

Irish Fisheries Bulletin No. 30 / 2007

VALIDATION OF STANDARD WEIGHTS AND RAISING
COEFFICIENTS FOR DISCARD ESTIMATION:
REPORT OF A SURVEY ABOARD
MFV ROISIN BAIRBRE

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ISSN: 16495055

ABSTRACT

This survey was carried out to verify the Marine Institute's discard sampling protocol and the standard weights and conversion factors used when calculating discard rates. The MFV *Roisin Bairbre* was chartered to fish as normal on the Aran Prawn Grounds using twin rig prawn gear. The entire bulk catch was weighed, as well as the entire retained catch, thereby getting an accurate rate of discarding for this trip, as well as accurate individual basket weights. Retained catch was also weighed by species prior to and after gutting, to check the raising factors used when changing gutted landings back to round.

This survey showed that the rate of discarding for this trip was 62% of the total bulk catch. There was no significant difference between the measured bulk catch weighed and the estimated bulk catch derived from using the standard weights. This validates the standard weights used. There was no significant differences between the observed conversion factors (from gutted to whole weight) and those currently used routinely in weight conversions. A standard weight for big baskets of bulk catch on a fish directed trip of 34.5 kg, and 28kg for a *Nephrops* directed trip were achieved.

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INTRODUCTION

Background

Accurate estimates of removals by fishing are an essential element in management of living marine resources (Dorn *et al.*, 1999). While landings can be calculated at point of sale, discards cannot be quantified unless total catches and discard rates are independently observed. In some fisheries, where significant discarding has been identified, it is mandatory to have independent observers on 100% of certain vessel size classes within the fleet. This is to assess total catch measurement, in season quota management, bycatch measurement and for the collection of biological data (e.g. U.S. North Pacific Program).

Where the presence of observers is mandatory on certain vessels, a detailed and accurate estimate of total catch, landings and discards can be made. Dorn *et al.* (1999) for example investigated the accuracy of a density factor used to convert volume of total catch to weight. Howell and Langan (1992) looked at discarding of commercial groundfish in the Gulf of Maine shrimp fishery, where as with most fisheries, accurate estimates of discard rates and mortality are vital for stock assessment analysis and management.

Where presence of an observer is mandatory for a vessel to participate in a particular fishery, it is easier to make modifications to the fishing practice to enable accurate sampling. The same is true when a vessel is chartered; a condition of the chartering process being that fishing practice is modified to facilitate accurate and exact sampling. However, discard sampling as conducted in Ireland by the Marine Institute's (MI) Fisheries Assessment Technicians (FATs) relies purely on the good will of fishing skippers. As such, fishing practice cannot be altered or held up significantly to facilitate sampling. Therefore, a simple unobtrusive protocol to obtain accurate discard estimates on board trawlers fishing commercially was devised. By its nature, this protocol (which allows the boat to fish as normal) has some assumptions inherent in it (e.g. standard weights of baskets of bulk catch, raising factors used etc.) Rochet and Trenkel (2005) investigated some of the assumptions implicit in discard estimations (e.g. proportionality of discards to catch or fishing time) and conclude that more studies are required to improve the understanding of discarding processes. This author's practical observations onboard various trawlers and also in auction halls, led to this review of the accuracy of standard basket weights and raising factors used in discard estimations, none of which had been verified prior to this survey

The Fisheries Assessment Technician's (FATs) discard programme was initiated in 1992 to collect information from commercial fisheries around the Irish coast. Fisheries Assessment Analysts were based in the main ports around the country to keep the MI's Fisheries Science Service informed of the activities of the fishing fleet and also to enable them to go on commercial vessels readily to gather information on discards. On most trawlers, bulk catch is either put in baskets, emptied onto a table and sorted, or else bulk catch goes directly from a hopper onto an attached table for sorting. FATs therefore estimate bulk catch by either one of two ways. The number of baskets/boxes of bulk catch is counted and multiplied by a standard weight for each box or basket, (22 kg / basket on a *Nephrops* trip, or 25 kg / basket on a fish directed trip). Alternatively the bulk catch per haul is estimated visually from the appearance of the codend or hopper (i.e. roughly how many baskets full in the codend/hopper) and multiplying by a standard weight. The FATs estimate the weight of catch retained (landings) in both cases from the number of whole or partially filled boxes/baskets sent down to the hold after each haul. Conversion factors are then used to convert gutted/tailed landings back to the landings whole weight equivalent. Bulk catch is calculated as the sum of the discarded and landed components of the catch.

In the case of boats using hoppers, catch can be incorrectly estimated by assessing the appearance of the codend/hopper incorrectly. On boats where the crew shovel bulk catch directly into baskets, incorrect estimation of catch can occur if the standard basket weights used are incorrect. Landings can be incorrectly estimated if the conversion factors used to convert gutted weights to round weights are incorrect. Incorrect estimates for either catch or landings result in incorrect estimates for discards.

Project Description

The aim of this survey was to validate the standard weights and conversion factors used by FATs when coming up with discard estimates for the different fisheries that they monitor. Rather than using values as per the FATs manual, or the FAT/skipper estimating the bulk catch visually, the entire bulk catch was weighed. The entire retained catch was also weighed with the difference being the exact figure for discards for each tow. Retained fish were weighed by species prior to and after gutting to check conversion factors. Big baskets were also used in two hauls to establish their standard weight for bulk catch.

Need

The Aran Prawn Grounds (see Figure 2.1) is a heavily fished area with prawn stocks appearing to hold up well under current fishing pressure. However, as with most prawn fisheries, discarding of juvenile fish can be an issue especially at certain times of the year. Also the relative abundance of prawns in the bulk catch varies greatly throughout the year, with prawns being all but absent at certain times, and then very large bulk of prawns being caught at other times. It was hoped to carry out this survey at a time when bulk catches of prawns (and consequently fishing effort) are traditionally at their peak (April/May or else at the end Sept/Oct), in order to come up with definitive weights and conversion factors. However, this was not possible for operational reasons.

Because the bulk catch is an estimate and raising factors or unit weights might not always be accurate, surveys such as this are important to minimise uncertainty, and will result in more exact estimates of discarding rates in the different fisheries. As species composition in the bulk catch varies greatly from fishery to fishery, and also within fisheries at certain times of year, input from FATs and fishermen is important to try and pinpoint the most relevant times when future surveys could be carried out for the other fisheries around the coast.

Objectives

1. To generate an exact weight of total bulk catch and total landings, thereby getting an exact weight of discards, thus testing the accuracy of bulk catch and discard estimates as per FATs manual.
2. To produce standard weights for big baskets of bulk catch, and also to validate the standard weights used for normal baskets.
3. To compare actual conversion factors obtained for each species with the figures in the FATs manual.

