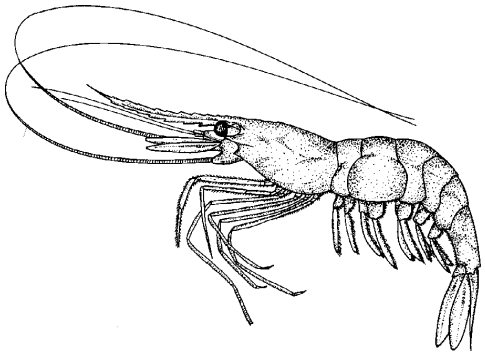
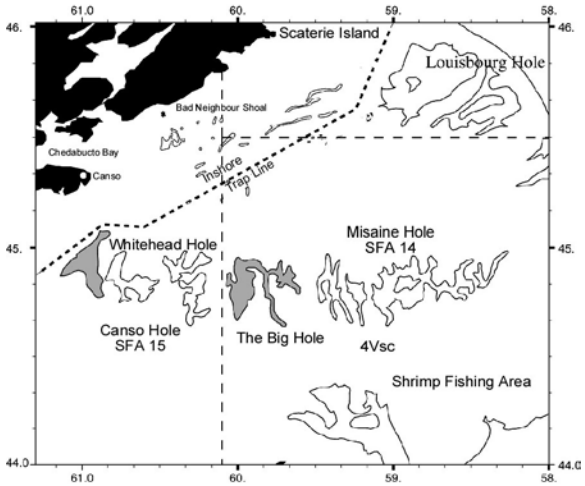


Northern Shrimp on the Eastern Scotian Shelf (SFA 13-15)



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 ºC, 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 9 active licenses, started in Chedebucto Bay in 1994. trap fishery in Mahone Bay on the South Shore.

Summary

- The DFO-industry survey abundance index increased for the first time in 3 years, suggesting that the recent population decline in 3 of the 4 survey areas bottomed out in 2002. Abundance in the fourth area (Misaine) remains high.

- Commercial catch rates (CPUEs) were the highest observed in the history of the fishery, but these have not been considered representative of abundance in most areas.

- The year-class recruiting to the 2004 fishery (1999) is about average. However, the 2001 year-class appears to be very strong. These shrimp should start to recruit to the fishery in 2005.

- The spawning stock (females) increased in 2003 to the second highest on record.

- Total exploitation and female exploitation indices in 2003 were the lowest observed.

- The proportion of the total catch taken during the ovigerous period was 32%, up from last year but lower than the peak in 2000 (37%).

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

- Bottom temperatures have declined since their peak in 2000. This may be related to improved recruitment as suggested by the strong 2001 year-class, however, surface temperatures are also associated with recruitment and these have remained relatively high.

- The distribution of the large 2001 year-class is widespread and fishers may have more difficulty avoiding small shrimp in 2004. This should be reviewed during the fishery.

- Current recruitment should support the 2004 fishery at least at the 2003 level. Most of the biomass is now concentrated in SFA 14 and the catch will likely be removed primarily from this area as fishers take advantage of the accumulated biomass of larger shrimp.

The Fishery

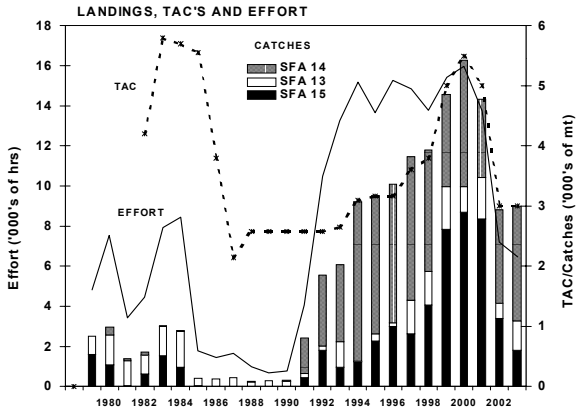
The introduction of the Nordmøre grate in 1991 reduced groundfish bycatches to low levels (2-4%) and allowed the shrimp fishery to expand to its full potential. In 1996, the inshore (23 vessels <65' LOA) component of the trawler fleet moved from individual quotas (IQs) to individual transferable quotas (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 and 2003.

