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Status of Northern Shrimp (Pandalus borealis) Resources in Areas off Baffin Island, Labrador and Northeastern Newfoundland - Interim Review

by

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Abstract

Data from the commercial fishery for northern shrimp were analyzed for four assessment/ management areas: Division 0B, Division 2G, Hopedale + Cartwright Channels and Hawke Channel + Division 3K - corresponding to shrimp fishing areas (SFA's) 2, 4, 5 and 6, respectively. Within each area, status of the resource was inferred by examining trends in catch, effort, catch per unit effort, fishing pattern and size/sex composition of the catches. Also, multispecies research trawl surveys in 1995, 1996 and 1997 provided information on distribution and abundance of shrimp in Hawke Channel + Div. 3K for all three years and throughout the Div. 2G-3K area for 1996 and 1997.

The northern shrimp offshore fishery again performed well in 1997 and an inshore component was successfully initiated. Catch rates of offshore vessels in the Hopedale + Cartwright and Hawke + 3K areas were as high as or higher than those observed since the fishery began. The effect of double trawling by a few vessels was not considered significant in the interpretation of the catch rate data. Research surveys showed that abundance/biomass remained high in both these areas, particularly in Hawke + 3K. In Div. 2G, the concern for a decline in catch rates between 1994 and 1996 was mollified after improved fishery performance in 1997 and the research survey indicated the possibility of low exploitation. A healthy spawning stock has been maintained in recent years. The status of the resource in Div. 0B remains uncertain in the absence of a time series of research trawl surveys.

It was concluded that the shrimp resource in Hawke Channel + Div. 3K (SFA 6) remains healthy and a further increase in the TAC for 1998, the second year of the three-year management plan, can be considered by managers. Given the healthy spawning stock and, possibly, low exploitation in Div. 2G (SFA 4), an increase in the TAC for 1998 also can be considered for this area, all or part of which to be assigned to the area south of 60^0 N in an attempt to spread effort beyond the preferred fishing grounds. TAC's for shrimp in Div. 0B (SFA 2) and Hopedale + Cartwright (SFA 5) in 1998 should remain unchanged from 1997 levels.

Résumé

Il a été procédé à l'analyse des données de la pêche commerciale de la crevette nordique de quatre zones de gestion ou d'évaluation : la division 0B, la division 2G, les chenaux Hopedale et Cartwright, et le chenal Hawke et la division 3K, qui correspondent respectivement aux zones de pêche de la crevette (ZPC) 2, 4, 5 et 6. Pour chaque zone, l'état de la ressource a été déduit à partir de l'examen des tendances des captures, de l'effort et des prises par unité d'effort, de l'allure de la pêche et de la composition par taille et sexe des captures. En outre, les relevés de recherche au chalut portant sur plusieurs espèces et réalisés en 1995, 1996 et 1997 ont permis d'obtenir des renseignements sur la distribution et l'abondance des crevettes dans le chenal Hawke et la division 3K pour ces trois années et dans les divisions 2G et 3K pour les années 1996 et 1997.

La pêche hauturière de la crevette nordique a encore été bonne en 1997 et une pêche côtière a été amorcée avec succès. Les taux de capture des bateaux hauturiers dans les chenaux Hopedale et Cartwright et le chenal Hawke et la division 3K ont été au moins aussi élevés que ceux obtenus depuis le début de la pêche. L'effet du double chalutage effectué par quelques bateaux n'a pas été jugé significatif pour l'interprétation des données sur les taux de capture. Les relevés de recherche indiquent que l'abondance ou la biomasse sont demeurées élevées dans ces deux zones, notamment dans le chenal Hawke et 3K. Dans la division 2G, la préoccupation relative à une baisse des taux de capture entre 1994 et 1996 a été amoindrie par le rendement accru de 1997 et le relevé de recherche indique la possibilité d'une faible exploitation. Il y a eu maintien d'un stock de géniteurs en bonne condition au cours des dernières années. L'état de la ressource dans la division 0B demeure incertain en l'absence d'une série chronologique de relevés de recherche au chalut.

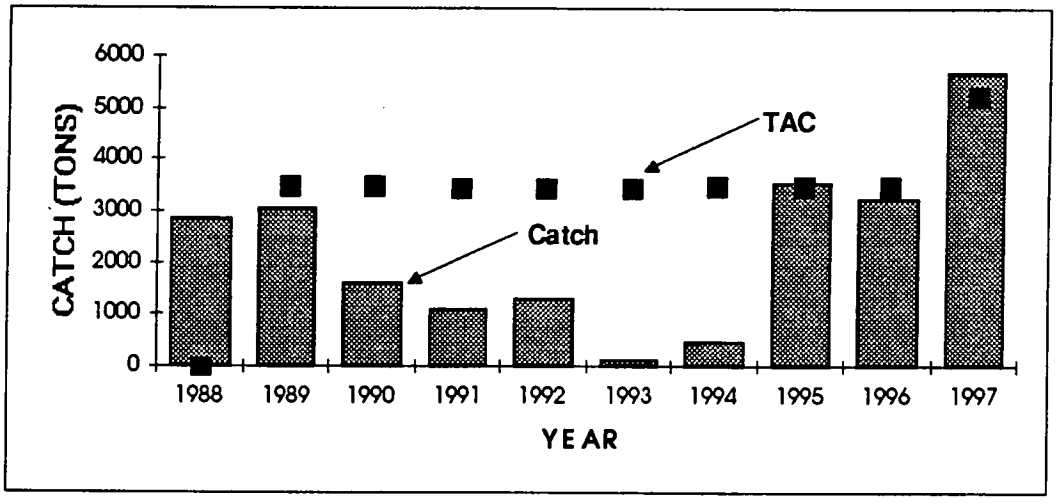
Il est conclu que la ressource en crevettes du chenal Hawke et de la division 3K (ZPC 6) demeure en bonne condition et que les gestionnaires peuvent envisager une autre hausse du TAC pour 1998, la deuxième année du plan de gestion triennal. Étant donné la bonne condition du stock de géniteurs et, peut-être, une faible exploitation dans la division 2G (ZPC 4), une augmentation du TAC de 1998 peut aussi être envisagée, mais cette augmentation devrait se faire, totalement ou en partie, au sud de 60°N afin de déplacer l'effort de pêche au-delà des fonds les plus exploités. Les TAC de 1998 de la division 0B (ZPC 2) et des chenaux Hopedale et Cartwright (ZPC 5) devraient être maintenus aux valeurs de 1997.

ASSESSMENT OF SHRIMP IN NAFO DIVISION 0B (SFA 2)

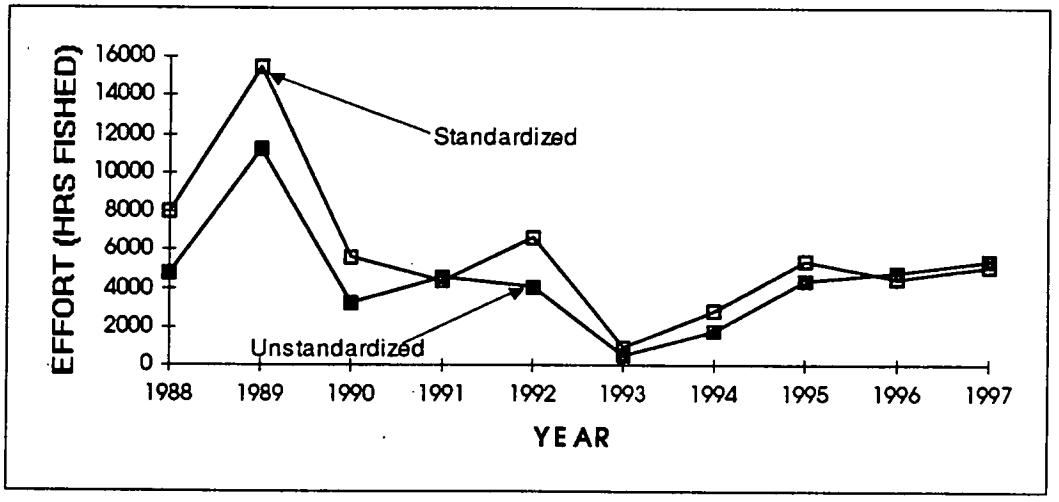
FISHERY DATA

Catch and effort

The northern shrimp fishery in Division 0B began in October, 1988. Catches increased from about 2800 tons that year to 3000 tons in 1989 but subsequently declined to 100 tons in 1993. Catch remained low in 1994 at 476 tons but increased substantially to 3564, 3220 and 5670 tons from 1995 to 1997, respectively. These recent catch estimates, based on vessel logbook data, have been separated as much as possible from the mixed fishery for *Pandalus borealis/montagui* in the area east of Resolution Island but their accuracy is still questionable. TAC's remained at 3500 tons from 1989 to 1996 but were increased, experimentally, to 5250 tons for the 1997 - 1999 multi-year management plan.



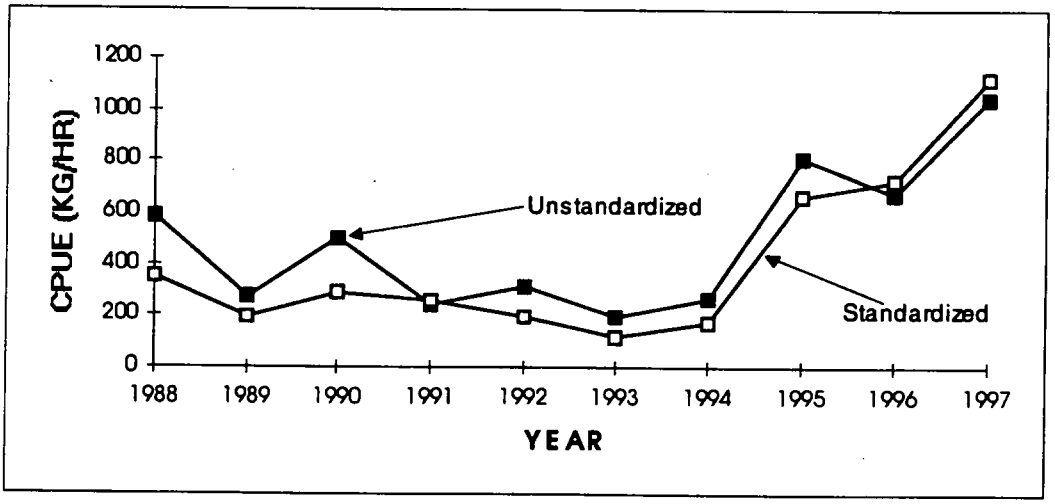
Fishing effort about doubled from 1988 to 1989, decreased to 1993, increased to 1995 and stabilized in 1996 and 1997.



In the late 1980's, fishing effort was primarily concentrated between 64^0 and 65^0 N. During the 1990 - 1994 period, while total effort declined, proportionately more effort was distributed south of 64^0 N. The areas fished extensively in the southwest from 1995 to 1997 reflect the targeting of dense concentrations of *P. borealis* and *P. montagui* east of Resolution Island (Fig. 1).

Catch per unit effort (CPUE)

Unstandardized, annual CPUE's decreased from 585 kg/hr in 1988 to 271 in 1989 and increased to 497 in 1990. Catch rates decreased during 1991 - 1994 to the 200 - 300 kg/hr range and increased to more than 600 kg/hr in 1995 and 1996 and 1000 kg/hr in 1997. The data were analyzed by multiple regression for year and vessel effects. The model showed that the standardized, 1997 catch rate of 1124 kg/hr was the highest in the time series (Table 1). Weighting the model by effort did not affect the results. Both CPUE series showed a declining trend to 1993 - 94 and a large increase during 1995 - 1997 when the fishery concentrated in the southwest. Although there was no significant month effect, more effort has occurred during the summer since 1994.



Historical fishery data for this management-assessment area are summarized in Table 2.

Size composition

Catches in most years were composed primarily of large, female shrimp (Fig. 2) with a modal length of about 27 mm carapace length (CL). Occurrence of higher proportions of the male component (<25 mm) after 1988 was coincident with the southward shift in fishing effort. In 1994, catches comprised mostly large males (23 - 24 mm) and females whereas, in 1995 and 1996, the female component (27 mm) was prominent. Several size/age groups of males were evident in 1996 and this recruitment is reflected in the strong male component of the 1997 catches.

RESOURCE STATUS

This area is difficult to fish due to the presence of ice, the sudden shifts in water masses and/or strong tides that are believed by fishermen to affect shrimp distribution. They have observed that, although shrimp concentrations in northeast are elusive, those adjacent to southeastern Resolution Island have persisted since first fished in 1995. Recently, they have questioned whether the boundary between SFA's 2 and 4 is appropriate with respect to shrimp distribution.

The status of this resource remains uncertain. The fishery has shifted to the southwest since 1995 and the CPUE and sampling data are not considered to be valid indicators of overall stock conditions. The mixed fishery for *Pandalus borealis/montagui* further confounds the assessment and knowledge of the distribution (i.e. the boundary question) and abundance/biomass of both species will be limited in the absence of a time series of research vessel trawl surveys.

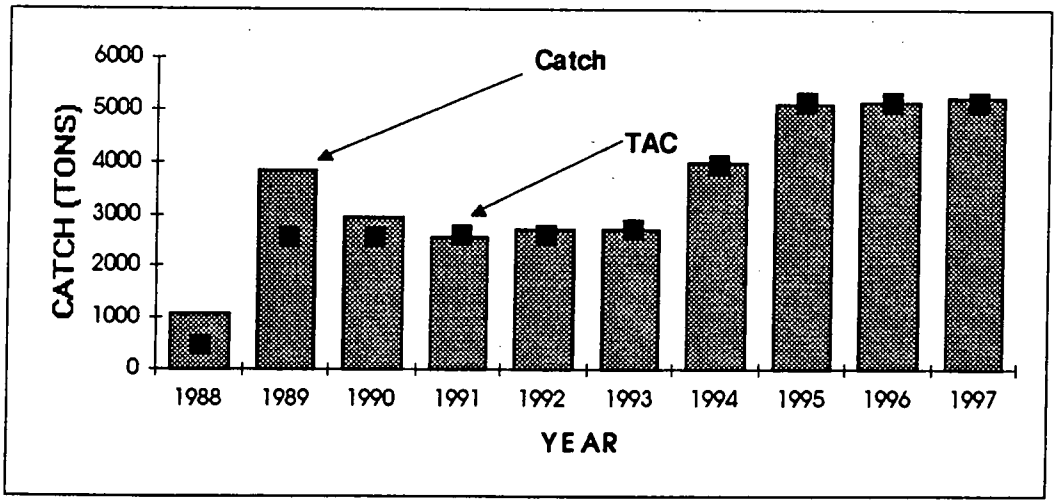
In 1997, there was no biological basis on which to advise a change in the TAC of 3500 tons, established in 1989 as a precautionary level in an exploratory area. However, it was increased "experimentally" by 50% to 5250 tons annually for the 1997 - 1999 Management Plan. The current assessment does not provide an alternative to the experimental approach.

ASSESSMENT OF SHRIMP IN NAFO DIVISION 2G (SFA 4)

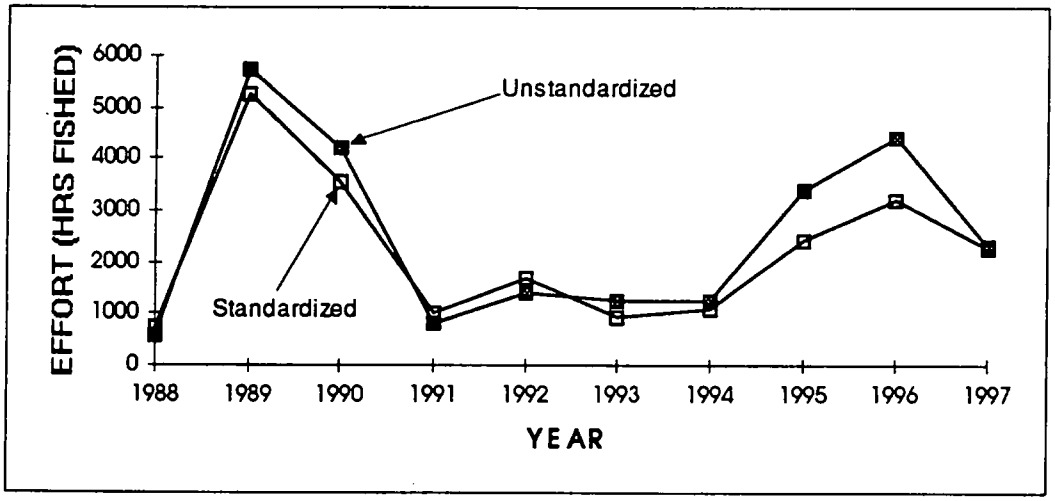
FISHERY DATA

Catch and effort

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 and including 1993. The 1994 catch increased to about 4000 tons with an increase in TAC to that level in the first year of the 1994 - 1996 Management Plan. A second, planned increase to 5200 tons for 1995 and 1996 resulted in catches of about 5100 tons in both years. The TAC was maintained for 1997 and catch was estimated at 5217 tons.



