# Separator Trawls as a Tool for Improving Selectivity for Cod

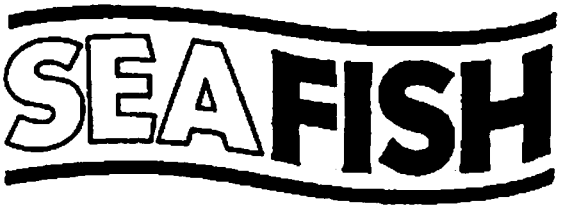
MAFF Commission

**Seafish Report No.464**

July 1996

Sea Fish Industry Authority

Technology Division




# Separator trawls as a tool for improving selectivity for cod

Seafish Report No. 464
MAFF R&D Commission 1995
Project Code MF0612

Authors: K. Arkley, J. Swarbrick
11 July 1996

# Sea Fish Industry Authority

**Technology Division**


# Separator trawls as a tool for improving selectivity for cod


Seafish Report No. 464



Author: K. Arkley



11 July 1996


## Summary


This paper describes the results of comparative fishing trials, under commercial conditions, using a standard trawl and a separator trawl. The target species in the fishing area were cod, haddock, whiting, lemon sole and plaice. The separator trawl was fitted with a 120mm lower codend; the upper codend and the codend on the standard net were 100mm. The trials involved about 90 paired tows over a period of 10 weeks. Sample sizes were generally good with the exception of plaice. The results were very encouraging. The separator trawl showed a useful reduction in catches of sub-legal fish as well as size grades around the minimum legal size. The data obtained were consistent with those from previous and more recent trials. The fishing skippers were initially very sceptical about the concept of a separator trawl but both subsequently became enthusiastic advocates of the advantages offered by this type of net for their fishery.

## Aeknowledgements

Seafish would like to acknowledge gratefully:

- The Ministry of Agriculture Fisheries and Food (MAFF) for commissioning and financing this work. In particular grateful thanks are extended to Fisheries Department IIIb for organising the necessary derogations to conduct this work.

- Dr. Tim Macer of MAFF's Directorate of Fisheries Research (DFR) Laboratory for his support to the initial proposals for this work.

- Skippers Andrew Sanderson and Paul Scotter and the crews of their respective vessels, *MFV Ocean Reward (FR28)* and *Pamela S (FR38),* for providing their valuable experience and assistance in conducting these trials.

- Mr. George Traves, chairman of the Bridlington and Flamborough Fishermen's Society, for his assistance in selecting the vessels for the trials and his general support for this work.

- Mr. Steve Leadley and the staff of Caedmon Nets for supplying the fishing gear and supporting the trials.

- The NFFO for their continuing support of the work of Seafish in developing technical conservation measures in general and in particular this work with separator trawls.

# Contents

## Appendix I

Trawling parameters as measured during instrumentation trials using a Scanmar acoustic measuring system

# 1. Background

In 1992 the UK Government published the Seafish (Conservation) Act, 1992. This aimed to reduce fishing effort, and therefore fishing mortality, to the levels set by the European Multi Annual Guidance Programme, in part by means of limiting days at sea. In response the National Federation of Fishermen's Organisations produced a set of proposals to satisfy that same MAGP target by a range of technical conservation measures combined with changes to the decommissioning and structural regimes.

Seafish assisted in formulating these initial technical proposals. One very promising technical measure proposed was the use of horizontal separator panels in demersal white fish trawls as a means of segregating different species in a mixed species catch.

Following some promising results from early evaluation trials in conjunction with NFFO, and in direct collaboration with the industry, it was felt that the separator trawl concept had potential for improving selectivity in mixed white fish fisheries. The potential benefit however was largely unproven and unquantified, hence a programme of systematic investigations that would satisfy both the UK and European authorities was required.

This resulted in the involvement of the UK Fisheries Departments in the form of financial support and advice for more sustained fishing and selectivity trials.

Two trials were conducted in 1994 by Seafish under MAFF Commission MF0612* in an attempt to gather the required separation and selectivity data for cod, haddock and whiting using separator trawls rigged with a range of codend mesh sizes. Data for target species were limited due to poor catch returns and the large mesh sizes used for evaluation (up to 140mm). Assessment of selectivity occurring when using large mesh sizes (>120mm) is difficult to achieve because many of the UK mixed species fisheries no longer provide adequate quantities of fish in the appropriate size ranges. It was concluded however that the separation levels achieved for cod, flatfish, whiting and haddock were high enough to enable cod and flatfish then to be subject to a more suitable mesh size regime and hence the separator trawl concept did offer good potential as a tool for improving the selectivity of cod.

Encouraged by the results from these trials certain sectors of the UK industry were keen to see further work carried out using separator trawls. However, a number of limitations to the scientific sea trials were identified by the industry and as a result strong reservations were expressed about further work being carried out along the same lines. Since the separator trawl work was brought about as a result of an industry initiative, Seafish had a role in covering the middle ground between MAFF's scientific research objectives and the industry's needs. To this end proposals were put forward for a series of sea trials aimed at gathering a greater quantity of data over a longer time period directly from the commercial fishery rather than from limited scientific sea trials. A programme of work was agreed after consultation with industry representatives and MAFF DFR scientific advisers and commenced in August 1995.

---

* Seafish Report Nos. 441 and 460 refer.

## 2. Introduction

This report describes the work carried out in the third and final stage of a three year MAFF Commission (MF 0612) to investigate the potential for the use of separator trawls as a tool for improving size and species selectivity in mixed white fish fisheries. It follows on from the Seafish work reported by Arkley et al. (1994)* and Swarbrick et al. (1995)** which examined separation levels and codend selectivity using twin rigged separator trawls in scientific trials.

The earlier work established that, under experimental conditions, high levels of separation of cod and flatfish from haddock and whiting can be achieved, and that the separator trawl principle provides potential for improved size selectivity. It was felt that in order to progress this work further it was necessary to establish if similar results could be reproduced consistently under rigorous commercial fishing conditions and if the separator trawl design is a practical workable option.

The Yorkshire coast, late summer/autumn cod fishery was highlighted by the industry as one which has reported relatively high levels of discarding of undersize codlings over recent years. This fishery is dependent on herring moving onto the inshore fishing grounds in late summer to spawn. This spawning concentrates the cod which move onto the spawn to feed. Traditionally this is a productive time of year for the inshore fishermen from the Yorkshire ports of Whitby, Scarborough and Bridlington. Following on from this late summer/autumn fishery with its mainstay of smaller cod/codling the east coast boats then concentrate on their "winter" fishery which tends to produce a run of larger cod.

It was felt that a programme of sea trials using vessels operating in these fisheries would provide a good evaluation of the performance of the separator trawl under commercial conditions with good prospects of encountering cod across a wide size range.

In consultation with industry representatives two matched trawlers were selected from the port of Bridlington to conduct comparative fishing operations.

To enable comparisons (where appropriate) with the findings of the previous work, the same trawls that were used for the first two trials were utilised once more. These nets were an established demersal "box" trawl design almost identical to the chosen vessels' own nets and very typical of those being used by the local fleet.

A programme of comparative fishing trials based on the parallel haul technique was formulated in consultation with scientists from MAFF DFR Lowestoft and put into effect in August 1995 with the intention of continuing as long as funding and the fishing conditions would allow.

---

* Seafish Report No. 441

** Seafish Report No. 460

## 3. Aims of the Exercise

i. To conduct a rigorous evaluation of the commercial practicability of an established trawl design modified to incorporate a horizontal separator panel when fished under commercial fishing conditions.

ii. To determine the levels of separation of the main target species in a mixed species fishery namely, cod, flatfish, whiting and haddock, via use of a separator panel used under commercial fishing conditions.

iii. To monitor the performance of a codend of increased mesh size (120mm) used to retain the catch from the lower half of the separator trawl. To establish whether this increased mesh size is effective in reducing discard levels of cod while maintaining acceptable catches of other species.

iv. To obtain separation and selectivity data that can be used in conjunction with those obtained from the previous trials to contribute to the debate as to whether separator trawls could be used as a tool for reducing the fishing mortality for some species in certain mixed species fisheries.

# 4. Materials

## 4.1 Fishing Vessels

The two vessels chosen for these trials were MFV Ocean Reward (FR28) and MFV Pamela S (FR38).

Both vessels are skipper owned and operate out of the Yorkshire port of Bridlington. They are very similar Scottish built vessels operating as side trawlers.

| | MFV Ocean Reward | MFV Pamela S |
|---|---|---|
| LOA | 16.58m | 16.92m |
| Gross tonnage | 24.78T | 24.5T |
| Engine power | 231KW (310hp) | 231KW (310hp) |

## 4.2 Fishing Gear

The trawls used for these trials were the same as used for the previous work, being an established box trawl design almost identical to those normally used by the selected vessels. The nets were rigged on the same 'rockhopper' ground gears as used in the first (1994) trials off the Whitby coast. Only one minor modification was made to the fishing gear in comparison with previous usage. The top chain running through the upper hole of the 'pancake' rubber discs on the ground gear was originally rigged as separate 6 x 10ft sections. These correspond to the separate ground gear sections. This was replaced by one continuous 60ft chain to be compatible with the skippers' preferred method of rigging. Otherwise no other changes were made to the ground gears or main body of the nets. A full description of the fishing gear including the ground gear and sweep/bridle arrangements is given in Seafish Report No. 441 (Figures 6, 7, 8).

One of the two trawls supplied by Seafish for these trials was modified to incorporate a full length horizontal separator panel which terminated in a double codend arrangement. The codend designed to retain the catch entering the upper half of the net was constructed in 100mm (nominal) double braid, 3.5mm PE twine. The lower codend of the arrangement was constructed of the same twine but in 120mm (nominal) mesh size. The other trawl, apart from the separator panel and double codend arrangement was identical in all other respects. This trawl was rigged with a single codend of the current legal minimum mesh size (MMS) of 100mm (nominal).

The lower codend mesh size of 120mm was selected as one which was expected to produce some reduction in discards of cod without excessive losses of marketable catch. This codend was also made approximately 2m longer than the upper one. This arrangement was designed to limit any masking of the lower codend meshes by the upper codend due to their relative positions. There was evidence of this masking effect from the previous two trials where the upper and lower codends were of the same length (see Figure 1).

The separator panel constructed in 115mm mesh was set and maintained at a height of 1m above the fishing line of the trawl. This height was selected based on previous experience and the results from the first two trials.

The codends on both the standard and separator trawls were rigged originally without any codend attachments, i.e. chafers or lifting bags, however as the trials progressed fishing conditions warranted the addition of some codend protection in the form of heavy PE twine netting chafers attached to the lower side of the codends. Both vessels made these changes which were normal practice under normal commercial fishing conditions on the grounds being fished.

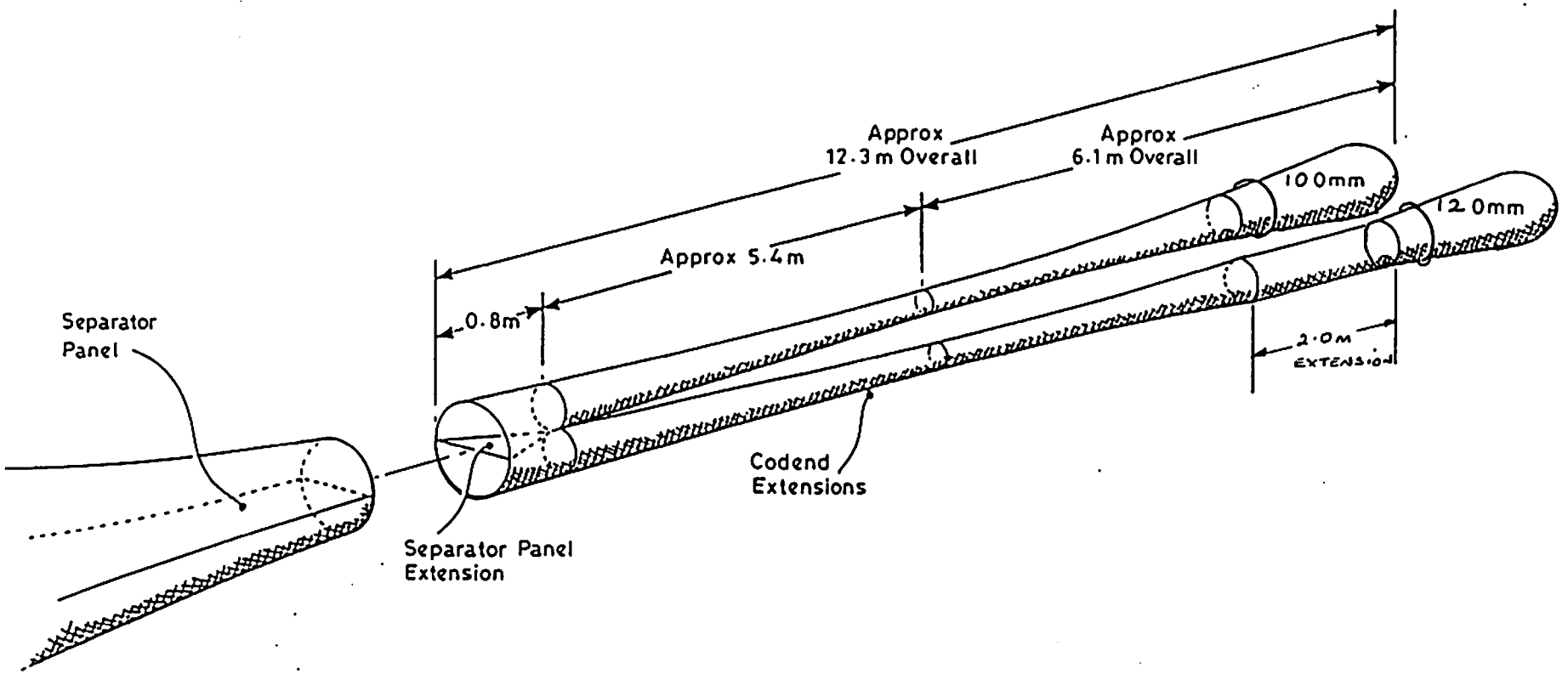



**Fig 1. Codend arrangement used in conjunction with the separator trawl**

### 4.3 Gear Geometry

The separator trawl used for this exercise had previously been checked for performance and geometry prior to the start of the first trials in 1994. This had been done using direct underwater observations using an RCTV carrying underwater video cameras. Gear parameters such as door spread, wingend spread, headline height etc. were measured using a Scanmar acoustic measuring system. This monitoring exercise confirmed that the separator trawl was achieving satisfactory geometry and that the panel was achieving the desired shape and height.

In order to confirm continuity of performance and geometry with the separator trawl when used on the MFVs Ocean Reward and Pamela S, further instrumentation trials were conducted using Scanmar equipment. It was important to check gear parameters of the separator trawl in comparison with the standard trawl in order to maintain comparability of results. To this end the main gear parameters of the separator trawl were measured and compared to those of the unmodified trawl. This was carried out for both vessels using each gear type.

The two vessels on which the instrumented trials took place were identical in propulsion/engine characteristics. The periods in which both trials were performed were ones of neap tidal conditions. This latter factor was reflected in the results which showed only very minor differences in the gear parameters measured, both with and against the tide. In all cases described, net speed through the water forms the base reference (x axis) for all geometrical measurements.

The results from the instrumentation trials are summarised in Table 1. Full details of the gear parameters measured are given in the table and figures in Appendix I. The tabulated results shown in Table 1 for both vessels indicate the headline height, wingend spread and trawl door (otterboard) spread at a common net speed through the water (Figures I to V, Appendix I). Figures I and II provide a direct graphical comparison of the two nets as towed by each vessel. The variations between the separator and standard trawls for headline height, wingend spread and trawl door spread are extremely low. The maximum difference in headline mean values recorded was 0.34 metres and that for wingend spread, 0.3 metres. Figures III and IV show the actual differences in the geometry for both nets when towed by MFV Pamela S and MFV Ocean Reward respectively. Within the accuracy limits of the Scanmar system (± 0.1m) there were no major differences at similar towing speeds. Figure V attempts to highlight the difference in the geometry of the separator trawl when towed by MFV Pamela S and MFV Ocean Reward on two, obviously separate occasions. The results show a difference in headline height of only 0.15 metres over the speed range and 0.2 metres difference in wingend spread. These differences are not significant considering the inherent accuracy of the measurement system.

**Table 1**
**Summary showing mean differences in geometry for separator and standard trawls**

| MFV Ocean Reward (FR28) | | | | | | |
|---|---|---|---|---|---|---|
| Headline height (metres) | | Wingend spread (metres) | | Otterboard spread (metres) | | Panel height (metres) |
| Standard net | Separator net | Standard net | Separator net | Standard net | Separator net | |
| 3.68 | 4.05 | 8.56 | 8.41 | 29.74 | 30.2 | 1.0 |

| MFV Pamela S (FR38) | | | | | | |
|---|---|---|---|---|---|---|
| Headline height (metres) | | Wingend spread (metres) | | Otterboard spread (metres) | | Panel height (metres) |
| Standard net | Separator net | Standard net | Separator net | Standard net | Separator net | |
| 4.01 | 4.02 | 8.7 | 8.44 | 31.6 | 31.4 | 0.99 |

### 4.4 Fishing Trials

This was a comparative fishing exercise. Two matched vessels operated alongside each other using a parallel haul technique to compare the performance of a separator trawl against an otherwise identical unmodified trawl. The aim was to gather as much data as possible over as long a period as was possible under commercial conditions.

The trials vessels were given financial support rather than full charter arrangements, i.e. the vessels were compensated for any shortfall in earnings below a pre-determined daily rate based on average earnings for the period concerned. This allowed for any losses in marketable catches attributable to the use of the separator trawl and it's associated large mesh codend arrangement.

The selection of the East coast autumn and winter fisheries provided two operating windows. The first between the middle of August and the end of September with good prospects of catching reasonable quantities of codling, and the second from September up until Christmas with the potential of encountering a larger size run of cod.

The selected vessels were given a free hand to operate under their normal procedures. One vessel of the pair (MFV Ocean Reward) was given the responsibility of 'lead vessel'. The skipper of the lead vessel determined the area of operation (in consultation with the other skipper) and the second vessel effectively shadowed the lead vessel in terms of position and operational procedures.

Fishing trials were based on daily operations consisting of an average two hauls per day. Tow lengths varied but were normally 4-4½ hours in duration. Both vessels operated in the closest proximity to each other as the nature of the ground and the prevailing conditions allowed. Hauling and shooting operations were timed to coincide with each other wherever practicable. All other operating procedures including warp:depth ratios and towing speeds were matched.

Fishing operations commenced in August 1995 with MFV Ocean Reward operating the separator trawl for the first half of the exercise. A total of 24 valid hauls were monitored onboard Ocean Reward and 22 from Pamela S from a total of 14 fishing days. A number of hauls were discounted over the course of the exercise as invalid due to problems such as net damage or mechanical problems causing reduced towing time.

The first half of the operations concentrated on locating 'marks' of herring and herring spawn in an attempt to target feeding cod. Operations were hampered by poor weather which restricted fishing time and also proved detrimental to fishing conditions. This resulted in some relatively poor catch returns. The expected concentrations of cod were not always located. The first half of the trials ended in October 1995.

The separator trawl was swapped over to MFV Pamela S for the second half of the trials which started at the end of October. Operations then concentrated on the traditional 'winter' fishery tows on the inside grounds. Here a total of 13 fishing days were completed ending in November 1995. Both vessels completed 22 valid hauls producing better catch returns compared to the first stage. As with the first half, weather again proved to be a problem.

Both stages of the trials produced a good species mix consisting mainly of cod, flatfish (plaice and lemon sole), haddock and whiting. This allowed a good evaluation of the separation performance of the experimental trawl.

**4.5 Catch Monitoring**

Both vessels carried Seafish staff throughout the exercise to monitor and sample catches.

For every valid tow the catch was separated by species and fish length measurements taken for all individuals of the main marketable species namely, cod, haddock, whiting, plaice and lemon sole. Where catch levels were high and individual measurements of the total catch were not practical, representative sub-samples were measured and the numbers raised by the appropriate factor.

The catches from the upper and lower codends of the separator trawl were kept separate in order to establish separation levels for the various species. Observations were made on any quality differences noted between catches from the upper and lower codends of the separator trawl.

The catch data were used to produce length/frequency distributions and percentage vertical separation levels for the main target species. Comparisons were then made between the catches from the separator trawl and the standard unmodified net.

Following the landing and sale of the catches from both vessels a breakdown of the catches by market grade was made and the earnings from the two vessels were compared for the duration of the trials.

## 5. Results

The data collected have been separated into two sections representing the two distinct halves of the exercise. The first half describes the comparative results from MFV Ocean Reward's experience with the separator trawl and the second half represents the findings following the changeover to MFV Pamela S. The changeover also reflects the changes within the fishery between the late summer herring spawning fishery and the winter fishery.

Catch data were collected for cod, haddock, whiting, plaice and lemon sole. These species formed the bulk of the catches throughout the trials. Catches consisted of a wide size range for all species.

Catch levels were lower than expected but generally, sufficient numbers were caught to produce significant results for most species. The exception was for plaice particularly in the second half of the trials.

