Fisheries and Oceans Canada | Pêches et Océans Canada
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Maritimes Region

Canadian Science Advisory Secretariat
Science Advisory Report 2015/004

ASSESSMENT OF NORTHERN SHRIMP ON THE EASTERN SCOTIAN SHELF (SFAS 13-15)

(J. Domm 2006)

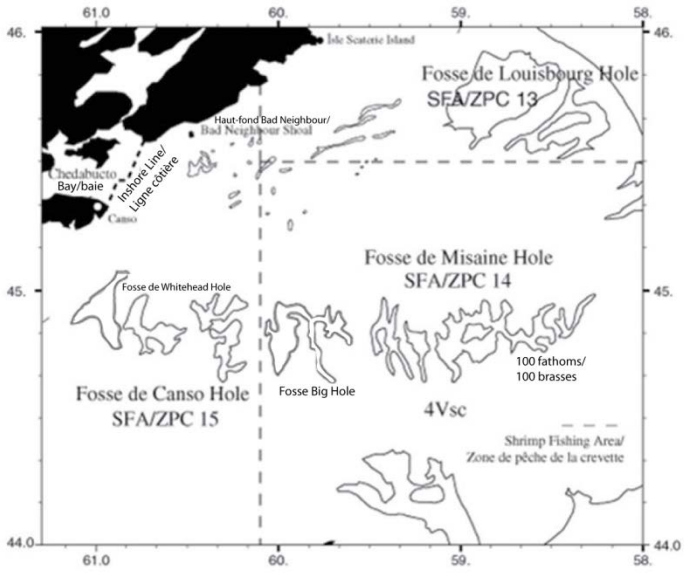

Figure 1. Shrimp Fishing Areas (SFAs) on the Eastern Scotian Shelf.

Context

Advice on the status of the Eastern Scotian Shelf shrimp stock is requested by DFO Fisheries and Aquaculture Management Branch and industry to help determine a Total Allowable Catch (TAC) that is consistent with the management plan. Annual assessments are required because of rapid changes in abundance, variable recruitment to the population and fishery, and changes in the size of shrimp available for harvest. The resource is near the southern limit of the species' distribution where it is thought to be more vulnerable to significant and rapid declines, as has been observed in the Gulf of Maine and southern Newfoundland stocks. The current report provides information and advice for management of the 2015 fishery.

The trawl fishery on the Scotian Shelf occurs primarily during late spring and early summer with some fishing during fall, in the deep offshore shrimp "holes", and on an inshore area near the Bad Neighbour 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 TAC. This fleet (about 14 active vessels) is divided into two sectors, a sector consisting of vessels 65-100' Length Over All (LOA) based in New Brunswick in the DFO Gulf Region, and asector consisting of vessels mainly <65' LOA based in the DFO Maritimes Region. A trap fishery, currently consisting of 7 active vessels is restricted to Chedabucto Bay. All licenses except traps operate under Individual Transferable Quotas (ITQs). Stock assessments have been conducted annually based on indicators from commercial, scientific survey, and environmental monitoring data.

This Science Advisory Report is from the November 27, 2014, Assessment of Eastern Scotian Shelf Shrimp. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

- As of November 17, 2014, 4,041 mt of the 4,500 mt Total Allowable Catch (TAC) for 2014 had been landed.
- Both the Gulf and Standardised catch per unit effort (CPUE) indices decreased by approximately 30%, which was a divergence from the survey CPUE, which remained high.
- Based on the survey, the total biomass estimate of 39,381 (95% confidence interval 32,435-46,328) mt remained approximately stable at a high level in 2014, decreasing only 1.5% from 2013.
- The spawning stock biomass (SSB, females) point estimate (20,359 mt) remained approximately stable well above the upper stock reference (USR) of 15,558 mt, decreasing only 1.5% from the 2013 value.
- The 18% increase in the TAC for 2014 (to 4500 from 3800 mt in 2013) to capitalise on the high fishable biomass of the abundant 2007-2008 year classes was sufficiently precautionary to maintain female exploitation at 15%, below the 20% removal reference for this stock.
- The moderately abundant 2007-2008 year classes continue to provide a detectable signal in the trawl survey and commercial catches, and make up most of the high fishable and spawning stock biomass, supplemented by less abundant subsequent year classes.
- Cohort tracking in length frequency distributions from survey and commercial samples corroborates the low belly-bag indices from 2010-2013 in predicting low contributions of the 2009-2012 year classes to fishable and spawning stock biomass.
- The very high value of the 2014 belly-bag index suggests strong juvenile recruitment from the 2013 year class, which should begin to recruit to the fishable biomass in 2016 if survival conditions are suitable.
- As predicted in recent assessments, the stock is beginning to decline, as the 2007-2008 year classes approach the end of their expected lifespan.
- Although cooling spring sea surface temperatures and very low cod recruitment suggest conditions will be favourable for shrimp, the increase in abundance of shrimp predators, warm bottom temperatures, and continued low or declining abundance of sympatric coldwater species suggest the opposite.
- Although the stock is expected to continue to gradually decline in 2015, the high fishable and spawning stock biomass in 2014 suggests that a *status quo* TAC will not exceed the removal reference in 2015. However, given the small size of the 2009-2012 year classes, reactive TAC reductions will be required if the stock declines towards to the Cautious Zone.

BACKGROUND

Species Biology

The Northern or Pink Shrimp, *Pandalus borealis*, is the only shrimp species of commercial importance in the DFO Maritimes Region. Shrimp are crustaceans that have a hard outer shell, which they must periodically shed (molt) in order to grow. Females generally produce eggs once a year (not more) in the late summer-fall and carry them, attached to their abdomen until the spring, when they hatch. Consequently, shrimp bear eggs, (i.e., are "ovigerous") for about 8 months of the year. Newly hatched shrimp spend 3-4 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 age 2, and generally changes sex at age 4, to spend another 1-2 years as a female. They generally live up to 8 years depending on environmental conditions and population dynamics. Shrimp concentrate in deep "holes" (>100 fathoms) on the Eastern Scotian Shelf (Figure 1), but nearshore concentrations along the coastline were discovered in 1995 by the DFO-Industry survey. In general, Northern Shrimp prefer temperatures of 2-6ºC, and a soft, muddy bottom with a high organic content.

The Fishery

The fishery consists of 28 DFO Maritimes Region-based licenses (fished by 9 vessels in 2014), mostly <65' length overall (LOA), and 14 DFO Gulf Region-based licenses (fished by 5 vessels in 2014) 65-100' LOA. All mobile licenses have been under Individual Transferable Quotas (ITQs) since 1998. A competitive trap fishery with 14 licenses (7 active in 2014) is largely restricted to Chedabucto Bay. The fishery operates under an "evergreen" management plan, which documents sharing agreements between fleet sectors.

