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Regional, Interim Review of the Status of Northern Shrimp (Pandalus borealis) Resources in Areas off Newfoundland and Labrador (Divisions $0 B$ to 3 K )
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${ }^{1}$ This series documents the scientific basis for the evaluation of fisheries resources in Atlantic Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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#### Abstract

Data from the commercial fishery for northern shrimp were presented for four assessment/management areas: Division OB, Division 2G, Hopedale + Cartwright Channels and Hawke Channel + Division 3K. Within each area, fishing pattern, catch, effort, catch per unit effort and size/sex composition were reviewed to infer the status of the resource.

With the exception of Division 0B, where the status remains uncertain, the shrimp fisheries performed well in 1994 with catch rates as high as or higher than observed since the fisheries began. Female shrimp were well-represented over time in catches from all areas, indicating a healthy spawning biomass is being maintained. High catch rates of smaller, male shrimp indicate good recruitment to the fishery in the short term.

Based on the favourable review of fishery data in 1994 and comparison to previous years, it was concluded that no decreases in TAC's were required in 1995, the second year of the 1994-1996 northern shrimp Management Plan. Itwas further concluded that the TAC in Division 2G could be increased to 5000 tons in 1995 as the second phase of the increase proposed in 1994.


## Résumé

Des données provenant de la pêche commerciale de la crevette nordique ont été présentées pour quatre zones de gestion/évaluation, soit la division 0B, la division 2G, les chenaux Hopedale + Cartwright et le chenal Hawke + la division 3 K . Dans chacune de ces zones, on a examiné les habitudes de pêche, les prises, l'effort, les prises par unité d'effort et la composition selon la taille et le sexe pour déterminer l'état de la ressource.

À l'exception de la division $0 B$, où la situation demeure incertaine, la pêche de la crevette a donné de bons résultats en 1994, les taux de prises étant aussi élevés ou plus élevés que ceux observés depuis le début de la pêche. Les femelles étaient bien représentées dans les prises de toutes les zones, ce qui dénote le maintien d'une bonne biomasse de reproducteurs. En outre, les forts taux de prises de petites crevettes mâles sont révélateurs d'un bon recrutement à la pêche à court terme.

Les résultats favorables de l'examen des données de la pêche de 1994 et les comparaisons avec les années précédentes permettent de conclure qu'une baisse des TAC n'est pas nécessaire en 1995, deuxième année d'application du Plan de gestion de la crevette nordique (1994-1996). On a également conclu que le TAC de la division 2G pouvait être augmenté à 5000 tonnes en 1995, cela représentant la deuxième phase de l'augmentation proposée en 1994.

## INTRODUCTION

The current Management Plan for northern shrimp was designed as a multi-year plan, covering the period 1994 - 1996. Before its implementation, detailed assessments were conducted in late 1993 and early 1994 for each of the following areas: Division OB, Division 2G, Hopedale + Cartwright Channels and Hawke Channel + Division 3K. The process provides for interim reviews of the status of the resource in each area to determine whether or not changes are required to the TAC's within the three year term. This paper presents the results of the first interim review, following the 1994 fishery.

## METHODS

Catch, effort and catch per unit effort (CPUE) were reviewed for each of the above shrimp fishing areas. Details of the fishing locations of the fleet were compared for the most recent years and CPUE's were standardized by multiple regression to account for variation due to seasonality (month effects), fishing power (vessel effects) and distribution of effort (area effects). Samples of the catches, obtained by observers, were analyzed for size and sex composition and compared over time.

Results were interpreted, qualitatively, to infer status of the resource in each area and provide prospects for the fishery in the short term.