The main considerations in this exercise were:-

i. To evaluate the performance of the separator trawl with regard to separation of cod and flatfish from haddock and whiting.

ii. To examine the potential for reducing discards of cod by using 120mm mesh lower codends.

iii. To identify any losses of marketable species as a result of the use of an increased mesh size in the lower codend.

The data are presented as length/frequency plots showing the numbers of fish at each centimetre length class for each of the main species for the catches from the upper (100mm) and lower (120mm) codends of the separator trawl. This is combined with plots describing the proportionate separation of each species into upper and lower codends.

The catching performance of the separator trawl compared with the standard trawl is shown in the form of mean numbers of fish caught per haul for each centimetre size class, again for all the main target species.

The catches for each species were broken down proportionately by EC size grade. These are described in Tables 2 and 3.

### 5.1 Separation Results - MFV Ocean Reward (FR28)

These results are based on 24 hauls with the separator trawl used onboard MFV Ocean Reward.

### 5.1.1 Cod
A consistently high proportion of the total cod caught were separated into the lower codend. Over all size ranges, from 25-70+ cms, almost 85% ended up in the lower codend [Figure 2 and Table 2(a)]. These results were based on relatively high numbers of fish.

### 5.1.2 Haddock
As expected the haddock results showed good separation into the upper codend averaging 95% across all size ranges [Figure 3 and Table 2(b)].

### 5.1.3 Whiting
The whiting results also reflected the expected behaviour pattern with over 94% of the total catch being retained in the upper (100mm) codend. This result was based on good sample sizes [Figure 4 and Table 2(c)].

### 5.1.4 Lemon sole
The catches of lemon sole retained in the lower (120mm) codend were relatively low compared to the standard trawl. However, their behavioural response to the separator trawl was as expected with a figure of 97% entering below the panel. The combination of the small size range of fish encountered and relatively large mesh codend resulted in small catch samples [Figure 5 and Table 2(d)].

### 5.1.5 Plaice
Very few plaice were encountered during these trials resulting in low sample sizes and less significant results. Despite the low numbers, the separation level of over 99% into the lower codend can be read as typical for this and most flatfish species based on results from previous work [Figure 6 and Table 2(e)].

## 5.2 Separation Results - MFV Pamela S (FR38)
A total of 22 hauls were conducted with the separator trawl onboard this vessel. The results in this section appear to reflect the seasonal change in the fishery with respect to the cod catches. A distinct change in the size classes of cod is noted.

### 5.2.1 Cod
A lower level of separation was noted for this second series of tows. Only 71% of cod were separated into the lower codend. The separation rate seemed to vary with the different size classes of cod [Figure 12 and Table 3(a)].

### 5.2.2 Haddock
Separation levels very similar to those obtained on the Ocean Reward were recorded for the Pamela S. Almost 98% (compared to 95%) of the total haddock catch were retained in upper codend. These fish were of a similar size range to those caught in the first half and showed consistent separation across the full range [Figure 13 and Table 3(b)].

### 5.2.3 Whiting

The size range and quantities of whiting retained in the separator trawl were very similar for both vessels. The resultant separation was 97% from a significant sample size [Figure 14 and Table 3(c)].

### 5.2.4 Lemon sole

Very low numbers of lemon soles were encountered in this section of the trials and this is reflected in the very low sample sizes retained in the 120mm lower codend. As with the results for Ocean Reward a high separation level was indicated [Figure 15 and Table 3(d)].

### 5.2.5 Plaice

The same situation applied for plaice as for lemon soles. Low catch rates produced insignificant results. Separation levels of 87% were recorded for the fish that were retained [Figure 16 and Table 3(e)].

The separation levels for all species and both vessels are summarised below.

| | SEPARATION LEVELS | | | |
|---|---|---|---|---|
| | MFV Ocean Reward | | MFV Pamela S | |
| Species | Upper codend | Lower codend | Upper codend | Lower codend |
| Cod | 15.3% | 84.7% | 28.9% | 71.1% |
| Haddock | 95.3% | 4.7% | 97.7% | 2.3% |
| Whiting | 94.4% | 5.6% | 96.6% | 3.4% |
| Lemon sole | 3.2% | 96.8% | 11.0% | 89.0% |
| Plaice | 0.5% | 99.5% | 12.5% | 87.5% |

## 5.3 Catch Comparisons

The catching performance of the separator trawl was compared to the standard unmodified trawl in a parallel haul procedure. Every effort was made to ensure that all hauls were matched and as comparable as was practically possible. Despite these efforts it is accepted that this technique does present a number of limitations that must be borne in mind when considering the results.

The catches retained in the 100mm upper codend of the separator trawl can be compared with those of the standard 100mm codend with a reasonable degree of confidence. The catches from the larger 120mm lower codend have to be considered bearing in mind that no comparable mesh size codend was used on the standard trawl. In the absence of any means of establishing full details of the fish populations sampled, no information is available on the catches that may have passed out through the gears. The catch comparisons described in this report are therefore just that and they are indicative rather than conclusive because of the lack of scientific rigour.

**5.3.1 Separator trawl (Ocean Reward) vs. Standard trawl (Pamela S)**
The catches from 24 hauls with the separator trawl are compared with 22 hauls with the standard net. The data have been normalised to take account of the difference in haul numbers between vessels. The results therefore are presented as mean numbers of fish caught per haul for each size class, for all the main target species.

*5.3.1.1 Cod*
Almost identical numbers of cod were caught by both vessels during the first half of the exercise, the results however [Figure 7 and Table 2(a)] show differences in the size distribution of those catches. Sample sizes were relatively large.

The standard trawl (100mm) retained more codling around the minimum landing size (MLS) of 35cms compared to the 120mm codend of the separator trawl. Discard levels (<MLS) for the standard trawl were 34% compared to 18% for the separator trawl. For fish above 40cms the separator trawl out fished the standard net. It was expected that some loss of the smaller size classes of cod would be observed for the 120mm codend but an increase in the larger size classes was not expected.

*5.3.1.2 Haddock*
The results for haddock showed a very marked difference in the catching performance of the two trawls in favour of the separator trawl. There was an almost tenfold difference in numbers of haddock caught. Most of the fish were in the smaller size categories peaking around the MLS (30cms). Results are based on significant numbers of fish sampled.

Of the total catches of haddock for each gear the separator trawl produced 41% discards compared to 52% for the standard trawl [Figure 8 and Table 2(b)].

A quality difference was noted for haddock and whiting retained in the upper codend. Here they were segregated from the main bulk of the catch and sea bed debris etc. which has a detrimental effect on softer bodied fish species.

*5.3.1.3 Whiting*
Similar results to haddock were obtained for whiting with an approximate fifteen fold increase in fish taken by the separator trawl. Here again sample sizes were relatively large. Only 5.5% of the whiting catch was discarded from the separator trawl compared to 34% from the standard gear [Figure 9 and Table 2(c)].

*5.3.1.4 Lemon sole*
The differences in catches for this species appear to be attributable to losses from the 120mm codend of the separator trawl. Most of the Lemon soles caught were just above MLS of 25cms. There was visual evidence of loss of small lemon soles during the hauling process which supported this [Figure 10 and Table 2(d)].

#### *5.3.1.5 Plaice*

Relatively low numbers of fish were caught with little difference in the catch rates between vessels. The results show a slight shift to the right for the length/frequency plot for the standard trawl. This would seem to indicate that the 100mm codend is retaining slightly larger fish than 120mm codend, contrary to expectations. This information however must be read with caution considering the low sample sizes obtained [Figure 11 and Table 2(e)].

### 5.3.2 Separator Trawl (Pamela S) vs. Standard trawl (Ocean Reward)

During the second stage of the trials, following the changeover of the separator trawl to the Pamela S, both vessels conducted 22 tows for which data were recorded. These data are presented in the same form as those for the first stage.

It is noticeable that there are a number of differences in these results compared to those from the first half of the trials.

#### *5.3.2.1 Cod*

It appears from the bimodal distribution that there were two prominent year classes of cod present on the grounds during the second stage. This seems to be consistent with the expected presence of the larger 'winter' cod at that particular time of year.

The standard trawl caught approximately 56% more fish than the separator, the bulk of this difference being made up of smaller fish peaking just above the MLS. The difference in numbers at this end of the size range is more marked than the first stage. For fish in the higher size grades (>47cms) both gears caught similar quantities. This was in contrast to the result observed for the Ocean Reward which showed a better performance for larger fish. Discard figures for the separator trawl were once again lower than for the standard net being 4% and 14% respectively. This appeared to be a further indication that the 120mm codend was reducing discards of undersize codling [Figure 17 and Table 3(a)].

#### *5.3.2.2 Haddock*

Another inconsistency with the Ocean Reward's findings appears with the haddock results. Catch figures do not show the significant difference in the numbers observed in the first stage, however the difference that is evident is in favour of the separator trawl. The standard trawl curve shows a shift to the right of the separator trawl resulting in the discard level being greater (39%) for the separator than for the standard trawl (25%) [Figure 18 and Table 3(b)].

#### *5.3.2.3 Whiting*

Ocean Reward's catch rates with the separator trawl were considerably higher (14x) in comparison to the standard trawl, the difference observed from the Pamela S was much less marked (61% increase) despite larger sample sizes. The discard levels for the two gears were 5% for the separator and 17% for the standard trawls.

The length/frequency curve for the separator trawl shows a slight shift to the right indicating a greater proportion of larger fish in the catch [Figure 19 and Table 3(c)].

#### *5.3.2.4 Lemon sole*

A smaller sample size was recorded for the second stage with a smaller differential between gear types. The size range of fish caught was the same for both stages. As with the first stage results it is likely that the difference is attributable to losses through the larger mesh codends [Figure 20 and Table 3(d)].

#### *5.3.2.5 Plaice*

The plaice results for the second stage can not be used with any degree of confidence due to the very low numbers sampled. No correlations with the first stage data could be made [Figure 21 and Table 3(e)].

Table 2

## EC Size Gradings: First Half of Trial

24 hauls with separator trawl (100mm / 120mm)
MFV OCEAN REWARD FR28

22 hauls with standard net (100mm)
MFV PAMELA S FR38

(a)

| | a | b | c=a+b | c/[total] | b/c | | d | d/[total] |
|---|---|---|---|---|---|---|---|---|
| Cod | Upper | Lower | Total | Total % | Lower Vertsep | Cod | Total | Total % |
| <MLS | 111 | 671 | 782 | 17.6% | 85.81% | <MLS | 1401 | 33.9% |
| Grade 5 | 407 | 2189 | 2596 | 58.4% | 84.32% | Grade 5 | 2374 | 57.5% |
| Grade 4 | 154 | 838 | 992 | 22.3% | 84.48% | Grade 4 | 343 | 8.3% |
| Grade 3 | 7 | 66 | 73 | 1.6% | 90.41% | Grade 3 | 10 | 0.2% |
| Grade 2 | 0 | 0 | 0 | 0.0% | - | Grade 2 | 0 | 0.0% |
| Grade 1 | 0 | 0 | 0 | 0.0% | - | Grade 1 | 0 | 0.0% |
| Total | 679 | 3764 | 4443 | 100.0% | 84.72% | Total | 4128 | 100.0% |

(b)

| Haddock | Upper | Lower | Total | Total % | Upper Vertsep | Haddock | Total | Total % |
|---|---|---|---|---|---|---|---|---|
| <MLS | 510 | 33 | 543 | 41.0% | 93.92% | <MLS | 71 | 51.8% |
| Grade 4 | 365 | 10 | 375 | 28.3% | 97.33% | Grade 4 | 39 | 28.5% |
| Grade 3 | 355 | 16 | 371 | 28.0% | 95.69% | Grade 3 | 22 | 16.1% |
| Grade 2 | 34 | 3 | 37 | 2.8% | 91.89% | Grade 2 | 1 | 0.7% |
| Grade 1 | 0 | 0 | 0 | 0.0% | - | Grade 1 | 4 | 2.9% |
| Total | 1264 | 62 | 1326 | 100.0% | 95.32% | Total | 137 | 100.0% |

(c)

| Whiting | Upper | Lower | Total | Total % | Upper Vertsep | Whiting | Total | Total % |
|---|---|---|---|---|---|---|---|---|
| <MLS | 99 | 22 | 121 | 5.5% | 81.82% | <MLS | 51 | 33.6% |
| Grade 4 | 926 | 52 | 978 | 44.1% | 94.68% | Grade 4 | 56 | 36.8% |
| Grade 3 | 740 | 40 | 780 | 35.2% | 94.87% | Grade 3 | 30 | 19.7% |
| Grade 2 | 276 | 10 | 286 | 12.9% | 96.50% | Grade 2 | 14 | 9.2% |
| Grade 1 | 53 | 1 | 54 | 2.4% | 98.15% | Grade 1 | 1 | 0.7% |
| Total | 2094 | 125 | 2219 | 100.0% | 94.37% | Total | 152 | 100.0% |

(d)

| Lemon Sole | Upper | Lower | Total | Total % | Lower Vertsep | Lemon Sole | Total | Total % |
|---|---|---|---|---|---|---|---|---|
| <MLS | 2 | 33 | 35 | 5.1% | 94.29% | <MLS | 253 | 7.5% |
| Grade 3 | 9 | 499 | 508 | 73.7% | 98.23% | Grade 3 | 2584 | 76.5% |
| Grade 2 | 10 | 121 | 131 | 19.0% | 92.37% | Grade 2 | 524 | 15.5% |
| Grade 1 | 1 | 14 | 15 | 2.2% | 93.33% | Grade 1 | 15 | 0.4% |
| Total | 22 | 667 | 689 | 100.0% | 96.81% | Total | 3376 | 100.0% |

(e)

| Plaice | Upper | Lower | Total | Total % | Lower Vertsep | Plaice | Total | Total % |
|---|---|---|---|---|---|---|---|---|
| <MLS | 0 | 36 | 36 | 8.6% | 100.00% | <MLS | 22 | 5.8% |
| Grade 4 | 1 | 219 | 220 | 52.6% | 99.55% | Grade 4 | 146 | 38.6% |
| Grade 3 | 1 | 71 | 72 | 17.2% | 98.61% | Grade 3 | 110 | 29.1% |
| Grade 2 | 0 | 62 | 62 | 14.8% | 100.00% | Grade 2 | 71 | 18.8% |
| Grade 1 | 0 | 28 | 28 | 6.7% | 100.00% | Grade 1 | 29 | 7.7% |
| Total | 2 | 416 | 418 | 100.0% | 99.52% | Total | 378 | 100.0% |

The EC grades here are theoretical, and not those used by the market. Market grades are given elsewhere

Table 3

## EC Size Gradings: Second Half of Trial

22 hauls (23-44) with separator trawl (100mm / 120mm)
MFV PAMELA-S FR38

22 hauls (25-46) with standard net (100mm)
MFV OCEAN REWARD FR28

(a)

| | a | b | c=a+b | c/[total] | b/c | | d | d/[total] |
|---|---|---|---|---|---|---|---|---|
| Cod | Upper | Lower | Total | Total % | Lower Vertsep | Cod | Total | Total % |
| <MLS | 46 | 79 | 125 | 3.7% | 63.2% | <MLS | 887 | 14.5% |
| Grade 5 | 326 | 917 | 1243 | 36.5% | 73.8% | Grade 5 | 3044 | 49.8% |
| Grade 4 | 514 | 1241 | 1755 | 51.5% | 70.7% | Grade 4 | 1777 | 29.0% |
| Grade 3 | 99 | 179 | 278 | 8.2% | 64.4% | Grade 3 | 385 | 6.3% |
| Grade 2 | 1 | 5 | 6 | 0.2% | 83.3% | Grade 2 | 23 | 0.4% |
| Grade 1 | 0 | 0 | 0 | 0.0% | - | Grade 1 | 2 | 0.03% |
| Total | 986 | 2421 | 3407 | 100.0% | 71.1% | Total | 6118 | 100.0% |

(b)

| Haddock | Upper | Lower | Total | Total % | Upper Vertsep | Haddock | Total | Total % |
|---|---|---|---|---|---|---|---|---|
| <MLS | 421 | 10 | 431 | 39.3% | 97.7% | <MLS | 242 | 24.7% |
| Grade 4 | 464 | 13 | 477 | 43.5% | 97.3% | Grade 4 | 510 | 52.0% |
| Grade 3 | 166 | 1 | 167 | 15.2% | 99.4% | Grade 3 | 215 | 21.9% |
| Grade 2 | 19 | 1 | 20 | 1.8% | 95.0% | Grade 2 | 14 | 1.4% |
| Grade 1 | 1 | 0 | 1 | 0.1% | 100.0% | Grade 1 | 0 | 0.0% |
| Total | 1071 | 25 | 1096 | 100.0% | 97.7% | Total | 981 | 100.0% |

(c)

| Whiting | Upper | Lower | Total | Total % | Upper Vertsep | Whiting | Total | Total % |
|---|---|---|---|---|---|---|---|---|
| <MLS | 111 | 10 | 121 | 5.2% | 91.7% | <MLS | 237 | 16.6% |
| Grade 4 | 1027 | 40 | 1067 | 45.6% | 96.3% | Grade 4 | 524 | 36.8% |
| Grade 3 | 781 | 25 | 806 | 34.4% | 96.9% | Grade 3 | 426 | 29.9% |
| Grade 2 | 305 | 4 | 309 | 13.2% | 98.7% | Grade 2 | 220 | 15.4% |
| Grade 1 | 38 | 1 | 39 | 1.7% | 97.4% | Grade 1 | 18 | 1.3% |
| Total | 2262 | 80 | 2342 | 100.0% | 96.6% | Total | 1425 | 100.0% |

(d)

| Lemon Sole | Upper | Lower | Total | Total % | Lower Vertsep | Lemon Sole | Total | Total % |
|---|---|---|---|---|---|---|---|---|
| <MLS | 7 | 16 | 23 | 11.0% | 69.6% | <MLS | 30 | 6.1% |
| Grade 3 | 13 | 148 | 161 | 77.0% | 91.9% | Grade 3 | 421 | 86.1% |
| Grade 2 | 3 | 21 | 24 | 11.5% | 87.5% | Grade 2 | 35 | 7.2% |
| Grade 1 | 0 | 1 | 1 | 0.5% | 100.0% | Grade 1 | 3 | 0.6% |
| Total | 23 | 186 | 209 | 100.0% | 89.0% | Total | 489 | 100.0% |

(e)

| Plaice | Upper | Lower | Total | Total % | Lower Vertsep | Plaice | Total | Total % |
|---|---|---|---|---|---|---|---|---|
| <MLS | 1 | 2 | 3 | 4.7% | 66.7% | <MLS | 9 | 17.3% |
| Grade 4 | 5 | 22 | 27 | 42.2% | 81.5% | Grade 4 | 17 | 32.7% |
| Grade 3 | 2 | 5 | 7 | 10.9% | 71.4% | Grade 3 | 9 | 17.3% |
| Grade 2 | 0 | 11 | 11 | 17.2% | 100.0% | Grade 2 | 9 | 17.3% |
| Grade 1 | 0 | 16 | 16 | 25.0% | 100.0% | Grade 1 | 8 | 15.4% |
| Total | 8 | 56 | 64 | 100.0% | 87.5% | Total | 52 | 100.0% |

The EC grades here are theoretical, and not those used by the market. Market grades are given elsewhere

