STOCK STATUS REPORT

LAURENTIAN REGION

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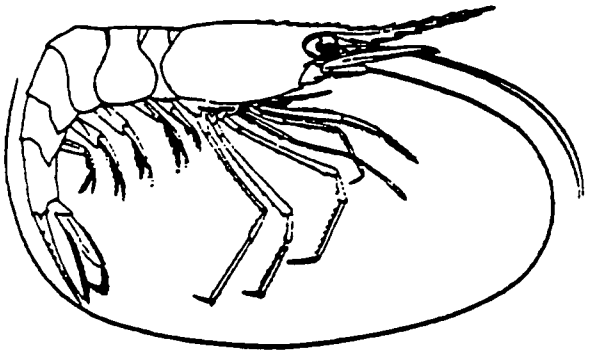
SHRIMP OF THE ESTUARY AND THE GULF OF ST-LAWRENCE



BIOLOGICAL CHARACTERISTICS

Peculiarities in the biology of the northern shrimp (*Pandalus borealis*) have had a direct impact on the type of fishing that has developed in the Gulf since the 1960s. Fishers have learned to take these peculiarities into account in seeking to optimize their performance and minimize their operating costs. The shrimp is found throughout the northern Gulf at depths varying from 150 to 300 m (80 to 160 fathoms); concentrations are found where the water temperature is between 4 and 6°C.

Life cycle

Commercial catches are made up of variable proportions of males and females. The females caught at the beginning and end of the fishing season often have eggs under their abdomen. This is because shrimp reproduce in fall, and the females carry their eggs under the abdomen all winter, from October to May. The eggs hatch and the larvae are released in spring, from April to mid-May. The larvae are pelagic and settle on the bottom in late summer, three or four months later. Their form and behaviour are then adult. They reach sexual maturity 30 months later, when they reproduce for the first time as males. Shrimp are hermaphroditic (an individual has both sexes during its

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life), spending about the first four years of their lives as males, then changing sex and reproducing as females for at least two more years. Egg-bearing shrimp are therefore among the largest caught commercially; male shrimp are smaller than female shrimp because they are younger. Towards the end of the summer it is easy to distinguish the males and the sexually mature females that will reproduce in the fall by examining their reproductive organs in the cephalothorax; the mature reproductive organs can be seen through the carapace. For example, females are then said to have a green head.

Migrations

Shrimp follow migratory patterns that are well known to commercial fishers. Each year, they migrate to hatch their eggs. In late fall and early winter, the females carrying eggs under the abdomen begin to migrate to shallower areas (80 to 100 fathoms) in their distribution range. In spring, they gather at sites suitable for releasing the larvae, while the males are still scattered throughout the distribution range. Fishers take full advantage of this spring gathering of egg-bearing females to obtain high yields. Once the larvae have been released, the females moult and then disperse to deeper areas (120 to 150 fathoms).

Shrimp also migrate vertically. They leave the bottom at night to rise in the water column, probably to feed on plankton, then return to the bottom during the day. The scale of vertical migrations may vary depending on the stage of development of the shrimp and local conditions. For example, small male shrimp may appear to leave the bottom earlier and rise higher in the water column than do female shrimp. Fishers usually fish only during the day, when shrimp are concentrated in the first few meters above the seabed. Yields are low enough at night that it may not be worthwhile fishing.

Geographical distribution

In general, the distribution of shrimp throughout the area differs with age and size. Young male shrimp are often found in shallower areas (100 to 120 fathoms), often at the heads of channels, while older shrimp, the females, are often found in deeper areas (120 to 150 fathoms). However, while all stages of sexual development can be found at all depths suitable for shrimp, it can be seen that for the same stage or age, shrimp in deeper water have better growth and are larger than those in shallower water. In addition, concentrations of small shrimp in shallower water are often more dense than those of large shrimp in deeper water. Fishers try to fish at spots where yields are highest, while at the same time exploring the entire area looking for large shrimp in an effort to optimize both their yield and the proportion of large shrimp in their catches.

Changes in the geographic distribution of shrimp have been observed in the last two years. Some shrimp aggregations have been found in sectors where few shrimp had been observed before. Research survey results indicate that in 1994 and 1995, shrimp were present not only on traditional fishing grounds but were also abundant in southern sectors of management units. In 1995, shrimp were distributed throughout the whole Gulf including the Laurentian Channel.

The shrimp may have reacted to environmental changes affecting their own geographic distribution or that of their food. The oceanographic conditions of the Gulf have changed in the last six years in response to extreme weather conditions. These changes have been rather gradual and cannot explain entirely the changes in resource distribution that have happened more recently, during the last two years. On the other hand, it is well known that for marine fish or invertebrates species, when the abundance of a population increases, individuals tend to extend their geographic distribution and are found in areas where they were less frequent before. The support capacity of an environment can be limiting (for example, because of competition between individuals for space or food) and individuals have to colonize other environments to insure their survival. It is possible that the spread of the shrimp distribution is a response at a higher level of the population. The increase in abundance and the subsequent spread of distribution are all the more possible due to the fact that predators have recently become very few abundant in the Gulf. The abundance levels of cod, redfish and turbot have been the lowest since the beginning of the shrimp fishery in the Gulf in the middle of 1960s. Natural mortality of shrimp by predation has probably decreased appreciably and thus survival, in locations traditionally exploited and in new locations, must have increased substantially.

MANAGEMENT APPROACH

The development of the fishery has varied with the sector and the fishing fleet. The Québec fleet chiefly harvests the western Gulf, while the Newfoundland fleet concentrates its operations in the Esquiman channel. The New Brunswick fleet divides its operations between the eastern and western Gulf. To more accurately reflect the fishing pattern and the geographic distribution of shrimp, a reorganization of the management units was proposed in 1992. Four units were established in 1993: Sept Îles (fishing area 10), Anticosti (area 9), Esquiman (area 8) and Estuary (area 12) (Figure 1).

