UPDATE OF THE STOCK STATUS INDICATORS FOR THE AMERICAN LOBSTER (*HOMARUS AMERICANUS)* STOCKS IN THE SOUTHERN GULF OF ST. LAWRENCE

Context

The most recent assessment for the American lobster stocks of the southern Gulf of St. Lawrence (sGSL) was completed in 2013 with information up to 2011 for landings and 2012 for some indicators (DFO 2013; Rondeau et al. 2015). An update of the stock status indicators was requested by DFO Gulf Region Fisheries and Aquaculture Management (FAM) in preparation for the December 2016 Lobster Advisory Committee meeting. This Science response was developed at a regional peer review meeting held on November 14, 2016 in Moncton, New Brunswick, with participants from DFO Gulf Region. Based on the updated indicators, the sGSL lobster stocks have been doing well since the last assessment, with landings at historically high levels. The next complete assessment for the stocks is scheduled for 2018.

Background

Five major Lobster Fishing Areas (LFAs; 23, 24, 25, 26A, and 26B) are defined in the sGSL. LFAs were established for management purposes. Management of the lobster fishery is based entirely on effort control (input fishery). The four most important measures in controlling effort are the fixed number of lobster fishing licences, individual trap allocations, restrictions on gear characteristics, and limited fishing seasons. In addition to those management controls, other measures were implemented to protect key components of the lobster population. Lobsters can only be retained if they comply with a minimum legal size (MLS) designed to allow at least 50% of females to reach sexual maturity before being harvested. Egg-bearing females must also be released as well as large-sized females. These management measures vary within and among the main LFAs, and sub-areas (Rondeau et al. 2015) of the major LFAs (Table 1).

Analysis and Response

Indicators of the lobster stocks status are presented for three categories: fishing pressure, abundance, and production. Both fishery-based (landings, at-sea sampling and recruitment-index logbooks) and fishery-independent (trawl and SCUBA surveys) data are used in this science response. Landings indicators are compared to the last assessment in terms of their levels or trends for the short term, mid-term (1968 to 2011) and long term (1947 to 2011). The state of other indicators was assessed mostly in comparison to their levels or trends at the last assessment or when data were last available. At-sea sampling data were available from 2012 to 2015 for most areas. The sampling intensity was not consistent between the years and LFAs because the field data collection was carried out by the PEI provincial government and harvesters' associations. Data from the recruitment-index program were available from at least 2012 up to 2015 for LFAs 24, 25, and 26A and 26B. Data from 2016 were only available for LFA 26B and from Nova Scotia licence holders in LFA 26A. There was no participation in the recruitment-index program in LFA 23 since 2004. The Northumberland Strait trawl survey is carried out annually between July and early-August in LFA 25 and part of LFA 26A. The SCUBA surveys are carried out every year from the end of June to early-August in LFAs 23, 25 and part of 26A (central Northumberland Strait).

Table 1. Key management measures in the lobster fishery in the southern Gulf of St. Lawrence for 2016.

	Lobster Fishing Area (LFA) and sub-area										
	23				24	25	26A			26B	
	23A	23B	23C	23D			26A1	26A2	26A3	North	South
Fishing season	April 30 to June 30				April 30 to June 30	Aug. 9 to Oct. 10	April 30 to June 30[1]			May 6 to July 6	April 30 to June 30
Number of licences											
Category A Category B	639 30				635	706 4	682 4			223 3	
Number of traps per licence	300				300	250 (NB) 240 (PE) 225 (NS)	280 (NS) 272[2] (PE)	255[3]	250	250	
Number of traps per line	na	na	3 (portion)		na	na	6 (part PEI) 5 (Gulf NS)	6	2	5	na
Maximum size entrance (mm diameter)	152				na	152	na[5]	152	na	152	na
Minimum legal carapace size (mm)	76	76	76	75	72	73	72	76	76	82.5	81
Female size restriction (mm)[4]	115-129				115-129	≥ 114	115-129			na	

[1] Fishing season for the portion of LFA26A1 from Point Prim to Victoria was May 7 to July 7, 2016
[2] Commercial licence holders can take part in a combining initiative and have a trap allocation of 374 or 476
[3] Commercial licence holders are fishing 255 traps, some Communal Commercial licence holders remain at 275
[4] Female size restriction refers to size of females which must be released, in addition to the minimum legal size and the restriction on egg-bearing females

As with the previous assessments, some LFAs were divided into sub-regions (Fig. 1) to reflect data availability as well as geographic and biological similarities (Rondeau et al. 2015). LFA 23 was divided into two sub-regions, 23BC (Baie des Chaleurs) and 23G (Gulf of St. Lawrence side). LFA 25 was divided into sub-regions 25N (northern part) and 25S (southern part, central Northumberland Strait); and LFA 26A was divided into three sub-regions: 26AD (west of Pictou Island, central Northumberland Strait), 26APEI (eastern side of PEI) and 26ANS (mainland Nova Scotia east of Pictou Island). LFAs 24 and 26B were not subdivided.

Indicators of the stock status

Fishing pressure

Fishing pressure indicators include the proportion of empty traps, and trends in nominal effort, expressed in terms of licences or traps. The data for the empty trap indicator are from the at-sea sampling and the recruitment-index programs. Data on the number of licences and traps come from DFO FAM. Estimates of exploitation rates are not presented because of violating underlying assumptions and data availability.

Since 2012, the percentage of empty traps has continued to decrease almost everywhere. Data from both sources are showing on average less than 20% empty traps per fishing trip. In sub-region 26AD, the percentage of empty traps is still slightly higher than 20% but values have decrease steadily from 2011 (47%) to its lowest point in 2016 at 23% (from the recruit-index program data). Compared to the last assessment, the percentage of empty traps in LFA 26B has remained almost stable with a value of 28% in 2016 from the recruit-index program data.

