**Seafish Marine Technology**

**Gary Dunlin**
**R. Allan Reese**
**April 2003**

**Financial Instrument for Fisheries Guidance (FIFG) Project**
**An industry-centred conservation project**

# Commercial proving trials of a new prawn trawl design

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### Summary

This report describes sea trials on a new design of *Nephrops* trawl. The design aims to minimise the bycatch of non-target species by precluding their entering the net, rather than releasing them post-capture.

The trials are the latest in a series and were carried out under commercial fishing conditions and supported by FIFG funds.

Using two vessels of similar size and power, the new trawl was tested against commercial trawls in the Farne Deeps fishery (NE England) over a fifteen day period through December 2002 and January 2003. Catches from each vessel were sampled in identical manners and the new trawl used by both vessels to negate any bias towards either vessel or Skipper.

The results show that the new design reduced the retention of haddock and whiting by 63% and 65% respectively, whilst *Nephrop*s catches were equal to or greater than (by up to 20%) those taken by the other vessel.

 

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# 1. Introduction

Targeted *Nephrops* (*Nephrops norvegicus*) fisheries frequently involve high catch rates of finfish. These are often unmarketable because of their size, quality or quota availability. Unmarketable fish should not be targeted but fishing mortality is often significant.

In 1997/98 Seafish started a programme of work to investigate ways of improving whitefish selectivity in trawls through the more effective use of technical conservation measures.

Interest focussed on UK *Nephrops* fisheries and a report entitled *A Review of Technical Conservation Measures in UK Nephrops Fisheries* (Seafish Report No. SR508) identified some technical options for further investigation.

The second stage of the programme examined the most promising of these options. The first to be investigated was the separator trawl. In 1998/99, gear engineering and commercial fishing trials were conducted using separator trawls on a range of vessels operating in the Irish Sea *Nephrops* fishery. This work is described in Seafish Report No. SR522, *Evaluation of* bycatch *reduction devices in UK Nephrops fisheries – The use of separator trawls in the Irish Sea.*

More recent work under this programme has concentrated on a different approach to bycatch reduction devices. Rather than reducing discarding by releasing the unwanted bycatch after it has been caught, this latest work places the emphasis on avoiding the capture of unwanted bycatch in the first place, thus precluding any question of the survival of escapees.

The aim of the project was to design a trawl that reduced the catch of certain fin fish species, whilst at the same time maintaining *Nephrops* catching performance. In other words, making the gear design more species-specific.

The gear is aimed at those *Nephrops* fisheries in which the bycatch of species such as haddock (*Melanogrammus aeglefinus*) and whiting (*Merlanius merlangus*) is seen as a nuisance factor and usually of little commercial value.

The task of introducing new net designs, especially ones originating from R&D as opposed to commercial gear manufacturers, is always a difficult one. For this reason, the gear design work was conducted in direct collaboration with established trawl designers/manufacturers. The credibility gained from this partnership was expected to increase the prospects of commercial uptake of any successful designs resulting from this work.

The initial development work relied heavily on trawl design work coupled with modelling and testing at the Authority's Flume Tank in Hull.

Some preliminary testing was conducted on the NE coast of England, the NW Highlands and the Clyde Estuary. Of the two designs initially developed, one is showing more promise than the other with respect to both bycatch avoidance and maintaining prawn-catching performance. At the end of those trials the results indicated that the new net design was operating at around 90% efficiency when comparing *Nephrops* catches with those from similar sized commercial nets. The new net design consistently showed significant reductions in the numbers of haddock and whiting caught.

Further commercial proving trials were needed in order to fine-tune the trawl's performance to enable it to compete commercially. Funding was sought and provided via the Financial Instrument for Fisheries Guidance (FIFG) in England. This report describes the development history of the trawl and the final set of commercial proving trials.

***Acknowledgements:***

Many individuals contributed to the success of these trials. Particular thanks go to:

the FIFG funding programme,
Dr Andrew Revill of CEFAS,
Walter Hay of Stuart Nets,
the Skippers and crew of MFVs Oceana BF 840 and Osprey BF 500,
the Sea Fisheries Inspectorate
Skipper John Smith and
Allan Reese, University of Hull for his statistical analysis of the results of this work.

## 2. Aims and Objectives

As with all the work within this programme, the overall aim is to reduce the level of discarding and resource wastage. A significant part of the discarded catch from the *Nephrops* fishery is made up of non-target species. Some of this bycatch is unavoidable. However, there are some species of finfish which, because of their behaviour, could be avoided.

The technical measures developed to date all rely on releasing the unwanted elements of the catch once they have entered the net. The objective of the underlying exercise was to determine ways of changing the design, construction and rigging of the *Nephrops* trawl so as to exclude the unwanted roundfish bycatch prior to it entering the net. This had to be achieved in a commercially acceptable manner without any detrimental effect on the *Nephrops* catching capability of the gear.

To achieve this overall aim two objectives were set as criteria for judging the outcome:

- To compare the catching performance of the new designs with that of an unmodified net of comparable dimensions for both target (*Nephrops*) and bycatch species under commercial fishing conditions.
- To complete the overall development process and demonstrate that the new net design developed over the preceding two years could operate successfully under commercial conditions. A successful outcome would show the trawl catching viable quantities of *Nephrops* with minimal round fish bycatches.

If successful, the positive benefits could then be used to encourage commercial acceptance and uptake of the new designs in other *Nephrops* fisheries.

A successful outcome could also lead to the development of technical guidelines on the modifications required to alter existing prawn trawl designs to achieve the desired level of bycatch avoidance.

# 3. Materials and Methods

## 3.1 Net and Vessel details

This net underwent modifications prior to evaluation in the Clyde Estuary fishery (see figure 1) and achieved bycatch reductions in the region of 70% for both haddock and whiting at the expense of an approximate 4% reduction in prawn catch. The same net, originally tested in the NE coast of England fishery, performed poorly with respect to the prawn catch (32% of the commercial catch). The improvements made prior to the Clyde exercise needed to be verified in the NE coast fishery for which this design was originally intended. This could be achieved by following the same catch comparison procedures using two vessels operating in partnership, (ideally the same two vessels that conducted the initial trials).

Fishing trials commenced in December 2002, operating from the port of Blyth in Northumberland using the vessels *Oceana* (BF 840) and *Osprey III* (BF 500).

These vessels are of similar size and power, (9.95m, 199kw and 9.9m, 194kw respectively), general design and layout and regularly operate together in various prawn fisheries around the UK. Both vessels were using the same size and style of prawn trawls and associated rigging arrangements. The nets were spread by Dunbar style ‘V’ doors (~1.8m) and 73m (40 fathom) of combination wire sweeps attached to 18m (10 fathom) of rubbered wire ‘legs’. These sweeps were attached directly to the nets by a spreader bar.

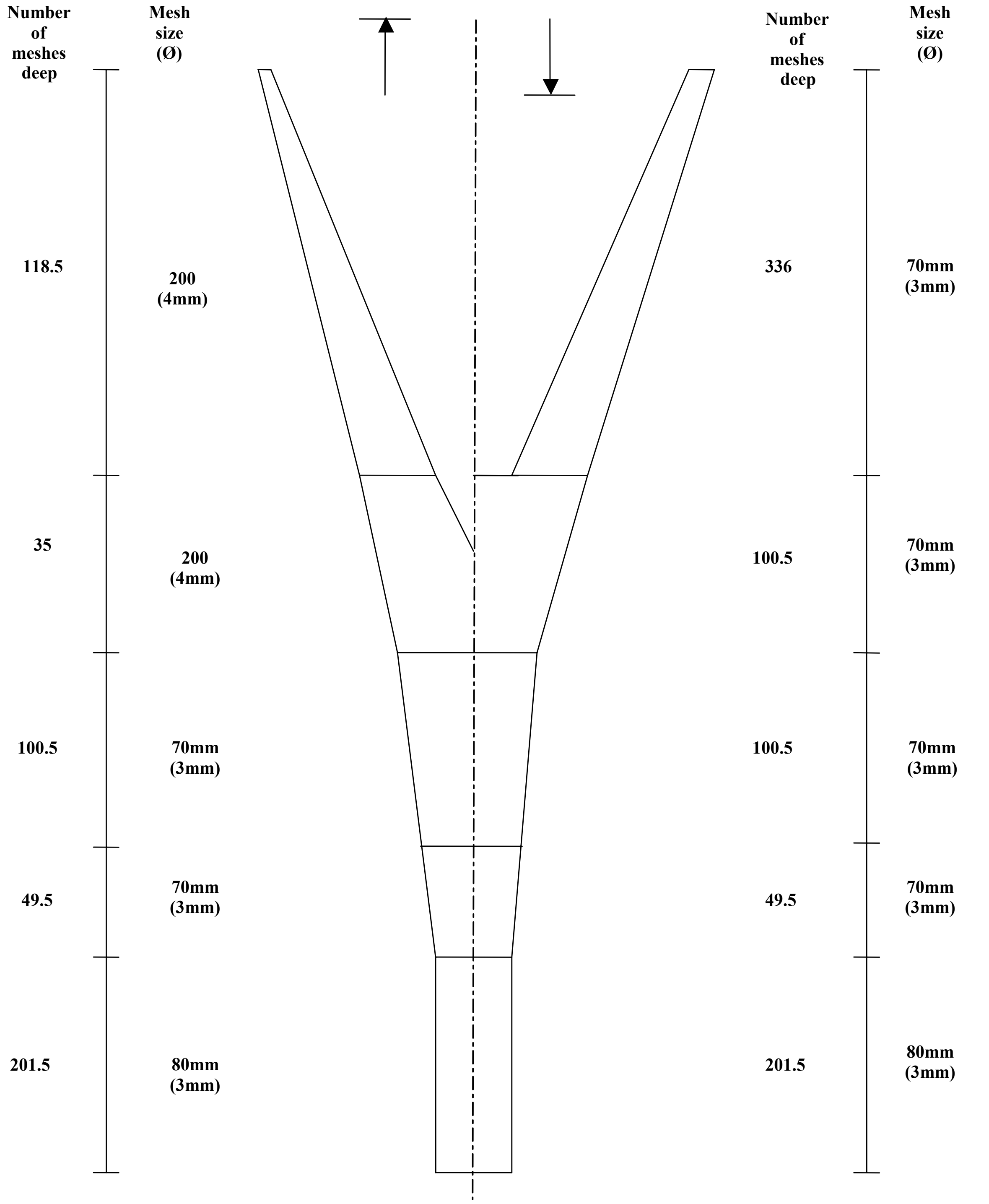



**Figure 1a: Schematic diagram of the Stuart Nets initial design.**

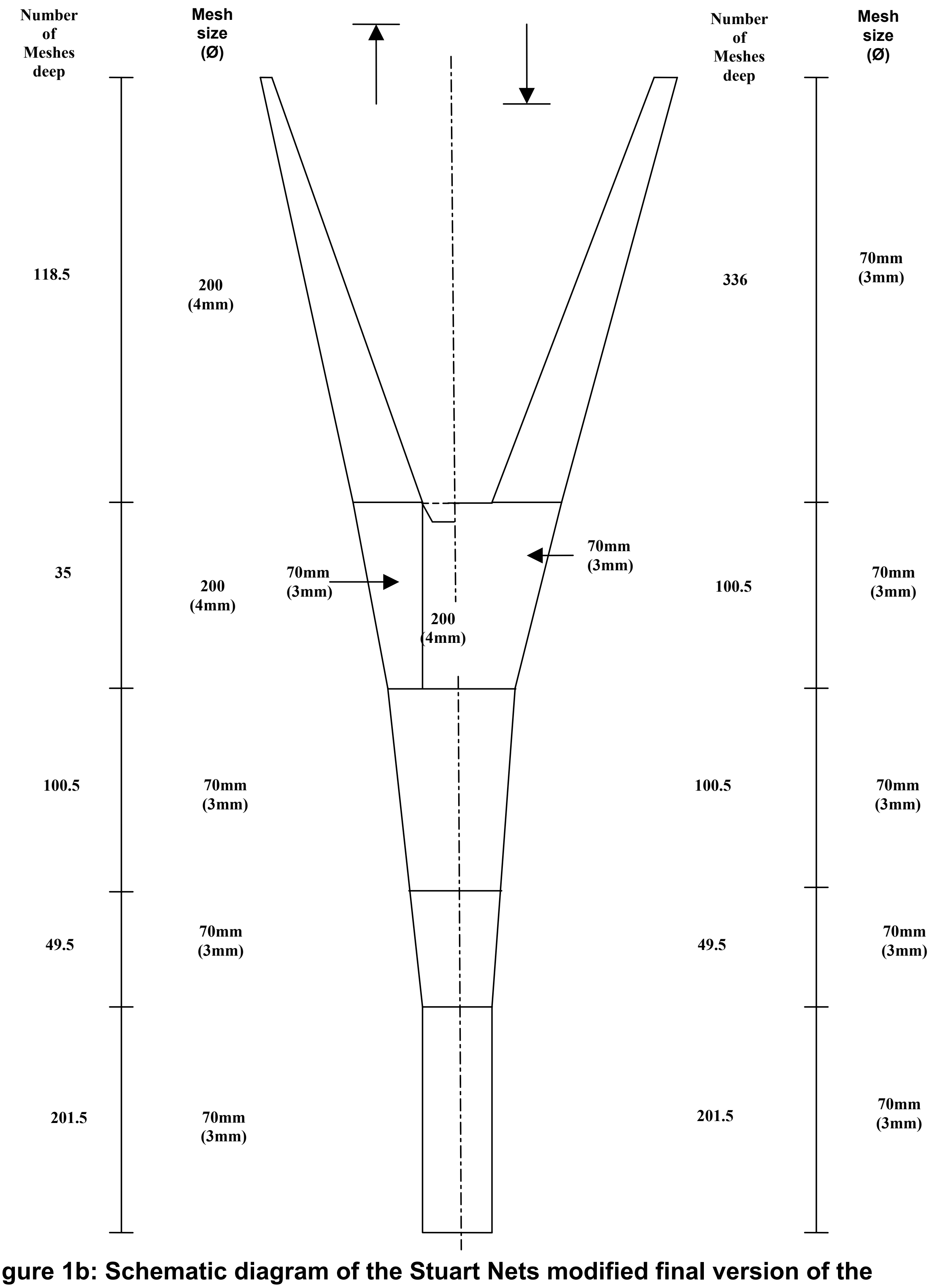



**Figure 1b: Schematic diagram of the Stuart Nets modified final version of the new *Nephrops* trawl design.**

The main design changes compared to a standard trawl design were:

- A reduced headline height
- Removal of cover (square panel)
- Increasing mesh size in the upper panels of the net, particularly the forepart.

The net plans (see figure 1a and 1b) show the main areas of alteration after previous trials.

### 3.2 Commercial fishing trials

The fishing trials were conducted as catch comparison exercises using a two-vessel arrangement.

Two similar vessels, using similar sized prawn trawls were selected to operate in partnership for the duration of the trials (~15 days of fishing).

The initial arrangement was for one vessel (chartered), to work with the experimental net and the other vessel to use their own standard prawn trawl for comparison. During these periods the vessel operating the experimental trawl was instructed to 'shadow' the partner vessel to try and sample similar populations of target and bycatch species.

The limitations of this type of comparative exercise were accepted on the understanding that the results were only expected to provide an indication of the relative performance of the experimental gear.

Each of the trials vessels carried a Seafish representative to record catch data and monitor the performance of the gear. Catch sampling entailed haul by haul quantification of the target species (*Nephrops*) and round fish bycatch species of haddock and whiting. Additionally, samples of the bycatch were measured to provide length/frequency data.

The fishing trials were split with each vessel operating either with the experimental net as the 'shadow' vessel or with a standard prawn trawl as the 'lead' vessel. This was intended to alleviate potential vessel/Skipper bias and test it against two different commercial *Nephrops* trawls. All operations took place on commercial fishing grounds.

Both vessels were of similar design and deck layout, which enabled the same catch sampling procedures to be followed on each vessel.

When the vessels hauled, the catch was emptied into the hoppers. All discarded fish and assorted debris were quantified and recorded. This was done by filling the waste chute running outboard with baskets (and part baskets) of discarded material and recording how much was required. This waste chute was filled with varying discard content a number of times to obtain an average amount needed to fill it. The chute was then filled and emptied during the catch sorting process and the number of times that this took place was recorded. This figure was multiplied by the number of baskets required to fill the chute.

Sample baskets were taken away for measurement at a number of stages throughout the catch sorting operation. One was taken from the start, one near the middle and one towards the end to enable a good profile of discarded fish to be obtained.

The marketable fish (bycatch) being kept in the fishroom was sampled by measuring either all of the cod, haddock and whiting, or a representative amount of each species if large quantities were being caught. The live weight of *Nephrops* sorted for retention was also recorded after the catch was sorted.

During the last week of the trials discarded *Nephrops* were retained to enable a count per kilogram to be carried out. This enabled a check to be made on the catch sorting procedures to ensure that both crews were retaining the same sizes of *Nephrops*.

To ensure that both nets were making similar ground contact data were taken at the end of the trials to provide a full analysis of benthic species by both trawls.

Seafish personnel on both vessels used the same methods of sampling for consistency. Observations on general gear performance were also recorded.

A full analysis of the data was carried out by a Statistician (R. Allan Reese) from Hull University and is fully reported on in Appendix II.

# 4. Results

## 4.1 Sea Trials – NE Coast of England

The indicators for evaluating the performance of the new trawl designs for the commercial sea trials were as follows:

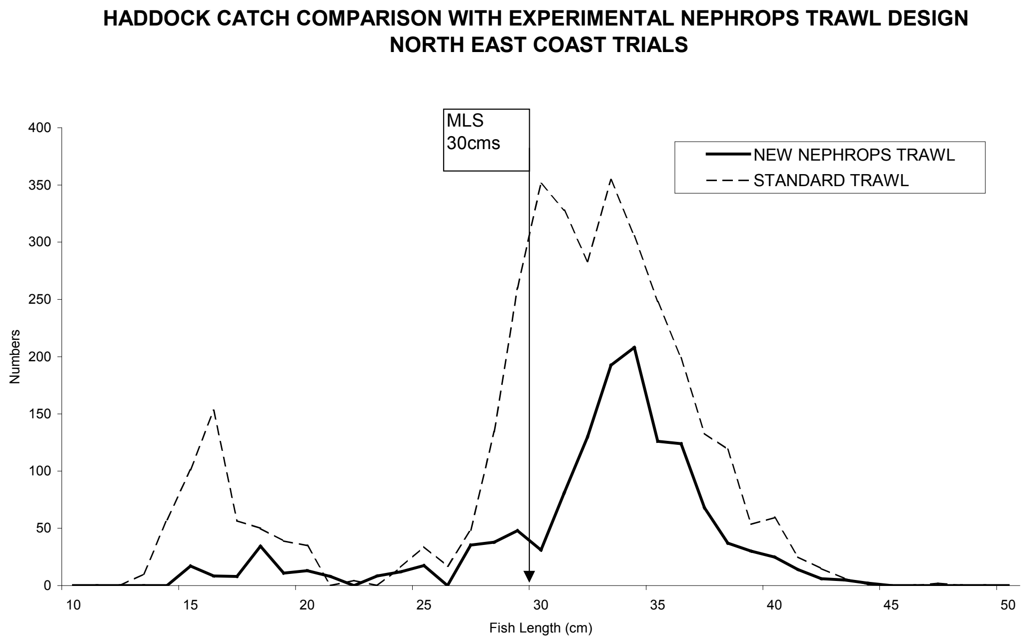
- The quantity of principal bycatch species - haddock and whiting - retained in the experimental trawl as compared to the standard trawl.
- The quantity of prawns (*Nephrops norvegicus*) caught

The catch details for these trials are shown in Appendix I and summarised in Table1.

