

Not to be cited without  
permission of the authors<sup>1</sup>

DFO Atlantic Fisheries  
Research Document 93/76

Ne pas citer sans  
autorisation des auteurs<sup>1</sup>

MPO Document de recherche sur les pêches  
dans l'Atlantique 93/76

## Biological Evaluation of the 1992 4WX Herring Fishery

by

R. L. Stephenson, M. J. Power, J. B. Sochasky  
U. Buerkle, F. J. Fife and G. D. Melvin

Department of Fisheries and Oceans  
Biological Station  
St. Andrews, New Brunswick E0G 2X0

<sup>1</sup>This series documents the scientific basis for the evaluation of fisheries resources in Atlantic Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the secretariat.

<sup>1</sup>La présente série documente les bases scientifiques des évaluations des ressources halieutiques sur la côte atlantique du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Les Documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au secrétariat.

## ABSTRACT

The 1992 4WX herring fishery was very similar to that of recent years with reported stock landings of 100,228 t and non-stock (N.B. weir and shutoff) landings of 31,967 t. The purse seine fleet dominated landings (73% of total 4WX) followed in importance by weirs (26% of total 4WX) and relatively minor landings by other gear components.

The spatial and temporal distribution of the purse seine fishery was well documented by logbooks and showed only a few differences in areas fished and the timing of fishing from recent years.

The larval abundance index was modified to account for inter-annual differences caused by age-based mortality. Summer research vessel bottom trawl results for recent years were analyzed by age, to investigate the validity of an age-disaggregated index. The Chedabucto Bay winter acoustic survey was found not to be an appropriate "index area" because of recent changes in herring availability and distribution.

A reconstruction of catch records for 1985-1991 based on purse seine vessel surveys and product back-calculations for 1985-1992 demonstrated that substantially more herring was landed than was reported.

An analytical assessment was, again, precluded by the combined problems surrounding the catch record and questions surrounding the abundance indices. Assuming the larval index is a valid indicator of abundance, the stock is at above average abundance.

## RÉSUMÉ

En 1992, la pêche du hareng dans les divisions 4WX a été très comparable à celle des dernières années. Les débarquements déclarés provenant du stock étaient de 100 228 t et les débarquements hors stock (pêcheries à fascines et sennes de plage au N.-B.) se chiffraient à 31 967 t. Les débarquements de la flottille de pêche à la senne coulissante ont été les plus abondants (73 % des prises totales dans 4WX) et étaient suivies par celles des pêcheries à fascines (26 % des prises totales dans 4WX) et par une proportion relativement faible de prises au moyen d'autres engins.

La distribution spatio-temporelle de la pêche, abondamment appuyée par les journaux de pêche, n'a révélé que des différences modestes par rapport aux dernières années pour ce qui est des lieux ainsi que des périodes de pêche.

L'indice d'abondance larvaire a été modifié pour tenir compte des différences inter-annuelles dues à la mortalité selon l'âge. Les résultats des opérations de chalutage réalisées ces dernières années durant l'été par les navires de recherche ont été analysés en fonction de l'âge afin d'établir la validité d'un indice dissocié selon l'âge. On a déterminé que le relevé acoustique effectué durant l'hiver dans la baie de Chedabucto ne constituait pas un repère pertinent, en raison de changements récents dans la disponibilité et la distribution du hareng.

Une reconstitution préliminaire des prises de 1985-1991, fondée sur les résultats des relevés réalisés par des navires de pêche à la senne coulissante et sur des rétrocalculs de la production pour 1985-1992, a révélé que les débarquements réels ont été considérablement supérieurs à ceux qui ont été déclarés.

Une fois encore, il s'est avéré impossible de procéder à une évaluation analytique en raison des problèmes concernant les statistiques de prises et des questions soulevées par les indices d'abondance. En admettant que l'indice larvaire soit un indicateur valable de l'abondance, le stock se situe au-dessus de l'abondance moyenne.

## INTRODUCTION

As in recent years, the 1991-1992 Div 4WX herring fisheries were dominated by purse seine and weir gear components, with relatively minor landings by midwater trawl, shutoff, trap, and gillnet (Table 1). As in previous years, the purse seine fleet of 40 vessels accounted for most (over 96%) of the total reported catch of 4WX stock herring (Table 2). The remaining landings of stock herring were taken by weirs on the Nova Scotia side of the Bay of Fundy (2% of total stock landings for 1992), midwater trawl, gillnets, and traps. Significant catches of what have traditionally been considered non-4WX stock herring intercepted in the 4WX area were taken by weir and shutoff on the New Brunswick side of the Bay of Fundy (see also the section on Assessment Data; Stock Components below).

The most intensive 4WX stock herring landings occurred in the purse seine 4X summer fishery on the pre-spawning and spawning aggregations off southwest Nova Scotia (subareas 4Xq and 4Xr; Fig. 1) from June to mid-October 1992 (Table 2). During this period, 84% of total reported purse seine landings for the 1991-1992 fishery were taken. Other major fishing activity occurred in the purse seine fisheries on over-wintering aggregations of herring around Chedabucto Bay (November 1991 through February 1992; 15% of reported purse seine landings), and off Grand Manan Island in the 4Xs fall and winter fishery (October 1991 through January 1992; 1% of reported purse seine landings).

The fishery continued to be highly influenced by markets and was again restricted by uncertainty in the major roe market. Other significant markets continued to be the adult shore (large fish) domestic market, juvenile herring for sardines/canned herring products, and over-the-side sales (OSS) to foreign vessels (Table 3,4).

## 1991-1992 MANAGEMENT PLAN

The 1991-1992 Herring Management Plan represented a continuation of 4WX herring annual management policy under the 10-Year (1983) Management Plan. Plan development was complicated by discussions of the impending end of the 10-yr plan and by an attempt to implement a mandatory, industry funded dockside monitoring program. In the absence of such a scheme, the overall TAC was set at 125,000 t, a decrease of approximately 25,000 t over recent years. Quotas for 4WX stock herring were established for: (i) the purse seine fleet of 40 vessels (117,563 t, including a bait quota of 2,600; or 94% of the total allowable catch of 125,000 t), (ii) a single mid-water trawl (1,250 t or 1% of the TAC), and (iii) an allocation to "inshore" gear components: gillnets, traps and weirs (6,187 t or 5% of TAC).

Under the guidelines of the 10-Year (1983) Management Plan and the companion 1991-1992 annual plan, individual vessel quotas were allocated to all purse seiners as a percentage of the total TAC and included fishery area, season and vessel class designations.

upper Bay of Fundy (Scots Bay) as part of the 4X summer purse seine fishery, and placed a continuous 18 day closure beginning Aug. 15, 1992 on the Trinity Ledge spawning grounds.

As in previous years, potential catches from the New Brunswick "fixed gears" fisheries (weirs and shutoffs) were excluded from the TAC under the annual plan on the grounds that they target primarily juveniles presumed to be non-4WX stock herring originating from the Gulf of Maine. The historical summaries of TACs, stock and non-stock catch totals are presented in Table 5.

## DESCRIPTION OF THE FISHERIES

### 4WX STOCK FISHERIES

#### *4W Chedabucto Bay Winter Purse Seine Fishery*

The 1991-1992 management plan allowed a fishery of up to 25,000 t on herring overwintering grounds around Chedabucto Bay between Nov. 1, 1991 and Mar. 1, 1992. A total of 14,310 t (15% of total reported purse seine landings for the 1991-1992 season) was taken in this fishery (see also Tables 2,3,5 and Fig. 2a). This total is less than that for the same fishery in 1990-1991 (Table 5, Fig. 3a), but is greater than landings during the period 1982-1990. There was an over-the-side sales (OSS) program of approximately 200 t (Table 3).

This fishery has traditionally been limited by markets. In recent years, the allocation has been set at approximately 30% of the 4X summer purse seine fishery and fished primarily by "mobile class B and C" vessels. The difference between the allocation and the actual catch is transferable to the 4X summer purse seine fishery exploited as well by the 24 vessels from class A "non-mobile".

Log records indicate that fish were readily available (see Purse Seine Logbook summary Figures in Appendix 1: A-2, A-3). The 1991 and 1992 winter acoustic surveys documented the aggregations of herring in the Chedabucto Bay area (Buerkle 1992).

#### *4Xs Bay of Fundy Fall and Winter Purse Seine Fishery*

The management plan divides the 4Xs fishery, executed primarily off Grand Manan and the southwestern New Brunswick shore, into fall (Oct. 15, 1991-Dec. 31, 1991) and winter (Jan. 1, 1992-Feb. 28, 1992) segments. The fall fishery (the opening fishery of the 1991-1992 season) was assigned a quota of 9,000 t and the winter fishery had a quota of 6,000 t, as each fishery had in the 1990-1991 plan. Landings were reported from east of Grand Manan in the fall (1,011 t; Fig. A-6) and winter (287 t; Fig. 2b, A-7) fisheries. Total landings in the combined fall and winter 4Xs fisheries amounted to 1,298 t, a slight decrease

over the previous year and the lowest reported in this fishery since 1981-1982 (Tables 2 and 5, Fig. 3a). The decrease reflects a continued low availability of large, overwintering fish in the area (recent years prior to 1980 had unusually high availability), the high volumes taken in Chedabucto Bay, and seiners exercising transfer rights to the summer fishery for roe.

#### *4Xqr Southwest Nova Scotia and Bay of Fundy Summer Fisheries*

##### **a) Purse Seines**

The management plan allocated the largest of the purse seine allocations (74,963 t, plus unused quota from the winter fisheries) to the 4Xqr summer fishery for the exploitation period from Apr. 1, 1992-Oct. 19, 1992. This fishery was fished by purse seiners of all classes (40 vessels) and marks the end of the 1991-1992 season (Oct. 19, 1992). The season was extended four days (from Oct. 15) due to late agreement on elements of the new plan (dockside monitoring program).

Since the beginning of the 10-Year (1983) Management Plan, this fishery has exploited herring spawning aggregations in 4Xqr (including most notably Trinity Ledge, German Bank, and Seal Island grounds) for the valuable roe herring export market to Japan. The 1992 fishery was well documented by logbook reports (see Appendix 1: Figs. 2c, A-9 to A-16). It was similar in spatial distribution within 4Xqr to previous years with the following exceptions:

- major landings for the first time from the "Western Hole" area in May and June
- a major increase in effort (X3) and catch (X4) in the Gannet/Dry Ledge area
- a substantial decrease (only 20% of searching and 15% of catch of the previous year) in the prominence of German Bank.

Reported landings in this fishery were 80,807 t or 84 % of total purse seine landings reported for the 1991-1992 season (Fig. 3a).

The 4X summer purse seine fishery also included a suballocation of 10,000 t in the upper Bay of Fundy at Scots Bay. This fishery was reopened in 1987 after a closure of about 5 years (Stephenson and Power, 1989) as a controlled roe fishery which included roe testing prior to the opening of the fishery to verify the roe yield of the spawning aggregation. In recent years, however, the fishery has been opened by date only and has been utilized for other markets besides roe. In 1992, the fishery lasted only two weeks (opened on July 27, and was closed Aug. 12). Logbook landings from this portion of the summer fishery amounted to 8554 t.

### b) Gillnets

The gillnet segment of the 4X summer fishery recorded catches of 395 t (Tables 2 and 5, Fig. 3b). The result is consistent with the landings reduction trend in this fishery since 1985 primarily due to reduced effort on the part of licensed gillnet vessels stemming from an absence of markets for gillnet caught herring.

### c) Weirs

Nova Scotia weirs recorded landings of 2,227 t (Tables 2 and 5; Figs. 2d, 3b), a slight increase over the previous year.

### d) Midwater Trawl

The single midwater trawler recorded landings of 761 t during the period January - April 1992, in the area off southwestern New Brunswick between Grand Manan and Point Lepreau (Fig. 2e).

## 4WX NON-STOCK FISHERIES

### *4Xs New Brunswick Weir and Shutoff Fishery*

The New Brunswick weir and shutoff fisheries recorded landings of 31,899 t and 68 t respectively, for a combined total of 31,967 t (Table 2; Fig. 2d, 3b). This represents an increase of approximately 6,000 t over 1991, and reflects the high abundance of herring in inshore weirs - an event which has not occurred for about a decade. OSS landings of 2,606 t were about 700 t higher than in 1991.

## CATCH STATISTICS

Reported landings for the 1992 fisheries (DFO, Scotia-Fundy Region, Statistics Div. records) are listed by month and gear segment in Table 2, and the amounts reported for domestic and OSS markets are recorded in Table 3.

Statistics for recent years were shown previously to be underestimates (Stephenson et al 1991, 1992) and as discussed during the last assessment an attempt was made to determine actual landings since 1984 (when a previous correction was made, Mace 1985; Stephenson et al 1985) through a combination of two initiatives:

- i) Interviews with purse seine captains to determine individual vessel landings over the past 7 years.
- ii) Back calculation from production using Departmental records and updated conversion factors with industry guidance on the amount of "reprocessing" of roe carcasses which typically are used for fish-meal.

## PURSE SEINER SURVEY

Purse seiner interviews resulted in revised data for 25 to 36 vessels active in each of the seven years (1985-1991). Most of the responses were based on estimates from records of fish sold ("stocked"), and resulted in confident statements from captains/owners about actual landings. Some, however, were from even more detailed records of fish caught per night and a few were only rough estimates. Survey estimates for each year were compared with Statistics Division totals for the same vessels for that year to calculate a ratio (survey/Stats), which was applied to the Statistics total for the year to estimate revised landings:

Year	# vessels responding	Ratio (revised/stats)
1985	25	1.34
1986	32	1.88
1987	33	1.49
1988	34	1.46
1989	34	1.61
1990	36	1.67
1991	35	1.49

Revised purse seine landings, when added to landings for other gear, indicate landings 1.2 to 1.8 (stock landings) and 1.2 to 1.6 (entire 4WX landings) times those recorded by the Department (Stephenson 1993). They also indicate that the quota has been exceeded in five of the past seven years:

Year	Interview revised stock (000's t)	Reported stock (000's t)	Revised/reported ratio
1985	134.6	112.4	1.20
1986	134.3	73.7	1.82
1987	145.9	101.2	1.44
1988	176.8	124.7	1.42
1989	136.5	84.5	1.62
1990	166.8	101.9	1.64
1991	140.1	97.0	1.44

The general feeling of members of the industry who have seen these results is that they are much closer to what has taken place, but that there may still be an underestimate in some cases.

### BACK-CALCULATION FROM PRODUCTION

Back-calculation of round weight from production was based upon conversion factors obtained from Industry applied to production records kept by DFO Statistics Division. These estimates of herring utilized by domestic processors were added to totals sold in OSS programs and corrected for fish transported into and out of the region to obtain estimates of round herring landed for processing (Stephenson 1993). The estimate from production supports the revised estimate of landings from the purse seiner survey; both are considerably higher than nominal statistics:

Year	Reported total 4WX (000's t)	Interview revised total 4WX (000's t)	Estimate from product	
			Total 4WX (000's t)	Stock 4WX (000's t)
1985	141.9	164.1	194.5	165.0
1986	101.8	162.5	128.2	100.0
1987	130.2	174.2	175.4	147.1
1988	159.9	212.0	234.8	199.6
1989	129.4	181.5	142.5	97.5
1990	141.4	206.3	212.4	172.9
1991	121.6	166.1	156.8	130.8
1992	132.2	n.a.	168.3	136.0

For 1992, there was no interview data, but the corresponding production calculation was calculated (Stephenson 1993). A comparison of the two series is presented in Fig. 4. The two series are remarkably similar - considering the situation and assumptions involved. It is



difficult to choose between the two series. The interview-based revision is the most thorough of its type ever conducted on this fishery, but it is still considered to be an underestimate in at least some years. The estimate from production contains a number of potential problems (including the use of averages of conversion values with considerable variation), but it is an ongoing series which should be free of misreporting. In addition, there is now a question of the comparability of that period with the previous modification for the years 1973-1984, and for the most recent, uncorrected year. These questions are being investigated further.

Further details of the catch revision are presented in an accompanying Research Document (Stephenson 1993).

The historical series of TAC's, 4WX stock reported, and total reported 4WX landings are as shown in Table 6.

## ASSESSMENT DATA

### STOCK COMPONENTS

As in previous assessments (e.g. Sinclair and Iles 1981; Stephenson et al. 1987), the 4WX fishery was divided into "stock" and "non-stock" components (Table 2). Stock fish were considered to belong primarily to the major SW Nova Scotia spawning groups, but this assessment unit also encompasses smaller local stocks (e.g. Grand Manan, Scots Bay). The non-stock component has been comprised of:

- 4Xs N.B. weirs - considered to be migrants from Division 5Y stocks
- 4Xs N.B. shutoffs - same argument as for N.B. weirs
- 4X miscellaneous - small localized Nova Scotia southshore stocks caught in 4Xm gillnet, 4Xm trap and by-catches in other fisheries
- 4W miscellaneous - 4W fish taken in gear other than purse seine, on the assumption that the fish are from local stocks.

During the last assessment it was agreed that the large fish (ages 3+) taken in weirs (and in recent years sold to OSS vessels) should be considered to have been of 4WX origin and included in the stock landings for the assessment. This is not reflected in the stock catch at age as presented in this document.

As in previous assessments, those segments of the fishery which span the winter months (4W and 4Xs purse seine), are considered on a quota year basis (Oct. 15, 1991-Oct. 14, 1992). All other segments are considered for the calendar year 1992.

## BIOLOGICAL SAMPLING

As in previous years, sampling of commercial catches was stratified by area, gear segment and month (Hunt 1987) by:

- 1) obtaining as many length frequencies from individual catches as is practical during routine port sampling in N.B. and N.S. and by observers on foreign vessels; and
- 2) collection of stratified "detail" samples (two fish per half cm size-class above 24 cm; one per half cm size-class at 24 cm and less) to a level of at least 200 fish per area, gear and month.

Sampling in 1992 resulted in 536 length frequencies and 6,754 fish analyzed in detail (including ages). In a continuing attempt to rationalize sampling effort, the number of detail fish analyzed was reduced by about 30% over the previous year. The spatial distribution of sampling is shown in Fig. 5.

Biological samples were matched to landings by gear component on a monthly basis as in previous assessments (Table 7). Numbers at age from commercial catches were generated on the St. Andrews VAX-6210 in the traditional manner, using programs HERNLWO2 and HERNAGO9. For all gear components, length frequency samples were applied on a monthly basis. Where there were sufficient samples, separate keys were applied for OSS and domestic markets because of the differences in fish size.

As in the past, a correction of 2% was applied to length measurements to account for shrinkage due to freezing. This is within the range of values observed in several studies in the Scotia-Fundy and Gulf Regions (Hunt et al. 1986).

## CATCH AT AGE

The age composition of landings in stock and non-stock segments of the 1992 fishery and the proportion by age for each fishery (based on reported, unadjusted landings) are presented in Tables 8 and 9 and in Fig. 6a, b. The 1988 year-class (age 4) was dominant in major stock fisheries in number (29%) and weight (28%), but the 1983 year-class was still strong at age 9 contributing 11% by weight (Table 8). Age 2 fish again dominated the non-stock fisheries on the New Brunswick side of the Bay of Fundy in number (71%) and weight (44%) (Table 9).

The historical series of catch at age in number and weight for 4WX herring which was compiled by Sinclair and Iles (1981) has been extended with the reported (unadjusted) landings for 1992 (Table 10, 11).

## LENGTH AND WEIGHT AT AGE

Average weight and length at age has been calculated by gear segment in Table 12. Recent assessments (e.g. Stephenson and Power 1988, 1989; Stephenson et al. 1990b, 1991, 1992) have used fishery weighted, weights at age (mean for stock fish weighted by gear) and this series has been extended in Table 13.

## PURSE SEINE LOGBOOKS

The detailed purse seine logbook introduced in 1985 (Power and Stephenson 1986, 1987, 1991) was used for the eighth consecutive year. Coverage was again high (93 % of Statistics Division landings for summer fishery) as logbook submission remained a condition of license, and information was of good quality as in previous years. The 1992 logbook information was used to document various aspects of the Div. 4WX purse seine fishery, including the distribution of effort and catches by fishing grounds and areas (Fig. 2c, Appendix 1). There was a substantial fishery for the first time in the Western Hole area (Fig. 2c), early in the summer fishery (May and June). Table 14 shows the relative importance of traditional fishing grounds. In 1992 there was a substantial increase in both effort and in catch on the Gannet/Dry Ledge grounds (approximately three fold increase in searching effort and a four fold increase in catch over 1991). There was a substantial decrease in the prominence of German Bank (only 20% of searching and 15% of the catch of 1991). Members of the industry have expressed some concern over the relative absence of herring on German Bank, particularly during the spawning season. There was a continued increase in effort and catch on Trinity Ledge, outside of the 18 day closure.

Table 15 lists the incidence of comments and anecdotal information. The most apparent change was an increase in the comment "fish in shallow water", which reflects the increased fishery in the Gannet/Dry Ledge area and Seal Island. There did not appear to be any abnormal patterns in the reasons for released sets (Table 16).

## RESEARCH SURVEY DATA

Lack of effective abundance indices has been a major problem in the assessment of this and other herring populations; and concern has been expressed regarding the effectiveness of assessment calibration of tuning in terms of both the validity of abundance indices, and the method in which they are used (Stephenson et al. 1990a; Stephenson 1991, 1992). For this reason, a major emphasis of this assessment has been in evaluating the research survey abundance indices.

### *a) Larval abundance*

The 1992 larval herring survey was undertaken using the standard protocol, with sampling between Oct. 29 and Nov. 11 (E.E. PRINCE, Cruise P437). All 79 of the traditional larval abundance index stations were sampled, as were most of the stations commonly covered in recent cruises (Fig. 7).

The traditional larval index has been calculated as the mean of larval density (no. m<sup>-2</sup>) for a set of 79 standard stations (Stephenson et al. 1990a). A major concern has been the potential impact of interannual differences in spawning time and/or cruise timing, which would bias the result (e.g. differences in length modes - Fig. 8). In an attempt to resolve this, we implemented a correction for length (age)-based mortality. Larval abundance at length was adjusted for mortality, assuming a hatching size of 5 mm, growth rate of 0.24 mm d<sup>-1</sup> and instantaneous rate of mortality of 0.07 (Chenoweth et al. 1989; Melvin et al. 1993). The results of the adjustment (Table 17 and Fig. 9a, b) reduce the relative strength of the 1988 survey, which had a high proportion of young larvae (mode 7 mm), and increases the relative strength of some earlier years (1986, 1982-1984, and particularly 1977). There is evidence of a 3-yr pattern of larval abundance. The 1992 survey result (adjusted) is the highest on record, and the adjustment did not alter the relative strength of the past 4 yr.

### *b) Acoustic surveys*

The winter acoustic survey planned for December 1992 was cancelled because of mechanical problems with the Alfred Needler, and the survey planned for January 1993 had to be transferred to the E.E. Prince. The E.E. Prince arrived in the Chedabucto Bay area on Jan. 7, and surveyed the southern portion of the Bay where the herring have concentrated in previous years; no herring were found. From Jan. 8-20, weather permitting, the E.E. Prince surveyed the area between Country Island and Gabarus Bay to about 10-20 mi offshore (Fig. 10), but no herring were found.

A seiner fleet of 5 vessels had been catching herring in November/December in the Canso, Grime Shoal areas, but had stopped for Christmas. Whales were sighted for a short period between Christmas and the New Year off Canso, but when the seiners returned to the area after Jan. 1, they could find neither whales nor herring. The seiners left the area on Jan. 15 and found herring in the approaches to Halifax Harbour, off Chebucto Head.

The E.E. Prince arrived in the Halifax area on Jan. 21, and surveyed the area from St. Margarets Bay to Shut-In Island (Fig. 11). Only two, very small, herring school echoes were recorded. The seiners reported that the catch for the night of Jan. 20-21 had been only 40 t, and that the herring had moved. The acoustic survey was terminated on Jan. 22.

The lack of success in finding major concentrations of herring by acoustic surveys alone since 1991 inspired an attempt to use aerial surveys for whales as a guide to potential acoustic survey locations. Whales in these waters are always associated with herring, and

since whales can be seen a long way off, it was thought that whale surveys could be used to direct the acoustic surveys to major concentrations of herring.

Two aerial surveys were undertaken Jan. 8 and Jan. 16 by helicopter using visual observation by an experienced whale watcher. Visibility was good in both surveys. The first survey covered the coastal area from Halifax to Scatarie Island, including Canso Banks. The second survey (Jan. 16) covered the coastal area from Port Hawkesbury to Scatarie Island, then to North Sydney and to Ingonish Bay. The helicopter flew about 5 mi offshore on the way north, and about 5 mi offshore on the return. The first survey observed two whales, located 20 mi off Point Michaud. The E.E. Prince later surveyed this area and found shrimp but no whales and no herring. The second survey found no whales at all.

Two additional surveys were undertaken using Aurora aircraft of the anti-submarine unit of the Department of Defense during the first week and during the third week in January. The Aurora detect whales using instrumentation including radar and infra-red sensors, but we were not informed which sensors were used in these surveys. The first survey covered a 300 mi<sup>2</sup> area east of Halifax. The second survey covered the coastal area from Halifax to Yarmouth. We were not informed of the exact areas covered. Neither survey reported whales.

There are two possible explanations for the absence of fish in the acoustic survey (a change in distribution or a serious reduction in abundance). We feel, for a variety of reasons (next section) that the acoustic result is the result of a change in distribution. It is now apparent that the Chedabucto Bay overwintering area is not an "index area" - containing "all or a constant proportion of the population" as had been hypothesized.

We have had previous indications that the use of Chedabucto Bay as a wintering area was changing. Herring left the Bay during the survey on some occasions, and we attempted to move the survey earlier to compensate. This year we were unable to survey (as had been planned) in December - and we missed the aggregation altogether. Had the herring been aggregated in the Chedabucto Bay area, we feel that the combination of aerial and acoustic survey would have located them for survey.

Acoustic surveys are becoming more prevalent for herring assessments and represent the major area of progress in abundance estimates for herring assessments generally (Stephenson 1991). We have discussed previously (Buerkle and Stephenson 1991; Stephenson et al. 1992) the necessity, and the difficulties, of matching the survey to particular characteristics of the stock. We have attempted to survey this population at other times (e.g. 1991 surveys of spawning areas in conjunction with the commercial fleet - Buerkle 1992), and have concluded that winter surveys hold the most potential - but that the survey area must be expanded. We can quantify herring in winter surveys using acoustics if we can find the aggregations. Aerial surveys offer a possible method of pre-survey, and we may have had some success in our plan to use this approach in December 1992 had the cruise not been cancelled. We feel that this approach is worth pursuing as an attempt to improve abundance

indices for this assessment. Unfortunately, the winter acoustic survey for 1993-94 was cancelled because of financial constraint.

*c) Bottom trawl survey index*

The summer bottom trawl survey of the Scotian shelf and Bay of Fundy has been proposed as an abundance index (Stephenson et al 1990a, 1990b, 1991, 1992). A similar (stratified random) spring bottom trawl survey index has been used to tune recent U.S. assessments for the Gulf of Maine (Fogarty et al 1990, NFSC 1992). The abundance of herring in this survey has been considerably higher in recent years than in the late 1970's and early 1980's (Fig. 12; Table 18). This is presumed to reflect the general increase in population size observed through the 1980's, and possibly a concurrent change in distribution of herring.

The 1992 survey result from all stations was very high, and was found to contain two sets of very large catches of juvenile herring from the western side of the Bay of Fundy (Stratum 93) (Fig. 13). Even with removal of this stratum, the 1992 result was the second highest in the time series (Table 18).

This index has the potential of being partitioned by age (as is done for standard groundfish assessments). Age-length keys from the July 4WX herring fisheries were applied to length frequencies from July surveys (with an adjustment for fork length; Melvin et al 1992), and the age disaggregated index results are presented in Table 19 and in Fig. 14. The survey results show the dominant features of this population, particularly the dominant 1983 year-class.

## FRAMEWORK FOR AN ANALYTICAL ASSESSMENT

An analytical assessment for Div 4WX herring was precluded in 1991 and 1992 by misreporting. Major revisions have been made to the catch figures for the period 1985-1991 on the basis of purse seiner interviews and backcalculation from production records compiled over the past two years. These figures are considered to be a major improvement, and will be added to the catch matrix revised previously (Mace 1985) to account for misreporting and errors in the years 1973-1984. The 1992 catch figures have not been revised, and should be considered in light of production records for that year. It is assumed that a new dockside monitoring program (D. M. P.) which involves measurement of calibrated holds, will improve the statistics from this fishery greatly in 1993.

While misreporting has been the primary limitation for an analytical assessment in recent years, there have also been problems with the performance of this assessment because of its analytical structure. The ADAPT formulations attempted in 1990 (Stephenson et al 1990b) involving either (1) larval abundance, acoustic biomass and bottom trawl survey (age

aggregated), or (2) only larval abundance were not refined enough to be specific about stock size.

The evaluation of abundance indices undertaken this year has resulted in several changes; removal of acoustic survey results, adjustment of the larval herring series to account for age-based mortality, and age disaggregation of the bottom trawl index. Further work needs to be done to complete the revised time series of larval and trawl data. When these are completed, an analytical assessment will be attempted.

Preliminary reconstruction of the catch record (since 1985) indicates that landings have been considerably higher than reported with stock landings estimated to have been 134,000 to 176,000 t, but there is still some uncertainty in the catch record; including the differences between reconstructions based on interview vs backcalculation from production, rationalizing recent (1985-1991 period) and previous revisions of catch, and adjusting the 1992 catch. In addition, further work is required in improving the fishery-independent indices of abundance (larval abundance and bottom trawl survey series) used for calibration. An analytical assessment was not presented, but will be attempted when these revisions are complete.

The winter acoustic survey was confined to January, and appears to have missed the overwintering aggregation. It is now apparent that Chedabucto Bay, in January, is not an appropriate index area. Larval and bottom trawl survey indices were high. Larval abundance, corrected for mortality to the time of the survey was the highest in the 20 yr time series. In that the larval abundance index is considered to be a valid index of abundance, it indicates that the stock is at above average abundance. The 1988 year-class (age 4) replaced the 1987 year-class in dominance. The combined indications from larval abundance and relative year-class strength indicate that a fishery at the level of recent years is acceptable.

This fishery is market limited, and in spite of a high degree of misreporting, has not changed much in size in recent years. The past year has seen a major change in monitoring, with the implementation of a mandatory dockside monitoring program (DMP), which involves mandatory measurement (dipping of calibrated holds) of all landings. This, combined with a sanctions program, which is in the process of being implemented, should overcome misreporting and limit the fishery even further.

### LITERATURE CITED

- Buerkle, U. 1992. Results of the 1991-92 acoustic herring surveys in NAFO Div. 4WX. Can. Atl. Fish. Sci. Advis. Comm. Res. Doc. 92/ : 25 p.
- Buerkle, U., and R.L. Stephenson. 1991. Herring school dynamics and its impact on acoustic abundance estimates, p. 185-207. In V. Weststad, J. Collie, and E. Collie (ed.)

Proceedings of the International Herring Symposium, Anchorage, Alaska, October 23-25, 1990 (9th Lowell Wakefield Fisheries Symp.). Univ. Alaska, Fairbanks.