[5] Erratum: March 2017, changed 152 to na

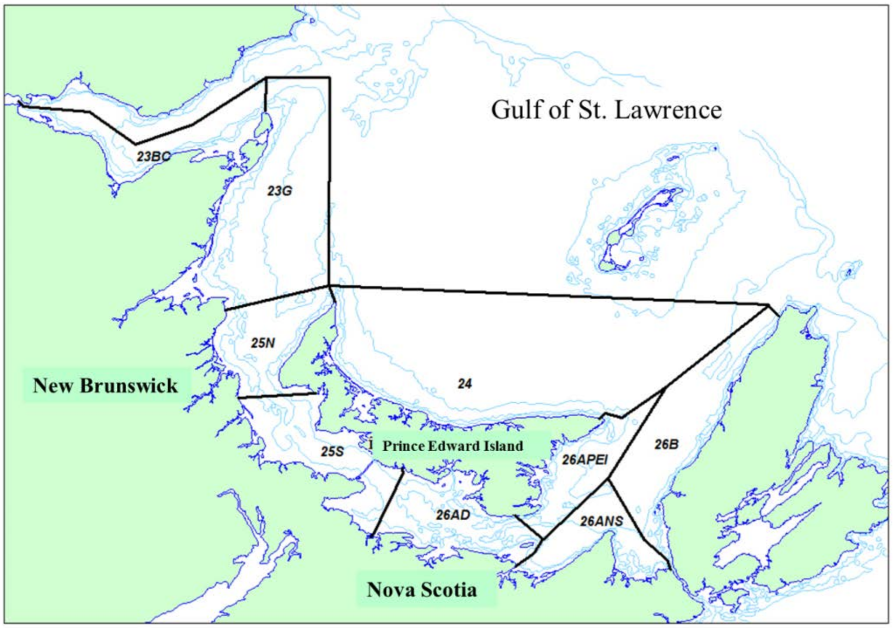

Figure 1. Sub-regions used for assessing the lobster stock status in the southern Gulf of St. Lawrence.

While a significant number of licences were removed from the fishery prior to the last assessment as part of the Atlantic Lobster Sustainability Measures program, virtually no change occurred recently for both the number of licences and trap allocations. The total number of licences in the sGSL decreased 1% from 2,957 in 2012 to 2,926 in 2016. Industry-led initiatives had the trap allocations reduced from 250 to 225 for Nova Scotia licence holders within LFA 25 and from 275 to 255 for commercial licence holders within sub-LFA 26A2. There was no other change in trap allocations since 2012. The effect of these reductions in nominal effort on lobster stocks and the fishery cannot be quantified but any release in fishing pressure is deemed beneficial for the stock.

Abundance

Abundance indicators include two fishery-dependent indices [landings and catch-per-unit-effort (CPUE)] and two fishery-independent indices (trawl and SCUBA surveys). Landings are considered to be a proxy of abundance for the lobster stocks (DFO 2013, 2014).

Preliminary landings in 2015 (27,462 t) were 2.5 times above the long-term median value (10,933 t) observed between 1947 and 2011 (Fig. 2). Reported landings have reached a historical high at 28,186 t in 2014. The recent increase in landings is believed to be the result of an increased egg production combined with favorable environmental factors that have boosted recruitment success which has resulted in very high catches in the sGSL. Landings reported since the last assessment are significantly higher than the Upper Stock Reference (USR) value of 13,798 t (DFO 2014; Fig. 2). The stock is therefore positioned in the healthy zone in the context of the precautionary approach.

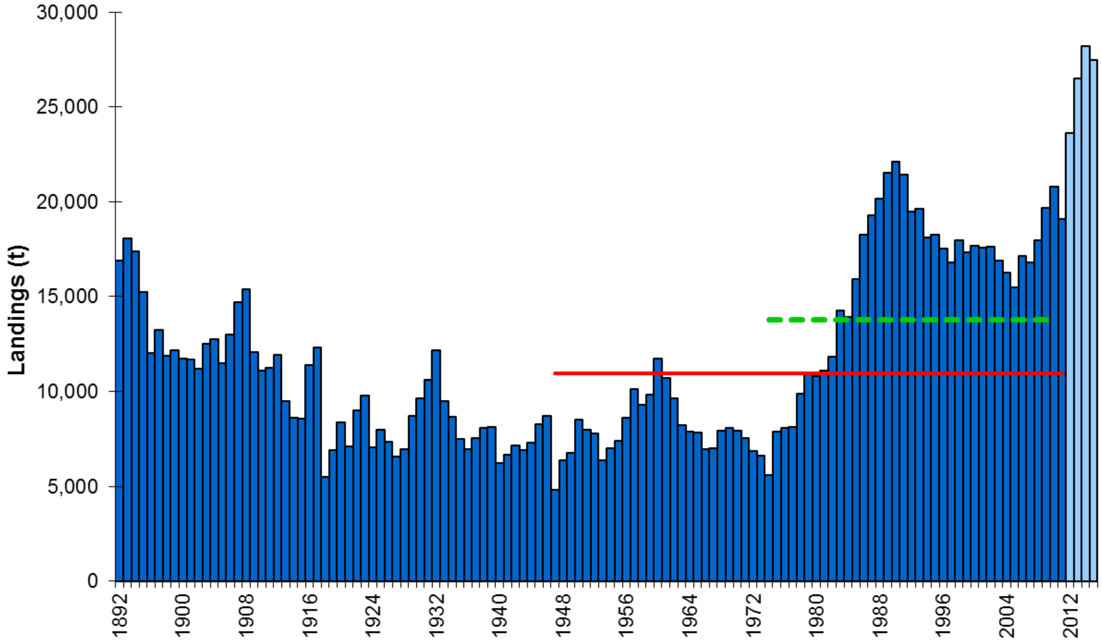

Figure 2. Recorded lobster landings (t) in the southern Gulf of St. Lawrence (DFO Gulf Region) from 1892 to 2015. The horizontal solid line is the median landing of the time series for 1947 to 2011 (10,933 t). The dashed line represents the Upper Stock Reference point (13,798 t) for the lobster fishery of the southern Gulf of St. Lawrence (DFO 2014). Data added since the last assessment are in light colour. Data for 2015 are preliminary.

