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SQUARE MESH PANEL STUDIES IN THE IRISH SEA *NEPHROPS* FISHERY

by

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ABSTRACT:
Studies of the Irish Sea *Nephrops* fishery have demonstrated that panels of square shaped mesh inserted in the top sheet of trawl nets allow a significant proportion of captured juvenile whiting to escape. This study examines the performance of a section of very large diamond shaped (150mm) netting inserted in the trawl compared to a square mesh panel, in facilitating fish escapes. Fish behaviour was observed using underwater video and catches were sorted to species, quantified and their length composition measured. Results showed that the large diamond mesh remained virtually closed during trawling and allowed negligible escapes, whilst the square meshes remained open allowing a high escape rate of small fish. The use of longitudinal strengthening ropes with the square mesh panel did not impede fish escapes. The paper describes the behaviour, in the trawl net, of a range of fish species.

INTRODUCTION:
Earlier work on the Irish Sea *Nephrops* fishery has demonstrated that the fitting of panels of square shaped mesh netting can reduce the capture of juvenile whiting by up to 80% (Briggs,1992). Other studies by Rihan & McCormick (1991), by Crummey (1991) and by Hillis & McCormick (1991) have also demonstrated the conservation attributes of square mesh panels. These studies along with those by Robertson (1982,1983a & 1993b) and Arkley (1990) in the North Sea and west of Scotland waters have provided a basis to new UK legislation for the Irish Sea which stipulates a square mesh panel be inserted into all trawl nets (SI1991:1380 as varied SI1992:1344). This paper compares the effectiveness of a panel of large diamond shaped mesh (150mm) as an alternative conservation measure to the square mesh panel.

METHODS:

The gear used was two identical prawn trawl nets (Figure 1) which were fished with the following panel arrangements:

a. Knotless square mesh (nominal 75mm,mean 73mm) panel in net extension piece with strengthening ropes. (Figure 1a)
b. Large diamond mesh panel (150mm) in front of net extension piece (Figure 1b)
c. Knotted diamond mesh panel (81mm) turned to make it square but without strengthening ropes. This panel was only part width of the sheet, having diamond mesh (80mm) strips (3 meshes wide) on each side joined into the selvedges.
d. Knotted diamond mesh as in 'c' but with 4 longitudinal strengthening ropes.

Fish behaviour was studied by an unmanned towed submersible (Urquhart and Stewart, 1993) called a remote controlled television vehicle or RCTV, using Low Band U-Matic video tape. The RCTV was deployed from *MRV Lough Foyle* during a research cruise in the Irish Sea during October 1992. The behaviour of fish inside the net were also filmed (VHS) using a miniature video camera (Osprey) enclosed in a waterproof housing which was fitted inside the trawl and was wired to a remote recorder and power device attached elsewhere on the trawl. Observations were made with and without lights.

Hauls were performed at stations selected from those sampled during Northern Ireland ground-fish surveys. The water depth of stations ranged from 28m to 70m and were over the muddy substrate typically inhabited by *Nephrops*. All catches were sorted to species level using multiple stage stratified sampling procedures. Catches were quantified and length frequencies recorded for all species captured. Fourteen successful hauls (Figure 2) were performed, 7 with a knotless square shaped mesh panel, 5 with a large diamond mesh panel and 2 with a knotted square mesh panel made from turned diamond mesh. Longitudinal strengthening ropes were used during two of the tows a with square mesh panel in order that any effect these ropes may have on escaping fish could be assessed. All but two tows were filmed, giving a total of 15 hours of U-matic video tape from the RCTV and 21 hours of VHS tape from the miniature camera inside the nets.

RESULTS:

Overview

Good quality video films of fish escape reactions and general behaviour were obtained during the filmed tows. Although a few small fish escapes were seen at the edges of the large diamond mesh, which showed some signs of opening towards the selvedges, there were very few escapes across the width of the panel. The large diamond meshes were open on average by 0.25 of the mesh length. Escapes through the square mesh panel, in which the meshes remained open, were frequent and supported the earlier Irish Sea studies (Briggs, 1992). Apart from isolated individuals, no *Nephrops* were seen escaping from either net. Evidence from the miniature camera inside the net demonstrated that *Nephrops* pass along the bottom of the net and seldom rise above the selvedges. Strengthening ropes did not appear to obstruct fish escapes through the square mesh panel or to distort the net shape during trawling. Although there was no evidence of knot slippage with the knotted twine a more extensive trial would be required to investigate this aspect further.