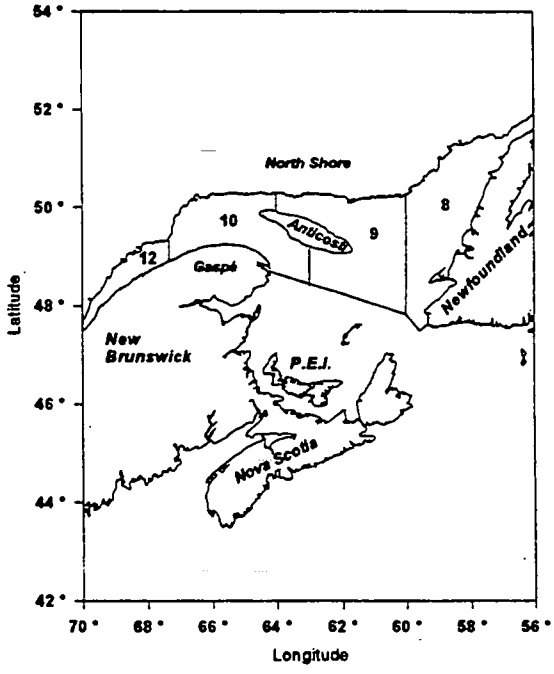


Figure 1. Northern shrimp management units in the Estuary and the Gulf of St.Lawrence. Area 12: Estuary; area 10: Sept Îles; area 9: Anticosti; area 8: Esquiman.

A three-year management plan for the shrimp fishery was adopted in early 1993 as a result of recommendations of the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) and consultations with the industry. Management of

the shrimp fishery of the northern Gulf consists of a range of measures, including control of catches by means of Total Allowable Catches (TACs) for the four management units (Figure 2). Québec and New Brunswick licence holders have had individual quotas since 1991, while those from the Lower North Shore and the west coast of Newfoundland fish under a competitive system in the Esquiman area. Other management measures include the setting of a minimum mesh size (40 mm) and the requirement, since 1993, to use the Nordmore grate to significantly reduce the groundfish by-catch.

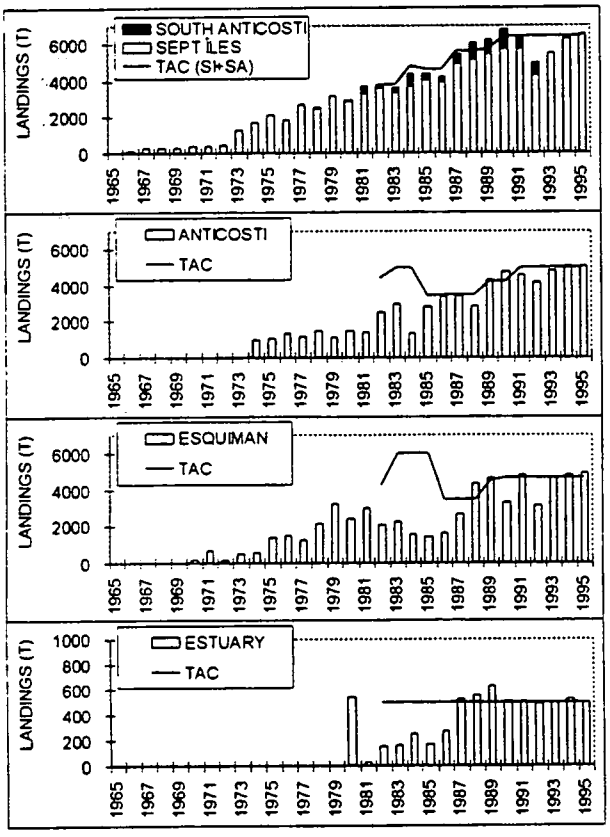


Figure 2. Northern shrimp landings (t) and total allowable catches (TAC; t) for the Estuary and the Gulf of St.Lawrence by management unit since 1965.

The shrimp fishery of the estuary and the Gulf is managed by TACs in an attempt to control the rate at which the shrimp stocks are harvested. The harvesting or exploitation rate is a measurement of the intensity at which a stock is fished and is a function of the catches and total abundance of the resource. For example, high catches taken from a stock that is not very abundant, having a low biomass, will translate into a very high exploitation rate; on the other hand, if the abundance increases and catches remain stable, the exploitation rate will go down.

The increase in the TACs of the Sept Îles management unit in the 1980s was intended as a cautious attempt at experimental management. In gradually increasing the TACs, the intention was to raise the exploitation rate by degrees so as to assess the impact on the resource and ultimately to determine the optimal exploitation rate. The abundance of shrimp increased simultaneously, so that, in actual fact, the exploitation rate in the early 1990s was probably lower than that in the early 1980s. Harvesting had no detectable negative impact on the resource in any of the management units. The growth in abundance occurred despite an increase in fishing effort between the first and second halves of the 1980s. Catches did not seem to affect either recruitment or participation of females in reproduction, despite the fact that shrimpers concentrated on catching females.

Maintaining the exploitation rate at a certain level should protect the reproductive potential of the stocks by allowing a certain proportion of shrimp to remain unharvested and thus available for repro-

duction. Participants at a scientific workshop on Atlantic shrimp conservation and management strategies held in 1989 remarked that fishing effort could potentially become high and that therefore the exploitation rate could reach very high levels. They emphasized that a ceiling should be set on the exploitation rate, even if it could not be quantitatively determined on an analytical basis. Nonetheless, they also stressed that the limit should not be unduly restrictive on fishers. To determine the appropriate harvesting level, they mentioned that the status of the resource must be assessed; the TAC can then be adjusted according to the status of the resource and the possible impact on the exploitation rate. The tools needed to quantitatively determine or calculate the TAC increases or decreases in response to perceived changes in the status of the resource are not available for northern shrimp in Northwest Atlantic, unfortunately.

For shrimp, it has so far not been possible to describe a direct relationship between the number of spawning females and the number of recruits they could produce. In the Gulf, for example, strong cohorts were produced in the mid-1980s, when the abundance of females was very likely at a low level. The recruitment of shrimp has varied considerably since 1982, but the fact that the fluctuations have occurred simultaneously in the various fishing areas suggests that environmental factors affecting the entire Gulf could have a major influence on recruitment success, larval survival and exchanges between the fishing areas.

