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# Assessment of the Nain Stock Unit Arctic charr population in 1990

by

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## Abstract

Reported landings of Arctic charr from the Nain assessment unit totaled 45 t in 1990. Landings were 96% of the TAC and about 12% below 1989. Landings in general have been moderately stable since the mid-1980's and generally close to the recommended TAC. Effort was similar to that of 1989. The Nain unit has contributed 40% of the commercial catch of Arctic charr from the Nain fishing region over the period 1977-90 but contributed 52% of the catch in 1990. Catch at age data from the 1990 fishery indicated that the 1981 and 1982 year-classes were the most abundant in the fishery representing 53% off the catch in numbers of fish. Standardized catch rates, estimated separately for both the inshore and offshore island zone, were derived using a multiplicative model and used in an age disaggregated formulation of ADAPT to estimate fishing mortality and stock size in 1990. The assessment indicated that fully recruited fishing mortality (age 10+ fish) was about 0.51 and that the estimated population size was about 193,000 fish.



## Résumé

Les débarquements déclarés d'omble chevalier provenant de l'unité d'évaluation de la baie Nain ont atteint 46 t en 1990, ce qui représentait 96 % du TPA et environ 12 % de moins qu'en 1989. Dans l'ensemble, les débarquements ont été assez stables depuis le milieu des années 1980 et généralement proches du TPA recommandé. L'effort a été comparable à celui de 1989. Les prises commerciales en provenance de l'unité ont représenté 40 % des prises commerciales totales d'omble chevalier de la baie Nain de 1977 à 1990, cette proportion étant passée à 52 % en 1990. Les données sur les prises selon l'âge en 1990 révèlent que les classes d'âge de 1981 et 1982 étaient les plus abondantes dans la pêche, représentant 53 % du nombre de poissons. On a eu recours à un modèle multiplicatif pour établir des taux de prises normalisés et distincts pour la pêche côtière et pour la pêche hauturière, puis on a appliqué ces taux de prises à une formulation de la méthode ADAPT décomposée par âge afin d'estimer la mortalité due à la pêche et la grosseur des stocks en 1990. Selon cette estimation, la mortalité due à la pêche dans les stocks pleinement recrutés (poissons de 10 ans et plus) était d'environ 0,51 et la population se chiffrait à environ 193 000 poissons.

## 1. Introduction

The Nain stock unit (Fig. 1) consists of an inshore zone made up of Anaktalik Bay, Nain Bay, Tikkoatokak Bay, and Webb Bay subareas, and an offshore island zone consisting of the Dog Island and Black Island subareas (Dempson and Kristofferson 1987). It was first assessed as a single unit in 1985 (Dempson and LeDrew 1986). Prior to this, individual assessments were conducted separately on Arctic charr populations from Nain-Tikkoatokak Bay and Anaktalik Bay. Annual landings from the Nain unit have ranged from 34 to 76 t (mean = 52 t, 1974-90) and from 1977 to 1990 have contributed 40% of the total commercial catch of charr from the Nain fishing region. During the past five years (1986-90) however, this value was 50% and specifically in 1990, was 52%. The recommended Total Allowable Catch (TAC) in 1990 was maintained at 47 t, the same value since 1987.

This paper summarizes information from the 1990 fishery and presents the results of the standardization of catch rates for the inshore and offshore fishing zones. An estimate of stock size and fishing mortality derived using a formulation of the adaptive framework (Gavaris 1988) is also provided.

## 2. Trends in catch and effort data - conventional series

Catch and effort data for the Nain stock unit are summarized in Table 1 for the period 1974-90. The highest catch of 76 t occurred in 1977, the lowest catch of 34 t was in 1975. The TACs listed in Table 1 for 1979 to 1983 applied only to the specific subareas of Anaktalik Bay and Nain-Tikkoatokak Bay. In 1984 and 1985, an offshore component was included in the TAC. The quota area catch in Table 1 summarizes landings for those subareas specifically under quota restrictions only, prior to the derivation of the assessment (stock) units in 1986. Since 1986, the TAC has applied to the entire stock unit.

Landings in 1990 totaled 45.3 t, about 12% below 1989 landings which exceeded the 47 t TAC. Landings have been moderately stable since the mid-1980s (coefficient of variation = 12%, 1984-90) and generally close to the recommended TAC (Fig. 2). Effort was slightly higher in 1990 and catch per unit effort (CUE) was 14% below 1989 but still high in relation to past years (Table 1). Catch rates declined in the inshore zone but rose to the highest value recorded in the offshore zone.

## 3. Catch and average weights at age

Catch at age data are available since 1977 and are summarized in Table 2. Catch at age, along with the estimated standard error and coefficient of variation for the 1990 data are provided in Table 3. Those ages that contribute to the majority of the catch (ages 7 - 10, 86% of the total catch) appear to have been estimated reasonably with the coefficient of variation less than 10%. The 1981 and 1982 year classes (year of hatching) represented by 8 and 9 year old fish in 1990 were the most abundant representing 53% of the catch (Table 2). The 1980 year class (age 10 fish) also remained relatively strong contributing 17% of the total catch. Mean age of the catch in 1990 was

8.9 years and has ranged from 8.46 in 1977 to 9.83 in 1982. A summary of the percent at age in the catch is provided in Table 4.

Weights at age were derived from length-weight relationships obtained from sampling the commercial fishery as explained in past years (Dempson 1990). A summary of the relationships used since 1980 is provided in Table 5. Gutted head-on weight was converted to whole weight using the conversion factor 1.22 (Dempson 1984). A comparison of recorded total landings with the cross product total (sum of the matrix of estimated numbers at age x matrix of weights at age) agrees quite well with the discrepancy between the two of less than 0.2% for 1990. Weight at age data are given in Table 6.

## 4. Standardization of catch rates

A multiplicative model (Gavaris 1980) was used to account for differences in catch rates between year and week separately for both inshore and offshore fishing zones. A combined analysis with classification variables zone, week, and year was also carried out. The regression of ln catch rate for the period 1977 to 1990 was initially fitted using SAS REG procedures (SAS 1985) to avail of the various diagnostics available. Diagnostics included leverage estimates (diagonal elements of the hat matrix) and influence statistics using the DFFITS calculation (Freund and Littell 1986; Myers 1986). Cumulative probability plots of residuals were used in assessing normality of residuals. Standardized catch rates were obtained using the STANDAR (APL) version of the multiplicative analysis program.

With respect to the inshore zone, the regression of ln catch rate of Arctic charr for the 1977-90 period explained about 58% of the variation in the data. Normal probability plots confirmed the general normality of the data (Fig. 3). Several observations in 1987 and 1989 appeared to have high leverage (Fig. 3) but little influence in the final model as evidenced by the lack of any high DFFITS values (Fig. 3). Both year and week classification variables were significant (Table 7). Highest catch rates occurred during weeks 31 to 33 (July 30 - August 19) and during the late 1970s and early 1980s (Table 8). A comparison of the standardized and unstandardized catch rates for the inshore zone is provided in Fig. 4.

For offshore zone, the regression of ln catch rate of charr for the 1977-90 period explained 73% of the variation in the data. Normal probability plots confirmed the general normality of the data (Fig. 5). Two observations in 1987 and 1988 appeared to have high leverage (Fig. 5) but influence diagnostics were reasonably well balanced. Again, both year and week classification variables were significant (Table 9). Highest catch rates occurred during weeks 30 to 32 (July 23 - August 12) and have been generally increasing over time (Table 8). A comparison of the standardized and unstandardized catch rates for the offshore zone is provided in Fig. 4.

Catch and effort data for the two zones were also analysed in a combined model with zone included as a classification variable. The regression of ln catch rate of charr for the 1977-90 period in this combined model explained 54% of the variation. Normal probability plots confirmed the general normality of the data (Fig. 6). In the combined model observations with high leverage identified in the individual analyses were again evident in 1983, 1987, 1988 and

1989 (Fig. 6) but little influence as indicated by the well balanced DIFFITS values. All classification variables were significant (Table 10). A comparison of the standardized and unstandardized catch rates for the combined inshore/offshore model is provided in Fig. 4.

Catch rate indices at age were estimated for the inshore (Table 11), offshore (Table 12), and total Nain stock unit (Table 13). The indices were derived using the catch at age of the inshore and offshore and combined total stock unit along with the estimated effort obtained from the standardization of commercial catch rates.

## 5. Estimation of stock size

Commercial catch rate indices for the inshore and offshore zones were analysed in a single age disaggregated formulation of the adaptive framework (Gavaris 1988) to estimate population size in 1990. The ADAPT process is based on established methods for nonlinear parameter estimation. The minimization procedure is applied to determine a set of parameter values such that the predicted catch at age and abundance indices by age group are closest to the observed values (further details provided in CAFSAC 1988, p. 32). Intercept terms were not significant in preliminary runs and thus were not fitted.

Initial ADAPT runs using the two catch rate indices in a single formulation were characterized with trends in residuals for the offshore catch rate index. Predicted values were higher than observed values at most ages for the early years (1977-81). It was noted that catches in the offshore zone were generally less than 30% of the total Nain unit catch during the 1970's and early 1980's (Table 1). Catches and catch rates for the offshore zone have increased over time, and this may have contributed to the pattern of residuals that resulted. As a result, the accepted formulation of ADAPT used the inshore catch rate series from 1977 to 1990, with the offshore series from 1982 to 1990. The accepted formulation is as follows:

**Parameters:**

- Year-class estimates

  Ni, 1990 $\quad i = 6$ to 14

- Calibration coefficients for inshore and offshore commercial catch rate (C/E) numbers

  $K_1,i \quad i = 6$ to 14 (inshore - IN)

  $K_2,i \quad i = 6$ to 14 (offshore - OFF)

**Structure:**

- Natural mortality assumed to be 0.2;
- Error in catch at age assumed negligible;
- Fishing mortality (F) for age groups 15-17 set equal to the weighted F for age groups 10-14;
- Intercepts not fitted.

**Input:**

| | | |
|---|---|---|
| Ci,t | i = 6 to 14, | t = 1977-90 |
| INi,t | i = 6 to 14, | t = 1977-90 |
| OFFi,t | i = 6 to 14, | t = 1982-90 |

**Objective function:**

- Minimize:

$$\sum_i \sum_t \{obs(lnINi,t) - pred(lnINi,t)\}^2 + \sum_i \sum_t \{obs(lnOFFi,t) - pred(lnOFFi,t)\}^2$$

**Summary:**

- Number of observations = 207
- Number of parameters = 27

## Results

Abundance estimates for all ages were significant with coefficient of variation (CV) between 0.25 and 0.29 for ages 8 to 14 (Table 14). Slopes for the inshore index peaked at age 12 and those for the offshore index peaked at age 10. The mean square residual was 0.389. Correlations among parameter estimates were low (Table 15). Predicted values were higher than observed values in the inshore catch rate index for 1988 and 1990, but the removal of the early years for the offshore index removed the trend for all negative values in early years and positive values in recent years (Table 16).

A summary of the estimated population numbers and fishing mortality are given in Table 17. Fishing mortality in 1990 was about 0.51 on 10+ fish. A conservative approach using a geometric mean from 1981-88 to estimate age 6 and 7 year old fish in 1990 results in a total estimated population of about 193,000 fish. This value, while below those of the late 1970's, is higher than those of the mid-1980's although slightly less than the estimated population size in more recent years (Fig. 7). In general, population size appears to have increased in recent years (1987-90) relative to the early and mid-1980's. There is currently no evidence to suggest that stock size should decline in the forthcoming year.

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**Table 1.** Summary of catch and effort statistics for the Nain assessment unit, 1974-90. Quotas and landings are in kg round weight, effort is expressed as person-weeks fished. Refer to text for information on quotas and quota area catch.

| | Inshore | | | Offshore | | | | Total | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Catch | Effort | CUE | Catch | Effort | CUE | % Catch offshore | Catch | Effort* | CUE | TAC | Quota area catch |
| 1974 | 30,822 | | | 6,923 | | | 18.1 | 37,745 | | | | |
| 1975 | 31,076 | | | 2,754 | | | 8.1 | 33,830 | | | | |
| 1976 | 50,813 | 146 | 348 | 2,500 | 52 | 48 | 4.7 | 53,313 | 196 | 272 | | |
| 1977 | 70,908 | 183 | 387 | 5,347 | 114 | 47 | 7.0 | 76,255 | 291 | 262 | | |
| 1978 | 70,465 | 212 | 332 | 3,298 | 106 | 31 | 4.5 | 73,763 | 314 | 235 | | |
| 1979 | 54,967 | 189 | 291 | 11,877 | 152 | 78 | 17.8 | 66,844 | 336 | 199 | 61,000 | 52,832 |
| 1980 | 52,328 | 183 | 286 | 22,727 | 215 | 106 | 30.3 | 75,055 | 390 | 192 | 61,000 | 50,176 |
| 1981 | 49,956 | 157 | 318 | 15,676 | 131 | 120 | 23.9 | 65,632 | 278 | 236 | 37,160 | 37,223 |
| 1982 | 43,108 | 119 | 362 | 12,509 | 117 | 107 | 22.2 | 55,617 | 235 | 237 | 43,660 | 39,119 |
| 1983 | 33,603 | 147 | 229 | 17,599 | 149 | 118 | 34.4 | 51,202 | 289 | 177 | 51,000 | 19,102 |
| 1984 | 24,558 | 131 | 187 | 14,342 | 128 | 112 | 36.9 | 38,900 | 244 | 159 | 43,200 | 29,063 |
| 1985 | 21,527 | 125 | 172 | 19,631 | 130 | 151 | 47.7 | 41,158 | 252 | 163 | 30,500 | 36,019 |
| 1986 | 16,347 | 91 | 180 | 20,748 | 101 | 205 | 55.9 | 37,095 | 185 | 201 | 43,000 | |
| 1987 | 17,840 | 71 | 251 | 28,032 | 135 | 208 | 61.1 | 45,872 | 200 | 229 | 47,000 | |
| 1988 | 14,535 | 90 | 162 | 23,759 | 149 | 159 | 62.1 | 38,295 | 229 | 167 | 47,000 | |
| 1989 | 30,449 | 103 | 296 | 21,016 | 87 | 242 | 40.8 | 51,465 | 183 | 281 | 47,000 | |
| 1990 | 17,069 | 88 | 194 | 28,205 | 108 | 261 | 62.3 | 45,275 | 188 | 241 | 47,000 | |

*Total effort should be equal to or less than the sum of the inshore and offshore effort.

