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Capelin in SA2 + Div. 3KL

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Abstract

This document contains a number of discrete research results which were considered during the 1999 assessment of capelin in SA2 + Div. 3KL. These results are arranged in ten chapters. In addition, a meeting report, cross-referenced by chapter, is provided as well as a chapter pertaining to capelin in Div. 3Ps. The data for SA2 + Div. 3KL available included the results of studies on inshore capelin, 0-group and larval capelin, bycatches of capelin in groundfish surveys, capelin lengths, and consumption of capelin by predators. The analytical assessment of stock status used a multiplicative model.

Résumé

Le présent document renferme divers résultats de recherches distinctes examinés dans le cadre de l'évaluation de 1999 du capelan de la sous-zone 2 («SA2») et des divisions 3KL. Les résultats sont répartis en dix chapitres. On y trouve aussi un rapport des réunions, avec renvois aux chapitres, ainsi qu'un chapitre sur le capelan de la division 3Ps. Les données obtenues pour la «SA2» et les divisions 3KL portent notamment sur les résultats d'études sur le capelan côtier, les capelans larvaires et du groupe 0, les prises accessoires de capelan au cours des relevés du poisson de fond, la longueur des capelans et leur consommation par les prédateurs. L'évaluation analytique de l'état des stocks est faite par modèle multiplicatif.

Capelin in SA2 + Div. 3KL

1) Introduction

A capelin assessment committee met during March 1999 at NAFC, St. John's to assess the capelin stock in SA2 + Div. 3KL. A list of attendees is given in Appendix 1. Since 1994, capelin in SA2 and Div. 3KL have been assessed as one stock, based on evidence of movement of capelin in these areas.

2) Catch Trends

i) SA2 + Div. 3K

The capelin fishery in NAFO SA2 + Div. 3K was, until 1972, limited to inshore catches during the spawning season. In 1972, substantial catches were taken offshore by vessels from several countries. Catches peaked in 1976 at 212,000 t before declining in the late 1970's to 11,000 t in 1979.

Offshore catches during 1980-91 were restricted by quota and ranged between 500 and 57,000 t. The offshore fishery was generally conducted during August-November. The offshore fishery was closed beginning in 1992.

During the 1980's, an inshore directed roe fishery during June and July occurred, primarily in Div. 3L. Beginning in 1988, landings increased because of an increased share of the market for Canadian capelin with the closure of the Barents Sea capelin fishery. TACs generally reflected market demand and the increase of the TACs during the late 1980's can be attributed to the larger market share. These did, however, remain below the 10% of total spawning biomass that had been set as the biological criterion for setting the TAC.

During 1994 and 1995, a fishery was not prosecuted largely because female fish were too small to meet the size criterion in the management plan (sea run 50 count/kg). This size criterion was excluded from the management plan beginning in 1996 and a fishery proceeded when fish were marketable based on monitoring. Preliminary landings in SA2 +

Div. 3K during 1998, were 10,400 t compared to the quota of 11,400 t.

ii) Div. 3L

Catches in NAFO Div. 3L were less than 4,000 t prior to 1970, increased to a peak of 58,000 t in 1974, and declined to 12,000 t in 1979. During the 1980's an inshore roe fishery employing purse seines, capelin traps and beach seines occurred during June and July. This fishery has been later since 1991 due to the late arrival of capelin. In recent years, TACs have reflected market demand. In years when biological data were adequate to advise a specific TAC, the actual TACs have been less than advised on a biological basis.

The situation in Div. 3L regarding low landings in 1994 and 1995, the exclusion of the size criterion in the management plan beginning in 1996 and the monitoring programme were similar to that in Div. 3K. Preliminary landings in Div. 3L during 1998 were 20,300 t compared to a quota of 21,730 t.

Area	1992	1993	1994	1995	1996	1997	1998
SA2 + Div. 3K							
Inshore	17	11.4	11.5	11.5	9.7	11.4	11.4
TAC	18	13a	11.5	1a	8.9a	9.2	10.4a
Nominal catch			<.1a				
Div. 3L							
Inshore							
TAC	19.3	21	21	22	18.3	21.7	21.7
Nominal catch	3	23a	1a	1a	16.8	3.6a	20.3a
SA 2 + Div. 3KL							
Total nominal catch	21	36	1	1	25.7	12.8	30.7

a provisional

3) Information from Licensed Fixed Gear Fishers (Ch. 1)

During 1994-95, a questionnaire was designed to quantitatively evaluate biological and fishery-related information obtained from capelin fishermen. This survey was undertaken because of concerns about the utility of qualitative information coming from comments in some research logbooks or made directly to research personnel.

For the 1998 survey, the survey population size (n = 1829) was defined as all capelin fixed gear (traps and beach seines) fishermen licenced to fish capelin in NAFO Div. 3L and 3K in 1998. Employing a simple random sampling design and an expected response rate of 85% a sample population with 216 names was chosen to achieve a ±7% margin of error with 95% confidence intervals. Telephone interviews were completed between October 20 and November 30, 1998. The 185 completed questionnaires represented an 85% response rate, equivalent to the 85% expected.

Most respondents indicated that capelin abundance in their area was low with a mean response equal to 4.1. This is lower than 5.4 in 1996 and comparable to 3.8 in 1997. The abundance of capelin in 1997 was estimated to be 3.7 by respondents of this survey the same as the 3.4 estimated by the 1997 survey. Respondents clearly indicated that capelin abundance in 1998 was lower than when they first started to fish capelin. This response has been the same for all five surveys. Generally, most respondents considered capelin abundance to be low and similar to 1997.

According to the respondents, capelin occupied a small proportion of the spawning beaches in 1998. The number of respondents reporting no spawning was similar to 1997. The intensity of spawning was 4.7 (scale of 1, lowest, to 10, highest) compared to 4.1 in 1997 and 6.5 in 1996.

Spawning times were again delayed compared to the 1980's. The distribution of spawning times was later than in 1997.

The general size of females in 1998 was reported to be small 49%) or average (33%) with few reports of large females.

4) Inshore Data

i) Research Logbooks (Ch. 2)

The return rate of completed logbooks was higher than in 1997, 66% for fixed gear and 72% for mobile gear. The main reasons for discarding (live and dumped) capelin were variable but the ones mentioned most often were low percentages of females, small fish and redfeed. The overall discarding rate of 58% for traps was lower than in 1997 and the rate of 12% for purse seines was the lowest in the series. Excluding fish given away, 97% of trap and 88% of purse seine discards were released alive at sea. The remaining 12% of the purse seine discards which were dead were due to boat quotas.

Effort increased slightly over 1997 but overall it remained low. Trap fishing days and purse seiner searching time is low in the 1990's primarily due to monitoring initiatives put in place to reduce discarding of unmarketable capelin. The effect on fishing effort has been to concentrate the effort only when capelin are highly available and to reduce fishing time dramatically. This reduction has been especially evident in recent years. Consequently catch rate data are not comparable to data from the 1980's and are probably not indicative of stock abundance.

ii) Sampling

Commercial and monitoring samples were collected where possible. Since the catch rate data were not used in the multiplicative analysis, age compositions from these collections were not relevant to the quantitative analysis of stock status and were not presented.

iii) Aerial Survey (Ch. 3)

From 1990 to 1996, school areas had been estimated from digital imagery but beginning in 1997, a video camera was used. The switch to video technology was necessitated by budget reductions.

The total number of hours flown in 1998 was comparable to 1996 and less than in 1997. The less frequent coverage in 1998 can be attributed to poorer

flying conditions, low amounts of capelin observed especially in Conception Bay, and fewer survey days. Compete coverage in Trinity Bay occurred eight times and six times in Conception Bay.

In Trinity Bay, the highest school area estimate was observed on July 13-14, similar to 1994-96. This time also corresponds to the peak period (July 11-21) of egg deposition on Bellevue Beach. In Conception Bay, the highest total school area (Trinity Bay and Conception Bay) was also observed on July 14. The total school surface area in 1997 was lower than the 1996 estimate and fourth highest in the series. The 1997 estimate was 554,095 m^2 (range 107,736 m^2 (1984) to 759,486 m^2 (1996)).

iv) Beach Survey (Ch. 4)

In 1990, spawning times, egg deposition and development, larval emergence and various environmental variables were monitored on two spawning beaches located at Arnold's Cove (Div. 3Ps) and Bellevue Beach (Div. 3L). The number of sites was expanded in 1991 to include five additional beaches in Div. 3KL. In 1995 only two beaches, Chapels Cove and Bellevue Beach were sampled and in 1996 and 1997, only Bellevue Beach was sampled.

Age compositions of spawning fish from 1990 to 1998 were dominated by age 3 fish in all years except 1992 when age 4's were most abundant. The 1998 spawning population consisted mainly of the 1995 yearclass (66%) followed by the 1994 yearclass (17%). The 1995 yearclass as age 2 represented 14% of the overall mature population spawning in the vicinity of Bellevue Beach.

One major spawning mode was observed in late July (July 21-31) with a few small modes on either side. Egg densities on Bellevue Beach were the highest in the series. This suggests for this area the mature population spawning on the beach sediment was considerably higher than in 1997.

The majority of pre-emergent larvae observed in beach sediments at Bellevue Beach in 1998 occurred July 31-August 4 and August 12-20. The density of pre-emergent larvae was the lowest in the series.

Emergent larval densities were very low in 1998 with one distinct peak on August 12 at night.

These results indicate that although there was a high density of eggs on Bellevue Beach, egg mortality was high. As a result, the production of pre-emergent and emergent larvae was low. These results imply that the 1998 yearclass is the weakest one produced at Bellevue Beach in the 1990's.

5) Offshore Data

i) Bycatch in Bottom Trawl Surveys in Div. 2J3KL (Ch. 5)

Capelin are frequently caught during bottom trawl surveys directed towards groundfish off southern Labrador and eastern Newfoundland. The distribution and magnitude of capelin catches from the surveys in Div. 2J and 3K during the autumns of 1978-94 have been compared with acoustic surveys for capelin to help evaluate acoustic survey coverage. As a result of these comparisons, acoustic surveys were expanded temporally and spatially during the late 1980's and 1990's.

Beginning in 1995, fall groundfish surveys have been conducted differently. The major difference was the adoption of a Campelen 1800 shrimp trawl as the sampling gear. Comparative fishing for capelin between the old and new gear was not conducted so the results starting in 1995 are not directly comparable to results from previous years. As a result trawl bycatch data after 1994 have not been incorporated into the multiplicative model.

The autumn distribution of capelin in Div. 2J and 3K changed in the early 1990's. In years prior to 1991 most of the capelin in Div. 2J3K were concentrated either in Div. 2J or in central Div. 3K, but after about 1991 most of the capelin caught during the

bottom-trawl surveys or found in stomachs of cod caught during those surveys came from southeastern Div. 3K. In 1997 the distribution was still concentrated toward the southeast but with some indication of a return to the west.

The movement of capelin to more closely resemble historic distribution patterns continued in 1998. In general, the distribution of capelin was similar to the distribution in the 1980's, most notably 1986 and 1987.

In the spring surveys in Div. 3L, the Campelen trawl was not used until 1996. The extensive distribution and moderate to large catches of capelin in Div. 3L in the springs of 1996 and 1998 contrast markedly with the very small catches in 1991-95. Part of the increase may be attributed to the change of the Campelen trawl in 1996.

There is a notable contrast between the autumn surveys and the spring surveys with respect to the increase in trawlable biomass of capelin attending the change to the Campelen trawl. In the autumn series the biomass estimates in 1995-98 were about an order of magnitude greater than estimates in the mid-1980's. The extent of the increase in the spring series is less clear because of the very low estimate in 1997. However, the estimate in 1997 was of similar magnitude to several estimates in the 1970's and 1980's. This might indicate that the quantity of capelin in Div. 3L at the time of the survey in 1997 was substantially lower than the quantity present at the time of several of the surveys in the 1970's and 1980's.

ii) Catches of Pelagic 0- and 1-group Surveys (Ch. 6 & 7)

A research program to develop a multispecies, pre-recruit survey was carried out during 1991-93, as part of the Northern Cod Science Program. Beginning in 1994, a two-ship survey was initiated to measure pre-recruit abundances of cod and capelin throughout NAFO Div. 2J3KLNO, including both inshore and offshore areas. Large and small gear types were used to sample capelin in the upper water column, for the larval state (0-group; 3-50 mm), one year old (50-120 mm), and two year old capelin and older (2+, >120 mm). The intent of the survey was to sample pelagic juvenile cod,

before they settle to the bottom and larval capelin, released from beach and bottom sediments.

The abundance data for larval (0-group) capelin were adjusted to account for different survey times in different years.

Bonavista Bay was not sampled in 1998 due to the early recall of the research vessel TELEOST. Bonavista Bay has been an important index area for capelin at both the larval stage and age one. The historical ratio for Bonavista Bay and other inshore bays was stable over years for larval capelin, so this ratio was used to account for the data lacking from Bonavista Bay. The yearclass strength estimate based on larval capelin increased from 1994 to a peak in 1996. The 1997 and 1998 yearclasses were weaker than 195 but greater than 1994. The mean length of larval capelin in 1998 was 11.7 mm, similar to means ranging from 8.9 to 10.7 mm during 1994-97.

For one-year-old capelin, the ratio between abundance in Bonavista Bay and other bays was high and as a result, a correction for the missing data from Bonavista Bay could not be made. As a result, the estimate of the 1997 yearclass for one-year-olds is underestimated. The patterns of yearclass abundance at age 1 are similar to the larval pattern, except for the 1997 yearclass at age 1 which, as noted, is biased down. The mean length of age one capelin in 1998 was 96.2 mm which is approximately in the middle of the range of mean lengths for the 1993-96 yearclasses.

Estimates of total abundance of capelin, age 1 and older, were calculated from the IYGPT catch data in these surveys. This was the first time that this approach has been attempted and the results were considered preliminary, pending further analysis and review.

6) Information on Capelin Predators (Ch. 8)

Estimates of consumption of capelin by predators are available, although many have not been updated for several years. Consumption estimates can vary depending on the assumptions underlying the calculations, however, they serve to illustrate sustenance provided to predators. Puffins were

estimated to consume about 12,000 tons during the breeding season alone. Capelin consumption by seabirds was estimated at about 250,000 tons annually in the mid 1980's. Minke and fin whales were estimated to have consumed about 400,000 tons prior to their decline several decades ago. There are no new consumption estimates for whales. The most recent estimates for harp seals indicate about 700,000 tons of capelin were consumed in 1998 compared to about 350,000 tons in the early 1980's. Previous estimates for cod consumption indicated that during the early 1980's, cod in Div. 2J3KL were consuming 0.7 to 2.25 million tons of capelin annually. During the same time period, a minimum of 200,000 tons of capelin was estimated to have been consumed by Greenland halibut. Because the consumption estimates are calculated using predator biomass, they will vary with the marked changes in biomass of the various predators over time. Groundfish predators of capelin, such as cod, Greenland halibut and American plaice have declined in abundance from the early 1980's to the present. Harp seals have increased in abundance during that time. Based on the consumption estimates available, the increase in capelin consumption by harp seals is not as great as the decrease in consumption by groundfish predators.

There is considerable evidence that seabird ecology has changed in recent years. Differential breeding success of two species of seabirds in the Witless Bay area during the 1990's appeared to be related to the vertical availability of capelin. Kittiwakes, which are shallow divers, experienced relatively low breeding success during the early 1990's. Breeding success improved during 1996 and 1997 and approached historical levels.

The timing of kittiwake breeding was later in the 1990's, and like the delay in capelin spawning, appeared to be related to environmental factors. Puffins are a deeper-diving species and in contrast to kittiwakes, they have experienced good breeding success during the 1990's. Data on breeding success for these species were not available for 1998, however, it was noted that the weight of capelin in the diet of puffin chicks was lower in 1998, compared to 1997.

On Funk Island, gannet chick diets have shown a food change over two decades (1977-97) with capelin occurring in higher proportions in the 1990's. This shift to capelin is believed to be a result of greater availability of capelin during the chick feeding period, consistent with the later

capelin spawning during the 1990's, and lower availability of warm-water species such as mackerel and squid. Data for 1998 were not available.

At the Gannet Islands, off the coast of Labrador, the weight of capelin in the diets of puffin chicks increased in 1997 and 1998, compared to 1996.

7) Other Studies

i) Predicting Mean Lengths (Ch. 9)

During recent assessments, positive relationships between mean lengths from fall offshore surveys and inshore the following year had been used to predict mean lengths of ripe females.

Because the size of females in 1997 had been incorrectly predicted from 1996 data, the evaluation of expected mean size of females in 1998 was modified. Two changes were made. First, data were grouped into two time periods, the 1980's and 1990's, because growth increments between fall and the following spawning season were different for these two time periods (specifically, growth in the 1980's was greater). Second, because it is not possible to predict whether growth will be more like the 1980's or the 1990's, the information was presented as two probability curves. These curves provided the probabilities of reaching mean lengths at spawning with a starting length measured in the fall under the two possible growth scenarios.

The mean length of maturing capelin in the fall of 1997 was 144 mm. The probability curves indicated that if growth was similar to the 1990's, there was about a 60% probability that the mean length of capelin in 1998 would be about 151 mm (average count of about 50). If however growth were more typical of the 1980's, there was a high probability that counts would be 50 or less.

Sampling data from the 1998 fishery indicated that the mean length of females was 147 mm indicating that the increment between the fall of 1997 and spawning season of 1998 more closely resembled the increments from the 1990's. This average is estimated from pooled data from the entire stock area and does not identify differences in mean lengths which might have been observed in the fishery.

The probability curves have been recalculated using the mean length of 139 mm of maturing female capelin from bycatch in the 1998 fall groundfish survey in Div. 2J3KL. These curves can be used to provide guidance on approximate counts in the mature female population in 1999 (counts are approximate because the weight-length relationship varies during the maturation process), depending on whether growth is more typical of the 1980's or 1990's. If growth is similar to that observed in the 1990's, there is virtually no chance that the average count will be less than 50 in 1999. If growth is similar to that of the 1980's, there is a 75% chance that the average counts will be less than 50. As noted previously, the analysis is based on pooled data from the stock area and consequently, it is not possible to account for differences that may occur between geographical areas and between spawning runs.

Biology and Resource Status

During the early 1990's, several biological changes, coincident with below normal water temperatures, have been documented. During offshore fall surveys in the 1980's, capelin were widely distributed from Div. 2J to Div. 3L, with a cline of larger to smaller capelin from north to south. In the early and mid-1990's, few capelin have been observed in Div. 2J and northern Div. 3K while most have been detected in southeastern Div. 3K and northern Div. 3L. The trends in size have been similar to the 1980's with larger capelin occurring in the northern part of the new distribution range and smaller capelin in the south. Also during the 1990's, capelin abundance measured by acoustic surveys was low.

Capelin distribution appears to be changing to more closely resemble the distribution observed in the 1980's. This was apparent in the distribution of capelin bycatch in the fall 1998 groundfish survey, continuing a trend that was first observed in fall 1997. In these years, capelin appeared more extensively in western Div. 3K and southern Div. 2J. Capelin bycatch in spring groundfish surveys in Div. 3L showed a broad distribution in 1996-98. This is similar to distributions observed in the mid- to late 1980's.

Surveys for young fish also detected 0-group capelin off the southern Labrador coast in 1998, the first appearance in the series (1994-98). In the same survey, ripe adult capelin and recently hatched larvae were detected in the Southeast Shoal area (Div. 3LNO); such occurrences had not

been recorded in earlier surveys. These changes in capelin distribution are reminiscent of distributions observed during the 1980's, and are considered the first indicators that capelin may be exhibiting distributions and behaviour considered more typical than previously observed in the early 1990's. These changes are also coincident with a general warming of seawater in the Newfoundland region.

During the late 1980's and through the 1990's, capelin bycatches increased one hundred fold in groundfish surveys on the eastern Scotian Shelf (Div. 4VW). Capelin occur sporadically in this area and as a result, it is not known whether the increase was a result of immigration or enhanced reproductive success. Capelin also appeared on the Flemish Cap (Div. 3M) during the 1990's as bycatch in groundfish surveys and the shrimp fishery. Historically, capelin were rare here and this appearance was most likely due to migration. Increases in abundance in both areas, both historically and recently, have coincided with cold water. There are no new data for Flemish Cap but preliminary results from the eastern Scotian Shelf indicate that March 1999 bycatch levels remain high.

The average size of capelin declined during the 1990's and has remained small. The timing of inshore spawning was delayed during the 1990's and this trend has also continued. The later spawning has been correlated with colder water and smaller fish size. Although there is a general warming trend in sea temperature, fish size remained small in 1998 and it may be that spawning will continue to be later unless sizes return to normal.

Other observations of unusual characteristics of capelin biology during the 1990's, not documented in the scientific literature, include: an increase in the relative proportion of spawning at night; changes in physical structure of the otoliths causing problems in age determinations; an increased incidence of females with ovaries full of unspawned eggs in the fall; a consistent and relatively high proportion of spent females in the fall since 1992.

In general, it appears that some characteristics of capelin such as offshore distributions are changing to more closely resemble patterns observed in the 1980's. Although the observations are at this stage qualitative, the dramatic shifts in the early 1990's appeared to be linked with below

normal seawater temperatures whereas the reversal of this pattern now seems to be occurring with a warming trend.

Evaluation of Resource Status (Ch. 10)

In the past evaluations of resource status, seven partially overlapping series of indicators were combined in a mathematical model to provide relative estimates of yearclass strength. The indicators and their years of existence are:

1) aerial survey index 1982-98
2) purse seine catch rate index 1981-96
3) trap catch rate index 1981-93
4) groundfish 3L fall bycatch 1985-94
5) groundfish 2J3K fall bycatch 1985-94
6) Russian 2J3K fall commercial catch rate index 1972-91
7) egg deposition index 1990-98

The 1998 aerial survey index was lower than 1997 and below the 1990-98 average. The egg deposition rate was the highest in the series (1990-98). Catch rate data from purse seines and traps in 1997 and 1998 are not considered comparable to catch rate from the 1980's because of low effort levels, in part due to quality monitoring. As a result, catch rate data for these years were not used in the model. A change in the gear in the fall groundfish survey in Div. 2J3KL in 1995 has effectively produced a new series which will be examined in more detail in the future for possible inclusion in the model.