Although there has been some shrimp fishing on the Scotian Shelf since the 1960s, the Nova Scotia fishery began to expand toward its full potential only when groundfish bycatch restrictions were overcome with the introduction of the Nordmøre grate in 1991. The total allowable catch (TAC) was first reached in 1994 when individual Shrimp Fishing Area (SFA) quotas were combined into a single TAC (Table 1, Figure 2). Since that time there have been some minor shortfalls associated with re-allocations of uncaught trap quotas to the mobile fleet late in the season. More substantial shortfalls occurred in 2005-2008 unrelated to resource availability. The gap between the TAC and catch has narrowed since 2005 as problems associated with market conditions and quota reallocations have been resolved.

As of November 17, 2014, 4,041 mt of the 4,500 mt TAC for 2014 had been landed. Commercial indices make use of all available data up until the assessment. Although trap fishing effort and catches had decreased to negligible amounts from 2005-2010 (e.g., 1 mt in 2010), there have been considerably higher landings since 2011. The trap fleet landed 224 mt in 2013 and 122 mt had been landed as of November 17, 2014 (fishing is ongoing). The mobile fleet continues to prefer a single quota to all SFAs because of the flexibility this offers in obtaining favourable combinations of good catch rates and counts (shrimp sizes).

Table 1. Recent shrimp TACs and landings ('000s mt) for SFAs 13-15

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
TAC	3.0	3.5	5.0	5.0	5.0	5.0	3.5	5.0	4.6	4.2	3.8	4.5
Landings	2.8	3.3	3.6	4.0	4.6	4.3	3.5	4.6	4.4	4.1	3.6	4.0[1]

[1]Landings to November 17, 2014.

The spatial pattern of the fishery catch has changed significantly over the years (Figure 2), reflecting changing distributions of biomass and size frequencies. In general, the bulk of the catch is taken from SFAs 14 and 15, although a large part of the TAC (57%) was taken in SFA 13 in 2004. Since then, effort has shifted back mostly to SFAs 14 and 15.

The fishery is open year round. Historically (up to 2009), however, fishing has begun in April and a large proportion of the catch has been taken by June, at which time fishing generally stops to avoid the moulting period. Fishing generally resumes in September-October and continues until December if catch rates and shrimp condition are suitable. In recent years, fishing has been starting earlier in the calendar year (as early as late-January), although it generally ceases in July-August and resumes in the fall.

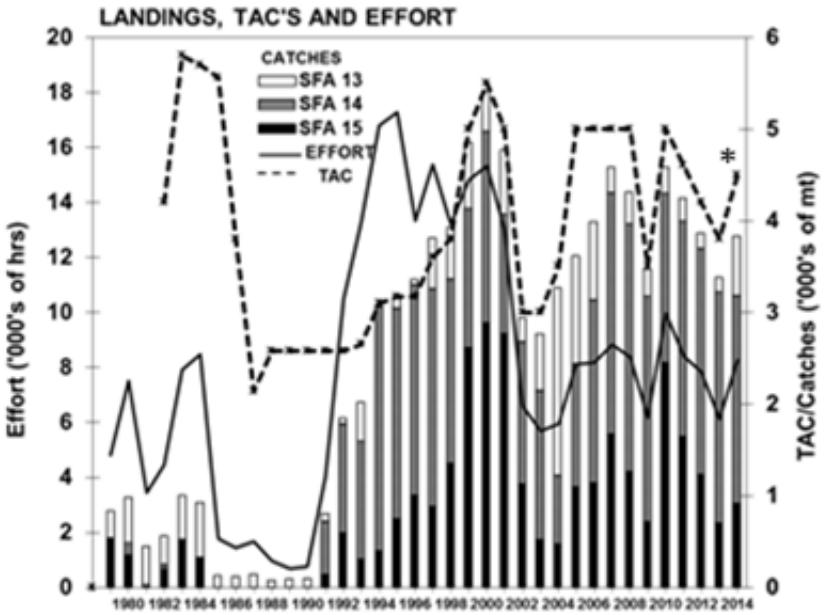

Figure 2. Landings, TACs, and Effort. The 2014 data, denoted by an asterisk on the figure, represents data up to November 17, 2014.

ASSESSMENT

Stock Trends and Current Status

After a sustained long-term increase commercial Catch Per Unit Effort (CPUE) indices levelled off and have been fluctuating at a high level since 2002, although both the Gulf and Standardised CPUE indices decreased by about 30% in 2014 (Figure 3A-B). The DFO-Industry trawl survey has shown two previous divergences from CPUE trends (Figure 3A). The first, between 2000 and 2003, was attributed to changing spatial distribution patterns of the relatively large 1994-1995 year classes, as these moved through the population and died off. The second, between 2005 and 2008, was at least partly due to a problem with the attack angle of the Nordmøre grate in the survey trawl. The direction of the 2014 divergence differs from past divergences because commercial CPUE declined while the survey CPUE remained high.

Commercial fishers from the DFO Gulf Region reported that abundant sea-ice and high winds made fishing difficult and resulted in low catch rates in March and April. Later in the season, they reported that the stock was evenly distributed with good catch rates, but lacked very dense aggregations of shrimp that account for very high catch rates in some recent years. This, and the stable survey CPUE index, is corroborated by the analysis of the distribution of areas of ranges of different catch rates, which showed a decline in the area of the highest catch rates (>450 kg/h) and increases in the areas of moderate catch rates (251-350 and 351-450 kg/h). Preliminary analysis of comparative fishing suggests that recent changes to the survey trawl have not affected the survey index. The reasons underlying this divergence will be further investigated in an upcoming framework assessment meeting tentatively planned for March 2015.

Based on the survey index, the total biomass estimate of 39,381 (32,435-46,328) mt remained approximately stable at a high level in 2014, decreasing only 1.5% from 2013. This value is only 15% lower than the peak in 2009. Similarly, the spawning stock biomass (SSB, females) point estimate (20,359 mt) remained approximately stable well above the upper stock reference (USR) of 15,558 mt,

decreasing only 1.5% from the 2013 value (Figure 4A). Although confidence limits around the SSB point estimate are not quantified and there is some uncertainty around this index, the SSB point estimate is well above the USR for 2014. The 18% increase in the TAC for 2014 (to 4500 from 3800 mt in 2013) to capitalise on the high fishable biomass of the abundant 2007-2008 year classes was sufficiently precautionary to maintain female exploitation at 15%, below the 20% removal reference for this stock (Figure 5). Both total and female exploitation indices remained low and relatively stable at 10% and 15%, respectively (Figure 4B).