Figure 2

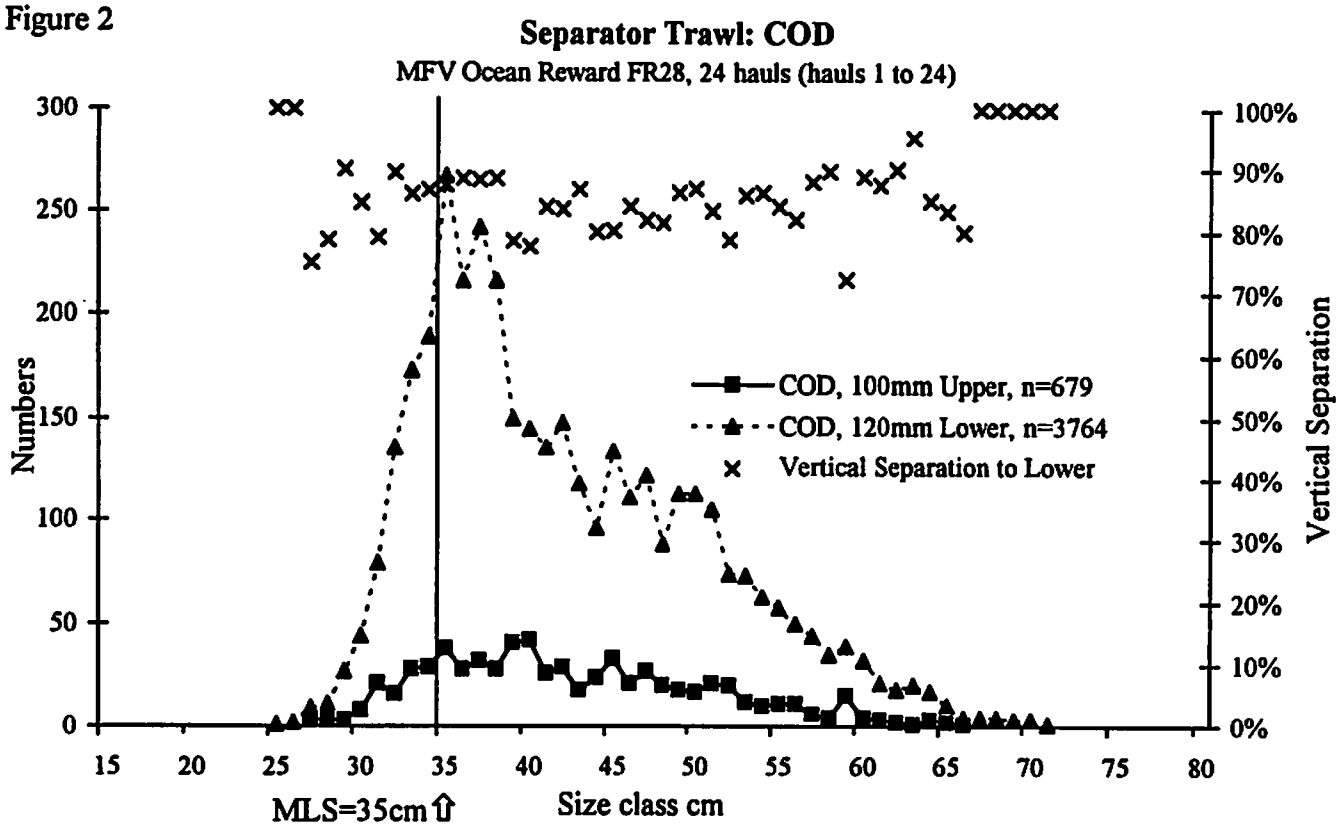



Figure 3

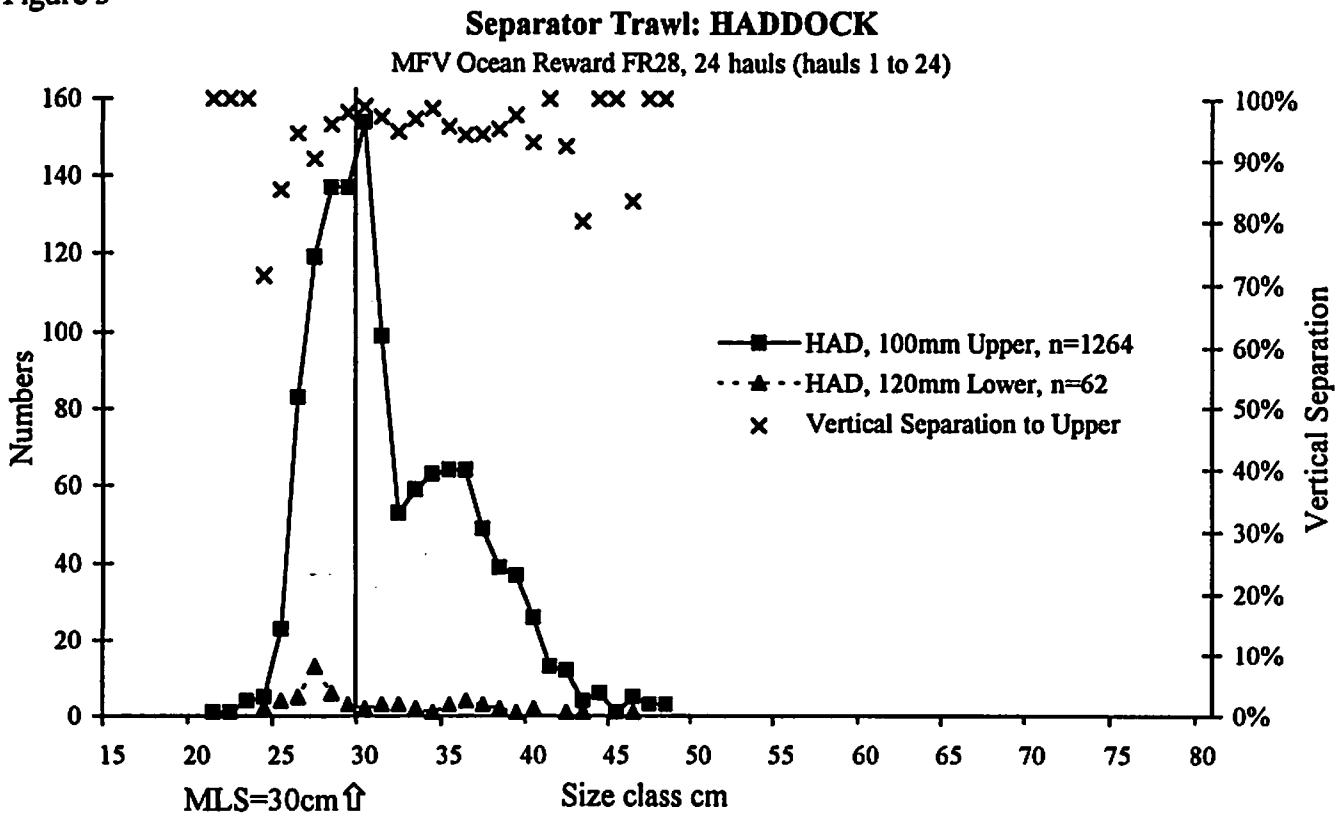


Figure 4

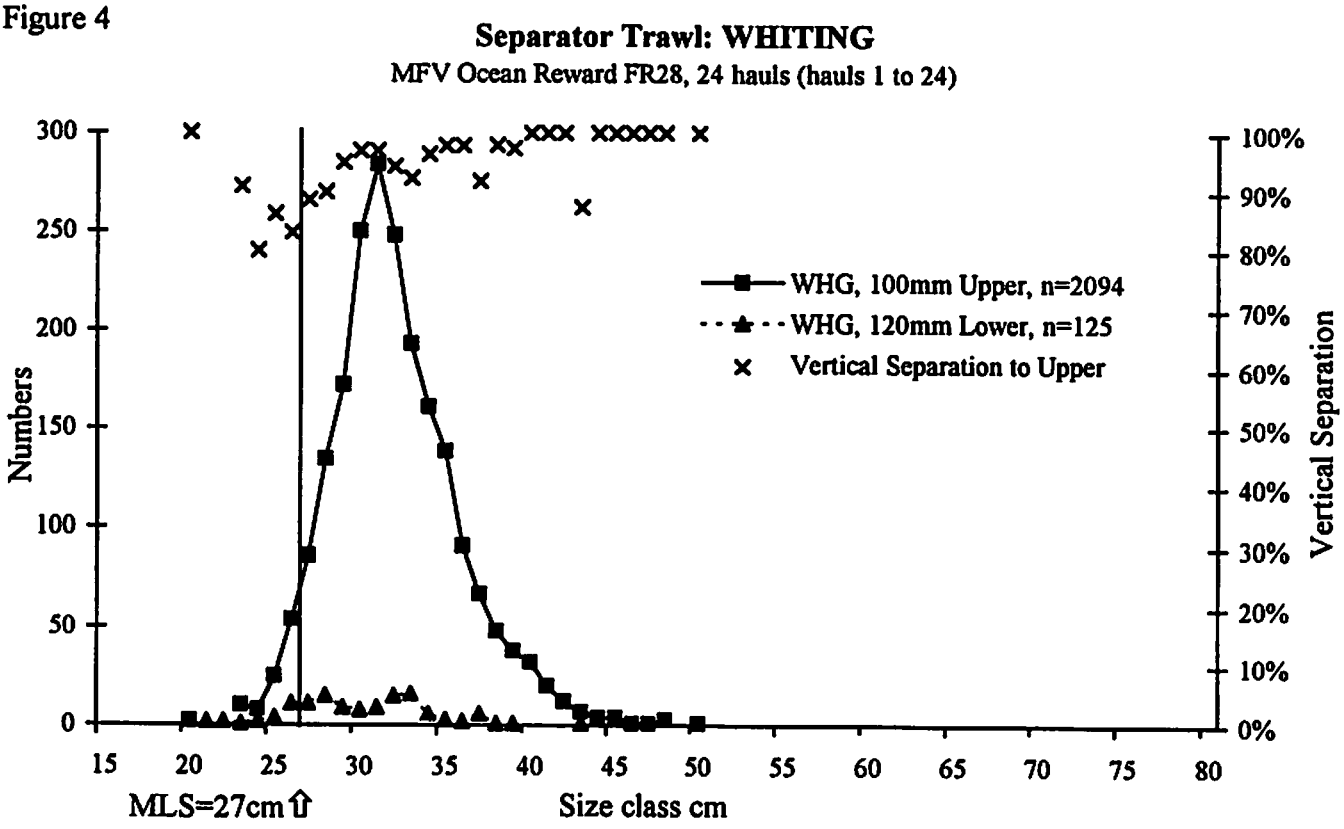



Figure 5

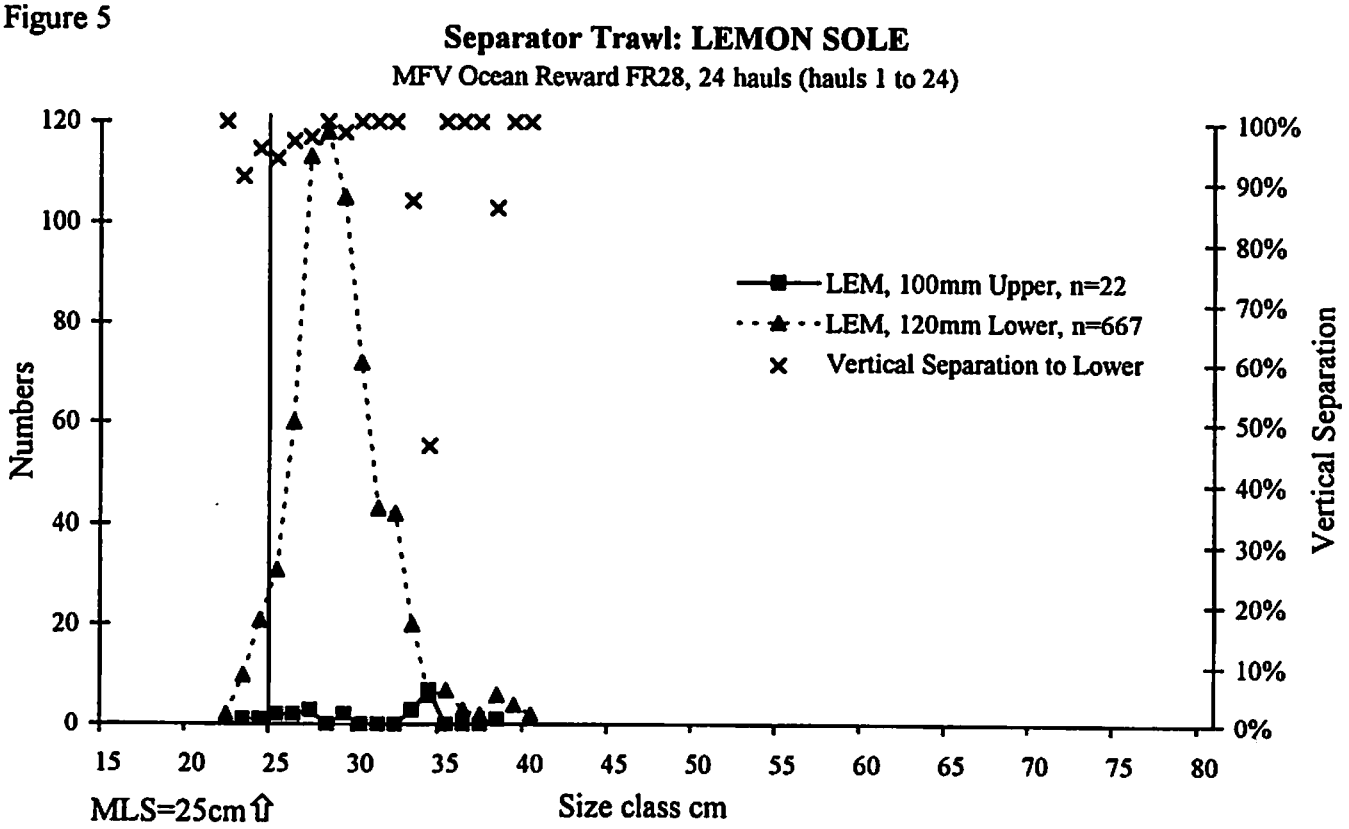


Figure 6

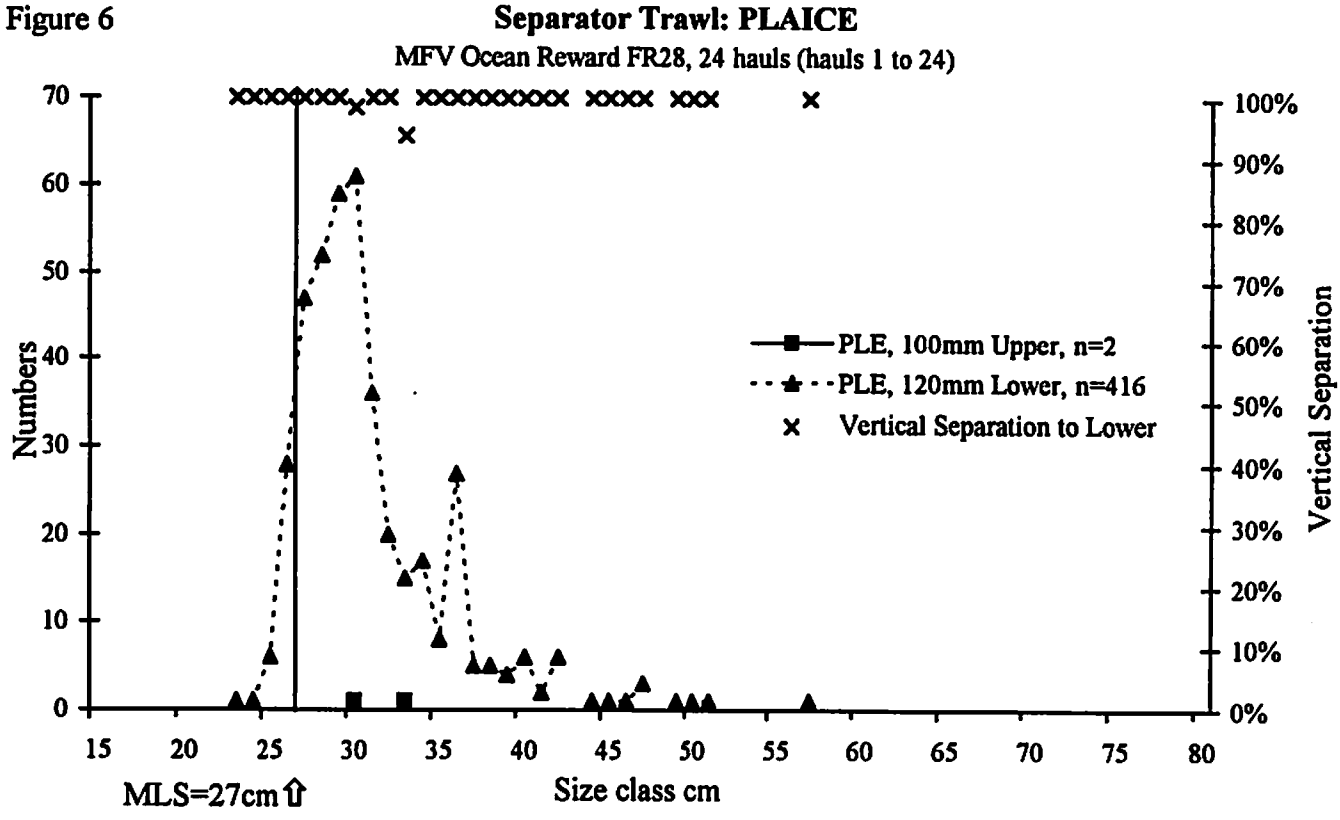

Separator Trawl: PLAICE
MFV Ocean Reward FR28, 24 hauls (hauls 1 to 24)
Numbers
Vertical Separation
PLE, 100mm Upper, n=2
PLE, 120mm Lower, n=416
Vertical Separation to Lower
MLS=27cm
Size class cm

