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The by-catch of whiting in the Northern Ireland fishery for *Nephrops norvegicus* (L)

by

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INTRODUCTION

The International Fishery Convention of 1946 specified that mesh sizes smaller than 70 mm could be used when trawling for *Nephrops norvegicus* (L). However, various species of white fish occur on the same fishing grounds as *Nephrops*, and were therefore captured by the small mesh *Nephrops* nets. Thomas (1965) showed that whiting (*Merlangius merlangus*) were among the most common white fish by-catch off the coast of Scotland, and the catch of undersized whiting was greater in small meshed *Nephrops* trawls than in 70 mm meshed trawls. The problems regarding conservation of protected species led in 1962 to a prohibition on nets of less than 70 mm mesh by British registered vessels except in the Irish Sea (ICES sub-area VIIa). *Nephrops* in this area were regarded as generally smaller than elsewhere, and therefore an increase in mesh size may have had a considerable effect on the fishery.

The by-catch of undersized protected species in the Northern Ireland fishery, and particularly of whiting, was still recognised as a problem. In an attempt to solve this, a modified *Nephrops* trawl was fished in 1968 (Ferris unpublished) and 1969 (Symonds and Simpson 1971). It was basically a trawl with a "double-storey" cod-end constructed to utilise the difference in behaviour of whiting and *Nephrops* inside a trawl. Whiting are believed to swim to the upper surface and sides of a trawl before reaching the cod-end (Margetts 1963) whereas large numbers of small

Nephrops have been shown to escape through the lower surfaces of a net (Cole and Simpson 1965). The top meshes of the cod-end were therefore of 70 mm to permit the release of undersized whiting, whereas the floor and divider between the upper and lower sections were of 44-50 mm mesh to retain the Nephrops. Results in both 1968 and 1969 showed that the catch of undersized whiting was reduced but it has not been used in the commercial fishery.

In order to assess the effect of the small mesh Nephrops fishery on whiting stocks in the Irish Sea, catches of marketable and undersized whiting have been sampled on board trawlers fishing for Nephrops from N. Ireland ports since 1971.

METHODS

Statistics of catches and fishing effort are recorded separately for white fish trawl and Nephrops trawl. The classification of the latter, up to and including 1970, was based on records from the port of Kilkeel only, where the majority of vessels were known to be using the small mesh (i.e. under 50 mm.). Recently, however, there has been a progressively more widespread use of small mesh by vessels from N. Ireland ports other than Kilkeel. Therefore, data on catch and effort for such trawlers since 1971 have taken into account the approximate proportion now using small mesh.

The terminology used to describe the various nets trawled by N. Ireland vessels for the capture of Nephrops requires clarification. A small number of Nephrops trawlers occasionally fish in British waters outside the Irish Sea area and retain the 70 mm net on return to the N. Ireland Nephrops fishery (Watson 1973). However, the majority of N. Ireland Nephrops trawlers fishing in the Irish Sea use nets constructed of meshes measuring under 50 mm., either in the cod-end (as in a dual purpose trawl rigged for Nephrops fishing) or throughout the entire net (as in the more specialised Nephrops or prawn trawl). Several designs of the latter type of net are now in use in this fishery.

In this study, a total of 21 one day sea trips was made on board commercial vessels fishing for Nephrops in the Irish Sea west of the Isle of Man. The gear used was, unless otherwise stated, a dual purpose trawl of meshes 70 mm and over in the body and wings of the net, but fitted with a small mesh cod-end measuring on average from 42 to 45 mm. This type of trawl is designed, by inter-change of cod-ends of at least 70 mm and under 50 mm. meshes, to fish mainly for either white fish or Nephrops. Each voyage normally involved three tows and samples of the total whiting catch were taken from each tow. After grading, the weight of the

retained catch was also recorded, samples measured, and in 1973 additional samples were taken from the rejected whiting catch. The total weights of Nephrops and other species landed during each trip were also noted. Statistics on landed catches taken by Nephrops and white fish trawls, as described above, were also obtained.

