Final Report

Programme 8: Hake selectivity

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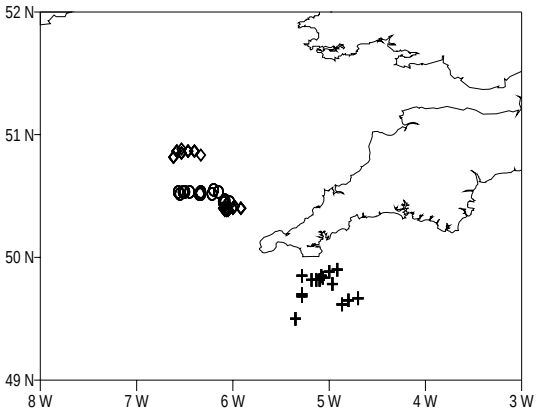
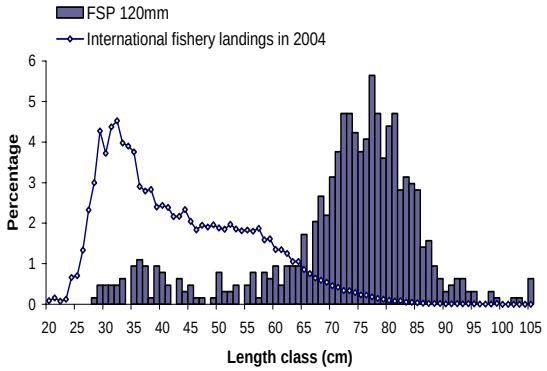
Summary

1) FSP Programme 8 demonstrated the selectivity characteristics of 120mm mesh gill nets used by UK hake fishermen off the south west coast of England. The experiment was carried out by comparing the catches in nets of mesh size 80, 100, 120 and 140mm deployed simultaneously at two fishing grounds. Additional 120mm nets were shot to obtain further data on size composition of hake. The work was carried out in October and November 2005, using the vessel *Carol H*.

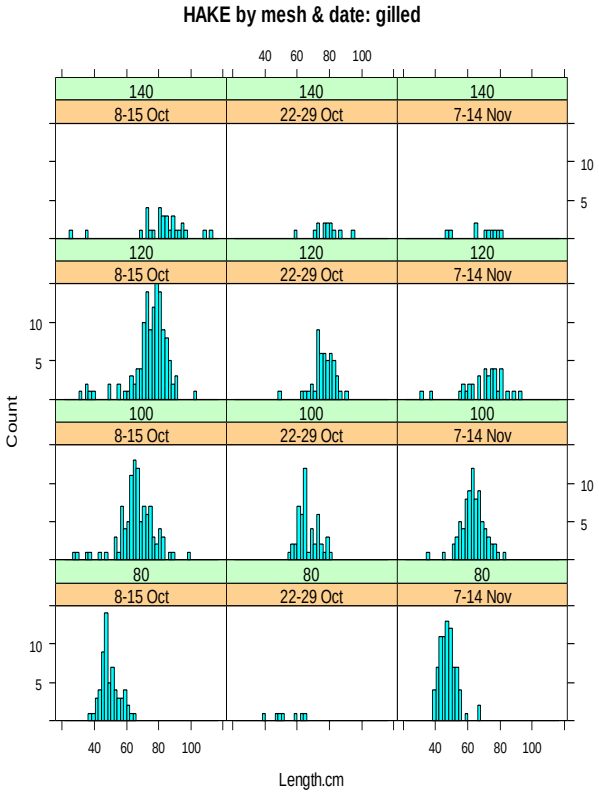
Location of selectivity experiments.



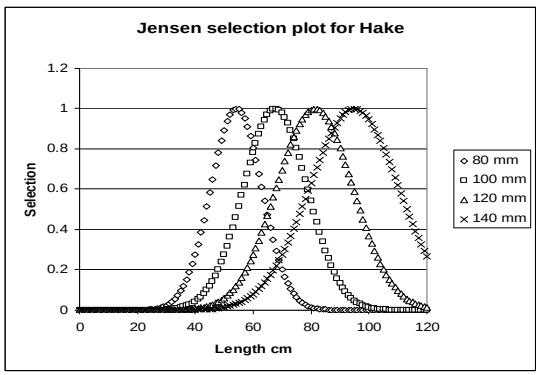


2) Hake taken by the 120mm nets were mainly in the length range 60 – 90cm. This contrasts markedly with the international fishery landings in 2004 which is predominantly fish of a much smaller size.

3) Three separate trials with the four mesh sizes showed that the mean size of hake gilled in the net increased with increasing mesh size, and that the 120mm mesh used by the fishery retains few hake < 60cm long (see opposite). The catches of the 80mm mesh net shows that hake < 60cm were common on the ground in two of the experiments. Smaller numbers of hake were entangled by their teeth – in this case the mesh size had less of an effect on the numbers caught in each length class (see main body of report).



Selection curves for different mesh sizes



4) Selection curves for the four mesh sizes are shown opposite for one of the analysis methods used. The probability of a hake being retained by a 120mm mesh net was greatest for fish of around 80 cm. The probability of being retained was relatively low for hake <60cm and > 100cm.

It is concluded that the 120mm mesh gill nets used by UK hake fishermen in the south west are optimum in terms of their catch rates of hake in the 60 – 100 cm range and their low selectivity for hake < 60cm long.

Introduction

The Fisheries Science Partnership (FSP) was established in 2003 to build relationships between fishermen and scientists, and to involve fishermen in the co-commissioning of science. The FSP is funded by the UK's Department for Environment, Food and Rural Affairs (Defra). Ten projects were carried out during 2003/04, and a further ten in 2004/05, comprising a mixture of time-series surveys, fishing gear selectivity studies, and examination of spatial patterns of catch compositions. Reports for FSP projects already completed are available on the FSP page of the Cefas web site (www.cefas.co.uk/FSP).

A further three years of the FSP programme has now been funded by Defra. Proposals for FSP projects have typically been developed by the fishing industry at a port/regional level, refined and agreed with Cefas and approved by the FSP Steering Group. Charter vessels are selected through an open tendering procedure, and are given dispensations from relevant quota and effort controls, and to fish in non-UK waters where appropriate.

This report presents the results of FSP Programme 8, which examined selectivity of hake gill nets used by UK fishermen off Cornwall. The project was initially proposed by the fishing industry to demonstrate that the fishery takes very few small hake, and was developed further with Cefas to include experiments to estimate the selectivity characteristics of the nets. The project used the commercial netter *Carol H* (skipper Phil Mitchell) during the periods 8-15 October, 22-29 October and 7-14 November 2005.

Hake off Cornwall form part of the northern hake stock which covers the continental shelf from Norway to the Bay of Biscay. They are fished by the international fleets using a wide variety of gears including trawls, gill nets and long-lines. The spawning stock biomass of northern hake reached a low level in the 1990s (ICES, 2006), and emergency measures were introduced in 2001 to conserve the stock (Council Regulations 1162/2001, 2602/2001 and 494/2002). This has been replaced by EC Regulation 811/2004 which implements measures for the recovery of the northern hake stock, with the objective of rebuilding the spawning stock biomass. Fishing gear selectivity is an important aspect for hake conservation, and the use of gears that have minimal catches of young, immature hake will assist stock recovery.

Objectives

The primary objective of Programme 8 was to demonstrate that gill nets used by the UK hake fishery off southwest England avoid catching small hake, and that this is due to the selectivity characteristics of the 120mm mesh used by the UK gill net vessels.

The objective was addressed firstly by demonstrating the size composition of hake taken by 120mm mesh gill nets on the hake fishing grounds off Cornwall, and secondly by carrying out experiments to determine the selectivity characteristics of the nets.

Although the target species was hake, the objectives for the project specified that "data for other sensitive species will also be recorded". Catches of other species taken in the experimental nets are therefore documented, and length frequencies are presented for cod, haddock, pollack and ling.

The detailed operation plan, drawn up in advance at a meeting between Cefas and the vessel skipper, is reproduced in Appendix 2.

Methods

General methods

The project objectives were addressed primarily through analysis of length frequency data. The length frequencies reflect a combination of the selectivity characteristics of the gear and the abundance of fish of different sizes present at the times and locations where the gear is fished. The selectivity of the gear can be represented by a curve showing the probability of fish of different sizes being caught when they try to escape the gear. In the case of a gill net where the majority of fish become gilled or wedged in the meshes, the curve is often bell shaped, with the peak corresponding to the sizes of fish most likely to be enmeshed. If additional fish are caught by entanglement (e.g. by teeth in the case of hake), the selection curve may cover a broader range of lengths or even have more than one length mode (dos Santos *et al*., 2003).

When estimating the shape of the hake gill net selectivity curves, the variations in abundance of fish of different sizes around the net have to be considered. For enmeshing gears such as gill nets, the normal approach is to hang fleets of nets of different mesh but otherwise identical construction, and to compare the length frequencies in each. This approach was adopted for the FSP project

Experimental design

The experiment was carried out on the hake fishing grounds off Cornwall (Fig. 1) using the fishing vessel *Carol H* (WY379), a steel-hulled netter of 17.5m reg. length and with a 195 Kw engine. The *Carol H* fished with fleets of 24 specially made, new gill nets consisting of 4 sets of 6 with 80 mm mesh, 100 mm, 120 mm, and 140 mm (full stretched mesh length). The dimensions of each net were 5.5 metres high x 107 metres long when set. The intention was to fish with nets of smaller and slightly larger mesh size than the usual commercial nets of 120 mm to see how selectivity varied with mesh size. Meshes larger than 140 mm were not considered because of the low expectations of any catches, and meshes smaller than 80 mm were not used because they were expected to catch excessive amounts of weed etc.

To allow a valid comparison of the catch rates and size compositions of the different mesh sizes, all nets were made with the same type and diameter (0.65 mm) monofilament nylon, and all the mesh sizes were fished at the same time and place and for the same soak time. Although the intended soak times were 24 hours, these had to be adjusted when necessary due to weather conditions and for other practical reasons. The hanging ratios were set to 0.6 in all cases, by setting staples every 0.36 m to hold five meshes into the space of three. Floats of 0.113 kg buoyancy were set every 1.8 m. The leadline was 10mm 3 x strand heavy leaded. The nets were always carefully cleaned before returning them to the water after a haul.

Additional fleets of the vessel's commercial 120mm mesh nets were shot in the vicinity of the selectivity experiments, as opportunities permitted, to provide more comprehensive data on the size composition of hake taken by commercial 120mm mesh gill nets.

All fish species caught were measured to the cm below. Weighing facilities were not available on the vessel. For hake, a record was kept of whether each fish was gilled in the net or entangled by its teeth, as this is likely to affect selectivity.

Hake taken in gill net on FV Carol H

Data analysis

Various methods exist to estimate gill net selectivity using data from several mesh sizes fished simultaneously. They differ in the assumptions they make about the shape of the selection curves and how the data are treated when fitting the curves. The results may therefore differ in detail. For comparative purposes, three relatively simple methods were applied in the present study: those due to Jensen (given in Hovgård and Lassen, 2000), Holt (1963), and McCrombie and Fry (1960). The technical aspects of the analyses are briefly described in Appendix 3. The distinction between fish gilled in the meshes, or entangled by their teeth, was dropped in order to produce one set of unified results. A separate analysis using gilled fish only was, however, carried out for comparison.

The parameters of the selection curves estimated by the three methods were the mean selection length (the length at which the fish have the highest probability of being caught), and the standard deviation (a measure of the spread of the curve). For example, in Figure 5, the mean selection length for the 120mm mesh is 81 cm and the standard deviation is 13.3 cm. Two standard deviations on either side correspond to fish lengths of roughly 55 – 105 cm, and 95% of the area under the selection curve is between these two lengths.

A potential limitation of the Holt method is the relatively large difference between the mesh sizes fished (20 mm), compared to Holt's example where the differences were only 5 to 10 mm. This could affect the results if nets differing in mesh size by 20mm had different fishing power or efficiency as well as different selectivity characteristics, as it is necessary to assume that the two nets in each pair have the same fishing power.

Results

Stations fished and soak times

Three netting trips were made within a 6-week period in 2005: 8-15 October, 22-29 October, and 7-14 November. This provided repetition of the trials to assist the statistical analysis. The trips are referred to as Trip 1, 2, and 3 below. Details of fishing activities using the experimental nets are summarised in Table 1. The position, date, and time of shooting of the nets, the soak time in hours, and the numbers of fish caught for most of the commercial species taken, are given for the experimental nets in each trip in the table in Appendix 1. Data for other species are held at Cefas.

Table 1. FSP 2005 Programme 8: hake selectivity. Number of tiers of nets of each mesh size shot during each selectivity experiment.

		Experimental nets			
		80mm	100mm	120mm	140mm
Trip 1	8-15 Oct	15	15	15	15
Trip 2	22– 29 Oct	15	15	15	15
Trip 3	7-14 Nov	14	14	14	14

Figure 1 shows the positions where experimental fleets were shot for each of the three trips. The first and third trips fished grounds to the NW of Lands End, whilst the second fished to the south of Lizard point. Standard 120 mm mesh commercial nets were fished in proximity to the experimental nets of shots 2, 3, 6, 11, 18, and 24 of Trip 1, shots 3, 9, 15, 16, and 20 of Trip 2, and shots 6, 14, and 20 of Trip 3, to provide additional data on size composition of hake taken by this mesh size.

