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# Northern shrimp (*Pandalus borealis*) on the eastern Scotian Shelf - review of the 2000 fishery and outlook for 2001

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**Abstract**

The 2000 TAC of 5500 was caught without difficulty. Commercial catch rates continue to be excellent and the standardized CPUE index for 2000 is the highest of the series, although there has been a decrease in SFA 13 (Louisbourg Hole) catch rates. Trawl fishing effort in the newly (since 1998) exploited inshore area continued, but at a lower level than in 1999. Effort appears to be concentrating in smaller areas in recent years. The percent of the TAC caught in the non-ovigerous period (May-July) has decreased from about 70% prior to 1999, to 59% in 1999 and 52% in 2000. The June 2000 trawl survey showed a 13% decrease in the overal biomass, which came mainly from the decrease in SFA 13. A decrease in commercial CPUEs was also observed in this area. A re-interpretation of the population length-age composition indicates that "year class splitting", presumably due to depensatory growth caused by high densities, may have ocurred several times since the survey began in 1995. The strength of the 1997 and 1998 year classes appears to be about average, and fears that the apparent failure of the 1996 yc was due to recruitment overfishing may have been unfounded. Exploitation in terms of biomass has increased from 13% in 1999 to 17% in 2000. Females are being exploited at about 20% and males at between 10-20%. Catch composition indicates that very large, older shrimp accumulated in the population have been removed by fishing, however the spawning stock biomass remains high. Increasing temperatures, incursion of silver hake on the shrimp grounds, and decreasing capelin abundance may indicate that a regime shift to one less favourable to shrimp is under way. However, predator abundances remain low. Juvenile survey results suggest that these surveys could provide an estimate of year class strength 1-2 years in advance of the present June survey, but additional annual surveys are needed before this can be fully evaluated. Results also suggest that the inshore may be an important nursery area. An increasing number of "warning lights" for stock status indicators in the last two years suggests a slight decrease in the TAC for 2001.

**Résumé**

Le TAC de 2000 (5,500 t) a été atteint sans difficulté. Bien que les taux de capture dans la ZPS 13 (Louisbourg Hole) aient connu une baisse, les taux de capture commerciale continuent d'être excellents, et l'indice normalisé des CPUE pour 2000 est le plus élevé de la série. L'effort de pêche au chalut s'est poursuivi dans la zone côtière nouvellement exploitée (depuis 1998), mais son niveau était plus faible qu'en 1999. Au cours des dernières années, l'effort semble s'être concentré dans des zones plus restreintes. Le pourcentage du TAC capturé en dehors de la période de ponte (de mai à juillet), qui était de 70% avant 1999, a chuté pour s'établir à 59% en 1999 et à 52% en 2000. Le relevé au chalut de juin 2000 a indiqué une baisse de 13% de la biomasse globale, principalement attribuable à la baisse dans la ZPS 13, où l'on a aussi observé une baisse dans les CPUE de la pêche commerciale. Selon une nouvelle interprétation de la composition de la population selon l'âge et la longueur, il se peut que la «division des classes d'âge», sans doute attribuable à une croissance anticompensatoire occasionnée par les densités élevées, se soit produite plusieurs fois depuis le début du relevé en 1995. L'importance des classes d'âge de 1997 et 1998 semble être à peu près moyenne, et les craintes que la faiblesse apparente de la classe d'âge de 1996 soit attribuable à la surpêche des recrues étaient peut-être injustifiées. L'exploitation de la biomasse est passée de 13% en 1999 à 17% en 2000. Environ 20% des femelles et de 10 à 20% des mâles sont exploités. La composition des prises démontre que l'accumulation des crevettes âgées et de grande taille dans la population a été prélevée par la pêche: la biomasse des stocks de géniteurs reste cependant élevée. L'augmentation des températures, l'incursion du merlu argenté dans les zones de pêche de la crevette et la raréfaction du capelan indiquent peut-être l'approche d'un changement vers un régime moins profitable pour les crevettes. Les prédateurs demeurent toutefois peu abondants. Les résultats provenant des relevés des juvéniles suggèrent que ces derniers pourraient fournir une estimation de l'importance des classes d'âge d'un à deux ans avant le présent relevé de juin, mais cette évaluation approfondie ne peut être effectuée sans des relevés annuels supplémentaires. Les résultats révèlent aussi que la zone côtière pourrait être une importante aire de croissance. Le nombre croissant d'«avertissements» donnés par les indicateurs de l'état des stocks au cours des deux dernières années laisse présager une légère baisse du TAC pour 2001.

## INTRODUCTION

The biology of northern shrimp, *Pandalus borealis*, is reviewed in Shumway *et al*. 1985 for various stocks world-wide, and by Koeller et al 1996a, Koeller 2000 and Koeller et al 2000a for the eastern Scotian Shelf stock. The history of the eastern Scotian Shelf shrimp fishery and recent stock assessments are given in Koeller et al 1996b, 1996d, 1997, 1998 and 1999. Although there has been some shrimp fishing on the Scotian Shelf since the 1960s the Nova Scotia fishery began to expand toward its full potential only when groundfish bycatch restrictions were overcome with the introduction of the Nordmore grate in 1991. The TAC has been caught every year since individual SFA quotas were lifted in 1994. With biomass at historical highs and continued good recruitment, the TAC was raised from 3100mt to 3600mt for 1997 and to 3800mt for 1998. There has been evidence of reduced recruitment in recent years , but because of continued high spawning stock biomasses, and a large year class (1995) recruiting to the fishery, the TAC was increased to 5000mt for 1999 and to 5500mt for 2000. Experimental trap fisheries in Chedebucto and Mahone Bays began in 1995 and 1996, respectively. This report reviews the fisheries and stock status to the end of 2000 and provides management advice for 2001.

## METHODS AND MATERIALS

### Commercial Data

Data on the fishery were gathered from logbooks, information provided by processors (counts), and DFO Maritimes Region Statistics Branch.

A CPUE index for Gulf based vessels, which have the longest history in the fishery, was calculated as a simple unstandardised mean catch/tow for all vessels fishing in any given year. A standardised CPUE series for 1993-2000 used data from April-July, the months when the majority of the TAC was caught, for vessels that have fished for at least 4 of the 8 yr series. A multiple regression analysis was conducted with year, month, area and vessel as categorical components. Predicted values and confidence limits for a reference vessel, month and area were then calculated for each year according to Gavaris (1980).

The industry-funded port sampling program which began in 1995 continued in 2000. Samples were collected throughout the fishery in all areas from all fleet components including vessels <65' LOA landing mainly in Canso and vessels >65' LOA landing mainly in Arichat. Note, however, that logistic problems during the 2000 sampling period resulted in significant undersampling of the Gulf component of the fishery, which takes 25% of the TAC. About 50 samples of about 500 shrimp were frozen annually and stored prior to analysis for carapace length, individual weight, sex and egg developmental stage. The number of samples per month and area was allocated in proportion to weight caught. Catch at length was determined from a weighted length frequency and a length-weight relationship.

Data on the count per pound by vessel and date landing in Canso, N.S. was collected by the main shrimp buyer in the area (Seafreeze Ltd.) who uses this information to determine landed value to

the fisher based on a pre-arranged pricing scale. Counts were made by taking a random sample of shrimp from 10 separate bags of shrimp from each fishing day.

In 2000, a questionnaire was developed to facilitate input of information from the fishing industry on various aspects of the fishery and the resource (Appendix 1). Vessel captains were interviewed by telephone at the end of the fishing season.

**Survey Data**

A sixth industry funded trawl survey, incorporating a stratified random design, was conducted in June 2000. Survey design and station selection methods were similar to previous surveys completed in 1995-99: >100 fathoms, randomly selected stations in strata 13 and 15; fixed stations in strata 14; 30 minute tow length; 2.5 knot vessel speed. Stations in Strata 17 (inshore) were selected randomly at all depths having a bottom type identfied as La Have clay on surficial geology maps. The 2000 survey was completed by MV *Carmel VI (previously named the Amelie Zoe )* fishing the standard survey trawl (Gourock #1126 2-bridle shrimp trawl and #9 Bison doors). Measurements of trawl wing spread and headline height were made throughout all survey sets using SCANMAR sensors. Near bottom temperatures were recorded throughout each survey set with a continuous temperature recorder (Vemco Ltd.) attached to the headline of the trawl. A random sample of 10 pounds of shrimp (approximately 500 individuals) was collected from the catch of each set and frozen for detailed analysis, i.e. observations as per commercial samples described above.

Catches were standardised to the target distance travelled at 2.5 knots for 30 min (1.25 nm). Biomass/population estimates and bootstrapped confidence intervals (Smith 1997) were calculated using the product of the average measured wing spread (17.4 m) of the survey trawl and the distance travelled during a standard survey set (1.25nm) as the standard unit area swept by each set (Halliday and Koeller 1981).

Survey population estimates per stratum were determined by the swept area method using individual set length frequencies and weights caught, and a length-weight relationship. Survey population estimates by age group were estimated by separating total population at length estimates from the swept area method into inferred age groups using MIX (MacDonald and Pitcher 1979).

Results from 2 winter research surveys using a beam trawl are presented in this document. These surveys were designed to determine year class strength at an early age (1-2 years) in order to improve the limited predictive capability of the summer trawl survey. The first survey, conducted in February 1999, was limited to 10-30min sets in a small area within LFA 14 (The Big Hole) to test the gear for its effectiveness in catching small shrimp. The second survey (February, 2000) completed 55-15min stations covered during the previous summer survey, plus additional shallow stations on harder bottom around and between the main shrimp holes. The trawl was lost before completion of the entire survey, so stations in LFA 15 were not completed. Bottom contact was determined by trawl mensuration equipment only during the second survey. This showed that the trawl reached bottom and lifted off almost immediately after completion of warp payout and beginning of retrival. Catches were processed as per the summer survey, except

that measurements were conducted onboard during the second survey, and developmental staging was not conducted. Due to incomplete coverage and the short length of what may be a continuing survey series, this data should be viewed cautiously in terms of recruitment prediction. The data are presented here mainly for evaluation purposes.

The Traffic Light analysis was conducted as outlined in Koeller et al 2000b.

## RESULTS AND DISCUSSION

### Catch and Effort

Catches in SFA 13 decreased in 2000 after the relatively high catches in 1999. (Table 1). Catches in SFA 14 returned to recent levels in 2000 after a decrease in 1998-1999 that was attributed to displacement of effort to the inshore area off Bad Neighbour Shoal. Catches in SFA 15 remained high in 2000 due to continuing high effort inshore but also due to increased effort in the offshore Canso (Whitehead) Hole (Figure 1). Inshore catches (>45º10.00' and >59º20.00') amounted to 44% of the total catch in 1999, but decreased to about 28% of the total in 2000.

The distribution of fishing effort by trawlers, showing the increase in the inshore area of SFA 15 during the last 3 years, is shown in Figure 2. Effort in the offshore SFA 15 area increased in 2000 after decreased activity during the previous year. There has been a tendency for effort to concentrate in smaller areas in recent years, especially in the inshore and the eastern edges of the Whitehead and Big Holes, and less effort directed to the eastern part of SFA 14. The monthly distribution of catches (Figure 3A) in 2000 was similar to previous years, with the bulk of the catch taken during May and June. However, slightly higher catches in March and April and after June in the last 2 years probably reflects a longer fishing season for some vessels due to increased TACs. The majority of the catch continues to be taken during the non-ovigerous period (May-July), but this has decreased from about 70% of the catch in 1996-1998 to 59% in 1999 and 52% in 2000. Changes in catch rates (Figure 3B) during the 2000 fishing season are also similar to previous years, although the May-June peak appeared to be sustained somewhat longer. High catch rates were again sustained throughout the year as in 1998-99.

In Scotia-Fundy, the TAC has been shared by permanent license holders and 5 temporary licences since 1998 (Table 2). The number of active vessels in this area has decreased slightly in recent years due to quota transfers. The number of active Gulf vessels increased by 4 in 1998.

### CPUE Indices

Unstandardised catch per unit effort (kg/hr) by Gulf vessels has shown an increasing trend since the mid 1980s and was the highest of the series in 2000 (Table 1). The raw catch rate for all vessels combined has been increasing since 1993, and was also the highest of this series in 2000. The standardized CPUE index has shown an increasing trend throughout the series (Figure 4A). The trend in the stratified survey abundance index closely parallelled the standardised CPUE series (Figure 4A) until 2000, when the stratified survey index decreased, although not

significantly, and the CPUE index increased, also not significantly, from the previous year. CPUEs (unstandardized) for individual SFAs (Figure 4B) indicate a decrease in catch rates in SFA 13 for 2000, with increases in other areas. Catch rates in the inshore area continued to be comparable to the offshore, consequently inshore fishing continues to be due to the area's proximity to markets rather than to poorer catch rates elsewhere.

**Survey**

Results for the 2000 survey are given in Table 3 and Figure 5. While the stratified catch weight per standard tow (Figure 5) shows an overall increasing trend, individual stratum estimates have had larger fluctuations. Increases in biomass during the last few years has come from the relatively lightly fished (i.e. prior to 1998) strata 13, 15 and 17 (inshore), while biomass in the heavily fished Strata 14 has remained relatively stable. The biomass increases in the inshore area during 1997-98 appear to have levelled off since 1998, perhaps because of increased exploitation in this area beginning that year.

Note also that the decrease in the stratified survey index, and therefore also the total biomass estimate, was due mainly to a large decrease in the estimate for SFA 13, a change also reflected in the CPUE for that area (Figure 4B).

Total biomass was estimated at 31,860 mt in 2000, down 13% from 36,625 in 1999. Note that work conducted during last year's survey (Koeller et al 1999) suggests that biomasses are underestimated by about 25% due to lack of coverage in areas <100 fathoms. Further underestimation is caused by low catchability of smaller shrimp by the survey trawl.

The distribution of catches from the survey during the series (Figure 6) indicates that there has been no major shift in the distribution of the resource.

**Population and Catch at Length and Age**

Total survey population at length estimates are given in Figure 6A, and at inferred ages in Table 4. Abundance in the mode representing the largest shrimp, i.e. mature females, or transitionals that will spawn in the fall of the year, has remained relatively stable throughout the series (Figure 6A). In the 1999 assessment the 1995 and 1996 year classes were identified as strong and very weak, respectively. The weakness of the latter was attributed to the large numbers of parasitized eggs observed that year, possibly furthered by increasing temperatures and high shrimp densities. The age interpretation of the 2000 population estimates at length given in Figure 6A implies that the strong 1995 year class did not change sex completely during 1999-2000 due to compensatory growth, a phenomenon which has been observed on the Scotian Shelf (Koeller et al, 2000) and in other areas (Unnur Skoladottir, personal communication). This is supported by the narrower size range of the « late changing » males in 2000 and lack of immature males seen the previous year i.e. the 1995 year class was male, transitional or female in June 2000. In summary, the large 1995 year class appears to have compensated for the weak 1996 year class by providing a viable male population for the 2000 breeding season. Such « splitting » of year classes, in addition to other problems, precludes use of age-based population models for this stock. Estimates based on statistical separation of modes as given in Table 4

must also be interpreted cautiously. For example, with the increased length of the time series it is now possible to refine the age interpretation of Figure 6A. The alternative interpretation given in Figure 6B suggests that year class splitting due to depensatory growth described for the 1995 year class above has ocurred twice before in this series, i.e. for the 1992 and 1994 year class. The 1992 year class was large in the first (1995) survey. It was most prominent in 1996, when the following year class (1993) was apparently weaker and difficult to distinguish. In 1997, the 1992 year class split, with one portion undergoing transition and the other remaining male in a mode that included the 1993 year class. By 1998, animals in this mode had all changed to females. That year, the population was dominated by the 1994 year class, which had also appeared strong the previous year. The 1994 year class split in 1999, when the dominant mode was comprised of it and the also relatively strong 1995 year class. Finally, in 2000 the 1995 year class split as described above.

