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DEVELOPMENT OF A SPECIES-SELECTIVE TRAWL FOR DEMERSAL GADOID FISHERIES

by

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ABSTRACT

An experiment was carried out to test a prototype species-selective bottom trawl for separating cod from haddock, secondarily saithe, in the Norwegian commercial roundfish fisheries. A sorting system incorporating a horizontal square mesh panel (150 mm bar length) dividing the trawl's body and extension sections into upper and lower compartments, leading aft to vertically-oriented trouser codends, was installed in a commercial roundfish trawl. First tests of the system, fishing around the clock, demonstrated approximately 90% haddock separation into the upper codend, 71% cod separation into the lower codend, and 72% saithe separation into the upper codend. *In situ* video observations showed that fish, apparently haddock, entered the trawl at all levels, but subsequently many of those in the lower half attacked upwards and through the separating panel along its length as they passed towards the trouser codends. Applicability of the sorting system to commercial fisheries is discussed.

INTRODUCTION

Quotas are an important tool for regulating the exploitation of individual species in multispecies fisheries. Variations in year class strength and differences in growth rates may consequently result in varying relationships from one year to another among the various species quotas.

In the Norwegian groundfish trawl fisheries in the Barents Sea the principal target species are cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and saithe (*Pollachius virens*). Exploitation of these species, especially cod and haddock, is presently regulated by individual vessel quotas. In situations where a vessel's initial quota for one species is low relative to the other, or it has caught a disproportionately large portion of its quota for one species, practical difficulties can arise in terms of catching the balance of its quotas for the other species since these species commonly occur together.

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Following up the implications of the classic description by Main and Sangster (1981) of species-related differences in the reactions of fish to trawls, which reported the behaviour of several roundfish species including cod, haddock and saithe, several experiments have been carried out attempting to utilize these behavioural differences in designing trawls that can separate these species. Main and Sangster (1982) tested a three-level trawl to determine in which level various species were caught. They found that cod primarily entered the lower part of the trawl, while the majority of haddock in the mouth of the trawl consistently rose from the seabed to enter the trawl in its uppermost level. However, a similar Norwegian experiment with a two-level trawl in the Barents Sea gave variable results from haul to haul with respect to the catch composition of cod and haddock in the two levels (Valdemarsen et al. 1985). Both of these experiments were carried out with a relatively small-meshed horizontal dividing panel or panels mounted above and more-or-less parallel to the fishing line which served to divide the trawl into different sections. Although no *in situ* observations or measurements were carried out, one possible explanation for the variable results in the Norwegian experiment is that the performance of this dividing panel, i.e. its height above bottom, may have varied with variations in the configuration and performance of the rest of the gear such as gear spread, towing speed, catch weight, etc. Supporting this reasoning is the observation that Main and Sangster reported expending considerable effort, including numerous direct observations and trial tows, before they obtained satisfactory gear configuration and sorting results.

In unreported Norwegian research, preliminary studies of the distribution and behaviour of cod and haddock in the extension of a bottom trawl were carried out by the use of underwater TV cameras, with horizontal ropes as reference marks to indicate the upper and lower regions of the extension section. These observations showed that haddock passing aftwards towards the codend tended to rise upwards within the extension. Few cod and saithe were observed during these studies. However, these observations led to the idea that it may be possible to separate cod and haddock within the body and extension of a trawl, and not just in the mouth area, by using a horizontal separating panel of a mesh size large enough for haddock to easily penetrate, and which would hopefully discourage cod in the lower level from escaping upwards and through it. Experiments in the Barents Sea in 1993 and 1994 with such a dividing panel, made of 300 mm square mesh (or 150 mm bar length), in the extension section of a experimental trawl gave promising results with respect to separating cod and haddock. Approximately 70% of the haddock captured were found in the upper codend, while around 70% of cod were caught in the lower codend (unpublished data). However, due to practical problems experienced while attempting to use this experimental trawl on all bottom types and due to handling problems onboard the vessel, we decided to repeat these experiments but this time incorporating the sorting modifications into a commercial trawl already in widespread use by commercial fishermen. Further encouragement was offered by the results of an experiment reported by Moth-Poulsen (1994), testing a similar technique for separating demersal roundfish species within the codend and extension section of a trawl.

MATERIALS AND METHODS

Cruise and vessel information

The experimental cruise was carried out between 19 April through 3 May 1995 on four different commercial fishing grounds (depths 120 to 280 m) in the Barents Sea onboard the 2400 Bhp Norwegian stern trawler "Anny Kræmer." This vessel is equipped with dual slipways so that two trawls may be rigged and ready for use at all times.

Experimental gear and operations

Three trawls were used for these experiments, one unmodified "Alfredo # 5" groundfish trawl belonging to the vessel, and two identical experimental trawls. The experimental trawls were modified "Maxi" two-panel commercial groundfish trawls, which are among the popular gear types presently used in the Norwegian Barents Sea fisheries, sized to suit the vessel's horsepower and similar in overall size and other characteristics to the vessel's "Alfredo # 5."

The experimental modifications to the Maxi trawls, depicted in Figure 1, comprised a replacement for the back body and extension sections. The primary functional purpose of the modification was to adapt the trawl from its original single-codend configuration to a vertically-oriented trouser configuration, with two identical full-sized commercial codends arranged one above the other. A horizontally-oriented large-mesh (150 mm bar length) square mesh separating panel was installed between the selvedges joining the upper and lower panels, extending from the front of the trouser junction forwards to the aft end of the first belly behind the fishing circle (see Figs. 1 & 2 for construction and general operating configuration). The separating panel was tailored to be stretched tight at an assumed transverse mesh opening coefficient of 30% in the meshes of the trawl body, dividing the trawl body into upper and lower compartments leading to the upper and lower codends. Otherwise, mesh sizes, twine diameters, etc., approximated normal commercial practice.

During the early stages of the cruise, the portside experimental trawl was additionally fitted with a small-mesh funnel (Fig. 3) in the lower extension section, approximately one meter aft of the end of the separating panel. The purpose of this funnel was to provide an artificial constriction in the lumen of the lower extension in order to interrupt the free passage of fish towards the codend and offer them an incentive and opportunity to make additional escape attempts. After fifteen tows with the trawl in this configuration the funnel was removed, and for the remainder of the cruise the port and starboard trawls were configured identically.

All codends used during this experiment were ordinary commercial codends legal for use in the Norwegian Barents Sea groundfish fisheries, of nominal 136 mm minimum inside mesh measurement. Since this was not a mesh selectivity experiment codend mesh measurements were given a low priority, and no measurements were made on the Alfredo trawl's codend. The upper codends on each of the two experimental trawls were made of double 6 mm polyethylene netting, while the two lower codends were made of double polyamide twine, 90 meters/kg runnage. At the end of the experiment, measurements were made of a sample of the meshes in the four experimental trawl codends, using a hand-held wedge-type gauge thrust into the netting. 20 meshes were measured on each codend, working forward from a point

five meshes above the cod-end closure and approximately one-half of the way across the upper panel of the codend. Average measured mesh sizes (inside measure) were as follows:

Codend	Starboard lower	Starboard upper	Port lower	Port upper
Mean:	141.05 mm	144.40 mm	147.80 mm	142.10 mm
S.D.:	2.65 mm	3.08 mm	2.55 mm	3.31 mm

The modified Maxi trawls were rigged with conventional rockhopper footropes (50 cm diameter) and a double bridle rigging system, 174.5 meters in overall length (Fig. 4). The vessel used steel V-doors of roughly 9 sq m surface area, weighing 2000 kg each.

The trouser trawl technique was employed for the bulk of the experiment. However, in order to verify qualitatively that the experimental trawls performed in a manner comparable to standard commercial gear, during the first three days four tows were made with the ship's conventional Alfredo trawl, interspersed among the experimental tows in a rough alternate-haul framework. Afterwards the Alfredo was replaced by the second experimental trawl and was not used any further during the study. Even though the analysis employed the trouser trawl methodology, in which each tow with an experimental trawl constituted an independent experiment, an effort was made to alternate hauls between the port and starboard experimental trawls in order to ensure that over the course of the cruise both trawls sampled the same fish populations. This also permitted an evaluation of the effectiveness of the funnel mentioned above, employing a rough alternate-haul analysis.

Fishing operations took place around the clock, although at this season and at these latitudes full darkness was not encountered. Tow durations varied between one and four hours (with most either one or two hours in length) depending on fish densities, since the goal was to approximate commercial practice and obtain commercially-sized catches. In an effort to follow normal fishing practice as much as possible other operational decisions such as the doors' scope and the vessel's speed and course were left to the captain's discretion.

Shooting and hauling the gear, and handling the two codends and their catches, were straightforward. Catches from the two cod-ends were kept separate throughout the entire dumping and sampling process.

Data recording and analytical methods

During each haul various parameters were recorded by the master or mate on watch, or by scientific staff present on the bridge. These included: the haul number; the date; the starting and ending positions and times; and the bottom depth.

