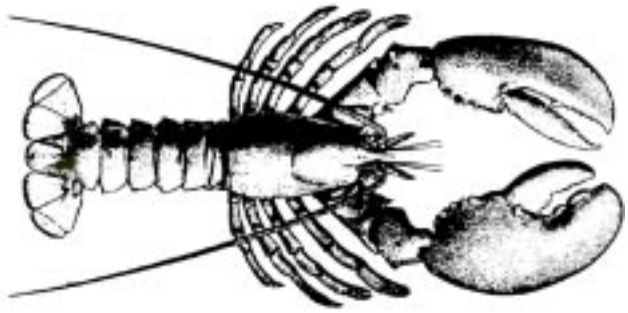
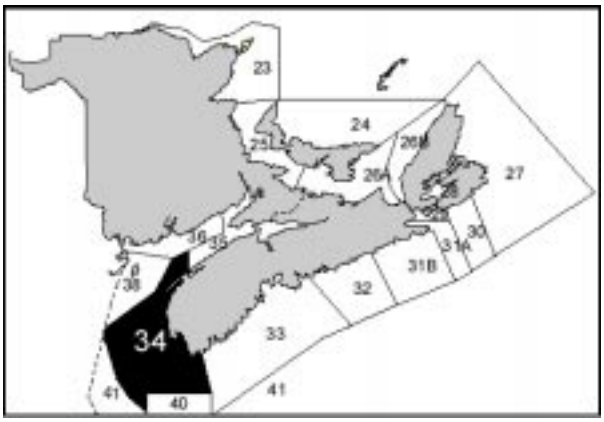
Fisheries and Oceans Pêches et Océans

Maritimes Region

DFO Science
Stock Status Report C3-62(1998)



Southwest Nova Scotia Lobster (LFA 34)



Background

A crustacean, the lobster 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 waters of the Bay of Fundy, lobsters take 8 or perhaps more years to reach legal size at 81 mm carapace length (CL). At that size, they weigh 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 3-4 years. The largest lobster ever reported was 20 kg (44 lb.), estimated to be 40-65 years old.

Off southwestern 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 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 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 around 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 back 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.

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 remained high and stable since the 1990-91 season, however a higher percentage of the landings are occurring earlier in the season, which is consistent with an increase in effective fishing effort.
- Landings may have remained high, in part, due to increased fishing in the midshore areas. There is a lack of information on spatial distribution of catch and effort due to the nature of the statistical collection system which only includes port of landing.
- Catch rates and size distributions in the nearshore fishery appear to be unchanged over the past decade.
- Exploitation rates are high and appear to be stable in the nearshore areas but over 70% of the landings are new recruits that have not spawned.
- Based on observation of the numbers of sublegal sized lobsters in traps, the recruitment since the late 1980s appears to be continually high.

- Size frequencies in midshore areas like German Bank, indicate a decline in proportion of mature females and exploitation rates appear to be as high as in the nearshore.

- Since the advent of the midshore fishery in the late 1970s, the number of eggs per recruit has declined by 2 to 8-fold for the entire LFA 34.

- Results of the egg-per-recruit analysis confirms that the stock is recruitment overfished and increased egg production would help reduce the risk of recruitment failure.

