Update on the fishing season extension issue in Lobster Fishing Area 36

by

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Abstract

Data on landings, size-frequency distributions, movement patterns, and mortality in the Bay of Fundy lobster fishery are assessed to ascertain the effect of a proposed season extension for Lobster Fishing Area (LFA) 36 into July and/or early November. It is concluded that the extension would adversely affect the fishery by increasing an already high exploitation rate. Additionally, an extended season in LFA 36 would likely redistribute landings within the Bay of Fundy, as there is evidence of lobster interchange between adjacent LFA's. From recent landings it cannot yet be determined whether the Bay of Fundy lobster fishery has achieved a new, stable, high level of production, or has passed a peak and is in decline. Further effort increases are not biologically prudent until this landings trend is more clearly resolved. Landings per active licence in LFA 36 are comparable to those in LFA 35, but approximately half those in the productive Grand Manan fishery. LFA 36 has a greater number of licences than the other LFA's, although only approximately 60% are utilized. This represents considerable latent fishing effort. While additional landings may be realized following a season extension, economic returns may be dissipated among a greater number of participants. To account for increased lobster catchability during the requested extension period it is recommended that additional days be deducted off the season during winter months (2 - 3 days for each day extension), rather than simply shifting season dates as requested by fishermen. Management should consider other mechanisms to increase yield per fisherman in the LFA 36 fishery, such as a reduction in the number of licences, or revision of the management structure within the Bay of Fundy, in preference to granting a season extension.

Résumé

Les données sur les débarquements, les distributions de fréquence de taille, les mouvements migratoires et les taux de mortalité, de la pêcherie du homard dans la Baie de Fundy sont évaluées afin de déterminer les répercussions d'un prolongement de la saison de pêche jusqu'en juillet et/ou en novembre dans la Zone de Pêche du Homard (ZPH) 36. C'est conclu qu'un prolongement de saison aurait un effet adverse sur la pêcherie en augmentant le taux d'exploitation déjà excessif. En plus, un prolongement de la saison de pêche dans la ZPH 36 aurait comme effet une redistribution des prises à travers la Baie de Fundy, puisqu'il y a évidence de mouvement de homards entre ZPH adjacents. D'après les récents débarquements, on ne peut pas déterminer si la pêcherie du homard dans la Baie de Fundy a atteint un nouveau niveau plus élevé et stable de production, ou qu'elle a atteint un pic et est en déclin. Jusqu'à ce que la tendance des débarquement soit plus clairement définit, une augmentation d'effort de pêche n'est pas biologiquement prudent. Les débarquements par permis actif dans la ZPH 36 sont comparable à ceux de la ZPH 35, mais approximativement la moitié de la ZPH 38. La ZPH 36 contient un plus grand nombre de permis, que les deux autres ZPH, même si que seulement approximativement 60% des permis sont utilisés. Ceci représente un effort

de pêche latente considérable. Même si une augmentation des prises peut être réalisée avec un prolongement de la saison de pêche, les revenus économiques pourraient être dissipés parmi un plus grand nombre de pêcheurs. Pour compenser un taux de capture plus élevé durant la periode de prolongement demandé, il est recommandé que chaque jour de prolongement soit déduit de la saison de pêche durant l'hiver (2 à 3 jour pour chaque jour de prolongation), au lieu de simplement prolonger la saison tel que demandé par les pêcheurs. Comme préférence d'accorder un prolongement de la saison de pêche, les gestionnaires devraient considerer d'autres mécanismes pour augmenter le rendement par pêcheur dans la pêcherie de la ZPH 36, telle q'une réduction du nombre de permis, ou une revision de la structure de gestion dans la Baie de Fundy.

Background to the Issue

During 1991, lobster fishermen in Lobster Fishing Area (LFA) 36 (Fig. 1) requested a change in their open fishing season, the latest in a series of requests dating back to the 1970's. The current proposal is for an open season as follows (existing season in parentheses): Fall, November 1 to January 7 (2nd Tuesday in November to January 14); Spring, April 15 to July 15 (April 1 to June 30). This would extend lobster fishing by 3 - 4 weeks at prime fishing times, but reduce the season by 3 weeks in January and April.

For the departmental response to this latest request, local scientific advice was incorporated into a discussion paper on the Bay of Fundy lobster fishery. Based on the paper, and subsequent consultations, a regional recommendation was made against the extension, citing an already high exploitation rate, considerable latent fishing effort, evidence of stock interchange between adjacent LFA's, and projected socio-economic impacts. While LFA 36 fishermen accept there is stock interchange between LFA's, they have challenged conclusions regarding impacts, as they were based on patterns of lobster movement revealed by tagging studies conducted in the late 1970's, and early 1980's.

This working paper updates CAFSAC Res. Doc. 86/49 (Campbell 1986) which analyzed an earlier request for the LFA 36 season to be changed to that of LFA 35 (15 October-31 December and 1 March-31 July), an approximately 8 week extension. Campbell (1986) recommended against the change, concluding that the increased effort and exploitation would be detrimental to the Bay of Fundy lobster stock. He expressed concern over the removal of more large mature lobsters, which would provide short-term increases in landings, but possibly cause long-term reduction in recruitment and landings. Campbell (1986) noted that the existing closed summer fishing season helped protect large lobsters moving into shallow waters to reproduce (mate, extrude and hatch eggs) and molt in LFA 36. Various alternative management strategies to improve the yield and economic benefits to fishermen in LFA 36 were suggested in Res Doc 86/49; all involved some compensatory mechanism to contain overall effort.

For various non-biological reasons, season extensions had been granted on a trial basis to LFA 36 fishermen for 8 d (29 June-6 July) at the end of the 1984-85 season and 8 d (5-12 November) at the beginning of the 1985-86 season. An analysis of the additional landings resulting from these extensions was included in Campbell (1986); however, there was no focused scientific monitoring of either season extension.

Trends in Landings

The Bay of Fundy lobster fishery, along with other Scotia-Fundy lobster fishing areas, has experienced a sustained period of increasing landings through the 1980's, although there are some signs that landings are stabilizing, or may be past peak levels (Fig. 2). Total landings for LFA's 35, 36, and 38 almost doubled between the 1980-81 and 1990-91 seasons; LFA 34 tripled over the same period.

The buoyancy of the LFA 38 fishery may, in part, be attributed to the continued effort directed toward fishing large mature lobsters in deep water. While increased effort, through exploitation of previously lightly fished deeper water areas, can also explain increased landings in LFA's 35 and 36, it is apparent that enhanced recruitment success, presently not fully explained in biological terms, is largely responsible for the recent upsurge of the fishery.

The Fall season yields greater landings than the Spring season in LFA 38 (Fig. 3A), and for LFA 36 generally (Fig. 3B). Conversely, LFA 35 fishermen rely principally on catches in the Spring season (Fig. 3C). Within LFA 36 there is a trend between Statistical Districts (SD) from reliance on Fall catches in the lower Bay of Fundy and Passamaquoddy Bay, to a pattern similar to LFA 35 in SD 48 (Fig. 5; Table 2). However, these data mask a pattern of fishing in which fishermen based in SD 49 fish in local waters in the Fall, then redirect effort towards SD 48 in the Spring. The success of the SD 49 fishery influences fishing in SD 48 (D. Robichaud, pers. obs.).

On a relative basis, the LFA 35 and 36 share of total lobster landings in the Bay of Fundy increased through the 1980's until the 1986-87 season, when landings were split almost equally between the three areas (Fig. 4). Subsequently, LFA 38 landings have increased to 52% of the total in 1990-91, with LFA 35 and 36 dropping to 20% and 28%, respectively, a situation comparable to the beginning of the decade (Fig 4).

In 1990, LFA 36 had 46% of the lobster licenses in the three Bay of Fundy LFA's, with a utilization level of 59% (Table 1). Yield per active fisherman in LFA's 35 and 36, at 2.5 metric tons, was approximately half that obtained by LFA 38 fishermen (Table 1).