Fishing effort increased substantially from 1988 to 1989, decreased to 1991 and remained relatively stable at a low level (< 2000 hours) up to 1994. Effort increased in 1995 and again in 1996 but declined in 1997.



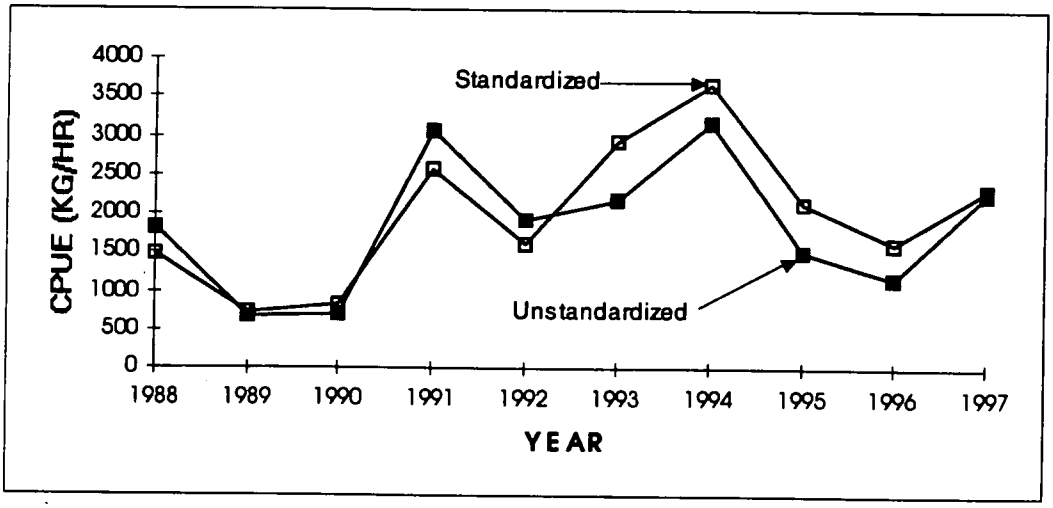
The fishery from 1988 to 1990 occurred throughout the Division which, during that period, was split into two management zones, north and south of 60^0 N. The 1991 - 1993 Management Plan combined the two zones and, since then, effort has concentrated primarily in the north (Fig. 3). Some substantial by-catches of *P. montagui* were encountered at some locations during the 1995 - 1997 period.

Catch per unit effort (CPUE)

The area north of 60^0 N is noted for producing high catch rates of large, high-quality shrimp. Unstandardized, annual CPUE's for the whole management area declined from 1823 kg/hr in 1988 to about 700 in 1989 and 1990. In 1991, catch rate increased substantially to over 3000 kg/hr as fishing effort concentrated in the northern grounds. High CPUE's in the range of 2000 to 3000

kg/hr were maintained up to 1994. The 1995 and 1996 catch rates declined to 1506 and 1168 kg/hr, respectively, but the 1997 estimate increased to 2258 kg/hr.

The CPUE data were analyzed by multiple regression for year, month and vessel effects. The model showed that the annual, standardized catch rate in 1997 for the whole area had recovered to about the level attained in 1991 and 1995 ($P > 0.6$, Table 3). Both series showed an overall increase from 1989 to 1994, followed by a decrease to 1996 and some increase in 1997.



Catch rates within the preferred fishing area (north of 60^0 N) were examined and, from 1991 onward, showed the same trends as those from the whole area. Standardized unweighted and standardized with effort weighting indices both showed increased CPUE in 1997 compared to 1995 and 1996 but the increase was not considered significant ($P > 0.05$).

Historical fishery data for this management-assessment area are summarized in Table 4.

Size composition

Catch-at-length data showed variable size distributions between years (Fig. 4). High proportions of male shrimp (< 25 mm CL) and overall lower catch rates in 1989 and 1990 reflect the fishing activity south of 60^0 N in those years. Since then, with effort concentrating in the north, the female component dominated the catches by number and weight in all years except 1992. Given the high catch rates in this area, averaging more than 2 tons per hour since 1991, it is concluded that a healthy spawning biomass is being maintained.

RESEARCH SURVEY DATA

Stock size

The 1996 fall multispecies research survey in Div. 2G did not provide sufficient sampling for a reliable estimation of shrimp biomass. Only 43 fishing stations were occupied and coverage was sparse in depths > 300 m in southern and central areas. The preferred fishing area to the north also was poorly sampled. Therefore, no inference on level of exploitation was possible.

Survey coverage in 1997 was improved to 66 stations but broad 95% confidence intervals were associated with the mean estimates of abundance and biomass (Table 5). The catch of about 5200 tons implies low exploitation when compared to the mean biomass estimate of 79,000 tons but, given the high variance, the actual biomass could be much less than the mean estimate and the exploitation higher.

Stock composition

Length distributions from the 1996 survey, possibly representing abundance at length and age, showed a predominance of male shrimp and two size groups of females at roughly 23 and 27 mm CL (Fig. 5, upper). Within the male component (76% by number), the 1992 year class (age 4) was most abundant (41%) and the 1991 year class (age 5) was well-represented (27%). Age 6 shrimp, about 22 mm CL, appeared to comprise both sexes and females were aged to 8+ years.

Abundance in 1997 (Fig. 5, lower) again was dominated by males (72%) most of which were estimated to belong to the 1993 and 1992 year classes (31% and 25%, respectively). Age 6 shrimp of both sexes also were well-represented, consistent with the substantial numbers at age 5 in 1996. It appears that significant recruitment to the survey gear does not occur till age 4. The fishery typically targets ages 6+ (see Fig. 4).

RESOURCE STATUS

The concern about declining catch rates between 1994 and 1996 was mollified after improved fishery performance in 1997. However, the increased CPUE in 1997 was likely overestimated slightly due to the use of double trawls. The mean biomass estimate of 79,000 tons from the 1997 research survey implies low exploitation but the survey results showed high variance. Thus, the actual biomass could be much less than the mean estimate and the estimate of exploitation higher. There is a high degree of uncertainty regarding stock size and exploitation level in this area.

The spawning stock remains healthy, as evidenced in continued high catch rates for female shrimp and after three years (1995 - 1997) of catches greater than 5000 tons. There are no immediate conservation concerns. Any increase in TAC considered for 1998 should be less than those recently implemented in SFA's 5 and 6, reflecting the greater uncertainty in stock status for this area compared to some other areas. Also, all or part of any increase should be applied to the

grounds south of 60^0 N which would spread effort over a larger area and determine fishery potential beyond the fishing grounds in the north were effort has been concentrated for the past several years. Fishermen recently have expressed interest in returning to the southern grounds with additional resource allocation.

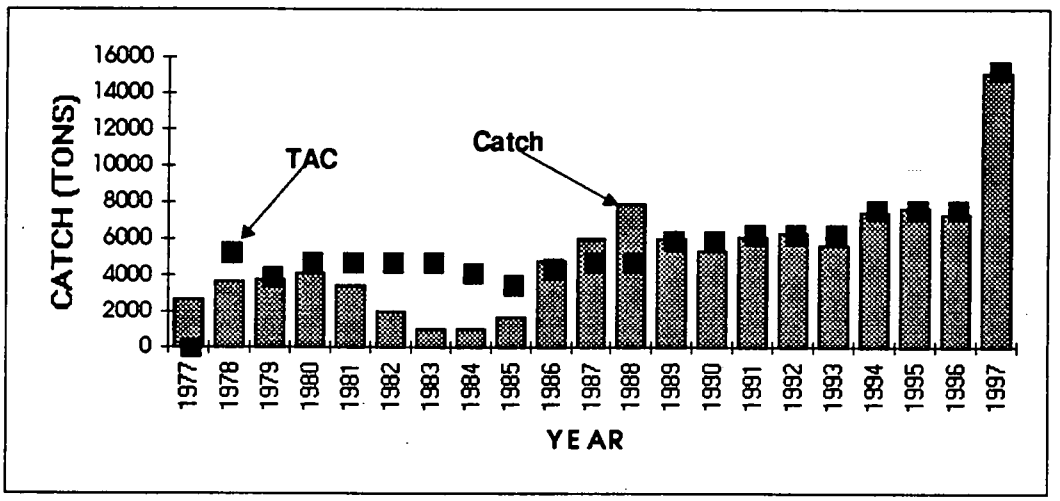
There is no basis on which to advise an appropriate level of TAC.

ASSESSMENT OF SHRIMP IN HOPEDALE & CARTWRIGHT CHANNELS (SFA 5)

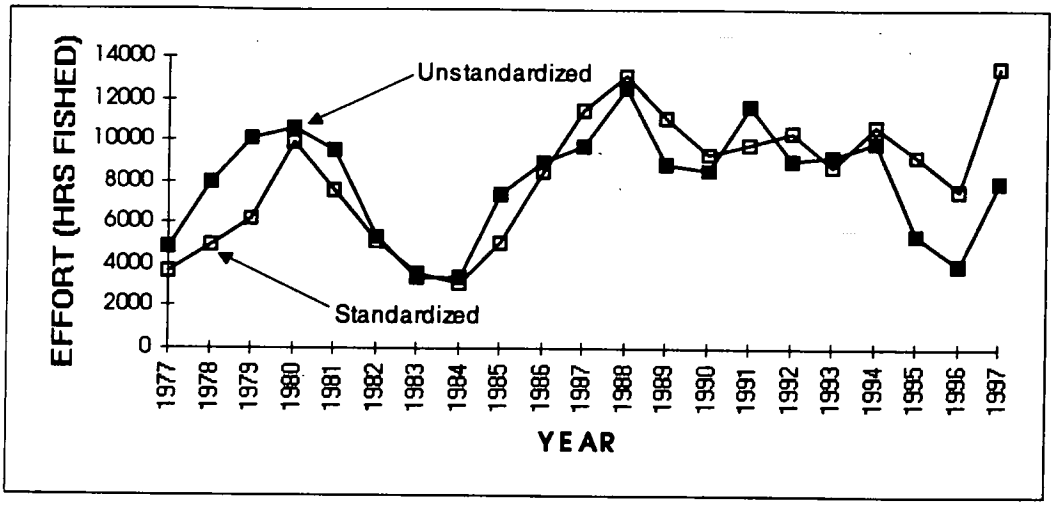
FISHERY DATA

Catch and effort

The northern shrimp fishery in Hopedale and Cartwright Channels began in 1977, following experimental 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. The TAC's for the 1994 - 1996 Management Plan, which combined the two channels as a single management area, were increased by 20% to 7650 tons annually and catches subsequently increased, averaging 7500 tons during that period. Based on analyses and interpretation of commercial fishery and research survey data in 1997 which indicated a healthy resource and low exploitation, TAC's for the 1997 - 1999 Plan were increased by 100% to 15,300 tons. The preliminary catch estimate for 1997 was 15,100 tons.



Fishing effort showed approximately the same trends over time as catch. In recent years, however, effort has decreased while catches have increased.



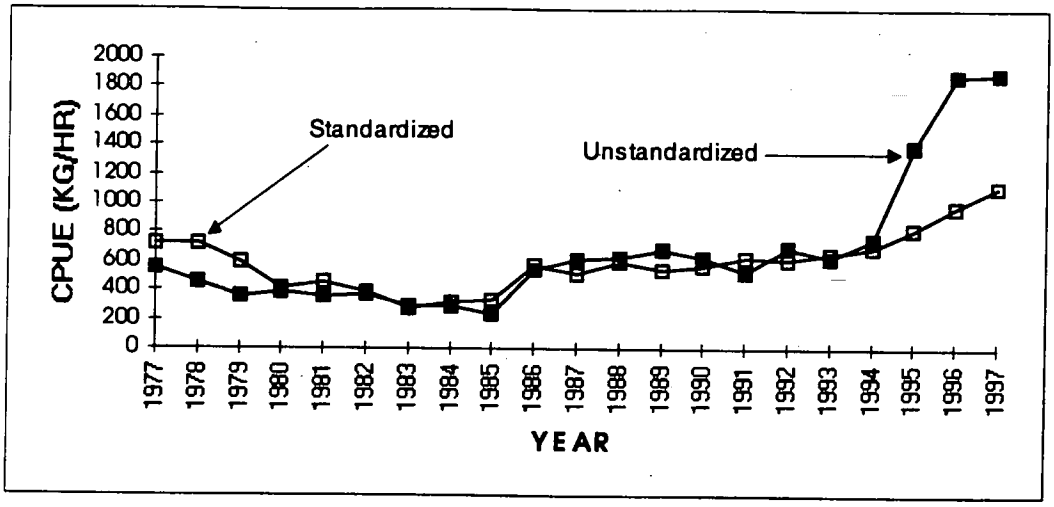
Traditionally, effort has concentrated in four main areas: northern, eastern and southern Hopedale Channel and Cartwright Channel (Fig. 6). In the 1990's, however, more effort was reported from the slopes of the shelf - north and east of Cartwright Channel. From 1994 to 1997, substantial effort occurred on the eastern slope during winter and spring. Historically a summer - fall fishery, since 1995 it has become mainly a winter - spring operation.

Catch per unit effort (CPUE)

Unstandardized, annual CPUE's declined from 552 kg/hr in 1977 to 230 in 1985, increased substantially in 1986 and stabilized around a mean level of 615 kg/hr during the 1986 - 1993 period. Catch rates increased, thereafter, to about 750 kg/hr in 1994, 1400 kg/hr in 1995 and 1900 kg/hr in 1996 and 1997.

The CPUE data were further analyzed by multiple regression for year, month, vessel and area effects. The standardized 1997 catch rate of 1118 kg/hr was the highest in the time series and was significantly higher ($P < 0.05$) than the estimates for all years of the fishery except 1996 (Table 6). Effort weighting in the regression analysis resulted in all years' estimates being lower than that of 1997.

Both the unstandardized and standardized series show approximately the same trend: a decline to the mid 1980's, a substantial increase in 1986 followed by stability to the early 1990's and an increase since then. Recent increases are more pronounced in the unstandardized data. The limited use of double trawls in 1997 is not considered to be an important factor in the interpretation of these results.



Historical fishery data for this management-assessment area are summarized in Table 7.

Size composition

Catch-at-length data from 1988 to 1997 (Fig. 7) showed a modal group of females about 24 mm CL occurring each year. Recruitment of males between 16 and 22 mm has been consistent from year to year and males have contributed substantially to the catch in numbers in all years. Both the male and female components showed increases in catch rates from 1994 to 1997. The length at which females begin to dominate in the size distributions was smaller during the 1995 - 1997 period than seen in previous years.

The recruitment, growth and maturation of the assumed 1991 year class can be tracked from the 1995 - 1997 sampling data. It first appeared as male at 18 mm CL (age 4) in 1995, dominated the male component at 20 mm (age 5) in 1996 and accounted for most of the females at 23 mm (age 6) in 1997. Similarly, the 1992 year class can be tracked as males in 1996 and 1997 and the 1993 year class first appears in 1997.

RESEARCH SURVEY DATA

Stock size

The 1996 fall multispecies research survey produced a biomass estimate of 192,000 tons with 95% confidence intervals of 0 and 451,000 tons (Table 8). Two trawl stations produced large catches and were highly influential to the biomass estimate. By omitting these stations from the analysis, a biomass of 75,000 tons was estimated with confidence intervals of 53,000 and 96,000 tons. The catch of approximately 7400 tons in 1996 implies low exploitation, accepting the results of the latter analysis.