- Chenoweth, S.B., D.A. Libby, R.L. Stephenson, and M.J. Power. 1989. Origin and dispersion of larval herring (*Clupea harengus*) in coastal waters of eastern Maine and southwestern New Brunswick. *Can. J. Fish. Aquat. Sci.* 46: 624-632.
- Fogarty, M.J., F.P. Almeida, J. Chenoweth, and J.S. Idoine. 1990. Population dynamics of Atlantic herring in the Gulf of Maine. US NMFS SAW-9 working paper No. 7.
- Hunt, J. J. 1987. Herring sampling program for the Scotia-Fundy Region, 1978-85. *Can. Manuscr. Rep. Fish. Aquat. Sci.* 1923: 21 p.
- Hunt, J. J., G. Martin, and G. A. Chouinard. 1986. The effect of freezer storage on herring length and maturity stage determination. *Can. Atl. Fish. Sci. Advis. Comm. Res. Doc.* 86/89: 13 p.
- Mace, P. M. 1985. Catch rates and total removals in the 4WX herring purse seine fisheries. *Can. Atl. Fish. Sci. Advis. Comm. Res. Doc.* 85/74:31 p.
- Melvin, G. D., F. J. Fife, J. B. Sochasky, M. J. Power, and R. L. Stephenson. 1993. Georges Bank (5Z) herring 1993 update. DFO Atl. Fish. Res. Doc. (In press).
- Melvin, G. D., J. B. Sochasky, M. J. Power, F. J. Fife, and W. H. Dougherty. 1992. Georges Bank (5Z) herring 1992 update. *Can. Atl. Sci. Advis. Comm. Res. Doc.* 92/68: 22 p.
- NFSC. 1992. Report of the thirteenth Northeast Regional stock assessment workshop (13th SAW), Fall 1991. *Northeast Fish. Sci. Center Ref. Doc.* 92-02. 183 p.
- Power, M. J., and R. L. Stephenson. 1986. An analysis of logs from the 1985 4Xa summer herring purse seine fishery. *Can. Atl. Fish. Sci. Advis. Comm. Res. Doc.* 86/44: 35 p.
- Power, M. J., and R. L. Stephenson. 1987. An analysis of logs from the 1986 4Xa summer herring purse seine fishery. *Can. Atl. Fish. Sci. Advis. Comm. Res. Doc.* 87/77: 21 p.
- Power, M. J., and R. L. Stephenson. 1991. Logbook analysis for the 1990 4WX herring purse seine fishery. *Can. Atl. Fish. Sci. Advis. Comm. Res. Doc.* 91/54: 27 p.
- Sinclair, M., and T. D. Iles. 1981. Assessment of the 1980 4WX herring fishery. *Can. Atl. Fish. Sci. Advis. Comm. Res. Doc.* 81/10: 42 p.
- Stephenson, R. L. 1991. Comparisons of tuning methods used in herring stock assessments in the northeast and northwest Atlantic. *Int. Counc. Explor. Sea Doc. C.M.* 1991/H:39: 8 p.



- Stephenson, R. L. 1992. An overview of herring assessments in the northeast and northwest Atlantic. *Int. Counc. Explor. Sea Doc. C.M. 1992/H:26*: 7 p.
- Stephenson, R. L. 1993. Revised estimates of landings from the 4WX herring fisheries: 1985-1992. *DFO Atl. Fish. Res. Doc.* (In press).
- Stephenson, R. L., and M. J. Power. 1988. Assessment of the 1987 4WX herring fishery. *Can. Atl. Fish. Soc. Advis. Comm. Res. Doc. 88/69*: 36 p.
- Stephenson, R. L., and M. J. Power. 1989. Assessment of the 1988 4WX herring fishery. *Can. Atl. Fish. Sci. Advis. Comm. Res. Doc. 89/59*: 39 p.
- Stephenson, R. L., M. J. Power, and T. D. Iles. 1987. Assessment of the 1986 4WX herring fishery. *Can. Atl. Fish. Sci. Advis. Comm. Res. Doc. 87/75*: 39 p.
- Stephenson, R. L., M. J. Power, T. D. Iles, and P. M. Mace. 1985. Assessment of the 1984 4WX herring fishery. *Can. Atl. Fish. Sci. Advis. Comm. Res. Doc. 85/78*: 58 p.
- Stephenson, R. L., M. J. Power, U. Buerkle, D. J. Gordon, J. B. Sochasky and W. H. Dougherty. 1990a. Review of abundance indices for the 4WX herring assessment. *Can. Atl. Fish. Sci. Advis. Comm. Res. Doc. 90/52*: 41 p.
- Stephenson, R. L., M. J. Power, W. H. Dougherty, D. J. Gordon and J. B. Sochasky. 1990b. Assessment of the 1989 4WX herring fishery. *Can. Atl. Fish. Sci. Advis. Comm. Res. Doc. 90/50*: 48 p.
- Stephenson, R. L., M. J. Power, U. Buerkle, W. H. Dougherty, D. J. Gordon and J. B. Sochasky. 1991. Assessment of the 1990 4WX herring fishery. *Can. Atl. Fish. Sci. Advis. Comm. Res. Doc. 91/58*: 49 p.
- Stephenson, R. L., M. J. Power, J. B. Sochasky, W. H. Dougherty, F. J. Fife, G. D. Melvin, and D. E. Lane. 1992. 1991 4WX herring assessment. *Can. Atl. Fish. Sci. Advis. Comm. Res. Doc. 92/69*: 51 p.

Table 1. Landings (t; calendar year totals) by gear type in NAFO Div. 4WX herring fisheries, 1985-92.

Gear	1985	1986	1987	1988	1989	1990	1991	1992
Purse seine	101337	67918	91625	14750	80154	96566	88838	96415
Weirs	30786	29470	33408	40072	46783	42273	25211	34126
Gillnet	5584	4318	2919	1151	382	457	776	504
Traps	1304	296	440	1284	123	183	60	70
Shutoffs	1139	371	698	867	637	554	863	68
Midwater trawl	98	28	17	423	783	871	1154	761
Miscellaneous	1612	103	74	1329	552	501	1	250
Total	141860	102504	129181	159876	129414	141405	116903	132195

Table 2. 1991-1992 reported monthly 4VWX herring landings (t) by major fishery.  
(Source: DFO Scotia-Fundy Region Statistics Division.)

4WX Stock Fisheries		1991			1992												1992	15 mo.	Quota	1991-1992
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Calendar Totals	Totals	Totals*	Plan Quota
1. 4W Winter Purse Seine	Note 1	0	9007	1797	3506	0	0	0	0	0	0	0	0	0	8451	576	12533	23337	14310	25000
2. 4Xs Fall Purse Seine	Note 2	636	375	0										1663	546	0	2209	3220	1011	9000
3. 4Xs Winter Purse Seine	Note 3	0	0	0	287	0											287	287	287	6000
4. 4Xqr Summer Purse Seine	Note 4,6	6170	0	0	0	0	0	0	848	12212	20701	12088	30503	4455	0	0	80807	86977	80807	77563
5. 4X Midwater Trawl		0	1	0	145	268	184	164	0	0	0	0	0	0	0	0	761	762	761	1250
4X Summer Gillnet		5	0	1	0	0	0	8	13	34	139	134	60	1	4	2	395	401	395	
4Xr Summer (N.S.) Weir		0	0	0	0	0	0	0	35	644	422	754	371	0	0	0	2227	2227	2227	
4X Trap		0	0	0	0	0	0	0	0	0	37	32	1	0	0	0	70	70	70	
4X Misc. Gears		0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	3	3	3	
4W Gillnet		5	0	0	0	0	0	6	71	14	13	4	0	0	0	0	109	114	109	
4W Misc. Gears (Trap)		1	0	0	0	0	0	3	5	3	11	0	0	0	35	0	57	58	57	
4WX Russian/Cuban/Domestic OTB		0	167	0	0	0	0	0	33	157	0	0	0	0	0	0	190	357	190	
6. 4WX Gillnet Trap Weir Misc.	Note 5	11	167	1	0	0	0	15	156	857	614	936	433	1	29	2	3052	3231	3052	6187
<b>Stock Totals</b>		6817	9550	1798	3939	268	184	179	1004	13068	21315	13024	30935	6119	9035	578	99649	117814	100228	125000
<b>4WX Non-Stock Fisheries</b>																				
1. 4X (N.B.) Weir		2023	93		0	0	0	15	50	812	5445	10935	9602	4357	684	0	31899	34015	31899	
2. 4X (N.B.) Shutoff		192	29		0	0	0	0	0	9	44	5	10	0	0	0	68	289	68	
<b>Non-Stock Totals</b>		2215	122	0	0	0	0	15	50	821	5489	10940	9611	4357	684	0	31967	34304	31967	
<b>Total 4WX Landings</b>		9032	9672	1798	3939	268	184	193	1054	13890	26803	23965	40547	10476	9719	578	131616	152118	132195	
<b>4Vn Fisheries</b>																				
1. 4Vn Winter Purse Seine	Note 1	0	4600	0	0	0	0	0	0	0	0	0	0	0	4228	0	4228	4228	4600	4600
2. 4Vn Gillnet		0	0	0	0	0	0	29	7	4	42	102	0	0	0	0	183	183	183	
3. 4Vn Traps and Misc Gear		0	0	0	0	0	0	0	35	42	22	0	0	5	50	0	154	154	154	
<b>4Vn Totals</b>		0	4600	0	0	0	0	29	42	46	63	102	0	5	4278	0	4565	4565	4937	4600
<b>Total 4VWX Landings</b>		9032	14272	1798	3939	268	184	223	1096	13936	26867	24067	40547	10480	13998	578	136181	156683	137133	

\* Reported landings against the annual plan quotas (shaded blocks) correspond to catches made in the seasonal periods (Notes 1-5).

\*\* Non-Stock totals are for the calendar year January 1, 1992 to December 31, 1992.

#### NOTES

- |  |   |
|--|---|
| 1. Quota period is November 1, 1991 to March 1, 1992     | 4. Quota period is April 1, 1992 to October 19, 1992                              |
| 2. Quota period is October 15, 1991 to December 31, 1991 | 5. Inshore/Fixed and Miscellaneous Gear allocation is for the calendar year 1992. |
| 3. Quota period is January 1, 1992 to February 28, 1992  | 6. Includes purse seine bait quota of 2600 t.                                     |

Table 3. Monthly landings (t) to domestic (Canadian) and OSS (foreign over-the-side sales)

Area 4VWX	1991		1991 Totals	1992										1992 Totals
	Nov	Dec		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
4X N.S. P.Seine Total					848	12212	20701	12088	30503	4455			80807	
4X N.S. P.Seine OSS					0	1814	6793	2542	1211	218			12579	
4X N.S. P.Seine Domestic					848	10397	13908	9546	29292	4237			68228	
4X N.S. Weirs Total					35	644	422	754	371				2227	
4X N.S. Weirs OSS					0	0	0	307	0				307	
4X N.S. Weirs Domestic					35	644	422	447	371				1919	
4X N.B. Weirs Total	93		93	15	50	812	5445	10935	9602	4357	684		31899	
4X N.B. Weirs OSS	0		0	0	0	0	68	1295	1230	13	0		2606	
4X N.B. Weirs Domestic	93		93	15	50	812	5377	9640	8371	4344	684		29293	
4W P.Seine Fall Total	9007	1797	10804								8541	576	9117	
4W P.Seine Fall OSS	210	0	210								0	0	0	
4W P.Seine Fall Domestic	8797	1797	10594								8541	576	9117	
4WX Gear Totals	9100	1797	10897	15	933	13668	26568	23778	40475	8812	9225	576	124049	
4WX OSS Totals	210	0	210	0	0	1814	6861	4145	2441	231	0	0	15492	
4WX Domestic Totals	8890	1797	10687	15	933	11853	19707	19633	38034	8581	9225	576	108557	
4Vn P.Seine Total	4600		4600								4228		4228	
4Vn P.Seine OSS	273		273								0		0	
4Vn P.Seine Domestic	4327		4327								4228		4228	

Table 4. Market components of the 4X summer purse seine fishery 1988-92 from logbook analysis (Power and Stephenson, unpubl. data).

Market	1988		1989		1990		1991		1992	
	Landings t (logged t)	%	Landings t (logged t)	%	Landings t (logged t)	%	Landings t (logged t)	%	Landings t (logged t)	%
Roe	32,509	38	13,268	21	31,523	43	29,960	42	30777	41
Adult shore <sup>1</sup>	29,361	34	24,201	39	25,941	35	21,664	30	29617	40
Over-the-side	21,755	25	19,190	31	13,387	18	13,548	19	9443	13
Bait	449	1	1,950	3	855	1	2,128	3	1247	2
Fillet	410	1	805	1	50	0	924	1	3090	4
Sardine <sup>2</sup>	99	0	57	0	308	0	1,744	2	60	<1
U.S. buyers	23	0	64	0	57	0	104	0	0	0
Unspecified	1,135	1	2,422	4	125	0	1,198	2	276	<1

<sup>1</sup>Includes a considerable amount of fish which actually went to the roe market.

<sup>2</sup>Sardine market was supplied predominantly by weirs and purse seine landings in other seasons.

Table 5. Historical series of nominal and adjusted annual landings (t) by major gear components and seasons of the 4WX herring fishery 1963-1992.

Year <sup>a</sup>	Stock Fisheries - Nominal Landings						4WX Stock Nominal Landings	4WX Stock Adjusted Landings**	4WX Stock TAC	Non-Stock 4Xs Weir and Shutoff	Total 4WX Adjusted Landings
	4W Winter Purse seine	4Xs Fall&Winter Purse seine	4Xqr Summer Purse seine	4X Summer Gillnet	4Xr Summer Weir	4WX Other*					
1963		6871	15093	2955	5345		30264			29366	29366
1964		15991	24894	4053	12458		57396			29432	29432
1965		15755	54527	4091	12021		86394	86394		3346	89740
1966		25645	112457	4413	7711		150226	150226		35805	186031
1967		20888	117382	5398	12475		156143	156741		30032	186773
1968		42223	133267	5884	12571		193945	196362		33145	229507
1969	25112	13202	84525	3474	10744		137057	150462		26539	177001
1970	27107	14749	74849	5019	11706		133430	190382		15840	206222
1971	52535	4868	35071	4607	8081		105162	129101		12660	141761
1972	25656	32174	61158	3789	6766		129543	153449		32699	186148
1973	8348	27322	36618	5205	12492		89985	122687		19935	142622
1974	27044	10563	76859	4285	6436		125187	149670		20602	170272
1975	27030	1152	79605	4995	7404		120186	143897		30819	174716
1976	37196	746	58395	8322	5959		110618	115178		29206	144384
1977	23251	1236	68538	18523	5213		116761	117171	109000	23487	140658
1978	17274	6519	57973	6059	8057		95882	114000	110000	38842	152842
1979	14073	3839	25265	4363	9307		56847	77500	99000	37828	115328
1980	8958	1443	44986	19804	2383		77574	107000	65000	13525	120525
1981	18588	1368	53799	11985	1966		87706	137000	100000	19080	156080
1982	12275	103	64344	6799	1212		84733	105800	80200	25963	131763
1983	8226	2157	63379	8762	918		83442	117400	82000	11383	128783
1984	6336	5683	58354	4490	2684		77547	135900	80000	8698	144598
1985	8751	5419	87167	5584	4062		110983	134600	125000	27863	162463
1986	8414	3365	56139	3533	1958		73409	134300	97600	27883	162183
1987	8780	5139	77706	2289	6786		100700	145900	126500	27320	173220
1988	8503	7876	98371	695	7518		122963	176800	151200	33421	210221
1989	6169	5896	68089	95	3308		83557	136500	151200	44112	180612
1990	8316	10705	77545	243	4049	1769	102627	166800	151200	38778	205578
1991	17878	2024	73619	538	1498	1453	97010	140100	151200	24576	164676
1992	14310	1298	80807	395	2227	1190	100227	?	125000	31967	?

<sup>a</sup>Annual landings by purse seiners are defined for the annual plan period from October 15 of the preceding year to October 14 of the current year.

All landings by other gear are for the calendar year.

\* Includes 4Xs stock catches taken by single midwater trawl, and 4WX stock catches by gillnets and traps, by foreign trawlers, and by miscellaneous gears.

\*\* Adjusted totals includes misreporting adjustments for 1978-1984 (Mace 1985), and purse seine catch revisions for 1985-1991 (Stephenson 1992).

Table 6. TAC, reported stock, adjusted stock and total 4WX (stock + non-stock) landings ('000 t).

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
TAC	109.0	110.0	99.9	65.0 <sup>1</sup>	100.0	80.2	82.0	80.0	125.0	97.6 <sup>2</sup>	126.5	151.2	151.2	151.2	151.2	125.0
Reported stock <sup>3</sup> 4WX catch	117.1	95.9	59.0	79.6	87.7	84.7	84.4	78.1	112.4	73.7	101.2	124.6	84.5	101.9	97.0	100.2
Reported total 4WX catch	150.7	134.7	96.2	93.2	106.8	110.7	94.1	88.7	141.9	101.8	130.2	159.9	129.4	141.4	121.6	132.2

<sup>1</sup>TAC raised from 60.0 t to 65.0 t in mid-season.

<sup>2</sup>Excludes an allowance of 13,000 t for inshore 4Xn fixed gear.

<sup>3</sup>Excludes 4Xb weir + shutoff, 4Xn gill + trap, 4W inshore gear.

Table 7. Distribution of biological samples from the 1992 4WX herring commercial fishery by area, gear component and month.\*

YEAR	NAFO	GEAR	MONT	MARK	L.F. Fish monthly pooled	Num. Samples monthly pooled	Lens/WT Detail Fish monthly pooled	Aged Fish	Detail Samples monthly pooled	CATCH(T)	Catch per Aged Fish	Catch per L.F. Sample
92	4W	PURSE	1	DOM	4918	21	437	436	8	3506	8.0	167.0
92	4W	PURSE	11	DOM	4661	22	389	200	9	9027	45.1	410.3
91	4X NS	PURSE	11	DOM	4187	24	651	651	14	8797	13.5	366.5
91	4X NS	PURSE	11	OSS	309	1	0	651	0	210	0.3	210.0
91	4X NS	PURSE	12	DOM	888	4	199	199	4	1797	9.0	449.3
92	4X NS	PURSE	6	DOM	3582	17	405	442	11	11245	34.2	661.5
92	4X NS	PURSE	6	OSS	4988	22	37	442	1	1814	5.5	82.5
92	4X NS	PURSE	7	DOM	4779	17	450	608	11	13908	33.0	818.1
92	4X NS	PURSE	7	OSS	16685	76	158	608	4	6793	16.1	89.4
92	4X NS	PURSE	8	DOM	2359	11	145	883	4	9546	15.7	867.8
92	4X NS	PURSE	8	OSS	7155	33	130	883	3	2542	4.2	77.0
92	4X NS	PURSE	9	DOM	1223	6	291	340	6	29292	129.6	4882.0
92	4X NS	PURSE	9	OSS	3832	18	49	340	1	1211	5.4	67.3
92	4X NS	PURSE	10	DOM	428	2	36	524	1	4237	11.8	2118.5
92	4X NS	PURSE	10	OSS	967	5	44	524	1	218	0.6	43.6
91	4X NB	PURSE	10/11	DOM	4537	19	565	565	16	1011	1.8	53.2
92	4X NB	PURSE	1	DOM	1297	5	191	191	5	287	1.5	57.4
92	4X NB	PURSE	10	DOM	660	3	104	216	3	1663	10.1	554.3
92	4X NB	PURSE	11	DOM	759	3	76	216	3	546	3.3	182.0
92	4X NB	MIDWAT	1	DOM	3169	12	239	376	12	145	0.4	12.1
92	4X NB	MIDWAT	2	DOM	1757	6	37	376	2	268	0.7	44.7
92	4X NB	MIDWAT	3	DOM	3651	8	92	302	5	184	0.6	23.0
92	4X NB	MIDWAT	4	DOM	2429	8	110	302	6	164	0.5	20.5
92	4X NS	MISC	5/6	DOM	0	34	0	390	0	346	1.1	10.2
92	4X NS	MISC	7	DOM	0	92	0	667	0	192	0.3	2.1
92	4X NS	MISC	8	DOM	0	51	0	667	0	182	0.4	3.6
92	4X NS	MISC	9	DOM	0	70	0	766	0	61	0.1	0.9
92	4X NS	MISC	10/12	DOM	0	27	0	433	0	42	0.2	1.6
92	4X NS	TRAP	6	DOM	160	1	0	0	0	70	...	70.0
92	4X NS	GILLNE	8	DOM	139	1	0	0	0	395	...	395.0
92	4X NS	NSWEIR	5	DOM	263	1	22	298	1	35	0.1	35.0
92	4X NS	NSWEIR	6	DOM	2762	10	276	298	7	644	2.6	64.4
92	4X NS	NSWEIR	7	DOM	758	4	133	409	4	422	1.2	105.5
92	4X NS	NSWEIR	8	DOM	1693	7	332	392	6	447	1.7	63.9
92	4X NS	NSWEIR	8	OSS	527	2	60	392	1	307	1.2	153.5
92	4X NS	NSWEIR	9	DOM	426	2	56	448	1	371	1.2	185.5
92	4X NB	NBWEIR	5	DOM	479	2	35	282	2	65	0.2	32.5
92	4X NB	NBWEIR	6	DOM	5835	22	247	581	13	812	1.5	36.9
92	4X NB	NBSHUT	7	DOM	0	49	0	581	0	5377	9.8	109.7
92	4X NB	NBWEIR	7	DOM	6381	27	257	334	10	5377	18.0	199.1
92	4X NB	NBWEIR	7	OSS	652	2	77	334	1	68	0.2	34.0
92	4X NB	NBSHUT	8	DOM	0	35	0	558	0	15	0.0	0.4
92	4X NB	NBWEIR	8	DOM	8271	35	303	558	7	9640	20.7	275.4
92	4X NB	NBWEIR	8	OSS	4837	20	255	558	5	1295	2.8	64.8
92	4X NB	NBWEIR	9	DOM	4071	18	152	370	5	8371	22.9	465.1
92	4X NB	NBWEIR	9	OSS	6123	26	218	370	5	1230	3.4	47.3
92	4X NB	NBWEIR	10	DOM	2685	11	43	447	2	4344	9.8	394.9
92	4X NB	NBWEIR	10	OSS	213	1	34	447	1	13	0.0	13.0
92	4X NB	NBWEIR	11	DOM	812	4	66	143	3	684	5.0	171.0
Totals					68214	309	4357		105	107650		348.4

\* Horizontal and vertical lines are intended to indicate the gear and month sources for those cases for which samples were "pooled" to get numbers sufficient for a given key.

\*\* Totals for the midwater trawl include one additional detail sample of 100 "research" fish.

\*\*\* Keys for trap and gillnet were pooled from the "Misc" gear type.



Table 8. Catches by age in numbers (thousands) and weight (t) for stock gear components of the 1992 4WX herring fishery.

Catch Nos.	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11 +	Total
4W Purse Seine	0	53	3562	23017	15248	8615	4287	5325	9863	4634	4509	79,113
4X N.S. P.Seine	0	40155	68609	154927	63867	38123	17572	16846	27909	17429	8760	454,197
4X N.B. P.Seine	0	1094	5559	3934	1359	1223	205	397	368	89	43	14,271
4X N.S. Weirs	6	9136	4154	4651	1692	848	339	448	464	417	182	22,337
4WX Misc.	0	733	710	1647	800	692	197	182	182	97	52	5,292
4X Midwater Trawl	0	59384	4403	10	9	0	0	0	0	0	0	63,806
												0
Total Nos. by Age	6	110555	86997	188186	82975	49501	22600	23198	38786	22666	13546	639,016

% Numbers	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11 +	Total
4W Purse Seine	0	0	5	29	19	11	5	7	12	6	6	100
4X N.S. P.Seine	0	9	15	34	14	8	4	4	6	4	2	100
4X N.B. P.Seine	0	8	39	28	10	9	1	3	3	1	0	100
4X N.S. Weirs	0	41	19	21	8	4	2	2	2	2	1	100
4WX Misc.	0	14	13	31	15	13	4	3	3	2	1	100
4X Midwater Trawl	0	93	7	0	0	0	0	0	0	0	0	100
Overall % Nos. by Age	0	17	14	29	13	8	4	4	6	4	2	100

Catch Weight (t.)	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11 +	Total
4W Purse Seine	0	1	289	2782	2315	1624	906	1243	2519	1257	1374	14310
4X N.S. P.Seine	0	1848	7601	23814	12123	8570	4619	4881	8649	5653	3047	80805
4X N.B. P.Seine	0	15	284	377	177	204	42	85	80	22	11	1298
4X N.S. Weirs	0	209	354	638	296	174	85	128	144	135	64	2226
4WX Misc.	0	21	71	243	145	144	48	50	53	30	18	823
4X Midwater Trawl	0	628	131	1	1	0	0	0	0	0	0	761
Totals Catch t. by Age	0	2722	8730	27855	15057	10715	5700	6387	11445	7097	4515	100223

% Catch Weight (t.)	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11 +	Total
4W Purse Seine	0	0	2	19	16	11	6	9	18	9	10	100
4X N.S. P.Seine	0	2	9	29	15	11	6	6	11	7	4	100
4X N.B. P.Seine	0	1	22	29	14	16	3	7	6	2	1	100
4X N.S. Weirs	0	9	16	29	13	8	4	6	6	6	3	100
4WX Misc.	0	3	9	30	18	17	6	6	6	4	2	100
4X Midwater Trawl	0	83	17	0	0	0	0	0	0	0	0	100
Overall % by Age	0	3	9	28	15	11	6	6	11	7	5	100

Table 9 Catches by age in numbers ('000) and weight (t) for non-stock gear components of the 1992 4WX herring fishery.

Catch Nos.('000s)	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
4X N.B. Weirs	798	374633	97320	36376	10358	3988	1611	1358	557	245	44	527,288
4X N.B. Shutoffs	1	1139	358	62	20	4	2	2	1	0	0	1,589
Total Nos. by Age	799	375,772	97,678	36,438	10,378	3,992	1,613	1,360	558	245	44	528,877

% Catch Nos.	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
4X N.B. Weirs	0	71	18	7	2	1	0	0	0	0	0	100
4X N.B. Shutoffs	0	72	23	4	1	0	0	0	0	0	0	100
Total Nos. by Age	0	71	18	7	2	1	0	0	0	0	0	100

Catch Weight (t.)	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
4X N.B. Weirs	10.85	14180.69	8719.58	5177.32	1835.2	891.44	422.72	389.94	173.7	81.09	17.13	31,900
4X N.B. Shutoffs	0.01	27.62	25.18	9.06	3.49	0.97	0.55	0.52	0.27	0.18	0.04	68
Total Catch t. by Age	11	14,208	8,745	5,186	1,839	892	423	390	174	81	17	31,968

% Catch Weight (t.)	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
4X N.B. Weirs	0	44	27	16	6	3	1	1	1	0	0	100
4X N.B. Shutoffs	0	41	37	13	5	1	1	1	0	0	0	100
Totals Catch t. by Age	0	44	27	16	6	3	1	1	1	0	0	100

Table 10. 4WX herring stock catch at age in numbers (thousands).

4WX HERRING STOCK CATCH AT AGE IN NUMBERS (THOUSANDS)									13/ 5/93	
	1965	1966	1967	1968	1969	1970	1971	1972	1973	
1	270378	154323	722208	164703	108875	699720	87570	0	754	
2	1084719	914093	613970	2389061	290329	576896	404224	649254	126421	
3	34835	448940	153626	224956	531812	76532	183896	71984	595992	
4	234383	73382	266454	83109	132319	286278	106630	148516	109530	
5	49925	321857	110051	290285	162439	201215	113566	77207	34422	
6	10592	45916	159203	73087	112631	120280	75593	75384	25562	
7	1693	13970	57948	90617	62506	111937	93620	49065	19361	
8	561	7722	4497	31977	22595	41257	50022	48700	17604	
9	54	1690	409	15441	6345	21271	36618	26055	19836	
10	37	215	296	5668	2693	7039	7536	13792	9661	
11	1	1	148	1175	722	2674	5695	11679	11120	
1+	1687178	1982109	2088810	3370079	1433266	2145099	1164970	1171636	970263	
2+	1416800	1827786	1366602	3205376	1324391	1445379	1077400	1171636	969509	
3+	332081	913693	752632	816315	1034062	868483	673176	522382	843088	
	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	14151	2870	240	1164	35381	311	1623	0	3589	3367
2	596153	264491	48470	140494	346719	170523	9566	75713	72591	128378
3	72381	180898	176226	28659	36177	226442	60559	33174	122380	101017
4	616622	92487	130598	192958	11338	47200	359484	68816	17756	168379
5	53199	384646	72334	106061	107627	4639	21958	306716	73025	16946
6	15254	50599	219788	55066	60431	19695	3583	21728	154542	41607
7	8120	9357	18960	150588	27286	15521	3507	1631	10910	63468
8	5313	3238	4967	12466	96741	9981	4951	1914	1535	7334
9	10964	3481	3556	2873	9838	35386	2009	1366	977	1351
10	5787	2842	1835	1253	2169	3834	8179	361	886	434
11	7359	4599	3071	3448	1499	2042	2105	1442	719	895
1+	1405303	999508	680045	695030	735206	535574	477524	512861	458910	533176
2+	1391152	996638	679805	693866	699825	535263	475901	512861	455321	529809
3+	794999	732147	631335	553372	353106	364740	466335	437148	382730	401431
	1984	1985	1986	1987	1988	1989	1990	1991	1992	
1	0	5762	40	1398	91	6	0	0	6	
2	72301	138419	80019	50422	89298	77698	96902	70319	110555	
3	141067	215599	176197	76865	68122	87092	70656	130153	86997	
4	131251	193369	186983	320651	117398	47206	93118	133187	188186	
5	84920	94308	36361	147483	261272	60647	48807	64133	82975	
6	13633	27081	20180	27924	142065	129020	54856	29990	49501	
7	13803	8989	6878	11843	25594	58535	109586	36537	22600	
8	16299	11609	2759	4433	12762	13971	63389	58550	23198	
9	5418	5107	1879	2043	2519	6313	17079	33010	38786	
10	1263	767	866	1897	2285	2911	5738	13265	22666	
11	5207	300	223	395	1712	2333	3717	9808	13546	
1+	485162	701310	512385	645354	723118	485732	563848	578952	639016	
2+	485162	695548	512345	643956	723027	485726	563848	578952	639010	
3+	412861	557129	432326	593534	633729	408028	466946	508633	528455	

Table 11. 4WX herring stock catch weight (t) at age.

