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The American Lobster, *Homarus americanus*, fishery in the Bay of Fundy (Lobster Fishing Areas 35, 36, and 38)

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ABSTRACT

The status of the lobster fishery in the Bay of Fundy (Lobster Fishing Areas (LFA's) 35, 36, and 38) is reviewed. Estimates of exploitation rate and levels of egg production per recruit (E/R) are presented. Projected impacts of conservation management changes currently in review are evaluated.

Landings have increased dramatically over the past two years and are well above average levels. The mean size of the catch in the upper bay has declined by about 10 mm (due to increased recruitment), but there has been no change in mean size in other areas where catches have been sampled. Because of the large number of pre-recruit lobsters appearing in at-sea samples, landings over 1000 t are expected to continue for several years.

A new analytical approach (length-based cohort analysis, LCA) generated lower estimates of exploitation rate than previous published estimates (based on moult-group comparison techniques). Current LCA estimates of exploitation rate range from 39-70%. A Bay of Fundy-wide exploitation rate was calculated for input into E/R analysis. For 1988-93 (stable landings period prior to recent increase) average exploitation rate was 53% (range 49 - 55%). Several options for doubling egg production per recruit in the Bay of Fundy are presented, using an exploitation rate of 53%, and a more conservative estimate of 70%.

RÉSUMÉ

L'état de la pêche au homard dans la Baie de Fundy (Zone de Pêche au Homard (ZPH's) 35, 36 et 38) est révisé. Des estimations du taux d'exploitation et des niveaux de production d'oeufs par recrue (O/R) sont présentées. Les impacts, résultants des changements dans la gestion de la conservation, sont évalués.

Les débarquements ont augmenté dramatiquement pendant les deux dernières années, et ils sont bien supérieurs aux moyennes. La taille moyenne des prises, dans la partie supérieure de la baie, a baissé de 10 mm environ (à cause de la hausse de recrutement). Cependant aucun changement dans la taille moyenne n'a eu lieu dans les autres zones dont les prises ont été échantillonnées. En raison du grand nombre de homards pré-recrues dans les échantillons prélevés en mer, les débarquements devraient rester supérieurs à 1000 tonnes pendant plusieurs années.

Une nouvelle méthode analytique (analyse par cohortes fondée sur la longueur, <<LCA>>) a produit à des estimations plus basses des taux d'exploitation, que ceux précédemment publiés (basé sur la technique de comparaison des groupe de mue). Présentement, les estimations des taux d'exploitation issus des <<LCA>>, varient de 39 à 70 %. Un taux d'exploitation pour l'ensemble la Baie de Fundy a été calculé pour être inclus dans les analyses O/R. Entre 1988-93 (période de débarquements stables avant la hausse récente) le taux d'exploitation moyen était 53 % (variation de 49 à 55 %). Plusieurs options, pour doubler la production d'oeufs par recrue dans la Baie de Fundy sont présentées en utilisant des taux d'exploitation de 53 %, et une estimation plus conservatrice de 70 %.

INTRODUCTION

The Fishery

In the Bay of Fundy, Canada, the American lobster (*Homarus americanus*) is a valued resource shared principally by lobster fishers from three lobster management units referred to as Lobster Fishing Areas or LFA' s (Fig. 1). Seasonal landings in the last full season for which data are available (1996/97) were worth $22.75 million dollars. Lobster fishing began in the Bay of Fundy in the mid 1800's and landings data exist from the 1890's (Williamson, 1992).

The fishery is managed under limited entry, size, and effort controls. There are a total of 319 full time licenses, 39 partnership licenses, and 7 part time licenses in the three LFA's. The number of participants, and trap limits vary among LFA's (Table 1A). With the present fishing season structure, which includes winter fishing off Grand Manan, lobsters are accessible to trap fisheries in various portions of the Bay of Fundy from Oct 15 to July 31 (Table 1B). There is a common 81mm carapace length (CL) minimum size, and a prohibition on landing egg-bearing females across the three LFA's.

During the early part of the fishery, management regimes evolved independently in each management unit (Appendix 1). This situation was not challenged by industry until the late 1970's when improvement in technology (such as hydraulic haulers, bigger and faster boats, loran C, etc.) changed the way that lobster fishing was conducted. Bay of Fundy lobster fishers began to fish in deeper water farther from shore and farther from their home port, thereby exploiting more of the available lobster grounds. Consequently, in 1986, outer boundary lines were established between LFA's (Figure 1, Appendix 1).

Shared boundaries between LFA's 34-38, and U.S. fishing grounds cover considerable distances due to the coastal physiography of the Bay of Fundy. This has resulted in contention over proposed changes in the management system of component LFA's, as well as concern over the impacts of changes in the management regime in Maine coastal waters. While historically the fisheries were restricted close to shore, fishing grounds have expanded both in the upper Bay of Fundy, along the New Brunswick shore, and in LFA 38. A small number of fishers from LFA 38 fish in deeper waters (to 205 m depths) over the winter months at the entrance to the Bay of Fundy (since the late 1970's), targeting the migratory movements of mature lobsters. Extension of fishing grounds off southern Grand Manan is also occurring.

Recent Management Issues

One of the continuing focal points in discussions on lobster management in the Bay of Fundy has been a series of demands, modulated over time, by LFA 36 fishers to extend their lobster fishing season, which is the shortest in the three LFA's (Table 1B). In response to these requests, several biological surveys and scientific assessments have been

undertaken (Campbell and Stasko, 1986; Campbell 1986a; Lawton and Robichaud, 1992a; Robichaud and Lawton, 1997). Although the most recent proposal included some compensatory mechanisms (e.g. v-notching) to offset potential increases in exploitation, none of these season change requests has been accepted by DFO management.

From the late-1980's, concerns have been raised by lobster fishermen on potential impacts on their fishery from coastal zone development and activities of other marine resource users, such as salmon aquaculture development (including the use of chemical theraputants to which lobster may be susceptible), dragging impacts from scallop, sea urchin, and groundfish fisheries, and changes in sedimentation related to proposed openings of causeways in the upper Bay of Fundy. These concerns have generated additional area-specific monitoring studies which have enhanced the regular fisheries monitoring programs.

However, the above issues have been preempted by the major conservation management issue currently being addressed in the Bay of Fundy lobster fishery, and other areas of Atlantic Canada. This issue is the development of additional stock conservation measures in light of the October 1995 review of the Atlantic lobster fishery by the Fisheries Research Conservation Council (FRCC, 1995). In their report, the FRCC concluded that under the current management regimes, lobster fishers generally were "taking too much, and leaving too little". Based on the scientific data available to the Council, they concluded that the current fishery is designed towards high exploitation rates, harvests primarily immature animals, and results in very low levels of egg production (estimated to be as low as 1-2% of what might be expected in an unfished population). While they accepted that lobster stocks have traditionally been quite resilient, they concluded that the risk of recruitment failure is unacceptably high.

Inshore lobster fishers which prosecute the "winter fisheries" (LFA's 33-38) are developing their response to a directive issued by the Minister of Fisheries and Oceans in December 1997, for Atlantic lobster fishers to set in place new management measures which will achieve a doubling in egg production. The timetable to respond to this directive for the winter fisheries is structured by the need to set new management measures in place for the earliest Fall fishery (LFA 35; October 15, 1998).

This lobster assessment reviews the status of the lobster fishery in LFA's 35, 36, and 38 as of the end of the 1997/98 season. Available information on historical catch levels, stock structure, recent trends in catch size composition and catch per unit of effort is summarized. Estimates of exploitation rate and estimated levels of egg production per recruit are presented, and projected impacts of conservation management changes currently in review are evaluated.

ASSESSMENT METHODOLOGY

Biological inputs

At-sea sampling: There are three main methods by which lobster biologists survey catches in lobster fisheries: port sampling, logbook records, and at-sea sampling. Of the three methods, at-sea sampling provides the most detailed information on lobster size-structure in the traps (including sub-legal, berried, and soft-shelled lobsters). As all lobsters retained in each trap haul are measured (carapace length, CL, in mm), biologists are able to convert the numbers caught into estimates of the catch rate of legal-sized animals by weight. An at-sea sampling program has been maintained in the Fall and Spring fisheries in LFA's 35, 36 and 38 since 1978. Emphasis was placed on maintaining an annual series at 4 representative ports. As local fishery issues were addressed (e.g. aquaculture development in Annapolis Basin; Lawton et al., 1995) additional area-specific sampling has been undertaken. For each trap haul made on a given day of sampling, the location, depth, and trap type are recorded. All lobsters retained in the trap are examined to determine size, sex, moult condition, and egg development stage for berried lobsters (criteria described by Robichaud and Campbell, 1991).

Fisher-supplied catch data: A new fishery-monitoring project was started in June 1997 in LFA 35. Participating fishers (3 in 1997) monitored the size structure of their catch at-sea using custom-made calipers sub-divided into 11 size categories, which may be combined to represent molt groups (see Figure 18 for details on size groups).

Research trapping studies: There have been numerous mark-recapture studies conducted in the Bay of Fundy to establish information on lobster movement (reviewed by Lawton and Lavalli, 1995; Robichaud and Lawton, 1997). A number of these studies have been conducted during closed seasons using a chartered lobster fishing boat to standardize trapping operations, and avoid the immediate recapture of lobsters by the commercial fishery. All tagging studies to date in the Bay of Fundy have been undertaken using sphyrion tags (Floy tag type: FTL69), inserted into the dorsal musculature between the abdomen and the carapace, using a hypodermic needle (as described by Campbell and Stasko, 1986).

Diving surveys: While at-sea trap sampling can provide significant information on the location of various segments of the lobster population, trap size-selectivity (e.g. Miller, 1990), behavioural interactions (e.g. Richards et al., 1983), and seasonal movement patterns (e.g. Robichaud and Campbell, 1991) interact to affect the sampled size distribution. From a lobster population perspective, there are two segments of lobster life history which are typically not well represented in trap catches: juvenile (sub-legal) lobsters, and berried females. Additionally, trap samples (whether from the fishery or research trap surveys) do not provide direct absolute estimates of lobster abundance, nor do they identify lobster:habitat relationships, except in the most general sense. Juvenile lobsters tend to occupy shallow subtidal habitats year-round. After their initial recruitment to the benthos they are subject to predation pressure, particularly from fish predators

(Wahle and Steneck, 1992), and remain cryptic (hidden) within shelters (Wahle and Steneck, 1991). Typically, they can only be censused by direct *in-situ* sampling techniques (Lawton and Robichaud, 1992b).

Three different bottom census techniques have been used to investigate lobster population characteristics in various areas of the Bay of Fundy from 1989 onwards. Belt transects (typically consisting of a 150 m weighted line) are deployed perpendicular to the shoreline, the shallowest end placed at approximately 3 m below the mean low water mark, extending out to a maximum depth of 14-20 m. Divers record all lobsters found within 1 m of either side of the line (for a total 300 m^2 of sea bottom searched). Lobster size and sex, moult stage and egg maturity stage on berried females are recorded on underwater slates. Records of lobsters captured are kept separately for each 25 m segment of the transect (the minimum sampling unit is thus 50 m^2); the primary and secondary substrate type, and depth range of each segment is also recorded.

Due to the presence of steep bottom slopes, high currents, or low visibility conditions, certain locations are not amenable to transect sampling. In these locations timed collection dives are made in which experienced DFO diver-biologists explore a general depth range, typically between 5 and 20 m, noting habitat characteristics, and measuring any lobsters encountered on the dive. These dives generate relative abundance estimates (expressed as catch per 60 min. search time) as opposed to absolute abundance estimates (expressed as number of lobsters per unit area) obtained from belt transect dives.

Air-lift suction sampling of small (0.25 m^2) quadrats set in juvenile nursery areas has been conducted in the Fundy Isles Region of the Bay of Fundy since 1990 (following techniques described by Wahle and Steneck, 1991) to document annual lobster settlement patterns. However, from 1996, diving-based studies have been reduced in the Bay of Fundy, due to the extension of these sampling techniques to other areas of the Maritimes under a DFO High Priority Research Program on lobsters. Emphasis in the Bay of Fundy has been on maintaining an annual time series on juvenile lobster abundance at a study site in LFA 36 (Beaver Harbour).

Landings and Fishing Effort Analysis

Trends in landings: Lobster landings data is accessed from Oracle database tables created by DFO's Marine Fisheries Division from data compiled by DFO Statistics Branch into the ZIFF (Zonal Interchange File Format) database. The ZIFF database includes lobster landings by Statistical District, (SD), port and date in a series of tables aggregated by year since 1989 (called Identified_catches_YYYY). In order to analyze seasonal trends in the lobster fishery a separate Oracle table (Lobland) has been created which combines data for all years since 1989 for LFA's 34, 35, 36, and 38, incorporating SD's 24 to 81 (Figure 2).

Determination of catch per unit effort is not yet possible as trap numbers are not routinely recorded in the inshore lobster fishery. However, various other effort measures can be derived from the existing data series, such as catch per boat by port, SD or LFA, for various

time periods. These analyses are compromised by certain landing data not being attributable to specific boats, but being aggregated to a port under a single code.

Interviews with lobster fishers: While there have been no Bay of Fundy-wide interview programs, area-specific studies have been conducted in recent years in portions of LFA 35: Annapolis Basin (Lawton et al., 1995), and Chignecto Bay/Minas Basin (1998; Lawton and Robichaud, unpublished). Questions covered the fishing background of the interviewees, and their general perspective on the local fishery including: distribution and extent of fishing effort in each season; expected catch rates; seasonal lobster movements; and, catch composition, including known concentrations of either under-sized or berried lobsters. Fishers were also asked to mark their fishing grounds on base maps of each locality. Subsequent to the interviews, composite maps were produced to derive generalized plots of lobster fishing activity.

Fishing Mortality and Exploitation Rate

Previous assessments of the Bay of Fundy lobster fishery, as was the case with most other lobster fishing areas, used molt group comparison methods to determine fishing mortality and exploitation rate (e.g. Lawton and Robichaud, 1992a). The 1996 Invertebrate Fisheries RAP recommended that a common method of determining Fishing Mortality (F) be used in future assessments. At this time, there were four methods in use the Length Cohort Analysis (Cadrin and Estrella 1996), a length-based method based on work by John Caddy (Caddy 1977), mark recapture methods and Leslie - Delury regression method (Miller and Mohn 1989). The latter two methods are not applicable to all areas but can be useful as a secondary method to verify results. The LCA was chosen as the common method of assessment because it uses all sizes and incorporates more information on growth and time at-size than the previously used length based methods, and has been routinely used in U.S. lobster fisheries assessments (Cadrin and Estrella 1996).

LCA was developed by Jones (Jones 1974; Jones 1981) based on Pope's (Pope 1972) cohort analysis which assumes that abundance at the end of year I can be estimated by the initial abundance (N_i), a half year of natural mortality (M), a mid year catch (C) and natural mortality for the remainder of the year.

$$\left(N_i e^{-0.5M} - C\right) e^{-0.5M} = N_{i+1}$$

Instantaneous mortality (F) can be estimated from a sequence of cohort abundance over several ages. The equation is arranged from oldest to youngest ages.

$$C_i e^{0.5M} + N_{i+1} e^{M} = N_i$$

Many species cannot be aged so an annual model cannot be applied. Jones (1974) modified the equation to include variable time intervals (Δt)

$$C_i e^{0.5M\Delta t} + N_{i+\Delta t} e^{M\Delta t} = N_i$$

Size distribution of landings was used to estimate the catch for the sequence of time intervals and von Bertalanffy growth parameters were applied to estimate the Δt. Since this method does not follow a single cohort over time, but instead assumes that the size frequency represents the abundance of a cohort over time, the method assumes constant

recruitment. In practice, however, this is not the case and estimates are generally based on the mean of several years. In conditions where the recruitment is trending down or up, as has been the case in the Bay of Fundy where recruitment is presently very high, such values should be used with caution..
The method was further modified by Cadrin and Estrella to include the time of the catch (T_c). This allows it to be varied from 0.5.

$$C_i e^{T_c M \Delta t} + N_{i+\Delta t} e^{M \Delta t} = N_i$$

They also incorporated a quadratic growth curve derived from molt increment and molt probability at-size to calculate Δt at-size.
The details of the method, sensitivity analysis and sample outputs are in Northeast Fisheries Center Reference Document 96-15 (Cadrin and Estrella 1996)

In the present assessments the method of deriving Δt was modified. Rather than calculating Δt at-size by fitting a quadratic growth curve derived from molt increment and molt probability at-size, Δt was obtained from the output of the Idoine-Rago Egg and Yield per Recruit program (22nd SAW Report). This program simulates the progression of a cohort through its life time. When the program is run with F=0.0 an output file produces a table of mean number of years at-size which can be used as the Δt's.

E/R Analyses

Female lobsters have a complex reproductive pattern and non-continuous growth which are not easily accommodated by the traditional dynamic pool models (Beverton and Holt 1957) The egg per recruit analysis is based on the size structured egg and yield per recruit model developed by Josef Idoine and Paul Rago (NMFS) and used in the SAW 22 assessment (Anonymous 1996). The model is based on an earlier work by (Fogarty and Idoine 1988).

The model includes size-specific annual molt increments and probabilities, proportion mature and egg bearing, fecundity and weight. The model runs on ¼ year time steps with growth, mortality, and fishing applied in the appropriate quarter. For example natural mortality is applied as hard shell mortality throughout the year and a soft-shell mortality at the time of molt in the fourth quarter. Fishing mortality is assigned to the appropriate quarter through the input parameters giving the proportion of the catch by quarter.

In lobsters, growth is a function of the molt increment and annual probability of molting. Molt increment is input as a distribution of increments at size based on tagging data results. Molt probability is based on observations of animals held in the lab at ambient Bay of Fundy temperatures (S. Waddy, unpublished) and tagging data (Campbell 1983; Pezzack 1990). Immature lobsters molted annually while mature lobsters had intermolt periods of 2 increasing to a maximum, of 4 years at large sizes. Maturity values were based on published and unpublished results using the pleopod method (Aiken and Waddy 1982) and ovary examination.

Maximum size and v-notch protection measures are incorporated into the model with an input parameter to specify the level of compliance by the fishing industry.

A more detailed description of the model is found in the 22nd SAW report and the Res. Doc. for the 1998 assessment of LFA 34 (Pezzack et al. 1999)

RESULTS AND DISCUSSION

Resource Status

General trends in landings: Lobster landings in the Bay of Fundy were first reported in 1892, on an annual basis. Landings peaked in 1895 at 1415 tonnes (t), then subsequently declined, over a 40-year period, to a low of 179 t in 1938 (Figure 3). From 1939 onwards, landings increased to a second peak of 897 t in 1953. In comparison with historical landings, current annual landings in LFA's 35 and 38 represent all time highs, while 1996 landings in LFA 36 are the highest this century (Figure 3).

It is more appropriate to compare contemporary landings in these fisheries on a Fall - Spring season basis, particularly as much of the catch is represented by lobsters which have molted into the first molt-group of the legal size during the previous summer. On a seasonal basis, for the Bay of Fundy as a whole, landings were relatively stable (between 491-897 t) from 1946/47 to 1974/75 (Figure 4). A post-war low of 296 t was reported in 1975/76; however landings rebounded to 545 t the following year, and began the current expansion phase.

For the fishing seasons 1987-88 to 1993-94, total landings from the Bay of Fundy appeared to have stabilized at approximately 1000 t (range 942-1046 t; Figure 4, Table 2). Over the next three years landings increased each year to 1865 t in the 1996-97 season. Total landed value (LFA's 35, 36, and 38) ranged from $6.5 million to $9.0 million between the 1988/89 and 1993/94 fishing seasons, then rose progressively to $22.8 million for the 1996/97 season. Fall 1997 landings, at $13.6 million were slightly above Fall 1996 value ($12.9 million).

The landings reporting system changed in 1995 (from collection of sales slip information to self-reporting logbooks), and so reporting differences may confound these recent landings increases. Nonetheless, this recent pattern of overall landings stability, with evidence of further potential increase, matches landings seen in LFA 34 and the US portion of the Gulf of Maine (Maine and Mass.) (Pezzack et al., 1998).

Area-specific trends: On a percentage basis, the contribution of the three LFA's has varied significantly over the last 50 years (Figure 4). LFA 38 represented approximately 50% of the total landings during most of the period, but currently ranks below LFA's 35 and 36 in seasonal landings.

The new capability to access the ZIFF database permits more detailed analysis of landing trends from the 1989/90 season onwards. Still under development, new query tools permit analysis at a variety of levels from SD to port to vessel on a daily, weekly, monthly and seasonal basis. Our initial exploration of these tools revealed several weaknesses in the

current statistical reporting system, and for this reason we include only a few sample analyses.

Of interest is the extent to which the recent surge in landings in LFA's 35 and 36 represent widespread increases. An intermediate level of analysis is to group data by general coastal areas of the Bay of Fundy, and examine the percentage increase in landings in each year relative to the reported landings in 1989/90 (the first full fishing season for which data is available in the ZIFF database).

Thus, for the lower Bay of Fundy landings for the Fundy Isles (SD 51, 52, 53) showed a progressive increase over 1989/90 landings, to >350% increase by 1996/97 (Figure 6). In comparison, landings from Grand Manan (SD 50) did not increase more than 50% over 1989/90 levels in any season, and were only marginally above the 1989/90 season in 1996/97 (see also Table 2).

Landings in the mid-Bay, along the open coastal stretches of SD's 48 and 49 on the New Brunswick shore, and 35 and 38 on the Nova Scotia shore (but including Annapolis Basin, SD 39) did not increase by more than 50% over 1989/90 levels until the 1995/96 season. For Nova Scotia, landings were below 1989/90 levels in 1992/93 and 1993/94. During these seasons a detailed study of the Annapolis Basin fishery was conducted (Lawton et al., 1995) and further at-sea monitoring is now underway. For the last full season (1996/97), landings were up 100% and 226% on the New Brunswick and Nova Scotia sides of the Bay, respectively.

In the Upper Bay of Fundy, reported landings declined initially from 1989/90 levels in both the Chignecto Bay area (SD's 24, 79, 81) and Minas Basin area (SD's 40, 41, and 44). Landings in these areas (which includes fishing prosecuted outside Chignecto Bay and Minas Basin themselves), have since increased substantially, particularly in the Minas Basin area, where landings are now 250% above 1989/90 levels. The landings analysis for the Chignecto Bay area revealed a significant drop in landings for certain ports during the review period which does not compare with local monitoring and interviews with fishers (see issues and uncertainties, below).

This intermediate level of analysis masks some dramatic changes in reported landings, as for example in SD 52 (Passamaquoddy Bay) where reported landings ranged between 1.31 and 2.8 t from 1989/90 until 1995/96 when they rose to 11.06 t and then to 50.11 t in 1996/97. Such dramatic changes at the SD level may be due to reactivation of licenses, shifts in port of landing by specific boats, improved reporting of catches previously not reported on sales slips, mis-reporting of landings, or a combination of these factors.