One test for the interpretation given in Figure 6B would be to determine if expected changes in the size at transition actually occured. When a year class splits, the portion that remains male will be a year older when it finally undergoes transition the following year; consequently it should be larger than average. The prediction would be that transitionals in 1995 should be relatively small since 4 modes are distinguishable and no splitting ocurred. In 1997, the remainder of the 1992 year class, which was a year older than normal, would have changed sex at a relatively large size. In 2000, the remainder of the 1995 year class was changing sex and should also have been relatively large. Figure 7A shows that mean sizes at transition are as expected under this interpretation i.e. small, large and large in 1995, 1997 and 2000 respectively. Further, it shows that size at transition was relatively small in 1998 and 1999, reflecting the slower growth of 2 large successive year classes i.e. 1994 and 1995. Changes in sex ratios are more difficult to interprete, and the reason for the narrowing of the range in this metric in all areas in 2000 is not known (Figure 7B).

The 2000 population at length and age estimates indicate that the 1997 and 1998 year classes are about average (Figure 6 and Table 4), and that they were present in all areas (Figure 8). This and the continuing high spawning biomasses reinforces the contention that the weak 1996 year class was due to egg disease and not recruitment overfishing.

The catch at length (Figure 9) generally reflects survey results, including the appearance of the 1994 and 1995 year classes as 2 year olds in 1997 and 1998, respectively, and the relative strength of the 1997 year class in 2000. Note that the 1998 year class does not show in commercial catches, probably due to the use of square mesh cod ends and the avoidance of small shrimp. Commercial catches suggest removal of accumulated larger shrimp, and a narrowing of the length frequency to a greater degree than does the survey.

Counts obtained from buyers (Figure 10A) indicate that the annual average for 2000 remained well below the count price limit of 65 per pound and that the variance was about the same as in previous years. The seasonal trend was also similar to previous years. (Figure 10B). Fishers were apparently having no difficulty finding larger shrimp.

Size specific exploitation rates (Figure 11) increased in 2000, reflecting the higher catch and lower biomass estimate. Exploitation was near 20% for females and between 10-20% for males.

Overall exploitation in terms of biomass was 17.0%, up from 13.2% in 1999 (Table 5). This figure must be considered an overestimate considering the underestimated survey biomass. Exploitation of the inshore decreased in 2000 and was lower than in SFA 14 and 15.

**The Inshore Trap Fishery**

The daily average catch weight per trap haul in the northern (LFA 29 & 30) and southern (LFA 31A) part of Chedebucto Bay since the beginning of these fisheries is given in Figure 12 (upper and middle panel, respectively). Catch rates appear to have dropped off in the northen part of the bay since this fishery began. Effort was very low in this area during the 1999-2000 season, apparently due to the low catch rates. Catch rates in the southern part of the Bay have remained stable. Fishing by the trawler fleet off Bad Neighbour Shoal continues to be controversial due to both gear conflicts between trappers and trawlers, and the contention by some trap fishers that inshore dragging is affecting their catches. While there has been some overlap in fishing seasons, peak catches in the trap fishery occur in winter, prior to the start of the trawl fishing season. Recent agreements exclude trawlers from the nearshore area during the trapping season, but it is possible that longer term effects are involved. However, it is not possible to discern such effects with the available data. Catches started to drop off on the northern part of Chedebucto Bay in 1997, before inshore trawl fishing began. In addition, it is not clear why catches should decrease in the northern part of the bay and not in the southern part when most of the trawler effort is approximately equidistant from these two trapping areas (Figure 2). Nevertheless, the decrease in catches in the northern part of Chedebucto Bay should be noted since changes in the peripheral areas of distribution could be an early indication of changes in the main part of the stock.

During the winter of 2000 the small trap fishery (3 licences) in Mahone Bay continued at about previous levels. It will not be discussed further here.

**Environmental Indicators**

Bottom temperatures in the shrimp holes from both the groundfish (July) and shrimp (June) surveys show an increasing trend since 1995, with 2000 having among the warmest temperatures of both series (Figure 13). There has been a decreasing trend in the capelin by-catch/tow during the shrimp survey series (Figure 14). There is no apparent trend in turbot, the other cold water indicator species in the area, however it should be noted that only capelin are small enough at all ages to pass through the survey trawl's sorting grate. An unusual ocurrence during the 2000 survey was the consistently high bycatch of silver hake in the Canso Hole. An average of over 700 silver hake per set were caught in this area. A total of only 100 silver hake had been caught in all 5 previous surveys, and all of these were caught in the Canso Hole during 1999. Silver hake are considered a warm water species preferring temperatures above the preferred range of *Pandalus borealis*. Its is likley that silver hake caught in the Canso hole in 1999-2000 originated from the known concentration in the adjacent Canso Bank. Temperatures in the Canso Hole where Silver hake were caught exceeded 5º C in 2000. As a rule, the warmest temperatures during the survey are encountered in Louisbourg Hole, however Canso Hole temperatures were the highest recorded during the 2000 survey and were the among the highest ever recorded during shrimp surveys. Groundfish abundance in the shrimp holes and surrounding area (mean

catch/tow in Strata 43-45 from the July groundfish survey) remained at low levels in 2000 (Figure 13).

**Juvenile Surveys**

A comparison of the relative abundances of shrimp in beam, commercial and standard survey trawl sets in the Big Hole area of SFA 14 during February and June 1999 (Figure 15A) indicates that the beam trawl caught proportionately more 1-group shrimp from the 1997 year class than did the commercial or standard survey trawl while still catching older age groups in representative numbers. As do the other trawls, the beam trawl length frequency shows a gap between the first 2 modes which is interpreted as representing the weak 1996 year class. Note that 0- group shrimp from the 1998 year class, which would actually have been just under one year old in February 1999 assuming March spawning, were not represented in the 1999 beam trawl catches. The beam trawl used during the synoptic Feb. 2000 survey did catch 0-group shrimp from the 1999 year class, although this was the least abundant group caught (Figure 15B). In addition, the pattern of decreasing numbers with decreasing age suggests that the trawl, while more efficient than the large trawls in catching juveniles, was selecting for larger animals to some degree. Nevertheless, determinations of relative year class strengths at 1 and 2 years of age i.e. 2-3 years before recruitment to the fishery, may be possible given an annual survey series of sufficient length.

A comparison of 0, 1 and 2-group distribution (Figure 16) suggests that 0-group shrimp have a patchier distribution than older age groups. More 0-group shrimp were caught in the inshore area, suggesting that this may be an important nursery area. 1-group shrimp also appeared to be more abundant inshore, with the exception of the large catches in the Big Hole. The results indicate that recruitment occurs in all major fishing areas, but may at times be restricted to relatively small areas within them. Shrimp then apparently spread into a wider area as they grow. It should be noted, however, that the observed distribution pattern could also be related to differences in the selectivity of the trawl at different locations, for example in the shallower inshore where smaller animals may be more closely associated with the bottom.

Results from the beam trawl surveys are promising for both year class strength determinations and in the investigation of recruitment mechanisms, but several more years of surveys are required before their usefullness for either purpose can be evaluated fully. A simpler, more cost effective method using a small meshed bag attached to the codend of the standard survey trawl during the June survey will also be evaluated, beginning in 2001.

**Questionnaire**

Results from the telephone survey are given in Table 6. In general, the average scores of individual questions support many of the observations made above from data analyses including: 1) an increase in the CPUE from the previous year 2) a decrease in the effort required to catch the quota 3) a decrease in the area of distribution of the stock, and 4) no change in the difficulty in making the count. The slight decrease in the depth fished appears to reflect the increased fishing effort in the inshore area. Most captains indicated that they had difficulties in judging

changes in the size of the stock and that their answers reflect their impression of changes in catch rates, hence the increase in the score for his question.

Common themes raised during elaborations to questions also supported findings from the data analysis. These included the decrease of capelin in the bycatch, and the increased bycatch of silver hake in the Whitehead (Canso) Hole. Many Captains indicated that catches in some holes which were previously productive had dropped off drastically, but catches were still good in holes where there were shrimp - this appears to support the observation that distribution has become patchier in recent years. In addition, some fishers indicated that there were more "fleas" (very small shrimp) in 2000, which supports the greater numbers of age 2 and 3 shrimp in the survey and age 3 shrimp in commercial catches. Captains remarked on the high catch rates in the Whitehead (Canso Hole) during 2000, reflecting the increased biomass estimates for this area during the 1999 and 2000 surveys. Fishers also supported the finding of fewer very large shrimp in the catch.

**Traffic Light Analysis**

Traffic scores for all years since annual monitoring by survey and port sampling began are given in Table 7. The rationale for the scoring (1 = green, 0 = yellow, -1 = red) is a follows :

FISHERY DATA

*CPUE*- CPUEs have shown an increasing trend since the fishery began in the 1990s (all years score 1).

*Spatial Pattern* : Fishing has varied in peripheral areas but until 1998 most of the effort has concentrated in the Misaine Hole. Beginning in 1998, the inshore near Bad Neighbour Shoal has received more effort, accounting for a relatively large portion of the catch, especially during the last 2 years. There appears to have been a tendancy for fishing to concentrate in smaller areas during recent years. Shift in effort geographically are accounted for to some degree in the standardised CPUE series, however such changes warrant caution in data interpretation, particularly when the overall survey index suggests a decline. For example, increasing effort in smaller areas of shrimp concentraion may overestimate overall abundance. (last three years score 0).

*Temporal pattern* : seasonal patterns in catches and catch rates have changed significantly in recent years, with a 20% increase in the proportion of the catch that is taken during the ovigerous period (last year scores 0).

*Length/age composition* : There has been a narrowing of the catch composition which is particularly evident during the last 2 years. While a decrease in the proportion of smaller shrimp can be attributed to the adoption of square mesh codends, the decrease in the proportion of large animals at the other end of the size frequency appears to be due to removal of accumulated older age groups in the population. Since fecundity is directly related to size, this may have affected reproductive potential (last 2 year scores 0).

*Industry counts* : counts taken by industry show no significant change since 1995 (all years score 1).

SURVEY DATA

*Biomass/abundance index :* The overall biomass decreased in the 2000 survey. While this warrants caution in the score, it should be noted that biomasses are still near historic highs. In addition, much of the decrease came from the lightly fished Louisbourg Hole, suggesting that this was caused by factors other than fishing. (last year scores 0 ).

*Spatial Pattern* : There has been no change in distribution within the stock area (all years score 1).

*Length/age composition* : Last year's concern of fewer year classes in the population appears to have been alleviated with the re-interpretation of the age composition. The fewer year classes seen previously were apparently due to depensatory growth under high densities. The emergence of the 1997 and 1998 year classes in the 2000 survey has restored the number of identifiable year classes/modes to 4. (last year scores 1).

*Recruitment (juveniles)* : Concerns about decreasing recruitment, especially with the weak 1996 year class, appear to have been alleviated with the emergence of the 1997 and 1998 year classes – 2000 scores 1 Note: This indicator is not included in the total score because it does not impact on the next year's catch.

*Recruitment (males)* : The late changing males from the 1995 year class are abundant and will support the fishery in 2001. (all years score 1)

*Spawning stock (females)* : SSB has remained high throughout the survey series (all years score 1).

*Exploitation rate* : exploitation rate increased in 2000. While this warrants caution in the score, particularly since biomasses may be decreasing and the exploitation rate is calculated with the current year's biomass estimate, exploitation rates remain comparable or lower than other *P. borealis* stocks. (2000 scores 0).

OTHER DATA

*Predation* : cod stock remains at historical lows – natural mortality is probably low (all years score 1).

*Temperature* : there has been an increasing trend in temperatures on the shrimp grounds. Incursions of warm water species (*Silver hake*) and declines in cold water species (capelin) suggest that a regime shift is underway. Conditions favourable to shrimp may be deteriorating (last 3 years score 0).

*Industry perspective* : This has not been included in the total score to allow comparability with last years indicators. In general, industry observations support analyses from survey and commercial fishery data.

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Table 1. TACs (trawls), catches (trawls and traps) and raw catch per unit effort (trawls) from the eastern Scotian Shelf shrimp fishery 1980-2000.

| | TAC | | Catch/Prises (tonnes) | | | | | | [5]CPUE/PUE (kg/h) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | trawl chalut | trap casier | trawl/chalut SFA/ZPA | | | | trap/ casier | | Gulf/ Golfe | All boats/ Tous bat. |
| | | | 13 | 14 | 15 | Total | | Total | | |
| 1980 | 5021 | | 491 | 133 | 360 | 984 | | 984 | 131 | |
| 1981 | - | | 418 | 26 | 10 | 454 | | 454 | 132 | |
| 1982 | 4200 | | 316 | 52 | 201 | 569 | | 569 | 128 | |
| 1983 | 5800 | | 483 | 15 | 512 | 1010 | | 1010 | 128 | |
| 1984 | 5700 | | 600 | 10 | 318 | 928 | | 928 | 110 | |
| 1985 | 5560 | | 118 | - | 15 | 133 | | 133 | 75 | |
| 1986 | 3800 | | 126 | - | - | 126 | | 126 | 87 | |
| 1987 | 2140 | | 148 | 4 | - | 152 | | 152 | 91 | |
| 1988 | 2580 | | 75 | 6 | 1 | 82 | | 82 | 85 | |
| 1989 | 2580 | | 91 | 2 | - | 93 | | 93 | 133 | |
| 1990 | 2580 | | 90 | 14 | - | 104 | | 104 | 135 | |
| [1]1991 | 2580 | | 81 | 586 | 140 | 804 | | 804 | 198 | |
| 1992 | 2580 | | 63 | 1181 | 606 | 1850 | | 1850 | 176 | |
| [2]1993 | 2650 | | 431 | 1279 | 317 | 2044 | | 2044 | 193 | 136 |
| [3]1994 | 3100 | | 8 | 2656 | 410 | 3074 | | 3074 | 202 | 186 |
| 1995 | 3170 | | 168 | 2265 | 715 | 3148 | 27 | 3175 | 234 | 206 |
| 1996 | 3170 | | 55 | 2299 | 817 | 3171 | 187 | 3358 | 249 | 228 |
| 1997 | 3600 | | 570 | 2422 | 583 | 3574 | 222 | 3773 | 237 | 232 |
| 1998 | 3800 | | 562 | 2014 | 1223 | 3800 | 131 | 3931 | 343 | 282 |
| 1999 | 4800 | 200 | 717 | 1521 | 2464 | 4702 | 149 | 4851 | 396 | 311 |
| [4]2000 | 5300 | 200 | 440 | 2088 | 2772 | 5300 | 117 | 5417 | 408 | 349 |

[1] Nordmore separator grate introduced.