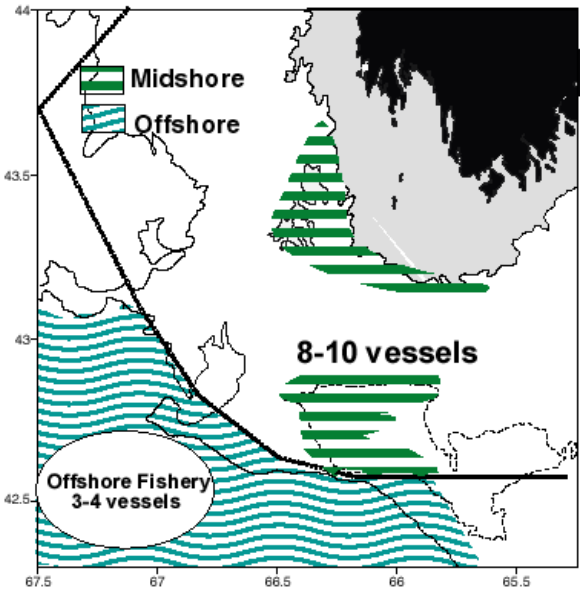
The Fishery

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

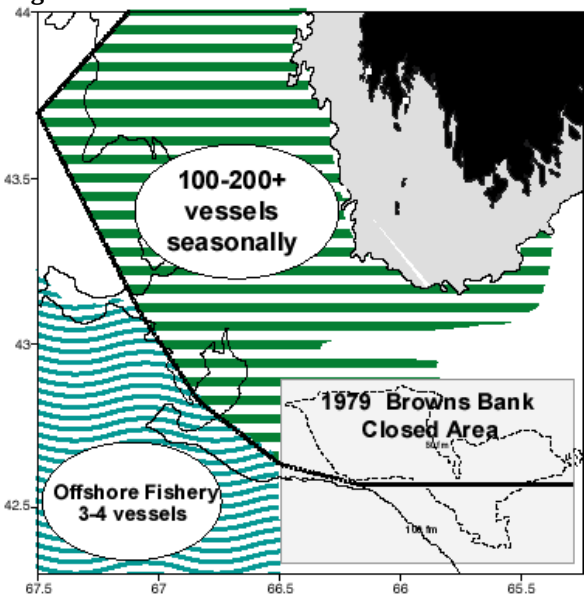
Season: last Monday in November- May 31
Minimum Size: 81 mm CL
Trap Limit: 375 1st day of season - March 31
400 April 1 - May 31st
No. Licenses: Class A(Full-time) 968
Class B (Part-time) 5
Partnerships 2

LFA 34 in southwestern Nova Scotia is one of the most productive lobster fishing areas in the world. It runs from Digby Neck to Barrington Bay with a total area of 21,000 sq. km. It is a diverse region, with fishing taking place in shallow near-shore areas extending to deep water areas just inside the offshore lobster line 92 km (50 nautical miles) from shore. The 977 licenses have in recent years had seasonal landings exceeding 10,000 t; over 25% of Canada's lobster landings.

Prior to the mid 1970s **lobster fishing grounds** were mainly 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. This deeper water fishery was referred to as the midshore fishery. This fishery has continued to expand with some fishermen fishing the Midshore all season and others fishing it for only part of the season, moving nearshore when catch rates are higher there. The midshore fishing effort has continued to expand and accounted for approximately 10% of the landings in 1992-93 (Duggan and Pezzack 1995) and may now represent over 25%.



Midshore and offshore fishing distribution when it began in the mid 1970s.



Midshore fishing areas based on information from fishermen, fisheries officer and surveillance overflights in 1996-97.

The midshore is an area of concern because it represents an expansion of the fishery into a portion of the stock previously not fished. This unfished portion of the population may have served as a source of recruitment and acted as a buffer during periods of poor recruitment.

In November 1995, the Fisheries Resource Conservation Council (FRCC) presented a review of the **conservation** status of the Atlantic lobster fishery (FRCC, 1995). They concluded that the present fisheries were operating at high exploitation rates, harvesting primarily immature animals and did not allow for adequate egg production. A new framework of seven large conservation units (Lobster Production Areas, LPA's) was proposed, within which measures should be taken to increase egg production. A target of egg production per recruit (E/R) equivalent to 5% that of an unfished population was recommended. LFA 34 is a major component of the Gulf of Maine LPA, which includes LFA 34-38, and portions of LFA 41.

