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**Resource status of northern shrimp (*Pandalus borealis*)
off Baffin Island, Labrador and northeastern Newfoundland
- second interim review**

by

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¹ This series documents the scientific basis for the evaluation of fisheries resources in 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.

¹ La présente série documente les bases scientifiques des évaluations des ressources halieutiques du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

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ABSTRACT

Assessments of northern shrimp (*Pandalus borealis*) were performed for shrimp fishing areas 2, 4, 5 and 6 which correspond to Division 0B, Division 2G, Hopedale + Cartwright Channels and Hawke Channel + Division 3K, respectively. Within each area, status of the resource was inferred partly by examining trends in commercial catch, effort, catch per unit effort, fishing pattern and size/sex/age composition of the catches. Also, multispecies research trawl surveys conducted from 1995 to 1998, inclusive, provided information on distribution, abundance and biomass of shrimp in Hawke Channel + Div. 3K for all four years, in Hopedale + Cartwright from 1996 to 1998 and in Div. 2G for 1996 and 1997.

In 1998, the northern shrimp fishery again performed well and the inshore vessel component, initiated in 1997, was increased. Catch rates of offshore vessels in the Hopedale + Cartwright and Hawke + 3K areas remained at the historically high level seen in recent years. Research surveys showed that abundance/biomass in 1998 remained high relative to catch in both these areas but the survey estimates for Hopedale + Cartwright were imprecise. Within Div. 2G, catch rates fluctuated about a high level since 1991 and a healthy spawning stock has been maintained in recent years. Low survey coverage limits the usefulness of research vessel data. The status of the resource in Div. 0B remains uncertain in the absence of information from research trawl surveys but recent catch rates are at a historically high level.

It was concluded that the shrimp resource in Hawke Channel + Div. 3K is currently healthy and prospects for the 1999 fishery seem favourable. However, the 1995 and 1996 year classes do not appear to be as strong as those produced in the early 1990's and reduced recruitment, beginning in 1999 and continuing into the next millennium, is possible. There was no scientific basis for changes in total allowable catches in Hopedale + Cartwright, Div. 2G and Div. 0B for 1999. The experimental fishery in Div. 0B has been confined to the area south of 63° N in recent years.

RÉSUMÉ

Des évaluations de la crevette nordique (*Pandalus borealis*) ont été effectuées pour les zones de pêche de la crevette 2, 4, 5 et 6 qui correspondent, respectivement, à la division 0B, à la division 2G, aux chenaux Hopedale et Cartwright, et au chenal Hawke et à la division 3K. Dans chacune de ces zones, l'état de la ressource a été déduit, en partie, par l'examen des tendances des captures commerciales, de l'effort de pêche, des captures par unité d'effort et de la composition de la taille, du sexe et de l'âge des prises. En outre, des relevés de recherche au chalut visant diverses espèces et effectués de 1995 à 1998 inclusivement, ont permis d'obtenir des renseignements sur la répartition, l'abondance et la biomasse de la crevette dans le chenal Hawke et la division 3K pendant ces quatre années, dans les chenaux Hopedale et Cartwright de 1996 à 1998 et dans la division 2G en 1996 et 1997.

En 1998, la pêche de la crevette nordique a encore été bonne et la participation des bateaux côtiers, amorcée en 1997, a été accrue. Les taux de capture des bateaux hauturiers dans les chenaux Hopedale et Cartwright et le chenal Hawke et la 3K se sont maintenus aux niveaux historiques élevés notés au cours des dernières années. Les relevés de recherche ont montré que l'abondance et la biomasse de 1998 sont demeurées élevées par rapport aux captures effectuées dans ces deux zones, mais les estimations des relevés pour les chenaux Hopedale et Cartwright étaient imprécises. Dans la division 2G, les taux de capture, élevés, ont fluctué depuis 1991 et un bon stock de géniteurs s'y maintient depuis les dernières années. La faible couverture des relevés limite cependant l'utilité des données du navire de recherche. L'état de la ressource dans la division 0B demeure incertain étant donné l'absence de renseignements pouvant être obtenus des relevés de recherche au chalut, mais les taux de capture récents sont à des niveaux historiques élevés.

Il a été conclu que la ressource en crevette du chenal Hawke et de la division 3K était actuellement en bon état et les perspectives semblent favorables pour la saison de 1999. Les classes de 1995 et 1996 ne semblent cependant pas aussi importantes que celles du début des années 1990 et il est possible que la baisse du recrutement, amorcée en 1999, se poursuive au cours du prochain millénaire. Les données scientifiques ne justifient pas de modifier les totaux de capture autorisés dans les chenaux Hopedale et Cartwright, la division 2G et la division 0B en 1999. La pêche expérimentale réalisée ces dernières années dans la division 0B a été limitée à la zone située au sud de 63° N.

INTRODUCTION

The Canadian fishery for northern shrimp (*Pandalus borealis*) from southern Davis Strait (Division 0B) to the northeast Newfoundland Shelf (Division 3K) is currently controlled within a three-year (1997 - 1999), integrated management plan. A Stock Status Report (SSR) was produced in 1997 at the beginning of the plan based on assessments that included a full review of commercial fishery and research survey data. Early in 1998, an interim review of resource status was performed, providing a basis for possible changes to the total allowable catches (TAC's) in the second year of the plan. The second interim review, conducted in February 1999, was used in the management process to consider whether changes to TAC's were required/warranted in the final year of the plan.

This document provides the details considered in the 1999 scientific assessment of *Pandalus borealis* in four shrimp fishing areas (SFA's): Hawke Channel + Division 3K (SFA 6), Hopedale + Cartwright Channels (SFA 5), Division 2G (SFA 4) and Division 0B (SFA 2). Not included in this review are *P. borealis* in Division 0A (SFA 1) and Flemish Cap (SFA 7), which are assessed by Scientific Council of NAFO. Also, *Pandalus montagui*, which are fished commercially in SFA's 2, 3 and 4, west of 63° W, were not considered because there was no new information on stock size or exploitation levels to use in assessing status of the resource or revising the TAC from its current level (3800 tons).

MATERIAL AND METHODS

Commercial fishery data

Trends in catch (tons) and effort (hours fished) from vessel log records were monitored for all available areas and years. The data also were analyzed spatially to consider changes in fishing pattern that might effect interpretations. Catch per unit effort (CPUE), expressed as kg per hour, was calculated by year for each SFA and used as an indicator of change in the fishable stock over time. Records of double trawling (two complete trawls towed concurrently) by some vessels were omitted in the calculation of CPUE. The raw data (catch/effort) for each SFA were standardized by multiple regression in an attempt to account for variation due to factors such as year, month, area and vessel. By including only vessels with several years' experience in the fishery, the number of parameters to be estimated was reduced. However, the individual models still require some refinement to further reduce the number of parameters and to investigate the effects of interactions, thereby increasing confidence in the interpretation of results. Final models included all significant class variables with the YEAR effect used to track the trend in stock size over time. The difference/similarity between the 1998 parameter estimate and those of previous years was inferred from the output statistics.

Sizes of male and female shrimp in the catches were obtained from samples taken by observers on offshore vessels. Samples were adjusted upward to set, month and year for each SFA to derive a series of annual catch-at-length compositions. Age composition was inferred by

identifying prominent year classes within the composite distributions and tracking their development over time. The data are considered representative up to 1996 but, to date, there is no reliable sampling scheme for inshore vessels. Therefore, composite length distributions for 1997 and 1998 based on sampling from only offshore vessels might not reflect the actual catch at length, especially in SFA 6.

Research survey data

Multispecies research trawl surveys have been conducted annually in the Newfoundland-Labrador offshore area since 1995. These surveys employ a stratified-random sampling design that was developed for groundfish but use a lined, Campelen 1800 shrimp trawl as the sampling gear. In Hawke Channel + Div. 3K (SFA 6), survey coverage has been extensive in areas where shrimp are abundant and reliable estimates of distribution as well as abundance/biomass indices have been obtained each year from 1995 to 1998. Farther north, coverage is not adequate to address the highly patchy distribution of shrimp seen in these areas. Therefore, survey results (1996 to 1998 for Hopedale + Cartwright; 1996 and 1997 for Div. 2G) are less reliable for interpretation of trends in the resource. No surveys have been conducted in Div. 0B.

In addition to the traditional, parametric method (STRAP) of calculating the abundance/biomass indices, a new, non-parametric method was introduced in the 1999 assessment. The method uses the observed survey catches of northern shrimp in conjunction with latitude, longitude and depth data to estimate an abundance/biomass index. It relies on estimating the whole probability distribution for shrimp at any point within the survey area where depth is known. An estimate of the expected value of shrimp abundance/biomass is derived by integrating the estimates over a network of triangles covering the area. Monte Carlo resampling from the probability distribution at every survey point produces a set of simulations from which median estimates and confidence intervals are determined. The new method produced point estimates that compared well with standard, stratified-random results. An important advantage of the non-parametric method is that it does not assume observations have a Gaussian distribution and, therefore, negative confidence limits are avoided. The method is not tied to the survey stratification and, therefore, expected concentrations in unsampled areas also are estimated.

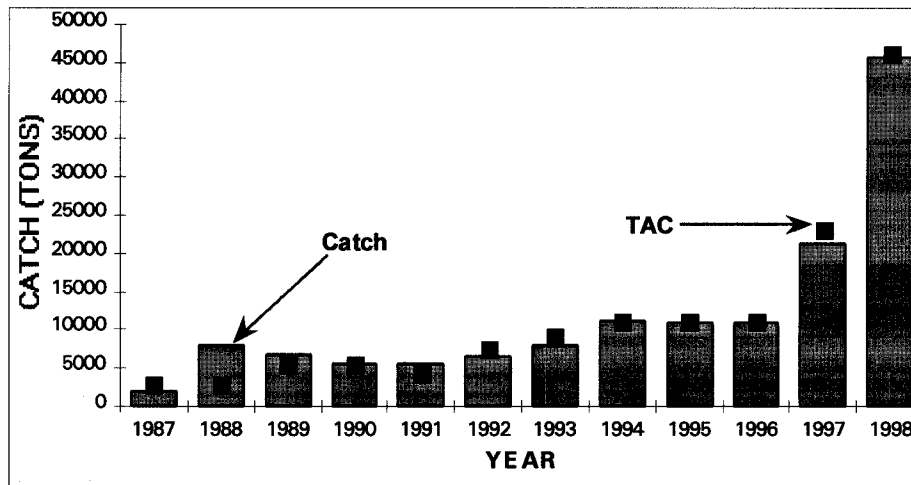
Sampling of survey catches provided the data for constructing estimates of abundance at length and sex by area and year. These estimates were constructed based on the results of the STRAP analyses and are assumed to be representative. Before the non-parametric method can be used as the primary analytical tool for survey data, abundance-at-length comparisons with the STRAP results are required. As for the commercial data, age composition from surveys was determined by identifying year classes within the composite distributions and tracking their development over time. No age-segregated modal analysis has been performed for the time series of survey data.

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

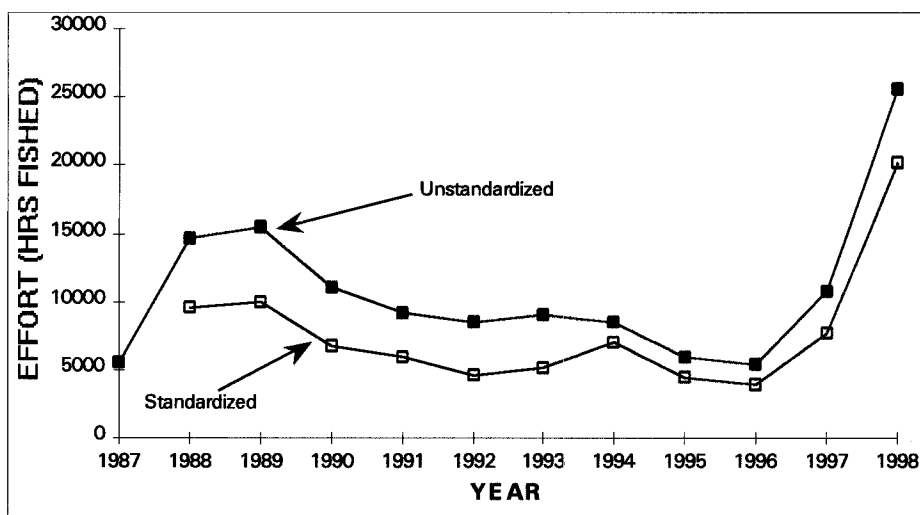
FISHERY DATA

Catch and effort

The shrimp fishery in Hawke Channel + Division 3K began in 1987 when about 1800 tons were caught. In previous years, only a few tons had been reported, primarily from Hawke Channel. 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. The assessment conducted in 1997 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. Catch in 1997 was estimated at 21,246 tons. Despite the large increase in catch, exploitation in 1997 remained low and the TAC for 1998 was increased again by 100% to 46,200 tons. Preliminary catches were about 45,700 tons.



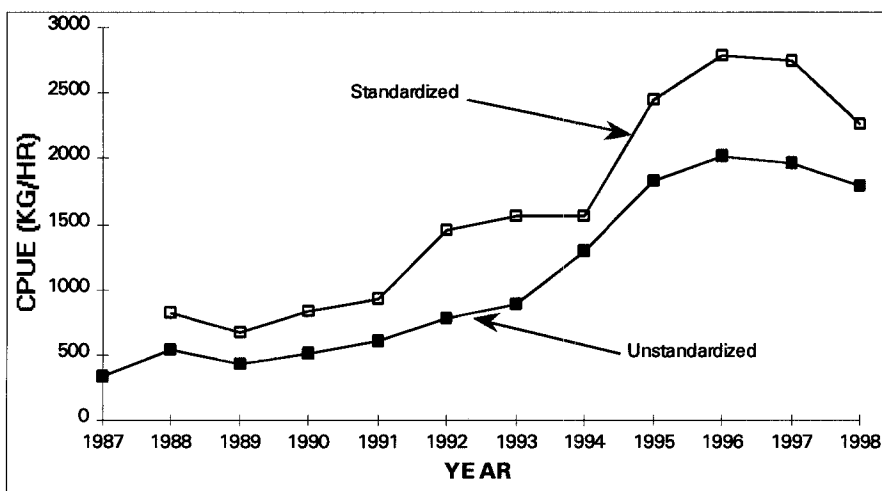
Fishing effort (expressed as hours fished for offshore vessels, i.e. total catch/offshore cpue) declined from 1989 to 1992, stabilized or increased slightly to 1994, declined again from 1994 to 1996 and increased in 1997 and 1998 with the large increases in TAC. The fishery by offshore vessels primarily occurs during the first five months of the year whereas inshore vessels fish in summer and fall.



An eastward displacement of fishing effort occurred during the early 1990's due to: 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 throughout the area 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. 1). The "inshore" fishery concentrated in Hawke Channel, St. Anthony Basin and southern Div. 3K in 1997 and but less effort was directed in the Basin in 1998.

Catch per unit effort (CPUE)

Unstandardized, annual CPUE's for the offshore vessels (single trawl data only) increased steadily from a level of about 500 kg/hr during the 1987 - 1990 period to 2000 kg/hr in 1996 and 1997, declining to 1800 kg/hr in 1998. The CPUE data also were analyzed by multiple regression for year, month, vessel and area effects to standardize the catch rates (Table 1). The analysis showed that the 1998 CPUE estimate was lower than those of 1996 and 1997 ($P = 0.05$) and similar to the 1995 estimate ($P = 0.46$). With effort weighting, the 1998 estimate was significantly lower than 1997 and similar to both the 1995 and 1996 estimates.



The standardized series revealed approximately the same overall increasing trend as the unstandardized. However, the 1992 to 1994 standardized rates were relatively stable whereas the raw data indicated a continual increase.

The preliminary catch rate for January, 1999 was the highest observed since the fishery began and the February value was similar to the 1998 estimate.

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

Size composition

Catch-at-length data from 1989 to 1998 showed dominance of the female component around 24 mm carapace length (CL) in most years and an abundance of males during the recent period (Fig. 2). 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 were well represented at 16 and 18 mm, respectively, in the 1996 samples and at 18 and 20 mm in the 1997 data but do not appear to be as strong as the 1991 year class. Samples for 1998 show that the 1993 year class dominated the male component. In addition to the good recruitment (males) since 1994, the spawning biomass, as evidenced in the catch rates of the female component, increased from the late 1980's and appears to have stabilized since 1996.

RESEARCH SURVEY DATA

Stock size

Results of the 1995 - 1998 fall multispecies research surveys showed that shrimp were widely distributed and abundant throughout Hawke Channel + Div. 3K each year (Figs. and Tables 3 - 6). The minimum trawlable biomass estimates, obtained using stratified random (parametric) and Monte Carlo (non-parametric) methods, are compared in the following table.

Biomass estimates (tons) and 95% confidence intervals using STRAP and Monte Carlo methods.								
	1995		1996		1997		1998	
	STRAP	MC	STRAP	MC	STRAP	MC	STRAP	MC
Lower C.I.	222,393	236,070	411,770	411,360	389,006	374,800	423,135	401,900
Point Estimate	291,243	289,900	517,960	503,600	434,548	435,300	475,573	464,000
Upper C.I.	360,093	371,650	624,150	607,410	480,090	487,200	528,012	530,980
Area (km²)	166,659	186,424	185,816	186,424	185,816	186,424	185,724	186,424

There was good agreement between methods. Considering both, the biomass estimates were about 290,000, 510,000, 435,000 and 470,000 tons from 1995 to 1998, respectively. The 95% confidence intervals for the mean values from 1996 to 1998, were less than $\pm 20\%$. The lower

95% confidence intervals for the biomass indices averaged approximately 400,000 tons (representing about 90 billion animals) during the 1996 - 1998 period.

The ratios of nominal catch to the lower confidence intervals of the survey biomass indices were about 5% in 1995, 3% in 1996, 6% in 1997 and 11% in 1998. Actual exploitation rates are unknown but could be lower than indicated above because the biomass index is believed to underestimate the absolute biomass (i.e. catchability of the survey gear is believed to be < 1).

Stock composition

Length distributions representing abundance-at-length in the 1995 survey showed the dominance of the 1993 year class (age 2) at approximately 14 mm CL and clear representation of the 1994 year class (age 1) at 10 mm (Fig. 7, upper panel). Severe overlap of components to the right in the male distribution created difficulty in separating ages 3, 4 and 5. Females (primarily ages 6+) comprised 27% of the estimated abundance.

In 1996, the 1993 year class was evident at 17 mm (Fig. 7, second panel). The 1994 year class was represented at 14 - 15 mm but the overlap between the two components was difficult to resolve and any estimated proportions might not be representative of the true values. The 1995 year class was apparent at 9 - 10 mm. Females accounted for 20% of the estimated numbers.

Abundance in 1997 (Fig. 7, third panel) again was dominated by the 1993 and 1994 year classes occurring within the 16 - 20 mm CL size range. The 1995 year class was evident at 14 mm and the 1996 year class in low numbers at 9 mm. Females comprised 23% of the estimated abundance.

The 1994 year class (about 19 mm CL) dominated in the 1998 survey (Fig. 7, lower panel). The 1996 and 1995 year classes were evident at about 14 and 16 mm, respectively, and there was good representation of the 1997 year class at 10 mm. Females (about 30% of estimated numbers) were smaller in 1998, possibly due to earlier sex change for part of the 1993 year class.

These data suggest that the 1995 year class, at age 3 in 1998, 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 2 in 1998 and age 1 in 1997, appears weaker than the 1993, 1994 and 1995 year classes. The ability to compare year-class strengths for partially recruited animals, especially age 1, is questionable with such a short time series. Therefore, it is premature to comment on the relative strength of the 1997 year class.

RESOURCE STATUS

Catch rates of offshore vessels in the 1998 fishery remained at the high level attained in the previous three years. The lower confidence intervals of the research survey biomass estimates

from 1996 to 1998 averaged 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 and it is possible that recruitment of males will decline, beginning in 1999 and continuing into the next millenium. 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, possibly less than 12% (i.e. the ratio of nominal catch to the research trawl survey biomass index).

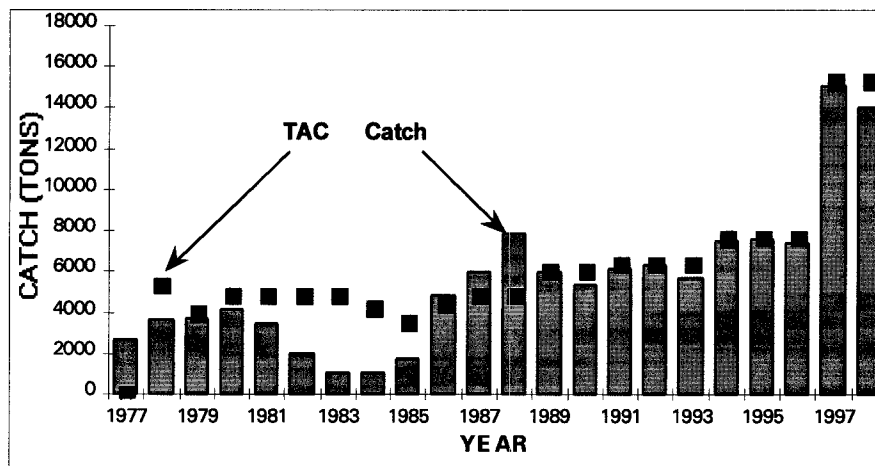
The 1997 assessment concluded that the TAC in this area could be increased to several times the 1994 - 1996 level of 11,050 tons without concern for overexploitation. This was accomplished in 1998 with a TAC of 46,200 tons, 4.18 times 1996 TAC. Although the current resource status is favourable with high biomass/abundance of male and female components, it is uncertain whether the current or an increased TAC can be sustained, considering the possibility for a decline in recruitment.