Figure 7

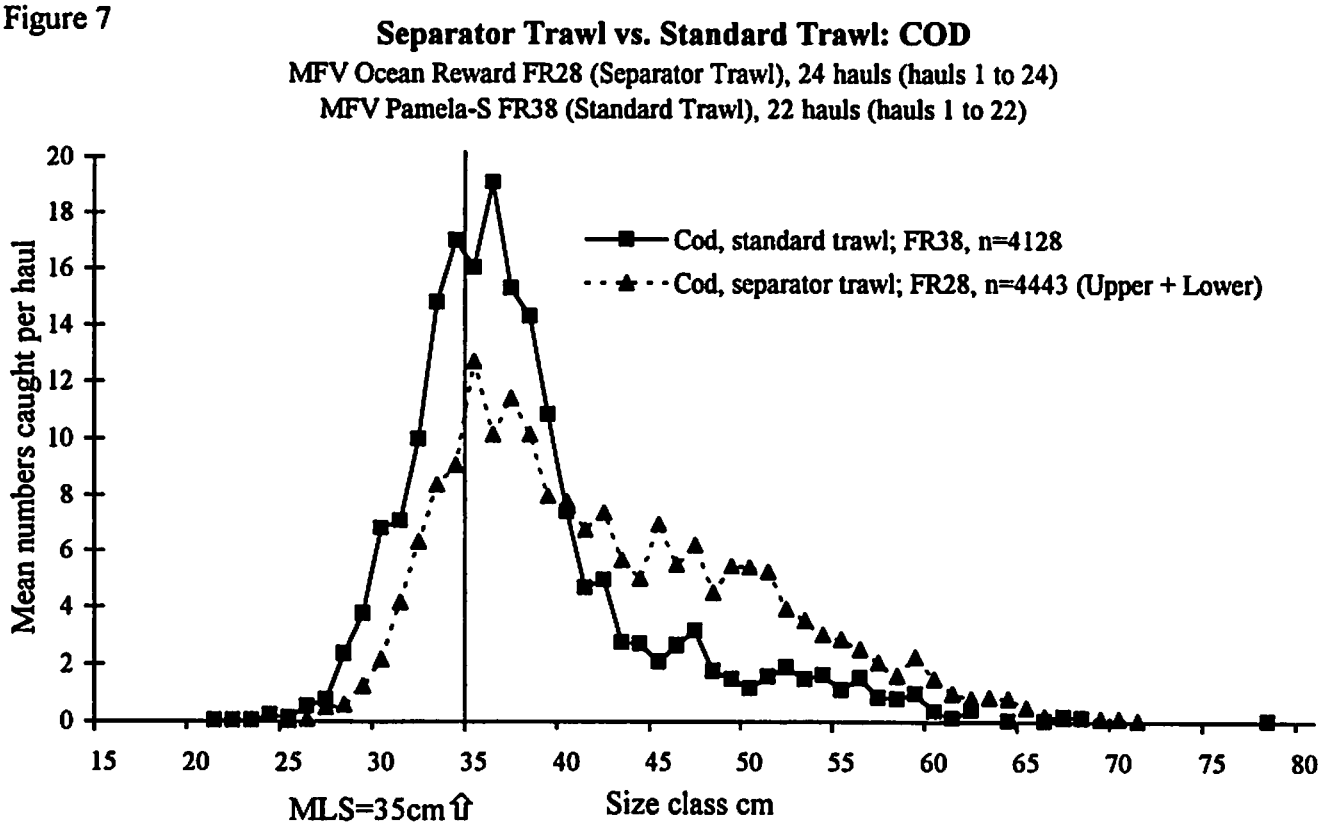



Figure 8

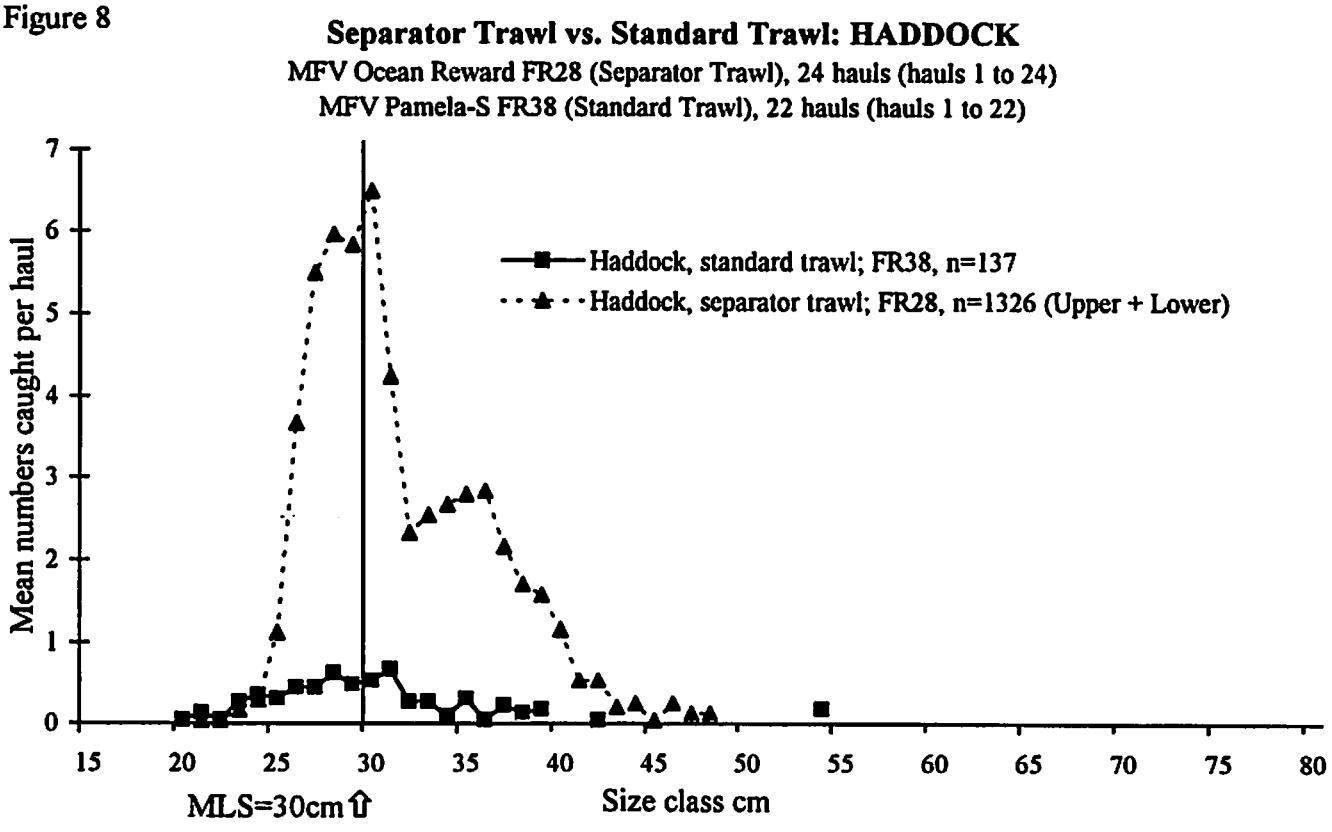


Figure 9

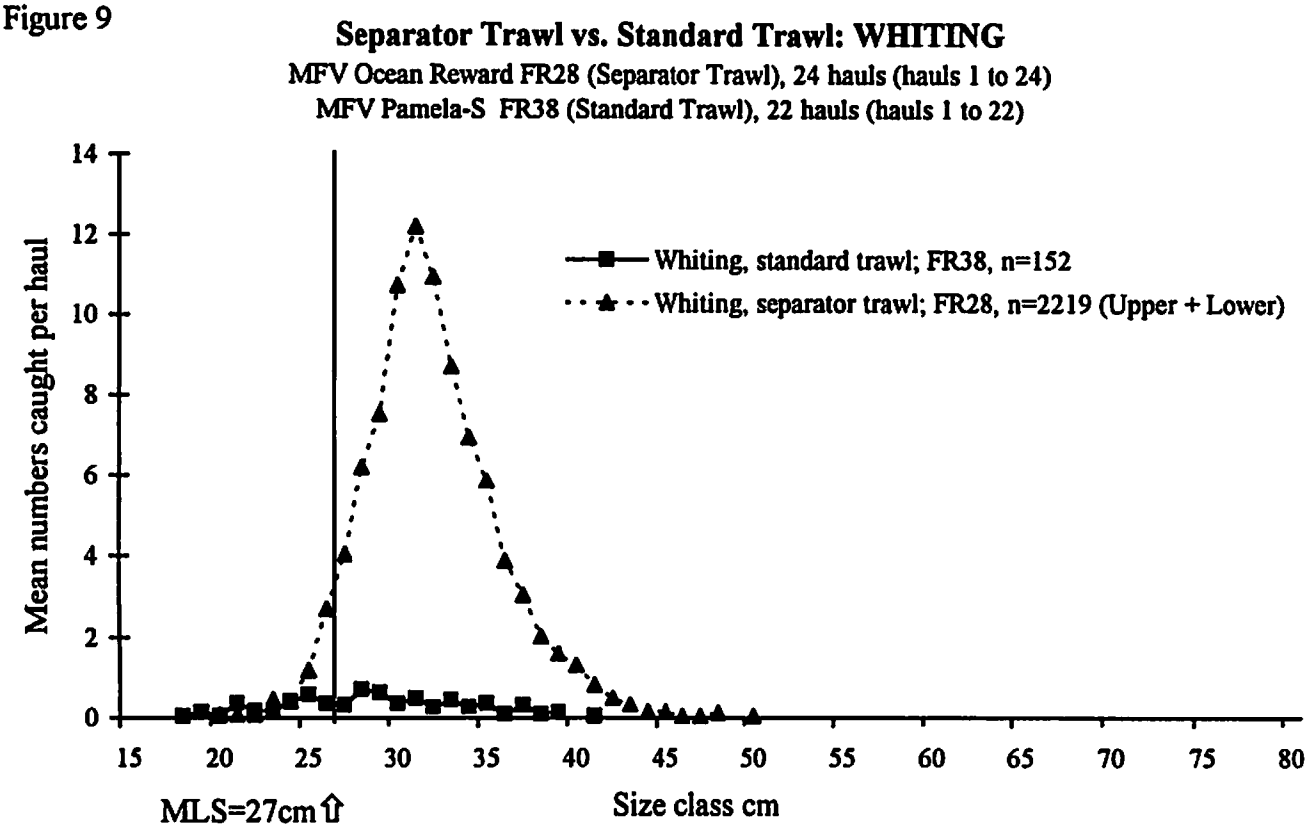



Figure 10

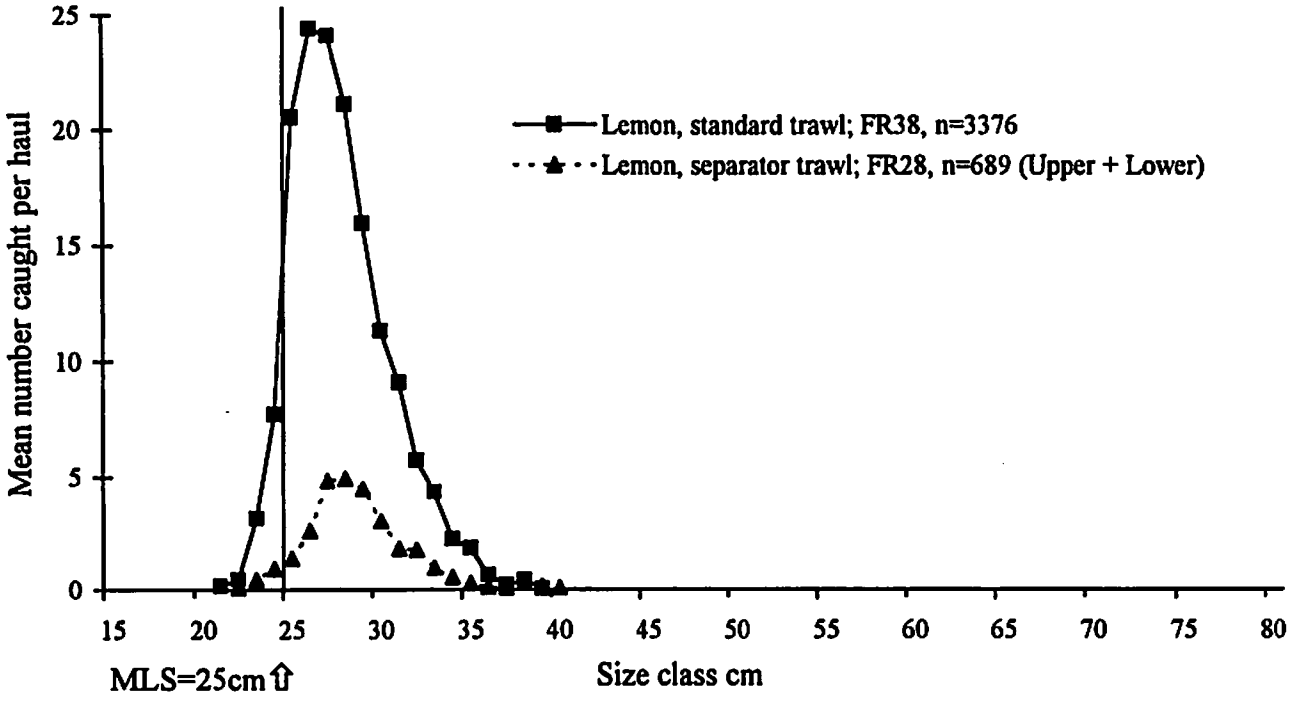


Figure 11

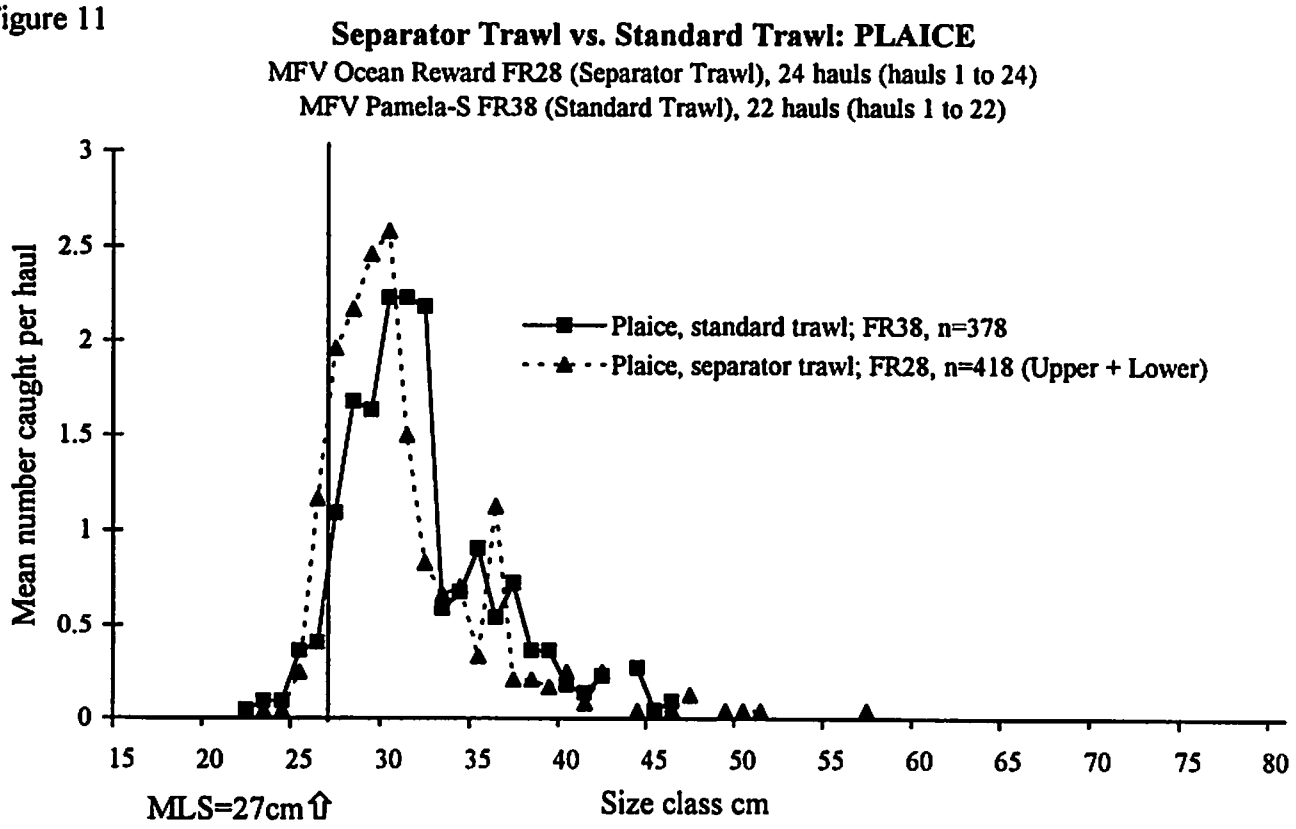

Separator Trawl vs. Standard Trawl: PLAICE
MFV Ocean Reward FR28 (Separator Trawl), 24 hauls (hauls 1 to 24)
MFV Pamela-S FR38 (Standard Trawl), 22 hauls (hauls 1 to 22)
Mean number caught per haul
3
2.5
2
1.5
1
0.5
0
Plaice, standard trawl; FR38, n=378
Plaice, separator trawl; FR28, n=418 (Upper + Lower)
15
20
25
30
35
40
45
50
55
60
65
70
75
80
MLS=27cm
Size class cm

