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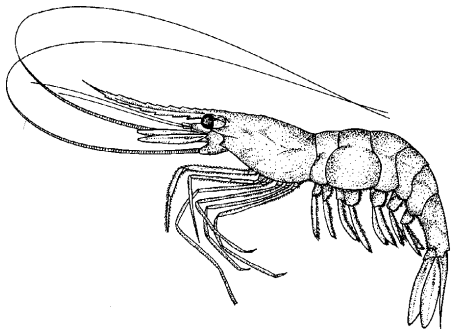
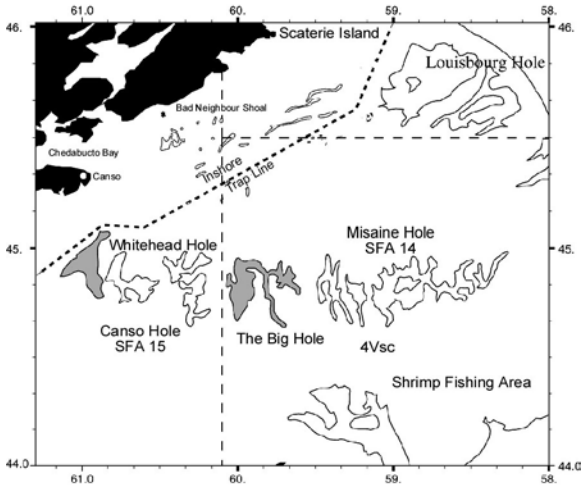
Maritimes Region **Stock Status Report C3-15(2002)**



Northern Shrimp on the Eastern Scotian Shelf (SFA 13-15)



Background

The northern or pink shrimp, Pandalus borealis*, is the only shrimp species of commercial importance in the Maritimes Region. Shrimp are crustaceans, and have a hard outer shell which they must periodically shed (molt) in order to grow. The females produce eggs once a year in the late summer- fall and carry them, attached to their abdomen, through the winter until the spring, when they hatch. Consequently, shrimp bear eggs, or are "ovigerous" for about 8 months of the year. Newly hatched shrimp spend 3 to 4 months as pelagic larvae, feeding near the surface. At the end of this period they move to the bottom and take up the life style of the adults. On the Scotian Shelf, the northern shrimp first matures as a male, at 2 years of age, and at age 4 it changes sex, to spend another 1 to 2 years as a female. Shrimp live 5 to 8 years, depending on conditions.*

Shrimp concentrate in deep "holes" on the eastern Scotian Shelf, but nearshore concentrations along coastlines closest to the offshore populations have recently been discovered. They prefer temperatures of 2 to 6 °C, and a soft, muddy bottom with a high organic content.

The trawl fishery on the Scotian Shelf has concentrated during summer in the offshore holes, and on an inshore area near the Bad Neighbor Shoal. The main management tools are limits on the number of licenses and size of vessels used, minimum codend mesh size (40mm), use of a Nordmøre separator grate, and a Total Allowable Catch (TAC). The fleet is divided into two sectors, a midshore sector consisting of vessels 65-100' LOA based in New Brunswick on the Gulf of St. Lawrence side, and an inshore sector consisting of vessels <65' LOA based on the Atlantic coast of Nova Scotia. A trap fishery, currently consisting of 10 active licenses, started in Chedebucto Bay in 1994. Three vessels are currently engaged in an experimental trap fishery in Mahone Bay on the South Shore.

Summary

- A decrease in the DFO-industry survey abundance index for the third consecutive year and below average recruitment confirms the continuation of a rapid population decline in 3 of the 4 survey areas. Abundance in a fourth area has continued to increase.

- Due to targeted fishing on dense shrimp concentrations, commercial catch rates (CPUEs) in the declining areas probably do not represent overall abundance.

- The strong 1995 year-class continued to support the fishery in 2002 but it is completing its life cycle and is declining. Incoming year-classes (1997-2000) which must support the fishery during the next few years are weaker. Pre-recruit surveys suggest that the 2001 year-class is stronger than the two preceding year-classes; these shrimp will not recruit to the fishery as females until 2006.

