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# An Update on the Newfoundland Lobster Fishery and its Recent Management.

# Une mise à jour de la pêche et de la gestion du homard à Terre-Neuve.

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## ABSTRACT

Historical catch and nominal effort for the Newfoundland lobster fishery and for individual lobster fishing areas (LFAs) are reviewed along with catch rate and size composition data from logbooks and at-sea sampling for four localized monitoring sites. Also provided is an evaluation of the status of the egg per recruit doubling objective of the 1998-2002 management plan.



## RÉSUMÉ

On examine ici les prises historiques et l'effort nominal dans l'ensemble de la pêche du homard à Terre-Neuve et dans chaque zone de pêche du homard (ZPP), ainsi que les données sur le taux de prises et la composition des prises selon la taille provenant des journaux de bord et de l'échantillonnage réalisé en mer dans quatre points de surveillance. On présente aussi une évaluation de l'objectif de doublement de la ponte par recrue, qui faisait partie du plan de gestion de 1998-2002.

## INTRODUCTION

In its 1995 report, the FRCC concluded that under the current management regime for lobsters throughout Atlantic Canada the risk of recruitment failure was unacceptably high because of the low level of egg production (Anon. 1995). It recommended that management measures be implemented to reduce the overall level of exploitation on the resource to allow increased egg production. In response, the 1998-2001 Lobster Management Plan for each DFO Region was developed under a directive from the Minister to achieve a doubling of the egg per recruit (E/R) level (an index of relative population egg production).

A series of Lobster Advisory Meetings, at which all stakeholders were represented, was held around Newfoundland during winter 1998. Presented at these were results of analyses indicating the extent to which E/R could be increased by implementation of different management measures. Conservation Harvesting Plans (CHPs) were developed for the 1998 through 2001 fishing seasons which included for all LFAs a 1.5 mm size limit increase from 81 to 82.5 mm carapace length (for which an estimated 56% E/R increase for a 2 mm size limit increase was credited, a commitment by harvesters to conduct v-notching at a rate of 25% annually (for which an estimated 35% E/R increase was credited), and the remainder of the 100% E/R increase was credited to various reductions in nominal effort even though it was considered unlikely that these would result in any reduction in exploitation rate.

A comprehensive review of the Newfoundland lobster fishery and assessment of the status of the resource, along with a stock status report, were provided prior to development of the 4-year management plan that expired at the end of the 2001 fishing season (Ennis et al 1997; Anon, 1998). These can be consulted for historical background, details of biological assessments, scientific context and perspective.

The 1998-2001 management plan was extended to include the 2002 fishing season. This document is intended to provide the basis for SOE Branch input to the development of a new management plan for implementation in the 2003 fishing season. It includes an update of catch and effort statistics by LFA and results from analyses of data from fishery monitoring (logbooks and at-sea sampling of commercial catches) conducted in recent years through cooperative arrangements with harvesters at several sites. A largely qualitative evaluation of the status of the E/R doubling objective of the old management plan is provided.

## LANDINGS AND NOMINAL FISHING EFFORT

Following a 17-year period of decline to around 1238 t in 1972, the downward trend in Newfoundland lobster landings quite unexpectedly reversed and increased rapidly to 2592 t in 1979, continuing generally upward to reach a long-term (since 1905) high of 3207 t in 1992. A new downward trend has developed which saw landings decline to 1756 t in 2000. (Fig. 1) As with the previous trends, this latest is part of a widespread pattern in Atlantic Canada.

The pattern of landings over the past 10 years has varied between LFAs (Fig. 2). The only exception to the overall downward trend is LFA 11 (Fortune Bay) where the high landings since the mid-1970s have continued beyond the early 1990s peak (Fig. 3). This contrasts most markedly with LFA 10 (Placentia Bay) just east on the opposite side of the Burin Peninsula where landings have declined precipitiously (Fig. 3) but historically trends in both areas have been similar. There is no obvious explanation for the difference between these two major producing areas on the south coast. Exploitation rates are very high in Fortune Bay and biological characteristics are undoubtedly very similar to those for Placentia Bay lobsters. The answer to this puzzle may lie in some sort of a more effective postlarval retention/delivery system or mechanism as part of recruitment processes in the immediate area. It could possibly be linked to lower predation pressure in Fortune Bay associated with differences in recovery or distribution patterns of various finfish in the general area.

In LFA 4 (Notre Dame Bay), the major producing area on the east and northeast coasts, landings have also declined precipitiously (Fig.3) whereas in LFA 5 (Bonavista Bay) the decline has been more gradual (Fig. 3).

An increase in total Newfoundland landings to around 2118 t in 2001 and 2275 t in 2002 (quota report and subject to substantive revision) was due mostly to LFA 11, however, increases were recorded for all the major west coast LFAs (13A, 13B, 14A, 14B) (Fig.3 ). These increases on the west coast, however, in contrast to Fortune Bay, followed the period of decline and landings are still well below highs of the early 1990s.

Whether the increased landings that occurred in some areas in 2001 and 2002 was due to greater abundance, increased yield per recruit associated with the 1998 size limit increase or higher overall exploitation rates is difficult to say. These possibilities will be considered further.

Despite a continuous reduction in number of licences issued, nominal effort (number of licences x trap limit) increased very dramatically from the mid-1980s to an all-time high in 1992. This increase is associated with a conversion to uniform trap limits (i.e. the same number for each licence) in all LFAs. With ongoing attrition and early retirement of licences as well as some trap limit reductions, this measure of nominal effort has declined from the 1992 high of 1,188,932 traps to 656,690 in 2002 (Fig. 1).

At each of the several advisory meetings held during winter 1998 that were part of the development of the 4-year (1998-2001) management plan for the Newfoundland lobster fishery, there was considerable debate regarding the extent to which nominal fishing

effort had been reduced (through licence retirement, lower trap limits, shorter fishing seasons) and its likely contribution to resource conservation. Stakeholders argued for an unrealistically high credit towards conservation objectives. The science perspective was that the nominal effort reductions had not been sufficiently large to have reduced effective effort (i.e. total trap hauls over the fishing season) enough to have resulted in a reduction in exploitation rate and only the latter would have any conservation merit. Nevertheless, in the Conservation Harvesting Plans that were developed to achieve the egg per recruit (E/R) doubling objective (i.e. a 100% increase) of the 4-year management plan, 9% was credited to the nominal effort reductions.

The long-term study of lobsters at Arnold's Cove (which was terminated in 1998 by withdrawal of stakeholder cooperation) yielded a 20-year time series of annual estimates of standing stock, exploitation rate and total trap hauls (Ennis et al, 1986). Over the period there was considerable inter-annual variation in exploitation rate and trap hauls but no obvious correlation between the two (Fig. 4a). The relationship depicted in Figure 4a indicates that exploitation rate remains quite high over a very broad range of effective fishing effort and only at quite low levels can any significant reduction in exploitation rate be expected. However, a strong positive correlation (r=.67) between effort and standing stock is apparent (Fig. 4b). This quite simply means that more effort is expended when abundance is high.

There clearly has been a reduction in nominal fishing effort (number of licenses X trap limit) in most LFAs over recent years (Fig. 3). Between 1998 and 2002 there was a 25% reduction in the number of licences overall. This has undoubtedly improved economic conditions for remaining licence holders compared to what they otherwise would have been. Elimination of active participants from the fishery, through early retirement, buy back, attrition, etc, is equivalent to increased abundance for those remaining in that they have access to a greater share of the resource. This provides greater incentive to haul all their traps daily, keep them freshly baited, and, through reduced competition for space on the fishing grounds, greater opportunity to move them around, all of which contribute to better quality fishing effort. Further, in most areas of Newfoundland the limited cod fishery is conducted on an IQ basis allowing lobster license holders to extend fishing right up to the end of the season. Although regulated seasons were shortened somewhat in most LFAs prior to and as part of the 1998-2001 management plan, it had been common in most areas for the bulk of the traps in use to be landed 2 or 3 weeks or longer before the end of the season. In effect, in terms of actual fishing days, it is much more likely that seasons have been lengthened.

Despite the reductions in nominal fishing effort in the Newfoundland lobster fishery over recent years, this has not resulted in any reduction in the overall exploitation rate on the standing stock (i.e. the commercially legal component of the population).

## LOBSTER FISHERY MONITORING

Lobster fishery monitoring that had been in place at the time of the last comprehensive review and assessment of the Newfoundland lobster fishery (Ennis et al, 1997) was subsequently terminated due to a combination of federal government downsizing and withdrawal of stakeholder cooperation. More, recently, fishery monitoring activities have been established at stakeholder initiative and carried out through partnering/cooperative

arrangements at Eastport (starting in 1997), around the Connaigre Peninsula (starting in 1999), at Eddies Cove West (starting in 2000) and at Crabbes River – St. David's (starting in 2001). This monitoring includes voluntary logbook completion by a number of harvesters at each site and at-sea sampling of commercial catches by observers throughout the fishing season. The focus in this document will be on results from recent monitoring but may include, where useful for comparison, results from earlier monitoring at certain sites.

## FISHERY MONITORING AT EASTPORT, BONAVISTA BAY (LFA 5)

### Logbooks

For data analysis and results summary purposes, the Eastport co-management zone has been divided into north (Burnside – N. side Eastport Bay), central (S. side Eastport Bay - Salvage) and south (Newman Sound) areas (Figs. 5 and 6, Table 1). Each area is fished by a different group of licence holders but there tends to be some overlap. Analyses of logbook data have been done for each area separately and simply summed to obtain any overall total for the zone.

The rapid decline in catch rate and leveling off of accumulated catch as effort continues to increase (Fig. 7) over the course of the fishing season, as bottom temperature increases rapidly, indicates nearly complete removal of the standing stock each year.

Estimated annual catch for Eastport from 1997 to 2001 (Table 2) is shown with historical landings for Bonavista Bay (LFA 5) and Statistical Sections 11 and 12 (two of the four that make up all of LFA 5) whose common boundary approximately bisects the Eastport zone (Fig. 8).

Standing stock at the start of the fishing season was also estimated using logbook data corrected for temperature change over the fishing season ((Fig 9, Tables 2 and 3) (see Ennis et al 1982, 1986 for details of methodology). Exploitation rates calculated from catch and standing stock estimates (overall, 5-year average = 94%) confirm this indication (Table 2).

Previous lobster fishery monitoring/research conducted at St. Chads-Burnside in the northern area of the current Eastport co-management zone yielded tag-recapture estimates of 63.1% and 65.2% in 1975 and 1976 and 83.9% and 82.3% in 1985 and 1986 (Ennis et al 1989). The trend to higher exploitation rates continued (Fig. 10) and the most recent estimates, albiet using different methods, indicate a continuing very high exploitation rate.

### At-Sea Sampling

A cursory evaluation of the composition of at-sea samples taken early and late in the fishing season indicates a marked reduction in the abundance of commercial lobsters. This is especially evident among females in which the commercial size range in late season samples is dominated by ovigerous and v-notched animals (Fig. 11). The near elimination of the commercially legal component of the population over the course of a fishing season is also evident from a comparison of the relative abundance of

animals in the recruit and recruit +1 size groups (Fig.12). The bulk of the commercial catch of both males and females is made up of recruits. Most lobsters in the recruit size range in a given year would have been smaller than the minimum legal size during the previous fishing season but molted and grew to commercial size during the intervening summer. A small proportion would be animals that reached this size in a previous year, avoided capture in the fishery but did not molt and grow to larger sizes. The upper limit of the recruit size range is defined by the mean post-molt length of lobsters just smaller than the minimum legal size. Similarly for the recruit +1 size group indicated along with recruits (Fig. 12) for males and females separately.

Using the methodology described by Miller (1987), exploitation rates were estimated for males and females separately from comparative numbers in the recruit and recruit +1 size groups (Table 4). These were consistently very high (96-97%) for males and ranged between 88 and 95% for females. The lower values for females reflects the protection of berried females which allows more to reach larger sizes.

At-sea samples also provide a basis for evaluating the effectiveness of the size limit increase implemented during the 1998 fishing season in terms of additional ovigerous females in the population. The size limit was increased from 81 to 82.5 mm CL on May 25, 1998. With rounding to the nearest 1 mm CL, the new minimum legal size is represented in our at-sea sampling by the 83 mm size and the 81 and 82 mm sizes represent additions to the undersize component of the population. The proportion of ovigerous females at 81 and 82 mm is comparable to that at smaller sizes and substantially greater than in the adjacent commercial sizes (Fig.13). Note, however, that the increasing relative abundance of lobsters over the sublegal size range, associated with increasing retention in commercial traps, is sharply reversed at the 82 mm size. This indicates some harvesting of animals just below the size limit. This is also indicated by the decreasing relative abundance of animals at and just below the upper end of the recruit size range.

## FISHERY MONITORING IN FORTUNE BAY (LFA 11)

### Logbooks

Harvesters participating in lobster fishery monitoring in Fortune Bay since 1999 have been broadly distributed (as indicated by community of residence) from the bottom of the bay and around the Connaigre Peninsula (Fig. 14, Table 5). For analysis and results summary purposes, logbook data collected by those fishing out of communities from Belleoram to Wreck Cove have been pooled and those from other communities treated separately.

The typical rapid decline in catch rate and leveling off of accumulated catch as effort continues to increase (Fig. 15), and as bottom temperature increases rapidly, over the course of the fishing season is evident. This indicates nearly complete removal of the standing stock during the season each year.

### At-Sea Sampling

Comparison of early and late-season at-sea samples shows a marked reduction in the abundance of commercial lobsters (Fig. 16). The near elimination of the commercially legal component of the population over the course of a fishing season is also evident from a comparison of the relative abundance of animals in the recruit and recruit +1 size groups (Fig. 17). Estimates of exploitation rates from the latter have been very high at 98-99% for males since 1999 and for females have ranged from 88 to 93% (Table 6).

The proportion of ovigerous females at 81 and 82 mm CL is comparable to that at smaller sizes and substantially greater than in the adjacent commercial sizes (Fig. 18). As was the intent, the size-limit increase implemented in 1998 has allowed additional females the opportunity to spawn before removal by the fishery.

## FISHERY MONITORING IN ST. JOHNS BAY (LFA 14B)

### Logbooks

Logbook data are available for 1994 and 1995 in addition to those for 2000 and 2001 from the recent initiative to establish basic lobster fishery monitoring in St. John Bay. Harvesters participating operate out of Eddies Cove West and Barr'd Harbour (Fig. 19, Table 7). Their fishing grounds overlap and extend southward and northward of these ports as well as outward to include most of St. John and the nearby smaller islands. For analysis and results summary purposes, the data from both groups have been pooled.

The typical rapid decline in catch rate and leveling off of accumulated catch as effort continues to increase (Fig. 20), and as bottom temperature increases rapidly, over the course of the fishing season is evident. This indicates nearly complete removal of the standing stock during the season each year.

### At – Sea Sampling

The near elimination of the commercially legal component of the population over the course of a fishing season is also evident from a comparison of the relative abundance of animals in the recruit and recruit +1 size groups (Fig. 21). Estimates of exploitation rates from the latter have been very high in recent years at 98-99% for males and 88-95% for females (Table 8).

The proportion of ovigerous females at 81 and 82 mm CL is comparable to that at smaller sizes and substantially greater than in the adjacent commercial sizes (Fig. 22).

## FISHERY MONITORING IN ST. GEORGE'S BAY (LFA 13A)

### Logbooks

Logbook data are available for 1994 and 1995 in addition to those for 2001 from the recent initiative to establish basic lobster fishery monitoring in St. George's Bay. Harvesters participating operate out of communities on the south shore of the bay and their fishing grounds extend from hear Highlands in the south to Fischells in the north (Fig. 23, Table 9).

The typical rapid decline in catch rate and leveling off of accumulated catch as effort continues to increase (Fig. 24), and as bottom temperature increases rapidly, over the course of the fishing season is evident. This indicates nearly complete removal of the standing stock during the season each year.

### At-Sea Sampling

The near elimination of the commercially legal component of the population over the course of a fishing season is also evident from a comparison of the relative abundance of animals in the recruit and recruit +1 size groups (Fig. 25). Estimates of exploitation rates from the latter are very high at 94% for males and 92% for females in 2001 (Table 10).

The proportion of ovigerous females at 81 and 82 mm CL is comparable to that at smaller sizes and greater than in the adjacent commercial sizes (Fig. 26).

## CURRENT STATUS OF THE EGG PER RECRUIT DOUBLING OBJECTIVE

Three conservation measures were included in the 1998-2001 management plan as a basis for doubling egg per recruit from current (current conditions defined as an overall average 85% exploitation rate and an 81 mm minimum legal size). These were an increase in minimum legal size from 81 to 82.5 mm carapace length (for which credit was provided for the full 56% E/R increase for a size limit increase to 83 mm), a commitment by stakeholders to voluntarily v-notch at a 25% rate annually (for which a 35% E/R increase was credited), and the remaining 9% was credited to nominal effort reduction more as a good-will gesture than for its conservation merit. This assumed that the exploitation rate on the commercially legal component of the population remained at 85%.

Our capacity to evaluate the extent to which the E/R doubling (i.e. 100% increase) objective has been achieved in the overall Newfoundland fishery is extremely limited and largely qualitative.

That the minor reductions in nominal fishing effort achieved during the years just prior to implementation of the old management plan had not been sufficient to reduce the exploitation rate is well supported by evidence presented previously in this document. The estimates of exploitation rate in recent years for four widely separated sites around the island indicate they have remained quite high in most areas and may

actually have increased in others despite the overall 25% reduction in number of licences since 1998.

In the absence of any scientific basis for estimating an overall average exploitation rate for the Newfoundland lobster fishery, for egg per recruit analyses it was assumed to be 85%. Estimates based on tag-recapture methodology close to and sometimes in excess of 90% were usual in some local study sites during the mid 1970's to mid 1990's period whereas estimates around 80% and sometimes less were usual in others. A value of 85% was judged to be a reasonable approximation for the Newfoundland fishery overall. Estimates of E/R increases associated with various management options to increase population egg production were based on the assumption that the exploitation rate on the commercially legal component would remain at 85%. The available evidence indicates that the exploitation rate has been increasing during the recent past throughout the fishery but especially in areas where a moderate rate had been the norm. There appears to have been a general compensatory reaction by fishers to initial losses associated with implementation of conservation measures, superimposed on which has been an economic incentive associated with access to an increased share of the available resource as the number of licences was reduced.

Although simulations demonstrated that poaching on undersize lobsters would significantly reduce the E/R value under any given management regime, it was not factored into the foregoing E/R analyses related to size limit increase or v-notching activity. The implicit assumption was that it at least would not increase following implementation of conservation measures. A size limit increase, in effect, makes more of the resource more readily available and vulnerable to poaching activity. In the same way that access to more of the resource has stimulated effort on commercial lobsters, it is conceivable that effort directed at undersize lobsters has increased. The level of exploitation on undersize lobsters must be considerably lower than on the commercially legal component of the population which means that any increase in effort directed at them would undoubtedly result in their increased removal from the population. However, there is no basis for estimating the level of exploitation on undersize lobsters or the extent to which it may have increased in recent years.

Acceptance of the v-notching commitment was conditional upon validation by way of broad-scale, at-sea sampling by observers during the 2000 and 2001 fishing seasons – this was not done. The only data available for this purpose are from the fishery monitoring carried out recently through cooperative arrangements with stakeholders at Eastport, Bonavista Bay (1998-2002), around the Connaigre Peninsula, Fortune Bay (1999-2001), at Eddies Cove West, St. John Bay (2000-2001), and at Crabbes River-St. David's, St. George's Bay (2001).

V-notching has been practiced at Eastport from at least as early as 1996 and there has been a significant incidence of v-notched lobsters in annual at-sea sampling since it was initiated in 1998. In the 2001 sampling, old notched animals (notched in previous years) made up 31.4% of the combined ovigerous plus old-notched females in the recruit size range (83-92 cm CL) and 83.1% at larger sizes (Fig. 13). Clearly, the vast majority of females that get the chance to spawn at large sizes do so by virtue of the protection from exploitation received from v-notching.

While participation by individual licence holders in the practice of v-notching is voluntary, representatives of stakeholders in all Newfoundland LFAs committed them collectively to v-notch to an extent that would result in at least 25% of the ovigerous females present in the population each year being v-notched over the course of the fishing season. We have estimated the v-notching rate at Eastport to have been 28.4% and 17.6% during the 1999 and 2000 seasons, respectively (Table 11). However, there are some inconsistencies in associated estimates that cannot be reconciled and therefore cast doubt on the veracity of the foregoing. For both years the estimated numbers of old-notched females is considerably lower than the accumulative total of estimated numbers of females notched in previous years. Further, the estimated number of old-notched females present in the population in 2000 was less than half the number estimated for 1999 (Table 11).

The incidence of newly-notched females in annual at-sea sampling at Eastport has been low and variable (Table 12). The seemingly low incidence may be due to a reduced probability of recapture within the same season that a spawner was captured and the v-notch applied. However, the incidence of old-notched females in relation to non-notched ovigerous animals has been quite high and their frequency distribution at commercial sizes compares favorably with one generated from running the egg per recruit model (at a minimum legal size of 83 mm = 82.5 mm CL and 85% exploitation rate) through a sequence of five annual cycles with an assumed v-notching rate of 25% and re-notching before the original notch disappears, i.e. once notched, always notched. In the distribution from the model (Fig. 27), old-notched animals make up 72% of those that get the opportunity to spawn in the recruit size range (83-92 mm CL) and the percentage is greater at larger sizes.

Compared to Eastport, the incidence of old-notched females is very low in at-sea sampling conducted in Fortune, St. John and St. George's bays (Table 12, Figs. 18, 22, 26). This indicates that outside the Eastport co-management area v-notching is not being practiced to any significant extent. This is consistent with the general consensus that most who practiced v-notching in years just prior to implementation of the old management plan stopped doing so as a back-lash to the increase in size limit in 1998. This was in spite of the provision in the plan for a further size limit increase if widespread participation in v-notching could not be validated.

As another measure to address lobster conservation concerns, in 1997 stakeholders at Eastport closed to lobster fishing two small areas within the boundary of their co-management area. Subsequently, local groups established four more lobster closed areas near Random Island, Trinity Bay; at Gander Bay, Notre Dame Bay; at Shoal Point near North Head, Bay of Islands; and near Trout River. Each of these closures resulted from initiatives by local stakeholders totally independent of the overall management plan. The two closed areas at Eastport represent about 1.8% of the lobster habitat in the area. No such estimates are available for the others but collectively these closed areas would represent a much smaller percentage of lobster habitat around Newfoundland. An early estimate suggested that a closed area protecting 1% of a population would increase current E/R (i.e., that at 81mm CL minimum legal size at 85% exploitation rate) by 24%. This was based on the very optimistic assumption that lobsters would not move out of the closed area and running

the E/R model at 0% exploitation rate, a highly questionable use for which the model was not designed.

Empirical estimates (not to be compared with any outports from the E/R model) for one year indicate that total egg production attributable to the Eastport closed areas amounted to 10% of the baseline population (i.e., before implementation of any conservation measures) egg production. While locally significant, the E/R increase that might be attributed to the closed areas that have been established around the island in recent years would be very small overall.

The foregoing indicates that the E/R doubling objective of the old management plan was not achieved. While progress was made it clearly fell far short of expectations, just how short is impossible to quantify with any confidence. Most of the progress can be attributed to the size limit increase but some of the E/R benefit associated with that measure was eroded by an overall increased level of exploitation on the commercially legal component of the population. V-notching has not been practiced throughout the fishery at anything near the 25% rate to which harvesters had committed. Reductions in nominal effort have not resulted in a reduction in exploitation rate. These appear to have stimulated greater effective effort and increased the level of exploitation on commercial lobsters overall.

## OUTLOOK

In its review of lobster conservation in Atlantic Canada, the FRCC concluded that population egg production was too low and the risk of recruitment failure unacceptably high. The E/R doubling objective of the old management plan was basically a strategy to start the process of reducing this risk over a much longer term. It was never considered as being all that would be necessary to eliminate the risk or reduce it to what might be considered acceptable.

Over the past 50 years, major long-term trends in Newfoundland lobster landings have been part of widespread phenomena indicating a strong environmental/ecological influence on recruitment. In Newfoundland as elsewhere, lobsters are very heavily exploited and the bulk of annual landings are made up of animals that recruited to the legal component of the population since the previous year's fishing season. In a production system where recruitment is limited by low egg production, fluctuations in annual landings will be especially subject to the vagaries of nature.