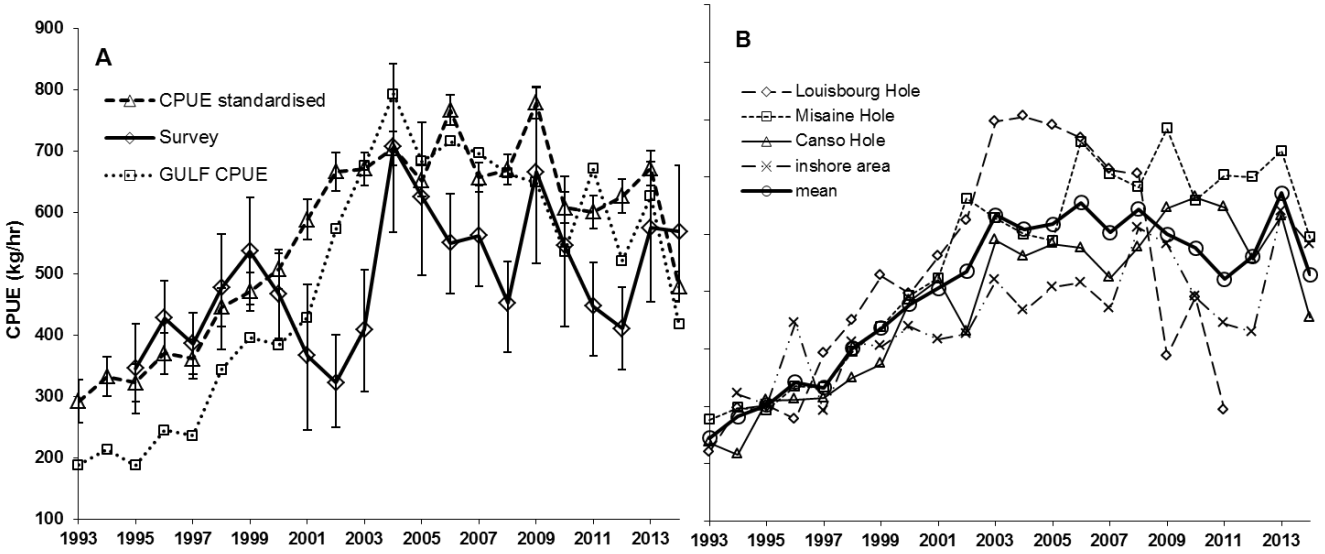

Figure 3. A – Commercial and survey CPUEs and B – unstandardised commercial CPUEs by stratum.

The interpretation of year class strength and longevity is complicated by a number of factors including: the low catchability of shrimp younger than age 4; the strong influence of growth rate on the catchability of age 4 shrimp; difficulty in distinguishing and assessing year classes after age 3; and changing longevities and natural mortalities associated with environmental or density dependent influences. Furthermore, the tendency of a single year class, especially large ones such as 2001, to change sex over a number of years makes it difficult to distinguish them from adjacent year classes. Nonetheless, the recruitment pulses of 2001 and 2007-2008 coincide with the maturation of strong year classes, i.e., 1993-1995 and 2001, respectively. Likewise, the very high value of the belly-bag index for 2014 (Table 2), which is the second highest on record, coincides with the maturation of the strong 2007-2008 year classes providing further evidence that strong year classes have produced large spawning stock biomasses.

The moderately abundant 2007-2008 year classes continue to provide a detectable signal in the trawl survey (Figure 6) and commercial catches (Figure 7), and make up most of the high fishable and spawning stock biomass, supplemented by less abundant subsequent year classes. As predicted (DFO 2014), the stock is beginning to decline, as the 2007-2008 year classes approach the end of their expected lifespan. Cohort tracking in length frequency distributions from survey and commercial samples corroborates the low belly-bag indices from 2010-2013 in predicting low contributions of the 2009-2012 year classes to fishable and spawning stock biomass. Results of modal analysis indicate that the abundance of age 2 shrimp is very low, which is consistent with the very low belly-bag index in 2013, and the age 4 cohort was indistinguishable from the 2007-2008 cohorts likely because the latter underwent sex transition over a number of years (as discussed above), and because the former is not very abundant. Based on these data, total and spawning stock biomass are likely to continue to

gradually decline in 2015, as the 2007 and 2008 year classes decline and are replaced by less abundant cohorts.

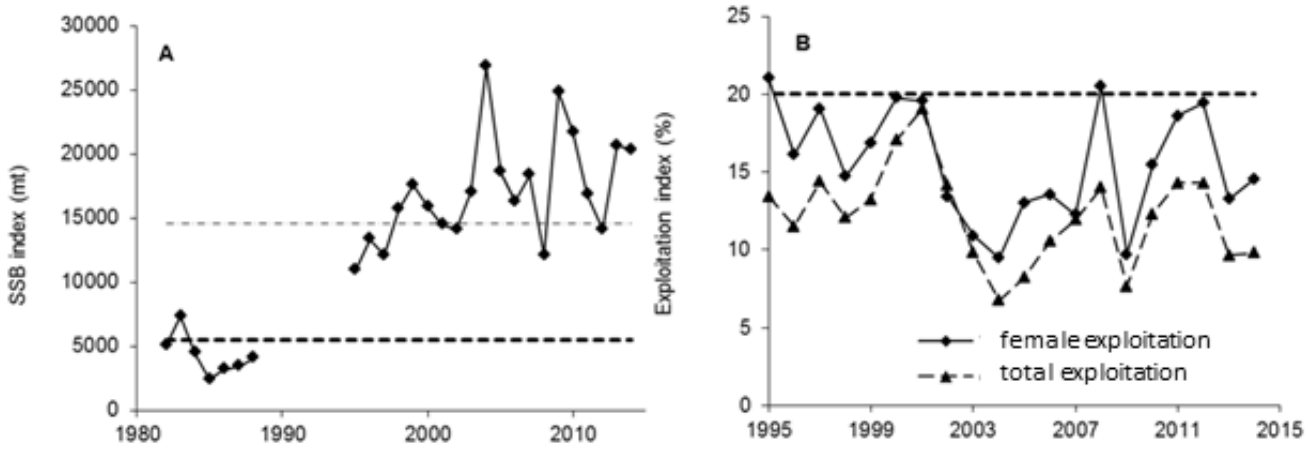

Figure 4. A - Changes in the spawning stock biomass index for the Eastern Scotian Shelf shrimp population. The dashed lines show the upper and lower limit reference point. B - Changes in the exploitation indices for the Eastern Scotian Shelf shrimp fishery. The dashed line shows the limit reference point of 20% for the female exploitation index.