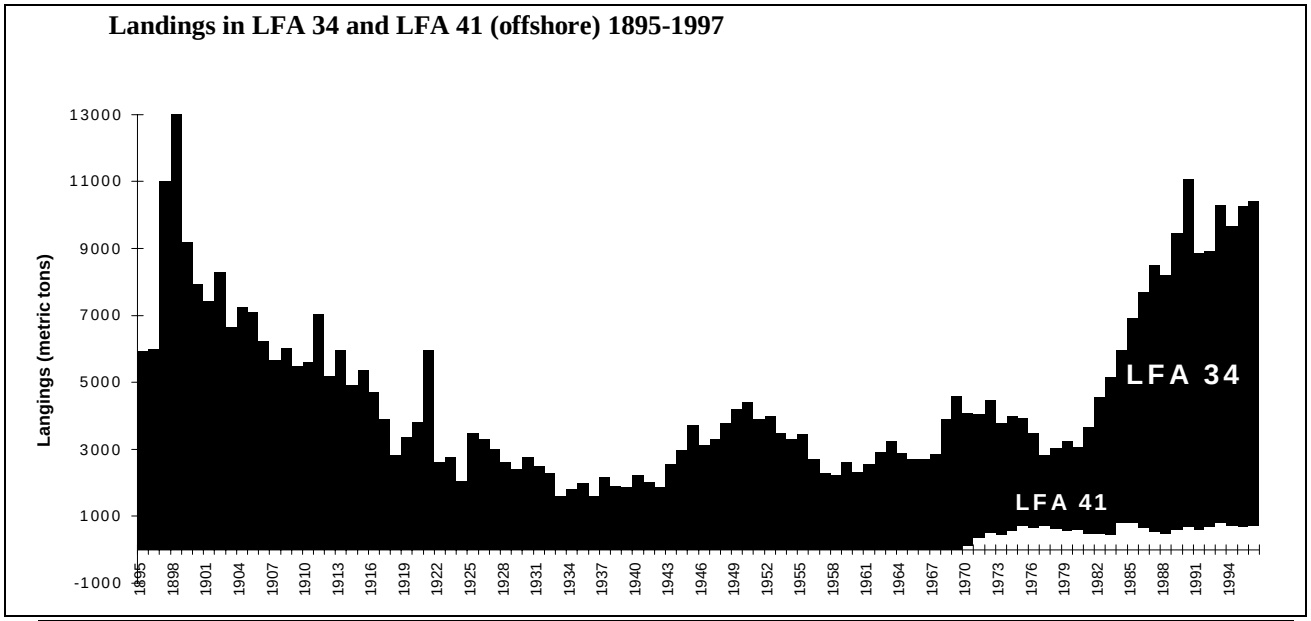
Despite general agreement by industry for the need to change there was no agreement on the FRCC target and as a result, doubling of E/R was selected. In December 1997, the Minister of Fisheries and Oceans issued a directive to Atlantic lobster fishers to implement new conservation measures, over a period of 4 years, which would achieve a doubling of egg production from current E/R levels.

Commercial lobster fishing began in the mid-1800s with **landings** exceeding 12,000t in the late 1890s. This was followed by a decline in landings, dropping to 1,700t by 1920. Concerns were raised as early as 1872 (Venning 1873) when a decline in the average size in the catch was first observed. Over the next 50 years numerous Government Commissions reviewed the decline and

LFA 34 Lobster Landings (metric tons)

1991-92	1992-93	1993-94	1994-95	1995-96	1996-97*	10 yr. averages		
						61-70	71-80	81-90
8876	8919	10308	9646	10263	10415	3231	3575	7734

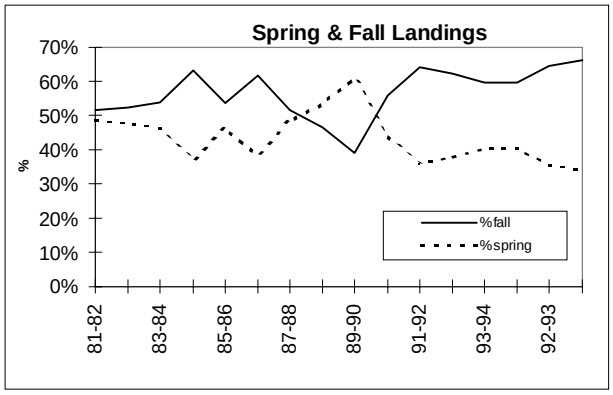
*preliminary



recommended changes in regulations in an attempt to stop further decrease and protect the fishery (DeWolf 1974). The landings remained low (1500-2500 t) from the early 1920s until the mid-1940s. Landings rose in 1946 following the war and remained between 2200 and 4500 t until the 1980s. Landings increased throughout the 1980s as a result of an increase in effort and as part of a western Atlantic wide recruitment pulse which peaked at 11,000t during the 1990-91 season. This recruitment pulse was most likely environment driven.

Landings have since remained high in LFA 34 and the remainder of the Gulf of Maine (LFA 35-41, Maine, New Hampshire and Massachusetts). LFA 34 landings in 1996-97 were 10,415t the second highest this century, 2.8 times the average for the 1971-1980 period.

