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Northern shrimp (*Pandalus borealis*) off Baffin Island, Labrador and northeastern Newfoundland – first interim review

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Abstract

Updates of northern shrimp (*Pandalus borealis*) assessments were performed for Division 0B, Division 2G, Hopedale + Cartwright Channels and Hawke Channel + Division 3K, which correspond to shrimp fishing areas 2, 4, 5 and 6, respectively. Status of the resource in each area was inferred, in part, by examining trends in commercial catch, effort, catch per unit effort, fishing pattern and size/sex/age composition of the catches. A multispecies research trawl survey was conducted in 2000 but reductions in survey coverage only provided information on distribution, abundance, biomass, size/sex composition and age structure of shrimp in Hawke Channel + Div. 3K. These findings were compared with results of previous surveys in this area since 1995.

Catch rates by offshore vessels in Hawke + 3K remained relatively stable at a high level while those in Hopedale + Cartwright show a continual increase. The research survey in fall, 2000 showed that abundance and biomass indices remained high in the Hawke + 3K area with indications of increase since 1997. Within Div. 2G, catch rates fluctuated about a high level since 1991 with stability indicated since 1997. Catch rates in Div. 0B also have varied at a high level since 1997.

The shrimp resource in Hawke Channel + Div. 3K is currently healthy with high abundance of males and females. Residual female biomass and stronger 1997 and 1998 year classes should buffer the effects of a weak 1996 year class for the next few years. Current status in Hopedale + Cartwright appears favourable from the fishery data but the absence of a complete survey in 2000 and lack of a recruitment index create uncertainty with respect to stock size and level of exploitation. Current status and prospects in Div. 2G are unknown because the lack of a research survey in 2000 precluded evaluation of the spawning stock, the level of exploitation and recruitment. Similarly, the lack of a research survey into Div. 0B creates uncertainty in understanding the current state of stock distribution, delineation and exploitation level, therefore, prospects in 0B are unknown.

Résumé

Le présent document est une mise à jour des évaluations de la crevette nordique (*Pandalus borealis*) de la division 0B, de la division 2G, des chenaux Hopedale et Cartwright et du chenal Hawke et de la division 3K, qui correspondent aux zones de pêche de la crevette 2, 4, 5 et 6, respectivement. L'état de la ressource dans chaque zone a été inféré, en partie, de l'examen des tendances des prises commerciales, de l'effort, des prises par unité d'effort, des patrons de pêche et de la composition des prises selon la taille, le sexe et l'âge. Un relevé de recherche plurispécifique au chalut a été mené en 2000, mais à cause d'une réduction de la superficie couverte, seules des données sur la distribution, l'abondance, la biomasse, la composition selon la taille et le sexe et la structure par âge de la crevette du chenal Hawke et de la division 3K ont été recueillies. Les résultats obtenus ont été comparés à ceux des relevés précédents effectués dans cette zone depuis 1995.

Les taux de capture obtenus par les bateaux hauturiers dans le chenal Hawke et 3K sont demeurés à un niveau élevé relativement stable, tandis que ceux obtenus dans Hopedale et Cartwright continuent à augmenter. Le relevé de recherche effectué à l'automne 2000 a révélé que les indices de l'abondance et de la biomasse demeurent élevés dans la zone du chenal Hawke et de 3K, continuant à augmenter depuis 1997. Dans la division 2G, les taux de capture, élevés mais fluctuants depuis 1991, sont stables depuis 1997. Les taux de capture dans la division 0B sont de même élevés mais fluctuants depuis 1997.

La ressource en crevettes du chenal Hawke et de la division 3K est actuellement en bon état, l'abondance de mâles et de femelles étant forte. La biomasse résiduelle de femelles et des classes d'âge 1997 et 1998 plus abondantes devraient permettre de neutraliser les incidences d'une faible classe 1996 au cours des prochaines années. D'après les données sur les pêches, la situation actuelle dans Hopedale et Cartwright semble bonne, mais l'absence d'un relevé complet pour 2000 et d'un indice du recrutement donnent lieu à hésiter quant à la taille du stock et au niveau d'exploitation. L'état actuel et les perspectives du stock de la division 2G sont inconnus du fait qu'il a été impossible de faire une évaluation du stock reproducteur, du niveau d'exploitation et du recrutement en l'absence d'un relevé de recherche en 2000. De même, comme il est difficile d'établir la distribution actuelle, les limites et le niveau d'exploitation du stock de la division 0B du fait qu'un relevé de recherche n'y a pas été effectué, on ne sait pas quelles sont les perspectives pour cette zone.

INTRODUCTION

The Canadian fishery for northern shrimp (*Pandalus borealis*) from southern Davis Strait (Division 0B) to the northeast Newfoundland Shelf (Division 3K) has been regulated within three-year, integrated management plans since 1991. The 2000 – 2002 plan was based, in part, on a Stock Status Report (DFO, 2000) produced during a full assessment of the resource that included detailed analyses of commercial fishery and research survey data up to and including 1999. Interim reviews and updates are performed routinely to monitor any changes in resource status within the multi-year term and, if necessary, to provide a basis for adjustments to the total allowable catches (TAC's) in the later years of the plan. This research document provides the information considered during the first interim review within the current plan.

The assessment update, conducted in March 2001, included four shrimp fishing areas (SFA's): Hawke Channel + NAFO Division 3K (SFA 6), Hopedale + Cartwright Channels (SFA 5), Division 2G (SFA 4) and Division 0B (SFA 2). *Pandalus borealis* in Divisions 0A (SFA 1), 3L and 3M (SFA 7), assessed annually by Scientific Council of NAFO, were not included. Also, *Pandalus montagui*, which are fished commercially as main species in SFA's 2, 3 and 4 west of 63^0 W and occur as by-catch elsewhere, were not considered because there was no new information relevant to distribution, stock size or exploitation levels to assess resource status. Therefore, there was no basis for revising the TAC for this species in SFA's 2, 3 and 4, west of 63^0 W from its current level (3800 tons).

MATERIAL AND METHODS

Commercial fishery data

Catch (tons) and effort (hours fished) from vessel log records for all available areas and years (supplemented, as required, by observer data) were examined for trend. The data also were analyzed spatially to consider changes in fishing patterns and practices that might affect interpretations. Catch per unit effort (CPUE), expressed as an index, 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. Raw catch/effort data for each SFA were standardized by multiple regression, weighted by effort, in an attempt to account for variation due to factors such as year, month, area and vessel. In order to track only experienced fishermen, and to reduce the number of estimated parameters, vessels with less than two years of experience were excluded from the analyses. This increased our confidence when interpreting the results. Only inshore vessels that had fished during each of the past three years were included in a new “inshore” vessel CPUE index for SFA 6. The use of windows in trawls (escape openings) when shrimp density is high was investigated but data were insufficient for modeling. Final models included all significant class variables with the YEAR effect used to track the trend in stock size over time. The difference (or similarity) between

the 2000 YEAR 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 both offshore and inshore vessels. Samples were adjusted upward to set, month and year for each SFA to derive a series of annual catch-at-length compositions. Age structure was inferred by identifying prominent year classes (modes) within the composite length distributions and tracking their developments over time. These samples are considered representative throughout the time series. However, the sampling scheme for inshore vessels was insufficient prior to 2000. Therefore, composite length distributions from 1997 to 1999 based on sampling from only offshore vessels might not reflect the actual catch at length and age, especially in SFA 6.

Research survey data

Multispecies research trawl surveys, conducted annually in the Newfoundland-Labrador offshore area since 1995, use a stratified-random sampling design with 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 occur and reliable estimates of distribution as well as abundance and biomass indices have been obtained each year from 1995 to 2000. Farther north, survey coverage has not been sufficient to resolve the highly patchy distribution of shrimp in these areas. The fall survey did not extend north of 2J (55^0 20' N) during 2000. Thus there was no survey in either the northern portion (Hopedale Channel) of SFA 5 or in SFA 4. The multispecies survey has never extended into SFA 2.

The non-parametric method of calculating abundance and biomass indices with Monte Carlo confidence intervals (Evans et al., 1999) was used in the current assessment. It also was applied to biological sampling data from the fall 2000 survey catches, providing estimates of abundance at length and sex. Age structure from survey data was determined by identifying year classes within the composite distributions.

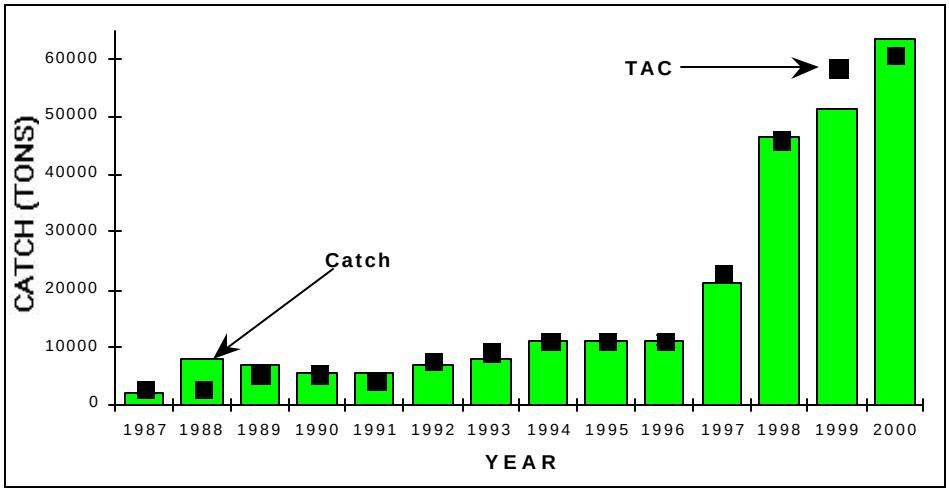
ASSESSMENT OF SHRIMP IN HAWKE CHANNEL+DIV. 3K (SFA 6)

FISHERY DATA

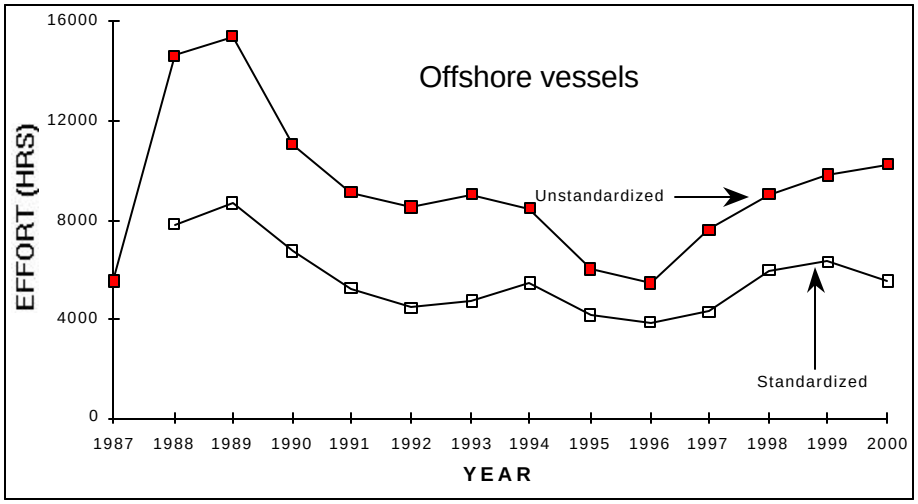
Catch and effort

Catches increased from about 1800 tons in 1987 to more than 7800 tons in 1988 and ranged between 5500 and 8000 tons from 1989 to 1993, inclusive. The TAC for SFA 6 in the 1994 - 1996 Management Plan was set at 11,050 tons annually and catches increased to 11,000 tons in each of those three years. The TAC for 1997, the first year of the 1997 - 1999 multi-year plan, was raised to 23,100 tons as a first step toward increasing the exploitation within a healthy resource. Most of the increase

was reserved for the development of an “inshore” fleet component. Catch in 1997 was estimated to be approximately 21,200 tons, about 6100 tons due to vessels less than 100 feet. Despite the large increase in catch, relative exploitation (catch/survey biomass) in 1997 remained low and the TAC for 1998 was increased again by 100% to 46, 200 tons. Catches exceeded 46,300 tons with the expanding inshore sector reporting about 30,000 tons. The 1999 TAC was increased further (27%) to 58,632 tons. Due to operational problems, the inshore sector failed to take the 41,029 ton quota by 7400 tons, whereas the offshore fleet achieved its 17,600 ton allocation. In 2000, the TAC was increased only by 4% to 60,908 tons. Preliminary data indicate that about 63,000 tons were taken, 20,000 tons by the offshore fleet, 43,000 by the inshore.



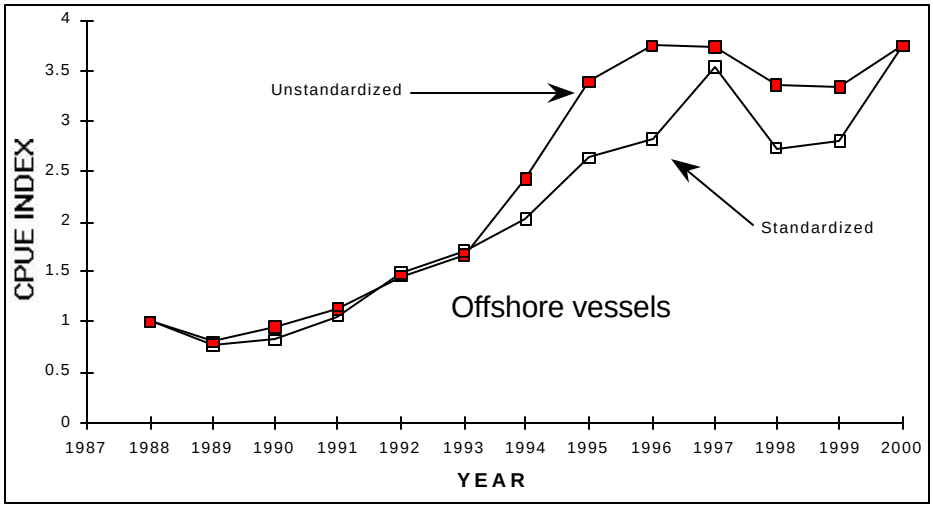
Fishing effort (hours fished = total catch/offshore cpue) estimated for the offshore vessels declined from 1989 to 1992, stabilized or increased slightly to 1994, declined again from 1994 to 1996 and increased thereafter with increases in TAC. Effort for the inshore fleet was relatively stable from 1988 to 2000. The fishery by offshore vessels primarily occurs during the first five months of the year (Fig.1) whereas inshore vessels fish from late spring to early fall (Fig. 2).



A displacement of fishing effort towards the shelf edge occurred during the early 1990's. This was due to the establishment of exploratory areas on the shelf slope in 1992 and 1993, the discovery of dense concentrations of shrimp within these areas, the occurrence of ice throughout the area in winter and spring each year and the flexibility to fish 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 during the 1994 – 1996 period (Fig. 3). The "inshore" fishery concentrated in Hawke Channel, St. Anthony Basin and southern Div. 3K in 1997. Effort within the Basin was less in 1998 but, in 1999 and 2000, effort was widespread throughout the management area (Fig. 4).

Catch per unit effort (CPUE)

Unstandardized, annual CPUE's for offshore vessels (single trawl data only) increased steadily from 1989 to 1995 and have since stabilized at a high level. The CPUE data were analyzed by multiple regression for year, month, vessel and area effects to standardize the catch rates (Table1). The analysis, which incorporated effort weighting, showed that the 1997 CPUE estimate was similar to the 2000 ($P > 0.05$) and that estimates for all other years were significantly lower ($P < 0.05$).



The preliminary catch rates for January and February 2001 were reported to be within the range observed during the first quarter in recent years.

Unstandardized, annual CPUE's for selected inshore vessels were similar in 1998 and 1999 but showed some increase in 2000. These data also were analyzed by multiple regression for year, vessel and area effects (Table 2) and showed the same pattern as the unstandardized series.

Historical fishery data for this management-assessment area are summarized in Table 3.

Size composition

Catch-at-length, estimated from samples taken by observers on offshore vessels, showed dominance of the female component around 23 - 24 mm carapace length (CL) in most years (Fig. 5). 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 year class also was well represented at 16 mm in the 1996 samples and at 18 mm in the 1997 data but did not appear to be as strong as the 1991 year class. Compared to 1994 and 1996, recruitment (partial) at age 3 has been less in recent years. However, relative strength of recruiting year classes is difficult to evaluate from fishery data.

The samples from the fishery in 2000 indicate a narrower distribution for the female component compared to other years, suggesting that most belonged to the 1994 year class.