Landings in most LFA's around the island remain at a low point in the downward trend of the past 10 years but in some they have increased somewhat in the past two years. This may represent the early stage of a broader upward trend. However, over the long term, landings can be expected to be lower, on average, less stable, and to decline to lower levels than under a management regime with a lower level of exploitation.

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Table 1. Summary of licence utilization and participation in lobster fishery monitoring at Eastport, 1997-2001.

| Year | NORTH | | | | | CENTRAL | | | | | SOUTH | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | licences | utilization | logs | At-sea sampling | | licences | utilization | logs | At-sea sampling | | licences | utilization | logs | At-sea sampling | |
| | | | | participating | samples | | | | participating | samples | | | | participating | samples |
| 1997 | 15 | 13.4 | 6 | - | - | 20 | 18.3 | 2 | - | - | 14 | 14 | 5 | - | - |
| 1998 | 14 | 12.4 | 6 | 4 | 6 | 19 | 17.3 | 5 | 5 | 15 | 14 | 13.3 | 5 | 6 | 11 |
| 1999 | 14 | 13.1 | 5 | 4 | 7 | 18 | 16.3 | 5 | 6 | 15 | 14 | 12 | 6 | 6 | 11 |
| 2000 | 12 | 11 | 4 | 4 | 7 | 18 | 16.2 | 4 | 9 | 19 | 14 | 12 | 5 | 7 | 13 |
| 2001 | 11 | 8.7 | 1 | 4 | 7 | 17 | 17 | 4 | 5 | 20 | 14 | 12 | 4 | 5 | 16 |

Table 2. Summary of lobster standing stock, catch and exploitation rate estimates from logbook data for Eastport, 1997-2001.

| Year | North | | | Central | | | South | | | Overall - Eastport | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Standing Stock | Catch | Exploitation Rate (%) | Standing Stock | Catch | Exploitation Rate (%) | Standing Stock | Catch | Exploitation Rate (%) | Standing Stock | Catch | Exploitation Rate (%) |
| | | | | | | | | | | | | |
| 1997 | 15,213 | 12,967 | 85.2 | 9,512 | 8,821 | 92.7 | 14,453 | 12,824 | 88.7 | 39,178 | 34,611 | 88.3 |
| 1998 | 14,512 | 14,657 | 101.0 | 14,983 | 15,319 | 102.2 | 18,675 | 18,958 | 101.5 | 48,170 | 48,934 | 101.6 |
| 1999 | 14,063 | 12,369 | 88.0 | 14,801 | 14,302 | 96.6 | 15,369 | 15,075 | 98.1 | 44,233 | 41,746 | 94.4 |
| 2000 | 11,271 | 10,093 | 89.6 | 16,990 | 15,836 | 93.2 | 14,035 | 13,908 | 99.1 | 42,296 | 39,836 | 94.2 |
| 2001 | 13,375 | 10,318 | 77.1 | 15,569 | 14,140 | 90.8 | 11,972 | 11,546 | 96.4 | 40,916 | 36,004 | 88.0 |
| **1997-2001** | **68,434** | **60,404** | **88.3** | **71,855** | **68,418** | **95.2** | **74,504** | **72,311** | **97.1** | **214,793** | **201,131** | **93.6** |

Table 3. Estimates of standing stock (number of commercially legal lobsters at start of fishing season) from Leslie analysis of logbook data at Eastport, 1997-2001.

| Year | NORTH | | | | CENTRAL | | | | SOUTH | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Standing Stock | Lower C.I. (-%) | Upper C.I. (+%) | $r^2$ | Standing Stock | Lower C.I. (-%) | Upper C.I. (+ %) | $r^2$ | Standing Stock | Lower C.I. (-%) | Upper C.I. (+ %) | $r^2$ |
| | | | | | | | | | | | | |
| 1997 | 15,213 | 7.4 | 9.7 | .96 | 9,512 | 10.4 | 16.3 | .90 | 14,453 | 8.7 | 11.9 | .95 |
| 1998 | 14,512 | 9.0 | 13.4 | .92 | 14,983 | 10.5 | 17.8 | .86 | 18,675 | 10.1 | 15.8 | .90 |
| 1999 | 14,063 | 5.8 | 7.4 | .97 | 14,801 | 8.5 | 13.0 | .92 | 15,369 | 9.8 | 15.5 | .91 |
| 2000 | 11,271 | 13.4 | 23.1 | .87 | 16,990 | 13.3 | 23.9 | .86 | 14,035 | 14.4 | 26.4 | .84 |
| 2001 | 13,375 | 14.1 | 24.2 | .89 | 15,569 | 9.2 | 13.3 | .94 | 11,972 | 8.4 | 11.8 | .94 |

Table 4. Estimates of exploitation rate from size frequencies for commercially legal lobsters in at-sea sampling around the Eastport Peninsula, 1998-2001.

| Year | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | Recruit | Recruit +1 | Exploitation Rate (%) | Recruit | Recruit +1 | Exploitation Rate (%) |
| 1998 | 545 | 62 | 96.8 | 423 | 32 | 94.9 |
| 1999 | 699 | 63 | 97.4 | 498 | 62 | 91.6 |
| 2000 | 760 | 100 | 96.2 | 792 | 127 | 89.2 |
| 2001 | 622 | 62 | 97.2 | 593 | 103 | 88.3 |

M1 = number of males in recruit size range (83-95)
M2 = number of males in recruit +1 size range (96-109)

F1 = number of females in recruit size range (83-92)
F2 = number of females in recruit +1 size range (93-102)

tm1 = reciprocal of proportion molting of midpoint male recruit size group (1.4848)
tm2 = reciprocal of proportion molting of midpoint male recruit +1 size group (5.2002)

tf1 = reciprocal of proportion molting of midpoint female recruit size group (1.3587)
tf2 = reciprocal of proportion molting of midpoint female recruit +1 size group (2.0227)

Ex. (for males): Exploitation rate = 1 – (M2/tm2) / (M1/tm1)
Methodology from Miller (1987).
Growth information from Ennis et al (1989).

Table 5. Summary of participation in lobster fishery monitoring in Fortune Bay, 1999 –2001.

| Year | # logbooks completed | At-sea sampling | |
|---|---|---|---|
| | | # harvesters participating | # samples |
| 1999 | 27 | 30 | 59 |
| 2000 | 11 | 21 | 46 |
| 2001 | 10 | 20 | 70 |

Table 6. Estimates of exploitation rate from size frequencies for commercially legal lobsters in at-sea sampling in Fortune Bay, 1999-2001.

| Year | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | Recruit | Recruit +1 | Exploitation Rate (%) | Recruit | Recruit +1 | Exploitation Rate (%) |
| 1999 | 1624 | 59 | 99.2 | 1083 | 105 | 93.3 |
| 2000 | 1796 | 90 | 98.9 | 1084 | 88 | 94.4 |
| 2001 | 2139 | 156 | 98.3 | 1785 | 233 | 90.9 |

M1 = number of males in recruit size range (83-95)
M2 = number of males in recruit +1 size range (96-110)

F1 = number of females in recruit size range (83-92)
F2 = number of females in recruit +1 size range (93-101)

tm1 = reciprocal of proportion molting of midpoint male recruit size group (1.4015)
tm2 = reciprocal of proportion molting of midpoint male recruit +1 size group (6.1200)

tf1 = reciprocal of proportion molting of midpoint female recruit size group (1.3680)
tf2 = reciprocal of proportion molting of midpoint female recruit +1 size group (1.9639)

Ex. (for males): Exploitation rate = 1 – (M2/tm2) / (M1/tm1)
Methodology from Miller (1987).
Growth information from Ennis et al (1986).

Table 7. Summary of participation in lobster fishery monitoring in St. John Bay, 2000 2001.

| Year | # logbooks completed | At-sea sampling | |
|---|---|---|---|
| | | # harvesters participating | # samples |
| 2000 | 7 | 10 | 29 |
| 2001 | 7 | 9 | 32 |

Table 8. Estimates of exploitation rate from size frequencies for commercially legal lobsters in at-sea sampling in St. John Bay, 2000-2001.

| Year | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | Recruit | Recruit +1 | Exploitation Rate (%) | Recruit | Recruit +1 | Exploitation Rate (%) |
| 2000 | 778 | 52 | 99.2 | 611 | 40 | 95.2 |
| 2001 | 972 | 119 | 98.6 | 813 | 136 | 87.6 |

M1 = number of males in recruit size range (83-94)
M2 = number of males in recruit +1 size range (95-108)

F1 = number of females in recruit size range (83-91)
F2 = number of females in recruit +1 size range (92-101)

tm1 = reciprocal of proportion molting of midpoint male recruit size group (2.0105)
tm2 = reciprocal of proportion molting of midpoint male recruit +1 size group (17.0068)

tf1 = reciprocal of proportion molting of midpoint female recruit size group (1.3063)
tf2 = reciprocal of proportion molting of midpoint female recruit +1 size group (1.7643)

Ex. (for males): Exploitation rate = 1 – (M2/tm2) / (M1/tm1)
Methodology from Miller (1987).
Growth information from Ennis et al (1994).

Table 9. Summary of participation in lobster fishery monitoring in St. George's Bay, 2001.

| Year | # logbooks completed | At-sea sampling | |
|---|---|---|---|
| | | # harvesters participating | # samples |
| 2001 | 4 | 10 | 38 |

Table 10. Estimates of exploitation rate from size frequencies for commercially legal lobsters in at-sea sampling in St. George's Bay, 2001.

| Year | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | Recruit | Recruit +1 | Exploitation Rate (%) | Recruit | Recruit +1 | Exploitation Rate (%) |
| 2001 | 1236 | 96 | 94.3 | 1161 | 93 | 92.3 |

M1 = number of males in recruit size range (83-96)
M2 = number of males in recruit +1 size range (97-109)

F1 = number of females in recruit size range (83-93)
F2 = number of females in recruit +1 size range (94-103)

tm1 = reciprocal of proportion molting of midpoint male recruit size group (1.0870)
tm2 = reciprocal of proportion molting of midpoint male recruit +1 size group (1.4925)

tf1 = reciprocal of proportion molting of midpoint female recruit size group (1.0638)
tf2 = reciprocal of proportion molting of midpoint female recruit +1 size group (1.1111)

Ex. (for males): Exploitation rate = 1-(M2/tm2)/(M1/tm1)
Methodology from Miller (1987).
Growth information from Ennis et al (1995).

Table 11. Estimates of numbers and percentages (1999-2000) of female lobsters v-notched at Eastport.

| Season | Number of notched during season[1] | Estimated ovigerous[2] | % notched | Estimated old – notched[2] | Totals notched in previous years |
|---|---|---|---|---|---|
| **1996** | ~ 1500 | | | | |
| **1997** | 1641 | | | | |
| **1998** | 2462 | | | | |
| **1999** | 1960 | 6896 | 28.4 | 2658 | 5603 |
| **2000** | 1634 | 9307 | 17.6 | 1299 | 7563 |

[1] Based on logbook enteries.
[2] From Leslie analysis of logbook data and incidence in early season at-sea sampling.

Table 12. Summary of incidence of v-notched female lobsters in at-sea sampling at Eastport and in Fortune, St. John and St. George's bays.

| Year | Eastport | | | | Fortune Bay | | | | St. John Bay | | | | St. George's Bay | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | # ovig + new-notch | % new-notch | # ovig old-notch | # non-ovig old-notch | # ovig + new-notch | % new-notch | # ovig old-notch | # non-ovig old-notch | # ovig + new-notch | % new-notch | # ovig old-notch | # non-ovig old-notch | # ovig + new-notch | % new-notch | # ovig old-notch | # non-ovig old-notch |
| **1998** | 378 | 16.1 | 29 | 52 | | | | | | | | | | | | |
| **1999** | 537 | 4.3 | 13 | 115 | 1155 | 0.4 | 2 | 11 | | | | | | | | |
| **2000** | 680 | 4.7 | 28 | 55 | 1527 | 0 | 0 | 3 | 707 | 1.4 | 12 | 31 | | | | |
| **2001** | 540 | 1.7 | 25 | 176 | 2430 | 0.5 | 8 | 10 | 1200 | 7.6 | 23 | 59 | 1272 | 0.5 | 0 | 4 |

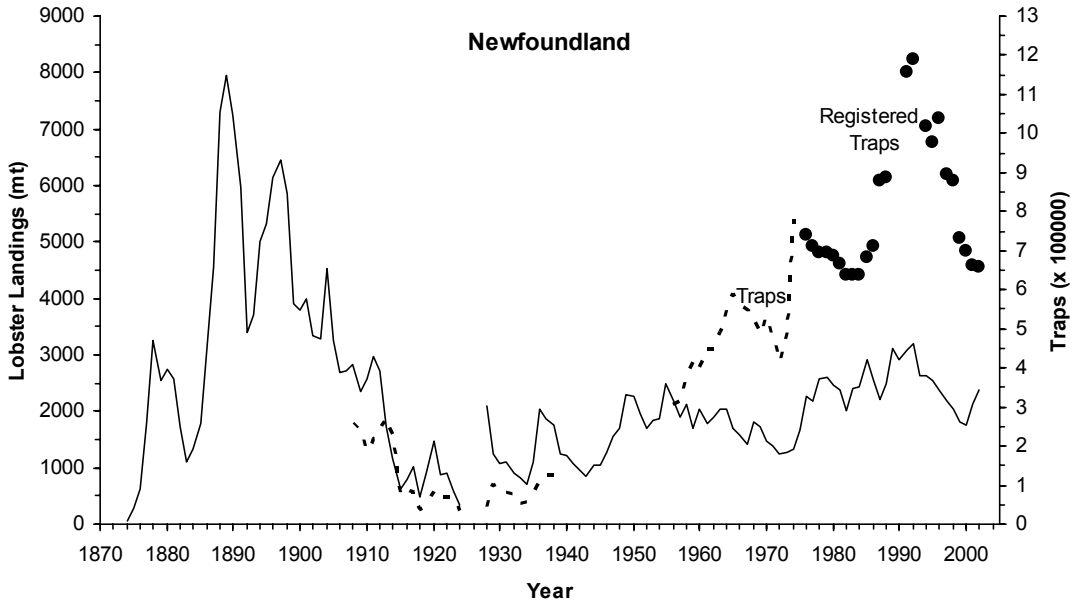


Fig. 1. Historical landings and nominal effort for the Newfoundland lobster fishery.

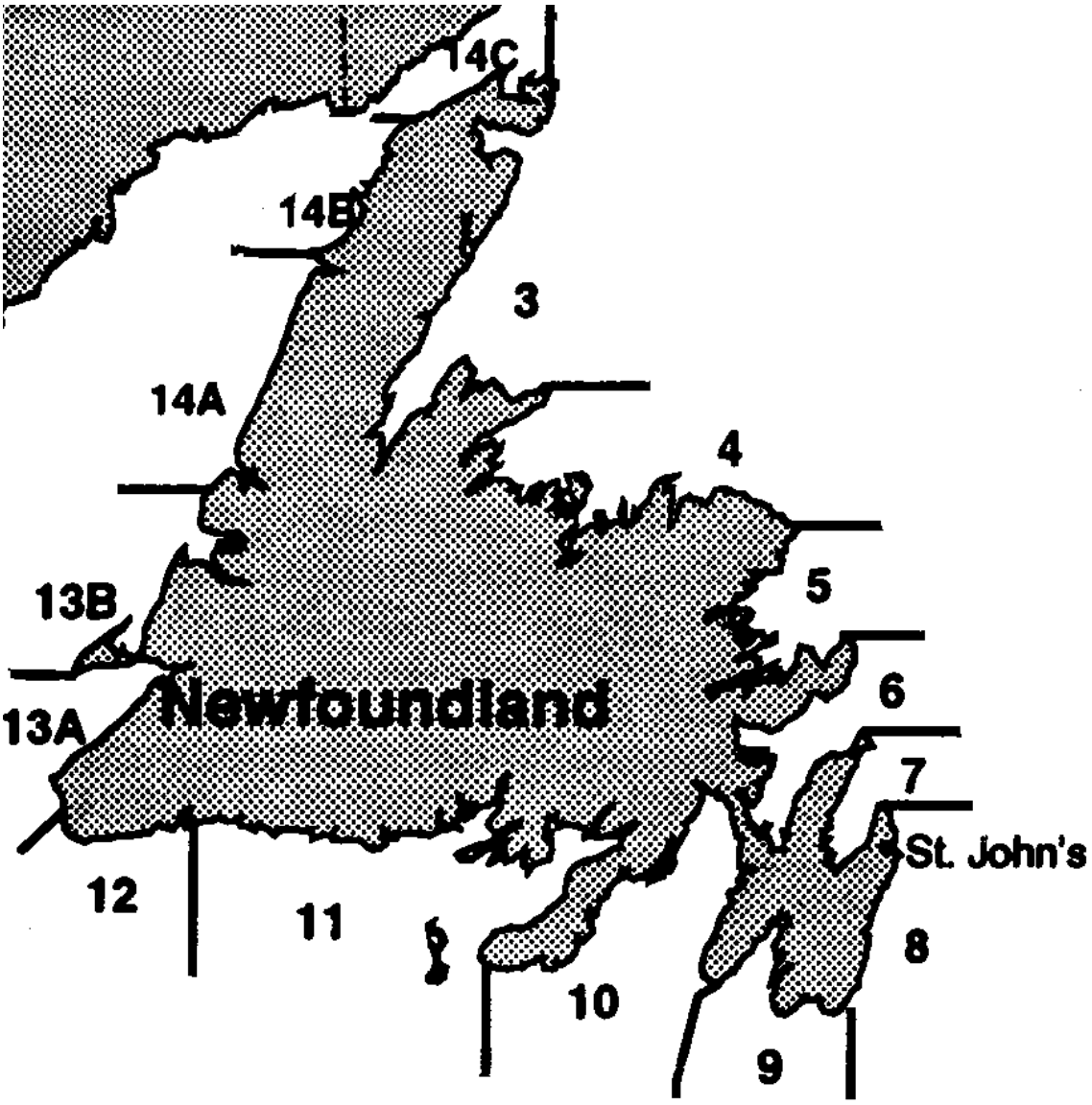


**Fig. 2. Newfoundland Lobster Fishing Areas**

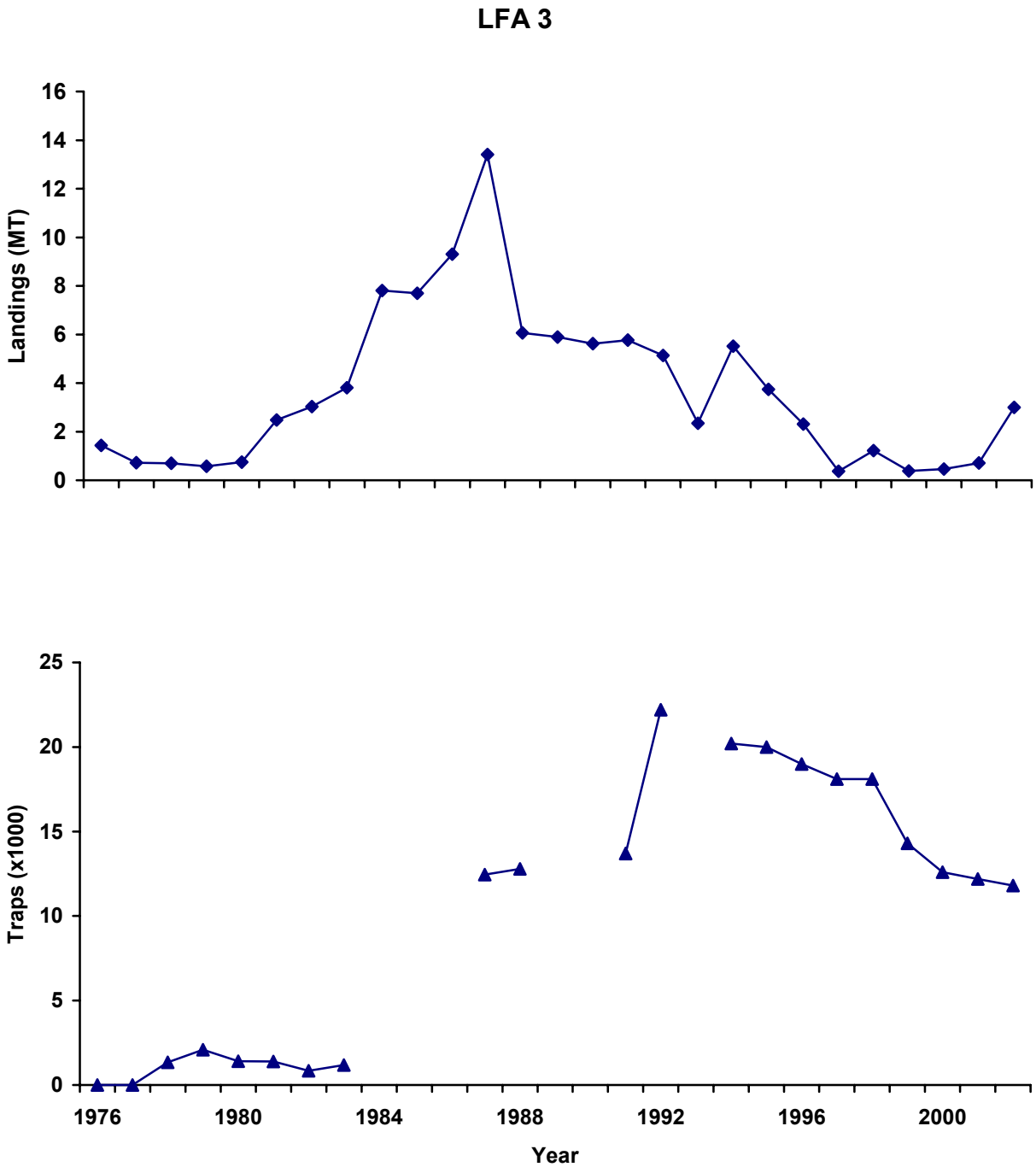


Fig. 3. Historical landings and nominal effort for individual lobster fishing areas (LFAs).