Another use of the ZIFF database is to document landings by component ports within SD's and/or LFA's to determine their relative contribution to overall landings, both within season, and for the season as a whole. This information is relevant to determining how representative fisheries sampling data may be of the LFA, and designing sampling strategies to improve data input to cohort analyses.

Grand Manan (LFA 38) is useful for documenting this approach as it represents one SD, with only 4 fishing ports, and a stable pattern of landings over the period 1989/90 to 1996/97 (Figure 7; Table 2). Although the maximum increase in total LFA landings was approximately 40% in 1994/95 (over 1989/90), landings reported from North Head were up >80% for the last three seasons in the analysis (Figure 7). This fishery originally represented approximately 10% of LFA 38 landings, but accounted for approximately 20% in 1996/97 (Figure 7). The at-sea sampling program for LFA 38 has targeted this fishery (particularly the segment which fishes in the deep-water entrance to the Bay of Fundy), and Seal Cove. Whereas Seal Cove represented 35% of the landings in 1989/90, it has since dropped to between 20 and 25%.

Seasonal trends in Bay of Fundy lobster landings have been documented previously (e.g. Robichaud and Campbell, 1991), particularly the high contribution of landings in the first few weeks of the Fall season, and last few weeks of the Spring season to total landings. We can now undertake such analyses on a routine basis. Of significance for LFA 38, and for later interpretation of at-sea sampling data, over the fishing seasons 1989/90 to 1996/97 landings in November and June represented 45.4% (1.7% SE), and 15.2% (0.6% SE) of total reported landings in each fishing season.

Issues and uncertainty: Prior to 1998 we had no capability to easily interrogate data on Bay of Fundy lobster landings in order to analyze area- and time-specific trends. Our preliminary exploration of the ZIFF database has yielded some anomalous reports (e.g. outliers in landings per boat for certain ports; reduced catch reports in 1994/95 and 1995/96) which need to be further investigated. An obvious major omission in the available data is the number of trap hauls that contribute to reported landings. With the development of appropriate tools to detect outliers in the data it should be possible to follow trends in catch rates over time, at least in terms of landings per boat per specified time period.

In meetings with Bay of Fundy fishers it has been noted that some of the shifts in effort applied to lobster are related to the relative performance of other fisheries in the Bay of Fundy, as a number of fishing enterprises hold multiple licenses. Access now available to the ZIFF database would allow some comparative analyses to be undertaken, but requires a clear definition of the areas, time periods, and gear sectors that may be interrelated.

Stock Structure

Lobster production characteristics: While a portion of the Bay of Fundy fishery is reliant on lobsters migrating into fishing areas at different times of the year there are, nonetheless, centres of benthic lobster production in the Bay, as evidenced by the presence of juvenile lobsters in the trap fishery, and in benthic biological censuses (e.g. Lawton et al., 1995, Lawton and Robichaud, unpublished data). Examples of these areas are southern Grand Manan (Figures 8 and 9), and the Fundy Isles/S.W. New Brunswick coastal area (Figures 10, 11, and 12). Historically, the fishery in the upper Bay of Fundy was considered to be principally reliant upon seasonal immigration of later benthic stages of lobsters (e.g. Robichaud and Campbell, 1991). However, fisheries monitoring during the 1990's, principally in the Alma area, has documented a dramatic change in trap size-frequency

distribution which suggests that local benthic production in the upper Bay has increased (Figures 13 and 14).

Major diving surveys on inshore lobster habitats were conducted in the Fundy Isles Region of the Bay of Fundy between 1989 and 1993. The presence of significant numbers of small juvenile lobsters in shallow water habitats there indicated a lobster nursery area function (*sensu* Lawton and Robichaud, 1992b). Additionally, in certain inshore locations within the Bay of Fundy, for example North Head, St. Martins and Alma, N.B., seasonal aggregations of berried female lobsters have been documented. Information on these inshore lobster spawning areas (*sensu* Lawton and Robichaud, 1992b) has been obtained both by trap sampling (Robichaud and Campbell, 1991; Campbell, 1990), bottom trawl survey (Lawton and Robichaud, unpublished data), and by direct diving observations (Campbell, 1990; Lawton and Robichaud, 1992b; unpublished data).

Lobster movement: Recent results on lobster movement in the Bay of Fundy (Lawton et al. 1995; Robichaud and Lawton (1997) are consistent with those obtained in earlier tagging studies (Campbell 1986b; Campbell and Stasko 1985, 1986) which demonstrate substantial mixing throughout the Bay of Fundy, and along the Maine coast. The total percentages of tag returns in the various tagging studies varied between 13% and 20%.

Fishing effort and catches are not uniformly distributed, spatially or temporally (Pezzack 1987). Thus, to better reflect fishing pattern and seasonality of lobster movement, movement data in recent studies have been analyzed by recapture periods when distinct fisheries in the Bay of Fundy were open, rather than by time at large, *per se*. A total of 3010 lobsters were tagged and released near St. Martins, N.B., in the northeastern part of LFA 36 during July 1992, shortly after the close of the spring season (Robichaud and Lawton, 1997). As of July 31, 1994, 459 lobsters had been recaptured (15.3%). Lobsters migrating into the northeastern portion of LFA 36, in July, did not simply move inshore to reside over summer. A portion of the population actively migrated further up the shore at average rates of 1.4 km/day and appeared in catches of the adjacent LFA 35 fishery, which was still open during the tagging study. In subsequent fall, winter and spring fisheries, from 1992 to 1994, lobsters initially tagged in LFA 36 appeared in the lobster catches from LFA's 34-38, as well as along the north-eastern US coast.

Bay of Fundy lobsters exhibit high dispersal rates. Long term movement rates of 1.2 km/day over a period of 454 days (15 mo.) were reported by Robichaud and Lawton (1997). Distances and rates of movement calculated over a long period of time can be misleading without understanding the dynamics of seasonal migration (Lawton and Lavalli 1995). For example, one of our multiple recaptures shows that after release in July, 1992, one lobster remained a relatively short distance (16 km) from the release site until November 4, 1992, when it was first recaptured. However, when recaptured a second time (on December 28) this lobster had traveled a distance of 152 km in 55 days (2.8 km/day).

Issues and uncertainties: While there are centers of local production (benthic settlement and growth of lobsters), much of the Bay of Fundy lobster fishery has developed over time to capitalize on well marked seasonal and long distance movements of legal-size lobsters

(Robichaud and Campbell 1991; Campbell and Stasko 1986). The Bay of Fundy lobster fishery has been stable over time (compared to some other lobster fishing areas), and in the recent phase of the fishery (from the late 1980's) has shown a sustained high level of landings, and potential for further increase. However, the degree to which the Bay of Fundy is reliant upon adjacent areas for larval production remains unclear. A number of historical studies did not consider the area to be very favorable for local larval production due to relatively cold summer water temperatures, though benthic censuses and other fisheries monitoring from 1989 onwards has verified there to be significant current levels of benthic settlement. There is a need to correlate the recent research findings on benthic settlement in the Bay of Fundy with environmental data on long-term temperature conditions.

The general conclusion from the available scientific studies on the Bay of Fundy lobster fishery is that it should be considered to be a component of a Gulf of Maine lobster metapopulation. The degree to which it represents a source of larval production for adjacent areas (such as the Maine coast), or a sink (receiving the benefits of larval production occurring outside the Bay of Fundy) is not known. There is a need to increase the capability of physical and biological oceanographic models of the Gulf of Maine system to model the Bay of Fundy as an integral component of the system.

Catch size structure

Trends in lobster size distribution: At-sea sampling has been conducted over a 20-year period at four major ports in the Bay of Fundy. Samples are generally available from the first two weeks of the Fall season, and from the last two weeks of the Spring season. As noted earlier, these periods represent the bulk of each season catch (e.g. approx. 60% on Grand Manan). Robichaud and Campbell (1991) summarized the initial sea sampling program design, and reported on catch size composition up to the 1988/89 fishing season. In this assessment document we provide annual size composition data from the 1990/91 season to date (i.e. June 1998 samples for LFA's 36 and 38).

For Seal Cove (LFA 36), annual sampling has indicated a stable size frequency, with mean sizes in the sampled catch ranging from 77 - 85 mm CL (Figures 8 and 9; Figure 19). In Fall sea samples very few berried females have been noted in the traps (0.8$\pm$ 0.3 (SE) berried females per 100 trap hauls over a 17 year period). Despite the move to include escape panels in lobster gear, pre-recruit lobsters are still retained in the traps and recent observations (June 1998) show a continued strong representation of prerecruit lobsters.

Fishery samples from Dipper Harbour (LFA 36; Figures 10 and 11) show a broader range of size classes of lobster, both in pre-recruit sizes (<81mm CL), and larger lobsters beyond the first molt group in the legal size range (81-94mm CL). Berried females are represented in the time series (17 years) at a slightly higher level (2.9$\pm$0.5 berried lobsters per 100 trap hauls) than in Seal Cove. A progressive increase in pre-recruit presence in the sampled catch is indicated for samples taken in June, such that the latest sample contains the highest number per trap haul (Figures 11, and 19) in the series.

Based on fishery sampling in the 1980's, Robichaud and Campbell (1991) characterized the size frequency of lobsters caught in various specific areas of the Bay of Fundy. They concluded that two fisheries (upper bay fishery in Chignecto Bay and Minas Basin areas; deep-water fishery at the entrance to the Bay of Fundy) were principally reliant on intercepting seasonal migrations of larger, mature lobsters, rather than capitalizing on local annual production of new recruits.

In the time series presented in this assessment, the mean size of lobsters sampled in Alma in the 1990/91 season was 93 and 100 mm CL in Fall and Spring samples. At the start of this series biologists measured between 1.5 and 2 lobsters per trap haul. Through the time period there has been a downward shift in mean size of lobster sampled (to 84 and 88 mm CL in July and October 1997, respectively), and an increase in the catch rate, both of pre-recruits, and the first molt group (Figures 13, 14, and 19). Current at-sea samples in the Alma area may yield 10 lobsters per trap haul. The increase in pre-recruit abundance is seen most clearly in the Spring season samples (Figures 13, 14) where the catch size composition is now similar to that in Seal Cove and Dipper Harbour. Results from the new fisher-supplied catch monitoring are consistent with this data (Figure 18).

In contrast to sea sampling in Dipper Harbour and Seal Cove (which is conducted in November), fishery sampling in October in Alma intercepts berried female lobsters at a substantially higher rate (21.3$\pm$3.5 berried lobsters per 100 trap hauls; 19 year series)

The final long-term time series, from North Head (LFA 38), is from a very different fishery which has a number of parallels to the midshore and offshore fisheries in LFA's 34 and 41 (in terms of fishing strategies, soak days, winter fishing period, and lobster size distribution). The average size of lobsters has ranged from 115 to 123 mm CL in Fall sampling, and 127 to 130 mm CL in Spring sampling over the period 1990 to 1998 (Figures 15, 16). Catch rates of berried females in the Fall sampling period are comparable with those seen off Alma (25.7$\pm$4.3 berried lobsters per 100 trap hauls; 17 year series).

Based on the occurrence of berried females in the at-sea sampling series from three ports over the period 1978 to 1997, an apparent shift in the average size of berried females has occurred (Table 4, Figure 17). Although sample sizes were 4 to 6 times greater for the period 1978-82 than for more recent time periods, the sample size range is comparable (Table 4). The mean size has decreased by approximately 8 mm, and there are now higher percentages of berried female lobsters in the first two molt groups. These data require further interpretation, particularly in light of recent studies on lobster maturity in the Bay of Fundy (S. Waddy, unpublished), and persistent reports by lobster fishers of smaller berried female lobster in trap catches. For example, two of the fishers in the new monitoring program in LFA 35 recorded berried female lobsters below minimum legal size during June 1997 monitoring.

Fisher-supplied information on catch size structure: Three logbooks were completed by LFA 35 fishers operating in Minas Basin (2 boats), and off Advocate Harbour (1 boat) during June 1997. The size and sex distribution of lobsters, including sub-legal animals and berried females was recorded on 9 to 11 fishing trips. The number of trap hauls sampled on

a given day ranged from 12 to 80, for a total of 1130 trap hauls and 4,051 lobsters measured by the three fishers during the month.

Although not analyzed in detail in this assessment cycle, this fisher-supplied information fills three important gaps in the present fisheries monitoring program:

1. Temporal sampling of catches during periods of the season when catch rates are relatively low, and it is cost-prohibitive to send out scientific observers;

2. Increased spatial coverage that has the potential to allow better interpretation of seasonal movement of lobsters into fishing areas;

3. Participation by fishers in the scientific assessment.

The fishers were unable to continue this level of sampling into the final month of their Spring season, and it would be impractical to expect them to undertake detailed monitoring at the opening of the Fall season. For comparison, science at-sea monitoring in Alma in July 1997 measured 790 lobsters in 167 trap hauls on a single day.

This program is being expanded in June 1998 to include a total of 6 fishers in the Upper Bay of Fundy, who in addition to monitoring their commercial gear, will also be monitoring catches in a research trap designed to intercept juvenile lobsters.

Trends in CPUE: For the Bay of Fundy there is no comprehensive logbook program in place which monitors fishing effort, and long-term trends in CPUE are available only from the at-sea monitoring program, and area-specific interview data. The new monitoring program in LFA 35 has provided some new information on catch rates, and as the program expands will provide an important source of additional information. The available data shows either a stable CPUE (in terms of Kg per trap haul), or general increase over time. Where index fisher logbook programs have been introduced (in other fishing areas) it is clear many factors influence in-season catch rates (e.g. temperature effects, non-linear relationship to abundance etc.).

Issues and uncertainty: Fisheries monitoring data in the Bay of Fundy is limited in area coverage, but contains several long-term series which have identified important shifts in the size distribution of lobsters, particularly in the upper Bay. A series of detailed fisheries monitoring and biological research studies were conducted in the Bay of Fundy in the late 1970's/early 1980's, a level of program activity which could not be maintained throughout the later 1980's/early 1990's. Nonetheless, a number of additional surveys were conducted during this period, in particular diving and research trapping-based studies, which provide a baseline on population size distribution and abundance against which current fisheries information may be indexed.

F and exploitation rate

Length-based cohort analysis (LCA): Application of the LCA approach for LFA 35 to 38 generated substantially lower estimates of F and exploitation rate (A) than were provided in earlier fishery assessments (Lawton and Robichaud, 1992a) and used by the FRCC in their review of the Atlantic lobster fishery (FRCC, 1995). The molt group comparison techniques used in those assessments provided exploitation rate estimates in the range 60-85%. Current estimates of exploitation rate (A) from LCA range from between 39 - 70% for LFA 35, 49-56% for LFA 36, and 54-66% for LFA 38 (Table 3; Figure 21). Using the available size frequency data for the three LFA's, and reported landings, a combined Bay of Fundy LCA was conducted yielding new estimates of exploitation rate in the range of 49-63% over the period 1988 to 1995 (Table 3).

As with all length composition analyses, LCA is sensitive to changes in size structure due to changes in recruitment level, which may bias the estimates of exploitation rate. Thus the increase in exploitation rate in LFA 35 in 1994 and 1995 should be interpreted with some caution (Figure 21). The pattern of fishing mortality and exploitation rate generated by these analyses for the period 1988 to 1993, when landings were more stable for the Bay of Fundy, were used in the calculations of egg per recruit and the impacts of proposed management changes. For the period 1998 to 1993 average exploitation rate for the Bay of Fundy-level analysis was 53%.

Issues and uncertainty: While LCA has been used routinely in US lobster assessments, the current assessment cycle represents its first widespread application in Canadian lobster fisheries. The existing sampling of length composition in most lobster fisheries is limited. For the current assessment it was not possible to break the landings data down much beyond the LFA level, and single samples of length frequency from at-sea samples were used to model Fall and Spring landings data.

However, comparison of the LCA results with those from other F estimation approaches (Leslie analysis, molt group comparison, mark-recapture studies) in other LFA's (Tremblay and Eagles 1998) has indicated some robustness and comparability in the estimates. The lower F and A estimates for the Bay of Fundy are consistent with general results from the first application of the LCA approach in other lobster fishing areas.

Further work needs to be undertaken to determine the appropriate spatial and temporal resolution of catch size structure needed to accurately translate landings to estimates of removals from the fishable stock. The recent ability to access the landings database at a finer scale of resolution will be an important tool in refining fishery-sampling strategies, though uncertainties in landings data quality need to be investigated. Additionally, the requirement to be able to sample catches in a cost-effective manner needs to be addressed. The use of fisher-supplied information, as in the new program in LFA 35, as input into cohort analysis needs to be evaluated.

Egg per Recruit Analyses

Present status: Due to uncertainty in the measurement of exploitation rates, E/R analyses were conducted for a range of exploitation rates. At the present minimum size of 81 mm CL and exploitation rates between 53% and 70%, E/R in the Bay of Fundy ranges from 1.3% to 0.36% of virgin population E/R. In terms of egg numbers, these scenarios yield between 990 and 276 eggs per recruit (Table 5).

Under new management scenarios: Changes in E/R are presented for two exploitation rate scenarios: 53% (based on LCA), and 70% (a high level, based on previous molt group comparison estimates). Incorporation of this high estimate of exploitation rate provides management and industry with an indication of the robustness of some management approaches (in some approaches E/R is doubled under both scenarios). To achieve a doubling of E/R, significant increases in minimum size (adopting this as the sole approach) would be required, beyond 86 mm CL, which by itself provides only an approximate 50% increase at an exploitation rate of 53% (Table 5; Figure 22). Management measures that would include a move to the current US minimum size, 83 mm CL, will require additional measures (e.g. maximum size regulations; v-notching) to achieve the target doubling (Table 5; Figure 22).

These (and other) management scenarios will lead to a loss of catch by certain sectors of the Bay of Fundy fleet, at least on an interim basis, and this will form the basis of significant discussion with industry. Table 6 indicates the catch composition by weight, for specified size ranges of lobsters, observed in the most recent at-sea fishery sampling (Fall 1997/Spring 1998 for LFA's 36 and 38; Spring 1997/Fall 1997 for LFA 35). It is important to note that this analysis is based on the catch sampled on a single day of fishing in each location. With the exception of the North Head fishery, female lobsters greater than 127 mm CL, and 133 mm CL, represented less than 2% by weight. For North Head the percent by weight of females over 127mm CL represented 45% and 2.8% in Spring and Fall samples (Table 6).

Lobsters between 81 and 83 mm CL ranged from not being part of the sampled catches of North Head fishers to a high of approximately 20% by weight for fishers sampled in Seal Cove and Wood Point (Table 6). In other fishing ports this size group of lobsters represented between 10 and 12% of the catch.

Issues and uncertainty: The analyses presented in this assessment are based on a more recent formulation of the E/R model than that used as the basis for the initial recommendations for management change presented by the FRCC (FRCC, 1995). Among the issues and uncertainties are:

1. The reduction in exploitation rates were calculated using the LCA. There will be uncertainty as to the validity of these estimates, and risk associated with the fact that the reduced estimates of fishing mortality lead to greater projected E/R benefits and change the value of the conservation measures.

2. Appropriate time scales and magnitude of credit for specific stock conservation measures (e.g. minimum size, maximum size, and v-notching), both for the Bay of Fundy fishery as a whole, and for specific fleet segments.

CONCLUSIONS

Outlook

The short-term outlook for the Bay of Fundy is for sustained landings well above 1000 t, based on recent landed catch trends and evidence of continued high levels of pre-recruit abundance in the commercial trap sampling program. While landings in LFA 35 and 36 are increasing, landings from LFA 38 appear more stable.

The apparent stability of the Bay of Fundy lobster fishery, recent increase in landings, and recruitment pulse in the Upper Bay need to be better understood in the context of the Gulf of Maine lobster population as a whole before long term projections on landings may be made.

Management Considerations

Consultations have been ongoing with Bay of Fundy lobster fishermen since the release of the FRCC report in October 1995 through direct mail-out of interpretive documents, community-level meetings, discussions at regular Lobster Advisory Committee meetings, and cross-LFA working group meetings. Further consultations are planned for late summer 1998, which will lead to the preparation of a 3 to 4 year conservation harvesting plan which the Minister of Fisheries and Oceans has directed should achieve a doubling of egg production.

Current scenarios, which will achieve this target, include substantial increases in minimum size (when used as a single measure), or a series of measures (e.g. a more modest minimum size increase and a maximum size regulation). As shown in Appendix 1, minimum and maximum size regulations have varied in the fishery, particularly in the 1930's and 40's. The current minimum size has been unchanged since 1951.

Given the size composition of lobsters in the catch, and the existence of particular segments in the fleet which actively target (or routinely intercept) the season movement of mature lobsters, some of the proposed conservation measures, particularly maximum size will have substantial impacts on particular fleet segments.

General issues and uncertainty

Resource management of lobsters in the Gulf of Maine is complicated by structural complexity inherent in the lobster population itself, and that imposed by multiple management jurisdictions (2 Canadian Provinces; Federal inshore and offshore management areas; state and federal jurisdiction in the US portion of the Gulf of Maine).

The relative importance of intrinsic and extrinsic larval production to the Bay of Fundy is not known, but available evidence from oceanographic modeling and benthic studies on movement demonstrates that management of these three LFA's will affect, and be affected by management change in adjacent areas.

The Bay of Fundy lobster fishery appeared to have reached a relatively stable (+/- 50 t) high level harvest of ca. 1000 t from the late 1980's to mid 1990's. Though perhaps modulated by changes in harvest reporting, and possible over-reporting, there appears to be a significant additional recruitment pulse which is challenging previous assumptions that the Bay of Fundy is a marginal area for lobster production due to its cold water regime. Additional research is required to correlate these recent landings trends with environmental conditions, and potential linkage with the wider Gulf of Maine lobster population.

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Table 1. Elements of the lobster fishery management regime in the Bay of Fundy (LFA's 35, 36, and 38). (A) Number of license holders by license category and trap limits per license. (B) Fishing season opening and closing dates.

(A)

LFA	License details	A licenses (full time)	Partnership (full time)	B licenses (part-time)
35	Number	93	-	4
	Trap limit	300	-	90
36	Number	149	9	2
	Trap limit	300	450	90
38	Number	77	30	1
	Trap limit	375	563	113

(B)

LFA	Fall season opening date	Fall season closing date	Spring season opening date	Spring season closing date
35	Oct. 15	Dec. 31	April 1	July 31
36	2nd Tues. in Nov.	Jan 14	March 31	June 30
38	2nd Tues. in Nov.	Open through winter	Open through winter	June 30

Table 2. Landings series for the last 10 complete fishing seasons in the Bay of Fundy.

Seasonal* Landings (t)

Season*	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97
LFA 35	262	270	254	228	254	239	241	311	546	720
LFA 36	340	309	222	271	249	257	274	317	421	642
LFA 38	383	467	466	496	512	471	523	648	600	503
Total	985	1046	942	995	1015	967	1038	1276	1567	1865

*Fall to subsequent Spring fishery

Table 3: Cohort F (F) and exploitation rate (A) estimates from length-based cohort analyses for LFA's 35, 36, 38, and all three areas combined (Bay of Fundy) for 1988 to 1995.