Estimates of total catch weight and species composition were recorded for each codend, based on the processed weight of the catch multiplied by a species-specific scaling factor for converting processed weight to round weight.

Catches from selected tows were sampled for length composition, recording total length (rounded down to the nearest whole centimeter). When this was done, efforts were made to

measure all individuals of the critical species (cod, haddock, and saithe), but often the catches of critical species, especially haddock in the upper codend and cod in the lower codend, were so large that it was necessary to subsample the catches. Whenever such subsampling was necessary, a scaling factor was obtained by counting all non-measured individuals as they passed through the processing line, and this factor was employed to scale up the numbers of individuals in each length class.

For each experimental haul, the following values were calculated: total catch (all species) in kilograms per hour in the upper and lower codends, and in both combined; similar catch/hr values for each of the critical species; and finally the proportion of each of the critical species captured in the upper codend during that tow. These values were then pooled for each experimental gear configuration, i.e. all hauls made with the port trawl with the funnel installed, all hauls made with the port trawl after the funnel had been removed, and all hauls made with the starboard experimental trawl. For each species, only those hauls where that species had been present in one of the codends were considered, hauls where that species was not observed in either codend were excluded from analysis.

An analysis of variance (ANOVA) was conducted on the individual haul upper codend catch rates and lower codend catch rates (Zar, 1974). We arbitrarily chose to treat the lower codend catch rates as the independent variable and the upper codend rates as the dependent variable in the case of cod, while the upper codend rates were the independent variable for haddock and saithe. The analysis of variance was conducted in two steps, first to determine whether or not there were significant differences in the species-based separation proportions between and among the three experimental gear configurations (port trawl with funnel vs. port trawl without funnel vs. starboard trawl), and then to determine whether the combined separation proportions were significantly different from an arbitrarily chosen target separation level. This critical target level was 50% separation (no effect) for cod and saithe, and 70% separation into the upper codend for haddock.

Absolute and relative length frequencies for each of the three species (all hauls pooled) were plotted to assess whether or not there were differences in the size composition of fish caught in the upper and lower codends. No attempt was made to assess the significance of these results.

Open-codend tests

Interspersed among the separation trials, several hauls were carried out with either the upper or the lower codend open. This was done in order to assess whether or not opening one codend would affect the catching performance of the closed codend. Such situations might arise in a fishery, for example if the fishermen were seeking haddock but had no wish to capture cod, or if they employed a relatively large mesh size in the lower codend so as to retain only the largest fish. We were concerned that having one codend open might unacceptably reduce the catching efficiency of the closed codend, or conversely result in unnaceptably high catches of the "wrong" species, either due to gear distortions arising from an imbalance in the hydrodynamic resistance between the upper and lower trouser legs or due to possible behavioural effects.

In order to assess this potential effect, catch rates by species during the open-codend tows were pooled and compared to the catch rates in the same codend taken during the "normal" tows made at about the same time, on a crude alternate-haul basis. No attempt was made to assess the significance of these results.

Behaviour observations

One haul was carried out solely in order to obtain video observations of the physical configuration of the experimental gear and the behaviour of fish within it. These were carried out with an "Ocean Rover" underwater towed vehicle, fitted with an S.I.T. camera and a high-frequency scanning sonar.

RESULTS

Haul data

In all, 60 hauls were carried out during the cruise, summarized in Appendix 1. Catches from the first haul made with the modified Maxi were compared to those from the four made with the Alfredo just to verify that the modified Maxi trawl was obtaining acceptable commercial-level catches, but were not otherwise analyzed. One of the remaining hauls was made with the Ocean Rover for the purposes of video observations and since this was necessarily conducted in shallower depths than the experimental tows the catch was not analyzed. Eleven hauls were conducted with one or the other codend open. Of the remaining 43 experimental hauls, one was excluded from the analysis due to an extremely large catch of redfish.

No difficulties were experienced in the installation, maintenance, or operation of the separating panel or trouser extension and codends. Combining the upper and codend catches, the modified Maxi trawl's catching performance was at least as good as the vessel's Alfredo trawl.

Sorting results

The pooled results from the sorting trials and the hauls with the Alfredo catches are summarized in Table 1, with haul-by-haul results presented in Appendix 2. Fifteen sorting trials were carried out with the port Maxi trawl with the funnel, ten with the same trawl without the funnel, and 17 with the starboard Maxi trawl.

The pooled results show a clear sorting effect for all three species and for all three experimental gear configurations. Combining all three configurations, 71% of the cod captured were taken in the lower codend, with 90% and 72% of the haddock and saithe taken in the upper codend, respectively.

The ANOVA results showed that the observed sorting performance levels for all three species significantly exceeded the target proportions, all three experimental gear configurations combined. In the case of cod, there were no significant differences among the sorting performance levels achieved by the three different experimental configurations. In the cases of haddock and saithe there were significant between-trawl differences in the levels of sorting performance. However, haul-to-haul variability in the catch rates for these two species was also higher than in the case of cod.

Table 1. Summary of results from sorting trials

Alfredo

Hauls: 2, 3, 5, 7

	Cod			Haddock			Saithe		
	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.	N
	619 kg/hr	516 kg/hr	4	399 kg/hr	345 kg/hr	4	49 kg/hr	66 kg/hr	4

Port Maxi trawl with funnel

Hauls: 4, 6, 8, 9, 10, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29

	Cod			Haddock			Saithe		
	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.	N
Upper	240 kg/hr	148 kg/hr	15	407 kg/hr	328 kg/hr	14	60 kg/hr	55 kg/hr	8
Lower	678 kg/hr	454 kg/hr	15	31 kg/hr	20 kg/hr	14	20 kg/hr	39 kg/hr	8
Combined	918 kg/hr	538 kg/hr	15	437 kg/hr	340 kg/hr	14	80 kg/hr	84 kg/hr	8
% upper	26 %			93 %			75 %		

Port Maxi trawl without funnel

Hauls: 33, 35, 40, 47, 51, 52, 57, 58, 59, 60

	Cod			Haddock			Saithe		
	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.	N
Upper	301 kg/hr	146 kg/hr	10	441 kg/hr	499 kg/hr	10	521 kg/hr	940 kg/hr	6
Lower	674 kg/hr	340 kg/hr	10	71 kg/hr	66 kg/hr	10	155 kg/hr	230 kg/hr	6
Combined	976 kg/hr	439 kg/hr	10	512 kg/hr	561 kg/hr	10	677 kg/hr	1167 kg/hr	6
% upper	31 %			86 %			77 %		

Starboard Maxi trawl without funnel

Hauls: 12, 14, 16, 18, 20, 24, 26, 30, 37, 42, 43, 45, 49, 53, 54, 55, 56

	Cod			Haddock			Saithe		
	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.	N
Upper	272 kg/hr	208 kg/hr	17	358 kg/hr	334 kg/hr	17	290 kg/hr	367 kg/hr	9
Lower	625 kg/hr	415 kg/hr	17	43 kg/hr	52 kg/hr	17	148 kg/hr	160 kg/hr	9
Combined	897 kg/hr	595 kg/hr	17	401 kg/hr	347 kg/hr	17	438 kg/hr	477 kg/hr	9
% upper	30 %			89 %			66 %		

All three experimental gear configurations combined

Hauls: All valid experimental hauls

	Cod			**Haddock**			**Saithe**		
	Mean	**S.D.**	**N**	**Mean**	**S.D.**	**N**	**Mean**	**S.D.**	**N**
Upper	**267 kg/hr**	**172 kg/hr**	**42**	**395 kg/hr**	**370 kg/hr**	**41**	**270 kg/hr**	**533 kg/hr**	**23**
Lower	**656 kg/hr**	**404 kg/hr**	**42**	**45 kg/hr**	**49 kg/hr**	**41**	**105 kg/hr**	**161 kg/hr**	**23**
Combined	**923 kg/hr**	**529 kg/hr**	**42**	**640 kg/hr**	**399 kg/hr**	**41**	**206 kg/hr**	**528 kg/hr**	**23**
% upper	**29 %**			**90 %**			**72 %**		

Table 2. Summary of results from open-codend comparisons

Port Maxi trawl without funnel, lower bag open
Hauls: 38, 39, 40, 41

	Cod	Haddock	Saithe
Upper	428 kg/hr	1036 kg/hr	588 kg/hr
Lower	N/A	N/A	N/A
Combined	N/A	N/A	N/A

Comparable tows with both bags closed
Hauls: 37, 42, 43

	Cod	Haddock	Saithe
Upper	303 kg/hr	465 kg/hr	149 kg/hr
Lower	830 kg/hr	28 kg/hr	121 kg/hr
Combined	1134 kg/hr	493 kg/hr	271 kg/hr

Starboard Maxi trawl without funnel, lower bag open
Hauls: 28, 34, 36

	Cod	Haddock	Saithe
Upper	589 kg/hr	168 kg/hr	103 kg/hr
Lower	N/A	N/A	N/A
Combined	N/A	N/A	N/A