[1]Introduction de la grille séparatrice Nordmöre

[2] overal TAC not caught because combined TAC for SFA 14 and 15 was exceeded.

[2]TAC total non atteint parce que le TAC combiné des ZPC 14 et 15 a été dépassé

[3]individual SFA TACs combined

[3]TAC des ZPC combinées

[4] projected to December 31.

[4]Prévu au 31 décembre

[5]raw data

[5]Données brutes

Table 2. Number of active vessels and total (brackets) licences for Scotian Shelf shrimp from each region and the proportion (%) of the total caught.

| | Exp. Trap<br>P. expérim.<br>au casier | Limited entry<br>Pêche restreinte | | Percent caught<br>% des prises | |
|---|---|---|---|---|---|
| Year/Année | S-F[1] | S-F[2] | Gulf/Golfe[3] | S-F | Gulf/Golfe |
| 1995 | 4 | 24(23) | 6(23) | 76 | 24 |
| 1996 | 9(17) | 21(24) | 6(23) | 75 | 25 |
| 1997 | 10(17) | 18(23) | 6(23) | 75 | 25 |
| 1998 | 15(26) | 17(28)[4] | 10(23)[5] | 75 | 25 |
| 1999 | 15(22) | 19(28)[4] | 10(23)[5] | 75 | 25 |
| 2000 | 12(21) | 18(32)[6] | 10(23)[5] | 75 | 25 |

[1] All active licences are vessels < 45'./Tous les permis actifs sont rattachés à des bateaux < 45 pi.

[2] 15 inactive NAFO 4X licences not included in total ( ). All licenses are vessels < 65' LOA./ Quinze permis inactifs pour la division 4X de l'OPANO ne sont pas inclus dans le total ( ). Tous les permis sont rattachés à des bateaux < 65 pi de LHT.

[3] All licences 65-100' LOA. Eligibility to fish in Scotia-Fundy and quota split under agreement that expires at the end of 2000./Tous les permis sont rattachés à des bateaux de 65 à 100 pi de LHT. L'admissibilité à la pêche dans Scotia-Fundy et la division des quotas sont régis par une entente qui expire à la fin de 2000.

[4] temporary allocation divided among 5 vessels/Allocation temporaire divisée entre cinq bateaux.

[5] temporary allocation divided among 4 vessels/Allocation temporaire divisée entre quatre bateaux.

[6] temporary allocation divided among 9 licences

Table 3. Station and set statistics from CA0001.

| TRAIT | SFA/ ZPC | DATE | LAT. | LONG. | SPEED (kts) VITESSE (noeuds) | DIST. (n. m./ milles marins) | WINGSPR. ÉCARTEM. (m) | HEAD-LINE HAUT. (m) | DEPTH (fth) PROF. (bra.) | TEMP (°C) | RAW CATCH/ PRISES BRUTES (kg) | DENSITY (gm/m$^2$ or m.t./km$^2$) DENSITÉ (g/m$^2$ ou tm/km$^2$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 17 | 31-May-00 | 45°22.03' | 60°59.85' | 2.5 | 1.23 | 17.6 | 6.1 | 58 | 2.7 | 103 | 2.6 |
| 2 | 17 | 31-May-00 | 45°24.92' | 60°50.77' | 2.4 | 1.16 | 16.8 | 5.8 | 65 | 2.7 | 353 | 9.8 |
| 3 | 17 | 31-May-00 | 45°27.96' | 60°43.51' | 2.5 | 1.21 | 16.3 | 6.2 | 76 | 2.7 | 407 | 11.1 |
| 4 | 17 | 31-May-00 | 45°26.92' | 60°34.31' | 2.5 | 1.22 | 17.8 | 5.9 | 99 | 2.7 | 367 | 9.1 |
| 5 | 17 | 01-Jun-00 | 45°27.72' | 60°22.79' | 2.5 | 1.22 | 17.0 | 5.9 | 108 | 2.8 | 84 | 2.2 |
| 6 | 17 | 01-Jun-00 | 45°29.12' | 60°18.81' | 2.1 | 1.04 | 17.0 | 5.9 | 97 | 2.8 | 130 | 4.0 |
| 7 | 17 | 01-Jun-00 | 45°30.53' | 60°09.94' | 2.5 | 1.16 | 16.8 | 6.0 | 96 | 2.7 | 216 | 6.0 |
| 8 | 17 | 01-Jun-00 | 45°33.38' | 60°02.55' | 2.3 | 1.21 | 17.2 | 6.0 | 96 | 2.8 | 115 | 3.0 |
| 9 | 17 | 01-Jun-00 | 45°29.57' | 60°59.17' | 2.4 | 1.21 | 17.3 | 6.3 | 84 | 2.9 | 9 | 0.2 |
| 10 | 17 | 01-Jun-00 | 45°21.95' | 59°59.12' | 2.2 | 1.07 | 17.6 | 6.1 | 91 | 2.9 | 342 | 9.8 |
| 11 | 17 | 01-Jun-00 | 45°20.18' | 60°18.76' | 2.1 | 1.01 | 17.4 | 6.1 | 97 | 2.8 | 251 | 7.7 |
| 12 | 17 | 01-Jun-00 | 45°17.21' | 60°21.42' | 2.3 | 1.02 | 17.3 | 6.5 | 95 | 2.8 | 259 | 8.0 |
| 13 | 13 | 02-Jun-00 | 45°47.35' | 59°00.46' | 2.3 | 1.25 | 17.6 | 5.9 | 122 | 4.0 | 50 | 1.2 |
| 14 | 13 | 02-Jun-00 | 45°43.72' | 58°48.56' | 2.4 | 1.23 | 17.7 | 5.6 | 142 | 4.1 | 159 | 3.9 |
| 15 | 13 | 02-Jun-00 | 45°47.92' | 58°47.41' | 2.5 | 1.23 | 18.2 | 6.8 | 146 | 4.3 | 323 | 7.8 |
| 16 | 13 | 02-Jun-00 | 45°47.44' | 58°40.74' | 2.4 | 1.28 | 17.8 | 6.1 | 152 | 4.4 | 193 | 4.6 |
| 17 | 13 | 02-Jun-00 | 45°50.19' | 58°38.36' | 2.1 | 1.09 | 17.6 | 6.1 | 149 | 4.3 | 246 | 6.9 |
| 18 | 13 | 02-Jun-00 | 45°53.34' | 58°39.59' | 2.1 | 1.14 | 17.6 | 6.1 | 137 | 4.1 | 155 | 4.2 |
| 19 | 13 | 02-Jun-00 | 45°52.80' | 58°34.03' | 2.4 | 1.14 | 17.6 | 6.1 | 123 | 4.0 | 8 | 0.2 |
| 20 | 13 | 02-Jun-00 | 45°49.63' | 58°30.60' | 2.2 | 1.06 | 18.2 | 6.0 | 168 | 4.3 | 130 | 3.7 |
| 21 | 13 | 02-Jun-00 | 45°38.74' | 58°50.35' | 2.2 | 1.03 | 17.8 | 6.0 | 120 | 3.8 | 270 | 8.4 |
| 22 | 13 | 02-Jun-00 | 45°40.08' | 58°56.27' | 2.4 | 1.20 | 16.9 | 6.0 | 137 | 3.9 | 137 | 3.6 |
| 23 | 15 | 04-Jun-00 | 44°58.83' | 61°02.15' | 2.5 | 1.22 | 17.3 | 6.1 | 105 | 3.6 | 308 | 8.0 |
| 24 | 15 | 04-Jun-00 | 44°57.65' | 60°56.26' | 2.4 | 1.18 | 16.9 | 5.8 | 103 | 3.8 | 302 | 7.9 |
| 25 | 15 | 04-Jun-00 | 44°54.07' | 60°58.31' | 2.4 | 1.10 | 17.5 | 6.1 | 135 | 4.2 | 55 | 1.6 |
| 26 | 15 | 04-Jun-00 | 44°52.40' | 60°53.87' | 2.4 | 1.16 | 17.2 | 5.8 | 109 | 5.3 | 127 | 3.5 |
| 27 | 15 | 04-Jun-00 | 44°45.72' | 60°52.37' | 2.5 | 1.19 | 18.3 | 5.8 | 153 | 5.3 | 119 | 3.0 |
| 28 | 15 | 04-Jun-00 | 44°44.40' | 60°41.90' | 2.3 | 1.17 | 17.7 | 6.0 | 103 | 5.2 | 909 | 23.7 |
| 29 | 15 | 04-Jun-00 | 44°49.61' | 60°45.62' | 2.2 | 1.15 | 17.6 | 6.1 | 151 | 5.4 | 424 | 11.3 |
| 30 | 15 | 04-Jun-00 | 44°56.58' | 60°46.85' | 2.1 | 1.07 | 17.3 | 5.9 | 118 | 5.1 | 292 | 8.5 |
| 31 | 15 | 04-Jun-00 | 44°51.27' | 60°38.73' | 2.2 | 1.07 | 17.6 | 6.1 | 154 | 5.2 | 511 | 14.7 |
| 32 | 15 | 04-Jun-00 | 44°51.01' | 60°32.95' | 2.3 | 1.09 | 17.4 | 6.4 | 112 | 4.9 | 91 | 2.6 |
| 33 | 15 | 05-Jun-00 | 44°55.71' | 60°25.82' | 2.4 | 1.16 | 17.6 | 6.1 | 135 | 3.8 | 584 | 15.5 |
| 34 | 15 | 05-Jun-00 | 44°55.79' | 60°14.63' | 2.3 | 1.20 | 16.7 | 6.1 | 108 | 3.5 | 213 | 5.7 |
| 35 | 15 | 05-Jun-00 | 44°50.17' | 60°21.59' | 2.5 | 1.08 | 17.6 | 6.1 | 153 | 3.7 | 128 | 3.7 |
| 36 | 15 | 05-Jun-00 | 44°44.53' | 60°18.12' | 2.6 | 1.18 | 17.6 | 6.1 | 172 | 3.7 | 68 | 1.8 |
| 37 | 15 | 05-Jun-00 | 44°41.99' | 60°12.29' | 2.2 | 1.09 | 18.0 | 6.1 | 114 | 4.2 | 129 | 3.5 |
| 38 | 14 | 05-Jun-00 | 44°39.43' | 60°00.95' | 1.8 | 0.97 | 17.2 | 5.8 | 108 | 3.8 | 40 | 1.3 |
| 39 | 14 | 05-Jun-00 | 44°40.82' | 59°45.30' | 2.1 | 1.06 | 16.5 | 6.0 | 139 | 3.9 | 81 | 2.5 |
| 40 | 14 | 05-Jun-00 | 44°48.05' | 59°48.75' | 2.2 | 1.08 | 17.7 | 6.1 | 131 | 3.8 | 289 | 8.2 |
| 41 | 14 | 05-Jun-00 | 44°48.44' | 59°54.49' | 2.4 | 1.09 | 17.1 | 6.0 | 136 | 4.1 | 200 | 5.8 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42 | 17 | 08-Jun-00 | 45°12.30' | 59°57.89' | 2.4 | 1.24 | 17.8 | 6.1 | 84 | 2.8 | 225 | 5.5 |
| 43 | 17 | 08-Jun-00 | 45°18.92' | 59°56.93' | 2.4 | 1.17 | 17.7 | 6.3 | 85 | 2.9 | 516 | 13.4 |
| 44 | 17 | 08-Jun-00 | 45°19.06' | 59°47.02' | 2.3 | 1.07 | 17.5 | 6.2 | 77 | 2.9 | 239 | 6.9 |
| 45 | 14 | 08-Jun-00 | 44°54.83' | 59°58.70' | 2.3 | 1.14 | 18.0 | 6.2 | 108 | 3.1 | 280 | 7.4 |
| 46 | 14 | 08-Jun-00 | 44°53.07' | 59°50.05' | 2.4 | 1.14 | 17.7 | 6.2 | 118 | 3.6 | 259 | 6.9 |
| 47 | 14 | 09-Jun-00 | 44°41.33' | 59°36.18' | 2.5 | 1.25 | 18.8 | 6.0 | 113 | 3.7 | 326 | 7.5 |
| 48 | 14 | 09-Jun-00 | 44°51.37' | 59°25.66' | 2.4 | 1.08 | 17.2 | 6.4 | 145 | 3.5 | 252 | 7.3 |
| 49 | 14 | 09-Jun-00 | 44°48.51' | 59°12.10' | 2.3 | 1.01 | 18.6 | 6.7 | 126 | 2.4 | 263 | 7.6 |
| 50 | 14 | 09-Jun-00 | 44°40.79' | 59°00.62' | 2.2 | 1.07 | 18.2 | 7.3 | 118 | 2.5 | 206 | 5.7 |
| 51 | 14 | 09-Jun-00 | 44°47.26' | 58°53.93' | 2.5 | 1.19 | 18.5 | 5.9 | 134 | 2.5 | 406 | 9.9 |
| 52 | 14 | 09-Jun-00 | 44°54.13' | 58°44.45' | 2.2 | 1.02 | 18.7 | 6.0 | 151 | 2.6 | 261 | 7.4 |
| 53 | 14 | 09-Jun-00 | 44°47.75' | 58°39.79' | 2.5 | 1.18 | 17.1 | 5.9 | 138 | 2.6 | 192 | 5.1 |
| 54 | 14 | 09-Jun-00 | 44°48.86' | 58°34.94' | 2.3 | 1.26 | 18.1 | 6.0 | 136 | 2.6 | 158 | 3.8 |
| 55 | 13 | 10-Jun-00 | 45°39.39' | 58°09.85' | 2.1 | 0.89 | 17.2 | 6.7 | 123 | 3.5 | 5 | 0.2 |
| 56 | 13 | 10-Jun-00 | 45°37.48' | 58°14.34' | 2.0 | 1.04 | 18.1 | 6.8 | 199 | 3.5 | 77 | 2.2 |
| 57 | 13 | 10-Jun-00 | 45°33.94' | 58°20.68' | 2.1 | 1.01 | 18.3 | 6.6 | 187 | 3.6 | 92 | 2.7 |
| 58 | 13 | 10-Jun-00 | 45°34.27' | 58°33.74' | 2.3 | 1.05 | 17.6 | 6.1 | 153 | 3.6 | 147 | 4.3 |
| 59 | 13 | 10-Jun-00 | 45°36.31' | 58°40.42' | 2.2 | 1.06 | 18.2 | 6.1 | 147 | 3.6 | 29 | 0.8 |
| | | | | | | | | | | | | |
| **MEAN/MOYENNE** | | | | | 2.3 | 1.1 | 17.6 | 6.1 | 122.5 | 3.6 | 222.2 | 6.0 |

