

**REPORT ON THE STATUS OF THE SHRIMP RESOURCE IN THE NORTHWEST
ATLANTIC IN AREAS OFF NEWFOUNDLAND AND LABRADOR, IN THE GULF
OF ST. LAWRENCE, AND ON THE SCOTIAN SHELF**

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INTRODUCTION

This report presents an overview of shrimp resources along the Canadian Atlantic coast with a compilation of the assessments of shrimp in areas off Newfoundland and Labrador, in the Gulf of St. Lawrence, and on the Scotian Shelf. Component parts of the report were released separately during the year. Scientists who work on invertebrates and marine plants of the Atlantic Coast and at the headquarters of the Department of Fisheries and Oceans reviewed the data and analyses that were used to do the assessments during a zonal meeting in November 1993, a teleconference in June 1994, and at some regional meetings during the winter 1993-94. The discussions were aimed at determining the status of the resource, the future prospects concerning the recruitment and the abundance of the populations, as well as the impact of certain fishing practices. The data used to do these assessments and the technical details of the analyses will be published in the DFO Atlantic Fisheries Research Document series or in regional reports.

OVERVIEW OF SHRIMP RESOURCES ALONG THE ATLANTIC COAST

TRENDS IN LANDINGS

Figures 1 and 2

Newfoundland and Labrador

Shrimp (*Pandalus borealis*) landings from the Newfoundland and Labrador area (excluding NAFO divisions 0A and 3M and *Pandalus montagui* in Hudson Strait) varied between 1,000 and 4,000 tonnes (t) annually from 1977 to 1985 and increased rapidly to about 20,000 t in 1988 and 1989. Landings declined thereafter to between 15,000 and 17,000 t during 1990 -1992 and preliminary statistics for 1993 indicate catches of about 13,000 t.

Gulf of St. Lawrence

Shrimp landings in the Gulf increased from 600 t in 1970 to a peak of approximately 16,000 t in 1991 with a plateau at 7,000 to 9,000 t during the 1979 to 1985 period. Landings exceeded 15,000 t from 1989 to 1991 and declined to about 13,000 t in 1992. Preliminary statistics indicate landings more than 15,000 t in 1993.

Scotian Shelf

Landings from the Scotian Shelf have been much lower than elsewhere on Canada's Atlantic coast, varying from 200 to 1,000 t from 1977 to 1984. Less than 200 t per year were taken from 1985 to 1990 but a rapid increase was reported thereafter to a maximum of 2,000 t (preliminary) in 1993.

Total

Total shrimp landings from eastern Canada showed two periods of increasing catches, from the early 1970s to 1980 and from 1985 to 1989. The first increase was due to the development of new fisheries off Labrador and on the Scotian Shelf and the continued growth of the Gulf of St. Lawrence fishery. There was a slight decrease in catches from 1980 to 1984, created by a decline in the new Labrador fishery and the implementation of TACs in all shrimp fishing areas. The second period of increase resulted from a rapid

expansion of the fishery off Newfoundland and Labrador into new areas and increased TACs in the Gulf of St. Lawrence. Landings since 1990 have stabilized at approximately 30,000 t.

SITUATION IN 1993

Shrimp resources in the traditional fishing areas appear to be either relatively stable or variable without trend and no significant negative effects of prolonged fishing are apparent. The resource off northern Newfoundland-southern Labrador is healthy and catch rates in recent years suggest that abundance is increasing. Exploratory fisheries in the offshore areas have shown that shrimp distribution is continuous over a broad range and that commercial concentrations exist on grounds which were previously unproductive or thought to be.

The introduction of the Nordmore grate on the Scotian Shelf in 1991 reactivated the shrimp fishery by resolving the groundfish by-catch problem. The resource is currently supporting a viable fishery and TACs were reached for the combined shrimp fishing areas (Canso and Misaine holes) in both 1992 and 1993. Participation has increased with all but two of the 29 licensed vessels actively fishing in 1993. The Nordmore grate is now mandatory in the Gulf of St. Lawrence and is being introduced, as well, into the fishery off Newfoundland and Labrador.

In 1993, a new international shrimp fishery began on the Flemish Cap (NAFO Div. 3M). Vessels from several nations were actively fishing shrimp in the area by early summer and preliminary reports suggest total catches of about 30,000 t in 1993. The NAFO Scientific Council conducted a preliminary assessment in September, 1993 but data were insufficient to provide a basis for a TAC. A cautious approach to exploitation was recommended.

MANAGEMENT APPROACH

The Atlantic shrimp fisheries are managed by means of TACs in an effort to control the exploitation rate of the populations. The exploitation rate is the intensity with which a stock is exploited and is a function of catches and the biomass of the resource. For example, high catches taken from a small stock with a low biomass will result in a very high exploitation rate. However, if the biomass increases and catches remain stable, the exploitation rate will decline. Maintaining the exploitation rate at a specific level aims to protect the reproductive potential of the populations by allowing a certain proportion of shrimp to be available for reproduction. The fact that shrimp change sex during their lifetime and that exploitation primarily targets large shrimp, which are females, are special considerations which are reviewed in determining TACs, the optimum exploitation rate that the populations can support, and the monitoring required to assess the status of the resource.

During the 1980s, TACs for the Sept-Îles management unit in the Gulf of St. Lawrence were increased as part of a cautious attempt at experimental management. The aim in gradually increasing the TAC of this fishing area was to cautiously increase the exploitation rate in order to assess the impact on the resource and ultimately determine the optimum exploitation rate which a shrimp population could support. However, because the abundance of shrimp in this area increased simultaneously, the exploitation rate in the early 1990s was probably actually lower than in the early 1980s. Exploitation at these levels had no discernible negative effects on the resource. The increase in abundance occurred despite an increase in the fishing effort between the first and second half of the 1980s. Catches did not appear to affect reproduction or recruitment, despite the fact that large shrimp, the majority of which are female, were the main target of the fishermen.

Subsequently, general principles concerning the determination of TACs were introduced during a scientific workshop on Atlantic shrimp conservation and management strategies held in late 1990. The workshop participants noted that there was a potential for a very high level of fishing effort in most of the Atlantic coast fisheries and that exploitation rates could therefore increase to very high levels. They emphasized that a ceiling should be set on potential effort in order to limit the exploitation rate even if this ceiling or limit could not be quantitatively determined on a strictly analytical basis. They also stressed that this limit should not be needlessly restrictive for shrimp fishermen. To determine the proper exploitation level, they proposed assessing the status of the resource qualitatively and then adjusting the TAC based on the status of the resource and the potential impact of catches on the exploitation rate. The TACs would thus be increased or decreased based on changes observed in the status of the resource. However, the relationship between the extent of increases and decreases in TACs and the extent of changes in the status of the stocks has not yet been quantitatively determined.

NEWFOUNDLAND AND LABRADOR SHRIMP STATUS

DESCRIPTION OF THE FISHERY

Figure 3

The fishery for northern shrimp off the coast of Labrador began in the mid-1970s in the Hopedale, Cartwright and Hawke channels, expanding in 1979 to include the offshore fishing grounds in Davis Strait (NAFO subareas 0+1). Annual shrimp catches increased steadily to about 9,000 t by 1981, but subsequently declined and remained relatively low during the 1982 to 1986 period. Beginning in 1987, renewed interest in the traditional areas and increased effort in Hawke Channel and St. Anthony Basin (Div. 3K) late in the year resulted in a total catch of about 15,000 t. In 1988, fishing for northern shrimp became even more widespread as vessels ventured into divisions 0B and 2G where both catch rates and sizes of shrimp proved to be very attractive to the industry. In Division 3K, commercial concentrations of shrimp also were located in a small area east of St. Anthony Basin and in the Funk Island Deep. Catches in both 1988 and 1989 exceeded 25,000 t and, since then, have remained in the 20,000 to 25,000 t range. In 1993, an international fishery developed on Flemish Cap (Div. 3M). Canadian vessels which participated in this new fishery were diverted from the traditionally fished areas within the Canadian zone where, as a result, both catch and effort decreased.

REDEFINITION OF ASSESSMENT AND MANAGEMENT UNITS

Figure 3

As the fishery developed, so did the complexity of the management plan with respect to TACs. Because of a lack of information on how areas of high shrimp density were related to one another, the fishing grounds were treated as separate stocks and separate TACs were implemented for different areas as they were discovered. The fleet has fished extensively over a wide geographic area only since 1988 and, at current levels of abundance, it is clear that distribution of the species throughout the northwest Atlantic is more continuous than once thought. Not only are the traditional areas still productive, but commercial concentrations of shrimp have recently been located between and outside these areas, on grounds which were previously unfished.

Bathymetric data showed that the potential habitat for shrimp was vast and that many of the previously isolated fishing areas are, in fact, interconnected—seaward on the slopes of the continental shelf and landward through the Labrador Marginal Trough. Cumulative fishing records since 1977 showed that the distribution of shrimp was continuous over the range with effort concentrated in the zones of highest density. Biological data, however, showed clear differences between shrimp from different areas. These data, while demonstrating how some aspects of the biology of the species vary over a broad range of habitat, do not define limits of shrimp populations or stocks. The continuous nature of the distribution, as evidenced through the fishing records,

suggests a single stock or stock complex within which localized retention mechanisms provide conditions which result in different rates of growth and maturation. Yet the potential for mixing between areas exists both through recruitment (drift) of larvae and migration of adults.

Sufficient information is now available to provide a biological basis for modification of the management plan by combining areas which, in the past, were treated separately. A proposal for modification of shrimp fishing areas was reviewed and it was subsequently agreed that four assessment units could be defined based on present biological knowledge (a reduction from the existing six, previously eight, fishing areas [Fig. 3]). Defining fishing areas based on these assessment units would facilitate future assessment of shrimp stocks. A version of the proposal was communicated to industry early in 1993 for their input and agreement in principle was unanimous.

The following describes the recommended shrimp assessment units between latitudes 49° 15' N and 66° 15' N which are based on biological information (Fig. 3). It would be appropriate for these units to also be used for management purposes. Fisheries assessed by NAFO in divisions 0A and 3M and the fishery for *Pandalus montagui* in Hudson Strait and Ungava Bay remain as separate assessment/management units.

NAFO Division 0B

Description - This area should be treated separately because of the uncertainty surrounding the status of the resource. Fishing is difficult due to ice and strong variable currents in the area. Shrimp concentrations are difficult to locate and catch rates difficult to maintain. Longevity is greater in this area. Sex change occurs two years later than in areas farther south and females attain very large sizes. The area is also physically separated from the southern grounds by deep water and the strong outflow from Hudson Strait.

Proposed coordinates - Between 61° N and 66° 15' N and east to the 200 Mile Limit/Median Line.

NAFO Division 2G

Description - This is a zone of transition from the large, long-lived animals found in Div. 0B to sizes and ages typically found in Hopedale and Cartwright channels off the mid-Labrador coast. No clear separation could be identified and the zone should be treated as a unit.

Proposed coordinates - Between 57° 15' N and 61° N and east to the 200 mile limit. (Note: the actual southern limit of Div. 2G is 57° 40' N.)

Hopedale and Cartwright channels

Description - These are the only areas which have been fished every year since the fishery began in the mid-1970s. Shrimp growth rates and timing of maturity stages are similar in each channel. Although the actual fishing grounds are well-separated, habitat suitable for shrimp exists between the channels both seaward and landward. If effort does tend to concentrate in one area, it likely will be in the larger Hopedale area.

Proposed coordinates - Between 57° 15' N and 53° 45' N east to 55° W, then north to 54° 45' N and east to the 200 Mile Limit.

Hawke Channel and NAFO Division 3K

Description - Three fishing areas within Div. 3K (St. Anthony Basin, east St. Anthony and Funk Island Deep) were combined for the 1993 season, based on evidence that shrimp over these grounds belonged to a biological unit. Hawke Channel should also belong in this unit. Rates of growth and maturation are more variable in the combined southern area of Hawke Channel and Div. 3K compared to the stable conditions observed in the Hopedale and Cartwright channels. Exploratory fisheries in 1992 and 1993 showed the occurrence of shrimp on the slopes of the shelf north and south of Hawke Channel and east of Funk Island Deep. These exploratory areas are included in the new, combined areas.

Proposed coordinates - Between 49° 15' N and 53° 45' N east to 55° W then north to 54° 45' N and east to the 200 Mile Limit.

ASSESSMENT OF SHRIMP IN THE HAWKE CHANNEL - DIV. 3K AREA**Figure 4 and Table 1****Catch and effort**

The shrimp fishery in the Hawke Channel - Div. 3K area began in 1987 when about 1,800 t were caught. Since then, the fishery has evolved as a winter- spring operation with most of the catch and effort occurring in the January-May period. Catches increased to more than 7,800 t in 1988 and have ranged between 5,500 and 7,900 t since 1989. Annual effort decreased under catch controls and increasing catch rates. In 1992, two exploratory areas were established, one on the seaward slope of the shelf between Hawke and Cartwright channels and the other between Hawke Channel and Funk Island Deep. In 1993, a third was established on the eastern slope of Funk Island Bank. The allocations provided effectively raised the TAC in 1992 by 1,700 t and in 1993 by 3,400 t.

Catch per unit of effort (CPUE)

Monthly catch rates from 1988 to 1990 were the highest in May but, in 1992 and 1993, the January rates were the highest. Unstandardized annual CPUE decreased from 536 kg/hr in 1988 to 432 in 1989 and increased steadily thereafter to 905 kg/hr in 1993. The CPUE data were analyzed by multiple regression to take into account, month, vessel and area effects. Standardized annual catch rates showed approximately the same trend as the unstandardized series for 1988 to 1991. In 1992 and 1993, the standardized catch rate increased more markedly than the unstandardized series.

Catch composition**Figure 5**

Catch-at-length data obtained from observer sampling from 1988 to 1993 showed dominance of the female component around 24 mm carapace length (CL) in all years. The increase in catch rates from 1989 to 1993 might have resulted from the recruitment of at least two strong year-classes which first appeared as males (< 22 mm CL) in 1990. Most of these younger animals were taken in Div. 3K. A prominent mode of males at roughly 19 mm was evident in 1993 and, together with the high CPUE, suggests continued good recruitment.

Resource status and prospects

The northern shrimp resource in the Hawke Channel-Div. 3K area is healthy and catch rate data suggest that abundance has increased in recent years. The expansion of the fishery to include the slope waters between the traditionally fished areas provides additional information on the extent of the distribution and abundance of the resource. Indeed, fishermen have stated that good catches of shrimp can be obtained "anywhere" within the southern 2J-3K area. Overall, the proportion of female shrimp in the catches remains high and there are no signs of weak recruitment for the near future. Negative effects of the fishery on the shrimp resources are not detectable within the range of naturally occurring events.