There is probably a minimum spawning biomass level below which recruitment is severely affected. Measures implemented under the shrimp management plan for the estuary and Gulf (TACs to regulate the catches and the exploitation rate, minimum mesh size for trawls to allow young shrimp to escape) are empirically designed to maintain a minimum spawning stock.

THE FISHERY

Landings of northern shrimp in the estuary and Gulf of St.Lawrence have grown steadily since the shrimp fishery began in the mid-1960s, increasing from approximately 1,000 t to 7,500 t during the 1970s and reaching over 15,000 t in the late 1980s (Figure 2). Data on the 1992 fishing season show that Gulf landings decreased by 22% between 1991 and 1992, while data for the 1993 season reveal that landings rose by 21% between 1992 and 1993. Data of 1994 and 1995 also point to an increase of 8 and 10 % over 1993, which means that the catches for the last two years represent the highest values ever recorded for this fishery. The TACs were reached in each of the fishing areas for the first time in 1994 since the implementation of the TAC system in 1982; TACs were reached again in all areas in 1995. It should be noted that the allocation still managed by a competitve system in Esquiman Channel (for the Newfoundland and Lower North Shore fleets) was reached quickly during the 1995 fishing season so that the fishrery had to be closed on June 16. It should also be noted that in 1995, Esquiman Channel total catches were probably higher than those indicated by the landing statistics.

West coast of Newfoundland fishers participated in a shrimp gear selectivity study conducted during the fall of 1995 and received a supplementary allocation of a few hundred tons.

The geographic distribution of fishing effort has changed since 1990. In 1990, 1991 and 1992, the fishing effort was concentrated at the heads of the channels in the Anticosti and Esquiman Channel areas and off the northwest side of Anticosti Island in Sept Îles area. In 1993, fishers began to exploit more southern locations while decreasing the effort in northern locations (at the heads of the channels). In 1994 and 1995, most of the effort was concentrated off the Gaspé Peninsula, southeast of Anticosti Island, and Laurentian Channel in the Sept Îles and Anticosti areas while fishers from New-Brunswick exploited more the western side of Esquiman Channel. These changes in the geographic fishing pattern are probably due to two factors. On one hand, the constraints or borders which restrained the spread of the effort to more southern locations were eliminated in 1993 when the management units were reorganized; the South Anticosti management area was dismantled and the southern border of Sept Îles area corresponding to the NAFO Division 4T line was eliminated. On the other hand, shrimp concentrations have increased in southern locations, in the Laurentian Channel in particular, where they have been less abundant before.

ABUNDANCE INDICES

Commercial fishery statistics (shrimper catch and effort data) are used to calculate annual catch rates or catch per unit of effort (CPUE) i.e. the quantity of shrimp caught in one hour of fishing. The data are standardized to account for the evolution of fishing fleets (changes in fishing power because of changes in fishing boats and renewal of the fleets) and the seasonal fishing pattern; statistics from the three fleets have been included in the analyses since 1982.

Catches per unit of effort for Anticosti and Esquiman Channel areas increased from the middle of the 1980s to the beginning of 1990s (Figure 3). Catches per unit of effort increased later in the Sept Îles and Estuary areas; they were relatively stable up to 1989, then increased in 1990 and 1991. Catches per unit of effort for the four areas all decreased in 1992. Sept Îles catches per unit of effort were relatively stable in 1992, 1993 and 1994 then increased in 1995 while that of the Estuary area increased in 1993, remained at the same level in 1994 and rose in 1995. Anticosti and Esquiman Channel catches per unit of effort remained at lower levels in 1992 and 1993 than in 1989, 1990 and 1991 then rose in 1994; they increased in 1995 in the Anticosti area while they decreased in 1995 in the Esquiman Channel to a level at least higher than that of 1992.

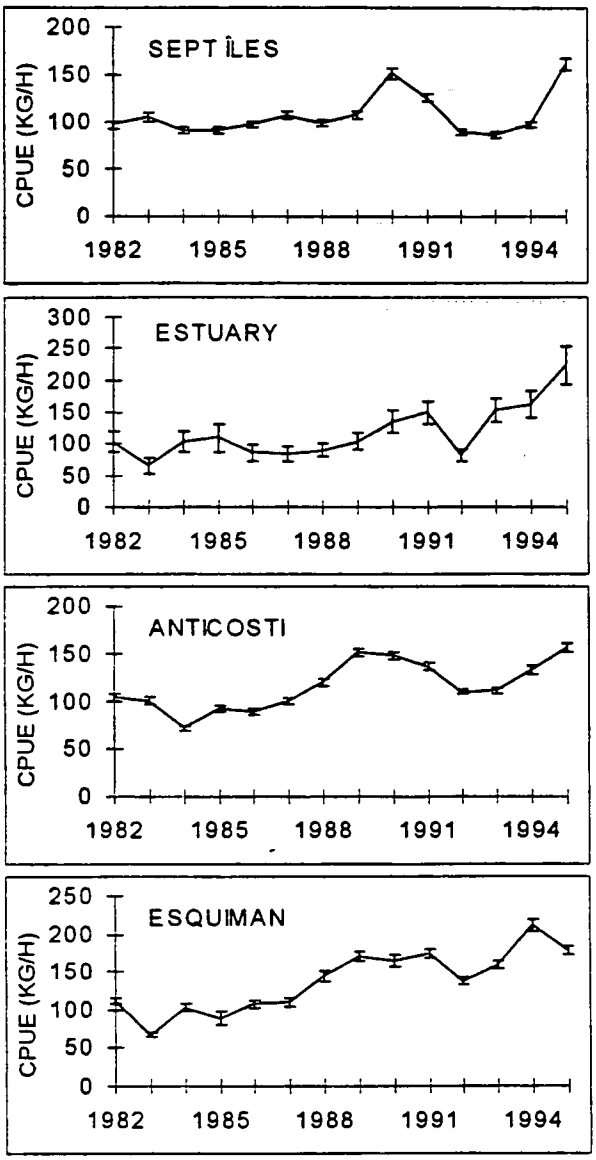


Figure 3. Catch per unit of effort (CPUE; kg/h) of shrimp fishers in the Estuary and the Gulf of St.Lawrence by management unit since 1982.