	35		36		38		Bay of Fundy	
Yr	F	A	F	A	F	A	F	A
88	0.60	0.45	0.81	0.56	0.91	0.60	0.78	0.54
89	0.50	0.39	0.67	0.49	0.94	0.61	0.68	0.50
90	0.75	0.53	0.77	0.54	0.93	0.60	0.83	0.56
91	0.67	0.49	0.82	0.56	0.77	0.54	0.74	0.52
92	0.50	0.39	0.81	0.56	0.86	0.58	0.73	0.52
93	0.61	0.45	0.66	0.49	1.01	0.64	0.80	0.55
94	1.21	0.70	0.77	0.54	1.08	0.66	1.00	0.63
95	1.20	0.70	0.82	0.56	0.98	0.62	0.97	0.62

Table 4. Frequency distribution information for berried female lobsters sampled during at-sea sampling program in the Bay of Fundy, 1978 - 1997. Frequency distributions presented graphically in Figure 17. Samples are pooled from the ports of North Head, Alma, and Dipper Harbour over 5-year periods.

	Sample period			
Variable	1993-97	1988-92	1983-87	1978-82
Number in sample	963	1177	2073	6254
Mean CW (mm)	116.8	116.4	125.0	123.8
Min. CW (mm)	82	83	87	85
Max. CW (mm)	197	185	193	197
% 81-93 mm CW	3.6	1.3	1.0	0.2
% 94-109 mm CW	34.3	30.3	16.1	14.4
% > 109 mm CW	4.4	2.0	8.0	6.4

Table 5. Change in E/R under different scenarios of conservation regulation change in terms of minimum and maximum carapace length, and target rates of v-notching.

Management measures			E/R as % virgin (%V), and % increase (%inc) over current regulations at various exploitation rates (A)					
Minimum Size	Maximum Size	V-notch	A = 53%		A = 65%		A = 70%	
			%V	%inc	%V	%inc	%V	%inc
81	(current regulation)		1.30	0%	0.54	0%	0.36	0%
81	127		2.83	118%	1.02	89%	0.63	75%
81		25	1.55	19%	0.68	26%	0.46	28%
81		50	1.87	44%	0.86	59%	0.61	69%
81	127	15	3.23	148%	1.25	131%	0.8	122%
81	127	25	3.51	170%	1.42	163%	0.93	158%
81	133	15	2.43	87%	0.93	72%	0.6	67%
81	133	25	2.69	107%	1.08	100%	0.71	97%
83			1.52	17%	0.66	22%	0.46	28%
83	127		3.34	157%	1.26	133%	0.81	125%
83	133		2.42	86%	0.91	69%	0.58	61%
83		25	1.82	40%	0.83	54%	0.58	61%
83		50	2.20	69%	1.06	96%	0.77	114%
83	152	15	1.85	42%	0.79	46%	0.55	53%
83	152	25	2.05	58%	0.9	67%	0.62	72%
86			1.93	48%	0.91	69%	0.65	81%
86	133		3.08	137%	1.67	209%	0.84	133%
86		15	2.15	65%	1.04	93%	0.75	108%
86		25	2.31	78%	1.14	111%	0.83	131%
86		50	2.78	114%	1.46	170%	1.09	203%
88			2.26	74%	1.13	109%	0.83	131%

Table 6. Percent composition by weight of various sizes of lobsters sampled at sea during the fishing season 1997/98. For 81, 82, and 83 mm CL lobsters data is presented as percent by mm class, and for the group 81-83 mm CL. For larger-sized lobsters data is presented as percent by weight for that size and larger (e.g. 127 mm CL females and greater).

Size Group	Alma		Dipper Harbour		North Head		Scotts Bay		Seal Cove		Victoria Beach		Wood Point	St. Martins
	Jul-97	Oct./97	Jun-98	Nov../97	Jun-98	Nov../97	Jul-97	Oct./97	Jun-98	Nov../97	Jul-97	Oct./97	Oct./97	Jun-98
81 mm	2.7	3.2	6.3	2.9	0.0	0.0	3.2	2.0	6.9	8.7	3.2	5.8	6.6	4.8
82 mm	3.7	4.2	4.1	3.6	0.0	0.0	3.4	3.3	7.9	8.5	2.2	7.0	7.6	2.1
83 mm	3.8	4.1	1.8	4.2	0.0	0.0	5.2	3.8	5.0	6.4	2.4	5.1	5.9	1.1
81-83 mm	**10.2**	**11.6**	**12.7**	**10.7**	**0.0**	**0.0**	**11.7**	**9.1**	**19.8**	**23.6**	**7.8**	**17.9**	**20.1**	**8.0**
>5" Fem (127 mm)	0.0	0.7	0.9	0.9	45.0	2.8	0.0	0.7	1.6	0.0	0.0	0.0	0.0	0.0
>5" Male (127 mm)	2.9	1.4	1.8	1.6	15.4	37.1	0.0	2.4	0.0	1.7	4.8	1.2	0.0	8.6
>5" M+F (127 mm)	**2.9**	**2.0**	**2.7**	**2.5**	**60.4**	**40.0**	**0.0**	**3.1**	**1.6**	**1.7**	**4.8**	**1.2**	**0.0**	**8.6**
>5 1/8" Fem (133 mm)	0.0	0.5	1.8	0.8	12.4	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
>5 1/8" Male (133 mm)	1.0	0.0	0.0	0.8	39.3	32.3	0.0	2.0	0.0	1.7	0.9	1.2	0.0	3.7
>5 1/8" M+F (133 mm)	**1.0**	**0.5**	**1.8**	**1.6**	**51.7**	**33.2**	**0.0**	**2.0**	**0.0**	**1.7**	**0.9**	**1.2**	**0.0**	**3.7**
> 6" Fem (152 mm)	0.0	0.0	1.8	0.0	4.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
> 6" Male (152 mm)	0.0	0.0	0.0	0.0	19.1	21.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
> 6" M+F (152 mm)	**0.0**	**0.0**	**1.8**	**0.0**	**23.8**	**21.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
6.5" Fem (165 mm)	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.5" Male (165 mm)	0.0	0.0	0.0	0.0	11.4	8.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.5" M+F (165 mm)	**0.0**	**0.0**	**1.8**	**0.0**	**11.4**	**8.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Figure 1. Bay of Fundy LFA's with approximate boundaries. LFA 37 is a buffer zone between LFA's 36 and 38.

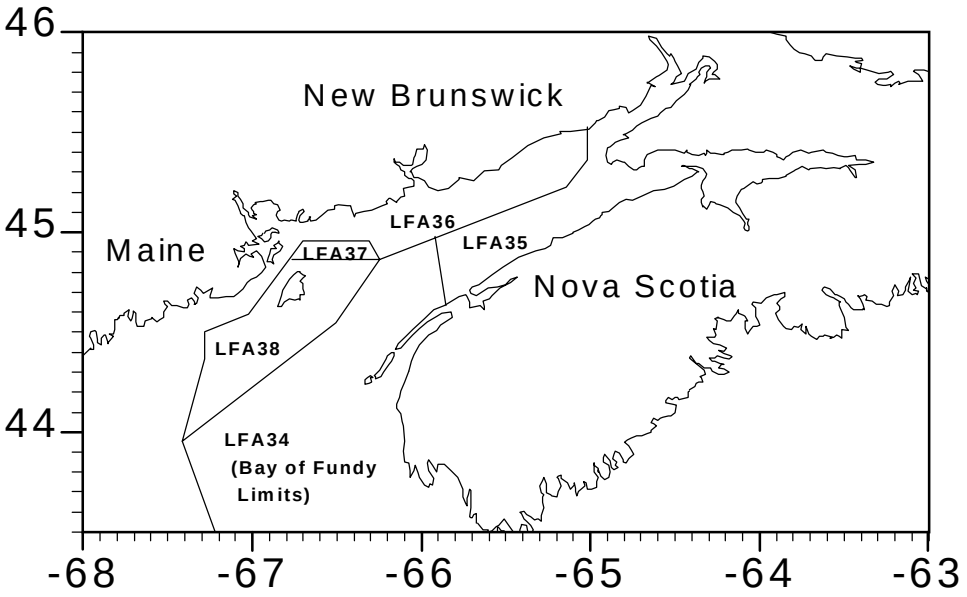


Figure 2. Statistical District Boundaries in the Bay of Fundy.

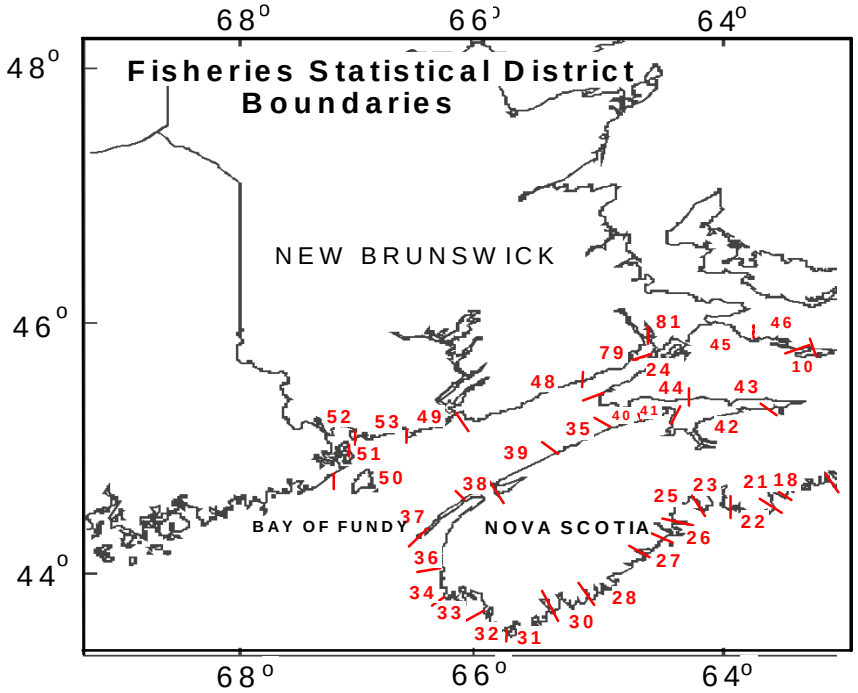


Figure 3. Historical landings from the Bay of Fundy (LFA's 35, 36, and 38). Data presented as annual landings from 1892 to 1996. Notes: Landings data are missing from some LFA's for early years of the fishery. See Williamson (1992) for details.

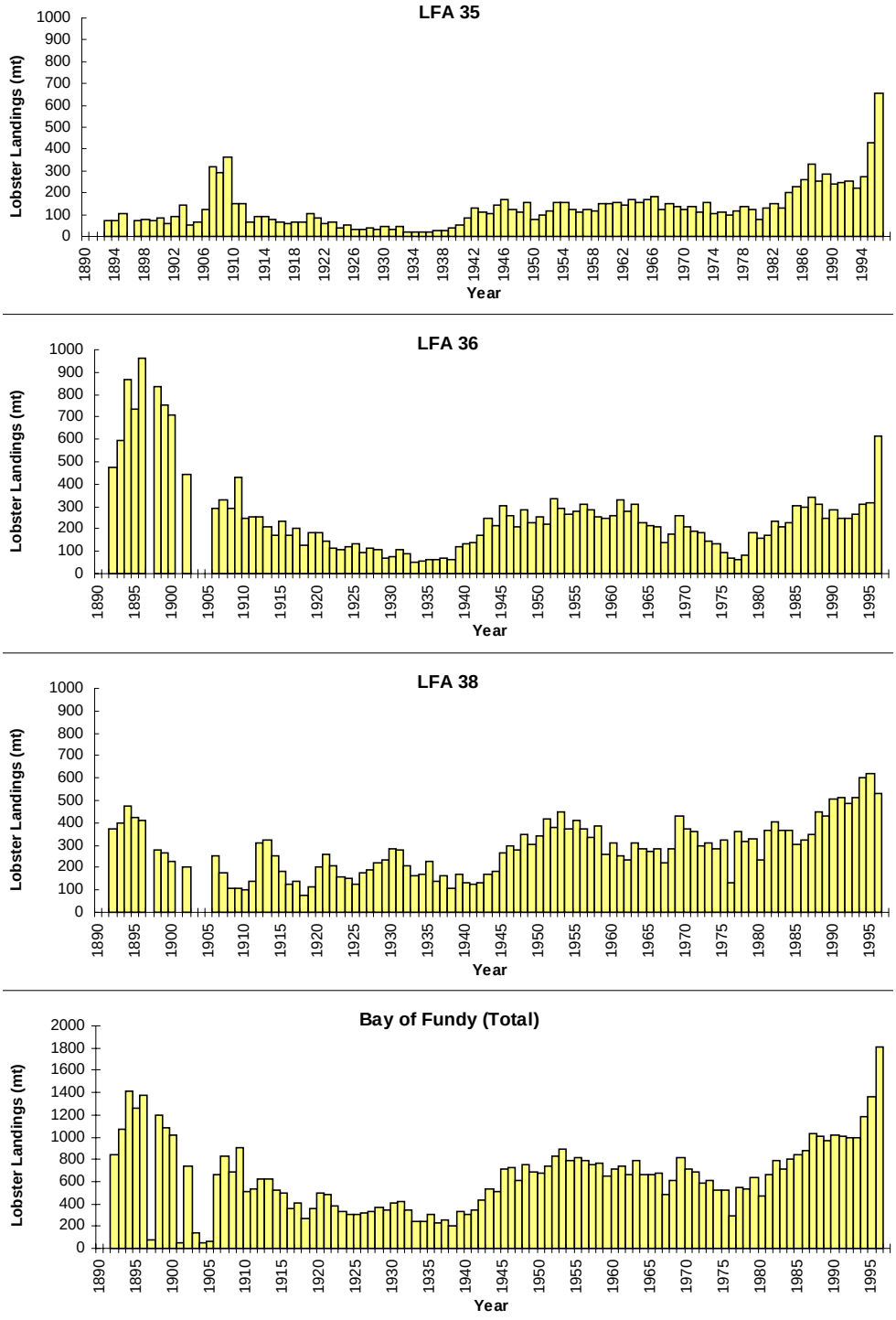


Figure 4. Seasonal landings from the Bay of Fundy (LFA's 35, 36, and 38 combined) from the late 1940's to the 1996/97 fishing season. Data presented as seasonal landings (from the opening of the Fall season in one year to close of the Spring season in the following year; season opening dates presented in Table 1). The percentage contribution of landings from each LFA to the seasonal totals is presented in the lower panel.

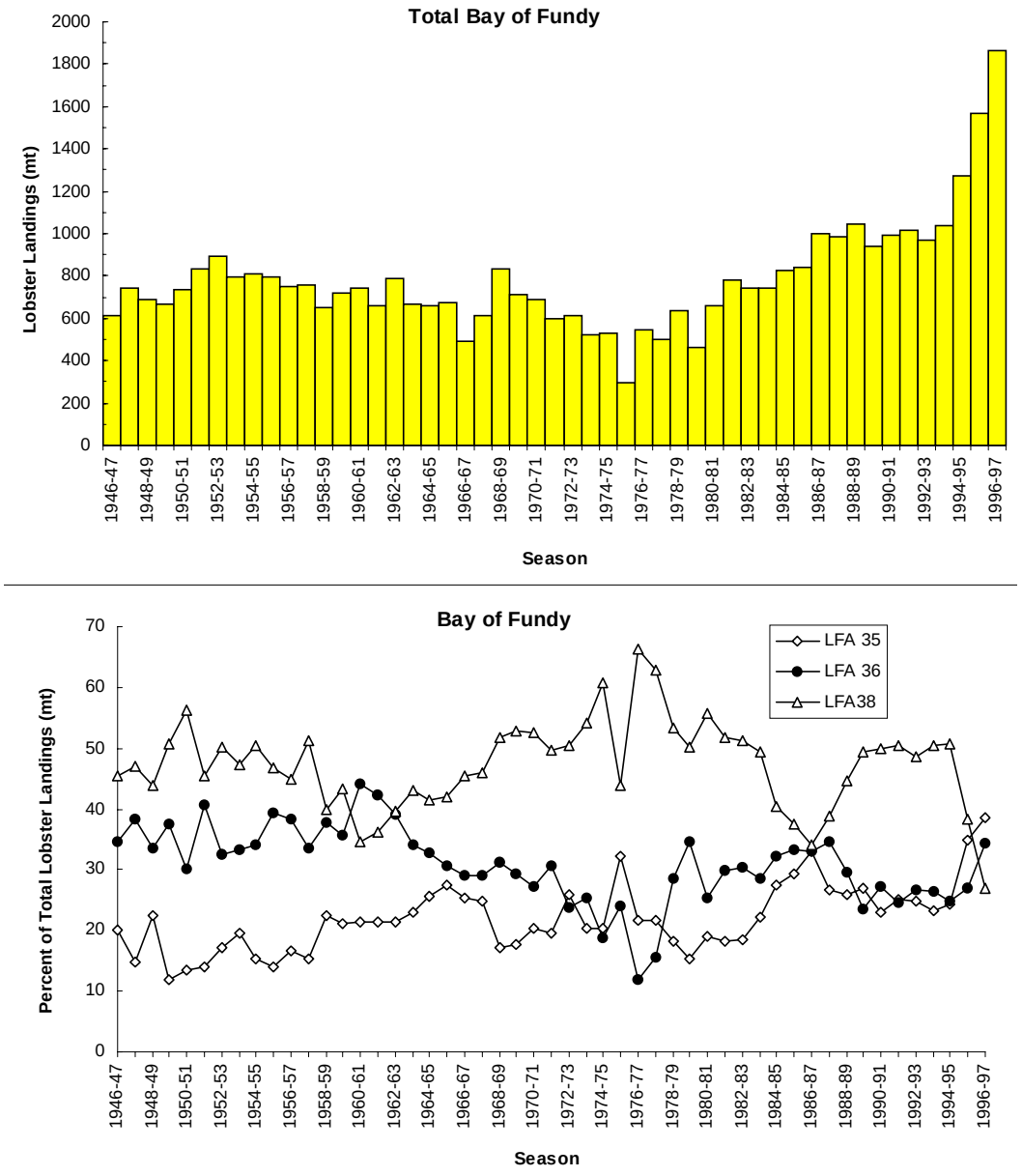


Figure 5. Seasonal landings from the Bay of Fundy (LFA's 35, 36, and 38) from the late 1940's to the 1996/97 fishing season. Data presented as seasonal landings (from the opening of the Fall season in one year to close of the Spring season in the following year; season opening dates presented in Table 1).

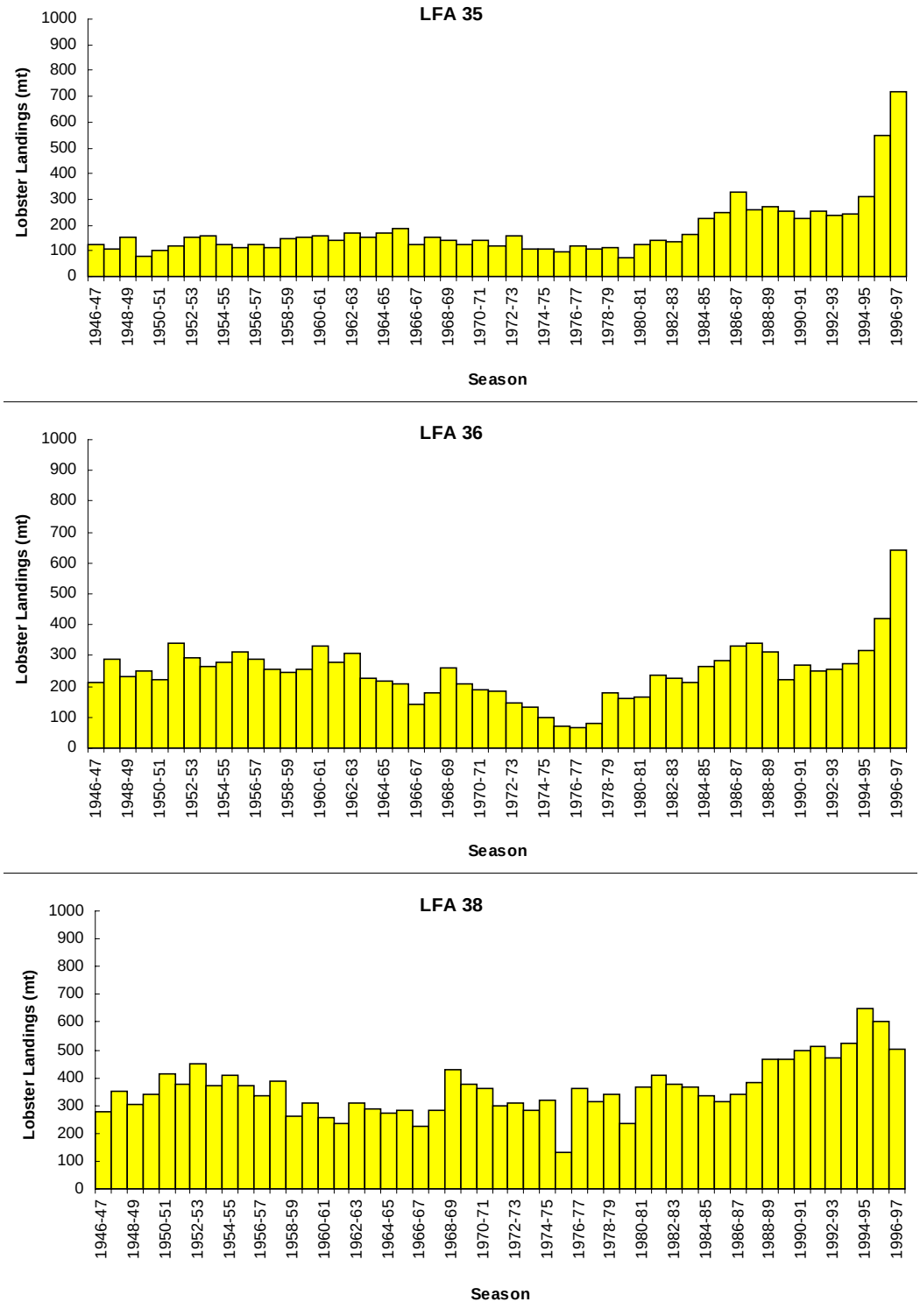
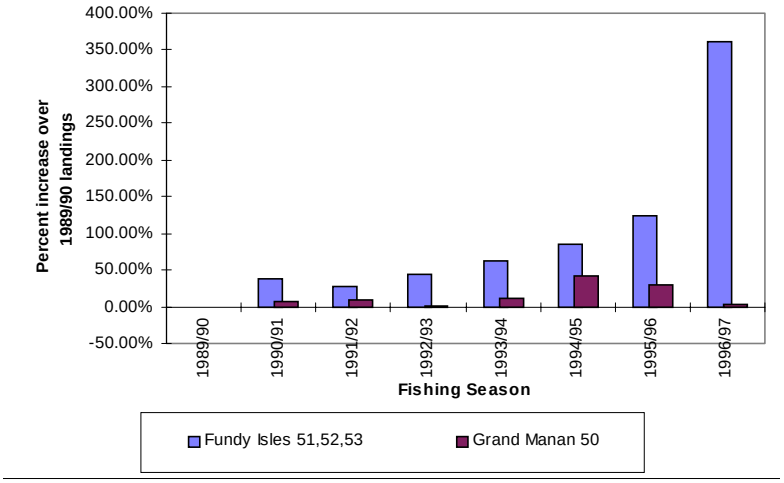
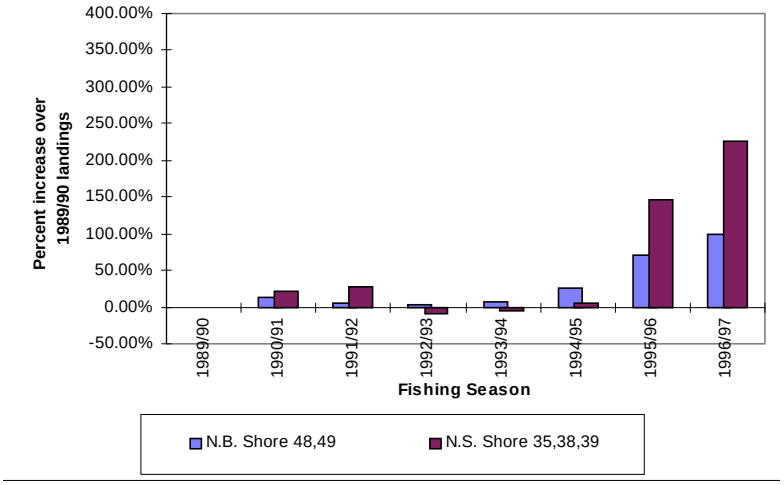


Figure 6. Landings trends in the Bay of Fundy. Percent increase in landings over 1989/90 season total in subsequent fishing seasons for (A) Lower Bay (Fundy Isles and Grand Manan), (B) Mid Bay (N.B. shore and N.S. shore), and (C) Upper Bay (Chignecto Bay and Minas Basin).