Soak times ranged between 12 and 36.5 hours (see Appendix 1). The average was 23.3 hours which was close to the intended 24 hours. There was no indication of a consistent relationship between soak time and numbers of hake caught, over the range of soak times observed (Fig. 2). Standardisation of catches to a 'per hour' basis was therefore not thought to be useful for interpretation and all catches are reported 'per immersion'. The soak times did not differ systematically between regions or trips. Hence, soak time was not taken into account in the data analysis.

Length frequencies of hake in commercial and experimental 120mm mesh nets

The total length frequency for hake recorded from the experimental and additional commercial 120mm mesh nets fished at each location were very similar, and showed that few hake less than approximately 60 cm in length were either gilled or entangled by their teeth (Fig. 3). The majority of hake caught were 70 – 85cm long. In contrast, the length frequency of hake of the northern stock landed by all international fleets in 2004 was dominated by hake smaller than 70cm long (ICES, 2006; Fig. 3). Data in ICES (2006) also indicate that discarding of hake by sampled international fleets is mainly of fish <25cm long (not shown on Fig. 3). If the FSP data are typical of hake catches taken by UK gill netters off the SW coast throughout they year, they indicate that the fishery is a highly selective component of the international fishery on northern hake.

Catch and size composition of hake in the 80 – 140mm experimental nets

The length frequencies of hake gilled in the experimental nets are shown by trip and mesh size in Figure 4a. Equivalent results showing the number of hake entangled by their teeth are shown in Figure 4b.

The main findings in Figure 4 are:

1. Few hake less than approximately 60 cm in length were either gilled or toothed in the 120mm mesh experimental nets. Catches of hake < 60cm long in the 80mm mesh nets during two of the trips show that small hake were present at the study sites, but fish of this size were caught in only small numbers in the larger mesh gill nets.

2. The majority of hake were enmeshed by their gills.

3. For 80 to 120 mm mesh nets, the average length of gilled hake tended to increase with increasing mesh size, whereas there was no clear relationship between mesh size and fish size when the fish were entangled by their teeth.

4. The mesh size of 120mm provided good catch rates of hake in the 70 – 85cm length range, and low catch rates of hake<60cm long due to mesh selection. Catches of gilled hake in the 140mm net were much lower than in the 120mm net, indicating a relatively low abundance of hake too large to be caught in the 120mm mesh nets.

Estimation of selectivity parameters

The mean selection lengths and standard deviations of the bell-shaped selection curves estimated by the three methods are presented in Table 2. The estimated selection curves are shown in Figures 5, 6 and 7. The Jensen and the McCrombie & Fry methods gave almost the same selectivity curve parameters (Table 2), as they have a similar theoretical basis. They indicate that the 120mm mesh nets used commercially are most effective at catching hake of around 80cm long, and very ineffective at catching hake outside the length range 55 - 105cm (+/- 2 standard deviations on either side of the mean).

The Holt method was not able to provide useful results for the 120/140mm mesh comparison due to the small catches in the 140mm mesh nets. The results for the 80/100mm and 100/120mm comparisons gave mean selection lengths in line with the values given by the other two methods (Table 2), but the estimates of standard deviations were larger due to the different assumptions made in fitting the model.

If the selectivity parameters are estimated after excluding fish entangled by their teeth (i.e. using only the data for gilled hake in Fig. 4), the mean selection length is reduced by 2 to 6cm compared to the results for gilled and entangled fish combined, and the standard deviations are increased (Table 3). (Note that this analysis uses a smaller overall length range due to the reduced data set, which may influence the results slightly.)

Table 2. FSP Hake net selectivity, 2005; (a) mean selection lengths and (b) standard deviations (spread) of selectivity curves for all hake caught (gilled or entangled by teeth) using gill nets with four different mesh sizes, as estimated by three different methods. Note that the Holt method estimates the parameters for the average mesh size of a pair of nets i.e. 80/100mm is equivalent to a 90mm mesh.

a) Mean selection lengths, cm

Mesh	80 mm	80/100 mm	100 mm	100/120 mm	120 mm	120/140 mm	140 mm
Jensen	54		68		81		95
Holt		59		72		85	
McCrombie & Fry	54		68		81		95

b) Standard deviations, cm

Mesh	80 mm	80/100 mm	100 mm	100/120 mm	120 mm	120/140 mm	140 mm
Jensen	8.8		11.1		13.3		15.5
Holt		15.4		18.8		58.7*	
McCrombie & Fry	8.2		10.3		12.3		14.4

*Unreliable result due to low catches at large mesh sizes

Table 3. FSP Hake net selectivity, 2005; as Table 2, but <u>for gilled hake only</u>.

a) Mean selection lengths, cm

Mesh	80 mm	80/100 mm	100 mm	100/120 mm	120 mm	120/140 mm	140 mm
Jensen	50		63		75		88
Holt		61		75		88	
McCrombie & Fry	51		63		76		88

b) Standard deviations, cm

Mesh	80 mm	80/100 mm	100 mm	100/120 mm	120 mm	120/140 mm	140 mm
Jensen	6.0		7.4		8.9		10.4
Holt		12.2		15.8		25.8*	
McCrombie & Fry	5.8		7.3		8.7		10.2

*Unreliable result due to low catches at large mesh sizes

Other commercial species

Hake, haddock, cod, ling and pollack made up the bulk of the commercial species taken in the 120mm mesh experimental net (Table 4, based on table in Appendix 1).

Table 4. FSP Hake net selectivity, 2005. Total numbers of fish taken in the experimental nets (from Appendix 1). Species are ordered by descending catches in the 120mm mesh nets.

mesh	Hake	Haddock	Cod	Bib	Ling	Pollack	Whiting	Megrim	Saithe	Monk
80mm	269	95	26	485	215	43	337	4	8	0
100mm	349	166	49	455	169	55	116	7	9	0
120mm	299	184	122	91	79	74	51	11	8	3
140mm	94	39	74	18	29	77	39	12	3	6

Length frequencies for haddock, cod, pollack and ling caught by the experimental nets during the three fishing trips are shown in Figures 8 to 11. These show that the 120mm mesh currently in use provides a good combination of catch rate and avoidance of small fish of these species present on the grounds. Generally, the fish caught were relatively large. Selectivity curves were not fitted since these species were peripheral to the main study.

Discussion

This project was successful in demonstrating that the 120mm mesh gill nets used by UK fishermen to target hake off the SW of England are highly selective and catch few hake less than 60 cm long compared with the international fishery as a whole. This is a result of the selectivity characteristics of the nets rather than the absence of small hake on the grounds. The majority of hake taken using 120mm mesh during the experiment were 70 – 85 cm long, and the mean selection length was around 80cm. Nets made from 140 mm mesh caught relatively few hake, indicating that there were insufficient numbers of large hake in the vicinity of the experiment to compensate for the increased escapement of smaller fish.

A similar study on the selectivity of hake gill nets in the fishery off Portugal provided mean selection lengths of 46.7 cm (± 2.4 cm) for 80mm mesh and 51.1 cm(± 3.1 cm) for 90mm (dos Santos *et al*, 2003) using a maximum likelihood statistical method. These figures refer only to hake wedged or gilled in the net, and exclude hake entangled by their teeth. The equivalent FSP results for gilled hake were 50 – 51cm for 80mm mesh (Jensen and McCrombie & Fry method) and 61 cm for 90mm mesh (Holt method) (Table 3). The results of the two studies are in reasonable agreement considering the different locations and times of the studies, and the different methods used to derive the selectivity curves.

A range of different methods are available to estimate selectivity of gill nets. Three relatively simple methods were applied in the present study. More sophisticated procedures such as the 'SELECT' method used by dos Santos *et al*. (2003) for hake off Portugal would be warranted if more comprehensive data for all the mesh sizes became available. However, the choice of analysis method would not alter the important conclusion of the present study, that 120mm mesh nets are highly selective and select strongly against hake less than 60 cm long.

The relatively small FSP catches in the 140mm mesh nets resulted in poor estimation of selectivity for this mesh size. Increasing the sample size by making more experimental sets in each trip, or carrying out more trips, would have allowed better parameter estimation for all the smaller mesh sizes, but this could not be arranged with the resources and time available. Other methods that use length-girth relationships to estimate selectivity (Hovgård and Lassen, 2000) might provide better estimates than any of the three methods applied here due to the additional information used in the calculations. They could also be extrapolated to better estimate selectivity for the 140 mm mesh. Collection of length-girth data for hake in the south west could allow further analysis using the FSP data collected in the present study.

All three analysis methods showed an increase in the standard deviation (spread) of the bell-shaped selection curves with increasing mesh size (Tables 2 and 3), which is an expected result for gill nets (McCrombie & Fry, 1960, citing Beverton). The selectivity of a 120mm mesh net is therefore spread over a greater length range than is the case for e.g. an 80 – 100 mm net. This is advantageous where there is a broad but variable range of lengths in the population. The results of the Holt method for "90" and "110" mm mesh (80/100mm and 100/120mm pairs) may give a better indication of how the standard deviation of the selectivity curve for hake may increase with mesh size, as the method is less constrained than the other methods in how it estimates the standard deviation.

It was noted by skipper Mitchell that brand new gill nets do not fish as efficiently as older nets. However, the percentage length frequencies of hake in the commercial and experimental 120mm mesh nets were similar (see Fig. 3), and the selection curves are therefore considered representative of the gears used by the UK commercial fishery.

A number of other factors will have affected the results obtained in the study. These include variable weather conditions and removal of fish by seals feeding at the nets. It was assumed that these would increase the variability in the data rather than bias the estimates of selectivity. The overall finding that 120mm mesh gill nets select strongly against small hake < 60cm long is likely to be robust to these sources of variability in the data.

Acknowledgements

Skipper Mitchell and the crew of the *Carol H* are warmly thanked for their enthusiastic co-operation throughout this project. John Dann is thanked for his assistance in setting up the project, as are all other Cefas staff who have been involved. The project was funded by Defra as part of the Fisheries Science Partnership.

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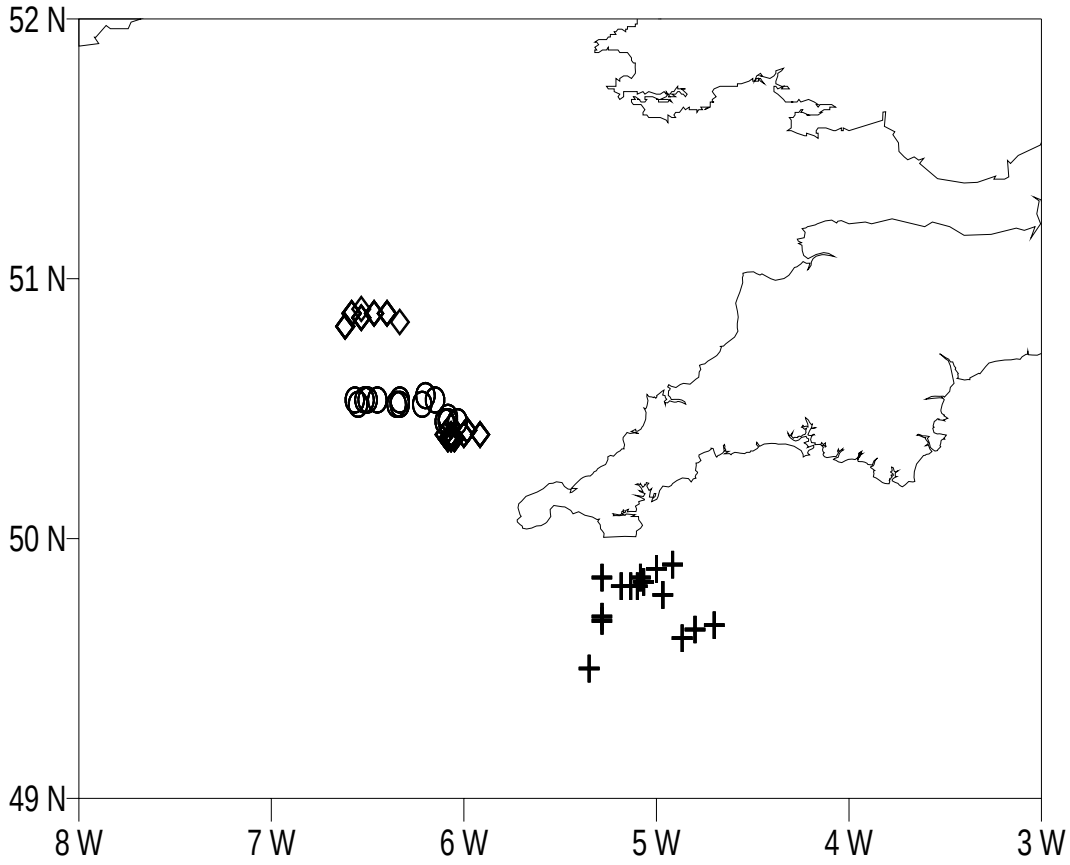


Fig. 1. FSP Hake selectivity 2005: shooting positions of fleets of nets. Circles = Trip 1 (8-15 October); crosses = Trip 2 (22-29 October); diamonds = Trip 3 (7-14 November).