Since 1990, research surveys have been conducted in the Estuary and the Gulf of St.Lawrence in August-September of each year. They are carried out on a vessel of the Department, *the C.S.S. Alfred Needler*, with a shrimp trawl and following a stratified random sampling scheme. Results are presented as mean catch per tow i.e. the mean quantity of shrimp caught by a standard tow of one hour.

In general, catches per tow decreased between 1990 and 1993 then increased in 1995 in the Sept Îles, Anticosti and Esquiman Channel areas while they were variable in the Estuary area (Figure 4). However, the catch per tow decrease or increase pattern is slightly different between the management units. The index decreased between 1990-91 and 1992-93 in the Sept Îles area then gradually increased up to 1995. In the Anticosti and Esquiman Channel areas, the index gradually decreased between 1990 and 1994, then rose in 1995.

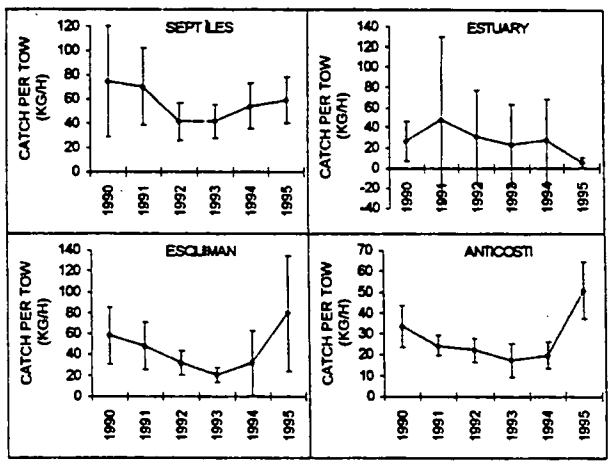


Figure 4. Mean catch per tow (kg/h) of northern shrimp by management unit obtained from research surveys conducted in the Estuary and the Gulf of St.Lawrence since 1990.

The vertical bars associated with the mean catches per tow represent the confidence interval of the estimate; this confidence interval indicates that the true mean value is contained in the interval 95 times out of 100. By looking at the range of the con-

fidence intervals, it can be seen that the variability of the data can be relatively high. Therefore, the survey indices should be examined in their whole to draw out the general trend in the time series. It is well known for shrimp that bottom trawl surveys are affected by the resource availability which has an impact on the catchability of the individuals. Indices obtained from trawl surveys represent the minimum quantity of shrimp present in the area covered at that particular time by the survey, because shrimp do vertical migrations in relation to the period of day or night and because shrimp are also distributed on untrawlable bottoms. These indices are relative from one year to the other and do not correspond to the absolute abundance of shrimp present in the population. It is generally agreed that surveys in the Gulf follow the general trends in shrimp populations quite well (for example, changes in distribution and population structures, direction of changes in abundance) but the difference between two data points does not necessarily correspond to the absolute difference between the shrimp biomass of two years. On the other hand, the confidence intervals which give an indication of the shrimp data variability are located in the range that is generally accepted for surveys on marine fish or invertebrates. It should be noted that it is not rare that the confidence intervals associated with the highest estimates are also the highest.

Generally speaking, both indices (commercial catches per unit of effort and survey mean catches per tow) are consistent and vary in the same direction; CPUEs are high when the survey indices are high. There is a certain synchronism among large events at the Gulf scale: low levels were observed in 1992-93 and high levels were observed in 1990 and 1995. The fisher catch rates represent an annual mean based on thousands of hours of effort. However, they represent the shrimp abundance on fishing grounds which do not entirely correspond to the shrimp distribution area, particularly in 1994 and 1995. For the Sept Îles area, fisher catch rate increase was relatively higher in 1995 than the survey index because fishers had changed their geographic fishing pattern over the last two years. They exploited more southern locations where the survey index rose the most. For the Anticosti area, fishers increased their catch rates in 1994 and 1995 by displacing their effort to southern locations where the survey index increased, while the northern sector survey index was variable from 1990 to 1995. For the Esquiman area, fishers maintained their catch rates at a high level in 1994 and 1995 because the concentrations of shrimp remained high on the traditional fishing grounds while they were also increasing in southern locations.

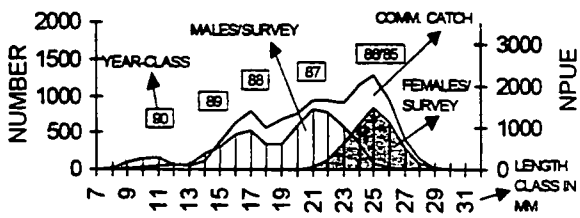
POPULATION STRUCTURE

Length frequency distributions are calculated from commercial catch and survey samples. Commercial catch length frequency distributions have been obtained since 1982 but are presented here from 1990 to facilitate the comparison with the survey length frequency distributions.

Cohorts can be identified by examining the length frequency distributions obtained from research surveys and commercial catches. A cohort is made up of

individuals born the same year. Since these individuals grow at essentially the same rate, on the basis of the abundance distributions by size class, it is possible to identify modes or groups composed of individuals of approximately the same size and presumably the same age. In the survey or commercial catches, four or five modes can be identified that correspond to different cohorts or year-classes; they are named according to their year of birth. The first year-class, with a modal size of approximately 11 mm, would be a year and a half old, meaning that the individuals in that year-class would have been born in the spring of the preceding year. The subsequent modes represent the preceding year-classes while the last mode represents an accumulation of female shrimp of one or more year-classes. It is therefore possible to follow the progress of the cohorts over several consecutive years and thus assess their relative abundance.