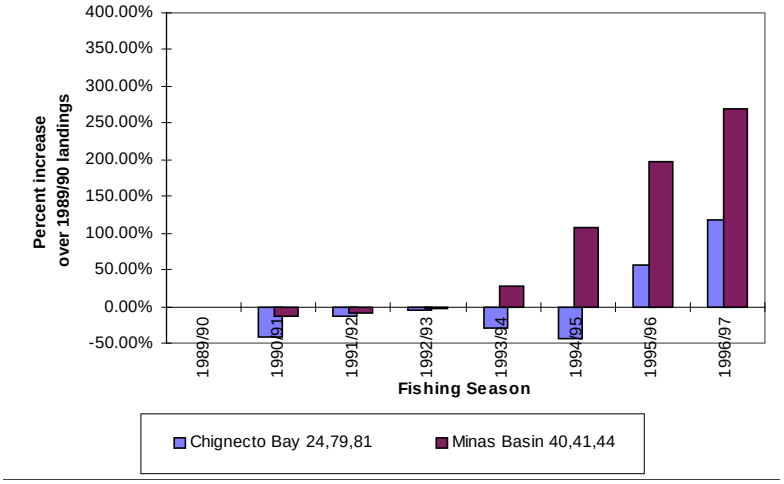


Figure 7. Landings trends for LFA 38 (Grand Manan) by port of landing: North Head (NHead), Seal Cove (SealC), Ingalls Head (IngallsH), and White Head (WhiteHd) for the fishing seasons 1989/90 to 1996/97. (A) Total landings (tonnes), (B) Percent increase in landings over 1989/90 season total in subsequent fishing seasons, (C) Percent contribution to LFA total landings by port.

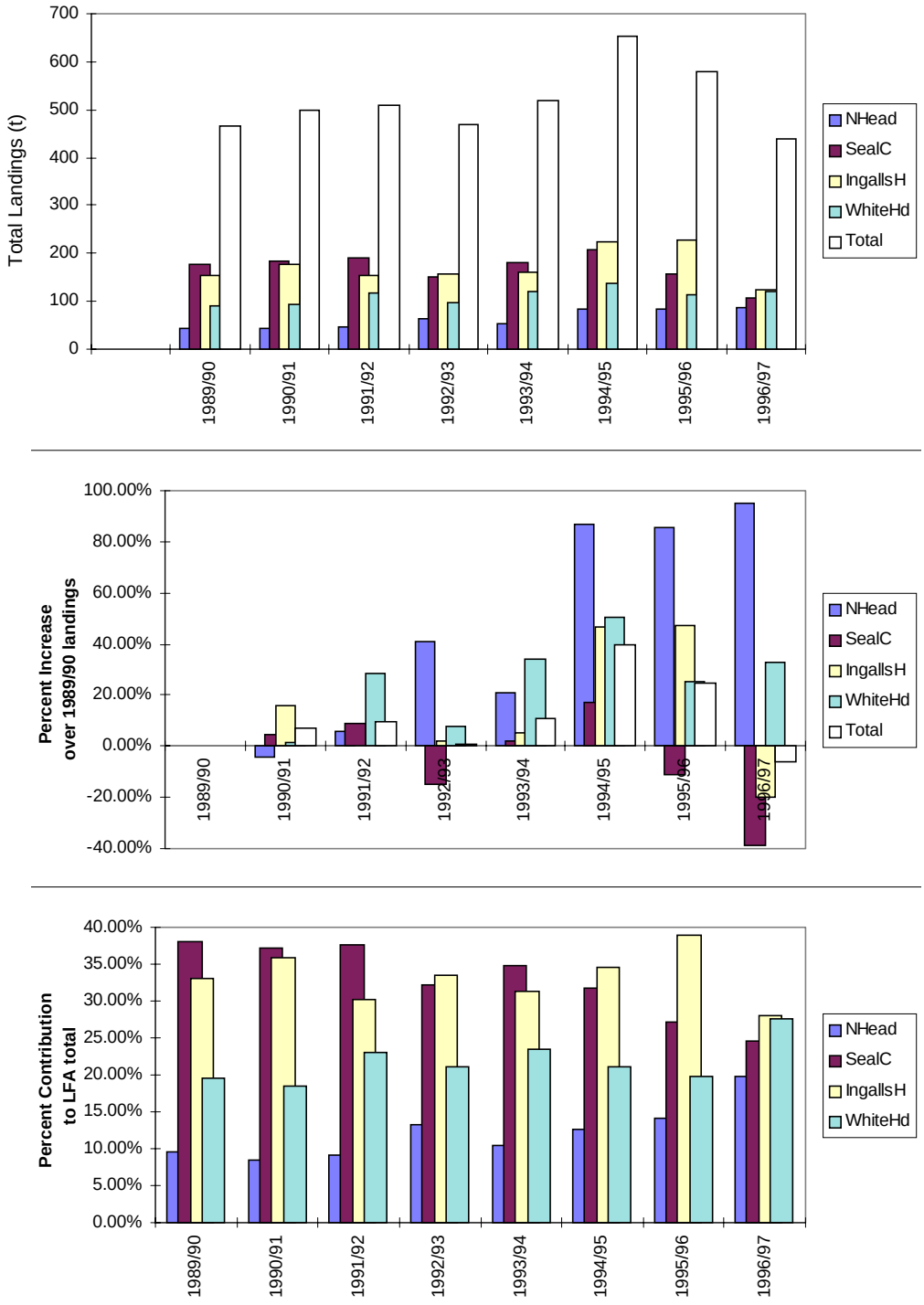


Figure 8. At-sea sampling size frequencies for fishing seasons 1990/91 to 1993/94 for Seal Cove (LFA 38).

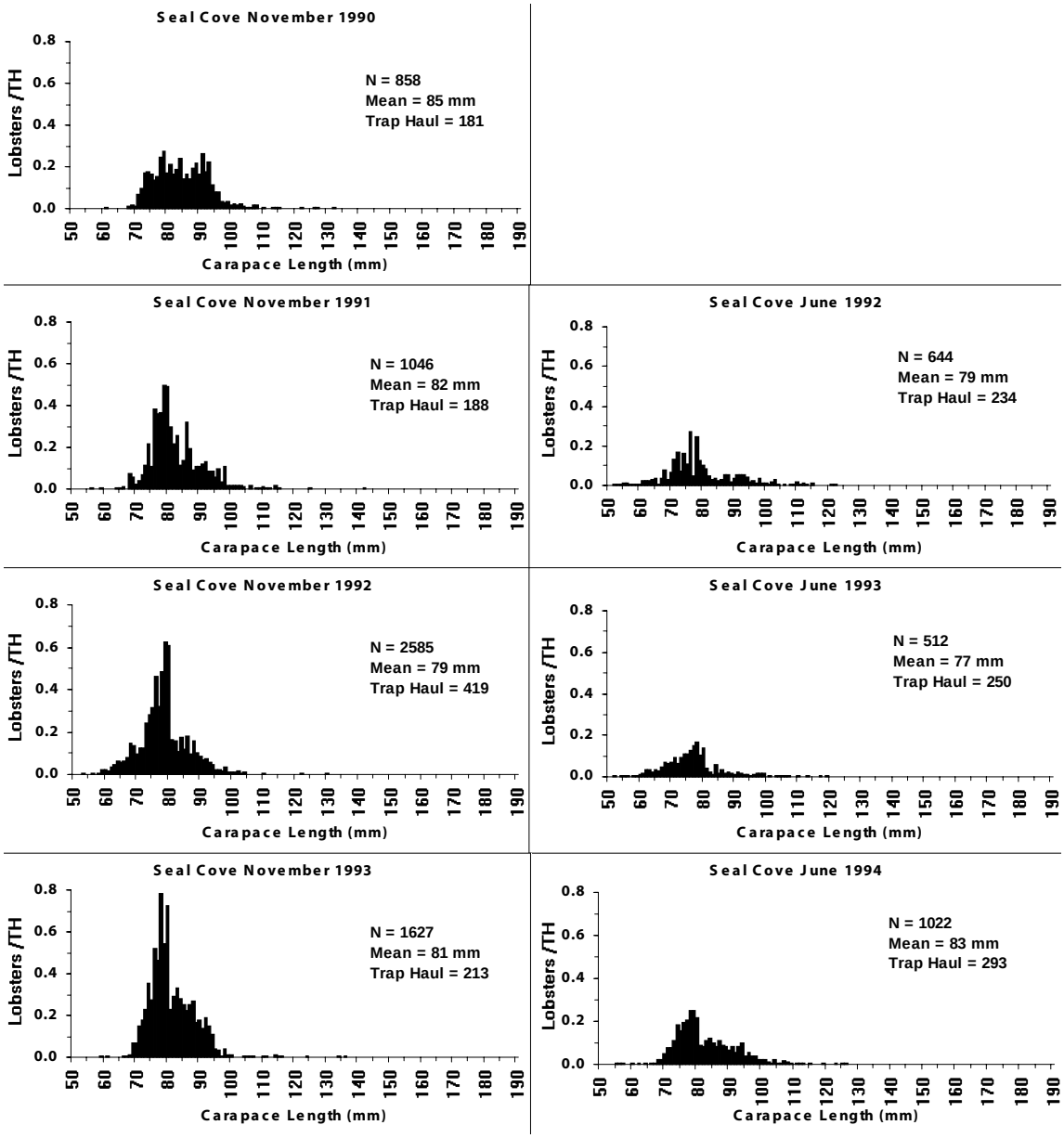


Figure 9. At-sea sampling size frequencies for fishing seasons 1994/95 to 1997/98 for Seal Cove (LFA 38).

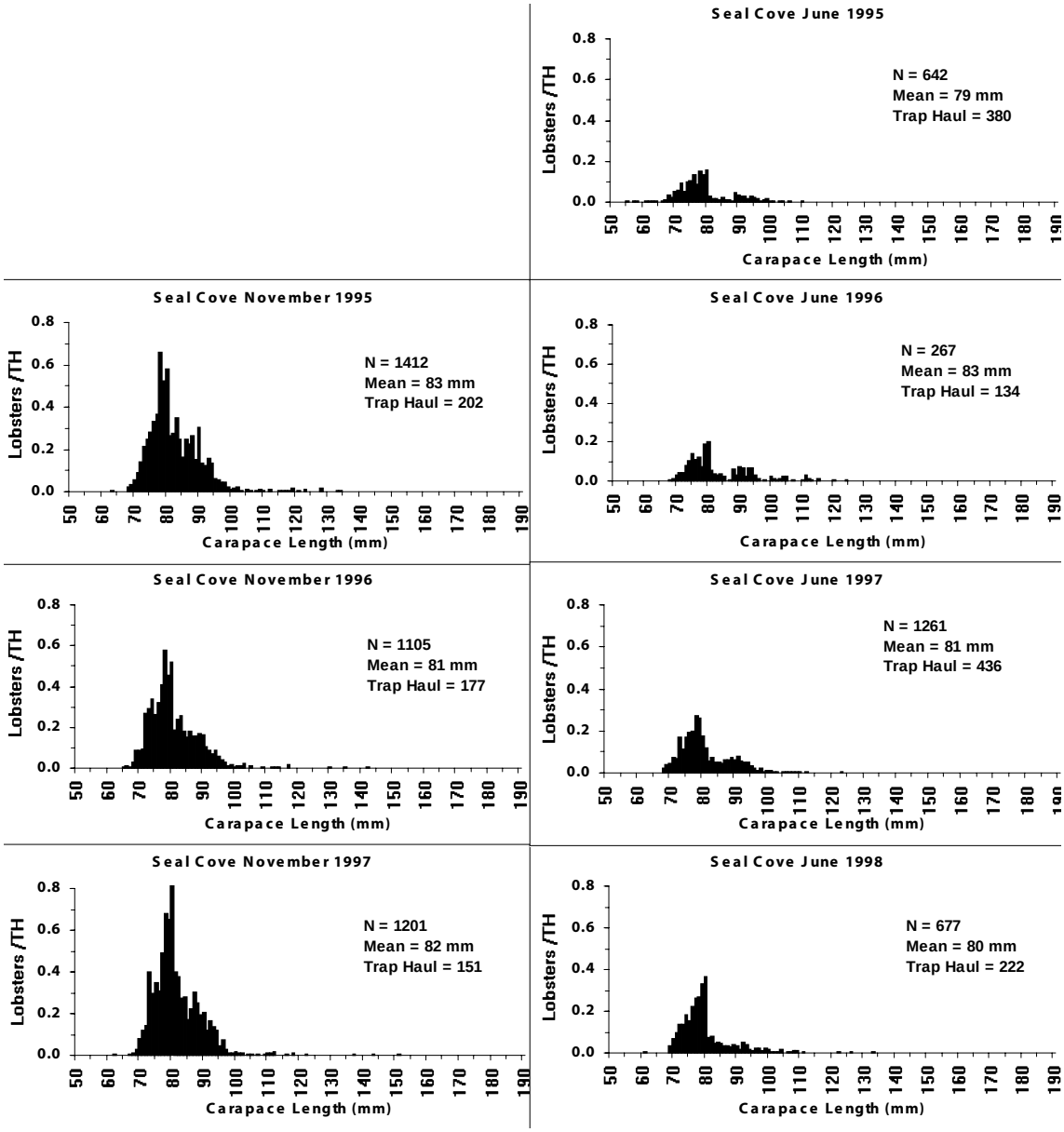


Figure 10. At-sea sampling size frequencies for fishing seasons 1990/91 to 1993/94 for Dipper Harbour (LFA 36).

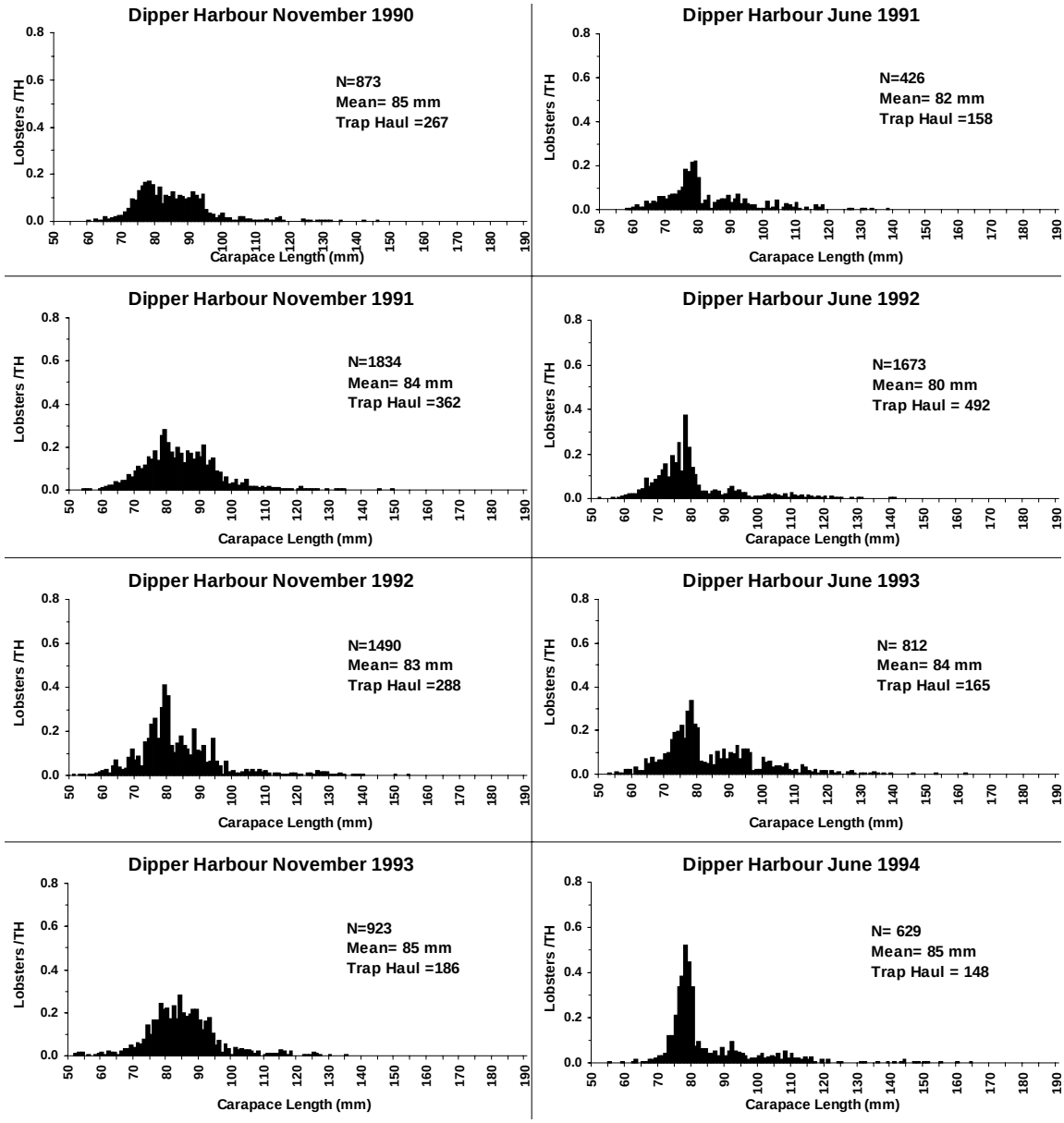


Figure 11. At-sea sampling size frequencies for fishing seasons 1993/94 to 1997/98 for Dipper Harbour (LFA 36).

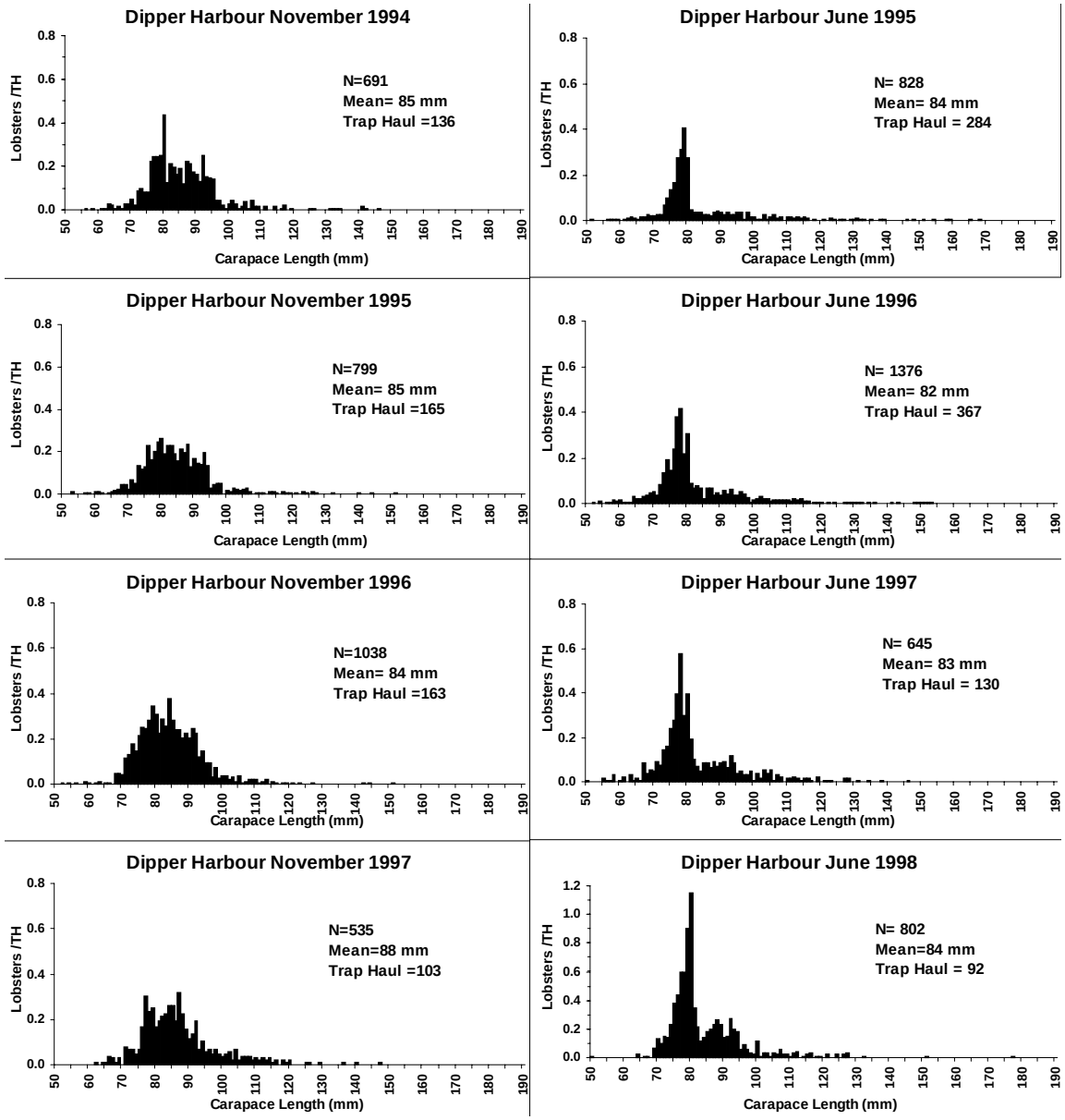


Figure 12. Size distributions from air-lift suction sampling for juvenile lobster at Beaver Harbour (LFA 36), 1991-97.

