

ICES 1992

Paper



C.M. 1992/G:77

ASPECTS OF THE EXPLOITATION OF THE NORTHERN HAKE Merluccius merluccius STOCK BY FLEETS BASED IN THE IRISH REPUBLIC

by

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ABSTRACT

The development of the hake fishery in the ICES divisions adjoining Ireland displays strong similarities to the fishery for megrim; Ireland's landings of hake rose from 100 t per year in 1979 to 2,000 t ten years later. Most hake comes from divisions VIIg-k.

The Communities Logbook of the Irish-Spanish joint venture fleet provides a short time series. CPUE by both demersal trawl and long line declined sharply between 1985 and 1991. The second quarter is the most productive of hake landings but otherwise there is no clear seasonal pattern.

Hake were sampled on a half yearly basis and the fish were aged on the otoliths with a success rate of 70%. Ages in the first half were adjusted to a birthdate of 1 January. Mean lengths at age were higher than those calculated by statistical methods (Normsep.) Length frequencies indicated two age groups in the discards.

Methods of capturing hake have altered over the past five years, gill nets have increased their share of the Irish catch and, in 1991, were a close second to demersal trawl. Age of recruitment to the landings is 3-4 years.

Discard hake was calculated at 25-163% by weight of landings per quarter in 1991, higher values coming from small meshed nets targetting Nephrops. Survivorship curves based on aged length frequencies of hake taken by whitefish boats provided F values of between 0.40 and 0.76. These results are high and together with sharply declining CPUE would seem to suggest the part of the stock in divisions VIIb-c and VIIg-k is more heavily fished than the stock in other parts of sub-area VII.

Development of the hake fishery

The exploitation of hake in the ICES divisions adjoining Ireland displays marked similarities with the development of the fishery for megrim (Fahy and Fannon, 1992). Divisions VIIg-k are the source of most hake (Fig 1). France, Spain, the U.K. and, latterly, Ireland, accounted for more than 99% of the landings taken in divisions VIa, VIIa and VIIg-k between 1960 and 1986, the last year for which finalized statistics are available. Of these four nations, France and Spain take the vast majority of the landings.

Prior to 1970 landings by Spain were reported to ICES only occasionally although, when a report was made in 1965, the tonnage was substantial. Between 1974 and 1976 Spain took as much hake as the other participants in the fishery combined and the total landings reached a peak in these years (Fig 2). The introduction of the European Common Fisheries Zone in 1977 appears to have curtailed Spanish landings.

Ireland rarely landed more than 100 t of hake annually until the formation of the first joint venture company, Eiranova, in Castletownbere in 1979, after which landings to this country increased rapidly to 1980 t in 1986 (Fig 2).

Throughout the 26 years reviewed, the relative contribution of hake by ICES divisions surrounding Ireland has remained fairly constant, VIIg-k producing most and Ireland's expanding hake fishery has become increasingly reliant on these.

Recent history of the fishery

Catch effort data by Spanish joint venture vessels as reported in the Communities' Logbook since 1985 provided a brief time series on this species (Table 1). Both joint venture demersal trawl and long line are fished in the vicinity of the 200 m depth contour, the latter having a wider range than the former (Fig 3; Fahy and Gleeson, in press). Several other indices of longer duration are available for sub-area VII and for other sub-areas. Whereas CPUE indices have been increasing in sub-area VIII, those in sub-areas IV, VI and VII have shown some decline. Over the brief time series almost all correlations of Irish joint venture data with time series for other nations proved non significant, the trawl and long line figures being in closest agreement (Table 2). The only significant correlation however ($P < 0.05$) was between the Irish joint venture trawl and a French trawl fleet in sub-area VIII and that was negative.

Seasonality

Table 1 indicates the importance of the second quarter in the catches of hake, particularly by long line. Information on the size composition of catches is however less seasonally distinguished. The most crude grading of landings is into Merluza, large hake, and Pescadilla, literally, small fish. The dividing weight for these is, roughly 1-1.5 kg. A

percentage breakdown of landings by the Eiranova joint venture fleet, confirms that longliners take larger fish than trawlers but otherwise there is no clear seasonal pattern in these figures (Table 3).

MATERIALS AND METHODS

Hake landings from ICES divisions other than VIIa have been sampled in varying intensity since 1986. Landings from Irish trawlers and gill-netters were sampled at Rossaveal (VIIf), Castletownbere (VIIj) and Dunmore East (VIIg) throughout the year. These collections were supplemented by samples from Dingle (VIIj) and Burtonport (VIa) in the summer months of some years. The landings of the joint venture (Spanish-Irish) fleet, longliners and demersal trawlers, were sampled at Castletownbere.

Length frequencies constituted the majority of samples but these were supplemented by quarterly aged hake for which weight data were also collected.

Discards were examined from Irish vessels targetting Nephrops and whitefish.

Hake were aged using the otoliths. Trial readings were carried out on sectioned material and on whole otoliths which had been immersed in a mixture of water (60%), glycerine (40%) and thymol (1 g per 4 litres) for at least 48 hours prior to interpretation. The latter technique was the one adopted.

There was insufficient material to provide quarterly age length keys but, because annulus formation occurs mid year (Hickling, 1930) it was necessary to treat the samples on a half yearly basis.

RESULTS

Growth

The interpretation of hake otoliths is controversial, there being a wide range of growth patterns, apparently dependent on date of spawning (Pineiro and Hunt, 1989). Ageing is best undertaken using length frequency material and by reference to aged individuals.

Length frequency distributions of discard hake were assembled by quarter (Fig 4). The distributions are not interpreted as a comprehensive sample of available hake; the smallest individuals were not sufficiently large to be retained by the commercial meshes in use.

The first quarter is dominated by hake in the length groups 9-24 cm. Otoliths from this group did not have an annulus and thus they were 0 group fish; however, going by the convention of a birth date of 1 January, they belong to the 1+ group. In the second quarter hake of 5-7 cm made their appearance;

those that were encountered had been fortuitously trapped among the legs of Nephrops and they were not representatively sampled so their absence from other samples should not be taken to indicate they were not present. This particularly applies to samples taken in the third quarter where the constraints of dealing with commercial material may have distorted the length distributions. Hake in the discards of the fourth quarter consisted of 0+ and 1+ age groups.

Otoliths were removed from 964 hake and 674 of these were confidently interpreted, a success rate of 70%, lower than Hickling's 80% (Hickling, 1930). The attribution of age to these fish (landings and discards) is set out in Table 4. In arranging the data in this table a decision on birthdate was essential. According to Hickling the formation of the translucent hyaline band takes place in August, corresponding with a period of recovery following spawning. This annual cycle is observed by immature fish also. Pineiro and Hunt (1989) maintained that, in the Southern hake stock, annulus formation is complete at the end of April. In the present investigations, the length of hake in a particular age group was lower in the second than in the first half of the year (Table 5), appearing to confirm Hickling's interpretation. In accordance with this interpretation, an extra year was added to all hake read in the first half of 1991.