Comparable tows with both bags closed
Hauls: 29, 30, 35, 37

	Cod	Haddock	Saithe
Upper	347 kg/hr	242 kg/hr	0
Lower	785 kg/hr	57 kg/hr	0
Combined	1132 kg/hr	299 kg/hr	0

Port Maxi trawl without funnel, upper bag open
Hauls: 44, 48

	Cod	Haddock	Saithe
Upper	N/A	N/A	N/A
Lower	266 kg/hr	56 kg/hr	196 kg/hr
Combined	N/A	N/A	N/A

Comparable tows with both bags closed
Hauls: 45, 47, 49, 51

	Cod	Haddock	Saithe
Upper	260 kg/hr	756 kg/hr	910 kg/hr
Lower	397 kg/hr	118 kg/hr	340 kg/hr
Combined	656 kg/hr	874 kg/hr	1250 kg/hr

Starboard Maxi trawl without funnel, upper bag open
Hauls: 46, 50

	Cod	Haddock	Saithe
Upper	N/A	N/A	N/A
Lower	251 kg/hr	28 kg/hr	56 kg/hr
Combined	N/A	N/A	N/A

Comparable tows with both bags closed
Hauls: 45, 47, 49, 51

	Cod	Haddock	Saithe
Upper	260 kg/hr	756 kg/hr	910 kg/hr
Lower	397 kg/hr	118 kg/hr	340 kg/hr
Combined	656 kg/hr	874 kg/hr	1250 kg/hr

Trawl performance and fish behaviour observations

The observations carried out with the towed vehicle confirmed that the physical configuration of the experimental trawl while fishing conformed to design expectations. The separating panel was stretched tight across the width of the trawl and roughly divided the trawl into equal upper and lower compartments. At its aft end, at the beginning of the trouser extension section, there was adequate room (estimated at 1.5-2 m diameter based on scanning sonar measurements) for passage into each leg of the extension.

Fish behaviour within the trawl could not be quantitatively assessed, but some overall impressions were clear and consistent. Fish entered the trawl mouth area at all levels, although there may have been some concentration towards the lower level just above the fishing line and bottom belly panel. As fish passed down the lower compartment of the trawl towards the codend many attempted, often successfully, to swim upwards and penetrate the separating panel. Such attempts appeared to increase in frequency and vigor as they approached the beginning of the trouser extension and as the cross-section of the trawl decreased. In no case were fish in the upper compartment ever seen attacking downwards towards the separating panel although it is possible that such attempts occurred unobserved.

While in many cases the black spot on the side of the fish made it possible to distinguish haddock, this was not always discernible and so our ability to identify the species of the observed fish was limited. However, in the shallow waters where the observation tow was conduced cod densities were expected to be low, supported by the small cod catch (32 kg) versus nearly 3 tons of haddock captured, so it is likely that most of the fish seen were haddock.

DISCUSSION

Clear and consistent sorting results were obtained for cod, haddock, and saithe throughout the entire course of the experiment. Pooling the data for the 42 experimental hauls, 71% of the cod were captured in the lower codend, while 90% and 72% of the haddock and saithe, respectively, were taken in the upper codend. Despite the fact that the experiments were carried out in four different areas at water depths ranging from 120 to 280 meters, and with tows carried out at all hours throughout the day, the haul to haul variability in haddock separation efficiency was low. Separation efficiency for haddock fell below 85% in only 8 out of the 41 hauls in which haddock were captured.

The sorting efficiencies for cod and saithe were less satisfactory and consistent from haul to haul. During 15 out of the 42 experimental hauls, less that 65 % of cod were caught in the lower codend. The situation for saithe was even more variable. Saithe were captured in at least one of the codends during only 23 hauls; in nine of these more than 40% were found in the lower codend including three where all saithe were caught there, although these catches were very small. Possible explanations for the higher haul-to-haul variability in sorting efficiency for these two species include greater variability in initial vertical distribution in the trawl mouth coupled with greater reluctance to penetrate the large-mesh separating panel, or intra- or inter-species interactions or density-dependent behavioural responses affecting within-trawl escape and swimming behaviour. It would be desirable to improve both the effectiveness and consistency of the separating efficiency for cod and saithe.

Since the length compositions for all species appeared to be roughly the same in the upper and lower codends there is no apparent relationship between fish size and sorting efficiency, at least over the range of sizes encountered here.

The fish behaviour observations suggest that the frequency and intensity of upwards-directed escape behaviour increased in frequency and intensity as the fish became more confined in the tapering after sections of the trawl. In view of this it is surprising that the small-mesh funnel did not have a stronger effect, since it should have increased the crowding in this region. However, it may have been placed to far aft to be effective, since in these experiments it was located one meter into the lower extension, by which point most fish may have already been "committed" to one trouser leg or the other. Further, if it had been effective in stimulating fish to avoid it by swimming upwards, it might also have stimulated more cod to escape upwards as well, thus reducing cod-sorting effectiveness. Further work with this concept, especially coupled with *in situ* observations under conditions where several species will be encountered and can be identified, will be necessary to determine whether or not it has any usable effect in this application.

Preliminary experiments with the lower codend open seemed to indicate higher than usual cod catch rates in the upper codend, although the limited data and simplistic analysis did not show any clear-cut effect on the fate of haddock and saithe. If the impact on cod sorting is real, it still remains to be seen whether this is due to changes in the configuration of the extension caused by relatively higher drag in the upper codend, behavioural responses, or some other factor or combination of factors. Further research, both by comparative fishing trials and direct observations, must be carried out to confirm or disprove this impression and to observe the performance of the separating system at different relative and absolute load levels. Further development of the separating system's design may be necessary to counter load imbalances if further research shows this to be a factor.

In spite of these remaining questions and with room for improvement in the sorting performance for cod and saithe, if the same results can be obtained at different seasons and at a wider range of depths and fishing areas, fish densities, and species mixtures, then the system as presently configured could have practical application with little or no further development or testing. No technical difficulties were encountered in the use of the horizontal separating panel and trouser extension and codends, and in fact trouser codends are already in fairly widespread use. Such modifications can easily be adapted and installed in any of the typical trawls presently used by Norwegian fishermen for the Barents Sea roundfish fisheries. Based on these results, fishermen targeting haddock using this system, and with the lower codend open in order to avoid cod, risk losing approximately only 10% of their potential landed weight of haddock. Even if more cod are captured in the upper codend as a result of having the lower codend open, the overall reduction in cod catch rates could offer advantages to fishermen who find their fishing opportunities limited due to low cod quotas coupled with unacceptably high cod bycatches when using conventional gear. Another potential refinement might be for fishermen to use a relatively large mesh size in the lower codend so that their cod catches are both reduced, and shifted towards larger fish, which presently command a 40% per kilogram price premium.

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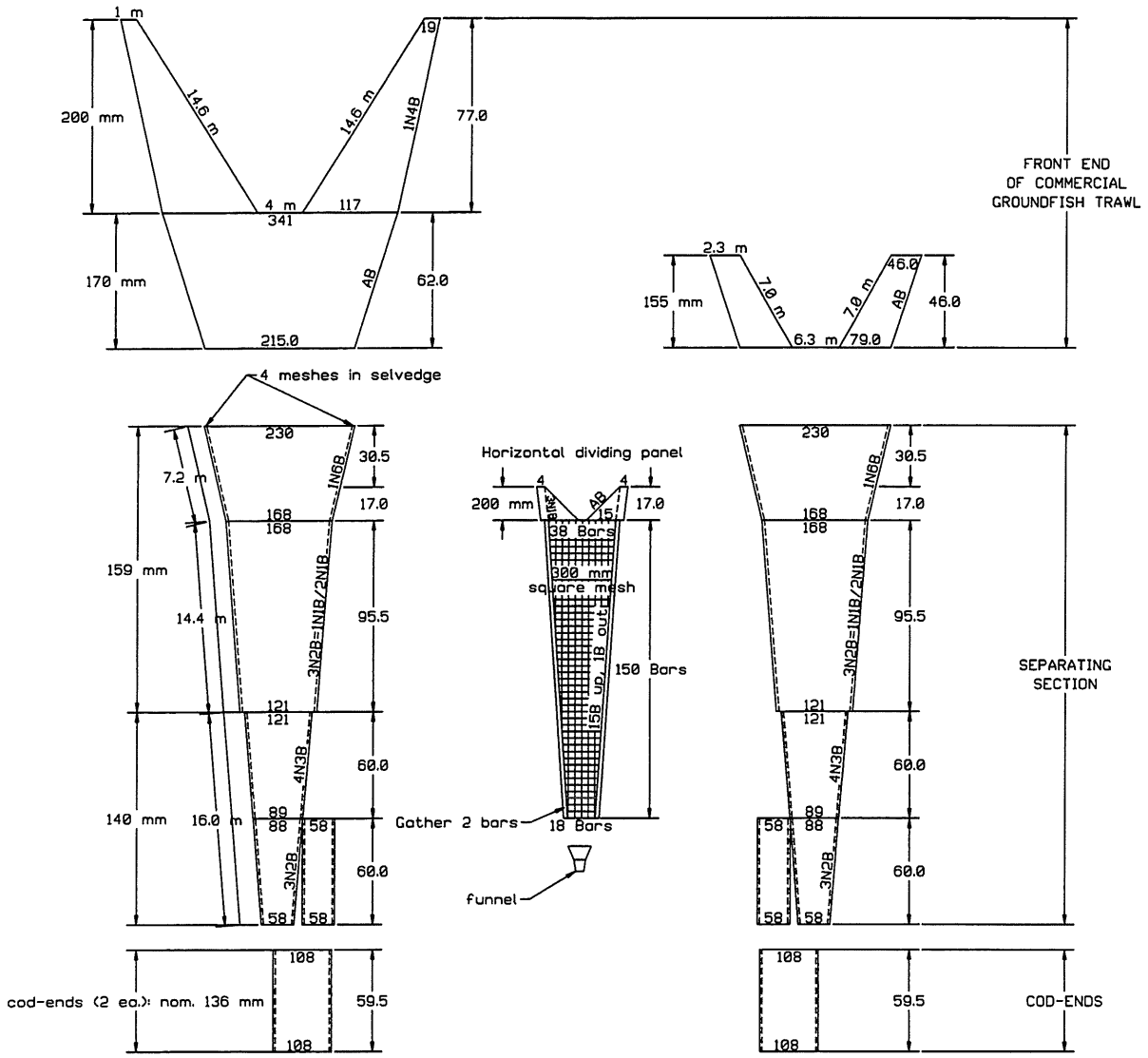