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)

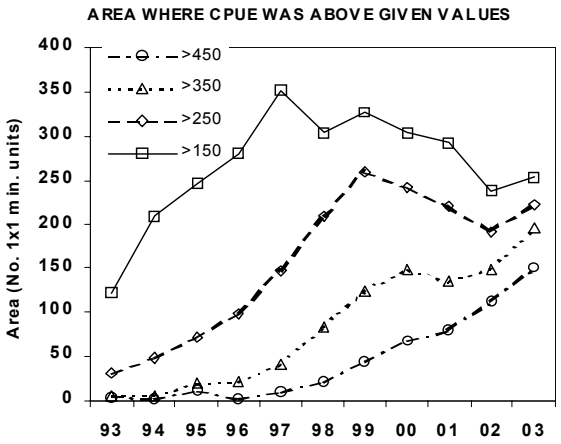
Year	1996	1997	1998	1999	2000	2001	2002	2003
TAC	3.2	3.6	3.8	5.0	5.5	5.0	3.0	3.0
Landings	3.4	3.8	3.9	4.9	5.4	4.8	2.9	3.0

[1]Landings projected to December 31, 2003.

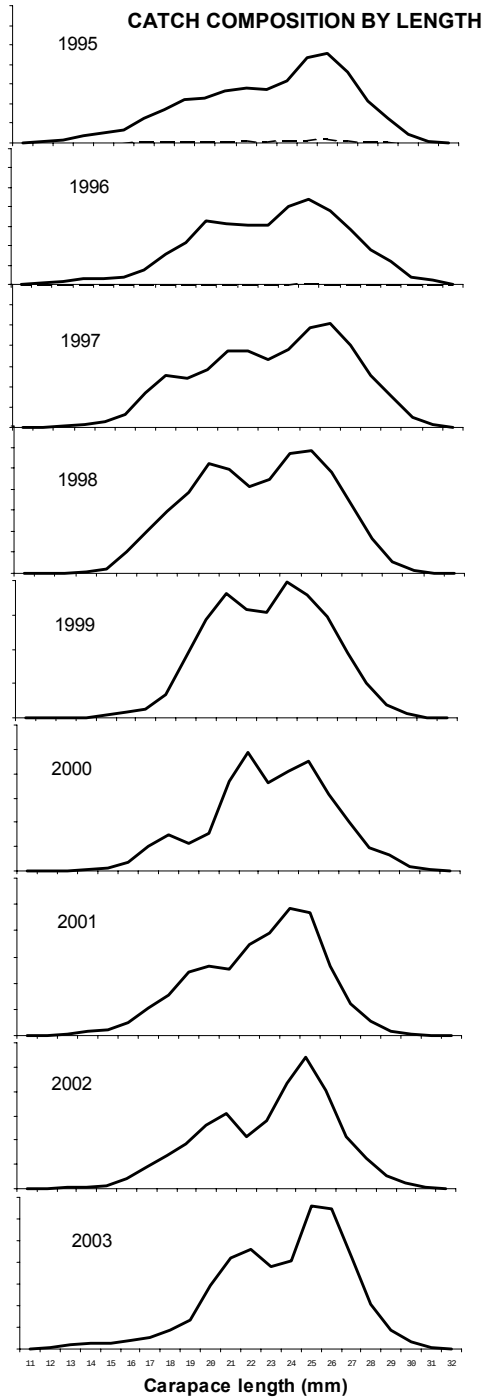


The **temporal pattern** of the fishery has changed considerably in recent years. The amount of the catch taken during the egg-bearing period (August-April) increased significantly to 37% in 2000 as fishers took longer to catch higher quotas, but it decreased to 25% in 2002 as a result of the TAC decrease (long term average – 23%). In 2003 this increased to 32% but this was primarily due to an unexpected summer slowdown to avoid "soft" shrimp, and may not reflect a longer term change in fishing patterns.