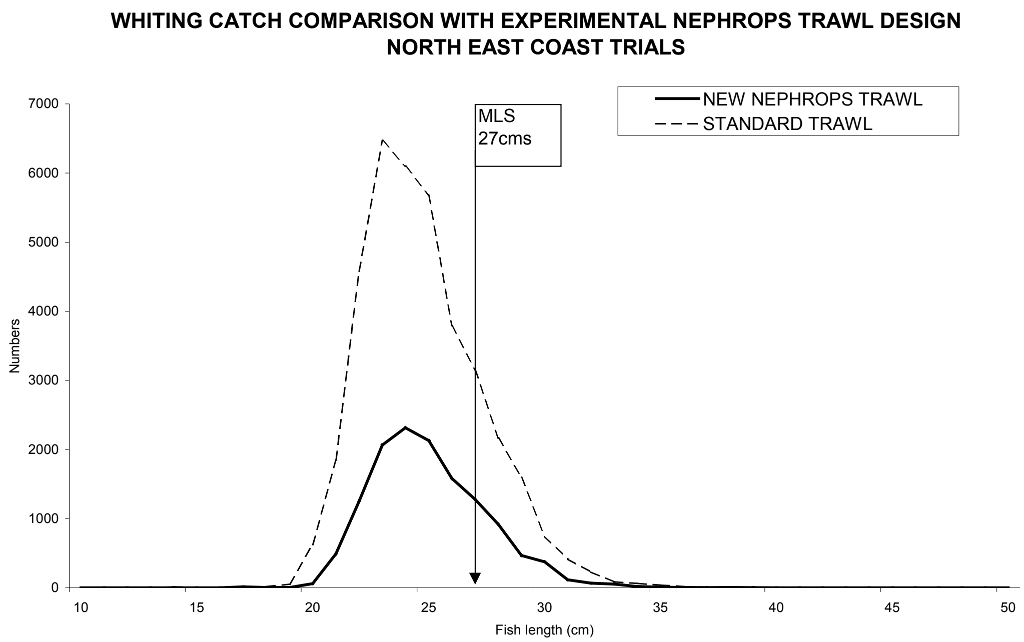
**Table 1: Catch summary for NE Coast UK Trials**

| **Species** | **Total No of fish caught** | | **Percentage reduction in catch observed in experimental trawl** |
|---|---|---|---|
| | Standard Trawl | Experimental trawl | |
| Haddock | 3,500 | 1,339 | 63% |
| Whiting | 37,739 | 13,240 | 65% |
| Cod | 1,789 | 1,597 | 11% |
| *Nephrops* | 950 Kg | 1,213 Kg | +20% |

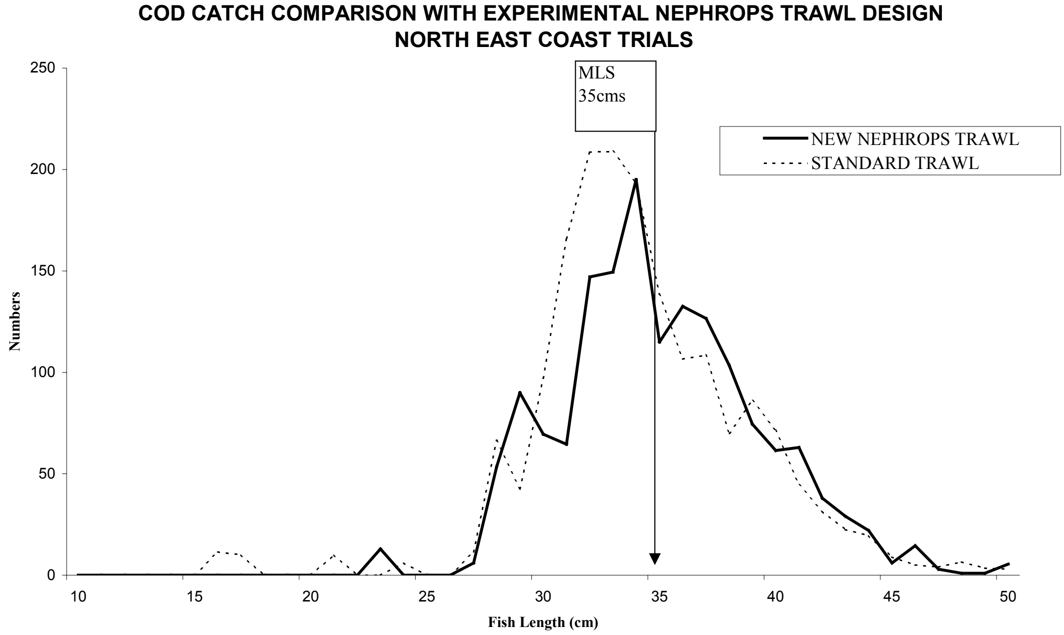
As well as quantifying the catches of haddock, whiting and cod (*Gadus morhua*) the data are presented as length/numbers plots showing the size range of fish encountered during the trials. These are shown in Figures 2, 3 and 4 for haddock, whiting and cod respectively.




## Figure 2: Length/numbers plot for haddock (North East Coast trials)




## Figure 3: Length/numbers plot for whiting (North East Coast trials)

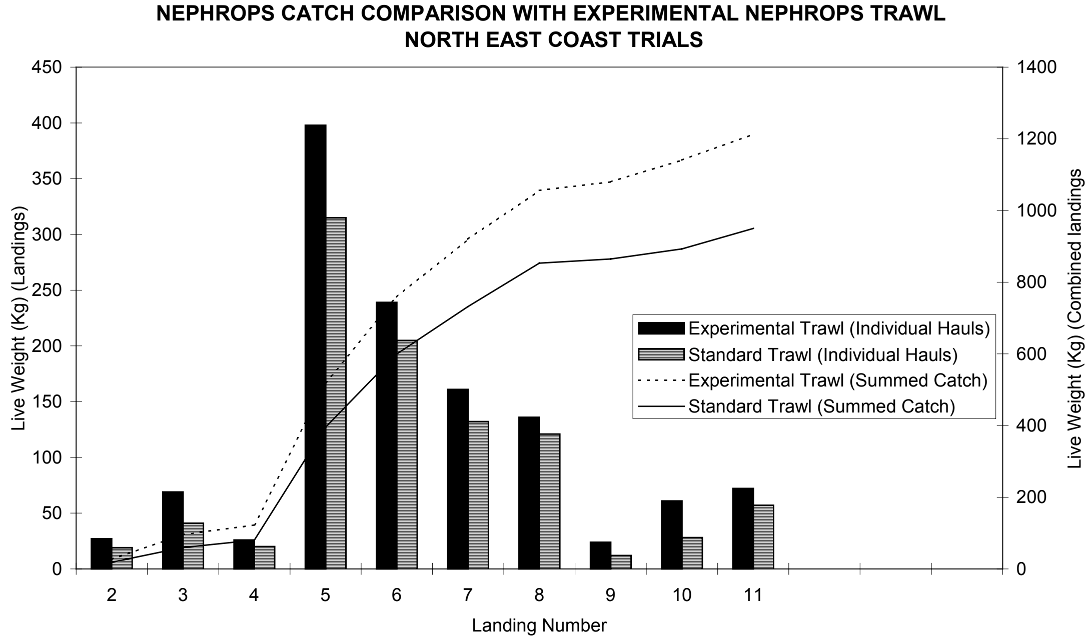



## Figure 4: Length/Numbers plot for cod (North East Coast trials)

### *The quantity of bycatch species retained*

The experimental *Nephrops* trawl demonstrated bycatch reduction in respect of the two principal bycatch species encountered (i.e. whiting and haddock). The experimental trawl was observed to significantly reduce the retention of both of these species across all observed length classes (i.e. 20-50 cm).

The experimental trawl reduced the retention of whiting in the cod end by 65%, whilst the retention of haddock in the experimental trawl cod end was reduced by 63%. This net also appeared to reduce the retention of cod by 11% mainly in the smaller size classes (15 to 30cms). These figures were based on the combined totals from the summed hauls from these sea trials.




## Figure 5: Comparison of *Nephrops* catches (North East Coast trials)

### *The quantity of target species (Nephrops norvegicus) caught*

There were no observed losses of the target species (*Nephrops norvegicus*) (see figure 5) rather an increase was observed of 20%.The experimental trawl therefore increased catches of the target species when directly compared to that of the standard trawls.

## 4.2 Discarded *Nephrops* and Benthos

Counts carried out on discarded *Nephrops* showed that the commercial trawls averaged 74 *Nephrops* per kilogram, whilst the new trawl design averaged discarded *Nephrops* counts of 78.

**Table 2: Benthos catch summary taken from 5 hauls**

| Species | Commercial trawl | New trawl design |
|---|---|---|
| Plaice | 192 | 147 |
| Lemon sole | 99 | 117 |
| Dover sole | 18 | 7 |
| Witch | 36 | 18 |
| Dab | 75 | 66 |
| Long rough dab | 122 | 276 |
| Turbot | 3 | 2 |
| Brill | 0 | 4 |
| Monk | 6 | 4 |
| Ray | 75 | 65 |
| Cuckoo ray | 71 | 118 |
| Invertebrates | 896 | 1234 |

Five hauls were sampled for a full benthic survey of the catch. The differences between trawls were not significant.

## 4.3 Statistical Analysis

SPSS output is appended and all output tables can be seen in Appendix II. The summary for the three species is:

- Whiting show significantly fewer caught by the experimental net, with a monotonic trend of decreased selectivity with increased size. There were no significant changes in catch throughout the trial.

- Haddock show significantly fewer caught in the experimental net, with no trend across the sizes but a (probably spurious) absence of difference for the size group 15-19cm. There was a significant difference in catches between the first and second half of the trial but this was not better explained by a linear trend.

- Cod show no significant difference in catches between the two nets, but a significant difference between the first and second half of the trial.

# 5. Discussion

The most common approach to solving the problem of bycatch reduction is the removal of the unwanted bycatch after it has been caught in the net. The concept investigated in this work was the avoidance of the bycatch before entering the gear, whilst maintaining commercial *Nephrops* catches.

This approach involved some radical changes to the overall design of the gear with the removal of the cover and introduction of large meshes being the most controversial part of the design. Previous attempts to make *Nephrops* trawls more selective in reducing bycatch were always resisted as fishermen associated this with a drop in commercial catches.

The initial intention of the original project was to test the trawl in three different *Nephrops* fisheries in England and Scotland to try and gain commercial acceptance in as many geographical areas as possible. However, it was not until the last set of trials in the Clyde area, after final adjustments had been made to the net, that commercial catches of *Nephrops* were taken in line with the lead vessel.

The results from the final trials in the Clyde showed bycatch reductions of 71% and 72% for haddock and whiting respectively whilst maintaining the prawn catches to within 4.5% of the standard net. This was a significant improvement on previous commercial trials which showed a loss of up to 45% of commercial *Nephrops* catches (the bycatch reduction figures in previous trials remained high) and it was thought that the trawl needed to repeat this success in a previously disappointing fishery.

It is generally accepted that comparative fishing experiments should be carried out on board twin rig vessels but the design and drag reduction properties of this trawl would make balancing two trawls in such a rig very difficult. The use of a “shadow” vessel in these trials for comparison can only give indicative performance results and not systematic selectivity figures.

The results from these trials demonstrate that a trawl of this type will significantly reduce the amount of whiting and haddock entering the net (65% and 63% respectively). This reduction of bycatch in these species did not extend to the *Nephrops* catches that were in fact consistently higher than the commercial trawls used (the increase in *Nephrops* catches were 20%). On a haul by haul basis *Nephrops* catches were always greater in the new design trawl.

The trials were carried out over a period of three weeks during the Farne Deeps *Nephrops* season and incorporated both spring and neap tides. During spring tides when *Nephrops* catches are naturally low, the new trawl maintained its increase in *Nephrops* quantities although on a much smaller percentage ( typically 5 to 10%). Interestingly, the amount of bycatch difference (particularly whiting) between the trawls reduced from ~60% to ~40% during the spring tides and it is thought that the exceptionally strong springs encountered affected their escape behaviour.

When the tides changed into the neap cycle and *Nephrops* catches increased, counts were carried out on the discarded *Nephrops* on both vessels. The counts showed that the new trawl did in fact catch more bulk overall in *Nephrops* (a count of 78 per kilo for the new trawl and 74 per kilo for the commercial trawl), but it is not known why.

Another general concern from fishermen about technical conservation measures is associated losses of bottom dwelling fish species such as Lemon Soles (*Microstomus kitt*) and Plaice (*Pleuronectes platessa*). Looking in table 2 where the benthos samples are summarised, it is obvious that no such losses are associated with this trawl.

Less quantitative aspects of this new trawl are the reduction in catch sorting times for crews and a corresponding improvement in catch quality. These qualitative benefits have been demonstrated with other technical conservation measures such as the separator trawl, but, unlike those technologies this trawl does not have the increased gear handling problems associated with it.

The single most significant success in these trials was the request by the skipper of one of the vessels to carry on using the trawl commercially over an extended period of time. He became convinced that the new design would consistently maintain – or improve – catch rates of *Nephrops,* whilst avoiding bulk catches of unmarketable whiting and haddock. Following the conclusion of the trials the skipper has purchased the net with the intention of using it in preference to his ‘normal’ *Nephrops* trawl.

# 6. Conclusions and recommendations

### *Conclusions*

Successful trials were undertaken to compare the catching performance of a novel design of *Nephrops* trawl with that of comparable standard designs. The indicators used were the catches of *Nephrops*, haddock, whiting, cod and various benthic species. The trials were carried out under commercial conditions to assess the likely commercial acceptability of the new design.

The new trawl consistently outperformed the conventional designs in its catch rate of *Nephrops* – typically by around 20% by weight. It also consistently reduced the retention of round fish : for haddock and whiting by about 63% and 65% respectively.

It is considered that the design process for this type of net is largely complete and it should be used more widely so that fishermen develop confidence in its application under a range of different conditions.

### *Recommendations*

As a result of this, and previous, trials it is recommended that:

- discussions should be opened with both the Fisheries Departments and fishermen's associations to consider whether and how the benefits of this net design could be incorporated into conservation-related legislation,

- further funding should be sought to extend the evaluation of this net design to a wider range of fishing circumstances, and

- promotional activities and further commercial trials should be used to build industry confidence in this new trawl design.

## Appendix I: Catch data from Farne Deeps trials (NE England)

## EXPERIMENTAL NEPHROPS TRAWL DESIGN
## NORTH EAST COAST TRIALS

| **NEW NEPHROPS TRAWL** | | | **NORMAL TRAWL** | | |
|---|---|---|---|---|---|
| SAMPLE TOTAL: | | 537 | SAMPLE TOTAL: | | 635 |
| RAISED TOTAL: | | 1597 | RAISED TOTAL: | | 1789 |
| MLS (cm) | | 35 | MLS (cm) | | 35 |
| %under MLS | | 49 | %under MLS | | 58 |
| % RETAINED | | 51 | % RETAINED | | 42 |
| | ***COD*** | | | ***COD*** | |
| **CLASS cm** | **RAISED NUMBERS** | **FREQ. %** | **CLASS cm** | **RAISED NUMBERS** | **FREQ. %** |
| 10 | 0 | 0.000 | 10 | 0 | 0.000 |
| 11 | 0 | 0.000 | 11 | 0 | 0.000 |
| 12 | 0 | 0.000 | 12 | 0 | 0.000 |
| 13 | 0 | 0.000 | 13 | 0 | 0.000 |
| 14 | 0 | 0.000 | 14 | 0 | 0.000 |
| 15 | 0 | 0.000 | 15 | 0 | 0.000 |
| 16 | 0 | 0.000 | 16 | 12 | 0.006 |
| 17 | 0 | 0.000 | 17 | 10 | 0.006 |
| 18 | 0 | 0.000 | 18 | 0 | 0.000 |
| 19 | 0 | 0.000 | 19 | 0 | 0.000 |
| 20 | 0 | 0.000 | 20 | 0 | 0.000 |
| 21 | 0 | 0.000 | 21 | 10 | 0.006 |
| 22 | 0 | 0.000 | 22 | 0 | 0.000 |
| 23 | 13 | 0.008 | 23 | 0 | 0.000 |
| 24 | 0 | 0.000 | 24 | 6 | 0.003 |
| 25 | 0 | 0.000 | 25 | 0 | 0.000 |
| 26 | 0 | 0.000 | 26 | 0 | 0.000 |
| 27 | 6 | 0.004 | 27 | 12 | 0.006 |
| 28 | 54 | 0.034 | 28 | 67 | 0.037 |
| 29 | 90 | 0.056 | 29 | 43 | 0.024 |
| 30 | 70 | 0.044 | 30 | 97 | 0.054 |
| 31 | 65 | 0.040 | 31 | 166 | 0.093 |
| 32 | 147 | 0.092 | 32 | 209 | 0.117 |
| 33 | 150 | 0.094 | 33 | 209 | 0.117 |
| 34 | 195 | 0.122 | 34 | 194 | 0.108 |
| 35 | 115 | 0.072 | 35 | 139 | 0.077 |
| 36 | 133 | 0.083 | 36 | 107 | 0.060 |
| 37 | 127 | 0.079 | 37 | 109 | 0.061 |
| 38 | 104 | 0.065 | 38 | 70 | 0.039 |
| 39 | 75 | 0.047 | 39 | 86 | 0.048 |
| 40 | 62 | 0.039 | 40 | 72 | 0.040 |
| 41 | 63 | 0.039 | 41 | 45 | 0.025 |
| 42 | 38 | 0.024 | 42 | 32 | 0.018 |
| 43 | 29 | 0.018 | 43 | 23 | 0.013 |
| 44 | 22 | 0.014 | 44 | 20 | 0.011 |
| 45 | 6 | 0.004 | 45 | 9 | 0.005 |
| 46 | 15 | 0.009 | 46 | 5 | 0.003 |
| 47 | 3 | 0.002 | 47 | 4 | 0.002 |
| 48 | 1 | 0.001 | 48 | 7 | 0.004 |
| 49 | 1 | 0.001 | 49 | 4 | 0.002 |
| 50 | 6 | 0.003 | 50 | 3 | 0.002 |

