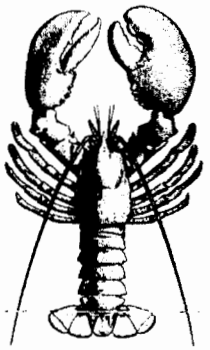
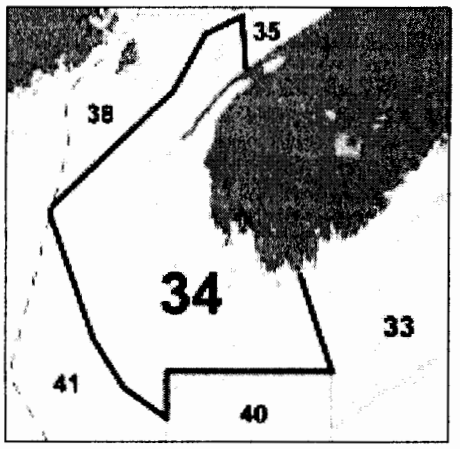
Fisheries and Oceans Pêches et Océans

Maritimes Region

DFO Science
Stock Status Report C3-62 (2001)





Southwest Nova Scotia Lobster
(Lobster Fishing Area 34)

Background

A crustacean, the lobster (Homarus americanus) has its skeleton on the outside of its body and to grow must shed the shell, a process called molting. Very young lobsters molt 3-4 times a year, increasing 50 % in weight and 15 % in length with each molt. In the Gulf of Maine, lobsters take 8 or more years to reach legal size at 82.5 mm carapace length (CL). At that size, they weigh approx. 0.45 kg (1 lb.) and molt once a year. Larger lobsters molt less often, with a 1.4 kg (3 lb.) lobster molting every 2-3 years. The largest lobster ever reported was 20 kg (44 lb.), estimated to be 40-65 years old.

Off south-western Nova Scotia, 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 during July and August. The larvae spend 30-60 days feeding and growing near the surface before settling to the bottom and seeking shelter. For the first 2-3 years, lobsters remain in or near their shelter to avoid the small fish that feed on them. As they grow and have less chance of being eaten, they spend more time outside the shelter. At this point, they become more catchable in lobster traps.

Lobsters are found in coastal waters from southern Labrador to Maryland, with the major fisheries concentrated in the Gulf of St. Lawrence and the Gulf of Maine. Though lobsters are most common in coastal waters, they are also found in deeper, warm water areas of the Gulf of Maine and along the outer edge of the continental shelf from Sable Island to off North Carolina. Lobsters make seasonal migrations, moving to shallower waters in summer and to deeper waters in winter. Over most of the lobster's range, these movements amount to a few kilometres for most lobsters, however, in the offshore regions of the Scotian Shelf, the Gulf of Maine and off the coast of New England, lobsters can undertake long distance migrations of 10's to 100's of km. Tagging studies have also shown that at least some of these lobsters return to the same areas each year.

LFA 34 in southwestern Nova Scotia is one of the most productive lobster fishing areas in the world. Extending from Digby Neck to Barrington Bay and from the coast to the LFA41 line, approximately 92km from shore it covers an area of 21,000 square kilometres.

Recently, the Gulf of Maine lobster population has become viewed as a metapopulation, meaning that there are a number of sub-populations linked in various ways by movements of larvae and adults. The number and distribution of these subpopulations remains unknown.

Summary

- Landings increased throughout the 1980s as part of a western Atlantic wide pattern. They have remained high in LFA 34 and the remainder of the Gulf of Maine but have declined in some other lobster areas.
- The 1998-1999 and 1999-2000 landings are the highest recorded in this fishery, being 3.6 times the average for the 1947-1980 period.
- According to the new logbook system introduced in 1998-99, the traditional nearshore areas (<30 fathoms) accounts for over 90% of the landings. The traditional nearshore has been heavily exploited for at least 50 years and possibly since the early 1900s.
- This is a recruitment based fishery dependent on immature lobsters or those mature but not yet reproduced, consistent with heavy exploitation.
- The 1998-99 and 1999-2000 exploitation rates were 68%.
- Estimates of the percent of captured berried females v-notched by fishermen, was 36 and 14% for 1998-99 and 1999-2000. With the current minimum size of 82.5 mm CL 25-35% of the required doubling of eggs per recruit would be obtained.