By stopping the play-back facility of the video recorder to look at single frames during preliminary viewing, it was possible to use the square meshes of the panel as a graticule to estimate the size of fish escaping. This method indicated that whiting escapes through the square mesh panels were mostly confined to undersized (<27cm) fish.

Figure 3 shows the length frequency distributions of whiting captured by the square panel net and the large diamond net respectively . These data have been pooled by adding the number of fish caught at each length by the Square mesh panel and large diamond panel nets. Figure 4 illustrates the size range of whiting captured during each tow and Figure 5 is the whiting catch per hour by tow. A breakdown of species and catch rate for each tow are presented in the Appendix.

Variability in the density of fish on the grounds prevented a meaningful comparison of catch composition and selection characteristics of the different gears. This highlights the unsuitability of the 'alternate haul' method for studying mesh selection, as discussed by Garrod (1976) who calculated that over 5000 alternate hauls would be required to provide statistically valid data. Parallel hauls or the use of twin rig gear are therefore preferred for quantitative studies of gear selectivity. This paper is primarily focussed at describing the escape behaviour of fish in different gear configurations.

<u>Behaviour patterns of captured fish species</u>

<u>PRAWNS</u> *(Nephrops norvegicus)*
Prawns were almost entirely passive when passing below the square mesh window. They tumble, trundle and spin out of control along the lower panel and never seem to drift higher than the selvedges on either side (although very occasionally the odd one is seen to pass through the meshes of the square mesh window). The square mesh window designs used during two tows had strips of diamond mesh against the selvedge which effectively stopped any prawns being washed out of the panel section whilst towing. Occasionally the odd *Nephrops* grasped a meshed fish or crustacean lying on the lower panel with its pincers, but could not hang on for long. The meshes in the large diamond mesh lower panel are never open enough for the animals to penetrate and escape. *Nephrops* were sometimes seen to tail-flick and momentarily keep station with the net, but this reaction was always brief and the effect on position within the net was negligible ie they are rarely able to move forward except by very small distances. It is likely that they are too exhausted or possibly disoriented. This is not the

case in front of the footrope where previous observations have demonstrated that they can tail-flick for moderate distances

<u>WHITING</u> (*Merlangius merlangus*)
Whiting can be termed a positive swimmer in that 1) it swims strongly within the trawl extension and codend 2) it has quite distinct body orientations at the various stages of capture 3) it apparently makes repeated attempts to escape from the gear, especially when confronted with the narrow confines of the extension and codend. The overriding and most outstanding behaviour characteristic is that it tends to swim upwards when making escape attempts. The fish almost always escapes from the top part of the net and can be observed pointing upwards at an angle as it drops back along the extension or codend. The nose-up attitude can vary between 5 to 90 degrees. Mostly the fish is facing forward as it is overtaken by the trawl. In passive mode the fish will be slightly nose-up but if escape attempts are being made the fish will dart at the netting at any angle. The more vigorous the attempt the greater the angle. This behaviour pattern is utilised by placing an escape panel in a narrow part of the extension or codend so that more open meshes are as near to the fish as possible. Thus, the upwards seeking whiting will be able to penetrate through the open mesh to freedom. Mini-camera camera pictures were particularly good for illustrating upwards behaviour and when linked with the external simultaneous video from the RCTV showed a forceful and vigorous body movement through the mesh. Many whiting were also observed to drift along the extension facing the sidewalls of netting. This lateral side-slip would be interrupted by sudden dashes at the netting.

<u>SCAD</u> (*Trachurus trachurus*)
Like many pelagic species this fish is extremely lively and is capable of swimming into, then out of a trawl. Endurance inside the net is phenomenal and video from several tows illustrated this by showing how scad can stay swimming at one position in the net for long periods and then with apparent ease swim steadily or by spurts forward for large distances along the extension. They push almost violently against the meshes, either from a standing position or by driving hard against the netting with a short burst of speed. As a consequence they can become enmeshed. This happened most graphically in several hauls, when one or two fish were meshed in the square mesh at the forward end of the window.