**EXPERIMENTAL NEPHROPS TRAWL DESIGN**
**NORTH EAST COAST TRIALS**

| **NEW NEPHROPS TRAWL** | | | **STANDARD TRAWL** | | |
|---|---|---|---|---|---|
| SAMPLE TOTAL: | | 781 | SAMPLE TOTAL: | | 1082 |
| RAISED TOTAL: | | 1339 | RAISED TOTAL: | | 3500 |
| MLS (cm) | | 30 | MLS (cm) | | 30 |
| %under MLS | | 19 | %under MLS | | 29 |
| % RETAINED | | 81 | % RETAINED | | 71 |
| | ***HADDOCK*** | | | ***HADDOCK*** | |
| **CLASS cm** | **RAISED NUMBERS** | **FREQ. %** | **CLASS cm** | **RAISED NUMBERS** | **FREQ. %** |
| 10 | 0 | 0.000 | 10 | 0 | 0.000 |
| 11 | 0 | 0.000 | 11 | 0 | 0.000 |
| 12 | 0 | 0.000 | 12 | 0 | 0.000 |
| 13 | 0 | 0.000 | 13 | 10 | 0.003 |
| 14 | 0 | 0.000 | 14 | 58 | 0.016 |
| 15 | 17 | 0.013 | 15 | 101 | 0.029 |
| 16 | 9 | 0.006 | 16 | 153 | 0.044 |
| 17 | 8 | 0.006 | 17 | 57 | 0.016 |
| 18 | 35 | 0.026 | 18 | 50 | 0.014 |
| 19 | 11 | 0.008 | 19 | 39 | 0.011 |
| 20 | 13 | 0.010 | 20 | 35 | 0.010 |
| 21 | 8 | 0.006 | 21 | 0 | 0.000 |
| 22 | 0 | 0.000 | 22 | 5 | 0.001 |
| 23 | 9 | 0.006 | 23 | 0 | 0.000 |
| 24 | 12 | 0.009 | 24 | 16 | 0.005 |
| 25 | 18 | 0.013 | 25 | 34 | 0.010 |
| 26 | 0 | 0.000 | 26 | 17 | 0.005 |
| 27 | 36 | 0.027 | 27 | 49 | 0.014 |
| 28 | 38 | 0.028 | 28 | 135 | 0.038 |
| 29 | 48 | 0.036 | 29 | 260 | 0.074 |
| 30 | 31 | 0.023 | 30 | 351 | 0.100 |
| 31 | 81 | 0.060 | 31 | 328 | 0.094 |
| 32 | 130 | 0.097 | 32 | 283 | 0.081 |
| 33 | 193 | 0.144 | 33 | 355 | 0.101 |
| 34 | 208 | 0.155 | 34 | 306 | 0.087 |
| 35 | 126 | 0.094 | 35 | 248 | 0.071 |
| 36 | 124 | 0.093 | 36 | 199 | 0.057 |
| 37 | 68 | 0.051 | 37 | 133 | 0.038 |
| 38 | 37 | 0.028 | 38 | 119 | 0.034 |
| 39 | 30 | 0.022 | 39 | 54 | 0.015 |
| 40 | 25 | 0.019 | 40 | 60 | 0.017 |
| 41 | 14 | 0.010 | 41 | 25 | 0.007 |
| 42 | 6 | 0.004 | 42 | 15 | 0.004 |
| 43 | 5 | 0.004 | 43 | 6 | 0.002 |
| 44 | 2 | 0.001 | 44 | 1 | 0.000 |
| 45 | 0 | 0.000 | 45 | 0 | 0.000 |
| 46 | 0 | 0.000 | 46 | 0 | 0.000 |
| 47 | 0 | 0.000 | 47 | 2 | 0.001 |
| 48 | 0 | 0.000 | 48 | 0 | 0.000 |
| 49 | 0 | 0.000 | 49 | 0 | 0.000 |
| 50 | 0 | 0.000 | 50 | 0 | 0.000 |

**EXPERIMENTAL NEPHROPS TRAWL DESIGN**
**NORTH EAST COAST TRIALS**

| NEW NEPHROPS TRAWL | | | STANDARD TRAWL | | |
|---|---|---|---|---|---|
| SAMPLE TOTAL: | | 2288 | SAMPLE TOTAL: | | 4521 |
| RAISED TOTAL: | | 13240 | RAISED TOTAL: | | 37739 |
| MLS (cm): | | 27 | MLS (cm): | | 27 |
| %under MLS | | 75 | %under MLS | | 77 |
| % RETAINED: | | 25 | % RETAINED: | | 23 |
| | ***WHITING*** | | | ***WHITING*** | |
| **CLASS (cm)** | **RAISED NUMBERS** | **FREQ. (%)** | **CLASS (cm)** | **RAISED NUMBERS** | **FREQ. (%)** |
| 10 | 0 | 0.000 | 10 | 0 | 0.000 |
| 11 | 0 | 0.000 | 11 | 0 | 0.000 |
| 12 | 0 | 0.000 | 12 | 0 | 0.000 |
| 13 | 0 | 0.000 | 13 | 0 | 0.000 |
| 14 | 0 | 0.000 | 14 | 12 | 0.000 |
| 15 | 0 | 0.000 | 15 | 6 | 0.000 |
| 16 | 0 | 0.000 | 16 | 0 | 0.000 |
| 17 | 13 | 0.001 | 17 | 18 | 0.000 |
| 18 | 4 | 0.000 | 18 | 19 | 0.000 |
| 19 | 5 | 0.000 | 19 | 52 | 0.001 |
| 20 | 61 | 0.005 | 20 | 623 | 0.017 |
| 21 | 492 | 0.037 | 21 | 1845 | 0.049 |
| 22 | 1251 | 0.094 | 22 | 4582 | 0.121 |
| 23 | 2065 | 0.156 | 23 | 6471 | 0.171 |
| 24 | 2315 | 0.175 | 24 | 6099 | 0.162 |
| 25 | 2130 | 0.161 | 25 | 5683 | 0.151 |
| 26 | 1584 | 0.120 | 26 | 3791 | 0.100 |
| 27 | 1279 | 0.097 | 27 | 3155 | 0.084 |
| 28 | 920 | 0.069 | 28 | 2168 | 0.057 |
| 29 | 468 | 0.035 | 29 | 1599 | 0.042 |
| 30 | 377 | 0.028 | 30 | 747 | 0.020 |
| 31 | 117 | 0.009 | 31 | 419 | 0.011 |
| 32 | 68 | 0.005 | 32 | 230 | 0.006 |
| 33 | 52 | 0.004 | 33 | 87 | 0.002 |
| 34 | 19 | 0.001 | 34 | 62 | 0.002 |
| 35 | 10 | 0.001 | 35 | 39 | 0.001 |
| 36 | 5 | 0.000 | 36 | 19 | 0.001 |
| 37 | 3 | 0.000 | 37 | 9 | 0.000 |
| 38 | 4 | 0.000 | 38 | 4 | 0.000 |
| 39 | 2 | 0.000 | 39 | 4 | 0.000 |
| 40 | 0 | 0.000 | 40 | 0 | 0.000 |
| 41 | 0 | 0.000 | 41 | 0 | 0.000 |
| 42 | 0 | 0.000 | 42 | 0 | 0.000 |
| 43 | 0 | 0.000 | 43 | 0 | 0.000 |
| 44 | 0 | 0.000 | 44 | 0 | 0.000 |
| 45 | 0 | 0.000 | 45 | 0 | 0.000 |
| 46 | 0 | 0.000 | 46 | 0 | 0.000 |
| 47 | 0 | 0.000 | 47 | 0 | 0.000 |
| 48 | 0 | 0.000 | 48 | 0 | 0.000 |
| 49 | 0 | 0.000 | 49 | 0 | 0.000 |
| 50 | 0 | 0.000 | 50 | 0 | 0.000 |

# Appendix II: Analysis of selectivity data for new *Nephrops* trawl by R. Allan Reese (June 2003)

## Analysis of selectivity data for new *Nephrops* trawl by R. Allan Reese (June 2003)

General considerations

Fishing-gear selectivity is difficult to measure because the variation due to external factors (eg, weather, seabed, size of stocks, shoaling behaviour, features or practices on the vessel, other vessels' prior activities in the area, etc) may be far greater than the difference between two types of gear. A common assumption is that the selectivity of a net for a particular species may be related to the size of fish by a smooth monotonically-increasing curve, at least over a size range of interest. However, the absolute selectivity of an individual net is generally unknown and unknowable (population at risk being vaguely defined), and what is measured by sampling is the relative selectivity of two or more gears. The relative selectivity is therefore the ratio of the two selectivity curves at each length. Again, it is an assumption that the relative selectivity will approximate to a smooth curve. The objective of most gear studies is to allow small fish to escape while retaining larger fish, so the logistic (or growth) curve is a model for relative selectivity with highly desirable qualities: the boundary values (asymptotes) at the lower and upper sizes are zero and one, and the slope parameter relates to the size range where the selectivity changes most rapidly. The performance of a net may be summarized using the single statistic, LD50, that size at which the catch in one net is half that in the other.

It is, however, unwise initially to put too much reliance on a mathematical model when analysing new data. While the comparison method described in Fryer, Zuur & Graham (2003) may be appropriate for summarizing and presenting the results of analyses, each trial should initially be examined using exploratory (forensic) techniques that can identify patterns and exceptions without relying upon prior assumptions. Diagnostic tests following model fitting may pick up violations of assumptions, but this argument may become circular: features of diagnostic plots may be considered noteworthy only because the investigator suspects a problem.

Fryer et al (op cit) points out that "most analyses of such data have compared catches that have been aggregated over all lengths or over a wide range of length classes." In particular, comparing catches below and above the minimum landing size (MLS) between gears addresses the pragmatic question of whether one gear is legally and commercially more efficient, but it suppresses the technical detail of how and where the selectivity applies. Fitting a logistic curve is particularly appropriate when the test gear is constrained to be not more effective than its comparator, for example in a covered cod-end trial, but is less relevant for a paired trial where either gear may randomly catch better.

The potentially large variation in catches between hauls (John 21, 3-6) raises two problems. One is that small counts should potentially be treated as binomial or Poisson variates because the distributions are inherently skewed. The second is that small catches are counted in full, while more productive hauls are sampled and haul estimates arrived at using a raising factor (inverse weight). The second problem creates issues of heteroscedasticity (variance that changes with the value being measured), because the variance of small counts is multiplied, and sensitivity, because small differences at one range of values have less effect than at another.

An alternative that does not seem to have been reported is to treat each haul as a multivariate observation and, because the length classes are ordered, to use a repeated measures analysis to examine the structure. Length is used here as equivalent to time in the classic repeated measures set-up. Fryer et al cites Millar (1993) as modelling a scallop dredge using step-function curves, but such curves still increase monotonically with fish size. Another approach would be to use Generalized Estimating Equations (GEE), which gives a choice between error functions, but the numbers caught in the present trials (especially when grouped) are large enough that the use of normal errors seems reasonable. An exploratory analysis should allow the possibility for any size category to behave differently. The analysis proposed here is flexible in this way. The software used is SPSS (version 11.5.1 2002).

Repeated measures data are usually analysed by converting the raw observations into orthogonal contrasts, but I agree with a caution in Hand & Taylor (Multivariate Analysis of Variance and Repeated Measures, 1987) that over-emphasis on orthogonal contrasts "constrains the researcher to pose questions that fit the mould of his research tools … [whereas if] a researcher has clear and well-defined research questions, then statistical methodology should provide tools to answer those questions and not instead answer related, but different, questions." There are many ways to set up orthogonal functions: The polynomial set of contrasts looks for specific shapes of response across the factor levels, but are difficult to interpret above a quadratic term; whereas Helmert contrasts appear to match the expectation of generally-increasing retention of larger fish while allowing for fluctuations: "each level of the factor except the last is compared to the mean of subsequent levels. In a balanced design, Helmert contrasts are orthogonal." (SPSS Advanced Models, GLM procedure). SPSS was used because Genstat (version 5 under Windows) has a procedure based on polynomial contrasts only.

MANOVA may be criticized if it assumes the data were generated under a multivariate normal distribution. The SPSS implementation addresses this by computing three estimates: one based upon the multivariate normal assumption, one (Huynh-Feldt) making an adjustment for deviations from the assumption, and a most conservative lower-bound. When these results differ markedly, it becomes a matter of judgment which to choose. Having a large number of length categories and hence contrasts may also be seen as a problem, except that one is looking for any pattern across the significance levels rather than considering each in isolation.

The current data

Data were provided for 17 hauls from a pair of trawlers that steamed in tandem. The experimental and control nets were swapped over after 8 hauls, so the hauls fell into two time periods in a crossover design. Numbers of fish caught per haul declined during the trial for Cod and Haddock but were relatively stable for Whiting. The crossover design confounds the effect of time period with the interaction between gear and vessel. Confounding means that arithmetically the effect may be attributed to either factor, but the trend makes it appropriate to interpret any effect as the former. On this reading, the two vessels were equivalent.

The method was to apply a two-way MANOVA model (factors: vessel and trawl) to the multivariate observation of number of fish of each (cm) length category. Since the numbers in some categories were small, they were then totalled in 5cm groupings to shorten the output and emphasize the pattern. A variation of the method would be to centre the groupings on the MLS for each species.

A specific reason not to apply the logistic model to these data is that the immediate impression is that the experimental net was selective across the whole size range for the whitefish species. Applying a curve when the data suggest only a constant term might give rise to over-fitting.

SPSS provides as output the test of sphericity and standard anova tests for each factor under the range of sphericity assumptions. The effects are measured for the between-subjects effects – comparing the two nets and time periods – and within-subject effects – how these factors apply across the length groups. The main effect of length is significant but not important, in that it is highly unlikely that the numbers of fish caught in each length group will be the same. Within-subject contrasts are examined with the expectation that they should show a pattern across the lengths, rather than looking for significant effects of individual contrasts.

Results

SPSS output is appended. The summary for the three species is:

- Whiting show significantly fewer caught by the experimental net, with a monotonic trend of decreased selectivity with increased size. There were no significant changes in catch throughout the trial.
- Haddock show significantly fewer caught in the experimental net, with no trend across the sizes but a (probably spurious) absence of difference for the size group 15-19cm. There was a significant difference in catches between the first and second half of the trial but this was not better explained by a linear trend.

- Cod show no significant difference in catches between the two nets, but a significant difference between the first and second half of the trial.

Whiting ranged from 14cm to 39cm, so were analysed as 26 length groups or collapsed into 6 groups (10 to 14cm, 15 to 19cm, etc). The sphericity (multivariate normality) test was very significant, and the adjusted and lower bound tests will be more reliable. On any basis, there was no effect of vessel or period, but a very significant difference between the normal and experimental trawl. The estimated means show the normal net caught better in the first period and the experimental net better in the second period; in both periods the normal net caught over twice as many as the experimental. The within-subject contrasts show as very significant (except for an anomaly at 21cm) until 36cm, above which the difference becomes increasingly non-selective. When reduced to six length groups, the effect is highly significant for all groups but with F values reducing as length increases. The interpretation is that selectivity is stronger for the smaller lengths.

Haddock ranged from 12cm to 46cm but with only single observations at the extremes. For the range 15-45cm, sphericity was rejected. The smaller amount of data makes the patterns of significance over length more variable, but the effects of trawl and trawl*vessel (ie period) are very significant over all lengths. When lengths were grouped, the differences between the nets were very significant for all lengths except the second (15-19cm). This is quite likely an anomalous result, a type 2 error.

Cod ranged from 16cm to 50cm, and again sphericity was rejected. No significant effects were observed for trawl, but there was a very significant effect of period. When reduced to seven length groups, no pattern is seen across lengths. The estimated marginal means for the two nets and periods are strikingly similar.

## Output Tables.

SPSS output for Cod

```
GET
  FILE='C:\Documents and Settings\administrator\My Documents\cod1.sav'.
freq var=l10 to l50 / format=notable / stats=min max.
```

# Frequencies

**Statistics**

| | | L10 | L11 | L12 | L13 | L14 | L15 | L16 | L17 | L18 | L19 | L20 | L21 | L22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | Vali | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Mis | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Minimur | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| Maximu | | .0 | .0 | .0 | .0 | .0 | .0 | 1.5 | 0.0 | .0 | .0 | .0 | 0.0 | .0 |

| | | L23 | L24 | L25 | L26 | L27 | L28 | L29 | L30 | L31 | L32 | L33 | L34 | L3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | Vali | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Mis | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ( |
| Minimur | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 0 | .( |
| Maximu | | 3.0 | 6.0 | .0 | .0 | 1.5 | 2.0 | 3.0 | 4.0 | 2.0 | 4.0 | 2.0 | 5 0 | 5.( |

```
GLM
  l12 to l50 BY vessel trawl
  /WSFACTOR = length 39 helmert
  /METHOD = SSTYPE(3)
  /CRITERIA = ALPHA(.05)
  /WSDESIGN = length
  /DESIGN = vessel trawl vessel*trawl .
```

# General Linear Model

**Within-Subjects Factors**

Measure: MEASURE_1

| LENGTH | Dependent Variable |
|---|---|
| 1 | L12 |
| 2 | L13 |
| 3 | L14 |
| 4 | L15 |
| 5 | L16 |
| 6 | L17 |
| 7 | L18 |
| 8 | L19 |
| 9 | L20 |
| 10 | L21 |
| 11 | L22 |
| 12 | L23 |
| 13 | L24 |
| 14 | L25 |
| 15 | L26 |
| 16 | L27 |
| 17 | L28 |
| 18 | L29 |
| 19 | L30 |
| 20 | L31 |
| 21 | L32 |
| 22 | L33 |
| 23 | L34 |
| 24 | L35 |
| 25 | L36 |
| 26 | L37 |
| 27 | L38 |
| 28 | L39 |
| 29 | L40 |
| 30 | L41 |
| 31 | L42 |
| 32 | L43 |
| 33 | L44 |
| 34 | L45 |
| 35 | L46 |
| 36 | L47 |
| 37 | L48 |
| 38 | L49 |
| 39 | L50 |

**Between-Subjects Factors**

| | | N |
|---|---|---|
| VESSEL | a | 17 |
| | b | 17 |
| TRAWL | e | 17 |
| | n | 17 |

**Multivariate Tests[b]**

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Pillai's Trace | .[a] | . | . | . | . |
| | Wilks' Lambda | .[a] | . | . | . | . |
| | Hotelling's Trace | .[a] | . | . | . | . |
| | Roy's Largest Root | .[a] | . | . | . | . |
| LENGTH * VESSEL | Pillai's Trace | .[a] | . | . | . | . |
| | Wilks' Lambda | .[a] | . | . | . | . |
| | Hotelling's Trace | .[a] | . | . | . | . |
| | Roy's Largest Root | .[a] | . | . | . | . |
| LENGTH * TRAWL | Pillai's Trace | .[a] | . | . | . | . |
| | Wilks' Lambda | .[a] | . | . | . | . |
| | Hotelling's Trace | .[a] | . | . | . | . |
| | Roy's Largest Root | .[a] | . | . | . | . |
| LENGTH * VESSEL * TRAWL | Pillai's Trace | .[a] | . | . | . | . |
| | Wilks' Lambda | .[a] | . | . | . | . |
| | Hotelling's Trace | .[a] | . | . | . | . |
| | Roy's Largest Root | .[a] | . | . | . | . |

a. Cannot produce multivariate test statistics because of insufficient residual degrees of freedom.

b.
Design: Intercept+VESSEL+TRAWL+VESSEL * TRAWL
Within Subjects Design: LENGTH

**Mauchly's Test of Sphericity[b]**

Measure: MEASURE_1

| Within Subjects Effect | Mauchly's W | Approx. Chi-Square | df | Sig. | Epsilon[a] | | |
|---|---|---|---|---|---|---|---|
| | | | | | Greenhouse-Geisser | Huynh-Feldt | Lower-bou |
| LENGTH | .000 | . | 740 | . | .105 | .136 | .0 |

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in t Tests of Within-Subjects Effects table.

b.
Design: Intercept+VESSEL+TRAWL+VESSEL * TRAWL
Within Subjects Design: LENGTH

**Tests of Within-Subjects Effects**

Measure: MEASURE_1

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Sphericity Assumed | 15842.361 | 38 | 416.904 | 18.455 | .000 |
| | Greenhouse-Geisser | 15842.361 | 3.998 | 3962.615 | 18.455 | .000 |
| | Huynh-Feldt | 15842.361 | 5.151 | 3075.727 | 18.455 | .000 |
| | Lower-bound | 15842.361 | 1.000 | 15842.361 | 18.455 | .000 |
| LENGTH * VESSEL | Sphericity Assumed | 1307.599 | 38 | 34.411 | 1.523 | .023 |
| | Greenhouse-Geisser | 1307.599 | 3.998 | 327.067 | 1.523 | .200 |
| | Huynh-Feldt | 1307.599 | 5.151 | 253.865 | 1.523 | .184 |
| | Lower-bound | 1307.599 | 1.000 | 1307.599 | 1.523 | .227 |
| LENGTH * TRAWL | Sphericity Assumed | 793.197 | 38 | 20.874 | .924 | .603 |
| | Greenhouse-Geisser | 793.197 | 3.998 | 198.401 | .924 | .452 |
| | Huynh-Feldt | 793.197 | 5.151 | 153.996 | .924 | .469 |
| | Lower-bound | 793.197 | 1.000 | 793.197 | .924 | .344 |
| LENGTH * VESSEL * TRAWL | Sphericity Assumed | 5717.286 | 38 | 150.455 | 6.660 | .000 |
| | Greenhouse-Geisser | 5717.286 | 3.998 | 1430.052 | 6.660 | .000 |
| | Huynh-Feldt | 5717.286 | 5.151 | 1109.987 | 6.660 | .000 |
| | Lower-bound | 5717.286 | 1.000 | 5717.286 | 6.660 | .015 |
| Error(LENGTH) | Sphericity Assumed | 25752.849 | 1140 | 22.590 | | |
| | Greenhouse-Geisser | 25752.849 | 119.939 | 214.717 | | |
| | Huynh-Feldt | 25752.849 | 154.523 | 166.660 | | |
| | Lower-bound | 25752.849 | 30.000 | 858.428 | | |