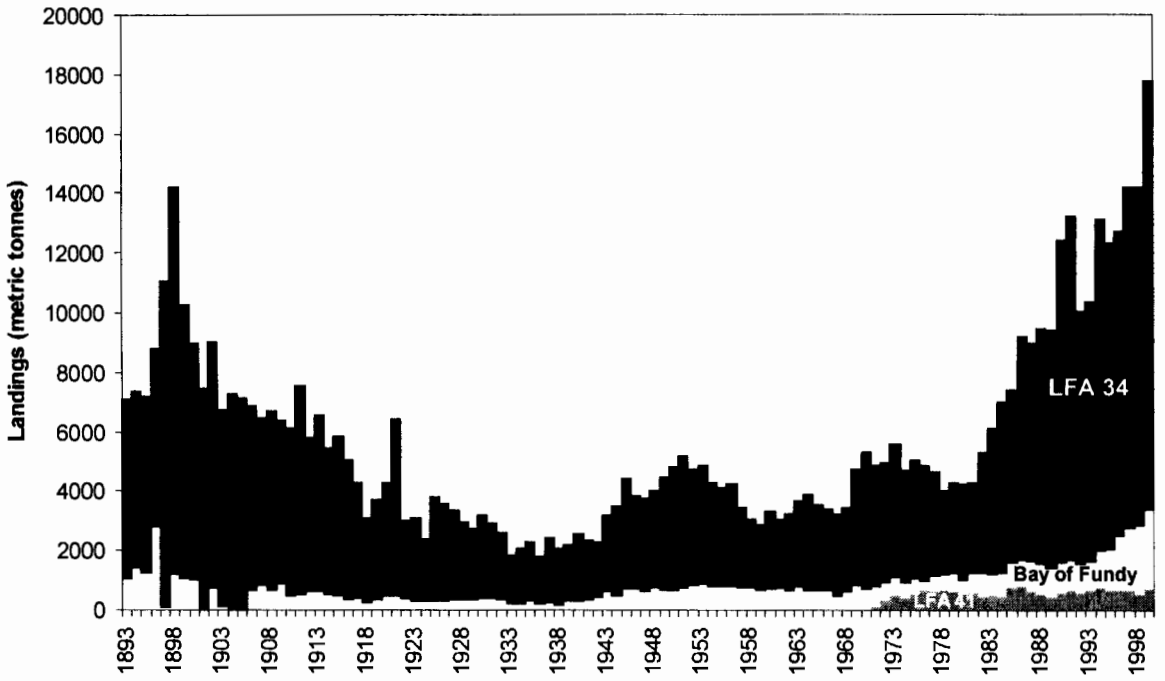
- In the short-term (1-2 yr.) if the current trends continue, landings may remain at high levels.
- In the longer term, the causes for the historical stability of the LFA 34 lobster fishery, recent increase in landings, and the recent wide spread recruitment pulse are not well understood.

The Fishery

The present management regime is based on limited entry and effort controls.

Season: last Tuesday in November-May 31
Minimum Size: 82.5 mm CL
Trap Limit: 375 1st day of season - March 31
400 April 1 - May 31
No. Licenses: Class A (Full-time) 971
Class B (Part-time) 1
Communal Based 7

Commercial lobster fishing began in the mid-1800s, with reported **landings** exceeding 12,000t in the late 1890s. This was followed by a decline in landings, dropping to 1,600t in the early 1930s. Concerns were raised as early as 1872, when a decline in the average size in the catch was first observed in nearshore catches. Over the next 50 years, numerous Government Commissions reviewed the decline and recommended changes in regulations in an attempt to stop further declines. The landings remained low (1600-3000t) during the 1930s and early 1940s. Landings rose following WW II averaging 3334t, varying between 2200 and 4500t until the 1980s. Landings increased throughout the 1980s as part of a western Atlantic wide pattern that saw landings increase over the entire lobster's range. LFA 34 landings first peaked at 11,000t during the 1990-91 season.



Annual landings (metric tons) in LFA 34, Bay of Fundy (LFA 25-38) and LFA 41 (offshore) 1893-1999

Lobster Landings (metric tons)

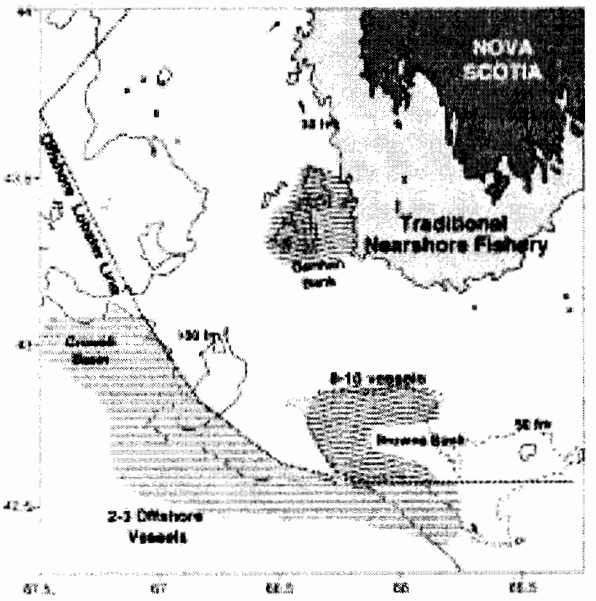
	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000
LFA 34	11,071	8,876	8,916	10,326	9,692	10,314	10,604	11,890	13,004	12,958
LFA 41*	713	609	544	701	718	722	670	622	585	711
LFA 35-38*	995	1,014	969	1,035	1,283	1,573	1,956	2,291	2,566	2,394
Total	12,779	10,499	10,429	12,062	11,693	12,609	13,230	14,803	16,155	16,0635