<u>COD</u> (*Gadus morhua*)
As in most other observations, cod are rather lugubrious in that they do not apparently make many attempts to escape. They drift slowly back along the extension and seem to be calm compared to the other species around them (such as scad, whiting, haddock) which may be making repeated attempts to escape. They do sometimes "nose" the netting but it is a soft and gentle motion rather than the hard pressing of the scad, for example. Nosing generally only takes place when other species around are frantically pushing or in some cases battering against the netting. The nosing is associated with a general tendency to tilt the body, head-up by approximately 5

to 10 degrees from the horizontal. They seem to be able to keep station in the net at one point for long periods without apparently becoming exhausted and this may often be associated with the use of a pectoral fin to hang onto the netting, as was observed on at least one occasion, or by pressing the body against the side or bottom netting.

DOVER SOLE (*Solea solea*)
Generally flatfish swam or drifted back along the net, with their head facing forwards. A lot are also observed to swim or drift back with their head facing aft. However, some flatfish were seen in the net extension and kept pace with the net for short periods.

HERRING (*Clupea harengus*)
Some good escape observations were made from the edges of the large diamond mesh. Generally escape behaviour was vigorous. These were small herring (<15cm) which required many tail beats as they attempted to keep station with the net, but could not and were gradually overtaken. Swift and many dashes at the netting were made along the extension with many escape attempt failures through the closed diamond meshes but first attempts through the more open large diamond and square mesh windows in particular were successful. More seemed to escape through the square meshes. Many were seen to turn side-on to the large diamond mesh panel when clouds of mud coursed high in the tunnel of the extension leaving little space between the top of the cloud and the underside of the large mesh panel.

ANGLERFISH (*Lophius piscatorius*)
Anglerfish tended to flash past the camera observation area either head first towards the codend or facing forwards. But there were times when they pressed down on the lower sheet and by sheer body friction and hydrodynamic pressure stayed immobile for long periods.

GREY GURNARD (*Eutrigla gurnardus*)
Gurnards tended to favour the lower sheet where they pressed down and often use both pectoral fins to steady themselves and sometimes use one pectoral to hang on to a mesh or block in front of an obstruction to hold station in the net.

CONCLUSIONS:

1. TV observation showed fish escapes, particularly whiting, to be more frequent from the net with the square mesh panel than from the one with the large diamond mesh.

2. The diamond mesh was partly open near the selvedges and closed elsewhere. Although some escapes occurred towards the selvedges of the large diamond sheet these were insignificant compared with the number of escapes from the square mesh panel. A greater lateral mesh opening would have allowed more fish to escape from the large diamond sheet, although this is still questionable given the panel position. It is possible that the large diamond

mesh panel would operate more successfully in the straight extension, though mesh closure when under tension would be expected.

3. Each species showed its own characteristic escape reaction

4. The longitudinal strengthening ropes attached to the square mesh knotted netting panel did not appear to impede fish escapes.

5. Virtually no *Nephrops* escapes were observed from either the large diamond or square mesh panels.

6. Variability in the density of fish on the grounds prevented a meaningful comparison of catch composition and selection properties of the different gears.

