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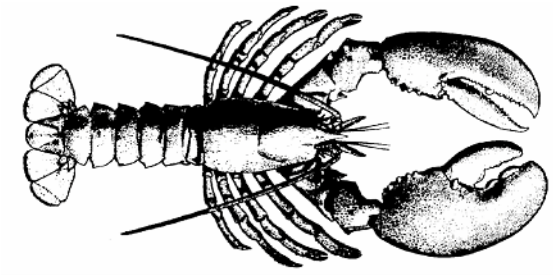
Science | Sciences

Canadian Science Advisory Secretariat
Science Advisory Report 2013/029

Gulf Region

AMERICAN LOBSTER, HOMARUS AMERICANUS, STOCK STATUS IN THE SOUTHERN GULF OF ST. LAWRENCE: LFA 23, 24, 25, 26A AND 26B



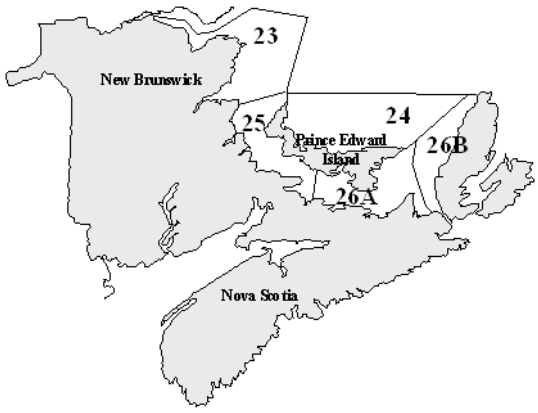


Figure 1. Lobster Fishing Areas in the southern Gulf of St. Lawrence.

Context:

The last assessment for the lobster stocks of the southern Gulf of St. Lawrence was completed in 2007 (DFO 2007). The lobster fishery in this area is an input control fishery, managed using measures that control effort and exploitation but without total allowable catches on the total fishery or for individual harvesters. A number of management measures were put in place over the last two decades, including increases in the minimum legal size, the mandatory release of window-size female, and reductions in fishing effort, with the objective of increasing egg production. The lobster fishery has been the subject of two reviews by the Fisheries Resource Conservation Council (FRCC 1995, 2007). Two multiyear conservation plans (1998-2001, 2003-2005) were developed. Important reductions in fishing effort reduction through licence retirement (reducing the number of harvesters) or reduction of the number of traps occurred as a result of the creation of the Atlantic Lobster Sustainability Measures (ALSM) program (DFO 2009). The establishment of the ALSM was triggered by substantial price declines in 2008 compared with 2007 caused by the global economic and financial crisis. The objective was to provide support for the development and implementation of lobster sustainability plans to help the industry in making changes that would enhance its economic prosperity (through self-rationalization) and long-term sustainability.

This Science Advisory Report provides an assessment of the status of the lobster stocks and the fisheries of the southern Gulf of St. Lawrence to the 2011 fishing year. This report was developed at a regional peer review meeting that took place Feb. 26 and 27, 2013 in Moncton, New Brunswick. The terms of reference for the meeting were developed by DFO Science in response to a request for advice from DFO Gulf Region Fisheries and Aquaculture Management. Reference points were not examined at the meeting. Participants at the meeting were from DFO Science (Gulf, National Headquarters), DFO Fisheries Management Gulf Region, an expert from the State of Maine Department of Marine Resources, fishing industry from the three Maritime provinces, aboriginal groups, and provincial departments of New Brunswick and Prince Edward Island.

SUMMARY

- Preliminary lobster landings in the southern Gulf of St. Lawrence in 2011 of 18,964 t are 73% above the long-term median value (10,933 t) for the period 1947 to 2011. Although part of the recent increase in landings could be attributed to an increase in egg production, favorable environmental factors are thought to have favoured strong lobster recruitment resulting in very high catches over most of the northern portion of its range.
- Stock status of lobster within the five Lobster Fishing Areas located in the Gulf Region is assessed using fishery-dependent and fishery-independent data.
- Fishing pressure indicators include estimates of exploitation rates, the proportion of empty traps, and trends in nominal effort. Exploitation rates, where and when estimates were available, averaged 47% to 83% and have not declined in the past decade. Reduced proportions of empty traps, and reductions in nominal effort (licences and total trap allocations) are indicative of reduced fishing pressure on the stock, however, the effect of this reduction on lobster stocks and the fishery is not yet known.
- Lobsters in the southern Gulf of St. Lawrence continue to be in high abundance with recent landings above long-term medians or the highest of the time series. The only area with weak or negative trends is central Northumberland Strait (sub-regions 25S and 26AD).
- Based on fishery dependent indices, there is an increase in the abundance of commercially exploitable lobster and in the abundance of berried females in all Lobster Fishing Areas of the southern Gulf with the exception of sub-region 26AD (eastern central Northumberland Strait).
- Where fisheries independent indices are available, an increase in abundance of commercially exploitable lobster is noted, with the exception of sub-region 26AD.
- There are no estimates of total biomass of lobster in the southern Gulf of St. Lawrence, in terms of biomass available to the fishery or biomass of reproductive females. In the absence of these measures, landings are used as a proxy of biomass and a berried female index from at-sea sampling as a measure of reproductive potential. The validity of these proxies has not been demonstrated.
- There is continued concern regarding the accuracy of the catch data derived from the official catch system and the delay of availability of these data and there are uncertainties in the amount of non-recorded lobster. Only preliminary landings data for 2011 were available for this assessment.
- Several indicators reviewed in this assessment can be used to assess the status of stocks in the intervening years of the multi-year assessment and management cycles.

INTRODUCTION

Species Biology

The American lobster (*Homarus americanus*) is distributed along the Atlantic coast from North Carolina to Labrador. In Canadian waters, lobsters may be fished in deep waters (e.g., Georges Bank, Bay of Fundy) but in the southern Gulf of St. Lawrence (sGSL), lobsters are generally fished close to shore in depths less than 30 m.

The life history of the lobster consists of planktonic and benthic phases. The planktonic phase follows the hatching of the eggs in July and August. The larvae go through a series of free-swimming stages which last from 3 to 10 weeks depending on environmental conditions, mostly water temperature. The planktonic phase ends at stage IV when the larvae settle to the bottom. Female lobsters in most of the sGSL have a size at 50% maturity (SOM_{50}) of 72 mm carapace length (CL), the exception being the eastern portion of the sGSL (western Cape Breton and part of St. Georges Bay) where SOM_{50} is 75 mm CL. Male lobsters become sexually mature at smaller sizes than females. Mating occurs between July and September. Generally, female lobsters extrude eggs one year after mating and carry the eggs, attached under the abdomen, for nearly another year before hatching.

Fishery

Catch records of the lobster fishery of the sGSL begin in the mid-1800s. For over a century, the fishery occurred as a nearshore, small-boat fishery, with a large number of participants. Lobster landings increased sharply (>2.5-fold) beginning in the mid-1970s, and reached a record reported catch of 22,099 t in 1990 (Fig. 2). After declining to 15,472 t in 2005, reported catches increased again into 2010. Preliminary landings in 2011 (18,964 t) were 73% above the long-term median value (10,933 t) observed between 1947 and 2011. Although part of the recent increase in landings could be attributed to an increase in egg production, favorable environmental factors are thought to be responsible for strong lobster recruitment success which has resulted in very high catches over most of its northern range.

Five major lobster fishing areas (LFA) are defined in the sGSL (Fig. 1). LFAs were established for management purposes. Management of the lobster fishery is based entirely on effort control (input fishery) (Table 1). The four most important measures in controlling effort are the fixed number of lobster fishing licences (reduced from 3,247 to 2,953 between 2006 and 2012), 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 some females to reach sexual maturity before being harvested. Egg-bearing females must also be released as well as large-sized females. Management measures vary within and among the main LFAs, and subareas of the major LFAs (Table 1).

