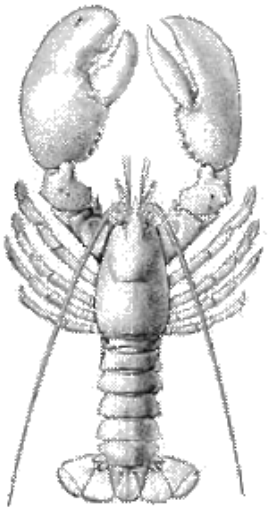
ASSESSMENT OF LOBSTER IN LOBSTER FISHING AREA 41 (4X + 5Zc)



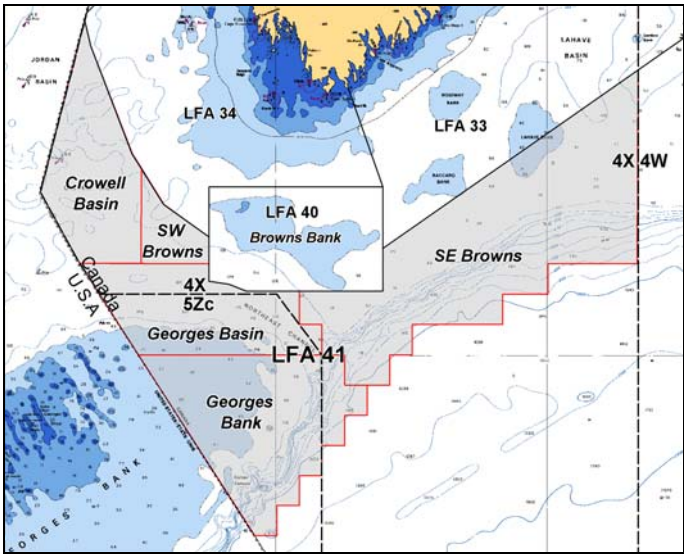


Figure 1: LFA 41 (4X + 5Zc) assessment areas.

Context :

Lobster (Homarus americanus) in Lobster Fishing Area (LFA) 41 (4X + 5Zc) are characterised by a large median size (females: 1-3 molt groups above the size of 50% maturity) and a very high percentage of females that reproduce more than once (relative to other areas). The management plan and past assessments have looked at maintaining the high reproductive potential in this area. There remains uncertainty with respect to the linkages between these lobster and the rest of the Gulf of Maine and Georges Bank area in terms of the degree of mixing during different life history stages.

The status of lobster in LFA 41 was last assessed in 2000. The fishery operates under the 2006-2010 Integrated Harvesting Plan with 8 licences and a total allowable catch (TAC) of 720t, and is authorized to fish in the 4X and 5Zc portions of LFA 41 (Figure 1). LFA 41 is the only lobster fishery in Canada that is managed with a TAC.

The Maritimes Region's Lobster Conservation Strategy (2004-2008) requires that, within each LFA, indicators be developed that are supported by a broad representation of stakeholders. Indicators for lobster in LFA 41 are required to remain consistent with the overall Lobster Conservation Strategy. The purpose of this Science Advisory Report is to evaluate the status of lobster in LFA 41 (4X + 5Zc) in 2008 based on indicators for monitoring the health of the lobster stock in this area.

SUMMARY

- The abundance indicators suggest that lobster abundance in LFA 41 has been either stable without trend or has trended higher since 1999. The current catch rate model indicates catch rates have trended inconsistently or increased in different areas of LFA 41. The DFO bottom trawl survey shows increased mean number of lobster per tow, but the time series is short and further development of this data set is recommended.

- Total trap hauls (fishing pressure indicator) in 2007 returned to pre-Jonah crab fishery levels of 225,000, down from the peak of 593,000 in 1998-99 season presumably because of reduced fishing for Jonah crab.
- Exploitation rate for lobster in LFA 41 has not been directly estimated but is inferred to be low. The size structure has remained stable except for apparent recent decreases in sizes in the Crowell Basin area. The results suggest a low exploitation level similar to that estimated in the USA 2006 lobster assessment of Georges Bank (Fishing Mortality, F, of 0.3).
- The sex ratio is skewed towards more females as conservation rules protecting berried females result in lower fishing mortality on females. The decrease in the proportion of males occurred during the first 10 years of the fishery, with the largest change on Georges Bank, and has since remained stable.
- Landings in adjacent fisheries have increased significantly in the last 10 years, indicating additional pressure on the lobster resources in these areas.
- Indicators of lobster recruitment in LFA 41 are not currently available. Standard size-based methods are not applicable in LFA 41 since the fishery is conducted primarily in deeper areas where recruitment is not expected to occur. The US National Marine Fisheries Service has used their trawl survey to track recruit abundance and, as the time series develops, a similar approach will be applied using Canadian data. The 2006 USA lobster assessment concluded stable abundance for the Georges Bank stock and much of the Gulf of Maine stock with very little variability in abundance in recruit and post-recruit size classes over the time series (1982-2004) on Georges Bank.
- A high percentage of females in the catch of the LFA 41 fishery catch are larger than the 50% size of maturity (Georges Bank 98%, Southeast Browns 96%, SWB 77%, Georges Basin 91%, Crowell Basin 63%); and data from length compositions indicate many have spawned more than once. Four of these areas show no trend in this proportion over time; Crowell Basin has shown a decrease in the proportion of mature females.
- Bycatch in the LFA 41 lobster fishery is recorded on observed trips. Species that occur most frequently as bycatch are Jonah crab, cusk, hake (red and white), cod, rock crab and redfish. Other than Jonah crab, all animals are required to be released. High survival is expected for invertebrates, but survival may be lower for some fish species.
- The effect of fishing on bottom habitat has not been evaluated but, relative to other bottom contact gear types, is expected to be low due to the small size of the gear footprint and relatively low density of traps in this large fishing area.