- The spawning stock (females) has remained stable and significantly higher than the period of low but increasing abundances in the late 1980s, however, it will decline as the 1995 year-class dies off.

- The decrease in TAC for 2002 has reduced overall exploitation from a high of 20% in 2001 to the long term average of 14% in 2002. The exploitation rate on females also decreased in 2002.

- The decrease in the TAC also decreased the proportion of the total catch taken during the ovigerous period from 35% in 2000 to only 9% in 2002.

- Groundfish predator abundance, and consequently shrimp natural mortality from predation, remain low.

- Temperatures in recent years were warmer than the cold period between the mid-1980s and mid-1990s which favoured increases in coldwater species suggesting that the environment may be becoming less favourable for shrimp.

- The TAC for 2003 should be no higher than 2002 in order to stabilize exploitation rates. Most of the biomass is now concentrated in SFA 14 and the catch should be removed primarily from this area to take advantage of the accumulated biomass of larger shrimp, and to prevent acceleration of the decline and prolong recovery in the other areas. It is not clear if this area can sustain present catch levels until recruitment improves.

The Fishery

The introduction of the Nordmøre grate in 1991 reduced groundfish bycatches to low levels (2-4%) and allowed the shrimp fishery to expand to its full potential. In 1996, the inshore (23 vessels <65' LOA) component of the trawler fleet moved from individual quotas (IQs) to individual transferable quotas (ITQs), while the midshore (6 vessels 65-100' LOA) moved from a competitive fishery to IQs. All vessels have been under ITQs since 1998. Temporary mobile licenses were introduced in 1998 as part of a co-management agreement to take advantage of increasing stock sizes and TACs, while facilitating effort reduction in the event of the rapid downturn often seen in shrimp fisheries. With the TAC decreased, temporary access was removed in 2002.

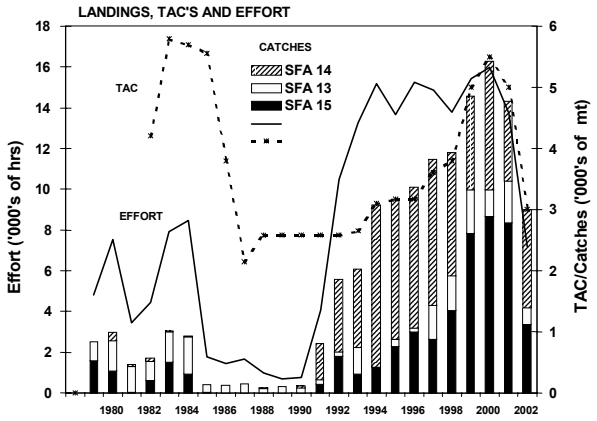
The TAC has essentially been caught every year since individual SFA quotas were combined into a single TAC in 1994, although there have been minor shortfalls due to late quota reallocations.

Landings (000s mt)

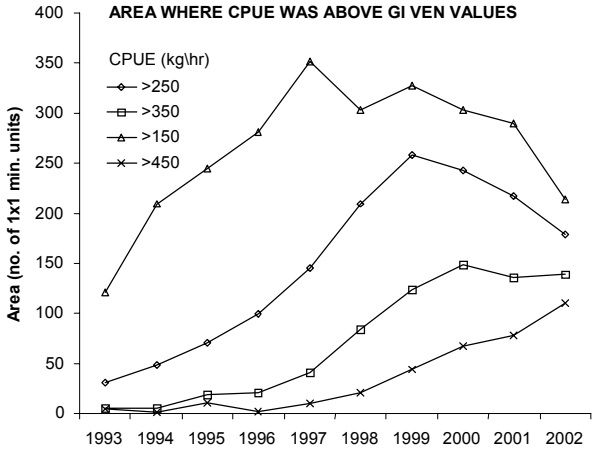
Year	1996	1997	1998	1999	2000	2001	2002[1]
TAC	3.2	3.6	3.8	5.0	5.5	5.0	3.0
Landings	3.4	3.8	3.9	4.9	5.4	4.8	3.0

[1]Landings projected to December 31, 2002.