MATERIALS AND METHODS

Survey description

The Marine Institute chartered the MFV *Roisin Bairbre* for this discard validation survey. The survey took place on a standard *Nephrops* fishing trip out of Ros a Mhil to the Back of the Aran Islands (Aran Prawn Grounds). The vessel sailed on the 7th of July and returned to Ros a Mhil on the morning of the 11th of July. A total of sixteen hauls were carried out using 27 fathom twin rig prawn gear with 6 inch discs on the footrope, graduating either side. The gear characteristics were as follows;

Mesh Size

- 100 mm top sheet.
- 90 mm bottom sheet.
- 80mm codend. *

*For haul 1, at the skipper's request, an 80mm codend was used in the port side net to compare it with a 90mm codend in the starboard side.

Twine thickness

- 6mm codend.
- 3mm extension.
- 2mm top sheet.
- 2.5mm bottom sheet

With the exception of the activities described below, the boat fished normally as it would have had Marine Institute staff not been aboard.

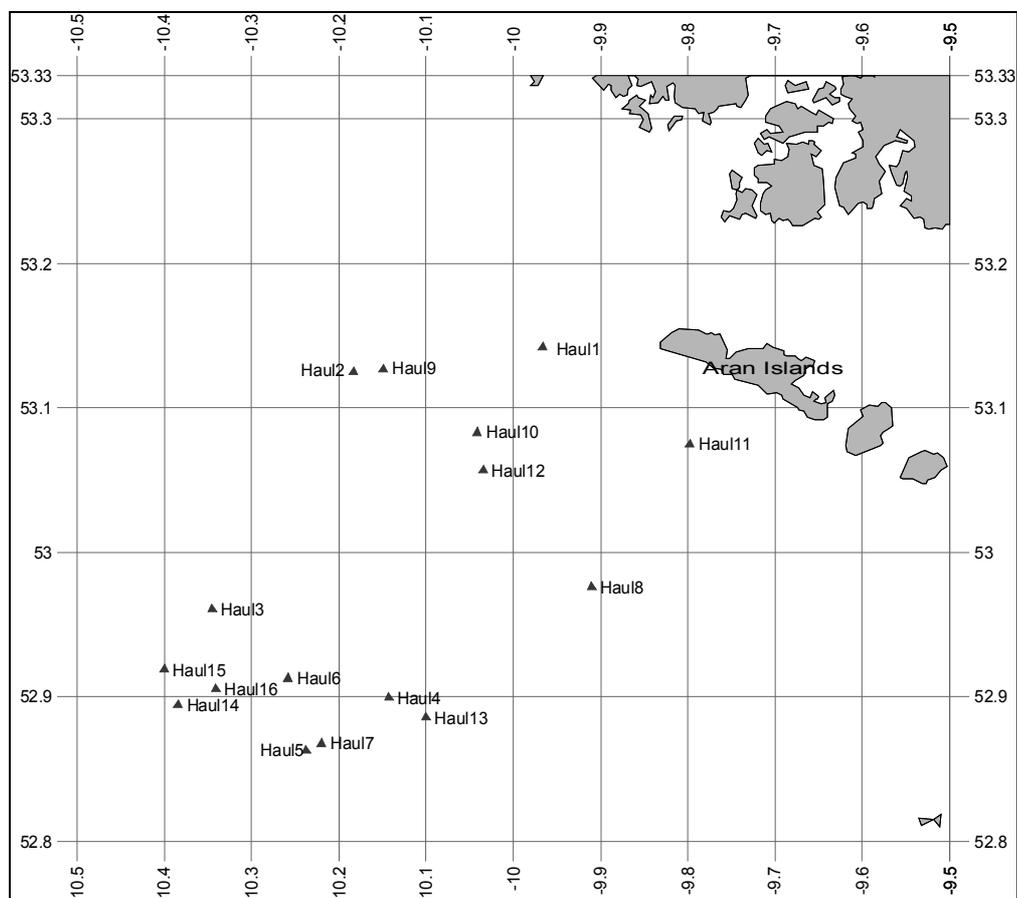


Figure 2.1 Area of survey showing shot positions for hauls (Latitude and Longitude in decimal degrees).

Sampling protocol

As the vessel was fishing with twin-rig gear, both cod-ends were emptied separately for each haul. The bulk catch data from each cod-end was recorded separately according to whether it came from port or starboard nets. This followed standard practice on this boat as the skipper continuously checked the port net against the starboard to see how they were fishing.

The crew shovelled the bulk catch from each cod-end into baskets. Each individual basket weight was noted before passing it along to the sorting table. A Pols marine scales (accurate to 20 gram) was used aboard the vessel, and tared appropriately for the different baskets. The crew separated bulk catch on the sorting table. Great efforts were required to ensure that discards, particularly dogfish, were not thrown overboard either before weighing the baskets or before collecting a box of discards from the sorting table. Normally crew would throw larger discard fish directly overboard, rather than basket them and then discard them. It was particularly here that the difficulty in changing crew methods (which are set in stone) became apparent. Un-eviscerated commercial fish were sorted by species, put into baskets and weighed, gutted and then re-weighed.

The bulk catch and round landings data were used to calculate a true discard rate for the trip and to compare this to discard rates calculated according to the FAT manual. The round landings and gutted landings data were used to calculate true conversion factors for the survey and to compare these to the conversion factors in the FAT manual. In Hauls 9 and 10 larger baskets supplied by the Marine Institute were used for bulk catch. These larger baskets are occasionally seen on commercial fishing trips and therefore a standard weight was required. All other methods used were according to the Marine Institute's FAT manual. Latitude and Longitude at the start and finish of hauls, times, depths, weather and sea state were recorded for each haul as per FATs manual.

RESULTS

Overall results

$$\text{Bulk Catch (C)} = \text{Landings (L)} + \text{Discards (D)}$$

$$14,286.28\text{kg} = 5471.92\text{kg} + 8814.36\text{kg}$$

The total bulk catch for this trip was 14,286.28 kg. This bulk catch was the sum of the basket weights for each haul for both landed and discarded components of the catch. The round landings were weighed as each haul was sorted and totalled 5,471.92 kg for the trip. Discards were calculated by subtracting the round landings from the bulk catch for each haul. The total weight of discards was 8,814.36 kg, representing a discard rate of 62% of the bulk catch.

Table 3.1. Total round commercial landings of species caught on this trip.