Figure 12

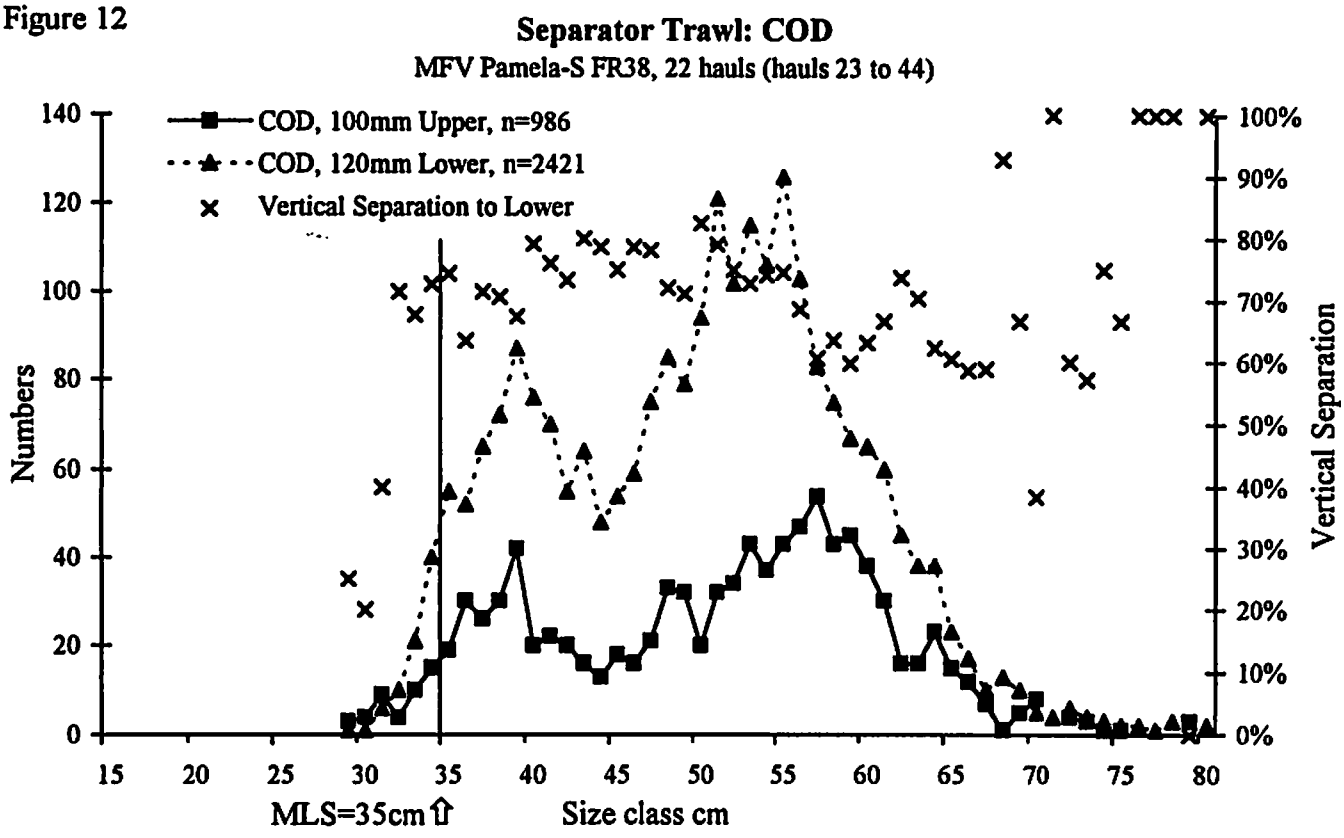



Figure 13

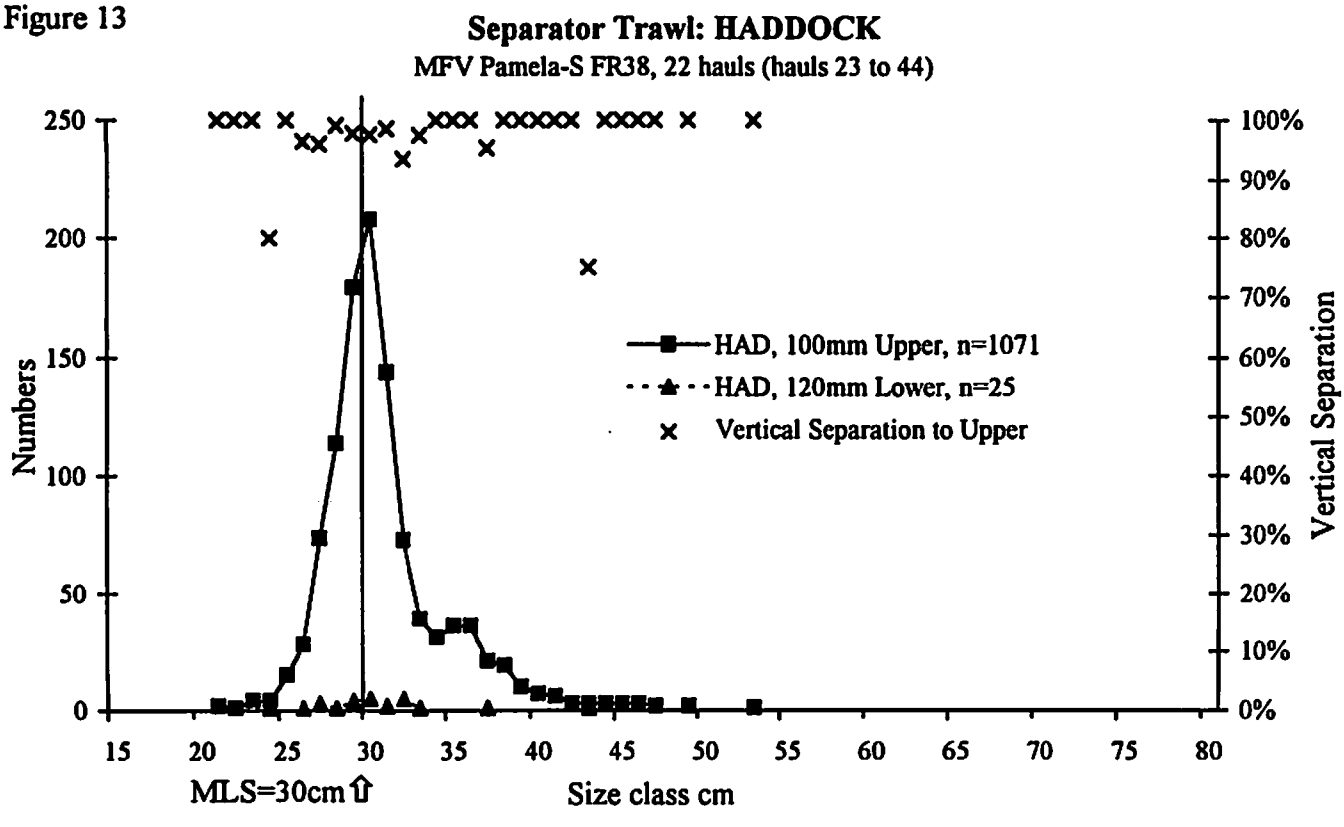


Figure 14

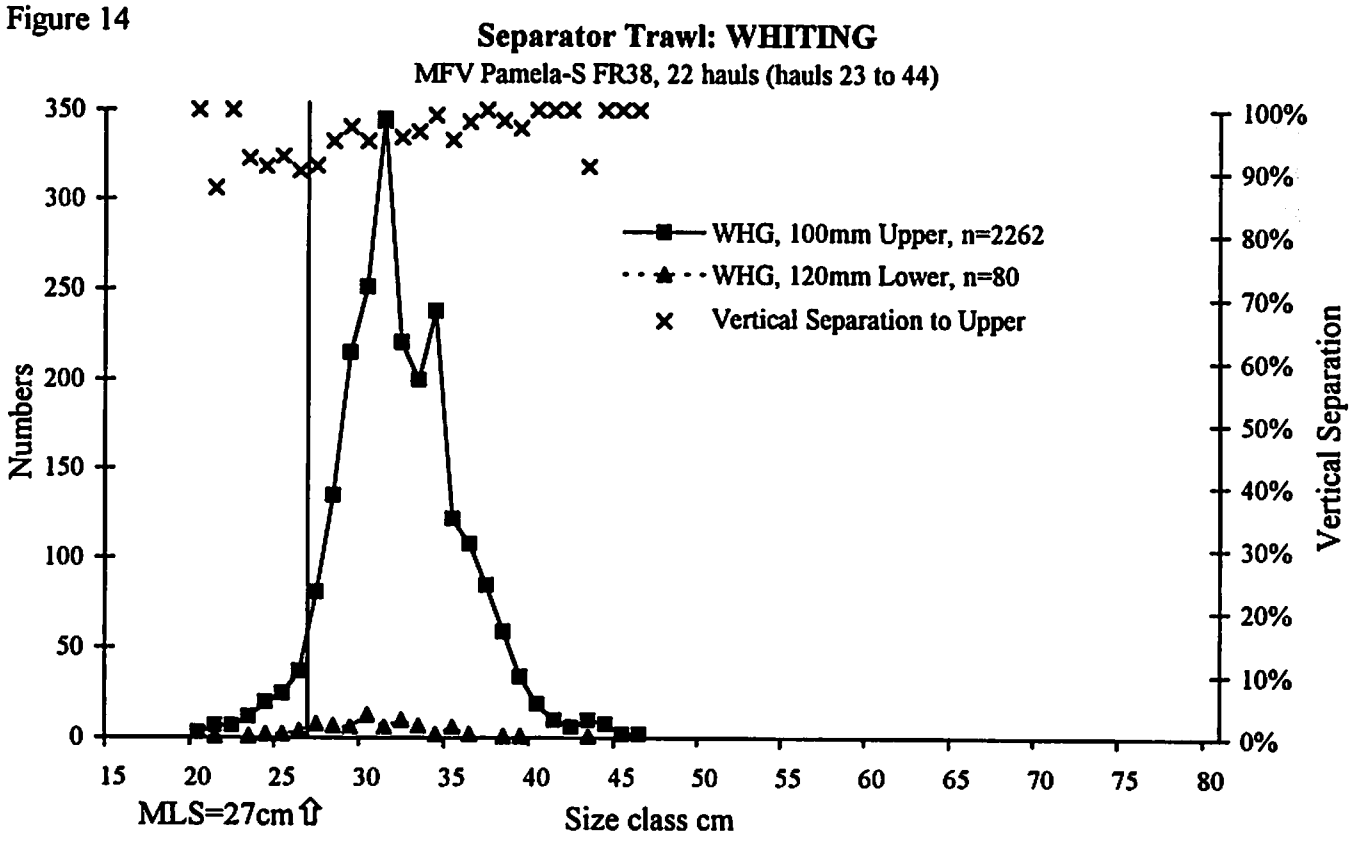



Figure 15

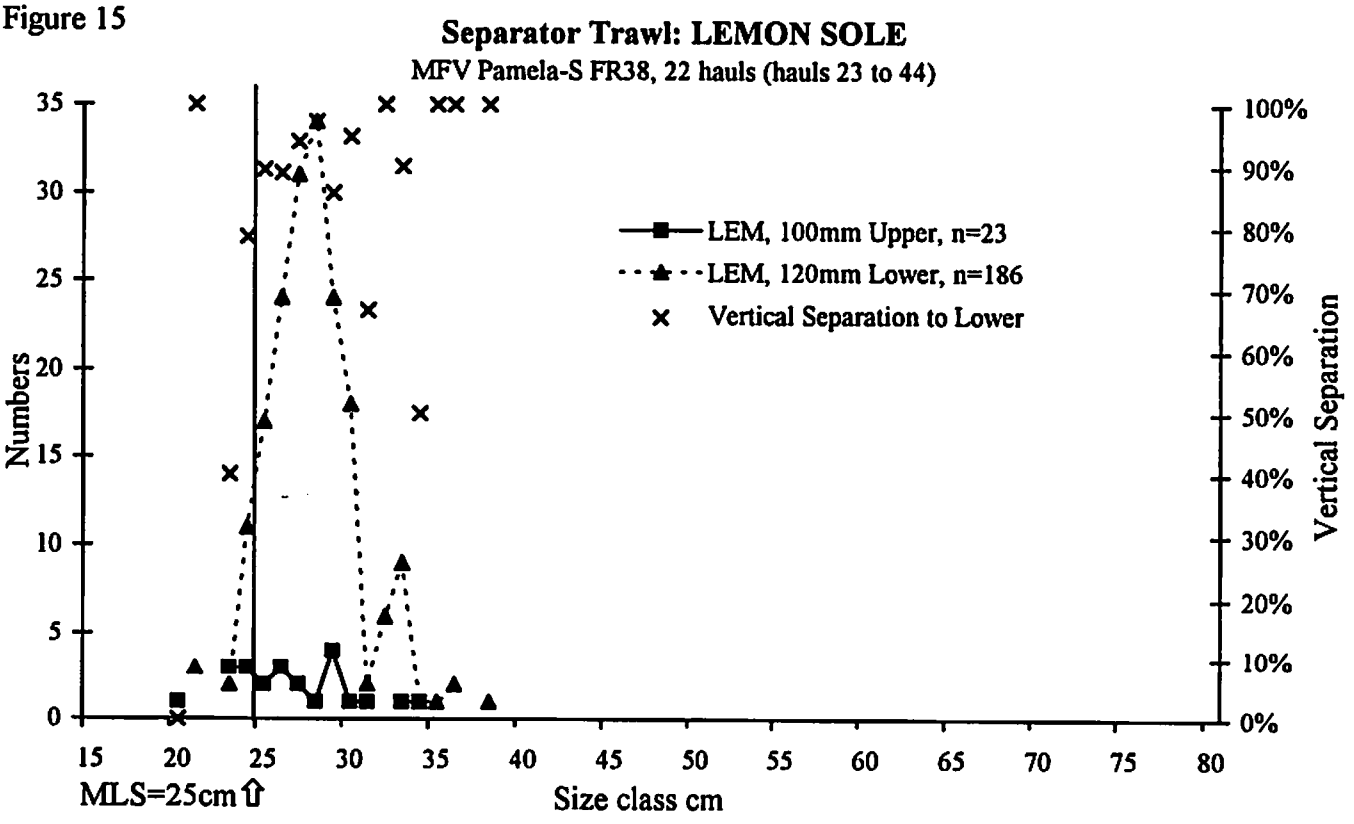


Figure 16

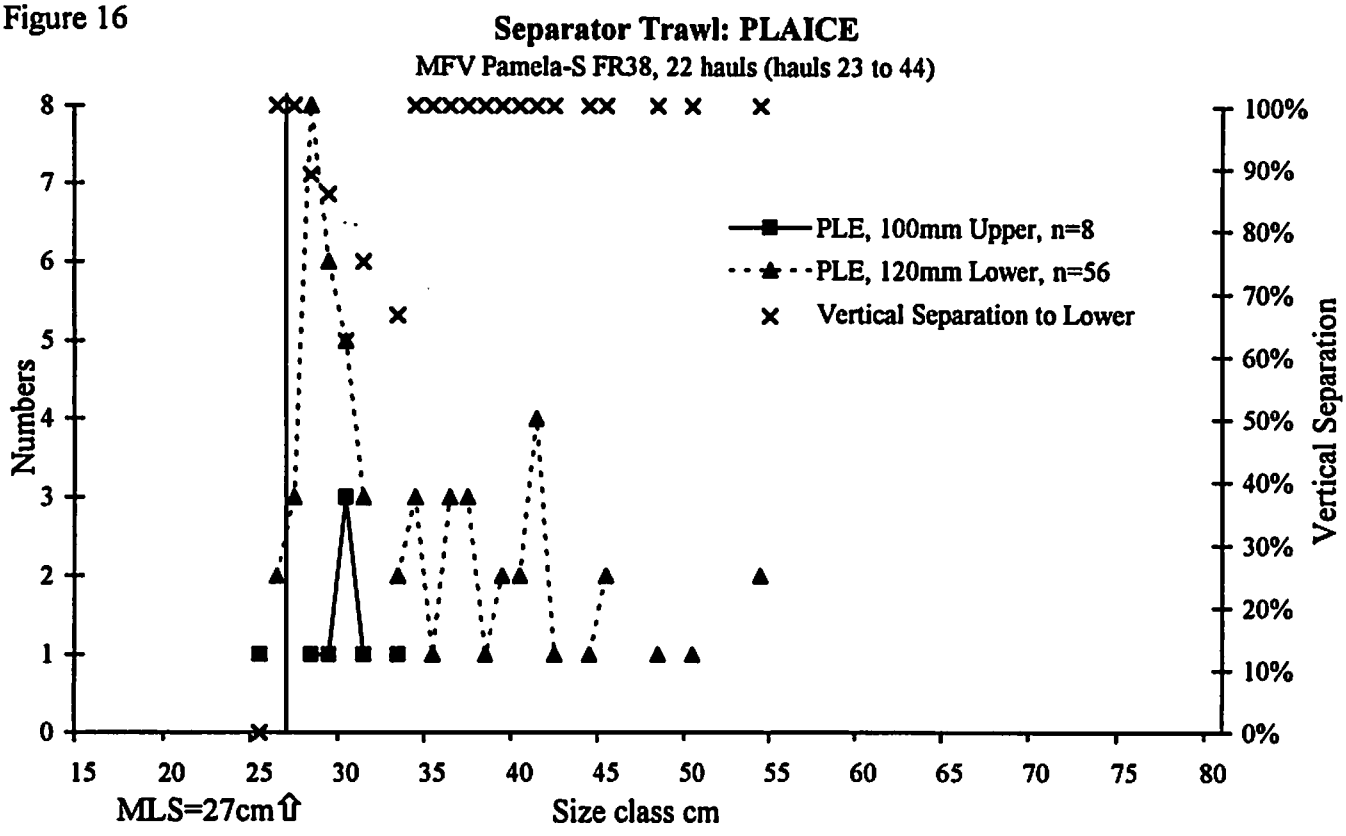

Separator Trawl: PLAICE
MFV Pamela-S FR38, 22 hauls (hauls 23 to 44)
PLE, 100mm Upper, n=8
PLE, 120mm Lower, n=56
Vertical Separation to Lower
Numbers
Vertical Separation
MLS=27cm
Size class cm
0
1
2
3
4
5
6
7
8
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
15
20
25
30
35
40
45
50
55
60
65
70
75
80

Figure 17

**Separator Trawl vs. Standard Trawl: COD**

MFV Pamela-S FR38 (Separator Trawl), 22 hauls (hauls 23 to 44)
MFV Ocean Reward FR28 (Standard Trawl), 22 hauls (hauls 25 to 46)

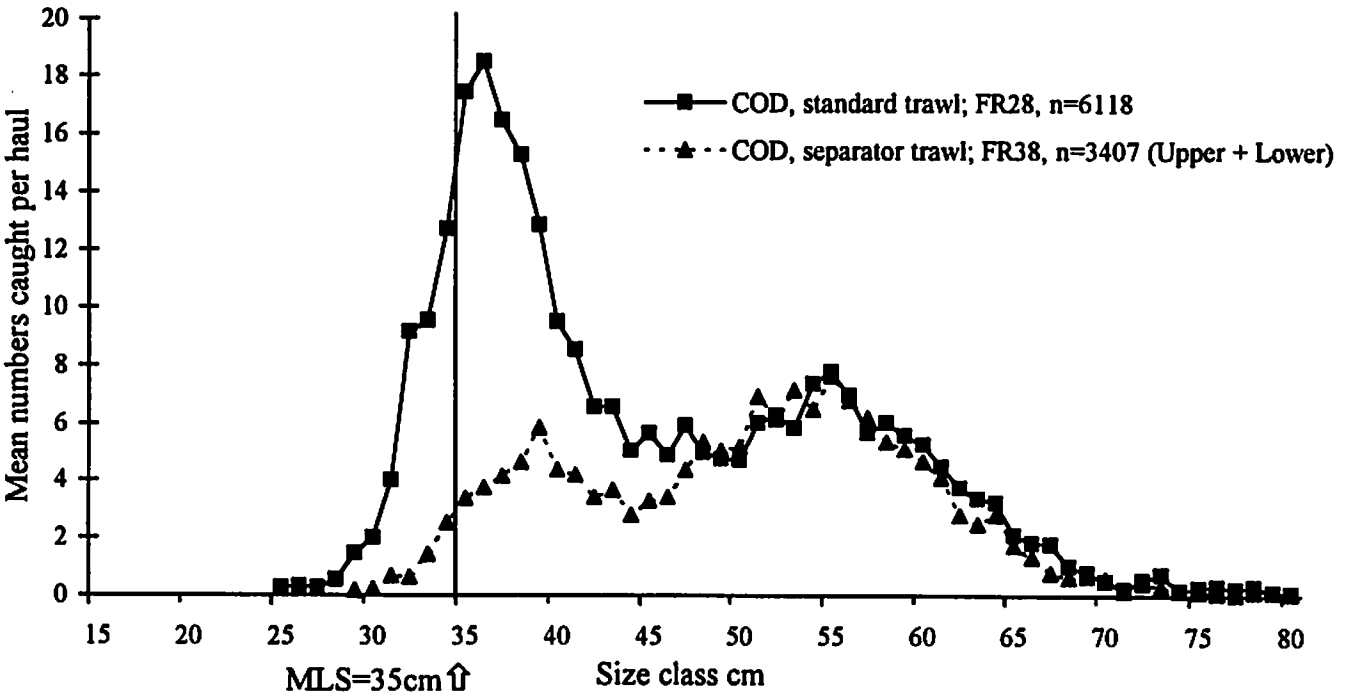



Figure 18

**Separator Trawl vs. Standard Trawl: HADDOCK**

MFV Pamela-S FR38 (Separator Trawl), 22 hauls (hauls 23 to 44)
MFV Ocean Reward FR28 (Standard Trawl), 22 hauls (hauls 25 to 46)

