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Evaluation of the 1993 4WX Herring Fishery

by

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ABSTRACT

The 1993 4WX herring fishery reported landings of 105,000 t from the stock portion of the fishery. The 1993 reported figure was very close to that estimated from product back-calculation, and indicates a successful Dockside Monitoring Program (DMP). Landings in 1993 were below average for recent years (corrected for under-reporting), and this difference is attributed to market limitations, an unusual distribution of the resource and the new mandatory Dockside Monitoring Program.

The purse seine fleet of 38 vessels dominated landings (72% of total 4WX), followed by weirs (27% of total 4WX), and minor landings by other gear types. Non-stock landings (New Brunswick weirs and shutoffs) accounted for 31,500 t or 25% of total 4WX landings.

The geographic patterns of purse seine landings were partially documented by logbooks (less than 40% coverage in 1993) and indicate some unusual fish distribution when comparing 1992 and 1993 to the past decade. The "over-wintering" fishery in Chedabucto Bay was reduced and shifted to the Halifax area. Fishing success also declined at several traditional spawning areas (Trinity Ledge and German Bank) and catches are now being taken in non-traditional areas in Western Hole, Liverpool and Browns Bank.

Changes in fish distribution, particularly in spawning areas have caused some concern within the industry. On the other hand, the two indices of abundance, larval herring survey and by-catch of adult herring in summer groundfish RV surveys, were high indicating that spawning stock size is also relatively high.

RÉSUMÉ

Les débarquements déclarés provenant du stock de hareng des divisions 4WX exploité par les pêcheurs en 1993 étaient de 105 000 t. Ce chiffre est très proche des estimations obtenues par calculs rétroactifs sur le produit, signe de l'efficacité du Programme de surveillance à quai. Ces débarquements étaient inférieurs à la moyenne des dernières années (corrigée pour tenir compte des sous-déclarations), l'écart étant attribué à des contraintes de marché, à une distribution inhabituelle de la ressource et au nouveau Programme de surveillance à quai obligatoire.

Les débarquements provenaient, par ordre d'importance, de la flottille des 38 bateaux de pêche à la senne coulissante (72 % du total de 4WX), des pêcheurs à fascines (27 % du total de 4WX) et, dans une proportion infime, des pêcheurs utilisant d'autres types d'engin. Les débarquements hors stock (pêcheries à fascines et sennes de plage au N.-B.) se chiffraient à 31 500 t, soit 25 % des débarquements totaux en provenance de 4WX.

La répartition géographique des débarquements des pêcheurs à la senne coulissante, partiellement appuyée par les journaux de pêche (dans une proportion inférieure à 40 % en 1993), dénote une distribution inhabituelle du poisson si l'on compare les années 1992 et 1993 à la décennie précédente. La pêche d'hiver dans la baie de Chedabucto a diminué et s'est déplacée vers la région de Halifax. Les résultats sont également en baisse dans plusieurs frayères traditionnelles (chaussée Trinity et banc German) et les prises proviennent maintenant de secteurs d'exploitation non traditionnels de la fosse Western, de Liverpool et du banc de Brown.

Les changements dans la distribution du poisson, en particulier dans les frayères, ont suscité quelques inquiétudes au sein de l'industrie. D'un autre côté, les deux indices d'abondance - celui du relevé de recherche sur les larves et celui des prises accidentelles de hareng adulte dans les relevés de recherche sur le poisson de fond réalisés l'été par les navires scientifiques - révèlent très nettement que le stock de reproducteurs est aussi relativement abondant.

OVERVIEW OF 1993 FISHERIES

The 1992-93 Management Plan - Context for the fisheries

October 14, 1992 marked the end of the "1983 Ten Year Plan" which formed the basis of annual Scotia Fundy herring fishery management plans for the past decade. Considerable discussions took place throughout 1992 and 1993 regarding the development of a successor to the plan, but there had been no agreement by the beginning of the 1992-1993 quota year. In the absence of a long-term context, plan development was awkward, and was not fully developed until part way through the season (the spring Scotia-Fundy Herring Advisory Committee (SFHAC) meeting). The plan was essentially a "rollover" of terms, etc. in recent years, with the exception that the TAC was returned to 151,200 t with the acceptance of a mandatory program of Dockside Monitoring. No single management plan document was produced; some details are recorded in the minutes of November 5, 1992 and May 12-13, 1993 SFHAC Meetings. Quotas for 4WX stock herring were established for: (i) the purse seine fleet of 38 vessels (141,688 t, or 93.7% of the total allowable catch of 151,200 t, including a bait quota of 2,600), (ii) a single mid-water trawler (1,512 t or 1 % of the TAC), and (iii) an allocation to "inshore" gear components: gillnets, traps and weirs (8,000 t or 5.3% of the TAC).

As had been the case under the guidelines of the 10-Year (1983) Management 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. The 1992-1993 plan allowed for a maximum catch of 10,000 t in the mid/upper Bay of Fundy (Area 21: "Scots Bay fishery") as part of the 4X summer purse seine fishery, a closure of the uppermost Bay (Area 22), and placed a continuous (18 day) closure Aug. 12 to Sept 2, 1993 on the Trinity Ledge spawning grounds.

As in previous years, potential catches from the New Brunswick "fixed gear" fisheries (weirs and shutoffs) were excluded from the TAC on the grounds that they target primarily juveniles presumed to be non-4WX stock herring originating from the Gulf of Maine.

The 1993 fishery saw a significant change in monitoring. The purse seine fleet became the first herring fleet in Canada to be placed on a complete, industry-funded, dockside monitoring program (DMP). Vessels (including carriers) were required to notify an operations room (prior to landing) of location and time of landing, and of the amount of fish on board. All landings were met by a Dockside Monitor who collected a monitoring document (containing location and amount of catch) and measured the amount of fish in each hold. All holds have been calibrated (by an accredited surveyor) and a volumetric determination made by measuring the depth of fish (using a dipping device), and converting to weight from calibration tables specific to each vessel (Rodman, 1992). Over-the-side sales (OSS) foreign vessels continued to have complete observer coverage.

Description of the Fisheries

As in recent years, the 1992-1993 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 (now 38 vessels) accounted for most (94,585 t, 96%) of the total reported quota catches 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 (2662 t, 3% of total stock landings for 1993), midwater trawl, gillnets, and traps. Significant catches (31,572 t) 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 1993 (Table 2). During this period, 86% of total reported purse seine landings for the 1992-1993 fishery were taken. Other major fishing activity occurred in the purse seine fisheries on over-wintering aggregations of herring around Chedabucto Bay (November 1992 through February 1993, 11% of reported purse seine landings), and off Grand Manan Island in the 4Xs fall and winter fishery (October 1992 through January 1993, 2.5% of reported purse seine landings).

The 1993 fishery continued to be highly influenced by markets and was again affected 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 to foreign vessels.

Catch Statistics

The historical summaries of TACs, stock and non-stock catch totals are presented in Table 3, and the historical record in major components of the fishery is presented in Table 4. Landings to OSS and domestic markets are summarized in Table 5.

The implementation of a complete dockside monitoring program represents a significant change in this fishery, which has been plagued by erroneous reporting (Stephenson 1993). It appears that we can now feel confident regarding the number of landings and the reported volume of fish landed. Comparison of measured landings (DMP dippings) with hails (Captain's estimate prior to landing) shows close agreement (most within 10%; M. Etter, Stats Div., pers. comm.)

There is, however, a minor problem created by the conversion of volume (as measured in the holds) to weight of fish. The industry and DFO agreed, for the purposes of monitoring, to use a bulk density conversion (BDC) of 860 kg m⁻³. Weighouts of entire holds and density measurements in smaller containers, however, indicate that this is an underestimate (W.K. Rodman, DFO Industry Services, pers. comm. and Reports to SFHAC). The density of herring

flesh is approx 1040 kg m^{-3} . A bulk density conversion of 860 kg m^{-3} is only achieved when herring is suspended in wet holds, under ideal conditions. Density in full holds is higher, with "dry" hold density measured as about 990 kg m^{-3} .

It is clear that the use of 860 kg m^{-3} is an underestimate of actual landings. This is particularly true of the OSS landings which are measured in dry (drained) volumetric pens, and in previous years were converted to 920 kg m^{-3} , but this year were also calculated at 860.

Correction of the purse seine landings to a bulk density conversion of 920 kg m^{-3} (i.e. multiplied by 1.0698 to account for the underestimate from a BDC of 860 kg m^{-3}) increases the 1993 landings by 6626 t (6.7% of stock landings) as follows:

Portion of fishery	Stats @ 860 (t) (from Table 2)	Stats @ 920 (t)
4W purse seine	10731	11479
4X fall p.s.	2209	2363
4X winter p.s.	167	179
4X summer p.s.	81478	87165
Midwater trawl	343	367
Total purse seine	94928	101554 (diff = 6626 t)
+ other stock gear	3535	3535
Total stock	98464	105089 (diff = 6.7%)
+ 4X NB weir/shutoff	31572	31572
Total 4WX	130036	136661

Comparison of catch statistics with production backcalculation

In recent years an attempt was made to overcome the problem of poor delivery note landings data by estimating landings from other sources. Stephenson (1993) reported calculation of estimates for the period 1985-1992 based on (1) interviews with members of the purse seine fleet, and (2) back calculation from records of processed herring products to round landed weight. The back calculation method, using conversion factors in Table 6 was accepted by the CAFSAC Pelagic Subcommittee as a useful, annually available, estimate to use on an ongoing basis. This is documented for 1993 and other years in Tables 7 and 8. Back calculation from 1993 production figures indicate a fishery of 107,764 mt. This

compares reasonably well with the recorded landings from DMP this year at 860 kg m^{-3} (98,464 mt), and very well with recorded landings at 920 kg m^{-3} (105,089 mt) (Fig. 2).

Biological Sampling

As in previous years, sampling of commercial catches was stratified by area, gear 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 1993 resulted in 604 length frequencies and 5,840 fish analyzed in detail (4459 aged). The distribution of sampling is shown in Table 9.

Biological samples were matched to landings by gear component on a monthly basis as in previous assessments, and numbers at age from commercial catches were generated in the traditional manner. Where possible, length frequency samples were applied for each gear component 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

Length frequency distributions of components of the 4WX herring fishery are presented in Fig. 3a and 3b. The age composition of landings in stock and non-stock segments of the 1993 fishery and the proportion by age for each fishery (based on reported, unadjusted landings) are presented in Tables 10 and 11. The 1989 year-class (age 4) was dominant in major stock fisheries in number (31%) and weight (28%). The strong 1983 year-class, now age 10, contributed 6% by weight to the landings (Table 10). Age 2 fish again dominated the non-stock fisheries on the New Brunswick side of the Bay of Fundy in number (56%), but age 3 made up 25% of the numbers and dominated by weight (30%) (Table 11).

The historical series of catch at age in number and weight for 4WX herring as was compiled by Sinclair and Iles (1981) has been extended with the reported (unadjusted) landings for 1993 (Table 12, 13).

LENGTH AND WEIGHT AT AGE

Average weight and length at age by gear segment is presented in Table 14. Recent assessments (e.g. Stephenson and Power 1988, 1989; Stephenson et al. 1990b, 1991, 1992, 1993a) have used fishery-weighted weights at age (mean for stock fish weighted by gear) and this series has been extended in Table 15.

INPUT FROM INDUSTRY

Purse Seine Fishery Logbooks

The purse seine logbook, introduced in 1985, has been a major source of input from the industry with respect to location and performance of major portions of the fishery, searching activity and effort, and observations and comments from members of the fleet (Power and Stephenson 1986, 1987, 1991). Data quality has been enhanced through provision of annual feedback to contributors of all individual data provided - and it has generally been agreed that the logbook is one of the most valuable sources of information available from this dominant sector of the Scotia-Fundy herring fishery.

Unfortunately, implementation of the Dockside Monitoring Program (DMP) (with its new Monitoring Document) and uncertainty surrounding the end of the long term management plan during 1993, resulted in a substantial decrease in use of the biological logbook for this year. Although submission remained a condition of licence, log submission decreased (from complete coverage of recent years) to only 18 of the 38 vessels or 38% of Statistics Division landings (Table 16). Some apparently thought that the log had been replaced by the Monitoring Document, and others stopped filling it out when it was not being collected by monitors (it had been collected by Fishery Officers in the past). Considerable effort is being made to return to the excellent logbook submission level of previous years through more explicit wording in license conditions, combined with the help of the seiner associations in distribution and collection of logs.

Records from those log records which were returned in 1993 were considered to be a useful indicator of activity and events in the purse seine fishery.

Logbooks document fleet activity with respect to traditional fishing areas grounds (Table 16, Fig. 4). They document not only the consistent overall pattern of the fishery over areas and time (e.g. Fig. 5a, b, c), but also some unique occurrences and changes each year. In the early and late summer of 1993 there was substantial fishery activity east of Cape Sable Island, extending a feature which had developed the previous year (Fig. 5a, Table 16). Logs verify the decreased contribution of Seal Island and Gannet/Dry Ledge spawning grounds and the absence of spawning fish on German Bank during the early portion of the expected roe fishery. The relative importance of Western Hole, Liverpool, S.W. Grounds and the area off Shelburne all increased. Significant landings were recorded from Lurcher Shoal. The winter

fishery which had, in recent years, been confined to the vicinity of Chedabucto Bay, took place near Halifax.

Logs have been used in recent years to synthesize some anecdotal information from this fishery. An individual familiar with the fishery interprets and codes general comments and reasons given for released sets (Table 17, 18). Comments in 1993 indicated an increase in "feedy" fish and a number of comments related to the fish being hard to catch or not suitable for market (fish deep, shallow, small, feedy). Importantly, there was no apparent sign of a problem of abundance - several comments indicated large area and schools, and we recorded the first observations in the series of large areas of "eyeball larvae".