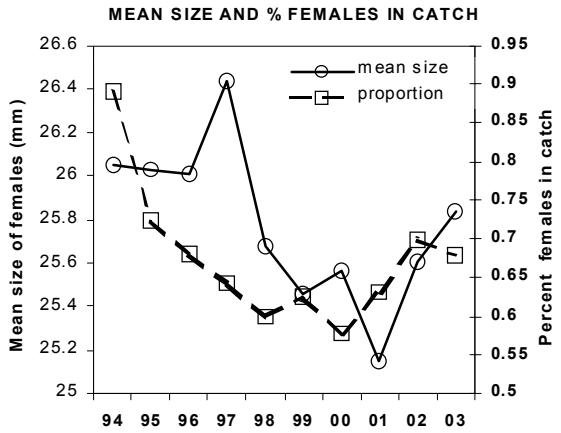
The **spatial pattern** of the fishery has also changed. Prior to 1999, most of the effort and catch was in the Misaine Hole (SFA 14), while fishing in other areas varied between years. In 1998, the N.S. trawler fleet (vessels <65' LOA) fished inshore in SFA 15 for the first time, taking 20% of the TAC in a small area near the Bad Neighbour Shoal. This rose to a maximum 44% of the catch in 1999, but has decreased to about 20% in 2003 as much of the effort shifted again to SFA 14 where most of the biomass now concentrates. 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 (>450 kg\hr) catch rates, but a decrease in the area with moderate catch rates, consistent with increased aggregation of shrimp on the fishing grounds. In 2003 there were signs that the aggregation was beginning to reverse, consistent with the increase in biomass observed in the survey. The widespread distribution of the large 2001 year-class suggests that this pattern may continue.



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 1993-1995 year-classes dominated the population and catch as females. Average **Count** (numbers of shrimp per pound) data provided by industry indicate that fishers continue to have no difficulty in staying below the 65 count limit to obtain maximum prices. Counts actually decreased and average female size increased considerably in 2002-2003 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.

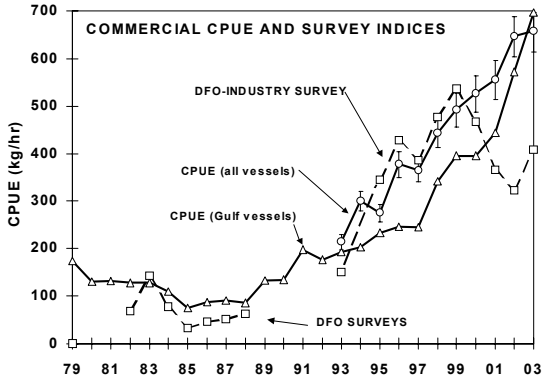


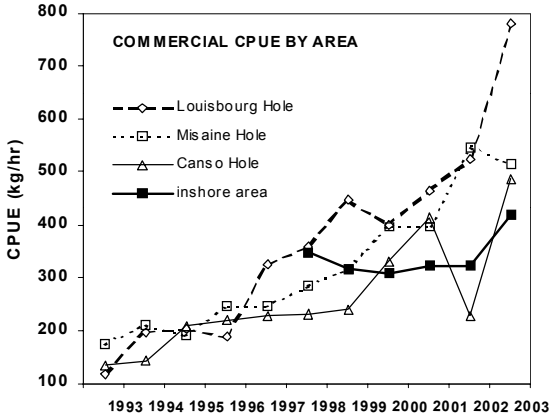
The trap fishery off Canso (SFA 15) continued to have above average catch rates during the 2002-2003 season. In addition, fishers in the northern part of Chedabucto Bay experienced exceptional catches. This may be related to the increased aggregation of shrimp within the inshore area and\or increased onshore migrations.

Resource Status

Assessments are based on two commercial catch rate (CPUE) indices (Gulf vessels only 1978-2003, and all vessels 1993-2003) 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.

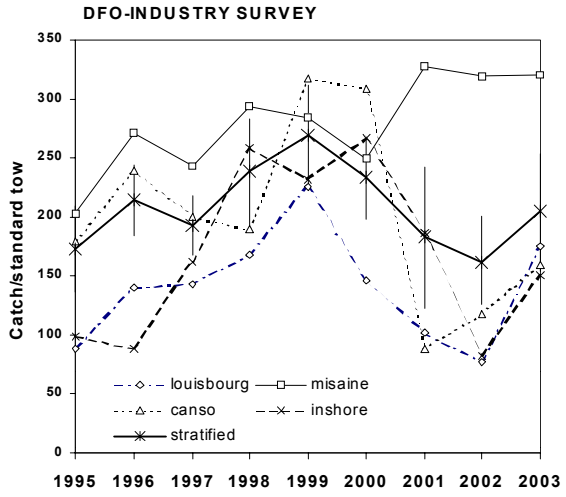
The two commercial **CPUE** indices continue to show an increasing trend, and were the highest in 2003 for both series. However, spatial analyses of commercial and survey data and the decrease in the survey abundance index (see below) indicate that commercial CPUEs were probably not representative of abundance in Louisbourg, Canso, and the inshore.