The explanation for the currently high abundance is uncertain. It is likely that several strong year-classes have been produced since the mid-1980s. A significant shift in distribution from the north is unlikely because the fishery is still performing well in those areas. Abundance of shrimp on the Flemish Cap has also increased. It is not clear how and if these events are related but it appears that recent conditions off northeastern Newfoundland and southern Labrador were highly favourable for shrimp. How long those conditions will last is unknown.

TACs and catches have increased over the period of expansion and the exploratory fisheries in 1992 and 1993 have addressed the need to find out more about the distribution, availability and abundance of the resource. Catch levels in the order of 5,500 to 8,000 t for the last six years do not appear to have adversely impacted the resource. Catches showed no relationship with effort from 1988 onward and neither did CPUE plotted against effort. Given the evidence for increased abundance and no reason to anticipate any change in recruitment to the fishery, a higher catch level could be considered as an option for the new multi-year fishing plan beginning in 1994.

Any increase should be cautious, given the uncertainty about how long the high abundance level will last. Catch rates increased about 20% between 1992 and 1993, suggesting an equivalent increase in abundance. It is suggested that a catch of about 11,000 t (equivalent to 20% more than the 1993 TAC) would maintain an approximately constant exploitation rate.

ASSESSMENT OF SHRIMP IN HOPEDALE AND CARTWRIGHT CHANNELS

Figure 6 and Table 2

Catch and effort

The northern shrimp fishery in Hopedale and Cartwright channels essentially began in 1977, following exploratory fishing in the previous two years. Catches increased from about 2700 t in 1977 to 4100 t in 1980, declined to 1000 t in 1983 and 1984, increased again to 7800 t in 1988 and then stabilized at roughly 6000 t during the 1989 - 1993 period. Fishing effort (both unstandardized and standardized) showed the same trends over time as catch. The fishery usually occurs from June to December but, in some years, significant effort has been reported in January and May.

Catch per unit effort (CPUE)

Typically, catch rates are high during June and July, decline thereafter to September or October and increase again late in the year. Unstandardized annual CPUE (kg/hr) declined from 552 in 1977 to 230 kg/hr in 1985, increased substantially in 1986 and stabilized around a mean level of 620 kg/hr during the 1986 - 1993 period. The CPUE data were further analyzed by multiple regression for year, month, vessel and area effects. The model, which explained 47% of the variation, showed that all class variables were significant ($P < 0.001$). None of the predicted, annual catch rates from 1986 to 1992 were significantly different from the 1993 level ($P > .18$).

The standardized series showed the same trend as the unstandardized except that recent CPUE only had recovered to about 80 - 90% of virgin levels.

Catch composition

Figure 7

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

Resource status and prospects

The northern shrimp resource in the Hopedale/Cartwright Channel area appears healthy and commercial catch rates have been stable in recent years. Industry representatives and vessel captains have agreed with this interpretation, as discussed in recent meetings (both formal and informal). No declining trend in the proportions or catch rates of female shrimp has emerged since 1986 and prospects for recruitment to the female component in the near future are favourable.

The increase in CPUE from the level observed during the early to mid-1980s to the period of stability since 1986 can be partly explained by regular recruitment of year-classes produced throughout the 1980s. The impact of fishing, although unquantifiable, appears minimal. Catches increased linearly with effort and CPUE shows no negative relationship with effort. The spawning biomass remains healthy and there are no indications of recruitment failure. The presence of refugia areas in waters both shallower and deeper than the fishing grounds also affords some protection for males and females, respectively. Annual catches since 1986, averaging 6000 t, have not adversely impacted the resource and a catch of over 7800 t in 1988 produced no noticeable negative effects thereafter.

It is possible that the stability observed over the past several years might not be affected by higher removals. To investigate this, an increase in the TAC can be considered as an option for the 1994 - 1996 management plan. Although there is no quantitative basis to define a higher level, it is noted that the highest annual catch reported since the fishery began was 7800 t and that sustained catches around this level might be considered. This would represent an increase of about 20% over the current TAC.

ASSESSMENT OF SHRIMP IN NAFO DIVISION 2G

Figure 8 and Table 3

Catch and effort

The northern shrimp fishery in Division 2G began in 1988, with only incidental catch and effort having been reported from previous years. Catches increased from 1083 t in 1988 to 3842 t in 1989 and remained within the 2500 - 3000 t range thereafter. Fishing effort (both unstandardized and standardized) increased substantially from 1988 to 1989 followed by a decrease to 1993. From 1988 to 1990, the fishery occurred throughout the division which, during that period, was split into two management zones, north and south of 60° N. The three-year management plan, implemented in 1991, combined the two zones and, since then, the

fishery has concentrated in the north. The fishery usually begins in June but, in 1989, significant effort was reported from January to May.

Catch per unit effort (CPUE)

The area is noted for producing high catch rates of very large shrimp, especially north of 60° N. Unstandardized annual CPUE declined from 1.8 t/hr in 1988 to about .7 t/hr in 1989 and 1990. In 1991, catch rates increased substantially to over 3 t/hr as fishing effort concentrated in the northern grounds. High rates of about 2 t/hr continued both in 1992 and 1993. The CPUE data also were analyzed by multiple regression for year, month and vessel effects. The model, explaining 81% of the variation, showed that all class variables were significant ($P < 0.02$) and that the annual catch rates from 1988 to 1992 were all significantly lower than the 1993 rate ($P < 0.05$). Although the trend in the standardized series is somewhat similar to the raw data, the highest CPUE from the latter series occurred in 1991 rather than 1993.

Catch composition

Figure 9

Estimates of catch at length, based on observer sampling data, showed highly variable size distributions between years. High proportions of male shrimp less than 25 mm CL and overall lower catch rates in 1989 and 1990 reflect the fishing activity south of 60° N in those years. Large, female shrimp dominated in 1991 when effort shifted to the northern grounds. The strong component of males observed in the 1992 catches recruited further as larger males and small females in 1993, possibly explaining the increase in CPUE between the two years. A reduction in the proportion and number of males caught per hour in 1993 is evident from the commercial sampling data but it is uncertain what influence this will have on recruitment in 1994. The female component, on the other hand, continued to support a high CPUE in 1993, indicating that a healthy spawning biomass is being maintained.

Resource status and prospects

The area is characterized by both variable catch rates and size compositions which reflect, to some extent, the grounds fished each year. If the high CPUE and large sizes attained in recent years continue in the north, it is likely that the enterprise allocations will be taken at low effort levels from that area alone, with little or no fishing south of 60° N. Fishermen have reported tows of less than a half hour producing several tonnes of shrimp and, not uncommonly, the daily production capacity for some vessels can be achieved in only a few hours of trawling.

The continuation of high catch rates of mostly large, female shrimp from the northern area in recent years indicates a healthy spawning stock and implies that the fishery is not significantly impacting the resource. The current TAC of about 2700 t appears to be overly restrictive to the fleet and an increase should be considered to determine if or how the resource responds to an increased annual exploitation. At recent catch rates, however, a marginal increase in TAC (e.g. 20%) would only represent two or three extra days of fishing per vessel and a more substantial increase is required to achieve a significant increase in the exploitation rate. Although there is no quantitative basis on which to advise a higher catch level, an experimental TAC of about 5000 t could be implemented. It is noted that the fleet fishes areas of highest density but, beyond that range, additional biomass of both small male and large female shrimp exists in shallower and deeper waters, respectively. In this management area, the option to return to the extensive grounds south of 60° N also exists.

ASSESSMENT OF SHRIMP IN NAFO DIVISION 0B

Figure 10 and Table 4

Catch and effort

The northern shrimp fishery in Division 0B also began in 1988. Tolerance of low catch rates in October and November was rewarded by high catches of large, valuable shrimp during December and resulted in a catch of about 2800 t for the year. Catches increased slightly to 3000 t in 1989 but subsequently declined to just over 100 t in 1993. Effort (both unstandardized and standardized) increased substantially from 1988 to 1989 but decreased thereafter to a token level in 1993. In 1988, the fishery occurred north of 64° N with occasional tows near 66° N. Effort shifted southward in 1989, concentrating between 64° and 65° N but extending as far south as 61° 30' N. Proportionately more effort was expended south of 64° N during the 1990 - 1993 period.

Catch per unit effort (CPUE)

Unstandardized annual CPUE decreased from 585 kg/hr in 1988 to 271 kg/hr in 1989 and increased to 497 kg/hr in 1990. Since then, catch rates have dropped to the 200 - 300 kg/hr range. The data were analyzed by multiple regression for year, month and vessel effects. The model explained 40% of the variation and showed that only year and vessel were significant ($P < 0.03$) class variables. Annual catch rates from 1988 to 1991 were all significantly higher than the 1993 rate ($P < 0.05$), whereas the 1992 estimate was not ($P = 0.19$). Both series showed a general, declining trend.

Catch composition

Figure 11

Catches in most years were composed primarily of large, female shrimp with a modal length of 27 mm CL. The occurrence of higher proportions of the male component (< 25 mm) after 1988 was coincident with the southward shift in fishing effort. The sampling data showed that the occurrence of smaller/younger male shrimp (< 22 mm) declined from 1990 to 1993 and modal progression of males from 20 mm in 1990 to 24 mm in 1993 reflects the slow growth rate of shrimp in this area.

Resource status and prospects

Fishermen report that the area is difficult to fish due to the presence of ice and the apparent sudden shifts in water masses that they believe affect shrimp distribution. Concentrations are difficult to locate and when they are found, tend to be short-lived. This contrasts to the situation farther south where known areas of high concentrations support substantial levels of effort, yet persist from year to year.

The status of this resource remains uncertain. The CPUE is not a reliable index of abundance for the area and the recent declines in both catch and catch rates are more likely a reflection of the difficulty in locating high concentrations of shrimp rather than indicators of a declining resource. The possibility of reduced recruitment in recent years exists but the commercial sampling data might not be representative of overall stock conditions, especially in 1993 when fishing effort was minimal. Occasional high catch rates still occur within the division but the fishing success achieved in December, 1988 has not been repeated. Due to the uncertainty about the status of this resource, there is no basis on which to advise a change in the TAC of 3500 t, established in 1989 as a precautionary level in an exploratory area.

GULF OF ST. LAWRENCE SHRIMP STATUS**DESCRIPTION OF THE FISHERY****Tables 5 and 6, Figure 12**

Northern shrimp landings in the Gulf of St. Lawrence have gradually increased since the start of harvesting in the mid-1960s. However, the fishery has developed differently depending on the sectors or fleets harvesting the shrimp. The Quebec fleet harvests primarily in the western Gulf, while the Newfoundland west coast fleet concentrates its activities in the Esquiman Channel. The New Brunswick fleet divides its activities between the western and eastern Gulf. A reorganization of the management units was proposed in 1992 in order to more accurately reflect the fishermen's activities and the geographical distribution of the shrimp. Four management units were established in 1993: Sept-Îles (Area 10), Anticosti (Area 9), Esquiman (Area 8) and Estuary (Area 12).

A multi-year (three-year) management plan for the shrimp fishery was adopted in early 1993. This management plan comprises a number of measures including controlling catches by TAC for the four management units. Licence holders from Quebec and New Brunswick have had individual quotas since 1991, while those from the Lower North Shore and the west coast of Newfoundland fish under a competitive system. The other management measures include the imposition of a minimum mesh size (40 mm) and mandatory installation of a device on the trawl which significantly reduces by-catches of groundfish.

In general, the fishermen reported that they were satisfied with their 1993 fishing season. The fishermen from the Lower North Shore and the west coast of Newfoundland quickly caught their quota in the Esquiman area. The effort expended by fishermen from the west coast of Newfoundland largely depends on the intensity of their groundfish activities and often varies from year to year. The Gulf fishermen harvest the same sectors year after year and the effort expended in 1993 followed the general pattern observed since 1982. However, it should be pointed out that in 1992 and 1993, there was little harvesting in the section of the territory northwest of Anticosti Island in the Sept-Îles area.

ASSESSMENT OF SHRIMP IN THE GULF OF ST. LAWRENCE**Catch and effort****Table 5, Figure 13**

The data for the 1992 fishing season indicated that landings in the Gulf fell 22% between 1991 and 1992, while preliminary data for the 1993 season indicate that landings increased 22% between 1992 and 1993. Landings in 1993 were therefore similar to those of 1989, 1990 and 1991. Landings in 1993 in the Sept-Îles, Anticosti and Esquiman areas rose by 11%, 15% and 49% respectively between 1992 and 1993, while landings in the Estuary area were at levels similar to those observed since 1990.

In general, catches depend on the effort expended. Catches increase when the effort increases. However, since the fishery is managed by quotas, actual effort in any one year will depend upon the catch rate and thus how soon the quota is caught. Effort levels in the last few years were higher than during the first half of the 1980s.

Catch per unit of effort (CPUE)**Figure 13**

A model was applied to catch and effort data to standardize the annual catch rates in each management unit based on certain parameters (the length and power of the vessels, in order to take into account changes in fishing power; the month, in order to take into account changes in the seasonal pattern of operations; and the

year). Since data from the logbooks of Newfoundland fishermen for the 1993 season were not available, only data from the New Brunswick fleet were used in analyses of the Esquiman Channel for 1993.

In the western Gulf, CPUE remained relatively stable from 1982 to 1989. They increased to very high levels in 1990 and 1991, then decreased in 1992. For the Estuary area, the 1993 level was higher than the 1992 level, while for the Sept-Îles area, the 1993 level was similar to that for 1992 and for the 1982-89 period. In the eastern Gulf, catches per unit of effort were variable from 1982 to 1987. They rose to very high levels during the 1988-91 period, then fell in 1992. In the Anticosti area, the 1993 level was similar to the 1992 level, while for the Esquiman Channel area, the figure was lower. In both instances, the 1993 CPUE was still higher than the CPUE for the 1982-87 period.

Catch composition

Figure 14

Data from samples of commercial catches are combined by area and by month and then weighted by the month's landing to obtain the numbers at length using a length-weight relationship. The numbers per unit of effort (NPUE) are then obtained by dividing the annual numbers at length by the standardized annual fishing effort. The numbers per unit of fishing effort of shrimp with a carapace length (CL) of less than 16 mm in the Anticosti area and of less than 17 mm in the Sept-Îles and Esquiman areas (pre-recruits) are considered indicators of the abundance of shrimp exceeding 23 mm (CL) (recruits) in the commercial fishery two or three years later. These shrimp are then fully recruited to the fishery and are targeted by fishermen. At this size, most of the shrimp are females. The size of the cohorts is estimated by comparing the numbers for a given year with the average observed since 1982.