4WX HERRING CATCH WEIGHT (MT) BY AGE										13/ 5/93
	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	2704	1543	7222	0	0	0	0	0	0	0
2	44473	37478	25173	78122	10800	18288	26719	28762	3641	28436
3	3902	50281	17206	25195	56106	9123	26224	9905	62996	7976
4	40314	12622	45830	12300	21475	48295	21230	28560	15696	108155
5	10884	70165	23991	53587	33657	42376	26132	17333	7731	10938
6	2690	11663	40438	17862	27234	30888	19170	19751	6429	3659
7	484	3995	16573	24983	17627	32708	27403	14302	5404	2251
8	181	2494	1453	12759	6910	13697	16447	15667	5830	1711
9	19	598	145	5216	2117	7840	13256	8989	7139	3754
10	14	84	115	2321	1051	2740	2922	5246	3757	2037
11	0	0	58	481	282	1041	2208	4443	4325	2590
1+	105666	190923	178203	232827	177260	206996	181710	152958	122948	171509
2+	102962	189380	170981	232827	177260	206996	181710	152958	122948	171509
3+	58489	151902	145808	154704	166460	188709	154991	124196	119307	143073
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0	0	0	0	3	16	0	36	34	0
2	5501	1585	9160	9812	6991	392	3104	2976	5263	2713
3	17059	20107	3247	4055	25362	6783	3715	13707	11314	18630
4	16555	20778	33613	2050	8118	61831	11836	3054	28961	25122
5	82930	16883	22665	24604	1011	4787	66864	15919	3694	19418
6	12124	54815	15099	15627	5003	910	5519	39254	10568	3533
7	2503	5256	44122	8243	4439	1003	466	3120	18152	3863
8	1079	1576	4055	31944	3224	1599	618	496	2369	4828
9	1246	1360	943	3453	12527	711	484	346	478	1674
10	1077	742	521	861	1491	3182	140	345	169	460
11	1743	1241	1433	595	794	819	561	280	348	1895
1+	141816	124343	134859	101245	68964	82033	93309	79532	81351	82135
2+	141816	124343	134859	101245	68960	82017	93309	79496	81317	82135
3+	136315	122758	125699	91433	61969	81625	90204	76520	76053	79422
	1985	1986	1987	1988	1989	1990	1991	1992		
1	0	0	17	1	0	0	0	0		
2	7313	4400	2539	1856	2531	2990	3376	2722		
3	25442	21781	7501	6006	6869	6482	13061	8730		
4	39432	34032	48975	18026	7644	14971	19581	27855		
5	23516	8704	29294	51108	12541	9750	11953	15057		
6	7536	5469	6843	34340	30699	12851	6514	10715		
7	2833	2102	3245	7201	16019	27929	9162	5700		
8	3879	907	1287	3878	4234	18206	15819	6387		
9	1757	677	650	817	2048	5447	10005	11445		
10	337	346	664	785	1026	1928	4276	7097		
11	132	89	138	635	850	1357	3260	4515		
1+	112177	78507	101153	124654	84462	101912	97009	100223		
2+	112177	78507	101136	124652	84462	101912	97009	100222		
3+	104864	74107	98597	122796	81931	98922	93633	97500		

Table 12. Average weight (g) and length (cm) at age for stock and non-stock gear components of the 1992 4WX herring fishery.

STOCK GEAR COMPONENTS											
Average Wt. at Age	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+
4W Purse Seine	0	25	81	121	152	188	211	233	255	271	305
4X N.S. P.Seine	0	46	111	154	190	225	263	290	310	324	348
4X N.B. P.Seine	0	14	51	96	130	167	204	214	219	241	269
4X N.S. Weirs	9	23	85	137	175	205	252	287	309	324	348
4WX Misc.	0	28	100	148	181	207	243	273	291	315	353
4X N.B. Midwater Trawl	0	11	30	92	140	0	0	0	0	0	0
Average for Stock Gears	9	25	100	148	181	216	252	275	295	313	333

Average Length at Age	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+
4W Purse Seine	0.0	15.5	23.1	26.2	28.3	30.3	31.5	32.5	33.4	34.1	35.4
4X N.S. P.Seine	0.0	18.8	24.3	27.0	28.9	30.5	32.2	33.4	34.1	34.6	35.4
4X N.B. P.Seine	0.0	13.2	19.7	24.3	27.0	29.3	31.3	31.8	32.0	33.1	34.3
4X N.S. Weirs	11.5	14.7	22.5	26.4	28.4	29.8	31.8	33.1	33.8	34.2	34.9
4WX Misc.	0.0	15.6	23.6	26.8	28.6	29.9	31.5	32.8	33.4	34.3	35.3
4X N.B. Midwater Trawl	0.0	12.2	17.0	24.2	26.2	0.0	0.0	0.0	0.0	0.0	0.0
Average for Stock Gears	11.5	14.9	23.5	26.8	28.7	30.5	32.0	33.1	33.9	34.5	35.4

NONSTOCK GEAR COMPONENTS											
Average weight	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+
4X N.B. Weirs	14	38	90	142	177	224	262	287	312	331	387
4X N.B. Shutoffs	11	24	70	147	180	238	289	291	311	0	0
Average for nonstock	14	38	90	142	177	224	262	287	312	331	387

Average length	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+
4X N.B. Weirs	12.9	17.6	22.9	26.5	28.2	30.2	31.7	32.6	33.3	34.1	34.2
4X N.B. Shutoffs	12.5	15.0	20.8	26.3	27.9	30.5	32.3	32.3	32.6	0.0	0.0
Average for nonstock	12.9	17.6	22.9	26.5	28.2	30.2	31.7	32.6	33.3	34.1	34.2

Table 13. Average weights at age for the 4WX herring fishery (stock gear components) for 1965-92.

AVERAGE WEIGHTS AT AGE FROM HISTORICAL 4WX HERRING ASSESSMENTS																13/ 5/93
	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	10	10	10	0	0	0	0	0	0	0	0	0	0	0	10	10
2	41	41	41	33	37	32	66	44	29	48	21	33	65	28	41	41
3	112	112	112	112	105	119	143	138	106	110	94	114	113	112	112	112
4	172	172	172	148	162	169	199	192	143	175	179	159	174	181	172	172
5	218	218	218	185	207	211	230	224	225	206	216	233	214	229	218	218
6	254	254	254	244	242	257	254	262	252	240	240	249	274	259	254	254
7	286	286	286	276	282	292	293	292	279	277	268	277	293	302	286	286
8	323	323	323	399	306	332	329	322	331	322	333	317	325	330	323	323
9	354	354	354	338	334	369	362	345	360	342	358	382	328	351	354	354
10	389	389	389	410	390	389	388	380	389	352	379	404	416	397	389	389
11	389	389	389	410	390	389	388	380	389	352	379	404	416	397	389	389
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992				
1	0	10	10	0	0	0	12	13	7	0	0	9				
2	41	41	41	38	53	55	50	21	33	31	48	25				
3	112	112	112	132	118	124	98	88	79	92	100	100				
4	172	172	172	191	204	182	153	154	162	161	147	148				
5	218	218	218	229	249	239	199	196	207	200	186	181				
6	254	254	254	259	278	271	245	242	238	234	217	216				
7	286	286	286	280	315	306	274	281	274	255	251	252				
8	323	323	323	296	334	329	290	304	303	287	270	275				
9	354	354	354	309	344	360	318	327	324	319	303	295				
10	389	389	389	364	440	400	350	341	353	336	322	313				
11	389	389	389	364	440	400	350	371	365	364	332	333				

Table 14. Changes in the relative importance of key fishing grounds in the 4X N.S. summer purse seine fishery.

Fishery	Grounds	Total Catch in Tons								Total Searching in Sonar Hours							
		1985	1986	1987	1988	1989	1990	1991	1992	1985	1986	1987	1988	1989	1990	1991	1992
4Xa	Long Island	857	3060	7309	10892	21915	18755	10139	3847	149	292	771	827	2406	1775	1437	453
4Xa	Trinity	35800	13419	18851	18586	266	1113	3255	4715	2110	1650	1700	1506	97	260	277	440
4Xa	Seal Island	13745	8894	11560	18947	23420	25321	13153	16077	718	542	1086	1133	1517	2035	1042	1252
4Xa	German Bank	15502	13346	16434	17692	8087	11744	24548	3733	679	873	985	789	644	885	1519	316
4Xa	Scots Bay		36	3649	3949	6583	8925	8750	8554		5	256	184	310	352	602	470
4Xa	Grand Manan	3584	2984	2217	301	968	877	3428	3400	184	284	220	27	77	75	338	295
4Xa	Gannet, Dry Ledge	5675	2187	1474	14901	2010	4163	6190	27696	526	203	162	1187	229	343	619	1956
4Xa	Yankee Bank				194	196	3646	967	119				21	35	331	104	12
4Xa	Western Hole								3592								235
	Total	83323	51626	68259	88503	64206	74907	71922	75364	5161	4517	5778	5859	5338	6097	6042	5701
4Xa	Grounds	Percentage of Total Catch								Percentage of Total Searching							
		1985	1986	1987	1988	1989	1990	1991	1992	1985	1986	1987	1988	1989	1990	1991	1992
4Xa	Long Island	1	6	11	12	34	25	14	5	3	6	13	14	45	29	24	8
4Xa	Trinity	43	26	28	21	0	1	5	6	41	37	29	26	2	4	5	8
4Xa	Seal Island	16	17	17	21	36	34	18	21	14	12	19	19	28	33	17	22
4Xa	German Bank	19	26	24	20	13	16	34	5	13	19	17	13	12	15	25	6
4Xa	Scots Bay	0	0	5	4	10	12	12	11	0	0	4	3	6	6	10	8
4Xa	Grand Manan	4	6	3	0	2	1	5	5	4	6	4	0	1	1	6	5
4Xa	Gannet, Dry Ledge	7	4	2	17	3	6	9	37	10	4	3	20	4	6	10	34
4Xa	Yankee Bank				0	0	5	1	0				0	1	5	2	0
4Xa	Western Hole								5								4
4Xa	Total	90	85	90	97	99	100	98	95	85	85	90	97	100	99	98	95

Table 15. Summary of comments coded from 1987 to 1992 in 4X N.S. summer purse seine fishery logbooks.

Year Comment code	Occurrence on logs											
	1987 Number of records	1988	1989	1990	1991	1992	1987 Percent all records	1988	1989	1990	1991	1992
Not specified	1971	1991	1319	1730	1883	1815	82.7	75.5	69.2	77.2	72.8	68.8
Brit sighting	1		1			2	0.0	0.0	0.1	0.0	0.0	0.1
Carrying			24						1.3	0.0	0.0	0.0
Catch not recorded			18	52	12	23			0.9	2.3	0.5	0.9
F.O. hail			8			12			0.4	0.0	0.0	0.5
Fish deep		21	23	37	49	19		0.8	1.2	1.7	1.9	0.7
Fish in shallow water	1	37	14	19	35	77	0.0	1.4	0.7	0.8	1.4	2.9
Fish on surface	5	6	12	3	5	19	0.2	0.2	0.6	0.1	0.2	0.7
Fish thinned out	50	44	21	16	39	49	2.1	1.7	1.1	0.7	1.5	1.9
Fish very fat		1		1		6		0.0	0.0	0.0	0.0	0.2
Gave fish away		3						0.1	0.0	0.0	0.0	0.0
Hard to catch	25	39	31	40	44	30	1.0	1.5	1.6	1.8	1.7	1.1
Large area of fish	194	172	144	115	90	118	8.1	6.5	7.6	5.1	3.5	4.5
Large bunches/schools	40	41	17	28	43	48	1.7	1.6	0.9	1.3	1.7	1.8
Little or no fish	14	17	7	10	11	17	0.6	0.6	0.4	0.4	0.4	0.6
Lots of small fish				22	36	5				1.0	1.4	0.2
No feed in fish	21	122	152	72	82	81	0.9	4.6	8.0	3.2	3.2	3.1
Pooling of catch	3	66	34	19	74	75	0.1	2.5	1.8	0.8	2.9	2.8
Poor bottom	15	13	3	6	10	18	0.6	0.5	0.2	0.3	0.4	0.7
Poor weather			17	1	18	7			0.9	0.0	0.7	0.3
Received fish				5	6	26				0.2	0.2	1.0
Small bunches/schools	26	30	16	28	59	63	1.1	1.1	0.8	1.3	2.3	2.4
Some feed in fish		30	35	25	80	71		1.1	1.8	1.1	3.1	2.7
Split market			9	4					0.5	0.2	0.0	0.0
Too many boats				1	3	8				0.0	0.1	0.3
Warmer water than normal			5	3					0.3	0.1	0.0	0.0
Whales	16	3	6	3	7	3	0.7	0.1	0.3	0.1	0.3	0.1
Various other combined						46						1.7
Total number of records	2382	2636	1905	2240	2586	2638	97.6	97.1	100.0	100.0	100.0	100.0



Table 16. Reasons for releases and release tonnage for 1985 to 1992 from 4X N.S. summer purse seine logbooks.

Reason for release	Occurrence on Logs % of total sets								Reported Releases % of released tonnage							
	1985	1986	1987	1988	1989	1990	1991	1992	1985	1986	1987	1988	1989	1990	1991	1992
No release code	78.8	80.4	72.5	74.2	74.8	77.5	75.3	77.7	4.5		11.1	2.6	0.9			
Carrying; no set made							0.7									
Condition	0.9	2.5	3.1	2.5	1.7	1	1.4	1.2	0.6	41.2	26.1	38.6	6.1	7.1	40.4	3.2
Dogfish	1.7	0.6	0.8	1.0	4.0	2	1.5	2.1	6.9	2.0	1.9	3.4	12.2	1.9	0.3	4.7
Feed	1.1	0.1	1.1	2.1	0.8	1.3	0.2	1.6	6.2		2.2	4.6	2.1	1.1		
Fish dove		0.2	0.5	0.2	0.3	0.6	0.2	0.5		2.7	9.2	3.0		40.8		
Fish inside box/line		0.3	0.3	0.2				0.5								
Fish moving fast		0.6	0.5	0.2	0.2	0.2	0.5	0.3								
Fish refused by buyer								0.1								2.7
Fish thinned out		0.4	0.3	0.8	1.3		0.3	0.5					0.2			
Fish too deep	0.9	1.8	2.4	1.4	1.2	1.2	1	1.1	0.1	0.1		0.3				0.3
Fish too shallow	1.1	0.4	1.9	1.3	0.2	0.2	1	0.5								
Gave fish away				0.0	1.9	1.6	0.3	0.6					1.5			
Gear/crew problems	0.6	0.9	1.4	1.4	1.9	1.3	1.9	1.3	0.1	7.8	3.0		0.6	0.1	6.1	2.9
Market filled	1.3	0.2	0.6	0.3	0.2		0.1	0.2	6.9	10.1	0.5	5.7	1.5		3.1	
Net sunk	0.3	0.6	0.1	0.5	0.6	0.2	0.1		12.5	26.4		3.0	24.4			
No fish found	3.3	3.7	2.7	3.4	0.1	0.1	3.6	2.8								
Other Species	0.1	0.4	0.3	0.1	0.2	0.3	0.3	0.3	0.8					1.4		4.2
Pooling; no set made						0.1	0.6	0.7								
Poor weather	0.9	0.8	1.9	0.9	0.2	0.2	1.5	0.5								
Set too large	0.4	0.4	0.9	0.9	0.3	0.4	0.2	0.1	16.2	3.7	31.9	18.5	0.9	1.6		
Set too small	0.4	0.1	0.2	0.4	0.4	0.7	0.8	0.2	0.1	0.1	0.2	1.1	0.3	1.6	5.5	2.1
Size of fish	3.0	1.0	1.6	1.3	4.2	3.5	3.7	2.3	41.7	2.9	8.1	13.1	42.5	43.2	32.8	60.2
Skunk set	1.8	1.8	1.5	2.2	1.8	4.1	3	2.8		0.3	0.2	0.1				
Tore up	1.3	1.3	1.9	1.5	0.8	1.3	1	0.9	3.1	2.7	4.1	0.8		0.3	10.4	
Unknown reason	2.2	1.6	2.3	2.0	3.2	2.2	0.9	1.2			1.5	5.2	65.9	1	1.4	19.6
Total No. of Observations	2471	1964	2382	2636	1916	2240	2586	2638								
Total Released Catch (t.)									2968	1341	3330	3012	2969	1669	651	854.6

Table 17 Larval herring abundance. Standard index (average no. per m<sup>2</sup> of 7 and adjusted index (corrected for mortality and age/size of larvae).

Year	Cruise	Standard Index		Adjusted Index	
		Mean	SE	Mean	SE
72	P109	9.4	1.80		
73	P127	6.6	1.30		
74	P147	49.5	10.90		
75	P160	12.93	2.57	1042.31	294.41
76	P175	13.5	2.90		
77	P190	6.3	1.00		
78	P207	5.45	2.17	361.47	77.13
79	P232	7.1	2.10		
80	P246	26.2	6.70		
81	P263	3.12	0.40	362.13	63.84
82	P280	12.57	2.10	591.09	107.84
83	P298	16.02	3.36	1037.17	363.78
84	P315	12.68	2.13	411.02	56.40
85	P329	54.88	9.25	824.26	96.76
86	P344	20.93	3.03	1241.66	168.75
87	P361	35.07	9.01	441.24	58.59
88	P377	99.46	22.82	870.83	109.37
89	P391	55.16	11.30	1060.25	208.87
90	P408	27.23	7.60	435.30	65.59
91	P422	45.48	7.50	1038.88	136.02
92	P437	57.88	11.18	1397.83	304.25

Table 18. An index of herring by-catch (stratified mean number per tow) in summer groundfish research surveys of 4WX, strata 52-95, 1970-1992; (N = number per set for all sets) (N<sup>h</sup> = number per set for sets with herring).

Year	Cruise	Date	Total sets (n)	No. sets with herring	Total herring	No./set (N)	No./set (N <sup>h</sup> )	Stratified mean no./tow	SE
1970	A175-176	06-30/07	95*	23	383.82	4.13	16.69	4.07	1.54
1971	A188-189	29/06-22/07	86*	23	296.88	3.49	12.91	3.97	1.87
1972	A200-201	23/06-19/07	105	23	117.41	1.12	5.10	1.37	0.62
1973	A212-213	09/07-02/08	96	20	77.08	0.80	3.85	0.92	0.31
1974	A225-226	09/07-03/08	102*	15	54.77	0.54	3.65	0.72	0.25
1975	A236-237	15/07-06/08	104	12	131.09	1.26	10.92	0.89	0.36
1976	A250-251	12/07-05/08	103*	10	53.43	0.52	5.34	0.36	0.20
1977	A265-266	09/07-30/08	106	9	81.54	0.77	9.06	0.54	0.30
1978	A279-280	09-31/07	103*	4	32.03	0.31	8.01	0.34	0.32
1979	A292-293	06-27/07	106*	5	71.06	0.68	14.21	0.64	0.46
1980	A306-307	07-27/07	105	3	93.51	0.89	31.17	0.54	0.51
1981	A321-322	04-25/07	104	4	195.05	1.88	48.76	1.51	1.35
1982	H080-081	10-30/07	108	14	130.44	1.21	9.32	1.54	0.90
1983	N012-013	05-27/07	106	25	230.95	2.18	9.24	2.36	0.80
1984	N031-032	01/07-02/08	102	31	678.06	6.65	21.87	6.98	3.53
1985	N048-049	04-25/07	111	19	418.58	3.77	22.03	3.38	1.83
1986	N065-066	07-17/07	118	36	2152.13	18.24	59.78	23.20	14.92
1987	N085-087	29/07-06/08	135	33	2118.70	15.69	64.20	10.35	5.56
1988	N105-106	04-27/07	127	31	280.90	2.21	9.06	2.08	0.62
1989	N123-124	05-27/07	124	46	939.52	7.58	20.42	8.35	1.78
1990	N139-140	03/07-31/08	156*	46	779.44	5.03	16.94	5.56	1.88
1991	N154/H231	04-28/07	137	45	1149.95	8.39	25.55	10.64	5.81
1992	N173/N174	23/06-17/07	139	53	4037.08	29.25	76.17	29.04	8.72
1992	N173/N174	w/o Strat.93	136	50	1440.74	10.59	28.81	16.46	4.85

\*Total includes strata with only one set.

Table 19. Herring by-catch age composition in summer groundfish research surveys.

Year	Percent Nos. by AGE												Total
	1	2	3	4	5	6	7	8	9	10	11-17	99	
87	0.0	9.7	35.3	26.2	10.2	8.0	4.2	3.1	1.8	0.6	0.8	0.0	100
88	0.0	13.0	5.9	17.2	34.9	20.4	4.7	1.6	0.4	0.5	0.4	0.9	100
89	2.5	2.8	4.4	10.0	12.8	36.3	22.7	4.3	1.1	0.7	0.8	1.4	100
90	1.8	4.6	11.6	14.5	12.3	13.1	24.0	13.5	2.2	0.5	1.1	0.7	100
91	0.0	0.8	4.3	14.1	17.6	10.5	14.9	25.3	8.8	2.3	1.3	0.1	100
92a	0.0	39.7	4.6	6.2	9.5	14.1	7.2	6.5	8.9	1.9	1.2	0.3	100
92b	0.0	0.1	2.0	9.9	16.8	25.2	12.9	11.6	16.0	3.5	2.1	0.0	100

Year	Stratified Total Numbers by AGE (thousands)												Total
	1	2	3	4	5	6	7	8	9	10	11-17	99	
87	14	3060	11187	8306	3236	2539	1336	983	562	206	267	0	31697
88	0	830	377	1095	2222	1298	298	104	28	34	26	56	6368
89	634	720	1122	2561	3274	9293	5821	1109	291	184	213	367	25588
90	291	753	1911	2400	2035	2164	3966	2225	363	84	188	119	16500
91	0	273	1397	4614	5734	3418	4874	8245	2865	739	435	23	32618
92a	0	35118	4038	5458	8423	12490	6349	5708	7920	1715	1033	238	88489
92b	0	52	975	4903	8287	12460	6349	5708	7920	1715	1033	0	49400

92a. All strata used.

92b. Strata 93 (sets 36,37,38) with large catches of juveniles removed.

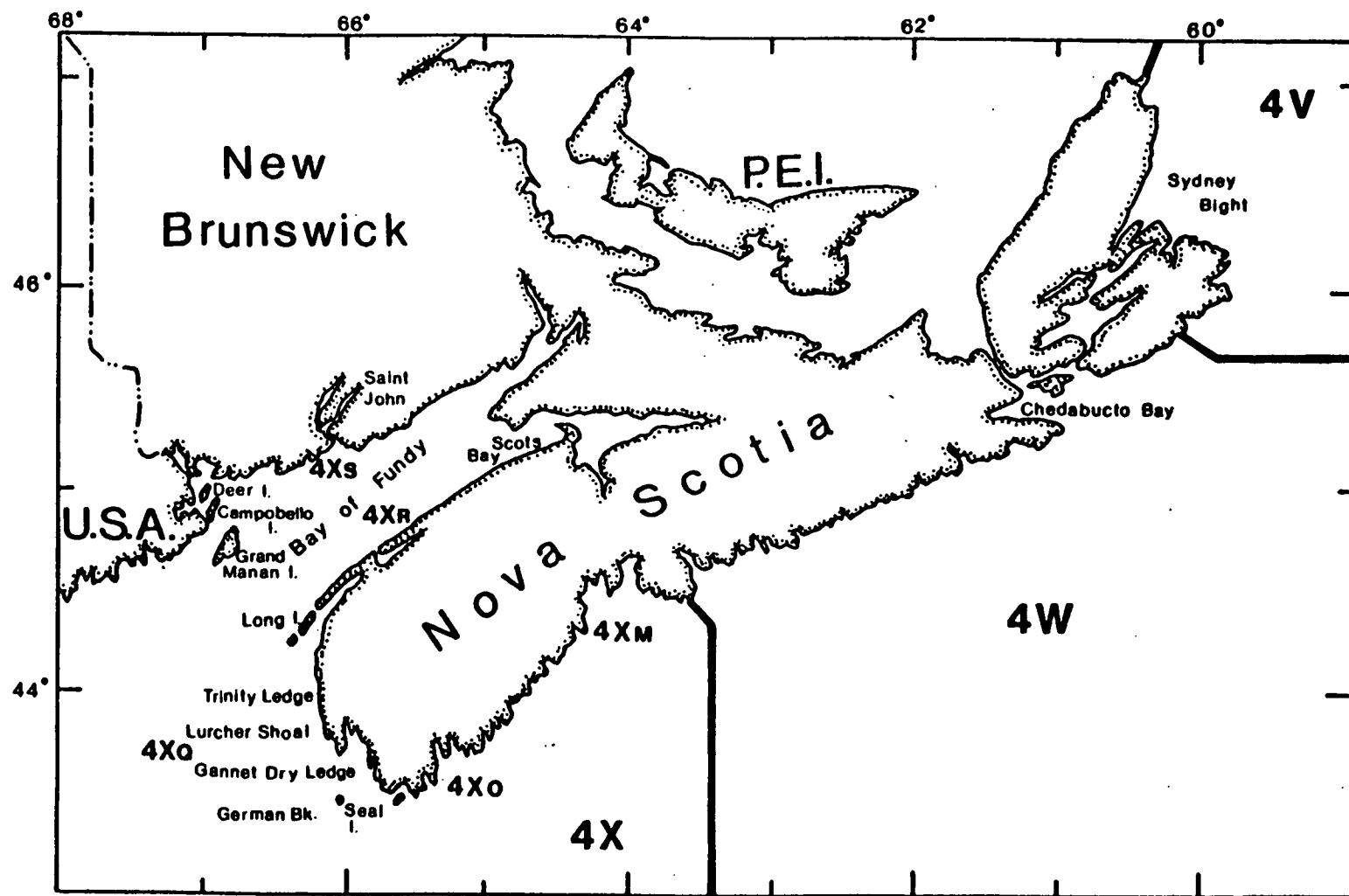


Fig. 1. Map of division 4WX showing major locations mentioned in text.

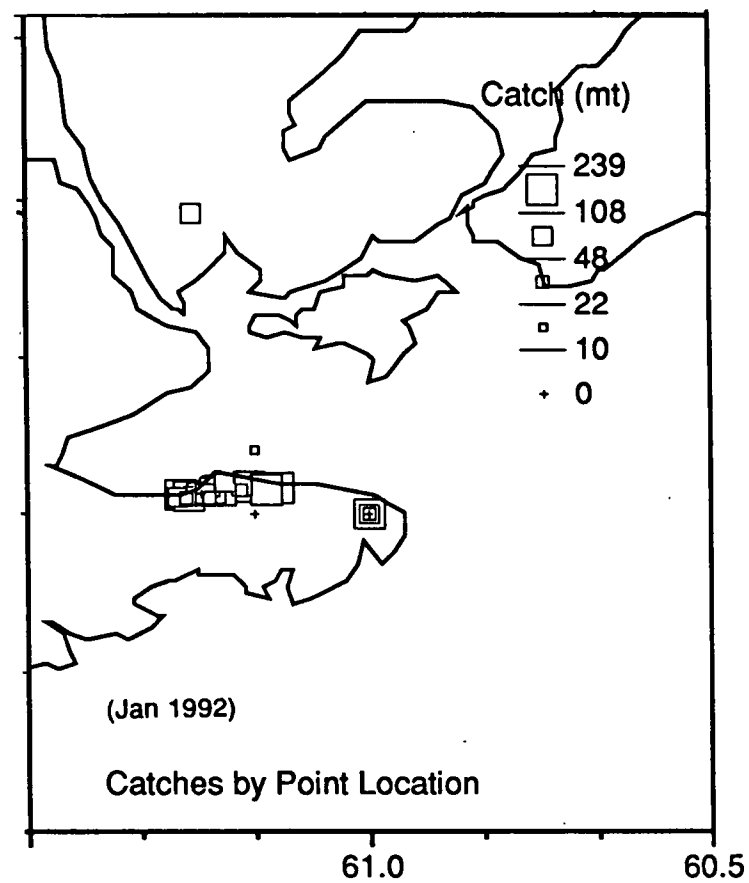
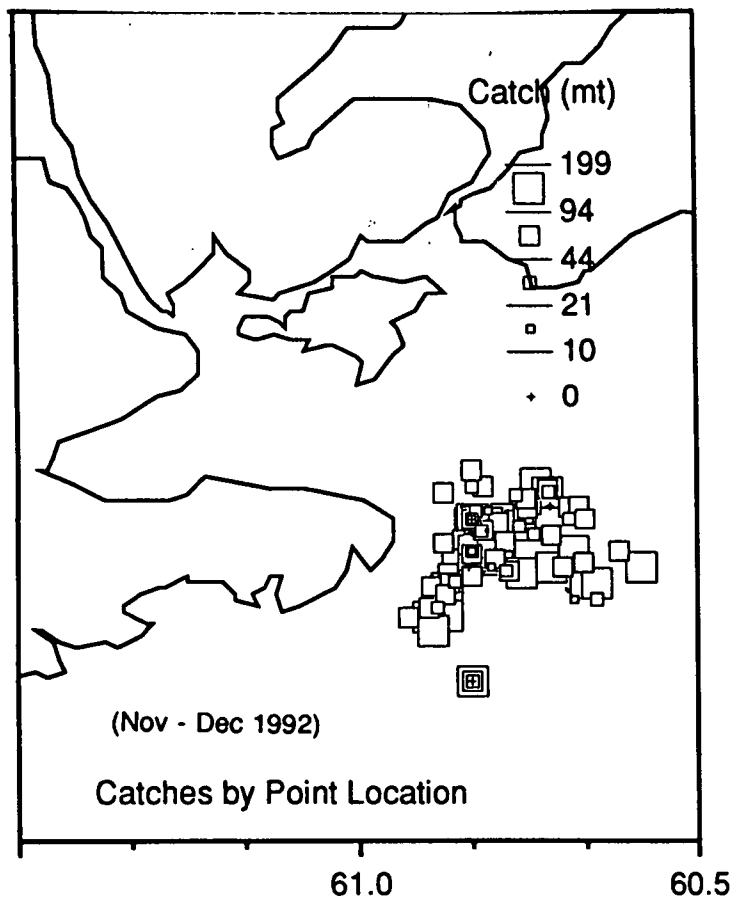


Fig. 2a. 1991-1992 4W Chedabucto Bay purse seine fishery catches by point location for fall 1991 and winter 1992.

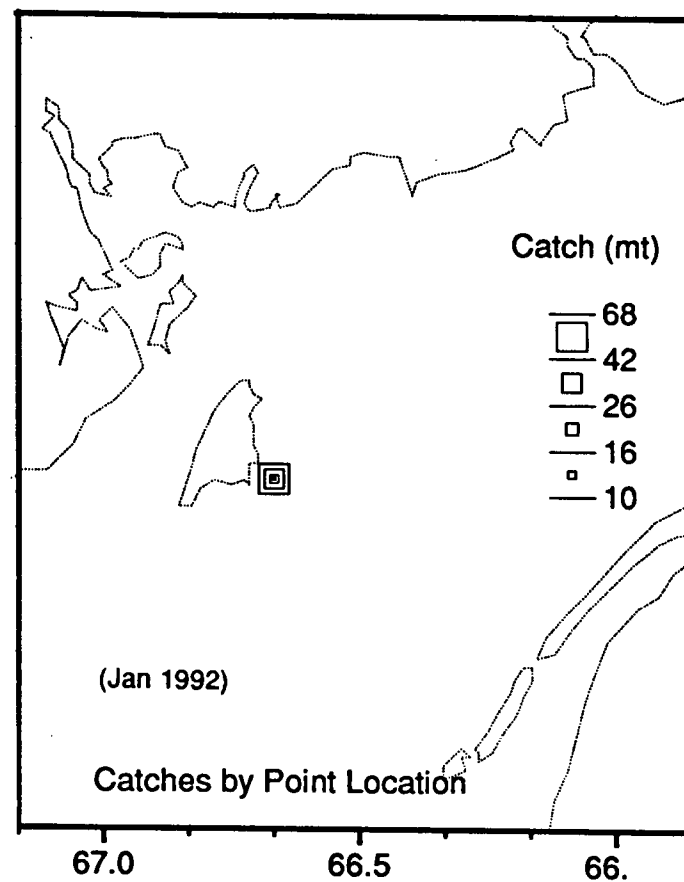
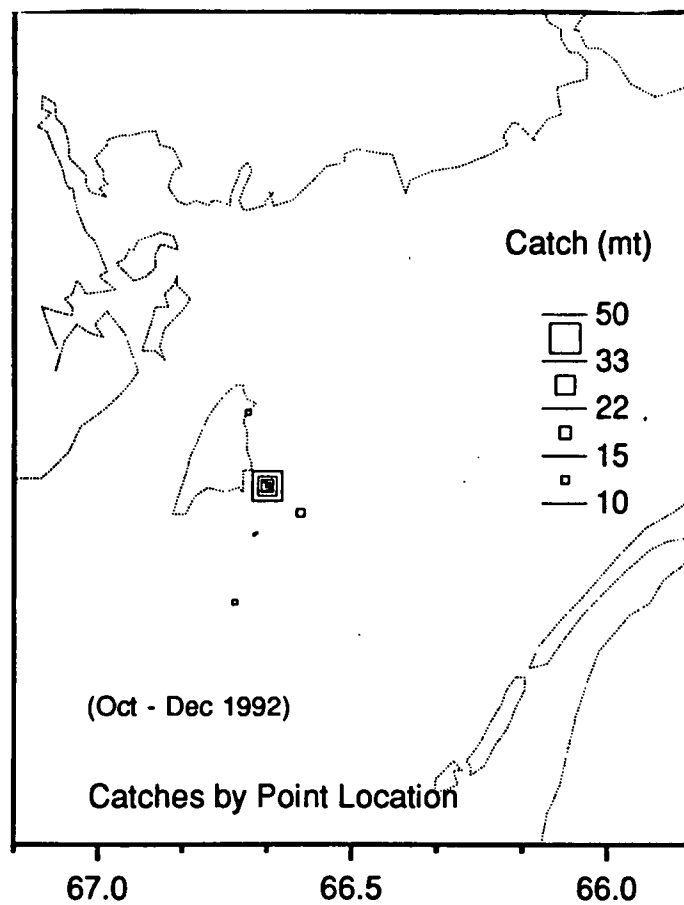


Fig. 2b. 1991-1992 4X New Brunswick purse seine fishery catches by point location for fall 1991 and winter 1992.