RESULTS

The Northern Ireland fishery for whiting:

The whiting catch landed each year in N. Ireland has decreased from 16,000 tonnes during the five-year period 1954-58 to 8,900 tonnes in 1969-73 (Table 1). It represented about a third of the value of the white fish catch and was a relatively important commercial species. However, the proportionate value of whiting in relation to the total seafish landings has fallen over the years and changed dramatically with the development of the Nephrops fishery (Table 1).

During the period 1966 to 1972 inclusively, the effort using a small mesh trawl increased significantly ($P<0.001$ Fig. 1) and now represents over 60% of the total effort involved in fishing for Nephrops. One consequence of this change has been an increase in the weight of fish caught as a by-catch to this fishery.

The landings by the Nephrops trawlers during this survey are shown in Table 2, which illustrates that whiting was the major by-catch (2699 Kg.) followed by cod (1197 Kg.). Estimates of the annual catch of whiting attributable to both white fish and Nephrops trawls are available from 1966 (Table 3). These statistical returns from the ports show that the percentage of marketable whiting taken by the small mesh nets has increased significantly as a result of the greater use of these nets ($P<0.001$, Fig. 1). It is also noticeable that there has been a significant decrease in the catch per effort of whiting by white fish trawl ($P<0.01$, Fig. 1) which will be referred to later. Catches of marketable whiting by Nephrops trawling are accompanied by a considerable proportion of rejected undersized whiting, varying with the month of fishing.

Length frequencies of whiting by-catch:

Garrod and Gamboll (1965) described how whiting in the Irish Sea aggregate at certain times of the year, forming local and dense concentrations of fish. In August and September a fishery develops off Dublin, and proceeds northwards towards the end of the year. This becomes the main County Down fishery which is very intensive and in the 1960's contributed 70% of the whiting landed from the Irish Sea by the United Kingdom and the Republic of Ireland (Garrod and Gamboll 1965). Most of

the fleet from N. Ireland trawl within this fishery, which occurs in the ICES statistical rectangles YY6 and YY7. The seasonal nature of the whiting catch landed into N. Ireland is given in Table 4 which shows that during 1971-73 more than 70% of the landings were in the first and fourth quarters, i.e. October to March. Part of this is due to the fleet diverting their attention to Nephrops and later herring in the spring and summer months. More important is a dispersion of young 1-group whiting from this fishery to the rest of the Irish Sea in the spring (Garrod and Gambell 1965). This will affect the length frequency distribution as the season progresses, and also the proportion of small whiting caught by the Nephrops trawl.

The mean length and percentage of undersized whiting in the total catch sampled at sea on board trawlers fishing for Nephrops are given in Table 5. Very few whiting were taken during trips in June 1972 and in May, June and July 1973. The minimum size limit for landed whiting is 25 cm., and although the mean percentage of undersized whiting in the samples was 78%, there was considerable variation. For example, seasonal grouping shows the percentage of undersized whiting to be 86.2%, 49.6%, 73.3% and 85.9% in the 1st, 2nd, 3rd and 4th quarters respectively. There are other factors which cannot be analysed separately for so few sea trips. For example, larger whiting tend to be found in deeper water (Garrod and Gambell 1965, Hillis 1971), which could give rise to geographical variations in length frequency. Nevertheless, the results are consistent with the knowledge that 0- group whiting begin to be recruited into the small mesh fishery in late July. At this time, the whiting are 5-10 cm in length growing to 10-15 cm in the last quarter (Hillis 1968). By May of the following year these fish are 1- group, 15-20 cm in length, and on maturing join adult stocks which are redistributed more uniformly throughout the Irish Sea (Garrod and Gambell 1965). As a result, the percentage of undersized whiting in the albeit smaller catches of the 2nd quarter is considerably lower than later in the year. The appearance and growth of 0- group whiting in the fishery can be illustrated by recording the percentage frequency distribution for length of whiting in the samples (Table 6). The 0- group fish are seen to predominate in samples taken during the 1st and 4th quarters.

