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# An assessment of the American plaice stock in NAFO Subarea 2 and Division 3K 

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#### Abstract

The stock of American plaice in NAFO Subarea 2 plus Division 3K remains at a very low level. Catches declined to an average of less than 10 t per year during 19971999. Research vessel surveys indicate that the stock size is currently about $10 \%$ of the values measured in the early 1980's. Stock size has remained at this low level for several years following the closure of the directed fishery. Changes in the distribution of the fish were observed in the mid to late 1980's, and size and age at maturity declined through the mid 1990's. The relatively small catches from this stock cannot explain the large decline in abundance or the lack of recovery. With no strong year-classes present in the population, and relatively high mortality rates, the prospects for stock rebuilding in the short to medium term continue to be extremely poor.


## Résumé

L'abondance du stock de plie canadienne dans la sous-zone 2 et la division 3K de l'OPANO reste très faible. De 1997 à 1999, la moyenne annuelle des captures a baissé à moins de 10 t . Selon des relevés de navires de recherche, la taille du stock représente actuellement environ $10 \%$ des valeurs mesurées au début des années 1980. Après la fermeture de la pêche dirigée à la plie canadienne, la taille du stock est restée à ce niveau peu élevé pendant plusieurs années. Dans la deuxième moitié des années 1980, on a observé des changements dans la répartition des plies canadiennes ainsi qu'une baisse de leur taille et de leur âge à maturité qui s'est poursuivie dans le milieu des années 1990. Les captures relativement faibles de plies appartenant à ce stock ne peuvent expliquer la forte baisse de l'abondance ou le fait que le stock ne se soit pas rétabli. Comme la population ne comprend aucune forte classe d'âge et que les taux de mortalité sont relativement élevés, les chances que le stock se rétablisse à court ou à moyen terme demeurent extrêmement faibles.

## Description of the fishery, TAC history

Catches increased steadily throughout the 1960's, peaking at $12,686 \mathrm{t}$ in 1970 (Table. 1). Vessels from Poland and USSR took most of the catches in the 1960's. After the declaration of the 200 mile limit in 1977, catches by non-Canadian fleets were greatly reduced, with the result that the total catch from the stock exceeded $2,000 \mathrm{t}$ on only 2 occasions after 1981. Reported catches from 1994 to 1999 were less than 30 t per year, mostly as by-catch in gillnet fisheries, and are by far the lowest in the time series. This is due to a drastic reduction in the TAC in 1994 (Table 1), as well as the moratorium and subsequent limited fishery for northern cod, which, after 1992, essentially eliminated a major source of A. plaice by-catch. An increase in the catch in 2000 was observed, probably as a result of by-catch from increased gillnetting of G.halibut in Div. 3K. Catches discarded in the shrimp fishery in Subarea $2+$ Div. 3K have not been included in the data presented here. Kulka (1995), using observer data, estimated these to be 64 t on average for Div. 2J3KL combined in 1980-94 (range 0 228 t ). Introduction of Nordmore grates in the shrimp fisheries in these areas in recent years has probably caused a reduction in finfish by-catch, although no recent estimates are available. There are no estimates of by-catch currently available from the newly developed shrimp fishery by vessels less than 65 feet.

In most years, a large percentage of the A. plaice catch came from Div. 3K, with recent exceptions of 1989 and 1990 when a directed fishery on this stock occurred in the autumn in Div. 2J. Catches from Div. 2GH combined have not exceeded 125 t in any year since 1972 (Table 2), and have been negligible in many years (zero since 1992). Only 2 tons of catch have been reported in Subarea 2 from 1993-99. In most years prior to 1991, the inshore catch from the stock ranged between 500 and $2,000 \mathrm{t}$. The offshore catch fluctuated widely, as it was often more economical for the offshore fleet to fish for A. plaice in the southern divisions of Subarea 3. Offshore fisheries occurred in the autumn of 1989 and 1990 in Div. 2J, often in conjunction with cod fisheries.

Stock assessments were conducted within ICNAF in the mid to late 1970's, and then within CAFSAC from the early 1980's until the early 1990's. TAC regulation began for this stock in 1974, and the TAC was 10,000 tons from 1982-92 (Table 1). After a reduction to $5,000 \mathrm{t}$ for 1993, the FRCC recommended that there be no directed catch from this stock in 1994 and that by-catches be limited to 500 t . This advice was implemented at the beginning of 1994, and was followed by similar advice for 1995-97, although by-catches were limited to a maximum of 100 t per year in this period. The FRCC advice for 1998-2000 did not reference the 100 t figure, therefore the TAC for these years was effectively 0 .

## Commercial fishery data

CPUE data are available from Canadian offshore otter trawlers for the period 1976-92. However, only twice since 1981 did the directed catch of A. plaice exceed 500 t , and in many years it was negligible. Therefore these data cannot be used as an index of abundance for this stock and by-catch catch rates are not considered to be representative of stock abundance (Brodie et al. 1993). In 1989, a substantial directed
fishery (1457 t) for American plaice occurred in October-November in Div. 2J, with catch rates averaging 714 kg . per hour. This is a relatively high CPUE for this species compared to the long time series of CPUE values in the Canadian fishery for the same species on the Grand Banks (Div 3LNO). The fishery in the fall of 1990 was essentially a mixed one for cod and A. plaice, and no comparable CPUE data are available. Offshore catches were negligible after 1991.

Catch at age data for this stock are available for the period 1984-90, based on samples from the Canadian fisheries. For many years prior to 1984, and for 1991 to 1999, sampling data are either non-existent or inadequate to calculate catch at age. In most years where sampling data are available, ages 9-12 comprised the bulk of the commercial fishery, and there was a declining trend in the catch numbers of older individuals up to 1990 (Brodie et al. 1993).

## Research vessel survey data

Stratified random bottom trawl surveys have been conducted in Div. 2G, 2H, 2J, and 3K since the late 1970's, although not annually in Div. 2GH. In 1995, the survey trawl was switched from an Engel 145 Hi-lift trawl with bobbin footgear to a Campelen 1800 shrimp trawl with rockhopper footgear (McCallum and Walsh 1996). The Campelen trawl, with its smaller mesh throughout, was more effective in capturing small fish. A comparative fishing experiment was carried out to quantify the differences, and the results are contained in Warren (1996). Morgan and Brodie (2000) converted the results of surveys in Div. 2J and 3K from 1978-94 into Campelen equivalents for A. plaice. The surveys in Div. 2GH were not converted.

From 1996-99, the fall surveys covered Subarea 2 and Divisions 3KLMNO, although the coverage was not comparable in all years, particularly in Div. 2G, and inshore 3 K. Table 3 shows the details of the surveys from 1996-99. Some changes were introduced during this period, notably the addition of inshore strata in Div. 3K in 1996. The inshore strata were surveyed in 1996-98, but not in 1999. Stratification schemes in use from 1997 onward are shown in Figs 1-4 for Divisions 2G, 2H, 2J, and 3K.

## Abundance and biomass estimates

The trawlable biomass index of A. plaice in Div. 2G was relatively low (< 610 tons) in all surveys from 1996-99, although coverage was incomplete in all years (Table 4). Biomass was distributed mainly in the $201-300 \mathrm{~m}$ strata, and despite the poor coverage in deeper water, there were few A. plaice found deeper than 500 m , and none beyond 750 m . In Div. 2H, the trawlable biomass estimates were between 925 and 1210 tons in 1996-99 (Table 5). The biomass in Div. 2H was more evenly distributed among depth zones, and some A. plaice were found in the 750-1000 m depth range. In Div. 2GH combined, the Engel biomass estimates declined substantially from a level in 1978-81 between 12,000 and 20,000 tons to around 4,000-7,000 tons in 1987-88 (Brodie et al. 1995). A Canadian survey in 1991, a Japanese survey in 1996 which gave a 2GH biomass estimate for A. plaice of 446 tons (Yokawa and Satani, 1997), and the recent Campelen surveys show that this decline continued into the 1990's.