**Tests of Within-Subjects Contrasts**

Measure: MEASURE_1

| Source | LENGTH | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Level 1 vs. Later | 242.595 | 1 | 242.595 | 84.120 | .000 |
| | Level 2 vs. Later | 255.886 | 1 | 255.886 | 84.120 | .000 |
| | Level 3 vs. Later | 270.299 | 1 | 270.299 | 84.120 | .000 |
| | Level 4 vs. Later | 285.965 | 1 | 285.965 | 84.120 | .000 |
| | Level 5 vs. Later | 240.056 | 1 | 240.056 | 30.281 | .000 |
| | Level 6 vs. Later | 262.866 | 1 | 262.866 | 35.235 | .000 |
| | Level 7 vs. Later | 338.090 | 1 | 338.090 | 82.579 | .000 |
| | Level 8 vs. Later | 360.254 | 1 | 360.254 | 82.579 | .000 |
| | Level 9 vs. Later | 384.672 | 1 | 384.672 | 82.579 | .000 |
| | Level 10 vs. Later | 338.840 | 1 | 338.840 | 33.136 | .000 |
| | Level 11 vs. Later | 438.861 | 1 | 438.861 | 80.867 | .000 |
| | Level 12 vs. Later | 382.010 | 1 | 382.010 | 32.752 | .000 |
| | Level 13 vs. Later | 461.054 | 1 | 461.054 | 66.412 | .000 |
| | Level 14 vs. Later | 544.756 | 1 | 544.756 | 79.939 | .000 |
| | Level 15 vs. Later | 591.098 | 1 | 591.098 | 79.939 | .000 |
| | Level 16 vs. Later | 496.863 | 1 | 496.863 | 33.797 | .000 |
| | Level 17 vs. Later | 18.285 | 1 | 18.285 | .510 | .481 |
| | Level 18 vs. Later | 3.360 | 1 | 3.360 | .054 | .819 |
| | Level 19 vs. Later | 14.887 | 1 | 14.887 | .291 | .594 |
| | Level 20 vs. Later | 266.901 | 1 | 266.901 | 2.226 | .146 |
| | Level 21 vs. Later | 1698.565 | 1 | 1698.565 | 13.985 | .001 |
| | Level 22 vs. Later | 1922.058 | 1 | 1922.058 | 13.821 | .001 |
| | Level 23 vs. Later | 2635.587 | 1 | 2635.587 | 19.110 | .000 |
| | Level 24 vs. Later | 911.047 | 1 | 911.047 | 20.925 | .000 |
| | Level 25 vs. Later | 857.046 | 1 | 857.046 | 34.047 | .000 |
| | Level 26 vs. Later | 931.176 | 1 | 931.176 | 38.286 | .000 |
| | Level 27 vs. Later | 456.501 | 1 | 456.501 | 45.810 | .000 |
| | Level 28 vs. Later | 435.174 | 1 | 435.174 | 44.995 | .000 |
| | Level 29 vs. Later | 312.112 | 1 | 312.112 | 35.346 | .000 |
| | Level 30 vs. Later | 214.124 | 1 | 214.124 | 60.586 | .000 |
| | Level 31 vs. Later | 79.445 | 1 | 79.445 | 24.710 | .000 |
| | Level 32 vs. Later | 41.532 | 1 | 41.532 | 25.744 | .000 |
| | Level 33 vs. Later | 30.668 | 1 | 30.668 | 14.340 | .001 |
| | Level 34 vs. Later | .918 | 1 | .918 | 1.554 | .222 |
| | Level 35 vs. Later | 5.274 | 1 | 5.274 | 3.513 | .071 |
| | Level 36 vs. Later | 1.135E-05 | 1 | 1.135E-05 | .000 | .995 |
| | Level 37 vs. Later | .041 | 1 | .041 | .094 | .762 |
| | Level 38 vs. Level 39 | .472 | 1 | .472 | .767 | .388 |
| LENGTH * VESSEL | Level 1 vs. Later | .998 | 1 | .998 | .346 | .561 |
| | Level 2 vs. Later | 1.052 | 1 | 1.052 | .346 | .561 |
| | Level 3 vs. Later | 1.112 | 1 | 1.112 | .346 | .561 |
| | Level 4 vs. Later | 1.176 | 1 | 1.176 | .346 | .561 |
| | Level 5 vs. Later | 9.184 | 1 | 9.184 | 1.158 | .290 |
| | Level 6 vs. Later | 8.251 | 1 | 8.251 | 1.106 | .301 |
| | Level 7 vs. Later | 1.676 | 1 | 1.676 | .409 | .527 |
| | Level 8 vs. Later | 1.786 | 1 | 1.786 | .409 | .527 |
| | Level 9 vs. Later | 1.907 | 1 | 1.907 | .409 | .527 |
| | Level 10 vs. Later | .205 | 1 | .205 | .020 | .888 |
| | Level 11 vs. Later | 2.002 | 1 | 2.002 | .369 | .548 |
| | Level 12 vs. Later | .508 | 1 | .508 | .044 | .836 |
| | Level 13 vs. Later | 6.004 | 1 | 6.004 | .865 | .360 |
| | Level 14 vs. Later | 2.369 | 1 | 2.369 | .348 | .560 |
| | Level 15 vs. Later | 2.571 | 1 | 2.571 | .348 | .560 |
| | Level 16 vs. Later | 22.584 | 1 | 22.584 | 1.536 | .225 |
| | Level 17 vs. Later | 47.266 | 1 | 47.266 | 1.318 | .260 |
| | Level 18 vs. Later | 77.900 | 1 | 77.900 | 1.242 | .274 |
| | Level 19 vs. Later | 17.268 | 1 | 17.268 | .337 | .566 |
| | Level 20 vs. Later | 212.136 | 1 | 212.136 | 1.769 | .194 |
| | Level 21 vs. Later | 365.506 | 1 | 365.506 | 3.009 | .093 |
| | Level 22 vs. Later | 104.383 | 1 | 104.383 | .751 | .393 |
| | Level 23 vs. Later | 361.188 | 1 | 361.188 | 2.619 | .116 |
| | Level 24 vs. Later | 97.361 | 1 | 97.361 | 2.236 | .145 |
| | Level 25 vs. Later | 5.705 | 1 | 5.705 | .227 | .637 |
| | Level 26 vs. Later | .673 | 1 | .673 | .028 | .869 |
| | Level 27 vs. Later | 5.143 | 1 | 5.143 | .516 | .478 |
| | Level 28 vs. Later | 1.083 | 1 | 1.083 | .112 | .740 |
| | Level 29 vs. Later | 14.793 | 1 | 14.793 | 1.675 | .205 |
| | Level 30 vs. Later | 3.491 | 1 | 3.491 | .988 | .328 |
| | Level 31 vs. Later | .176 | 1 | .176 | .055 | .817 |
| | Level 32 vs. Later | .094 | 1 | .094 | .058 | .811 |
| | Level 33 vs. Later | .158 | 1 | .158 | .074 | .788 |
| | Level 34 vs. Later | 2.397 | 1 | 2.397 | 4.058 | .053 |
| | Level 35 vs. Later | 1.786 | 1 | 1.786 | 1.190 | .284 |
| | Level 36 vs. Later | .372 | 1 | .372 | 1.579 | .219 |
| | Level 37 vs. Later | .098 | 1 | .098 | .225 | .639 |
| | Level 38 vs. Level 39 | .827 | 1 | .827 | 1.344 | .255 |
| LENGTH * TRAWL | Level 1 vs. Later | .737 | 1 | .737 | .256 | .617 |
| | Level 2 vs. Later | .777 | 1 | .777 | .256 | .617 |
| | Level 3 vs. Later | .821 | 1 | .821 | .256 | .617 |
| | Level 4 vs. Later | .869 | 1 | .869 | .256 | .617 |
| | Level 5 vs. Later | .911 | 1 | .911 | .115 | .737 |
| | Level 6 vs. Later | .538 | 1 | .538 | .072 | .790 |
| | Level 7 vs. Later | .830 | 1 | .830 | .203 | .656 |
| | Level 8 vs. Later | .884 | 1 | .884 | .203 | .656 |
| | Level 9 vs. Later | .944 | 1 | .944 | .203 | .656 |
| | Level 10 vs. Later | .769 | 1 | .769 | .075 | .786 |
| | Level 11 vs. Later | .952 | 1 | .952 | .175 | .678 |
| | Level 12 vs. Later | 10.188 | 1 | 10.188 | .874 | .357 |
| | Level 13 vs. Later | .015 | 1 | .015 | .002 | .963 |
| | Level 14 vs. Later | 1.296 | 1 | 1.296 | .190 | .666 |
| | Level 15 vs. Later | 1.406 | 1 | 1.406 | .190 | .666 |
| | Level 16 vs. Later | .190 | 1 | .190 | .013 | .910 |
| | Level 17 vs. Later | 2.507 | 1 | 2.507 | .070 | .793 |
| | Level 18 vs. Later | 102.718 | 1 | 102.718 | 1.638 | .210 |

**Tests of Between-Subjects Effects**

Measure: MEASURE_1
Transformed Variable: Average

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Intercept | 230.314 | 1 | 230.314 | 84.120 | .000 |
| VESSEL | .947 | 1 | .947 | .346 | .561 |
| TRAWL | .700 | 1 | .700 | .256 | .617 |
| VESSEL * TRAWL | 68.171 | 1 | 68.171 | 24.899 | .000 |
| Error | 82.137 | 30 | 2.738 | | |

```
compute s10=sum(l10 to l14).
compute s15=sum(l15 to l19).
compute s20=sum(l20 to l24).
compute s25=sum(l25 to l29).
compute s30=sum(l30 to l34).
compute s35=sum(l35 to l39).
compute s40=sum(l40 to l44).
compute s45=sum(l45 to l50).
recode haul (1 thru 8=1) (9 thru highest=2) into period.
GLM
  s15 to s45 BY trawl period
  /WSFACTOR = length 7 helmert
  /METHOD = SSTYPE(3)
  /CRITERIA = ALPHA(.05)
  /WSDESIGN = length
  /EMMEANS=TABLES(trawl*period)
  /DESIGN = period trawl  period*trawl .
```

# General Linear Model

**Within-Subjects Factors**

Measure: MEASURE_1

| LENGTH | Dependent Variable |
|---|---|
| 1 | S15 |
| 2 | S20 |
| 3 | S25 |
| 4 | S30 |
| 5 | S35 |
| 6 | S40 |
| 7 | S45 |

**Between-Subjects Factors**

| | | N |
|---|---|---|
| TRAWL | e | 17 |
| | n | 17 |
| PERIOD | 1.00 | 16 |
| | 2.00 | 18 |

**Multivariate Tests[b]**

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Pillai's Trace | .791 | 15.736[a] | 6.000 | 25.000 | .000 |
| | Wilks' Lambda | .209 | 15.736[a] | 6.000 | 25.000 | .000 |
| | Hotelling's Trace | 3.777 | 15.736[a] | 6.000 | 25.000 | .000 |
| | Roy's Largest Root | 3.777 | 15.736[a] | 6.000 | 25.000 | .000 |
| LENGTH * PERIOD | Pillai's Trace | .618 | 6.733[a] | 6.000 | 25.000 | .000 |
| | Wilks' Lambda | .382 | 6.733[a] | 6.000 | 25.000 | .000 |
| | Hotelling's Trace | 1.616 | 6.733[a] | 6.000 | 25.000 | .000 |
| | Roy's Largest Root | 1.616 | 6.733[a] | 6.000 | 25.000 | .000 |
| LENGTH * TRAWL | Pillai's Trace | .197 | 1.020[a] | 6.000 | 25.000 | .435 |
| | Wilks' Lambda | .803 | 1.020[a] | 6.000 | 25.000 | .435 |
| | Hotelling's Trace | .245 | 1.020[a] | 6.000 | 25.000 | .435 |
| | Roy's Largest Root | .245 | 1.020[a] | 6.000 | 25.000 | .435 |
| LENGTH * TRAWL * PERIOD | Pillai's Trace | .127 | .605[a] | 6.000 | 25.000 | .724 |
| | Wilks' Lambda | .873 | .605[a] | 6.000 | 25.000 | .724 |
| | Hotelling's Trace | .145 | .605[a] | 6.000 | 25.000 | .724 |
| | Roy's Largest Root | .145 | .605[a] | 6.000 | 25.000 | .724 |

a. Exact statistic

b. Design: Intercept+PERIOD+TRAWL+TRAWL * PERIOD
Within Subjects Design: LENGTH

**Mauchly's Test of Sphericity[b]**

Measure: MEASURE_1

| Within Subjects Effect | Mauchly's W | Approx. Chi-Square | df | Sig. | Epsilon[a] Greenhouse-Geisser | Huynh-Feldt | Lower-bou |
|---|---|---|---|---|---|---|---|
| LENGTH | .000 | 300.202 | 20 | .000 | .250 | .286 | .1 |

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in t Tests of Within-Subjects Effects table.

b.
Design: Intercept+PERIOD+TRAWL+TRAWL * PERIOD
Within Subjects Design: LENGTH

**Tests of Within-Subjects Effects**

Measure: MEASURE_1

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Sphericity Assumed | 63286.398 | 6 | 10547.733 | 33.337 | .000 |
| | Greenhouse-Geisser | 63286.398 | 1.499 | 42226.622 | 33.337 | .000 |
| | Huynh-Feldt | 63286.398 | 1.718 | 36843.484 | 33.337 | .000 |
| | Lower-bound | 63286.398 | 1.000 | 63286.398 | 33.337 | .000 |
| LENGTH * PERIOD | Sphericity Assumed | 20874.078 | 6 | 3479.013 | 10.996 | .000 |
| | Greenhouse-Geisser | 20874.078 | 1.499 | 13927.824 | 10.996 | .000 |
| | Huynh-Feldt | 20874.078 | 1.718 | 12152.276 | 10.996 | .000 |
| | Lower-bound | 20874.078 | 1.000 | 20874.078 | 10.996 | .002 |
| LENGTH * TRAWL | Sphericity Assumed | 1922.979 | 6 | 320.496 | 1.013 | .418 |
| | Greenhouse-Geisser | 1922.979 | 1.499 | 1283.070 | 1.013 | .351 |
| | Huynh-Feldt | 1922.979 | 1.718 | 1119.502 | 1.013 | .360 |
| | Lower-bound | 1922.979 | 1.000 | 1922.979 | 1.013 | .322 |
| LENGTH * TRAWL * PERIOD | Sphericity Assumed | 843.945 | 6 | 140.658 | .445 | .848 |
| | Greenhouse-Geisser | 843.945 | 1.499 | 563.106 | .445 | .587 |
| | Huynh-Feldt | 843.945 | 1.718 | 491.320 | .445 | .614 |
| | Lower-bound | 843.945 | 1.000 | 843.945 | .445 | .510 |
| Error(LENGTH) | Sphericity Assumed | 56951.863 | 180 | 316.399 | | |
| | Greenhouse-Geisser | 56951.863 | 44.962 | 1266.668 | | |
| | Huynh-Feldt | 56951.863 | 51.531 | 1105.190 | | |
| | Lower-bound | 56951.863 | 30.000 | 1898.395 | | |

**Tests of Within-Subjects Contrasts**

Measure: MEASURE_1

| Source | LENGTH | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Level 1 vs. Later | 8947.059 | 1 | 8947.059 | 69.810 | .000 |
| | Level 2 vs. Later | 12501.235 | 1 | 12501.235 | 64.273 | .000 |
| | Level 3 vs. Later | 7421.939 | 1 | 7421.939 | 21.486 | .000 |
| | Level 4 vs. Later | 30800.767 | 1 | 30800.767 | 20.416 | .000 |
| | Level 5 vs. Later | 21507.163 | 1 | 21507.163 | 76.228 | .000 |
| | Level 6 vs. Level 7 | 3647.118 | 1 | 3647.118 | 59.775 | .000 |
| LENGTH * PERIOD | Level 1 vs. Later | 3332.000 | 1 | 3332.000 | 25.998 | .000 |
| | Level 2 vs. Later | 4435.598 | 1 | 4435.598 | 22.805 | .000 |
| | Level 3 vs. Later | 2365.704 | 1 | 2365.704 | 6.849 | .014 |
| | Level 4 vs. Later | 10052.375 | 1 | 10052.375 | 6.663 | .015 |
| | Level 5 vs. Later | 6457.752 | 1 | 6457.752 | 22.888 | .000 |
| | Level 6 vs. Level 7 | 1169.471 | 1 | 1169.471 | 19.167 | .000 |
| LENGTH * TRAWL | Level 1 vs. Later | 1.907 | 1 | 1.907 | .015 | .904 |
| | Level 2 vs. Later | 25.043 | 1 | 25.043 | .129 | .722 |
| | Level 3 vs. Later | 180.376 | 1 | 180.376 | .522 | .476 |
| | Level 4 vs. Later | 2307.412 | 1 | 2307.412 | 1.529 | .226 |
| | Level 5 vs. Later | 26.044 | 1 | 26.044 | .092 | .763 |
| | Level 6 vs. Level 7 | 16.504 | 1 | 16.504 | .270 | .607 |
| LENGTH * TRAWL * PERIOD | Level 1 vs. Later | 107.783 | 1 | 107.783 | .841 | .366 |
| | Level 2 vs. Later | 22.521 | 1 | 22.521 | .116 | .736 |
| | Level 3 vs. Later | 132.023 | 1 | 132.023 | .382 | .541 |
| | Level 4 vs. Later | 832.222 | 1 | 832.222 | .552 | .463 |
| | Level 5 vs. Later | 4.044 | 1 | 4.044 | .014 | .905 |
| | Level 6 vs. Level 7 | .621 | 1 | .621 | .010 | .920 |
| Error(LENGTH) | Level 1 vs. Later | 3844.871 | 30 | 128.162 | | |
| | Level 2 vs. Later | 5835.054 | 30 | 194.502 | | |
| | Level 3 vs. Later | 10362.819 | 30 | 345.427 | | |
| | Level 4 vs. Later | 45260.543 | 30 | 1508.685 | | |
| | Level 5 vs. Later | 8464.248 | 30 | 282.142 | | |
| | Level 6 vs. Level 7 | 1830.437 | 30 | 61.015 | | |

**Tests of Between-Subjects Effects**

Measure: MEASURE_1
Transformed Variable: Average

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Intercept | 7149.132 | 1 | 7149.132 | 84.120 | .000 |
| PERIOD | 2116.085 | 1 | 2116.085 | 24.899 | .000 |
| TRAWL | 21.717 | 1 | 21.717 | .256 | .617 |
| TRAWL * PERIOD | 29.402 | 1 | 29.402 | .346 | .561 |
| Error | 2549.613 | 30 | 84.987 | | |

