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Observations on the Size Composition of Haddock and
Whiting Catches Taken by the Different Fishing Methods
Used in the Scottish North Sea Demersal Fisheries

by

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ABSTRACT

The Marine Laboratory routinely collects data on the Scottish commercial fisheries, by sampling landings at the ports and fish discarded at sea from fishing vessels. The landings and discards are classified by method of capture and area and records of total fleet landings enable estimates to be made of the catch by each fishing method used. Catch data were extracted from the records for the Buchan sector of the North Sea (overlapping ICES areas IVa and IVb) for each quarter of the years 1987 to 1992. The fishery is dominated by mobile fishing methods - the seine net, the trawl, the pair trawl and the Nephrops trawl. The length frequencies of the catches and catch per unit effort by each method were compared. Fishing effort and discard data by method are presented. The Nephrops trawl has the highest discard rate and effort levels. Rates of discarding with the other methods are often high but none showed consistently lower size selectivity than the others. The quantities of fish discarded appear to be highest with the seine and pair trawl which have the highest catch per unit effort.

INTRODUCTION

In the Scottish demersal fisheries, three main methods of capture are used (Strange, 1981): the single boat trawl, the pair trawl (a trawl towed by two vessels) and the seine net (both the traditional Scottish fly-dragging method and the pair seine). The principal target species are haddock, whiting and cod but there is also a significant directed fishery for *Nephrops norvegicus*, the Norway lobster, with the single boat (Nephrops) trawl. To illustrate the relative importance of these gears and trends in their use, the total Scottish catch of demersal fish species (in tonnes) by method of capture is shown in Figure 1.

Catches by the seine net and pair trawl have been declining but catches by single boat trawl and Nephrops trawl have remained fairly constant.

Operation of these gears is regulated by minimum mesh sizes and minimum landing sizes (MLS). Nevertheless, large quantities of juvenile fish are caught by the fleet and then discarded, particularly when abundant year classes are just below the minimum permitted landing sizes. Legal minimum mesh sizes have been progressively increased in an attempt to improve the exploitation pattern (Table 1), and are now at 100 mm for whitefish. The minimum landing size for haddock was increased to 30 cm in 1989. The fishery for *Nephrops norvegicus* is allowed to use a smaller mesh size (70 mm) and there is a significant by-catch of whitefish. To limit the use of 70 mm mesh, the by-catch of whitefish which may be landed is limited to 60% by weight of the *Nephrops* catch. Anecdotal evidence suggests that, with the same cod-end mesh sizes, the pair trawl and seine net retain more small fish than the single-boat trawl. Given the pressing need to conserve the stocks, any gear which is significantly less size selective than the others should be subject to more restrictive regulations.

As an essential part of stock assessment work, the Marine Laboratory has since 1960 gathered data on the length and age composition of the landings of the commercially important fish species (Reeves, 1990). In 1975 this programme was extended to include that part of the catch which is discarded at sea. There is now an 18 year record of the length and age structure of the total catch of several stocks. Sampling is stratified by time, species, geographical area, fleet and fishing method. Records of total fleet landings enable the catches by each fishing method to be estimated for each area. These records offered an opportunity to assess comparative gear selectivity in the fisheries and this paper describes an initial investigation of the data.

SAMPLING METHODS

As far as possible, sampling data on landings and discards have been made compatible so that the information can be combined. The geographical zones (Fig. 2) have been selected mainly on a biological basis after taking into consideration factors such as growth rates and nursery areas. The four main types of fishing gear are referred to as seine net, light trawl, pair trawl and Nephrops trawl. Seine net includes pair seining. The light trawl category covers side and stern trawlers under 90 ft in length. Landings are sampled by the month and each combination of area, gear and month is referred to as a cell. Discard rates are sampled quarterly by area and gear. Monthly landings data are

aggregated for each quarter and then combined with the relevant discard data.

The sampling intensity for each cell varies according to the amount of fish landed in that cell and many cells are not sampled on a regular basis. Since 1975 however, the Buchan area has provided a high level of sampling and the data for this area for years 1987 to 1992 for haddock and whiting were selected for examination. Recent data were chosen because current practices are of immediate interest for fishery management.

The strategy for sampling landings is to measure one box of each grade of each species in the catch landed by a selected boat then raise the numbers to boat level. These data are then aggregated with any other data from the cell and raised to fleet level using total landed weights. Discard data are treated similarly, but sometimes raising factors are based on fleet effort.

CATCH DATA BY FISHING METHOD

The data considered were length frequencies for each quarter of 1987 to 1992, for haddock and whiting by each of four methods of capture, plus information on fishing effort and weight of landings and discards by method. This is a large amount of data and it is not possible to present it all in this paper. Examples have been chosen to illustrate the nature of the data, its variability and what might be gleaned from it on gear selectivity. The data are presented either as groups of length frequencies or as time series. The catch but not the effort data for the Nephrops trawl were incomplete for 1988, 1989 and 1990 so in most of the time series graphs the points for the Nephrops trawl are not joined.

Catches with the light trawl for the four quarters of 1989 are shown in Figure 3 for a) haddock and b) whiting. These present landings and discard data raised to fleet level and combined. In some of the graphs there is a suggestion of an irregularity at the length where the sets overlap, but this effect is not large in the whole collection, indicating that the raising procedure is reliable. With MLS now at 30 cm for haddock and 27 cm for whiting the high level of discarding is apparent. In general, it is not possible to track the growth of a year class in these plots. Variation in the catch size through the year with one gear might be attributed to variation in area fished (inshore or off-shore), effort and selectivity. The data come from vessels which, although nominally using the same method and cod-end mesh size, actually have different size selectivity. This could be by accident or design. Increases in catch levels by one particular method tend to be related to increased effort (see Fig. 6 below).

Length frequencies for each quarter by each method were compared. Figure 4 is an example for the first quarter of 1991 for a) haddock and b) whiting. In Figure 5a and 5b these plots are converted to catch per unit effort (CPUE). The same year classes are usually evident in the catches by the four methods but overall there is more variation in the shapes of the length frequencies than might be expected. The Nephrops trawl, with 70 mm mesh size, retains more undersized fish than the other gears. Fishing effort with this gear is often high. CPUE for the seine net and the pair trawl are consistently higher than for the light trawl, though not always as much as in this example. The pair trawl data are directly comparable, being for single vessels not pairs, since each vessel in a pair lands a catch which is separately recorded.

All 48 graphs in the series including Figure 4 were examined and a visual assessment made of which method of capture produced in each quarter the largest numbers of undersized fish. The findings are listed in Table 2 which identifies the seine net as being responsible for most discards of haddock and whiting.

Fishing effort (defined as hours fishing) by method for the Buchan area is shown in Figure 6. The Nephrops trawl effort is both large and seasonal, peaking in the third quarter. Most effort on whitefish was with the light trawl. Seine net effort was lowest and this gear is less used in this area than in Scottish fisheries generally. Seasonal changes in effort by pair and light trawl are apparent, with light trawl activity tending to be higher in the first half of the year. The peak in pair trawl activity is later and could be a diversion of effort. The effort by both seine net and pair trawl is declining.

Figure 7 gives the CPUE data for a) haddock and b) whiting (not total catch but weight of landed fish per unit effort). CPUE for both species is significantly higher for the seine net and pair trawl than for the light trawl. Seasonal changes are very marked for whiting and peak seine net CPUE tends to lag peak pair trawl CPUE. There were strong year classes of 1-group haddock in 1987, 1991 and 1992 and of 1-group whiting in 1989, 1991 and 1992. The haddock stock has been at a low level for this period and catches have been under tight quota limits. The low CPUE values for the last quarters of 1989 and 1992 result from closure of the fishery and prohibition of landings during these quarters.

Discard weight by method for the fleet and area is shown in Figure 8 for a) haddock and b) whiting. There are some particularly high levels recorded for the seine net which can be linked with the 1987 and 1991 haddock and 1989 whiting year classes.

The proportion (by weight) of the catch discarded is shown in Figure 9 for a) haddock and b) whiting. The highest proportions discarded are in the *Nephrops* fishery, although the discard weights with this gear are not generally very high (Fig. 8). The need to meet the low by-catch limits may partly account for these high levels. Discard rates with the whitefish gears vary markedly by season and there are some very high proportions. No gear has a discard rate consistently higher than the others.

DISCUSSION

Any conclusions extracted from this investigation of a segment of the Scottish landings and discard data must be viewed with caution. This paper describes a first approach to the data and there are probably more definitive ways of examining the records. It has been possible so far to account for any anomalies in the plots by reference to these records. They have explained for example, that a particularly high discard rate for the light trawl in the second quarter of 1991 was due to the sampled vessel operating inshore where small fish were plentiful, whereas the other three quarters were samples from the off-shore grounds.

Table 2 suggests, from a comparison of numbers of fish discarded, that the seine net was responsible for most whitefish discards in the Buchan area over the period considered. Although Figure 9, showing the proportion by weight of the catch discarded, does not identify any of these gears as consistently the least selective, catch levels must be taken into account. The total catch (landings + discards) by seine net and pair trawl (not shown here) appeared generally to be higher than that with the light trawl and so fewer fish were caught and discarded with the latter gear. The implication is that the higher discard levels for the seine net and pair trawl are simply due to total catch size and not to inherently poorer size selectivity. These ideas are similar to the conclusions reached by Reeves (1990) who fitted linear models to some of the catch, discard and effort data.