Figure 1. Construction and installation plan for experimental separating section.

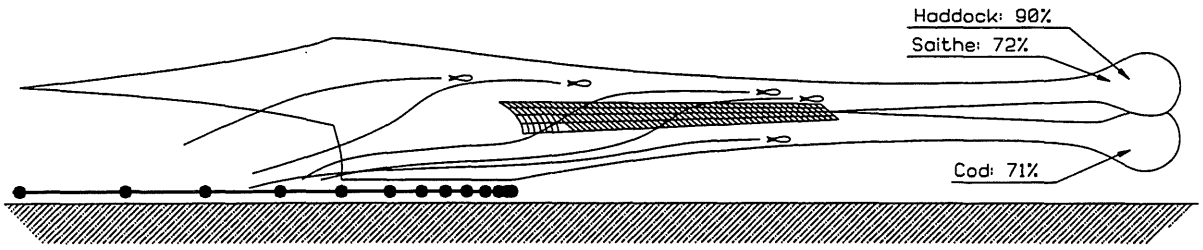

Figure 2. Schematic of sorting trawl configuration and typical fish responses

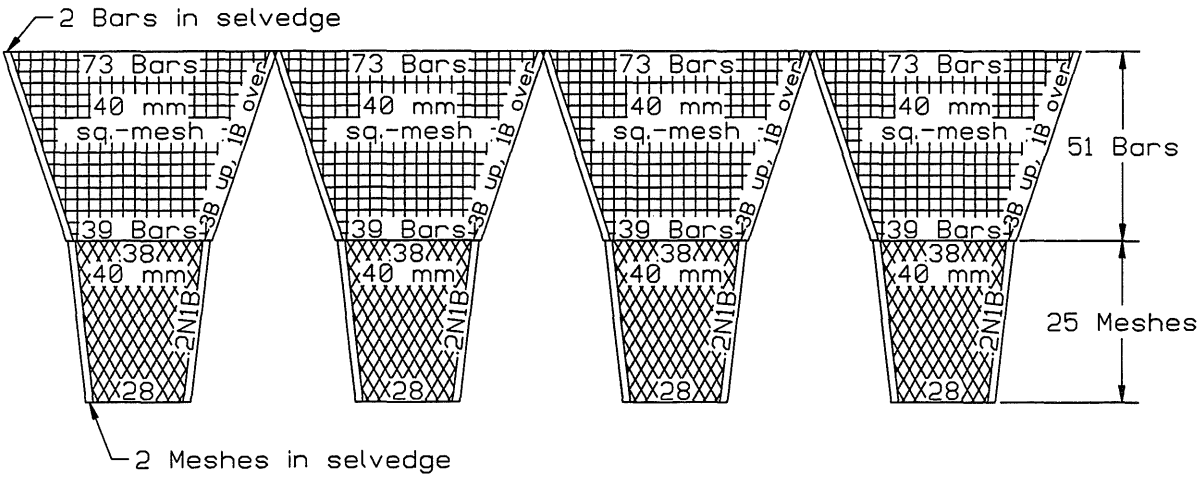

Figure 3. Design for small-mesh funnel used in lower extension section

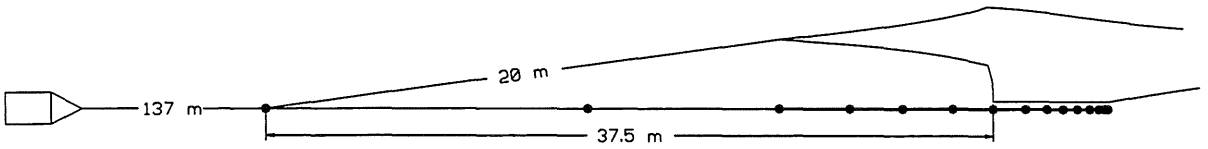

Figure 4. Rigging schematic for experimental trawls

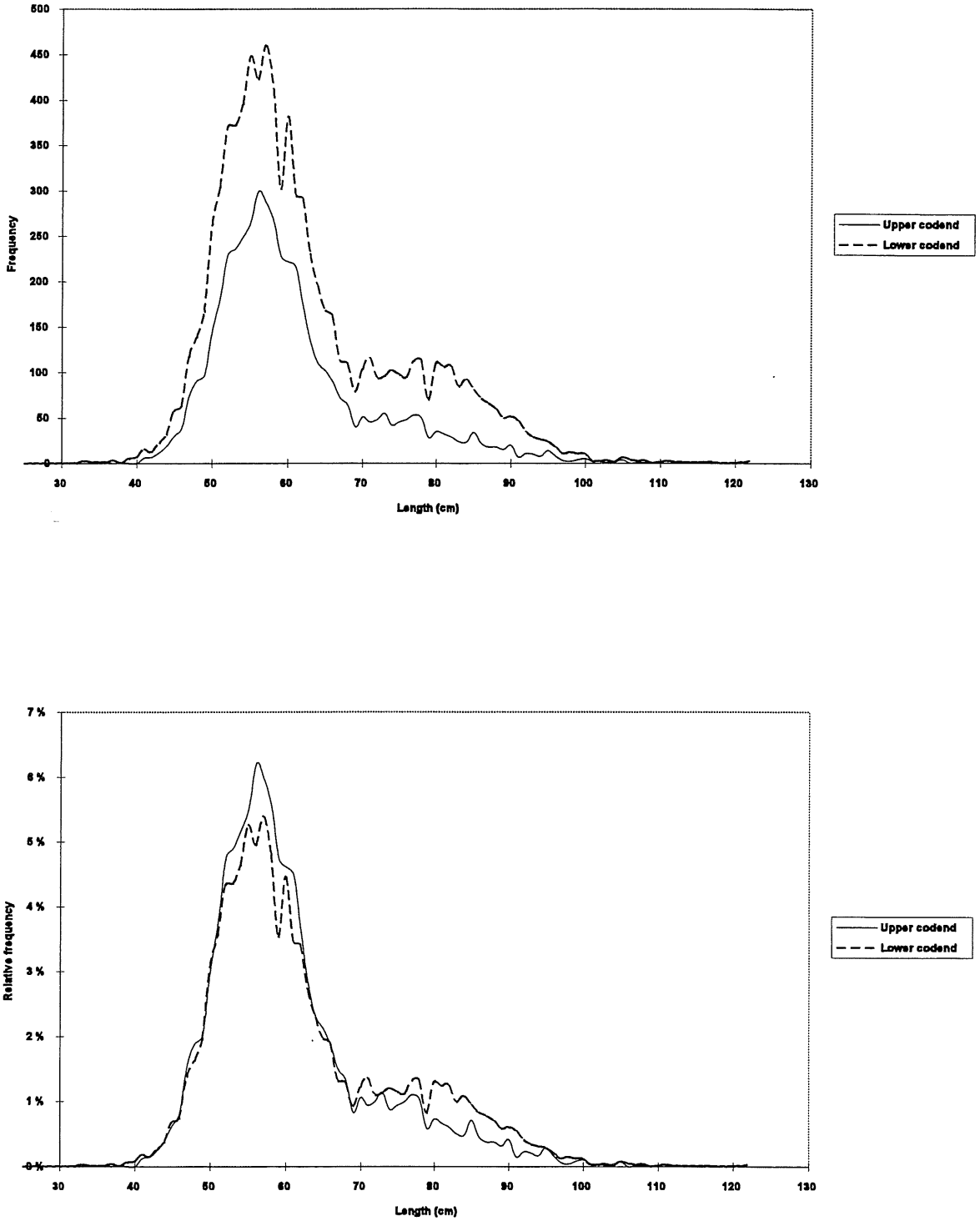

Figure 5. Absolute (upper) and relative (lower) cod length composition, all experimental hauls pooled