In Div. 2J, the trawlable biomass index declined drastically from estimates over $220,000 \mathrm{t}$ in 1982-83 to estimates below 10,000 t in each year after 1991 (Fig. 5) Estimated biomass since the Campelen surveys started in 1995 has been less than 6000 tons in each year (Table 6). The 1999 estimate was 4850 t with an approximate $95 \%$ confidence interval of $+/-702 \mathrm{t}$. Div. 3K shows a similar pattern, with the biomass declining from a high of over 100,000 tons (1981, 1984) to between 10,000 and 16,000 t in the 1992-99 period (Table 7, Fig. 5). The 1999 estimate was $11,715 \mathrm{t}$, with an approximate $95 \%$ confidence interval of $+/-2140 \mathrm{t}$. It should be noted that the inshore strata were surveyed in Div. 3K only in the years 1996-98, and these values, which are shown in Table 7, have been included in the annual totals. The inshore biomass estimates were similar in all 3 years (range 764 - 992 tons), and accounted for 6 to $9 \%$ of the total biomass estimate in Div. 3K.

Age compositions (mean numbers per tow) from the Campelen surveys in Div. 2GH are presented in Table 8. No fish beyond age 11 were found in Div. 2G, and only in low numbers in Div. 2H. For Div. 2GH combined, ages 2 and 3 were the most abundant age groups in the 1999 survey, and represented the largest catch of any year classes in the 4 year time series. However, the surveys in Div. 2J and 3K in 1999 did not show these year classes to be dominant in the age compositions. Ages 5-7 were dominant in these areas, although the age compositions in the 2 Divisions were somewhat different (Tables 9 and 10). Few fish older than 12 have occurred in the Campelen surveys of 1995-99 (Table 11), consistent with the truncation of the age range observed in the 1980's and 90's. Overall, the abundance index of American plaice for Div. 2J3K combined was at its lowest level in 1999, about $10 \%$ of the mean Campelen equivalent value for 1979-83 (Table 11, Fig. 6).

There was a gradual reduction in the numbers of older fish caught in the 1980's surveys, consistent with the commercial fishery data in this period. Virtually all cohorts declined at very high rates from 1990 to 1993 (Tables 9-11).

## Distribution by depth and area

Shifts in the depth distribution of the A. plaice biomass to deeper water occurred after the mid-1980's in both Division 2J and 3K (Fig. 7, modified from Bowering et al. 1997), and were followed by continued steep declines in the biomass to very low levels. In Div. 2J, plaice in the shallowest depth zone (101-200 m) accounted for 45 to 85 percent of the biomass (unconverted Engel data) in that division in the years 1977 to 1988. In 1989, this percentage dropped sharply to less than 5, and has remained less than $20 \%$ in all subsequent surveys. The proportion of biomass found in depths greater than 500 m was negligible in both areas prior to the 1990's, but increased in the 1990's (Tables 6 and 7, Fig. 7). Recent surveys indicate a decline in the proportion of biomass deeper than 500 m , but the proportion of biomass deeper than 300 m remains high relative to the historic pattern. It should be noted, for Div. 3 K , that the strata in the 101200 m depth range (618 and 619, Fig. 4) were added to the fall surveys in 1984, so prior to then there were no survey sets in this depth range in Div. 3K. Also, the inshore strata in Div. 3K were not included in these comparisons, as these strata were surveyed only in 1996-98.

The spatial distribution of American plaice in 1999 is seen in Fig. 8a in number of fish per tow, and in Fig. 8b in weight of fish per tow. Fish remain widely distributed throughout Subarea 2 and Division 3K in 1999, but at relatively low densities. The southern portion of Division 3K contained several of the largest catches in numbers, although it should be noted that the inshore areas of Div. 3K, which contained A. plaice in the 1996-98 surveys, was not surveyed in 1999. Most of the sets with no A. plaice in 1999 were in the deepest strata, although the central part of Div. 2G and the near-shore area around southern Div. 2J and northern Div. 3K had several sets with no A. plaice.

The concentrations of A. plaice on Hamilton Bank and in the southwestern portion of Div. 2J, present in most surveys up to 1988, were generally not found in subsequent surveys (Brodie et al. 1995). In 1989 and 1990, before the biomass declined to the current low level, A. plaice in Div. 2J were found to the east of Hamilton Bank, and south in the Hawke Channel. Similar changes were observed in Div. 3K, with A. plaice becoming less abundant in the shallower shelf areas west of Funk Island Deep. Fig 9 shows a comparison of the distribution patterns observed in the Campelen surveys of 1995-99.

## Mean size and weight at age

Data on mean length and weight at age were available from research vessel survey data. Beginning in 1990, weights for sampled fish were collected at sea during the surveys. Fig. 10 shows the mean size and weight of 6 year old American plaice collected in the fall surveys of Div. 2 J and 3 K . For Divs 2 J and 3 K , both sexes showed a decline in size and weight at age 6 from 1990-95, a sharp increase in 1996, and levels in recent years similar to those of the early 1990's. The reason for the fluctuations in 1995-97 is not clear, but it is unlikely the data reflect real changes in growth. The changes appear to be for reasons other than the new survey gear, as the first Campelen survey occurred in 1995. The same pattern also was evident for ages other than age 6 . The fish were sampled using a length-based stratified sampling scheme, and no account has been made for potential biases in analysing these data. As well, the sampled fish are generally spread by depth and area throughout an entire Divison, and no analysis has been made of spatial differences on a smaller scale. Further examination of these size and weight at age data is warranted.

## Maturity at Age and Size

Proportions mature at age were calculated according to the method described in Morgan and Hoenig (1997) to correct for bias introduced by length-stratified sampling.

Maturities were modelled by cohort using the PROBIT procedure of SAS with a logit link function (SAS Inst. Inc., 1989):
pmat $=\log \left(\frac{u}{1-u}\right)$
where: $\quad$ pmat= proportion mature at age or length

$$
\begin{aligned}
u=\tau+ & \delta_{j} v_{i}+\beta_{j} \\
& \tau=\text { intercept } \\
& v_{i}=\text { age } i \text { or length } i \\
& \delta_{j}=\text { combined age }{ }^{*} \text { cohort effect for cohort } j \\
& \beta_{j}=\text { cohort effect }
\end{aligned}
$$

Before a cohort was included in the model it was first tested separately to ensure that there was sufficient data to which to fit a model. Only cohorts with both a significant slope and intercept were included in the overall model. From this model, estimates of proportion mature at age as well as age at $50 \%$ maturity ( $A_{50}$ ), and length at $50 \%$ maturity ( $L_{50}$ ) were produced for males and females for Div. 2J3K combined.
$A_{50}$ has been declining for both males and females from the earliest cohorts that could be estimated (1968 for females, 1972 for males, Fig 11). Female $A_{50}$ has declined from just under 11 years to 8 years. For males $A_{50}$ has declined from 7 to 4 years. $L_{50}$ has also shown a large decline over the time period (Fig 12). For females, cohorts of the late 1960's had an $L_{50}$ of 36 cm while the most recent cohorts have had an $L_{50}$ of less than 30 cm . For males, cohorts of the early 1970's had $\mathrm{L}_{50}$ 's in the mid 20 cm range while the most recent $L_{50}$ 's have averaged around 17 cm . Length at $50 \%$ maturity has shown a tendency to increase for the most recent cohorts.