The results of otolith interpretation reveal a wide range of length at age. Comparison with Hickling's results is shown (Fig 5), suggesting that a fairly similar size range occurs in both investigations. The mean lengths at age are however larger in this investigation than in Hickling's or in the majority of others available to date. This is also true of the lengths at age used by Mesnil and Guichet (1991), the most recent assessment available.

Weight:length relationships

The following weight at length relationships, resulting from investigations in 1991 have been used to convert length frequencies to weights:

Source	Comment	Slope	Intercept
Longline/gillnet	First half	2.8912425	-4.6742392
Longline/gillnet	Second half	2.8741801	-4.6388912
Trawl caught (Ir)	First half	2.8842046	-4.6390095
Trawl caught (Ir)	Second half	2.9367561	-4.7953558
Trawl caught (Sp)	First half	2.9310186	-4.6390095
Trawl caught (Sp)	Second half	2.9541702	-4.9784722
All landings	Annual	2.8720667	-4.5898619
Trawl discards	Annual	3.0776265	-5.3404613

All landings were gutted; discards were round.

Landings

Length frequency distributions of hake landings in 1991 are set out in Table 6 where they are arranged by gear, the length frequencies having been standardised to 1000 tonnes for comparability. Samples were collected randomly, and the apportionment of proportions taken among them, on this basis, in 1991 to landings mainly in VIIj is set out in Table 7. Of the four gear/fleet combinations in this table, Irish trawl takes the greatest share of the landings with gill nets a close second.

The evolution of the hake fishery since 1986 is set out in Table 8. The data contained are based on market intelligence and information obtained during sampling. They are not however absolutely reliable and should be regarded as indicators only.

Irish fleets have taken an increasing share of the landings from sub-area VII and, since 1989, a growing proportion of this has been captured by gill-net.

Year class strength

Several of the fishing methods used by the Irish and joint venture fleets are selective: notably gill nets and long lines taking larger fish. Insufficient sampling of joint venture trawls had been undertaken but annual length frequency distributions of hake taken by Irish trawl are available since 1986 (Table 9). These data are distributed among age groups using three age at length keys: the one devised in the present investigations, an ALK from the vessel Cirolana (Anon 1986) and the 1987 Normsep distribution obtained by Guichet (pers comm).

The results are set out in Table 10 where the first two keys provide fairly similar age distributions suggesting the age of recruitment is 3+ years. The ALK from Guichet suggests an age of recruitment of 4+.

There are few notable features in the age frequencies apart from a strong 3 year class in 1987 which remains prominent as a 4 year old one the next year.

Discards

In 1991 18 samples of discards were analyzed from fleets targetting Nephrops and whitefish in Divison VIIj. The weight of discarded hake was estimated as a percentage of the total landings associated with each sample. Two Co-operatives, one buying-in from a fleet fishing Nephrops and whitefish, the other from a whitefish fleet using a larger cod end mesh size, provided details of all purchases in 1991 from which the percentage of hake in the total sales was calculated. The proportion of hake discards to total landings per sample was then expressed as a percentage of the hake fraction in the total landings handled by the Co-operatives. This method of calculating the discard fraction (Table 11) is cumbersome

and, because the total purchases to a Co-operative will include an increasing quantity of gill net caught hake which have no discards, it is likely to be an underestimate of the discard fraction. It is notable that the Co-operative which has a prawn directed fishery has greater discards of juvenile hake than the other whose boats use a larger mesh size.

Survival

In order to compile a survivorship curve, annual length frequency distributions, raised to the relevant proportions of estimated catch (Table 12) were assembled with discard data from the trawl fisheries (Irish and joint venture) (Table 11). The discard figure applied to the Irish trawl fishery was averaged from the data in all quarters in Table 11 (*0.85) but, for the joint venture fleet, the average was taken from the data pertaining to the large meshed whitefish fleet (*0.27). Applying the ALK derived from these investigations to the totalled length frequencies, gives the percentage age distributions in Table 13.

The second survivorship table is derived from graded landings to the Co-operative buying from whitefish vessels (Table 14). The numbers per grade were derived from the average weight per grade as observed in 1990. Using the weight:length relationship for Irish trawl caught hake, the numbers of hake per grade were equally distributed among each 5cm length interval in that grade. Finally, the totalled numbers per 5 cm interval were disaggregated by the ALK derived from this work.

The total mortality coefficient (Z) was calculated from the slope of the log percentages ages 3-10 of the 1991 landings, most of the discards being in the earlier age groups. In the case of graded hake, ages 3-10 were also used, recruitment being regarded as complete at age 3.

The values of Z arising from these regressions are, in the case of catches in 1991, -0.96 ($r=-0.9972$ $P<0.001$) or, taking an M value of 0.2 into account, -0.76 , which is very high. Based on the graded landings, the value of Z is -0.5954 ($r=-0.9833$), or, taking an M value of 0.2 into account, -0.3954 , a value which is also high (Fig 6).

DISCUSSION

This assessment of the Northern hake stock, mainly in division VIIj, is heavily dependent on the ALK derived from material collected in the course of the investigations. While this is in agreement with keys for the Northern stock devised by similar means, notably those from the Cirolana (Anon 1986) and Hickling (1930), keys devised by statistical methods, particularly Normsep, tend to give lower mean lengths at age. Success at interpreting otoliths was in this case low (compared with Hickling) and it is possible that the more easily read were those of the faster growing fish whose annuli were more widely spaced and, hence, easier to interpret. Thus, it is accepted that there may have been a

bias towards greater lengths at age.

Calculated on this basis, the values of F are very high and would have been reduced had a slower growth rate been used. However, even if they were reduced by half, the F values would still be high compared with those used by Mesnil and Guichet (1991).

That the hake stock exploited by vessels based in Ireland has declined over the past six years there can be little doubt. Its brief history does not permit the nature of this decline, whether it be short or long term, to be identified. Attempts to correlate the CPUE index with others for the same period concluded that while the fraction of the stock fished by Irish vessels appeared to be reducing, the Southern hake stock was increasing. The Northern hake stock is however an administrative concept which may comprise sub-divisions.

Indicators suggest that that part of the Northern hake stock fished by Irish based vessels is apparently under some pressure. Interest in it, not least by Irish vessels, has been sharply increasing. Not merely has the share of the landings to Irish vessels increased in the recent past, but the methods by which the Irish catch is taken have continued to diversify, the latest development being a directed gill net fishery. While this improves the exploitation pattern its significance for the spawning biomass on the Western shelf remains to be evaluated.

REFERENCES

Anon (1986) Report of the ad hoc study group on hake I.C.E.S. C.M. 1986/G93.

_____ (1991) Report of the working group on the assessment of the stocks of hake I.C.E.S. C.M. 1991/Assess:20

Fahy, E and E Fannon (1991) The exploitation of megrim (Lepidorhombus whiffiagonis) by the Irish demersal fleet. Irish Fisheries Investigations Series B, No 38; 18pp.