BACKGROUND

Species Biology

Nova Scotia lobsters take 8-10 years to reach 82.5 mm carapace length (CL), the legal size in LFA 41. At that size, they weigh 0.45 kg (one pound) and molt once a year. Larger lobsters molt less often, with a 1.4 kg (three pound) lobster molting every two to three years. Off southwestern Nova Scotia, most female lobsters mature between 95 and 100 mm CL at an average weight of 0.7 kg (1.5 lb.). The mature female mates after molting in midsummer and the following summer produces eggs that attach to the underside of the tail. The eggs are carried for 10-12 months and hatch in July or August. The larvae spend 30-60 days feeding and growing near the surface before settling to the bottom and seeking shelter. For the first few years lobsters remain in or near their shelter to avoid predation. As they grow, they spend more time outside the shelter.

Mature lobsters seasonally migrate to shallower waters in summer and deeper waters in winter. Over most of the lobster's range these movements amount to a few kilometers; however, in the Gulf of Maine, the offshore regions of the Scotian Shelf and off New England, lobsters can undertake long distance migrations of tens to hundreds of kilometers.

The lobster stock structure in the Gulf of Maine is not fully understood and is viewed as a stock complex, which means that there may be a number of sub-populations linked in various ways by movements of larvae and adults. The linkages between them could vary from year to year, as wind events alter the drift of planktonic larvae or water mass movements influence migration patterns. Migration patterns are affected by bottom topography, depth, water temperatures and possible homing characteristics.

The number and distribution of the subpopulations remains uncertain. Lobster concentrations are highest in coastal regions and lower concentrations are associated with the offshore Banks of Browns and Georges. Lobsters are found in higher concentrations on the banks in summer and migrate to deeper water in winter.

Fishery

The offshore lobster fishery (LFA 41), established in 1972, fishes from the 50 nautical mile line (92 km) to the upper continental slope. While LFA 41 includes parts of the Northwest Atlantic Fisheries Organization (NAFO) Subareas 4Vs, 4W, 4X and 5Z, lobster fishing is authorized only in 4X and 5Zc.

Management Measures

There are 8 licenses to fish lobster in LFA 41, with a TAC of 720t lobster and 720t Jonah crab (status of Jonah crab in LFA 41 is assessed in DFO 2009). The fishery is managed by input and output controls including a minimum size CL, prohibition on landing berried or v-notched female lobsters, limited entry, and a TAC (Table 1). An area encompassing all parts of Browns Bank <50 fathoms (91.4m) was closed to lobster fishing in 1979, though other fishing activity still occurs within it. This is referred to as the Browns Bank closed area or LFA 40 (Figure 1).

Table 1. Specifics of some current lobster management measures in LFA 41.

Season:	Year round Quota year Jan1-Dec 31
Minimum Legal Size:	82.5mm CL
Landings of Berried and V-Notched Females:	Prohibited
Trap Limit:	None
Number of Licences:	8
TAC:	720t

Landings and Effort

The monthly trends in landings and effort vary with area (Crowell Basin, Southwest Browns, Georges Basin, Southeast Browns, and Georges Bank) and over time, but there are persistent annual trends within an area (Figure 2; Table 2). Fishermen stated that they are targeting lobster movements on and off the banks and the timing of such movements determines their fishing locations and landings. These seasonal movements are documented in numerous tagging studies.

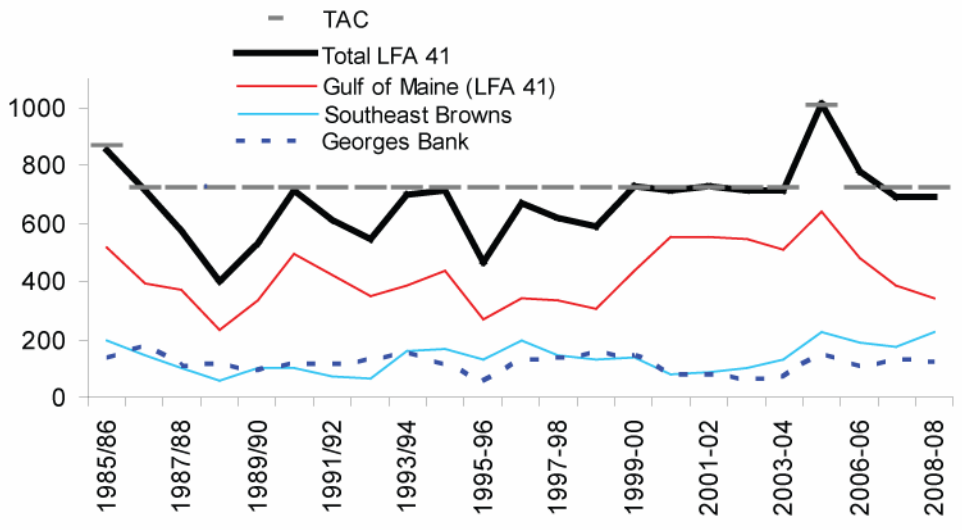


Figure 2. Quota season landings by fishing areas (SE Browns; Georges Bank; and Gulf of Maine (GOM), which combines landings from Crowell Basin, Georges Basin and SW Browns) showing TAC for the quota period. Higher TAC in 1985-1986 and 2004-2005 were due to extended seasons during transition to a new quota period (1984-1985 change from annual to Oct 15-Oct 14; 2004-2005 change back to annual). The change in the quota year resulted in seven of the eight licences having an extended season during the transition in 2004-2005, and an annual TAC (Jan-Dec) during 2006 to 2007, while one licence continued under the Oct 16-Oct 15 TAC during those years. The remaining licence switched to an annual quota year in 2007. For simplicity in this report the landings and TAC are expressed on an annual basis for 2006 and 2007 to reflect the majority of the fishery.

Table 2. Total Allowable Catch (TAC), landings, number of vessels, and total trap hauls.