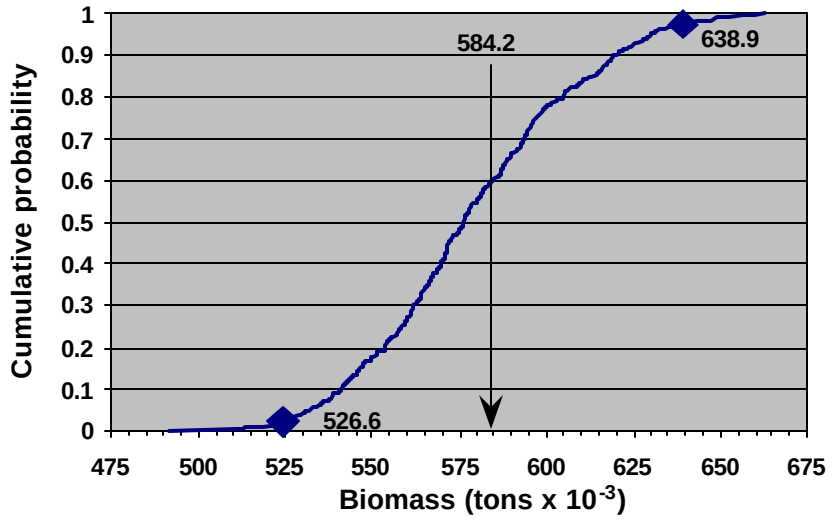
Mean size of females and the size at sex inversion declined slightly in recent years, indicating a possible change in growth within the area. Although smaller females carry fewer eggs, reproductive potential has been maintained by the continued high abundance of females.

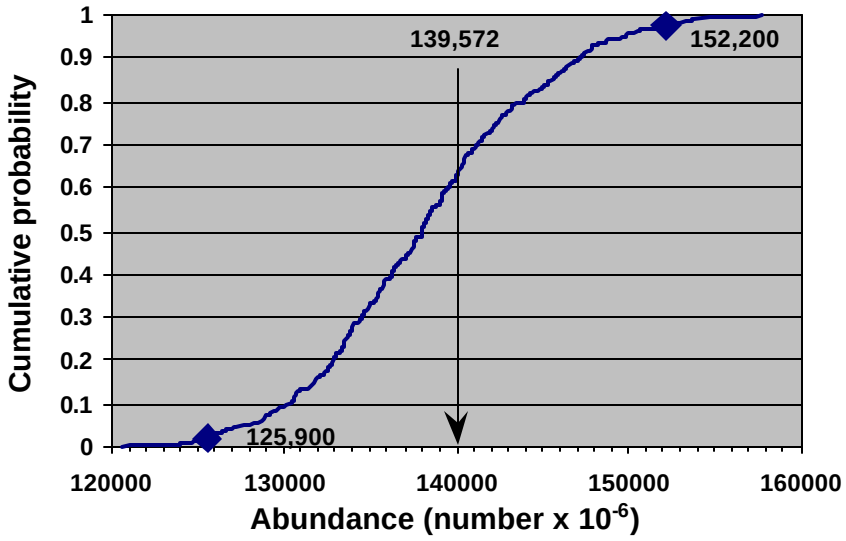
Length frequency data were available, from the inshore fleet, during 2000. As illustrated in fig. 6, the inshore catches were dominated by 16 mm males (age 3). This contrasts the offshore catches which were dominated by larger males and females.

RESEARCH SURVEY DATA

Stock size

Results of the 2000 fall multispecies research survey showed that shrimp continue to be widely distributed and abundant throughout Hawke Channel + Div. 3K (Fig. 7). Minimum trawlable biomass was estimated at 584,000 tons and abundance at 140 billion animals , the highest in the series. Monte Carlo confidence limits reflect the high level of precision for the estimates from this area.



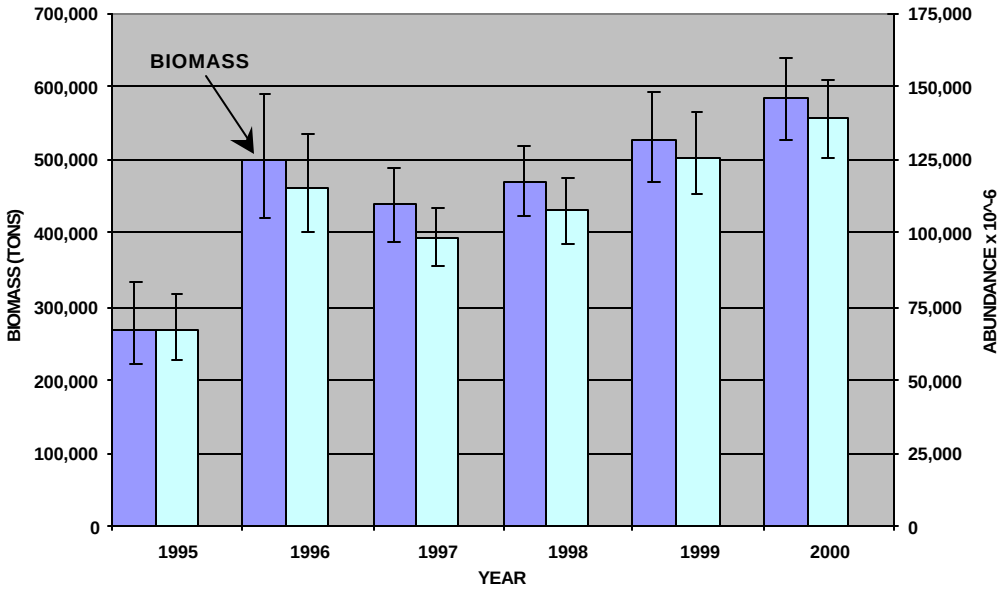


Biomass/abundance estimates and their confidence intervals from 1995 to 2000 are compared in the following table and figure.

Northern shrimp stock size estimates and 95% confidence intervals (C.I.) in Hawke Channel + Div. 3K (SFA 6) [1] from research surveys - offshore, 1995 - 2000.

	Biomass (tons)			Abundance (numbers x 10^{-6})			No. Sets
	Lower C.I.	Estimate	Upper C.I.	Lower C.I.	Estimate	Upper C.I.	
1995	220,000	267,000	332,100	56,480	67,023	79,450	195
1996	420,600	501,300	589,100	100,000	115,400	133,900	238
1997	387,400	438,500	487,800	88,420	98,721	108,500	232
1998	424,400	468,400	517,600	96,730	107,422	118,600	234
1999	470,600	526,100	592,300	113,300	125,612	141,600	233
2000	526,600	584,200	638,900	125,900	139,572	152,200	241

[1] Area compared each year = 171,048.5 sq. km.



Inshore strata along the northeast Newfoundland coast were not sampled in 1995 or 1999. Therefore, the analyses were confined to the offshore strata for comparative purposes. Inshore areas, sampled during the other surveys, generally produced low catches of shrimp that did not contribute substantially to the biomass/abundance estimates.

Point estimates for biomass (abundance) increased from about 270,000 tons (67 billion) in 1995 to 500,000 tons (115 billion) in 1996 and declined to 440,000 tons (99 billion) in 1997. Since then, estimates increased steadily to 584,000 tons (140 billion) in 2000. The lower 95% confidence intervals for the biomass indices averaged 446,000 tons (about 105 billion animals) during the 1996 - 2000 period.

The ratios of nominal catch to the lower confidence intervals of the survey biomass indices were about 5% in 1995, 3% in 1996, 5% in 1997, 11% in 1998 and 1999 and 12% in 2000. Actual exploitation rates are unknown but are likely 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).

Biomass/abundance of males was relatively stable from 1996 to 2000, varying between 250,000 and 300,000 tons (75 billion to 100 billion animals). The female stock increased from an estimated 184,000 tons (22 billion) in 1997 to 302,000 tons (41 billion) in 2000.

Stock size estimates for male and female shrimp in Hawke Channel + Div. 3K (SFA 6) from fall research trawl surveys - offshore, 1995 - 2000.

	Biomass (tons)			Abundance (numbers x 10^{-6})		
	Males	Females	Total	Males	Females	Total
1995	129,700	137,300	267,000	49,954	17,068	67,023
1996	294,900	206,400	501,300	91,157	24,243	115,400
1997	254,200	184,200	438,500	76,462	22,259	98,721

1998	254,100	214,300	468,400	79,233	28,190	107,422
1999	266,600	259,500	526,100	90,576	35,036	125,612
2000	281,900	302,400	584,300	98,472	41,100	139,572

Stock composition

Length distributions representing abundance-at-length from the 1995 – 2000 surveys are compared in Fig. 8.

Abundance estimated from the 2000 survey data was dominated by a component of males with a modal length of about 17 mm CL, believed to be the 1997 year class (age 3). The 1998 year class was evident near 14 mm and the 1999 between 8 and 10 mm. Largest males (> 19 mm) and smallest females (< 22 mm) are thought to belong to the 1995 year class. The weak 1996 year class cannot be identified on the right side of the male size distribution where overlap of length at age is extensive. The relatively narrow distribution for females, which comprised 29% of the estimated abundance, suggests that most belonged to the 1994 year class.
The time series provides a basis for comparison of relative year-class strength and illustrates the changes in stock composition over time. The 1995 year class, at age 4 in 1999, age 3 in 1998, age 2 in 1997 and age 1 in 1996, was weaker than both the 1994 or 1993 year classes at those ages. Further, the 1996 year class, at age 4 in 2000, age 3 in 1999, age 2 in 1998 and age 1 in 1997, is the weakest observed. The 1997 year class is stronger than the 1995 and 1996 and, at age 3 in 2000, also appears stronger than the 1992, 1993 and 1994 year class were in 1995, 1996 and 1997, respectively. The 1998 year class appears similar in strength to the 1997 at ages 1 and 2. The 1999 year class, at first glance, appears weaker than both the 1997 and 1998. Modal length at age varies between years reflecting different growth rates for the different cohorts.

RESOURCE STATUS

Catch rates of both inshore and offshore vessels in 2000 remained at the high level attained since the mid 1990's. The research survey biomass/abundance estimates showed an increase since 1997 and the lower confidence intervals averaged approximately 446,000 tons/105 billion animals over the 1996 – 2000 period. Research data showed that the 1996 year classes was weak compared to others produced during the 1990's. Also, the 1995 year class appeared weaker than most. However, the 1997 and 1998 year classes are strong, the former being the most abundant year class at age 3 within the time series. While it is likely that male abundance and biomass will be maintained in 2001/2002, it is possible that the spawning stock (females) will decrease as the weaker year classes change sex and year classes produced before 1995 are further reduced through both fishing and natural mortality. Positive effects of the stronger 1997 and 1998 year classes on the spawning stock should be evident by 2003. Over the next few years, the residual female stock and the stronger 1997 and 1998 year classes should buffer the negative effects of a weak 1996 year class. However, the impact of fishing mortality imposed by the inshore fleet upon the 1997 and 1998 is uncertain.

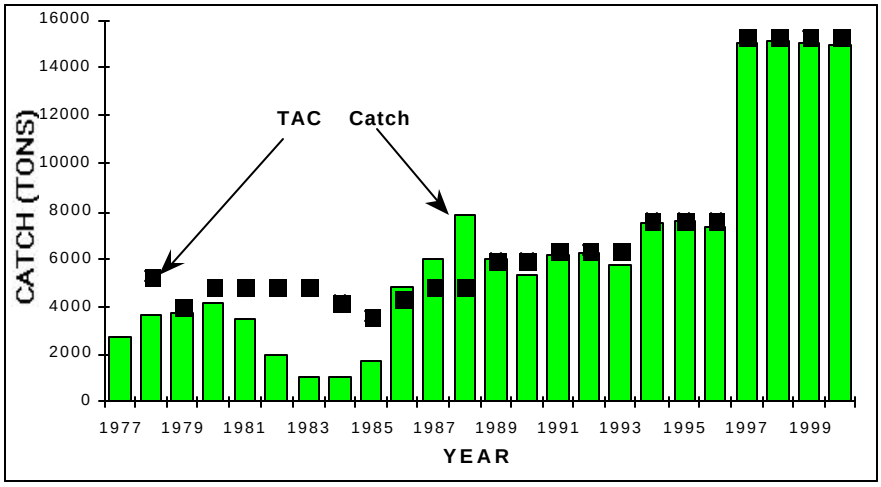
Commercial catch rates and research indices of stock size have been, at worse, stable in recent years, the latter showing some increase since 1997. The resource in this area remains healthy with high biomass/abundance of male and female components. Further, exploitation likely has been less than 12% over the past several years (i.e. the ratio of nominal catch to the lower 95% confidence interval of the research trawl survey biomass index).

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

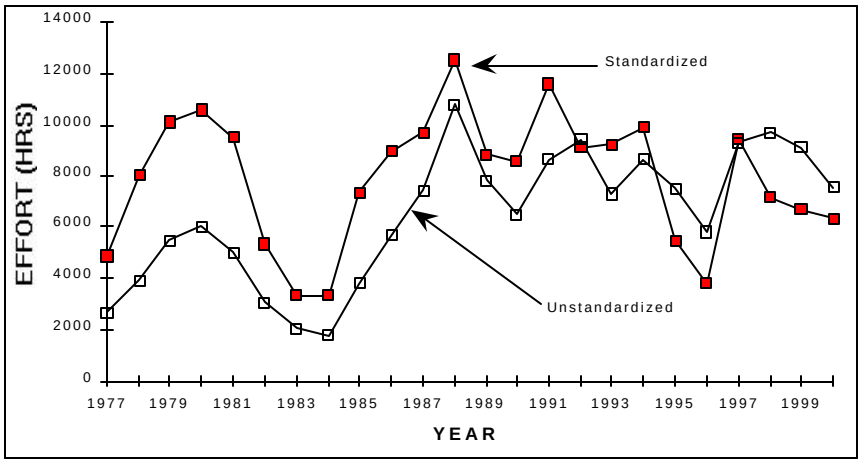
FISHERY DATA

Catch and effort

Shrimp catches in Hopedale and Cartwright Channels 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 to 7650 tons annually and catches subsequently increased, averaging 7500 tons during that period. Annual TAC's for the 1997 - 1999 plan were increased 100% to 15,300 tons and catches exceeded 15,000 tons each year. The TAC for the first year of the 2000 – 2002 plan was maintained at 15,300 tons and preliminary data indicate that about 15,000 tons were caught.



Fishing effort showed approximately the same trends over time as catch. From 1994 to 1996, however, effort decreased while catches remained stable. Effort increased from 1996 to 1997 with the doubling of the TAC and has since declined.



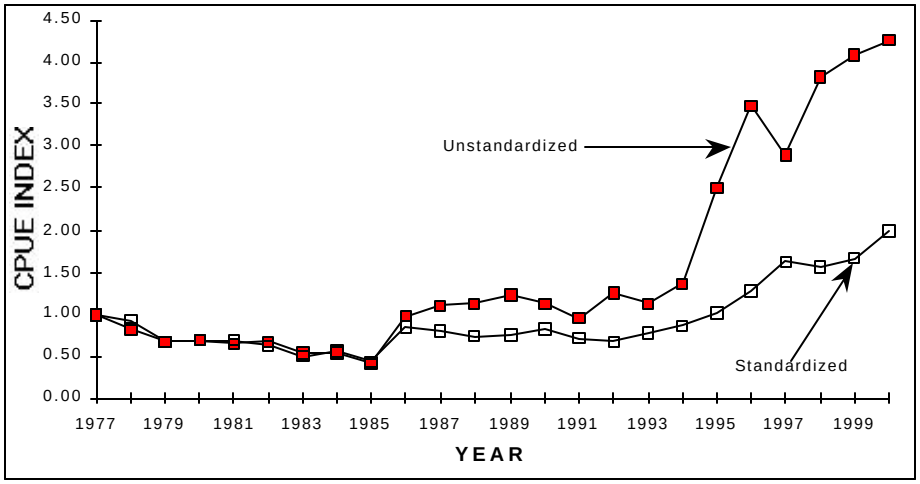
In the late 1970's and throughout the 1980's, the fishery concentrated in four main areas: northern, eastern and southern Hopedale Channel and Cartwright Channel. Fishing continued in the traditional areas during the 1990's, however, more effort was reported from the slopes of the shelf, north and east of Cartwright Channel (Fig.9). From 1994 to 2000, substantial effort occurred on the eastern slope during winter and spring. Historically a summer - fall fishery for the offshore fleet, since 1995 it has become mainly a winter - spring operation (Fig. 10). An allocation has been available in recent years for inshore vessels but this fleet sector contributes only in a minor way to the fishery, relative to the offshore fleet.

Catch per unit effort (CPUE)

Unstandardized, annual CPUE's (single trawl data for offshore vessels) declined from 1977 to 1985, increased substantially in 1986 and stabilized until the early 1990's. Catch rates increased from 1993 to 1996, declined in 1997 and increased again during 1998 - 2000 to the highest level observed.

The CPUE data were further analyzed by multiple regression with effort weighting for year, month, vessel and area effects (Table 4). The standardized 2000 catch rate index was the highest in the time series. All previous year estimates were significantly lower ($P < 0.05$).