**other area landings provided for information*

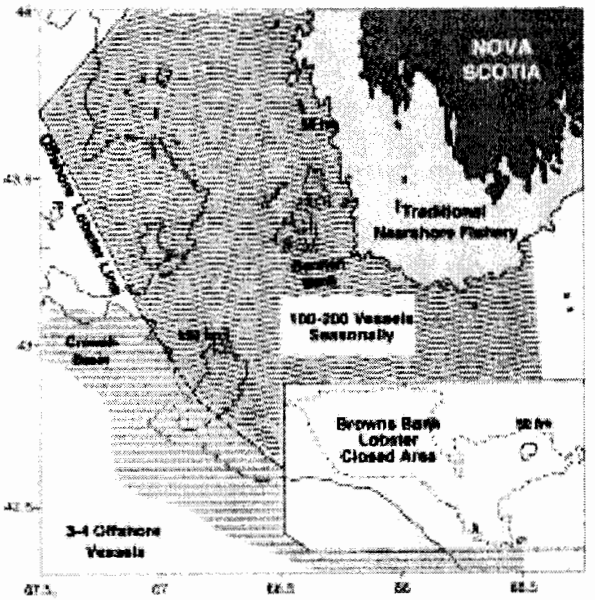
Landings have remained high in LFA 34 and the remainder of the Gulf of Maine (LFA 35-41, Maine, New Hampshire and Massachusetts). LFA 34 landings represent about 30% of the Canadian Atlantic total, and in 1998-1999 and 1999-2000 were 13,000t, the highest recorded, 3.6 times the average for the 1947-80 period.

The LFA 34 fishery is dominated by fall landings with an average of 48% occurring in the first 4 weeks (Nov/Dec.) of the season. January landings represent 12%, February 4%, March 5%, April 11% and May 21% on average.

Based on fishermen interviews, prior to the mid 1970s lobster fishing grounds were generally limited to depths less than 30 fathoms. Inshore vessels began exploring further from shore and by the mid 1970s were fishing Browns Bank and German Bank, which has become known as the midshore. This fishery continued to expand with some fishermen fishing the midshore all season, and others fishing it for only part of the season, and moving nearshore when catch rates are higher there. The midshore fishing effort expanded during the 1980s and in 1994 represented approximately 10% of the LFA 34 landings

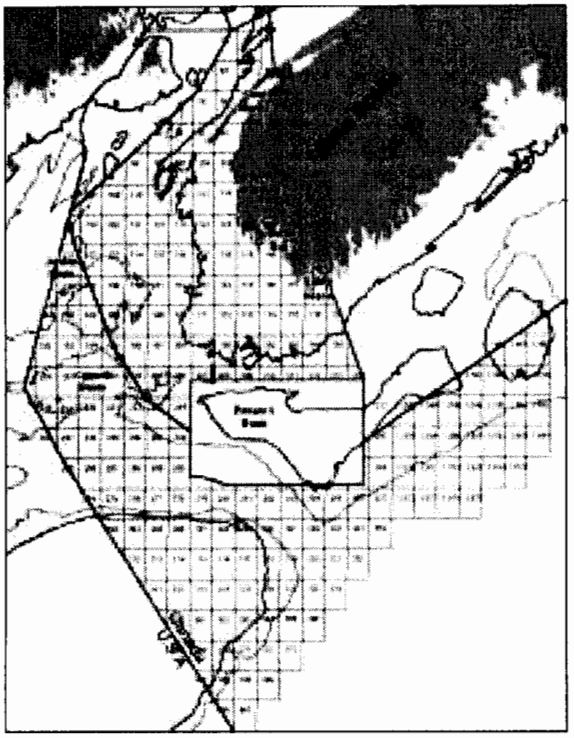


Midshore and offshore fishing distribution in the late 1970s (based on fishermen interviews)



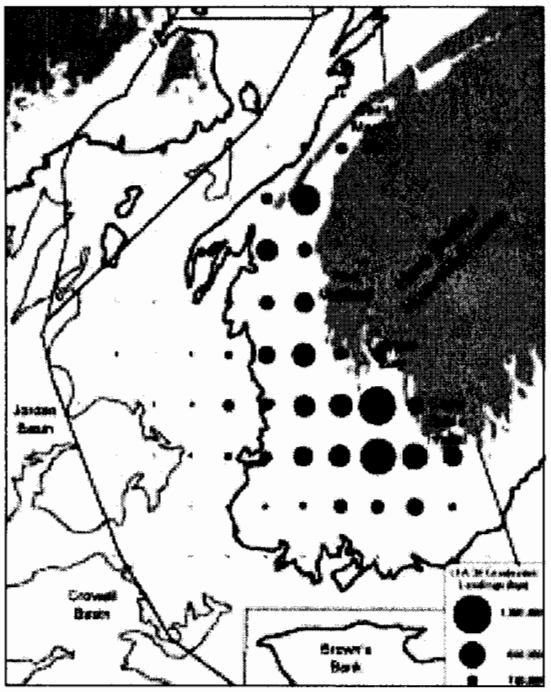
Midshore fishing areas since the mid 1990s based on fishermen, fisheries officer interviews and surveillance overflights

In 1998-99, a new **logbook** system was introduced which records location (by 10x10 min. grid) and effort data for the first time.