## Mortality

Estimates of total mortality (Z) from the Campelen (or equivalent) fall 2J3K survey data were calculated from the abundance index for ages $8+$ in year $n$ and $7+$ in year $n-1$ (Table 11, Fig. 13). Despite the low catches, these values were generally higher in the 1990's (mean $1990-99=1.27$ ) than in the $1979-89$ period (mean $=0.78$ ). Age by age estimates of total mortality were also calculated for ages 1 to 16 for Div. 2J3K (Fig. 14). A Lowess smoother has been added to the plots to help visualise trends. The results for ages 2 to 14 are probably the most reliable. The results indicate that there have been increases in mortality over the time period. There is very little indication of a decline in mortality in the years following the end of directed fishing in 1994, and it is quite likely that natural mortality is higher than 0.2.

Catch divided by the index of survey biomass (C/B) gives a proxy for fishing mortality, and the time series of $\mathrm{C} / \mathrm{B}$ ratios is shown in Fig. 15. Biomass estimates are Campelen equivalents for Div. 2 J and 3 K combined, and the catches are the reported data for Subarea 2+ Div. 3K combined (Tables 1 and 2). For much of the time period when surveys were available, a substantial part of the commercial catch occurred during the first quarter of the year. Thus the survey estimates of biomass, which were generally from November-December, were taken to represent the biomass on January 1 of the following year. The analysis showed that the C/B ratios were all less than $4 \%$, exceeded $3 \%$ on only 2 occasions, and have been less than 1\% each year from 1991-99. During the years of the largest stock decline (1982-88), the C/B ratio did not reach $2 \%$, and was around $0.5 \%$ for 1983-85. Morgan et al. (2000), in a more detailed examination of these data, concluded that fishing mortality could not explain the decline in biomass of this stock which occurred from the early 1980's to the early 1990's.

## Relative Cohort Strength

Cohort strengths were estimated using the following model using Campelen or equivalent data from spring RV surveys from 1978 to 1999:

$$
\log \left(N_{a j t}\right)=\tau+\alpha_{a}+\delta_{j}+\varepsilon
$$

where: $N_{a j t}=$ number at age a belonging to cohort $j$ in year $t$
$\tau=$ intercept
$\alpha_{a}=$ age effect for ages $a=2 \ldots 5$
$\boldsymbol{\delta}_{j}=$ cohort effect
$\varepsilon=$ residuals from the fitted model
This model showed no obvious pattern in the residuals and a significant fit to the data.
$R^{2}=0.82, n=85$

| Source | DF | Type III SS | F value | Pr>F |
| :--- | :--- | :--- | :--- | :--- |
| AGE | 3 | 95.37 | 51.48 | 0.0001 |
| COHORT | 24 | 42.15 | 2.84 | 0.0007 |

The strengths of the 1973 to 1996 cohorts, relative to the 1997 cohort, were estimated by this model. The cohorts of 1973 and 1974 were generally stronger than later cohorts (Fig.16), although the 1973 cohort is estimated using only a single observation. The 1983 cohort was almost as strong as the 1974 cohort. There have been no other cohorts of similar strength over the time period.

## Assessment

The stock of American plaice in NAFO Subarea 2 plus Division 3K showed a large decline from the early 1980's to the early 1990's. The stock size is currently about onetenth of the values measured in the early 1980's. Stock size has remained at this low level for several years following the closure of the directed fishery in 1994. The relatively small catches from this stock cannot explain the large decline in abundance or the lack of recovery. Total mortality rates are estimated to be higher in the 1990's than in the 1980's. Changes in the distribution of the fish were observed in the mid to late 1980's, and size and age at maturity declined through the mid 1990's. With no strong year-classes present in the population, and relatively high mortality rates, the prospects for stock rebuilding in the short to medium term continue to be extremely poor.

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Table I. Nominal catches (1963-92) and TACs (1974-2000) of American plaice, NAFO Subarea plus Division 3K. All values in metric tons.

| Year | Canada |  |  | Poland | USSR | Other | Total | TAC |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Inshore | Offshore ${ }^{\text {a }}$ | Total |  |  |  |  |  |
| 1963 | 116 | - | 116 | 675 | 627 | 3 | 1,421 |  |
| 1964 | 95 | - | 95 | 1,678 | 1,268 | 27 | 3,068 |  |
| 1965 | 224 | - | 224 | 3,195 | 2,155 | 14 | 5,558 |  |
| 1966 | 228 | - | 228 | 1,860 | 765 | 96 | 2,949 |  |
| 1967 | 395 | - | 395 | 1,134 | 1,701 | 361 | 3,591 |  |
| 1968 | 1,023 | - | 1,023 | 1,889 | 2,911 | 128 | 5,951 |  |
| 1969 | 1,689 | - | 1,869 | 867 | 4,129 | 217 | 6,902 |  |
| 1970 | 3,751 | - | 3,751 | 378 | 8,160 | 397 | 12,686 |  |
| 1971 | 2,486 | - | 2,486 | 233 | 2,597 | 32 | 5,348 |  |
| 1972 | 1,188 | 9 | 1,197 | 849 | 6,760 | 315 | 9,121 |  |
| 1973 | 1,368 | 16 | 1,384 | 225 | 3,011 | 520 | 5,140 |  |
| 1974 | 462 | 106 | 568 | 91 | 4,643 | 318 | 5,620 | 10,000 |
| 1975 | 813 | 46 | 859 | 95 | 4,449 | 344 | 5,747 | 8,000 |
| 1976 | 1,741 | 736 | 2,477 | 118 | 3,373 | 139 | 6,107 | 8,000 |
| 1977 | 1,925 | 4,691 | 6,616 | 27 | 698 | 184 | 7,525 | 8,000 |
| 1978 | 1,723 | 1,452 | 3,175 | 138 | 123 | 86 | 3,522 | 6,000 |
| 1979 | 1,792 | 1,058 | 2,850 | 31 | 39 | 45 | 2,965 | 6,000 |
| 1980 | 1,140 | 3,746 | 4,886 | 39 | 26 | 89 | 5,040 | 6,000 |
| 1981 | 1,069 | 6,322 | 7,401 | 58 | 56 | 30 | 7,545 | 6,000 |
| 1982 | 576 | 1,265 | 1,841 | 13 | 8 | 38 | 1,900 | 10,000 |
| 1983 | 445 | 863 | 1,308 | 266 | 11 | 48 | 1,633 | 10,000 |
| 1984 | 559 | 502 | 1,061 | 81 | 6 | 27 | 1,175 | 10,000 |
| 1985 | 558 | 160 | 718 | 14 | 7 | 14 | 753 | 10,000 |
| 1986 | 1,007 | 1,903 | 2,910 | 1 | 39 | 68 | 3,018 | 10,000 |
| 1987 | 737 | 165 | 902 | 38 | 111 | 12 | 1,063 | 10,000 |
| 1988 | 630 | 252 | 882 | 41 | 21 | 9 | 953 | 10,000 |
| 1989 | 861 | 3,291 | 4,152 | 84 | 8 | 4 | 4,248 | 10,000 |
| 1990 | 573 | 1,225 | 1,798 | - | 29 | - | 1,825 | 10,000 |
| 1991 | 212 | 282 | 494 | - | 14 | 2 | 510 | 10,000 |
| 1992 | 82 | 21 | 103 | - | - | - | 104 | 10,000 |
| 1993 | 1 | 76 | 77 | - | - | - | 77 | 5,000 |
| 1994 |  |  | 16 | - | - | - | 16 | $500^{\text {b }}$ |
| 1995 |  |  | 28 | - | - | - | 28 | $100^{\text {b }}$ |
| 1996 |  |  | 16 | - | - | - | 16 | $100^{\text {b }}$ |
| 1997 |  |  | 9 | - | - | - | 9 | $100^{\text {b }}$ |
| 1998 |  |  | 2 | - | - | - | 2 | 0 |
| 1999 |  |  | 7 | - | - | - | 7 | 0 |
| 2000 |  |  | 55 | - | - | - | 55 | 0 |

"Includes some catches by inshore otter trawlers in some years.
${ }^{6}$ By-catch only.
Data for 1994-2000 are provisional. 2000 is inshore data only, to Oct. 3.