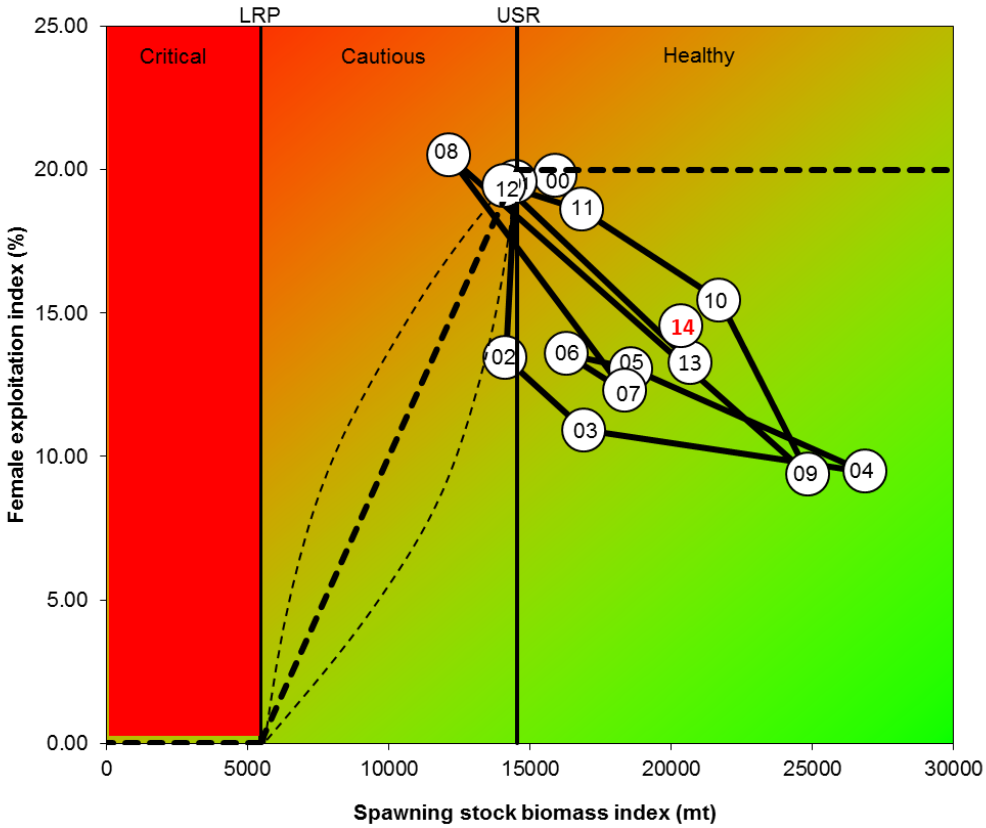

Figure 5. Graphical representation of the precautionary approach for Scotian Shelf shrimp. The dotted lines in the cautious zone represent a range of management actions possible, depending on whether the stock is stable, increasing or decreasing, or on trends in other indicators of stock or ecosystem health. LRP = limit reference point; USR = upper stock reference.

Table 2. Minimum survey population numbers at age from modal analysis. Numbers x 10^6.

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Avg.
1[1]	-	-	-	-	980	196	316	198	61	194	484	567	263	97	113	25	790	316
2	40	166	280	175	134	616	354	187	121	39	114	304	188	85	348	302	125	215
3	785	27	757	362	383	312	3118	652	880	506	396	267	1020	752	1018	1157	628	754
4	1884	3010	0[4]	1184	399	1506	839	4502	0[4]	0[4]	1190	463	1036	1044	1022	1693	0[4]	1428
5+	2047	1952	3374	2110	1847	1727	3324	2224	5106	5506	3017	6020	4109	2488	1666	2398	4980	2891
TOTAL	4755	5155	4412	3831	2763	4161	7636	7763	6169	6244	5201	7622	6616	4467	4167	5574	6523	5161
Age 4+ males[2]	2243	3235	1784	1771	938	1526	1549	4956	3916	2804	3317	4263	3454	1755	1211	1032	3276	2424
Primiparous[3]	889	736	728	817	678	551	870	786	771	1739	892	1492	1324	930	281	860	659	868
Multiparous	647	991	863	706	630	1188	1698	1183	480	1157	482	1295	630	945	1309	2224	1835	885
Total females	1535	1727	1591	1523	1308	1739	2568	1969	1251	2896	1374	2787	1954	1875	1590	3084	2494	1753

Notes:
[1]Belly-bag.
[2]Total population less ages 2-3 males, transitionals and females, i.e. males that will potentially change to females the following year.
[3]Includes transitionals.
[4]Four year olds of the 1996 and 2002, 2003 year classes were not distinguishable in the modal analysis. These year classes appear to be small and are contained in the ages 3 or 5+ categories.

