 | .618 | .339 | .423 | .472 | .304 | .372 | .509 | .521 | .319 | .185 | .321 | .537 |
| 8 | .433 | .699 | .706 | .631 | .354 | .441 | .452 | .306 | .287 | .400 | .395 | .314 | .232 | .296 | .601 |
| 9 | .339 | .378 | .656 | .403 | .288 | .563 | .484 | .312 | .268 | .256 | .344 | .386 | .375 | .422 | .613 |

Table 19. ADAPT summary for divs. 4VWX + Subdiv. 5Zc pollock.

Parameters

Year-class estimates

$N_i$ 1988 i = 6 to 9

Calibration constants for July RV numbers

$K_i$ i = 4 to 9

Structure Imposed

- natural mortality equal to 0.2
- error in catch-at-age assumed negligible
- no intercepts
- partial recruitment for ages 2 - 5 in 1988 was the average from 1977-1985 and ages 10 and 11 were set to 1.0.

| Age | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| PR | .012 | .163 | .411 | .670 | .851 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |

- F for oldest age groups calculated as a weighted F for ages 7, 8 and 9

Input

- $C_{i,t}$ i = 2 to 11 t = 1974-1988
- $RV_{i,t}$ i = 4 to 9 t = 1974-1988

Objective Function

- log transformation
- minimize
- $i \Sigma_t \Sigma_i$ (obs.(Ln $RV_{i,t}$) - pred (Ln $RV_{i,t}$))$^2$

Summary

- number of observations = 87 (The 1983 year class at ages 4 and 5 and the 1984 year class at age 4 were not used.)
- number of parameters = 10

Table 20. Final parameter estimates and significant statistics for age 6 - 9 numbers and 4 - 9 slopes from ADAPT. Correlation matrix pertains to the correlations between the estimated parameters.

ESTIMATED PARAMETERS AND STANDARD ERRORS
APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET..... 0.008407
MEAN SQUARE RESIDUALS ..... 0.462981

| PAR. EST. | STD. ERR. | T-STATISTIC |
|---|---|---|
| 2.19911E0004 | 9.38425E0003 | 2.34341E0000 |
| 9.55906E0003 | 3.73892E0003 | 2.55663E0000 |
| 4.89020E0003 | 1.99897E0003 | 2.44637E0000 |
| 2.77813E0003 | 1.12459E0003 | 2.47036E0000 |
| 1.97772E0002 | 3.83602E0001 | 5.15565E0000 |
| 4.73603E0002 | 8.91429E0001 | 5.31285E0000 |
| 5.54952E0002 | 1.02494E0002 | 5.41450E0000 |
| 8.00877E0002 | 1.48854E0002 | 5.38027E0000 |
| 1.27103E0003 | 2.38493E0002 | 5.32941E0000 |
| 1.21658E0003 | 2.30987E0002 | 5.26686E0000 |

Parameter Correlation Matrix

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.000 | .068 | .052 | .039 | -.150 | -.166 | -.193 | -.028 | -.025 | -.025 |
| 2 | .068 | 1.000 | .036 | .057 | -.125 | -.142 | -.176 | -.219 | -.087 | -.135 |
| 3 | .052 | .036 | 1.000 | .084 | -.091 | -.108 | -.139 | -.189 | -.261 | -.132 |
| 4 | .039 | .057 | .084 | 1.000 | -.063 | -.078 | -.108 | -.156 | -.227 | -.334 |
| 5 | -.150 | -.125 | -.091 | -.063 | 1.000 | .050 | .061 | .049 | .043 | .043 |
| 6 | -.166 | -.142 | -.108 | -.078 | .050 | 1.000 | .070 | .058 | .051 | .052 |
| 7 | -.193 | -.176 | -.139 | -.108 | .061 | .070 | 1.000 | .074 | .067 | .068 |
| 8 | -.028 | -.219 | -.189 | -.156 | .049 | .058 | .074 | 1.000 | .092 | .094 |
| 9 | -.025 | -.087 | -.261 | -.227 | .043 | .051 | .067 | .092 | 1.000 | .109 |
| 10 | -.025 | -.135 | -.132 | -.334 | .043 | .052 | .068 | .094 | .109 | 1.000 |

Table 21. Residuals between observed RV (log transformed) and the predicted RV by age and year.

Standardized Residuals for RV index (s.e.=1 for log model)

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 |
|---|---|---|---|---|---|---|---|---|---|
| 4 | -.560 | -.655 | .583 | .503 | -.396 | -.579 | 2.095 | -.764 | -.164 |
| 5 | -.941 | -.467 | .401 | 1.328 | .081 | -.578 | 1.175 | -.149 | -.244 |
| 6 | -.798 | -.025 | .187 | 1.093 | .009 | .009 | .343 | -.677 | .131 |
| 7 | .286 | -.939 | .909 | .184 | .068 | -.153 | .486 | -.574 | -.984 |
| 8 | .096 | .425 | .730 | 1.027 | .097 | -.401 | -.210 | -.332 | -.996 |
| 9 | .272 | .206 | .489 | 1.061 | .503 | -1.435 | -.628 | -.225 | -.001 |

| | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|
| 4 | -.033 | -.535 | 1.072 | -.566 | .000 | .000 |
| 5 | -.885 | -.271 | .555 | -.710 | .705 | .000 |
| 6 | -.772 | -.147 | .443 | -.020 | .403 | -.179 |
| 7 | -.904 | .768 | .503 | -.263 | .353 | .261 |
| 8 | -.693 | .813 | .169 | -.867 | .223 | -.081 |
| 9 | .102 | .819 | .565 | -1.503 | -.328 | .103 |

Table 22. Fishing mortality matrix for 4VWX5 pollock.

FISHING MORTALITY

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 |
|---|---|---|---|---|---|---|---|---|---|
| 2 | .013 | .007 | .005 | .001 | .001 | .021 | .013 | .001 | .003 |
| 3 | .251 | .089 | .073 | .056 | .024 | .204 | .082 | .131 | .067 |
| 4 | .340 | .288 | .238 | .217 | .159 | .235 | .206 | .279 | .227 |
| 5 | .376 | .491 | .461 | .352 | .382 | .269 | .351 | .376 | .394 |
| 6 | .494 | .599 | .516 | .558 | .460 | .377 | .419 | .498 | .693 |
| 7 | .571 | .914 | .850 | .809 | .669 | .350 | .435 | .674 | .595 |
| 8 | .678 | .867 | .603 | .985 | .765 | .286 | .313 | .591 | .727 |
| 9 | .510 | .510 | .377 | .749 | 1.217 | .293 | .318 | .426 | .789 |
| 10 | .758 | .873 | .237 | .350 | .245 | .368 | .342 | .517 | .758 |
| 11 | .602 | .871 | .765 | .839 | .706 | .324 | .390 | .627 | .651 |

| | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|
| 2 | .002 | .000 | .001 | .000 | .001 | .004 |
| 3 | .056 | .021 | .012 | .012 | .019 | .051 |
| 4 | .241 | .133 | .083 | .079 | .103 | .128 |
| 5 | .282 | .291 | .230 | .189 | .188 | .208 |
| 6 | .294 | .228 | .444 | .323 | .291 | .190 |
| 7 | .420 | .179 | .779 | .455 | .369 | .248 |
| 8 | .455 | .316 | .390 | .529 | .444 | .317 |
| 9 | .751 | .196 | .332 | .462 | .643 | .516 |
| 10 | .941 | .348 | .333 | .547 | .392 | .311 |
| 11 | .519 | .243 | .582 | .463 | .405 | .311 |

Table 23 . Beginning of year population numbers for 4VWX5 pollock

POPULATION NUMBERS (000S)

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 17011 | 26336 | 37107 | 46791 | 30244 | 5105 | 14861 | 77931 | 49200 |
| 3 | 27914 | 13749 | 21404 | 30219 | 38276 | 16553 | 4091 | 12013 | 63710 |
| 4 | 10215 | 17784 | 10299 | 16293 | 23405 | 30582 | 11052 | 3086 | 8624 |
| 5 | 8310 | 5955 | 10920 | 6646 | 10740 | 16340 | 19803 | 7362 | 1912 |
| 6 | 3085 | 4671 | 2985 | 5639 | 3826 | 6003 | 10228 | 11413 | 4140 |
| 7 | 806 | 1541 | 2102 | 1458 | 2643 | 1978 | 3372 | 5506 | 5681 |
| 8 | 368 | 373 | 506 | 736 | 531 | 1108 | 1141 | 1788 | 2297 |
| 9 | 221 | 153 | 128 | 227 | 225 | 202 | 682 | 684 | 811 |
| 10 | 173 | 109 | 75 | 72 | 88 | 55 | 124 | 406 | 365 |
| 11 | 178 | 66 | 37 | 49 | 42 | 56 | 31 | 72 | 198 |
| | 68279 | 70738 | 85563 | 108129 | 100021 | 77983 | 65385 | 120261 | 136938 |

| | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|
| 2 | 46408 | 64325 | 39584 | 35732 | 18025 | 8296 |
| 3 | 40150 | 37935 | 52644 | 32363 | 29250 | 14748 |
| 4 | 48779 | 31073 | 30405 | 42603 | 26182 | 23508 |
| 5 | 5627 | 31384 | 22272 | 22906 | 32245 | 19338 |
| 6 | 1056 | 3474 | 19200 | 14483 | 15521 | 21885 |
| 7 | 1695 | 645 | 2264 | 10083 | 8581 | 9504 |
| 8 | 2566 | 912 | 442 | 850 | 5239 | 4856 |
| 9 | 909 | 1333 | 544 | 245 | 410 | 2750 |
| 10 | 301 | 351 | 897 | 320 | 126 | 177 |
| 11 | 140 | 96 | 203 | 526 | 151 | 70 |
| | 147632 | 171527 | 168454 | 160111 | 135731 | 105132 |

Table 24 . Mid-year biomass for Divs. 4VWX and Subdiv. 5Ze pollock.

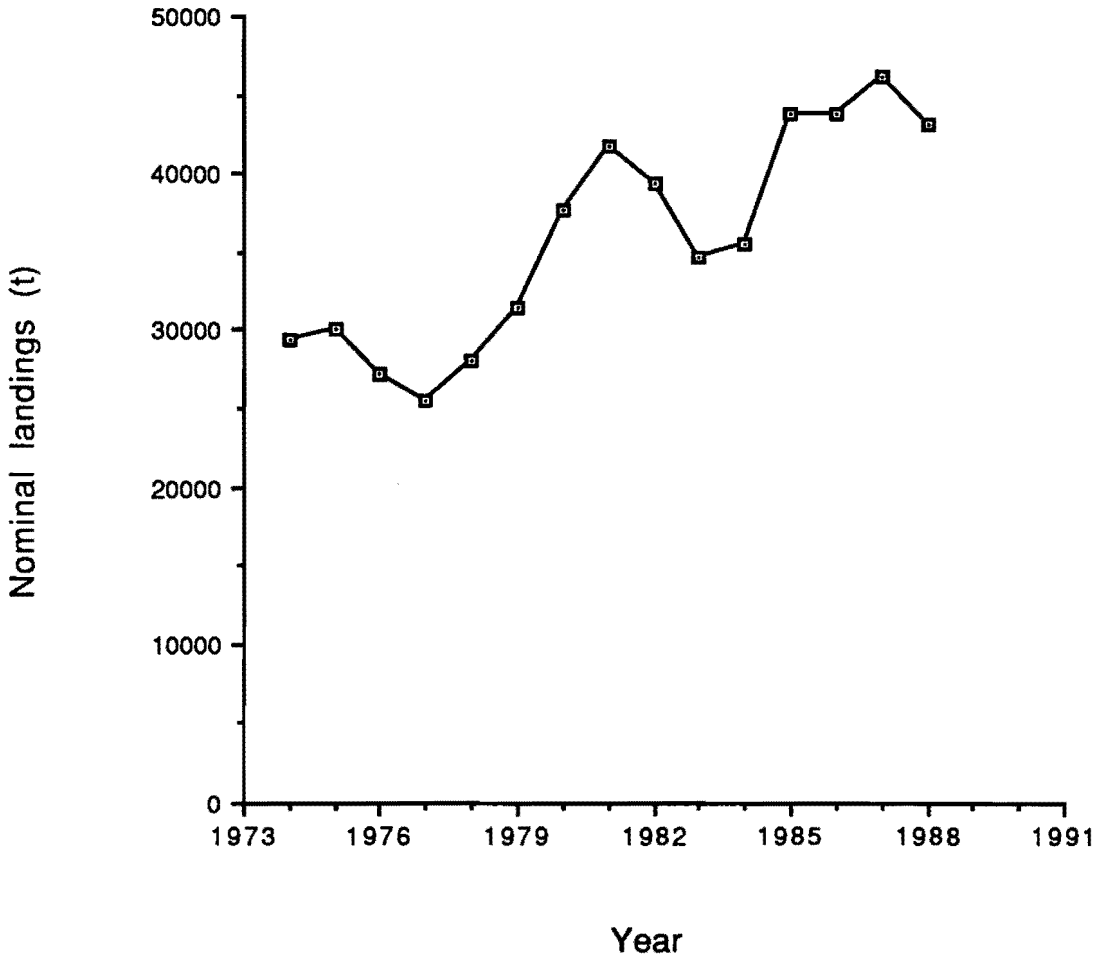
| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 12491 | 20372 | 19750 | 33395 | 20883 | 3529 | 13824 | 56554 | 33462 |
| 3 | 31071 | 15026 | 23627 | 29233 | 42318 | 16066 | 5997 | 17768 | 67969 |
| 4 | 15325 | 27400 | 15980 | 20209 | 35482 | 38535 | 19906 | 6216 | 18916 |
| 5 | 18915 | 13155 | 22488 | 12669 | 21154 | 34225 | 42208 | 16283 | 5068 |
| 6 | 9103 | 12263 | 7908 | 13852 | 10920 | 15520 | 26348 | 27473 | 11445 |
| 7 | 2852 | 4704 | 6083 | 4148 | 8105 | 6602 | 10281 | 15850 | 17447 |
| 8 | 1507 | 1496 | 1963 | 2358 | 2052 | 4867 | 4991 | 7313 | 7775 |
| 9 | 1055 | 919 | 625 | 969 | 931 | 1057 | 3461 | 3513 | 3135 |
| 10 | 822 | 199 | 474 | 402 | 522 | 297 | 866 | 2252 | 1795 |
| 11 | 1049 | 335 | 209 | 302 | 230 | 385 | 196 | 369 | 1068 |

| | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|
| 2 | 32121 | 82627 | 23146 | 21373 | 9977 | 8538 |
| 3 | 44147 | 57266 | 66507 | 39059 | 34183 | 18273 |
| 4 | 65712 | 62452 | 51736 | 75095 | 44011 | 38196 |
| 5 | 13952 | 66173 | 49501 | 47867 | 66643 | 41888 |
| 6 | 3435 | 10856 | 44197 | 27066 | 36115 | 57979 |
| 7 | 6096 | 2896 | 4942 | 26679 | 24271 | 26831 |
| 8 | 9543 | 4244 | 1464 | 2524 | 15592 | 15052 |
| 9 | 3419 | 6487 | 2575 | 1014 | 1261 | 8659 |
| 10 | 1166 | 1709 | 4075 | 1372 | 599 | 728 |
| 11 | 798 | 596 | 870 | 2348 | 705 | 439 |

Table 25. Divs. 4VWX and Subdiv. 5Zc pollock stock projections for 1990 assuming a 1989 catch of 43,000 t and fishing at $F_{0.1}$ in 1990.

| Age | Population Numbers (000's) | Catch Biomass (t) | Population Biomass (t) | Fishing mortality |
|---|---|---|---|---|
| 2 | 30000 | 65 | 21802 | .003 |
| 3 | 24475 | 1197 | 29364 | .041 |
| 4 | 19095 | 3318 | 32292 | .103 |
| 5 | 8360 | 2988 | 17840 | .168 |
| 6 | 11513 | 6301 | 29619 | .213 |
| 7 | 8348 | 6067 | 24269 | .250 |
| 8 | 8593 | 7179 | 28717 | .250 |
| 9 | 3579 | 3509 | 14037 | .250 |
| 10 | 1829 | 2165 | 8660 | .250 |
| 11 | 1036 | 1414 | 5655 | .250 |
| Total | 116828 | 34203 | 212255 | |

Fig.1. Nominal landings for all countries of Divs. 4VWX and Subdiv. 5Zc pollock.