Although landings have remained high since the peak season in 1990-91, there has been an increasing proportion of the landings being taken in the first half of the season. This may indicate growing efficiency of fishermen and more effort in the fall.



A percentage of the landings in fall and spring for LFA 34

Recent landings are compared on a seasonal basis as this is more consistent with lobster life history and the fishery. Lobsters grow into the first molt-group of the fishable stock over summer and comprise most of the landed catch in the following fall and spring fisheries.

Landings are recorded by the port of landing with no actual information on fishing location. As a result, there is no reliable information on landings from the midshore. The lack of landings data by area fished is a dangerous situation as it makes a full assessment of the fishery impossible.

Resource Status

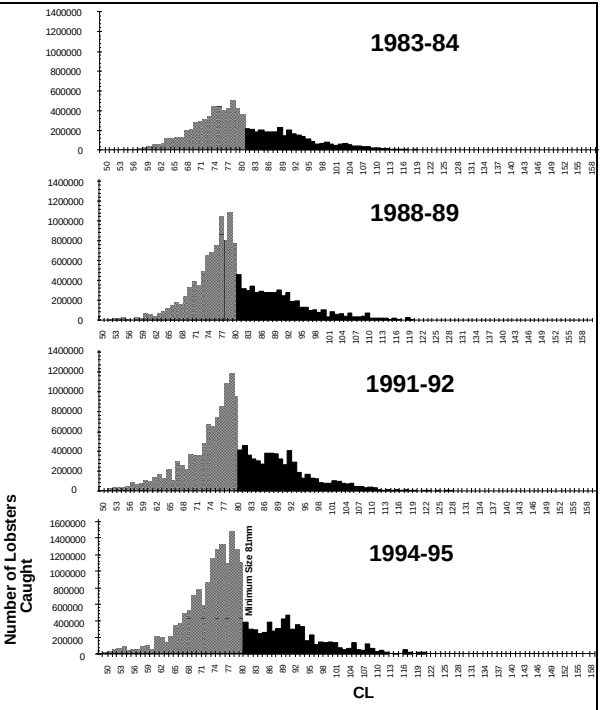
Resource status is evaluated by examining trends in landings, size frequencies of the commercial catch, exploitation rates and trends in catch rate (CPUE) from voluntary log book holders.

At-sea sampling has been conducted over a 20-year period at major ports in LFA 34. Samples are generally available from the second to third weeks of the season, and from the last two weeks of the season. The level of sampling has varied over time reaching a low level in the mid 1990s with only 3 ports sampled in the spring. Expanded sampling in the 1997-98 season was initiated to provide monthly sampling over the grounds within a corridor extending from Lobster Bay to the offshore line. Additional offshore samples were taken the adjacent areas in LFA 41. Fall and spring samples were also conducted at Port Maitland and South of Cape Sable Island.

Size frequencies in the catch vary along the coast, with depth or distance from shore and with season. Using length based assessment methods requires knowledge of the overall size structure but this cannot be obtained without knowledge of the spatial and temporal patterns in size structure and landings.

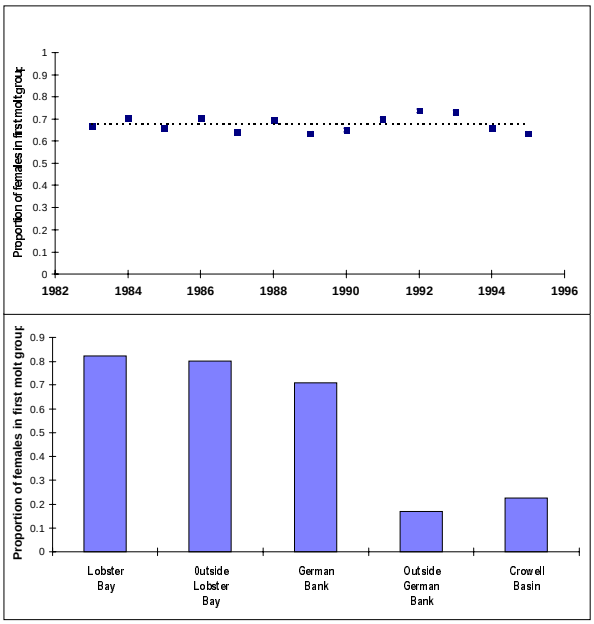
Pre 1997 sampling lack both the spatial and temporal components required and even the improved sampling in 1997-98 only covers a portion of the fishery. Science is presently unable to provide a complete picture of the changes in size distribution of lobsters for the entire LFA 34.