An example of the presentation of the length frequency distributions is given below. Commercial catch length frequency distributions (NPUE: number per unit of effort i.e. number of shrimp caught during the fishing season divided by the total number of hours fished as estimated from the catch rate standardization) are represented by the full line; those of the research survey (NUMBER: total abundance in millions) have vertical lines and are separated for males (empty area) and females (gray area).



Shrimp are caught using bottom trawls with 40-mm mesh when they are two or three years old; they then measure approximately 14 mm in length (cephalothorax length) and are male. They are fully recruited to the fishery i.e. 100% vulnerable to capture by trawls at about 22 mm, when they are four or five years old and are female. The representation of young cohorts in the first sizes to be selected by the trawls will depend not only on their abundance but also on their growth. A cohort with greater growth will appear earlier in the catches, sometimes giving the impression of being highly abundant. Moreover, because the shrimp, as they grow, are increasingly retained by trawls, the numbers of individuals in the cohorts rise in the catches from year to year while in the population, their abundance declines owing to natural mortality and fishing.

Fishers particularly target large shrimp, with the result that their catch rates depend on the abundance of shrimp having a cephalothorax length greater than 22 mm. Fluctuations in the abundance of shrimp having a cephalothorax length greater than 22 mm may be explained by the strength of the cohorts. The biomass of the stock will increase substantially, producing an impact on the catch rates of shrimpers when several cohorts stronger than the mean successfully enter the fishery. A very strong cohort may support

the fishery for a year or two when the shrimp reach the size at which they change sex. The successive arrival of several strong cohorts may thus maintain the biomass and catch rates at a high level for several years. The abundance of a cohort of strength less than or equal to the mean will decline rapidly as a result of natural mortality and mortality through fishing while the succession of several strong cohorts will have a cumulative effect that allows catch rates to remain at high levels.

The increase in the abundance indices in the late 1980s and early 1990s was due to the very high abundance of some cohorts produced in the mid-1980s (the 1984, 1985, 1986 and 1987 year-classes) that reached the size retained by fishing gear and that were targeted by the fishers during the same years (Figures 5, 6 et 7). The decline in catch rates and survey indices observed in 1992 and 1993 was due to the fact that the cohorts produced in the late 1980s which sustained the fishery in 1992 and 1993 (the 1988 and 1989 year-classes) were much less abundant. The 1990 year-class seems to have an abundance equal to or lower than the mean; its impact was to maintain the catch rates and survey indices without making them rise. Catch rates and survey indices rose in 1994 and 1995 thanks to the growing contribution of the 1991 and 1992 year-classes; these cohorts, which seem more abundant than the preceding ones, are contributing to the fishery increasingly as they grow and approach the sizes targeted by shrimpers. The 1991 year-class changed sex in 1995 and should still sustain the fishery in 1996 along with the 1992 year-class that should then change sex itself.

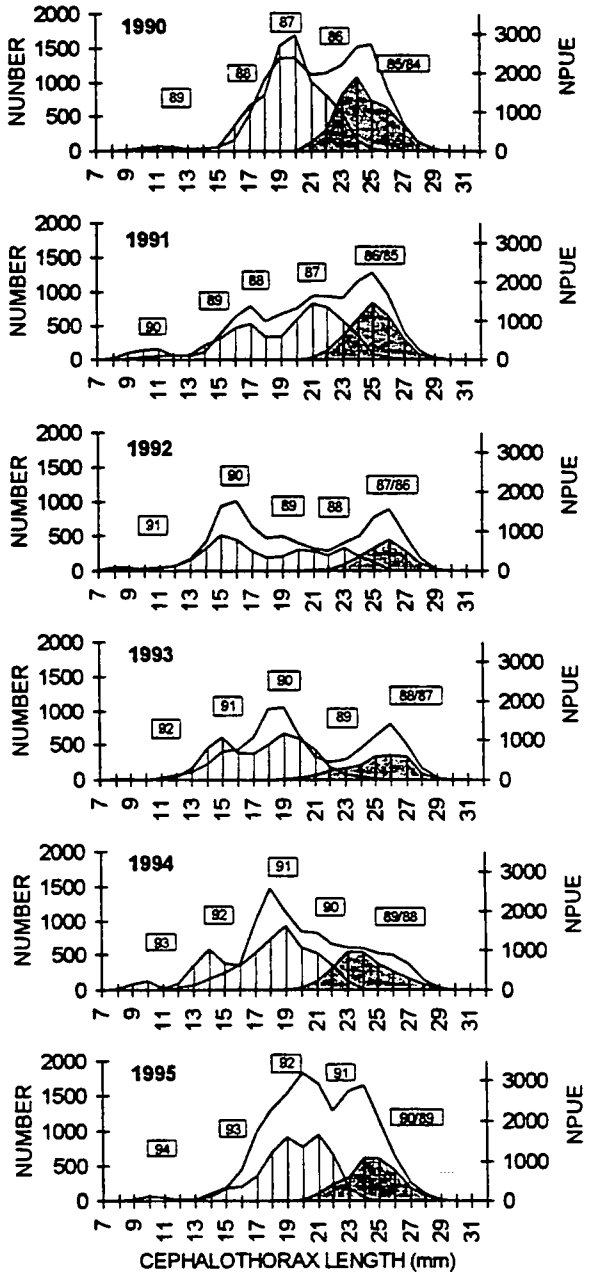


Figure 5. Length frequency distributions of northern shrimp obtained from commercial catches (NPUE; number per unit of effort) and research surveys (Number; abundance in millions) for Sept Îles area since 1982.