# Estimated Marginal Means

**TRAWL * PERIOD**

Measure: MEASURE_1

| TRAWL | PERIOD | Mean | Std. Error | 95% Confidence Interval | |
|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound |
| e | 1.00 | 20.696 | 3.259 | 14.040 | 27.353 |
| | 2.00 | 6.754 | 3.073 | .478 | 13.030 |
| n | 1.00 | 24.161 | 3.259 | 17.504 | 30.817 |
| | 2.00 | 6.492 | 3.073 | .216 | 12.768 |

```
GLM
  s10 to s40 BY trawl period with haul
  /WSFACTOR = length 7 helmert
  /METHOD = SSTYPE(3)
  /CRITERIA = ALPHA(.05)
  /WSDESIGN = length
  /EMMEANS=TABLES(trawl*period)
  /DESIGN = period haul trawl  period*trawl .
```

# General Linear Model

**Within-Subjects Factors**

Measure: MEASURE_1

| LENGTH | Dependent Variable |
|---|---|
| 1 | S10 |
| 2 | S15 |
| 3 | S20 |
| 4 | S25 |
| 5 | S30 |
| 6 | S35 |
| 7 | S40 |

**Between-Subjects Factors**

| | | N |
|---|---|---|
| TRAWL | e | 17 |
| | n | 17 |
| PERIOD | 1.00 | 16 |
| | 2.00 | 18 |

**Multivariate Tests[b]**

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Pillai's Trace | .366 | 2.311[a] | 6.000 | 24.000 | .067 |
| | Wilks' Lambda | .634 | 2.311[a] | 6.000 | 24.000 | .067 |
| | Hotelling's Trace | .578 | 2.311[a] | 6.000 | 24.000 | .067 |
| | Roy's Largest Root | .578 | 2.311[a] | 6.000 | 24.000 | .067 |
| LENGTH * PERIOD | Pillai's Trace | .453 | 3.317[a] | 6.000 | 24.000 | .016 |
| | Wilks' Lambda | .547 | 3.317[a] | 6.000 | 24.000 | .016 |
| | Hotelling's Trace | .829 | 3.317[a] | 6.000 | 24.000 | .016 |
| | Roy's Largest Root | .829 | 3.317[a] | 6.000 | 24.000 | .016 |
| LENGTH * HAUL | Pillai's Trace | .233 | 1.217[a] | 6.000 | 24.000 | .332 |
| | Wilks' Lambda | .767 | 1.217[a] | 6.000 | 24.000 | .332 |
| | Hotelling's Trace | .304 | 1.217[a] | 6.000 | 24.000 | .332 |
| | Roy's Largest Root | .304 | 1.217[a] | 6.000 | 24.000 | .332 |
| LENGTH * TRAWL | Pillai's Trace | .220 | 1.125[a] | 6.000 | 24.000 | .378 |
| | Wilks' Lambda | .780 | 1.125[a] | 6.000 | 24.000 | .378 |
| | Hotelling's Trace | .281 | 1.125[a] | 6.000 | 24.000 | .378 |
| | Roy's Largest Root | .281 | 1.125[a] | 6.000 | 24.000 | .378 |
| LENGTH * TRAWL * PERIOD | Pillai's Trace | .130 | .599[a] | 6.000 | 24.000 | .728 |
| | Wilks' Lambda | .870 | .599[a] | 6.000 | 24.000 | .728 |
| | Hotelling's Trace | .150 | .599[a] | 6.000 | 24.000 | .728 |
| | Roy's Largest Root | .150 | .599[a] | 6.000 | 24.000 | .728 |

a. Exact statistic

b.

Design: Intercept+PERIOD+HAUL+TRAWL+TRAWL * PERIOD
Within Subjects Design: LENGTH

**Mauchly's Test of Sphericity[b]**

Measure: MEASURE_1

| Within Subjects Effect | Mauchly's W | Approx. Chi-Square | df | Sig. | Epsilon[a] | | |
|---|---|---|---|---|---|---|---|
| | | | | | Greenhouse-Geisser | Huynh-Feldt | Lower-bou |
| LENGTH | .000 | 319.481 | 20 | .000 | .248 | .294 | .1 |

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in t Tests of Within-Subjects Effects table.

b.
Design: Intercept+PERIOD+HAUL+TRAWL+TRAWL * PERIOD
Within Subjects Design: LENGTH

**Tests of Within-Subjects Effects**

Measure: MEASURE_1

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Sphericity Assumed | 6316.006 | 6 | 1052.668 | 3.225 | .005 |
| | Greenhouse-Geisser | 6316.006 | 1.487 | 4248.809 | 3.225 | .063 |
| | Huynh-Feldt | 6316.006 | 1.764 | 3579.878 | 3.225 | .054 |
| | Lower-bound | 6316.006 | 1.000 | 6316.006 | 3.225 | .083 |
| LENGTH * PERIOD | Sphericity Assumed | 4194.512 | 6 | 699.085 | 2.142 | .051 |
| | Greenhouse-Geisser | 4194.512 | 1.487 | 2821.670 | 2.142 | .141 |
| | Huynh-Feldt | 4194.512 | 1.764 | 2377.427 | 2.142 | .133 |
| | Lower-bound | 4194.512 | 1.000 | 4194.512 | 2.142 | .154 |
| LENGTH * HAUL | Sphericity Assumed | 199.972 | 6 | 33.329 | .102 | .996 |
| | Greenhouse-Geisser | 199.972 | 1.487 | 134.522 | .102 | .846 |
| | Huynh-Feldt | 199.972 | 1.764 | 113.343 | .102 | .880 |
| | Lower-bound | 199.972 | 1.000 | 199.972 | .102 | .752 |
| LENGTH * TRAWL | Sphericity Assumed | 1923.909 | 6 | 320.651 | .982 | .439 |
| | Greenhouse-Geisser | 1923.909 | 1.487 | 1294.223 | .982 | .360 |
| | Huynh-Feldt | 1923.909 | 1.764 | 1090.461 | .982 | .372 |
| | Lower-bound | 1923.909 | 1.000 | 1923.909 | .982 | .330 |
| LENGTH * TRAWL * PERIOD | Sphericity Assumed | 859.203 | 6 | 143.200 | .439 | .852 |
| | Greenhouse-Geisser | 859.203 | 1.487 | 577.990 | .439 | .589 |
| | Huynh-Feldt | 859.203 | 1.764 | 486.992 | .439 | .623 |
| | Lower-bound | 859.203 | 1.000 | 859.203 | .439 | .513 |
| Error(LENGTH) | Sphericity Assumed | 56800.014 | 174 | 326.437 | | |
| | Greenhouse-Geisser | 56800.014 | 43.110 | 1317.574 | | |
| | Huynh-Feldt | 56800.014 | 51.165 | 1110.136 | | |
| | Lower-bound | 56800.014 | 29.000 | 1958.621 | | |

**Tests of Within-Subjects Contrasts**

Measure: MEASURE_1

| Source | LENGTH | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Level 1 vs. Later | 817.425 | 1 | 817.425 | 6.915 | .014 |
| | Level 2 vs. Later | 775.246 | 1 | 775.246 | 4.196 | .050 |
| | Level 3 vs. Later | 1944.942 | 1 | 1944.942 | 6.491 | .016 |
| | Level 4 vs. Later | 2023.151 | 1 | 2023.151 | 3.827 | .060 |
| | Level 5 vs. Later | 1567.611 | 1 | 1567.611 | 1.094 | .304 |
| | Level 6 vs. Level 7 | 1701.853 | 1 | 1701.853 | 7.619 | .010 |
| LENGTH * PERIOD | Level 1 vs. Later | 581.799 | 1 | 581.799 | 4.922 | .035 |
| | Level 2 vs. Later | 1283.976 | 1 | 1283.976 | 6.950 | .013 |
| | Level 3 vs. Later | 1197.806 | 1 | 1197.806 | 3.997 | .055 |
| | Level 4 vs. Later | 688.060 | 1 | 688.060 | 1.302 | .263 |
| | Level 5 vs. Later | 1337.167 | 1 | 1337.167 | .933 | .342 |
| | Level 6 vs. Level 7 | 520.226 | 1 | 520.226 | 2.329 | .138 |
| LENGTH * HAUL | Level 1 vs. Later | 6.471 | 1 | 6.471 | .055 | .817 |
| | Level 2 vs. Later | 6.213 | 1 | 6.213 | .034 | .856 |
| | Level 3 vs. Later | 49.511 | 1 | 49.511 | .165 | .687 |
| | Level 4 vs. Later | 122.373 | 1 | 122.373 | .231 | .634 |
| | Level 5 vs. Later | 8.959 | 1 | 8.959 | .006 | .938 |
| | Level 6 vs. Level 7 | 103.776 | 1 | 103.776 | .465 | .501 |
| LENGTH * TRAWL | Level 1 vs. Later | 29.376 | 1 | 29.376 | .249 | .622 |
| | Level 2 vs. Later | 5.440 | 1 | 5.440 | .029 | .865 |
| | Level 3 vs. Later | 40.985 | 1 | 40.985 | .137 | .714 |
| | Level 4 vs. Later | 262.092 | 1 | 262.092 | .496 | .487 |
| | Level 5 vs. Later | 2490.180 | 1 | 2490.180 | 1.737 | .198 |
| | Level 6 vs. Level 7 | 9.438 | 1 | 9.438 | .042 | .839 |
| LENGTH * TRAWL * PERIOD | Level 1 vs. Later | 36.479 | 1 | 36.479 | .309 | .583 |
| | Level 2 vs. Later | 130.402 | 1 | 130.402 | .706 | .408 |
| | Level 3 vs. Later | 38.941 | 1 | 38.941 | .130 | .721 |
| | Level 4 vs. Later | 203.033 | 1 | 203.033 | .384 | .540 |
| | Level 5 vs. Later | 801.798 | 1 | 801.798 | .559 | .461 |
| | Level 6 vs. Level 7 | 2.614 | 1 | 2.614 | .012 | .915 |
| Error(LENGTH) | Level 1 vs. Later | 3428.036 | 29 | 118.208 | | |
| | Level 2 vs. Later | 5357.451 | 29 | 184.740 | | |
| | Level 3 vs. Later | 8689.964 | 29 | 299.654 | | |
| | Level 4 vs. Later | 15329.867 | 29 | 528.616 | | |
| | Level 5 vs. Later | 41563.402 | 29 | 1433.221 | | |
| | Level 6 vs. Level 7 | 6477.696 | 29 | 223.369 | | |

**Tests of Between-Subjects Effects**

Measure: MEASURE_1
Transformed Variable: Average

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Intercept | 600.557 | 1 | 600.557 | 6.915 | .014 |
| PERIOD | 427.444 | 1 | 427.444 | 4.922 | .035 |
| HAUL | 4.754 | 1 | 4.754 | .055 | .817 |
| TRAWL | 21.583 | 1 | 21.583 | .249 | .622 |
| TRAWL * PERIOD | 26.801 | 1 | 26.801 | .309 | .583 |
| Error | 2518.557 | 29 | 86.847 | | |

## Estimated Marginal Means

**TRAWL * PERIOD**

Measure: MEASURE_1

| TRAWL | PERIOD | Mean | Std. Error | 95% Confidence Interval | |
|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound |
| e | 1.00 | 19.634[a] | 4.413 | 10.608 | 28.661 |
| | 2.00 | 7.206[a] | 4.057 | -1.092 | 15.504 |
| n | 1.00 | 23.009[a] | 4.413 | 13.983 | 32.036 |
| | 2.00 | 7.023[a] | 4.057 | -1.275 | 15.321 |

a. Covariates appearing in the model are evaluated at the following values: HAUL = 9.0000.

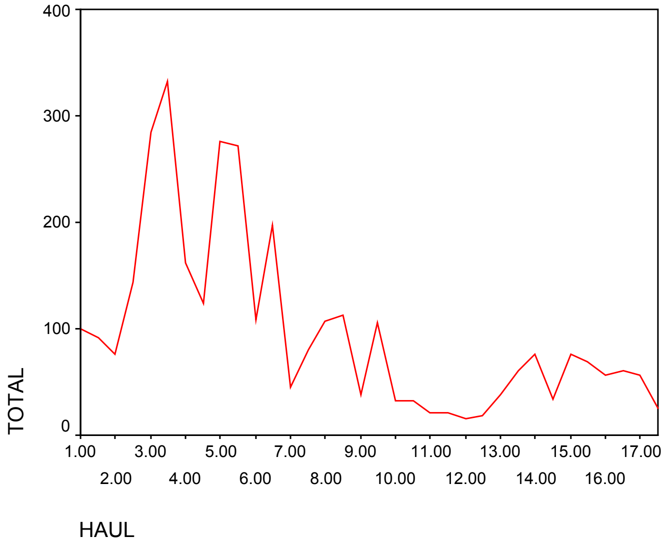
```
compute total=sum(l10 to l50).

*Sequence Charts .
TSPLOT VARIABLES= total
  /ID= haul
  /NOLOG
  /FORMAT NOFILL NOREFERENCE.
```

## TSPLOT

```
MODEL:  MOD_1.
```


400
300
200
100
0
TOTAL
1.00
3.00
5.00
7.00
9.00
11.00
13.00
15.00
17.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
HAUL

SPSS output for Haddock

```
* data list free / haul * vessel(a1) trawl(a1) l10 to l50 (f4.1).
* Copy data from spreadsheet.
get file  "c:\data files\sfia\nephrops\haddock1.sav".
freq var=l10 to l50  / format=notable / stats=min max.
```

# Frequencies

**Statistics**

| | | L10 | L11 | L12 | L13 | L14 | L15 | L16 | L17 | L18 | L19 | L20 | L21 | L22 | L23 | L24 | L25 | L26 | L27 | L28 | L29 | L30 | L31 | L32 | L33 | L34 | L35 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | Vali | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Miss | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Minimum | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| Maximun | | .0 | .0 | 8.0 | 4.0 | 8.0 | 13.0 | 30.0 | 30.0 | 46.0 | 23.0 | 23.0 | 19.0 | 19.0 | 8.5 | 12.0 | 18.0 | 17.0 | 18.0 | 30.0 | 36.0 | 60.0 | 90.0 | 58.5 | 78.0 | 72.[illegible] | 52.0 |

```
GLM
  l12 to l46 BY vessel trawl
  /WSFACTOR = length 35 helmert
  /METHOD = SSTYPE(3)
  /CRITERIA = ALPHA(.05)
  /WSDESIGN = length
  /DESIGN = vessel trawl vessel*trawl .
```

# General Linear Model

**Within-Subjects Factors**

Measure: MEASURE_1

| LENGTH | Dependent Variable |
|---|---|
| 1 | L12 |
| 2 | L13 |
| 3 | L14 |
| 4 | L15 |
| 5 | L16 |
| 6 | L17 |
| 7 | L18 |
| 8 | L19 |
| 9 | L20 |
| 10 | L21 |
| 11 | L22 |
| 12 | L23 |
| 13 | L24 |
| 14 | L25 |
| 15 | L26 |
| 16 | L27 |
| 17 | L28 |
| 18 | L29 |
| 19 | L30 |
| 20 | L31 |
| 21 | L32 |
| 22 | L33 |
| 23 | L34 |
| 24 | L35 |
| 25 | L36 |
| 26 | L37 |
| 27 | L38 |
| 28 | L39 |
| 29 | L40 |
| 30 | L41 |
| 31 | L42 |
| 32 | L43 |
| 33 | L44 |
| 34 | L45 |
| 35 | L46 |

**Between-Subjects Factors**

| | | N |
|---|---|---|
| VESSEL | a | 17 |
| | b | 17 |
| TRAWL | e | 17 |
| | n | 17 |

**Multivariate Tests [b]**

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Pillai's Trace | .[a] | . | . | . | . |
| | Wilks' Lambda | .[a] | . | . | . | . |
| | Hotelling's Trace | .[a] | . | . | . | . |
| | Roy's Largest Root | .[a] | . | . | . | . |
| LENGTH * VESSEL | Pillai's Trace | .[a] | . | . | . | . |
| | Wilks' Lambda | .[a] | . | . | . | . |
| | Hotelling's Trace | .[a] | . | . | . | . |
| | Roy's Largest Root | .[a] | . | . | . | . |
| LENGTH * TRAWL | Pillai's Trace | .[a] | . | . | . | . |
| | Wilks' Lambda | .[a] | . | . | . | . |
| | Hotelling's Trace | .[a] | . | . | . | . |
| | Roy's Largest Root | .[a] | . | . | . | . |
| LENGTH * VESSEL * TRAWL | Pillai's Trace | .[a] | . | . | . | . |
| | Wilks' Lambda | .[a] | . | . | . | . |
| | Hotelling's Trace | .[a] | . | . | . | . |
| | Roy's Largest Root | .[a] | . | . | . | . |

a. Cannot produce multivariate test statistics because of insufficient residual degrees of freedom.

b. Design: Intercept+VESSEL+TRAWL+VESSEL * TRAWL
Within Subjects Design: LENGTH

**Mauchly's Test of Sphericity [b]**

Measure: MEASURE_1

| | | | | | Epsilon [a] | | |
|---|---|---|---|---|---|---|---|
| Within Subjects Effect | Mauchly's W | Approx. Chi-Square | df | Sig. | Greenhouse -Geisser | Huynh-Feldt | Lower-bound |
| LENGTH | .000 | . | 594 | . | .131 | .172 | .029 |

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b. Design: Intercept+VESSEL+TRAWL+VESSEL * TRAWL
Within Subjects Design: LENGTH

**Tests of Within-Subjects Effects**

Measure: MEASURE_1

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Sphericity Assumed | 28021.059 | 34 | 824.149 | 18.569 | .000 |
| | Greenhouse-Geisser | 28021.059 | 4.449 | 6297.922 | 18.569 | .000 |
| | Huynh-Feldt | 28021.059 | 5.842 | 4796.253 | 18.569 | .000 |
| | Lower-bound | 28021.059 | 1.000 | 28021.059 | 18.569 | .000 |
| LENGTH * VESSEL | Sphericity Assumed | 3645.286 | 34 | 107.214 | 2.416 | .000 |
| | Greenhouse-Geisser | 3645.286 | 4.449 | 819.303 | 2.416 | .046 |
| | Huynh-Feldt | 3645.286 | 5.842 | 623.949 | 2.416 | .030 |
| | Lower-bound | 3645.286 | 1.000 | 3645.286 | 2.416 | .131 |
| LENGTH * TRAWL | Sphericity Assumed | 6038.789 | 34 | 177.611 | 4.002 | .000 |
| | Greenhouse-Geisser | 6038.789 | 4.449 | 1357.259 | 4.002 | .003 |
| | Huynh-Feldt | 6038.789 | 5.842 | 1033.635 | 4.002 | .001 |
| | Lower-bound | 6038.789 | 1.000 | 6038.789 | 4.002 | .055 |
| LENGTH * VESSEL * TRAWL | Sphericity Assumed | 8819.623 | 34 | 259.401 | 5.845 | .000 |
| | Greenhouse-Geisser | 8819.623 | 4.449 | 1982.270 | 5.845 | .000 |
| | Huynh-Feldt | 8819.623 | 5.842 | 1509.620 | 5.845 | .000 |
| | Lower-bound | 8819.623 | 1.000 | 8819.623 | 5.845 | .022 |
| Error(LENGTH) | Sphericity Assumed | 45269.849 | 1020 | 44.382 | | |
| | Greenhouse-Geisser | 45269.849 | 133.478 | 339.157 | | |
| | Huynh-Feldt | 45269.849 | 175.268 | 258.289 | | |
| | Lower-bound | 45269.849 | 30.000 | 1508.995 | | |