As with the unstandardized series, the standardized series shows 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. The last increase is more pronounced in the unstandardized data.



Preliminary catch rates for January and February 2001 were reported to be as high as those for the same months in recent years.

Historical fishery data for this management-assessment area are summarized in Table 5.

Size composition

Catch-at-length data from 1991 to 2000 (Fig. 11) showed a modal group of females about 23-24 mm CL occurring each year. While the catch rates for this component increased since the early 1990's, the mean size and median size at sex change declined slightly after 1996.

Recruitment of males between approximately 16 and 22 mm was consistent from year to year and males contributed substantially to the catch in numbers up to 1999. The male component showed a decline since 1998, possibly a reflection of weaker 1995 and 1996 year classes.

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 part 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, at about 20 mm (age 5) in 1998 and as females (age 6) in 1999. The 1994 year class dominated the male component in 1999 and contributed substantially to the female group in 2000. The relatively narrow distribution of female sizes in 2000 reflects fewer older females in the catches.

RESEARCH SURVEY DATA

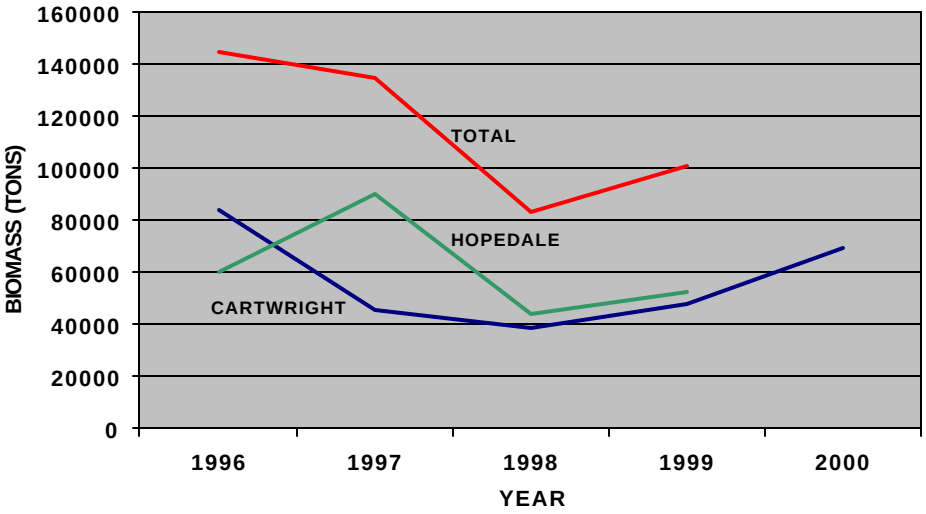
Stock size

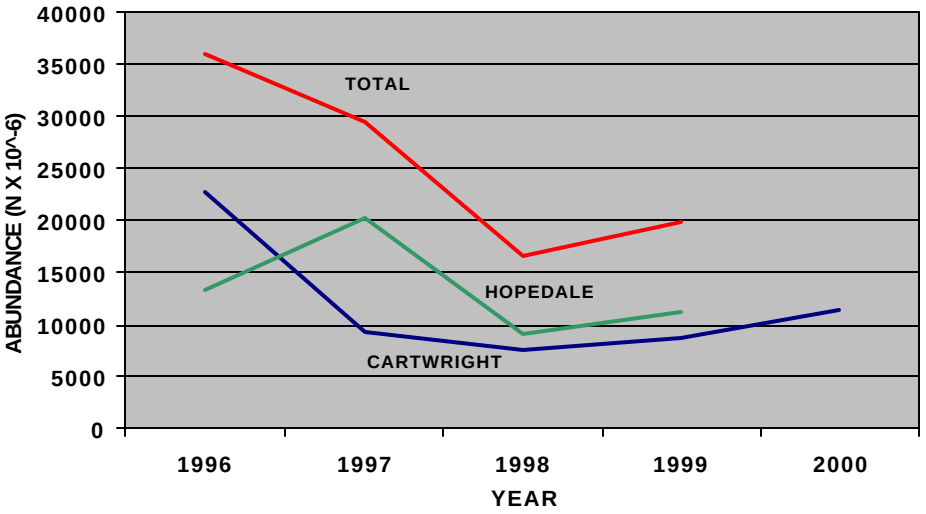
Only the southern portion of SFA 5 (Cartwright Channel – Div. 2J) was surveyed in 2000. Therefore, no direct comparison with previous stock size estimates is possible.

Long-term research plans call for the northern portion of SFA 5 (Hopedale Channel - Div. 2H) to be surveyed every second year. The research data available since 1996 (Parsons et al., 2000) were reanalyzed by area for possible relationships between areas.

Northern shrimp stock size estimates in Hopedale and Cartwright Channels (SFA 5) from fall research trawl surveys - offshore, 1996 - 2000.

	Biomass (tons)			Abundance (numbers x 10^{-6})			No. Sets
	Cartwright	Hopedale	Total	Cartwright	Hopedale	Total	
1996	83,900	60,200	144,100	22,672	13,307	35,979	111
1997	45,000	89,900	134,900	9,288	20,097	29,385	112
1998	39,000	44,200	83,200	7,410	9,145	16,555	119
1999	48,000	52,700	100,700	8,764	11,054	19,818	117
2000	69,500			11,378			35





Between 1996 and 1997, stock indices increased for Hopedale Channel but decreased for Cartwright. Confidence intervals for the 1996 survey estimates were wide due to two large catches. Therefore, usefulness of the results by area or for the total was limited. In 1997, the Hopedale Channel results were overestimated because shallow areas (< 200 m) of the Nain Bank were not sampled and the method interpolated shrimp catches from deeper water over a large area where densities are known to be lower. Although the similarity between areas for the 1998 and 1999 surveys is encouraging, it is not yet possible to assume that trends observed within the Cartwright Channel reflect conditions throughout the whole management area.

Stock composition

Given the lack of a complete survey in 2000 and the argument presented above, there is no information on the size/age/sex composition of the resource further to that reported by Parsons et al. (2000).

RESOURCE STATUS

The current status of the northern shrimp resource in the Hopedale and Cartwright Channels appears favourable from the fishery data but the absence of a complete research trawl survey for 2000 creates uncertainty with respect to stock size and the level and effect of exploitation in 2000. Commercial catch rates, which were stable from the mid 1980's to the early 1990's, have since continued to increase. Good recruitment of year classes produced during the 1990's has resulted in high catch rates of males over the past several years and the female component appears healthy. Weaker 1995 and 1996 year classes could account for the reduction in the catch of males in 2000. Lacking a recruitment index, prospects are uncertain.

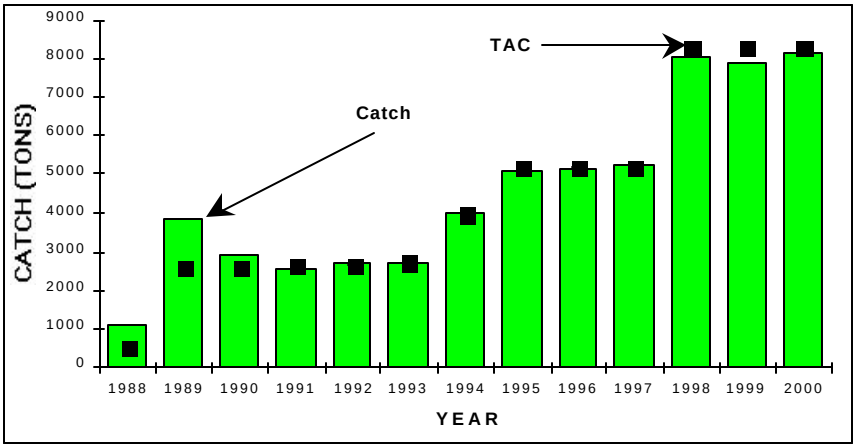
ASSESSMENT OF SHRIMP IN NAFO DIVISION 2G (SFA 4)

FISHERY DATA

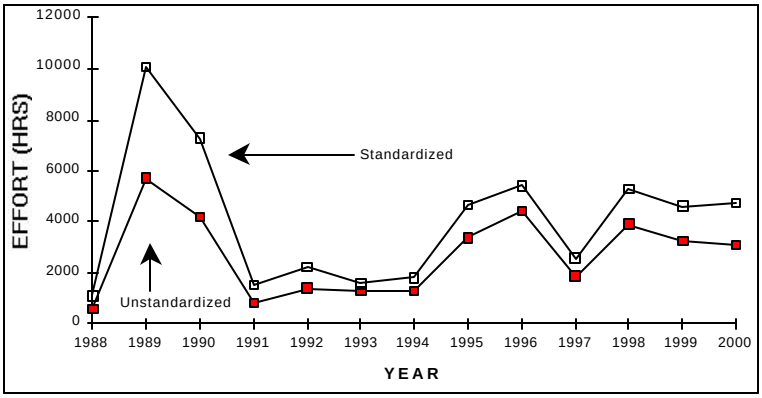
Catch and effort

Shrimp 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 3982 tons with an increase in TAC to 4000 tons in the first year of the 1994 - 1996 Management Plan. A second 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 could be considered. Lacking the basis on which to advise an appropriate level of TAC, an increase of 60% (3120 tons) to 8320 tons was chosen in the management process. Furthermore, 70% of the increase (2184 tons) was applied to the area south of 60^0 N where very little fishing had occurred since 1990. Catches from 1998 to 2000 were estimated at approximately 8000 tons each year.



Effort increased substantially from 1988 to 1989, then decreased until 1991 after which it remained at a relatively stable low level until 1994. It increased during 1995 and varied at a higher level, thereafter.

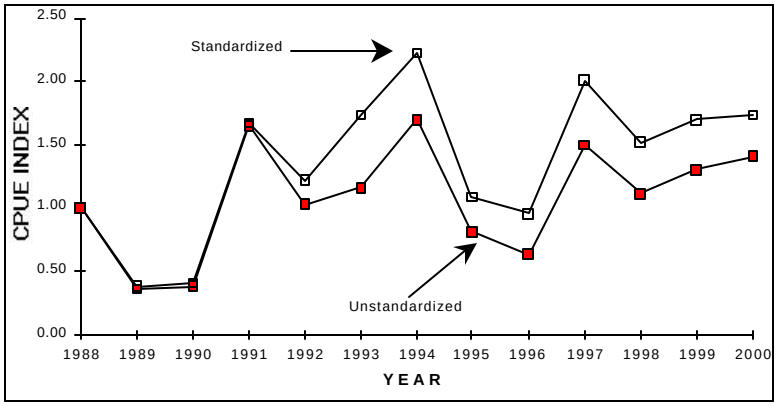


The fishery from 1988 to 1990 occurred throughout the Division, which, during that period, was split into two management zones, north and south of 60^0 N. The 1991 - 1993 Management Plan combined the two zones and, up to 1997, effort concentrated primarily in the north (Fig. 12). From 1998 to 2000, more effort was deployed south of 60^0 N because of the separate quota for that area. By-catches of *P. montagui* were reported at some northwestern locations during the 1995 - 2000 period. Most of the fishing in 2000 occurred during the fall (Fig. 13).

Catch per unit effort (CPUE)

Unstandardized, annual CPUE's for the whole management area (single trawl data for offshore vessels) in 1989 and 1990 were lower than the 1988 estimate. In 1991, catch rate increased substantially as fishing effort concentrated in the northern grounds and high CPUE's were maintained up to 1994. The 1995 and 1996 catch rates declined but recovered during the 1997 – 2000 period.

The CPUE data were analyzed by multiple regression, weighted by effort, for year, month and vessel effects. The model showed that the annual, standardized catch rate indices for 1997, 1998 and 1999 were similar ($P > 0.05$, Table 6) to the 2000 estimate. Both series showed that, since 1991, catch rates have fluctuated without any long-term trend.



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

Size composition

Catch-at-length data for the 1991 - 2000 period showed variable size distributions between years (Fig. 14). From 1991 to 1997, when effort concentrated in the north where males appeared to be less abundant, the female component dominated the catches by number and weight in all years except 1992. Since 1991, the mean length of females and median size at sex inversion has declined. However, decreases since 1998 are thought to reflect increased fishing in southern 2G where growth rates and maturity schedules resemble those seen in the Hopedale + Cartwright area.

Given the recent high and stable catch rates of primarily female shrimp in this area, it appears that a healthy spawning biomass is being maintained. The narrow distribution of female sizes in 2000 compared to previous years suggests fewer older females in the catches.

RESEARCH SURVEY DATA

No research survey was conducted in this area in 2000. Therefore, no direct comparison with previous stock size estimates and stock composition (Parsons et al. 2000) is possible.

RESOURCE STATUS

The spawning stock appears healthy, as evidenced in continued high catch rates of large female shrimp and stability in catch rates since 1997. However, current status and prospects are unknown because the lack of a survey precludes evaluation of stock size, level of exploitation and future recruitment.

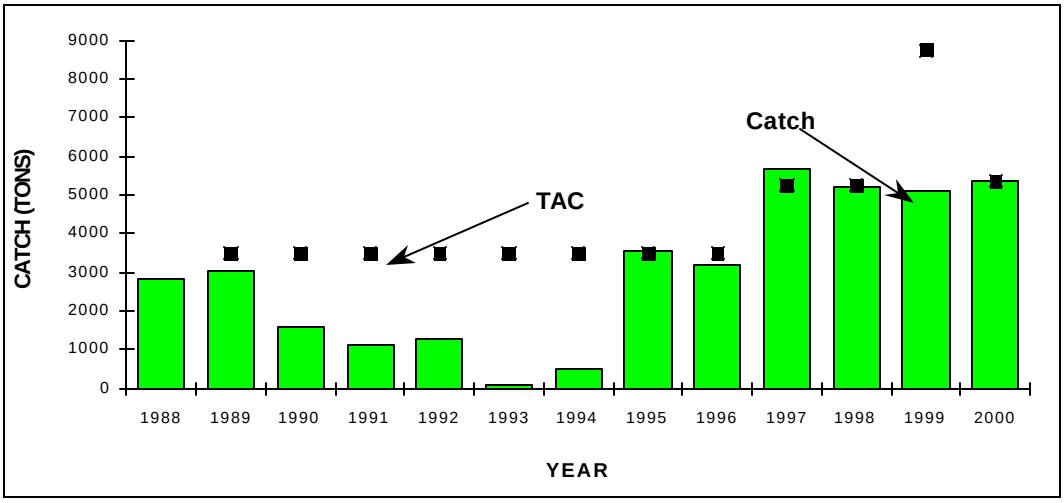
ASSESSMENT OF SHRIMP IN NAFO DIVISION 0B (SFA 2)

FISHERY DATA

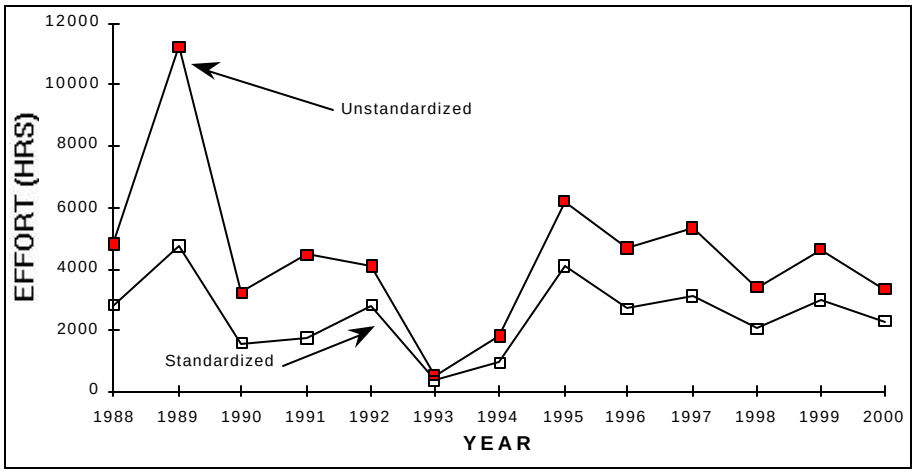
Catch and effort

Catches of *Pandalus borealis* in Div. 0B increased from about 2800 tons in 1988 to 3000 tons in 1989 but subsequently declined to 100 tons in 1993. The 1994, catch was less than 500 tons; however, catches increased substantially to about 3600 and 3200 tons in 1995 and 1996, respectively, and to more than 5000 tons each year from 1997 to 1999. Preliminary estimates indicate that approximately 5400 tons were caught during 2000.

Recent catches for the species have been estimated, in part, from the mixed fishery data for *P. borealis/montagui* in the area east of Resolution Island but their accuracy is questionable. *Pandalus borealis* taken in the immediately adjacent areas of SFA's 3 and 4 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 1997 and 1998. In 1999, an additional 3500 tons were provided for the area north of 63^0 N as an incentive for the offshore fleet to return to grounds not fished extensively since 1995. However, just over 100 tons were taken within this area in 1999. In 2000, the additional 3500 tons was not included in the quota report, and accordingly the catch was not counted against the TAC for the south (5353 tons).