Lobster Catch Composition

Geographic differences

Lobster catch composition (length frequency) varies considerably from area to area in the Bay of Fundy (Campbell 1986; Robichaud and Campbell 1991). In general, the mean size of lobsters increases further up the Bay of Fundy (e.g. Alma; Fig. 6). In shallow water areas near southern Grand Manan and Statistical Districts 53 and 49 within LFA 36 (e.g. Chance Harbour; Fig. 7), the fishery consists principally of recently recruited lobsters (1-2 molts into the legal size). In recent years there has been an increase in the proportion of pre-recruits, and lobsters within the first molt group in sea samples taken in the Alma area (Fig. 6), whereas the size composition at Dipper Harbour has remained relatively stable (Fig. 7). Hitherto, the fisheries in the upper portion of the Bay of Fundy were considered to be principally based on a seasonally migrating stock (Fig. 6B), but recent data suggests that there is local production capacity (Fig. 6A). The change in size composition in the LFA 35 fishery also reflects targeted fishing for smaller lobsters by local fishermen.

Notwithstanding the local production capacity in LFA 35, the principal centres of lobster productivity within the Bay of Fundy, based on the abundance of pre-recruit lobsters in sea samples, and recent diving surveys, are considered to be within LFA 36 (New Brunswick coastline from L'Etete Passage to St. John), and off southern Grand Manan (Lawton and Robichaud, unpubl. data).

Seasonal changes

Campbell (1986), and Robichaud and Campbell (1991), showed how the effects of fishing, molting, and movement of large lobsters into shallow waters during summer, influenced the size frequency of lobsters taken in traps set through the fishing seasons and over the closed summer period in LFA 36 (samples from Chance Harbour; Fig. 8) and LFA 35 (samples from Alma; Fig. 9) during 1979 and 1980. These extensive studies on catch composition, together with large-scale tagging studies (see **Movement Patterns**) have not been repeated in subsequent years, and they remain the most comprehensive data set on the seasonal movement patterns of lobsters in the Bay of Fundy.

In Chance Harbour samples, there was an increase in the proportion of first molt lobsters into the fishery (81-94 mm CL), in addition to an increase in the number of berried females and mature lobsters (> 94 mm L), during August and September (Fig. 8). In Alma, the number of berried females caught in traps increased during summer (Fig. 9). Given the closer correspondence in St. Martins trap-sample size distribution to Alma than to Chance Harbour (D. Robichaud, pers. obs.), the Alma data should indicate the seasonal changes in the northeastern border of LFA 36.

Based on the extensive fishery sampling conducted in the early 1980's in LFA's 35 - 38, subsequent at-sea sampling has been restricted to the first two weeks of the Fall season, and the last two weeks of the Spring season in each LFA. Catch rates in each fishery are maximal at these times, and the data obtained from the two sampling periods can be used to estimate exploitation rates (see **Mortality Estimates**). Biologists board between one and three fishing vessels in each fishing locality and measure all lobsters present in traps hauled during one day's fishing. Figure 10 shows the catch rates (by molt groups) observed in Fall at-sea surveys in four major fishing areas within the Bay of Fundy, from 1978 to 1991. Figure 11 displays the sea-sampling data as weight (kg) of commercial-sized lobsters per trap haul. It should be noted that data for Fall at-sea samples from Alma comes from the last two weeks in October, whereas data for Dipper Harbour, Seal Cove, and North Head is obtained in mid-November. Catch rates (kg per trap haul) in Dipper Harbour are consistent with those from Seal Cove (in LFA 38) where the fishery principally targets lobsters in the 81 - 94 mm CL range (compare Figs. 10B and 10C). Catch rates (kg. per trap haul) in both of these areas typically fall below Alma and North Head, where the fishery is directed towards mature lobsters.

Movement Patterns

Tagging studies (Campbell and Stasko, 1985, 1986; Campbell 1986) have revealed that mature lobsters are capable of moving considerable distances (>50 km), and that there is some interchange of lobsters throughout the Bay of Fundy, Gulf of Maine and adjoining Continental Shelf. In certain areas (Bay of Fundy, Browns Bank, Continental Shelf), many mature lobsters move seasonally into shallow, warm waters during spring-summer and into deeper waters during fall-winter. The tagging studies conducted in the early 1980's provide the most extensive data set on lobster movement within the Bay of Fundy. Subsequently, only small-scale tagging studies have been undertaken to examine specific movement patterns (such as the seasonal use of inshore spawning areas off Grand Manan (Campbell 1990; Lawton and Robichaud, unpublished data).

During 1977-80, a total of 18,359 lobsters were tagged near Alma, Chance Harbour and Grand Manan. Within 6 yr of release, 5375 lobsters (29.3%) were recaptured. Campbell (1986) concluded from these studies:

1) Immature lobsters (< 95 mm CL) on average moved less than 7.3 km; 88% were recaptured < 18 km from the release sites.
2) Mature lobsters (> 95 mm CL) moved greater distances, with as much as 46% moving > 18 km, and 16.2% moving greater than 92.6 km.
3) Mature lobsters make seasonal deep-shallow migrations probably associated with the seasonal temperature changes in the Bay of Fundy. Mature lobsters tended to be in shallow, warm waters during July-November and in deeper waters during January-May. Depending on the local temperature conditions, the seasonal lobster movements were highest during October-December into deep waters and May-July

to shallow waters. These migrations help mature lobsters maintain optimum temperatures required for molting, reproduction and egg hatching.

4) Distances moved for mature lobsters released in the upper half of the Bay of Fundy were greater than for those in the lower half of the Bay.

5) Some mature lobsters returned to the original area of release after making the seasonal deep-shallow migration. Other lobsters moved to different areas after making the migration. There was a general mixing of mature lobsters in the Bay of Fundy. LFA 36 fishermen caught about 27% of the mature lobsters tagged in Alma that moved more than 30 km. This confirmed that mature lobsters tagged in other areas of the Bay of Fundy are caught in LFA 36. Also, mature lobsters can seasonally move through LFA 36 in transit from the upper part of the mouth of the Bay of Fundy.

6) In some areas, mature females moved earlier than mature males. Consequently, the males would be more vulnerable to removal by the local fishery. The timing of the local fishing season in relation to the seasonal movement of mature lobsters has an important effect on the proportion of mature lobsters removed in an area.

The above conclusions have been disseminated to fishermens groups on numerous occasions, and are generally accepted. However, LFA 36 fishermen contend that the timing of the inshore movement of mature lobsters has changed over time resulting in a mis-match between their present season and the availability of mature lobsters. As there have been no contemporary tagging studies comparable to those cited above, it is hard to counter this assertion. Additionally, the present, compressed, at-sea sampling program does not provide information on the current catch profile over the full season.

However, some inferences on recent movement patterns can be drawn from the lobster size composition in at-sea trap samples (Fig. 10). There has been a slight, but persistent, increase in the number of mature lobsters (> 95 mm CL) per trap haul during the first two weeks of the Fall season in each LFA, except for the 1991 trap sample from North Head (Fig. 10). Evidently, fishermen can still intercept mature lobsters before they move to deep water in the Fall. The Spring 1991 fishery, which was poor throughout the Bay of Fundy, was largely responsible for the concerted effort by LFA 36 fishermen to press their claim for a season change. However, from the Dipper Harbour sample, the catch (kg) per trap haul was close to the long term average (Fig. 13B). Indeed, fishermen in the Alma area have experienced a more dramatic fall in Spring catch rates over the last two years (Fig. 13A). Trends in catch rates from at-sea samples in LFA 35 and 36 (Figs. 12 and 13) do not support fishermens claims that the inshore migration of mature lobsters has become progressively later in the Spring, apart from the decline over the last 1 - 2 years. However, recent experience may also be reflective of a recruitment pulse having passed through the fishery.

A recent review of the Bay of Fundy tagging database has revealed a tagging series not included in Campbell (1986). A total of 1257 lobsters were tagged off St.

Martins, at the north-eastern border of LFA 36, between July 25 and August 3, 1979, co-incident with the tagging studies in Alma, Chance Harbour, and Grand Manan. A total of 309 lobsters were recaptured, up to November 1988. A preliminary examination of tag recaptures indicates that they support the general conclusions of Campbell (1986). In addition, they demonstrate the potential for lobsters tagged in the north-eastern portion of LFA 36 during July and August, to appear in the catches of LFA 35 and LFA 38 fishermen in the Fall and subsequent Spring fisheries.