Log records confirm the impact of market on fishing activity (Table 19). The OSS market was proportionately more important than in recent years. The reduced proportion taken for roe reflects both an unexpected (late) timing and distribution of spawning (Fig. 5c) (lack of fish on German Bank during the expected time), and market conditions (low price relative to OSS, poor roe quality early in season, rigid DMP).

Industry consultations

Aspects of biology and management of the fishery were discussed informally with members of the industry, and formally in a variety of consultations including; biological presentations at the SFHAC, a formal program consultation (June in St. Andrews), and participation in annual and ad hoc sector association meetings. As in the past, these provided a useful overview of the fishery and industry concerns. Significant this year was concern expressed regarding the relatively odd distribution of herring during both summer and winter fisheries, and particularly the absence of herring during the early portion of the spawning season. Some expressed concern that there was a decrease in abundance, but others felt that the fish were simply distributed differently. Many emphasized the degree of limitation placed on the fishery by the new dockside monitoring program, combined with market restriction. There was generally agreement that DMP had been effective. The restriction of roe quality, large fish size required for adult shore (fillet, etc.) and OSS, and nightly catch limits due to production capacity during the (short) roe season all restricted landings.

INDICES OF ABUNDANCE

RESEARCH SURVEY DATA

a) Larval abundance

The 1993 larval herring survey was undertaken using the standard protocol, with sampling between Oct. 24 and Nov. 3 (E.E. PRINCE, Cruise P451).

The traditional index of larval herring abundance has been calculated as the mean of larval density (no. m⁻²) for a standard set of 79 standard stations (Table 20, Fig 6)

(Stephenson et al. 1990a). The time series, shown in Table 20 and Fig. 7, indicates that larval abundance has increased in recent years, and remains above average.

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, 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. 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 Scattarie Island, including Canso Banks. The second survey (Jan. 16) covered the coastal area from Port Hawkesbury to Scattarie 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 mi² 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 (last assessment) 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.

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.

Herring can be quantified in surveys using acoustics if we can find the aggregations. Aerial surveys and fleet activity offer possible methods of pre-survey. The retirement of U. Buerkle from DFO (May 1994) reduces the capability for further development of quantitative acoustics.

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, 1993a). 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. 7; Table 21). 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 1993 survey result was high (Fig. 8). This index has been partitioned by age for recent years (Table 22). 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). Results did not appear to contain the problem of undue influence by single large sets of

juveniles (which resulted in elimination of Stratum 93 in the 1992 index) (Fig. 9). The survey results reflect dominant features of this population, particularly the dominant 1983 year-class.

ENVIRONMENTAL, ECOLOGICAL AND MULTISPECIES CONSIDERATIONS

Recent years have seen some changes in distribution of major portions of the fishery, linked to changes in local availability of herring. These include the absence of overwintering herring in Chedabucto Bay, and odd distribution of herring on summer feeding grounds. Abundance indices indicate that these are not the result of a reduction in overall population size. There is the suggestion that these may have been the result of environmental changes, such as temperature which has been lower than average in areas of relevance to this stock in the last two years (K. Drinkwater, BIO, pers. comm.).

Herring is obviously an important prey item for many species. We have not quantified the degree to which recent changes in abundance of herring is related to changes in other species.

STOCK TRENDS AND FORECAST

Framework for an analytical assessment

An analytical assessment for Div 4WX herring has been precluded in recent years by lack of an appropriate catch record (due to misreporting etc.) and by problems in the analytical assessment. Attempted assessments since 1990 have shown poor analytical resolution in tuning, and unrealistically large increases in estimated population size.

Major investigation of the catch figures for the period 1985-1991 (on the basis of purse seiner interviews and backcalculation from production records) has resulted in catch values which are considered to be a major improvement. This seems to have been confirmed by complete DMP monitoring in 1993.

It is proposed that the most appropriate catch matrix for this assessment would use:

- (1) 1993; recorded landings, converted from volume to weight at 920 (rather than 860) kg m^{-3}
- (2) 1985-1992; landings estimated by backcalculation from herring plant production records, as outlined by Stephenson (1993) (Table 8)
- (3) 1973-1984; a modified catch matrix presented previously (Mace 1985, Stephenson et al. 1985) to account for misreporting and errors in the years 1973-1984.

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 in recent years has resulted in several changes; removal of acoustic survey results, adjustment of the larval herring series to account for age-based mortality, proposed use of an age desegregated bottom trawl index.

Further work needs to be done to evaluate the full impact of these changes on the analytical assessment.

Prognosis

In the absence of an analytical assessment, this evaluation is based primarily on the research survey indications regarding stock status.

Previous assessments indicate a peak in abundance (age 2+) above 600,000 t in the late 1960's, a decrease by approximately half during the 1970's, and an increase during the late 1980's to, or perhaps beyond, the 1967 level (CAFSAC 1987, 1988). Projections for this fishery during the early 1980's indicated that a sustained yield in excess of 100,000 t was possible (Canada 1985), and with the improved stock status of the 1980's the stock was considered to be able to yield 150,000 t (Rivard et al. 1988).

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. The non-stock component has been comprised of landings from New Brunswick weir and shutoff (traditionally considered to be migrants from Division 5 stocks), as well as miscellaneous landings from gillnet and trap in 4Xm and 4W which were considered to be from localized stocks.

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). Within the major SW Nova Scotia spawning area there is additional structure, as individual spawning components are considered to be discrete on time and space scales of relevance to management. The recent history of the fishery reveals changes in the relative contribution of components to the summer fishery (Table 16).

There is concern over the way in which this fishery seems to focus on individual spawning components. The fishery saw a major erosion of the Trinity Ledge and Lurcher spawning components in the past, and is concerned over the potential for local overexploitation of other spawning grounds. The lack of spawning during the early part of

the German Bank fishery in 1993, and the new focus on a spawning aggregation east of Cape Sable are points of concern.

Larval and bottom trawl survey indices have shown an increase over the past decade, and remain high, indicating that the stock is at above-average abundance. At present, the fishery is limited by market, and the serious problem of misreporting appears to have been overcome. However, there is concern regarding changes in distribution. While the changes observed in Chedabucto Bay winter and summer feeding aggregation location may be responses to environmental conditions such as temperature, changes to the relative wellbeing of spawning components is cause for concern.

There are mixed signals from the biological indicators in this fishery which also cause concern. Survey indices indicate above-average biomass, but there have been changes in distribution which suggest some erosion of spawning components. It is recommended that catches should not exceed those of recent years, and that measures be put in place to spread effort across spawning components in order to avoid disproportionate effort on individual spawning grounds and to maintain spawning components.

Major sources of uncertainty and suggested remedies

- 1) Evaluation of stock status requires an improved analytical basis. The committee recommended investigation of formulations of analytical assessment, or alternate methods of evaluation.
- 2) There should be further investigation of the current designation of N.B. weir and shutoff landings as "non-stock". In recent years, an OSS weir component took larger fish than the traditional sardine market and not only "juveniles" which were the basis for the previous assumption. An analytical assessment should investigate scenarios with and without portions of the juveniles landed in the weir fishery.
- 3) The lack of effective abundance indices has been a major problem in the assessment of this and other herring populations (Stephenson et. al. 1990a; Stephenson 1991,1992). 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. For this reason, the committee recommended that continued emphasis be placed on evaluation of the research survey abundance indices.
- 4) The reduction of biological logbook coverage in 1993 resulted in an unfortunate loss of data from the purse seine fisheries. This logbook series is considered to be very valuable to the biological evaluation, and every effort should be made to improve coverage.
- 5) Consideration should be given to individual spawning grounds. This fishery, especially with the current dominance of the roe market, is focused on spawning areas. These are considered to be discrete elements of the stock complex on the scales that are

relevant to management. Disproportionately high effort on some spawning grounds has been considered to have been detrimental to those components (e.g. Trinity Ledge, Lurcher). An attempt should be made to establish the relative size of various spawning components, and further attention given to these in management.

- 6) Long-term strategic planning for this fishery should be explored. The end of the 1983 10-yr plan left this industry without a framework which can guide annual management plans. A recent review of the performance of the 10-yr plan (Stephenson et. al. 1993b) showed the importance of a long term strategy in management, and suggested several improvements which could be made in a future long term plan. The committee encouraged further work on the biological basis for management of this fishery (including the development of appropriate biological reference points), and work on integrating biological considerations with socioeconomic elements in management of this fishery.

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Table 1. Landings (t; calendar year totals) by gear type in NAFO Div. 4WX herring fisheries, 1986-93.

Gear	1986	1987	1988	1989	1990	1991	1992	1993
Purse seine	67918	91625	14750	80154	96566	88838	96415	92223
Weirs	29470	33408	40072	46783	42273	25211	34126	34093
Gillnet	4318	2919	1151	382	457	776	504	653
Traps	296	440	1284	123	183	60	70	164
Shutoffs	371	698	867	637	554	863	68	142
Midwater trawl	28	17	423	783	871	1154	761	343
Miscellaneous	103	74	1329	552	501	1	250	57
Total	102504	129181	159876	129414	141405	116903	132195	127675

Table 2. 1992-1993 reported monthly 4VWX herring landings (t) by major fishery.
(Source: DFO Scotia-Fundy Region Statistics Division.)

4WX Stock Fisheries	1992			1993									1993 Calendar Totals	15 mo. Totals	Quota Totals*	1992-1993 Plan Quota			
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept					Oct	Nov	Dec
1. 4W Winter Purse Seine Note 1		8451	576	1632	73								869	4831		7405	16431	10731	28470
2. 4Xs Fall Purse Seine Note 2	1663	546											1618	1446	109	3174	5383	2209	9000
3. 4Xs Winter Purse Seine Note 3				113	14	39										167	167	167	6000
4. 4Xqr Summer Purse Seine Note 4,6	4455							1255	16707	25758	12168	12024	13566			81478	85933	81478	98218
5. 4X Midwater Trawl				312	31											343	343	343	1512
4X Summer Gillnet	1	4	2				13	12	38	109	168	176			39	556	562	556	
4Xr Summer (N.S.) Weir								226	908	608	867	53				2662	2662	2662	
4X Trap									6	15	53	86				160	160	160	
4X Misc. Gears			0						0	0					0	1	1	1	
4W Gillnet					5	22	55	1	2	6	2			3	2	97	97	97	
4W Misc. Gears (Trap)		35							0	2	2	2				5	40	5	
4WX Russian/Cuban/Domestic OTB									5	3	2	45	0		0	55	55	55	
6. 4WX Gillnet Trap Weir Misc Note 5	1	39	2		5	35	298	956	738	1142	319		42	2	0	3535	3577	3535	8000
Stock Totals	6119	9035	578	2057	87	75	35	1552	17663	26496	13310	12343	16095	6279	109	96102	111834	98464	151200
4WX Non-Stock Fisheries																			
1. 4X (N.B.) Weir	4357	684						14	168	5561	14117	8614	2406	540	10	31431	36471		
2. 4X (N.B.) Shutoff										54	35	29	11	12		142	142		
Non-Stock Totals	4357	684						14	168	5615	14153	8643	2417	552	10	31572	36613		
Total 4WX Landings	10476	9719	578	2057	87	75	35	1566	17831	32112	27462	20986	18512	6831	119	127674	148447		
4Vn Fisheries																			
1. 4Vn Winter Purse Seine Note 1		4228											8	3948		3956	8184	4228	4200
2. 4Vn Gillnet						20	25	8	5	1	1		1	1		64	64	64	
3. 4Vn Traps and Misc Gear	5	50					58	15	17				10	75		173	228	173	
4Vn Totals	5	4278				20	83	22	22	1	1		19	4024		4193	8475	4465	4200
Total 4VWX Landings	10480	13998	578	2057	87	75	55	1649	17854	32133	27464	20987	18531	10855	119	131867	156922	4465	

* 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, 1993 to December 31, 1993.

NOTES

1. Quota period is November 1, 1992 to March 1, 1993	4. Quota period is April 1, 1993 to October 19, 1993
2. Quota period is October 15, 1992 to December 31, 1992	5. Inshore/Fixed and Miscellaneous Gear allocation is for the calendar year 1993.
3. Quota period is January 1, 1993 to February 28, 1993 (? season extended)	6. Includes purse seine bait quota of 2600 t.

Table 3. Recent history of TAC, reported stock, and total 4WX (stock + non-stock) landings ('000 t).

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
TAC	110.0	99.9	65.0 ¹	100.0	80.2	82.0	80.0	125.0	97.6 ²	126.5	151.2	151.2	151.2	151.2	125.0	151.2
Reported stock ³ 4WX catch	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	98.5
Reported total 4WX catch	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	130.0

¹TAC raised from 60.0 t to 65.0 t in mid-season.

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

³Excludes 4Xb weir + shutoff, 4Xn gill + trap, 4W inshore gear.

Table 4. Historical series of nominal and adjusted annual landings (t) by major gear components and seasons of the 4WX herring fishery 1963-1993.