Since the data for single and pair seining are combined in the records and the use of the latter is increasing, it may be that higher discard levels are associated with the higher catch levels arising from pair fishing. The ropes of a pair seines or the warps of a pair trawl are towed so as to sweep a large area and more fish, possibly including more small fish, are herded into the mouth of the net than with a single vessel rig. The high CPUE of the seine net and pair trawl explains their popularity in the fisheries but given the higher discard levels, this is not an encouraging development.

The high discard rates suspected for Nephrops trawls are confirmed. Combined with the high levels of fishing effort with this gear, it is clear that the *Nephrops* fishery needs close regulation to limit the destruction of juvenile fish.

There is no indication in these data that discard levels or rates of discarding declined following increases in mesh size or MLS. The indications are that there has been no change.

It would be useful to extend this investigation to cover all the areas for which sampling data exists to obtain an overview of gear selectivity at fleet level and to test the ideas discussed above.

REFERENCES

- STRANGE, E.S, 1981. An Introduction to Commercial Fishing Gear and Methods used in Scotland. Scottish Fisheries Information Pamphlet, No 1 1981 (2nd edition, Revised). ISSN 0309 9105.
- REEVES, S.A., 1990. Linear modelling of discard data from Scottish Demersal Fisheries. ICES CM 1990/G:53.

TABLE 1. Minimum mesh sizes and minimum landing sizes for whitefish applied by the UK in ICES area IV

	Minimum mesh (mm)	Minimum landing size (cm)	
		Haddock	Whiting
Pre 1987	80	27	27
1987 and 1988	85	27	27
1989 to May 1992	90	30	27
June 1992 on	100	30	27

TABLE 2. Fishing method considered, for each quarter, by inspection of the length frequency data for landings and discards, to have retained most undersized fish. [S - seine net; T - light trawl; P - pair trawl; O - none; Nephrops trawl excluded]

Quarter	Haddock	Whiting	Quarter	Haddock	Whiting
1987/ 1	S	S	1990/ 1	S	S
2	P	P	2	S	S
3	P	P	3	S	S
4	P	P	4	O	O
1988/ 1	S	S	1991/ 1	S	S
2	S	S	2	T	T
3	O	O	3	S	S
4	S	S	4	S	S
1989/ 1	S	S	1992/ 1	S	S
2	P	P	2	T	T
3	O	O	3	T	T
4	T	T	4	S	S
Summary					
Seine Net	13	14			
Light trawl	4	7			
Pair trawl	4	3			
None	3	0			

- x SEINE NET
- o LIGHT TRAWL
- PAIR TRAWL
- ⊕ NEPHROPS TRAWL

SCOTTISH LANDINGS BY METHOD

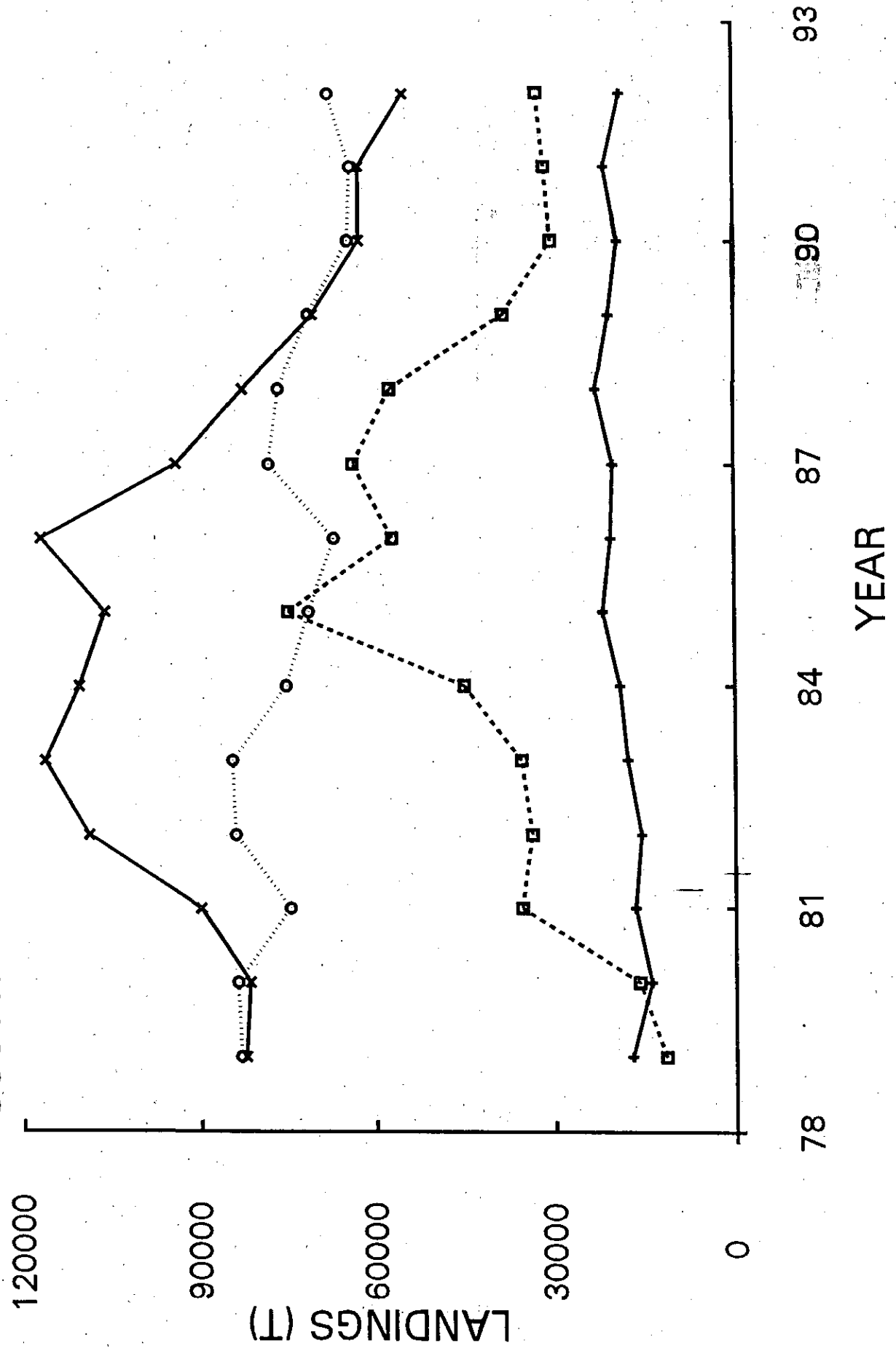
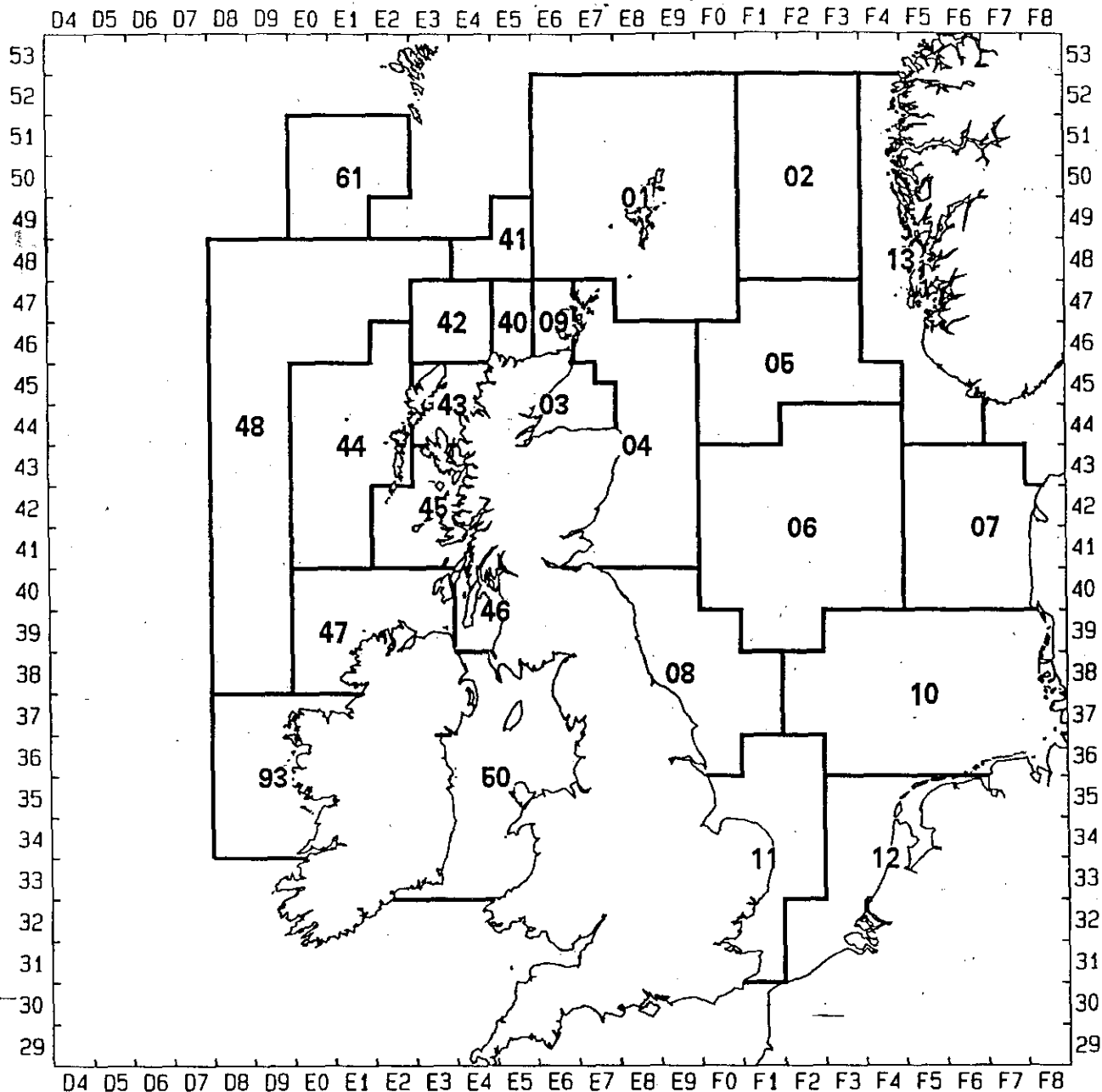


Figure 1 The weight (tonnes) of demersal fish caught and landed in Scotland from 1979 to 1992 by the commonly used fishing methods.