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

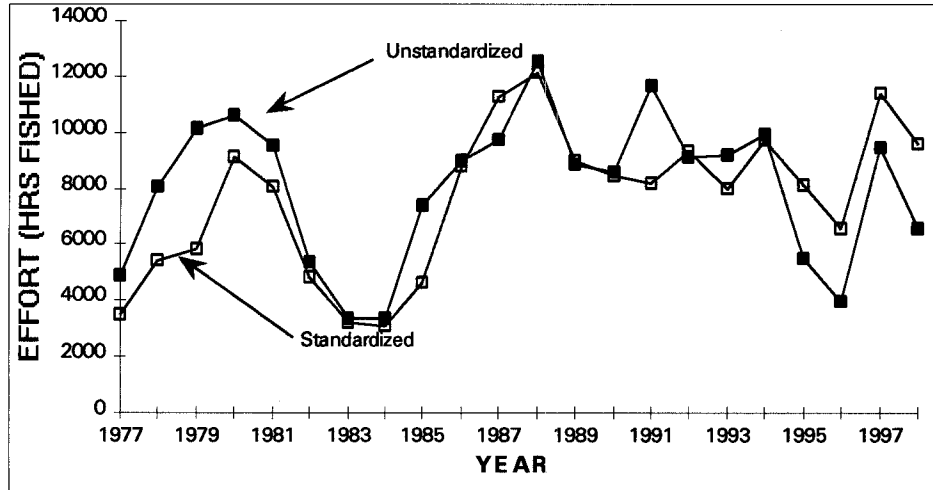
FISHERY DATA

Catch and effort

The northern shrimp fishery in Hopedale and Cartwright Channels began in 1977, following 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. 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. Annual TAC's for the 1997 - 1999 plan were increased by 100% to 15,300 tons based on analyses and interpretation of commercial fishery and research survey data that indicated a healthy resource and low exploitation. Catch in 1997 was 15,103 tons and the preliminary estimate for 1998 is about 14,000 tons.



Fishing effort (expressed as hours fished for offshore vessels, i.e. total catch/offshore cpue) showed approximately the same trends over time as catch. From 1994 to 1996, however, effort decreased while catches remained stable. Effort increased in 1997 and 1998 with the doubling of the TAC.



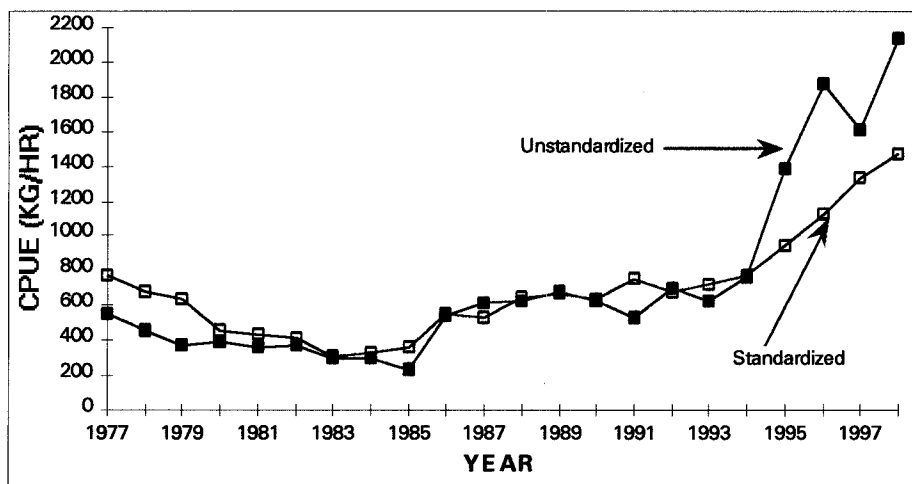
Traditionally, effort concentrated in four main areas: northern, eastern and southern Hopedale Channel and Cartwright Channel (Fig. 8). In the 1990's, however, more effort was reported from the slopes of the shelf - north and east of Cartwright Channel. From 1994 to 1998, substantial effort occurred 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 (single trawl data for offshore vessels) 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 1900 kg/hr in 1996, declined to 1600 kg/hr in 1997 and increased again to over 2100 kg/hr in 1998, the highest observed.

The CPUE data were further analyzed by multiple regression for year, month, vessel and area effects. The standardized 1998 catch rate of 1466 kg/hr was the highest in the time series, significantly higher ($P < 0.05$) than all other years except 1997 ($P = 0.25$) (Table 7). Effort weighting in the regression analysis produced a similar trend but estimated the 1997 CPUE to be greater than the 1998. The difference was not significant, however.

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 preliminary catch rate for January, 1999 was the second highest observed since the fishery began and the February value was the highest.

Historical fishery data for this management-assessment area are summarized in Table 8.

Size composition

Catch-at-length data from 1989 to 1998 (Fig. 9) 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. After 1994, the male component of the catch increased substantially. Catch rates for females increased from 1993 to 1996 and stabilized in 1997 and 1998. The median size at sex change shifted from greater than 22 mm CL prior to 1995 to less than 22 mm from 1995 onward.

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 roughly 20 mm (age 5) in 1996 and accounted for most of the females at 23 mm (age 6) in 1997. Similarly, the 1993 year class can be tracked as males at 18 mm (age 4) in 1997 and about 20 mm (age 5) in 1998.

RESEARCH SURVEY DATA

Stock size

Results of the 1996 - 1998 fall multispecies research surveys showed that shrimp were widely distributed throughout the Hopedale + Cartwright Channel area each year but very high catches occur in some locations (Figs. 10 - 12, Tables 9 - 11). The minimum trawlable biomass estimates, obtained using stratified random (parametric) and Monte Carlo (non-parametric) methods, are compared in the following table.

Biomass estimates (tons) and 95% confidence intervals using STRAP and Monte Carlo methods.						
	1996		1997		1998	
	STRAP	MC	STRAP	MC	STRAP	MC
Lower C.I.	-65,945	51,163	39,315	78,280	49,803	57,004
Point Estimate	192,373	161,000	94,715	133,400	85,521	85,700
Upper C.I.	450,690	341,870	150,114	181,590	121,238	123,810
Area (km²)	66,540	63,425	55,050	63,425	60,385	63,425

Both methods showed a decline in the estimates from 1996 to 1998. However, two trawl stations in 1996 produced large catches that were highly influential to the biomass estimate that year and resulted in wide confidence intervals. The Monte Carlo method avoids negative confidence intervals but the uncertainty in the 1996 estimate remains. With low survey coverage, results must be interpreted cautiously. The trend in biomass/abundance is unknown.

The ratios of nominal annual catches to the lower confidence intervals of the survey biomass indices were less than 40% from 1996 to 1998 (excluding the negative value from STRAP in 1996). This high value (compared to the Hawke+3K area) is more likely a reflection of the uncertainty in the survey estimates than an estimate of the level of exploitation. The exploitation rate is unknown.

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. 13, upper panel). 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 in the 1996 survey are thought to belong to the 1993 year class (age 3).

Males about 18 mm dominated in the 1997 survey (Fig. 13, middle panel). Using the same growth model mentioned above, these male shrimp also represent the 1993 year class at age 4 in 1997. This interpretation is consistent with the 1996 survey observations and the 1997 fishery data (see Fig. 9). 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 age composition is uncertain.

The prominent size group of males in the 1998 survey samples at 19 mm (Fig. 13, lower panel) represents a combination of the 1993 and 1994 year classes. Some of the former changed sex between 1997 and 1998 and occurred as small females. Based on the limited data available from surveys, the 1995 and 1996 year classes appear to be weaker than the 1993 and 1994.

RESOURCE STATUS

The current status of the northern shrimp resource in the Hopedale and Cartwright Channels appears favourable from the fishery data but is uncertain from the survey data. Commercial catch rates, which were stable from the mid 1980's to the early 1990's, continue to increase in recent years. Good recruitment of year classes produced in the early 1990's has resulted in high catch rates of males since 1995 and the spawning component remains healthy. Data from the research surveys from 1996 to 1998, however, produced highly variable estimates of stock size and must be interpreted cautiously.

Although female abundance could be maintained in 1999 by the continued recruitment of the 1993 year class to the female component, male abundance (recruitment to the fishery) could decline if the 1995 and 1996 year classes are weaker as the data suggest. There is no scientific basis for a change in the TAC of 15,300 tons for the third year of the multi-year plan.

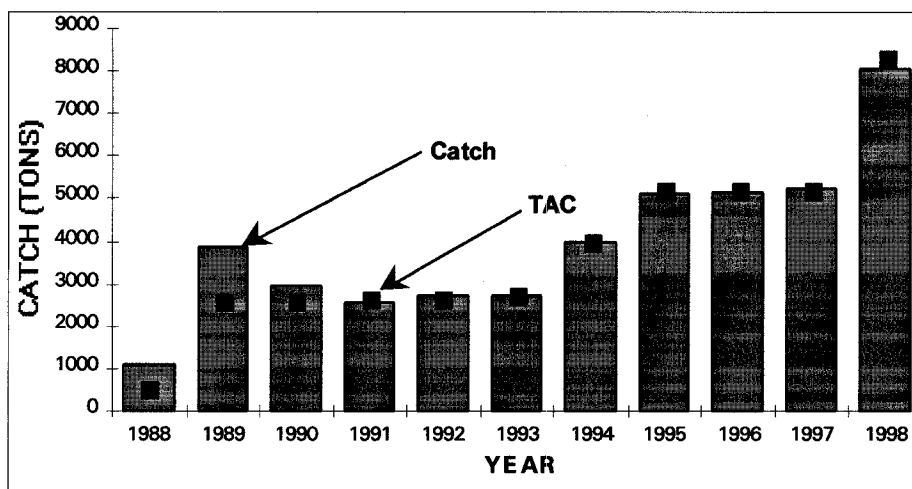
ASSESSMENT OF SHRIMP IN NAFO DIVISION 2G (SFA 4)

FISHERY DATA

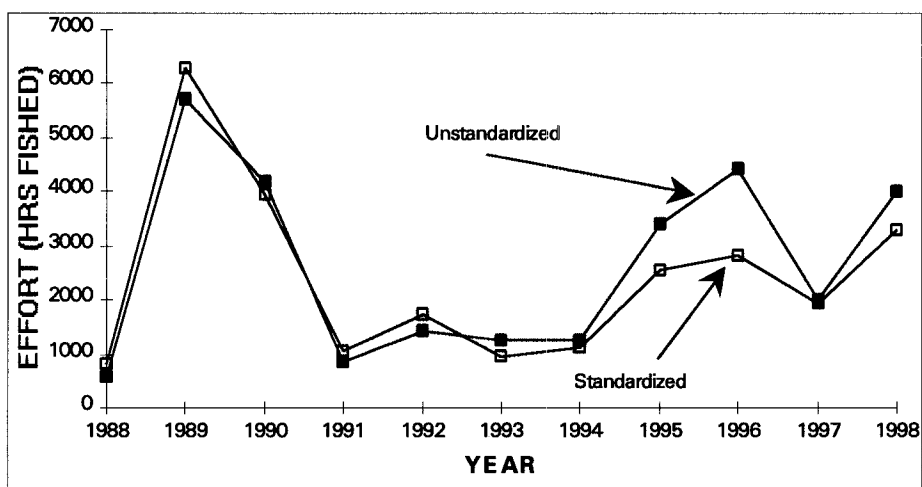
Catch and effort

The northern shrimp fishery in Div. 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 of 5200 tons was maintained for 1997 and catch was estimated at 5217 tons.

The interim review of stock status in the winter of 1998 indicated that an increase in TAC for 1998 could be considered. Lacking the basis on which to advise an appropriate level of TAC, an increase of 60% to 8320 tons was chosen in the management process. Further, as recommended by Science, part (70%) of the increase was applied to the area south of 60°N. Catches in 1998 were estimated at approximately 6000 tons in the area north of 60°N and 2100 tons south of 60°N. TAC's were 6136 and 2184 tons, respectively.



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 varied at a higher level (about 3000 hours), thereafter.



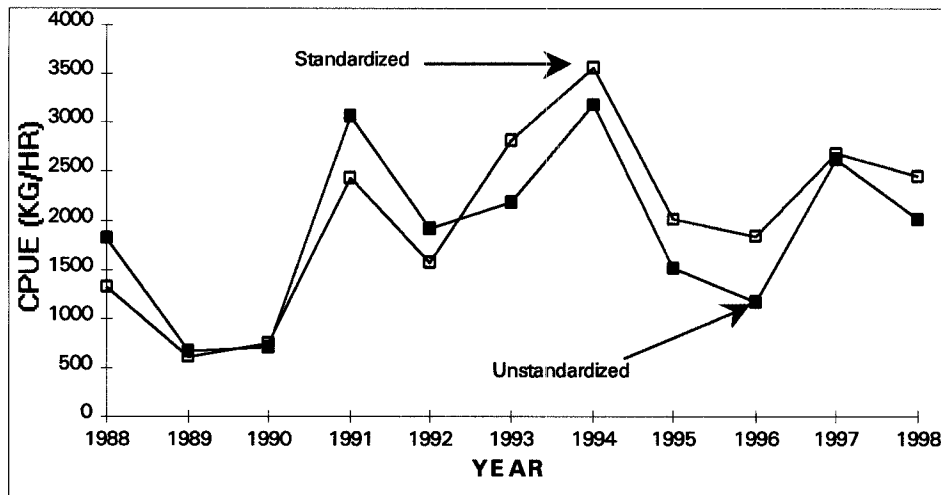
The fishery from 1988 to 1990 occurred throughout the Division which, during that period, was split into two management zones, north and south of 60°N. The 1991 - 1993 Management Plan combined the two zones and, up to 1997, effort concentrated primarily in the north (Fig. 14). In 1998, more effort was deployed south of 60°N because of the separate quota for that area. By-catches of *P. montagui* were reported at some northwestern locations during the 1995 - 1998 period.

Catch per unit effort (CPUE)

The area north of 60° N is noted for producing high catch rates of large, high-quality shrimp. Unstandardized, annual CPUE's for the whole management area (single trawl data for offshore vessels) 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 recovered to 2258 kg/hr. The preliminary estimate for 1998 was 2015 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 1998 was higher than those of 1995 and 1996 and lower than the 1997 estimate but the differences were not significant ($P > 0.05$, Table 12). Both series showed that, since 1991, catch rates have fluctuated about a mean of approximately 2300 kg/hr.



With effort weighting, standardized indices showed the same trend as the analysis without weighting.

Historical fishery data for this management-assessment area are summarized in Table 13.

Size composition

Catch-at-length data showed variable size distributions between years (Fig. 15). High proportions of male shrimp (< 25 mm CL) and overall lower catch rates in 1989 and 1990 reflect the fishing activity south of 60° N in those years. From 1991 to 1997, with effort concentrating in the north where males appear to be less abundant, the female component dominated the catches by number and weight in all years except 1992. By 1998, the median size at sex change had decreased from 24-25 mm CL to 22 mm. This is thought to reflect increased fishing in southern 2G where growth rates and maturity schedules resemble those seen in the Hopedale + Cartwright area.

Given the high catch rates for primarily female shrimp in this area, averaging more than 2 tons per hour since 1991, it appears that a healthy spawning biomass is being maintained.

RESEARCH SURVEY DATA

Stock size

The 1996 fall multispecies research survey data from Div. 2G were reanalyzed using Monte Carlo methods in an attempt to improve the estimate (Fig. 16). The point estimate of 69,400 tons (with 95% confidence limits of about 30,000 and 122,000 tons) was higher than the 61,600 tons estimated using parametric methods (1600 - 122,000 tons) (Table 14) and the confidence limits were narrower. 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.

Survey coverage in 1997 was improved to 66 stations but broad 95% confidence intervals (11,400 - 146,700 tons) again were associated with the mean estimate of biomass (79,000 tons) calculated using traditional, parametric methods (Table 15). No survey was completed in 1998.

With current low survey coverage, results must be interpreted with caution. The data available cannot be used to establish trend in biomass/abundance.

The ratios of nominal catch to the lower confidence intervals of survey biomass indices were about 17% in 1996 and 45% in 1997. These ratios are more a reflection of uncertainty in the survey estimates than estimates of exploitation which, at present, are unknown.

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. 17, upper). Within the male component, the assumed 1992 year class (age 4) was most abundant and the 1991 year class (age 5) was well-represented. Age 6 shrimp, about 22 mm CL, appeared to comprise both sexes and females were aged to 8+ years.

Abundance in 1997 (Fig. 17, lower) again was dominated by males, most of which were assumed to belong to the 1993 and 1992 year classes. Age 6 shrimp of both sexes also were well-represented, consistent with the substantial numbers of males at age 5 in 1996.

It appears that significant recruitment of males to the survey gear does not occur till age 4. With the available data, no inference on the relative strength of recent year classes is possible. Also, age interpretation is confounded by the mixing of animals which, over a latitudinal scale, exhibit different growth rates and maturity schedules.

RESOURCE STATUS

The spawning stock remains healthy, as evidenced in continued high catch rates of large female shrimp, the target of the fishery. However, trend in stock size cannot be determined from the limited data available from research trawl surveys and current status is uncertain in the absence of a trawl survey in 1998. Furthermore, future prospects are uncertain in the absence of data on relative strengths of recruiting year classes (males).

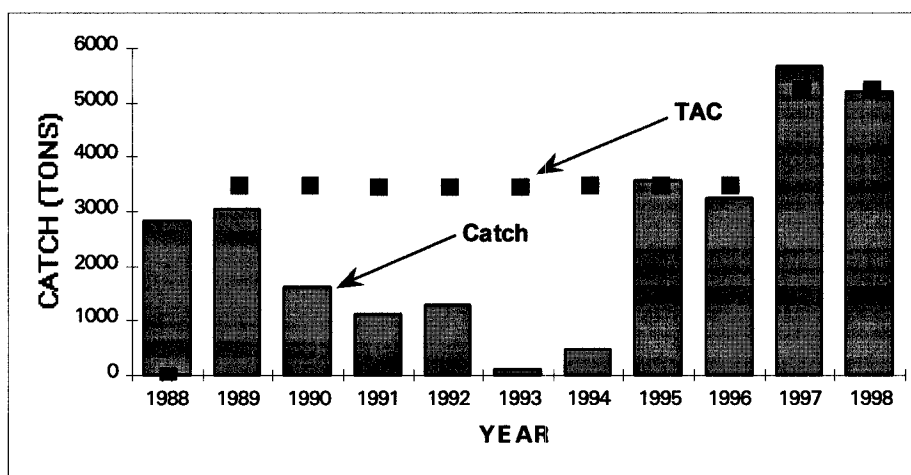
There was no scientific basis for a change in TAC for 1999.

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

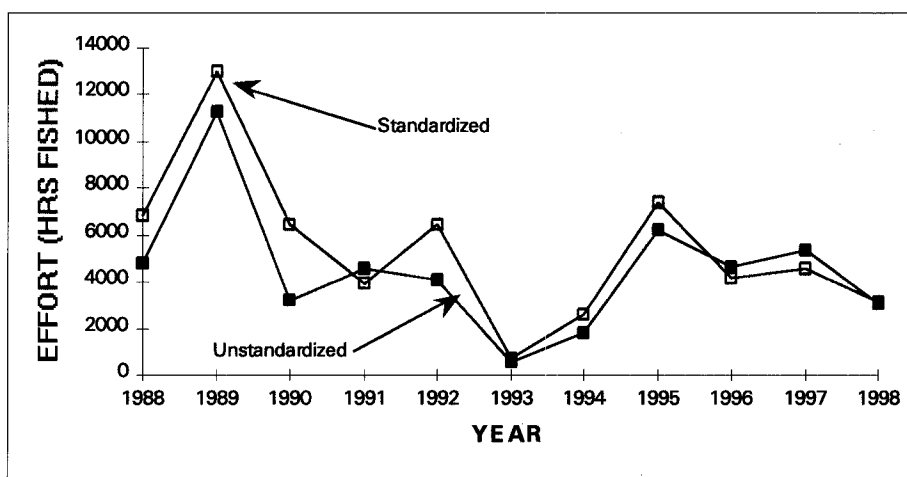
FISHERY DATA

Catch and effort

The fishery for *Pandalus borealis* in Div. 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. In 1994, catch remained low at less than 500 tons but increased substantially to about 3600 and 3200 tons in 1995 and 1996, respectively, and to more than 5000 tons in both 1997 and 1998. Recent catch estimates for the species have been separated as much as possible from the mixed fishery data for *P. borealis/montagu* in the area east of Resolution Island but their accuracy is still questionable. *P. borealis* taken in the adjacent areas of SFA's 3 and 4 in 1998 were included in the catches reported for SFA 2. 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.