	Mean 1986-1995	**Mean 1995-2000**	**2000-2001**	**2001-2002**	**2002-2003**	**2003-2004**	**2004-2005**	**2006**	**2007**	**2008**
TAC	720	720	720	720	720	720	1008 *	720	720	720
Total	613	615	717	726	718	717	1013	780	691	692
Crowell Basin	99	86	139	125	166	101	72	21	12	11
Southwest Browns	176	152	252	291	286	284	390	294	224	216
Georges Basin	106	100	163	140	95	122	177	170	149	117
Southeast Browns	149	149	84	86	103	133	224	190	175	223
Georges Bank	126	126	79	83	67	76	150	106	132	123
Number of vessels	6	8	8	9	8	8	7	6	4	4
Total Trap Hauls (,000)		455	409	420	308	281	444	294	288	304

*2004/2005 SEASON October 16, 2004 to December 31, 2005
** Does not include experimental fishing in 4W

Georges Bank (Corsair Canyon and the slope east of it) has been fished since 1972. There is little area for expansion on Georges Bank as the USA lobster fishery lies to the south, and once lobsters move onto the banks they disperse. This is also an area where significant mobile gear activity would interfere with lobster fishing.

Southeast (SE) Browns has been fished since 1973. During the late 1990s, fishing effort on SE Browns expanded eastward in part due to the expansion of the Jonah crab effort to these areas. With the decline of the Jonah crab catch in 2003, lobster landings shifted back to more traditional grounds. Since 2000, landings from SE Browns have been relatively stable with annual catch per unit effort (CPUE) increasing.

Southwest (SW) Browns has had persistent effort while Georges Basin and Crowell Basin have varied over the time series. Georges Basin was first fished heavily in 1985 following the International Court of Justice (ICJ) Canada USA boundary settlement that removed USA effort from the area. SW Browns and Georges Basin have showed increased landings since 2000.

Crowell Basin landings increased from 2000 to 2003 then declined, though CPUE did not. A major shift in effort and landings out of Crowell Basin began in 2004 with little or no fishing in the basin in 2006 and 2007 (Figure 3). Industry representatives and captains indicate that the move was the result of no longer targeting Jonah crab, which had made up a portion of the catch. Removal of the vessel which previously fished this area was part of the industry's fleet reduction.

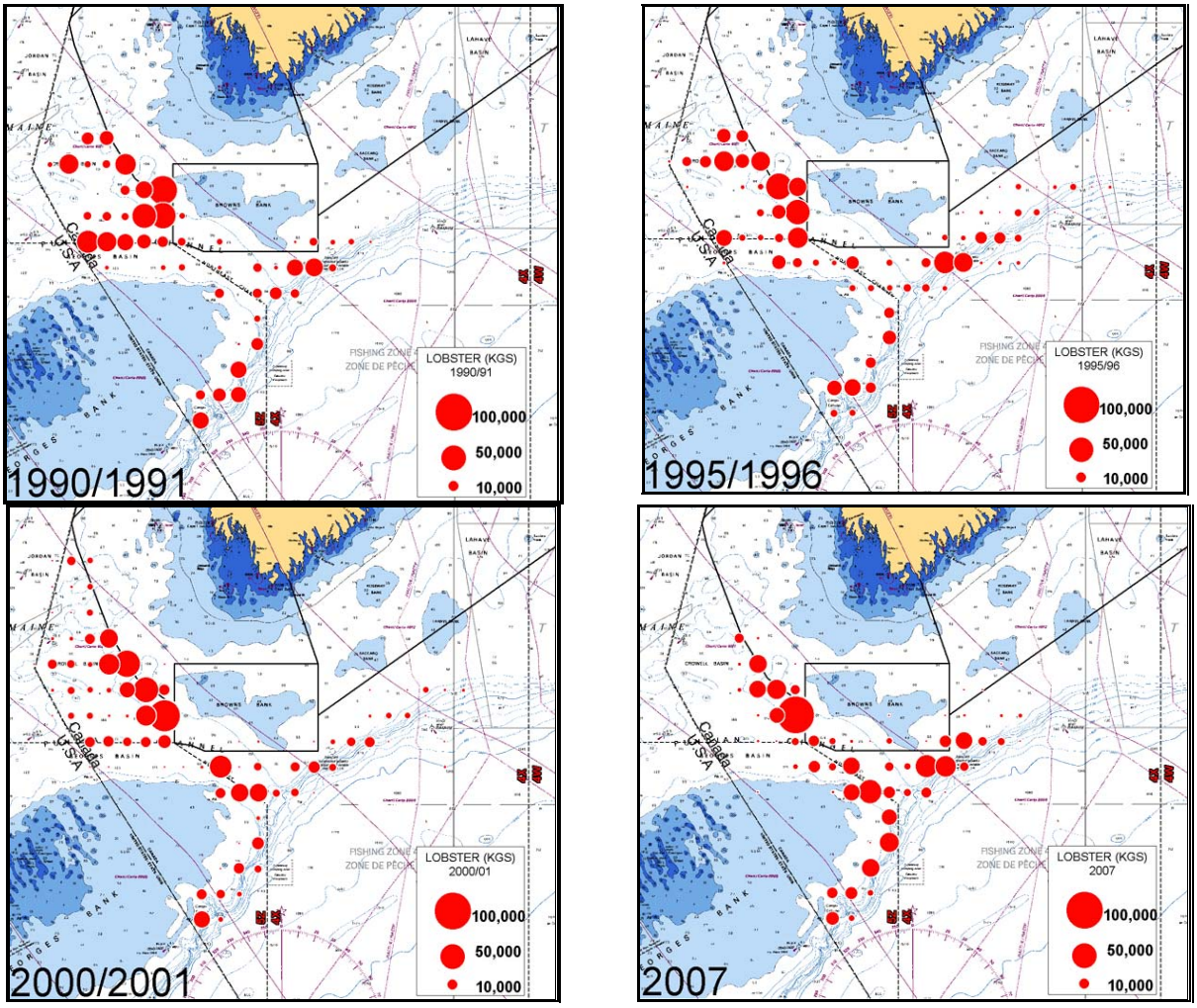


Figure 3. Distribution of lobster landings in LFA 41 (4X + 5Zc). (Aggregated by 10 min grids.)