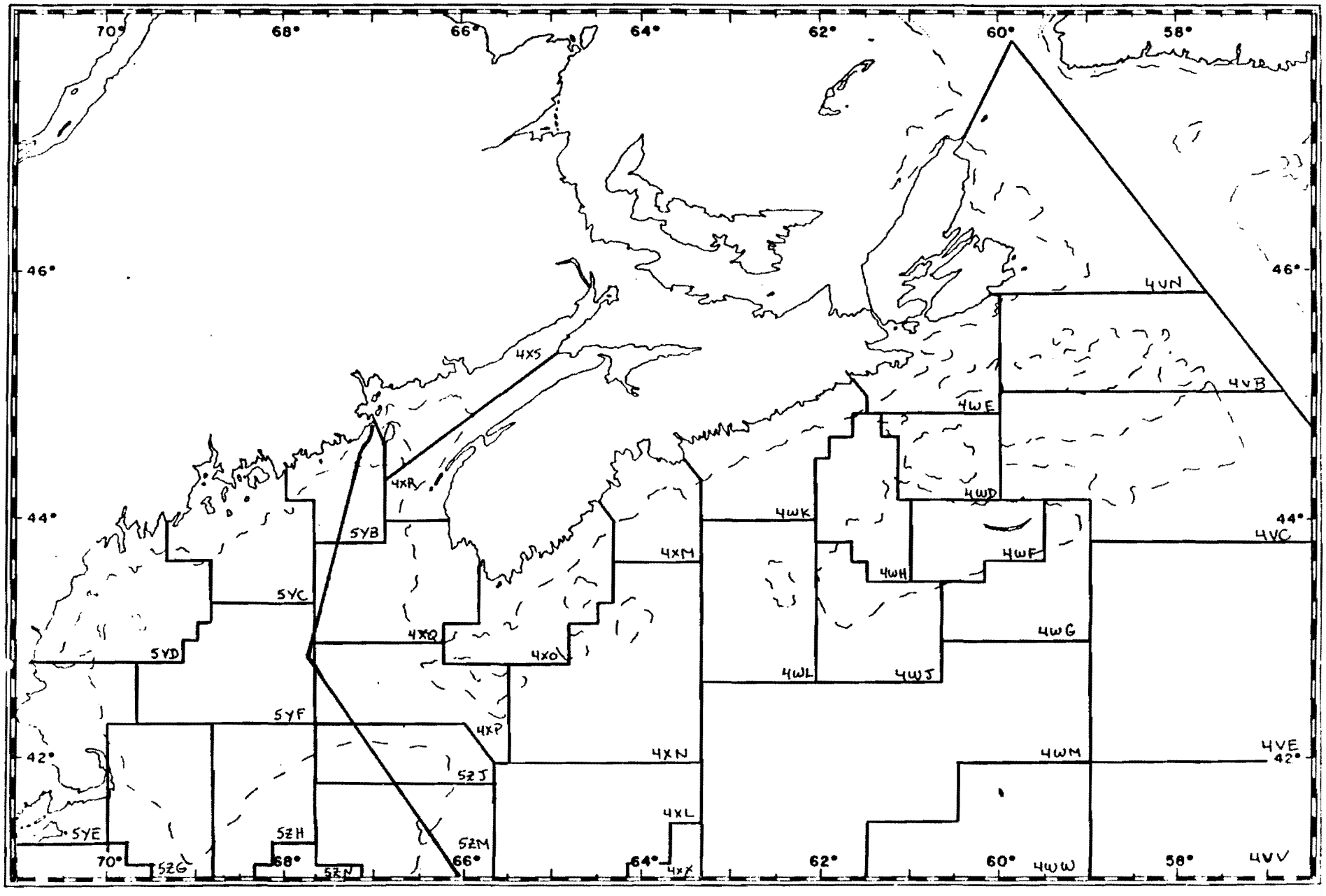
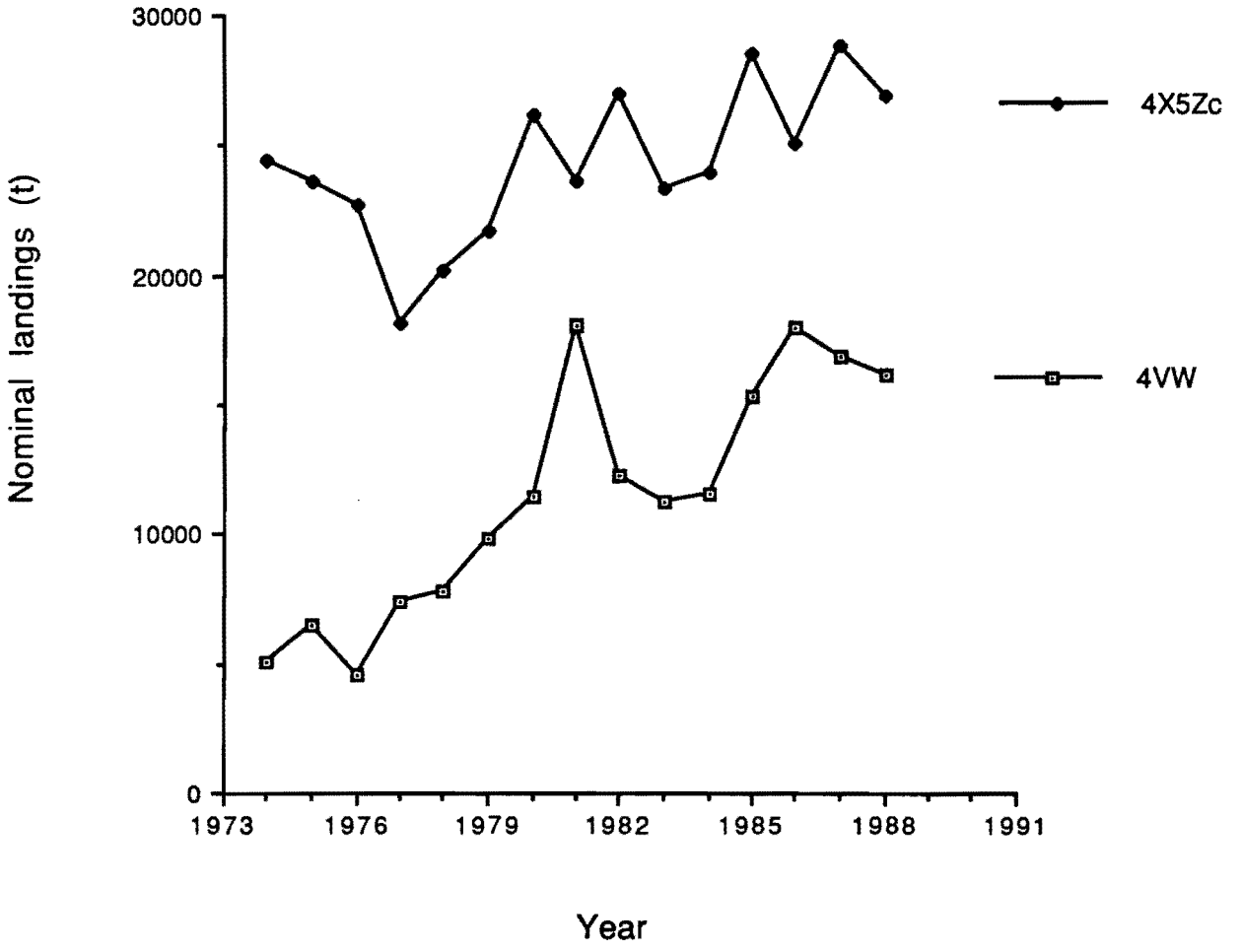



Figure 2. Diagram of ICJ line which now defines the boundary for the new management unit for 4VWX5 pollock.

Fig. 3. Nominal landings for all countries of Divs. 4VWX and Subdiv. 5Zc pollock.



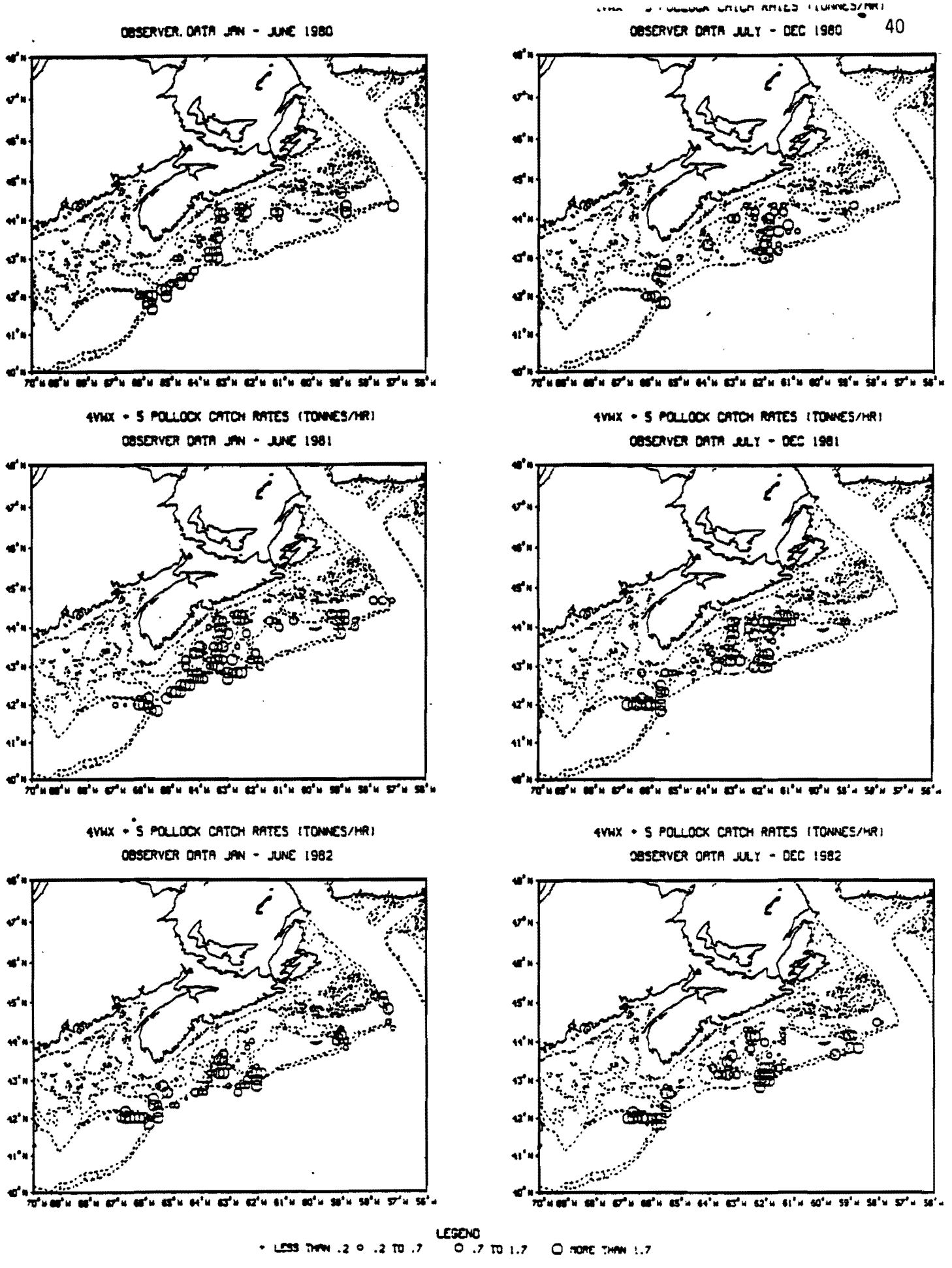
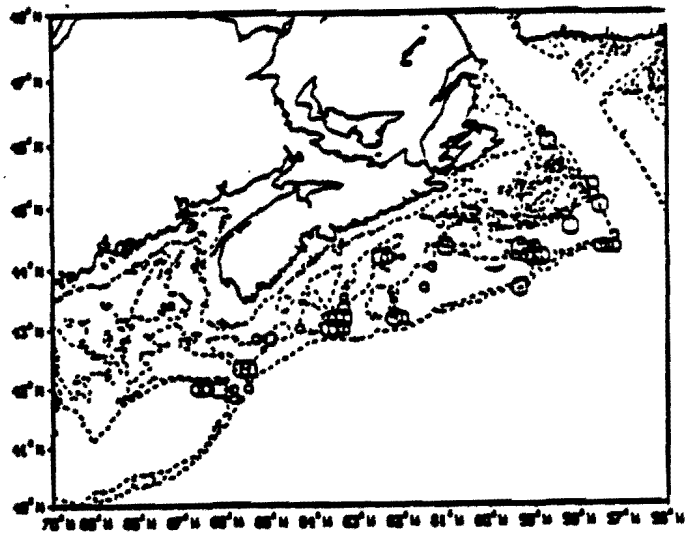
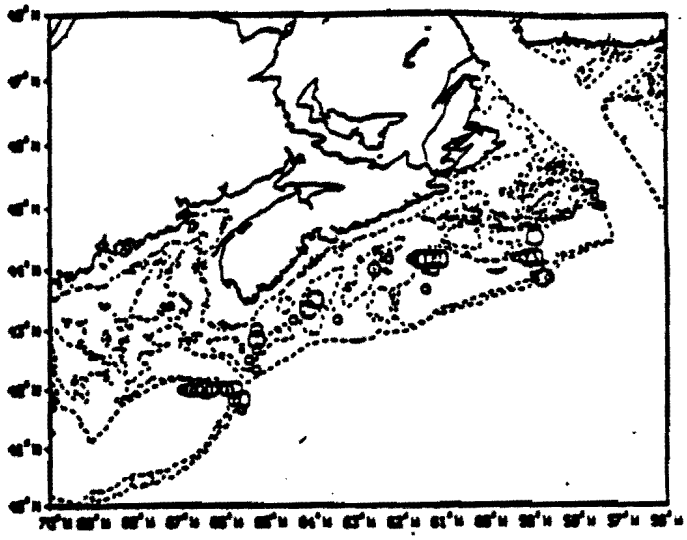


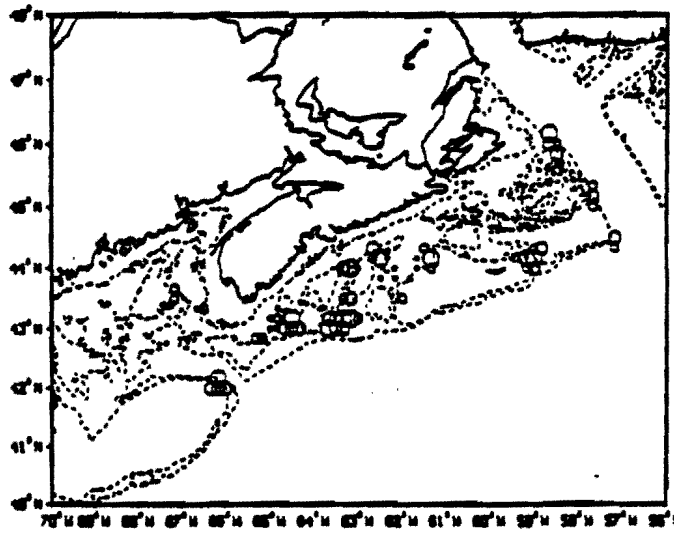

Figure 4. International Observer plots of catch rates for pollock (Jan.-June; July-Dec.; 1980-1987).