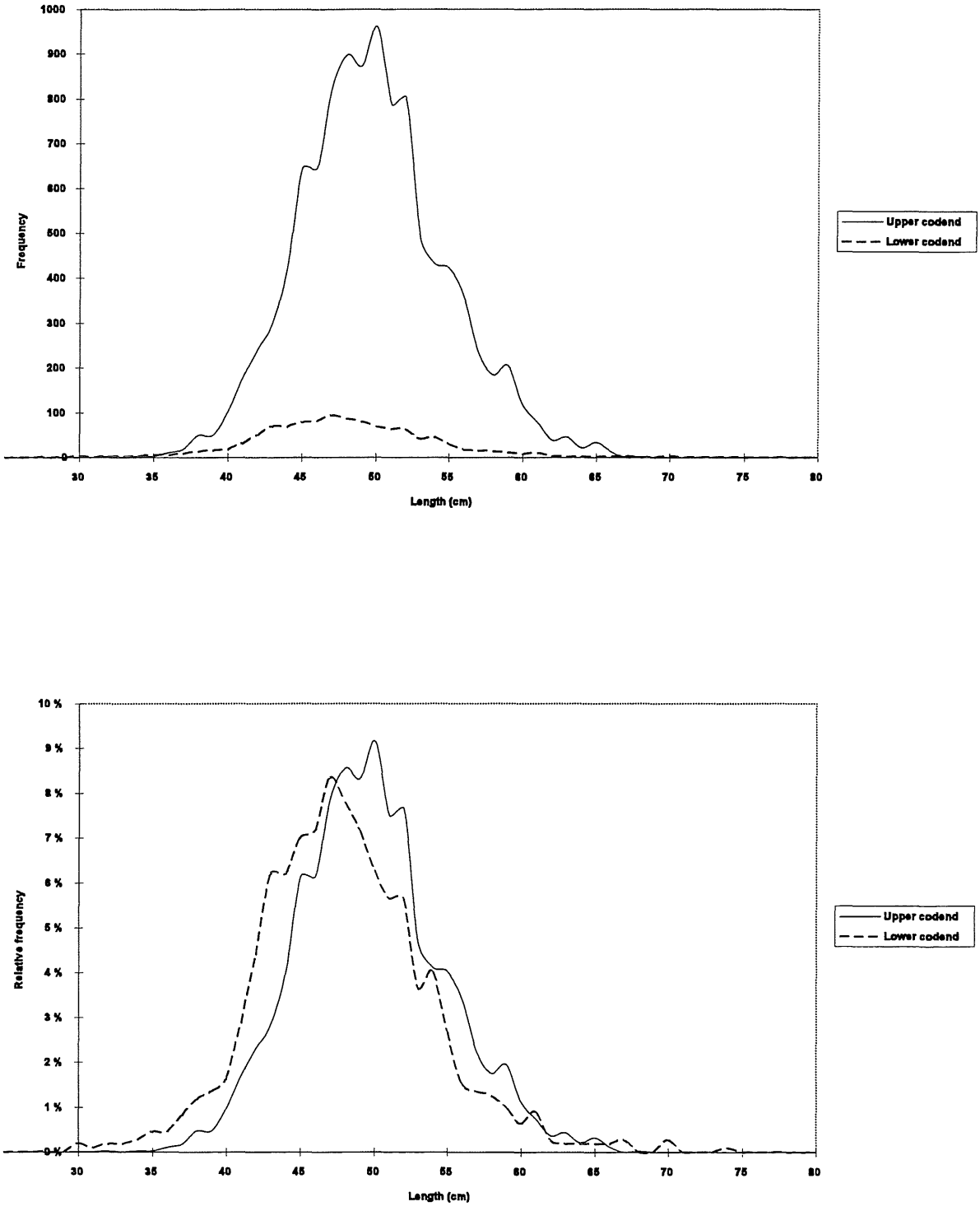

Figure 6. Absolute (upper) and relative (lower) haddock length composition, all experimental hauls pooled

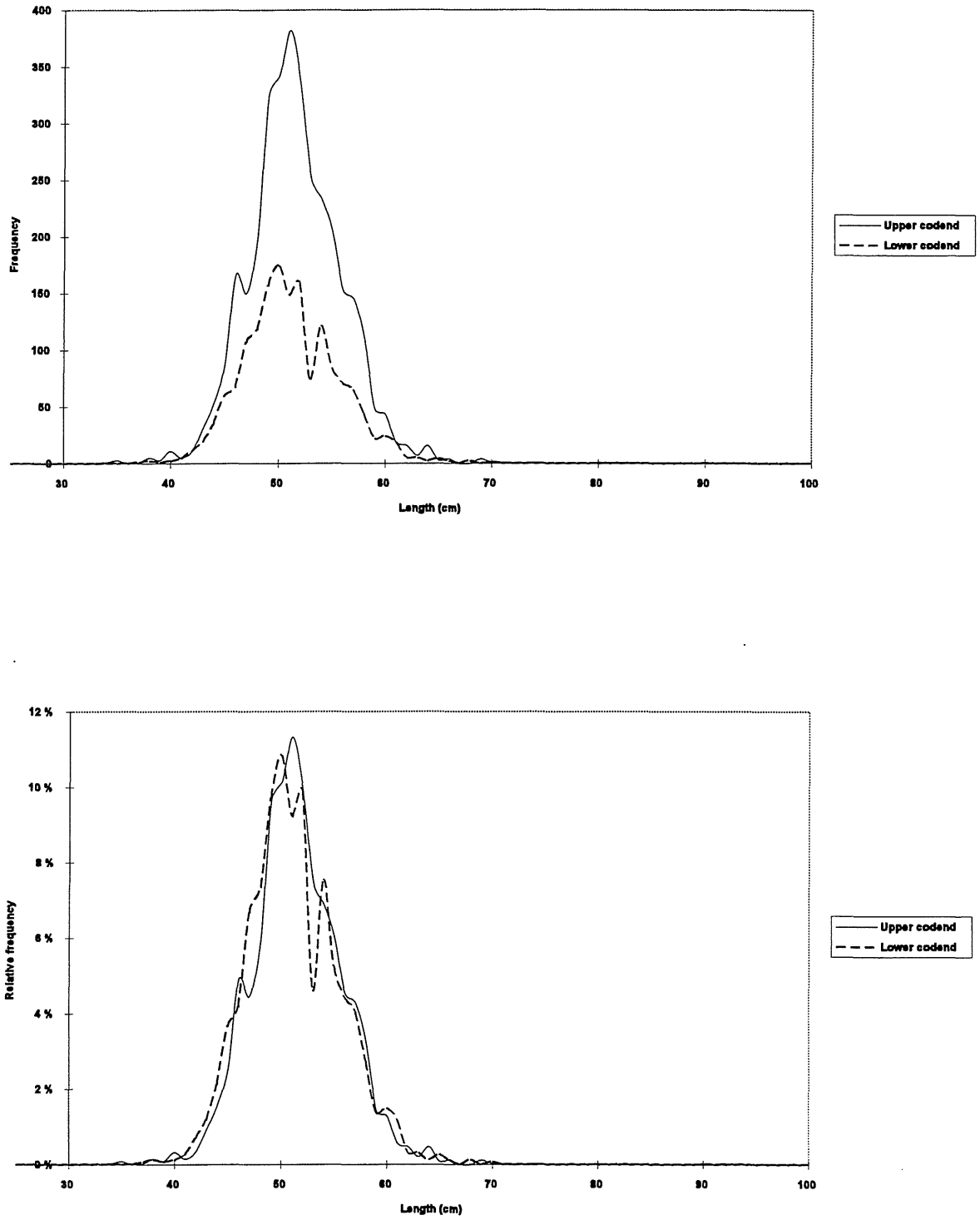

Figure 7. Absolute (upper) and relative (lower) saithe length composition, all experimental hauls pooled