Mortality Estimates

Campbell (1985, 1986) conducted detailed analyses of exploitation rates in the Bay of Fundy fishery, and the effects of various management measures, through their influence on exploitation rate, on yield per recruit and eggs per recruit in the Bay of Fundy fishery. Using size frequencies from sea samples, and weighting these according to the local landings obtained at the beginning and end of each fishing season in Statistical Districts 49 and 52, for 1983-84 and 1984-85, Campbell (1986) determined the proportion of recruits (% first molt into legal size) in the catch to be from 76-79%. Overall mortality, Z (following Campbell 1980), was calculated as 1.94 and 1.81; assuming natural mortality = 0.1, exploitation rates were determined to be 82 - 84% over the two years. Campbell (1986) used these analyses in formulating his response to the requested season extension, and demonstrated that management changes which would increase exploitation rates would be detrimental to the fishery.

Sea sampling in LFA's 35 - 38 has continued annually through the 1980's, and this information can be used to derive exploitation rates (Fig. 14), using methods based on Campbell (1986), and subsequent revisions (Mohn, and Pezzack, unpubl. manuscripts). The formula used is

$$A = \left(1 - \frac{(M_2 \times \bar{I}_2)}{(M_1 \times \bar{I}_1)}\right)$$

A = exploitation rate, M_1 and M_2 are the percentage of catch in the first and second molt groups (81 - 94, and 95 -109 mm CL), respectively , and I_1 and I_2 represent the intermolt periods of the first and second molt groups.

In the case of Dipper Harbour (LFA 36), and Seal Cove (LFA 38), where the fishery is principally based on annual recruitment, estimated exploitation rates have exhibited only a slight downward trend through the 1980's from approximately 0.85 to 0.80. Conversely, there have been major changes in the calculated exploitation rates in the Alma fishery, particularly after 1985 (Fig. 14).

Exploitation rate values such as those in Fig. 14 have been used routinely in Scotia-Fundy in developing advice for management. However, recent work by Pezzack (unpubl. ms) indicates that these simple formulations may be unreliable when basic assumptions are violated, particularly those concerning recruitment. As elaborated by Pezzack (unpubl ms.), the danger in using the present exploitation rate values for management advice is that it can give results opposite to the actual situation. In a fishery with increasing recruitment, overall exploitation rate could decline, but calculated rates may show a modest increase. Management changes to reduce exploitation may thus be unwarranted. Conversely, if recruitment were declining while real exploitation rate was increasing, calculated exploitation rates could show a decline, and advice may be to lengthen seasons. Pezzack cites a number of alternate methods of calculating exploitation rates which may be more robust under non-equilibrium conditions. The database on the Bay of Fundy fishery may be amenable to alternative analyses, although this has not yet been tested. The assumptions of alternative methods may not be supported in the existing database.

The problem in determining appropriate management methods is exacerbated in areas such as Alma and North Head (Fig. 10) where the presence of a migratory component to the fishable stock further confounds estimates of exploitation rate. For example, in the North Head Fall fishery, the catch of lobsters > 109 mm CI exceeds that of both lower size groups (Fig. 10D). Clearly, without recourse to quantitative measures of exploitation rate, other indicators of fishery dynamics, such as consistent local recruitment, lobster movement patterns, catch per trap haul, and overall yield per fisherman, must be used for developing advice on season extension requests.

Fishing Season Changes

The lobster fishing season in LFA 36 has basically remained fall-spring since the turn of the century, with few modifications. During the consultation process over the recent background paper, a consistent concern voiced by lobster fishermen in LFA's adjacent to LFA 36 was the impact that a change in season structure would have on the pricing arrangements within the Bay, and within Scotia-Fundy generally.

Since temperatures are warmer in shallow waters during the summer months, lobster catchability becomes substantially higher than during low winter temperatures (McLeese and Wilder 1958). Water temperature becomes warmer more rapidly, making lobsters more catchable, at the eastern end than at the western end of LFA 36 during May-July (Campbell 1986). Consequently, seasonal timing (period) and length of the fishing season has an important effect on exploitation.

Campbell (1986) considered that extending the fishing season by 8 weeks into July and/or October would increase exploitation by removing more lobsters from LFA 36 fishing grounds. Large mature lobsters would become vulnerable to removal since they

move seasonally from deep waters in winter to shallow waters in the summer months. Campbell (1986) considered that this effect would be most pronounced in Statistical District 48. While the present request is only for a 3 - 4 week extension from July 1 - 15, and November 1 - 14 (variable, as present opening date is 2nd Tues of November), there would undoubtedly be additional pressure on the resource, especially if inactive licensed fishermen (approximately 80 licences; Table 2) took advantage of the better fishing conditions in these periods.

However, given that lobsters migrate between LFA's in the Bay of Fundy, it does not follow directly that a season extension in LFA 36 will increase exploitation of mature lobsters. There may simply be a redistribution of existing landings, as mature lobsters thus taken in LFA 36 would not appear in the subsequent Fall and Spring landings in other LFA's. Exploitation of new recruits to the fishery would increase, as movement is limited at these sizes. This effect would be most pronounced in the western portion of LFA 36, but there, most of the recruiting cohort is cropped within the current fishing season.

The present request from LFA 36 fishermen includes a compensatory mechanism in the form of an equivalent number of days dropped from the winter portion of the present season. As Campbell (1986) explained, a more appropriate mechanism for adjustment of fishing season would have to incorporate some multiplier to take into account the different catchability of lobsters during these periods. This is amenable to analysis, using degree day calculations, and such an attempt was made by Campbell (1986), from which he arrived at a factor of between 2 and 3 days off the end of the season for each extended day in prime fishing season.

Such a degree-day closure period would not guarantee maintaining the same (or reducing) exploitation, since latent fishing effort could increase (by reactivation of licences, and by increasing trap hauls among active fishermen), and seasonal temperatures could vary from one year to another. Additional to lowered catchability, the typical fishing effort applied during the proposed winter closure period is very low in comparison to that applied during the early Fall and late Spring periods. Campbell (1986) acknowledged that a more sophisticated analysis could be derived, but would require detailed information on the effect of effort changes, seasonal temperature changes, and the interaction of trap-lobster densities on lobster catchability. It is clear that LFA 36 fishermens' proposal for a simple shift in fishing season cannot be supported, and some multiplier, probably between 2 and 3, should be applied by management against the winter closure period.

A compounding problem for assessment of the season extension request from LFA 36 is that fishermen from other LFA's, notably LFA 38 would seek comparable gains in their seasons. Consequences of an extension to both fishing seasons have not been specifically addressed in this report.

Carapace Length Changes

During the 1980's, biologists repeatedly pressed for increases in the minimum size regulation in the Scotia-Fundy lobster fishery generally, as the most effective management tool to increase yield in the fishery over the long term. Industry opposition against such a change has been particularly polarised in LFA 36. As noted in **Background to the Issue**, carapace length arguments have been brought into the debate, but are considered to be peripheral to the issue by fishermen. Campbell (1986) included detailed considerations of carapace length regulations in the Bay of Fundy fishery, and these have not been restated in this report.

Assessment of Extension Request

While increased effort, through exploitation of previously lightly fished deeper waters areas, may explain some of the increase in landings, enhanced recruitment success, appears largely responsible for the recent upsurge in the Bay of Fundy lobster fishery. Nevertheless, current biological advice remains that the lobster fishery is heavily exploited, and effort should be contained, and reduced where possible. Containing or reducing effort and exploitation is a biologically prudent management objective for the long-term viability of the fishery, until current scientific debates on the exact relationships between spawning stock size, recruitment during the juvenile phase, and subsequent fishery yields are resolved.

The present season extension request from LFA 36 fishermen is more modest than the 8 week extension request considered by Campbell (1986), and thus some concerns, e.g. fishing closer to the molting period are lessened. However, the current proposal would:

1) Increase effort and exploitation of the lobster stock. LFA 36 has 196 licenses compared to 95 and 136 in LFA 35 and LFA 38, respectively. Present utilization rate of licences in LFA 36 is only 59% (Table 2), thus there is considerable latent fishing effort. A 4 week extension of fishing at favourable times of the year could increase licence utilization up to or over the level in LFA's 35 and 38 (presently 79 and 83%, respectively). If licences are reactivated, yield per fishermen may not increase much above the present 2.5 metric tons, although total landings may increase in the short term.

2) Change the present catch profile. In areas where there is substantial local productivity, e.g. western LFA 36, an advanced Fall opening may simply result in a shift of existing landings, as much of the recruiting year class is already cropped under the current season. Any additional removal of these lobsters in the Fall may result in lowered Spring catches before larger migratory lobsters move into the area.