Survey catches in 1997 were less variable than in 1996 producing a preliminary biomass estimate of 95,000 tons with 95% confidence intervals of 39,000 and 150,000 tons (Table 9). Increasing

the catch to about 15,000 tons in 1997 appears to have been effective in increasing the exploitation in this area.

Stock composition

Length distributions from the 1996 survey, representing abundance at length (and age), showed a predominance of male shrimp about 16 mm CL within the survey area (Fig. 8, upper). The modal size structure did not conform to the growth model determined previously for this area but was consistent with the model for the southern management area. This implies either a change in growth within the area or immigration from the south. The change in the length at which females begin to dominate the size distribution, noted above for the commercial data, is consistent with the alternative growth model. Assuming the alternative, most animals (estimated by modal analysis at 55%) from the 1996 survey are thought to belong to the 1993 year class (age 3).

Males also dominated in the 1997 survey (Fig. 8, lower). Modal analysis of the composite length distribution estimated 47% of the abundance within a component with mean length of about 18 mm CL. Using the same growth model mentioned above, these male shrimp would represent the 1993 year class at age 4 in 1997, which is consistent with the 1996 survey observations and the 1997 fishery data (see Fig. 7). Although the 1994 year class at age 3 in 1997 appears weaker than the 1993 in 1996, it is noted that there is a high degree of overlap in the modal size/age groups and, therefore, the aging is approximate.

RESOURCE STATUS

The northern shrimp resource in the Hopedale and Cartwright Channels remains healthy with commercial catch rates stable over the late 1980's and increasing in recent years. The increase is evident in both the male and female catch components. Data from the research surveys in 1996 and 1997 and from the commercial fishery since 1995 suggest that year classes produced in the early 1990's will maintain high catch rates in 1998 and 1999. Preliminary data from daily vessel hails show that the 1998 fishery has performed well in January and February, with monthly catch rates similar to those for the same months in 1996 and 1997. The TAC of 15,300 tons should be maintained for the second year of the multi-year plan.

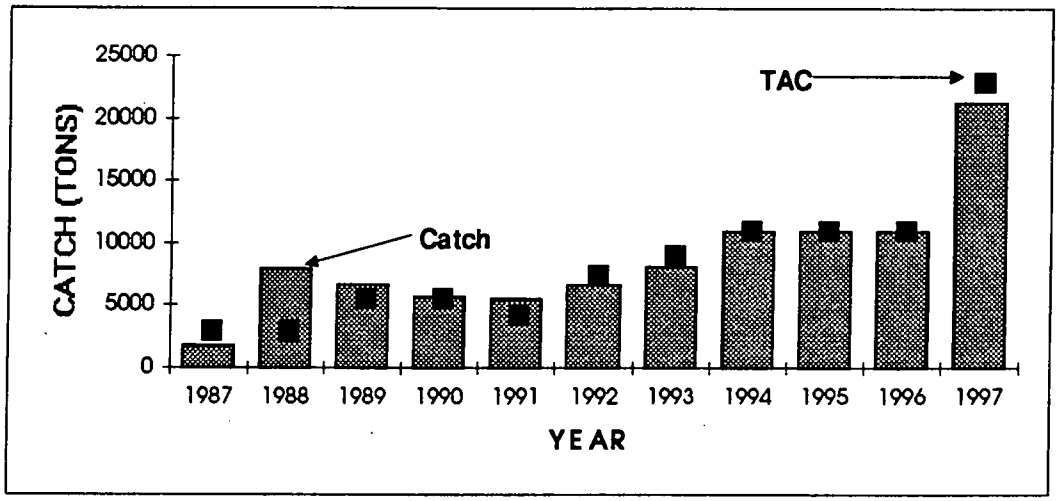
ASSESSMENT OF SHRIMP IN HAWKE CHANNEL + DIV. 3K (SFA 6)

FISHERY DATA

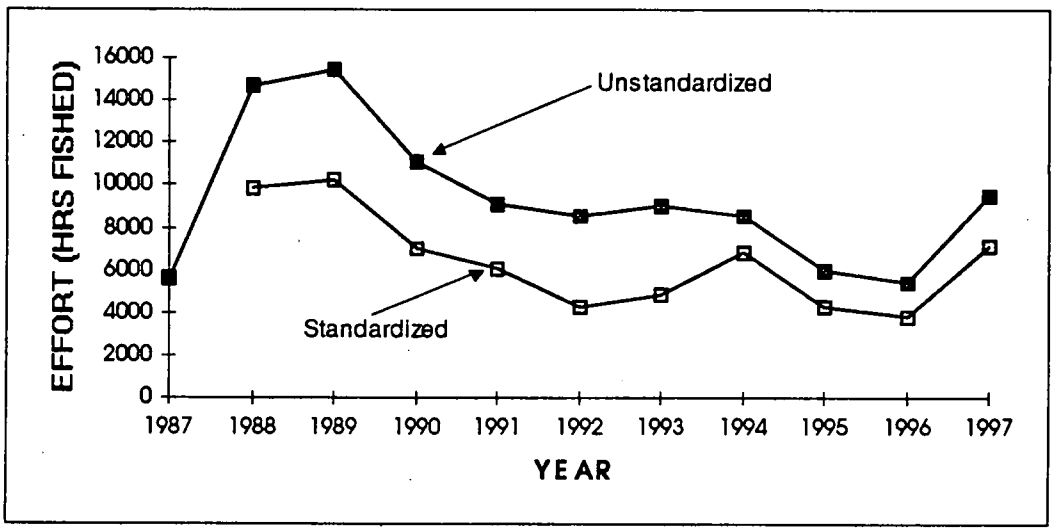
Catch and effort

The shrimp fishery in Hawke Channel + Division 3K began in 1987 when about 1800 tons were caught. In the previous decade, only a few tons had been reported from Hawke Channel in some

years. 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 increased to 11,000 tons in each of those three years. Based on analyses and interpretation of commercial fishery and research survey data, the 1997 assessment concluded that the resource was healthy and exploitation low. Consequently, the TAC for 1997, the first year of the 1997 - 1999 multi-year plan, was raised to 23,100 tons as a first step in increasing the exploitation. Most of the increase was reserved for the development of an "inshore" component which was implemented successfully. The preliminary catch estimate for 1997 was about 21,200 tons.



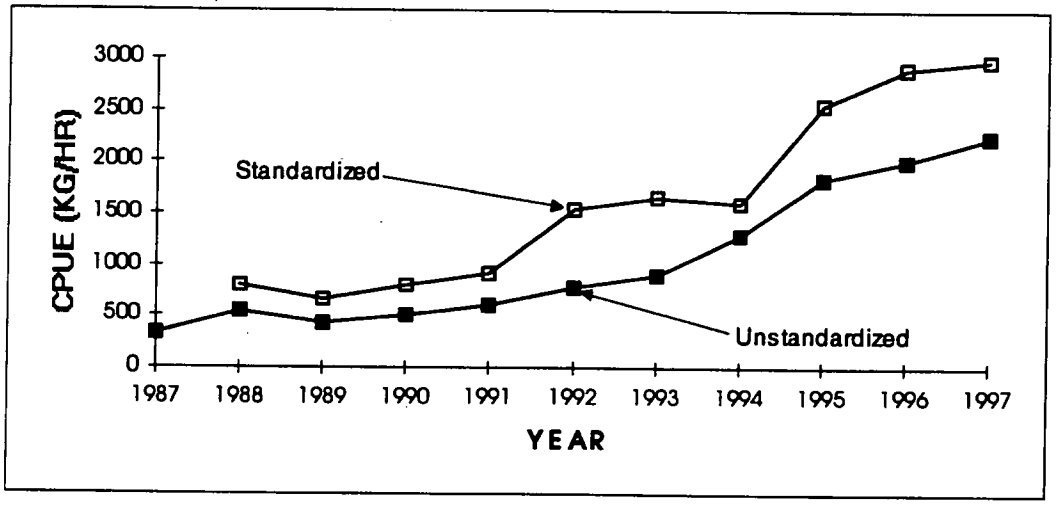
Fishing effort declined from 1989 to 1992, stabilized or increased slightly to 1994 , declined again from 1994 to 1996 and increased in 1997 with the large increase in TAC. The fishery occurs, primarily, during the first five months of the year.



A displacement of fishing effort to the east occurred during the early 1990's due to several 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 recent TAC's anywhere within the large management area. The displacement was particularly evident in St. Anthony Basin and Funk Island Deep where both catch and effort declined markedly after 1993 (Fig. 9). The 1997 "inshore" fishery in the second half of the year concentrated in Hawke Channel, St. Anthony Basin and southern Div. 3K.

Catch per unit effort (CPUE)

Unstandardized, annual CPUE's decreased from 536 kg/hr in 1988 to 432 in 1989 and increased steadily thereafter to 2238 kg/hr in 1997. The CPUE data also were analyzed by multiple regression for year, month, vessel and area effects to standardize the catch rates (Table 10). The analysis showed that the 1997 CPUE estimate was the highest in the series but not significantly higher than those of 1995 and 1996 ($P > 0.05$). With effort weighting, the 1997 estimate was significantly higher than all other years.



Standardized values revealed approximately the same overall increasing trend as the unstandardized series. However, the 1992 to 1994 standardized rates were relatively stable whereas the raw data indicated a continual increase. As for the other SFA's, the limited use of double trawls in 1997 is not considered to be an important factor in the interpretation of these results.

Preliminary catch rates for January, 1998 were lower than those of recent years but February values recovered and are comparable to those of 1995, 1996 and 1997.

Historical fishery data for this management-assessment area are summarized in Table 11.

Size composition

Catch-at-length data from 1988 to 1997 showed dominance of the female component around 24 mm CL in most years and an abundance of males during the recent period (Fig. 10). The relatively strong 1991 year class, first appearing at approximately 16 mm in 1994 (age 3), dominated the male component at 18 mm in 1995 (age 4) and at 20 mm in 1996 (age 5). In 1997, at age 6, most were female. The 1993 and 1992 year classes also are well represented at 16 and 18 mm, respectively, in the 1996 samples and at 18 and 20 mm in the 1997 data. In addition to the good recruitment (males) in recent years, the spawning biomass has increased through the 1990's as evidenced in the catch rates of the female component.

RESEARCH SURVEY DATA

Stock size

The fall multispecies research surveys in 1995, 1996 and 1997 showed that shrimp were widely distributed and abundant throughout Hawke Channel + Div. 3K each year. The minimum trawlable biomass estimated in 1995 was 291,000 tons with 95% confidence intervals of 222,000 - 360,000 tons (Table 12). The 1996 estimate (Table 13) was 518,000 tons (412,000 - 624,000 tons) and the 1997 preliminary estimate (Table 14) was 435,000 tons (389,000 - 480,000 tons). The confidence intervals for the mean values improved over time; ± 24% in 1995, ± 20% in 1996 and ± 10% in 1997.

Catches of 11,000 tons in 1995 and 1996 and 21,000 tons in 1997, when compared with even the lower confidence interval for stock size from the surveys, imply very low exploitation.

Stock composition

Length distributions representing abundance-at-length in the 1995 survey showed the dominance (34%) of the 1993 year class (age 2) at approximately 14 mm CL and clear representation (10%) of the 1994 year class (age 1) at 10 mm (Fig. 11, upper). Severe overlap of components to the right in the male distribution created difficulty in separating ages 3, 4 and 5. Females (ages 6+) comprised 22% of the estimated abundance.

In 1996, the 1993 year class was evident at 17 mm and comprised 28% of the estimated abundance (Fig. 11, middle). The 1994 year class was equally represented at 14 - 15 mm but the overlap between the two components was difficult to resolve and the estimated proportions might not be representative of the true values. The 1995 year class, apparent at 9 - 10 mm, comprised 3% and females (ages 6+) about 20%.

Abundance in 1997 (Fig. 11, lower) again was dominated by the 1993 and 1994 year classes (about 55%) covering the size range between 16 and 20 mm CL. The 1995 year class at 14 mm

and females (ages 6+) occurred in similar proportions and the 1996 year class at 9 mm comprised only 2%.

These data suggest that the 1995 year class, at age 2 in 1997 and age 1 in 1996, is weaker than either the 1994 or 1993 year classes. Further, the 1996 year class, at age 1 in 1997, appears weaker than the 1994 year class in 1995 and the 1995 year class in 1996. However, with such a short time series, the ability to compare year-class strengths for partially recruited animals, especially age 1, is questionable.

RESOURCE STATUS

Catch rates in the 1997 fishery were the highest observed but might be overestimated slightly due to the use of double trawls. At worst, they remain within the high level of the previous two years. Although the mean estimate of the research survey biomass was lower in 1997 than in 1996, the lower confidence limit was similar at approximately 400,000 tons. Research data suggest that recent year classes (i.e. 1995 and 1996) might be weaker than some produced during the early 1990's but it is not yet possible to quantify the effect on future recruitment. Assuming that commercial catch rates have stabilized, it is likely that abundance is no longer increasing. The resource in this area remains healthy and exploitation low.

The 1997 assessment concluded that the TAC in this area could be increased to several times the 1994 - 1996 level without concern for overexploitation. Management decided that an increase of 100% would be appropriate as a first step in the expansion of the fishery. Despite the increased catch, exploitation in 1997 remained low. The next step for 1998 also should be based on a balanced view of how the fishery will be developed in the absence of any guarantee of resource sustainability at unprecedented high levels.

TABLE 1. MULTIPLICATIVE, YEAR VESSEL MODEL DIV. 0B, 1988 - 1997

General Linear Models Procedure
Class Level Information

Class	Levels	Values
YEAR	10	88 89 90 91 92 93 94 95 96 97
MONTH	7	6 7 8 9 10 12 99
VESSEL	28	5 12 13 21 29 30 32 33 34 36 37 38 39 40 41 42 44 46 47 57 58 59 67 68 69 70 71 99

Number of observations in data set = 316

Dependent Variable: LNCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	36	208.87355208	5.80204311	7.27	0.0001
Error	279	222.71903290	0.79827610		
Corrected Total	315	431.59258497			

R-Square	C.V.	Root MSE	LNCPUE Mean
0.483960	15.57549	0.89346298	5.73633865

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YEAR	9	160.11661728	17.79073525	22.29	0.0001
VESSEL	27	48.75693480	1.80581240	2.26	0.0005

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	9	127.95995681	14.21777298	17.81	0.0001
VESSEL	27	48.75693480	1.80581240	2.26	0.0005

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate	Retransformed Estimate
INTERCEPT		6.648617673 B	30.16	0.0001	0.22044601	1124.17
YEAR	88	-1.132075333 B	-3.46	0.0006	0.32675894	352.60
	89	-1.743770497 B	-7.34	0.0001	0.23767608	196.01
	90	-1.366891751 B	-5.32	0.0001	0.25678930	285.12
	91	-1.480160393 B	-5.76	0.0001	0.25691047	254.33
	92	-1.759212096 B	-7.47	0.0001	0.23535643	193.17
	93	-2.289264946 B	-8.44	0.0001	0.27128184	112.78
	94	-1.884303146 B	-8.67	0.0001	0.21745584	170.61
	95	-0.533171021 B	-2.68	0.0078	0.19898222	661.92
	96	-0.442093304 B	-1.95	0.0520	0.22652018	721.45
	97	0.000000000 B	.	.	.	1124.17

TABLE 2. NORTHERN SHRIMP FISHERY DATA FOR DIV. 0B (SFA 2), 1988 - 1997.

YEAR	TAC[1] (t)	CATCH[2] (t)	UNSTANDARDIZED CPUE (KG/HR)	UNSTANDARDIZED INDEX	UNSTANDARDIZED EFFORT[3] (HR)	STANDARDIZED CPUE (KG/HR)	STANDARDIZED INDEX	STANDARDIZED EFFORT[3] (HR)
1988	na	2826	585	1.00	4831	353	1.00	8006
1989	3500	3039	271	0.46	11214	196	0.56	15505
1990	3500	1609	497	0.85	3237	285	0.81	5646
1991	3485	1107	242	0.41	4574	254	0.72	4358
1992	3485	1291	315	0.54	4098	193	0.55	6689
1993	3485	106	193	0.33	549	113	0.32	938
1994	3500	476	262	0.45	1817	171	0.48	2784
1995	3500	3564	810	1.38	4400	662	1.88	5384
1996	3500	3220	673	1.15	4785	721	2.04	4466
1997	5250	5670	1042	1.78	5441	1124	3.18	5044

[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.