The **temporal pattern** of the fishery has changed as TACs increased and fishers took longer to catch their quota. The amount of the catch taken during the egg-bearing period (August-April) increased significantly to 35% in 2000 but it decreased to only 9% in 2002 as a result of the TAC decrease.

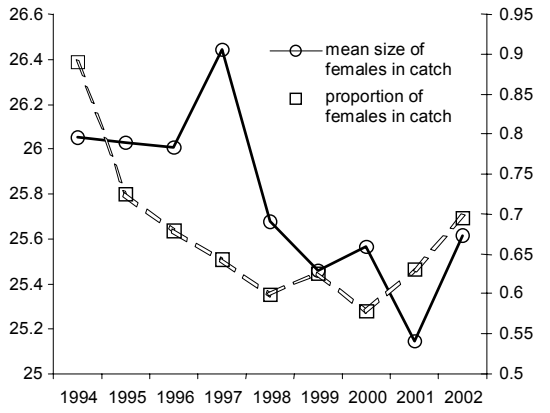


The **spatial pattern** of the fishery has also changed. Prior to 1999, most of the effort and catch was in the Misaine Hole (SFA 14), while fishing in other areas varied between years. In 1998, the N.S. trawler fleet (vessels <65' LOA) fished inshore in SFA 15 for the first time, taking 20% of the TAC in a small area near the Bad Neighbour Shoal. This rose to a maximum 44% of the catch in 1999, but decreased to 26% in 2002 as much of the effort shifted again to SFA 14 where most of the biomass was concentrated. The Gulf fleet is restricted to the offshore holes and did not exhibit this shift in effort. Spatial analysis of catch and effort data shows an overall increase in the area with very high catch rates, but a decrease in the area with moderate catch rates, consistent with increased aggregation of shrimp on the fishing grounds.



The **length composition** of the catch has changed in recent years and shows a progressive narrowing of the shrimp size distribution. A decrease in the number of smaller (<20mm) shrimp caught can be attributed to the increased use of square meshed codends beginning in 1996, and to decreased recruitment. A decreasing trend in the **average size of females** in the catch is interpreted to be due in part to the removal of accumulated older and larger animals in the population by the fishery. A decreasing trend in the **proportion of females** caught is due to the relatively good recruitment of males to the fishery before 2000. This trend then reversed as males became less abundant and the strong 1994 and 1995 year-classes dominated the population and catch as females. Average **Count** (numbers of shrimp per pound) data provided by industry show no trend and indicate that fishers continue to have no difficulty in staying below the 65 count limit to obtain maximum prices. In fact, counts decreased and average female size increased considerably in 2002 as the biomass accumulated in the larger sized shrimp due to decreased recruitment, and possibly due to size-

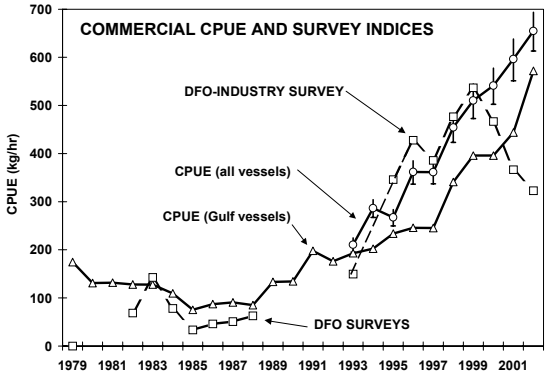
specific concentration of these sizes on the fishing grounds.