## ASSESSMENT OF SHRIMP IN NAFO DIVISION OB

## Catch and effort

Figures 1,2 and Table 1
The northern shrimp fishery in Division OB began in 1988. Low catches in October and November of that year were replaced by high catches of large, valuable shrimp during December, resulting in total removals of about 2800 tons. Catches increased to 3039 tons in 1989 but subsequently declined to 106 tons in 1993. The 1994 catch increased to 475 tons but remained well below the level of the late 1980's. Effort (both unstandardized and standardized) increased substantially from 1988 to 1989 but decreased thereafter. There was about a three-fold increase in effort from 1993 to 1994. In 1988, the fishery occurred north of $64^{\circ} \mathrm{N}$ with occasional tows near $66^{\circ} \mathrm{N}$. Effort shifted southward in 1989, concentrating between $64^{\circ}$ and $65^{\circ} \mathrm{N}$ but extending as far south as $61^{\circ} 30^{\prime} \mathrm{N}$. Proportionately, more effort was expended south of $64^{\circ} \mathrm{N}$ in subsequent years. The grounds fished in 1994 were similar to those of 1993.

Catch per unit effort (CPUE)
Figure 1 and Table 1
Unstandardized, annual CPUE's decreased from $585 \mathrm{~kg} / \mathrm{hr}$ in 1988 to 271 in 1989 and increased to 497 in 1990. Since then, catch rates have decreased to the $200-300 \mathrm{~kg} / \mathrm{hr}$ range. The data were analyzed by multiple regression for year and vessel effects. The model explained 41\% of the variation and showed that both class variables were highly significant ( $\mathrm{P}<0.01$ ). Month effects were shown to be not significant ( $\mathrm{P}>0.05$ ) in the initial run. The 1989, 1992 and 1993 catch rates were shown to be similar to the 1994 estimate ( $P$ $>0.10$ ) whereas those of 1988,1990 and 1991 were significantly higher ( $\mathrm{P}<0.02$ ) . Both series showed an overall declining trend.

## Catch composition

Figure 3
Catches in most years were composed primarily of large, female shrimp with a modal length of 27 mm CL. The occurrence of higher proportions of the male component ( $<25 \mathrm{~mm}$ ) after 1988 was coincident with the southward shift in fishing effort. The sampling data showed that the occurrence of smaller/younger male shrimp (< 22 mm ) has declined since 1990 and, for the first time in 1994, catches (numbers) were dominated by male shrimp with a modal length of $23-24 \mathrm{~mm}$.

## RESOURCE STATUS AND PERSPECTIVES

Fishermen have stated that the area is difficult to fish due to the presence of ice and/or the apparent sudden shifts in water masses that might affect shrimp distribution. They have observed, and the data indicate, that concentrations of shrimp are difficult to find and, when they are, tend to be short-lived. This contrasts the situation in several southern locations where areas of high concentration support substantial levels of effort and CPUE, yet persist from year to year. The status of this resource remains uncertain. The CPUE is not considered a reliable index of abundance for the area and the declines in both catch and catch rates are more likely a reflection of the difficulty locating high concentrations of shrimp than they are indicators of a decreasing resource. The possibility of reduced recruitment in recent years exists but the commercial sampling data might not be representative of overall stock conditions, especially in 1993 when fishing effort was minimal. Occasional high catch rates still occur throughout the Division but the sustained fishing success achieved in December, 1988 has not been repeated. Due to the uncertainty about the status of this resource, there is no basis on which to advise a change in the 1994 - 1996 Management Plan which set the TAC at 3500 tons. This level was established in 1989 as a precautionary level in an exploratory area and is still considered in this context.

## ASSESSMENT OF SHRIMP IN NAFO DIVISION 2G

## Catch and effort

Figures 4, 5 and Table 2
The northern shrimp fishery in Division 2G began in 1988, only incidental catch and effort having been reported from previous years. Catches increased from 1083 tons in 1988 to 3842 tons in 1989 and remained within the $2500-3000$ ton range up to 1993. The 1994 catch increased to 3975 tons with an increase in TAC to 4000 tons in the first year of the 1994 - 1996 Management Plan. Fishing effort (unstandardized and standardized) increased substantially from 1988 to 1989, decreased to 1991 and has been relatively stable since then. From 1988 to 1990, the fishery occurred throughout the Division which, during that period, was split into two management zones, north and south of $60^{\circ} \mathrm{N}$. The 1991 - 1993 Management Plan combined the two zones and, since then, effort has concentrated in the north. The fishery usually begins in June but, in 1989, significant effort was reported for the January - May period.