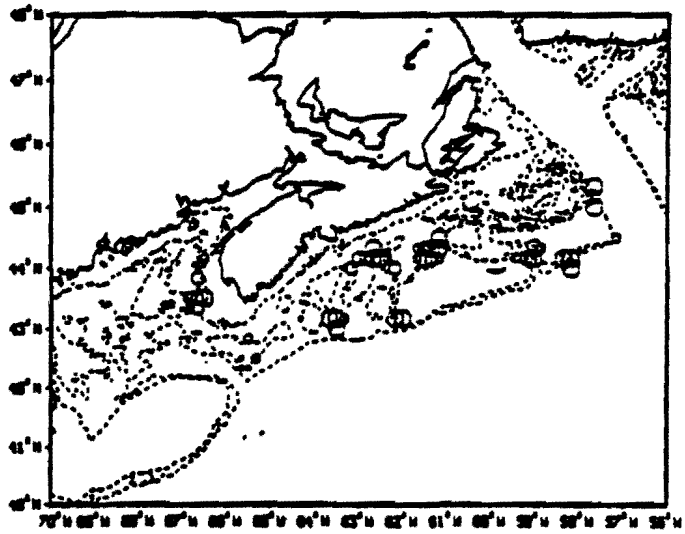
4VWX + 5 POLLOCK CATCH RATES (TONNES/HR)
OBSERVER DATA JAN - JUNE 1984



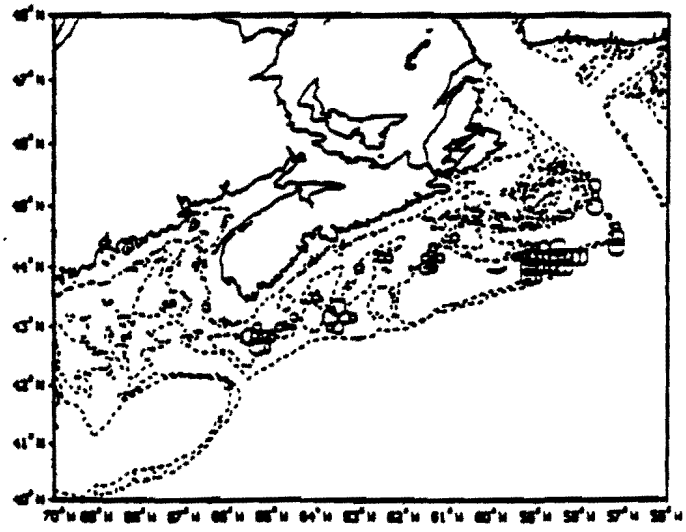
4VWX + 5 POLLOCK CATCH RATES (TONNES/HR)
OBSERVER DATA JULY - DEC 1984



4VWX + 5 POLLOCK CATCH RATES (TONNES/HR)
OBSERVER DATA JAN - JUNE 1985



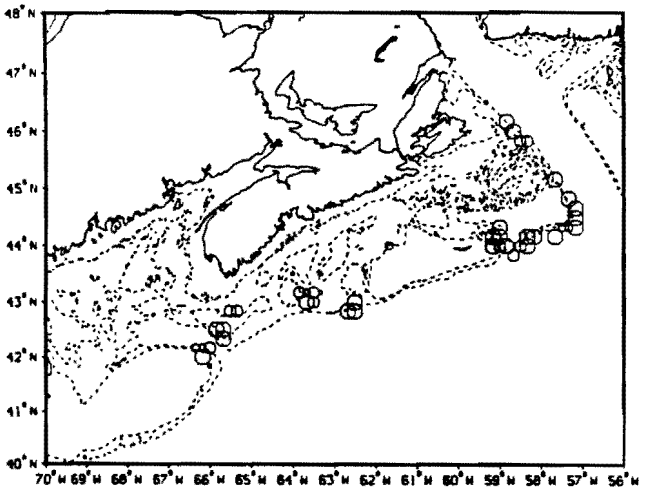
4VWX + 5 POLLOCK CATCH RATES (TONNES/HR)
- OBSERVER DATA JULY - DEC 1985



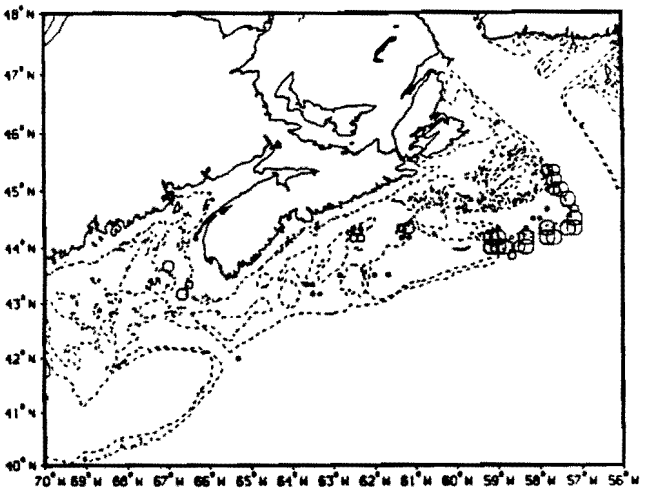
LEGEND
• LESS THAN .2 ○ .2 TO .7 ○ .7 TO 1.7 ○ MORE THAN 1.7

Figure 4. (Continued).

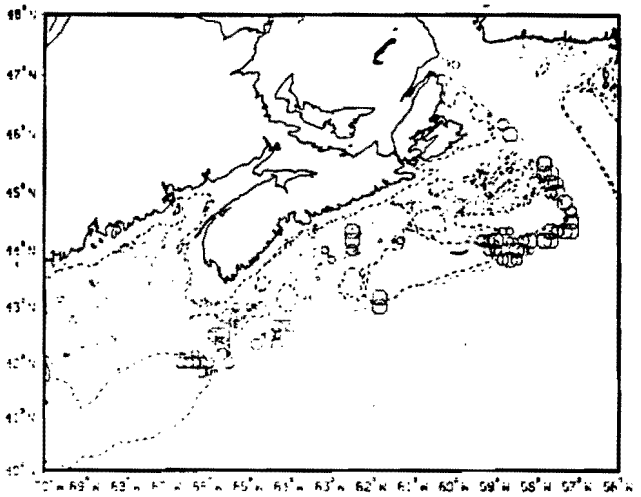
4VWX + 5 POLLOCK CATCH RATES (TONNES/HR)
OBSERVER DATA JAN - JUNE 1986



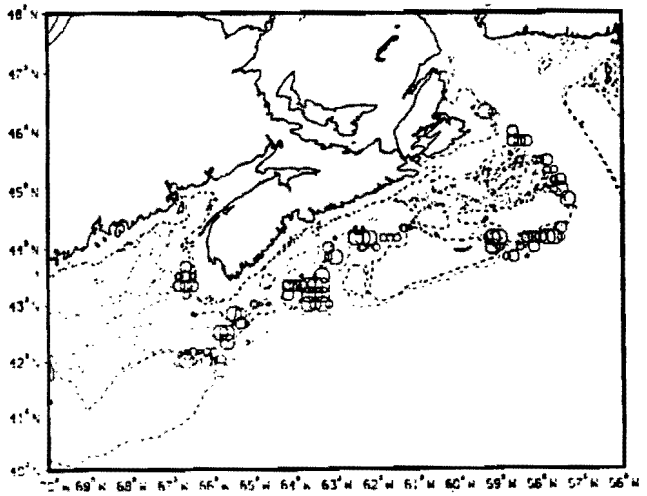
4VWX + 5 POLLOCK CATCH RATES (TONNES/HR)
OBSERVER DATA JULY - DEC 1986



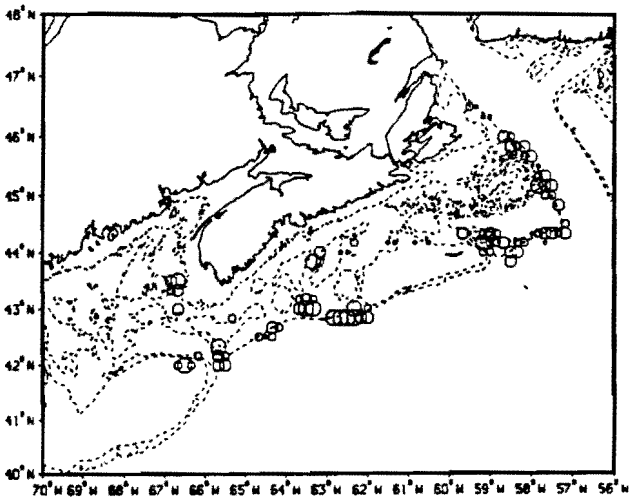
4VWX + 5 POLLOCK CATCH RATES (TONNES/HR)
OBSERVER DATA JAN - JUNE 1987



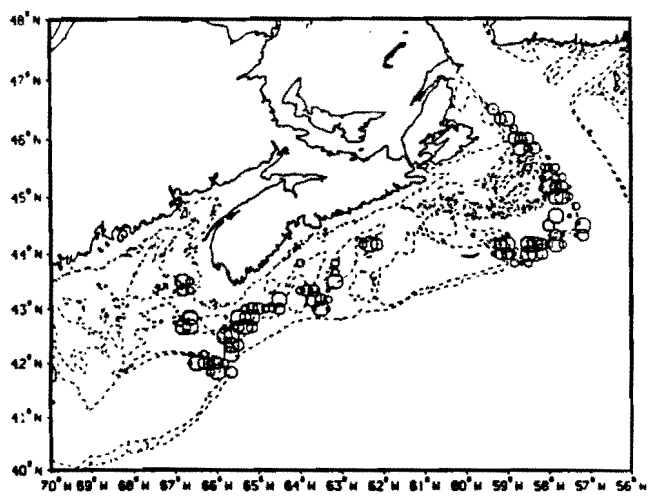
4VWX + 5 POLLOCK CATCH RATES (TONNES/HR)
OBSERVER DATA JULY - DEC 1987



4VWX + 5 POLLOCK CATCH RATES (TONNES/HR)
OBSERVER DATA JAN - JUNE 1988



4VWX + 5 POLLOCK CATCH RATES (TONNES/HR)
OBSERVER DATA JULY - DEC 1988



LEGEND
• LESS THAN .2 ○ .2 TO .7 O .7 TO 1.7 O MORE THAN 1.7

Figure 4. (Continued)

Fig. 5. Comparison of Canadian percent catch at age for large trawlers in 4VW and 4X5Zc.

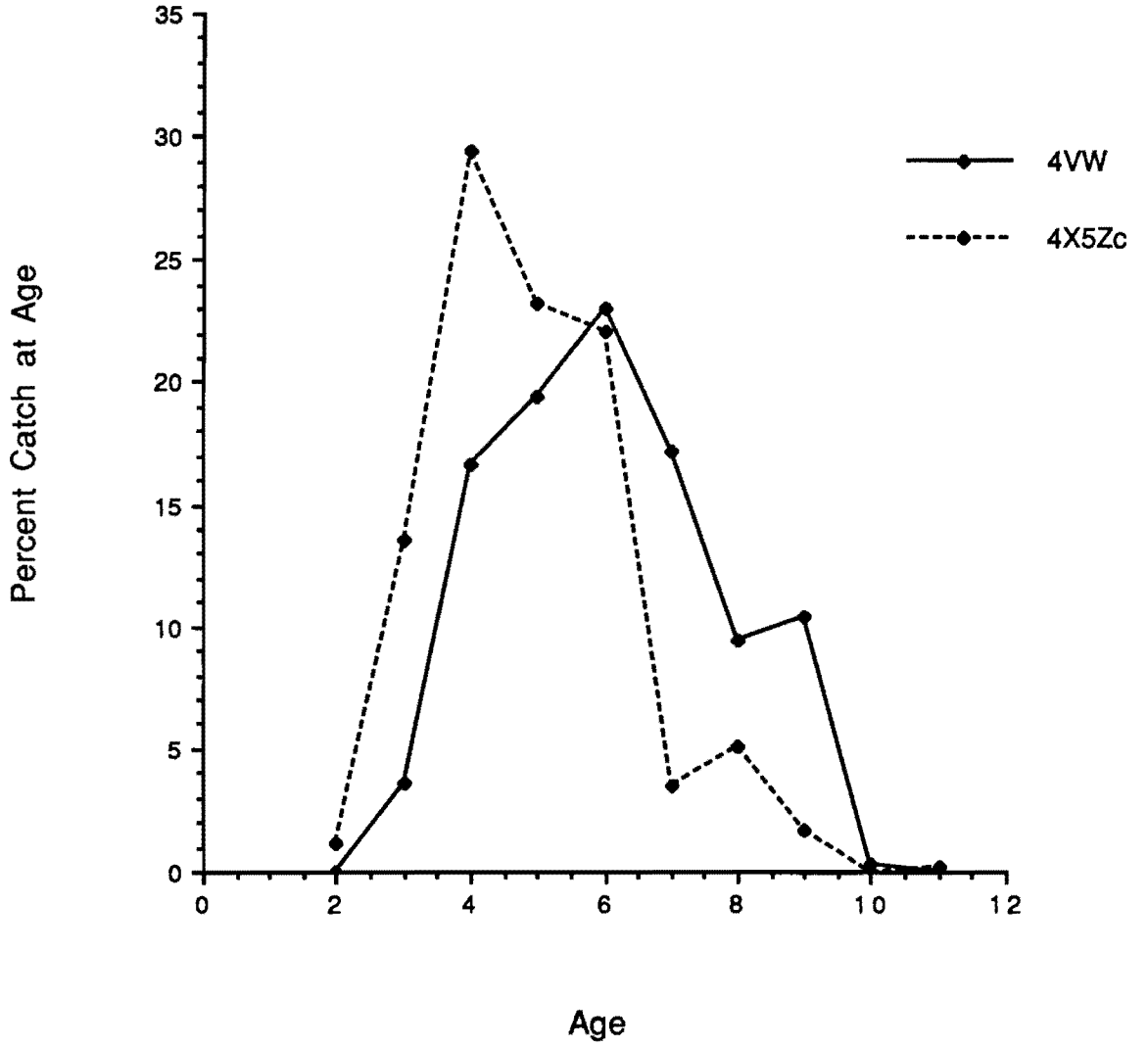
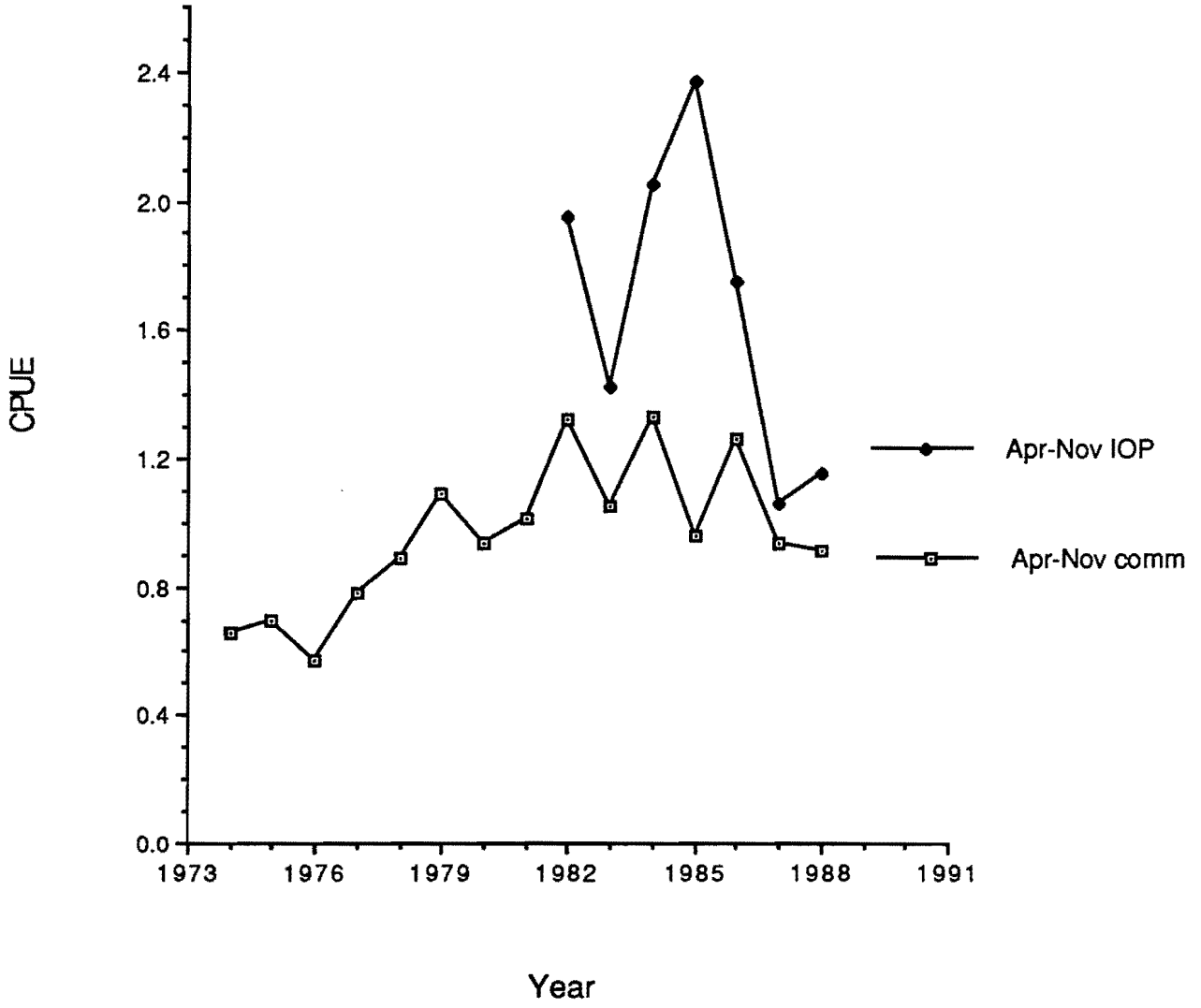


Fig. 6. Catch rate indices for Divs.4VWX and Subdiv. 5Zc pollock (commercial statistics and IOP).