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

TABLE 3. MULTIPLICATIVE, YEAR MONTH VESSEL MODEL DIV. 2G, 1988 - 1997

General Linear Models Procedure
Class Level Information

Class	Levels	Values
YEAR	10	88 89 90 91 92 93 94 95 96 97
MONTH	10	1 2 5 7 8 9 10 11 12 99
VESSEL	28	5 12 21 29 30 32 33 34 36 37 38 39 40 42 43 44 46 47 48 57 58 66 67 68 69 70 71 99

Number of observations in data set = 239

Dependent Variable: LNCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	45	103.51672911	2.30037176	8.64	0.0001
Error	193	51.37883717	0.26621159		
Corrected Total	238	154.89556628			

R-Square	C.V.	Root MSE	LNCPUE Mean
0.668300	7.088140	0.51595697	7.27915918

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YEAR	9	77.45654484	8.60628276	32.33	0.0001
MONTH	9	14.12407964	1.56934218	5.90	0.0001
VESSEL	27	11.93610463	0.44207795	1.66	0.0271

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	9	36.76444983	4.08493887	15.34	0.0001
MONTH	9	11.23781763	1.24864640	4.69	0.0001
VESSEL	27	11.93610463	0.44207795	1.66	0.0271

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate	Retransformed Estimate
INTERCEPT		7.631218218 B	43.21	0.0001	0.17659341	2320.04
YEAR	88	-0.433596446 B	-1.54	0.1241	0.28069499	1469.85
	89	-1.150785391 B	-6.12	0.0001	0.18809973	732.13
	90	-1.021534166 B	-5.71	0.0001	0.17901487	834.88
	91	0.112369356 B	0.49	0.6233	0.22840611	2575.56
	92	-0.369952207 B	-2.15	0.0325	0.17176644	1601.94
	93	0.238351612 B	1.40	0.1645	0.17083054	2937.28
	94	0.458100763 B	2.94	0.0037	0.15600946	3665.60
	95	-0.085667357 B	-0.51	0.6120	0.16861576	2123.76
	96	-0.358747220 B	-1.89	0.0598	0.18948965	1610.78
	97	0.000000000 B	.	.	.	2320.04

TABLE 4. NORTHERN SHRIMP FISHERY DATA FOR DIV. 2G (SFA 4), 1979 - 1997.

			UNSTANDARDIZED			STANDARDIZED		
YEAR	TAC[1] (t)	CATCH[2] (t)	CPUE (KG/HR)	INDEX	EFFORT[3] (HR)	CPUE (KG/HR)	INDEX	EFFORT[3] (HR)
1979	500	3	823		4			
1980	500	<1	6		8			
1981	500	2	381		5			
1982	500	5	252		20			
1983	500	30	441		68			
1986	500	2	450		4			
1987	500	7	303		23			
1988	500	1083	1823	1.00	594	1470	1.00	737
1989	2580	3842	672	0.37	5716	732	0.50	5249
1990	2580	2945	703	0.39	4190	835	0.57	3527
1991	2635	2561	3071	1.68	834	2576	1.75	994
1992	2635	2706	1910	1.05	1417	1602	1.09	1689
1993	2735	2723	2174	1.19	1253	2937	2.00	927
1994	4000	3982	3169	1.74	1257	3666	2.49	1086
1995	5200	5104	1506	0.83	3389	2124	1.44	2403
1996	5200	5160	1168	0.64	4418	1611	1.10	3203
1997	5200	5217	2258	1.24	2310	2320	1.58	2249

[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 CATCH/CPUE. CPUE CALCULATED FROM VESSEL LOG DATA.

TABLE 5. SURVEY ANALYSIS (STRAP) FOR SHRIMP IN DIV. 2G, 1997.

STRATUM	NO. SETS	TOTAL	AV./SET	UNITS	TOTAL WGT.	VARIANCE
901	8	102.04	12.755	177985.70	2270259.30	108.59
902	3	9.97	3.325	17607.82	58542.76	19.98
903	3	1.40	0.465	11738.55	5463.83	0.37
904	2	0.01	0.005	22449.97	112.25	0.00
906	2	0.00	0.000	33601.59	0.00	0.00
908	4	206.26	51.565	85838.12	4426256.74	1583.00
911	5	565.43	113.087	101538.42	11482651.74	5986.82
912	2	5.52	2.761	10711.42	29573.57	13.34
913	2	1.38	0.690	9097.37	6277.19	0.92
914	2	0.00	0.000	16580.70	0.00	0.00
919	2	0.00	0.000	46367.26	0.00	0.00
921	2	0.00	0.000	20835.92	0.00	0.00
922	2	1.20	0.600	27292.12	16375.27	0.72
923	2	42.45	21.223	27292.12	579219.05	769.66
924	5	2300.31	460.061	110929.26	51034278.36	228318.79
926	3	6.72	2.240	63534.88	142318.13	2.01
927	6	266.05	44.341	122080.88	5413169.88	4025.11
928	3	89.74	29.915	114891.02	3436947.43	1249.66
929	8	6.39	0.799	185028.83	147826.88	1.43

95 % CONFIDENCE INTERVALS FOR TOTAL AND MEAN NUMBERS

TOTAL	UPPER	LOWER	MEAN
13533288048.51	24451794624.48	2614781472.54	11227.20

TOTAL	UPPER	LOWER	DEGREES OF FREEDOM	STUDENTS T-VALUE
13533288048.51	20285.18	2169.22	4	2.776

95 % CONFIDENCE INTERVALS FOR TOTAL AND MEAN WEIGHTS

TOTAL	UPPER	LOWER	MEAN
79,049,272.38	146,670,131.46	11,428,413.30	65.5792

TOTAL	UPPER	LOWER	DEGREES OF FREEDOM	STUDENTS T-VALUE
79,049,272.38	121.677	9.48100	4	2.776

TABLE 6. MULTIPLICATIVE, YEAR MONTH VESSEL AREA MODEL HOPEDALE+CARTWRIGHT, 1977 - 1997

General Linear Models Procedure
Class Level Information

Class	Levels	Values
YEAR	21	77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97
MONTH	12	1 2 3 4 5 6 8 9 10 11 12 99
VESSEL	50	1 2 4 5 6 7 10 13 15 21 22 26 29 30 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 56 57 58 59 64 65 66 67 68 69 70 71 99
AREA	4	52 53 54 99

Number of observations in data set = 1382

Dependent Variable: LNCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	83	546.23020317	6.58108679	24.49	0.0001
Error	1298	348.85223516	0.26876135		
Corrected Total	1381	895.08243833			

R-Square	C.V.	Root MSE	LNCPUE Mean
0.610257	8.196824	0.51842198	6.32466928

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YEAR	20	393.00446437	19.65022322	73.11	0.0001
MONTH	11	97.97800092	8.90709099	33.14	0.0001
VESSEL	49	47.51423820	0.96967833	3.61	0.0001
AREA	3	7.73349968	2.57783323	9.59	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	20	57.77245831	2.88862292	10.75	0.0001
MONTH	11	85.56974742	7.77906795	28.94	0.0001
VESSEL	49	47.67015352	0.97286028	3.62	0.0001
AREA	3	7.73349968	2.57783323	9.59	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate	Retransformed Estimate
INTERCEPT		6.889071990 B	76.39	0.0001	0.09017855	1118.21
YEAR	77	-0.432692901 B	-2.55	0.0110	0.16986285	718.67
	78	-0.420629737 B	-2.30	0.0214	0.18260013	725.88
	79	-0.617893857 B	-4.19	0.0001	0.14754209	599.48
	80	-0.989569685 B	-8.39	0.0001	0.11789437	415.01
	81	-0.903006086 B	-7.29	0.0001	0.12395148	452.34
	82	-1.059748598 B	-8.28	0.0001	0.12804584	386.56
	83	-1.376830327 B	-10.30	0.0001	0.13364918	281.23
	84	-1.229955681 B	-9.33	0.0001	0.13185465	325.76
	85	-1.208509856 B	-10.19	0.0001	0.11855869	333.30
	86	-0.667948413 B	-5.29	0.0001	0.12632957	571.74
	87	-0.764325991 B	-7.66	0.0001	0.09977863	520.37
	88	-0.626326185 B	-6.23	0.0001	0.10047768	597.04
	89	-0.637741316 B	-7.49	0.0001	0.08515185	540.93
	90	-0.662807881 B	-7.33	0.0001	0.09039166	576.05
	91	-0.588994739 B	-6.68	0.0001	0.08814672	620.25
	92	-0.611797568 B	-7.98	0.0001	0.07670686	606.50
	93	-0.535614264 B	-6.67	0.0001	0.08028393	654.58
	94	-0.469540505 B	-6.16	0.0001	0.07627405	699.39
	95	-0.307391984 B	-3.86	0.0001	0.07957560	821.51
	96	-0.139139888 B	-1.63	0.1040	0.08553465	971.59
	97	0.000000000 B	.	.	.	1118.21

TABLE 7. NORTHERN SHRIMP FISHERY DATA FOR HOPEDALE + CARTWRIGHT CHANNELS (SFA 5), 1977 - 1997.

			UNSTANDARDIZED			STANDARDIZED		
YEAR	TAC[1] (t)	CATCH[2] (t)	CPUE (KG/HR)	INDEX	EFFORT[3] (HR)	CPUE (KG/HR)	INDEX	EFFORT[3] (HR)
1977	.	2686	552	1.00	4865	719	1.00	3736
1978	5300	3630	453	0.82	8011	726	1.01	5000
1979	4000	3727	368	0.67	10136	600	0.83	6212
1980	4800	4108	388	0.70	10594	415	0.58	9899
1981	4800	3449	364	0.66	9485	452	0.63	7631
1982	4800	1983	372	0.67	5335	387	0.54	5124
1983	4800	1000	297	0.54	3368	281	0.39	3559
1984	4200	1002	297	0.54	3373	326	0.45	3074
1985	3570	1689	230	0.42	7350	333	0.46	5072
1986	4400	4826	538	0.97	8970	572	0.80	8437
1987	4800	5956	613	1.11	9714	520	0.72	11454
1988	4800	7838	625	1.13	12532	597	0.83	13129
1989	6000	5985	677	1.23	8847	541	0.75	11063
1990	6000	5360	626	1.13	8559	576	0.80	9306
1991	6375	6118	526	0.95	11634	620	0.86	9868
1992	6375	6315	695	1.26	9083	607	0.84	10404
1993	6375	5719	622	1.13	9201	655	0.91	8731
1994	7650	7499	757	1.37	9911	699	0.97	10728
1995	7650	7616	1387	2.51	5493	822	1.14	9265
1996	7650	7383	1870	3.39	3948	972	1.35	7596
1997	15300	15102	1885	3.41	8012	1118	1.55	13508

[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 8. SURVEY ANALYSIS (STRAP) FOR SHRIMP IN HOPEDALE + CARTWRIGHT, 1996.

STRATUM	NO. SETS	TOTAL	AV./SET	UNITS	TOTAL WGT.	VARIANCE
201	2	14.92	7.459	92881.25	692844.58	4.43
202	2	81.50	40.748	91120.46	3713016.51	2903.93
203	2	215.50	107.750	71458.40	7699664.80	1294.42
204	2	170.00	84.998	42258.77	3591929.05	0.15
220	2	0.00	0.000	33454.86	0.00	0.00
221	2	0.00	0.000	36242.76	0.00	0.00
234	2	15.89	7.945	86278.31	685508.16	121.53
237	3	0.41	0.137	80555.77	11009.29	0.06
238	3	11.24	3.747	114157.36	427733.36	42.12
239	2	152.28	76.142	17607.82	1340691.38	0.22
930	4	10.28	2.570	150840.32	387659.61	2.20
931	2	9.07	4.536	40497.98	183683.67	16.87
932	2	0.40	0.198	8070.25	1598.92	0.00
933	2	0.14	0.070	7336.59	513.56	0.01
938	2	0.00	0.000	28025.78	0.00	0.00
939	2	0.00	0.000	19075.14	0.00	0.00
940	2	0.00	0.000	14232.99	0.00	0.00
941	2	0.00	0.000	13059.13	0.00	0.00
942	2	0.00	0.000	8070.25	0.00	0.00
943	2	5.48	2.742	51943.07	142437.63	7.94
944	3	21.80	7.267	126189.37	916974.54	90.95
945	2	3.53	1.767	67643.37	119538.52	1.35
946	3	35.98	11.992	105793.65	1268642.14	161.63
947	2	21.40	10.702	33308.12	356469.79	13.34
948	2	55.48	27.738	36096.03	1001246.78	148.53
949	2	388.84	194.419	30226.76	5876648.11	456.78
950	2	212.69	106.345	38297.01	4072707.11	22427.63
951	2	56.01	28.005	34335.25	961558.59	817.29
952	2	60.22	30.108	25971.53	781937.93	484.69
953	2	981.54	490.769	42698.96	20955315.76	399763.29
954	4	12.63	3.157	142476.60	449842.37	6.64
955	2	632.39	316.194	57078.68	18047926.05	1168.75
956	3	0.38	0.128	154215.15	19758.82	0.01
957	5	5.40	1.081	201169.33	217396.01	1.77
958	2	114.85	57.425	43139.16	2477266.07	4502.06
959	2	27.78	13.891	26118.26	362798.16	0.11
960	2	0.77	0.387	15700.31	6078.96	0.04
961	2	0.00	0.000	30960.42	0.00	0.00
962	2	0.14	0.070	35509.10	2496.73	0.01
963	2	0.00	0.000	38883.93	0.00	0.00
964	2	0.00	0.000	50182.28	0.00	0.00
991	3	15.23	5.075	133819.42	679133.58	54.95
992	6	2616.86	436.143	256633.96	111929039.10	882690.15
993	2	92.63	46.315	64415.27	2983374.34	301.28
994	3	0.48	0.159	50915.94	8114.73	0.08

95 % CONFIDENCE INTERVALS FOR TOTAL AND MEAN NUMBERS

	TOTAL	UPPER	LOWER	MEAN
	51631684272.21	134779621707.98	-31516253163.56	18123.09
*	15816993291.79	21801382590.79	9832603992.78	5551.88

	TOTAL	UPPER	LOWER	DEGREES OF FREEDOM	STUDENTS T-VALUE
	51631684272.21	47308.61	-11062.43	5	2.571
*	15816993291.79	7652.44	3451.31	5	2.571

95 % CONFIDENCE INTERVALS FOR TOTAL AND MEAN WEIGHTS

	TOTAL	UPPER	LOWER	MEAN
	192,372,554.68	450,690,390.81	-65,945,281.44	67.5241
*	74,723,588.98	96,432,786.90	53,014,391.06	26.2285

	TOTAL	UPPER	LOWER	DEGREES OF FREEDOM	STUDENTS T-VALUE
	192,372,554.68	158.1960	-23.1473	5	2.571
*	74,723,588.98	33.8486	18.6084	5	2.365

* Sets 51 (937.85 kg) and 83 (2351.13 kg) deleted.

TABLE 9. SURVEY ANALYSIS (STRAP) FOR SHRIMP IN HOPEDALE + CARTWRIGHT, 1997.