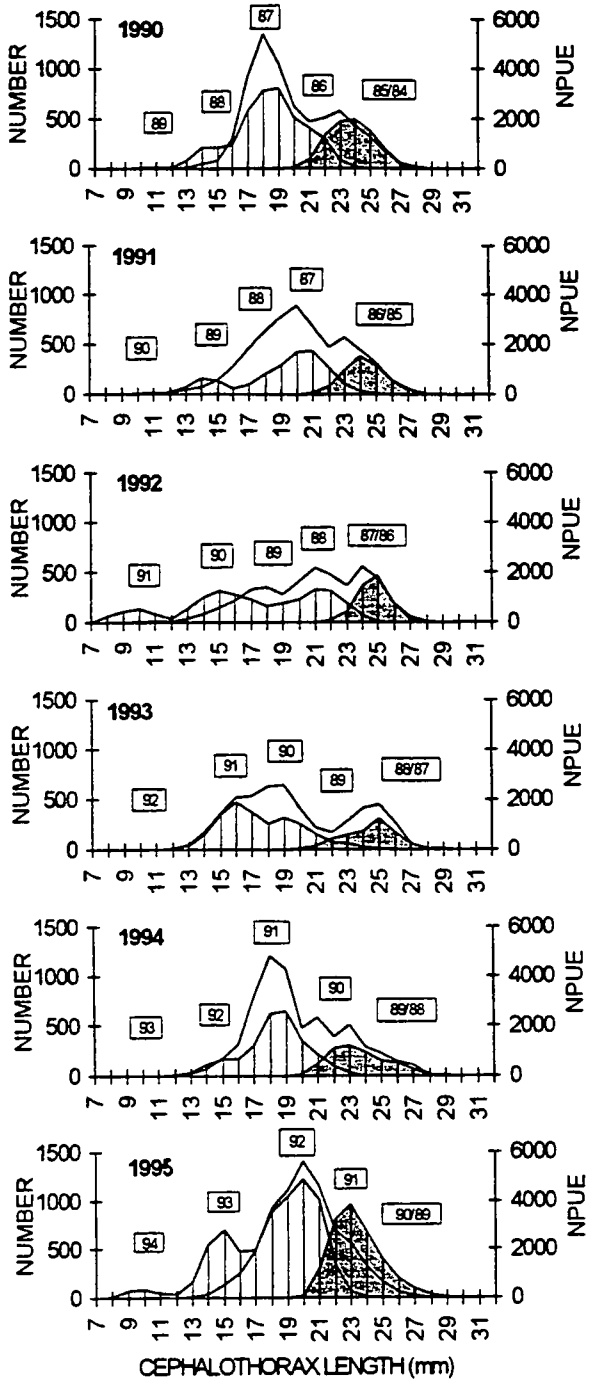


Figure 6. Length frequency distributions of northern shrimp obtained from commercial catches (NPUE; number per unit of effort) and research surveys (Number; abundance in millions) for Anticosti area since 1990.

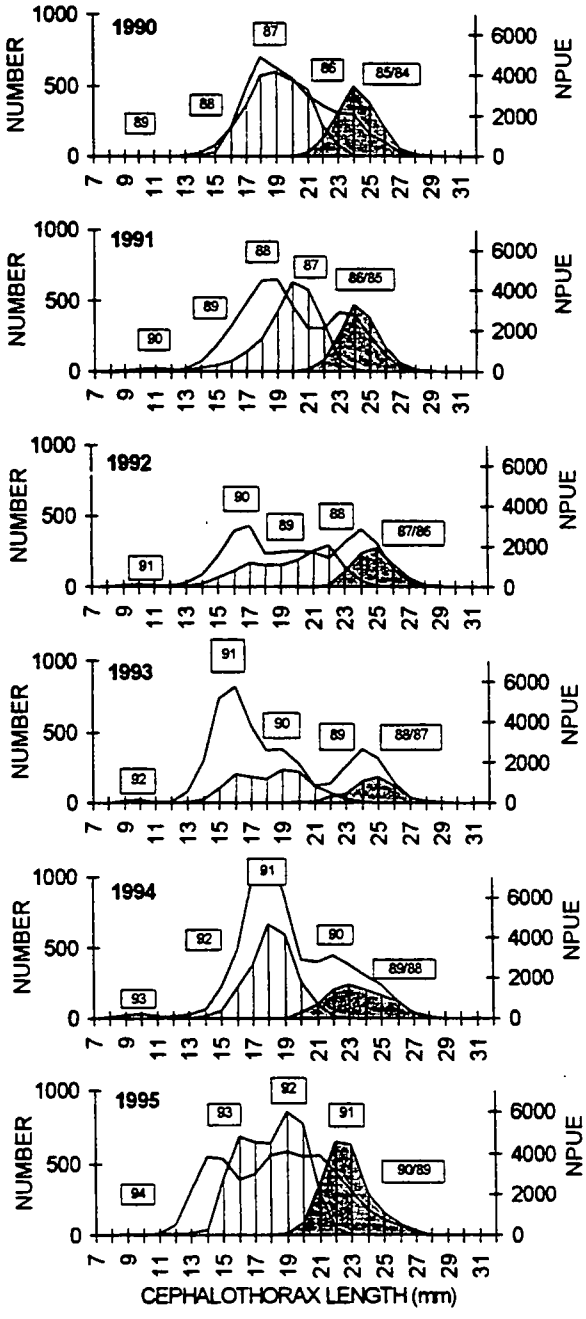


Figure 7. Length frequency distributions of northern shrimp obtained from commercial catches (NPUE; number per unit of effort) and research surveys (Number; abundance in millions) for Esquiman area since 1990.

The female (shrimp greater than 22 mm of cephalothorax length) abundance did not steadily decrease between 1990 and 1995 (Figure 8, 9 and 10). As for the commercial fishery and research survey indices, the female abundance varied and depends on the strength of cohorts going through the fishery. Male shrimp, smaller than 22 mm of cephalothorax length, decreased gradually between 1990 and 1993, as the 1988, 1989 and 1990 year-classes recruited to the fishery. Female shrimp, greater than 22 mm, decreased subsequently and reached their lowest level in 1993 and 1994. Male shrimp increased in abundance in 1993, 1994 and 1995 with the contribution of the 1991, 1992 and 1993 year-classes. The female abundance then began to increase in 1994 and 1995.