Table 2. Estimated catch at age from the commercial Arctic charr fishery in the Nain stock unit, 1977-90.

CATCH AT AGE

| AGE | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 2003 | 371 | 430 | 75 | 145 | 83 | 470 | 182 | 103 | 210 |
| 7 | 9250 | 6703 | 4306 | 960 | 2118 | 977 | 2791 | 2612 | 2463 | 4129 |
| 8 | 12453 | 13122 | 11568 | 10519 | 6877 | 4782 | 5842 | 4619 | 6506 | 7713 |
| 9 | 7630 | 7984 | 9593 | 16342 | 15435 | 7255 | 6996 | 5671 | 4722 | 5862 |
| 10 | 5052 | 4406 | 4208 | 8345 | 9787 | 7987 | 4177 | 4374 | 4111 | 2857 |
| 11 | 2454 | 2367 | 2168 | 4077 | 3746 | 4936 | 4357 | 2173 | 2494 | 1284 |
| 12 | 988 | 1688 | 1573 | 1340 | 991 | 2976 | 2762 | 1495 | 1605 | 625 |
| 13 | 358 | 312 | 418 | 813 | 304 | 561 | 600 | 738 | 901 | 240 |
| 14 | 180 | 272 | 312 | 522 | 151 | 451 | 557 | 281 | 534 | 199 |
| 15 | 1 | 118 | 34 | 43 | 42 | 59 | 70 | 96 | 322 | 205 |
| 16 | 1 | 97 | 14 | 1 | 13 | 46 | 27 | 57 | 93 | 50 |
| 17 | 1 | 1 | 1 | 66 | 10 | 23 | 95 | 89 | 21 | 42 |
| 6+ | 40371 | 37441 | 34625 | 43103 | 39619 | 30136 | 28744 | 22387 | 23875 | 23416 |
| 7+ | 38368 | 37070 | 34195 | 43028 | 39474 | 30053 | 28274 | 22205 | 23772 | 23206 |

| AGE | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|
| 6 | 483 | 204 | 903 | 459 |
| 7 | 5462 | 6288 | 4750 | 4726 |
| 8 | 6293 | 7166 | 9707 | 6115 |
| 9 | 7548 | 4688 | 8464 | 8844 |
| 10 | 4498 | 3607 | 3785 | 4681 |
| 11 | 2013 | 1631 | 2853 | 1908 |
| 12 | 1375 | 650 | 1234 | 927 |
| 13 | 898 | 324 | 665 | 378 |
| 14 | 306 | 136 | 277 | 137 |
| 15 | 357 | 52 | 28 | 186 |
| 16 | 180 | 20 | 6 | 1 |
| 17 | 37 | 40 | 1 | 1 |
| 6+ | 29450 | 24806 | 32673 | 28363 |
| 7+ | 28967 | 24602 | 31770 | 27904 |

**Table 3.** Summary of catch-at-age data for the Nain stock unit in 1990, with standard error and coefficient of variation (C.V.).

| Age | Catch at age | Standard Error | C.V. (%) |
|---|---|---|---|
| 6 | 459 | 127.9 | 27.9 |
| 7 | 4726 | 434.0 | 9.2 |
| 8 | 6115 | 487.5 | 8.0 |
| 9 | 8844 | 524.1 | 5.9 |
| 10 | 4681 | 404.5 | 8.6 |
| 11 | 1908 | 282.0 | 14.8 |
| 12 | 927 | 202.9 | 21.9 |
| 13 | 378 | 137.7 | 36.4 |
| 14 | 137 | 81.5 | 59.5 |
| 15 | 186 | 91.1 | 49.0 |

Table 4. Summary of the percent at age in the commercial catch of Arctic charr from the Nain stock unit, 1977-90.

PERCENT AT AGE

| | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 5.0 | 1.0 | 1.2 | 0.2 | 0.4 | 0.3 | 1.6 | 0.8 | 0.4 | 0.9 | 1.6 | 0.8 |
| 7 | 22.9 | 17.9 | 12.4 | 2.2 | 5.3 | 3.2 | 9.7 | 11.7 | 10.3 | 17.6 | 18.5 | 25.3 |
| 8 | 30.8 | 35.0 | 33.4 | 24.4 | 17.4 | 15.9 | 20.3 | 20.6 | 27.3 | 32.9 | 21.4 | 28.9 |
| 9 | 18.9 | 21.3 | 27.7 | 37.9 | 39.0 | 24.1 | 24.3 | 25.3 | 19.8 | 25.0 | 25.6 | 18.9 |
| 10 | 12.5 | 11.8 | 12.2 | 19.4 | 24.7 | 26.5 | 14.5 | 19.5 | 17.2 | 12.2 | 15.3 | 14.5 |
| 11 | 6.1 | 6.3 | 6.3 | 9.5 | 9.5 | 16.4 | 15.2 | 9.7 | 10.4 | 5.5 | 6.8 | 6.6 |
| 12 | 2.4 | 4.5 | 4.5 | 3.1 | 2.5 | 9.9 | 9.6 | 6.7 | 6.7 | 2.7 | 4.7 | 2.6 |
| 13 | 0.9 | 0.8 | 1.2 | 1.9 | 0.8 | 1.9 | 2.1 | 3.3 | 3.8 | 1.0 | 3.0 | 1.3 |
| 14 | 0.4 | 0.7 | 0.9 | 1.2 | 0.4 | 1.5 | 1.9 | 1.3 | 2.2 | 0.8 | 1.0 | 0.5 |
| 15 | 0.0 | 0.3 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.4 | 1.3 | 0.9 | 1.2 | 0.2 |
| 16 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.2 | 0.1 | 0.3 | 0.4 | 0.2 | 0.6 | 0.1 |
| 17 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.1 | 0.3 | 0.4 | 0.1 | 0.2 | 0.1 | 0.2 |

| | 1989 | 1990 |
|---|---|---|
| 6 | 2.8 | 1.6 |
| 7 | 14.5 | 16.7 |
| 8 | 29.7 | 21.6 |
| 9 | 25.9 | 31.2 |
| 10 | 11.6 | 16.5 |
| 11 | 8.7 | 6.7 |
| 12 | 3.8 | 3.3 |
| 13 | 2.0 | 1.3 |
| 14 | 0.8 | 0.5 |
| 15 | 0.1 | 0.7 |
| 16 | 0.0 | 0.0 |
| 17 | 0.0 | 0.0 |

**Table 5.** Summary of slope and intercept parameters from log - log weight length relationship for Arctic charr from the Nain Stock unit.

| Year | N | Slope | Intercept | $R^2$ | P |
|---|---|---|---|---|---|
| 1980 | 640 | 3.228 | -5.330 | 0.877 | 0.0001 |
| 1981 | 736 | 3.156 | -5.215 | 0.912 | 0.0001 |
| 1982 | 888 | 2.894 | -4.738 | 0.852 | 0.0001 |
| 1983 | 1030 | 2.911 | -4.754 | 0.851 | 0.001 |
| 1984 | 1017 | 2.688 | -4.386 | 0.874 | 0.0001 |
| 1985 | 1272 | 2.725 | -4.462 | 0.878 | 0.0001 |
| 1986 | 1160 | 2.527 | -4.099 | 0.8573 | 0.0001 |
| 1987 | 1506 | 2.537 | -4.122 | 0.8587 | 0.0001 |
| 1988 | 1635 | 2.587 | -4.218 | 0.837 | 0.0001 |
| 1989 | 931 | 2.523 | -4.096 | 0.807 | 0.0001 |
| 1990 | 852 | 2.549 | -4.144 | 0.860 | 0.0001 |

Table 6. Average weight at age (kg - round) from the commercial Arctic charr fishery, Nain stock unit, 1977-90.

AVERAGE WEIGHT AT AGE

| AGE | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 0.89 | 1.31 | 1.37 | 0.89 | 0.79 | 1.13 | 1.27 | 1.18 | 1.10 | 1.15 | 1.14 | 1.13 |
| 7 | 1.28 | 1.71 | 1.52 | 1.20 | 1.18 | 1.37 | 1.56 | 1.40 | 1.43 | 1.37 | 1.33 | 1.38 |
| 8 | 1.77 | 1.86 | 1.85 | 1.52 | 1.51 | 1.68 | 1.66 | 1.63 | 1.65 | 1.56 | 1.53 | 1.55 |
| 9 | 2.07 | 2.24 | 2.02 | 1.78 | 1.70 | 1.84 | 1.84 | 1.78 | 1.78 | 1.69 | 1.62 | 1.63 |
| 10 | 2.59 | 2.41 | 2.08 | 1.93 | 1.76 | 1.89 | 1.88 | 1.88 | 1.83 | 1.69 | 1.65 | 1.64 |
| 11 | 2.86 | 2.35 | 2.18 | 1.83 | 1.78 | 1.93 | 1.88 | 1.87 | 1.81 | 1.68 | 1.68 | 1.67 |
| 12 | 2.74 | 2.67 | 2.41 | 1.91 | 1.80 | 1.96 | 1.92 | 1.89 | 1.83 | 1.70 | 1.71 | 1.71 |
| 13 | 3.16 | 3.34 | 2.25 | 1.93 | 1.74 | 2.11 | 1.96 | 1.93 | 1.82 | 1.95 | 1.68 | 1.70 |
| 14 | 3.28 | 2.88 | 1.94 | 1.97 | 1.72 | 1.93 | 1.77 | 2.07 | 1.90 | 1.79 | 1.74 | 1.44 |
| 15 | 2.65 | 2.65 | 2.65 | 2.71 | 2.87 | 2.26 | 1.84 | 1.84 | 1.89 | 1.61 | 1.80 | 1.68 |
| 16 | 2.15 | 2.15 | 2.15 | 2.15 | 3.88 | 2.69 | 2.05 | 1.46 | 1.53 | 1.71 | 1.61 | 1.75 |
| 17 | 2.45 | 2.45 | 2.45 | 4.43 | 2.45 | 2.69 | 2.28 | 1.91 | 1.64 | 1.64 | 2.03 | 1.75 |

| AGE | 1989 | 1990 |
|---|---|---|
| 6 | 1.16 | 1.17 |
| 7 | 1.38 | 1.42 |
| 8 | 1.56 | 1.50 |
| 9 | 1.63 | 1.66 |
| 10 | 1.71 | 1.76 |
| 11 | 1.68 | 1.68 |
| 12 | 1.64 | 1.77 |
| 13 | 1.69 | 1.65 |
| 14 | 1.74 | 1.75 |
| 15 | 1.97 | 1.46 |
| 16 | 2.56 | 1.97 |
| 17 | 1.64 | 1.81 |

Table 7. Results of the analysis of variance of log transformed catch rate from the inshore zone of the Nain stock unit, 1977-90.