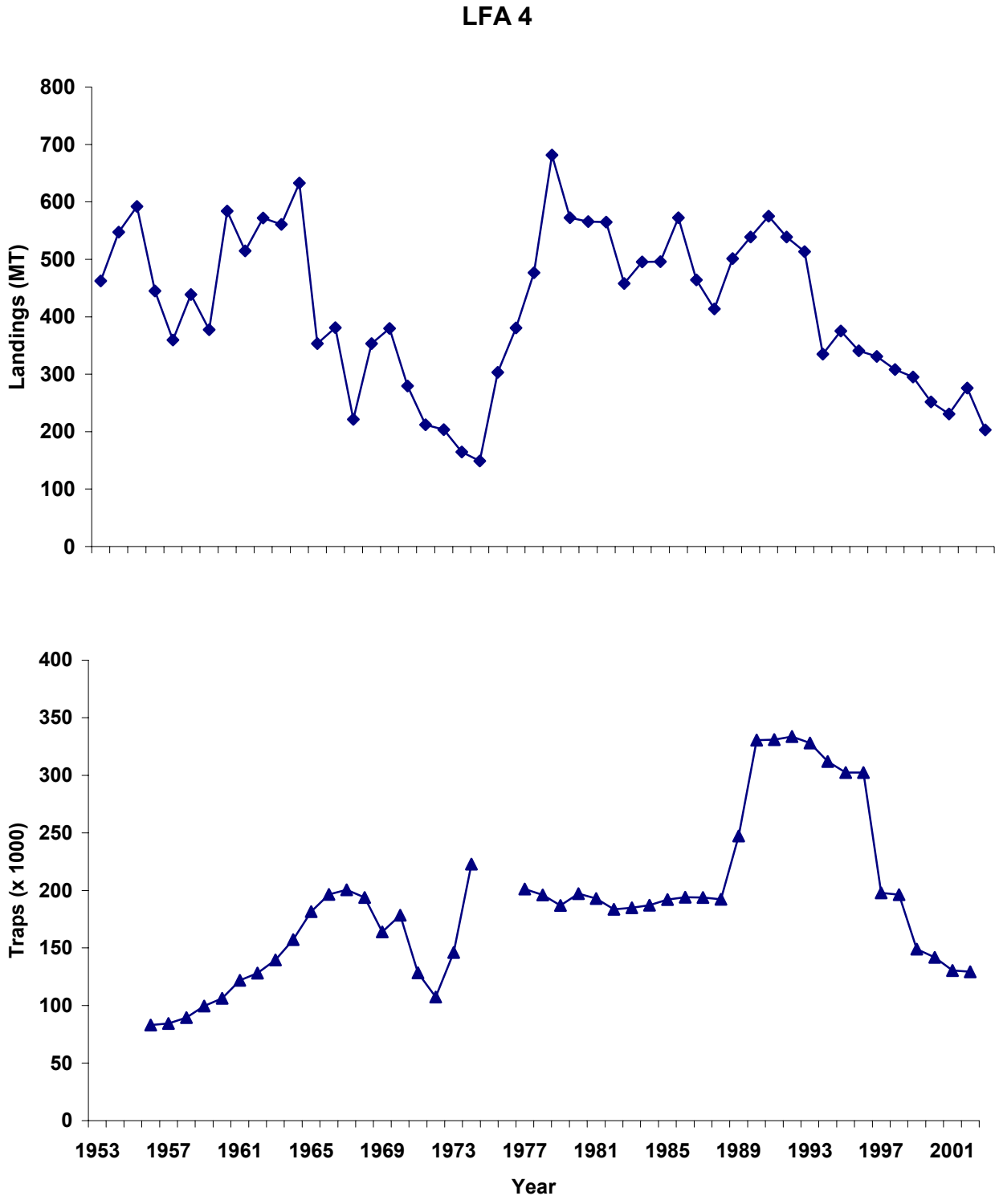


Fig. 3. Continued…

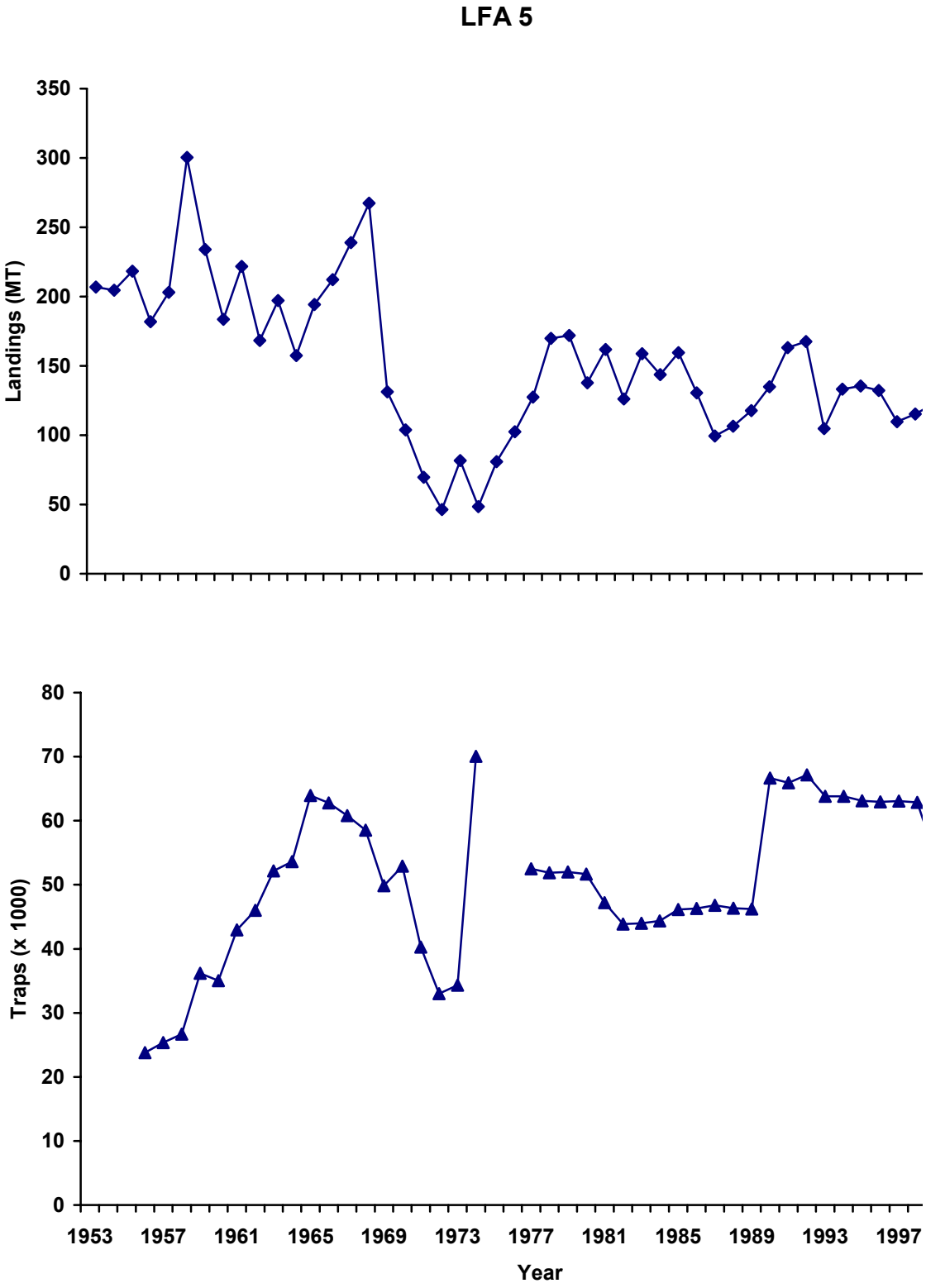


**Fig. 3. Continued…**

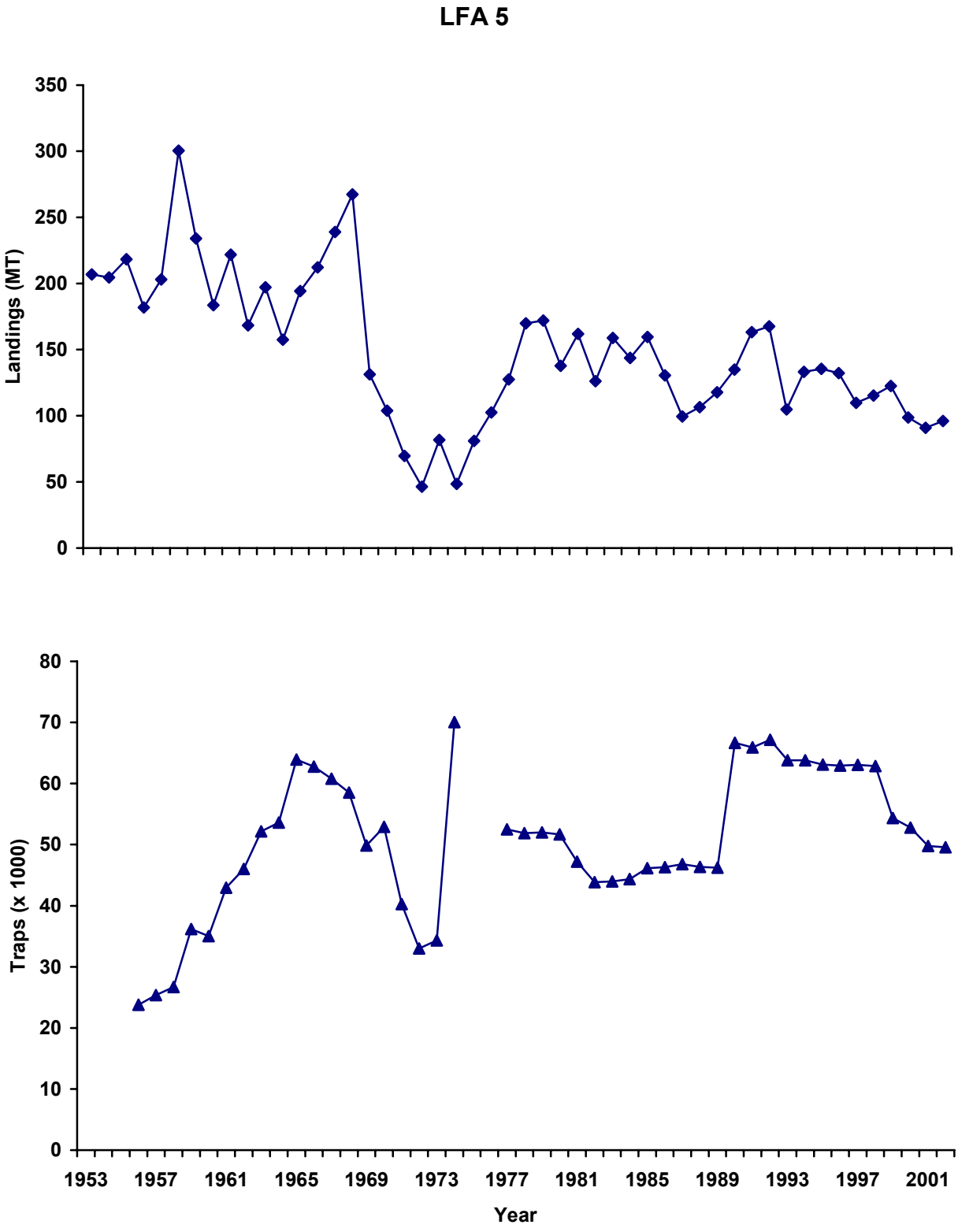


Fig. 3. Continued…

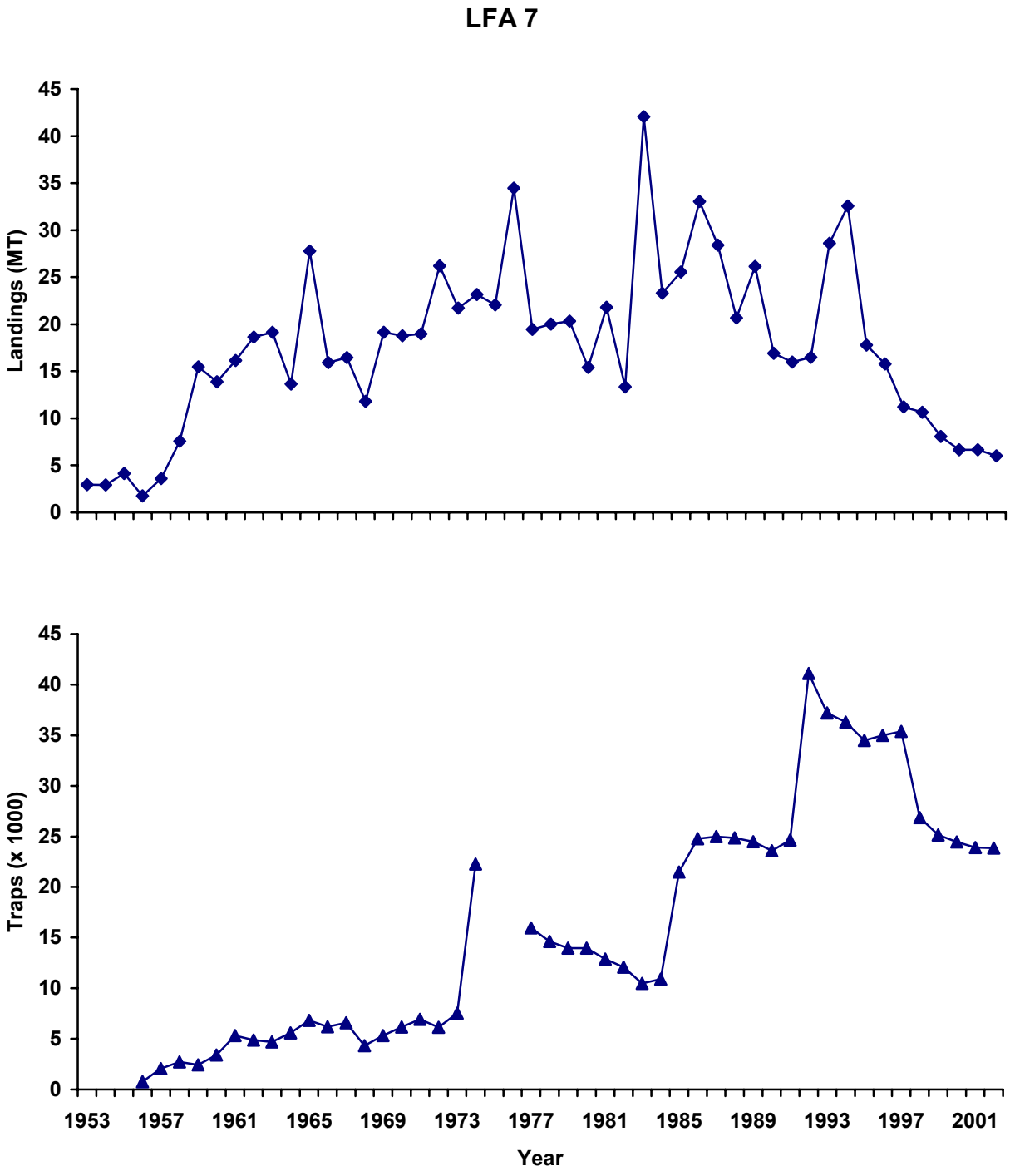


Fig. 3. Continued…

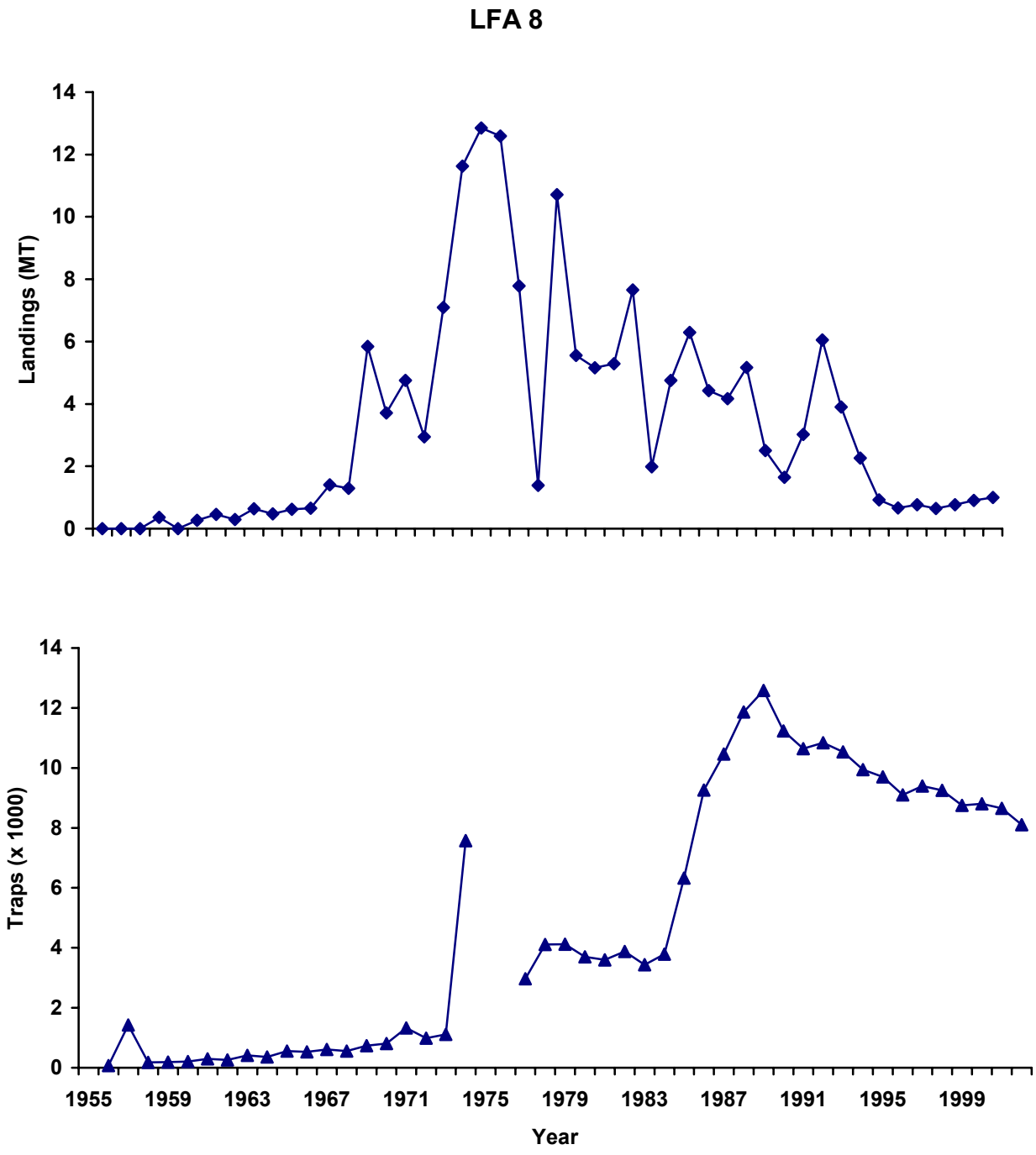


Fig. 3. Continued…

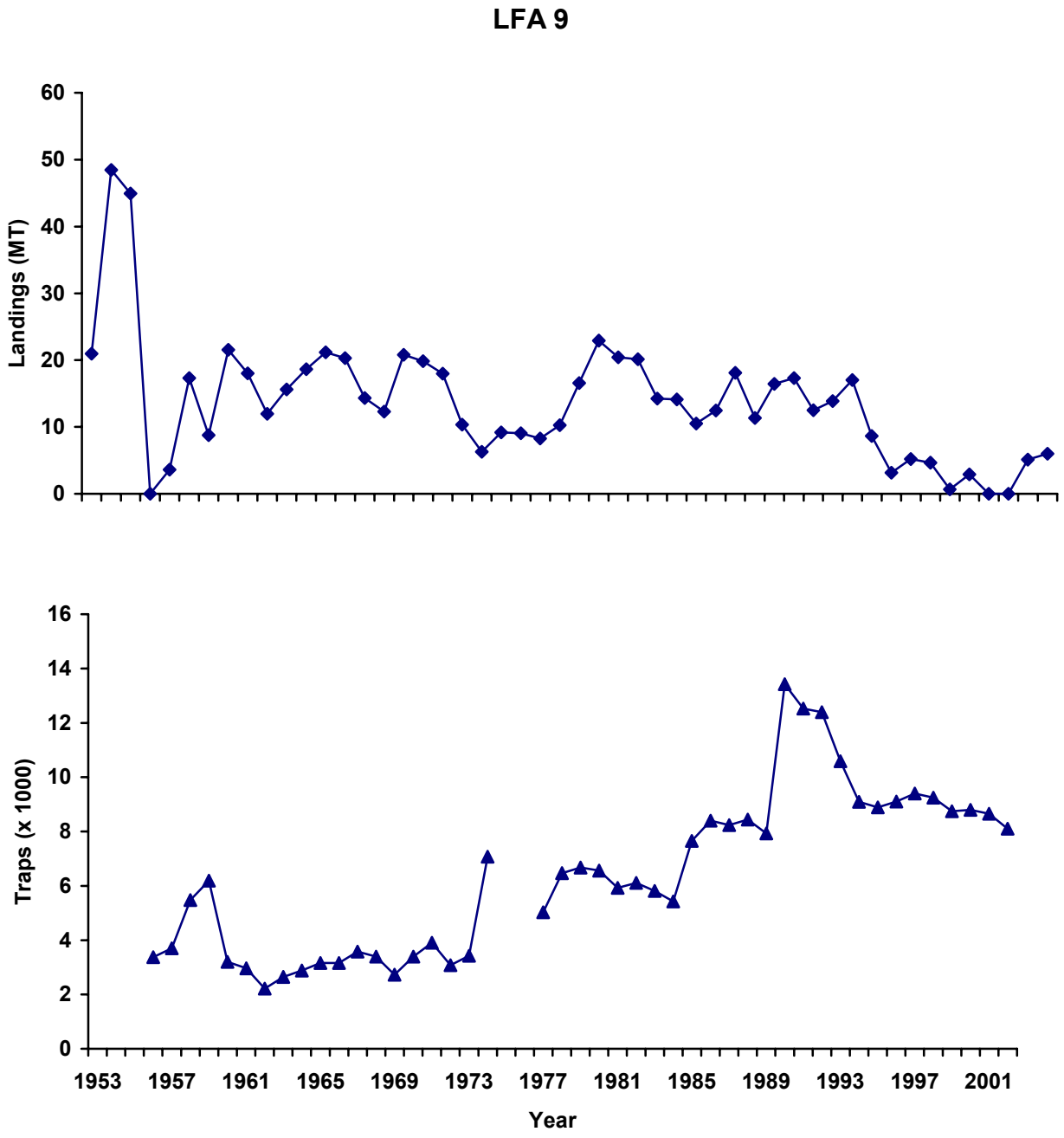


Fig. 3. Continued…

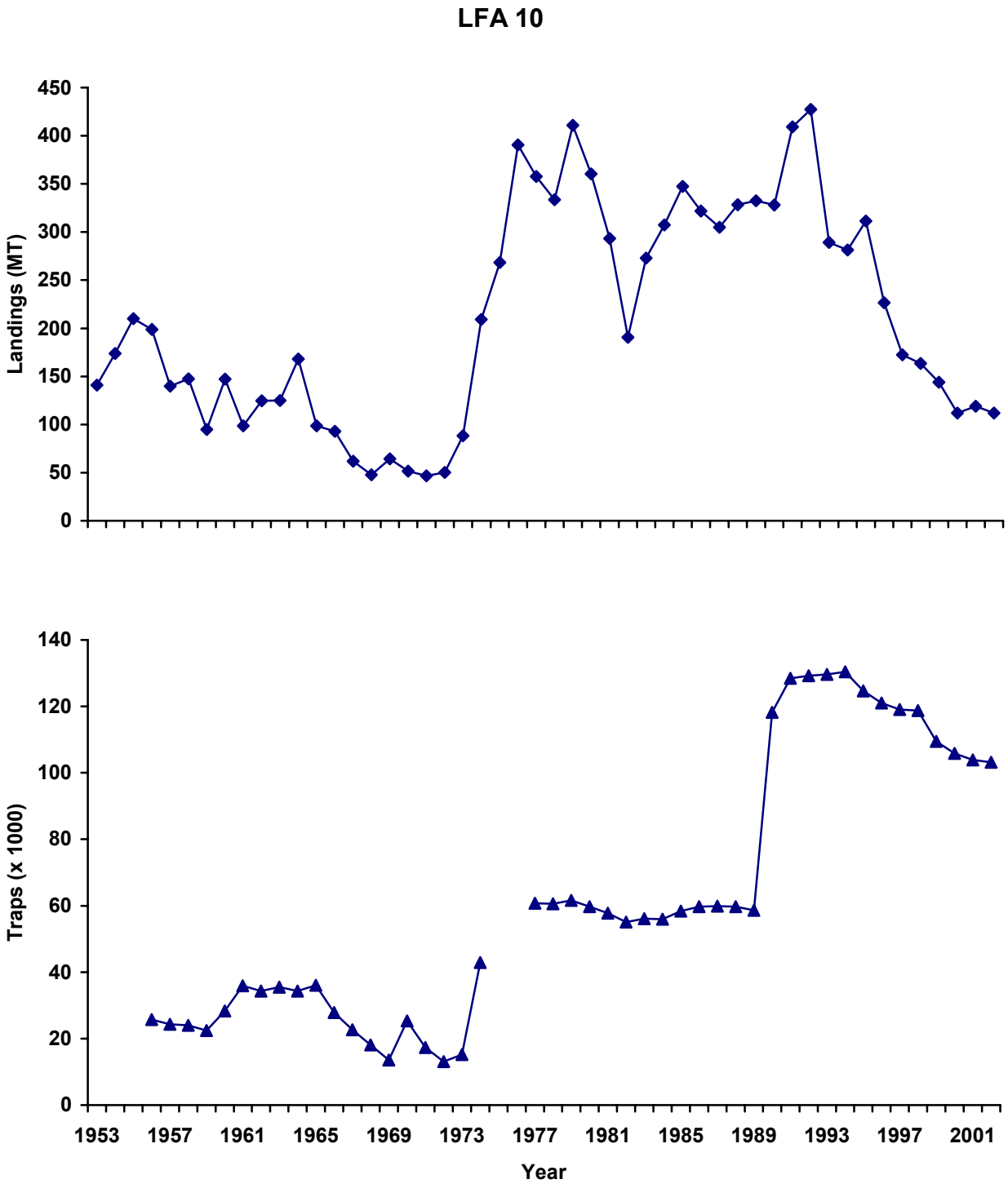