Abundance indicators based on landings for legal-size lobsters from all LFAs are still well above the long-term (1947 to 2011) and the mid-term (1968 to 2011) median values (Fig. 3). Landings from all LFAs are also above their respective values presented at last assessment; with increases ranging from 28% in LFA 23 to 54% in LFA 24. Since 2011, landings have reached historical levels in LFAs 23, 24 and 26B, exceeding landings peaks observed in the late 1980s - early 1990s. Landings have also greatly increased in LFAs 25 and 26A since the last assessment, approaching the historical high values observed in the late 1980s (Fig. 3).

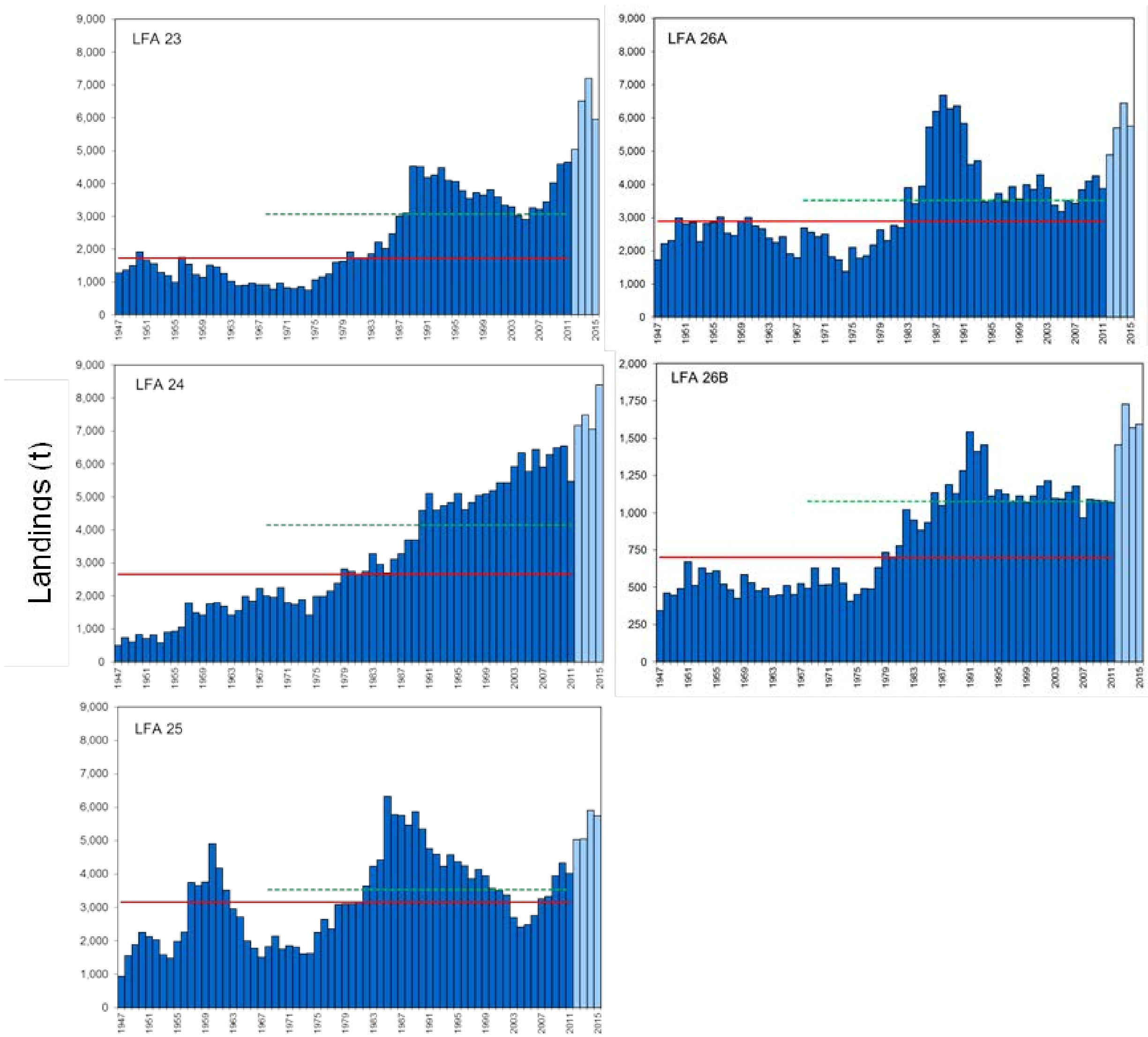

Figure 3. Reported lobster landings (t) by Lobster Fishing Area (23, 24, 25, 26A, 26B) in the southern Gulf of St. Lawrence, 1947 to 2015. The solid horizontal line is the median value for 1947 to 2011 (long-term) and the dashed horizontal line is the median value for 1968 to 2011 (mid-term). Data added since the last assessment are in light colour. Data for 2015 are preliminary.

In the last stock assessment (DFO 2013, Rondeau et al. 2015), the only area with a weak or negative trend in landings was central Northumberland Strait (sub-regions 25S and 26AD). Although the recent increase in landings in LFA 25 is mostly driven by high catches in sub-region 25N, catches in 25S now show an increasing trend (Fig. 4). Similarly, 26AD also shows an increase since the last assessment (Fig. 4). However, both sub-regions are still well below the record landings observed in the late 1980s - early 1990s.