3) Remove more large mature lobsters. Tagging studies show that mature lobsters move seasonally from deep waters in winter to shallow waters in summer months. Increasing exploitation of large mature lobsters, especially in Statistical District 48, may reduce the quantity of larvae recruiting to downstream areas, e.g. rest of LFA 36.

4) Change the sharing arrangement between LFA's within the Bay of Fundy. Our understanding of the stock characteristics and movement patterns of Bay of Fundy lobsters is largely based on studies conducted during the late 1970's and early 1980's. Accepting that the earlier studies provide a picture of stock interchange throughout the Bay, then changes in the LFA 36 season will lead to a reallocation of catches. From a biological perspective, as long as overall effort does not increase, reallocation of existing effort could be considered to be principally a socio-economic concern. A change in fishing season which lead to increased removal of mature lobsters, which may otherwise move into LFA 35 either in the same year, or subsequent years, would reduce fishery yields in that area.

Alternative management strategies to improve the yield and economic benefits to fishermen in LFA 36 need to be explored, within an objective of containing overall effort on the resource. Approaches could include:

1) A compensatory mechanism, based on degree-day calculations, and knowledge of seasonal effort patterns, to adjust for extra fishing days in early July, and/or early November. A multiplier, probably between 2 and 3 would be needed to ensure that extra fishing days were fully compensated for in the winter months. There is less concern over the request for an advance in the Fall opening date, especially if this were combined with a reduction in fishing days later in the Fall season, and/or a delayed Spring opening date. The more contentious proposal is for an extension of the Spring season in LFA 36 into July.

2) Reduction in the number of licences in LFA 36. This would have the effect of reducing concerns over the latent fishing effort in LFA 36 in relation to a season extension request and, if sufficiently comprehensive, improve yields to fishermen remaining in the fishery.

3). In biological terms, compensation within the Bay of Fundy fishery need not necessarily come from the LFA requesting a season change. Reductions in the seasons, trap limits, or other controls on adjacent LFA's could permit a readjustment in the LFA 36 season. Change to the general structure of the Bay of Fundy lobster fishery to accommodate the requests from LFA 36 fishermen is a bioeconomic question beyond the focus of this paper.

4) Splitting LFA 36 into two management areas or incorporating part of LFA 36 into another management unit. One of the difficult problems in seeking a resolution to

the season issue is that the western and eastern LFA 36 fisheries are quite distinct. In the northeastern area, at the border with LFA 35, the fishery is Spring-based, while in the western portion of LFA 36, the fishery is principally Fall-based. It is known that there is considerable fleet movement within LFA 36, with effort being redirected to the north-eastern border by fishermen that also fish below St. John in the Fall season. Rationalisation of LFA 36 boundaries, based on functional aspects of these distinct fisheries, could be investigated by management.

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Table 1: Utilization of lobster licences in the Bay of Fundy fishery in 1990.

	LFA 35	LFA 36	LFA 38	Total
Total licences [1]	95	196	136	427
Percentage of licences	22%	46%	32%	100%
Licences issued [2]	109	190	121	420
Active licences [3]	91	113	96	300
Percent utilized [4]	83%	59%	79%	71%
Landings (metric tons) [5]	229	282	504	1015
Landings/active licence (metric tons)	2.52	2.50	5.25	3.38

[1] Includes part-time and partnership licences
[2] Includes transfers of licences within the year
[3] Licences for which lobster landings were reported
[4] Active licences / Licences issued
[5] Landings for 1990 calendar year

Source: J. Nelson, Economics Branch, Halifax

Table 2: Percent of lobster landings by season total for the various statistical districts in LFA 36 during the 1989-90 and 1990-91 fishing seasons. Values in brackets are metric tons.

Season	SD 51	SD 52	SD 53	SD 49	SD 48	Total
Fall 1990	92	99	85	76	58	75
Spring 1991	8	1	15	24	42	25
Total (metric tons)	(51)	(1)	(33)	(113)	(74)	(272)
Fall 1989	90	99	83	66	49	68
Spring 1990	10	1	17	34	51	32
Total (metric tons)	(51)	(1)	(18)	(80)	(75)	(225)

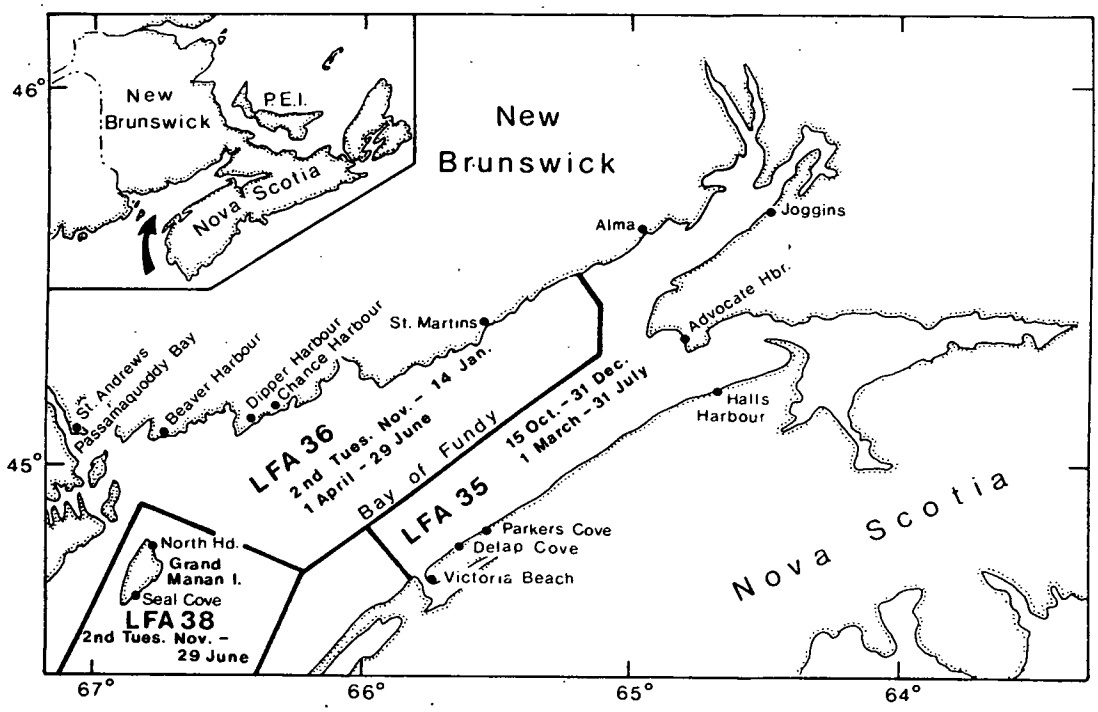


Figure 1. Lobster Fishing Areas (LFA's) in the Bay of Fundy and existing seasons

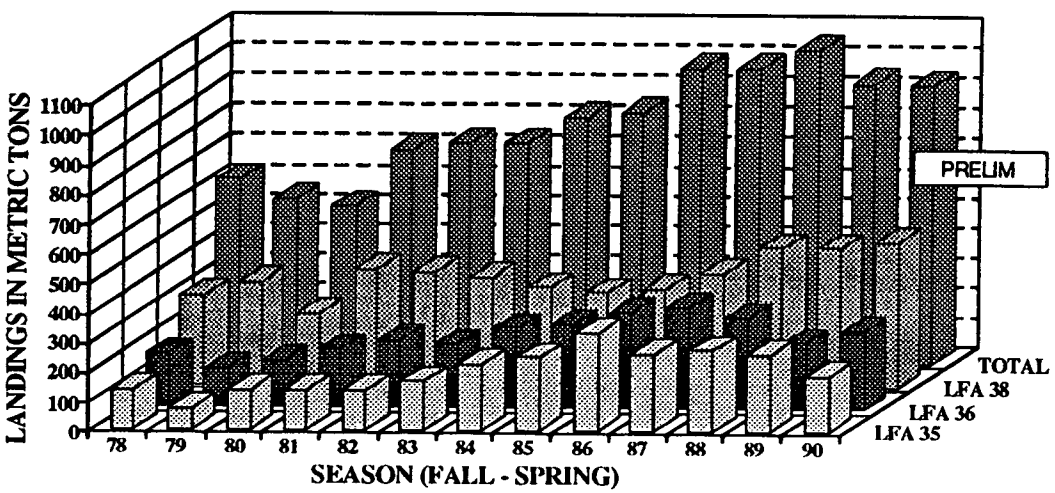


Figure 2. Lobster landings in the Bay of Fundy, 1978 - 1990. Season comprises landings from the opening of the Fall season in the year indicated to the closure of the Spring fishery in the subsequent year.