Appendix 1. Summary of haul information

Haul	Date	Depth	Trawl	Start Time	Shoot Lat.	Shoot Long.	Haul Lat.	Haul Long.	Duration	Comments
1	20.04.95		Port Maxi	13:20	71 d 13 m	27 d 8 m	71 d 13 m	27 d 25 m	60 min	Test tow
2	21.04.95	150 m	Alfredo	22:15	71 d 10 m	28 d 27 m	71 d 4 m	28 d 58 m	225 min	Test tow
3	22.04.95	150 m	Alfredo	02:45	71 d 2 m	29 d 3 m	70 d 56 m	29 d 24 m	150 min	Test tow
4	22.04.95	120 m	Port Maxi	09:15	70 d 42 m	30 d 26 m	70 d 38 m	30 d 38 m	60 min	
5	22.04.95	120 m	Alfredo	12:05	70 d 42 m	30 d 26 m	70 d 39 m	30 d 38 m	60 min	Test tow
6	22.04.95	120 m	Port Maxi	14:45	70 d 38 m	30 d 40 m	70 d 35 m	30 d 47 m	60 min	
7	22.04.95	120 m	Alfredo	17:10	70 d 38 m	30 d 40 m	70 d 35 m	30 d 48 m	60 min	Test tow
8	22.04.95	120 m	Port Maxi	18:45	70 d 36 m	30 d 52 m	70 d 38 m	30 d 44 m	60 min	
9	22.04.95	120 m	Port Maxi	22:45	70 d 33 m	31 d 2 m	70 d 42 m	30 d 28 m	270 min	
10	23.04.95	120 m	Port Maxi	04:00	70 d 41 m	30 d 29 m	70 d 33 m	31 d 3 m	210 min	
11	23.04.95	(72 m)	Port Maxi	11:40	70 d 35 m	30 d 42 m	70 d 38 m	30 d 33 m	80 min	
12	23.04.95	150 m	S/B Maxi	15:20	70 d 36 m	30 d 46 m	70 d 34 m	30 d 57 m	60 min	
13	23.04.95	150 m	Port Maxi	20:25	70 d 38 m	30 d 30 m	70 d 35 m	30 d 50 m	60 min	
14	23.04.95	150 m	S/B Maxi	22:20	70 d 34 m	30 d 54 m	70 d 39 m	30 d 40 m	150 min	
15	24.04.95	150 m	Port Maxi	01:45	70 d 39 m	30 d 40 m	70 d 32 m	31 d 4 m	150 min	
16	24.04.95	150 m	S/B Maxi	06:05	70 d 37 m	30 d 45 m	70 d 33 m	31 d 1 m	90 min	
17	24.04.95	150 m	Port Maxi	08:20	70 d 33 m	31 d 1 m	70 d 35 m	30 d 51 m	60 min	
18	24.04.95	150 m	S/B Maxi	10:15	70 d 35 m	30 d 50 m	70 d 33 m	30 d 2 m	60 min	
19	24.04.95	280 m	Port Maxi	13:45	70 d 36 m	31 d 49 m	70 d 32 m	31 d 55 m	60 min	
20	24.04.95	280 m	S/B Maxi	16:30	70 d 36 m	31 d 49 m	70 d 29 m	31 d 59 m	120 min	
21	24.04.95	280 m	Port Maxi	21:00	70 d 38 m	31 d 45 m	70 d 31 m	31 d 47 m	120 min	
22	25.04.95	280 m	S/B Maxi	00:45	70 d 38 m	31 d 46 m	70 d 29 m	31 d 53 m	120 min	Debris in codend
23	25.04.95	280 m	Port Maxi	04:40	70 d 31 m	31 d 47 m	70 d 29 m	31 d 54 m	120 min	
24	25.04.95	280 m	S/B Maxi	08:35	70 d 38 m	31 d 46 m	70 d 31 m	31 d 51 m	120 min	
25	25.04.95	280 m	Port Maxi	12:20	70 d 38 m	31 d 45 m	70 d 29 m	31 d 53 m	120 min	
26	25.04.95	280 m	S/B Maxi	18:00	70 d 31 m	31 d 50 m	70 d 25 m	32 d 3 m	120 min	
27	25.04.95	280 m	Port Maxi	22:10	70 d 34 m	31 d 47 m	70 d 27 m	31 d 52 m	120 min	
28	26.04.95	280 m	S/B Maxi	01:05	70 d 26 m	31 d 51 m	70 d 33 m	31 d 47 m	120 min	Lower codend open
29	26.04.95	280 m	Port Maxi	04:00	70 d 34 m	31 d 47 m	70 d 27 m	31 d 56 m	120 min	
30	26.04.95	280 m	S/B Maxi	06:55	70 d 27 m	31 d 56 m	70 d 32 m	31 d 48 m	75 min	
31	26.04.95	(75 m)	Port Maxi	11:15	70 d 34 m	30 d 45 m	70 d 38 m	30 d 33 m	180 min	ROV observations
32	27.04.95	240 m	S/B Maxi	11:15	70 d 42 m	30 d 37 m	70 d 44 m	30 d 28 m	45 min	Large catch of redfish
33	28.04.95	280 m	Port Maxi	01:10	70 d 34 m	31 d 50 m	70 d 25 m	31 d 54 m	120 min	
34	28.04.95	280 m	S/B Maxi	04:05	70 d 26 m	31 d 54 m	70 d 34 m	31 d 49 m	120 min	Lower codend open
35	28.04.95	280 m	Port Maxi	07:00	70 d 34 m	31 d 49 m	70 d 27 m	31 d 56 m	120 min	
36	28.04.95	280 m	S/B Maxi	09:50	70 d 27 m	31 d 57 m	70 d 36 m	31 d 46 m	120 min	Lower codend open
37	28.04.95	280 m	S/B Maxi	12:40	70 d 38 m	31 d 43 m	70 d 29 m	31 d 53 m	120 min	
38	28.04.95	280 m	Port Maxi	15:30	70 d 30 m	31 d 56 m	70 d 38 m	31 d 44 m	30 min	Lower codend open
39	28.04.95	280 m	Port Maxi	16:15	70 d 30 m	31 d 56 m	70 d 38 m	31 d 44 m	120 min	Lower codend open
40	28.04.95	280 m	Port Maxi	19:50	70 d 38 m	31 d 44 m	70 d 30 m	31 d 50 m	120 min	
41	29.04.95	280 m	Port Maxi	02:25	70 d 50 m	29 d 42 m	70 d 54 m	29 d 22 m	120 min	Lower codend open
42	29.04.95	200 m	S/B Maxi	05:05	70 d 55 m	29 d 21 m	70 d 52 m	29 d 32 m	70 min	
43	29.04.95	150 m	S/B Maxi	09:55	71 d 3 m	28 d 45 m	71 d 8 m	28 d 23 m	120 min	
44	29.04.95	150 m	Port Maxi	12:40	71 d 8 m	28 d 19 m	71 d 30 m	28 d 41 m	120 min	Upper codend open
45	29.04.95	150 m	S/B Maxi	15:30	71 d 3 m	28 d 43 m	71 d 7 m	28 d 25 m	120 min	
46	29.04.95	150 m	S/B Maxi	18:20	71 d 8 m	28 d 25 m	71 d 3 m	28 d 44 m	120 min	Upper codend open
47	29.04.95	150 m	Port Maxi	21:10	71 d 2 m	28 d 48 m	71 d 7 m	28 d 24 m	120 min	
48	30.04.95	150 m	Port Maxi	01:55	71 d 8 m	28 d 19 m	71 d 3 m	28 d 43 m	120 min	Upper codend open
49	30.04.95	150 m	S/B Maxi	04:40	71 d 3 m	28 d 45 m	71 d 7 m	28 d 24 m	120 min	
50	30.04.95	150 m	S/B Maxi	07:55	71 d 9 m	28 d 20 m	71 d 5 m	28 d 39 m	120 min	Upper codend open

Appendix 1. Summary of haul information

Haul	Date	Depth	Trawl	Start Time		Lat.	Long.			Lat.	Long.		Duration	Comments
51	30.04.95	150 m	Port Maxi	10:55	71 d	6 m	28 d	52 m	71 d	10 m	28 d	20 m	150 min	
52	30.04.95	150 m	Port Maxi	18:00	71 d	10 m	28 d	24 m	71 d	8 m	28 d	38 m	60 min	
53	30.04.95	150 m	S/B Maxi	19:40	71 d	7 m	28 d	44 m	71 d	12 m	28 d	7 m	180 min	
54	01.05.95	150 m	S/B Maxi	01:40	71 d	10 m	28 d	44 m	71 d	13 m	28 d	10 m	180 min	
55	01.05.95	260 m	S/B Maxi	05:20	71 d	13 m	28 d	7 m	71 d	14 m	27 d	38 m	180 min	
56	01.05.95	260 m	S/B Maxi	09:35	71 d	13 m	27 d	28 m	71 d	12 m	27 d	13 m	60 min	
57	01.05.95	260 m	Port Maxi	11:35	71 d	13 m	27 d	19 m	71 d	14 m	26 d	50 m	150 min	
58	01.05.95	260 m	Port Maxi	15:05	71 d	14 m	26 d	58 m	71 d	14 m	27 d	2 m	180 min	
59	01.05.95	260 m	Port Maxi	18:55	71 d	14 m	27 d	4 m	71 d	16 m	26 d	51 m	180 min	
60	01.05.95	260 m	Port Maxi	23:00	71 d	16 m	26 d	59 m	71 d	14 m	26 d	58 m	195 min	

Appendix 2. Haul-by-haul results from sorting trials

Alfredo

Haul no.	Total	Cod	Haddock	Saithe
2	691 kg/hr	461 kg/hr	224 kg/hr	0 kg/hr
3	2069 kg/hr	1344 kg/hr	532 kg/hr	0 kg/hr
5	1412 kg/hr	544 kg/hr	812 kg/hr	56 kg/hr
7	296 kg/hr	128 kg/hr	28 kg/hr	140 kg/hr
All hauls	**1117 kg/hr**	**619 kg/hr**	**399 kg/hr**	**49 kg/hr**