Table 2. Nominal catches (t) of American plaice in Subarea $2+$ Division 3K, 1960-2000.

| Year | 2G | 2H | 2J | 3K | Total | TAC | Catch | \% of total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1960 |  |  |  |  | 16 |  | 15 | 93.8 |
| 1961 |  |  |  |  | 67 |  | 67 | 100.0 |
| 1962 |  |  |  |  | 64 |  | 60 | 93.8 |
| 1963 | $0$ | 0 | 238 | 1183 | 1,421 |  | 116 | 8.2 |
| 1964 | 0 | 21 | 1193 | 1854 | 3,068 |  | 95 | 3.1 |
| 1965 |  | 694 | 2657 | 2236 | 5,588 |  | 224 | 4.0 |
| 1966 | 1 2 | 102 | 575 | 2270 | 2,949 |  | 228 | 7.7 |
| 1967 | 1 | 440 | 1267 | 1883 | 3,591 |  | 395 | 11.0 |
| 1968 | 01 | 32 | 938 | 4981 | 5,951 |  | 1023 | 17.2 |
| 1969 |  | 160 | 2268 | 4473 | 6,902 |  | 1689 | 24.5 |
| 1970 | 1 11 | 103 | 2128 | 10444 | 12,686 |  | 3751 | 29.6 |
| 1971 |  | 58 | 925 | 3619 | 5,348 |  | 2486 | 46.5 |
| 1972 | 746 1 | 196 | 4818 | 4106 | 9,121 |  | 1197 | 13.1 |
| 1973 | 0 | 26 | 1788 | 3326 | 5,140 |  | 1384 | 26.9 |
| 1974 | 0 | 11 | 938 | 4671 | 5,620 | 10000 | 568 | 10.1 |
| 1975 | 73 | 0 | 1101 | 4573 | 5,747 | 8000 | 859 | 14.9 |
| 1976 | 24 | 43 | 645 | 5395 | 6,107 | 8000 | 2477 | 40.6 |
| 1977 | 0 | 0 | 224 | 7301 | 7,525 | 8000 | 6616 | 87.9 |
| 1978 | 1 | 49 | 145 | 3327 | 3,522 | 6000 | 3175 | 90.1 |
| 1979 | 0 | 11 | 221 | 2733 | 2,965 | 6000 | 2850 | 96.1 |
| 1980 | 0 | 36 | 142 | 4862 | 5,040 | 6000 | 4886 | 96.9 |
| 1981 | 0 | 38 | 96 | 7411 | 7,545 | 6000 | 7401 | 98.1 |
| 1982 | 0 | 108 | 204 | 1588 | 1,900 | 10000 | 1841 | 96.9 |
| 1983 | 0 | 124 | 168 | 1341 | 1,633 | 10000 | 1308 | 80.1 |
| 1984 | 0 | 54 | 92 | 1029 | 1,175 | 10000 | 1061 | 90.3 |
| 1985 | 0 | 11 | 34 | 708 | 753 | 10000 | 718 | 95.4 |
| 1986 | 0 | 4 | 100 | 2914 | 3,018 | 10000 | 2910 | 96.4 |
| 1987 | 0 | 1 | 239 | 823 | 1,063 | 10000 | 902 | 84.9 |
| 1988 | 0 | 50 | 106 | 797 | 953 | 10000 | 882 | 92.5 |
| 1989 | 0 | 9 | 3225 | 1014 | 4,248 | 10000 | 4152 | 97.7 |
| 1990 | 1 | 1 | 991 | 816 | 1,809 | 10000 | 1798 | 99.4 |
| 1991 | 0 | 1 | 69 | 428 | 498 | 10000 | 494 | 99.2 |
| 1992 | 0 | 1 | 5 | 97 | 103 | 10000 | 103 | 100.0 |
| 1993 | 0 | 0 | 0 | 77 | 77 | 5000 | 77 | 100.0 |
| 1994 | 0 | 0 | 0 | 16 | 16 | 500 | 16 | 100.0 |
| 1995 | 0 | 0 | 0 | 28 | 28 | 100 | 28 | 100.0 |
| 1996 | 0 | 0 | 1 | 16 | 17 | 100 | 17 | 100.0 |
| 1997 | 0 | 0 | 1 | 9 | 10 | 100 | 10 | 100.0 |
| 1998 | 0 | 0 | 0 | 2 | 2 | 0 | 2 | 100.0 |
| 1999 | 0 | 0 | 0 | 7 | 7 | 0 | 7 | 100.0 |
| 2000 |  |  |  | 55 | 55* | 0 |  |  |

Data for 1994-2000 are provisional.
TAC's for 1994-97 are by-catch only.

* Inshore catch up to October 3, 2000

Table 3. Summary of sets in Campelen fall surveys in SA 2+3 in 1996-1999. Depth range is given in meters, numbers of sets appear in parentheses.

| Year Division |  | Ship |  |  | Total |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Teleost | W.Templeman | A.Needler |  |
| 1996 | 2G | 127-1436 (47) |  |  | 47 |
|  | 2 H | 122-1415 (77) |  |  | 77 |
|  | 2 J | 126-1410 (117) |  |  | 117 |
|  | 3K | 111-1368(115) | 126-472 (60) |  | 175 |
|  | 3L | 805-1433 (31) | 51-671 (180) |  | 211 |
|  | 3M | 784-1400 (18) | 127-707 (68) |  | 86 |
|  | 3 N | 390-1147 (13) |  | 37-309 (54) | 67 |
|  | 30 | 68-690 (24) | 65-139 (19) | 63-304 (15) | 58 |

1997 | 2G | $201-1209(69)$ |  | 69 |
| ---: | :---: | :---: | ---: |
| 2H | $220-1382(71)$ |  | 71 |
| 2J | $123-1488(117)$ |  | 117 |
| 3K | $143-1431(155)$ | $117-421(20)$ | 205 |
| 3L | $161-1436(71)$ | $35-714(134)$ | 26 |
| 3M | $799-1379(26)$ |  | 74 |
| 3N |  | $41-769(74)$ | 73 |
| 3O |  | $62-611(73)$ | $\mathbf{8 1 0}$ |

| Year Division |  | Ship |  | Total |
| :---: | :---: | :---: | :---: | :---: |
|  |  | Teleost | W.Templeman |  |
| 1998 | 2G | 143-1488 (34) |  | 34 |
|  | 2 H | 98-1473 (83) |  | 83 |
|  | 2 J | 126-1398 (118) |  | 118 |
|  | 3K | 122-1415 (154) | 121-346 (17) | 171 |
|  | 3L | 691-1437 (32) | 34-675 (172) | 204 |
|  | 3M | 768-1436 (26) |  | 26 |
|  | 3 N | 834-1447 (12) | 37-1079 (78) | 90 |
|  | 30 |  | 82-1076 (87) | 87 |
|  |  |  |  | 813 |
| 1999 | 2G | 142-1415(69) |  | 69 |
|  | 2 H | 104-1454(81) |  | 81 |
|  | 2 J | 109-1375(115) |  | 115 |
|  | 3K | 146-1477(154) |  | 154 |
|  | 3L | 1366(1) | 63-1407 (169) | 170 |
|  | 3M | 853-1403(12) |  | 12 |
|  | 3 N |  | 39-664(68) | 68 |
|  | 30 |  | 58-692(75) | 75 |
|  |  |  |  | 744 |

Table 4. Biomass (t) per stratum of A. plaice from fall Campelen surveys, Div. 2G, 1996-99.