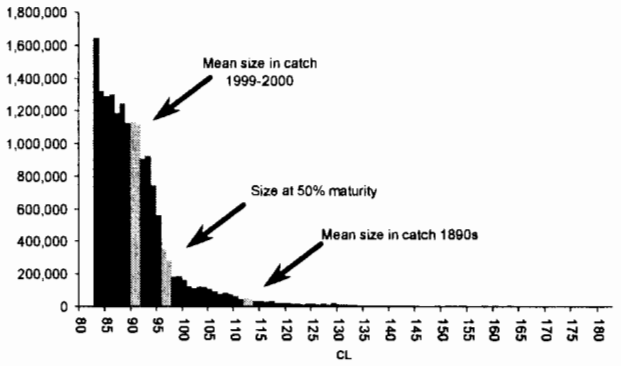
Grids (10x10 min) used in LFA 34 logbooks and in assessment of LFA 34 and 41

These data indicate that catches in 1998-99 and 1999-2000 were concentrated in the traditional nearshore areas (<30 fathoms), which accounts for over 90% of the landings.



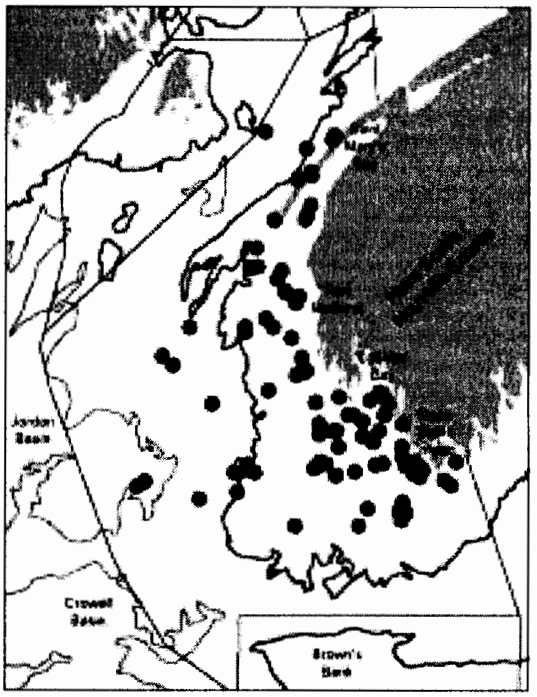
Landings distribution 1999-2000

Size information does not exist for most of the history of the fishery, so information on historic size structures is based on market reports, opportunistic observation and comments by fishermen and scientists. Early records within the Gulf of Maine indicated that the average size of lobster marketed in 1890s was greater than 2.5 lb. (approx. 106mm CL). The average size of lobster in these areas today is 1.1 lb. (87.9mm CL).



Length frequency of landed catch in LFA 34, 1999-2000

At-sea sampling has been conducted at major ports in LFA 34 since 1980. Samples are generally available from the second to third and last two weeks of the season. The level of sampling has varied over time, reaching a low in the mid 1990s, with only three ports sampled in the spring. Expanded sampling in the 1997-98 season covered a corridor from Lobster Bay to the offshore, and in 1999-2000, the first full season LFA wide program was initiated, with close to 100 samples taken. Sampling level in the various parts of the LFA was based by reported landings of the previous season.



Distribution of LFA34 1999-2000 at sea samples

Resource Status

Resource status is evaluated by examining trends in landings, size frequencies of the commercial catch, trends in catch per unit effort (CPUE), from logbooks in 1998/99 and 1999/2000 and exploitation rates calculated from size data.

In LFA 34, approximately 85% of the animals landed were new recruits (81-94mm CL size range) (minimum size was 81 mm 1998-99 and first month of 1999-2000). The high proportion of new recruits indicates that this is a recruitment-based fishery and is consistent with heavy exploitation. In contrast, the much smaller LFA 41 catch is dominated by lobsters larger than 110mm CL.