Catch per unit effort (CPUE)
Figure 4 and Table 2
The area is noted for producing high catch rates of large shrimp, especially north of $60^{\circ} \mathrm{N}$. Unstandardized annual CPUE's declined from $1823 \mathrm{~kg} / \mathrm{hr}$ in 1988 to about 700 in 1989 and 1990. In 1991, catch rate increased substantially to over 3 tons per hour as fishing effort concentrated in the northern grounds. High CPUE's in the range of 2 to 3 tons per hour have been maintained since then. The CPUE data were analyzed by multiple regression for year, month and vessel effects. The model, explaining 84\% of the variation, showed that all class variables were highly significant ( $\mathrm{P}<0.001$ ) and that the annual catch rates from 1988 to 1990 and 1992 were significantly lower than the 1994 rate ( $\mathrm{P}<0.01$ ). The 1991 and 1993 estimates were similar to 1994 ( $\mathrm{P}>0.10$ ). The trend in the standardized series is also seen in the raw data, both showing an increase since 1990.

Catch composition
Figure 6
Estimates of catch-at-length, based on observer sampling data, showed highly variable size distributions between years. High proportions of male shrimp less than 25 mm CL and overall lower catch rates in 1989 and 1990 reflect the fishing activity south of $60^{\circ} \mathrm{N}$ in those years. Large, female shrimp dominated in 1991 when effort shifted to the northern grounds. The strong component of males observed in the 1992 catches recruited further as larger males and small females in 1993, possibly explaining the increase in CPUE between the two years and the higher proportion of females in the latter. The reduction in the proportion and number of males
caught per hour in 1993 compared to 1992 did not negatively impact catch rates in 1994. The female component continued to support high CPUE's in 1994, indicating that a healthy spawning biomass is being maintained. Average size of females was slightly smaller in 1994.

## RESOURCE STATUS AND PERSPECTIVES

The area is characterized by both variable catch rates and size compositions which reflect, to some extent, the grounds fished each year. If the high CPUE's and large sizes attained in recent years persist in the north, it is likely that the EA's will continue to be taken from that area alone, with little or no fishing south of $60^{\circ} \mathrm{N}$. Fishermen frequently report tows of less than a half hour's duration producing several tons of shrimp and, not uncommonly, the daily production capacity for some vessels is achieved in only a few hours of trawling.

The continuation of high catch rates of mostly large, female shrimp from the northern area in recent years indicates a healthy spawning stock and implies that the fishery, so far, has not significantly impacted the resource. In 1994, the TAC previously set at 2700 tons for the 1991 - 1993 period was viewed as overly restrictive to the fleet and, although there was no quantitative basis on which to advise a higher catch level, it was suggested that the TAC be increased experimentally to about 5000 tons. It also was noted that the fleet fishes areas of highest density but, beyond that range, additional biomass of both small male and large female shrimp exists in shallower and deeper waters, respectively. Industry chose to implement the proposed increase over two years - an initial increase to 4000 tons in 1994, the first year of the multi-year management plan, and a further increase to 5000 tons in 1995, provided that the review of the status of the resource in early 1995 was favourable. Based on the present review of fishery performance and catch composition up to and including 1994, there are no immediate concerns for the health of the northern shrimp resource in Division 2 G and the increase proposed for 1995 (i.e. $\mathrm{TAC}_{1995}=5000$ tons) can be implemented.

## ASSESSMENT OF SHRIMP IN HOPEDALE \& CARTWRIGHT CHANNELS

## Catch and effort

Figures 7, 8 and Table 3
The northern shrimp fishery in Hopedale and Cartwright Channels essentially began in 1977, following exploratory fishing in the previous two years. Catches increased from about 2700 tons in 1977 to 4100 tons in 1980, declined to 1000 tons in 1983 and 1984, increased again to 7800 tons in 1988 and then stabilized at roughly

6000 tons during the 1989 - 1993 period. In 1994, the TAC for the 1994 - 1996 Management Plan was increased by 20\% to 7650 tons annually and preliminary estimates indicate that 7475 tons were taken.