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: CUE

| SOURCE | DF | SUM OF SQUARES | MEAN SQUARE | F VALUE | PR > F | R-SQUARE | C.V. |
|---|---|---|---|---|---|---|---|
| MODEL | 26 | 48.52927488 | 1.86651057 | 6.48 | 0.0001 | 0.576016 | 10.2233 |
| ERROR | 124 | 35.72056261 | 0.28806905 | | ROOT MSE | | CUE MEAN |
| CORRECTED TOTAL | 150 | 84.24983749 | | | 0.53672065 | | 5.24994901 |

| SOURCE | DF | TYPE I SS | F VALUE | PR > F | DF | TYPE III SS | F VALUE | PR > F |
|---|---|---|---|---|---|---|---|---|
| YY | 13 | 20.01363417 | 5.34 | 0.0001 | 13 | 13.60354284 | 3.63 | 0.0001 |
| WK | 13 | 28.51564071 | 7.61 | 0.0001 | 13 | 28.51564071 | 7.61 | 0.0001 |

PARAMETER ESTIMATES

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T FOR H0: PARAMETER=0 | PROB > \|T\| |
|---|---|---|---|---|---|
| INTERCEP | 1 | 6.18387939 | 0.23246672 | 26.601 | 0.0001 |
| YY78 | 1 | -0.146867 | 0.26972054 | -0.545 | 0.5871 |
| YY79 | 1 | -0.320545 | 0.26174758 | -1.225 | 0.2230 |
| YY80 | 1 | -0.116426 | 0.25173538 | -0.462 | 0.6445 |
| YY81 | 1 | -0.0889587 | 0.25600730 | -0.347 | 0.7288 |
| YY82 | 1 | 0.12712681 | 0.25130847 | 0.506 | 0.6139 |
| YY83 | 1 | -0.317423 | 0.24881085 | -1.276 | 0.2044 |
| YY84 | 1 | -0.464251 | 0.25586758 | -1.814 | 0.0720 |
| YY85 | 1 | -0.488124 | 0.25173538 | -1.939 | 0.0548 |
| YY86 | 1 | -0.881976 | 0.25130847 | -3.510 | 0.0006 |
| YY87 | 1 | -0.28426 | 0.24911374 | -1.141 | 0.2560 |
| YY88 | 1 | -0.83282 | 0.24523111 | -3.396 | 0.0009 |
| YY89 | 1 | -0.538688 | 0.24347469 | -2.213 | 0.0288 |
| YY90 | 1 | -0.767187 | 0.25130847 | -3.053 | 0.0028 |
| WK24 | 1 | -1.84032 | 0.41874049 | -4.395 | 0.0001 |
| WK25 | 1 | -0.6768 | 0.24116501 | -2.806 | 0.0058 |
| WK26 | 1 | -0.588077 | 0.20286134 | -2.899 | 0.0044 |
| WK27 | 1 | -0.624975 | 0.20286134 | -3.081 | 0.0025 |
| WK28 | 1 | -0.580916 | 0.20286134 | -2.864 | 0.0049 |
| WK29 | 1 | -0.6269 | 0.20286134 | -3.090 | 0.0025 |
| WK30 | 1 | -0.47192 | 0.20286134 | -2.326 | 0.0216 |
| WK32 | 1 | 0.06810979 | 0.20720454 | 0.329 | 0.7429 |
| WK33 | 1 | -0.280581 | 0.20286134 | -1.383 | 0.1691 |
| WK34 | 1 | -0.510901 | 0.21210188 | -2.409 | 0.0175 |
| WK35 | 1 | -0.877765 | 0.22430657 | -3.913 | 0.0001 |
| WK36 | 1 | -1.48135 | 0.28608041 | -5.178 | 0.0001 |
| WK37 | 1 | -2.49954 | 0.35130968 | -7.115 | 0.0001 |

**Table 8.** Standardized catch rates (C/E) and standard errors (SE) for the inshore and offshore zones, and combined catch rate for the Nain stock unit, 1977-90.

| | Inshore | | Offshore | | Total (combined) | |
|---|---|---|---|---|---|---|
| | C/E | SE | C/E | SE | C/E | SE |
| 1977 | 546 | 126 | 69 | 15 | 316 | 63 |
| 1978 | 471 | 108 | 55 | 13 | 278 | 56 |
| 1979 | 397 | 88 | 134 | 30 | 381 | 74 |
| 1980 | 488 | 103 | 175 | 38 | 499 | 93 |
| 1981 | 501 | 108 | 198 | 44 | 525 | 100 |
| 1982 | 622 | 131 | 185 | 41 | 594 | 111 |
| 1983 | 399 | 83 | 201 | 43 | 476 | 88 |
| 1984 | 344 | 74 | 255 | 52 | 474 | 88 |
| 1985 | 336 | 71 | 270 | 55 | 488 | 89 |
| 1986 | 227 | 47 | 301 | 67 | 406 | 76 |
| 1987 | 413 | 86 | 319 | 66 | 560 | 102 |
| 1988 | 238 | 49 | 220 | 46 | 354 | 64 |
| 1989 | 320 | 65 | 406 | 88 | 550 | 99 |
| 1990 | 254 | 54 | 316 | 66 | 448 | 83 |

Table 9. Results of the analysis of variance of log transformed catch rate from the offshore zone of the Nain stock unit, 1977-90

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: CUE

| SOURCE | DF | SUM OF SQUARES | MEAN SQUARE | F VALUE | PR > F | R-SQUARE | C.V. |
|---|---|---|---|---|---|---|---|
| MODEL | 24 | 74.50081901 | 3.10420079 | 11.60 | 0.0001 | 0.729887 | 11.4699 |
| ERROR | 103 | 27.57083287 | 0.26767799 | | ROOT MSE | | CUE MEAN |
| CORRECTED TOTAL | 127 | 102.07165188 | | | 0.51737606 | | 4.51073199 |

| SOURCE | DF | TYPE I SS | F VALUE | PR > F | DF | TYPE III SS | F VALUE | PR > F |
|---|---|---|---|---|---|---|---|---|
| YY | 13 | 33.34912750 | 9.58 | 0.0001 | 13 | 31.61156134 | 9.08 | 0.0001 |
| WK | 11 | 41.15169151 | 13.98 | 0.0001 | 11 | 41.15169151 | 13.98 | 0.0001 |

PARAMETER ESTIMATES

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T FOR H0: PARAMETER=0 | PROB > \|T\| |
|---|---|---|---|---|---|
| INTERCEP | 1 | 4.12292456 | 0.22565148 | 18.271 | 0.0001 |
| YY78 | 1 | -0.228956 | 0.26848492 | -0.853 | 0.3958 |
| YY79 | 1 | 0.66895096 | 0.26300368 | 2.544 | 0.0125 |
| YY80 | 1 | 0.93248534 | 0.25203895 | 3.700 | 0.0003 |
| YY81 | 1 | 1.05615270 | 0.26300368 | 4.016 | 0.0001 |
| YY82 | 1 | 0.98886290 | 0.26116228 | 3.786 | 0.0003 |
| YY83 | 1 | 1.07132203 | 0.25468559 | 4.206 | 0.0001 |
| YY84 | 1 | 1.30635072 | 0.24272347 | 5.382 | 0.0001 |
| YY85 | 1 | 1.36152413 | 0.24272347 | 5.609 | 0.0001 |
| YY86 | 1 | 1.47402399 | 0.26116228 | 5.644 | 0.0001 |
| YY87 | 1 | 1.53193537 | 0.24722530 | 6.197 | 0.0001 |
| YY88 | 1 | 1.15821365 | 0.24722530 | 4.685 | 0.0001 |
| YY89 | 1 | 1.77103933 | 0.25675253 | 6.898 | 0.0001 |
| YY90 | 1 | 1.52132619 | 0.24967392 | 6.093 | 0.0001 |
| WK25 | 1 | -2.30225 | 0.40619409 | -5.668 | 0.0001 |
| WK26 | 1 | -1.35367 | 0.25833858 | -5.240 | 0.0001 |
| WK27 | 1 | -1.02213 | 0.22415023 | -4.560 | 0.0001 |
| WK28 | 1 | -1.04569 | 0.20463046 | -5.110 | 0.0001 |
| WK29 | 1 | -0.750492 | 0.19981524 | -3.756 | 0.0003 |
| WK30 | 1 | -0.267626 | 0.19554977 | -1.369 | 0.1741 |
| WK32 | 1 | -0.00648821 | 0.19554977 | -0.033 | 0.9736 |
| WK33 | 1 | -0.358397 | 0.19554977 | -1.833 | 0.0697 |
| WK34 | 1 | -0.84609 | 0.19554977 | -4.327 | 0.0001 |
| WK35 | 1 | -1.36426 | 0.21000556 | -6.496 | 0.0001 |
| WK36 | 1 | -2.08989 | 0.27737191 | -7.535 | 0.0001 |

Table 10. Results of the analysis of variance of log transformed catch rate from the Nain stock unit, 1977-90.

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: CUE

| SOURCE | DF | SUM OF SQUARES | MEAN SQUARE | F VALUE | PR > F | R-SQUARE | C.V. |
|---|---|---|---|---|---|---|---|
| MODEL | 27 | 122.09322764 | 4.52197139 | 11.12 | 0.0001 | 0.544629 | 12.9864 |
| ERROR | 251 | 102.08355628 | 0.40670740 | | ROOT MSE | | CUE MEAN |
| CORRECTED TOTAL | 278 | 224.17678392 | | | 0.63773615 | | 4.91081002 |

| SOURCE | DF | TYPE I SS | F VALUE | PR > F | DF | TYPE III SS | F VALUE | PR > F |
|---|---|---|---|---|---|---|---|---|
| YY | 13 | 12.99894196 | 2.46 | 0.0037 | 13 | 11.68414059 | 2.21 | 0.0097 |
| ZN | 1 | 37.03304025 | 91.06 | 0.0001 | 1 | 45.80390960 | 112.62 | 0.0001 |
| WK | 13 | 72.06124543 | 13.63 | 0.0001 | 13 | 72.06124543 | 13.63 | 0.0001 |

PARAMETER ESTIMATES

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T FOR H0: PARAMETER=0 | PROB > \|T\| |
|---|---|---|---|---|---|
| INTERCEP | 1 | 5.57277302 | 0.19911026 | 27.988 | 0.0001 |
| YY78 | 1 | -0.128146 | 0.22962464 | -0.558 | 0.5773 |
| YY79 | 1 | 0.18613329 | 0.22326745 | 0.834 | 0.4053 |
| YY80 | 1 | 0.45407746 | 0.21437648 | 2.118 | 0.0351 |
| YY81 | 1 | 0.50423959 | 0.22030407 | 2.289 | 0.0229 |
| YY82 | 1 | 0.62712663 | 0.21740535 | 2.885 | 0.0043 |
| YY83 | 1 | 0.40612442 | 0.21277561 | 1.909 | 0.0574 |
| YY84 | 1 | 0.40242902 | 0.21204761 | 1.898 | 0.0589 |
| YY85 | 1 | 0.42965990 | 0.20999825 | 2.046 | 0.0418 |
| YY86 | 1 | 0.24718741 | 0.21740535 | 1.137 | 0.2566 |
| YY87 | 1 | 0.56872800 | 0.21018930 | 2.706 | 0.0073 |
| YY88 | 1 | 0.10928989 | 0.20759557 | 0.526 | 0.5990 |
| YY89 | 1 | 0.55027868 | 0.20988292 | 2.622 | 0.0093 |
| YY90 | 1 | 0.34550350 | 0.21263536 | 1.625 | 0.1054 |
| ZN2 | 1 | -0.832487 | 0.07844537 | -10.612 | 0.0001 |
| WK24 | 1 | -2.20019 | 0.47717994 | -4.611 | 0.0001 |
| WK25 | 1 | -1.10784 | 0.23914971 | -4.632 | 0.0001 |
| WK26 | 1 | -0.754115 | 0.18789090 | -4.014 | 0.0001 |
| WK27 | 1 | -0.731658 | 0.18006712 | -4.063 | 0.0001 |
| WK28 | 1 | -0.744059 | 0.17390274 | -4.279 | 0.0001 |
| WK29 | 1 | -0.659809 | 0.17211908 | -3.833 | 0.0002 |
| WK30 | 1 | -0.369773 | 0.17044216 | -2.169 | 0.0310 |
| WK32 | 1 | 0.007489123 | 0.17211830 | 0.044 | 0.9653 |
| WK33 | 1 | -0.319489 | 0.17044216 | -1.874 | 0.0620 |
| WK34 | 1 | -0.718908 | 0.17389424 | -4.134 | 0.0001 |
| WK35 | 1 | -1.21494 | 0.18514641 | -6.562 | 0.0001 |
| WK36 | 1 | -1.9917 | 0.23803381 | -8.367 | 0.0001 |
| WK37 | 1 | -2.80664 | 0.39585438 | -7.090 | 0.0001 |

Table 11. Catch rate index for the inshore zone of the Main stock unit, 1977-90.

NAIN UNIT INSHORE COMMERCIAL CATCH RATE AT AGE

| | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 14.3 | 2.4 | 2.5 | 0.5 | 1.1 | 1.0 | 2.6 | 1.0 | 0.2 | 1.5 | 4.7 | 1.4 |
| 7 | 66.2 | 42.7 | 25.5 | 6.3 | 16.1 | 7.7 | 19.1 | 19.3 | 14.6 | 24.4 | 47.0 | 41.1 |
| 8 | 89.1 | 83.6 | 68.4 | 68.5 | 52.4 | 49.7 | 40.5 | 35.5 | 42.1 | 46.3 | 50.2 | 45.3 |
| 9 | 54.6 | 50.8 | 56.8 | 106.4 | 117.3 | 86.1 | 52.0 | 49.3 | 37.6 | 34.7 | 65.1 | 27.8 |
| 10 | 36.1 | 28.1 | 24.9 | 54.4 | 74.5 | 88.6 | 32.9 | 43.7 | 37.8 | 16.7 | 42.4 | 20.5 |
| 11 | 17.6 | 15.1 | 12.8 | 26.5 | 28.5 | 58.8 | 33.2 | 20.1 | 22.9 | 7.6 | 20.5 | 9.6 |
| 12 | 7.1 | 10.8 | 9.3 | 8.7 | 7.5 | 34.8 | 24.5 | 14.4 | 15.0 | 4.5 | 13.2 | 3.9 |
| 13 | 2.6 | 2.0 | 2.5 | 5.3 | 2.3 | 6.1 | 5.2 | 6.3 | 7.9 | 1.7 | 9.7 | 2.3 |
| 14 | 1.3 | 1.7 | 1.8 | 3.4 | 1.1 | 4.7 | 4.3 | 1.3 | 4.8 | 1.5 | 3.5 | 1.0 |
| 15 | 0.0 | 0.8 | 0.2 | 0.3 | 0.3 | 0.8 | 0.3 | 0.4 | 3.2 | 1.2 | 4.0 | 0.4 |
| 16 | 0.0 | 0.6 | 0.1 | 0.0 | 0.1 | 0.3 | 0.3 | 0.0 | 0.8 | 0.4 | 1.7 | 0.2 |
| 17 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.4 | 0.4 | 0.2 | 0.3 | 1.3 | 0.2 |

| | 1989 | 1990 |
|---|---|---|
| 6 | 6.1 | 3.2 |
| 7 | 32.2 | 29.3 |
| 8 | 60.0 | 33.4 |
| 9 | 53.2 | 48.1 |
| 10 | 21.9 | 24.8 |
| 11 | 16.8 | 11.5 |
| 12 | 6.3 | 5.1 |
| 13 | 2.9 | 1.9 |
| 14 | 1.8 | 0.8 |
| 15 | 0.3 | 0.9 |
| 16 | 0.0 | 0.0 |
| 17 | 0.0 | 0.0 |

Table 12. Catch rate index for the offshore zone of the Nain stock unit, 1977-90.