 # (000s) Landed per Molt Group for LFA 34

Season	Molt Group 1 81 - 94	Molt Group 2 95 - 109	Molt Group 3+ 110 +	Total
1998/99	17,933	2,428	822	21,183
1999/00	18,245	2,498	847	21,590

Percent of Total for LFA 34

Season	81-94	95-109	110+
1998/99	85%	11%	4%
1999/00	84%	12%	4%

 # (000s) Landed per Molt Group for LFA 41 (4X)

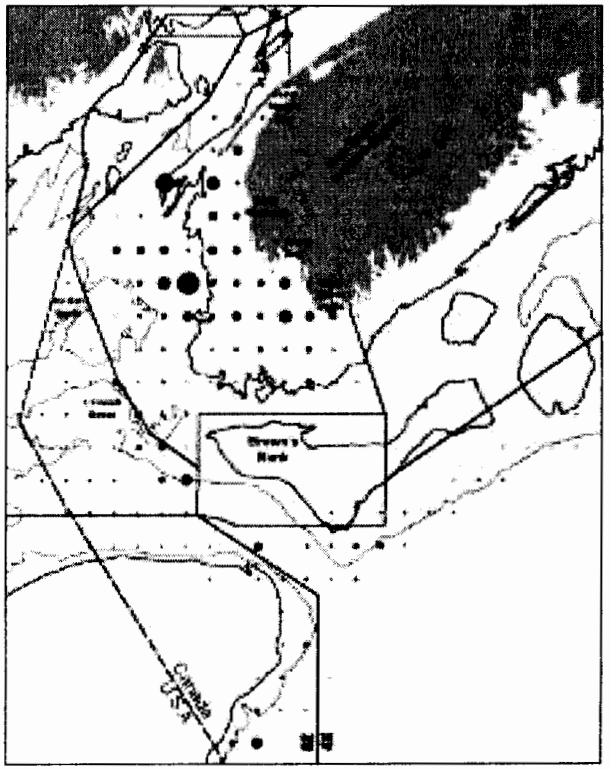
Season	Molt Group 1 81 - 94	Molt Group 2 95 - 109	Molt Group 3+ 110 +	Total
1998/99	70	141	249	460
1999/00	104	197	290	591

Percent of Total for LFA 41

Season	81-94	95-109	110+
1998/99	15%	31%	54%
1999/00	17%	33%	50%

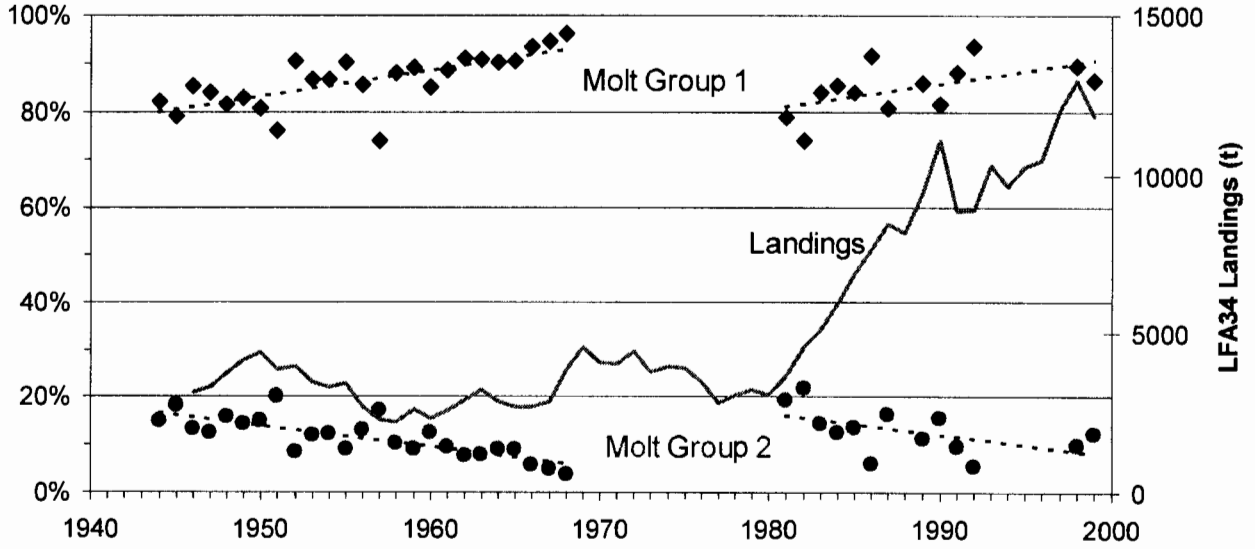
The majority of new recruits in LFA 34 are immature, since 50% of the females do not mature until 97mm CL and those that mature at smaller size must survive the fishery if they are to extrude eggs the following summer. Thus the LFA 34 fishery is dependent on lobsters that are immature or mature but not yet reproduced.

Removal of animals in molt group 3+, which are mature and have reproduced at least once, is highest in the nearshore and midshore regions adjacent to Jordan Basin and represent 3 times the removals from the NAFO 4X portion of LFA 41.