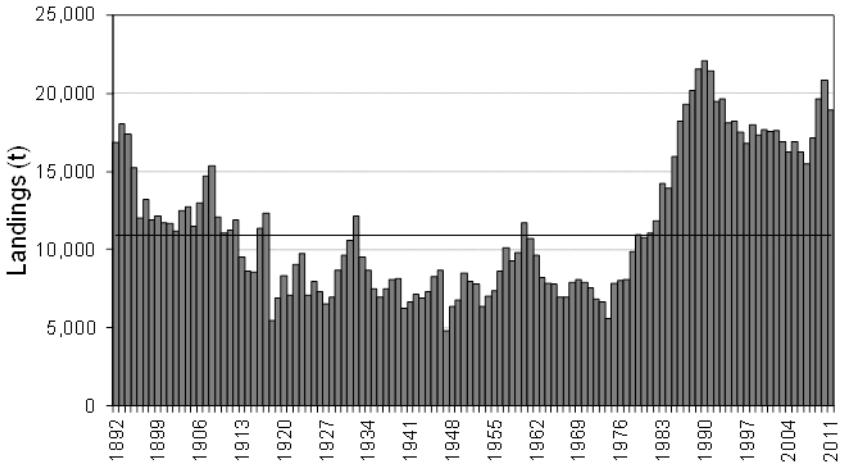


Figure 2. Recorded lobster landings (t) in the southern Gulf of St. Lawrence (DFO Gulf Region) from 1892 to 2011. The horizontal line is the median landing of the time series for 1947 to 2011. Data for 2011 are preliminary.

Table 1. Key management measures in the lobster fishery in the southern Gulf of St. Lawrence that were in effect in 2012.

	Lobster Fishing Area (LFA) and subarea										
	23				24	25	26A			26B	
	23A	23B	23C	23D			26A1	26A2	26A3	North	South
Fishing season	May 1 to June 30				May 1 to June 30	Aug. 13 to Oct. 14	May 1 to June 30[1]			May 2 to June 30	May 1 to June 30
Number of licences											
Category A Category B	636 33				635 1	708 6	703 5			223 3	
Number of traps per licence	300				300	250 (PEI 240)	280 (PEI 273)	275	250	250	
Number of traps per line	na	na	3 (portion)		na	na	6 (part of PEI) 5 Gulf NS	6	2	5	na
Maximum size entrance (mm diameter)	152				na	152	na	152	na	152	na
Minimum legal carapace size (mm)	75	75	72	71	71	71	71	73	76	81	79
Female size restriction (mm)[2]	115-129				115-129	>= 114	115-129			na	

[1] Fishing season for the portion of LFA26A from Point Prim to Victoria was May 7 to July 8, 2012
[2] Female size restriction refers to size of females which must be released, in addition to the minimum legal size and the restriction on berried females

ASSESSMENT

The stock status of lobster within the five LFAs located in the sGSL is assessed using fishery-dependent and fishery-independent data. The fishery dependent data include DFO official catch statistics, at-sea sampling activities (1982-present), voluntary recruitment-index logbook program (1999-present), and biological sampling indicators. The fishery-independent data consists of a trawl survey conducted in LFA 25 and part of LFA 26A (2001-2009, 2012), and SCUBA survey indices from LFAs 23, 25, 26A (2003-2012).

Indicators of the status of the lobster stocks are presented for three categories: fishing pressure, abundance, and production. Landing indicators are assessed in the context of their state (levels or trends) in the short term (2005 to 2011, since the last assessment), mid-term (1968 to 2011) and long term (1947 to 2011). The state of the landing indicators is presented as positive which corresponds to a change of greater than +15% from the previous period, negative corresponding to a change of greater than -15%, and no change if the indicator is within those upper and lower bounds. The state of the other indicators was assessed mostly in comparison to their level or trend at the last assessment or when data were last available.

For the purpose of this assessment some LFAs were divided into sub-regions that reflected availability of data as well as geographic and biological similarities. LFA 24 and 26B are not sub-divided. LFA23 is divided into two areas, LFA 23BC (Baie des Chaleurs) and LFA 23G (Gulf of St. Lawrence side). LFA 25 was divided into LFA 25N (northern part) and LFA 25S (southern part, central Northumberland Strait); and LFA 26A was divided into LFA 26AD (west of Pictou Island, central Northumberland Strait) LFA 26APEI (eastern side of PEI) and LFA 26ANS (mainland Nova Scotia east of Pictou Island).

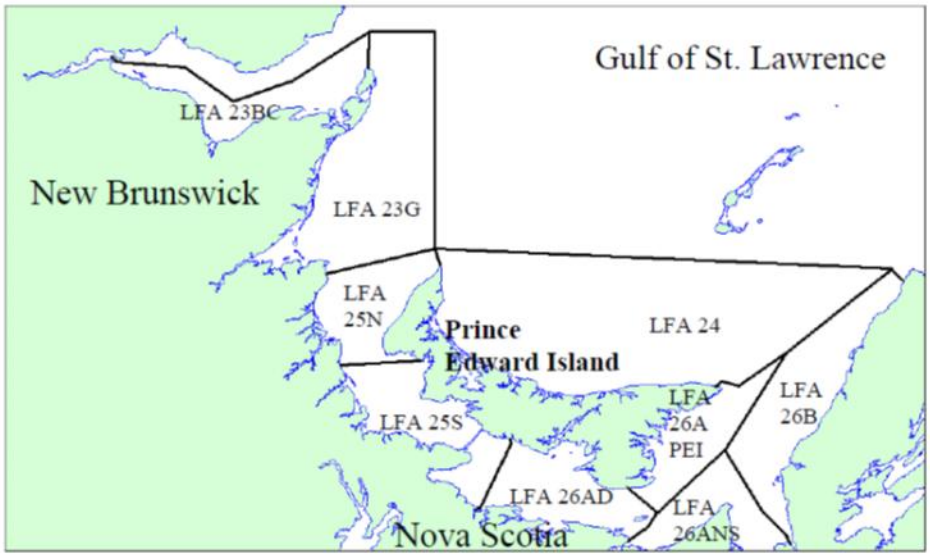


Figure 3. Lobster Fishing Areas (LFA) of the southern Gulf of St. Lawrence showing the sub-regions used for assessing the stock status.

Fishing Pressure

Fishing pressure indicators include estimates of exploitation rates, the proportion of empty traps, and trends in nominal effort, expressed in terms of licences or traps. The data for these indicators are from the at-sea sampling and the recruitment-index programs.

Exploitation rates by sub-region were estimated using two methods. The change in ratio method (CIR), is a within season indicator, and estimates the exploitation rate using the change in ratio of legal-sized lobsters to sub-legal plus legal-sized lobsters at the beginning and end of the fishing season. The data for this estimate are taken from catches in modified lobster traps which have blocked escape vents and allow for the retention of sub-legal size lobsters. The second method is based on cohorts and uses data from two successive years of fishing and calculates the ratio of the relative abundance of lobster of the first molt class recruiting to the fishery in the first year to the relative abundance at the second molt of the same group of lobster in the second year. The data for this estimate are taken from catches in regular lobster traps from the recruitment-index program. Both methods make assumptions regarding the catchability of lobster within and between years as well as limited exchanges in the population.

Using other methods such as mark and recapture, the change in ratio method has been shown to overestimate exploitation rates, due mostly to the violation of the assumption of constant catchability of lobster size groups through the season. Despite this concern, the estimates of exploitation rates from both methods remain high at over 60% on average in most regions, with the exception of 25S and 26APEI, with no trend over time (Table 2).