Demersal Sampling Areas



- | | | |
|-----------------|-------------------|------------------|
| 01 Shetland | 10 German Bight | 45 South Minch |
| 02 Viking | 11 Thames | 46 Clyde |
| 03 Moray Firth | 12 IJmuiden | 47 North Ireland |
| 04 Buchan | 13 Utsire | 48 Western Deeps |
| 05 Forties | 40 Solun | 50 Irish Sea |
| 06 Central | 41 Rising Ground | 61 Faroe Bank |
| 07 Danish Coast | 42 Butt of Lewis | 93 West Ireland |
| 08 Humber | 43 Inner Hebrides | |
| 09 West Orkney | 44 Outer Hebrides | |

Figure 2 The areas from which catches are recorded in the demersal fish sampling programme. Buchan is area 04.

HADDOCK 1989 LIGHT TRAWL

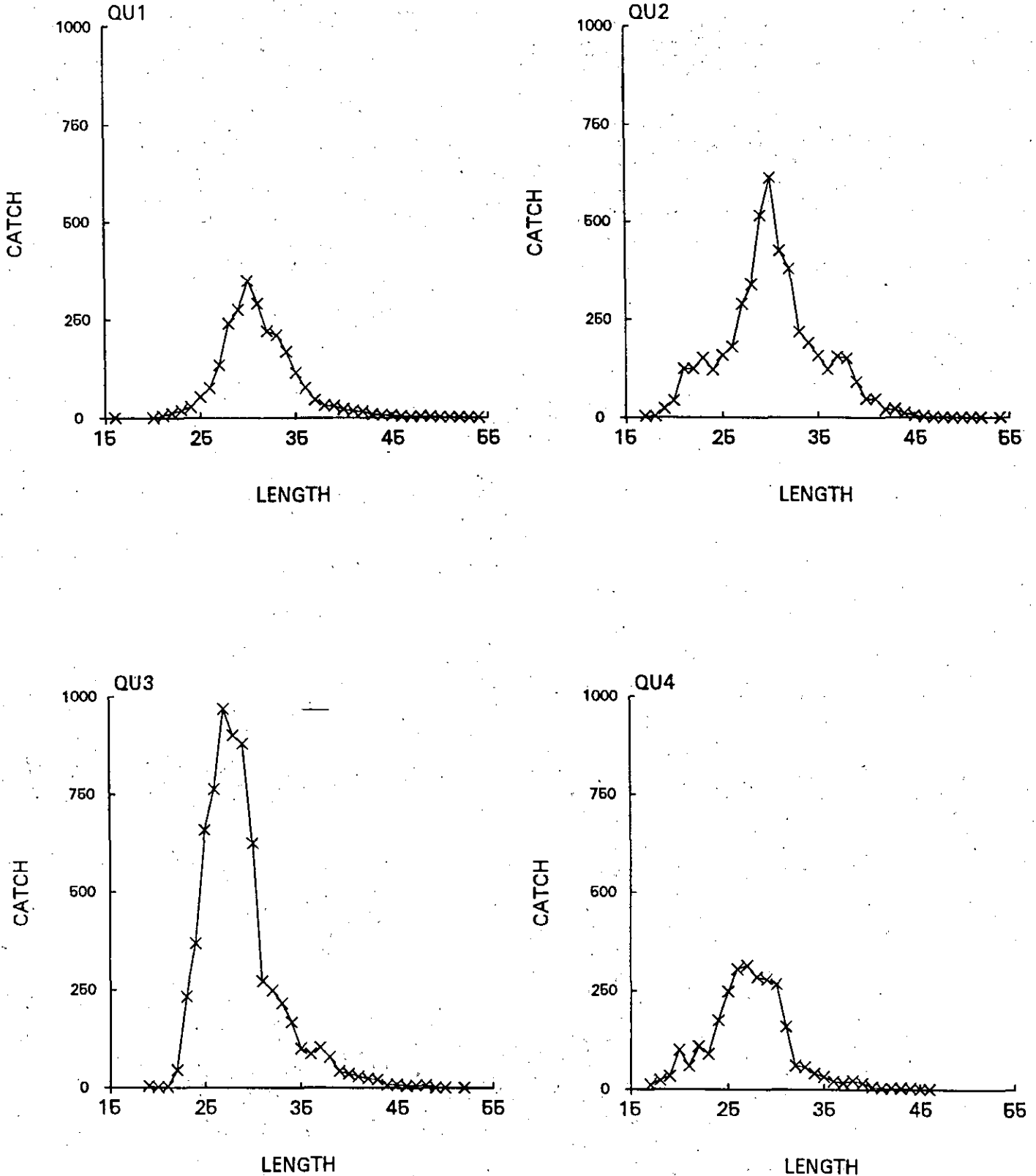


Figure 3a Numbers ($\pm 1,000$) of haddock caught in the Buchan area with the light trawl in the four quarters of 1989.

WHITING 1989 LIGHT TRAWL

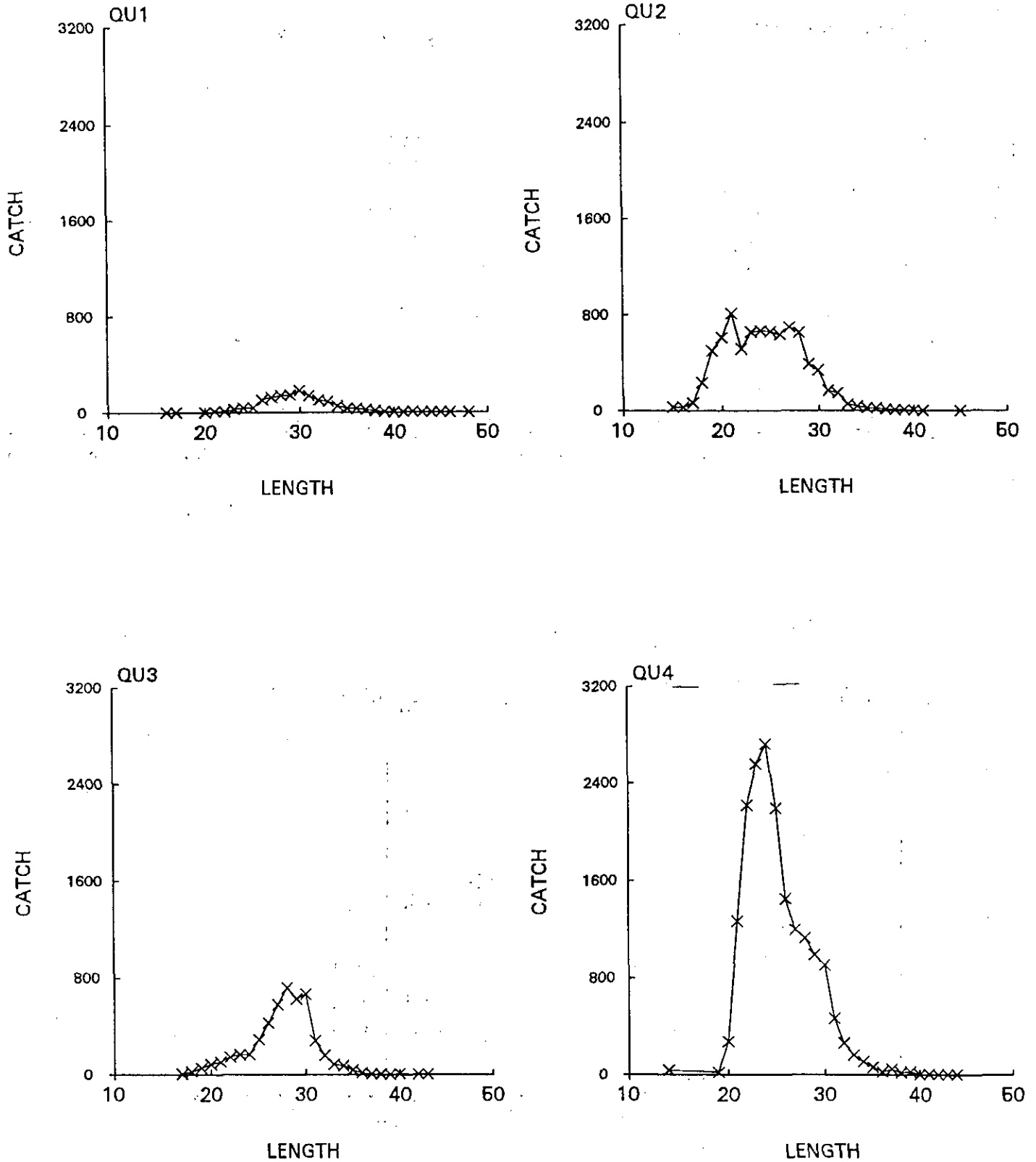


Figure 3b Numbers ($\pm 1,000$) of whiting caught in the Buchan area with the light trawl in the four quarters of 1989.