**Tests of Within-Subjects Contrasts**

Measure: MEASURE_1

| Source | LENGTH | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Level 1 vs. Later | 543.572 | 1 | 543.572 | 62.677 | .000 |
| | Level 2 vs. Later | 613.592 | 1 | 613.592 | 83.641 | .000 |
| | Level 3 vs. Later | 573.621 | 1 | 573.621 | 47.581 | .000 |
| | Level 4 vs. Later | 354.535 | 1 | 354.535 | 15.234 | .000 |
| | Level 5 vs. Later | 174.560 | 1 | 174.560 | 2.752 | .108 |
| | Level 6 vs. Later | 153.829 | 1 | 153.829 | 2.958 | .096 |
| | Level 7 vs. Later | 3.641 | 1 | 3.641 | .034 | .854 |
| | Level 8 vs. Later | 251.358 | 1 | 251.358 | 5.487 | .026 |
| | Level 9 vs. Later | 353.207 | 1 | 353.207 | 12.471 | .001 |
| | Level 10 vs. Later | 646.739 | 1 | 646.739 | 24.686 | .000 |
| | Level 11 vs. Later | 598.245 | 1 | 598.245 | 19.970 | .000 |
| | Level 12 vs. Later | 951.582 | 1 | 951.582 | 57.160 | .000 |
| | Level 13 vs. Later | 870.426 | 1 | 870.426 | 32.238 | .000 |
| | Level 14 vs. Later | 780.843 | 1 | 780.843 | 51.325 | .000 |
| | Level 15 vs. Later | 1039.943 | 1 | 1039.943 | 40.163 | .000 |
| | Level 16 vs. Later | 667.686 | 1 | 667.686 | 21.643 | .000 |
| | Level 17 vs. Later | 330.760 | 1 | 330.760 | 5.229 | .029 |
| | Level 18 vs. Later | 1.751 | 1 | 1.751 | .032 | .860 |
| | Level 19 vs. Later | 540.912 | 1 | 540.912 | 5.623 | .024 |
| | Level 20 vs. Later | 1764.093 | 1 | 1764.093 | 8.712 | .006 |
| | Level 21 vs. Later | 2294.693 | 1 | 2294.693 | 24.467 | .000 |
| | Level 22 vs. Later | 4361.338 | 1 | 4361.338 | 17.335 | .000 |
| | Level 23 vs. Later | 5140.470 | 1 | 5140.470 | 38.927 | .000 |
| | Level 24 vs. Later | 3405.905 | 1 | 3405.905 | 35.938 | .000 |
| | Level 25 vs. Later | 1691.677 | 1 | 1691.677 | 45.800 | .000 |
| | Level 26 vs. Later | 796.845 | 1 | 796.845 | 51.682 | .000 |
| | Level 27 vs. Later | 627.472 | 1 | 627.472 | 31.528 | .000 |
| | Level 28 vs. Later | 214.040 | 1 | 214.040 | 22.581 | .000 |
| | Level 29 vs. Later | 233.368 | 1 | 233.368 | 23.950 | .000 |
| | Level 30 vs. Later | 35.549 | 1 | 35.549 | 11.344 | .002 |
| | Level 31 vs. Later | 15.137 | 1 | 15.137 | 8.966 | .005 |
| | Level 32 vs. Later | 5.185 | 1 | 5.185 | 4.063 | .053 |
| | Level 33 vs. Later | 1.520 | 1 | 1.520 | 3.467 | .072 |
| | Level 34 vs. Level 35 | .026 | 1 | .026 | .271 | .606 |
| LENGTH * VESSEL | Level 1 vs. Later | 17.927 | 1 | 17.927 | 2.067 | .161 |
| | Level 2 vs. Later | 13.051 | 1 | 13.051 | 1.779 | .192 |
| | Level 3 vs. Later | 13.189 | 1 | 13.189 | 1.094 | .304 |
| | Level 4 vs. Later | .096 | 1 | .096 | .004 | .949 |
| | Level 5 vs. Later | 39.705 | 1 | 39.705 | .626 | .435 |
| | Level 6 vs. Later | 185.418 | 1 | 185.418 | 3.566 | .069 |
| | Level 7 vs. Later | 675.101 | 1 | 675.101 | 6.358 | .017 |
| | Level 8 vs. Later | 101.030 | 1 | 101.030 | 2.205 | .148 |
| | Level 9 vs. Later | 127.656 | 1 | 127.656 | 4.507 | .042 |
| | Level 10 vs. Later | 104.797 | 1 | 104.797 | 4.000 | .055 |
| | Level 11 vs. Later | 120.778 | 1 | 120.778 | 4.032 | .054 |
| | Level 12 vs. Later | 24.826 | 1 | 24.826 | 1.491 | .232 |
| | Level 13 vs. Later | 49.367 | 1 | 49.367 | 1.828 | .186 |
| | Level 14 vs. Later | 1.816 | 1 | 1.816 | .119 | .732 |
| | Level 15 vs. Later | 23.344 | 1 | 23.344 | .902 | .350 |
| | Level 16 vs. Later | 11.886 | 1 | 11.886 | .385 | .539 |
| | Level 17 vs. Later | .858 | 1 | .858 | .014 | .908 |
| | Level 18 vs. Later | 287.146 | 1 | 287.146 | 5.207 | .030 |
| | Level 19 vs. Later | 1112.090 | 1 | 1112.090 | 11.560 | .002 |
| | Level 20 vs. Later | 137.276 | 1 | 137.276 | .678 | .417 |
| | Level 21 vs. Later | 80.258 | 1 | 80.258 | .856 | .362 |
| | Level 22 vs. Later | 128.721 | 1 | 128.721 | .512 | .480 |
| | Level 23 vs. Later | 495.218 | 1 | 495.218 | 3.750 | .062 |
| | Level 24 vs. Later | 3.811 | 1 | 3.811 | .040 | .842 |
| | Level 25 vs. Later | 78.726 | 1 | 78.726 | 2.131 | .155 |
| | Level 26 vs. Later | 2.401 | 1 | 2.401 | .156 | .696 |
| | Level 27 vs. Later | 9.798 | 1 | 9.798 | .492 | .488 |
| | Level 28 vs. Later | 3.174 | 1 | 3.174 | .335 | .567 |
| | Level 29 vs. Later | .226 | 1 | .226 | .023 | .880 |
| | Level 30 vs. Later | .512 | 1 | .512 | .163 | .689 |
| | Level 31 vs. Later | .037 | 1 | .037 | .022 | .884 |
| | Level 32 vs. Later | .864 | 1 | .864 | .677 | .417 |
| | Level 33 vs. Later | .827 | 1 | .827 | 1.887 | .180 |
| | Level 34 vs. Level 35 | .026 | 1 | .026 | .271 | .606 |
| LENGTH * TRAWL | Level 1 vs. Later | 156.944 | 1 | 156.944 | 18.097 | .000 |
| | Level 2 vs. Later | 147.810 | 1 | 147.810 | 20.149 | .000 |
| | Level 3 vs. Later | 154.849 | 1 | 154.849 | 12.844 | .001 |
| | Level 4 vs. Later | 71.462 | 1 | 71.462 | 3.071 | .090 |
| | Level 5 vs. Later | .267 | 1 | .267 | .004 | .949 |
| | Level 6 vs. Later | 10.922 | 1 | 10.922 | .210 | .650 |
| | Level 7 vs. Later | 11.788 | 1 | 11.788 | .111 | .741 |
| | Level 8 vs. Later | 12.418 | 1 | 12.418 | .271 | .606 |
| | Level 9 vs. Later | 38.428 | 1 | 38.428 | 1.357 | .253 |
| | Level 10 vs. Later | 120.720 | 1 | 120.720 | 4.608 | .040 |
| | Level 11 vs. Later | 40.726 | 1 | 40.726 | 1.360 | .253 |
| | Level 12 vs. Later | 220.602 | 1 | 220.602 | 13.251 | .001 |
| | Level 13 vs. Later | 209.418 | 1 | 209.418 | 7.756 | .009 |
| | Level 14 vs. Later | 227.277 | 1 | 227.277 | 14.939 | .001 |
| | Level 15 vs. Later | 126.941 | 1 | 126.941 | 4.902 | .035 |
| | Level 16 vs. Later | 261.748 | 1 | 261.748 | 8.485 | .007 |
| | Level 17 vs. Later | 73.727 | 1 | 73.727 | 1.166 | .289 |
| | Level 18 vs. Later | 24.898 | 1 | 24.898 | .451 | .507 |
| | Level 19 vs. Later | 1279.011 | 1 | 1279.011 | 13.295 | .001 |
| | Level 20 vs. Later | 1310.181 | 1 | 1310.181 | 6.471 | .016 |
| | Level 21 vs. Later | 523.821 | 1 | 523.821 | 5.585 | .025 |
| | Level 22 vs. Later | 252.738 | 1 | 252.738 | 1.005 | .324 |
| | Level 23 vs. Later | 134.453 | 1 | 134.453 | 1.018 | .321 |
| | Level 24 vs. Later | 559.930 | 1 | 559.930 | 5.908 | .021 |
| | Level 25 vs. Later | 18.464 | 1 | 18.464 | .500 | .485 |
| | Level 26 vs. Later | 81.743 | 1 | 81.743 | 5.302 | .028 |
| | Level 27 vs. Later | 247.813 | 1 | 247.813 | 12.451 | .001 |
| | Level 29 vs. Later | 62.931 | 1 | 62.931 | 6.459 | .016 |
| | Level 30 vs. Later | 3.265 | 1 | 3.265 | 1.042 | .316 |
| | Level 31 vs. Later | 6.434 | 1 | 6.434 | 3.811 | .060 |
| | Level 32 vs. Later | .472 | 1 | .472 | .370 | .548 |

**Tests of Between-Subjects Effects**

Measure: MEASURE_1

Transformed Variable: Average

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Intercept | 580.989 | 1 | 580.989 | 101.550 | .000 |
| VESSEL | 7.064 | 1 | 7.064 | 1.235 | .275 |
| TRAWL | 114.802 | 1 | 114.802 | 20.066 | .000 |
| VESSEL * TRAWL | 57.511 | 1 | 57.511 | 10.052 | .003 |
| Error | 171.637 | 30 | 5.721 | | |

```
compute s10=sum(l10 to l14).
compute s15=sum(l15 to l19).
compute s20=sum(l20 to l24).
compute s25=sum(l25 to l29).
compute s30=sum(l30 to l34).
compute s35=sum(l35 to l39).
compute s40=sum(l40 to l44).
compute s45=sum(l45 to l49).
recode haul (1 thru 8=1) (9 thru highest=2) into period.
GLM
  s10 to s45 BY trawl period
  /WSFACTOR = length 8 helmert
  /METHOD = SSTYPE(3)
  /CRITERIA = ALPHA(.05)
  /WSDESIGN = length
  /EMMEANS=TABLES(trawl*period)
  /DESIGN = period trawl  period*trawl .
```

# General Linear Model

**Within-Subjects Factors**

Measure: MEASURE_1

| LENGTH | Dependent Variable |
|---|---|
| 1 | S10 |
| 2 | S15 |
| 3 | S20 |
| 4 | S25 |
| 5 | S30 |
| 6 | S35 |
| 7 | S40 |
| 8 | S45 |

**Between-Subjects Factors**

| | | N |
|---|---|---|
| TRAWL | e | 17 |
| | n | 17 |
| PERIOD | 1.00 | 16 |
| | 2.00 | 18 |

**Multivariate Tests** [b]

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Pillai's Trace | .865 | 21.914[a] | 7.000 | 24.000 | .000 |
| | Wilks' Lambda | .135 | 21.914[a] | 7.000 | 24.000 | .000 |
| | Hotelling's Trace | 6.392 | 21.914[a] | 7.000 | 24.000 | .000 |
| | Roy's Largest Root | 6.392 | 21.914[a] | 7.000 | 24.000 | .000 |
| LENGTH * PERIOD | Pillai's Trace | .399 | 2.274[a] | 7.000 | 24.000 | .063 |
| | Wilks' Lambda | .601 | 2.274[a] | 7.000 | 24.000 | .063 |
| | Hotelling's Trace | .663 | 2.274[a] | 7.000 | 24.000 | .063 |
| | Roy's Largest Root | .663 | 2.274[a] | 7.000 | 24.000 | .063 |
| LENGTH * TRAWL | Pillai's Trace | .579 | 4.724[a] | 7.000 | 24.000 | .002 |
| | Wilks' Lambda | .421 | 4.724[a] | 7.000 | 24.000 | .002 |
| | Hotelling's Trace | 1.378 | 4.724[a] | 7.000 | 24.000 | .002 |
| | Roy's Largest Root | 1.378 | 4.724[a] | 7.000 | 24.000 | .002 |
| LENGTH * TRAWL * PERIOD | Pillai's Trace | .364 | 1.963[a] | 7.000 | 24.000 | .103 |
| | Wilks' Lambda | .636 | 1.963[a] | 7.000 | 24.000 | .103 |
| | Hotelling's Trace | .573 | 1.963[a] | 7.000 | 24.000 | .103 |
| | Roy's Largest Root | .573 | 1.963[a] | 7.000 | 24.000 | .103 |

a. Exact statistic

b.
Design: Intercept+PERIOD+TRAWL+TRAWL * PERIOD
Within Subjects Design: LENGTH

**Mauchly's Test of Sphericity** [b]

Measure: MEASURE_1

| | | | | | Epsilon [a] | | |
|---|---|---|---|---|---|---|---|
| Within Subjects Effect | Mauchly's W | Approx. Chi-Square | df | Sig. | Greenhouse -Geisser | Huynh-Feldt | Lower-bound |
| LENGTH | .000 | 347.128 | 27 | .000 | .244 | .283 | .143 |

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b.
Design: Intercept+PERIOD+TRAWL+TRAWL * PERIOD
Within Subjects Design: LENGTH

**Tests of Within-Subjects Effects**

Measure: MEASURE_1

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Sphericity Assumed | 134624.792 | 7 | 19232.113 | 34.077 | .000 |
| | Greenhouse-Geisser | 134624.792 | 1.709 | 78779.566 | 34.077 | .000 |
| | Huynh-Feldt | 134624.792 | 1.983 | 67888.713 | 34.077 | .000 |
| | Lower-bound | 134624.792 | 1.000 | 134624.792 | 34.077 | .000 |
| LENGTH * PERIOD | Sphericity Assumed | 37245.969 | 7 | 5320.853 | 9.428 | .000 |
| | Greenhouse-Geisser | 37245.969 | 1.709 | 21795.549 | 9.428 | .001 |
| | Huynh-Feldt | 37245.969 | 1.983 | 18782.431 | 9.428 | .000 |
| | Lower-bound | 37245.969 | 1.000 | 37245.969 | 9.428 | .005 |
| LENGTH * TRAWL | Sphericity Assumed | 25079.001 | 7 | 3582.714 | 6.348 | .000 |
| | Greenhouse-Geisser | 25079.001 | 1.709 | 14675.698 | 6.348 | .005 |
| | Huynh-Feldt | 25079.001 | 1.983 | 12646.862 | 6.348 | .003 |
| | Lower-bound | 25079.001 | 1.000 | 25079.001 | 6.348 | .017 |
| LENGTH * TRAWL * PERIOD | Sphericity Assumed | 12474.031 | 7 | 1782.004 | 3.158 | .003 |
| | Greenhouse-Geisser | 12474.031 | 1.709 | 7299.538 | 3.158 | .058 |
| | Huynh-Feldt | 12474.031 | 1.983 | 6290.416 | 3.158 | .050 |
| | Lower-bound | 12474.031 | 1.000 | 12474.031 | 3.158 | .086 |
| Error(LENGTH) | Sphericity Assumed | 118517.408 | 210 | 564.369 | | |
| | Greenhouse-Geisser | 118517.408 | 51.266 | 2311.796 | | |
| | Huynh-Feldt | 118517.408 | 59.491 | 1992.202 | | |
| | Lower-bound | 118517.408 | 30.000 | 3950.580 | | |

**Tests of Within-Subjects Contrasts**

Measure: MEASURE_1

| Source | LENGTH | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Level 1 vs. Later | 13323.000 | 1 | 13323.000 | 75.603 | .000 |
| | Level 2 vs. Later | 2681.134 | 1 | 2681.134 | 2.921 | .098 |
| | Level 3 vs. Later | 14605.564 | 1 | 14605.564 | 37.841 | .000 |
| | Level 4 vs. Later | 7031.097 | 1 | 7031.097 | 21.944 | .000 |
| | Level 5 vs. Later | 100703.187 | 1 | 100703.187 | 35.545 | .000 |
| | Level 6 vs. Later | 40085.309 | 1 | 40085.309 | 91.394 | .000 |
| | Level 7 vs. Level 8 | 1243.883 | 1 | 1243.883 | 43.224 | .000 |
| LENGTH * PERIOD | Level 1 vs. Later | 1077.454 | 1 | 1077.454 | 6.114 | .019 |
| | Level 2 vs. Later | 6815.286 | 1 | 6815.286 | 7.425 | .011 |
| | Level 3 vs. Later | 5731.931 | 1 | 5731.931 | 14.850 | .001 |
| | Level 4 vs. Later | 939.759 | 1 | 939.759 | 2.933 | .097 |
| | Level 5 vs. Later | 29078.010 | 1 | 29078.010 | 10.264 | .003 |
| | Level 6 vs. Later | 4661.309 | 1 | 4661.309 | 10.628 | .003 |
| | Level 7 vs. Level 8 | 34.118 | 1 | 34.118 | 1.186 | .285 |
| LENGTH * TRAWL | Level 1 vs. Later | 3225.695 | 1 | 3225.695 | 18.305 | .000 |
| | Level 2 vs. Later | 1.802 | 1 | 1.802 | .002 | .965 |
| | Level 3 vs. Later | 2473.466 | 1 | 2473.466 | 6.408 | .017 |
| | Level 4 vs. Later | 1316.553 | 1 | 1316.553 | 4.109 | .052 |
| | Level 5 vs. Later | 20455.267 | 1 | 20455.267 | 7.220 | .012 |
| | Level 6 vs. Later | 5487.020 | 1 | 5487.020 | 12.510 | .001 |
| | Level 7 vs. Level 8 | 282.092 | 1 | 282.092 | 9.803 | .004 |
| LENGTH * TRAWL * PERIOD | Level 1 vs. Later | 272.619 | 1 | 272.619 | 1.547 | .223 |
| | Level 2 vs. Later | 3413.970 | 1 | 3413.970 | 3.719 | .063 |
| | Level 3 vs. Later | 1905.706 | 1 | 1905.706 | 4.937 | .034 |
| | Level 4 vs. Later | 261.928 | 1 | 261.928 | .817 | .373 |
| | Level 5 vs. Later | 9830.705 | 1 | 9830.705 | 3.470 | .072 |
| | Level 6 vs. Later | 185.020 | 1 | 185.020 | .422 | .521 |
| | Level 7 vs. Level 8 | 30.445 | 1 | 30.445 | 1.058 | .312 |
| Error(LENGTH) | Level 1 vs. Later | 5286.705 | 30 | 176.223 | | |
| | Level 2 vs. Later | 27537.604 | 30 | 917.920 | | |
| | Level 3 vs. Later | 11579.273 | 30 | 385.976 | | |
| | Level 4 vs. Later | 9612.454 | 30 | 320.415 | | |
| | Level 5 vs. Later | 84993.184 | 30 | 2833.106 | | |
| | Level 6 vs. Later | 13157.965 | 30 | 438.599 | | |
| | Level 7 vs. Level 8 | 863.319 | 30 | 28.777 | | |

**Tests of Between-Subjects Effects**

Measure: MEASURE_1

Transformed Variable: Average

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Intercept | 11120.490 | 1 | 11120.490 | 101.550 | .000 |
| PERIOD | 1100.787 | 1 | 1100.787 | 10.052 | .003 |
| TRAWL | 2197.390 | 1 | 2197.390 | 20.066 | .000 |
| TRAWL * PERIOD | 135.206 | 1 | 135.206 | 1.235 | .275 |
| Error | 3285.235 | 30 | 109.508 | | |