A second mathematical model was also incorporated into past assessments. This model produced a recruitment index using results from surveys for larvae and one-year-olds. The indicators used in this model and their years of availability are:

1) 0-group index 1994-98
2) sediment larval index 1990-98
3) emergent larval index 1990-98
4) Conception Bay sediment larval abundance 1987-93
5) oceanic age 1 index 1994-98

The trends in relative yearclass strength between the two indices were similar and as a result, the 12 indicators were combined into one model in this assessment. Combining the data provides more information for the evaluation of

yearclasses that are expected to contribute to the spawning stock in 1999. It also contains the information on the youngest yearclasses (1997 and 1998) which was previously contained in the recruitment model alone.

The method of combining the indices in the model was also refined in this assessment. In previous assessments, individual indicators were given equal weight in the process of combining them. In the current assessments, importance of inclusion of each indicator was determined by the amount of uncertainty in its contribution to the overall index. Indicators with high uncertainty contributed less to the final index.

According to these results, the 1990's might be characterized as a period of relatively strong yearclasses compared to the 1980's. However, the standard errors are so large in recent years that the relative abundances of many of the yearclasses are statistically indistinguishable.

In previous years, an additional mathematical model (which included an assumption that recruitment does not change) provided trends in mature biomass. This model was not updated. It is clear that one of the major assumptions, that is, constant yearclass strength, is violated. Furthermore, standard errors were so large that trends in mature biomass over the time series (1980-present) could not be identified.

Sources of Uncertainty

Many sources of uncertainty cited previously remain. These included the large-scale changes in distribution, the unreconciled divergence between low offshore acoustic estimates and inshore indices in the 1990's, difficulties in ageing capelin in the 1990's compared to earlier years and the large statistical uncertainties from the mathematical model. The mathematical models used assume that a number of things are constant over time; for example, maturity schedules and survival rates. The effects of violations of these assumptions have not been examined.

While the use of the method to determine the relative contribution of indicators in the formulation of the model is considered an improvement, there remains particular concerns about the indices themselves and whether they are now providing reliable indicators of stock status.

During the 1980's, catch rates and other indices showed similar annual patterns. However, catch rates may now be poor indicators of stock status. Fishing effort has declined in recent years, due in part to monitoring for quality and fishing only when the fish meet market requirements. This results in catch rates which probably cannot be compared to the 1980's and may not reflect stock status. Both the aerial survey and egg deposition studies which provide fishery-independent indices, have been reduced in geographical coverage and/or intensity. The aerial survey now covers only the transects in the inner parts of Trinity and Conception Bays. The only beach study area is Bellevue Beach compared to six study beaches (three in each of Div. 3L and 3K) in the original study. There are two major concerns with the 1997 and 1998 aerial and beach surveys: 1) they are so limited in geographical coverage compared to the overall stock area that the results may not reflect status of the whole stock, and 2) there were indications from the 1997 opinion survey that abundance may be changing at different rates within the stock area, for example, within the bays versus near headlands. If this is the case, the limited geographical coverage by the aerial and beach survey may not detect these changes. While the offshore surveys for early life stages (primarily 0- and 1-group) are continuing, acoustic surveys for older juveniles and adults have been discontinued. While it appears that the acoustic survey may be re-instated, there is likely to be a period of a few years before estimates of abundance will be available. The concern that scientific investigations have been reduced to such an extent that it may not be possible to assess the status of capelin stocks, expressed in last year's report has not diminished.

There is also concern over the divergence between the assessment using the mathematical model and the opinions of fixed gear fishermen, particularly the contradiction in comparisons between the 1990's and earlier periods. A longer timeseries and further evaluation are necessary to determine whether the opinion survey can be used as a stock status indicator but this evaluation will be very difficult without other sources of data, which as noted, may be compromised by reduced coverage.

Outlook for 1999

The 1995 and 1996 yearclasses are expected to be major contributors to the 1999 spawning stock. The analyses presented here indicate that these yearclasses are relatively abundant compared to other yearclasses. Even if average fish size is small in 1999, the presence of two relatively strong yearclasses would be expected to result in a spawning biomass in 1999 that is above average when compared to biomasses in the 1990's.

The results from the mathematical model suggest that both the 1997 and 1998 yearclasses are weaker than the 1995 and 1996 yearclasses. The 1998 yearclass appears to be as weak as the 1991 yearclass, the weakest yearclass in the 1990's. If the relative strengths of these yearclasses do not change with additional data, then the capelin stock will probably decline in the future.

There have been many problems and uncertainties in assessing the capelin stocks in recent years in part perhaps to changing behaviour during unusual oceanographic conditions, as well as reduced directed scientific research. It is unlikely that future assessments will be improved at the current level of research activity.

Results of Capelin Studies from Other Areas (Ch. 11)

Although not directly relevant to the assessment of the capelin stock in SA2 + Div. 3KL, data were presented on capelin in Placentia Bay (Div. 3Ps) and these results are included.

The abundance and distribution of capelin (Mallotus villosus) in Placentia Bay, southeastern Newfoundland, were assessed during four acoustic surveys in January, March, and June 1998, and in January 1999. Most capelin observed were immature (75% < 130 mm). Capelin biomass was highest in June 1998, with an acoustic estimate of 132,000 t for outer Placentia Bay. Capelin biomass in the outer Bay was much lower in January 1998 (13,000 t), March 1998 (2,100 t), and January 1999 (390 t), suggesting seasonal changes in spatial distribution. There were also seasonal differences in vertical distribution of capelin. In June capelin were close to the surface at night and near the bottom during the day. At other times no diurnal vertical migration was evident.

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Results of a Telephone Opinion Survey of Fixed Gear Capelin Licence Holders for 1998

by

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Introduction

A questionnaire was used to quantitatively evaluate biological and fishery-related information obtained from capelin (Mallotus villosus) fishers in 1998. The questions were developed to supplement information collected by the research logbook and beach sampling programmes and to quantify to some extent the impressions of fishers on the status of the capelin stock in Div. 3KL. All questions were the same as in the 1997 survey.

Methods

The survey population size of 1829 (3L: 803, 3K: 1026) was defined as all capelin fixed gear (traps and beach seines) fishers licensed to fish capelin in NAFO Div. 3L and 3K in 1998. A list of names and telephone numbers was provided by the Resource Management Division, Fisheries and Habitat Management Branch, DFO. Employing a simple random sampling design and an expected response rate of 85% a sample population with 216 names was chosen to achieve a ±7% margin of error with 95% confidence intervals (Gower and Kelly 1993). The sampling statistics do not apply to the comments presented in Table 4 nor the geographical comparisons in Figure 14 and Tables 1-3. The survey was conducted by telephone interview.

Telephone interviews commenced October 20, 1998 and were completed on November 30, 1998. Interviewers were unable to contact 31 individuals on the licensing list who were in the random sample population. Of these 10 could not be contacted despite five attempts to do so, 9 had no telephone in service (disconnected, wrong number, no

telephone number), 1 was out of the province during the survey, 2 declined to participate, 7 did not fish, and 2 persons were deceased. The 185 completed questionnaires represent an 85% response rate equivalent to the expected.

Results and Discussion

Abundance Questions

Three questions (Appendix A) comparing abundance of capelin in 1998 to previous years were asked in the survey. Most respondents indicated that capelin abundance in 1998 in their area was low (Fig. 2) with a mean response equal to 4.1. This is lower than 5.4 in 1996 and comparable to the 3.8 average for last year. The abundance of capelin in 1997 was estimated to be 3.7 by respondents of this survey, the same as the 3.8 estimated by the 1997 survey (Fig. 3). In all fishing areas except for the Southern Shore the average abundance of capelin in 1998 was similar to or slightly higher than estimated in 1997 (Table 1). In general those areas with a 'better' fishery tended to have higher abundance. When given three options in question 3 (Appendix A) respondents clearly indicated that capelin abundance in 1998 was lower than when they first started to fish capelin (Fig. 4). This response has held firm for all five surveys. Generally most respondents considered capelin abundance to be low and similar to 1997.

Spawning Questions

Questions 4-13 (Appendix A) relate to spawning. According to respondents capelin in 1998 occupied a small proportion of the available spawning beaches (Fig. 5). The number of respondents reporting 'no spawning' was similar to the response in 1997. The responses in the 1-5 beaches category is lower than in 1997 (Nakashima 1998), however most responses were at the low end of the range. Capelin spawned on more or the same number of beaches in 1998 compared to 1997 (Fig. 6). The intensity of spawning in 1998 (Fig. 7) was similar to 1997 with a mean spawning intensity of 4.7 compared to 4.1 in 1997. Spawning intensity in 1998 was similar among geographic areas (Table 2). Spawning intensity in 1998 was generally higher or the same compared to 1997 (Fig. 8). Approximately 40% of respondents were unable to make a comparison. Egg densities at Bellevue Beach in 1998 were almost twice as much as in 1997 (Nakashima and Slaney 1999b) while the

total school area estimated by the aerial survey in 1998 was lower than the 1997 estimate (Nakashima 1999). Respondents felt spawning on beaches in 1998 was more intense than in 1997.

Capelin spawned off beaches more often in 1998 than in 1997 (Fig. 9). Non-responses remain high at almost 30%. The historical view of capelin spawning off beaches is similar among the three most recent surveys (Fig. 10). The 111 persons who responded in the affirmative to question 8 were asked to give reasons why capelin may have spawned in deeper water in 1998 (Appendix A: question 9). The most frequent response was warmer water temperatures in deeper water (45%). Other possibilities suggested were the presence of predators (e.g. humans, seagulls) driving capelin away from beaches (15%), dirty water (4%), low capelin abundance (3%), and no cod to drive capelin ashore (2%). Approximately 8% said capelin in their area always spawned in deep water which has remained consistent for all years surveyed. The remaining 21% gave no response.

The time when spawning began in 1998 was delayed compared to the 1980s. The distribution of times was later than in 1997. This is the first time since the survey began in 1994 that first spawning times were reported for September. Of those answering question 11a who recalled when spawning began in 1998 the majority suggested late June to late July with most respondents favouring early July to early August (Fig. 11). Spawning was later than in 1996 or 1997. Almost 8% observed no spawning in 1998, much less than the 28% in 1997. Comparing the start of the spawning season in 1998 to 1997 in question 11b most respondents who expressed an opinion indicated that it was the same or later (Fig. 12). Compared to when fishers first started fishing capelin, there has been an overwhelming majority who felt that spawning times in 1994-98 have been later (Fig. 13). Spawning began in early July at Bellevue Beach, Trinity Bay in 1998 (Nakashima and Slaney 1999b) but the majority of the spawning took place in late July.

The size of females was small (49%) or average (33%) with very few reports of large females (1%) (Fig. 14). These observations are consistent with the low mean lengths observed in samples collected in 1998 (Carscadden 1999; Nakashima and Slaney 1999b).

Questions on the Fishery

Almost all licensed respondents (94%) intended to fish capelin in 1998 and 60% of them set out fishing gear or searched for capelin. Of the 104 respondents who fished in 1998, 45 used one trap, 36 used two traps, 3 fished more than 2 traps, 13 used trap(s) and a beach seine, and 20 used a beach seine. Only 18% who fished had no landings in 1998 (Fig. 15) and average reported landings were 68,500 lbs (31,100 kg). The majority reported discards of less than 25,000 lbs (11,340 kg) (Fig. 16). Combining estimates of landings and discards the average catch per telephone respondent in 1998 was 118,100 lbs (53,600 kg) (Fig. 17) which compares favourably with the average catch from research logbook estimates (48,100 kg, Nakashima and Slaney 1999a). Table 3 compares the average catch per fisher reported in the opinion survey and the research logbook program by fishing area. Most comparisons are similar with the opinion survey always having the higher catch rate. The research logbook catch rates are considerably lower for Notre Dame Bay and the Southern Shore where landings and logbook returns were low. Also, the research logbook data were only for capelin traps. Most of the discarded capelin were released alive (Fig. 18), comparable to what was reported in research logbooks. The reasons for discarding were low percentage of females (34%), redfeed (19%), small fish (16%), capelin mixed with cod (9%), spent fish (5%), problems with buyers and selling capelin (5%), catch too small amount to land (3%), capelin mixed with other species (3%), and capelin caught after the season was closed (2%). Research logbook results suggest small females, the presence of redfeed, and low percentage of females as the major reasons capelin were discarded from traps (Nakashima and Slaney 1999a). Discarding in 1998 was reported to be lower than in previous years (Fig. 19). In contrast trap research logbooks report one of the highest discarding rates in recent years (Nakashima and Slaney 1999a). The same situation arose in 1997 (Nakashima and Clark 1998). Of those who fished, 57% reported bycatches of a few pounds to several thousand pounds. The most frequent bycatch species based on estimated weight were cod (60%), herring (11%), and small cod (9%). Squid, flatfish, and rock cod were also mentioned. Of these 79% were released alive.

Questions on Climate and Ocean Conditions

The sample population was asked question 24 (Appendix A) pertaining to general weather and oceanic conditions during the summer of 1998. Wind conditions in the summer of 1998 were considered calm by 4% of the population, light or favourable by 62%, moderate by 26%, and windy by 9%. Air temperatures were reported to be cool (3%), average (10 %), warm (68%), or hot (19%). The summer was mainly sunny (75%) or half sunny and half overcast (22%). Ice was not a concern in 1998 with only 2% reporting moderate or heavy ice. Fifty-four percent reported icebergs in their area. Water temperatures were generally warm (62%) or average (27%). Reports of cold (3%) or cool (7%) water temperatures were rare. Overall weather conditions were considered to be good (54%) to excellent (26%) for fishing throughout the region.

Comments by Respondents

At the end of the telephone interview each of the 185 respondents were provided the opportunity to make comments. The range of topics covered most aspects of capelin biology and the fishery and also on other fisheries. The comments relative to capelin have been summarized in Table 1. In many instances more than one comment was given but only one comment per respondent was reported in Table 1.

Demographics of the Sample Population

All respondents were asked questions 25-28 to characterize the sample population of fixed gear fishers and to be able to relate in subsequent analyses responses to areas fished and experience in the fishery. The distribution of responses to question 25 shows the number of years of involvement in the capelin fishery (Fig. 20). Fishing vessel lengths varied from 17 to 55 feet with 83% less than 36 feet (Fig. 21). Estimated vessel capacity for capelin was less than 30,000 lbs (13,600 kg) for 80% of the fishing fleet involved in the fixed gear capelin fishery (Fig. 22). Most licensed fixed gear capelin fishers are between 35 to 55 years of age (Fig. 23). The average age was 46 years. Average vessel capacity (20000 lbs or 9,100 kg) and vessel length (30 ft) of the fleet and the age structure of the licence-holders (Fig. 23) are comparable to previous surveys. The highest proportion of respondents was from Notre Dame Bay with the fewest fishers

in the sample population from Bonavista Bay and St. Mary's Bay (Fig. 24). The distribution of responses from Div. 3KL in the sample population is similar to other years except for the small number from Bonavista Bay.

Summary

Results from the telephone survey of fixed gear capelin fishermen provided observations on beach spawning, local capelin abundance, fishing activities, and summer weather conditions. In 1998 most respondents indicated that capelin spawned later, spawned on fewer beaches than in the past, and spawned subtidally away from beaches more so than in the 1980s. Spawning intensity was 4.7. Most licensed fishers intended to fish in 1998 and 60% of them actually put their gear in the water or searched for capelin. Commercial fixed gear fishing occurred in all areas of Div. 3KL. The weather was generally considered favourable for fishing and water temperatures were considered warmer than normal. Overall respondents felt capelin abundance and spawning on beaches in 1998 was slightly more than observed in 1997 but continues to be lower than in the 1980s. The results of this survey as applied to Div. 3KL represent the opinions of the survey population at the time the survey was conducted with a ±7% margin of error 19 times out of 20.

Acknowledgements

Morris Clark and Barry Slaney conducted the telephone interviews. Our appreciation to the individuals who took the time to share their knowledge with us. M.Y. Farrell assisted in the preparation of the manuscript.

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Table 1. Average capelin abundance in 1997 and in 1998 by fishing area. The number of responses is given (N).

Area	N	Abundance	
		1998	1997
White Bay	42	5.6	4.8
Notre Dame Bay	69	3.2	3.0
Bonavista Bay	4	3.3	3.0
Trinity ay	21	4.1	3.5
Conception bay	28	4.5	3.8
Southern Shore	15	3.7	4.1
St. Mary's Bay	5	5.2	5.0

Table 2. Average spawning intensity in 1998 by geographical area. The number of responses is given (N).

Area	N	1998 Spawning intensity
White Bay	42	4.5
Notre Dame Bay	70	4.7
Bonavista Bay	4	5.0
Trinity ay	21	4.8
Conception bay	26	5.0
Southern Shore	15	4.3
St. Mary's Bay	5	4.0

Table 3. Catch rates (catch (t) per fisher) by fishing area estimated from the opinion survey and research logbooks. Sample sizes are given (N).

Fishing area	Opinion		Logbook	
	N	Catch rate	N	Catch rate
White Bay	42	48.5	13	34.6
Notre Dame Bay	70	43.3	2	4.0
Bonavista Bay	4	21.0	4	16.7
Trinity Bay	21	66.1	17	64.4
Conception Bay	28	74.9	12	64.5
Southern Shore	15	41.9	1	19.1
St. Mary's Bay	5	33.3	2	22.9

Table 4. Summary of comments pertinent to capelin or the capelin fishery.

Comment	Number of responses	% response
No capelin/scarce	26	14.1
Lots outside and after quota closed	2	1.1
Most capelin and biggest after quota closed	4	2.2
Not much and small	2	1.1
Good size and abundant	1	0.5
Fair amount/abundant and small	5	2.7
Small	1	0.5
Bay stocks of large capelin gone, small offshore ones left	1	0.5
Capelin only in a few spots	1	0.5
Capelin around long time	2	1.1
Capelin deep not come to land	22	11.9
Later coming in every year	3	1.6
Spawning on unusual beaches	1	0.5
Spawning night time only	1	0.5
Spawning in fall (Sept.)	3	1.6
Spawning later; all sizes mixed	1	0.5
Caught/destroyed by seiners/longliners	11	5.9
Capelin are overfished	1	0.5
Fishery should be closed	25	13.5
Cod closed; capelin should be closed	5	2.7
Should not be destroyed for nothing/low price	7	3.8
Low abundance, close fishery	5	2.7
Leave along for a while	3	1.6
Need better monitoring	4	2.2
IQ system	9	4.9
Need bigger quota	2	1.1
Opened too early	6	3.2
Opened too late	4	2.2
Buyers not interested in buying	4	2.2
No comments	23	12.4

Appendix A

SURVEY QUESTIONNAIRE OF FIXED GEAR CAPELIN Licence HOLDERS

Questions on Abundance:

1. Using a scale of 1 to 10 with 1 being the lowest and 10 the highest how abundant (i.e. numbers of fish) were capelin in your area this year?

2. Using a scale of 1 to 10 with 1 being the lowest and 10 the highest how abundant (i.e. numbers of fish) were capelin in your area last year?

3. How would you describe the abundance of capelin this year compared to when you first started fishing capelin?

Questions on Spawning:

4. Approximately on how many beaches in your area do capelin usually spawn?

5. Approximately on how many beaches did capelin spawn this year?

   If 'none' or 'don't know' go to Ques. 8

6. How many beaches did capelin spawn on this year compared to last year?

7a. On a scale of 1 to 10 with 1 being low and 10 being high how intense was capelin spawning in your area this year?

7b. What was the intensity of capelin spawning this year compared to last year?

8. Did capelin spawn off beaches in your area in deeper water?

   If yes go to Ques. 9
   If 'no' or 'don't know' go to Ques. 10
   If no spawning on beaches or in deep water go to Ques. 14

9. Why do you think capelin spawned in deeper water this year?

10. How often since you started fishing have you observed capelin spawning off beaches in deeper water?

11a. When did capelin first spawn in your area this year?

11b. Did spawning start at the same time this year as last year?

12. What was the overall size of female capelin this year?

13. How does the timing of capelin spawning (beginning and end) this year compare to when you first started fishing capelin?

Questions on the Fishery.

14. Did you intend to fish for capelin this year?

If 'yes' continue, if 'no' go to Ques. 24

14b. Did you set your fishing gear or go out and search for capelin this year?

If 'yes' continue, if 'no' go to Ques. 24

15a. What type of fishing gear did you use?

If a 'trap' go to Ques. 15b if other gear types go to Ques. 15d

15b. How many traps did you fish?

15c. How much capelin does your trap(s) hold when full?

15d. Did you always fish this gear type or have you fished other types in the past?

If fished other gear types what were they?

16. Approximately how much capelin did you and your crew land this year?

17. Approximately how much capelin (live or dead) did you and your crew discard (i.e. did not land or sell)?

    If discarding >0 continue, if discarding is '0' go to Ques. 21

18. What percent of the discarded capelin do you think survived?

19. Why were capelin discarded? Please give reasons in order of importance.

20. How does the amount discarded this year compare to all the other years you've fished capelin?

21. While fishing capelin did you and your crew catch any other species (i.e. by catch)?

    If 'yes' continue, if 'no' go to Ques. 24

22. What species (three maximum) were they and approximately how many (weight) of each?

23. What was the condition of the by catch when released?

Questions on Climate/Ocean Conditions:

24. Weather plays an important role in the biology of capelin. Please describe the local weather and sea conditions in your area during capelin spawning season (usually June/July).

    Winds-force and direction, air temperature, sun or overcast, ice, water temperature

General Information:

25. In what year did you first start fishing capelin commercially?

26. What is the length and capacity (maximum weight of capelin it can carry) of your vessel?

27a. Have you always fished for capelin in the same location?

If 'no' continue, if 'yes' go to Ques. 28

27b. Where else have you fished for capelin?