ASSESSMENT

Sources of Information

Data sources are as follows:

1. Lobster log books (1981-2008) that provide daily records (1982-2000) and string by string records of catch, effort and location (2001-2008).
2. Independent at-sea samples of the commercial catch (1972-2008).
3. DFO Research Vessel (RV) stratified random summer (1999-2008) and winter (2007-2008) trawl surveys; NMFS data on USA landings and trawl survey catches.

Indicators for abundance (legal sizes), fishing pressure and production (pre-recruits and spawners) were developed from the above data sources. Indicators for abundance include landings, catch rate and the trawl surveys. Indicators for fishing pressure are numbers of trap hauls, changes in size frequencies from independent at-sea samples of the commercial catch and the trawl survey. Indicators for spawners were also developed from these same sources.

In the absence of direct estimates of population abundance, this assessment has developed a number of indicators that can provide knowledge on trends in the stock and assist in determining appropriate management and harvest strategies.

Status and Trends

Abundance

Indicators of abundance include landings, catch rates and catch/tow from trawl surveys.

The TAC has been caught in 8 of the last 10 years and 5 of the past 5 years. Although landings are not a good indicator of lobster abundance in LFA 41, in part because the fishery is limited by a TAC, an **inability to catch the TAC** over several years may be an indicator of low lobster abundance and would warrant investigation as to the cause.

Non-standardized catch rates from the commercial fishery (CPUE, landed kg/trap haul) have increased overall since 1999-2000 (1.2 kg/trap haul) but appears to have leveled off in the past 3 years (2.3-2.7kg/trap haul). Catch rates have also been evaluated for 5 assessment areas within LFA 41 and showed similar trends.

A modeled CPUE index was developed to adjust for the effects of fishing season, vessel and bi-weekly interval. A log-linear regression was fit to each subset of area/period, with the additive main effects of fishing season, bi-weekly interval and vessel as factors. Model runs were made for each area/period group iteratively. The model found that within season differences (bi-weekly) in CPUE indices seem to be the most consistent, generally indicating higher levels in the early to mid portion of the season, with lower levels toward the end. The annual CPUE indices by area and seasonal period (summer *vs.* winter) since 1996 suggest either no trend or an increasing trend.

DFO Research Vessel (RV) summer bottom trawl survey (1999-2008) adjusted stratified mean numbers of lobster per tow in 4X (LFA 41) have increased since 2000, but the variance around the mean values needs to be evaluated (Figure 4). A measure of the total or relative abundance of lobster in LFA 41 may be developed from the DFO RV survey, but issues of catchability and trawlable bottom have not been resolved.

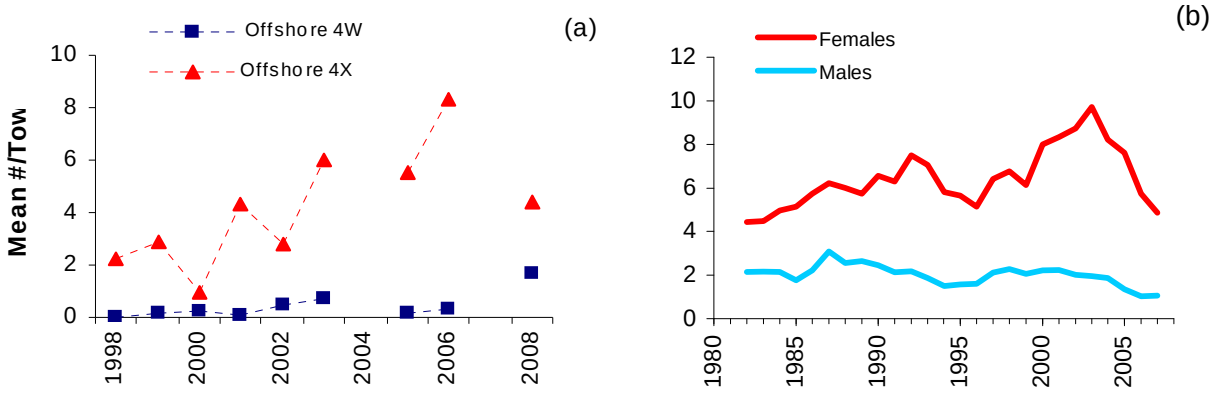


Figure 4. (a)DFO Research Vessel summer bottom trawl survey adjusted stratified mean numbers of lobster per tow for LFA 41 portion of 4W and 4X. (b) Abundance estimates from NMFS fall bottom trawl survey (1982-2007).

The DFO RV bottom trawl survey on Georges Bank (winter) has only included detailed information on lobster catches since 2007, so trends in lobster abundance from this index are not reported here. The **National Marine Fisheries Service (NMFS) RV fall bottom trawl survey** on the US side of Georges Bank indicates that relative lobster abundance increased from 2000 to 2003 and then declined again to 2007.

Fishing Pressure

Indicators of fishing pressure include measurements of fishing effort (trap hauls), landings in adjacent lobster fisheries that may target the same lobster concentrations, exploitation rate, and changes in size frequencies and sex ratios.

Total trap hauls in 2007 (288,000) returned to levels seen in 1995 (228,000), down from the peak of 593,000 in 1998-1999. While much of this decrease is attributed to the decline in Jonah crab fishing activity, it may also be influenced by changes in trap efficiency, fleet reduction and fishing strategy.

Canadian landings in adjacent fisheries have increased significantly during the last 10 years in the areas adjacent to Georges Basin, Crowell Basin, and SW Browns, indicating additional pressure on the lobster in these areas (Figure 5). Without assessing these other fisheries, it is difficult to determine if this is due to abundance or effort changes. The deep-water fishery in LFA 34 (outside of the 100m contour) began in the early 1980s and has expanded with vessels fishing adjacent to the offshore 50 mile line. The landings in the deep water area of LFA 34 directly adjacent to LFA 41 now exceed the total LFA 41 landings and are 3 times higher than the adjacent GOM portion of LFA 41 (SW Browns, Crowell Basin, and Georges Basin).