STRATUM	SETS	TOTAL	AV./SET	UNITS	TOTAL WGT.	VARIANCE
202	2	38.14	19.071	91120.46	1737754.34	409.46
203	2	94.64	47.320	71458.40	3381411.43	134.81
204	2	258.59	129.293	42258.77	5463778.74	1994.80
214	3	536.12	178.707	65589.13	11721214.04	2149.74
215	5	178.23	35.647	191044.84	6810135.47	576.96
216	2	131.86	65.928	36829.69	2428100.77	2.94
217	2	20.38	10.190	27585.58	281097.09	126.41
218	2	0.34	0.171	39470.86	6766.43	0.06
221	2	0.09	0.045	36242.76	1630.92	0.00
234	2	13.89	6.943	86278.31	598987.19	56.87
237	2	0.00	0.000	80555.77	0.00	0.00
238	3	2.96	0.985	114157.36	112468.78	1.15
239	2	134.28	67.139	17607.82	1182163.07	1240.87
931	2	46.43	23.213	40497.98	940059.45	408.27
932	2	12.70	6.352	8070.25	51258.70	70.54
933	2	0.49	0.244	7336.59	1788.29	0.12
934	2	0.00	0.000	11445.08	0.00	0.00
935	2	0.00	0.000	14086.26	0.00	0.00
936	2	0.00	0.000	11445.08	0.00	0.00
937	2	0.00	0.000	13792.79	0.00	0.00
938	2	0.16	0.079	28025.78	2225.58	0.01
939	2	0.00	0.000	19075.14	0.00	0.00
940	2	0.00	0.000	14232.99	0.00	0.00
941	2	0.00	0.000	13059.13	0.00	0.00
942	2	2.93	1.465	8070.25	11822.92	3.56
943	2	10.69	5.345	51943.07	277635.69	16.88
944	6	652.87	108.811	126189.37	13730783.60	33776.66
945	3	9.21	3.069	67643.37	207622.87	0.49
946	5	33.33	6.666	105793.65	705184.66	9.12
947	2	42.92	21.458	33308.12	714716.42	358.86
948	2	126.78	63.391	36096.03	2288180.36	7591.95
949	2	1059.55	529.773	30226.76	16013316.67	333645.79
950	2	58.96	29.482	38297.01	1129055.59	543.08
951	2	126.50	63.250	34335.25	2171707.53	7600.70
952	2	176.44	88.219	25971.53	2291176.18	713.71
953	2	241.00	120.498	42698.96	5145126.70	463.55
955	3	513.33	171.109	57078.68	9766697.25	21924.32
958	2	184.65	92.325	43139.16	3982822.63	15373.81
959	2	31.83	15.915	26118.26	415672.19	212.80
960	2	41.54	20.771	15700.31	326108.42	772.57
961	2	0.00	0.000	30960.42	0.00	0.00
962	2	0.00	0.000	35509.10	0.00	0.00
963	2	0.00	0.000	38883.93	0.00	0.00
964	2	0.00	0.000	50182.28	0.00	0.00
991	5	18.42	3.685	133819.42	493074.40	27.22
996	2	2.65	1.326	243721.56	323235.72	1.67

95 % CONFIDENCE INTERVALS FOR TOTAL AND MEAN NUMBERS

TOTAL	UPPER	LOWER	MEAN
21114293276.28	35740481980.67	6488104571.88	8958.30

TOTAL	UPPER	LOWER	DEGREES OF FREEDOM	STUDENTS T-VALUE
21114293276.28	15163.85	2752.75	3	3.182

95 % CONFIDENCE INTERVALS FOR TOTAL AND MEAN WEIGHTS

TOTAL	UPPER	LOWER	MEAN
94,714,780.09	150,114,457.31	39,315,102.88	40.1853

TOTAL	UPPER	LOWER	DEGREES OF FREEDOM	STUDENTS T-VALUE
94,714,780.09	63.6900	16.6805	3	3.182

TABLE 10. MULTIPLICATIVE, YEAR MONTH VESSEL AREA MODEL HAWKE+3K, 1988 - 1997

General Linear Models Procedure
Class Level Information

Class	Levels	Values
YEAR	10	88 89 90 91 92 93 94 95 96 97
MONTH	5	2 3 4 5 99
VESSEL	28	5 12 13 21 30 32 33 34 36 37 38 39 40 41 42 43 44 46 47 48 57 58 66 67 69 70 71 99
AREA	7	67 68 69 90 91 92 99

Number of observations in data set = 904

Dependent Variable: LNCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	46	443.66362028	9.64486131	25.07	0.0001
Error	857	329.74276753	0.38476402		
Corrected Total	903	773.40638781			

R-Square	C.V.	Root MSE	LNCPUE Mean
0.573649	9.225527	0.62029350	6.72366447

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YEAR	9	329.00304445	36.55589383	95.01	0.0001
MONTH	4	17.68003498	4.42000874	11.49	0.0001
VESSEL	27	43.64018057	1.61630298	4.20	0.0001
AREA	6	53.34036028	8.89006005	23.11	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	9	104.54410934	11.61601215	30.19	0.0001
MONTH	4	20.57770358	5.14442589	13.37	0.0001
VESSEL	27	41.18608109	1.52541041	3.96	0.0001
AREA	6	53.34036028	8.89006005	23.11	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate	Retransformed Estimate
INTERCEPT		7.813429686 B	71.08	0.0001	0.10991704	2980.92
YEAR	88	-1.319940547 B	-10.43	0.0001	0.12657621	793.51
	89	-1.514163552 B	-13.60	0.0001	0.11135934	654.41
	90	-1.311358449 B	-10.77	0.0001	0.12177470	800.76
	91	-1.187585771 B	-10.74	0.0001	0.11054391	907.86
	92	-0.663648381 B	-6.88	0.0001	0.09647845	1534.70
	93	-0.589986160 B	-6.05	0.0001	0.09746083	1652.07
	94	-0.619662410 B	-6.65	0.0001	0.09322895	1603.35
	95	-0.152503844 B	-1.62	0.1045	0.09385088	2558.01
	96	-0.025489309 B	-0.28	0.7806	0.09147158	2904.69
	97	0.000000000 B	.	.	.	2980.82

TABLE 11. NORTHERN SHRIMP FISHERY DATA FOR HAWKE CHANNEL + DIVISION 3K (SFA 6), 1977 - 1997.

			UNSTANDARDIZED			STANDARDIZED		
YEAR	TAC[1] (t)	CATCH[2] (t)	CPUE (KG/HR)	INDEX	EFFORT[3] (HR)	CPUE (KG/HR)	INDEX	EFFORT[3] (HR)
1977		1	177		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		5544			
1988	3000	7849	536	1.00	14640	794	1.00	9885
1989	5600	6662	432	0.81	15407	654	0.82	10187
1990	5600	5598	507	0.95	11048	801	1.01	6989
1991	4301	5500	603	1.12	9120	908	1.14	6057
1992	7565	6609	774	1.44	8538	1535	1.93	4306
1993	9180	8035	891	1.66	9021	1652	2.08	4864
1994	11050	10978	1287	2.40	8533	1603	2.02	6848
1995	11050	10914	1836	3.42	5944	2558	3.22	4267
1996	11050	10923	2012	3.75	5429	2905	3.66	3760
1997	23100	21246	2238	4.17	9493	2981	3.75	7127

[1] HISTORICAL TAC'S APPLIED AS FOLLOWS:

1978 TO 1985 - INCLUDES 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 to 1997 - 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).

[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 12. SURVEY ANALYSIS (STRAP) FOR SHRIMP IN HAWKE+3K, 1995.

STRATUM	NO. SETS	TOTAL	AV./SET	UNITS	TOTAL WGT.	VARIANCE
206	5	152.179	30.436	242987.90	7395549.42	4112.95
207	9	17.399	1.933	359199.51	694427.44	29.81
208	2	460.860	230.430	86278.31	19881111.69	98.56
209	2	117.100	58.550	91267.20	5343694.28	5694.58
210	3	332.193	110.731	151867.44	16816426.15	2618.58
211	2	383.620	191.810	36829.69	7064302.47	6732.64
212	2	76.746	38.373	81729.63	3136202.36	1259.31
213	8	980.569	122.571	363454.73	44549043.86	35195.27
222	2	182.980	91.490	82023.09	7504292.52	11464.01
223	2	12.962	6.481	30960.42	200652.52	25.08
224	4	10.444	2.611	47100.92	122977.55	26.24
227	2	145.803	72.902	87745.63	6396793.63	989.99
228	7	429.882	61.412	322223.09	19788266.45	1516.63
229	2	414.628	207.314	78648.26	16304865.34	52018.44
230	2	0.000	0.000	27145.39	0.00	0.00
231	2	0.110	0.055	27292.12	1501.07	0.01
235	2	185.908	92.954	60746.98	5646659.18	2246.68
236	4	0.000	0.000	37269.88	0.00	0.00
240	2	7.595	3.798	19515.33	74109.48	0.31
617	2	152.390	76.195	87011.97	6629877.23	449.10
618	5	13.809	2.762	197647.77	545846.67	23.90
619	4	0.067	0.017	257220.89	4287.01	0.00
620	3	46.254	15.418	373432.49	5757523.63	74.46
621	6	31.978	5.330	372258.64	1984042.51	28.25
622	3	301.668	100.556	101391.69	10195534.28	1411.74
623	2	44.360	22.180	72485.52	1607728.87	637.25
624	4	139.860	34.965	162138.67	5669178.48	237.95
625	3	210.405	70.135	130297.86	9138444.74	1255.13
626	4	19.306	4.827	163312.52	788232.09	31.77
627	5	184.352	36.870	184148.44	6789614.49	1535.64
628	5	107.109	21.422	159204.03	3410431.27	1509.46
629	2	26.233	13.116	72632.25	952678.82	58.03
630	2	37.892	18.946	48714.97	922956.07	1.18
631	5	228.722	45.744	193832.74	8866756.16	237.63
633	8	687.334	85.917	303294.68	26058097.49	2839.07
634	7	193.271	27.610	228167.99	6299738.52	538.05
635	6	71.525	11.921	186936.35	2228437.01	6.79
636	7	188.768	26.967	213494.81	5757268.67	285.55
637	5	70.641	14.128	166100.43	2346687.58	271.60
638	9	422.133	46.904	302120.83	14170588.57	1744.71
639	7	318.208	45.458	214668.66	9758483.26	580.17
640	2	53.740	26.870	10124.50	272045.21	95.22
641	2	0.000	0.000	33748.32	0.00	0.00
642	2	0.000	0.000	61333.90	0.00	0.00
643	3	0.000	0.000	107554.43	0.00	0.00
644	2	0.000	0.000	69550.89	0.00	0.00
645	2	5.486	2.743	31694.07	86930.90	11.74
646	2	0.100	0.050	47687.84	2384.39	0.01
647	2	0.000	0.000	52823.46	0.00	0.00
650	2	7.530	3.765	19662.06	74027.67	28.35
651	2	0.16	0.08	52676.73	4214.14	0.0128
652	2	0.00	0.00	75713.62	0.00	0.0000
653	2	0.00	0.00	77914.60	0.00	0.0000
654	2	0.00	0.00	70284.54	0.00	0.0000

95 % CONFIDENCE INTERVALS FOR TOTAL AND MEAN NUMBERS

TOTAL	UPPER	LOWER	MEAN
70616131521.37	83466879075.37	57765383967.37	9896.36

TOTAL	UPPER	LOWER	DEGREES OF FREEDOM	STUDENTS T-VALUE
70616131521.37	11697.30	8095.41	24	2.064

95 % CONFIDENCE INTERVALS FOR TOTAL AND MEAN WEIGHTS

TOTAL	UPPER	LOWER	MEAN
291,242,911.12	360,092,858.36	222,392,963.88	40.8157

TOTAL	UPPER	LOWER	DEGREES OF FREEDOM	STUDENTS T-VALUE
291,242,911.12	50.4645	31.1668	13	2.16

TABLE 13. SURVEY ANALYSIS (STRAP) FOR SHRIMP IN HAWKE+3K, 1996.

STRATUM	NO. SETS	TOTAL	AV./SET	UNITS	TOTAL WGT.	VARIANCE
205	4	36.35	9.088	131471.72	1194851.92	54.33
206	6	28.09	4.682	242987.90	1137664.30	54.87
207	9	14.29	1.588	359199.51	570478.66	2.77
208	2	274.26	137.128	86278.31	11831183.31	1391.94
209	3	477.32	159.105	91267.20	14521067.09	42327.47
210	4	766.58	191.644	151867.44	29104445.50	31482.14
211	2	583.34	291.670	36829.69	10742126.63	55235.53
212	2	13.66	6.828	81729.63	558030.06	14.41
213	10	931.43	93.143	363454.73	33853145.05	13612.00
222	3	204.51	68.168	82023.09	5591378.36	1074.26
223	3	63.17	21.056	30960.42	651887.48	524.12
224	3	0.00	0.000	47100.92	0.00	0.00
225	2	0.00	0.000	39617.59	0.00	0.00
226	2	0.00	0.000	41671.84	0.00	0.00
227	2	115.04	57.521	87745.63	5047180.33	114.89
228	8	2857.71	357.213	322223.09	115102367.96	112145.28
229	2	440.82	220.412	78648.26	17335001.39	78338.13
230	2	0.00	0.000	27145.39	0.00	0.00
231	2	0.10	0.052	27292.12	1407.25	0.01
232	2	0.01	0.005	33454.86	156.82	0.00
233	2	0.00	0.000	34775.44	0.00	0.00
235	2	63.22	31.610	60746.98	1920229.76	1677.74
236	4	0.09	0.023	37269.88	873.51	0.00
240	2	4.51	2.257	19515.33	44049.77	9.44
608	3	0.23	0.077	117092.00	9037.10	0.01
609	2	0.73	0.363	50182.28	18209.53	0.21
610	2	22.40	11.198	37563.35	420650.80	15.14
611	3	0.75	0.251	88039.10	22070.91	0.11
612	2	0.31	0.154	65295.66	10082.42	0.05
613	2	0.00	0.000	4401.95	0.00	0.00
614	2	0.04	0.018	38590.47	681.01	0.00
615	2	0.79	0.397	36829.69	14609.11	0.20
616	2	0.06	0.029	36682.96	1054.63	0.00
617	3	391.27	130.423	87011.97	11348391.46	87.73
618	6	2.18	0.363	197647.77	71835.03	0.09
619	7	0.98	0.140	257220.89	36010.92	0.03
620	11	383.54	34.868	373432.49	13020741.96	1000.11
621	11	293.82	26.711	372258.64	9943453.37	423.65
622	3	262.05	87.348	101391.69	8856404.24	232.47
623	2	90.63	45.316	72485.52	3284772.02	442.46
624	5	610.77	122.155	162138.67	19806039.29	7546.14
625	4	428.77	107.193	130297.86	13967003.45	2808.96
626	5	82.44	16.488	163312.52	2692671.23	288.39
627	5	212.25	42.450	184148.44	7817072.41	1153.10
628	5	84.16	16.831	159204.03	2679619.22	172.16
629	2	110.76	55.381	72632.25	4022442.29	967.20
630	2	74.57	37.285	48714.97	1816337.50	814.06
631	6	367.85	61.308	193832.74	11883568.23	788.26
633	9	1408.99	156.555	303294.68	47482205.37	8577.81
634	7	650.06	92.866	228167.99	21189046.69	2729.41
635	5	122.75	24.549	186936.35	4589115.46	42.91
636	6	405.12	67.521	213494.81	14415345.87	1422.43
637	5	125.00	24.999	166100.43	4152365.31	100.81
638	9	745.58	82.842	302120.83	25028199.14	1347.01
639	6	1081.06	180.177	214668.66	38678255.98	4311.10
640	2	46.03	23.016	10124.50	233027.18	925.89
641	2	2.52	1.261	33748.32	42554.52	0.01
642	2	1.75	0.875	61333.90	53667.17	1.53
643	3	0.00	0.000	107554.43	0.00	0.00
644	2	0.00	0.000	69550.89	0.00	0.00
645	2	1.73	0.863	31694.07	27336.14	1.49
646	2	0.02	0.009	47687.84	447.07	0.00
647	2	0.02	0.009	52823.46	495.22	0.00
648	2	0.00	0.000	33454.86	0.00	0.00
649	2	0.00	0.000	31107.15	0.00	0.00
650	2	111.32	55.659	19662.06	1094378.22	32.50
651	2	0.87	0.435	52676.73	22914.38	0.16
652	2	0.00	0.000	75713.62	0.00	0.00
653	2	0.00	0.000	77914.60	0.00	0.00
654	2	0.00	0.000	70284.54	0.00	0.00

95 % CONFIDENCE INTERVALS FOR TOTAL AND MEAN NUMBERS

TOTAL	UPPER	LOWER	MEAN
120083039234.12	139532032658.71	100634045809.54	15093.77

TOTAL	UPPER	LOWER	DEGREES OF FREEDOM	STUDENTS T-VALUE
120083039234.12	17538.40	12649.14	19	2.093

95 % CONFIDENCE INTERVALS FOR TOTAL AND MEAN WEIGHTS

TOTAL	UPPER	LOWER	MEAN
517,959,636.98	624,149,504.34	411,769,769.63	65.1047

TOTAL	UPPER	LOWER	DEGREES OF FREEDOM	STUDENTS T-VALUE
517,959,636.98	78.4521	51.7572	15	2.131

TABLE 14. SURVEY ANALYSIS (STRAP) FOR SHRIMP IN HAWKE+3K, 1997.