NAIN UNIT OFFSHORE COMMERCIAL CATCH RATE AT AGE

| | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 1.8 | 0.3 | 0.9 | 0.2 | 0.4 | 0.3 | 3.1 | 1.7 | 2.4 | 0.4 | 2.2 | 0.9 |
| 7 | 8.3 | 5.0 | 8.7 | 2.2 | 6.4 | 12.1 | 13.6 | 18.1 | 27.9 | 34.7 | 44.0 | 31.8 |
| 8 | 11.2 | 9.8 | 23.4 | 24.5 | 20.8 | 22.6 | 29.3 | 35.9 | 65.4 | 62.4 | 64.8 | 39.6 |
| 9 | 6.9 | 6.0 | 19.4 | 38.1 | 46.6 | 12.9 | 33.2 | 39.0 | 31.5 | 52.4 | 59.9 | 29.4 |
| 10 | 4.5 | 3.3 | 8.5 | 19.4 | 29.5 | 31.3 | 16.4 | 24.2 | 17.8 | 27.0 | 26.5 | 24.4 |
| 11 | 2.2 | 1.8 | 4.4 | 9.5 | 11.3 | 10.0 | 19.5 | 14.4 | 9.2 | 10.8 | 6.1 | 10.5 |
| 12 | 0.9 | 1.2 | 3.2 | 3.1 | 3.0 | 9.1 | 5.6 | 8.8 | 5.0 | 2.0 | 7.6 | 4.1 |
| 13 | 0.3 | 0.2 | 0.8 | 1.9 | 0.9 | 1.6 | 1.9 | 5.6 | 4.6 | 1.1 | 1.7 | 1.3 |
| 14 | 0.2 | 0.2 | 0.6 | 1.2 | 0.5 | 1.4 | 2.4 | 2.9 | 2.4 | 0.6 | 0.0 | 0.4 |
| 15 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.8 | 0.8 | 0.5 | 2.0 | 0.6 | 0.1 |
| 16 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 1.1 | 0.0 | 0.0 | 1.2 | 0.0 |
| 17 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.3 | 0.6 | 0.6 | 0.0 | 0.0 | 0.2 | 0.4 |

| | 1989 | 1990 |
|---|---|---|
| 6 | 7.3 | 2.0 |
| 7 | 33.3 | 27.5 |
| 8 | 76.9 | 44.1 |
| 9 | 65.5 | 64.4 |
| 10 | 33.1 | 36.6 |
| 11 | 23.5 | 11.8 |
| 12 | 12.9 | 6.9 |
| 13 | 8.4 | 3.0 |
| 14 | 2.2 | 1.0 |
| 15 | 0.0 | 1.6 |
| 16 | 0.1 | 0.0 |
| 17 | 0.0 | 0.0 |

Table 13. Catch rate index for the Nain stock unit (inshore and offshore zones combined), 1977-90.

NAIN UNIT (INSHORE + OFFSHORE) COMMERCIAL CATCH RATE AT AGE

| | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 8.3 | 1.4 | 2.5 | 0.5 | 1.2 | 0.9 | 4.4 | 2.2 | 1.2 | 2.3 | 5.9 | 1.9 |
| 7 | 38.4 | 25.3 | 24.6 | 6.4 | 16.9 | 10.4 | 25.8 | 31.9 | 29.3 | 45.4 | 66.6 | 58.2 |
| 8 | 51.7 | 49.5 | 66.1 | 70.1 | 55.0 | 50.9 | 54.1 | 56.3 | 77.5 | 84.8 | 76.7 | 66.4 |
| 9 | 31.7 | 30.1 | 54.8 | 108.9 | 123.5 | 77.2 | 64.8 | 69.2 | 56.2 | 64.4 | 92.0 | 43.4 |
| 10 | 21.0 | 16.6 | 24.0 | 55.6 | 78.3 | 85.0 | 38.7 | 53.3 | 48.9 | 31.4 | 54.9 | 33.4 |
| 11 | 10.2 | 8.9 | 12.4 | 27.2 | 30.0 | 52.5 | 40.3 | 26.5 | 29.7 | 14.1 | 24.5 | 15.1 |
| 12 | 4.1 | 6.4 | 9.0 | 8.9 | 7.9 | 31.7 | 25.6 | 18.2 | 19.1 | 6.9 | 16.8 | 6.0 |
| 13 | 1.5 | 1.2 | 2.4 | 5.4 | 2.4 | 6.0 | 5.6 | 9.0 | 10.7 | 2.6 | 11.0 | 3.0 |
| 14 | 0.7 | 1.0 | 1.8 | 3.5 | 1.2 | 4.8 | 5.2 | 3.4 | 6.4 | 2.2 | 3.7 | 1.3 |
| 15 | 0.0 | 0.4 | 0.2 | 0.3 | 0.3 | 0.6 | 0.6 | 1.2 | 3.8 | 2.3 | 4.4 | 0.5 |
| 16 | 0.0 | 0.4 | 0.1 | 0.0 | 0.1 | 0.5 | 0.2 | 0.7 | 1.1 | 0.5 | 2.2 | 0.2 |
| 17 | 0.0 | 0.0 | 0.0 | 0.4 | 0.1 | 0.2 | 0.9 | 1.1 | 0.2 | 0.5 | 0.5 | 0.4 |

| | 1989 | 1990 |
|---|---|---|
| 6 | 9.6 | 4.5 |
| 7 | 50.5 | 46.8 |
| 8 | 103.3 | 60.5 |
| 9 | 90.0 | 87.6 |
| 10 | 40.3 | 46.3 |
| 11 | 30.4 | 18.9 |
| 12 | 13.1 | 9.2 |
| 13 | 7.1 | 3.7 |
| 14 | 2.9 | 1.4 |
| 15 | 0.3 | 1.8 |
| 16 | 0.1 | 0.0 |
| 17 | 0.0 | 0.0 |

Table 14. Parameter estimates from ADAPT using inshore (1977-90) and offshore (1982-90) catch rates, ages 6-14, in a single analysis.

ESTIMATED PARAMETERS AND STANDARD ERRORS
APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET,..... 0.087910
MEAN SQUARE RESIDUALS ..... 0.388931

| AGE | PARAMETER | ESTIMATE | STD. ERR. | T-STATISTIC | C.V. |
|---|---|---|---|---|---|
| 6 | ABUNDANCE | 1.03541E5 | 4.80298E4 | 2.15576E0 | 0.46 |
| 7 | ABUNDANCE | 1.14981E5 | 3.73911E4 | 3.07509E0 | 0.33 |
| 8 | ABUNDANCE | 3.46879E4 | 9.23155E3 | 3.75754E0 | 0.27 |
| 9 | ABUNDANCE | 3.52361E4 | 8.67653E3 | 4.06108E0 | 0.25 |
| 10 | ABUNDANCE | 1.23373E4 | 2.81411E3 | 4.38410E0 | 0.23 |
| 11 | ABUNDANCE | 5.21529E3 | 1.27978E3 | 4.07514E0 | 0.25 |
| 12 | ABUNDANCE | 2.78025E3 | 7.40286E2 | 3.75564E0 | 0.27 |
| 13 | ABUNDANCE | 1.29358E3 | 3.57125E2 | 3.62222E0 | 0.28 |
| 14 | ABUNDANCE | 4.95411E2 | 1.42259E2 | 3.48245E0 | 0.29 |
| 6 | 1 SLOPE | 3.09968E-5 | 5.41323E-6 | 5.72612E0 | 0.17 |
| 7 | 1 SLOPE | 5.06119E-4 | 8.66163E-5 | 5.84322E0 | 0.17 |
| 8 | 1 SLOPE | 1.75448E-3 | 2.98342E-4 | 5.88078E0 | 0.17 |
| 9 | 1 SLOPE | 3.22472E-3 | 5.47409E-4 | 5.89087E0 | 0.17 |
| 10 | 1 SLOPE | 4.04347E-3 | 6.88478E-4 | 5.87306E0 | 0.17 |
| 11 | 1 SLOPE | 4.39656E-3 | 7.49892E-4 | 5.86292E0 | 0.17 |
| 12 | 1 SLOPE | 4.98171E-3 | 8.50553E-4 | 5.85703E0 | 0.17 |
| 13 | 1 SLOPE | 4.10050E-3 | 6.98783E-4 | 5.86805E0 | 0.17 |
| 14 | 1 SLOPE | 5.66885E-3 | 9.62147E-4 | 5.89188E0 | 0.17 |
| 6 | 2 SLOPE | 2.56987E-5 | 5.73114E-6 | 4.48405E0 | 0.22 |
| 7 | 2 SLOPE | 5.98622E-4 | 1.29584E-4 | 4.61959E0 | 0.22 |
| 8 | 2 SLOPE | 1.80480E-3 | 3.86894E-4 | 4.66484E0 | 0.21 |
| 9 | 2 SLOPE | 2.66841E-3 | 5.70498E-4 | 4.67733E0 | 0.21 |
| 10 | 2 SLOPE | 3.43670E-3 | 7.38017E-4 | 4.65666E0 | 0.21 |
| 11 | 2 SLOPE | 3.06622E-3 | 6.60193E-4 | 4.64443E0 | 0.22 |
| 12 | 2 SLOPE | 3.19375E-3 | 6.88656E-4 | 4.63765E0 | 0.22 |
| 13 | 2 SLOPE | 2.88763E-3 | 6.20934E-4 | 4.65047E0 | 0.22 |
| 14 | 2 SLOPE | 2.22540E-3 | 4.75335E-4 | 4.68175E0 | 0.21 |

Table 15. Parameter correlation matrix from ADAPT using inshore (1977-90) and offshore (1982-90) zone catch rates, ages 6-14, in a single analysis.

PARAMETER CORRELATION MATRIX

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.000 | 0.079 | 0.063 | 0.051 | 0.033 | 0.024 | 0.017 | 0.013 | 0.009 | -0.214 |
| 2 | 0.079 | 1.000 | 0.088 | 0.071 | 0.046 | 0.035 | 0.023 | 0.018 | 0.013 | -0.166 |
| 3 | 0.063 | 0.088 | 1.000 | 0.089 | 0.059 | 0.044 | 0.029 | 0.022 | 0.016 | -0.132 |
| 4 | 0.051 | 0.071 | 0.089 | 1.000 | 0.077 | 0.056 | 0.037 | 0.028 | 0.021 | -0.107 |
| 5 | 0.033 | 0.046 | 0.059 | 0.077 | 1.000 | 0.035 | 0.038 | 0.049 | 0.058 | -0.070 |
| 6 | 0.024 | 0.035 | 0.044 | 0.056 | 0.035 | 1.000 | 0.069 | 0.056 | 0.048 | -0.052 |
| 7 | 0.017 | 0.023 | 0.029 | 0.037 | 0.038 | 0.069 | 1.000 | 0.081 | 0.058 | -0.035 |
| 8 | 0.013 | 0.018 | 0.022 | 0.028 | 0.049 | 0.056 | 0.081 | 1.000 | 0.080 | -0.027 |
| 9 | 0.009 | 0.013 | 0.016 | 0.021 | 0.058 | 0.048 | 0.058 | 0.080 | 1.000 | -0.020 |
| 10 | -0.214 | -0.166 | -0.132 | -0.107 | -0.070 | -0.052 | -0.035 | -0.027 | -0.020 | 1.000 |
| 11 | -0.025 | -0.160 | -0.132 | -0.107 | -0.071 | -0.052 | -0.035 | -0.026 | -0.020 | 0.052 |
| 12 | -0.017 | -0.024 | -0.146 | -0.117 | -0.079 | -0.059 | -0.039 | -0.029 | -0.022 | 0.036 |
| 13 | -0.012 | -0.017 | -0.021 | -0.143 | -0.106 | -0.074 | -0.051 | -0.038 | -0.028 | 0.026 |
| 14 | -0.009 | -0.013 | -0.016 | -0.021 | -0.162 | -0.107 | -0.071 | -0.056 | -0.040 | 0.019 |
| 15 | -0.007 | -0.010 | -0.013 | -0.016 | -0.029 | -0.169 | -0.117 | -0.078 | -0.053 | 0.015 |
| 16 | -0.006 | -0.008 | -0.010 | -0.013 | -0.041 | -0.032 | -0.177 | -0.123 | -0.072 | 0.012 |
| 17 | -0.005 | -0.007 | -0.009 | -0.011 | -0.054 | -0.034 | -0.035 | -0.173 | -0.120 | 0.010 |
| 18 | -0.005 | -0.007 | -0.009 | -0.011 | -0.076 | -0.041 | -0.036 | -0.032 | -0.172 | 0.010 |
| 19 | -0.260 | -0.201 | -0.161 | -0.130 | -0.081 | -0.061 | -0.041 | -0.032 | -0.023 | 0.108 |
| 20 | -0.031 | -0.196 | -0.163 | -0.131 | -0.087 | -0.064 | -0.042 | -0.032 | -0.024 | 0.064 |
| 21 | -0.021 | -0.029 | -0.180 | -0.145 | -0.097 | -0.073 | -0.047 | -0.036 | -0.027 | 0.044 |
| 22 | -0.015 | -0.021 | -0.026 | -0.177 | -0.131 | -0.092 | -0.063 | -0.046 | -0.034 | 0.032 |
| 23 | -0.011 | -0.015 | -0.020 | -0.025 | -0.199 | -0.132 | -0.087 | -0.068 | -0.048 | 0.023 |
| 24 | -0.009 | -0.012 | -0.015 | -0.020 | -0.035 | -0.208 | -0.144 | -0.096 | -0.064 | 0.018 |
| 25 | -0.007 | -0.010 | -0.012 | -0.016 | -0.049 | -0.039 | -0.218 | -0.151 | -0.087 | 0.015 |
| 26 | -0.006 | -0.008 | -0.010 | -0.013 | -0.064 | -0.040 | -0.042 | -0.213 | -0.148 | 0.013 |
| 27 | -0.006 | -0.008 | -0.010 | -0.013 | -0.088 | -0.048 | -0.043 | -0.038 | -0.212 | 0.012 |

| | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | -0.025 | -0.017 | -0.012 | -0.009 | -0.007 | -0.006 | -0.005 | -0.005 | -0.260 | -0.031 |
| 2 | -0.160 | -0.024 | -0.017 | -0.013 | -0.010 | -0.008 | -0.007 | -0.007 | -0.201 | -0.196 |
| 3 | -0.132 | -0.146 | -0.021 | -0.016 | -0.013 | -0.010 | -0.009 | -0.009 | -0.161 | -0.163 |
| 4 | -0.107 | -0.117 | -0.143 | -0.021 | -0.016 | -0.013 | -0.011 | -0.011 | -0.130 | -0.131 |
| 5 | -0.071 | -0.079 | -0.106 | -0.162 | -0.029 | -0.041 | -0.054 | -0.076 | -0.081 | -0.087 |
| 6 | -0.052 | -0.059 | -0.074 | -0.107 | -0.169 | -0.032 | -0.034 | -0.041 | -0.061 | -0.064 |
| 7 | -0.035 | -0.039 | -0.051 | -0.071 | -0.117 | -0.177 | -0.035 | -0.036 | -0.041 | -0.042 |
| 8 | -0.026 | -0.029 | -0.038 | -0.056 | -0.078 | -0.123 | -0.173 | -0.032 | -0.032 | -0.032 |
| 9 | -0.020 | -0.022 | -0.028 | -0.040 | -0.053 | -0.072 | -0.120 | -0.172 | -0.023 | -0.024 |
| 10 | 0.052 | 0.036 | 0.026 | 0.019 | 0.015 | 0.012 | 0.010 | 0.010 | 0.108 | 0.064 |
| 11 | 1.000 | 0.035 | 0.026 | 0.019 | 0.015 | 0.012 | 0.010 | 0.010 | 0.063 | 0.063 |
| 12 | 0.035 | 1.000 | 0.028 | 0.021 | 0.017 | 0.013 | 0.012 | 0.012 | 0.043 | 0.044 |
| 13 | 0.026 | 0.028 | 1.000 | 0.028 | 0.022 | 0.017 | 0.015 | 0.015 | 0.031 | 0.031 |
| 14 | 0.019 | 0.021 | 0.028 | 1.000 | 0.031 | 0.025 | 0.022 | 0.022 | 0.022 | 0.023 |
| 15 | 0.015 | 0.017 | 0.022 | 0.031 | 1.000 | 0.033 | 0.024 | 0.019 | 0.018 | 0.018 |
| 16 | 0.012 | 0.013 | 0.017 | 0.025 | 0.033 | 1.000 | 0.032 | 0.021 | 0.014 | 0.015 |
| 17 | 0.010 | 0.012 | 0.015 | 0.022 | 0.024 | 0.032 | 1.000 | 0.027 | 0.012 | 0.013 |
| 18 | 0.010 | 0.012 | 0.015 | 0.022 | 0.019 | 0.021 | 0.027 | 1.000 | 0.012 | 0.013 |
| 19 | 0.063 | 0.043 | 0.031 | 0.022 | 0.018 | 0.014 | 0.012 | 0.012 | 1.000 | 0.078 |
| 20 | 0.063 | 0.044 | 0.031 | 0.023 | 0.018 | 0.015 | 0.013 | 0.013 | 0.078 | 1.000 |
| 21 | 0.044 | 0.048 | 0.035 | 0.026 | 0.021 | 0.016 | 0.014 | 0.014 | 0.053 | 0.054 |
| 22 | 0.032 | 0.035 | 0.044 | 0.035 | 0.026 | 0.021 | 0.018 | 0.019 | 0.038 | 0.039 |
| 23 | 0.023 | 0.026 | 0.035 | 0.051 | 0.038 | 0.031 | 0.027 | 0.027 | 0.027 | 0.029 |
| 24 | 0.018 | 0.021 | 0.026 | 0.038 | 0.055 | 0.040 | 0.029 | 0.023 | 0.022 | 0.022 |
| 25 | 0.014 | 0.016 | 0.021 | 0.030 | 0.040 | 0.058 | 0.039 | 0.025 | 0.017 | 0.018 |
| 26 | 0.013 | 0.014 | 0.018 | 0.027 | 0.029 | 0.039 | 0.053 | 0.033 | 0.015 | 0.015 |
| 27 | 0.012 | 0.014 | 0.018 | 0.026 | 0.023 | 0.025 | 0.033 | 0.043 | 0.014 | 0.015 |

Table 15. continued.

| | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
|---|---|---|---|---|---|---|---|
| 1 | -0.021 | -0.015 | -0.011 | -0.009 | -0.007 | -0.006 | -0.006 |
| 2 | -0.029 | -0.021 | -0.015 | -0.012 | -0.010 | -0.008 | -0.008 |
| 3 | -0.180 | -0.026 | -0.020 | -0.015 | -0.012 | -0.010 | -0.010 |
| 4 | -0.145 | -0.177 | -0.025 | -0.020 | -0.016 | -0.013 | -0.013 |
| 5 | -0.097 | -0.131 | -0.199 | -0.035 | -0.049 | -0.064 | -0.088 |
| 6 | -0.073 | -0.092 | -0.132 | -0.208 | -0.039 | -0.040 | -0.048 |
| 7 | -0.047 | -0.063 | -0.087 | -0.144 | -0.218 | -0.042 | -0.043 |
| 8 | -0.036 | -0.046 | -0.068 | -0,096 | -0.151 | -0.213 | -0.038 |
| 9 | -0.027 | -0.034 | -0.048 | -0.064 | -0.087 | -0.148 | -0.212 |
| 10 | 0.044 | 0.032 | 0.023 | 0.018 | 0.015 | 0.013 | 0.012 |
| 11 | 0.044 | 0.032 | 0.023 | 0.018 | 0.014 | 0.013 | 0.012 |
| 12 | 0.048 | 0.035 | 0.026 | 0.021 | 0.016 | 0.014 | 0.014 |
| 13 | 0.035 | 0.044 | 0.035 | 0.026 | 0.021 | 0.018 | 0.018 |
| 14 | 0.026 | 0.035 | 0.051 | 0.038 | 0.030 | 0.027 | 0.026 |
| 15 | 0.021 | 0.026 | 0.038 | 0.055 | 0.040 | 0.029 | 0.023 |
| 16 | 0.016 | 0.021 | 0.031 | 0.040 | 0.058 | 0.039 | 0.025 |
| 17 | 0.014 | 0.018 | 0.027 | 0.029 | 0.039 | 0.053 | 0.033 |
| 18 | 0.014 | 0.019 | 0.027 | 0.023 | 0.025 | 0.033 | 0.043 |
| 19 | 0.053 | 0.038 | 0.027 | 0.022 | 0.017 | 0.015 | 0.014 |
| 20 | 0.054 | 0.039 | 0.029 | 0.022 | 0.018 | 0.015 | 0.015 |
| 21 | 1.000 | 0.043 | 0.032 | 0.025 | 0.020 | 0.017 | 0.017 |
| 22 | 0.043 | 1.000 | 0.043 | 0.032 | 0.026 | 0.022 | 0.022 |
| 23 | 0.032 | 0.043 | 1.000 | 0.046 | 0.037 | 0.033 | 0.032 |
| 24 | 0.025 | 0.032 | 0.046 | 1.000 | 0.049 | 0.035 | 0.027 |
| 25 | 0.020 | 0.026 | 0.037 | 0.049 | 1.000 | 0.047 | 0.030 |
| 26 | 0.017 | 0.022 | 0.033 | 0.035 | 0.047 | 1.000 | 0.040 |
| 27 | 0.017 | 0.022 | 0.032 | 0.027 | 0.030 | 0.040 | 1.000 |

Table 16. Residuals from ADAPT using inshore zone (1977-90) and offshore zone (1982-90) catch rates, ages 6-14, in a single analysis.

LOG RESIDUALS FOR INSHORE INDEX

| | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 1.473 | -0.142 | 0.567 | -1.015 | -0.140 | -0.140 | 0.602 | -0.495 | -1.800 | -0.138 |
| 7 | 0.651 | 0.030 | -0.315 | -1.095 | -0.086 | -0.785 | 0.294 | 0.074 | -0.323 | 0.405 |
| 8 | 0.423 | 0.064 | -0.390 | -0.213 | 0.146 | 0.138 | -0.001 | 0.054 | 0.003 | -0.014 |
| 9 | 0.101 | -0.178 | -0.424 | 0.000 | 0.330 | 0.615 | 0.127 | 0.115 | 0.026 | -0.264 |
| 10 | -0.039 | -0.108 | -0.554 | -0.035 | 0.112 | 0.565 | 0.115 | 0.439 | 0.292 | -0.415 |
| 11 | -0.239 | -0.346 | -0.276 | 0.216 | -0.071 | 0.530 | 0.347 | 0.268 | 0.562 | -0.819 |
| 12 | 0.081 | -0.106 | -0.217 | 0.023 | -0.490 | 0.957 | 0.370 | 0.174 | 0.929 | -0.502 |
| 13 | 0.182 | -0.292 | -0.785 | 0.277 | -0.486 | 0.050 | 0.053 | -0.105 | 0.638 | -0.229 |
| 14 | -0.725 | 0.794 | 0.366 | -0.014 | -0.978 | 0.898 | 0.207 | -1.059 | -0.017 | -0.687 |

| | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|
| 6 | 0.682 | -0.121 | 0.470 | 0.147 |
| 7 | 0.797 | 0.317 | 0.506 | -0.520 |
| 8 | 0.306 | -0.084 | -0.165 | -0.316 |
| 9 | 0.308 | -0.376 | 0.073 | -0.503 |
| 10 | 0.412 | -0.453 | -0.190 | -0.191 |
| 11 | 0.429 | -0.493 | 0.042 | -0.200 |
| 12 | 0.305 | -0.730 | -0.286 | -0.558 |
| 13 | 1.892 | -0.646 | 0.029 | -0.628 |
| 14 | 1.577 | 1.112 | -0.679 | -0.846 |

SUM OF INDEX 1 RESIDUALS : -0.4461577166 MEAN RESIDUAL : -0.0035409343

LOG RESIDUALS FOR OFFSHORE INDEX 14/ 2/91

| | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|
| 6 | -1.267 | 0.981 | 0.243 | 0.765 | -1.223 | 0.103 | -0.362 | 0.836 | -0.125 |
| 7 | -0.497 | -0.215 | -0.158 | 0.156 | 0.588 | 0.564 | -0.108 | 0.372 | -0.752 |
| 8 | -0.677 | -0.354 | 0.034 | 0.415 | 0.256 | 0.533 | -0.245 | 0.056 | -0.066 |
| 9 | -1.091 | -0.132 | 0.070 | 0.037 | 0.338 | 0.413 | -0.132 | 0.469 | -0.022 |
| 10 | -0.311 | -0.419 | 0.012 | -0.298 | 0.231 | 0.107 | -0.118 | 0.388 | 0.360 |
| 11 | -0.887 | 0.174 | 0.296 | 0.016 | -0.108 | -0.420 | -0.046 | 0.737 | 0.189 |
| 12 | 0.056 | -0.669 | 0.121 | 0.283 | -0.888 | 0.205 | -0.225 | 0.869 | 0.198 |
| 13 | -0.941 | -0.627 | 0.121 | 0.463 | -0.349 | 0.498 | -0.846 | 1.445 | 0.186 |
| 14 | 0.590 | 0.548 | 0.675 | 0.214 | -0.726 | -3.214 | 1.123 | 0.465 | 0.275 |

SUM OF INDEX 2 RESIDUALS : -0.4457039925 MEAN RESIDUAL : -0.0055025184

Table 17. Estimated population numbers and fishing mortality from ADAPT using inshore (1977-90) and offshore (1982-90) catch rates, ages 6-14, in a single analysis.

