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## Evaluation of the Stock Status of 4WX Herring

by

R. L. Stephenson, M. J. Power, J. B. Sochasky  
F. J. Fife, G. D. Melvin, S. Gavaris, T.D. Iles and F. Page

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

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## ABSTRACT

Landings in the stock portion of the 1994 4WX herring fishery declined to 80,100t, the lowest since 1979. An additional 22,200t was recorded from the non-stock weir and shutoff fisheries on the New Brunswick side of the Bay of Fundy. The purse seine fleet dominated landings with catches of 77,500t. The fishery continued to be highly influenced by markets which increasingly sought herring of specific sizes, condition or roe maturity.

The 1991 yearclass (age 3) replaced the 1989 in dominance in major stock fisheries by number but the 1989 yearclass (age 5) continued to dominate by weight. Noticeable in the catch at age for 1994 is the relative weakness of the 1990 yearclass (age 4) which made up only 9% of the landed weight and numbers. Age 2 fish dominated the non-stock fisheries in number (73%) and in weight (40%). Both average weight and average length at age were lower in 1994 than in recent years for most ages. Fat content was also unusually low throughout the summer of 1994 and this was reflected as well in low condition factor as measured in biological samples.

The timing and location of fishing on major fishing grounds have not changed but the relative contribution to the total landings has changed. Comments from the purse seine fleet indicated a general inability to locate and catch large herring needed by markets and an apparent increase in the abundance of small fish. Explanations for release or lack of catch in the purse seine fishery show that herring were behaving unusually and were hard to catch. Herring were reported as being offshore and deep. The proportion of unsuccessful nights were higher in 1994 than in previous years.

Stock status evaluation was based on sampling and analysis of the commercial fishery and the results of independent research surveys. The annual survey of herring larvae showed a dramatic drop in 1994. An analytical assessment conducted with the revised catch at age data and calibrated with larval survey data indicated an increase in biomass during the 1980's, peaking in 1987, followed by a moderate decline. However, the low 1994 larval abundance index combined with apparent physiological and behavioral changes in herring in 1994 are cause for concern and a VPA matching the most recent larval survey point indicates that the population has decreased to approximately 200,000t.

## RÉSUMÉ

Les débarquements provenant de la partie du stock de hareng des divisions 4WX exploitée par les pêcheurs en 1994 ont chuté à 80 100 t, ce qui représente leur plus bas niveau depuis 1979. S'y ajoutent des prises de 22 200 t de hareng hors stock capturé dans les pêcheries à fascines et à senne de plage du côté néo-brunswickois de la baie de Fundy. Les débarquements provenaient essentiellement de la flottille de pêche à la senne coulissante (77 500 t). La pêche a continué d'être très influencée par les marchés, qui cherchaient de plus en plus du hareng répondant à des critères précis de taille, de condition ou de maturité de la rogue.

La classe d'âge de 1991 (âge 3) a remplacé celle de 1989 (âge 5) comme classe numériquement prédominante dans les prises intrastock, mais la classe d'âge de 1989 est demeurée la plus importante pour ce qui est du poids. En ce qui concerne les prises selon l'âge en 1994, il convient de signaler la faiblesse relative de la classe d'âge de 1990 (âge 4), qui ne représentait que 9 % du poids et du nombre des prises. Les poissons de 2 ans ont été prédominants dans les prises hors stock, tant en nombre (73 %) qu'en poids (40 %). Le poids moyen et la longueur moyenne selon l'âge étaient inférieurs en 1994 à ceux des années précédentes pour ce qui est de la plupart des âges. La teneur en matière grasse a aussi été exceptionnellement basse durant tout l'été 1994, ce qui s'est reflété dans le faible coefficient de condition établi d'après des échantillons biologiques.

La période et les lieux de pêche sur les principaux bancs n'ont pas changé, mais on ne peut en dire autant des diverses contributions aux débarquements totaux. Les pêcheurs à la senne coulissante ont fait état d'une incapacité générale à repérer et capturer le gros hareng réclamé par les marchés et d'une augmentation apparente de l'abondance du petit hareng. Les remises à l'eau ou l'absence de prises par la flottille de pêche à la senne coulissante s'expliquent par le comportement inhabituel du hareng et la difficulté à le capturer. On a indiqué que le hareng se trouvait dans les eaux du large et à de grandes profondeurs. La proportion de nuits de pêche infructueuses a été plus élevée en 1994 que dans les années précédentes.

L'évaluation de l'état du stock a été fondée sur l'échantillonnage et l'analyse des prises commerciales ainsi que sur les résultats de relevés de recherche indépendants. Le relevé annuel sur les larves de hareng dénotait une chute considérable en 1994. Une évaluation analytique des données sur les prises selon l'âge révisées et étalonnées d'après les résultats du relevé sur les larves révélait un accroissement de la biomasse durant les années 1980, ayant atteint son point culminant en 1987 pour ensuite diminuer légèrement. Toutefois, la faible abondance des larves en 1994, combinée à des changements dans la physiologie et le comportement du hareng, est source d'inquiétudes et une APV correspondant au plus récent relevé sur les larves révèle que la population a diminué et se situe maintenant à environ 200 000 t.

## OVERVIEW OF 1994 FISHERIES

### The 1993-94 Management Plan - Context for the fisheries

The 1993-94 management plan was essentially a rollover of terms and conditions of the previous year. No formal management plan document was produced but details of the plan are recorded in the minutes of the Scotia-Fundy Herring Advisory Committee (SFHAC) meetings. The TAC remained at 151,200 t and there was a continuation of the mandatory program of Dockside Monitoring. Quotas for 4WX stock herring were established for: (i) the purse seine fleet (141,688 t), (ii) a single mid-water trawler (1,512 t), and (iii) an allocation to "inshore" gear components: gillnets, traps and weirs (8,000 t or 5.3% of the TAC). The plan included fishery area and season restrictions, exclusion from the very upper Bay of Fundy (Scots Bay), and a closure of approximately three weeks on the Trinity ledge spawning grounds. As under the guidelines of the 10-Year (1983) Management Plan, individual quotas were allocated to the approximately 40 purse seine vessels as a percentage of the total TAC.

As in previous years, potential catches from the New Brunswick fixed gear fisheries (weirs and shutoffs) were excluded from the TAC under the annual plan. These fisheries are presumed to target primarily juveniles that are non 4WX stock herring originating from the Gulf of Maine. Also excluded from the quota were inshore herring fisheries along the coast of Nova Scotia (and into 4Vn) which were assumed to be fishing small localized stocks.

### Description of the fisheries and landings

The 1993-1994 4WX herring fisheries were dominated by purse seine and weir components, with relatively minor landings by midwater trawl, shutoff, trap, and gillnet (Table 1, 2 and Fig. 1, 2). Reported landings from the stock portions of the fishery were 80,100t. Most of these landings (64,500 t) came from the 4X summer purse seine fishery that targets pre-spawning and spawning aggregations off southwest Nova Scotia (subareas 4Xq and 4Xr) from late May to mid-October 1994. Other major fishing activity occurred in the purse seine fisheries on over-wintering aggregations of herring in eastern Nova Scotia (November 1993 through February 1994; 9,900 t) and off Grand Manan in the 4Xs fall and winter fishery (October 1993 through January 1994; 3,200 t). For the first time a significant portion of the winter fishery (4,100t) was taken in 4X off Halifax rather than in the Chedabucto Bay (4W) area. Additional information on the location and timing of these fisheries is presented in a later section on the purse seine logbooks.

Non-stock landings from N.B. weir and shutoff fisheries accounted for an additional 22,200t which is not included in the 4WX quota catches (Table 2, Fig. 2).

The fisheries continued to be highly influenced by markets that sought herring of specific sizes, condition (e.g., fat content) and/or roe maturity for the domestic adult fish and canned herring markets, and for Over-the-Side Sales (OSS) to foreign ships. Total OSS landings were 13,900t (Table 3).

The system of mandatory dockside monitoring, involving measurement (by dipping) of calibrated holds on every landing, continued in 1994 and was thought to have ensured good catch records. The comparison of landings with product backcalculation (as introduced in Stephenson et al., 1993), was not completed because of incomplete production records at the time of evaluation.

Landings were low in comparison with recent years (Table 4), and some markets for large fish products went unfilled. This is directly linked to the problem of availability of large fish (see Purse Seine fishery logbook section).

### Biological Sampling

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

- 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.

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 monthly. When sufficient samples were available, separate keys were applied for OSS and domestic markets because of the differences in fish size. A correction of 2% was applied to length measurements to account for shrinkage due to freezing (Hunt et al. 1986).

Sampling, although reduced considerably in recent years, was thorough and adequate to document the diversity within the commercial fisheries. There was good coverage of OSS vessels in 1994. Sampling in 1994 resulted in 451 length frequencies and 5,583 fish analyzed in detail (5239 aged). The distribution of sampling is shown in Table 5 and Figure 3. Length frequency distributions for the components of the 4WX herring fishery are presented in Figure 4.

Lab sampling protocol was upgraded this year to an on-line data entry system. A paper record was still used for length frequencies in the field, but these were transferred to the database immediately upon return to the lab. The on-line entry system allowed immediate data editing, and made the database available for quick response to questions from clients.

Age reader precision (within reader agreement between separate interpretations of otolith ages) was examined for the first time in several years. Precision ranged from 65% to 99% depending upon the location and age distribution of the samples used in the analysis.

### Catch at age

The age composition of landings from stock and non-stock segments of the 1994 fishery by gear are presented in Tables 6 and 7 and Figure 5. The 1991 year-class (age 3) replaced the 1989 in dominance in major stock fisheries in number (25%), but the 1989 yearclass continued to dominate by weight (26%). Very noticeable in the catch at age for 1994 is the relative weakness of the 1990 yearclass (age 4), which made up only 9% of the landed weight and numbers (Table 6 and Fig. 6). The age span remained similar to previous years and ages 11+ made up a higher percentage than average, because of the presence of the strong 1983 yearclass and the relative absence of 1990 (Fig. 7).

Age 2 fish again dominated the non-stock fisheries on the New Brunswick side of the Bay of Fundy in number (73%) and in weight (40%) (Table 7). These data are presented for completeness only and are not included in the stock catch at age used in the analytical assessment. The proportion of larger fish (ages 4+) has been increasing in recent years and some of these may be allocated to the stock component in the future assessments.

### Length and weight at age

Average weight and length at age for each gear segment are presented for stock and non-stock gears in Table 8. Both average weights and average length at age were lower in 1994 than in 1993 and recent years (Table 9). While a change in timing of the overall fishery (earlier) could account for some of this change, it was assumed that the decline represents a change in growth rate. Fat content was unusually low throughout the summer of 1994. It was the lowest in all processor records of herring for the specific areas and months examined, some extending back 10 years. Concurrently, there was little problem reported from industry of "redfeed" or food in the gut. This was also reflected in low condition factor measured in biological samples.

Recent assessments (e.g., Stephenson and Power 1988, 1989; Stephenson et al. 1990, 1991, 1992, 1993, 1994) have used fishery-weighted weights at age (mean for stock fish weighted by gear) in the assessment model. This procedure was continued for 1994 and the series has been extended in Table 9.

### Issues of stock structure

There are several stock structure issues relevant to the assessment and management of the 4WX stock, including:

- 1) need for increased consideration of spawning groups in management,
- 2) continued consideration of small, "local/inshore" spawning groups, and the interaction of those fish with major fisheries (such as Chedabucto Bay),

- 3) the occurrence of herring on offshore banks (4X and 4W) and extent of offshore spawning,
- 4) review of the western (Bay of Fundy) "non-stock" designation and
- 5) stock structure in 4Vn and its implications for 4WX management.

Management of these fisheries continues to move toward an individual spawning group approach. In 1994 there was a continued Trinity Ledge closure and restrictions on Scots Bay, and the development of a Spawning Stock Working Group (by the Scotia Fundy Herring Advisory Committee) to review information on stock structure and to improve management of spawning areas.

## **Input from Industry**

### 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 Scotia Fundy Herring Advisory Committee (SFHAC), 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 large herring throughout the summer fishery. Fish were lean (low fat content) throughout the summer. Several expressed concern that there was a decrease in abundance, but others felt that the fish were simply distributed differently . . . specifically "offshore and down deep". There appears to have been an above average abundance of small fish. There was also generally agreement that DMP had been effective. The limited availability of fish of good roe quality, and the large fish size required for adult shore (fillet etc.) and OSS markets resulted in restricted landings.

### Purse seine fishery logbooks

Purse seine logbooks have been useful in documenting the spatial and temporal distribution of fleet activity in recent years (Power and Stephenson 1986, 1987, 1991; Stephenson et al. 1993, 1994). Unfortunately, application of the Dockside Monitoring Program, (with its new Monitoring Document) and disorganization surrounding details of the management plan during 1993, resulted in a substantial decrease in use of the biological logbook for that year (Stephenson et al 1994). Although submission remained a condition of licence, log submission decreased from complete coverage in recent previous years to only 18 of the 38 vessels in 1993. Some captains 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 was made during 1994 to return

to the very good logbook submission level of earlier years through more explicit wording in license conditions, combined with the help of the seiner associations in distribution and collection of logs. This seems to have been effective, as submission rate (logged tonnage) increased from 38% of reported Statistics landings in 1993 to 76% in 1994 (Table 10).

While there has been consistency in the timing and location of fishing on some grounds, there has also been some change in the relative contribution of these grounds to the total landings, and the development of fishing on new grounds (Table 10, Fig. 8-11). Reduced relative importance of Seal Island and of Gannet Dry Ledge spawning grounds in 1994 was coincident with relative increases in landings from Scots Bay, from Long Island and Grand Manan fisheries. For the second consecutive year, a significant fishery took place on spawning grounds off Shelburne/Liverpool and a major portion (4,200t) of the winter fishery (normally in area 4W around Chedabucto Bay) occurred off Halifax in area 4X (Table 2).

Comments in 1994 (Table 11) showed a general inability to catch large herring demanded by markets, and an apparent increase in the abundance of small fish. There was an increase in comments "fish deep", "fish in shallow water", "hard to catch", "little or no fish" and "small bunches/schools". Interestingly there was an increase in comments "lots of small fish". There was a decrease in the comments "large area of fish" and in feed related comments such as "full of feed" and "some feed in fish". Many of these comments were corroborated in the post season survey results (see next section) and from information received from processors and sampling of this fishery (e.g., low fat content, low condition factor, large fish markets not filled).

Reasons for release, or lack of catch in the purse seine fishery (Table 12) were that the herring were too small, were behaving unusually, and/or were hard to catch with increases in comments of "fish too deep", and "skunk set". There was also an increase in "fish inside box/line" as a reason for lack of catch. This occurred mostly near the Scots Bay closure line in the upper Bay of Fundy where fishermen were unable to make sets on the spawning aggregations due to the position of the line near aggregations of fish. Influences of market, and unusual distribution were reflected in the increased use of "size of fish" as a release reason.

Questions were raised during, and after, the 1994 summer fishery regarding the apparently high incidence of unsuccessful nights fishing. Logbook success rates were compared with Statistics Division data as obtained from 'No Fish' hail reports (Table 13). There was a close correspondence, with Statistics showing 75% success and logbooks with 74% overall success. Table 14 (using the logbook series only) shows that the proportion of successful nights were reduced in 1994, down 12% from 1993 and down 15% from 1992. Industry members agree that the incidence of zero catch was somewhat (but not dramatically) higher, and claim that it was mainly due to the size of fish in relation to market requirements.

Increased emphasis on care of spawning grounds, and changes in the fishery in recent years have raised questions regarding the potential use of effort and catch rates as indicators of the abundance of spawning aggregations. Several definitions of catch rate show very similar patterns and little change over the time series (Table 15, Fig. 12). Set rate (set/hr searching) has



a different pattern with a decline since 1990 but the general contrast of this variable is also low (range from 0.4 to 0.6 only).

Monthly catch rates for all areas combined (Table 16, Fig. 13) may indicate some decline for all months since 1985. Notable is the June 1994 catch rate of 4.9 t/hr which is the lowest recorded, showing a substantial decrease in return (catch) for a given effort (searching time). Overall catch rates by fishing ground (Table 17, Fig. 14) are stable over the time series at 10 to 25t/hr searching. These do not appear to track major changes thought to have taken place. For example, the collapse of Trinity Ledge in 1989 is reflected in only moderately lower catch rates. The high 1989 catch rates for Grand Manan were the result of an easily available local aggregation of fish in October of that year. Catch rates for the major purse seine fisheries: 4Wd Chedabucto Bay, 4Xs Nova Scotia summer, 4Xb New Brunswick fall/winter are presented in Table 18. Search per trip has increased for all fisheries while catch per hour has decreased, reflecting the general reported trend of difficulty in finding and catching large fish in 1994.

In an attempt to simplify and improve the use and collection of logbooks a new, combined, logbook/monitoring document was designed during early 1995. This document (Appendix A), which was modified through collaboration by Science, Statistics and Industry, will be collected after each trip, and will be at least partially entered into the database by the DMP program. It should again ensure complete logbook coverage of the purse seine fishery as in previous years.

#### Post-season survey

In an attempt to qualify "wharf talk", and to obtain more quantifiable information from industry, an experimental post-season questionnaire was implemented (Appendix B). This was distributed to purse seine captains, and focussed on the summer fishery. The questionnaire was optional and anonymous and returns were received from approximately half the fleet. These showed:

- 1994 abundance of large fish was less or much less than average
- 1994 abundance of small fish more or much more than average
- the primary reason for low landings was the low abundance of large (9-12") fish
- Grand Manan and Scots Bay portions of the fishery were reported as having had "average abundance" of fish. Long Island and Little Hope were reported as having had "less", and Seal Island "much less" than average abundance.
- biggest concerns included the protection of spawning grounds and protection of small fish (which are considered reasonably abundant at present)

## Research Survey Data

### Larval Abundance

An annual (late October and early November) survey of recently hatched herring larvae in the Bay of Fundy and eastern Gulf of Maine has been conducted since 1972 using consistent methodology. Each year an index of larval herring abundance has been calculated as the mean of larval density (no. per m<sup>2</sup> to bottom) for a standard set of 79 stations. This index is considered to reflect post-fishery spawning stock biomass. Larval herring abundance has been shown to reflect the general state of herring stocks elsewhere (including the collapse and recovery of the North Sea and Georges Bank stocks).

The spatial distribution of herring larvae was sampled in November 1994 using a fixed grid system with initial emphasis on completion of the 79 stations required for calculation of the traditional index. For the past 22 years, this survey has used the E. E. Prince, but this year due to the Prince's decommissioning, the Alfred Needler was used for the first time. Standard survey protocol was followed and for the first time a Netminder II gear monitoring system was used to monitor gear deployment and behavior. This is considered a major improvement over the previous technique using a gear-depth telemetry system and further details are available in Power, 1994.

The larval abundance index (Fig. 15, Table 19) shows a dramatic drop in 1994. Since results of this survey form such an important part of assessment, there was concern that the potential impact of spawning time and/or cruise timing, or the ship change, might have biased the results. The normal dates for the midpoint of this annual survey have in recent years been between Nov. 1-3. The 1994 survey (N211) started about one week later than usual, though, due to cruise scheduling. The "index stations" (those 79 historical stations used to calculate the larval index) were completed by 2000 hrs, Nov. 9 so that the mid-date for these samples was about Nov. 5; only 3-4 days later than on average. In addition, the vessel and gear changes (improvements) in 1994 are unlikely to have resulted in such a dramatic decline in the index as the same vessel and gear was used on Georges Bank where increased numbers of larvae were caught over the previous year (Melvin et al, 1995).

### July 4WX bottom trawl survey

Catches of herring in the summer bottom trawl survey on the Scotian Shelf and Bay of Fundy has been previously investigated as a potential indicator of stock abundance (Stephenson et al. 1990, 1994). 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. This is presumed to reflect a general increase in population size observed through the 1980's, but possibly also a concurrent change in herring distribution (Stephenson et al. 1994). The survey offers a great potential advantage as an abundance index, in that it is age

structured - but is inappropriate as an abundance index if influenced to a significant degree by distribution or catchability, rather than abundance.

The 1994 survey result was very high - the highest in the 25 year time series (Table 20 and Fig. 16a). This was in large part due to large sets of large fish in strata 56 and 58 (north of Sable Island; Fig. 16b) and juvenile (small) herring in stratum 93 along the New Brunswick shore. Even with these three strata removed the survey result is high. Due to the possibility of a gear/vessel effect, discussion was based on the series since 1983 when the Alfred Needler was used.

The examination of the occurrence of herring by age shows that it does not track yearclass abundance: herring of all ages appeared in the survey in recent years and there was not a progression of yearclasses (Table 21, Fig. 17). It appears that the bottom trawl series is influenced to a significant degree by changes in distribution or catchability rather than abundance and therefore is not an appropriate abundance index for this assessment. The survey still provides useful information on distribution - in fact, we think it helps explain the absence of large herring in inshore waters and other events in the 1994 herring fishery that suggest the possible impact of changes in distribution or behavior. Purse seiners reported herring remaining "hard on bottom" and being "offshore" and "deep". This is presumed to be linked to odd water conditions, lack of food, and low fat content.

#### Spring bottom trawl survey

The 4VW spring bottom trawl survey results were examined for the first time in an attempt to shed some light on the apparently odd distribution of herring. This March survey series extends back to 1979 with reasonable coverage. Before 1986, the survey was of areas 4VWX, but since 1986 it has been restricted to 4VW. Plots of the 4VW portion (Figure 18) show a much greater abundance of herring in recent years (especially 1990 and 1994) when compared with the early portion of the survey (1979 through 1986). This high incidence of herring offshore may be linked to the recent absence of over-wintering herring in Chedabucto Bay.

#### US bottom trawl survey

The Autumn (September) U.S. bottom trawl survey has extended into the lower part of the Bay of Fundy and the area off southwest Nova Scotia during the period 1981-1994. However, examination of this series reveals few sets (10 to 17 per survey in Canadian waters) containing small amounts of herring (< 100 fish per survey). Due to limited herring catch the data were not examined further.

## Analytical evaluation, stock trends and forecast

An analytical assessment for Div. 4WX herring has been precluded in recent years by the lack of an appropriate catch record (due to misreporting etc.) and by problems associated with the analytical structure of the assessment (Stephenson et al. 1994). Attempted assessments since 1990 have shown poor resolution in tuning and unrealistically large increases in estimated population size.

Stephenson (1993) reported calculation of landings 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 two estimates overlapped, and showed landings in the order of 1.4 times those previously recorded. The result of the back calculation method, using conversion factors derived from industry for each product form, matched the 1993 landings as recorded by an improved dockside monitoring program - and was accepted as a suitable basis for the revision of 1985-1992 (Stephenson et al 1994). Catch at age for this assessment was compiled as follows:

- (1) 1994: recorded landings from the Dockside Monitoring Program (which involved mandatory dipping of calibrated holds).
- (2) 1985-1993: landings estimated by backcalculation from herring processing plant production records, as outlined by Stephenson (1993) (increased proportionately from the nominal catch at age). This series overlaps, but has greater year to year variation than the series derived from purse seine interview.
- (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 (matched to Mace's catch numbers, not weights).

Stock status evaluation was based on sampling and analysis of the commercial fishery combined with the results of independent research surveys. Several assessment formulations using both larval abundance and bottom trawl survey catches (aggregate and age disaggregated) were attempted before elimination of the bottom trawl series as an index. These exhibited poor parameter estimation and resolution.

With only the larval abundance as an index the analytical structure is limited. Larval abundance is considered to reflect population size after most of the fishery has taken place (similar to escapement). To model this, larval abundance was related to spawning stock biomass (population X weight at age X maturity ( based on maturities of 50% at age 3, 90% at age 4 and 100% for 5+ ages)) at the beginning of the year immediately following the November survey. The use of an aggregated index reduces the resolution of an analytical model. The proposed formulation estimates only one age (5) in the final year, constraining other ages with a partial recruitment vector.