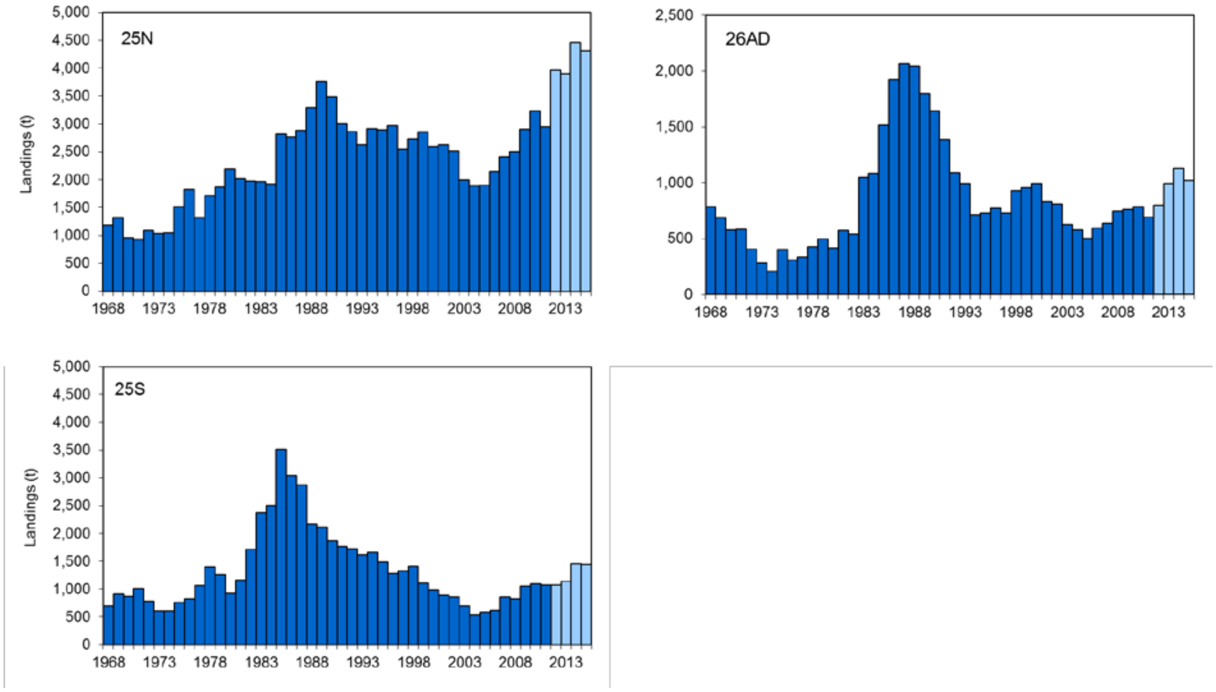

Figure 4. Reported lobster landings (t) for sub-regions 25N, 25S, and 26AD in the southern Gulf of St. Lawrence, 1968 to 2015. Data added since the last assessment are in light colour. Data for 2015 are preliminary.

Trends in average CPUE from both the at-sea sampling (kg per trap) and the recruitment-index programs (number per trap, regular traps only) remain similar with higher values in recent years for most sub-regions when compared to the last assessment. From both data sources, CPUE of males and non-berried females in sub-region 26AD have more than doubled since the last assessment, going from 0.9 to 2.7 lobsters per trap from the recruitment-index data (data from 2016 was only available for Nova Scotia), and from 0.4 to 1.2 kg per trap from the at-sea sampling data. For sub-region 25N, the two data sets are showing conflicting values, with a 16% increase in CPUE from the recruitment-index program but a decrease of 16% from the at-sea sampling data. The decrease in CPUE could be explained by the slightly higher CPUE value observed in 2012 (2.2 kg per trap) compared to 2015 (1.8 kg per trap). A release in fishing pressure following the removal of 90 licences in LFA 25 from 2011 to 2012 could explain the very high catch rates in 2012. Average CPUE values have also increased in LFA 24 but to a lesser extent than everywhere else. Limited data for LFA 23 and sub-region 26ANS precluded evaluating trends in the CPUE indicator, nevertheless, based on this limited information the average values were also in their highest range.

Positive trends in abundance were also observed in the fishery-independent trawl survey (Fig. 5). In the three sub-regions covered by the survey, abundance indices for all-size lobsters in 2016 were higher than the 2012 values (DFO 2013). The mean lobster weight in kg per standardized tow increased by 1.9, 3.3, and 7.5-fold for sub-regions 25N, 25S, and 26AD respectively (Fig. 5).

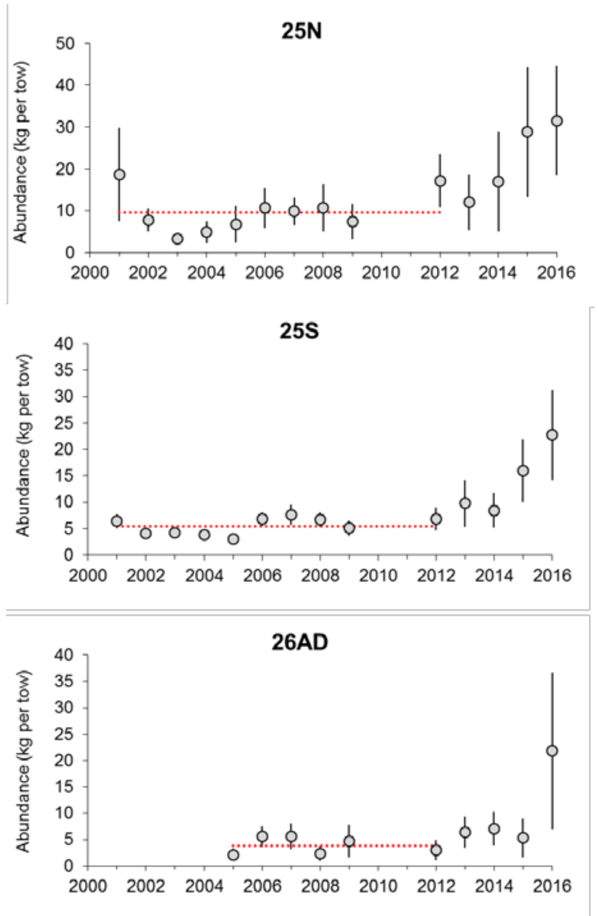

Figure 5. Trends in the abundance indicator (kg per standardized tow, mean and 95% confidence interval) for all lobster sizes in sub-regions 25N (upper panel), 25S (middle panel) and 26AD (bottom panel) from the bottom trawl survey for 2001 to 2009, and 2012 to 2016. The horizontal lines are the mean values for the time series presented at the last lobster stock status; 2001 to 2012 except for sub-region 26AD (2005 to 2012).