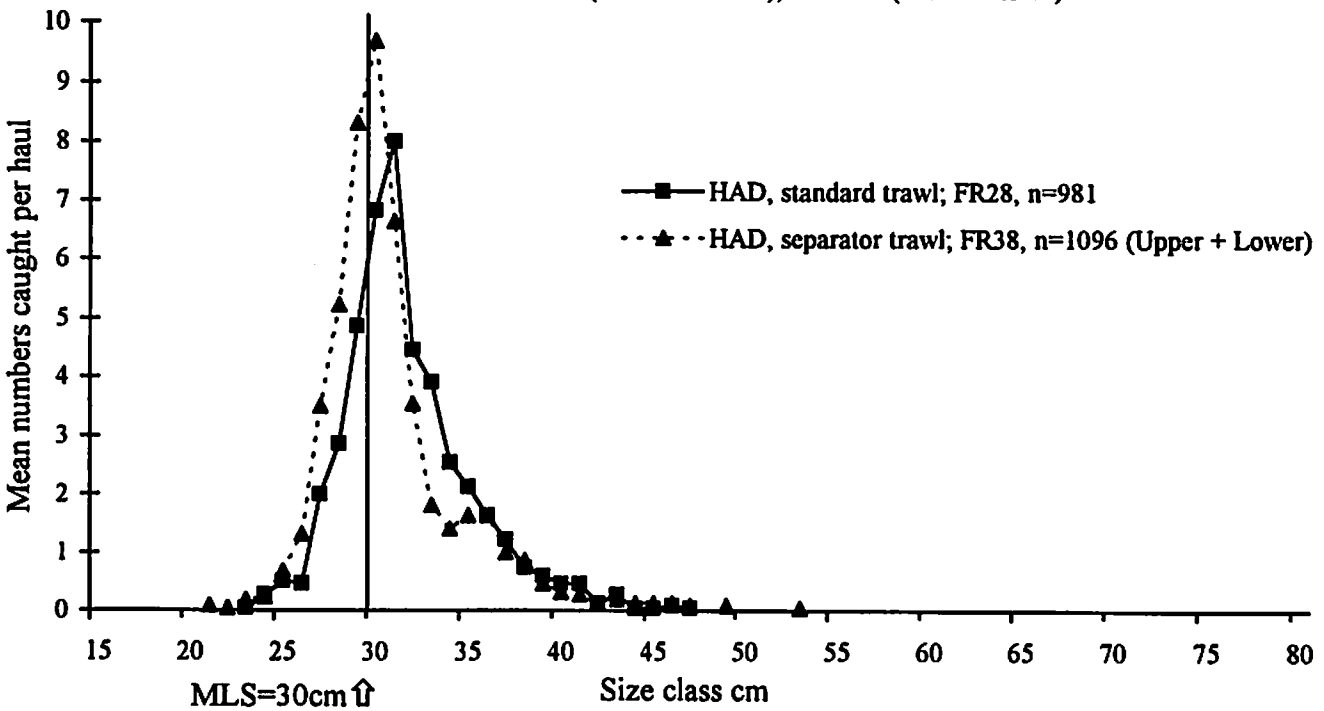


Figure 19

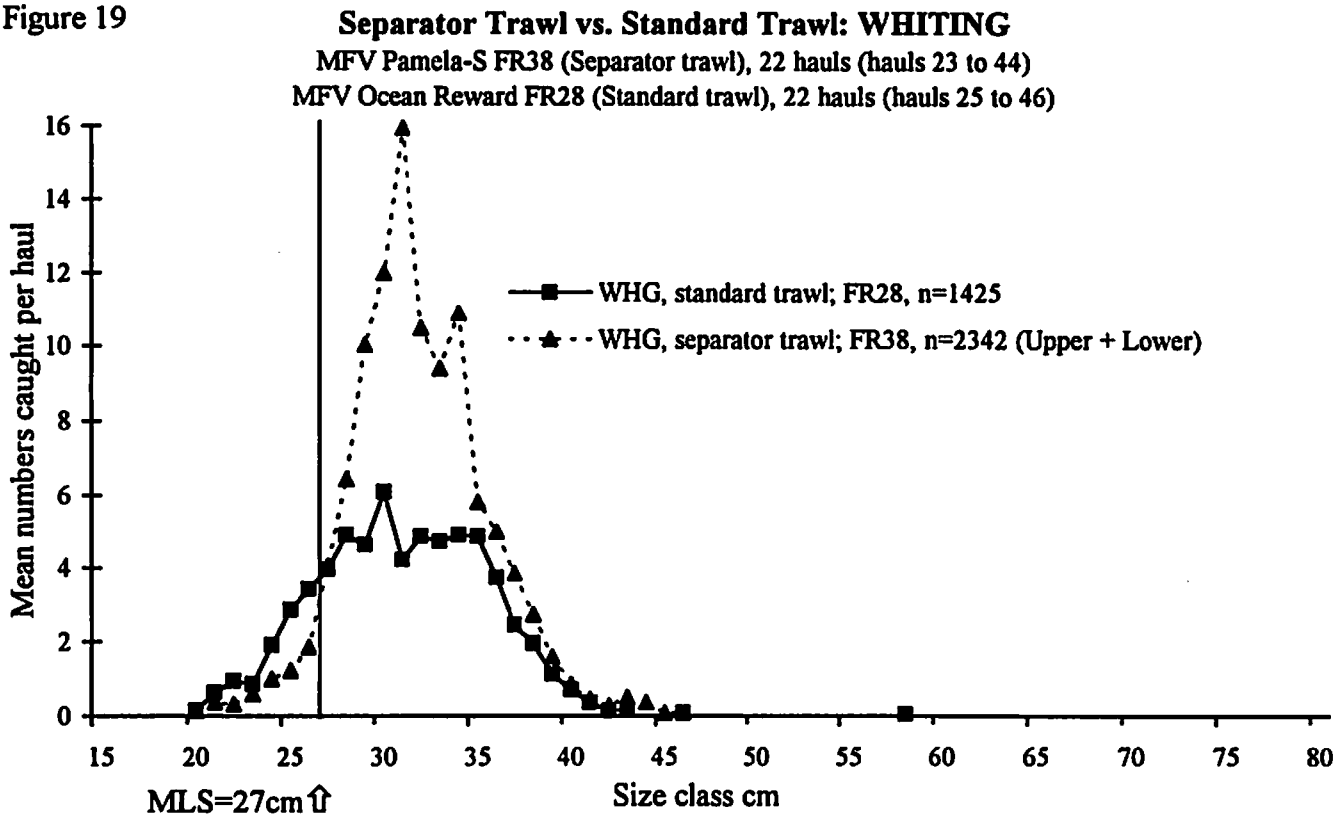



Figure 20

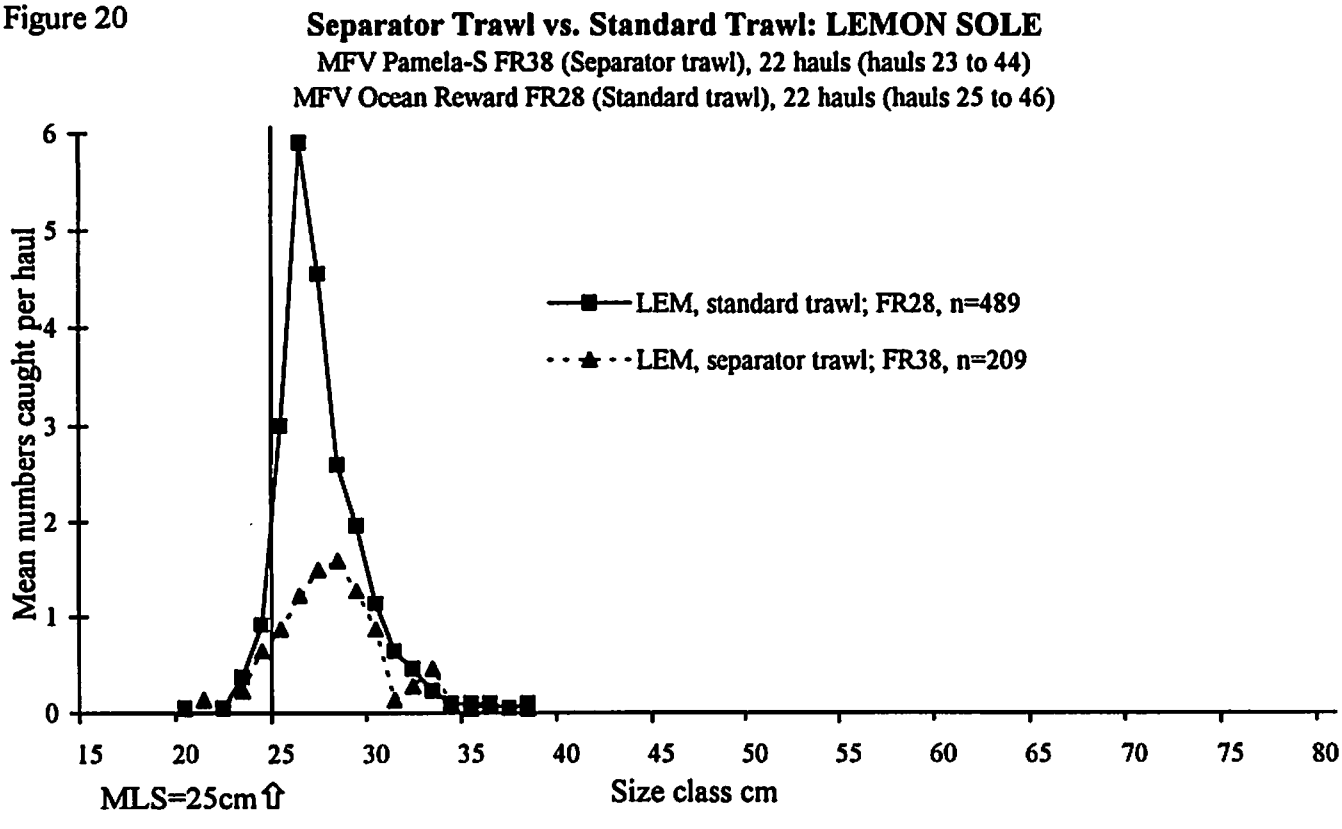
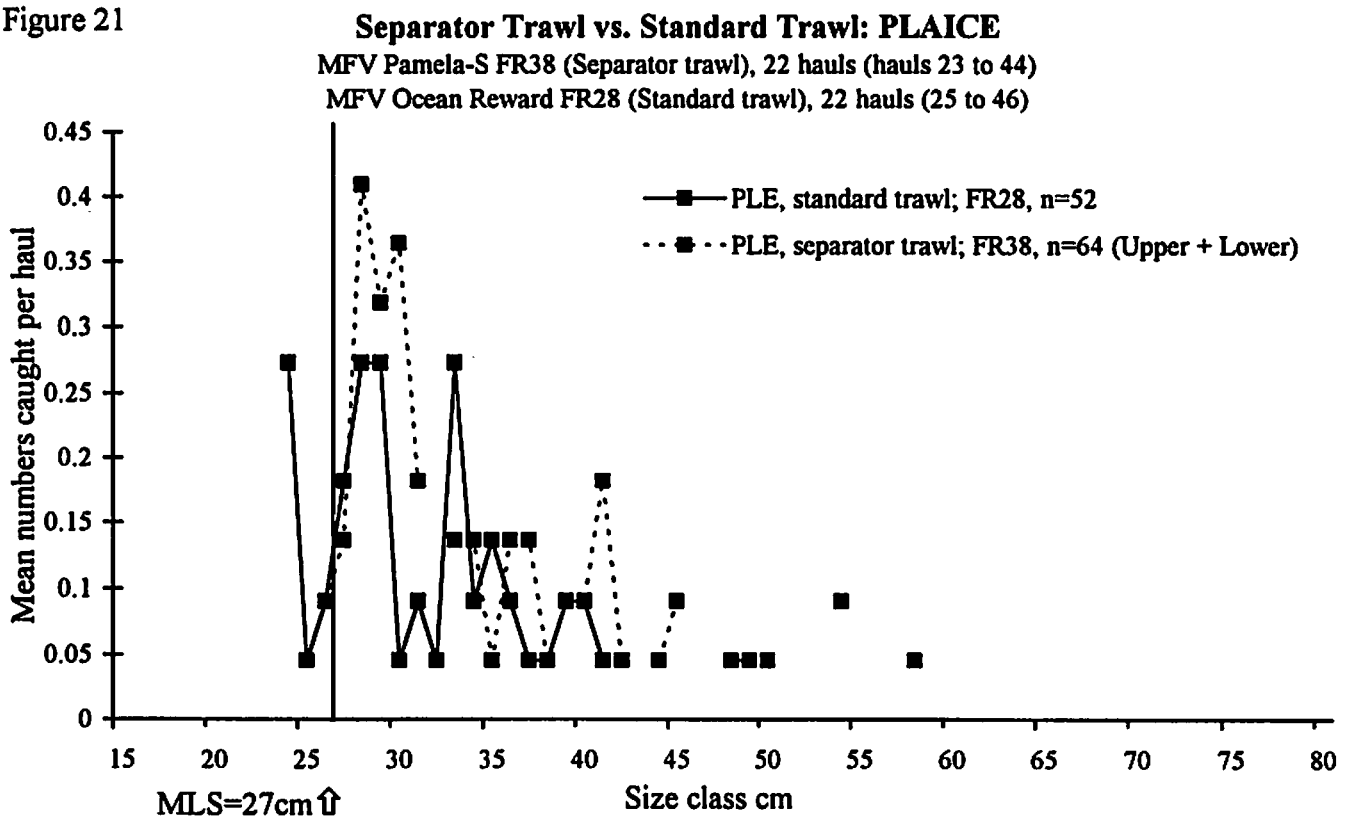


Figure 21


Separator Trawl vs. Standard Trawl: PLAICE
MFV Pamela-S FR38 (Separator trawl), 22 hauls (hauls 23 to 44)
MFV Ocean Reward FR28 (Standard trawl), 22 hauls (25 to 46)
PLE, standard trawl; FR28, n=52
PLE, separator trawl; FR38, n=64 (Upper + Lower)
Mean numbers caught per haul
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
15 20 25 30 35 40 45 50 55 60 65 70 75 80
MLS=27cm⇧
Size class cm

### 5.4 Comparison of Landings and Revenues

Tables 4-11 show the breakdown of catches of 5 main species for both vessels on a weekly basis.

For each of the five main target species the catches are shown in kilograms for each market grade with the corresponding value alongside.

This same information is also shown graphically as differences in market landings and market revenue between the separator trawl and the standard trawl in Figures 22-25. The landings information presents the differences between the two gear types for each market grade, for each species. Each day of operations is represented along the x axis. The revenue attributable to all grades for each species is depicted by the lines overlying the bar presentations. The difference in quantity (kgs) and revenue (£) are shown on the same y axis.

The overall comparative earnings for the two vessels are shown in Tables 12 and 13. These represent the matched landings, i.e. from all days when both vessels conducted the same number of valid tows. In Tables 4 and 9, the catch breakdowns for 3 days have been highlighted. These data have been omitted from the overall comparative earnings as a result of unmatched fishing performance on these days.

#### 5.4.1 Cod landings

Figure 22 shows the differences in landings and revenue for the first half of the trials (up to 20th October 1995). This information shows that the differences in landings changed during the course of the trial. The trials showed the separator trawl was much more effective at catching grade E4 fish than the standard trawl. The bulk of cod earnings for both sets of gear came from the 'small' grade E5 fish (Table 14).

There was an influx of large cod onto the fishing grounds during the second half of the trials (after 20th October 1995). This is reflected in the size distributions of Figures 26 and 27. The separator trawl consistently caught more of these large grade E3 fish than the standard trawl during the second half of the trial, but the overall revenue for this species was less than that for the standard trawl. The bulk of cod revenues for both sets of gear came from the 'medium' grade E4 fish (Table 14).

#### 5.4.2 Haddock landings

Landings of haddocks (Figure 23) were inconsistent during the course of the trials. Overall, the standard trawl caught more of the 'small' grade E5 fish than the separator trawl and the bulk of the revenues for both sets of gear came from the 'small' E4 grade.

#### 5.4.3 Whiting landings

Whiting landings were graded as all E4. The separator trawl consistently caught more whiting than the standard trawl on all days except one (8th November 1995, Figure 24). Differences in whiting catches between the gears generally became less as the trial progressed. Differences in revenues closely followed the landing differences in direct proportion.

### 5.4.4 Lemon sole landings

Due to inconsistencies on the market, lemon sole were divided into two categories - grade E3 and 'ungraded'. Throughout the trial the standard trawl always caught more lemon sole than did the separator trawl, although this difference tended to decrease as the trial progressed, reflecting lower general catches of this species taken by both gears towards the end of the trial. As for whiting, differences in revenues closely followed the landing differences in direct proportion.

Tables 4-11

Weekly breakdown of catches of 5 main species by weight and by value for both vessels fishing with both gear types

Table 4

| WEEK 1 FIRST HALF | | SEPARATOR TRAWL MFV OCEAN REWARD FR28 | | | | | | | | STANDARD TRAWL MFV PAMELA-S FR38 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 18/09/95 | | 20/09/95 | | 21/09/95 | | 22/09/95 | | 18/09/95 | | 20/09/95 | | 21/09/95 | | 22/09/95 | |
| SPECIES | GRADE | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ |
| COD | E3 | | | | | | | | | | | | | | | | |
| COD | E4 | 32 | 33.75 | 29 | 39.60 | | | 140 | 170.00 | 45 | 48.40 | 51 | 56.00 | | | 108 | 106.75 |
| COD | E5 | 86 | 71.50 | 130 | 112.10 | 32 | 32.56 | 229 | 221.00 | 153 | 126.75 | 151 | 121.10 | 22 | 17.50 | 102 | 78.00 |
| HAD | E2 | | | | | | | | | | | | | | | | |
| HAD | E3 | 10 | 4.50 | 22 | 17.50 | | | 32 | 30.00 | | | | | | | | |
| HAD | E4 | | | | | | | 35 | 22.00 | 6 | 4.00 | 6 | 4.00 | | | | |
| LEM | * | | | | | | | | | 87 | 115.00 | 84 | 106.00 | 13 | 17.20 | 81 | 62.88 |
| LEM | E3 | 19 | 27.00 | 19 | 36.00 | | | 22 | 17.00 | | | | | | | | |
| PLE | * | 10 | 15.00 | 3 | 3.00 | | | | | | | 3 | 3.00 | | | | |
| PLE | E1 | | | | | | | | | | | | | | | | |
| PLE | E2 | | | | | | | 3 | 6.00 | 3 | 5.00 | | | | | | |
| PLE | E3 | | | | | | | | | 3 | 2.50 | | | | | 38 | 30.00 |
| PLE | E4 | | | | | | | 6 | 4.00 | | | | | | | | |
| WHG | E4 | 45 | 11.20 | 102 | 32.00 | 41 | 10.46 | 86 | 47.00 | | | 16 | 4.00 | | | 17 | 4.40 |

* Ungraded landings ☐ Rejected data sets

Upper codend=100mm; Lower codend=120mm; Standard codend=100mm

Table 5

| WEEK 2 FIRST HALF | | SEPARATOR TRAWL MFV OCEAN REWARD FR28 | | | | | | | STANDARD TRAWL MFV PAMELA-S FR38 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 25/09/95 | | 27/09/95 | | 28/09/95 | | | 25/09/95 | | 27/09/95 | | 28/09/95 | | |
| SPECIES | GRADE | kg | £ | kg | £ | kg | £ | | kg | £ | kg | £ | kg | £ | |
| COD | E3 | | | | | | | | 64 | 80.00 | | | | | |
| COD | E4 | 76 | 93.60 | 132 | 190.63 | 48 | 71.25 | | 45 | 63.00 | 102 | 115.20 | 19 | 27.25 | |
| COD | E5 | 169 | 155.50 | 191 | 185.10 | 191 | 210.21 | | 226 | 195.70 | 280 | 326.55 | 395 | 401.60 | |
| HAD | E2 | | | | | | | | | | | | | | |
| HAD | E3 | | | 3 | 3.20 | 29 | 24.75 | | | | 6 | 6.00 | 41 | 42.25 | |
| HAD | E4 | 19 | 10.50 | 16 | 8.75 | 32 | 18.05 | | | | 13 | 8.00 | 41 | 22.75 | |
| LEM | * | | | | | | | | 81 | 79.50 | 102 | 113.50 | 32 | 42.50 | |
| LEM | E3 | 29 | 45.00 | 35 | 69.30 | 6 | 9.00 | | | | | | | | |
| PLE | * | 16 | 19.50 | 5 | 3.75 | | | | | | | | | | |
| PLE | E1 | | | | | | | | | | | | | | |
| PLE | E2 | | | | | | | | 5 | 6.75 | 3 | 4.50 | | | |
| PLE | E3 | | | | | | | | | | 13 | 9.00 | 3 | 2.50 | |
| PLE | E4 | | | | | | | | | | | | | | |
| WHG | E4 | 25 | 6.40 | 83 | 20.80 | 33 | 10.50 | | | | 33 | 10.50 | | | |

* Ungraded landings

Upper codend=100mm; Lower codend=120mm; Standard codend=100mm

Tables 4-11

Weekly breakdown of catches of 5 main species by weight and by value for both vessels fishing with both gear types

Table 6

| WEEK 3 FIRST HALF | | SEPARATOR TRAWL MFV OCEAN REWARD FR28 | | | | | | | STANDARD TRAWL MFV PAMELA-S FR38 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 11/10/95 | | 12/10/95 | | 13/10/95 | | | 11/10/95 | | 12/10/95 | | 13/10/95 | | |
| SPECIES | GRADE | kg | £ | kg | £ | kg | £ | | kg | £ | kg | £ | kg | £ | |
| COD | E3 | | | | | | | | | | | | | | |
| COD | E4 | 45 | 51.00 | 89 | 95.05 | 51 | 72.05 | | | | | | 64 | 66.00 | |
| COD | E5 | 197 | 165.00 | 80 | 58.75 | 185 | 160.90 | | 372 | 300.95 | 51 | 33.30 | 204 | 161.75 | |
| HAD | E2 | | | | | | | | | | | | | | |
| HAD | E3 | | | | | | | | | | | | | | |
| HAD | E4 | | | 10 | 7.50 | 25 | 14.00 | | | | | | | | |
| LEM | * | | | | | | | | 73 | 96.05 | 70 | 84.75 | 46 | 60.33 | |
| LEM | E3 | 19 | 36.00 | 30 | 47.50 | 11 | 22.05 | | | | | | | | |
| PLE | * | | | 3 | 6.00 | | | | | | | | | | |
| PLE | E1 | | | | | | | | | | | | | | |
| PLE | E2 | | | | | | | | | | | | 6 | 10.00 | |
| PLE | E3 | 6 | 15.00 | | | | | | | | 6 | 6.00 | 29 | 26.50 | |
| PLE | E4 | 6 | 5.00 | | | 40 | 43.75 | | | | | | | | |
| WHG | E4 | 64 | 16.00 | 35 | 8.80 | 30 | 9.50 | | 13 | 3.20 | | | | | |

* Ungraded landings

Upper codend=100mm; Lower codend=120mm; Standard codend=100mm

Table 7

| WEEK 4 FIRST HALF | | SEPARATOR TRAWL MFV OCEAN REWARD FR28 | | | | | | | | STANDARD TRAWL MFV PAMELA-S FR38 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 16/10/95 | | 17/10/95 | | 19/10/95 | | 20/10/95 | | 16/10/95 | | 17/10/95 | | 19/10/95 | | 20/10/95 | |
| SPECIES | GRADE | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ |
| COD | E3 | 51 | 86.40 | | | | | | | | | 84 | 114.61 | | | | |
| COD | E4 | 210 | 295.15 | 127 | 179.90 | 156 | 181.25 | 13 | 15.20 | 156 | 194.00 | 19 | 21.00 | 29 | 43.43 | | |
| COD | E5 | 48 | 34.88 | 146 | 134.50 | 118 | 83.25 | 118 | 93.00 | 70 | 48.50 | 99 | 89.50 | 153 | 130.60 | 143 | 101.25 |
| HAD | E2 | | | 3 | 3.75 | | | | | | | | | | | | |
| HAD | E3 | | | | | | | | | | | | | | | | |
| HAD | E4 | | | 10 | 5.25 | | | | | | | 6 | 4.00 | | | | |
| LEM | * | 5 | 9.00 | | | | | | | 17 | 23.00 | 6 | 9.00 | 59 | 46.25 | 46 | 43.00 |
| LEM | E3 | | | | | 25 | 24.80 | 6 | 6.20 | | | | | | | | |
| PLE | * | 6 | 15.00 | 5 | 8.75 | 5 | 3.00 | | | | | | | | | | |
| PLE | E1 | | | | | | | | | | | | | | | | |
| PLE | E2 | | | | | | | | | | | | | 3 | 4.00 | | |
| PLE | E3 | | | | | 5 | 9.00 | | | 5 | 5.25 | 3 | 3.50 | | | 2 | 1.25 |
| PLE | E4 | | | | | | | | | | | | | | | | |
| WHG | E4 | 51 | 13.20 | 54 | 17.00 | 13 | 3.20 | 54 | 17.00 | 13 | 6.00 | 51 | 12.80 | | | | |

* Ungraded landings

Upper codend=100mm; Lower codend=120mm; Standard codend=100mm

Tables 4-11

Weekly breakdown of catches of 5 main species by weight and by value for both vessels fishing with both gear types

Table 8

| WEEK 1 SECOND HALF | | SEPARATOR TRAWL MFV PAMELA-S FR38 | | | | | | | | | | STANDARD TRAWL MFV OCEAN REWARD FR28 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 30/10/95 | | 31/10/95 | | 01/11/95 | | 02/11/95 | | 03/11/95 | | 30/10/95 | | 31/10/95 | | 01/11/95 | | 02/11/95 | | 03/11/95 | |
| SPECIES | GRADE | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ |
| COD | E3 | 46 | 66.70 | 200 | 369.75 | 142 | 222.50 | 118 | 181.30 | | | 48 | 82.80 | | | | | | | | |
| COD | E4 | 41 | 65.00 | 274 | 324.50 | 393 | 466.38 | 172 | 207.20 | 248 | 253.50 | | | 655 | 1087.20 | 547 | 845.05 | 200 | 236.25 | 197 | 248.00 |
| COD | E5 | 83 | 75.78 | 146 | 170.50 | 17 | 12.10 | 16 | 16.25 | 46 | 36.63 | 288 | 274.40 | 51 | 38.80 | 181 | 188.90 | 270 | 233.20 | 108 | 103.50 |
| HAD | E2 | | | | | | | | | | | | | | | | | | | | |
| HAD | E3 | | | | | | | | | | | | | | | | | 6 | 7.50 | | |
| HAD | E4 | 17 | 9.63 | | | 57 | 31.00 | | | | | 30 | 16.60 | | | 32 | 17.50 | 6 | 5.00 | 6 | 3.50 |
| LEM | * | 16 | 27.50 | 2 | 2.63 | | | | | | | 38 | 54.00 | | | 5 | 9.00 | 2 | 3.00 | | |
| LEM | E3 | | | | | | | | | | | | | 6 | 12.00 | | | | | | |
| PLE | * | | | | | | | | | | | | | | | 3 | 4.00 | 3 | 5.50 | | |
| PLE | E1 | | | | | | | | | | | | | | | | | | | | |
| PLE | E2 | | | | | | | | | | | | | | | | | | | | |
| PLE | E3 | 13 | 5.00 | | | | | | | | | 2 | 3.20 | | | | | | | | |
| PLE | E4 | | | | | | | | | | | 6 | 5.50 | | | | | | | | |
| WHG | E4 | 102 | 25.60 | 35 | 8.80 | 40 | 11.25 | | | | | 64 | 18.00 | 16 | 4.00 | 35 | 9.90 | 5 | 3.75 | | |

* Ungraded landings

Upper codend=100mm; Lower codend=120mm; Standard codend=100mm

Table 9

| WEEK 2 SECOND HALF | | SEPARATOR TRAWL MFV PAMELA-S FR38 | | | | | | | | | | STANDARD TRAWL MFV OCEAN REWARD FR28 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 06/11/95 | | 07/11/95 | | 08/11/95 | | 09/11/95 | | 10/11/95 | | 06/11/95 | | 07/11/95 | | 08/11/95 | | 09/11/95 | | 10/11/95 | |
| SPECIES | GRADE | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ | kg | £ |
| COD | E3 | 24 | 31.87 | 75 | 104.55 | 51 | 65.60 | | | 21 | 27.63 | | | 13 | 19.20 | | | | | 13 | 18.60 |
| COD | E4 | 130 | 122.55 | 65 | 75.85 | 226 | 230.88 | 234 | 227.85 | 239 | 249.60 | 146 | 180.00 | 83 | 97.50 | 146 | 180.70 | 137 | 150.43 | 137 | 162.85 |
| COD | E5 | 43 | 40.50 | 54 | 49.30 | 24 | 17.25 | 111 | 92.25 | 45 | 36.40 | 32 | 22.00 | 70 | 69.85 | 328 | 289.75 | 433 | 370.93 | 153 | 127.50 |
| HAD | E2 | | | | | | | | | | | | | | | | | | | | |
| HAD | E3 | | | | | | | | | | | | | | | 10 | 9.75 | | | | |
| HAD | E4 | 3 | 2.00 | | | | | 78 | 55.13 | 5 | 3.00 | | | | | 76 | 49.00 | 51 | 30.00 | | |
| LEM | * | | | | | 3 | 4.00 | 14 | 16.88 | 6 | 8.20 | 6 | 12.00 | | | | | 51 | 60.00 | 8 | 15.00 |
| LEM | E3 | | | | | | | | | | | | | | | 16 | 30.00 | | | | |
| PLE | * | | | | | | | | | | | | | | | 6 | 7.00 | | | | |
| PLE | E1 | | | | | | | 5 | 9.00 | | | | | | | | | | | | |
| PLE | E2 | | | | | | | | | 3 | 4.00 | | | | | | | | | | |
| PLE | E3 | | | | | 5 | 3.75 | | | | | | | | | | | | | | |
| PLE | E4 | | | | | | | | | | | | | | | | | | | | |
| WHG | E4 | 102 | 28.80 | 54 | 14.45 | 51 | 14.40 | 51 | 13.60 | 70 | 18.70 | 16 | 4.00 | 29 | 7.20 | 159 | 45.00 | 38 | 10.80 | 38 | 10.80 |