Year ^a	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		6,871	15,093	2,955	5,345		30,264			29,366	29,366
1964		15,991	24,894	4,053	12,458		57,396			29,432	29,432
1965		15,755	54,527	4,091	12,021		86,394	86,394		33,346	119,740
1966		25,645	112,457	4,413	7,711		150,226	150,226		35,805	186,031
1967		20,888	117,382	5,398	12,475		156,143	156,741		30,032	186,773
1968		42,223	133,267	5,884	12,571		193,945	196,362		33,145	229,507
1969	25,112	13,202	84,525	3,474	10,744		137,057	150,462		26,539	177,001
1970	27,107	14,749	74,849	5,019	11,706		133,430	190,382		15,840	206,222
1971	52,535	4,868	35,071	4,607	8,081		105,162	129,101		12,660	141,761
1972	25,656	32,174	61,158	3,789	6,766		129,543	153,449		32,699	186,148
1973	8,348	27,322	36,618	5,205	12,492		89,985	122,687		19,935	142,622
1974	27,044	10,563	76,859	4,285	6,436		125,187	149,670		20,602	170,272
1975	27,030	1,152	79,605	4,995	7,404		120,186	143,897		30,819	174,716
1976	37,196	746	58,395	8,322	5,959		110,618	115,178		29,206	144,384
1977	23,251	1,236	68,538	18,523	5,213		116,761	117,171	109,000	23,487	140,658
1978	17,274	6,519	57,973	6,059	8,057		95,882	114,000	110,000	38,842	152,842
1979	14,073	3,839	25,265	4,363	9,307		56,847	77,500	99,000	37,828	115,328
1980	8,958	1,443	44,986	19,804	2,383		77,574	107,000	65,000	13,525	120,525
1981	18,588	1,368	53,799	11,985	1,966		87,706	137,000	100,000	19,080	156,080
1982	12,275	103	64,344	6,799	1,212		84,733	105,800	80,200	25,963	131,763
1983	8,226	2,157	63,379	8,762	918		83,442	117,400	82,000	11,383	128,783
1984	6,336	5,683	58,354	4,490	2,684		77,547	135,900	80,000	8,698	144,598
1985	8,751	5,419	87,167	5,584	4,062		110,983	165,000	125,000	27,863	
1986	8,414	3,365	56,139	3,533	1,958		73,409	100,000	97,600	27,883	
1987	8,780	5,139	77,706	2,289	6,786		100,700	147,100	126,500	27,320	
1988	8,503	7,876	98,371	695	7,518	1,690	124,653	199,600	151,200	33,421	
1989	6,169	5,896	68,089	95	3,308		83,557	97,500	151,200	44,112	
1990	8,316	10,705	77,545	243	4,049	1,769	102,627	172,900	151,200	38,778	
1991	17,878	2,024	73,619	538	1,498	1,453	97,010	130,800	151,200	24,576	
1992	14,310	1,298	80,807	395	2,227	1,190	100,227	136,000	125,000	31,967	
1993	10,731	2,376	81,478	556	2,662	660	98,464	105,089	151,200	31,573	

^aAnnual 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).

Table 5. 1993 herring Over-the-Side-Sales (OSS) and domestic landings from Statistics Division.

Area & Geartype	MONTH								Year Totals
	5	6	7	8	9	10	11	12	
4X N.B. Weirs Total	14	168	5,561	14,117	8,614	2,406	540	10	31,431
4X N.B. Weirs OSS			95	3,067	527				3,688
4X N.B. Weirs Domestic	14	168	5,466	11,051	8,087	2,406	540	10	27,742
4X N.S. P.Seine Total	1,255	16,707	25,758	12,168	12,024	13,566	0	0	81,478
4X N.S. P.Seine OSS	97	5,125	11,404	5,319	1,924				23,870
4X N.S. P.Seine Domestic	1,157	11,582	14,354	6,849	10,100	13,566	0	0	57,608
4X N.S. Weirs Total	226	908	608	867	53	0	0	0	2,662
4X N.S. Weirs OSS			38	393					431
4X N.S. Weirs domestic	226	908	570	475	53	0	0	0	2,231
4X Total all Gears	1,494	17,783	31,928	27,153	20,691	15,972	540	10	115,570
4X Total OSS	97	5,125	11,538	8,778	2,451	0	0	0	27,989
4X Total Domestic	1,397	12,658	20,390	18,374	18,240	15,972	540	10	87,581

Table 6. Conversions to round herring weight from various finished products - from Scotia-Fundy herring industry sources; 1991/92.

PRODUCT	CONVERSION
Fresh or frozen:	
Round, whole	1.0
Bait	1.0
Animal feed	1.0
Dressed; head on	1.2
Knobbed; guts in, head off	1.3 (1.25-1.3)
Dressed; head off	1.7
Smoked kippers	2.5
Fillets; butterfly	2.7 (2.2-3.3)
Fillets; boneless	2.7
Fillets; skin off	3.0 (estimate)
Roe	20.0 (17.0-20.0)
Milt	20.0
Canned:	
Ovals	2.0
Sardines; regular can	3.0 (2.5-6.1)
Steaks	3.0
Sardines; deep can	3.2
Fillets; snacks	3.2
Centre cut	3.3
Sardine; two fish	3.4
Cures and others:	
Salted bait	1.1
Salted barrel	1.1 (STACAC=1.5)
Pickled dressed/split	1.9
Pickled fillets	2.7
Vinegar cured fillets; skin off	2.7?
Bloaters	2.5
Boneless smoked	4.0
Meal	5.0

Table 7. Scotia-Fundy Region herring production conversion to round herring equivalent. Production figures are from DFO Statistics Division.

Year	Round equivalence (mt)
1985	175,730
1986	123,022
1987	166,635
1988	207,479
1989	110,763
1990	187,851
1991	133,632
1992	152,811
1993	107,764

Table 8. Estimates of 4WX herring landings from production and transfers, 1985-93 ('000 t)

Year	Estimate from domestic production (S-F Region) ¹	+	OSS ²	+	Estimate tracked to Gulf Region	-	Estimate of fish acquired from other regions	=	Estimated 4WX landings (total)	-	Nonstock plus misc. ³	=	Stock estimated from production
1985	175.7		12.8		7.0		1.0		194.5		29.5		165.0
1986	123.0		3.2		7.0		5.0		128.2		28.2		100.0
1987	166.6		6.8		7.0		5.0		175.4		28.3		147.1
1988	207.5		26.3		7.0		6.0		234.8		35.2		199.6
1989	110.8		33.7		5.0		7.0		142.5		45.0		97.5
1990	187.9		24.5		5.0		5.0		212.4		39.5		172.9
1991	133.6		23.2		5.0		5.0		156.8		26.0		130.8
1992	152.8		15.5		5.0		5.0		168.3		32.3		136.0
1993	107.8		28.0		0.0		0.0		135.8		31.5		104.3

¹From Table 8.

²From DFO Scotia-Fundy Region Statistics.

³N.B. weir + shutoff + nonstock misc.

Table 9. Summary of 1993 4WX herring biological detail and length frequency sampling by area, gear, month and market type.

Year	Area	Gearname	Number Month	Number LF_Samp	Number Measured	Number DetSamp	Number Process	Number Aged
93	4X	Gillnet	09	1	160	0	0	0
		*****	*****	-----	-----	-----	-----	-----
		sum		1	160	0	0	0
		Midwater Trawl	01	3	960	3	46	45
			03	1	287	1	17	17
			11	1	236	1	228	228
		*****	*****	-----	-----	-----	-----	-----
		sum		5	1483	5	291	290
		N.B. Purse Seine	10	7	1733	5	107	107
			11	4	931	3	64	64
		*****	*****	-----	-----	-----	-----	-----
		sum		11	2664	8	171	171
		N.B. Weirs	06	5	1468	3	68	37
			07	12	3190	8	247	246
			08	46	11202	17	757	507
			09	33	8030	9	424	264
			10	21	5531	9	190	190
			11	4	1031	2	31	31
		*****	*****	-----	-----	-----	-----	-----
		sum		121	30452	48	1717	1275
		N.S. Purse Seine	05	6	1120	1	34	34
			06	95	19492	11	421	334
			07	196	41026	15	572	420
			08	79	17242	13	537	203
			09	40	9155	11	486	267
			10	7	1564	5	197	197
		*****	*****	-----	-----	-----	-----	-----
		sum		423	89599	56	2247	1455
		N.S. Weirs	06	8	2379	6	305	249
			07	5	1293	2	41	41
			08	9	2183	7	317	316
****		*****	*****	-----	-----	-----	-----	-----
		sum		22	5855	15	663	606
	4W	Purse Seine	01	7	1975	5	236	236
			02	3	810	2	93	93
			10	2	496	2	91	91
			11	9	2301	6	331	242
		*****	*****	-----	-----	-----	-----	-----
		sum		21	5582	15	751	662
****				-----	-----	-----	-----	-----
****	sum			604	135795	147	5840	4459

Table 10. Catches by age in numbers (thousands) and weight (t) from stock gear components of the 1993 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	2,054	1,927	12,473	6,484	6,399	3,795	6,876	5,625	4,795	1,386	51,814
4X N.S. P.Seine	0	18,143	26,279	152,408	106,990	53,710	26,290	12,216	13,809	13,837	8,585	432,267
4X N.B. P.Seine	152	11,254	7,263	3,259	1,140	389	25	98	52	0	0	23,632
4X N.S. Weirs	0	6,172	2,419	7,518	3,614	868	559	297	377	156	169	22,149
4WX Misc.	0	110	549	1,779	1,203	498	232	140	140	111	71	4,833
4X Midwater Trawl	0	32,078	1,552	0	0	0	0	0	0	0	0	33,630
Total Nos. by Age	152	69,811	39,989	177,437	119,431	61,864	30,901	19,627	20,003	18,899	10,211	568,325

% 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	4	4	24	13	12	7	13	11	9	3	100
4X N.S. P.Seine	0	4	6	35	25	12	6	3	3	3	2	100
4X N.B. P.Seine	1	48	31	14	5	2	0	0	0	0	0	100
4X N.S. Weirs	0	28	11	34	16	4	3	1	2	1	1	100
4WX Misc.	0	2	11	37	25	10	5	3	3	2	1	100
4X Midwater Trawl	0	95	5	0	0	0	0	0	0	0	0	100
Overall % Nos. by Age	0	12	7	31	21	11	5	3	4	3	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	141	169	1,829	1,072	1,379	927	1,814	1,560	1,394	449	10,732
4X N.S. P.Seine	0	786	2,982	23,590	20,346	11,572	6,628	3,504	4,315	4,638	3,114	81,476
4X N.B. P.Seine	3	513	847	493	216	88	6	27	15	0	0	2,209
4X N.S. Weirs	0	152	210	1,029	627	184	142	89	118	50	62	2,663
4WX Misc.	0	4	69	268	225	107	58	40	42	35	24	873
4X Midwater Trawl	0	460	49	0	0	0	0	0	0	0	0	509
Totals Catch t by Age	3	2,056	4,326	27,209	22,486	13,330	7,761	5,474	6,050	6,118	3,650	98,463

% 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	2	17	10	13	9	17	15	13	4	100
4X N.S. P.Seine	0	1	4	29	25	14	8	4	5	6	4	100
4X N.B. P.Seine	0	23	38	22	10	4	0	1	1	0	0	100
4X N.S. Weirs	0	6	8	39	24	7	5	3	4	2	2	100
4WX Misc.	0	1	8	31	26	12	7	5	5	4	3	100
4X Midwater Trawl	0	90	10	0	0	0	0	0	0	0	0	100
Overall % by Age	0	2	4	28	23	14	8	6	6	6	4	100

Table 11. Catches by age in numbers (thousands) and weight (t) for non-stock gear components of the 1993 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 plus shutoff	1,718	244,079	106,099	37,186	23,218	12,260	4,915	1,120	1,101	864	175	432,735
Total Nos. by Age	1,718	244,079	106,099	37,186	23,218	12,260	4,915	1,120	1,101	864	175	432,735

% 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 plus shutoff	0	56	25	9	5	3	1	0	0	0	0	100
Total Nos. by Age	0	56	25	9	5	3	1	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 plus shutoff	28	8,132	9,361	5,314	4,107	2,520	1,158	310	316	269	57	31,572
Total Catch t. by Age	28	8,132	9,361	5,314	4,107	2,520	1,158	310	316	269	57	31,572

% 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 plus shutoff	0	26	30	17	13	8	4	1	1	1	0	100
Total Catch t. by Age	0	26	30	17	13	8	4	1	1	1	0	100

Table 12. 4WX herring catch at age in numbers (thousands) from nominal landings for stock gear components only.

	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	1993
1	0	5762	40	1398	91	6	0	0	6	152
2	72301	138419	80019	50422	89298	77698	96902	70319	110555	69811
3	141067	215599	176197	76865	68122	87092	70656	130153	86997	39989
4	131251	193369	186983	320651	117398	47206	93118	133187	188186	177437
5	84920	94308	36361	147483	261272	60647	48807	64133	82975	119431
6	13633	27081	20180	27924	142065	129020	54856	29990	49501	61864
7	13803	8989	6878	11843	25594	58535	109586	36537	22600	30901
8	16299	11609	2759	4433	12762	13971	63389	58550	23198	19627
9	5418	5107	1879	2043	2519	6313	17079	33010	38786	20003
10	1263	767	866	1897	2285	2911	5738	13265	22666	18899
11+	5207	300	223	395	1712	2333	3717	9808	13546	10211
1+	485162	701310	512385	645354	723118	485732	563848	578952	639016	568325
2+	485162	695548	512345	643956	723027	485726	563848	578952	639010	568173
3+	412861	557129	432326	593534	633729	408028	466946	508633	528455	498362

Table 13. 4WX herring catch weight (t) at age from nominal landings for stock gear components only.