28. How old are you?

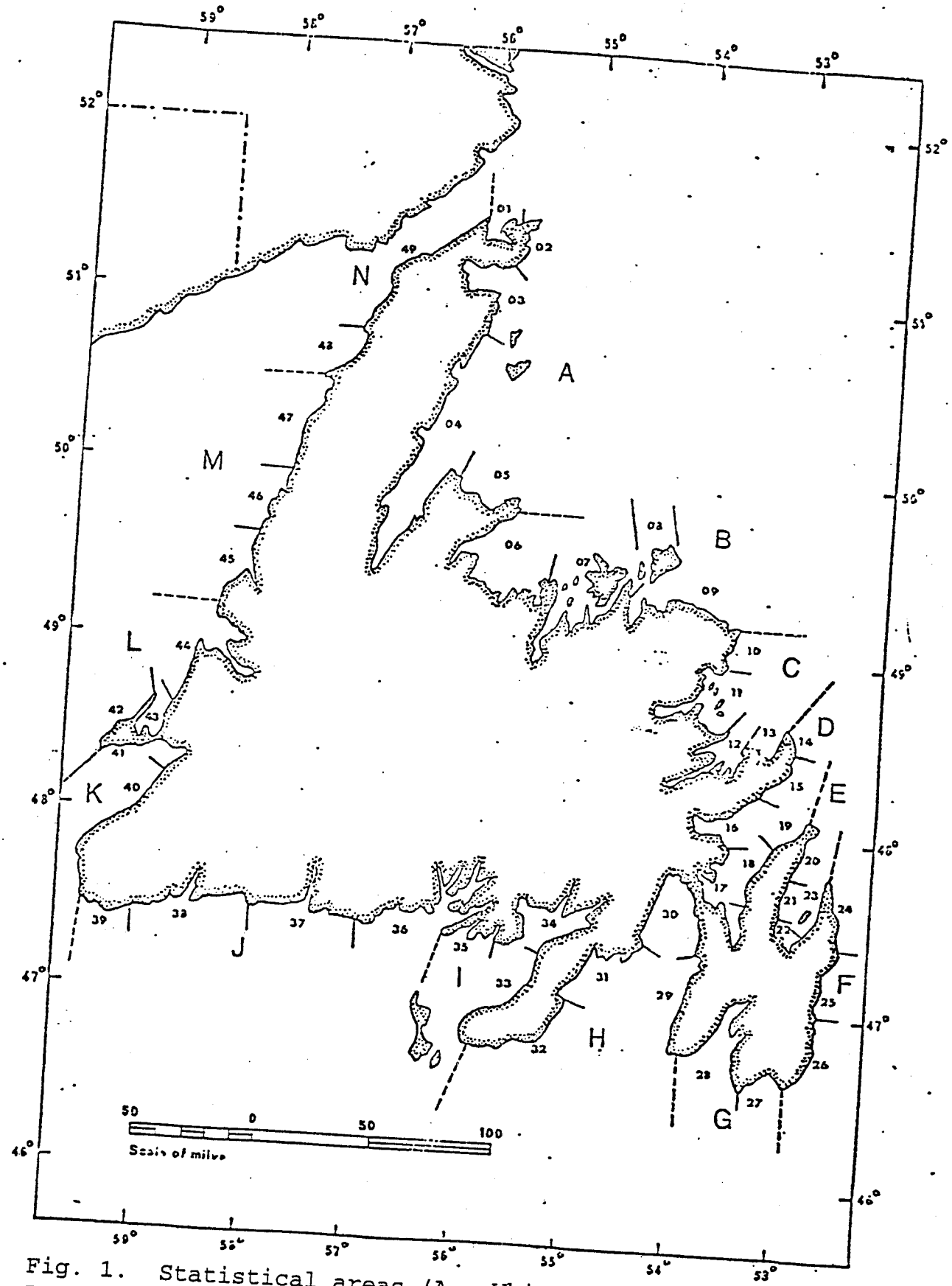

Fig. 1. Statistical areas (A = White Bay, B = Notre Dame Bay, C = Bonavista Bay, D = Trinity Bay, E = Conception Bay, F = Southern Shore, and G = St. Mary's Bay) for the Newfoundland Region.

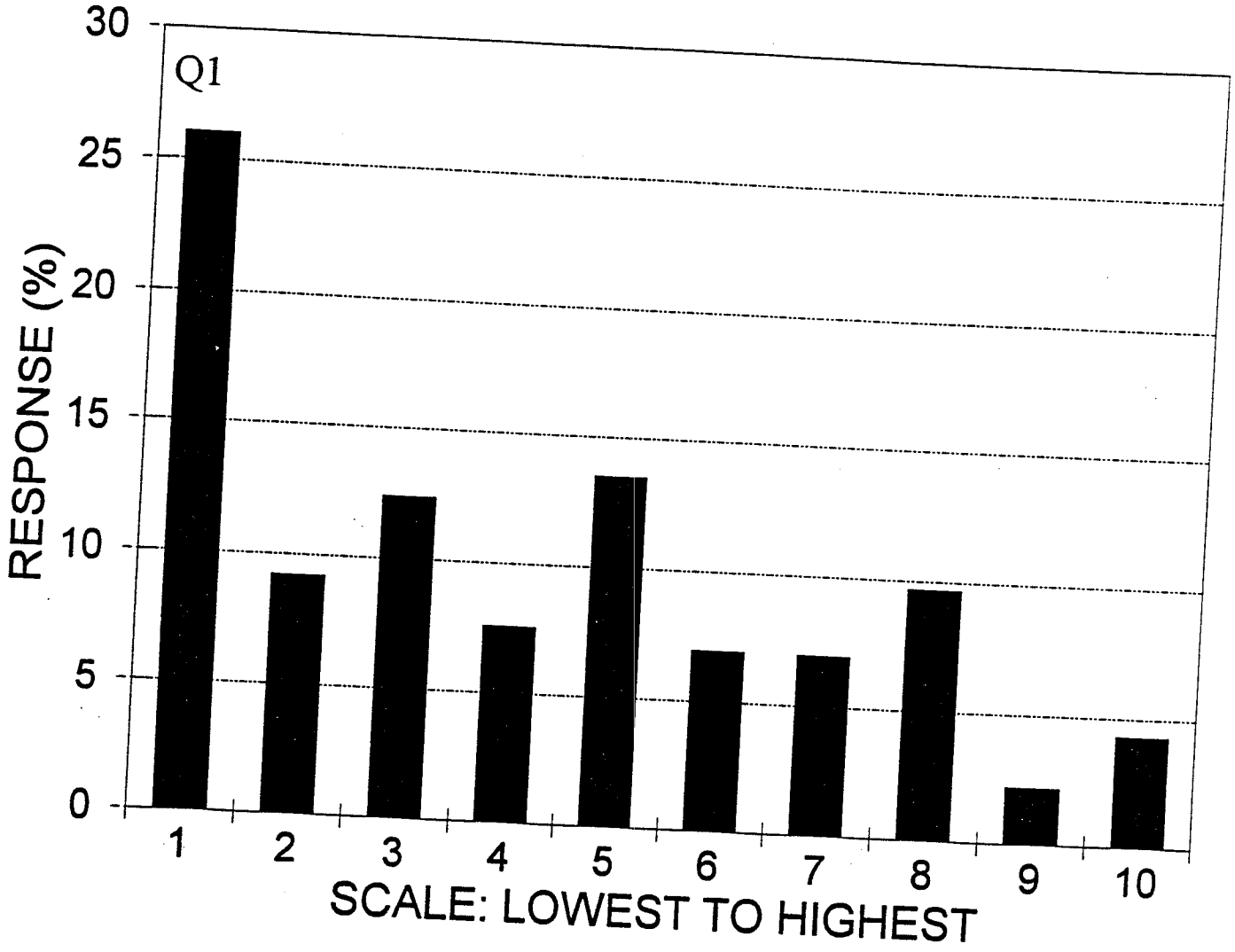

Fig. 2. Response to question 1 on the abundance of capelin in 1998.

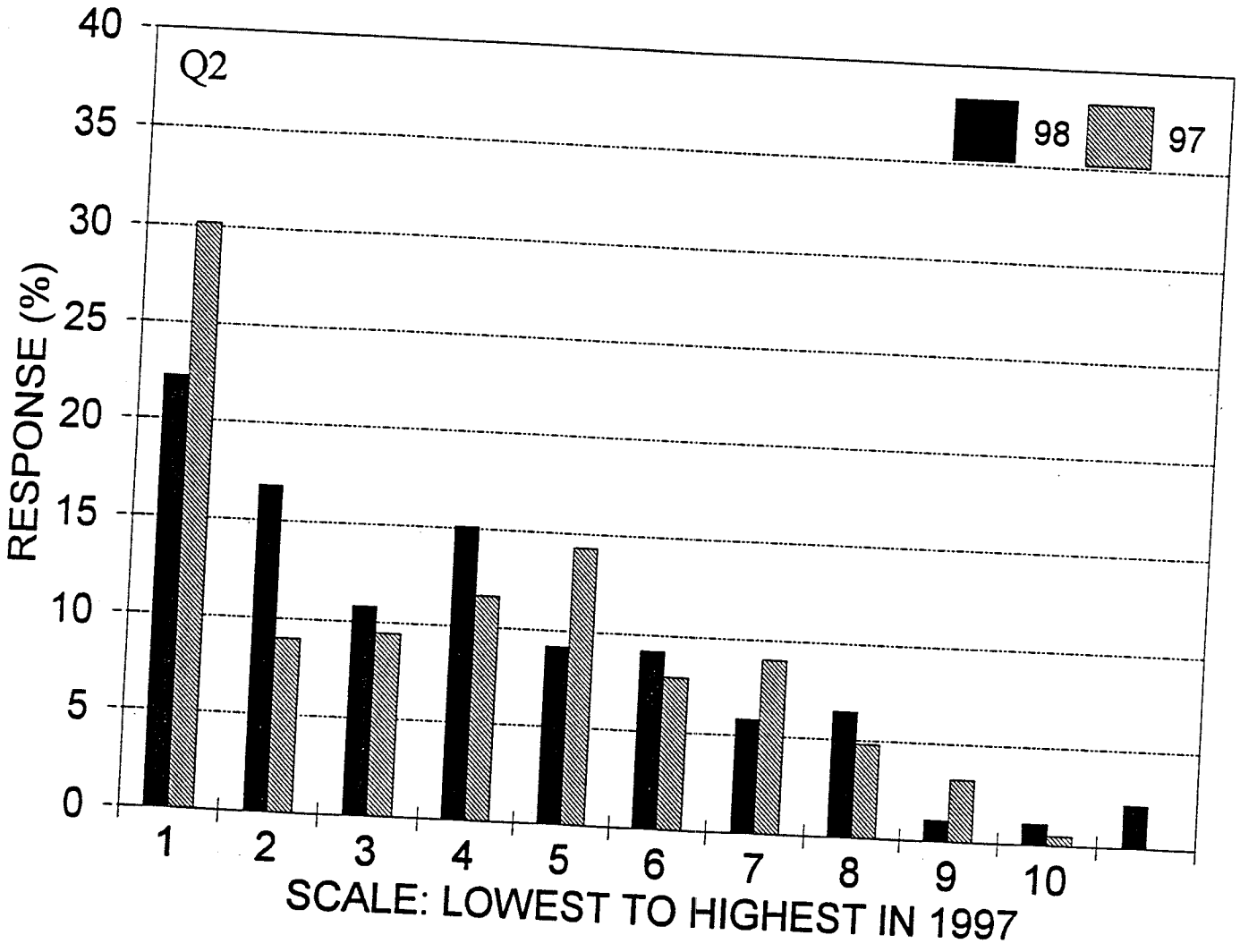

Fig. 3. Impression of capelin abundance in 1997 from the 1997 (Nakashima and Clark 1998) and 1998 surveys.

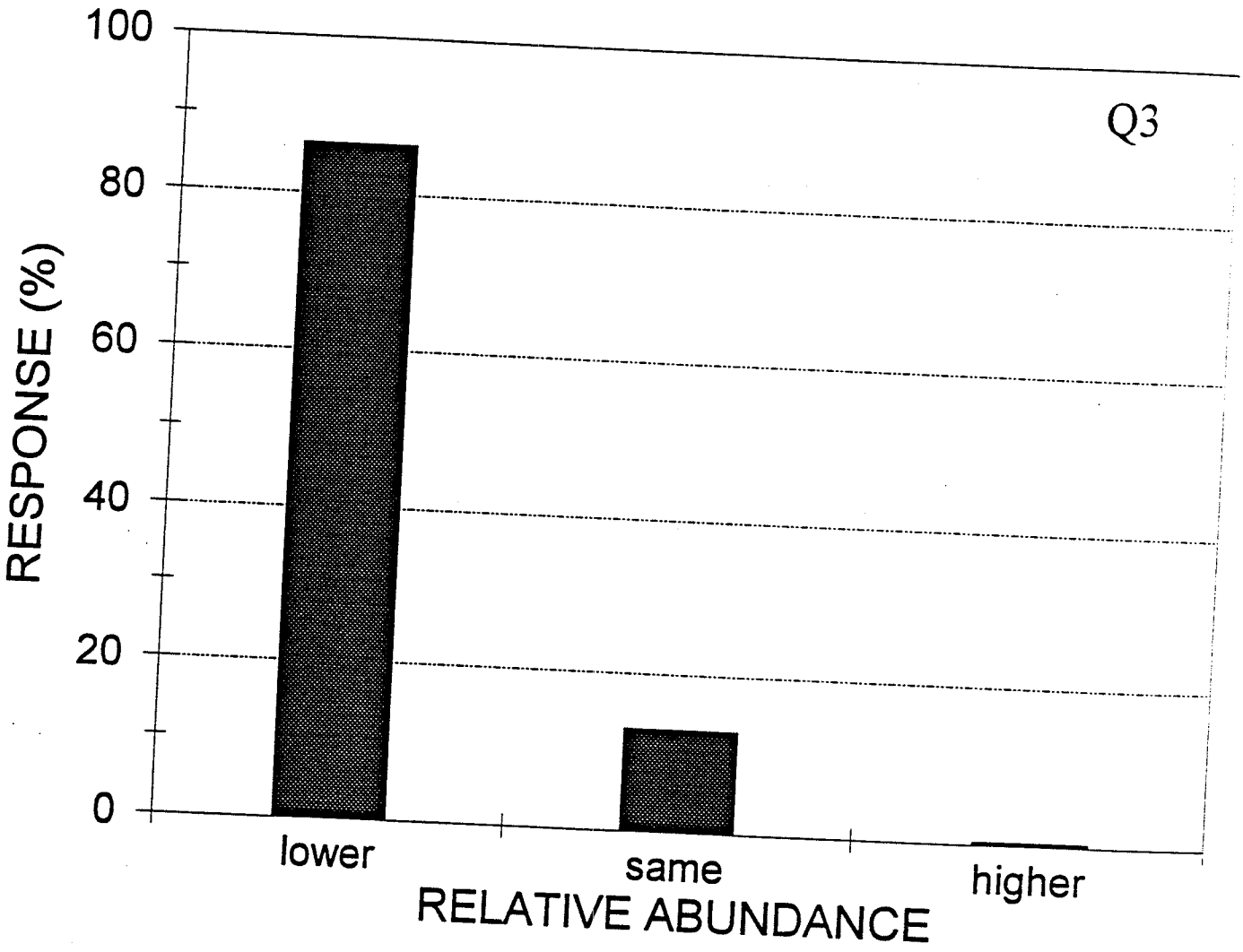

Fig. 4. Response to question 3 concerning abundance in 1998 compared to first started fishing. No answer given (na).

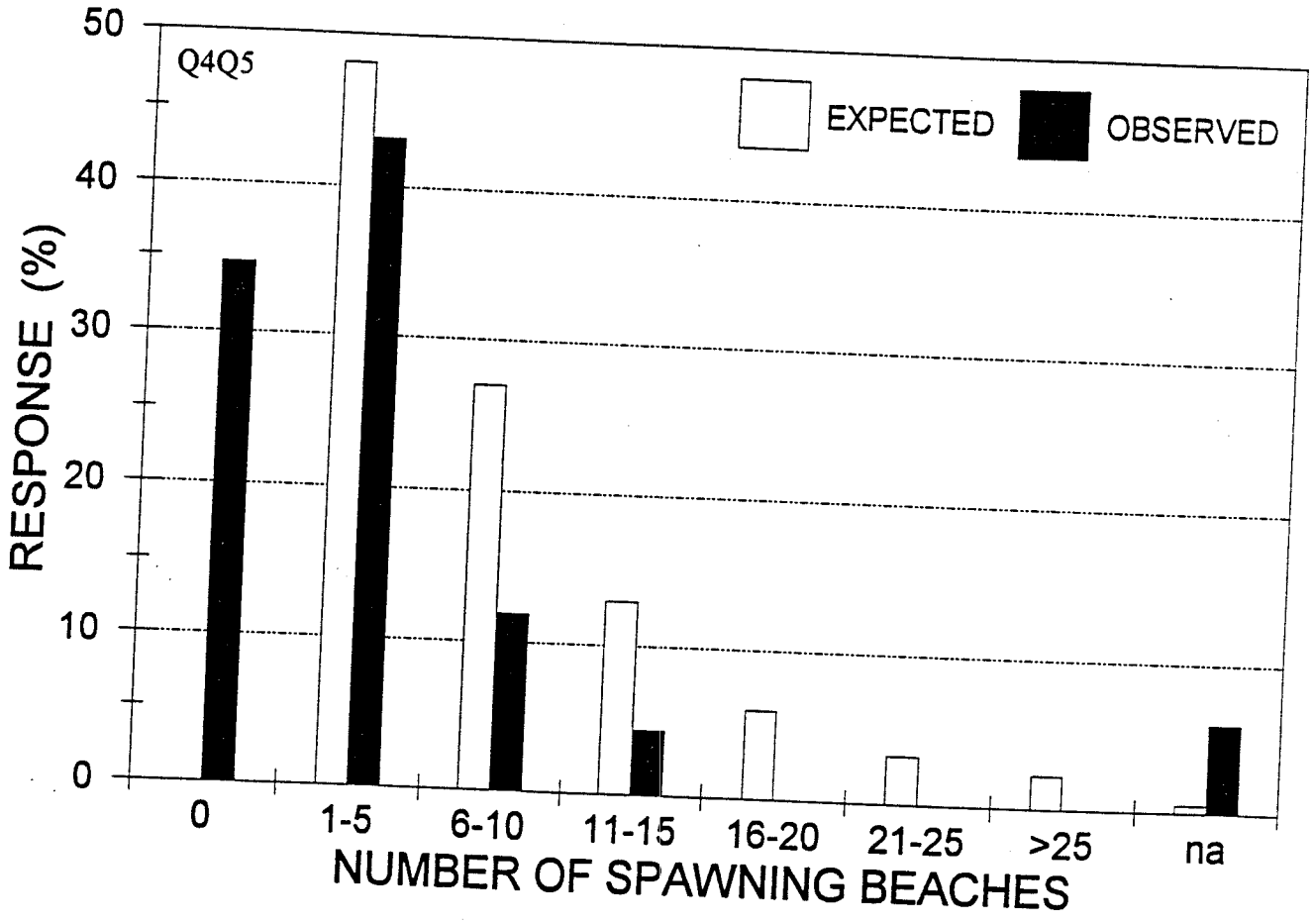

Fig. 5. Comparison of the number of beaches capelin spawned on in 1998 to the available beaches. No answer given (na).

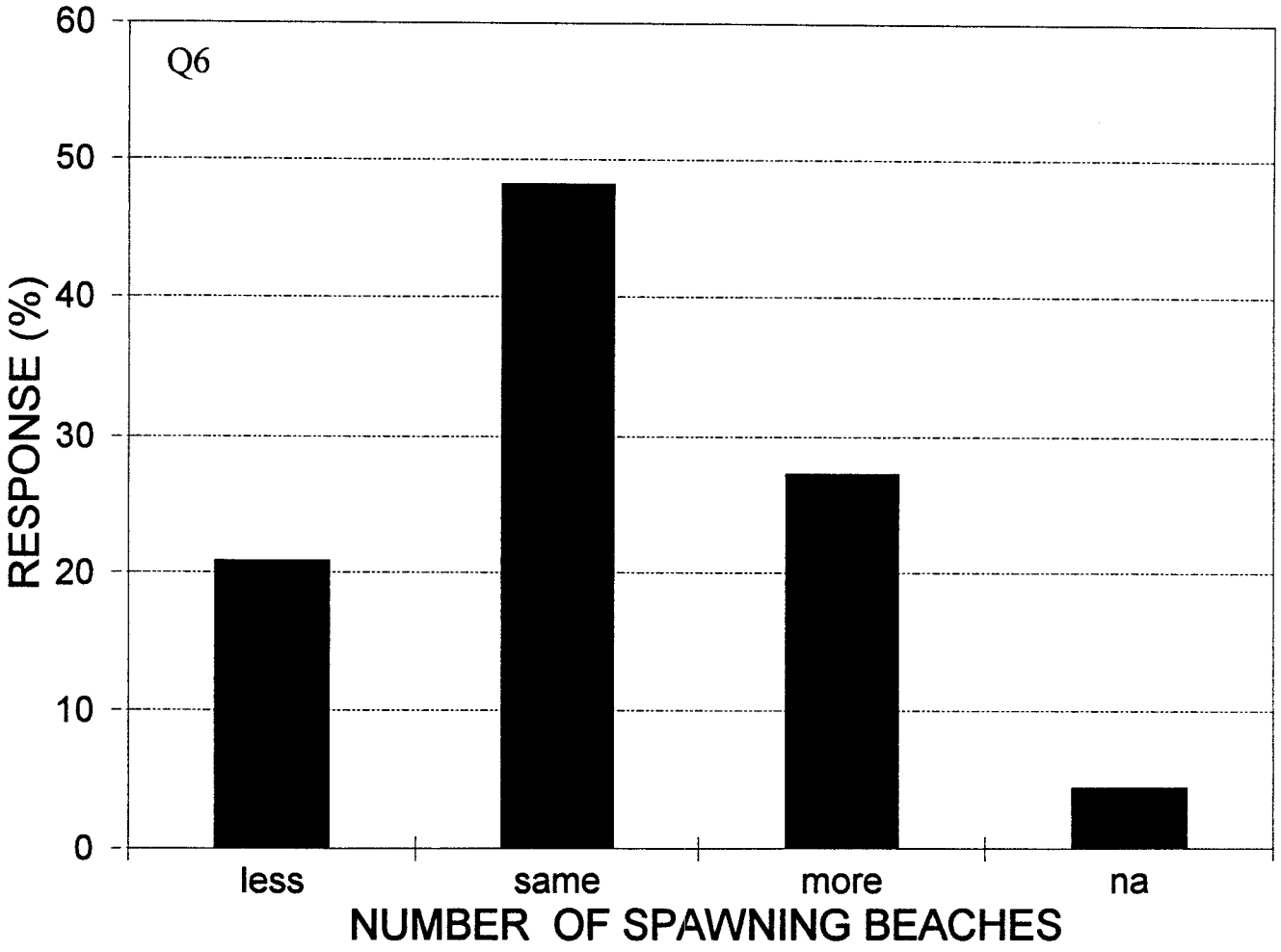

Fig. 6. Response to question 6 concerning the relative number of spawning beaches occupied in 1998 compared to 1997. No answer given (na).