Species	Scientific name	Landings (kg)	% of Landings
Prawns	<i>Nephrops norvegicus</i>	2,986.66	54.58
Megrim	<i>Lepidorhombus whiffiagonis</i>	1,136.07	20.76
Angler	<i>Lophius spp</i>	524.27	9.58
Whiting	<i>Merlangius merlangus</i>	273.00	4.99
Skate/Ray	<i>Raja spp</i>	158.72	2.90
Turbot	<i>Psetta maxima</i>	58.73	1.07
Lemon sole	<i>Microstomus kitt</i>	48.20	0.88
Spurdog	<i>Squalus acanthias</i>	42.80	0.78
Black sole	<i>Solea solea</i>	40.85	0.75
Angler tails	<i>Lophius sps</i>	36.74	0.67
Plaice	<i>Pleuronectes platessa</i>	35.96	0.66
Haddock	<i>Melanogrammus aeglefinus</i>	33.12	0.61
Hake	<i>Merluccius merluccius</i>	21.68	0.40
John dory	<i>Zeus faber</i>	21.22	0.39
Brill	<i>Scophthalmus rhombus</i>	18.30	0.33
Witch	<i>Glyptocephalus cynoglossus</i>	10.14	0.19
Cod	<i>Gadus morhua</i>	8.10	0.15
Pollack	<i>Pollachius pollachius</i>	6.06	0.11
Saithe	<i>Pollachius virens</i>	4.06	0.07
Ling	<i>Molva molva</i>	2.98	0.05
Red gurnard	<i>Aspitrigla cuculus</i>	2.46	0.04
Squid	<i>Loligo spp</i>	1.78	0.03
Total		5471.90	100

Discard rates derived from 22 kg / basket and 25 kg / basket standard weights were calculated by multiplying up the total number of baskets of bulk catch for the trip by either 22 kg (for *Nephrops*) or 25 kg (for fish) to determine bulk catch. Landings were already known and discards and discard rates were calculated (see above). Discard rates calculated by the corrected method used the relationship between basket weight and catch composition to calculate bulk catch as described below.

Table 3.2. Comparison of discard rates calculated by the survey; 22 kg per basket; 25 kg per basket and corrected method.

Accurately measured	22 kg per basket	25 kg per basket	Corrected method
62	56	62	60

Standard basket weights

Discard sampling protocol dictates that bulk catch is calculated as follows; where prawns are present in the catch, a standard basket weight of 22kg is applied, otherwise (where the bulk catch is fish only) a standard basket weight of 25kg is applied. On this trip, *Nephrops* were present in all hauls with the exception of Haul 14. The ratio of *Nephrops* to fish in the hauls varied a great deal as is the case for most prawn surveys.

Table 3.3. Actual bulk catch by haul with associated estimations of bulk catch. Hauls 9 and 10 are omitted as big baskets were used.

Haul no.	Actual bulk catch (kg)	Bulk catch estimated using 22 kg standard weight	Bulk catch estimated using 25 kg standard weight
1	480.42	396	450
2	487.60	374	425
3	1,248.06	1,254	1,425
4	859.80	863	981
5	869.57	748	850
6	793.12	660	750
7	1,357.28	1,188	1,350
8	944.68	990	1,125
11	627.42	506	575
12	594.30	594	675
13	1,074.28	1,100	1,250
14	2,123.72	1,518	1,725
15	976.88	748	850
16	917.65	858	975

In total, 534 small fishing baskets of bulk catch were weighed on this survey, the details of which are summarised in Table 3.4.

Table 3.4. Descriptive statistics of all the small baskets of bulk catch weighed for this survey.

Number of Baskets weighed	Mean Basket weight	Standard Deviation	Range
534	24.91	4.509	7.84 – 39.26

Mann-Whitney Tests indicated that there were no significant differences between the actual bulk catch weighed on board and the estimations of bulk catch derived from counting baskets at either 22 kg / basket or 25 kg / basket ($P = 0.4397$ and 0.9549 , respectively) (see Table 3.2). It was found that basket weight of bulk catch varied with species composition. A Pearson correlation test was carried out, and indicated a strong negative relationship between the mean weight of baskets per haul, and the ratio of *Nephrops* to fish by weight in the hauls ($r = -0.918$, $P < 0.01$). The linear regression of this relationship was given by the equation:

$$\text{Mean basket weight} = 28.3 - 1.83 \text{ Nephrops / fish ratio, } R^2 \text{ value of } 84.2\%.$$

Equation 1

This relationship indicates that bulk catches with a *Nephrops* / fish ratio ranging from 2 to 4.5 had a mean basket weight of about 22 kg (Figure 3.1.). Where the *Nephrops* / fish ratio in the bulk catch was less than 2 the mean basket weights exceeded 25 kg.

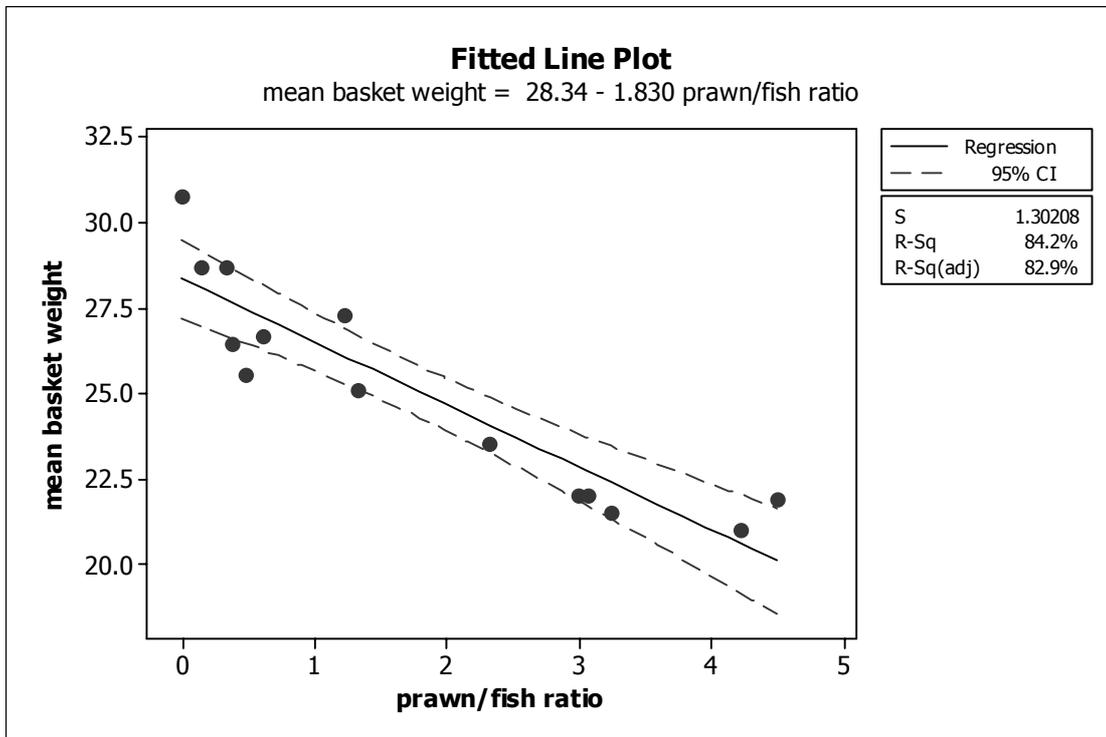


Figure 3.1. Fitted line plot of mean basket weights per haul (kg) against *Nephrops*/fish ratio.