Table 4. Minimum survey population numbers at age with proportions at each age determined with MIX. Numbers x 10-7.

| | 95 | 96 | 97 | 98 | 99 | 00 | Average |
|---|---|---|---|---|---|---|---|
| **2** | 358 | 307 | 128 | 39 | 165 | 280 | 213 |
| **3** | 1046 | 276 | 1159 | 784 | 27 | 757 | 675 |
| **4** | 875 | 1247 | 1257 | 1883 | 3010 | 1372 | 1607 |
| **5+** | 1702 | 2161 | 1538 | 2046 | 1951 | 2002 | 1900 |
| | 3982 | 3993 | 4083 | 4754 | 5154 | 4411 | 4396 |

Table 5. Survey biomasses, commercial shrimp catches and exploitation rates (catch/biomass) by SFA (offshore part), and the inshore area, 1995-2000.

| | | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|
| | **13** | 4837 | 6838 | 5920 | 7187 | 9517 | 5919 |
| | **14** | 9067 | 12094 | 9471 | 11278 | 11039 | 9544 |
| **BIOMASS(mt)** | **15** | 5299 | 6610 | 4736 | 4548 | 7806 | 7213 |
| | **17** | 4415 | 3663 | 6220 | 9530 | 8262 | 9183 |
| | **total** | **23620** | **29206** | **26349** | **32545** | **36625** | **31860** |
| | **13** | 168 | 55 | 570 | 514 | 612 | 301 |
| | **14** | 2265 | 2299 | 2422 | 2012 | 1503 | 2009 |
| **CATCH(mt)** | **15** | 715 | 817 | 583 | 618 | 589 | 1609 |
| | **17** | 0 | 0 | 0 | 787 | 2121 | 1498 |
| | **total** | **3148** | **3171** | **3575** | **3930** | **4825** | **5417** |
| | **13** | 3.5 | 0.8 | 9.6 | 7.1 | 6.4 | 5.1 |
| | **14** | 25.0 | 19.0 | 25.6 | 17.8 | 13.6 | 21.0 |
| **EXPLOITATION(%)** | **15** | 13.5 | 12.4 | 12.3 | 13.6 | 7.5 | 22.3 |
| | **17** | 0.0 | 0.0 | 0.0 | 8.3 | 25.7 | 16.3 |
| | **total** | **13.3** | **10.9** | **13.6** | **12.1** | **13.2** | **17.0** |

Table 6. Scores to individual questions in Appendix 1 provided by each vessel captain interviewed by telephone, including years fished shrimp (years); conditions in 2000 versus previous year, including catch rates (cpue), amount of shrimp in the stock (amount), effort required to catch their quota (effort), size of the area fished (area); depth fished, difficulty in making the count (count) and opinion on size of current TAC (TAC); and common themes from comments made. Scores range from 1-5 where 1 is much less, 3 is no change and 5 is much more.

| Captain | years | cpue | amount | Effort | area | depth | count | TAC |
|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 5 |
| 2 | 8 | 4 | 4 | 4 | 3 | 3 | 3 | 2 |
| 3 | 9 | 4 | 4 | 2 | 1 | 1 | 3 | 3 |
| 4 | 6 | 4 | 3 | 3 | 3 | 3 | 2 | 3 |
| 5 | 0 | 3 | 4 | 2 | 2 | 3 | 3 | 2 |
| 6 | 3 | 5 | 4 | 1 | 3 | 3 | 3 | 3 |
| 7 | 3 | 3 | 3.5 | 2.5 | 3 | 3 | 3 | 3 |
| 8 | 3 | 4 | 4 | 1 | 1 | 3 | 1 | 4 |
| 9 | 2 | 3 | 4 | 3 | 3 | 3 | 2 | 4 |
| 10 | 7 | 3.5 | 3.5 | 3 | 2 | 3 | 3.5 | 2 |
| 11 | 9 | 4 | 3 | 3 | 3 | 3 | 3.5 | 3 |
| 12 | 11 | 5 | 3.5 | 1 | 2 | 2 | 3 | 3 |
| 13 | 10 | 5 | 3.5 | 1 | 1 | 2 | 3 | 3 |
| Ave. | 5.7 | 3.9 | 3.6 | 2.3 | 2.3 | 2.7 | 2.8 | 3.1 |

Common themes discussed by captains when elaborating on scored questions:

1. Less capelin in bycatch recently. Silver hake seen in Whitehead Hole.
2. Fewer very large shrimp to be found, but counts still good.
3. In 2000 some places that were usually good had nothing, others had very good catches that appeared to stand up i.e. when I was good it was very, very good. Shrimp seem o be bunching up more.
4. Crab gear conflicts forced us to fish differently this year. Fortunately catch rates were good outside the closed areas, e.g. the Whitehead Hole, otherwise it could have caused problems. Closure of inshore for shrimp trappers was a problem for those fishing late in year because they couln't get close to shore in bad weather.
5. Appears to have been more eggs on shrimp this year, also may have released eggs earlier.
6. More shrimp in Big Hole and Whitehead Hole this year.
7. More "fleas" (small shrimp) this year.

Table 7. Retrospective Traffic Light Analysis (1995-99) and current assessment (2000).

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|
| ***FISHERY DATA/DONNÉES DE LA PÊCHE*** | | | | | | |
| CPUE - KG/HR/PUE KG/H | 1 | 1 | 1 | 1 | 1 | 1 |
| Spatial pattern/Profil spatial | 1 | 1 | 1 | 0 | 0 | 0 |
| Temporal pattern/Profil temporel | 1 | 1 | 1 | 1 | 1 | 0 |
| Age/length composition Composition âge/longueur | 1 | 1 | 1 | 1 | 0 | 0 |
| Industry counts/Comptes de l'industrie | 1 | 1 | 1 | 1 | 1 | 1 |
| ***SURVEY DATA/DONNÉES DU RELEVÉ*** | | | | | | |
| Biomass/abundance index/Indice de biomasse/d'abondance | 1 | 1 | 1 | 1 | 1 | 0 |
| Spatial pattern/Profil spatial | 1 | 1 | 1 | 1 | 1 | 1 |
| Age composition/Composition selon l'âge | 1 | 1 | 1 | 1 | 0 | 1 |
| Recruitment (juveniles)/Recrutement (juvéniles) - not included in total score | 1 | 1 | 1 | 0 | -1 | 1 |
| Recruitment (males)/Recrutement (mâles) | 1 | 1 | 1 | 1 | 1 | 1 |
| Spawning stock (females)/Stock de reproducteurs (femelles) | 1 | 1 | 1 | 1 | 1 | 1 |
| Exploitation rate/Taux d'exploitation | 1 | 1 | 1 | 1 | 1 | 0 |
| ***OTHER DATA/AUTRES DONNÉES*** | | | | | | |
| Predation (cod stock)/Prédation (stock de morue) | 1 | 1 | 1 | 1 | 1 | 1 |
| temperature/Température | 1 | 1 | 1 | 0 | 0 | 0 |
| Industry perspective/Point de vue de l'industrie | | | | | | |
| ***TOTAL SCORE*** | 13 | 13 | 12 | 12 | 8 | 8 |

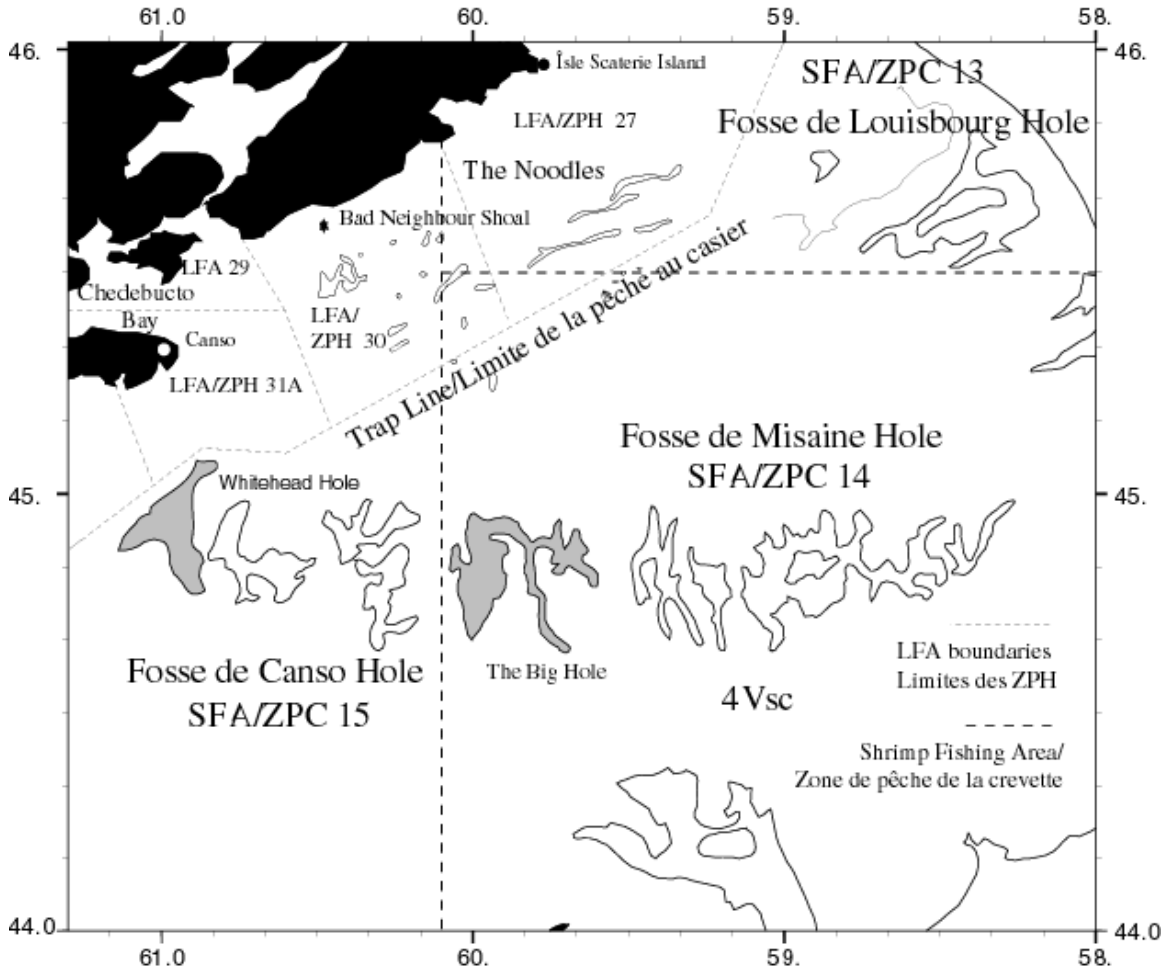


Figure 1. Shrimp Fishing Areas (SFAs) on the Eastern Scotian Shelf. The lobster Fishing Areas (LFAs) used to allocate shrimp trap licences, and the shrimp trap line are also shown.

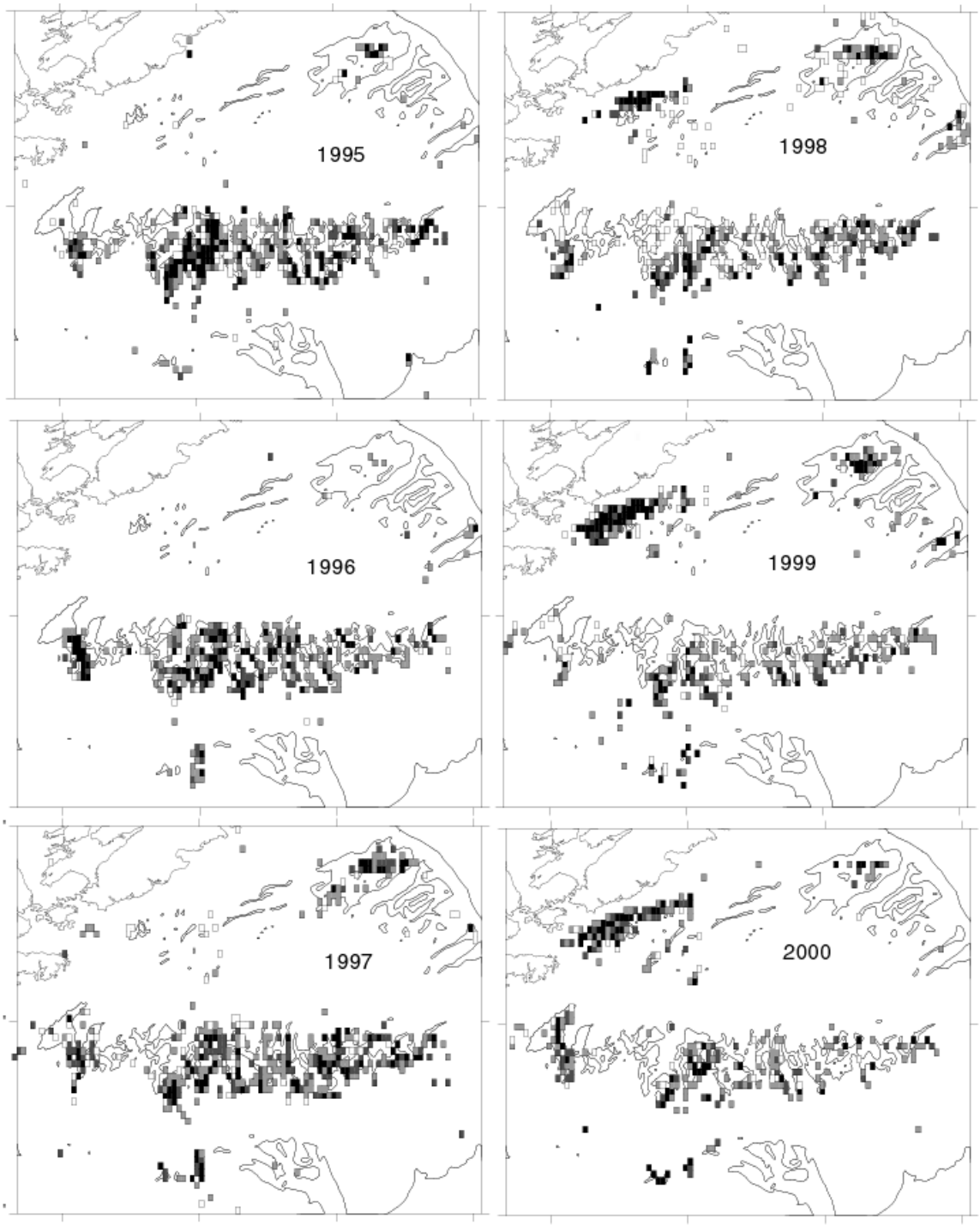


Figure 2. Distribution of fishing effort in the shrimp trawl fishery on the eastern Scotian Shelf 1995-2000.