Distribution of catch of Molt Group 3+ (mature) 1999-2000

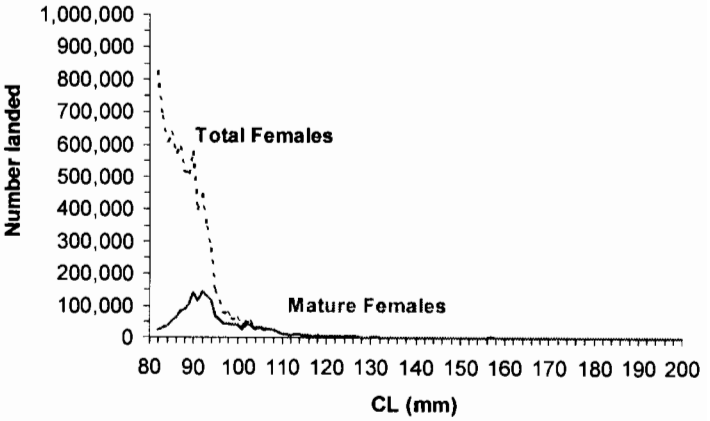
Historical size sampling data (1944-68, 1980-2000) from Port Maitland shows that the traditional nearshore has been heavily exploited for at least 50 years and likely since the early 1900s. In Port Maitland, 80% of the landings were in the first molt group during the mid 1940s and increased to over 95% by the late 1960s. During this period, landings were restricted to nearshore areas. No data exist for the 1970s but in the 1980-90s, the percentage in the first molt group varied between 75 and 92%. The values are lower and more variable than the earlier period possibly because many vessels are fishing further from shore in deeper waters.



Percentage of animals in Molt Group 1 and 2 in Port Maitland at-sea samples 1944-2000 for December and total LFA 34 landings

Estimates of the mature females removed and the egg production they would have produced the following summer can be used to estimate the relative impacts that the fishery in these areas could have on the overall egg production. Areas removing more females would have a larger impact than those removing smaller numbers. This is a measure of the potential impact but does not account for the long term loss or previous egg production. Thus removal of immature sizes that have never reproduced, and have contributed nothing to the stock would have a greater long term impact than larger mature lobsters that have, depending upon size, previously reproduced one or more times.

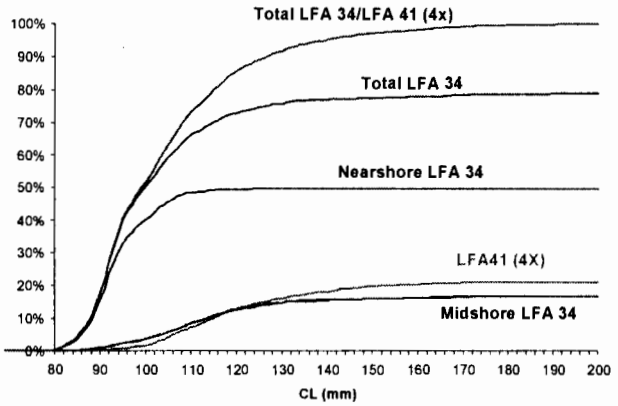
The majority of mature females removed in the LFA 34 / 41(4X) area are taken in the first two molt groups (81-104 mm CL) in nearshore LFA 34. The majority of these are newly mature and have not reproduced before.



Numbers of females (mature +immature) and mature females landed in LFA 34 and 41 (NAFO 4X) 1999-2000

In the combined LFA 34/LFA 41 (4X) area, LFA 34 accounts for close to 80% of the

removed potential egg production, with 50% of the total accounted for by the nearshore fishery. The longer term impact of the nearshore removals is even greater as most of these have not reproduced while the majority of females removed from the midshore and offshore are larger and have reproduced at least once.



Cumulative % of potential egg production that was removed (mean 1998-99, 1999-2000) from LFA 34

Length cohort analysis (LCA) was used to estimate **exploitation rate**. It uses size frequency and growth data inputs. The method is sensitive to changes in recruitment or fishing mortality over time. It is assumed that the recent recruitment has been relatively stable. In relation to fishing mortality it is assumed that, since the mid 1990s, fishing effort has been stable. The method also assumes a closed population and no migration in or out. The present assessment uses data from all of LFA 34 and LFA 34+LFA 41 (4X), which have potential links and sharing of a portion of the resources. Using data from the larger area reduces the potential errors due to migration.

Exploitation rates were 68% for LFA34 in 1998-99 and 1999-2000 and 59-63% for LFA 34 and LFA 41 (NAFO 4X) combined. These estimates are higher than the 55% estimated in the last assessment (1998) for nearshore portion of LFA 34 only. The new estimate is based on more accurate and complete landings and size frequency data

The last assessment indicated that nearshore exploitation rates remained relatively constant through the 1980s and 90s in spite of increased abundance and a shift of part of the effort to the midshore area. Thus the fishery has been able to respond to increased abundance and maintain the exploitation rate at a high level.