STRATUM	No. SETS	TOTAL	AV./SET	UNITS	TOTAL WGT.	VARIANCE
205	2	6.35	3.173	131471.72	417135.10	13.45
206	6	209.77	34.962	242987.90	8495363.29	2122.87
207	10	30.98	3.098	359199.51	1112844.97	23.07
208	2	238.16	119.078	86278.31	10273877.73	1569.31
209	3	227.54	75.846	91267.20	6922293.52	3225.17
210	4	338.86	84.715	151867.44	12865402.63	2918.36
211	2	695.61	347.803	36829.69	12809469.10	11306.23
212	2	153.84	76.920	81729.63	6286642.87	4098.75
213	8	1092.37	136.547	363454.73	49628480.73	6901.56
222	2	148.24	74.119	82023.09	6079448.92	3350.73
223	2	0.00	0.000	30960.42	0.00	0.00
224	2	0.00	0.000	47100.92	0.00	0.00
225	3	0.39	0.131	39617.59	5199.81	0.05
226	2	0.00	0.000	41671.84	0.00	0.00
227	2	85.09	42.545	87745.63	3733137.89	667.22
228	8	831.67	103.959	322223.09	33498033.81	1726.13
229	2	519.72	259.861	78648.26	20437588.43	14705.49
230	2	4.11	2.055	27145.39	55783.77	8.45
231	2	0.00	0.000	27292.12	0.00	0.00
232	2	0.08	0.040	33454.86	1338.19	0.00
233	2	0.00	0.000	34775.44	0.00	0.00
235	2	91.24	45.620	60746.98	2771277.03	8.82
236	3	0.00	0.000	37269.88	0.00	0.00
240	2	0.43	0.215	19515.33	4195.80	0.09
608	3	0.03	0.010	117092.00	1170.92	0.00
609	2	3.04	1.520	50182.28	76277.07	3.70
610	2	10.43	5.215	37563.35	195892.86	3.84
611	3	0.44	0.147	88039.10	12912.40	0.04
612	2	0.10	0.050	65295.66	3264.78	0.00
613	2	0.00	0.000	4401.95	0.00	0.00
614	2	0.09	0.045	38590.47	1736.57	0.00
615	2	0.63	0.315	36829.69	11601.35	0.01
616	2	0.04	0.020	36682.96	733.66	0.00
617	3	191.90	63.967	87011.97	5565865.82	559.56
618	6	34.85	5.809	197647.77	1148127.65	52.22
619	7	3.27	0.467	257220.89	120135.93	0.67
620	11	463.38	42.126	373432.49	15731034.80	1193.08
621	11	164.56	14.960	372258.64	5568862.35	257.92
622	3	293.95	97.985	101391.69	9934822.61	1131.86
623	2	188.15	94.074	72485.52	6819007.49	167.59
624	5	482.98	96.596	162138.67	15662007.45	2292.34
625	4	482.25	120.562	130297.86	15708974.75	1509.13
626	5	333.42	66.684	163312.52	10890332.17	415.26
627	5	318.37	63.675	184148.44	11725575.22	957.26
628	5	109.69	21.939	159204.03	3492737.42	57.91
629	2	59.30	29.650	72632.25	2153546.31	635.82
630	2	181.08	90.540	48714.97	4410653.01	3940.94
631	6	446.46	74.409	193832.74	14422954.10	9533.11
633	9	1422.06	158.007	303294.68	47922539.65	4459.74
634	7	375.37	53.624	228167.99	12235202.77	157.61
635	5	204.713	40.943	186936.35	7653668.80	412.66
636	6	264.416	44.069	213494.81	9408560.40	91.46
637	5	188.116	37.623	166100.43	6249237.85	333.19
638	9	570.824	63.425	302120.83	19161992.52	1295.22
639	6	917.330	152.888	214668.66	32820333.65	7103.44
640	2	3.080	1.540	10124.50	15591.72	0.00
641	2	0.040	0.020	33748.32	674.97	0.00
642	2	0.172	0.086	61333.90	5260.56	0.01
643	3	0.010	0.003	107554.43	358.51	0.00
644	2	0.000	0.000	69550.89	0.00	0.00
645	2	0.046	0.023	31694.07	734.09	0.00
646	2	0.000	0.000	47687.84	0.00	0.00
647	2	0.010	0.005	52823.46	264.12	0.00
648	2	0.525	0.263	33454.86	8781.90	0.14
649	2	0.000	0.000	31107.15	0.00	0.00
650	2	0.891	0.445	19662.06	8755.76	0.19
651	2	0.000	0.000	52676.73	0.00	0.00
652	2	0.009	0.005	75713.62	354.91	0.00
653	2	0.000	0.000	77914.60	0.00	0.00
654	2	0.000	0.000	70284.54	0.00	0.00

95 % CONFIDENCE INTERVALS FOR TOTAL AND MEAN NUMBERS

TOTAL	UPPER	LOWER	MEAN
97180914706.51	106510205100.92	87851624312.10	12215.10

TOTAL	UPPER	LOWER	DEGREES OF FREEDOM	STUDENTS T-VALUE
97180914706.51	13387.74	11042.46	46	2.013

95 % CONFIDENCE INTERVALS FOR TOTAL AND MEAN WEIGHTS

TOTAL	UPPER	LOWER	MEAN
434,548,052.46	480,090,410.11	389,005,694.81	54.6203

TOTAL	UPPER	LOWER	DEGREES OF FREEDOM	STUDENTS T-VALUE
434,548,052.46	60.3447	48.8959	40	2.021

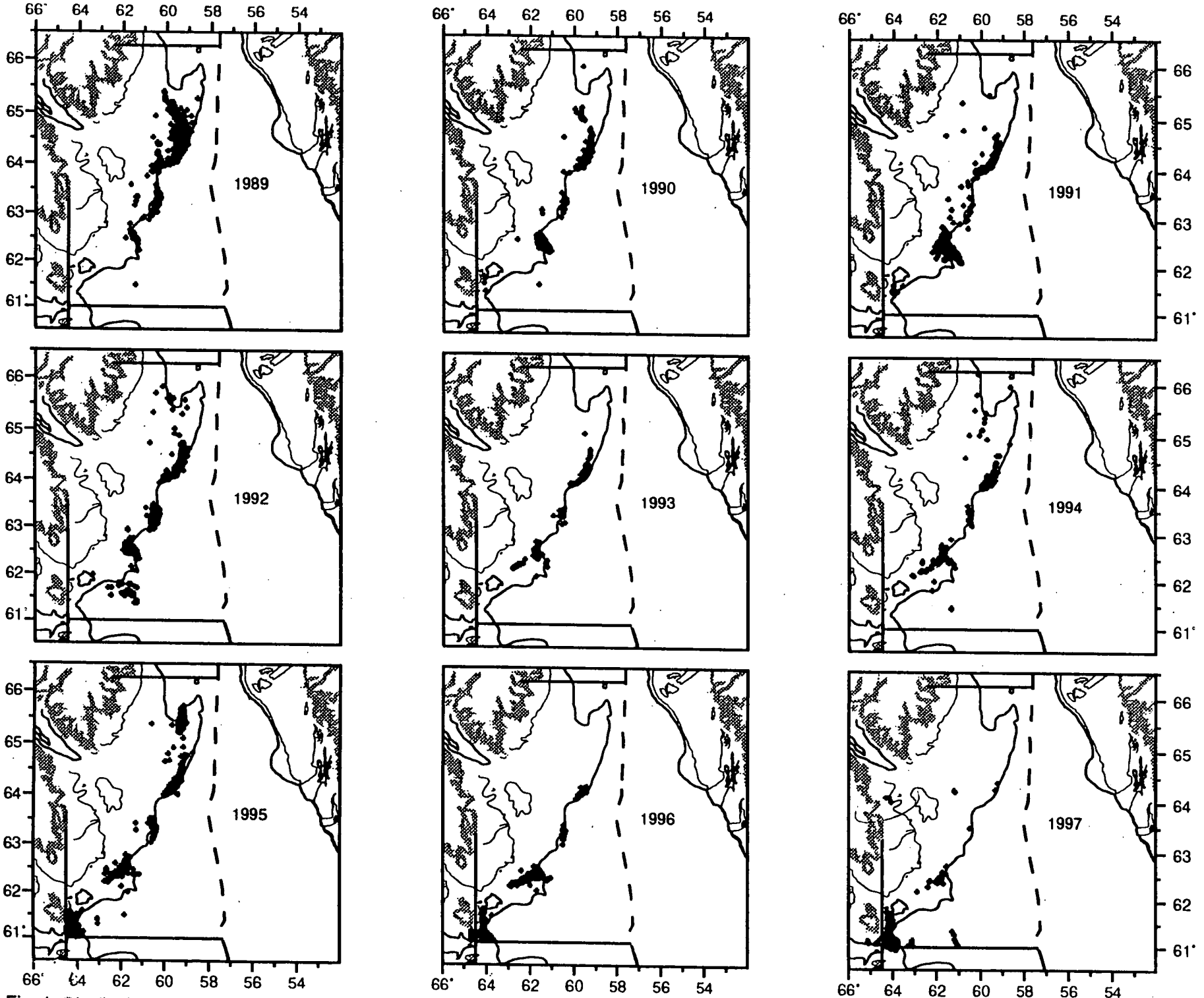
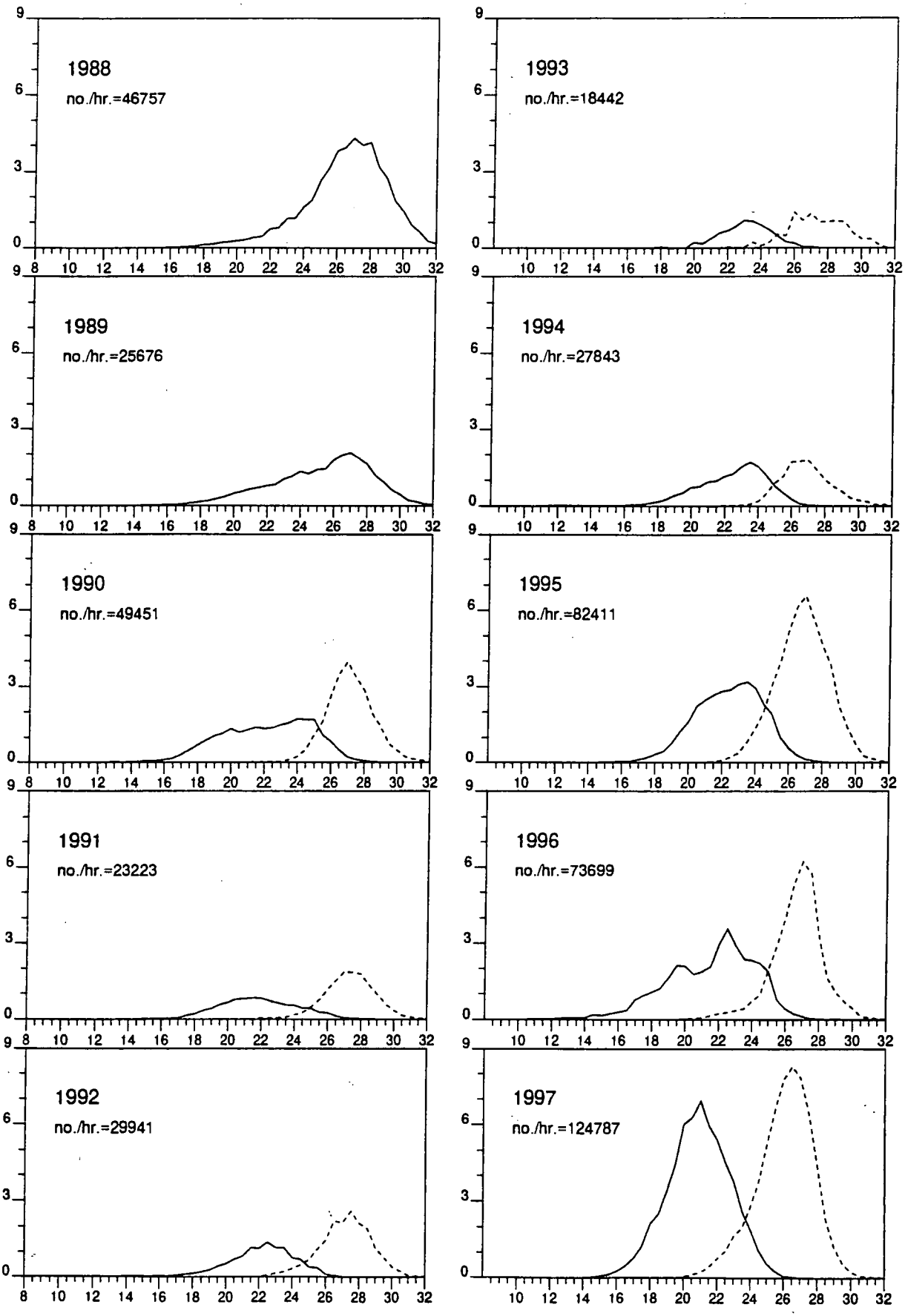


Fig. 1. Distribution of fishing effort in Div. 0B (SFA 2), 1988-97.

Fig. 2. Catch ...numbers-per-hour..000s in NAFO Division 0B (SFA 2), 1988-97. Single-line graphs represent unsexed samples, broken line=females.



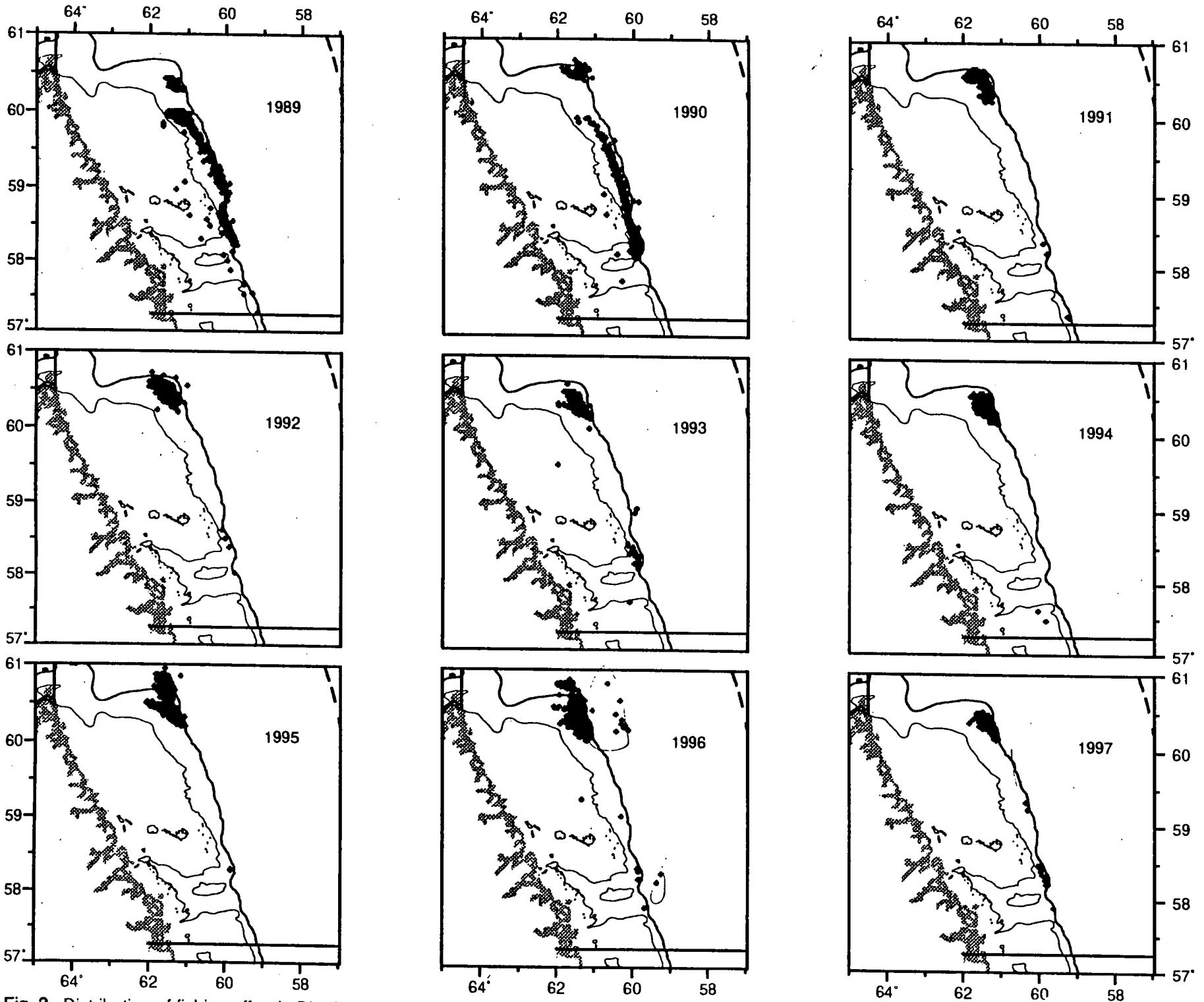


Fig. 3. Distribution of fishing effort in Div. 2G (SFA 4), 1988-97.