The percentage of empty traps has diminished almost everywhere since 2006 with an average reduction of about 20% globally. With the exception of sub-region 26AD, no area reported more than 50% of empty traps over the course of the season. In some areas the reduction in the percentage of empty traps may be explained by reductions in trap allocations, for example in LFA 26B, trap allocation in 2012 was 250 traps compared to 300 traps in 2006.

Table 2. Estimates of exploitation rates (%) of commercial-size lobster by sub-region of Lobster Fishing Areas for the years with available data in 1999 to 2011 based on two methods: cohort (COH) and change in ratio (CIR). For the cohort method, the exploitation rate estimate is for the year of the fishery on the first molt class.

	23G		24		25N		25S		26APEI		26B	
Year	COH	CIR	COH	CIR	COH	CIR	COH	CIR	COH	CIR	COH	CIR
1999	33	78	61	78	77	65	43		32		63	63
2000	68	55	68	87	65	73	51		61	55	63	81
2001	64	78	66	84	58	49	58		44	63	58	46
2002	68	63	64	81	68	70	44		60	81	74	55
2003	71	50	67	86	53	60	43		63	63	79	
2004		73	71	87	58	52			58	55		
2005			66	74	58	66			53	69		
2006			68	86	65	86			61	81		
2007			59	80	64	59			30	43		
2008			66	84	54	59			57	68		
2009			62	81	57	81			43	76		
2010			66	77	73	78	41		47	78		
2011				71		84				70		
Mean	61	66	65	81	63	68	47		51	67	67	61

The number of licences in the sGSL was reduced by 9.1% between 2006 and 2012, with most of the reduction (7.5%) occurring after 2009 following the announcement of the Atlantic Lobster Sustainability Measures (ALSM) program. Licence number reductions were not equal among LFAs, with no Category-A licences retired in LFA 24 nor in sub-LFA 26A-2 (Table 3). In the other areas, the reduction ranged from 2.1% in LFA 23B to 26.5% in management zone 26A-3, with an average reduction of 10.7% in the other management zones. The effect of the reduction in number of harvesters is still unknown but in areas where a higher proportion of licences were removed a release in fishing pressure is expected.

The nominal effort reduction in terms of maximum trap allocation was 12.3% between 2006 and 2012. The reduction is directly linked to changes in number of fishing licences but when combined with diminishing trap allocations it gives another perspective. As for licence retirements, most changes occurred after the implementation of the ALSM program. The largest decrease in nominal effort was observed in management zones 26A-3 (37.5%) and 26B south (23.9%) for type-A licences and is the result of reduction in both the number of fishing licences and trap allocations (Table 3). In LFA 24 no change in nominal effort occurred over the last 7 years for type-A licences. For other areas, the reduction in nominal effort averaged 14.2%. Based on the number of traps, the total reduction in nominal effort corresponds to 111,154 traps for type-A licences alone. As for the reduction in licence number, the effect of such a reduction in nominal effort on lobster stocks and the fishery is unknown.

Overall, the fishing pressure indicators are positive.

Table 3. Summary of trends or levels for the fishing pressure indicators used to assess changes since 2006 in the status of the lobster stocks for Lobster Fishing Areas 23, 24, 25, 26A and 26B of the southern Gulf of St. Lawrence. ↓ positive; ⇔ indicates that there is no change; ↑ negative. Lobster Fishing Areas were divided into nine sub-regions.

Indicator	Gulf	23		24	25		26A			26B
		23BC	23G		25N	25S	26AD	26APEI	26ANS	
Empty traps	↓	↓	↓	↓	↓	↓	⇔	↓	⇔	↓
Nominal effort – licence	↓	↓	↓	⇔	↓		↓		⇔	↓
Nominal effort - traps	↓	↓	↓	⇔	↓		↓		↓	↓

Abundance

Abundance indicators include two fishery dependent indices (landings, catch per unit effort) and two fishery independent indices (from trawl and dive surveys). Landings are considered to be a proxy of abundance. The catch per unit effort (CPUE) data are derived from the at-sea sampling program and the recruitment-index program. A trawl survey (random-block design) was conducted in 2001 to 2009 and 2012 and covered all LFA 25 and most of LFA 26A. Sampling intensity varied between about 100 to 235 stations with 15 minutes tows. Interpolated densities of legal and sub-legal size lobsters over the survey area were produced using a delta-lognormal model. Mean weight per standardized tow were calculated based on length-frequency distributions within the sub-regions (25N, 25S, 26AD) consistently covered by the survey. Yearly proportions of the high density area (>= 400 kg of lobster per km^2) within LFA 25 were calculated. Because of changes in the survey's spatial coverage, this index has not been produced for LFA 26A. SCUBA diving surveys were conducted using transects in LFAs 23, 25 and 26AD between 2003 and 2012. Lobsters sampled along each transects (total of 663 transects) were measured and sexed. Age were assigned using a length rule and cohort (age by year of sampling) abundances were analyzed using a Bayesian generalized linear mixed model (GLMM) for spatial and temporal trends.

Abundance indicators based on landings for legal size lobster from all LFAs are above the long-term (1947 to 2011) median value (Table 4). Since 2006, landings in LFAs 23 and 25 have continued to increase while elsewhere they were approximately stable (Fig. 4). No decrease in the mid-term (1968 to 2011) or short-term (2005 to 2011) abundance indicators are noted in any LFA (Table 4). Whereas landings generally increased since 1947 (74% overall), the timing of peaks and the pattern of decline afterward varied among LFAs (Fig. 4). This reflects the heterogeneity of the spatial distribution and the temporal variability of the lobster resource in the sGSL. The exception is LFA 24 where landings show a steady increase from 1947 to 2010.

Landing trends have improved since 2005 (Table 4). In LFA 23, the preliminary landings for 2011 (4,576 t) were 2.5 times the long-term median (1,732 t) (Fig. 4). In LFA 26A, the 2011 landings of 3,866 t were 34% above the long-term median, however, landing trends within LFA 26A varied with location, with sub-region 26AD having the weakest trend (Fig. 5, Table 4). Conversely, landings have been somewhat stable for the last two decades for fisheries operating in sub-regions 26ANS and 26APEI (Fig. 5, Table 4). The landing trends in LFA 25 were characterized by wide fluctuations with no stable period but the preliminary values for 2011 (4,015 t) were 27% above the long-term median (Fig. 4; Table 4). For sub-region 25S, landings in 2011 were slightly below the mid-term median (Fig. 5).

Table 4. Summary of abundance indicators used to assess the changes in status of lobster by Lobster Fishing Area and overall for the southern Gulf of St. Lawrence. ↑ positive; ⇔ indicates that there is no change; ↓ negative. LFAs were divided into nine sub-areas.