	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	1993	
1	0	0	17	1	0	0	0	0	3	
2	7313	4400	2539	1856	2531	2990	3376	2722	2056	
3	25442	21781	7501	6006	6869	6482	13061	8730	4326	
4	39432	34032	48975	18026	7644	14971	19581	27855	27209	
5	23516	8704	29294	51108	12541	9750	11953	15057	22486	
6	7536	5469	6843	34340	30699	12851	6514	10715	13330	
7	2833	2102	3245	7201	16019	27929	9162	5700	7761	
8	3879	907	1287	3878	4234	18206	15819	6387	5474	
9	1757	677	650	817	2048	5447	10005	11445	6050	
10	337	346	664	785	1026	1928	4276	7097	6118	
11+	132	89	138	635	850	1357	3260	4515	3650	
1+	112177	78507	101153	124654	84462	101912	97009	100223	98463	
2+	112177	78507	101136	124652	84462	101912	97009	100222	98460	
3+	104864	74107	98597	122796	81931	98922	93633	97500	96404	

Table 14. Average weight (g) and length (cm) at age for stock and non-stock gear components of the 1993 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	68	88	147	165	215	244	264	277	291	324
4X N.S. P.Seine	0	43	113	155	190	215	252	287	313	335	363
4X N.B. P.Seine	18	46	117	151	190	227	249	274	282	0	0
4X N.S. Weirs	0	25	87	137	174	211	254	300	314	322	368
4WX Misc.	0	40	126	150	187	215	249	288	304	321	345
4X N.B. Midwater Trawl	0	14	32	0	0	0	0	0	0	0	0
Average for Stock Gears	18	29	108	153	188	215	251	279	302	324	357

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	21.7	23.3	27.8	29.0	31.6	32.9	33.7	34.2	34.8	36.0
4X N.S. P.Seine	0.0	18.6	24.7	27.1	28.8	29.9	31.5	32.9	33.9	34.7	35.5
4X N.B. P.Seine	13.4	18.4	25.0	27.2	29.2	31.0	32.0	33.0	33.0	0.0	0.0
4X N.S. Weirs	0.0	15.7	23.1	26.6	28.6	30.3	32.0	33.8	34.1	34.3	35.5
4WX Misc.	0.0	18.0	25.8	27.2	29.0	30.2	31.6	33.2	33.9	34.5	35.1
4X N.B. Midwater Trawl	0.0	13.2	16.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average for Stock Gears	13.4	15.9	24.3	27.1	28.8	30.1	31.7	33.2	34.0	34.7	35.6

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 and Shutoffs	16	33	88	143	177	206	236	277	287	311	328
Average for nonstock	16	33	88	143	177	206	236	277	287	311	328

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 and Shutoffs	13.9	17.1	23.0	26.6	28.4	29.7	30.9	32.4	32.7	33.4	18.2
Average for nonstock	13.9	17.1	23.0	26.6	28.4	29.7	30.9	32.4	32.7	33.4	18.2

Table 15. Average weights (g.) at age for the 4WX herring fishery (weighting by stock gear components) for 1965-93.

	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	1993
1	0	10	10	0	0	0	12	13	7	0	0	9	18
2	41	41	41	38	53	55	50	21	33	31	48	25	29
3	112	112	112	132	118	124	98	88	79	92	100	100	108
4	172	172	172	191	204	182	153	154	162	161	147	148	153
5	218	218	218	229	249	239	199	196	207	200	186	181	188
6	254	254	254	259	278	271	245	242	238	234	217	216	215
7	286	286	286	280	315	306	274	281	274	255	251	252	251
8	323	323	323	296	334	329	290	304	303	287	270	275	279
9	354	354	354	309	344	360	318	327	324	319	303	295	302
10	389	389	389	364	440	400	350	341	353	336	322	313	324
11+	389	389	389	364	440	400	350	371	365	364	332	333	357

Table 16. Changes in the relative importance of key fishing grounds in the 4X summer purse seine fishery.

		Total Catch in Tons								
Fishery Grounds		1985	1986	1987	1988	1989	1990	1991	1992	1993
4Xa	Long Island	857	3,060	7,309	10,892	21,915	18,755	10,139	3,847	2,364
4Xa	Trinity	35,800	13,419	18,851	18,586	266	1,113	3,255	4,715	1,313
4Xa	Seal Island	13,745	8,894	11,560	18,947	23,420	25,321	13,153	16,077	3,613
4Xa	German Bank	15,502	13,346	16,434	17,692	8,087	11,744	24,548	3,733	4,057
4Xa	Scots Bay		36	3,649	3,949	6,583	8,925	8,750	8,554	4,352
4Xa	Grand Manan	3,584	2,984	2,217	301	968	877	3,428	3,400	521
4Xa	Gannet, Dry Ledge	5,675	2,187	1,474	14,901	2,010	4,163	6,190	27,696	2,737
4Xa	Yankee Bank				194	196	3,646	967	119	
4Xa	Western Hole								3,592	2,172
4Xa	Liverpool							49		4,067
4Xa	S.W. Grounds	558	1,839	184	181	223	56	565	290	2,949
4Xa	Lurcher	308			2,928	18	65	108	2,189	1,616
4Xa	Shelburne									515
4Xa	N.B. Coastal		621	138	126	276	27	530	800	
4Xa	Other or no area	7,294	5,240	6,443		440	214	166	352	
	Total Log Catches	83,323	51,626	68,259	88,503	64,206	74,907	71,922	75,364	30,565
	Total Stats Catch	87167	56139	77706	98370	68089	77545	73619	80807	81478
	Percent Log/Stats	96	92	88	90	94	97	98	93	38
		Percentage of Total Logbook Catches								
Fishery Grounds		1985	1986	1987	1988	1989	1990	1991	1992	1993
4Xa	Long Island	1	6	11	12	34	25	14	5	8
4Xa	Trinity	43	26	28	21	0	1	5	6	4
4Xa	Seal Island	16	17	17	21	36	34	18	21	12
4Xa	German Bank	19	26	24	20	13	16	34	5	13
4Xa	Scots Bay	0	0	5	4	10	12	12	11	14
4Xa	Grand Manan	4	6	3	0	2	1	5	5	2
4Xa	Gannet, Dry Ledge	7	4	2	17	3	6	9	37	9
4Xa	Yankee Bank	0	0	0	0	0	5	1	0	0
4Xa	Western Hole	0	0	0	0	0	0	0	5	7
4Xa	Liverpool	0	0	0	0	0	0	0	0	13
4Xa	S.W. Grounds	1	4	0	0	0	0	1	0	10
4Xa	Lurcher	0	0	0	3	0	0	0	3	5
4Xa	Shelburne	0	0	0	0	0	0	0	0	2
4Xa	N.B. Coastal	0	1	0	0	0	0	1	1	0
4Xa	Other or no area	9	10	9	0	1	0	0	0	0

Table 17. Summary of comments coded from 1987 to 1992 in 4X summer purse seine fishery logbooks.

Year Comment code	Occurence on logs													
	1987	1988	1989	1990	1991	1992	1993	1987	1988	1989	1990	1991	1992	1993
	Number of records							Percent all records						
Not specified	1971	1991	1319	1730	1883	1815	394	82.7	75.5	69.2	77.2	72.8	68.8	47.5
Brit sighting	1		1			2		0.0		0.1			0.1	
Carrying			24							1.3				
Catch not recorded			18	52	12	23	28			0.9	2.3	0.5	0.9	3.4
Eyeball larvae							3							0.4
F.O. hail			8			12	1			0.4			0.5	0.1
Fish deep		21	23	37	49	19	19		0.8	1.2	1.7	1.9	0.7	2.3
Fish in shallow water	1	37	14	19	35	77	21	0.0	1.4	0.7	0.8	1.4	2.9	2.5
Fish on surface	5	6	12	3	5	19	10	0.2	0.2	0.6	0.1	0.2	0.7	1.2
Fish thinned out	50	44	21	16	39	49	20	2.1	1.7	1.1	0.7	1.5	1.9	2.4
Fish very fat		1		1		6	2		0.0		0.0		0.2	0.2
Full of feed							10							1.2
Gave fish away		3							0.1					
Hard to catch	25	39	31	40	44	30	19	1.0	1.5	1.6	1.8	1.7	1.1	2.3
Large area of fish	194	172	144	115	90	118	54	8.1	6.5	7.6	5.1	3.5	4.5	6.5
Large bunches/schools	40	41	17	28	43	48	45	1.7	1.6	0.9	1.3	1.7	1.8	5.4
Little or no fish	14	17	7	10	11	17	5	0.6	0.6	0.4	0.4	0.4	0.6	0.6
Lots of small fish				22	36	5	6				1.0	1.4	0.2	0.7
No feed in fish	21	122	152	72	82	81	27	0.9	4.6	8.0	3.2	3.2	3.1	3.3
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	1	0.6	0.5	0.2	0.3	0.4	0.7	0.1
Poor weather			17	1	18	7	11			0.9	0.0	0.7	0.3	1.3
Received fish				5	6	26	9				0.2	0.2	1.0	1.1
Small area of fish							9							1.1
Small bunches/schools	26	30	16	28	59	63	35	1.1	1.1	0.8	1.3	2.3	2.4	4.2
Some feed in fish		30	35	25	80	71	64		1.1	1.8	1.1	3.1	2.7	7.7
Split market			9	4						0.5	0.2			
Too many boats				1	3	8	1				0.0	0.1	0.3	0.1
Warmer water than normal			5	3						0.3	0.1			
Whales	16	3	6	3	7	3	4	0.7	0.1	0.3	0.1	0.3	0.1	0.5
Various other combined						46	2						1.7	0.2
Total number of records	2382	2636	1905	2240	2586	2638	830	97.6	97.1	100.0	100.0	100.0	100.0	96.4

Table 18. Reasons for releases from 4X summer purse seine logbooks for 1985 to 1993.

Reason for release	Occurrence on Logs % of total sets								
	1985	1986	1987	1988	1989	1990	1991	1992	1993
No release code	78.8	80.4	72.5	74.2	74.8	77.5	75.3	77.7	81.3
Carrying; no set made							0.7		
Condition	0.9	2.5	3.1	2.5	1.7	1	1.4	1.2	0.8
Dogfish	1.7	0.6	0.8	1.0	4.0	2	1.5	2.1	2.3
Feed	1.1	0.1	1.1	2.1	0.8	1.3	0.2	1.6	0.8
Fish dove		0.2	0.5	0.2	0.3	0.6	0.2	0.5	0.2
Fish inside box/line		0.3	0.3	0.2				0.5	0.2
Fish moving fast		0.6	0.5	0.2	0.2	0.2	0.5	0.3	
Fish refused by buyer								0.1	
Fish thinned out		0.4	0.3	0.8	1.3		0.3	0.5	0.5
Fish too deep	0.9	1.8	2.4	1.4	1.2	1.2	1	1.1	0.3
Fish too shallow	1.1	0.4	1.9	1.3	0.2	0.2	1	0.5	0.5
Gave fish away				0.0	1.9	1.6	0.3	0.6	1.9
Gear/crew problems	0.6	0.9	1.4	1.4	1.9	1.3	1.9	1.3	0.7
Market filled	1.3	0.2	0.6	0.3	0.2		0.1	0.2	0.1
Net sunk	0.3	0.6	0.1	0.5	0.6	0.2	0.1		
No fish found	3.3	3.7	2.7	3.4	0.1	0.1	3.6	2.8	0.2
Other Species	0.1	0.4	0.3	0.1	0.2	0.3	0.3	0.3	1.6
Pooling; no set made						0.1	0.6	0.7	0.1
Poor weather	0.9	0.8	1.9	0.9	0.2	0.2	1.5	0.5	0.2
Set too large	0.4	0.4	0.9	0.9	0.3	0.4	0.2	0.1	0.2
Set too small	0.4	0.1	0.2	0.4	0.4	0.7	0.8	0.2	
Size of fish	3.0	1.0	1.6	1.3	4.2	3.5	3.7	2.3	1.3
Skunk set	1.8	1.8	1.5	2.2	1.8	4.1	3	2.8	2.8
Tore up	1.3	1.3	1.9	1.5	0.8	1.3	1	0.9	0.5
Unknown reason	2.2	1.6	2.3	2.0	3.2	2.2	0.9	1.2	1.6
Total No. of Observations	2471	1964	2382	2636	1916	2240	2586	2638	830
Total Released Catch (t.)	2968	1341	3330	3012	2969	1669	651	855	535

Table 19. Market components of the 4X summer purse seine fishery 1989-93 from logbook analysis (Power and Stephenson, unpubl. data).

Market	1989		1990		1991		1992		1993	
	Landings t (logged t)	%	Landings t (logged t)	%	Landings t (logged t)	%	Landings t (logged t)	%	Landings t (logged t)	%
Roe	13,268	21	31,523	43	29,960	42	30777	41	6080	20
Adult shore ¹	24,201	39	25,941	35	21,664	30	29617	40	14219	47
Over-the-side	19,190	31	13,387	18	13,548	19	9443	13	9362	32
Bait	1,950	3	855	1	2,128	3	1247	2	621	2
Fillet	805	1	50	0	924	1	3090	4	40	<1
Sardine ²	57	0	308	0	1,744	2	60	<1	31	<1
U.S. buyers	64	0	57	0	104	0	0	0	0	0
Unspecified	2,422	4	125	0	1,198	2	276	<1	212	1

¹Includes, in some years, a considerable amount of fish which actually went to the roe market.

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

Table 20. Herring abundance indices; larval abundance index (average number of larvae per m2 from 79 index stations) and herring by-catch (stratified mean numbers per tow) from July groundfish research surveys.