Fishing effort (both unstandardized and standardized) showed the same trends over time as catch. The fishery usually occurs from June to December but, since 1988, significant effort has been reported in the January - May period. Traditionally, effort has concentrated in four main areas: northern, eastern and southern Hopedale Channel and Cartwright Channel. In the 1990's, however, occasional effort has been reported on the slope of the shelf north between Cartwright and Hopedale Channels and south between Cartwright and Hawke Channels. In 1994, substantial effort was reported from the latter.

Catch per unit effort (CPUE)
Figure 7 and Table 3
Typically, catch rates are high during June and July, decline thereafter to September or October and increase again late in the year. Unstandardized annual CPUE's ( $\mathrm{kg} / \mathrm{hr}$ ) declined from 552 in 1977 to $230 \mathrm{~kg} / \mathrm{hr}$ in 1985, increased substantially in 1986 and stabilized around a mean level of $615 \mathrm{~kg} / \mathrm{hr}$ during the 1986 - 1993 period. The 1994 catch rate increased to $790 \mathrm{~kg} / \mathrm{hr}$.

The CPUE data were further analyzed by multiple regression for year, month, vessel and area effects. The model, which explained 47\% of the variation, showed that all class variables were highly significant ( $\mathrm{P}<0.001$ ) and indicated that the 1994 catch rate reached approximately the level observed in the first two years of the fishery - 1977 and 1978 ( $\mathrm{P}>0.70$ ). Both series show the same trend - a decline to 1985, a substantial increase in 1986 followed by stability to the early $1990^{\prime}$ s and an increase since then.

## Catch composition

Figure 9
Catch-at-length, estimated from commercial sampling data for the Hopedale and Cartwright Channels, combined, showed a modal group of females at 24 - 25 mm CL occurring each year. In most cases, males (approx. < 22 mm ) contributed substantially to the catch in numbers. Although the increase in CPUE from 1985 to 1986 occurred across all size/age groups, the length sampling data from 1986 show the recruitment of one or more strong year classes of the early 1980's. Recruitment of ages 4,5 and 6 (approx. $16-23 \mathrm{~mm}$ males) has been regular during the recent period of stable and/or increasing catch rates and at a higher level than observed during the early to mid 1980's. Catch rates of the female component also tended to be higher from 1986 onward compared to earlier years. The 1993 and 1994 data suggest that year classes produced in the late 1980's and 1990 will prolong this trend in the short term.

## RESOURCE STATUS AND PERSPECTIVES

The northern shrimp resource in the Hopedale and Cartwright Channels remains healthy with commercial catch rates stable over the late 1980's and showing some increase in recent years. No declining trend in the proportions or catch rates of female shrimp has emerged since 1986 and prospects for recruitment to the female component in the near future are favourable.

The increase in CPUE from the level observed during the early to mid 1980's to the period from 1986, onward, can be partly explained by regular recruitment of year classes produced throughout the 1980's. The impact of fishing, although unquantifiable, appears minimal. Catch increased linearly with effort and CPUE showed no negative relationship with effort. The spawning biomass remains healthy and there are no signs of recruitment failure. The presence of refugia areas in waters both shallower and deeper than the fishing grounds also affords some protection for males and females, respectively. Preliminary data from daily vessel hails show that the 1995 fishery performed well in January and February with catch rates (unstandardized) of 1.4 and 2.8 tons per hour, respectively. Given the current, positive view of the status of the resource, no immediate changes in the TAC are required for the current management plan.

Combining the two channels as a single management/assessment area in 1994 resulted in a substantially higher catch from Cartwright, compared to previous years. Preliminary data show that about 44\% or 3300 tons were taken in this area, more than twice the average catch taken during the 1989 - 1993 period. Despite the increase in catch and effort, CPUE (unstandardized) in 1994 was higher than in 1993 and, as noted above, the early 1995 fishery has performed well.