For the Sept-Îles area, the NPUE of pre-recruits in 1986, 1987 and 1988 was above the average for the 1982-93 period. It dropped to below average in 1989 and 1990. The NPUE of recruits followed the same trends but with a three-year lag. It was above average in 1989, 1990 and 1991, but below average in 1992 and 1993. The NPUE of pre-recruits rose again in 1991 and 1992, reaching an above-average level, before dipping to slightly below average in 1993.

The relationship between the NPUE of pre-recruits and recruits is less evident in the Anticosti area. The NPUE of pre-recruits was above average from 1986 to 1989 and then fell below average from 1990 to 1992. The NPUE of recruits remained above average from 1988 to 1993. The NPUE of pre-recruits rose again in 1993 but was still below average.

For the Esquiman Channel, the NPUE of pre-recruits was above average in 1987, 1988 and 1989, falling below average in 1990. The NPUE of recruits remained above average from 1989 to 1992 and then dropped in 1993 to a value close to the average. The NPUE of pre-recruits rose to above average in 1991, 1992 and 1993.

Abundance surveys

Table 7

A bottom trawling research survey has been conducted every summer (August-September) since 1990 in the estuary and northern section of the Gulf of St. Lawrence. The trawl used is a shrimp trawl and fishing operations are conducted according to a stratified random sampling pattern. Biomass estimates are produced using a swept area method as well as a geostatistical method, kriging, which also makes it possible to map the distribution of the resource.

The spring biomass (the autumn biomass estimated at the time of the survey plus commercial catches up to the time of the survey) was relatively stable between 1990 and 1991 for the Sept-Îles and Esquiman Channel areas, but decreased 35% to 40% in 1992-93. The spring biomass varied from year to year for the Anticosti and Estuary areas. The biomass of the entire Gulf (the four fishing areas) declined by one third between 1990-91 and 1992-93. It was observed that the biomass was concentrated in the more northerly sections in 1990

and 1991, but these sections had the lowest stocks after 1991, especially in the Sept-Îles area.

Shrimp are, first of all, distributed preferentially by depth, with the youngest at shallow depths and the oldest at the deepest depths. Every year, the shrimp are distributed across the full range of temperatures (between 2° and 5°C) and there is no indication of possible avoidance of certain temperatures. A preferential distribution of pre-recruits was observed for the colder temperatures, which are characteristic of the shallower areas. Furthermore, the distribution of shrimp larger than 18 mm (CL) roughly parallels the temperature distribution, with the younger individuals being slightly more concentrated in the intermediate temperatures while the older individuals appear to be somewhat less well represented in the coldest temperatures.

Resource status and prospects

Abundance indices, CPUE and biomass estimated by trawling all show similar variations. CPUE increased between the first half of the 1980s and the latter part of the decade and in the early 1990s, before decreasing in 1992-93. Generally, for the entire Gulf, the spring biomass decreased between 1990-91 and 1992-93. The abundance of shrimp in the Gulf thus apparently increased between the first half and the end of the 1980s, remained high at the start of the 1990s and then decreased in 1992, stabilizing in 1993.

Since fishermen target large shrimp in particular, their catch rates are dependent on the abundance of shrimp with a carapace length of more than 23 mm. These shrimp, the majority of which are female, are also responsible for the biomass fluctuations for each unit. When several above-average sized cohorts successively enter the fishery, the abundance and biomass of the population will increase substantially, thereby affecting catch rates. The increase in biomass and abundance in the late 1980s was the result of several very large cohorts produced in the mid-1980s. The abundance of shrimp smaller than 16-17 mm (CL) was higher than average during the 1986-89 period. These shrimp reached the sizes targeted by fishermen in 1989, 1990 and 1991 and were responsible for the increase in catch rates during those years. The decrease in biomass and catch rates observed in 1992 and 1993 was due to the fact that the cohorts produced during the second half of the 1980s were smaller. In fact, the abundance of shrimp smaller than 16-17 mm (CL) decreased in 1989-90-91 and this is reflected in the decrease in shrimp catches in 1992 and 1993.

In the next few years, the fishery will be harvesting the cohorts of shrimp that were smaller than 16-17 mm (CL) in 1991, 1992 and 1993. In the Sept-Îles and Esquiman areas, the abundance of this category of shrimp increased between 1990 and 1992-93. In the Anticosti area, the abundance of these shrimp varied between 1990 and 1993. If the relationship observed between the abundance of shrimp smaller than 16-17 mm (CL) and that of shrimp larger than 23 mm (CL) continues in the future, shrimp larger than 23 mm (CL) will likely become more abundant over the next two or three years in the Sept-Îles and Esquiman areas. Since the success of the fishery depends on the abundance of shrimp larger than 23 mm (CL), catch rates will likely fluctuate in the same manner during the next few years.

SCOTIAN SHELF SHRIMP STATUS

DESCRIPTION OF THE FISHERY

The shrimp fishery on the Scotian Shelf is pursued by vessels < 65' LOA from the Scotia-Fundy Region (9 limited entry and 14 exploratory licences) and by six vessels between 65 and 100' LOA from the Gulf Region. The TAC is split between the two vessel categories - 75%, < 65' and 25%, 65-100' LOA. In 1993, the TAC was taken in the main shrimp fishing areas, SFA 14 and 15, for the second consecutive year and the fishery was closed in June. Effort and catches in 1993 also increased substantially in SFA 13, an area believed to produce smaller shrimp and, therefore, not exploited to the same extent as the other areas.

The resurgence of the fishery in recent years is due to the Nordmore grate which was introduced in 1991 to minimize groundfish by-catch. The technology proved effective and is now mandatory for all vessels fishing shrimp on the Scotian Shelf.

DEFINITION OF ASSESSMENT AND MANAGEMENT UNITS

Figure 15

The area was initially divided into three management areas which corresponded to depressions in the Shelf where shrimp fishing occurred, known as the Canso, Misaine and Louisbourg holes. In the Louisbourg Hole, allocations of groundfish also had been provided for Gulf-based vessels prior to the start of the shrimp fishery in the late 1970s.

It has been shown in other areas within the distribution range that the species is capable of dispersion over large areas. Commercial logbook data, earlier survey work and by-catch in groundfish trawls show that the shrimp resource on the Scotian Shelf extends well beyond the boundaries of the deep holes where the commercial concentrations are found, and the present management areas probably do not correspond to separate biological units.

One TAC for the whole area might result in increased exploitation in areas 14 and 15 if the distribution of effort remains similar to that of 1992 and 1993. This, however, would probably not be a biological problem in the context of overall stock status.

ASSESSMENT OF SHRIMP ON THE SCOTIAN SHELF

Figure 16 and Table 8

Catch and effort

The fishery began in 1977 when 269 t were taken and increased to 984 t in 1980. TACs were implemented for each area in 1980 but have not been achieved until recently. Catches declined from about 1,000 t in 1983 and 1984 to less than 200 t during the 1985-1990 period, when effort was very low, but they have since increased to over 2,000 t with the introduction of the Nordmore grate. Prior to 1991, the fishery occurred primarily in the Louisbourg Hole (SFA 13) but since then has been concentrated in the Misaine and Canso holes (SFA 14 and 15).

Catch per unit of effort (CPUE)

There are few vessels in this fishery with several years of fishing experience, making it difficult to construct a CPUE index which is representative of changes in abundance. The index used is based on correction factors to convert catch rates for the various types of trawls to that of a standard, a Western 2A.

The standardized index, based only on Gulf Region vessels, (correction factors are not available for Scotia-Fundy vessels) shows a slight increase from 1992 to 1993 but, overall, appears stable for the 1989 to 1993 period. Some caution is necessary in interpreting the catch rate series, as changes in gear composition in the fleet suggest that neither the standardized nor unstandardized catch rate data are directly comparable over the complete time series.

Monitoring survey

Table 9, Figure 17

With renewed interest in, and exploitation of the shrimp resource on the Scotian Shelf, an industry-sponsored survey was carried out in 1993 using two commercial vessels, one conducting a survey in Louisbourg Hole (July 23-24), and the other in Misaine (Aug 17-19) and Canso (Sept 1-2) holes. All stations were surveyed during daylight hours.

In keeping with the design used in previous research surveys, ten random stations were allocated within the 100 fathom contour for Canso and Louisbourg holes. Also, the Misaine stations were the same ten sampled systematically in previous years. Biomass estimates were calculated by areal expansion of the catch per standard tow and samples from each station were analyzed for length and sex composition.

Problems with fishing gear and weather were encountered during both surveys and adjustments for towing time and wing spread were required to make the results obtained from each of the two vessels comparable. Catches were adjusted to a standard tow length of 1.25 nautical miles and the area swept was calculated from this distance and the estimated wing spread. The area of each hole, as defined by the 100 fathom contour, has been calculated as, 276.4, 472.2 and 442.2 square nautical miles for Canso, Louisbourg and Misaine, respectively.

The results obtained from areal expansion showed that, in both Canso and Misaine holes, the estimated biomass was similar to the average of the 1988 spring and fall estimates whereas, in Louisbourg Hole, it was higher. The 1993 estimates may not be comparable with previous survey results due to major changes in gear, vessel and season.

The length frequency distributions by sex obtained from the 1993 survey are compared to those obtained from the 1988 survey. There appears to be a slight increase in the modal length for males and females in 1993. This is consistent with observations from fishermen and processors who reported an increase in the size of the shrimp in the catches over the last few years. Size distributions for the three areas show that similar modal structures and sex ratios exist in all three areas.

Resource status and prospects

With the introduction of the Nordmore grate and the decline in groundfish by-catch, this fishery has attracted more interest and TACs in Canso and Misaine holes in 1992 and 1993 have been reached. The annual CPUE data indicate a stable biomass as do the research survey results although both series are limited in their

usefulness as indices of abundance. Fishermen and processors say that the catches in recent years are composed of larger shrimp and the survey length frequency data from 1988 and 1993 support this view.

TACs for shrimp in eastern Canadian waters are currently based on the evaluation of recent catch levels with adjustments made, when appropriate, for apparent increases or decreases in the stock. The Scotian Shelf shrimp fishery, however, does not have a history on which to revise catch levels by this method. Past sampling over the Shelf area, current shrimp fishing patterns and the occurrence of shrimp as by-catch in groundfish surveys show that shrimp are distributed well beyond the 100 fathom holes where the highest concentrations are found.

Based on the available information, the resource appears healthy and the recent level of exploitation does not appear to have negatively affected the resource. In other areas under similar circumstances, TACs were cautiously increased to test the effects of increased fishing on the resource. Should the TAC be increased, it should be by no more than 20% and the increase should apply for a multi-year period during which the stock status should be monitored closely. A commercial sampling program should be initiated to ensure an adequate data base for future assessments.

Table 1. Hawke Channel, Division 3 K and exploratory areas fishery data from 1977 to 1993.

YEAR	TAC ¹ (t)	CATCH ² (t)	UNSTANDARDIZED			STANDARDIZED		
			CPUE (KG/H)	INDEX	EFFORT ³ (H)	CPUE (KG/H)	INDEX	EFFORT ³ (H)
1977	-	1	117		6			
1978	800	0						
1979	1750	5	189		29			
1980	850	0						
1981	850	135	207		652			
1982	850	< 1	151		3			
1983	850	0						
1984	850	0						
1985	850	0						
1986	2050	0						
1987	3000	1845	333		5541			
1988	3000	7849	536	1.00	14644	760	1.00	10328
1989	5600	6662	432	0.81	15421	646	0.85	10313
1990	5600	5598	507	0.95	11041	771	1.01	7261
1991	4301	5500	603	1.13	9121	853	1.12	6448
1992	7565	6609	774	1.44	8539	1583	2.08	4175
1993	9180	7896	905	1.69	8725	1932	2.54	4087

¹ Historical TACs were applied as follows:

1978 to 1985 - Hawke Channel only;

1986 to 1988 - Hawke Channel plus St. Anthony Basin;

1989 to 1991 - Hawke Channel, St. Anthony Basin, east St. Anthony and Funk Island Deep;

1992 and 1993 - include the above as well as 1700 and 3400 t exploratory quota, respectively.

TACs from 1987 to 1990, inclusive, are for the fishing season May 1 to April 30, making 1986 a 16 month year (January 1, 1986 to April 30, 1987) and 1991 an 8 month year (May 1, 1991 to December 31, 1991).

² Catch corresponds to the estimated catch for the calendar year (annual landing statistics prorated by month from vessel log records). The 1993 catch is provisional to November 3.

³ Effort calculated from catch/CPUE. CPUE calculated from vessel log data.

Table 2. Northern shrimp fishery data for Hopedale and Cartwright channels, 1977-93.

YEAR	TAC ¹ (t)	CATCH ² (t)	CPUE (KG/HR)	UNSTANDARDIZED ³		CPUE (KG/HR)	STANDARDIZED ³	
				INDEX	EFFORT (HR)		INDEX	EFFORT (HR)
1977		2686	552	1	4866	764	1	3516
1978	5300	3630	453	0.82	8013	765	1	4745
1979	4000	3727	368	0.67	10128	621	0.81	6002
1980	4800	4108	388	0.7	10588	448	0.59	9170
1981	4800	3449	364	0.66	9475	446	0.58	7733
1982	4800	1983	372	0.67	5331	398	0.52	4982
1983	4800	1000	297	0.54	3367	289	0.38	3460
1984	4200	1002	297	0.54	3374	348	0.46	2879
1985	3570	1689	230	0.42	7343	349	0.46	4840
1986	4400	4826	538	0.97	8970	606	0.79	7964
1987	4800	5956	613	1.11	9716	592	0.77	10061
1988	4800	7838	625	1.13	12541	633	0.83	12382
1989	6000	5985	677	1.23	8840	634	0.83	9440
1990	6000	5360	626	1.13	8562	608	0.8	8816
1991	6375	6118	526	0.95	11631	637	0.83	9604
1992	6375	6315	695	1.26	9086	617	0.81	10235
1993	6375	5718	653	1.18	8757	686	0.9	8335

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-DECEMBER 31).

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

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

Table 3. Northern shrimp fishery data from Div. 2G, 1979-1993.