Year	Larval Cruise	No.per m2 to bottom			Herring groundfish by-catch			
		Mean	SE	N	Cruise	Mean	SE	N
70					A175/176	4.07	1.54	95
71					A188/189	3.97	1.87	86
72	P109	9.4	1.80		A200/201	1.37	0.62	105
73	P127	6.6	1.30		A212/213	0.92	0.31	96
74	P147	49.5	10.90		A225/226	0.72	0.25	102
75	P160	11.68	1.53	58	A236/237	0.89	0.36	104
76	P175	13.5	2.90		A250/251	0.36	0.20	103
77	P190	6.3	1.00		A265/266	0.54	0.30	106
78	P207	4.54	0.52	77	A279/280	0.34	0.32	103
79	P232	7.1	2.10		A292/293	0.64	0.46	106
80	P246	26.2	6.70		A305/306	0.54	0.51	105
81	P263	2.72	0.31	78	A321/322	1.51	1.35	104
82	P280	10.62	1.21	77	H080/081	1.54	0.90	108
83	P298	13.88	1.61	74	N012/013	2.36	0.80	106
84	P315	12.69	1.44	78	N031/032	6.98	3.53	102
85	P329	40.80	4.59	79	N048/049	3.38	1.83	111
86	P344	18.93	2.14	78	N065/066	23.20	14.92	118
87	P361	27.92	3.16	78	N085/087	10.35	5.56	135
88	P377	100.69	11.55	76	N105/106	2.08	0.62	127
89	P391	54.47	6.13	79	N123/124	8.35	1.78	124
90	P408	27.23	3.06	79	N139/140	5.56	1.88	156
91	P422	48.17	5.45	78	N154/H231	10.64	5.81	137
92	P437	57.00	6.41	79	N173/174	16.46	4.85	136
93	P451	55.01	6.23	78	N189/190	18.65	4.51	137

Table 21. An index of herring by-catch (stratified mean number per tow) in summer groundfish research surveys of 4WX, strata 52-95, 1970-1993; (N = number per set for all sets) (N^h = 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 ^h)	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
1993	N189/190		137	64	2460.15	17.96	38.44	18.65	4.51

*Total includes strata with only one set.

Table 22. Herring by-catch age composition in summer groundfish research surveys.

Year	Percent Numbers 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		100
88		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		0.8	4.3	14.1	17.6	10.5	14.9	25.3	8.8	2.3	1.3	0.1	100
92a		39.7	4.6	6.2	9.5	14.1	7.2	6.5	8.9	1.9	1.2	0.3	100
92b		0.1	2.0	9.9	16.8	25.2	12.9	11.6	16.0	3.5	2.1		100
93		0.4	4.3	16.7	22.1	21.7	16.6	6.7	4.9	4.3	2.3		100

Year	Stratified Total Numbers by Age (thousands)												Total
	1	2	3	4	5	6	7	8	9	10	11-17	99	
87	14	3,060	11,187	8,306	3,236	2,539	1,336	983	562	206	267		31,697
88		830	377	1,095	2,222	1,298	298	104	28	34	26	56	6,368
89	634	720	1,122	2,561	3,274	9,293	5,821	1,109	291	184	213	367	25,588
90	291	753	1,911	2,400	2,035	2,164	3,966	2,225	363	84	188	119	16,500
91		273	1,397	4,614	5,734	3,418	4,874	8,245	2,865	739	435	23	32,618
92a		35,118	4,038	5,458	8,423	12,490	6,349	5,708	7,920	1,715	1,033	238	88,489
92b		52	975	4,903	8,287	12,460	6,349	5,708	7,920	1,715	1,033		49,400
93		228	2,480	9,559	12,622	12,424	9,465	3,838	2,794	2,455	1,293		57,158

92a. All strata used.

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

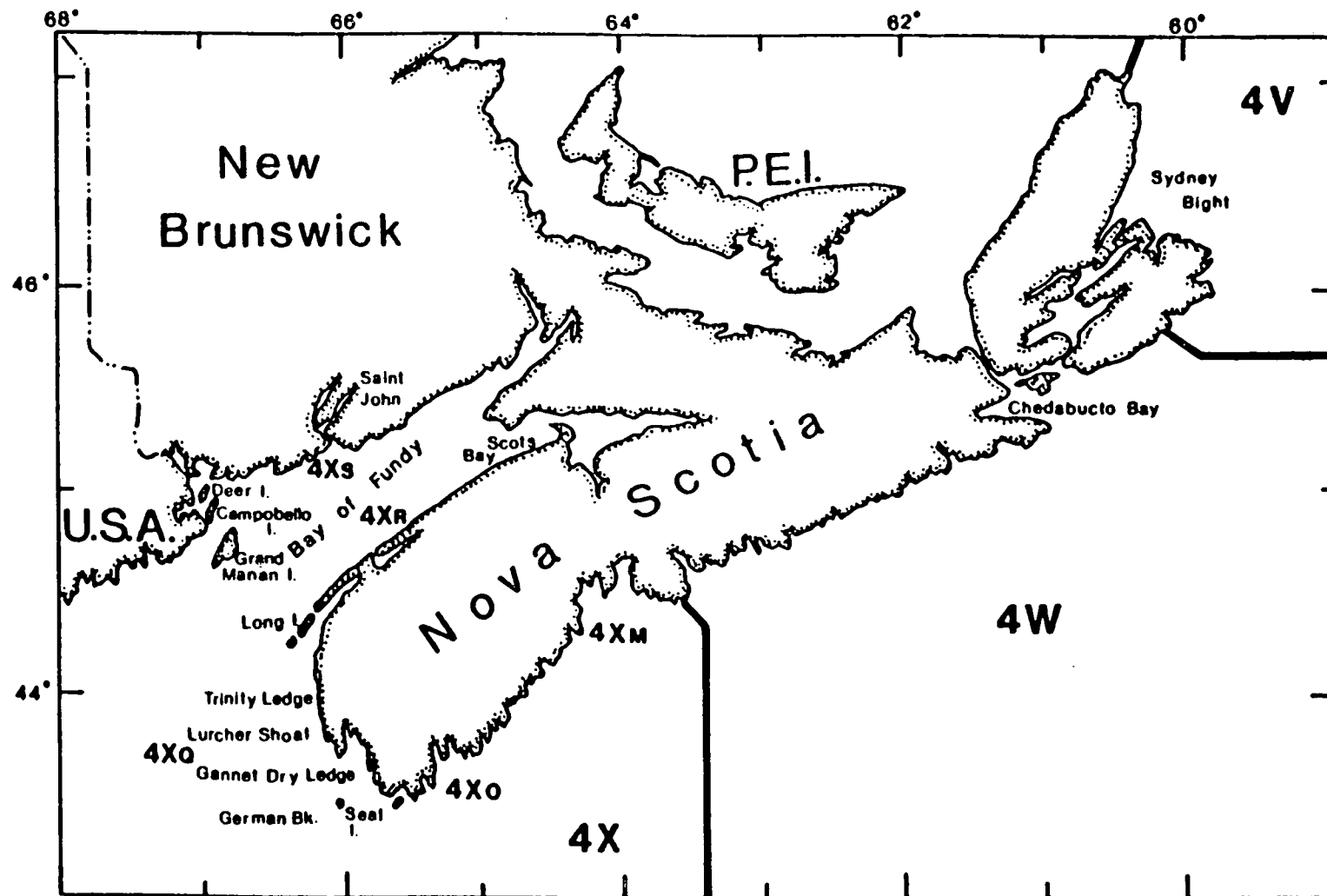


Fig. 1. Map of division 4WX showing major locations mentioned in text.

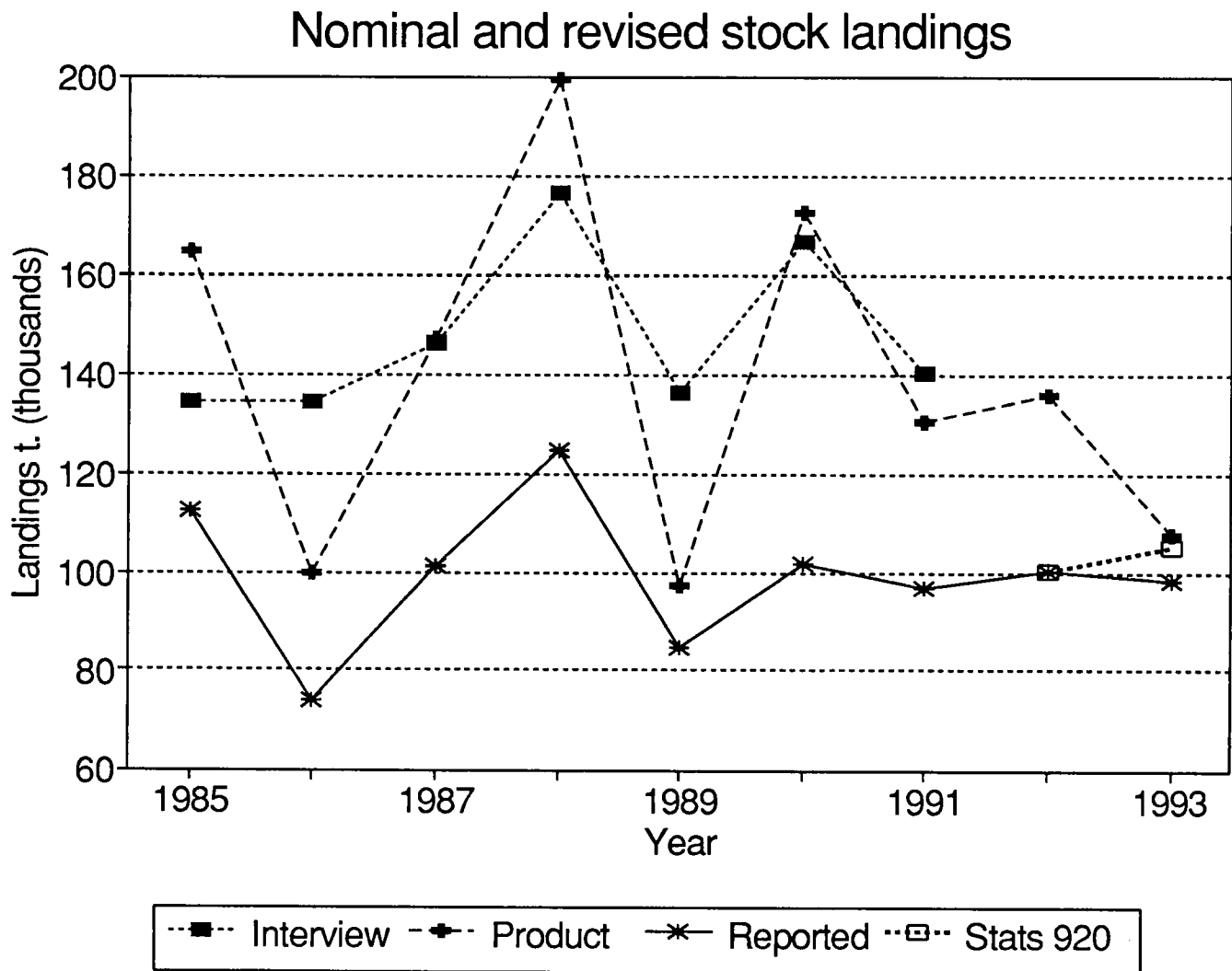


Fig. 2. Comparison of interview and product revised estimated stock landings with nominal (reported) landings - 1985 to 1993.