Indicator	Gulf	23		24	25		26A			26B
		23BC	23G		25N	25S	26AD	26APEI	26ANS	
2011 landings relative to										
Median 1947 to 2011	↑	↑		↑	↑			↑		↑
Median 1968 to 2011	↑	↑	↑	↑	↑	⇔	⇔	↑	↑	⇔
Median 2005 to 2011	↑	↑	↑	⇔	↑	↑	⇔	⇔	⇔	⇔
Catch per unit effort	↑	↑	↑	⇔	↑	↑	⇔	↑	⇔	↑
Density – trawl survey 2012					↑	↑	⇔			
SCUBA surveys		↑	↑		↑	⇔	↓			

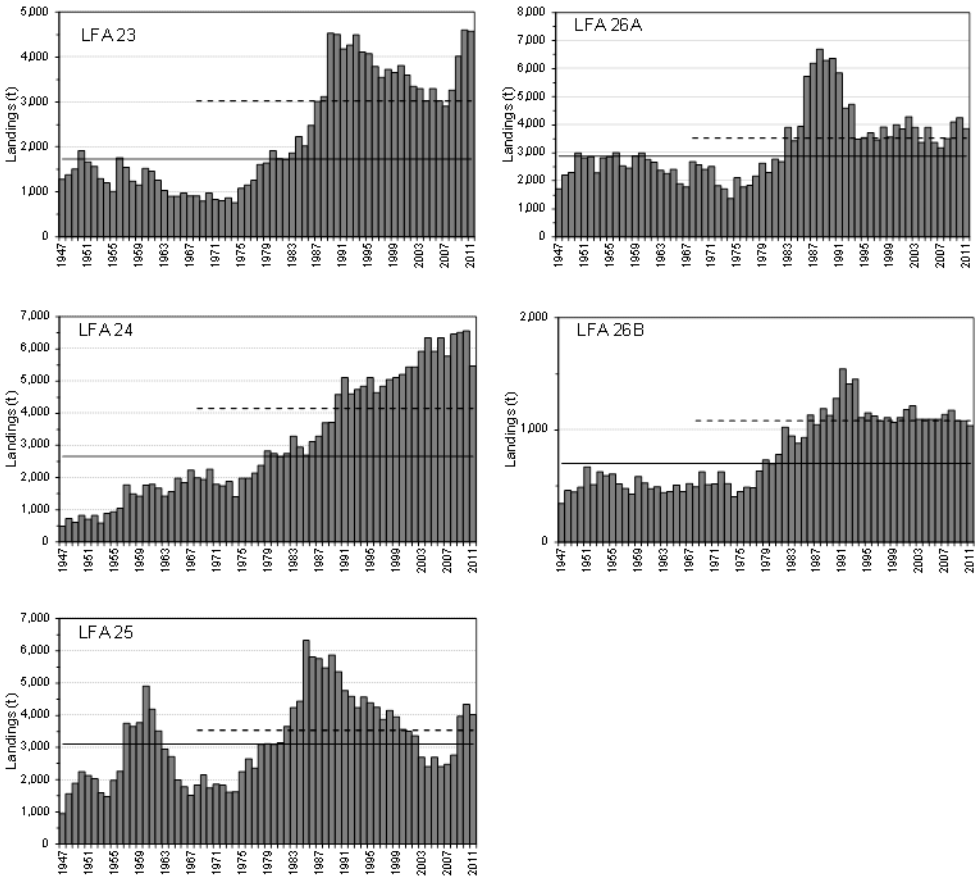


Figure 4. Reported lobster landings (t) by Lobster Fishing Area (23, 24, 25, 26A, 26B) in the southern Gulf of St. Lawrence, 1947 to 2011. The solid horizontal line is the median value for 1947 to 2011 (long-term) and the dashed horizontal line is the median value for 1968 to 2011 (mid-term).

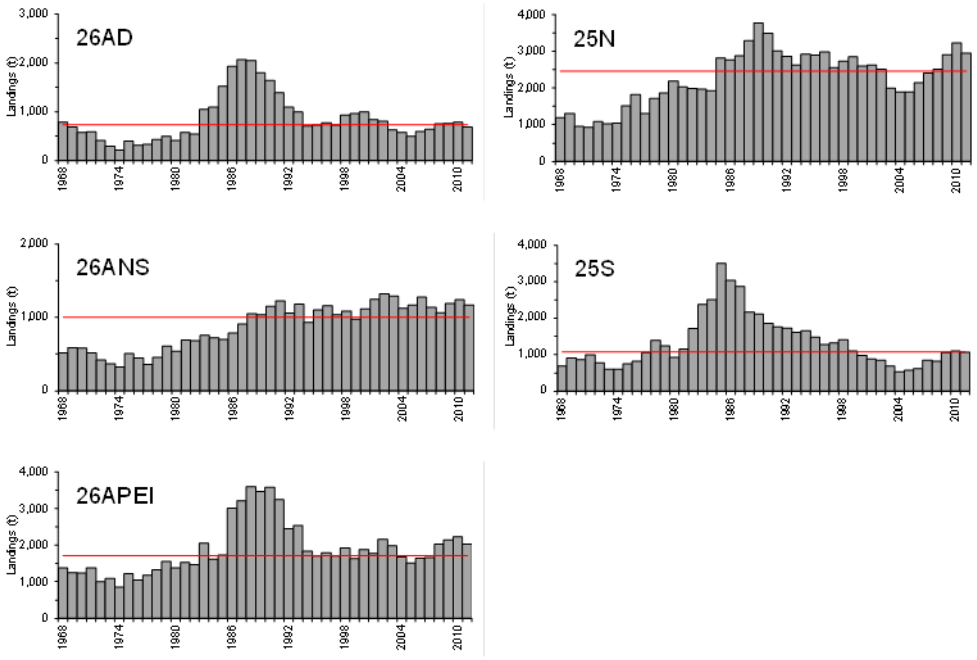


Figure 5. Reported lobster landings (t) by sub-region of Lobster Fishing Areas 25 and 26A in the southern Gulf of St. Lawrence, 1968 to 2011. The horizontal line is the median value for 1968 to 2011 (mid-term).

Trends in average CPUE from the at-sea sampling (in kg/trap) and the recruitment-index programs (in number/trap, regular traps only) are similar with increasing values in most sub-regions. No increase in CPUE was seen in LFA 24 and very limited data were available in sub-region 26ANS to define an indicator (Table 3). The highest increase in CPUE was observed in sub-regions 25N and 25S with up to a 5-fold increase in 2012 compared to 2006. Those two sub-regions also had the highest catch rates. The lowest CPUE (2011-2012) values both in number and in kg per trap were seen in sub-region 26AD.

Similar positive trends in abundance were observed in the fishery-independent trawl survey. Commercial size lobsters were caught in high concentrations around Pictou Island (26ANS), eastern PEI (26APEI), and in increasing abundance in LFA 25N (Table 4; Fig. 6). Lobsters were at very low abundance in the area east of Cape Tormentine to River John (sub-region 26AD). In 2012, the proportion of high density areas (>400 kg of legal-size lobster per km^2), the density index, and the biomass indices (observed and from model) were the highest of the survey time series (2001-2009, 2012) for LFA 25 as a whole (Table 4). In 2012, both sub-regions within LFA 25 had a biomass index for all sizes lobster above the time series average (2001-2009, 2012) (Table 4; Fig. 7). For sub-region 26AD, the 2012 biomass index was also above the time series average (2005-2009, 2012) which was shorter because of spatial coverage gaps before 2005. Length frequency analysis from the trawl surveys revealed an increased abundance of lobsters of all sizes in 2012 for LFA 25 but not in LFA 26A where the survey is conducted just after the fishery.