_____ and P Gleeson (in press) A second assessment of the stock of megrim Lepidorhombus whiffiagonis in divisions VIIb,c,j and k with particular reference to the landings of joint venture vessels.

Hickling, C F (1930) The natural history of the hake. Part IV Age determination and the growth rate. London H.M.S.O.

Mesnil, B and R Guichet (1991) A tentative age-based assessment of the Northern stock of European hake I.C.E.S. C.M. 1991/G:68.

Pineiro, C and J J Hunt (1989) Comparative study on growth of European hake (Merluccius merluccius) from southern stock using whole and sectioned otoliths and length frequency distributions. I.C.E.S. C.M. 1989/G:37

Table 1. Catch per effort of hake by the Spanish joint venture fleet.

Year	Quarter	T R R W L		L O N G L I N E	
		CPUE	CPUE	CPUE	CPUE
		monthly	annual	monthly	annual
		(kg/hr)	(kg/hr)	(kg/hr)	(kg/hr)

1985	1				
	2	82.67			
	3	23.57			
	4	16.01	30.05		
1986	1	24.13		36.56	
	2	56.10		84.62	
	3	22.42		60.31	
	4	24.12	35.41	22.92	62.57
1987	1	77.00		46.38	
	2	33.20		76.00	
	3	38.76		37.78	
	4	41.22	47.31	31.37	52.17
1988	1	48.41		62.21	
	2	56.10		84.62	
	3	19.29		70.01	
	4	19.07	42.33	40.20	76.26
1989	1	30.41		25.75	
	2	21.55		113.67	
	3	15.44		29.53	
	4	9.32	16.84	11.05	52.77
1990	1	7.23			
	2	12.77			
	3	12.09		30.39	
	4	5.00	10.69	21.84	26.66
1991	1	7.87		12.34	
	2	12.08		32.71	
	3	12.35		17.26	
	4	10.54	10.86	36.21	23.21

Table 2 Correlation of CPUE indices for hake in sub-areas IV, VI, VII and VIII with data from the Irish joint venture fleet, 1985-1990.

	r	P
1. Irish joint venture OTB		
2. Irish joint venture LL	.79	n.s.
3. Spanish OTB	.65	n.s.
4. Spanish LL	.2	n.s.
5. French, Lorient, OTB, IV and VI	.27	n.s.
6. Spanish, sub-area VIII	.34	n.s.
7. French, OTB, Lesconil, VIII	-.83	<0.05

Table 3 Percentage division of hake landings by joint venture vessels into Merluza (large hake) and Pescadilla (little fish).

The percentage given is of Merluza: n.a. = not available.

Year	Qtr 1	Qtr 2	Qtr 3	Qtr 4

Captures by long line				
1989	76.9	81.5	95.4	73.9
1988	100	61.9	70.7	88.4
1987	49.2	77	52.6	45.2
Captures by demersal trawl				
1989	2.8	6.1	n.a.	n.a.
1988	7.3	7.3	10	n.a.
1987	29.2	22.6	18.3	12.9

Table 4 Length at age data for hake sampled in 1991

Length interval cm	1	2	3	4	5	6	7	8	9	10	TOTALS
5											
10		5									5
15	4	24									28
20	27	29	4								60
25	32	37	8	1							78
30	19	53	30	8							110
35	9	29	37	9							84
40		19	30	11	3	1					64
45		6	16	13	6	2					43
50		5	12	15	7	3					42
55		1	16	28	13	1					59
60			9	12	5	2					28
65			1	6	11	4					25
70			3	6	8	5	2				24
75				2	1	3	2				8
80					2	1	1				4
85					1	1		2			4
90						2	1				3
95								1	1		2
100									1	1	2
105										1	1
TOTALS	91	202	169	111	57	25	6	3	2	2	44

AVE

LENGTHS 24.5 28.5 40.5 50.9 58.8 65.4 76.0 88.3 100 105

Table 5 Length at age of hake sampled in the landings during 1991. Growth in the first half is interpreted as age=annuli+1.

Age group	S A M P L E S	
	Landings first half	Landings second half
Length, cm		
1		32.4
2	38.6	35.9
3	47.1	43.7
4	59.6	47
5	68.3	62.4
6	74.4	72.4
7	79.6	78.1
8		88.9
9		102.5
10	102.8	
11	108.6	

Table 6. Length frequency distributions of hake captured by gill net, Irish trawl, longline and Spanish trawl in the first and second halves of 1991.

Numbers are in thousands per 1000 tonnes.

FIRST HALF					SECOND HALF				
Length cm	Gill net	Irish trawl	Long line	Spanish trawl	Gill net	Irish trawl	Long line	Spanish trawl	
20		1		1		1		21	
25		16		53		18		456	
30		91		343		195		779	
35	1	155	8	327		207		420	
40	13	130	24	275		145	16	180	
45	6	80	24	193	2	83	6	195	
50	11	82	73	101	15	90	61	123	
55	24	84	73	70	15	92	99	108	
60	103	88	81	75	48	84	163	41	
65	94	66	89	63	57	76	125	51	
70	123	63	89	30	86	33	80	21	
75	64	30	65	9	73	18	45	5	
80	33	21	16	7	58	20	29	10	
85	6	10	8	4	38	11			
90	9	7	8	1	15	2			
95	1	4	0	2	6	2			
100	1	1	9	4	2	2			
105		9		1					
110		1							
TOTAL	490	930	569	1562	415	1079	624	2410	
Ave Wt (kg)	2.04	1.08	1.77	.64	2.40	.93	1.60	.41	

Table 7 Details of hake sampled in 1991

	Irish trawl	Spanish trawl	Long line	Gill net
Numbers				
Half 1	1661	1332	70	343
Half 2	470	1322	195	576
Weights				
Half 1	1.08	.64	1.77	2.04
Half 2	.93	.41	1.6	2.4
Sampled weights (kg)				
Half 1	1793.88	852.48	123.90	697.72
Half 2	437.10	542.02	312.00	1382.40
Totals	2230.98	1394.50	435.90	2082.12
Percentage weights				
	36.31	22.70	7.10	33.89

Table 8. Method/fleet of capture of hake landed to Ireland from sub-area VII, expressed as a percentage, 1986 - 1991.

Method of capture	1986	1987	1988	1989	1990	1991
GN				8	28	34
LL	22	11	4	4	5	7
Irish trawl	34	31	55	66	48	36
Spanish trawl	44	58	41	13	15	23
other (Danish seine)				8	4	

Table 2 Length frequency distribution of hake landings from Irish trawl to Ireland, between 1986 and 1991 inclusive.

Landings come mainly from Divisions VIIb and VII k and VII q and the following length frequencies are based on landed weights of 100 t (above) with percentage length frequencies (below).