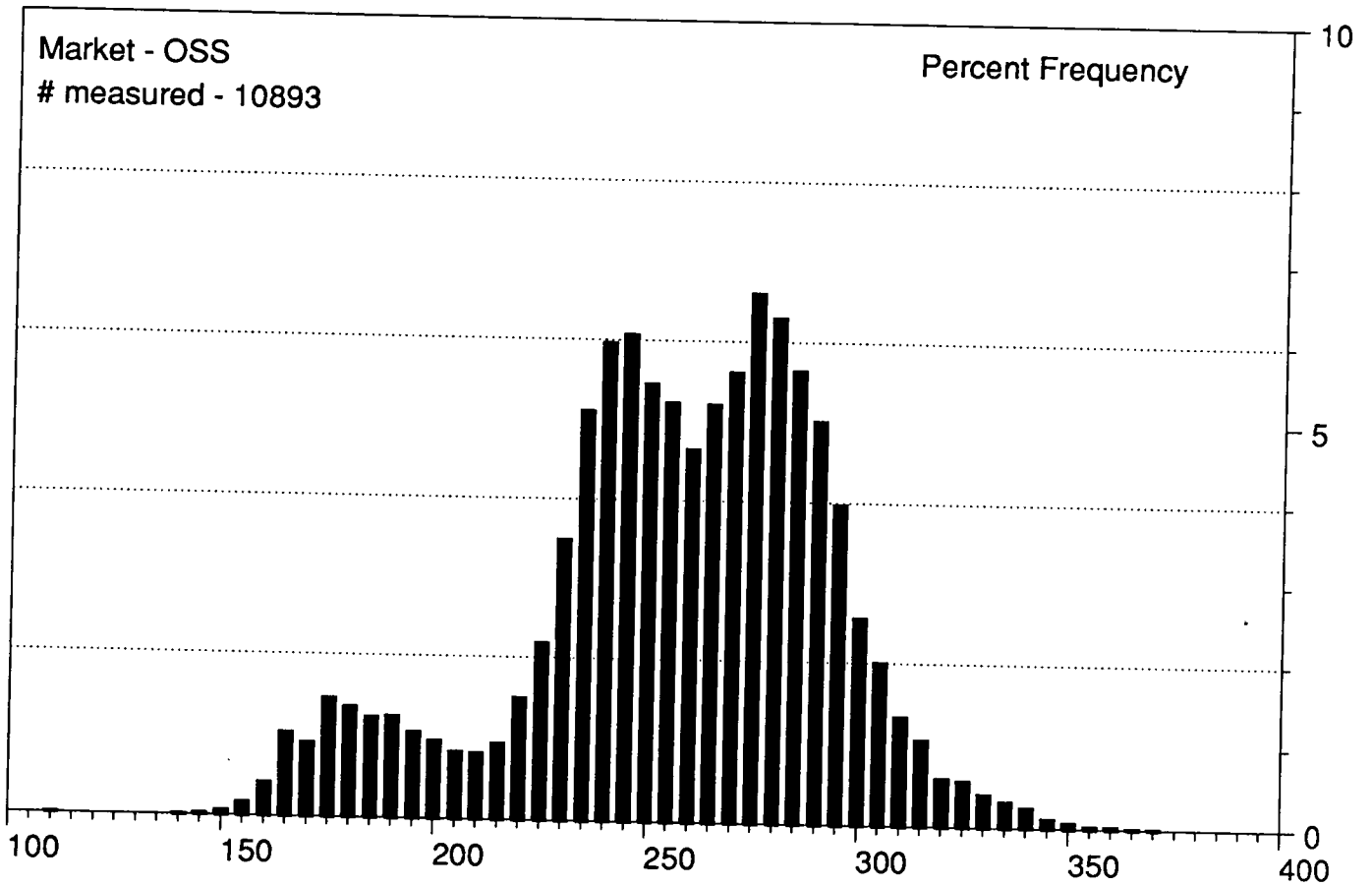
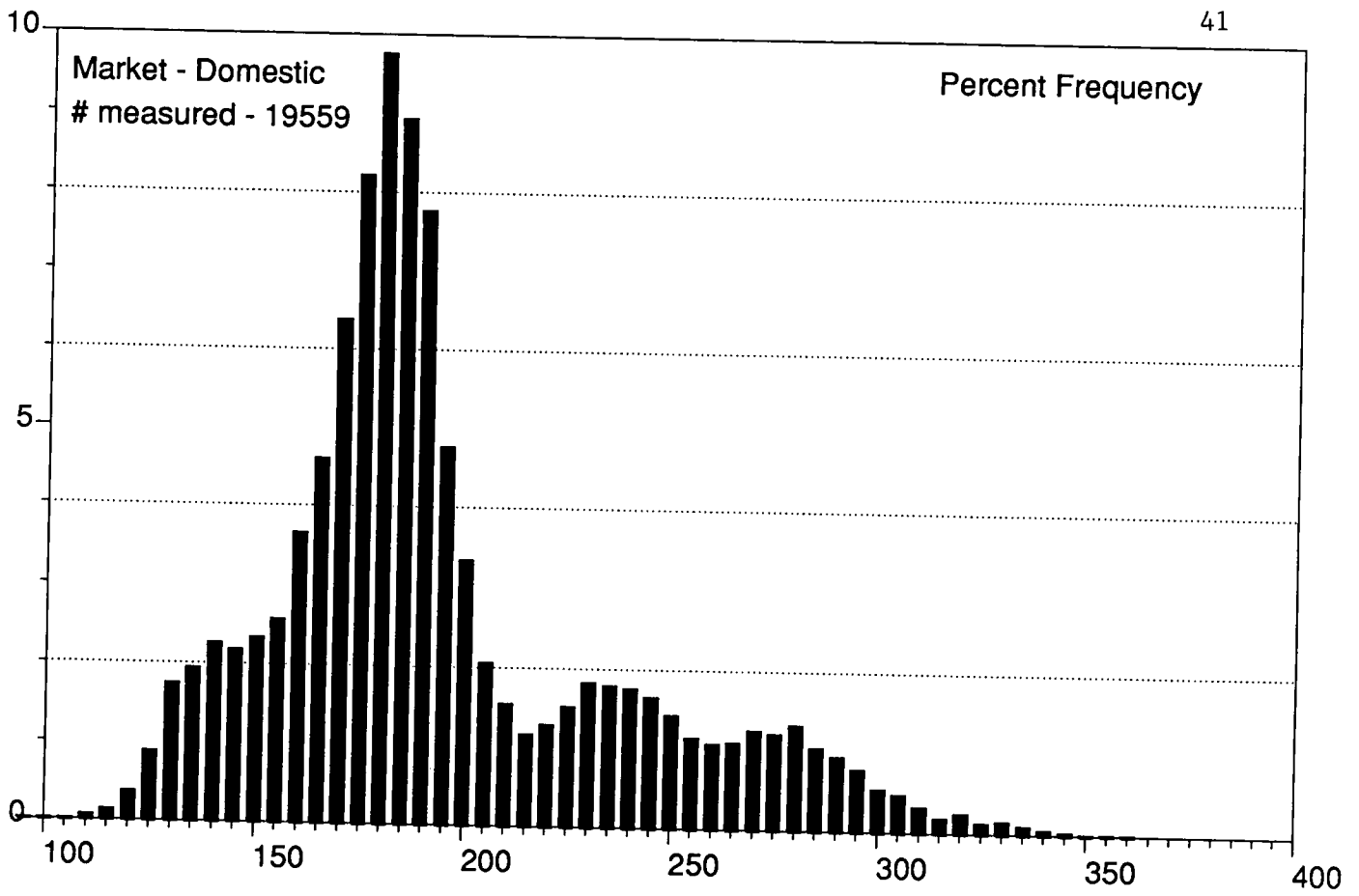


Fig. 3a. Length frequencies by major market type from 1993 4WX herring commercial sampling data.

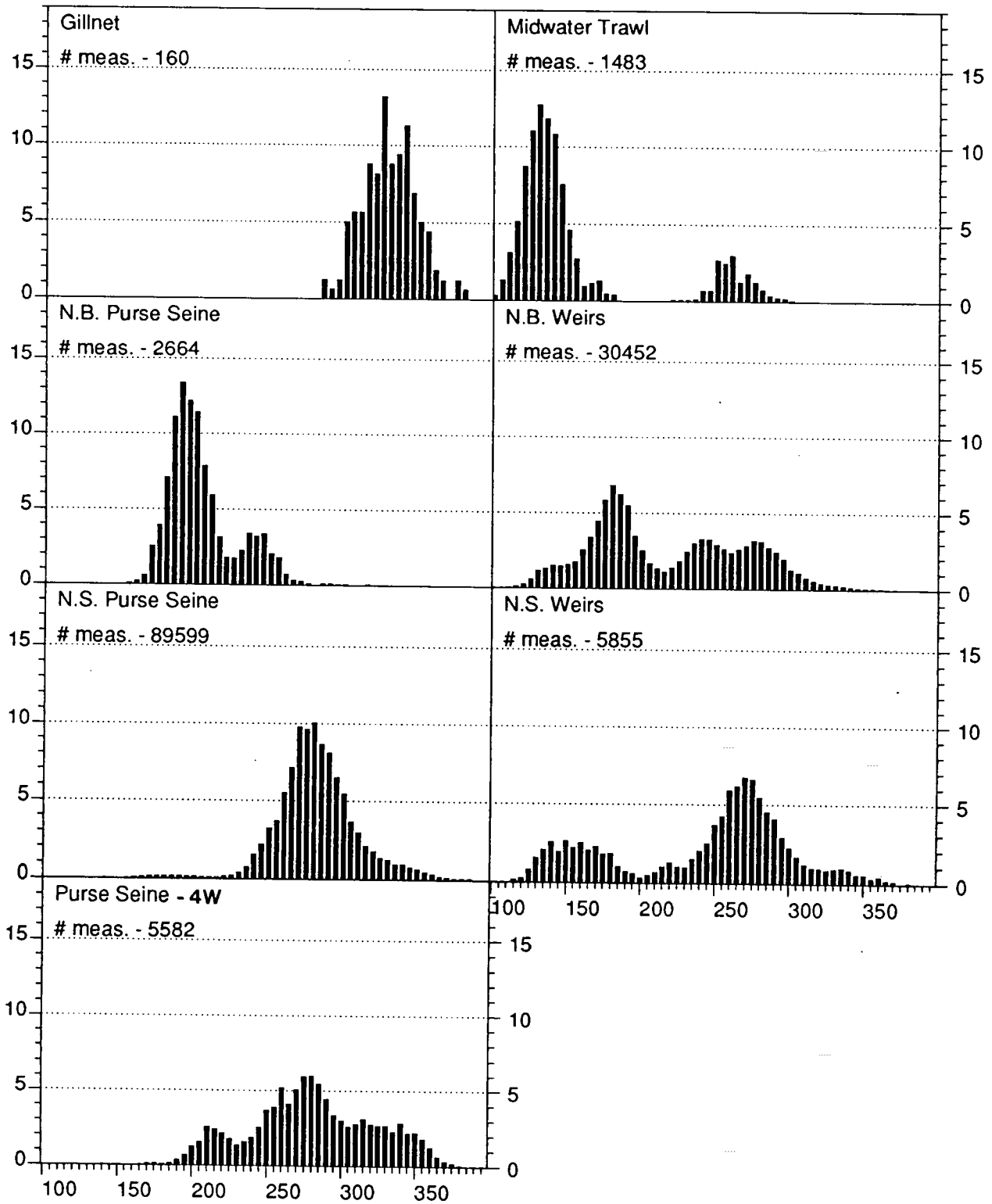


Fig. 3b. Length frequencies by gear type from 1993 4WX herring commercial sampling data.

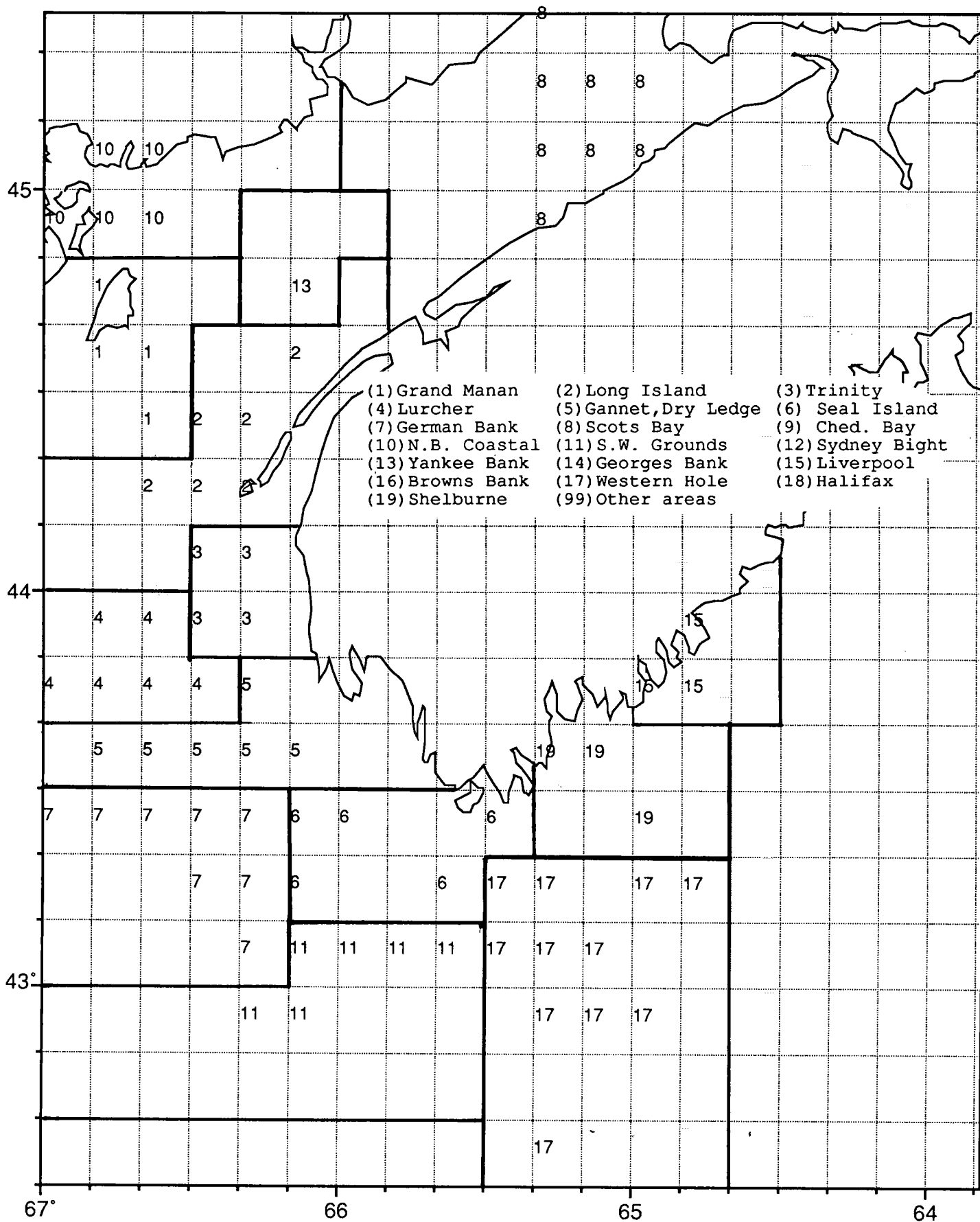


Fig. 4. 4X purse seine fishing ground definitions as defined by 10 mile squares.