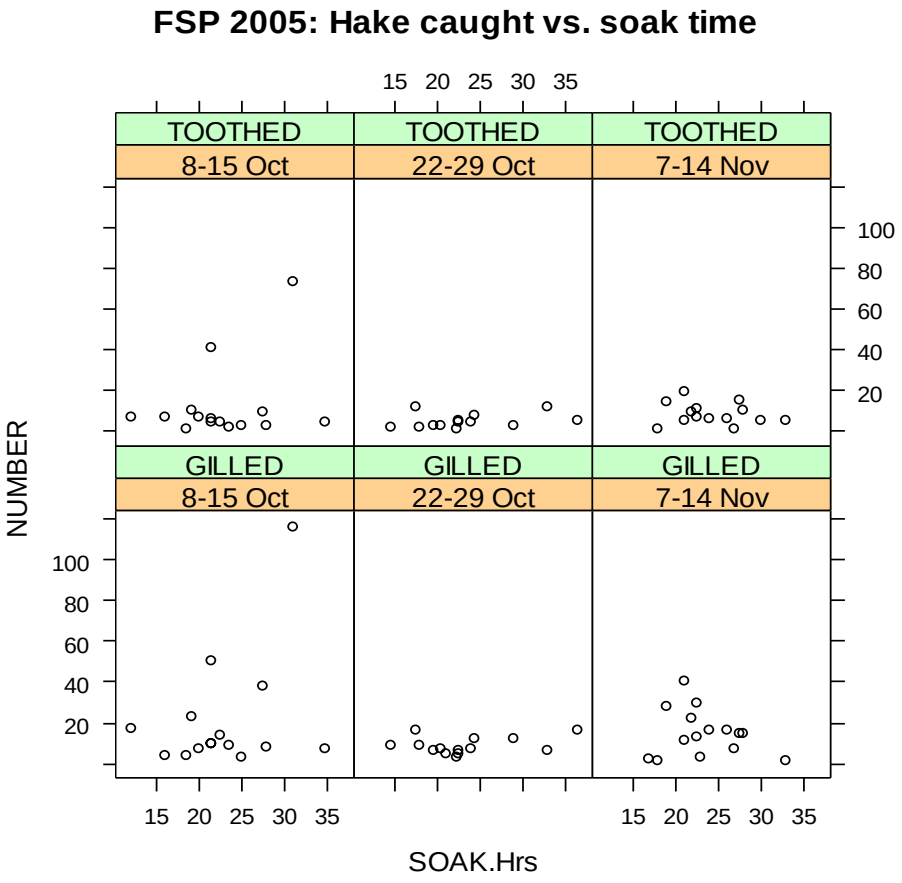


Fig. 2. FSP Hake selectivity, 2005. Effect of soak time on numbers of hake caught during each of the three trips.

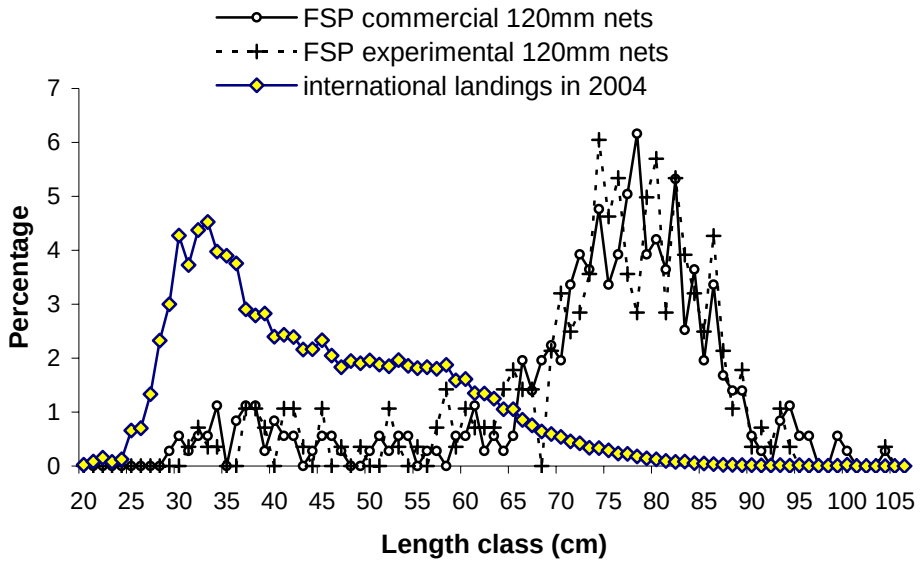


Fig. 3. FSP Hake selectivity, 2005**.** Percentage length frequency of hake caught by 120 mm mesh gill nets (experimental gear and additional commercial gear shot at the same time), compared with the length frequency of international landings of Northern hake in 2004 (from ICES, 2006).

a)

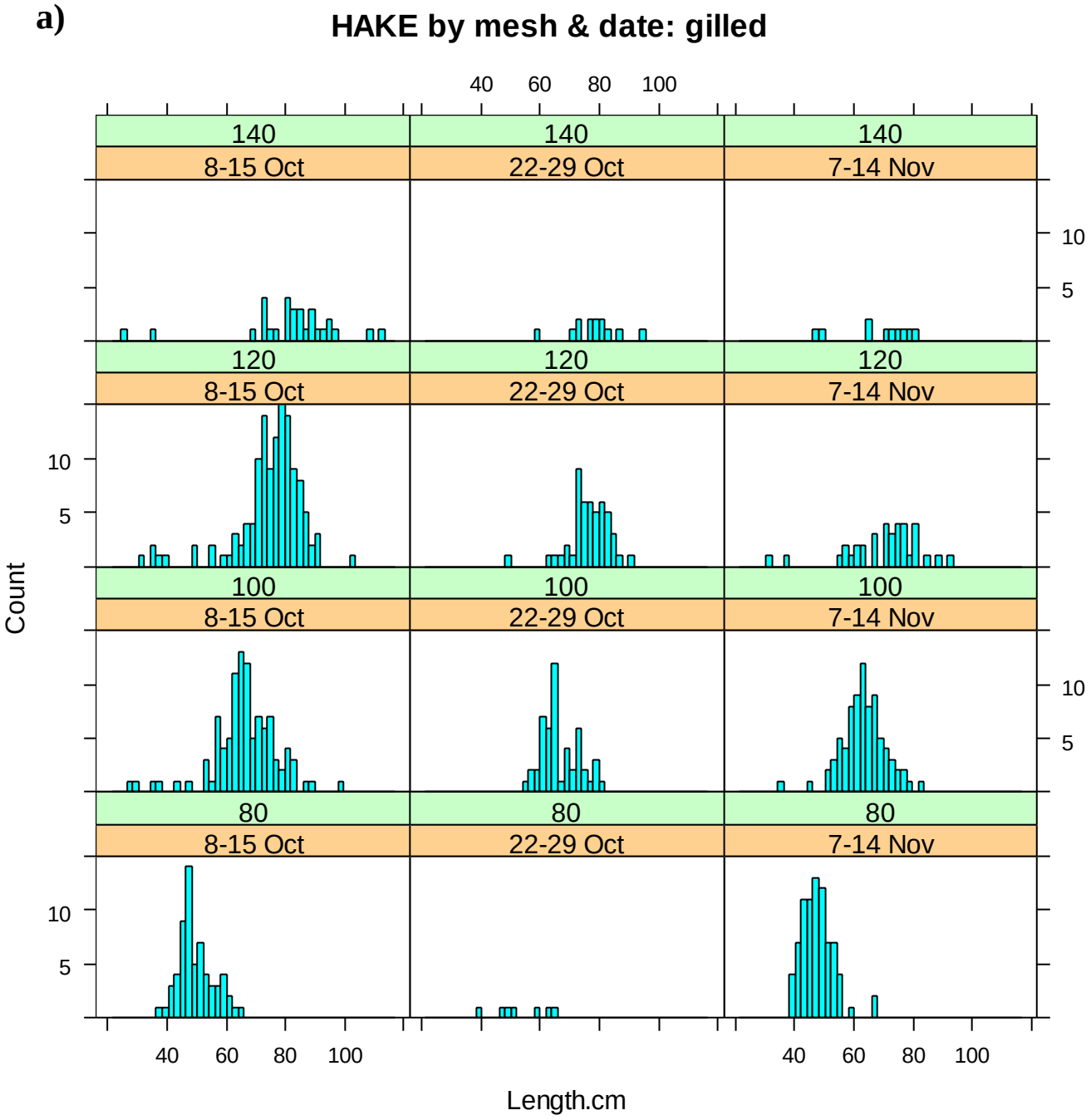
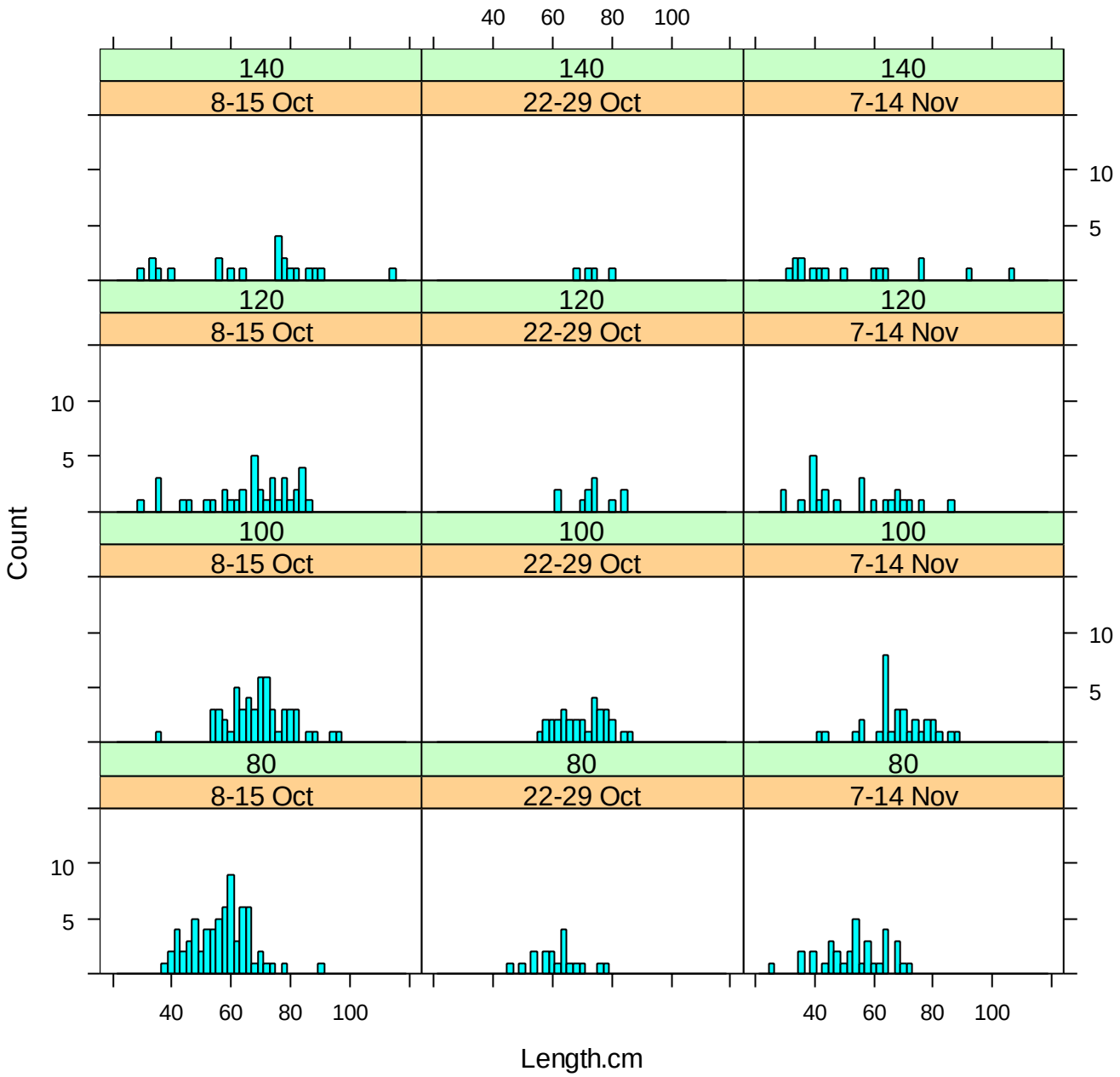


Fig. 4. FSP Hake selectivity, 2005**.** Effects of trip date and fish length on numbers of hake caught: a) enmeshed at or near the gills; b) (*overleaf*) entangled by teeth.