USA landings from Northeast (NE) Georges Bank have increased dramatically in recent years (Figure 5). USA landings from NE Georges Bank increased from 152t in 2000 to 1062t in 2005 and were at 643t in 2007. During the 1990s, Canadian and USA landings were similar, but over the last 5 years (2003-2007) landings from the USA portion of NE Georges Bank averaged 7.9 times that of the Canadian landings on Georges Bank. USA landings on the southern portion of Georges Bank have increased slightly over the last 10 years.

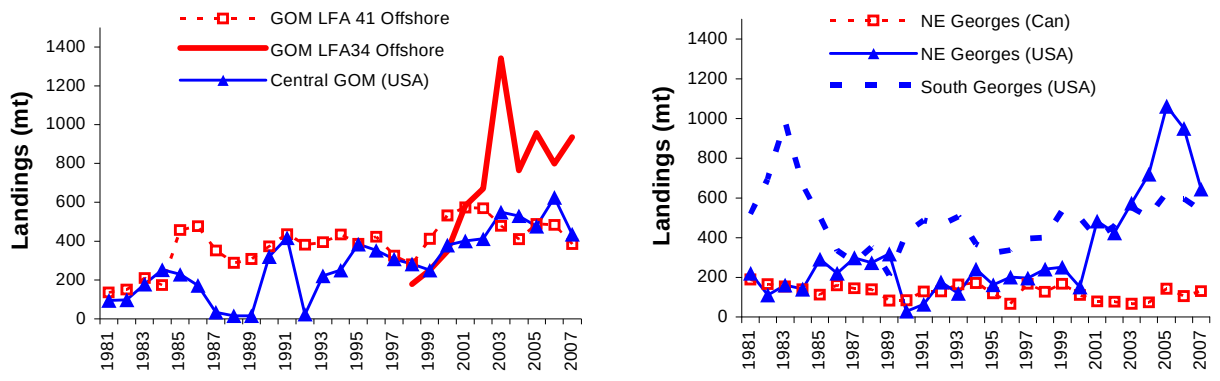


Figure 5. Landings by fishing area, 1981-2008.

The **size structure** of the lobster in the commercial catch has been relatively stable over the 35 years of fishing with minor shifts to smaller sizes in some areas (Figure 6). The most significant change was in Crowell Basin where a decrease in median size and a change in the size frequency distribution were observed in recent years (2000 -2005). This area is adjacent to LFA 34 and the USA portion of the Gulf of Maine.

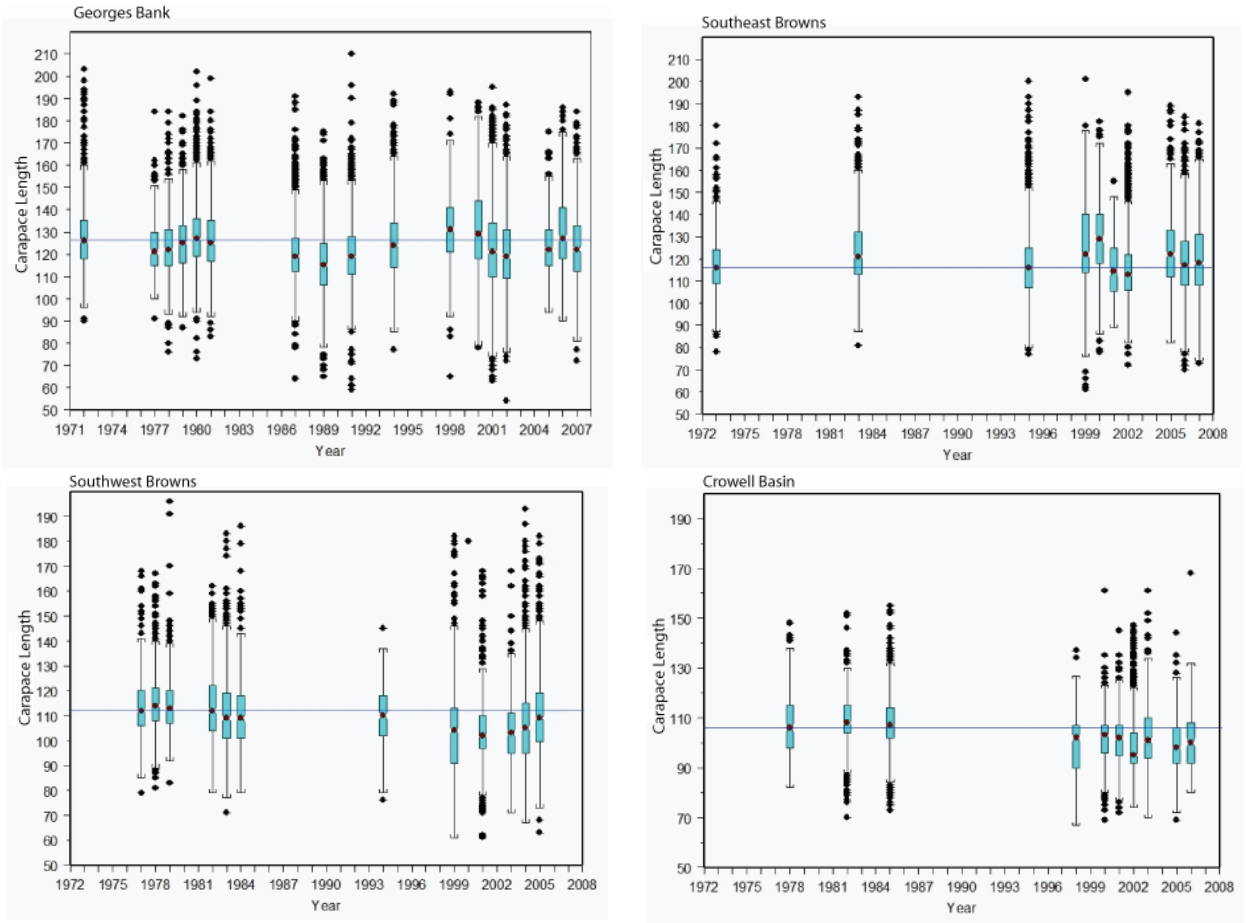


Figure 6. Box plots of female lobster sizes from at sea samples of the catch for Georges Bank, SE Browns, SW Browns and Crowell Basin. The central dot represents the median size with the box defining the upper and lower quartiles. Horizontal line indicates the median size of the first sample in the time series.