Fig. 3. Continued…

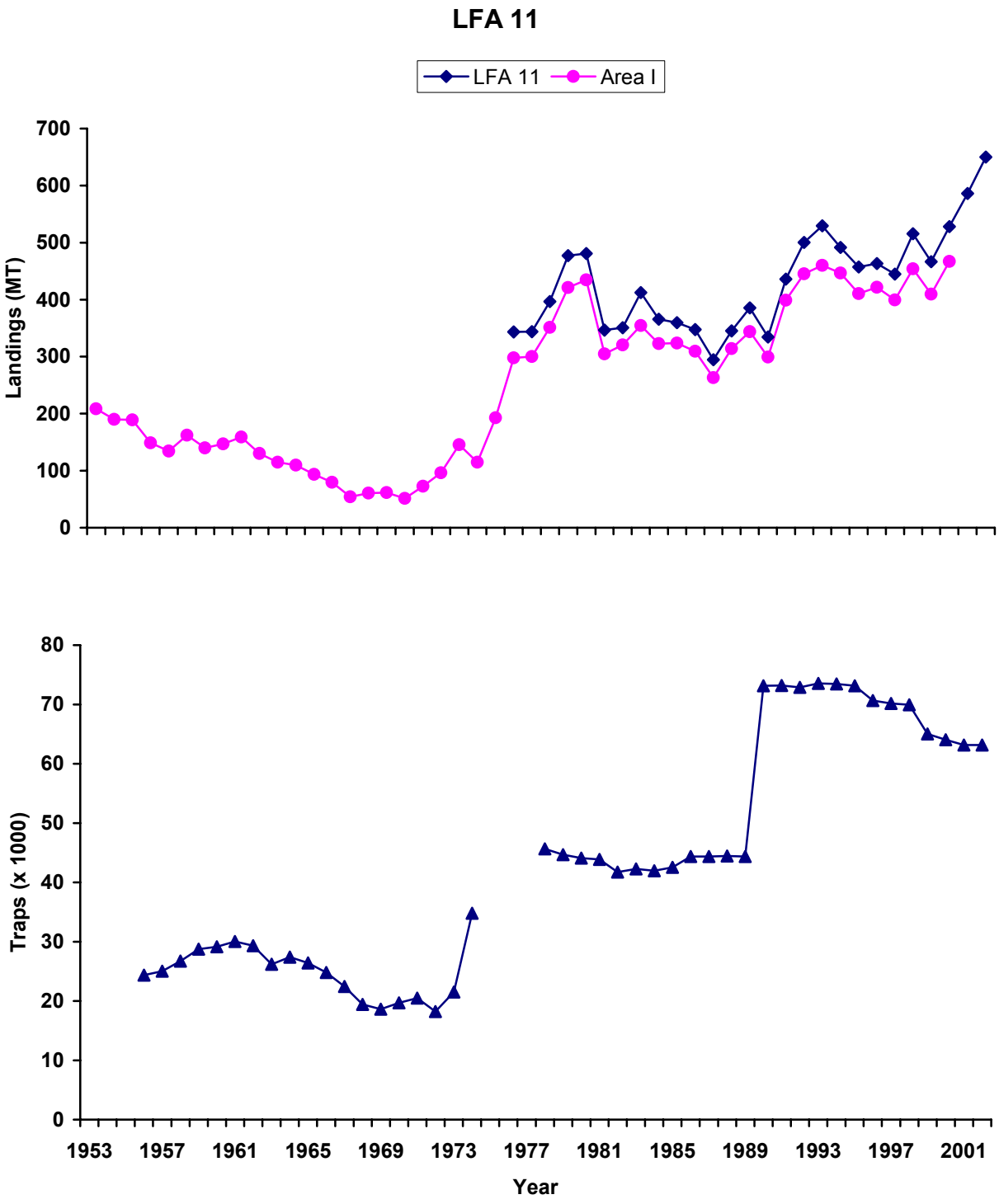


Fig. 3. Continued…

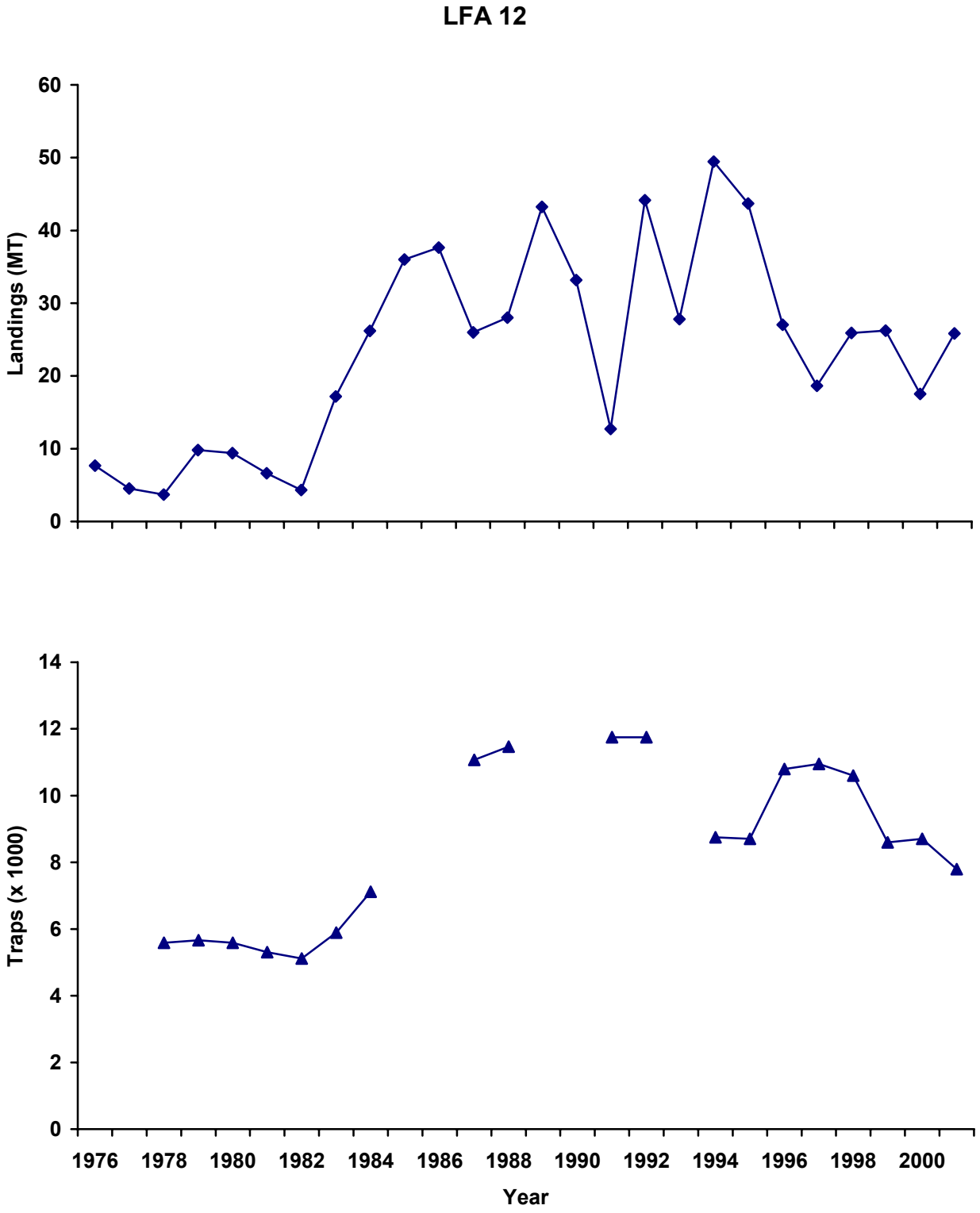


Fig. 3. Continued…

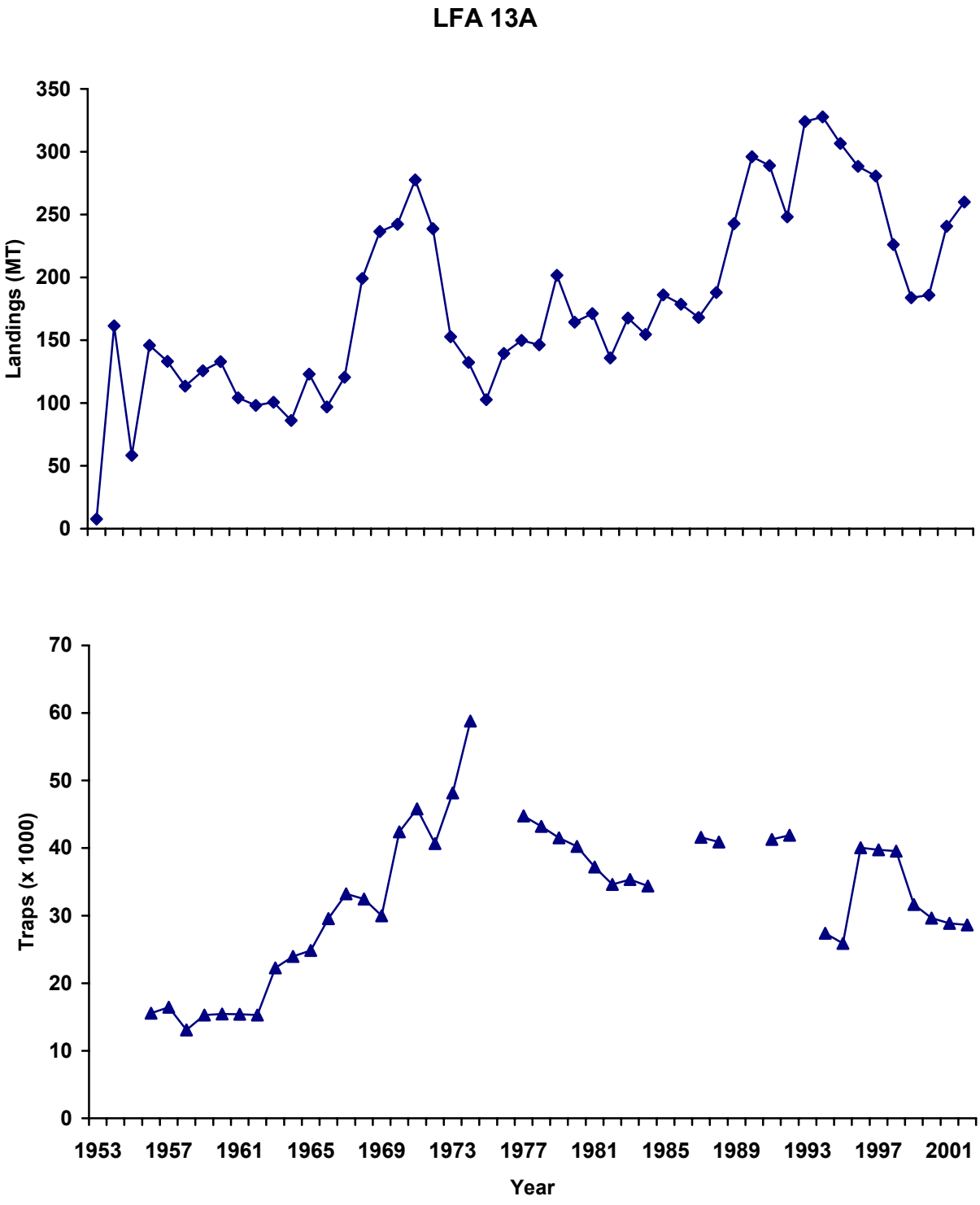


Fig. 3. Continued…

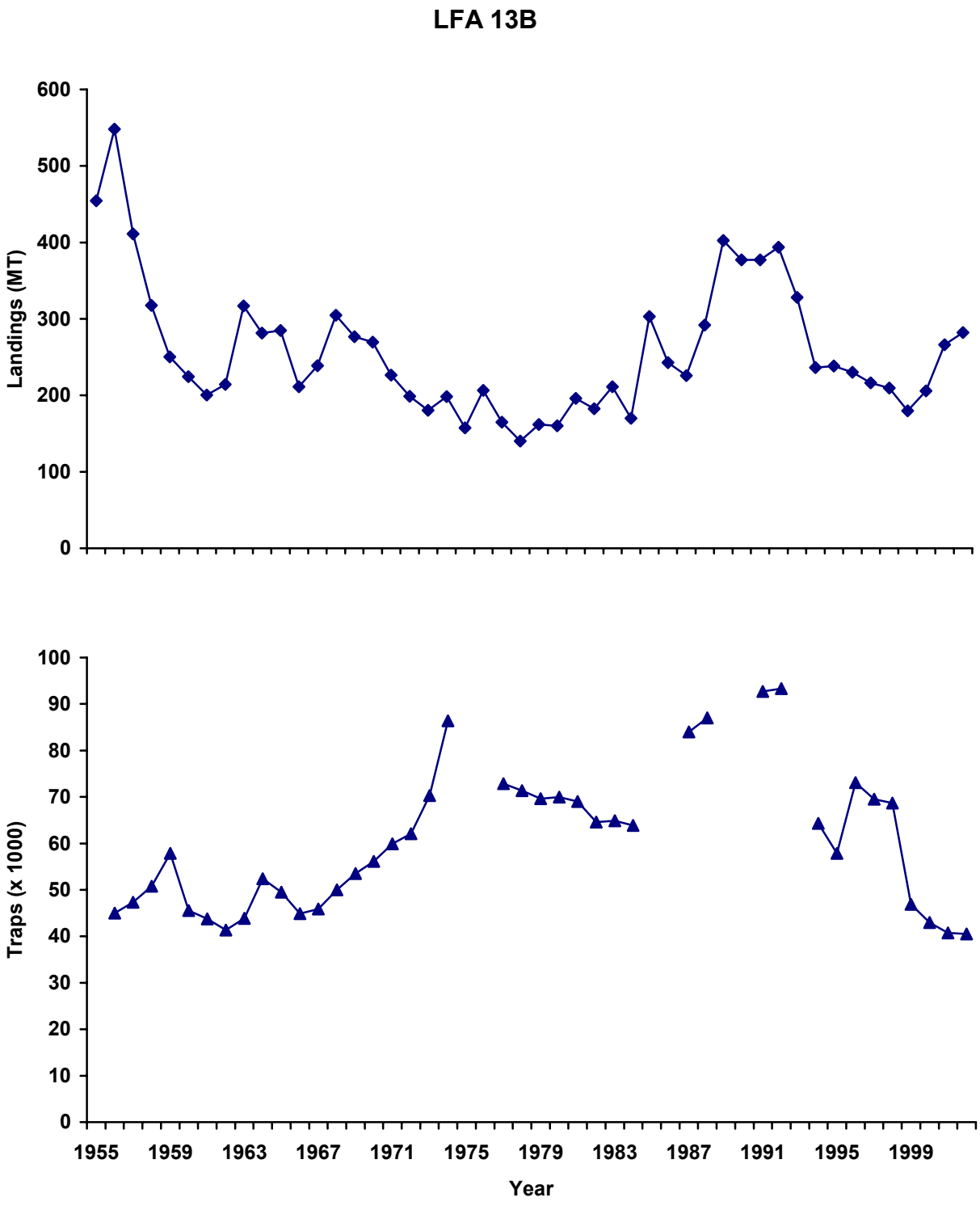


Fig. 3. Continued…

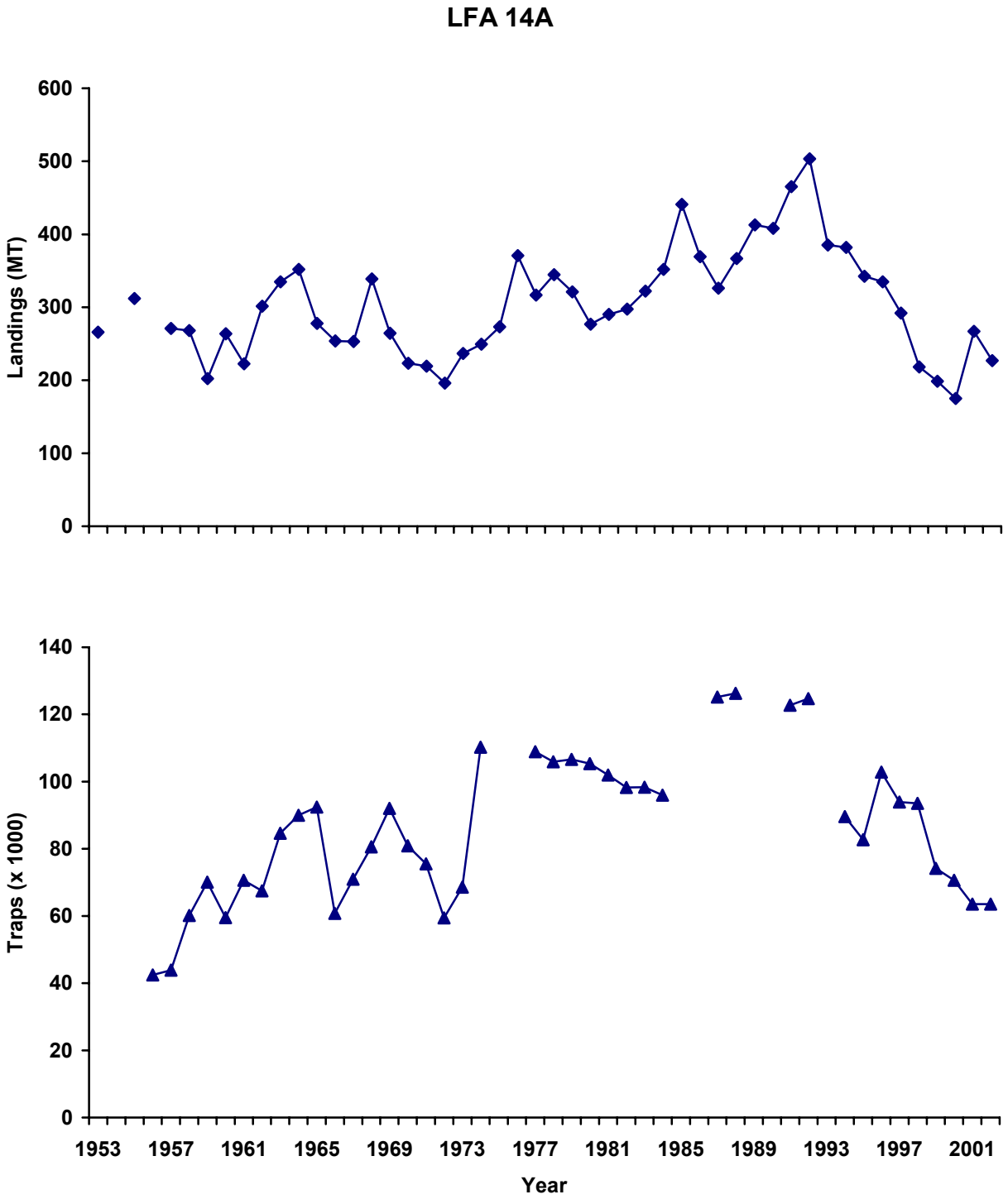


Fig. 3. Continued…

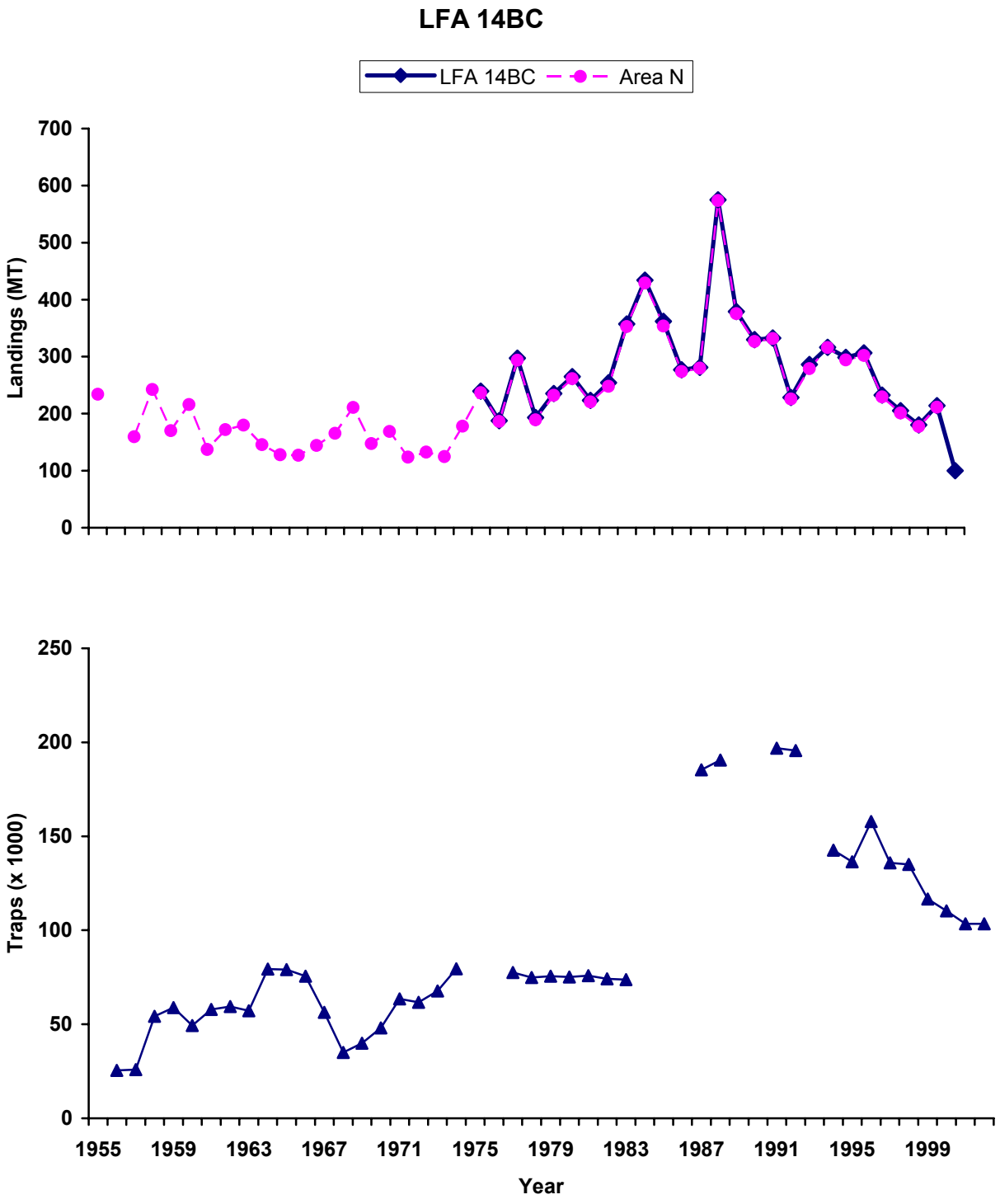


Fig. 3. Continued.