## Parameters being estimated:

- yearclass strength; age 5 in 1995
- calibration constant (slope) of relationship; larval abundance year (t) versus mature biomass year t+1

## Structure:

- PR reflecting historical pattern (age 2=.3, age 3=.6, age 4+=1)

## Input:

- larval abundance index (23 years; 1972-1994, applied to 1973-1995)

Summary: No. of observations= 24

No. of parameters estimated = 2

This analysis indicated an increase in biomass during the 1980's, peaking in 1987, followed by a moderate decline (Fig. 19, Appendix C). This scenario shows continued high biomass (600,000t) and very low F's in recent years, with the 1994 larval abundance point as a large outlier (Fig. 20). However, the low 1994 larval abundance index suggests a severe decline in the 1994 spawning stock. A VPA matching the 1994 larval point shows that the population has decreased from the peak in the late 1980's to approximately 200,000t. There are a few possible explanations for this apparent discrepancy in 1994:

1) Larval production was affected either by changes in the distribution of the spawning stock (absence of a large portion of the spawning stock from the traditional spawning areas). Several observations from the 1994 fishery are consistent with these hypotheses:

- i) There was an unexpected absence of large (>28 cm or 11 in.) herring in traditional fishing areas (apparently an above average abundance of small (<18 cm or 7 in.) herring, however).
- ii) Herring were reported by the industry as behaving oddly, being offshore and remaining deep.
- iii) There was a large increase in the last three years for herring taken in 4WX bottom trawl research surveys (however, larval abundance remained high in two of the last three years).
- iv) There was a hydrographic anomaly (higher temperatures in the areas of relevance to this stock (eg. highest temperature since 1945 in Lurcher area (Fred Page pers. comm.)) in 1994 that may have an impact on behavior or food supply.
- v) Unusually low herring fat content throughout the summer of 1994, which was apparently accompanied by a low incidence of food in the gut, and a lower condition index.

- 2) The larval index is not proportional to population size. In this case, there would have been high fishing mortality for the past several years. This is considered less likely, but possible.
- 3) The 1994 larval abundance index point may not reflect the actual larval abundance (due to a problem in survey gear performance for example). This is considered unlikely.

#### Environmental, ecological and multispecies considerations

Many observations in the 4WX herring fishery in the past year suggest the possibility of environmental change or impact, and suggest the need for broader ecological considerations:

- low fat content throughout the summer,
- little if any problem of feed in the guts,
- herring reported as offshore and remaining deep,
- an apparent large increase in herring offshore, reflected in both March and July research surveys,
- an apparent high abundance of small herring and
- high temperatures in areas of relevance to this stock off southwest Nova Scotia.

In addition, larval abundance (which is considered an index of spawning stock size) was low, raising questions concerning the interactions among changes in large fish distribution ( i.e., fish did not spawn?), low fat/condition (eg. spawning was not as successful?) and spawning stock size (eg. has there been a large reduction in SSB?).

#### Major sources of uncertainty and suggested remedies

The analytical assessment assumes a ln linear relationship between spawning stock biomass and larval abundance and continued testing of aspects of this relationship is needed. The index also does not allow for differences in spawning or survey timing.

There is a great need for further consideration of individual spawning components in management; continue to work toward estimation of the size of individual spawning components, and explore options for greater consideration in management.

There are signs of an unusual environmental event influencing herring in this area; continue to explore environmental correlates (including temperature and plankton records) and work with industry to expand monitoring of fat content and environment.

Occurrence of herring on offshore areas appears to have increased in recent years and there is evidence of spawning on offshore banks; increased survey effort is required in the offshore 4W and 4X areas, particularly around spawning time (autumn) to determine if these fish are part of the major southwest Nova Scotia Spawning stock or if they are a separate offshore spawning component.

## Outlook

The low 1994 larval abundance index, combined with apparent physiological and behavioral changes in herring in 1994, is cause for concern. Hypothesis 2 suggests that spawning stock biomass may have declined from about 600,000t in the late 1980's to about 200,000 t in 1994 and that the exploitation rate has been higher than previously perceived. Hypothesis 1 indicates an unprecedented change in distribution and behavior which implies uncertainties regarding our understanding of spawning stock biomass. Lacking experience or observation of such an event in the past, it cannot be safely assumed that the conditions will revert to normal. Both hypotheses suggest accepting the larval index result at face value. This indicates a spawning stock biomass as low as it was in the late 1970's (about 200,000 t), which would imply an F0.1 reference catch level of about 50,000 t.

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Table 1. Landings (t; calendar year totals) by gear type in NAFO Div. 4WX herring fisheries, 1986-94.

Gear	1986	1987	1988	1989	1990	1991	1992	1993	1994
Purse seine	67918	91625	114750	80154	96566	88838	96415	92223	75593
Weirs	29470	33408	40072	46783	42273	25211	34126	34093	22657
Gillnet	4318	2919	1151	382	457	776	504	653	339
Traps	296	440	1284	123	183	60	70	164	93
Shutoffs	371	698	867	637	554	863	68	142	1630
Midwater trawl	28	17	423	783	871	1154	761	343	0
Miscellaneous	103	74	1329	552	501	1	250	57	69
Total	102504	129181	159876	129414	141405	116903	132195	127675	100381

Table 2. 1993-1994 reported monthly 4VWX herring landings (t) by major fishery (REVISED MAY 19, 1995)  
(Source: DFO Scotia-Fundy Region Statistics Division.)

4VWX Stock Fisheries	1993			1994									1994			1993-1994			
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Calendar Totals	15 mo. Totals	Quota Totals	Plan Quota
1. 4W Winter Purse Seine Note 1	309	5375	0	0	0	0	0	0	0	0	0	0	154	1188	528	1870	8115	6245	28470
2. 4Xs Fall Purse Seine Note 2	1655	1453	109	0	0	0	0	0	0	0	0	0	4049	1015	0	5064	8292	3228	9000
3. 4Xs Winter Purse Seine Note 3	0	0	0	4171	0	0	0	0	0	0	0	0	0	0	0	4171	4171	4171	6000
4. 4Xor Summer Purse Seir Note 4,6	13566	0	0	0	0	0	7	2197	820	4691	16253	18940	7268	0	0	64546	78112	64546	98218
5. 4X Midwater Trawl	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1512
4X Summer Gillnet	39	5	2	0	0	0	17	9	30	49	119	102	14	0	0	340	387	340	
4Xr Summer (N.S.) Weir	0	0	0	0	0	0	0	111	736	499	519	180	0	0	0	2045	2045	2045	
4X Trap	0	0	0	0	0	0	0	35	16	33	0	4	0	0	5	93	93	93	
4X Misc. Gears	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	3	3	3	
4W Gillnet	3	2	0	0	0	0	15	22	1	3	3	11	3	1	0	58	63	58	
4W Misc. Gears (Trap)	0	0	0	0	0	0	0	0	2	2	5	1	1	0	0	10	10	10	
6. 4WX Gillnet, Trap, Weir, M Note 5	42	2	0	0	0	0	32	177	785	897	647	277	10	1	5	2549	2600	2549	8000
<b>Stock Totals</b>	<b>16133</b>	<b>6846</b>	<b>111</b>	<b>4171</b>	<b>0</b>	<b>0</b>	<b>39</b>	<b>2374</b>	<b>8986</b>	<b>15268</b>	<b>13900</b>	<b>19236</b>	<b>11490</b>	<b>2204</b>	<b>533</b>	<b>78201</b>	<b>101291</b>	<b>80740</b>	<b>151200</b>
<b>4VWX Non-Stock Fisheries</b>																			
1. 4X (N.B.) Weir	2406	540	10	0	0	0	18	0	55	4529	10586	3805	1599	30	0	20622	23578		
2. 4X (N.B.) Shutoff	11	12	0	0	0	0	0	0	7	5	43	658	786	121	0	1620	1643		
<b>Non-Stock Totals</b>	<b>2417</b>	<b>552</b>	<b>10</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>18</b>	<b>0</b>	<b>62</b>	<b>4534</b>	<b>10629</b>	<b>4463</b>	<b>2385</b>	<b>151</b>	<b>0</b>	<b>22241</b>	<b>25221</b>		
<b>Total 4VWX Landings</b>	<b>18550</b>	<b>7398</b>	<b>121</b>	<b>4171</b>	<b>0</b>	<b>0</b>	<b>57</b>	<b>2374</b>	<b>9048</b>	<b>19802</b>	<b>24529</b>	<b>23699</b>	<b>13875</b>	<b>2355</b>	<b>533</b>	<b>100442</b>	<b>126511</b>		
<b>4Vn Fisheries</b>																			
1. 4Vn Winter Purse Seine Note 1	0	0	0	0	0	0	0	0	0	0	0	0	0	3176	8	3184	7017	3833	4200
2. 4Vn Gillnet	1	1	0	0	0	0	140	26	0	1	0	0	0	0	0	167	170	167	
3. 4Vn Traps and Misc Gear	10	75	0	0	0	0	4	30	26	0	0	0	0	0	0	60	144	60	
<b>4Vn Totals</b>	<b>11</b>	<b>3900</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>144</b>	<b>56</b>	<b>26</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3176</b>	<b>8</b>	<b>3411</b>	<b>7331</b>	<b>4060</b>	<b>4200</b>
<b>Total 4VWX Landings</b>	<b>18561</b>	<b>11307</b>	<b>121</b>	<b>4171</b>	<b>0</b>	<b>0</b>	<b>202</b>	<b>2429</b>	<b>9074</b>	<b>19802</b>	<b>24529</b>	<b>23699</b>	<b>13875</b>	<b>5531</b>	<b>541</b>	<b>103853</b>	<b>133842</b>	<b>4060</b>	

\* 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, 1994 to December 31, 1994.

**NOTES**

1. Quota period is November 1, 1993 to March 1, 1994	4. Quota period is April 1, 1994 to October 19, 1994
2. Quota period is October 15, 1993 to December 31, 1993	5. Inshore/Fixed and Miscellaneous Gear allocation is for the calendar year 1994.
3. Quota period is January 1, 1994 to February 28, 1994	6. Includes purse seine bait quota of 2600 t.

Table 3. 4WX and 5Z herring landings to the OSS and domestic markets in 1994.

Area & Geartype	MONTH												Year Totals
	1	2	3	4	5	6	7	8	9	10	11	12	
4X N.B. Weirs Total	0	0	0	18	0	55	4529	10586	3805	1589	30	0	20612
4X N.B. Weirs OSS								145					145
4X N.B. Weirs Domestic					0	55	4529	10442	3805	1589	30	0	20449
4X N.S. P.Seine Total	0	0	0	0	2197	8201	14681	13193	18940	7291	0	0	64502
4X N.S. P.Seine OSS					982	3499	5094	4214					13788
4X N.S. P.Seine Domestic					1215	4702	9587	8979	18940	7291	0	0	50713
5ZE Purse Seine Total	0	0	0	0	0	225	3	0	0	0	0	0	228
5ZE Purse Seine OSS						20							20
5ZE Purse Seine Domestic					0	205	3	0	0	0	0	0	208
4X,5Z Total all Gears					2197	8481	19213	23779	22744	8880	30	0	85341
4X,5Z Total OSS					982	3519	5094	4358	0	0	0	0	19959
4X,5Z Total Domestic					1215	4962	14119	19421	22744	8880	30	0	71371

Table 4. Historical series of nominal and adjusted annual landings (t) by major gear components and seasons of the 4WX herring fishery 1963-1994.

Year	Stock Catches - Nominal Landings						4WX Stock Nominal Landings	4WX Stock Adjusted Landings*	4WX Stock TAC	Non-Stock 4Xs Wair and Shut-off	Total 4WX Adjusted Landings
	4W Winter Purse seine	4Xs Fall/Winter Purse seine	4Xs Summer Purse seine	4X Summer Gillnet	4Xr Summer Wair	4WX Other*					
1963		6,871	15,093	2,955	5,345		30,264	30,264		29,366	59,630
1964		15,991	24,894	4,053	12,458		57,396	57,396		29,432	86,828
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	192,863
1986	8,414	3,365	56,139	3,533	1,958		73,409	100,000	97,600	27,883	127,883
1987	8,780	5,139	77,706	2,289	6,786		100,700	147,100	126,500	27,320	174,420
1988	8,503	7,876	98,371	695	7,518	1,690	124,653	199,600	151,200	33,421	233,021
1989	6,169	5,896	68,089	95	3,308		83,557	97,500	151,200	44,112	141,612
1990	8,316	10,705	77,545	243	4,049	1,769	102,627	172,900	151,200	38,778	211,678
1991	17,878	2,024	73,619	538	1,498	1,453	97,010	130,800	151,200	24,576	155,376
1992	14,310	1,298	80,807	395	2,227	1,190	100,227	136,000	125,000	31,967	167,967
1993	10,731	2,376	81,478	556	2,662	660	98,464	105,089	151,200	31,573	136,662
1994	9,872	3,174	64,509	339	2,045	161	80,099	80,099	151,200	22,241	102,340

^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 geartypes 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 gear.

\*\* Adjusted totals includes misreporting adjustments for 1978-1984 (Mace 1985).

Table 5. 1994 4WX and 5Z herring sampling by gear component and month.

Year	Gearname	Month	Number LenFreq Samples	Min. LenFreq Length	Max. LenFreq Length	LenFreq Number Measured	Number Detail Samples	Min. Detail Length	Max. Detail Length	Detail Number Process	Detail Number Aged
94	4W Purse Seine	10	3	185	400	1126	3	182	380	226	217
		11	13	180	375	3868	6	188	367	253	253
		12	4	175	365	1062	4	179	346	125	125
	5Z Purse Seine	08	1	260	325	203	1	253	318	20	20
		07	1	270	330	219	1	261	318	18	18
	N.B. Purse Seine	10	8	125	310	2199	8	122	301	181	181
		11	4	125	315	885	4	128	312	104	104
	N.B. Shut-off	09	2	120	195	853	2	120	188	27	27
		10	5	110	315	1281	5	111	304	103	102
		11	2	180	335	506	2	181	330	98	98
	N.B. Weirs	01	1	130	265	315	1	131	261	18	18
		05	1	85	205	354	0	0	0	0	0
		06	3	100	305	1118	3	101	288	81	81
		07	17	125	360	4266	6	130	318	221	221
		08	33	80	350	8780	10	83	338	308	308
		09	18	105	345	4580	12	104	342	276	276
		10	8	125	345	2094	6	122	338	131	131
	N.S. Purse Seine	01	10	135	365	3118	5	133	357	263	263
		05	17	120	370	3435	11	200	338	305	243
		08	78	120	380	16138	12	125	357	433	433
07		98	135	380	21185	8	155	372	348	308	
08		65	130	375	14486	10	148	388	463	342	
09		21	140	375	5655	14	138	372	520	408	
10		11	110	385	3085	8	110	376	372	372	
N.S. Weirs	05	3	100	325	1013	2	98	320	47	47	
	08	4	110	360	1081	3	114	355	70	70	
	07	1	150	360	152	1	157	358	52	52	
	08	3	145	340	752	3	150	381	154	154	
	09	1	180	305	218	1	180	301	41	41	
Resrch. Otter Trawl	08	1	70	170	272	1	72	161	11	11	
	11	13	215	340	837	13	205	335	315	315	
Trap	05	1	290	350	122	0	0	0	0	0	
****	*****	****	-----			-----			-----		
sum			451		108517	167			5583	5238	
95	4W Purse Seine	01	8	115	380	1810	7	112	374	285	285
	N.B. Midwater Trawl	01	2	105	185	948	2	107	182	37	37
		02	1	100	185	258	0	0	0	0	0
N.S. Purse Seine	01	2	130	285	465	2	128	258	51	51	
****	*****	****	-----			-----			-----		
sum			13		3580	11			353	353	
DSS 94	5Z Purse Seine	08	1	260	325	203	1	253	318	20	20
	N.B. Weirs	08	2	205	350	427	0	0	0	0	0
		08	15	120	370	3084	8	200	338	261	188
	N.S. Purse Seine	08	70	180	380	14211	4	198	334	122	122
		07	87	135	380	18523	0	0	0	0	0
08		53	130	375	11502	1	232	348	47	0	
*****	*****	****	-----			-----			-----		
sum			228		47860	15			450	341	

Table 6. Catches by age in numbers (thousands) and weight (t) from stock gear components of the 1994 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	1,028	13,325	7,244	15,922	8,229	5,128	4,285	2,798	2,879	3,114	63,952
4X N.S. P.Seine	151	81,393	78,820	35,884	98,946	61,941	30,388	10,340	5,652	7,289	12,091	422,875
4X N.B. P.Seine	0	0	46,152	9,204	282	83	14	0	0	0	0	55,735
4X N.S. Weirs	0	21,156	3,582	1,041	2,003	1,707	252	175	206	247	248	30,617
4WX Misc.	0	308	381	327	862	552	277	89	50	52	80	2,978
4X Midwater Trawl	0	0	0	0	0	0	0	0	0	0	0	0
<b>Total Nos. by Age</b>	<b>151</b>	<b>103,885</b>	<b>142,260</b>	<b>53,700</b>	<b>118,015</b>	<b>72,512</b>	<b>36,059</b>	<b>14,989</b>	<b>8,706</b>	<b>10,447</b>	<b>15,533</b>	<b>576,157</b>

% 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	2	21	11	25	13	8	7	4	5	5	100
4X N.S. P.Seine	0	19	19	8	23	15	7	2	1	2	3	100
4X N.B. P.Seine	0	0	83	17	1	0	0	0	0	0	0	100
4X N.S. Weirs	0	69	12	3	7	6	1	1	1	1	1	100
4WX Misc.	0	10	13	11	29	19	9	3	2	2	3	100
4X Midwater Trawl												
<b>Overall % Nos. by Age</b>	<b>0</b>	<b>18</b>	<b>25</b>	<b>9</b>	<b>20</b>	<b>13</b>	<b>6</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>100</b>

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	33	790	828	2,273	1,477	1,058	1,018	732	777	888	9,871
4X N.S. P.Seine	2	3,259	7,840	5,176	17,850	12,783	6,863	2,679	1,701	2,301	4,054	64,507
4X N.B. P.Seine	0	0	2,250	869	36	14	3	0	0	0	0	3,173
4X N.S. Weirs	0	556	284	143	350	368	54	54	66	78	91	2,045
4WX Misc.	0	12	39	46	153	113	61	22	14	15	26	500
4X Midwater Trawl	0	0	0	0	0	0	0	0	0	0	0	0
<b>Totals Catch t. by Age</b>	<b>2</b>	<b>3,860</b>	<b>11,203</b>	<b>7,059</b>	<b>20,662</b>	<b>14,755</b>	<b>8,040</b>	<b>3,772</b>	<b>2,512</b>	<b>3,172</b>	<b>5,059</b>	<b>80,096</b>

% 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	8	8	23	15	11	10	7	8	9	100
4X N.S. P.Seine	0	5	12	8	28	20	11	4	3	4	6	100
4X N.B. P.Seine	0	0	71	27	1	0	0	0	0	0	0	100
4X N.S. Weirs	0	27	14	7	17	18	3	3	3	4	4	100
4WX Misc.	0	2	8	9	31	23	12	4	3	3	5	100
4X Midwater Trawl												
<b>Overall % by Age</b>	<b>0</b>	<b>5</b>	<b>14</b>	<b>9</b>	<b>26</b>	<b>18</b>	<b>10</b>	<b>5</b>	<b>3</b>	<b>4</b>	<b>6</b>	<b>100</b>

Table 7. Catches at age in numbers ('000) and weight (t) for non-stock gear components of the 1994 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	1,455	247,387	60,741	9,676	16,159	9,225	3,869	1,456	1,080	541	333	351,922
4X N.B. shutoff	531	44,569	3,161	296	99	107	24	23	0	3	1	48,814
<b>Total Nos. by Age</b>	<b>1,986</b>	<b>291,956</b>	<b>63,902</b>	<b>9,972</b>	<b>16,258</b>	<b>9,332</b>	<b>3,893</b>	<b>1,479</b>	<b>1,080</b>	<b>544</b>	<b>334</b>	<b>400,736</b>

% 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	70	17	3	5	3	1	0	0	0	0	100
4X N.B. shutoff	1	91	6	1	0	0	0	0	0	0	0	100
<b>Total Nos. by Age</b>	<b>0</b>	<b>73</b>	<b>16</b>	<b>2</b>	<b>4</b>	<b>2</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>100</b>

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	17	7,698	5,305	1,327	2,743	1,795	835	346	286	155	104	20,613
4X N.B. shutoff	10	1,240	300	37	15	18	5	5	0	1	0	1,630
<b>Total Catch t. by Age</b>	<b>27</b>	<b>8,938</b>	<b>5,605</b>	<b>1,365</b>	<b>2,758</b>	<b>1,814</b>	<b>840</b>	<b>350</b>	<b>286</b>	<b>156</b>	<b>104</b>	<b>22,243</b>

% 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	37	26	6	13	9	4	2	1	1	1	100
4X N.B. shutoff	1	76	18	2	1	1	0	0	0	0	0	100
<b>Total Catch t. by Age</b>	<b>0</b>	<b>40</b>	<b>25</b>	<b>6</b>	<b>12</b>	<b>8</b>	<b>4</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>100</b>

Table 8. Average weight (g) and length (cm) at age for stock and non-stock gear components of the 1994 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	32	59	114	143	179	206	237	262	270	285
4X N.S. P.Seine	12	40	99	144	180	206	226	259	301	317	335
4X N.B. P.Seine	0	0	49	94	130	173	223	0	0	0	0
4X N.S. Weirs	0	26	79	137	175	215	216	309	322	318	367
4WX Misc.	0	38	101	141	177	204	220	248	278	301	322
4X N.B. Midwater Trawl	0	0	0	0	0	0	0	0	0	0	0
Average for Stock Gears	12	37	79	131	175	203	223	253	289	304	326

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	17.0	21.1	26.1	28.1	30.3	31.7	33.2	34.3	34.6	35.2
4X N.S. P.Seine	12.5	17.9	23.9	26.8	28.7	29.9	30.8	32.2	33.6	34.3	34.8
4X N.B. P.Seine	0.0	0.0	19.4	23.9	26.5	29.0	31.5	0.0	0.0	0.0	0.0
4X N.S. Weirs	0.0	15.6	22.1	26.3	28.3	30.1	30.4	33.3	33.8	33.7	35.1
4WX Misc.	0.0	17.5	24.0	26.7	28.6	29.9	30.7	31.9	32.9	33.9	34.5
4X N.B. Midwater Trawl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average for Stock Gears	12.5	17.4	22.1	26.2	28.6	29.9	31.0	32.5	33.8	34.4	34.9

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	12	31	87	137	170	195	216	237	265	287	312
4X N.B. Shutoffs	18	28	95	126	150	173	191	203	0	206	246
Average for nonstock	14	31	88	137	170	194	216	237	265	287	312
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	12.4	16.6	22.9	26.5	28.2	29.6	30.5	31.6	32.5	33.4	33.6
4X N.B. Shutoffs	13.7	16.0	24.0	26.6	28.2	29.6	30.6	31.3	0.0	31.5	33.5
Average for nonstock	12.7	16.5	23.0	26.5	28.2	29.6	30.5	31.6	32.5	33.4	33.6



Table 9 . Average weights (g.) at age for the 4WX herring fishery (weighting by stock gear components) for 1965-94.

	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	1994
1	0	10	10	0	0	0	12	13	7	0	0	9	18	12
2	41	41	41	38	53	55	50	21	33	31	48	25	29	37
3	112	112	112	132	118	124	98	88	79	92	100	100	108	79
4	172	172	172	191	204	182	153	154	162	161	147	148	153	131
5	218	218	218	229	249	239	199	196	207	200	186	181	188	175
6	254	254	254	259	278	271	245	242	238	234	217	216	215	203
7	286	286	286	280	315	306	274	281	274	255	251	252	251	223
8	323	323	323	296	334	329	290	304	303	287	270	275	279	253
9	354	354	354	309	344	360	318	327	324	319	303	295	302	289
10	389	389	389	364	440	400	350	341	353	336	322	313	324	304
11+	389	389	389	364	440	400	350	371	365	364	332	333	357	326

Table 10. Changes in the relative importance of key fishing grounds in the 4X N.S. summer purse seine fishery.