Proportion

| $<200$ | 0.119 | 0.000 | 0.260 | 0.117 |
| :--- | :--- | :--- | :--- | :--- |
| $201-300$ | 0.740 | 0.713 | 0.729 | 0.720 |
| $301-500$ | 0.141 | 0.248 | 0.000 | 0.137 |
| $>500$ | 0.000 | 0.039 | 0.011 | 0.026 |

Table 5. Biomass (t) per stratum of A. plaice from fall Campelen surveys, Div. 2H, 1996-99.

| stratum | depth (m) | 1996 | 1997 | 1998 | 1999 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 930 | <200 | 49 |  | 98 | 148 |
| 954 | $<200$ | 89 |  | 53 | 85 |
| 956 | $<200$ | 163 |  | 72 | 106 |
| 957 | <200 | 100 |  | 33 | 27 |
| 931 | 201-300 | 184 | 32 | 56 | 72 |
| 943 | 201-300 | 0 | 5 | 10 | 16 |
| 950 | 201-300 | 86 | 9 |  | 15 |
| 953 | 201-300 | 24 | 40 | 38 | 26 |
| 955 | 201-300 | 90 | 80 | 67 | 26 |
| 958 | 201-300 | 48 | 98 | 59 | 98 |
| 932 | 301-400 | 6 | 8 | 2 | 6 |
| 944 | 301-400 | 41 | 111 | 81 | 98 |
| 949 | 301-400 | 98 | 26 |  |  |
| 952 | 301-400 | 12 | 204 | 2 | 54 |
| 959 | 301-400 | 7 | 7 | 1 | 9 |
| 933 | 401-500 | 4 | 4 | 8 | 8 |
| 942 | 401-500 | 0.3 | 0.5 | 0.1 | 2 |
| 945 | 401-500 | 16 | 90 | 81 | 26 |
| 948 | 401-500 | 8 | 96 | 126 |  |
| 951 | 401-500 | 89 | 11 | 20 | 26 |
| 960 | 401-500 | 0.4 | 13 | 8 | 24 |
| 934 | 501-750 | 1 | 17 | 9 | 16 |
| 941 | 501-750 | 1 | 0 | 0 | 9 |
| 946 | 501-750 | 66 | 74 | 41 | 120 |
| 947 | 501-750 | 13 | 26 | 34 | 84 |
| 961 | 501-750 | 10 | 13 | 12 | 25 |
| 935 | 751-1000 |  | 7 | 12 | 0 |
| 940 | 751-1000 | 0 | 0 | 5 | 0 |
| 962 | 751-1000 | 0 | 5 | 0 | 0 |
| 936 | 1001-1250 |  | 0 | 0 |  |
| 939 | 1001-1250 | 0 | 0 |  | 0 |
| 963 | 1001-1250 | 0 | 0 | 0 | 0 |
| 937 | 1251-1500 |  | 0 | 0 |  |
| 938 | 1251-1500 | 0 | 0 | 0 | 0 |
| 964 | 1251-1500 | 0 | 0 | 0 | 0 |


| Sum |  |  |  |  |  |
| ---: | :--- | ---: | ---: | ---: | ---: |
|  | 200 | 401.0 | 0.0 | 256.0 | 366.0 |
|  | $201-300$ | 432.0 | 264.0 | 230.0 | 253.0 |
|  | $301-500$ | 281.7 | 570.5 | 329.1 | 253.0 |
|  | $>500$ | 91.0 | 142.0 | 113.0 | 254.0 |
|  | Total | 1205.7 | 976.5 | 928.1 | 1126.0 |

Proportion

| $<200$ | 0.333 | 0.000 | 0.276 | 0.325 |
| :--- | :--- | :--- | :--- | :--- |
| $201-300$ | 0.358 | 0.270 | 0.248 | 0.225 |
| $301-500$ | 0.234 | 0.584 | 0.355 | 0.225 |
| $>500$ | 0.075 | 0.145 | 0.122 | 0.226 |

Table 6. Blomass (t) per stratum of A. plalce from fall Campelen surveys, Div. $2 \mathrm{~J}, 1995$ to 1999

| Depth Range (m) | Stratum | Area (sq. nm) | Trawlable Units (000) | 1995 | 1996 | 1997 | 1998 | 1999 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 101-200 | 201 | 633 | 87.076 |  | 89 | 10 | 94 | 20 |
|  | 205 | 1594 | 219.272 |  | 133 | 52 | 148 | 154 |
|  | 206 | 1870 | 257.239 | 74 | 89 | 239 | 452 | 204 |
|  | 207 | 2264 | 311.438 | 18 | 37 | 131 | 113 | 50 |
|  | 237 | 733 | 100.832 | 0 | 31 | 15 | 2 | 39 |
|  | 238 | 778 | 107.022 |  | 7 | 5 | 18 | 65 |
| 201-300 | 202 | 621 | 85.425 | 0 | 242 | 71 | 225 | 94 |
|  | 209 | 680 | 93.542 | 122 | 94 | 137 | 84 | 141 |
|  | 210 | 1035 | 142.376 | 158 | 336 | 210 | 174 | 250 |
|  | 213 | 1583 | 217.759 | 86 | 174 | 492 | 542 | 446 |
|  | 214 | 1341 | 184.469 | 49 | 257 | 260 | 334 | 327 |
|  | 215 | 1302 | 179.105 | 16 | 426 | 132 | 272 | 174 |
|  | 228 | 2196 | 302.084 | 351 | 704 | 706 | 648 | 391 |
|  | 234 | 530 | 72.907 |  | 1 | 74 | 58 | 7 |
| 301-400 | 203 | 487 | 66.992 | 251 | 205 | 126 | 157 | 234 |
|  | 208 | 588 | 80.886 | 593 | 49 | 1320 | 659 | 656 |
|  | 211 | 251 | 34.528 | 80 | 42 | 60 | 96 | 390 |
|  | 2.16 | 360 | 49.522 | 61 | 84 | 109 | 46 | 46 |
|  | 222 | 450 | 61.902 | 9 | 117 | 132 | 65 | 87 |
|  | 229 | 536 | 73.733 | 77 | 52 | 44 | 103 | 131 |
| 401-500 | 204 | 288 | 39.618 | 72 | 329 | 187 | 211 | 69 |
|  | 217 | 241 | 33.152 | 91 | 31 | 80 | 47 | 9 |
|  | 223 | 158 | 21.735 | 47 | 30 | 26 | 46 | 51 |
|  | 227 | 598 | 82.262 | 69 | 108 | 88 | 109 | 58 |
|  | 235 | 414 | 56.950 | 261 | 170 | 174 | 383 | 305 |
|  | 240 | 133 | 18.296 | 14 | 9 | 0 | 0 | 12 |
| 501-750 | 2.12 | 557 | 76.622 | 670 | 144 | 283 | 220 | 228 |
|  | 218 | 362 | 49.797 | 101 | 130 | 117 | 79 | 83 |
|  | 224 | 228 | 31.364 | 65 | 264 | 118 | 128 | 12 |
|  | 230 | 185 | 25.449 | 72 | 17 | 20 | 19 | 27 |
|  | 239 | 120 | 16.507 | 109 | 151 | 57 | 60 | 71 |
| 751-1000 | 219 | 283 | 38.930 | 41 | 19 | 0 | 29 | 14 |
|  | 231 | 186 | 25.586 | 78 | 0 | 0 | 11 | 0 |
|  | 236 | 193 | 26.549 | 116 | 0 | 8 | 14 | 2 |
| 1001-1250 | 220 | 303 | 41.681 |  | 0 | 0 | 0 |  |
|  | 225 | 195 | 26.824 |  | 4 | 9 | 0 | 6 |
|  | 232 | 228 | 31.364 |  | 0 | 0 | 0 | 0 |
| 1251-1500 | 221 | 330 | 45.395 |  | 0 | 0 | 0 | 0 |
|  | 226 | 201 | 27.650 |  | 0 | 0 | 0 | 0 |
|  | 233 | 237 | 32.602 |  | 0 | 0 | 0 | 0 |
| 101-200 |  | 7872 | 1082.879 | 92 | 386 | 452 | 827 | 532 |
| 201-300 |  | 9288 | 1277.667 | 782 | 2234 | 2082 | 2337 | 1830 |
| 301-500 |  | 4504 | 619.576 | 1625 | 1226 | 2346 | 1922 | 2048 |
| $>500$ |  | 3608 | 496.320 | 1252 | 729 | 612 | 560 | 443 |
| Total |  | 25272 | 3476.442 | 3751 | 4575 | 5492 | 5646 | 4853 |
| Proportion |  |  |  |  |  |  |  |  |
| 101-200 |  | 0.311 |  | 0.025 | 0.084 | 0.082 | 0.146 | 0.110 |
| 201-300 |  | 0.368 |  | 0.208 | 0.488 | 0.379 | 0.414 | 0.377 |
| 301-500 |  | 0.178 |  | 0.433 | 0.268 | 0.427 | 0.340 | 0.422 |
| $>500$ |  | 0.143 |  | 0.334 | 0.159 | 0.111 | 0.099 | 0.091 |