Fig. 4. Catch ...numbers-per-hour..000s in NAFO Division 2G (SFA 4), 1988-97. Single-line graphs represent unsexed samples, broken line=females.

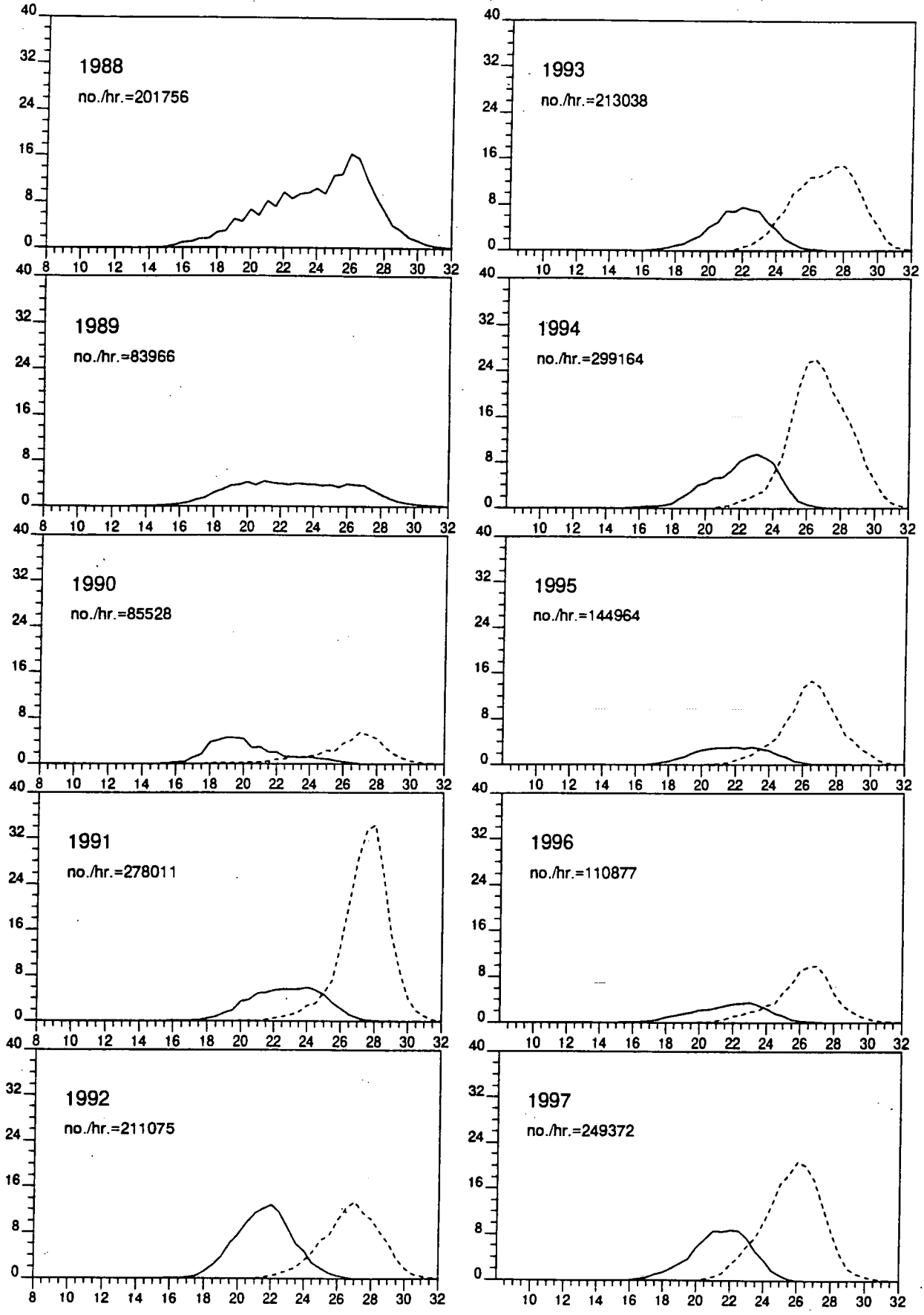
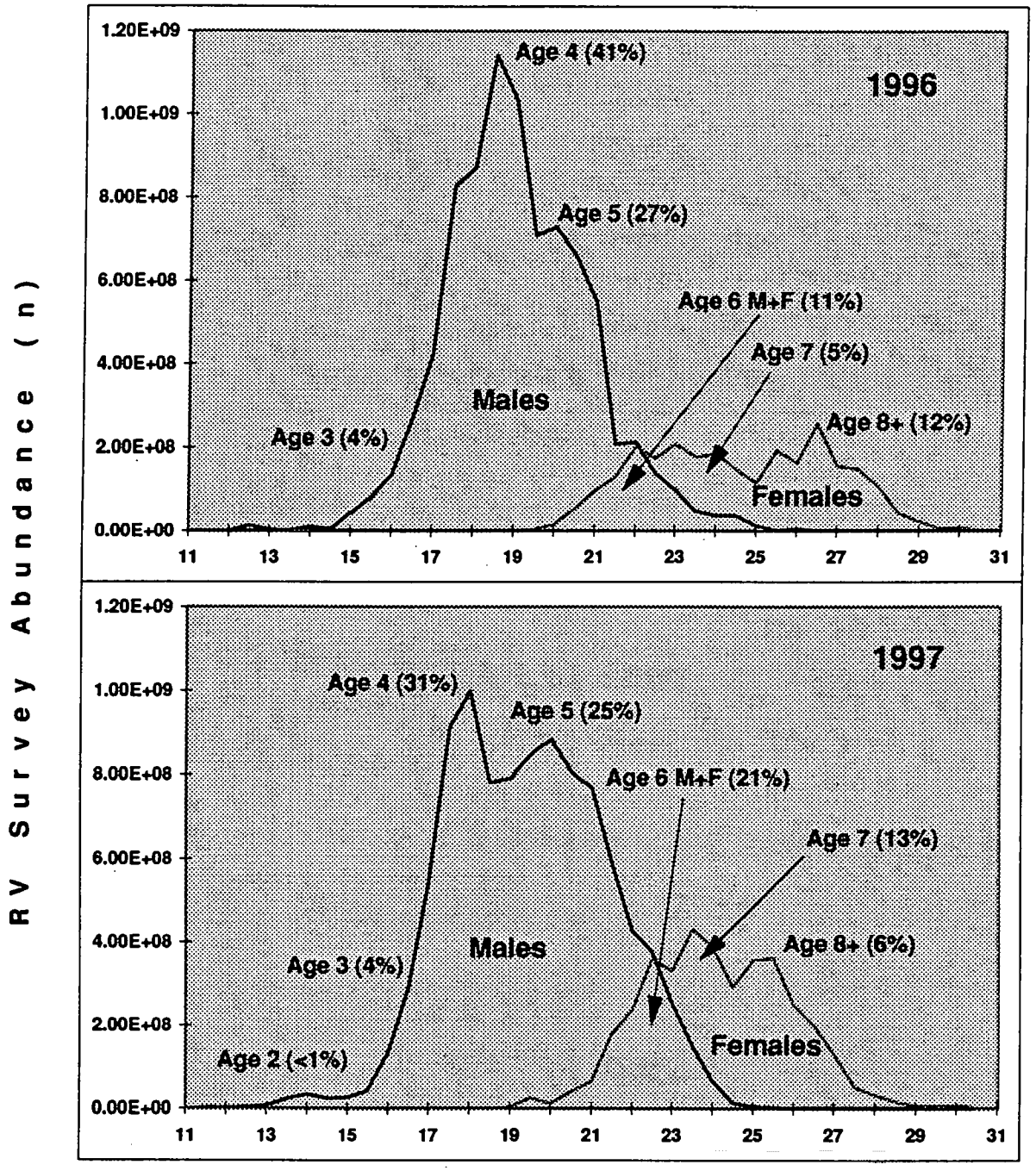


Figure 5. Abundance at length and age for shrimp in Div. 2G, estimated from 1996 and 1997 RV fall surveys.



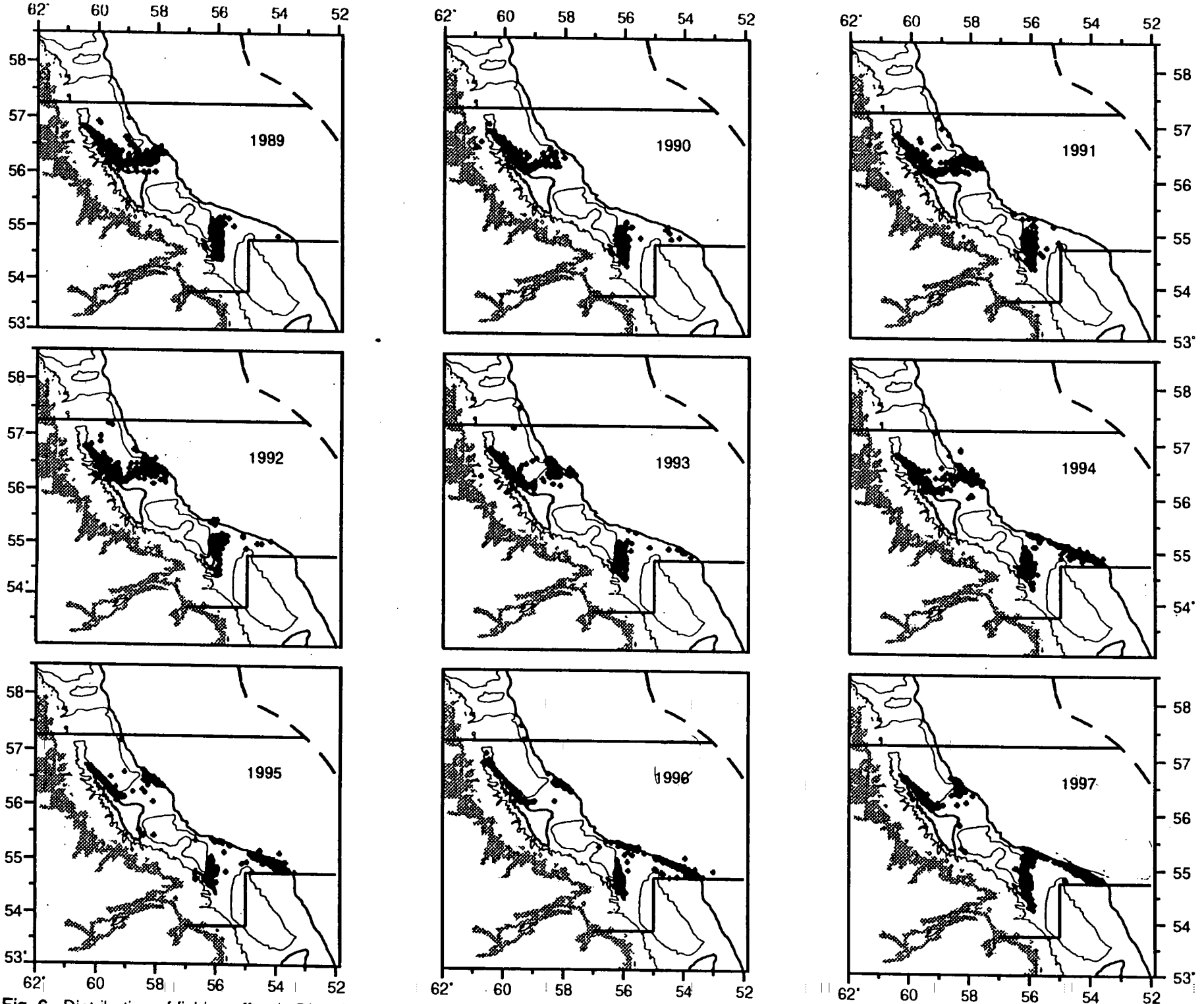


Fig. 6. Distribution of fishing effort in Div. 2H-2J (SFA 5), 1988-97.

Fig. 7. Catch ...numbers-per-hour..000s in NAFO Division 2H-2J (SFA 5), 1988-97. Single-line graphs represent unsexed samples, broken line=females.