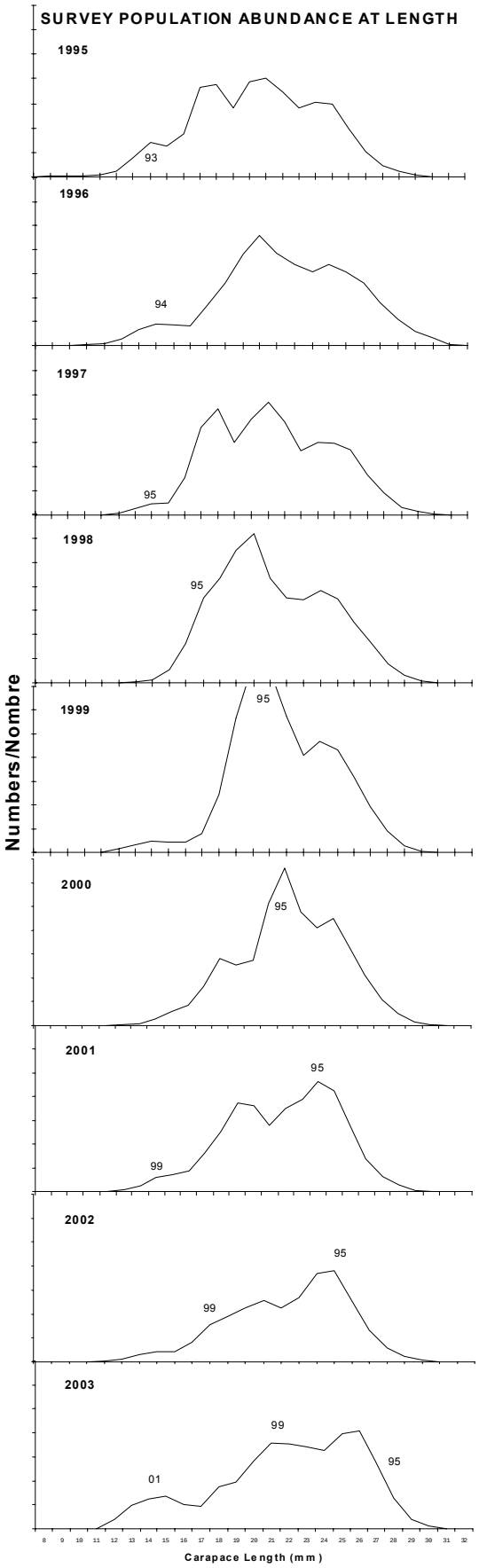


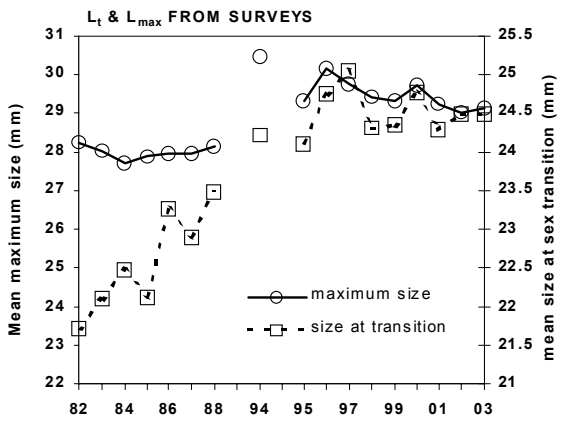
The overall DFO-industry survey **abundance** index increased in 2003 for the first time after a 3-year declining trend, suggesting that the decline, first

observed in 2000, has bottomed out. The decline was observed in 3 of the four survey areas while a fourth (Stratum\SFA 14\Misaine) has increased to the highest levels observed, which have been maintained for the last 3 years. The **spawning stock biomass** (female) increased in 2003 to the second highest on record and it has remained at a high level during the last 9 years relative to the period of low, but increasing biomasses, in the 1980s.



The survey **age composition** during the last few years has been dominated by the strong group of year-classes (1993-1995), which were near the end of their life cycle in the early 2000s. **Abundance of age 4 shrimp** in 2003 (i.e. 1999 year-class shrimp that will be entering the fishery as females in 2004) was about average. The **abundance of age 2 shrimp** (2001 year-class) in the standard survey is the highest observed in the series. Although this estimate is usually considered unreliable, the strength of this year-class has been confirmed by two independent **juvenile surveys**, which also found this year-class to be widely distributed.