The larger baskets used for Hauls 9 and 10 were supplied by MI and are occasionally seen on some commercial fishing boats. As no standard weights are published for them in the FAT manual, weights were calculated using the data from the discard validation survey. The standard big basket weight for fish was taken as being the mean bulk catch big basket weight (34.5 kg) from this survey, as hauls 9 and 10 were predominantly fish. The descriptive statistics of the 27 big baskets sampled aboard this trip are summarised in Table 3.5. below:

Table 3.5. Descriptive statistics of all the larger baskets of bulk catch weighed for this trip.

Number of Baskets weighed	Mean Basket weight	Standard Deviation	Range
27	34.5	4.087	28.66 – 43.16

The new standard basket weight for larger baskets of bulk catch for hauls predominated by fish is therefore **34.5 kg**. To calculate the mean big basket weight for a *Nephrops* haul, the ratio between mean small basket weight for *Nephrops* and the mean small basket weight for fish for the survey was multiplied by the standard big basket weight:

$$\frac{\text{Mean basket weight Nephrops } 22.00}{\text{Mean basket weight fish } 27.41} \times \text{Standard big basket weight } 34.50 = 27.69 \approx 28$$

Equation 2

The new standard basket weight for big baskets of bulk catch is therefore 28 kg for hauls predominated by *Nephrops*.

Partial Weight Conversion Factors

Table 3.6. presents the condition factors for species encountered on this trip and those found in the FATs manual. A Chi-square test did not indicate any significant differences between the partial weight conversion factors listed in the FAT manual and those observed on the survey:

$$\chi^2_{\text{calculated}} 0.34 < \chi^2_{\text{critical}} 37.65 \quad (P=0.05, \text{d.f.}= 24).$$

However, whilst not statistically significant, notable differences were found between the observed and listed conversion factors for some species (identified in bold type in Table 3.6.).

Table 3.6. Observed & listed conversion factors for species caught on this survey.

Species	Conversion Factor from Manual	Observed Conversion Factor from Survey
<i>Nephrops</i>	3.00	3.00
Megrim	1.05	1.08
<i>L. piscatorius</i>	1.28	1.37
<i>L. budegassa.</i>	1.28	1.26
Anglerfish	1.28	1.36
Anglerfish tails	3.00	3.87
Pollack	1.18	1.13
Whiting	1.12	1.12
Black Sole	1.05	1.06
Lemon Sole	1.04	1.18
Brill	1.05	1.06
Witch	1.05	1.07
Plaice	1.05	1.06
Ray	1.15	1.13
Common Skate	1.15	1.14
Cuckoo ray	1.15	1.11
John Dory	1.13	1.25
Thornback Ray	1.15	1.17
Skate/Ray	1.15	1.27
Cod	1.18	1.13
Saithe	1.18	1.15
Ling	1.12	1.27
Turbot	1.05	1.10
Haddock	1.18	1.19
Hake	1.12	1.13

DISCUSSION

Exact weights of bulk catch, commercial landings and discards

This objective, which was to come up with an accurate weight for total bulk catch and total commercial landings, thereby getting an accurate weight of discards and discard rate for this trip, was achieved. A complete breakdown by species of commercial landings is also included (Table 3.1.). Bulk catch is shovelled directly into baskets from the pound on the *Roisin Bairbre* and it is a simple matter to tally the baskets of bulk catch and multiply by the basket weight. It was therefore not necessary for either the FAT or the skipper to estimate the bulk catch in the net or in the pound as would be required on a boat where the fish were emptied into a hopper and not basketted prior to sorting.

Standard weights for baskets

The second objective was to get definitive weights of different size baskets of bulk catch and landings, thereby verifying the standard weights as per FAT's manual. This was achieved for both big and small baskets. This survey verified the standard basket weights used for small baskets and also generated standard weights for big baskets (to be included in the updated FAT manual). Due to time constraints on board the vessel during the survey no data were collected to verify box weights for bulk catch.

Boats such as the MFV *Roisin Bairbre*, where the crew shovel bulk catch directly into baskets from the pound make it easier for the FAT to estimate bulk catch (simply multiply up the number of baskets by the standard weight). This is however only viable if the standard weights for the baskets are sufficiently accurate. The structure of the validation survey allowed the comparison of actual bulk weights with those that would have been estimated by applying either the 22 kg / basket for prawns or 25 kg / basket for fish. Mann-Whitney Tests carried out indicated that there is no significant difference between the bulk catch as measured on the survey, the bulk catch multiplied up at 22 kg / basket, and the bulk catch multiplied up at 25 kg / basket.

Because this was a *Nephrops* survey a basket weight of 22 kg / basket was applied to bulk catch according to the protocol in the FAT manual. This contrasts with the observed mean basket weight of 24.92 kg for the trip. Due to logistical constraints this trip was carried out at a time when *Nephrops* landings were very low, so bulk catch weights were closer to those for a non-*Nephrops* trip.

This however raises another question; given that *Nephrops* were caught in large numbers for several hauls, and were present in all hauls except haul 14, it would be expected that a mean basket weight of considerably less than 25 kg would be recorded. The fact that a mean weight for small baskets of 24.92 kg was recorded may imply that the standard weight of 25 kg for small baskets of bulk on a fish discard trip actually underestimates the true weight. This is further illustrated in Table 3.2, which shows a discard rate of 62% for the survey. Using 25 kg / basket also estimated discarding correctly while both 22 kg / basket and the corrected bulk weight method both underestimated discarding. Examination of the relationship between mean basket weight per haul for small baskets and the ratio between *Nephrops* and fish landings (Table 3.1.) opens up the possibility of using the observed ratio of *Nephrops* to fish in each haul to determine which standard basket weight, 22 kg or 25 kg should be applied to that haul. This may increase the accuracy of bulk catch estimates for future discard surveys, and thus increase the accuracy of discard rate estimation. The results of this survey indicate that bulk catch tended to be underestimated; therefore discarding would also tend to be underestimated.

Conversion factors

The third objective, to verify conversion factors used to convert gutted fish weights back to round fish weights, was also achieved. Statistical tests validated the existing conversion factors. An exception to this was small anglerfish from which only the tails are kept. The conversion factor given in the manual for anglerfish tails is 3.00 whereas the observed conversion factor was 3.87 (to be amended in the updated FATs manual)

Large anglerfish were identified by species (*Lophius budegassa* and *L. piscatorius*) in the first three hauls but were both combined as anglerfish thereafter. This was due to the fact that it proved very difficult onboard to keep them both separated before and after the gutting process, as both species were combined in the commercial landings. Therefore both species were combined to reduce the risk of weighing a basket twice, or omitting a basket.