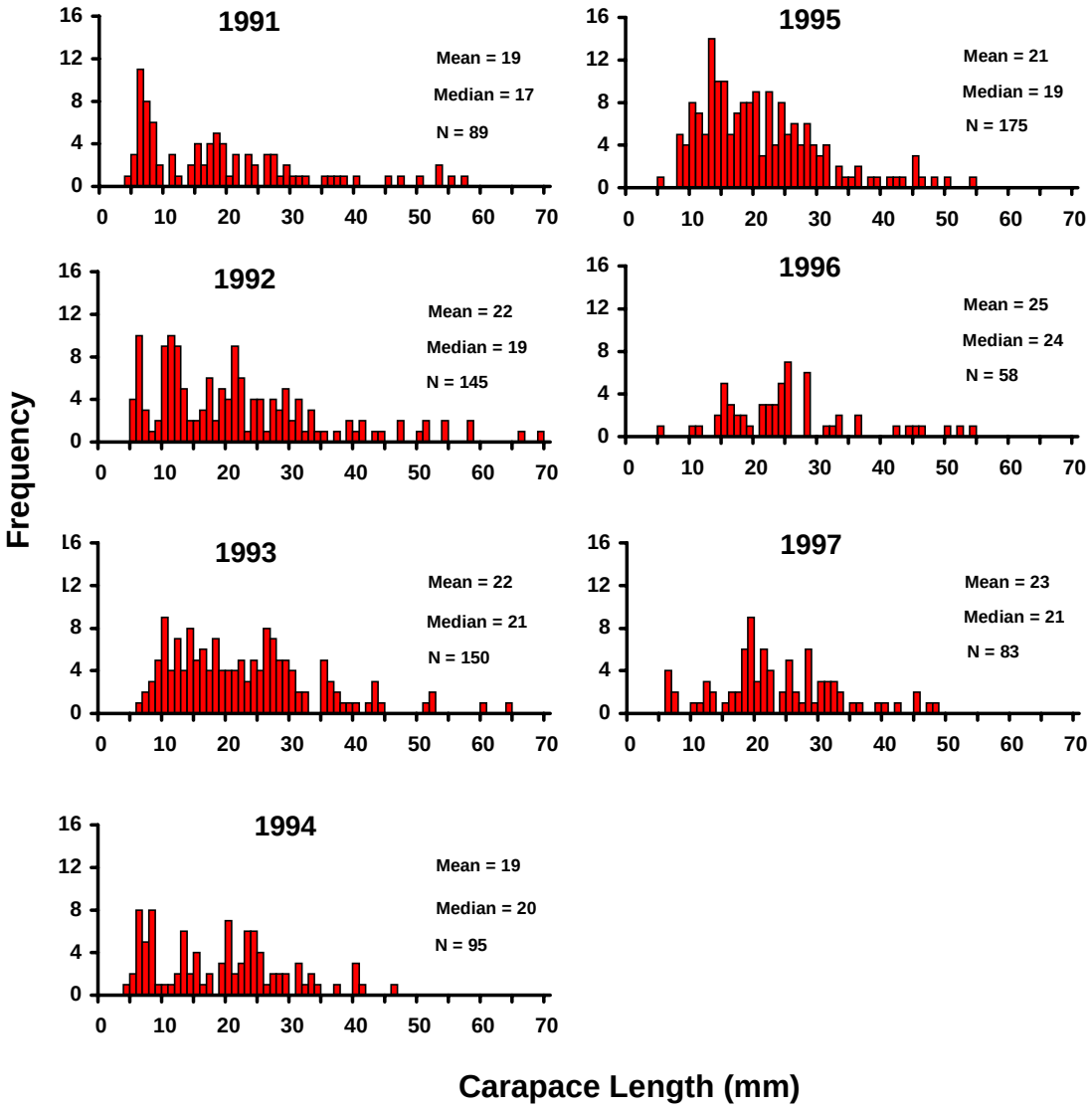


Figure 13. At-sea sampling size frequencies for fishing seasons 1990/91 to 1993/94 for Alma (LFA 35).

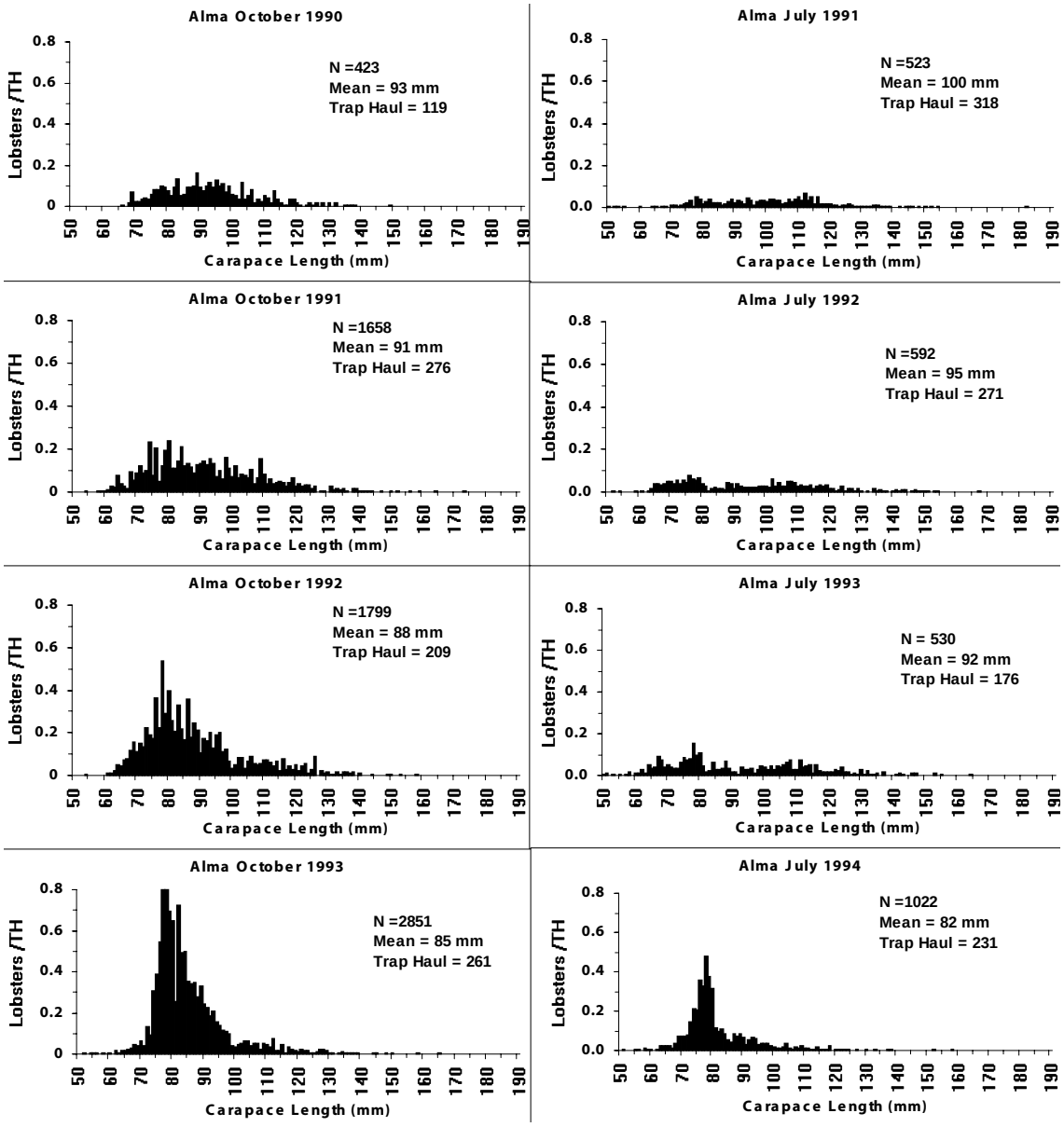


Figure 14. At-sea sampling size frequencies for fishing seasons 1994/95 to 1997/98 for Alma (LFA 35).

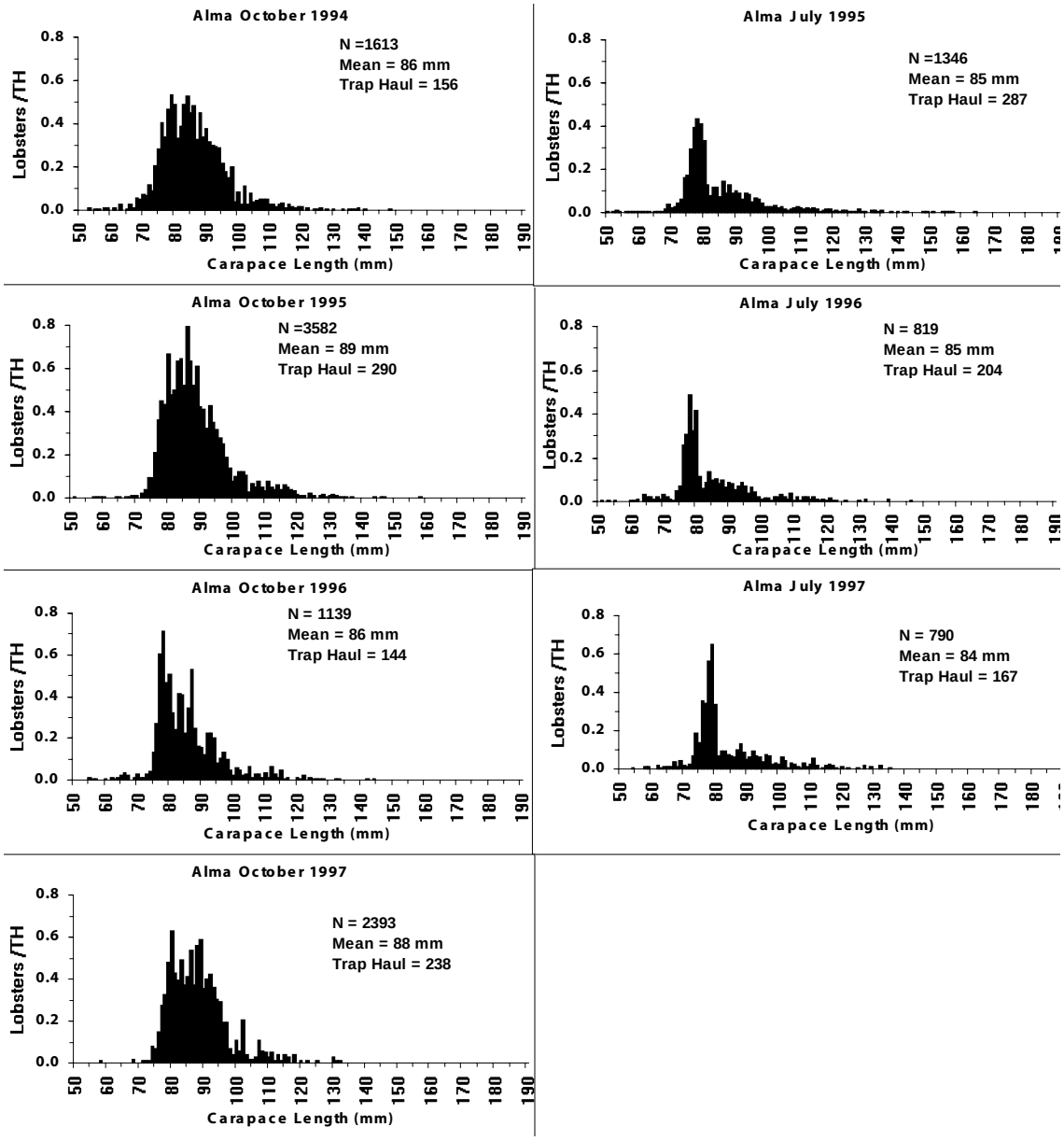


Figure 15. At-sea sampling size frequencies for fishing seasons 1990/91 to 1993/94 for North Head (LFA 38).

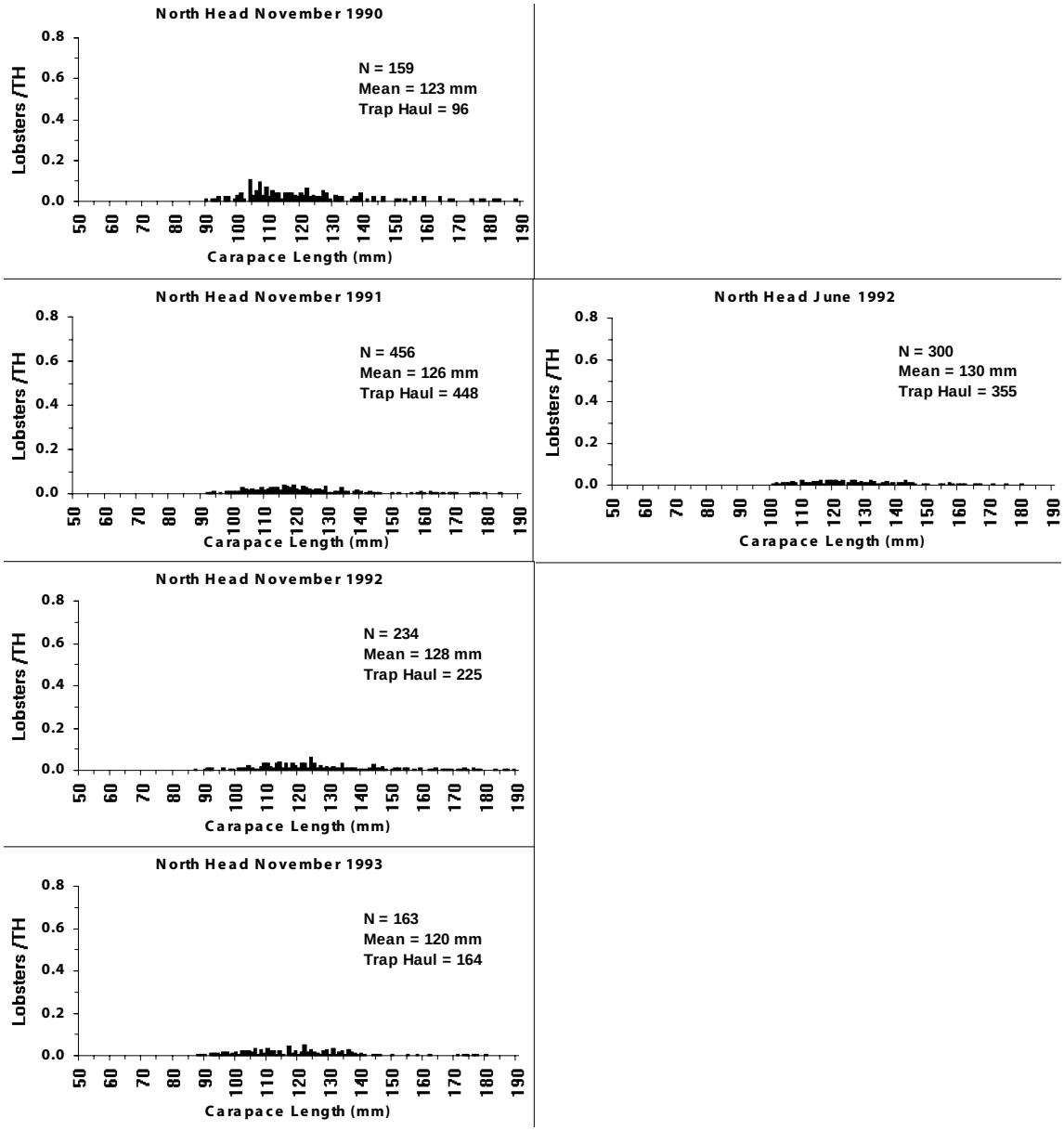


Figure 16. At-sea sampling size frequencies for fishing seasons 1994/95 to 1997/98 for North Head (LFA 38).

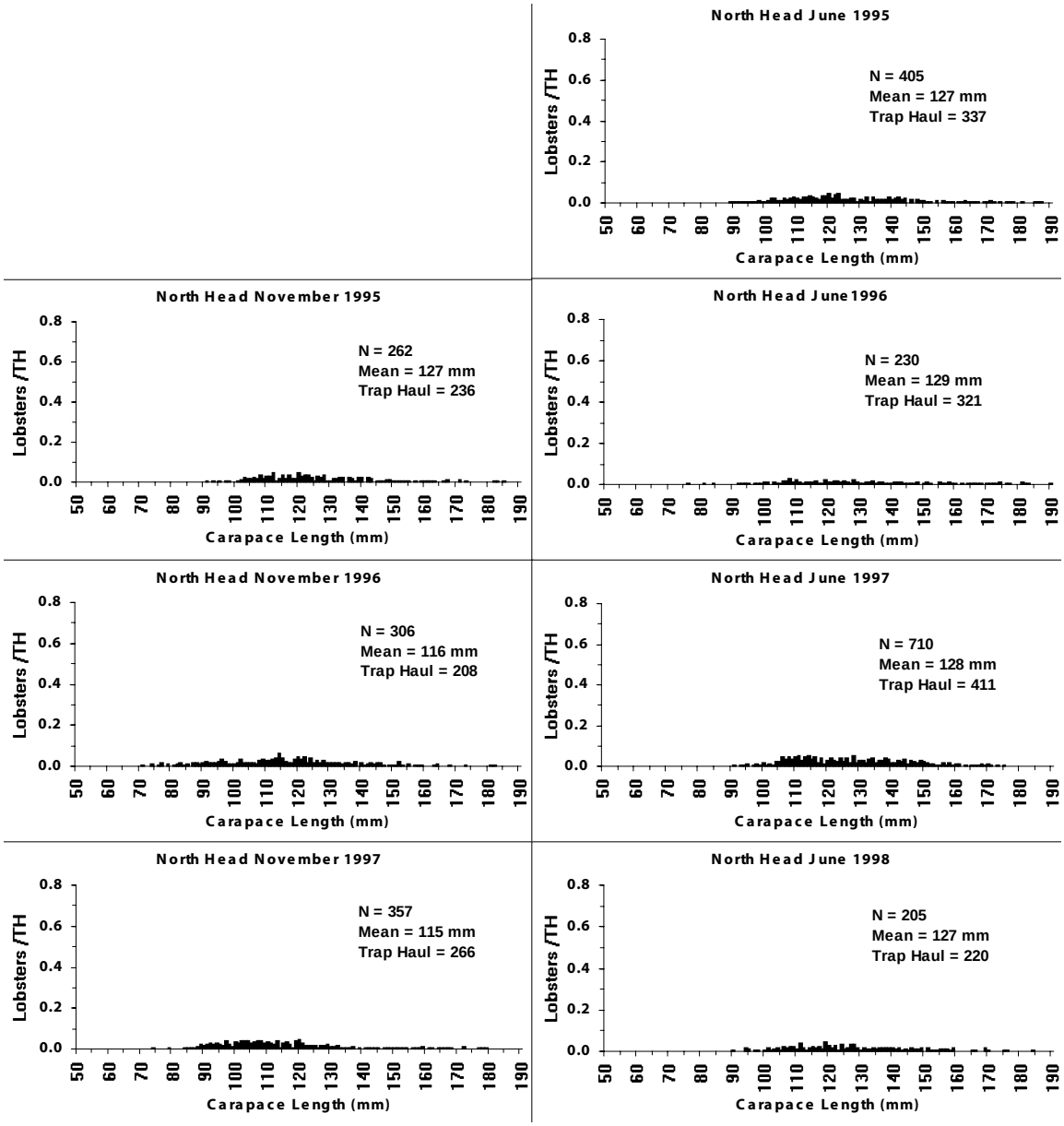


Figure 17. Cumulative frequency distribution of berried female lobsters sampled at-sea in the Bay of Fundy between 1978 and 1997, grouped by 5 year time-period. Sample sizes and sample distribution information in Table 4.

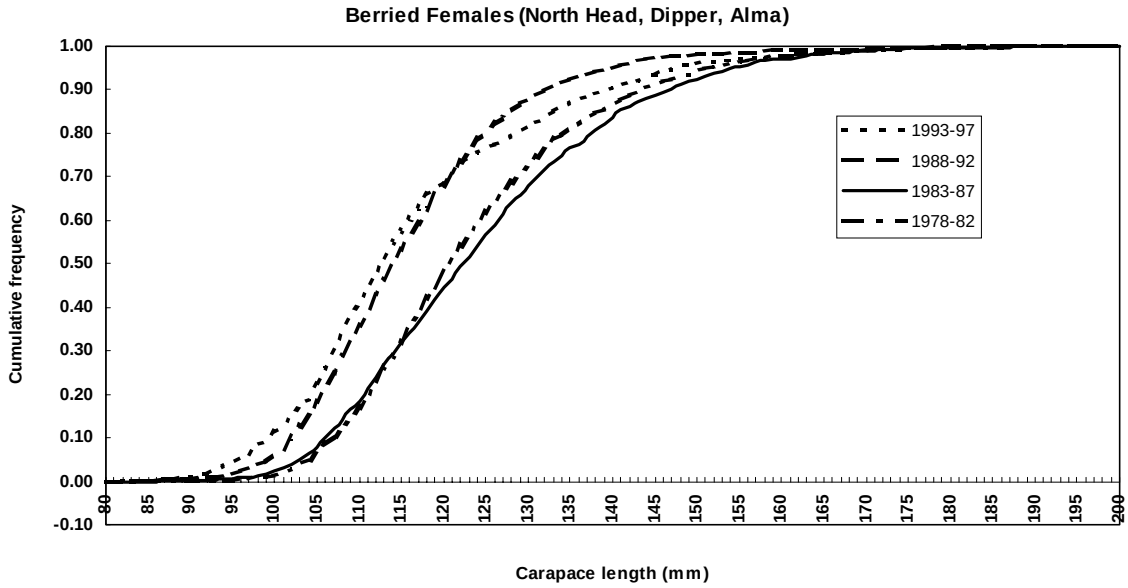
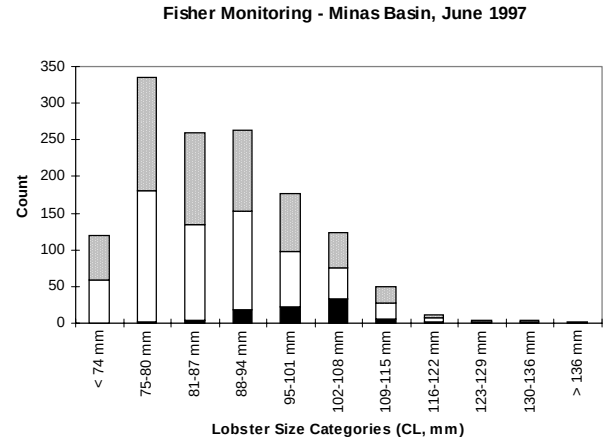
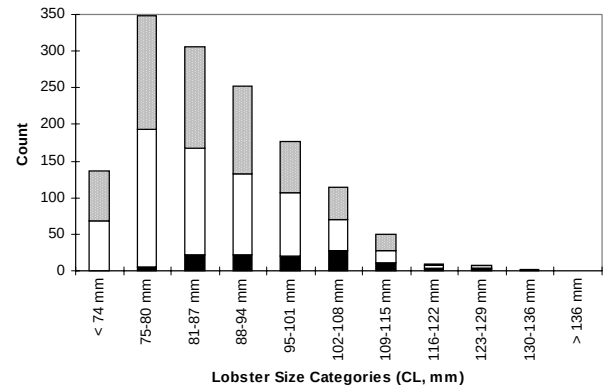


Figure 18. Fisher-supplied lobster size distribution from at-sea samples in the Minas Basin (2 boats) and off Advocate Harbour (LFA 35), during June 1997. Males (shaded bars), females (white bars), and berried females (black bars) indicated for 11 size categories.