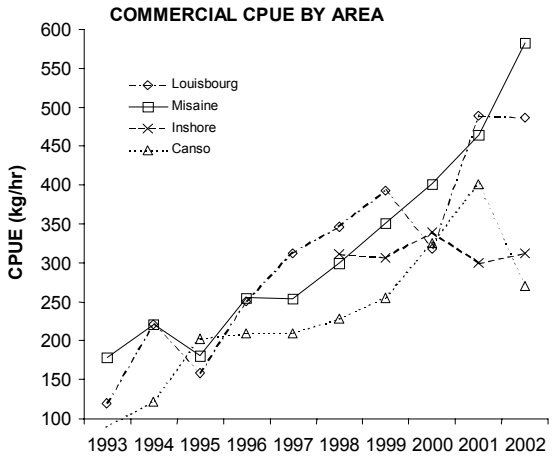


The trap fishery off Canso (SFA 15) continued to have above average catch rates in 2002, possibly due to increased inshore migration of ovigerous females. This may be related to the increased aggregation of shrimp mentioned above. The small Mahone Bay (SFA 16) fishery caught considerably less in 2002 than the previous year (7 versus 19 mt) due to a large decrease in effort unrelated to resource availability.

Resource Status

Assessments are based on two commercial catch rate (CPUE) indices (Gulf vessels only 1978-2002, and all vessels 1993-2002) obtained from trawler logbooks, samples from commercial trawl and trap catches (since 1995), a DFO shrimp survey (1982-88), a DFO-industry shrimp survey (since 1995), and logs from the trap fishery.

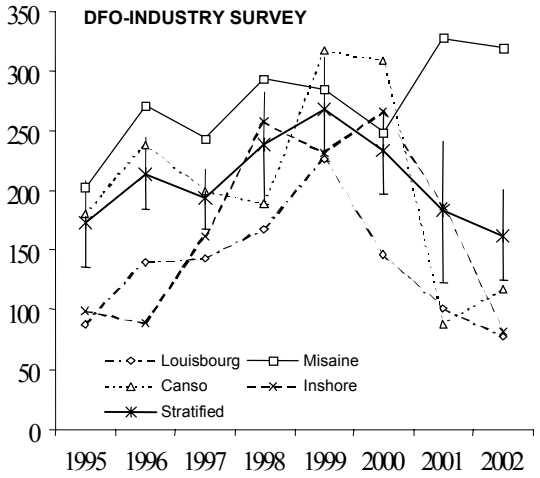




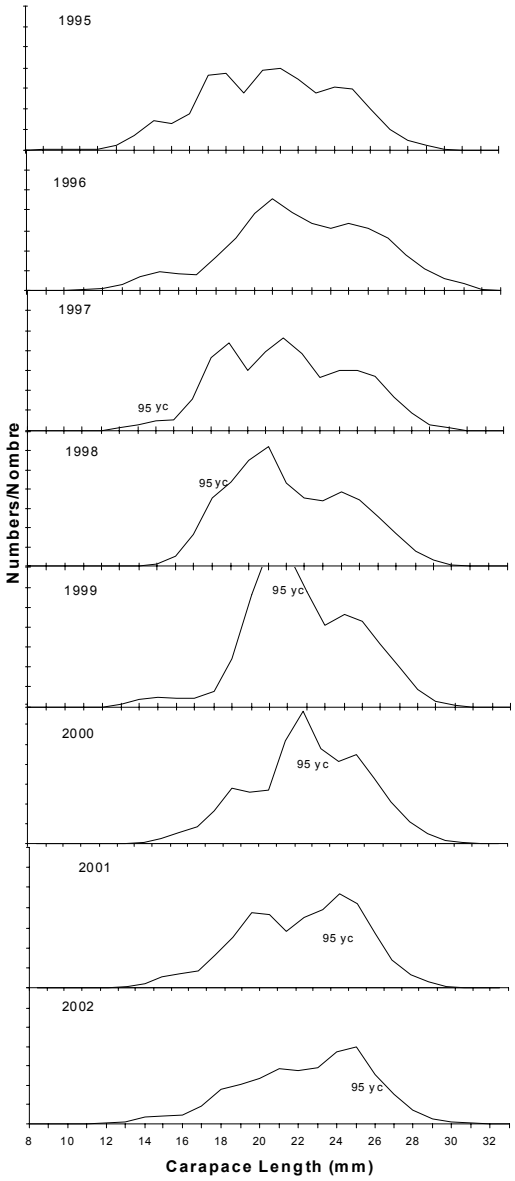
The two commercial **CPUE** indices continue to show an increasing trend, and were the highest in 2002 for both series. However, spatial analyses of commercial and survey data and the decrease in the survey abundance index (see below) indicate that commercial CPUEs may no longer be representative of abundance in Louisbourg, Canso, and the inshore.