While not significant, the raising factors observed for some species differed from those in the FATs manual, most notably for anglerfish, ling, skate/ray and lemon sole. These differences between the observed conversion factors and those from the FATs manual may be attributable to seasonal factors such as maturity stage or available food/gut content. More likely however, is the fact that whole anglerfish for example, were weighed prior to any washing, while gutted fish were weighed after washing and just prior to putting down into the hold. The bottom substrate on the Aran Prawn Grounds is by nature a fine muddy sand. This mud becomes clogged in the fish's gills, often totally filling the gill cavity. This therefore leads to a higher round weight being recorded than is actually the case. The conversion factor for anglerfish has been examined subsequently (Gerritsen and Lordan, 2006), and was found to be 1.23, lower than the figure used in the FATs manual, and much lower than the observed figure for this trip.

The discrepancies in lemon sole conversion factors (1.18 observed as compared to 1.05 in FATs manual) are possibly caused by a sampling error, as in lemon sole the gill cavity is much smaller and unlikely to clog with silt. In haul 14 (see Appendix I, Table 14,); a basket of gutted fish appears not to have been re-weighed, leading to a lower than expected gutted weight for that haul. Omitting haul 14 from calculations results in a revised conversion factor of 1.10 for lemon sole.

As the results of the discard validation survey are not significantly different from normal discard trips, it will not be necessary to apply corrections to historical figures. The protocol for this survey worked well at sea. However considerable efforts were required to explain to the crew the different routine of this survey compared to a normal fishing trip. Survey staff had to be extremely watchful and vigilant to ensure that all data was collected in a methodical way, and that nothing escaped weighing/re-weighing. Two survey staff were required on deck at all times during work periods.

RECOMMENDATIONS

It is recommended that similar discard validation surveys be carried out in the future for different areas and different times of year. This would verify or otherwise the findings of this survey and would also address issues not covered by this survey. It would be useful to carry out a survey both at a time when *Nephrops* catches are much higher, to validate the protocols for *Nephrops* trips, and to carry out a survey on a fish only trip to investigate the bulk catch basket weights for fish.

More data are required to validate the suggested higher conversion factor for anglerfish tails as this may vary according to area and time of year. In future surveys the gill cavity of whole fish needs to be checked prior to weighing (especially when fishing on silty/muddy substrate) to ensure it is not clogged and therefore biasing the whole (ungutted) weight.

The conversion factor for *Nephrops* tails was not investigated during the validation survey due to time constraints. This work should be done, but could as easily be done ashore with samples from commercial trips. It would be valuable to verify the standard weights for big baskets defined by this survey.

Another survey of this kind on a vessel that employs a hopper or similar arrangement for bulk catch is necessary. It would enable comparison between actual bulk catch as weighed by survey staff and visually estimated bulk catch as estimated by skipper, crew or FAT. This information would help quantify sampling error for past and future discards trips, though it may only reflect under- or over-estimation by individuals. Further work is required to verify the standard box weights of bulk catch, which was not attempted on this survey.

It would be useful to sample basket weights and *Nephrops* to fish ratios on other surveys to see if the relationship is consistent. If it proves to be consistent, then the application of corrected basket weights as described above may be a useful method for use on future discard trips. Correcting basket weights may reduce the under-estimation of bulk catch and therefore discarding and, if valid, could be applied to historical data.

ACKNOWLEDGEMENTS

We wish to thank the skipper and crew of the MFV *Roisin Bairbre*. Their interest in this survey proved invaluable, and helped us maximise the quantity and quality of data collected. We wish to thank also the Galway and Aran Fisherman's Co-Operative for their assistance and their proactive approach towards the work of the Marine Institute. We would also like to thank the other skippers who have taken Marine Institute personnel to sea. This project was funded as a core project of the Marine Institute's Fisheries Science Service.

REFERENCES

- Borges, L., Zuur, A.F., Rogan, E. and Officer, R. (2004). Optimum sampling levels in discard sampling programmes. *Can. J. Fish. Aquat. Sci.* **61**: 1918-1928 (2004).
- Dorn, M.W., Gaichas, S.K and Fitzgerald, S.M. (1999). Measuring total catch at sea: Use of a Motion-Compensated flow Scale to Evaluate Observer volumetric Methods. *North American Journal of Fisheries Management* **19**: 999-1016 (1999)
- Howell, W.H. and Langan, R. (1992). Discarding of commercial groundfish species in the Gulf of Maine shrimp fishery. *North American Journal of Fisheries Management* **12**: 568-580, 1992.
- ICES. (2003). Report of the Working Group on the Assessment of Northern Shelf Demersal Stocks, (ICES CM 2003/ACFM:04)
- Rochet, M. J. and Trenkel, V.M. (2005). Factors for the variability of discards: assumptions and field evidence. *Can. J. Fish. Aquat. Sci.* **62**: 224-235 (2005).
- Marine Institute. (2005). Fisheries Assessment Technicians Manual.
- Gerritsen, H. and Lordan, C. (2006). Guttred to round-weight conversion factors for anglerfish (*Lophius piscatorius* and *Lophius budegassa*). Irish Fisheries Bulletin No.26, 2006. 8 pp.

APPENDIX I

The following tables give details of the bulk catch and commercial landings for each haul of the validation survey.

Table1: Bulk catch and commercial landings FAT/ROS/05/03 Haul 1

Haul 1	Bulk Catch (kg) small baskets		Commercial Landings (kg)		
	Starboard net	Port net	Species	Round	Gutted
	25.78	26.18	prawns jumbo	3.94	
	28.28	22.26	prawns medium	40.80	
	30.12	27.20	prawns tailed	33.30	11.10
	26.26	22.44	megrim	71.10	65.44
	26.32	26.74	<i>L.pisc</i>	20.68	15.20
	26.92	27.20	<i>L.bud</i>	1.46	1.18
	27.48	29.60	monkfish		
	26.40	28.24	monkfish tails		
		27.40	squid	1.78	
		25.60	pollack	5.00	4.44
			whiting	1.78	1.68
subtotals	217.56	262.86	whiting (round)	1.92	
total bulk catch		480.42	spurdog	8.80	
			black sole	2.90	2.70
mean basket weight	27.20	26.29	lemon sole	0.64	0.50
			brill	3.20	2.94
mean basket weight for haul		26.69	witch	0.98	0.86
			plaice	0.88	0.76
nephrops/fish ratio		0.61	ray	2.20	1.86
			common skate		
			cuckoo ray		
			john dory	2.28	1.86
			thornback ray		
			skate/ray		
			skate(wings)		
			cod		
			saithe		
			red gurnard		
			ling	2.02	1.42
			turbot	0.53	0.50
			haddock		
			haddock (round)		
			hake		
			totals	206.19	112.44