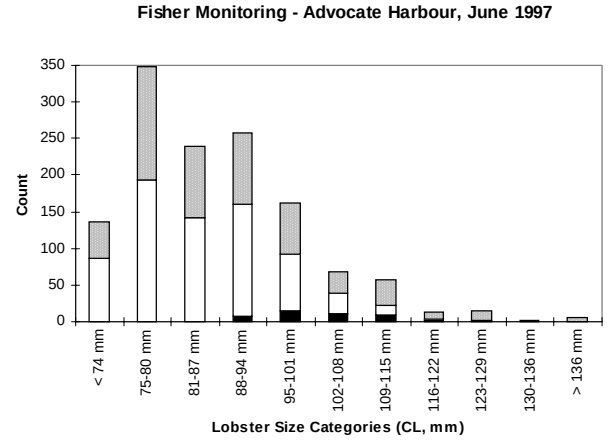


Figure 19. Trends in catch per unit of effort observed in at-sea sampling of lobster catches in the Bay of Fundy1978-1998. Number of lobsters per trap haul by molt group.

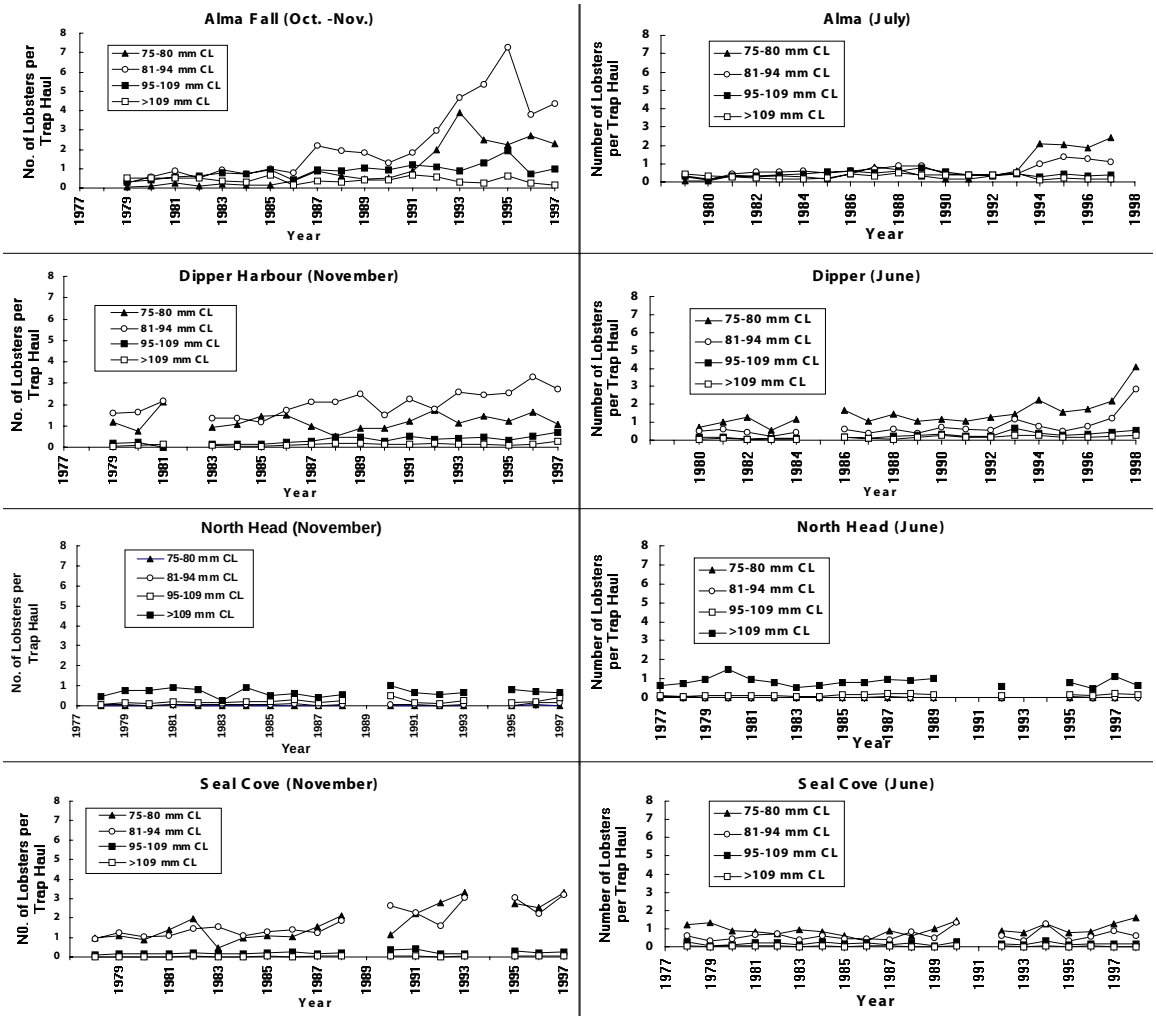


Figure 20. Trends in catch per unit of effort observed in at-sea sampling of lobster catches in the Bay of Fundy1978-1998. Kg. of lobsters per trap haul.

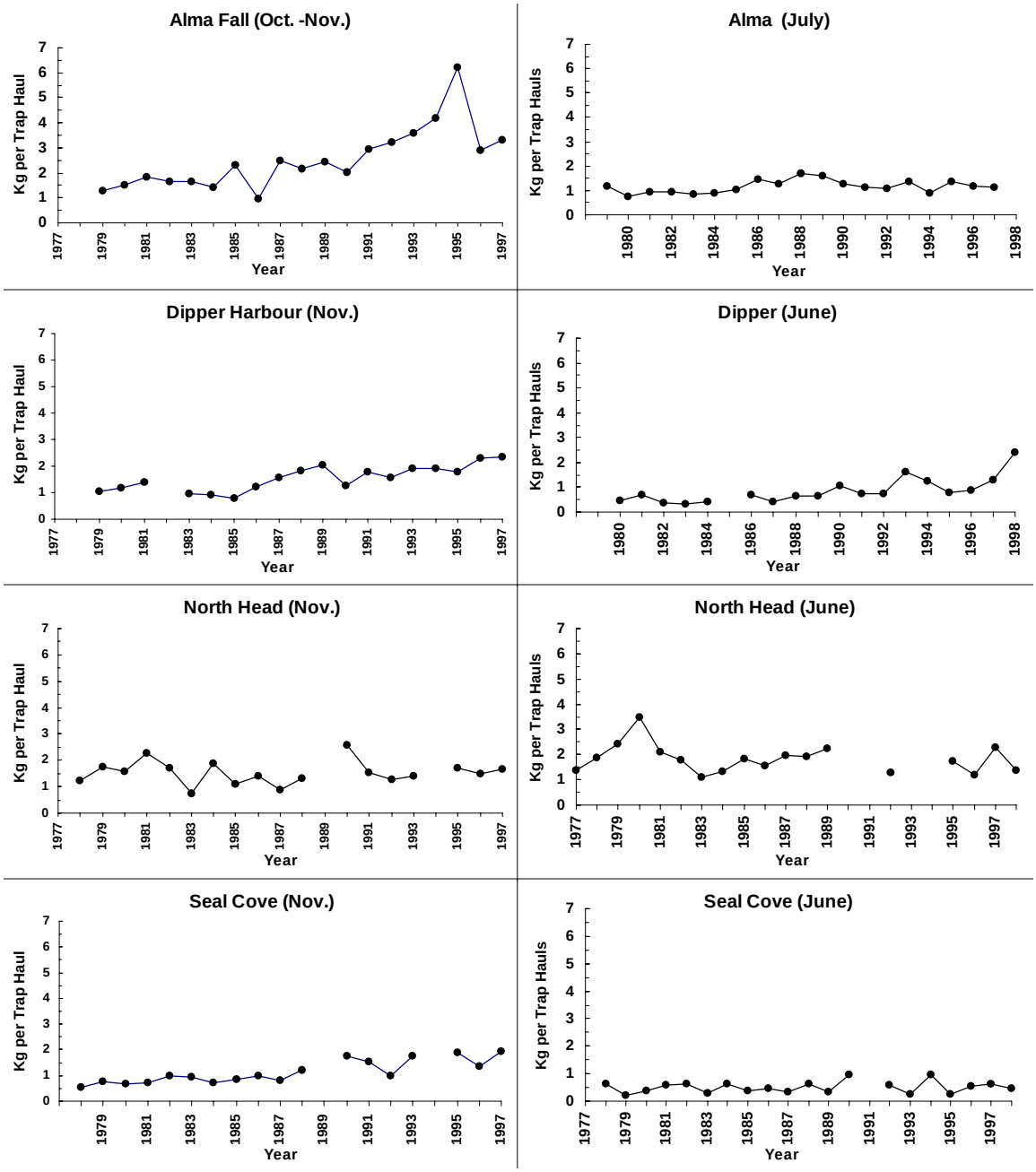


Figure 21. Summary Plots of F and Exploitation Rate for LFA's 35, 36, and 38, and for the three LFA's combined (Bay of Fundy) from Length-based Cohort Analysis. Note that scales for F and Exploitation Rate plots are different. Data points connected with dotted line; solid line is 2 year moving average.

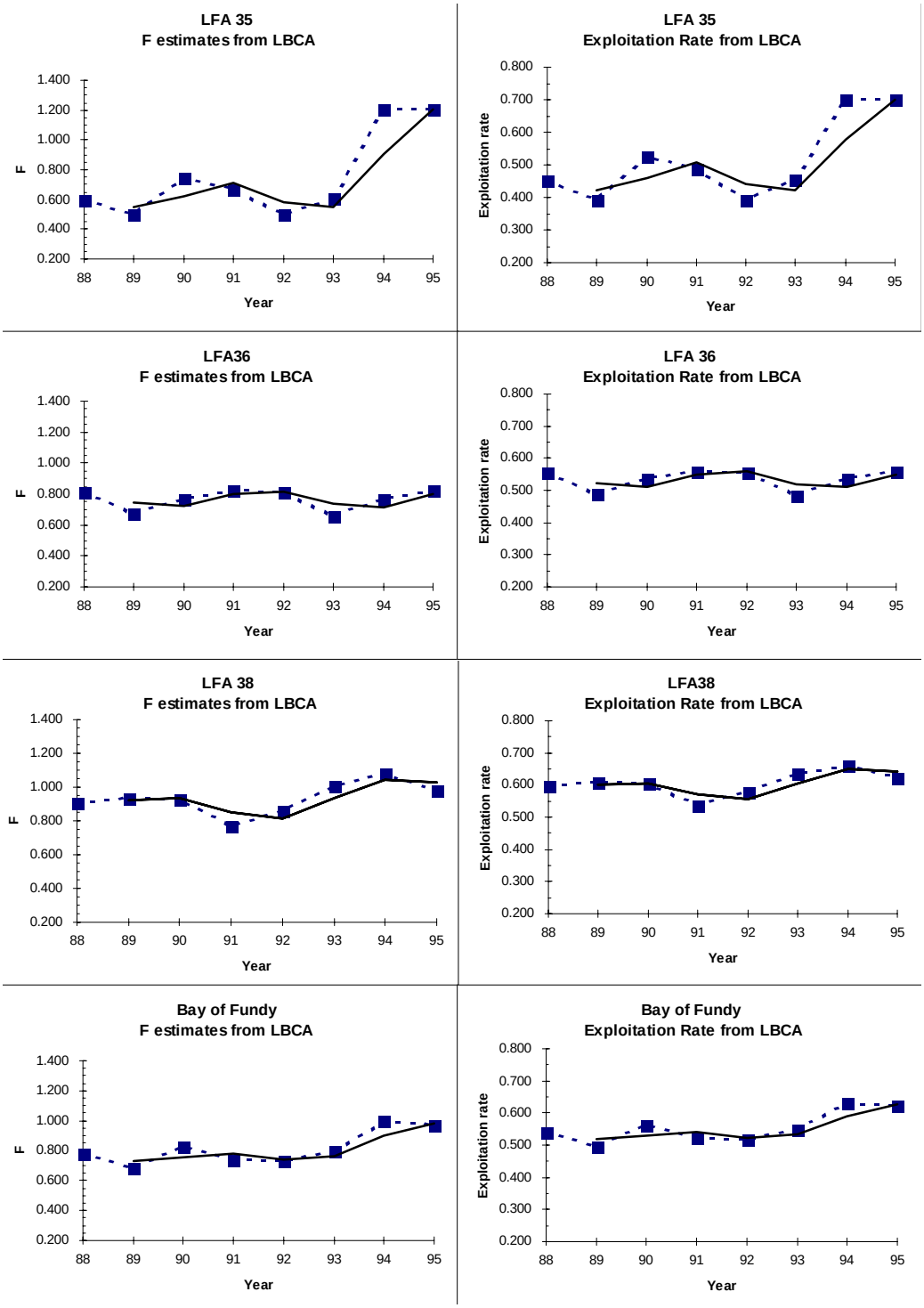
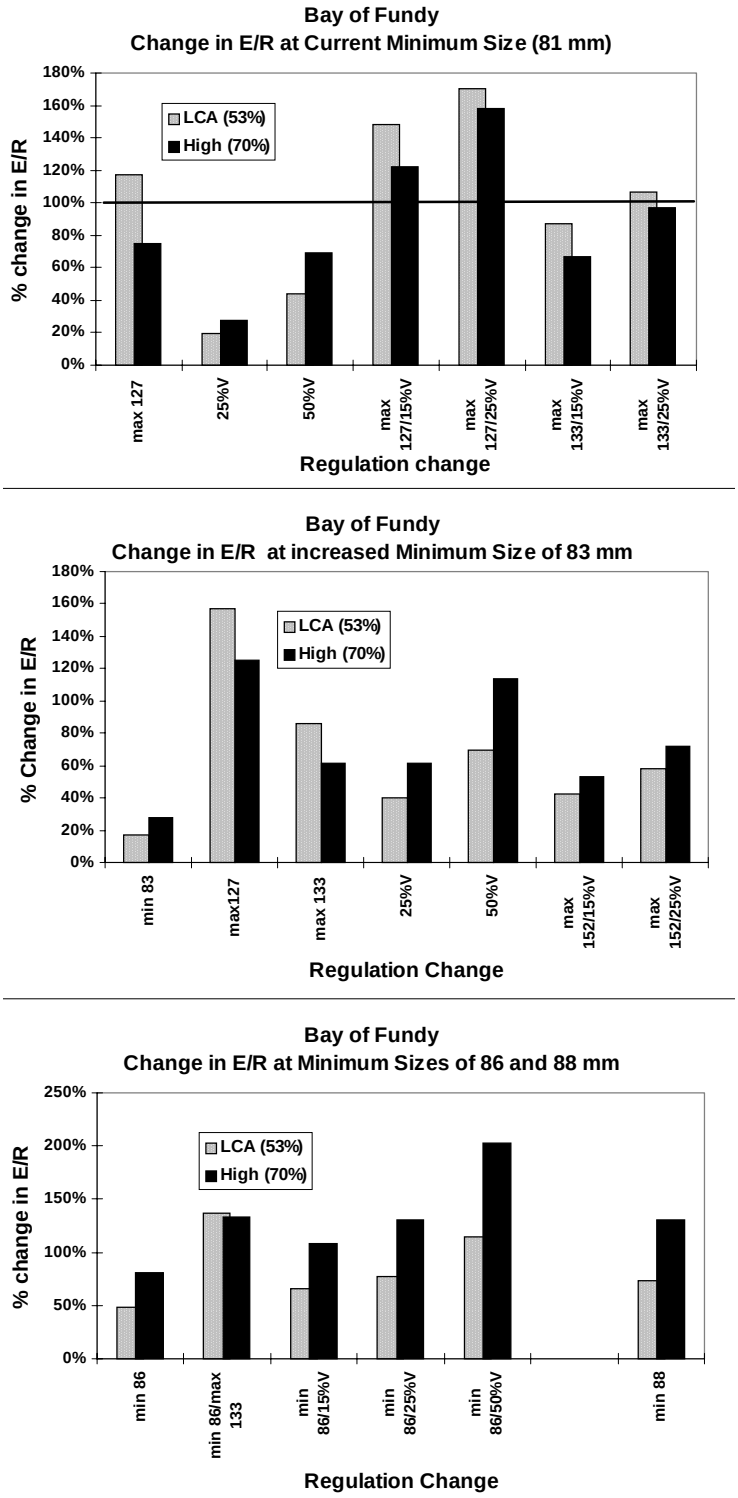


Figure 22. Percent change in E/R in the Bay of Fundy under different combinations of regulation change. Percent change in E/R is presented for three minimum size scenarios.



Appendix 1. Historical review of management policies introduced in the Bay of Fundy lobster fishery (updated from material presented in Robichaud and Lawton, 1997).

Late 1800's: Initial lobster fishing season established for Bay of Fundy. Fishery open May 1 to July 31.

1910: Initial management areas established, called Districts (D) (see Williamson 1992 for details of boundaries). For the most part equivalent to current Lobster Fishing Areas (LFA's), Districts were distinguished only by coastline features. To cross reference between D's and LFA' s, approximate LFA' s are indicated in brackets after each mention of a District even though LFA's were only created in 1986. Open fishing season established as Jan. 6 to June 15 for D1 (LFA's 36 and 38) and Jan. 15 to June 29 for D2 (LFA 35). A minimum size limit of 4 3/4 in. (120 mm CL) introduced in D1.

1914: Open fishing season for D1 changed to Nov. 15 to June 15.

1918: In February, D1 sub-divided by county lines: Charlotte County, including Grand Manan, became D1 (LFA 38), while St. John County became D2 (LFA 36). The old D2 renamed D3 (LFA 35). Open fishing seasons changed to Nov. 15 to June 15 in D1, and between Nov. 15 and May 31 in D2. Minimum size limit of 9 in. total length (229 mm) introduced in D2. In September, fishing seasons changed again: open from Nov. 15 to June 8 in D1; from Nov. 15 to May 23 in D2. In D3 (LFA 35) open fishing season remained Jan. 15 to June 29. Minimum size limit of 9 in. total length (229 mm) introduced in D3.

1932: Open fishing season in D1 (LFA 38) changed to Nov. 15 to Jan. 15, and from April 25 to June 24.

1934: Fishing season in D1 (LFA 38) changed to be open from Nov. 15 to June 8 and in D2 (LFA 36) from Nov. 15 to Jan 15 and from April 25 to June 24. Minimum size limits of 3 1/2 in. (89 mm) and 3 1/16 in. (78 mm) CL were introduced in D1 and D2, respectively.

1935: During May, D1 was sub-divided: D1a included Grand Manan only (LFA 38), while D1b included Charlotte County. Open fishing season in D1a (LFA 38) changed to be open from Nov. 15 to May 31, and in D1b from Nov. 15 to June 8. During October, a minimum size limit of 3 1/2 in. (89 mm) CL and a maximum size limit of 4 3/4 in. (120 mm) CL was introduced in D1a. Minimum and maximum size limit of 3 1/16 in. (78 mm) CL and 4 3/4 in. (120 mm) CL introduced in D1b. During November, fishing season in D1a was changed to be open from Nov. 15 until the last day of February.

1938: Open fishing season in D1a (LFA 38) changed to Nov. 15 to Dec. 31, and from April 15 to May 31. Minimum and maximum size limit changed to 3 1/4 in. (83 mm CL), and 5 in. (127 mm CL).

1941: Minimum and maximum size limit in D1a changed to 3 1/8 in. (79 mm) CL and 4 3/4 in. (120 mm) CL. Minimum size in D2 and D3 set at 3 1/8 in. (79 mm) CL and maximum size limits removed.

1942: Open fishing season in D1a, D1b and D2 changed to Nov. 15 to Jan. 15 and from April 14 to June 24. Open season in D3 changed to between Jan 15 and June 12. Maximum size limits in D1a and D1b were removed and the minimum size limit in D1b was increased to 3 1/4 in. (83 mm) CL.

1947: Fishing season for D3 (LFA 35) was changed to be open from Jan. 15 to July 20.

1948: D1a and D1b re-combined to form D1 which included Charlotte Co. and Grand Manan. Minimum size limit in D1 and D2 now 3 1/4 in. (83 mm) CL.

1951: Districts 1, 2 and 3 moved to a consistent minimum size limit of 3 3/16 in. (81 mm) CL.

1952: Fishing season in D3 (LFA 35) changed to open from Nov. 1 to Dec. 30 and March 1 to July 20.

1955: Fishing season in D3 (LFA 35) changed to open from Oct. 15 to Dec. 30 and March 1 to July 20.

1956: Fishing seasons in D's 1 and 2 changed to be open from Nov. 15 to June 24.

1962: D1 and D2 were combined into one District called D1.

1968: License limits introduced. Trap limits introduced, based on average number of traps fished in each District prior to 1968. D1 (LFA's 36 and 38) limited to 375 traps; D3 (LFA 35) limited to 300 traps.

1973: Fishing season for D3 (LFA 35) open from Oct. 15 to Dec. 31 and from March 1 to July 31.

1977: Closing date for spring season in D1 (LFA' s 36 and 38) changed to third Friday in June, and opening of fall season changed to second Tuesday in November. D1 was divided into D1 (LFA 36) and D2 (LFA 38). Charlotte Co. remained in D1. Trap limits in D1 (LFA 36) reduced from 375 to 300 traps.

1978: Introduction of "Lobster Buy-Back Program" (ran from 1978 to 1981).

1979: End of winter season in D1 (LFA 36). Fishery now open from second Tuesday in Nov. to Jan. 15 and from April 1 to the third Friday in June.

Appendix 1 (cont.)

1980: Change of D1 (LFA 36) and D2 (LFA 38) spring closing date to the fourth Friday in June.

1982: Change of D1 (LFA 36) closing date to June 30.

1986: Establishment of Mid-Bay line and Buffer Zone. Old Districts renamed Lobster Fishing Areas. D1 became LFA 36, D2 became LFA 38 and D3 became LFA 35.

Appendix 2. Outputs from Length Based Cohort Analyses (LCA) for the Bay of Fundy Lobster Fishery, 1988 - 1995.