		Total Catch in Tons									
Fishery	Grounds	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
4Xa	Long Island	857	3,060	7,309	10,892	21,915	18,755	10,139	3,847	2,384	6,846
4Xa	Trinity	35,800	13,419	18,851	18,586	266	1,113	3,255	4,715	1,313	2,290
4Xa	Seal Island	13,745	8,694	11,560	18,947	23,420	25,321	13,153	16,077	3,613	2,854
4Xa	German Bank	15,502	13,346	16,434	17,692	8,087	11,744	24,548	3,733	4,057	9,747
4Xa	Scots Bay		36	3,649	3,949	6,583	8,925	8,750	8,554	4,352	10,722
4Xa	Grand Manan	3,584	2,984	2,217	301	968	877	3,428	3,400	521	4,752
4Xa	Gannet, Dry Ledge	5,675	2,187	1,474	14,901	2,010	4,163	6,190	27,696	2,737	2,332
4Xa	Yankee Bank				194	196	3,646	967	119		175
4Xa	Western Hole								3,592	2,172	1,453
4Xa	Liverpool							49		4,067	4,257
4Xa	S.W. Grounds	558	1,839	184	181	223	58	565	290	2,949	5,168
4Xa	Lurcher	308			2,928	18	65	108	2,189	1,616	565
4Xa	Shelburne									515	161
4Xa	N.B. Coastal		621	138	126	276	27	530	800		99
4Xa	Other or no area	7,294	5,240	6,443		440	214	166	352		488
	Total Log Catches	83,323	51,626	68,259	88,503	64,206	74,907	71,922	75,364	30,565	51,908
	Total Stats Catch	87,167	56,139	77,706	98,370	68,089	77,545	73,619	80,807	81,478	68,536
	Percent Log/Stats	96	92	88	90	94	97	98	93	38	76
		Percentage of Total Logbook Catches									
		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
4Xa	Long Island	1	6	11	12	34	25	14	5	8	13
4Xa	Trinity	43	26	28	21	0	1	5	6	4	4
4Xa	Seal Island	16	17	17	21	36	34	18	21	12	5
4Xa	German Bank	19	26	24	20	13	16	34	5	13	19
4Xa	Scots Bay		0	5	4	10	12	12	11	14	21
4Xa	Grand Manan	4	6	3	0	2	1	5	5	2	9
4Xa	Gannet, Dry Ledge	7	4	2	17	3	6	9	37	9	4
4Xa	Yankee Bank				0	0	5	1	0		0
4Xa	Western Hole								5	7	3
4Xa	Liverpool							0		13	8
4Xa	S.W. Grounds	1	4	0	0	0	0	1	0	10	10
4Xa	Lurcher	0			3	0	0	0	3	5	1
4Xa	Shelburne									2	0
4Xa	N.B. Coastal		1	0	0	0	0	1	1		0
4Xa	Other or no area	9	10	9		1	0	0	0		1

Table 11. Summary of comments coded from 1987 to 1994 in 4X summer purse seine fishery logbooks.

Year Comment code	Occurrence on logs															
	1987	1988	1989	1990	1991	1992	1993	1994	1987	1988	1989	1990	1991	1992	1993	1994
	Number of records								Percent all records							
Not specified	1971	1991	1319	1730	1883	1815	394	996	82.7	75.5	69.2	77.2	72.8	68.8	47.5	60.3
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	28				0.9	2.3	0.5	0.9	3.4	
Easy to catch								2								0.1
Eyeball larvae							3								0.4	
F.O. hail			8			12	1				0.4	0.0	0.0	0.5	0.1	
Fish deep		21	23	37	49	19	19	73		0.8	1.2	1.7	1.9	0.7	2.3	4.4
Fish in shallow water	1	37	14	19	35	77	21	55	0.0	1.4	0.7	0.8	1.4	2.9	2.5	3.3
Fish on surface	5	6	12	3	5	19	10	7	0.2	0.2	0.6	0.1	0.2	0.7	1.2	0.4
Fish thinned out	50	44	21	16	39	49	20	27	2.1	1.7	1.1	0.7	1.5	1.9	2.4	1.6
Fish very fat		1		1		6	2	1		0.0	0.0	0.0	0.0	0.2	0.2	0.1
Full of feed							10	13							1.2	0.8
Gave fish away		3								0.1	0.0	0.0	0.0	0.0		
Hard to catch	25	39	31	40	44	30	19	80	1.0	1.5	1.6	1.8	1.7	1.1	2.3	4.8
Large area of fish	194	172	144	115	90	118	54	31	8.1	6.5	7.6	5.1	3.5	4.5	6.5	1.9
Large bunches/schools	40	41	17	28	43	48	45	34	1.7	1.6	0.9	1.3	1.7	1.8	5.4	2.1
Little or no fish	14	17	7	10	11	17	5	55	0.6	0.6	0.4	0.4	0.4	0.6	0.6	3.3
Lots of small fish				22	36	5	6	47				1.0	1.4	0.2	0.7	2.8
Low fat content								3								0.2
No feed in fish	21	122	152	72	82	81	27	20	0.9	4.6	8.0	3.2	3.2	3.1	3.3	1.2
No big fish								12								0.7
Pooling of catch	3	66	34	19	74	75		2	0.1	2.5	1.8	0.8	2.9	2.8		0.1
Poor bottom	15	13	3	6	10	18	1	9	0.6	0.5	0.2	0.3	0.4	0.7	0.1	0.5
Poor weather			17	1	18	7	11	42			0.9	0.0	0.7	0.3	1.3	2.5
Received fish				5	6	26	9	5				0.2	0.2	1.0	1.1	0.3
Small area of fish							9	29							1.1	1.8
Small bunches/schools	26	30	16	28	59	63	35	59	1.1	1.1	0.8	1.3	2.3	2.4	4.2	3.6
Some feed in fish		30	35	25	80	71	64	29		1.1	1.8	1.1	3.1	2.7	7.7	1.8
Split market			9	4							0.5	0.2	0.0	0.0		
Too many boats				1	3	8	1	5				0.0	0.1	0.3	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	4		0.7	0.1	0.3	0.1	0.3	0.1	0.5	
Various other combined						46	2	16						1.7	0.2	1.0
Total number of records	2382	2636	1905	2240	2586	2638	830	1652	97.6	97.1	100.0	100.0	100.0	100.0	96.4	100.0

Table 12. Reasons for release or lack of catch from 4X summer purse seine logbooks; 1985 to 1994.

Reason for release	Occurrence on Logs % of total sets									
	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
No release code	78.8	80.4	72.5	74.2	74.8	77.5	75.3	77.7	81.3	72.2
Carrying; no set made							0.7			
Condition	0.9	2.5	3.1	2.5	1.7	1	1.4	1.2	0.8	0.8
Dogfish	1.7	0.6	0.8	1.0	4.0	2	1.5	2.1	2.3	2.4
Feed	1.1	0.1	1.1	2.1	0.8	1.3	0.2	1.6	0.8	0.5
Fish dove		0.2	0.5	0.2	0.3	0.6	0.2	0.5	0.2	0.3
Fish inside box/line		0.3	0.3	0.2				0.5	0.2	1.7
Fish moving fast		0.6	0.5	0.2	0.2	0.2	0.5	0.3		0.7
Fish refused by buyer								0.1		
Fish thinned out		0.4	0.3	0.8	1.3		0.3	0.5	0.5	0.2
Fish too deep	0.9	1.8	2.4	1.4	1.2	1.2	1	1.1	0.3	3.8
Fish too shallow	1.1	0.4	1.9	1.3	0.2	0.2	1	0.5	0.5	0.9
Gave fish away				0.0	1.9	1.6	0.3	0.6	1.9	0.9
Gear/crew problems	0.6	0.9	1.4	1.4	1.9	1.3	1.9	1.3	0.7	1.2
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			0.1
No fish found	3.3	3.7	2.7	3.4	0.1	0.1	3.6	2.8	0.2	0.6
Other Species	0.1	0.4	0.3	0.1	0.2	0.3	0.3	0.3	1.6	0.5
Pooling; no set made						0.1	0.6	0.7	0.1	0.1
Poor weather	0.9	0.8	1.9	0.9	0.2	0.2	1.5	0.5	0.2	0.3
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		0.6
Size of fish	3.0	1.0	1.6	1.3	4.2	3.5	3.7	2.3	1.3	4.0
Skunk set	1.8	1.8	1.5	2.2	1.8	4.1	3	2.8	2.8	5.5
Tore up	1.3	1.3	1.9	1.5	0.8	1.3	1	0.9	0.5	1.4
Unknown reason	2.2	1.6	2.3	2.0	3.2	2.2	0.9	1.2	1.6	1.4
Total No. of Observations	2471	1964	2382	2636	1916	2240	2586	2638	830	1652
Total Released Catch (t.)	2968	1341	3330	3012	2969	1669	651	855	535	1774

Table 13. 1994 4X summer purse seine summary of successful and unsuccessful trips from Statistics and logbook data

Stats Data	Catch (mt)	Successful Trips	Unsuccessful Trips	Percent Success	Catch per Successful Trip	Catch per All Trips
April	7	1	2	33.3	7.0	2.3
May	2,197	45	20	69.2	48.8	33.8
June	8,201	208	78	72.7	39.4	28.7
July	14,681	355	145	71.0	41.4	29.4
August	13,193	322	83	79.5	41.0	32.6
September	18,940	359	111	76.4	52.8	40.3
October	11,318	243	75	76.4	46.6	35.6
Overall 4X	68,536	1,533	514	74.9	44.7	33.5

Logbook Data	Catch (mt)	Successful Trips	Unsuccessful Trips	Percent Success	Catch per Successful Trip	Catch per All Trips
April			1			
May	2,273	49	13	79.0	46.4	36.7
June	6,826	167	39	81.1	40.9	33.1
July	12,032	253	113	69.1	47.6	32.9
August	9,995	235	93	71.6	42.5	30.5
September	15,251	242	66	78.6	63.0	49.5
October	5,531	103	47	68.7	53.7	36.9
Overall 4X	51,908	1,049	372	73.8	49.5	36.5

Table 14. 1985-94 4X Nova Scotia summer purse seine fishery success rates from logbook data.

Year	Success Total MT Caught	Success No.Days Fished	Unsuccess No.Days Fished	Percent Success No.Days	Success Total Search Hours	Unsuccess Total Search Hours	Percent Success Search Hours	Success Total Number of Sets	Unsuccess Total Number of Sets	Percent Success Number of Sets
85	83,396	1,540	263	85.4	3,968	1,193	76.9	2,188	111	95.2
86	51,648	1,260	167	88.3	3,790	730	83.9	1,770	83	95.5
87	68,211	1,541	256	85.8	4,666	1,092	81.0	2,098	117	94.7
88	89,235	1,667	254	86.8	4,813	1,060	81.9	2,365	123	95.1
89	64,207	1,333	276	82.8	3,937	1,396	73.8	1,787	129	93.3
90	74,907	1,437	306	82.4	4,535	1,561	74.4	2,108	132	94.1
91	69,964	1,460	285	83.7	4,889	1,364	78.2	2,256	163	93.3
92	57,678	1,390	182	88.4	3,974	691	85.2	1,888	93	95.3
93	30,565	587	98	85.7	180	15	92.4	777	53	93.6
94	51,908	1,049	372	73.8	2,570	1,755	59.4	1,496	156	90.6
	641,719	13,264	2,459	84.4	37,322	10,857	77.5	18,733	1,160	94.2

Table 15. 1985 to 1994 4VWX herring purse seine CPUE by fishery and year.

Fishery	Year	No. Days Fished	Total MT Caught	Total Search Hours	Total Number of Sets	Catch per Hrs Srch	Catch per Set	Sets per Hrs Srch	Catch per Set per Hrs Srch	
4Wd	84	4	142.4	25.5	5	6.00	30.39	.21	5.79	
	85	42	2761.2	152.5	58	56.21	48.81	1.12	49.44	
	86	73	4978.8	196.5	87	62.25	53.59	1.08	48.02	
	87	92	5126.4	247.0	141	45.61	38.29	1.07	37.19	
	88	105	5363.7	387.8	151	29.68	40.93	.69	28.50	
	89	77	4270.2	239.7	105	30.97	41.34	.89	23.12	
	90	52	4194.9	131.3	86	43.98	58.53	.90	33.66	
	91	92	6498.6	268.7	158	56.73	45.18	1.20	41.90	
	92	16	1534.8	44.6	27	54.44	57.65	.97	29.20	
	93	4	0.0	43.8	.	0.00	0.00	.	0.00	
	94	35	938.0	209.3	25	10.91	23.12	.41	9.45	
	Total		592	35807.0	1946.7	853	42.89	43.95	.98	33.77
	4Wk	93	14	543.0	65.0	17	24.33	30.07	.74	22.37
		94	26	1215.0	129.7	29	12.50	25.25	.54	7.75
Total		40	1758.0	194.7	46	16.64	26.93	.62	12.87	
4Xa	85	1178	51721.2	5160.9	1542	22.46	32.62	.62	18.61	
	86	1008	36528.4	4519.7	1363	16.22	26.96	.59	13.28	
	87	1270	48049.5	5758.4	1653	16.98	28.04	.55	13.22	
	88	1292	59499.8	5872.8	1739	19.73	34.09	.57	15.64	
	89	1100	41971.1	5333.2	1341	16.03	29.69	.51	13.30	
	90	1094	43461.9	6098.4	1419	12.77	29.84	.43	9.98	
	91	1105	42286.1	6253.4	1551	12.58	26.92	.46	9.60	
	92	921	35214.8	4665.4	1181	14.12	29.53	.47	11.75	
	93	37	2171.8	194.3	48	18.22	46.19	.34	14.56	
	94	699	22802.3	4324.7	822	13.18	22.87	.49	10.52	
	Total		9702	383816.7	48179	12659	16.31	29.39	.52	13.10
	4Xb	85	9	275.2	26.4	10	43.02	27.30	1.28	36.47
		86	79	1980.1	203.9	90	19.94	21.90	.89	19.01
		87	71	2530.0	237.6	86	23.38	30.12	.88	20.81
88		81	3242.3	206.0	94	25.08	34.03	.83	23.10	
89		115	3470.4	361.1	128	18.88	28.34	.72	18.19	
90		170	4523.1	503.3	187	16.83	24.18	.76	15.79	
91		31	860.7	144.7	35	8.83	26.28	.38	8.54	
92		4	183.7	11.8	5	22.47	38.11	.64	17.26	
94		29	1382.0	217.2	32	15.13	41.64	.43	13.35	
Total			589	18427.5	1812.0	667	19.46	27.87	.76	18.12
4Vn		86	7	712.3	25.5	16	54.76	53.04	1.13	29.36
	87	9	775.7	29.0	18	30.32	49.73	.69	19.38	
	88	1	45.4	1.0	1	45.40	45.40	1.00	45.40	
	89	7	853.2	12.0	11	57.66	56.27	1.03	38.32	
	90	5	625.9	11.0	9	69.84	72.87	1.05	36.89	
	91	9	1242.8	18.0	19	78.27	65.69	1.15	36.04	

Table 16. 1985 to 1994 4X herring summer purse seine CPUE by month and year.

Fishery	Month	Year	No. Days Fished	Total MT Caught	Total Search Hours	Total Number of Sets	Catch per Hrs Srch	Catch per Set	Sets per Hrs Srch	Catch per Set per Hrs Srch
	June	85	7	394.2	29.1	8	18.18	45.87	.44	16.13
		86	10	315.8	43.1	12	17.33	29.51	.58	16.87
		87	87	2590.8	343.1	95	12.96	26.24	.45	11.48
		88	203	8037.4	722.9	248	21.69	31.46	.64	18.75
		89	210	8824.0	939.4	252	12.25	25.86	.46	9.72
		90	163	4999.2	767.0	194	9.96	25.87	.40	8.54
		91	220	5760.0	1232.9	271	8.58	20.76	.41	7.23
		92	227	6962.7	906.5	259	16.46	27.50	.58	15.45
		93	5	199.0	22.0	6	12.53	32.90	.33	11.38
		94	106	2879.3	704.3	126	6.71	18.79	.39	4.90
	Total		1238	38962.4	5710.3	1471	13.27	25.85	.49	11.47
	July	85	276	9330.8	1276.6	317	16.72	27.09	.52	14.92
		86	178	5439.7	698.8	187	14.28	27.64	.54	13.03
		87	339	9643.7	1485.3	412	11.64	23.57	.50	9.94
		88	368	16798.6	1509.9	469	23.71	35.25	.69	18.83
		89	356	11828.7	1804.9	388	12.07	27.10	.41	10.49
		90	340	12291.9	1588.7	415	14.17	29.82	.49	12.24
		91	364	11040.1	2160.1	472	8.98	23.68	.38	7.39
		92	341	12363.2	1637.8	403	13.38	30.57	.43	11.74
		93	19	1072.4	109.0	26	15.10	44.17	.31	12.40
		94	177	5227.0	1077.0	187	13.80	22.26	.52	11.44
	Total		2758	95038.1	13346	3276	14.32	27.88	.49	12.18
	August	85	453	19627.7	2157.7	615	18.27	30.38	.55	13.50
		86	370	13043.7	1777.0	500	14.70	25.48	.53	11.42
		87	437	15199.1	2242.2	588	14.71	24.02	.52	11.06
		88	343	12837.9	1945.1	453	11.19	25.65	.42	7.95
		89	219	6761.3	1006.3	241	19.81	25.47	.63	17.69
		90	214	5653.7	1386.7	221	9.24	20.28	.38	7.65
		91	239	9022.2	1211.5	333	14.57	27.24	.58	11.52
		92	178	6218.9	987.7	224	14.30	25.84	.51	11.02
		93	8	388.4	43.3	10	14.94	39.24	.38	13.93
		94	163	4271.4	930.8	156	12.69	20.56	.54	11.08
	Total		2624	93004.3	13868	3341	14.69	25.61	.52	11.45
4Xa	Sept.	85	408	20381.6	1558.2	554	30.34	37.99	.75	26.32
		86	401	15749.6	1830.5	606	16.46	27.37	.59	13.09
		87	340	17084.5	1476.0	468	23.44	35.98	.63	17.41
		88	349	20084.0	1548.0	525	22.50	41.81	.56	17.71
		89	235	11488.0	1218.8	329	16.99	37.05	.50	12.74
		90	308	15869.6	1889.7	480	13.86	34.61	.39	8.82
		91	231	13884.3	1400.0	415	18.79	34.29	.51	12.02
		92	160	9060.5	1091.0	268	11.47	34.50	.33	6.98
		93	2	92.0	8.0	2	10.00	46.00	.23	10.00
		94	157	6599.2	924.8	222	19.15	27.68	.53	14.66
	Total		2569	130283.3	13046	3869	20.16	34.94	.56	15.44



Table 17. 1985 to 1994 4WX herring purse seine CPUE by fishery, grounds and year.

Fishery	AREA	Year	Days Fished	Total MT Caught	Search Hours	Number of Sets	Catch per Hrs Search	Catch per Valid Set	No. Sets/ Hrs Search	Catch per Set per Hrs Strch		
4Wd	Ched. Bay	84	3	128.8	18.5	4	8.15	35.88	.24	7.08		
		85	32	2081.0	185.3	45	33.48	46.48	.80	27.83		
		86	71	4808.2	181.3	83	63.75	54.08	1.07	48.13		
		87	81	5082.8	244.5	138	45.13	38.38	1.07	37.48		
		88	105	5383.7	387.8	151	28.88	40.82	.88	28.50		
		88	77	4270.2	239.7	105	38.87	41.34	.88	23.12		
		88	52	4184.8	131.3	88	42.88	58.52	.80	33.88		
		81	18	8274.3	288.2	154	57.22	44.71	1.21	42.23		
		82	18	1534.8	44.8	27	54.44	57.85	.87	28.20		
		83	4	0.0	43.8	.	0.00	8.80	.	0.00		
		84	35	938.0	209.3	25	10.91	23.12	.41	8.45		
			Total		575	34754.7	1805.3	828	41.81	43.78	.94	32.47
		4Xa	Grand Manan	85	88	2544.1	184.1	88	24.80	33.42	.73	23.31
86	85			2514.8	284.1	88	21.36	27.67	.81	28.88		
87	58			1738.9	205.3	62	18.78	27.11	.57	18.88		
88	8			277.8	37.3	11	8.88	38.28	.80	7.83		
88	22			880.8	77.3	27	51.84	31.33	1.84	48.88		
88	22			548.8	75.4	25	8.85	21.84	.50	9.27		
81	77			2884.8	318.8	88	18.78	38.85	.51	15.50		
82	73			1782.0	238.2	71	14.24	23.85	.82	14.88		
84	44			1848.0	173.1	45	28.85	32.70	.42	28.74		
	Total				458	14482.8	1581.8	488	21.88	28.72	.87	28.88
4Xa	Trinity	85	481	18582.3	2188.8	847	24.88	38.28	.78	21.48		
		88	321	1872.5	1848.8	378	8.50	22.83	.41	8.43		
		87	384	11532.7	1888.8	438	11.47	25.77	.48	8.75		
		88	288	12278.8	1488.1	388	14.70	28.88	.48	18.85		
		88	15	288.8	88.8	8	8.43	11.87	.45	8.83		
		88	44	833.3	288.4	58	4.23	13.70	.43	2.75		
		81	48	1782.4	282.7	67	8.61	24.38	.38	7.15		
		82	82	2878.5	448.8	97	18.28	28.84	.34	8.50		
		83	1	8.8	4.8	.	8.88	8.88	.	8.88		
		84	45	1722.1	237.5	88	18.73	25.88	.85	14.42		
			Total		1878	58738.7	8283.4	2188	15.48	28.81	.52	12.72
		4Xa	Seal Island	85	188	9588.7	718.4	237	25.38	38.48	.88	18.92
				88	131	5824.4	541.8	184	18.83	31.25	.81	14.48
				87	288	7843.1	1885.7	388	12.82	23.88	.54	8.28
88	232			11731.8	1137.1	254	15.35	34.77	.48	18.81		
88	384			14128.8	1517.8	421	18.78	34.47	.53	18.81		
88	322			15117.2	2835.8	477	11.78	32.55	.38	8.28		
81	181			8888.3	1854.8	288	13.28	22.31	.81	7.83		
82	144			5852.8	882.2	214	11.83	27.31	.43	8.81		
83	3			288.8	18.8	5	18.87	43.83	.42	18.83		
84	85			1333.4	385.8	88	18.47	14.88	.53	8.81		
	Total				1787	78438.8	8388.3	2554	15.71	38.58	.51	11.51
4Xa	German Bank			85	175	8843.8	878.3	282	25.88	38.41	.82	18.88
				88	188	8838.7	873.2	341	17.84	27.24	.88	11.58
		87	238	11748.8	882.8	332	25.22	33.88	.88	18.44		
		88	188	11712.3	787.4	283	31.23	44.78	.74	25.88		
		88	118	4888.5	851.1	138	13.83	32.33	.43	8.43		
		88	141	8888.4	885.5	183	15.61	31.38	.48	18.17		
		81	284	12785.4	1575.8	487	15.61	31.88	.45	11.34		
		82	88	2137.1	288.4	84	11.88	31.73	.41	18.72		
		83	1	258.8	2.8	1	125.88	258.88	.58	125.88		
		84	88	3885.7	588.7	128	15.28	28.18	.48	18.85		
			Total		1478	73882.8	7287.8	2154	28.48	33.88	.57	15.27
4Xa	Scotts Bay	88	1	38.3	4.5	1	8.87	38.38	.22	8.87		
		87	55	2238.8	255.5	81	31.88	35.28	.51	18.78		
		88	44	2884.4	184.3	77	25.88	38.84	.82	15.45		
		88	115	4178.4	388.7	131	25.48	31.81	.78	22.52		
		88	75	4488.2	351.5	108	24.28	44.73	.58	28.84		
		81	113	5833.8	844.5	152	15.92	34.71	.48	13.82		
		82	88	4555.2	431.8	118	21.52	37.88	.55	18.31		
		83	18	388.4	58.3	13	18.58	32.88	.34	8.32		
		84	118	3788.8	887.4	115	18.82	24.38	.43	8.88		
			Total		838	27558.5	2828.8	774	18.64	34.12	.55	18.83

Table 18. 1985 to 1994 4VWX herring purse seine catch rates per trip by major fishery.