Validation of Standard Weights and Raising Coefficients for Discard Estimation

Table2: Bulk catch and commercial landings FAT/ROS/05/03 Haul 2

Haul 2	Bulk Catch (kg) small baskets		Commercial Landings (kg)		
	Starboard net	Port net	Species	Round	Gutted
	28.34	28.38	prawns jumbo	0.92	
	27.72	30.72	prawns medium	7.62	
	29.76	28.74	prawns tailed	7.80	2.60
	28.96	28.74	megrin	68.48	65.22
	28.58	29.96	<i>L.pisc</i>	13.86	10.38
	28.74	29.42	<i>L.bud</i>	6.94	5.40
	27.22	32.28	monkfish		
	27.40	30.16	monkfish tails	1.90	0.44
		22.48	squid		
			pollack	1.06	0.92
subtotals	226.72	260.88	whiting	0.94	0.86
Total		487.60	whiting (round)	2.36	
			spurdog	1.26	
mean basket weight	28.34	28.99	black sole	1.84	1.76
			lemon sole	3.76	2.90
mean basket weight for haul		28.68	brill	0.82	0.78
			witch	0.32	0.22
nephrops/fish ratio		0.14	plaice	4.72	4.46
			ray		
			common skate	2.80	2.46
			cuckoo ray	1.44	1.26
			john dory	1.66	1.28
			thornback ray		
			skate/ray		
			skate(wings)		
			cod		
			saithe		
			red gurnard		
			ling		
			turbot		
			haddock		
			haddock (round)		
			hake		
			totals	130.50	100.94

Table3: Bulk catch and commercial landings FAT/ROS/05/03 Haul 3

Haul 3	Bulk Catch (kg) small baskets		Commercial Landings (kg)		
	Starboard net	Port net	Species	Round	Gutted
	22.90	21.76	prawns jumbo	9.74	
	20.82	23.08	prawns medium	210.90	
	18.70	21.66	prawns tailed	379.38	126.46
	17.28	22.58	megrim	50.38	46.64
	20.52	22.50	<i>L.pisc</i>	33.82	24.20
	17.98	22.42	<i>L.bud</i>	5.98	4.80
	16.96	23.18	monkfish		
	21.18	22.38	monkfish tails	3.80	1.05
	19.46	21.90	squid		
	19.08	23.12	pollack		
	18.26	22.94	whiting	11.96	10.50
	23.30	28.92	whiting (round)	4.50	
	17.60	22.18	spurdog	8.50	
	19.66	22.90	black sole	1.90	1.80
	18.62	27.80	lemon sole	1.32	1.24
	22.84	26.96	brill		
	18.96	25.30	witch	0.24	0.24
	22.36	22.44	plaice	0.30	0.22
	20.56	27.52	ray		
	24.80	23.80	common skate		
	25.02	25.40	cuckoo ray		
	18.32	21.14	john dory		
	26.00	19.62	thornback ray		
	21.74	22.90	skate/ray		
	26.54	23.10	skate(wings)		
	18.84	17.80	cod		
	15.22		saithe		
	28.98		red gurnard		
	19.54		ling	0.96	0.92
	23.36		turbot	6.76	6.50
	22.87		haddock	0.74	0.64
			haddock (round)		
subtotals	648.27	605.30	hake	2.26	1.90
Total		1253.57			
			totals	733.44	227.11
mean basket weight	20.91	23.28			
mean basket weight for haul		21.90			
nephrops/fish ratio		4.50			

Validation of Standard Weights and Raising Coefficients for Discard Estimation

Table4: Bulk catch and commercial landings FAT/ROS/05/03 Haul 4

Haul 4	Bulk Catch (kg) small baskets		Commercial Landings (kg)		
	Starboard net	Port net	Species	Round	Gutted
	23.58	24.18	prawns jumbo	3.06	
	17.58	22.10	prawns medium	127.26	
	21.04	22.72	prawns tailed	206.04	68.68
	23.30	20.04	megrim	34.46	31.64
	21.30	24.68	<i>L.pisc</i>		
	18.86	25.52	<i>L.bud</i>		
	21.34	25.08	monkfish	20.72	14.94
	23.36	20.86	monkfish tails	4.36	1.06
	23.58	18.90	squid		
	24.78	24.16	pollack		
	18.70	23.96	whiting	15.86	14.10
	23.12	21.82	whiting (round)	7.88	
	23.56	25.34	spurdog		
	23.50	19.88	black sole	2.10	1.92
	24.14	20.98	lemon sole	0.40	0.38
	21.62	19.96	brill		
	23.16	19.32	witch	0.56	0.52
	18.88	20.58	plaice	0.64	0.62
	19.36	26.02	ray		
	18.94		common skate		
			cuckoo ray		
subtotals	433.70	426.10	john dory	0.82	0.72
Total		859.80	thornback ray		
			skate/ray		
mean basket weight	21.69	22.43	skate(wings)		
			cod	6.94	6.10
mean basket weight for haul		22.05	saithe		
			red gurnard		
nephrops/fish ratio		3.07	ling		
			turbot	10.16	7.90
			haddock	2.34	2.02
			haddock (round)		
			hake	2.24	1.80
			totals	445.84	152.40

Table 5: Bulk catch and commercial landings FAT/ROS/05/03 Haul 5

Haul 5	Bulk Catch (kg) small baskets		Commercial Landings (kg)		
	Starboard net	Port net	Species	Round	Gutted
	20.88	28.34	prawns jumbo	4.04	
	27.86	23.38	prawns medium	55.68	
	27.72	31.14	prawns tailed	45.84	15.28
	26.58	30.30	megrim	99.76	96.10
	28.82	23.83	<i>L.pisc</i>		
	26.88	24.70	<i>L.bud</i>		
	26.88	25.30	monkfish	19.10	12.38
	23.66	25.48	monkfish tails	0.94	0.20
	30.56	25.54	squid		
	30.86	26.70	pollack		
	30.00	27.76	whiting	55.72	49.64
	24.72	20.94	whiting (round)	28.32	
	25.48	20.76	spurdog		
	26.84	24.32	black sole	0.46	0.44
	24.16	25.14	lemon sole	1.08	1.04
	24.92	21.98	brill		
		23.98	witch	0.46	0.42
		13.16	plaice	0.32	0.30
			ray		
subtotals	426.82	442.75	common skate		
Total		869.57	cuckoo ray	1.48	1.36
			john dory	3.64	2.92
mean basket weight	26.68	24.60	thornback ray	6.74	5.76
			skate/ray		
mean basket weight for haul		25.58	skate(wings)		
			cod		
nephrops/fish ratio		0.47	saithe		
			red gurnard		
			ling		
			turbot		
			haddock	3.96	3.24
			haddock (round)		
			hake	1.52	1.40
			totals	329.06	190.48