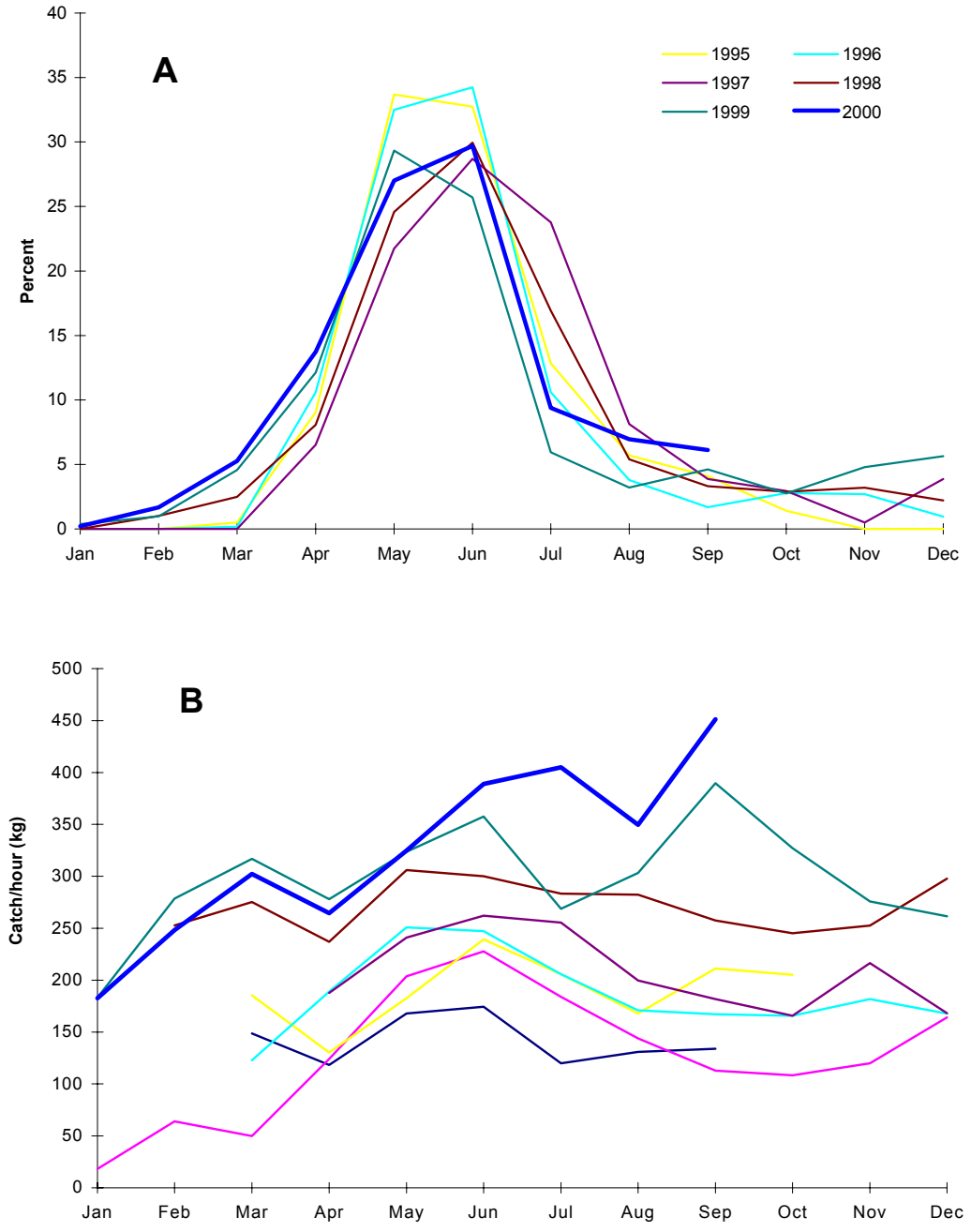


Figure 3. Monthly distribution of A. catches and B. catch per unit effort in the eastern Scotian Shelf trawl fishery, 1995-2000.

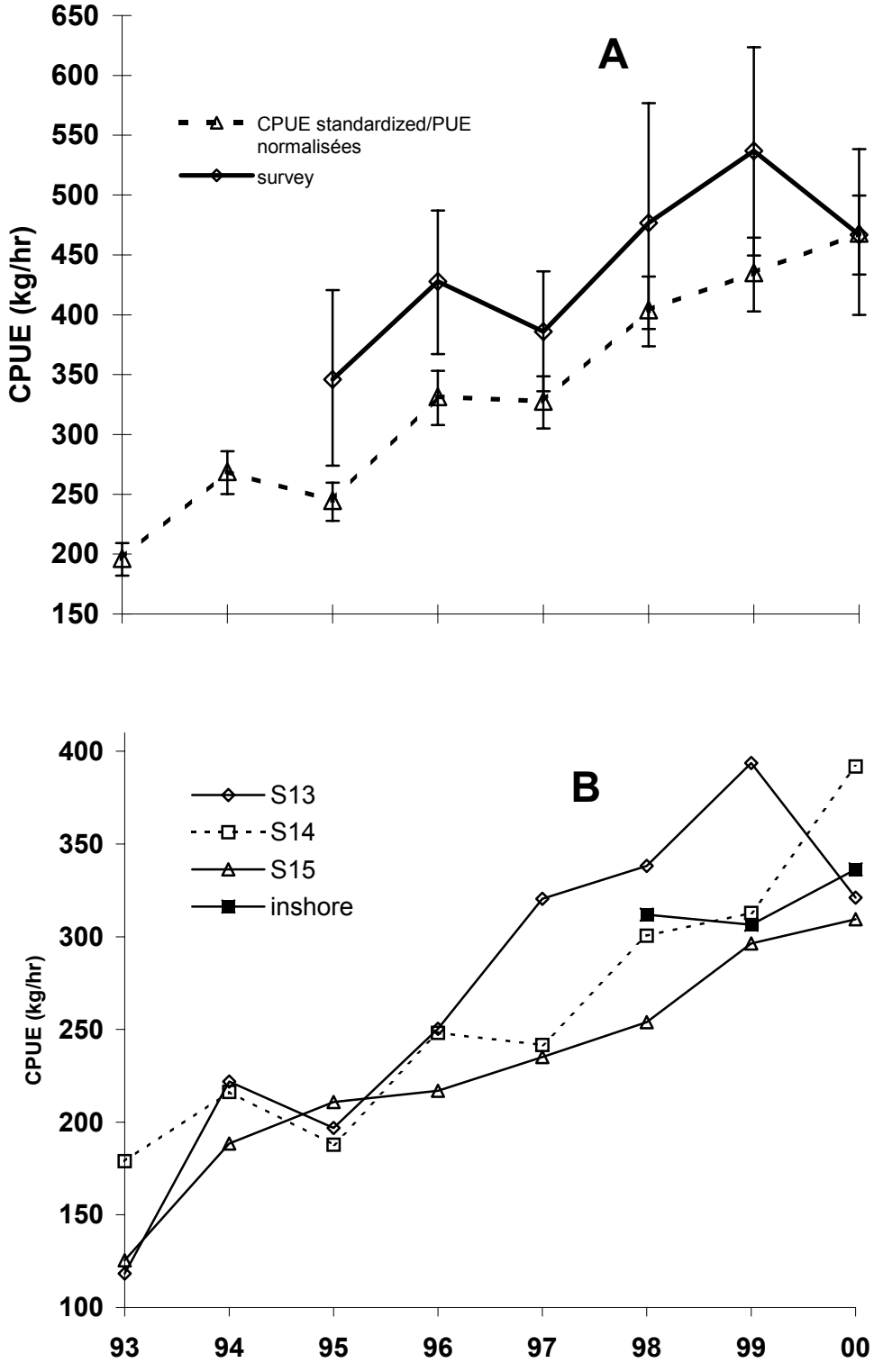


Figure 4. A. A. Standardised and B. unstandardised CPUE(Kg/hr) from shrimp fishing areas, vessels fishing at least 4 yr, April-July.

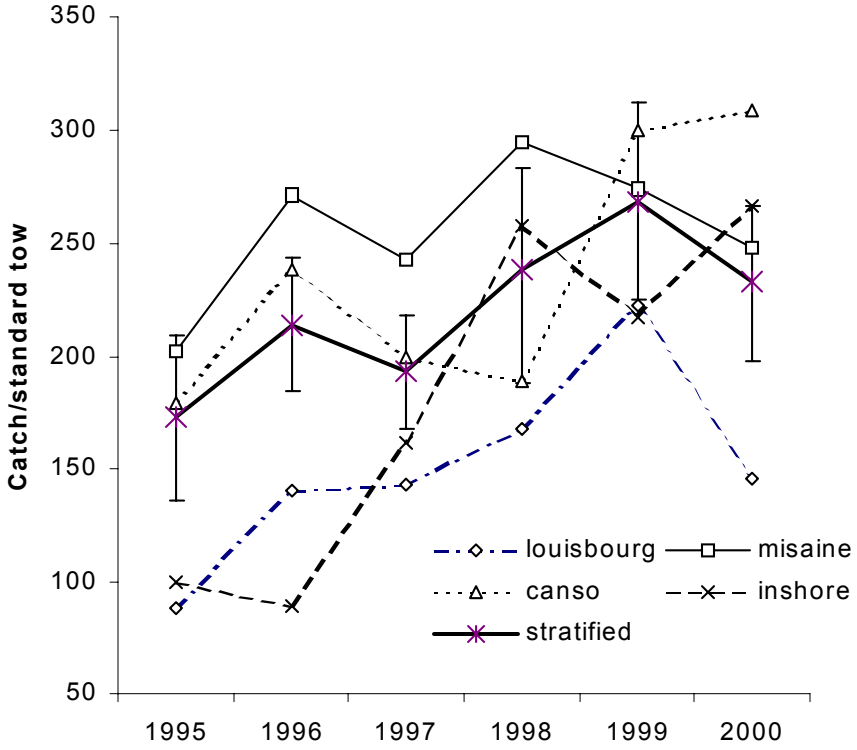


Figure 5. Stratified mean (with bootstrapped 95% confidence intervals) and individual stratum survey indices (weight/tow) from DFO-industry surveys. Survey strata are idenfied as Louisbourg (Stratum 13), Misaine (Stratum 14), Canso offshore (Stratum 15) and inshore (Stratum 17).

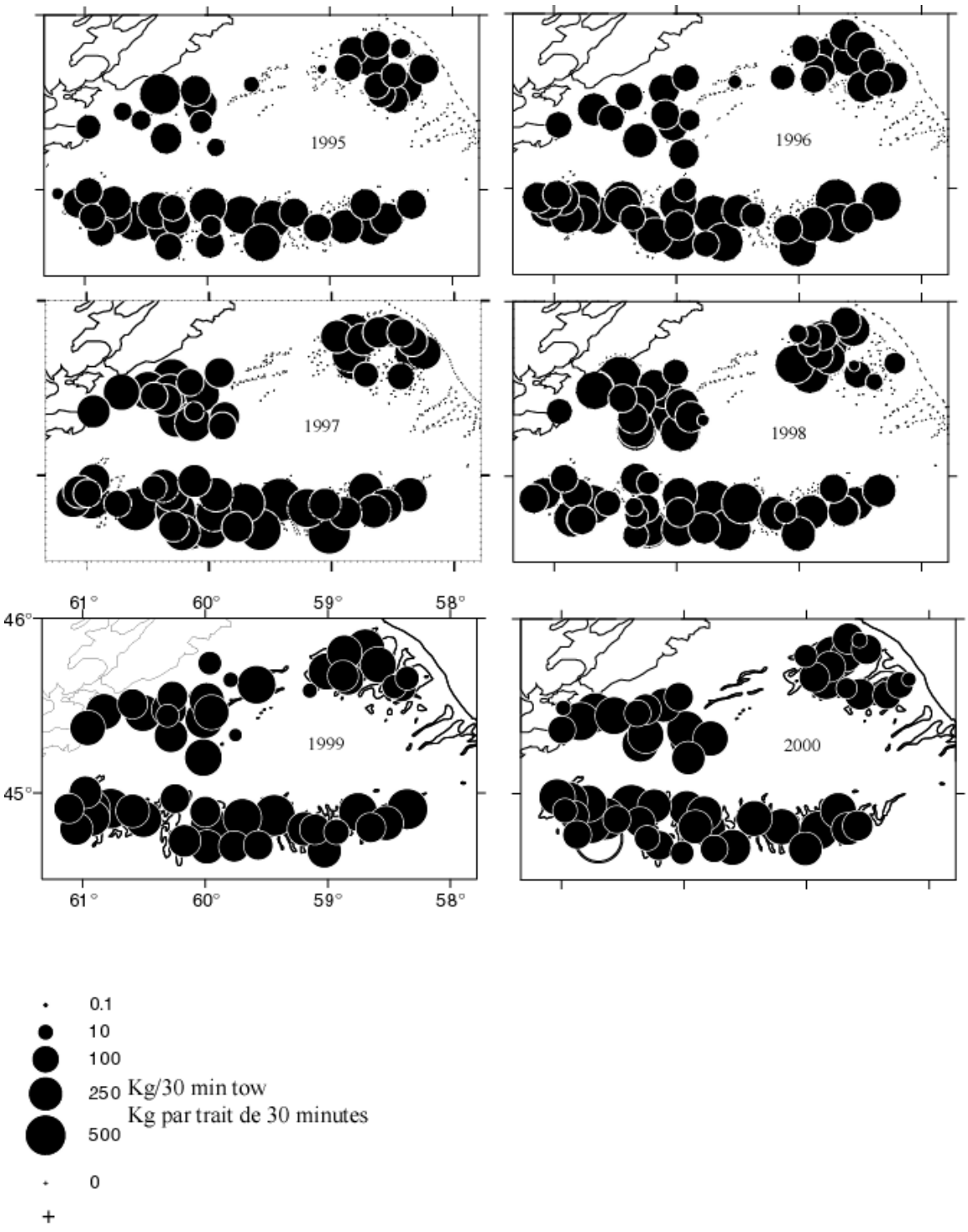


Figure 6. Distribution of survey catches, June 1995-2000.