Fishing effort doubled from 1988 to 1989, decreased sharply in 1990 and remained near the 1990 level for the next two years. Effort increased from a low in 1993 to 1995 and has since remained relatively stable or decreased slightly.

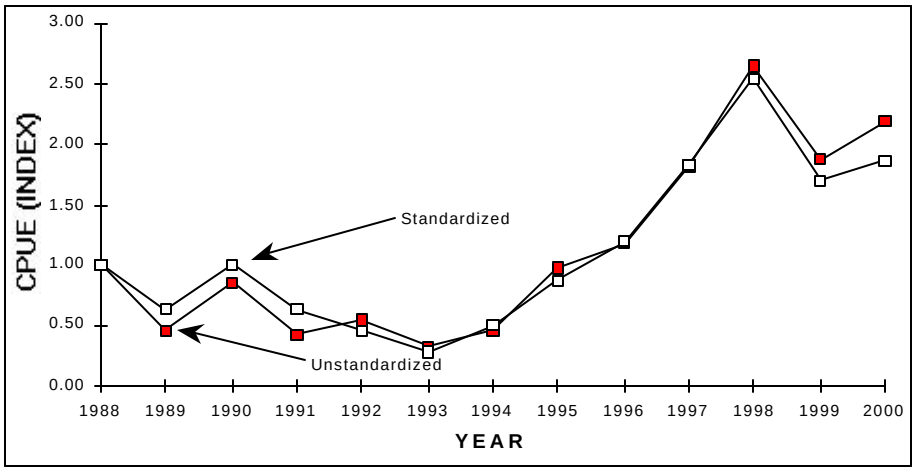


In the late 1980's, fishing effort was primarily concentrated between 64^0 and 65^0 N whereas, during the 1990 - 1994 period, proportionately more was distributed south of 64^0 N. The areas fished extensively in the southwest from 1995 to 2000 reflect the targeting of *Pandalus borealis* and *P. montagui* concentrations east of Resolution Island. Most effort since 1996 occurred south of 63^0 N (Fig. 15). In 2000, fishing occurred during the second half of the year (Fig. 16).

Catch per unit effort (CPUE)

Both the unstandardized and standardized annual CPUE's showed an overall decline from 1988 to 1993. Catch rates increased sharply from 1993 to 1998, decreased in 1999 to the level observed in 1997 and increased again in 2000. The standardized model for year, month and vessel effects with effort weighting showed that the 1997 and 1999 catch rates were similar to the 2000 estimate ($P > 0.05$) while the 1998 estimate was significantly higher ($P < 0.05$). All years prior to 1997 were lower than

the 2000 estimate (Table 8). The pronounced increase in CPUE after 1994 is associated with the shift of fishing effort to the southwest.



Historical fishery data for this management-assessment area are summarized in Table 9

Size composition

Catches in most years were composed primarily of large, female shrimp (Fig. 17) with a modal length of about 27 mm CL. However, the mean size of females and the median size at sex change declined after 1996. The occurrence of males <22 mm in the catches, as well as the overall catch rates of male and female components, increased with the southward shift in fishing effort. As seen in the southern areas, the narrow distribution of female sizes in 2000 compared to previous years suggests fewer older females in the catches.

RESOURCE STATUS

Although shrimp concentrations in northeast are elusive, as evidenced by the low catch in recent years from the area north of 63^0 N, those adjacent to eastern Resolution Island have persisted since first fished in 1995. However, the population structure is uncertain throughout Div. 0B and distribution is unknown for much of the year. Therefore, the current status of this resource remains uncertain.
The fishery shifted to the southwest, east of Resolution Island, after 1994 and the CPUE and sampling data are not considered to be representative of stock conditions. The mixed fishery for *Pandalus borealis/montagui* confounds the assessment and the lack of knowledge on the distribution and abundance/biomass of both species will persist in the absence of a time series of research trawl surveys. Prospects are unknown.

REFERENCES

DFO, 2000. Northern Shrimp (*Pandalus borealis*) - Div. 0B to 3K. DFO Science, Stock Status Report C2-05 (2000).

Evans, G.T., D.C. Orr, D.G. Parsons, and P.J. Veitch. 1999. A Non-parametric methods of estimating biomass from trawl surveys with Monte Carlo confidence intervals. NAFO SCR Doc. 99/72, Serial No. N4143: 8 p.

Parsons, D.G., P.J. Veitch, D. Orr, and G.T. Evans. 2000. Assessment of northern shrimp (Pandalus borealis) off Baffin Island, Labrador and northeastern Newfoundland. CSAS Res. Doc. 00/069: 65 p.

TABLE 1 MULTIPLICATIVE, YEAR MONTH VESSEL AREA MODEL FOR CPUE IN HAWKE CHANNEL + DIV.3K, 1988 - 2000, WEIGHTED BY EFFORT

General Linear Models Procedure

Class Level Information

Class	Levels	Values
YEAR	13	88 89 90 91 92 93 94 95 96 97 98 99 100
MONTH	5	2 3 4 5 99
VESSEL	20	5 12 13 21 30 32 38 39 40 41 42 43 44 47 58 67 69 70 71 99
AREA	7	67 68 69 90 91 92 99

Number of observations in data set = 1219

Dependent Variable: LNCPUE

Weight: WFACTOR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	41	48669.24309876	1187.05470973	94.78	0.0001
Error	1177	14740.46683312	12.52376112		
Corrected Total	1218	63409.70993188			

R-Square	C.V.	Root MSE	LNCPUE Mean
0.767536	51.79305	3.53889264	6.83275582

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	12	8119.73773250	676.64481104	54.03	0.0001
MONTH	4	465.79832906	116.44958227	9.30	0.0001
VESSEL	19	2418.46279732	127.28751565	10.16	0.0001
AREA	6	2998.83053234	499.80508872	39.91	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		7.933505855 B	107.29	0.0001	0.07394235
YEAR	88	-1.276868067 B	-16.36	0.0001	0.07806835
	89	-1.548772507 B	-21.07	0.0001	0.07352092
	90	-1.475729736 B	-17.81	0.0001	0.08284909
	91	-1.232285217 B	-15.76	0.0001	0.07816876
	92	-0.899796949 B	-12.32	0.0001	0.07305039
	93	-0.763786031 B	-10.25	0.0001	0.07451935
	94	-0.577578238 B	-8.03	0.0001	0.07188634
	95	-0.321260440 B	-4.37	0.0001	0.07351168
	96	-0.247091231 B	-3.41	0.0007	0.07254267
	97	-0.018339379 B	-0.25	0.8058	0.07456274
	98	-0.283710979 B	-4.22	0.0001	0.06726008
	99	-0.215759309 B	-3.12	0.0019	0.06919925
	100	0.000000000 B	.	.	

TABLE 2. MULTIPLICATIVE, YEAR, AREA AND VESSEL MODEL FOR INSHORE VESSEL CPUE IN HAWKE CHANNEL + DIV. 3K, 1998 - 2000, WEIGHTED BY EFFORT

General Linear Models Procedure

Class Level Information

Class	Levels	Values
year	3	1998 1999 2000
area	7	67 68 69 90 91 92 99
vessel	42	298 1001 2769 5745 10042 60667 62452 64796 66908 67624 76193 86901 87285 87789 88969 89300 90762 92702 92856 93614 93687 93688 93712 93831 93933 94072 94639 100551 100745 100990 101242 101469 102010 102084 103094 103677 129966 130029 130395 130492 130714 130718

Number of observations 646

Dependent Variable: LNCPUE
Weight: WFACTOR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	49	1766.567701	36.052402	6.59	<.0001
Error	596	3262.484046	5.473967		
Corrected Total	645	5029.051747			

R-Square	Coeff Var	Root MSE	LNCPUE Mean
0.351273	39.81827	2.339651	5.875823

Source	DF	Type I SS	Mean Square	F Value	Pr > F
year	2	313.776522	156.888261	28.66	<.0001
area	6	154.124887	25.687481	4.69	0.0001
vessel	41	1298.666291	31.674788	5.79	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
year	2	209.824007	104.912003	19.17	<.0001
area	6	180.313129	30.052188	5.49	<.0001
vessel	41	1298.666291	31.674788	5.79	<.0001

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		6.048553715	B	0.08741894	69.19	<.0001
year	1998	-0.184345313	B	0.03462817	-5.32	<.0001
year	1999	-0.167039425	B	0.03047591	-5.48	<.0001
year	2000	0.000000000	B	.	.	.

TABLE 3 NORTHERN SHRIMP FISHERY DATA FOR HAWKE CHANNEL + DIVISION 3K (SFA 6), 1987 - 2000.

			OFFSHORE UNSTANDARDIZED				OFFSHORE STANDARDIZED			INSHORE UNSTANDARDIZED				INSHORE STANDARDIZED		
YEAR	TAC[1] (t)	TOTAL CATCH (t)	OFFSHORE CATCH (t)	CPUE (KG/HR)	CPUE INDEX	EFFORT[2] (HR)	RELATIVE CPUE	CPUE INDEX	EFFORT INDEX	INSHORE CATCH (t)	CPUE (KG/HR)	CPUE INDEX	EFFORT (HR)	RELATIVE CPUE	CPUE INDEX	EFFORT INDEX
1987	3000	1845	1845	333		5544										
1988	3000	7849	7849	536	1.00	14637	0.27	1.00	7849							
1989	5600	6662	6662	433	0.81	15403	0.21	0.77	8659							
1990	5600	5598	5598	508	0.95	11027	0.22	0.83	6751							
1991	4301	5500	5500	603	1.12	9120	0.28	1.06	5206							
1992	7565	6609	6609	774	1.44	8534	0.40	1.48	4462							
1993	9180	8035	8035	892	1.66	9012	0.45	1.70	4726							
1994	11050	10978	10978	1295	2.41	8477	0.54	2.03	5420							
1995	11050	10914	10914	1821	3.40	5992	0.70	2.63	4146							
1996	11050	10923	10923	2008	3.74	5440	0.75	2.82	3874							
1997	23100	21246	15182	1998	3.72	7600	0.95	3.54	4293	6064						
1998	46200	46337	16264	1795	3.35	9062	0.73	2.73	5957	30073	358	1.00	84003	0.83	1.00	30073
1999	58632	51202	17587	1790	3.34	9827	0.75	2.79	6302	33615	363	1.01	92603	0.85	1.02	32824
2000	60908	63266	20615	2011	3.75	10252	1.00	3.74	5511	42651	421	1.18	101309	1.00	1.20	35400

[1] **HISTORICAL TAC'S APPLIED AS FOLLOWS:**

1987 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 2000 - ALL AREAS COMBINED.

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

[2] **EFFORT CALCULATED FROM CATCH/CPUE. CPUE CALCULATED FROM LOGBOOK DATA - SINGLE TRAWL.**

TABLE 4 MULTIPLICATIVE, YEAR MONTH VESSEL AREA MODEL FOR CPUE IN HOPEDALE + CARTWRIGHT CHANNELS, 1977 - 2000, WEIGHTED BY EFFORT.

General Linear Models Procedure
Class Level Information

Class	Levels	Values
YEAR	24	77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100
MONTH	12	1 2 3 4 5 6 8 9 10 11 12 99
VESSEL	26	1 4 5 7 13 15 21 29 30 33 39 40 41 43 44 45 46 47 49 53 58 67 69 70 72 99
AREA	4	52 53 54 99

Number of observations in data set = 1527
Dependent Variable: LNCPUE
Weight: WFACTOR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	62	58707.69715596	946.89834123	86.40	0.0001
Error	1464	16044.23292420	10.95917549		
Corrected Total	1526	74751.93008016			

R-Square	C.V.	Root MSE	LNCPUE Mean
0.785367	51.72125	3.31046454	6.40058856

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	23	9431.47388320	410.06408188	37.42	0.0001
MONTH	11	5632.17727710	512.01611610	46.72	0.0001
VESSEL	25	3168.14479353	126.72579174	11.56	0.0001
AREA	3	107.36175868	35.78725289	3.27	0.0207

Parameter		Estimate		T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		7.237711251	B	96.61	0.0001	0.07491584
YEAR	77	-0.685995815	B	-5.93	0.0001	0.11562924
	78	-0.766453440	B	-6.87	0.0001	0.11154007
	79	-1.069650519	B	-10.91	0.0001	0.09806640
	80	-1.068883922	B	-12.68	0.0001	0.08431206
	81	-1.059863664	B	-12.85	0.0001	0.08250253
	82	-1.135279686	B	-12.90	0.0001	0.08800756
	83	-1.402886307	B	-14.97	0.0001	0.09371890
	84	-1.263906560	B	-13.48	0.0001	0.09375161
	85	-1.499437039	B	-18.42	0.0001	0.08138573
	86	-0.851147684	B	-10.09	0.0001	0.08438642
	87	-0.910428628	B	-10.84	0.0001	0.08402499
	88	-1.006514678	B	-12.45	0.0001	0.08082226
	89	-0.955031847	B	-11.91	0.0001	0.08021716
	90	-0.877307724	B	-11.00	0.0001	0.07976864
	91	-1.028634215	B	-13.17	0.0001	0.07809274
	92	-1.086828824	B	-14.45	0.0001	0.07521417
	93	-0.928147708	B	-12.48	0.0001	0.07439250
	94	-0.828692018	B	-11.46	0.0001	0.07230128
	95	-0.670143674	B	-8.32	0.0001	0.08056044
	96	-0.449451052	B	-5.20	0.0001	0.08643558
	97	-0.200898981	B	-2.78	0.0056	0.07234409
	98	-0.243324029	B	-3.17	0.0016	0.07677915
	99	-0.177155173	B	-2.27	0.0231	0.07791323
	100	0.000000000	B	.	.	.

TABLE 5 NORTHERN SHRIMP FISHERY DATA FOR HOPEDALE + CARTWRIGHT CHANNELS (SFA 5) 1977-2000.

YEAR	TAC [1] (t)	CATCH [2] (t)	UNSTANDARDIZED CPUE (KG/HR)	UNSTANDARDIZED CPUE INDEX	UNSTANDARDIZED EFFORT [3] (HR)	STANDARDIZED RELATIVE CPUE	STANDARDIZED CPUE INDEX	STANDARDIZED EFFORT [3] INDEX
1977		2686	552	1.00	4865	0.50	1.00	2686
1978	5300	3630	453	0.82	8011	0.46	0.92	3934
1979	4000	3727	368	0.67	10136	0.34	0.68	5470
1980	4800	4108	388	0.70	10594	0.34	0.68	6025
1981	4800	3449	364	0.66	9485	0.35	0.69	5013
1982	4800	1983	372	0.67	5329	0.32	0.64	3108
1983	4800	1000	297	0.54	3368	0.25	0.49	2048
1984	4200	1002	297	0.54	3373	0.28	0.56	1786
1985	3570	1689	230	0.42	7350	0.22	0.44	3810
1986	4400	4826	538	0.97	8970	0.43	0.85	5692
1987	4800	5956	615	1.11	9685	0.40	0.80	7454
1988	4800	7838	627	1.13	12510	0.37	0.73	10799
1989	6000	5985	677	1.23	8847	0.38	0.76	7832
1990	6000	5360	627	1.13	8555	0.42	0.83	6490
1991	6375	6118	528	0.96	11589	0.36	0.71	8618
1992	6375	6315	694	1.26	9093	0.34	0.67	9428
1993	6375	5719	620	1.12	9228	0.40	0.78	7286
1994	7650	7499	754	1.37	9944	0.44	0.87	8649
1995	7650	7616	1386	2.51	5496	0.51	1.02	7496
1996	7650	7383	1921	3.48	3842	0.64	1.27	5827
1997	15300	15103	1603	2.90	9422	0.82	1.62	9298
1998	15300	15170	2117	3.83	7165	0.78	1.56	9744
1999	15300	15109	2262	4.10	6681	0.84	1.66	9083
2000	15300	14971	2359	4.27	6348	1.00	1.99	7539

[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 6 MULTIPLICATIVE, YEAR MONTH VESSEL MODEL FOR CPUE IN DIVISION 2G, 1988 - 2000, WEIGHTED BY EFFORT.