On the following 8 pages:

LFA 35 females, 1988 fishing season

LENGTH-BASED COHORT ANALYSIS

	(INPUT)
Terminal F =	0.2
Natural Mortality (m)=	0.147
Tc =	0.38

Length (mm)			(INPUT) Catch (numbers)	(INPUT) Delta-t (y)	Stock Numbers	Mean Number	F/Z	Z	F		F*C
====	=	===	==========	=======	----------------	----------------	------------------	-------------	-------------		::::::::::::
131	-	140	469	2.055	814						
121	-	130	2203	1.983	3550	3628	0.805	0.754	0.607		1337
116	-	120	3596	0.932	7859	4853	0.834	0.888	0.741		2664
111	-	115	4043	0.839	13128	8338	0.767	0.632	0.485		1961
106	-	110	10446	0.726	25486	13007	0.845	0.950	0.803		8389
101	-	105	10503	0.619	38785	19023	0.790	0.699	0.552		5799
96	-	100	12194	0.533	54512	24034	0.775	0.654	0.507		6187
91	-	95	19626	0.486	78717	31147	0.811	0.777	0.630		12367
86	-	90	25943	0.465	110915	42553	0.806	0.757	0.610		15817
81	-	85	24806	0.457	144074	56819	0.748	0.584	0.437		10830
7070	=	===	==========	=======	----------------	----------------	------------------	-------------	-------------		::::::::::::
Total			113,829			203,402	Wtd.Ave.F =		0.574		65351
							A =		0.437		

LFA 35 females, 1989 fishing season

LENGTH-BASED COHORT ANALYSIS

	(INPUT)
Terminal F =	0.2
Natural Mortality (m)=	0.147
Tc =	0.38

Length (mm)			(INPUT) Catch (numbers)	(INPUT) Delta-t (y)	Stock Numbers	Mean Number	F/Z	Z	F		F*C
====	=	===	==========	=======	----------------	----------------	------------------	-------------	-------------		::::::::::::
131	-	140	938	2.055	1628						
121	-	130	4690	1.983	7418	7483	0.810	0.774	0.627		2940
116	-	120	5151	0.932	13933	9282	0.791	0.702	0.555		2858
111	-	115	8664	0.839	24842	15270	0.794	0.714	0.567		4916
106	-	110	13568	0.726	41771	22867	0.801	0.740	0.593		8050
101	-	105	17043	0.619	63391	31137	0.788	0.694	0.547		9329
96	-	100	17052	0.533	86130	38689	0.750	0.588	0.441		7515
91	-	95	25716	0.486	118934	48221	0.784	0.680	0.533		13714
86	-	90	23840	0.465	151821	61542	0.725	0.534	0.387		9235
81	-	85	21980	0.457	184924	75667	0.664	0.437	0.290		6385
======		===	==========	=======	----------------	----------------	------------------	-------------	-------------		::::::::::::
Total			138,641			310,158	Wtd.Ave.F =		0.468		64942
							A =		0.374		

LFA 35 females, 1990 fishing season

LENGTH-BASED COHORT ANALYSIS

	(INPUT)
Terminal F =	0.2
Natural Mortality (m)=	0.147
Tc =	0.38

Length (mm)			(INPUT) Catch (numbers)	(INPUT) Delta-t (y)	Stock Numbers	Mean Number	F/Z	Z	F		F*C
====	=	===	==========	=======	----------------	----------------	------------------	-------------	-------------		::::::::::::
141	-	150	115	2.096	199						
131	-	140	115	2.055	398	573	0.577	0.347	0.200		23
121	-	130	460	1.983	1047	1284	0.709	0.505	0.358		165
116	-	120	1043	0.932	2300	1425	0.833	0.879	0.732		764
111	-	115	3011	0.839	5757	3036	0.871	1.139	0.992		2986
106	-	110	4413	0.726	11002	5657	0.841	0.927	0.780		3443
101	-	105	6946	0.619	19239	8789	0.843	0.937	0.790		5489
96	-	100	12273	0.533	33453	13203	0.863	1.077	0.930		11409
91	-	95	18497	0.486	54937	20323	0.861	1.057	0.910		16834
86	-	90	18707	0.465	78026	29806	0.810	0.775	0.628		11742
81	-	85	15481	0.457	99332	39624	0.727	0.538	0.391		6048
====	=	===	==========	=======	----------------	----------------	------------------	-------------	-------------		::::::::::::
Total			81,061			123,719	Wtd.Ave.F =		0.727		58903
							A =		0.516		

LFA 35females, 1991 fishing season

LENGTH-BASED COHORT ANALYSIS

	(INPUT)
Terminal F =	0.2
Natural Mortality (m)=	0.147
Tc =	0.38

Length (mm)			(INPUT) Catch (numbers)	(INPUT) Delta-t (y)	Stock Numbers	Mean Number	F/Z	Z	F		F*C
====	=	===	==========	=======	----------------	----------------	------------------	-------------	-------------		::::::::::::
131	-	140	235	2.055	407						
121	-	130	1636	1.983	2372	2240	0.832	0.877	0.730		1195
116	-	120	1167	0.932	3950	2794	0.740	0.565	0.418		488
111	-	115	5149	0.839	9865	5208	0.871	1.136	0.989		5090
106	-	110	7942	0.726	19247	9800	0.846	0.957	0.810		6436
101	-	105	9791	0.619	31215	14811	0.818	0.808	0.661		6473
96	-	100	17472	0.533	51762	20919	0.850	0.982	0.835		14593
91	-	95	22573	0.486	78791	30313	0.835	0.892	0.745		16809
86	-	90	21400	0.465	106332	41775	0.777	0.659	0.512		10963
81	-	85	14892	0.457	129002	52907	0.657	0.428	0.281		4192
====	=	===	==========	=======	----------------	----------------	------------------	-------------	-------------		::::::::::::
Total			102,257			180,767	Wtd.Ave.F =		0.648		66237
							A =		0.477		

LFA 35 females, 1992 fishing season

(ALMA only sample)

LENGTH-BASED COHORT ANALYSIS

												(INPUT)	
											Terminal F =	0.2	
											Natural Mortality (m)=	0.147	
											Tc =	0.38	
			(INPUT)	(INPUT)									
Length			Catch	Delta-t	Stock	Mean							
(mm)			(numbers)	(y)	Numbers	Number	F/Z	Z	F	F*C			
141	-	150	684	2.096	1187								
131	-	140	849	2.055	2558	3550	0.619	0.386	0.239	203			
121	-	130	5092	1.983	9112	9946	0.777	0.659	0.512	2607			
116	-	120	5310	0.932	16044	11032	0.766	0.628	0.481	2556			
111	-	115	6652	0.839	25122	16499	0.733	0.550	0.403	2682			
106	-	110	11497	0.726	39925	22498	0.777	0.658	0.511	5875			
101	-	105	11470	0.619	55600	28608	0.732	0.548	0.401	4598			
96	-	100	16974	0.533	77624	34350	0.771	0.641	0.494	8388			
91	-	95	22836	0.486	106839	43395	0.782	0.673	0.526	12017			
86	-	90	30671	0.465	145880	56941	0.786	0.686	0.539	16520			
81	-	85	27497	0.457	184229	73828	0.717	0.519	0.372	10241			
Total			139,531			300,646	Wtd.Ave.F =		**0.471**	65688			
							A =		**0.375**				

LFA 35 females, 1993 fishing season

LENGTH-BASED COHORT ANALYSIS

												(INPUT)	
											Terminal F =	0.2	
											Natural Mortality (m)=	0.147	
											Tc =	0.38	
			(INPUT)	(INPUT)									
Length			Catch	Delta-t	Stock	Mean							
(mm)			(numbers)	(y)	Numbers	Number	F/Z	Z	F	F*C			
141	-	150	100	2.096	174								
131	-	140	1560	2.055	1985	1708	0.861	1.060	0.913	1425			
121	-	130	3001	1.983	6010	6961	0.746	0.578	0.431	1294			
116	-	120	4041	0.932	11150	7472	0.786	0.688	0.541	2186			
111	-	115	5601	0.839	18484	11785	0.764	0.622	0.475	2662			
106	-	110	6723	0.726	27568	16064	0.740	0.566	0.419	2814			
101	-	105	7645	0.619	38107	19688	0.725	0.535	0.388	2968			
96	-	100	10208	0.533	51733	23249	0.749	0.586	0.439	4482			
91	-	95	14550	0.486	70516	28796	0.775	0.652	0.505	7352			
86	-	90	25861	0.465	102050	38589	0.820	0.817	0.670	17331			
81	-	85	37501	0.457	147615	54861	0.823	0.831	0.684	25634			
7070	=	===	==========	=======	----------	----------	----------	----------	----------	:::::::::::			
Total			116,793			209,173	Wtd.Ave.F =		**0.584**	68149			
							A =		**0.442**				

LFA 35 females, 1994 fishing season

LENGTH-BASED COHORT ANALYSIS

												(INPUT)	
											Terminal F =	0.2	
											Natural Mortality (m)=	0.147	
											Tc =	0.38	
			(INPUT)	(INPUT)									
Length			Catch	Delta-t	Stock	Mean							
(mm)			(numbers)	(y)	Numbers	Number	F/Z	Z	F	F*C			
131	-	140	194	2.055	336,026								
121	-	130	520	1.983	1,031	1,188	0.749	0.585	0.438	228			
116	-	120	2080	0.932	3,373	1,786	0.888	1.312	1.165	2423			
111	-	115	1560	0.839	5,451	3,521	0.751	0.590	0.443	691			
106	-	110	2661	0.726	8,836	4,928	0.786	0.687	0.540	1437			
101	-	105	5322	0.619	15,187	6,997	0.838	0.908	0.761	4048			
96	-	100	12714	0.533	29,524	11,045	0.887	1.298	1.151	14635			
91	-	95	34530	0.486	67,192	21,345	0.917	1.765	1.618	55859			
86	-	90	55550	0.465	128,961	42,306	0.899	1.460	1.313	72941			
81	-	85	69386	0.457	209,108	73,199	0.866	1.095	0.948	65772			
======	===	==========	=======	----------	----------	----------	----------	----------	:::::::::::				
Total			184,517			166,315	Wtd.Ave.F =		**1.182**	218033			
							A =		**0.693**				

LFA 35 females, 1995 fishing season

LENGTH-BASED COHORT ANALYSIS

												(INPUT)	
											Terminal F =	0.2	
											Natural Mortality (m)=	0.147	
											Tc =	0.38	
			(INPUT)	(INPUT)									
Length			Catch	Delta-t	Stock	Mean							
(mm)			(numbers)	(y)	Numbers	Number	F/Z	Z	F	F*C			
151	-	160	520	2.096	902								
131	-	150	520	2.055	1804	2594	0.577	0.347	0.200	104			
121	-	130	922	1.983	3444	4887	0.562	0.336	0.189	174			
116	-	120	2482	0.932	6565	4342	0.795	0.719	0.572	1419			
111	-	115	2498	0.839	10044	6677	0.718	0.521	0.374	935			
106	-	110	4074	0.726	15420	8848	0.758	0.607	0.460	1876			
101	-	105	8299	0.619	25479	11974	0.825	0.840	0.693	5752			
96	-	100	23085	0.533	51341	18891	0.893	1.369	1.222	28212			
91	-	95	61054	0.486	117880	37307	0.918	1.784	1.637	99917			
86	-	90	105108	0.465	234100	75591	0.904	1.537	1.390	146151			
81	-	85	90906	0.457	343632	126708	0.830	0.864	0.717	65221			
====	=	===	==========	=======	----------	----------	----------	----------	----------	:::::::::::			
Total			299,471			297,820	Wtd.Ave.F =		**1.168**	349761			
							A =		**0.689**				

LFA 36 females, 1988 fishing season

LENGTH-BASED COHORT ANALYSIS

(INPUT)
Terminal F = 0.2
Natural Mortality (m)= 0.147
Tc = 0.38

Length (mm)			(INPUT) Catch (numbers)	(INPUT) Delta-t (y)	Stock Numbers	Mean Number	F/Z	Z	F	F*C
131	-	140	482	2.055	837					
121	-	130	4055	1.983	5650	5157	0.843	0.933	0.786	3189
116	-	120	4352	0.932	11064	7225	0.804	0.749	0.602	2621
111	-	115	4735	0.839	17479	11426	0.738	0.561	0.414	1962
106	-	110	4253	0.726	23878	14598	0.665	0.438	0.291	1239
101	-	105	9557	0.619	36044	17754	0.785	0.685	0.538	5144
96	-	100	17395	0.533	56907	23583	0.834	0.885	0.738	12831
91	-	95	47378	0.486	109804	37550	0.896	1.409	1.262	59776
86	-	90	45449	0.465	164222	61016	0.835	0.892	0.745	33853
81	-	85	41295	0.457	218002	84931	0.768	0.633	0.486	20078
7070	=									
Total			178,951			263,241	Wtd.Ave.F =		0.786	140695
							A =		0.544	

LFA 36 females, 1989 fishing season

LENGTH-BASED COHORT ANALYSIS

(INPUT)
Terminal F = 0.2
Natural Mortality (m)= 0.147
Tc = 0.38

Length (mm)			(INPUT) Catch (numbers)	(INPUT) Delta-t (y)	Stock Numbers	Mean Number	F/Z	Z	F	F*C
141	-	160	964	4.216	1673					
131	-	140	1446	2.055	3885	5210	0.654	0.425	0.278	402
121	-	130	3339	1.983	8931	11605	0.662	0.435	0.288	961
116	-	120	3839	0.932	14286	10316	0.717	0.519	0.372	1429
111	-	115	2393	0.839	18670	13539	0.546	0.324	0.177	423
106	-	110	6714	0.726	27766	16204	0.738	0.561	0.414	2782
101	-	105	10572	0.619	41354	20516	0.778	0.662	0.515	5447
96	-	100	16286	0.533	61506	26301	0.808	0.766	0.619	10084
91	-	95	33804	0.486	100797	37326	0.860	1.053	0.906	30614
86	-	90	44250	0.465	153347	56464	0.842	0.931	0.784	34678
81	-	85	30920	0.457	195727	77962	0.730	0.544	0.397	12263
Total			154,528			275,443	Wtd.Ave.F =		0.641	99083
							A =		0.473	

LFA 36 females, 1990 fishing season

LENGTH-BASED COHORT ANALYSIS

(INPUT)
Terminal F = 0.2
Natural Mortality (m)= 0.147
Tc = 0.38

Length (mm)			(INPUT) Catch (numbers)	(INPUT) Delta-t (y)	Stock Numbers	Mean Number	F/Z	Z	F	F*C
151	-	160	964	2.119	1673					
141	-	150	482	2.096	2819	4516	0.421	0.254	0.107	51
131	-	140	2470	2.055	6584	8805	0.656	0.428	0.281	693
121	-	130	3615	1.983	12850	18035	0.577	0.347	0.200	725
116	-	120	4097	0.932	19052	14324	0.661	0.433	0.286	1172
111	-	115	10847	0.839	32921	20554	0.782	0.675	0.528	5725
106	-	110	10907	0.726	47989	28310	0.724	0.532	0.385	4202
101	-	105	12412	0.619	65408	34057	0.713	0.511	0.364	4524
96	-	100	23559	0.533	95015	41147	0.796	0.720	0.573	13488
91	-	95	70067	0.486	174050	61004	0.887	1.296	1.149	80476
86	-	90	79287	0.465	267745	98015	0.846	0.956	0.809	64138
81	-	85	76634	0.457	364975	140108	0.788	0.694	0.547	41916
Total			295,341			468,876	Wtd.Ave.F =		0.735	217109
							A =		0.521	

LFA 36 females, 1991 fishing season

LENGTH-BASED COHORT ANALYSIS

(INPUT)
Terminal F = 0.2
Natural Mortality (m)= 0.147
Tc = 0.38

Length (mm)			(INPUT) Catch (numbers)	(INPUT) Delta-t (y)	Stock Numbers	Mean Number	F/Z	Z	F	F*C
141	-	150	766	2.096	1330					
131	-	140	2114	2.055	4169	4938	0.744	0.575	0.428	905
121	-	130	2880	1.983	8797	11892	0.622	0.389	0.242	698
116	-	120	3943	0.932	14243	10221	0.724	0.533	0.386	1521
111	-	115	3263	0.839	19533	13784	0.617	0.384	0.237	773
106	-	110	9518	0.726	31646	17656	0.786	0.686	0.539	5131
101	-	105	15451	0.619	50654	24197	0.813	0.786	0.639	9866
96	-	100	16686	0.533	71977	31545	0.783	0.676	0.529	8826
91	-	95	57351	0.486	136239	47013	0.892	1.367	1.220	69963
86	-	90	68660	0.465	216352	77904	0.857	1.028	0.881	60514
81	-	85	62801	0.457	295818	113369	0.790	0.701	0.554	34789
Total			243,435			352,518	Wtd.Ave.F =		0.793	192986
							A =		0.547	

LFA 36 females, 1992 fishing season

									(INPUT)	
LENGTH-BASED COHORT ANALYSIS								Terminal F =	0.2	
								Natural Mortality (m)=	0.147	
								Tc =	0.38	
			(INPUT)	(INPUT)						
Length			Catch	Delta-t	Stock	Mean				
(mm)			(numbers)	(y)	Numbers	Number	F/Z	Z	F	F*C
131	-	140	482	2.055	837					
121	-	130	4055	1.983	5650	5157	0.843	0.933	0.786	3189
116	-	120	4352	0.932	11064	7225	0.804	0.749	0.602	2621
111	-	115	4735	0.839	17479	11426	0.738	0.561	0.414	1962
106	-	110	4253	0.726	23878	14598	0.665	0.438	0.291	1239
101	-	105	9557	0.619	36044	17754	0.785	0.685	0.538	5144
96	-	100	17395	0.533	56907	23583	0.834	0.885	0.738	12831
91	-	95	47378	0.486	109804	37550	0.896	1.409	1.262	59776
86	-	90	45449	0.465	164222	61016	0.835	0.892	0.745	33853
81	-	85	41295	0.457	218002	84931	0.768	0.633	0.486	20078
Total			178,951			263,241	Wtd.Ave.F =		0.786	140695
							A =		0.544	

LFA 36 females, 1993 fishing season

									(INPUT)	
LENGTH-BASED COHORT ANALYSIS								Terminal F =	0.2	
								Natural Mortality (m)=	0.147	
								Tc =	0.38	
			(INPUT)	(INPUT)						
Length			Catch	Delta-t	Stock	Mean				
(mm)			(numbers)	(y)	Numbers	Number	F/Z	Z	F	F*C
151	-	160	964	2.096	1673					
131	-	150	1446	4.151	4904	12138	0.448	0.266	0.119	172
121	-	130	3339	1.983	10294	13949	0.620	0.386	0.239	799
116	-	120	3839	0.932	15850	11678	0.691	0.476	0.329	1262
111	-	115	2393	0.839	20438	14935	0.522	0.307	0.160	383
106	-	110	6714	0.726	29734	17560	0.722	0.529	0.382	2567
101	-	105	10572	0.619	43509	21791	0.767	0.632	0.485	5129
96	-	100	16286	0.533	63837	27497	0.801	0.739	0.592	9646
91	-	95	33804	0.486	103300	38501	0.857	1.025	0.878	29680
86	-	90	44250	0.465	156028	57670	0.839	0.914	0.767	33953
81	-	85	30920	0.457	198594	79230	0.726	0.537	0.390	12067
7070	=	===	========	========	----------	----------	----------	----------	----------	::::::::::::
Total			154,528			294,947	Wtd.Ave.F =		0.619	95659
							A =		0.462	

LFA 36 females, 1994 fishing season

									(INPUT)	
LENGTH-BASED COHORT ANALYSIS								Terminal F =	0.2	
								Natural Mortality (m)=	0.147	
								Tc =	0.38	
			(INPUT)	(INPUT)						
Length			Catch	Delta-t	Stock	Mean				
(mm)			(numbers)	(y)	Numbers	Number	F/Z	Z	F	F*C
151	-	160	964.316	2.119	1673					
141	-	150	482.158	2.096	2819	4516	0.421	0.254	0.107	51
131	-	140	2470.071	2.055	6584	8805	0.656	0.428	0.281	693
121	-	130	3614.867	1.983	12850	18035	0.577	0.347	0.200	725
116	-	120	4097.025	0.932	19052	14324	0.661	0.433	0.286	1172
111	-	115	10847.235	0.839	32921	20554	0.782	0.675	0.528	5725
106	-	110	10906.517	0.726	47989	28310	0.724	0.532	0.385	4202
101	-	105	12412.273	0.619	65408	34057	0.713	0.511	0.364	4524
96	-	100	23558.552	0.533	95015	41147	0.796	0.720	0.573	13488
91	-	95	70067.034	0.486	174050	61004	0.887	1.296	1.149	80476
86	-	90	79287.315	0.465	267745	98015	0.846	0.956	0.809	64138
81	-	85	76634.131	0.457	364975	140108	0.788	0.694	0.547	41916
======	===		========	========	----------	----------	----------	----------	----------	::::::::::::
Total			295,341			468,876	Wtd.Ave.F =		0.735	217109
							A =		0.521	

LFA 36 females, 1995 fishing season

									(INPUT)	
LENGTH-BASED COHORT ANALYSIS								Terminal F =	0.2	
								Natural Mortality (m)=	0.147	
								Tc =	0.38	
			(INPUT)	(INPUT)						
Length			Catch	Delta-t	Stock	Mean				
(mm)			(numbers)	(y)	Numbers	Number	F/Z	Z	F	F*C
141	-	150	766	2.096	1330					
131	-	140	2114	2.055	4169	4938	0.744	0.575	0.428	905
121	-	130	2880	1.983	8797	11892	0.622	0.389	0.242	698
116	-	120	3943	0.932	14243	10221	0.724	0.533	0.386	1521
111	-	115	3263	0.839	19533	13784	0.617	0.384	0.237	773
106	-	110	9518	0.726	31646	17656	0.786	0.686	0.539	5131
101	-	105	15451	0.619	50654	24197	0.813	0.786	0.639	9866
96	-	100	16686	0.533	71977	31545	0.783	0.676	0.529	8826
91	-	95	57351	0.486	136239	47013	0.892	1.367	1.220	69963
86	-	90	68660	0.465	216352	77904	0.857	1.028	0.881	60514
81	-	85	62801	0.457	295818	113369	0.790	0.701	0.554	34789
====	=	===	========	========	----------	----------	----------	----------	----------	::::::::::::
Total			243,435			352,518	Wtd.Ave.F =		0.793	192986
							A =		0.547	