HADDOCK 1991 QU1

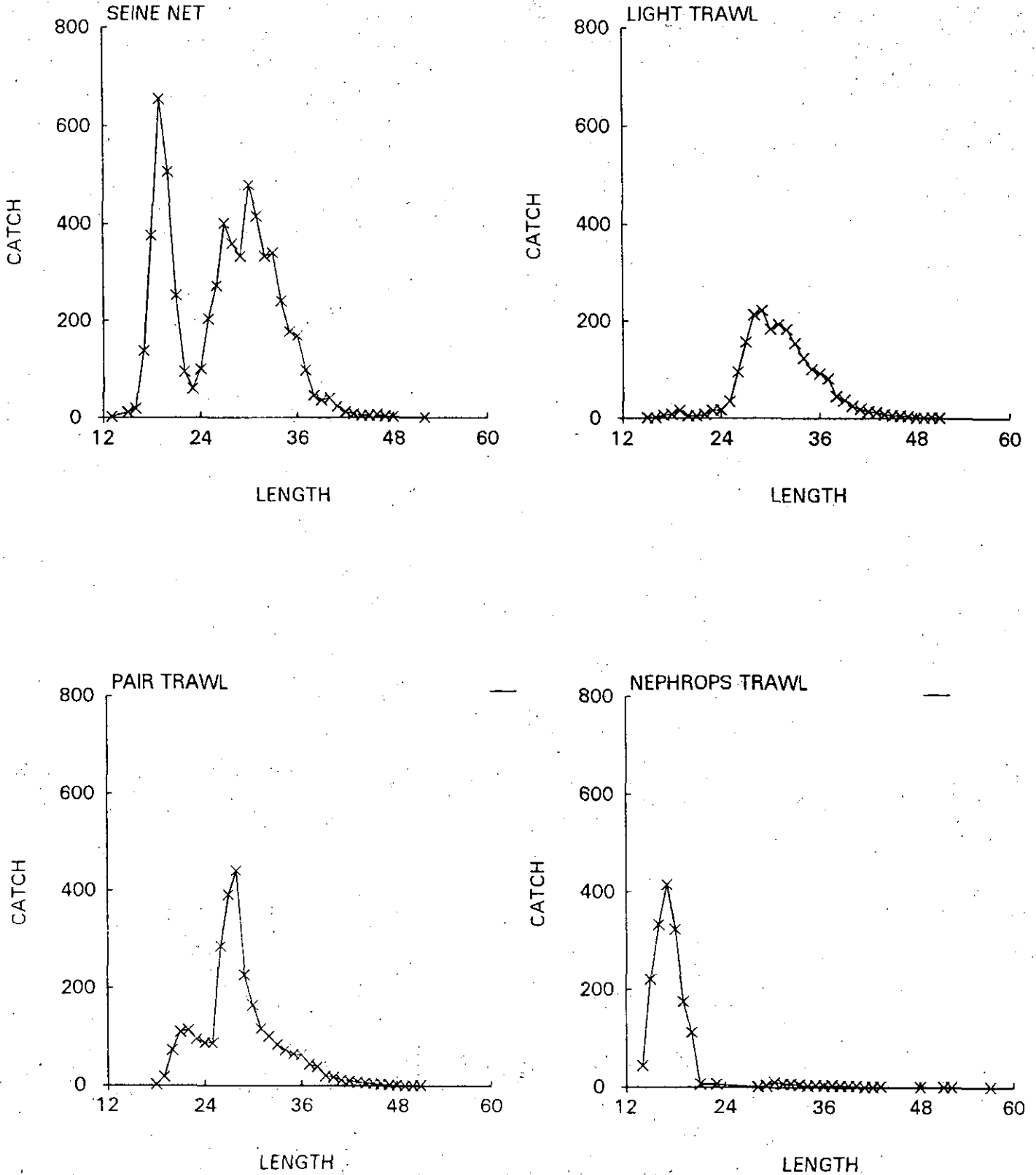


Figure 4a Numbers ($\pm 1,000$) of haddock caught in the Buchan area by the four fishing methods in the first quarter of 1991.

WHITING 1991 QU1

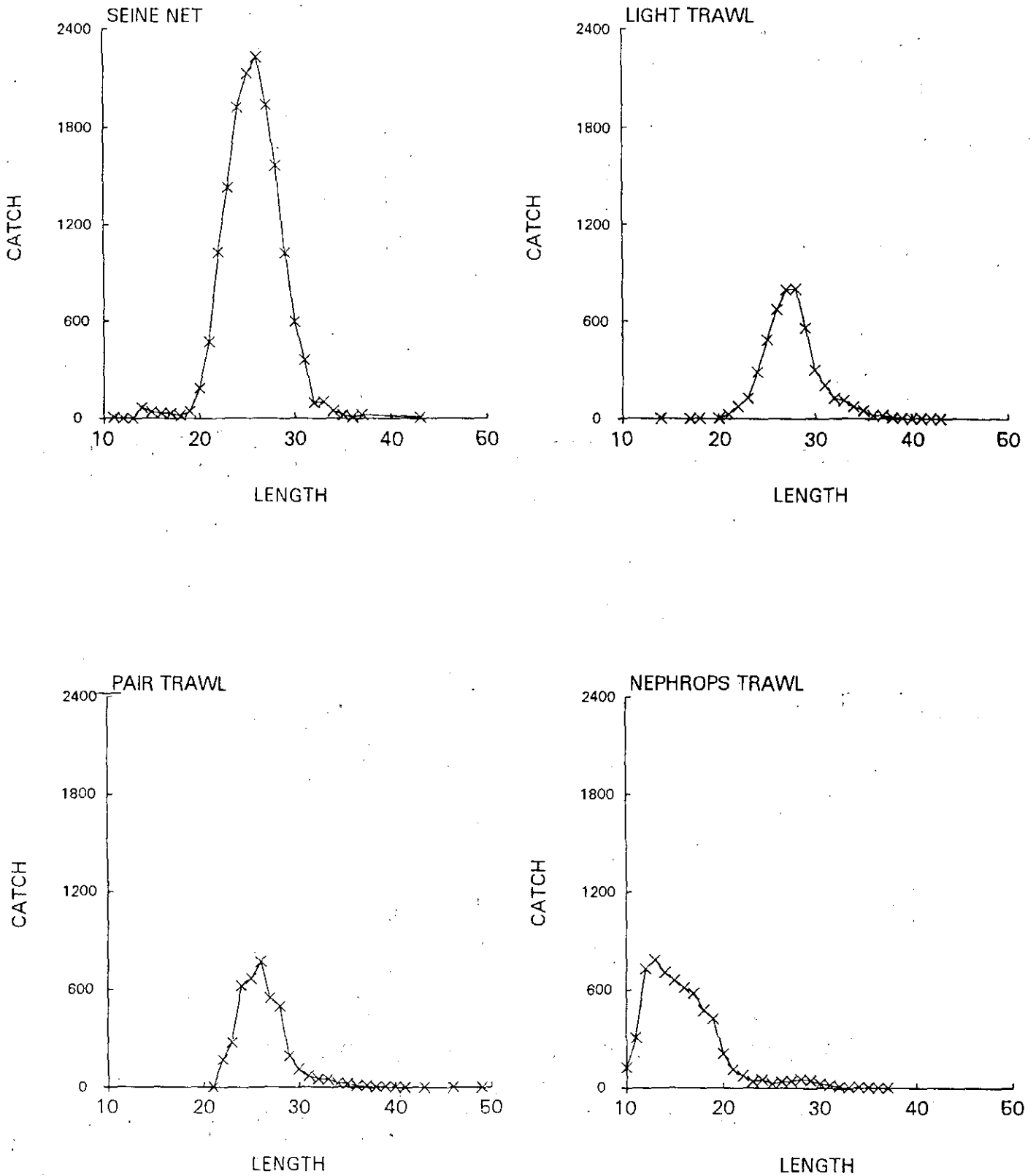


Figure 4b Numbers ($\pm 1,000$) of whiting caught in the Buchan area by the four fishing methods in the first quarter of 1991.