General Linear Models Procedure

Class Level Information

Class	Levels	Values
YEAR	13	88 89 90 91 92 93 94 95 96 97 98 99 100
MONTH	8	5 7 8 9 10 11 12 99
VESSEL	19	5 12 21 29 33 34 37 40 42 43 44 47 58 67 69 70 71 72 99

Number of observations in data set = 346

Dependent Variable: LNCPUE
Weight: WFACTOR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	37	8780.14341145	237.30117328	22.37	0.0001
Error	308	3267.02073507	10.60721018		
Corrected Total	345	12047.16414651			

R-Square	C.V.	Root MSE	LNCPUE Mean
0.728814	44.49647	3.25687123	7.31939220

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	12	4185.42440245	348.78536687	32.88	0.0001
MONTH	7	201.56151018	28.79450145	2.71	0.0096
VESSEL	18	747.63883232	41.53549068	3.92	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		7.655178481 B	56.41	0.0001	0.13570699
YEAR	88	-0.547253340 B	-2.13	0.0342	0.25732939
	89	-1.514250353 B	-11.26	0.0001	0.13443574
	90	-1.452336212 B	-12.23	0.0001	0.11879075
	91	-0.030177027 B	-0.16	0.8743	0.19057015
	92	-0.346053519 B	-2.47	0.0142	0.14031314
	93	0.005108264 B	0.04	0.9697	0.13448924
	94	0.249865129 B	1.93	0.0548	0.12962429
	95	-0.458010449 B	-4.33	0.0001	0.10571514
	96	-0.592508774 B	-4.97	0.0001	0.11928020
	97	0.152513637 B	1.32	0.1866	0.11522756
	98	-0.132836636 B	-1.34	0.1798	0.09880360
	99	-0.015018842 B	-0.15	0.8833	0.10224160
	100	0.000000000 B	.	.	.

TABLE 7 NORTHERN SHRIMP FISHERY DATA FOR DIV. 2G (SFA 4), 1979 - 2000.

YEAR	TAC [1] (t)	CATCH [2] (t)	UNSTANDARDIZED CPUE (KG/HR)	UNSTANDARDIZED INDEX	UNSTANDARDIZED EFFORT [3] (HR)	STANDARDIZED RELATIVE CPUE	STANDARDIZED CPUE INDEX	STANDARDIZED EFFORT [3] INDEX
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	660		11			
1988	500	1083	1856	1.00	584	0.58	1.00	1083
1989	2580	3842	673	0.36	5709	0.22	0.38	10105
1990	2580	2945	703	0.38	4190	0.23	0.40	7280
1991	2635	2561	3071	1.66	834	0.97	1.68	1527
1992	2635	2706	1901	1.02	1423	0.71	1.22	2213
1993	2735	2723	2160	1.16	1261	1.01	1.74	1567
1994	4000	3982	3142	1.69	1267	1.28	2.22	1794
1995	5200	5104	1503	0.81	3397	0.63	1.09	4668
1996	5200	5160	1173	0.63	4399	0.55	0.96	5399
1997	5200	5217	2779	1.50	1877	1.16	2.01	2591
1998	8320	8051	2074	1.12	3882	0.88	1.51	5319
1999	8320	7884	2410	1.30	3271	0.99	1.70	4630
2000	8320	8130	2614	1.41	3110	1.00	1.73	4703

[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 LOGS FOR SINGLE TRAWLS.**

TABLE 8 MULTIPLICATIVE, YEAR MONTH VESSEL MODEL FOR CPUE IN DIVISION 0B, 1988 - 2000, WEIGHTED BY EFFORT.

General Linear Models Procedure

Class Level Information

Class	Levels	Values
YEAR	13	88 89 90 91 92 93 94 95 96 97 98 99 100
MONTH	7	6 7 8 9 10 12 99
VESSEL	18	5 12 21 29 30 32 39 40 41 42 44 47 58 67 69 70 71 99

Number of observations in data set = 412

Dependent Variable: LNCPUE
Weight: WFACTOR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	35	21985.76085372	628.16459582	17.38	0.0001
Error	376	13590.39530685	36.14466837		
Corrected Total	411	35576.15616058			

R-Square	C.V.	Root MSE	LNCPUE Mean
0.617991	96.31838	6.01204361	6.24184484

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	12	6658.11251870	554.84270989	15.35	0.0001
MONTH	6	489.68569159	81.61428193	2.26	0.0374
VESSEL	17	2046.93311219	120.40783013	3.33	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		6.431314848 B	35.58	0.0001	0.18075927
YEAR	88	-0.621678490 B	-3.11	0.0020	0.20005930
	89	-1.068114478 B	-6.21	0.0001	0.17190946
	90	-0.615614078 B	-3.10	0.0021	0.19887266
	91	-1.066937079 B	-5.40	0.0001	0.19741408
	92	-1.405583993 B	-8.10	0.0001	0.17347015
	93	-1.870956889 B	-5.24	0.0001	0.35730216
	94	-1.314188162 B	-7.13	0.0001	0.18421275
	95	-0.762849536 B	-5.84	0.0001	0.13063438
	96	-0.441067100 B	-2.93	0.0036	0.15066324
	97	-0.020041752 B	-0.15	0.8828	0.13584398
	98	0.308347613 B	2.10	0.0365	0.14695037
	99	-0.091870156 B	-0.67	0.5064	0.13813207
	100	0.000000000 B	.	.	.

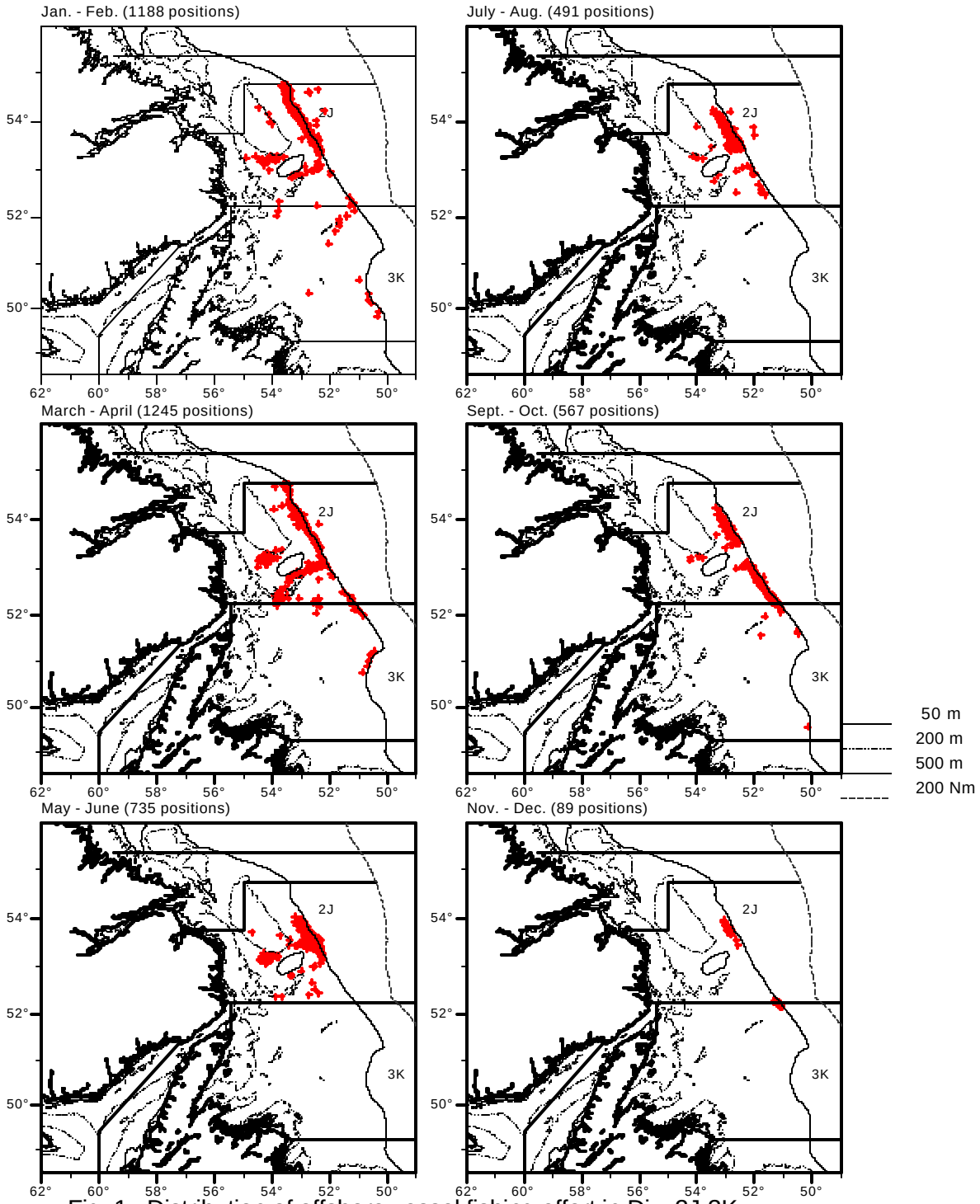


Fig. 1 Distribution of offshore vessel fishing effort in Div. 2J-3K (SFA 6) during 2000

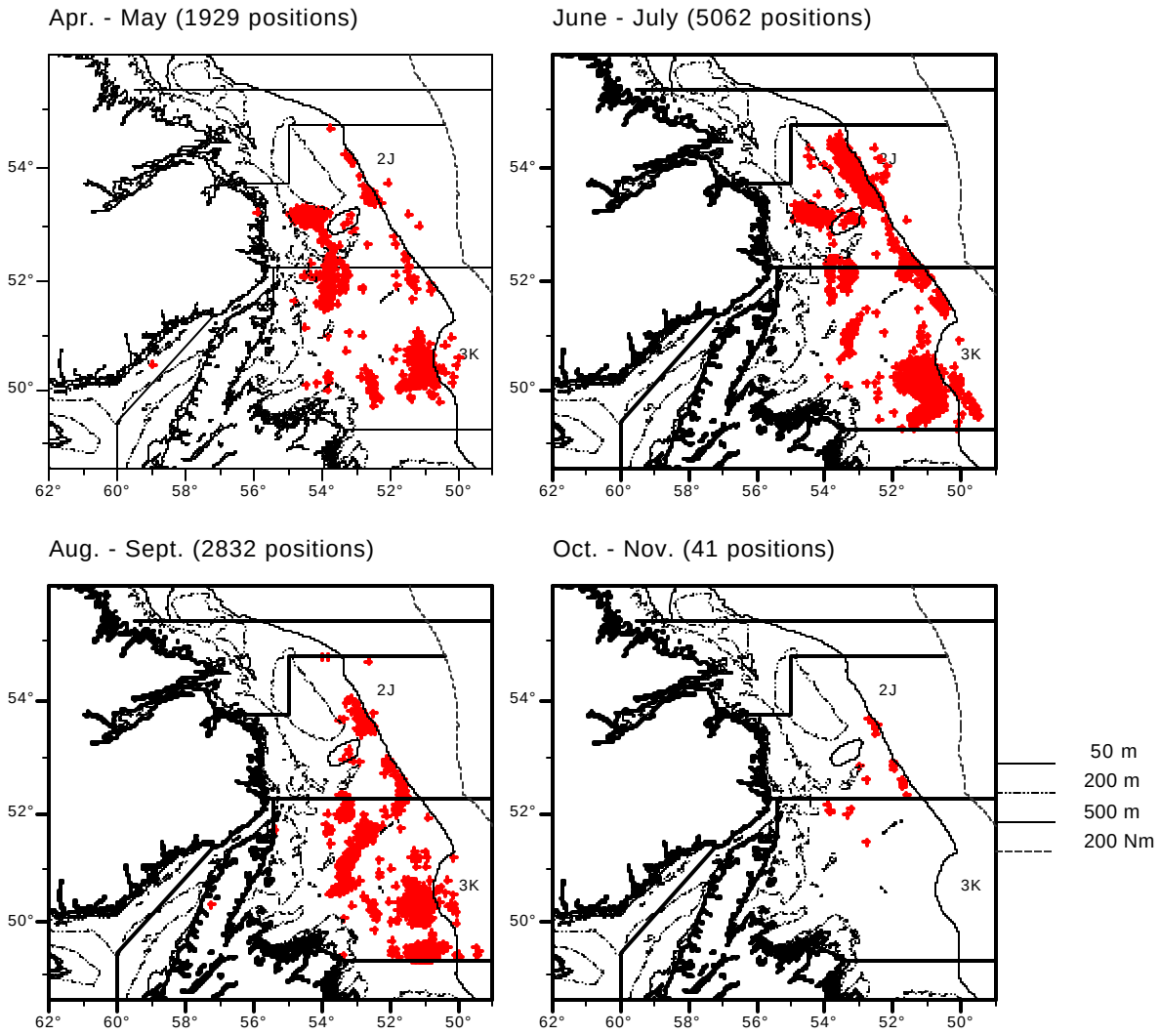


Fig. 2 Distribution of inshore vessel fishing effort in Div. 2J-3K (SFA 6) during 2000.

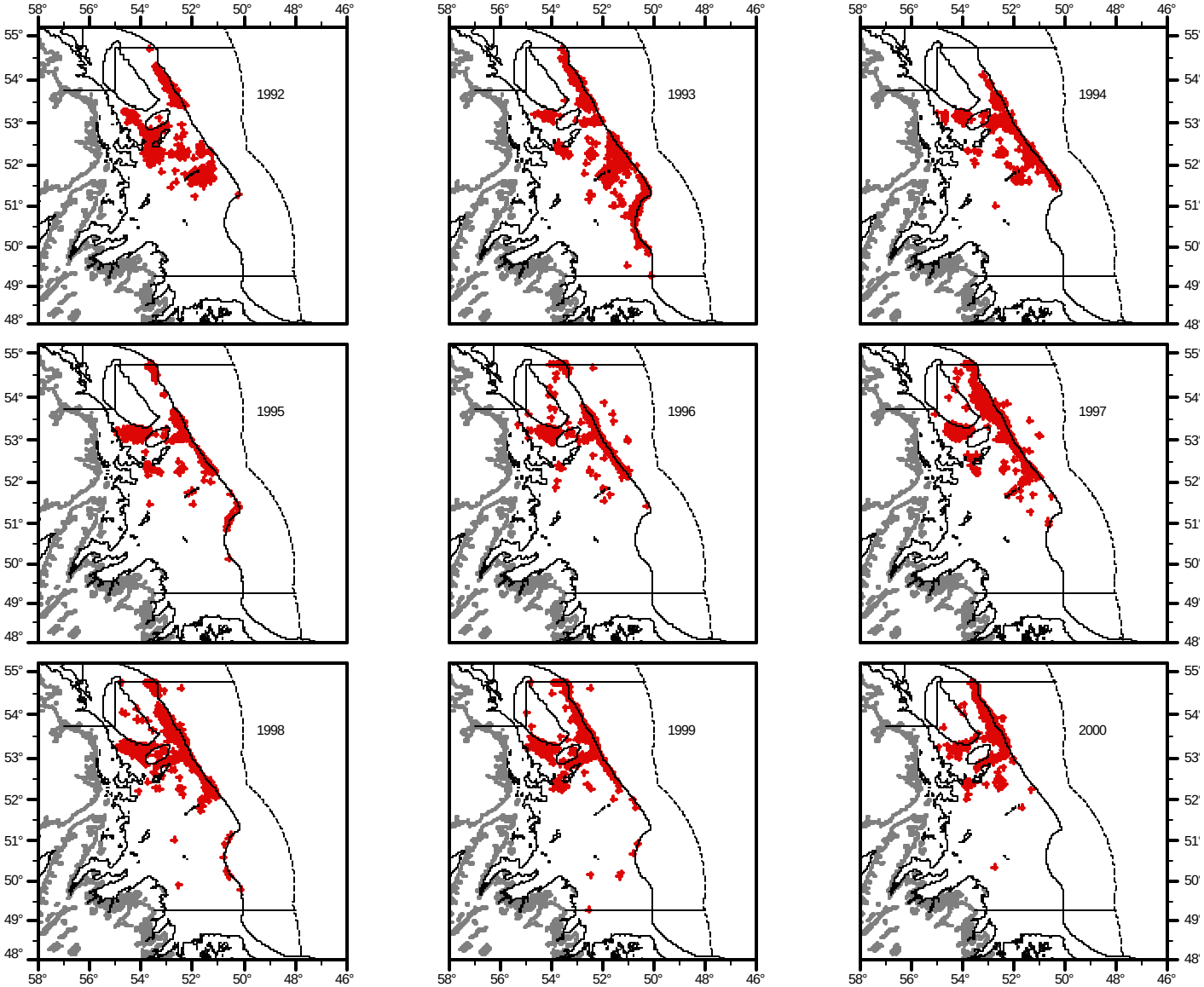


Fig. 3. Distribution of offshore vessel fishing effort in Div. 2J-3K (SFA 6), 1992-2000.