Fig. 4, continued.

b)



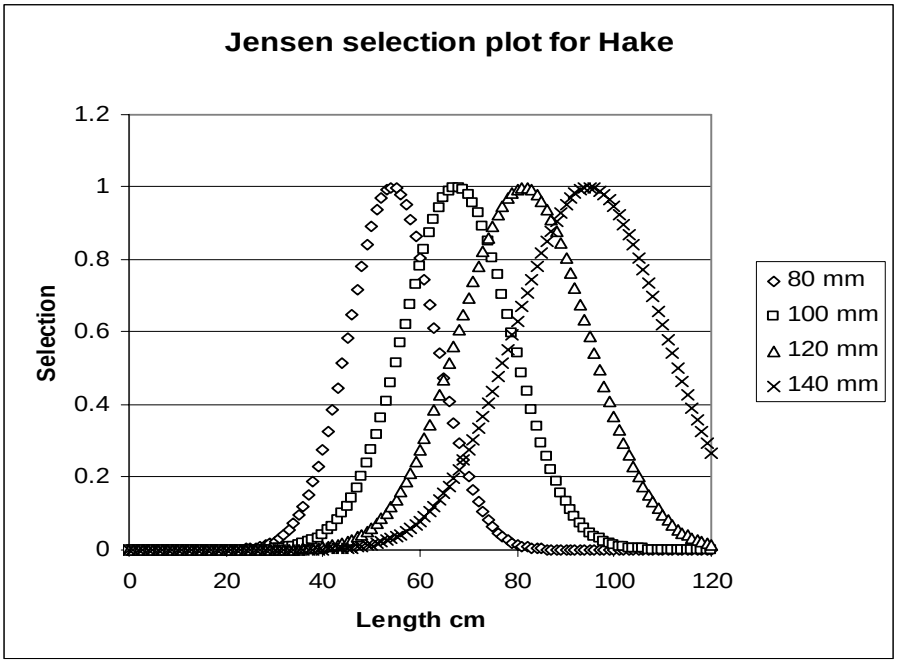


Fig. 5 FSP Hake selectivity, 2005. Jensen selection plots for four mesh sizes, as estimated for gilled and toothed hake, all trips combined.

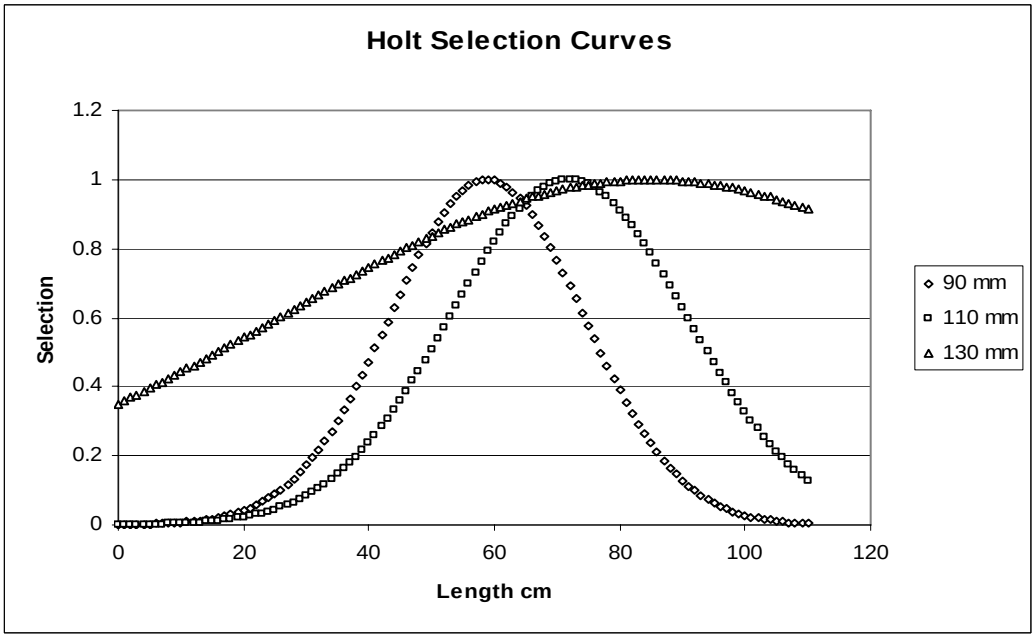


Fig. 6 FSP Hake selectivity, 2005. Holt selection plots for three pairs of mesh sizes, as estimated for gilled and toothed hake, all trips combined. The pairs were 80/100, 100/120, and 120/140mm. The key shows the average mesh. The wide spread of the 120/140mm curve is an unreliable result due to low catches at 140mm.

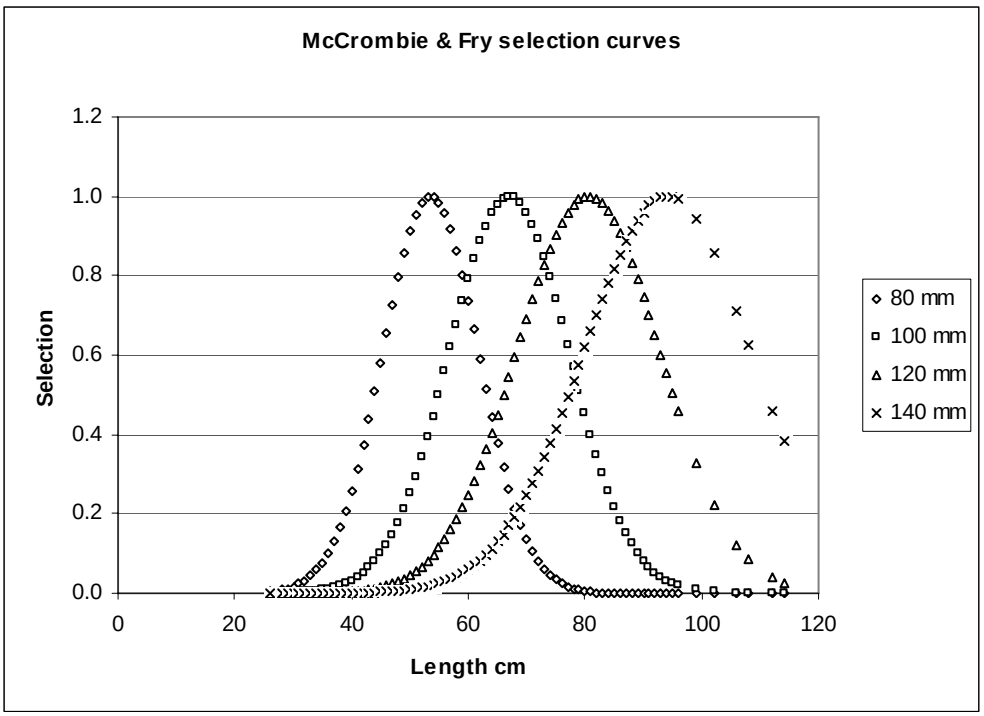


Fig. 7 FSP Hake selectivity, 2005. McCrombie & Fry selection plots for four mesh sizes, as estimated for gilled and toothed hake, all trips combined.

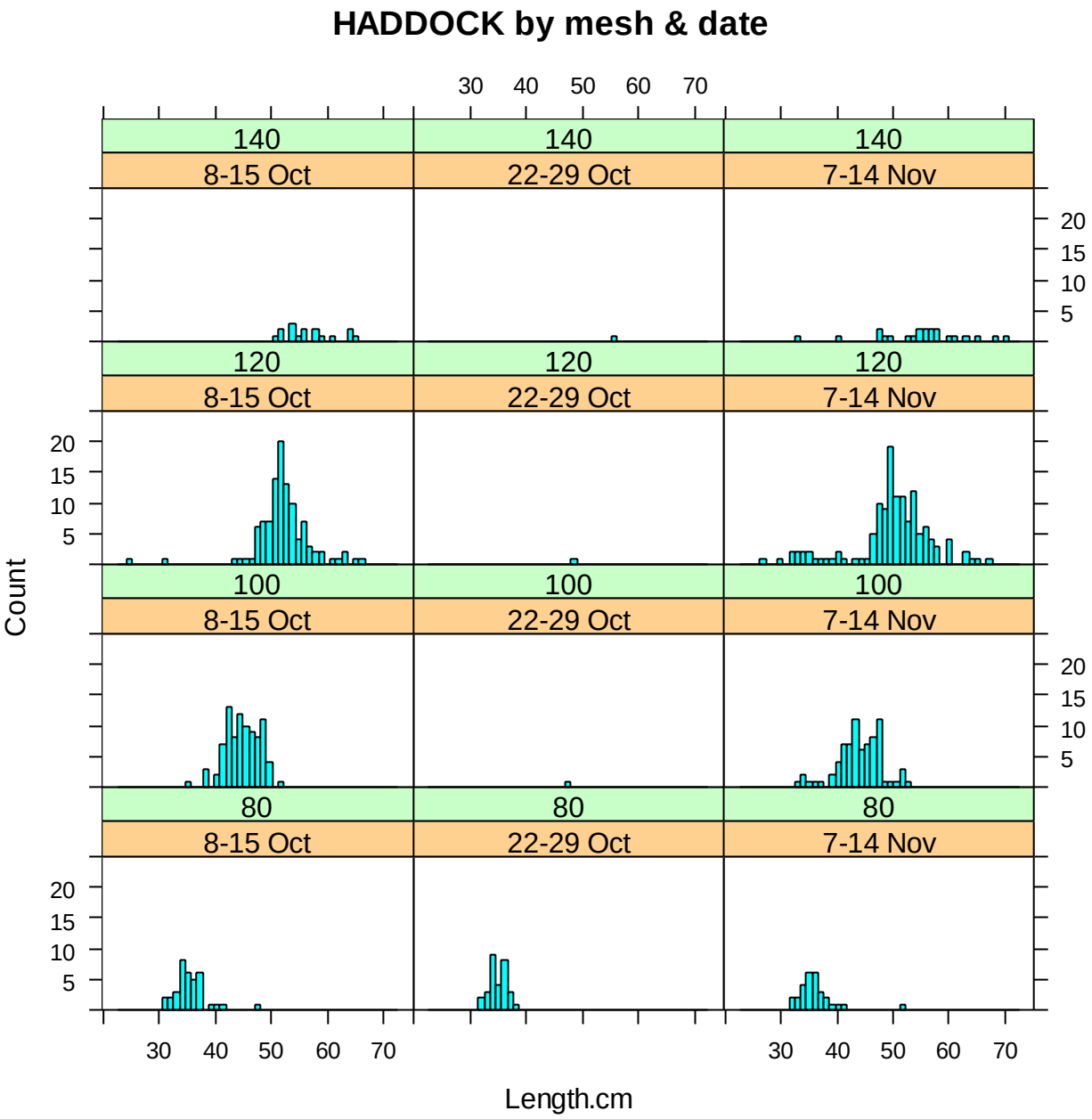


Fig. 8. FSP Hake selectivity, 2005. Effects of trip date and fish length on total numbers of HADDOCK caught in each length class.

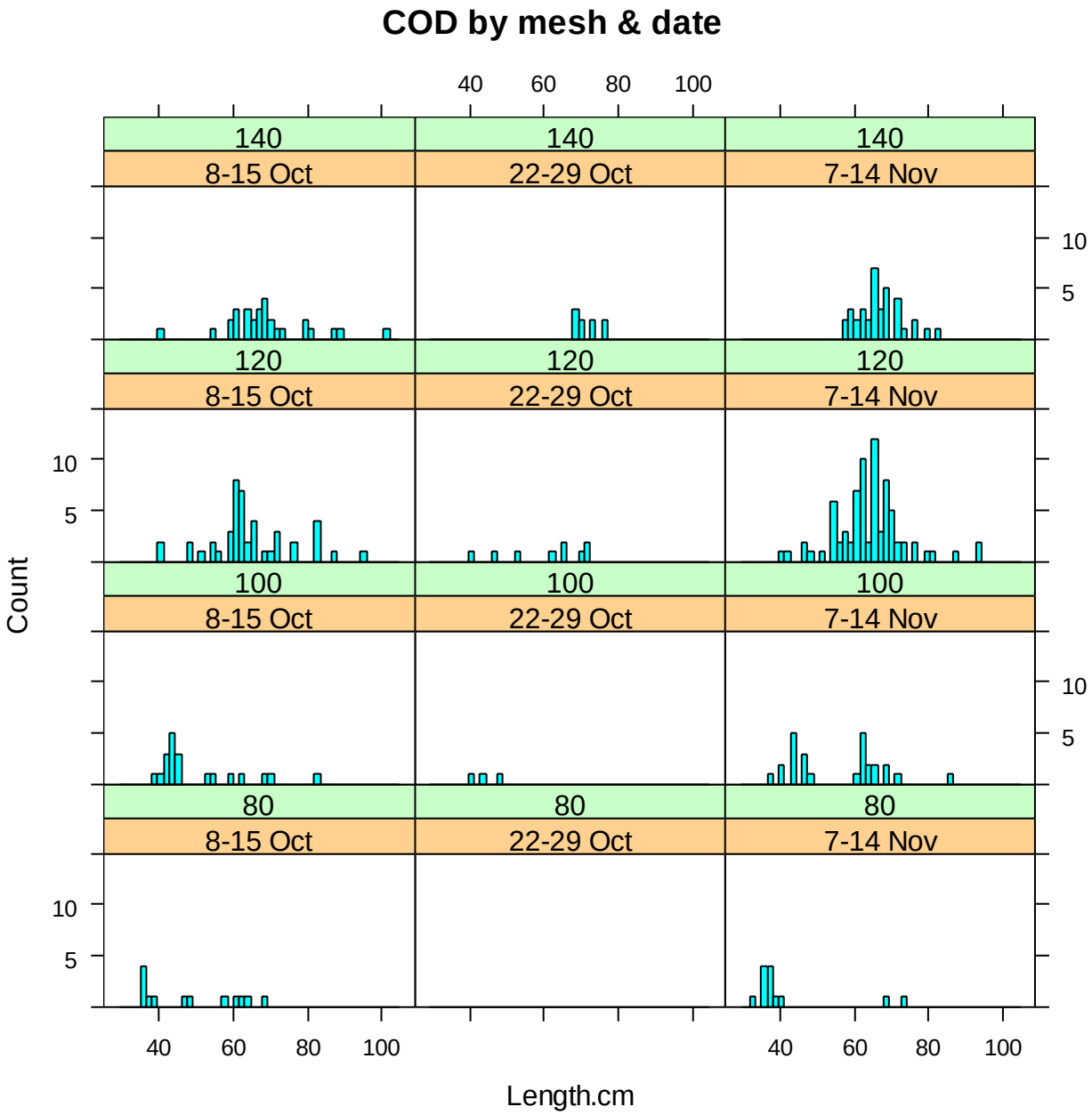


Fig. 9. FSP Hake selectivity, 2005. Effects of trip date and fish length on total numbers of COD caught in each length class.