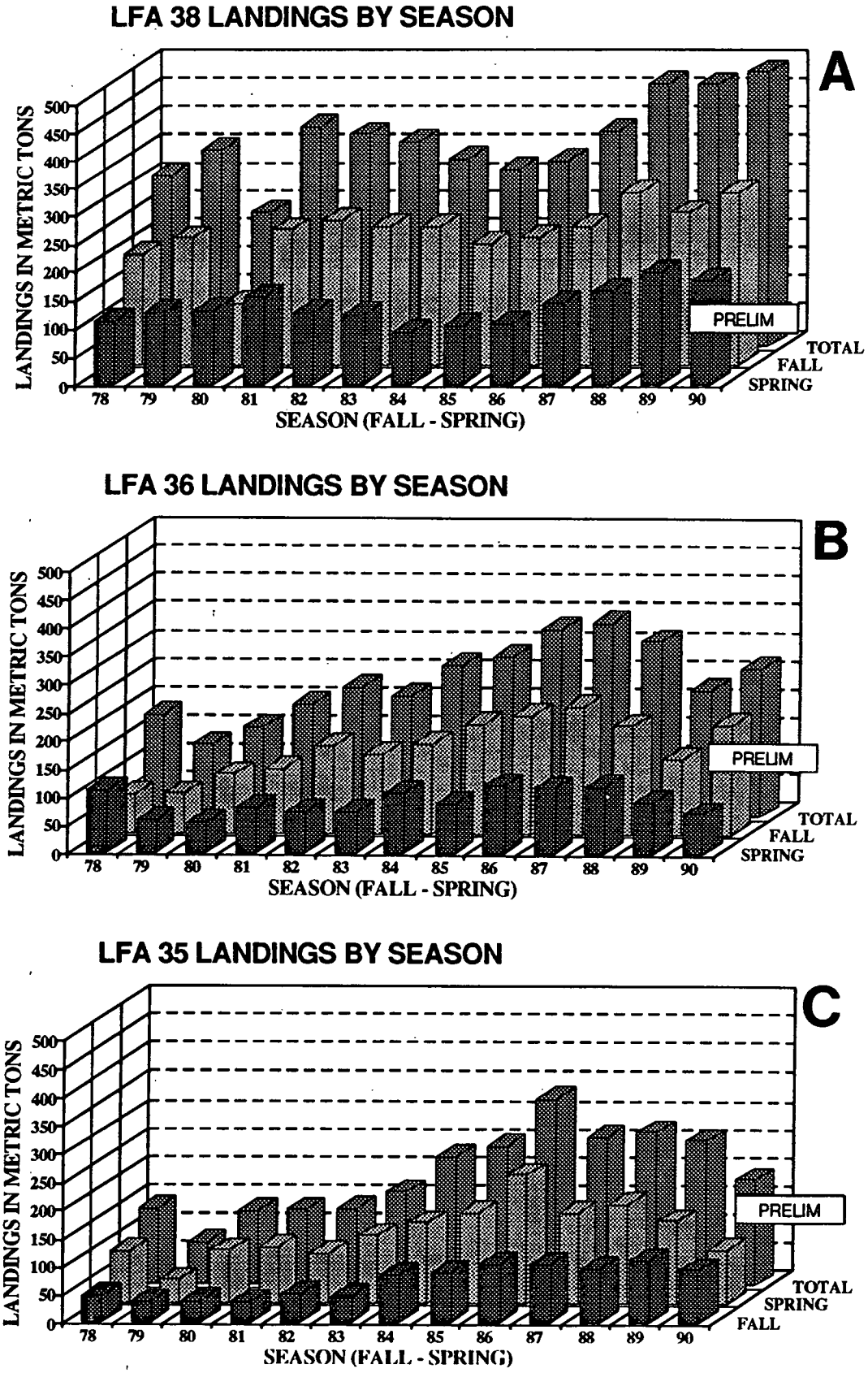


Figure 3. Lobster landings by fishing season, 1978 - 1990, for: (A) LFA 38; (B) LFA 36; (C) LFA 35.

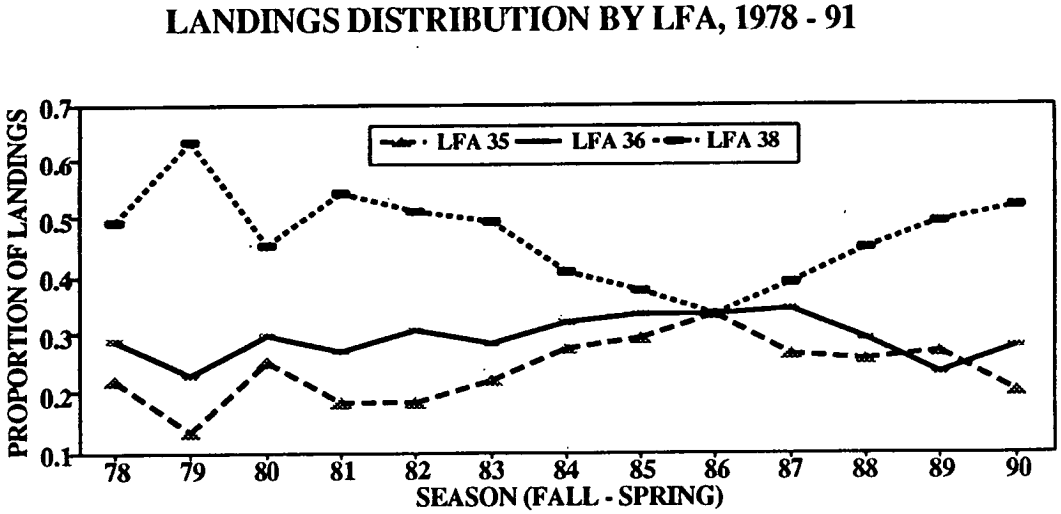


Figure 4. Landings distribution by LFA, 1978 - 1990, as a proportion of total landings. Seasons as in Fig. 1.