* Ungraded landings

☐ Rejected data sets

Upper codend=100mm; Lower codend=120mm; Standard codend=100mm

Tables 4-11

Weekly breakdown of catches of 5 main species by weight and by value for both vessels fishing with both gear types

Table 10

| WEEK 3 SECOND HALF | | SEPARATOR TRAWL MFV PAMELA-S FR38 | | | | | | STANDARD TRAWL MFV OCEAN REWARD FR28 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 15/11/95 | | 16/11/95 | | | | 15/11/95 | | 16/11/95 | | | |
| SPECIES | GRADE | kg | £ | kg | £ | | | kg | £ | kg | £ | | |
| COD | E3 | 92 | 140.50 | 35 | 57.75 | | | | | | | | |
| COD | E4 | 480 | 589.50 | 127 | 156.60 | | | 439 | 610.73 | 80 | 100.05 | | |
| COD | E5 | 75 | 73.55 | 22 | 17.50 | | | 229 | 238.65 | 57 | 54.60 | | |
| HAD | E2 | | | | | | | | | | | | |
| HAD | E3 | | | | | | | | | | | | |
| HAD | E4 | 33 | 18.20 | | | | | 29 | 20.25 | | | | |
| LEM | * | 2 | 1.75 | | | | | 3 | 5.00 | | | | |
| LEM | E3 | | | | | | | | | 3 | 6.00 | | |
| PLE | * | | | | | | | | | | | | |
| PLE | E1 | | | | | | | | | | | | |
| PLE | E2 | | | | | | | | | | | | |
| PLE | E3 | | | | | | | | | | | | |
| PLE | E4 | | | | | | | | | | | | |
| WHG | E4 | 89 | 26.20 | 40 | 11.25 | | | 41 | 10.40 | 19 | 5.40 | | |

* Ungraded landings

Upper codend=100mm; Lower codend=120mm; Standard codend=100mm

Table 11

| WEEK 4 SECOND HALF | | SEPARATOR TRAWL MFV PAMELA-S FR38 | | | | | | STANDARD TRAWL MFV OCEAN REWARD FR28 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 22/11/95 | | | | | | 22/11/95 | | | | | |
| SPECIES | GRADE | kg | £ | | | | | kg | £ | | | | |
| COD | E3 | 69 | 103.00 | | | | | 132 | 198.50 | | | | |
| COD | E4 | 159 | 174.66 | | | | | 57 | 62.55 | | | | |
| COD | E5 | 62 | 53.75 | | | | | 76 | 65.99 | | | | |
| HAD | E2 | | | | | | | | | | | | |
| HAD | E3 | | | | | | | | | | | | |
| HAD | E4 | | | | | | | | | | | | |
| LEM | * | | | | | | | | | | | | |
| LEM | E3 | | | | | | | | | | | | |
| PLE | * | | | | | | | | | | | | |
| PLE | E1 | | | | | | | | | | | | |
| PLE | E2 | | | | | | | | | | | | |
| PLE | E3 | | | | | | | | | | | | |
| PLE | E4 | | | | | | | | | | | | |
| WHG | E4 | 86 | 24.30 | | | | | 43 | 12.04 | | | | |

* Ungraded landings

Upper codend=100mm; Lower codend=120mm; Standard codend=100mm

**Table 12**

**Total vessel earnings compared - first half of trial**

| Date | Standard Trawl Pamela S (FR38) | Separator Trawl Ocean Reward (FR28) |
|---|---|---|
| 20-9-95 | £343.06 | £322.30 |
| 21-9-95 | £72.90 | £45.90 |
| 22-9-95 | £338.53 | £638.78 |
| | | |
| 25-9-95 | £480.61 | £380.50 |
| 27-9-95 | £651.18 | £561.78 |
| 28-9-95 | £546.75 | £343.71 |
| | | |
| 11-10-95 | £435.95 | £347.63 |
| 12-10-95 | £138.05 | £244.60 |
| 13-10-95 | £456.33 | £407.75 |
| | | |
| 16-10-95 | £453.95 | £506.13 |
| 17-10-95 | £337.33 | £450.46 |
| 19-10-95 | £230.28 | £348.00 |
| 20-10-95 | £160.00 | £153.15 |
| | | |
| **TOTAL** | **£4644.92** | **£4750.69** |

## Table 13

## Total vessel earnings compared - second half of trial

| Date | Standard Trawl Ocean Reward (FR28) | Separator Trawl Pamela S (FR38) |
|---|---|---|
| 30-10-95 | £495.21 | £293.20 |
| 31-10-95 | £1290.60 | £898.93 |
| 1-11-95 | £1169.45 | £800.68 |
| 2-11-95 | £537.70 | £416.25 |
| 3-11-95 | £370.50 | £305.43 |
| | | |
| 7-11-95 | £199.00 | £243.88 |
| 8-11-95 | £744.45 | £413.76 |
| 10-11-95 | £379.75 | £357.53 |
| | | |
| 15-11-95 | £888.78 | £885.36 |
| 16-11-95 | £171.05 | £243.10 |
| | | |
| *22-11-95 | £346.11 | £362.98 |
| | | |
| **TOTAL** | **£6592.60** | **£5221.10** |

* Catch taken by Seafish Fish Technology Department
Values based on average prices on the day (Brid Fish)
These values include minor species not accounted for in Tables 4-11

Figure 22

**COD**

**Differences in Market Landings (histogram - kg) and Market Revenue (line graph - £) between the Separator Trawl and Standard Trawl [Separator values *minus* Standard values]**

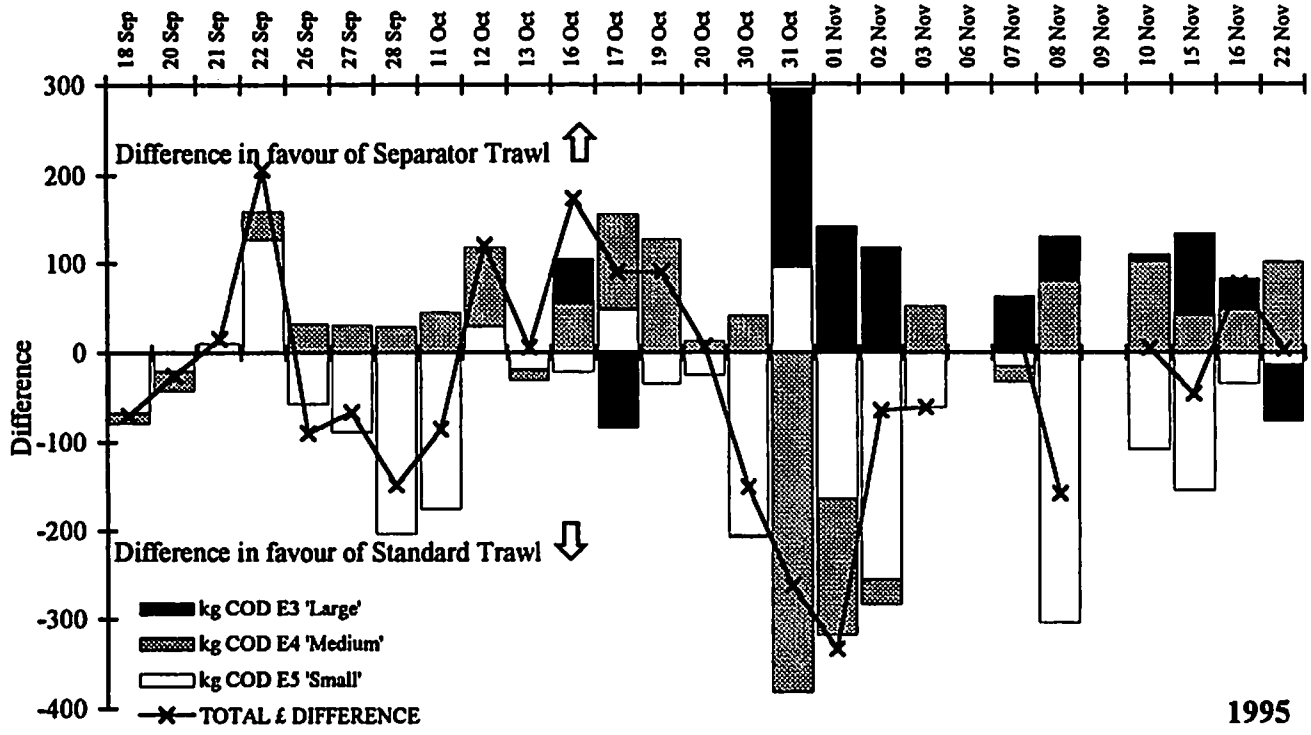



Figure 23

**HADDOCK**

**Differences in Market Landings (histogram - kg) and Market Revenue (line graph - £) between the Separator Trawl and Standard Trawl [Separator values minus Standard values]**

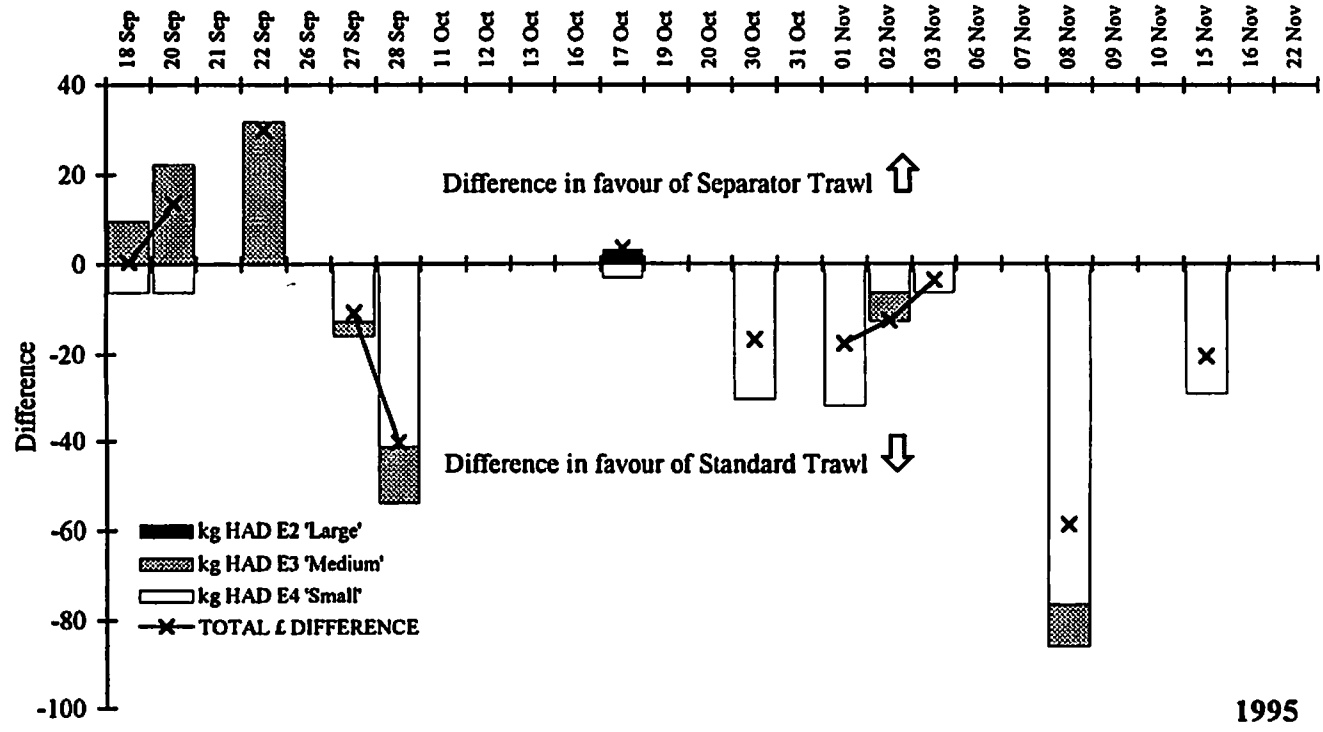


Figure 24

**WHITING**

**Differences in Market Landings (histogram - kg) and Market Revenue (line graph - £) between the Separator Trawl and Standard Trawl [Separator values minus Standard values]**

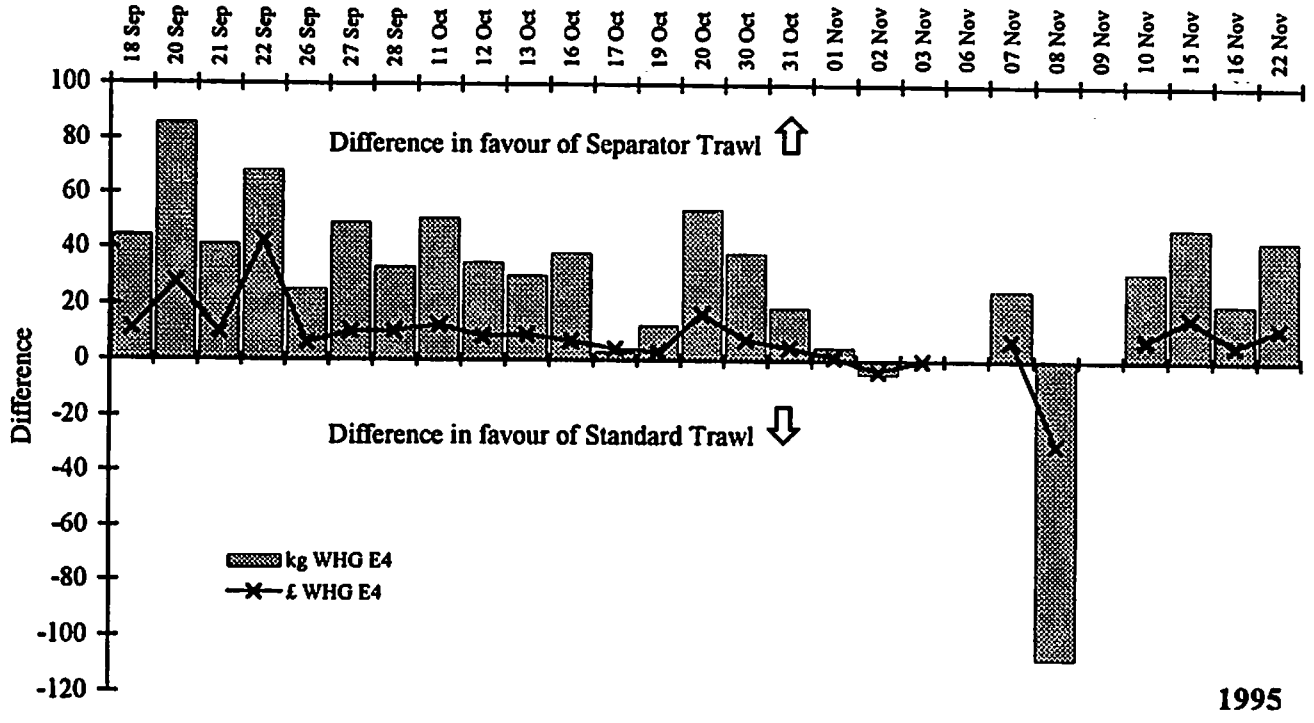



Figure 25

**LEMON SOLE**

**Differences in Market Landings (histogram - kg) and Market Revenue (line graph - £) between the Separator Trawl and Standard Trawl [Separator values minus Standard values]**