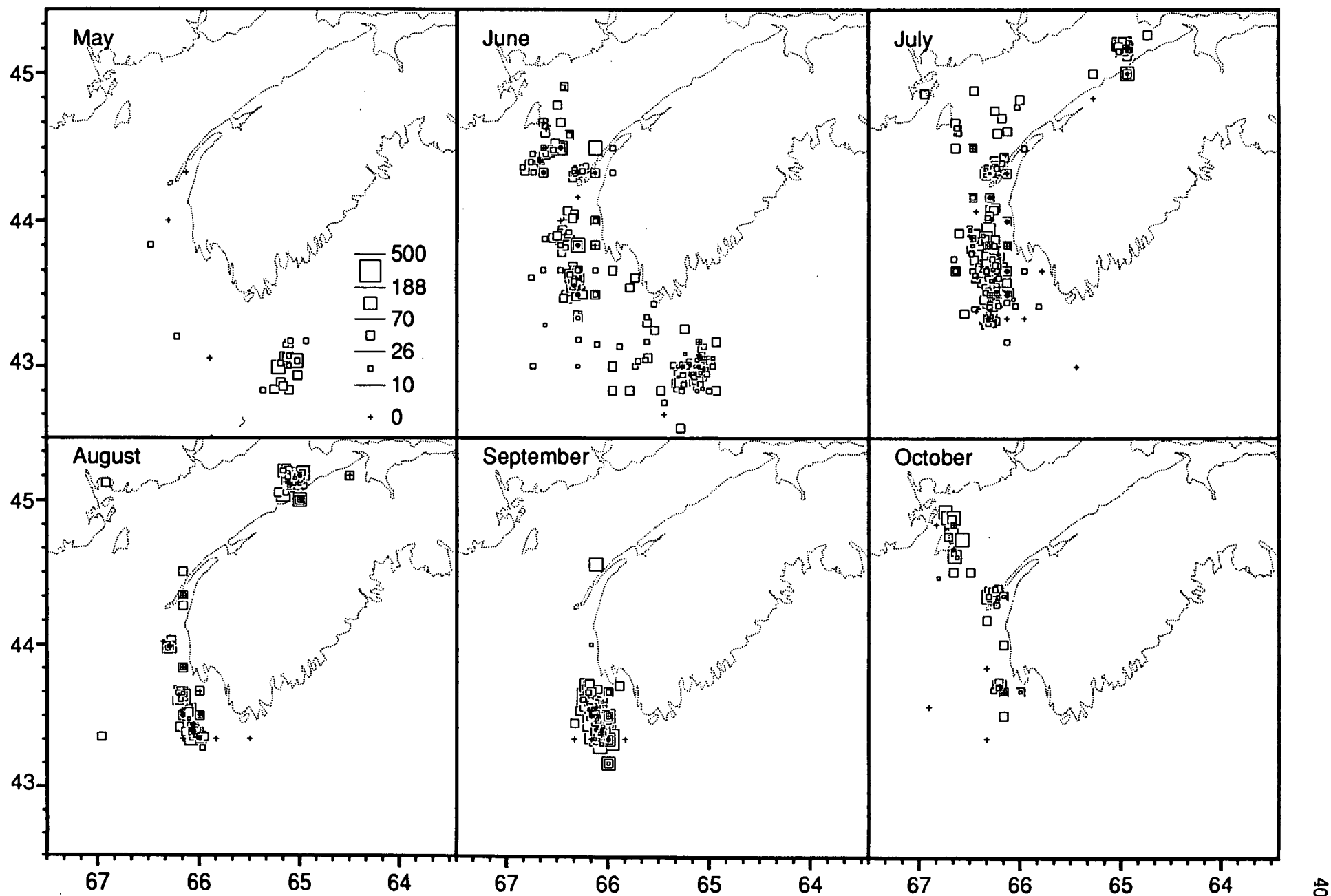


Fig. 2c. 1992 4X N.S. summer purse seine fishery monthly catch distribution by point location of catch.



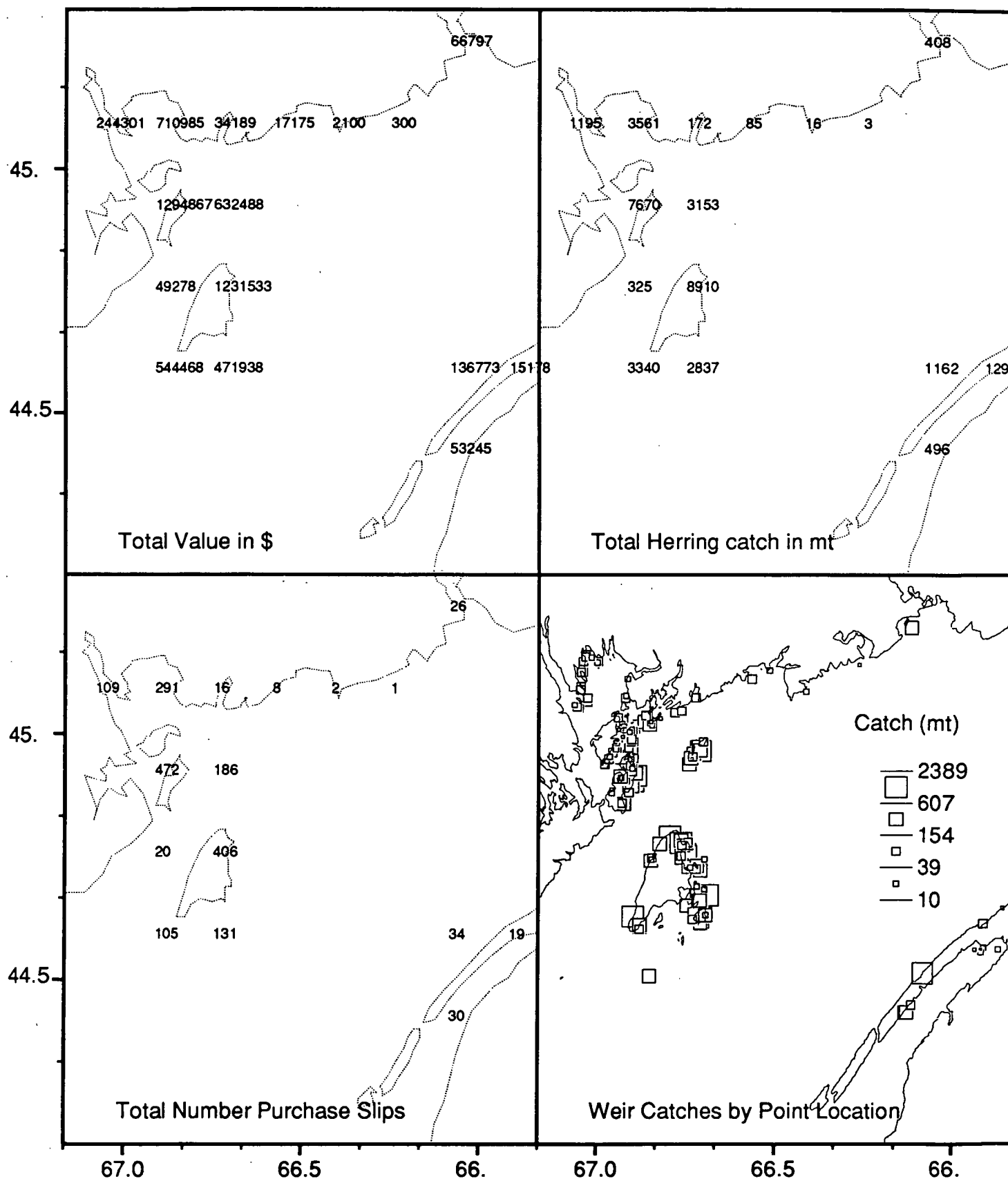


Fig. 2d. 1992 4X New Brunswick and Nova Scotia weir catch distribution by 10 mile squares and point location of catch.

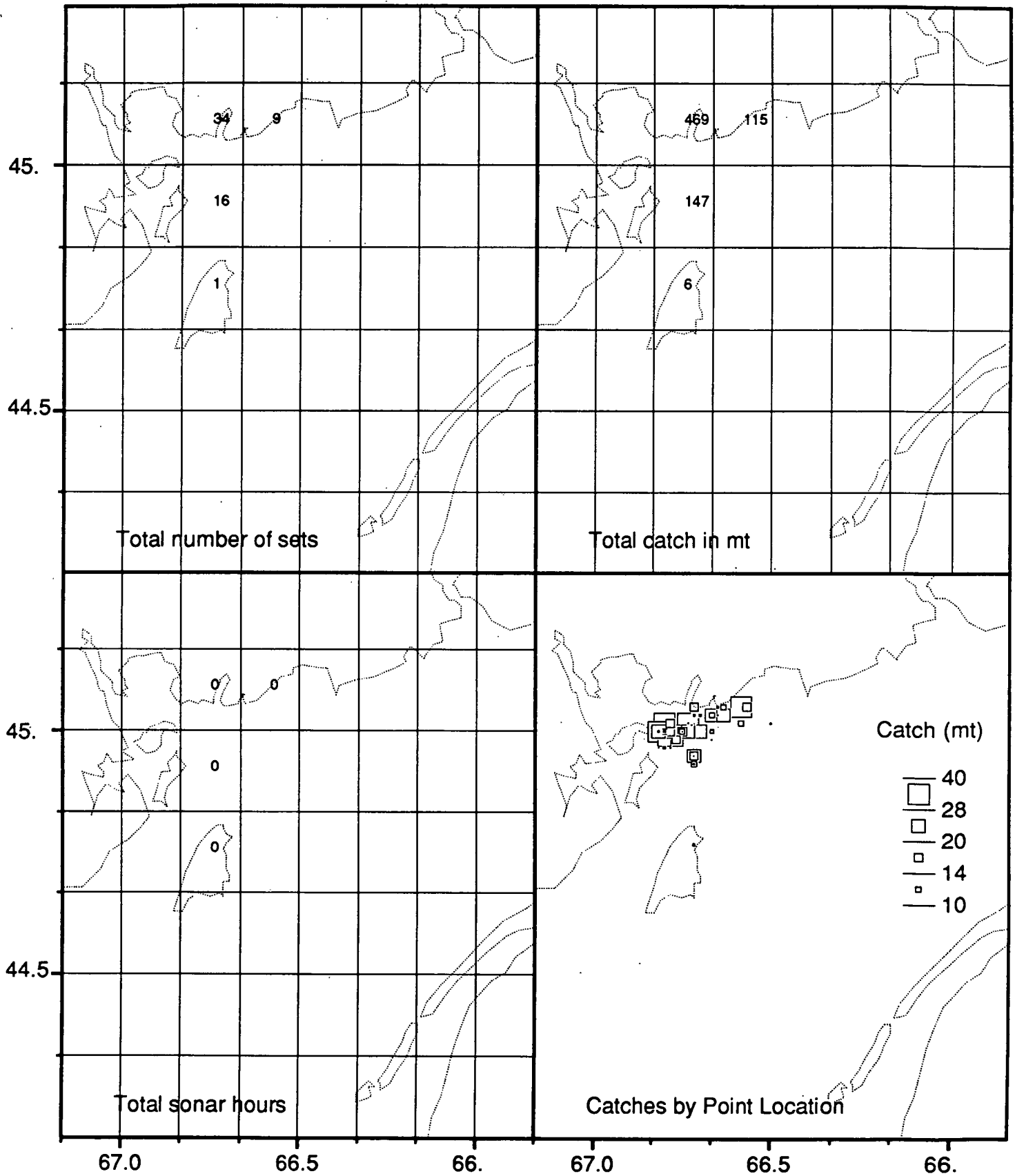


Fig. 2e. 1992 4X New Brunswick midwater trawl catch distribution by 10 mile squares and point location of catch.

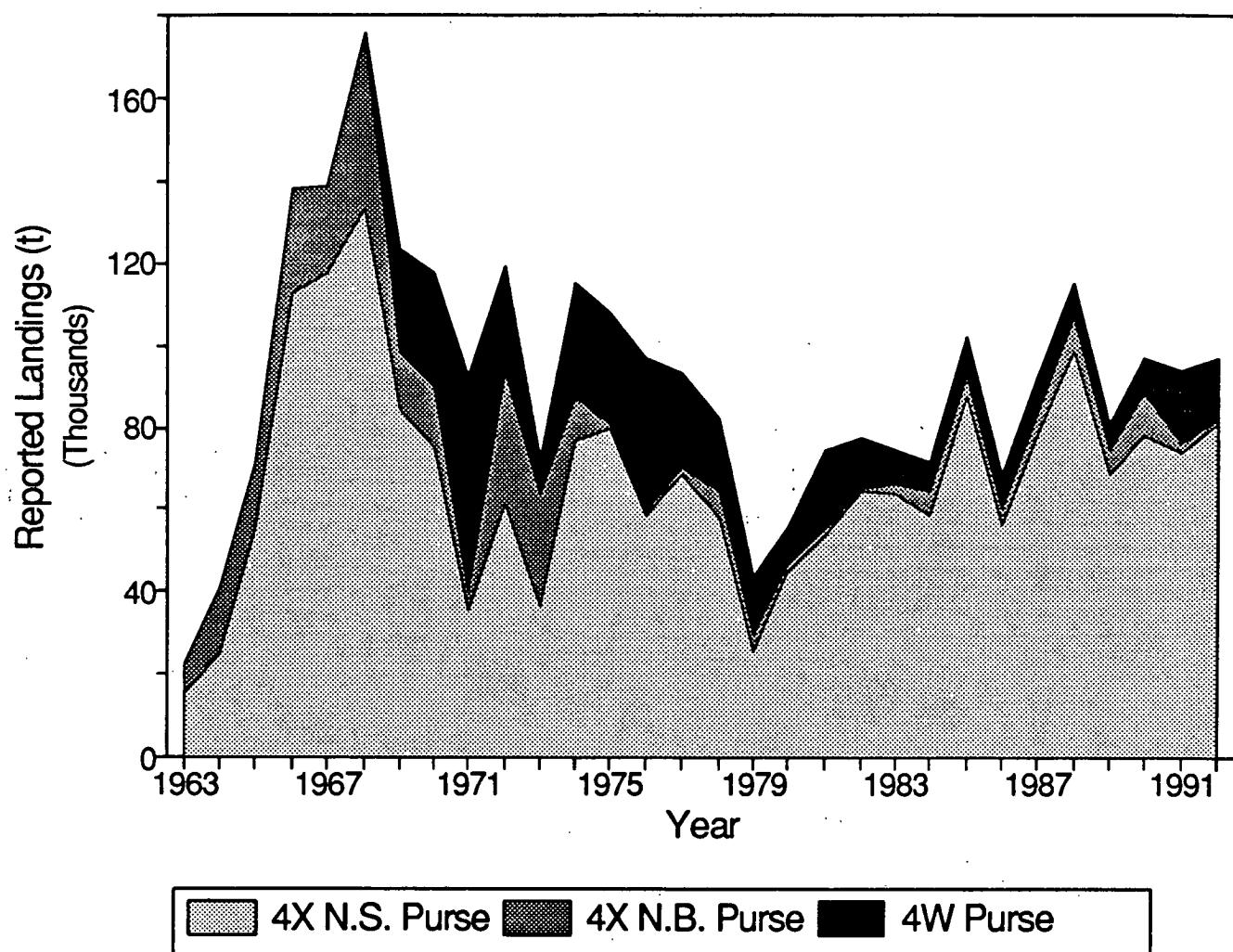


Fig. 3a. Historical series of reported herring landings for 4WX herring purse seine gear components; 1963-1992.

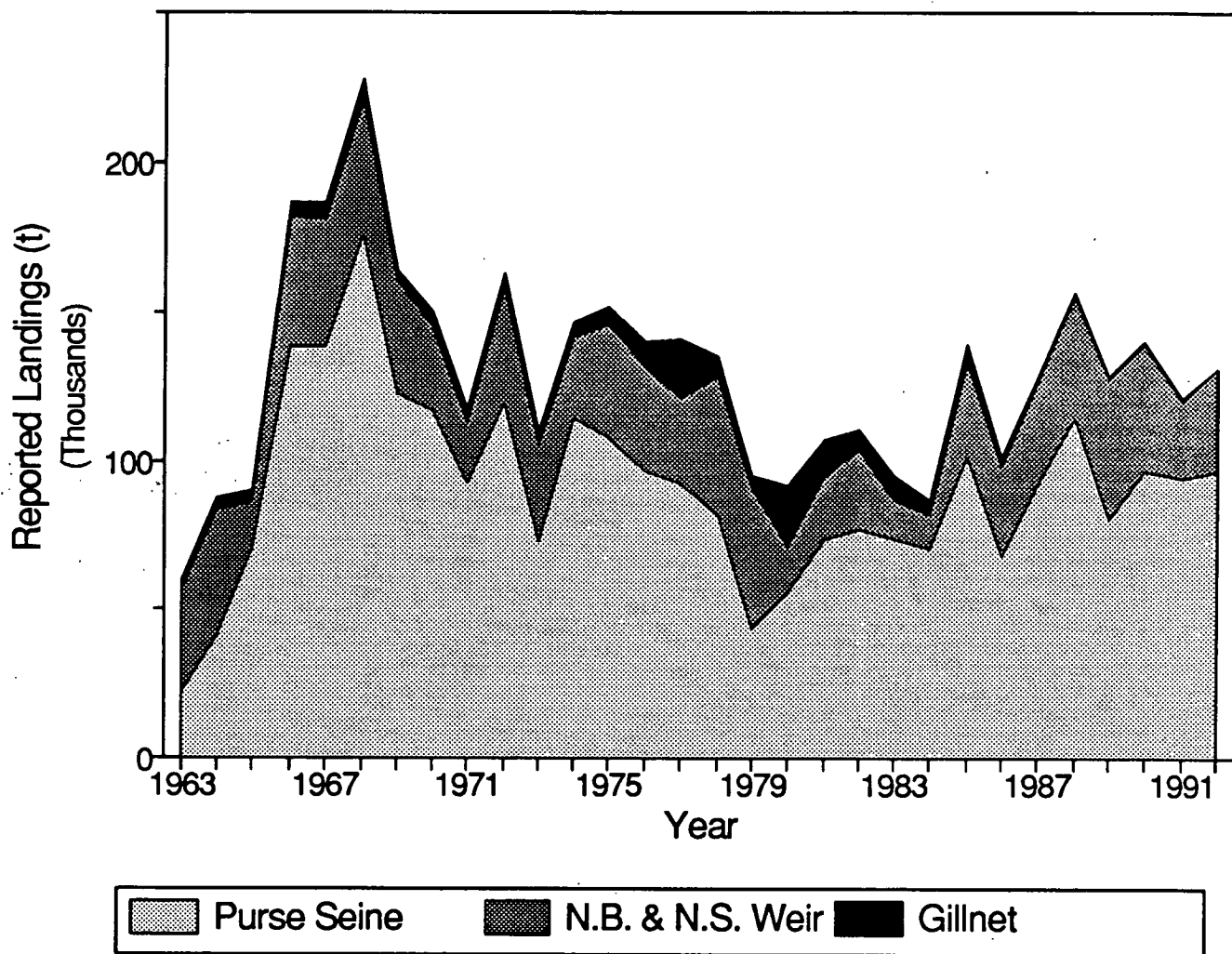


Fig. 3b. Historical series of reported herring landings for major gear components of the 4WX herring fishery; purse seine, weir (N.B. and N.S. combined) and gillnet; 1963-1992.

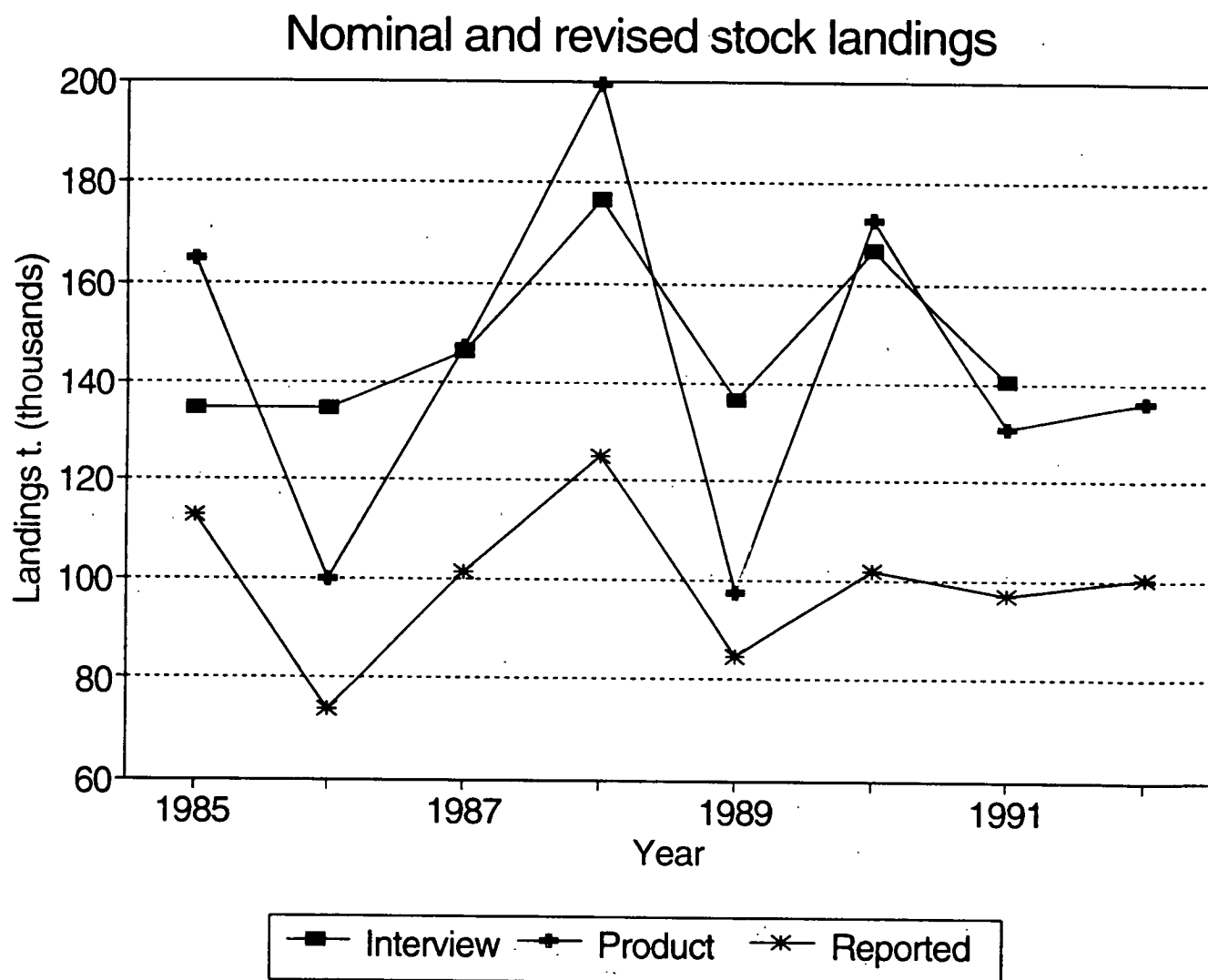


Fig. 4. Comparison of interview and product revised estimated stock landings with nominal (reported) landings - 1985 to 1992.

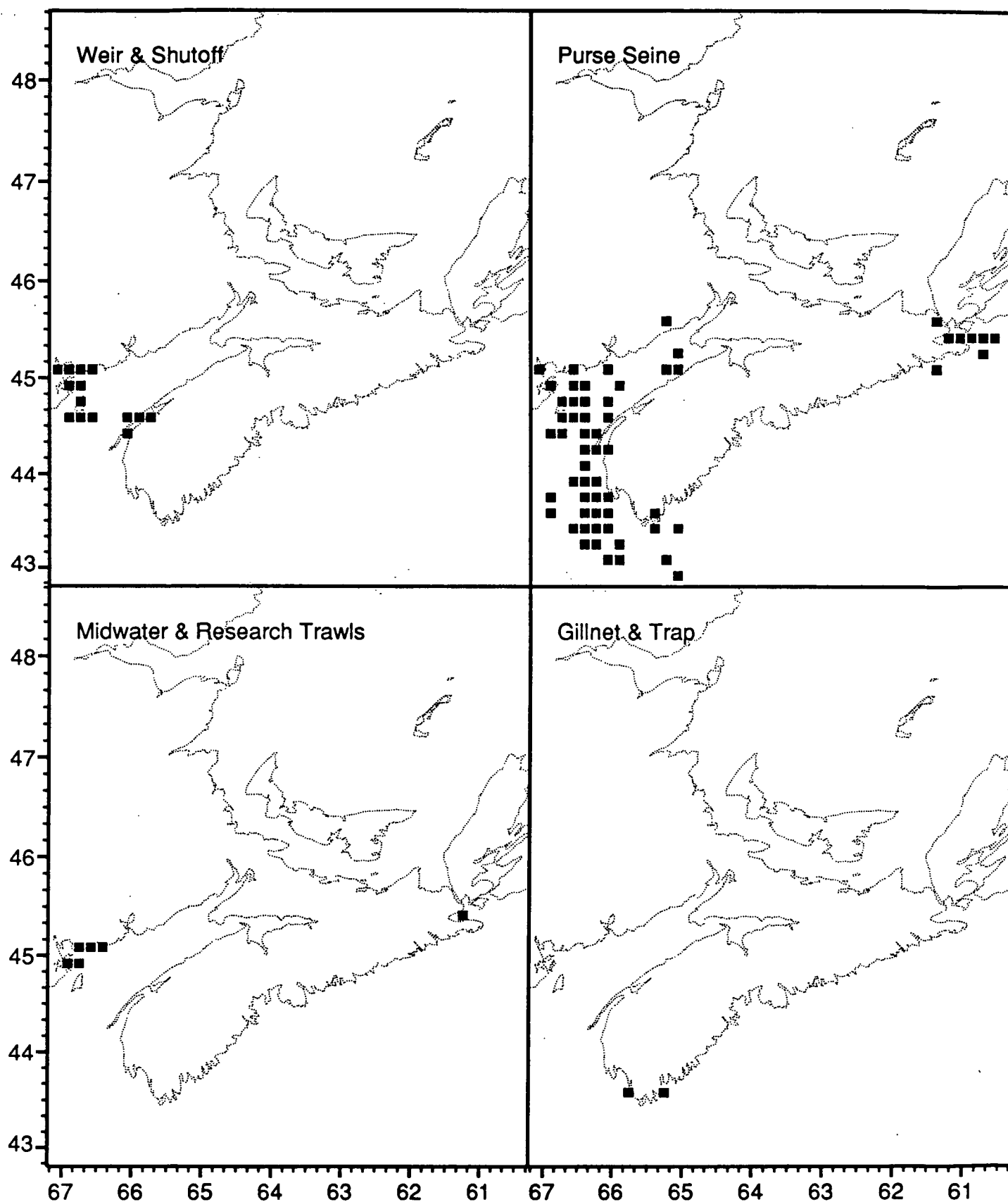


Fig. 5. Geographical distribution of biological sampling of the 1992 4WX herring fishery by gear component (resolution = 10 minute square).

### Catch Weight at age for 4WX stock gears

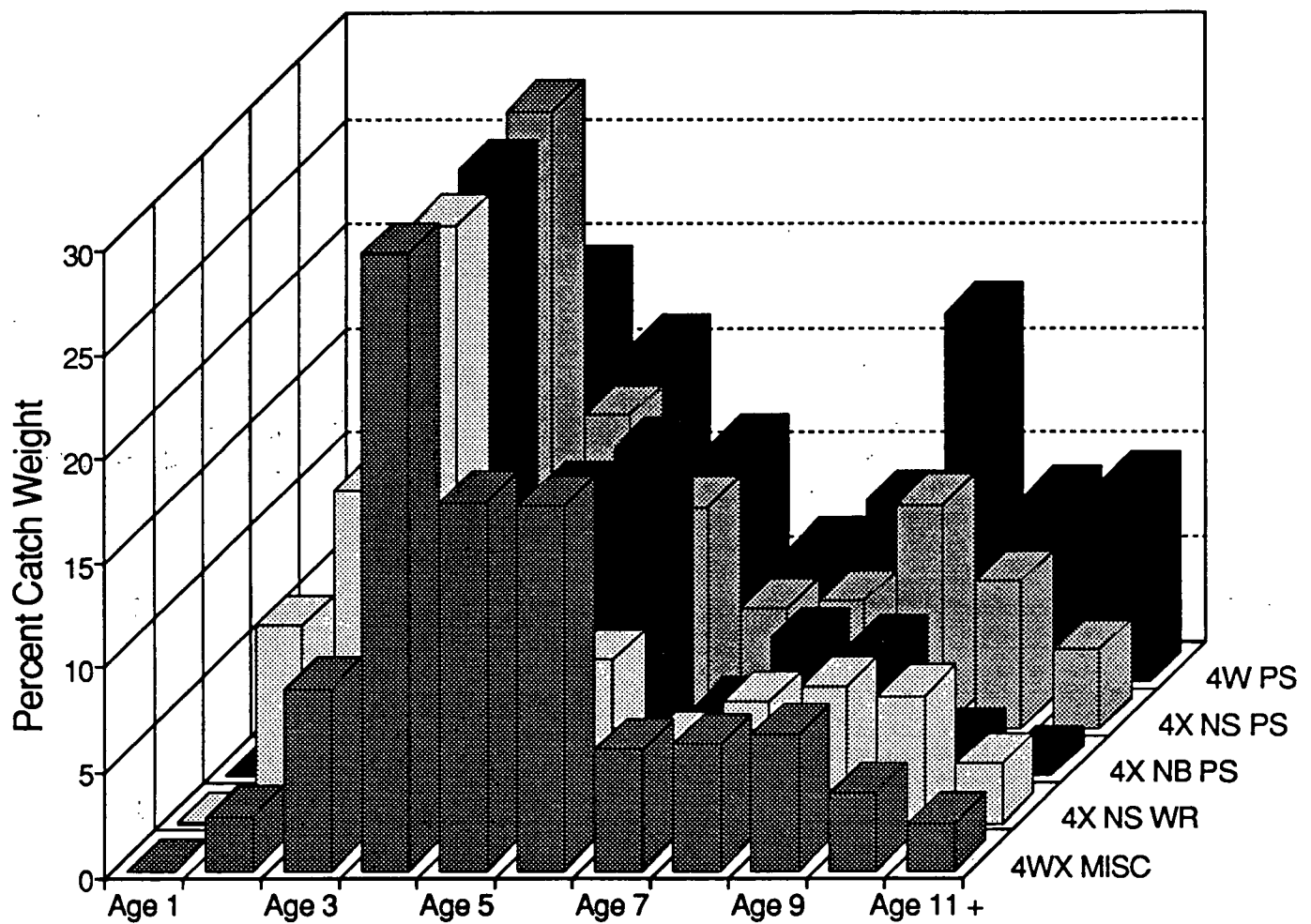


Fig. 6a. Catch at age (% catch weight in t.) for stock gear components of the 1992 4WX herring fishery.