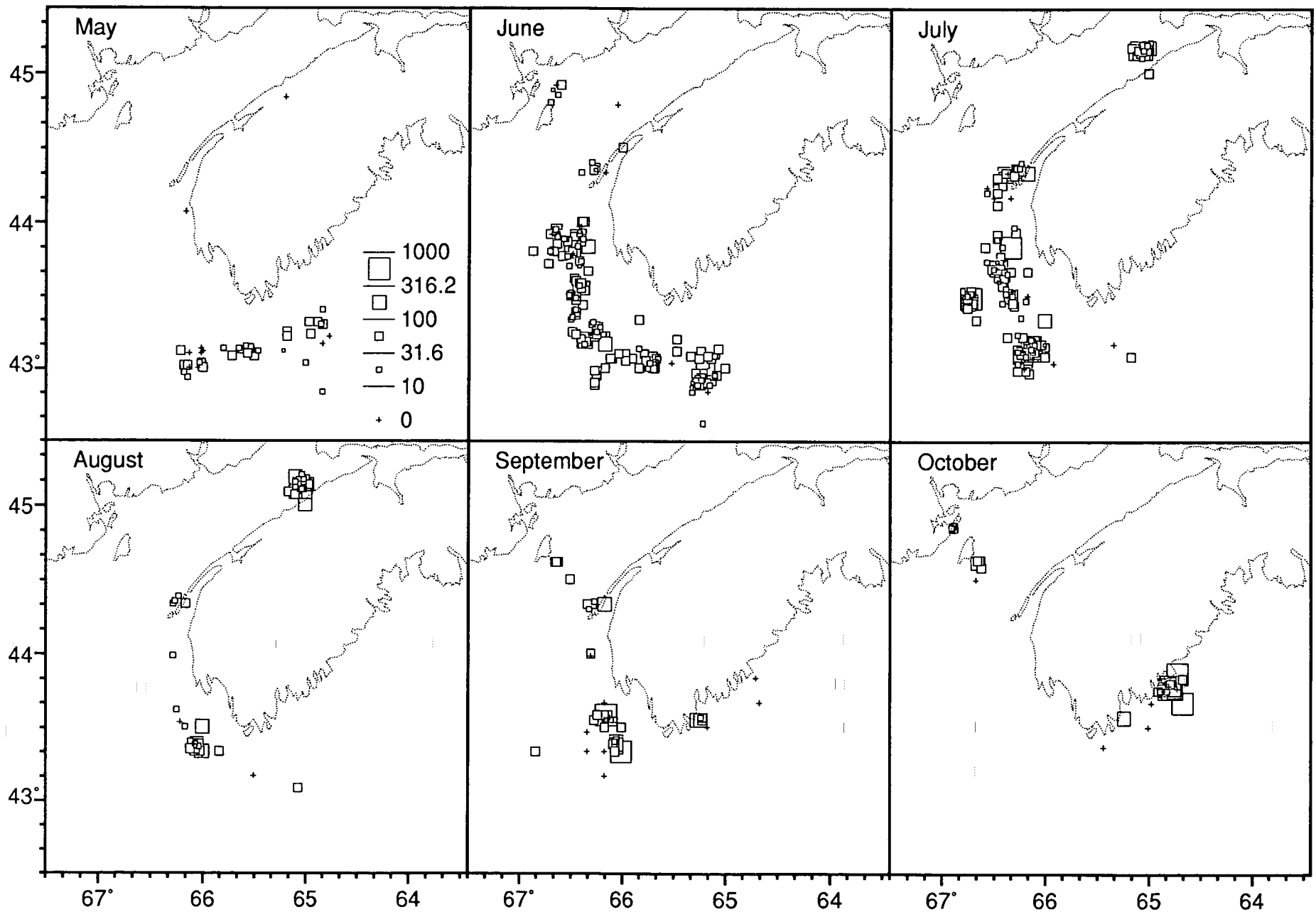


Fig. 5a. 1993 4X N.S. summer purse seine fishery monthly catch distribution by point location of catch (catches summed by 1 mile squares).

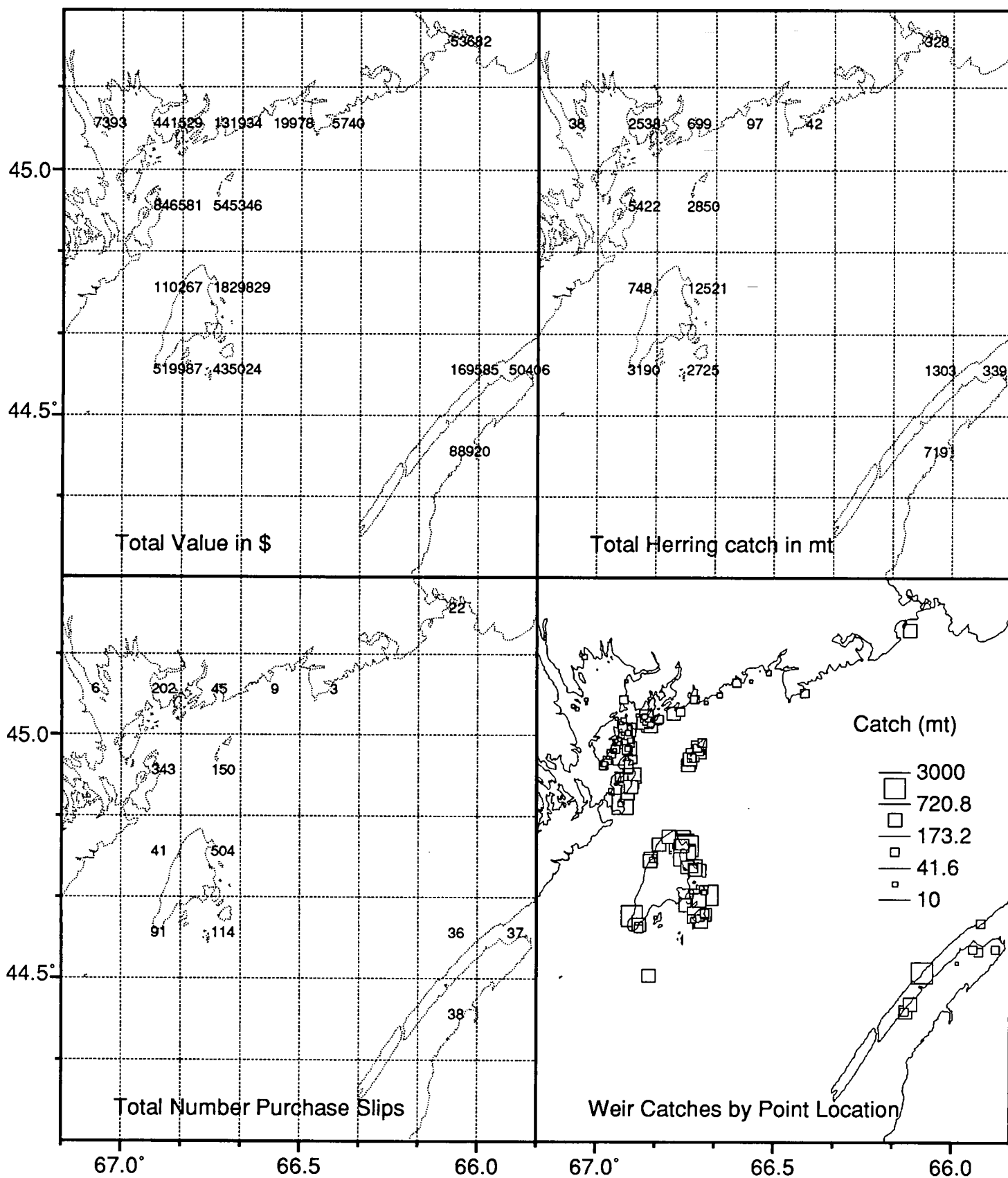


Fig. 5b. 1993 4X New Brunswick and Nova Scotia weir catch distribution by 10 mile squares and point location of catch.

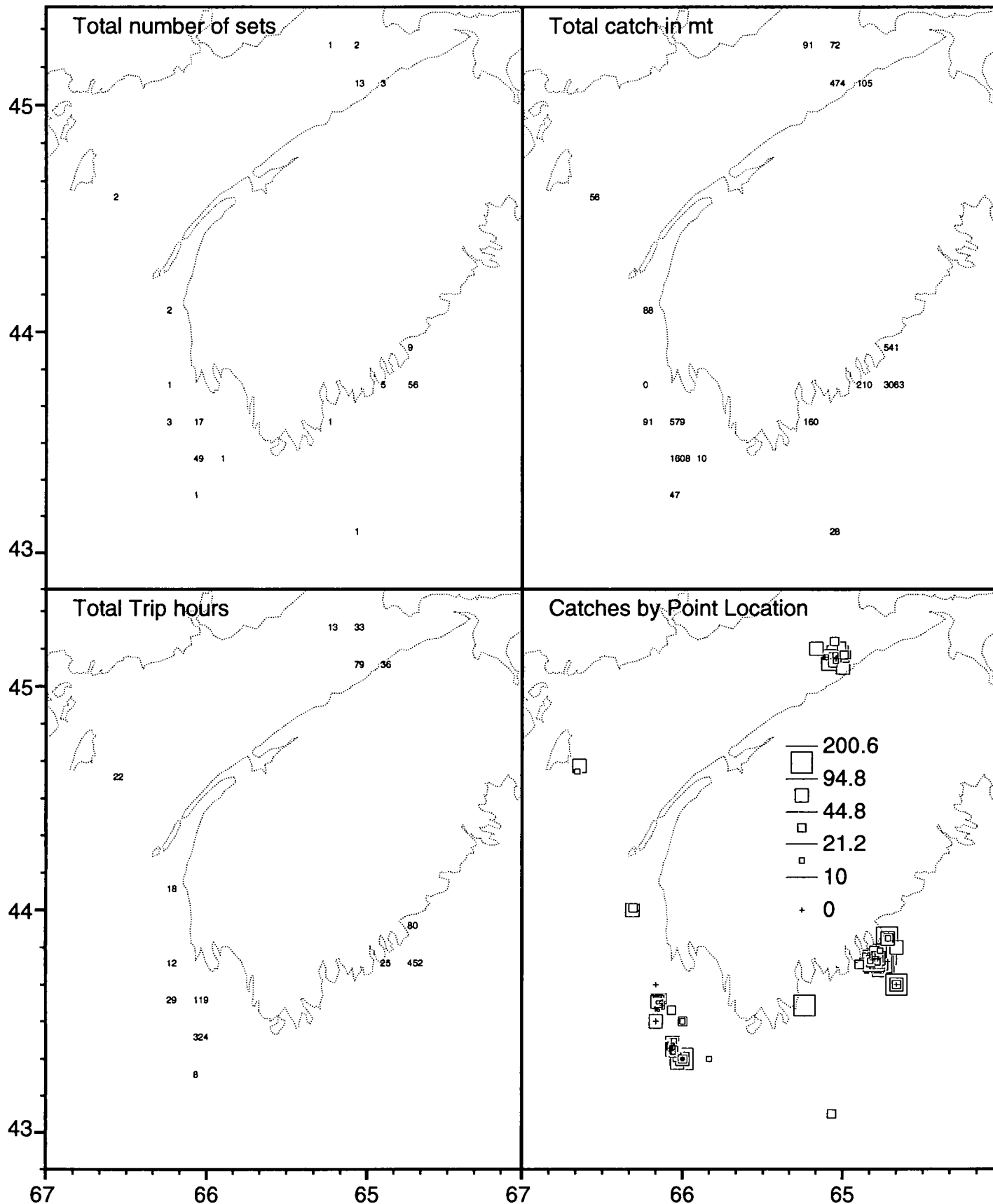


Fig. 5c. 1993 4X N.S. summer purse seine fishery catch and effort distribution by 10 mile square and individual catches by point location for all records where fish roe condition was specified as ripe or spawning (maturity stages 5 and 6).

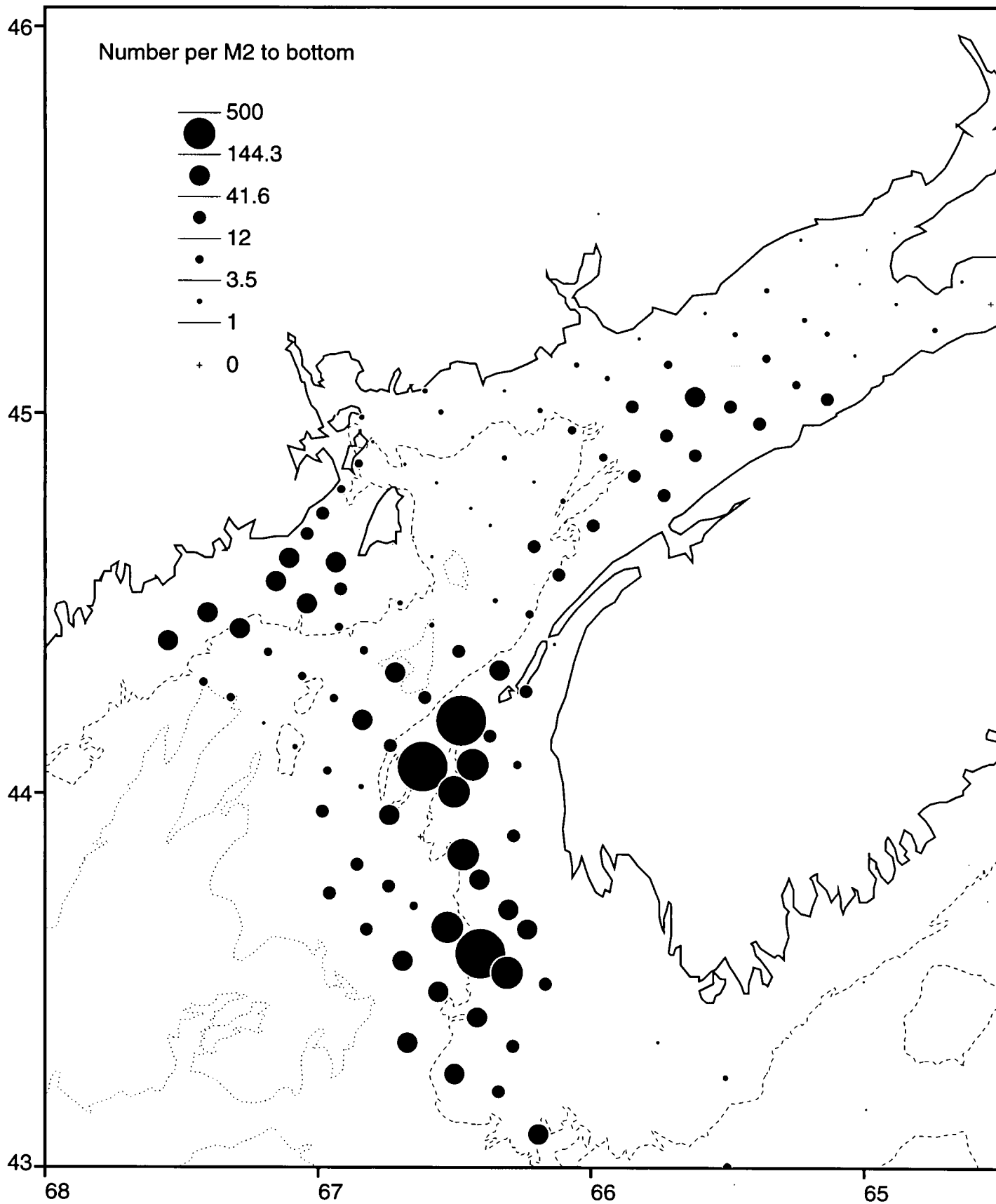


Fig. 6. Larval herring abundance (numbers per m^2 to bottom) by station for EEP-451 larval herring survey (Nov. 1993).