Length, cm	1986	1987	1988	1989	1990	1991
20		13	20	580	72	100
25	2846	1821	643	6540	1514	1690
30	13127	23745	2851	21110	8961	13600
35	9244	28316	4991	12130	17459	17970
40	5290	16384	8156	10150	23423	13910
45	4674	10036	13556	6410	18719	8260
50	4918	6434	14216	5840	12900	8700
55	7105	3952	12190	5590	9040	8900
60	6687	5417	8942	7390	8690	8830
65	8074	4586	5408	7430	7016	7140
70	7646	4346	4099	5940	3987	5180
75	4768	2641	2071	2760	2152	2570
80	1893	2527	1745	1060	1306	2060
85	600	1277	1111	1270	718	1050
90	199	266	717	1310	383	510
95	151	240	391	870	176	340
100	19		86	260	90	100
105			144	200	16	0
110			80		48	30
115			40		16	
120			23			
Totals	77240	112001	81370	96840	116676	100940
Ave lts (cm)	53.02	46.05	55.26	49.14	49.57	47.84
Length, cm						
20	.00	.01	.02	.60	.06	.10
25	3.68	1.63	.79	6.75	1.30	1.67
30	17.00	21.20	3.50	21.90	7.69	13.47
35	11.97	25.26	6.13	12.53	14.96	17.80
40	6.85	14.63	10.02	10.48	20.08	13.78
45	6.05	8.96	16.66	6.62	16.04	8.19
50	6.37	5.74	17.47	5.03	11.06	8.62
55	9.20	3.53	14.99	5.77	7.75	8.92
60	8.66	4.84	10.87	7.63	7.45	8.75
65	10.45	4.09	6.65	7.67	6.01	7.07
70	9.90	3.88	5.04	6.13	3.42	5.13
75	6.17	2.36	2.55	2.85	1.84	2.55
80	2.45	2.26	2.14	1.09	1.12	2.04
85	.73	1.14	1.37	1.31	.62	1.04
90	.26	.24	.88	1.35	.33	.51
95	.20	.21	.47	.90	.15	.34
100	.02	.00	.11	.27	.07	.10
105	.00	.00	.18	.21	.01	.00
110	.00	.00	.10	.00	.04	.03
115	.00	.00	.05	.00	.01	.00
120	.00	.00	.03	.00	.00	.00

Table 10 Age frequency distributions of hake
in the Irish trawl catches, 1986 - 1991, from the

Key arising from this work

Age groups	1986	1987	1988	1989	1990	1991	Averages
1	5.66	6.97	1.58	8.05	3.46	4.92	5.11
2	17.60	25.67	11.66	22.81	18.82	19.58	19.36
3	25.85	32.92	28.94	27.55	33.62	30.86	29.96
4	23.14	18.23	29.79	19.62	24.41	22.85	23.01
5	15.61	9.03	17.29	11.44	12.52	12.95	13.14
6	8.46	4.84	7.24	6.55	5.44	6.11	6.44
7	3.07	1.56	1.89	1.95	1.14	1.74	1.89
8	.49	.68	.92	1.10	.38	.69	.71
9	.11	.11	.29	.58	.11	.22	.24
10	.01	.00	.41	.34	.10	.08	.16

Cirolana key

Age groups	1986	1987	1988	1989	1990	1991	Averages
1	.00	.00	.00	.00	.00	.00	.00
2	11.57	15.75	3.63	15.64	10.92	8.00	10.92
3	10.21	46.33	29.85	36.96	38.97	42.77	37.52
4	22.10	18.57	31.76	20.00	23.03	25.96	23.57
5	27.98	14.12	26.27	19.35	20.06	18.11	20.98
6	4.64	2.37	3.65	3.03	3.31	2.58	3.26
7	2.67	2.07	3.38	3.39	2.73	2.00	2.71
8	.61	.67	.77	.72	.68	.36	.64
9	.10	.11	.23	.45	.17	.08	.19
10	.02	.00	.46	.48	.13	.14	.21

Alk from Guichet for the year 1987

Age groups	1986	1987	1988	1989	1990	1991	Averages
1	1.29	.68	.29	2.76	.51	.71	1.04
2	13.33	15.70	3.13	18.27	6.73	10.59	11.29
3	19.61	35.13	9.84	23.32	22.28	25.22	22.57
4	23.67	28.96	44.76	23.92	43.76	30.31	32.55
plus group	42.10	19.53	41.98	31.83	26.72	33.17	32.56

Table 11 The estimation of hake discards at two Co-operatives in 1991. Co-op A: vessels target Nephrops and whitefish; Co-op B vessels target whitefish.

Hake as a percentage of total landings (from Co-op statistics).

Location	QUARTERS			
	Qtr 1	Qtr 2	Qtr 3	Qtr 4
Co-op A	3	10	7	4
Co-op B	5	16	9	5

Hake discards as a percentage of total landings (from samples)

Co-op A	Mean	4.44	6.43	5.72	6.52
	Range	1.92-7.46		3.04-8.87	1.08-17.07
	No samples	3	1	5	3
Co-op B	Mean		4.02	2.74	
	Range		0.79-9.36		
	No samples		5	1	

Ratio of hake discarded to hake landed

Unionhall	1.48	0.64	0.92	1.63
Castletownbere		0.25	0.30	

Table 12. Length frequencies of hake landings and discards in 1991, based on material collected in division VIIj.

Min length cm	Irish trawl	Spanish trawl	Trawl discards	Longline	Gillnet	Totals
15			1779.40			1779.40
20	.72	1.18	1657.53			1659.43
25	11.09	31.76	987.21			1030.06
30	67.54	103.09	219.38		.34	410.35
35	98.87	80.58	36.56	.21		216.22
40	68.25	61.38		1.72		131.35
45	41.00	45.26		1.07	1.36	88.69
50	30.63	24.88		5.37	1.7	62.58
55	28.21	16.83		3.87	3.4	52.31
60	23.88	14.93		5.16	11.91	55.88
65	20.74	13.98		6.45	23.48	64.65
70	17.85	6.64		7.31	24.84	56.64
75	10.13	2.13		4.73	22.11	39.10
80	5.79	1.66		2.36	21.77	31.58
85	2.41	.71		.21	12.59	15.92
90	1.21	.24		.21	5.44	7.10
95	1.45	.47			2.38	4.30
100	.48	.71		.21	.34	1.74
105	.00	.24				.24
110	.24					.24

Table 13 Percentage age frequencies of hake
based on landings and discard data in 1991 and
on occasional graded landings in a whitefish
Co-operative between Qtr1 1988 and Qtr4 1991.

Age group	1991 Landings and discards	Graded landings 1988- 1991
1	26.69	6.86
2	55.19	16.55
3	10.07	24.65
4	4.07	24.08
5	2.09	14.61
6	1.2	7.83
7	.43	2.39
8	.19	1.47
9	.05	.93
10	.02	.63
Totals	99.99	100

Table 14 Graded hake landings, mainly from division VIII.