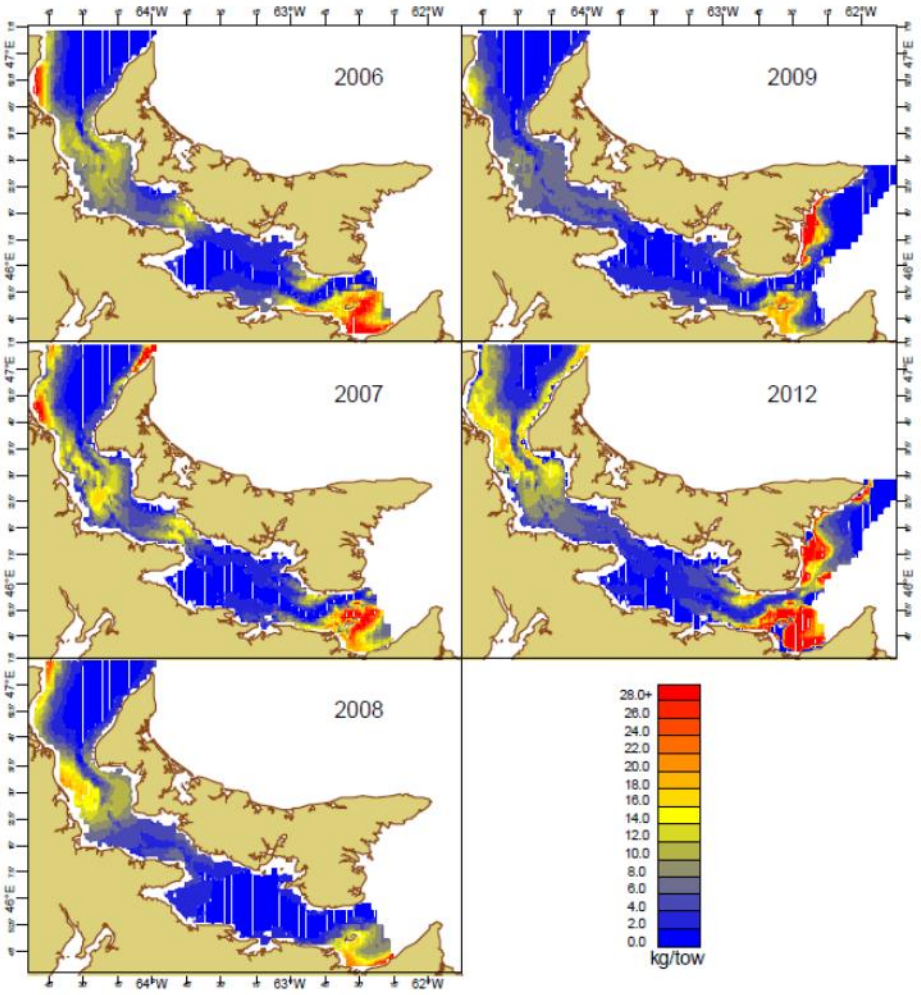


Figure 6. Spatial distribution of abundance (kg per tow) of legal-size lobster estimated from the Northumberland Strait bottom trawl survey during 2006 to 2009 and 2012. Legal-size lobster for 2006 to 2009 are ≥70 mm CL and for 2012 are ≥71 mm CL.

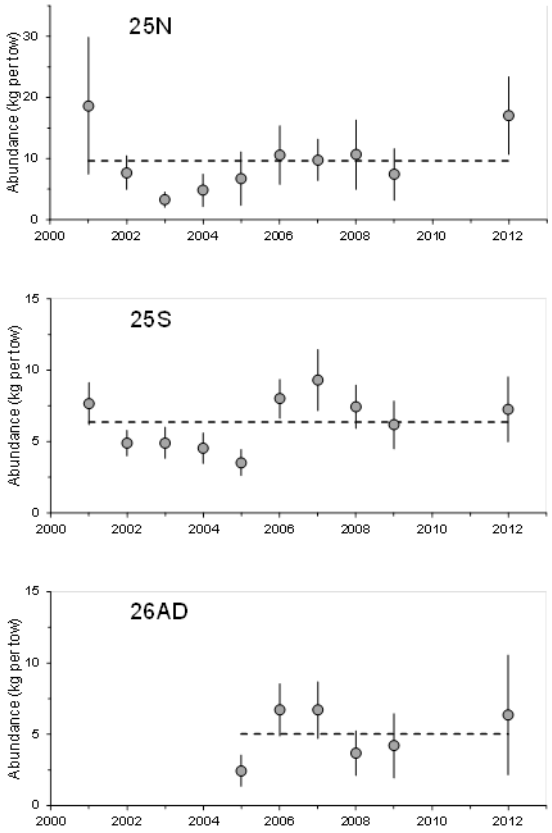


Figure 7. Trends in indicators of abundance (kg per tow, mean and 95% confidence interval range) of all sizes of lobster by sub-region 25N (upper panel), 25S (middle panel) and 26AD (bottom panel) from the bottom trawl survey for 2001 to 2009, and 2012. The horizontal lines are the mean values for the time series, 2001 to 2012 except for sub-region 26AD where the mean is calculated for the years 2005 to 2012.

Based on a Bayesian estimation model, the standardized abundance of all size groups of lobster observed from SCUBA surveys in the sGSL increased steadily and significantly between 2003 and 2012 (Fig. 8). The mean abundance increased by more than 6.5-fold, from 2.0 to 13.1 lobsters per 400 m², between 2003 and 2012. Spatially, differences were observed among sites along the north to south axis, but reflected a separation of lobster abundances within and outside central Northumberland Strait. Higher abundances (8.3-16.7 lobsters per 400 m²) were observed in LFAs 23 and 25N, while abundances in sub-regions 25S and 26AD ranged between 0.5 and 5.4 lobsters per 400 m² (Fig. 9).

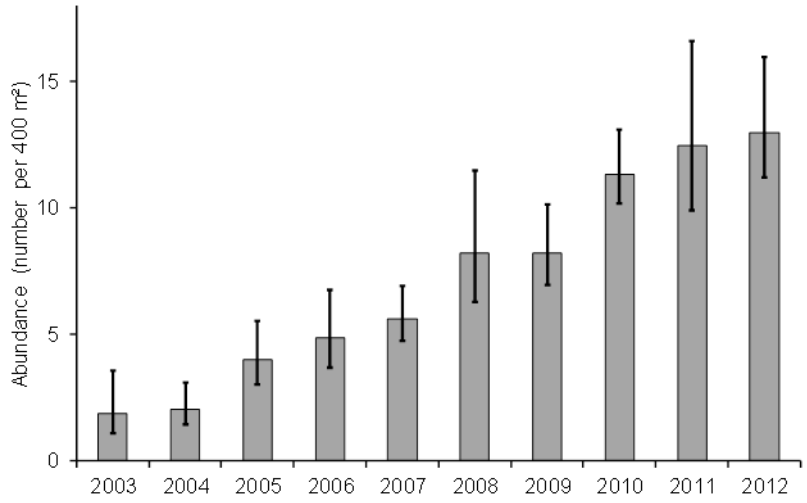


Figure 8. Standardized mean abundance (number of lobsters per 400 m²) for 2003 to 2012, averaged over sites and cohorts from the Bayesian model. Also shown are 95% credibility intervals from the posterior distributions of the model fits.

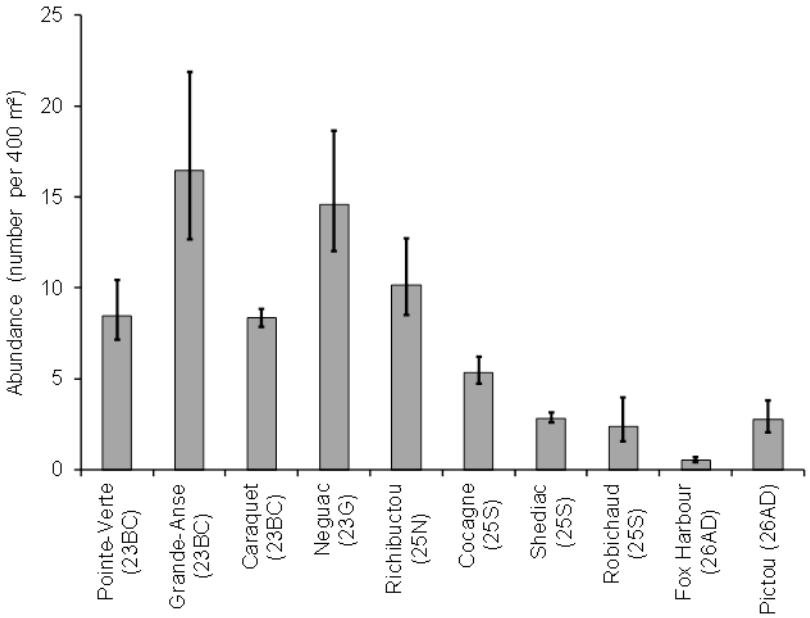


Figure 9. Standardized mean abundance (number of lobsters per 400 m²) by site, averaged over years and cohorts from the Bayesian model. Also shown are 95% credibility intervals from the posterior distributions of the model fits.