HADDOCK 1991 QU1 CPUE

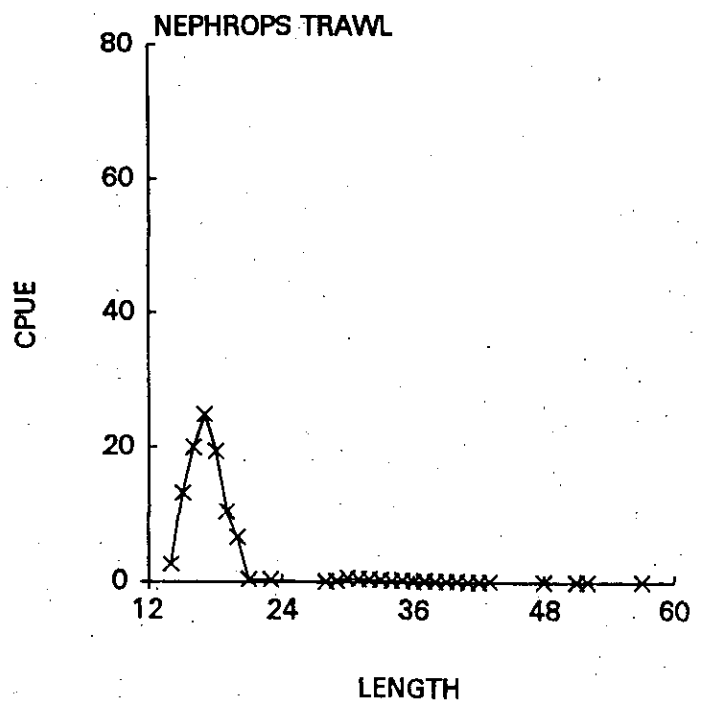
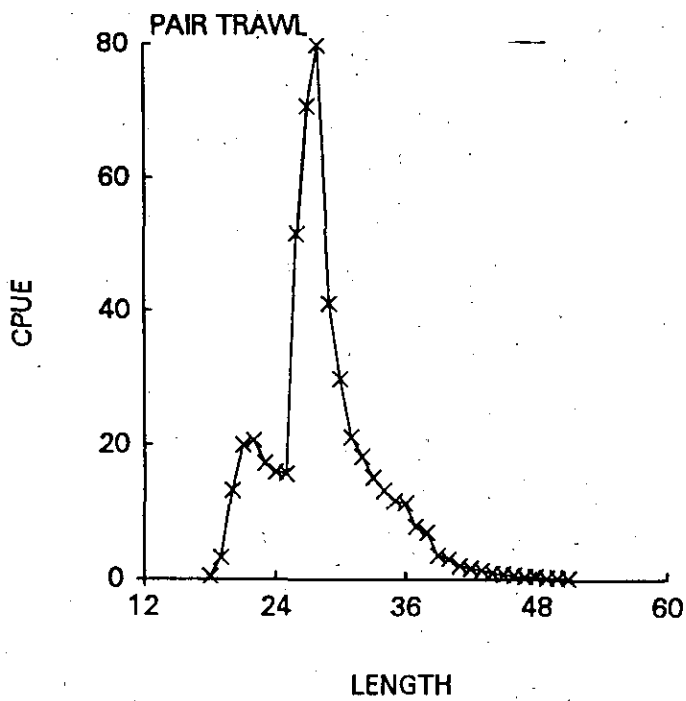
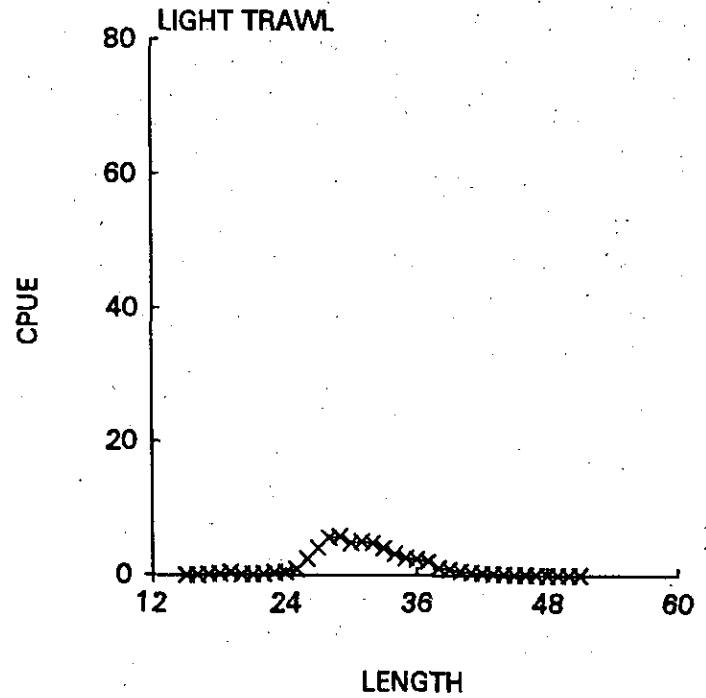
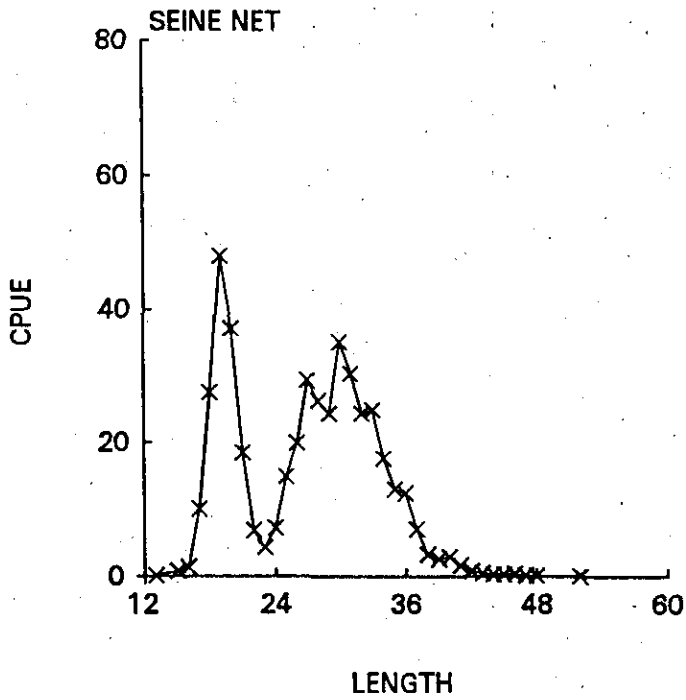


Figure 5a Catch per unit effort (CPUE) in numbers/hour fishing, for haddock caught in the Buchan area by the four fishing methods in the first quarter of 1991.

WHITING 1991 QU1 CPUE

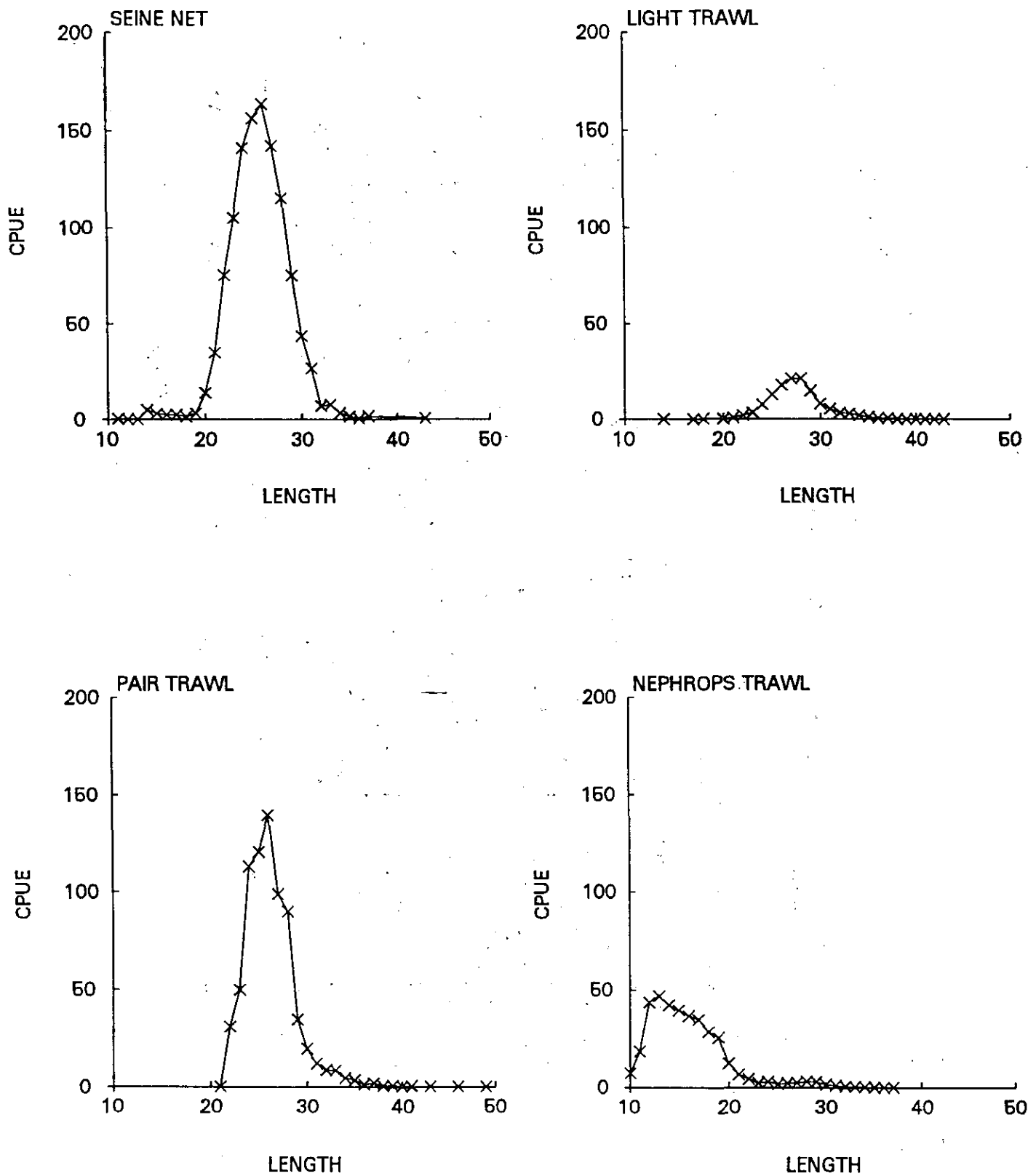


Figure 5b Catch per unit effort (CPUE) in numbers/hour fishing, for whiting caught in the Buchan area by the four fishing methods in the first quarter of 1991.