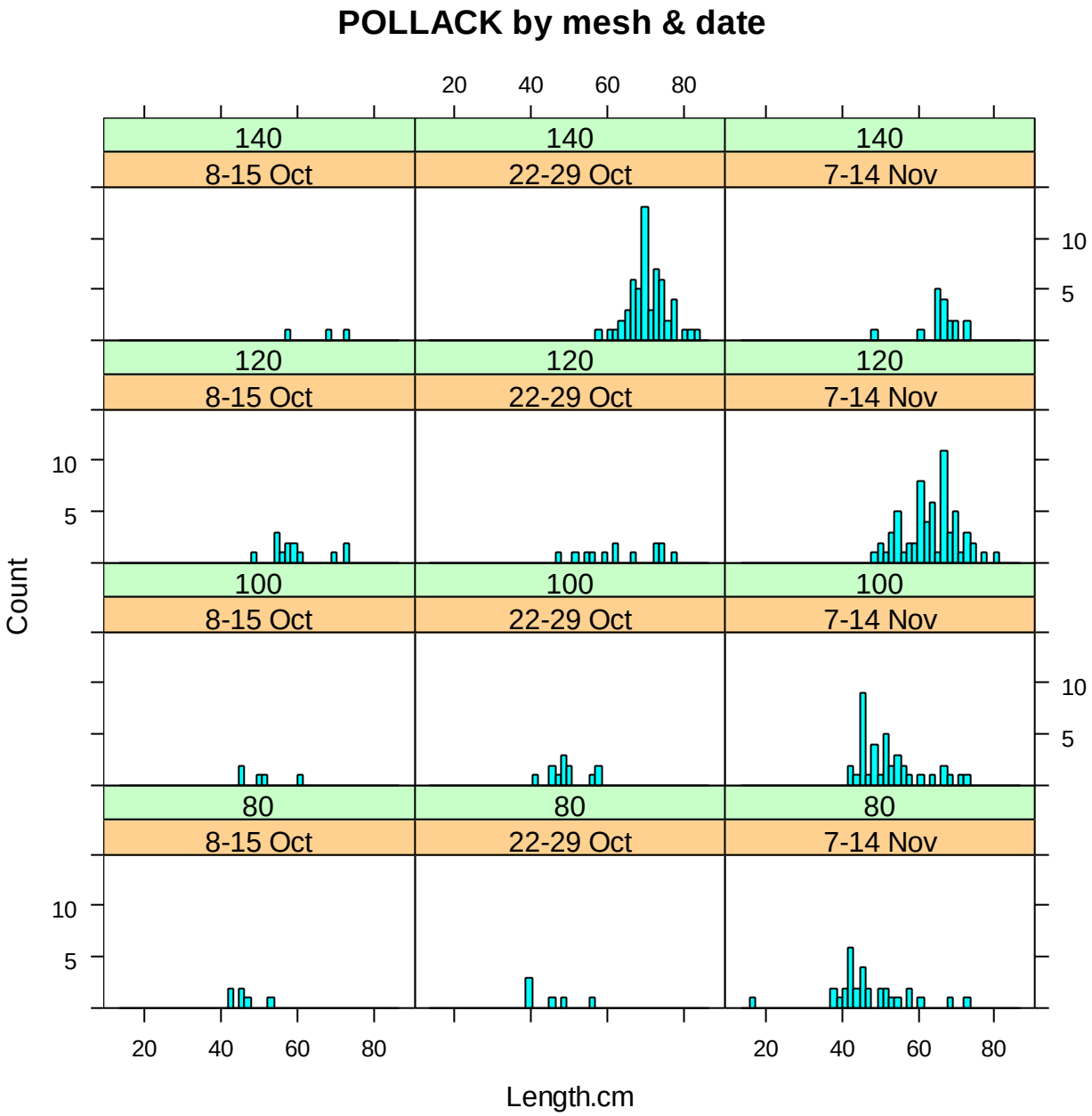


Fig. 10. FSP Hake selectivity, 2005. Effects of trip date and fish length on total numbers of POLLACK caught in each length class.

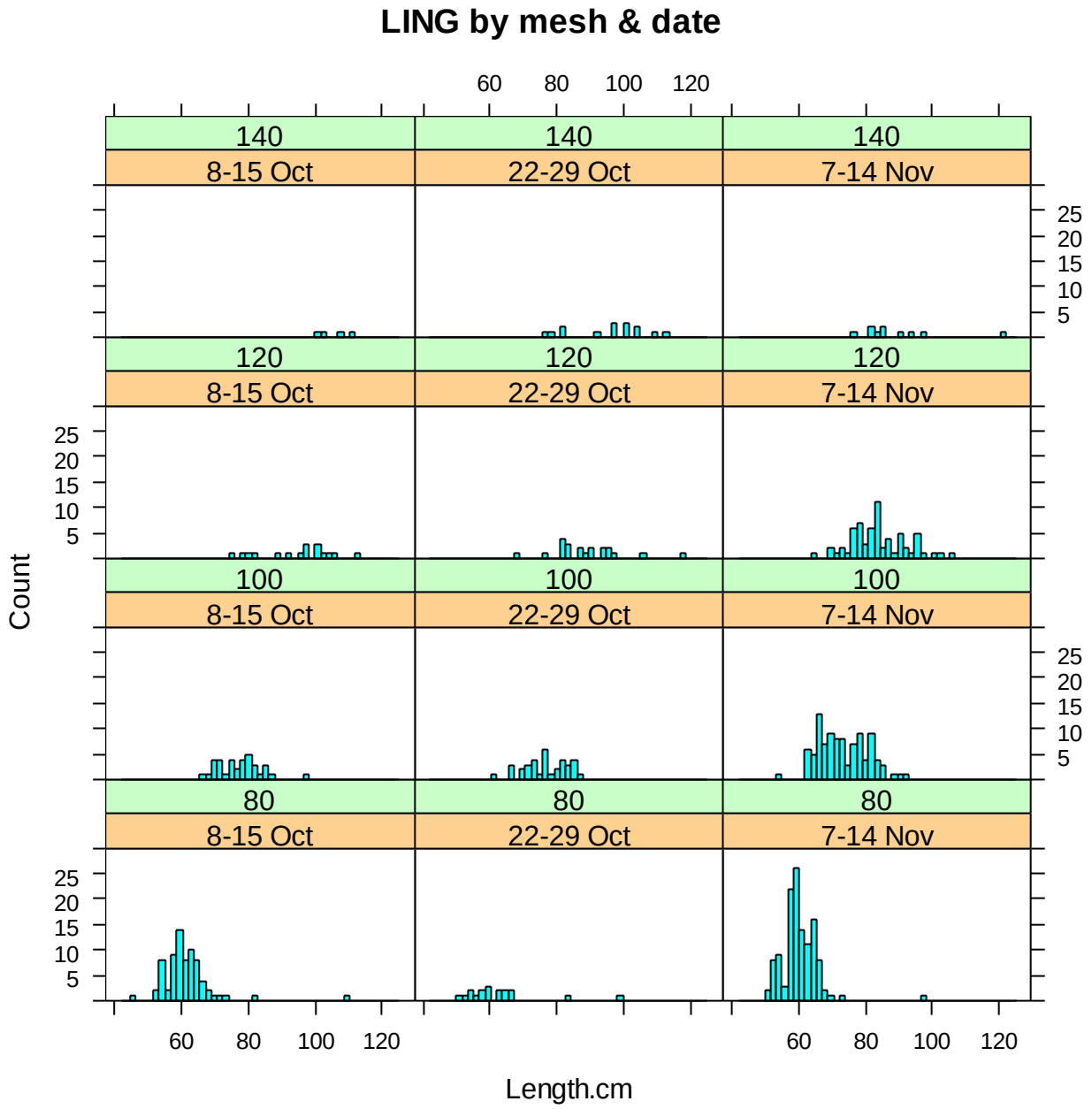


Fig. 11. FSP Hake selectivity, 2005. Effects of trip date and fish length on total numbers of LING caught in each length class.

APPENDIX 1: FSP hake selectivity, 2005. Station and catch (in numbers) details for 11 species of fish.
Selected abbreviations: HKE=hake, HAD=haddock, MON=monk, WHG=whiting, POL=pollack, MEG=megrim, BIB = bib (pout whiting), MUR=red mullet, LIN=Ling, POK=saithe.

TRIP No	HAUL	SHOT LAT	SHOT LONG	SHOT DATE	SHOT TIME	SOAK hrs	MESH mm	HKE_N	HAD_N	COD_N	MON_N	WHG_N	POL_N	MEG_N	BIB_N	MUR_N	LIN_N	POK_N
22-29 Oct	1	49.65	-4.8	22-Oct-05	17:00	18.00	80	2	1	0	0	0	0	0	79	2	0	0
22-29 Oct	1	49.65	-4.8	22-Oct-05	17:00	18.00	100	6	0	0	0	0	0	0	17	0	0	0
22-29 Oct	1	49.65	-4.8	22-Oct-05	17:00	18.00	120	3	0	0	0	0	0	0	2	0	0	0
22-29 Oct	1	49.65	-4.8	22-Oct-05	17:00	18.00	140	0	0	1	1	0	0	0	1	0	0	0
22-29 Oct	2	49.667	-4.7	22-Oct-05	16:30	22.50	80	2	10	0	0	1	0	0	69	0	0	0
22-29 Oct	2	49.667	-4.7	22-Oct-05	16:30	22.50	100	5	1	0	0	1	0	0	19	0	0	0
22-29 Oct	2	49.667	-4.7	22-Oct-05	16:30	22.50	120	3	1	0	0	0	0	0	3	0	1	0
22-29 Oct	2	49.667	-4.7	22-Oct-05	16:30	22.50	140	0	0	1	0	0	0	0	0	0	1	0
22-29 Oct	4	49.617	-4.867	22-Oct-05	19:00	17.50	80	6	3	0	0	0	0	0	114	2	1	0
22-29 Oct	4	49.617	-4.867	22-Oct-05	19:00	17.50	100	18	0	0	0	0	0	0	6	0	0	0
22-29 Oct	4	49.617	-4.867	22-Oct-05	19:00	17.50	120	4	0	0	0	0	0	0	3	0	0	0
22-29 Oct	4	49.617	-4.867	22-Oct-05	19:00	17.50	140	0	0	0	0	0	0	0	3	0	0	0
22-29 Oct	5	49.783	-4.967	23-Oct-05	23:30	15.50	80	0	0	0	0	0	0	0	9	0	0	0
22-29 Oct	5	49.783	-4.967	23-Oct-05	23:30	15.50	100	0	0	0	0	0	1	0	0	0	1	0
22-29 Oct	5	49.783	-4.967	23-Oct-05	23:30	15.50	120	0	0	0	0	0	0	0	4	0	1	0
22-29 Oct	5	49.783	-4.967	23-Oct-05	23:30	15.50	140	0	0	0	0	0	0	0	0	0	0	0
22-29 Oct	6	49.9	-4.917	24-Oct-05	02:00	33.00	80	1	0	0	0	0	1	0	2	1	1	0
22-29 Oct	6	49.9	-4.917	24-Oct-05	02:00	33.00	100	10	0	1	0	0	0	0	15	0	0	0
22-29 Oct	6	49.9	-4.917	24-Oct-05	02:00	33.00	120	5	0	0	0	0	0	0	3	0	0	0
22-29 Oct	6	49.9	-4.917	24-Oct-05	02:00	33.00	140	2	0	2	0	0	0	0	0	0	1	0
22-29 Oct	7	49.883	-5	24-Oct-05	02:30	36.50	80	2	0	0	0	0	1	0	0	0	3	0
22-29 Oct	7	49.883	-5	24-Oct-05	02:30	36.50	100	14	0	0	0	0	0	0	1	0	3	0
22-29 Oct	7	49.883	-5	24-Oct-05	02:30	36.50	120	5	0	1	0	0	1	0	0	0	5	0
22-29 Oct	7	49.883	-5	24-Oct-05	02:30	36.50	140	0	0	1	0	0	0	0	0	0	0	0
22-29 Oct	8	49.85	-5.083	24-Oct-05	18:00	29.00	80	4	0	0	0	0	0	0	2	0	1	0
22-29 Oct	8	49.85	-5.083	24-Oct-05	18:00	29.00	100	4	0	0	0	0	4	0	4	0	5	0
22-29 Oct	8	49.85	-5.083	24-Oct-05	18:00	29.00	120	6	0	0	0	0	11	0	0	0	4	0
22-29 Oct	8	49.85	-5.083	24-Oct-05	18:00	29.00	140	1	0	1	0	0	0	0	0	0	1	0

APPENDIX 1 continued: Station and catch (in numbers) details for 11 species of fish.