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Figure 1a

Diagram of trawl net showing position of strengthening ropes

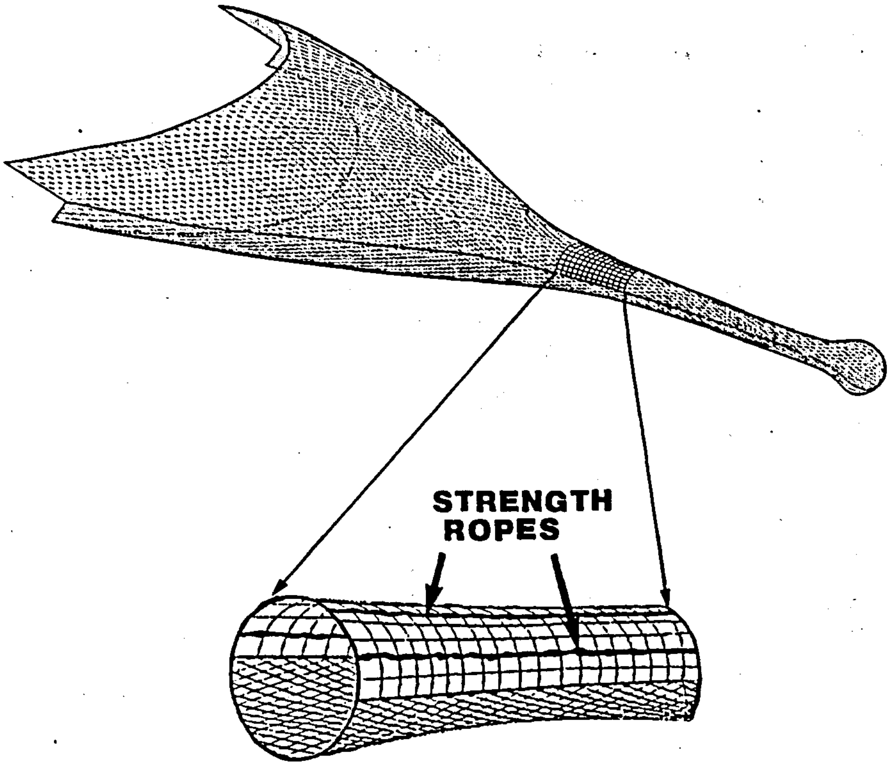


Figure 1b

Net plan of trawl used during trials with details of large diamond mesh panel and square mesh panel (inset)