L F A 3 8 females, 1988 fishing season

LENGTH-BASED COHORT ANALYSIS

	(INPUT)
Terminal F =	0.2
Natural Mortality (m)=	0.147
Tc =	0.38

Length (mm)			(INPUT) Catch (numbers)	(INPUT) Delta-t (y)	Stock Numbers	Mean Number	F/Z	Z	F	F*C
161	-	170	54	2.343	93					
151	-	160	107	2.331	253	360	0.669	0.445	0.298	32
141	-	150	375	2.306	781	1045	0.709	0.506	0.359	134
131	-	140	2080	2.260	3449	3999	0.780	0.667	0.520	1082
121	-	130	7080	2.181	12751	15110	0.761	0.616	0.469	3318
116	-	120	7239	0.932	22248	15368	0.762	0.618	0.471	3410
111	-	115	5995	0.839	31452	21824	0.651	0.422	0.275	1647
106	-	110	8924	0.726	44289	26625	0.695	0.482	0.335	2991
101	-	105	11557	0.619	60470	31456	0.714	0.514	0.367	4246
96	-	100	28008	0.533	94258	39323	0.829	0.859	0.712	19949
91	-	95	61632	0.486	164570	59043	0.877	1.191	1.044	64334
86	-	90	115693	0.465	294959	99970	0.887	1.304	1.157	133889
81	-	85	126468	0.457	445203	161747	0.842	0.929	0.782	98884
Total			375,211			475,870	Wtd.Ave.F =		0.890	333915
							A =		0.589	

L F A 3 8 females, 1989 fishing season

LENGTH-BASED COHORT ANALYSIS

	(INPUT)
Terminal F =	0.2
Natural Mortality (m)=	0.147
Tc =	0.38

Length (mm)			(INPUT) Catch (numbers)	(INPUT) Delta-t (y)	Stock Numbers	Mean Number	F/Z	Z	F	F*C
151	-	160	295	2.331	511					
141	-	150	562	2.306	1356	1928	0.665	0.438	0.291	164
131	-	140	2168	2.260	4351	5621	0.724	0.533	0.386	836
121	-	130	5732	2.181	12470	16240	0.706	0.500	0.353	2023
116	-	120	4323	0.932	18856	14028	0.677	0.455	0.308	1332
111	-	115	4925	0.839	26492	18445	0.645	0.414	0.267	1315
106	-	110	7059	0.726	36829	22298	0.683	0.464	0.317	2235
101	-	105	9591	0.619	50264	26152	0.714	0.514	0.367	3517
96	-	100	21521	0.533	76536	32324	0.819	0.813	0.666	14329
91	-	95	58959	0.486	142788	49612	0.890	1.335	1.188	70067
86	-	90	100229	0.465	255764	86712	0.887	1.303	1.156	115854
81	-	85	109037	0.457	385402	140144	0.841	0.925	0.778	84835
Total			324,401			413,504	Wtd.Ave.F =		0.914	296507
							A =		0.599	

L F A 3 8 females, 1990 fishing season

LENGTH-BASED COHORT ANALYSIS

	(INPUT)
Terminal F =	0.2
Natural Mortality (m)=	0.147
Tc =	0.38

Length (mm)			(INPUT) Catch (numbers)	(INPUT) Delta-t (y)	Stock Numbers	Mean Number	F/Z	Z	F	F*C
151	-	160	107	2.331	186					
141	-	150	375	2.306	687	861	0.748	0.583	0.436	163
131	-	140	3470	2.260	4895	5019	0.825	0.838	0.691	2399
121	-	130	6864	2.181	14499	18637	0.715	0.515	0.368	2528
116	-	120	5541	0.932	22465	16497	0.696	0.483	0.336	1861
111	-	115	5027	0.83904	30683	21702	0.612	0.379	0.232	1165
106	-	110	14896	0.72642	49653	27719	0.785	0.684	0.537	8005
101	-	105	15802	0.61878	70740	35946	0.749	0.587	0.440	6947
96	-	100	28028	0.5335	105386	45026	0.809	0.769	0.622	17447
91	-	95	102441	0.48616	218454	72294	0.906	1.564	1.417	145159
86	-	90	128182	0.46527	365475	128155	0.872	1.147	1.000	128210
81	-	85	129965	0.45721	524210	195711	0.819	0.811	0.664	86306
Total			440,699			567,567	Wtd.Ave.F =		0.908	400190
							A =		0.597	

L F A 3 8 females, 1991 fishing season

LENGTH-BASED COHORT ANALYSIS

	(INPUT)
Terminal F =	0.2
Natural Mortality (m)=	0.147
Tc =	0.38

Length (mm)			(INPUT) Catch (numbers)	(INPUT) Delta-t (y)	Stock Numbers	Mean Number	F/Z	Z	F	F*C
151	-	160	311	2.331	539					
141	-	150	1518	2.306	2483	2899	0.781	0.671	0.524	795
131	-	140	2681	2.260	6503	9110	0.667	0.441	0.294	789
121	-	130	6979	2.181	16844	22872	0.675	0.452	0.305	2129
116	-	120	5888	0.932	25520	18965	0.679	0.457	0.310	1828
111	-	115	9411	0.839	38732	25861	0.712	0.511	0.364	3425
106	-	110	9760	0.726	53261	32443	0.672	0.448	0.301	2936
101	-	105	16310	0.619	75217	38405	0.743	0.572	0.425	6927
96	-	100	35566	0.533	117995	49062	0.831	0.872	0.725	25783
91	-	95	65608	0.486	194151	71750	0.862	1.061	0.914	59992
86	-	90	105344	0.465	316012	112361	0.864	1.085	0.938	98766
81	-	85	116777	0.457	457779	169998	0.824	0.834	0.687	80218
Total			376,153			553,725	Wtd.Ave.F =		0.754	283587
							A =		0.529	

LFA 38 females, 1992 fishing season

LENGTH-BASED COHORT ANALYSIS

									(INPUT)	
							Terminal F =		0.2	
							Natural Mortality (m)=		0.147	
								Tc =	0.38	
			(INPUT)	(INPUT)						
Length			Catch	Delta-t	Stock	Mean				
(mm)			(numbers)	(y)	Numbers	Number	F/Z	Z	F	F*C
171		180	618	2.347	1073					
151	-	170	61	4.675	2211	7332	0.053	0.155	0.008	0
141	-	150	767	2.306	3976	6787	0.435	0.260	0.113	87
131	-	140	2537	2.260	8422	12982	0.571	0.342	0.195	496
121	-	130	5833	2.181	18194	26796	0.597	0.365	0.218	1270
116	-	120	5012	0.932	26145	19995	0.630	0.398	0.251	1256
111	-	115	10048	0.839	40106	26626	0.720	0.524	0.377	3791
106	-	110	14997	0.726	60244	34971	0.745	0.576	0.429	6431
101	-	105	16184	0.619	82734	42898	0.720	0.524	0.377	6106
96	-	100	33948	0.533	124458	52901	0.814	0.789	0.642	21785
91	-	95	85137	0.486	221159	78665	0.880	1.229	1.082	92143
86	-	90	138478	0.465	378939	131302	0.878	1.202	1.055	146046
81	-	85	138194	0.457	547052	203527	0.822	0.826	0.679	93834
Total			451,814			644,782	Wtd.Ave.F =		0.826	373245
							A =		0.562	

LFA 38 females, 1993 fishing season

LENGTH-BASED COHORT ANALYSIS

									(INPUT)	
							Terminal F =		0.2	
							Natural Mortality (m)=		0.147	
								Tc =	0.38	
			(INPUT)	(INPUT)						
Length			Catch	Delta-t	Stock	Mean				
(mm)			(numbers)	(y)	Numbers	Number	F/Z	Z	F	F*C
151		160	323	2.331	560					
141		150	848	2.306	1750	2330	0.712	0.511	0.364	308
131	-	140	4405	2.260	7437	8724	0.775	0.652	0.505	2224
121	-	130	4472	2.181	15300	23065	0.569	0.341	0.194	867
116	-	120	6287	0.932	24169	17568	0.709	0.505	0.358	2250
111	-	115	3944	0.839	31475	22870	0.540	0.319	0.172	680
106	-	110	8798	0.726	44185	26608	0.692	0.478	0.331	2909
101	-	105	7838	0.619	56506	30498	0.636	0.404	0.257	2014
96	-	100	26126	0.533	88032	36736	0.829	0.858	0.711	18580
91	-	95	69089	0.486	165545	57302	0.891	1.353	1.206	83301
86	-	90	119466	0.465	299875	101116	0.889	1.328	1.181	141147
81	-	85	159733	0.457	484587	169926	0.865	1.087	0.940	150151
7070	=	===		=======	----------	----------	----------	----------	----------	:::::::::::::
Total			411,328			496,743	Wtd.Ave.F =		0.983	404432
							A =		0.626	

LFA 38 females, 1994 fishing season

LENGTH-BASED COHORT ANALYSIS

									(INPUT)	
							Terminal F =		0.2	
							Natural Mortality (m)=		0.147	
								Tc =	0.38	
			(INPUT)	(INPUT)						
Length			Catch	Delta-t	Stock	Mean				
(mm)			(numbers)	(y)	Numbers	Number	F/Z	Z	F	F*C
151	-	160	323	2.331	560					
141	-	150	1208	2.306	2160	2667	0.755	0.600	0.453	547
131	-	140	3839	2.260	7367	9305	0.737	0.560	0.413	1584
121	-	130	7029	2.181	18092	25138	0.655	0.427	0.280	1966
116	-	120	4978	0.932	25992	19881	0.630	0.397	0.250	1246
111	-	115	6541	0.839	36259	25345	0.637	0.405	0.258	1688
106	-	110	15210	0.726	56184	32081	0.763	0.621	0.474	7211
101	-	105	19414	0.619	81631	41041	0.763	0.620	0.473	9183
96	-	100	72822	0.533	163315	60288	0.892	1.355	1.208	87961
91	-	95	162781	0.486	342675	112787	0.908	1.590	1.443	234935
86	-	90	248603	0.465	622081	209543	0.890	1.333	1.186	294944
81	-	85	285810	0.457	958531	344490	0.849	0.977	0.830	237125
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Total			828,557			882,567	Wtd.Ave.F =		1.060	878390
							A =		0.654	

LFA 38 females, 1995 fishing season

LENGTH-BASED COHORT ANALYSIS

									(INPUT)	
							Terminal F =		0.2	
							Natural Mortality (m)=		0.147	
								Tc =	0.38	
			(INPUT)	(INPUT)						
Length			Catch	Delta-t	Stock	Mean				
(mm)			(numbers)	(y)	Numbers	Number	F/Z	Z	F	F*C
151	-	160	484	2.331	840					
141	-	150	1598	2.306	2998	3802	0.741	0.567	0.420	672
131	-	140	3369	2.260	8001	11120	0.673	0.450	0.303	1021
121	-	130	8848	2.181	21020	28372	0.680	0.459	0.312	2760
116	-	120	6096	0.932	30529	23212	0.641	0.410	0.263	1601
111	-	115	6024	0.839	40850	29228	0.584	0.353	0.206	1242
106	-	110	8210	0.726	54004	33629	0.624	0.391	0.244	2005
101	-	105	12170	0.619	71744	37895	0.686	0.468	0.321	3908
96	-	100	35529	0.533	114201	47127	0.837	0.901	0.754	26785
91	-	95	98901	0.486	224284	76073	0.898	1.447	1.300	128579
86	-	90	162279	0.465	406713	137070	0.890	1.331	1.184	192125
81	-	85	162616	0.457	601810	220959	0.834	0.883	0.736	119678
====	===		==========	=======	----------	----------	----------	----------	----------	:::::::::::::
Total			506,126			648,487	Wtd.Ave.F =		0.949	480375
							A =		0.613	

Bay of Fundy females, 1988 fishing season

LENGTH-BASED COHORT ANALYSIS

	(INPUT)
Terminal F =	0.2
Natural Mortality (m)=	0.147
Tc =	0.38

Length (mm)			Catch (numbers) *(INPUT)*	Delta-t (y) *(INPUT)*	Stock Numbers	Mean Number	F/Z	Z	F	F*C
161	-	170	54	2.343	93					
151	-	160	107	2.331	253	360	0.669	0.445	0.298	32
141	-	150	375	2.306	781	1045	0.709	0.506	0.359	134
131	-	140	3031	2.260	4528	4869	0.809	0.770	0.623	1887
121	-	130	13338	2.181	21307	23400	0.795	0.717	0.570	7603
116	-	120	15186	0.932	40433	26803	0.794	0.714	0.567	8604
111	-	115	14774	0.839	61223	40928	0.711	0.508	0.361	5333
106	-	110	23623	0.726	92724	53590	0.750	0.588	0.441	10413
101	-	105	31616	0.619	134282	67631	0.761	0.614	0.467	14780
96	-	100	57597	0.533	204576	86375	0.819	0.814	0.667	38407
91	-	95	128636	0.486	351908	127186	0.873	1.158	1.011	130102
86	-	90	187085	0.465	568830	202970	0.862	1.069	0.922	172444
81	-	85	192569	0.457	805925	302899	0.812	0.783	0.636	122427
Total			667,992			938,056	Wtd.Ave.F =		0.767	512167
								A =	0.535	

Bay of Fundy females, 1989 fishing season

LENGTH-BASED COHORT ANALYSIS

	(INPUT)
Terminal F =	0.2
Natural Mortality (m)=	0.147
Tc =	0.38

Length (mm)			Catch (numbers) *(INPUT)*	Delta-t (y) *(INPUT)*	Stock Numbers	Mean Number	F/Z	Z	F	F*C
151	-	160	1259	2.331	2184					
141	-	160	562	2.306	3705	6521	0.370	0.233	0.086	48
131	-	140	4553	2.260	10330	14099	0.687	0.470	0.323	1470
121	-	130	13762	2.181	29779	38691	0.708	0.503	0.356	4895
116	-	120	13313	0.932	48177	34585	0.724	0.532	0.385	5125
111	-	115	15982	0.839	71249	48238	0.693	0.478	0.331	5295
106	-	110	27341	0.726	107752	62324	0.749	0.586	0.439	11995
101	-	105	37205	0.619	156527	78703	0.763	0.620	0.473	17588
96	-	100	54859	0.533	225815	98157	0.792	0.706	0.559	30660
91	-	95	118478	0.486	364283	135987	0.856	1.018	0.871	103224
86	-	90	168319	0.465	562820	205568	0.848	0.966	0.819	137820
81	-	85	161937	0.457	768073	294666	0.789	0.697	0.550	88994
Total			617,570			1,017,538	Wtd.Ave.F =		0.659	407114
								A =	0.483	

Bay of Fundy 35 females, 1990 fishing season

LENGTH-BASED COHORT ANALYSIS

	(INPUT)
Terminal F =	0.2
Natural Mortality (m)=	0.147
Tc =	0.38

Length (mm)			Catch (numbers) *(INPUT)*	Delta-t (y) *(INPUT)*	Stock Numbers	Mean Number	F/Z	Z	F	F*C
151	-	160	1071	2.331	1859					
141	-	150	972	2.306	3715	6012	0.524	0.309	0.162	157
131	-	140	6055	2.260	12048	15501	0.727	0.538	0.391	2365
121	-	130	10938	2.181	28958	40621	0.647	0.416	0.269	2946
116	-	120	10682	0.932	44463	32808	0.689	0.473	0.326	3478
111	-	115	18885	0.839	70091	45869	0.737	0.559	0.412	7776
106	-	110	30215	0.726	109457	62246	0.768	0.632	0.485	14667
101	-	105	35160	0.619	156277	79318	0.751	0.590	0.443	15586
96	-	100	63860	0.533	234817	99870	0.813	0.786	0.639	40834
91	-	95	191004	0.486	448475	154106	0.894	1.386	1.239	236738
86	-	90	226177	0.465	712354	256473	0.857	1.029	0.882	199460
81	-	85	222080	0.457	989702	375967	0.801	0.738	0.591	131181
Total			817,102			1,168,793	Wtd.Ave.F =		0.802	655186
								A =	0.551	

Bay of Fundy females, 1991 fishing season

LENGTH-BASED COHORT ANALYSIS

	(INPUT)
Terminal F =	0.2
Natural Mortality (m)=	0.147
Tc =	0.38

Length (mm)			Catch (numbers) *(INPUT)*	Delta-t (y) *(INPUT)*	Stock Numbers	Mean Number	F/Z	Z	F	F*C
151	-	160	311	2.331	539					
141	-	150	2284	2.306	3354	3615	0.811	0.779	0.632	1443
131	-	140	5029	2.260	10382	13596	0.716	0.517	0.370	1860
121	-	130	11495	2.181	27291	36827	0.680	0.459	0.312	3588
116	-	120	10999	0.932	42885	31258	0.705	0.499	0.352	3870
111	-	115	17823	0.839	67192	44113	0.733	0.551	0.404	7201
106	-	110	27220	0.726	103111	59179	0.758	0.607	0.460	12520
101	-	105	41552	0.619	155943	76737	0.786	0.688	0.541	22500
96	-	100	69724	0.533	240499	100892	0.825	0.838	0.691	48185
91	-	95	145532	0.486	407854	148453	0.870	1.127	0.980	142669
86	-	90	195405	0.465	637275	231401	0.852	0.991	0.844	165009
81	-	85	194471	0.457	881079	335602	0.798	0.726	0.579	112689
Total			721,844			1,081,674	Wtd.Ave.F =		0.723	521534
								A =	0.514	

Bay of Fundy females, 1992 fishing season

LENGTH-BASED COHORT ANALYSIS

											(INPUT)
									Terminal F =		0.2
									Natural Mortality (m)=		0.147
									Tc =		0.38
			(INPUT)	(INPUT)							
Length			Catch	Delta-t	Stock	Mean					
(mm)			(numbers)	(y)	Numbers	Number	F/Z	Z	F		F*C
171	-	180	618	2.347	1073						
151	-	170	61	4.675	2211	7332	0.053	0.155	0.008		0
141	-	150	1452	2.306	4755	7427	0.571	0.342	0.195		284
131	-	140	3868	2.260	11017	16287	0.618	0.385	0.238		919
121	-	130	14980	2.181	32102	41531	0.710	0.508	0.361		5403
116	-	120	14674	0.932	52274	37400	0.727	0.539	0.392		5758
111	-	115	21435	0.839	81599	53677	0.731	0.546	0.399		8560
106	-	110	30747	0.726	122815	71218	0.746	0.579	0.432		13274
101	-	105	37211	0.619	173030	88462	0.741	0.568	0.421		15652
96	-	100	68317	0.533	257529	110085	0.808	0.768	0.621		42396
91	-	95	155351	0.486	436235	158875	0.869	1.125	0.978		151906
86	-	90	214598	0.465	687363	248505	0.855	1.011	0.864		185317
81	-	85	206986	0.457	947488	361492	0.796	0.720	0.573		118517
Total			770,297			1,202,292	Wtd.Ave.F =		0.711		547986
							A =		0.509		

Bay of Fundy females, 1993 fishing season

LENGTH-BASED COHORT ANALYSIS

											(INPUT)
									Terminal F =		0.2
									Natural Mortality (m)=		0.147
									Tc =		0.38
			(INPUT)	(INPUT)							
Length			Catch	Delta-t	Stock	Mean					
(mm)			(numbers)	(y)	Numbers	Number	F/Z	Z	F		F*C
151	-	160	1287	2.331	2233						
141	-	150	948	2.306	4213	7017	0.479	0.282	0.135		128
131	-	140	7411	2.260	14281	18077	0.736	0.557	0.410		3038
121	-	130	10813	2.181	31893	46251	0.614	0.381	0.234		2528
116	-	120	14167	0.932	51500	37007	0.723	0.530	0.383		5424
111	-	115	11938	0.839	70772	49886	0.619	0.386	0.239		2857
106	-	110	22236	0.726	101905	60520	0.714	0.514	0.367		8170
101	-	105	26055	0.619	138579	72247	0.710	0.508	0.361		9396
96	-	100	52620	0.533	204096	87736	0.803	0.747	0.600		31559
91	-	95	117443	0.486	339892	124848	0.865	1.088	0.941		110477
86	-	90	189578	0.465	558521	197630	0.867	1.106	0.959		181853
81	-	85	228153	0.457	831404	304285	0.836	0.897	0.750		171069
7070	=	===		=======	----------	----------	----------	----------	----------		:::::::::::
Total			682,649			1,005,504	Wtd.Ave.F =		0.771		526500
							A =		0.538		

Bay of Fundy females, 1994 fishing season

LENGTH-BASED COHORT ANALYSIS

											(INPUT)
									Terminal F =		0.2
									Natural Mortality (m)=		0.147
									Tc =		0.38
			(INPUT)	(INPUT)							
Length			Catch	Delta-t	Stock	Mean					
(mm)			(numbers)	(y)	Numbers	Number	F/Z	Z	F		F*C
151	-	160	1287	2.331	2233.248						
141	-	150	1690	2.306	5,057	7,711	0.599	0.366	0.219		370
131	-	140	6503	2.260	14,427	19,509	0.694	0.480	0.333		2168
121	-	130	11164	2.181	32,491	46,937	0.618	0.385	0.238		2656
116	-	120	11155	0.932	49,013	36,509	0.675	0.453	0.306		3408
111	-	115	18948	0.83904	75,304	49,953	0.721	0.526	0.379		7188
106	-	110	28777	0.72642	113,760	65,837	0.748	0.584	0.437		12578
101	-	105	37148	0.61878	163,047	82,581	0.754	0.597	0.450		16711
96	-	100	109094	0.5335	288,743	112,936	0.868	1.113	0.966		105383
91	-	95	267378	0.48616	584,871	195,584	0.903	1.514	1.367		365525
86	-	90	383441	0.46527	1,019,809	350,323	0.882	1.242	1.095		419689
81	-	85	431830	0.45721	1,533,706	558,280	0.840	0.921	0.774		334021
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Total			1,308,415			1,526,159	Wtd.Ave.F =		0.970		1269696
							A =		0.621		

Bay of Fundy females, 1995 fishing season

LENGTH-BASED COHORT ANALYSIS

											(INPUT)
									Terminal F =		0.2
									Natural Mortality (m)=		0.147
									Tc =		0.38
			(INPUT)	(INPUT)							
Length			Catch	Delta-t	Stock	Mean					
(mm)			(numbers)	(y)	Numbers	Number	F/Z	Z	F		F*C
151	-	160	1004	2.331	1742						
141	-	150	2885	2.306	5727	7481	0.724	0.533	0.386		1112
131	-	140	5483	2.260	14204	20372	0.647	0.416	0.269		1476
121	-	130	12651	2.181	33863	47673	0.644	0.412	0.265		3357
116	-	120	12522	0.932	52026	38376	0.689	0.473	0.326		4086
111	-	115	11786	0.839	71207	50306	0.614	0.381	0.234		2761
106	-	110	21803	0.726	101938	60731	0.709	0.506	0.359		7828
101	-	105	35920	0.619	148828	74629	0.766	0.628	0.481		17288
96	-	100	75301	0.533	238548	98091	0.839	0.915	0.768		57806
91	-	95	217306	0.486	479508	160911	0.902	1.497	1.350		293466
86	-	90	336048	0.465	858347	291097	0.887	1.301	1.154		387940
81	-	85	316324	0.457	1242525	461595	0.823	0.832	0.685		216772
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Total			1,049,031			1,311,261	Wtd.Ave.F =		0.947		993892
							A =		0.612		