B/B Maxi with funnel, both bags closed

Haul no.	Bag	Total	Cod	Haddock	Saithe
4	Upper	1260 kg/hr	224 kg/hr	980 kg/hr	56 kg/hr
	Lower	656 kg/hr	448 kg/hr	28 kg/hr	0 kg/hr
	Both	1916 kg/hr	672 kg/hr	1008 kg/hr	56 kg/hr
	% up:		33 %	97 %	100 %
6	Upper	356 kg/hr	160 kg/hr	196 kg/hr	0 kg/hr
	Lower	664 kg/hr	608 kg/hr	28 kg/hr	28 kg/hr
	Both	1020 kg/hr	768 kg/hr	224 kg/hr	28 kg/hr
	% up:		21 %	88 %	0 %
8	Upper	868 kg/hr	224 kg/hr	560 kg/hr	84 kg/hr
	Lower	1756 kg/hr	1728 kg/hr	28 kg/hr	0 kg/hr
	Both	2624 kg/hr	1952 kg/hr	588 kg/hr	84 kg/hr
	% up:		11 %	95 %	100 %
9	Upper	248 kg/hr	92 kg/hr	137 kg/hr	19 kg/hr
	Lower	340 kg/hr	334 kg/hr	6 kg/hr	0 kg/hr
	Both	588 kg/hr	427 kg/hr	143 kg/hr	19 kg/hr
	% up:		22 %	96 %	100 %
10	Upper	813 kg/hr	229 kg/hr	568 kg/hr	16 kg/hr
	Lower	862 kg/hr	713 kg/hr	72 kg/hr	0 kg/hr
	Both	1675 kg/hr	942 kg/hr	640 kg/hr	16 kg/hr
	% up:		24 %	89 %	100 %
11	Upper	1338 kg/hr	120 kg/hr	1218 kg/hr	0 kg/hr
	Lower	159 kg/hr	96 kg/hr	63 kg/hr	0 kg/hr
	Both	1497 kg/hr	216 kg/hr	1281 kg/hr	0 kg/hr
	% up:		56 %	95 %	#DIV/0!
13	Upper	480 kg/hr	32 kg/hr	308 kg/hr	140 kg/hr
	Lower	422 kg/hr	160 kg/hr	0 kg/hr	112 kg/hr
	Both	902 kg/hr	192 kg/hr	308 kg/hr	252 kg/hr
	% up:		17 %	100 %	56 %
15	Upper	549 kg/hr	90 kg/hr	325 kg/hr	134 kg/hr
	Lower	800 kg/hr	755 kg/hr	22 kg/hr	22 kg/hr
	Both	1349 kg/hr	845 kg/hr	347 kg/hr	157 kg/hr
	% up:		11 %	94 %	86 %
17	Upper	476 kg/hr	448 kg/hr	0 kg/hr	28 kg/hr
	Lower	768 kg/hr	768 kg/hr	0 kg/hr	0 kg/hr
	Both	1244 kg/hr	1216 kg/hr	0 kg/hr	28 kg/hr
	% up:		37 %	#DIV/0!	100 %
19	Upper	564 kg/hr	256 kg/hr	308 kg/hr	0 kg/hr
	Lower	1180 kg/hr	1152 kg/hr	28 kg/hr	0 kg/hr
	Both	1744 kg/hr	1408 kg/hr	336 kg/hr	0 kg/hr
	% up:		18 %	92 %	#DIV/0!
21	Upper	396 kg/hr	160 kg/hr	196 kg/hr	0 kg/hr
	Lower	352 kg/hr	304 kg/hr	28 kg/hr	0 kg/hr
	Both	748 kg/hr	464 kg/hr	224 kg/hr	0 kg/hr
	% up:		34 %	88 %	#DIV/0!

B/B Maxi without funnel, both bags closed

Haul no.	Bag	Total	Cod	Haddock	Saithe
33	Upper	631 kg/hr	295 kg/hr	336 kg/hr	0 kg/hr
	Lower	603 kg/hr	502 kg/hr	84 kg/hr	0 kg/hr
	Both	1234 kg/hr	797 kg/hr	420 kg/hr	0 kg/hr
	% up:		37 %	80 %	#DIV/0!
35	Upper	617 kg/hr	295 kg/hr	252 kg/hr	0 kg/hr
	Lower	870 kg/hr	797 kg/hr	56 kg/hr	0 kg/hr
	Both	1487 kg/hr	1092 kg/hr	308 kg/hr	0 kg/hr
	% up:		27 %	82 %	#DIV/0!
40	Upper	307 kg/hr	177 kg/hr	112 kg/hr	0 kg/hr
	Lower	351 kg/hr	295 kg/hr	56 kg/hr	0 kg/hr
	Both	658 kg/hr	472 kg/hr	168 kg/hr	0 kg/hr
	% up:		38 %	67 %	#DIV/0!
47	Upper	4433 kg/hr	177 kg/hr	1820 kg/hr	2436 kg/hr
	Lower	1163 kg/hr	295 kg/hr	252 kg/hr	616 kg/hr
	Both	5596 kg/hr	472 kg/hr	2072 kg/hr	3052 kg/hr
	% up:		38 %	88 %	80 %
51	Upper	1406 kg/hr	566 kg/hr	336 kg/hr	224 kg/hr
	Lower	1057 kg/hr	850 kg/hr	22 kg/hr	45 kg/hr
	Both	2463 kg/hr	1416 kg/hr	358 kg/hr	269 kg/hr
	% up:		40 %	94 %	83 %
52	Upper	638 kg/hr	295 kg/hr	168 kg/hr	0 kg/hr
	Lower	585 kg/hr	354 kg/hr	56 kg/hr	0 kg/hr
	Both	1223 kg/hr	649 kg/hr	224 kg/hr	0 kg/hr
	% up:		45 %	75 %	#DIV/0!
57	Upper	640 kg/hr	94 kg/hr	246 kg/hr	90 kg/hr
	Lower	719 kg/hr	425 kg/hr	45 kg/hr	67 kg/hr
	Both	1359 kg/hr	519 kg/hr	291 kg/hr	157 kg/hr
	% up:		18 %	85 %	57 %
58	Upper	796 kg/hr	236 kg/hr	299 kg/hr	168 kg/hr
	Lower	1499 kg/hr	1219 kg/hr	37 kg/hr	149 kg/hr
	Both	2295 kg/hr	1455 kg/hr	336 kg/hr	317 kg/hr
	% up:		16 %	89 %	53 %
59	Upper	1187 kg/hr	384 kg/hr	560 kg/hr	149 kg/hr
	Lower	1200 kg/hr	1013 kg/hr	56 kg/hr	37 kg/hr
	Both	2387 kg/hr	1397 kg/hr	616 kg/hr	187 kg/hr
	% up:		27 %	91 %	80 %
60	Upper	837 kg/hr	492 kg/hr	284 kg/hr	60 kg/hr
	Lower	1190 kg/hr	994 kg/hr	43 kg/hr	17 kg/hr
	Both	2027 kg/hr	1487 kg/hr	327 kg/hr	78 kg/hr
	% up:		33 %	87 %	78 %
All hauls	**Upper**	**1149 kg/hr**	**301 kg/hr**	**441 kg/hr**	**521 kg/hr**
(N=10)	**Lower**	**924 kg/hr**	**674 kg/hr**	**71 kg/hr**	**155 kg/hr**
	Both	**2073 kg/hr**	**976 kg/hr**	**512 kg/hr**	**677 kg/hr**
	% up:		**31 %**	**86 %**	**77 %**

Appendix 2. Haul-by-haul results from sorting trials

B/B Maxi with funnel, both bags closed (cont.)