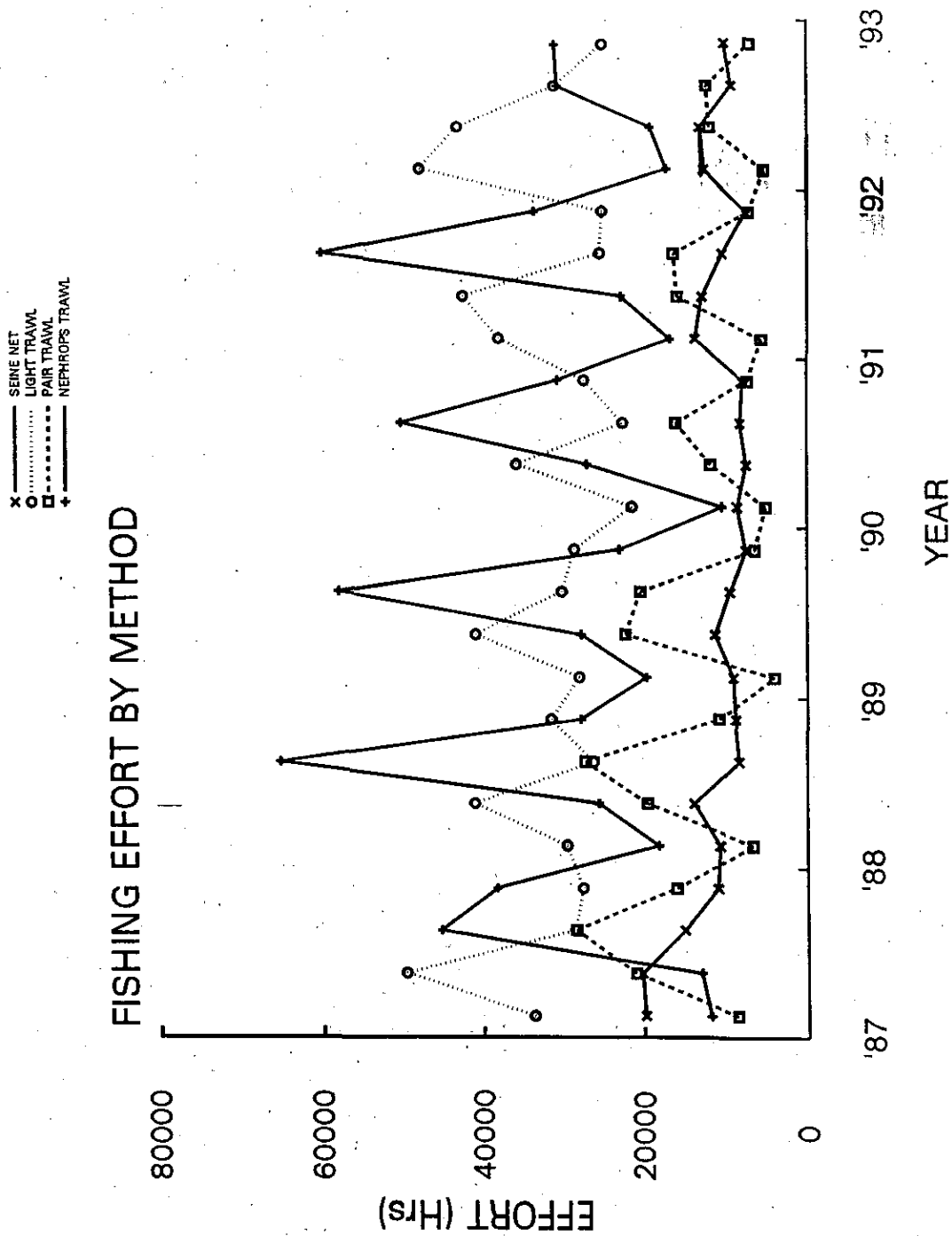


Figure 6 Fishing effort in hours with the four fishing methods used in the Buchan area for each quarter from 1987 to 1992.

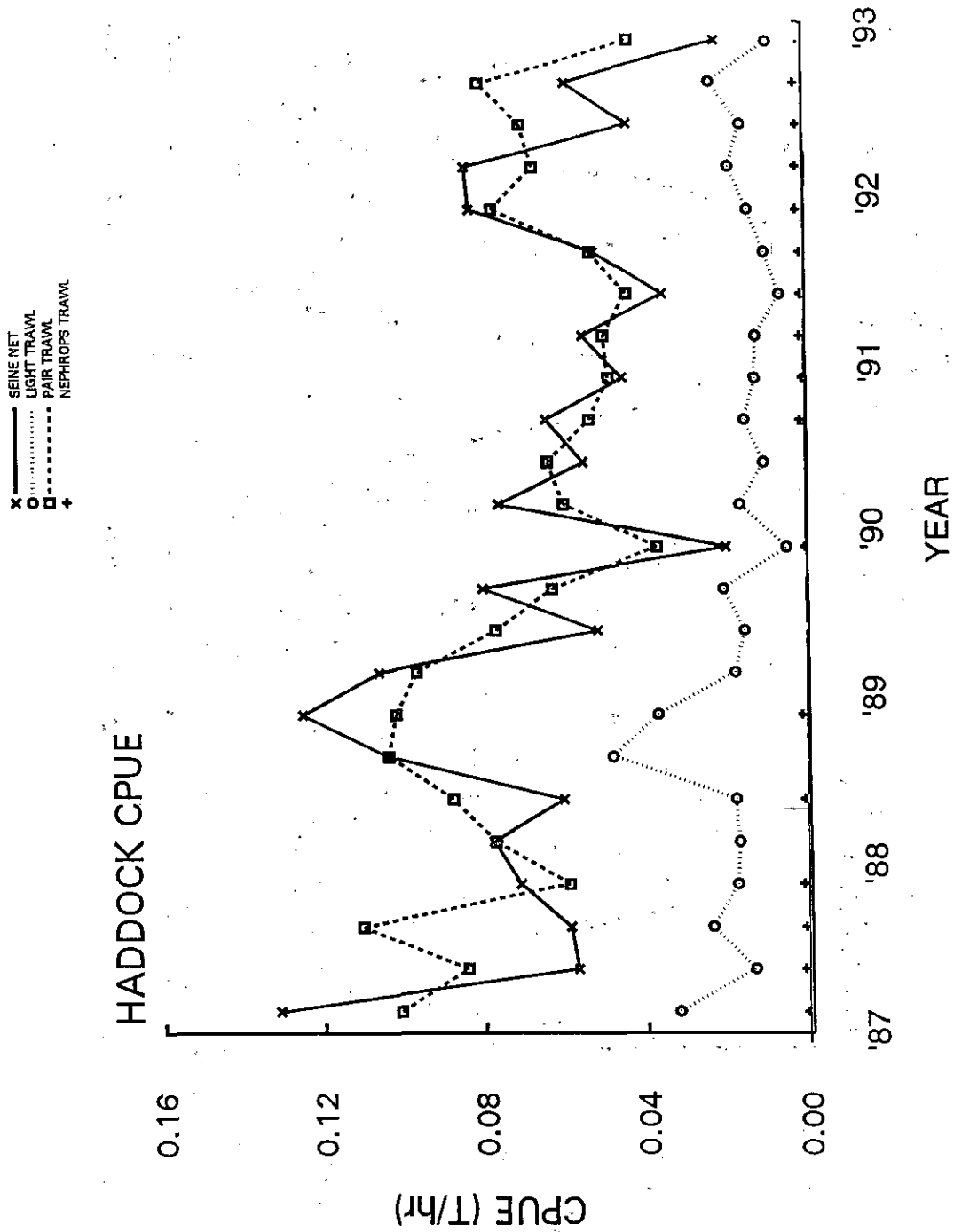


Figure 7a Catch per unit effort (CPUE) in Tonnes landed per hour fishing for haddock for the four fishing methods used in the Buchan area for each quarter of 1987 to 1992.