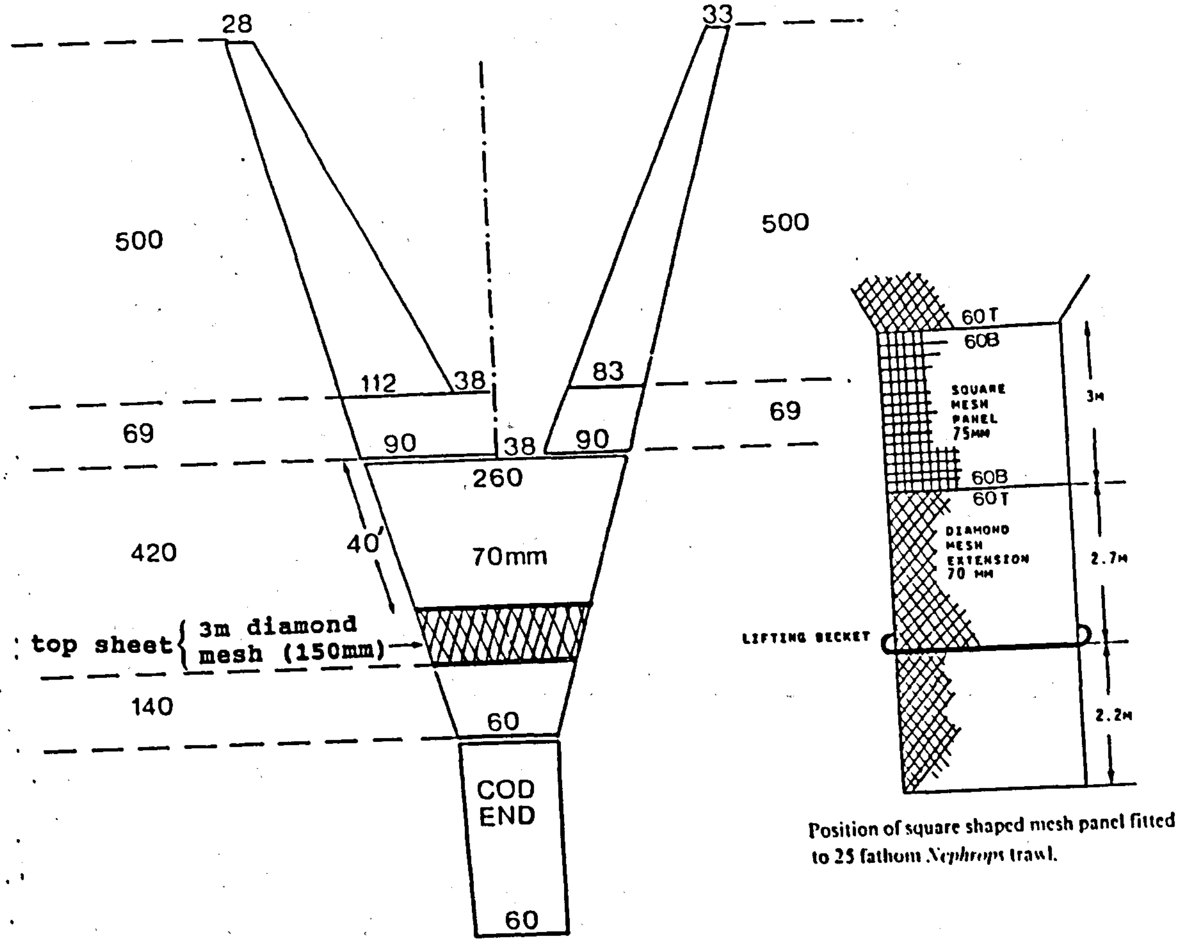


Figure 2

Map showing position of trawl stations

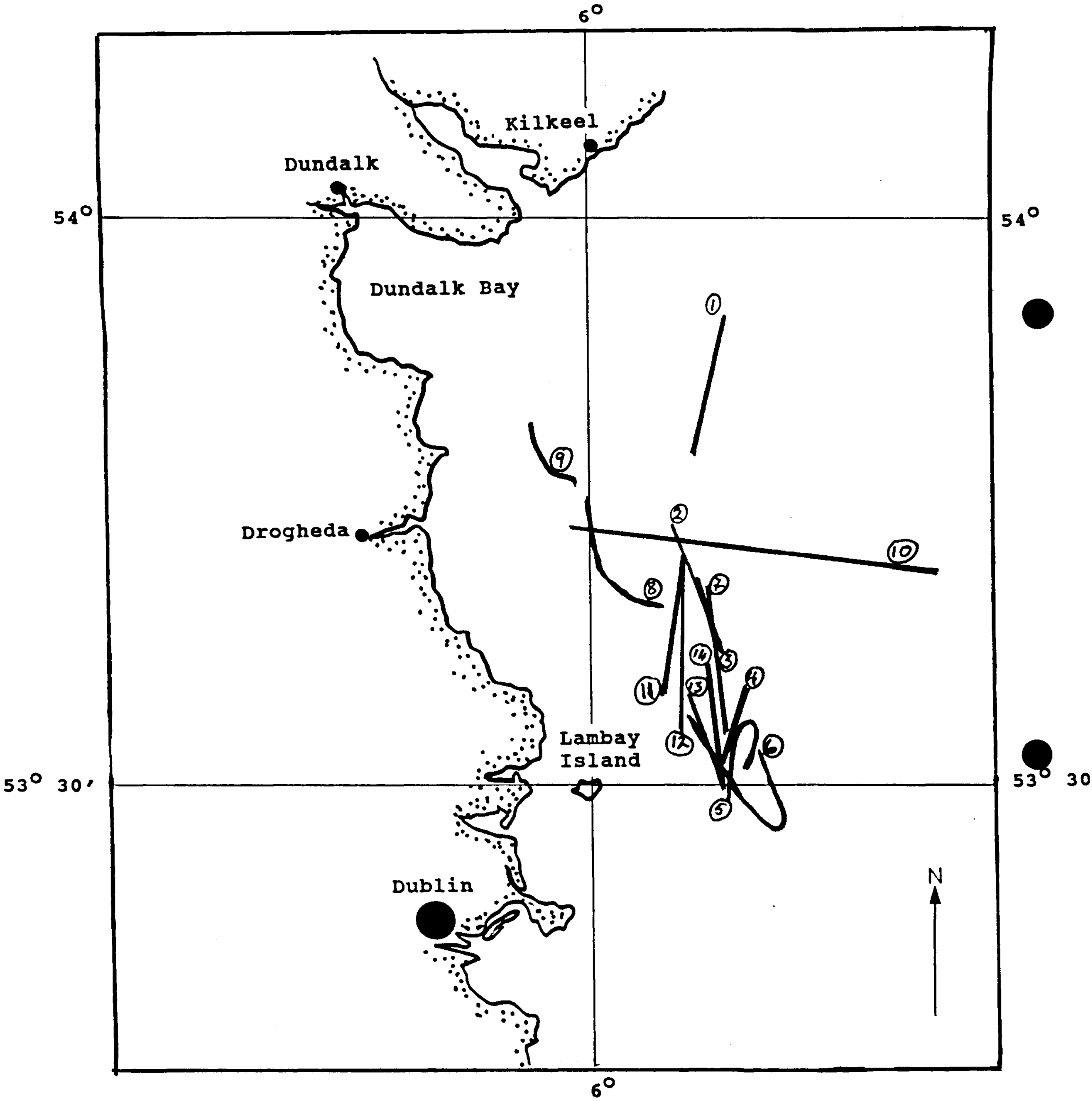


Figure 3

Length composition of whiting catch by the two main gear types expressed as percentage of catch at length (pooled data)