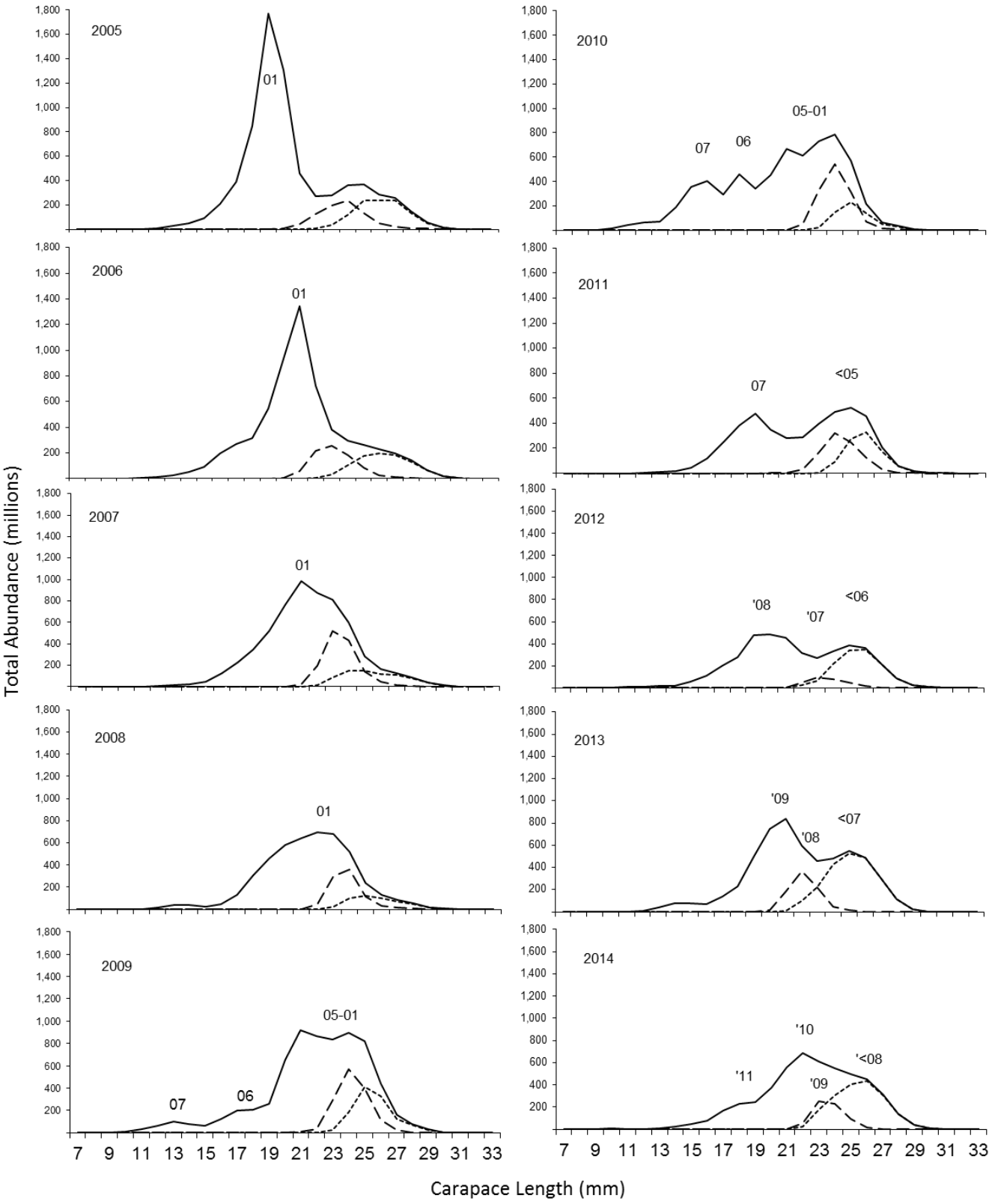

Figure 6. Population estimates at length from DFO-industry surveys 2005-2014 (solid line). The heavy dotted line in each figure represents transitional and primiparous shrimp. The stippled line represents multiparous shrimp.

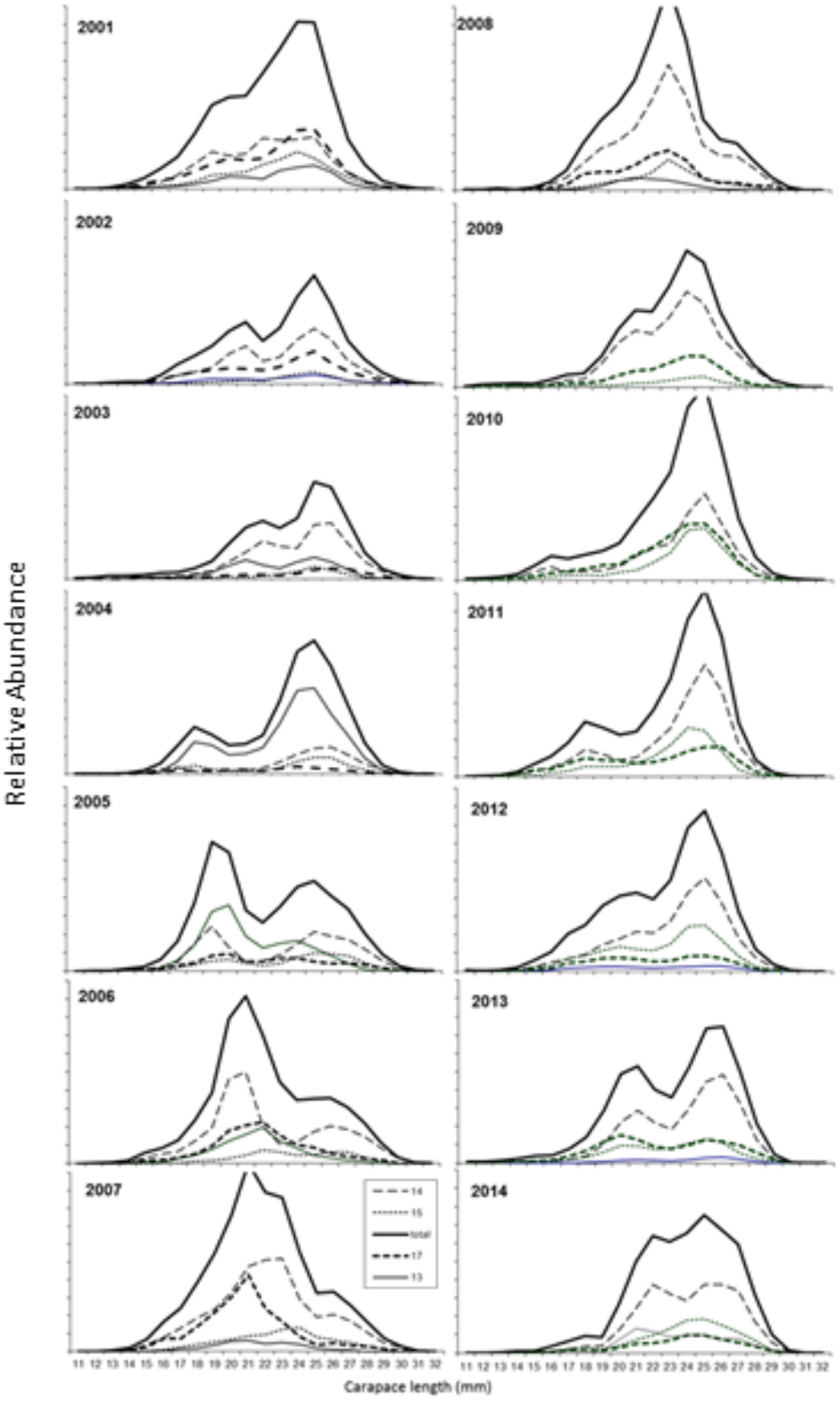

Figure 7. Catch at length from commercial sampling by survey strata, 2001-2014.

Commercial count estimates (numbers of shrimp per pound) increased in 2005-2007 as abundant males from the 2001 year class recruited to the fishery (Figure 8A). Counts then decreased starting in 2007 as these shrimp changed sex and continued to grow as females. The increase in the 2011 commercial count index was likely due to recruitment of the 2007 cohort to the fishery as smaller age 4 males, while spawning stock biomass (large shrimp) decreased. Commercial counts have been decreasing since 2011; rather sharply in 2014. This is probably because the relatively abundant 2007-2008 year classes account for a large proportion of the catch as large mature shrimp relative to much less abundant succeeding year classes (i.e., few small shrimp).