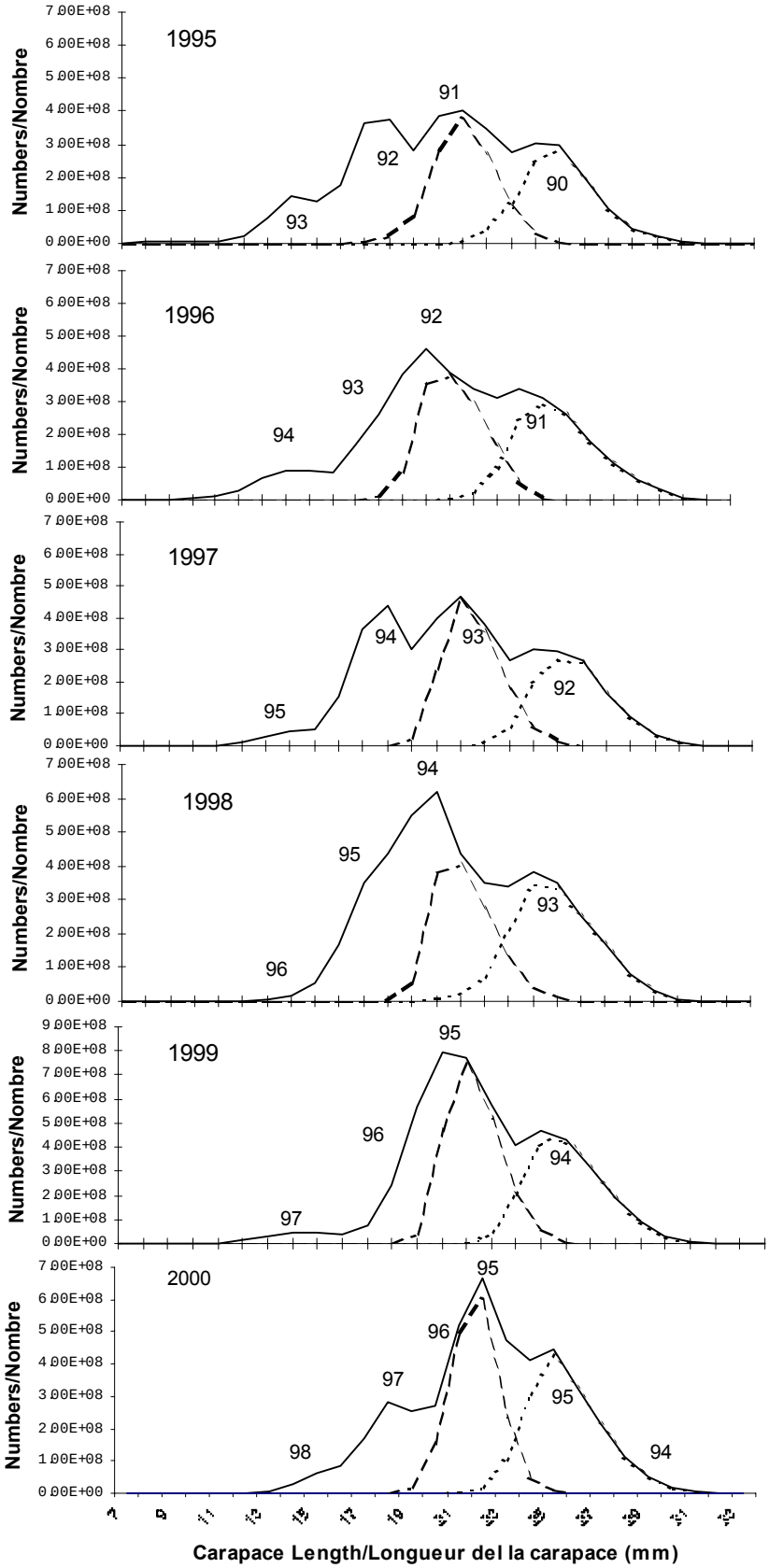


Figure 6A. Total population numbers (all SFAs) at length from surveys conducted from 1995-2000. Year classes are identified by mode. Light dashed line - females, heavy dash - males.

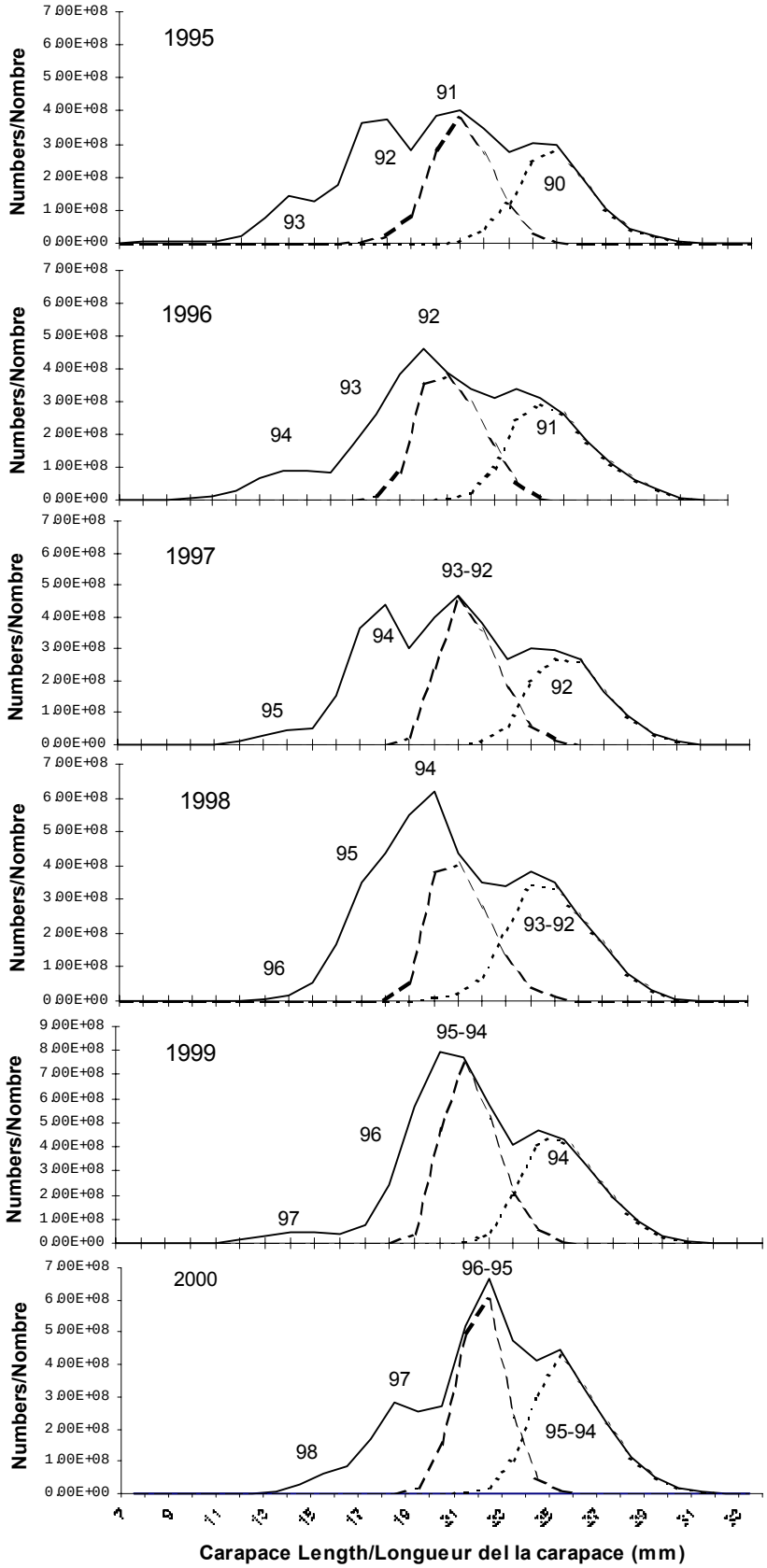


Figure 6B. Alternative age interpretation to that given in Figure 6A.

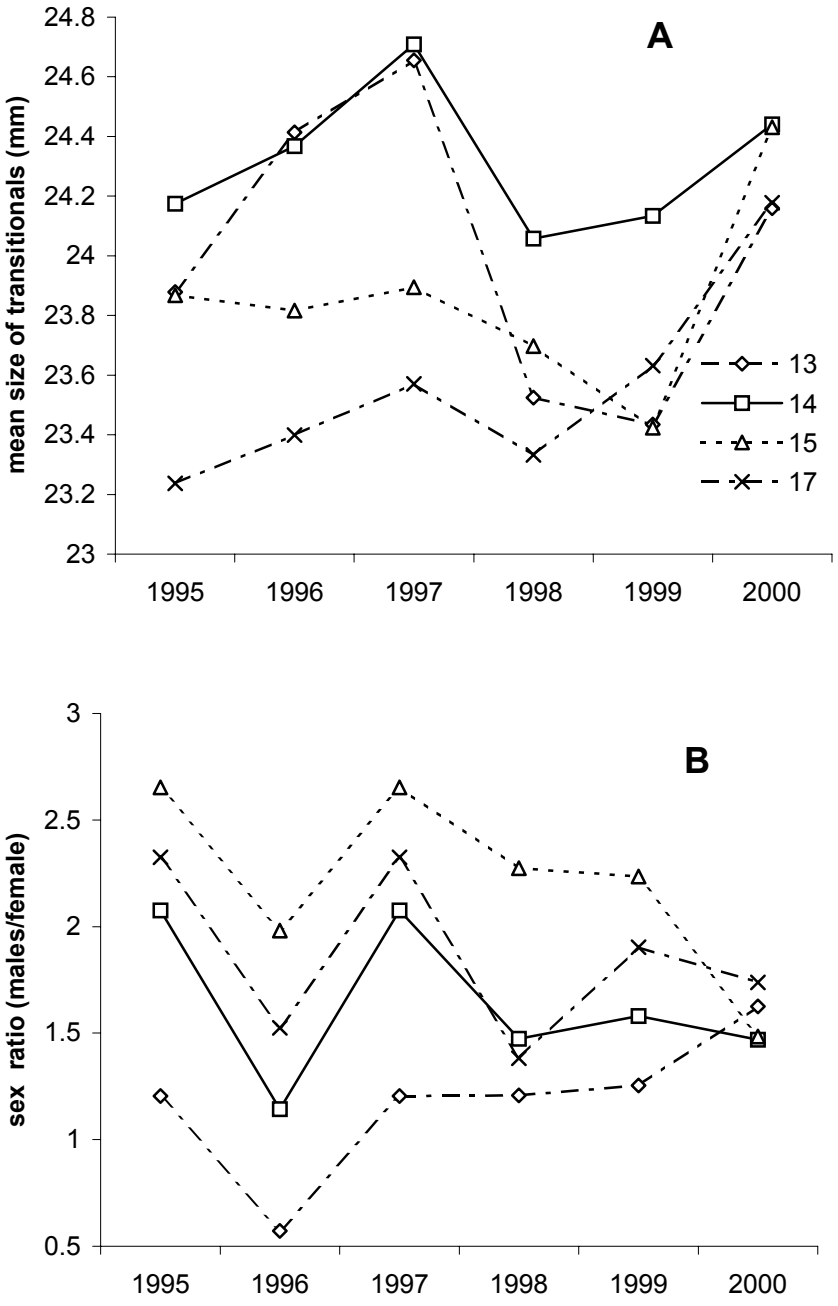


Figure 7. A. Mean size of shrimp identified as transitionals in each of the survey strata from 1995-2000, and B. male:female sex ratio in the survey strata 1996-2000

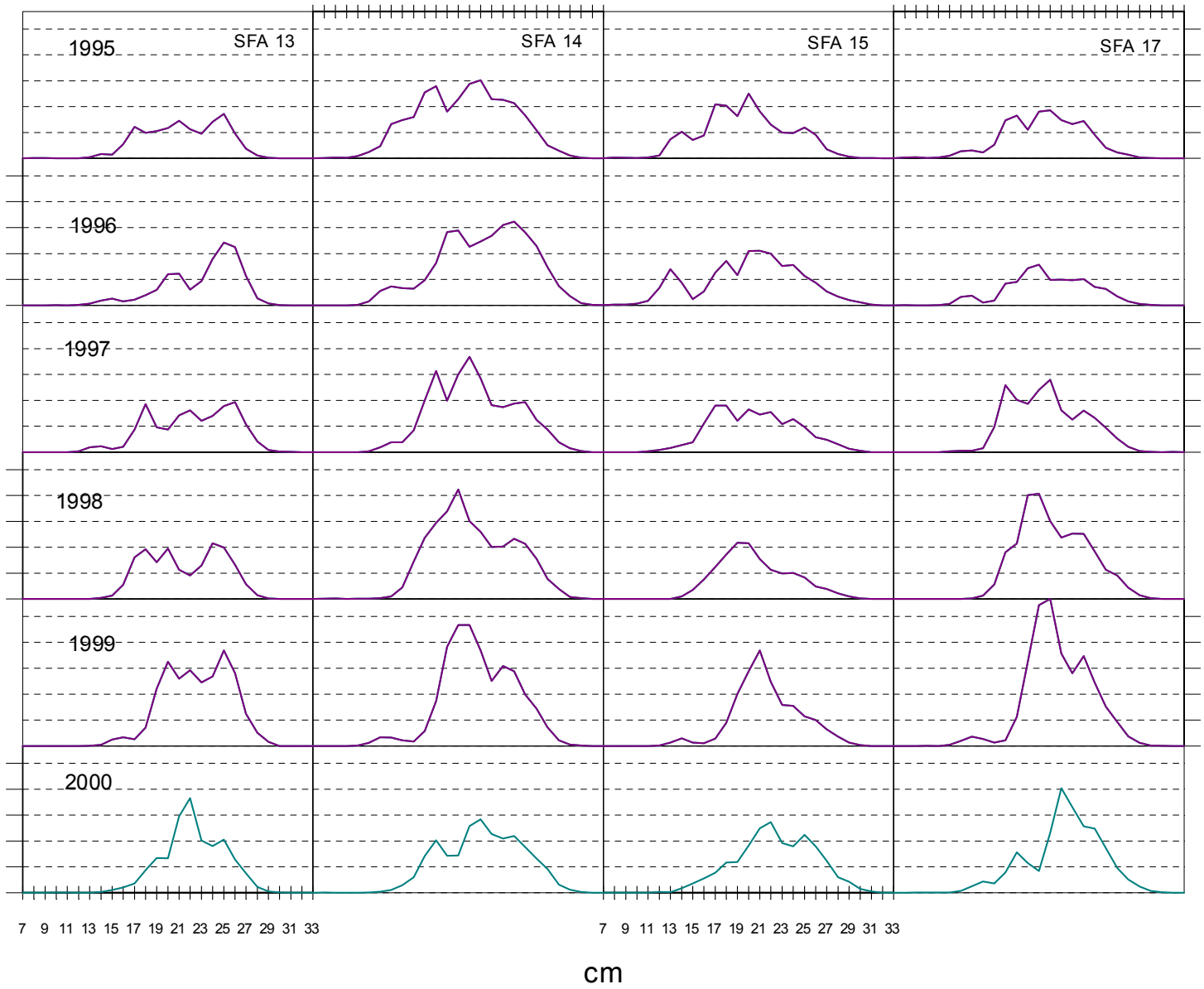


Figure 8. Survey population estimates (numbers) by length and SFA, 1995-2000. Scales are the same for all years and areas.