In contrast to the nearshore, which has been exploited for over 100 years, the deeper water midshore was first fished extensively in the early 1980s (based on fishermen and fishery officer interviews). Thus exploitation on this portion of the population has increased significantly from the pre 1980s level. The additional pressure on these previously lightly fished areas needs to be considered when viewing the overall estimates of exploitation rates.

Ecological considerations

The Gulf of Maine likely represents a population complex or metapopulation with varying degrees of linkages at the adult and larval period of the life cycle. Understanding the structure and relationships is difficult and incomplete but it is clear that the biological units do not correspond to the management areas. Larval and adult movement was reviewed in the LFA 41 RAP (2000).

Lobsters in the Browns Bank and the Crowell/Jordan Basin areas are fished by LFA 34, LFA 41 and USA fleets, and lobster movement occurs between these LFAs. For this reason, information on the 4X portion of LFA 41 is included in this report. Information from larval and adult movement and abundance trends suggests that Georges Bank is not closely linked to LFA 34 and is thus not included.

The increase in landings observed in LFA 34 is part of a wide scale increase observed over most of the range of lobsters in the western Atlantic. The cause of the wide spread increase is not known but its large scale suggests an environmental and/or ecological link. If the abundance trends are related to large-scale events, then the reversal of the landing trends recently observed in other areas is cause for concern.

During the early 1990s, most areas approached or exceeded the historic highs of the 1890s, though it was achieved with greater effort and over larger fishing grounds. The exception is the Atlantic coast of Nova Scotia that peaked at levels lower than the last upswing in the 1950s.

During the late 1990s, some areas declined, including portions of Southern Gulf of St Lawrence, Quebec, Newfoundland, Cape Breton and South Shore of Nova Scotia. Southern New England and the Eastern Shore of Nova Scotia have reached a plateau while the Canadian and portions of the American Gulf of Maine fisheries have continued to increase. The latter is due in part to the recent increases in eastern Maine and the Bay of Fundy areas that did not experience as dramatic an increase during the 1980s as in other areas.

Sources of Uncertainty

Landings are a function of abundance, level of fishing effort (trap hauls, set over days, timing of effort and fishing strategy), catchability (environmental, gear efficiency, density, and migrations) and distribution of animals and effort. Changes in any of these can affect landings. Thus landings are not an exact reflection of abundance. Increasing effective effort or serial depletion of grounds can maintain landings at a high level for a period of time while absolute abundance is declining. It must be noted however that much of the increase observed coast wide in the 1980s appears to have been due to increased recruitment levels.

The landings reporting system changed in 1995 (from collection of sales slip information to self-reporting logbooks), so recent landings trends may be influenced by reporting differences.

An analysis of **landings size structure** was undertaken for the 1998/99 and 1999/00 fishing seasons using information from the recently expanded at-sea sampling program and the logbook data. The analysis required grouping of grids and use of size data from adjacent areas or time periods when actual data was not available. The 1999/00 fishing season was based on a higher sampling rate and fewer adjustments were needed.

Experience with the LCA method in lobster fisheries is limited and some of the uncertainties with this method are being worked on. The method is dependent on accurate estimates of landings, growth and size structure from at sea sampling.

Management Considerations

In November 1995, the Fisheries Resource Conservation Council (FRCC) presented a review of the **conservation** status of the Atlantic lobster fishery (FRCC, 1995). They observed that the present fisheries were operating at high exploitation rates, harvesting primarily immature animals and concluded that this did not allow for adequate eggs per recruit.

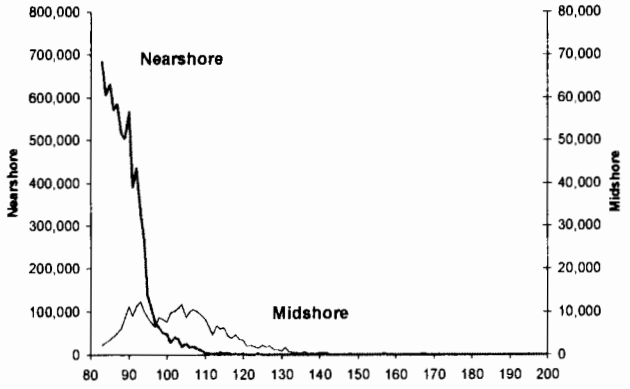
In December 1997, the Minister of Fisheries and Oceans issued a directive to Atlantic lobster fishers to implement new conservation measures, over a period of 4 years, which would achieve a doubling of eggs per recruit from current levels.

Regulation change	LFA 34	LFA 41
V-notching program & prohibition on possession of V-notched lobsters	Fall 1998	Fall 1998*
Minimum size increase from 81 to 82.5 mm	Fall 1999	Fall 1999

(* LFA 41 vessels not actively engaged in v-notching of lobsters)

The eggs per recruit values are estimated to be 1-2% of the unfished condition. Low values of eggs per recruit results in a higher risk of recruitment failure over the long term under varied environmental and ecological conditions.