Fig. 6

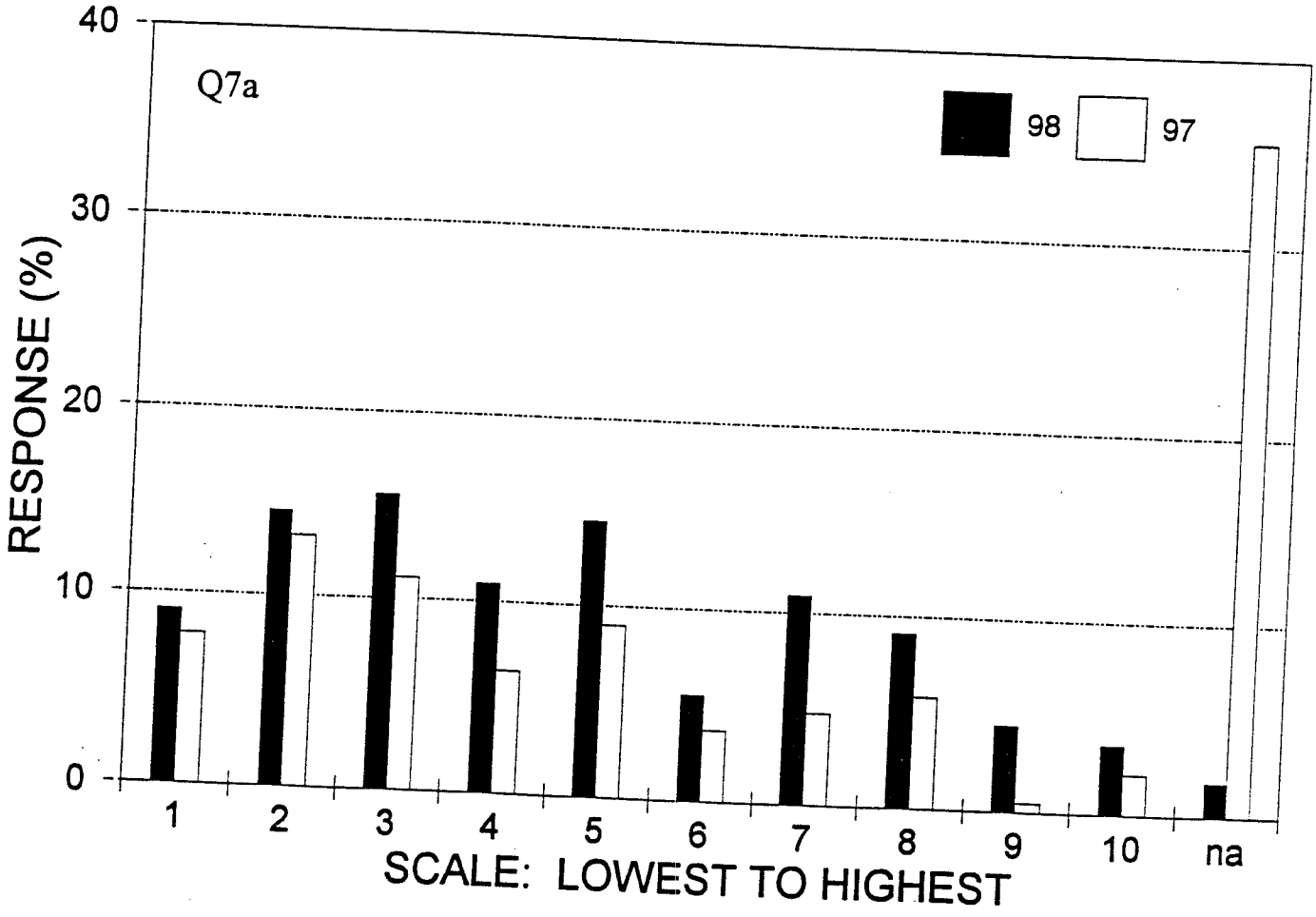

Fig. 7. Response to question 7a concerning the intensity of spawning on an increasing scale of 1 to 10 in 1998 compared to 1997. No answer given (na).

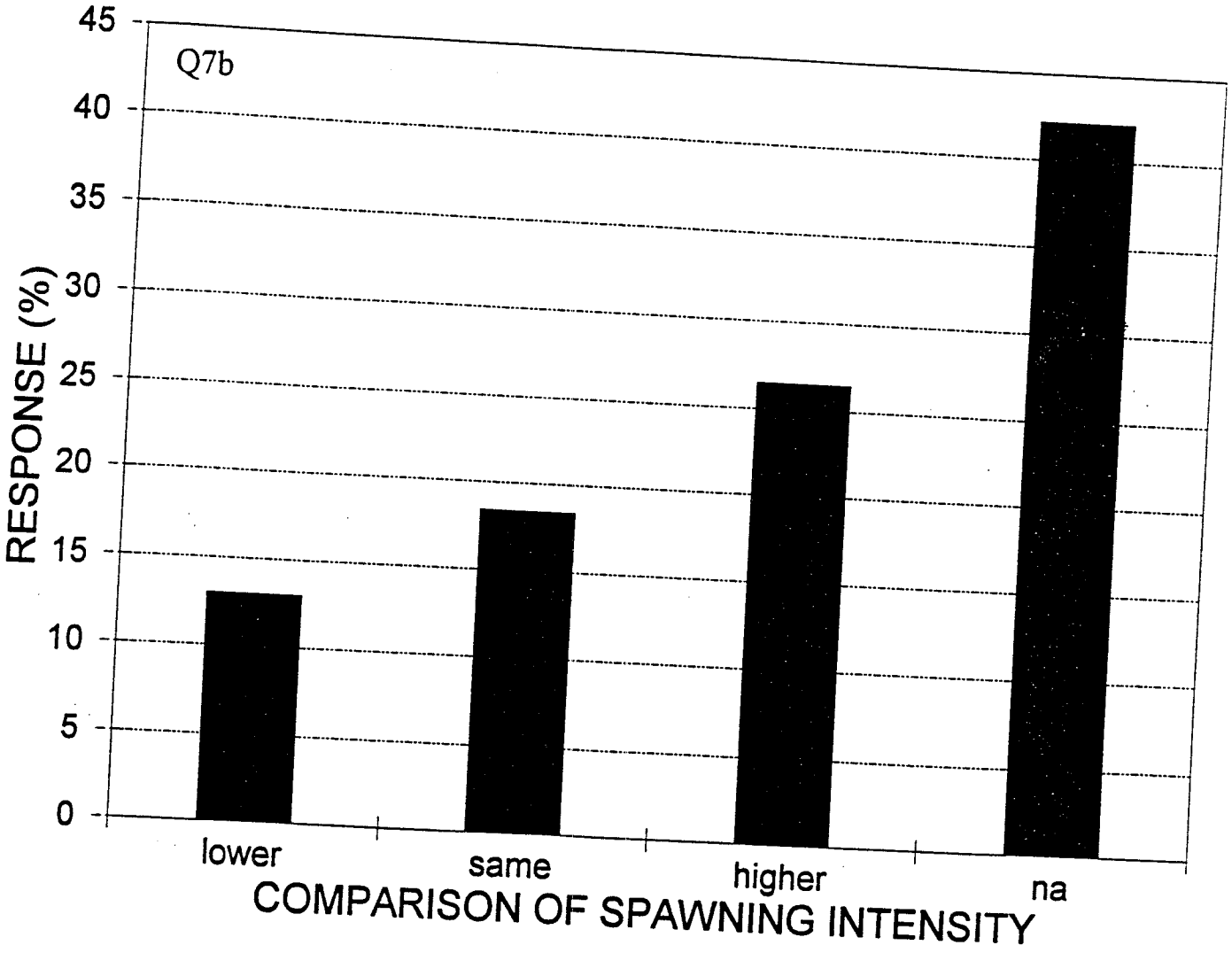

Fig. 8. Response to question 7b comparing the spawning intensity in 1998 relative to 1997. No answer given (na).

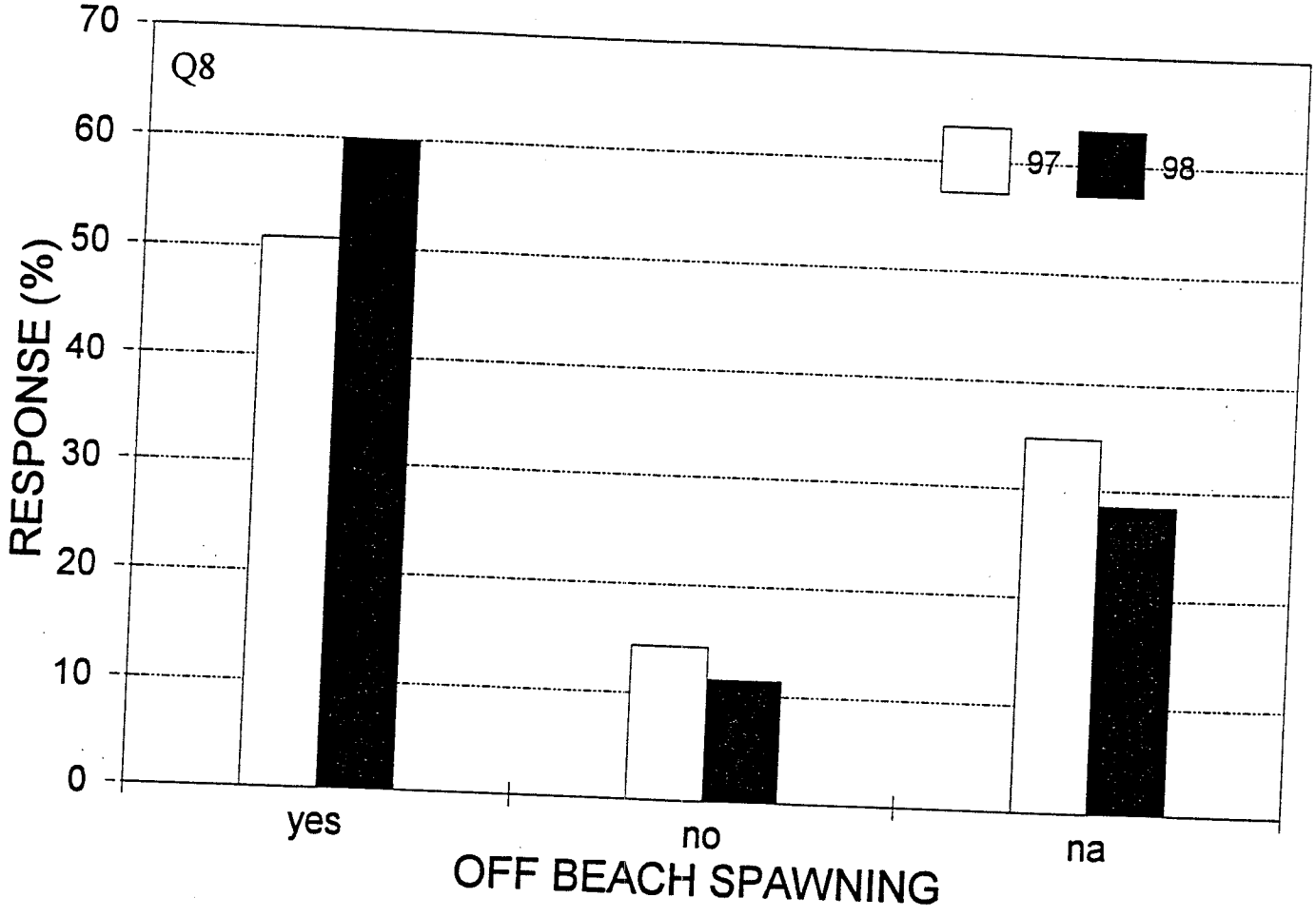

Fig. 9. The extent that off beach spawning occured in 1998 compared to1997 (Nakashima and Clark 1998). No answer given (na).

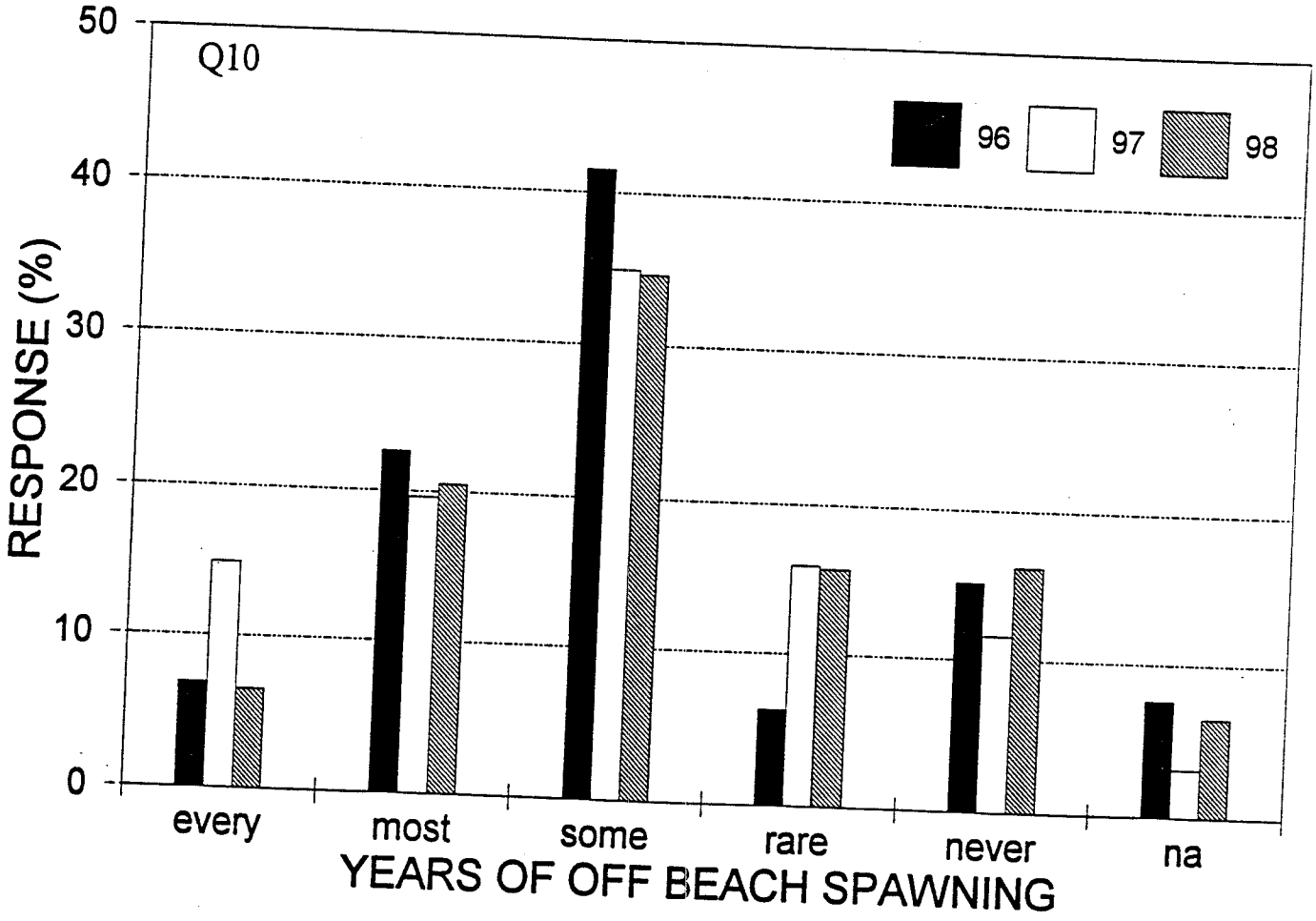

Fig. 10. The prevalence of off beach spawning reported in the 1996, 1997 and 1998 surveys. No answer given (na).

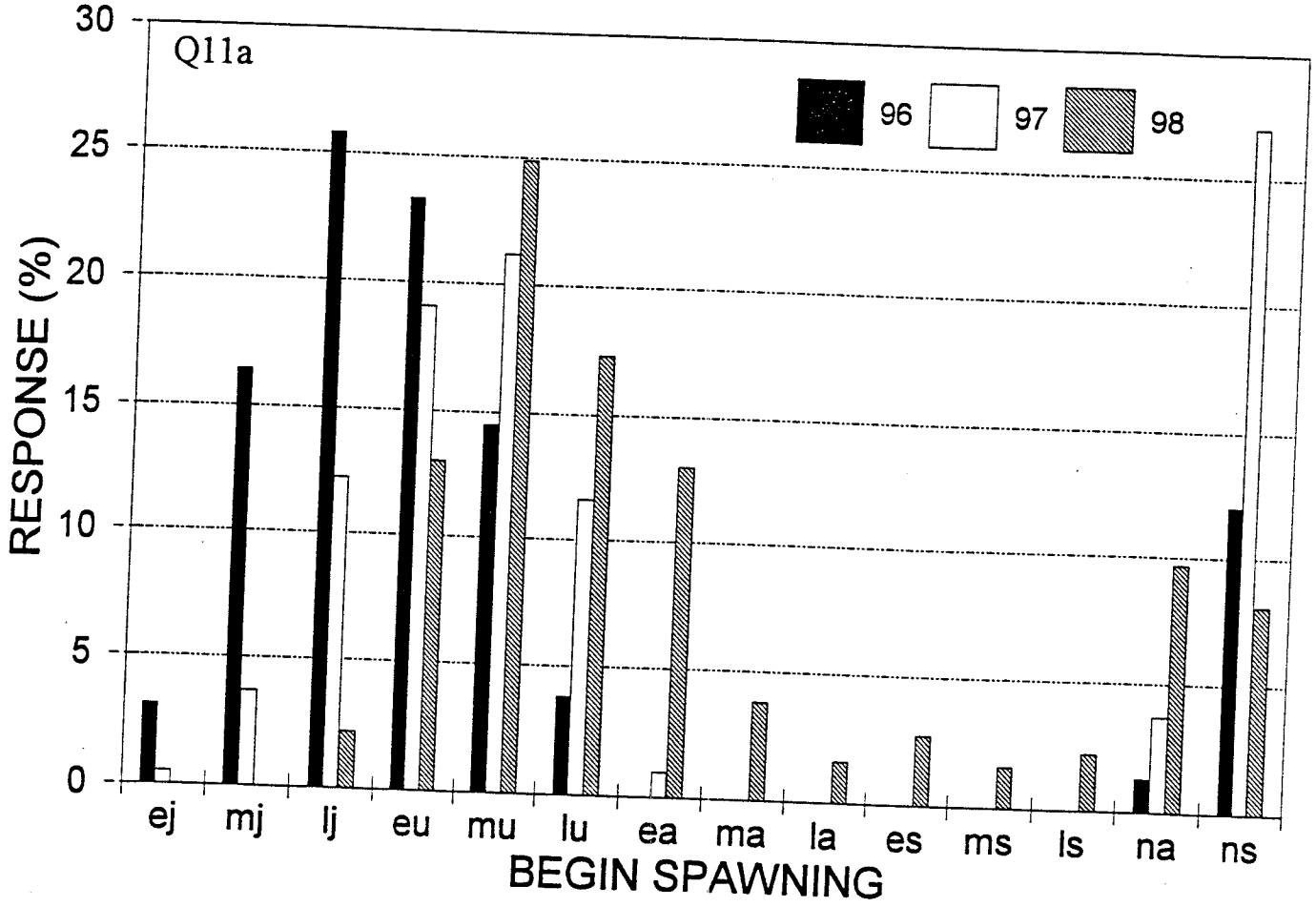

Fig. 11. The time when capelin began spawning in 1996 (Nakashima 1997), 1997 (Nakashima and Clark 1998) and 1998. Spawning times are early June = ej, mid June = mj, late June = lj, early July = eu, mid July = mu, late July = lu, early August = ea, mid August = ma, late August = la, early September = es, mid September = ms, and late September = ls. No answer given (na) and no spawning (ns).