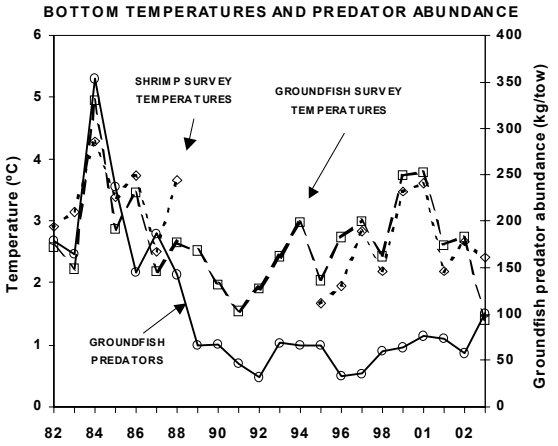


Largely due to TAC decreases, the indices for **total exploitation** and **female exploitation,** based on catch weight and the survey biomass, have decreased to about half of the maximum values (approximately 20%) observed in 2001.

Decreases in average **size at sex change** (L_t) and **maximum size** (L_{max}) 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 Greenland. 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 was probably not a factor in the recent decreases in the shrimp population.

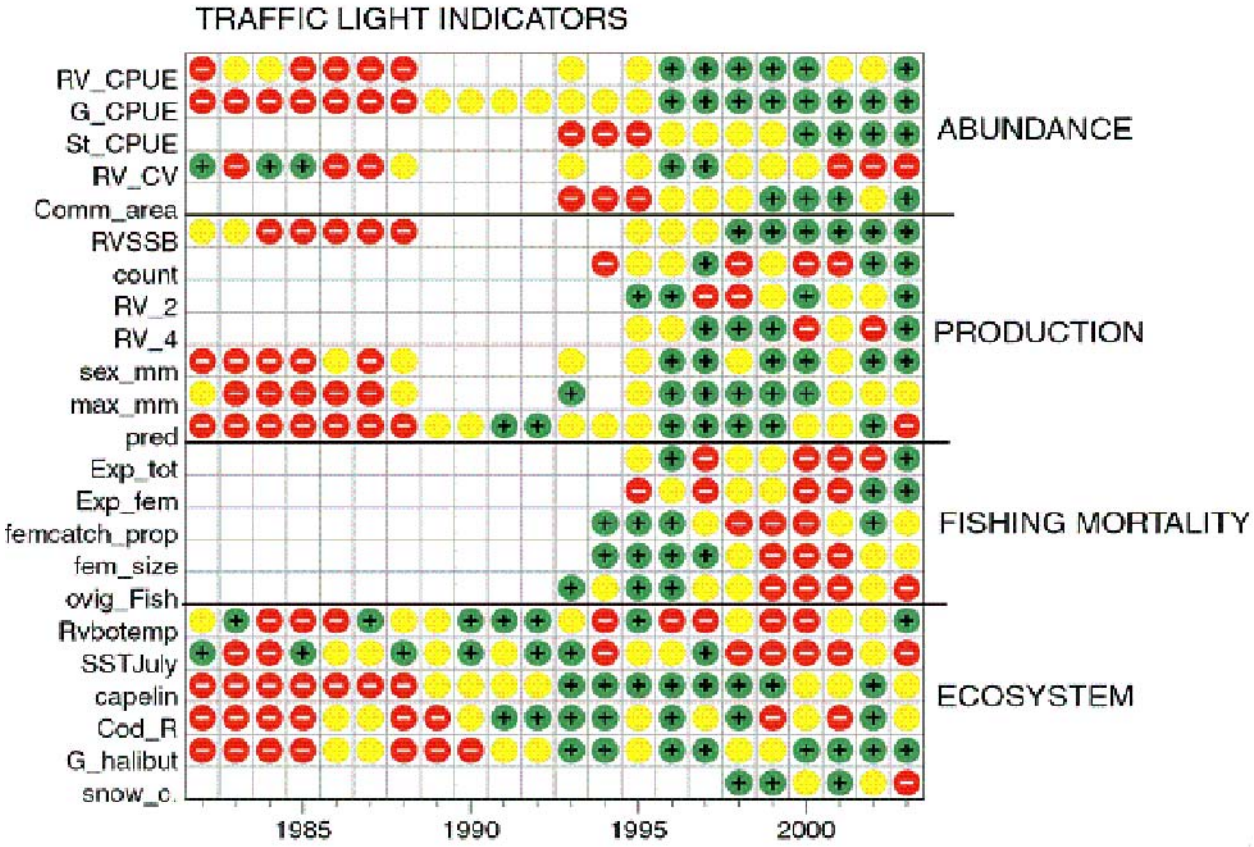
Population fluctuations of northern shrimp stocks near the southern limits of the species range also show negative correlations with water temperatures. On the Scotian Shelf, the population increase since the late 1980s may be associated with colder surface and bottom **water temperatures**. Warmer temperatures in the late 1990s may have contributed to decreased recruitment of some cold water indicator species including shrimp, capelin and snow crab, however, Greenland halibut has not shown this trend. Bottom temperatures appear to have cooled on the shrimp grounds since 2000 and may be related to the strong 2001 year-class. Continuing stable and high biomasses in the Misaine area despite relatively heavy fishing during the late 1990s, suggest that the cause of the recent decline in the other areas is due more to environmental factors than to fishing.