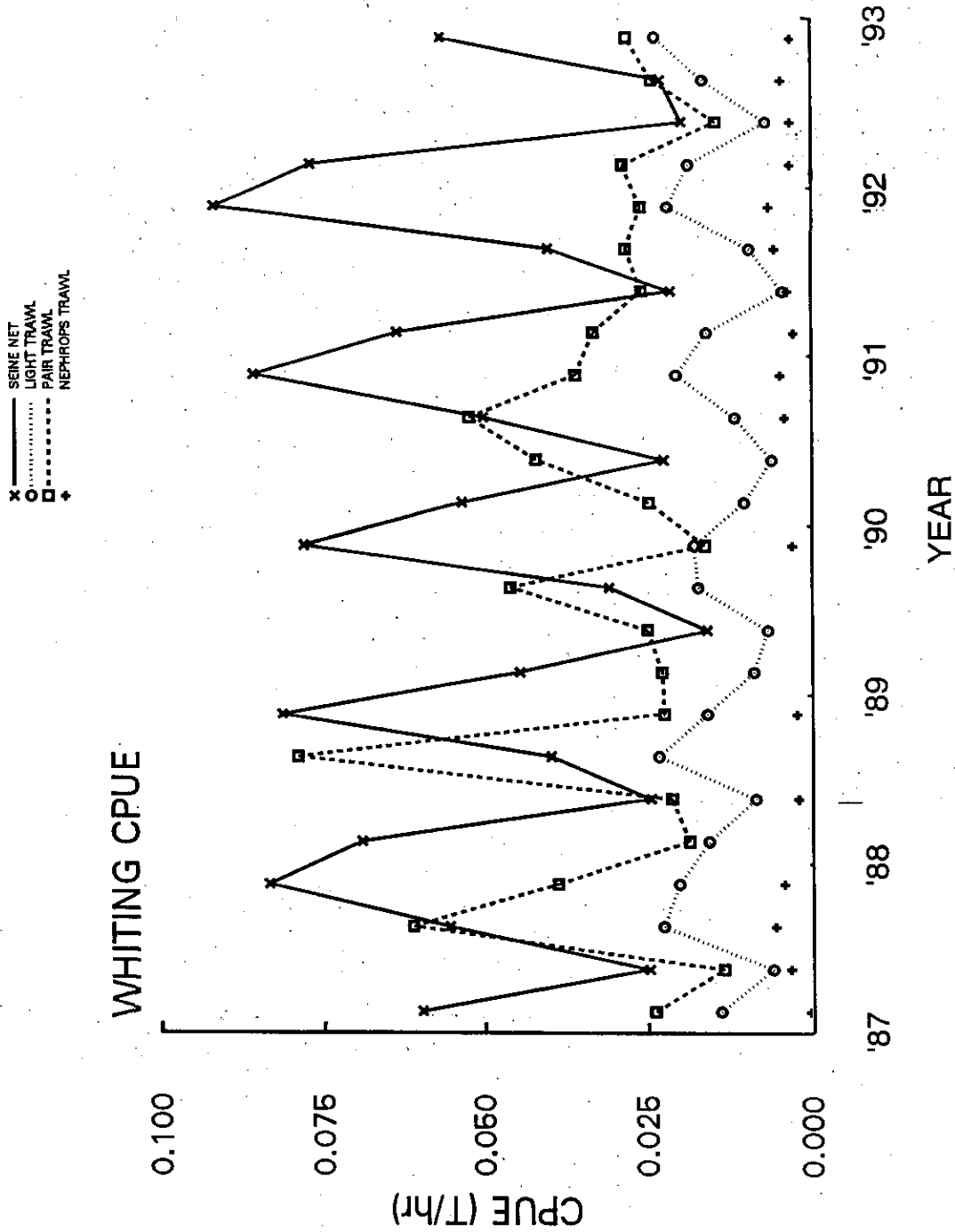


Figure 7b Catch per unit effort (CPUE) in Tonnes landed per hour fishing for whiting for the four fishing methods used in the Buchan area for each quarter of 1987 to 1992.

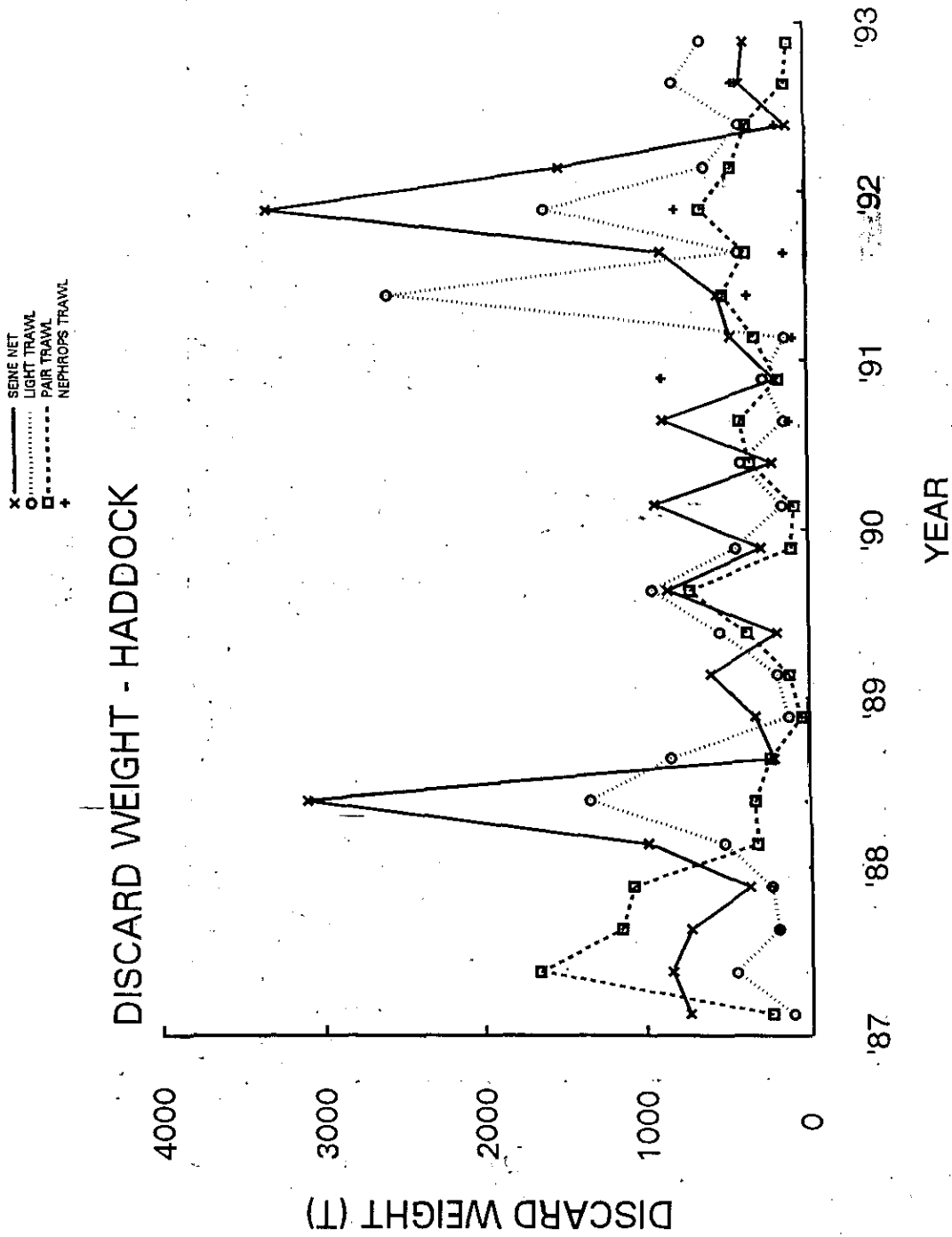


Figure 8a Weight (tonnes) of haddock discarded for each fishing method used in the Buchan area for each quarter of 1987 to 1992.