Fishery	Year	No.Days Fished	Total MT Caught	Total Search Hours	Total Number of Sets	Search per Trip	Catch per Trip	Total Catch per hr
4Wd	84	4	142.4	25.5	5	6.4	35.6	5.58
	85	42	2761.2	152.5	58	3.6	65.7	18.11
	86	73	4978.8	196.5	97	2.7	68.2	25.34
	87	92	5126.4	247	141	2.7	55.7	20.75
	88	105	5363.7	387.8	151	3.7	51.1	13.83
	89	77	4270.2	239.7	105	3.1	55.5	17.81
	90	52	4194.9	131.3	86	2.5	80.7	31.95
	91	92	6496.6	268.7	158	2.9	70.6	24.18
	92	16	1534.8	44.6	27	2.8	95.9	34.41
	93	4	0	43.8				
94	35	938	209.3	25	6.0	26.8	4.48	
4Wk	93	14	543	65	17	4.6	38.8	8.35
	94	26	1215	129.7	29	5.0	46.7	9.37
4Xa	85	1178	51721.2	5160.9	1542	4.4	43.9	10.02
	86	1006	36528.4	4519.7	1363	4.5	36.3	8.08
	87	1270	48049.5	5758.4	1653	4.5	37.8	8.34
	88	1292	59499.6	5872.8	1739	4.5	46.1	10.13
	89	1100	41971.1	5333.2	1341	4.8	38.2	7.87
	90	1094	43461.9	6096.4	1419	5.6	39.7	7.13
	91	1105	42296.1	6253.4	1551	5.7	38.3	6.76
	92	921	35214.8	4665.4	1181	5.1	38.2	7.55
	93	37	2171.8					
	94	699	22902.3	4324.7	822	6.2	32.8	5.30
4Xb	85	9	275.2	26.4	10	2.9	30.6	10.42
	86	79	1960.1	203.9	90	2.6	24.8	9.61
	87	71	2530	237.6	86	3.3	35.6	10.65
	88	81	3242.3	206	94	2.5	40.0	15.74
	89	115	3470.4	361.1	128	3.1	30.2	9.61
	90	170	4523.1	503.3	187	3.0	26.6	8.99
	91	31	860.7	144.7	35	4.7	27.8	5.95
	92	4	183.7	11.8	5	3.0	45.9	15.57
	94	29	1382	217.2	32	7.5	47.7	6.36
4Vn	86	7	712.3	25.5	16	3.6	101.8	27.93
	87	9	775.7	29	18	3.2	86.2	26.75
	88	1	45.4	1	1	1.0	45.4	45.40
	89	7	653.2	12	11	1.7	93.3	54.43
	90	5	625.9	11	9	2.2	125.2	56.90
	91	9	1242.8	18	19	2.0	138.1	69.04

Table 19. Herring abundance indices; larval abundance index (average number of larvae per m2 from 79 index stations), and herring by-catch (stratified numbers per tow) from July groundfish survey.

Larval Herring Bongo Survey					Herring groundfish by-catch (mean numbers per tow)								Mean Weight (kg per tow)			
Year	Cruise	No. per m2 to bottom		N	4WX Area Combined				4W Area Only		4X Area Only		4W Area Only		4X Area Only	
		Mean	SE		Cruise	Mean#	SE	N	Mean#	SE	Mean#	SE	MeanWt	SE	MeanWt	SE
70					A175/176	4.1	1.5	95	4.9	2.4	1.6	0.6	1.5	0.7	0.5	0.2
71					A188/189	4.0	1.9	86	2.6	1.2	3.6	2.6	0.7	0.4	1.3	1.0
72	P109	9.4	1.8		A200/201	1.4	0.6	105	1.7	1.0	0.5	0.1	0.5	0.4	0.1	0.0
73	P127	6.6	1.3		A212/213	0.9	0.3	96	0.4	0.3	1.0	0.4	0.1	0.1	0.2	0.1
74	P147	49.5	10.9		A225/226	0.7	0.3	102	0.2	0.0	1.0	0.4	0.1	0.0	0.2	0.1
75	P160	11.7	1.5	58	A236/237	0.9	0.4	104	0.8	0.4	0.7	0.4	0.3	0.2	0.2	0.1
76	P175	13.5	2.9		A250/251	0.4	0.2	103	0.1	0.1	0.5	0.3	0.0	0.0	0.1	0.1
77	P190	6.3	1.0		A265/266	0.5	0.3	106	0.0	0.0	0.8	0.5	0.0	0.0	0.1	0.0
78	P207	4.5	0.5	77	A279/280	0.3	0.3	103	0.5	0.5	0.1	0.0	0.3	0.3	0.0	0.0
79	P232	7.1	2.1		A292/293	0.6	0.5	106	0.0	0.0	1.0	0.7	0.0	0.0	0.2	0.1
80	P246	26.2	6.7		A305/306	0.5	0.5	105	0.0	0.0	0.8	0.8	0.0	0.0	0.0	0.0
81	P263	2.7	0.3	78	A321/322	1.5	1.4	104	0.0	0.0	2.3	2.1	0.0	0.0	0.4	0.4
82	P280	10.6	1.2	77	H080/081	1.5	0.9	108	0.5	0.3	1.9	1.4	0.2	0.1	0.5	0.4
83	P298	13.9	1.6	74	N012/013	2.4	0.8	106	2.6	1.2	2.2	1.0	0.8	0.4	0.2	0.1
84	P315	12.7	1.4	78	N031/032	7.0	3.5	102	3.3	1.2	10.5	6.8	1.0	0.4	3.1	2.2
85	P329	40.8	4.6	79	N048/049	3.4	1.8	111	6.6	3.8	0.3	0.1	2.1	1.2	0.1	0.0
86	P344	18.9	2.1	78	N065/066	23.2	14.9	118	30.8	26.7	16.0	14.3	9.4	8.3	3.1	2.8
87	P361	27.9	3.2	78	N085/087	10.4	5.6	135	17.0	11.3	4.0	1.8	3.9	2.0	0.5	0.2
88	P377	100.7	11.5	76	N105/106	2.1	0.6	127	2.7	1.2	1.5	0.5	0.7	0.3	0.2	0.1
89	P391	54.5	6.1	79	N123/124	8.4	1.8	124	11.8	3.4	4.5	1.2	3.9	1.2	1.0	0.3
90	P408	27.2	3.1	79	N139/140	5.6	1.9	156	7.4	3.6	3.4	1.0	2.2	1.0	0.7	0.3
91	P422	48.2	5.5	78	N154/H231	10.6	5.8	137	13.0	8.8	5.0	1.8	4.3	2.9	1.2	0.4
92	P437	57.0	6.4	79	N173/174	16.5	4.9	136	16.2	6.6	40.8	15.7	5.0	2.2	5.5	2.6
93	P451	55.0	6.2	78	N189/190	18.7	4.5	137	6.3	2.5	30.4	8.5	2.0	0.8	7.1	2.0
94	N211	5.4	6.4	77	N211/222	76.4	30.2	140	108.4	58.9	45.9	18.4	29.1	13.5	8.3	3.4

Table 20. Abundance of herring (stratified mean number per tow) in summer groundfish research surveys of 4WX, strata 52-95, 1970-1994; (N = number per set for all sets) (N<sup>b</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>b</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
1993	N189/190		137	64	2460.15	17.96	38.44	18.65	4.51
1994	N221/222		140	76	16327.86	116.63	214.84	76.36	30.20

\*Total includes strata with only one set.

Table 21. 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
94a		0.2	6.7	12.3	30.1	24.1	9.4	0.7	2.0	4.9	1.8	7.9	100
94b		0.2	1.8	8.3	31.2	30.3	13.0	1.2	3.3	7.9	2.9	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	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
94a		39	1,562	2,879	7,048	5,648	2,191	166	477	1,147	426	1,845	23,428
94b		205	1,931	8,685	32,718	31,852	13,622	1,258	3,453	8,285	2,998	17	105,023

92a, 94a: all strata used.

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

94b. Strata 56,58 and 93 removed (total of 8, 8 & 3 sets respectively)

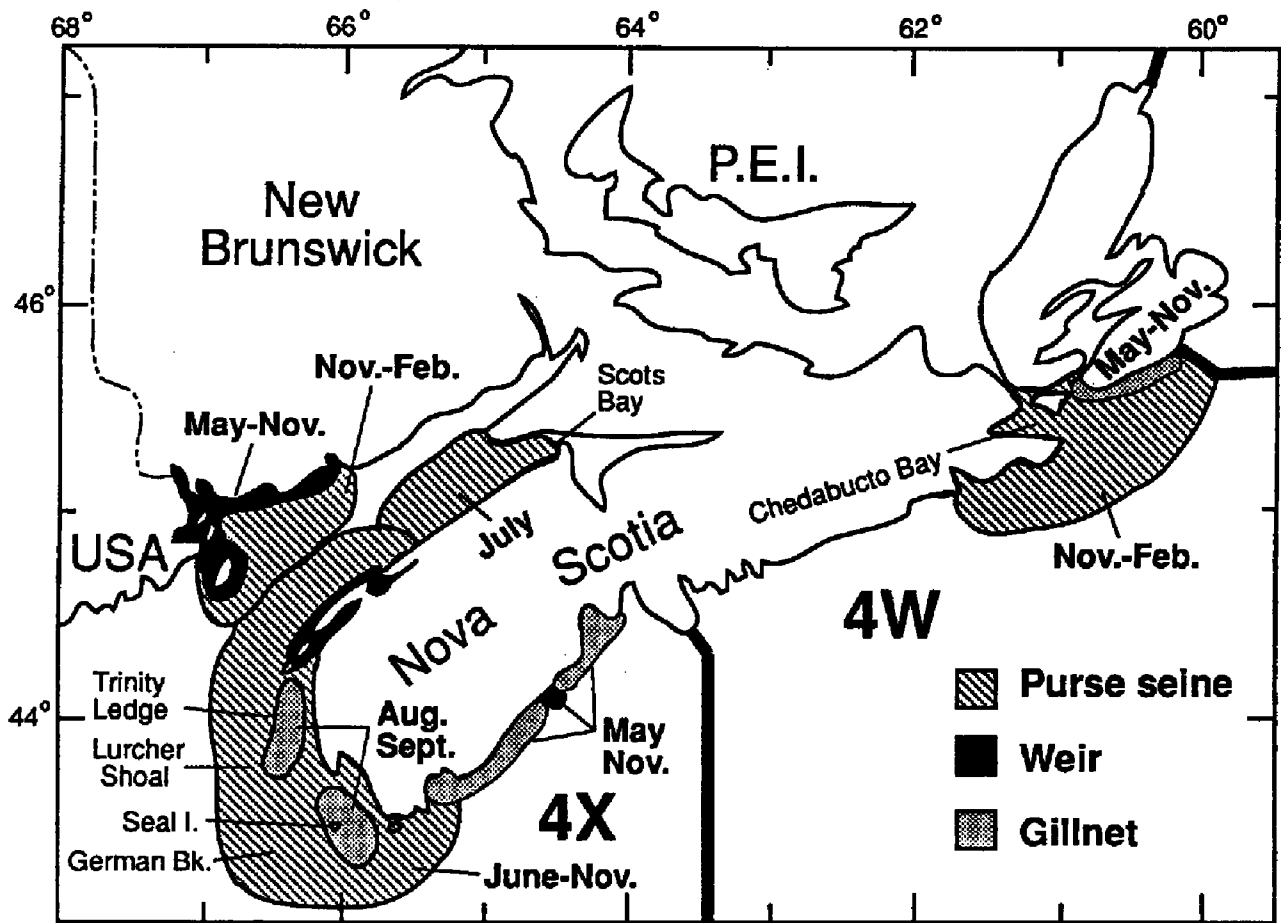
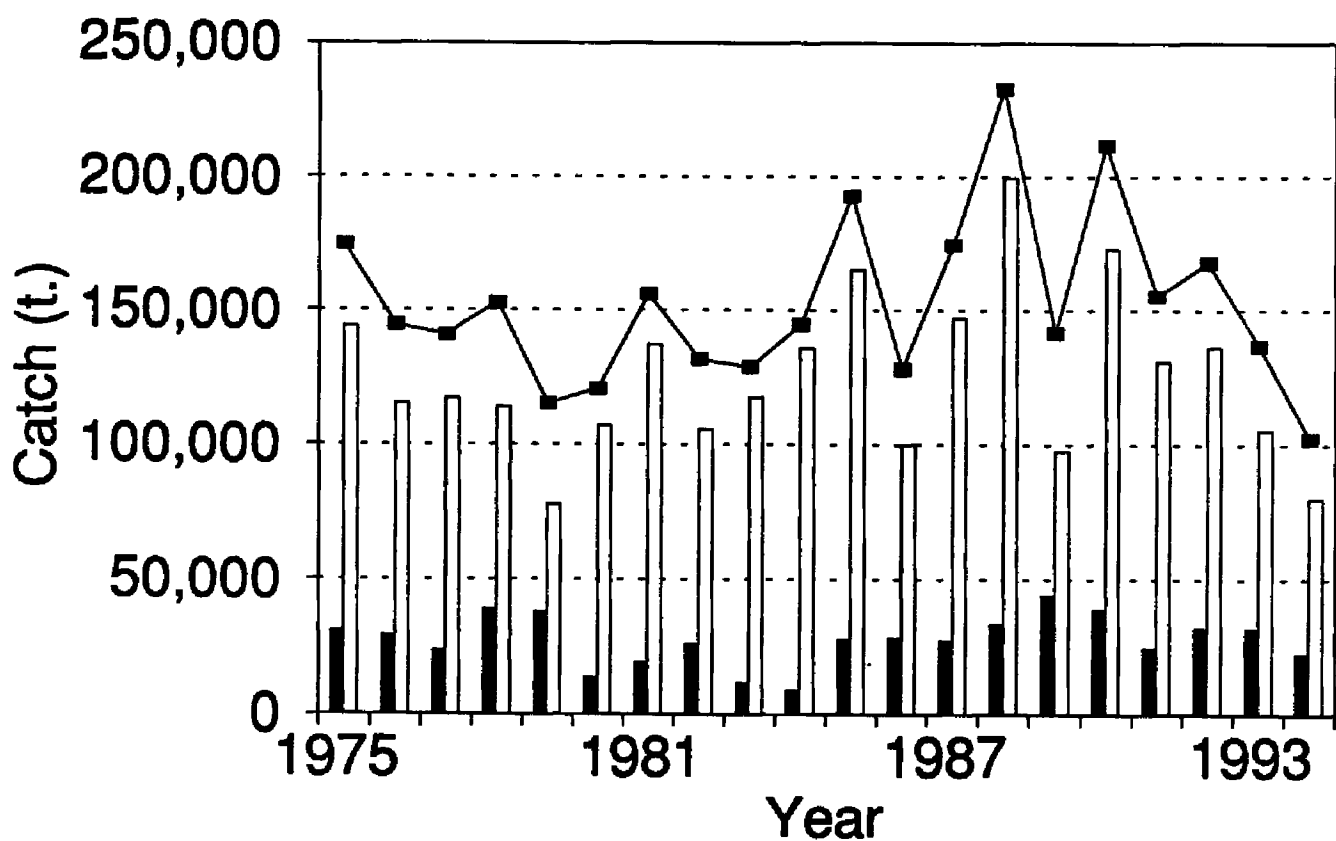


Fig. 1. Map of 4WX herring fishery showing locations of major fishing activity.

### 4WX herring landings



Total 4WX
  Non-stock
  Stock Adjusted

Fig. 2. Landings for stock and non-stock portions and TAC of the 1975 to 1994 4WX herring fishery.

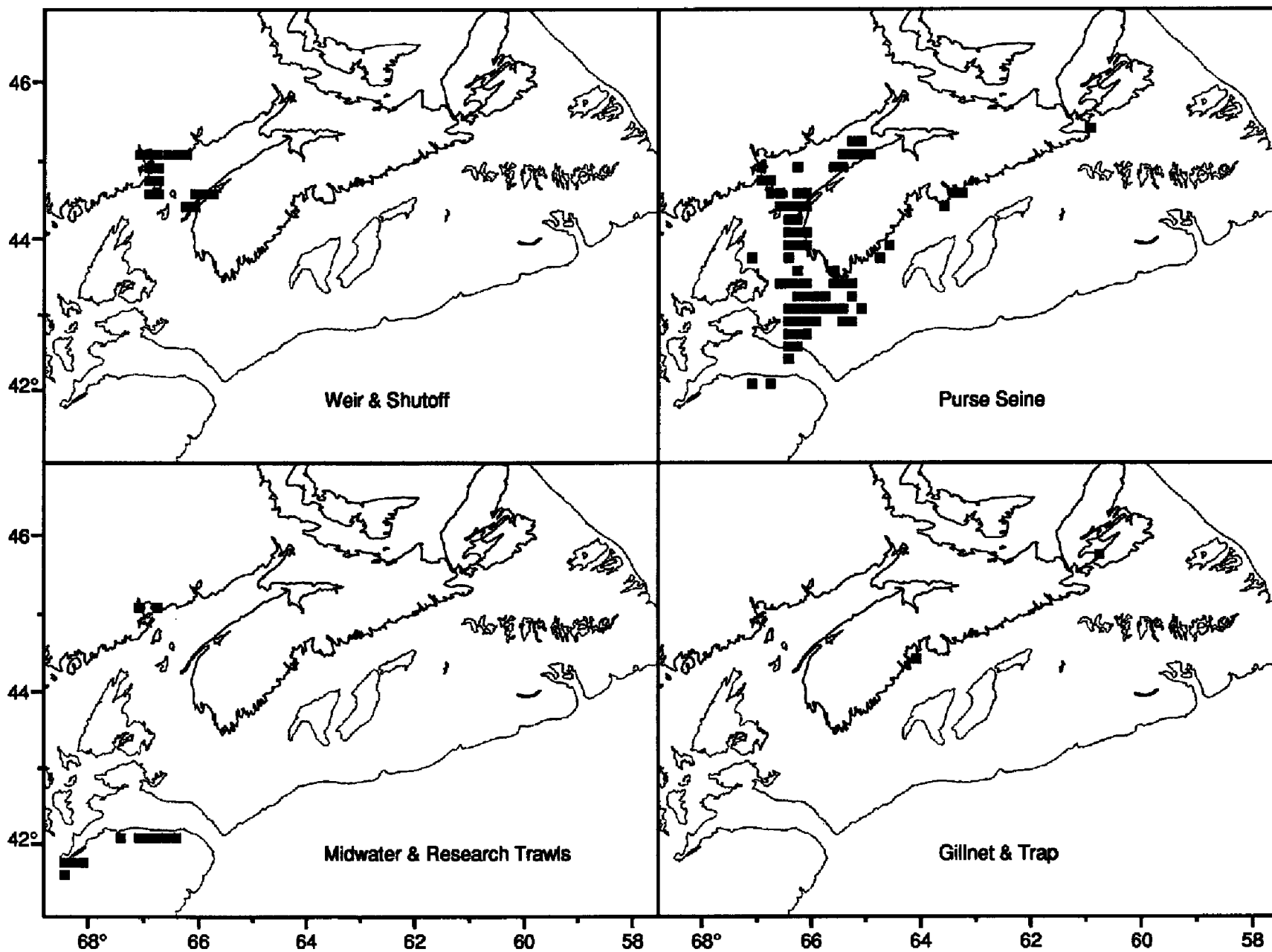


Figure 3. 1994 4WX and 5Z herring sampling coverage by 10 minute squares for major geartypes.



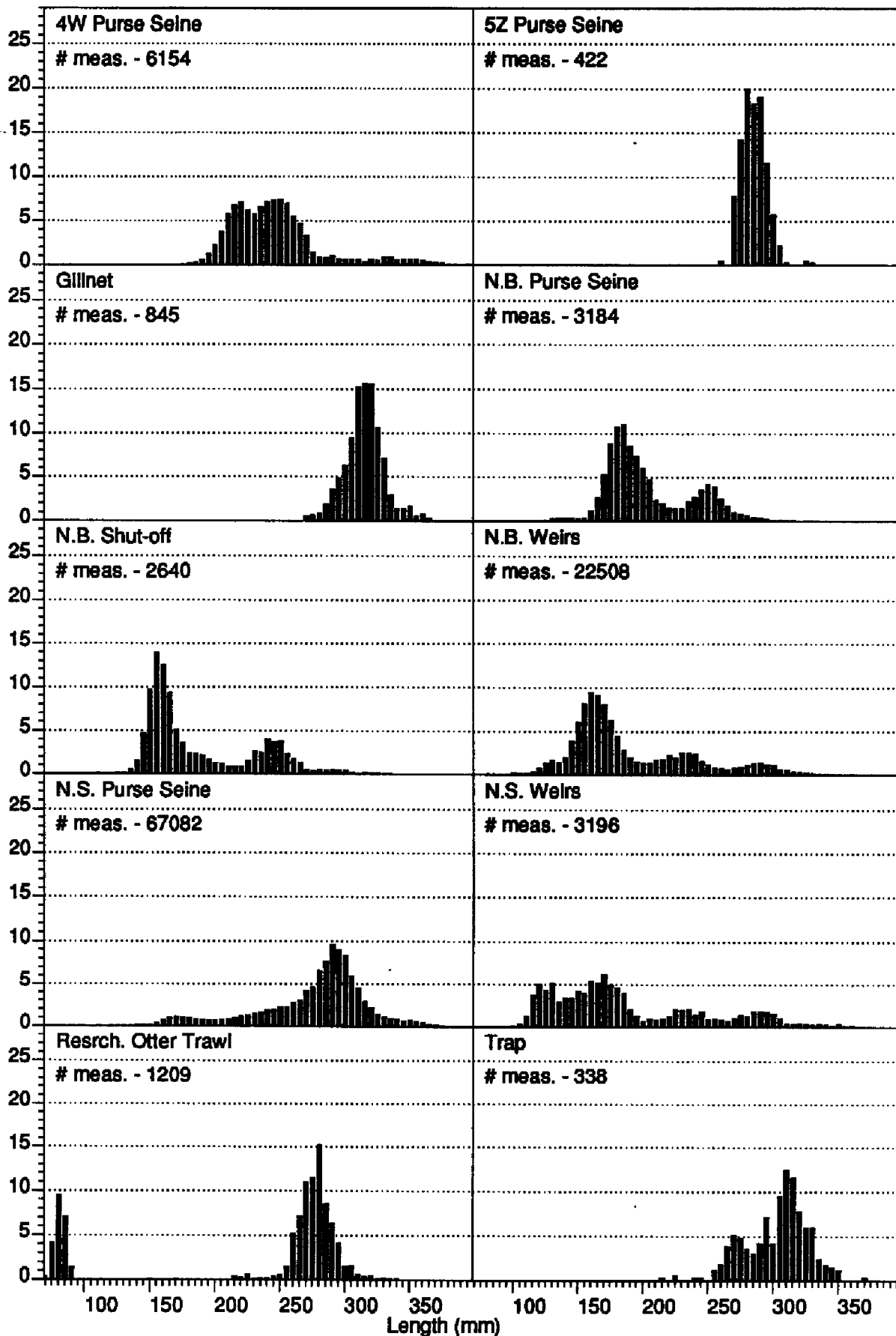


Figure 4. 1994 herring sample length frequencies (percent numbers) by major geartypes.