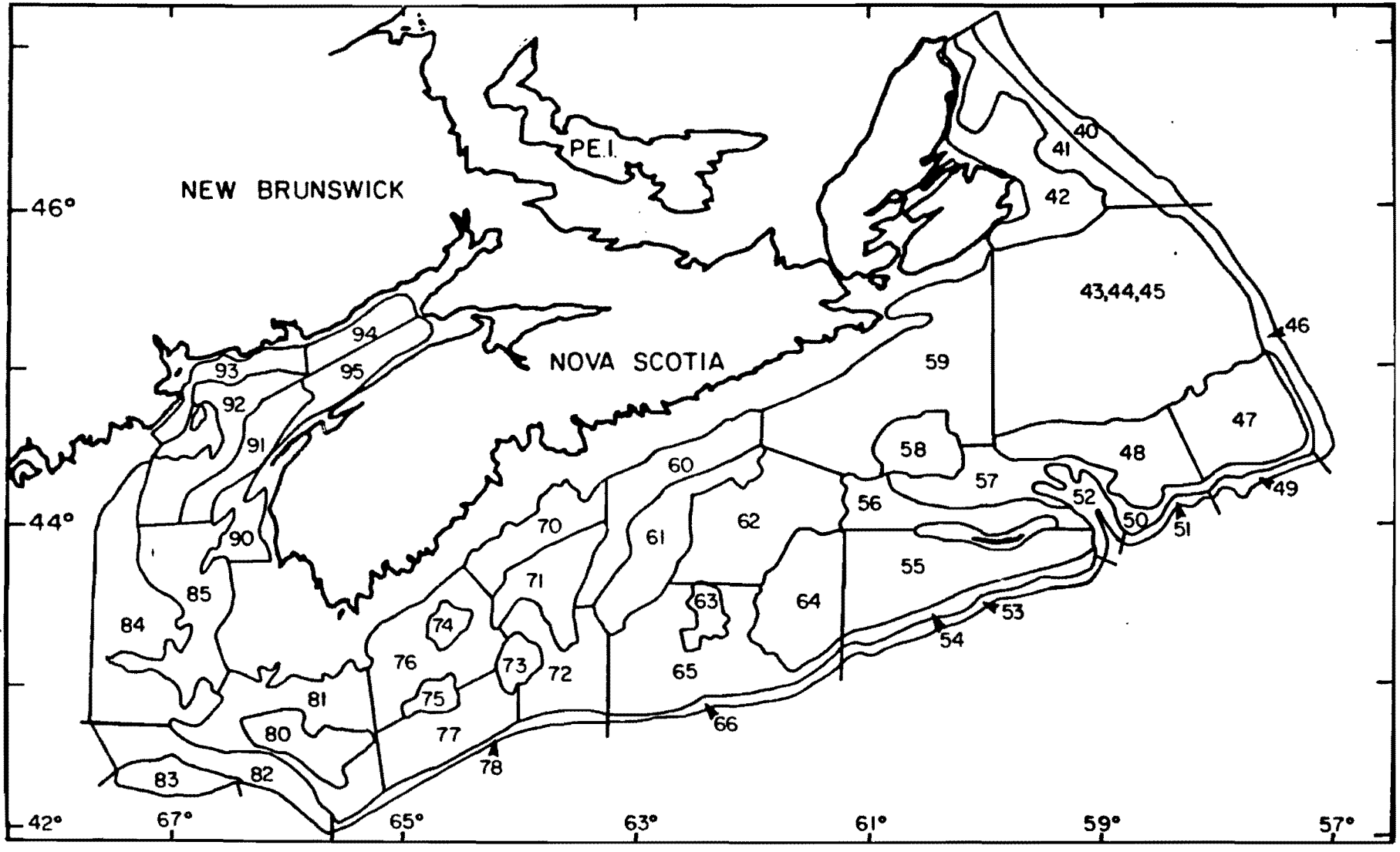



Figure 7. Stratification used for Canadian RV bottom trawl surveys (Divisions 4VWX + Subarea 5).

Fig.8. July RV stratified numbers (ages 4 - 9) for Divs. 4VWX and Subdiv.5Zc pollock.

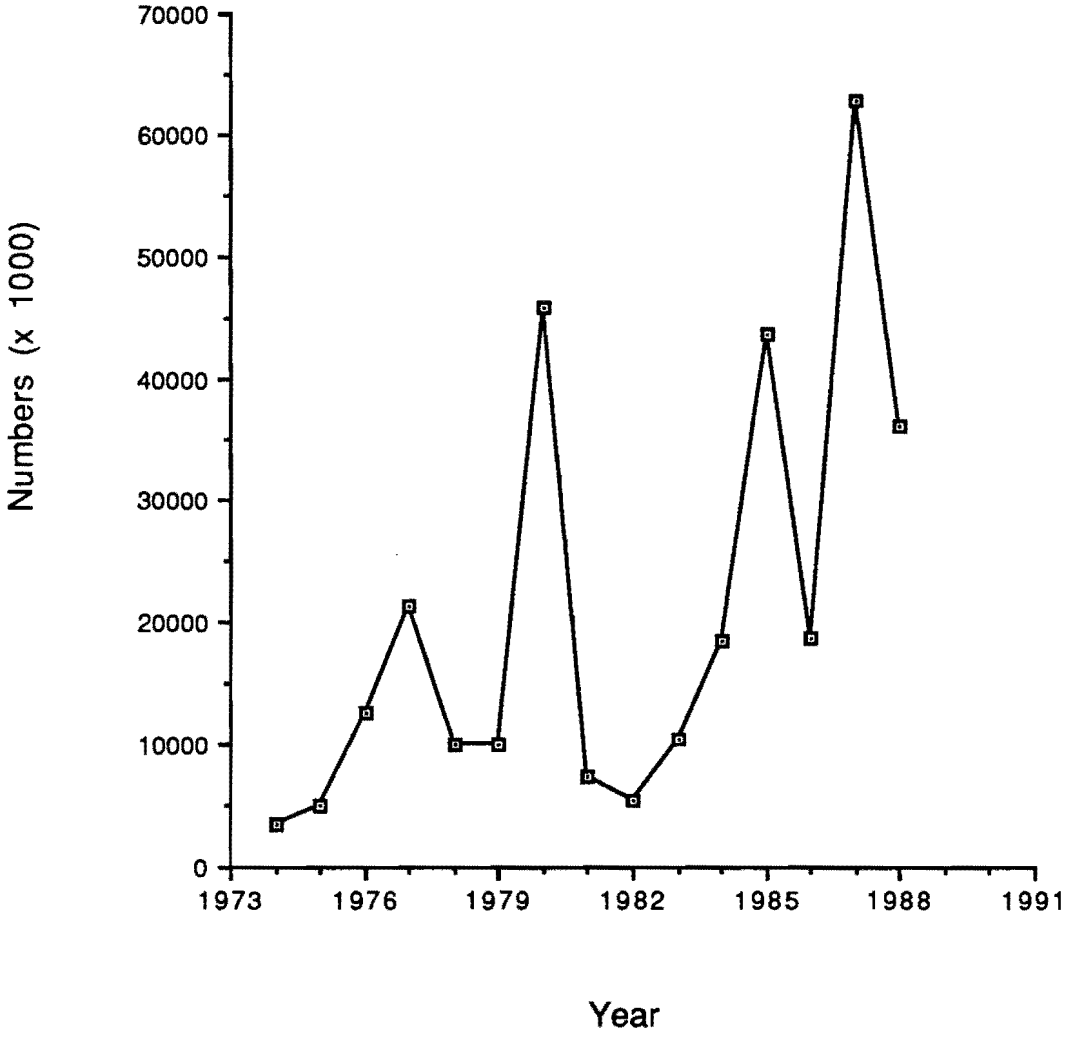


Fig. 9. Age-by-age tuning plots resulting from ADAPT tuning of SPA with RV ages 4 to 9 and age aggregated CPUE.

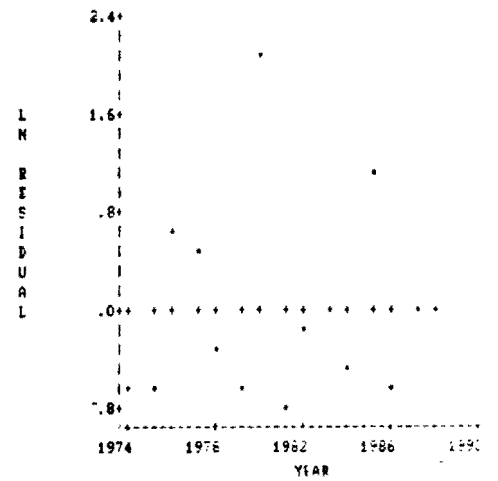


SUMMARY OF DATA FROM PLOT

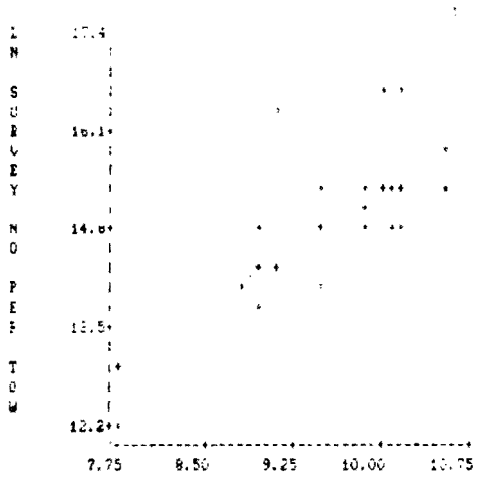
CARRIER VARIABLE: POPULATION NOS
RESPONSE VARIABLE(S): SURVEY - O:OBSERVED, +:PREDICTED

| INDEX | CARRIER | * | + | RANK |
|---|---|---|---|---|
| 1974 | 8.917 | 13.64 | 14.2 | 1981 |
| 1975 | 9.502 | 14.13 | 14.79 | 1982 |
| 1976 | 8.984 | 14.85 | 14.27 | 1974 |
| 1977 | 9.455 | 15.25 | 14.74 | 1976 |
| 1978 | 9.851 | 14.74 | 15.14 | 1980 |
| 1979 | 10.07 | 14.78 | 15.36 | 1977 |
| 1980 | 9.073 | 16.46 | 14.36 | 1975 |
| 1981 | 7.756 | 12.28 | 13.04 | 1978 |
| 1982 | 8.813 | 13.94 | 14.1 | 1988 |
| 1983 | 10.54 | 15.79 | 15.82 | 1987 |
| 1984 | 10.15 | 14.9 | 15.44 | 1979 |
| 1985 | 10.16 | 16.52 | 15.44 | 1984 |
| 1986 | 10.5 | 15.22 | 15.78 | 1985 |
| 1987 | 9.996 | 16.56 | 15.28 | 1986 |
| 1988 | 9.874 | 15.35 | 15.16 | 1983 |

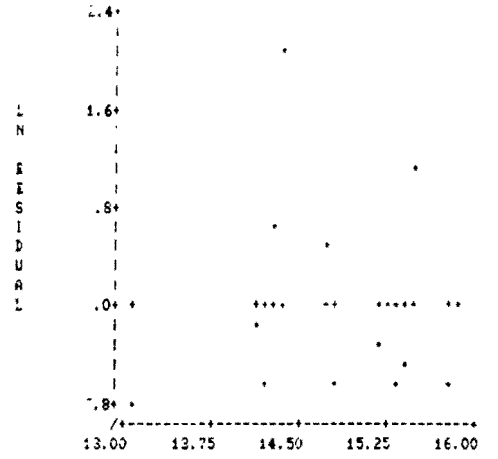
TREND IN LN RESIDUAL OVER TIME



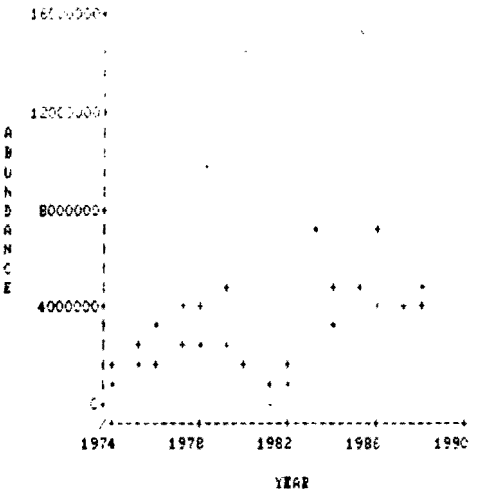

AGE 4 PLOTS
LN SURVEY NO. PER TOW VS LN SPA NUMBERS




LN RESIDUAL VS LN PREDICTED VALUE




?? ... FOR LATIC' -E'NDENT VARIABLE OVER TIME




LN RESIDUAL VS OBSERVED LN X

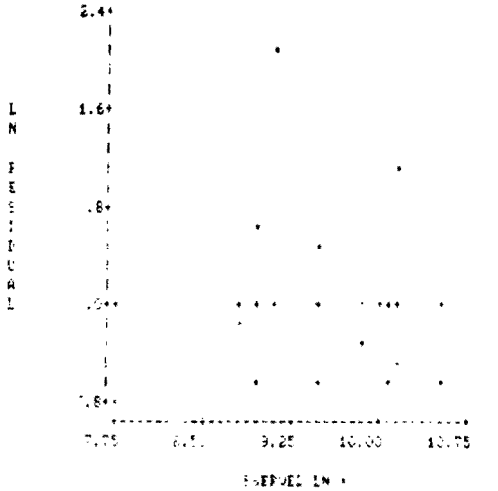


Fig. 9. (Continued)