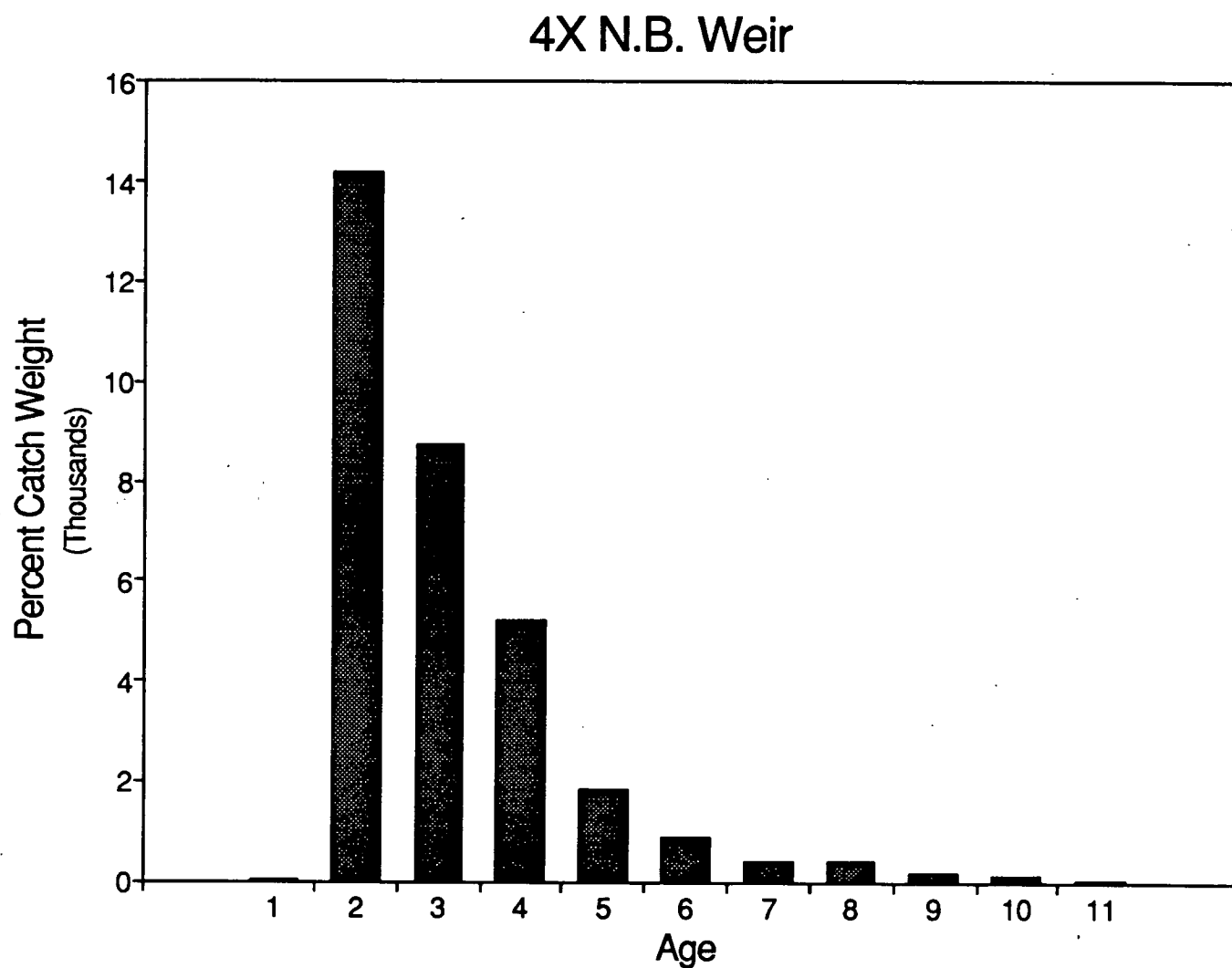


Fig. 6b. Catch at age (% catch weight in t.) for non-stock gear components of the 1992 4WX herring fishery.



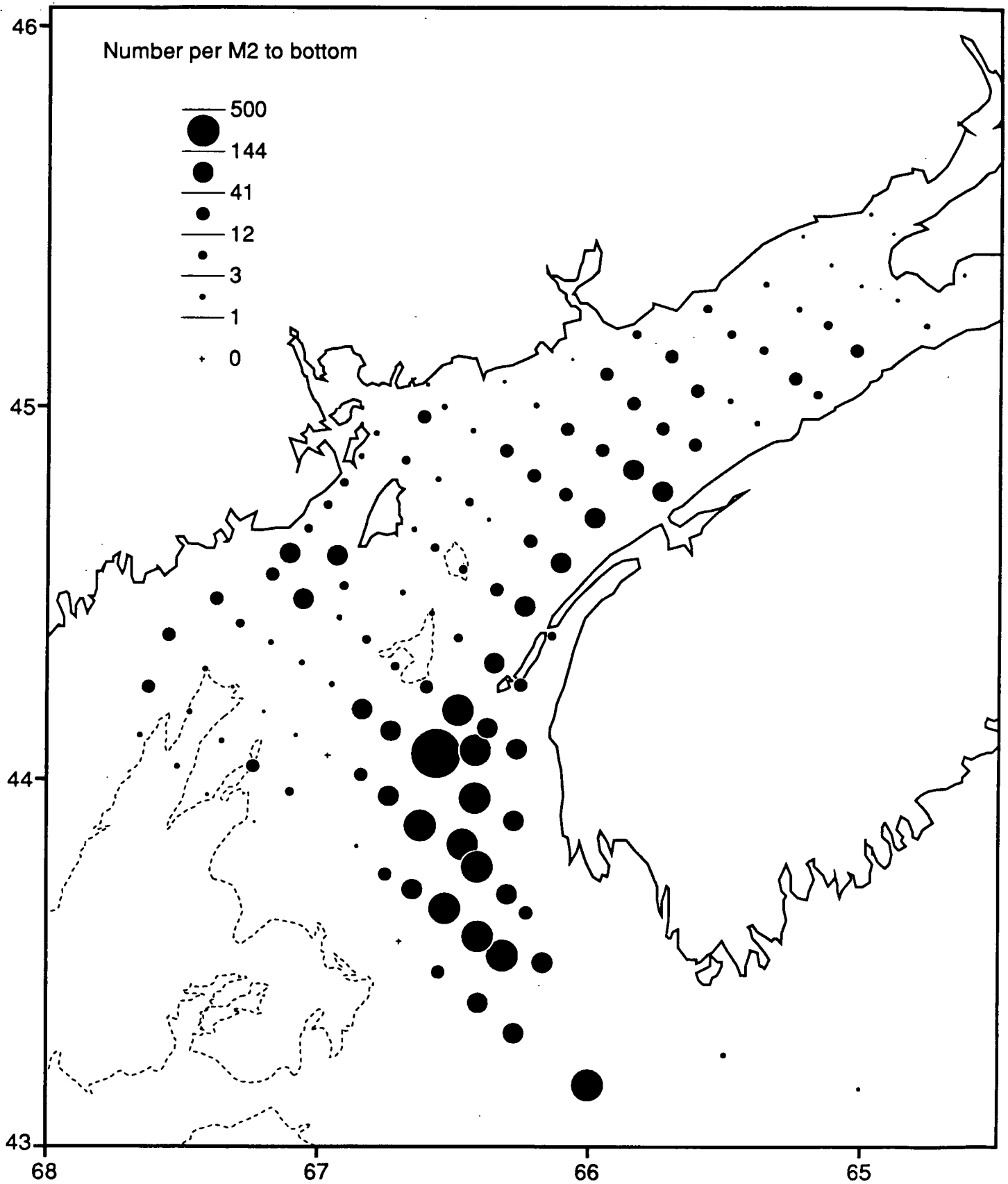


Fig. 7. Larval herring abundance (numbers per m<sup>2</sup> to bottom) by station for EEP-437 larval herring survey (Nov. 1992).

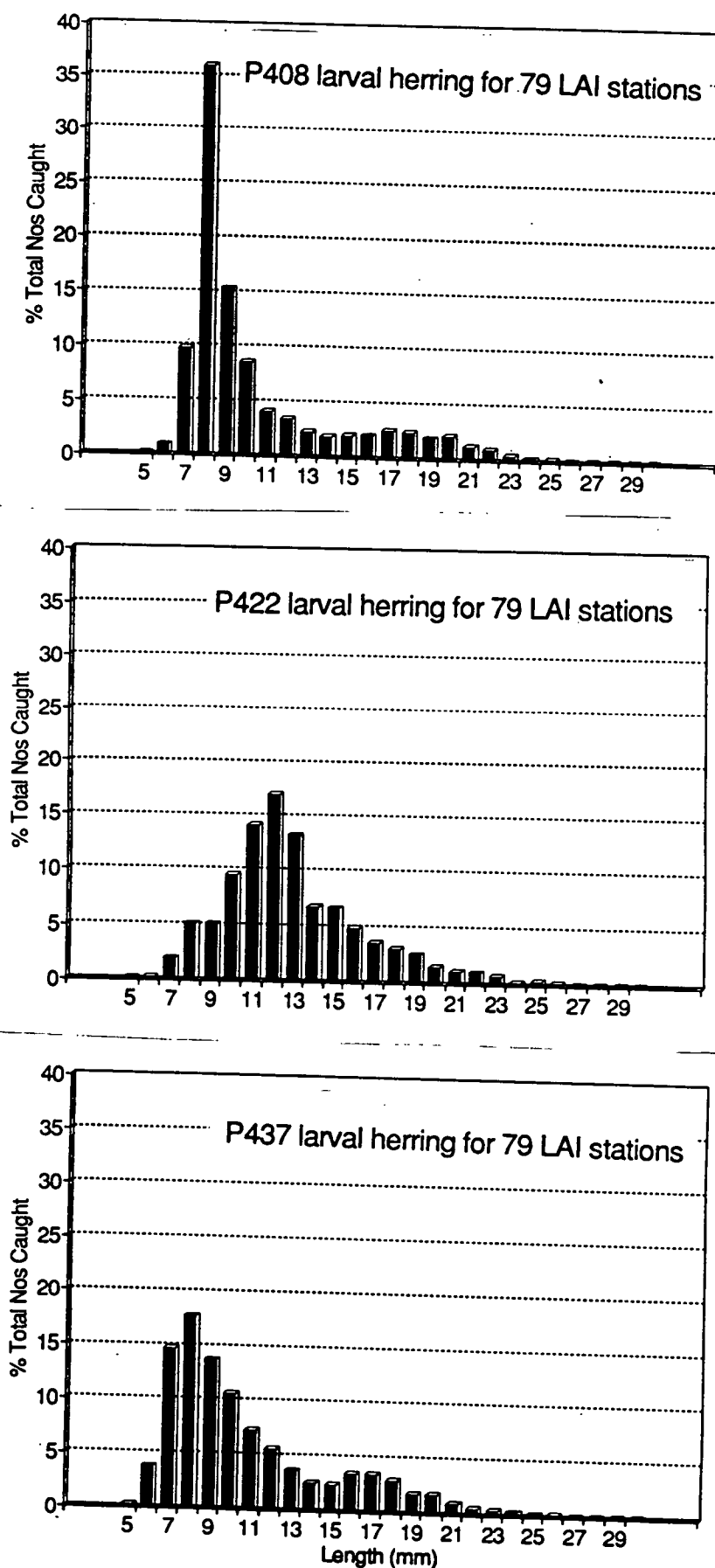


Fig. 8. Larval herring length frequency distributions (% total nos. caught) for three most recent surveys using only data for standard index grid of 79 stations.

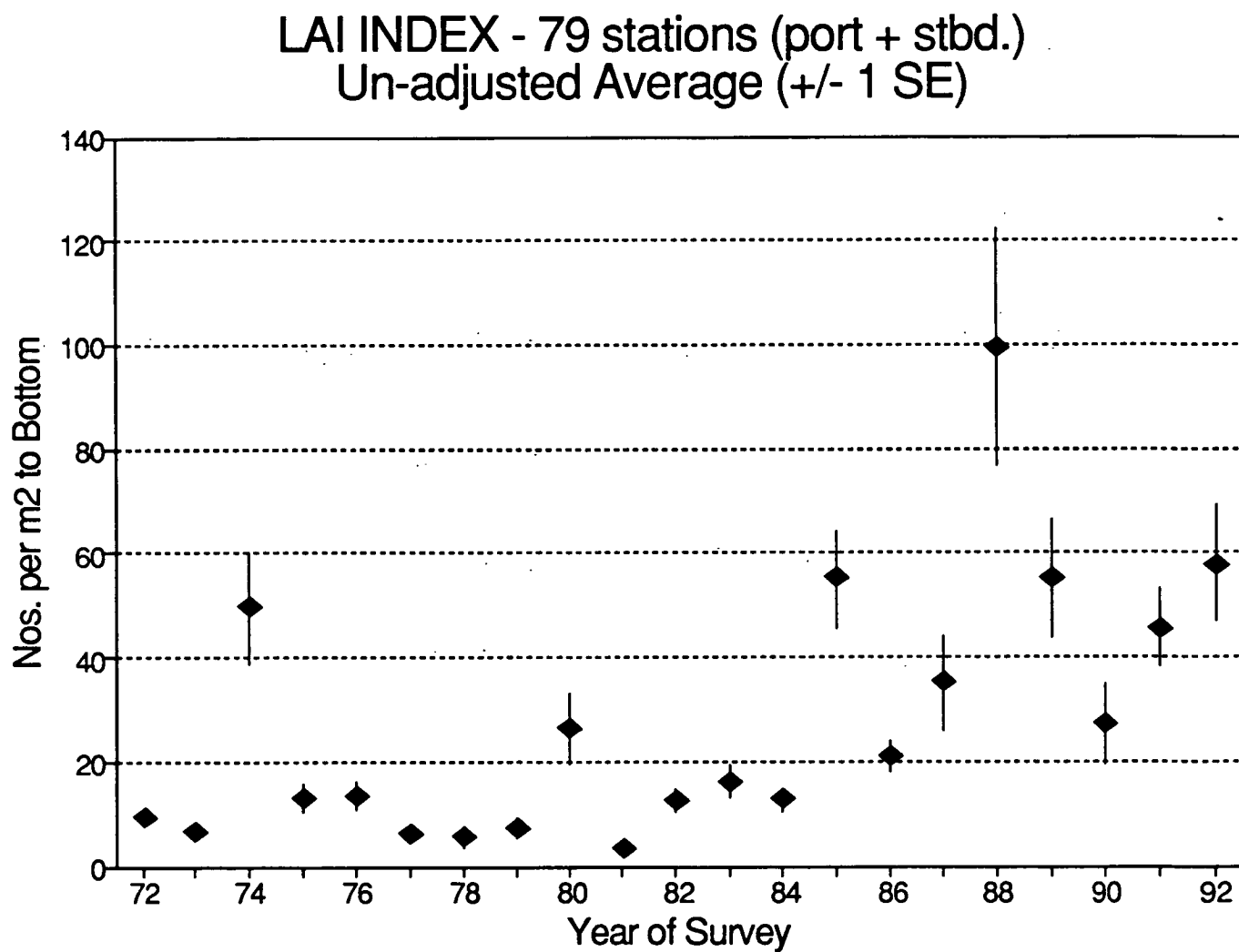


Fig. 9a. Larval herring abundance index (mean number of larvae per m2 to bottom for the 79 index stations sampled in November) for 4WX herring, 1972-92.

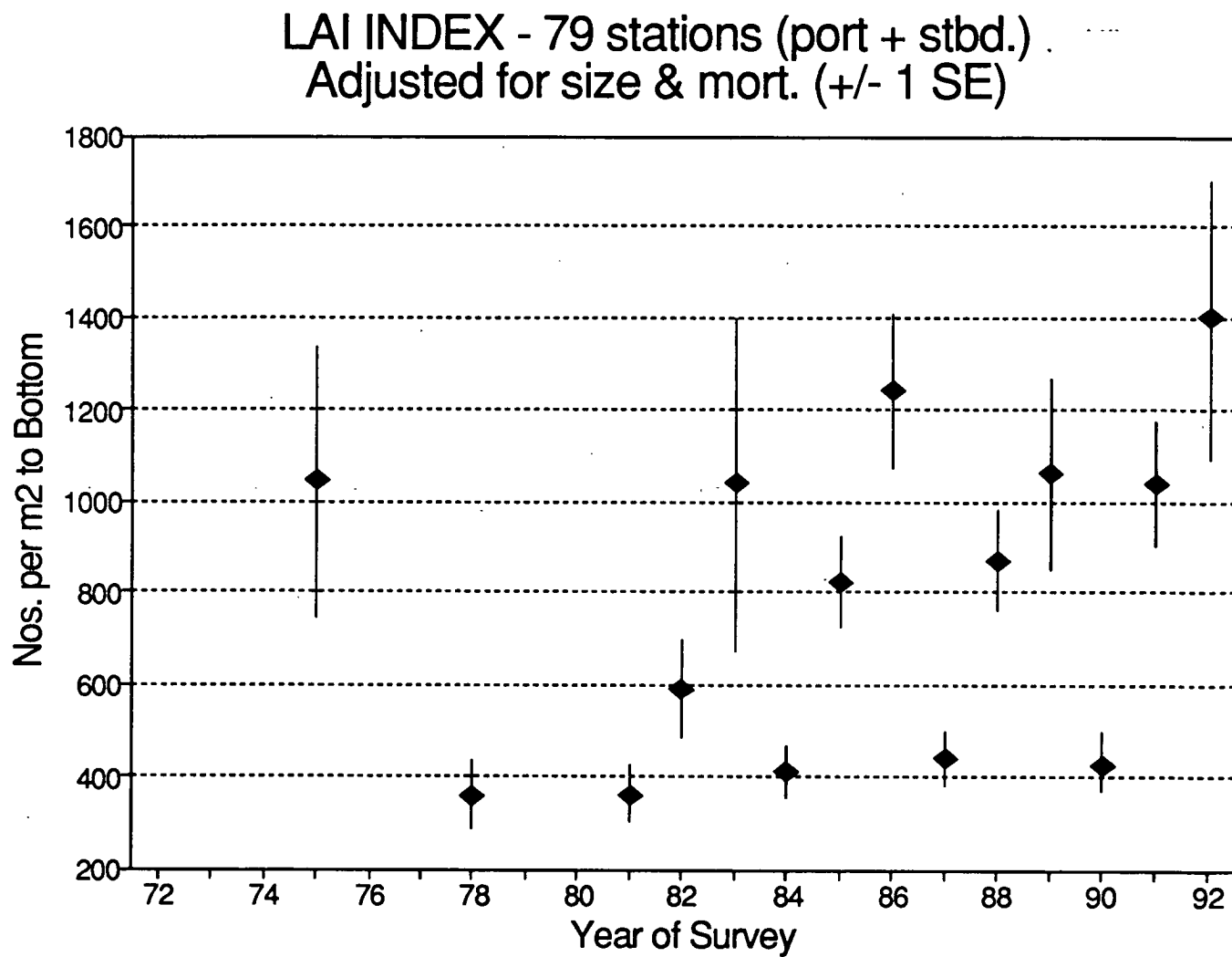


Fig. 9b. Length and mortality adjusted ( $Z=0.07$ , growth rate=0.24 mm d<sup>-1</sup>) larval herring abundance index (mean number of larvae per m<sup>2</sup> to bottom for the 79 index stations sampled in November) for 4WX herring, 1972-92.

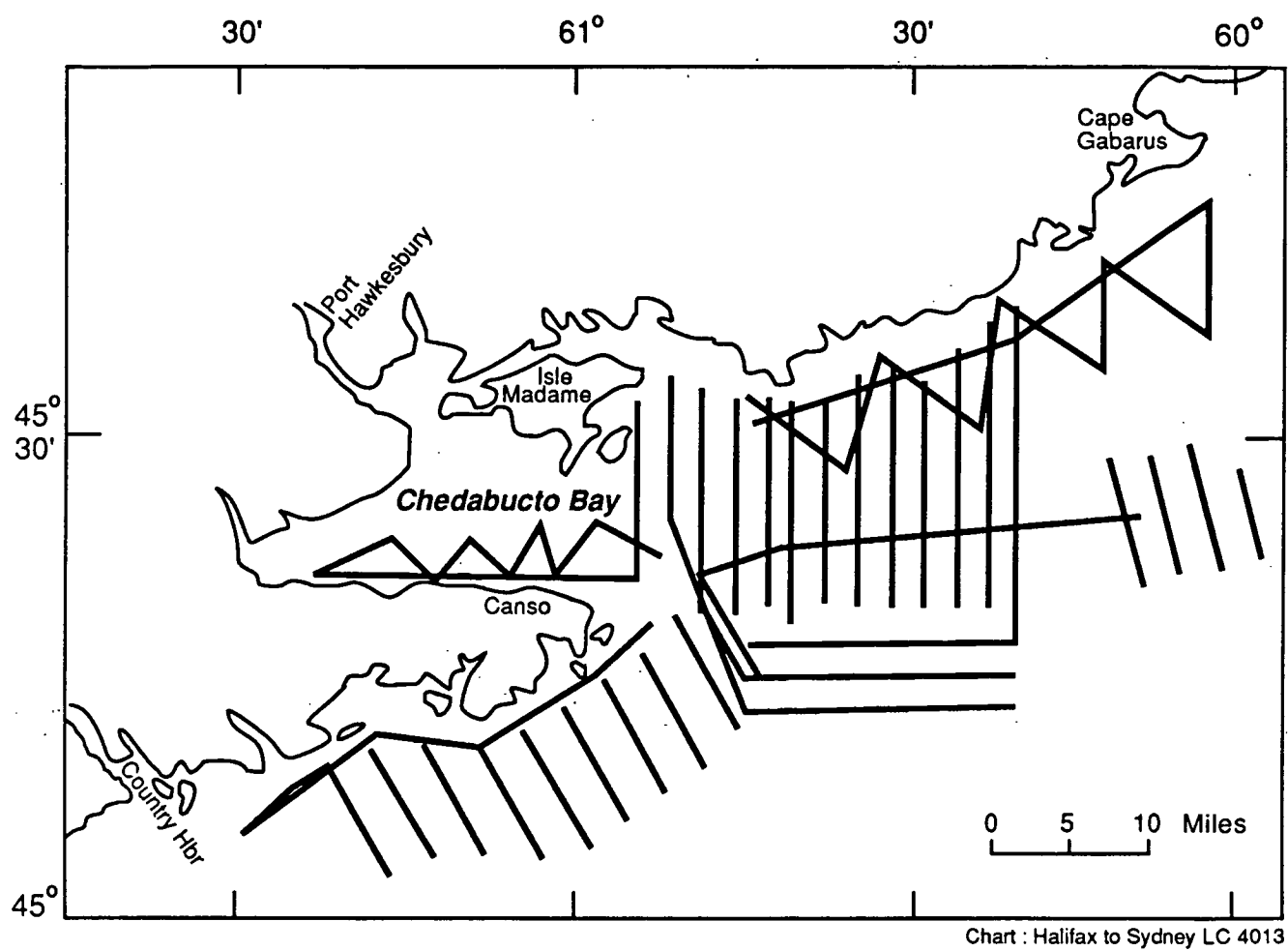


Fig. 10. Survey tracks for 4W Chedabucto Bay acoustic survey; Jan. 1993.

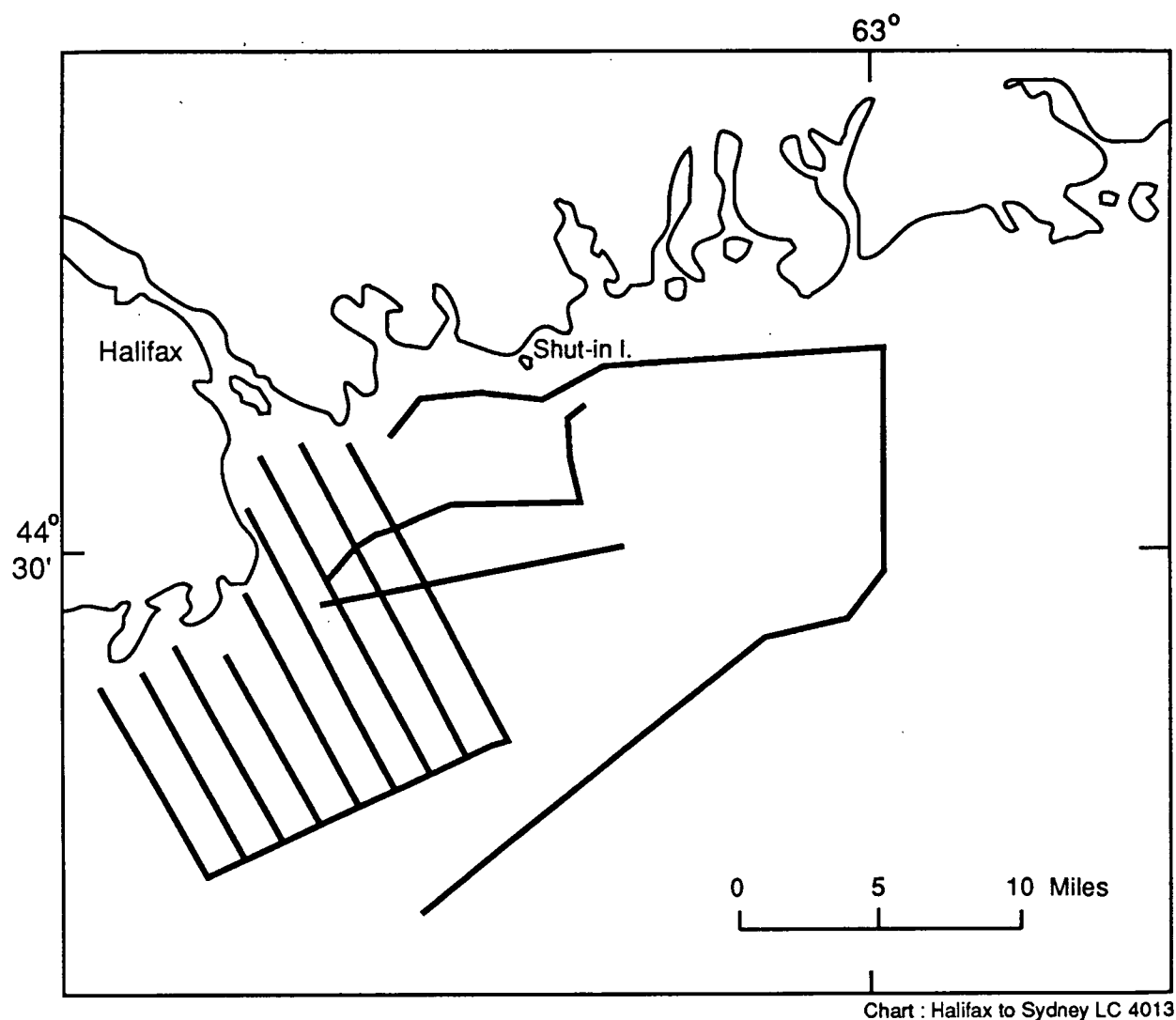


Fig. 11. Survey tracks for acoustic survey off Halifax; Jan. 1993.

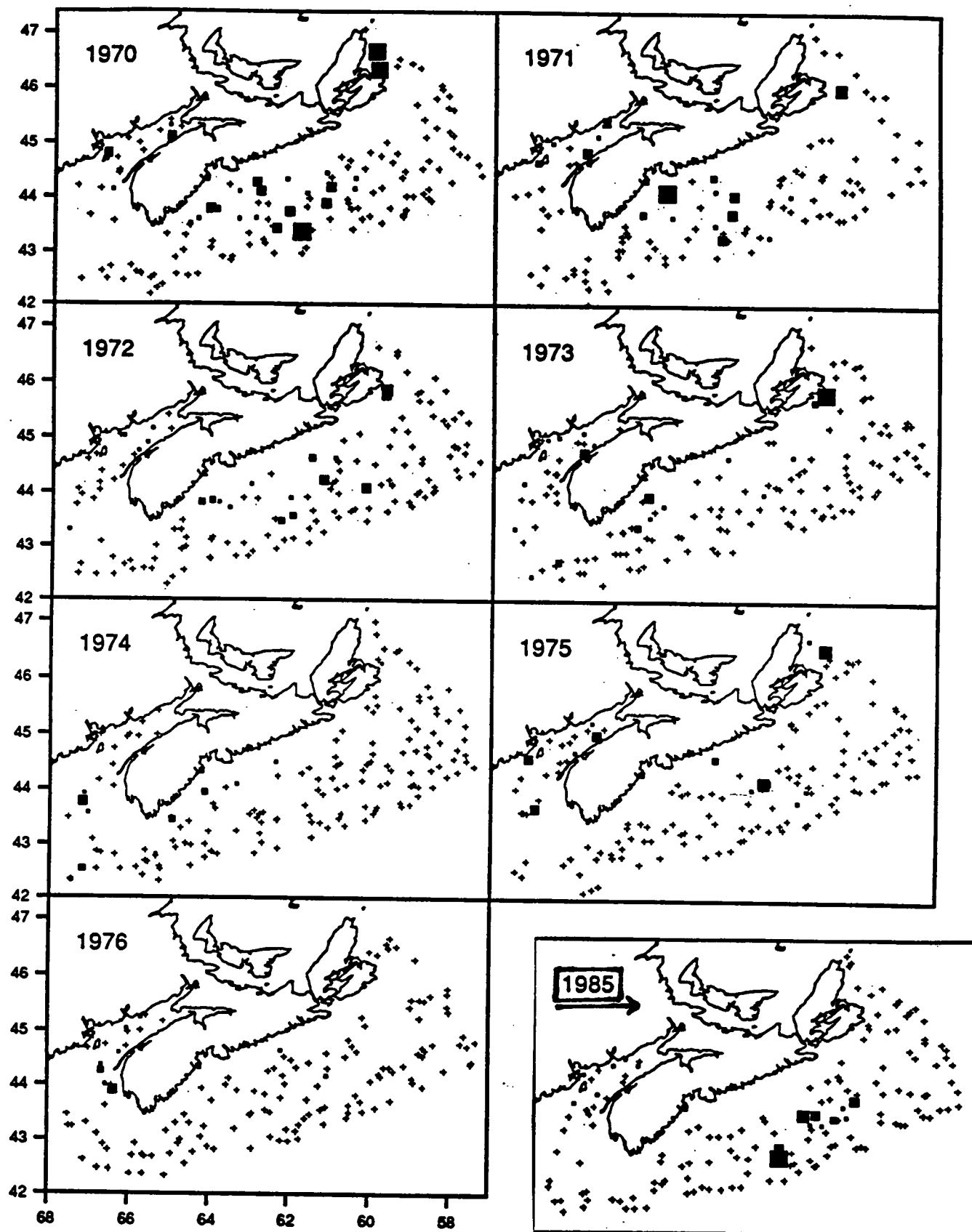


Fig. 12a. Occurance of herring (number per tow) in summer research groundfish survey (bottom trawl) sets, 1970-1992.