The trawl survey data shows that the modelled biomass index for the whole LFA 25 has increased 2.6-fold between 2012 and 2016, from a mean of 11.0 to 28.8 kg per tow. Since 2012, the survey coverage has remained constant in LFA 26A. The biomass index for the area sampled has increased 2.0-fold between 2012 and 2016, from a mean of 13.2 to 26.7 kg per tow. High concentrations of legal-size lobsters have been observed in similar areas as reported in the previous assessment, but the areas of high abundances have recently expanded with even higher concentrations (Fig 6).

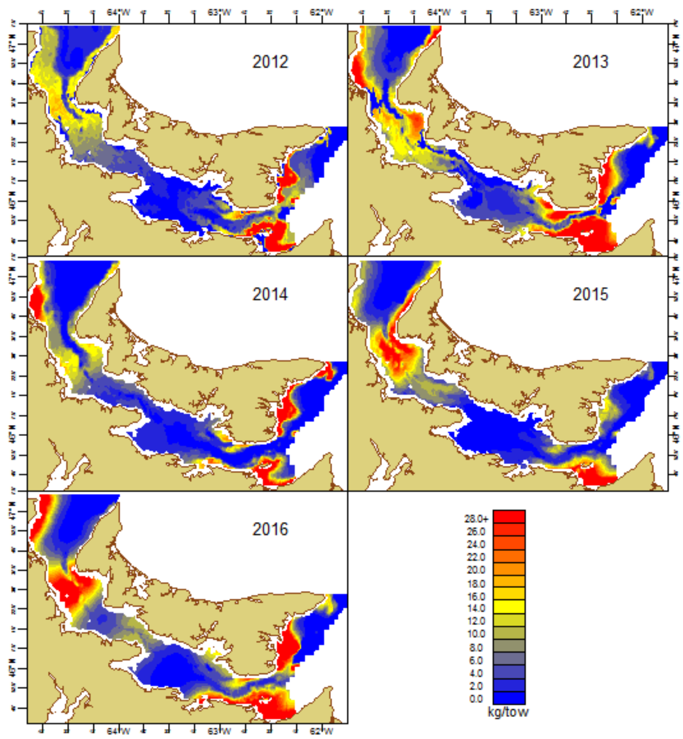

Figure 6. Spatial distribution of legal-size lobster abundance (kg per tow) estimated from the Northumberland Strait bottom trawl survey between 2012 and 2016. Legal-size lobsters for 2012 are ≥71 mm of carapace length (CL), for 2013 to 2015 ≥72 mm CL and for 2016 ≥73 mm CL.

Based on a Bayesian estimation model, the standardized abundance of all-size groups of lobster observed from SCUBA surveys in the sGSL has increased steadily and significantly from 2003 to 2016 (Fig. 7). From 2012 to 2016, the mean abundance increased more than 3.7-fold, from 12.1 to 44.4 lobsters per 100 m². Spatially, differences were observed among sites along the north to south axis again, but the separation of lobster abundances within and outside central Northumberland Strait observed in the last assessment is now localized in the eastern end of the central Strait (i.e., sub-region 26AD, Fig. 8). Significant increases in abundances were observed in LFAs 23 and 25, while values in sub-region 26AD remained the lowest and unchanged (Fig. 8). Sites in Grande-Anse and Robichaud were removed since the last assessment as they were not surveyed from 2013 to 2016 (removed as permanent sites), and Murray Corner, surveyed since 2012, was added as a new permanent site.

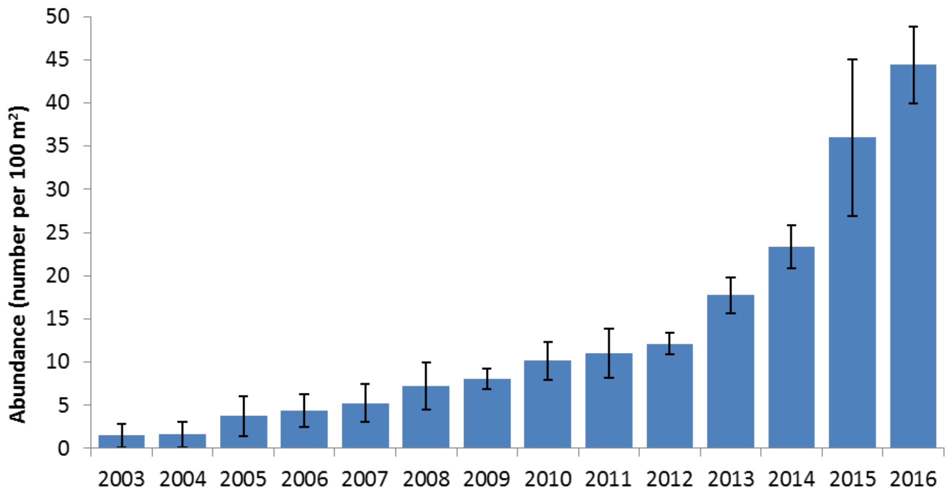

Figure 7. Standardized mean abundance (number of lobsters per 100 m²) from SCUBA surveys between 2003 and 2016, averaged over sites and cohorts from the Bayesian model. Also shown are 95% credibility intervals from the posterior distributions of the model fits.