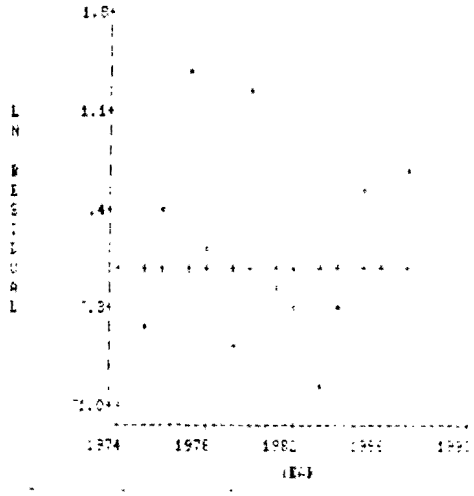


SUMMARY OF DATA FROM PLOT

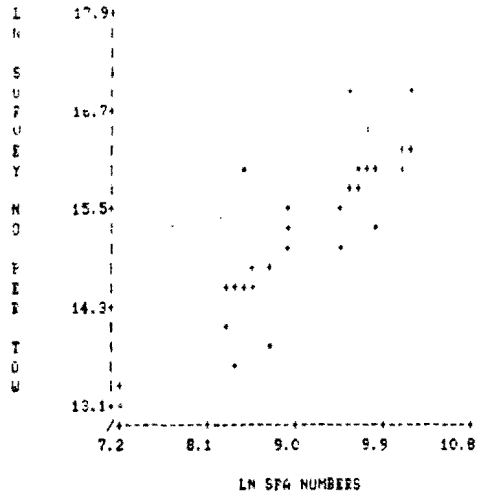
CARRIER VARIABLE: POPULATION NOS
RESPONSE VARIABLE(S): SURVEY - O:OBSERVED, +:PREDICTED

| INDEX | CARRIER | * | + | RANK |
|---|---|---|---|---|
| 1974 | 8.689 | 13.91 | 14.85 | 1982 |
| 1975 | 8.289 | 13.96 | 14.45 | 1975 |
| 1976 | 8.913 | 15.47 | 15.07 | 1983 |
| 1977 | 8.48 | 15.97 | 14.64 | 1977 |
| 1978 | 8.942 | 15.18 | 15.1 | 1981 |
| 1979 | 9.428 | 15.01 | 15.59 | 1974 |
| 1980 | 9.572 | 16.91 | 15.73 | 1976 |
| 1981 | 8.568 | 14.58 | 14.73 | 1978 |
| 1982 | 7.21 | 13.13 | 13.37 | 1979 |
| 1983 | 8.954 | 13.63 | 14.51 | 1980 |
| 1984 | 10.07 | 15.96 | 16.23 | 1989 |
| 1985 | 9.76 | 16.46 | 15.92 | 1985 |
| 1986 | 9.812 | 15.26 | 15.97 | 1988 |
| 1987 | 10.16 | 17.02 | 16.32 | 1984 |
| 1988 | 9.632 | 16.02 | 15.79 | 1987 |

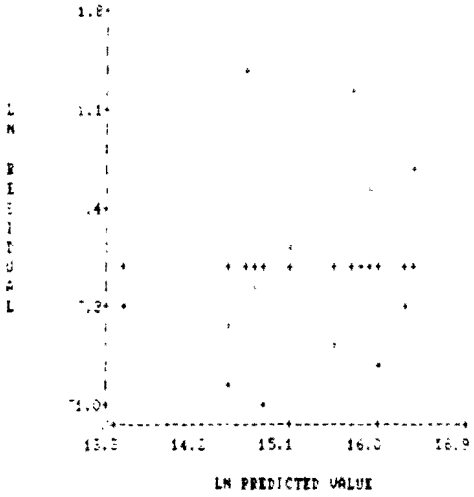
TREND IN LN RESIDUAL OVER TIME



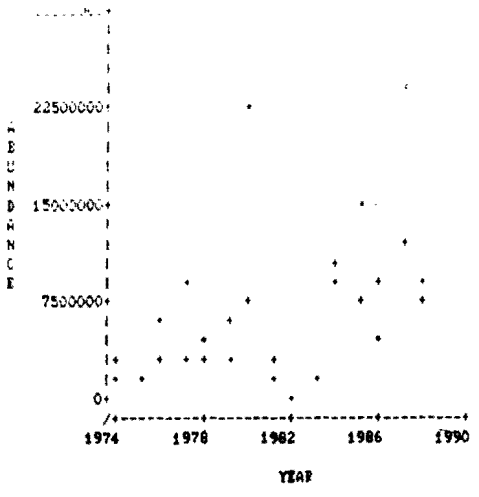

HALF E PLOTS
LN SURVEY NO. PER TOW VS LN SPA NUMBERS



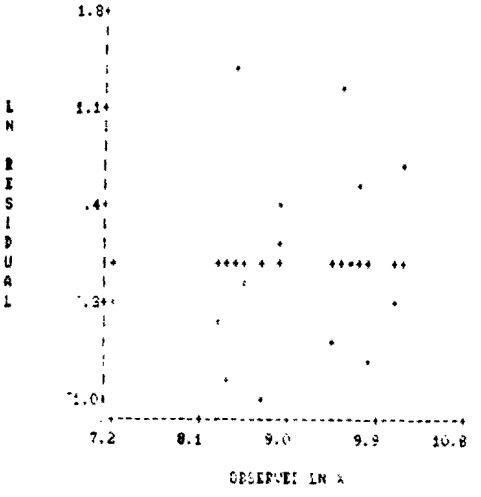

LN RESIDUAL VS LN PREDICTED VALUE




TREND IN POPULATION ABUNDANCE OVER TIME




LN RESIDUAL VS OBSERVED LN Y



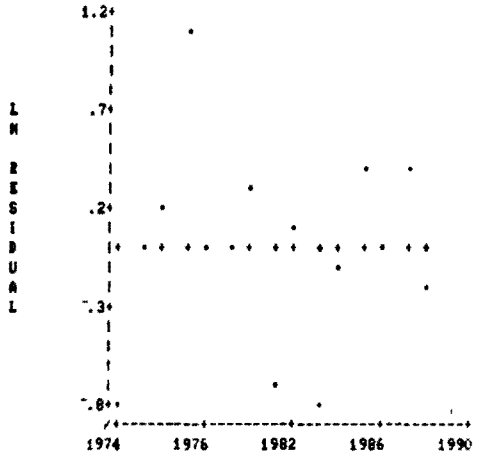
## Fig. 9. (Continued)

SUMMARY OF DATA FROM PLOT

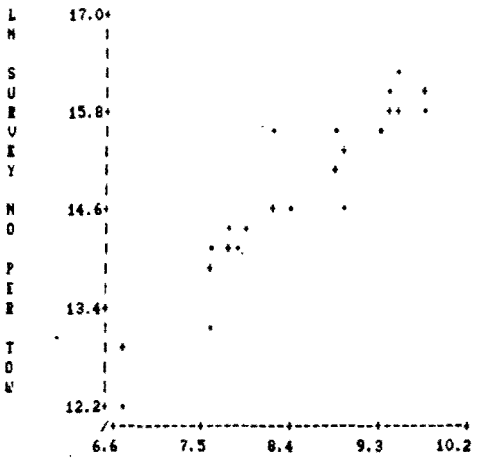
CARRIER VARIABLE: POPULATION NOS
RESPONSE VARIABLE(S): SURVEY - o:OBSERVED, +:PREDICTED

| INDEX | CARRIER | + | + | RANK |
|---|---|---|---|---|
| 1974 | 7.629 | 13.15 | 13.95 | 1983 |
| 1975 | 7.983 | 14.28 | 14.3 | 1976 |
| 1976 | 7.583 | 14.09 | 13.9 | 1974 |
| 1977 | 8.195 | 15.61 | 14.51 | 1982 |
| 1978 | 7.865 | 14.19 | 14.18 | 1978 |
| 1979 | 8.364 | 14.69 | 14.68 | 1984 |
| 1980 | 8.872 | 15.53 | 15.19 | 1975 |
| 1981 | 8.936 | 14.58 | 15.25 | 1977 |
| 1982 | 7.807 | 14.26 | 14.13 | 1979 |
| 1983 | 6.674 | 12.22 | 12.99 | 1980 |
| 1984 | 7.903 | 14.08 | 14.22 | 1981 |
| 1985 | 9.487 | 16.25 | 15.81 | 1986 |
| 1986 | 9.275 | 15.57 | 15.59 | 1987 |
| 1987 | 9.364 | 16.09 | 15.68 | 1985 |
| 1988 | 9.766 | 15.91 | 16.08 | 1988 |

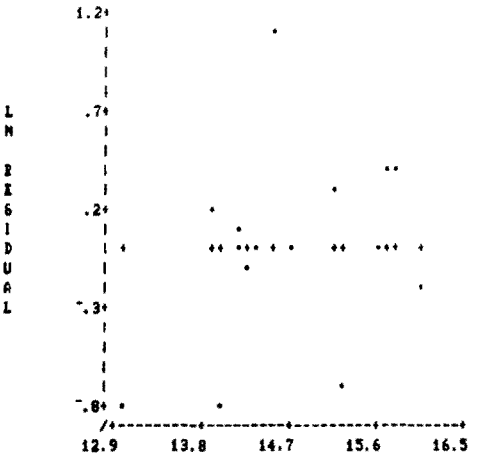
TREND IN LN RESIDUAL OVER TIME



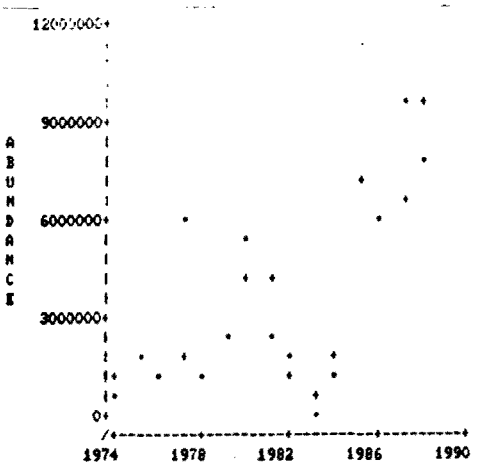

AGE & PLOTS
LN SURVEY NO. PER TOW VS LN SPA NUMBERS




LN RESIDUAL VS LN PREDICTED VALUE




TREND IN POPULATION ABUNDANCE OVER TIME




LN RESIDUAL VS OBSERVED LN X

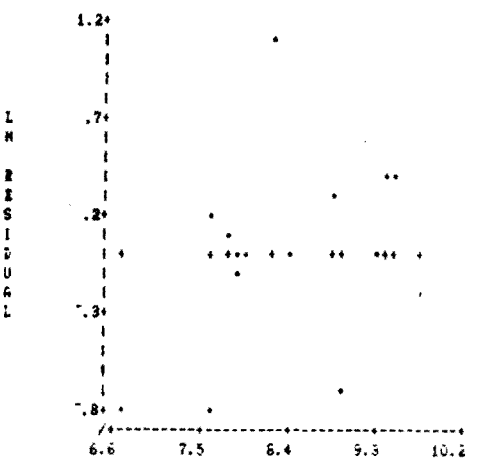


Fig. 9. (Continued)

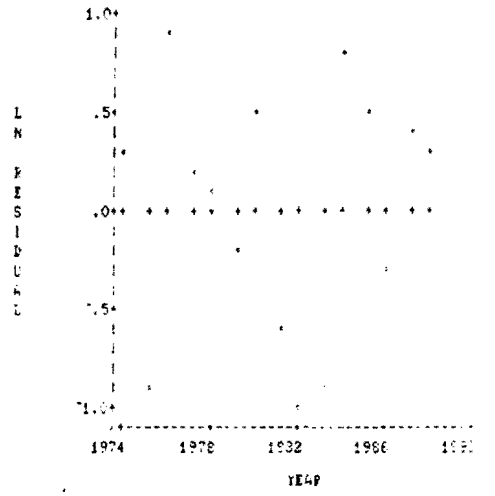


SUMMARY OF DATA FROM PLOT

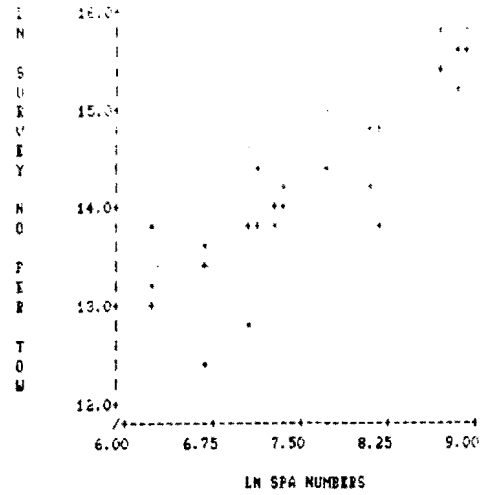
CARRIER VARIABLE: POPULATION NOS
RESPONSE VARIABLE(S): SURVEY - O:OBSERVED, +:PREDICTED

| INDEX | CARRIER | * | + | RANK |
|---|---|---|---|---|
| 1974 | 6.242 | 13.21 | 12.93 | 1974 |
| 1975 | 6.691 | 12.44 | 13.38 | 1964 |
| 1976 | 7.038 | 14.69 | 13.72 | 1975 |
| 1977 | 6.696 | 13.57 | 13.38 | 1977 |
| 1978 | 7.373 | 14.13 | 14.06 | 1976 |
| 1979 | 7.269 | 13.6 | 13.95 | 1963 |
| 1980 | 7.753 | 14.92 | 14.44 | 1985 |
| 1981 | 8.104 | 14.22 | 14.79 | 1979 |
| 1982 | 8.181 | 15.88 | 14.87 | 1978 |
| 1983 | 7.074 | 12.66 | 13.72 | 1987 |
| 1984 | 6.246 | 13.7 | 12.92 | 1981 |
| 1985 | 7.154 | 14.34 | 13.84 | 1982 |
| 1986 | 8.837 | 15.26 | 15.52 | 1987 |
| 1987 | 8.725 | 15.76 | 15.41 | 1986 |
| 1988 | 8.898 | 15.64 | 15.56 | 1988 |

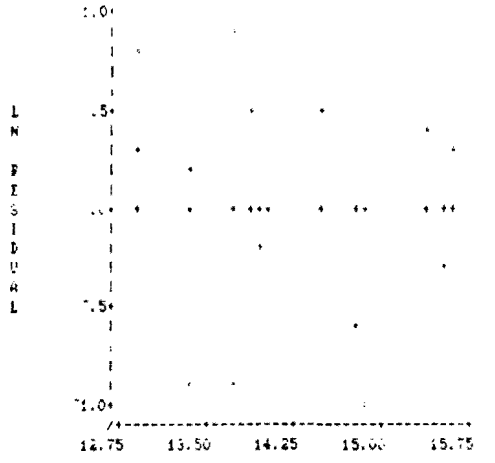
TREND IN LN RESIDUAL OVER TIME



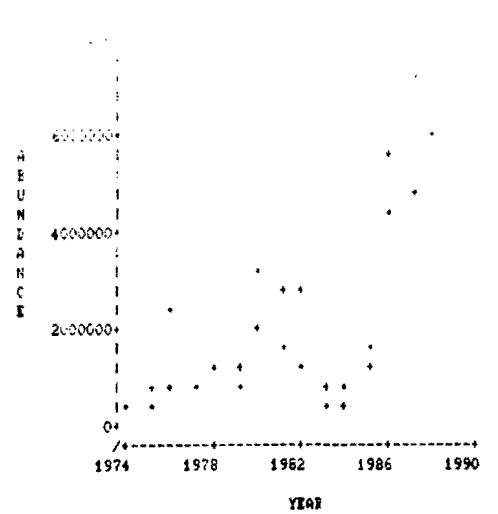

PLOT 7 PLOTS
LN SURVEY NO. PER TOE VS LN SPA NUMBERS




LN RESIDUAL VS LN PREDICTED VALUE




TREND IN POPULATION ABUNDANCE OVER TIME




LN RESIDUAL VS OBSERVED LN Y

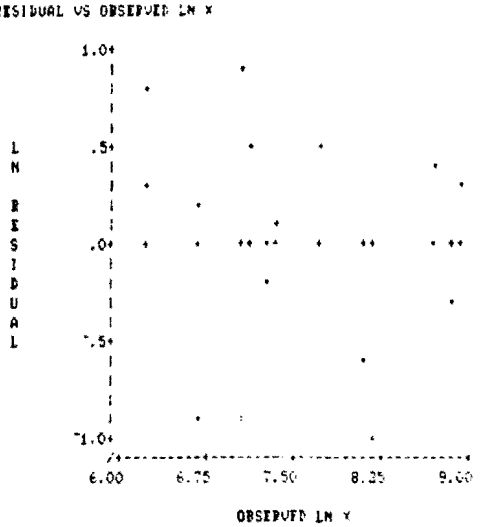


Fig. 9. (Continued)