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, production, fishing effects and ecosystem.

The overall improvement in the traffic light table during the last two years (e.g. 13 green and 5 red lights in 2003 versus 7 green and 10 red in 2001) is encouraging, but should be interpreted cautiously. For example, the two commercial CPUE indicators are green, but are not currently representative of overall abundance. Fishing mortality indicators show a marked improvement during the last 2 years mainly due to the decreased TAC in 2002-2003. The majority of production indicators are now green due to improved recruitment.



Note: Not all indicators in the Traffic Light table are discussed in the text. Please consult CSAS Research Document 2004/001 for further details.

Ecosystem indicators have been somewhat ambivalent, with no strong signals that could suggest a regime shift. However, there has been a trend toward more yellow and red lights since the period of rapid shrimp biomass increases in the early 1990s.

Sources of Uncertainty

As with most research vessel survey estimates, DFO-industry shrimp survey results are associated with high variances. The spatial analyses which discounted commercial catch\effort indices in favor of survey results as correctly depicting recent abundance changes, are subject to interpretation. Age 2 recruitment estimates from the standard survey trawl are not considered consistently reliable, and such estimates from juvenile surveys are based on short time series. There is considerable subjectivity associated with assigning modal groups to year-classes in the length frequency analyses, consequently estimates of year-class strength and population numbers-at-age using these analysis must be interpreted cautiously. Although consistent, the boundaries between traffic lights are arbitrary and may not be appropriate for all indicators. The traffic light analysis is for discussion/consensus building purposes and is not intended to be definitive of stock health.

Outlook

The strong 1993-1995 year-classes, which supported the increasing TACs during the late 1990s were followed by weaker year-classes, decreasing biomasses, and lower TACs in the early 2000s. Despite this, the fishery continued to enjoy high catch rates and good counts as larger shrimp concentrated into dense aggregations.

After a three year decline, biomasses in three of the four main fishing areas appear to have bottomed out in 2002. The small increase in these areas observed in 2003, together with signs of improved recruitment, may signal the beginning of a biomass resurgence. However, biomasses in these areas are still relatively low. Abundance in SFA 14 (Misaine) remains near the highest values observed. The bulk of the catch in 2003 was again taken from this area as fishers took advantage of the biomass accumulated as larger and older shrimp. A similar situation can be expected in 2004.

Abundance of 4 year old shrimp in 2003 was about average. These shrimp will recruit to the 2004 fishery as females and should sustain it at least at the 2003 level. Two independent juvenile surveys and the standard survey indicate that the 2001 year-class is very strong. It is not possible to determine if this signals the beginning of another round of above average year-classes such as occurred in the early to mid 1990s, but the decreased temperatures since 2000 suggest that this may be the case. If so, biomasses can be expected to continue increasing, especially when the 2001 year-class begins to recruit significantly to the fishery in 2005 as males. In 2004, the average carapace length of this year-class will probably be below <20mm, with an average count >100 individuals per pound, consequently it may be more difficult for fishers to avoid small shrimp.

For more Information

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References

Koeller, P. 2000. Relative importance of environmental and ecological factors to the management of the northern shrimp (*Pandalus borealis*) fishery on the Scotian Shelf. J. Northwest Atl. Fish. Sci. 27: 21-33.

Koeller, P., M. Covey, and M. King. 2004. An assessment of the eastern Scotian Shelf shrimp stock and fishery for 2003 and outlook to 2004. DFO Can. Sci. Adv. Sec. Res. Doc. 2004/001.

Koeller, P., L. Savard, D. Parsons, and C. Fu. 2000. A precautionary approach to assessment and management of shrimp stocks in the Northwest Atlantic. J. Northw. Atl. Fish. Sci. 27:235-247.

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