Production

Fishery dependent indicators of production include catch rates of berried females from at-sea sampling activities and catch rates of pre-fishery recruit sizes in modified traps from the recruitment-index program. Fishery independent indices of production included density indices of sublegal size lobsters from the trawl survey, sex ratio of lobster from the trawl survey, and indices of abundance of 1-year old lobster assessed by SCUBA diving surveys in sub-regions 23BC, 23G, 25N, 25S, and 26AD between 2003 and 2012.

Since 2006, the CPUE indices of berried females in the at-sea samples have generally increased or remained stable (Table 5). High catch rates were seen in sub-regions 25N and 25S, with the peak seen in 2010 for 25S the highest ever recorded. In other sub-regions, the increase seen in the 2012 berried females CPUE coincide with MLS increases that took place since 2003. Sub-region 26AD had the lowest catch rate value of berried females with not much change since 2006.

The modified traps used in the recruitment-index program provide an index of recruitment size lobsters. The CPUE of fishery recruits have increased in the last few years in many areas while in others (LFA 24 and sub-region 26APEI) no trend was observed (Table 5). Sub-region 26AD was characterized by the lowest CPUE of fishery recruits with no distinction between the modified and the regular traps. The absence of a difference between data from the modified versus regular traps could indicate very low fishery recruitment in that sub-region. This observation corroborates the low level of recruitment in central Northumberland Strait observed from other fishery dependent and fishery independent indicators.

Concentrations of sub-legal lobsters were detected in the trawl survey along the eastern coast of NB, and most recently around Pictou Island and on the east coast of PEI as the spatial coverage of the survey was increased (Fig. 10). Biomass indices of sub-legal size lobsters were above the time series average in the three sub-regions covered by the survey (Fig. 11) and the spatial proportion of high densities areas of sub-legal lobsters for LFA 25 was more than three times higher in 2012 compared to the 2001-09 series averages. No concentration of sub-legal lobsters was observed in central Northumberland Strait during the surveys (Fig. 10).

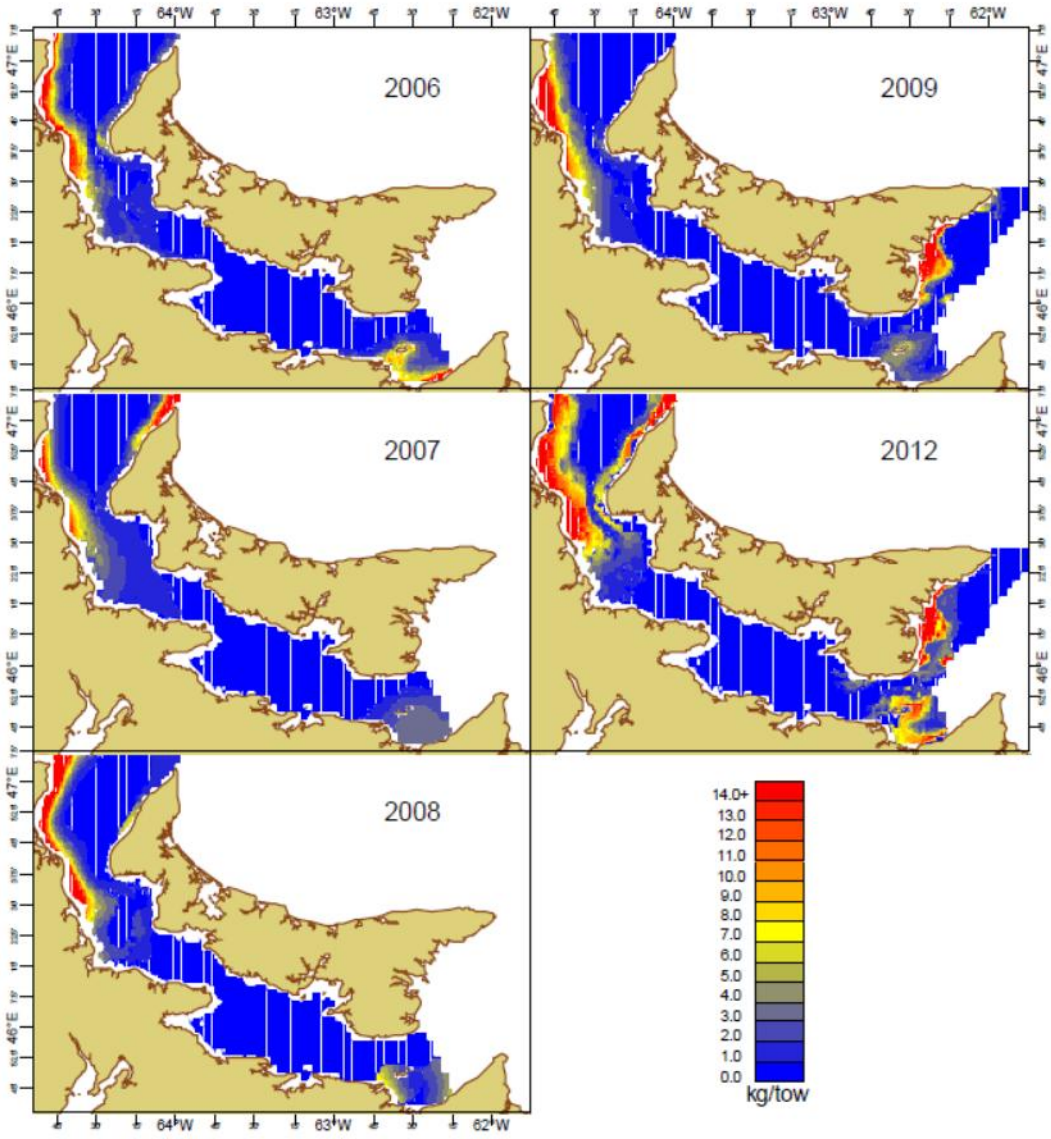


Figure 10. Spatial distribution of abundance (kg per tow) of sub legal-sizes of lobster estimated from the Northumberland Strait bottom trawl survey during 2006 to 2009 and 2012. Sub legal-sizes of lobster for 2006 to 2009 are < 70 mm CL and for 2012 are < 71 mm CL.

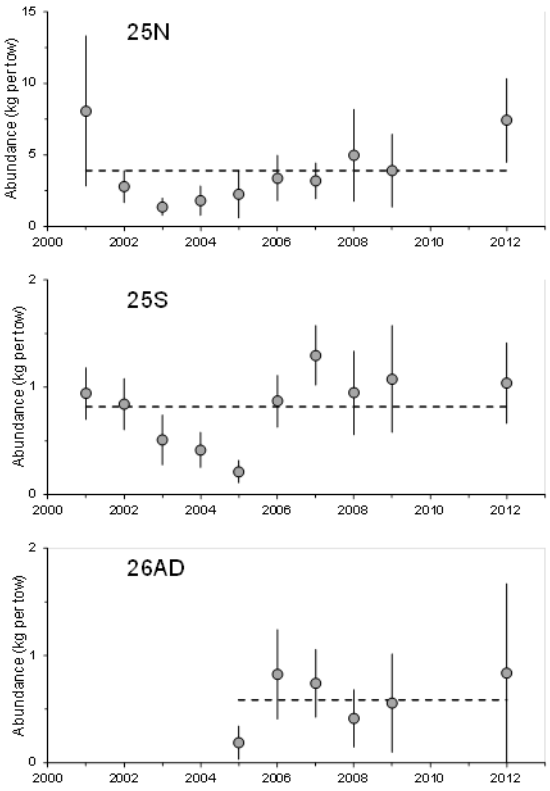


Figure 11. Trends in abundance (kg per tow, mean and 95% confidence interval range) of sub-legal sizes of lobster in sub-region 25N (upper panel), 25S (middle panel) and 26AD (bottom panel) as estimated from the bottom trawl survey, 2001 to 2009 and 2012. The horizontal lines are the mean values for the time series, 2001 to 2012 except for sub-region 26AD where the mean is calculated for the years 2005 to 2012.