Table 7. Biomass (t) per stratum of A. plalce from fall Campelen surveys, Div. 3K, 1995 to 1999 Inshore strata surveyed in 1996-98. Strata 611 and 621 modified slightly in 1997.


Table 8. Mean number of American plaice per tow from Campelen surveys in Div. 2GH, 1996-99.

|  | $2 G$ |  |  |  |
| ---: | :---: | :---: | :---: | :---: |
| Age | 1996 | 1997 | 1998 | 1999 |
| 0 |  |  |  |  |
| 1 | 0.01 |  | 0.16 | 0.15 |
| 2 | 0.09 | 0.05 | 0.22 | 0.59 |
| 3 | 0.02 | 0.19 | 0.36 | 0.56 |
| 4 | 0.14 | 0.05 | 0.46 | 0.49 |
| 5 | 0.42 | 0.12 | 0.25 | 0.61 |
| 6 | 0.39 | 0.27 | 0.14 | 0.23 |
| 7 | 0.24 | 0.28 | 0.24 | 0.11 |
| 8 | 0.09 | 0.24 | 0.19 | 0.14 |
| 9 | 0.03 | 0.20 | 0.07 | 0.09 |
| 10 |  | 0.04 | 0.02 | 0.01 |
| 11 |  | 0.04 | 0.01 |  |
| 12 |  |  |  |  |
| 13 |  |  |  |  |
| 14 |  |  |  |  |
| 15 |  |  |  |  |
| 16 |  |  | $\mathbf{2 . 1 2}$ | $\mathbf{2 . 9 8}$ |


| Age | 1996 | 1997 | $\mathbf{y H}$ |  |
| ---: | :---: | :---: | :---: | :---: |
| 0 |  |  |  | 1999 |
| 1 | 0.27 |  | 0.05 | 0.33 |
| 2 | 0.81 | 0.09 | 1.25 | 3.19 |
| 3 | 0.35 | 0.34 | 0.95 | 3.27 |
| 4 | 0.82 | 0.23 | 1.09 | 1.52 |
| 5 | 1.24 | 0.50 | 0.93 | 1.43 |
| 6 | 1.07 | 0.73 | 0.44 | 0.63 |
| 7 | 0.75 | 1.02 | 0.52 | 0.32 |
| 8 | 0.24 | 0.96 | 0.23 | 0.25 |
| 9 | 0.10 | 0.50 | 0.20 | 0.18 |
| 10 | 0.01 | 0.16 | 0.07 | 0.06 |
| 11 |  | 0.06 | 0.04 | 0.06 |
| 12 |  | 0.02 | 0.01 |  |
| 13 | 0.01 | 0.02 |  |  |
| 14 |  | 0.01 | 0.02 |  |
| 15 | 0.01 | 0.01 | 0.01 |  |
| 16 |  |  |  |  |
| unk |  |  |  |  |
| Total | 5.68 | $\mathbf{4 . 6 5}$ | $\mathbf{5 . 8 1}$ | $\mathbf{1 1 . 2 4}$ |

Table 9. Mean number per tow of American plaice, by age, from fall surveys in Div. 2 J . Data inCampelen equivalents.

| Age Mear | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0 | 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 | 0.00 | 0.00 |
| 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 | 0.00 | 0.00 | 0.08 | 0.03 | 0.55 | 0.27 | 0.08 |
| 2 | 0.00 | 0.00 | 0.00 | 0.16 | 0.13 | 0.00 | 0.00 | 0.25 | 0.00 | 0.14 | 0.00 | 0.27 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 | 0.44 | 0.48 | 0.86 | 0.58 |
| 3 | 0.40 | 0.00 | 0.00 | 0.16 | 1.71 | 0.42 | 0.00 | 0.64 | 2.82 | 0.88 | 0.00 | 0.92 | 0.49 | 0.71 | 0.00 | 0.00 | 0.00 | 0.22 | 1.19 | 1.24 | 0.70 | 1.18 |
| 4 | 6.34 | 3.08 | 0.72 | 3.34 | 2.07 | 4.48 | 2.47 | 0.98 | 2.49 | 3.52 | 1.26 | 2.62 | 1.54 | 1.27 | 0.78 | 1.04 | 1.61 | 1.01 | 1.70 | 1.83 | 0.94 | 0.77 |
| 5 | 30.20 | 15.48 | 4.04 | 10.38 | 14.14 | 6.34 | 5.80 | 7.63 | 5.48 | 3.14 | 5.55 | 9.22 | 3.96 | 5.24 | 2.91 | 2.45 | 2.16 | 1.06 | 2.38 | 2.13 | 2.00 | 2.53 |
| 6 | 64.82 | 43.65 | 20.61 | 41.02 | 27.20 | 23.62 | 12.69 | 17.95 | 13.85 | 11.28 | 9.80 | 20.74 | 13.08 | 8.94 | 4.70 | 5.70 | 5.27 | 1.89 | 2.40 | 2.09 | 2.62 | 1.99 |
| 7 | 78.74 | 54.89 | 72.78 | 41.35 | 61.20 | 54.18 | 29.36 | 28.80 | 20.64 | 10.96 | 12.33 | 15.45 | 14.91 | 6.82 | 5.34 | 3.91 | 5.64 | 2.80 | 0.88 | 1.72 | 2.24 | 1.17 |
| 8 | 42.75 | 38.98 | 42.02 | 24.47 | 58.26 | 47.33 | 29.83 | 25.01 | 15.68 | 8.84 | 12.75 | 13.85 | 8.66 | 4.64 | 2.38 | 2.55 | 2.58 | 1.83 | 0.34 | 1.22 | 0.87 | 0.85 |
| 9 | 30.28 | 16.48 | 17.92 | 6.86 | 44.77 | 20.41 | 16.96 | 15.82 | 10.95 | 5.02 | 8.72 | 9.01 | 6.31 | 1.57 | 0.76 | 0.49 | 0.48 | 0.31 | 0.05 | 0.59 | 0.45 | 0.25 |
| 10 | 12.55 | 6.69 | 8.98 | 4.39 | 15.33 | 12.57 | 6.05 | 4.33 | 4.06 | 3.03 | 4.57 | 3.33 | 3.60 | 0.48 | 0.24 | 0.25 | 0.11 | 0.03 | 0.01 | 0.21 | 0.18 | 0.07 |
| 11 | 5.93 | 2.56 | 4.49 | 1.58 | 4.92 | 6.20 | 3.08 | 1.62 | 1.05 | 0.89 | 1.62 | 2.00 | 0.94 | 0.23 | 0.14 | 0.07 | 0.01 | 0.01 | 0.00 | 0.05 | 0.03 | 0.01 |
| 12 | 4.34 | 3.15 | 3.86 | 0.63 | 2.97 | 1.77 | 1.01 | 1.02 | 0.88 | 0.54 | 0.58 | 0.70 | 0.59 | 0.08 | 0.06 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| 13 | 3.58 | 1.84 | 1.69 | 0.05 | 1.83 | 1.13 | 0.84 | 0.49 | 0.38 | 0.21 | 0.23 | 0.16 | 0.20 | 0.03 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| 14 | 1.64 | 0.55 | 1.00 | 0.00 | 0.80 | 0.29 | 0.15 | 0.08 | 0.08 | 0.05 | 0.02 | 0.03 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 15 | 1.17 | 0.14 | 0.30 | 0.00 | 0.15 | 0.11 | 0.06 | 0.00 | 0.03 | 0.01 | 0.00 | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 16 | 0.56 | 0.06 | 0.13 | 0.00 | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 17 | 0.19 | 0.00 | 0.05 | 0.00 | 0.02 | 0.01 | 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 |
| 18 | 0.01 | 0.00 | 0.02 | 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 |
| 19 | 0.01 | 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 | 0.00 |
| Unk | 0.37 | 0.00 | 0.00 | 0.06 | 0.02 | 0.01 | 0.30 | 0.27 | 0.00 | 0.39 | 0.00 | 0.01 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 | 0.03 | 0.01 | 0.00 |
| TOTAL | 283.88 | 187.55 | 178.61 | 134.45 | 235.60 | 178.87 | 108.80 | 104.89 | 78.39 | 48.90 | 57.43 | 78.35 | 54.33 | 30.05 | 17.32 | 16.47 | 17.86 | 9.76 | 9.43 | 12.15 | 11.17 | 9.49 |