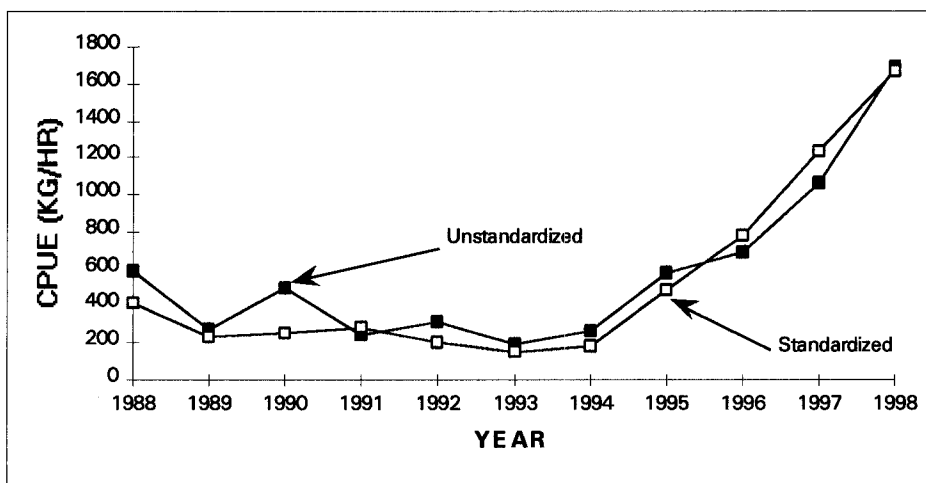
Fishing effort about doubled from 1988 to 1989, decreased sharply in 1990 and continued to decline up to 1993. Effort increased from 1993 to 1995 and declined gradually, thereafter.



In the late 1980's, fishing effort was primarily concentrated between 64° and 65° N whereas, during the 1990 - 1994 period, proportionately more was distributed south of 64° N. The areas fished extensively in the southwest from 1995 to 1998 reflect the targeting of dense concentrations of *P. borealis* and *P. montagui* east of Resolution Island. Virtually all the effort in 1997 and 1998 occurred south of 63° N (Fig. 18).

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 500 kg/hr in 1995 and 1996 and to 1000 kg/hr in 1997. The 1998 estimate of 1684 kg/hr was the highest observed. The data were analyzed by multiple regression for year and vessel effects. The model showed that the standardized, 1998 catch rate (1664 kg/hr) was the highest in the time series, significantly higher than all other years except 1997 (Table 16). 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 - 1998 when the fishery concentrated in the southwest. The 1998 CPUE was 3 - 4 times the 1988 estimate. Although MONTH effect was not significant in the regression analysis, more effort has occurred during the summer since 1994.



Historical fishery data for this management-assessment area are summarized in Table 17.

Size composition

Catches in most years were composed primarily of large, female shrimp (Fig. 19) with a modal length of about 27 mm CL. The importance of the male component of the catch (<25 mm) increased 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. Both male and female components were represented in good numbers in 1997 and 1998. The median size at sex change (24 - 25 mm) is large compared to southern areas but similar to that found in the northern part of Div. 2G.

RESOURCE STATUS

This area is difficult to fish, particularly in the northeast, 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. Although shrimp concentrations in northeast are elusive, those adjacent to eastern Resolution Island have persisted since first fished in 1995. Recently, fishermen have questioned whether the boundaries between SFA's 2, 3 and 4 are appropriate with respect to shrimp distribution.

The current status of this resource remains uncertain. The fishery has shifted to the southwest, east of Resolution Island, 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 and abundance/biomass of both species (i.e. the boundary question) will remain uncertain in the absence of a time series of research vessel trawl surveys. Future prospects also are unknown.

In 1997, the TAC of 3500 tons, established in 1989 as a precautionary level in an exploratory area, was increased "experimentally" by 50% to 5250 tons annually for the 1997 - 1999 Management Plan. The current assessment notes that, since the increase, little or no effort has occurred north of 63° N and the experimental approach could be applied to this area.

TABLE 1. MULTIPLICATIVE, YEAR MONTH VESSEL AREA MODEL, HAWKE+3K, 1988 - 1998

General Linear Models Procedure
Class Level Information

Class	Levels	Values
YEAR	11	88 89 90 91 92 93 94 95 96 97 98
MONTH	5	2 3 4 5 99
VESSEL	19	5 12 13 21 30 32 38 39 40 41 42 43 44 47 58 67 69 70 99
AREA	7	67 68 69 90 91 92 99

Number of observations in data set = 922

Dependent Variable: LNCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	38	429.79574357	11.31041430	24.46	0.0001
Error	883	408.22727587	0.46231855		
Corrected Total	921	838.02301944			

R-Square	C.V.	Root MSE	LNCPUE Mean
0.512869	10.02573	0.67994010	6.78195284

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YEAR	10	307.14539338	30.71453934	66.44	0.0001
MONTH	4	14.14566768	3.53641692	7.65	0.0001
VESSEL	18	41.60565996	2.31142555	5.00	0.0001
AREA	6	66.89902255	11.14983709	24.12	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	10	98.45818099	9.84581810	21.30	0.0001
MONTH	4	22.69114443	5.67278611	12.27	0.0001
VESSEL	18	38.94901668	2.16383426	4.68	0.0001
AREA	6	66.89902255	11.14983709	24.12	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > T	Std Error of Estimate
INTERCEPT	7.500292986 B	64.39	0.0001	0.11648878
YEAR 88	-1.005782693 B	-6.96	0.0001	0.14448015
YEAR 89	-1.219379760 B	-9.76	0.0001	0.12489579
YEAR 90	-0.989297586 B	-7.32	0.0001	0.13506984
YEAR 91	-0.887603396 B	-7.23	0.0001	0.12276855
YEAR 92	-0.443011976 B	-4.07	0.0001	0.10887465
YEAR 93	-0.367448084 B	-3.33	0.0009	0.11020470
YEAR 94	-0.368388442 B	-3.46	0.0006	0.10653440
YEAR 95	0.080752297 B	0.74	0.4602	0.10928584
YEAR 96	0.208789860 B	1.96	0.0505	0.10661739
YEAR 97	0.193914543 B	1.94	0.0527	0.09997063
YEAR 98	0.000000000 B	.	.	.

TABLE 2. NORTHERN SHRIMP FISHERY DATA FOR HAWKE CHANNEL + DIVISION 3K (SFA 6), 1977 - 1998.

YEAR	TAC ¹ (t)	CATCH ² (t)	<u>UNSTANDARDIZED</u>			<u>STANDARDIZED</u>		
			CPUE (KG/HR)	INDEX	EFFORT ³ (HR)	CPUE (KG/HR)	INDEX	EFFORT ³ (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		5544			
1988	3000	7849	536	1.00	14640	824	1.00	9525
1989	5600	6662	432	0.81	15407	667	0.81	9988
1990	5600	5598	507	0.95	11048	839	1.02	6672
1991	4301	5500	603	1.12	9120	931	1.13	5908
1992	7565	6609	774	1.44	8538	1454	1.76	4545
1993	9180	8035	891	1.66	9021	1567	1.90	5128
1994	11050	10978	1287	2.40	8533	1566	1.90	7010
1995	11050	10914	1836	3.42	5944	2453	2.98	4449
1996	11050	10923	2012	3.75	5429	2789	3.38	3916
1997	23100	21246	1966	3.67	10807	2749	3.34	7729
1998	46200	45676	1790	3.34	25517	2264	2.75	20175

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 OFFSHORE VESSEL LOG DATA.**

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

STRATUM	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	MEAN
70616131521.37	11697.30	8095.41	2.064

DEGREES OF
FREEDOM
24

STUDENTS
T-VALUE

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	MEAN
291,242,911.12	50.4645	31.1668	2.16

DEGREES OF
FREEDOM
13

STUDENTS
T-VALUE

TABLE 4. SURVEY ANALYSIS (STRAP) FOR SHRIMP IN HAWKE+3K, 1996.

STRATUM	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	MEAN
120083039234.12	17538.40	12649.14	2.093

DEGREES OF
FREEDOM
19

STUDENTS
T-VALUE
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	MEAN
517,959,636.98	78.4521	51.7572	2.131

DEGREES OF
FREEDOM
15

STUDENTS
T-VALUE
2.131

TABLE 5. SURVEY ANALYSIS (STRAP) FOR SHRIMP IN HAWKE+3K, 1997.

STRATUM	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

TABLE 6. SURVEY ANALYSIS (STRAP) FOR SHRIMP IN HAWKE+3K, 1998.

STRATUM	SETS	TOTAL	AV./SET	UNITS	TOTAL WGT.	VARIANCE
205	5	141.19	28.238	131471.72	3712558.23	885.32
206	7	273.85	39.121	242987.90	9505947.08	1210.62
207	11	85.37	7.761	359199.51	2787586.44	95.68
208	2	279.08	139.540	86278.31	12039275.81	4346.85
209	3	61.51	20.503	91267.20	1871290.67	128.48
210	4	334.10	83.524	151867.44	12684632.92	4657.82
211	2	423.99	211.994	36829.69	7807677.23	5365.26
212	2	15.04	7.522	81729.63	614785.58	1.85
213	8	1071.26	133.908	363454.73	48669442.95	3216.16
222	2	169.28	84.639	82023.09	6942387.61	6577.77
223	2	14.87	7.436	30960.42	230214.97	107.97
224	3	0.02	0.006	47100.92	277.06	0.00
225	3	0.00	0.000	39617.59	0.00	0.00
226	2	0.00	0.000	41671.84	0.00	0.00
227	2	86.15	43.073	87745.63	3779505.97	1661.58
228	8	1150.38	143.797	322223.09	46334798.94	20539.66
229	2	323.67	161.837	78648.26	12728163.76	2123.36
230	2	0.47	0.234	27145.39	6362.20	0.11
231	2	0.33	0.166	27292.12	4524.75	0.05
232	2	0.00	0.000	33454.86	0.00	0.00
233	2	0.08	0.038	34775.44	1315.70	0.00
235	2	243.97	121.985	60746.98	7410219.81	3693.70
236	2	0.04	0.019	37269.88	698.81	0.00
240	2	0.32	0.161	19515.33	3136.39	0.04
608	3	1.35	0.450	117092.00	52691.40	0.38
609	2	23.83	11.915	50182.28	597939.84	110.87
610	2	59.96	29.982	37563.35	1126219.58	342.60
611	2	5.72	2.861	84077.34	240581.29	7.36
612	2	0.24	0.120	65295.66	7835.48	0.02
613	2	0.00	0.000	4401.95	0.00	0.00
614	2	0.18	0.090	38590.47	3473.14	0.02
615	2	1.49	0.743	36829.69	27379.97	0.25
616	2	0.06	0.030	36682.96	1100.49	0.00
617	3	301.38	100.460	87011.97	8741248.32	252.72
618	4	3.84	0.960	197647.77	189834.50	2.96
619	6	13.36	2.227	257220.89	572745.18	20.84
620	11	553.18	50.289	373432.49	18779432.15	401.03
621	11	239.18	21.744	372258.64	8094379.68	651.34
622	3	240.01	80.003	101391.69	8111631.01	744.10
623	2	318.24	159.122	72485.52	11534067.87	1444.81
624	5	467.12	93.423	162138.67	15147480.66	2636.65
625	4	420.34	105.085	130297.86	13692350.68	795.29
626	5	158.69	31.738	163312.52	5183233.21	163.12
627	5	229.14	45.829	184148.44	8439292.84	258.01
628	5	194.51	38.902	159204.03	6193302.11	619.80
629	2	133.28	66.640	72632.25	4840213.37	20.22
630	2	168.83	84.415	48714.97	4112273.85	54.18
631	6	500.17	83.362	193832.74	16158341.48	2329.01
633	9	1470.37	163.374	303294.68	49550452.80	7323.37
634	7	727.88	103.983	228167.99	23725681.53	2434.93
635	5	177.676	35.535	186936.35	6642829.76	23.91
636	6	441.277	73.546	213494.81	15701720.09	1932.12
637	5	262.414	52.483	166100.43	8717407.13	497.72
638	9	919.796	102.200	302120.83	30876622.71	1927.28
639	6	868.309	144.718	214668.66	31066468.34	6795.84
640	2	0.609	0.305	10124.50	3084.81	0.14
641	2	0.020	0.010	33748.32	337.48	0.00
642	2	0.000	0.000	61333.90	0.00	0.00
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	9.688	4.844	31694.07	153520.50	9.04
646	2	0.030	0.015	47687.84	715.32	0.00
647	2	1.110	0.555	52823.46	29317.02	0.62
648	2	0.280	0.140	33454.86	4683.68	0.04
649	2	0.000	0.000	31107.15	0.00	0.00
650	2	0.000	0.000	19662.06	0.00	0.00
651	2	2.210	1.105	52676.73	58207.78	2.31
652	2	1.590	0.795	75713.62	60192.33	1.26
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
113329998621.66	140406457532.34	86253539710.99	14252.05
TOTAL	UPPER	LOWER	DEGREES OF FREEDOM
113329998621.66	17657.11	10846.99	3
TOTAL	UPPER	LOWER	DEGREES OF FREEDOM
113329998621.66	17657.11	10846.99	3

95 % CONFIDENCE INTERVALS FOR TOTAL AND MEAN WEIGHTS

TOTAL	UPPER	LOWER	MEAN
475,573,450.79	528,011,672.95	423,135,228.62	59.8067
TOTAL	UPPER	LOWER	DEGREES OF FREEDOM
475,573,450.79	66.4012	53.2123	33
TOTAL	UPPER	LOWER	DEGREES OF FREEDOM
475,573,450.79	66.4012	53.2123	33

TABLE 7. MULTIPLICATIVE, YEAR MONTH VESSEL AREA MODEL, HOPEDALE+CARTWRIGHT, 1977 - 1998

General Linear Models Procedure																									
Class Level Information																									
Class	Levels	Values																							
YEAR	22	77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98																							
MONTH	12	1 2 3 4 5 6 8 9 10 11 12 99																							
VESSEL	25	1 4 5 7 13 15 21 29 30 33 39 40 41 43 44 45 46 47 49 53 58 67 69 70 99																							
AREA	4	52 53 54 99																							
Number of observations in data set = 1301																									
Dependent Variable: LNCPUE																									
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F																				
Model	59	646.80476303	10.96279259	28.14	0.0001																				
Error	1241	483.39496091	0.38952052																						
Corrected Total	1300	1130.19972394																							
R-Square																									
0.572292																									
C.V.																									
9.788118																									
Root MSE																									
0.62411579																									
LNCPUE Mean																									
6.37625959																									
Source	DF	Type I SS	Mean Square	F Value	Pr > F																				
YEAR	21	486.25458998	23.15498048	59.44	0.0001																				
MONTH	11	102.08831593	9.28075599	23.83	0.0001																				
VESSEL	24	44.63320155	1.85971673	4.77	0.0001																				
AREA	3	13.82865557	4.60955186	11.83	0.0001																				
Source	DF	Type III SS	Mean Square	F Value	Pr > F																				
YEAR	21	96.00770247	4.57179536	11.74	0.0001																				
MONTH	11	98.90987464	8.99180679	23.08	0.0001																				
VESSEL	24	45.02240802	1.87593367	4.82	0.0001																				
AREA	3	13.82865557	4.60955186	11.83	0.0001																				
T for H0:																									
Parameter=0																									
Parameter	Estimate	Pr > T																							
INTERCEPT	7.102269377 B	0.0001																							
YEAR	-0.626788562 B	0.0024																							
77	-0.762997216 B	0.0006																							
78	-0.828403692 B	0.0001																							
79	-4.60	0.0001																							
80	-8.09	0.0001																							
81	-8.14	0.0001																							
82	-8.02	0.0001																							
83	-9.46	0.0001																							
84	-9.55	0.0001																							
85	-9.60	0.0001																							
86	-6.10	0.0001																							
87	-7.47	0.0001																							
88	-5.95	0.0001																							
89	-7.02	0.0001																							
90	-7.32	0.0001																							
91	-6.03	0.0001																							
92	-7.95	0.0001																							
93	-7.24	0.0001																							
94	-6.90	0.0001																							
95	-4.50	0.0001																							
96	-2.58	0.0100																							
97	-1.15	0.2513																							
98	0.00000000 B	.																							

TABLE 8. NORTHERN SHRIMP FISHERY DATA FOR HOPEDALE + CARTWRIGHT CHANNELS (SFA 5), 1977 - 1998.

YEAR	TAC ¹ (t)	CATCH ² (t)	UNSTANDARDIZED			STANDARDIZED		
			CPUE (KG/HR)	INDEX	EFFORT ³ (HR)	CPUE (KG/HR)	INDEX	EFFORT ³ (HR)
1977	.	2686	552	1.00	4865	773	1.00	3475
1978	5300	3630	453	0.82	8011	673	0.87	5394
1979	4000	3727	368	0.67	10136	636	0.82	5860
1980	4800	4108	388	0.70	10594	452	0.58	9088
1981	4800	3449	364	0.66	9485	430	0.56	8021
1982	4800	1983	372	0.67	5335	414	0.54	4790
1983	4800	1000	297	0.54	3368	311	0.40	3215
1984	4200	1002	297	0.54	3373	325	0.42	3083
1985	3570	1689	230	0.42	7350	364	0.47	4640
1986	4400	4826	538	0.97	8970	552	0.71	8743
1987	4800	5956	613	1.11	9714	530	0.69	11238
1988	4800	7838	625	1.13	12532	646	0.84	12133
1989	6000	5985	677	1.23	8847	666	0.86	8986
1990	6000	5360	626	1.13	8559	634	0.82	8454
1991	6375	6118	526	0.95	11634	748	0.97	8179
1992	6375	6315	695	1.26	9083	676	0.87	9342
1993	6375	5719	622	1.13	9201	719	0.93	7954
1994	7650	7499	757	1.37	9911	770	1.00	9739
1995	7650	7616	1387	2.51	5493	940	1.22	8102
1996	7650	7383	1870	3.39	3948	1119	1.45	6598
1997	15300	15103	1604	2.90	9416	1328	1.72	11373
1998	15300	14046	2133	3.86	6585	1466	1.90	9581

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 OFFSHORE VESSEL LOG DATA FOR SINGLE TRAWLS.

TABLE 9. SURVEY ANALYSIS (STRAP) FOR SHRIMP IN HOPEDALE + CARTWRIGHT, 1996.

STRATUM	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
	51631684272.21	47308.61	-11062.43	5
*	15816993291.79	7652.44	3451.31	5
				STUDENTS T-VALUE
				2.571
*				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
	192,372,554.68	158.1960	-23.1473	5
*	74,723,588.98	33.8486	18.6084	5
				STUDENTS T-VALUE
				2.571
*				2.365

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

TABLE 10. 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	MEAN
21114293276.28	15163.85	2752.75	3
TOTAL	UPPER	LOWER	MEAN
21114293276.28	15163.85	2752.75	3

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	MEAN
94,714,780.09	63.6900	16.6805	3
TOTAL	UPPER	LOWER	MEAN
94,714,780.09	63.6900	16.6805	3

TABLE 11. SURVEY ANALYSIS (STRAP) FOR SHRIMP IN HOPEDALE + CARTWRIGHT, 1998.