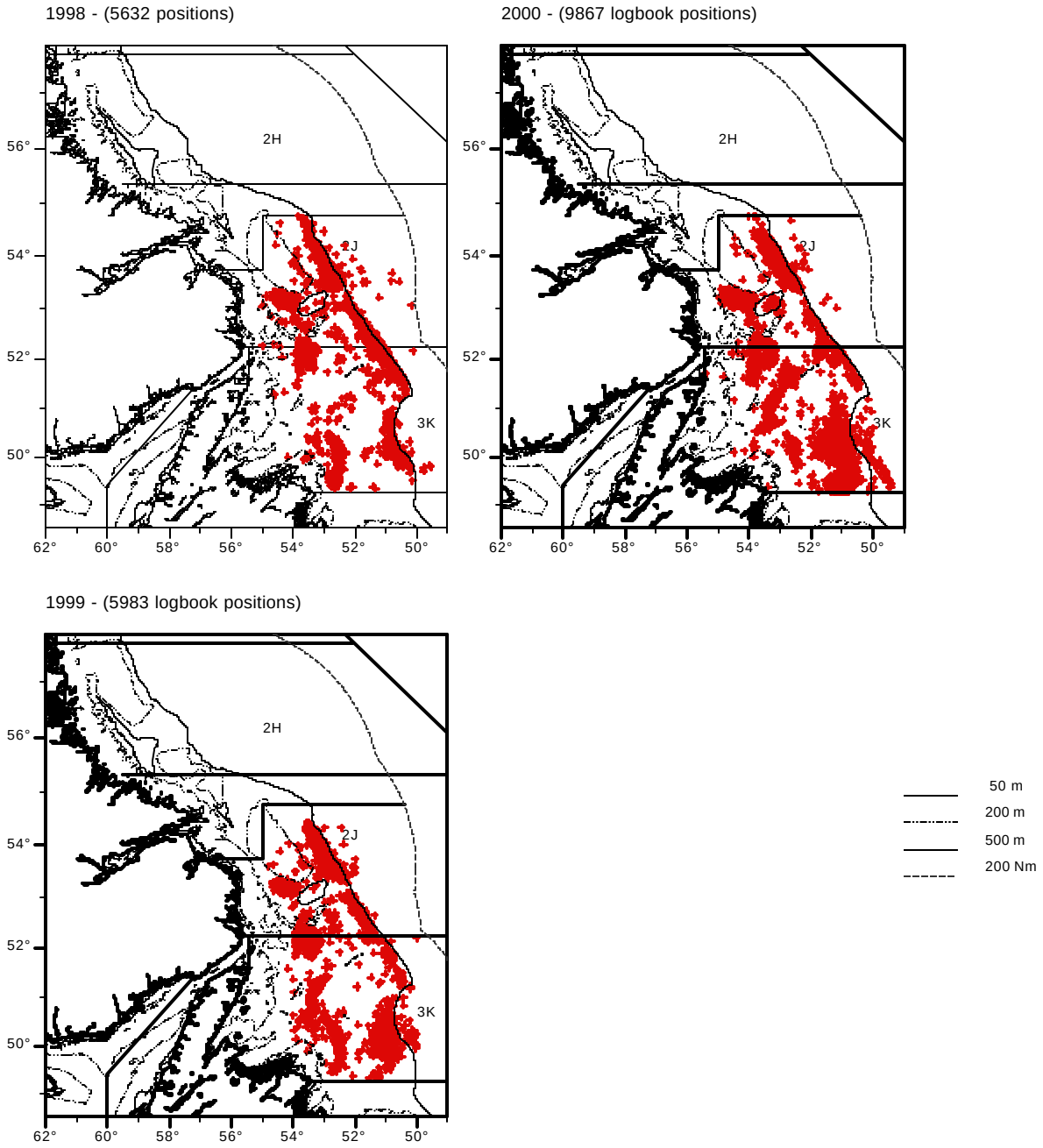


Fig. 4 Distribution of inshore vessel fishing effort in Div. 2J-3K (SFA 6), 1998 - 2000.

Fig. 5 Catch ...numbers-per-hour..000s in NAFO Division 2J-3K (SFA 6), 1991-2000.
(Solid line = males, broken line = females)

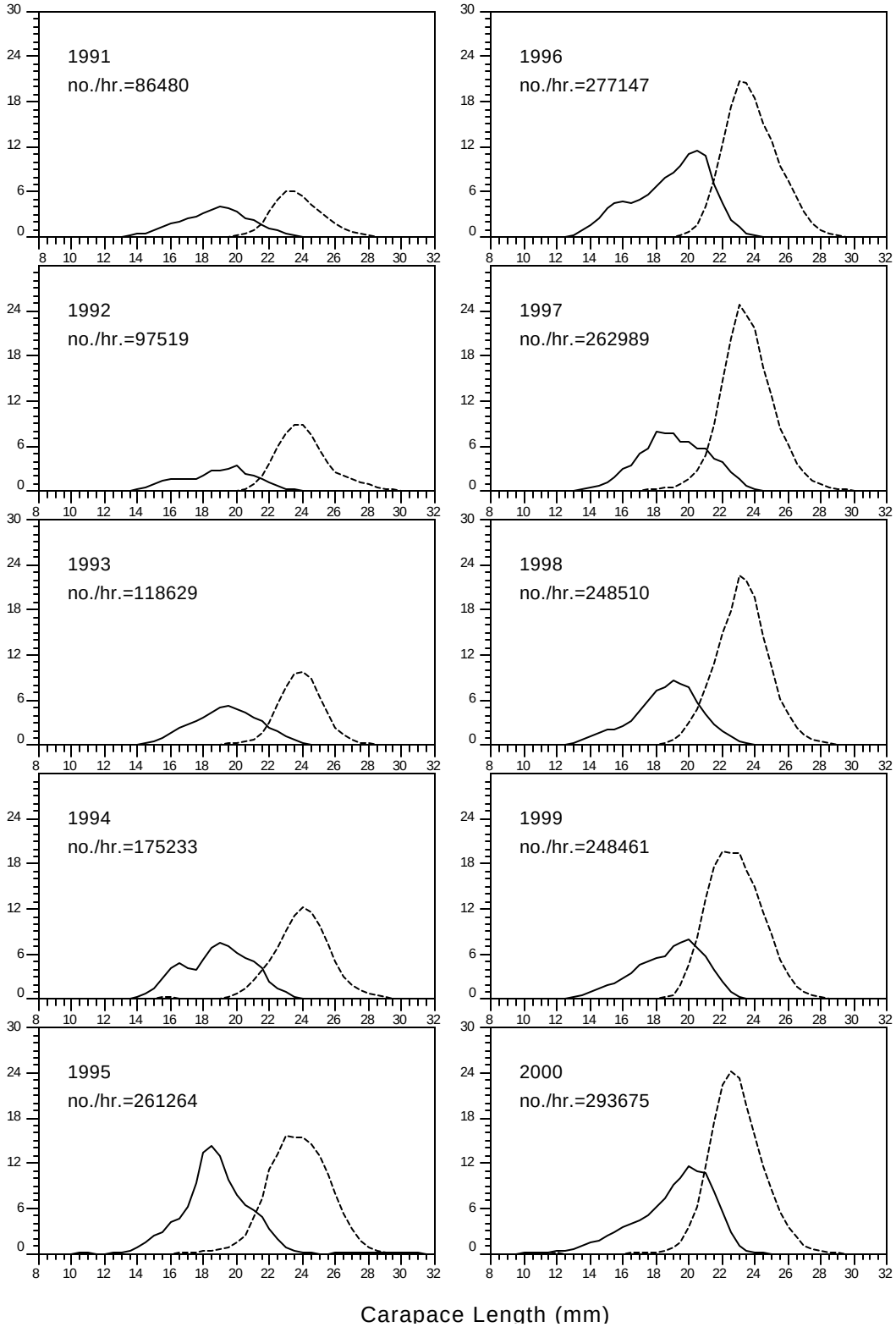
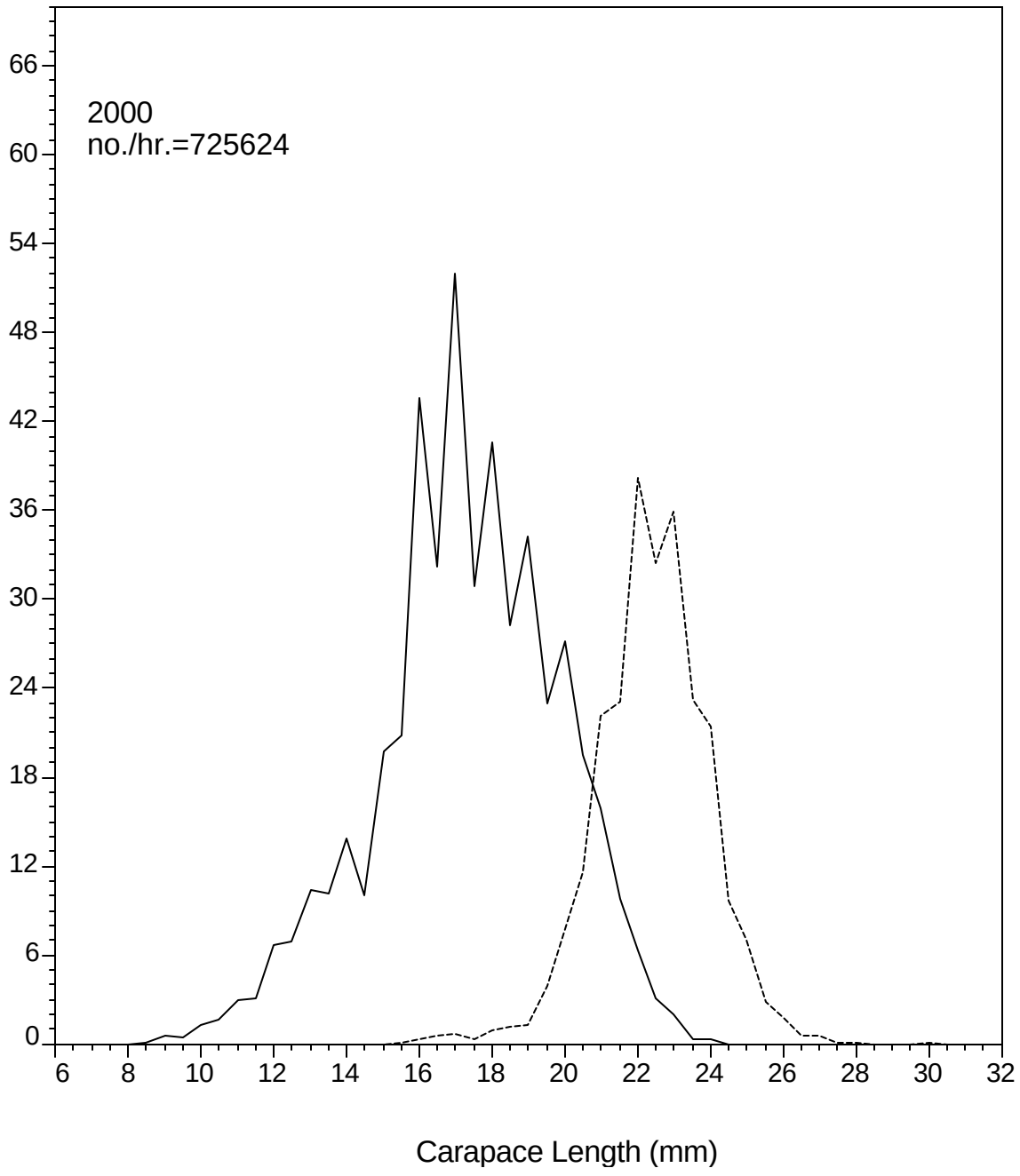


Fig. 6 Inshore vessel catch ...numbers-per-hour..000s in NAFO Division 2J-3K (SFA 6), 1991-2000. (Solid line = males, broken line = females)



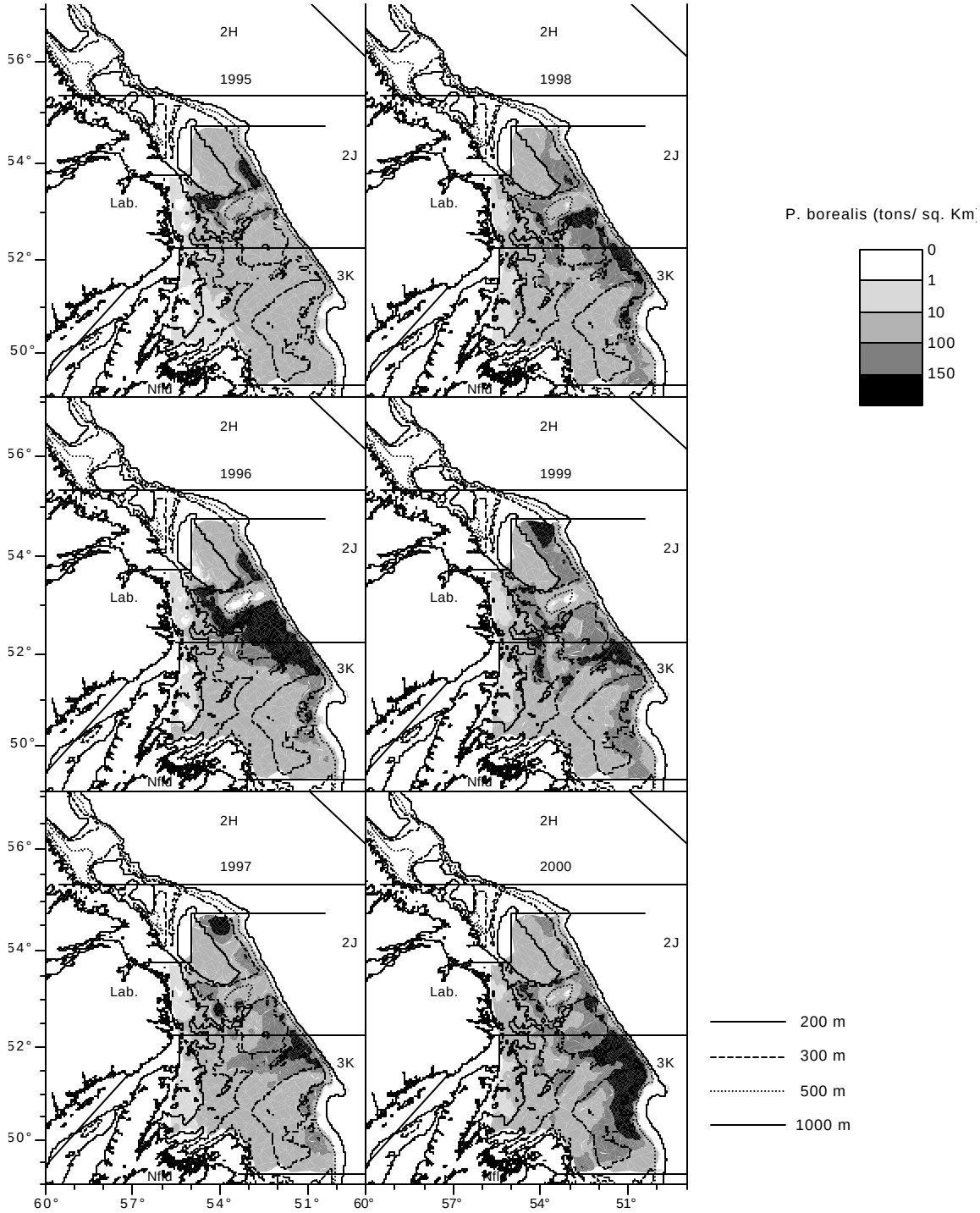
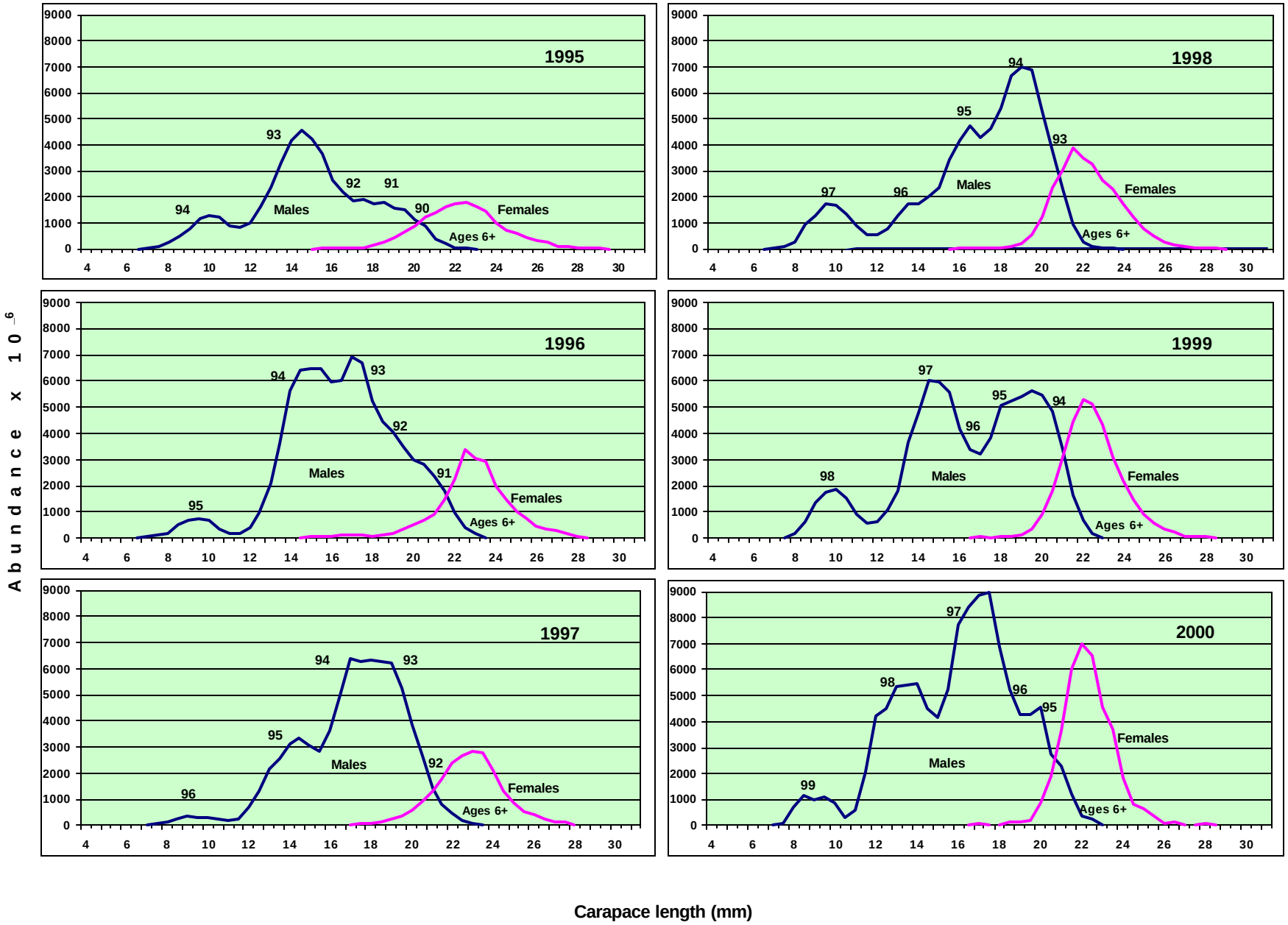