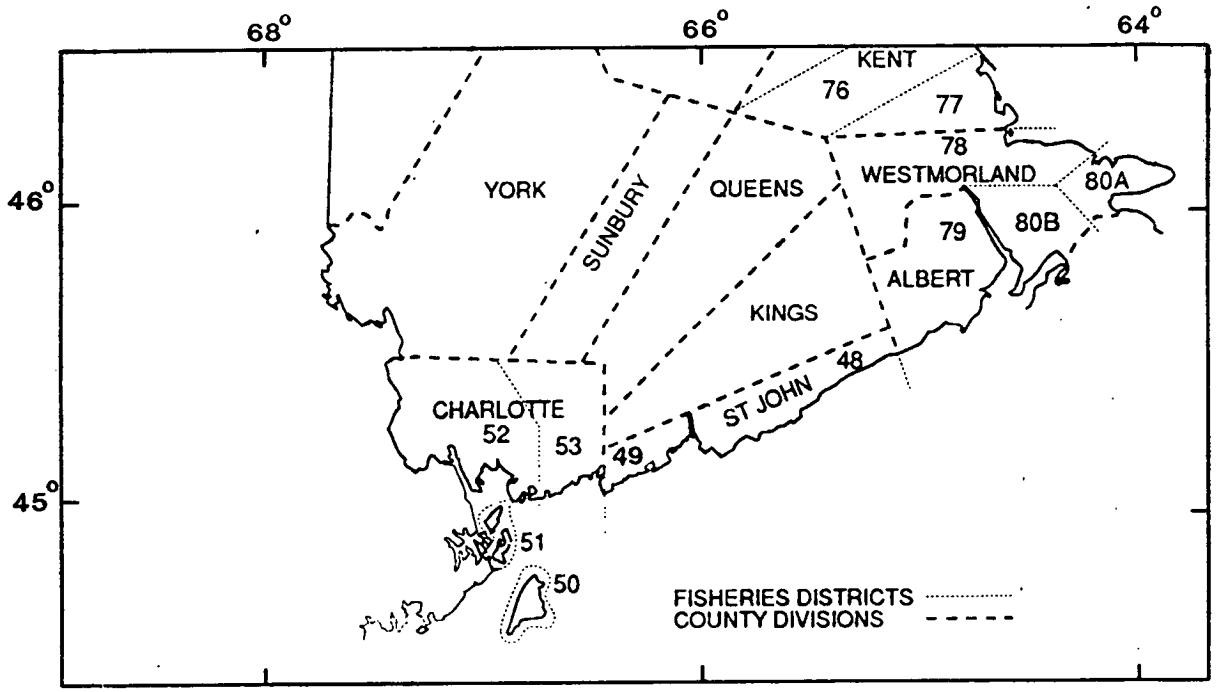
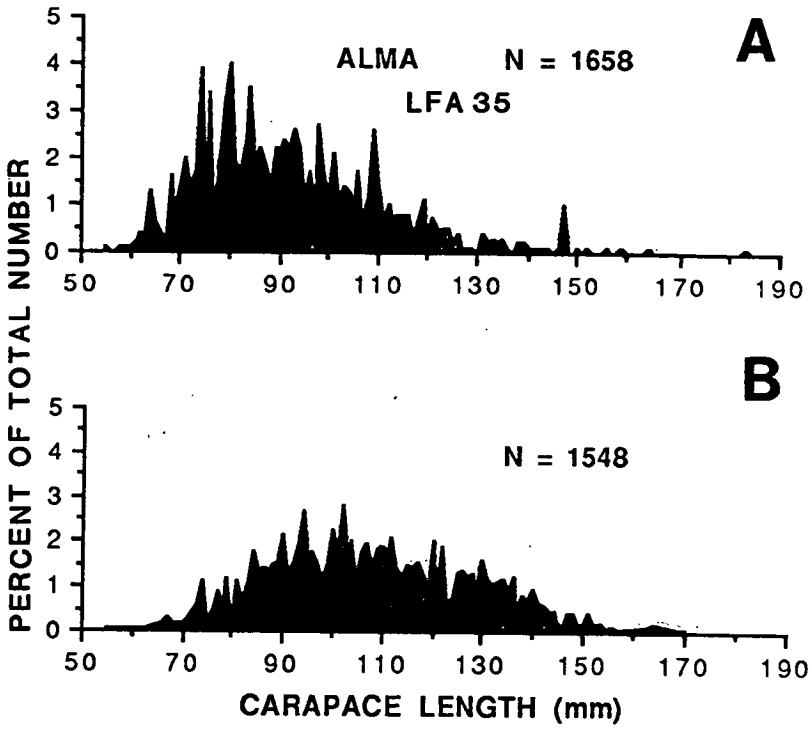


Figure 5. Statistical Districts within the Bay of Fundy.

Figure 6. Size frequencies from at-sea trap samples obtained in the Bay of Fundy near Alma during (A) October - November, 1991, and (B) October - December, 1979.



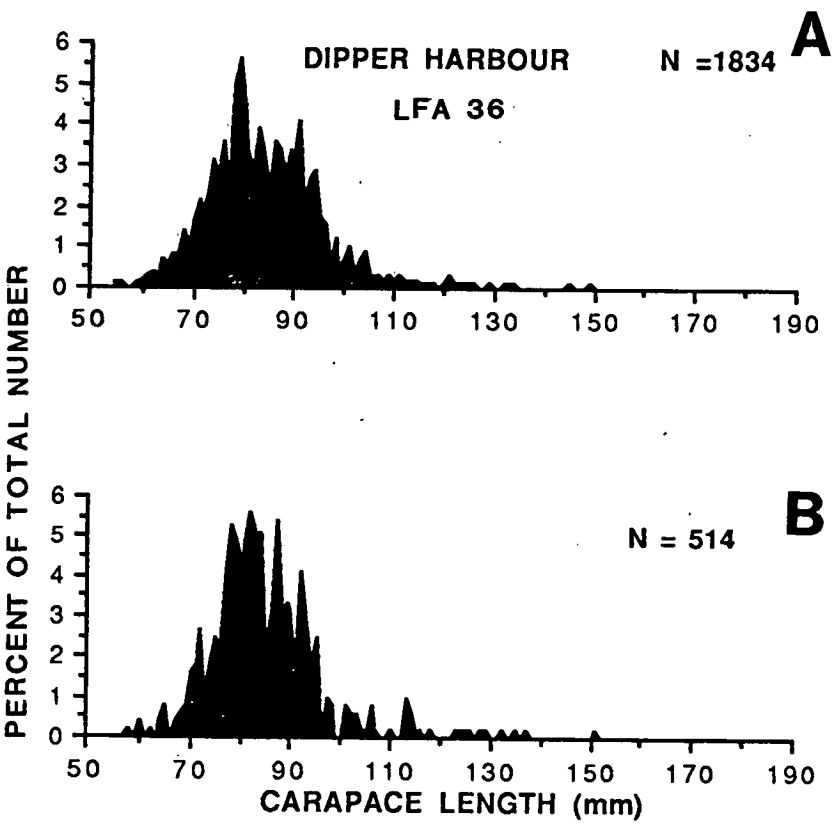


Figure 7. Size frequencies from at-sea trap samples obtained in the Bay of Fundy near Dipper Harbour during (A) November, 1991, and (B) November, 1980.

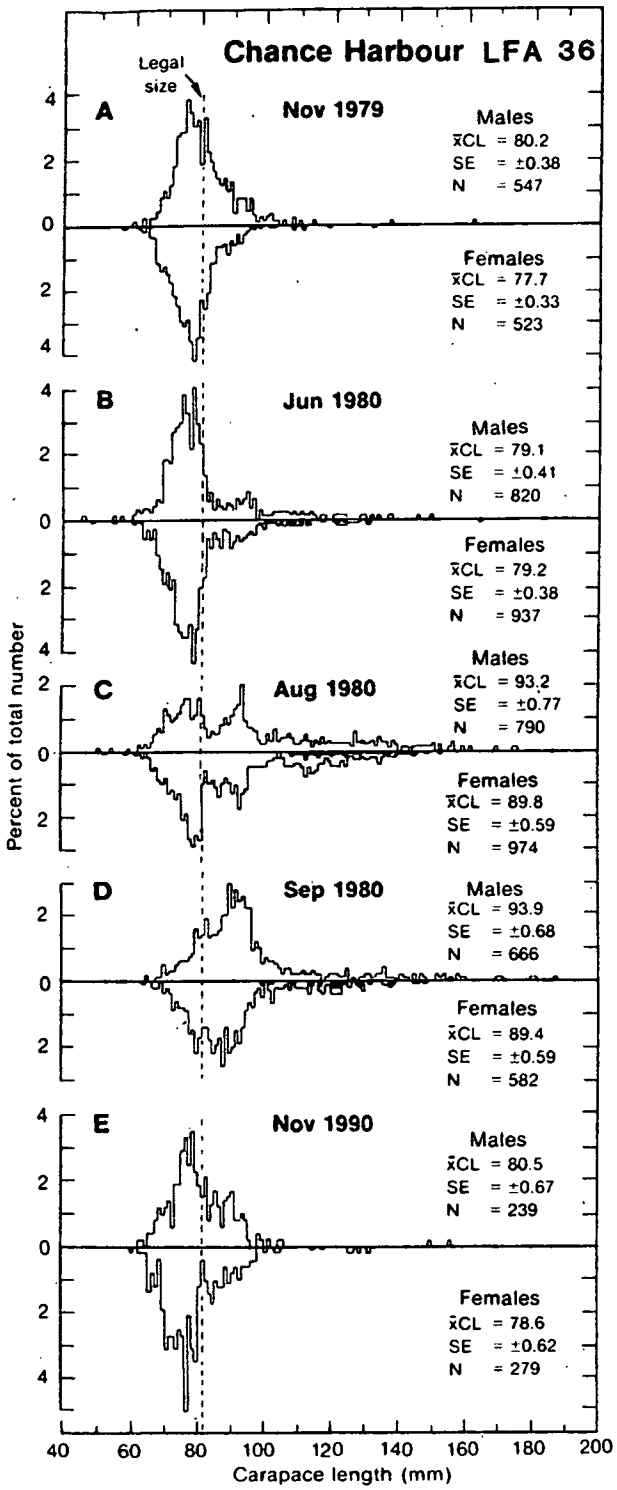


Figure 8. Seasonal changes in size frequencies as a percentage of total number of male, non-berried female (light histograms) and berried female (dark histograms) lobsters in each 1-mm size class obtained at-sea near Chance Harbour, 1979-80. From Robichaud and Campbell (1991).