Possible effects of small mesh nets on the whiting fishery:

The sampling shows that large numbers of small whiting may be caught by the Nephrops trawls. Although undersized fish are returned to the sea, virtually none survive the trawling, handling on deck and predation by gulls after rejection. Using the weight of whiting landed, it is possible to obtain an approximate estimation of the numbers of undersized whiting killed during the year by Nephrops trawlers:

$$\text{No. undersized whiting} = L \times \left(\frac{100}{100-U} - 1\right)$$

where L = numbers of whiting in landed catch (equal to boxes landed x number of fish per box)

U = % undersized whiting in catch prior to grading

It is assumed that the percentage undersized whiting calculated from the length frequency of samples is the same as the percentage of fish rejected by the fishermen. In 1973, a check during seven sea trips demonstrated the validity by giving mean percentages of 89.5% compared with 89.3% respectively.

The estimated rejection of undersized whiting is given in Table 7 for each quarter of 1972 and 1973. This is based on an average percentage of undersized fish for each quarter (U), and an average number of whiting per Kg. in the landed catch. Both these quantities vary seasonally, but for the purposes of this estimation, it is assumed that there is no variation from one year to the next. The results show that for every whiting landed in N. Ireland by Nephrops trawl at least five are rejected at sea. The increased effort by this method of fishing has therefore given an estimated minimum mortality of 25 and 34 million undersized whiting in 1972 and 1973 respectively (Table 7), whereas in the preceding years 1968-71 the range was from 9 to 17 million whiting.

It is difficult to ascertain whether this has had a direct effect on the whiting stocks in the Irish Sea. If, however, the catch per effort for whiting caught by white fish trawl is examined (Table 3), there has been a significant decrease during recent years, coincident with an increasing effort by Nephrops trawlers. It should be noted, however, that there has been no decrease in the catch per effort of whiting caught by prawn trawlers, and the reasons for this are obscure. There is therefore a significant negative correlation between the numbers of hours fished by Nephrops trawl and the catch per effort of whiting caught by white fish trawl 1966-73 ($R = -0.79$, $N = 8$, $P<0.02$). The correlation coefficient is larger when catch per effort by white fish trawl is correlated with the Nephrops trawl fishing effort in the previous year ($R = -0.82$ Fig. 2). Since the latter is causing a considerable mortality of 0- group and 1- group whiting, its effects should be more noticeable the following year when the white fish trawlers are fishing for I and II groups whiting.

Discussion:

The use of meshes of under 50 mm. for Nephrops trawls in the Irish Sea has resulted in considerable catches of undersized whiting. The proportion of whiting rejected at sea varies seasonally, but is especially high during the winter months, i.e. 4th and 1st quarters when 0- group whiting become vulnerable to the fishery. The increasing

intensity of Nephrops trawling has inevitably increased mortality of small whiting, and it is possible that this change in effort has caused a significant decrease in the weight of whiting landed per 100 hours of white fish trawling.

Thomas (1965) found that very few whiting below 20 cm length were caught in a 70 mm trawl, whereas fish smaller than 10 cm were recorded in a Nephrops trawl. Hillis' (1968) mesh selection curves for Irish Sea whiting indicated that the 70 mm mesh would release whiting of less than 21 cm length. The effect of fishing with a 70 mm mesh rather than a Nephrops trawl during the present survey can be calculated on the assumption that only whiting longer than 19 cm would have been caught by the larger mesh, under normal fishing conditions. On this basis, the percentage rejection of fish of 20–24 cm length in each quarter becomes 31.9%, 53.9%, 46.0% and 42.7% respectively. The variation in successive quarters is much less marked since the late summer and winter stock of 0- group whiting are not captured by the larger mesh. As a result, the estimated number of whiting rejected at sea from Nephrops trawlers would have been 3.6 millions from a 70 mm mesh in 1972 instead of 25.0 millions from the under 50 mm. mesh. In 1973 these figures are 4.7 and 34.0 millions respectively. No sampling of rejected whiting catch has been carried out on white fish trawlers using a 70 mm mesh to verify these conclusions.