Grades:	Number	Limits	Ave. weight (kg)
1		<0.5	.4
2		>0.5	.6
3		1-2	1.5
4		2-3	2.5
5		3-4	3.5
6		4-6	5
7		>6	6.5

Weights, kg, per grade

GRADE	Q1'88	Q2'88	Q3'88	Q4'88	Q2'89	Q3'89	Q4'89	Q1'91	Q2'91	Q3'91	Q4'91	Totals
kg												
1	888	12034	3316	747	7027	4142	808	675	1260	1620	2250	34767
2	3227	15376	4173	990	17255	4107	1320	2250	2115	1800	1170	53783
3	1630	32083	8159	663	31706	18809	3449	855	765	810	495	99424
4	907	28306	5276	742	15426	9426	5292	450	225	225	360	66625
5	534	10102	1822	977	11090	3669	1753	225	90	90	135	30387
6	453	10398	1791	3298	10738	5025	9368	0	0	0	540	41601
7					1154	5656	8577	0	0	0	315	15702
Totals	7639	108297	24537	7307	94396	50834	30557	4455	4455	4545	5265	342289

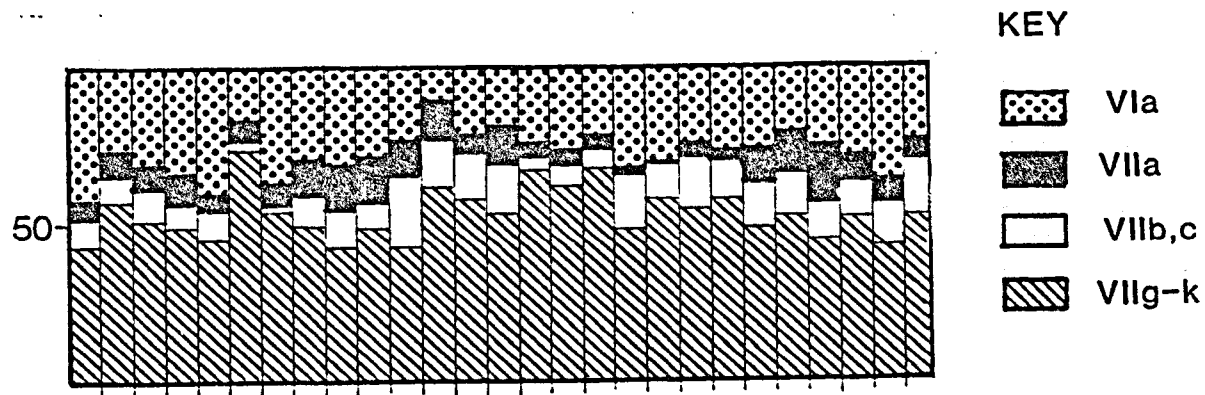
Numbers per grade

GRADE	Q1'88	Q2'88	Q3'88	Q4'88	Q2'89	Q3'89	Q4'89	Q1'91	Q2'91	Q3'91	Q4'91	Totals
1	2220	30085	8290	1869	17568	10355	2020	1688	3150	4050	5625	86918
2	5378	25627	6955	1650	28752	6845	2200	3750	3525	3000	1950	89639
3	1087	21389	5439	442	21137	12539	2299	570	510	540	330	36293
4	363	11322	2110	297	6170	3770	2113	180	90	90	144	26650
5	153	2896	521	251	3169	1048	501	64	26	26	39	8682
6	91	2080	358	658	2148	1005	1874	0	0	0	168	8320
7	0	0	0	0	178	870	1320	0	0	0	48	2416
Totals	9291	93399	23674	5164	79127	36433	12326	6252	7301	7706	8244	289906

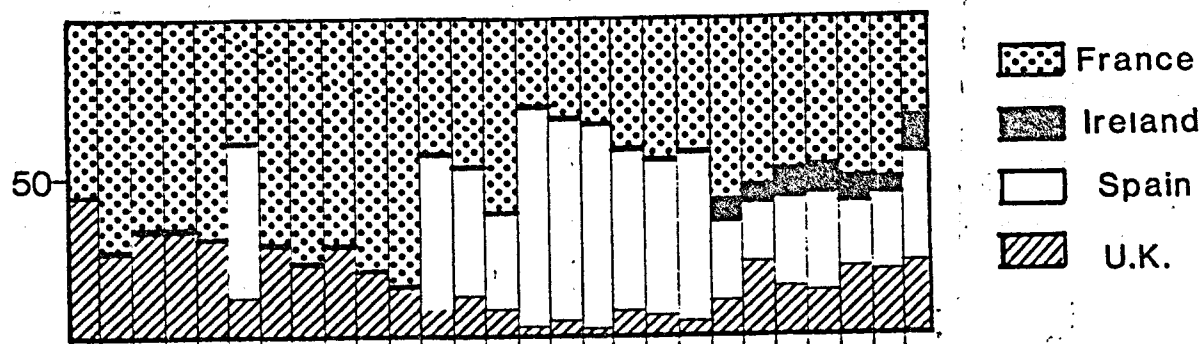
Ave wt (kg)	.82	1.16	1.94	1.41	1.19	1.40	2.48	.71	.61	.57	.64	1.18
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Min length cm	Q1'88	Q2'88	Q3'88	Q4'88	Q2'89	Q3'89	Q4'89	Q1'91	Q2'91	Q3'91	Q4'91	Totals
20	144	6017	1658	374	3514	2071	404	338	630	810	1125	17384
25	444	6017	1658	374	3514	2071	404	338	630	810	1125	17384
30	444	6017	1658	374	3514	2071	404	338	630	810	1125	17384
35	444	6017	1658	374	3514	2071	404	338	630	810	1125	17384
40	444	6017	1658	374	3514	2071	404	338	630	810	1125	17384
45	2699	12913	3478	925	14377	3423	1100	1975	1763	1500	975	44819
50	2699	12913	3478	925	14377	3423	1100	1975	1763	1500	975	44819
55	362	7130	1813	147	7046	4180	766	190	170	130	110	22094
60	362	7130	1813	147	7046	4180	766	190	170	130	110	22094
65	362	7130	1813	147	7046	4180	766	190	170	130	110	22094
70	181	5661	1055	148	3085	1395	1056	90	45	45	72	13325
75	181	5661	1055	148	3085	1395	1056	90	45	45	72	13325
80	76	1443	260	125	1594	524	250	32	13	13	19	4341
85	76	1443	260	125	1594	524	250	32	13	13	19	4341
90	45	1040	179	329	1074	503	937	0	0	0	54	1160
95	45	1040	179	329	1074	503	937	0	0	0	54	1160
100	0	0	0	0	39	175	660	0	0	0	24	1208
105	0	0	0	0	39	175	660	0	0	0	24	1208