Size frequencies of nearshore landings during the 1980s indicate that a pulse in recruitment that fuelled the increased landings. The levels of pre-recruits increased throughout the 1980s even with the gradual introduction of escape vents, which allow sublegal lobsters to escape.



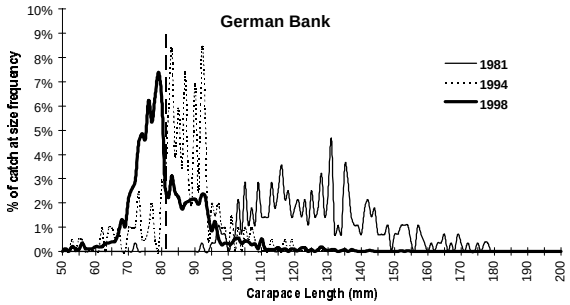
Relative numbers landed at size for the nearshore fishery of LFA 34

In the nearshore, between 1983-1995, a high but stable proportion (70%) of the catch was in the first molt group (81-92mm for females). The percentage in the first molt group is highest nearshore and lower in the midshore and offshore areas, though the proportion on German Bank is similar to nearshore levels.



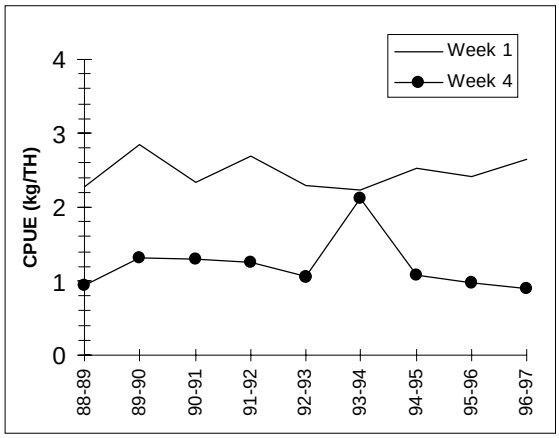
The proportion of females in the first molt group landed in LFA 34 (81-92mm); the proportion of females in the first molt group from 1997-98 sea samples from specific areas.

German Bank was one of the first midshore areas to be fished and is still an important fishing ground. Size data are limited from this area, but comparisons of a sample taken in 1981, with samples in 1991 and 1998 suggest a major shift in the size structure from a multi-cohort size frequency dominated by mature sizes to a recruit based fishery with 70% of the catch in the first molt group. The present exploitation rate on this portion of the stock is equal to or greater than that on the nearshore grounds. The loss of mature sizes has a significant affect on egg production and estimates of E/R. By contrast, the size frequency has been relatively stable on the various offshore grounds since the fishery began in 1972 (DFO 1997).

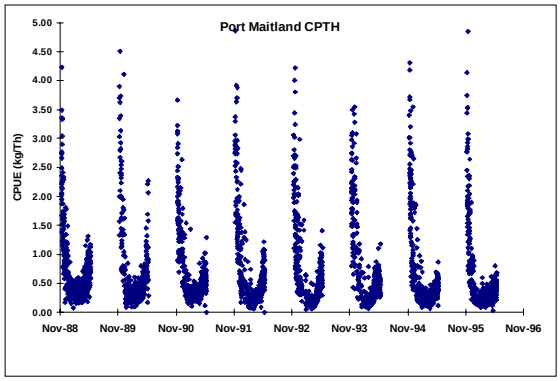


Changes in the size frequency (carapace length mm) of between 1981 - 1998 on German Bank

Catch rates (kg/trap haul) from voluntary logbook holders have not shown any consistent change over the past decade.

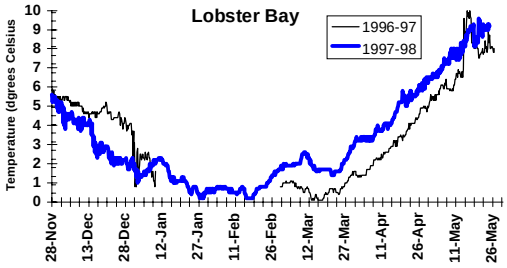


The landings (kg) per trap haul for the first and fourth week .