Tabte 10. Mean number per tow of Amencan plaice, by age, from tall surveys in Div. 3K. Data converted to Campelen equivalents.

| Age/Year | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 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 | 0.00 | 0.00 |
| 1 | 0.00 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 | 0.20 | 0.21 | 0.13 | 0.00 | 0.15 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.03 | 0.08 | 0.09 | 0.0 |
| 2 | 0.00 | 0.00 | 0.22 | 0.00 | 0.17 | 0.11 | 1.02 | 2.47 | 1.14 | 0.57 | 2.64 | 1.15 | 0.00 | 0.16 | 0.02 | 0.00 | 0.73 | 1.99 | 0.40 | 0.08 | 0.38 | 0.2 |
| 3 | 3.22 | 0.18 | 1.26 | 1.54 | 3.31 | 5.90 | 1.67 | 2.62 | 16.99 | 4.98 | 4.21 | 6.60 | 1.19 | 0.36 | 0.94 | 1.08 | 0.58 | 1.19 | 3.86 | 0.30 | 0.73 | 0.3 |
| 4 | 50.56 | 4.25 | 1.32 | 1.92 | 3.74 | 5.40 | 11.77 | 4.69 | 16.32 | 15.49 | 7.16 | 10.00 | 2.82 | 3.64 | 1.28 | 3.20 | 2.13 | 1.95 | 6.16 | 1.69 | 1.36 | 0.7 |
| 5 | 84.34 | 18.61 | 8.30 | 6.09 | 5.56 | 12.07 | 11.91 | 9.88 | 10.87 | 10.92 | 20.76 | 10.47 | 4.88 | 6.96 | 4.07 | 8.21 | 3.71 | 4.17 | 6.69 | 5.31 | 4.01 | 2.0 |
| 6 | 85.28 | 27.85 | 19.45 | 10.15 | 9.74 | 16.00 | 22.33 | 10.25 | 13.84 | 11.58 | 10.40 | 17.84 | 6.29 | 6.95 | 5.40 | 9.55 | 5.91 | 5.78 | 3.82 | 5.28 | 4.08 | 3.8 |
| 7 | 51.67 | 24.97 | 32.64 | 23.53 | 14.35 | 19.17 | 14.40 | 12.01 | 10.22 | 9.39 | 6.95 | 11.27 | 6.52 | 5.08 | 3.84 | 3.98 | 9.08 | 4.19 | 1.33 | 2.36 | 3.52 | 2.6 |
| 8 | 21.15 | 17.46 | 15.97 | 23.32 | 13.94 | 13.39 | 18.03 | 8.24 | 9.27 | 6.51 | 4.83 | 4.74 | 3.14 | 2.42 | 1.63 | 2.16 | 2.70 | 1.70 | 0.21 | 0.95 | 1.93 | 1.47 |
| 9 | 16.56 | 9.84 | 7.63 | 9.12 | 8.17 | 4.02 | 6.96 | 4.75 | 6.23 | 4.25 | 2.85 | 4.13 | 1.82 | 1.32 | 0.81 | 0.63 | 0.70 | 0.39 | 0.10 | 0.60 | 0.73 | 0.7 |
| 10 | 9.10 | 5.26 | 4.98 | 7.70 | 3.39 | 2.72 | 2.92 | 2.02 | 2.96 | 1.61 | 1.39 | 1.71 | 0.76 | 0.55 | 0.32 | 0.27 | 0.26 | 0.13 | 0.02 | 0.10 | 0.12 | 0.3 |
| 11 | 4.75 | 2.15 | 2.71 | 1.93 | 1.90 | 1.00 | 1.69 | 0.85 | 1.16 | 0.71 | 0.59 | 0.85 | 0.42 | 0.15 | 0.05 | 0.13 | 0.05 | 0.02 | 0.00 | 0.04 | 0.09 | 0.11 |
| 12 | 3.76 | 2.63 | 2.11 | 2.61 | 0.92 | 1.08 | 1.10 | 0.91 | 0.78 | 0.46 | 0.32 | 0.57 | 0.19 | 0.10 | 0.05 | 0.06 | 0.01 | 0.00 | 0.01 | 0.02 | 0.02 | 0.0 |
| 13 | 3.23 | 1.32 | 1.04 | 1.25 | 0.74 | 0.50 | 0.53 | 0.44 | 0.37 | 0.17 | 0.16 | 0.23 | 0.14 | 0.04 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 |
| 14 | 1.67 | 0.43 | 0.67 | 0.53 | 0.37 | 0.26 | 0.23 | 0.11 | 0.14 | 0.10 | 0.11 | 0.09 | 0.01 | 0.03 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 |
| 15 | 1.30 | 0.17 | 0.27 | 0.33 | 0.20 | 0.10 | 0.15 | 0.07 | 0.04 | 0.06 | 0.02 | 0.04 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 |
| 16 | 0.67 | 0.15 | 0.10 | 0.23 | 0.06 | 0.02 | 0.04 | 0.02 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 |
| 17 | 0.25 | 0.01 | 0.05 | 0.00 | 0.04 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 18 | 0.08 | 0.03 | 0.03 | 0.03 | 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 |
| 19 | 0.01 | 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 | 0.0 |
| Unk | 0.37 | 0.02 | 0.00 | 0.11 | 0.01 | 0.04 | 0.00 | 0.00 | 0.01 | 0.01 | 0.24 | 0.23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.02 | 0.00 | 0.0 |

Tabde 11. Abundance at age (millions) in from surveys, Div. 2JJK combined. All data in Campelen equivalents.