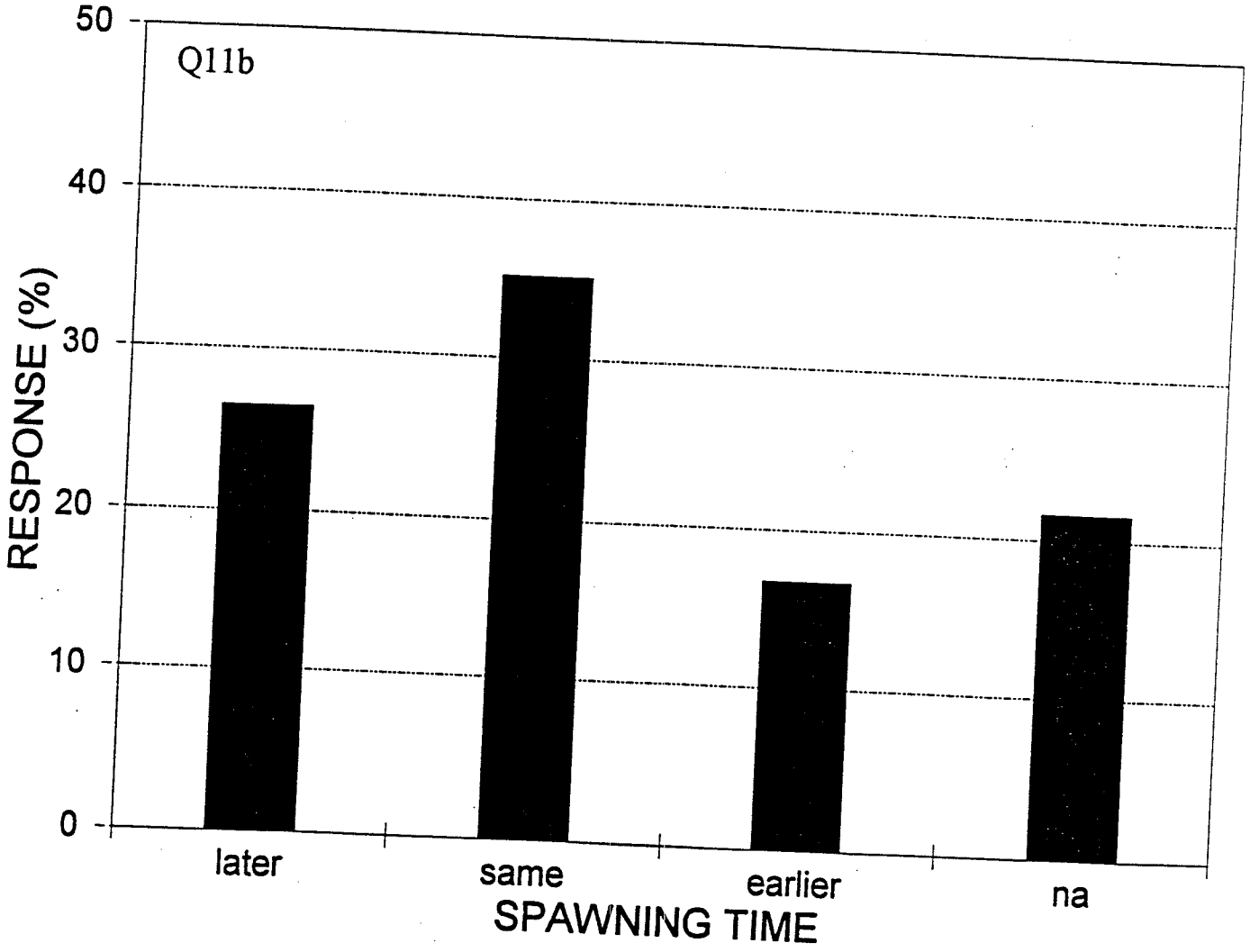

Fig. 12. The start of spawning in 1998 compared to 1997 in response to question 11b. No answer given (na).

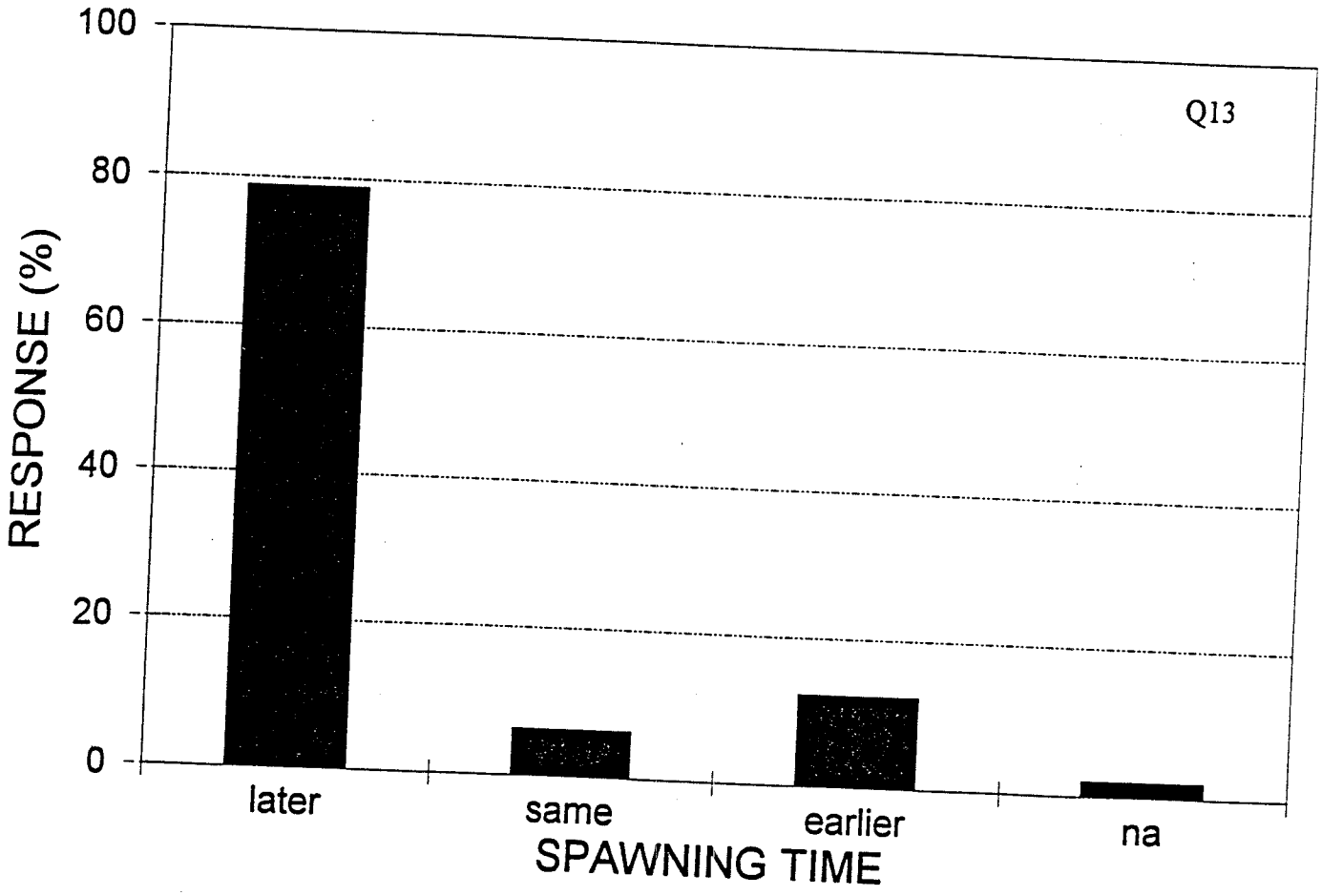

Fig. 13. Comparison of spawning times in 1998 to when respondents first fished capelin. No answer given (na).

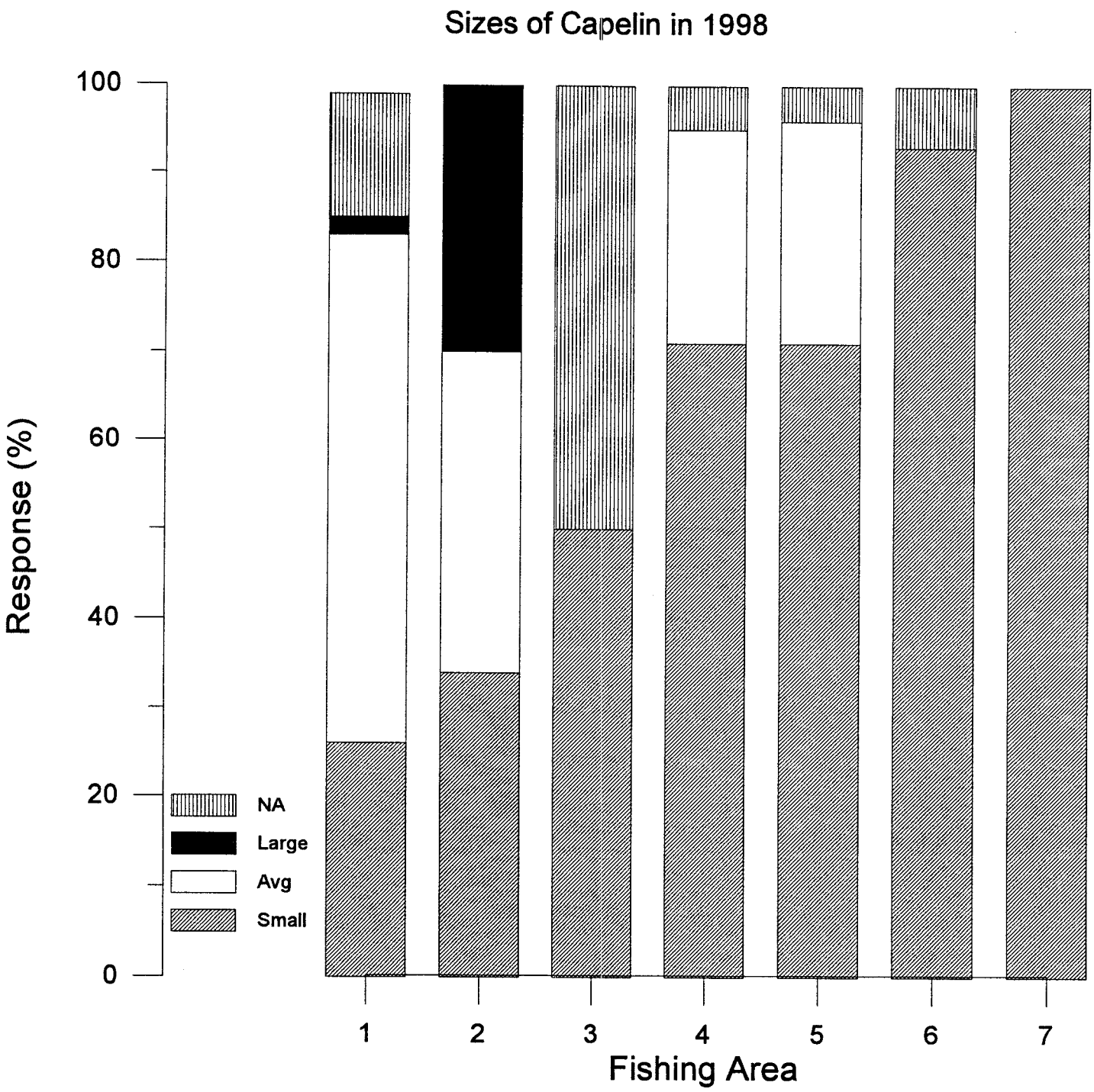

Fig. 14. Sizes of capelin by fishing area (White Bay = 1, Notre Dame Bay = 2, Bonavista Bay = 3, Trinity Bay = 4, Conception Bay = 5, Southern Shore = 6, St. Mary's Bay = 7).

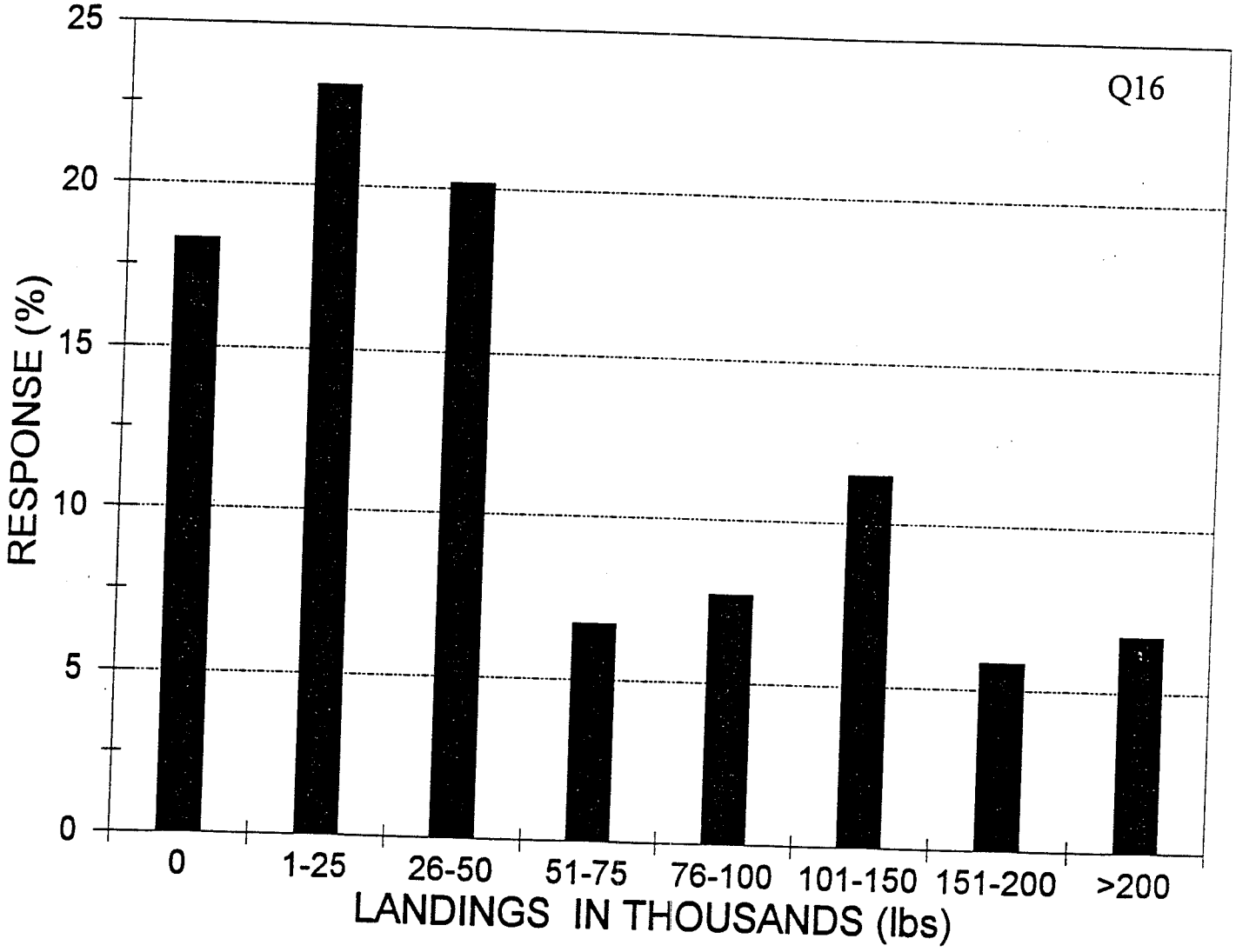

Fig. 15. Estimated landings in 1998 by respondents of question 16.

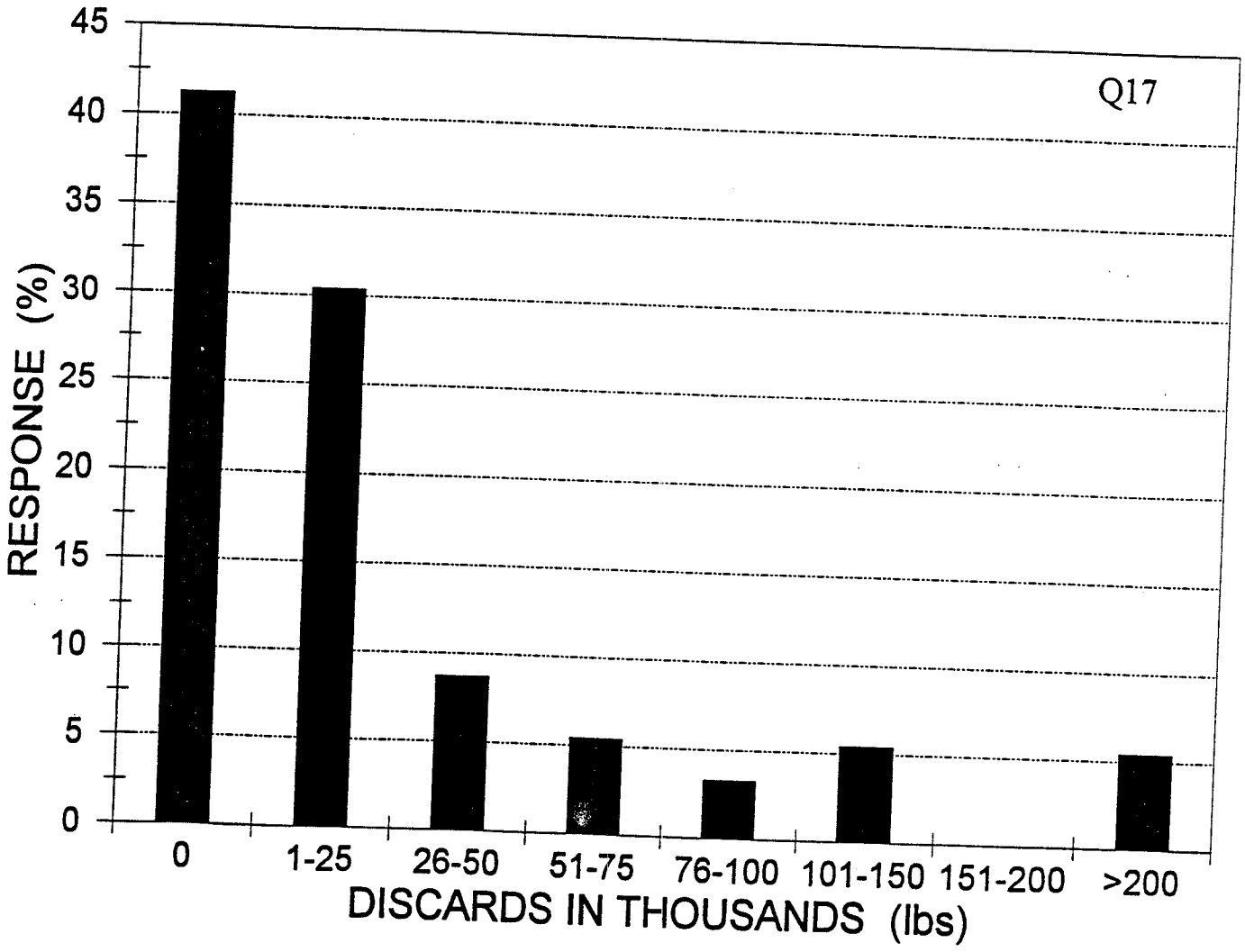

Fig. 16. Estimated discards in 1998 by respondents of question 17.

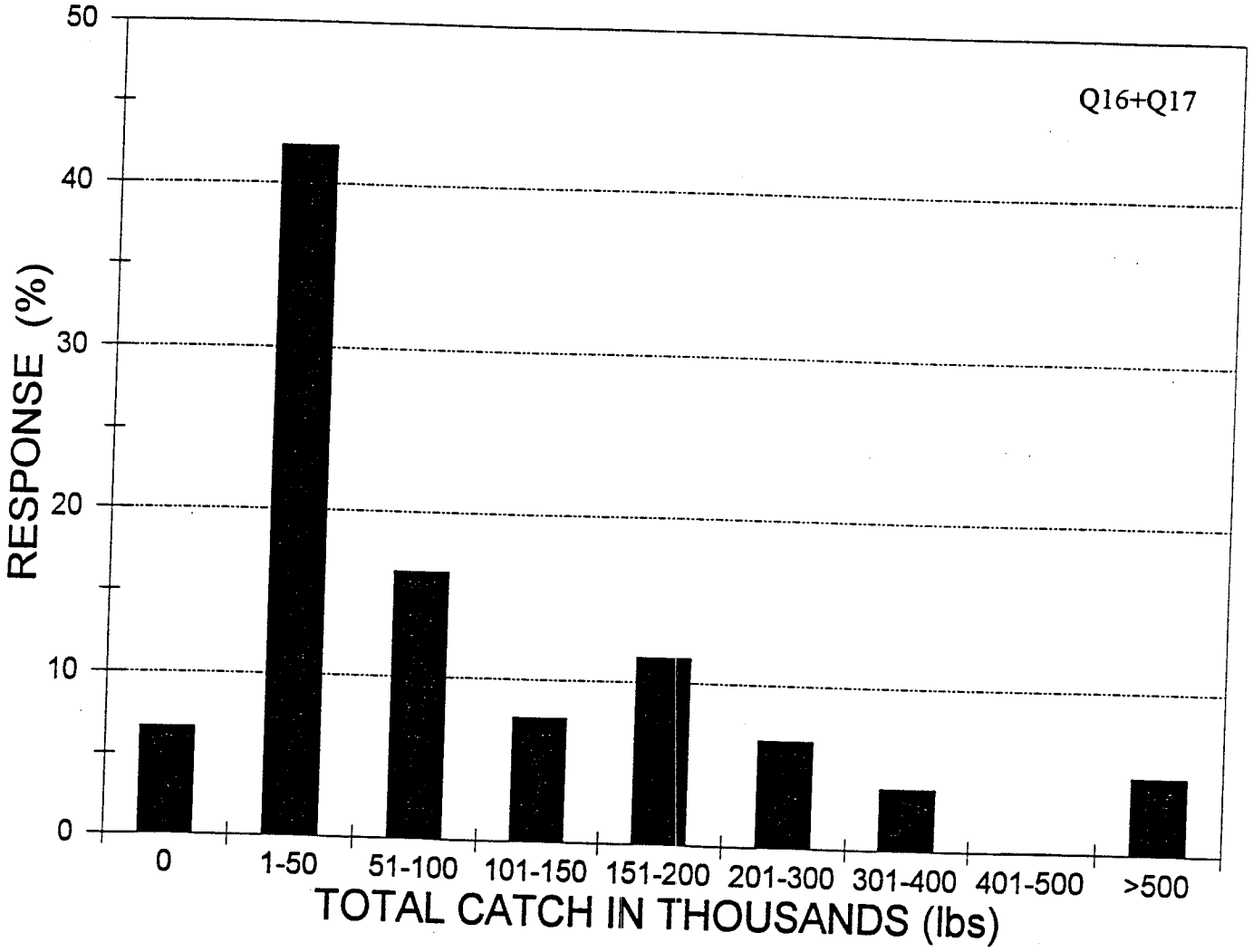

Fig. 17. Estimated total catch in 1998 combining landings and discards.