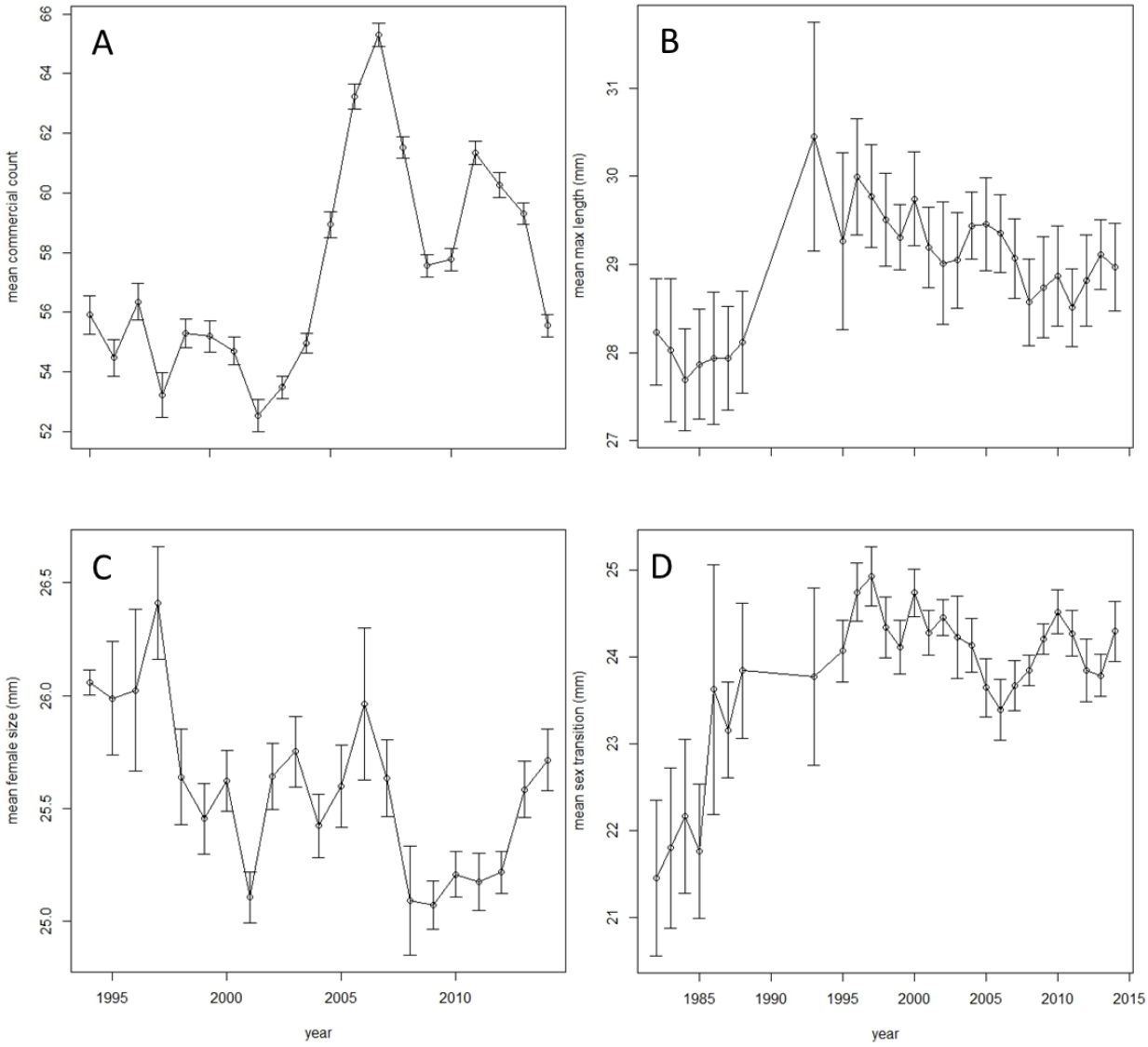

Figure 8. Average: A – commercial count; B – maximum length; C – female size; and D – size at sex transition for all SFAs combined for 1995-2014 with 95% confidence intervals.

Mean female size and mean maximum size show a decreasing trend since the mid-1990s overall, although both indices have shown an increasing trend for the past 5 years (Figure 8B-C). The increase in mean female size in 2013 and 2014 is likely due to the contribution of more abundant, large females from the 2007-2008 year classes relative to less abundant, smaller females from succeeding year classes. The possibility that the observed long-term decreasing trend in both indicators is a cumulative

fishing effect that may be having a negative impact on the population's reproductive capacity bears consideration.

Decreases in average length at sex change (Lt) in shrimp stocks can contribute to population downturns due to decreased female fecundity (smaller shrimp produce fewer eggs). On the Scotian Shelf, length at sex change began to decrease in the late-1990s. Length at sex change increased from 2006-2010, probably due to late sex change of 2001 year class males, some of which had an additional year(s) to grow. Size at sex transition has been decreasing back toward an average level (for the high-productivity period, 2000-present) for this stock, and continues to fluctuate around a high value (about 24 mm) (Figure 8D).

Predator feeding studies have shown that shrimp are important prey for many finfish species, and significant negative correlations between shrimp and finfish abundance have been demonstrated from the Gulf of Maine to Greenland. The 2013 and 2014 values for the predation index have returned to a high level relative to the past two decades (Figure 9). Nonetheless, the index remains low relative to the early-1980s when shrimp abundance was low. This, coupled with continued low values of the cod recruitment index, suggests that natural mortality of shrimp due to predation will continue to be low.