## ASSESSMENT OF SHRIMP IN HAWKE CHANNEL + DIVISION 3K

Catch and effort
Figures 10, 11 and Table 4
The shrimp fishery in the Hawke Channel + Division 3 K area began in 1987 when 1845 tons were caught. Since then, the fishery has evolved as a winter - spring operation with most of the catch and effort occurring in the January - May period. Catches increased to more than 7800 tons in 1988 and ranged between 5500 and 8000 tons from 1989 to 1993, inclusive. The annual TAC for the 1994 - 1996 Management Plan was set at 11,050 tons ( $20 \%$ more than the 1993 TAC) to include Hawke Channel, St. Anthony Basin, east St. Anthony, Funk Island Deep as well as three exploratory areas on the seaward slope of the shelf. Catches in 1994 totalled 10,937 tons (preliminary)
and logbook data indicate that over 8000 tons were taken from Hawke Channel. Fishing effort declined from the 1988/89 level but has remained relatively stable since 1991.

A displacement of fishing effort to the east has occurred since 1992. This was due to a number of factors: the establishment of exploratory areas on the shelf slope in 1992 and 1993, the discovery of concentrations of shrimp in these areas, the occurrence of ice in winter and spring each year and the flexibility to fish the 1994 TAC anywhere within the management area. This displacement was particularly evident in St. Anthony Basin where both catch and effort declined markedly since 1992.

## CPUE

Figure 10 and Table 4
Monthly catch rates from 1988 to 1990 were highest in May but, in 1992 and 1993, January rates were highest. In 1994, CPUE's exceeded those observed in previous years and increased steadily from January to May. Unstandardized, annual CPUE's decreased from 536 $\mathrm{kg} / \mathrm{hr}$ in 1988 to 432 in 1989 and increased steadily thereafter to $1289 \mathrm{~kg} / \mathrm{hr}$ in 1994. The CPUE data were analyzed by multiple regression for year, month, vessel and area effects. The model explained 41\% of the variation and showed that all class variables were highly significant ( $\mathrm{P}<0.001$ ). Standardized, annual catch rates revealed approximately the same trend as the unstandardized series from 1988 to 1991. However, the increases in 1992 and 1993 were more pronounced in the standardized series and there was no increase in 1994 as observed in the raw data. Despite the high catch from Hawke Channel in 1994 compared to previous years, catch rates from that area alone continued to increase. If the "area" class variable is omitted from the standardization model, the 1994 CPUE becomes the highest in the series.

## Size composition

Catch-at-length data from 1988 to 1994 showed dominance of the female component around 24 mm CL in most years. The increase in catch rates following 1989 was likely due to recruitment of at least two strong year classes which first appeared as males (< 22 mm CL ) in 1990. Substantial components of male shrimp between 16 and 22 mm were evident in both 1993 and 1994 and, together with the high CPUE's, suggest continued good recruitment.

## RESOURCE STATUS AND PERSPECTIVES

The northern shrimp resource in Hawke Channel + Division 3 K remains healthy and catch rate data suggest that abundance has increased in recent years. The expansion of the fishery to include the slope waters between the traditionally fished areas provides additional
information on the extent of the distribution and abundance of the resource. The eastward displacement of the fishery in recent years is more a reflection of the flexibility in the choice of fishing area than a change in shrimp distribution. Areas to the west, although fished less intensively in 1993 and 1994, continue to produce high catch rates. Further, the proportion of female shrimp in the catches remains high and there are no signs of weak recruitment for the near future. The effects of the fishery are not detectable within the range of naturally occurring events.

Although the precise explanation of the current high abundance is not clear, it is likely that several strong year classes have been produced since the mid 1980's. A significant shift in distribution from the north is not evident as the fishery is still performing well in those areas. It appears that recent conditions within the system off northeastern Newfoundland and southern Labrador were highly favourable for shrimp. How long those conditions will last is unknown. It is noteworthy that daily vessel hails for 1995 indicate that catch rates (unstandardized) for January and February were higher than those observed for the same months in any previous year.