YEAR	TAC ¹ (t)	CATCH ² (t)	CPUE (KG/HR)	UNSTANDARDIZED ³		STANDARDIZED ³		
				INDEX	EFFORT (HR)	CPUE (KG/HR)	INDEX	EFFORT (HR)
1979	500	3	823		4			
1980	500	<1	6		8			
1981	500	2	381		5			
1982	500	5	252		20			
1983	500	30	441		68			
1986	500	2	450		4			
1987	500	7	303		23			
1988	500	1083	1823	1	594	1812	1	598
1989	2580	3842	672	0.37	5717	890	0.49	4317
1990	2580	2945	703	0.39	4189	1463	0.81	2013
1991	2635	2561	3078	1.69	832	2440	1.35	1050
1992	2635	2706	1910	1.05	1417	1676	0.92	1615
1993	2735	2716	2352	1.29	1155	4274	2.36	635

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-DECEMBER 31).

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

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

Table 4. Northern shrimp fishery data from Div. OB, 1988-93.

YEAR	TAC ¹ (t)	CATCH ² (t)	UNSTANDARDIZED			STANDARDIZED		
			CPUE (KG/HR)	INDEX	EFFORT ³ (HR)	CPUE (KG/HR)	INDEX	EFFORT ³ (HR)
1988		2826	585	1	4831	354	1	7983
1989	3500	3039	271	0.46	11214	202	0.57	15045
1990	3500	1609	497	0.85	3237	275	0.78	5851
1991	3485	1107	242	0.41	4574	263	0.74	4209
1992	3485	1291	315	0.54	4098	145	0.41	8903
1993	3485	106	209	0.36	507	87	0.25	1218

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-DECEMBER 31).

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

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

Table 5. Landings (t) of shrimp (*Pandalus borealis*) in the Estuary and the Gulf of St. Lawrence by year, by fleet, and by management unit.

Year	Sept-Iles			South Anticosti			North Anticosti			Esquiman				Estuary			Gulf
	Qc	NB	Total	Qc	NB	Total	Qc	NB	Total	Qc	NB	NFLD	Total	Qc	NB	Total	
1965	11	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	11
1966	95	-	95	-	-	-	-	-	-	-	-	-	-	-	-	-	95
1967	278	-	278	-	-	-	-	-	-	-	-	-	-	-	-	-	278
1968	271	-	271	-	-	-	-	-	-	-	-	-	-	-	-	-	271
1969	273	-	273	-	-	-	-	-	-	-	-	-	-	-	-	-	273
1970	413	-	413	-	-	-	-	-	-	-	-	-	159	-	-	-	572
1971	393	-	393	-	-	-	-	-	-	-	-	-	691	-	-	-	1084
1972	481	-	481	-	-	-	-	-	-	-	-	-	184	-	-	-	665
1973	1273	-	1273	-	-	-	-	-	-	-	-	-	520	-	-	-	1793
1974	1743	-	1743	-	-	-	-	-	980	-	-	-	594	-	-	-	3317
1975	2135	-	2135	-	-	-	-	-	1025	-	-	-	1368	-	-	-	4528
1976	1841	-	1841	-	-	-	-	-	1310	-	-	-	1494	-	-	-	4645
1977	2746	-	2746	-	-	-	-	-	1185	-	-	-	1249	-	-	-	5180
1978	2470	-	2470	56	-	56	-	-	1460	-	-	-	2166	-	-	-	6152
1979	3195	-	3195	12	-	12	-	-	1108	-	-	-	3226	-	-	-	7541
1980	2921	-	2921	57	-	57	-	-	1454	-	-	-	2441	-	-	539	7412
1981	3326	-	3326	337	17	354	-	-	1385	-	-	-	3014	-	-	27	8106
1982	3562	33	3595	99	80	179	1610	854	2464	-	313	1798	2111	152	-	152	8501
1983	3356	23	3379	192	76	268	2131	794	2925	19	262	1961	2242	158	-	158	8972
1984	3634	85	3719	528	136	664	720	616	1336	8	61	1509	1578	248	-	248	7545
1985	3904	124	4028	335	36	371	1673	1113	2786	9	134	1278	1421	164	-	164	8770
1986	3625	282	3907	254	55	309	2072	1268	3340	23	140	1429	1592	261	1	262	9410
1987	4576	316	4892	338	181	519	1913	1509	3422	38	432	2215	2685	523	-	523	12041
1988	4800	343	5143	542	362	904	1902	942	2844	120	912	3303	4335	551	-	551	13777
1989	5070	353	5423	584	247	831	3424	829	4253	144	1661	2809	4614	629	-	629	15750
1990	5204	552	5756	547	536	1083	3078	1645	4723	207	968	2128	3303	489	18	507	15372
1991	5249	466	5715	438	258	696	2956	1634	4590	197	1112	3464	4773	505	-	505	16279
1992	4014	241	4255	445	257	702	2942	1220	4162	33	1048	2068	3149	489	-	489	12757
	Sept-Iles			Anticosti			Esquiman				Estuary			Gulf			
	Qc	NB	Total	Qc	NB	Total	Qc	NB	NFLD	Total	Qc	NB	Total				
1993*	5327	163	5490	3608	1184	4792	47	1016	3620	4683	496	-	496	15461			

*Preliminary data to December 31, 1993

Table 6. Total allowable catches by fishing area since 1982.

Year	Sept-Iles	South Anticosti	North Anticosti	Esquiman	Estuary	Total
1982	3300	500	4400	4200	500	12900
1983	3300	500	5000	6000	500	15300
1984	3800	1000	5000	6000	500	16300
1985	3900	700	3400	6000	500	14500
1986	3900	700	3500	3500	500	12100
1987	4900	700	3500	3500	500	13100
1988	4900	700	3500	3500	500	13100
1989	5000	700	4200	4500	500	14900
1990	5700	700	4200	4700	500	15800
1991	5700	700	5000	4700	500	16600
1992	5700	700	5000	4700	500	16600
	Sept-Iles		Anticosti	Esquiman	Estuary	Total
1993	6400		5000	4700	500	16600

Table 7. Autumn and spring biomass (t) by fishing area based on research surveys conducted since 1990.

Autumn biomass: biomass at the time of the survey

Spring biomass: biomass at the time of the survey plus commercial catches during the season up to the time of the survey

	1990	1991	1992	1993
SEPT-ÎLES				
BIOMASS ESTIMATE USING SWEEPED AREA METHOD:				
Autumn biomass	31,171 (\pm 18 897)	27,107 (\pm 12 090)	16,447 (\pm 5,995)	17,399 (\pm 5,855)
Commercial catches	5,937	5,378	3,606	4,033
Spring biomass	37,108	32,485	20,053	21,432
BIOMASS ESTIMATE USING KRIGING:				
Autumn biomass	26,429	34,677	19,705	20,272
ANTICOSTI				
BIOMASS ESTIMATE USING SWEEPED AREA METHOD:				
Autumn biomass	16,520 (\pm 4,727)	11,716 (\pm 2 193)	13,136 (\pm 3,135)	9,722 (\pm 4,282)
Commercial catches	4,260	3,674	3,916	4,606
Spring biomass	20,780	15,380	17,052	14,328
BIOMASS ESTIMATE USING KRIGING:				
Autumn biomass	18,374	14,876	17,738	11,506
ESQUIMAN				
BIOMASS ESTIMATE USING SWEEPED AREA METHOD:				
Fall biomass	15,066 (\pm 6,828)	13,497 (\pm 6,080)	8,539 (\pm 3,137)	5,427 (\pm 1,852)
Commercial catches	3,118	4,599	3,121	4,613
Spring biomass	18,184	18,546	11,660	10,040
BIOMASS ESTIMATE USING KRIGING:				
Autumn biomass	14,257	15,765	7,791	7,430
ESTUARY				
BIOMASS ESTIMATE USING SWEEPED AREA METHOD:				
Autumn biomass	1,651 (\pm 1,284)	2,924 (\pm 5,722)	1,742 (\pm 2,557)	1,398 (\pm 2,472)
Commercial catches	507	505	462	410
Spring biomass	2,158	3,429	2,204	1,808
BIOMASS ESTIMATE USING KRIGING:				
Autumn biomass	2,338	1,009	2,676	279

Table 8. Scotian Shelf shrimp fishery data from 1977 to 1993.

YEAR	TAC (T)			TAC TOTAL	CATCH (T)			CATCH TOTAL	CPUE (KG/H) ¹	
	SHRIMP FISHING AREA				SHRIMP FISHING AREA				UNSTD	STD
	13	14	15		13	14	15			
1977								269	128.5	104.5
1978								306	121.9	97.3
1979					295	8	534	838	174.6	128.0
1980	1553	2382	1086	5021	491	133	360	984	130.9	87.3
1981					418	26	10	454	131.8	92.8
1982	1400	1800	1000	4200	316	52	201	569	128.0	80.4
1983	2000	2400	1400	5800	483	15	512	1010	127.7	81.2
1984	1800	2500	1400	5700	600	10	318	928	109.5	77.6
1985	1790	2420	1350	5560	118		15	133	75.4	40.7
1986	1460	1600	740	3800	126			126	87.3	58.1
1987	1070	860	210	2140	148	4		152	90.7	39.9
1988	1160	1050	370	2580	75	6	1	82	85.1	51.0
1989	1060	1050	370	2580	91	2		93	133.4	44.4
1990	1060	1050	370	2580	90	14		104	134.5	44.9
1991	1060	1050	370	2580	81	586	140	804	197.9	45.6
1992	1060	1050	370	2580	62	1168	599	1829	176.3	43.8
1993 ²	1060	1050	370	2580	431	1279	317	2044	193.0	47.0

¹ CPUE from Gulf based vessels² Preliminary

Table 9. Biomass estimates for Scotian Shelf from spring and fall surveys from 1982 to 1993.

YEAR	SHRIMP FISHING AREA						TOTAL MEAN (t)
	LOUISBOURG (SFA 13)		MISAINÉ (SFA 14)		CANSO (SFA 15)		
	SPRING (t)	FALL (t)	SPRING (t)	FALL (t)	SPRING (t)	FALL (t)	
1982	3944	13611	5793	6153	4411	8496	10230
1983	7159	8375	10743		8894	5244	22940
1984	6882	3637	7169	5658	4758	1578	11920
1985	1244	4595	2384	3157	1138	940	5260
1986	5561	1953	3938	1700	341	585	6980
1987	1972	3752	2429	4007	1248	2082	7550
1988	2288	3628	3258	5667	2306	3218	10180
1993		5021		4442		3070	12533

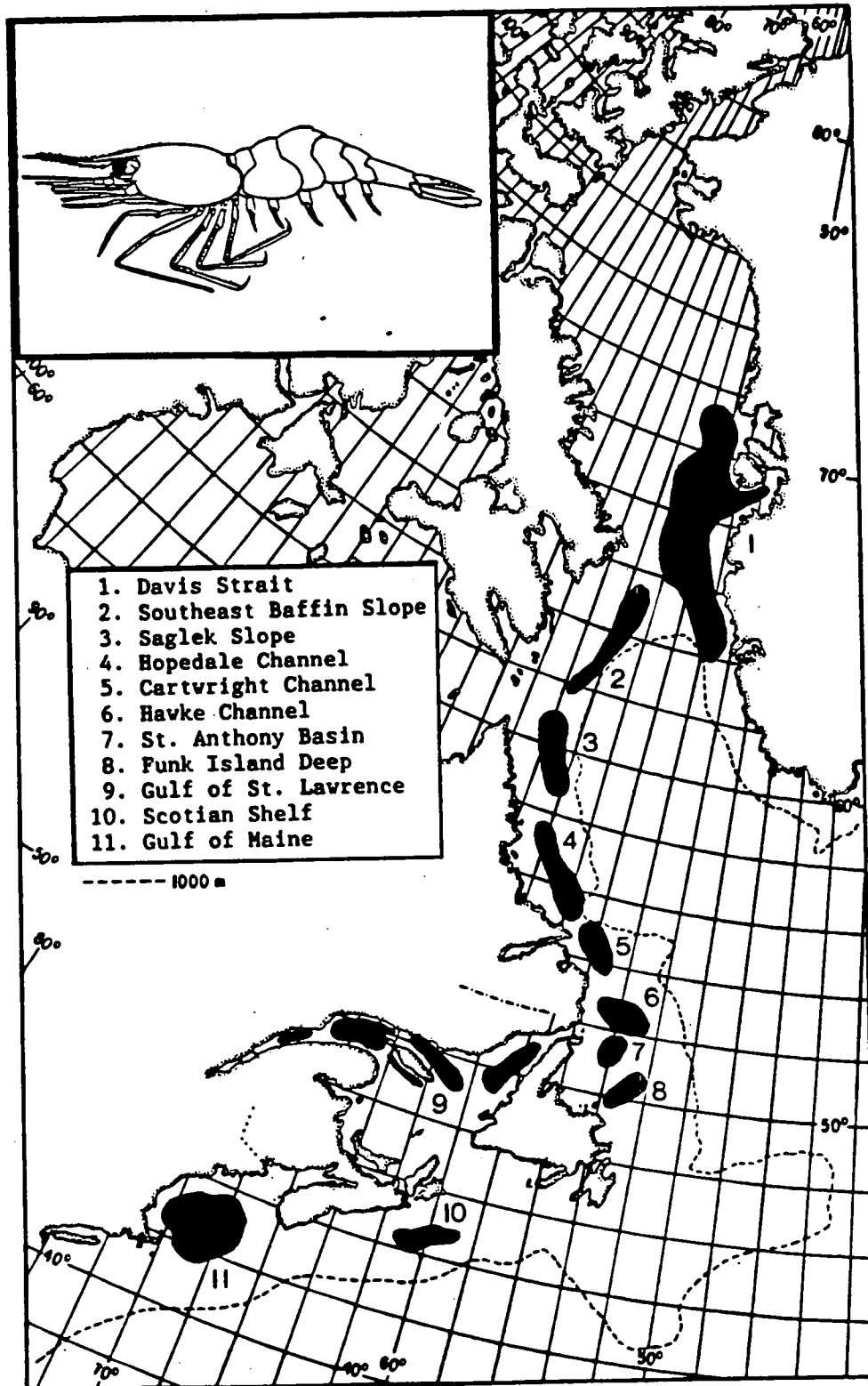


Figure 1. Shrimp fishery locations along the Atlantic Coast.