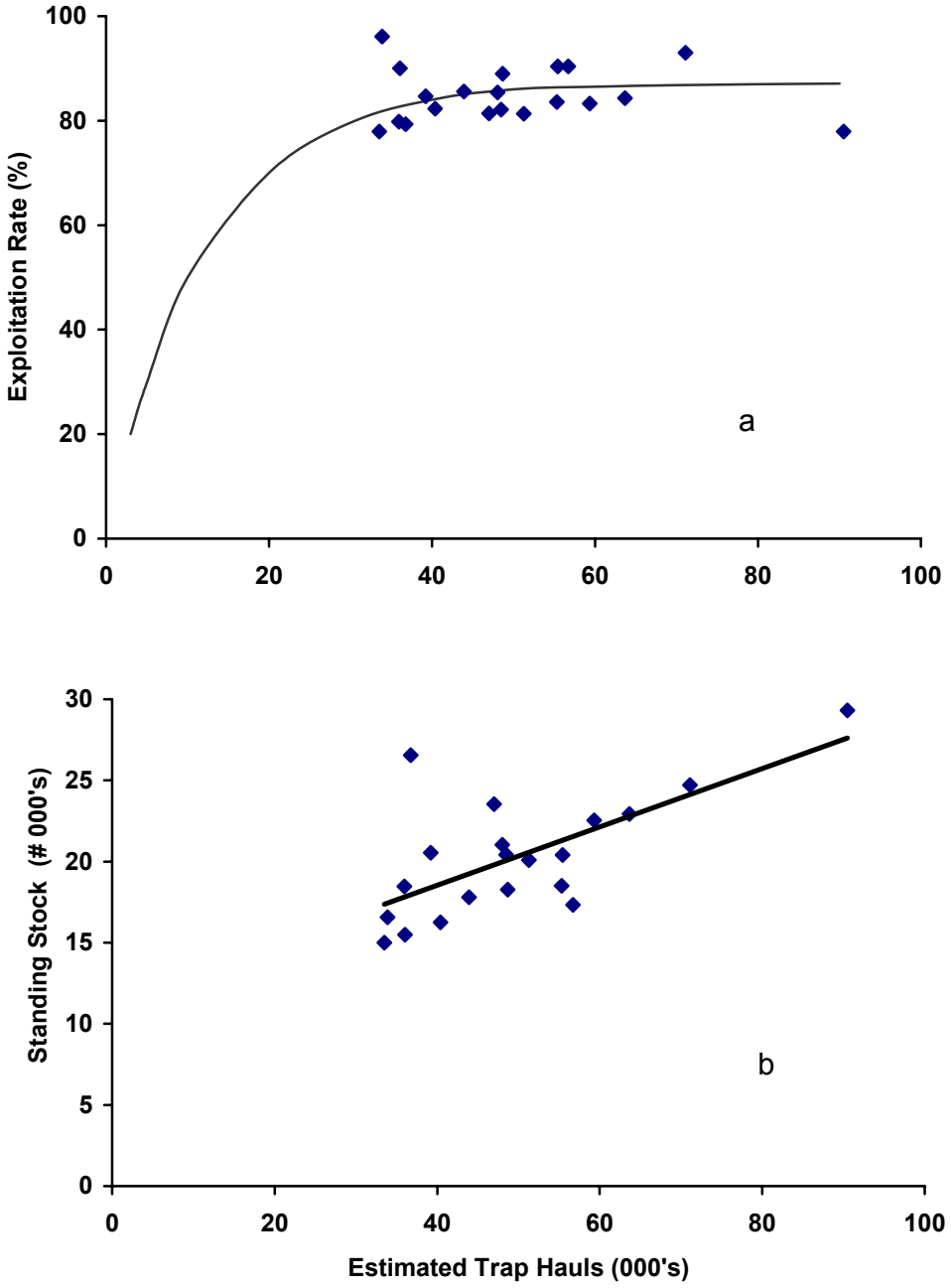


**Fig. 4. Annual estimates of exploitation rate (a) and standing stock (b) versus effective effort for Arnold's Cove, Placentia Bay, 1976-1995.**

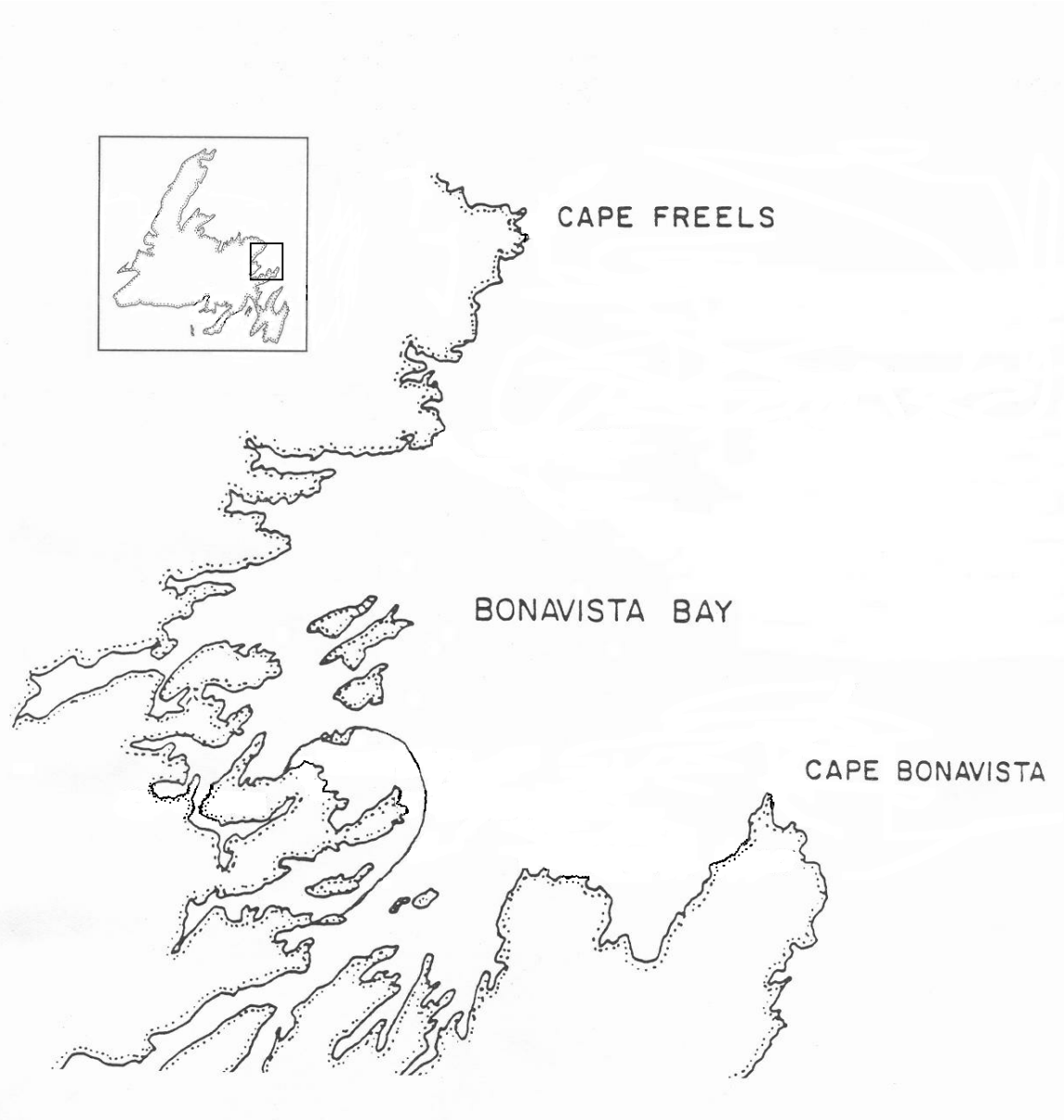


**Fig. 5. Bonavista Bay with the inner boundary of the Eastport Peninsula Lobster Management area indicated.**


**Fig. 6. Eastport management area with fishing ports and closed areas (Duck Islands, Round Island) indicated.**

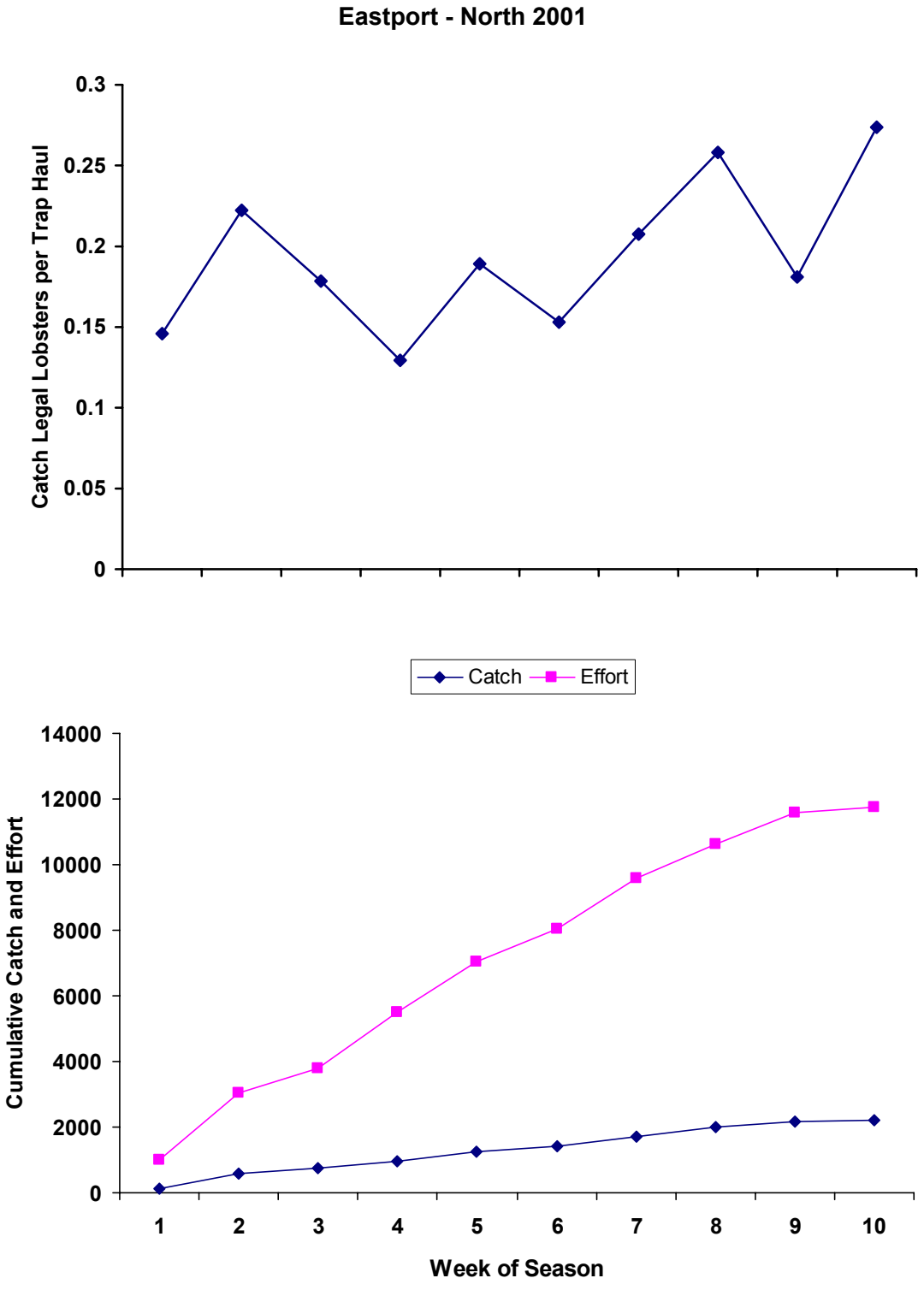


**Fig. 7. Catch rate, cumulative catch and effort over the 2001 fishing season at Eastport.**

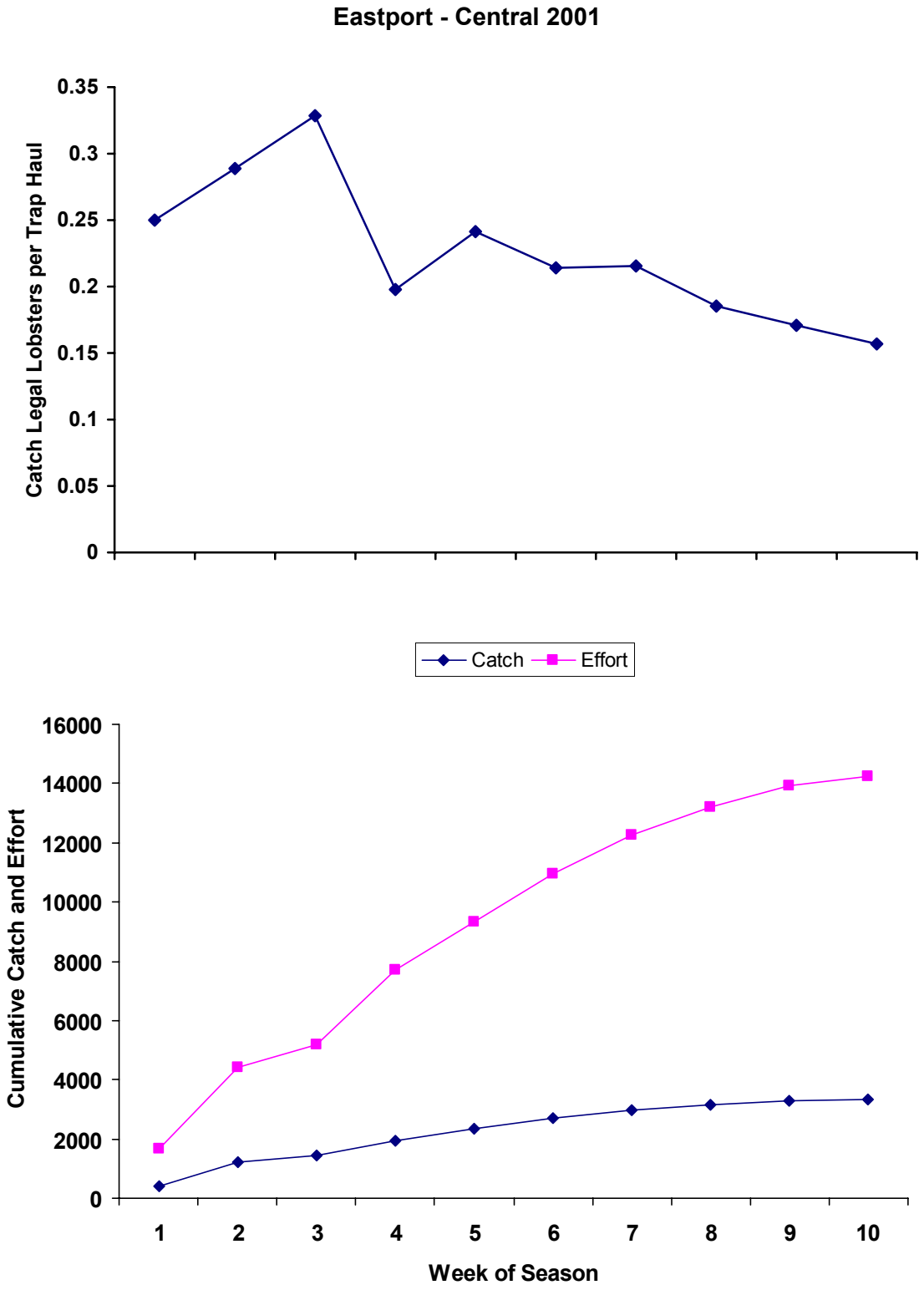


**Fig. 7. Continued…**

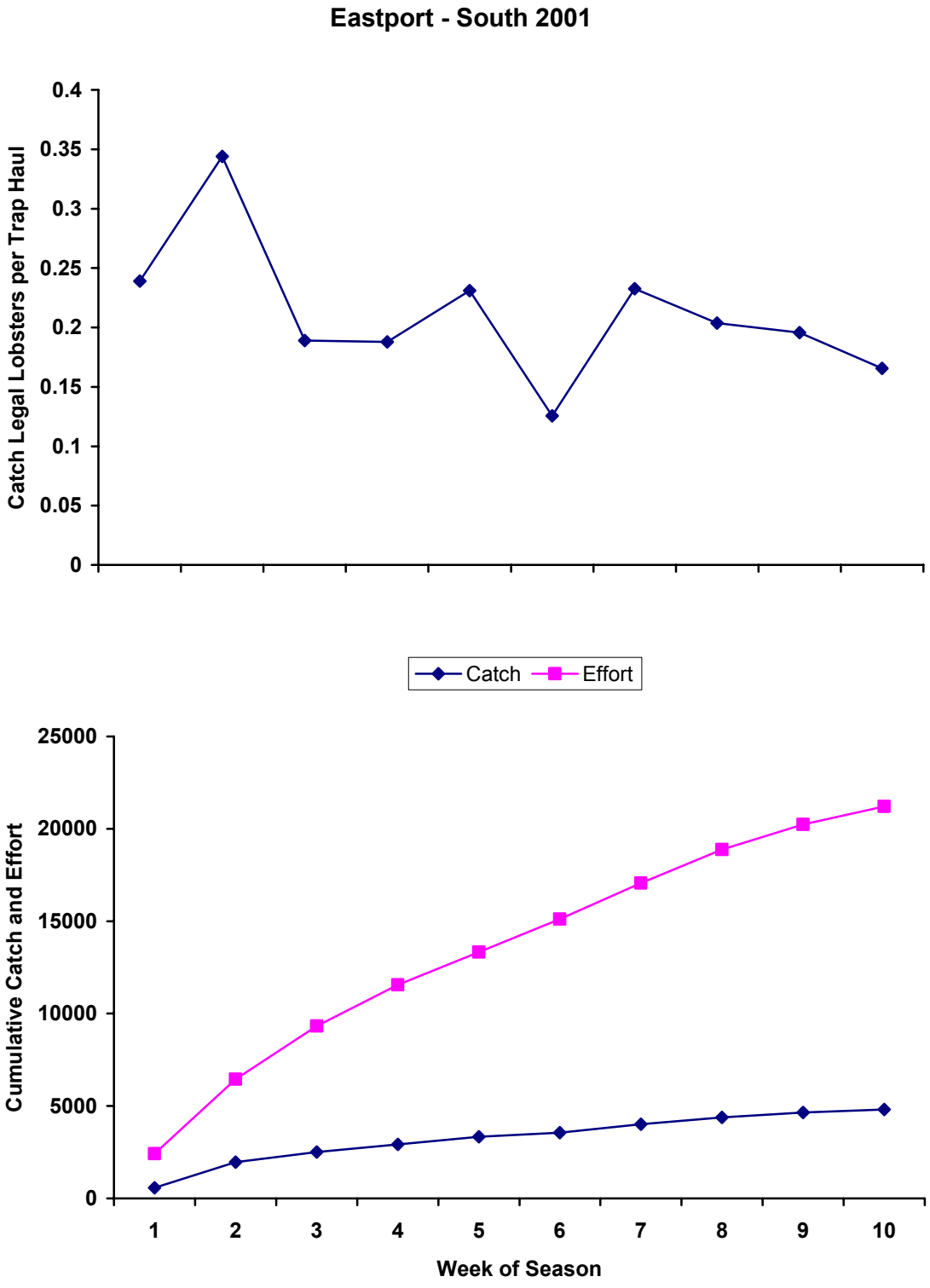


**Fig. 7. Continued.**

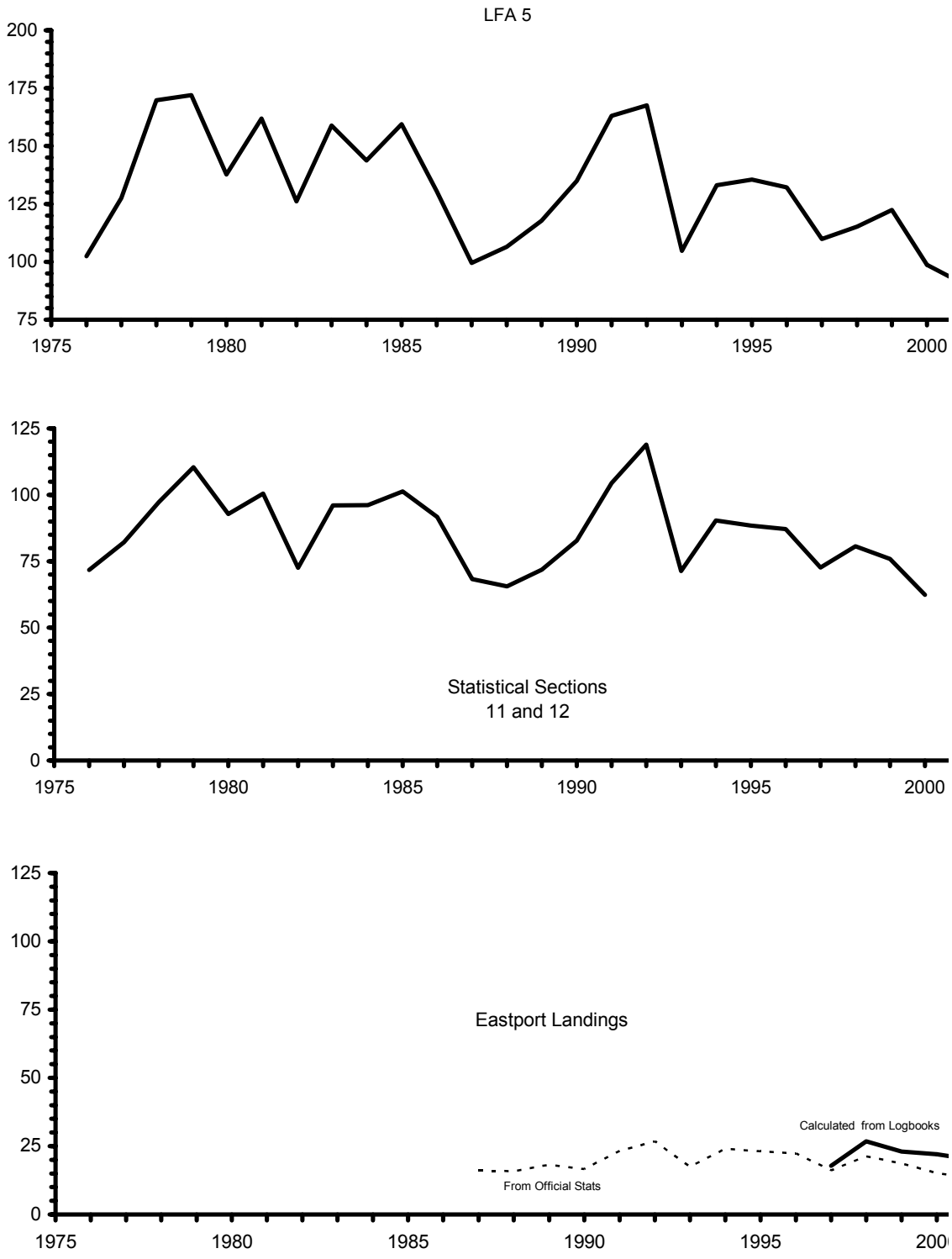


**Fig. 8. Landings for Bonavista Bay (from 1976), for Statistical Sections 11 and 12 (from 1976), for Eastport from DFO community statistics (from 1987) and from logbook estimates (from 1997).**

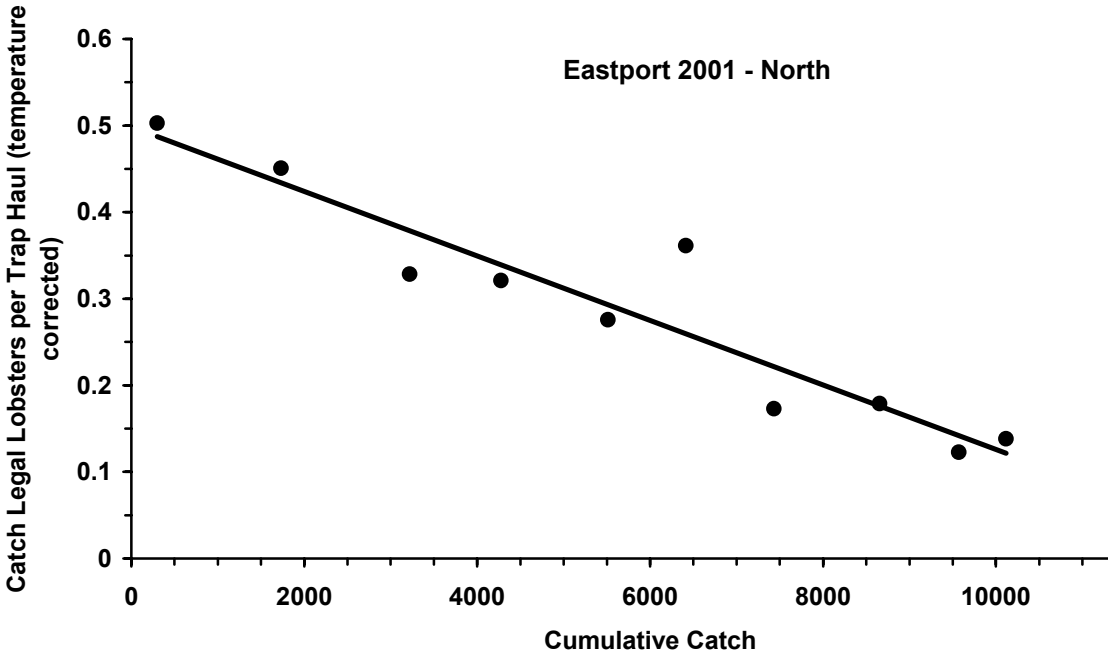


**Fig. 9. Leslie plots for 2001 logbook data from which standing stock at Eastport was estimated. Details and similar estimates of these for 1997 to 2000 are included in Table 3.**