The **sex ratio** of lobster in the commercial fishery in LFA 41 is currently skewed towards females (Figure 7). Conservation rules protect berried females and should result in lower fishing mortality (F) on females. The decrease in the proportion of males occurred during the first 10 years of the fishery with the largest change on Georges Bank. This change suggests that fishing pressure has had an impact on the population, as an unfished population is expected to have a sex ratio closer to 1:1.

Although the **sex ratio** is currently skewed towards females, males are able to mate with a number of females each year and, with approximately 50% of the females available to mate each year (as low as 33% at larger sizes), the present sex ratio may have little impact on breeding success as long as the wide size range of males is maintained. Whether the current sex ratio is a concern for population productivity should be investigated further.

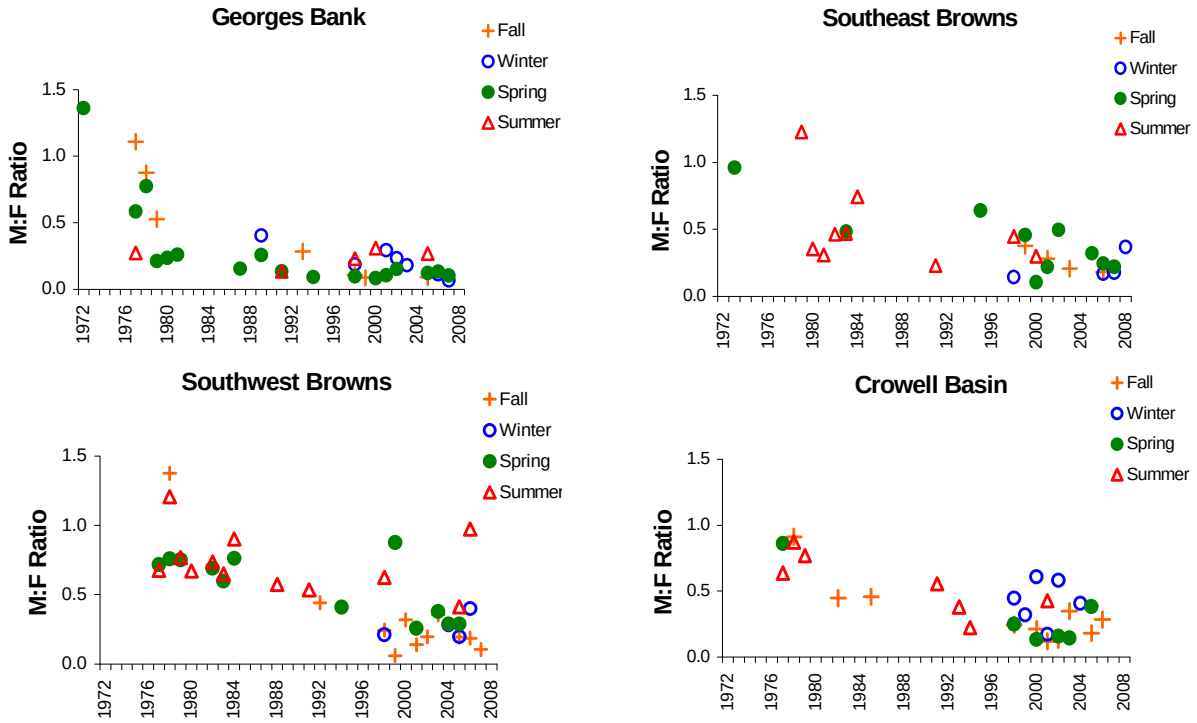


Figure 7. Male to female (M:F) sex ratio of lobsters in LFA 41 from at-sea samples from Georges Bank, SE Browns, SW Browns and Crowell Basin.

Exploitation rate has not been directly estimated but is inferred to be low relative to other lobster fisheries. Standard size based methods for estimating exploitation are not applicable in LFA 41. Inferences are made based on size structure relative to modeled lobster populations, expected changes in sizes at various levels of exploitation, and the USA estimates of F on Georges Bank (which has similar size frequencies to the Canadian fishery). The LFA 41 size structure has remained stable except for the apparent recent decreases in sizes for the Crowell Basin area. The results suggest a low exploitation level similar to that measured in the USA 2006 assessment of Georges Bank (F=0.3). Estimation of exploitation rates using the DFO RV survey data should be explored.

Production

There are currently no direct measurements of egg production, but the abundance of females above the size of 50% maturity in the LFA 41 fishery indicates a high level of potential egg

production. From 1997-2007, the mean **percentage of females larger than the size at 50% maturity** (97mm CL) has been high in LFA 41 (Georges Bank=98%, Southeast Browns=96%, SW Browns=77%, Georges Basin=91%, Crowell Basin=63%).

From 1997-2007, the mean **percentage of multiparous females** (females above 115mm CL) in LFA 41 (Georges Bank=72%, SE Browns=63%, SWB=25%, Georges Basin=33%, Crowell Basin, based on summer rather than spring samples=11%) has been high (Figure 8) relative to Gulf of Maine inshore areas (e.g., LFA 34 =3%).