It is evident that measures are required to reduce the by-catch of undersized whiting in the Irish Sea. Solutions could include a licensing system for use of small mesh nets, or prohibition on nets under 70 mm. Other considerations could be "closed areas" covering whiting nursery grounds, or prohibition of small mesh nets during the last quarter when 0- group fish are most vulnerable. This would be less detrimental to the Nephrops fishery, since only 10–13% of the annual catch is taken from October to December.

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SUMMARY

The increased intensity of Nephrops trawling by Northern Ireland vessels, many of which use nets containing meshes of under 50 mm., has inevitably increased mortality of small whiting, the main protected species in the by-catch. Estimates of rejection at sea of undersized (less than 25 cm length) whiting, based on data collected at sea and from the recorded total number of trawlers fishing for Nephrops, vary between 9 and 34 million fish in any one year over the period 1968 to 1973 inclusively. The possible effects of this mortality on whiting stocks in the Irish Sea are discussed.

TABLE 1

THE RELATIVE CATCH AND VALUE OF WHITING LANDED IN NORTHERN IRELAND IN FIVE YEAR PERIODS SINCE 1954

Period	Whiting		Whitefish		Value of whiting as % Whitefish	Shellfish value £ x 1000	Value of whiting as % total
	Quantity Tonnes x 1000	Value £ x 1000	Quantity Tonnes x 1000	Value £ x 1000			
1954-58	16.0	322.1	35.4	836.6	38.5	207.5	30.9
1959-63	16.5	262.6	35.9	663.5	39.6	415.9	24.3
1964-68	13.1	308.4	34.9	936.8	32.9	855.7	17.2
1969-73	8.9	456.3	41.2	2218.3	20.6	3085.4	8.6

TABLE 2

TOTAL WEIGHT OF FISH LANDED AFTER 18 ONE DAY SEA TRIPS ON TRAWLERS USING SMALL MESH NETS

Landed Catch	Weight Kg.	% Total Weight
Nephrops tails	1801	22.3
Whiting	2699	33.4
Cod	1197	14.8
Coalfish	628	7.8
Monk	524	6.5
Hake	228	2.8
Others *	1003	12.4

* Others are mainly, in order of frequency, plaice, haddock, squid, ling, skate, turbot and brill.

TABLE 3

THE LANDED CATCH AND EFFORT FOR WHITING IN WHITEFISH AND *Nephrops* TRAWLS 1966-73

Year	Whitefish Trawl			*Nephrops* Trawl			% Whiting caught in *Nephrops* trawl
	Tonnes	Hours fished	Tonnes/ 100 hrs.	Tonnes	Hours fished	Tonnes/ 100 hrs.	
1966	971.1	28223	3.44	319.1	21803	1.46	24.7
1967	2263.6	62903	3.60	154.5	9720	1.59	6.4
1968	1738.0	51712	3.36	783.6	32341	2.42	31.1
1969	1105.6	51521	2.15	710.2	48740	1.46	39.1
1970	627.1	52062	1.20	449.6	43908	1.02	41.8
1971	817.8	48162	1.70	832.5	47106	1.77	50.4
1972	602.1	40988	1.47	1145.4	78094	1.47	65.5
1973	722.3	43848	1.65	1442.0	81684	1.77	66.6

TABLE 4

THE PERCENTAGE OF THE ANNUAL WHITING CATCH LANDED INTO NORTHERN IRELAND DURING EACH QUARTER 1971-73

Quarter	1971	1972	1973
1st	41	34	40
2nd	14	16	18
3rd	16	5	8
4th	29	45	34

TABLE 5

The mean length and percentage undersized whiting sampled on board trawlers fishing for Nephrops, 1971-1973