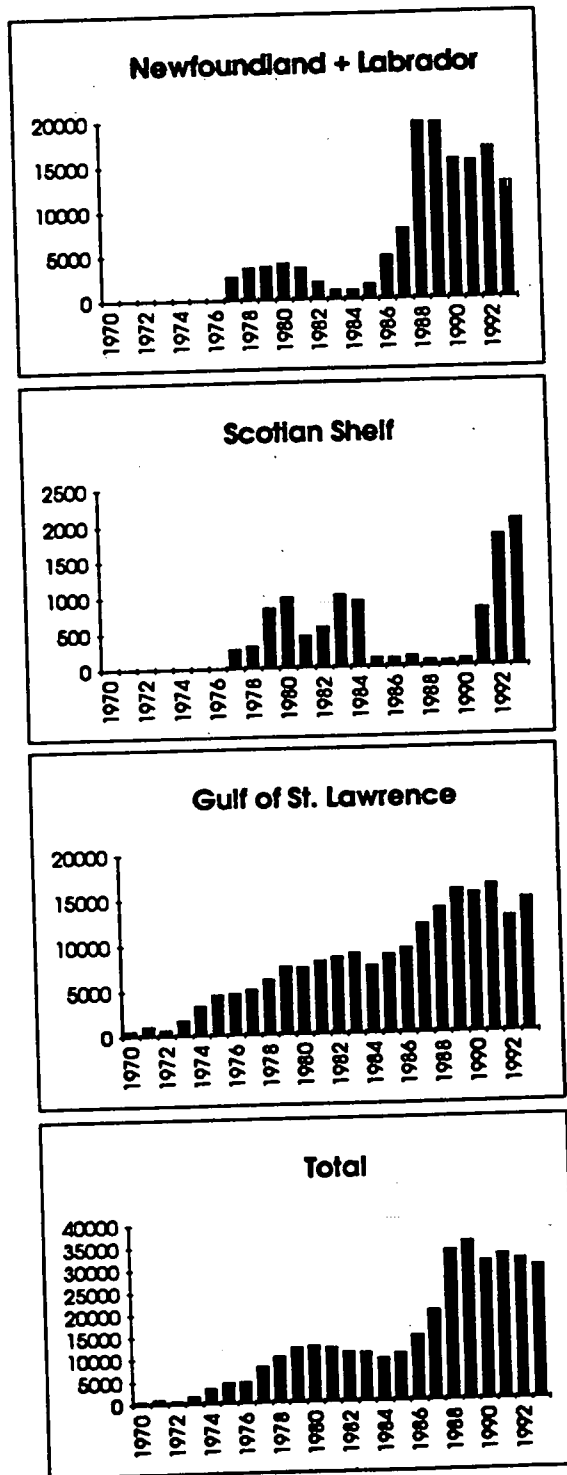


Figure 2. Shrimp landings for the Labrador and Newfoundland, Gulf of St. Lawrence and Scotian Shelf fisheries since 1970.

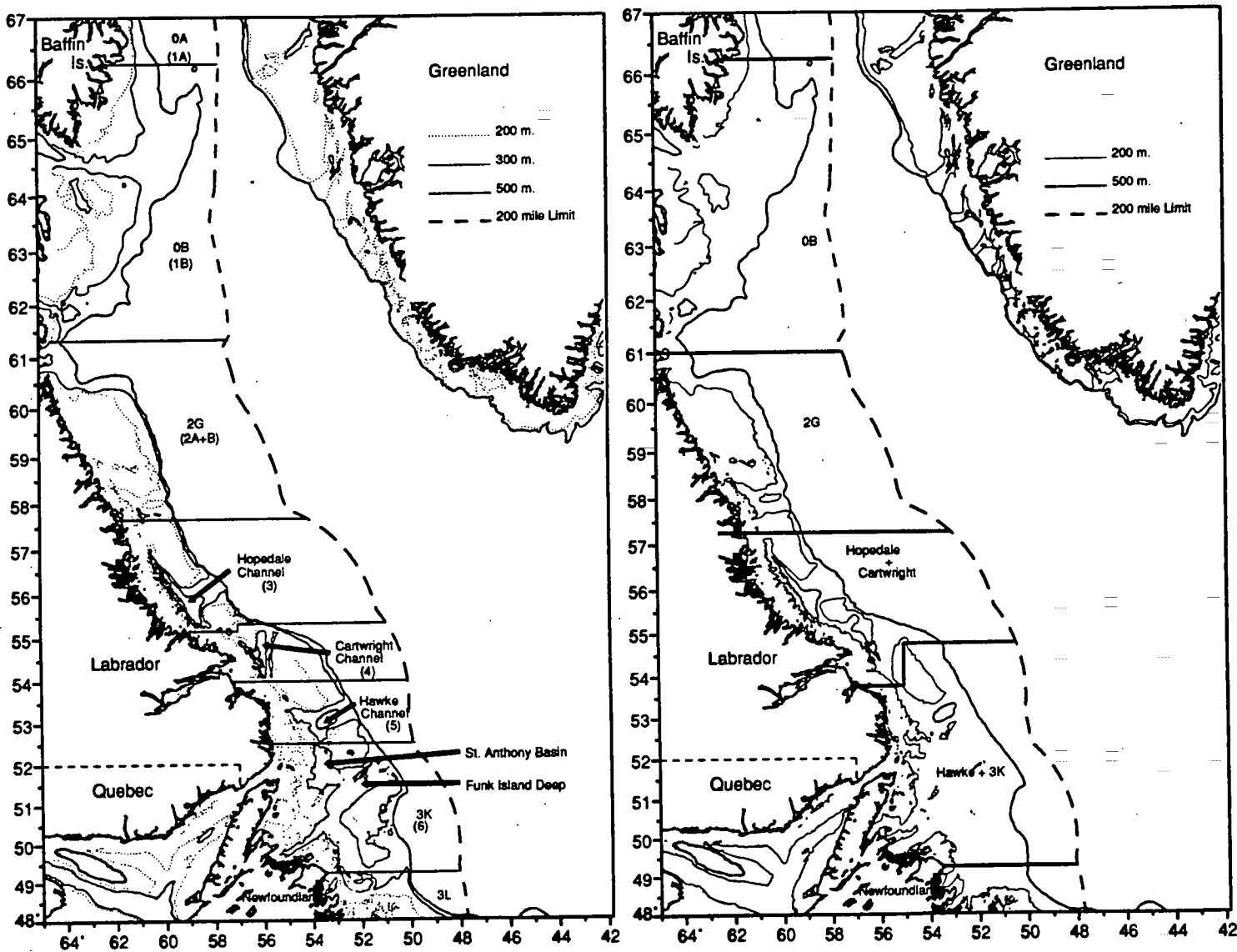


Figure 3. Existing (left) and proposed (right) northern shrimp management units in the Canadian northwest Atlantic.

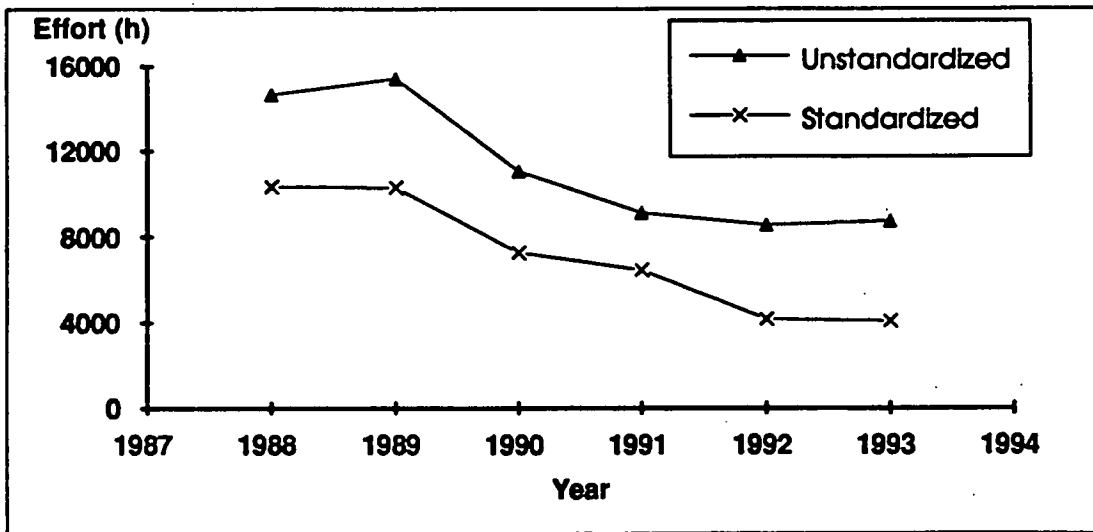
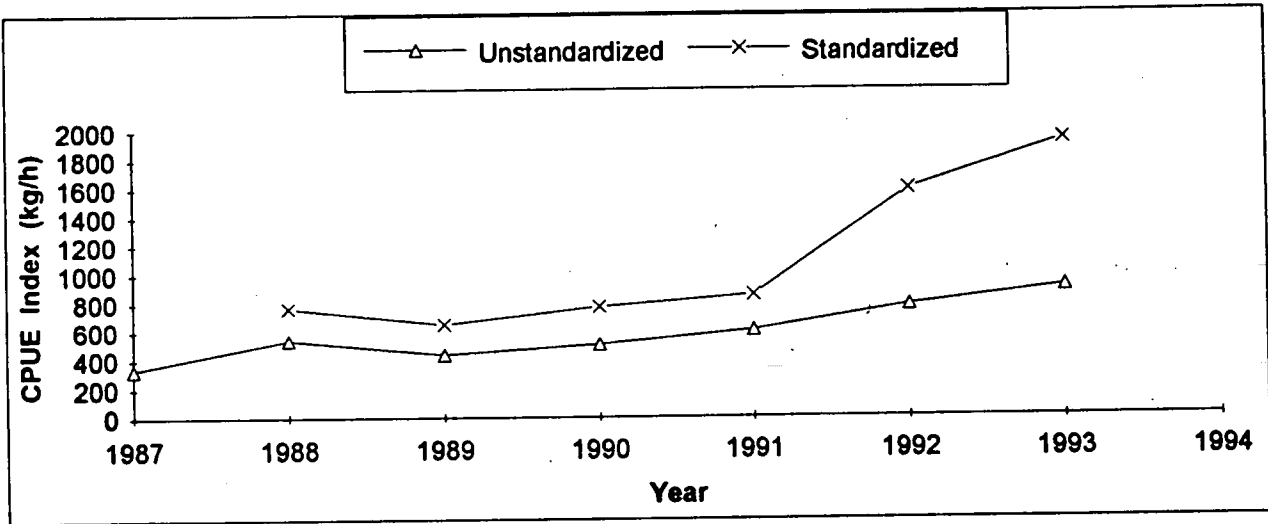


Figure 4. Effort and catch per unit of effort index for the Hawke Channel - Division 3 K northern shrimp fishery.

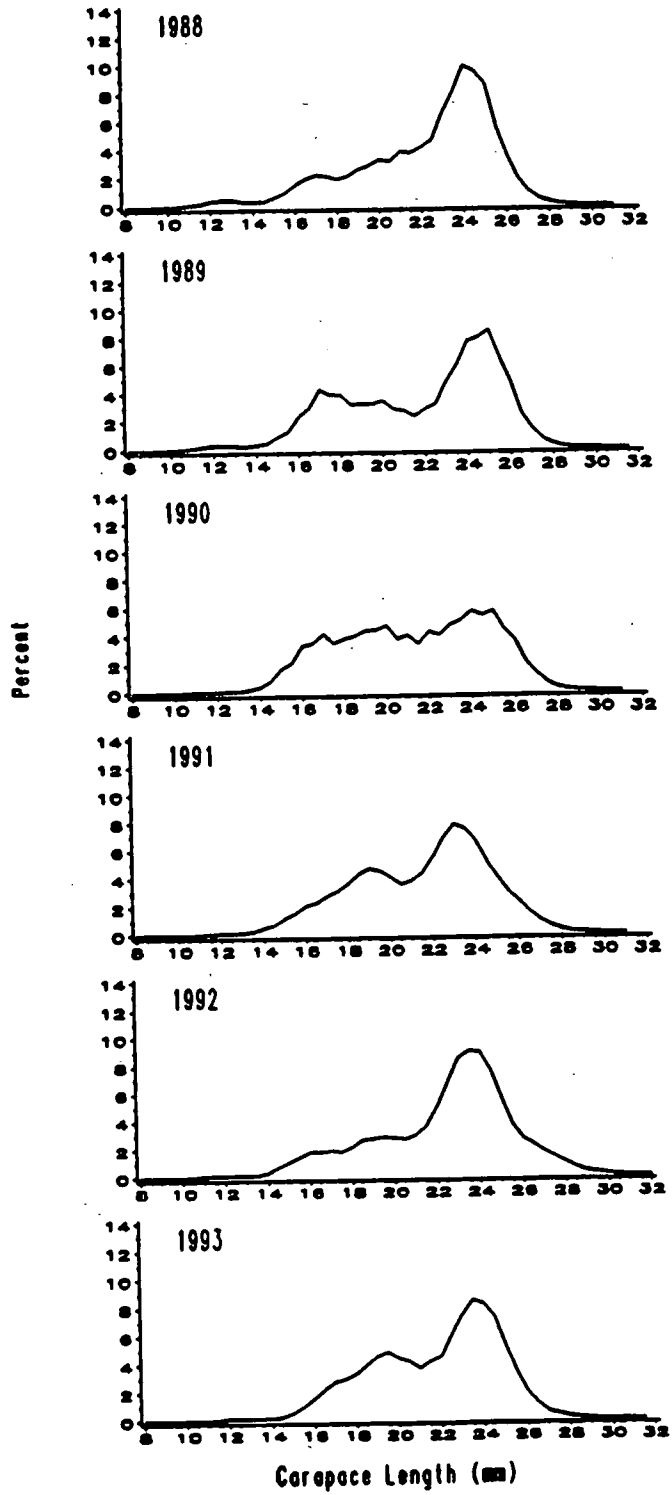


Figure 5. Length frequency distributions of shrimp in Hawke Channel - Division 3 K from 1988 to 1993.