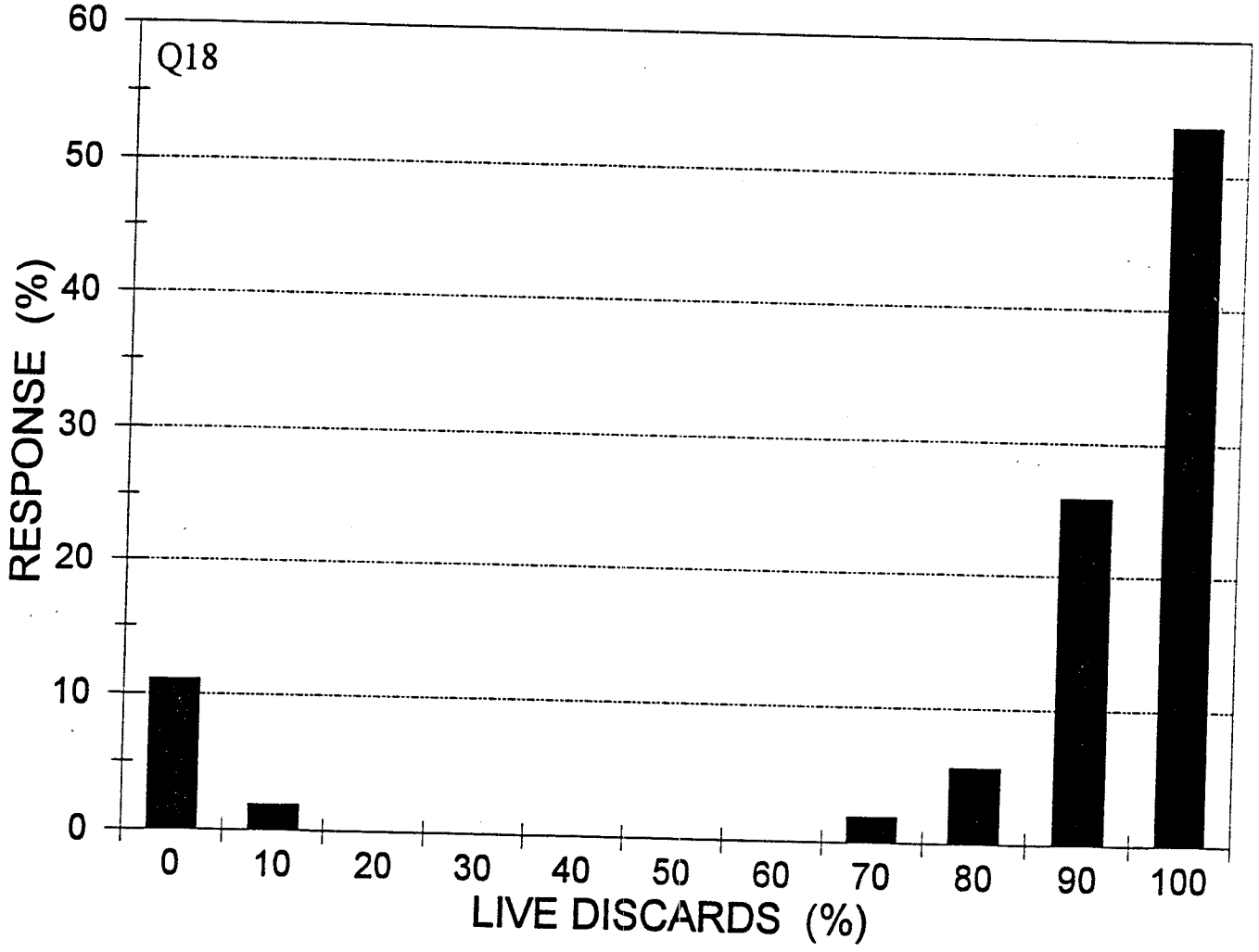

Fig. 18. Estimated survival of discarded capelin by respondent of question 18.

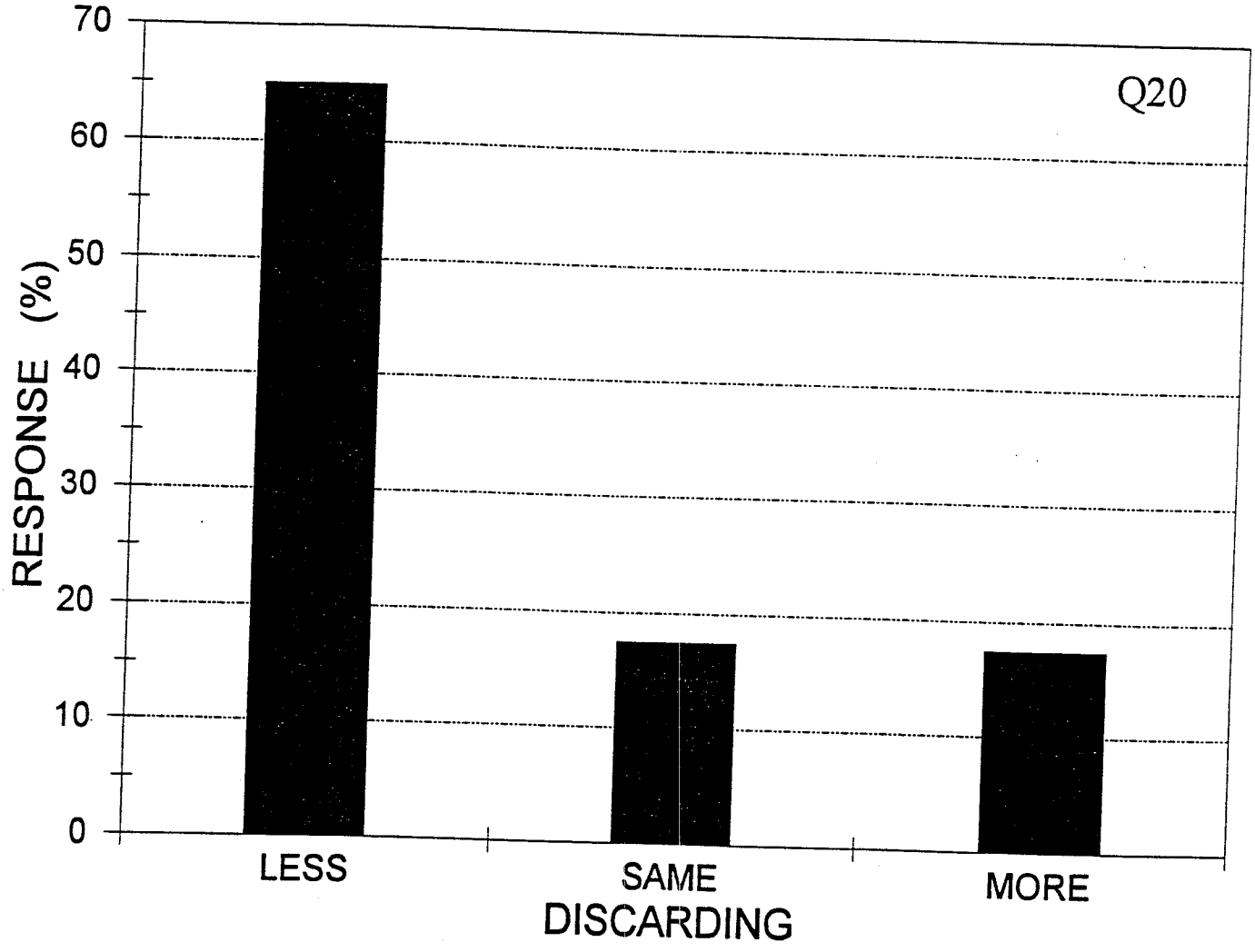

Fig. 19. Comparison of amount of discarding in 1998 compared to earlier years in response to question 20.

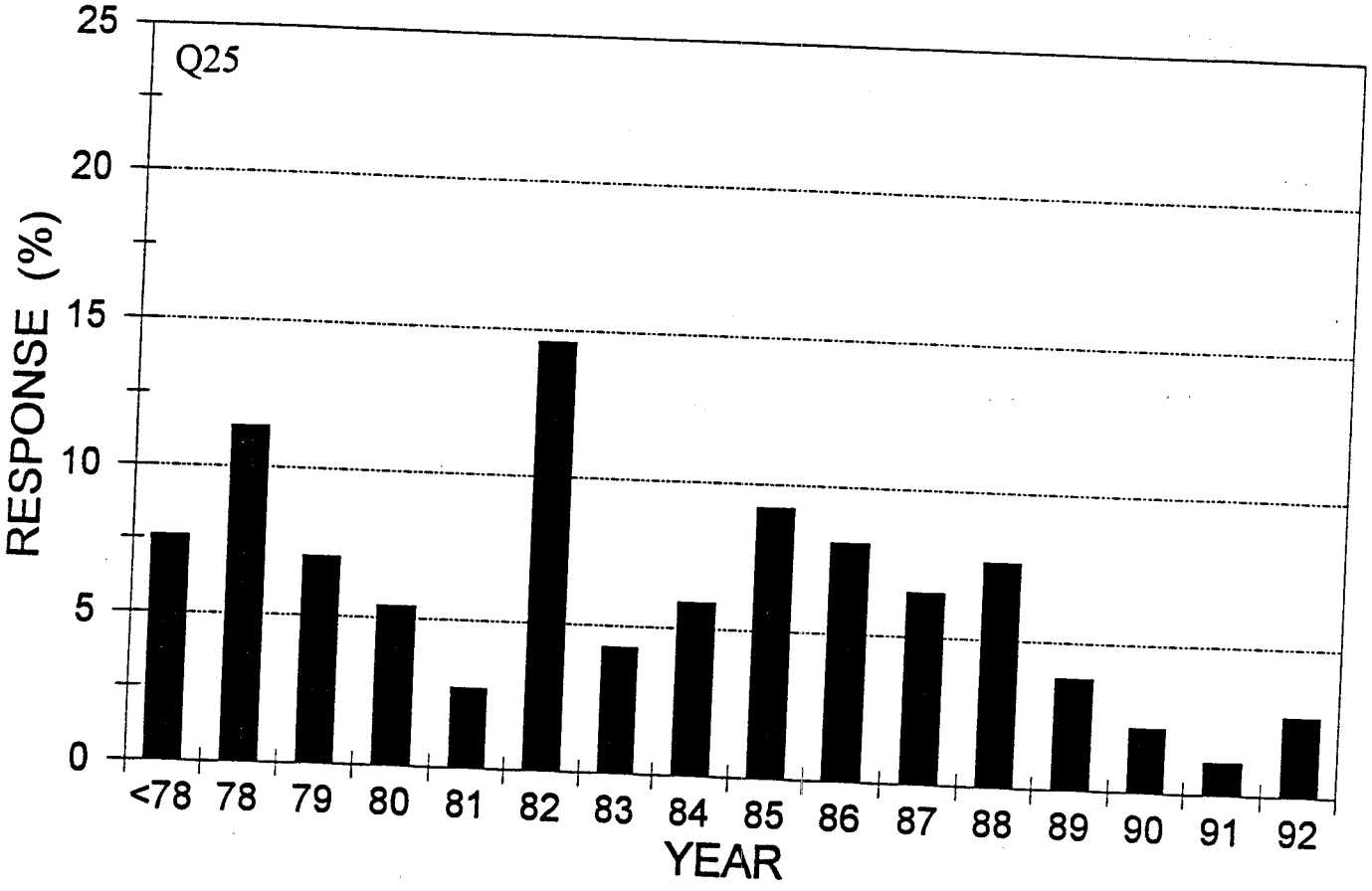

Fig. 20. Experience in the inshore capelin fishery.

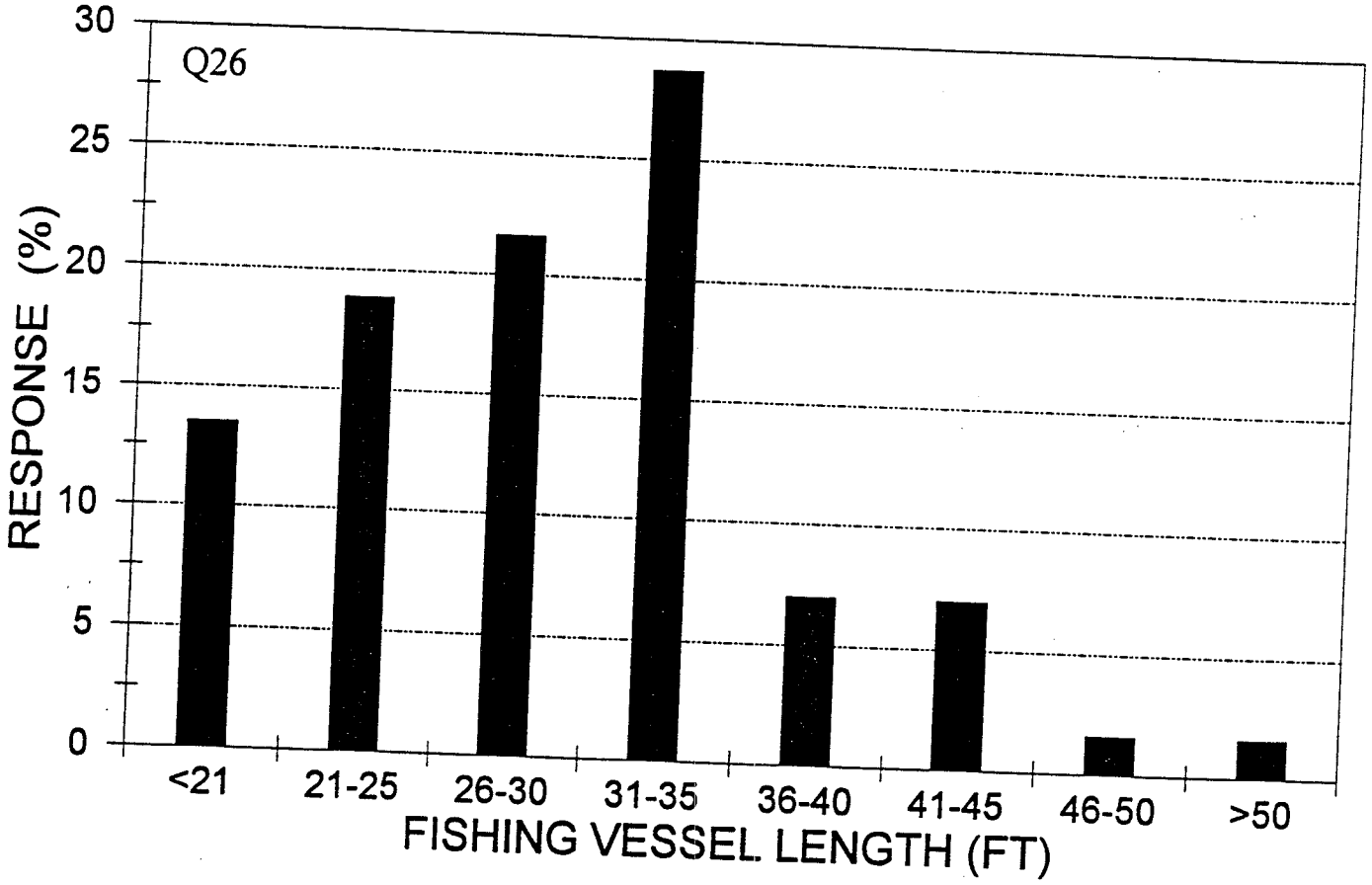

Fig. 21. Lengths of fishing vessels involved in the fixed gear fishery.

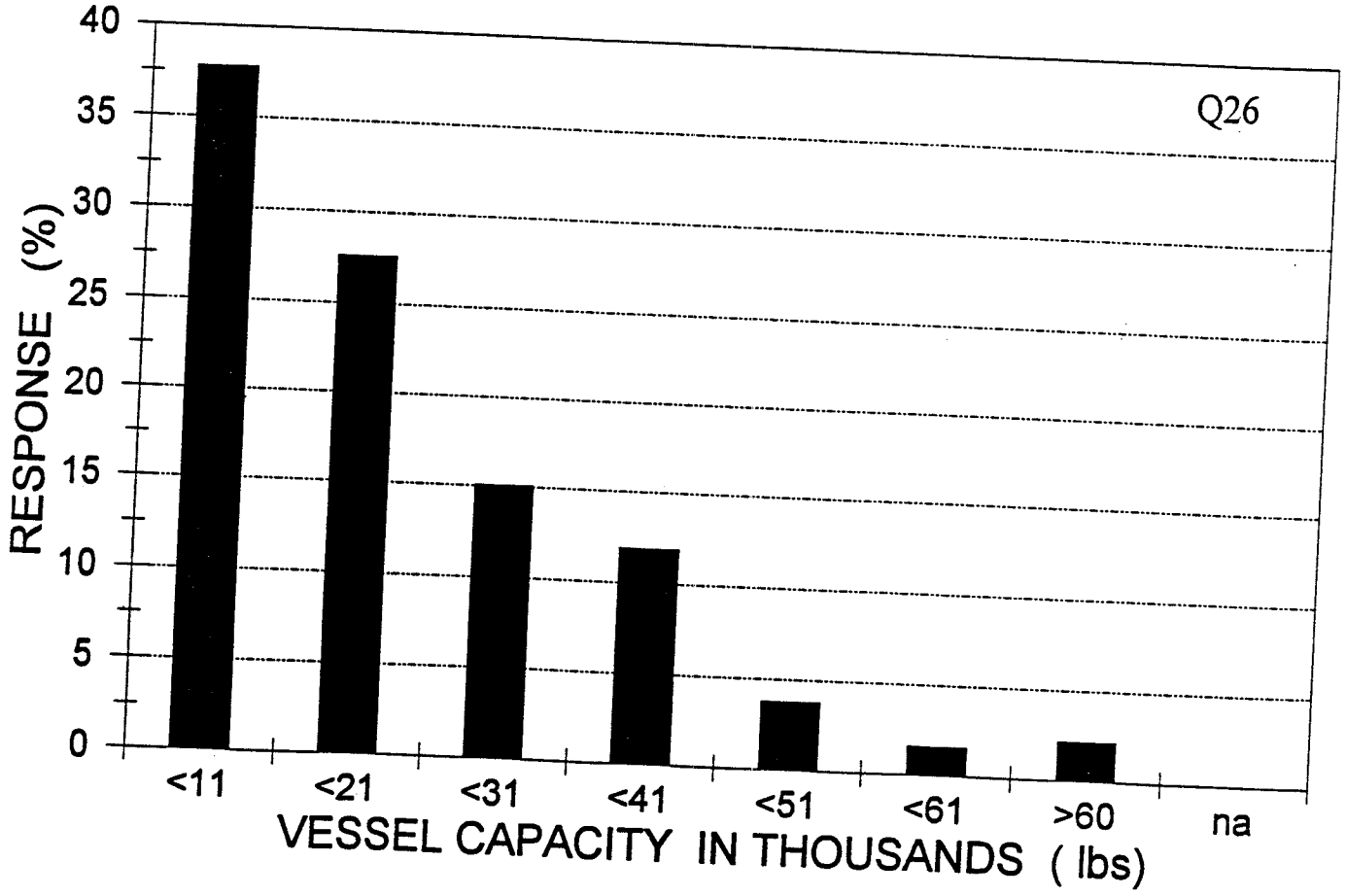

Fig. 22. Estimated fishing vessel capacity for capelin. No answer given (na).

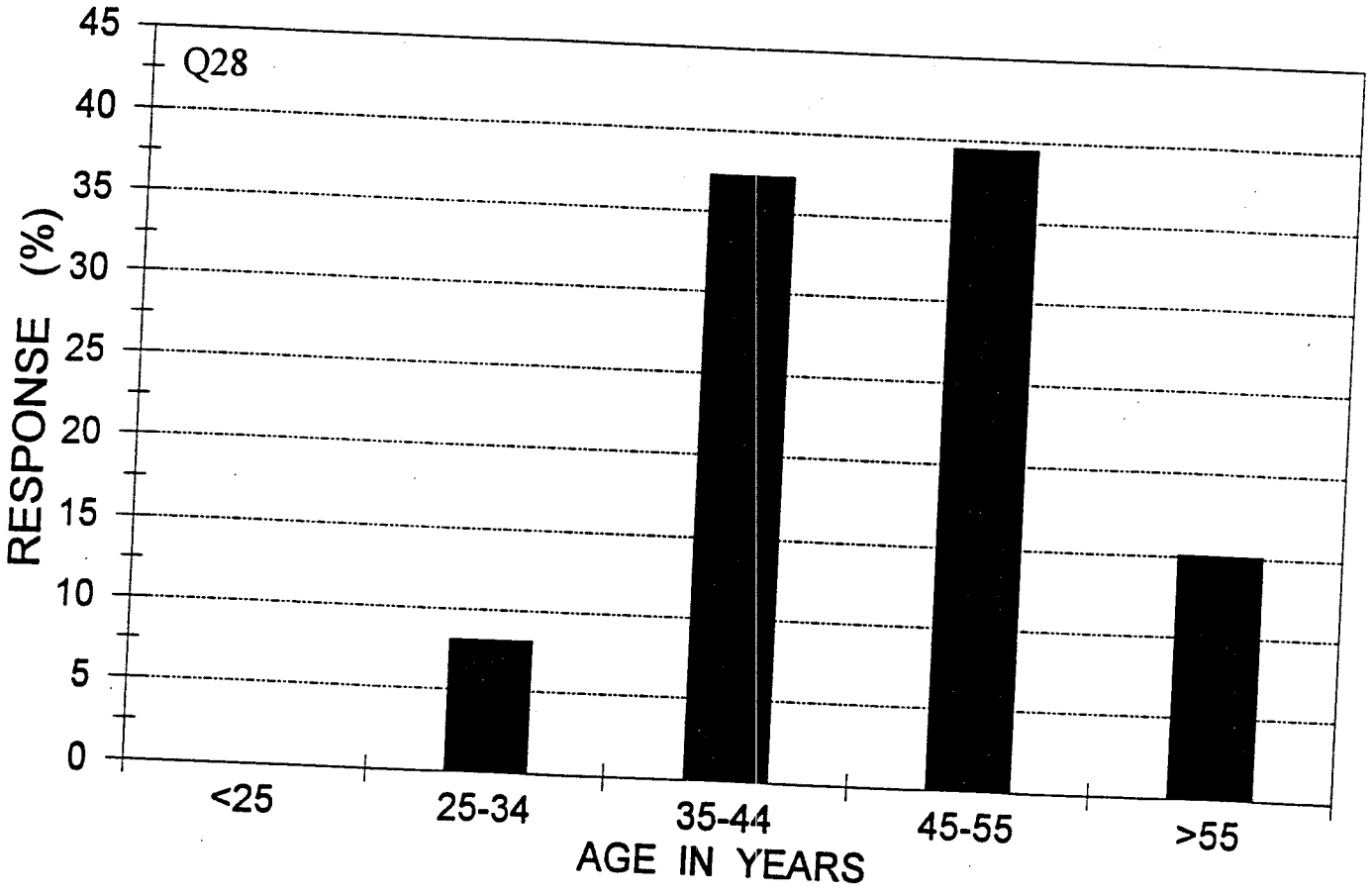

Fig. 23. Age range of capelin fishers in 1998.