Source of all hake by I.C.E.S. division



Landings by nation



Source of Ireland's hake by selected I.C.E.S. division

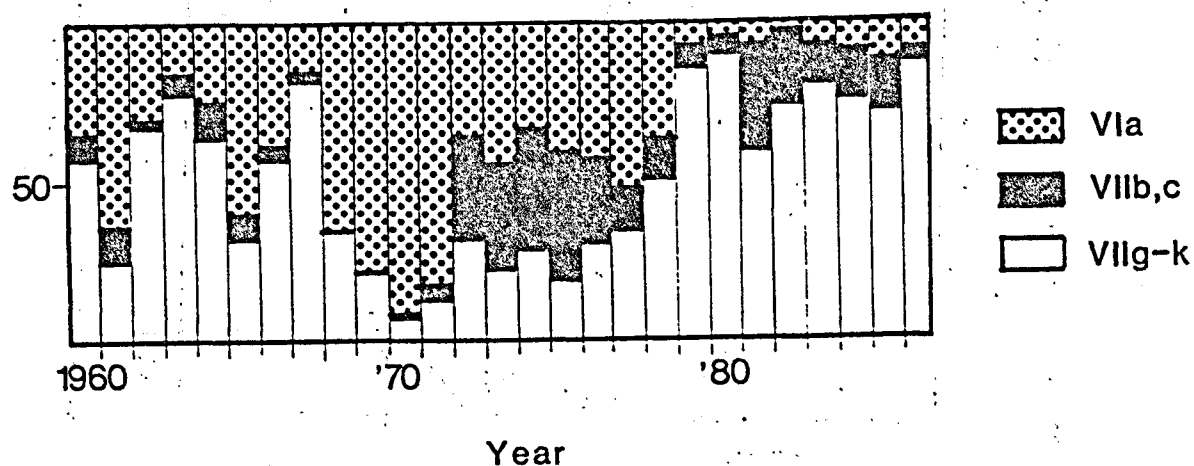


Fig 1: Hake from I.C.E.S. divisions adjoining Ireland between 1960 and 1986 inclusive.

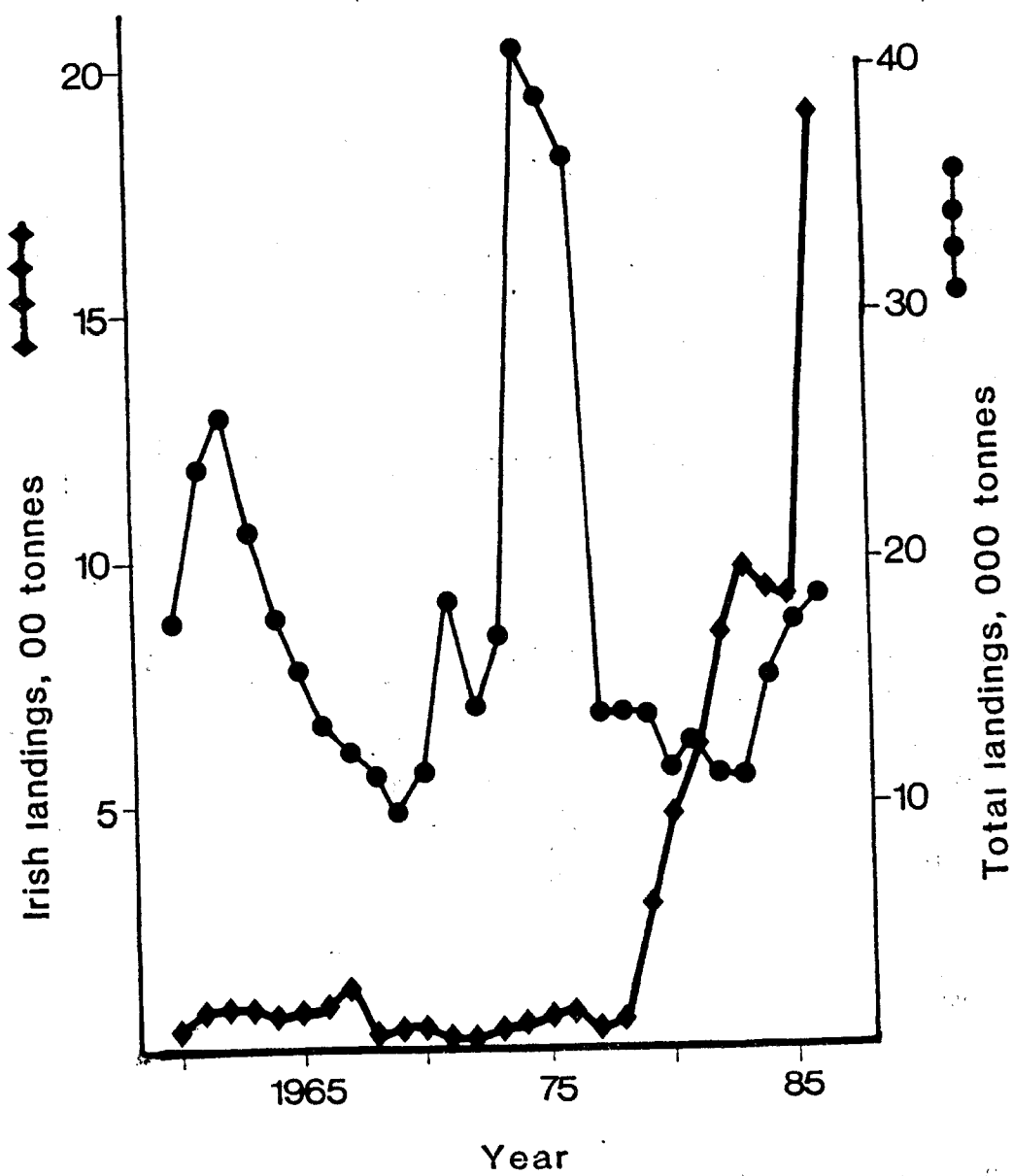


Fig 2: Landings of hake by Ireland and all nations from 1960 to 1986.