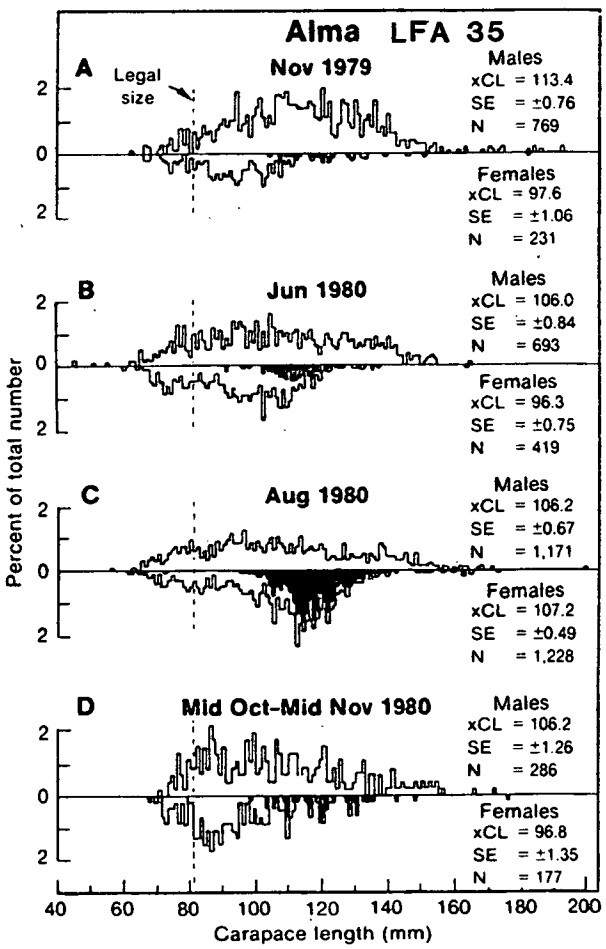


Figure 9. Seasonal changes in size frequencies as a percentage of total number of male, non-berried female (light histograms) and berried female (dark histograms) lobsters in each 1-mm size class obtained at-sea near Alma, 1979-80. From Robichaud and Campbell (1991).

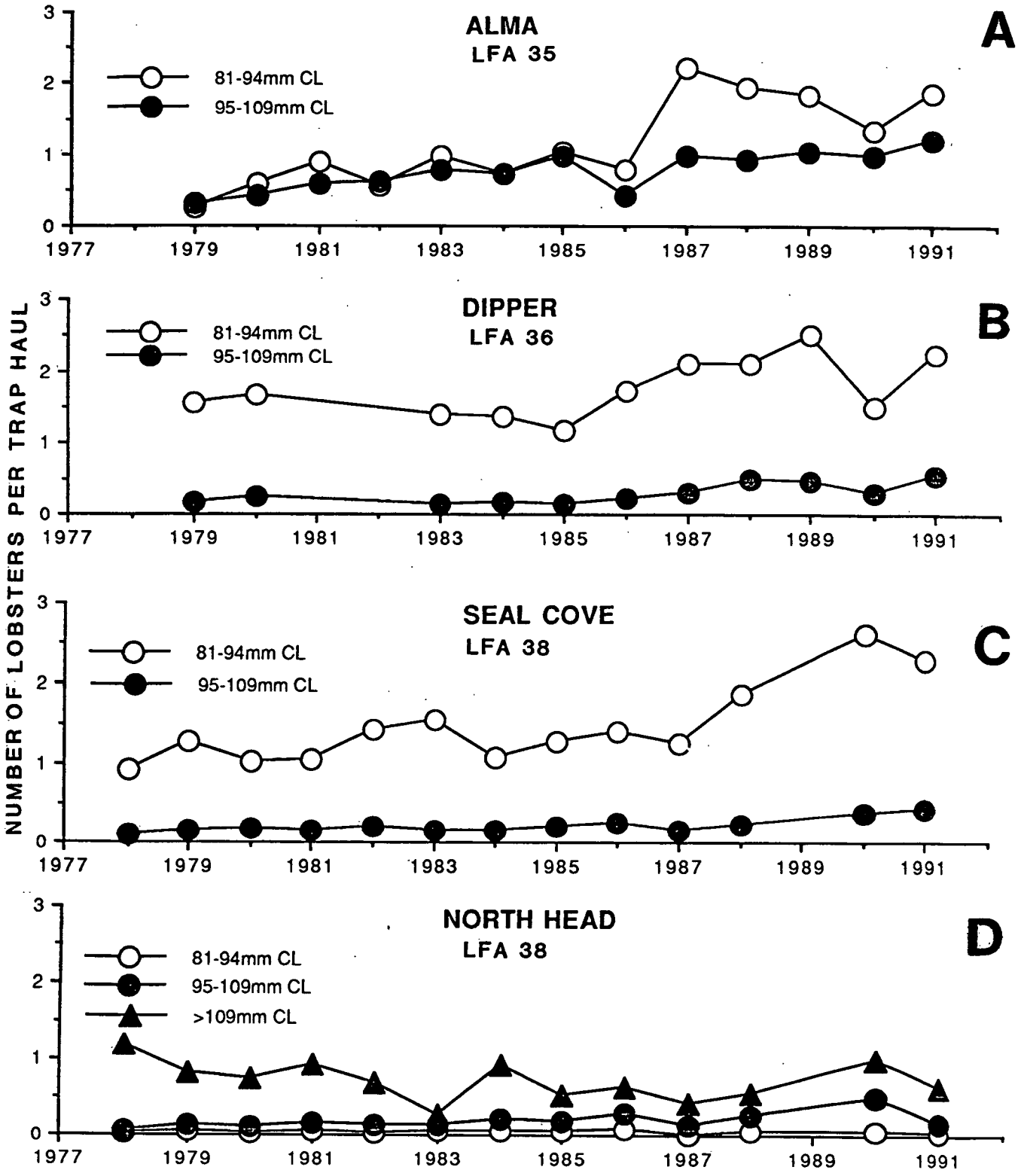


Figure 10. Number of lobsters per trap haul, by defined molt groups, from at-sea samples taken following the opening of the Fall season off (A) Alma, (B) Dipper Harbour, (C) Seal Cove, and (D) North Head, 1978 - 1991.

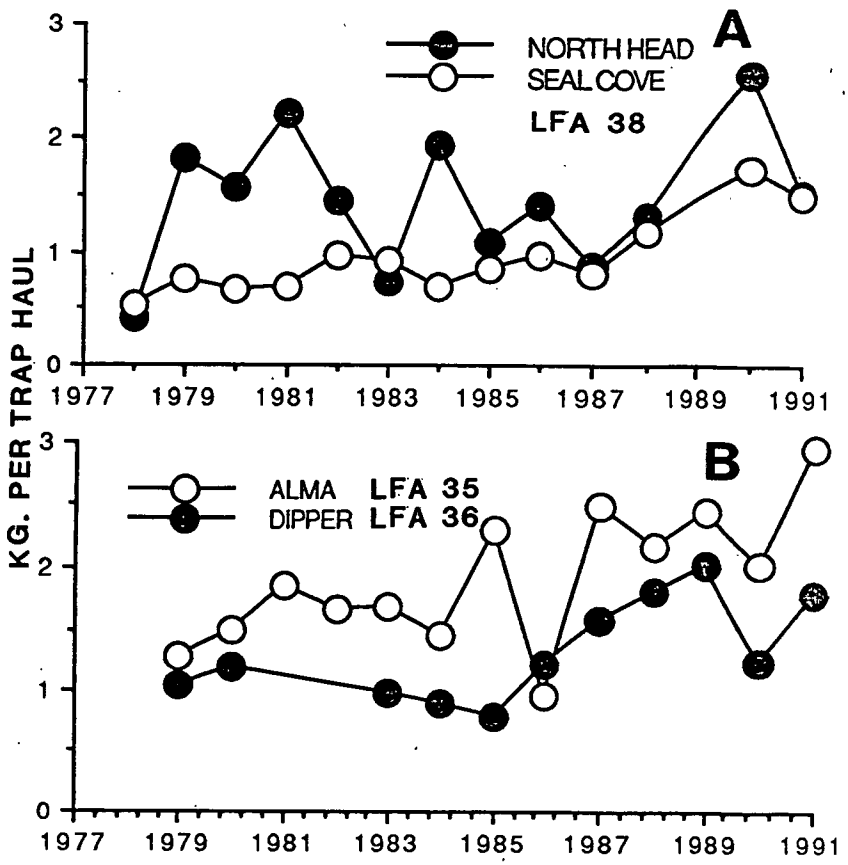


Figure 11. Catch (kg) of lobster per trap haul from at-sea samples taken following the opening of the Fall season off (A) Seal Cove, and North Head, 1978 - 1991, and (B) Alma and Dipper Harbour, 1979 - 1991.