The overall DFO-industry survey **abundance** index decreased for the third consecutive year indicating the continuation of a population decline first observed in 2000. From 1999 to 2001/2002, survey abundance in 3 of the 4 areas decreased to the lowest, while the fourth area (Stratum\SFA 14\Misaine) has continued to increase to the highest levels observed in the eight year series. The **spawning stock**

biomass (female) has remained relatively stable at a level higher than the period of low but increasing biomasses in the 1980s.



SURVEY POPULATION ESTIMATES AT LENGTH

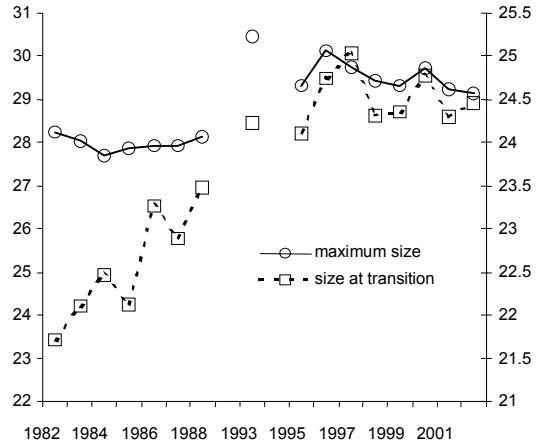


The survey **age composition** during the last few years has been dominated by the strong 1994 and 1995 year-classes, which were near the end of their life cycle in 2001-2002, and comprised the largest distinguishable mode in the length frequency in terms of length and abundance. **Abundance of age 4 shrimp** in 2002 (i.e. 1998 year-class shrimp that will be entering the fishery as females in 2003) was the second lowest in the series after the very poor 1996 year-class. The **abundance of**

age 2 shrimp is also below average but this estimate may be unreliable. **Juvenile (0-group)** surveys conducted from 2000-2002 suggest that the 2001 year-class is larger than others in recent years, however this series is short and its reliability has not been established. Consequently recruitment to the fishery does not appear to be good for the next 2-3 years.

Due to the decrease in the TAC, the **exploitation index** based on catch weight and the survey biomass decreased from about 20% in 2001 to 14% in 2002. The **female exploitation index**, based on the survey spawning stock biomass estimate and the catch of females from commercial samples, also decreased from 20% in 2001 to 13% in 2002.

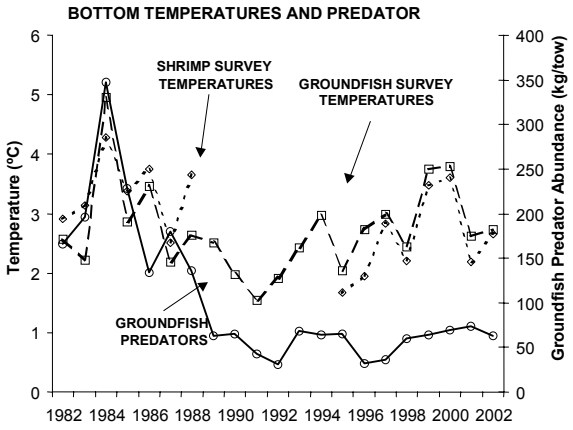
Decreases in average **size at sex change** and **maximum size** are associated with population downturns, possibly due to decreased population fecundity (smaller shrimp produce fewer eggs). Size at sex change and maximum size have shown a slight decreasing trend during the 1990s, possibly caused by warmer temperatures which increased growth rate and decreased size at sex change and maximum size. However, size at sex change and maximum size remain substantially larger than the period of low abundance in the 1980s.