4WX herring abundance indices

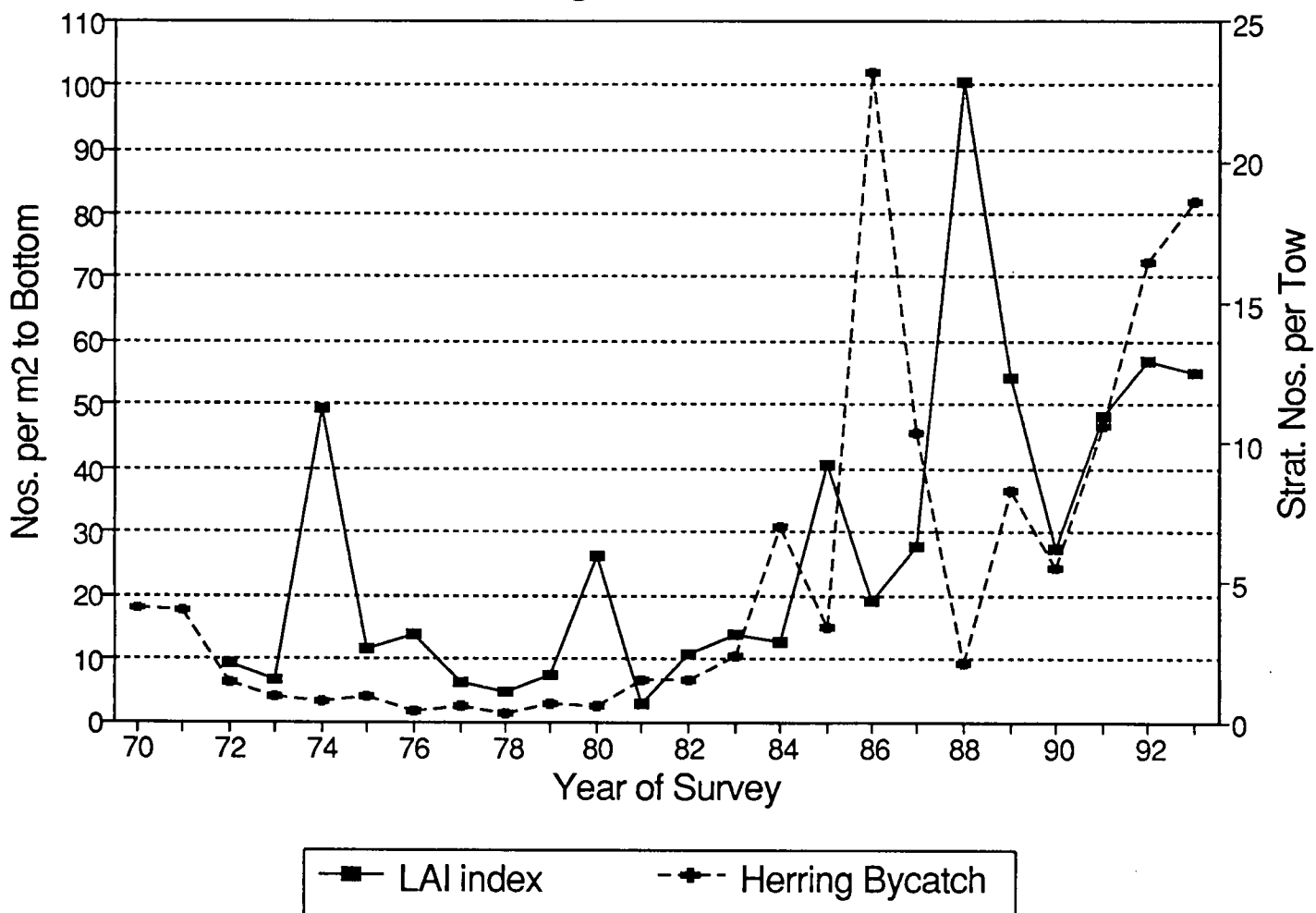


Fig. 7. Herring abundance indices; larval herring abundance index (mean number of larvae per m² to bottom for the 79 index stations) and adult herring bycatch index from summer Scotian Shelf groundfish surveys (stratified mean numbers per tow).

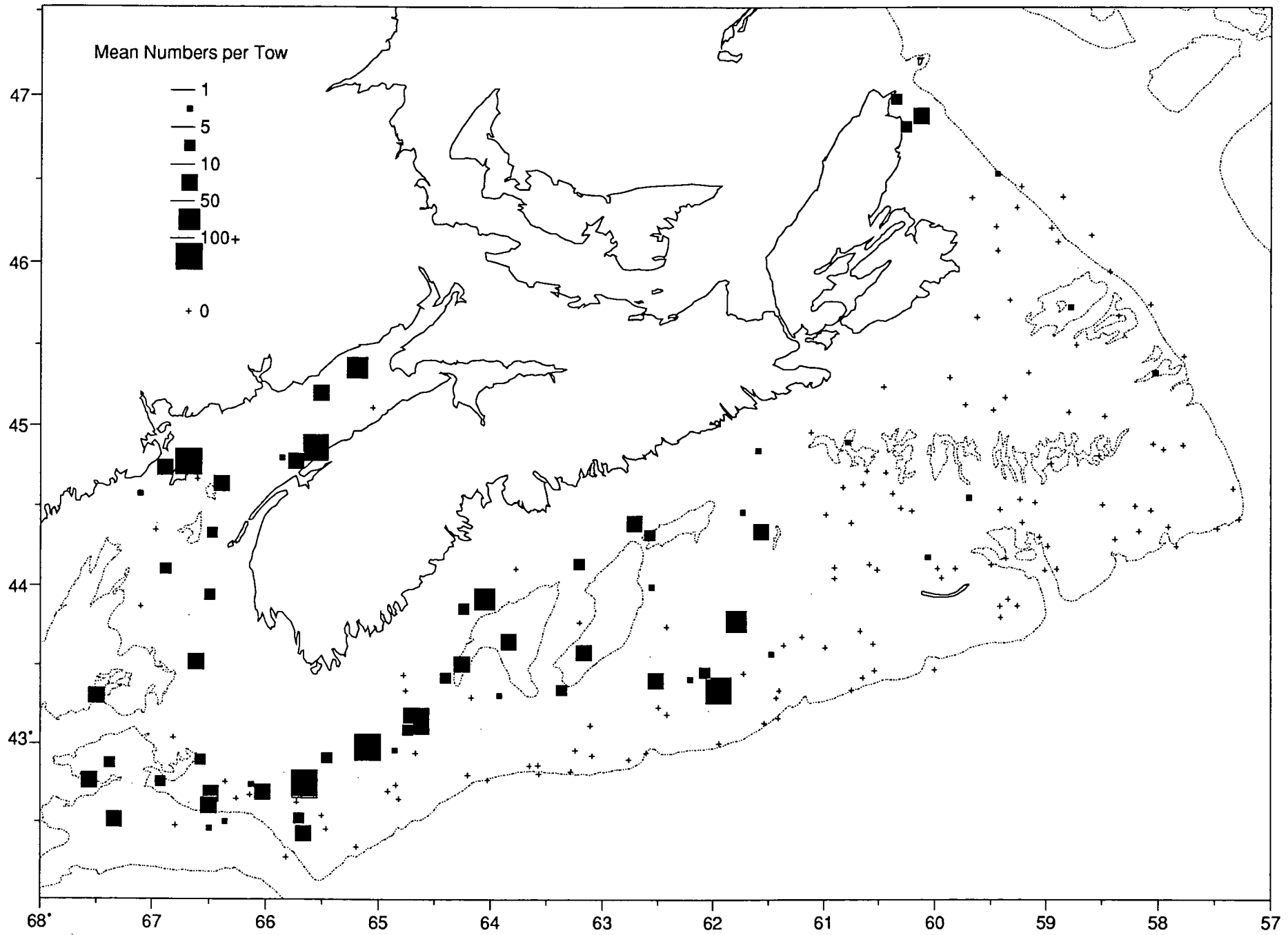


Fig. 8. Occurrence of herring (number per tow) in summer research groundfish survey (bottom trawl) sets for 1993 summer surveys (N173, N174).

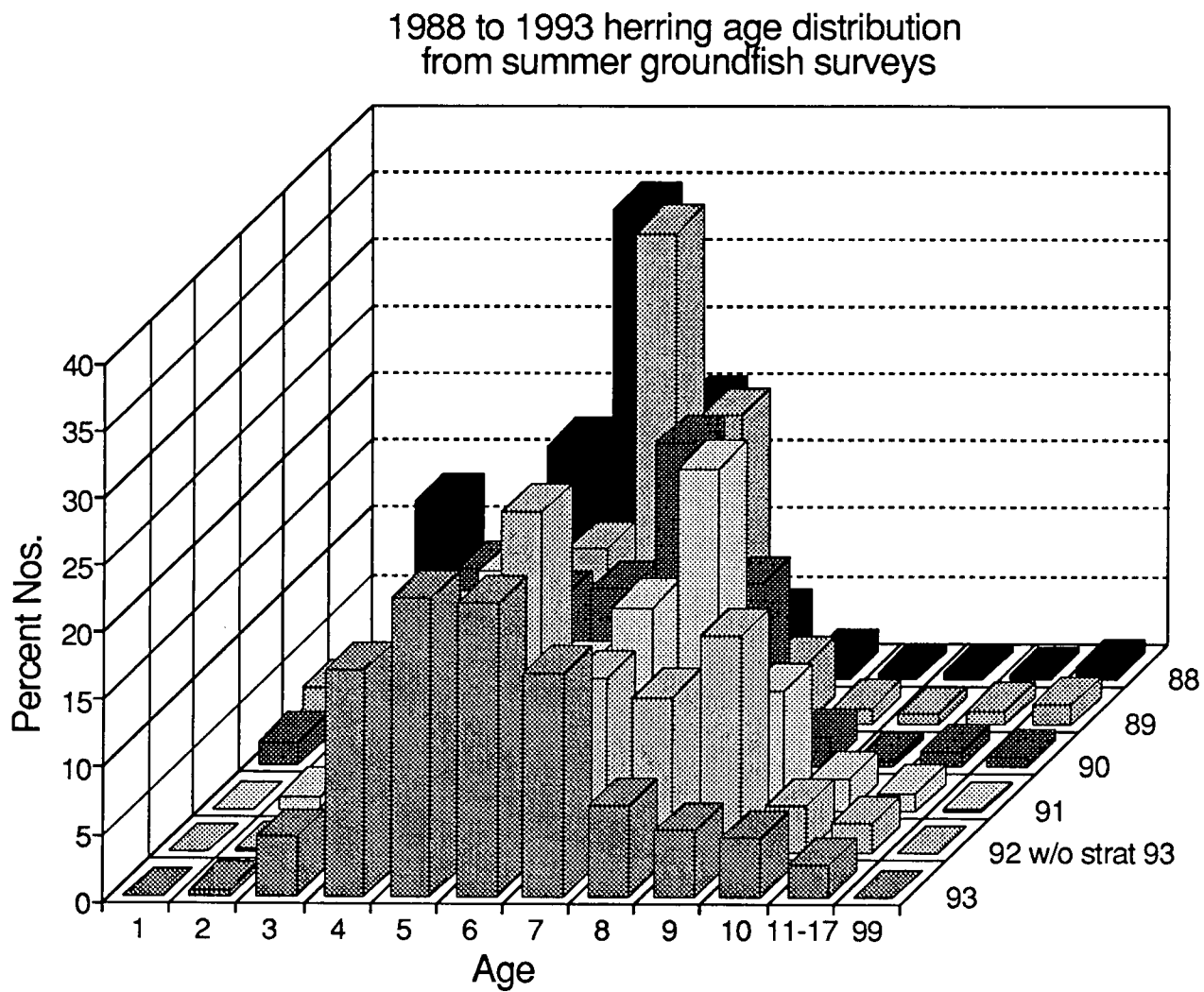


Fig. 9. Age composition of herring from summer research bottom trawl surveys; 1988 to 1993.