STRATUM	SETS	TOTAL	AV./SET	UNITS	TOTAL WGT.	VARIANCE
201	2	25.490	12.745	92881.25	1183771.47	246.64
202	2	51.904	25.952	91120.46	2364759.08	165.81
203	2	255.721	127.860	71458.40	9136693.20	7075.82
204	2	96.974	48.487	42258.77	2049008.69	2.66
214	3	226.427	75.476	65589.13	4950375.44	2619.26
215	5	396.820	79.364	191044.84	15162083.78	3603.54
216	2	198.843	99.421	36829.69	3661661.75	579.26
217	2	78.805	39.402	27585.58	1086935.36	2914.79
218	2	0.532	0.266	39470.86	10491.70	0.01
219	2	0.370	0.185	32574.47	6026.28	0.01
221	2	0.000	0.000	36242.76	0.00	0.00
234	2	7.978	3.989	86278.31	344169.58	11.39
238	3	1.820	0.607	114157.36	69255.46	1.10
239	2	71.239	35.620	17607.82	627185.33	226.43
930	5	3.390	0.678	150840.32	102269.73	0.62
931	2	27.936	13.968	40497.98	565685.37	348.05
932	2	1.298	0.649	8070.25	5237.26	0.09
933	2	0.682	0.341	7336.59	2502.40	0.19
934	2	0.020	0.010	11445.08	114.45	0.00
935	2	0.038	0.019	14086.26	264.12	0.00
936	2	0.000	0.000	11445.08	0.00	0.00
937	2	0.000	0.000	13792.79	0.00	0.00
938	2	0.000	0.000	28025.78	0.00	0.00
940	2	0.020	0.010	14232.99	142.33	0.00
941	2	0.000	0.000	13059.13	0.00	0.00
942	2	0.028	0.014	8070.25	113.49	0.00
943	2	2.997	1.498	51943.07	77833.44	0.24
944	4	81.997	20.499	126189.37	2586802.05	398.45
945	2	16.160	8.080	67643.37	546558.44	14.80
946	4	44.007	11.002	105793.65	1163917.45	141.23
947	2	19.079	9.539	33308.12	317738.69	7.00
948	2	129.439	64.720	36096.03	2336124.38	2571.84
951	2	12.506	6.253	34335.25	214702.59	23.42
952	2	136.313	68.156	25971.53	1770122.30	4993.75
953	2	60.470	30.235	42698.96	1291003.09	154.35
954	5	441.704	88.341	142476.60	12586489.89	35939.43
955	2	76.966	38.483	57078.68	2196560.88	98.58
956	5	249.039	49.808	154215.15	7681128.82	9245.64
957	7	60.853	8.693	201169.33	1748828.64	303.44
958	2	418.441	209.220	43139.16	9025587.82	213.40
959	2	49.640	24.820	26118.26	648255.33	140.11
960	2	0.018	0.009	15700.31	138.53	0.00
961	2	0.000	0.000	30960.42	0.00	0.00
962	2	0.000	0.000	35509.10	0.00	0.00
963	2	0.000	0.000	38883.93	0.00	0.00
964	2	0.000	0.000	50182.28	0.00	0.00

95 % CONFIDENCE INTERVALS FOR TOTAL AND MEAN NUMBERS

TOTAL	UPPER	LOWER	MEAN
16934819899.04	24387402901.02	9482236897.06	6550.14
TOTAL	UPPER	LOWER	MEAN
16934819899.04	9432.68	3667.59	2.262

DEGREES OF
FREEDOM
9

STUDENTS
T-VALUE
2.262

95 % CONFIDENCE INTERVALS FOR TOTAL AND MEAN WEIGHTS

TOTAL	UPPER	LOWER	MEAN
85,520,538.60	121,237,729.06	49,803,348.15	33.0781
TOTAL	UPPER	LOWER	MEAN
85,520,538.60	46.8930	19.2632	2.262

DEGREES OF
FREEDOM
9

STUDENTS
T-VALUE
2.262

TABLE 12. MULTIPLICATIVE, YEAR MONTH VESSEL MODEL - SINGLE TRAWL - DIV.2G, 1988 - 1998

General Linear Models Procedure
Class Level Information

Class	Levels	Values
YEAR	11	88 89 90 91 92 93 94 95 96 97 98
MONTH	8	5 7 8 9 10 11 12 99
VESSEL	20	5 12 21 29 30 33 34 36 37 38 40 42 43 44 47 58 67 69 70 99

Number of observations in data set = 262

Dependent Variable: LNCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	36	81.63938631	2.26776073	9.34	0.0001
Error	225	54.62628740	0.24278350		
Corrected Total	261	136.26567371			

R-Square	C.V.	Root MSE	LNCPUE Mean
0.599119	6.608377	0.49273066	7.45615225

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YEAR	10	61.99305151	6.19930515	25.53	0.0001
MONTH	7	7.53707106	1.07672444	4.43	0.0001
VESSEL	19	12.10926374	0.63732967	2.63	0.0004

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	10	41.80628081	4.18062808	17.22	0.0001
MONTH	7	5.16412930	0.73773276	3.04	0.0045
VESSEL	19	12.10926374	0.63732967	2.63	0.0004

Parameter	Estimate	T for H0: Parameter=0	Pr > T	Std Error of Estimate
INTERCEPT	7.697365896 B	49.64	0.0001	0.15504934
YEAR	-0.593328230 B	-2.28	0.0235	0.26020737
88	-1.386839591 B	-8.04	0.0001	0.17245386
89	-1.188312258 B	-8.16	0.0001	0.14570195
90	-0.000249789 B	-0.00	0.9991	0.21211294
91	-0.452204620 B	-3.06	0.0025	0.14790414
92	0.138235075 B	1.08	0.2819	0.12814858
93	0.374384457 B	3.30	0.0011	0.11334370
94	-0.202563212 B	-1.75	0.0820	0.11593719
95	-0.280686371 B	-1.79	0.0745	0.15665734
96	0.086745126 B	0.72	0.4692	0.11965422
97	0.000000000 B	.	.	.
98	0.000000000 B	.	.	.

TABLE 13. NORTHERN SHRIMP FISHERY DATA FOR DIV. 2G (SFA 4), 1979 - 1998.

YEAR	TAC ¹ (t)	CATCH ² (t)	<u>UNSTANDARDIZED</u>			<u>STANDARDIZED</u>		
			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	1325	1.00	817
1989	2580	3842	672	0.37	5716	611	0.46	6288
1990	2580	2945	703	0.39	4190	747	0.56	3942
1991	2635	2561	3071	1.68	834	2432	1.84	1053
1992	2635	2706	1910	1.05	1417	1561	1.18	1734
1993	2735	2723	2174	1.19	1253	2814	2.12	968
1994	4000	3982	3169	1.74	1257	3568	2.69	1116
1995	5200	5104	1506	0.83	3389	2002	1.51	2549
1996	5200	5160	1168	0.64	4418	1840	1.39	2804
1997	5200	5217	2620	1.44	1991	2678	2.02	1948
1998	8320	8069	2015	1.11	4004	2458	1.86	3283

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 OFFSHORE VESSEL LOG DATA.

TABLE 14. SURVEY ANALYSIS (STRAP) FOR SHRIMP IN DIV. 2G, 1996.

STRATUM	SETS	TOTAL	AV./SET	UNITS	TOTAL WGT.	VARIANCE
901	4	77.883	19.471	177985.70	3465508.16	555.12
902	2	24.065	12.033	17607.82	211866.08	54.24
908	2	293.350	146.675	85838.12	12590305.91	38600.31
909	8	27.722	3.465	406887.35	1409976.86	10.12
910	6	0.291	0.048	343205.74	16624.03	0.01
911	3	322.893	107.631	101538.42	10928693.28	32945.67
923	2	111.984	55.992	27292.12	1528145.47	919.80
924	2	213.448	106.724	110929.26	11838786.58	20664.94
925	4	1.775	0.444	264704.21	117469.79	0.19
926	2	8.414	4.207	63534.88	267276.29	1.03
927	2	98.108	49.054	122080.88	5988524.89	4579.96
928	3	313.640	104.547	114891.02	12011473.07	10081.42
929	3	20.033	6.678	185028.83	1235557.23	56.88

95 % CONFIDENCE INTERVALS FOR TOTAL AND MEAN NUMBERS

TOTAL	UPPER	LOWER	MEAN
10894509749.82	24854779947.16	-3065760447.52	5389.25
TOTAL	UPPER	LOWER	DEGREES OF FREEDOM
10894509749.82	12295.07	-1516.56	3
TOTAL	UPPER	LOWER	MEAN
10894509749.82	12295.07	-1516.56	5389.25

95 % CONFIDENCE INTERVALS FOR TOTAL AND MEAN WEIGHTS

TOTAL	UPPER	LOWER	MEAN
61,610,207.65	121,578,440.78	1,641,974.51	30.4771
TOTAL	UPPER	LOWER	DEGREES OF FREEDOM
61,610,207.65	60.1420	0.81225	4
TOTAL	UPPER	LOWER	MEAN
61,610,207.65	60.1420	0.81225	30.4771

TABLE 15. SURVEY ANALYSIS (STRAP) FOR SHRIMP IN DIV. 2G, 1997.

STRATUM	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
13533288048.51	20285.18	2169.22	4
TOTAL	UPPER	LOWER	MEAN
13533288048.51	20285.18	2169.22	11227.20

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
79,049,272.38	121.677	9.48100	4
TOTAL	UPPER	LOWER	MEAN
79,049,272.38	121.677	9.48100	65.5792

TABLE 16. MULTIPLICATIVE, YEAR VESSEL MODEL - SINGLE TRAWL, 1988 - 1998
General Linear Models Procedure

Class Level Information																
Class	Levels	Values														
YEAR	11	88 89 90 91 92 93 94 95 96 97 98														
MONTH	7	6 7 8 9 10 12 99														
VESSEL	18	5 12 21 29 30 32 33 39 40 41 42 44 47 58 67 69 70 99														
			Number of observations in data set = 322													
Dependent Variable: LNCPUE																
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F											
Model	27	228.94436165	8.47942080	10.70	0.0001											
Error	294	232.99406549	0.79249682													
Corrected Total	321	461.93842714														
R-Square			C.V.	Root MSE	LNCPUE Mean											
	0.495617	15.04729	0.89022291		5.91616918											
Source			Type I SS	Mean Square	F Value	Pr > F										
YEAR	10	202.50688123	20.25068812	25.55	0.0001	0.0001										
VESSEL	17	26.43748042	1.55514591	1.96	0.0134	0.0134										
Source			Type III SS	Mean Square	F Value	Pr > F										
YEAR	10	164.47526948	16.44752695	20.75	0.0001	0.0001										
VESSEL	17	26.43748042	1.55514591	1.96	0.0134	0.0134										
Parameter			Estimate	T for H0:	Pr > T	Std Error of Estimate										
INTERCEPT		7.042463202	32.68	Parameter=0	0.0001	0.21547634										
YEAR	88	-1.368269164	-4.01		0.0001	0.34152142										
	89	-1.958038335	-7.91		0.0001	0.24752828										
	90	-1.893763174	-7.25		0.0001	0.26121559										
	91	-1.777261257	-6.82		0.0001	0.26041748										
	92	-2.108917921	-8.67		0.0001	0.24331183										
	93	-2.365338705	-8.76		0.0001	0.26990048										
	94	-2.191117653	-9.73		0.0001	0.22513872										
	95	-1.238191358	-6.14		0.0001	0.20176180										
	96	-0.760038200	-3.36		0.0009	0.22641676										
	97	-0.300214856	-1.41		0.1589	0.21254488										
	98	0.000000000	0.		0.	0.										

TABLE 17. NORTHERN SHRIMP FISHERY DATA FOR DIV. 0B (SFA 2), 1988 - 1998.

YEAR	TAC ¹ (t)	CATCH ² (t)	<u>UNSTANDARDIZED</u>			<u>STANDARDIZED</u>		
			CPUE (KG/HR)	INDEX	EFFORT ³ (HR)	CPUE (KG/HR)	INDEX	EFFORT ³ (HR)
1988	.	2826	585	1.00	4831	411	1.00	6876
1989	3500	3039	271	0.46	11214	234	0.57	12987
1990	3500	1609	497	0.85	3237	249	0.61	6462
1991	3485	1107	242	0.41	4574	280	0.68	3954
1992	3485	1291	315	0.54	4098	201	0.49	6423
1993	3485	106	193	0.33	549	155	0.38	684
1994	3500	476	262	0.45	1817	186	0.45	2559
1995	3500	3564	573	0.98	6220	484	1.18	7364
1996	3500	3220	690	1.18	4667	777	1.89	4144
1997	5250	5670	1059	1.81	5354	1234	3.00	4595
1998	5250	5206	1684	2.88	3091	1664	4.05	3129

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 OFFSHORE VESSEL LOG DATA.

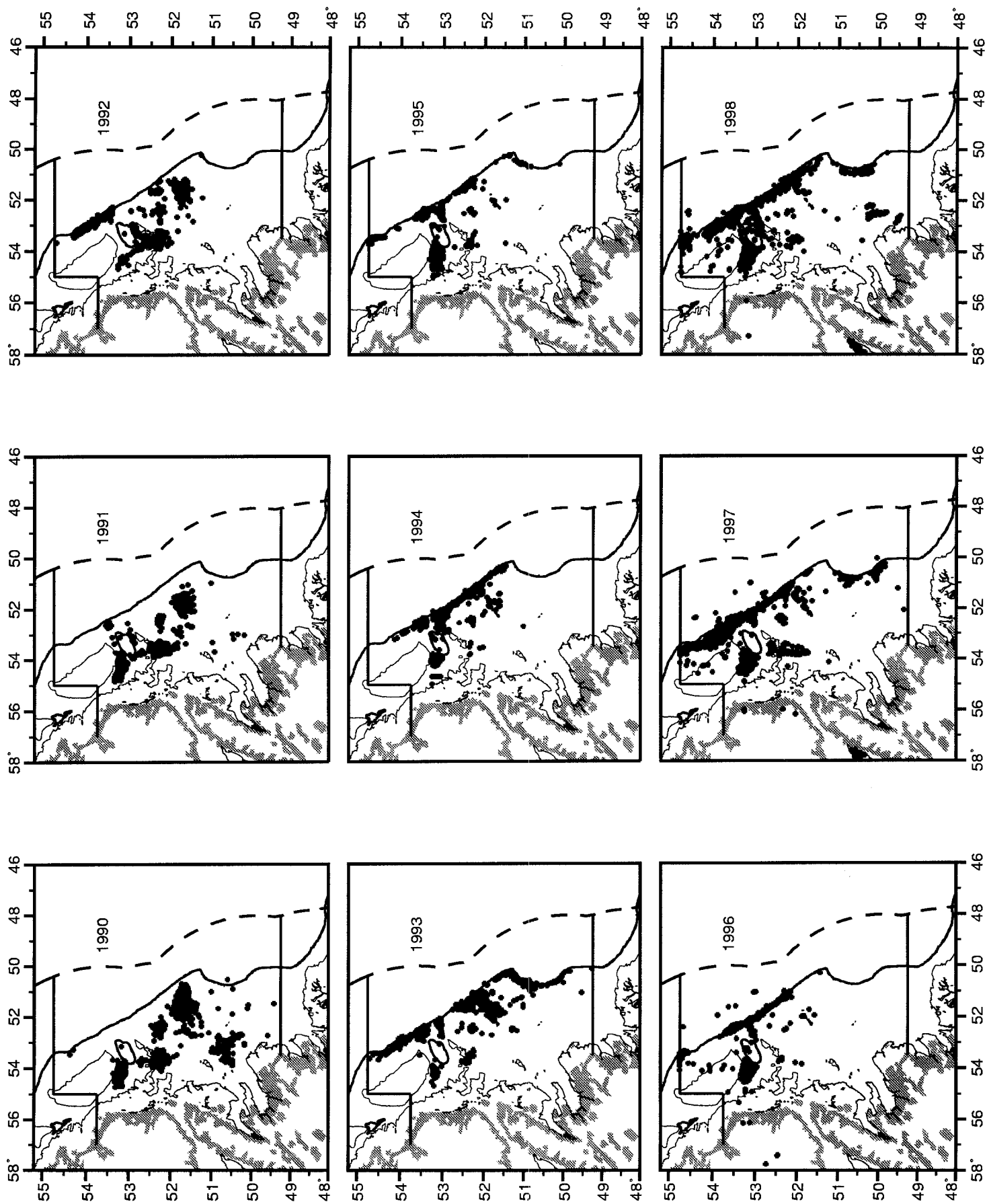
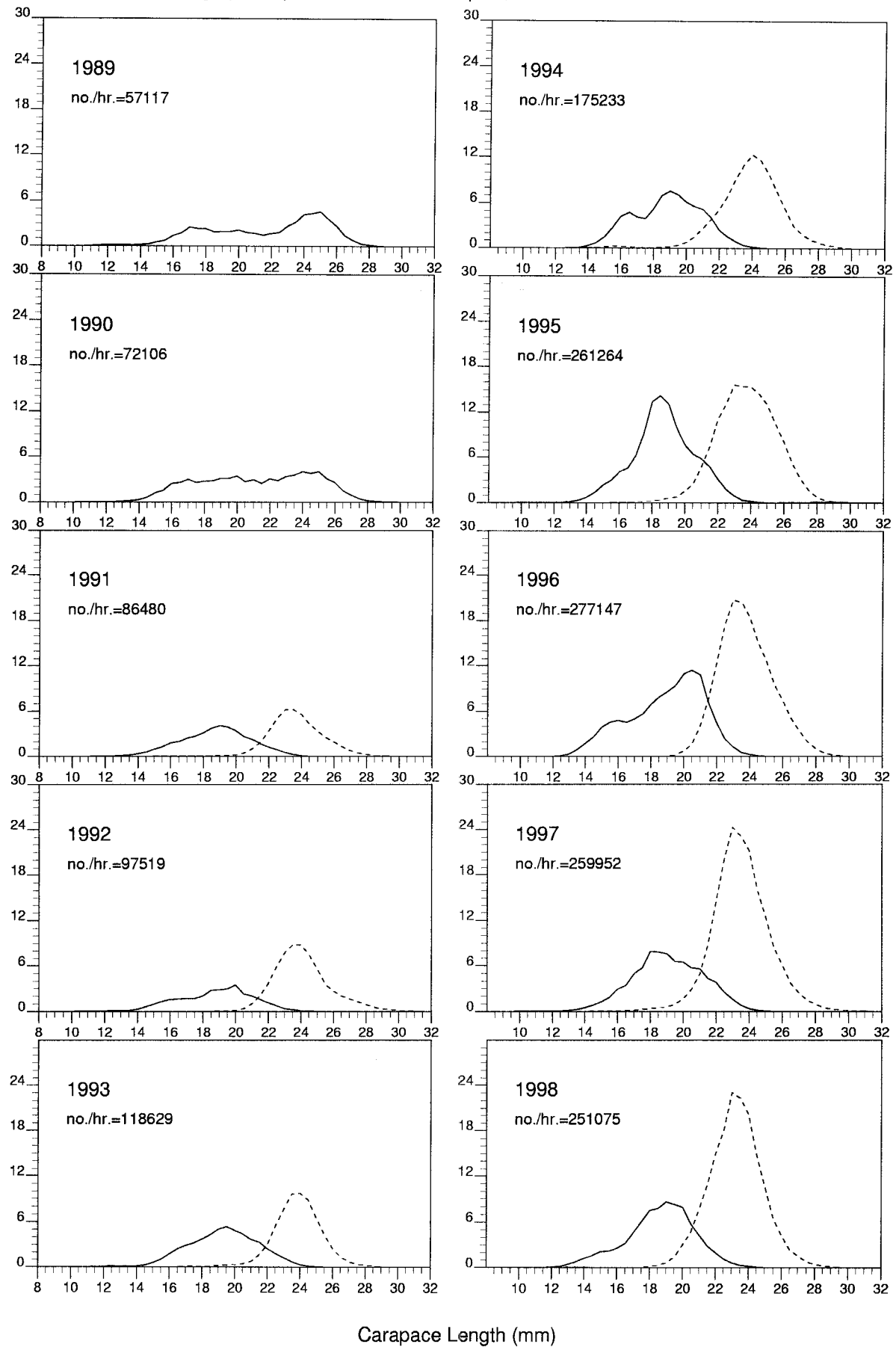


Fig. 1. Distribution of fishing effort in Div. 2J-3K (SFA 6), 1990-98.

Fig. 2. Catch ...numbers-per-hour...000s in NAFO Division 2J-3K (SFA 6), 1989-98.
Single-line graphs represent unsexed samples, broken line=females.