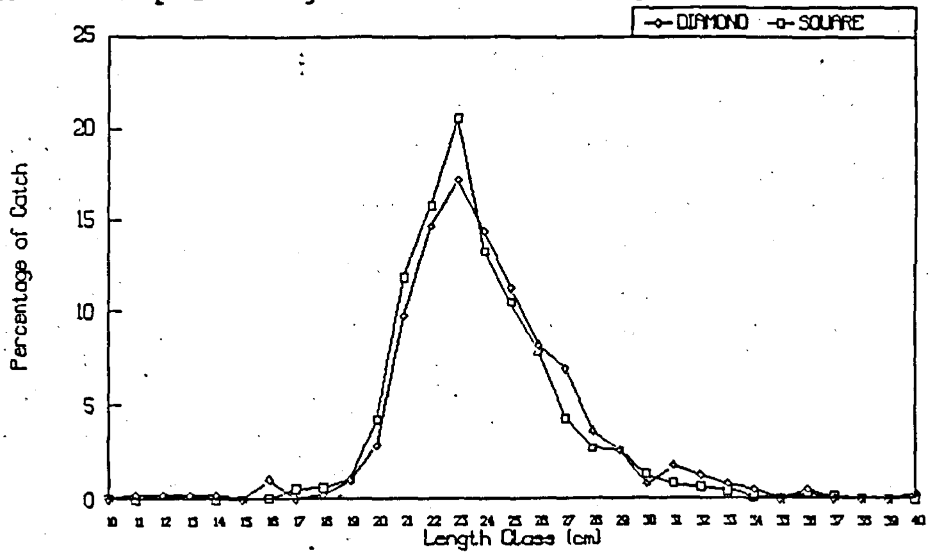


Figure 4

Length range of whiting in catch by tow

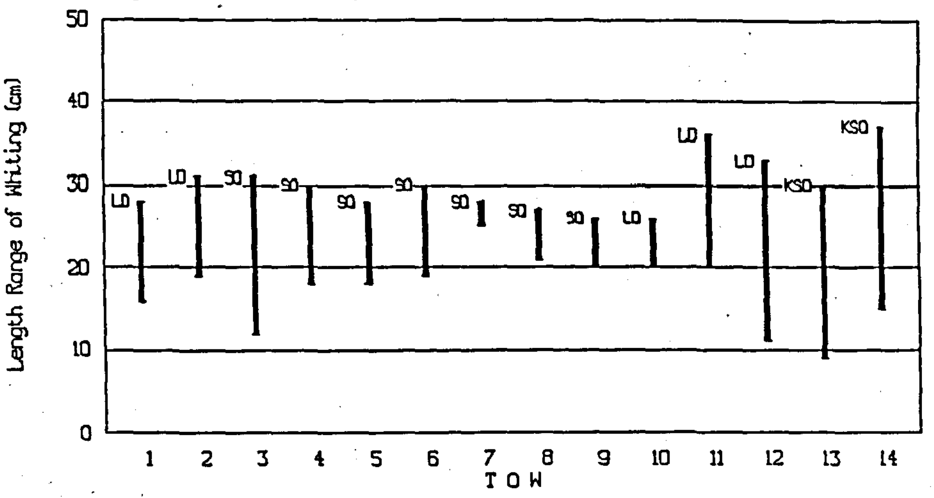
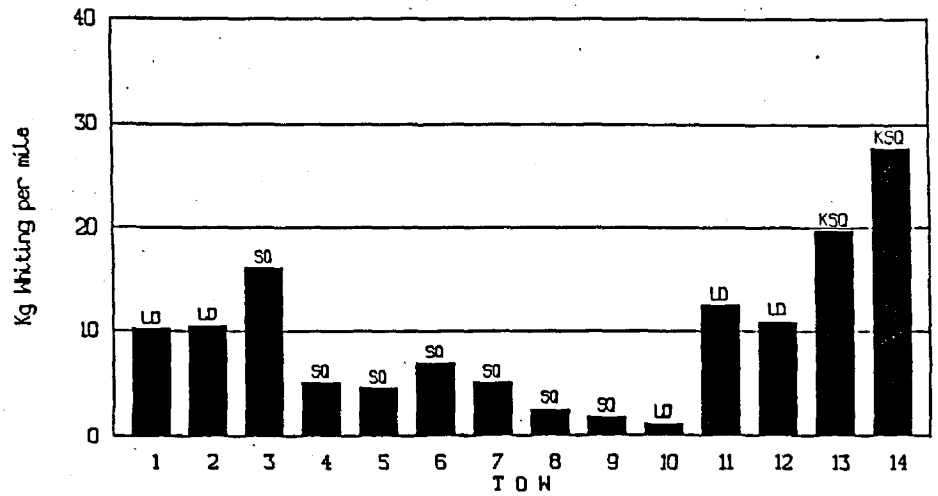