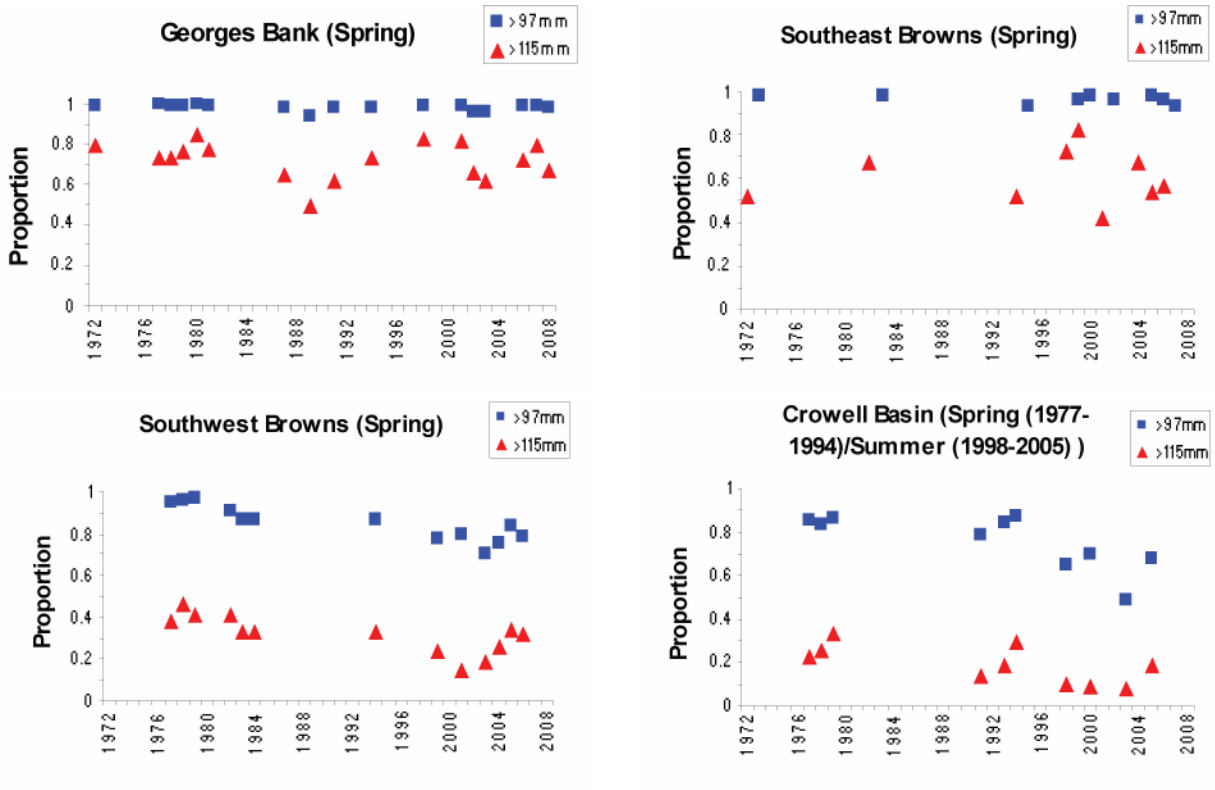


Figure 8. Proportion of female lobsters over 97mm and 115mm on Georges Bank, SE Browns, SW Browns and Crowell Basin.

Indices of prerecruits are currently unavailable for the lobster fishery in LFA 41, since the fishery is conducted primarily in deeper areas (>100m) along the continental slope and in deep basins where recruitment is not expected to occur. This is reflected in the size frequencies of the commercial catch, in which there are few animals under legal size. Median sized lobsters in LFA 41 are 5-7 years beyond the minimum legal size, and identifying short term changes in recruitment from size data collected at sea is unlikely. This differs from LFA 34, which is a recruitment based fishery where up to 90% of the catch is in the first molt group and a large number of lobsters are caught under the legal size.

The DFO RV surveys offer an opportunity to identify recruitment to the fishery by sampling shallower areas on the banks which are not commercially fished and where recruitment may occur. The NMFS trawl survey has been used to track recruit abundance and a similar approach will be applied using DFO survey data as the time series develops. The 2006 US assessment concluded stable abundance for the Georges Bank stock and much of the Gulf of Maine stock with very little variability in the abundance of recruit and post-recruit size classes over the time series (1982-2003) on Georges Bank.

Ecosystem

Based on available literature, it is expected that the **impact of traps on bottom habitat** is restricted to areas immediately around the trap footprint; however, few studies have been conducted on this issue. The type of bottom fished is varied (e.g., mud, sand, gravel), and includes the sides of banks, basins, and offshore canyons with some high energy areas subject to large natural sediment movements. One area of known coral concentration is closed to fishing. The density of lobster gear in LFA 41 (4X + 5Zc) is considered to be low (approximately 12,000 traps over roughly 32,000 km^2) relative to the inshore fisheries (LFA 34 - approximately 386,800 traps over roughly 21,000 km^2).

Gear loss is believed to be minimal, and all traps are equipped with devices to minimize ghost fishing.

Bycatch species are recorded on observed trips. All bycatch must be released (Jonah crab can be retained); survival of bycatch is assumed to be high for invertebrates and lower for fish (e.g., cusk mortality was estimated to be >86% in LFA 41). Species that occur most frequently as bycatch are Jonah crab (*Cancer borealis*), cusk (*Brosme brosme*), red hake (*Urophycis chuss*), white hake (*Urophycis tenuis*), cod (Gadus morhua), rock crab (*Cancer irroratus*), and redfish (Sebastes spp.).

While there is potential for interaction between lobster gear and whales, lobster fishing grounds in LFA 41 do not overlap with areas of known whale concentrations (e.g. Roseway Basin) and overall trap densities are low. However, little is know of whale migration routes between the summer and winter grounds. There is also potential for interaction with sea turtles. There have been no reported interactions between whales/turtles and lobster gear in LFA 41.

Sources of Uncertainty

The waters of the outer shelf and basins in the Gulf of Maine are influenced by water mass movements caused by larger scale oceanographic events. Fishery-based indicators of abundance in LFA 41 may be influenced by these oceanographic events that could mask short-term changes in population size. Long-term trends in these indices may be more reliable.

The linkages between lobster in LFA 41 and adjacent areas are uncertain, including sources of recruitment.

The absence of an accurate estimate of the exploitation rate is reason for caution, and further work should be undertaken to explore development of an exploitation rate based on the RV data.

Caution is needed in interpreting changes in size and sex ration as lobster fishing gear has changed over the history of the fishery. At sea samples are not taken at the same location or bottom type from year to year, nor are they consistently taken during the same period in the migration.