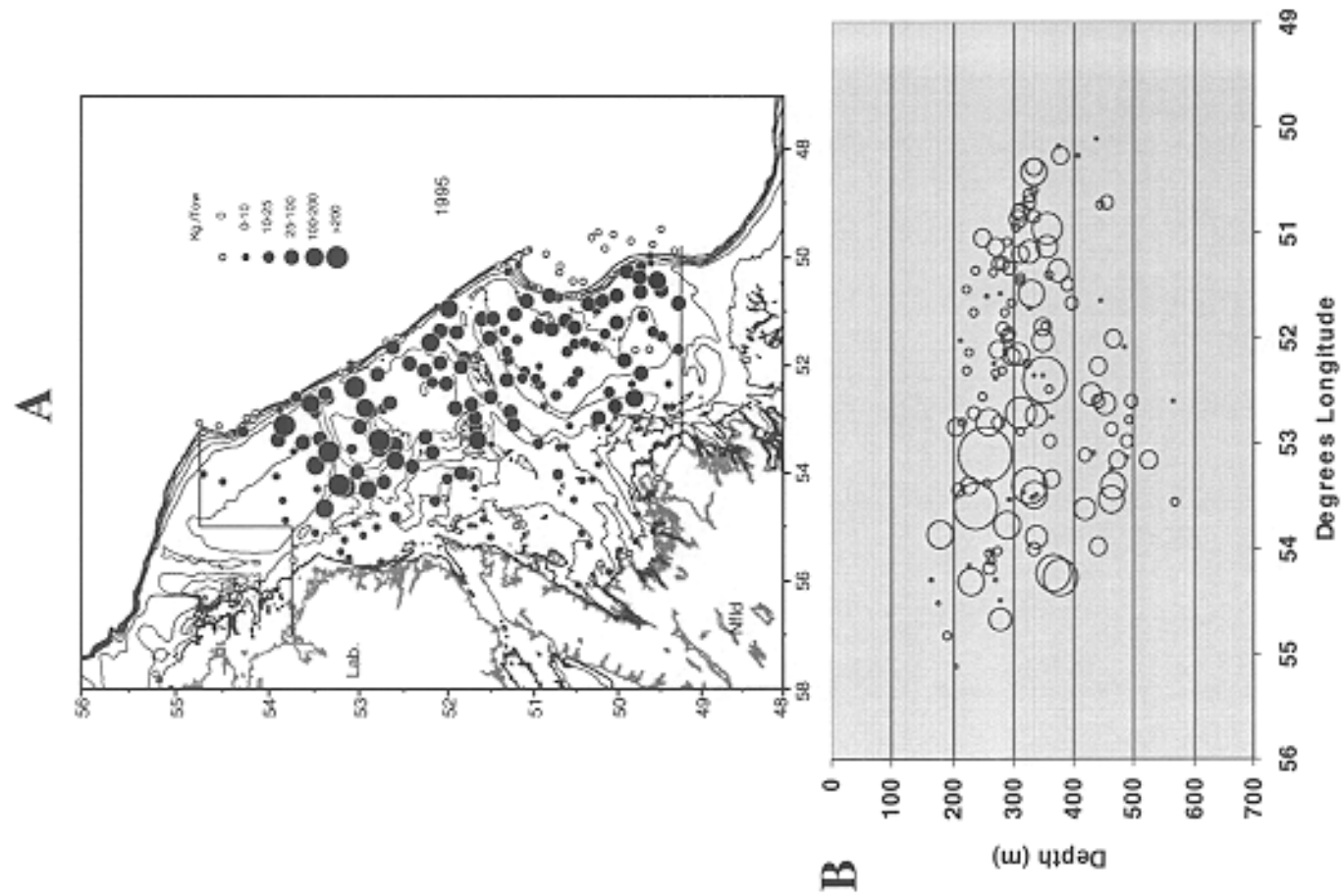
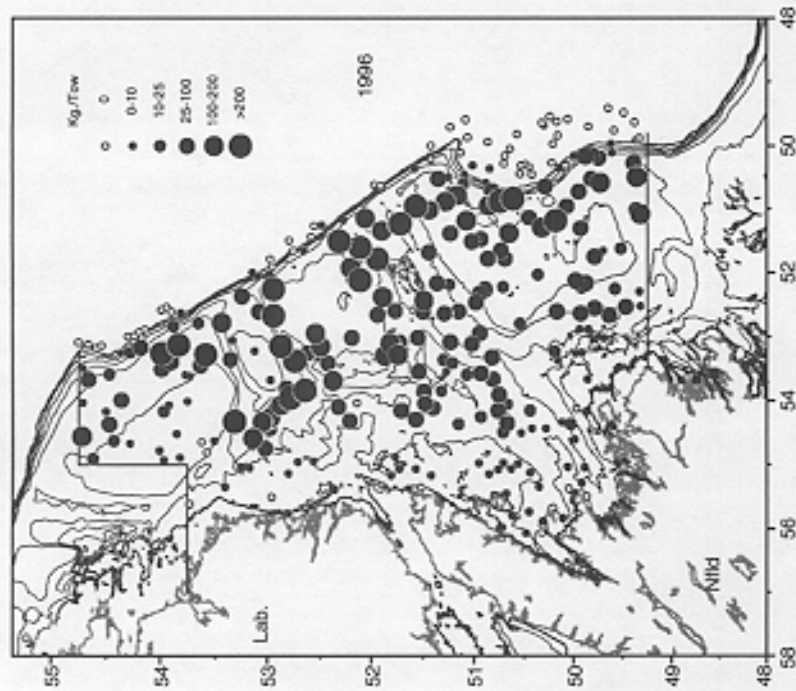
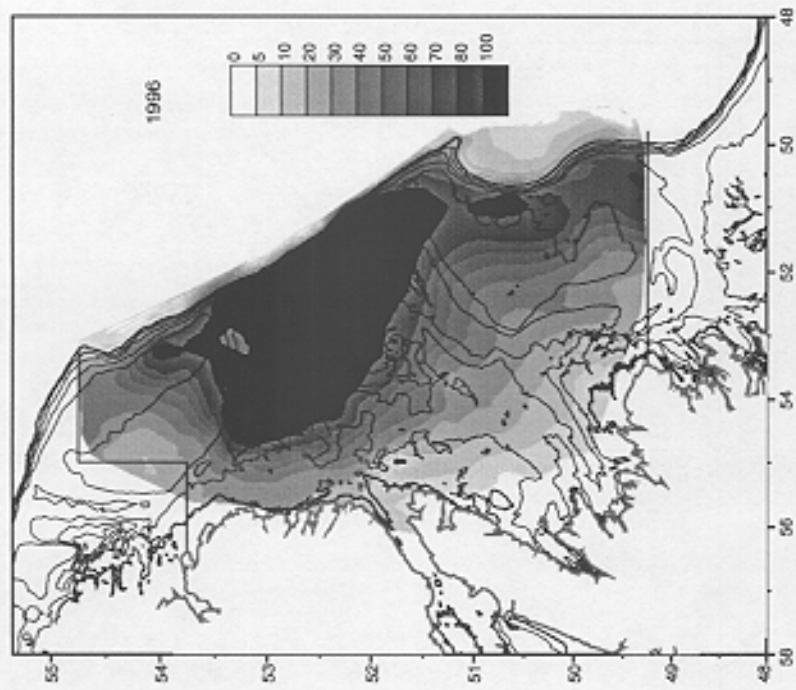


Figure 3. Trawl Survey Analysis, 1995 - Hawke+3K: A - Catch weight per standard tow; B - Catch weight by depth and longitude; C - Ogm density (mass) contours; D - Monte Carlo biomass estimates.

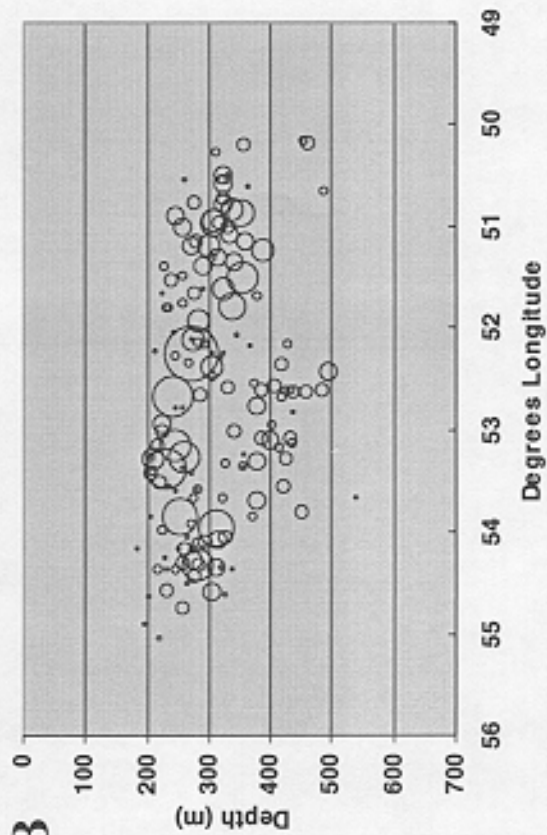
A



C



B



D

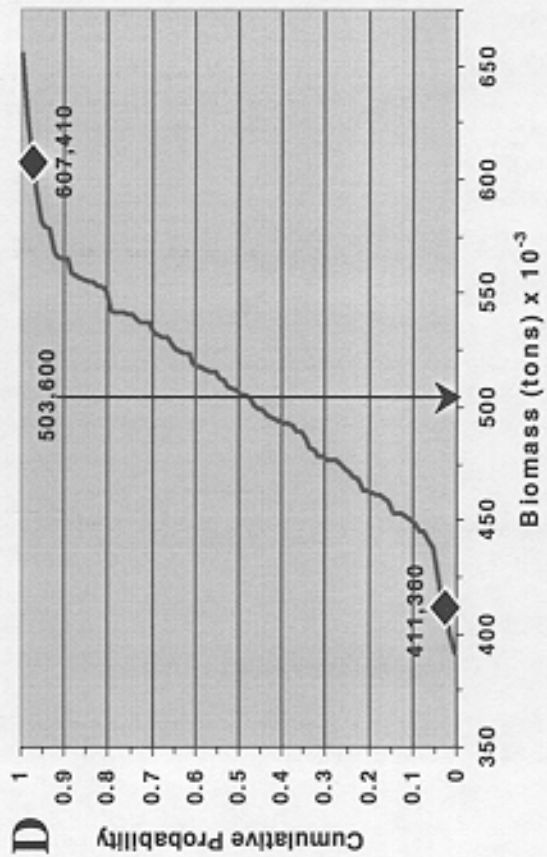
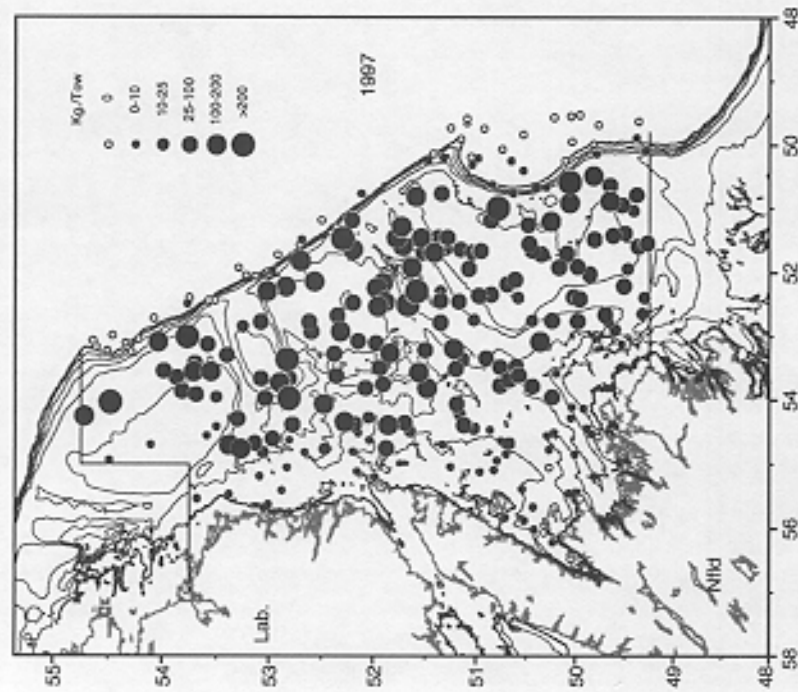
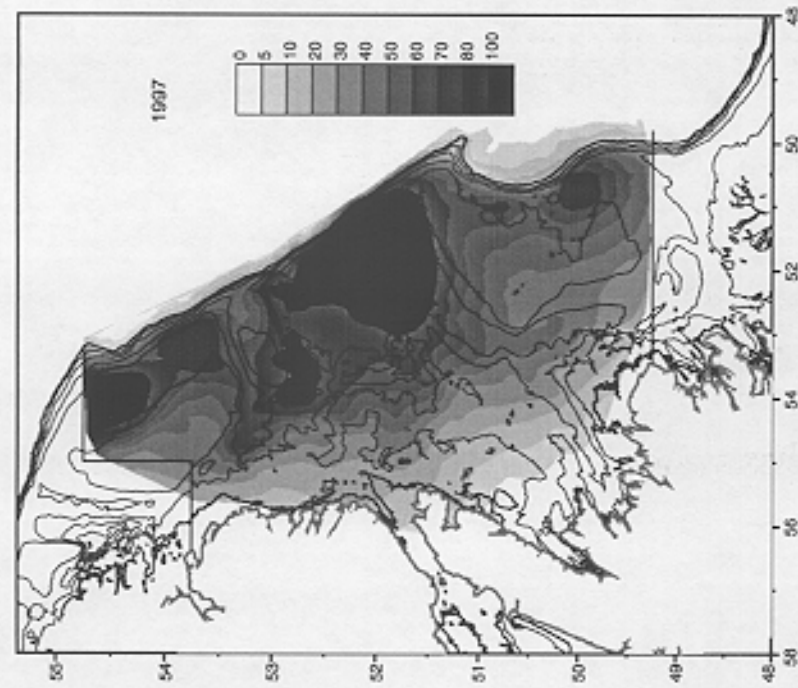


Figure 4. Trawl Survey Analysis, 1996 - Hawke+3K: A - Catch weight per standard tow; B - Catch weight by depth and longitude; C - Ognmap density (mass) contours; D - Monte Carlo biomass estimates.

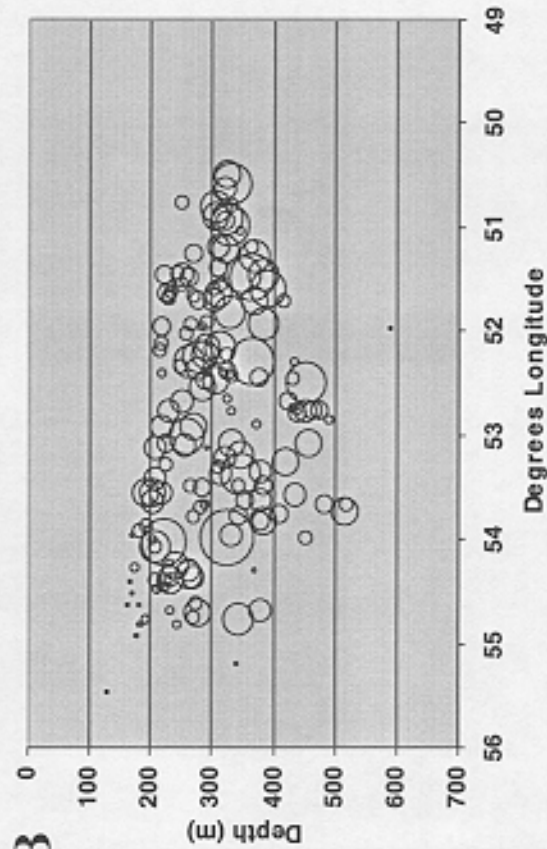
A



C



B



D

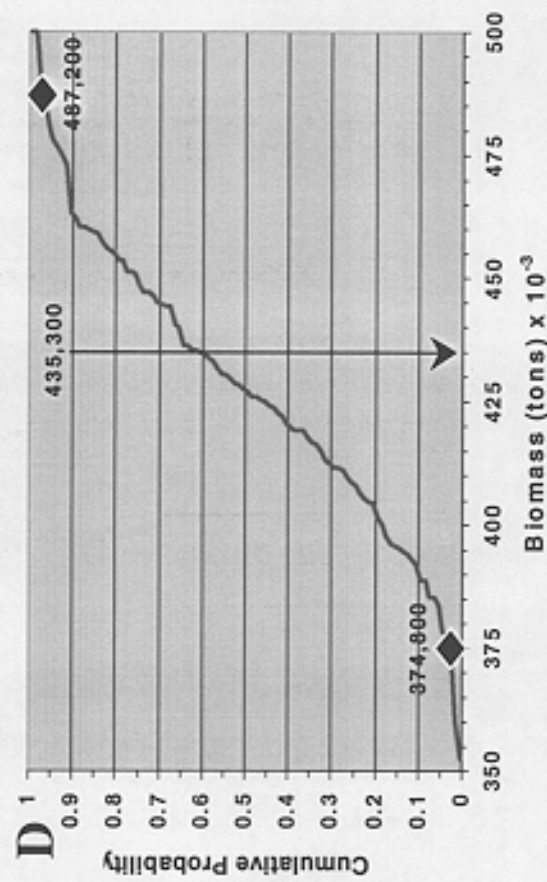


Figure 5. Trawl Survey Analysis, 1997 – Hawke+3K: A – Catch weight per standard tow; B – Catch weight by depth and longitude; C – Ogmap density (mass) contours; D – Monte Carlo biomass estimates.

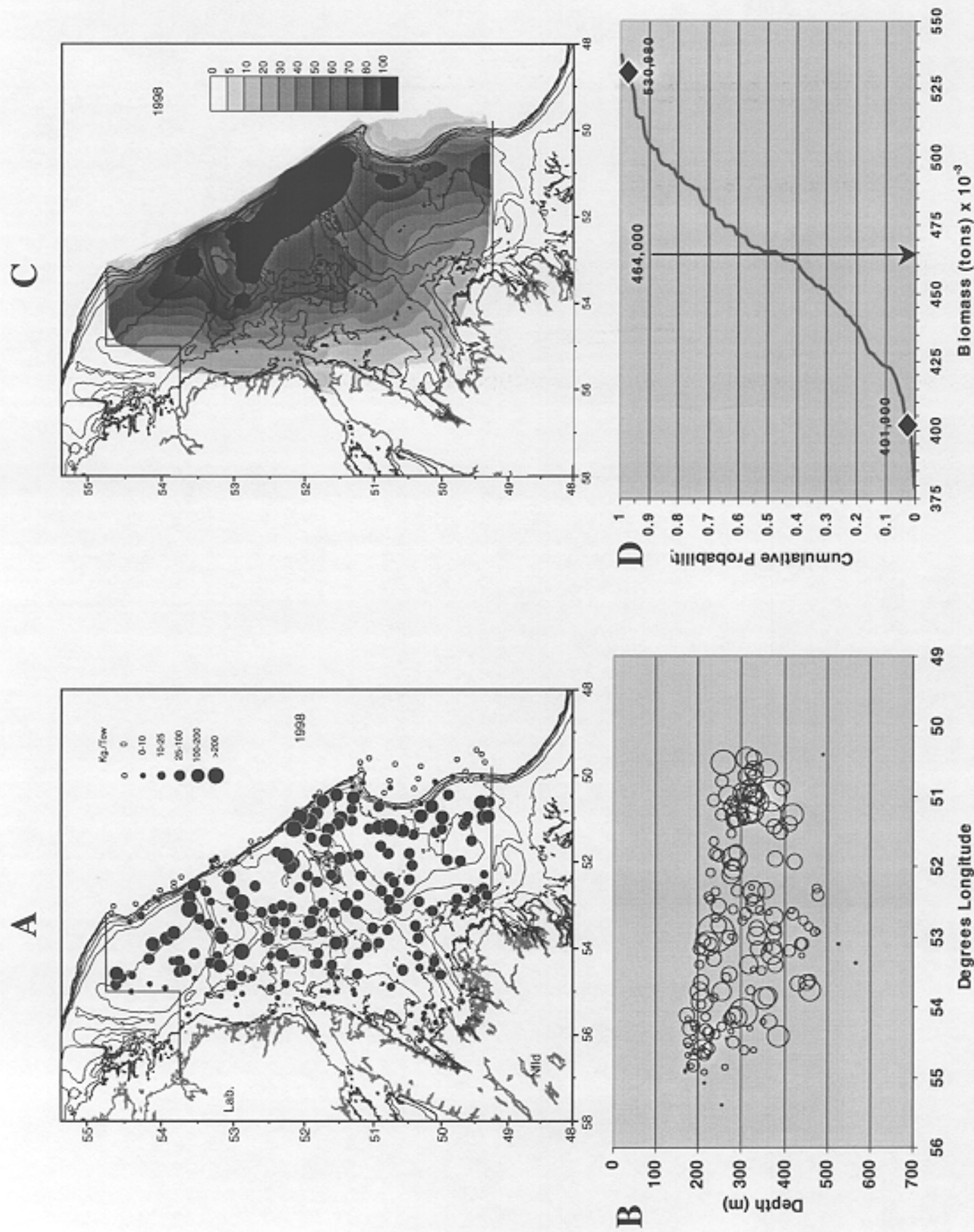
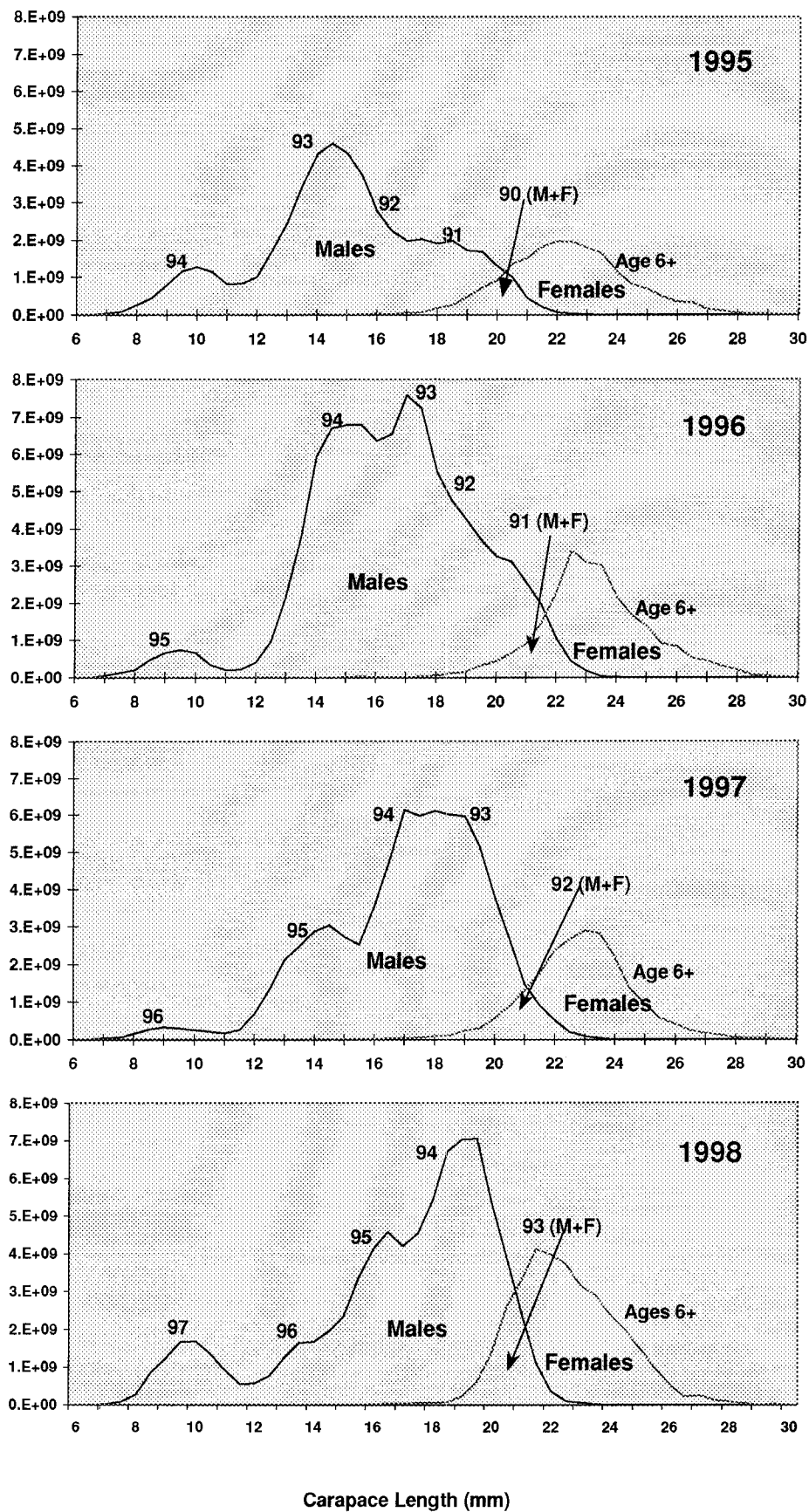


Figure 6. Trawl Survey Analysis, 1998 – Hawke+3K: A – Catch weight per standard tow; B – Catch weight by depth and longitude; C – Ogmap density (mass) contours; D – Monte Carlo biomass estimates.