Daily catch per trap haul by fishermen in the Port Maitland Co-op

The pattern in catch and CPUE are similar in all parts of LFA 34. Landings and CPUE start high at the beginning of the season but drop sharply over the first 2-3 weeks as 30-50% of the total seasons catch is removed from the population during this time. Temperature is also dropping at this time so part of the decline in CPUE may be related to reduced catchability. Catch rates remain low during the winter months and increase again in the spring.



Ambient water temperatures from Lobster Bay

Length Cohort Analysis (LCA) was used to estimate **exploitation rate**. These were generally lower than were provided in earlier assessments (FRCC, 1995: range 60-80%). The current estimates range from between 50-64%.

The LCA was originally developed for groundfish but modified for use in the American lobster assessment (Cadrin and Estrella 1996). It uses size frequency and growth data inputs. LCA was also used in the 1996 LFA 34 assessment but improvements in growth information have resulted in lower estimates for the nearshore, while new size data have resulted in higher estimates for the midshore.

The lack of information of the distribution of catches within LFA makes it impossible to combine size data from the midshore and nearshore areas which is necessary to estimate an overall exploitation rate for LFA 34. As a result, separated estimates are given for the nearshore, German Bank portion of the midshore and the deep water portion of the midshore. The exploitation rate for the Scotian Shelf portion of LFA 41 (offshore) is also given.

Exploitation Rates

Area	Exploitation rate (%) estimates 1996	Exploitation rate (%) estimates 1998
Nearshore	70	55 (range 50-64)
Midshore German Bank	45	66
Midshore Outside German Bank	not available	30
Offshore Scotian Shelf (LFA 41)	20	20

Nearshore exploitation rates have remained relatively constant throughout the 1980-1990s in spite of increasing abundance and a shift of a portion of the fishing effort to the midshore region. In contrast, exploitation rates in the midshore have increased from near zero in the 1970s to levels similar to the nearshore on German Bank and to 30% in the deep water portion of the LFA.

Uncertainties

Both spatial (location) and temporal (time) information on **landings** are critical to assessing the stock. Distribution of landings and when they are caught is not known for this area making it difficult to follow changes in fishing patterns and to assess the overall exploitation rates. The relative proportion of landings from the midshore areas are unknown which makes it impossible to estimate overall exploitation rates.

Understanding the nature of the **stock structure** is important to correctly address the need for conservation in different areas and in predicting the benefits of any changes. The relationship between nearshore, midshore and offshore fishing is critical to management of these fisheries. It is still unclear what the relationship is between the different parts of the Gulf of Maine but the possibility exist that we are dealing with a metapopulation. In this metapopulation, numerous subpopulations may exist which to varying degrees are self contained but who exchange larvae and adult lobsters with adjacent stocks. The degree of exchange will vary spatially and possibly temporally. These subpopulations do not correspond to management or international boundaries.

The use of the LCA method in the current assessment introduces a new method to Canadian lobster assessment. Experience with this method is limited and many of the uncertainties surrounding this type of assessment are being worked through. Lower estimates of exploitation rate than previously used were found with this method. The model is dependent on accurate estimates of growth and size structure from at sea sampling. The present sea sampling program may be insufficient to detect changes in exploitation rates.

The LCA makes certain assumptions on stable recruitment and exploitation rate over time that may not be valid in all years or areas. The treatment of protected portions of the population, such as berried females, in this method also needs to be investigated. Inclusion of them may lower present estimates of exploitation rates slightly.

The **egg per recruit** analysis on present E/R levels and the benefits of various management scenarios are based on an improved E/R model, developed since the FRCC review (FRCC, 1995). Remaining uncertainties in applying the model include:

1. The lower exploitation rates from LCA. There is uncertainty in these new estimates, and risk associated with the fact that they may lead to greater projected benefits from some stock conservation measures. For this reason,

additional runs of the model were completed using a higher exploitation rate.

2. Appropriate time scales within which the increase in the egg per recruit resulting from a specific conservation strategy can be measured. For example, measures such as the maximum size do not provide the full projected increase in E/R for up to 40 years after introduction.