Sex ratios (male : female) of legal size lobsters from the survey data were always above 1 in LFA 25 and around 1 in 26A (from 0.95 to 1.08).

The abundance of 1-year old lobsters was assessed by SCUBA diving surveys in sub-regions 23BC, 23G, 25N, 25S, and 26AD between 2003 and 2012. Increasing trends and high values in the recent years were observed at the 2 sites outside Northumberland Strait (Fig. 12; Table 5). No increase in lobsters < 32 mm carapace size was observed at the Shediac (25N) and Fox Harbour (26AD) sites where the estimated abundances were the lowest.

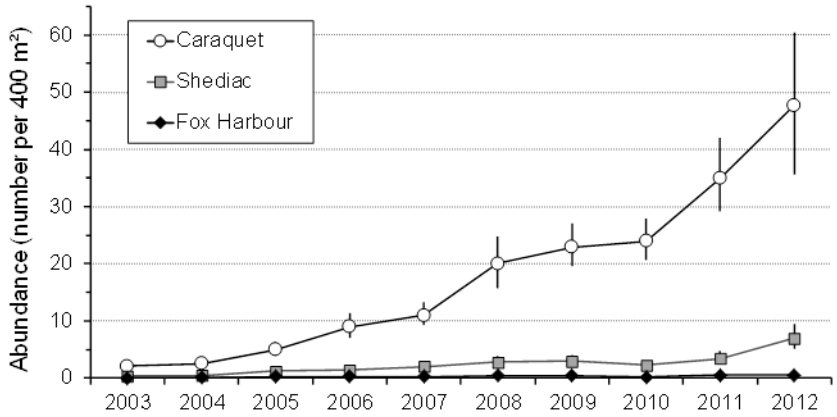


Figure 12. Standardized mean abundance (number of lobsters per 400 m²) for cohort 1 for Caraquet (23G), Shediac (25S), and Fox Harbour (26AD) derived from the Bayesian model for the years 2003 to 2012. Also shown are 95% credibility intervals from the posterior distributions of the model fits.

The production indicators from various data sources are still negative in the sub-region 26AD (eastern portion of Northumberland Strait) while being positive or at least stable elsewhere in the sGSL.

Table 5. Summary of production indicators used to assess the changes in status of lobster by Lobster Fishing Area and overall for the southern Gulf of St. Lawrence. ↑ positive; ⇔ indicates that there is no change; ↓ negative. LFAs were divided into nine sub-areas.

Indicator	Gulf	23		24	25		26A			26B
		23BC	23G		25N	25S	26AD	26APEI	26ANS	
Berried females – at sea sampling	↑	↑	↑	⇔	↑	↑	↓	↑	↑	↑
Pre-recruit CPUE – recruitment index				⇔	↑	↑	↓	⇔	↑	↑
Pre-recruit density – trawl survey					↑	↑	⇔	↑	↑	
Sex ratio – trawl survey					⇔		⇔			
1-year old abundance - SCUBA surveys		↑	↑		↑	⇔	↓			

Ecosystem considerations

Environmental conditions, such as water temperature, can influence the distribution of lobster as well as their catches. The distribution of lobster is restricted to the coastal water of the sGSL (i.e., typically <30 m) where bottom temperature can reach >20°C (e.g., central Northumberland Strait) during the summer.

Overall, environmental conditions have been warming up in the sGSL over the last two decades. However, Sea Surface Temperature (SST) has been relatively stable in summer over the lobster grounds since 2000. Noticeable exceptions are June 2006 and August 2012 when warmer-than-normal temperatures were observed at the surface over most LFAs. August 2008 and August 2011 are also outstanding months as they exhibited cooler conditions.

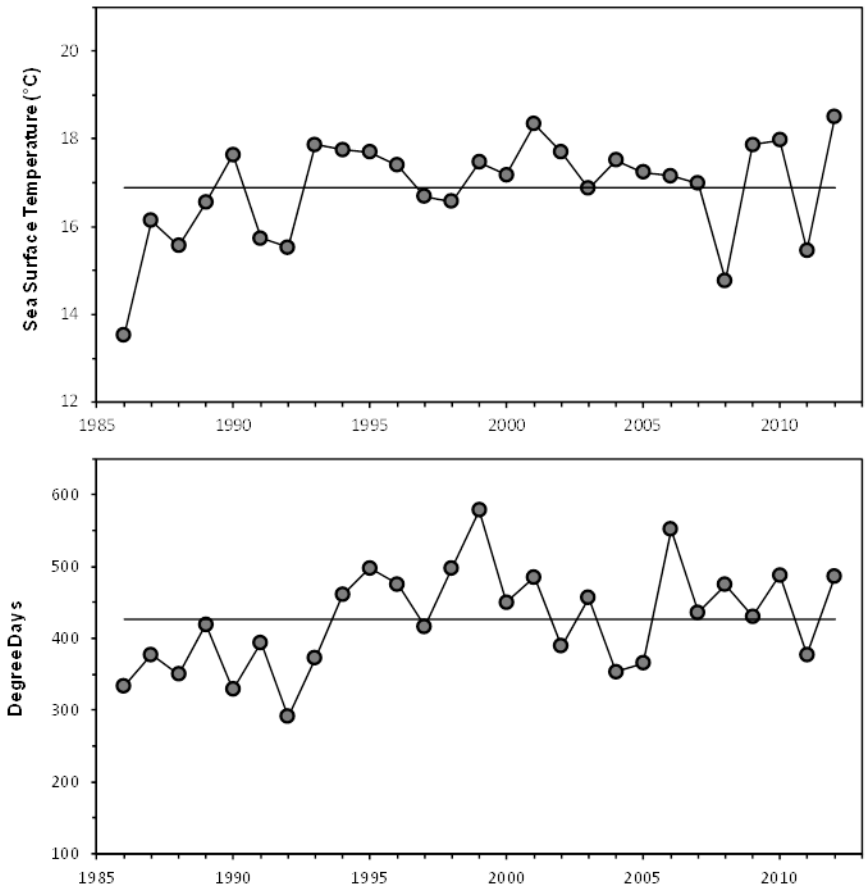


Figure 13. Time series of Sea Surface Temperature (SST) in August (upper panel) and cumulative degree days over 4ºC (May 1 to July 15) (lower panel) for the southern Gulf of St. Lawrence, 1986 to 2012. The horizontal line is the mean of the time series for each.

Consequent with the overall warming conditions, there has been significantly less than normal ice coverage since 2004 with very low ice volume from 2010 to 2012. The volume of the cold intermediate layer decreased to record low in 2012. This decrease may favour an expansion of the lobster distribution.

In terms of larval drift and survival, current observations and models suggest that the Northumberland Strait is essentially a more isolated system in terms of larval recruitment than other areas of the sGSL, with estimates from circulation models suggesting an exchange of 35% of the larval drift with adjacent areas from outside LFA 25S and LFA 25N.