Figure 7. Abundance (billions) at length and age for shrimp in Hawke+3K estimated from RV surveys, 1995 - 1998.



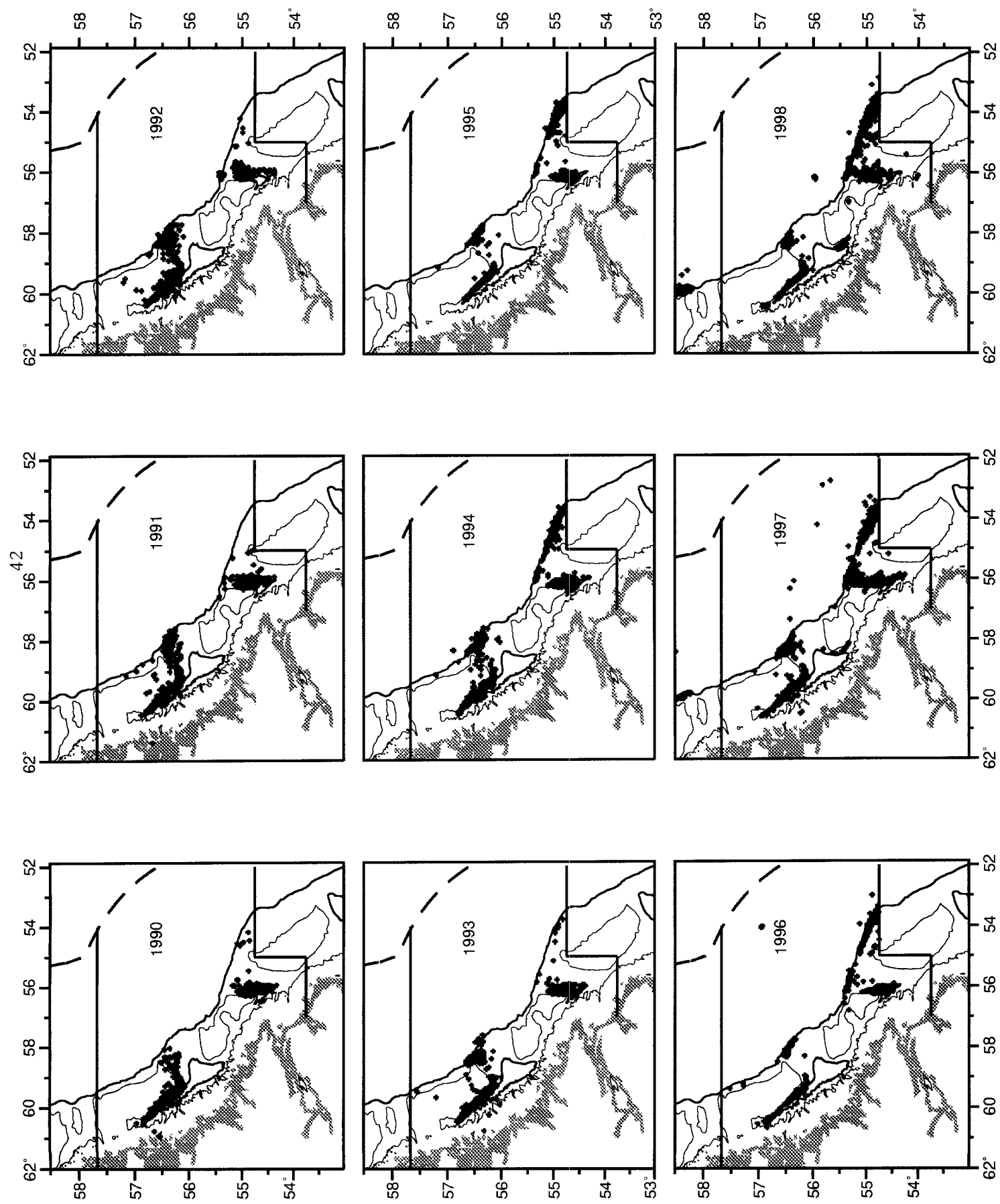
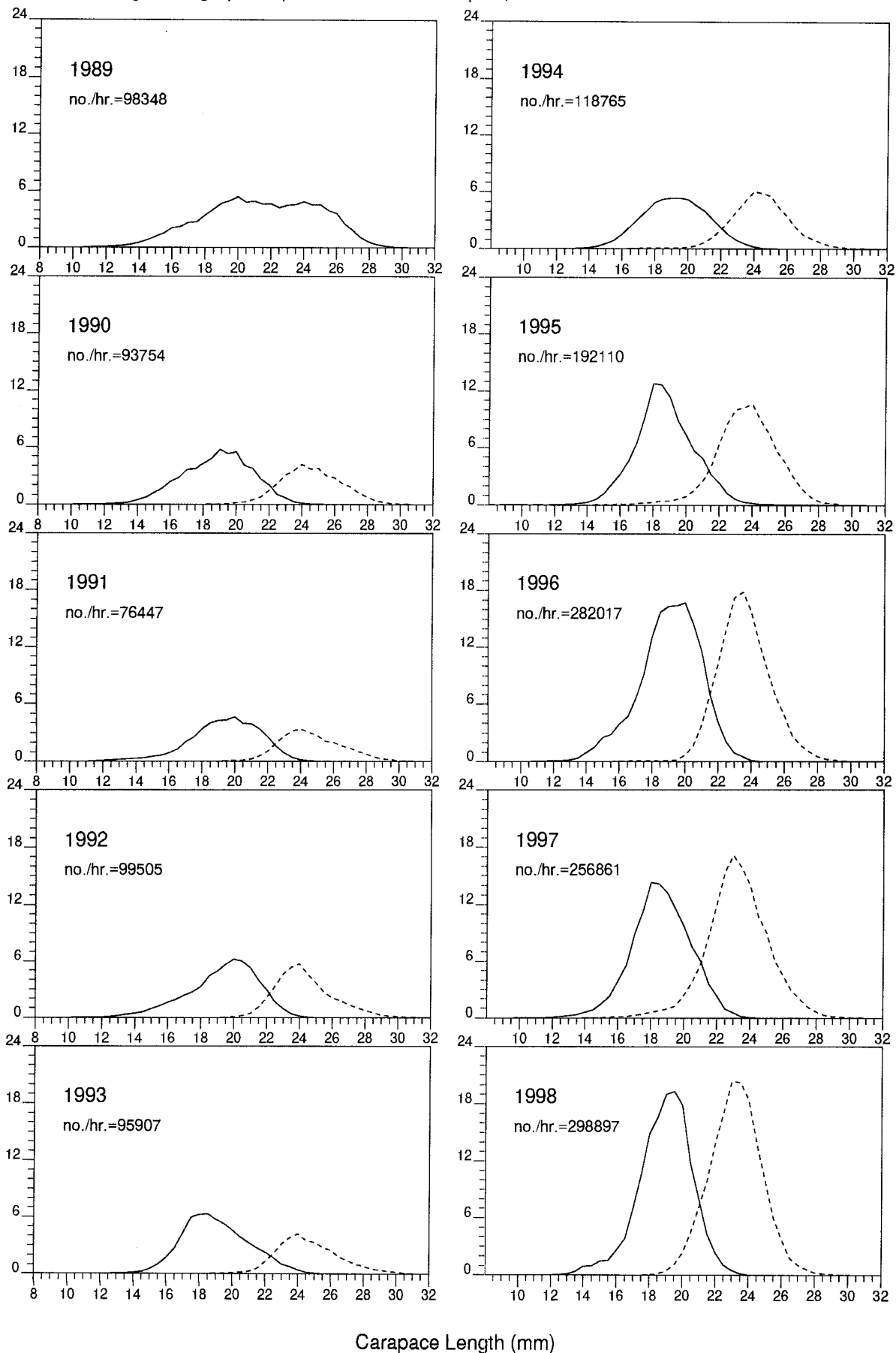


Fig. 8. Distribution of fishing effort in Div. 2H-2J (SFA 5), 1990-98.

Fig. 9. Catch ...numbers-per-hour...000s in NAFO Division 2H-2J (SFA 5), 1989-98.
Single-line graphs represent unsexed samples, broken line=females.



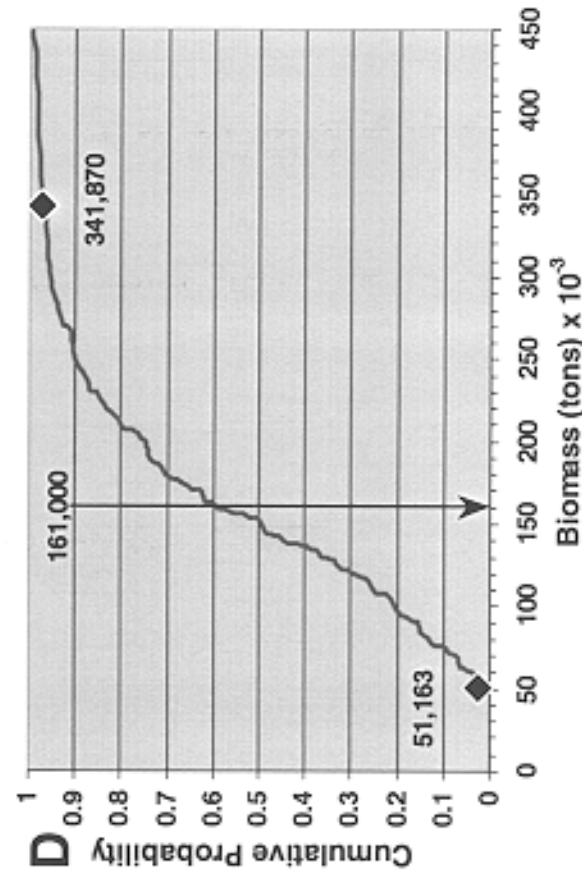
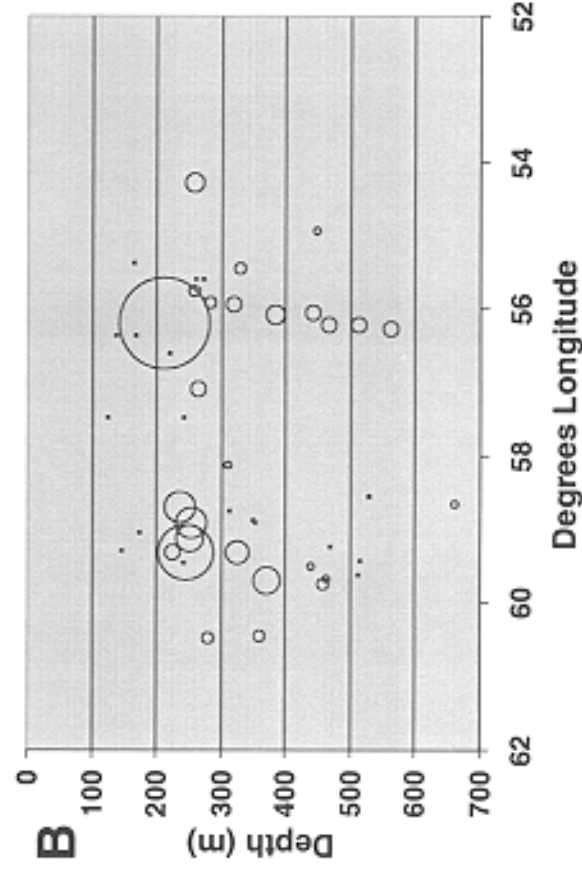
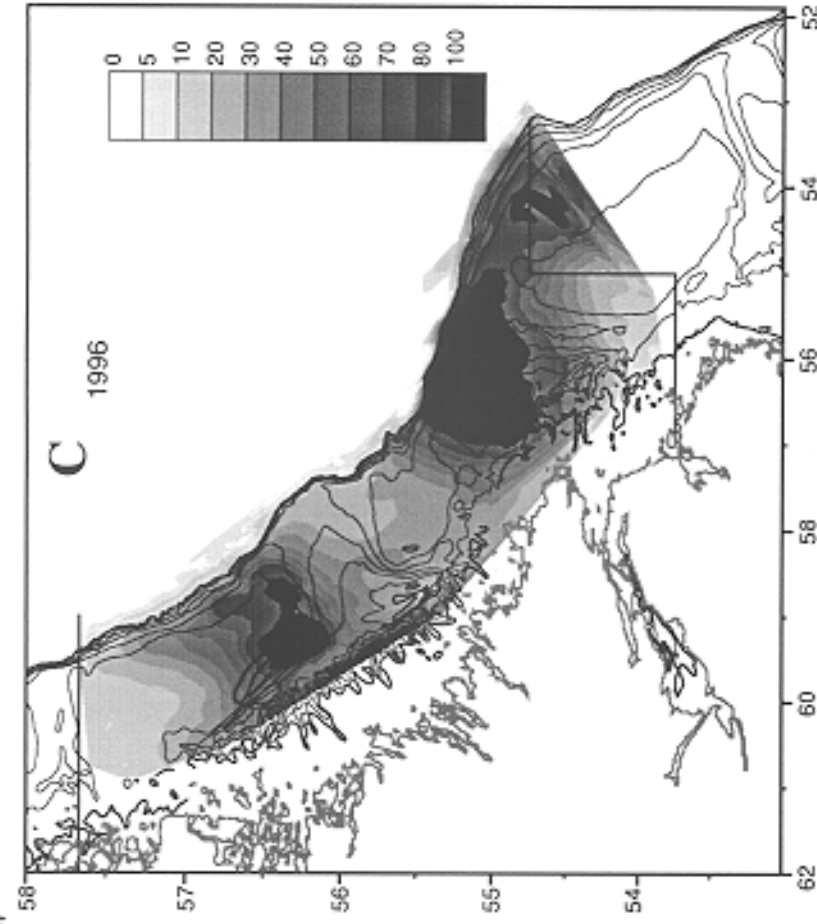
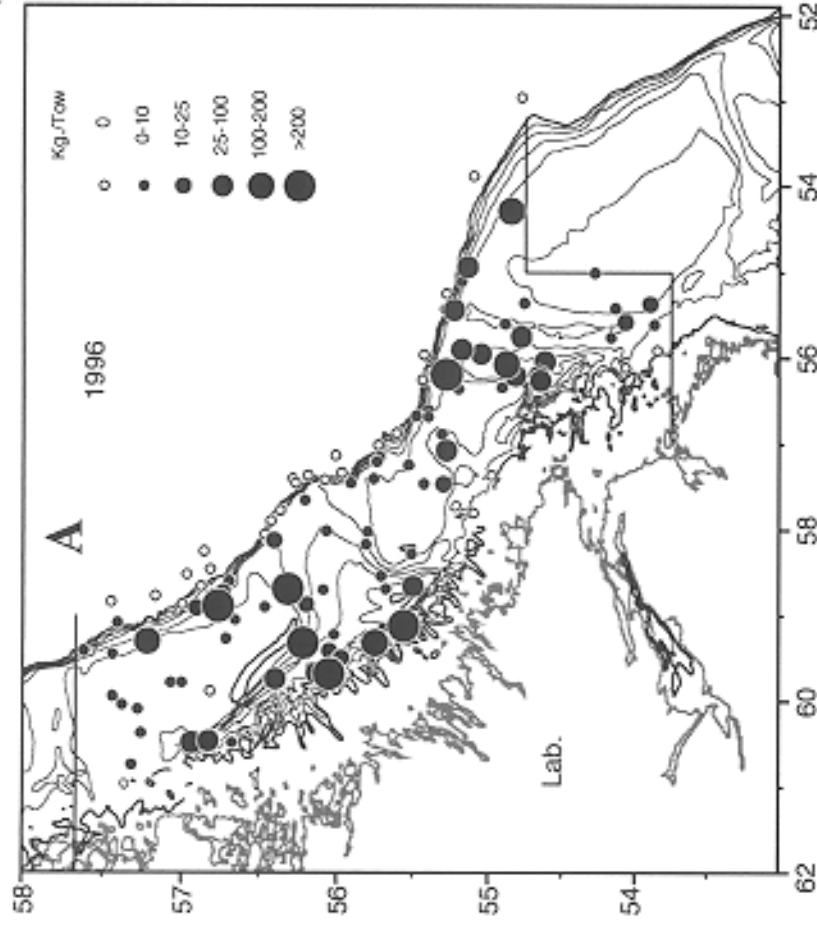


Figure 10. Trawl Survey Analysis, 1996 – Hopedale+Cartwright: A – Catch weight per standard tow; B – Catch weight by depth and longitude; C – Ogmap density (mass) contours; D – Monte Carlo biomass estimates.