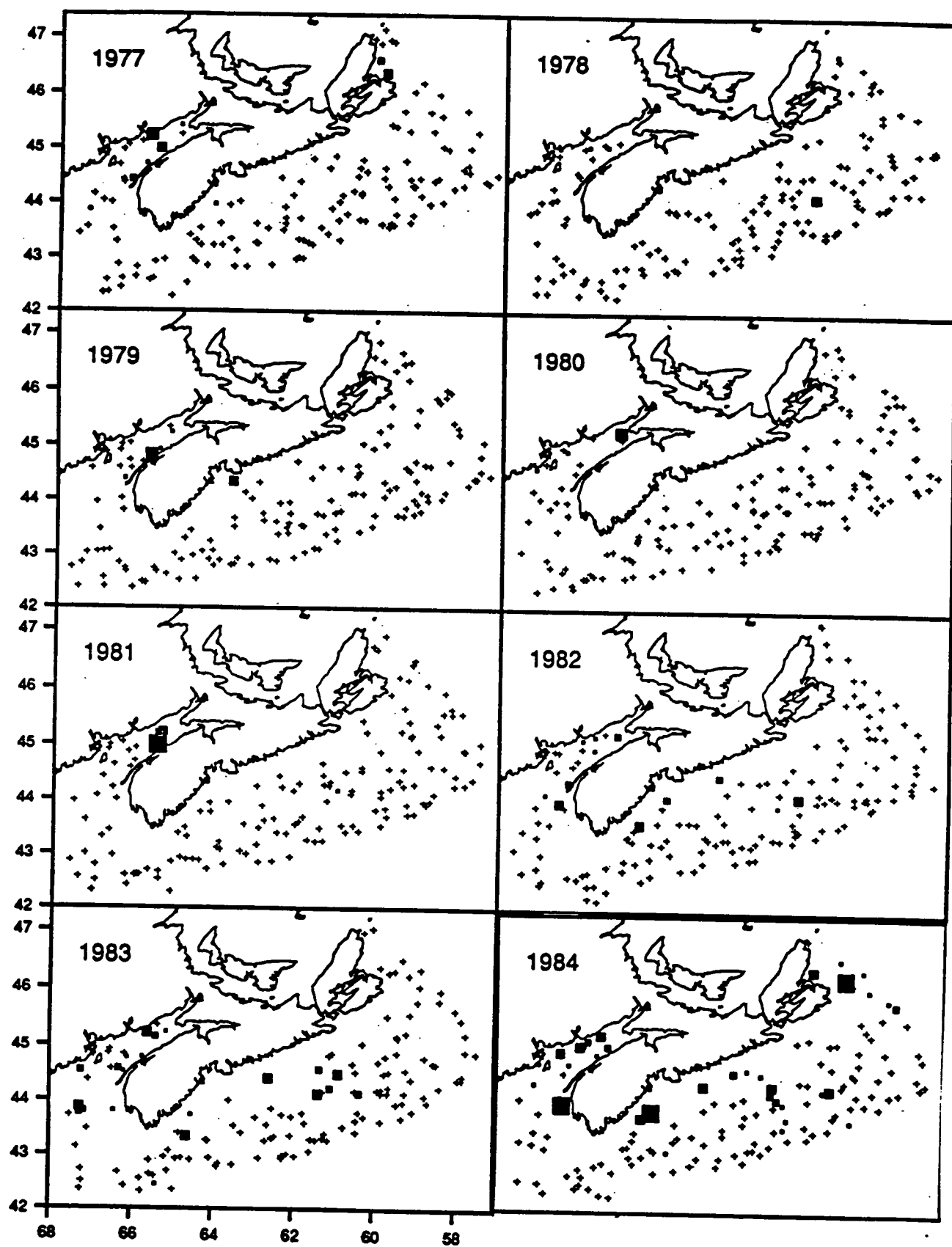


Fig. 12a. con't.



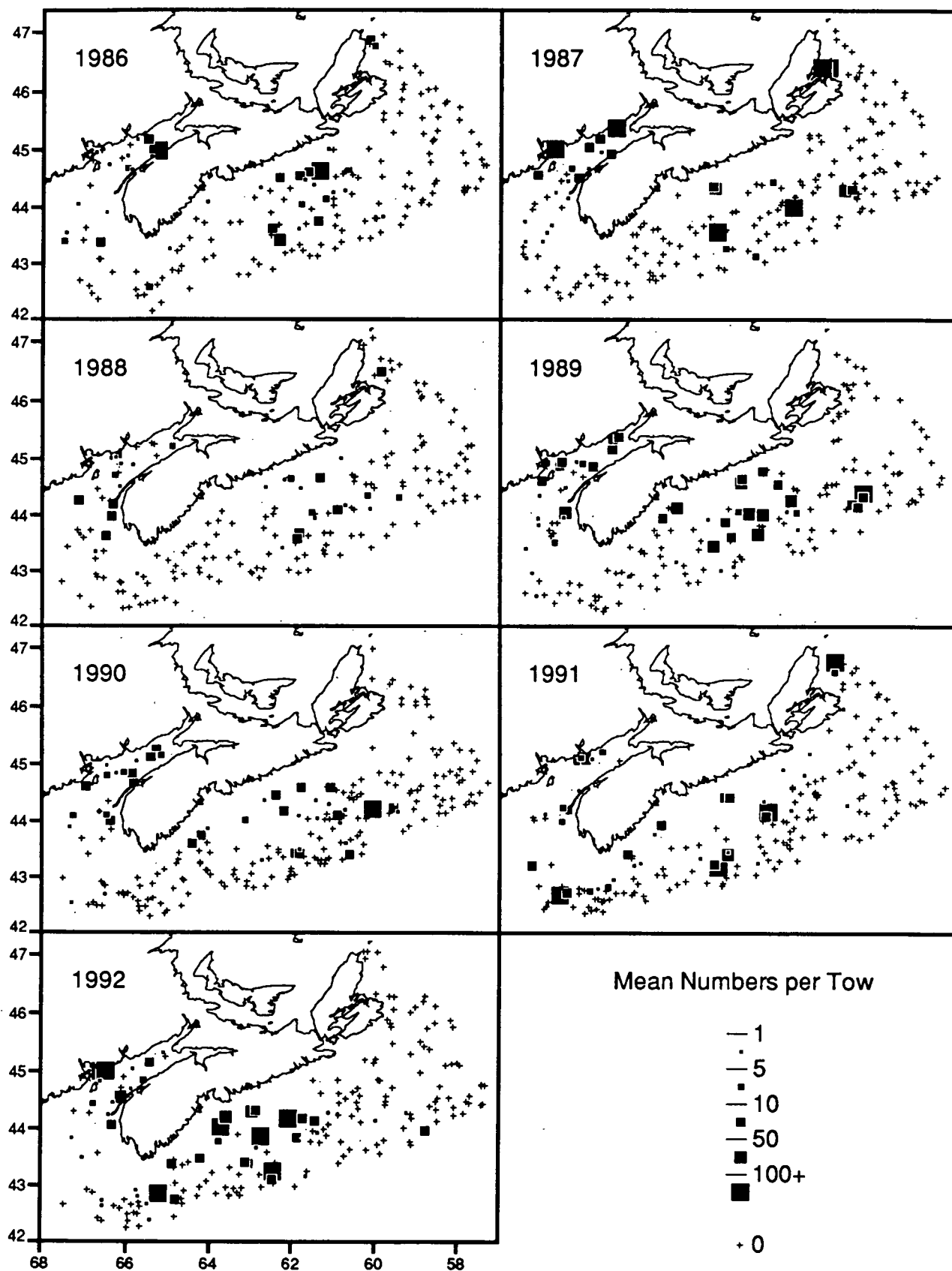


Fig. 12a. con't.

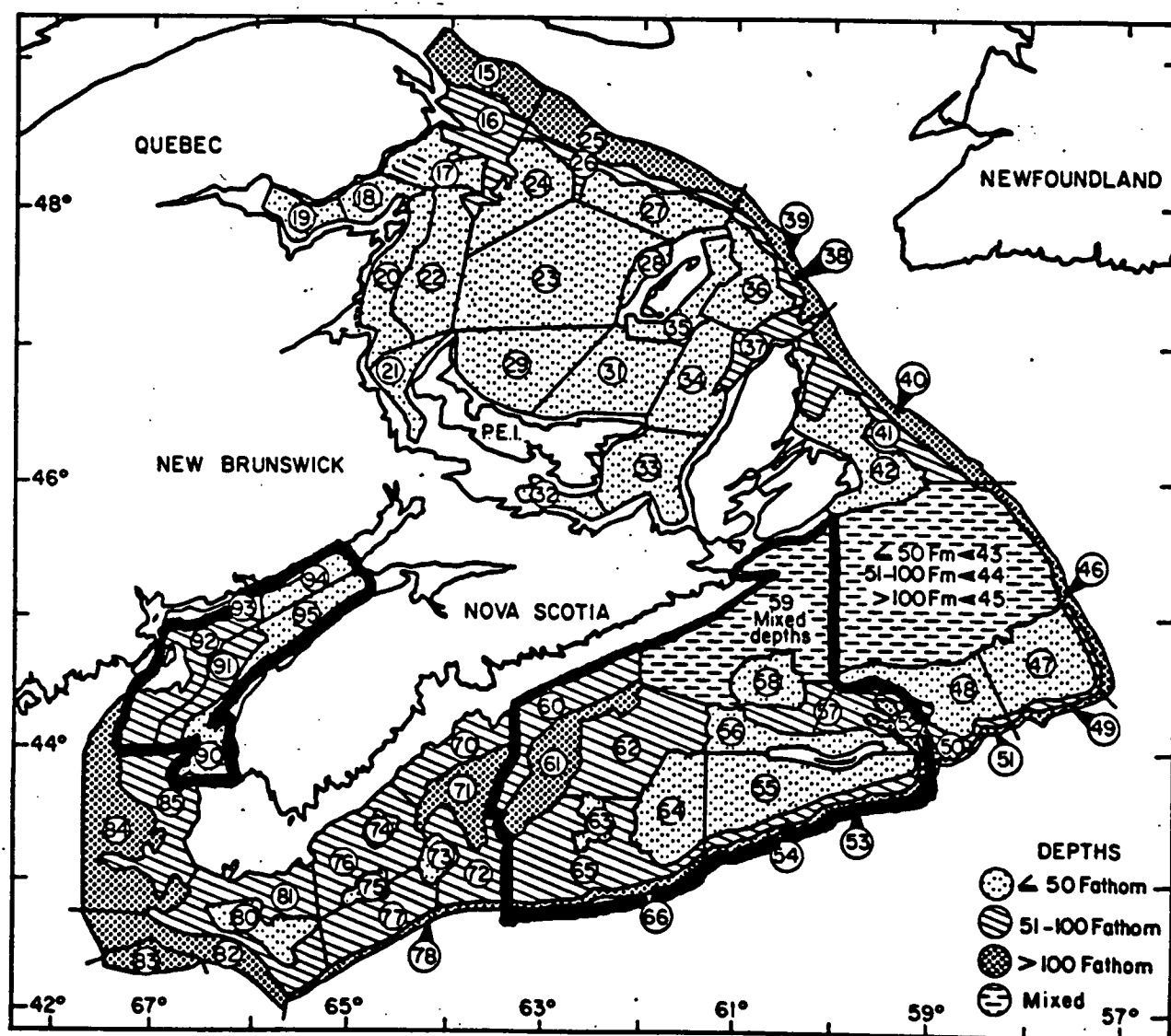


Fig. 12b. Strata in NAFO division 4WX outlining two areas where herring by-catch predominantly occurred.

1992 Herring % at Age with & w/o Str.93  
from summer Groundfish surveys

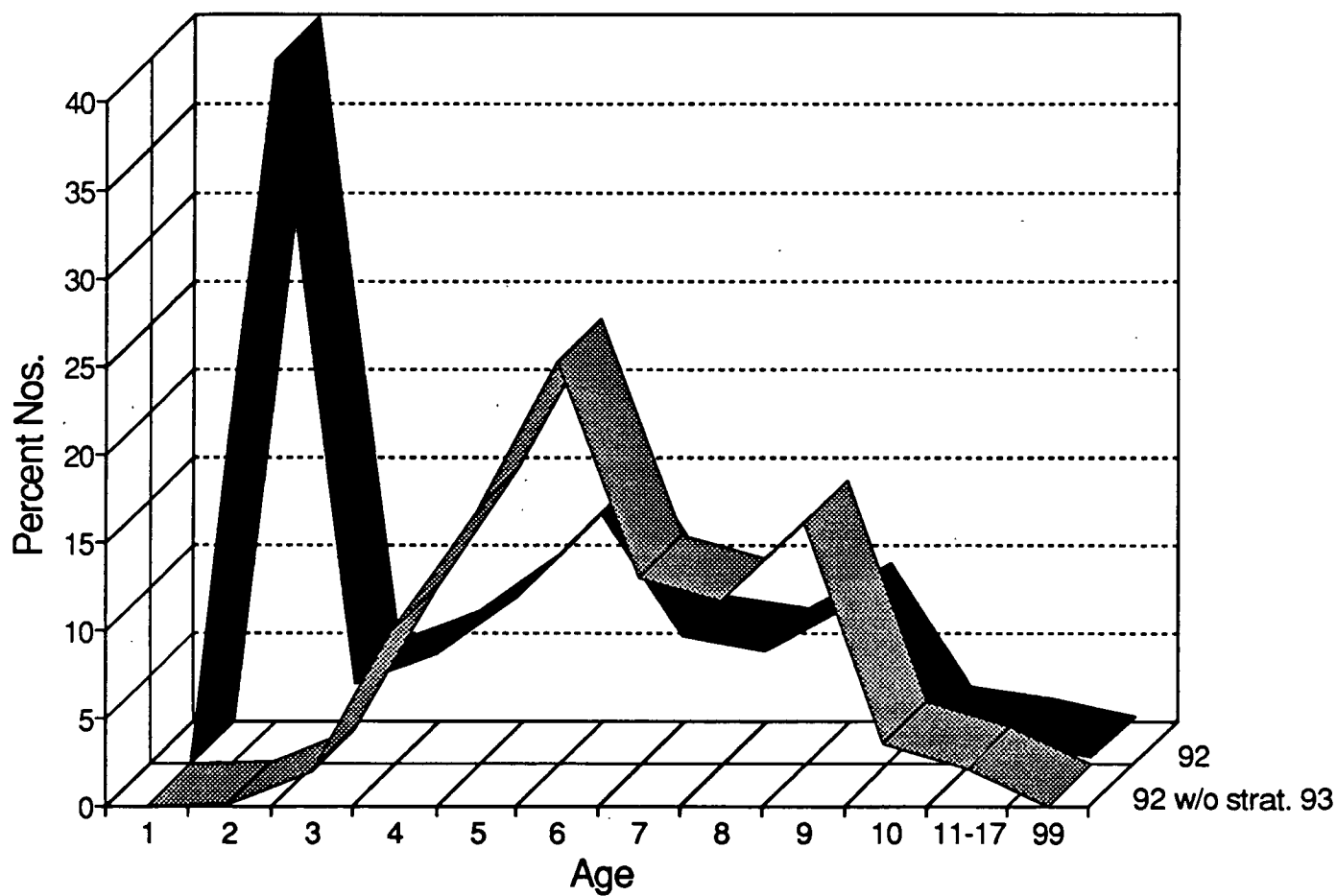


Fig. 13. Age distribution of herring from the 1992 summer research bottom trawl survey with (black) and without (grey) stratum 93.

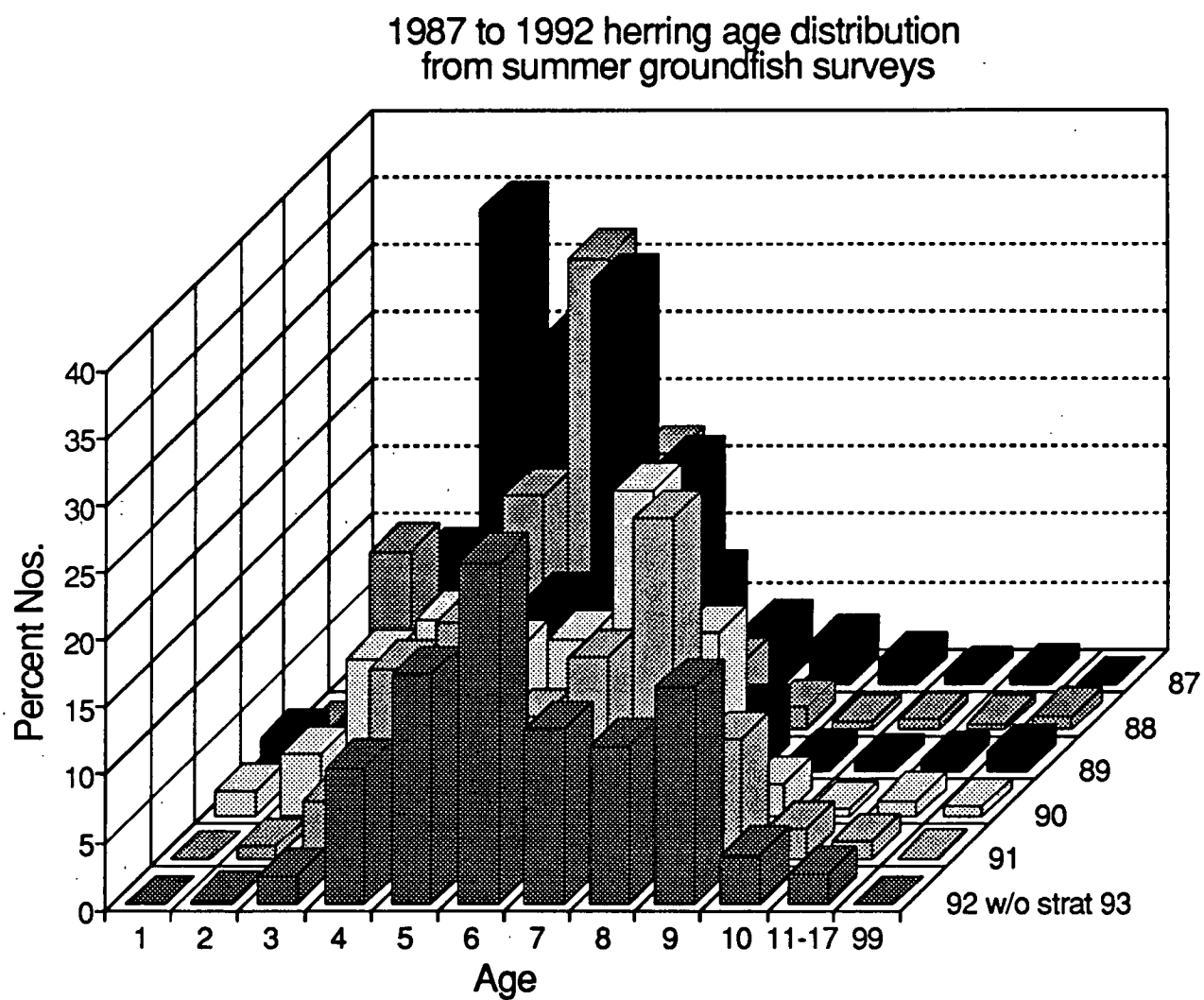


Fig. 14. Age composition of herring from summer research bottom trawl surveys; 1987 to 1992.

**APPENDIX A:****Summary of Purse Seine Logbook analysis from the 1991-92 4WX herring fishery****Contents**

Fig	A-1	- Fishing grounds definitions
Fig	A-2	- 4W 1991 Nov - Dec
	A-3	- 4W 1992 Jan - Feb
	A-4	- 4W 1992 Nov - Dec
Fig	A-5	- 4Wd 1993 Jan Chedabucto Bay
	A-6	- 4Wk 1993 Jan Halifax Area
Fig	A-7	- 4X (N.B. Fall) 1991 Oct - Dec
	A-8	- 4X (N.B. Winter) 1992 Jan - Mar
	A-9	- 4X (N.B. Fall) 1992 Oct - Dec
Fig	A-10	- 4X (Summer) 1992 summary
	A-11	- " 1992 May
	A-12	- " 1992 Jun
	A-13	- " 1992 Jul
	A-14	- " 1992 Aug
	A-15	- " 1992 Sep
	A-16	- " 1992 Oct
Fig	A-17	- 1992 Summer 4X monthly summary
	A-18	- 1991 " " " "
Fig	A-19	- 1992 4X roe fishery summary

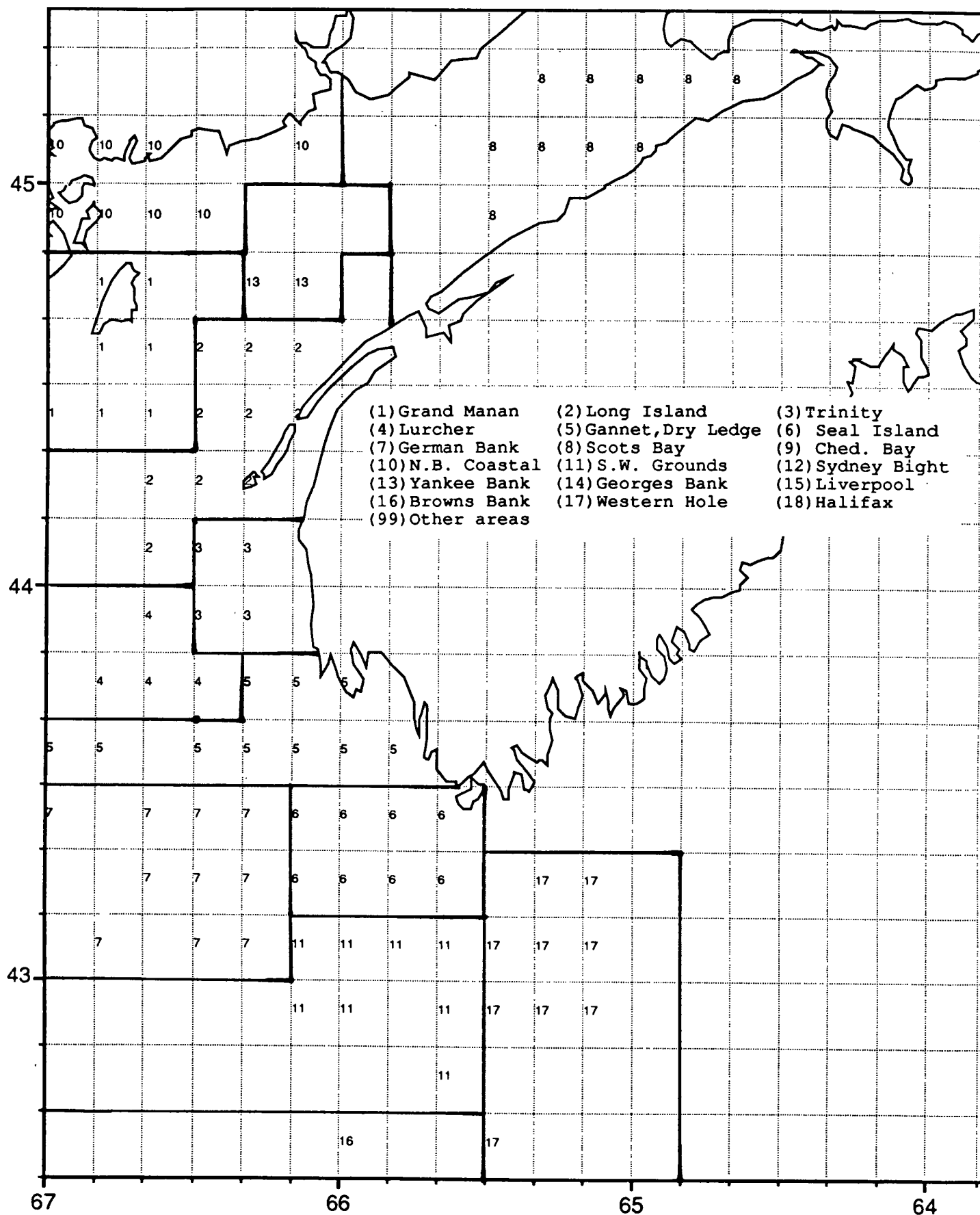


Fig. A-1. 4X purse seine fishing grounds as defined by 10 mile squares.

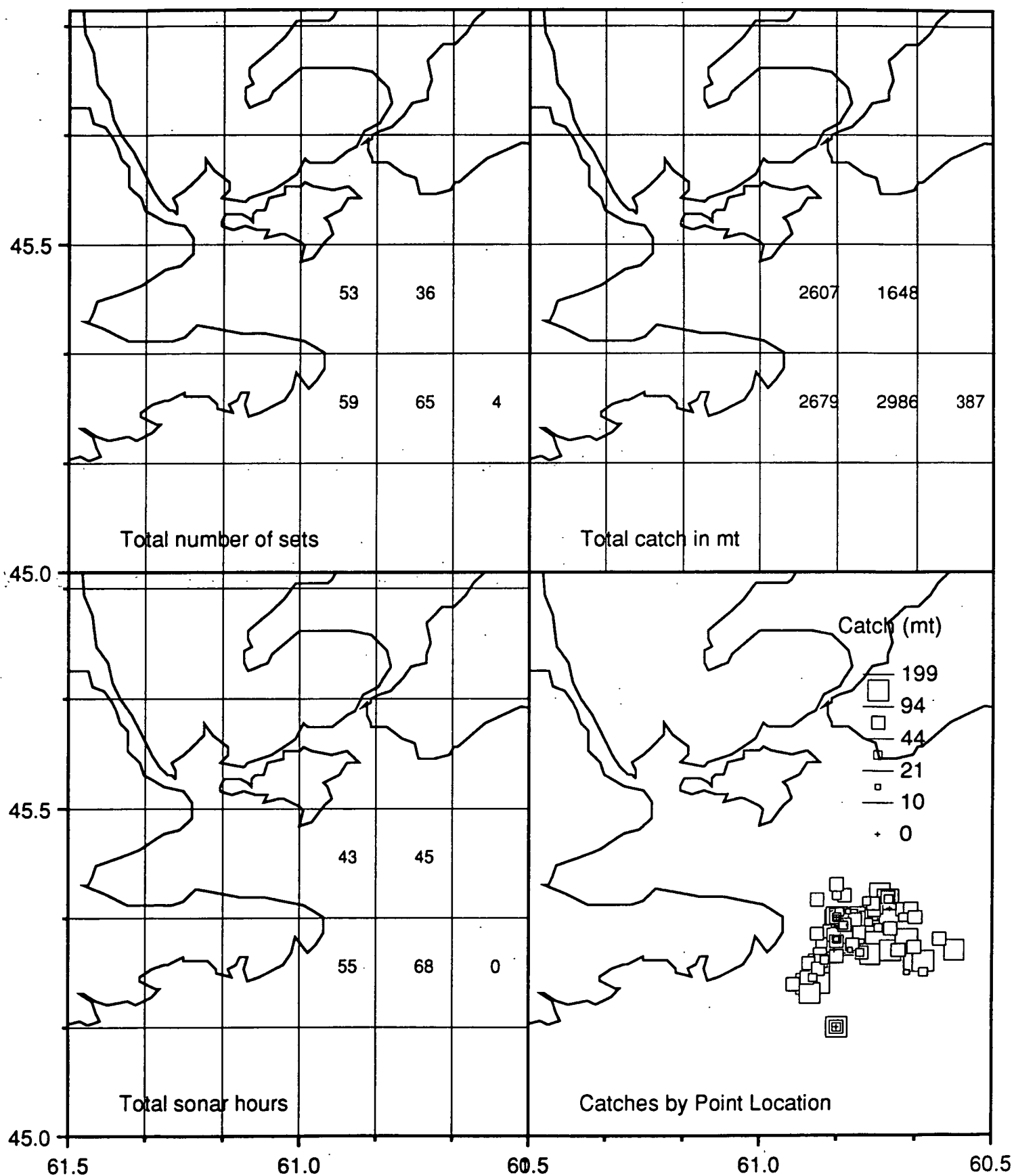


Fig. A-2. Chedabucto Bay area (Nov-Dec 1991) purse seine catch and effort distribution by 10 mile square and by point location.

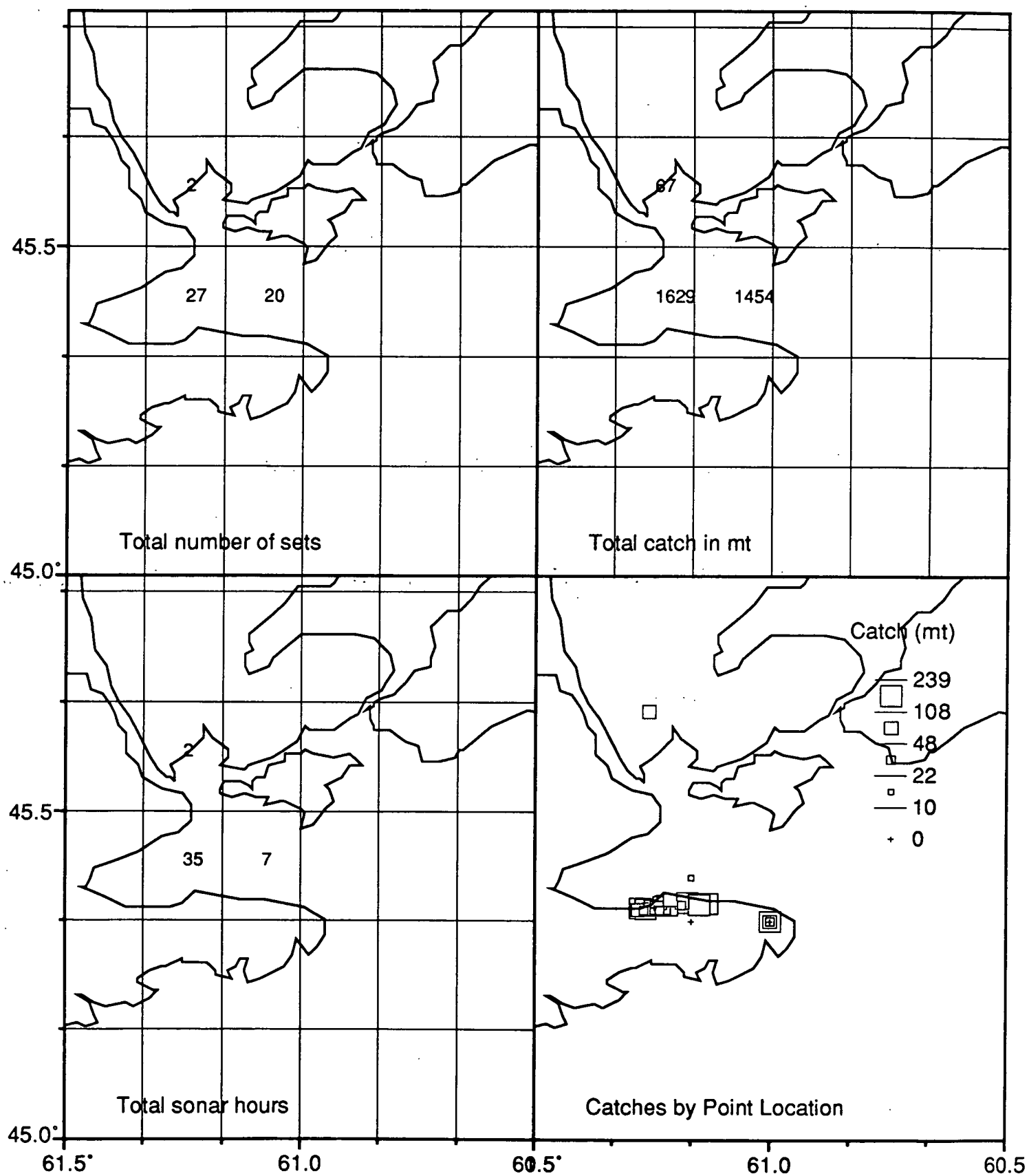


Fig. A-3. Chedabucto Bay area (Jan-Feb 1992) purse seine catch and effort distribution by 10 mile square and by point location.