Validation of Standard Weights and Raising Coefficients for Discard Estimation

Table 6: Bulk catch and commercial landings FAT/ROS/05/03 Haul 6

Haul 6	Bulk Catch (kg) small baskets		Commercial Landings (kg)		
	Starboard net	Port net	Species	Round	Gutted
	25.78	26.34	prawns jumbo	3.02	
	25.48	28.96	prawns medium	39.78	
	26.04	27.34	prawns tailed	38.28	12.76
	30.40	27.40	megrim	101.68	93.08
	32.18	23.20	<i>L.pisc</i>		
	26.48	26.92	<i>L.bud</i>		
	28.44	26.94	monkfish	34.82	26.26
	32.52	27.94	monkfish tails	1.60	0.42
	25.44	26.06	squid		
	25.10	26.14	pollack		
	28.62	25.92	whiting	26.40	23.62
	29.40	27.88	whiting (round)	30.90	
	28.76	28.50	spurdog		
	28.40	24.54	black sole	4.14	3.88
	15.30	10.70	lemon sole	2.12	1.98
			brill		
subtotals	408.34	384.78	witch		
Total		793.12	plaice		
			ray		
mean basket weight	27.22	25.65	common skate		
			cuckoo ray	1.58	1.40
mean basket weight for haul		26.44	john dory	2.70	2.34
			thornback ray		
nephrops/fish ratio		0.38	skate/ray		
			skate(wings)		
			cod		
			saithe		
			red gurnard		
			ling		
			turbot		
			haddock	0.80	0.68
			haddock (round)		
			hake	4.70	4.26
			totals	292.52	170.68

Validation of Standard Weights and Raising Coefficients for Discard Estimation

Table 8: Bulk catch and commercial landings FAT/ROS/05/03 Haul 8

Haul 8	Bulk Catch (kg) small baskets		Commercial Landings (kg)		
	Starboard net	Port net	Species	Round	Gutted
	17.14	22.46	prawns jumbo	5.36	
	19.08	19.62	prawns medium	123.54	
	22.62	18.32	prawns tailed	210.24	70.08
	18.20	19.80	megrim	22.36	21.02
	22.16	18.60	<i>L.pisc</i>		
	21.56	22.40	<i>L.bud</i>		
	19.40	21.12	monkfish	36.30	24.82
	22.40	19.16	monkfish tails	0.92	0.28
	20.54	21.98	squid		
	23.66	25.02	pollack		
	24.22	18.74	whiting		
	20.42	22.30	whiting (round)	3.06	
	26.24	22.00	spurdog	1.42	
	18.72	24.36	black sole	1.05	0.90
	25.00	19.20	lemon sole	3.64	3.34
	19.98	20.10	brill	1.54	1.44
	22.48	17.18	witch		
	22.76	17.20	plaice		
	22.82	23.96	ray		
	22.62	21.48	common skate		
	23.88	20.88	cuckoo ray		
		17.38	john dory	0.34	0.28
		16.52	thornback ray		
		19.00	skate/ray		
			skate(wings)		
subtotals	455.90	488.78	cod		
Total		944.68	saithe		
			red gurnard		
mean basket weight	21.71	20.37	ling		
			turbot	9.76	9.24
mean basket weight for haul		20.99	haddock		
			haddock (round)		
nephrops/fish ratio		4.22	hake		
			totals	419.53	131.40

Table 9: Bulk catch and commercial landings FAT/ROS/05/03 Haul 9

Haul 9	Bulk Catch (kg) big baskets		Commercial Landings (kg)		
	Starboard net	Port net	Species	Round	Gutted
	36.52	34.26	prawns jumbo	2.86	
	37.26	31.22	prawns medium	24.52	
	28.76	33.02	prawns tailed	11.34	3.78
	28.68	33.70	megrim	73.92	68.82
	37.86	31.98	<i>L.pisc</i>		
	38.18	31.10	<i>L.bud</i>		
		29.04	monkfish	10.50	8.14
		33.72	monkfish tails	1.12	0.14
			squid		
subtotals	207.26	258.04	pollack		
Total		465.30	whiting	0.60	0.56
			whiting (round)	7.66	
mean basket weight	34.54	32.26	spurdog	5.02	
			black sole	1.42	1.40
mean basket weight for haul		33.24	lemon sole		
			brill		
nephrops/fish ratio		0.33	witch	0.42	0.41
			plaice	4.12	3.90
			ray		
			common skate		
			cuckoo ray	2.72	2.48
			john dory	1.40	1.02
			thornback ray		
			skate/ray		
			skate(wings)		
			cod	1.16	1.06
			saithe	4.06	3.52
			red gurnard (round)	1.92	
			ling		
			turbot		
			haddock		
			haddock (round)		
			hake		
			totals	154.76	95.23

Validation of Standard Weights and Raising Coefficients for Discard Estimation

Table 10: Bulk catch and commercial landings FAT/ROS/05/03 Haul 10

Haul 10	Bulk Catch (kg) big baskets		Commercial Landings (kg)		
	Starboard net	Port net	Species	Round	Gutted
	31.88	36.20	prawns jumbo	1.76	
	33.40	43.16	prawns medium	12.56	
	33.04	40.32	prawns tailed	4.80	1.60
	40.42	40.68	megrim	74.24	69.96
	34.62	32.50	<i>L.pisc</i>		
	31.60	28.66	<i>L.bud</i>		
	39.72		monkfish	11.55	9.02
			monkfish tails	0.24	0.08
subtotals	244.68	221.52	squid		
Total		466.20	pollack		
			whiting		
mean basket weight	34.95	36.92	whiting (round)	0.96	
			spurdog	4.04	
mean basket weight for haul		35.86	black sole	1.70	1.62
			lemon sole		
nephrops/fish ratio		0.15	brill	7.46	7.12
			witch		
			plaice	8.96	8.54
			ray	13.60	12.14
			common skate		
			cuckoo ray		
			john dory	2.18	1.72
			thornback ray		
			skate/ray		
			skate(wings)		
			cod		
			saithe		
			red gurnard		
			ling		
			turbot		
			haddock		
			haddock (round)		
			hake	0.78	0.70
			totals	144.83	112.50