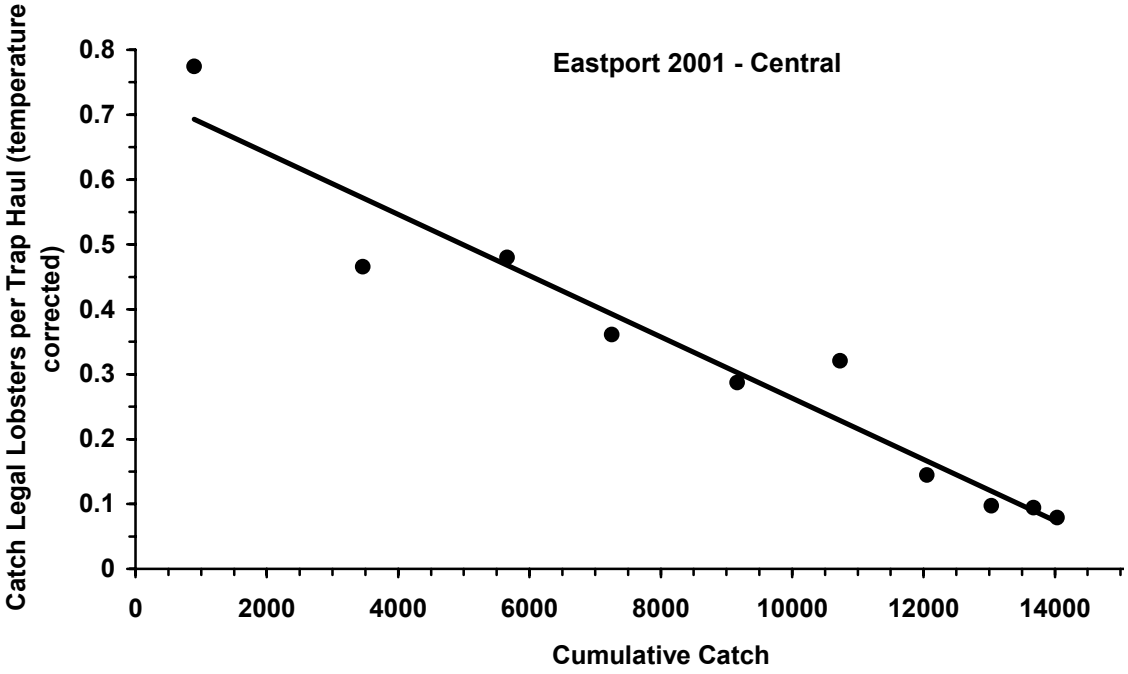


**Fig. 9. Continued…**

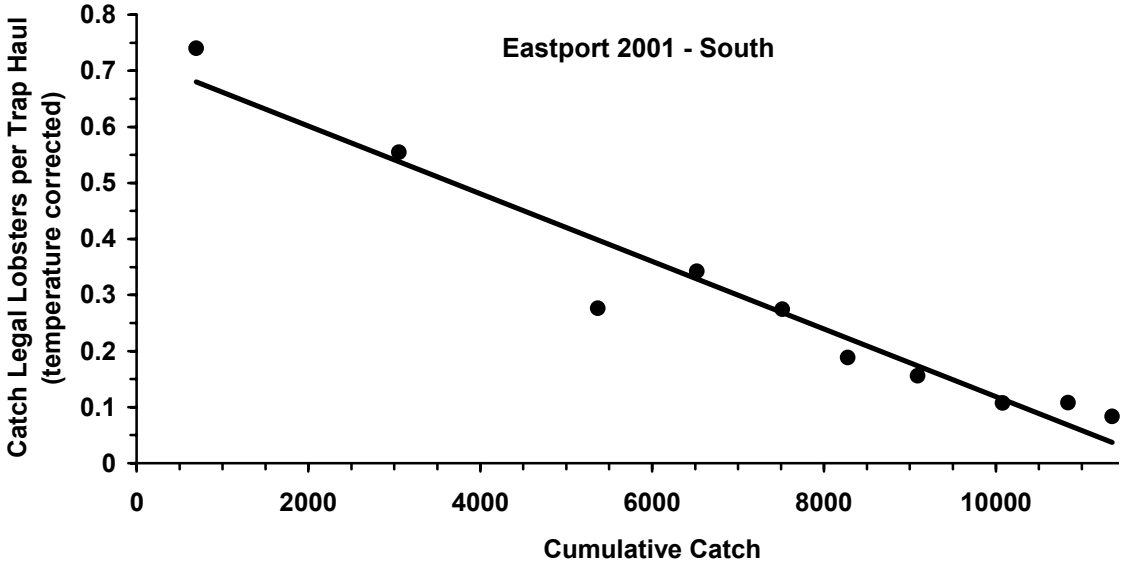


**Fig. 9. Continued.**

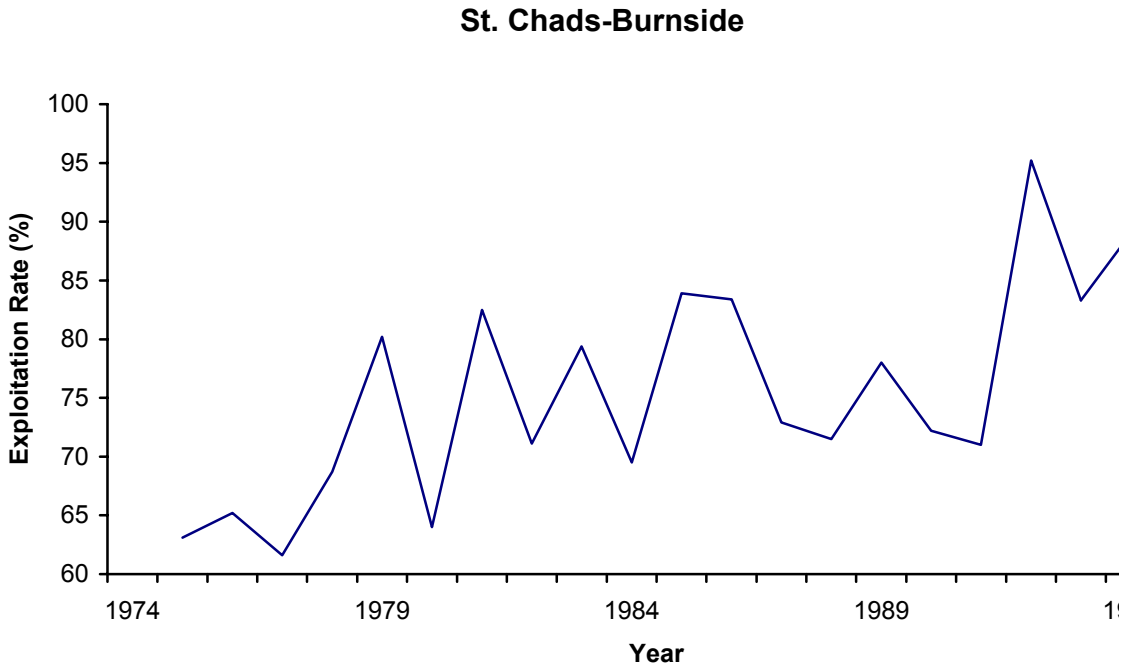


**Fig. 10. Tag recapture estimates of exploitation rate at St. Chad's-Burnside, Bonavista Bay, 1975-1994.**

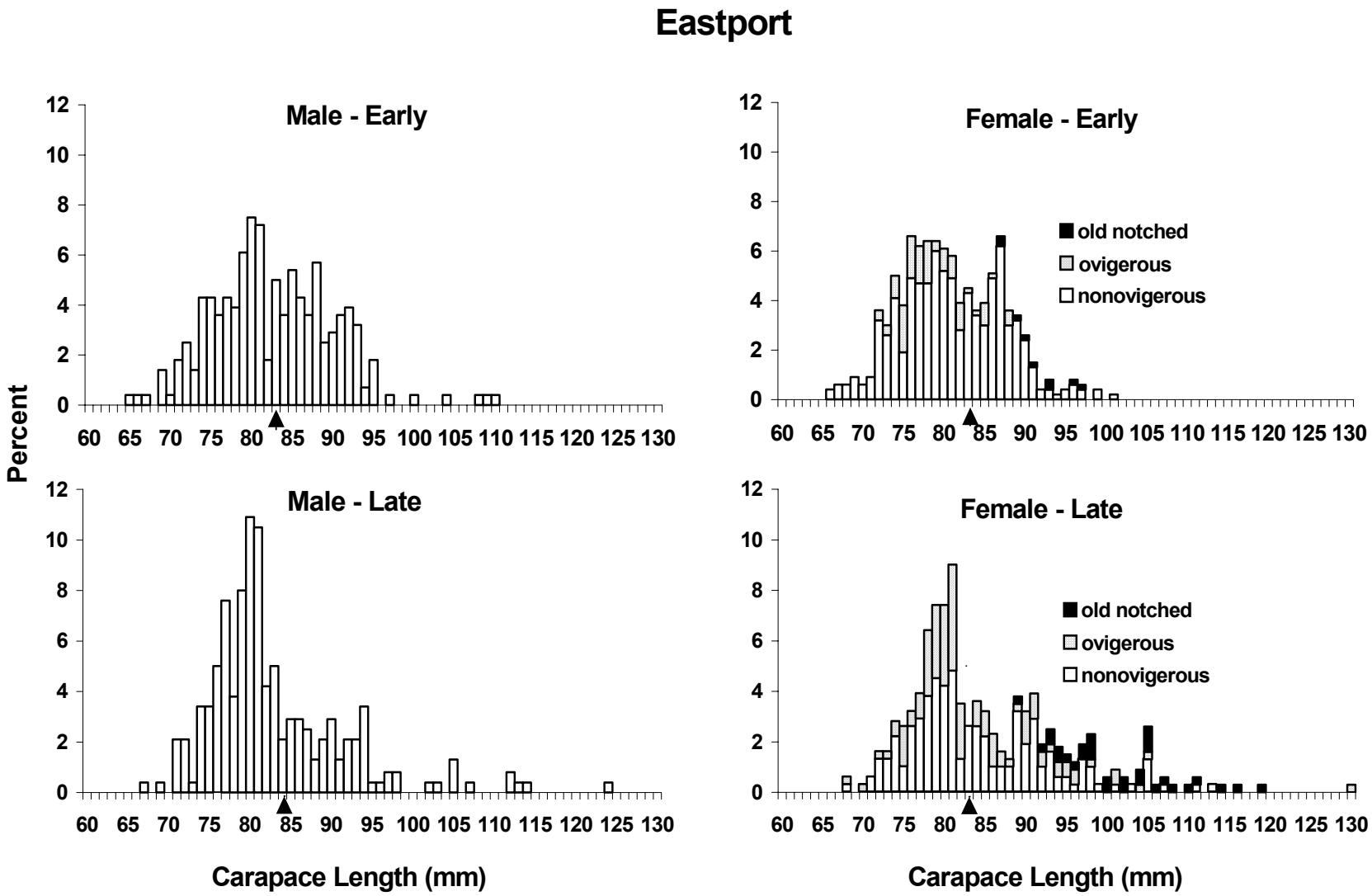


**Fig. 11. Size-distributions for male and female lobsters in early (May 10-19, top) and late (June 28-July 12, bottom) season at-sea sampling at Eastport in 2001. Arrows at 83 mm CL indicate minimum legal size.**

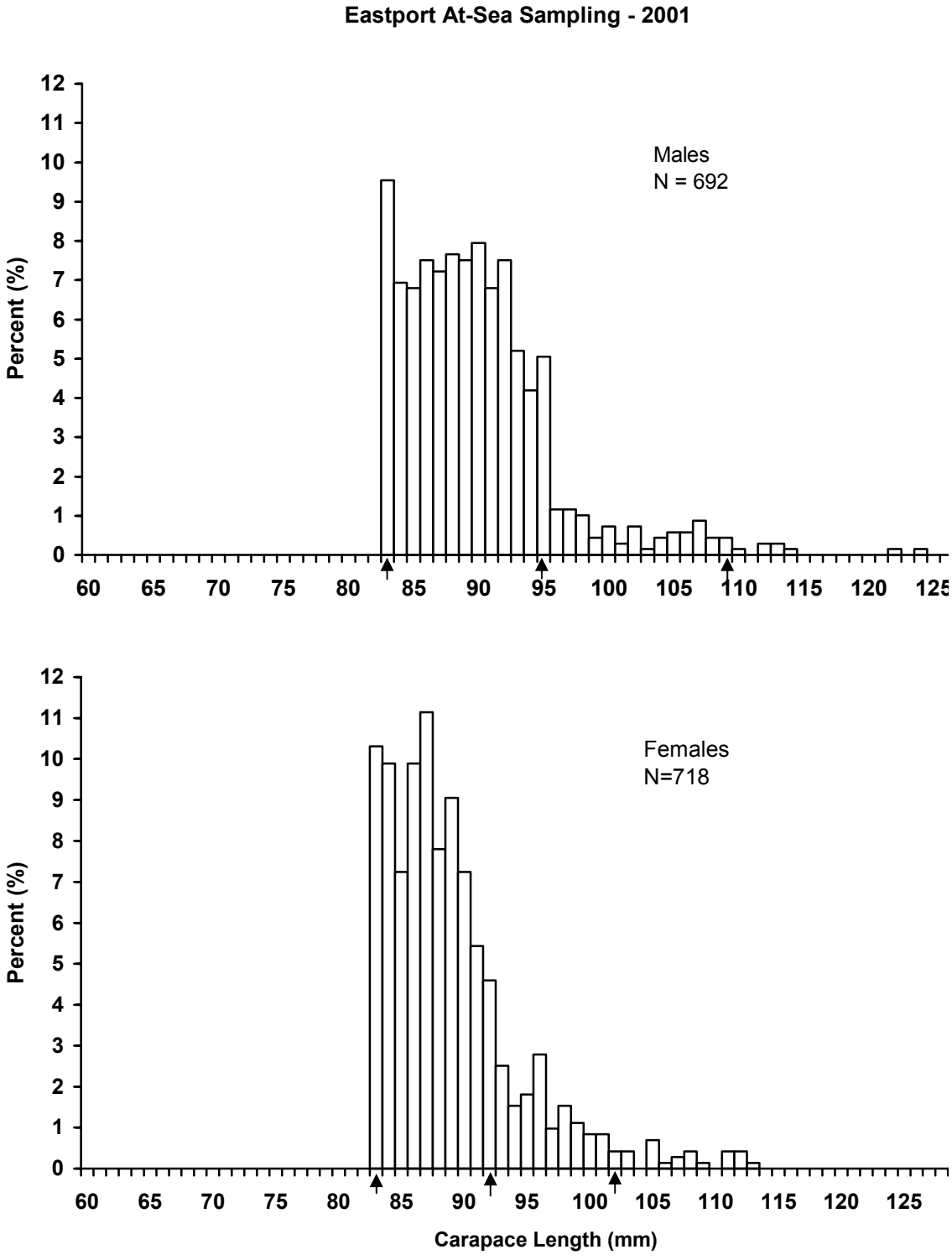


**Fig. 12. Size-frequency distributions for commercial lobsters in 2001 at-sea sampling at Eastport. Arrows indicate recruit and recruit+1 size ranges.**

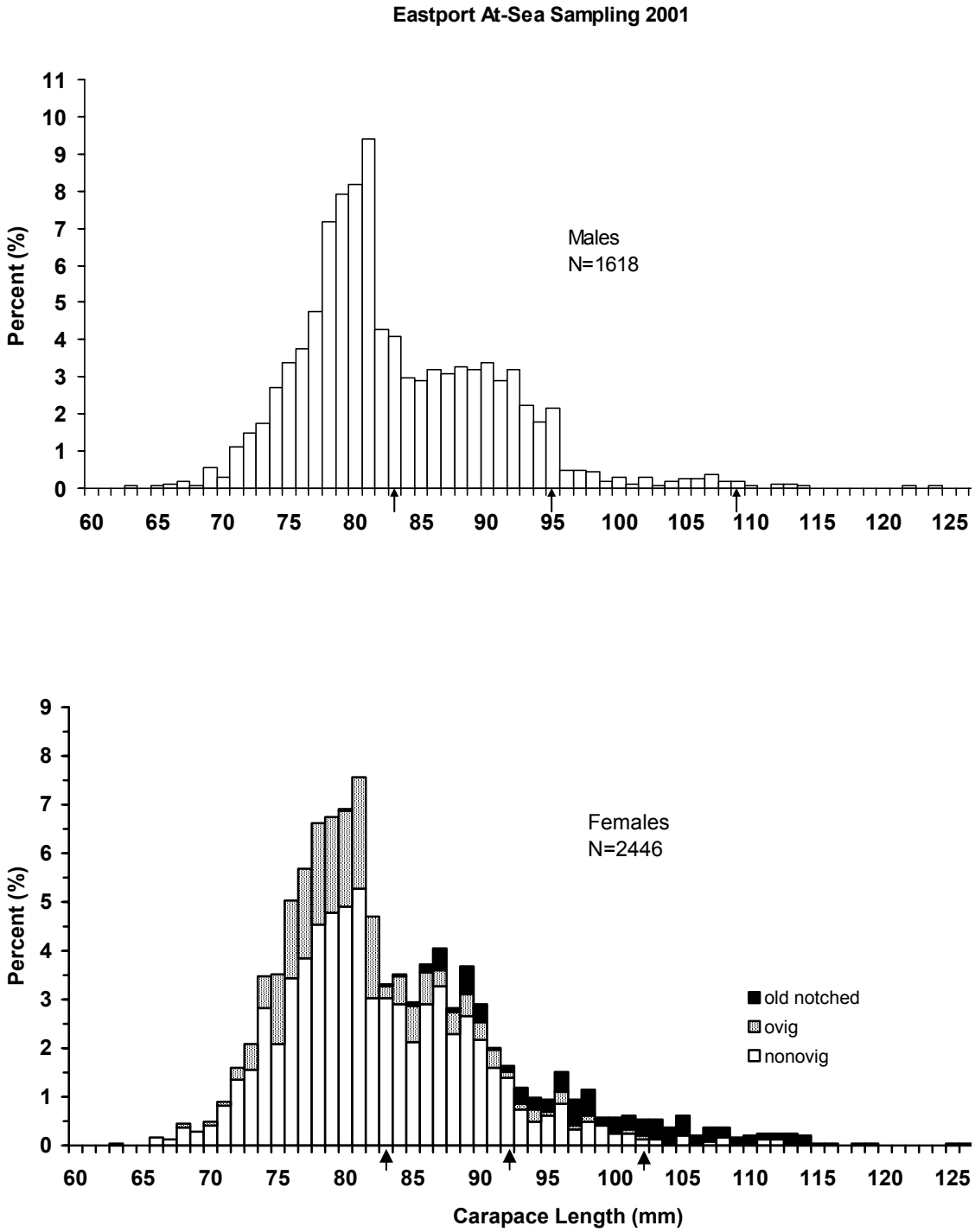


**Fig. 13. Size-frequency distributions for males and females showing relative incidence of various components of the female population in 2001 at-sea sampling at Eastport. Arrows indicate recruit and recruit+1 size ranges.**