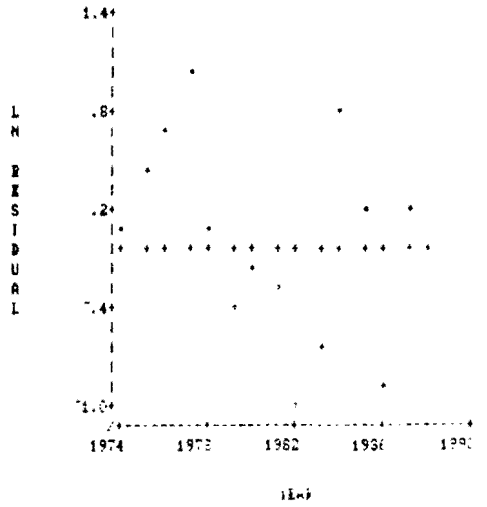


SUMMARY OF DATA FROM PLOT

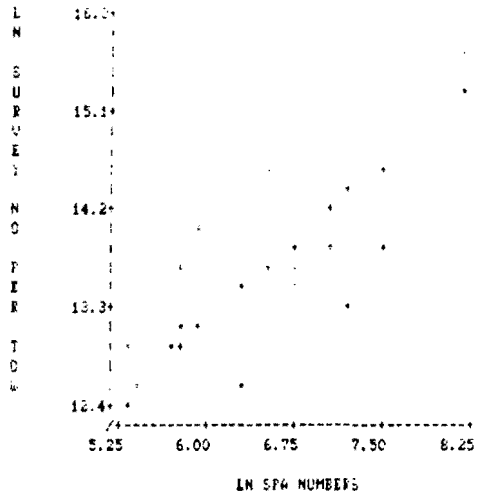
CARRIER VARIABLE: POPULATION NOS
RESPONSE VARIABLE(S): SURVEY + O:OBSERVED, *:PREDICTED

| INDEX | CARRIER | * | + | RANK |
|---|---|---|---|---|
| 1974 | 5.395 | 12.64 | 12.54 | 1975 |
| 1975 | 5.299 | 12.87 | 12.45 | 1974 |
| 1976 | 5.758 | 13.64 | 12.91 | 1978 |
| 1977 | 5.91 | 14.08 | 13.06 | 1985 |
| 1978 | 5.713 | 12.96 | 12.86 | 1976 |
| 1979 | 6.727 | 13.47 | 13.87 | 1977 |
| 1980 | 6.741 | 13.68 | 13.89 | 1986 |
| 1981 | 7.027 | 13.84 | 14.17 | 1984 |
| 1982 | 7.199 | 13.35 | 14.35 | 1979 |
| 1983 | 7.468 | 13.92 | 14.62 | 1980 |
| 1984 | 6.514 | 14.48 | 13.66 | 1981 |
| 1985 | 5.746 | 13.06 | 12.89 | 1982 |
| 1986 | 6.32 | 12.6 | 13.47 | 1983 |
| 1987 | 8.188 | 15.56 | 15.34 | 1988 |
| 1988 | 8.186 | 15.25 | 15.33 | 1987 |

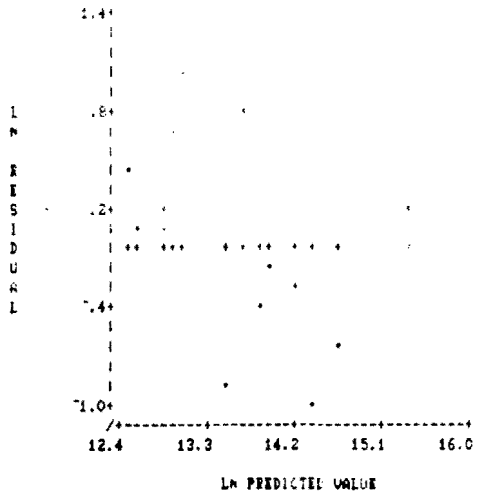
TREND IN LN RESIDUAL OVER TIME



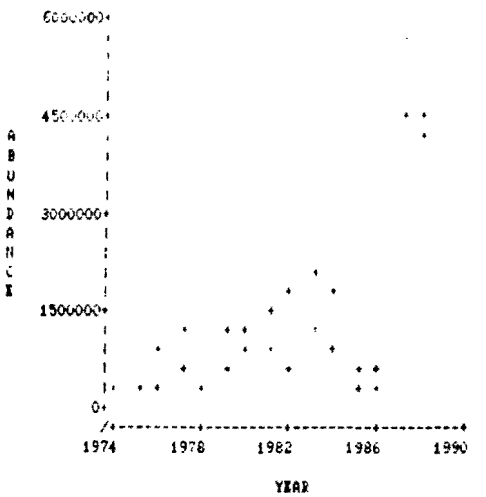

PAGE 1 PLOT
LN SURVEY NO. PER PLOT'S LN POPULATION.




LN RESIDUAL VS LN PREDICTED VALUE




TREND IN POPULATION ABUNDANCE OVER TIME




LN RESIDUAL VS OBSERVED LN X

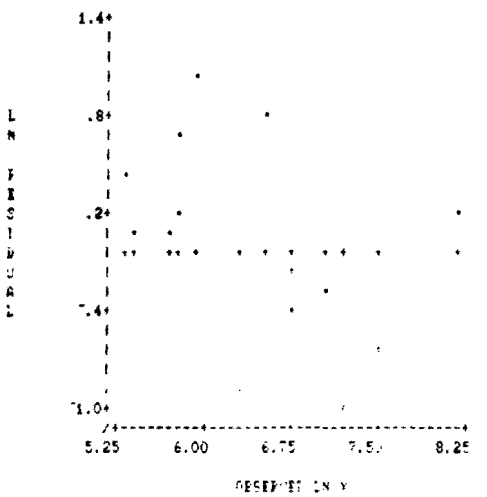


Fig. 9. (Continued)

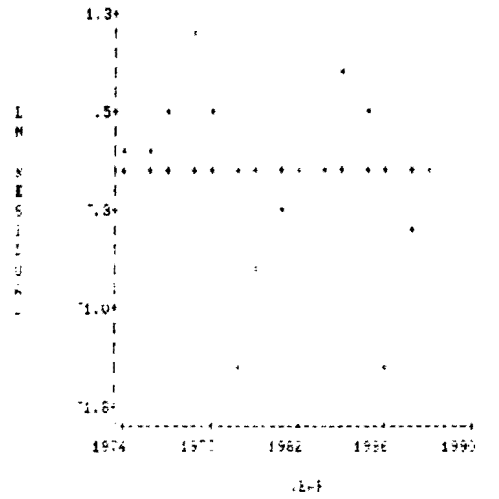


SUMMARY OF DATA FROM PLOT

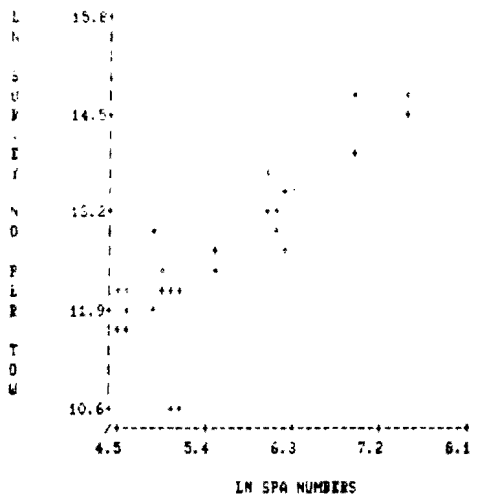
CARRIER VARIABLE: POPULATION NOS
RESPONSE VARIABLE(S): SURVEY - O:OBSERVED, +:PREDICTED

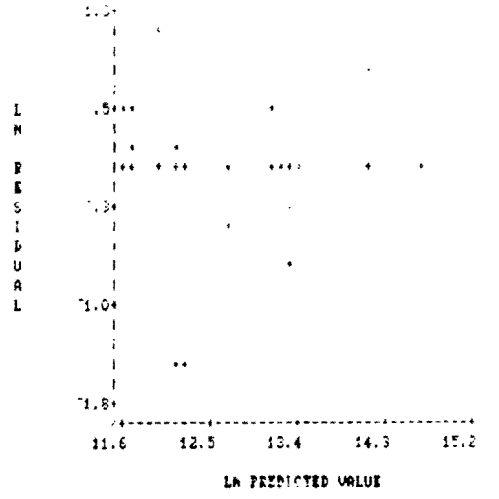
| INDEX | CARRIER | + | + | RANK |
|---|---|---|---|---|
| 1974 | 4.983 | 12.36 | 12.1 | 1976 |
| 1975 | 4.615 | 11.93 | 11.73 | 1978 |
| 1976 | 4.518 | 12.11 | 11.63 | 1975 |
| 1977 | 4.87 | 13.03 | 11.98 | 1977 |
| 1978 | 4.589 | 12.2 | 11.7 | 1974 |
| 1979 | 5.023 | 10.69 | 12.14 | 1979 |
| 1980 | 6.222 | 12.7 | 13.34 | 1986 |
| 1981 | 6.162 | 13.04 | 13.28 | 1987 |
| 1982 | 6.12 | 13.22 | 13.23 | 1985 |
| 1983 | 6.257 | 13.46 | 13.37 | 1982 |
| 1984 | 6.964 | 14.89 | 14.08 | 1981 |
| 1985 | 5.969 | 13.66 | 13.1 | 1980 |
| 1986 | 5.114 | 10.71 | 12.23 | 1983 |
| 1987 | 5.525 | 12.3 | 12.64 | 1984 |
| 1988 | 7.502 | 14.71 | 14.62 | 1988 |

TREND IN LN RESIDUAL OVER TIME

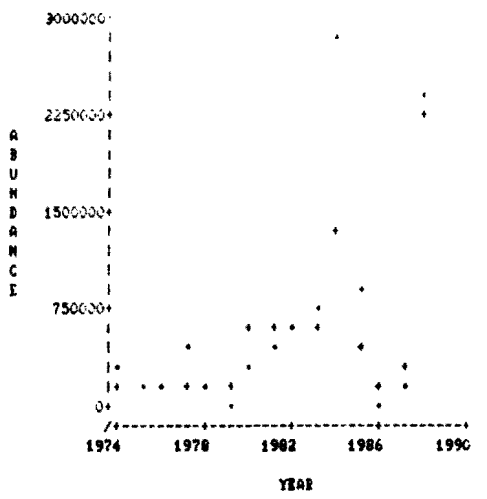



PAGE 9 PLOTS
LN SURVEY NO. PER TOW VS LN SPA NUMBERS




TREND IN POPULATION ABUNDANCE OVER TIME




LN RESIDUAL VS OBSERVED LN X

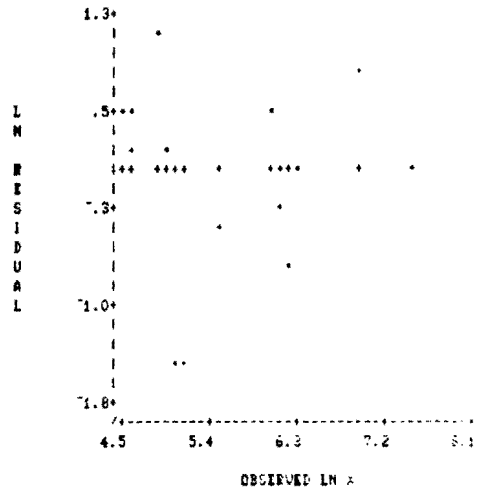


Fig. 10. Number of recruits at age 2 for Divs. 4VWX and Subdiv. 5Zc pollock.

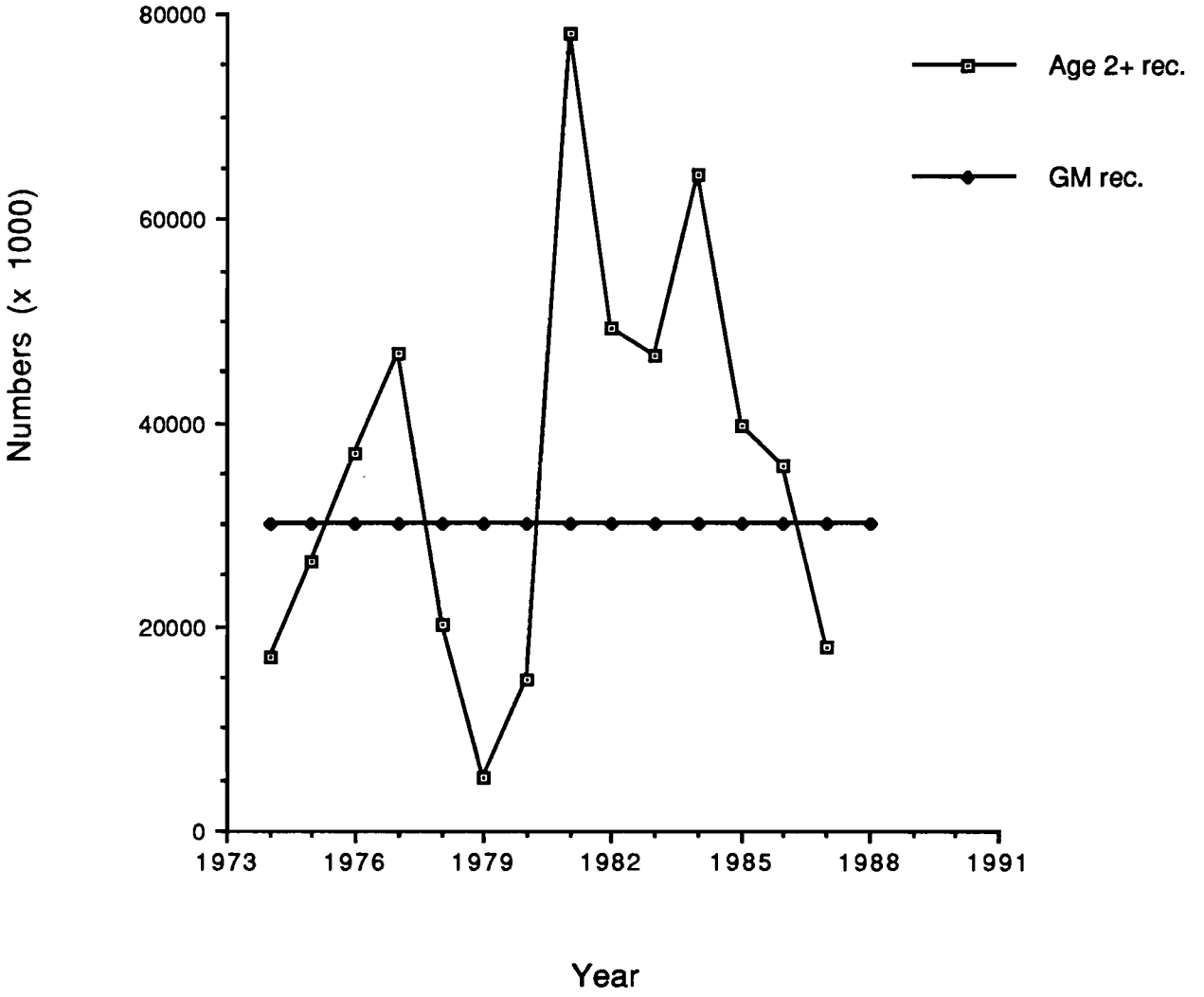


Fig. 11. Age 2+ mid-year biomass for Divs. 4VWX and Subdiv. 5Zc pollock.