Fig. 7 Densities of (Pandalus borealis) obtained during the 1995 - 2000 fall multi-species surveys into Hawke Channel + 3K (SFA 6) using a Campelen 1800 shrimp trawl. (standard 15 min. tows)

Fig. 8 Abundance-at-length for shrimp in Hawke Channel + Div. 3K (SFA 6) estimated by ogive mapping (ogmap) of research survey data, 1995 - 2000.



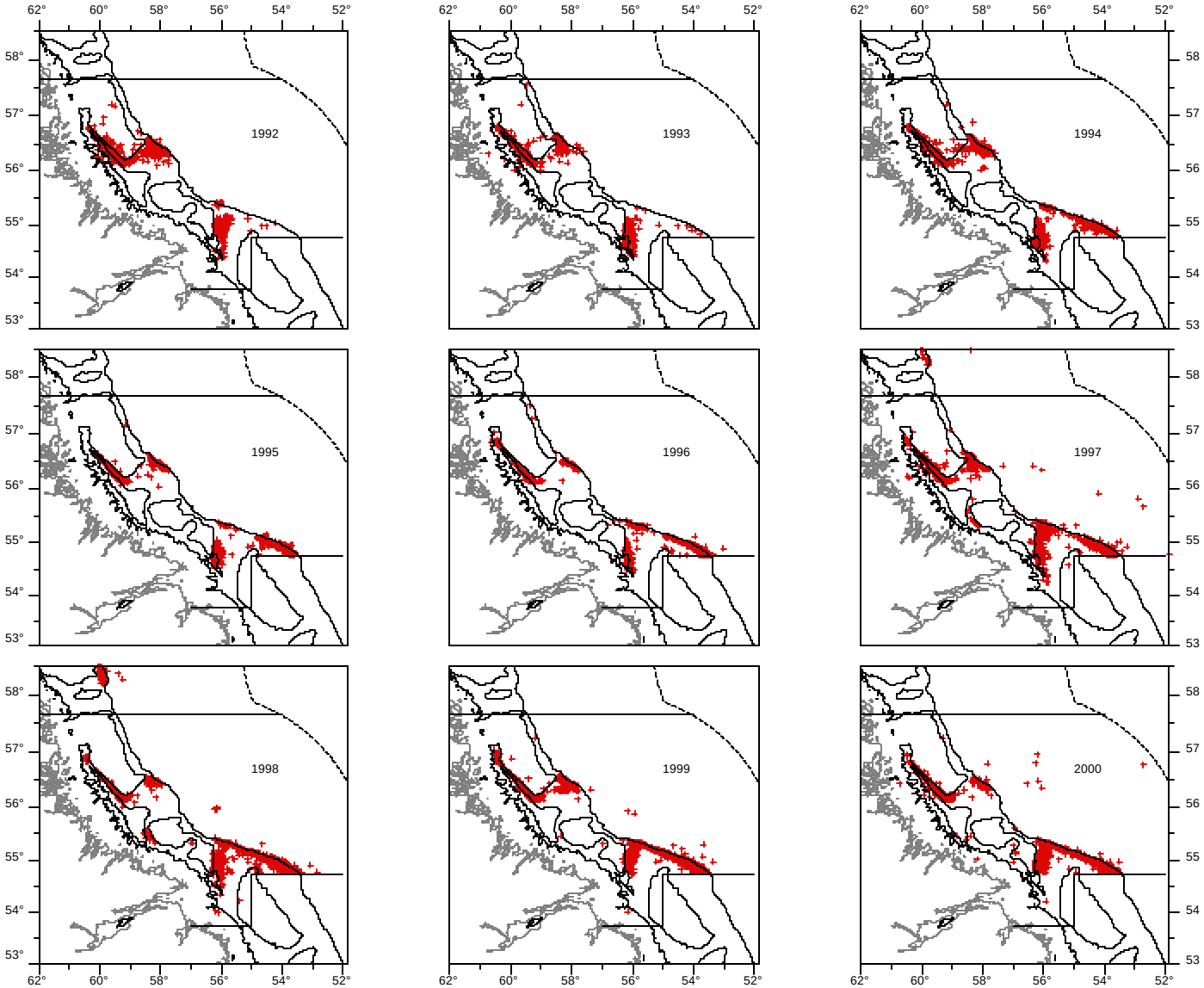


Fig. 9. Distribution of offshore vessel fishing effort in Div. 2H-2J (SFA 5), 1992-2000.

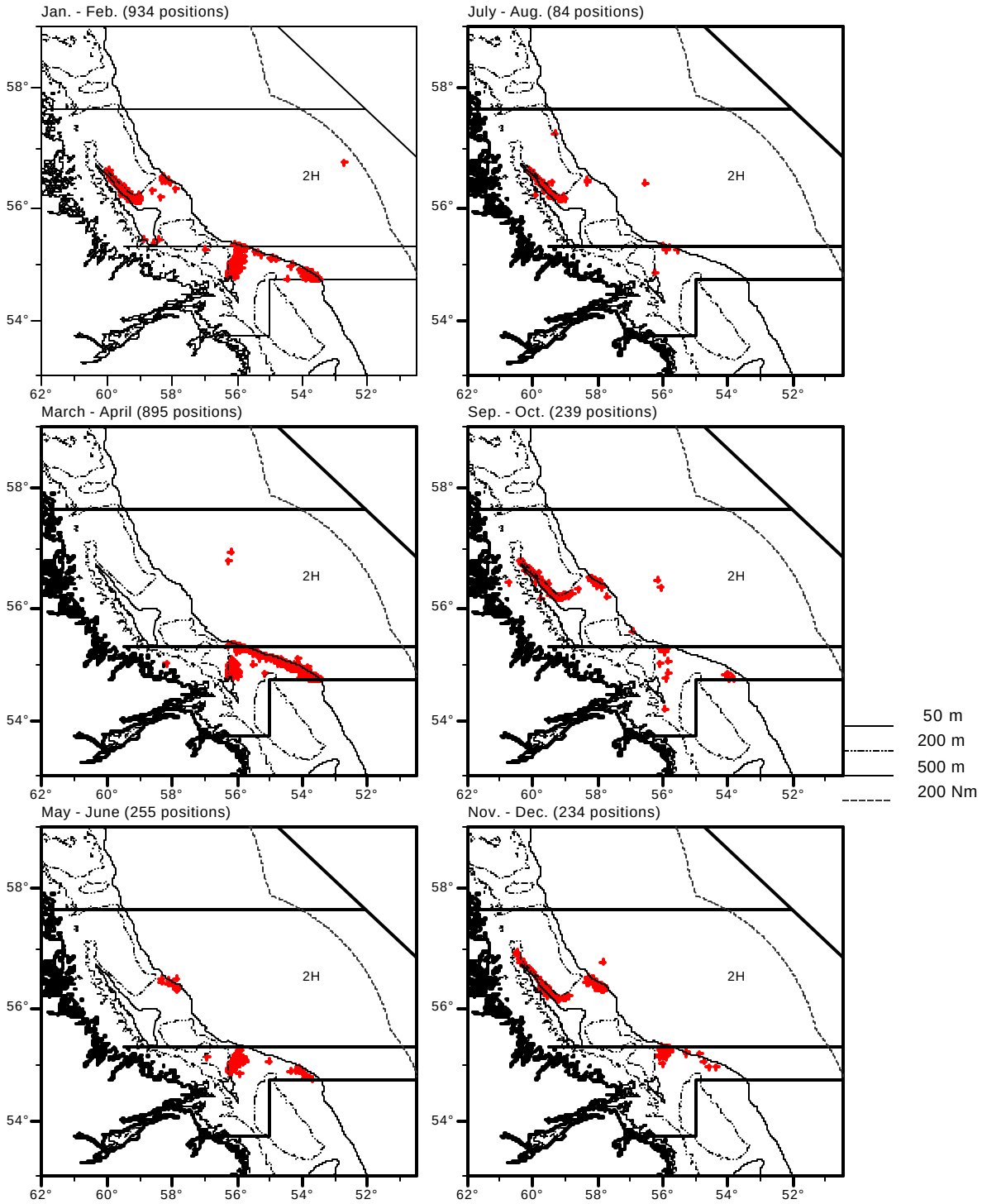
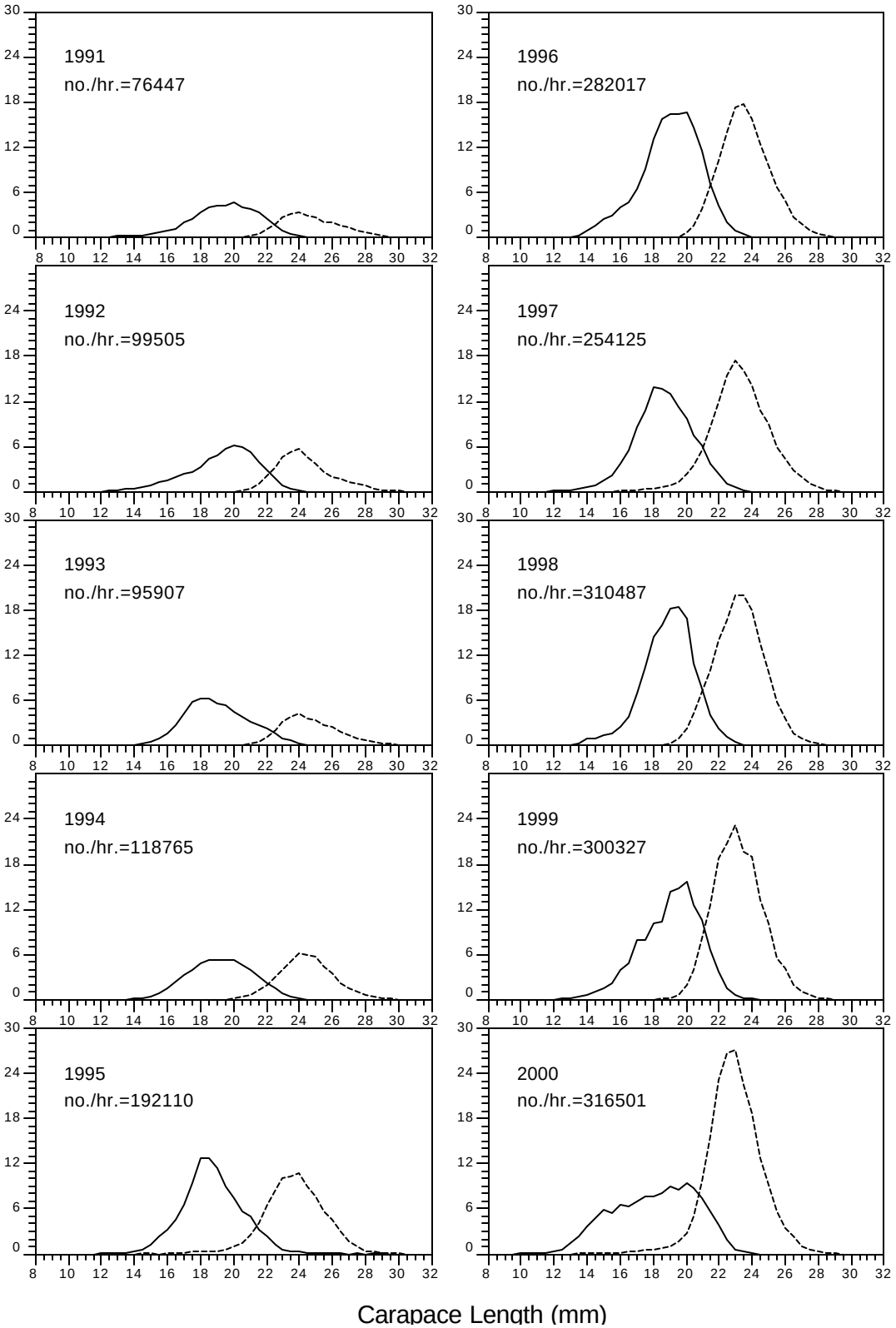


Fig. 10 Distribution of offshore vessel effort in Hopedale - Cartwright (SFA 5) during 2000.

Fig. 11 Catch ...numbers-per-hour..000s in NAFO Division 2H-2J (SFA 5), 1991-2000
(Solid line = males, broken line=females)



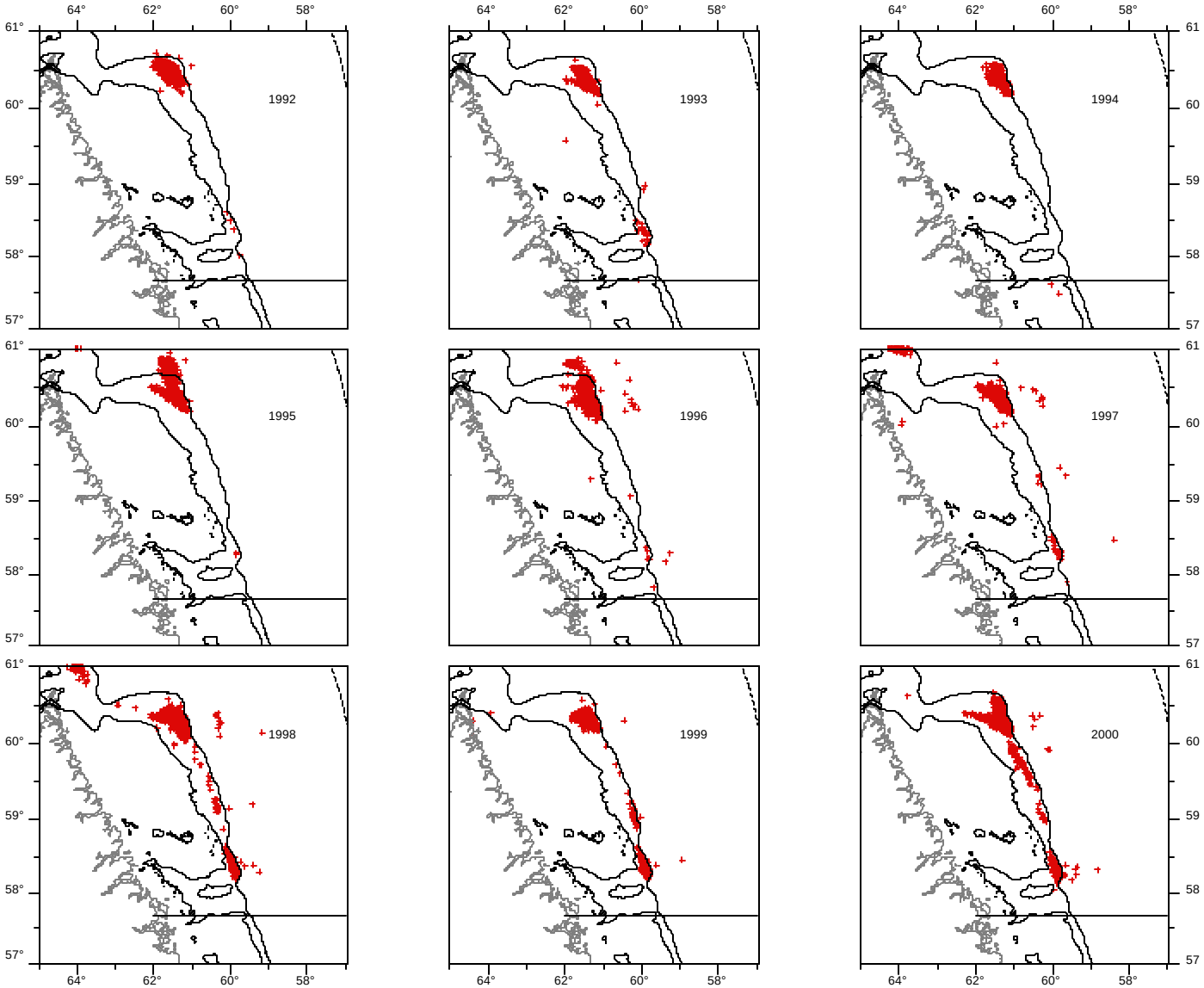


Fig. 12. Distribution of offshore vessel fishing effort in Div. 2G (SFA 4), 1992-2000.