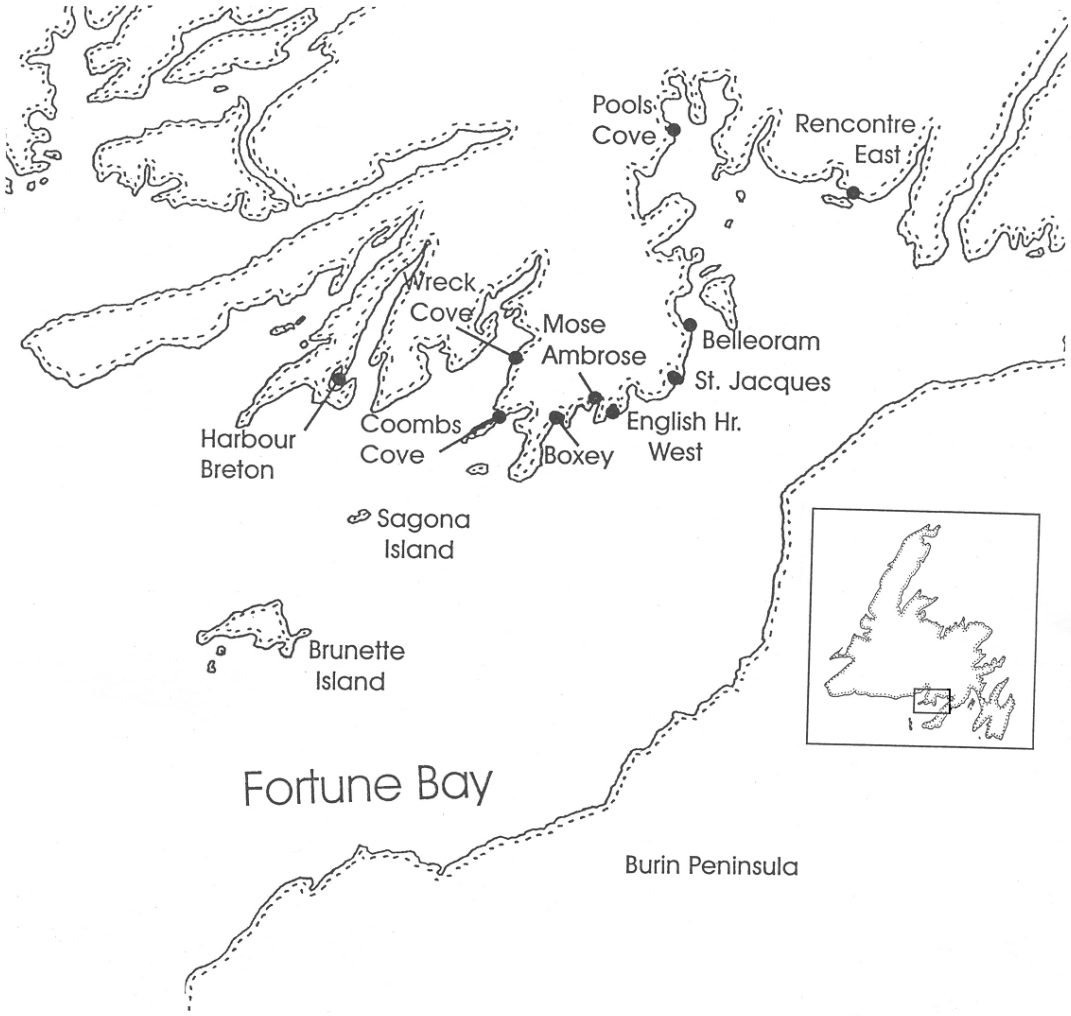


**Fig. 14. Fortune Bay showing communities from which lobster fishery monitoring was conducted, 1999-2001.**

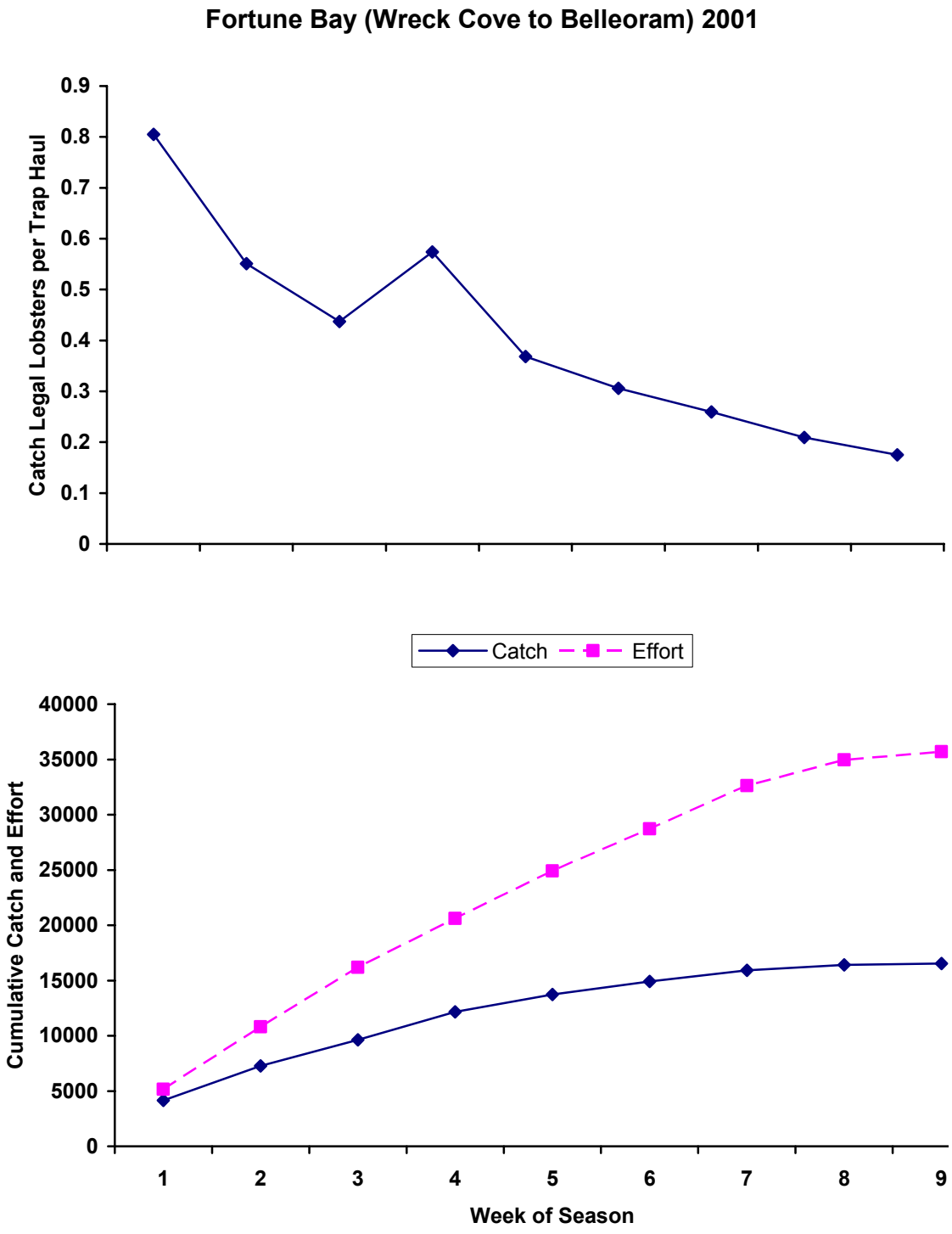


**Fig. 15. Catch rate, cumulative catch and effort over the 2001 fishing season at Fortune Bay.**

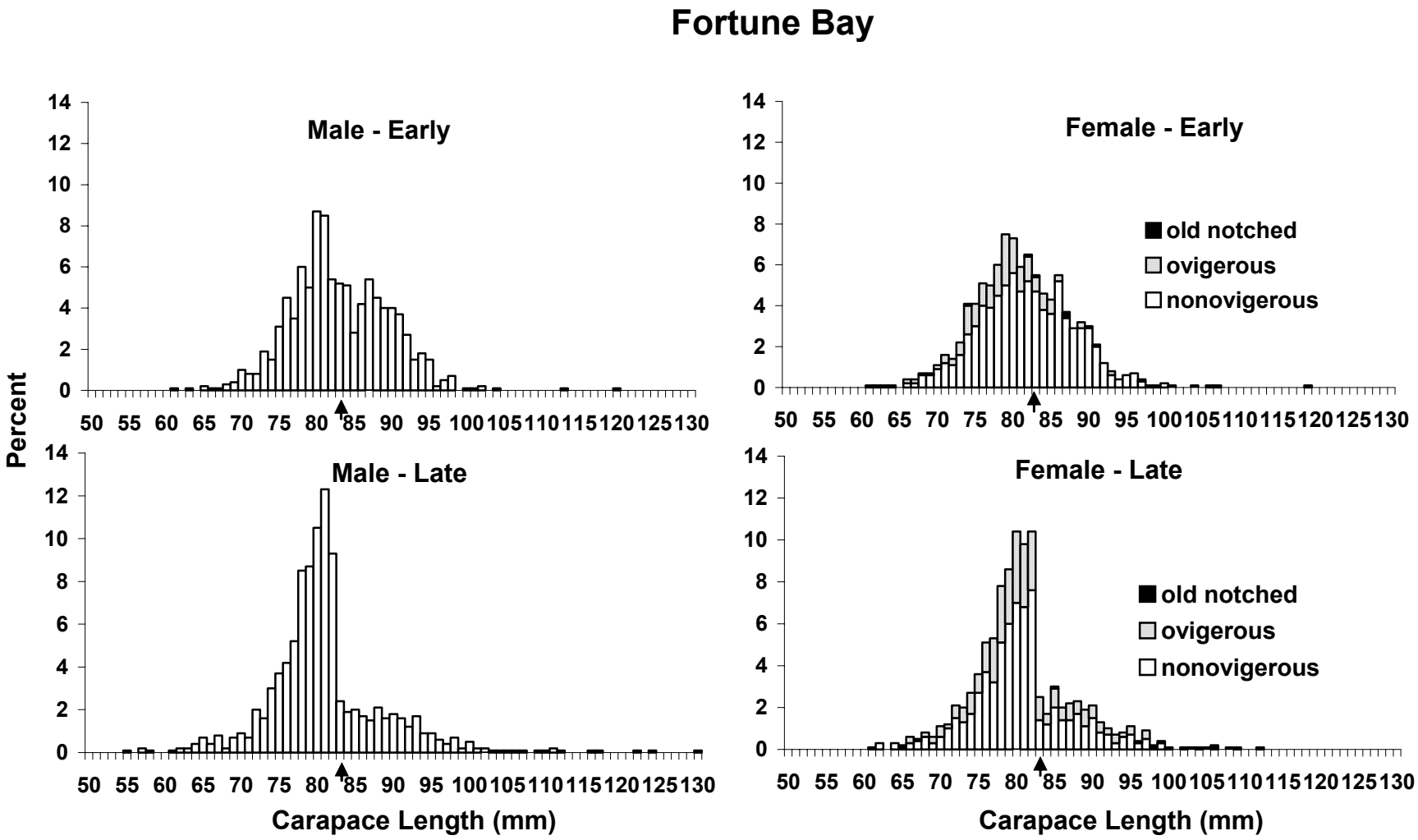


**Fig. 16. Size-distributions for male and female lobsters in early (April 26- May 2, top) and late (June 1-20, bottom) season at-sea sampling at Fortune Bay in 2001. Arrows at 83 mm CL indicate minmum legal size.**

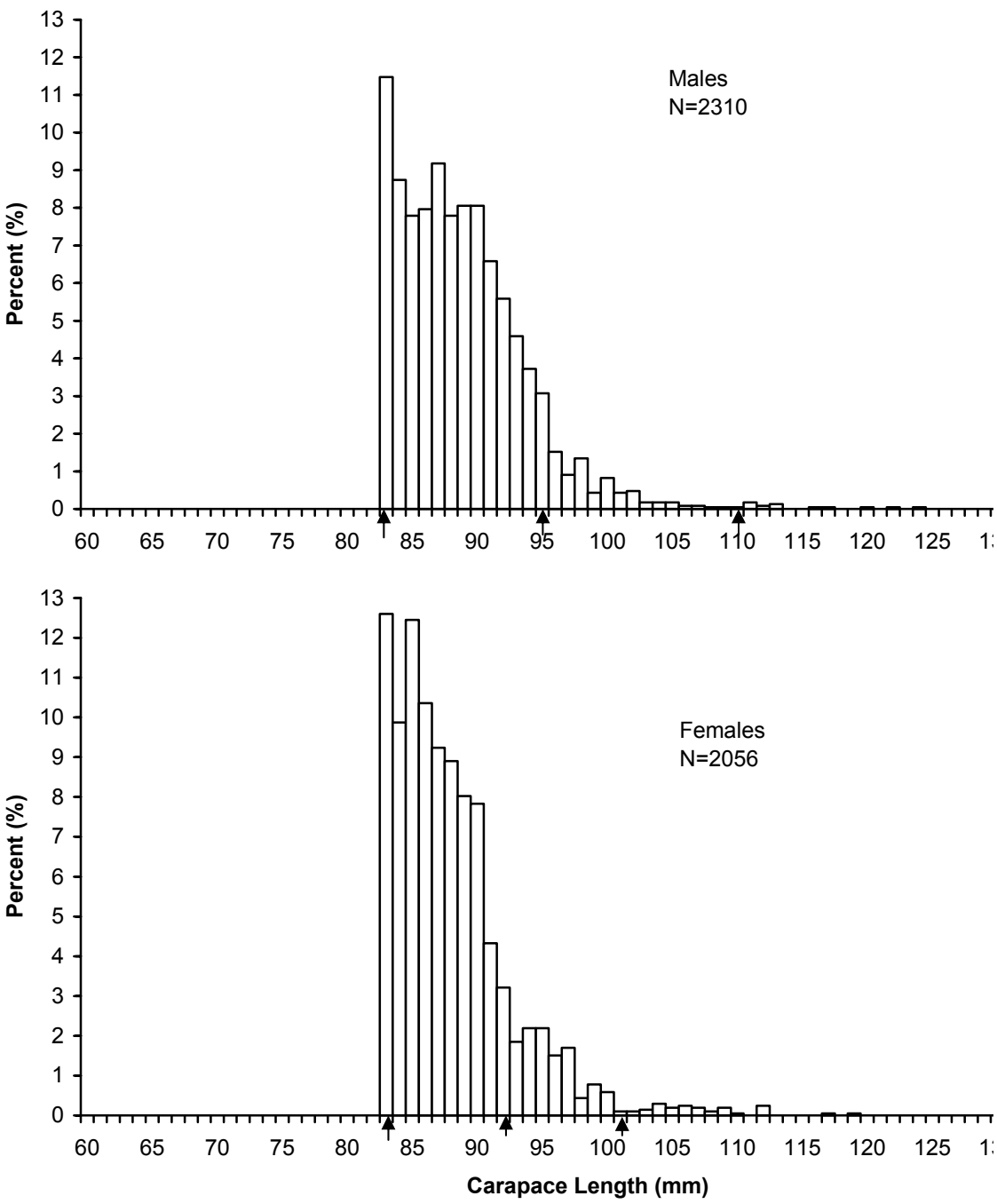


**Fig. 17. Size-frequency distributions for commercial lobsters in 2001 at-sea sampling at Fortune Bay. Arrows indicate recruit and recruit+1 size ranges.**

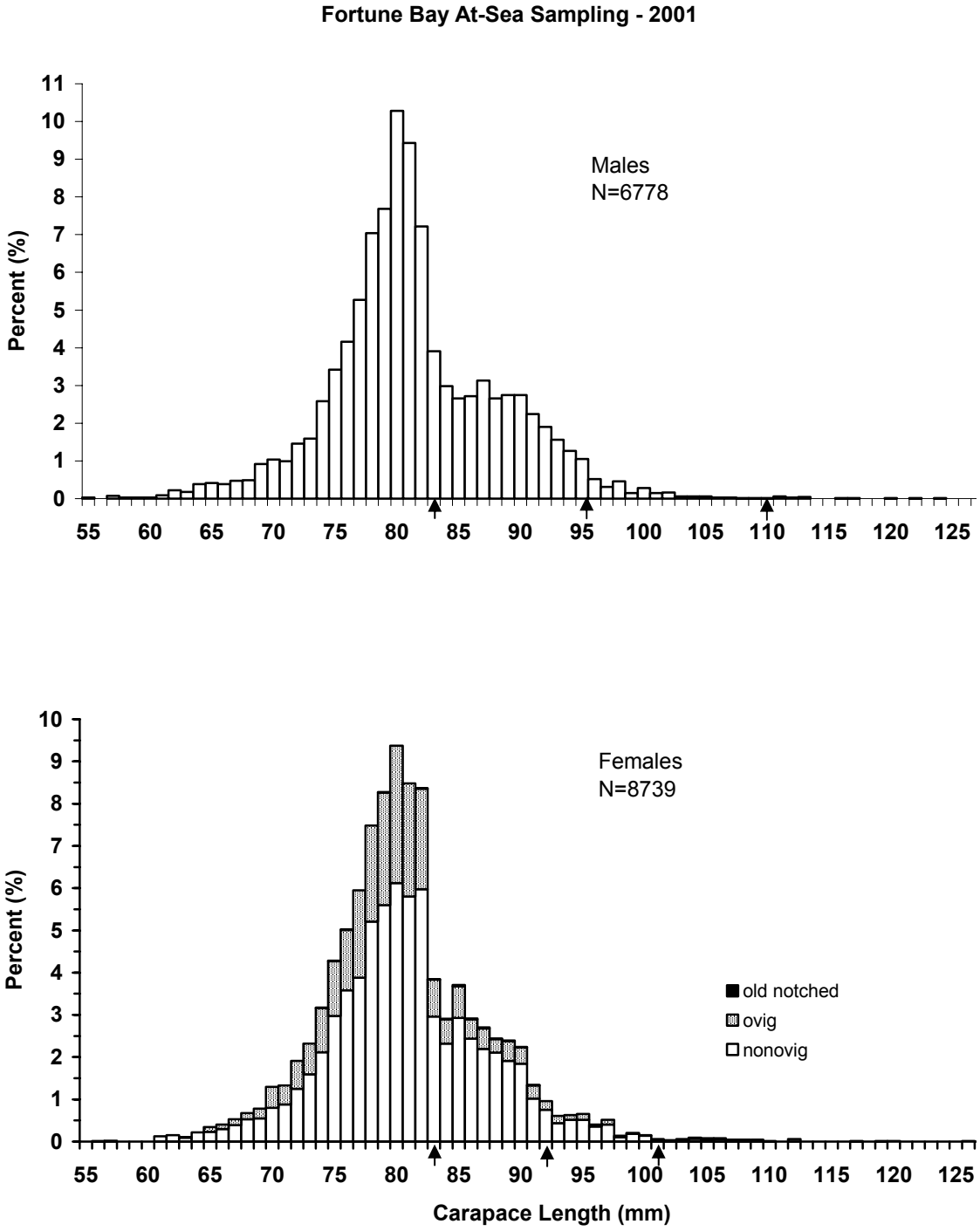


**Fig. 18. Size-frequency distributions for males and females showing relative incidence of various components of the female population in 2001 at-sea sampling at Fortune Bay. Arrows indicate recruit and recruit+1 size ranges.**

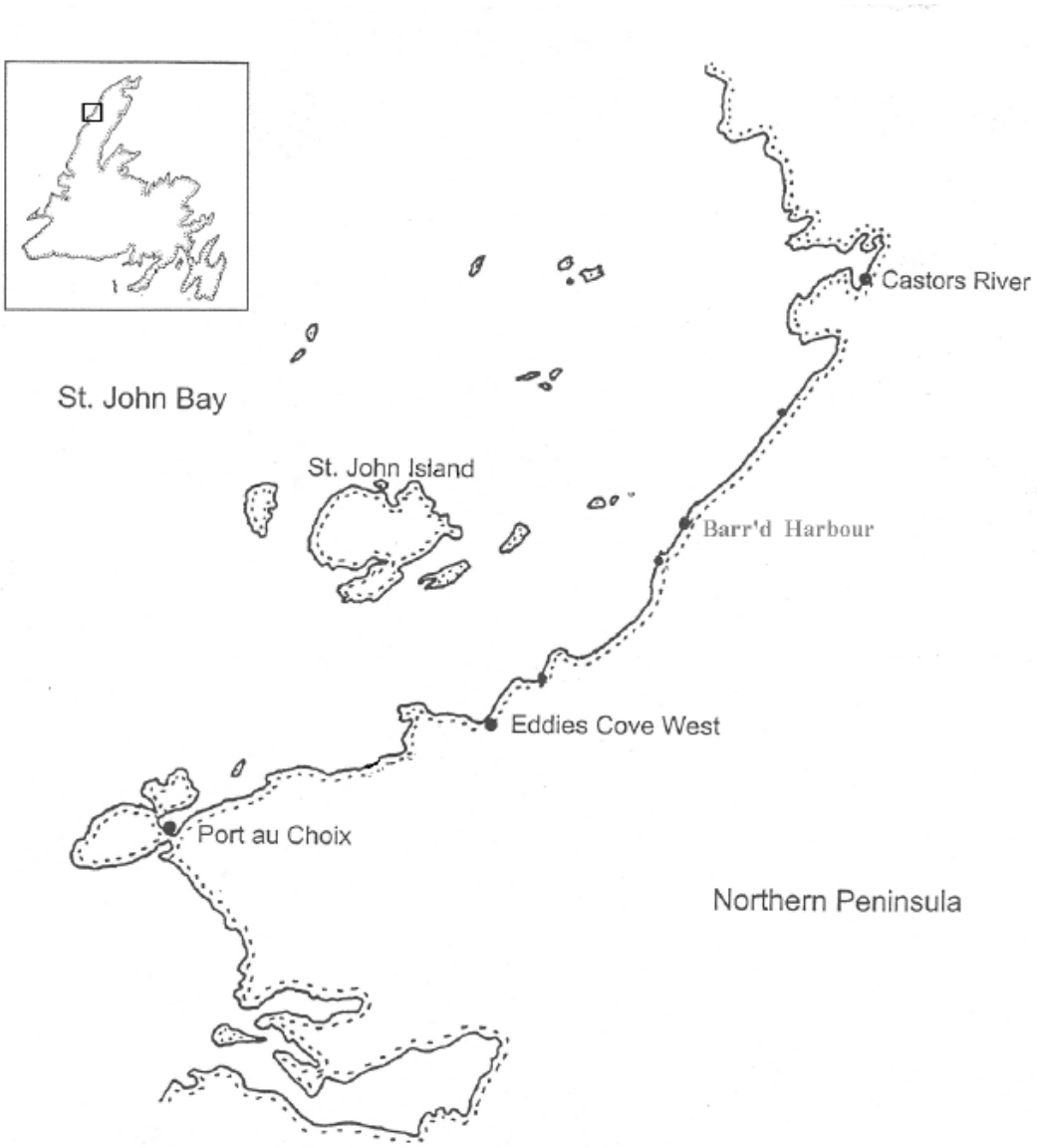


**Fig. 19. St. John Bay showing communities from which lobster fishery monitoring was conducted, 2000-2001.**

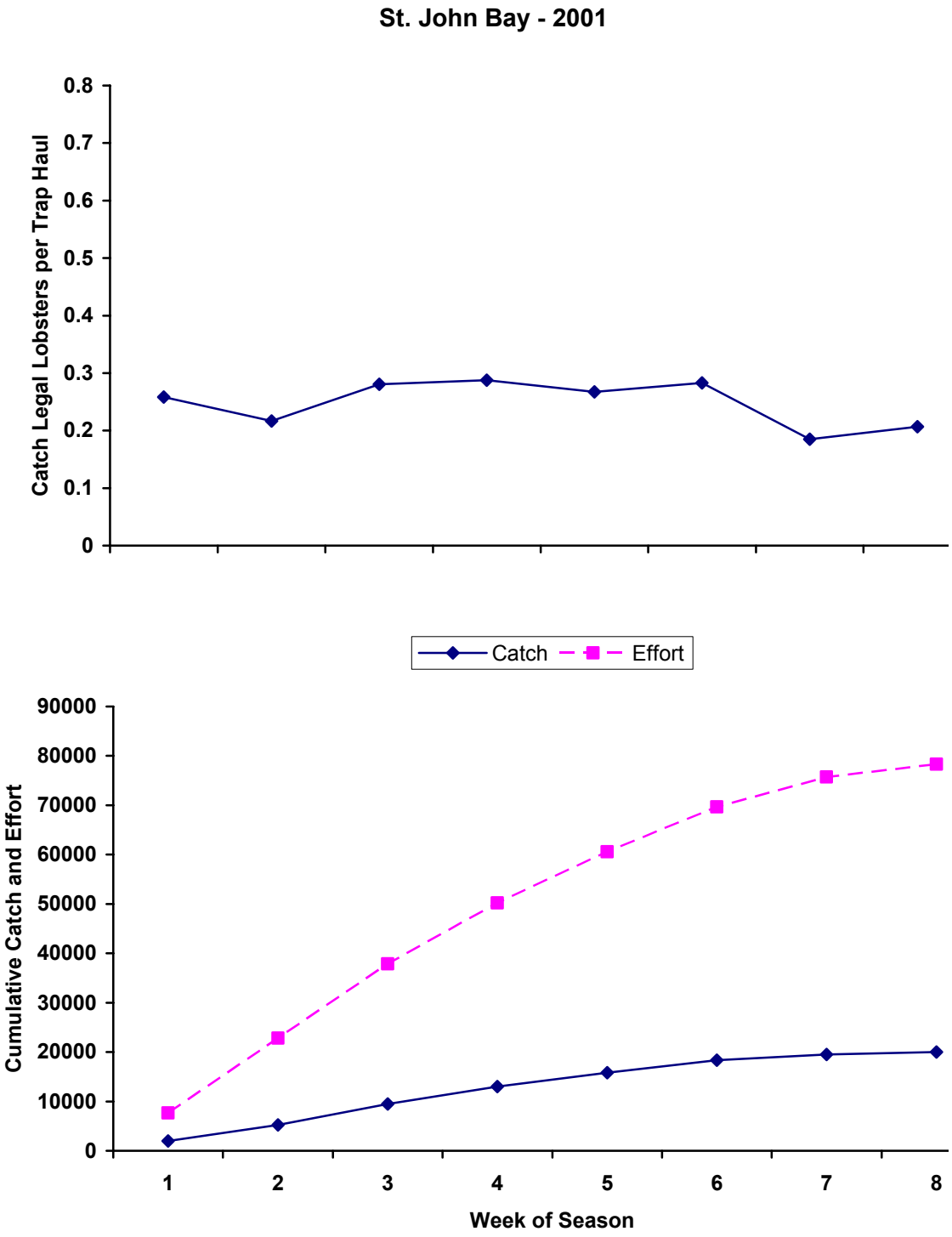


**Fig. 20. Catch rate, cumulative catch and effort over the 2001 fishing season at St. John Bay.**

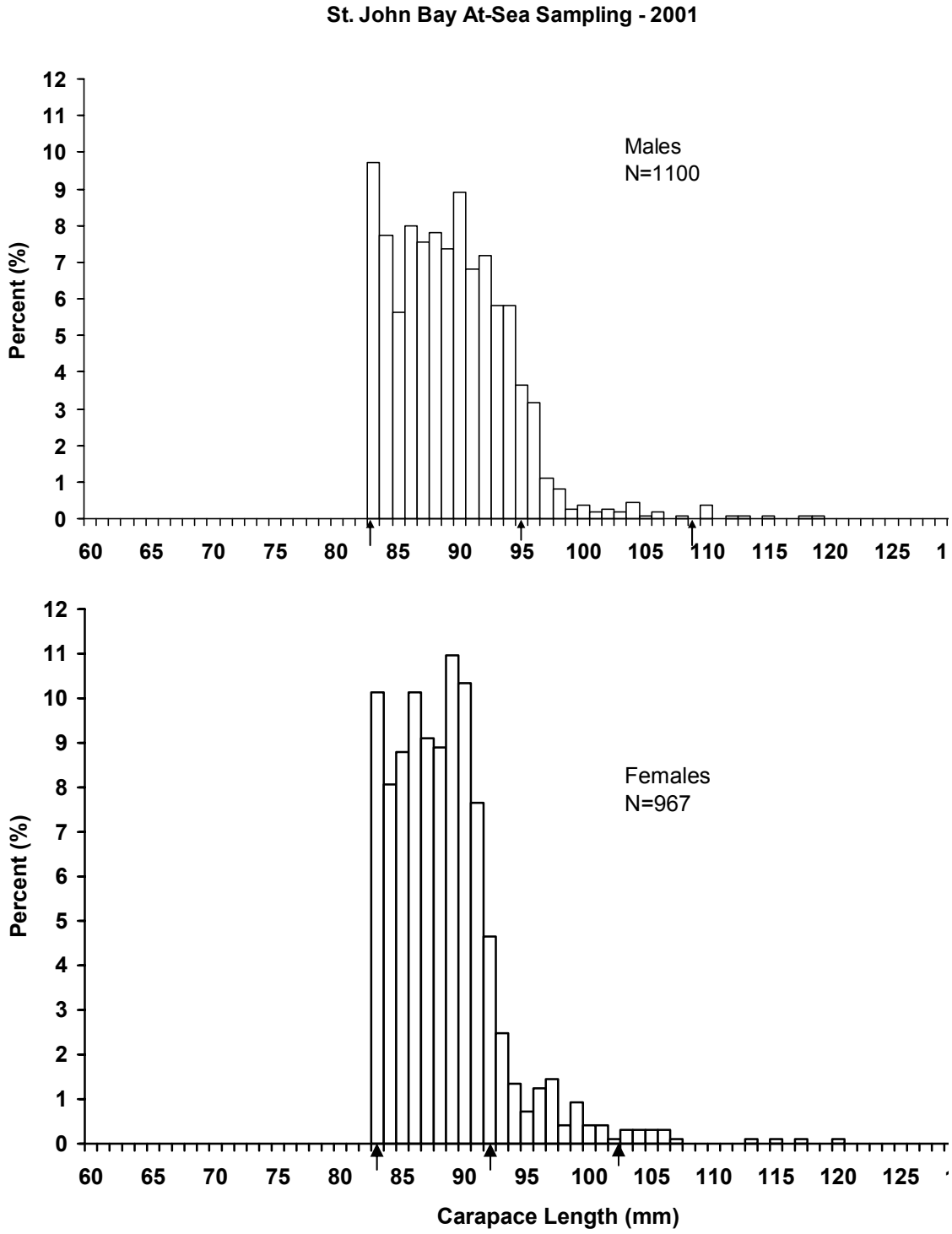


**Fig. 21. Size-frequency distributions for commercial lobsters in 2001 at-sea sampling at St. John Bay. Arrows indicate recruit and recruit+1 size ranges.**