TRIP No	HAUL	SHOT LAT	SHOT LONG	SHOT DATE	SHOT TIME	SOAK hrs	MESH mm	HKE_ N	HAD_ N	COD_ N	MON_ N	WHG_ N	POL _N	MEG_N	BIB_N	MUR_ N	LIN_N	POK_ N
22-29 Oct	10	49.833	-5.067	25-Oct-05	17:30	20.50	80	0	0	0	0	0	0	0	9	0	2	0
22-29 Oct	10	49.833	-5.067	25-Oct-05	17:30	20.50	100	2	0	1	0	0	0	0	12	0	3	0
22-29 Oct	10	49.833	-5.067	25-Oct-05	17:30	20.50	120	8	0	1	0	0	0	0	7	0	5	0
22-29 Oct	10	49.833	-5.067	25-Oct-05	17:30	20.50	140	0	0	0	0	0	0	0	0	0	2	0
22-29 Oct	11	49.817	-5.133	25-Oct-05	18:00	24.00	80	2	1	0	0	0	1	0	3	6	2	0
22-29 Oct	11	49.817	-5.133	25-Oct-05	18:00	24.00	100	4	0	0	0	0	0	0	4	0	2	0
22-29 Oct	11	49.817	-5.133	25-Oct-05	18:00	24.00	120	4	0	0	0	0	0	0	1	0	2	0
22-29 Oct	11	49.817	-5.133	25-Oct-05	18:00	24.00	140	1	0	0	0	0	2	0	0	0	0	0
22-29 Oct	13	49.85	-5.283	26-Oct-05	00:30	22.50	80	1	0	0	0	0	1	0	2	4	4	0
22-29 Oct	13	49.85	-5.283	26-Oct-05	00:30	22.50	100	4	0	0	0	0	1	0	16	1	1	0
22-29 Oct	13	49.85	-5.283	26-Oct-05	00:30	22.50	120	4	0	0	0	0	0	0	4	0	0	0
22-29 Oct	13	49.85	-5.283	26-Oct-05	00:30	22.50	140	1	0	0	0	0	35	0	0	0	3	0
22-29 Oct	14	49.817	-5.1	26-Oct-05	15:30	19.50	80	1	0	0	0	0	1	0	3	0	2	0
22-29 Oct	14	49.817	-5.1	26-Oct-05	15:30	19.50	100	2	0	0	0	0	1	0	18	0	7	0
22-29 Oct	14	49.817	-5.1	26-Oct-05	15:30	19.50	120	2	0	1	0	0	0	0	3	0	0	0
22-29 Oct	14	49.817	-5.1	26-Oct-05	15:30	19.50	140	4	0	0	0	0	1	0	0	0	0	0
22-29 Oct	17	49.5	-5.35	26-Oct-05	23:30	21.00	80	0	1	0	0	0	1	0	1	9	0	0
22-29 Oct	17	49.5	-5.35	26-Oct-05	23:30	21.00	100	2	0	1	0	0	1	0	9	0	2	0
22-29 Oct	17	49.5	-5.35	26-Oct-05	23:30	21.00	120	3	0	0	0	0	0	0	12	0	0	0
22-29 Oct	17	49.5	-5.35	26-Oct-05	23:30	21.00	140	0	1	1	0	0	17	0	1	0	1	0
22-29 Oct	18	49.817	-5.183	26-Oct-05	21:30	14.50	80	0	2	0	0	0	0	0	0	4	0	0
22-29 Oct	18	49.817	-5.183	26-Oct-05	21:30	14.50	100	4	0	0	0	0	4	0	2	1	11	0
22-29 Oct	18	49.817	-5.183	26-Oct-05	21:30	14.50	120	7	0	1	0	0	1	0	0	0	0	0
22-29 Oct	18	49.817	-5.183	26-Oct-05	21:30	14.50	140	0	0	0	0	0	0	0	0	1	1	0
22-29 Oct	19	49.683	-5.283	27-Oct-05	15:30	24.50	80	4	9	0	0	2	0	0	4	4	0	0
22-29 Oct	19	49.683	-5.283	27-Oct-05	15:30	24.50	100	4	0	0	0	0	0	0	2	0	0	0
22-29 Oct	19	49.683	-5.283	27-Oct-05	15:30	24.50	120	6	0	1	0	1	0	0	2	0	0	0
22-29 Oct	19	49.683	-5.283	27-Oct-05	15:30	24.50	140	6	0	0	1	0	0	0	1	0	0	0
22-29 Oct	21	49.7	-5.283	27-Oct-05	23:45	22.25	80	0	3	0	0	0	0	0	57	3	2	0
22-29 Oct	21	49.7	-5.283	27-Oct-05	23:45	22.25	100	2	0	0	0	0	0	0	17	0	0	2
22-29 Oct	21	49.7	-5.283	27-Oct-05	23:45	22.25	120	0	0	4	0	0	0	0	1	0	3	0

APPENDIX 1 continued: Station and catch (in numbers) details for 11 species of fish.

TRIP No	HAUL	SHOT LAT	SHOT LONG	SHOT DATE	SHOT TIME	SOAK hrs	MESH mm	HKE_ N	HAD_ N	COD_ N	MON_ N	WHG_ N	POL _N	MEG_N	BIB_N	MUR_ N	LIN_N	POK_ N
22-29 Oct	21	49.7	-5.283	27-Oct-05	23:45	22.25	140	2	0	2	0	0	2	0	0	0	5	0
7-14 Nov	1	50.4	-6	07-Nov-05	13:30	22.50	80	28	2	1	0	6	0	0	6	8	6	0
7-14 Nov	1	50.4	-6	07-Nov-05	13:30	22.50	100	6	0	3	0	6	0	0	24	0	2	0
7-14 Nov	1	50.4	-6	07-Nov-05	13:30	22.50	120	6	0	6	0	3	0	1	2	0	1	0
7-14 Nov	1	50.4	-6	07-Nov-05	13:30	22.50	140	1	0	2	0	0	0	1	1	0	0	0
7-14 Nov	2	50.383	-6.083	07-Nov-05	14:00	26.00	80	7	0	0	0	3	3	0	7	5	6	1
7-14 Nov	2	50.383	-6.083	07-Nov-05	14:00	26.00	100	8	0	1	0	1	5	0	8	0	4	0
7-14 Nov	2	50.383	-6.083	07-Nov-05	14:00	26.00	120	7	0	1	0	1	15	0	0	0	3	0
7-14 Nov	2	50.383	-6.083	07-Nov-05	14:00	26.00	140	0	0	5	0	0	2	0	0	0	2	0
7-14 Nov	4	50.433	-6.067	07-Nov-05	17:00	28.00	80	4	0	1	0	12	1	0	0	1	8	0
7-14 Nov	4	50.433	-6.067	07-Nov-05	17:00	28.00	100	13	0	2	0	1	8	0	17	0	4	0
7-14 Nov	4	50.433	-6.067	07-Nov-05	17:00	28.00	120	4	1	2	0	3	2	0	4	0	0	1
7-14 Nov	4	50.433	-6.067	07-Nov-05	17:00	28.00	140	4	0	0	0	2	1	1	0	0	1	0
7-14 Nov	5	50.4	-6.067	08-Nov-05	13:30	22.50	80	8	0	0	0	10	4	0	9	1	9	1
7-14 Nov	5	50.4	-6.067	08-Nov-05	13:30	22.50	100	6	1	1	0	3	1	0	24	0	5	0
7-14 Nov	5	50.4	-6.067	08-Nov-05	13:30	22.50	120	4	0	2	1	0	18	0	5	0	3	0
7-14 Nov	5	50.4	-6.067	08-Nov-05	13:30	22.50	140	2	0	1	0	0	3	0	0	0	2	0
7-14 Nov	6	50.383	-6.05	08-Nov-05	17:00	21.00	80	10	0	2	0	4	0	0	4	4	3	0
7-14 Nov	6	50.383	-6.05	08-Nov-05	17:00	21.00	100	13	0	2	0	10	0	0	8	0	3	0
7-14 Nov	6	50.383	-6.05	08-Nov-05	17:00	21.00	120	34	4	13	0	1	4	0	15	1	3	0
7-14 Nov	6	50.383	-6.05	08-Nov-05	17:00	21.00	140	2	0	1	0	1	0	0	0	0	0	0
7-14 Nov	7	50.4	-6.1	09-Nov-05	00:00	19.00	80	9	0	1	0	6	3	0	7	5	7	0
7-14 Nov	7	50.4	-6.1	09-Nov-05	00:00	19.00	100	23	1	3	0	3	2	0	9	0	2	0
7-14 Nov	7	50.4	-6.1	09-Nov-05	00:00	19.00	120	6	2	10	0	3	0	0	1	0	0	0
7-14 Nov	7	50.4	-6.1	09-Nov-05	00:00	19.00	140	4	0	6	1	2	0	0	0	0	0	0
7-14 Nov	10	50.4	-5.917	09-Nov-05	16:00	21.00	80	10	0	1	0	2	4	0	31	4	8	0
7-14 Nov	10	50.4	-5.917	09-Nov-05	16:00	21.00	100	2	0	1	0	0	10	0	109	1	6	0
7-14 Nov	10	50.4	-5.917	09-Nov-05	16:00	21.00	120	3	0	2	0	1	0	0	0	0	0	0
7-14 Nov	10	50.4	-5.917	09-Nov-05	16:00	21.00	140	1	1	2	0	0	5	0	5	0	2	0
7-14 Nov	11	50.417	-5.983	09-Nov-05	17:00	24.00	80	2	3	0	0	34	0	0	16	2	4	0
7-14 Nov	11	50.417	-5.983	09-Nov-05	17:00	24.00	100	14	1	1	0	19	1	0	15	0	2	0

APPENDIX 1 continued: Station and catch (in numbers) details for 11 species of fish.

TRIP No	HAUL	SHOT LAT	SHOT LONG	SHOT DATE	SHOT TIME	SOAK hrs	MESH mm	HKE_N	HAD_N	COD_N	MON_N	WHG_N	POL_N	MEG_N	BIB_N	MUR_N	LIN_N	POK_N
7-14 Nov	11	50.417	-5.983	09-Nov-05	17:00	24.00	120	3	2	10	0	9	0	0	2	0	1	0
7-14 Nov	11	50.417	-5.983	09-Nov-05	17:00	24.00	140	3	0	3	1	8	0	2	1	0	0	0
7-14 Nov	13	50.383	-6.067	10-Nov-05	00:00	22.00	80	21	3	2	0	10	0	0	5	3	2	0
7-14 Nov	13	50.383	-6.067	10-Nov-05	00:00	22.00	100	4	1	1	0	10	1	0	39	0	1	0
7-14 Nov	13	50.383	-6.067	10-Nov-05	00:00	22.00	120	2	1	3	0	5	0	0	0	0	0	0
7-14 Nov	13	50.383	-6.067	10-Nov-05	00:00	22.00	140	4	1	6	0	15	0	0	2	0	0	0
7-14 Nov	15	50.867	-6.4	11-Nov-05	04:00	30.00	80	0	10	2	0	41	0	1	0	0	15	0
7-14 Nov	15	50.867	-6.4	11-Nov-05	04:00	30.00	100	2	23	3	0	11	1	0	0	0	12	0
7-14 Nov	15	50.867	-6.4	11-Nov-05	04:00	30.00	120	1	19	6	0	4	3	1	0	0	2	0
7-14 Nov	15	50.867	-6.4	11-Nov-05	04:00	30.00	140	2	6	2	0	0	1	2	0	0	0	0
7-14 Nov	16	50.867	-6.467	11-Nov-05	05:00	33.00	80	1	2	1	0	14	11	0	0	0	27	0
7-14 Nov	16	50.867	-6.467	11-Nov-05	05:00	33.00	100	1	15	1	0	2	4	0	2	0	26	0
7-14 Nov	16	50.867	-6.467	11-Nov-05	05:00	33.00	120	3	15	5	0	8	1	1	0	0	6	2
7-14 Nov	16	50.867	-6.467	11-Nov-05	05:00	33.00	140	1	5	4	0	6	0	0	0	0	2	0
7-14 Nov	17	50.867	-6.583	11-Nov-05	16:30	27.50	80	11	4	2	0	33	0	2	0	0	5	3
7-14 Nov	17	50.867	-6.583	11-Nov-05	16:30	27.50	100	16	11	4	0	10	1	2	8	0	15	3
7-14 Nov	17	50.867	-6.583	11-Nov-05	16:30	27.50	120	1	12	4	0	7	1	1	1	0	2	0
7-14 Nov	17	50.867	-6.583	11-Nov-05	16:30	27.50	140	2	4	2	0	2	1	0	0	0	1	1
7-14 Nov	19	50.85	-6.533	12-Nov-05	11:00	23.00	80	1	4	0	0	31	2	1	2	0	8	0
7-14 Nov	19	50.85	-6.533	12-Nov-05	11:00	23.00	100	1	11	3	0	10	1	0	1	0	6	1
7-14 Nov	19	50.85	-6.533	12-Nov-05	11:00	23.00	120	1	11	4	0	1	0	0	0	0	3	1
7-14 Nov	19	50.85	-6.533	12-Nov-05	11:00	23.00	140	0	2	0	0	0	1	0	0	0	0	0
7-14 Nov	22	50.817	-6.617	12-Nov-05	15:00	27.00	80	1	1	0	0	3	3	0	0	0	16	0
7-14 Nov	22	50.817	-6.617	12-Nov-05	15:00	27.00	100	3	12	0	0	1	3	0	2	0	11	0
7-14 Nov	22	50.817	-6.617	12-Nov-05	15:00	27.00	120	4	9	0	0	2	4	2	1	0	17	0
7-14 Nov	22	50.817	-6.617	12-Nov-05	15:00	27.00	140	0	3	2	0	0	3	0	1	0	0	0
8-15 Oct	1	50.517	-6.35	08-Oct-05	16:00	18.50	80	1	0	2	0	3	0	0	1	0	2	0
8-15 Oct	1	50.517	-6.35	08-Oct-05	16:00	18.50	100	0	3	1	0	0	1	1	9	0	1	0
8-15 Oct	1	50.517	-6.35	08-Oct-05	16:00	18.50	120	1	3	3	0	0	1	1	1	0	0	0

APPENDIX 1 continued: Station and catch (in numbers) details for 11 species of fish.