CONCLUSIONS AND ADVICE

Abundance indicators for commercial sized lobsters in different subareas of LFA 41 suggest that lobster abundance has been either stable without trend or has trended higher since 1999. Annual fishery catch rates (non-standardized) are stable or increasing in 4 of 5 areas. The multiplicative catch rate model indicates catch rates have trended inconsistently or increased in different areas

of LFA 41. The DFO summer bottom trawl survey shows an increase in mean number per tow, but the time series is short (1999-2008) and further development is recommended. The NMFS fall trawl survey indicates that on the US side of Georges Bank, lobster abundance increased from 2000 to 2003 and then declined to 2007.

Fishing pressure was evaluated in terms of total trap hauls, size structure and sex ratio. Total trap hauls in 2007 (288,000) returned to levels observed in 1995 (228,000), down from the peak of 593,000 in the 1998-1999 season presumably because of reduced fishing for Jonah crab. The size structure has remained stable except for apparent decreases in median size in Crowell Basin. A decrease in the proportion of males occurred during the first 10 years of the fishery, with the largest change on Georges Bank. Whether the female biased sex ratio is a concern for population productivity needs to be investigated further. Exploitation rate has not been directly estimated but is inferred to be low. Further estimation of exploitation (including DFO RV bottom trawl survey data) is recommended.

Landings in adjacent fisheries increased significantly during the last 10 years, indicating additional pressure on the lobster resources in these areas. Landings by the deeper water (>100m) LFA 34 fishery directly adjacent to LFA 41 now exceed the total LFA 41 landings and are 3 times higher than the adjacent Gulf of Maine portion of LFA 41 (SW Browns, Crowell Basin, and Georges Basin). Over the last 5 years (2003-2007) landings from the USA portion of NE Georges Bank averaged 7.9 times that of the Canadian landings on Georges Bank.

Indicators of **recruitment** are currently unavailable. DFO RV trawl surveys may offer an opportunity to identify recruitment by sampling in shallower areas on the banks *and by having a broader size selectivity*. The NMFS fall trawl survey indicates very little variability in abundance in recruit and post-recruit size classes over the time series (1982-2003) on Georges Bank. The high proportion of females above 97mm CL (the estimated size of 50% maturity) and 115mm CL (multiparous females) in the LFA 41 fishery indicates a high level of **potential egg production** in this area relative to the inshore. Four assessment areas have shown no trend in this proportion over time; the Crowell Basin assessment area has shown a decrease in the proportion of mature females.

Potential **ecosystem interactions** include impacts of traps on bottom habitat, impacts of lost gear, bycatch, and interactions with other species. **Bycatch** species that occur most frequently in the LFA 41 lobster fishery include Jonah crab, cusk, hake (red and white), cod, rock crab and redfish. Other than Jonah crab, all animals are released. High survival is assumed for invertebrates, but survival may be lower for some fish species. The effect of fishing on **bottom habitat** has not been evaluated but is expected to be low relative to other bottom contact gear types. This expectation is based on the small size of the gear footprint and the relatively low density of traps in this large fishing area. There have been no reports of **interactions with whales or sea turtles** from this fishery.

Based on the current indicators of abundance, fishing pressure and production, the current TAC of 720 mt (in place since 1985) does not appear to have had negative impacts on the lobster in LFA 41 overall and is considered to represent an acceptable harvest strategy at this time. Better estimates of lobster abundance and exploitation rate would enhance the ability to evaluate LFA 41 (4X + 5Zc) harvest strategies in the future.

MANAGEMENT CONSIDERATIONS

Decline in median size in Crowell Basin (the only assessment area of 5 to show this decline) is cause for further investigation. This decline may reflect the influence of fisheries in adjacent areas. Increasing catches in adjacent areas may affect LFA 41 (4X + 5Zc) overall.

SOURCES OF INFORMATION

DFO. 2009. Assessment of Jonah crab in Lobster Fishing Area 41 (4X + 5Zc). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/034.

Pezzack, D.S., C.M. Frail, A. Reeves, and M.J. Tremblay. 2009. Offshore Lobster in LFA 41 (4X + 5Zc). DFO Can. Sci. Advis. Sec. Res. Doc. 2009/023.

Appendices A: Indicator Summary

Indicators were categorized as positive ("+") if values or trends were positive compared to the period of the last assessment (1995-99) and to early period of the fishery prior to present TAC, Enterprise Allocation (EA) and the ICJ Canada/USA boundary settlement; negative ("–") if values were less or trends were negative in this period; and neutral ("o") if otherwise. Empty cells means no data is available or the indicator cannot be applied on that scale or time period.

			2000-2007 Period Compared to Previous Periods in the Fishery						
			Pre EA and ICJ 1972-1985	Previous Assessment Period 1995-99					
	Data Source	**Indicator**	**Overall**	**Overall**	**Georges Bank**	**SE Browns**	**SW Browns**	**Crowell Basin**	**Georges Basin**
Abundance	Landings	90% TAC	+	+					
		# of grids fished to obtain TAC		o					
	Trawl surveys	Mean # / tow Canada				+	+	+	+
	Catch Rate	Annual Catch rate		+	+	+	–	+	+
		Catch rate Model		+	+	+	o	o	+
Fishing Pressure	Effort	Trap Hauls		o					
		# of grids fished to obtain TAC		o					
	Exploitation Rate								
		Landings in adjacent fisheries	–	–	–	o	–	–	o
	Size Distribution	Median size	+	+	+	+	o	–	+
		Size Structure	+	+	+	+	o	–	+
	Sex Ratio		-	o	o	o	o	o	o
Production/ Recruitment	Egg Production	Proportion of females mature	+	+	+	+	+	+	+
		Proportion of females multi-parous	+	+	+	+	+	+	+
	Sex Ratio		–	o	o	o	o	o	o
Environment/ Ecosystem	Predators			o					
	Food Sources		o	o					
	Impact of traps on bottom		o	o					
	Lost gear			o					
	Bycatch			o					
	Interaction with whales			o					

FOR MORE INFORMATION

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