Lobster diet and predator-prey relationships were established based on samples collected during the May, July, August and October trawl surveys. Lobster is largely carnivorous and decapods were the principal prey (57% to 84% of prey biomass), with rock crab being the single most important component of the diet (45% to 78%). About 70% of the rock crab consumed by lobster represented fresh prey (muscle or gills attached) and the remainder consisted of old carapaces. Lobster represented 8% to 13% of the prey biomass; however, a substantial portion (39% to 79%) of the lobster remains consisted of old carapaces. The only demersal fish demonstrated to consume large amounts of intact lobster was the shorthorn sculpin. Rock crab is an essential prey for lobster molt processes.

Sources of Uncertainty

There is 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 assessment, as the analysis of landing trends could only be done on 2011 preliminary data. Furthermore, in terms of stock assessment, the current system does not collect any information on fishing effort. Complete information on catch, effort and fishing location from all the users are required to properly assess lobster stocks and the fishery status.

Landings and information gathered from recruitment-index program and at-sea sampling program are a function of abundance, the level of fishing effort (trap hauls, soak-days, timing of effort and fishing strategy) and catchability. Catchability in turn is affected by environmental conditions, gear efficiency (including trap design and bait), and other factors. Changes in any of these can affect landings and indices of abundance based on catch rates. Thus, indicators derived from these sources would not necessarily reflect changes in abundance, fishing pressure, or production.

None of the fishery independent indicators of stock status are available for all LFAs and only landings data provide an index of abundance for the entire sGSL, which makes an assessment of the status of the resource difficult.

Estimates of exploitation rates derived from the analysis of the change in abundance of first molt class or the change in ratio estimator can be very uncertain and potentially biased if the assumptions of the methods (similar catchability among size groups, and among years) are not respected and there is inadequate sampling. Additional modeling approaches or alternate approaches may address these uncertainties.

There are no estimates of total biomass of lobster in the sGSL, in terms of biomass available to the fishery or biomass of reproductive females. In the absence of these measures, landings are used as a proxy of biomass and berried female index from at-sea sampling as a measure of reproductive potential. The validity of these proxies has not been demonstrated.

Localized movements of benthic stages of lobster within the sGSL related to Northumberland Strait are not well understood.

The contribution of larval settling versus benthic movements to the recruitment of lobster into Northumberland Strait fisheries (sub-regions 25S, 26AD) is not well understood. Particle drift modeling indicates that there is limited larval exchange between this area and the outside area. From SCUBA survey indices of abundance, recruitment to the fishery in this area cannot be explained by larval settlement in the area. Industry-led monitoring with bio-collectors to enumerate settling success of lobsters in several sub-regions has begun and although the time series is short, initial results suggest higher settling densities in LFA 24 compared to those noted in regions of Northumberland Strait. Such data may be useful in the future in furthering the exploration of hypotheses regarding recruitment dynamics of lobster.

Size at onset of maturity (SOM) has been measured on a decadal cycles and from the recent assessments has not changed. It would be appropriate to re-estimate this value considering the changes in environmental conditions observed in the past decade and anticipated in the future.

Effects of changes in temperatures on lobster larvae survival, benthic stages, recruitment, growth, behavior and the response of these to stressful conditions are also not understood. Physiological responses to increasing and higher than usual bottom temperature need to be evaluated.

CONCLUSIONS AND ADVICE

Indicators of status for the sGSL lobster stock include both fishery dependent and fishery independent indices.

Based on fishery dependent indices, there is an increase in abundance of commercially exploitable lobster and in abundance of berried females in all LFAs of the sGSL with the exception of sub-region 26AD.

Where fisheries independent indices are available, an increase in abundance of commercially exploitable lobster is indicated, with the exception of sub-region 26AD.

Lobsters in the sGSL continue to be in high abundance with recent landings above long-term medians or the highest of the time series. The only area with weak or negative trends is still central Northumberland Strait (sub-regions 25S and 26AD) and based on the SCUBA abundance index, the abundance of small animals (<50 mm CL) in this area is low.

The two multi-year management plans aimed at increasing egg production through increases in MLS and the protection of large females seem to have had a positive effect on lobster production. The recent reduction in nominal effort, both in licence numbers and in maximum trap allocations will most likely release some fishing pressure on lobster stocks but its benefit is presently not fully known. The drop in the percentage of empty traps during the fishery in several areas is interpreted as an indication of reduced fishing pressure on the lobster stock.

The lobster fishery in the sGSL continues to have high exploitation rates and to be heavily dependent on new recruits to the fishery, making this fishery directly dependent on the level of recruitment. Exploitation rates, where and when estimates were available, averaged over years from 47% to 83% and have not declined in the past decade.

Egg production, expressed as the index of berried females from at-sea sampling, has increased in most monitored areas over the past decade.

Early stage recruitment indicators, cohort 1 from SCUBA surveys, show an increasing abundance of this life stage over the 2003 to 2012 period. In one area, the increase in abundance coincides with the increase in MLS measures in that area and although untested, the cohort 1 index increase may be related to the increased egg production. Whether the increase in the index of cohort 1 translates into increased exploitable biomass and landings remains to be seen. The only area that systematically shows negative indicators for the level of 1-yr old lobsters, pre-recruits into the fishery and berried females is central Northumberland Strait (sub-region 26AD).

The indices of abundance of pre-fishery size recruits derived as the CPUE from the modified traps have increased in many areas with the exception of LFA 24 and sub-region 26APEI where no change over time was observed. For LFA 24, pre-recruit indices are as high as in other areas but in subarea 26AD, characterized by the lowest CPUE of fishery recruits, there is no distinction in abundance between the modified and the regular traps. The absence of a difference in abundance in modified versus regular traps could indicate very low fishery recruitment.

No reference points are defined for this stock. Potential candidate reference points were not examined and their application to the sGSL stock requires analysis and review.

Annual monitoring of the above indicators can be used to assess status of stocks in the intervening years of the multi-year assessment and management cycles.

OTHER CONSIDERATIONS

Within the lobster fishery operating in the Gulf region rock crab, cunner, and sculpin are allowed to be landed. While the amount of rock crab landed as by-catch is recorded and incorporated in the assessment of that species no information is available for rock crab used as bait. Removals of cunner and sculpin are undocumented with unknown consequences to their populations or the ecosystem. Harvesters indicated they were seeing large numbers of cunner in lobster, interpreted as cunner being in high abundance.

The gear impact or “footprint” from the lobster fishery on the benthic habitat has not been assessed. Contact area between traps and the benthic habitat is less than 1% in all LFAs but that does not take into account any type of impact associated with movements of traps along the bottom.

The trophic link between lobster and rock crab is well documented. The directed rock crab fishery is restricted to large males which are very little preyed upon by lobsters. There is presently no minimum size limit or harvest limit on removals of male rock from the by-catch and the bait fisheries in lobster traps. The extent of rock crab catches in lobster gear may be decreasing with the use of larger escape mechanisms in lobster traps adjusted to the lobster minimum legal size which would reduce the retention of small rock crab.

Lobster by-catch during the scallop fishery has been evaluated to represent a very small fraction of the total lobster population. Based on 24 trips sampled during 2006 to 2008, a total of 51 lobsters were caught (mean of 1.7 lobsters per fishing trip) and most animals were in good to excellent condition when returned to the water. Buffer zones are in place in the scallop fishery to reduce or avoid dredging on lobster grounds. No information is available on lobster by-catch in other fisheries in the sGSL but no landing of lobster is allowed other than from the lobster fishery.

SOURCES OF INFORMATION

This Science Advisory Report is from the regional peer review meeting of February 26 to 28, 2013 on the assessment of the status of the lobster (*Homarus americanus*) and rock crab (*Cancer irroratus*) stocks of the southern Gulf of St. Lawrence. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

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