Outlook

The landings have essentially remained high and stable since 1991, and there are no indications of immediate decline in recruitment on nearshore grounds. Landings, however, are occurring earlier in the season suggesting an increase in effective effort. The exploitation rates are high on these grounds, despite the movement of a portion of this fishing effort out into the midshore area. Continued high levels of fishing in the midshore have reduced the abundance of mature sizes on German Bank. This reduction has potentially reduced egg per recruit to 10% to 50% of previous levels when the midshore area was not heavily fished. The trend to lower overall E/R has greatly increased the risk of recruitment overfishing.

Management Considerations

Consultations have been ongoing with LFA 34 lobster fishermen since the release of the FRCC report in October 1995 through direct mail-out of interpretative documents, community-level meetings, discussions at regular Lobster Advisory Committee meetings, and two workshops. Fishers are currently preparing their response to the Minister's December 1997 directive to introduce new stock conservation measures in Fall 1998 which will lead to a doubling of **egg production per recruit** (E/R).

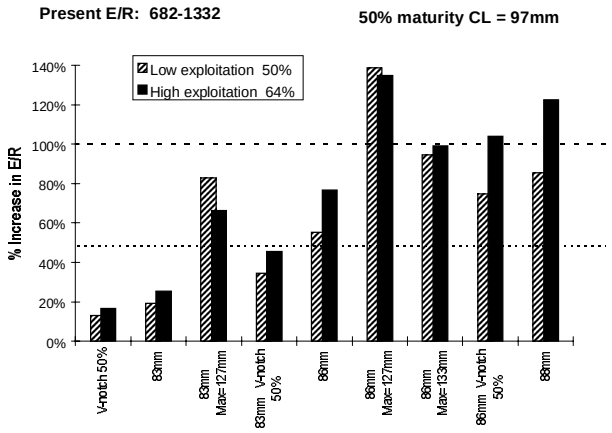
Egg per recruit estimates were derived using the Idoine-Rago E/R model (Anonymous 1996) and estimates of exploitation rate from the LCA.

The E/R values for nearshore and the German Bank area are between 682 and 1322 eggs per recruit. The overall E/R values for LFA 34 cannot be determined because information on the relative sizes of the nearshore and midshore are not available because landings are not recorded by areas fished.

Low values of E/R results in a higher risk of recruitment failure over the long term. In the past, the midshore portion of the district was not fished and had a high E/R which may have acted as a buffer against high exploitation rates and a low E/R in the nearshore areas. Models show that the contribution 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 is exposed to very high exploitation rate. However if high exploitation is applied to both portions of the populations, a collapse of both may result.

The stability of landings in the Gulf of Maine is likely due in part to the fact that a segment of the mature animals were not exploited and thus served as a brood stock and buffer against shifts in effort and climate.

If the loss of mature sizes observed on German Bank is representative of a major portion of the midshore then LFA 34 E/R has been decreased to 10-50% of what it was in the 1970s. If the current level of exploitation is maintained, further reductions in E/R are likely which will increase the already unacceptably high risk.



The percent increase in E/R from an increase V-notching, increase in minimum size and maximum size (MS) combinations applied to females.

The options available to double egg production include combinations of v-notching, minimum and maximum sizes limits. The combination of a minimum and maximum size increase allows more animals to reach maturity and reproduce while also establishing a pool of larger lobsters which can serve as a buffer during years of lower than average larval survival. A maximum size applied only to females will have a small reduction in yield but the increase in the minimum size will increase yield. It is possible that not protecting larger males could have a long-term effect on reproduction but it is felt that the faster growth rate of males and their ability to mate with a number of females each year will prevent that, though further study and monitoring will be necessary to confirm it.

Adopting v-notching as a conservation measure would require wide acceptance over the entire LFA. In estimating the benefits of v-notching it was assumed that 50% of the berried females caught would be notched. However based on current information from at-sea sampling it is assumed that berried females are not fully available to the fishery during the fishing season and catch rates are only 30% those of non berried females.

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Erratum

Please note the following corrections in regards to certain references in the Stock Status Report:

Document Referenced:

Pezzack, D.S., P. Lawton, D.R. Duggan, D.A. Robichaud, M.B. Strong, and I.M. Gutt. 1998. The American Lobster, *Homarus americanus*, fishery off of Southwestern Nova Scotia (Lobster Fishing Areas 34). Can. Stock Assess. Sec. Res. Doc. ***98/74***.

Correction:

Document number should be ***99/32***.