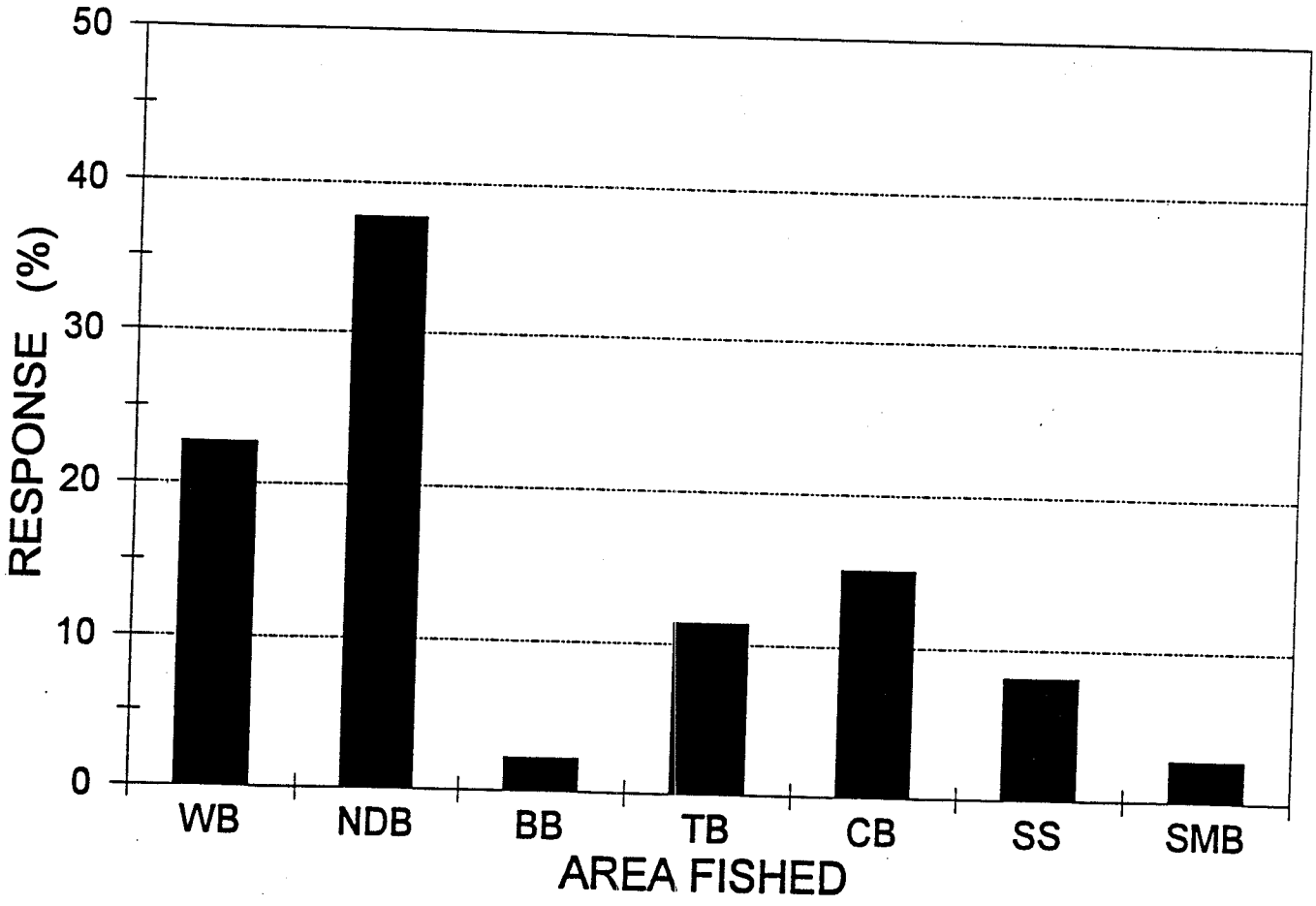

Fig. 24. Distribution of respondents among fishing areas (WB = White Bay, Notre Dame Bay = NDB, BB = Bonavista Bay, TB = Trinity Bay, CB = Conception Bay, SS = Southern Shore, SMB = Trepassey and St. Mary's Bay) for the 1996-98 telephone surveys.

The 1998 Inshore Capelin (Mallotus villosus) Fishery in NAFO Div. 3KL

by

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Introduction

Reported landings based on hails in 1998 were 30,693 t (Table 1) in Div. 2J3KL compared to a quota allocation of 33,280 t (Appendix A). Research logbooks were used to estimate catch and effort for mobile and fixed gear fisheries.

Materials and Methods

Capelin landings are normally extracted from Table M-18, Policy and Economics Branch, however not all purchase slips have been processed from the 1998 fishery to produce the final estimates. Consequently the results for 1998 are based on industry hails, some purchase slips, and commercial logbook records and are to be considered preliminary. Fixed gear landings are not reconciled among gear types.

Research logbooks were mailed to 43 purse seine and 154 fixed gear licensed fishers residing in Div. 3KL. In October 1998, many of the logbooks were collected by staff. Some trap logbooks were completed by fishers who were involved in the monitoring program, however these results are not presented here.

Results and Discussion

The Inshore Fishery

The inshore fishery in Div. 3KL is normally prosecuted by purse seines, capelin traps, and beach seines and has been regulated by quota management since 1982. Quotas by

area and gear type established for 1998 are presented in Appendix A. The purse seine fishery opened in all areas on June 30 and continued until the quota was caught or fish specifications failed to meet market criteria (Appendix B). Monitoring programs were established in some areas to open the fishery when fish conformed to criteria defined in the 1998 Capelin Management Plan. The presence of small females in the catch (more than 50 females/kg) was the main reason areas experienced multiple openings and closings in 1998. Unlike 1997 fixed-gear fisheries were opened in Conception Bay, Trinity Bay, Bonavista Bay, and all parts of White Bay and Notre Dame Bay (Fig. 1). The reported landings for 1998 (Table 1) were considerably more than 1997 and amongst the highest in the 1990s (Fig. 2, Table 1). In some areas 'tuck seines' were deployed when fishers observed that capelin stayed in deep water unavailable to traps and beach seines. How these catches are being categorized is unknown at this time.

Research Logbooks

The return rate of completed logbooks was higher than in 1997. Discounting those who did not fish in 1998, 66% of fixed gear and 72% of mobile gear fishers returned research logbooks (Table 2). One fixed gear logbook was returned but the information was insufficient to code into the database. Thirteen fished (five mobile and eight fixed gear) but did not send in a logbook. One fixed gear fisher had no landings and did not fill in his logbook. The higher return rate may be due to the higher catches and greater fishing activity in 1998 and to our efforts in the fall of 1998 to personally visit many of the logbook participants and discuss the events surrounding the 1998 fishery.

The main reasons reported for discarding capelin were variable. The ones mentioned most often were low percentage of females, small size fish, and redfeed (Table 3). In White Bay capelin were discarded from traps because the percentage of females was low and redfeed levels were too high. The reasons for trap discards in the 'miscellaneous' category was a catch in excess of vessel capacity. In Notre Dame Bay small fish was the main problem (69%). In Bonavista Bay redfeed (61%) was often reported as a problem. In Trinity Bay low percentage of females (37%) and small females (31%) were most often mentioned. Low female percentage (65%) was the major

reason for trap discards in Conception Bay. The 'miscellaneous'category included discarding because capelin were mixed with herring and gear damage. On the Southern Shore small females (100%) was the only reason reported. For the mobile fleet in White Bay, all discards were fish given away to other vessels which isn't included in Table 3. In Notre Dame Bay low female percentage (55%) and boat quotas (45%) were the reasons purse seine catches were released. Discarding by seiners in Bonavista Bay was due to boat quotas (100%). Redfeed (89%) was the dominant reason capelin were discarded in Trinity Bay by purse seiners. Redfeed (33%), low percentage of females (33%) and small females (26%) were equally important in Conception Bay. In St. Mary's Bay all discards were in the 'miscellaneous' category consisting of mixed sets with herring and amounts too small to land.

Discarding as a percentage of reported landings varied among areas for traps (Table 4: 0% to all discards) and for purse seines (Table 5: 0 to 21%). The overall discarding rate of 58% for traps was lower than in 1997 (Table 6) and the rate of 12% for purse seines was the lowest in the series (Table 7). The reported discards include 68 t given away by purse seiners to other vessels. Excluding fish given away, according to the logbook reports 97% of trap and 88% of purse seine discards were released alive at sea. The remaining 12% of the purse seine discards were discarded dead due to boat quotas. In the present analysis (Tables 3-7) discards are defined as capelin caught but not landed by the fishers who caught them and includes capelin released alive and those dumped as dead fish.

Fishing effort for traps and for purse seines were somewhat higher than the low rates estimated in 1997. Traps averaged 5.4 fishing days and were hauled 11.5 times (Table 6). Purse seines searched for 5.2 days and averaged 9.5 sets (Table 7). While trap logbook data are from all areas, most of the fishing activity was in White Bay, Trinity Bay, and Conception Bay (Table 4). Purse seine logbook data were available from all areas (Table 5).

Catch/effort (CPUE) estimates were available since 1981 for traps and for purse seines (Tables 6 and 7). The 1998 trap CPUE of 6.2 t/day was lower than in 1997 and equivalent to the series (1981-1997) average of 6.1. The estimate of 2.9 t/haul was less than the series average of 3.5. The 1998 purse seine CPUE of 21.0 t/day was one of

the highest in the series and the CPUE of 11.5 t/set was higher than the series (1981-1997) average of 10.0.

Conclusions

Discarding varied among areas and gear types. Discarding was 58% from traps and 12% from purse seines indicating that capelin caught by the mobile fleet was more likely to have met market demands. Most were reported as released live at sea. The main reasons for releasing capelin were low percentage of females, redfeed, and small females. Boat quotas were an important consideration for purse seiners. The 1998 trap and purse seine CPUEs were lower than 1997 in the C/D series. The purse seine C/S was among the higher ones in its C/S series and the trap C/H was one of the lower ones in the C/H series. When staff were meeting with logbook participants in the fall many fixed gear fishers reported that capelin stayed off in deeper water and were unavailable to capelin traps. In some areas fishers used 'tuck' seines to fish capelin. Last year we suspected that fishing in recent years was very different than in the 1980s (Nakashima and Slaney 1998). Even though effort increased slightly from 1997, trap and purse seine effort remains low (Fig. 3, 4). Trap fishing days and purse seine searching time is low in the 1990s primarily due to monitoring initiatives put in place to reduce discarding of unmarketable capelin. The effect on fishing effort has been to concentrate the effort only when capelin are highly available and to reduce fishing time dramatically. This reduction especially in recent years is so severe that no method has been proposed to utilize the catch rate data in recent years as indicators of stock abundance (Nakashima 1998; Nakashima and Slaney 1998).

Acknowledgments

The continuing support of those who have participated in the research logbook program has provided valuable insights about the fishery and fishing. M. Y. Farrell assisted in the preparation of the manuscript.

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Table 1. Inshore capelin landings (t) by fishing gear (vessels <21 m in length) by area (White Bay = WB, Notre Dame Bay = NDB, Bonavista Bay = BB, Trinity Bay = TB, Conception Bay = CB, Southern Shore = SS, St. Mary's and Trepassey Bays = SMB) and by NAFO Division.

Year	Div.	Area	Purse seine	Beach seine	Trap	Dipnet	Total
1989	**2J**		**0**	**3**	**304**		**307**
		WB	3276	643	9513		13432
		NDB	3235	2793	7938		13966
	3K		**6511**	**3436**	**17451**		**27398**
		BB	2800	111	4426		7337
		TB	4822	172	14845		19839
		CB	8643	75	8579		17297
		SS	225	10	3048		3283
		SMB	3327	1	643		3971
	3L		**19817**	**369**	**31541**		**51727**
1990	**2J**		**0**	**1**	**0**		**1**
		WB	4507	318	11820		16645
		NDB	5782	3403	9294		18479
	3K		**10289**	**3721**	**21114**		**35124**
		BB	3186	90	5619		8895
		TB	4790	108	11723		16621
		CB	6470	41	11381		17892
		SS	31	45	2897		2973
		SMB	610	0	1016		1626
	3L		**15087**	**284**	**32636**		**48007**
1991	**2J**		**0**	**1**	**0**		**1**
		WB	239	227	12045		12511
		NDB	426	2709	4291		7426
	3K		**665**	**2937**	**16336**		**19937**
		BB	3066	70	3180		6316
		TB	4450	154	6474		11078
		CB	1889	20	2925		4834
		SS	0	7	0		7
		SMB	69	0	3		72
	3L		**9474**	**251**	**12582**		**22307**
1992	**2J**		**0**	**0**	**0**		**0**
		WB	2995	126	7602		10723
		NDB	2819	1113	1695		5627
	3K		**5814**	**1239**	**9297**		**16350**
		BB	977	28	60		1065
		TB	69	26	53		148
		CB	411	57	160		628
		SS	0	5	21		26
		SMB	25	3	26		54
	3L		**1482**	**119**	**320**		**1921**
1993	**2J**		**0**	**1**	**0**		**1**
		WB	1583	197	5108		6888
		NDB	1447	2503	2323		6273
	3K		**3030**	**2700**	**7431**		**13161**
		BB	1734	92	1920		3746
		TB	1989	365	4568		6922
		CB	4712	50	3377		8139
		SS	57	31	1480		1568
		SMB	2102	4	404		2510
	3L		**10594**	**542**	**11749**		**22885**

Table 1. Continued ...

Year	Div.	Area	Purse seine	Beach seine	Trap	Dipnet	Total
1994	**2J**		**0**	**0**	**0**		**0**
		WB	0	20	0		20
		NDB	23	23	1		47
	3K		**23**	**43**	**1**		**67**
		BB	0	2	0		2
		TB	23	54	4		81
		CB	0	4	10		14
		SS	0	16	722		738
		SMB	0	3	55		58
	3L		**23**	**79**	**791**		**893**
1995*	**2J**		**0**	**0**	**0**	**0**	**0**
		WB	0	2	0	0	2
		NDB	0	25	1	2	28
	3K		**0**	**27**	**1**	**2**	**30**
		BB	0	35	0	5	40
		TB	0	16	1	4	21
		CB	0	19	2	1	22
		SS	0	9	0	0	9
		SMB	0	6	0	0	6
	3L		**0**	**85**	**3**	**10**	**98**
1996*	**2J**		**15**	**0**	**7**	**0**	**22**
		WB	1278	1	3462	0	4741
		NDB	1258	1121	1772	0	4151
	3K		**2551**	**1122**	**5241**	**0**	**8914**
		BB	1204	9	1942	0	3155
		TB	1906	31	2934	1	4872
		CB	3242	14	3774	0	7030
		SS	8	0	90	0	98
		SMB	1129	16	535	0	1680
	3L		**7489**	**70**	**9275**	**1**	**16835**
1997*	**2J**		**14**	**0**	**0**		**14**
		WB	2964	139	3178		6281
		NDB	1558	886	508		2952
	3K		**4522**	**1025**	**3686**		**9233**
		BB	463	0	0		463
		TB	468	8	4		480
		CB	639	0	0		639
		SS	17	0	127		144
		SMB	1832	0	3		1835
	3L		**3419**	**8**	**134**		**3561**
1998**	**2J**		**0**	**0**	**0**		**0**
		WB	2136		4371		6507
		NDB	1720		2189		3909
	3K		**3856**		**6560**		**10416**
		BB	1564		1290		2854
		TB	2190		5220		7410
		CB	3512		3724		7236
		SS	77		408		485
		SMB	1920		372		2292
	3L		**9263**		**11014**		**20277**

* provisional
** quota report

Table 2. Summary of inshore commercial samples processed and aged from 1998 in Div. 3KL.

Gear type	No. of LSM/strat. samples	No. of otoliths aged (N)	Mean no. otoliths ± SD per sample
Div. 3K			
Purse seine	9	262	29.1 ± 2.4
Capelin trap	11	355	32.3 ± 4.0
Beach seine	6	196	32.7 ± 2.8
TOTAL	26	813	
Div. 3L			
Purse seine	18	577	32.1 ± 3.5
Capelin trap	26	827	31.8 ± 3.6
Beach seine	2	63	31.5 ± 2.1
TOTAL	46	1467	

Table 3. Age compositions (%) of capelin from the inshore commercial capelin fishery, Div. 3KL.

Year/Sex	Age 2	3	4	5	6
Males					
1982	+	90.5	8.7	0.7	+
1983	0.3	60.8	38.5	0.3	0
1984	0.3	36.0	62.9	0.8	0
1985	4.9	65.4	27.9	1.7	+
1986	0.2	56.7	42.5	0.5	0
1987	0.2	11.4	86.8	1.5	0
1988	3.7	70.2	23.1	3.0	0
1989	0.3	76.8	22.8	0.1	0
1990	0.4	33.6	65.7	0.2	0
1991	9.2	47.8	41.6	1.4	+
1992	7.9	81.4	10.5	0.2	0
1993	5.9	88.4	5.6	0.1	0
1994[a]	23.8	56.7	19.5	0	0
1995[b]	34.7	63.4	1.9	0	0
1996	25.0	73.4	1.5	0	0
1997	58.7	34.1	7.1	0	0
1998	33.9	60.0	3.5	0	0
Females					
1982	1.5	77.9	12.4	6.4	1.8
1983	5.8	58.8	33.4	2.0	+
1984	2.6	41.0	48.0	8.1	0.3
1985	13.4	57.3	18.5	10.3	0.5
1986	0.2	65.5	29.5	3.7	1.1
1987	4.8	19.1	67.1	8.5	0.4
1988	11.6	51.8	12.1	23.0	1.5
1989	1.3	70.7	23.4	2.0	2.6
1990	1.4	44.1	51.9	2.5	+
1991	12.6	49.5	29.4	8.4	0.1
1992	17.6	67.8	12.9	1.7	+
1993	10.4	82.1	7.3	0.2	+
1994[a]	33.4	43.1	19.7	3.8	0
1995[b]	55.8	37.3	6.4	0.4	0.1
1996	33.3	58.1	8.5	0.2	0
1997	47.7	22.5	25.1	4.7	0
1998	48.3	39.3	8.0	1.4	0
Sexes combined					
1982	0.7	84.6	10.5	3.4	0.8
1983	3.3	59.7	35.7	1.3	+
1984	1.5	38.6	55.2	4.5	0.2
1985	10.1	60.4	22.1	7.0	0.4
1986	0.2	62.1	34.5	2.5	0.7
1987	2.9	15.9	75.5	5.5	0.2
1988	8.4	59.1	16.5	15.1	0.9
1989	0.8	73.5	23.1	1.2	1.4
1990	1.0	39.7	57.8	1.5	+
1991	11.1	48.8	34.5	5.5	0.1
1992	13.3	73.9	11.8	1.0	+
1993	8.5	84.8	6.6	0.1	+
1994[a]	31.1	46.3	19.7	2.9	0
1995[b]	43.7	52.3	3.8	0.2	0
1996	29.9	64.4	5.6	0.1	0
1997	52.2	27.3	17.8	2.8	0
1998	42.0	48.3	6.0	0.8	0

[a] low sample numbers (N = 11) and from a small area
[b] research samples, no commercial samples collected

Table 4. The distribution of research logbooks in 1998.

NAFO Div.	Gear type	No. of fishers	No. returned	No. never fished	No logbook
3K	Mobile	17	11	5	1
	Fixed	57	21	21	15[a]
3L	Mobile	26	15	2	9[b]
	Fixed	97	40[c]	40	17[d]

a - 1 fished trap, no landings, and no logbook completed
  - 1 searched few days but no capelin, beach seine logbook

b - 5 fished, landed capelin, but did not complete logbook

c - 1 returned log but information incomplete to include in analysis

d - 7 fished but didn't complete logbook

Table 5. Percent contribution by weight of reasons for discarding capelin in 1998. This analysis excludes capelin given to other fishers.

Area	Redfeed	Low % females	Small females	Males picked out	Females spawned out	Boat quota/ quota filled	Misc.	Not given
Traps:								
White Bay	33	39	1	1	0	16	10	0
Notre Dame Bay	17	14	69	0	0	0	0	0
Bonavista Bay	61	0	38	0	0	0	1	0
Trinity Bay	14	37	31	0	8	3	6	0
Conception Bay	0	65	4	0	5	0	26	0
Southern Shore	0	0	100	0	0	0	0	0
St. Mary's Bay	0	0	0	0	0	0	0	0
Purse seine:								
White Bay	0	0	0	0	0	0	0	0
Notre Dame Bay	0	55	0	0	0	45	0	0
Bonavista Bay	0	0	0	0	0	100	0	0
Trinity Bay	89	0	9	0	0	2	0	0
Conception Bay	33	33	26	0	0	7	1	0
St. Mary's Bay	0	0	0	0	0	0	100	0

Table 6. Capelin landings (t), discards (t), and catch/effort from research logbook records for capelin traps in Div. 3KL in 1998.

Area	No. fishers	No. traps	Landings	Discard logbook	Bycatch		No. days fished (D)	No. times hauled (H)	C = Landings + discards	
					Cod	Herring			C/D	C/H
White Bay	13	18	340.5	109.4	2.6	6.1	83.6	195	5.4	2/3
Notre Dame Bay	2	2	0	7.9	0.3	+	2.6	6	3.0	1.3
Bonavista Bay	4	4	30.8	35.8	10.0	+	23.7	49	2.8	1.4
Trinity Bay	17	28	747.6	346.7	3.2	+	118.9	323	9.2	3.4
Conception Bay	12	18	389.3	384.2	7.9	28.3	154.0	246	5.0	3.1
Southern Shore	1	1	0	19.1	0.5	+	4.5	8	4.2	2.4
St. Mary's Bay	2	2	40.4	5.4	0	0	6.5	13	7.0	3.5

Table 7. Capelin landings (t), discards (t), bycatch (t), and catch/effort compiled from research logbooks for purse seines in Div. 3KL in 1998.