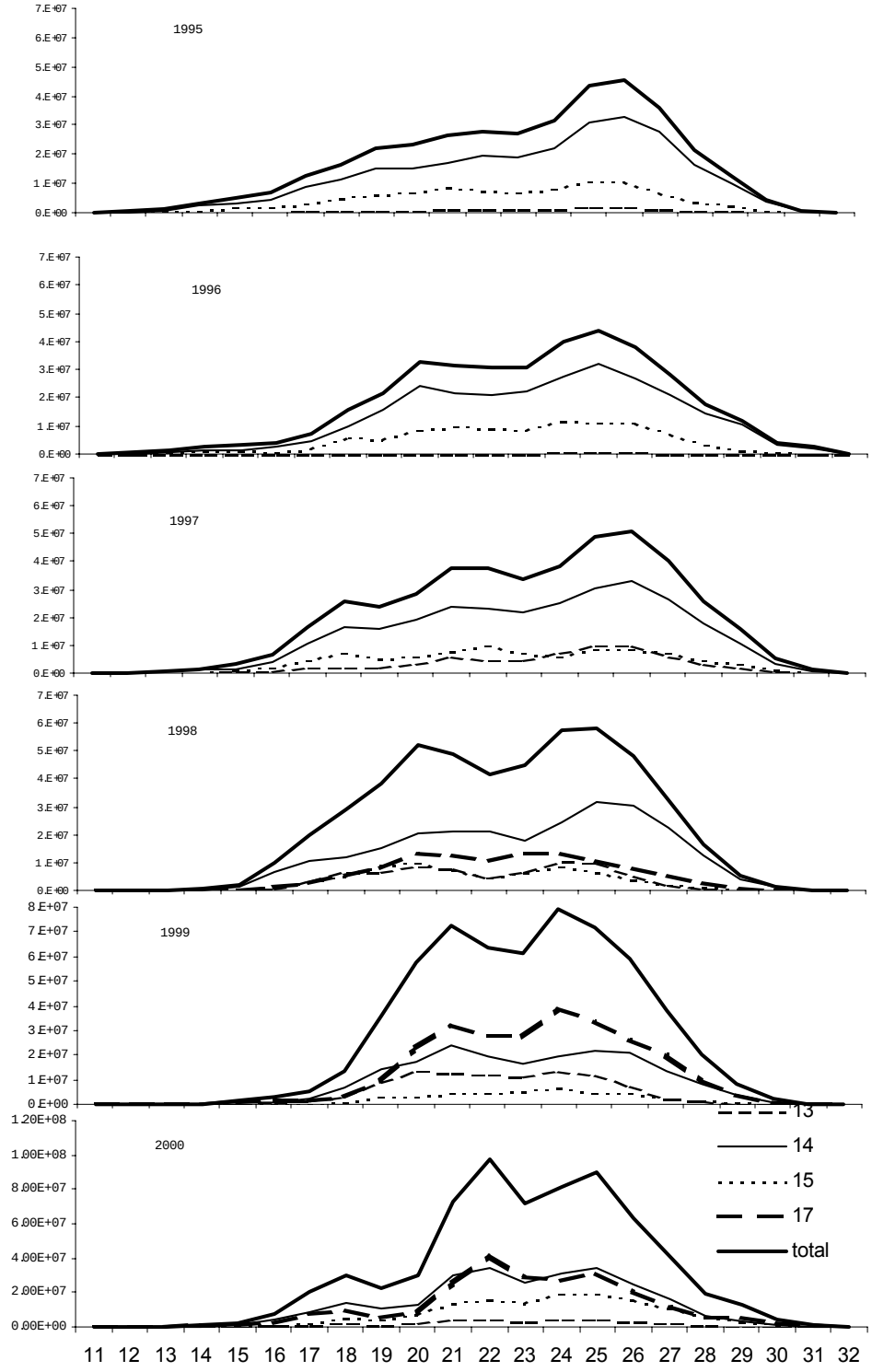


Figure 9. Catch at length (numbers) from commercial samples collected during the shrimp fisheries on the eastern Scotian Shelf 1995-99. Note change in scale for last 2 years.

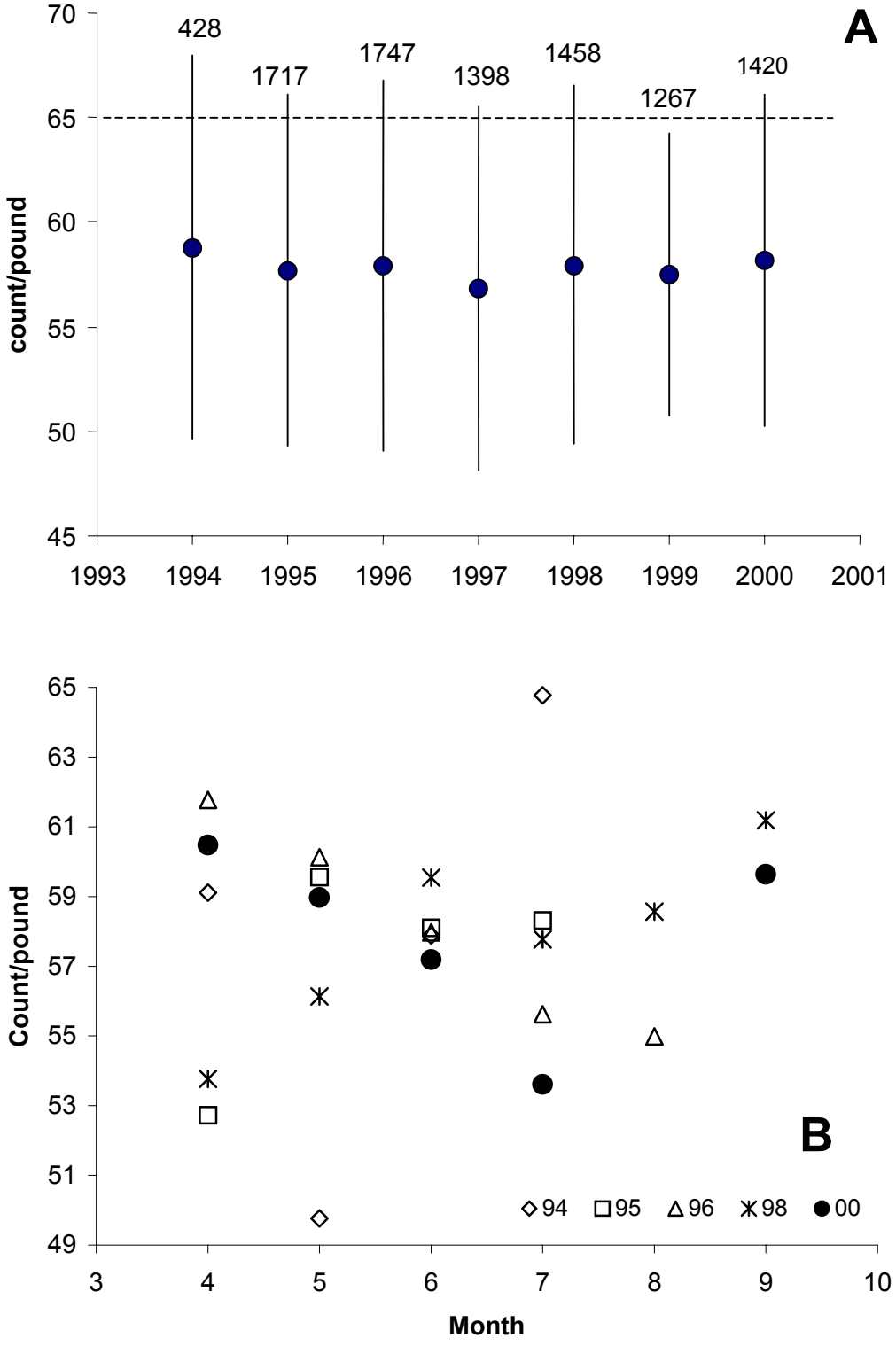


Figure 10. A. Annual counts/pound (1994-2000) from samples taken from the catches of one buyer in Canso, N.S. The horizontal line indicates the 65 count. The numbers above each year gives the sample size. B. counts/per pound by month from 1994-2000.

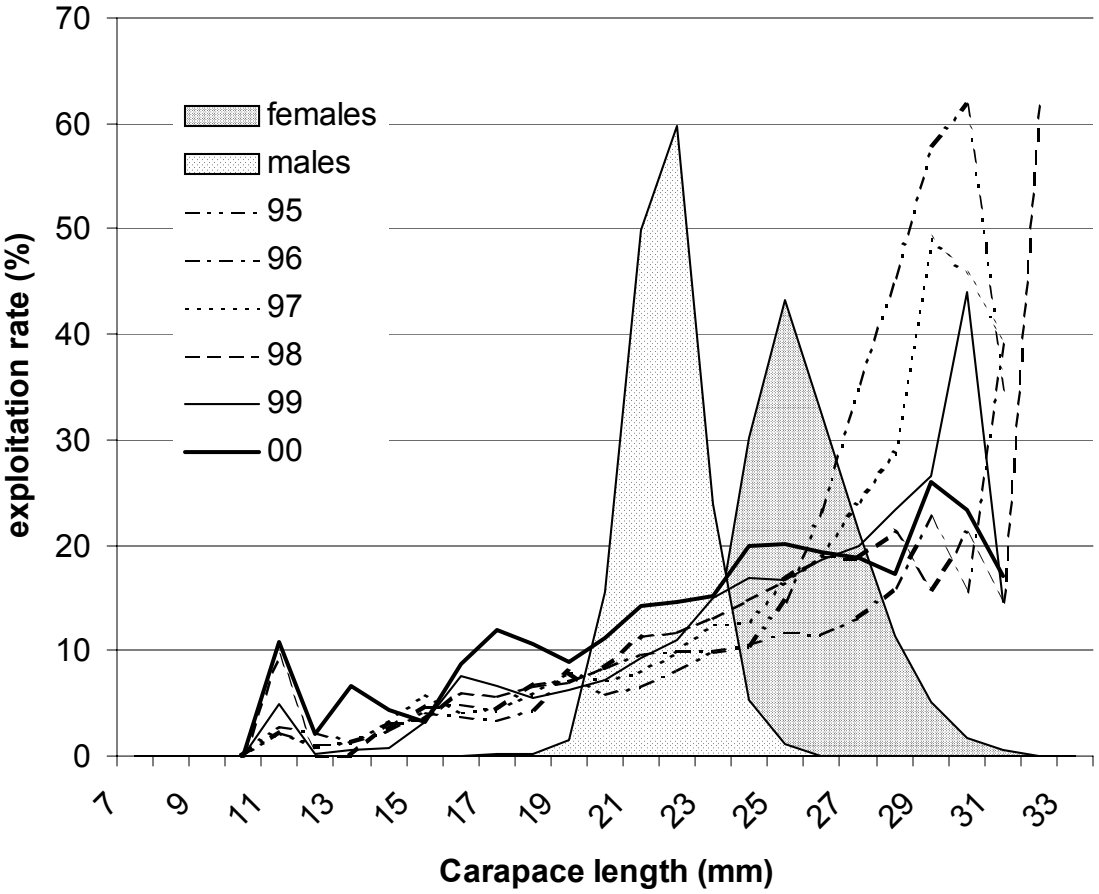


Figure 11. Annual size specific exploitation rates calculated from population at length estimates from surveys and and catch at length from commercial sampling.

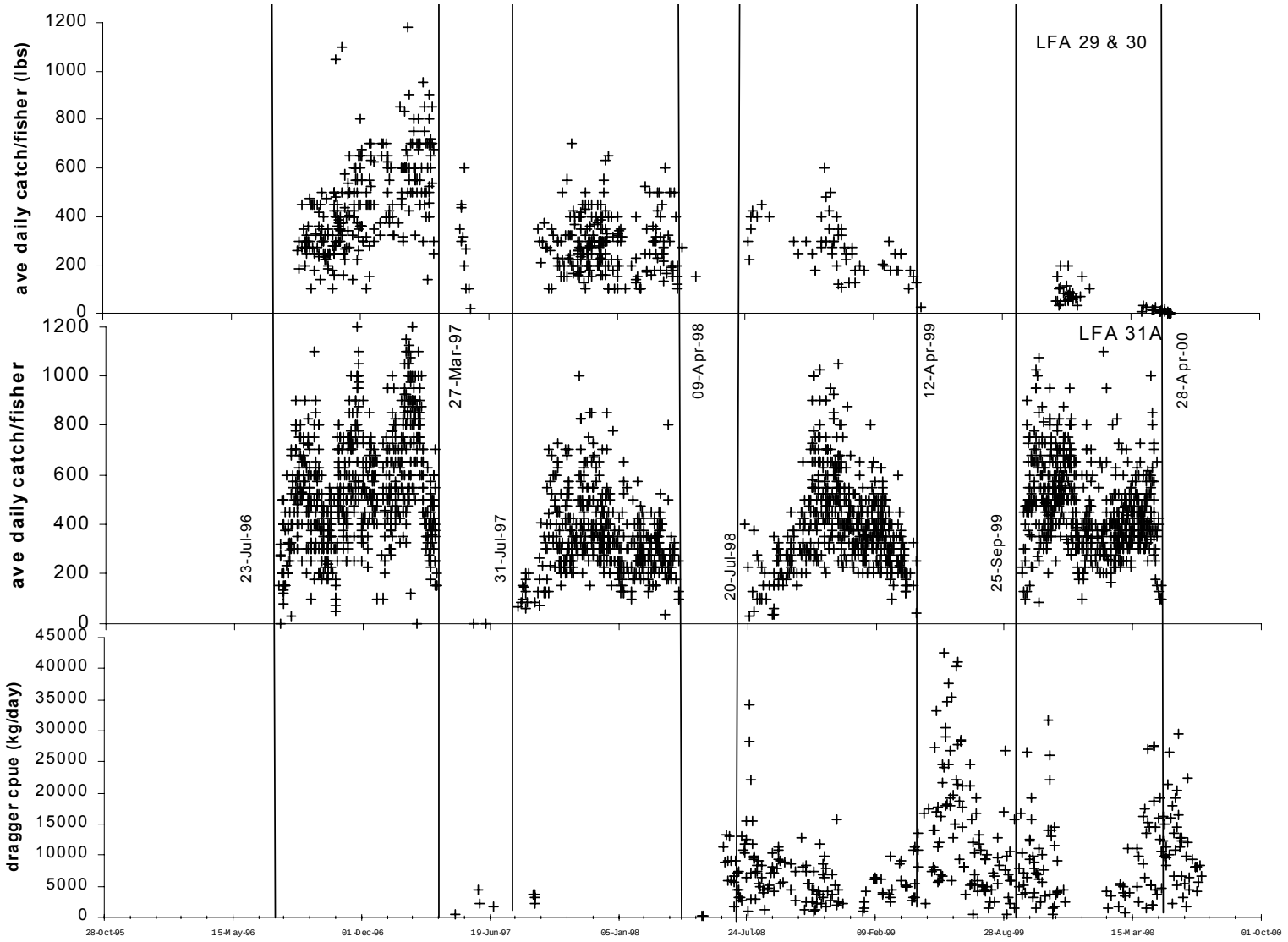


Figure 12. Average daily catches per fisher from the Chedebucto Bay trap fishery, including the northern part of the bay from Arichat to Bad Neighbour Shoal, (LFA 29 & 30, upper panel), the southern part of the bay off Canso (LFA 31A, middle panel) and total catch per day for all draggers operating inshore (lower panel) since the beginning of the trap fishery. Vertical lines and dates show the beginning and end of the main trap fishery off Canso.