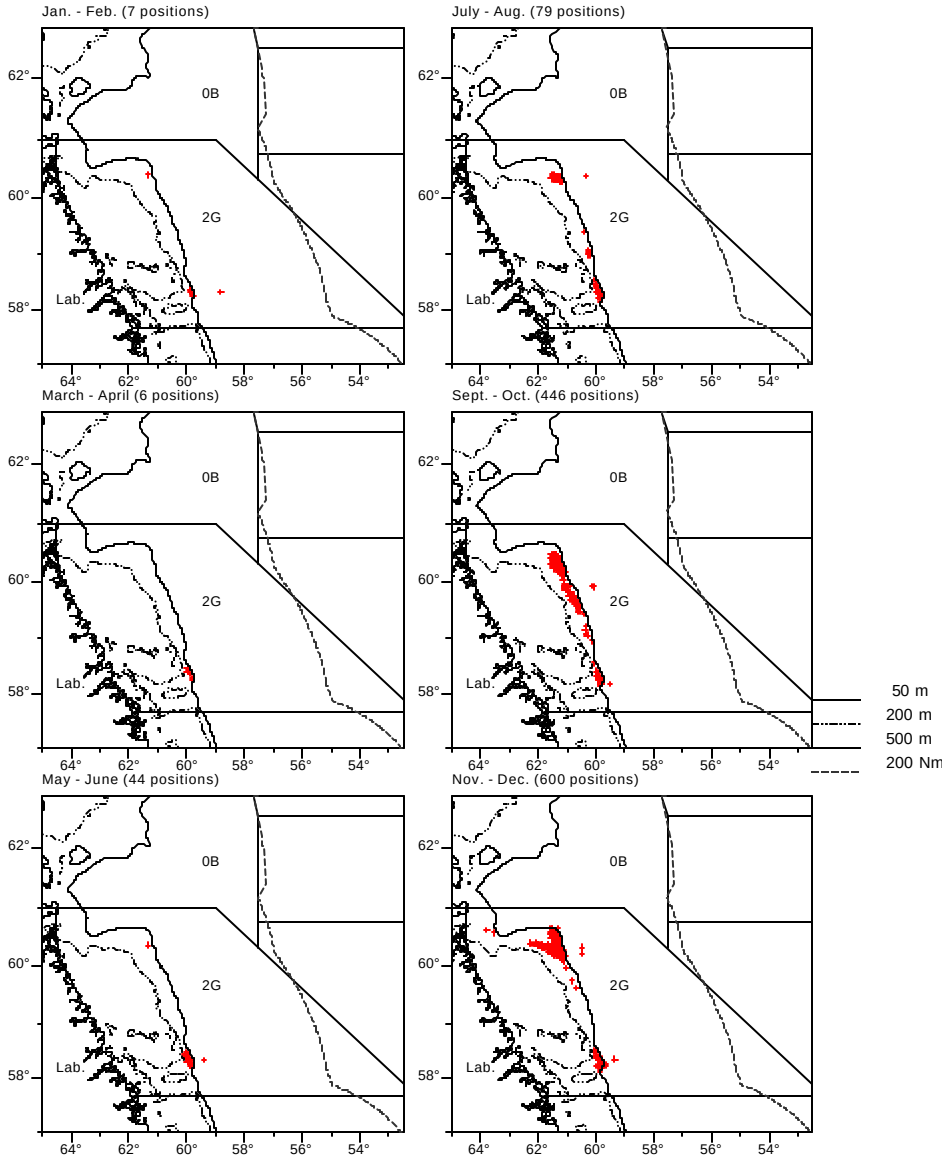
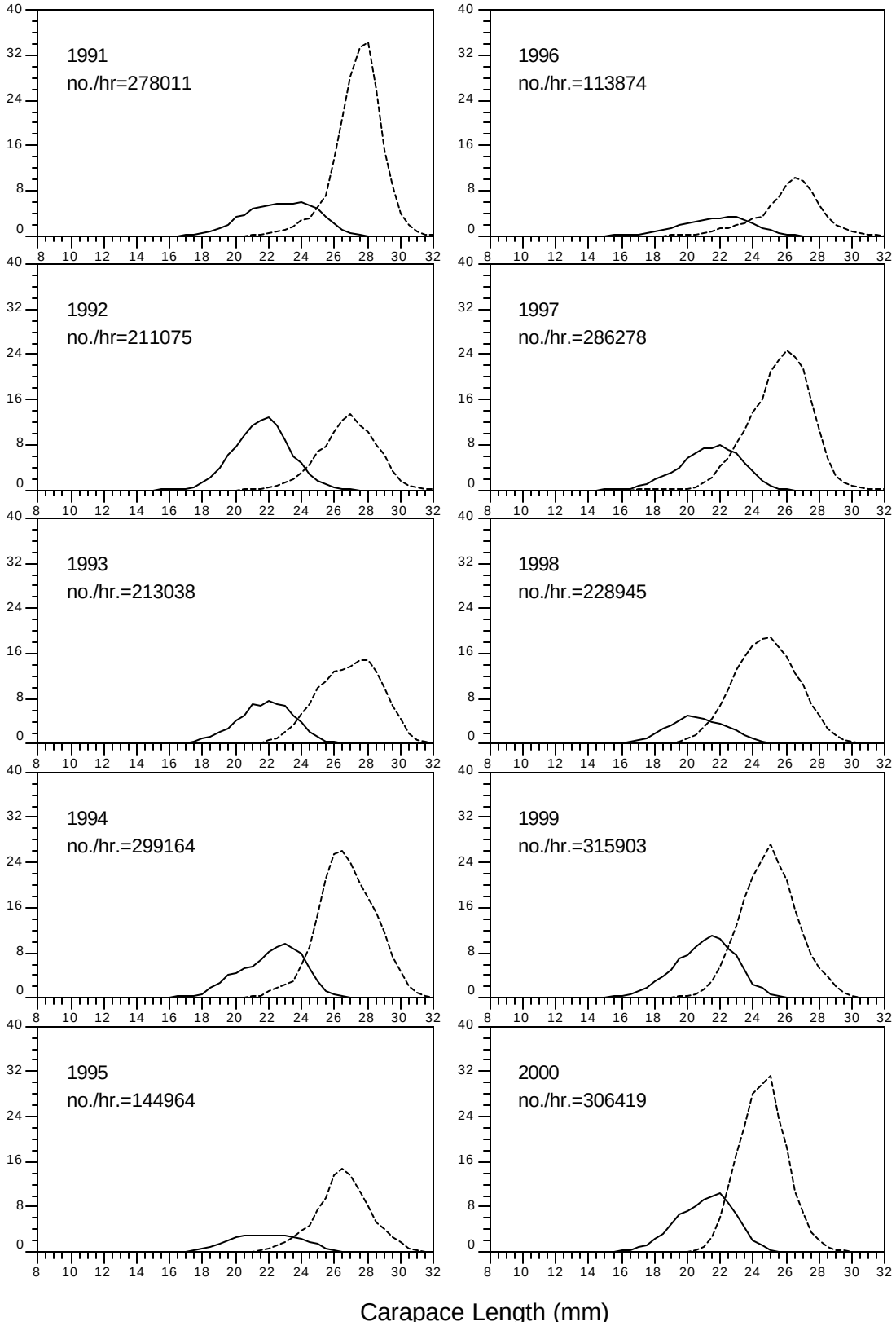


Fig. 13 Distribution of offshore vessel fishing effort in 2G (SFA 4) during 2000

Fig. 14 Catch ...numbers-per-hour..000s in NAFO Division 2G (SFA 4), 1991-2000.
(Solid line = males, broken line = females)



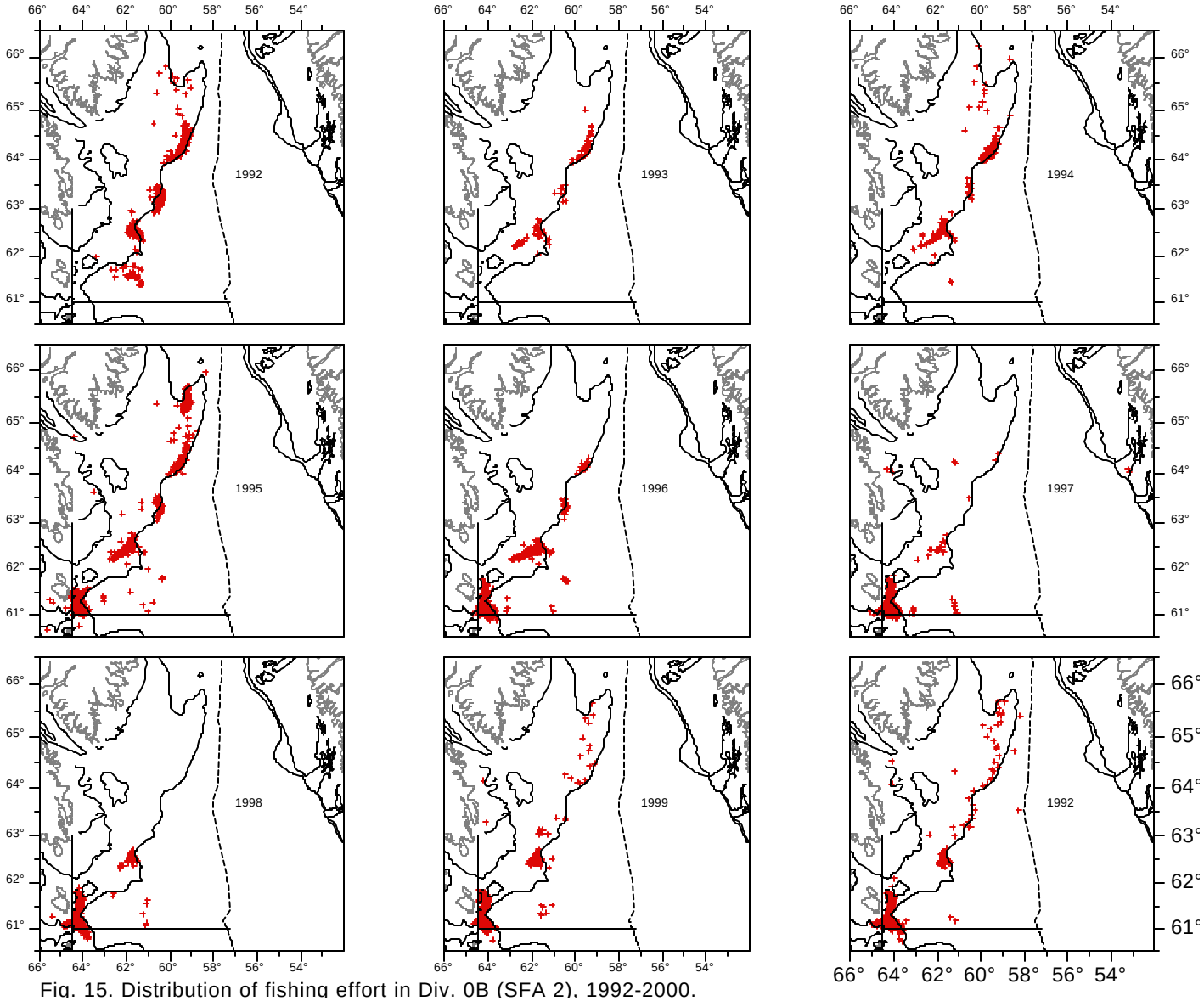


Fig. 15. Distribution of fishing effort in Div. 0B (SFA 2), 1992-2000.

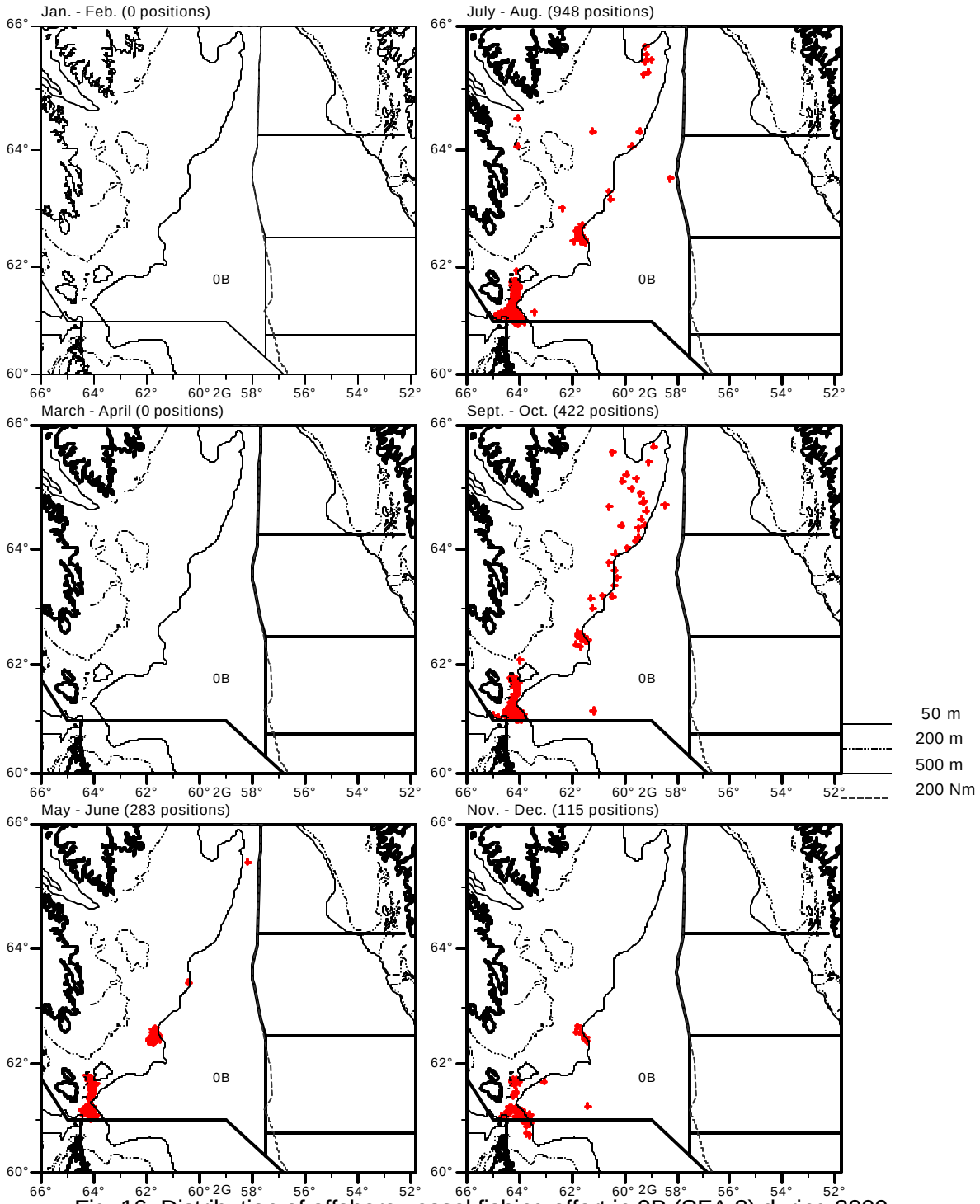


Fig. 16 Distribution of offshore vessel fishing effort in 0B (SFA 2) during 2000.

Fig. 17 Catch ...number-per-hour..000s in NAFO Division 0B (SFA 2), 1991-2000.
(Solid line = males, broken line = females)