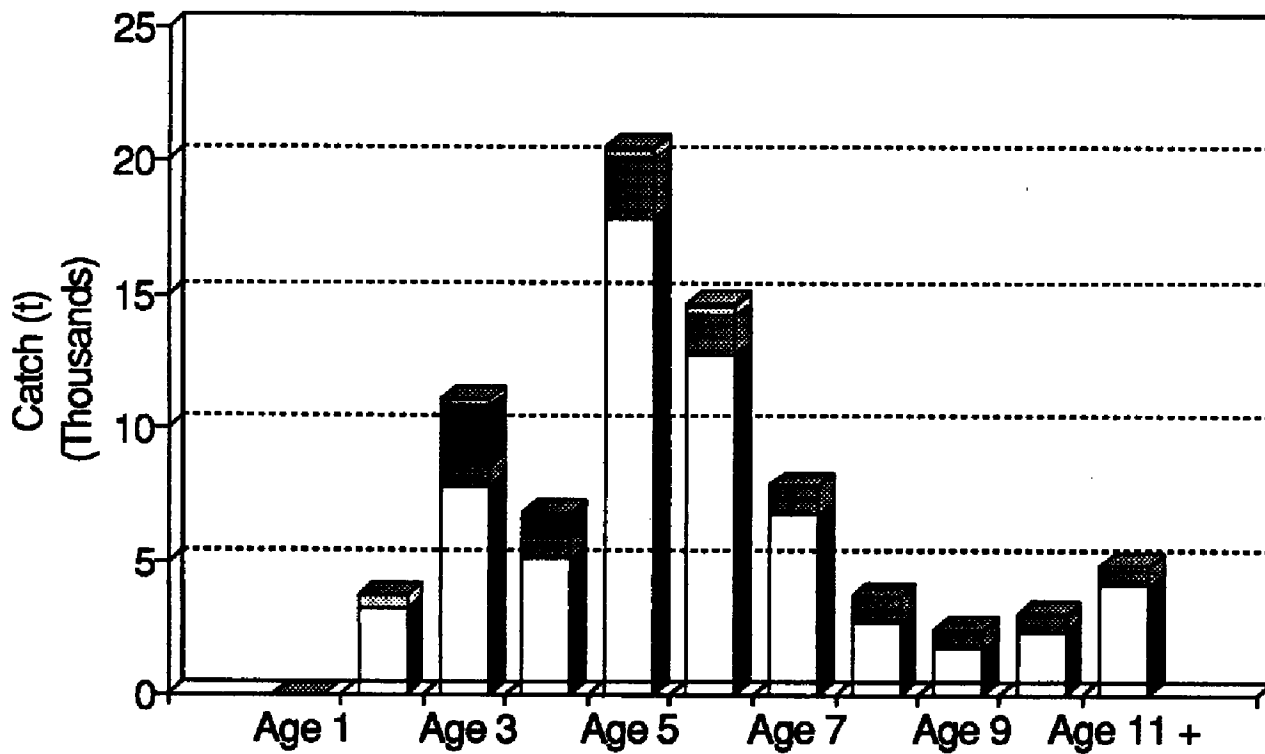
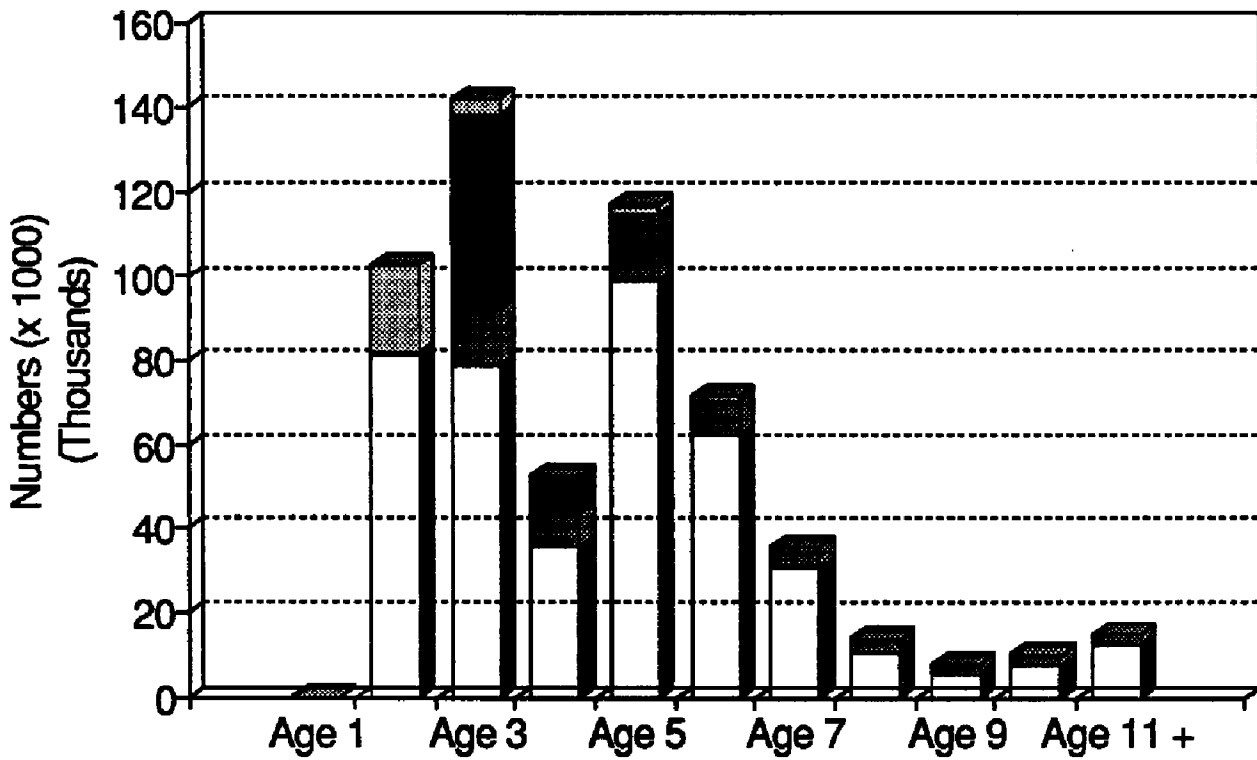


Fig. 5. Catch at age in numbers (top) and weight (bottom) by major gear segment of the 4WX herring fishery.

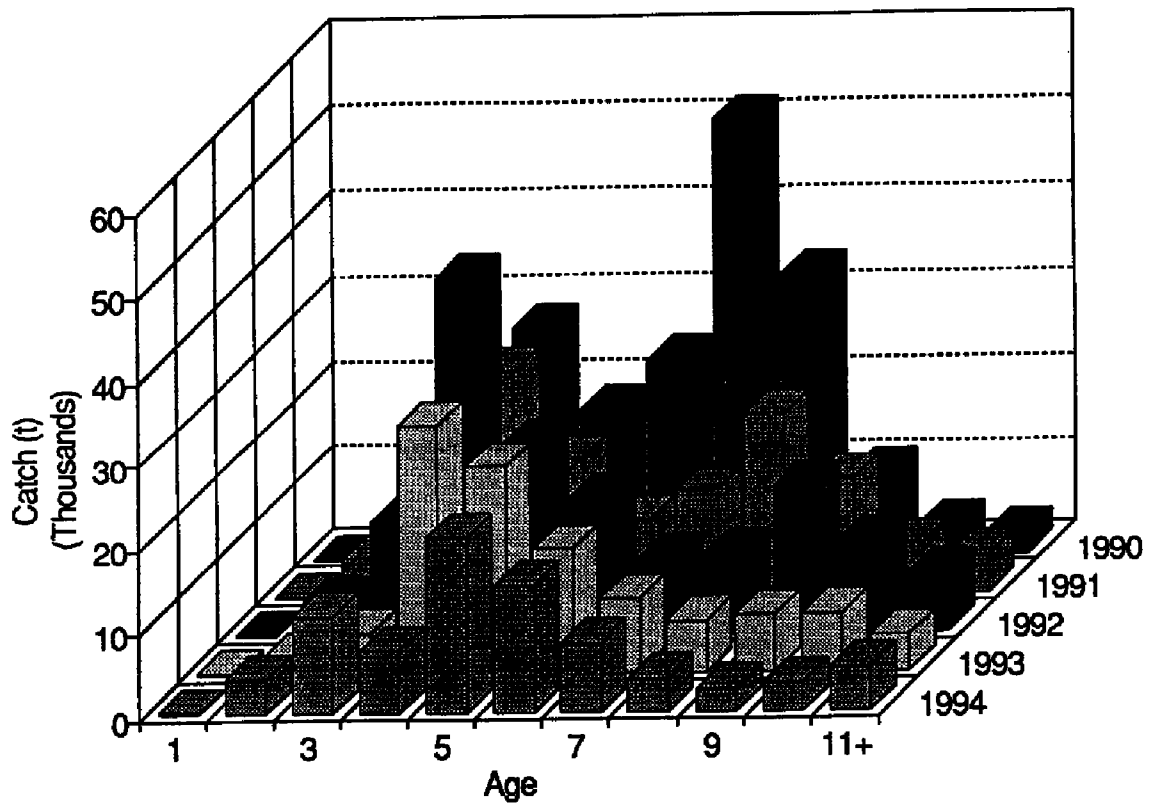
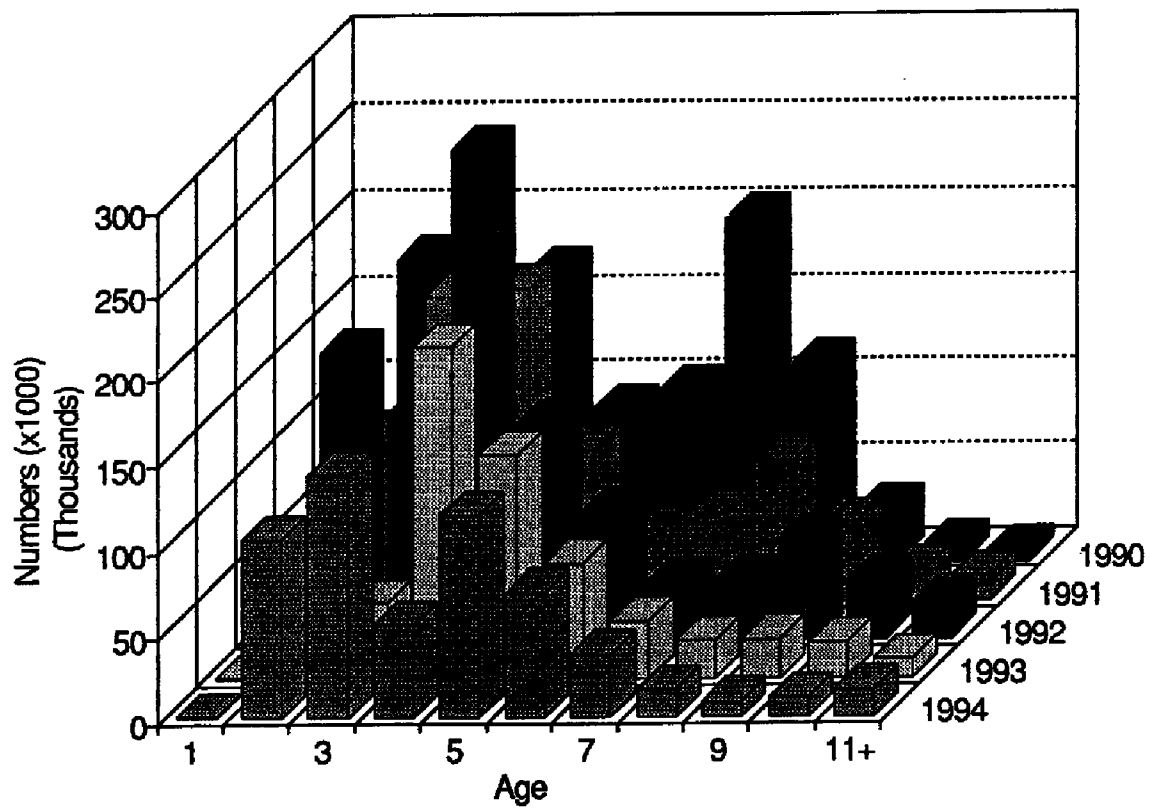


Fig. 6. Catch at age in numbers (top) and weight (bottom) for the stock portion of the 4WX herring fishery; 1990-1994.

### 4WX herring numbers at age

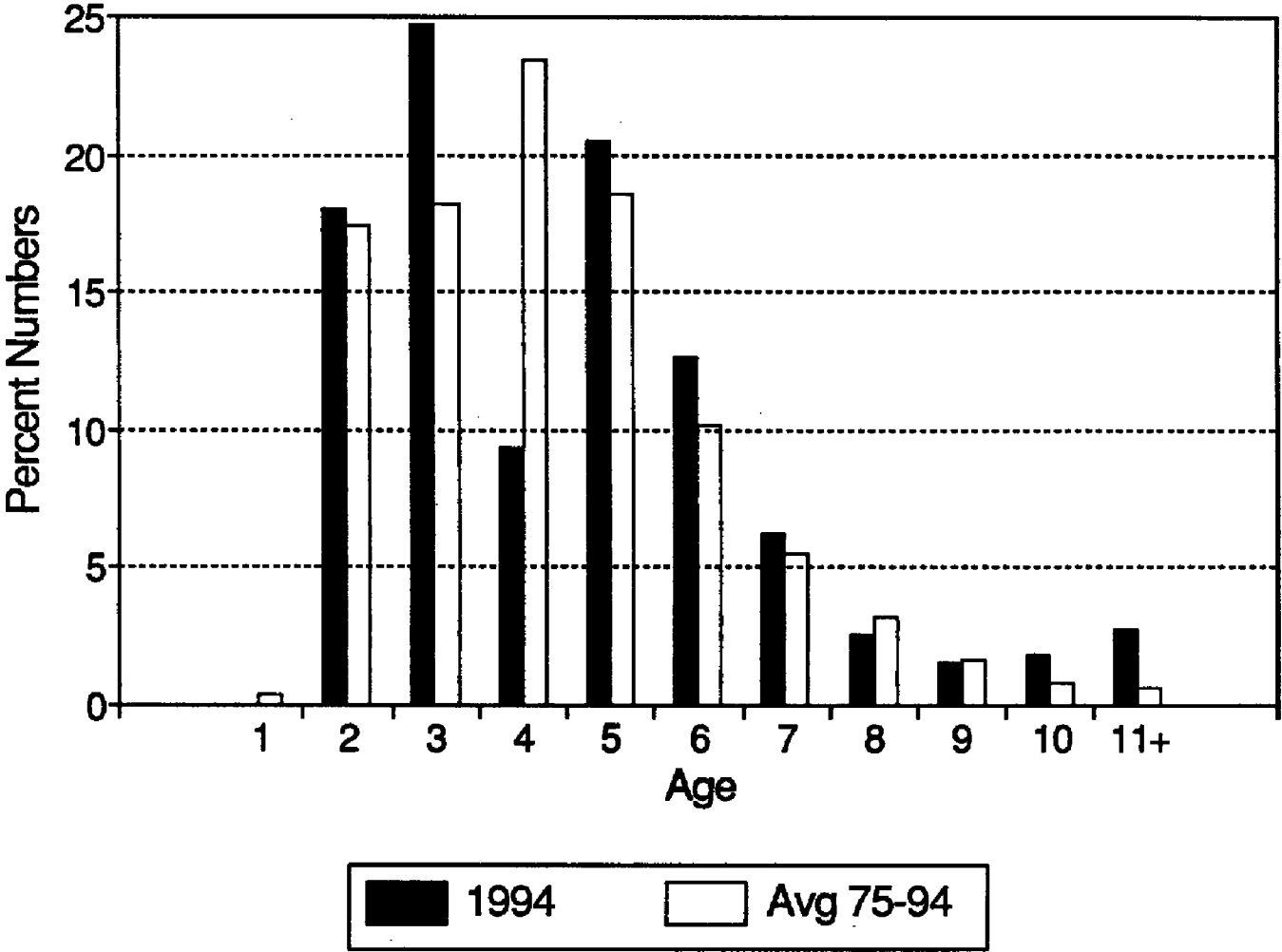


Fig. 7. 4WX herring numbers at age for 1994 and the average for 1975 to 1994.

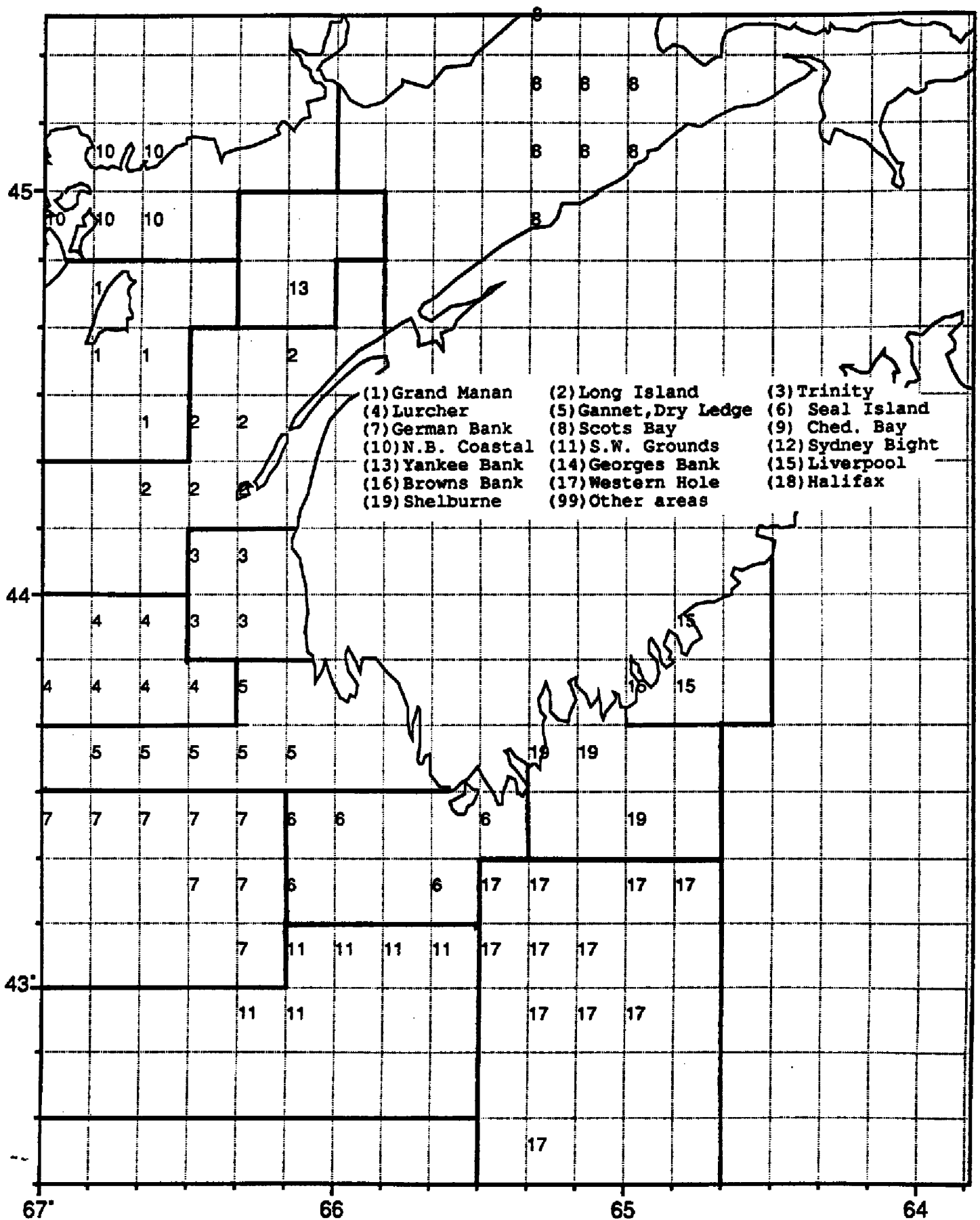


Fig. 8. 4X purse seine fishing grounds as defined by 10 mile squares.

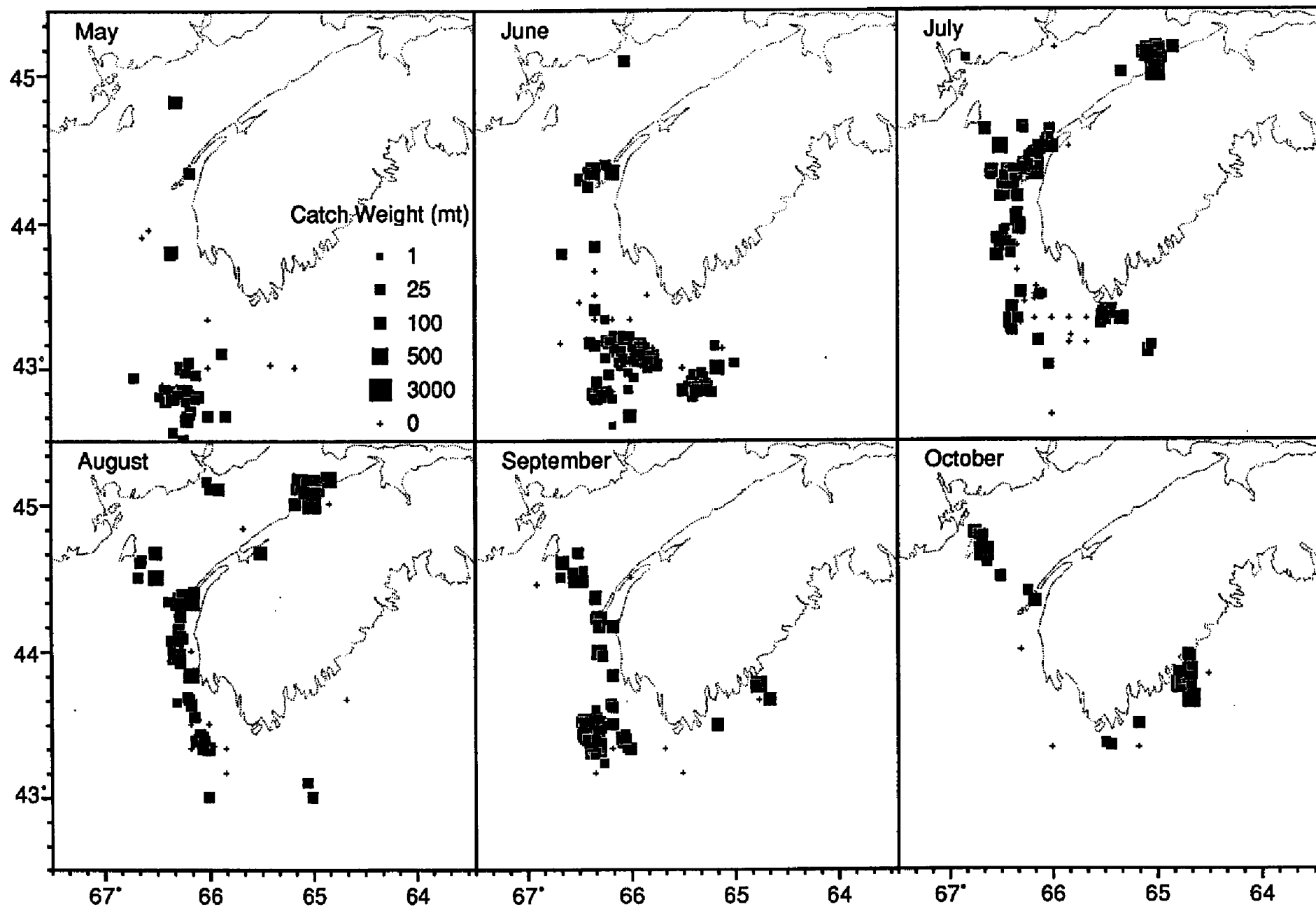


Fig. 9. 1994 4X summer purse seine fishery monthly catch distribution by point location of catch (catches summed by 1 mile squares).

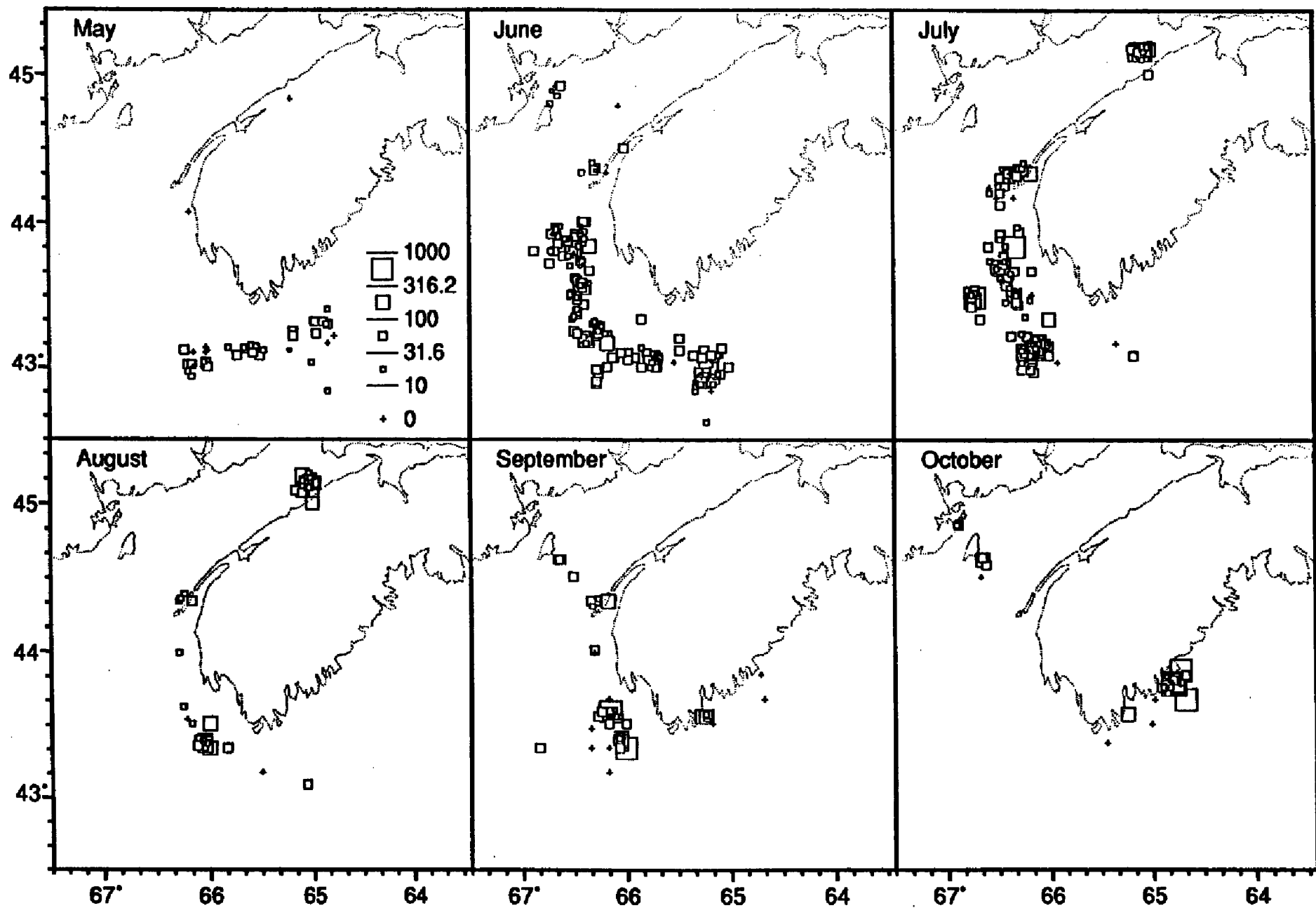


Fig. 10. 1993 4X summer purse seine fishery monthly catch distribution by point location of catch (catches summed by 1 mile squares).