POPULATION NUMBERS

| | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|
| 6 | 122542 | 100567 | 53582 | 50435 | 47576 | 41858 | 52271 | 58030 | 48845 |
| 7 | 84890 | 98517 | 82002 | 43480 | 41225 | 38821 | 34196 | 42370 | 47347 |
| 8 | 47691 | 61132 | 74594 | 63241 | 34730 | 31835 | 30900 | 25472 | 32326 |
| 9 | 23506 | 27779 | 38177 | 50605 | 42259 | 22212 | 21738 | 20013 | 16675 |
| 10 | 14627 | 12341 | 15519 | 22577 | 26645 | 20633 | 11621 | 11467 | 11254 |
| 11 | 7728 | 7404 | 6117 | 8898 | 10934 | 12959 | 9666 | 5735 | 5431 |
| 12 | 2298 | 4106 | 3920 | 3047 | 3596 | 5562 | 6144 | 3971 | 2729 |
| 13 | 884 | 987 | 1835 | 1786 | 1282 | 2048 | 1861 | 2531 | 1899 |
| 14 | 675 | 400 | 526 | 1124 | 727 | 774 | 1169 | 981 | 1405 |
| 15 | 137 | 390 | 81 | 148 | 448 | 459 | 226 | 453 | 549 |
| 16 | 4 | 111 | 212 | 36 | 82 | 329 | 322 | 122 | 284 |
| 17 | 3 | 3 | 3 | 161 | 28 | 56 | 227 | 239 | 48 |
| 6+ | 304984 | 313737 | 276568 | 245538 | 209532 | 177546 | 170340 | 171384 | 168791 |

| | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|
| 6 | 63630 | 88779 | 58114 | 141093 | 103360 |
| 7 | 39898 | 51906 | 72249 | 47395 | 114700 |
| 8 | 36536 | 28930 | 37555 | 53463 | 34506 |
| 9 | 20580 | 22934 | 17991 | 24263 | 34988 |
| 10 | 9380 | 11545 | 11947 | 10488 | 12207 |
| 11 | 5494 | 5094 | 5382 | 6517 | 5162 |
| 12 | 2190 | 3336 | 2349 | 2931 | 2755 |
| 13 | 782 | 1227 | 1487 | 1335 | 1283 |
| 14 | 739 | 423 | 192 | 925 | 492 |
| 15 | 667 | 425 | 70 | 34 | 506 |
| 16 | 158 | 360 | 25 | 10 | 3 |
| 17 | 148 | 84 | 132 | 2 | 3 |
| 6+ | 180201 | 215044 | 207494 | 288458 | 309964 |

FISHING MORTALITY

| | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 14/ 2/ 1987 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 0.018 | 0.004 | 0.009 | 0.002 | 0.003 | 0.002 | 0.010 | 0.003 | 0.002 | 0.004 | 0.006 |
| 7 | 0.128 | 0.078 | 0.060 | 0.025 | 0.058 | 0.028 | 0.095 | 0.071 | 0.059 | 0.121 | 0.124 |
| 8 | 0.340 | 0.271 | 0.188 | 0.203 | 0.247 | 0.182 | 0.234 | 0.224 | 0.252 | 0.266 | 0.275 |
| 9 | 0.444 | 0.382 | 0.325 | 0.441 | 0.517 | 0.448 | 0.440 | 0.376 | 0.375 | 0.378 | 0.452 |
| 10 | 0.481 | 0.502 | 0.356 | 0.525 | 0.521 | 0.558 | 0.506 | 0.547 | 0.517 | 0.410 | 0.563 |
| 11 | 0.432 | 0.436 | 0.497 | 0.706 | 0.476 | 0.546 | 0.689 | 0.543 | 0.708 | 0.299 | 0.574 |
| 12 | 0.645 | 0.606 | 0.586 | 0.666 | 0.363 | 0.895 | 0.687 | 0.538 | 1.050 | 0.379 | 0.608 |
| 13 | 0.593 | 0.430 | 0.290 | 0.699 | 0.304 | 0.361 | 0.441 | 0.389 | 0.743 | 0.414 | 1.654 |
| 14 | 0.349 | 1.393 | 1.066 | 0.720 | 0.261 | 1.032 | 0.748 | 0.381 | 0.545 | 0.353 | 1.605 |
| 15 | 0.008 | 0.407 | 0.620 | 0.387 | 0.109 | 0.153 | 0.419 | 0.267 | 1.046 | 0.415 | 2.629 |
| 16 | 0.284 | 3.364 | 0.076 | 0.031 | 0.191 | 0.168 | 0.097 | 0.730 | 0.449 | 0.431 | 0.803 |
| 17 | 0.478 | 0.507 | 0.428 | 0.593 | 0.487 | 0.599 | 0.609 | 0.522 | 0.649 | 0.372 | 0.655 |

| | 1988 | 1989 | 1990 |
|---|---|---|---|
| 6 | 0.004 | 0.007 | 0.005 |
| 7 | 0.101 | 0.117 | 0.046 |
| 8 | 0.237 | 0.224 | 0.217 |
| 9 | 0.340 | 0.487 | 0.325 |
| 10 | 0.406 | 0.509 | 0.544 |
| 11 | 0.408 | 0.661 | 0.518 |
| 12 | 0.365 | 0.626 | 0.460 |
| 13 | 0.275 | 0.799 | 0.390 |
| 14 | 1.524 | 0.402 | 0.365 |
| 15 | 1.745 | 2.333 | 0.514 |
| 16 | 2.117 | 1.097 | 0.514 |
| 17 | 0.403 | 0.582 | 0.514 |

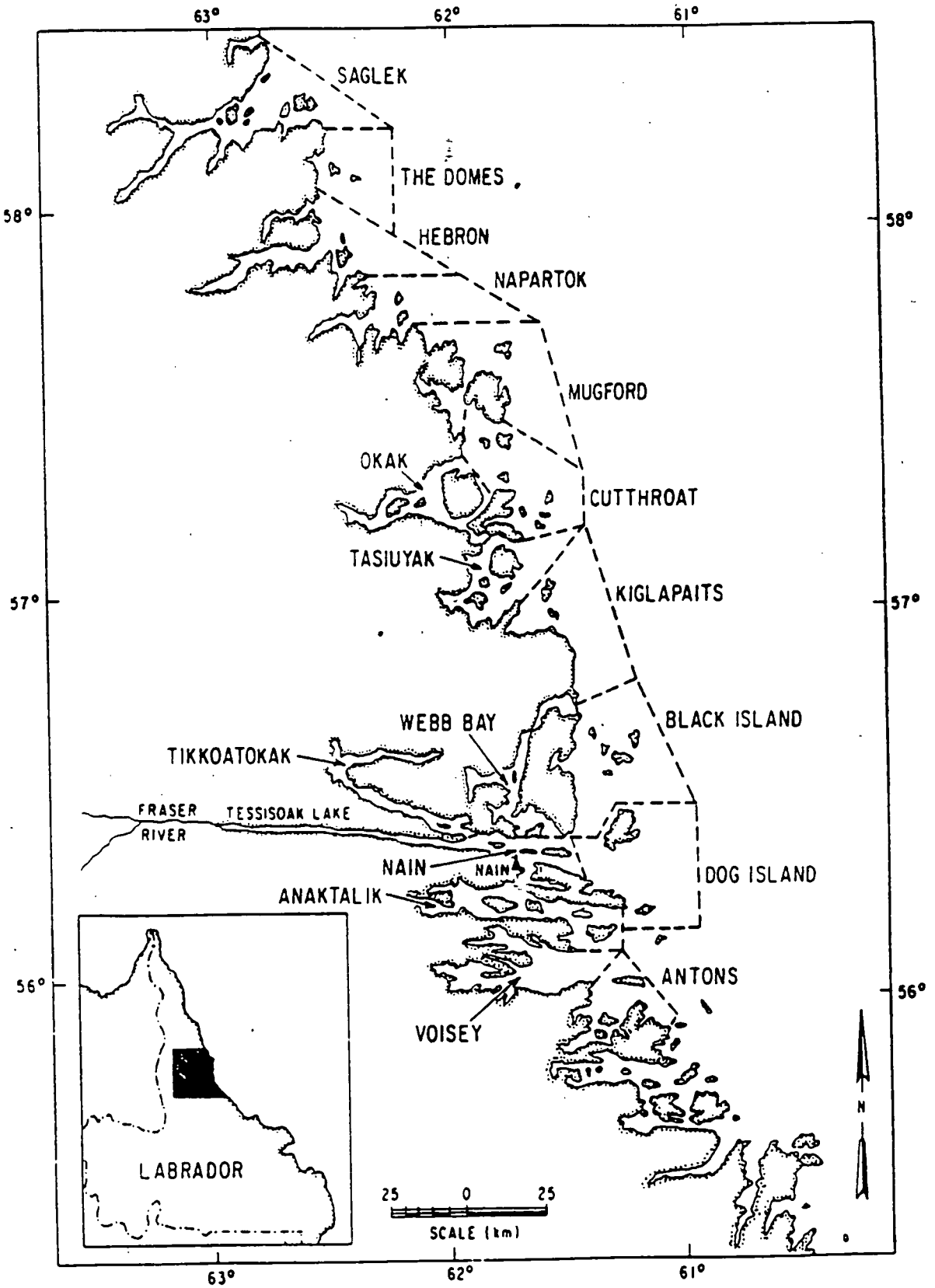



Fig. 1. Geographical separation of the Nain Fishing Region subareas.