The midshore has been an area of concern because it represents an expansion of the fishery into a portion of the stock previously not fished extensively. This unfished portion of the population has a higher percentage of mature animals and may have served as a source of recruitment and acted as a buffer to the low eggs per recruit in the nearshore areas and during past periods of poor recruitment. This may be part of the reason for the higher stability of landings in the Gulf of Maine relative to other lobster areas.



Comparison of Nearshore and midshore size frequencies (1999-2000)

Population simulation models indicate that the contributions of a small portion of the population with a low exploitation rate that provides recruitment to a larger portion of the population can maintain the larger portion even when it in exposed to very high exploitation rate. However if high exploitation is applied to both portions of the model populations, a collapse of both may result. The greatest benefit and stability is obtained with a balanced approach in each area.

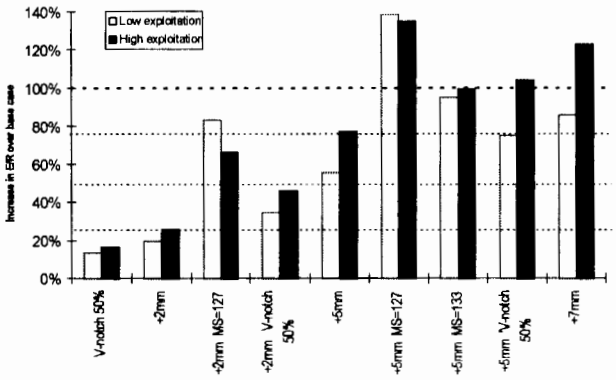
With the current minimum size of 82.5 mm CL and an assumed 50% rate of v-notching, 35-45% of the required doubling of eggs per recruit would be obtained. An increase in minimum size to 82.5 mm CL by itself is estimated to provide a 20-25% increase. Given the lower observed v-notching rate the actual percentages obtained to date would be in the range of 25- 35%

The logbooks allowed determination of **v-notching numbers** as reported by fishermen. At sea samples should provide information on numbers recovered but difficulty in identifying and classifying notches the first year meant that the data was unreliable. The recovery rate however appears to be very low. In the initial year, 117,727 notches were reported. Second year participation rates declined, with 41,209 notches reported. V-notching levels in 1999-2000 were significantly lower than in the previous year and concentrated in a few areas. There were fewer participants but with similar levels of v-notching for those who continued to notch.

Most of the v-notching occurs in the spring (April-May) while the majority of the landings are in the fall and winter (Nov-March). Two possible reasons for the higher spring v-notching rate are a higher catch rate of berried females in the spring and more time to notch in the spring due to a lower overall catch rates and more favorable

weather. The eggs per recruit model assumes constant catch rates of berried females and v-notching rates over the season. Adjustments will be needed for future assessments to account for the observed difference.

Preliminary estimates of the percent of berried females captured that were notched, based on reported numbers notched and numbers of berried females seen by fishermen estimated from sea samples expanded by landings, were 36 and 14% for 1998-99 and 1999-2000 respectively. Eggs per recruit estimates for v-notching were based on a 50% v-notching rate.



The percent increase in eggs per recruit from V-notching, increase in minimum size and maximum size (MS) combinations applied to females. Percentage increase from a base eggs per recruit level at starting minimum size of 81 mm CL

Even with 50%, v-notching a significant increase in minimum size only to 87 mm CL or inclusion of a maximum size of 127mm CL or a combination of measures such as 85mm CL and a maximum size of 133mm CL would be required to reach the doubling of eggs per recruit. If the 50% v-notching level is not reached and maintained, additional measures would be required.

Subsequent to the last assessment, a default conservation management plan for LFA 34 proposed to introduce a maximum size on female lobsters. Industry challenged the science assessment of this conservation approach, listing as major concerns the differential impacts it would have on fleet segments, and the potential for relocation of fishing effort in some LFAs, that would reduce its overall effectiveness.

Given the recent catch history in LFA 34, and uncertainty over the final realized benefits of default measures, Industry has been reluctant to adopt additional conservation measures.

Consideration of additional conservation measures and timetables for their introduction should acknowledge complex regional circumstances, including the adjacency of US fisheries, the uncertainty in the science assessment, and the general level of risk indicated by recent catch trends.

New spatial analyses of catch size distribution show promise in providing information on conservation management options that would be more accessible for industry than current targets based on egg production per recruit.

Outlook

In the short-term (1-2 yr.), if the current trends continue, landings may remain at high levels. The fishery and egg production is based heavily on newly recruited animals, so that any downturn in incoming recruitment to the fishery would have an immediate effect on landings and reproduction.

In relation to longer term, the causes for the historical stability of the LFA34 lobster fishery, recent increase in landings, and the recent wide spread recruitment pulse are not well understood. Changes in fishing patterns over the last 20 years, notably expansion to areas previously unfished by LFA 34 lobster fishermen, may result in different responses by the population to recruitment levels at

lower more historic levels, than have been seen in the past.

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