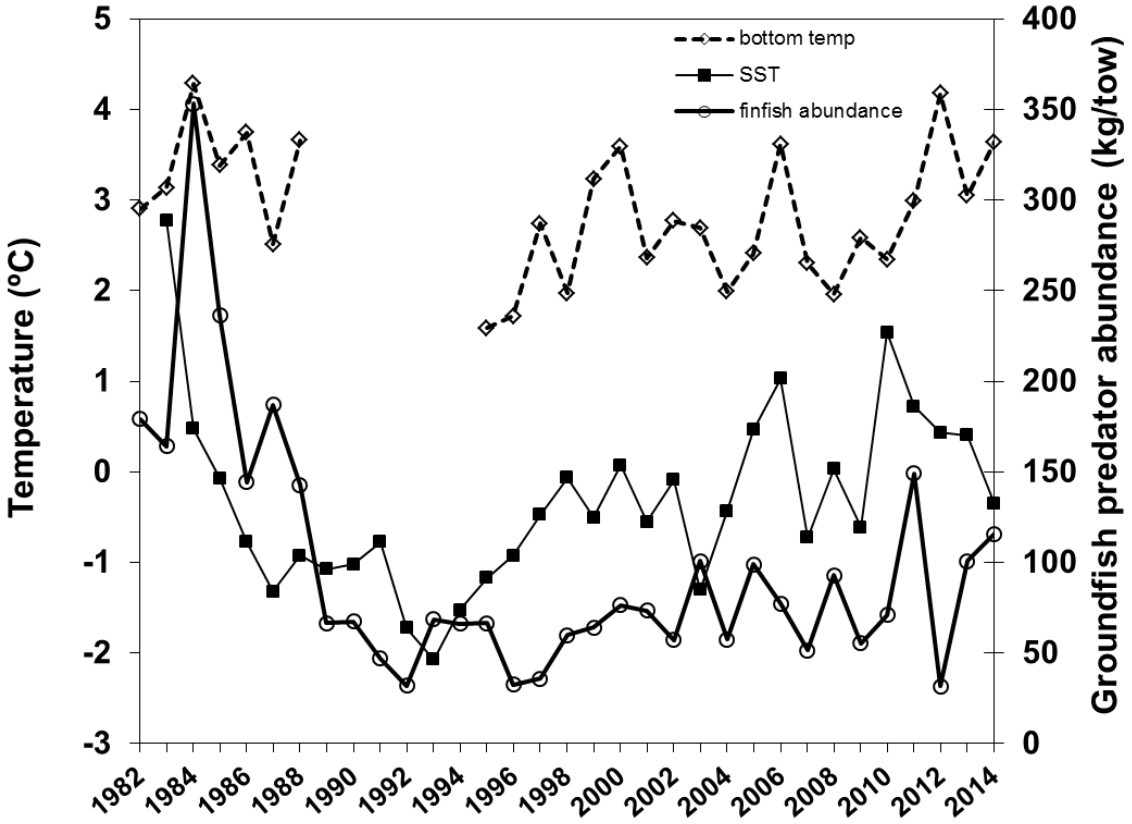

Figure 9. Bottom and spring sea surface temperatures and predator abundance on the Eastern Scotian Shelf shrimp grounds. SST = sea surface temperature.

For some Northern Shrimp stocks near the southern limits of the species' range, abundance is negatively correlated with water temperatures. On the Eastern Scotian Shelf, the large population increase that occurred from the mid-1980s to the mid-1990s is associated with colder surface and bottom water temperatures. This is at least partly because colder temperatures increase the length of the egg incubation period, resulting in later egg hatchings that are closer to the spring phytoplankton bloom and warming of the surface layers where larvae feed and grow. Large fluctuations in bottom

water temperatures (Figure 9) may also be associated with the cyclical recruitment pattern experienced since the early-1990s (i.e., 1993-1995, 2001, and 2007-2008 year classes). Spring sea surface temperatures and survey bottom temperatures (June) were equivocal in 2014. Spring sea surface temperatures continued the fourth year of a cooling trend, which is thought to have a positive influence on juvenile recruitment. In contrast, bottom temperatures increased to a high level, which is thought to exert a negative influence. The abundance of cold water indicator species (i.e., capelin, snow crab, and Greenland halibut) declined or remained low, suggesting that current environmental conditions are not optimal for coldwater species such as shrimp.

Figure 10 provides a summary of 24 indicators related to the health of the Eastern Scotian Shelf shrimp stock. Each indicator was assigned a color for every year there was data according to its percentile value in the series (i.e., >0.66 percentile = green or healthy; 0.66-0.33 percentile = yellow or cautious; and <0.33 percentile = red or critical). Indicators have been grouped into stock characteristics of Abundance, Production, Fishing Effects, and Ecosystem. Note that indicators are not weighted in terms of their importance, and the summary given at the top of the figure was determined as a simple average of individual indicators.

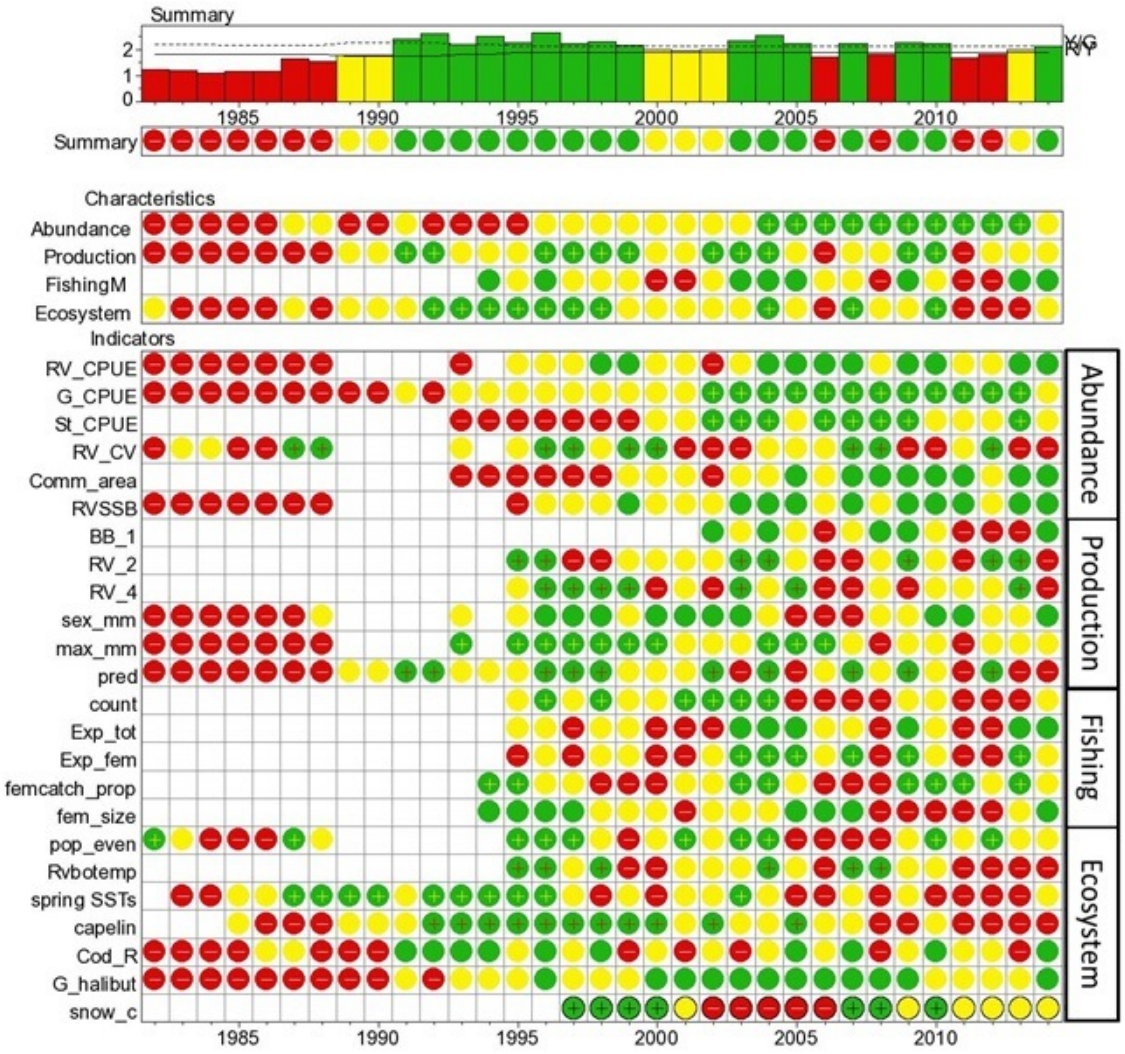

Figure 10. Traffic Light Analysis. Not all indicators in the Traffic Light table are discussed in the text. Please consult the CSAS Research Document published in conjunction with this assessment for a detailed description.