Figure 5

Whiting catch rate by tow



LD - Large Diamond
SQ - Knotless Square
KSQ - Knotted square

APPENDIX

Quantities of Each Species Caught by Tow (Kg)

(LD = large diamond S = square KS = knotted square)

TOW 1 dist	(LD) 8.2nm	TOW 2 dist	(LD) 6.6nm	TOW 3 dist	(S) 4.9nm	TOW 4 dist	(S) 3.6nm	TOW 5 dist	(S) 7.4nm	TOW 6 dist		TOW 7 dist	(S) 8.7nm
WHITING	82.68	NEPHROPS	87.00	NEPHROPS	100.50	NEPHROPS	46.50	HADDOCK	282.50	SCAD		SCAD	91.00
NEPHROPS	18.00	WHG	69.00	SCAD	96.00	LS.DOG	22.50	NEPHROPS	43.00	WHITING		WHITING	42.00
LSD	15.50	SCAD	26.00	WHITING	76.20	HAD	21.62	WHITING	32.03	HADDOCK		ANGLER	17.67
SCAD	7.95	SQUID	9.76	CRAB	5.38	WHITING	17.30	COD	13.51	NEPHROPS		NEPHROPS	12.00
CONGER	2.71	MACK	6.13	ELEDONE	3.21	SCAD	7.40	SCAD	13.00	COD		HADDOCK	5.41
SQUID	2.57	ELEDONE	1.88	SQUID	1.78	WITCH	4.28	LS.DOGS	11.00	D.SOLE		COD	4.05
MONK	2.49	COD	1.78	WITCH	1.74	D.SOLE	3.07	CANCER	5.18	CANCER		CANCER	1.87
HERR	1.73	WITCH	1.47	MAC	1.45	ELEDONE	2.31	MONK	4.67	LRD		SQUID	1.62
MAC	1.43	J.DORY	1.32	COD	.66	CRAB	1.38	WITCH	3.39	SQUID		D.SOLE	1.19
WITCH	.74	CANCER	1.32	G.GURN	.59	SQUID	1.35	D.SOLE	3.29	LS.DOG		G.GURNARD	.93
CANCER	.64	HERR	.92	LRD	.57	LRD	.65	MIX CRB	1.55	CONGER		LR.DAB	.92
HAKE	.52	MONK	.89	HERR	.56	G.GURN	.53	PLAICE	1.51	PLAICE		MACK	.75
LRD	.48	LRD	.78	PLAICE	.30	HAKE	.46	POGGE	1.16	DAB		WITCH	.46
DAB	.40	G.GURN	.68	DAB	.28	Q.SCAL	.42	Q.SCAL	.76	G.GURN		MIXED CRA	.38
ELEDONE	.39	HAKE	.41	HAKE	.28	P.COD	.33	SQUID	.73	MONK		HAKE	.33
GUG	.30	HADD	.31	J.DORY	.25	L.SOLE	.19	G.GURNARD	.62	POGGE		PLAICE	.27
N.POUT	.23	DAB	.22	MONK	.10	POGGE	.16	LRD	.39	MACK		DAB	.25
R.GURN	.20	LS.DOG	.15	NEPHROPS	.10	N.POUT	.06	P.COD	.35	ELEDONE		J.DORY	.23
J.DOR	.17	N.POUT	.13	POGGE	.10			ELEDONE	.32	J.DORY		ELEDONE	.15
BIB	.14	P.COD	.08	Q.SCAL	.08			N.POUT	.12	P.COD		Q.SCALLOP	.05
CDT	.06	POGGE	.02	TB-SOLE	.04			HERRING	.11	LING			
SPRAT	.03	4B-ROCK	.02	P.COD	.04			BIB	.09	DRAGON			
P.COD	.01			4B-ROCK	.01			DAB	.09	N.POUT			
				SEPIOLA	.01			H.RAY	.08	Q.SCAL			
				S.BLEN	.01					HERRING			
				CDT	.01					WITCH			
				SPRAT	.01					BIB			
										SPRAT			
TOTAL	151.91	TOTAL	139.38	TOTAL	290.24	TOTAL	130.49	TOTAL	419.44	TOTAL		TOTAL	181.52