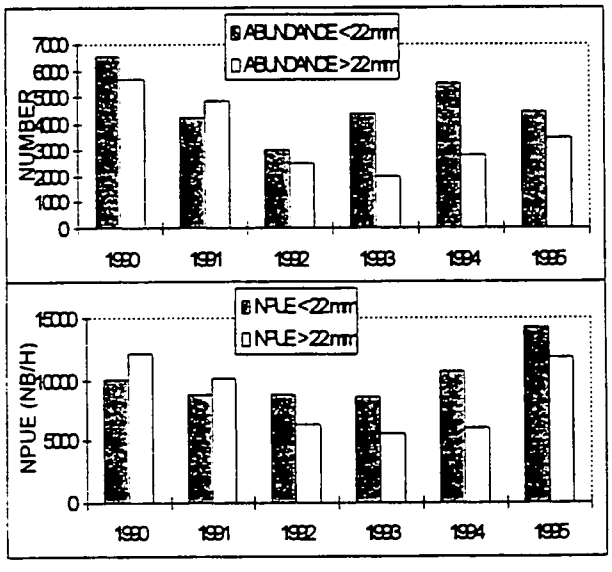


Figure 8. Abundance in millions and number per unit of effort of shrimp smaller and greater than 22 mm of cephalothorax length for Sept Îles area since 1990.

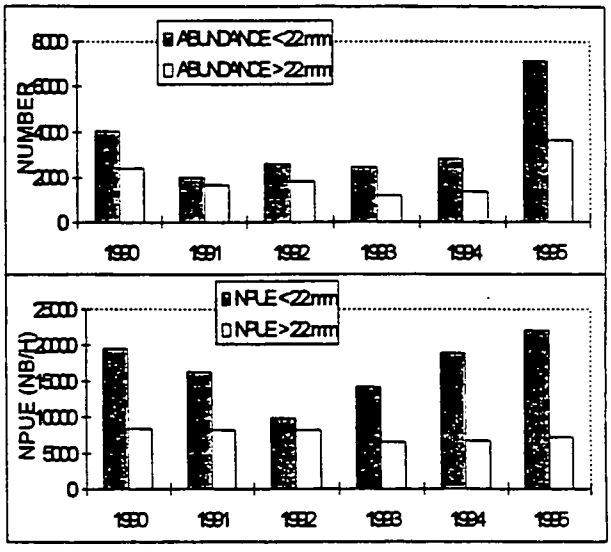


Figure 9. Abundance in millions and number per unit of effort of shrimp smaller and greater than 22 mm of cephalothorax length for Anticosti area since 1990.

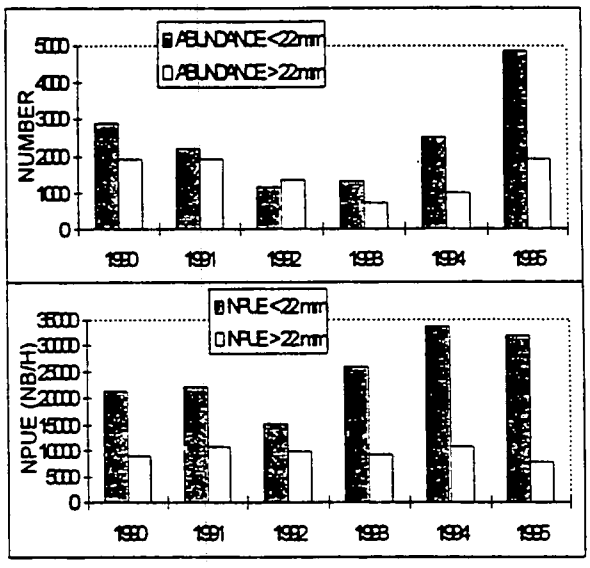


Figure 10. Abundance in millions and number per unit of effort of shrimp smaller and greater than 22 mm of cephalothorax length for Esquiman area since 1990.

The cohort strength has an impact on the mean size of females. Indeed, the female mean size is greatly determined by the size of the year-class that is the most

abundant in this shrimp category. Thus, for the Anticosti and Esquiman areas, the female mean size was lower in 1994 and 1995 than that observed in 1992 and 1993. In 1994, females were mostly composed of the 1989 and 1990 year-classes. As the 1990 year-class was more abundant than that of 1989, the female mean size was smaller. The same is observed in 1995 with the 1991 year-class contributing more to the abundance of females than the 1990 year-class. It was the opposite in 1992 and 1993 when older females contributed more to the total abundance of females, making the mean size increases.

The same trend is observed in the Sept Îles area with an exception, however. In 1995, the individuals of the 1991 year-class did not all change sex; some remained males and the mean size of females, which is higher than in 1994, was more dependant on the 1990 year-class. It seems also that the size at sex change has varied since 1990. It was greater in all areas in 1992 than in 1990 and 1995. The factors influencing the size or the age at sex change for shrimp are still uncertain. However, for some marine fish or invertebrates, growth or sexual maturity may be affected by the density of the population. The individuals of a population that is in a state of low abundance may tend to reach sexual maturity younger in order to accelerate the egg or recruit production and thus contribute to the increase of the total population abundance. Inversely, individuals of a dense population would tend to reproduce later and contribute to the slowing down of the population increase.

Differences in this general pattern may be observed between fishing areas. First, the 1993 year-class seems better represented in 1995 in the survey samples for the Anticosti and Esquiman areas than in those for the Sept Îles area. The abundance increase of males smaller than 22 mm of cephalothorax length is therefore more significant in the Anticosti and Esquiman areas in 1995. As well, shrimp smaller than 22 mm of cephalothorax length are proportionaly better represented in the commercial catches of the Anticosti and Esquiman areas than those of the Sept Îles area. This characteristic is more obvious for shrimp smaller than 19 mm in the Esquiman Channel. This could be explained by the fact that shrimpers who exploit the Anticosti and Esquiman areas fish more frequently the locations at the head of the channels where young shrimp are found. Therefore, small shrimp are more abundant in the commercial catches of these areas than in Sept Îles where the effort is spread more homogeneously in all sectors.