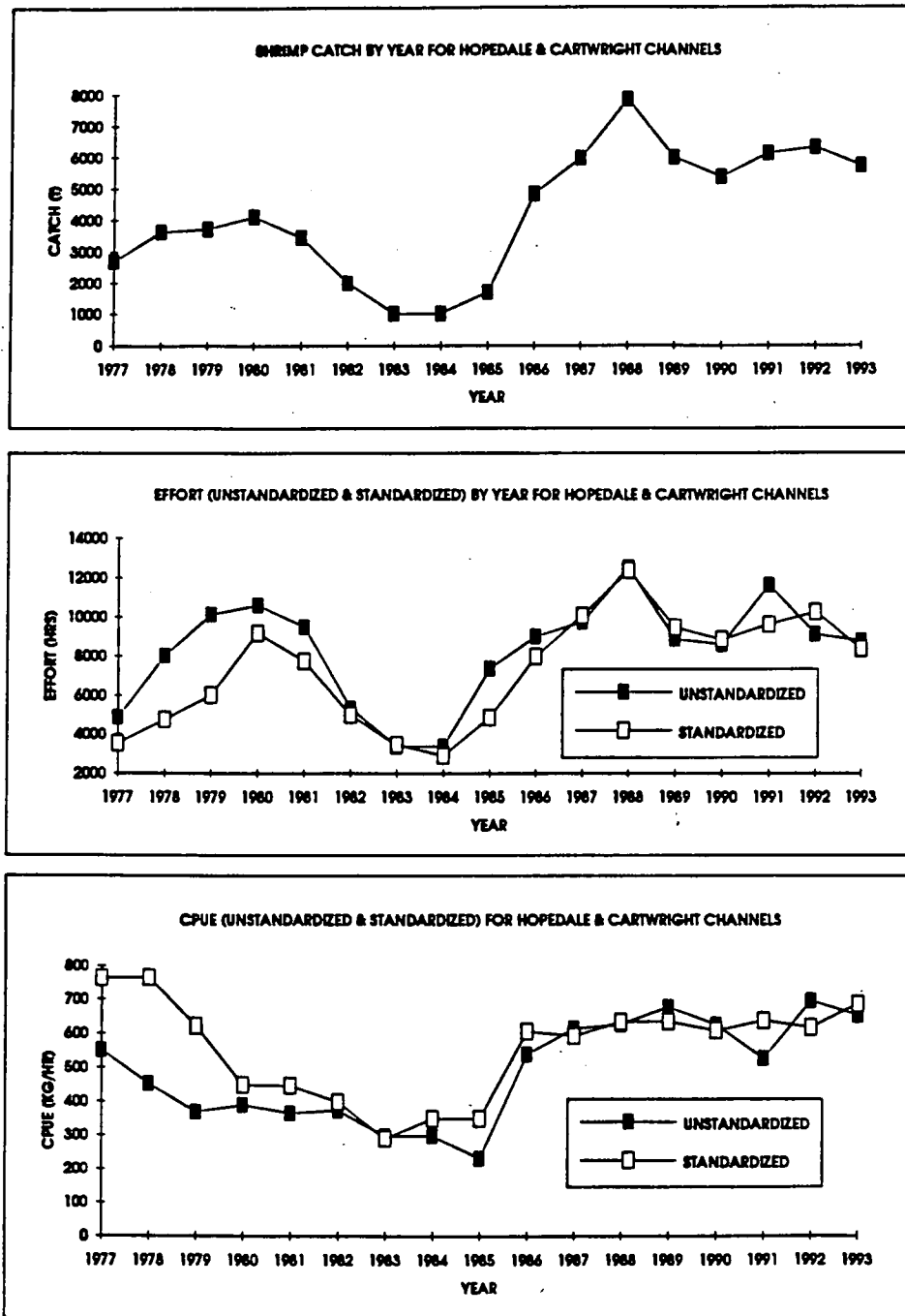


Figure 6. Hopedale and Cartwright channels catch, effort and CPUE 1977-1993.

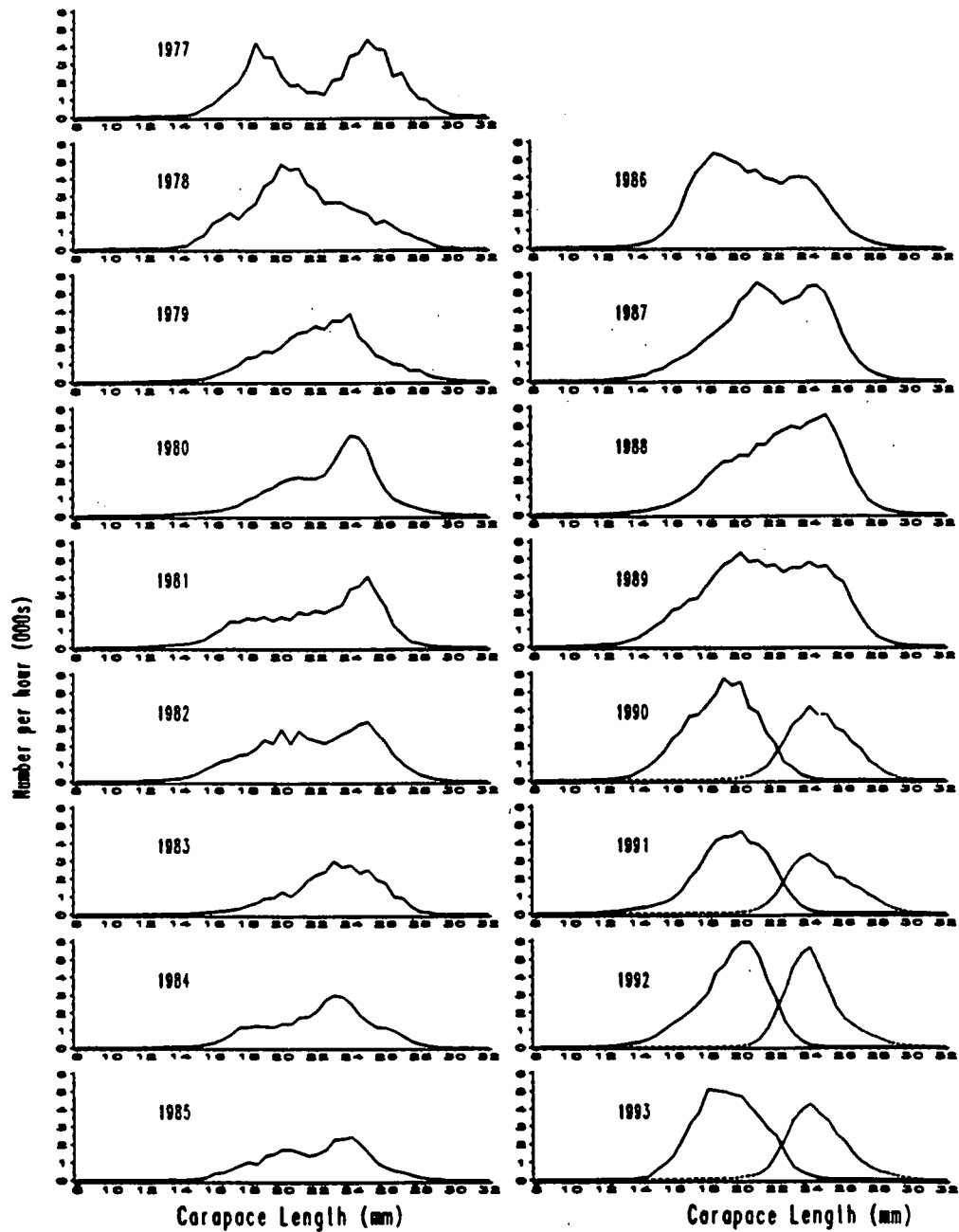


Figure 7. Cartwright and Hopedale channels catch in number/hour, unsexed samples 1977-89, sexed samples 1990-93 (solid line = males)

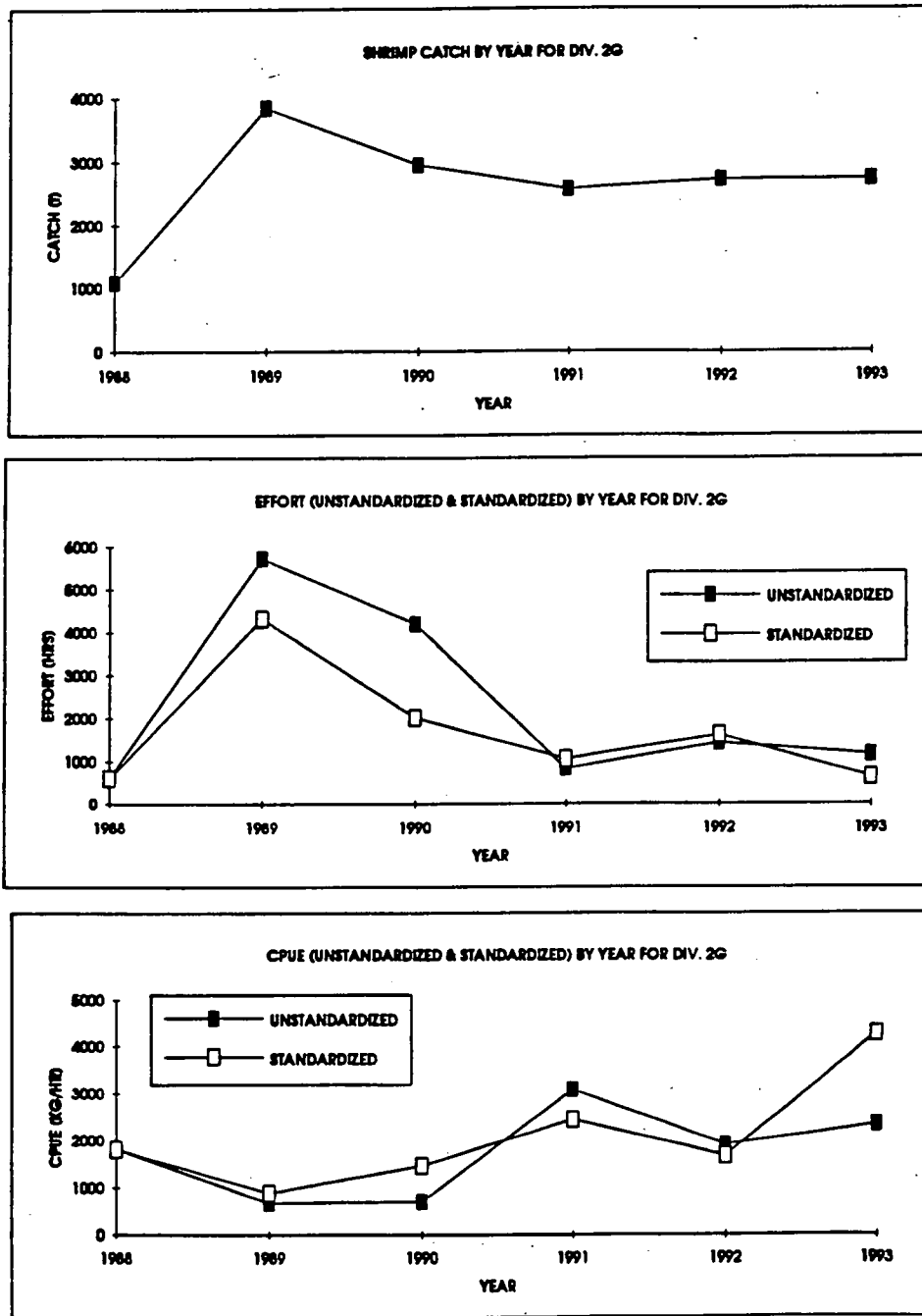


Figure 8. Division 2G catch, effort and CPUE 1988-1993.

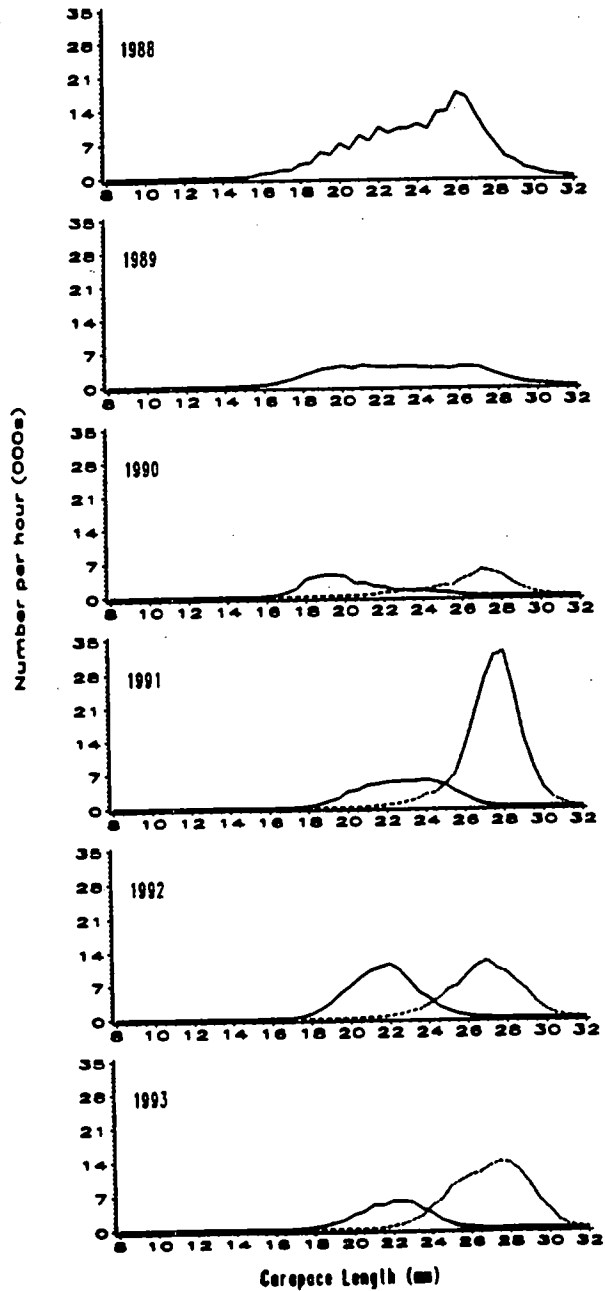


Figure 9. Division 2G catch in number/hour, unsexed samples 1988-89, sexed samples from 1990-93 (solid line = males)