TRIP No	HAUL	SHOT LAT	SHOT LONG	SHOT DATE	SHOT TIME	SOAK hrs	MESH mm	HKE_ N	HAD_ N	COD_ N	MON_ N	WHG_ N	POL _N	MEG_N	BIB_N	MUR_ N	LIN_N	POK_ N
8-15 Oct	1	50.517	-6.35	08-Oct-05	16:00	18.50	140	3	0	1	0	0	0	0	0	0	0	0
8-15 Oct	3	50.517	-6.55	08-Oct-05	17:30	23.50	80	2	2	1	0	2	0	0	0	0	7	0
8-15 Oct	3	50.517	-6.55	08-Oct-05	17:30	23.50	100	5	8	2	0	0	0	0	0	0	2	0
8-15 Oct	3	50.517	-6.55	08-Oct-05	17:30	23.50	120	3	10	2	0	0	2	0	0	0	1	0
8-15 Oct	3	50.517	-6.55	08-Oct-05	17:30	23.50	140	1	1	2	0	0	0	0	0	0	0	0
8-15 Oct	5	50.533	-6.5	08-Oct-05	19:00	28.00	80	0	13	0	0	14	1	0	0	0	4	1
8-15 Oct	5	50.533	-6.5	08-Oct-05	19:00	28.00	100	3	11	3	0	1	0	0	0	0	6	2
8-15 Oct	5	50.533	-6.5	08-Oct-05	19:00	28.00	120	4	12	2	0	0	0	1	0	0	3	0
8-15 Oct	5	50.533	-6.5	08-Oct-05	19:00	28.00	140	4	2	0	0	0	0	0	0	0	0	0
8-15 Oct	7	50.533	-6.45	09-Oct-05	15:00	25.00	80	1	4	1	0	8	0	0	0	0	4	0
8-15 Oct	7	50.533	-6.45	09-Oct-05	15:00	25.00	100	0	14	3	0	0	0	1	0	0	4	1
8-15 Oct	7	50.533	-6.45	09-Oct-05	15:00	25.00	120	4	13	3	0	1	2	1	0	0	0	0
8-15 Oct	7	50.533	-6.45	09-Oct-05	15:00	25.00	140	1	4	2	0	0	0	0	0	0	0	0
8-15 Oct	9	50.533	-6.567	09-Oct-05	23:00	21.50	80	3	3	0	0	2	0	0	0	0	4	0
8-15 Oct	9	50.533	-6.567	09-Oct-05	23:00	21.50	100	5	8	1	0	0	0	1	0	0	2	0
8-15 Oct	9	50.533	-6.567	09-Oct-05	23:00	21.50	120	4	10	2	0	0	0	0	1	0	0	0
8-15 Oct	9	50.533	-6.567	09-Oct-05	23:00	21.50	140	2	2	3	0	0	0	0	0	0	0	0
8-15 Oct	10	50.533	-6.517	10-Oct-05	00:15	34.75	80	2	4	0	0	5	0	0	0	0	7	0
8-15 Oct	10	50.533	-6.517	10-Oct-05	00:15	34.75	100	6	19	1	0	1	2	0	0	0	3	0
8-15 Oct	10	50.533	-6.517	10-Oct-05	00:15	34.75	120	2	26	2	0	0	0	0	0	0	0	0
8-15 Oct	10	50.533	-6.517	10-Oct-05	00:15	34.75	140	1	2	0	0	0	0	0	0	0	1	0
8-15 Oct	12	50.533	-6.333	10-Oct-05	21:30	20.00	80	3	2	0	0	6	0	0	0	0	6	0
8-15 Oct	12	50.533	-6.333	10-Oct-05	21:30	20.00	100	4	5	0	0	1	0	0	0	0	1	0
8-15 Oct	12	50.533	-6.333	10-Oct-05	21:30	20.00	120	6	16	4	0	0	3	1	0	0	1	0
8-15 Oct	12	50.533	-6.333	10-Oct-05	21:30	20.00	140	1	1	2	0	0	0	0	0	0	0	0
8-15 Oct	14	50.517	-6.333	10-Oct-05	23:00	12.00	80	4	1	2	0	4	0	0	7	0	14	2
8-15 Oct	14	50.517	-6.333	10-Oct-05	23:00	12.00	100	7	11	2	0	3	2	0	0	0	0	0
8-15 Oct	14	50.517	-6.333	10-Oct-05	23:00	12.00	120	10	13	3	1	1	0	0	0	0	1	0
8-15 Oct	14	50.517	-6.333	10-Oct-05	23:00	12.00	140	3	2	3	0	1	0	0	0	0	0	0
8-15 Oct	15	50.55	-6.2	11-Oct-05	15:30	21.50	80	1	3	2	0	9	0	0	0	1	6	0
8-15 Oct	15	50.55	-6.2	11-Oct-05	15:30	21.50	100	7	4	0	0	2	0	0	2	0	0	0

APPENDIX 1 continued: Station and catch (in numbers) details for 11 species of fish.

TRIP No	HAUL	SHOT LAT	SHOT LONG	SHOT DATE	SHOT TIME	SOAK hrs	MESH mm	HKE_N	HAD_N	COD_N	MON_N	WHG_N	POL_N	MEG_N	BIB_N	MUR_N	LIN_N	POK_N
8-15 Oct	15	50.55	-6.2	11-Oct-05	15:30	21.50	120	5	2	0	0	0	0	1	1	0	0	0
8-15 Oct	15	50.55	-6.2	11-Oct-05	15:30	21.50	140	3	0	1	1	0	0	0	0	0	0	0
8-15 Oct	16	50.517	-6.217	11-Oct-05	23:00	16.00	80	0	1	2	0	4	0	0	0	0	4	0
8-15 Oct	16	50.517	-6.217	11-Oct-05	23:00	16.00	100	2	1	0	0	2	0	0	2	0	2	0
8-15 Oct	16	50.517	-6.217	11-Oct-05	23:00	16.00	120	4	0	0	0	0	0	0	0	0	0	0
8-15 Oct	16	50.517	-6.217	11-Oct-05	23:00	16.00	140	5	0	1	0	0	0	0	0	0	0	0
8-15 Oct	20	50.533	-6.15	12-Oct-05	18:30	22.50	80	4	0	0	0	11	2	0	6	0	2	0
8-15 Oct	20	50.533	-6.15	12-Oct-05	18:30	22.50	100	1	1	1	0	2	0	0	2	0	1	0
8-15 Oct	20	50.533	-6.15	12-Oct-05	18:30	22.50	120	11	2	1	1	0	0	0	0	0	0	1
8-15 Oct	20	50.533	-6.15	12-Oct-05	18:30	22.50	140	2	2	2	1	2	0	2	1	0	0	0
8-15 Oct	21	50.45	-6.1	12-Oct-05	16:00	27.50	80	8	0	0	0	31	1	0	5	1	5	0
8-15 Oct	21	50.45	-6.1	12-Oct-05	16:00	27.50	100	16	0	2	0	12	0	0	1	0	2	0
8-15 Oct	21	50.45	-6.1	12-Oct-05	16:00	27.50	120	12	0	4	0	0	0	0	2	0	1	0
8-15 Oct	21	50.45	-6.1	12-Oct-05	16:00	27.50	140	11	0	4	0	0	1	3	0	0	0	0
8-15 Oct	22	50.45	-6.033	12-Oct-05	15:30	31.00	80	63	1	1	0	2	1	0	17	7	2	0
8-15 Oct	22	50.45	-6.033	12-Oct-05	15:30	31.00	100	64	1	2	0	0	0	0	14	0	8	0
8-15 Oct	22	50.45	-6.033	12-Oct-05	15:30	31.00	120	50	0	14	0	0	3	0	8	0	6	1
8-15 Oct	22	50.45	-6.033	12-Oct-05	15:30	31.00	140	12	0	3	0	0	1	0	0	0	2	1
8-15 Oct	25	50.467	-6.083	13-Oct-05	23:45	19.25	80	4	1	0	0	21	0	0	0	0	2	0
8-15 Oct	25	50.467	-6.083	13-Oct-05	23:45	19.25	100	9	0	0	0	2	0	2	7	0	0	0
8-15 Oct	25	50.467	-6.083	13-Oct-05	23:45	19.25	120	19	0	0	0	0	2	0	3	0	1	1
8-15 Oct	25	50.467	-6.083	13-Oct-05	23:45	19.25	140	1	0	4	0	0	0	1	0	0	1	0
8-15 Oct	26	50.45	-6.083	14-Oct-05	00:30	21.50	80	35	1	2	0	3	1	0	8	2	4	0
8-15 Oct	26	50.45	-6.083	14-Oct-05	00:30	21.50	100	27	3	2	0	2	0	0	10	0	3	0
8-15 Oct	26	50.45	-6.083	14-Oct-05	00:30	21.50	120	28	0	5	0	0	0	0	1	0	3	1
8-15 Oct	26	50.45	-6.083	14-Oct-05	00:30	21.50	140	1	0	1	0	0	1	0	1	0	0	1

Appendix 2: Detailed Operational Plan

Fisheries Science Partnership 2005/6

Hake Gill Net Selectivity

Detailed Operational Plan

1. Vessel: Carole H

2. Skipper: Phil Mitchell

3. Owner: Barney Thomas

4. Port of operations: Newlyn, Cornwall

5. Period and location of Survey: 3 trips (each one up to a maximum of nine days per trip). Total survey time not to exceed 27 days. To be conducted during the period between 22 September and 30th November 2005. Vessel can fish within ICES area VII e, f, g and h for the period of the survey.

6. Quota: Vessel will be off quota and the relevant dispensation from European Council Regulation 850/98 will be issued. This is to be carried onboard by CEFAS representative scientist all times onboard during the survey. The dispensation will only be valid if the terms of the dispensation are met in full. CEFAS will make arrangements with Defra for the dispensation to be issued.

7. Primary aim of the survey: To target hake with gill nets and record hake catches using a range of mesh sizes. These will include the industry standard mesh size, and meshes both above and below that industry standard mesh size. Obtaining the data from the gill nets over the range of mesh sizes must take precedence over all other fishing considerations, other than those concerning safety and the well being of the crew.

8. Why do this survey? The data obtained will potentially demonstrate the length ranges of hake currently caught by the commercial hake gill net fleet in SW England. The catches from the larger and smaller mesh-sized gill-nets will demonstrate the catches of hake in relation to these mesh sizes. A comparison of the catches from all the different meshes can be used to estimate the selectivity of the industry standard nets, i.e. to demonstrate what proportion of hake at each length group are caught by a certain mesh size of gill net and what proportion are not caught.

9. Gill net plan and deployment regimen. A plan of the gill nets and the fleets must be drawn up prior to sailing. This must detail exactly how many gill nets are in each fleet and what are the mesh sizes of the gill nets in each fleet. This must be provided to all participants before departure. It is extremely important that catches can be specifically related back to a particular gill net mesh size at all times. An agreed protocol for the deployment and retrieval of the gill nets must be agreed prior to departure.

10. What data needs to be recorded? It is particularly important in selectivity studies to obtain good quality data with as little data raised as possible. It should therefore be made a priority to obtain such data and preference should be given to obtaining fewer hauls, with quality data, rather than many hauls with lower quality data.

Preference should also be given to obtaining data from similar haul quantities of each mesh size. i.e. There is little point in collecting data from 50 hauls of mesh size 100mm and only data from 2 hauls with 80mm.

a) Haul details

Date
Time
Position of nets (Markers buoys lat and long)
Length of net
No of nets in fleet
Specific mesh sizes of nets in fleet and how many of each mesh size in each fleet and in what order
Depth range
ICES rectangle
Time of shooting
Time of hauling
Soak time
Any other useful comments such as tidal flow, weather etc.

b) Catch
All catch needs to be recorded (not benthos)
Species
Length
How the animal is caught on net i.e. by teeth (T) / gilled (G)/ ? any other way
Whether discarded / retained
What gill net (mesh size) the catch originates from
Any other useful comments

11. Crew and skipper. The crew are to be available to assist the CEFAS scientist onboard whenever requested / required. The skipper will retain the usual authority and responsibilities and has the overriding responsibility to ensure safety of the vessel and all persons aboard.

12. Cruise reports. On completion of each of the three trips a short summary of the cruise, including successes and failures, points of interest should be complied by the CEFAS scientist. The skipper / owner should sign to agree with the contents of the cruise report.