Date	N	Whiting sampled Mean Length cm.	st.dev.	% undersized	Total landed catch Kg.
1971					
8 July (1)	147	28.9	4.5	21.1	47.6
22 Sept.	111	20.0	6.1	74.8	63.5
17 Nov.	336	22.8	6.8	40.8	511.2
1972					
25 Jan.	77	16.0	3.7	94.8	12.7
11 Apr.	51	26.4	4.5	25.5	77.8
27 July	249	15.4	5.9	94.4	44.5
7 Sept.	408	14.0	5.6	90.7	222.3
24 Oct.	611	14.6	5.0	96.4	133.4
29 Nov.	268	13.6	4.8	94.8	122.2
1973					
9 Jan.	380	13.5	4.3	96.6	266.7
20 Feb.	457	14.1	6.3	89.7	444.5
13 Mar.	149	22.6	6.8	63.8	200.0
10 Apr.	400	18.9	3.3	73.6	333.4
30 Aug.(2)	87	19.5	6.9	85.4	44.5
25 Oct.(1)	418	14.9	6.2	97.3	255.6
22 Nov.(2)	371	15.0	3.8	97.7	88.9
13 Dec.	306	15.2	2.7	88.4	88.9

NB. A negligible whiting catch was taken during sea trips in June 1972 and in May, June and July 1973.

(1) Dual purpose trawl with 70 mm cod-end

(2) Nephrops or prawn trawl of<50 mm throughout

TABLE 6

Percentage frequency of length of whiting in samples taken on board trawlers fishing for Nephrops, 1971-1973

Date	% Frequency						
	Length cm.						
	5-9	10-14	15-19	20-24	25-29	30-34	35+
8. 7.71(1)	0	0.7	0	20.4	32.7	38.8	7.4
22. 9.71	0.9	10.8	48.7	14.4	18.9	4.5	1.8
17.11.71	2.4	16.7	10.7	11.0	52.4	5.7	1.1
25. 1.72	0	40.3	44.2	10.4	5.1	0	0
11. 4.72	0	3.9	3.9	17.7	52.9	15.7	5.9
27. 7.72	27.7	11.7	35.3	19.7	4.8	0.8	0
7. 9.72	17.5	55.2	12.1	5.9	8.1	0.7	0.5
24.10.72	12.6	42.7	33.4	7.7	2.1	1.0	0.5
29.11.72	10.1	60.1	22.0	2.6	3.4	1.5	0.3
9. 1.73	0.5	80.5	12.6	2.9	0.8	1.8	0.9
20. 2.73	5.3	73.5	7.0	3.9	4.2	4.8	1.3
13. 3.73	0	6.7	36.9	20.1	16.8	16.1	3.4
10. 4.73	0	4.0	60.5	31.5	1.8	1.8	0.4
30. 8.73(2)	12.6	17.2	9.2	34.5	23.0	3.5	0
25.10.73(1)	6.2	66.7	8.6	3.8	11.5	2.4	0.8
22.11.73(2)	3.2	49.1	39.1	5.9	2.4	0.3	0
13.12.73	0.7	42.8	52.0	2.3	2.2	0	0

NB See footnotes, Table 5.

TABLE 7

ESTIMATED NUMBER OF UNDERSIZED WHITING REJECTED AT SEA DURING EACH QUARTER OF 1972 AND 1973

Quarter	Landed Catch from Nephrops trawl			% undersized in total catch	Estimated No. rejected at sea millions
	Tonnes	No.Whiting/Kg.	Estimated No. Millions		
1972					
1st quarter	473.3	3.8	1.80	86.2	11.2
2nd quarter	168.1	3.4	0.57	49.6	0.6
3rd quarter	196.6	5.0	0.98	73.3	2.7
4th quarter	307.4	5.6	1.72	85.9	10.5
TOTAL	1145.4		5.07		25.0
1973					
1st quarter	555.3	3.8	2.11	86.2	13.2
2nd quarter	238.7	3.4	0.81	49.6	0.8
3rd quarter	105.9	5.0	0.53	73.3	1.5
4th quarter	542.1	5.6	3.04	85.9	18.5
TOTAL	1442.0		6.49		34.0

FIGURE 1. (a) Whiting catch per effort in white fish trawl,
(b) Percentage whiting caught by Nephrops trawl, and
(c) Hours fished by Nephrops trawl, for N.Ireland vessels 1966-1973.