|  | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| ! | 0.000 | 0.623 | 0.000 | 0.000 | 0.000 | 0.000 | 0.351 | 0.000 | 0.801 | 0.906 | 0.534 | 0.000 | 0.662 | 0.000 | 0.000 | 0.000 | 0.000 | 0.899 | 0.220 | 2.298 | 1.365 | 0.559 |
| 2 | 0.000 | 0.000 | 0.676 | 0.517 | 1.076 | 0.398 | 4.290 | 11.526 | 4.557 | 2.868 | 10.589 | 5.502 | 0.000 | 0.693 | 0.071 | 0.000 | 3.136 | 10.550 | 3.564 | 2.089 | 4.926 | 2.917 |
| 3 | 10.837 | 0.561 | 3.953 | 6.566 | 18.197 | 23.207 | 7.070 | 13.432 | 77.089 | 24.119 | 16.958 | 29.540 | 6.749 | 3.865 | 4.069 | 4.739 | 2.541 | 6.096 | 23.845 | 5.862 | 6.161 | 5.677 |
| 4 | 169.860 | 21.450 | 6.074 | 18.298 | 21.036 | 34.602 | 57.312 | 23.475 | 73.342 | 77.737 | 32.813 | 49.001 | 17.221 | 19.913 | 8.128 | 17.374 | 14.453 | 11.818 | 37.354 | 15.003 | 10.227 | 6.219 |
| 5 | 330.193 | 99.154 | 36.962 | 57.393 | 66.987 | 65.374 | 68.390 | 67.686 | 61.215 | 56.938 | 101.296 | 71.507 | 34.045 | 47.215 | 27.086 | 43.794 | 23.098 | 22.233 | 42.400 | 34.453 | 27.441 | 18.455 |
| 6 | 415.760 | 202.437 | 116.690 | 172.246 | 125.149 | 136.133 | 134.514 | 102.888 | 100.404 | 86.289 | 73.146 | 138.340 | 69.838 | 59.203 | 38.673 | 59.972 | 42.745 | 31.970 | 27.832 | 34.096 | 29.929 | 24.580 |
| 7 | 346.147 | 223.013 | 299.064 | 225.748 | 252.563 | 247.395 | 152.712 | 145.822 | 108.040 | 75.821 | 67.348 | 94.929 | 76.782 | 44.207 | 33.973 | 29.878 | 57.654 | 27.159 | 9.866 | 18.006 | 25.713 | 16.484 |
| a | 166.807 | 157.524 | 163.683 | 170.403 | 241.508 | 203.729 | 169.464 | 117.159 | 88.067 | 56.623 | 60.152 | 63.521 | 41.841 | 25.560 | 14.843 | 17.571 | 20.095 | 12.970 | 2.273 | 9.072 | 12.867 | 9.785 |
| 9 | 122.993 | 74.283 | 72.377 | 57.907 | 175.855 | 81.373 | 82.440 | 72.066 | 60.523 | 34.505 | 39.316 | 45.669 | 28.433 | 10.845 | 6.006 | 4.343 | 4.580 | 2.672 | 0.682 | 5.091 | 5.292 | 4.442 |
| 10 | 57.828 | 34.138 | 39.861 | 44.356 | 62.465 | 51.010 | 31.245 | 22.837 | 24.985 | 16.751 | 20.181 | 17.543 | 15.025 | 3.973 | 2.124 | 1.974 | 1.512 | 0.681 | 0.140 | 1.198 | 1.225 | 1.713 |
| 11 | 28.698 | 13.513 | 20.616 | 12.640 | 23.138 | 23.856 | 16.799 | 8.97 | 8.077 | 5.914 | 7.541 | 9.844 | 4.878 | 1.394 | 0.674 | 0.807 | 0.271 | 0.110 | 0.000 | 0.414 | 0.541 | 0.554 |
| 12 | 21.882 | 16.590 | 17.035 | 12.274 | 13.109 | 9.766 | 7.792 | 7.283 | 6.026 | 3.745 | 3.135 | 4.553 | 2.771 | 0.706 | 0.381 | 0.316 | 0.063 | 0.022 | 0.035 | 0.099 | 0.110 | 0.031 |
| 13 | 18.438 | 8.992 | 7.828 | 5.053 | 8.735 | 5.550 | 4.838 | 3.516 | 2.705 | 1.426 | 1.388 | 1.468 | 1.240 | 0.241 | 0.143 | 0.013 | 0.013 | 0.000 | 0.000 | 0.054 | 0.029 | 0.000 |
| 14 | 9.050 | 2.860 | 4.817 | 2.073 | 4.024 | 1.924 | 1.423 | 0.712 | 0.869 | 0.604 | 1.465 | 1.357 | 0.126 | 0.126 | 0.044 | 0.000 | 0.000 | 0.031 | 0.037 | 0.036 | 0.000 | 0.027 |
| 15 | 6.790 | 0.904 | 1.650 | 1.282 | 1.249 | 0.726 | 0.813 | 0.311 | 0.254 | 0.276 | 0.099 | 0.284 | 0.122 | 0.016 | 0.010 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 16 | 3.387 | 0.604 | 0.657 | 0.894 | 0.484 | 0.090 | 0.153 | 0.103 | 0.000 | 0.087 | 0.000 | 0.057 | 0.059 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 17 | 1.228 | 0.046 | 0.283 | 0.000 | 0.211 | 0.025 | 0.056 | 0.000 | 0.000 | 0.000 | 0.035 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 18 | 0.280 | 0.103 | 0.141 | 0.130 | 0.019 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 19 | 0.055 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Unk | 1.067 | 0.000 | 0.000 | 0.634 | 0.073 | 0.135 | 0.954 | 0.879 | 0.014 | 1.282 | 0.000 | 0.052 | 0.000 | 0.145 | 0.011 | 0.000 | 0.000 | 0.047 | 0.076 | 0.139 | 0.036 | 0.000 |
| rotal | 1711.300 | 856.797 | 792.369 | 788.414 | 1015.878 | 885.292 | 740.615 | 598.670 | 616.967 | 445.890 | 435.996 | 533.168 | 299.793 | 218.102 | 136237 | 180.780 | 170.162 | 127258 | 324 | 127.910 | 125.862 | 43 |



Fig. 1. Stratification used in trawl surveys of NAFO Div. 2G.


Fig. 2. Stratification scheme used in trawl surveys in Div. 2H.


Fig. 3. Stratification used in trawl surveys of NAFO Div. 2J.


Fig. 4. Stratification used in trawl surveys of NAFO Div. 3K.


Fig. 5. Biomass index ( 000 tons) of A. plaice, in Campelen units, from fall surveys, 2 J 3 K .


Fig. 6. Mean number per tow of A. plaice, in Campelen units, from fall surveys, 2 J 3 K .


Fig 7. Proportion of biomass, by depth zone, A. plaice in Div. 2J and 3K. Data for 1977-94 are unconverted Engel data, 1995-99 are Campelen data.


Number of fish(/0.8nm)
-1
$\div-25$
$\div 50$
$\bullet 75$
$\div-150$
$\div-300+$
+0

Fig. 8A. Distribution of American plaice (number per set) in Div.2GHJ3K.


Weight of catch(/0.8nm)


Fig. 8B. Distribution of American plaice (kg per set) in Div.2GHJ3K.
200 m
$\cdots$
400 m
1000 m


Number of fish ( $/ 0.8 \mathrm{~nm}$ )


Fig. 9. Distribution of American plaice (number per set) in Div.2GHJ3K.



Fig. 11. Age at $50 \%$ maturity by cohort for male and female American plaice in Div 2J3K


Fig. 12. Length at $50 \%$ maturity by cohort for male and female American plaice in Div 2 J 3 K


Fig. 13. Total mortality from survey estimates of abundance, 2 J 3 K , ages $8+\mathrm{in} \mathrm{yr} \mathrm{n}$ compared to $7+\mathrm{in} \mathrm{yr} \mathrm{n}-1$.


Fig. 14. Estimates of mortality for ages 1 to 16 from fall surveys from 1978 to 1999.


Fig. 15. Ratio of catch $(2+3 \mathrm{~K})$ to Campelen survey biomass ( 2 J 3 K ), American plaice.


Fig. 16. Relative cohort strength as estimated from a multiplicative model of data from fall RV surveys from 1978 to 1999.