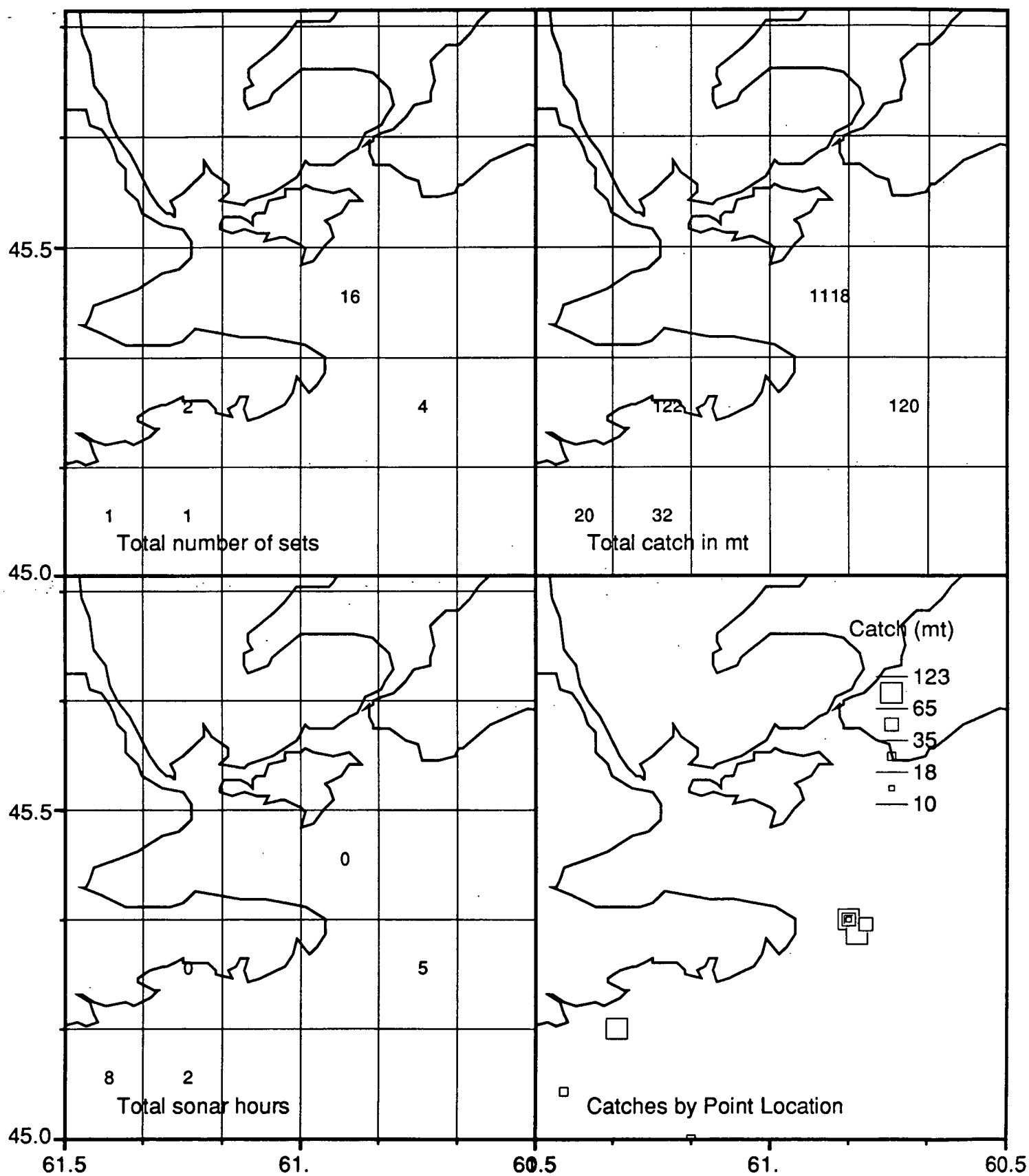


Fig. A-4. Chedabucto Bay area (Nov-Dec 1992) purse seine catch and effort distribution by 10 mile square and by point location.

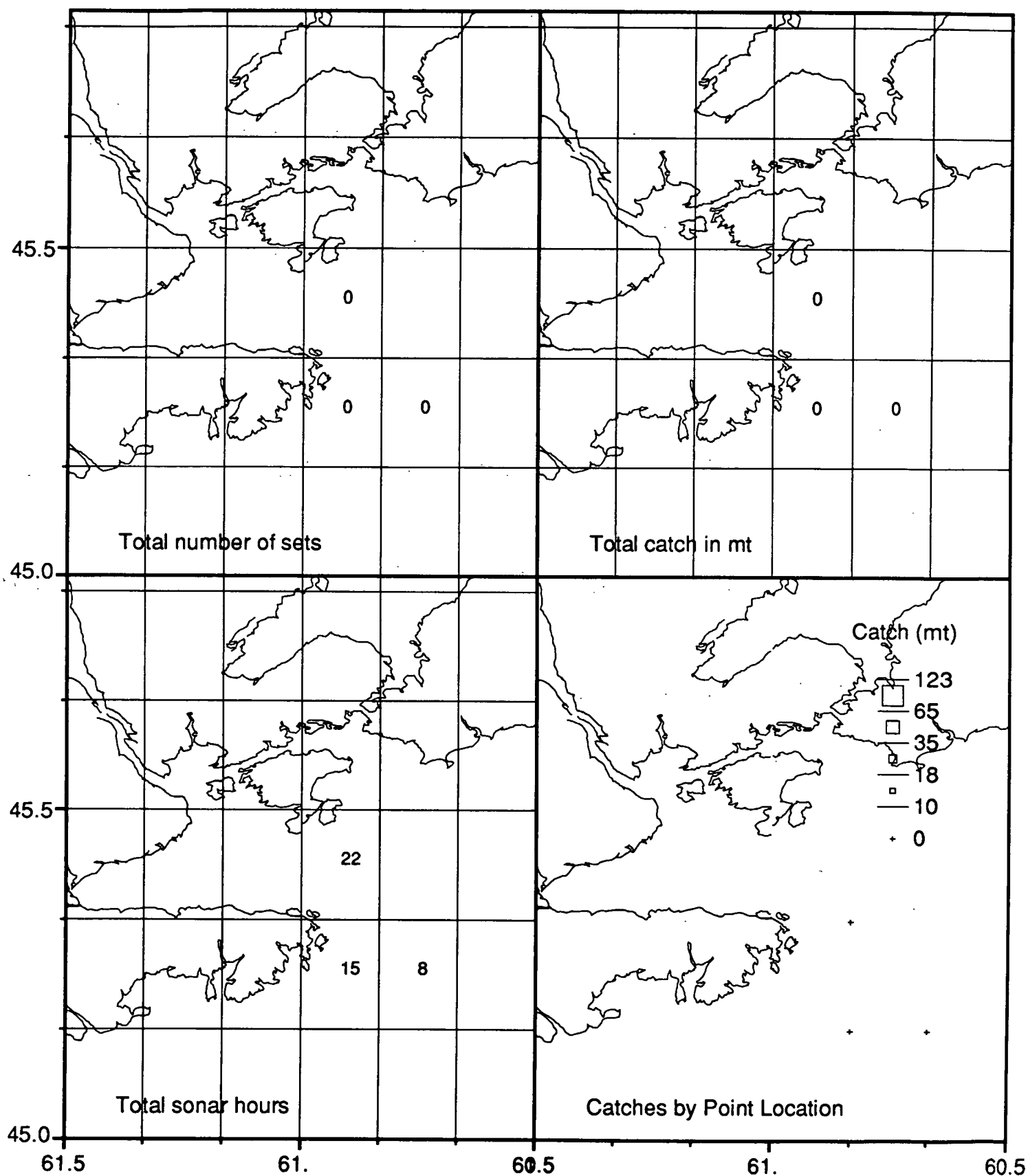


Fig. A-5. Chedabucto Bay area (Jan 1993) purse seine catch and effort distribution by 10 mile square and by point location.

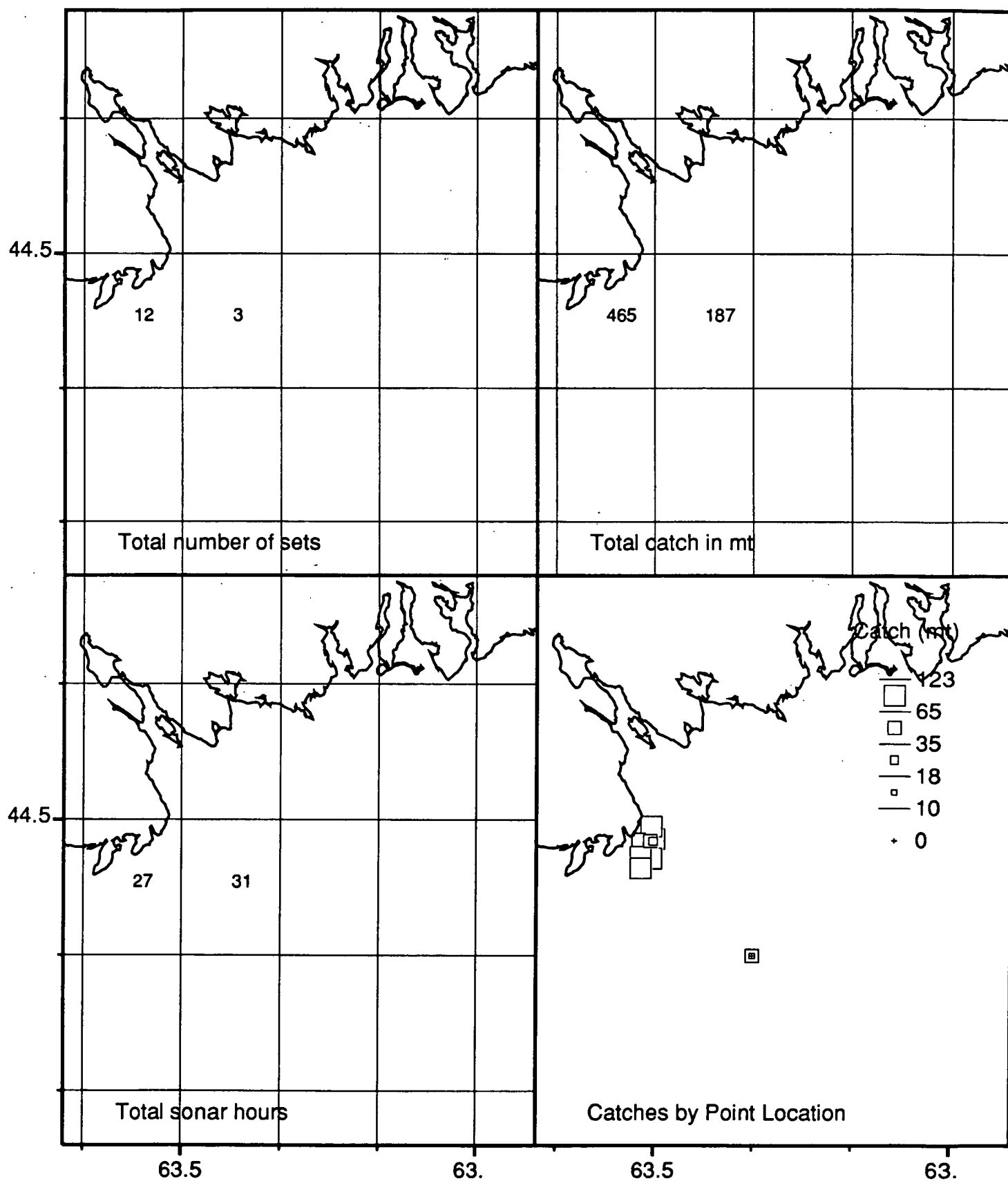


Fig. A-6. Halifax area (Jan 1993) purse seine catch and effort distribution by 10 mile square and by point location.

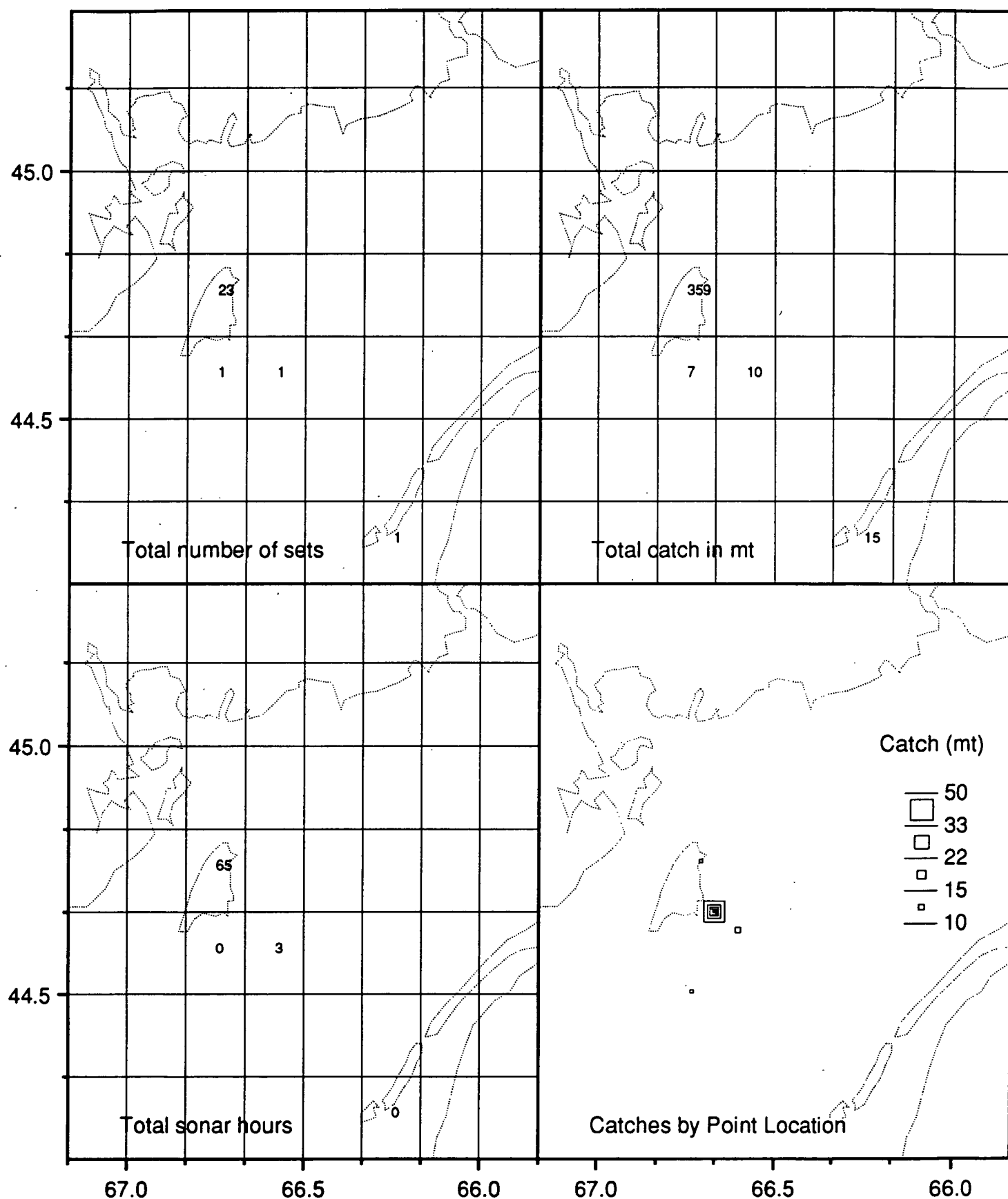


Fig. A-7. New Brunswick area (Oct 15-Dec 31, 1991) fall purse seine catch and effort distribution by 10 mile square and by point location.

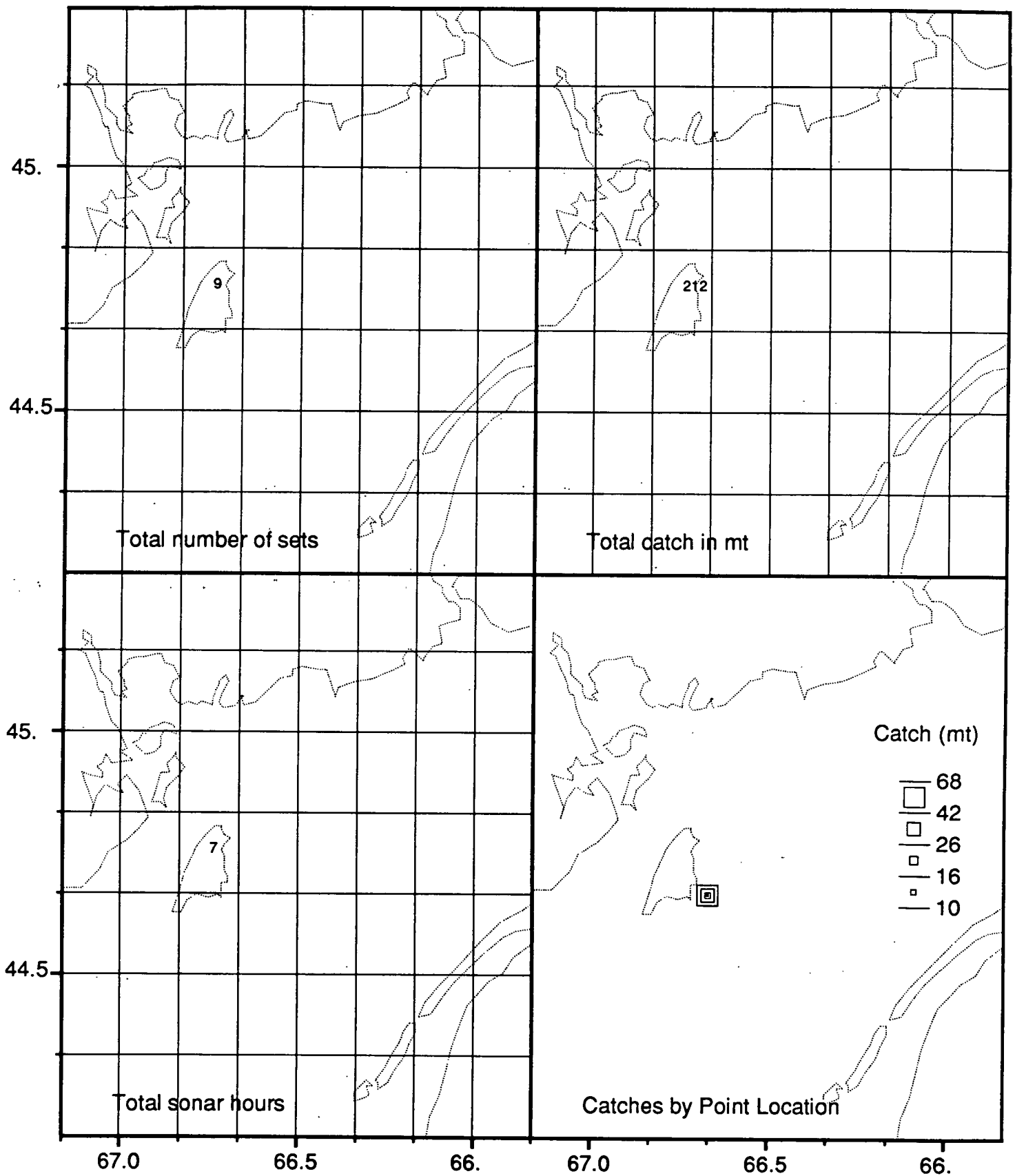


Fig. A-8. New Brunswick area (Jan 1992) winter purse seine catch and effort distribution by 10 mile square and by point location.

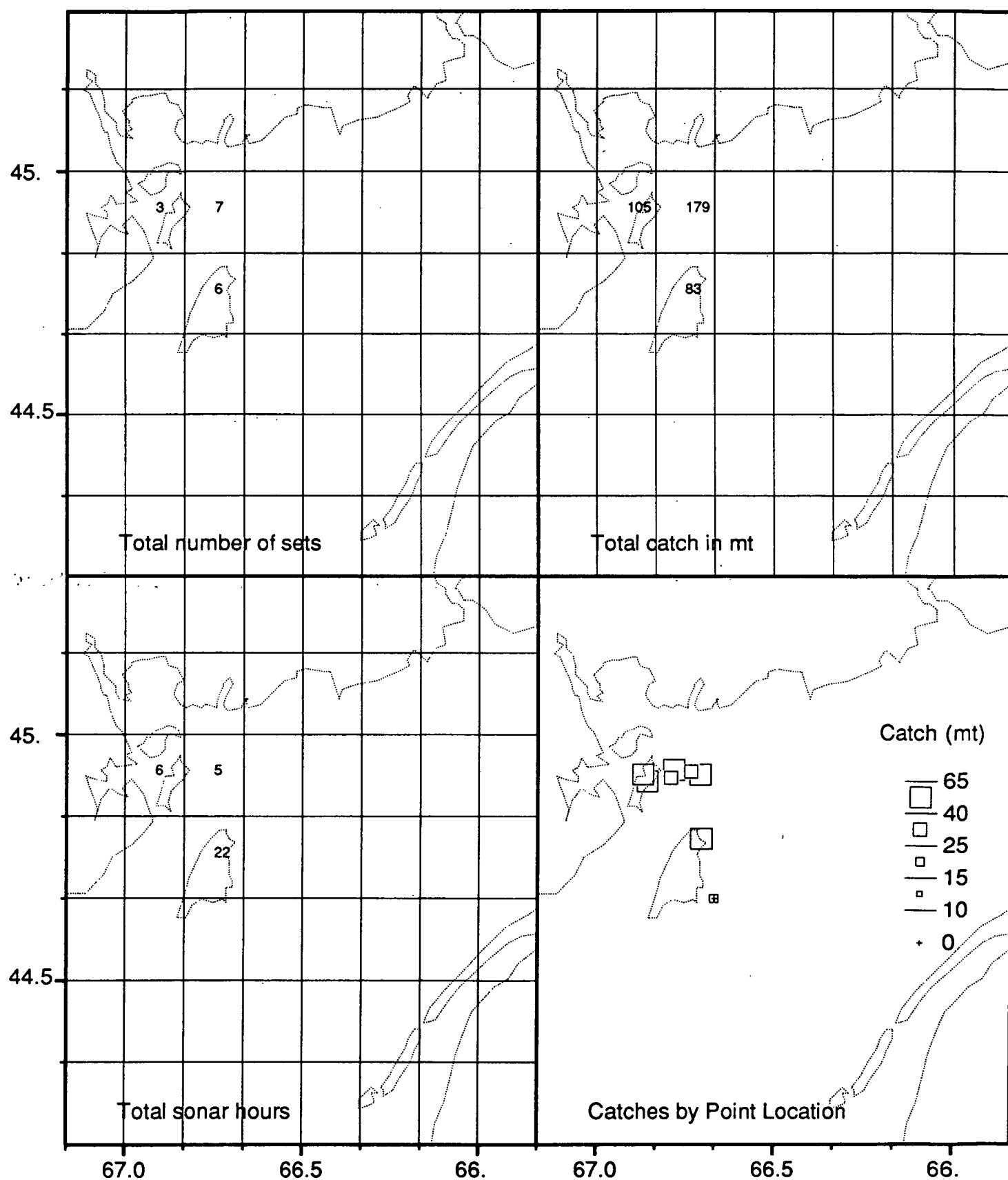


Fig. A-9. New Brunswick area (Oct 15-Dec 31, 1992) fall purse seine catch and effort distribution by 10 mile square and by point location.

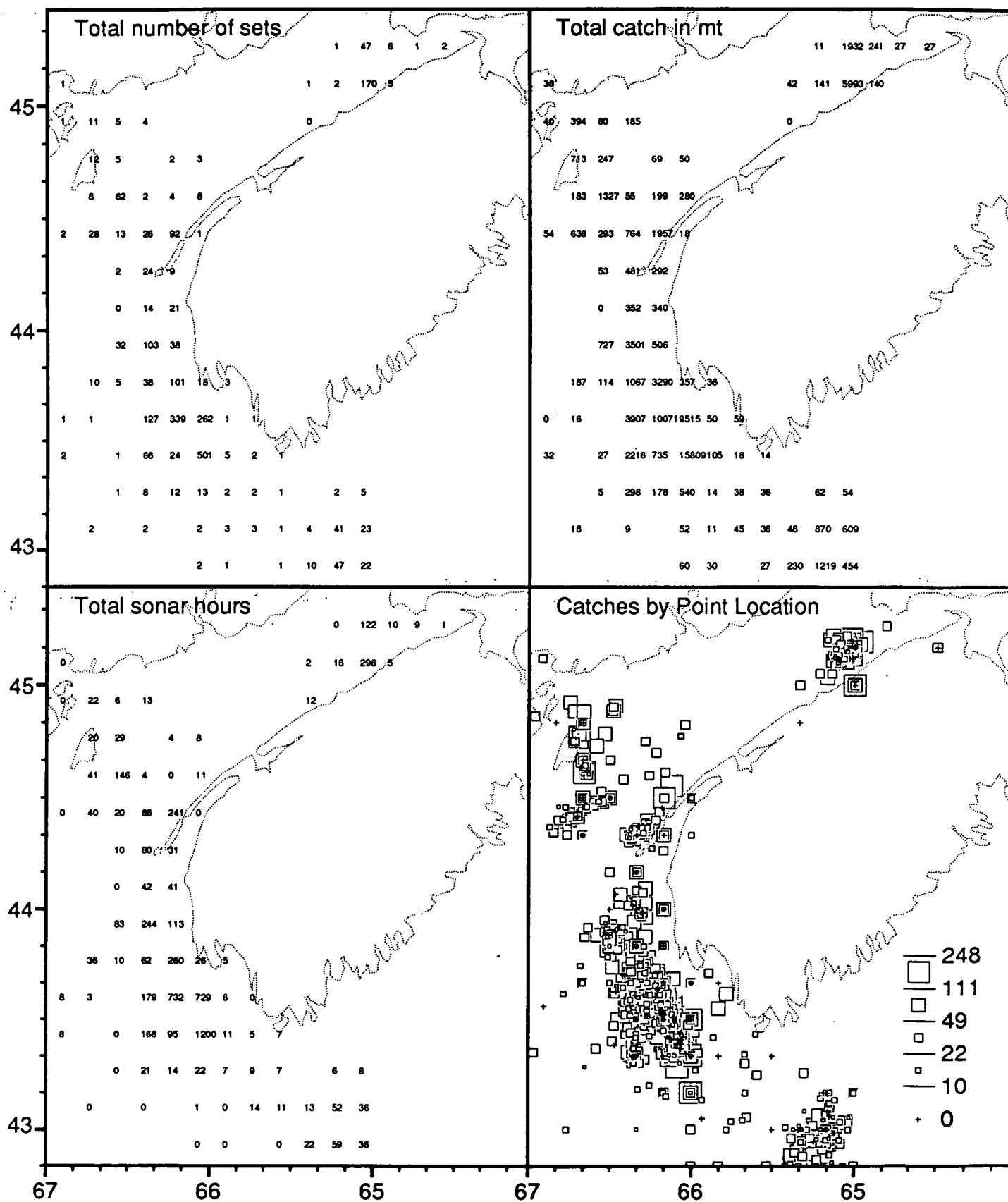


Fig. A-10. 1992 4X summer (May 15 to Oct. 15) purse seine catch and effort distribution by 10 mile square and by point location.

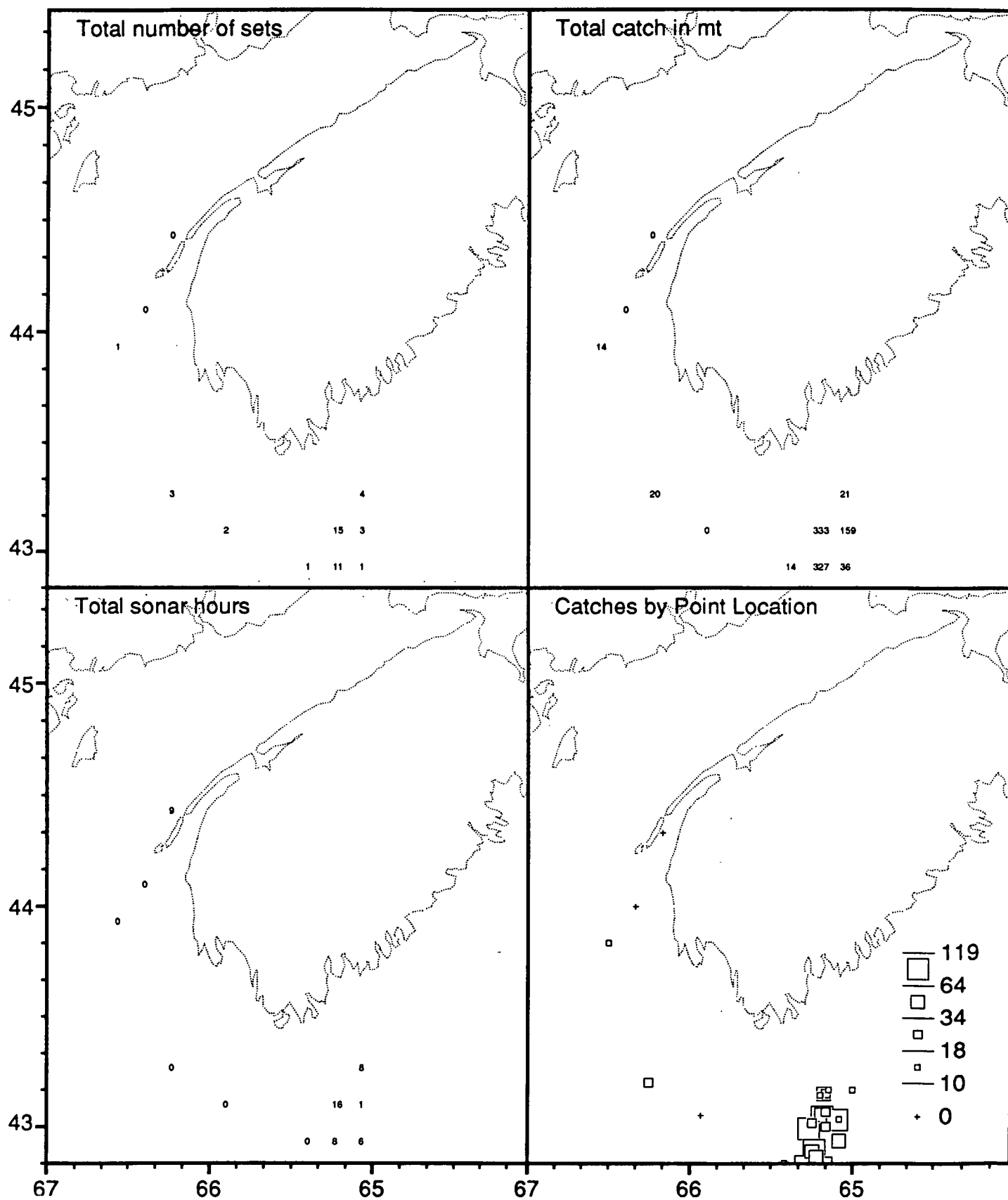


Fig. A-11. 1992 4X summer (May only) purse seine catch and effort distribution by 10 mile square and by point location.