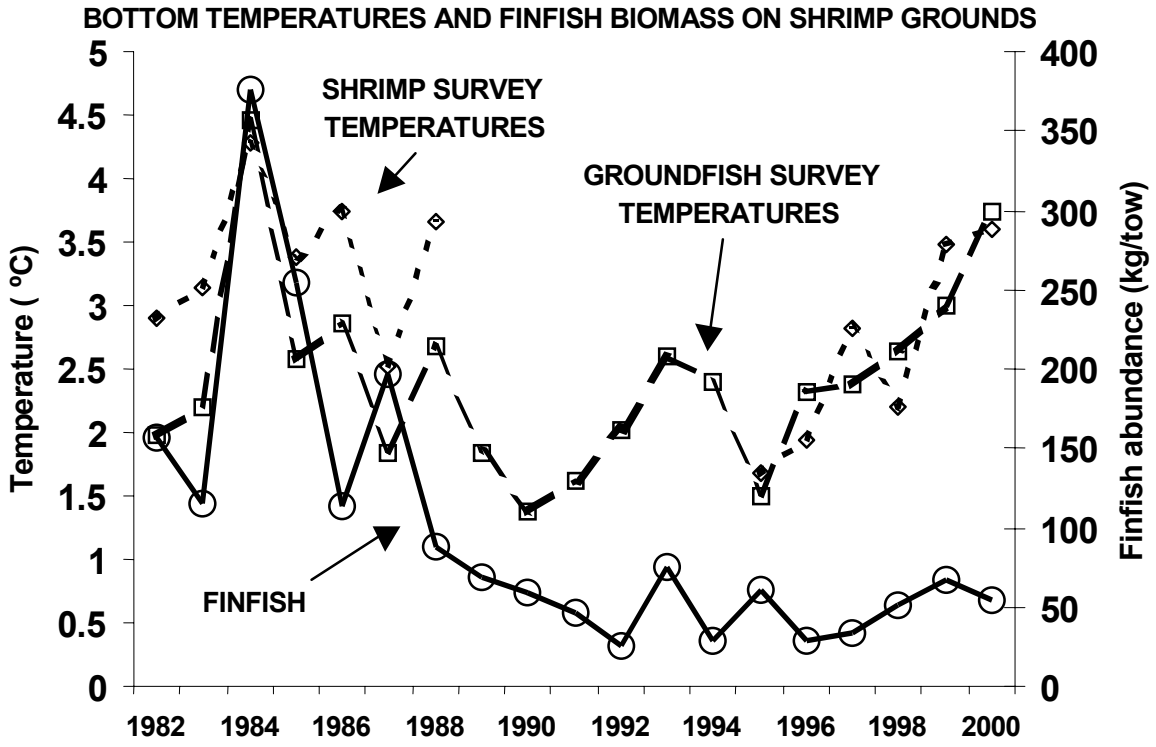


Figure 13. Average bottom temperatures taken during DFO and DFO-industry shrimp surveys and DFO groundfish surveys (>200m) on the eastern Scotian Shelf./Températures moyennes au fond dans les relevés sur la crevette du MPO ainsi que du MPO et de l'industrie et dans les relevés sur le poisson de fond (>200m) dans l'est du plateau néo-écossais.

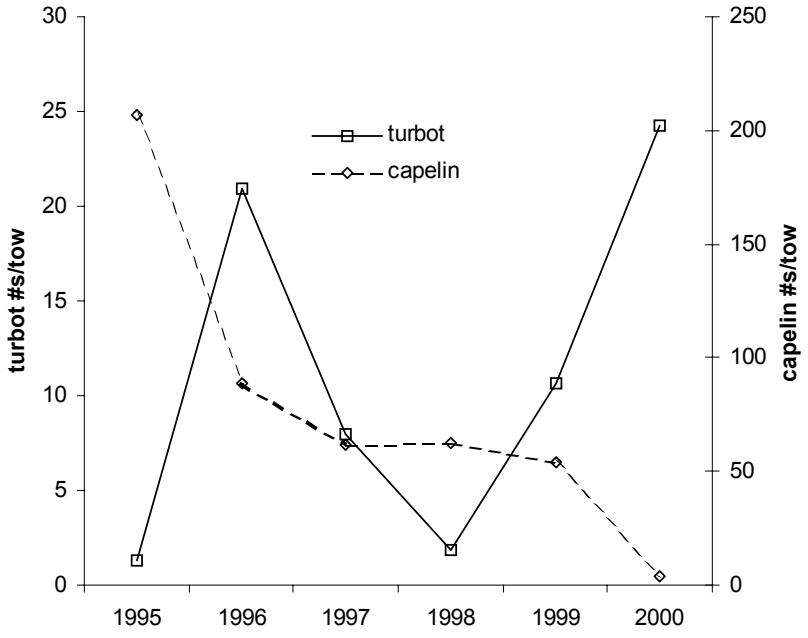


Figure 14. Bycatch of two cold water indicator species from shrimp surveys.

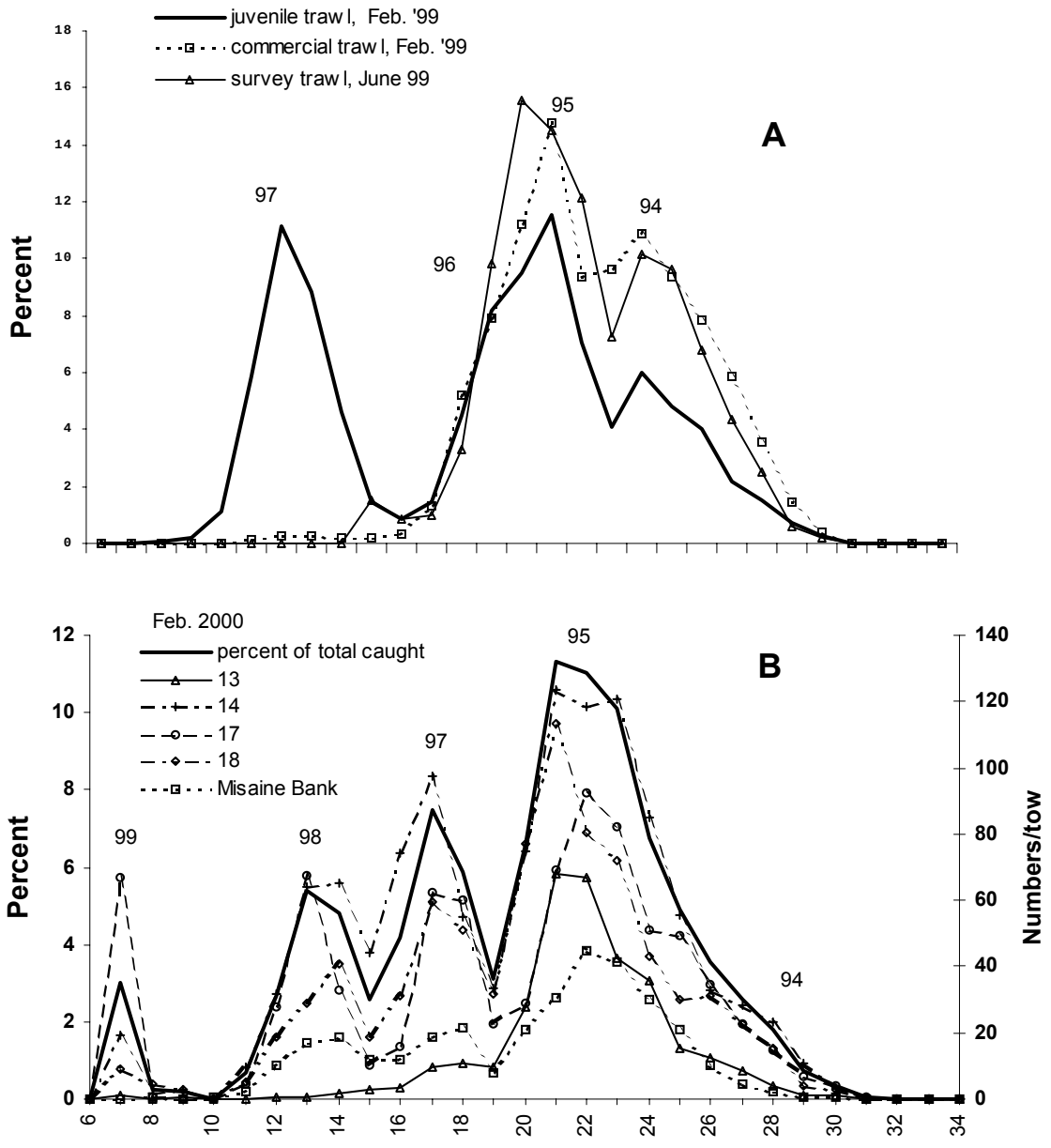


Figure 15. A. Percent of catch at length from beam, commercial and survey trawls made in the Big Hole area of SFA 14 in February 1999, February 1999, and June 1999, respectively. B. Mean numbers/tow at length caught in each area during the beam trawl conducted in February 2000, and percent of catch at length overal.

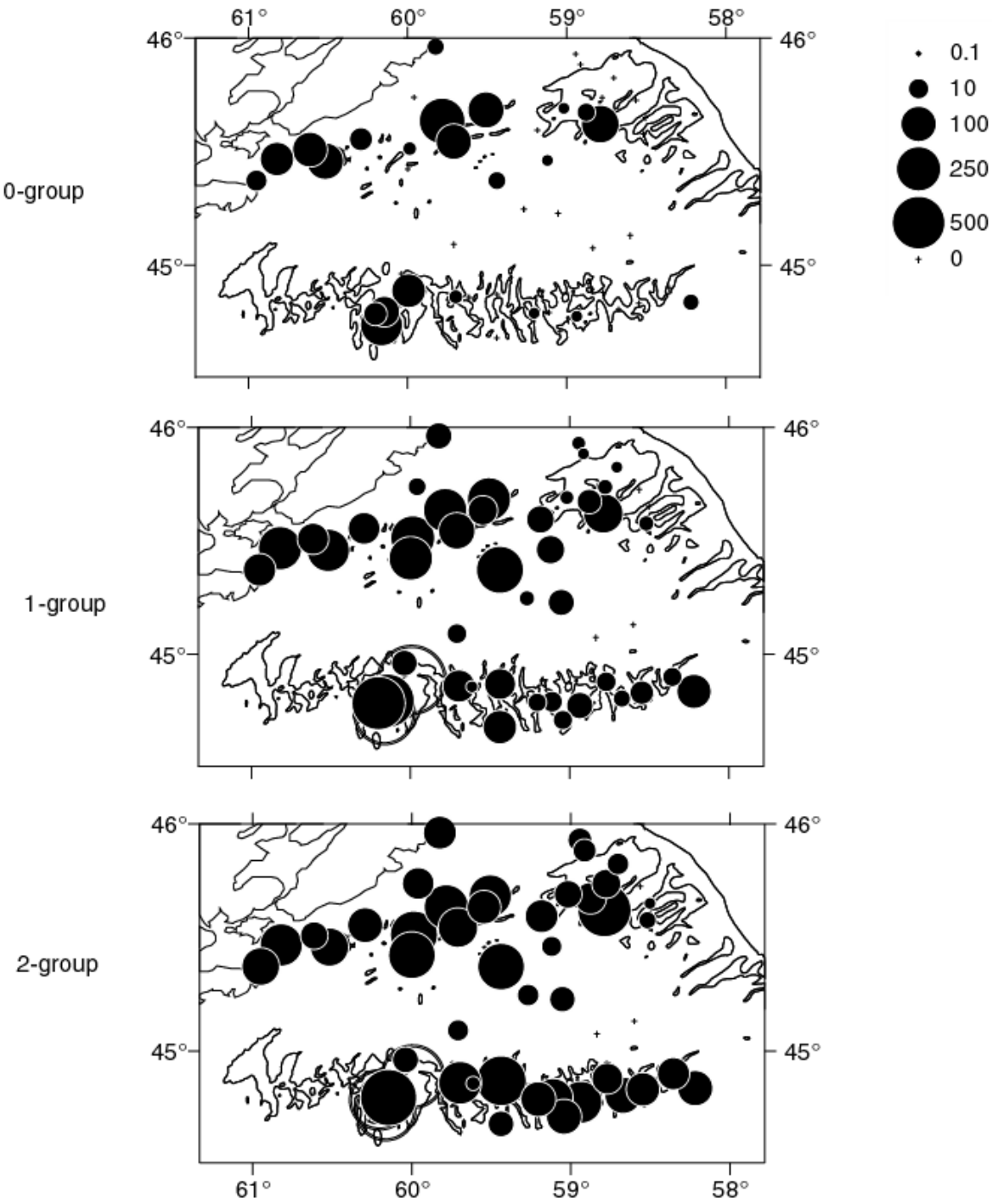


Figure 16. Distribution of 0, 1 and 2 group shrimp from the 1999, 1998 and 1997 year classes caught during the beam trawl survey conducted in February 2000. The scale is in numbers per tow.

Appendix 1. 2000 Questionnaire

# Questionnaire on the 2000 Scotian Shelf Shrimp fishery

**Background**

Name of Captain: _____

Shrimp license number: _____

CFV number: _____

Percentage of the above vessel's shrimp trips in 2000 for which you were aboard:_____

Total number of years you have fished shrimp:_____

Non-shrimp fishing experience:_____

**Shrimp Gear:**

What type/make of shrimp trawl was used on this vessel in 2000?:_____

Who is the manufacturer?: _____

What type/make of doors were used?: _____

What type of codend did you use in 2000? square____ % of trips: diamond____ % of trips

What type of grate do you use (spacing, material, 2nd grate, floats):_____

_____

Describe any significant changes to your gear in the last few years that may have affected your

fishing_____

_____

**Please circle the appropriate number in answer to the following questions**

**Stock status in shrimp fishing areas 13, 14 and 15**

My shrimp catch per haul (per hour fished) in 2000 was:
1 - much lower, 3 - about the same, 5 - much higher than in 1999. 1 2 3 4 5

In 2000 there was: 1 - Much less shrimp, 3 - about the
same amount of shrimp, 5 - much more shrimp than in 1999. 1 2 3 4 5

**Fishing Effort**

In 2000, to catch my quota I had to fish :
1 – not as hard, 3 - about the same, 5 - much harder than in 1999. 1 2 3 4 5

In 2000 I fished in:
1 - a much smaller area, 3 - about the same area, 5 - a much larger area than 1999. 1 2 3 4 5

In 2000 I fished:
1 - shallower, 3 - about the same area, 5 - deeper than 1999. 1 2 3 4 5

Making the count in 2000 was:
1 – much easier, 3 - about the same area, 5 – much harder than in 1999. 1 2 3 4 5

Describe any change in circumstances e.g. price structure of shrimp, catch rates, gear problems/changes, gear conflicts, etc. that changed the way you fished in 2000._____
_____
_____
_____

## Biology

Have you noticed any differences in the shrimp recently (eggs, softness, size, distribution, etc.)?

_____

Have you noticed any difference in the bycatch amounts or composition? e.g. capelin, turbot

_____

Do you have any questions about the biology of shrimp?

_____

**Management of the fishery**

The current size of the shrimp Total Allowable Catch is:
1 - much too low, 3 - about the right size, 5 - much too high. 1 2 3 4 5

Describe any changes to the management of shrimp stock that you would like to see discussed and/ or implimented (e.g. new management measures that should be considered to protect the resource)_____
_____
_____
_____

**additional comments on any subject:**