# Estimated Marginal Means

**TRAWL * PERIOD**

Measure: MEASURE_1

| | | | | 95% Confidence Interval | |
|---|---|---|---|---|---|
| TRAWL | PERIOD | Mean | Std. Error | Lower Bound | Upper Bound |
| e | 1.00 | 13.766 | 3.700 | 6.210 | 21.322 |
| | 2.00 | 6.361 | 3.488 | -.763 | 13.485 |
| n | 1.00 | 33.867 | 3.700 | 26.311 | 41.423 |
| | 2.00 | 18.472 | 3.488 | 11.348 | 25.596 |

```
GLM
  s10 to s40 BY trawl period with haul
  /WSFACTOR = length 7 helmert
  /METHOD = SSTYPE(3)
  /CRITERIA = ALPHA(.05)
  /WSDESIGN = length
  /EMMEANS=TABLES(trawl*period)
  /DESIGN = period haul trawl  period*trawl .
```

# General Linear Model

**Within-Subjects Factors**

Measure: MEASURE_1

| LENGTH | Dependent Variable |
|---|---|
| 1 | S10 |
| 2 | S15 |
| 3 | S20 |
| 4 | S25 |
| 5 | S30 |
| 6 | S35 |
| 7 | S40 |

**Between-Subjects Factors**

| | | N |
|---|---|---|
| TRAWL | e | 17 |
| | n | 17 |
| PERIOD | 1.00 | 16 |
| | 2.00 | 18 |

**Multivariate Tests** [b]

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Pillai's Trace | .467 | 3.501[a] | 6.000 | 24.000 | .012 |
| | Wilks' Lambda | .533 | 3.501[a] | 6.000 | 24.000 | .012 |
| | Hotelling's Trace | .875 | 3.501[a] | 6.000 | 24.000 | .012 |
| | Roy's Largest Root | .875 | 3.501[a] | 6.000 | 24.000 | .012 |
| LENGTH * PERIOD | Pillai's Trace | .311 | 1.802[a] | 6.000 | 24.000 | .141 |
| | Wilks' Lambda | .689 | 1.802[a] | 6.000 | 24.000 | .141 |
| | Hotelling's Trace | .451 | 1.802[a] | 6.000 | 24.000 | .141 |
| | Roy's Largest Root | .451 | 1.802[a] | 6.000 | 24.000 | .141 |
| LENGTH * HAUL | Pillai's Trace | .280 | 1.553[a] | 6.000 | 24.000 | .204 |
| | Wilks' Lambda | .720 | 1.553[a] | 6.000 | 24.000 | .204 |
| | Hotelling's Trace | .388 | 1.553[a] | 6.000 | 24.000 | .204 |
| | Roy's Largest Root | .388 | 1.553[a] | 6.000 | 24.000 | .204 |
| LENGTH * TRAWL | Pillai's Trace | .497 | 3.957[a] | 6.000 | 24.000 | .007 |
| | Wilks' Lambda | .503 | 3.957[a] | 6.000 | 24.000 | .007 |
| | Hotelling's Trace | .989 | 3.957[a] | 6.000 | 24.000 | .007 |
| | Roy's Largest Root | .989 | 3.957[a] | 6.000 | 24.000 | .007 |
| LENGTH * TRAWL * PERIOD | Pillai's Trace | .336 | 2.022[a] | 6.000 | 24.000 | .102 |
| | Wilks' Lambda | .664 | 2.022[a] | 6.000 | 24.000 | .102 |
| | Hotelling's Trace | .505 | 2.022[a] | 6.000 | 24.000 | .102 |
| | Roy's Largest Root | .505 | 2.022[a] | 6.000 | 24.000 | .102 |

a. Exact statistic

b.
Design: Intercept+PERIOD+HAUL+TRAWL+TRAWL * PERIOD
Within Subjects Design: LENGTH

**Mauchly's Test of Sphericity [b]**

Measure: MEASURE_1

| Within Subjects Effect | Mauchly's W | Approx. Chi-Square | df | Sig. | Epsilon [a] Greenhouse -Geisser | Epsilon [a] Huynh-Feldt | Epsilon [a] Lower-bound |
|---|---|---|---|---|---|---|---|
| LENGTH | .000 | 231.079 | 20 | .000 | .278 | .333 | .167 |

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b.
Design: Intercept+PERIOD+HAUL+TRAWL+TRAWL * PERIOD
Within Subjects Design: LENGTH

**Tests of Within-Subjects Effects**

Measure: MEASURE_1

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Sphericity Assumed | 9884.211 | 6 | 1647.369 | 2.545 | .022 |
| | Greenhouse-Geisser | 9884.211 | 1.667 | 5929.760 | 2.545 | .098 |
| | Huynh-Feldt | 9884.211 | 2.000 | 4941.405 | 2.545 | .087 |
| | Lower-bound | 9884.211 | 1.000 | 9884.211 | 2.545 | .121 |
| LENGTH * PERIOD | Sphericity Assumed | 13540.237 | 6 | 2256.706 | 3.486 | .003 |
| | Greenhouse-Geisser | 13540.237 | 1.667 | 8123.092 | 3.486 | .046 |
| | Huynh-Feldt | 13540.237 | 2.000 | 6769.158 | 3.486 | .037 |
| | Lower-bound | 13540.237 | 1.000 | 13540.237 | 3.486 | .072 |
| LENGTH * HAUL | Sphericity Assumed | 2085.454 | 6 | 347.576 | .537 | .780 |
| | Greenhouse-Geisser | 2085.454 | 1.667 | 1251.111 | .537 | .556 |
| | Huynh-Feldt | 2085.454 | 2.000 | 1042.579 | .537 | .587 |
| | Lower-bound | 2085.454 | 1.000 | 2085.454 | .537 | .470 |
| LENGTH * TRAWL | Sphericity Assumed | 22619.403 | 6 | 3769.901 | 5.824 | .000 |
| | Greenhouse-Geisser | 22619.403 | 1.667 | 13569.888 | 5.824 | .008 |
| | Huynh-Feldt | 22619.403 | 2.000 | 11308.097 | 5.824 | .005 |
| | Lower-bound | 22619.403 | 1.000 | 22619.403 | 5.824 | .022 |
| LENGTH * TRAWL * PERIOD | Sphericity Assumed | 12306.349 | 6 | 2051.058 | 3.169 | .006 |
| | Greenhouse-Geisser | 12306.349 | 1.667 | 7382.855 | 3.169 | .060 |
| | Huynh-Feldt | 12306.349 | 2.000 | 6152.301 | 3.169 | .049 |
| | Lower-bound | 12306.349 | 1.000 | 12306.349 | 3.169 | .086 |
| Error(LENGTH) | Sphericity Assumed | 112628.448 | 174 | 647.290 | | |
| | Greenhouse-Geisser | 112628.448 | 48.340 | 2329.943 | | |
| | Huynh-Feldt | 112628.448 | 58.008 | 1941.594 | | |
| | Lower-bound | 112628.448 | 29.000 | 3883.740 | | |

**Tests of Within-Subjects Contrasts**

Measure: MEASURE_1

| Source | LENGTH | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Level 1 vs. Later | 1406.662 | 1 | 1406.662 | 5.859 | .022 |
| | Level 2 vs. Later | 499.224 | 1 | 499.224 | .506 | .483 |
| | Level 3 vs. Later | 935.929 | 1 | 935.929 | 1.636 | .211 |
| | Level 4 vs. Later | 2866.864 | 1 | 2866.864 | 5.535 | .026 |
| | Level 5 vs. Later | 5265.912 | 1 | 5265.912 | 1.939 | .174 |
| | Level 6 vs. Level 7 | 3705.963 | 1 | 3705.963 | 9.317 | .005 |
| LENGTH * PERIOD | Level 1 vs. Later | 349.331 | 1 | 349.331 | 1.455 | .237 |
| | Level 2 vs. Later | 7235.766 | 1 | 7235.766 | 7.334 | .011 |
| | Level 3 vs. Later | 3178.925 | 1 | 3178.925 | 5.556 | .025 |
| | Level 4 vs. Later | 148.123 | 1 | 148.123 | .286 | .597 |
| | Level 5 vs. Later | 6463.438 | 1 | 6463.438 | 2.380 | .134 |
| | Level 6 vs. Level 7 | 495.630 | 1 | 495.630 | 1.246 | .273 |
| LENGTH * HAUL | Level 1 vs. Later | 1.007 | 1 | 1.007 | .004 | .949 |
| | Level 2 vs. Later | 2010.354 | 1 | 2010.354 | 2.038 | .164 |
| | Level 3 vs. Later | 154.225 | 1 | 154.225 | .270 | .608 |
| | Level 4 vs. Later | 281.961 | 1 | 281.961 | .544 | .467 |
| | Level 5 vs. Later | 3.219 | 1 | 3.219 | .001 | .973 |
| | Level 6 vs. Level 7 | 144.598 | 1 | 144.598 | .364 | .551 |
| LENGTH * TRAWL | Level 1 vs. Later | 4317.845 | 1 | 4317.845 | 17.983 | .000 |
| | Level 2 vs. Later | 86.814 | 1 | 86.814 | .088 | .769 |
| | Level 3 vs. Later | 4242.037 | 1 | 4242.037 | 7.414 | .011 |
| | Level 4 vs. Later | 3508.500 | 1 | 3508.500 | 6.774 | .014 |
| | Level 5 vs. Later | 15996.501 | 1 | 15996.501 | 5.890 | .022 |
| | Level 6 vs. Level 7 | 4313.419 | 1 | 4313.419 | 10.844 | .003 |
| LENGTH * TRAWL * PERIOD | Level 1 vs. Later | 356.227 | 1 | 356.227 | 1.484 | .233 |
| | Level 2 vs. Later | 3960.682 | 1 | 3960.682 | 4.014 | .055 |
| | Level 3 vs. Later | 2611.647 | 1 | 2611.647 | 4.565 | .041 |
| | Level 4 vs. Later | 53.728 | 1 | 53.728 | .104 | .750 |
| | Level 5 vs. Later | 9655.479 | 1 | 9655.479 | 3.555 | .069 |
| | Level 6 vs. Level 7 | 267.684 | 1 | 267.684 | .673 | .419 |
| Error(LENGTH) | Level 1 vs. Later | 6962.993 | 29 | 240.103 | | |
| | Level 2 vs. Later | 28611.879 | 29 | 986.617 | | |
| | Level 3 vs. Later | 16591.777 | 29 | 572.130 | | |
| | Level 4 vs. Later | 15019.388 | 29 | 517.910 | | |
| | Level 5 vs. Later | 78766.641 | 29 | 2716.091 | | |
| | Level 6 vs. Level 7 | 11535.759 | 29 | 397.785 | | |

**Tests of Between-Subjects Effects**

Measure: MEASURE_1

Transformed Variable: Average

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Intercept | 1531.282 | 1 | 1531.282 | 10.447 | .003 |
| PERIOD | 170.284 | 1 | 170.284 | 1.162 | .290 |
| HAUL | 47.113 | 1 | 47.113 | .321 | .575 |
| TRAWL | 2862.640 | 1 | 2862.640 | 19.531 | .000 |
| TRAWL * PERIOD | 178.442 | 1 | 178.442 | 1.217 | .279 |
| Error | 4250.514 | 29 | 146.569 | | |

# Estimated Marginal Means

**TRAWL * PERIOD**

Measure: MEASURE_1

| TRAWL | PERIOD | Mean | Std. Error | 95% Confidence Interval Lower Bound | 95% Confidence Interval Upper Bound |
|---|---|---|---|---|---|
| e | 1.00 | 13.570[a] | 5.733 | 1.844 | 25.295 |
| | 2.00 | 9.192[a] | 5.271 | -1.588 | 19.972 |
| n | 1.00 | 36.543[a] | 5.733 | 24.817 | 48.269 |
| | 2.00 | 22.986[a] | 5.271 | 12.206 | 33.766 |

a. Covariates appearing in the model are evaluated at the following values: HAUL = 9.0000.

SPSS output for Whiting

```
* data list free / haul * vessel(a1) trawl(a1) l10 to l50 (f4.1).
* Copy data from spreadsheet.
get file  "c:\data files\sfia\nephrops\whiting1.sav".
freq var=l10 to l50  / format=notable / stats=min max.
```

# Frequencies

**Statistics**

| | | L10 | L11 | L12 | L13 | L14 | L15 | L16 | L17 | L18 | L19 | L20 | L21 | L22 | L23 | L24 | L25 | L26 | L27 | L28 | L29 | L30 | L31 | L32 | L33 | L34 | L35 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | Valid | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Miss | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Minimum | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 8.0 | 8.5 | 20.0 | 18.0 | 16.0 | 8.0 | 8.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| Maximum | | .0 | .0 | .0 | .0 | 6.0 | 6.0 | .0 | 13.0 | 8.0 | 20.0 | 40.0 | 12.0 | 85.0 | 28.0 | 04.0 | 80.0 | 40.0 | 26.0 | 14.0 | 26.0 | 00.0 | 60.0 | 40.0 | 33.0 | 16.0 | 13.0 |

```
GLM
  l12 to l39 BY vessel trawl
  /WSFACTOR = length 28 helmert
  /METHOD = SSTYPE(3)
  /CRITERIA = ALPHA(.05)
  /WSDESIGN = length
  /DESIGN = vessel trawl vessel*trawl .
```

# General Linear Model

**Within-Subjects Factors**

Measure: MEASURE_1

| LENGTH | Dependent Variable |
|---|---|
| 1 | L12 |
| 2 | L13 |
| 3 | L14 |
| 4 | L15 |
| 5 | L16 |
| 6 | L17 |
| 7 | L18 |
| 8 | L19 |
| 9 | L20 |
| 10 | L21 |
| 11 | L22 |
| 12 | L23 |
| 13 | L24 |
| 14 | L25 |
| 15 | L26 |
| 16 | L27 |
| 17 | L28 |
| 18 | L29 |
| 19 | L30 |
| 20 | L31 |
| 21 | L32 |
| 22 | L33 |
| 23 | L34 |
| 24 | L35 |
| 25 | L36 |
| 26 | L37 |
| 27 | L38 |
| 28 | L39 |

**Between-Subjects Factors**

| | | N |
|---|---|---|
| VESSEL | a | 17 |
| | b | 17 |
| TRAWL | e | 17 |
| | n | 17 |

**Multivariate Tests [b]**

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Pillai's Trace | .987 | 18.719[a] | 25.000 | 6.000 | .001 |
| | Wilks' Lambda | .013 | 18.719[a] | 25.000 | 6.000 | .001 |
| | Hotelling's Trace | 77.996 | 18.719[a] | 25.000 | 6.000 | .001 |
| | Roy's Largest Root | 77.996 | 18.719[a] | 25.000 | 6.000 | .001 |
| LENGTH * VESSEL | Pillai's Trace | .908 | 2.370[a] | 25.000 | 6.000 | .143 |
| | Wilks' Lambda | .092 | 2.370[a] | 25.000 | 6.000 | .143 |
| | Hotelling's Trace | 9.874 | 2.370[a] | 25.000 | 6.000 | .143 |
| | Roy's Largest Root | 9.874 | 2.370[a] | 25.000 | 6.000 | .143 |
| LENGTH * TRAWL | Pillai's Trace | .971 | 8.013[a] | 25.000 | 6.000 | .008 |
| | Wilks' Lambda | .029 | 8.013[a] | 25.000 | 6.000 | .008 |
| | Hotelling's Trace | 33.386 | 8.013[a] | 25.000 | 6.000 | .008 |
| | Roy's Largest Root | 33.386 | 8.013[a] | 25.000 | 6.000 | .008 |
| LENGTH * VESSEL * TRAWL | Pillai's Trace | .851 | 1.375[a] | 25.000 | 6.000 | .368 |
| | Wilks' Lambda | .149 | 1.375[a] | 25.000 | 6.000 | .368 |
| | Hotelling's Trace | 5.730 | 1.375[a] | 25.000 | 6.000 | .368 |
| | Roy's Largest Root | 5.730 | 1.375[a] | 25.000 | 6.000 | .368 |

a. Exact statistic

b. Design: Intercept+VESSEL+TRAWL+VESSEL * TRAWL
Within Subjects Design: LENGTH

**Mauchly's Test of Sphericity [b]**

Measure: MEASURE_1

| | | | | | Epsilon [a] | | |
|---|---|---|---|---|---|---|---|
| Within Subjects Effect | Mauchly's W | Approx. Chi-Square | df | Sig. | Greenhouse -Geisser | Huynh-Feldt | Lower-bound |
| LENGTH | .000 | . | 377 | . | .085 | .101 | .037 |

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b. Design: Intercept+VESSEL+TRAWL+VESSEL * TRAWL
Within Subjects Design: LENGTH

**Tests of Within-Subjects Effects**

Measure: MEASURE_1

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Sphericity Assumed | 6338681.921 | 27 | 234765.997 | 81.530 | .000 |
| | Greenhouse-Geisser | 6338681.921 | 2.288 | 2770059.738 | 81.530 | .000 |
| | Huynh-Feldt | 6338681.921 | 2.735 | 2317308.186 | 81.530 | .000 |
| | Lower-bound | 6338681.921 | 1.000 | 6338681.921 | 81.530 | .000 |
| LENGTH * VESSEL | Sphericity Assumed | 210316.262 | 27 | 7789.491 | 2.705 | .000 |
| | Greenhouse-Geisser | 210316.262 | 2.288 | 91910.056 | 2.705 | .067 |
| | Huynh-Feldt | 210316.262 | 2.735 | 76887.845 | 2.705 | .056 |
| | Lower-bound | 210316.262 | 1.000 | 210316.262 | 2.705 | .110 |
| LENGTH * TRAWL | Sphericity Assumed | 1516455.774 | 27 | 56165.029 | 19.505 | .000 |
| | Greenhouse-Geisser | 1516455.774 | 2.288 | 662704.508 | 19.505 | .000 |
| | Huynh-Feldt | 1516455.774 | 2.735 | 554388.976 | 19.505 | .000 |
| | Lower-bound | 1516455.774 | 1.000 | 1516455.774 | 19.505 | .000 |
| LENGTH * VESSEL * TRAWL | Sphericity Assumed | 18517.940 | 27 | 685.850 | .238 | 1.000 |
| | Greenhouse-Geisser | 18517.940 | 2.288 | 8092.503 | .238 | .817 |
| | Huynh-Feldt | 18517.940 | 2.735 | 6769.826 | .238 | .852 |
| | Lower-bound | 18517.940 | 1.000 | 18517.940 | .238 | .629 |
| Error(LENGTH) | Sphericity Assumed | 2332398.581 | 810 | 2879.504 | | |
| | Greenhouse-Geisser | 2332398.581 | 68.649 | 33975.956 | | |
| | Huynh-Feldt | 2332398.581 | 82.061 | 28422.767 | | |
| | Lower-bound | 2332398.581 | 30.000 | 77746.619 | | |

Tests of Within-Subjects Contrasts

**Tests of Between-Subjects Effects**

Measure: MEASURE_1

Transformed Variable: Average

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Intercept | 97336.834 | 1 | 97336.834 | 141.261 | .000 |
| VESSEL | 2097.630 | 1 | 2097.630 | 3.044 | .091 |
| TRAWL | 23253.953 | 1 | 23253.953 | 33.747 | .000 |
| VESSEL * TRAWL | 24.047 | 1 | 24.047 | .035 | .853 |
| Error | 20671.754 | 30 | 689.058 | | |

```
compute s10=sum(l10 to l14).
compute s15=sum(l15 to l19).
compute s20=sum(l20 to l24).
compute s25=sum(l25 to l29).
compute s30=sum(l30 to l34).
compute s35=sum(l35 to l39).
recode haul (1 thru 8=1) (9 thru highest=2) into period.
GLM
  s10 to s35 BY trawl period
  /WSFACTOR = length 6 helmert
  /METHOD = SSTYPE(3)
  /CRITERIA = ALPHA(.05)
  /WSDESIGN = length
  /EMMEANS=TABLES(trawl*period)
  /DESIGN = period trawl  period*trawl .
```