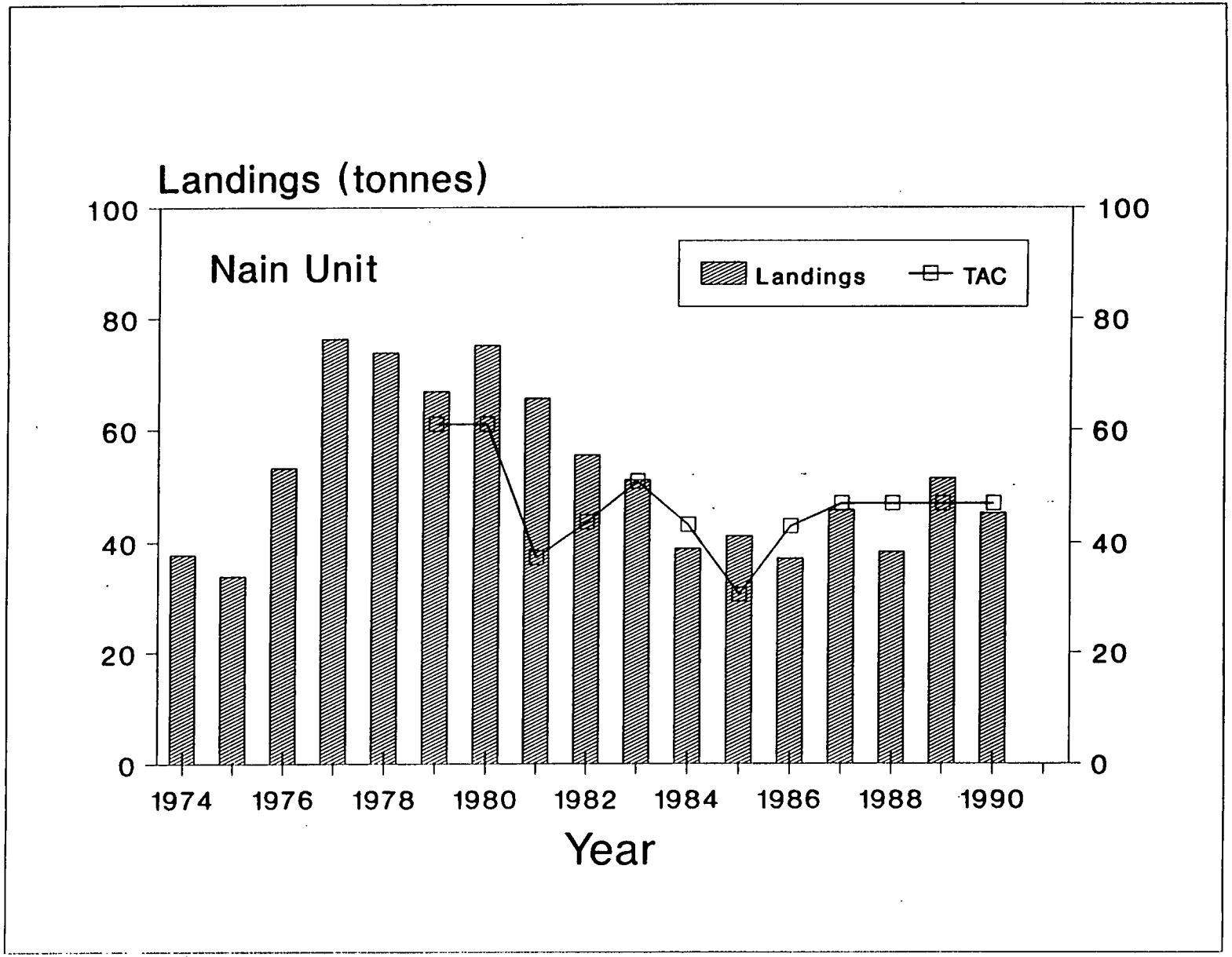
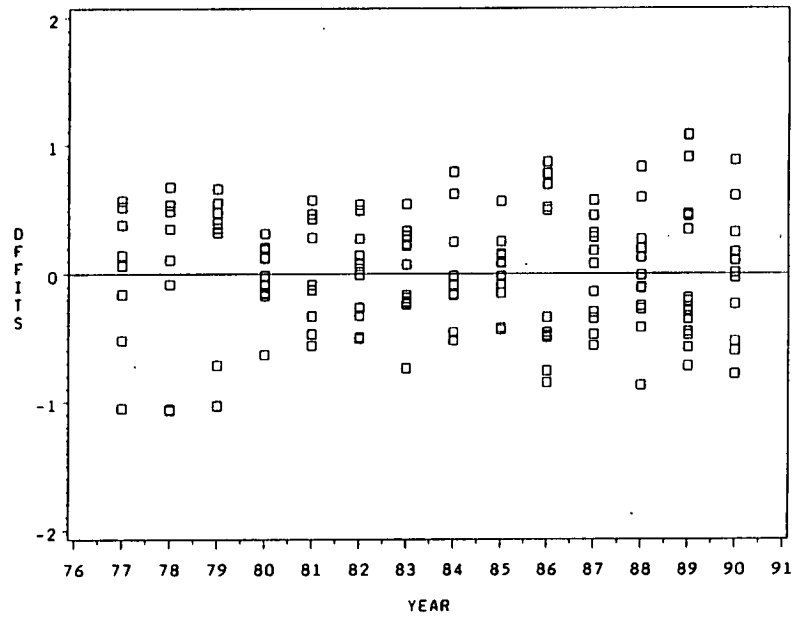
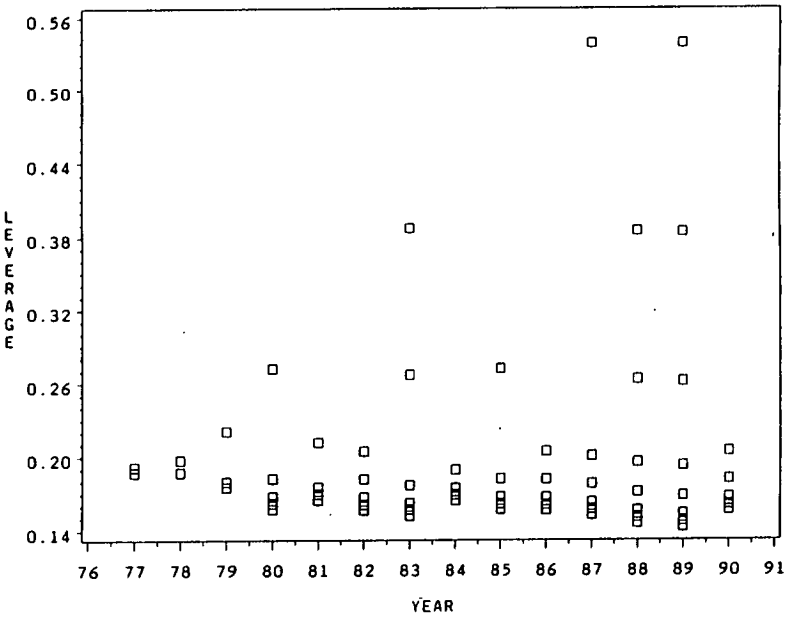
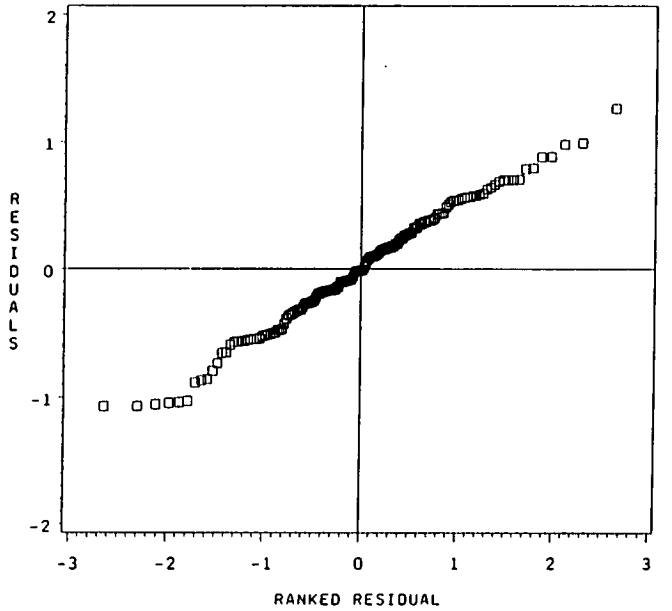



Fig. 2. Summary of Arctic charr landings from the Nain stock unit in relation to the TAC.



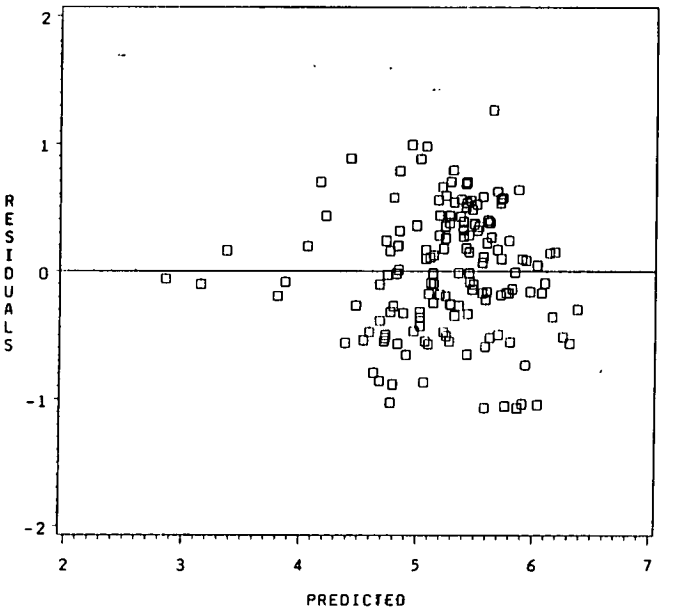
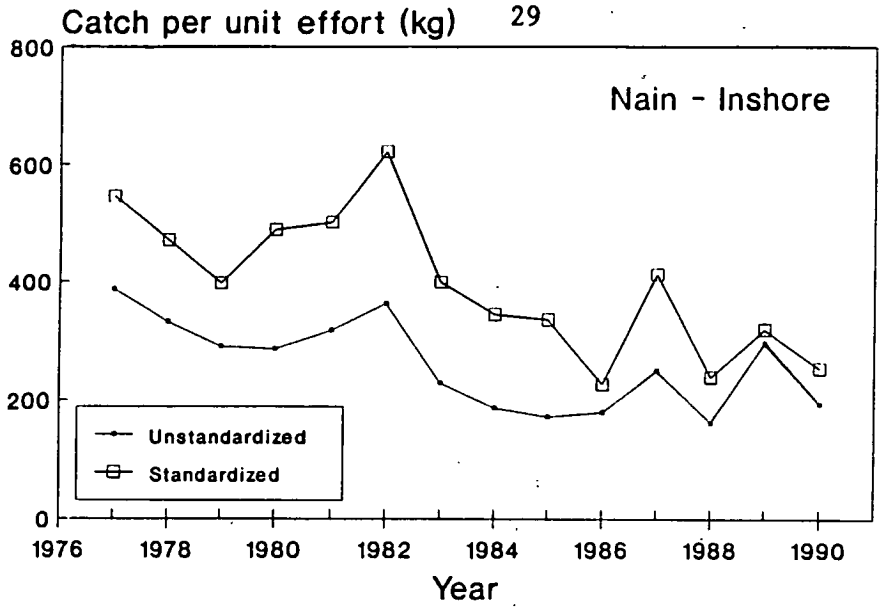
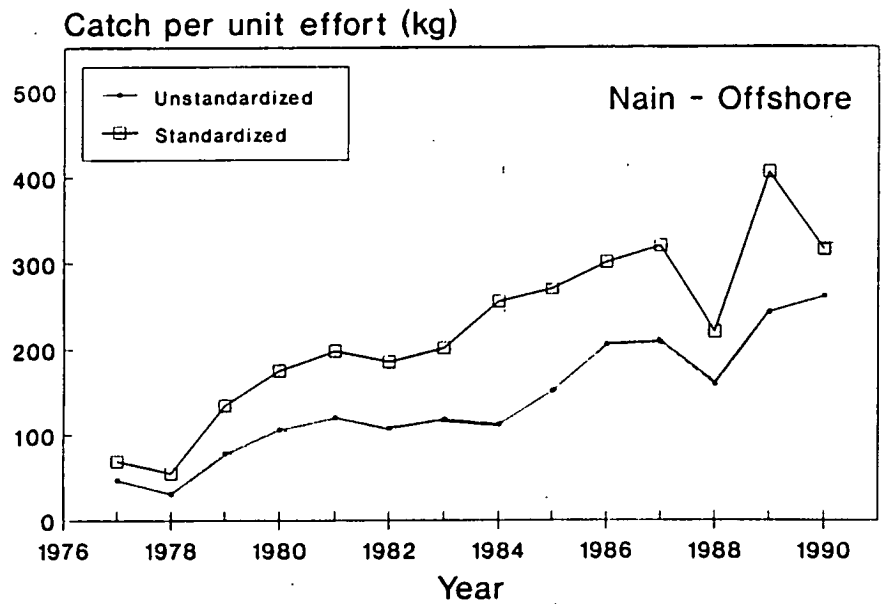




Fig. 3. Residual plots and influence diagnostics for the inshore catch rate series of the Nain stock unit, 1977-90.



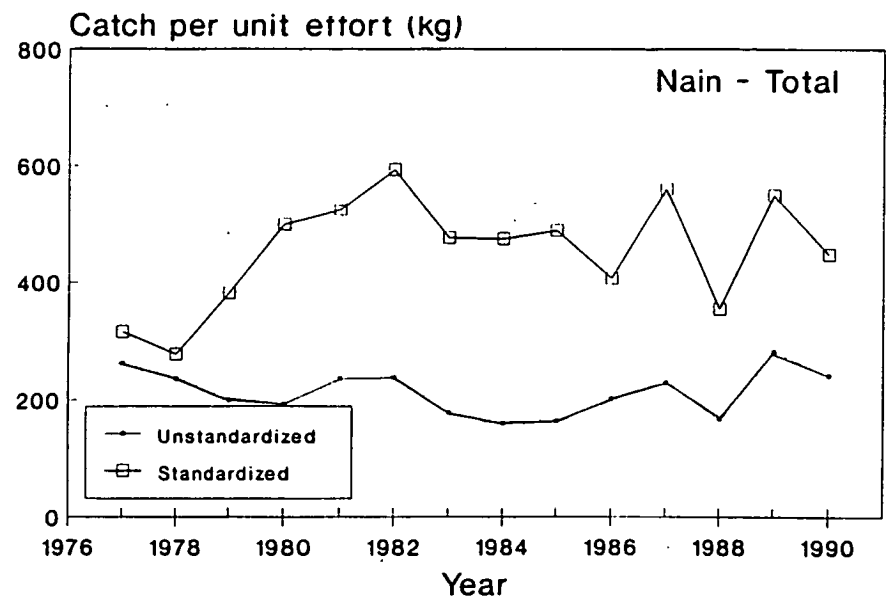




Fig. 4. Comparison of standardized and unstandardized catch rates for the Nain stock unit, 1977-90.