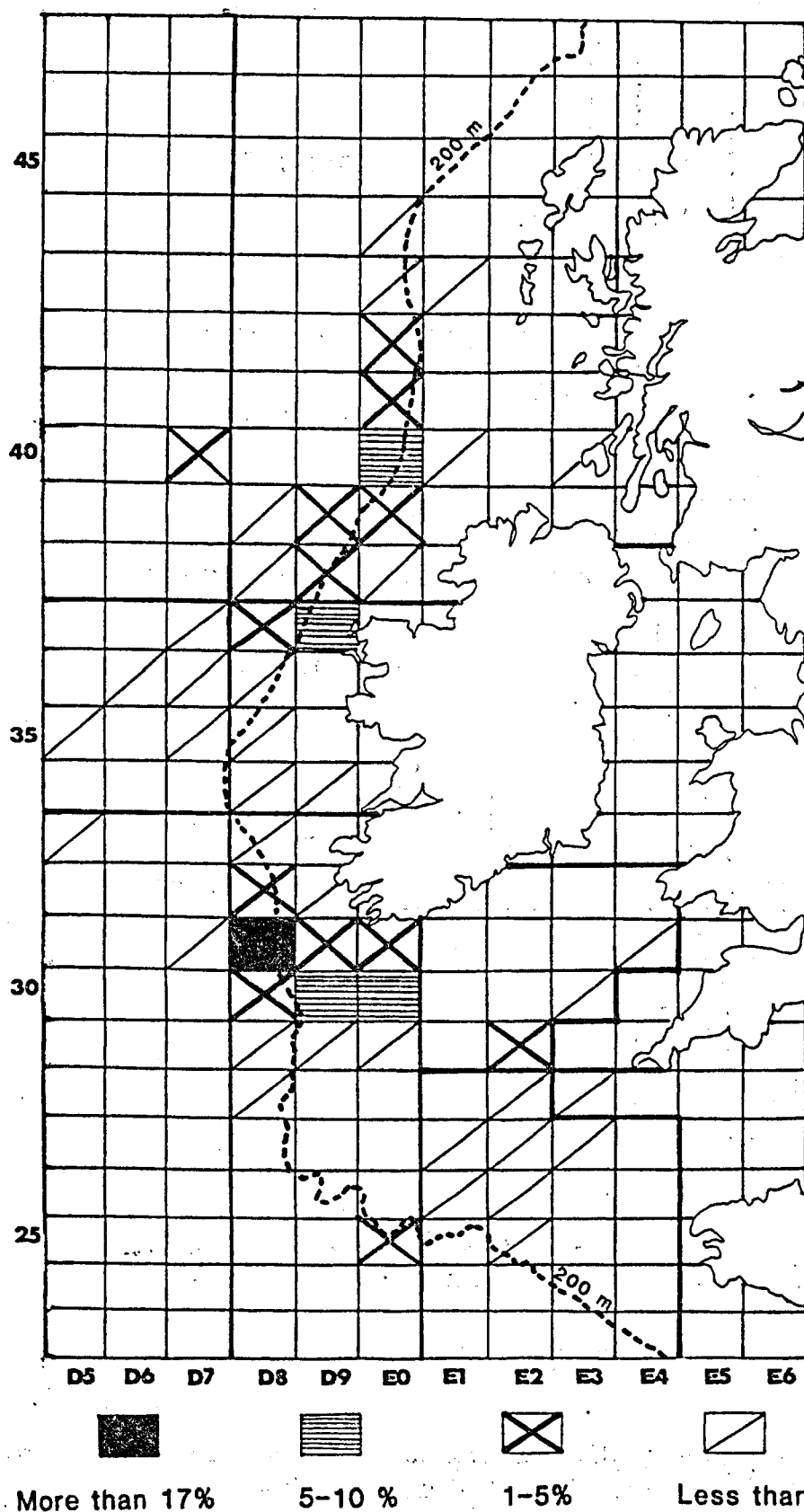


Fig 3: Distribution of effort by longliners of the joint venture fleet targetting hake between 1985 and 1991. The percentages are based on an analysis of 24,795 hours.

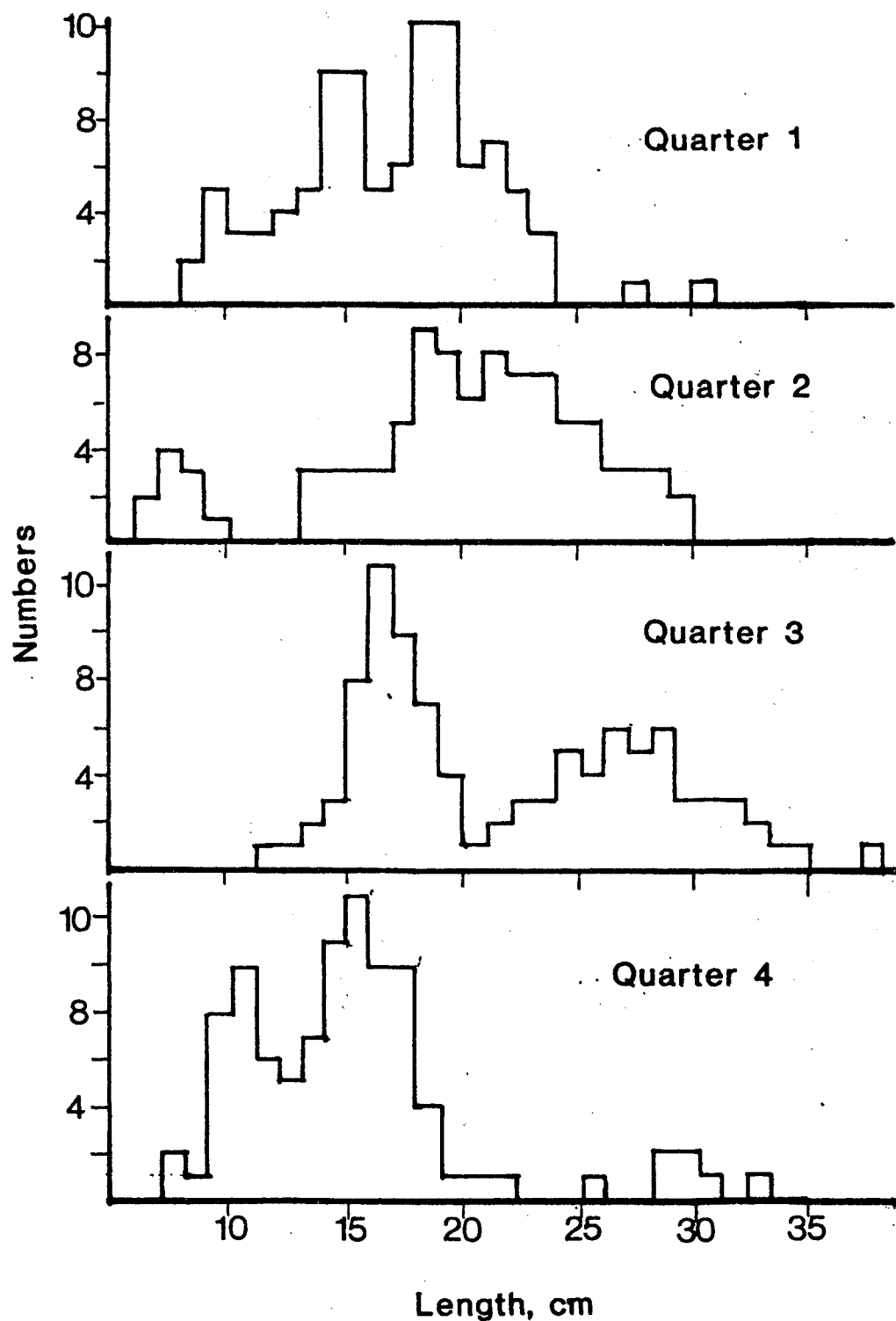


Fig 4: Length frequency distributions of juvenile hake from trawls fishing whitefish and Nephrops in 1991.