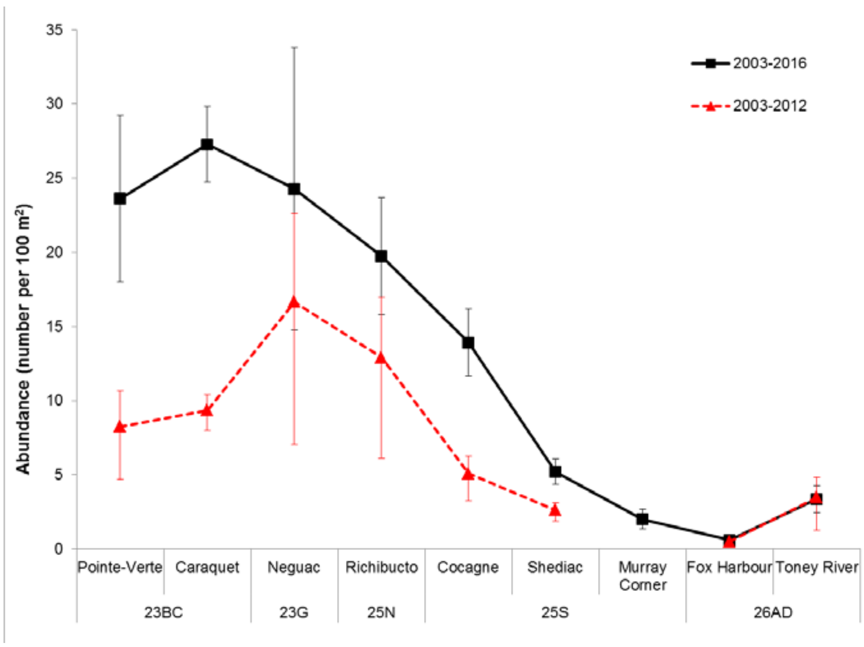

Figure 8. Standardized mean abundance (number of lobsters per 100 m²) by site from SCUBA surveys, averaged over years and cohorts for two time periods; 2003-2012 (dash line) and 2003-2016 (solid line). Also shown are 95% credibility intervals from the posterior distributions of the Bayesian model fits.

Production

Catch rates of pre-fishery recruit size lobsters (<MLS represents bin sizes 1-4) in modified traps from the recruitment-index program were used as a fishery-dependent indicator of pre-fishery recruitment. Since the last assessment, CPUE have increased markedly in all areas, but to a lesser extent in LFA 24 (Fig. 9). The sharp increase of this indicator for 25S and 26AD (2016 data from Nova Scotia only for the latter) might indicate a recent pulse of pre-fishery recruits in an area that has been showing very little positive production indicators in the last two assessments.

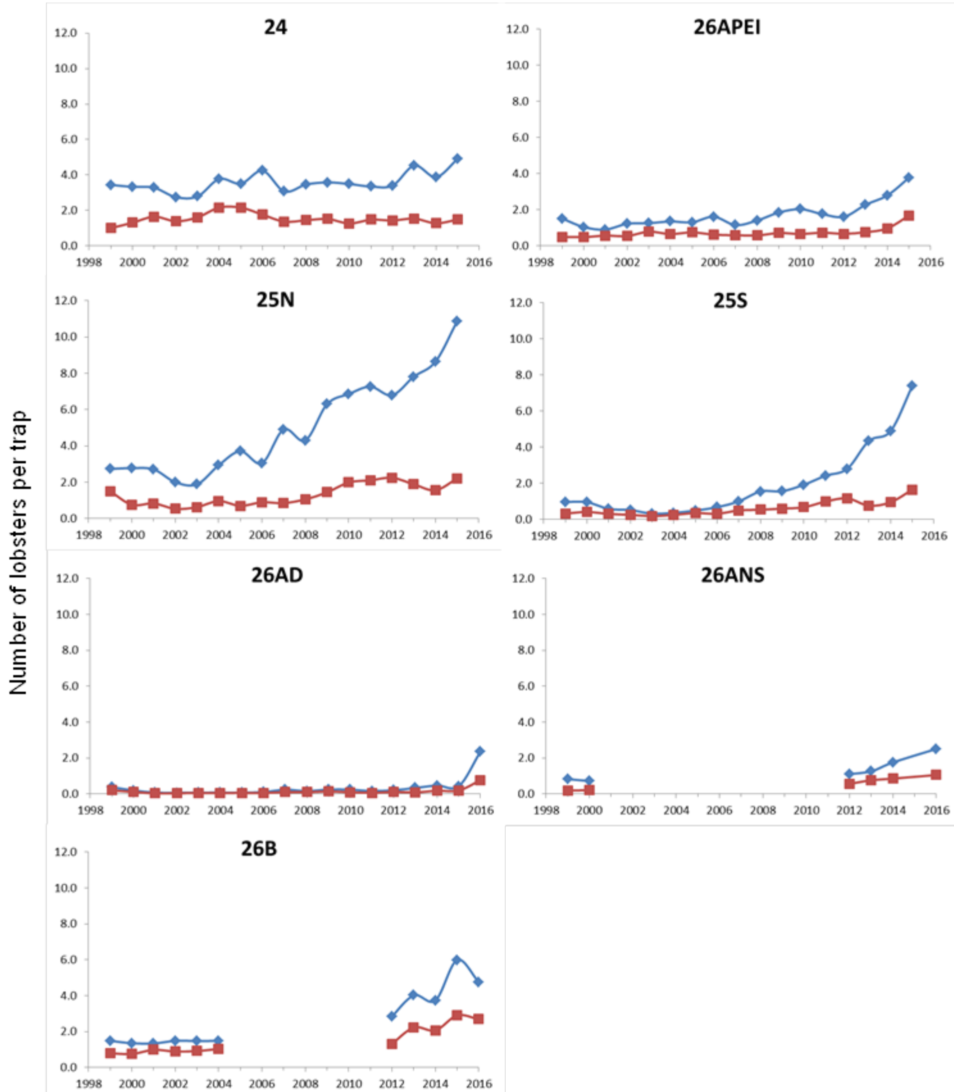

Figure 9. Annual catch per unit effort (number of lobsters per trap) for pre-fishery recruit size (bin sizes 1-4) male and non-berried-female lobsters in regular (square symbols) and modified (diamond symbols) traps from the recruitment-index program 1999 to 2015 or to 2016 according to data availability.

Catch rates of berried females from the recruitment-index and at-sea sampling data were used as a production indicator. From both data sources, CPUE of berried females have reached their highest values in recent years (2013-2016) compare to the early 2000s. The index is similar for both types of trap (modified and regular) in the recruitment-index program because of the relationship between the size of berried females and escape vents (i.e., too big to escape). Based on the at-sea sampling data, sub-regions 23BC and 26ANS are displaying the highest increase in CPUE (kg per trap) of berried females with recent values at least doubling those observed in 2012. Nonetheless, these results should be viewed with caution because harvesters tend to avoid grounds, sometimes unsuccessfully, where berried females are present in high densities.