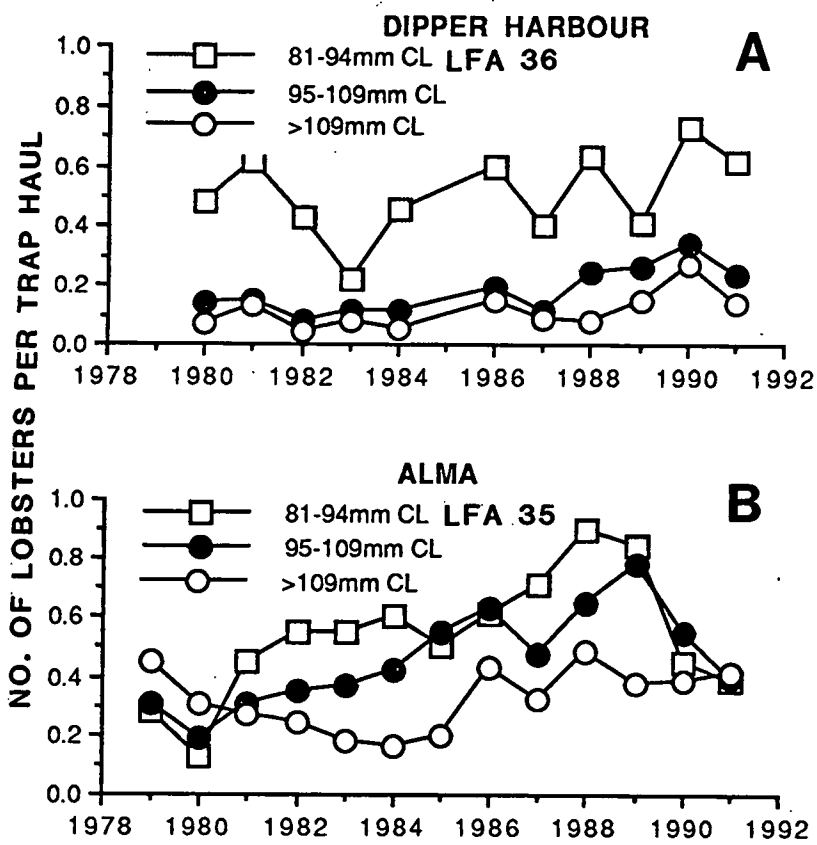


Figure 12. Number of lobster per trap haul, by defined molt groups, from at-sea samples taken prior to the closing of the Spring season off (A) Dipper Harbour, 1979 - 1991, and (B) Alma, 1979 - 1991.

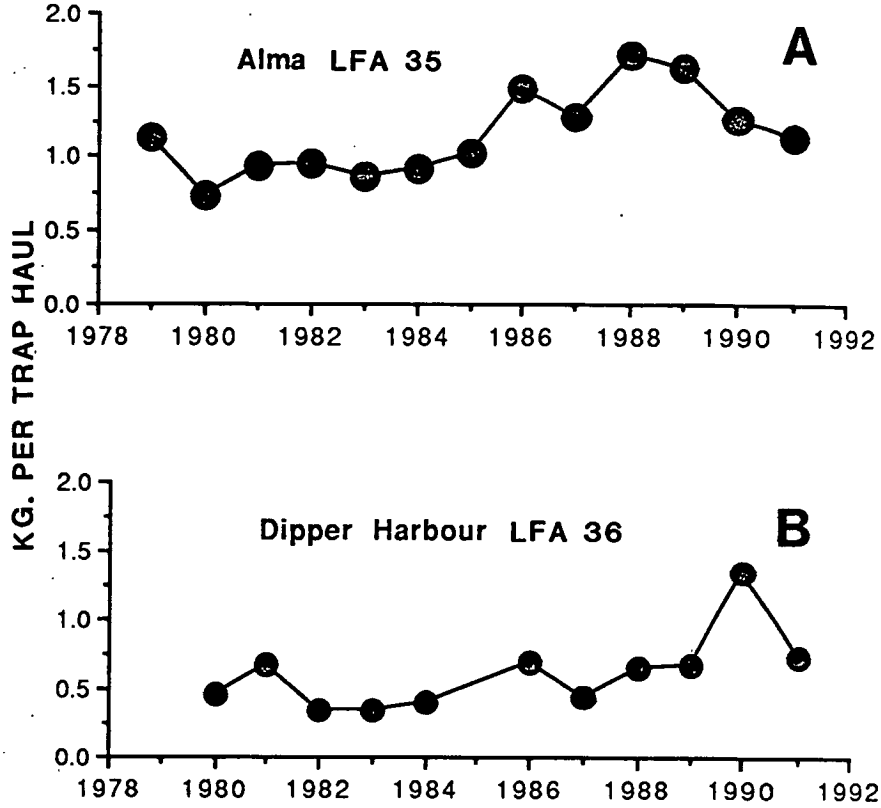


Figure 13. Catch (kg) of lobsters per trap haul from at-sea samples taken prior to the closing of the Spring season off (A) Alma, 1979 - 1991, and (B) Dipper Harbour, 1980 - 1991.

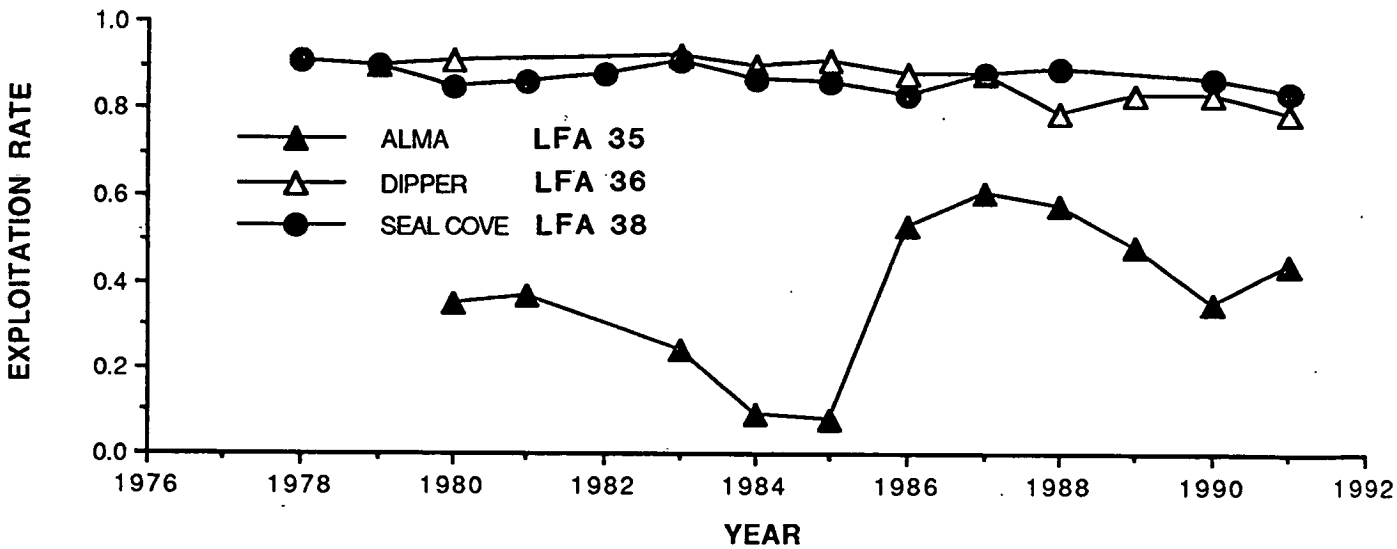


Figure 14. Exploitation rates in the Bay of Fundy fishery, derived from at-sea samples of catches in Alma, Dipper Harbour, and Seal Cove, 1977 - 1991.