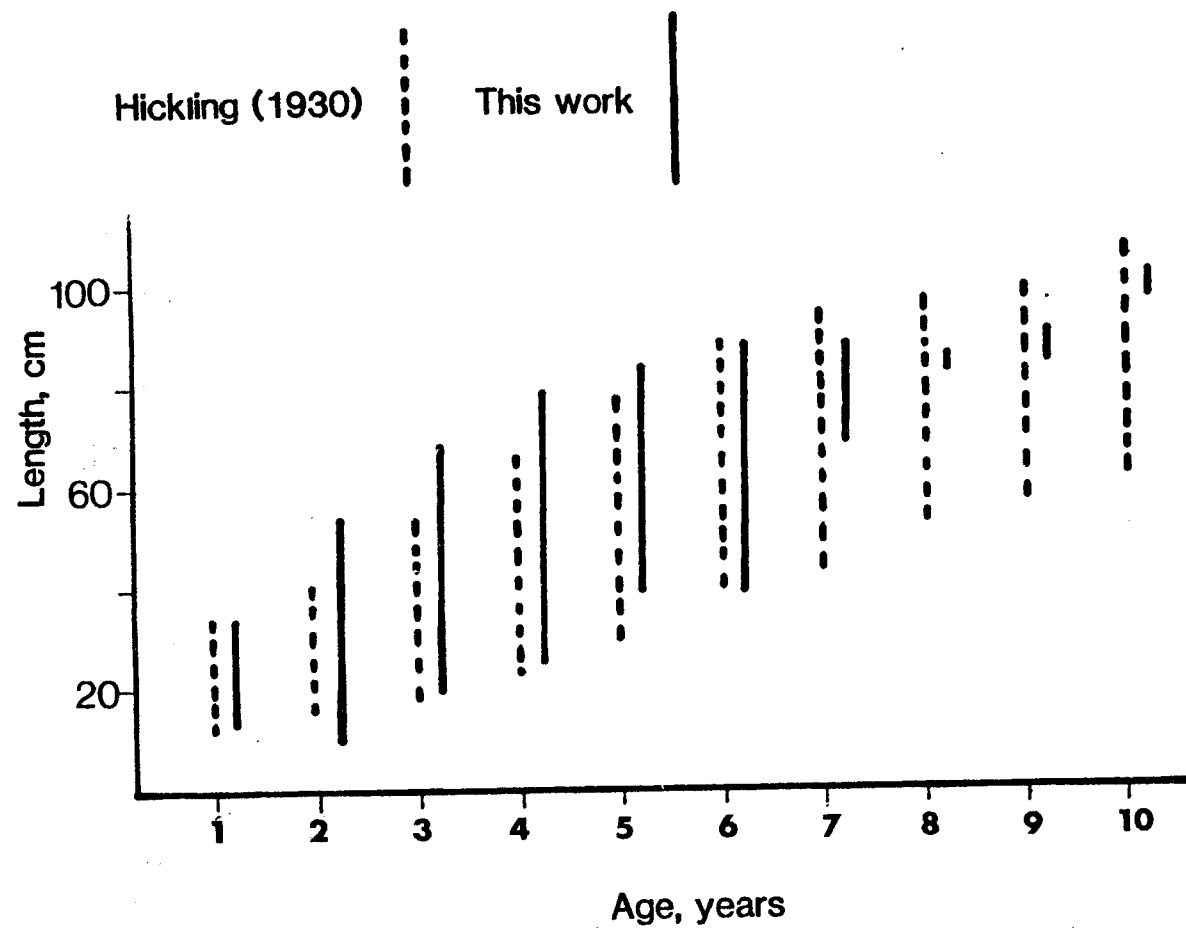


Fig 5: The range of length at age of hake interpreted in this work and by Hickling (1930).

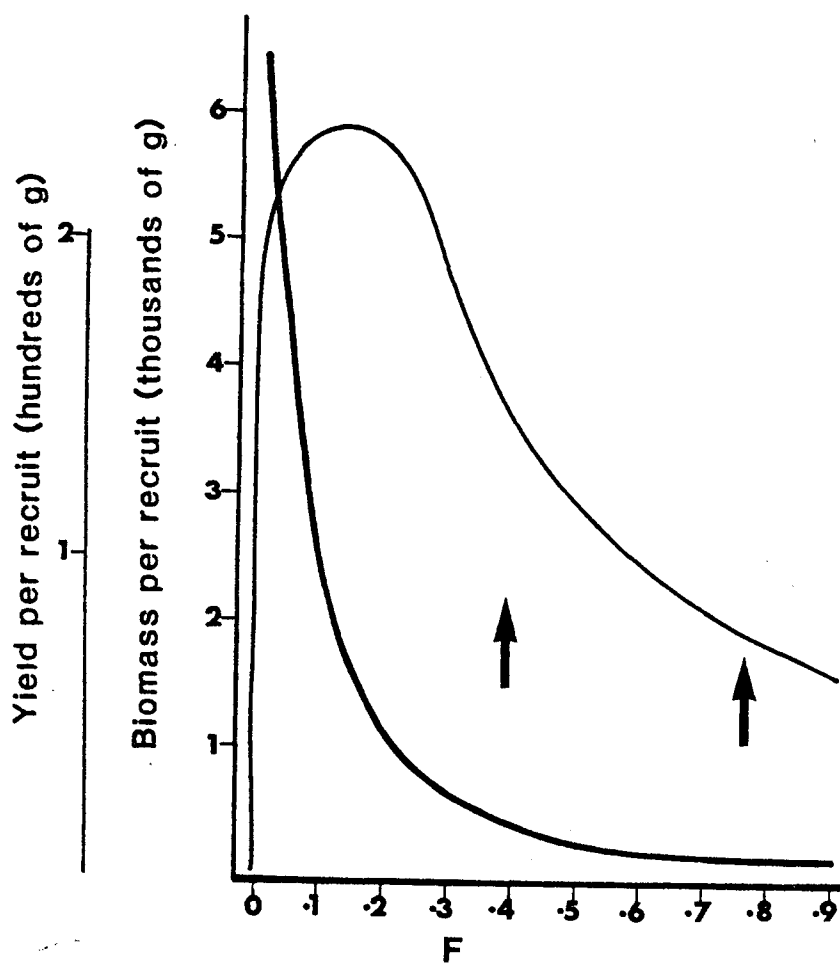


Fig 6: Yield and biomass per recruit curves for hake based on growth parameters in Anon 1991. Estimates of current fishing mortality (F) are arrowed. (Parameters for these calculations are: $W_{inf}=8202$; $k=0.09$; $t_0=-0.07$; $M=0.2$; $t_c=1$; $t_r=3$).