Given the evidence for increased abundance in recent years and no concern for future recruitment to the fishery, no immediate changes in the TAC are required for the current management plan. However, the changing fishing pattern, due to the combination of Hawke Channel and Division 3 K as a single assessment/management area, should be closely monitored for signs of localized depletion of the resource.

TABLE 1. NORTHERN SHRIMP FISHERY DATA FOR DIV. OB, 1988-1994.

| YEAR | TAC ${ }^{11}$ <br> (t) | CATCH ${ }^{2}$ <br> (t) | UNSTANDARDIZED |  |  | STANDARDIZED |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | CPUE <br> (KG/HR) | INDEX | EFFORT ${ }^{3}$ <br> (HR) | CPUE (KG/HR) | INDEX | EFFORT ${ }^{3}$ <br> (HR) |
| 1988 |  | 2826 | 585 | 1.00 | 4831 | 339 | 1.00 | 8336 |
| 1989 | 3500 | 3039 | 271 | 0.46 | 11214 | 191 | 0.56 | 15911 |
| 1990 | 3500 | 1609 | 497 | 0.85 | 3237 | 257 | 0.76 | 6261 |
| 1991 | 3485 | 1107 | 242 | 0.41 | 4574 | 241 | 0.71 | 4593 |
| 1992 | 3485 | 1291 | 315 | 0.54 | 4098 | 132 | 0.39 | 9780 |
| 1993 | 3485 | 106 | 193 | 0.33 | 549 | 78 | 0.23 | 1359 |
| 1994 | 3500 | 475 | 275 | 0.47 | 1727 | 119 | 0.35 | 3992 |

1 TAC'S FOR 1989 AND 1990 ARE FOR THE FISHING SEASON MAY 1 TO APRIL 30 AND FOR THE CALENDAR YEAR, THEREAFTER, MAKING 1991 AN 8 MONTH YEAR (MAY 1 - DEC. 31)

2 CATCH (TONS) FOR 1988 AND 1989 AS REPORTED IN ECONOMIC ASSESSMENT OF THE NORTHERN SHRIMP FISHERY AND FROM YEAR-END QUOTA REPORTS AND/OR LOGBOOK RECORDS, THEREAFTER.EFFORT CALCULATED FROM CATCH/CPUE. CPUE CALCULATED FROM VESSEL LOG DATA.

TABLE 2. NORTHERN SHRIMP FISHERY DATA FOR DIV. 2G, 1979-1994.

(1)

TAC'S FROM 1987 TO 1990, INCLUSIVE ARE FOR THE FISHING SEASON MAY 1 TO APRIL 30, MAKING 1986 A 16 MONTH YEAR (JAN.1, 1986 - APRIL 30, 1987) AND 1991 AN 8 MONTH YEAR (MAY 1 - DEC. 31).

2
CATCH (TONS) AS REPORTED IN: LOGBOOKS FOR 1979, ECONOMIC ASSESSMENT OF THE NORTHERN SHRIMP FISHERY FROM 1980 TO 1989 AND FROM YEAR-END QUOTA REPORTS AND/OR LOGBOOKS, THEREAFTER.

3 EFFORT CALCULATED FROM CATCHICPUE. CPUE CALCULATED FROM VESSEL LOG DATA.

TABLE 3. NORTHERN SHRIMP FISHERY DATA FOR HOPEDALE AND CARTWRIGHT CHANNELS, 1977-1994.