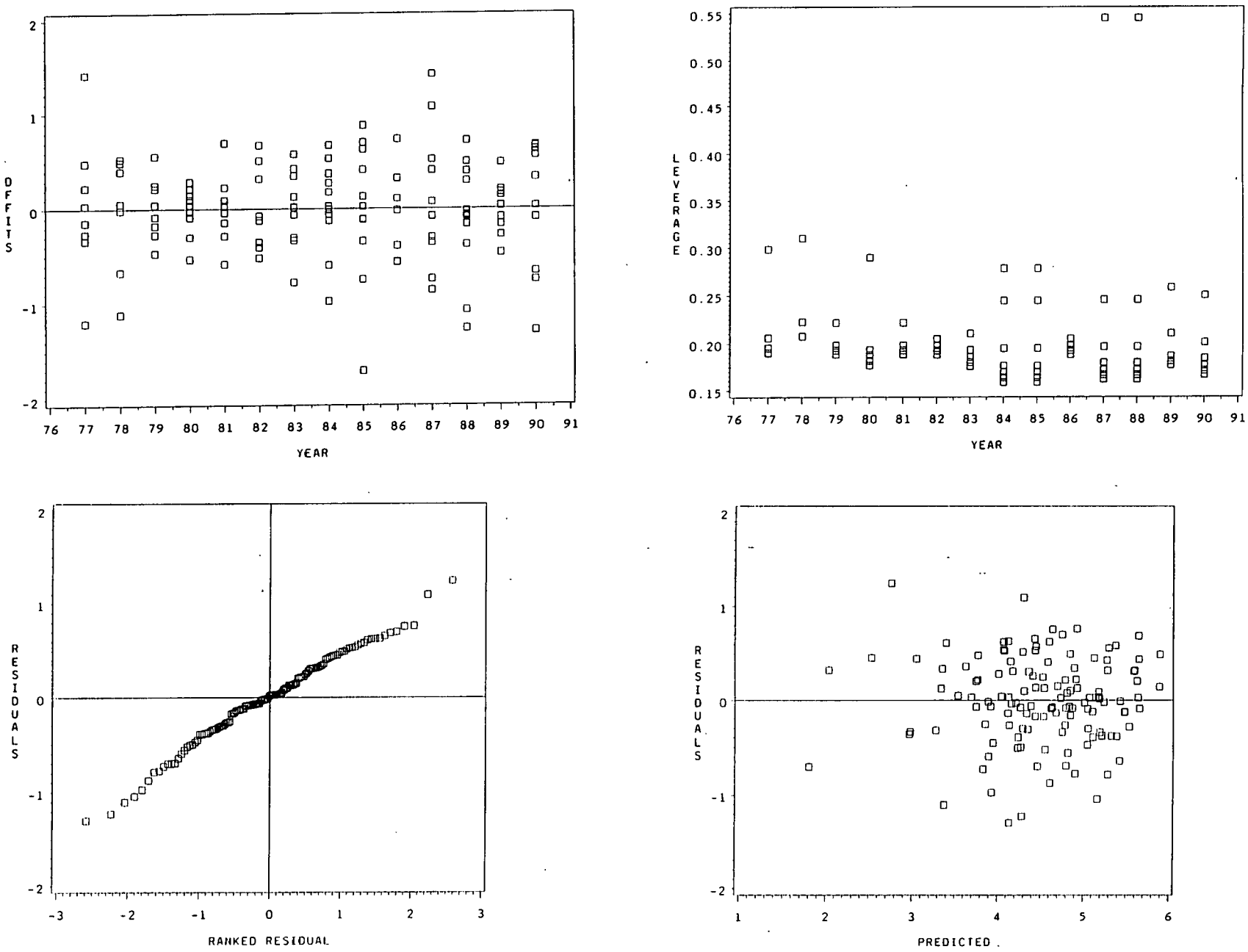
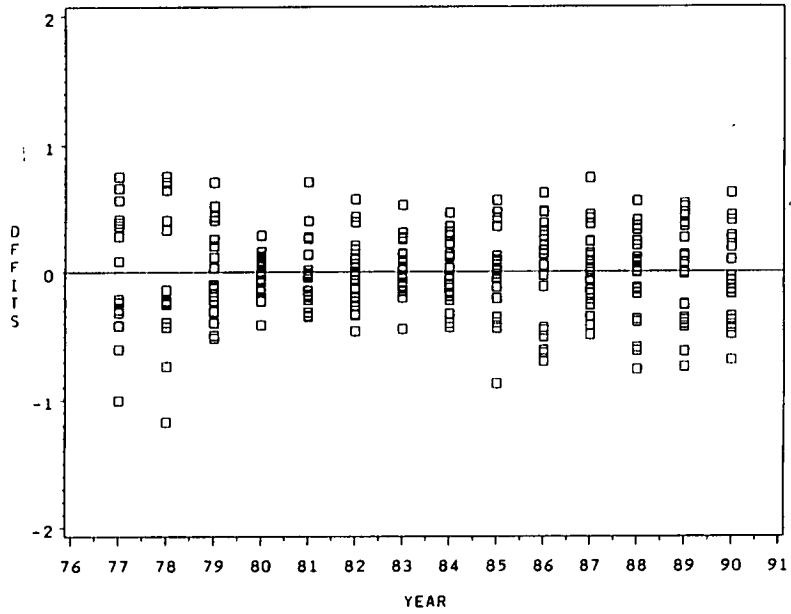
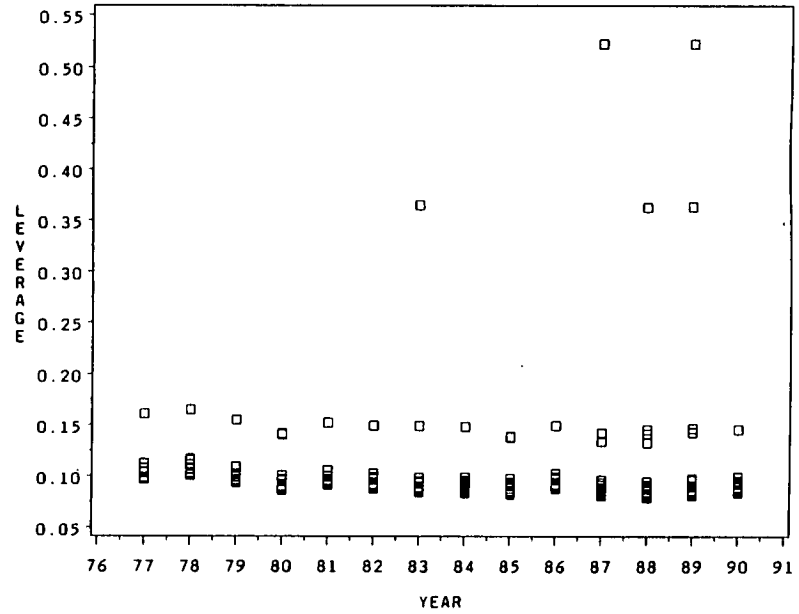
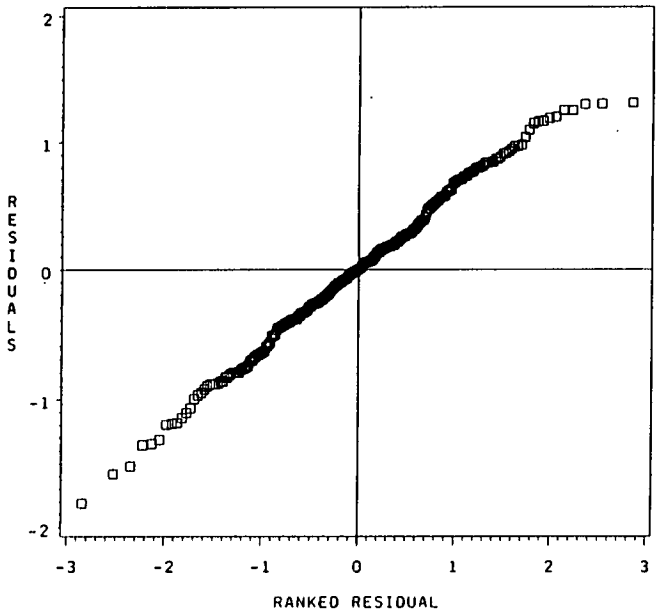



Fig. 5. Residual plots and influence diagnostics for the offshore catch rate series of the Nain stock unit, 1977-90.



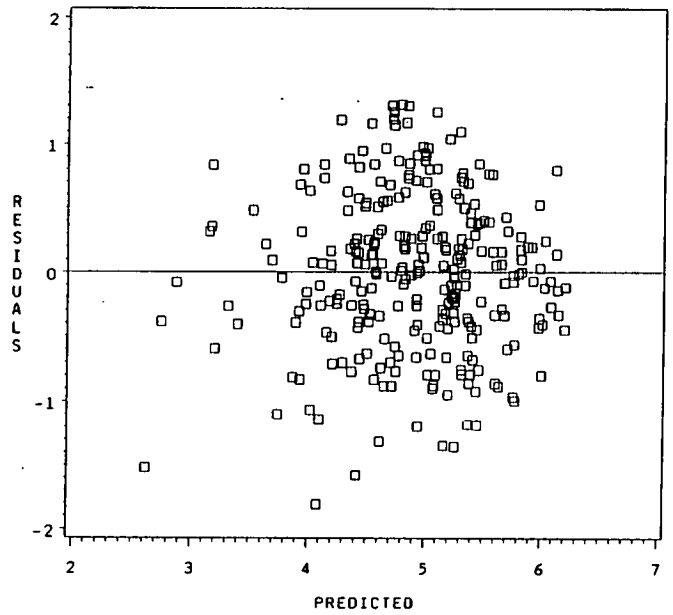
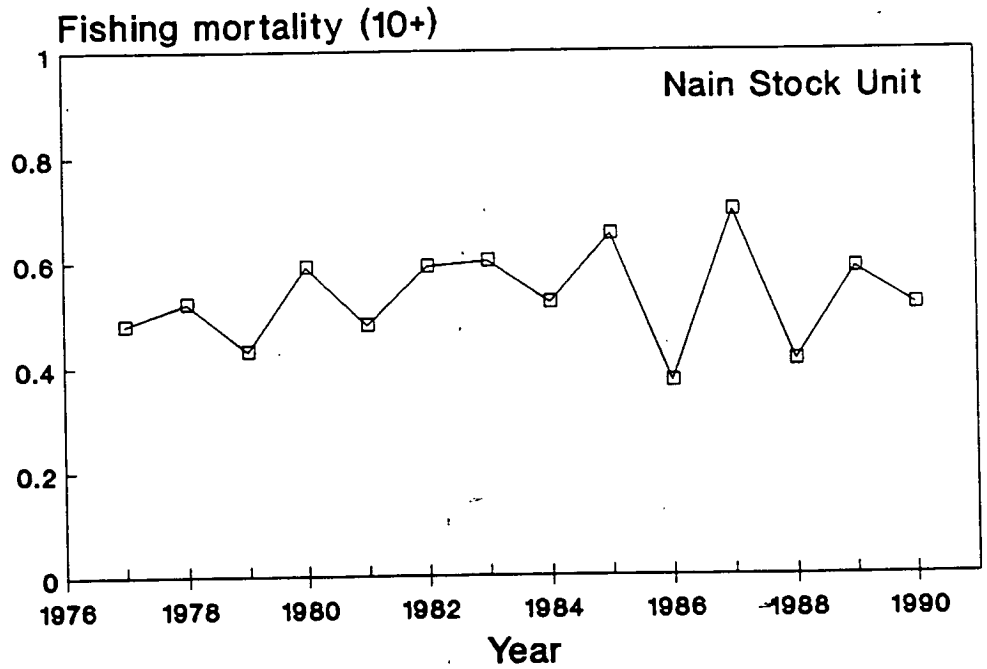




Fig. 6. Residual plots and influence diagnostics for the Main stock unit (combined inshore and offshore zones), 1977-90.



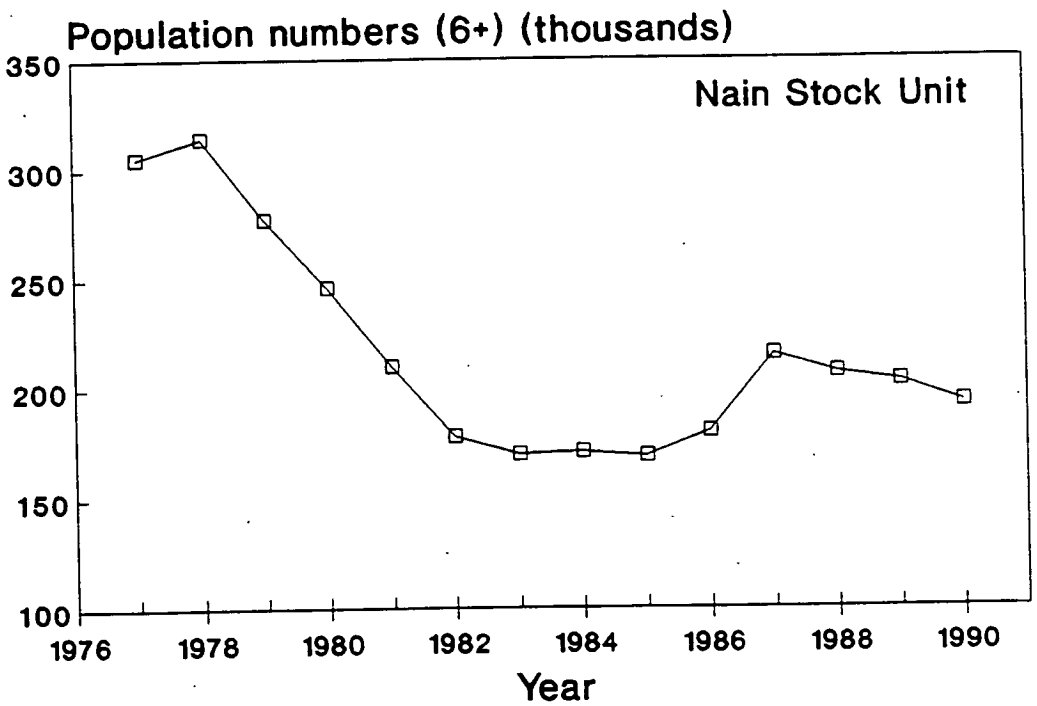




Fig. 7. Estimated population numbers and fishing mortality from the Nain stock unit Arctic charr population, 1977-90.