STATUS OF THE RESOURCE AND FUTURE PROSPECTS

The abundance indices (commercial fisher catch rates and research survey indices) show an increase in 1995 over 1992 and 1993. Generally speaking for the entire Gulf, the shrimp abundance increased between the first half of the 1980s and the end of the decade, remained high in the early 1990s, and then decreased in 1992. It remained stable in 1993 and increased again in 1994 and 1995. This increase resulted in higher catches in 1994 and 1995, and the TACs, which had remained the same since 1991, were reached in all

fishing areas in 1994 and 1995. **The results of the assessment indicate that the shrimp populations of the Gulf were in good condition at the end of the 1995 fishing season.**

The results of the assessment of shrimp status in the Estuary and the Gulf of St Lawrence have already been discussed with the fishers involved in this fishery. Generally speaking, the commercial fishery and research survey indices correspond well to the perception the fishers have about the abundance of the resource.

Fluctuations in abundance indices can be explained by the strength of the cohorts supporting the fishery. The rise in the abundance indices in 1994 and 1995 is probably due to the growing contribution of the cohorts produced in the early 1990s. Shrimp recruitment has fluctuated considerably since 1982. However, the fact that the fluctuations in the various fishing areas have occurred at the same time suggests that environmental factors affecting the entire Gulf could have a major influence on larval survival as well as larval exchange between areas. Also, the probable decline in the predation of shrimp by certain groundfish (cod, redfish, turbot) may have had an impact on the total productivity of shrimp by favouring survival at all stages of development but without cancelling out the effects of fluctuations in recruitment. In this case, the productivity of shrimp populations would be higher now than in the mid-1980s.

The fishery in the next few years will depend on the cohorts produced during the first half of the 1990s. **The 1992 year-class, that should change sex in 1996 and reach the sizes fully retained by the gears and targeted by the fishers, seems as abundant as the 1991 year-class. It should contribute to maintaining the catch rates at a high level, similar to those of 1995 or at least higher than those of 1992.** The 1993 year-class, that should be fully recruited to the fishery in 1997, is well represented in Anticosti and Esquiman catches and surveys but not in Sept Îles. It is therefore difficult to forecast its global contribution to the fishery success in the Gulf before it grows and approaches the size at sex change. The strength of a cohort relative to its predecessors can be determined with more confidence as it grows and is retained by the trawls. In general, the abundance of shrimp smaller than 22 mm of cephalothorax length, which will support the fishery in the next years, is higher in 1995 than in 1992 in all areas.

A recruitment index has previously been estimated from commercial catches and was presented in the preceding resource assessments. This index was based on the number per unit of effort of shrimp smaller than 17 mm of cephalothorax length and was used to forecast the global catch per unit of effort a few years later. The behavior of this index appears to be quite variable and its predictive value is questionable; therefore, it has not been used in this assessment.

Experience has shown that the abundance of shrimp aggregations can change quite rapidly. In light of this, discussions on catch levels should be oriented towards a perspective of more than one year so that the chosen levels would be sustainable at

all resource abundance levels. The tools to yearly calculate the TACs in relation to the fluctuations in the resource are unavailable. Moreover, a cautious approach for the long term determination of the TACs seems particularily appropriate in relation to the future abundance of shrimp predators. Shrimp productivity in the Gulf is probably higher now than what it was when the predators were present. The return of the predators would probably cause an increase in mortality and it is likely that the shrimp aggregations would not be able to sustain an exploitation rate as high as it was when the predators were absent.

The catches of the Sept Îles, Anticosti and Esquiman Channel areas varied during the last years eventhough the TACs were stable. The catches varied along with the abundance levels: they were high in 1991, decreased in 1992 and increased in 1993, 1994 and 1995. The exact causes for the decrease in the 1992 landings are still uncertain. However, it seems that the fishers were unable to catch the TACs in using the same fishing strategy as the year before when the catches were 22% higher. One of the possible factors that caused the decrease is the strong decrease in catch rates in 1992 over 1991. Moreover, it is possible that the borders of the former management units prevented the fishers from accessing the best resource concentrations in the Sept Îles area; it is also possible that the fishers shared their effort between the shrimp and cod fisheries, the latter being still open at that time. In 1993, the TAC of Esquiman Channel area was reached, while those of the Sept Îles (corresponding to the combinaison of the TACs of the former Sept Îles and South Anticosti areas) and Anticosti areas were not caught. The TACs were finally reached in 1994 and 1995 in the three areas. It is possible that the TACs, in place since 1990, are at a level that allows catches to vary in relation to the resource abundance; in this case, this would result in the exploitation rates of the last years being relatively stable while these levels of catches happened to be sustainable.

The catches of the Estuary area have been relatively stable since several years. This area supports a spring fishery and when the egg-bearing female concentrations are good, the fishers can catch their TAC relatively rapidly. The 500 ton TAC has been in place since 1982 and turned out to be sustainable in the long term eventhough the abundance showed important fluctuations. However, the surface of the management unit decreased in 1993 when the management units were reorganized. The Estuary area no longer includes the southern sector of the Sept Îles area (the NAFO Division 4T sector) and thus it is possible that the exploitation rate increased in 1993 because the catches were restricted to the maritime estuary of the St.Lawrence.

To know more:

Savard, L. (ed.) 1994. Status Report on Invertebrates in 1993: Crustaceans and Molluscs on the Québec Coast and Northern Shrimp in the Estuary and the Gulf of St Lawrence. Can. Man. Rep. Fish. Aquat. Sci. 2257: x + 113 p.

Savard, L. (ed.) 1995. Status Report on Invertebrates in 1994: Crustaceans and Molluscs on the Québec Coast, Northern Shrimp and Zooplankton in the Estuary and the Gulf of St Lawrence. Can. Man. Rep. Fish. Aquat. Sci. 2323: xi + 132 p.

Mohn, R.K., D.G. Parsons and L. Savard. 1992. Report of Canadian Atlantic Fisheries Scientific Advisory Committee Special Meeting, Invertebrates and Marine Plants Subcommittee, Shrimp Management Alternatives, December 5-8, 1989, Ottawa, Canada. Can. Tech. Rep. Fish. Aquat. Sci. 1884: iv + 30 p.

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