| YEAR | TAC 1 <br> (t) | $\begin{gathered} \text { CATCH }{ }^{2} \\ (t) \end{gathered}$ | UNSTANDARDIZED |  |  | STANDARDIZED |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | CPUE (KG/HR) | INDEX | $\begin{gathered} \text { EFFORT }{ }^{3} \\ \text { (HR) } \end{gathered}$ | $\begin{gathered} \text { CPUE } \\ \text { (KG/HR) } \end{gathered}$ | INDEX | EFFORT ${ }^{3}$ <br> (HR) |
| 1977 | . | 2686 | 552 | 1.00 | 4866 | 766 | 1.00 | 3507 |
| 1978 | 5300 | 3630 | 453 | 0.82 | 8013 | 774 | 1.01 | 4690 |
| 1979 | 4000 | 3727 | 368 | 0.67 | 10128 | 636 | 0.83 | 5860 |
| 1980 | 4800 | 4108 | 388 | 0.70 | 10588 | 444 | 0.58 | 9252 |
| 1981 | 4800 | 3449 | 364 | 0.66 | 9475 | 478 | 0.62 | 7215 |
| 1982 | 4800 | 1983 | 372 | 0.67 | 5331 | 401 | 0.52 | 4945 |
| 1983 | 4800 | 1000 | 297 | 0.54 | 3367 | 287 | 0.37 | 3484 |
| 1984 | 4200 | 1002 | 297 | 0.54 | 3374 | 341 | 0.45 | 2938 |
| 1985 | 3570 | 1689 | 230 | 0.42 | 7343 | 346 | 0.45 | 4882 |
| 1986 | 4400 | 4826 | 538 | 0.97 | 8970 | 599 | 0.78 | 8057 |
| 1987 | 4800 | 5956 | 613 | 1.11 | 9716 | 584 | 0.76 | 10199 |
| 1988 | 4800 | 7838 | 625 | 1.13 | 12541 | 631 | 0.82 | 12422 |
| 1989 | 6000 | 5985 | 677 | 1.23 | 8840 | 633 | 0.83 | 9455 |
| 1990 | 6000 | 5360 | 626 | 1.13 | 8562 | 596 | 0.78 | 8993 |
| 1991 | 6375 | 6118 | 526 | 0.95 | 11631 | 637 | 0.83 | 9604 |
| 1992 | 6375 | 6315 | 695 | 1.26 | 9086 | 610 | 0.80 | 10352 |
| 1993 | 6375 | 5719 | 622 | 1.13 | 9195 | 672 | 0.88 | 8510 |
| 1994 | 7650 | 7475 | 790 | 1.43 | 9462 | 737 | 0.96 | 10142 |

1 TAC'S FROM 1987 TO 1990, INCLUSIVE ARE FOR THE FISHING SEASON MAY 1 TO APRIL 30, MAKING 1986 A 16 MONTH YEAR (JAN.1, 1986 - APRIL 30, 1987) AND 1991 AN 8 MONTH YEAR (MAY 1 - DEC. 31).

2 CATCH (TONS) IN CALENDAR YEAR AS REPORTED IN : LOG BOOKS FOR 1977, ECONOMIC ASSESSMENT OF THE NORTHERN SHRIMP FISHERY FROM 1978 TO 1989 AND YEAR-END QUOTA REPORTS, THEREAFTER.

3 EFFORT CALCULATED FROM CATCH/CPUE. CPUE CALCULATED FROM VESSEL LOG DATA.

TABLE 4. NORTHERN SHRIMP FISHERY DATA FOR HAWKE CHANNEL + DIVISION 3K, 1977-1994.