Regarding **ecosystem considerations**, feeding studies have shown that shrimp are important prey for many groundfish species and significant negative correlations between shrimp and groundfish (that eat shrimp) abundance have been demonstrated from the Gulf of Maine to the Newfoundland Shelf. Many groundfish stocks remain at low levels on the eastern Scotian Shelf and **natural mortality** due to predation is probably below the long-term average and probably not a factor in the recent decreases in the shrimp population.

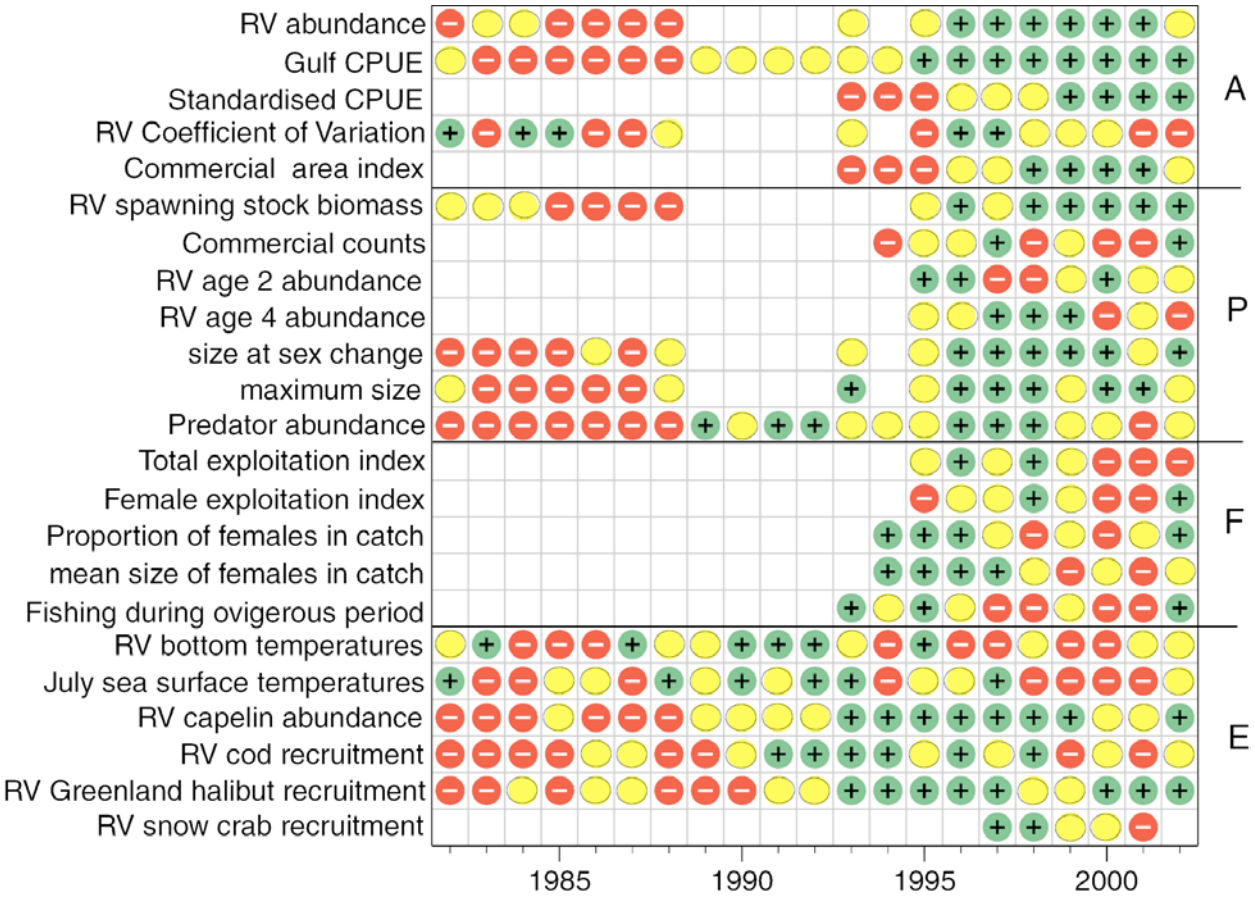
Population fluctuations of northern shrimp stocks near the southern limits of the species range also show negative correlations with water temperatures. On the Scotian Shelf, the population increase since the late 1980s may be associated with colder surface and bottom **water temperatures**. There has been a warming trend in the 1990s and recruitment of some important cold water indicator species including capelin and snow crab has decreased recently, but Greenland halibut has not shown such a trend. While this suggests that a shift may be occurring to conditions also less favorable for shrimp, bottom temperatures still remain within the species' preferred range. In addition, there is no clear indication that fishing