# General Linear Model

**Within-Subjects Factors**

Measure: MEASURE_1

| LENGTH | Dependent Variable |
|---|---|
| 1 | S10 |
| 2 | S15 |
| 3 | S20 |
| 4 | S25 |
| 5 | S30 |
| 6 | S35 |

**Between-Subjects Factors**

| | | N |
|---|---|---|
| TRAWL | e | 17 |
| | n | 17 |
| PERIOD | 1.00 | 16 |
| | 2.00 | 18 |

**Multivariate Tests [b]**

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Pillai's Trace | .853 | 30.250[a] | 5.000 | 26.000 | .000 |
| | Wilks' Lambda | .147 | 30.250[a] | 5.000 | 26.000 | .000 |
| | Hotelling's Trace | 5.817 | 30.250[a] | 5.000 | 26.000 | .000 |
| | Roy's Largest Root | 5.817 | 30.250[a] | 5.000 | 26.000 | .000 |
| LENGTH * PERIOD | Pillai's Trace | .250 | 1.736[a] | 5.000 | 26.000 | .162 |
| | Wilks' Lambda | .750 | 1.736[a] | 5.000 | 26.000 | .162 |
| | Hotelling's Trace | .334 | 1.736[a] | 5.000 | 26.000 | .162 |
| | Roy's Largest Root | .334 | 1.736[a] | 5.000 | 26.000 | .162 |
| LENGTH * TRAWL | Pillai's Trace | .598 | 7.740[a] | 5.000 | 26.000 | .000 |
| | Wilks' Lambda | .402 | 7.740[a] | 5.000 | 26.000 | .000 |
| | Hotelling's Trace | 1.489 | 7.740[a] | 5.000 | 26.000 | .000 |
| | Roy's Largest Root | 1.489 | 7.740[a] | 5.000 | 26.000 | .000 |
| LENGTH * TRAWL * PERIOD | Pillai's Trace | .278 | 1.999[a] | 5.000 | 26.000 | .112 |
| | Wilks' Lambda | .722 | 1.999[a] | 5.000 | 26.000 | .112 |
| | Hotelling's Trace | .384 | 1.999[a] | 5.000 | 26.000 | .112 |
| | Roy's Largest Root | .384 | 1.999[a] | 5.000 | 26.000 | .112 |

a. Exact statistic

b.
Design: Intercept+PERIOD+TRAWL+TRAWL * PERIOD
Within Subjects Design: LENGTH

**Mauchly's Test of Sphericity [b]**

Measure: MEASURE_1

| | | | | | Epsilon [a] | | |
|---|---|---|---|---|---|---|---|
| Within Subjects Effect | Mauchly's W | Approx. Chi-Square | df | Sig. | Greenhouse-Geisser | Huynh-Feldt | Lower-bound |
| LENGTH | .000 | 552.569 | 14 | .000 | .369 | .431 | .200 |

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b.
Design: Intercept+PERIOD+TRAWL+TRAWL * PERIOD
Within Subjects Design: LENGTH

**Tests of Within-Subjects Effects**

Measure: MEASURE_1

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Sphericity Assumed | 22214499.15 | 5 | 4442899.829 | 85.778 | .000 |
| | Greenhouse-Geisser | 22214499.15 | 1.844 | 12045114.53 | 85.778 | .000 |
| | Huynh-Feldt | 22214499.15 | 2.156 | 10303300.56 | 85.778 | .000 |
| | Lower-bound | 22214499.15 | 1.000 | 22214499.15 | 85.778 | .000 |
| LENGTH * PERIOD | Sphericity Assumed | 62198.617 | 5 | 12439.723 | .240 | .944 |
| | Greenhouse-Geisser | 62198.617 | 1.844 | 33725.247 | .240 | .770 |
| | Huynh-Feldt | 62198.617 | 2.156 | 28848.323 | .240 | .803 |
| | Lower-bound | 62198.617 | 1.000 | 62198.617 | .240 | .628 |
| LENGTH * TRAWL | Sphericity Assumed | 5550776.560 | 5 | 1110155.312 | 21.434 | .000 |
| | Greenhouse-Geisser | 5550776.560 | 1.844 | 3009734.270 | 21.434 | .000 |
| | Huynh-Feldt | 5550776.560 | 2.156 | 2574504.105 | 21.434 | .000 |
| | Lower-bound | 5550776.560 | 1.000 | 5550776.560 | 21.434 | .000 |
| LENGTH * TRAWL * PERIOD | Sphericity Assumed | 800899.688 | 5 | 160179.938 | 3.093 | .011 |
| | Greenhouse-Geisser | 800899.688 | 1.844 | 434262.704 | 3.093 | .057 |
| | Huynh-Feldt | 800899.688 | 2.156 | 371465.057 | 3.093 | .048 |
| | Lower-bound | 800899.688 | 1.000 | 800899.688 | 3.093 | .089 |
| Error(LENGTH) | Sphericity Assumed | 7769260.004 | 150 | 51795.067 | | |
| | Greenhouse-Geisser | 7769260.004 | 55.328 | 140421.242 | | |
| | Huynh-Feldt | 7769260.004 | 64.682 | 120115.276 | | |
| | Lower-bound | 7769260.004 | 30.000 | 258975.333 | | |

**Tests of Within-Subjects Contrasts**

Measure: MEASURE_1

| Source | LENGTH | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Level 1 vs. Later | 3044352.688 | 1 | 3044352.688 | 140.301 | .000 |
| | Level 2 vs. Later | 4663099.014 | 1 | 4663099.014 | 139.432 | .000 |
| | Level 3 vs. Later | 9021258.353 | 1 | 9021258.353 | 58.801 | .000 |
| | Level 4 vs. Later | 13676895.41 | 1 | 13676895.41 | 93.024 | .000 |
| | Level 5 vs. Level 6 | 126370.642 | 1 | 126370.642 | 59.864 | .000 |
| LENGTH * PERIOD | Level 1 vs. Later | 887.411 | 1 | 887.411 | .041 | .841 |
| | Level 2 vs. Later | 2020.951 | 1 | 2020.951 | .060 | .807 |
| | Level 3 vs. Later | 70219.902 | 1 | 70219.902 | .458 | .504 |
| | Level 4 vs. Later | 10766.090 | 1 | 10766.090 | .073 | .789 |
| | Level 5 vs. Level 6 | .054 | 1 | .054 | .000 | .996 |
| LENGTH * TRAWL | Level 1 vs. Later | 725272.785 | 1 | 725272.785 | 33.425 | .000 |
| | Level 2 vs. Later | 1106370.827 | 1 | 1106370.827 | 33.082 | .000 |
| | Level 3 vs. Later | 2980650.877 | 1 | 2980650.877 | 19.428 | .000 |
| | Level 4 vs. Later | 2722483.900 | 1 | 2722483.900 | 18.517 | .000 |
| | Level 5 vs. Level 6 | 21616.973 | 1 | 21616.973 | 10.240 | .003 |
| LENGTH * TRAWL * PERIOD | Level 1 vs. Later | 66981.449 | 1 | 66981.449 | 3.087 | .089 |
| | Level 2 vs. Later | 106258.353 | 1 | 106258.353 | 3.177 | .085 |
| | Level 3 vs. Later | 801007.354 | 1 | 801007.354 | 5.221 | .030 |
| | Level 4 vs. Later | 88960.959 | 1 | 88960.959 | .605 | .443 |
| | Level 5 vs. Level 6 | 24.620 | 1 | 24.620 | .012 | .915 |
| Error(LENGTH) | Level 1 vs. Later | 650961.243 | 30 | 21698.708 | | |
| | Level 2 vs. Later | 1003304.496 | 30 | 33443.483 | | |
| | Level 3 vs. Later | 4602622.610 | 30 | 153420.754 | | |
| | Level 4 vs. Later | 4410775.760 | 30 | 147025.859 | | |
| | Level 5 vs. Level 6 | 63329.149 | 30 | 2110.972 | | |

**Tests of Between-Subjects Effects**

Measure: MEASURE_1

Transformed Variable: Average

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Intercept | 2119779.949 | 1 | 2119779.949 | 141.261 | .000 |
| PERIOD | 523.689 | 1 | 523.689 | .035 | .853 |
| TRAWL | 506419.427 | 1 | 506419.427 | 33.747 | .000 |
| TRAWL * PERIOD | 45681.725 | 1 | 45681.725 | 3.044 | .091 |
| Error | 450184.863 | 30 | 15006.162 | | |

# Estimated Marginal Means

**TRAWL * PERIOD**

Measure: MEASURE_1

| TRAWL | PERIOD | Mean | Std. Error | 95% Confidence Interval Lower Bound | Upper Bound |
|---|---|---|---|---|---|
| e | 1.00 | 95.083 | 43.310 | 6.632 | 183.534 |
| | 2.00 | 160.657 | 40.833 | 77.265 | 244.050 |
| n | 1.00 | 413.031 | 43.310 | 324.580 | 501.482 |
| | 2.00 | 331.731 | 40.833 | 248.339 | 415.124 |

```
GLM
  s10 to s35 BY trawl period with haul
  /WSFACTOR = length 6 helmert
  /METHOD = SSTYPE(3)
  /CRITERIA = ALPHA(.05)
  /WSDESIGN = length
  /EMMEANS=TABLES(trawl*period)
  /DESIGN = period haul trawl  period*trawl .
```

# General Linear Model

**Within-Subjects Factors**

Measure: MEASURE_1

| LENGTH | Dependent Variable |
|---|---|
| 1 | S10 |
| 2 | S15 |
| 3 | S20 |
| 4 | S25 |
| 5 | S30 |
| 6 | S35 |

**Between-Subjects Factors**

| | | N |
|---|---|---|
| TRAWL | e | 17 |
| | n | 17 |
| PERIOD | 1.00 | 16 |
| | 2.00 | 18 |

**Multivariate Tests** [b]

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Pillai's Trace | .270 | 1.845[a] | 5.000 | 25.000 | .140 |
| | Wilks' Lambda | .730 | 1.845[a] | 5.000 | 25.000 | .140 |
| | Hotelling's Trace | .369 | 1.845[a] | 5.000 | 25.000 | .140 |
| | Roy's Largest Root | .369 | 1.845[a] | 5.000 | 25.000 | .140 |
| LENGTH * PERIOD | Pillai's Trace | .204 | 1.278[a] | 5.000 | 25.000 | .304 |
| | Wilks' Lambda | .796 | 1.278[a] | 5.000 | 25.000 | .304 |
| | Hotelling's Trace | .256 | 1.278[a] | 5.000 | 25.000 | .304 |
| | Roy's Largest Root | .256 | 1.278[a] | 5.000 | 25.000 | .304 |
| LENGTH * HAUL | Pillai's Trace | .221 | 1.420[a] | 5.000 | 25.000 | .251 |
| | Wilks' Lambda | .779 | 1.420[a] | 5.000 | 25.000 | .251 |
| | Hotelling's Trace | .284 | 1.420[a] | 5.000 | 25.000 | .251 |
| | Roy's Largest Root | .284 | 1.420[a] | 5.000 | 25.000 | .251 |
| LENGTH * TRAWL | Pillai's Trace | .613 | 7.904[a] | 5.000 | 25.000 | .000 |
| | Wilks' Lambda | .387 | 7.904[a] | 5.000 | 25.000 | .000 |
| | Hotelling's Trace | 1.581 | 7.904[a] | 5.000 | 25.000 | .000 |
| | Roy's Largest Root | 1.581 | 7.904[a] | 5.000 | 25.000 | .000 |
| LENGTH * TRAWL * PERIOD | Pillai's Trace | .287 | 2.009[a] | 5.000 | 25.000 | .112 |
| | Wilks' Lambda | .713 | 2.009[a] | 5.000 | 25.000 | .112 |
| | Hotelling's Trace | .402 | 2.009[a] | 5.000 | 25.000 | .112 |
| | Roy's Largest Root | .402 | 2.009[a] | 5.000 | 25.000 | .112 |

a. Exact statistic

b.
Design: Intercept+PERIOD+HAUL+TRAWL+TRAWL * PERIOD
Within Subjects Design: LENGTH

**Mauchly's Test of Sphericity** [b]

Measure: MEASURE_1

| | | | | | Epsilon [a] | | |
|---|---|---|---|---|---|---|---|
| Within Subjects Effect | Mauchly's W | Approx. Chi-Square | df | Sig. | Greenhouse -Geisser | Huynh-Feldt | Lower-bound |
| LENGTH | .000 | 525.842 | 14 | .000 | .382 | .465 | .200 |

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b.
Design: Intercept+PERIOD+HAUL+TRAWL+TRAWL * PERIOD
Within Subjects Design: LENGTH

**Tests of Within-Subjects Effects**

Measure: MEASURE_1

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Sphericity Assumed | 240320.155 | 5 | 48064.031 | .993 | .424 |
| | Greenhouse-Geisser | 240320.155 | 1.911 | 125737.773 | .993 | .374 |
| | Huynh-Feldt | 240320.155 | 2.325 | 103359.791 | .993 | .386 |
| | Lower-bound | 240320.155 | 1.000 | 240320.155 | .993 | .327 |
| LENGTH * PERIOD | Sphericity Assumed | 687131.819 | 5 | 137426.364 | 2.841 | .018 |
| | Greenhouse-Geisser | 687131.819 | 1.911 | 359513.851 | 2.841 | .069 |
| | Huynh-Feldt | 687131.819 | 2.325 | 295529.941 | 2.841 | .058 |
| | Lower-bound | 687131.819 | 1.000 | 687131.819 | 2.841 | .103 |
| LENGTH * HAUL | Sphericity Assumed | 754237.449 | 5 | 150847.490 | 3.118 | .011 |
| | Greenhouse-Geisser | 754237.449 | 1.911 | 394624.151 | 3.118 | .054 |
| | Huynh-Feldt | 754237.449 | 2.325 | 324391.540 | 3.118 | .043 |
| | Lower-bound | 754237.449 | 1.000 | 754237.449 | 3.118 | .088 |
| LENGTH * TRAWL | Sphericity Assumed | 5550776.560 | 5 | 1110155.312 | 22.947 | .000 |
| | Greenhouse-Geisser | 5550776.560 | 1.911 | 2904218.675 | 22.947 | .000 |
| | Huynh-Feldt | 5550776.560 | 2.325 | 2387344.936 | 22.947 | .000 |
| | Lower-bound | 5550776.560 | 1.000 | 5550776.560 | 22.947 | .000 |
| LENGTH * TRAWL * PERIOD | Sphericity Assumed | 800899.688 | 5 | 160179.938 | 3.311 | .007 |
| | Greenhouse-Geisser | 800899.688 | 1.911 | 419038.274 | 3.311 | .046 |
| | Huynh-Feldt | 800899.688 | 2.325 | 344460.598 | 3.311 | .036 |
| | Lower-bound | 800899.688 | 1.000 | 800899.688 | 3.311 | .079 |
| Error(LENGTH) | Sphericity Assumed | 7015022.555 | 145 | 48379.466 | | |
| | Greenhouse-Geisser | 7015022.555 | 55.427 | 126562.965 | | |
| | Huynh-Feldt | 7015022.555 | 67.427 | 104038.121 | | |
| | Lower-bound | 7015022.555 | 29.000 | 241897.329 | | |

**Tests of Within-Subjects Contrasts**

Measure: MEASURE_1

| Source | LENGTH | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| LENGTH | Level 1 vs. Later | 40749.499 | 1 | 40749.499 | 2.063 | .162 |
| | Level 2 vs. Later | 60028.194 | 1 | 60028.194 | 1.978 | .170 |
| | Level 3 vs. Later | 15701.416 | 1 | 15701.416 | .111 | .741 |
| | Level 4 vs. Later | 210011.498 | 1 | 210011.498 | 1.487 | .233 |
| | Level 5 vs. Level 6 | 13111.912 | 1 | 13111.912 | 6.040 | .020 |
| LENGTH * PERIOD | Level 1 vs. Later | 66084.765 | 1 | 66084.765 | 3.346 | .078 |
| | Level 2 vs. Later | 106629.270 | 1 | 106629.270 | 3.514 | .071 |
| | Level 3 vs. Later | 561334.898 | 1 | 561334.898 | 3.975 | .056 |
| | Level 4 vs. Later | 188423.827 | 1 | 188423.827 | 1.334 | .258 |
| | Level 5 vs. Level 6 | 281.413 | 1 | 281.413 | .130 | .721 |
| LENGTH * HAUL | Level 1 vs. Later | 78198.213 | 1 | 78198.213 | 3.959 | .056 |
| | Level 2 vs. Later | 123273.125 | 1 | 123273.125 | 4.062 | .053 |
| | Level 3 vs. Later | 507137.362 | 1 | 507137.362 | 3.591 | .068 |
| | Level 4 vs. Later | 314873.598 | 1 | 314873.598 | 2.229 | .146 |
| | Level 5 vs. Level 6 | 370.037 | 1 | 370.037 | .170 | .683 |
| LENGTH * TRAWL | Level 1 vs. Later | 725272.785 | 1 | 725272.785 | 36.722 | .000 |
| | Level 2 vs. Later | 1106370.827 | 1 | 1106370.827 | 36.459 | .000 |
| | Level 3 vs. Later | 2980650.877 | 1 | 2980650.877 | 21.106 | .000 |
| | Level 4 vs. Later | 2722483.900 | 1 | 2722483.900 | 19.276 | .000 |
| | Level 5 vs. Level 6 | 21616.973 | 1 | 21616.973 | 9.957 | .004 |
| LENGTH * TRAWL * PERIOD | Level 1 vs. Later | 66981.449 | 1 | 66981.449 | 3.391 | .076 |
| | Level 2 vs. Later | 106258.353 | 1 | 106258.353 | 3.502 | .071 |
| | Level 3 vs. Later | 801007.354 | 1 | 801007.354 | 5.672 | .024 |
| | Level 4 vs. Later | 88960.959 | 1 | 88960.959 | .630 | .434 |
| | Level 5 vs. Level 6 | 24.620 | 1 | 24.620 | .011 | .916 |
| Error(LENGTH) | Level 1 vs. Later | 572763.030 | 29 | 19750.449 | | |
| | Level 2 vs. Later | 880031.370 | 29 | 30345.909 | | |
| | Level 3 vs. Later | 4095485.248 | 29 | 141223.629 | | |
| | Level 4 vs. Later | 4095902.162 | 29 | 141238.006 | | |
| | Level 5 vs. Level 6 | 62959.112 | 29 | 2171.004 | | |

**Tests of Between-Subjects Effects**

Measure: MEASURE_1

Transformed Variable: Average

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Intercept | 28338.455 | 1 | 28338.455 | 2.077 | .160 |
| PERIOD | 45632.780 | 1 | 45632.780 | 3.344 | .078 |
| HAUL | 54500.278 | 1 | 54500.278 | 3.994 | .055 |
| TRAWL | 506419.427 | 1 | 506419.427 | 37.116 | .000 |
| TRAWL * PERIOD | 45681.725 | 1 | 45681.725 | 3.348 | .078 |
| Error | 395684.586 | 29 | 13644.296 | | |

# Estimated Marginal Means

**TRAWL * PERIOD**

Measure: MEASURE_1

| | | | | 95% Confidence Interval | |
|---|---|---|---|---|---|
| TRAWL | PERIOD | Mean | Std. Error | Lower Bound | Upper Bound |
| e | 1.00 | 168.636[a] | 55.317 | 55.500 | 281.771 |
| | 2.00 | 95.278[a] | 50.854 | -8.731 | 199.287 |
| n | 1.00 | 486.584[a] | 55.317 | 373.448 | 599.719 |
| | 2.00 | 266.352[a] | 50.854 | 162.343 | 370.361 |

a. Covariates appearing in the model are evaluated at the following values: HAUL = 9.0000.