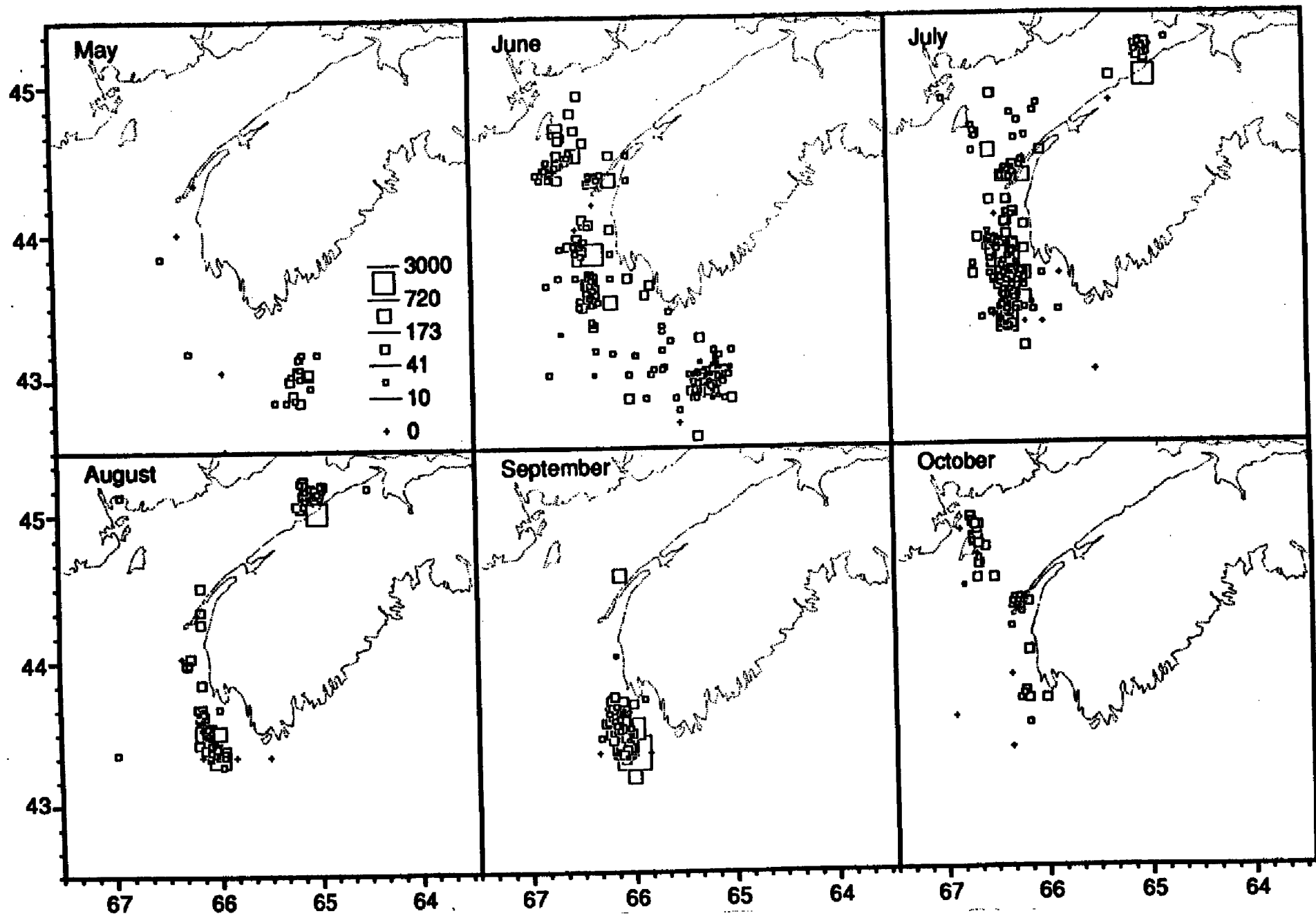


Fig. 11. 1992 4X summer purse seine fishery monthly catch distribution by point location of catch (catches summed by 1 mile squares).



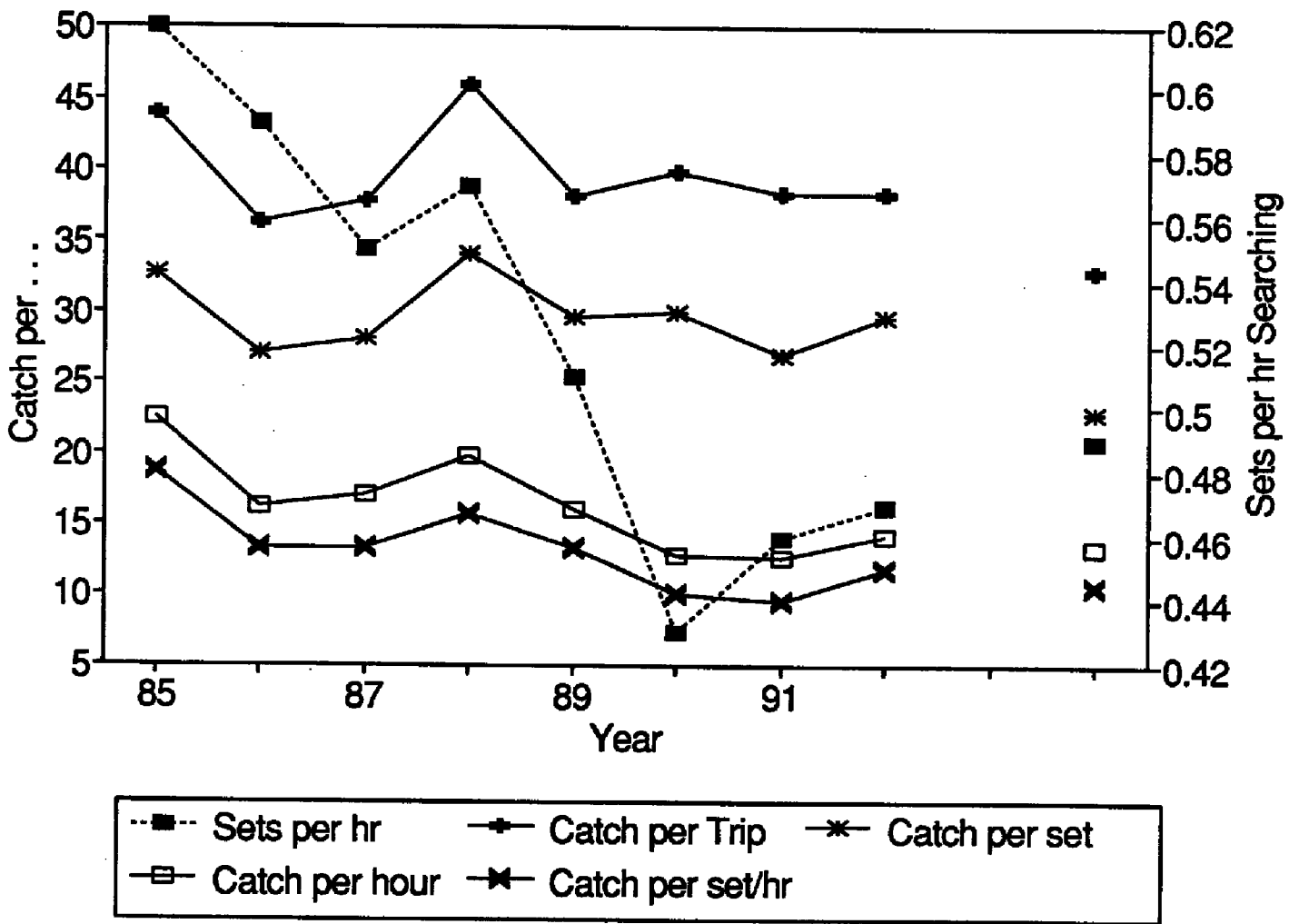


Fig. 12. 4X summer purse seine overall catch rates from logbook data, 1985-1994.

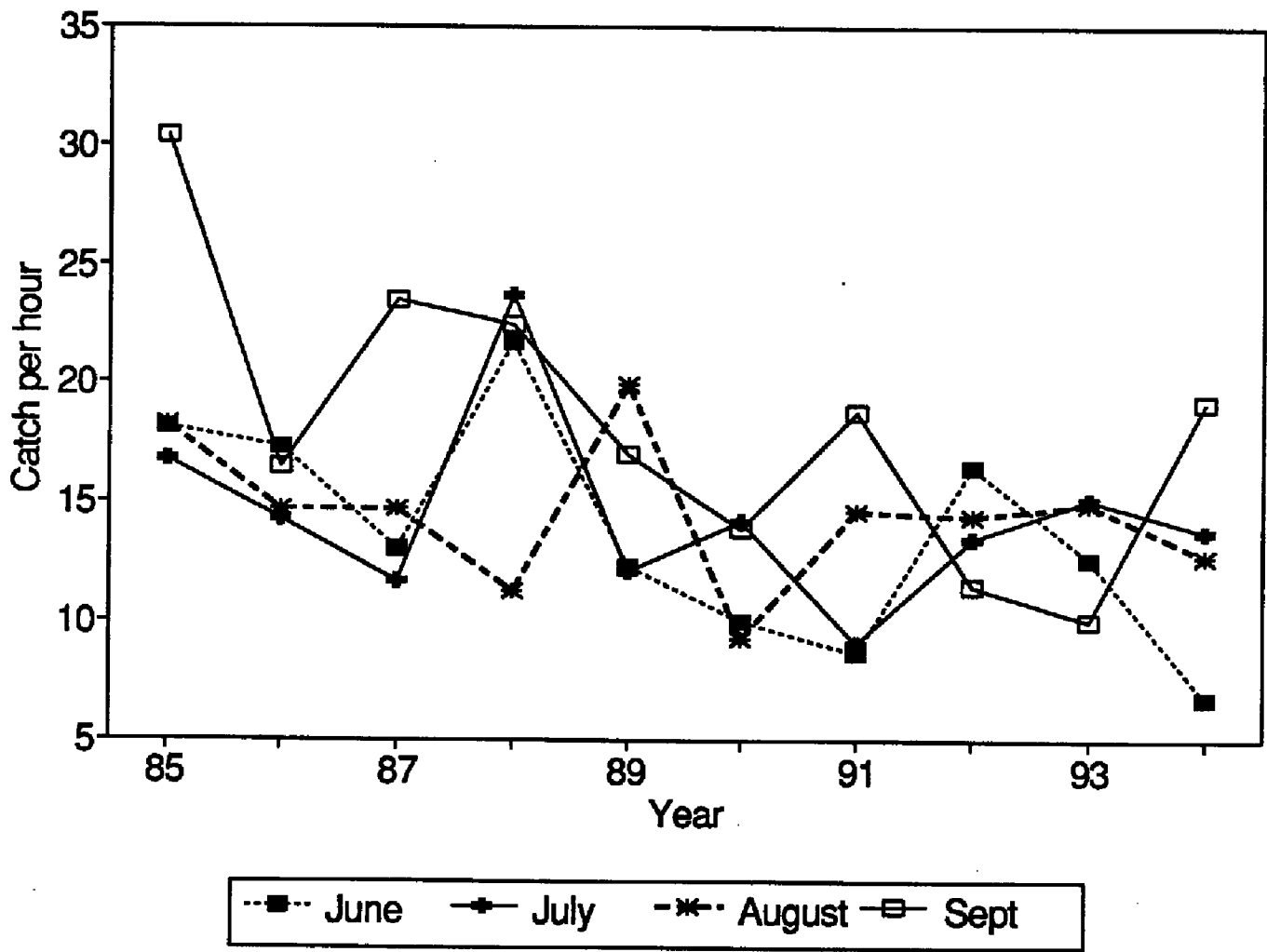


Fig. 13. 4X summer purse seine catch rates by month from logbook data, 1985-1994.

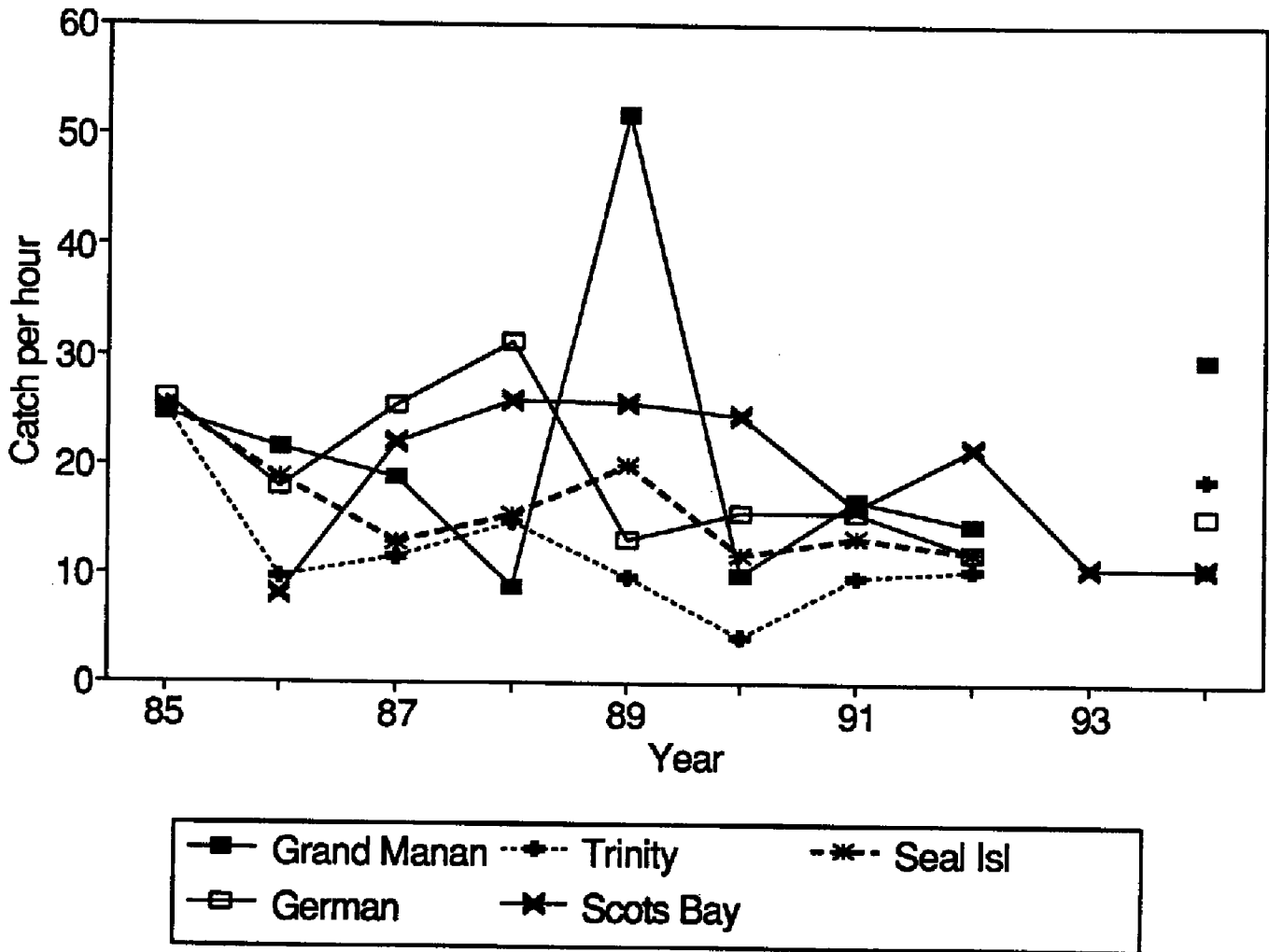


Fig. 14. 4X summer purse seine catch rates by major fishing grounds from logbook data, 1985-1994.

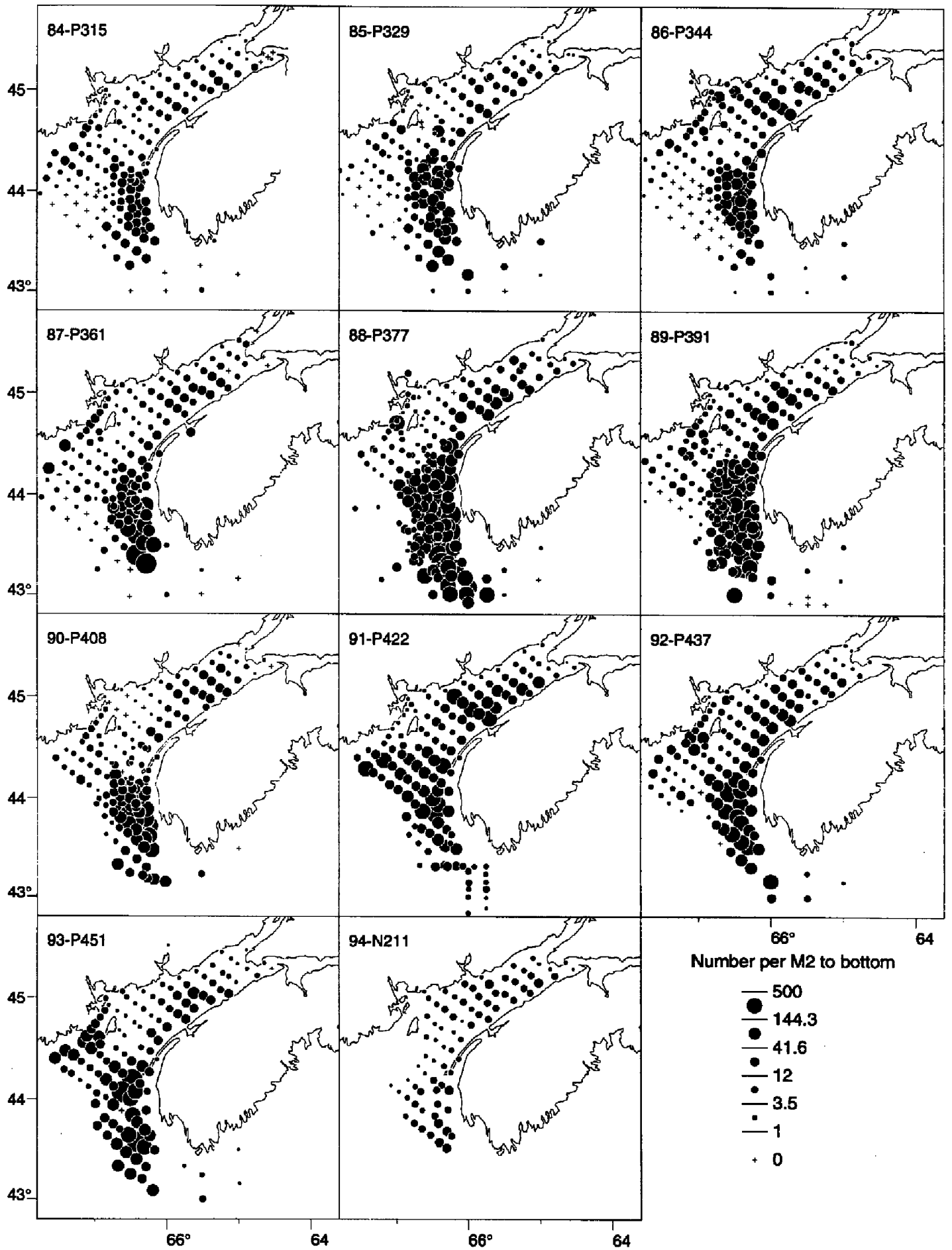


Fig. 15. Larval herring abundance (numbers per m<sup>2</sup> to bottom) by station for larval herring surveys; 1984-1994.

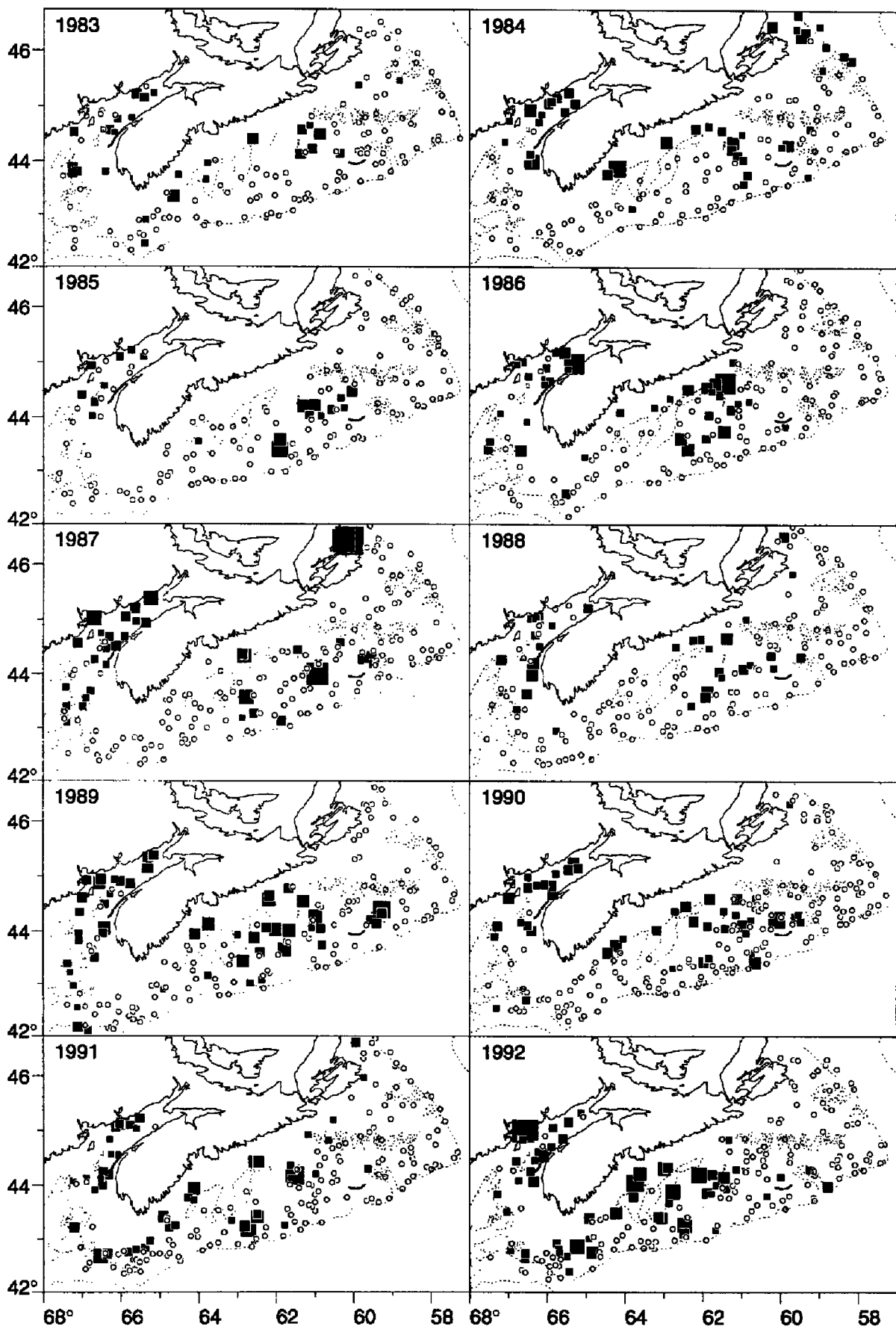
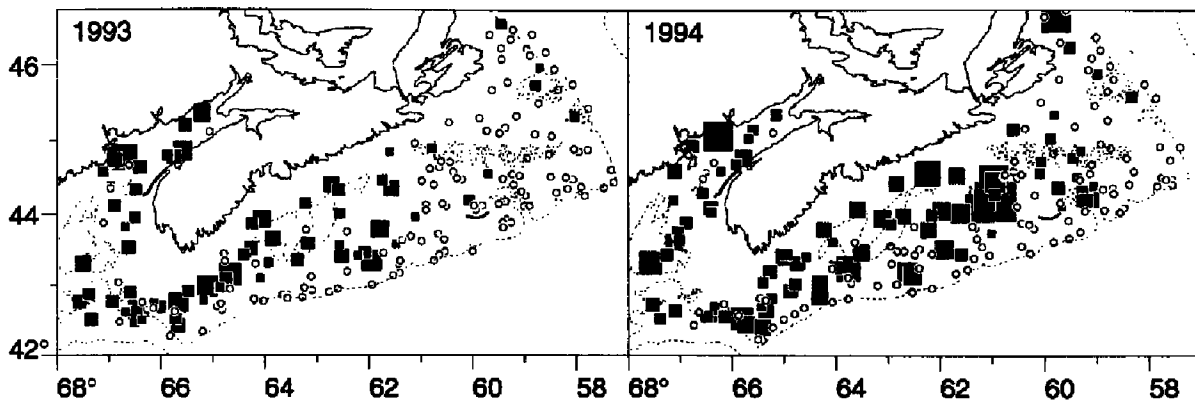


Fig. 16a. Occurrence of herring (number per tow) in July groundfish research survey data (bottom trawl) for 1983 to 1994.