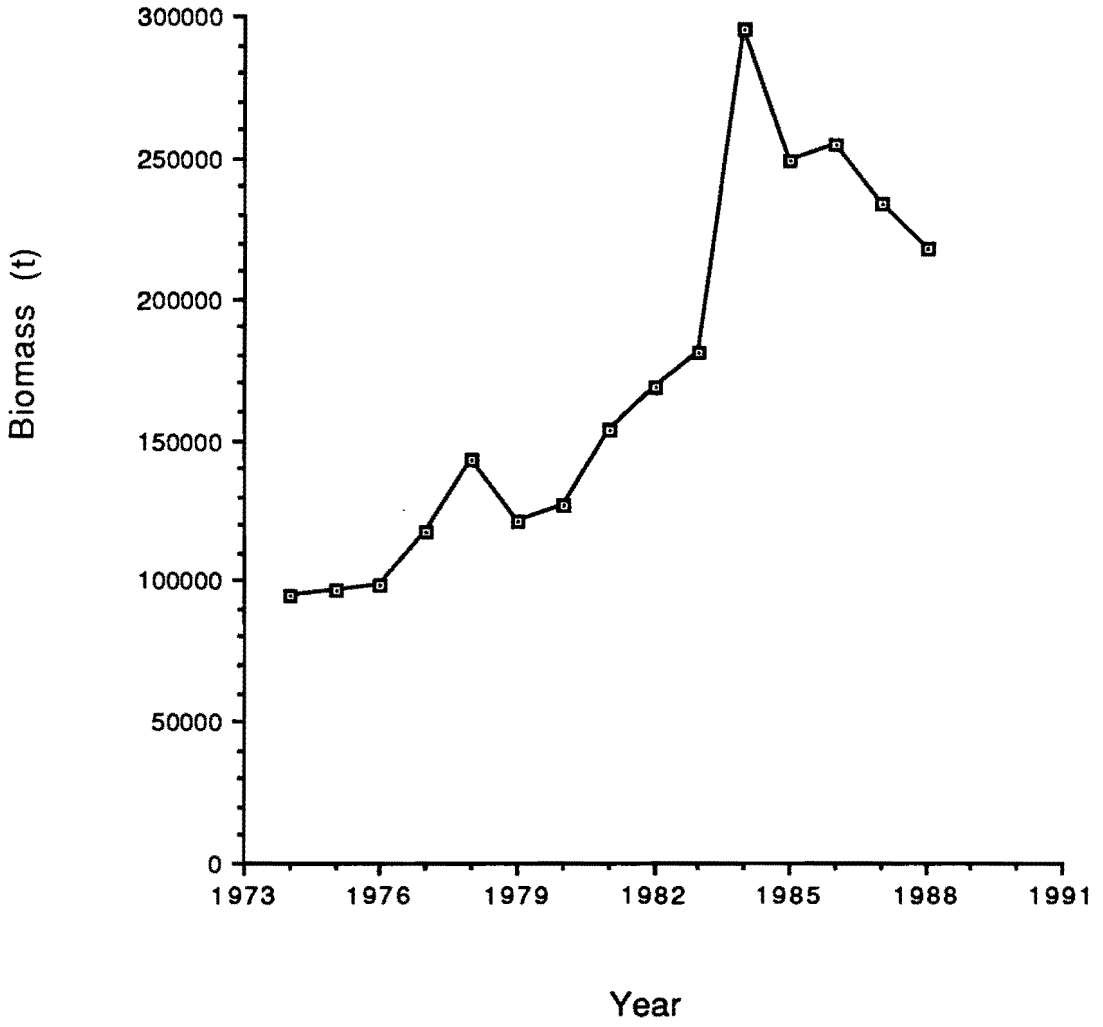


Fig.12. Pollock population numbers (ages 4 - 9) for Divs. 4VWX and Subdiv. 5Zc.

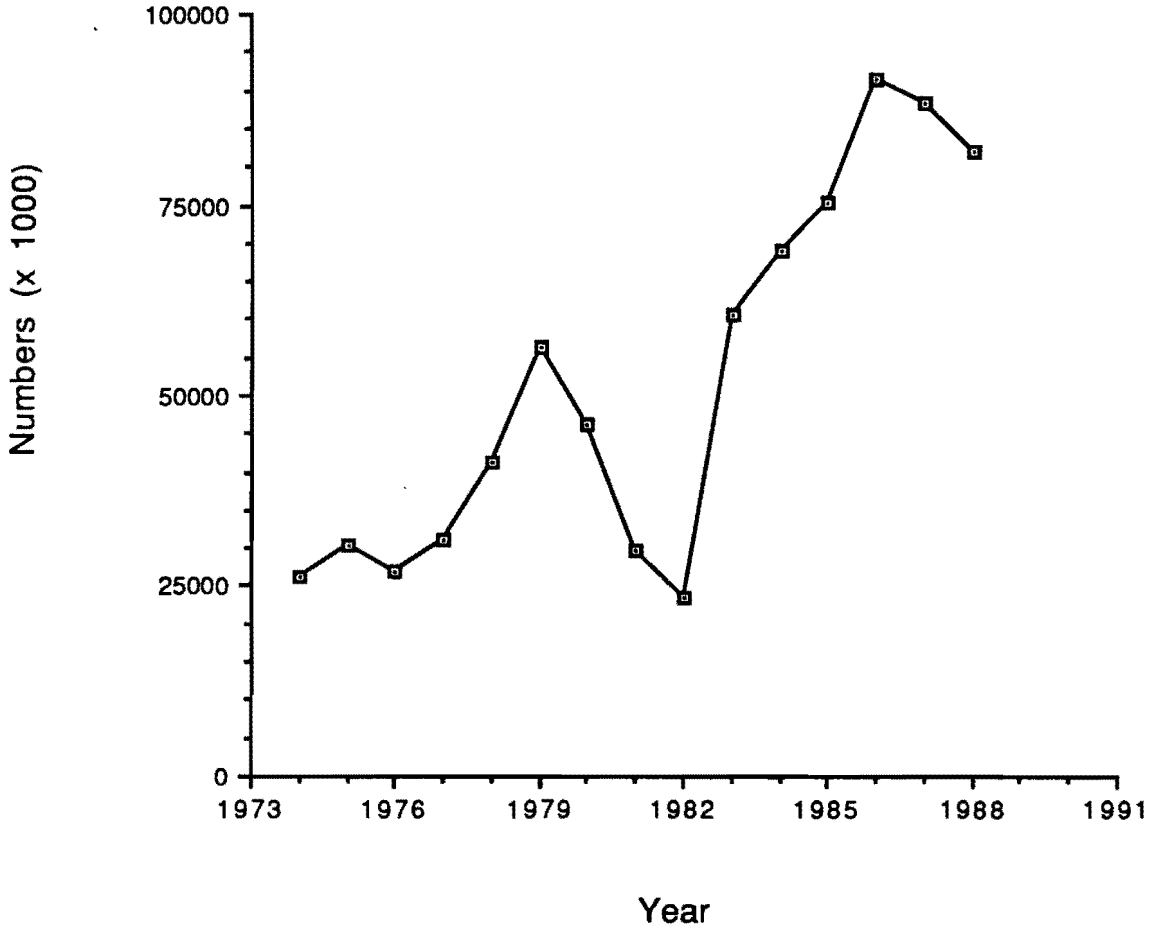
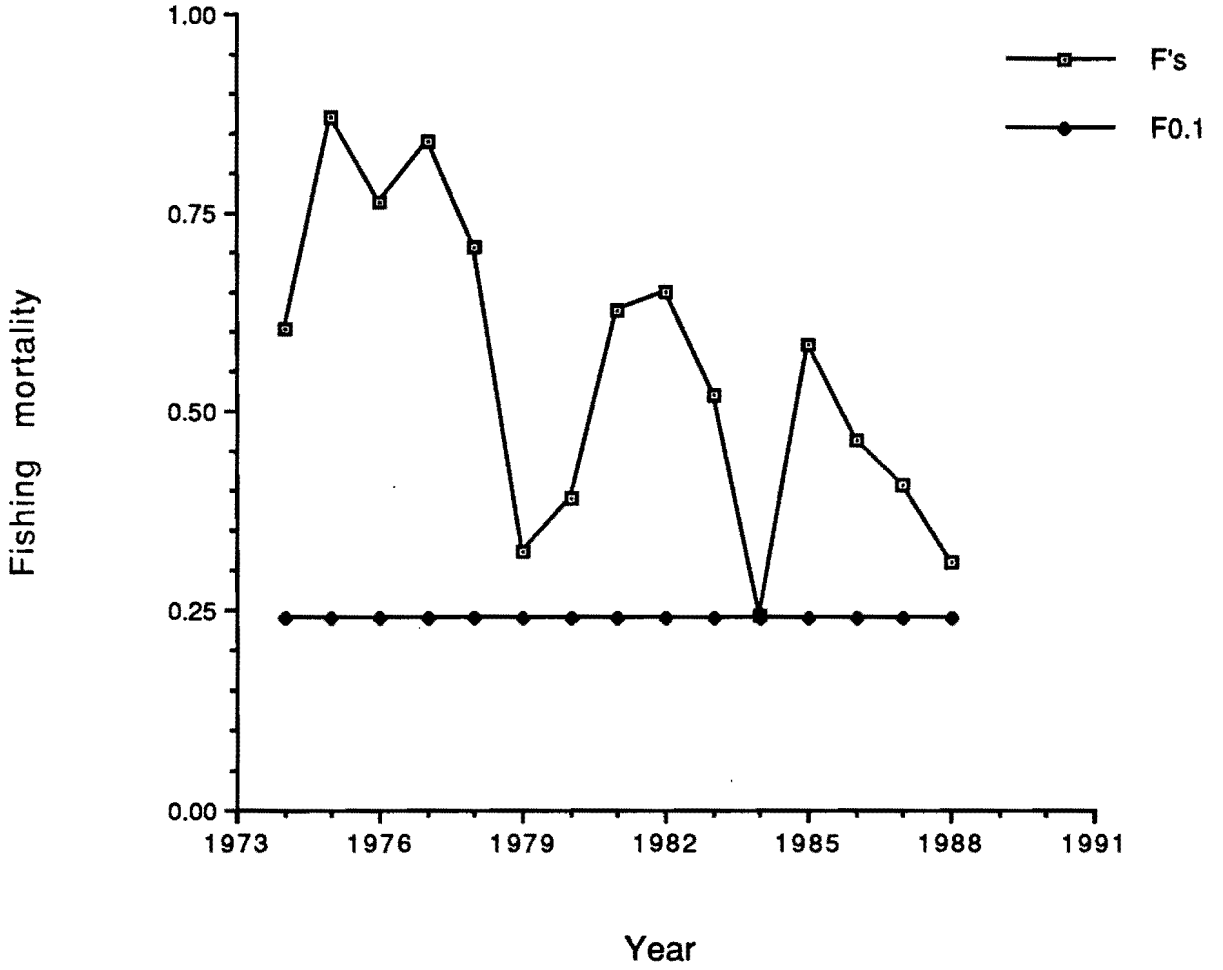


Fig. 13. Fully recruited fishing mortality and F0.1 for Divs. 4VWX and Subdiv. 5Zc pollock.



## Appendix I

## Report of MFD Special Meeting on the Groundfish Management Units in the Gulf of Maine Area

Conference Room
Biological Station
St. Andrews, N.B.

12 April 1989

### Introduction

The Canadian fisheries management system currently incorporates the Canadian part of Subdiv. 5Ze (i.e. Subdiv. 5Zc) in the following management units for cod, haddock and pollock:

| | |
|---|---|
| Cod | Divisions 5Z-6 |
| Haddock | Subarea 5 |
| Pollock | Divisions 4VWX + 5 |

The rationale for these was established in the ICNAF era. Since then, the establishment of domestic management systems in both Canada and the USA (1977) coupled with definition of a new international boundary (1984) has created the need for a re-examination of the management unit definition. A review of these was conducted under the auspices of CAFSAC in 1986. Although a number of modifications to management unit boundaries appeared possible, the process was not completed. More information is now available from tagging experiments and was examined along with previous results. A meeting of MFD staff was held in St. Andrews on 12 April 1989 to consider the available data, historical and current, relevant to the cod, haddock and pollock management units. This report summarizes the findings and rationale used in arriving at them.

### Pollock

The distribution of egg and larval pollock on the Scotian Shelf and the Gulf of Maine was determined from the Scotian Shelf Ichthyoplankton Program (SSIP), the Bay of Fundy herring larval surveys, the Southwest Nova Scotia Fisheries Ecology Program (FEP), the Marine Resources Monitoring Assessment and Prediction (MARMAP) program as well as historical data. The accumulated evidence suggests that spawning is widespread on the Scotia Shelf and in the Gulf of Maine. There is no evidence for spawning aggregates in the upper part of the Gulf of Maine and in the Bay of Fundy. Canadian bottom trawl survey data support the presence of spawning aggregations in the areas identified by these egg and larval surveys.

Estimation of growth parameters and mean age and size at maturity indicated no consistent differences between samples from the Scotian Shelf and the Gulf of Maine. The

results from analyses of the meristic and morphometric data showed some distinction between the Scotian Shelf as a whole and the Gulf of Maine. While individuals from the Gulf of Maine and the Scotian Shelf can be consistently discriminated, the data do not support the discreteness of the Western Scotian Shelf and the Georges Bank area.

Results of tagging juvenile pollock in coastal areas of Nova Scotia show that they move along the full length of the Scotian Shelf into the Bay of Fundy and across to the North East peak of Georges Bank. Movement further south of this is not significant. In general, juvenile pollock appear to remain inshore near the tagging sites and as 3 year-olds move offshore where they become available to the commercial fishery. As they grow older, they are captured progressively further from the site of tagging. Tagging on the New Brunswick side of the Bay of Fundy (1982-84) indicate movement to Subarea 5 and along the Scotian Shelf. While a majority of the Subarea 5 returns are from Georges Bank, most particularly the Northeast Peak, a significant number have been recaptured in the inner Gulf of Maine. Thus limited numbers of pollock tagged on the Scotian Shelf and in the Bay of Fundy were recovered by the USA fishery in American waters.

Canadian commercial catches have come from the Scotian Shelf, Bay of Fundy and Northeast Peak of Georges Bank. The USA fishery is centered in Div. 5Y, particularly in the Jeffrey's Ledge area, and in the western portion of Subdiv. 5Ze (5Zeg, 5Zeh). Prior to the boundary decision approximately 60% of the USA catches taken on northeastern Georges Bank were predominantly from what is now the Canadian zone. The USA pollock fishery operates on the North East Peak and in the Great South Channel with a discontinuity between these two areas. This discontinuity suggests that the pollock which migrate form the Scotian Shelf to the Northeast Peak of Georges Bank may not continue further south. Most transboundary movement would appear to occur in the inner Gulf of Maine.

The stock origin of the juvenile pollock tagged in the coastal nursery areas is not known. These juveniles clearly migrate and mix extensively when they join the adult populations offshore. Morphological and meristic analysis allows definition of some discrete groups. Further, about 15 spawning locations have been identified within the species range. Thus although it is not possible, at least at present, to draw geographic boundaries which separate the distributional areas of these stocks, this does not imply that there is complete mixing throughout the species range. With regard to the USA/Canada boundary it seems likely that the emigration to USA waters is low. It would appear that the amount of transboundary movement is not sufficient to seriously prejudice the benefits Canada could expect to obtain from unilateral management action within the Canadian zone.