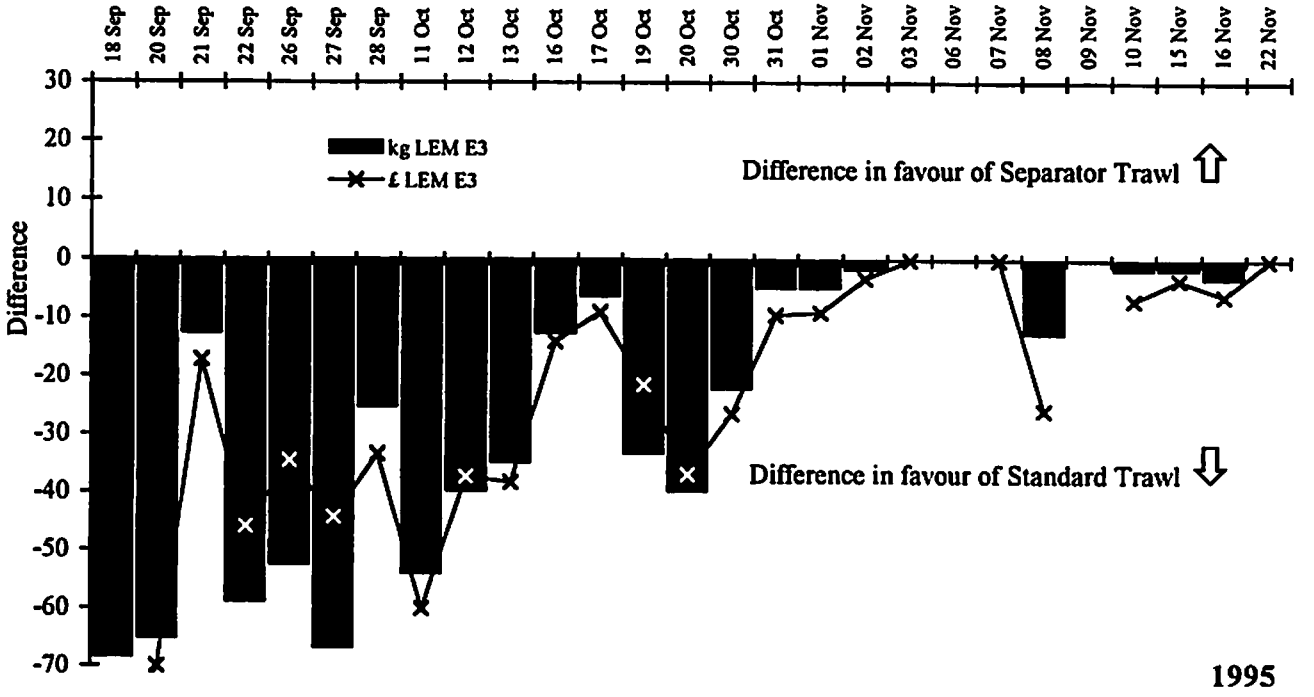


Figure 26

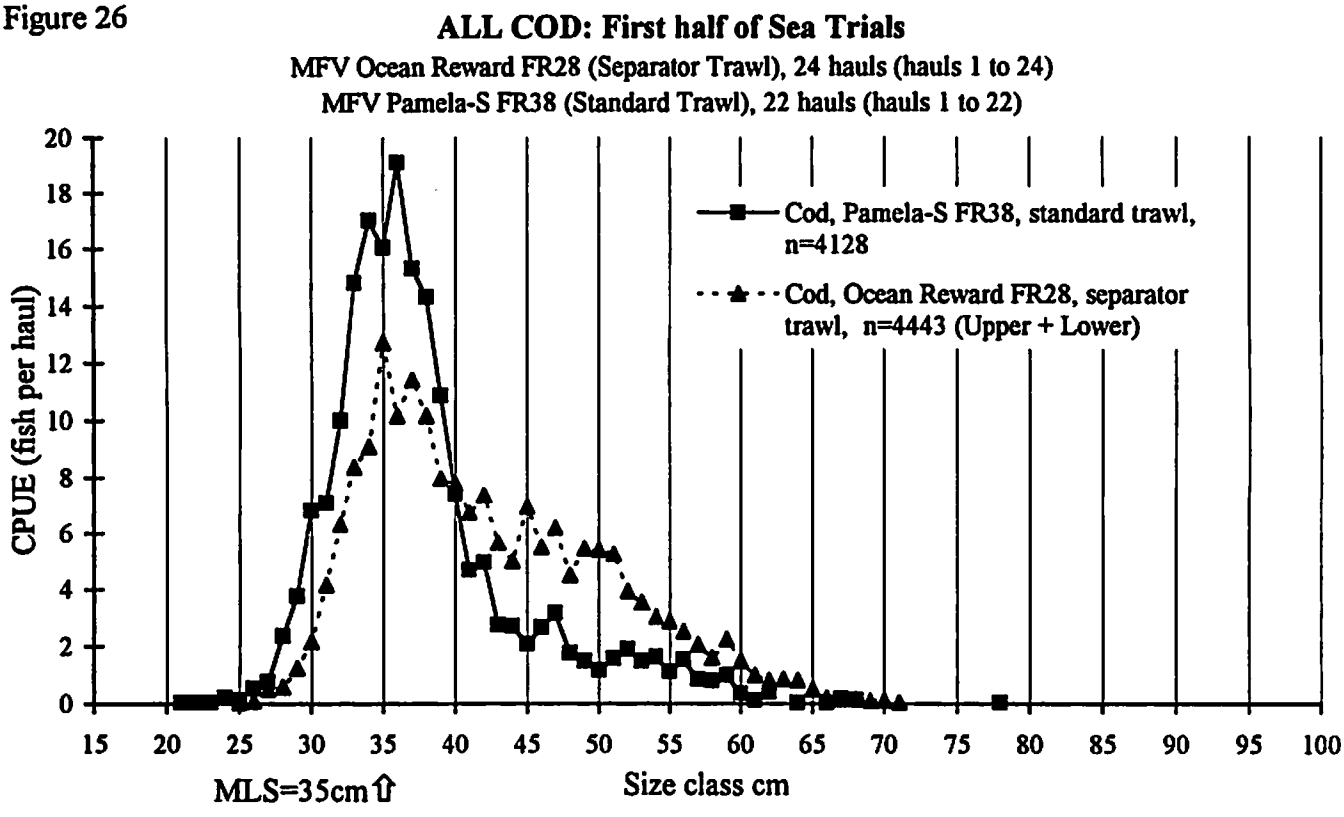
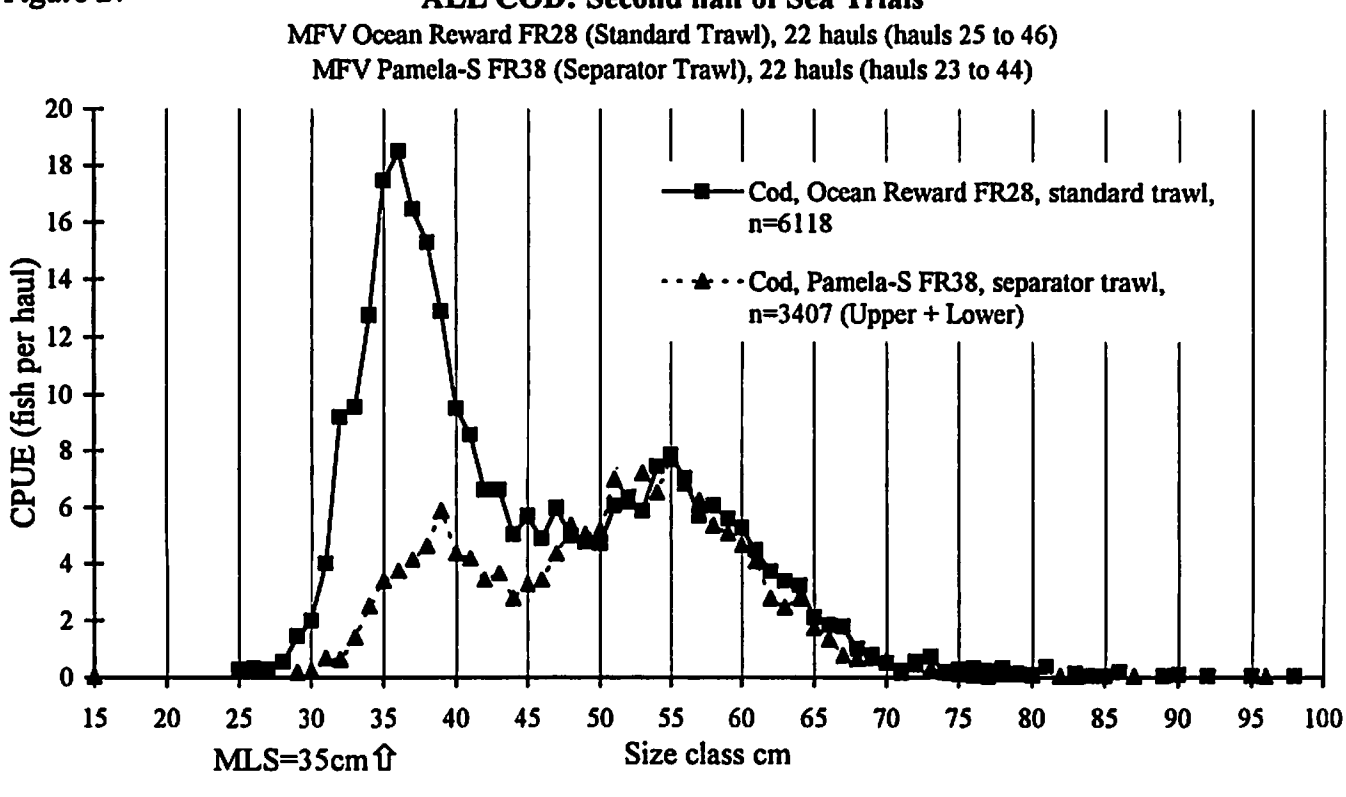



Figure 27



# 6. Observations and Discussion

These discussion notes have been produced on the basis of a relatively superficial analysis of the trials data. They are therefore subject to revision in the light of fuller analyses.

## 6.1 Comparability

The Yorkshire coast fisheries selected for this work provided the desired species mix in quantities sufficient to conduct a valid evaluation of the catching performance of the separator trawl. This was despite a poorer than expected autumn codling fishery. Catch sample sizes were large enough for all species except plaice to produce significant results.

As with all exercises of this nature the outcome was influenced by the vagaries of weather and sea conditions. Fortunately in this case, although poor weather did intermittently interrupt operations, the fact that the trials were not heavily constrained by time, did allow a full commercial evaluation to take place. The selection of two very competent and respected local skippers to conduct the work also added to the credibility of the trials.

When conducting comparative fishing trials of this nature, it is important to realise the limitations imposed by the method although every effort was made to ensure a close comparison of the two gear types. The vessels selected were very similar being built to the same design with the same horsepower and operating procedures. Towing speeds and tow durations were matched to ensure the fishing effort was comparable. One of the most difficult elements to ensure is that both vessels are sampling the same populations of fish. In this exercise the vessels worked as close to each other as the nature of the fishing grounds allowed and as was safe to do, hopefully ensuring similar populations were sampled. In most cases the length/frequency distributions support this aspiration.

The effects of variables can be mitigated to some degree by replication, i.e. conducting as many tows as possible. In these trials a total of 90 hauls were conducted between the two vessels.

The skippers can also have an influence on the outcome of this type of trial. The effect of this influence was balanced to a certain degree in this exercise by allowing the same skipper to take the lead for both sections of the trials. In this way both gear types were subject to any such effects.

## 6.2 Operational Aspects

The fishing gears used in these trials were all similar in size and type to the vessels' own equipment and therefore compatible with existing operating procedures. No major problems were encountered with either vessel using the separator trawl. One observation however, was made which applied to both vessels, concerning the overall length of the separator trawl. Since both vessels operated as side trawlers, more care was required during the hauling and shooting procedures to ensure that the additional lengtheners required to incorporate the double codend arrangement did not become foul. This minor problem can be reduced by adjusting the codend extensions (lengtheners) to suit side trawling operations.

With respect to the separator panel itself, no additional handling problems were observed. This was consistent with the experience of skippers and crews from the previous Seafish trials. Prior to any of the separator trawl work being carried out, concern had been voiced by some fishermen that the separator trawl would prove problematical from the point of view of repair. Experience has failed to justify this concern. Considerable damage has been sustained to separator trawls in these and previous trials. In most cases, even with damage to the belly sections of the net, the separator panel remained unscathed. It can be argued that additional work and time may be incurred in repairing a damaged panel, however the nature of the repair can be no more complicated than that for a standard trawl. It appears that, in most incidences of net damage, the separator panel does not suffer.

The double codend arrangement associated with the separator trawl is one which neither skipper was familiar with. Despite this, and the added complication of having one codend longer than the other, no particular difficulties were experienced by either vessel.

Considering the general overall performance of the trawls and ground gears, both skippers were very pleased with the results they achieved. They felt that they performed on par with their own gears. This provided further confidence that the work was representative of the commercial fishery.

### 6.3 Separation

The results obtained for the separation of cod and flatfish from haddock and whiting supported those obtained from the previous Seafish trials and from work carried out by other organisations. Separation levels of between 80% and 90% are typical for these species. The result obtained for the separator trawl onboard Pamela S was lower (71%) than observed onboard Ocean Reward. The separation was more variable across the different size ranges. Bearing in mind that this result came from the winter fishery which typically consists of a larger size run of cod, it can be speculated that this difference may be attributable to variations in behaviour. During the period in which these fish were caught there was evidence from stomach contents that these larger cod were feeding on 'live feed' namely juvenile haddocks and whiting. Echo sounder traces also showed heavy concentrations of feed in the water column on numerous occasions. If the cod were more actively chasing live feed off the seabed it is feasible that they would enter the trawl at a higher level, explaining the greater numbers in the upper level of the separator trawl. Larger fish are, in any case, stronger swimmers and this factor may have some influence on fish reaction on encountering the separator panel.

During the first half of the trials cod were feeding on herring spawn laid on the seabed. It would be expected that in these circumstances they would enter the lower half of the trawl more readily.

If we consider the separation of haddock and whiting into the upper level of the trawl there is some evidence (Swarbrick *et al,* 1995, Seafish Report No. 460) to suggest a trend towards higher separation in the larger fish size range.

Consistent separation of haddock and whiting into the upper 100mm codend was achieved for the separator trawl on both vessels. Here again a trend was noted towards higher separation with increasing fish size for the whiting catches (Figures 4 and 14). The levels of separation

for haddock and whiting were very high for both vessels (94-98%). These levels were higher than observed in previous Seafish trials. It must be borne in mind that these comparisons are made within different fisheries under different conditions.

When examining the separation of haddock and whiting we must consider the possibility that more fish may have entered the net below the level of the panel but then have been released through the larger 120mm mesh codend. Since no measure of the total population sampled was available here, assumptions are made based on the supportive evidence of previous work. Previous Seafish trials using small mesh codends to obtain population samples obtained separation levels of 69% for whiting and 70-80% for haddock. Differences in separation levels for these species appear to be variable, dependant on prevailing conditions and behaviour. Where inconsistent separation is observed, it may be possible to improve results by adjusting the separator panel height to better suit behaviour patterns.

Despite the low numbers of flatfish caught, the separation levels were as expected. It appears from the work carried out to date that flatfish pose the least problems with regard to segregation from other species.

**6.4 Catching Performance**

The comparison of catches between the separator trawl and the standard trawl raised a number of questions when considering the results between the two vessels. The size distributions for cod in Figures 7 and 17 have been extracted together and are shown in Figures 26 and 27 in terms of CPUE for easy comparison. These figures clearly show the differences in the cod populations sampled. The results for cod for the separator trawl onboard Pamela S were very much as was expected. The lower 120mm codend produced a reduction in discards compared to the standard trawl when used on both vessels. There was also some loss of the lower marketable grades. The results for the larger size classes showed similar catching performance (for fish above 47cms) as would be expected once the fish are above size preventing release from the 120mm mesh. The results for the separator onboard Ocean Reward however, show similar results for the smaller grades of cod (up to ~42cms) but then greater numbers of larger fish were caught compared to the standard net. This may simply be attributable to the Ocean Reward encountering more large fish. Another explanation may be the influence of the different codend arrangements. However, in the second case the difference would be expected to show up on the Pamela S. Some anecdotal evidence was offered by the skippers as a possible explanation. Some skippers have observed that when using heavy duty codends (>6.0mm double braid PE twine) catches of large cod are often smaller in comparison to lighter constructed codends of larger mesh size. The suggested reason for this concerns water flow through the codends. If it is assumed that the water flow through the heavier, smaller mesh codends is reduced and/or a greater 'back pressure' is present, then the larger, stronger cod may not be pushed into the codend as easily as the smaller fish. These larger fish can often be seen swimming in the extension or bellies of a net during hauling. It is feasible that a greater proportion of these fish could escape under these conditions. If this is a possible explanation however it still does not explain why similar results were not observed onboard Pamela S.

Another inconsistency with the use of the separator trawl between vessels was noted with the haddock and whiting catches. The separator trawl caught more haddock and whiting in both

cases but the differences were less marked for the Pamela S. Discard levels were also reduced for the separator trawl except for the haddock catch onboard Pamela S. This was shown by a shift of the length plot to the right of that of the separator trawl which is not easily explained.

The differences in the catching performance of the separator trawl for haddock and whiting were not expected. If we assume that the separation results are reliable and that the majority of fish enter the net above the separator panel, then the observed differences do not appear to be attributable to losses through the larger mesh of the lower codend. The results do suggest that the separator panel is encountering more haddock and whiting. If these fish are spread over a wider band of the water column they would be more vulnerable to a net achieving a greater headline height. There were only small differences measured in the headline heights of the two trawls. These differences were too small to account for the differences in catches of haddock and whiting between the two gear types. These differences are difficult to explain. One suggestion is that these species may be reacting to the presence of the separator panel's leading edge in the early stages of the 'herding' process. In such a situation, fish in the mouth of the separator trawl may be rising and falling back into the net earlier in the tow. In the standard net situation, without the influence of the panel, the fish may tend to remain just ahead of the ground gear for longer. This may increase their chances of avoiding capture. At this stage we can only speculate. Further underwater observations may shed more light on the situation.

The most significant effect of the separator trawl on the flatfish catches related to the use of the larger mesh lower codend, designed to reduce discard levels of cod. It was inevitable that such a mesh size would result in losses of marketable grade fish. As well as losses of some of the smaller grades of codling, significant differences in catches of lemon sole between the two gear types were noted. These differences were attributable to the 120mm mesh codends in combination with the very small sizes of lemon sole encountered.

### 6.5 Landings and Revenues

There are several points that need special explanation:-

- The gears were exchanged between vessels at the half-way point of the trials (after 20th October), in order to confound any differences inherent in the abilities of skippers and crews. Unfortunately, the changeover point coincided with a change in the cod fishery which made it impossible to isolate any such differences.

- Different merchants were used to sell the fish. This could have led to inherent differences in grading and pricing, and as each merchant has his own preferred buyers, market forces played a part in the prices obtained on the quayside. In the light of this experience, it is recommended that further trials of this kind should use the same merchant.

- There are notable differences in the values of certain categories of fish between the two gears. Tables 14, 15 and 16 show the value of catches expressed as £ per kg.

At the end of the first half of the trial the separator trawl catch revenue was slightly higher than those from the standard trawl (4%); at the end of the second half of the trial they were slightly lower (14%) [Tables 14, 15 and 16]. Overall, the value of catches made with the separator trawl were 10% less than with the standard trawl. For all the largest grades of all species, the value per unit weight was significantly greater for catches from the separator trawl when compared with those from the standard trawl (Table 16). The increased value of grade E3 cod certainly offset losses of grade E4 and E5 cod from the large 120mm mesh in the lower codend of the separator trawl (compared with the standard 100mm mesh size).

# Summary Tables of Revenues for Landings

(matched pairs of landings for Separator and Standard trawls)

Table 14

| FIRST HALF OF TRIAL | | SEPARATOR TRAWL MFV OCEAN REWARD FR28 | | | STANDARD TRAWL MFV PAMELAS FR38 | | |
|---|---|---|---|---|---|---|---|
| SPECIES | GRADE | kg | £ | £/kg | kg | £ | £/kg |
| COD | E3 | 51 | 86.40 | 1.70 | 148 | 194.61 | 1.32 |
| COD | E4 | 1115 | 1454.68 | 1.30 | 592 | 692.63 | 1.17 |
| COD | E5 | 1833 | 1646.75 | 0.90 | 2267 | 2006.30 | 0.88 |
| HAD | E2 | 3 | 3.75 | 1.18 | 0 | 0.00 | - |
| HAD | E3 | 86 | 75.45 | 0.88 | 48 | 48.25 | 1.01 |
| HAD | E4 | 146 | 86.05 | 0.59 | 67 | 38.75 | 0.58 |
| LEM | * | 5 | 9.00 | 1.89 | 711 | 783.96 | 1.10 |
| LEM | E3 | 204 | 312.85 | 1.54 | 0 | 0.00 | - |
| PLE | * | 43 | 59.00 | 1.37 | 3 | 3.00 | 0.94 |
| PLE | E1 | 0 | 0.00 | - | 0 | 0.00 | - |
| PLE | E2 | 3 | 6.00 | 1.89 | 17 | 25.25 | 1.44 |
| PLE | E3 | 11 | 24.00 | 2.16 | 99 | 84.00 | 0.85 |
| PLE | E4 | 52 | 52.75 | 1.00 | 0 | 0.00 | - |
| WHG | E4 | 671 | 211.86 | 0.32 | 143 | 40.90 | 0.29 |
| 1st HALF TOTAL: | | 4224 | 4029 | | 4095 | 3918 | |

* Ungraded landings

Table 15

| SECOND HALF OF TRIAL | | SEPARATOR TRAWL MFV PAMELAS FR38 | | | STANDARD TRAWL MFV OCEAN REWARD FR28 | | |
|---|---|---|---|---|---|---|---|
| SPECIES | GRADE | kg | £ | £/kg | kg | £ | £/kg |
| COD | E3 | 848 | 1339.28 | 1.58 | 73 | 120.60 | 1.65 |
| COD | E4 | 2176 | 2540.17 | 1.17 | 2485 | 3568.33 | 1.44 |
| COD | E5 | 544 | 522.38 | 0.96 | 1736 | 1619.15 | 0.93 |
| HAD | E2 | 0 | 0.00 | - | 0 | 0.00 | - |
| HAD | E3 | 0 | 0.00 | - | 16 | 17.25 | 1.08 |
| HAD | E4 | 113 | 61.83 | 0.55 | 180 | 111.85 | 0.62 |
| LEM | * | 29 | 44.08 | 1.54 | 56 | 86.00 | 1.54 |
| LEM | E3 | 0 | 0.00 | | 25 | 48.00 | 1.89 |
| PLE | * | 0 | 0.00 | - | 13 | 16.50 | 1.30 |
| PLE | E1 | 0 | 0.00 | - | 0 | 0.00 | - |
| PLE | E2 | 3 | 4.00 | 1.26 | 0 | 0.00 | - |
| PLE | E3 | 17 | 8.75 | 0.50 | 2 | 3.20 | 2.01 |
| PLE | E4 | 0 | 0.00 | - | 6 | 5.50 | 0.86 |
| WHG | E4 | 566 | 154.95 | 0.27 | 406 | 114.45 | 0.28 |
| 2nd HALF TOTAL: | | 4296 | 4675 | | 4997 | 5711 | |

* Ungraded landings

Table 16

| TOTAL FOR TRIAL | | SEPARATOR TRAWL BOTH VESSELS | | | STANDARD TRAWL BOTH VESSELS | | |
|---|---|---|---|---|---|---|---|
| SPECIES | GRADE | kg | £ | £/kg | kg | £ | £/kg |
| COD | E3 | 899 | 1425.68 | 1.59 | 221 | 315.21 | 1.43 |
| COD | E4 | 3291 | 3994.85 | 1.21 | 3077 | 4260.96 | 1.38 |
| COD | E5 | 2376 | 2169.13 | 0.91 | 4003 | 3625.45 | 0.91 |
| HAD | E2 | 3 | 3.75 | 1.18 | 0 | 0.00 | - |
| HAD | E3 | 86 | 75.45 | 0.88 | 64 | 65.50 | 1.03 |
| HAD | E4 | 259 | 147.88 | 0.57 | 247 | 150.60 | 0.61 |
| LEM | * | 33 | 53.08 | 1.59 | 767 | 869.96 | 1.13 |
| LEM | E3 | 204 | 312.85 | 1.54 | 25 | 48.00 | 1.89 |
| PLE | * | 43 | 59.00 | 1.37 | 16 | 19.50 | 1.23 |
| PLE | E1 | 0 | 0.00 | - | 0 | 0.00 | - |
| PLE | E2 | 6 | 10.00 | 1.57 | 17 | 25.25 | 1.44 |
| PLE | E3 | 29 | 32.75 | 1.14 | 100 | 87.20 | 0.87 |
| PLE | E4 | 52 | 52.75 | 1.00 | 6 | 5.50 | 0.86 |
| WHG | E4 | 1238 | 366.81 | 0.30 | 549 | 155.35 | 0.28 |
| TRIAL TOTAL: | | 8520 | 8703.98 | | 9092 | 9628.48 | |

* Ungraded landings

# 7. Conclusions

The separator trawl was evaluated for its commercial acceptability. Both the skippers who used it were initially sceptical as to its practicability. Both ended up completely convinced of its utility for their applications. The discard reduction for cod was noticeable, quality of some species was improved and earnings were comparable between the two nets.

Separation levels were obtained which were comparable to those from previous trials. Inconsistencies and reduced separation efficiency were generally associated with the presence of larger fish. The mesh size configurations used meant that very few marketable large fish would have been lost because of reduced separation efficiency.

The use of 120mm mesh in the lower codend seemed to be appropriate in these trials. The main loss of marketable fish comprised cod and lemon sole which were clustered around their respective minimum sizes. Other aspects of the catch in the separator trawl meant that the fishermen were content to accept losses of small cod and lemon soles.

There is scope to look for further applications of the separator principle. This view is strongly supported by NFFO. An SFF view will be sought.