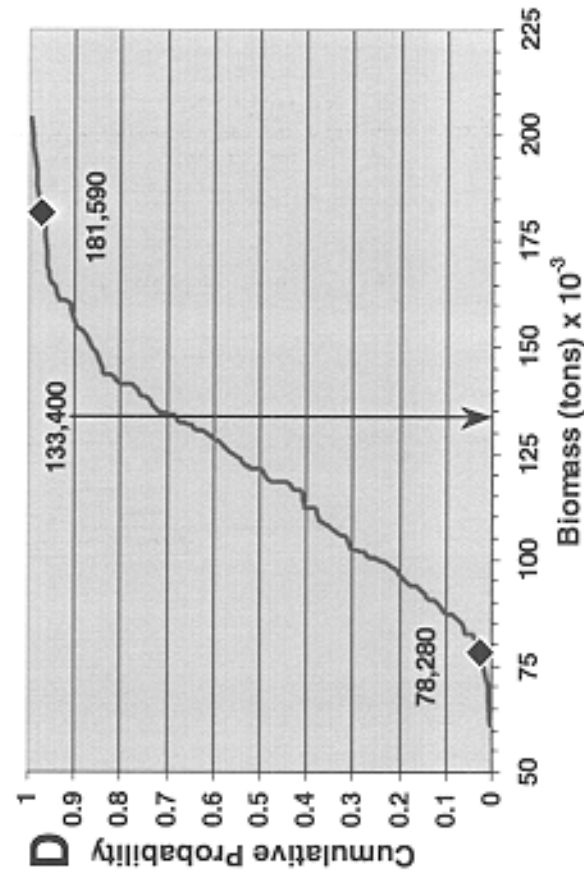
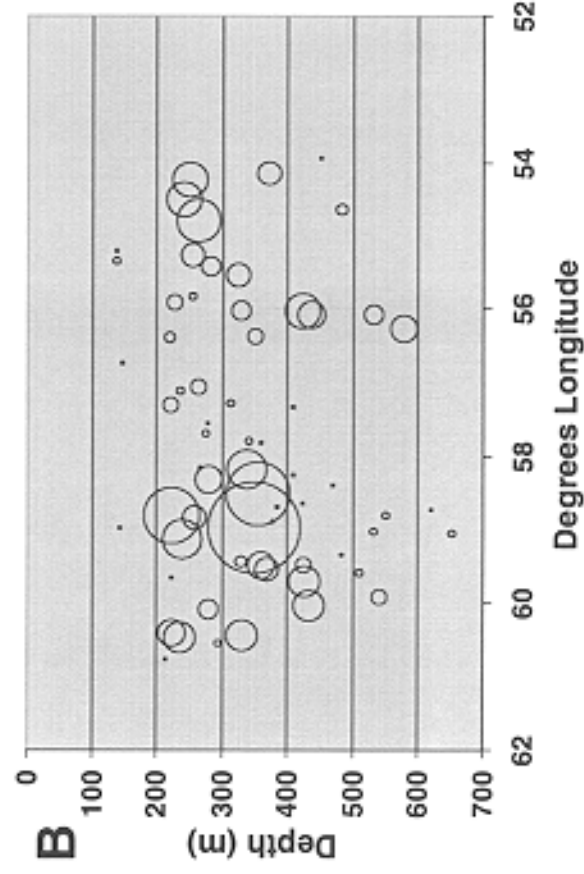
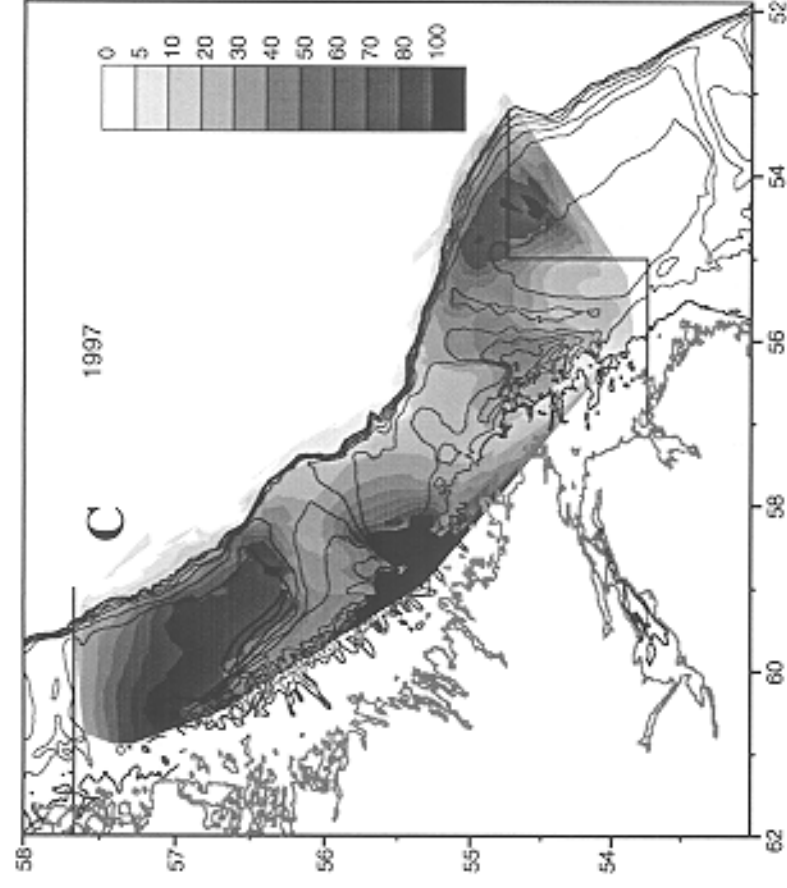
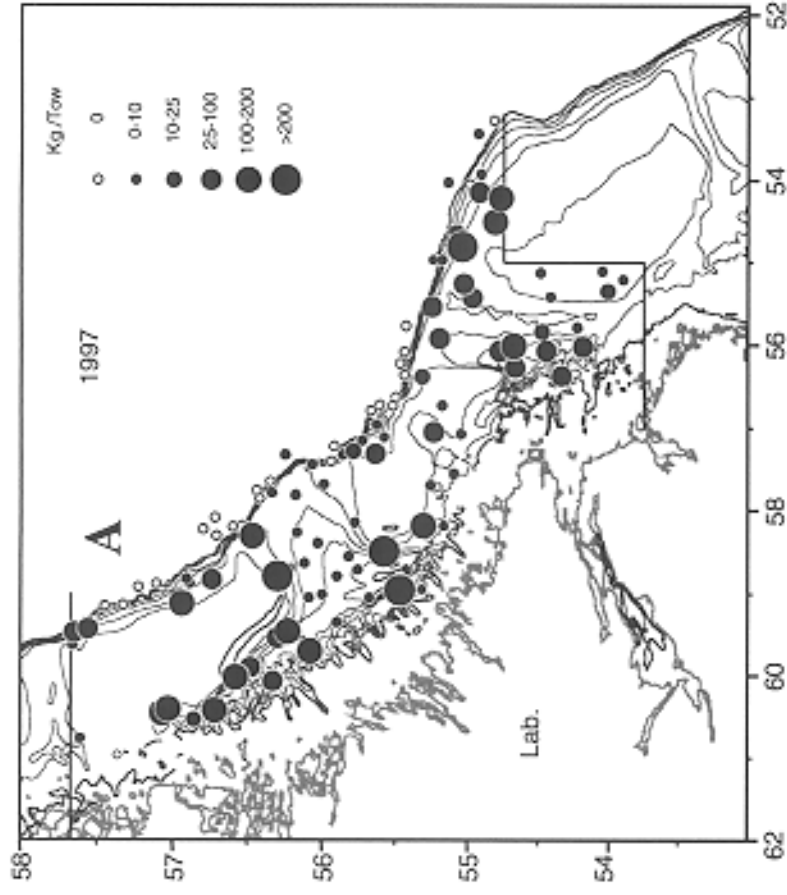


Figure 11. Trawl Survey Analysis, 1997 – Hopedale+Cartwright: A – Catch weight per standard tow; B – Catch weight by depth and longitude; C – Ogmap density (mass) contours; D – Monte Carlo biomass estimates.

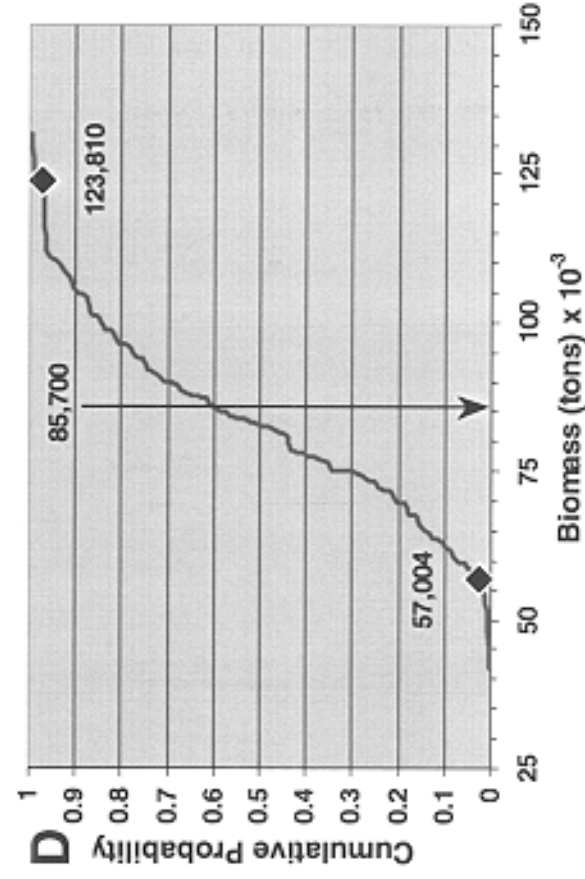
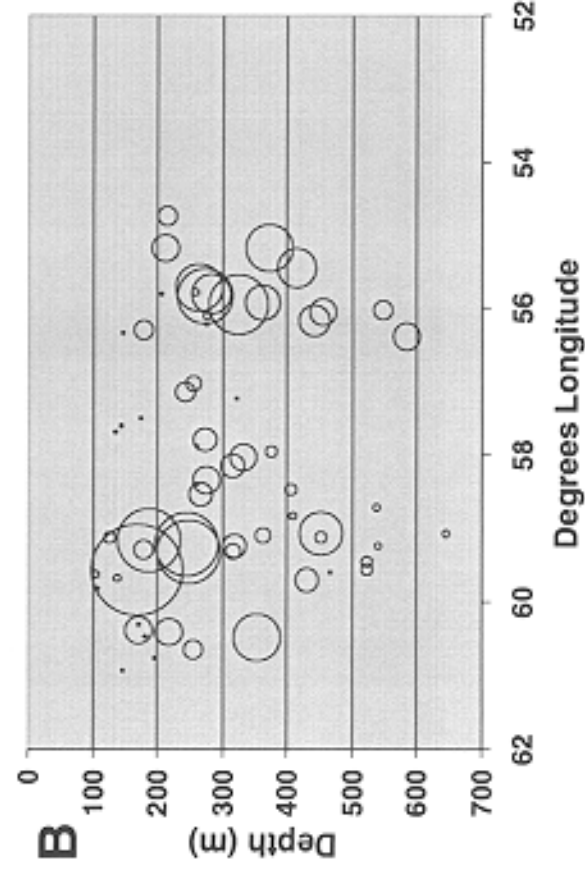
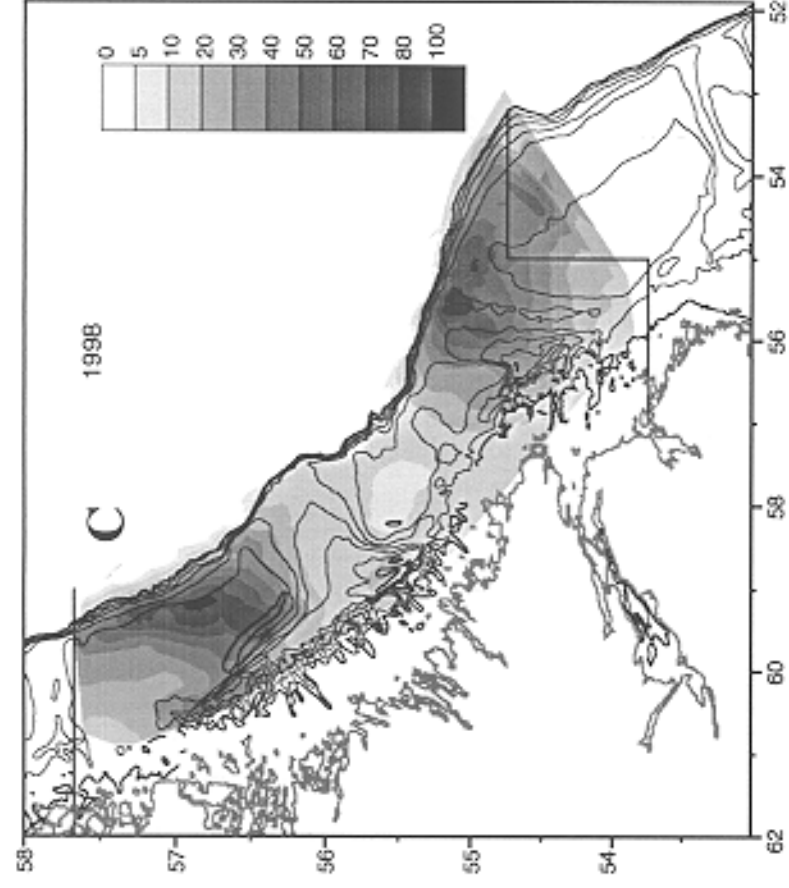
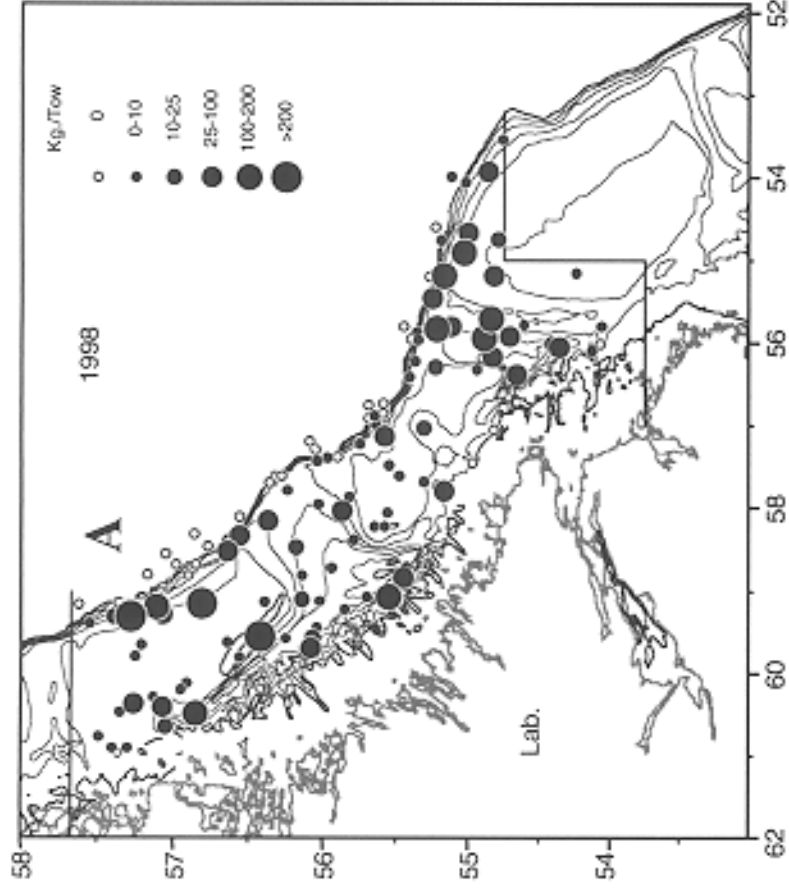
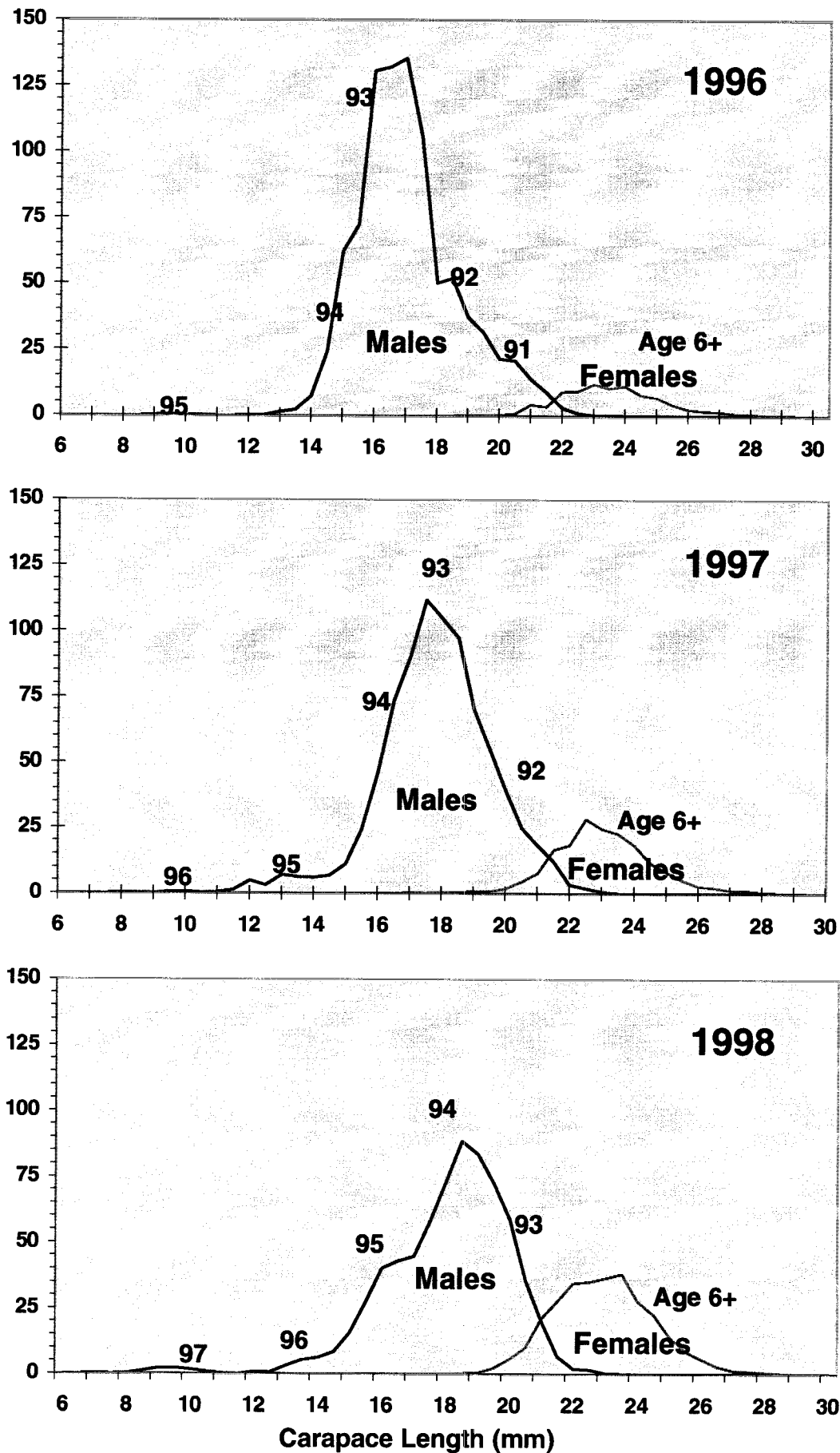


Figure 12. Trawl Survey Analysis, 1998 – Hopedale+Cartwright: A – Catch weight per standard tow; B – Catch weight by depth and longitude; C – Ogmap density (mass) contours; D – Monte Carlo biomass estimates.

Figure 13. Abundance of shrimp (number per thousand) at length and age in Hopedale + Cartwright Channels estimated from RV surveys, 1996 - 1998.