The size at the onset of maturity (SOM) for female lobsters can be estimated by ovarian condition (colour and weight) and cement-gland staging (Comeau and Savoie 2002). The importance of validating the latter with the ovarian condition and the growth status of the female was recommended at a workshop on lobster reference points (Comeau 2003). Thus, it was decided that a combination of these techniques would produce better SOM estimates. The minimum level of protection for first time spawners has been chosen to be the size at 50% maturity (SOM_{50}) (Rondeau et al. 2015). Overall, the 2014 estimates (Table 2) are consistent with the 72 mm carapace length (CL) previously reported by Comeau and Savoie (2002). Interestingly, there are contrasting patterns in the 2014 SOM_{50} estimates. In Caraquet, a significantly higher SOM_{50} compared to 1994-1997 estimates was observed, whereas in Cheticamp the SOM_{50} is significantly lower compared to the 2002 value. The SOM_{50} estimate for Malpeque is not significantly different from 2002 (Table 2). Furthermore, estimates done by Conan et al. (1985) in Malpeque in the early 1980s showed that SOM_{50} was at 70.9 and 71.7 mm CL based on the ovarian condition and the cement-gland staging, respectively, and are quite comparable to the 2014 estimate.

Table 2. Size at the onset of 50% sexual maturity (SOM_{50}) with 95% confidence intervals (C.I.) for female lobsters collected in various Lobster Fishing Areas (LFA) in the southern Gulf of St. Lawrence between 1994 and 2014. The SOM_{50} was established using a combination of cement-gland staging, colour, and weight of the ovaries.

Year	LFA	Location	n_{mature}	n_{total}	SOM_{50}	$C.I.$
1994	23B	Caraquet	170	337	71.2	70.4 - 72.0
1994	23C	Miscou	86	153	71.9	70.7 - 73.0
1995	23A	Stonehaven	98	310	72.3	71.4 - 73.2
1995	23B	Caraquet	157	317	70.5	69.7 - 71.3
1996	23B	Caraquet	121	256	69.5	69.7 - 70.5
1996	23C	Val Comeau	94	324	72.2	71.2 - 73.3
1997	23B	Caraquet	161	295	70.5	69.5 - 71.5
2002	24	Malpeque	151	457	72.8	72.0 - 73.8
2002	26B	Cheticamp	172	485	75.1	74.3 - 76.0
2004	26A	Arisaig	227	452	72.3	71.6 - 73.1
2004	26B	Port Hood	180	417	74.8	73.9 - 75.7
2005	26A	Cribbons Point	269	498	73.5	72.7 - 74.3
2005	26B	Baxters Cove	179	371	77.6	76.7 - 78.5
2006	26A	Havre Boucher	263	467	75.8	74.9 - 76.6
2014	23B	Caraquet	233	464	72.7	71.9 - 73.5
2014	24	Malpeque	245	405	71.8	70.9 - 72.7
2014	26B	Cheticamp	290	504	73.1	72.3 - 73.9

Fishery-independent indices of production based on the density of sub-legal size lobsters from the trawl survey indicate that the biomass of sub-legal size lobsters has increased sharply since 2012 in all three sub-regions (Fig. 10). Compared to 2012, the 2016 indices are 2.9, 13.8, and 71.8 times higher for sub-regions 25N, 25S, and 26AD respectively. In addition, the spatial proportion of high density areas of sub-legal lobsters in LFA 25 as a whole has more than doubled in 2016 compared to 2012. In recent years, very high concentrations of sub-legal lobsters were observed during the survey at both ends of the Northumberland Strait and also within its central part. Positive indicators for sub-region 26AD are mostly driven by the high productivity area around Pictou Island.

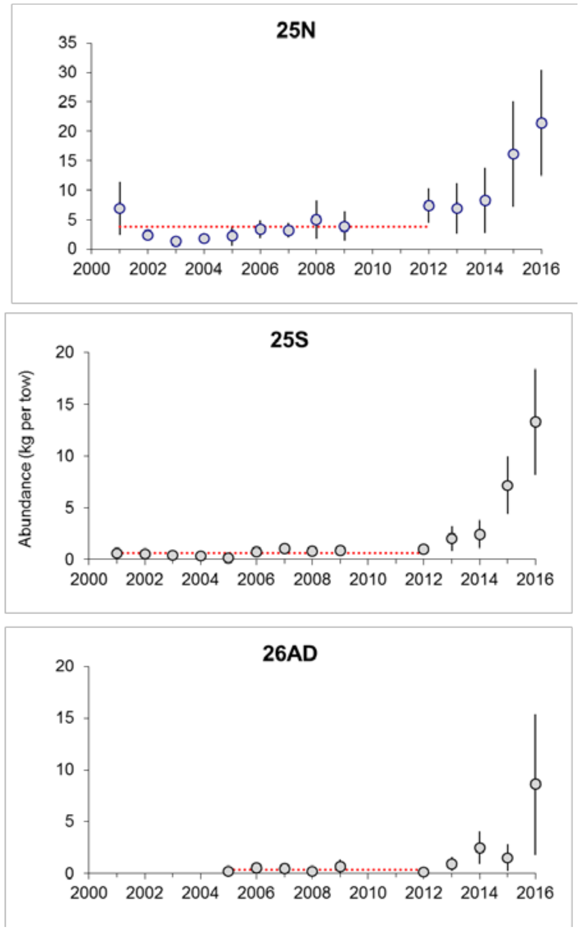

Figure 10. Trends in abundance (kg per tow, mean and 95% confidence interval) of sub-legal size lobsters in sub-regions 25N (upper panel), 25S (middle panel) and 26AD (bottom panel) as estimated from the bottom trawl survey, 2001 to 2009 and 2012 to 2016. The horizontal lines are the mean values for the time series 2001-2012, except for sub-region 26AD (2005-2012).