The summary indicator for 2014 improved to green for the first time since 2010 (Figure 10). In general, the Abundance and Production characteristics declined slightly, while the Fishing Effects characteristic remained favourable (green) and the Ecosystem characteristic improved. The Abundance characteristic declined to yellow for the first time in a decade due to declines in the Gulf and Standardised CPUE indices. The Production characteristic remained yellow in 2014. The negative influence of declines in the abundance of young shrimp associated with poor juvenile recruitment over the past four years were offset by the positive influence of a very strong recruitment signal of the 2013 year class in the 2014 belly bag and the maintenance of high SSB. The Fishing Effects characteristic remained green for 2014 after having improved from red values for 2011 and 2012. This is due mostly to relatively low total and female exploitation indices and a high proportion of large females in the catch. Last, the 2014 Ecosystem characteristic improved to yellow after three years as red. This improvement is accounted for by a decrease in spring sea surface temperature (good juvenile recruitment conditions), a very low cod recruitment index (expectation of low predation by cod), and an increase in Greenland halibut recruitment (sympatric coldwater species).

Last, the 2014 Ecosystem characteristic improved to yellow after three years as red. This improvement is accounted for by a decrease in spring sea surface temperature (good juvenile recruitment conditions), a very low cod recruitment index (expectation of low predation by cod), and an increase in Greenland halibut recruitment (sympatric coldwater species).

Bycatch

The introduction of the Nordmøre grate in 1991 reduced bycatch and allowed the fishery to expand to its present size. Bycatch information from Observer coverage of 22 commercial sets (of 2250 total commercial sets – as of the assessment date) from two trips in 2014 suggests that the fleet's trawl configurations, including the use of the Nordmøre grate, continue to ensure low total bycatch (2.86%) by weight. It should be noted, however, that 92% of herring bycatch was reported in 2 sets, which accounted for 80% of the total bycatch by weight. In the absence of herring from the two sets, the total bycatch estimate by weight would otherwise have been 0.57%. Bycatch esimates from observer coverage likely further over-estimate actual bycatch due to a minimum 1-kg weight recorded by the observers (e.g., a single sand lance would be recorded as 1-kg despite weighing only a few grams). Both observed trips took place during the spring/summer and covered portions of SFA 14 and inshore of SFA 15. There was no observer coverage of SFA 13 during 2014.

Sources of Uncertainty

DFO-Industry shrimp survey results are associated with high variances and biases associated with survey gear changes. Spatial and temporal variability in the distribution of shrimp is a source of uncertainty with regard to the accuracy of survey estimates; the survey is conducted consistently during the first 10 days of June to try to mitigate this effect. In 2007-2008, problems with NETMIND distance sensors and data logging required use of historical average instead of actual wing spread data to calculate swept areas and abundance. Given the inability to accurately age shrimp, modal groups are assigned to age classes; a process that is somewhat subjective, particularly for larger individuals. Growth rates can change dramatically due to density dependence, as happened with the strong 2001 year class. Consequently, recruitment to the fishery will be delayed and spread over a longer time period.

Commercial abundance indices are susceptible to logistic, economic, analytical, and other factors that influence index values in ways that may be unrelated to shrimp abundance. For example, periods of bad weather or abundance sea ice can cause low CPUEs, as can fishing areas targeting large shrimp for market reasons. The standardized commercial CPUE index subsamples the data for vessels that meet certain criteria, which can also result in particularly successful or particularly unsuccessful vessels influencing this index in ways that may be unrelated to shrimp abundance in any given year.

Because of the timing of the shrimp assessment relative to the collection and analysis of samples, the advice of the Regional Advisory Process has generally been provided based on only a portion of these samples. We have taken steps to expedite the analysis of samples such that, for 2014, all 120 survey samples and 43 commercial samples were included in this analysis.

CONCLUSIONS AND ADVICE

At present, the fishable (adult) biomass of shrimp on the Eastern Scotian Shelf is high. The TAC was increased in 2014 to take advantage of this very high biomass and exploitation remains well below the removal reference. Trends in commercial and survey CPUEs corroborate cohort tracking and modal analysis of length frequency distributions in commercial and survey (belly-bag and main trawl) samples from recent years to suggest that the stock is currently supported primarily by the 2007-2008 year classes as multiparous females, supplemented by the less abundant succeeding year classes. The levelling off (decrease of 1.5%) of the total and spawning stock biomass in 2014 is likely the start of the

gradual decrease in abundance predicted in 2012 and 2013 assessments, attributable to the 2007 year class beginning to reach the end of its expected lifespan. Evidence of poor juvenile recruitment from 2009-2012 year classes (low 2010-2013 belly-bag index values) is also corroborated by cohort tracking and modal analysis of survey and commercial length frequencies to suggest that recruitment to the fishable and spawning stock biomass from these year classes is likely to be low. As a result, the stock is expected to continue to gradually decline from its current high level.

The very high value of the 2014 belly-bag index suggests strong juvenile recruitment from the 2013 year class, which should begin to recruit to the fishable biomass in 2016 if survival conditions are suitable. Current ecosystem indicators for shrimp are conflicting. Although cooling spring sea surface temperatures and very low cod recruitment suggest conditions will be favourable for shrimp, the increase in abundance of shrimp predators, warm bottom temperatures, and continued low or declining abundance of sympatric coldwater species suggest the opposite. With respect to abundance indicators, concurrent declines in Gulf and Standardised CPUE indices in 2014 contrast with the continued high survey CPUE index. Changes in temperature and shrimp distribution among the shrimp "holes" and poor fishing conditions (rough weather and abundant sea ice) during the early season provide possible explanations for the low commercial CPUE indices. Although the stock is expected to continue to gradually decline in 2015, the high fishable and spawning stock biomass in 2014 suggests that a *status quo* TAC will not exceed the removal reference in 2015. Given the small size of the 2009-2012 year classes, however, reactive TAC reductions will be required if the stock declines towards to the Cautious Zone.

SOURCES OF INFORMATION

This Science Advisory Report is from the November 27, 2014, Assessment of Eastern Scotian Shelf Shrimp. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

DFO. 2014. Eastern Scotian Shelf Shrimp Stock Status Update for 2013-2014. DFO Can. Sci. Advis. Sec. Sci. Resp. 2014/012.

Hardie, D., M. Covey, M. King, and B. Zisserson. 2011. Scotian Shelf Shrimp 2010-2011. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/102.

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