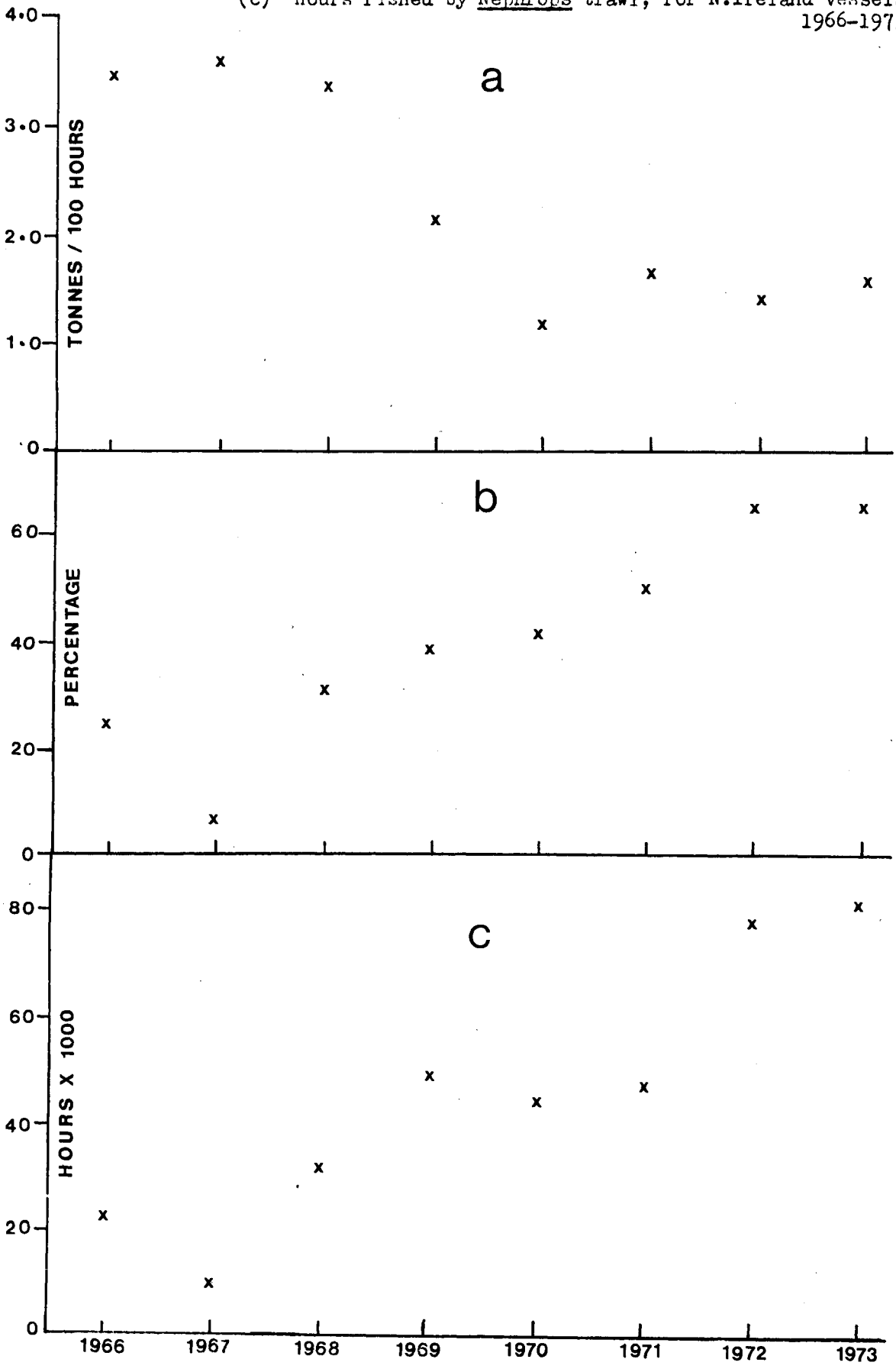

FIGURE 2. Correlation of hours fished by Nephrops trawl against the catch per effort of whiting landed by white fish trawlers one year later, 1966-1973.