| YEAR |  |  | UNSTANDARDIZED |  |  | STANDARDIZED |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | TAC ${ }^{1}$ <br> (t) | $\begin{aligned} & \text { CATCH } 2 \\ & \text { (t) } \end{aligned}$ | CPUE (KG/HR) | INDEX | $\begin{aligned} & \text { EFFORT }{ }^{3} \\ & \text { (HR) } \end{aligned}$ | $\begin{gathered} \text { CPUE } \\ \text { (KG/HR) } \end{gathered}$ | INDEX | EFFORT ${ }^{\sqrt[3]{3}}$ <br> (HR) |
| 1977 |  | 1 | 117 |  | 6 |  |  |  |
| 1978 | 1300 |  |  |  |  |  |  |  |
| 1979 | 2250 | 5 | 189 |  | 29 |  |  |  |
| 1980 | 1350 |  |  |  |  |  |  |  |
| 1981 | 1350 | 135 | 207 |  | 652 |  |  |  |
| 1982 | 1350 | 1 | 151 |  | 3 |  |  |  |
| 1983 | 1350 |  |  |  |  |  |  |  |
| 1984 | 1350 |  |  |  |  |  |  |  |
| 1985 | 1350 |  |  |  |  |  |  |  |
| 1986 | 2050 |  |  |  |  |  |  |  |
| 1987 | 3000 | 1845 | 333 |  | 5541 |  |  |  |
| 1988 | 3000 | 7849 | 536 | 1.00 | 14644 | 754 | 1.00 | 10410 |
| 1989 | 5600 | 6662 | 432 | 0.81 | 15421 | 642 | 0.85 | 10377 |
| 1990 | 5600 | 5598 | 507 | 0.95 | 11041 | 757 | 1.00 | 7395 |
| 1991 | 4301 | 5500 | 603 | 1.13 | 9121 | 843 | 1.12 | 6524 |
| 1992 | 7565 | 6609 | 774 | 1.44 | 8539 | 1508 | 2.00 | 4383 |
| 1993 | 9180 | 8035 | 891 | 1.66 | 9018 | 1829 | 2.43 | 4393 |
| 1994 | 11050 | 10937 | 1289 | 2.40 | 8485 | 1741 | 2.31 | 6282 |HISTORICAL TAC'S APPLIED AS FOLLOWS:

1978 TO 1985-HAWKE CHANNEL + 500 TON EXPLORATORY TAC FOR DIVISION 3K;
1986 TO 1988 - HAWKE CHANNEL + ST. ANTHONY BASIN;
1989 TO 1991 - HAWKE CHANNEL, ST. ANTHONY BASIN, EAST ST. ANTHONY AND FUNK ISLAND DEEP; 1992 - INCLUDES 1700 TONS EXPLORATORY; 1993 - INCLUDES 3400 TONS EXPLORATORY; 1994 - ALL AREAS COMBINED.
TAC'S FROM 1987 TO 1990, INCLUSIVE, ARE FOR THE FISHING SEASON MAY 1 TO APRIL 30, MAKING 1986 A 16 MONTH YEAR (JAN.1, 1986 - APRIL 30, 1987) AND 1991 AN 8 MONTH YEAR (MAY 1 - DEC. 31).CATCH (TONS) IN CALENDAR YEAR AS REPORTED IN: LOG BOOKS FOR 1977, ECONOMIC ASSESSMENT OF THE NORTHERN SHRIMP FISHERY FROM 1978 TO 1989 AND YEAR-END QUOTA REPORTS, THEREAFTER.EFFORT CALCULATED FROM CATCH/CPUE. CPUE CALCULATED FROM VESSEL LOG DATA.

Figure 1. Catch, effort and CPUE - Division OB, 1988-1994




Fig. 2. Fishing pattern in Div. 0B, 1993-1994.


Fig. 3 Catch (numbers-per-hour. 000 's) in Div. 0B, unsexed in 1988-89, sexed from 1990 (broken line=females).


Figure 4. Catch, effort and CPUE - Division 2G, 1988-1994




Fig. 5. Fishing pattern in Div. 2G, 1993-1994.


Fig. 6 Catch (numbers-per-hour. 000 's) in Div. 2G, unsexed in 1988-89, sexed from 1990 (broken line=females).


# Figure 7. Catch, effort and CPUE - Hopedale + Cartwright Channels, 1977-1994 





Fig. 8. Fishing pattern in Hopedale and Cartwright Channels, 1993-1994.


Fig. 9 Catch (numbers-per-hour. 000 's) in Hopedale and Cartwright Channels, unsexed from 1977-89, sexed from 1990 (broken line=females).


Figure 10. Catch, effort and CPUE - Hawke Channel + Division 3K, 1987-1994




Fig. 11. Fishing pattern in Hawke Channel and Div. 3K, 1987-1994.


Fig. 11. Continued.




Fig. 12 Catch (numbers-per-hour. 000 's) in Hawke Channel and Div. 3K, unsexed in 1988-90, sexed from 1991 (broken line=females).