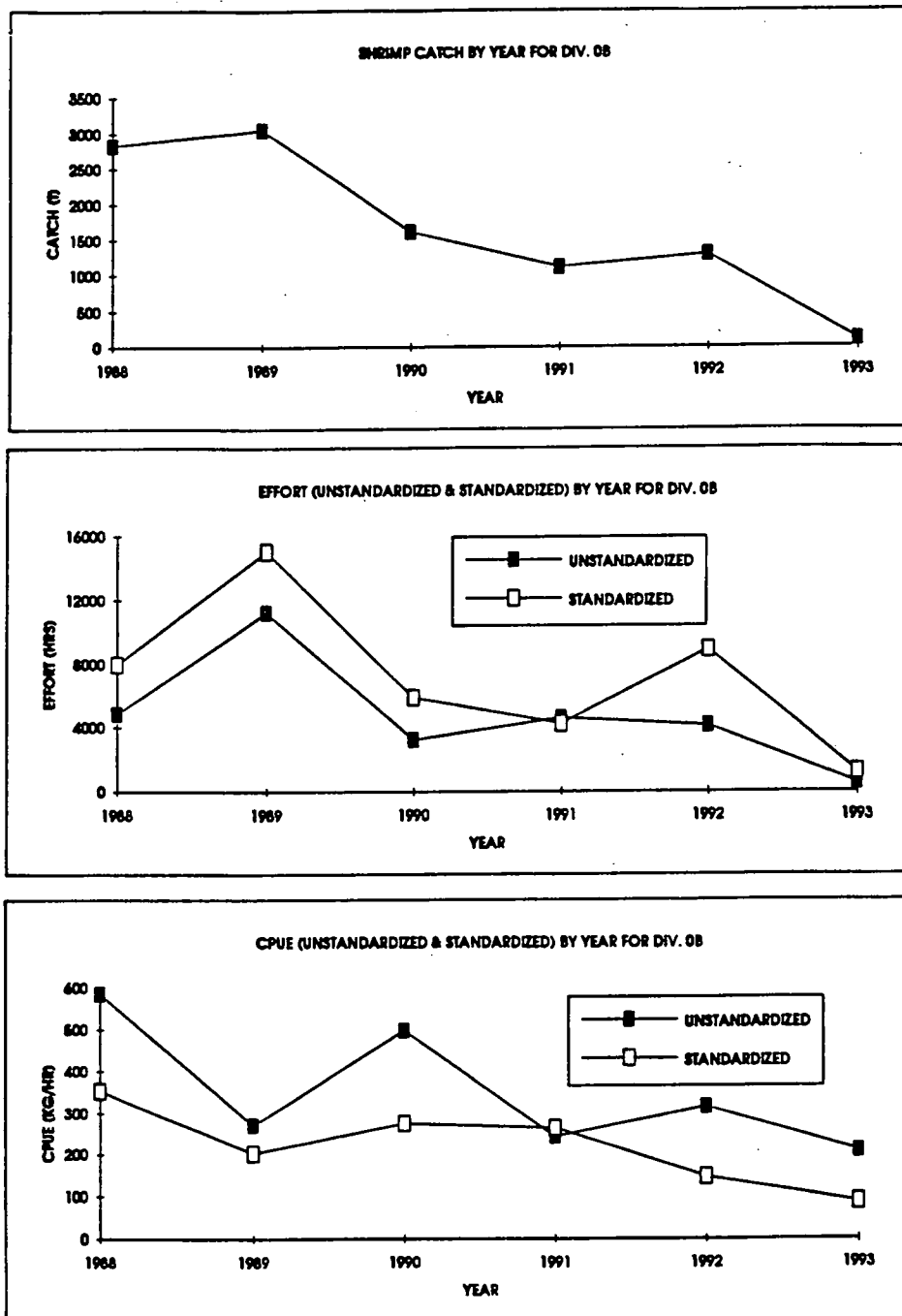


Figure 10. Division 0B shrimp catch, effort and CPUE 1988-1993.

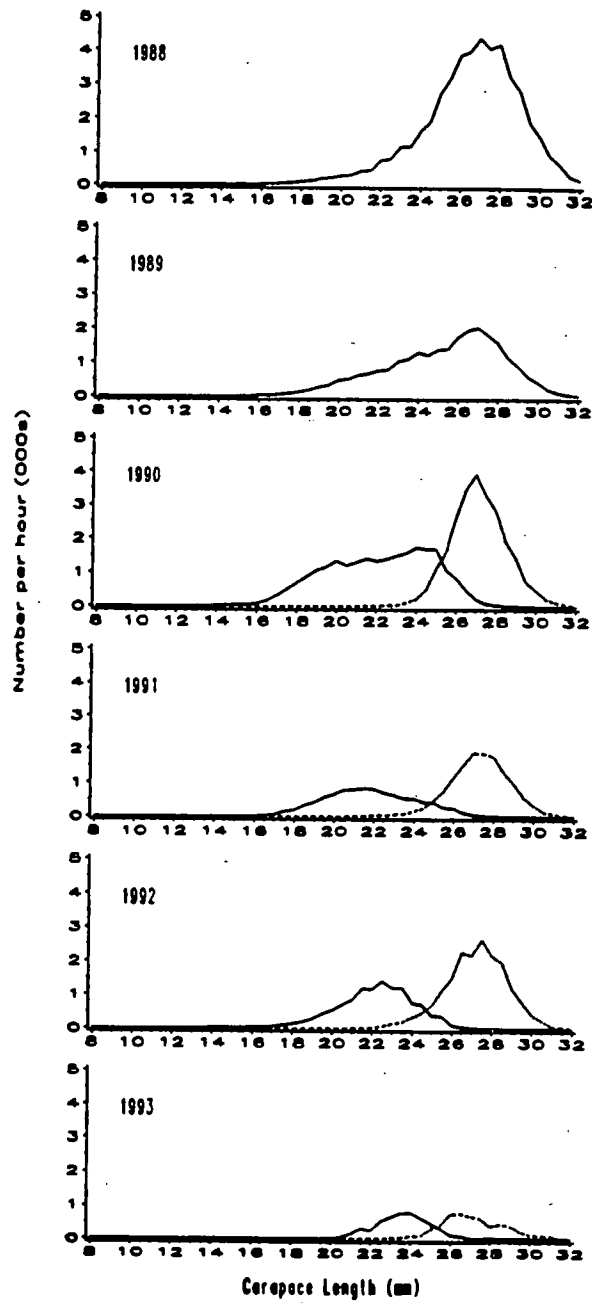


Figure 11. Division OB catch in number per hour, unsexed samples 1988-89, sexed samples from 1990-93 (solid line = males)

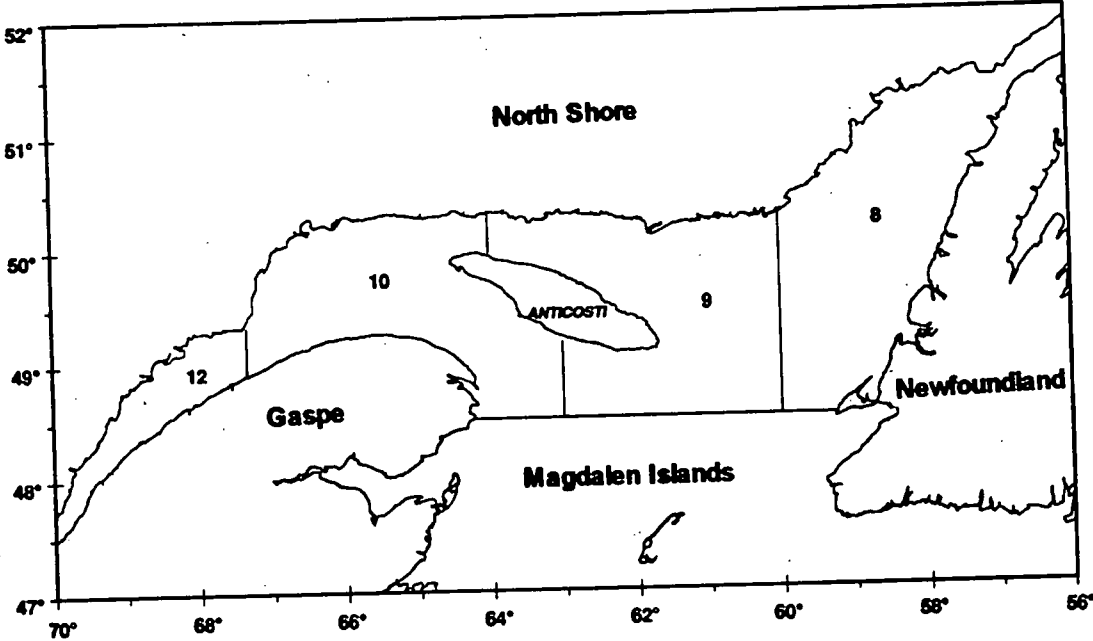


Figure 12. Gulf of St. Lawrence shrimp areas: 8 = Esquiman; 9 = Anticosti; 10 = Sept-Iles; 12 = Estuary.

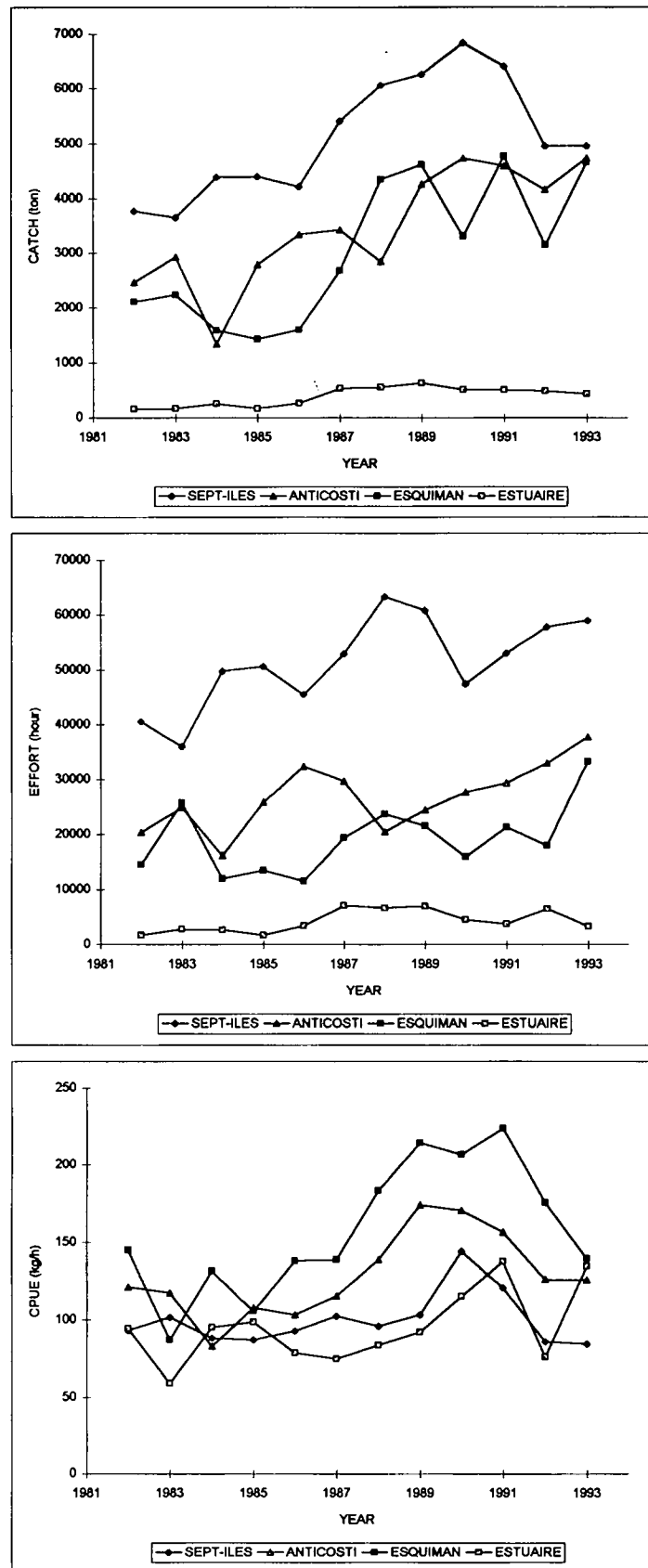


Figure 13. Catch, effort, and standardized catch per unit of effort for the four fishing areas in the Estuary and Gulf of St. Lawrence from 1982 to 1993.

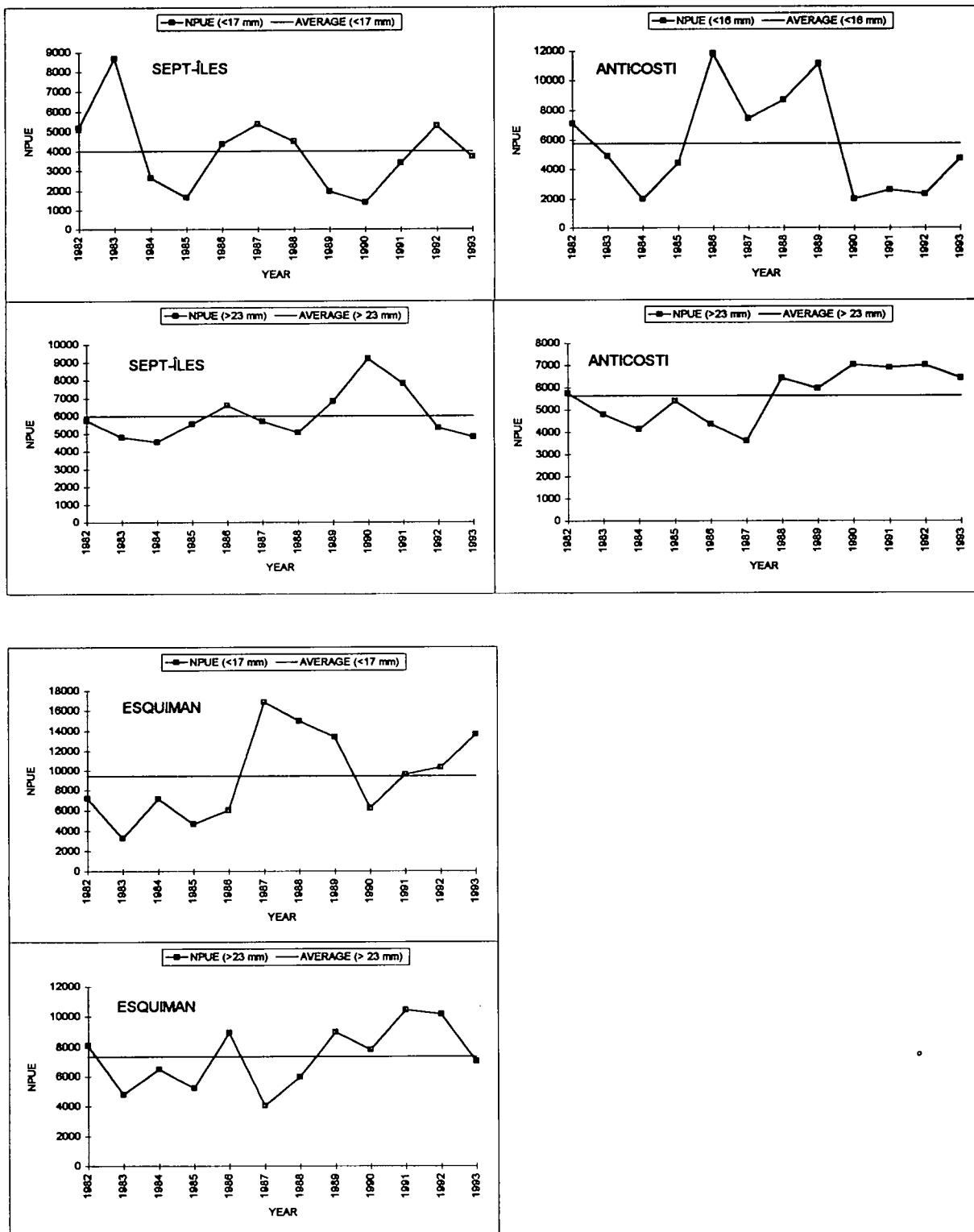


Figure 14. Number per unit of effort (NPUE) of pre-recruits (shrimp smaller than 16 or 17 mm CL) and recruits (shrimp larger than 23 mm CL) by fishing area from 1982 to 1993. The average of NPUE for the 1982-1993 period is also presented.