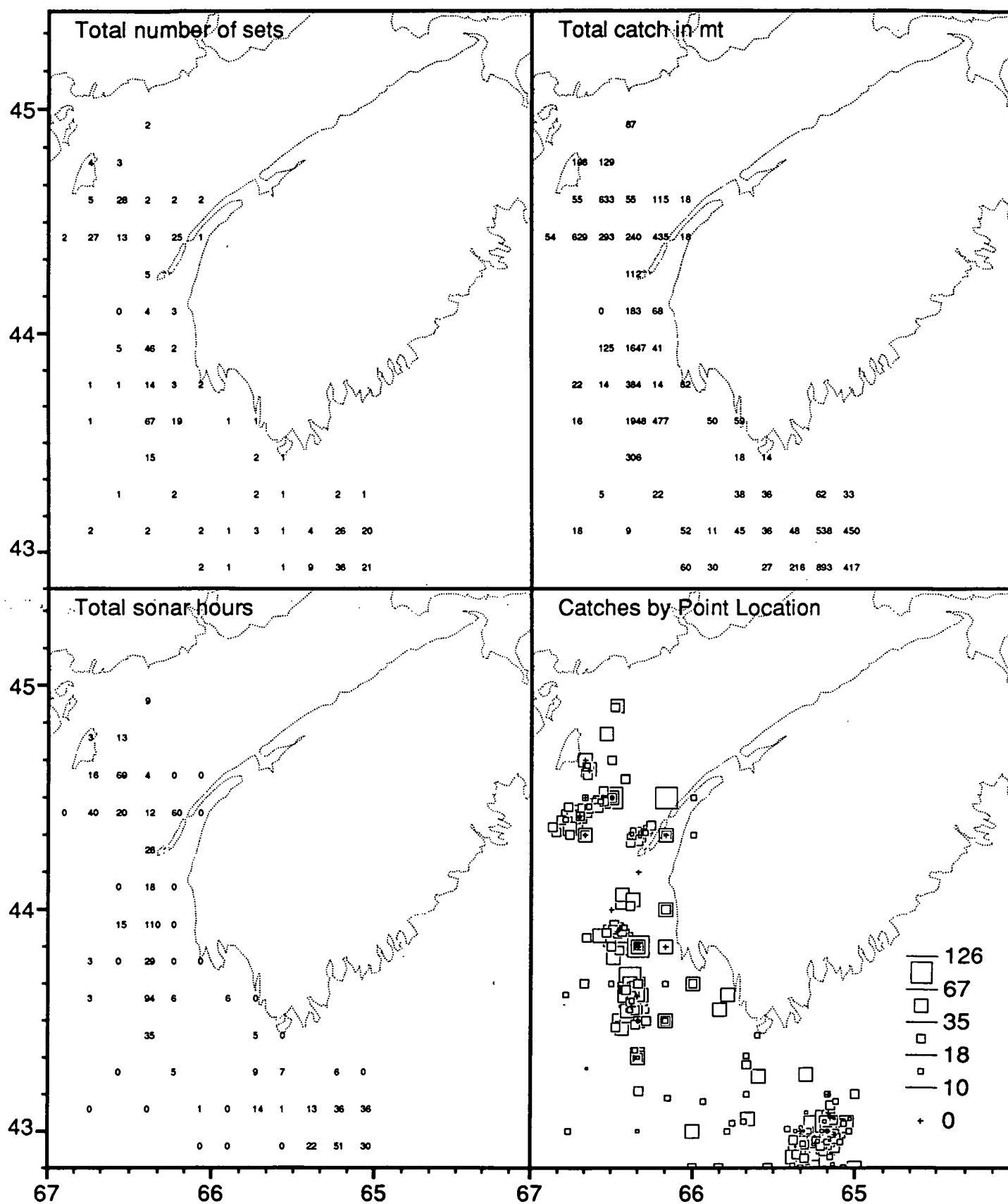
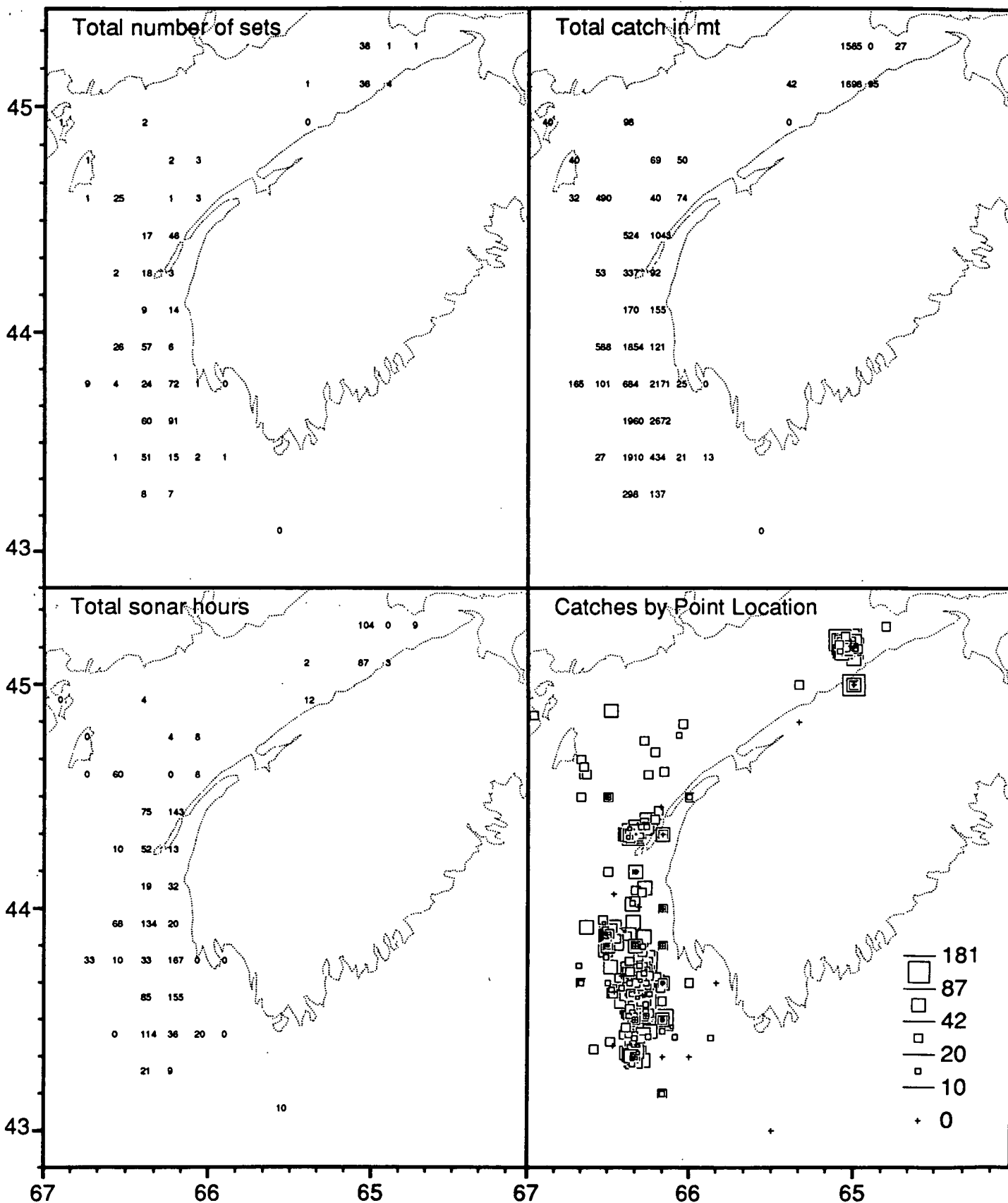


Fig. A-12. 1992 4X summer (June only) purse seine catch and effort distribution by 10 mile square and by point location.



**Fig. A-13. 1992 4X summer (July only) purse seine catch and effort distribution by 10 mile square and by point location.**

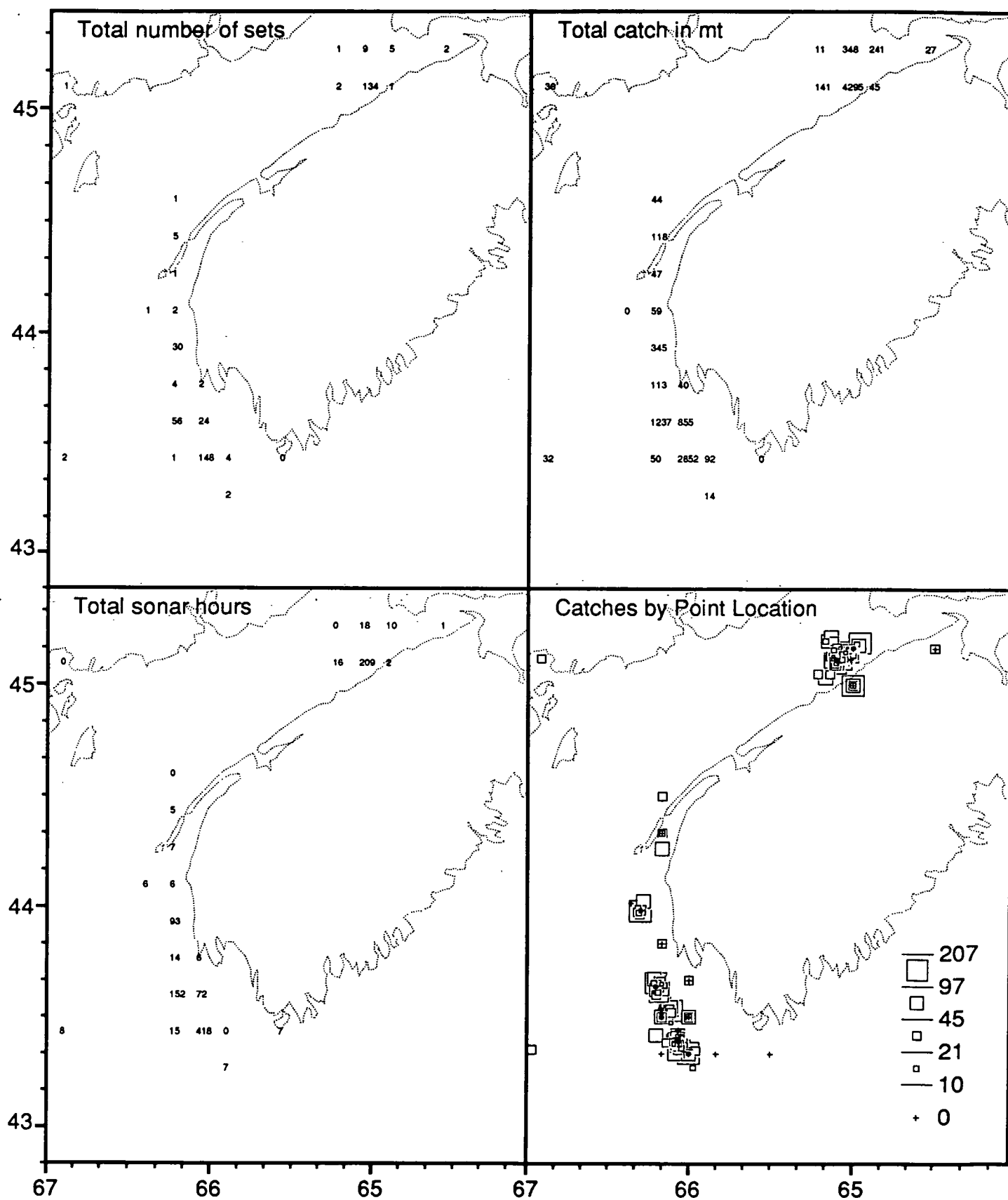


Fig. A-14. 1992 4X summer (August only) purse seine catch and effort distribution by 10 mile square and by point location.

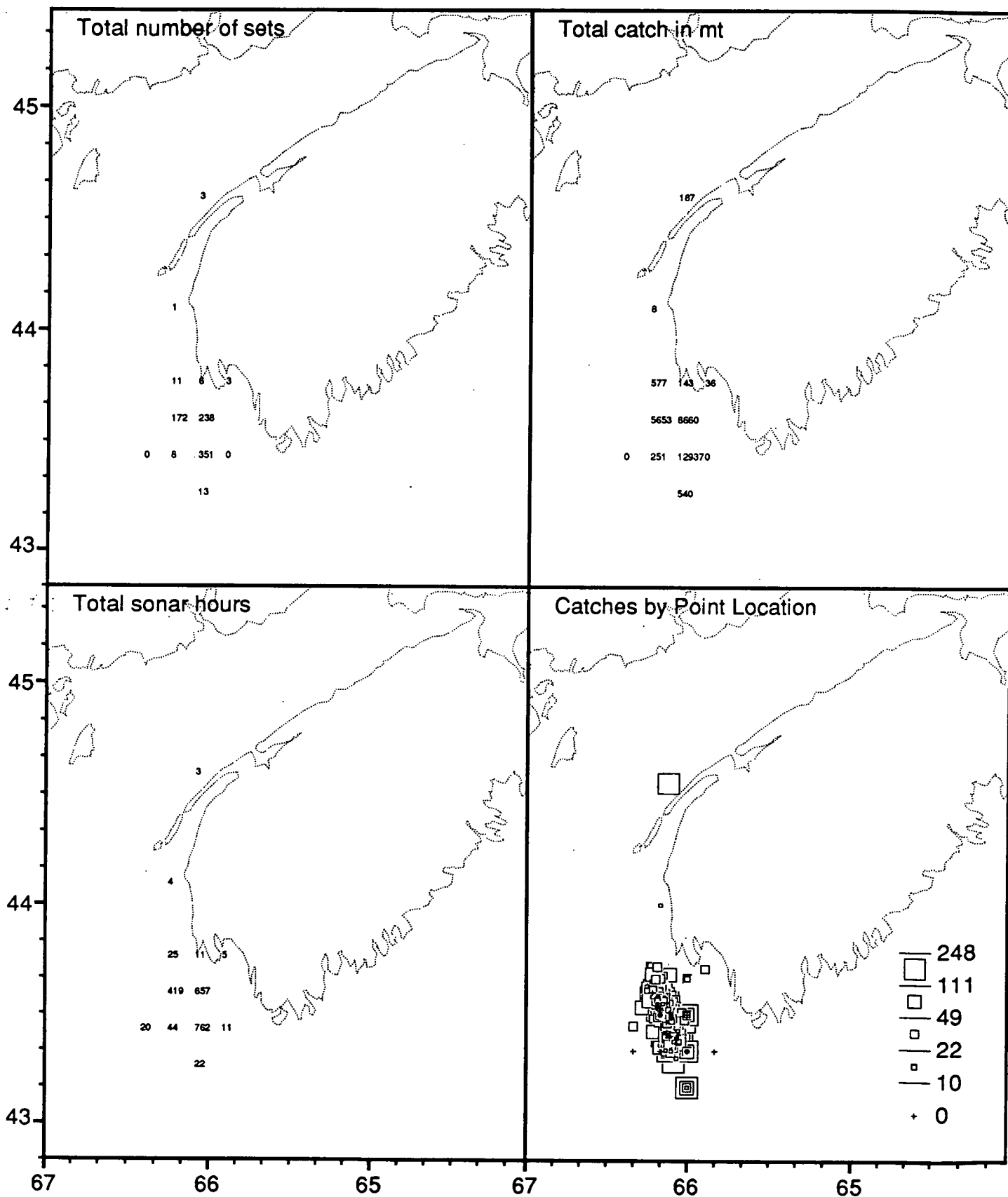


Fig. A-15. 1992 4X summer (September only) purse seine catch and effort distribution by 10 mile square and by point location.

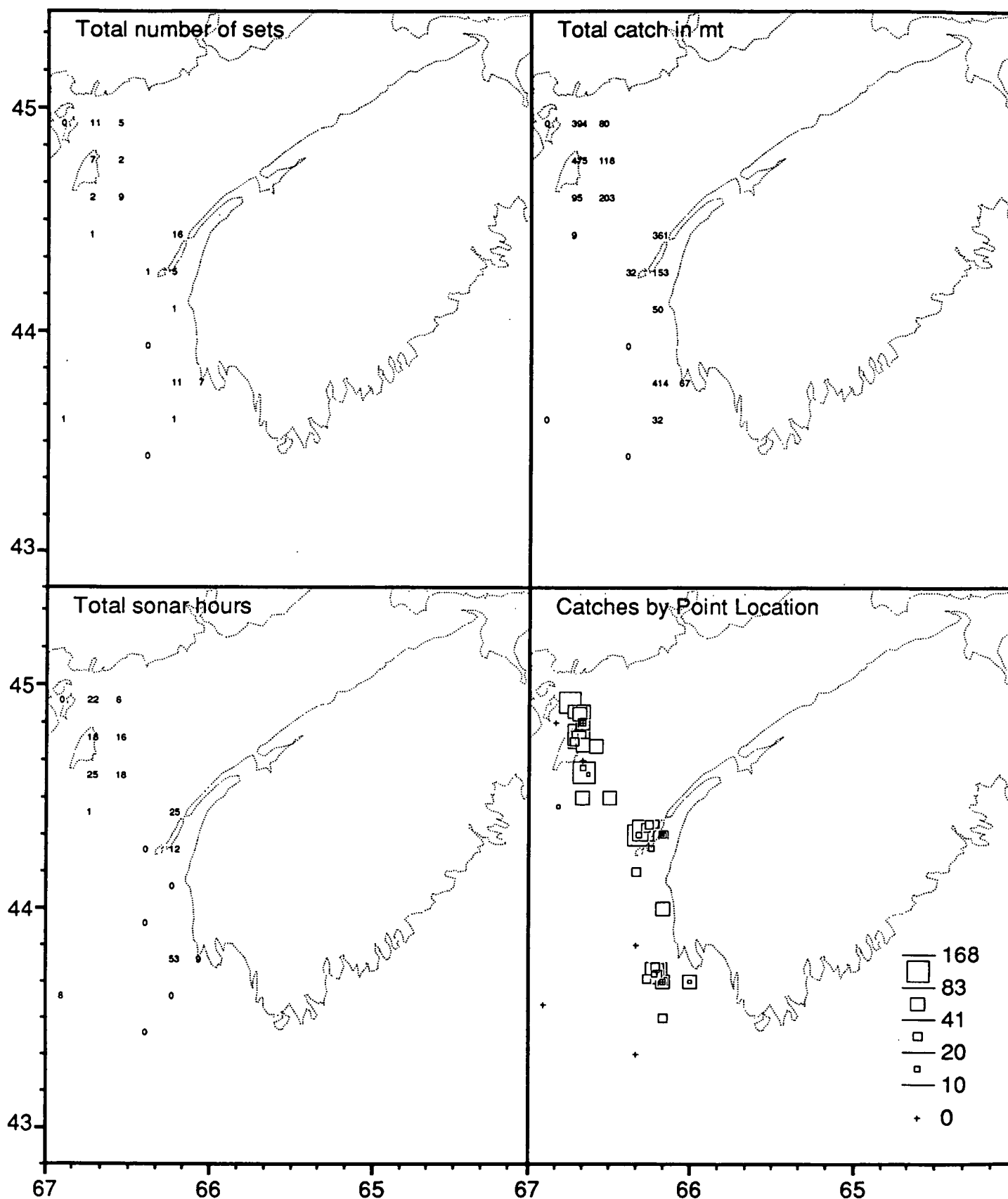


Fig. A-16. 1992 4X summer (October only) purse seine catch and effort distribution by 10 mile square and by point location.

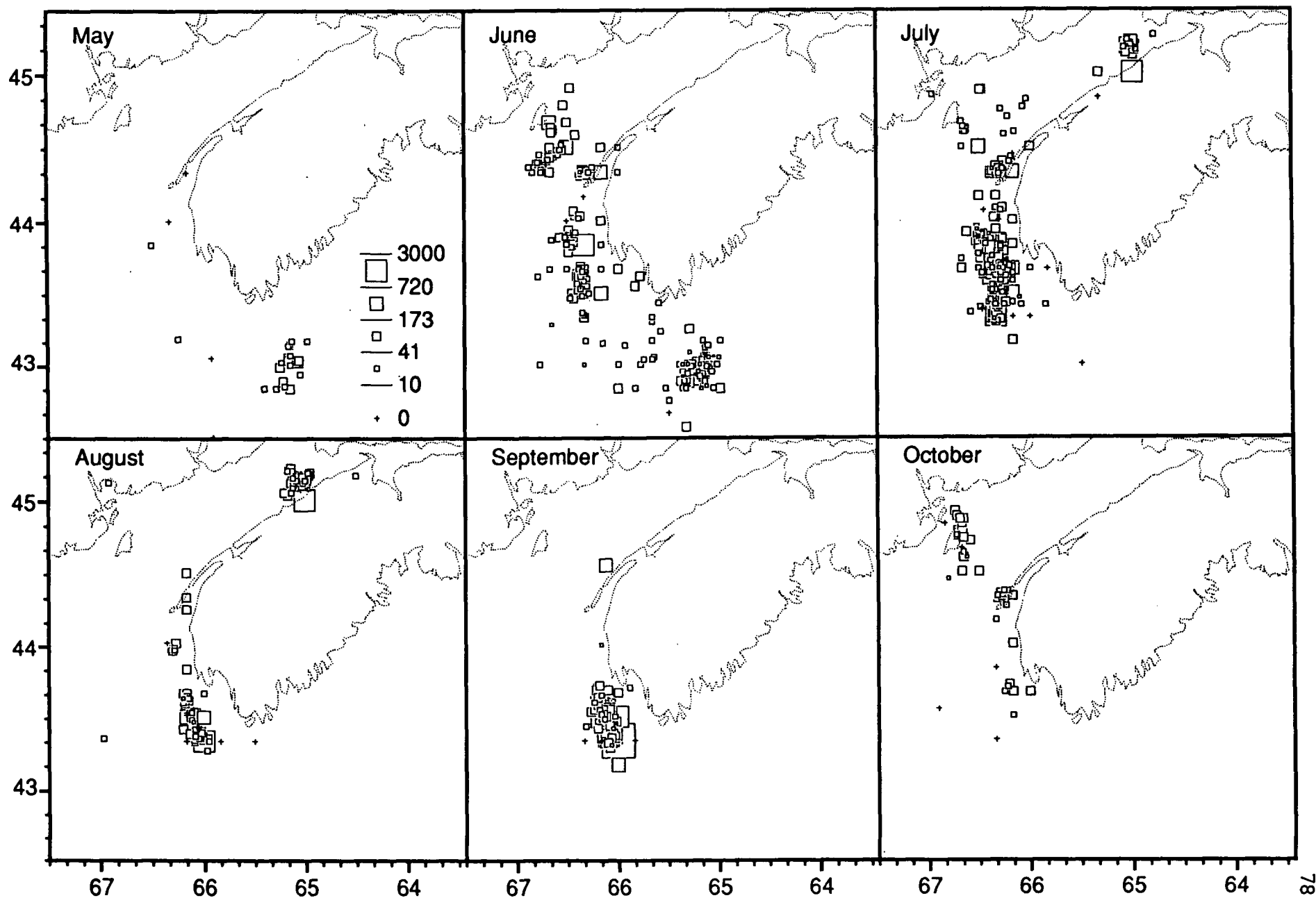


Fig. A-17. 1992 4X summer purse seine catch and effort distribution monthly from May to October (catches in t aggregated by 1 mile squares).

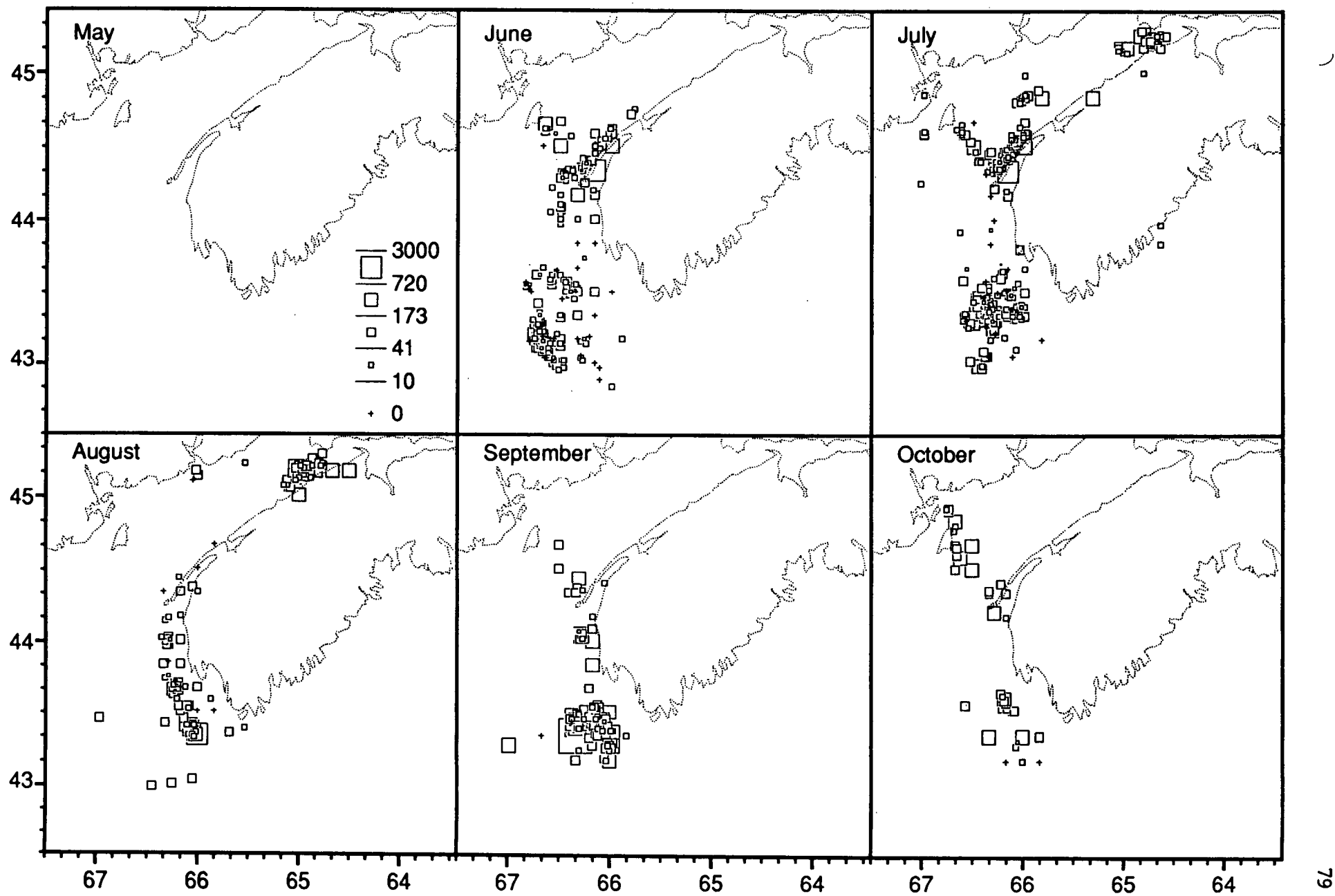


Fig. A-18. 1991 4X summer purse seine catch and effort distribution monthly from May to October (catches in t aggregated by 1 mile squares).

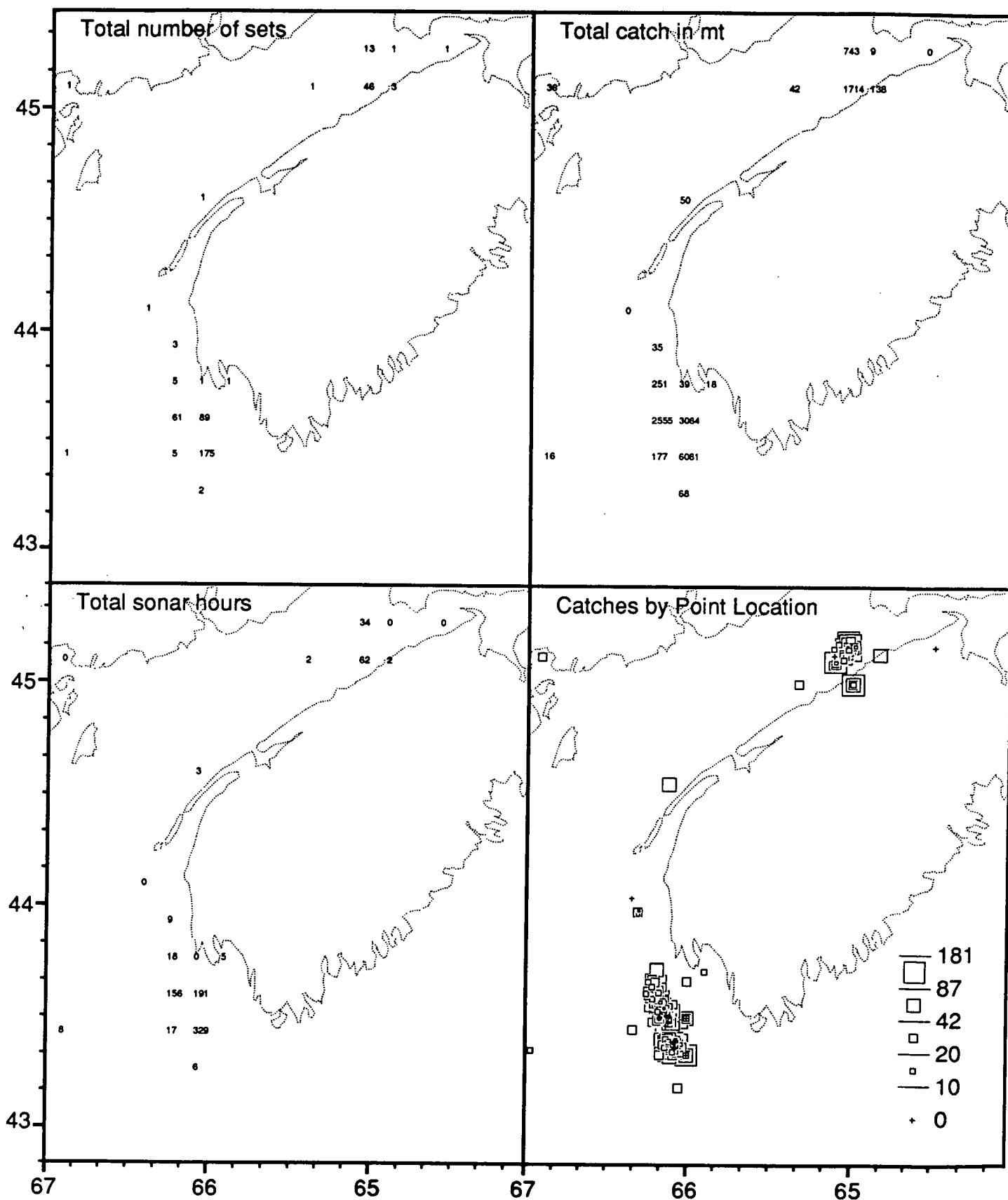


Fig. A-19. 1992 4X N.S. summer purse seine fishery catch and effort distribution by 10 mile square and individual catches by point location for all records where fish roe condition was specified as ripe or spawning (roe stages 5 and 6).