Mean Numbers per Tow

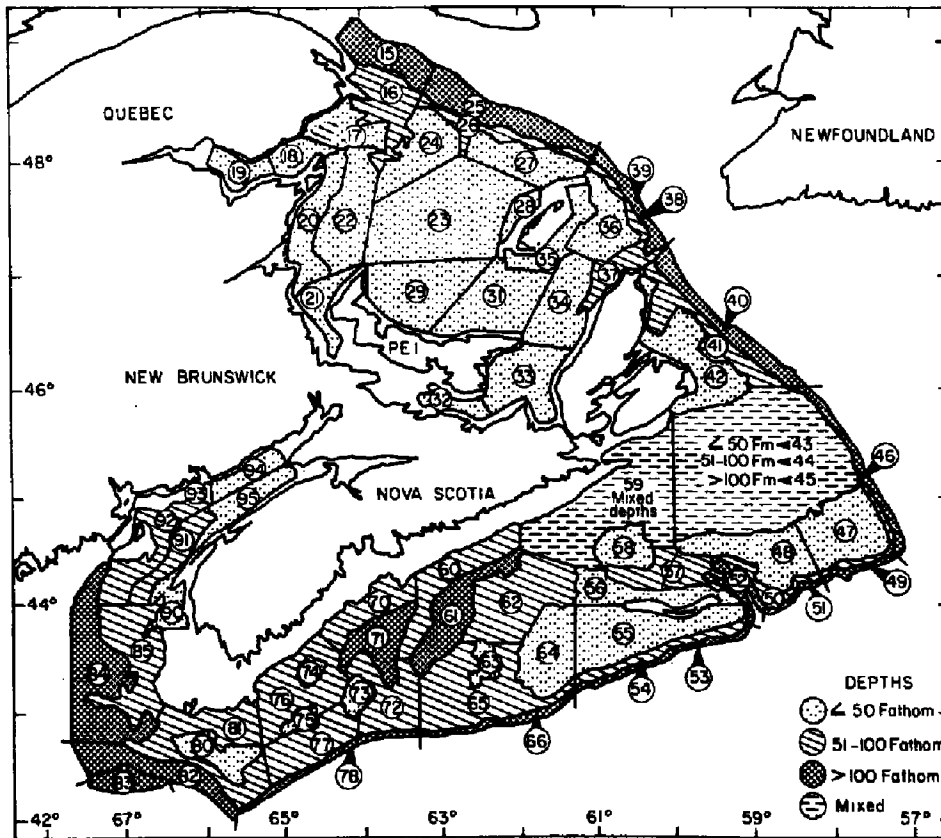
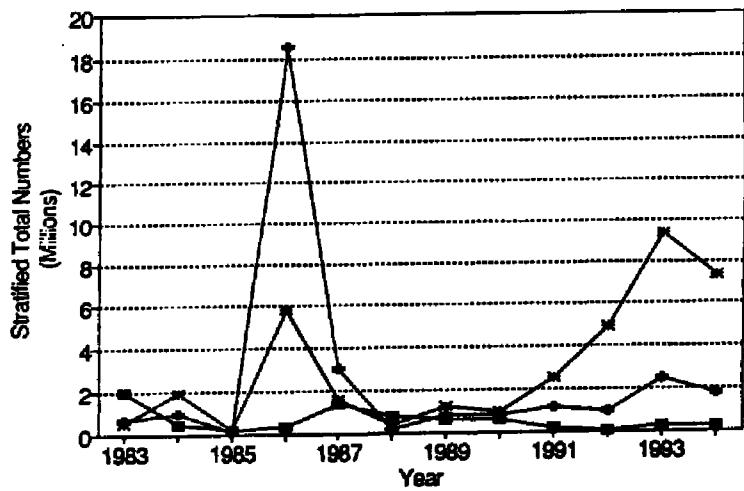
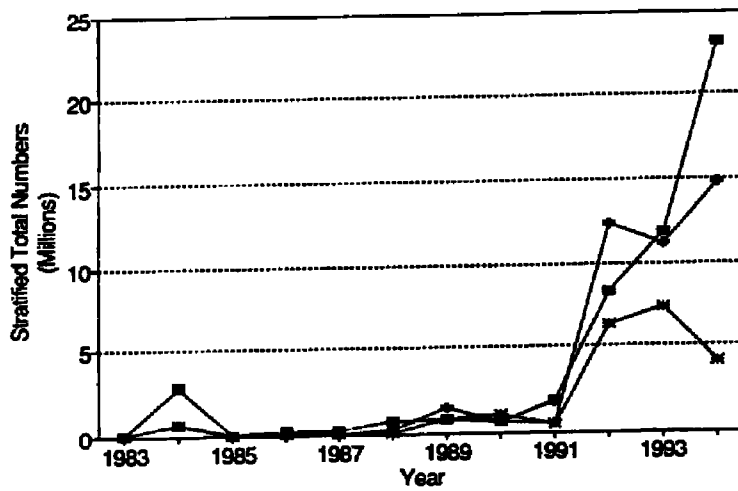


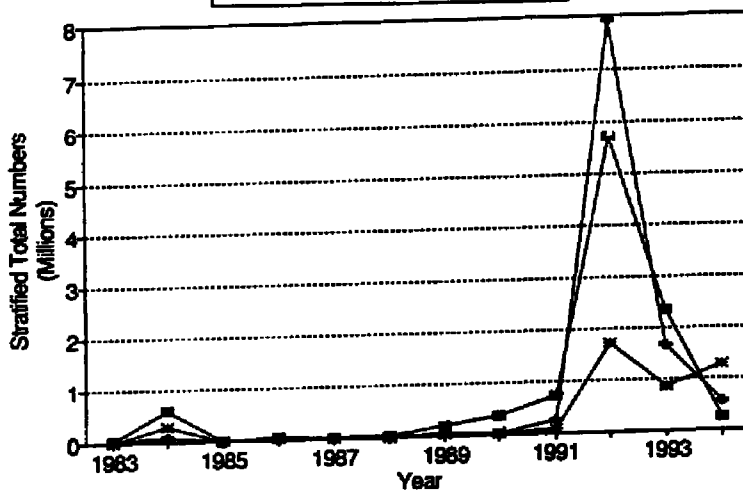
Fig. 16a. continued (top panel). b) Strata in NAFO Divisions 4T, 4V, 4W and 4X (bottom).



—■— Age 2 —◆— Age 3 —\*— Age 4



—■— Age 5 —◆— Age 6 —\*— Age 7



—■— Age 8 —◆— Age 9 —\*— Age 10

Figure 17. Catch at age of herring in the 4WX herring summer bottom trawl survey; 1983 to present.

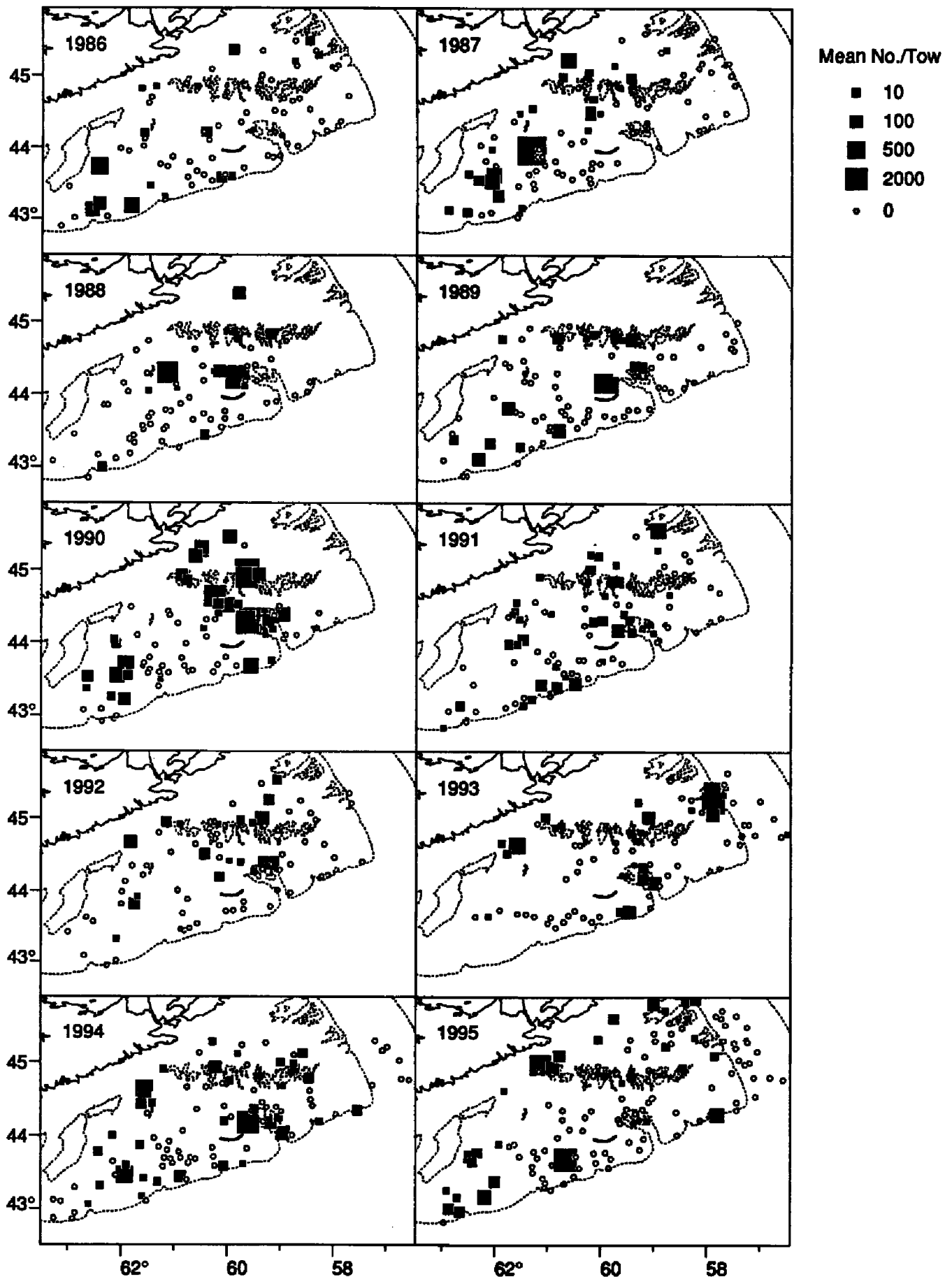
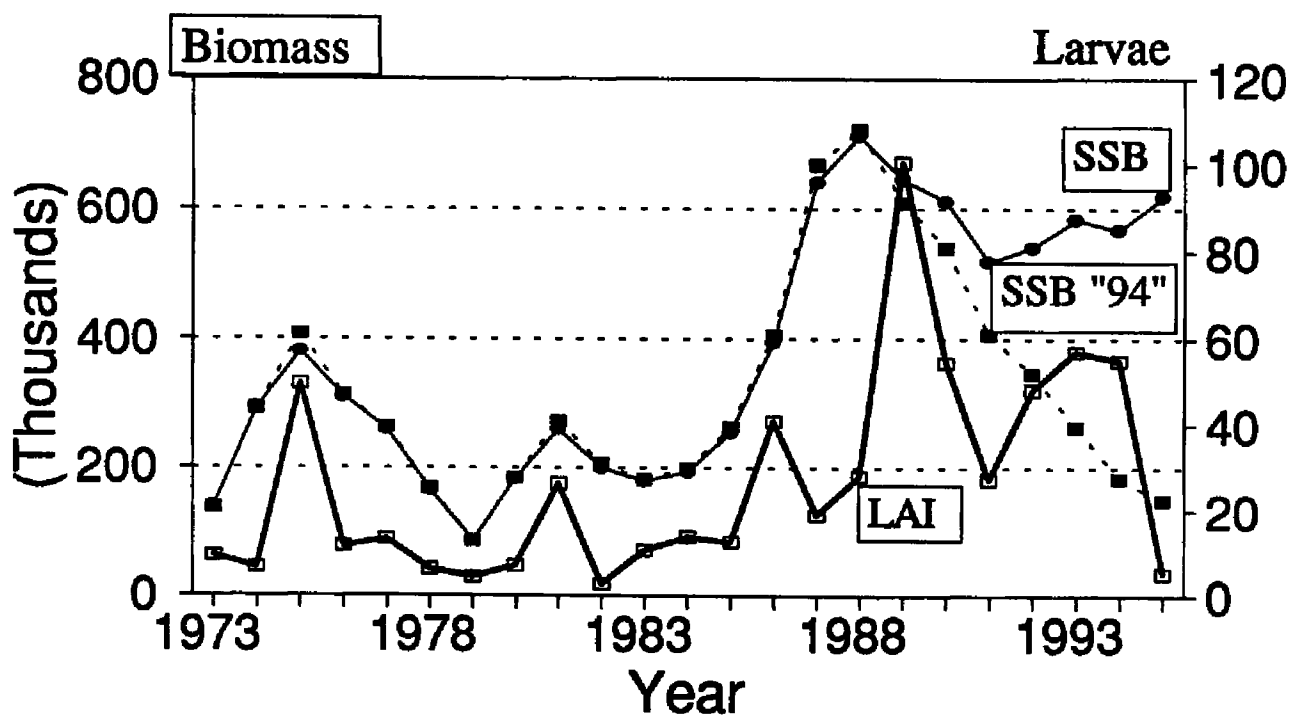


Fig. 18. 1986 to 1995 herring catches (number per tow) in 4VW spring (Feb-March) groundfish research survey data.



### 4WX SSB vs Larval Index



● Spawning Stock Biomass      ■ LAI in year used  
 ■ SSB "94" - predicted by 1994 LAI

Fig. 19. Larval herring abundance index and 4WX spawning stock biomass; 1973 to present.

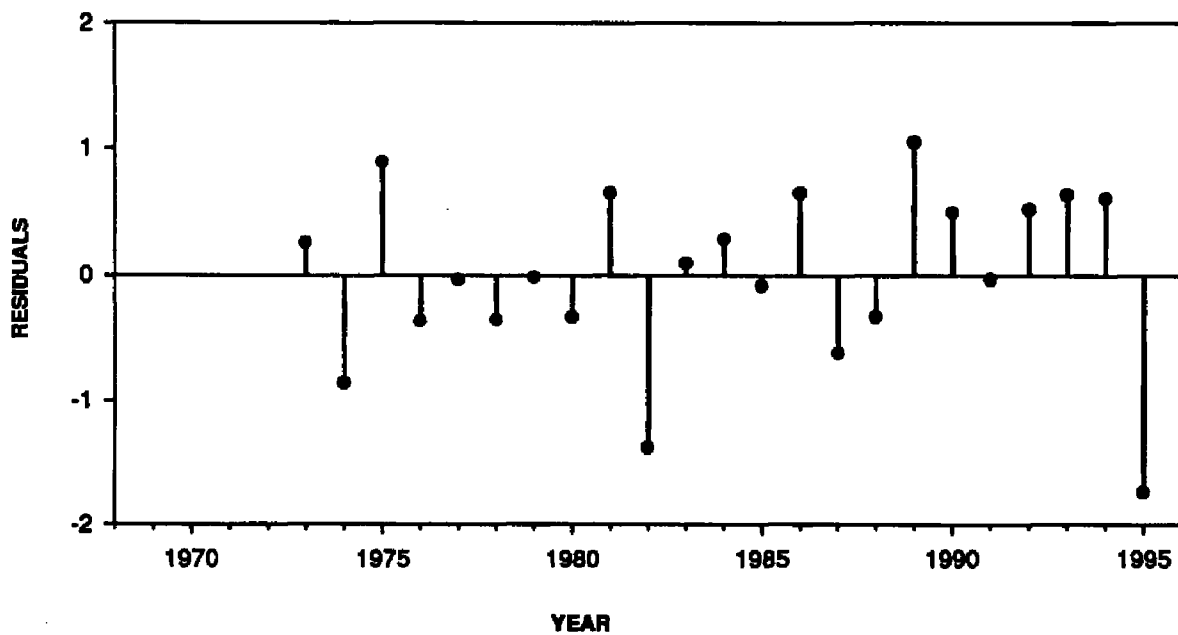
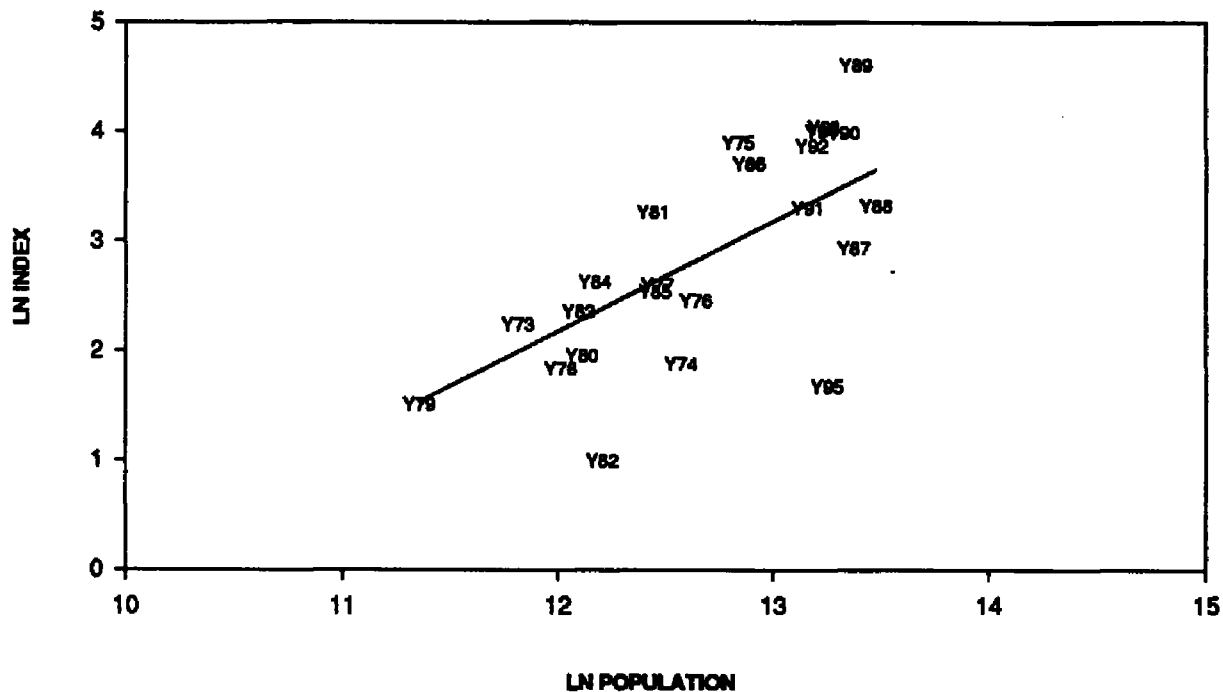


Figure 20. Observed and predicted (top panel) ln larval abundance index versus ln spawning biomass and (bottom panel) residuals plotted against year survey used in the relationship for 4WX herring.

### HERRING MOBILE GEAR MONITORING DOCUMENT

(TO BE COMPLETED BY ALL VESSELS INVOLVED IN THE MOBILE GEAR HERRING FISHERY INCLUDING SEINERS AND CARRIERS)

<b>A. GENERAL INFORMATION</b>		DATE/TIME SAILED	<table border="1" style="width: 100%; text-align: center;"> <tr> <td> </td><td> </td><td> </td><td> </td><td> </td><td> </td> </tr> <tr> <td>YR</td><td>MO</td><td>DAY</td><td>H</td><td>M</td><td>M</td> </tr> </table>										YR	MO	DAY	H	M	M	<b>D. WEIGHOUT INFORMATION</b>																												
YR	MO	DAY	H	M	M																																										
VESSEL NAME _____		DATE/TIME LANDED	<table border="1" style="width: 100%; text-align: center;"> <tr> <td> </td><td> </td><td> </td><td> </td><td> </td><td> </td> </tr> <tr> <td>YR</td><td>MO</td><td>DAY</td><td>H</td><td>M</td><td>M</td> </tr> </table>										YR	MO	DAY	H	M	M	TOTAL METRIC TONS ON BOARD THIS VESSEL	BAIT <input type="checkbox"/> Yes																											
YR	MO	DAY	H	M	M																																										
VESSEL CFV <table border="1" style="width: 100%; text-align: center;"><tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>								PORT SAILED FROM _____	OBSERVER'S NAME & ID _____				OBSERVER'S SIGNATURE _____																																		
IS THIS VESSEL FISHING THIS TRIP? <input type="checkbox"/> Yes <input type="checkbox"/> No		PORT LANDED _____	CAPTAIN'S NAME _____				CAPTAIN'S SIGNATURE _____																																								
IS THIS VESSEL USING A CARRIER? <input type="checkbox"/> Yes <input type="checkbox"/> No		HERRING LICENSE # <table border="1" style="width: 100%; text-align: center;"><tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>							<b>E. SLIP INFORMATION</b>																																						
IS THIS VESSEL A CARRIER THIS TRIP? <input type="checkbox"/> Yes <input type="checkbox"/> No		GEAR: PURSE SEINE <input type="checkbox"/> MIDWATER TRAWL <input type="checkbox"/> GEAR SIZE, OTHER GEAR _____	<table border="1" style="width: 100%; text-align: center;"> <tr> <td>SLIP #</td> <td>A</td> <td>B</td> <td>C</td> <td>D</td> </tr> <tr> <td>CFV #</td> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td>LICENSE #</td> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td>METRIC TONS</td> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td>HERRING FISHING AREA</td> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td>NAFO AREA</td> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td>BUYER</td> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td>BUYER LOCATION</td> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </table>					SLIP #	A	B	C	D	CFV #					LICENSE #					METRIC TONS					HERRING FISHING AREA					NAFO AREA					BUYER					BUYER LOCATION				
SLIP #	A	B						C	D																																						
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HERRING FISHING AREA																																															
NAFO AREA																																															
BUYER																																															
BUYER LOCATION																																															
<b>B. CARRIER INFORMATION</b>		IF USING A CARRIER, NAME THE VESSEL(S). IF CARRYING, NAME THE VESSEL(S) YOU ARE CARRYING FOR. ESTIMATE THE AMOUNT PUMPED ON BOARD FROM EACH AND THE LAT/LONG WHERE FISH WERE CAUGHT. IF POOLING FISH, NAME THE VESSEL(S), AMOUNTS TO BE POOLED AND THE LAT/LONG WHERE FISH WERE CAUGHT.																																													
VESSEL NAME		CFV #	LATITUDE & LONGITUDE		METRIC TONS																																										
A																																															
B																																															
C																																															
D																																															
<b>C. HAIL INFORMATION</b>		EST. TIME OF ARRIVAL (24 HR CLOCK)																																													
CONFIRMATION # <table border="1" style="width: 100%; text-align: center;"><tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>												<table border="1" style="width: 100%; text-align: center;"> <tr> <td> </td><td> </td><td> </td><td> </td><td> </td> </tr> <tr> <td>H</td><td>H</td><td>M</td><td>M</td><td> </td> </tr> </table>										H	H	M	M		TOTAL MT ON BOARD	WHARF																			
H	H	M	M																																												
<b>F. BIOLOGICAL INFORMATION</b>		(FILL IN IF THIS VESSEL WAS FISHING.)																																													
FISHING GROUNDS SEARCHED _____		SONAR TIME ON: _____				OFF: _____																																									
SET NO.	SET TIME		SET LOCATION ALSO INCLUDE UNSUCCESSFUL SETS. PROVIDE LATITUDE AND LONGITUDE.	ESTIMATED CATCH (MT)	MARKET TYPE	FISH SIZE	ROE STAGE	COMMENTS ON SET, FISH BEHAVIOR, ETC.																																							
	START	END																																													
1																																															
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1994 4WX Herring Fishery Questionnaire - Purse Seine Fleet

1. How long have you fished in the summer fishery (Area 4X; April to October)?

- 0 - 2 years
- 2 - 5 years
- 5 -10 years
- 10+ years

2. In the 1994 summer fishery, the abundance of large (9-12") fish was

- much less than average
- less than average
- average
- more than average
- much more than average

3. In the 1994 summer fishery, the abundance of small (5-9") fish was

- much less than average
- less than average
- average
- more than average
- much more than average

**Appendix B - Sample questionnaire used to interview the 4WX herring purse seine fleet.**

4. Overall landings in the summer fishery were lower than in recent years. What were the primary reasons?

	<u>Definitely a reason</u>	<u>Yes</u>	<u>Perhaps</u>	<u>No</u>	<u>Definitely not</u>
Low overall abundance of fish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Low abundance of large (9-12") fish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Low abundance of small (5-9") fish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Shortage of market	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Shortage of quota	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Poor roe quality	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fish "feedy"	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Low fat content	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fish abundant but hard to catch	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bad weather	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Others (specify)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

5. Please comment on the 1994 abundance of fish (compared with recent years) in the following portions of the summer fishery in which you were involved

	<u>Much less than average</u>	<u>Less than average</u>	<u>Average</u>	<u>More than average</u>	<u>Much more than average</u>	<u>Did not fish</u>
Scots Bay	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Seal Is./Gannet/Dry Ledge	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Little Hope/Shelburne	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Trinity Ledge	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tongue Ground	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
German Bank	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lurcher Shoal	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Western Bank	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Grand Manan	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Appendix B - Sample questionnaire used to interview the 4WX herring purse seine fleet.