TOW 8 dist	(S) 10.6nm	TOW 9 dist	(S) 7.4nm	TOW 10 dist	(LD) 10nm	TOW 11 dist	(LD) 7.1nm	TOW 12 dist	(LD) 8.2nm	TOW 13 dist	(KS) 6.6nm	TOW 14 dist	(KS) 5.6nm
WHITING	25.03	LS.DOGS	42.50	PLAICE	58.00	NEPHROPS	110.50	WHITING	89.47	WHITING	130.57	WHITING	155.56
PLAICE	22.00	PLAICE	28.00	DABS	52.00	WHITING	88.08	SCAD	78.50	HADDOCK	33.00	HADDOCK	26.01
DAB	11.38	WHITING	12.85	LS.DOGS	36.09	SCAD	27.22	NEPHROPS	64.00	SQUID	22.00	ANGLER	16.44
CANCER	4.68	DABS	12.07	POGGE	18.00	SQUID	11.40	CANCER	20.47	NEPHROPS	17.00	SCAD	16.00
SQUID	4.30	CANCER	3.68	WHITNG	10.47	CANCER	9.44	SQUID	12.50	CANCER	13.46	NEPHROPS	11.00
MONK	1.81	WITCH	1.94	CANCER	9.50	PLAICE	7.04	LR.DAB	3.48	SCAD	12.76	SQUID	9.96
WITCH	1.57	DRAG	1.26	ANGLER	3.92	DAB	5.71	WITCH	3.48	COD	11.33	COD	7.97
G.GURN	1.29	ANGLER	1.15	MAC	2.82	COD	5.51	COD	3.44	GR GURN	8.62	SW.CRAB	4.77
COD	.95	TURBOT	1.12	WITCH	2.58	WITCH	3.55	G.GURN	3.21	PLAICE	6.52	CANCER	4.41
J.DORY	.61	D.SOLE	1.03	SQUID	2.40	G.GURN	3.27	MACK	2.90	ANGLER	5.94	G.GURN	4.12
HAKE	.60	G.GURN	.96	G.GURN	2.37	LRD	2.62	ANGLER	2.39	LR.DAB	2.82	LR.DAB	3.39
SCAD	.46	THB.RAY	.76	HAKE	2.29	ELEDONE	2.13	DAB	2.12	WITCH	2.71	LS.DOG	3.22
D.SOLE	.43	MACK	.47	SW.CRABS	1.53	ANGLER	2.01	HAKE	1.69	SW.CRAB	2.47	WITCH	2.08
DRAGON	.29	SQUID	.46	D.SOLE	1.40	HERRING	1.65	ELEDONE	1.64	DAB	2.19	MACK	2.04
MACK	.27	J.DORY	.25	DRAG	1.26	J.DORY	1.56	PLAICE	.87	MACK	2.10	HERRING	[illegible]
NEPHROPS	.26	S.CRAB	.24	LRD	1.01	D.SOLE	1.40	J.DORY	.67	D.SOLE	1.94	DAB	[illegible]
LRD	.20	NEPHROPS	.17	COD	.80	MACKEREL	1.18	T.GURN	.65	LS.DOG	1.71	D.SOLE	1.44
ELEDONE	.12	LRD	.17	CYPRINA	.46	HAKE	1.16	N.POUT	.42	HAKE	1.17	ELEDONE	1.17
R.GURN	.11	HERRING	.17	L.SOLE	.32	HADDOCK	.08	LS.DOGS	.31	N.POUT	1.04	PLAICE	.97
LS.DOG	.02			J.DORY	.30	LMPSUCK	.65	HERRING	.25	J.DORY	.92	HAKE	.67
				TURBOT	.20	POGGE	.57	D.SOLE	.24	TUB GURN	.84	J.DORY	.45
				SCAD	.20	N.POUT	.45	POGGE	.22	POGGE	.64	N.POUT	.44
				HERRING	.17	DRAG	.13	Q.SCAL	.11	ELEDONE	.63	DRAG	.26
				NEPHROPS	.13	Q.SCAL	.11	SW.CRAB	.10	P.COD	.49	Q.SCAL	.24
				SPRAT	.00	P.COD	.08	P.COD	.05	DRAG	.37	P.COD	.22
								SEPIOLA	.01	HERRING	.34	POGGE	.20
										Q.SCAL	.10		
										HOM.RAY	.08		
TOTAL	76.37	TOTAL	109.25	TOTAL	208.20	TOTAL	287.50	TOTAL	293.16	TOTAL	283.77	TOTAL	276.45