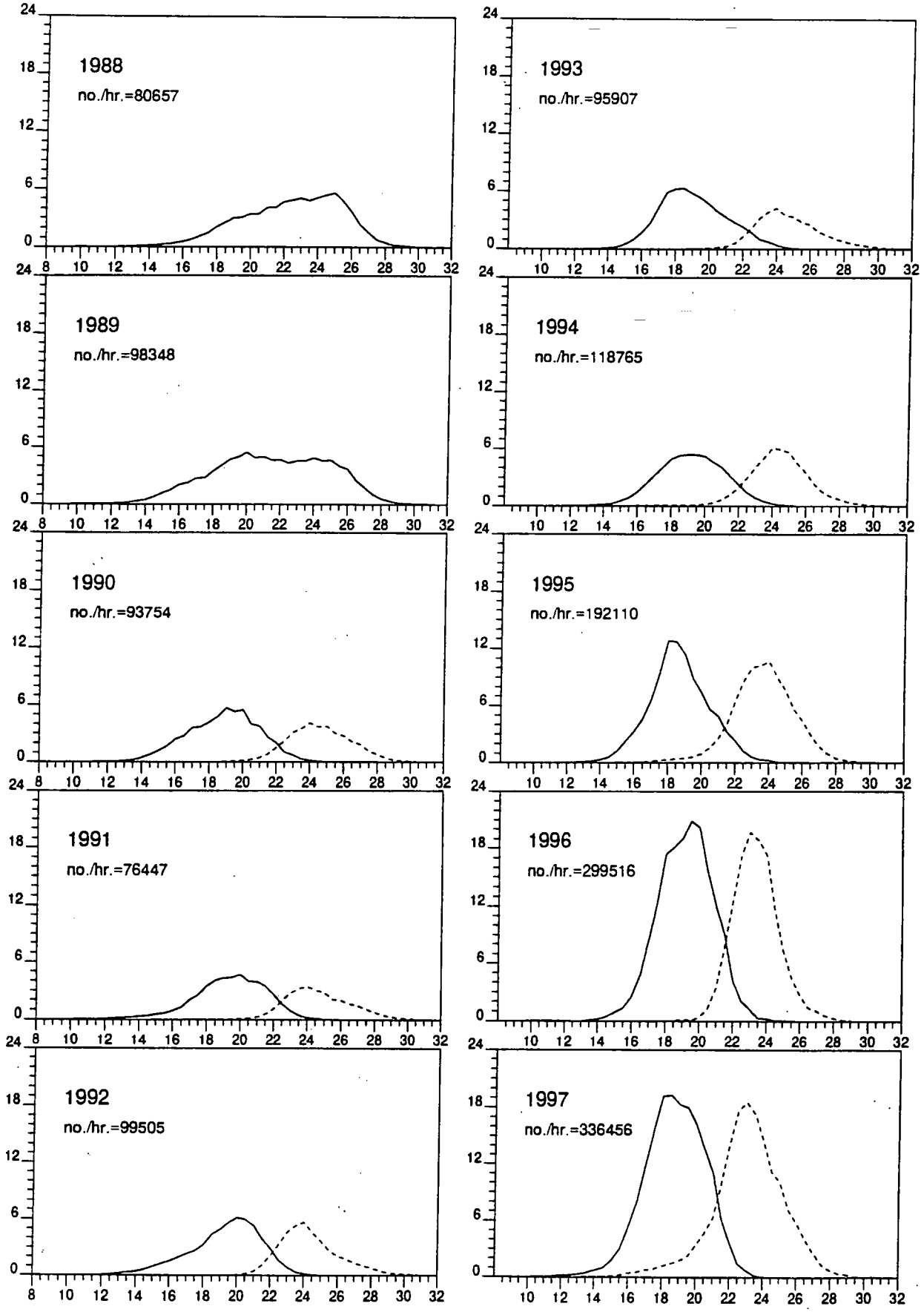
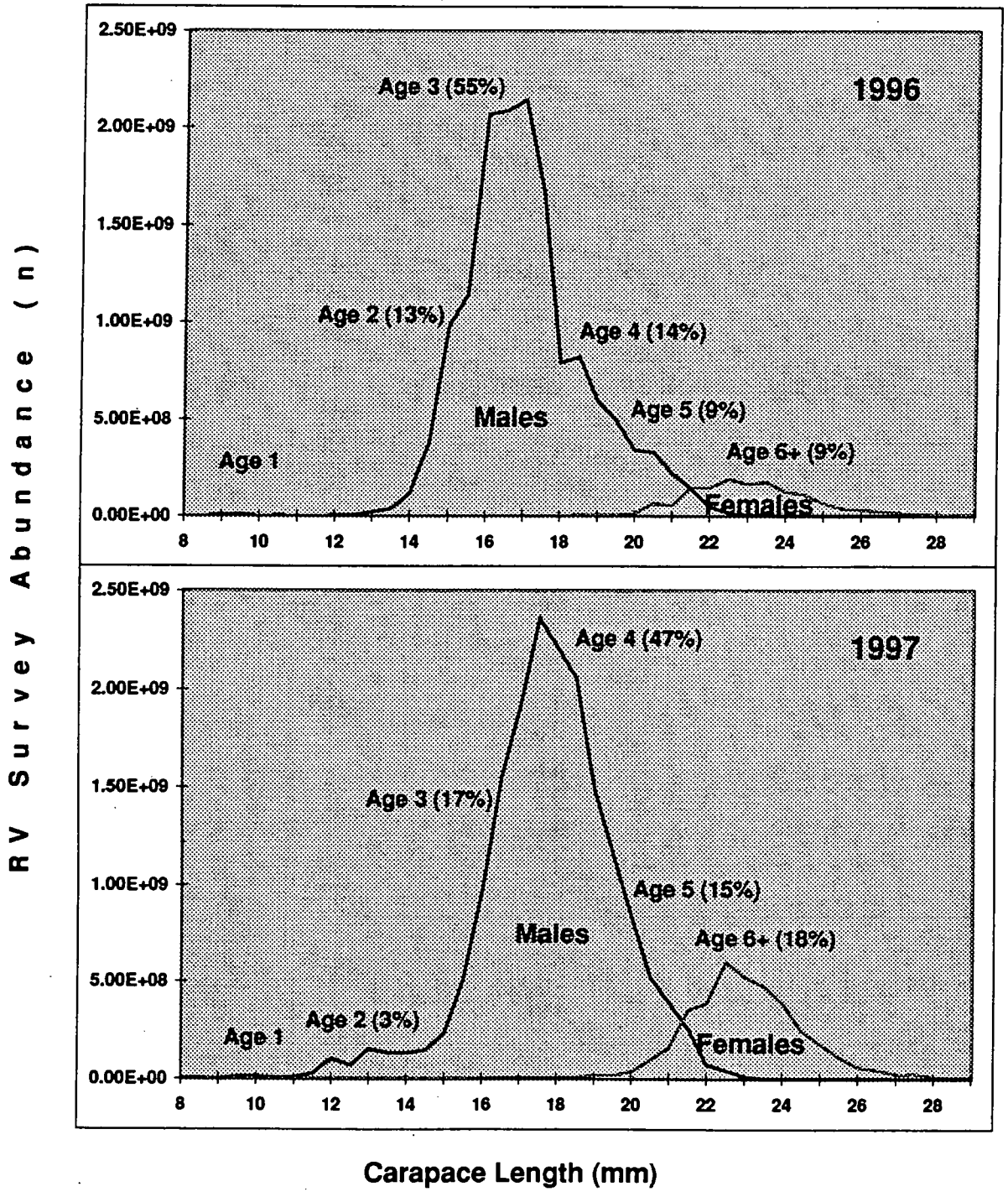


Figure 8. Abundance at length and age for shrimp in Hopedale + Cartwright, estimated from 1996 and 1997 RV fall surveys.



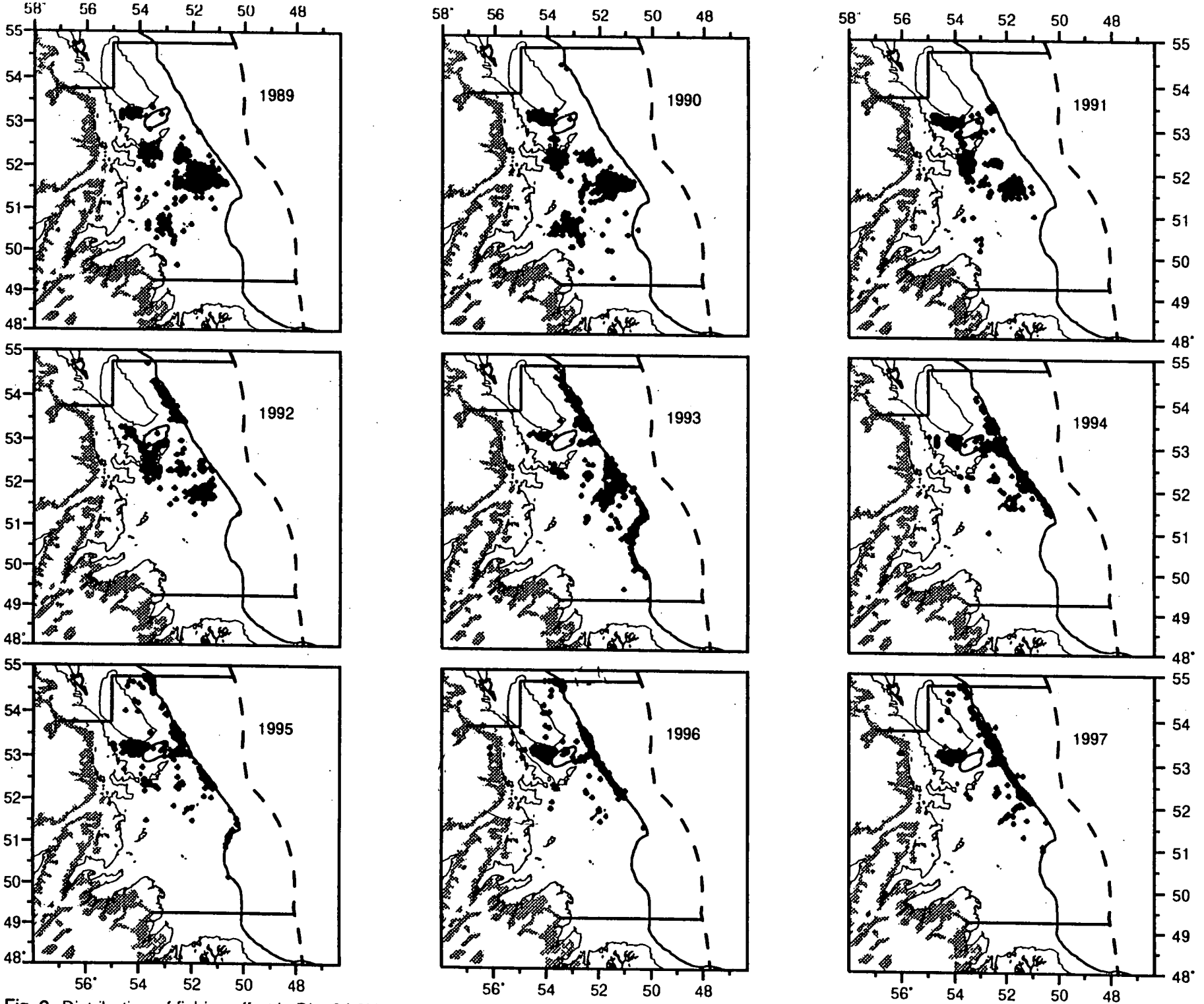


Fig. 9. Distribution of fishing effort in Div. 2J-3K (SFA 6), 1988-97.

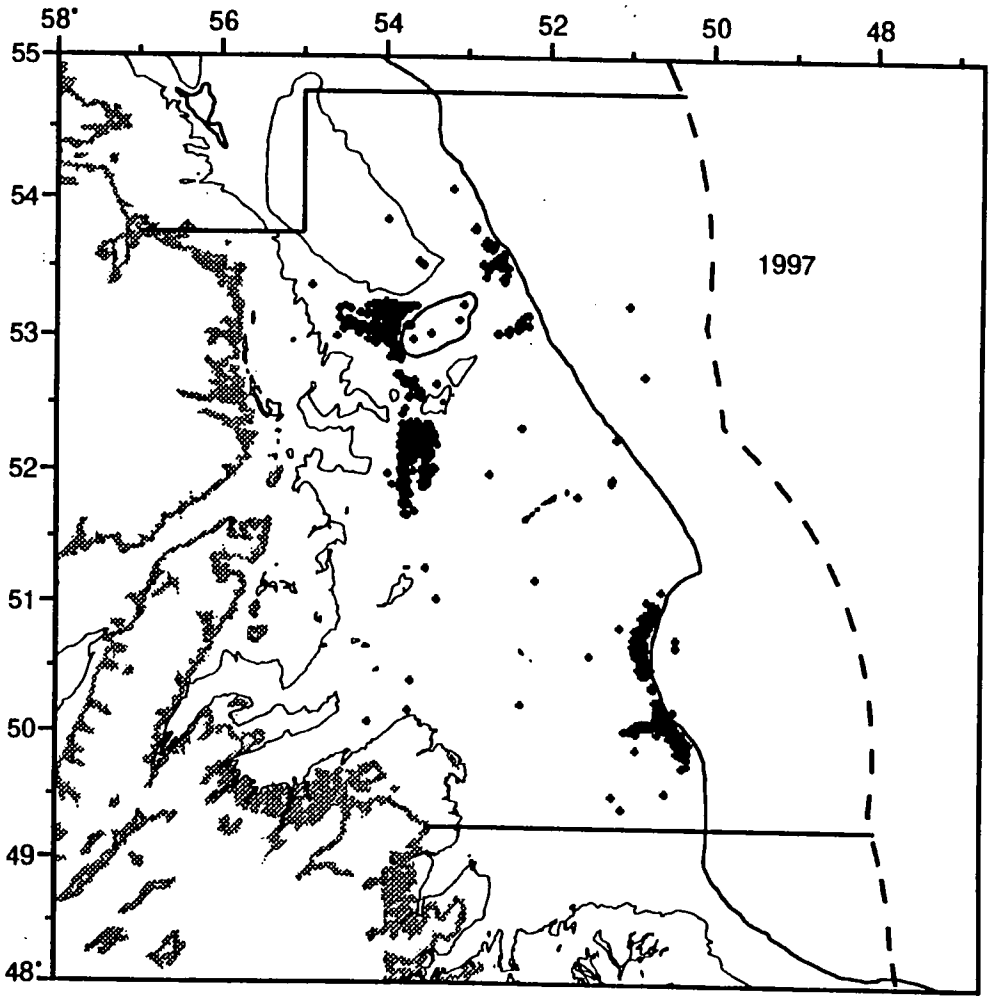


Fig. 9 (cont'd.). Distribution of fishing effort by vessels <20 m. in Div. 2J-3K (SFA 6), 1997.

Fig. 10. Catch ...numbers-per-hour..000s in NAFO Division 2J-3K (SFA 6), 1988-97. Single-line graphs represent unsexed samples, broken line=females.

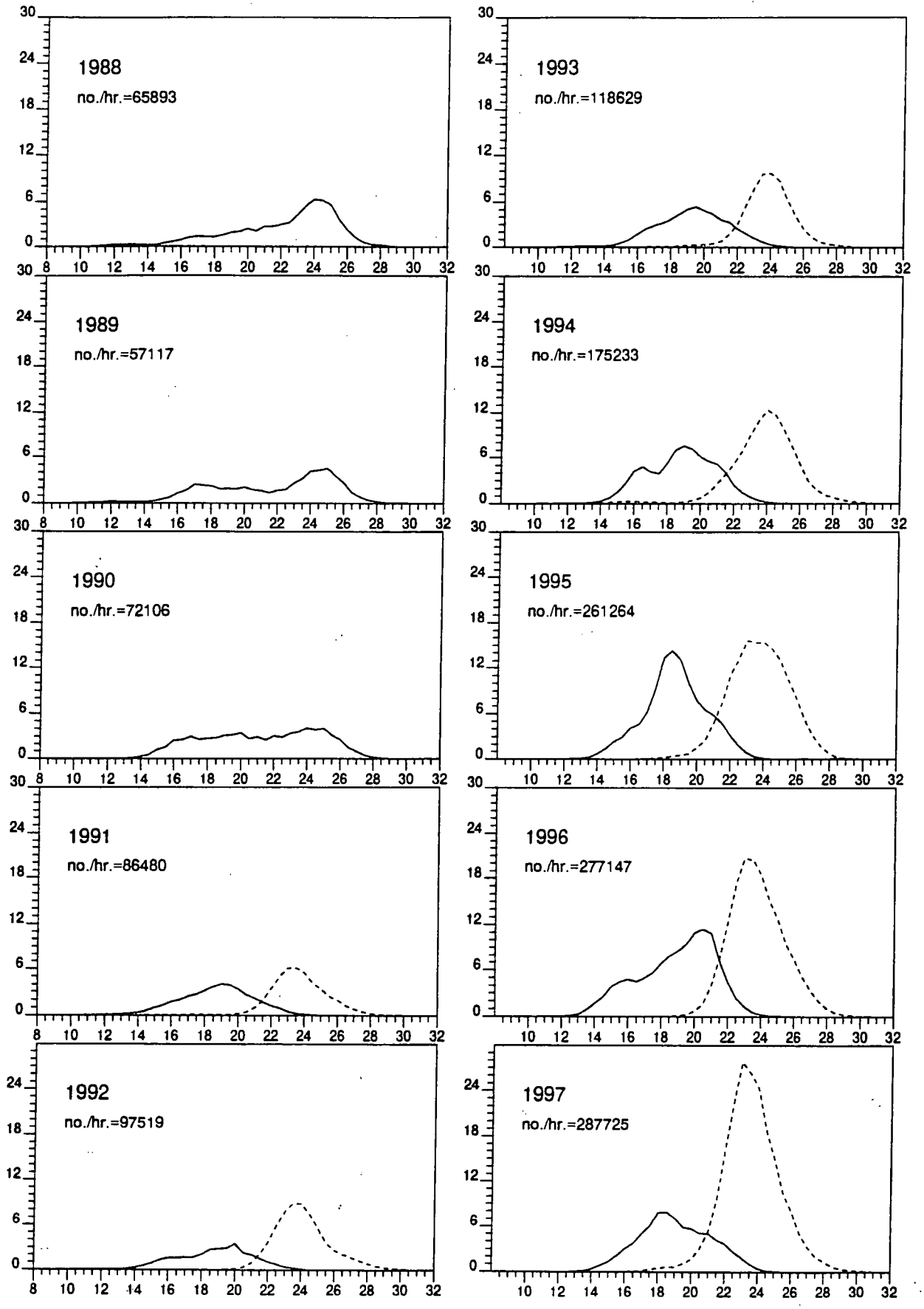


Figure 11. Abundance at length and age for shrimp in Hawke +3K, estimated from RV fall surveys, 1995 - 1997.