Area	No. of fishers	Landings By logbook	Discards by logbook*	No. days fished	No. sets made	C = landings + discards	
						C/D	C/S
White Bay	10	342.9	49.9	18	24	21.8	16.4
Notre Dame Bay	10	300.7	24.9	20	26	16.3	12.5
Bonavista Bay	6	385.6	22.7	9	24	45.4	17.0
Trinity Bay	14	398.3	85.3	22	36	22.0	13.4
Conception Bay	22	747.7	107.3	47	98	18.2	8.7
Southern Shore	1	13.6	0	1	2	13.6	6.8
St. Mary's Bay	9	344.7	5.4	18	37	19.5	9.5

* includes capelin given to other fishers

Table 8. Capelin landings (t), discards (t), bycatch (t), and catch/effort from research logbook records for capelin traps in Div. 3KL, 1981-93, 1996-98. Data available from Div. 3L only for 1981 and 1982.

Year	No. fishers	No. traps	Landings	Discard logbook	Bycatch		No. days fished (D)	No. Times Hauled (H)	C = Landings + discards	
					Cod	Herring			C/D	C/H
1981	35	41	1281.0	417.7	6.4	0	577	680	2.9	2.5
1982	60	81	4366.5	605.2	58.5	0	1630	1996	3.1	2.5
1983	50	71	3051.2	1338.0	30.1	38.5	1277	1460	3.4	3.0
1984	67	89	4172.5	634.1	45.1	0.4	1615	2442	3.0	2.0
1985	60	80	3011.3	1850.1	34.2	0.2	1108	1508	4.4	3.2
1986	64	91	5056.4	1436.4	18.0	0.5	1567	2095	4.8	3.6
1987	68	93	3150.6	2437.5	11.5	+	622	1104	9.0	5.1
1988	86	125	6792.6	1500.4	35.9	1.1	1353	2415	6.1	3.4
1989	102	154	6275.8	2188.1	55.5	0.2	1314	2431	6.4	3.5
1990	106	167	5538.1	2986.6	10.7	1.9	1041	1825	9.2	5.3
1991	59	76	2793.0	1187.5	16.7	1.5	860	1325	5.9	3.8
1992	28	34	1225.8	567.1	1.5	5.7	297	666	6.0	2.7
1993	59	78	2261.1	297.0	20.7	37.0	400	863	6.4	3.0
1996	52	68	1719.4	930.8	79.2	3.6	274	692	9.7	3.8
1997	17	22	516.3	384.7	5.5	6.6	84	198	10.7	4.6
1998	51	73	1548.6	903.1	24.5	34.4	394	840	6.2	2.9

Table 9. Capelin landings (t), discards (t), and catch/effort from research logbook records for purse seines in Div. 3KL, 1981-93, 1996-98.

Year	No. fishers	Landings	Discards logbook	No. days fished (D)	No. sets Made (S)	C = landings + discards	
						C/D	C/S
1981	23	2705.3	810.4	376	707	9.4	5.0
1982	61	11541.9	2484.8	859	1670	16.3	8.4
1983	48	6439.0	4551.3	626	1155	17.6	9.5
1984	46	8185.5	1517.2	679	1305	14.3	7.4
1985	35	4191.0	2314.3	396	696	16.4	9.3
1986	36	8654.5	2745.2	605	991	18.8	11.5
1987	29	2100.5	869.1	169	267	17.6	11.1
1988	41	8282.7	1247.1	476	927	20.0	10.3
1989	46	7463.5	1687.1	421	863	21.7	10.6
1990	32	5081.4	2327.4	344	630	21.5	11.8
1991	9	699.0	413.7	74	95	15.0	11.7
1992	17	1719.8	254.0	95	146	20.8	13.5
1993	21	2448.7	291.5	169	292	16.2	9.4
1996	23	1327.9	396.6	101	181	17.1	9.5
1997	27	1489.8	648.7	91	192	23.5	11.1
1998	26	2533.5	300.9	135	247	21.0	11.5

Appendix A

1998 Capelin Allocations

NAFO Area	Coastal area	Quotas (tonnes)		
		Fixed gear	Purse seine	Total
2J	Labrador	150	-	150
3K	White Bay	4475	1500	5975
	Notre Dame Bay	3925	1500	5425
Totals - 3K		8400	3000	11400
3L	Bonavista Bay	2245	1425	3670
	Trinity Bay	4490	1870	6360
	Conception Bay	3710	3370	7080
	Southern Shore	2300	190	2490
	St. Mary's Bay	450	1680	2130
Totals - 3L		13195	8535	21730

1998 Capelin Quotas - Fixed Gear Sub-divisions

Area	Sub-division	Quota
White Bay	Cape Bauld to Fischot Island	965
	Fischot Island to Cape Fox	325
	Cape Fox to Hampden, inclusive	1274
	Bottom of Bay to Cape St. John	1911
Notre Dame Bay	Cape St. John to North Head	1105
	North Head to Dog Bay Point	2300
	Dog Bay Point to Cape Freels	520
Southern Shore	Cape St. Francis to Long Point	600
	Long Point to Cape Neddick	400
	Cape Neddick to Cape Pine	1300

Appendix B

1998 Opening and Closing Dates

Mobile Gear

St. Mary's Bay - June 30-July 1

Southern Shore - June 30-July 2

Conception Bay - June 30-July 4, July 9

Trinity Bay - June 30-July 7, July 15

Bonavista Bay - June 30-July 12, July 20

Notre Dame Bay - June 30-July 25

White Bay - June 30-July 2

Fixed Gear

St. Mary's Bay - June 30-July 4

Southern Shore:
- Cape St. Francis to Long Point - July 7-24
- Long Point to Cape Neddick - July 8-17
- Cape Neddick to Cape Pine - July 3-16

Conception Bay - July 9-22

Trinity Bay - July 14, July 16-20

Bonavista Bay - June 26-August 7 (except Cannings Cove to Cape Bonavista - June 26-July 26, July 30-August 7)

Notre Dame Bay:
- Cape St. John to North Head - July 13-15
- North Head to Dog Bay Point - July 7-August 5
- Dog Bay Point to Cape Freels - July 7-31

White Bay:
- Cape Bauld to Fischot Island - July 4-29
- Fischot Island to Cape Fox - July 4-9
- Cape Fox to Hampden - July 2-6
- Hampden to Cape St. John - July 9-15

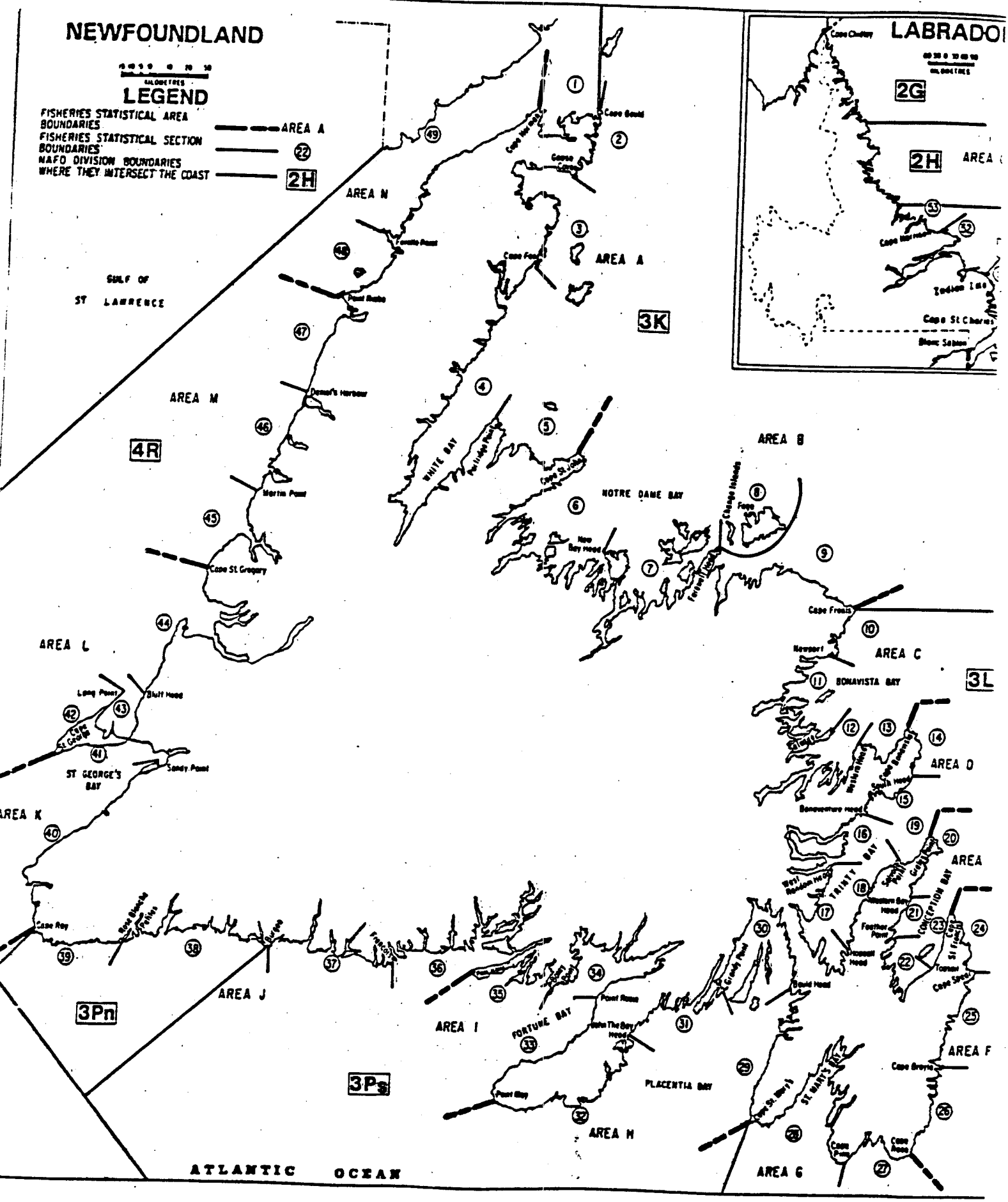

Fig. 1. Statistical areas (A=White Bay, B=Notre Dame Bay, C=Bonavista Bay, D=Trinity Bay, E=Conception Bay, F=Southern Shore, G=St. Mary's and Trepassey Bays) and sections (numeric) for Newfoundland.

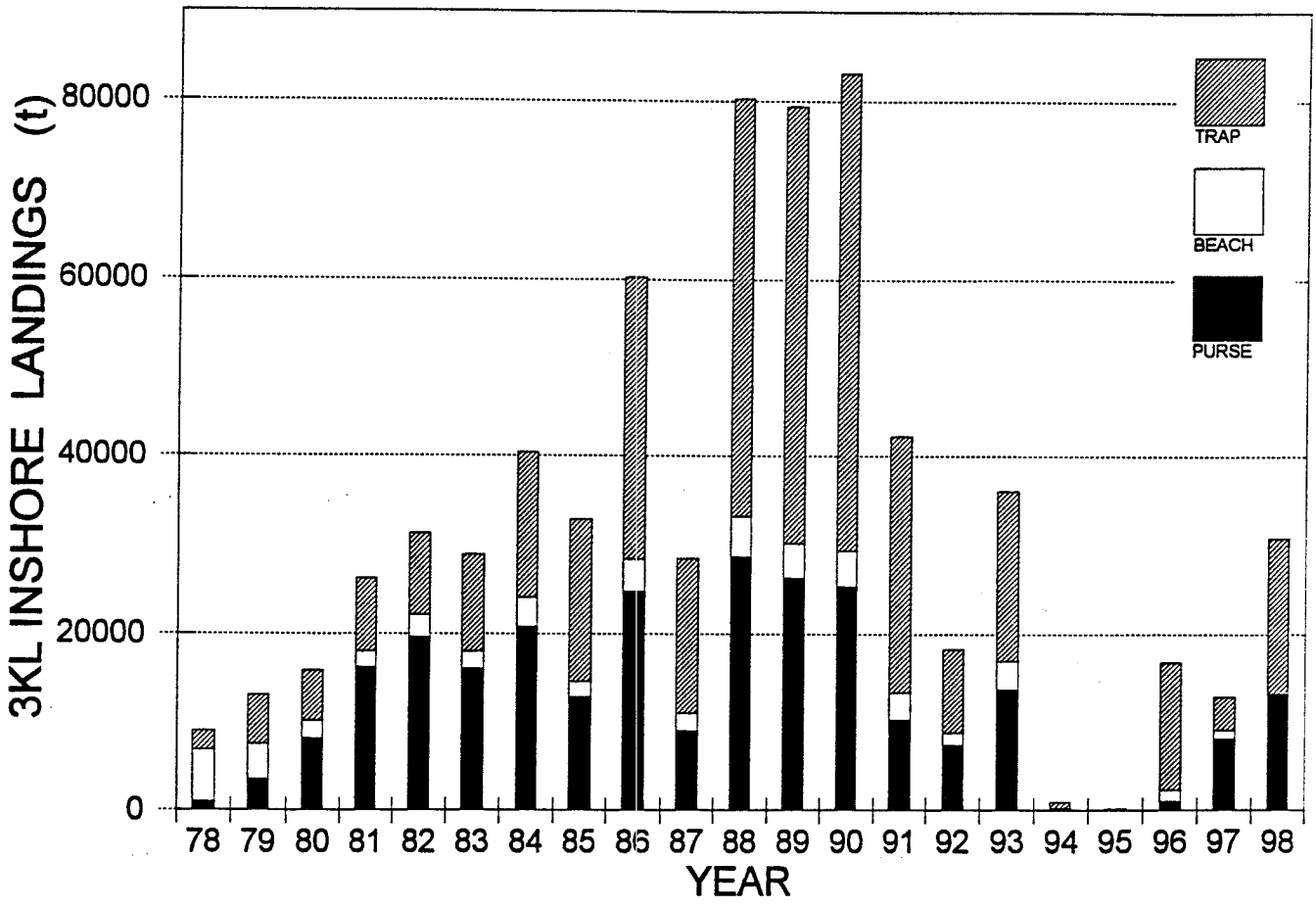

Fig. 2. Inshore capelin landings (t) in Div. 3KL.

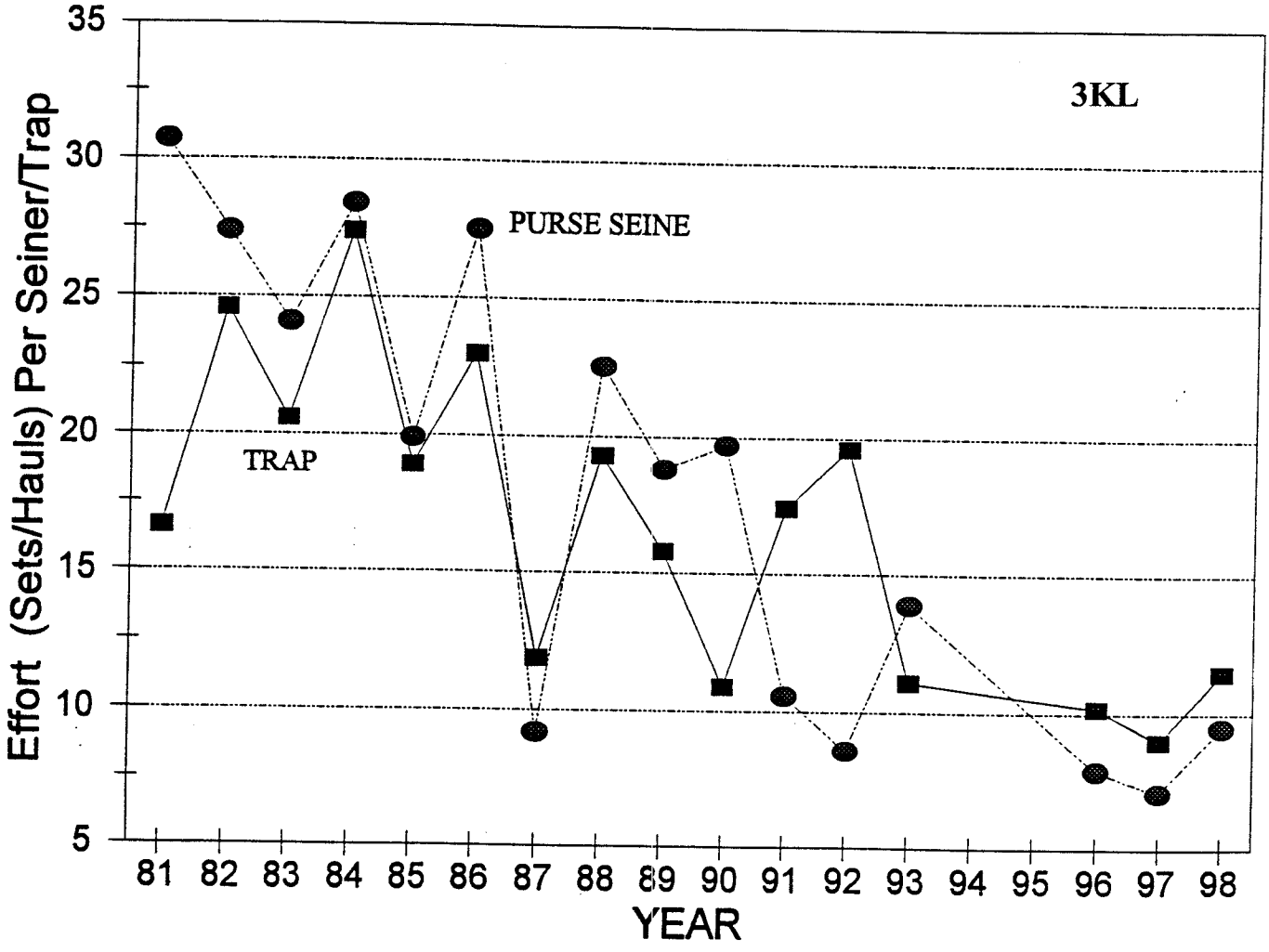

Fig. 3. Trends in average fishing effort for trap hauls (square) and purse seine sets (circle).

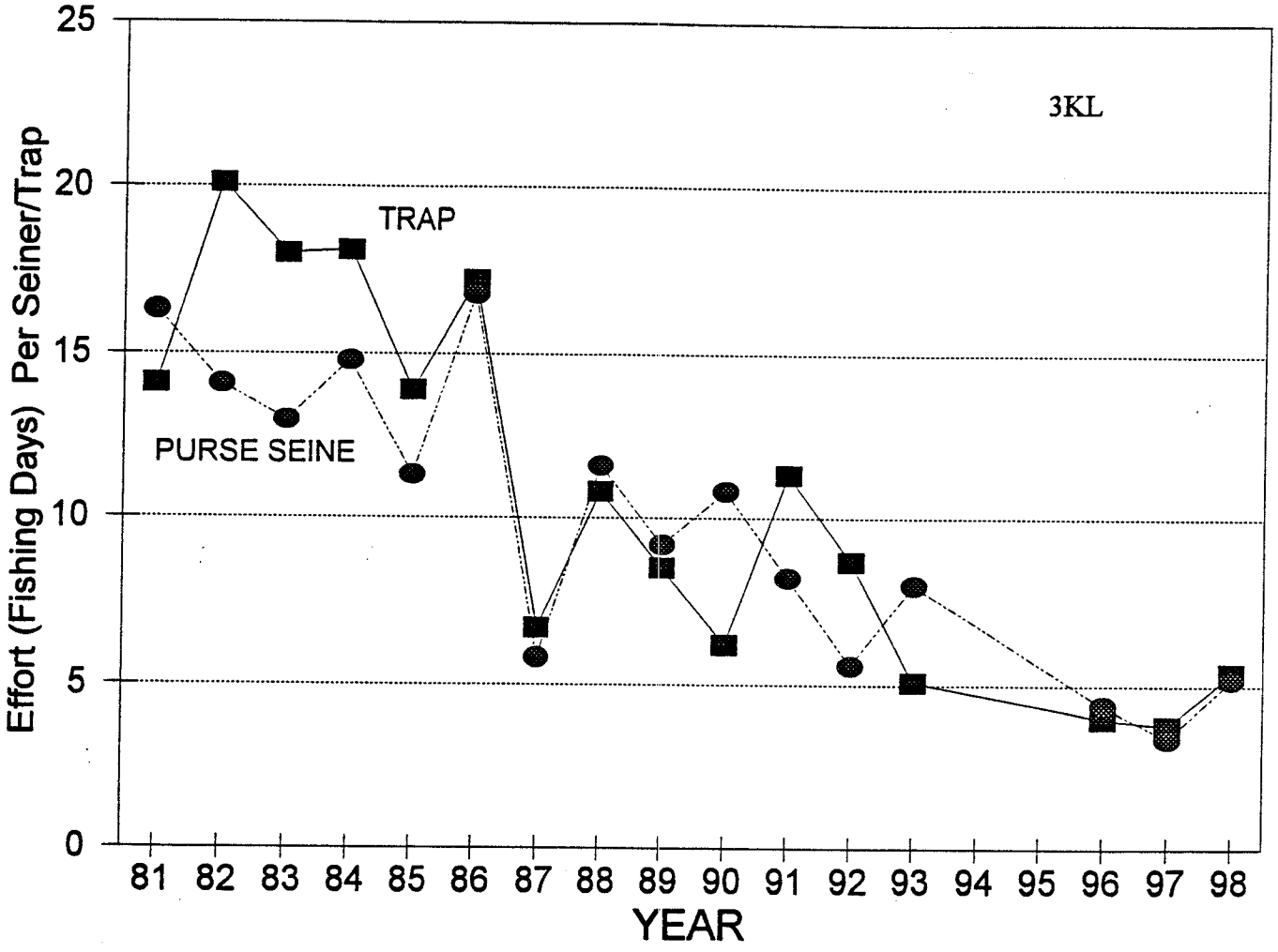

Fig. 4. Trends in average fishing effort for trap fishing days (square) and purse seine searching days (circle).