Abundances of 1-year old lobsters (Rondeau et al. 2015) assessed by SCUBA surveys between 2003 and 2016 have significantly increased in all sub-regions except 26AD (Fig. 11). Increasing trends and high values were observed between 2012 and 2016 for sites outside central Northumberland Strait (Fig. 11). In contrast with the last assessment, significant increases were also observed for sites within the sub-region 25S; 11.0, 11.4 and 69.1-fold increases in Shediac, Cocagne and Murray Corner, respectively. However, the abundances in these sites remain lower compared to those outside the Strait (Fig. 11). As observed from other fishery-independent indicators, sub-region 26AD (Fox Harbour) shows no increase and has the lowest abundance of 1-year old lobsters (Fig. 11).

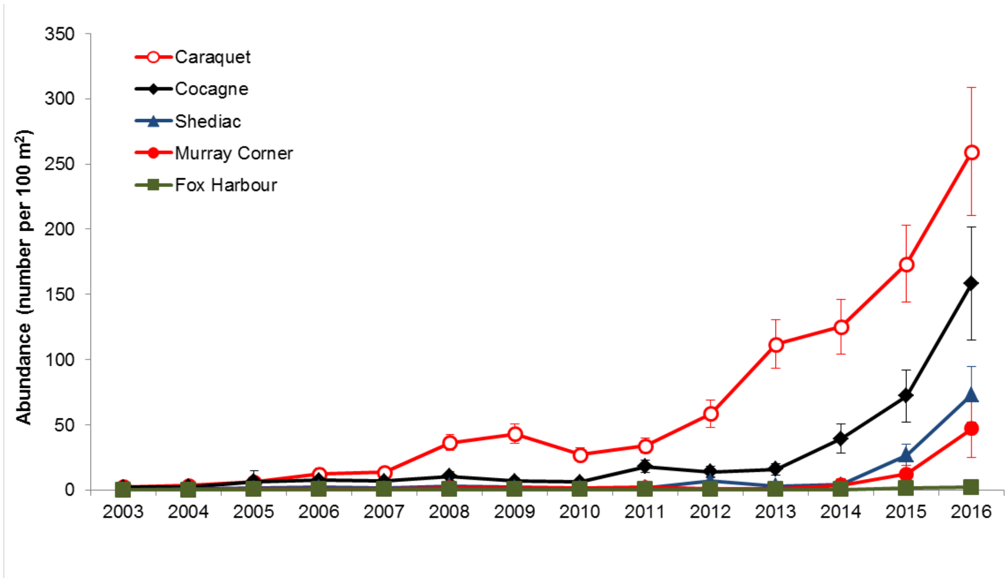

Figure 11. Standardized mean abundance (number of lobsters per 100 m²) from SCUBA surveys for 1-year old lobsters for Caraquet (23BC), Cocagne (25S), Shediac (25S), Murray Corner (25S), and Fox Harbour (26AD) derived from the Bayesian model for the years 2003 to 2016. Also shown are 95% credibility intervals from the posterior distributions of the model fits.

The abundance of settlers (young-of-the-year per m^2) estimated from the industry-led monitoring of bio-collectors showed extremely high lobster settlement in LFA 24 and sub-region 25N reaching record high abundances (~8 settlers per m^2) within the entire geographical range of the American lobster. High abundances of lobster settlement are considered ~2 settlers per m^2 throughout the lobster's range. Between 2012 and 2015, the abundances of settlers increased 1.9, 3.0 and 4.4-fold in Covehead, Alberton, and Skinners Pond, respectively. During the same period, the abundances dropped to zero settler per m^2 in Murray Harbour and by 90% in Fortune. Lower settlements were also observed in central Northumberland Strait. A new site in Cape Egmont (25S) showed abundances <0.2 settler per m^2 and only one settler was observed in Nine Mile Creek between 2013 and 2015. In comparison, abundances in the United States waters are at their lowest, at or near zero, since 2012 (M. Comeau, personal communication).

Conclusions

Based on the updated fishery-dependent and independent indices, lobsters in the sGSL continue to be in high abundance and recruitment signs are positive everywhere except, in sub-region 26AD (eastern end of central Northumberland Strait). Recent landings are either above long-term medians or the highest of the time series. The 2015 preliminary landings are well above the precautionary approach's USR, therefore positioning the sGSL lobster stocks in the healthy zone.

While increased landings reflect a high abundance of commercially exploitable lobsters, fishery-independent recruitment indicators are also showing significant increases since the last assessment. Other production indicators based on fishery-dependent data are also positive with CPUE of berried females and pre-fishery recruits in their highest range. The only exception is sub-region 26AD.

Increases in MLS over the last 25 years, to allow 50% of first time spawners to produce eggs, and the protection of highly fecund large females seem to have had a positive effect on lobster egg production and recruitment, consistent with the expected outcomes of these management measures. The 2014 SOM estimates show that all LFAs are at or above the 50% protection level (in terms of producing eggs) of first time spawners.

There is still continued concern regarding the accuracy of the catch data derived from the official catch system and the delay of availability of these data. There are uncertainties in the amount of non-recorded lobster catches corresponding to other sales, personal consumption, and potential illegal fishing. The time delay limitation is obvious in the present stock status update, as the analysis of landings trends could only be done to 2015 using preliminary data. Furthermore, the current system is not adequate to process fishing effort information. Complete and integrated information on catch, effort and fishing location from all the users are required to properly assess lobster stocks and the fishery status.

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Sources of information

This Science Response Report results from the Science Response Process of November 14, 2016 on the Update to 2016 of the indicators of the American lobster (*Homarus americanus*) and rock crab (*Cancer irroratus*) stocks of the southern Gulf of St. Lawrence.

Comeau, M. (ed.). 2003. Workshop on lobster (*Homarus americanus* and *H. gammarus*) reference points for fishery management held in Tracadie-Sheila, New Brunswick, 8-10 September 2003: Abstracts and proceedings. Can. Tech. Rep. Fish. Aquat. Sci. 2506: vii + 35 p.

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MPO. 2016. Mise à jour des indicateurs de l'état des stocks de homard américain (Homarus americanus) du sud du golfe du Saint-Laurent. Secr. can. de consult. sci. du MPO, Rép. des Sci. 2016/051 (Erratum : mars 2017).