has primarily caused the recent decline. An area which has experienced low exploitation rates has declined in parallel with others that have been fished harder, while another area which has also been fished hard has continued to increase. This, together with the continuing stable and high spawning stock biomasses, indicates that the cause of the current decline is due at least in part to environmental factors.



The figure below provides a summary of 23 indicators related to the health of the eastern Scotian Shelf shrimp stock. Each indicator was assigned a color for every year there is data according to its percentile value in the series i.e. >0.66 percentile = green or good, 0.66-0.33 = yellow or intermediate and <0.33 = red or bad. It should be noted that these boundaries, although consistent across indicators, may not be appropriate for some and need to be refined. Indicators have been grouped into stock characteristics of abundance (A), production (P), fishing effects (F) and ecosystem (E).

The overall improvement in the traffic light table (10 green and 3 red lights in 2002 versus 7 green and 10 red in 2001) is encouraging but should be interpreted cautiously. Although the two commercial CPUE indicators are green, they are not currently representative of overall abundance, and the most reliable indicator (RV abundance) has declined into the yellow zone. Four of the seven production indicators are yellow or red and the count indicator is green only because decreased recruitment has resulted in the accumulation of the biomass in the larger sized shrimp. Fishing mortality indicators do show a marked improvement over previous years mainly due to the TAC decrease in 2002.



Note: Not all indicators in the Traffic Light table are discussed in the text. Please consult research document 2003/05 for further details.

Ecosystem indicators also appear to show some improvement but are ambivalent.

Outlook

The 1995 year-class, which has supported the fishery during the last few years, is at the end of its life cycle in 2002. Year-classes since then have been weaker and the population decline, which began in 2000, can be expected to continue for the next few years. Although the fishery may continue to enjoy high catch rates in the immediate future due to shrimp aggregation in some areas, it is unlikely that these can be sustained as the population continues to decline, the high density aggregations continue to be fished hard, or shrimp disperse again over a wider area. Juvenile surveys suggest that the 2001 year-class is larger than preceding year-classes, consequently, the present decline may not be reversed until this year-class recruits to the fishery (2006 as females).

The resource is declining rapidly, and biomasses in three of the four main fishing areas are now at the lowest values observed in the 8 year DFO-industry survey series. Catches in these areas should be minimized to decrease the risk of an accelerated downturn and prolonged recovery caused by the

combined negative impact of fishing and environmental factors such as occurred in the Gulf of Maine in the 1970s. On the other hand, abundance in SFA 14 (Misaine) has continued to increase to the highest values observed. It is expected that the bulk of the catch in 2003 will be taken from this area as fishers take advantage of the biomass accumulated as larger and older shrimp. Assuming that the biomass in this area will remain at the present level in 2003 and the catch is taken entirely from it, a catch of 3,000 mt will result in an exploitation rate of 25%, which is near the maximum this area has experienced in the past. However, it is unlikely that catches of this magnitude can be sustained if this area begins to decline as have the other areas.

For more Information

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