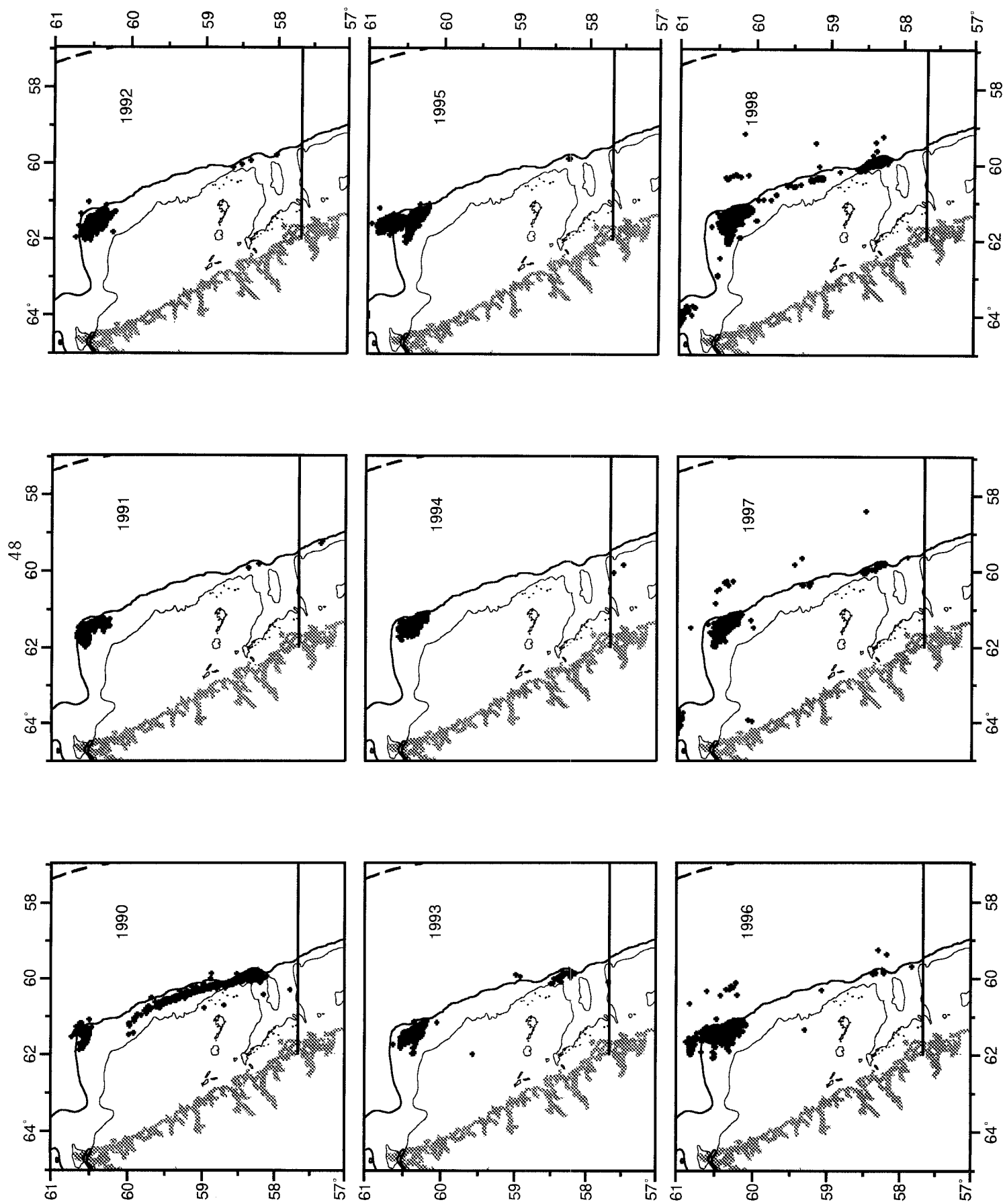
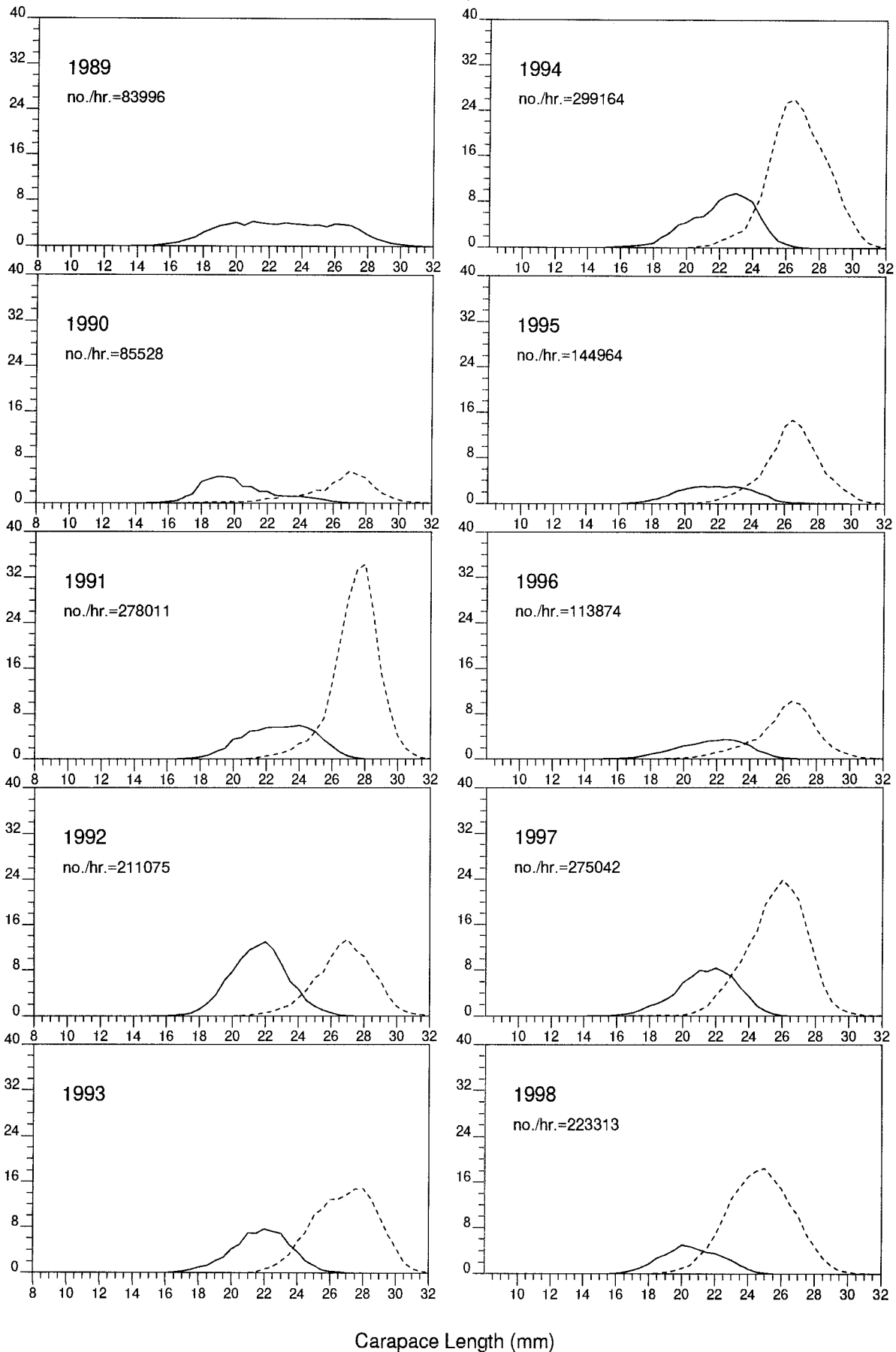


Fig. 14. Distribution of fishing effort in Div. 2G (SFA 4), 1990-98.

Fig. 15. Catch ...numbers-per-hour..000s in NAFO Division 2G (SFA 4), 1989-98.
Single-line graphs represent unsexed samples, broken line=females.



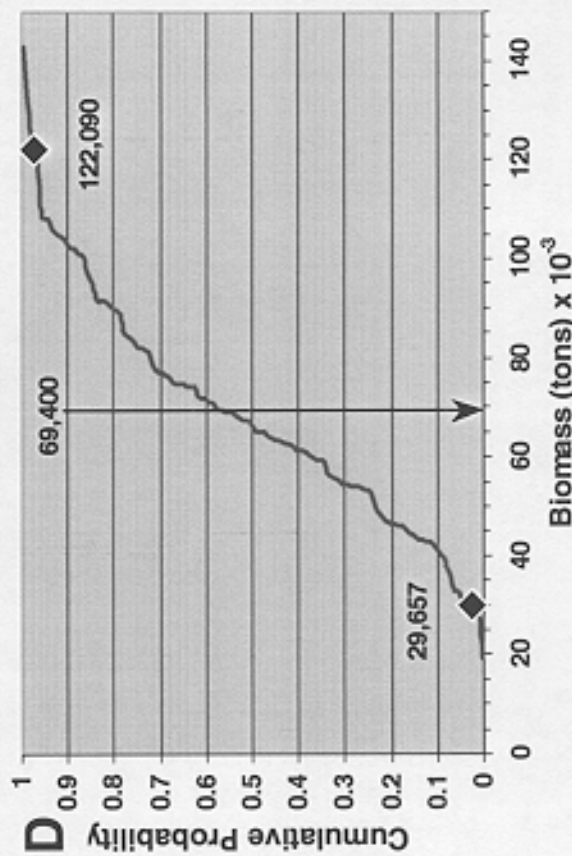
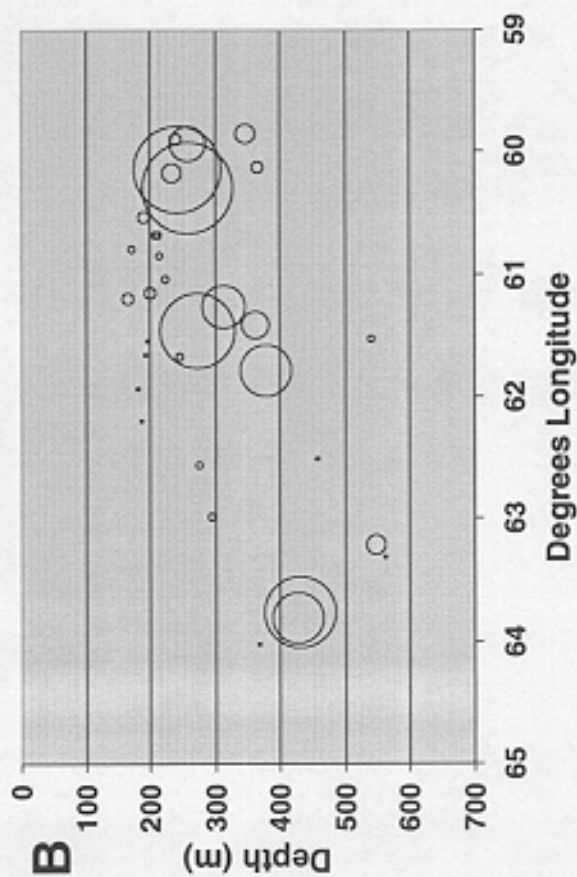
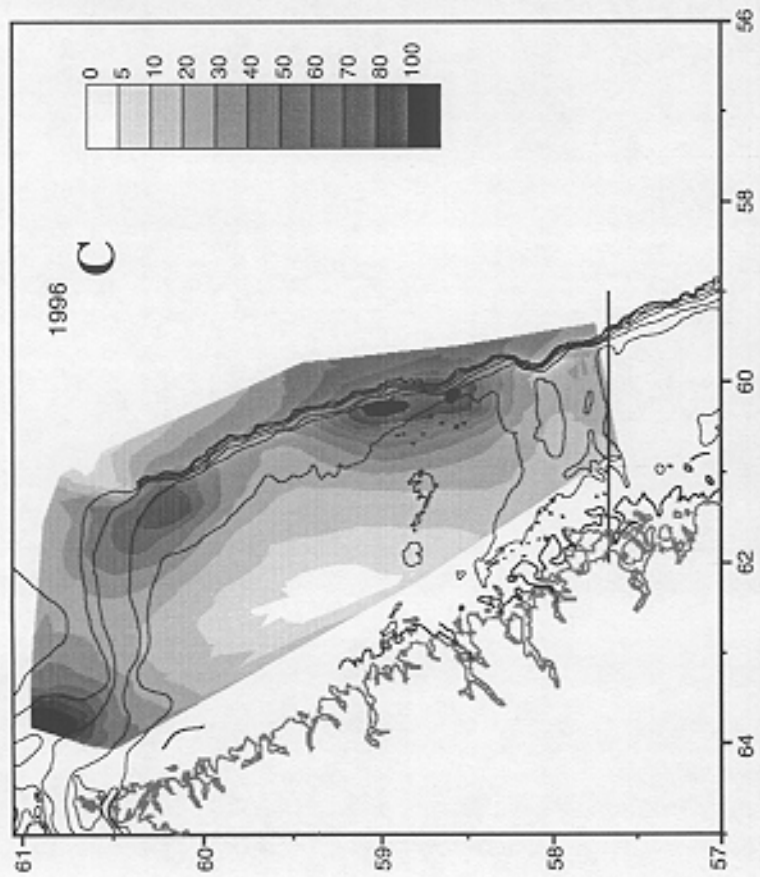
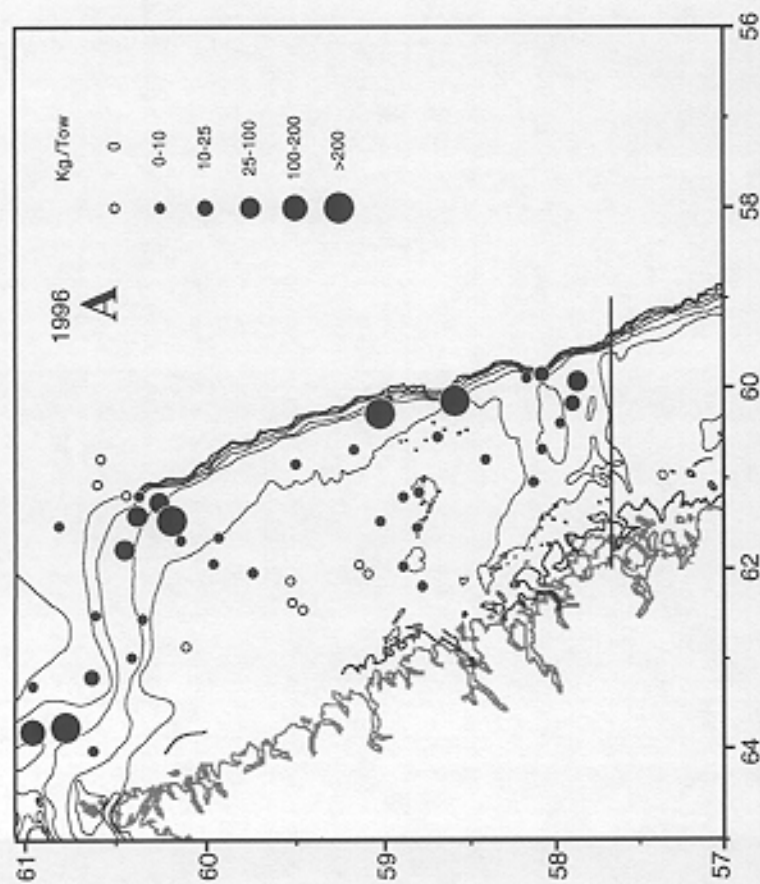
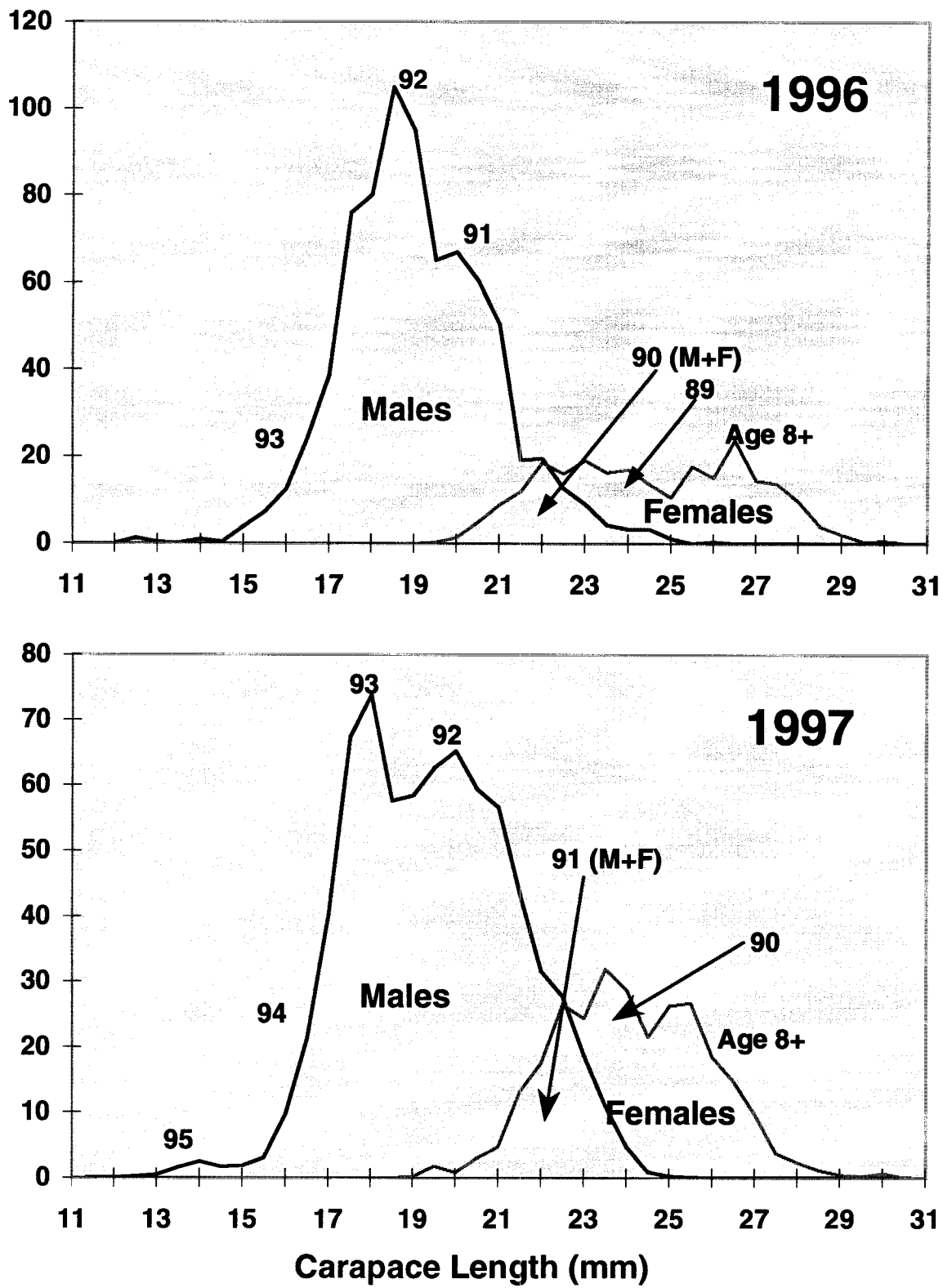


Figure 6. Trawl Survey Analysis, 1996 – Division 2G: A – Catch weight per standard tow; B – Catch weight by depth and longitude; C – Ogmap density (mass) contours; D – Monte Carlo biomass estimates.

Figure 7. Abundance of shrimp (number per thousand) at length and age in Div. 2G estimated from RV surveys, 1996 and 1997.



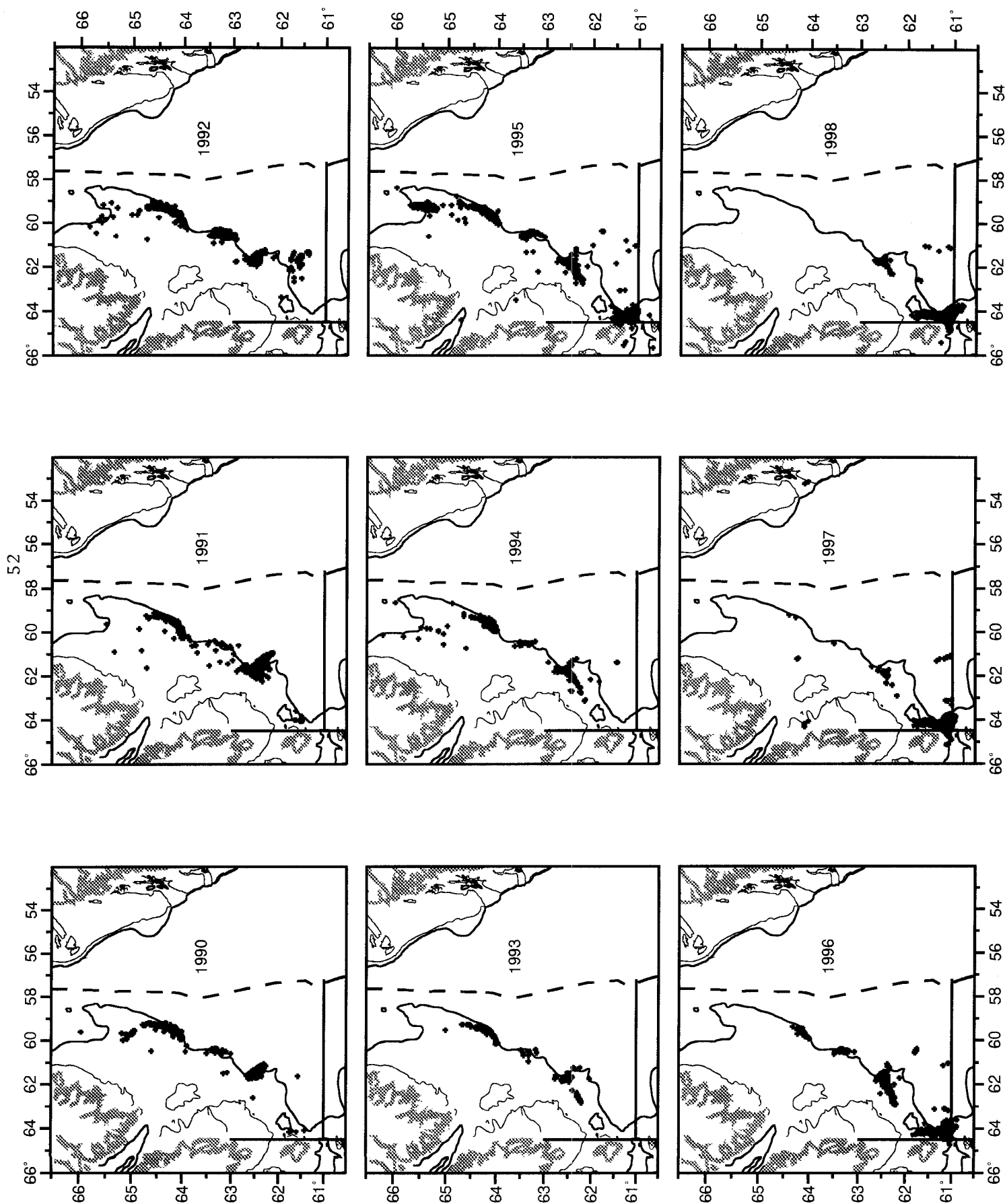


Fig. 18. Distribution of fishing effort in Div. 0B (SFA 2), 1990-98.

Fig. 19. Catch ...numbers-per-hour..000s in NAFO Division 0B (SFA 2), 1989-98.
Single-line graphs represent unsexed samples, broken line=females.