I agree to adhere to this detailed operational plan

……on behalf of CEFAS ……..Date

…….....Skipper Carole H……Date

APPENDIX 3: Hake Programme 8, 2005: Estimation of net selectivity.

General points

Methods for estimating the selectivity of gill nets generally require that different mesh sizes are fished and retrieved together as different panels in each fleet of nets. In this way, the numbers of fish present in the vicinity of the nets, and the fishing effort applied is common for all mesh sizes and can be ignored in the calculations.

Baranov's principle of geometric similarity provides an important basis for several methods for estimating the selectivity of gill nets. This principle states that fish girth tends to be proportional to length for each species, and that the modal (most frequent) length that will be caught by a gill net will therefore be proportional to length. Modal catch rates from different mesh sizes can be made to coincide approximately by transforming the length scale to units of length/mesh size. This is referred to as 'transformed length'.

The data analysed were from the mesh comparison fleets only and excluded those from the 120 mm nets fished commercially. The analyses ignore the distinction between gilled and toothed fish in order to produce one overall result. Small numbers caught were retained in the analyses in order to have sufficient results to work with. Unfortunately, this increases the expected variability of the estimates. Slightly different ranges of length classes were chosen for each method, as seemed most appropriate for the calculations to be made.

Estimated mean selection lengths and standard deviations, and the selection plots on length (untransformed) from all methods are given in the main part of this report. For the Jensen and McCrombie&Fry methods, these represent back-transformations from the average means and standard deviations fitted to all mesh sizes (shown as Appendix figures A3.1 and A3.3).

Jensen method (Hovgård and Lassen, 2000)

Numbers of fish caught by each mesh size in each length class are transformed to fractions of the maximum number caught by any of the mesh sizes that caught that length class. The fractions, referred to as 'selection' fractions are plotted against transformed length for all meshes. A mean and standard deviation are then fitted to the combined selection curve and back-transformed to the original length scale. Jensen's method:

1. Assumes Baranov's principle of geometric similarity.
2. Assumes that ratio of catches, C, at any length l by two gears, $g1$, $g2$, depend only on their relative selectivity, S:
$$\frac{C_{l,g1}}{C_{l,g2}} = \frac{S_{l,g1}}{S_{l,g2}}$$
3. Since there are 2 unknown selectivity values, the method must also assume that the gear catching the most fish at a particular l is selecting 100% of the fish of that size. This limits the length range that may be used in the analysis because if the largest catch occurs in the smallest or largest mesh size one cannot assume that a larger catch would not have been obtained in a more extreme mesh size.
4. Assumes normal distribution for selection curve with the same mean and variance in terms of transformed lengths. This means that the selectivity of different meshes are

assumed only to relate to modal length, i.e. they differ by one parameter only. This avoids the problem of relative selectivity of different meshes varying with length.

The analysis was carried out with length classes from 55 to 90 cm. The Jensen selection plots on transformed length are shown in Figure A3.1.

Holt method (Holt, 1963)

Mesh sizes are paired sequentially. We used: 80 and 100, 100 and 120, 120 and 140 mm. The log of the catch ratios for each pair in each length class are regressed against length. The estimated intercept and slope allow calculation of mean selection length and standard deviation. Holt's method:

1. Assumes that the length-selection curve is a normal distribution of constant variance for nets of similar mesh size. This forms the starting point for the mathematics. Baranov's principle of geometric similarity is not used.
2. Assumes that the fishing power (but not the selectivity) of two nets of similar but not identical meshes is the same. This allows cancellation of abundance and availability terms; also, as an approximation, of relative fishing powers.
3. Log catch ratios at length, *l*, for two nearly similar mesh sizes, A & B, become a linear function of length. Estimation of slope and intercept allows calculation of $k = E(l/m)$ and σ^2 for $m = mean(A, B)$.
4. Selection curves are $N(km, \sigma^2)$. One has the choice of averaging *k* and σ^2 across all mesh pairs, or using individual values for each, depending whether $-2a/b \propto meshA + meshB$. If not, the initial normal distribution assumption is inadequate.

The analysis was carried out with length classes from 51 to 91 cm. The Holt plots of log catch ratios on length for the three pairs of mesh sizes are shown in Figure A3.2. Results for the 120/140mm were highly variable because of the low catches in 140mm. The estimate of *k* was therefore taken as the average of estimates from 80/100 and 100/120mm only. The standard deviation of the selection curves was found to increase with increasing mesh size, being 15.4 for the 80/100 mm pair, 18.8 for the 100/120 mm pair, and 58.7 for the 120/140 mm pair. Separate normal distributions were therefore fitted to each pair with no attempt to pool the estimates. The selection curve for 120/140 mm should be considered unreliable as a consequence of the low catches in 140mm.

McCrombie and Fry method (McCrombie and Fry, 1960)

Numbers of fish caught by each mesh size in each length class are transformed to fractions of the total number caught by all the mesh sizes that caught that length class. The fractions, referred to as 'selection' fractions (but constructed in relation to the total numbers rather than to the maximum as used for the Jensen method), are plotted against transformed length for all lengths. A mean and standard deviation are then fitted to the combined selection curve and back-transformed to the original length scale. McCrombie and Fry's method:

1. Assumes Baranov's principle of geometric similarity.
2. Assumes that catches at different lengths are made with equal efficiency by the most effective mesh size for each length.

3. Assumes that transformed catch numbers can be fitted by the same distribution at each length, usually normal, with constant mean and variance.

The analysis was carried out with length classes from 55 to 90 cm. The McCrombie and Fry selection curves on transformed length are shown in Figure A3.3. The data form a bell shaped pattern, as expected for a normal distribution.

References

Holt, S. J. (1963). A method for determining gear selectivity and its application. *ICNAF Special Publication* 5: 106-115.

Hovgård, H. and H. Lassen (2000). *Manual on estimation of selectivity for gillnet and longline gears in abundance surveys.* Rome, FAO. 84pp.

McCrombie, A. M. and F. E. J. Fry (1960). Selectivity of gill nets for lake whitefish, *Coregonus clupeaformis*. *Transactions of the American Fisheries Society* 89: 176-184.

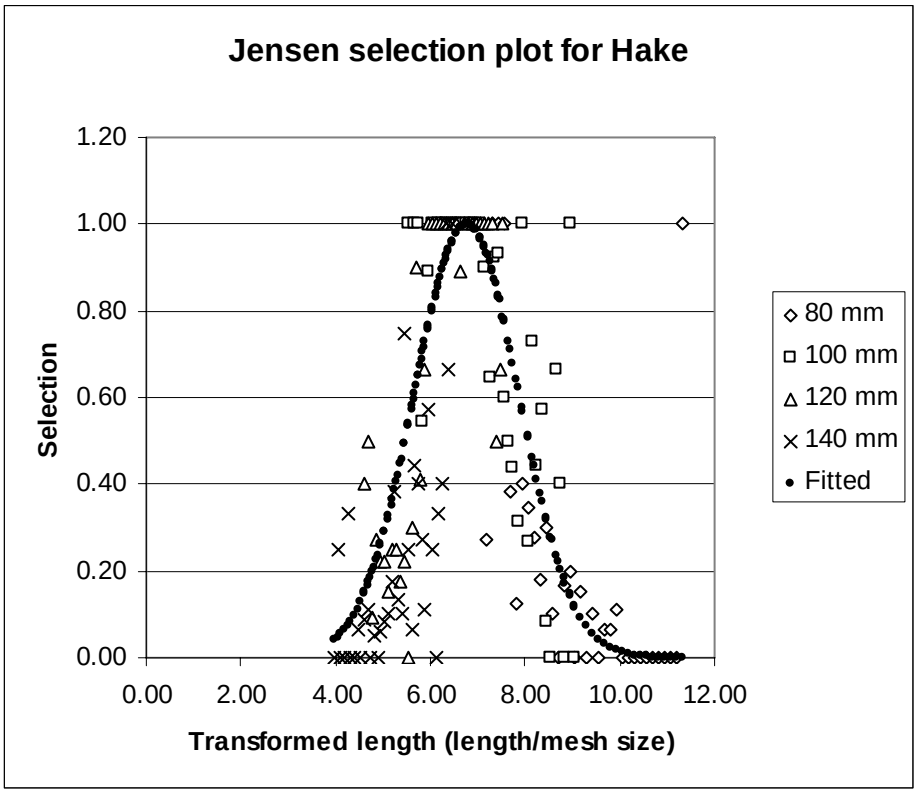


Fig. A3.1 FSP Hake selectivity, 2005. Jensen method: selection vs transformed length, as estimated for gilled and toothed hake, all trips combined.

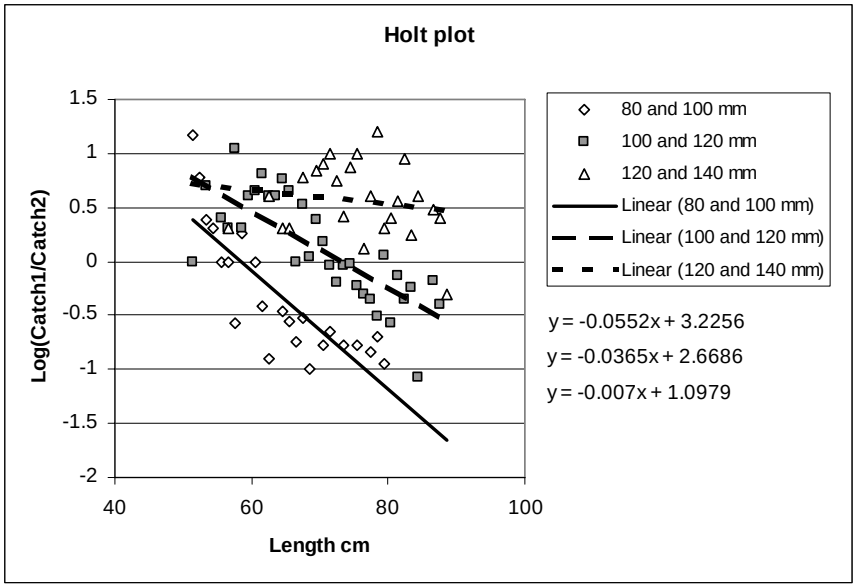


Fig. A3.2 FSP Hake selectivity, 2005. Holt plot of log catch ratios vs fish length for pairs of mesh sizes, as estimated for gilled and toothed hake. All trips combined. Regression equations for the lines (in mesh order) are in lower right corner.

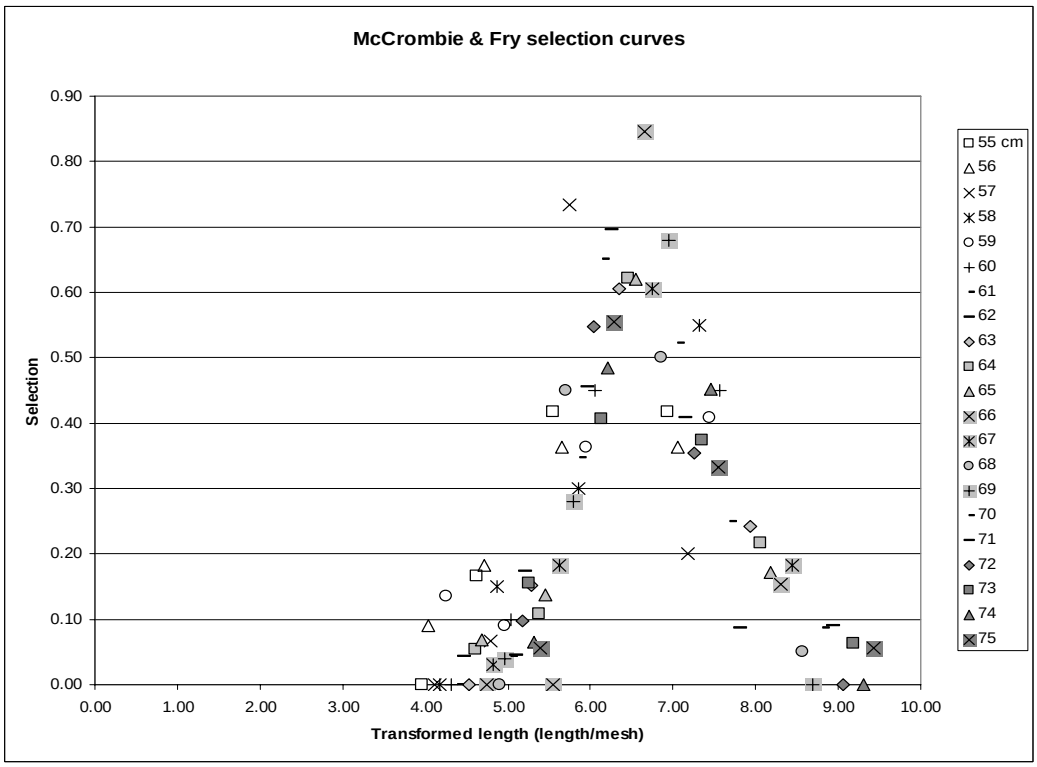


Fig. A3.3 FSP Hake selectivity, 2005. McCrombie & Fry method: Selection vs transformed length, as estimated for gilled and toothed hake, all trips combined. Key at right shows cm-length classes used. Length classes > 75 cm are omitted for clarity.