6. How would you rank the current relative amount of fish in each of these spawning components (1 = largest → 7 = smallest)?

	<u>Rank (1-7)</u>
German Bank	<input type="text"/>
Little Hope/Shelburne	<input type="text"/>
Lurcher Shoal	<input type="text"/>
Scots Bay	<input type="text"/>
Seal Is./Gannet/Dry Ledge	<input type="text"/>
Tongue Ground	<input type="text"/>
Trinity Ledge	<input type="text"/>

7. What are your biggest concerns with respect to the 4WX herring fishery?

Appendix B - Sample questionnaire used to interview the 4WX herring purse seine fleet.

Page 4 of 4

8. What comments do you have on the following portions of the fishery in 1994?

German Bank:

Tongue Ground:

Scots Bay:

Seal Is./Gannet/Dry Ledge:

Little Hope/Sheburne:

Trinity Ledge:

Lurcher:

Other:

Please return completed questionnaire to Rob Stephenson, Biological Station, St. Andrews, N. B. E0G 2X0

Appendix C - 4WX herring assessment details.

		Catch								
		1965	1966	1967	1968	1969	1970	1971	1972	
1	270378	154323	722208	164703	108875	699720	87570	0		
2	1084719	914093	613970	2389061	290329	576896	404224	649254		
3	34835	448940	153626	224956	531812	76532	183896	71984		
4	234383	73382	266454	83109	132319	286278	106630	148516		
5	49925	321857	110051	290285	162439	201215	113566	77207		
6	10592	45916	159203	73087	112631	120280	75593	75384		
7	1693	13970	57948	90617	62506	111937	93620	49065		
8	561	7722	4497	31977	22595	41257	50022	48700		
9	54	1690	409	15441	6345	21271	36618	26055		
10	37	215	296	5668	2693	7039	7536	13792		
1+	1687177	1982108	2088662	3368904	1432544	2142425	1159275	1159957		
2+	1416799	1827785	1366454	3204201	1323669	1442705	1071705	1159957		
3+	332080	913692	752484	815140	1033340	865809	667481	510703		
4+	297245	464752	598858	590184	501528	789277	483585	438719		
		1973	1974	1975	1976	1977	1978	1979	1980	1981
1	1018	18411	3199	240	1170	35381	342	2339	0	
2	167454	766064	317641	55596	153921	383611	183982	12503	103051	
3	781061	93606	239827	206535	31572	40887	250393	80518	50883	
4	130851	803651	124599	153782	218478	12906	54620	474091	102743	
5	40128	68276	514605	68804	119234	122108	5430	27930	451482	
6	30334	19093	66302	268839	51173	68410	23142	4373	32978	
7	22046	10232	12298	21460	177247	31088	18255	4692	2418	
8	20249	6565	4409	5571	13977	108975	11836	6560	2767	
9	23871	12786	4778	3951	3170	11082	41389	2985	1917	
10	11630	7102	3847	2059	1415	2425	4527	10641	538	
1+	1228642	1805786	1291505	786837	771357	816873	593916	626632	748777	
2+	1227624	1787375	1288306	786597	770187	781492	593574	624293	748777	
3+	1060170	1021311	970665	731001	616266	397881	409592	611790	645726	
4+	279109	927705	730838	524466	584694	356994	159199	531272	594843	
		1982	1983	1984	1985	1986	1987	1988	1989	1990
1	3589	5488	0	9022	63	2300	151	8	0	
2	102133	191682	88433	216740	125300	82940	148399	101788	178532	
3	150764	150328	243542	337591	275903	126436	113208	114095	130176	
4	22640	244007	224354	302782	292792	527443	195096	61842	171560	
5	98206	24483	146096	147670	56937	242597	434192	79451	89922	
6	211043	60678	22716	42404	31599	45933	236089	169023	101066	
7	14627	89982	21654	14075	10770	19481	42533	76684	201901	
8	2080	10352	28299	18178	4320	7292	21208	18303	116788	
9	1354	1728	9515	7997	2942	3361	4186	8270	31466	
10	1250	642	2183	1201	1356	3120	3797	3814	10572	
1+	607686	779370	786792	1097660	801982	1060903	1198859	633278	1031983	
2+	604097	773882	786792	1088638	801919	1058603	1198708	633270	1031983	
3+	501964	582200	698359	871898	676619	975663	1050309	531482	853451	
4+	351200	431872	454817	534307	400716	849227	937101	417387	723275	



Appendix C - 4WX herring assessment details.

	1991	1992	1993	1994
1	0	9	166	151
2	96960	168561	76405	103885
3	179463	132642	43766	142260
4	183647	286923	194198	53700
5	88431	126510	130713	118015
6	41352	75473	67708	72512
7	50380	34458	33820	36059
8	80732	35369	21481	14889
9	45516	59136	21893	8706
10	18291	34558	20684	10447
1+	784772	953639	610834	560624
2+	784772	953630	610668	560473
3+	687812	785069	534263	456588
4+	508349	652427	490497	314328

Weight (Beginning-Year)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.01	0.00	0.00
2	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.01	0.02	0.03	0.02	0.02
3	0.07	0.07	0.07	0.07	0.06	0.07	0.07	0.10	0.07	0.06	0.07	0.05	0.06	0.09	0.06
4	0.14	0.14	0.14	0.13	0.13	0.13	0.15	0.17	0.14	0.14	0.14	0.12	0.14	0.14	0.14
5	0.19	0.19	0.19	0.18	0.18	0.18	0.20	0.21	0.21	0.17	0.19	0.20	0.18	0.20	0.20
6	0.24	0.24	0.24	0.23	0.21	0.23	0.23	0.25	0.24	0.23	0.22	0.23	0.25	0.24	0.24
7	0.27	0.27	0.27	0.26	0.26	0.27	0.27	0.27	0.27	0.26	0.25	0.26	0.27	0.29	0.27
8	0.30	0.30	0.30	0.34	0.29	0.31	0.31	0.31	0.31	0.30	0.30	0.29	0.30	0.31	0.31
9	0.34	0.34	0.34	0.33	0.37	0.34	0.35	0.34	0.34	0.34	0.34	0.36	0.32	0.34	0.34
10	0.37	0.37	0.37	0.38	0.36	0.36	0.38	0.37	0.37	0.36	0.36	0.38	0.40	0.36	0.37
11	0.41	0.41	0.41	0.41	0.44	0.42	0.42	0.40	0.39	0.41	0.35	0.40	0.43	0.43	0.44
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01
2	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.03
3	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.07	0.07	0.04	0.06	0.06	0.07	0.05	0.05
4	0.14	0.14	0.14	0.14	0.15	0.16	0.15	0.14	0.12	0.12	0.11	0.12	0.12	0.12	0.12
5	0.19	0.19	0.19	0.19	0.20	0.22	0.22	0.19	0.17	0.18	0.18	0.17	0.16	0.17	0.16
6	0.24	0.24	0.24	0.24	0.24	0.25	0.26	0.24	0.22	0.22	0.22	0.21	0.20	0.20	0.20
7	0.27	0.27	0.27	0.27	0.27	0.29	0.29	0.27	0.26	0.26	0.25	0.24	0.23	0.23	0.22
8	0.30	0.30	0.30	0.30	0.29	0.31	0.32	0.30	0.29	0.29	0.28	0.26	0.26	0.27	0.25
9	0.34	0.34	0.34	0.34	0.32	0.32	0.35	0.32	0.31	0.31	0.31	0.29	0.28	0.29	0.28
10	0.37	0.37	0.37	0.37	0.36	0.37	0.37	0.35	0.33	0.34	0.33	0.32	0.31	0.31	0.30
11	0.41	0.41	0.41	0.41	0.41	0.37	0.53	0.43	0.35	0.35	0.37	0.34	0.32	0.32	0.34

Appendix C - 4WX herring assessment details.

1995

1 0.01  
 2 0.02  
 3 0.06  
 4 0.12  
 5 0.16  
 6 0.20  
 7 0.23  
 8 0.26  
 9 0.28  
 10 0.31  
 11 0.33

LAI 1972-94 APPLIED TO 73-95

1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
9.40	6.60	49.50	11.68	13.50	6.30	4.54	7.10	26.20	2.72	10.62
1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
13.88	12.69	40.80	18.93	27.92	100.69	54.47	27.23	48.17	57.00	55.01
1994	1995									5.37

INITIAL

AGES OF CATCH DATA

1 2 3 4 5 6 7 8 9 10

AGES TO BE ESTIMATED (ALL OR A SUBSET OF THE ABOVE)

5

INITIAL GUESS (ONE FOR EACH AGE)

10000

CALCULATE SURVIVORS AT SOME AGES USING PR ? (Y/N)

Y

AGES TO BE CALCULATED USING PR

3 4 6 7 8 9 10

ESTIMATED AGES TO BE USED FOR AVERAGE FULLY RECRUITED F

5

PR FOR AGES

2 3 5 6 7 8 9

.3 .6 1 1 1 1 1

AGES NOT ESTIMATED OR CALCULATED USING PR

1 2

ASSIGNED VALUES (ONE FOR EACH AGE)

1000000 1000000

AGES TO AVERAGE FOR OLDEST AGE F

6 7 8

NATURAL MORTALITY

.2

Appendix C - 4WX herring assessment details.

PAR\_STATS

APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET..... 0.001057  
 MEAN SQUARE RESIDUALS ..... 0.523059

PAR. EST.	STD. ERR.	REL. ERR.	BIAS	REL. BIAS
1.291E1	4.977E-1	3.855E-2	-1.750E-2	-1.356E-3
5.451E-5	1.032E-5	1.894E-1	6.233E-7	1.143E-2

BIAS\_ADJ

PAR. EST.	STD. ERR.	REL. ERR.	BIAS	REL. BIAS
1000000	0	0.00	0	0.00
1000000	0	0.00	0	0.00
2712362	1298940	0.48	276962	0.10
1824557	889101	0.49	189708	0.10
404971	201575	0.50	43071	0.11
886839	442211	0.50	94511	0.11
544901	271708	0.50	58071	0.11
270970	135116	0.50	28877	0.11
111885	55790	0.50	11924	0.11
65422	32622	0.50	6972	0.11
78226	39076	0.50	8353	0.11
96095	42846	0.45	9159	0.10
125560	46609	0.37	9956	0.08
71446	20698	0.29	4386	0.06
25433	5936	0.23	1249	0.05
22149	3583	0.16	751	0.03
12795	1977	0.15	417	0.03
18209	2278	0.13	476	0.03
7290	743	0.10	156	0.02
2595	247	0.10	52	0.02
3479	198	0.06	41	0.01
709	21	0.03	4	0.01
2104	29	0.01	6	0.00
1055	12	0.01	2	0.00
18323	150	0.01	30	0.00
2757	9	0.00	2	0.00
1583	3	0.00	1	0.00
1852	1	0.00	0	0.00
3644	2	0.00	0	0.00
5567	2	0.00	0	0.00
12588	2	0.00	0	0.00
13054	1	0.00	0	0.00
13018	1	0.00	0	0.00
10307	0	0.00	0	0.00
11464	0	0.00	0	0.00
6186	0	0.00	0	0.00
7563	0	0.00	0	0.00
548	0	0.00	0	0.00
624	0	0.00	0	0.00
283	0	0.00	0	0.00
0	0	1.00	0	1.00

**Appendix C - 4WX herring assessment details.**

Population Numbers (Bias Adjusted)								
	1965	1966	1967	1968	1969	1970	1971	1972
1	3547176	2766301	6159312	1297935	1772732	2320925	7524288	1149076
2	3884930	2659534	2125219	4389337	913630	1352876	1267080	6081129
3	1004511	2199218	1350337	1184439	1431974	485316	585644	671640
4	1327383	790904	1394349	966556	766188	691197	328094	313089
5	351904	874691	581139	900499	716149	507575	306870	172138
6	92512	242941	424908	376218	474606	439352	233500	148485
7	41214	66158	157356	203832	241889	286661	250877	122774
8	4388	32211	41525	76399	84890	141485	133414	120690
9	1281	3085	19385	29929	33616	49057	78507	63968
10	386	1000	997	15501	10532	21781	20918	31143
11	0	283	624	548	7563	6186	11464	10307
<hr/>								
1+	10255687	9636327	12255152	9441194	6453768	6302412	10740655	8884440
2+	6708510	6870025	6095840	8143259	4681036	3981487	3216367	7735364
3+	2823580	4210491	3970621	3753922	3767407	2628611	1949288	1654234
4+	1819069	2011273	2620284	2569483	2335433	2143295	1363644	982594
<hr/>								
	1973	1974	1975	1976	1977	1978	1979	1980
1	2369809	1645986	250775	732181	4193672	1379853	481456	1647079
2	940784	1939315	1330961	202422	599242	3432430	1097714	393873
3	4391338	618730	894613	802285	115424	351344	2463130	732259
4	484758	2888591	421875	515443	469975	65934	250660	1790075
5	121953	278488	1637804	232660	282861	187096	42304	155801
6	71075	63537	166228	875287	128230	123700	42693	29722
7	53359	30744	34744	76103	473369	58682	39377	14014
8	56123	23738	15913	17318	42890	227182	19915	15721
9	54747	27628	13495	9039	9138	22469	87396	5596
10	28797	23224	11050	6726	3825	4613	8368	34104
11	13018	13054	12588	5566	3643	1852	1583	2755
<hr/>								
1+	8585762	7553034	4790046	3475031	6322270	5855154	4534598	4821000
2+	6215952	5907048	4539271	2742850	2128597	4475301	4053142	3173921
3+	5275169	3967733	3208310	2540427	1529356	1042871	2955427	2780048
4+	883830	3349003	2313697	1738142	1413931	691527	492297	2047789
<hr/>								
	1981	1982	1983	1984	1985	1986	1987	1988
1	1756823	2580141	4716775	5592335	2328834	1392578	1866625	2350625
2	1346397	1438365	2109193	3856803	4578616	1898525	1140089	1526182
3	311163	1009093	1085220	1553420	3077665	3552540	1441004	858379
4	526667	208718	689758	752480	1051467	2214314	2658926	1065391
5	1036615	338233	150398	343940	413075	586900	1547998	1699694
6	102287	440190	188061	100983	149401	204580	428994	1047883
7	20378	53906	169438	99068	62123	83950	138904	309669
8	7229	14496	30899	57305	61516	38127	58988	96098
9	6936	3415	9986	15931	21311	33917	27307	41697
10	1880	3944	1570	6613	4434	10212	25107	19316
11	18293	1053	2098	705	3439	2543	7134	17733
<hr/>								
1+	5134668	6091553	9153397	12379582	11751882	10018186	9341076	9032666
2+	3377845	3511411	4436622	6787247	9423048	8625608	7474451	6682041
3+	2031447	2073047	2327429	2930444	4844432	6727084	6334362	5155859
4+	1720284	1063954	1242209	1377024	1766766	3174544	4893358	4297480

Appendix C - 4WX herring assessment details.

	1989	1990	1991	1992	1993	1994	1995
1	3270352	3184679	1213253	3316583	3773605	1221570	1000000
2	1924392	2677530	2607395	993328	2715380	3089416	1000000
3	1115255	1483458	2030634	2047021	660748	2154031	2435401
4	600346	809856	1096764	1500158	1555940	501373	1634849
5	695738	435565	507820	731784	968607	1098178	361900
6	998719	497732	275246	335753	484663	674754	792328
7	644312	664744	316060	187935	206600	335544	486830
8	215050	458131	361558	213182	122690	138548	242093
9	59488	159507	269412	222970	142536	81013	99962
10	30351	41222	102122	179391	129044	96889	58450
11	12379	21398	24184	67060	115604	86936	69873
1+	9566382	10433822	8804448	9795164	10875414	9478252	8181685
2+	6296030	7249143	7591195	6478581	7101810	8256682	7181685
3+	4371638	4571613	4983800	5485254	4386430	5167266	6181685
4+	3256383	3088155	2953166	3438232	3725682	3013235	3746285

Population Biomass (Bias Adjusted)

	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	17518	13662	33906	6748	9910	9034	35871	6748	10817
2	78664	53851	43032	79736	17574	24201	32552	127559	16021
3	68070	149028	91505	80263	84292	32203	39617	64099	299900
4	184234	109773	193528	124442	103205	92075	50489	51878	68098
5	68142	169374	112531	160632	125349	93842	60501	36344	25347
6	21769	57167	99986	86769	100421	101336	54056	36450	16887
7	11108	17831	42412	53969	63451	76202	68843	33436	14426
8	1334	9790	12621	25808	24670	43291	41351	37071	17448
9	433	1043	6555	9889	12272	16485	27216	21551	18640
10	143	371	370	5906	3824	7851	7915	11551	10550
11	0	115	255	224	3337	2592	4813	4101	5068
1+	451416	582007	636701	634385	548305	499113	423224	430786	503201
2+	433898	568346	602795	627637	538395	490079	387353	424039	492385
3+	355234	514494	559762	547901	520821	465878	354801	296480	476364
4+	287164	365466	468258	467638	436529	433674	315185	232381	176464
	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	11358	1380	2872	25062	6815	2378	8134	8676	12742
2	42488	19287	3677	15278	57436	22227	7975	27262	29125
3	34946	60092	39255	7048	29978	137935	49621	21086	68380
4	393421	59198	63015	66191	9429	34790	248453	73099	28969
5	47798	318426	47515	52177	37347	8403	30169	200729	65495
6	14765	36961	202991	32400	29122	10297	6994	24069	103582
7	8123	8811	19622	127860	16881	10717	3777	5492	14529
8	7115	4833	5048	12869	70642	6220	4778	2197	4406
9	9295	4582	3224	2947	7589	29871	1892	2345	1155
10	8267	3978	2558	1525	1665	3092	12655	698	1464
11	5392	4381	2221	1564	804	691	1128	7460	429
1+	582969	521931	391997	344920	267707	266622	375578	373113	330276
2+	571610	520550	389125	319858	260892	264244	367444	364437	317534
3+	529122	501263	385448	304580	203457	242017	359469	337175	288409
4+	494176	441171	346193	297532	173479	104082	309848	316089	220029

**Appendix C - 4WX herring assessment details.**

	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	24197	24292	9930	6228	16932	19180	10878	14536	7673
2	42708	75183	105408	44524	25493	24227	39859	39442	57125
3	73539	114279	206089	287997	105794	56938	45425	81738	113061
4	95735	110058	172543	324501	366238	130883	71680	91334	127546
5	29123	68260	90083	129592	294600	294337	124220	78402	87878
6	44253	23995	37696	53143	103809	229957	215705	109544	57341
7	45668	26420	17744	24485	37851	81252	165912	163762	76597
8	9391	16673	18812	12274	17572	27735	62750	128471	94870
9	3377	5033	6800	11761	8832	12840	18670	49590	79447
10	583	2374	1635	3788	8912	6361	10312	13601	32730
11	856	287	1269	1335	3077	6120	4371	7848	8275
<hr/>									
1+	369429	466854	668010	899629	989110	889830	769783	778269	742544
2+	345232	442562	658080	893401	972177	870650	758904	763733	734870
3+	302524	367379	552672	848877	946684	846422	719046	724291	677745
4+	228985	253100	346584	560880	840890	789484	673620	642553	564684
<hr/>									
	1992	1993	1994	1995					
1	16629	47377	15336	10041					
2	15706	43868	79728	19258					
3	141822	34333	103101	137282					
4	182502	192459	59636	198522					
5	119366	161569	179696	59539					
6	67298	95609	131817	156634					
7	43948	48105	73472	111266					
8	56009	32532	34914	62934					
9	62927	41077	23004	28468					
10	55245	39895	29357	17927					
11	21695	36776	29519	22853					
<hr/>									
1+	783146	773600	759582	824723					
2+	766517	726224	744245	814682					
3+	750811	682355	664517	795424					
4+	608990	648022	561415	658142					

Appendix C - 4WX herring assessment details.

Fishing Mortality (Bias Adjusted)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1	0.09	0.06	0.14	0.15	0.07	0.41	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.03
2	0.37	0.48	0.38	0.92	0.43	0.64	0.43	0.13	0.22	0.57	0.31	0.36	0.33	0.13
3	0.04	0.26	0.13	0.24	0.53	0.19	0.43	0.13	0.22	0.18	0.35	0.33	0.36	0.14
4	0.22	0.11	0.24	0.10	0.21	0.61	0.45	0.74	0.35	0.37	0.40	0.40	0.72	0.24
5	0.17	0.52	0.23	0.44	0.29	0.58	0.53	0.68	0.45	0.32	0.43	0.40	0.63	1.28
6	0.14	0.23	0.53	0.24	0.30	0.36	0.44	0.82	0.64	0.40	0.58	0.41	0.58	0.94
7	0.05	0.27	0.52	0.68	0.34	0.56	0.53	0.58	0.61	0.46	0.50	0.37	0.53	0.88
8	0.15	0.31	0.13	0.62	0.35	0.39	0.54	0.59	0.51	0.36	0.37	0.44	0.45	0.76
9	0.05	0.93	0.02	0.84	0.23	0.65	0.72	0.60	0.66	0.72	0.50	0.66	0.48	0.79
10	0.11	0.27	0.40	0.52	0.33	0.44	0.51	0.67	0.59	0.41	0.49	0.41	0.53	0.87

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.20	0.04	0.09	0.08	0.11	0.03	0.05	0.08	0.08	0.11	0.06	0.08	0.04	0.21
3	0.12	0.13	0.20	0.18	0.17	0.19	0.13	0.09	0.10	0.16	0.12	0.10	0.10	0.07
4	0.28	0.35	0.24	0.13	0.50	0.40	0.38	0.16	0.25	0.23	0.12	0.27	0.20	0.24
5	0.15	0.22	0.66	0.39	0.20	0.63	0.50	0.11	0.19	0.33	0.13	0.26	0.21	0.21
6	0.91	0.18	0.44	0.75	0.44	0.29	0.38	0.19	0.13	0.29	0.21	0.25	0.18	0.29
7	0.72	0.46	0.14	0.36	0.88	0.28	0.29	0.15	0.17	0.16	0.14	0.41	0.19	0.23
8	1.07	0.62	0.55	0.17	0.46	0.79	0.40	0.13	0.15	0.28	0.10	0.33	0.28	0.20
9	0.74	0.89	0.36	0.58	0.21	1.08	0.54	0.10	0.15	0.12	0.17	0.25	0.21	0.35
10	0.91	0.42	0.38	0.43	0.60	0.45	0.36	0.16	0.15	0.24	0.15	0.33	0.22	0.24

	1993	1994
1	0.00	0.00
2	0.03	0.04
3	0.08	0.08
4	0.15	0.13
5	0.16	0.13
6	0.17	0.13
7	0.20	0.13
8	0.22	0.13
9	0.19	0.13
10	0.19	0.13

SPAWNING BIOMASS RESIDUALS (MID-YEAR INDICES)

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	0.25	-0.86	0.88	-0.36	-0.04	-0.35	-0.02	-0.33	0.64	-1.38	0.09	0.28	-0.08

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	0.65	-0.61	-0.32	1.06	0.50	-0.02	0.54	0.66	0.63	-1.79

Parameter Correlation Matrix

	1	2
1	1.00	-0.60
2	-0.60	1.00