Haul no.	Bag	Total	Cod	Haddock	Saithe
23	Upper	714 kg/hr	384 kg/hr	210 kg/hr	0 kg/hr
	Lower	1276 kg/hr	1248 kg/hr	28 kg/hr	0 kg/hr
	Both	1990 kg/hr	1632 kg/hr	238 kg/hr	0 kg/hr
	% up:		24 %	88 %	#DIV/0!
25	Upper	924 kg/hr	512 kg/hr	392 kg/hr	0 kg/hr
	Lower	1084 kg/hr	1008 kg/hr	56 kg/hr	0 kg/hr
	Both	2008 kg/hr	1520 kg/hr	448 kg/hr	0 kg/hr
	% up:		34 %	88 %	#DIV/0!
27	Upper	348 kg/hr	208 kg/hr	140 kg/hr	0 kg/hr
	Lower	290 kg/hr	256 kg/hr	14 kg/hr	0 kg/hr
	Both	638 kg/hr	464 kg/hr	154 kg/hr	0 kg/hr
	% up:		45 %	91 %	#DIV/0!
29	Upper	618 kg/hr	464 kg/hr	154 kg/hr	0 kg/hr
	Lower	640 kg/hr	592 kg/hr	28 kg/hr	0 kg/hr
	Both	1258 kg/hr	1056 kg/hr	182 kg/hr	0 kg/hr
	% up:		44 %	85 %	#DIV/0!
All hauls	**Upper**	**663 kg/hr**	**240 kg/hr**	**407 kg/hr**	**60 kg/hr**
(N=15)	**Lower**	**750 kg/hr**	**678 kg/hr**	**31 kg/hr**	**20 kg/hr**
	Both	**1413 kg/hr**	**918 kg/hr**	**437 kg/hr**	**80 kg/hr**
	% up:		**26 %**	**93 %**	**75 %**

S/B Maxi without funnel, both bags closed

Haul no.	Bag	Total	Cod	Haddock	Saithe
12	Upper	3208 kg/hr	800 kg/hr	1344 kg/hr	1064 kg/hr
	Lower	1448 kg/hr	1280 kg/hr	28 kg/hr	140 kg/hr
	Both	4656 kg/hr	2080 kg/hr	1372 kg/hr	1204 kg/hr
	% up:		38 %	98 %	88 %
14	Upper	422 kg/hr	64 kg/hr	314 kg/hr	45 kg/hr
	Lower	410 kg/hr	320 kg/hr	45 kg/hr	34 kg/hr
	Both	833 kg/hr	384 kg/hr	358 kg/hr	78 kg/hr
	% up:		17 %	88 %	57 %
16	Upper	235 kg/hr	85 kg/hr	93 kg/hr	56 kg/hr
	Lower	488 kg/hr	469 kg/hr	0 kg/hr	19 kg/hr
	Both	723 kg/hr	555 kg/hr	93 kg/hr	75 kg/hr
	% up:		15 %	100 %	75 %
18	Upper	220 kg/hr	192 kg/hr	28 kg/hr	0 kg/hr
	Lower	544 kg/hr	544 kg/hr	0 kg/hr	0 kg/hr
	Both	764 kg/hr	736 kg/hr	28 kg/hr	0 kg/hr
	% up:		26 %	100 %	#DIV/0!
20	Upper	904 kg/hr	320 kg/hr	364 kg/hr	0 kg/hr
	Lower	670 kg/hr	608 kg/hr	42 kg/hr	0 kg/hr
	Both	1574 kg/hr	928 kg/hr	406 kg/hr	0 kg/hr
	% up:		34 %	90 %	#DIV/0!
24	Upper	1440 kg/hr	512 kg/hr	448 kg/hr	0 kg/hr
	Lower	1428 kg/hr	1232 kg/hr	56 kg/hr	0 kg/hr
	Both	2868 kg/hr	1744 kg/hr	504 kg/hr	0 kg/hr
	% up:		29 %	89 %	#DIV/0!
26	Upper	914 kg/hr	320 kg/hr	574 kg/hr	0 kg/hr
	Lower	304 kg/hr	192 kg/hr	112 kg/hr	0 kg/hr
	Both	1218 kg/hr	512 kg/hr	686 kg/hr	0 kg/hr
	% up:		63 %	84 %	#DIV/0!

B/B Maxi without funnel, lower bag open

Haul no.	Bag	Total	Cod	Haddock	Saithe
38	Upper	4332 kg/hr	944 kg/hr	3248 kg/hr	0 kg/hr
39	Upper	808 kg/hr	118 kg/hr	672 kg/hr	0 kg/hr
40	Upper	307 kg/hr	177 kg/hr	112 kg/hr	0 kg/hr
41	Upper	3006 kg/hr	472 kg/hr	112 kg/hr	2352 kg/hr
All hauls	**Upper**	**2113 kg/hr**	**428 kg/hr**	**1036 kg/hr**	**2352 kg/hr**

B/B Maxi without funnel, upper bag open

Haul no.	Bag	Total	Cod	Haddock	Saithe
44	Lower	382 kg/hr	354 kg/hr	28 kg/hr	0 kg/hr
48	Lower	457 kg/hr	177 kg/hr	84 kg/hr	196 kg/hr
All hauls	**Lower**	**420 kg/hr**	**266 kg/hr**	**56 kg/hr**	**196 kg/hr**

S/B Maxi without funnel, lower bag open

Haul no.	Bag	Total	Cod	Haddock	Saithe
28	Upper	844 kg/hr	704 kg/hr	140 kg/hr	0 kg/hr
34	Upper	919 kg/hr	443 kg/hr	168 kg/hr	308 kg/hr
36	Upper	886 kg/hr	620 kg/hr	196 kg/hr	0 kg/hr
All hauls	**Upper**	**883 kg/hr**	**589 kg/hr**	**168 kg/hr**	**308 kg/hr**

S/B Maxi without funnel, upper bag open

Haul no.	Bag	Total	Cod	Haddock	Saithe
46	Lower	496 kg/hr	384 kg/hr	28 kg/hr	84 kg/hr
50	Lower	174 kg/hr	118 kg/hr	28 kg/hr	28 kg/hr
All hauls	**Lower**	**335 kg/hr**	**251 kg/hr**	**28 kg/hr**	**56 kg/hr**

Appendix 2. Haul-by-haul results from sorting trials

S/B Maxi without funnel, both bags closed (cont.)

Haul no.	Bag	Total	Cod	Haddock	Saithe
30	Upper	928 kg/hr	512 kg/hr	224 kg/hr	0 kg/hr
	Lower	1286 kg/hr	1101 kg/hr	90 kg/hr	0 kg/hr
	Both	2214 kg/hr	1613 kg/hr	314 kg/hr	0 kg/hr
	% up:		32 %	71 %	#DIV/0!
37	Upper	507 kg/hr	118 kg/hr	336 kg/hr	0 kg/hr
	Lower	705 kg/hr	649 kg/hr	56 kg/hr	0 kg/hr
	Both	1212 kg/hr	767 kg/hr	392 kg/hr	0 kg/hr
	% up:		15 %	86 %	#DIV/0!
42	Upper	1100 kg/hr	556 kg/hr	192 kg/hr	0 kg/hr
	Lower	1809 kg/hr	1517 kg/hr	0 kg/hr	0 kg/hr
	Both	2908 kg/hr	2073 kg/hr	192 kg/hr	0 kg/hr
	% up:		27 %	100 %	#DIV/0!
43	Upper	1582 kg/hr	236 kg/hr	868 kg/hr	448 kg/hr
	Lower	747 kg/hr	325 kg/hr	28 kg/hr	364 kg/hr
	Both	2329 kg/hr	561 kg/hr	896 kg/hr	812 kg/hr
	% up:		42 %	97 %	55 %
45	Upper	1215 kg/hr	207 kg/hr	420 kg/hr	588 kg/hr
	Lower	827 kg/hr	295 kg/hr	196 kg/hr	336 kg/hr
	Both	2042 kg/hr	502 kg/hr	616 kg/hr	924 kg/hr
	% up:		41 %	68 %	64 %
49	Upper	929 kg/hr	89 kg/hr	448 kg/hr	392 kg/hr
	Lower	512 kg/hr	148 kg/hr	0 kg/hr	364 kg/hr
	Both	1440 kg/hr	236 kg/hr	448 kg/hr	756 kg/hr
	% up:		38 %	100 %	52 %
53	Upper	216 kg/hr	118 kg/hr	75 kg/hr	0 kg/hr
	Lower	393 kg/hr	334 kg/hr	0 kg/hr	0 kg/hr
	Both	609 kg/hr	452 kg/hr	75 kg/hr	0 kg/hr
	% up:		26 %	100 %	#DIV/0!
54	Upper	297 kg/hr	157 kg/hr	75 kg/hr	19 kg/hr
	Lower	583 kg/hr	492 kg/hr	56 kg/hr	0 kg/hr
	Both	880 kg/hr	649 kg/hr	131 kg/hr	19 kg/hr
	% up:		24 %	57 %	100 %
55	Upper	387 kg/hr	216 kg/hr	112 kg/hr	0 kg/hr
	Lower	508 kg/hr	354 kg/hr	19 kg/hr	19 kg/hr
	Both	895 kg/hr	570 kg/hr	131 kg/hr	19 kg/hr
	% up:		38 %	86 %	0 %
56	Upper	741 kg/hr	118 kg/hr	168 kg/hr	0 kg/hr
	Lower	1348 kg/hr	767 kg/hr	0 kg/hr	56 kg/hr
	Both	2089 kg/hr	885 kg/hr	168 kg/hr	56 kg/hr
	% up:		13 %	100 %	0 %
All hauls	**Upper**	**897 kg/hr**	**272 kg/hr**	**358 kg/hr**	**290 kg/hr**
(N=17)	**Lower**	**824 kg/hr**	**625 kg/hr**	**43 kg/hr**	**148 kg/hr**
	Both	**1721 kg/hr**	**897 kg/hr**	**401 kg/hr**	**438 kg/hr**
	% up:		**30 %**	**89 %**	**66 %**