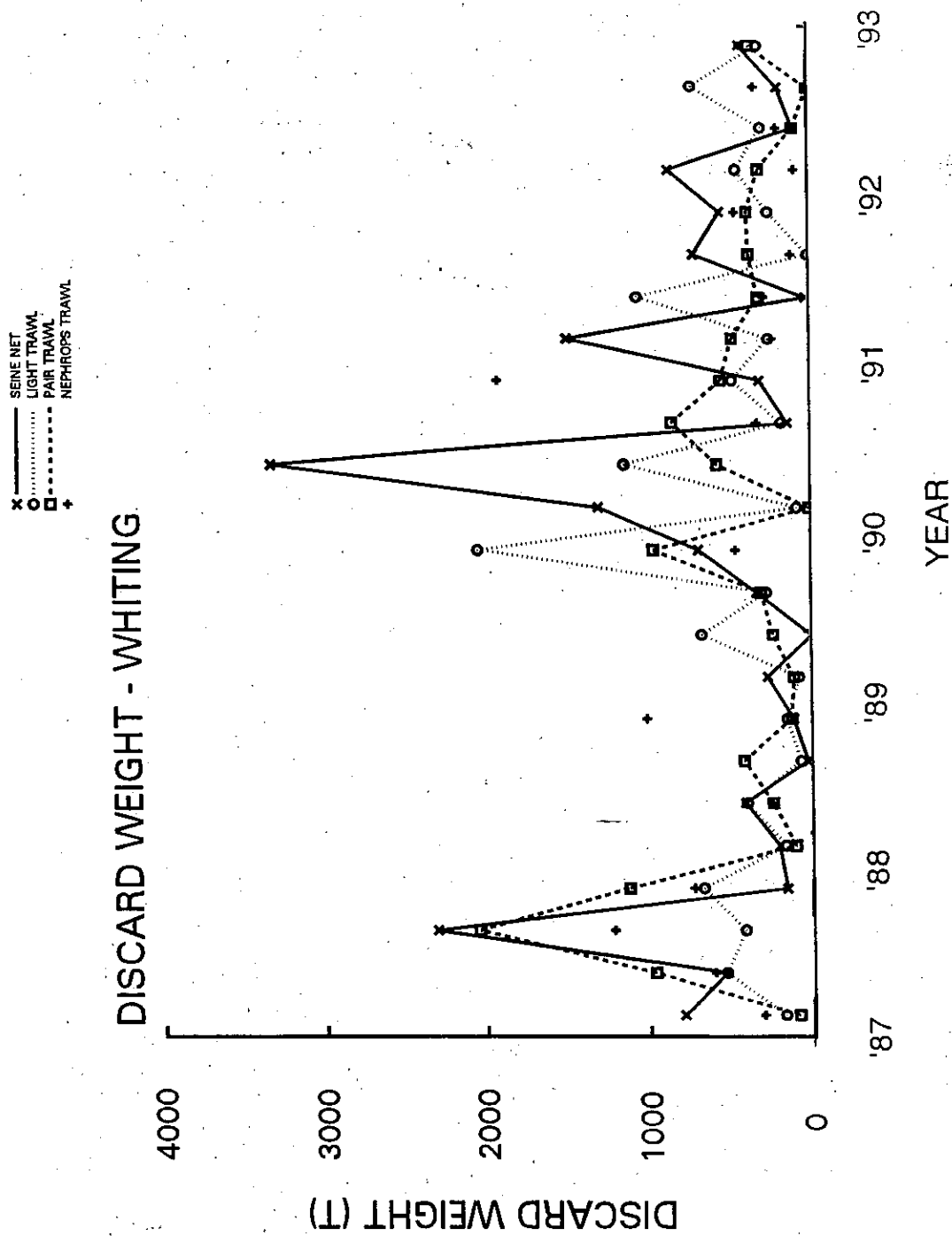


Figure 8b Weight (tonnes) of whiting discarded for each fishing method used in the Buchan area for each quarter of 1987 to 1992.

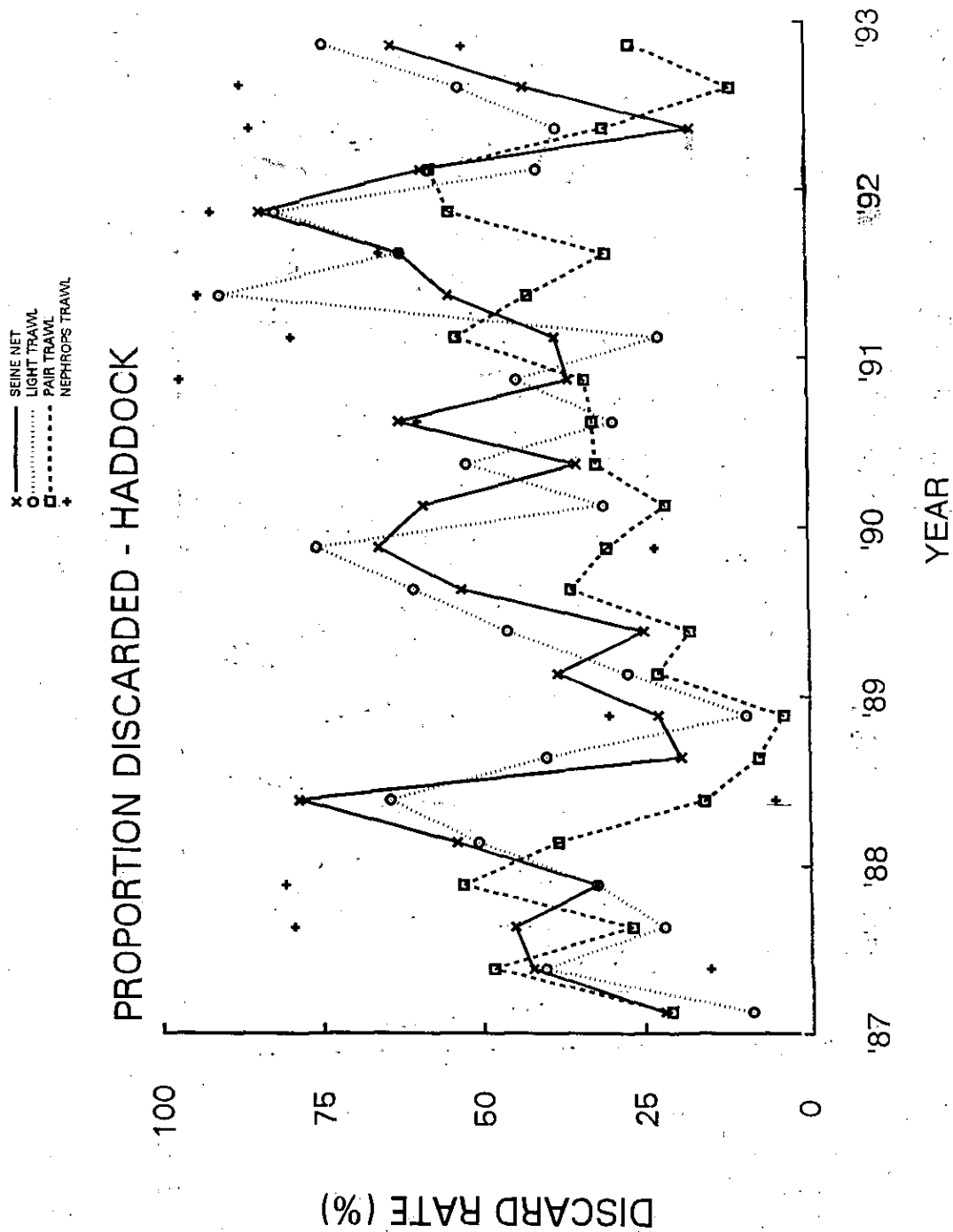


Figure 9a Proportion (percentage by weight) of the catch of haddock discarded for each fishing method used in the Buchan area for each quarter of 1987 to 1992.

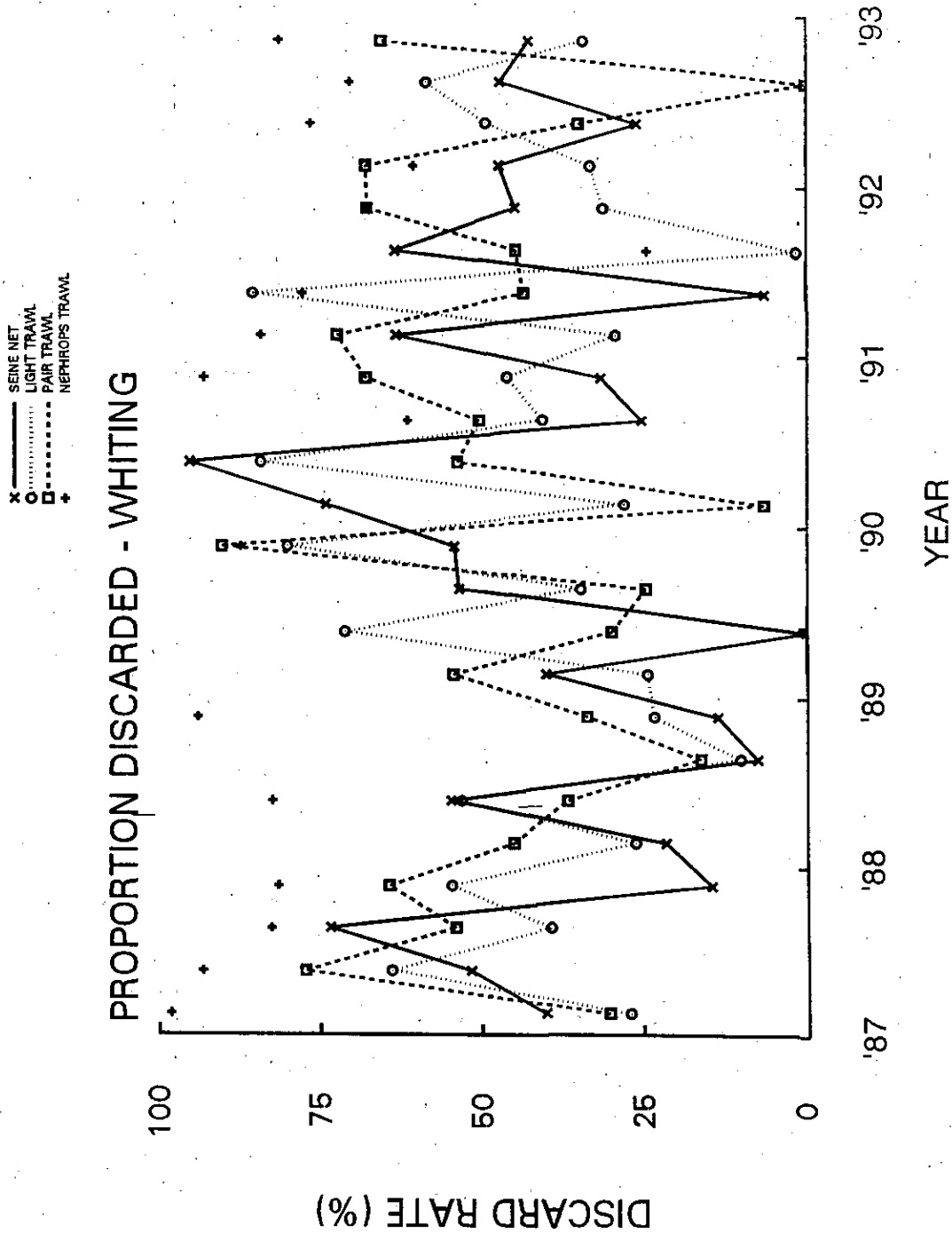


Figure 9b Proportion (percentage by weight) of the catch of whiting discarded for each fishing method used in the Buchan area for each quarter of 1987 to 1992.