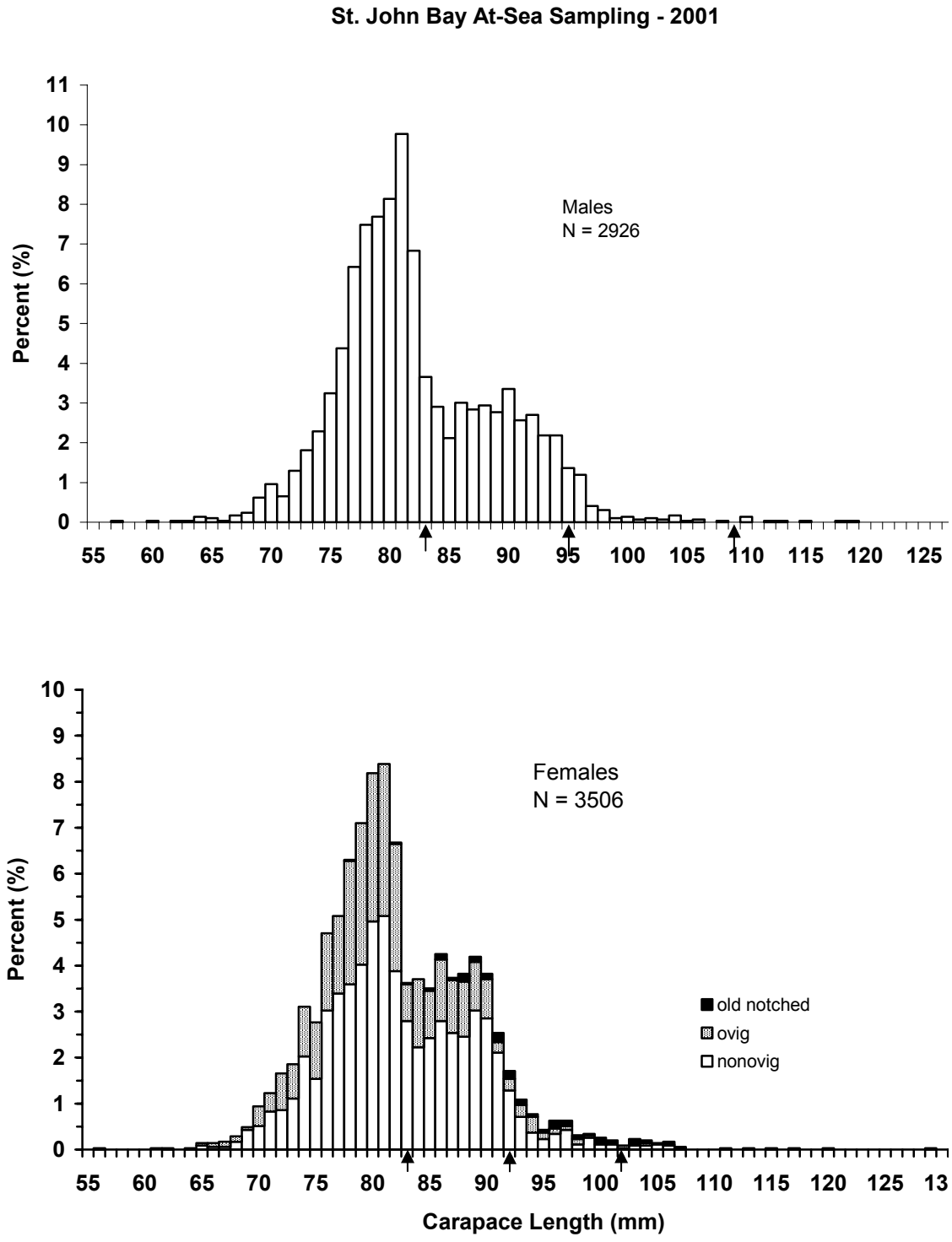


**Fig. 22. Size-frequency distributions for males and females showing the relative incidence of various components of the female population in 2001 at-sea sampling at St. John Bay. Arrows indicate recruit and recruit+1 size ranges.**

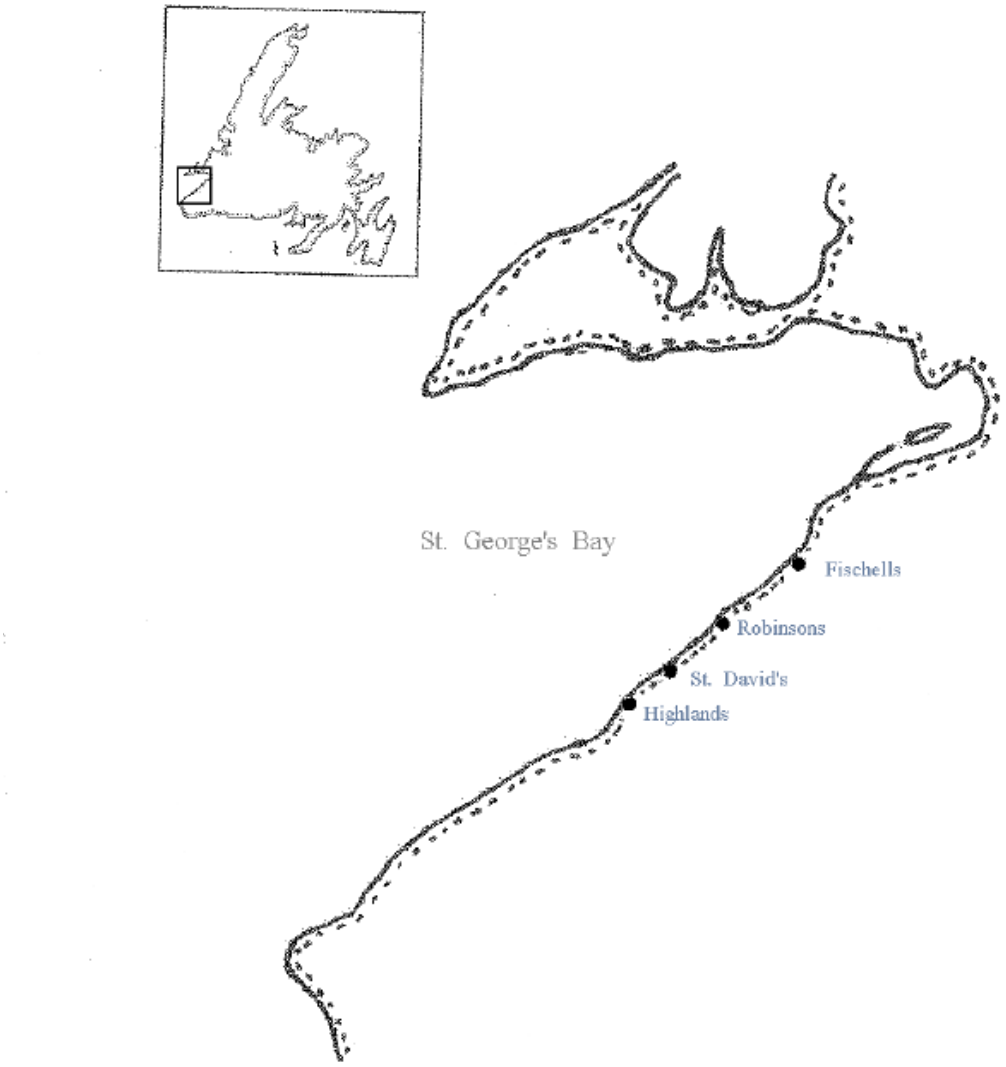


**Fig. 23. St. George's Bay showing communities from which lobster fishery monitoring was conducted in 2001.**

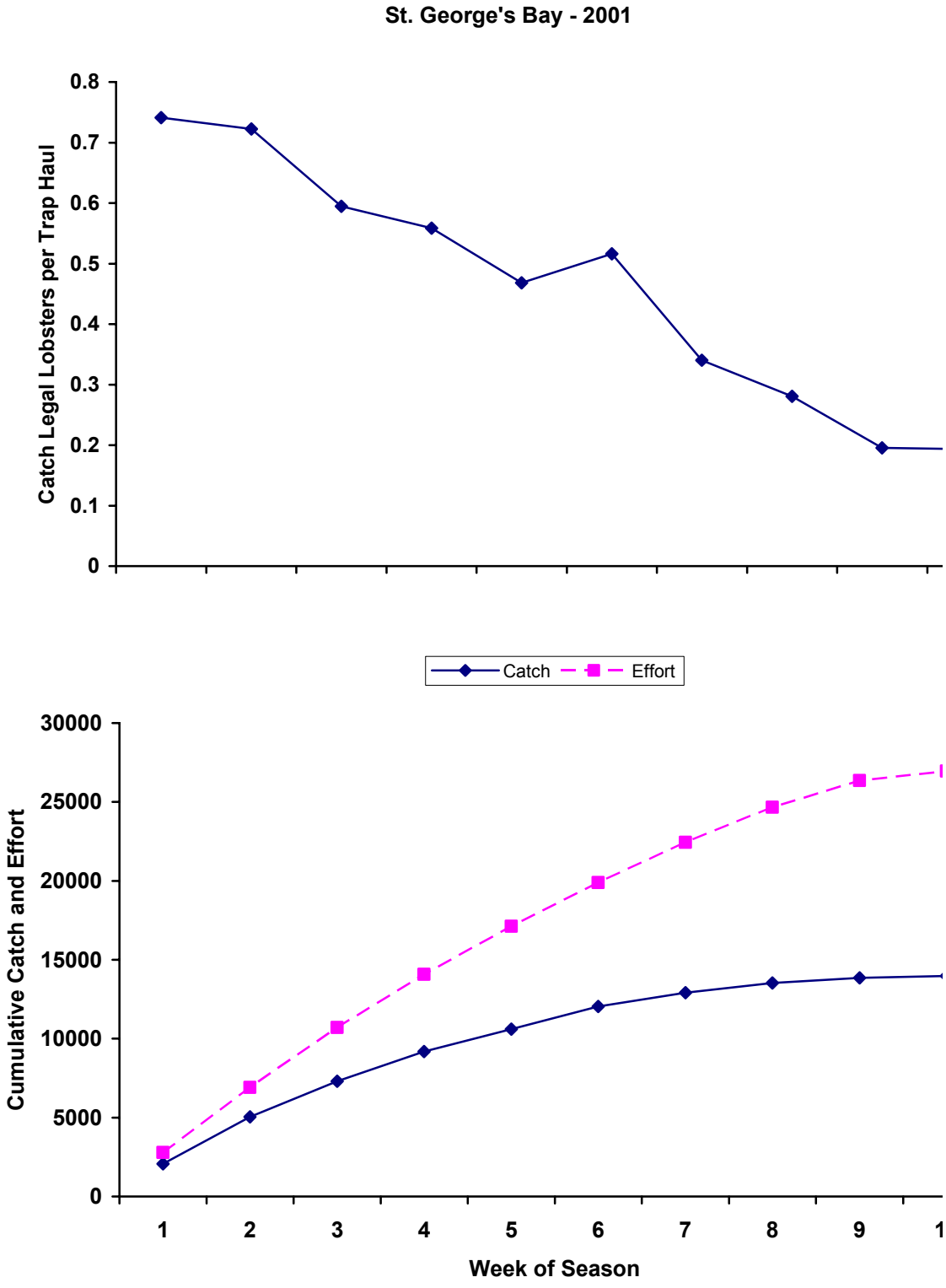


**Fig. 24. Catch rate, cumulative catch and effort over the 2001 fishing season at St. George's Bay.**

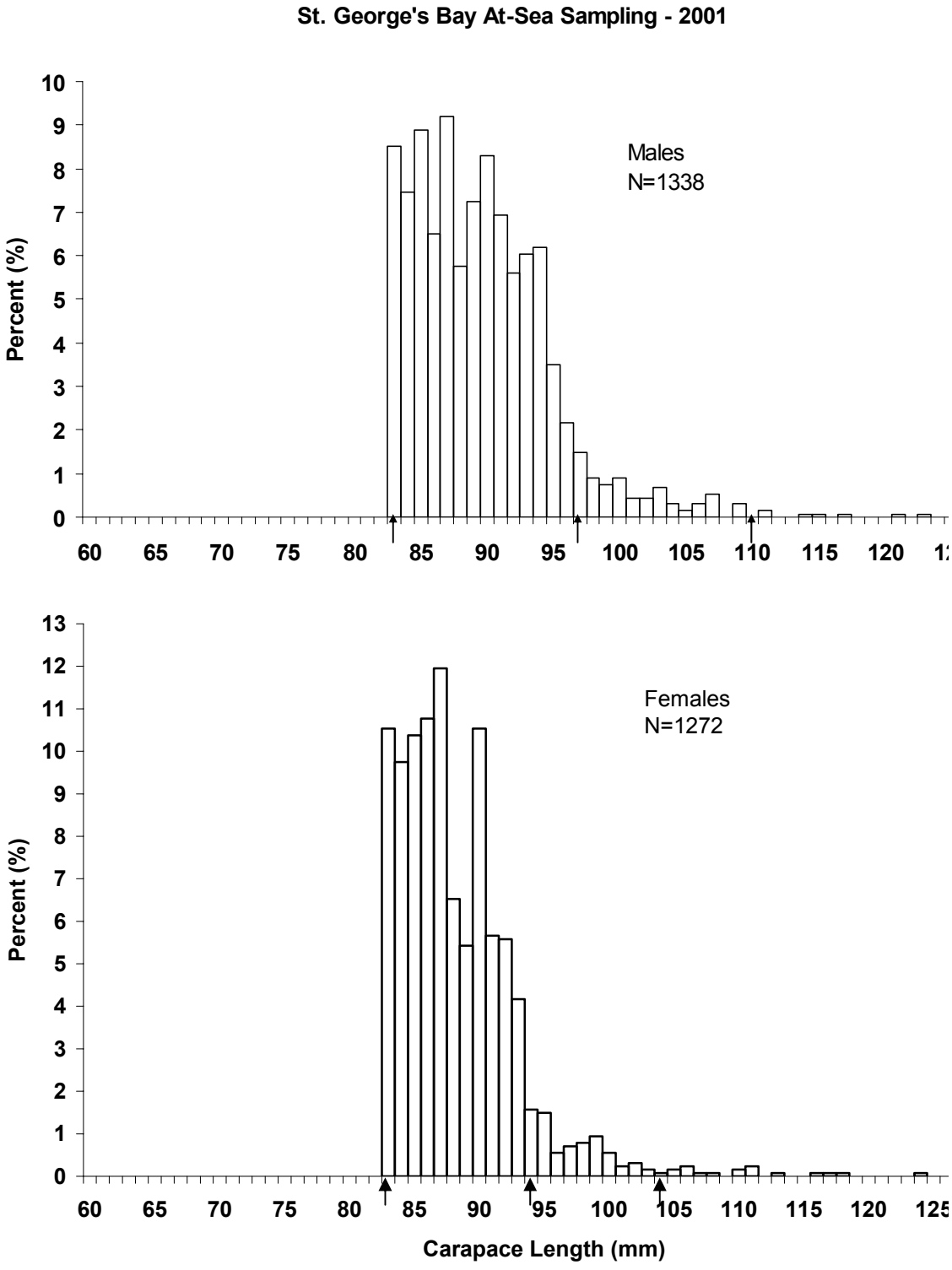


**Fig. 25. Size-frequency distributions for commercial lobsters in 2001 at-sea sampling at St. George's Bay. Arrows indicate recruit and recruit+1 size ranges.**

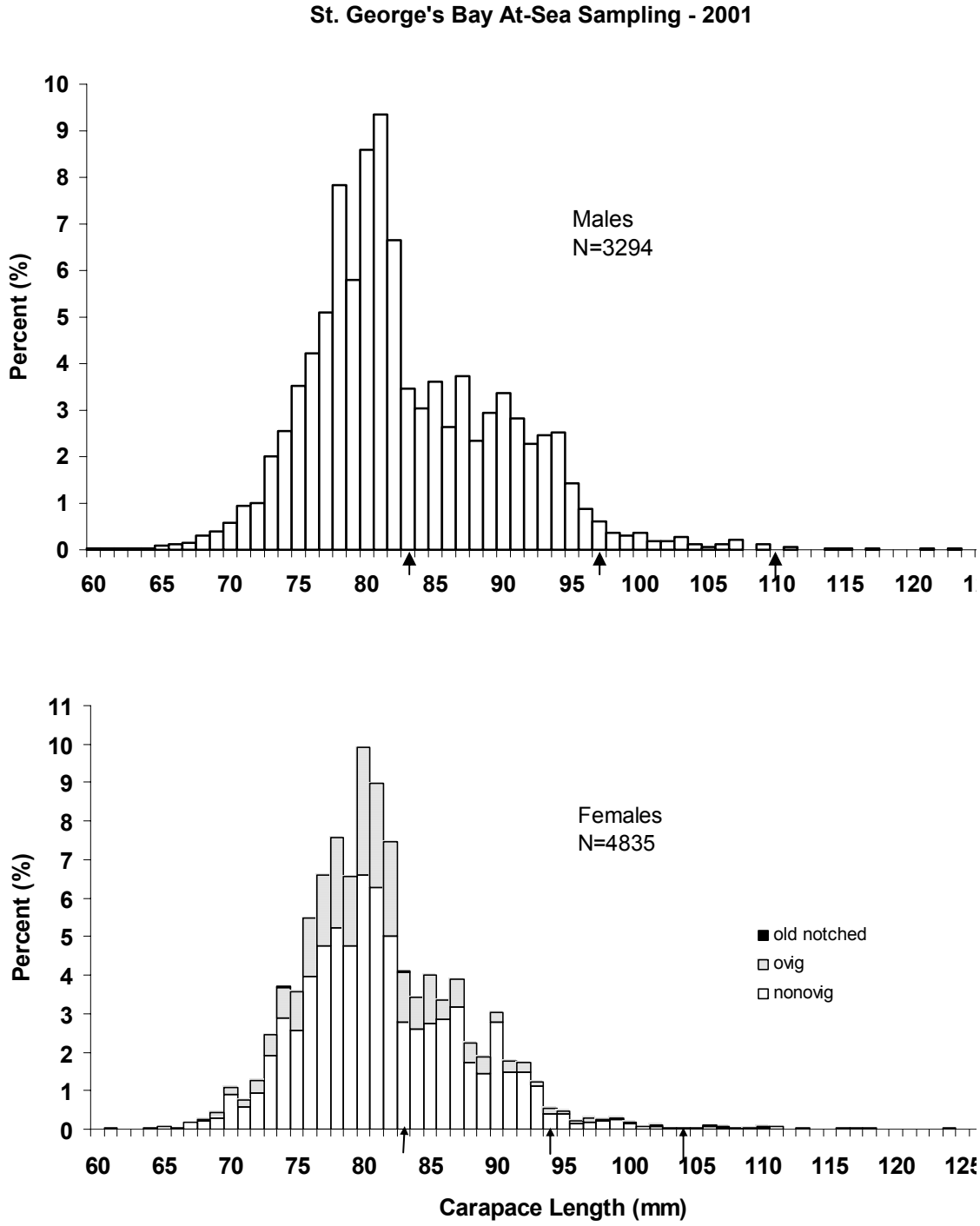


**Fig. 26. Size-frequency distributions for males and females showing relative incidence of various components of the female population in 2001 at-sea sampling at St. George's Bay. Arrows indicate recruit and recruit+1 size ranges.**

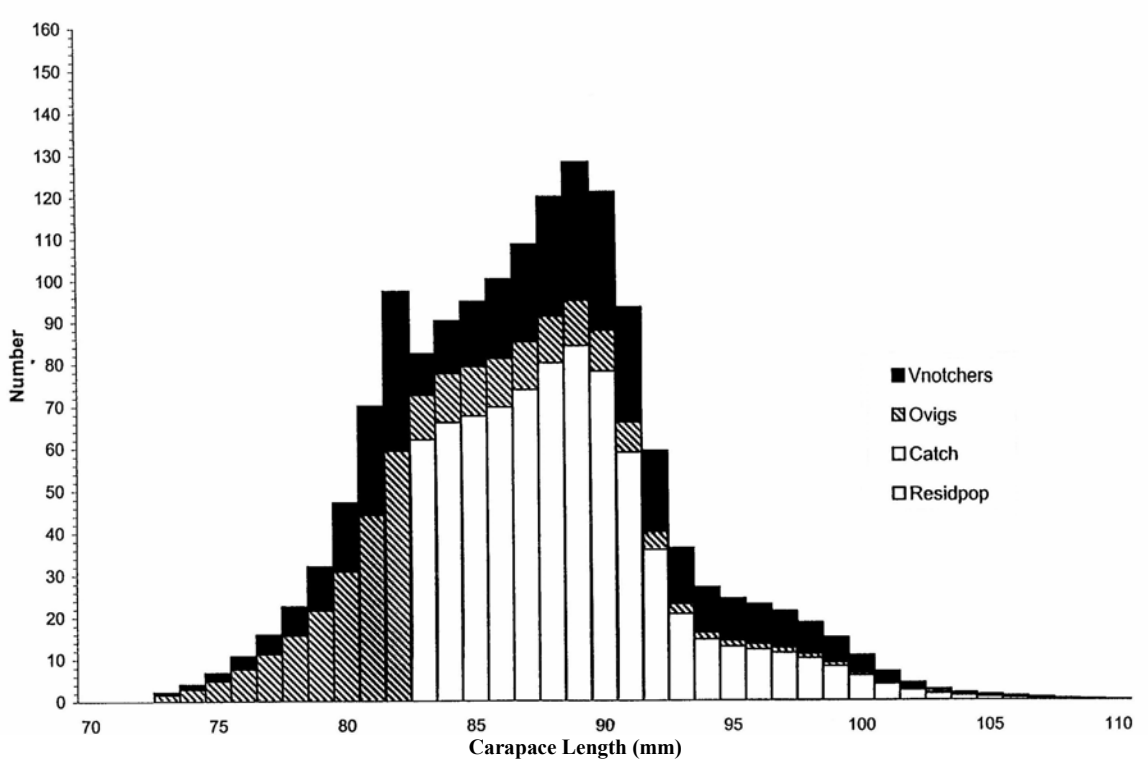


**Fig. 27. Size frequency distribution of various female population components accumulated after 5 annual cycles by the E/R model run with a 25% v-notching rate, a size limit of 83 mm CL and an 85% exploitation rate on the legal animals.**