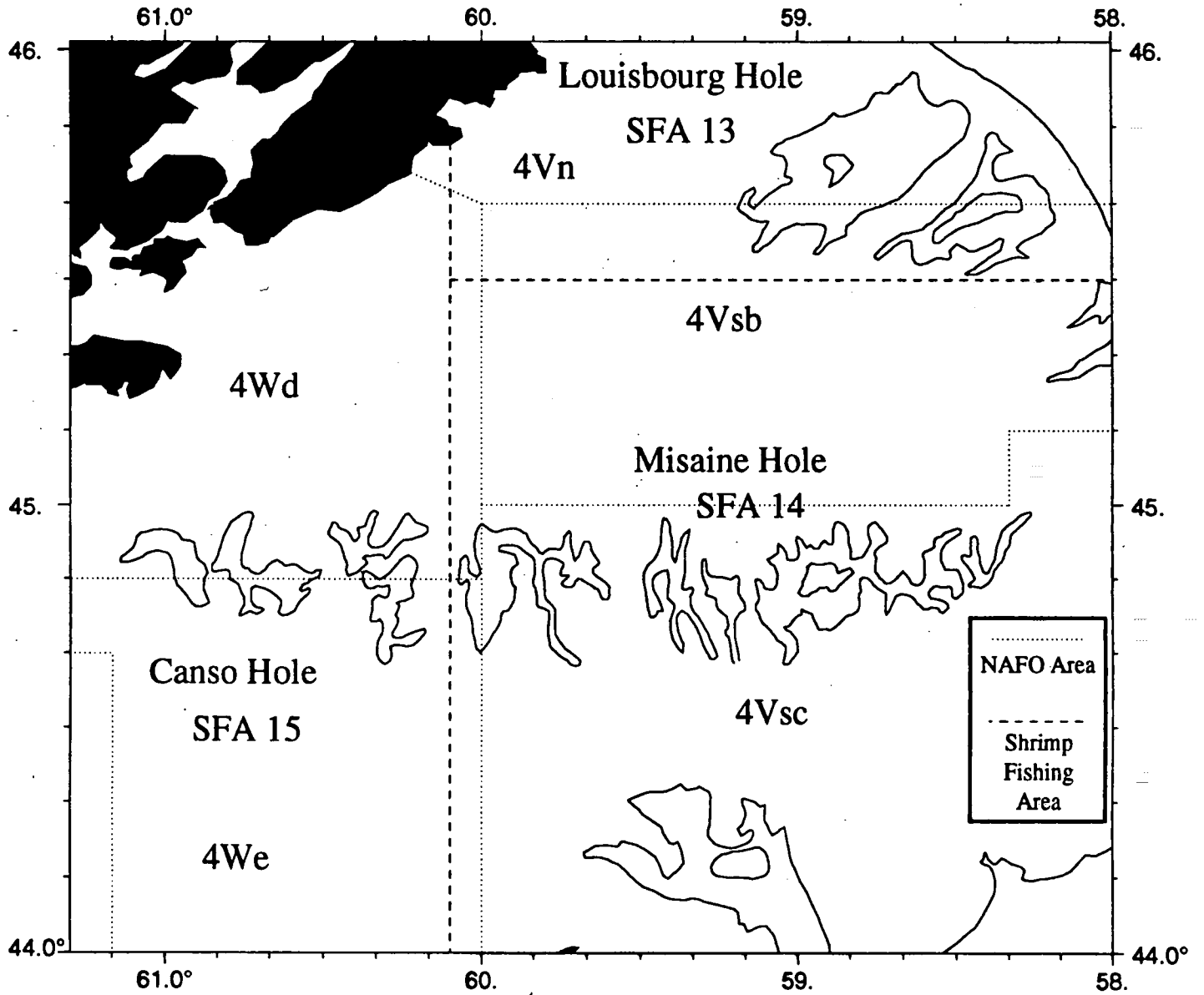


Figure 15. Shrimp fishery locations on the Scotian Shelf.

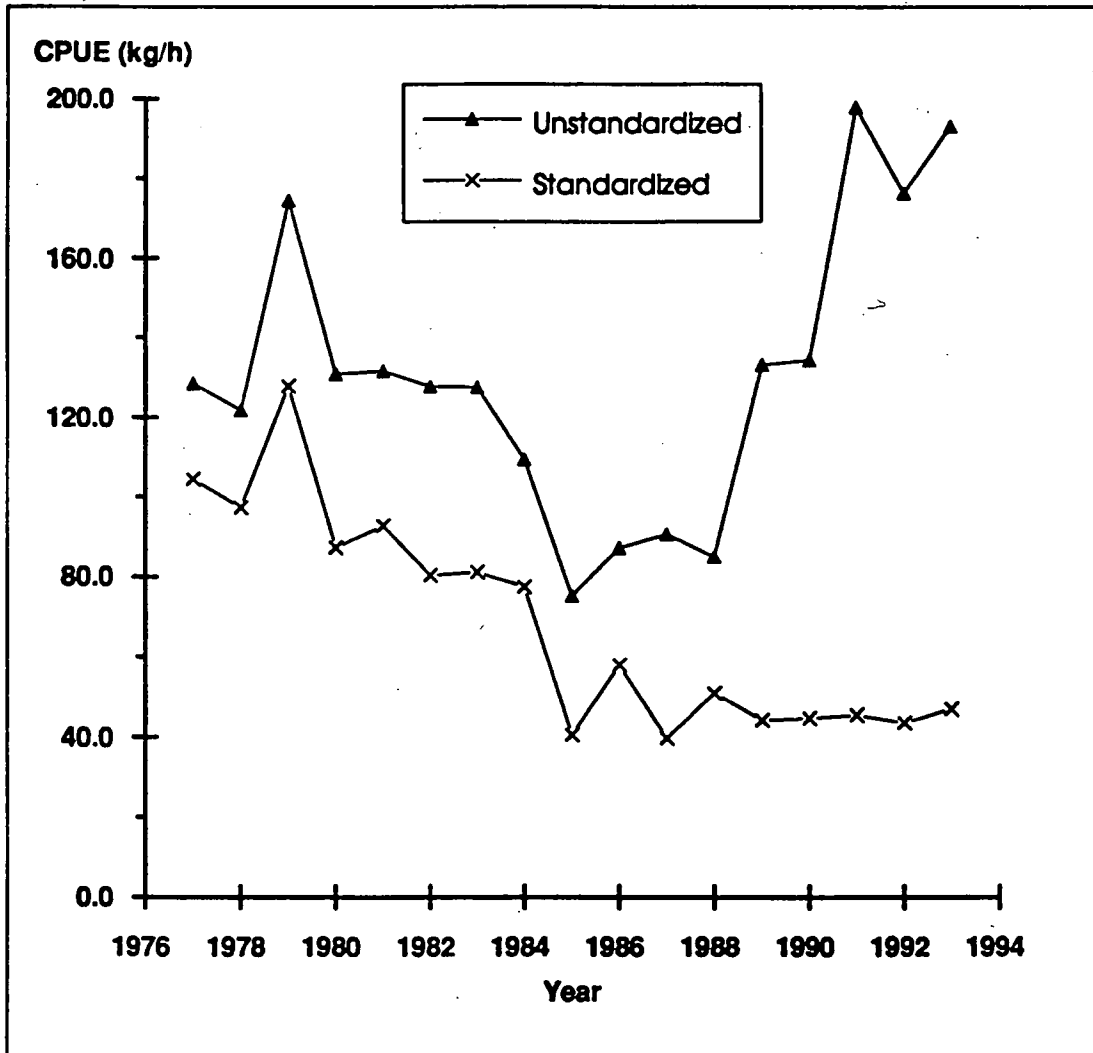


Figure 16. Catch per unit of effort for the Scotian Shelf shrimp fishery from 1977 to 1993.

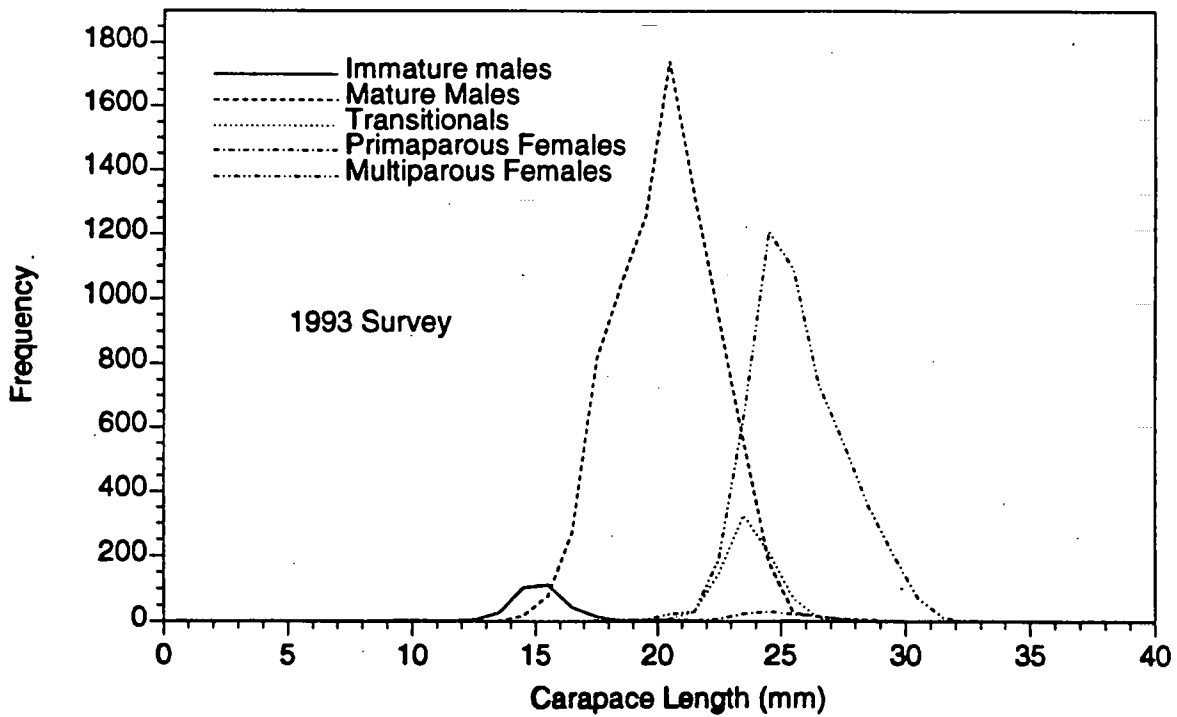
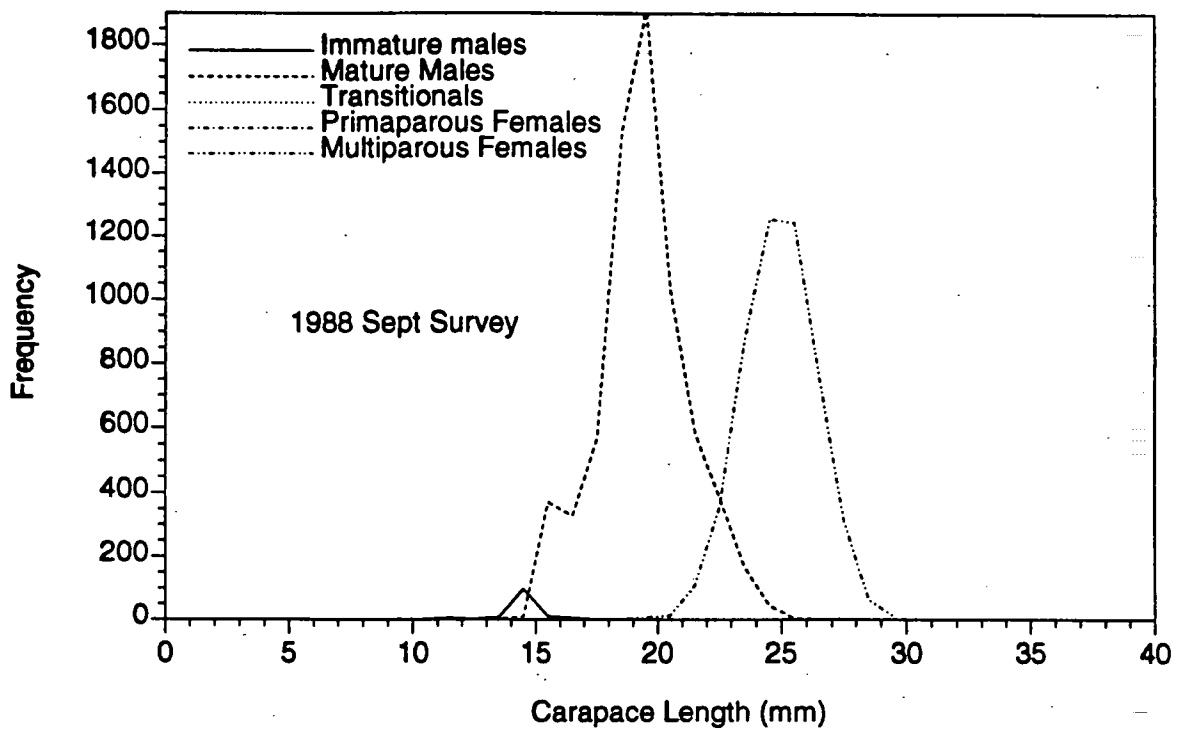


Figure 17. Length frequency distributions from Scotian Shelf survey samples in 1988 and 1993.