## Summary

The following changes in management units which incorporate the Canadian part of Subdiv. 5Ze (i.e. Subdiv. 5Zc) are recommended:

Pollock: Div. 4VWX + Subdiv. 5Zc be established as a separate management unit, replacing (in part) Div. 4VWX + Subarea 5.

```
     ▽INPUT[⎕]▽
[0]  INPUT;ANS
[1]   c←⎕EX 'K'
[2]   ⍎(0=⎕NC 'STOCK∆NAME')/'''STOCK NAME?''⋄STOCK∆NAME←⎕'
[3]   'CATCH MATRIX FOR ',STOCK∆NAME
[4]   c←⎕
[5]   'FIRST YEAR AND YOUNGEST AGE IN CATCH MATRIX ? '
[6]   ANS←⎕
[7]   YR←((1↑ANS)-1)+⍳¯1↑⍴c
[8]   AG←((¯1↑ANS)-1)+⍳1↑⍴c
[9]   'ENTER PARTIAL RECRUITMENT VECTOR FOR ALL AGES'
[10]  PR←⎕
[11]  'ASSUMED AGES OF FULL RECRUITMENT (START WITH FIRST FULLY RECRUITED AGE) ? '
[12]  AGE←AG⍳⎕
[13]  'PRESENCE OR ABSENCE OF PLUS GROUP (P/A) ? '
[14]  NUM←'P'=⎕
[15]  'NATURAL MORTALITY ? '
[16]  m←⎕
[17]  'ENTER STARTING ESTIMATES OF AGE-SPECIFIC FS (TO BE ESTIMATED) FOR LAST YEAR '
[18]  ' EXCLUDE VALUE FOR PLUS ( IF ANY) GROUP '
[19]  FLY←⎕
[20]  'ENTER AGES TO ESTIMATE'
[21]  ROWS←AG⍳AGES←⎕
[22]  FRST←1↑ROWS ⋄ LAST←¯1↑ROWS
[23]
[24]  'AGES IN CALIBRATION INDEX ? '
[25]  ROWS←AG⍳AGES←⎕
[26]
[27]  'STARTING ESTIMATES OF YEAR-SPECIFIC FS FOR OLDEST'
[28]  ' NON-PLUS GROUP AGE (ENTER 0 IF NOT DESIRED)'
[29]  FAG←⎕
[30]  FVECT←FLY[¯1+FRST+⍳1+LAST-FRST],1↓⊖FAG
[31]  CVECT←,c[(¯1+FRST+⍳1+LAST-FRST);¯1↑⍴c]
[32]  →(FAG=0)/S1
[33]  CVECT←CVECT,1↓⊖,c[LAST;]
[34] S1:NVECT←(CVECT×(FVECT*m))÷(FVECT×(1-*-FVECT*m))
[35]  lbnd←CVECT×*m÷2
[36]  ubnd←(⍴NVECT)⍴10000000
[37]  'RV INDEX OF ABUNDANCE'
[38]  '             SAME YEARS AS CATCH AT AGE MATRIX '
[39]  '             SAME AGES AS CALIBRATION BLOCK'
[40]  'ENTER 0 IF NO RV INDEX'
[41]  INDEX∆TYPE← 0 0 ⍝ Indicator of indices available (RV,CPUE)
[42]  i∆rv←⎕
[43]  →(0=+/+/i∆rv)/cpue ⍝ No RV index so go to cpue input
[44]  INDEX∆TYPE[1]←1
[45]  'ESTIMATES OF STANDARD ERROR OF INDEX  (ENTER 1 IF LOG MODEL)? '
[46]  ise∆rv←⎕
[47]  weight←(÷ise∆rv)×MASK
[48]  'INDEX FOR WHAT MONTH ( NO. FROM 1 TO 12 ) ? '
[49]  MNTH←⎕÷12
[50]  'STARTING AGE - SPECIFIC COEFFICIENTS FOR RV INDEX'
[51]  ' '
[52]  ' MATRIX OF AGE BY AGE COEFFICIENTS (1 OR 2 COLUMNS)'
[53]  (1≠+/+/ise∆rv)/' MODEL IS      I = [BO] + B1 x POP '
[54]  (1=+/+/ise∆rv)/' LOG MODEL IS    LN(I) = LN( [BO] + B1 x POP ) '
[55]  ' '
[56]  K←⎕
[57]  lbnd←lbnd,(⍴,K)⍴(-¯1↑⍴K)↑ ¯9000 0 ⍝ MIN SLOPE =0, MIN INTER.=¯9000
```

```
[58]  ubnd←ubnd,(⍴,K)⍴9000 ⍝ MAX SLOPE AND INTER. = 9000
[59] cpue:'CPUE INDEX OF ABUNDANCE'
[60]  '              SAME YEARS AS CATCH AT AGE MATRIX'
[61]  'ENTER 0 IF NO CPUE INDEX'
[62]  i∆cpue←⍬
[63]  →(0=+/+/i∆cpue)/exit ⍝ No cpue index so go to exit
[64]  INDEX∆TYPE[2]←1
[65] 11:'ESTIMATES OF STANDARD ERROR OF CPUE?  (LOG MODEL ASSUMES EQUAL SCALE) '
[66]  ise∆cpue←⍬
[67]  →((⍴i∆cpue)≠⍴ise∆cpue)/11 ⍝ must be same length as i∆cpue
[68]  'ENTER MEAN WEIGHTS AT AGE - SAME YEARS AND AGES AS CATCH'
[69]  MWT←⍬
[70]  'STARTING COEFFICIENTS FOR CPUE INDEX (AGE AGGREGATED)'
[71]  ''
[72]  →(0=⎕NC 'K')/norv
[73]  'ENTER ',(⍕¯1↑⍴K),' VALUE(S) FOR COEFFICIENT(S)'
[74]  K←K;⍬
[75]  →exit1
[76] norv:
[77]  'ENTER 1 (SLOPE) OR 2 (INTERCEPT AND SLOPE) COEFFICIENTS'
[78]  K←(1,⍴,K)⍴K←,⍬
[79] exit1:lbnd←lbnd,((|1-¯1↑⍴K)↑¯9000),0
[80]  ubnd←ubnd,((|1-¯1↑⍴K)↑9000),9000
[81] exit:initial←NVECT,,K
[82]  alpha←1E¯3×NVECT
[83]  limit←100
[84]  'Penalty constraints ON initially (Y/N)? Default is OFF'
[85]  USE∆CONSTRAINTS←0
[86]  ⍎(('Y'=ANS)∨'y'=ANS←⍞⊣INKEY)/'USE∆CONSTRAINTS←1'
[87]  'Penalty functions turned ',(2 3 ⍴'OFFON ')[1+USE∆CONSTRAINTS;]
[88]  ' '
[89]  'Ready to run minipop'
[90]
[91]
```

```
     ∇minipop[⎕]∇
[0]  minipop;BOOL;J;DIAG;Q;LAMBDA;HESS;N;P;PAR;RSS;de;CAUSE;I;V;NPHI;PHI;pnlty;dpnlty;SHESS;NORM;I;Δts;ANS
[1]  ⍝ NON-LINEAR LEAST SQUARES USING MARQUARDT ALGORITHM
[2]   Δts←¯7↓TIMEFMT ⎕TS
[3]   'Do you wish to document your input ?'
[4]   ⍎((,'Y'=ANS)∨'y'=ANS←⎕INKEY)/'miniDOC'
[5]   page Δts
[6]   rssvec←⍳0
[7]   P←⍴par←PAR←,initial
[8]   RSS←e+.xe←OBJΔFN PAR ⍝ RESIDUAL SUM OF SQUARES
[9]   N←⍴,e
[10]  pnlty←alpha PNLTYΔFN PAR ⍝ PENALTY FOR CONSTRAINTS
[11]  NPHI←PHI←RSS+pnlty
[12]  LAMBDA←0.01
[13]  BOOL←(P×P)⍴1,P⍴0 ⍝ USED TO CREATE DIAG MATRIX
[14]  con←10
[15]  J←1
[16]  PRNT
[17]  rssvec←rssvec,RSS
[18] L3:→(limit<J←J+1)/L6 ⍝MAIN LOOP
[19]  PAR←par
[20]  PHI←NPHI
[21]  de←DIFFΔOBJ
[22]  Q←2×e+.×de ⍝ GRADIENT
[23]  HESS←2×(⍉de)+.×de ⍝ HESSIAN
[24]  dpnlty←DIFFΔPNLTY ⍝ DIFFERENCE FOR PENALTY
[25]  Q←Q+dpnlty[1;]
[26]  DIAG← 1 1 ⍉HESS←HESS+(2⍴P)⍴BOOL\dpnlty[2;]
[27]  LAMBDA←9.9999999999999E¯7⌈LAMBDA×0.01
[28]  I←1
[29]  SHESS←HESS+(2⍴P)⍴BOOL\DIAG×LAMBDA←LAMBDA×10 ⍝ MARQUARDT METHOD
[30]  NORM←(+⌿SHESS*2)*0.5 ⍝ COLUMN NORMS
[31]  SHESS←SHESS÷(⍴SHESS)⍴NORM ⍝ SCALE HESSIAN
[32]  par←PAR+V←(Q⌹SHESS)÷NORM ⍝ STEP DIRECTION; STEP SIZE=1
[33]  →(~FRGNΔFN par)/L4
[34]  RSS←e+.xe←OBJΔFN par
[35]  pnlty←alpha PNLTYΔFN par
[36]  →(PHI≥NPHI←RSS+pnlty)/L6
[37] L4:LAMBDA←LAMBDA×100
[38] L5:par←PAR+V←V×0.1*I ⍝INNER LOOP  REDUCE STEP SIZE
[39]  →(10<I←I+1)/L6
[40]  →(~FRGNΔFN par)/L5
[41]  RSS←e+.xe←OBJΔFN par
[42]  pnlty←alpha PNLTYΔFN par
[43]  →(PHI≥NPHI←RSS+pnlty)/L6
[44]  →L5
[45] L6:PRNT
[46]  rssvec←rssvec,RSS
[47]  msr←RSS÷N-P
[48]  →(1=∧/CAUSE←(10≥I),(limit≥J),(1E¯3<con←(((N-P)×|Q+.×V)÷P×RSS)*0.5),(1E¯4<|(NPHI-PHI)÷PHI),(9.9999999
[49]  (~CAUSE)/[1]exit
[50]  ⍎(USEΔCONSTRAINTS)/'USEΔCONSTRAINTS←0 ⋄ ''TURNING CONSTRAINTS OFF''⋄→L3'
[51]  page Δts
[52]  OUTPUT
```

```
      ∇ITERCOHORT[□]∇
[0]   ITERCOHORT;CATCH;J;MORT;FI;FC;ITER;I;Y;X;FCNEW;DIFF1
[1]    CATCH←c
[2]    J←¯1↑⍴CATCH
[3]    MORT←(⍴CATCH)⍴m
[4]    F←(⍴CATCH)⍴0
[5]    FI←FLY
[6]    →(NUM=0)/S3
[7]    FI←FI,¯1↑FI
[8]   S3:→(FAG=0)/S2
[9]    FC←FAG
[10]   →S1
[11]  S2:FC←(¯1↑⍴CATCH)⍴(¯1↑FI)
[12]  S1:ITER←0
[13]  OK9:I←⍴FI
[14]   F[(⍳I);J]←I⍴FI
[15]   F[I;]←J⍴FC
[16]   ITER←ITER+1
[17]   →(ITER≥20)/0
[18]   POP←(⍴CATCH)⍴0
[19]   POP[(⍳I);J]←((,CATCH[(⍳I);J])×FI+(,MORT[(⍳I);J]))÷FI×1-*-FI+(,MORT[(⍳I);J])
[20]   POP[I;]←((,CATCH[I;])×FC+(,MORT[I;]))÷FC×1-*-FC+(,MORT[I;])
[21]   →(NUM=0)/SK1
[22]   I←I-1
[23]   POP[I;]←((,CATCH[I;])×FC+(,MORT[I;]))÷FC×1-*-FC+(,MORT[I;])
[24]   F[I;]←J⍴FC
[25]  SK1:Y←J-1
[26]  AA:X←MORT[⍳I-1;Y]
[27]   POP[⍳I-1;Y]←(CATCH[⍳I-1;Y]×*X÷2)+(POP[1↓⍳I;Y+1]×*X)
[28]   →(1≤Y←Y-1)/AA
[29]   F[⍳I-1;⍳J-1]←(⊗(¯1 ¯1↓POP[⍳((1↑⍴POP)-NUM);])÷ 1 1↓POP[⍳((1↑⍴POP)-NUM);])- ¯1 ¯1↓MORT[⍳((1↑⍴POP)-NU
[30]   →(FAG≠0)/0
[31]   FCNEW←(+/[1]POP[AGE;]×F[AGE;])÷+/[1]POP[AGE;]
[32]   DIFF1←|(FCNEW-FC)÷FCNEW
[33]   FC←(¯1↓FCNEW),¯1↑FC
[34]   →((⌈/¯1↓DIFF1)>0.01)/OK9


      ∇OBJ△FN[□]∇
[0]   R←OBJ△FN A
[1]    s←(⍴NVECT)⍴A ⍝ survivors at designated age
[2]    FVECT←(⊗s÷(s-CVECT×*m÷2)×*-m)-m
[3]    →(∧/PR=1)/NOPR ⍝ skips PR if no PR was imposed
[4]    FRF←(+/((1↑AGE)-FRST)↓FVECT×s)÷+/((1↑AGE)-FRST)↓s ⍝ fully recruited F
[5]    FLY←PR×FRF
[6]   NOPR:FLY[¯1+FRST+⍳1+LAST-FRST]←FVECT
[7]    →(FAG=0)/S1
[8]    FAG←(⊗(⍴FAG)↑⊗FVECT)
[9]   S1:k←((INDEX△TYPE[2]+⍴ROWS),(¯1↑⍴K))⍴(-(INDEX△TYPE[2]+⍴ROWS)×¯1↑⍴K)↑A
[10] ⍝ k is the current calibration coefficients
[11]   ITERCOHORT
[12]   INTERFACE POP
[13]   R←,RESI k ⍝ calculate index residuals
```

```
      ∇DIFF∆PNLTY[□]∇
[0]   R←DIFF∆PNLTY;I;R1;DELTA;TPAR;fpnlty;bpnlty
[1]   ⍝ CALCULATES FIRST AND SECOND DIFFERENCES OF PENALTY FUNCTION
[2]    I←1
[3]    R← 2 0 ⍴0
[4]    DELTA←(0.01×PAR)+0.01×PAR=0
[5]   L1:TPAR←((I-1)↑PAR),(PAR[I]+DELTA[I]),I↓PAR
[6]    R1←(pnlty-fpnlty←alpha PNLTY∆FN TPAR)÷DELTA[I]
[7]    TPAR←((I-1)↑PAR),(PAR[I]-DELTA[I]),I↓PAR
[8]    bpnlty←alpha PNLTY∆FN TPAR
[9]    R←R,,R1,(fpnlty+bpnlty-2×pnlty)÷DELTA[I]
[10]   →L1×⍳I←I+1


      ∇FRGN∆FN[□]∇
[0]   R←FRGN∆FN A
[1]    R←∧/(A)⌷lbnd),A(ubnd
[2]   ⍝ THIS FUNCTION SHOULD RETURN A 1 IF THE PARAMETERS
[3]   ⍝ ARE IN THE FEASIBLE REGION AND 0 OTHERWISE
[4]   ⍝ R←1 DEFAULT RETURNS 1


      ∇INTERFACE[□]∇
[0]   INTERFACE POPN;pr;FRF
[1]   ⍝ Produces 1 or 2 global variables POPIND and FBIOM
[2]    →(0=INDEX∆TYPE[1])/CPUE
[3]    POPIND←POPN×⍟-(F+m)×MNTH ⍝ Adjusts SPA population to the survey month
[4]    POPIND←POPIND[ROWS;] ⍝ selects calibration block
[5]   CPUE:→(0=INDEX∆TYPE[2])/EXIT
[6]    FRF←(+⌿(POPN×F)[AGE;])÷+⌿POPN[AGE;] ⍝ Calculates fully recruited F
[7]    pr←1⌊F÷(⍴F)⍴FRF ⍝ calculates PR matrix
[8]    pr[AGE;]←1 ⍝ Sets defined fully recruited ages to 1
[9]    FBIOM←+⌿POPN×pr×MWT
[10]  EXIT:


      ∇PNLTY∆FN[□]∇
[0]   R←alpha PNLTY∆FN A
[1]    R←USE∆CONSTRAINTS×+/alpha÷(⍴NVECT)↑A
[2]   ⍝ State variable 'USE∆CONSTRAINTS' controls penalty function
[3]   ⍝ 1 → constraints on; 0 → constraints off


      ∇RESI[□]∇
[0]   R←RESI K
[1]    R←⍳0
[2]    →(0=INDEX∆TYPE[1])/cpue ⍝ NO RV SURVEY
[3]    R←R,,(POPIND RESI∆RV(⌽-INDEX∆TYPE[2]),0)↓K)×MASKr
[4]    →(0=INDEX∆TYPE[2])/res ⍝ NO CATCH RATE SERIES
[5]   cpue:K←(⊖K)[1;] ⍝ get bottom row of K
[6]    R←R,,(FBIOM RESI∆CPUE K)×MASKc
```