Table 11: Bulk catch and commercial landings FAT/ROS/05/03 Haul 11

Haul 11	Bulk Catch (kg) small baskets		Commercial Landings (kg)		
	Starboard net	Port net	Species	Round	Gutted
	25.86	23.62	prawns jumbo	2.08	
	24.38	26.88	prawns medium	39.94	
	27.76	30.62	prawns tailed	44.10	14.70
	28.94	28.70	megrim	38.30	35.64
	30.02	26.76	<i>L.pisc</i>		
	27.38	26.82	<i>L.bud</i>		
	30.34	28.76	monkfish	9.98	7.92
	24.86	26.90	monkfish tails	0.70	0.16
	27.06	26.66	squid		
	22.14	27.28	pollack		
	27.50	31.28	whiting		
	26.90		whiting (round)		
			spurdog	2.34	
subtotals	323.14	304.28	black sole	1.90	1.84
Total		627.42	lemon sole	1.50	1.36
			brill	2.30	2.16
mean basket weight	26.93	27.66	witch	0.40	0.38
			plaice	4.64	4.26
mean basket weight for haul		27.28	ray	4.80	4.16
			common skate		
nephrops/fish ratio		1.23	cuckoo ray		
			john dory		
			thornback ray		
			skate/ray		
			skate(wings)		
			cod		
			saithe		
			red gurnard	0.54	
			ling		
			turbot	0.58	0.54
			haddock		
			haddock (round)		
			hake	1.96	1.84
			totals	156.06	74.96

Validation of Standard Weights and Raising Coefficients for Discard Estimation

Table 12: Bulk catch and commercial landings FAT/ROS/05/03 Haul 12

Haul 12	Bulk Catch (kg) small baskets		Commercial Landings (kg)		
	Starboard net	Port net	Species	Round	Gutted
	20.72	22.98	prawns jumbo	1.48	
	17.22	21.76	prawns medium	47.00	
	23.32	23.66	prawns tailed	118.56	39.52
	20.02	19.90	megrim	20.48	19.24
	23.98	19.56	<i>L.pisc</i>		
	24.80	19.68	<i>L.bud</i>		
	27.02	20.94	monkfish	13.04	10.44
	22.02	15.96	monkfish tails	1.60	0.42
	22.30	21.02	squid		
	23.98	23.76	pollack		
	22.06	20.02	whiting	0.84	0.74
	26.32	25.02	whiting (round)		
	24.14	18.82	spurdog	1.68	
	23.32		black sole	2.10	2.04
			lemon sole	1.72	1.60
subtotals	321.22	273.08	brill	0.92	0.90
Total		594.30	witch	0.34	0.32
			plaice	1.58	1.46
mean basket weight	22.94	21.01	ray		
			common skate		
mean basket weight for haul		22.01	cuckoo ray		
			john dory		
nephrops/fish ratio		2.99	thornback ray		
			skate/ray		
			skate(wings)		
			cod		
			saithe		
			red gurnard		
			ling		
			turbot	10.50	9.72
			haddock		
			haddock (round)		
			hake	1.06	0.92
			totals	222.90	87.32

Validation of Standard Weights and Raising Coefficients for Discard Estimation

Table14: Bulk catch and commercial landings FAT/ROS/05/03 Haul 14

Haul 14	Bulk Catch (kg) small baskets		Commercial Landings (kg)		
	Starboard net	Port net	Species	Round	Gutted
	31.12	30.10	prawns jumbo		
	28.70	32.16	prawns medium		
	27.24	31.56	prawns tailed		
	26.56	29.90	megrin	187.41	168.42
	25.12	31.04	<i>L.pisc</i>		
	28.70	32.00	<i>L.bud</i>		
	31.38	26.10	monkfish	55.70	41.56
	31.88	36.60	monkfish tails	3.10	0.78
	32.78	30.96	squid		
	34.08	30.00	pollack		
	27.50	33.38	whiting	3.22	2.96
	30.90	30.88	whiting (round)	10.54	
	30.10	31.04	spurdog	4.20	
	30.42	33.00	black sole	4.28	4.04
	31.78	28.00	lemon sole	22.52	17.66
	29.62	29.90	brill	1.24	1.14
	33.36	29.02	witch	2.56	2.40
	31.26	26.96	plaice	5.38	5.04
	33.34	28.60	ray		
	33.52	27.44	common skate		
	30.44	29.54	cuckoo ray		
	31.68	31.68	john dory	2.30	1.82
	30.02	29.76	thornback ray		
	33.14	27.48	skate/ray	73.88	63.48
	32.90	28.14	skate(wings)		
	33.98	29.52	cod		
	32.20	37.34	saithe		
	29.00	33.90	red gurnard		
	29.40	27.36	ling		
	34.12	20.04	turbot	3.06	2.74
	31.88		haddock	8.48	7.14
	34.62		haddock (round)	7.44	
	29.74		hake		
	33.14				
	33.92		totals	395.31	319.18
	30.50				
	31.44				
	31.62				
	37.22				
subtotals	1220.32	903.40			
Total		2123.72			
mean basket weight	31.29	30.11			
mean basket weight for haul		30.78			
nephrops/fish ratio		0.00			

Table15: Bulk catch and commercial landings FAT/ROS/05/03 Haul 15

Haul 15	Bulk Catch (kg) small baskets		Commercial Landings (kg)		
	Starboard net	Port net	Species	Round	Gutted
	29.68	27.60	prawns jumbo	3.60	
	30.64	35.94	prawns medium	53.24	
	31.10	28.42	prawns tailed	21.96	7.32
	29.82	33.32	megrim	119.70	108.36
	28.18	28.48	<i>L.pisc</i>		
	30.20	27.78	<i>L.bud</i>		
	25.52	30.20	monkfish	30.94	23.62
	29.98	29.18	monkfish tails	4.42	1.14
	26.80	28.24	squid		
	30.44	30.30	pollack		
	24.66	30.04	whiting	16.32	14.83
	24.48	24.52	whiting (round)	5.92	
	30.00	29.42	spurdog	2.72	
	26.78	28.26	black sole	1.58	1.38
	26.28	30.20	lemon sole	4.60	4.24
		31.94	brill		
		26.02	witch	2.84	2.72
		28.18	plaice		
		24.28	ray		
			common skate		
subtotals	424.56	552.32	cuckoo ray		
Total		976.88	john dory	2.10	1.66
			thornback ray		
mean basket weight	28.30	29.07	skate/ray	32.06	19.78
			skate(wings)	15.42	7.32
mean basket weight for haul		28.73	cod		
			saithe		
nephrops/fish ratio		0.33	red gurnard		
			ling		
			turbot		
			haddock	2.12	1.68
			haddock (round)	0.42	
			hake	1.22	0.96
			totals	321.18	195.01

Validation of Standard Weights and Raising Coefficients for Discard Estimation

Table16: Bulk catch and commercial landings FAT/ROS/05/03 Haul 16

Haul 16	Bulk Catch (kg) small baskets		Commercial Landings (kg)		
	Starboard net	Port net	Species	Round	Gutted
	20.72	23.24	prawns jumbo	5.08	
	17.44	19.74	prawns medium	157.82	
	17.84	24.16	prawns tailed	162.54	54.18
	21.04	25.16	megrim	40.36	37.20
	21.82	26.48	<i>L.pisc</i>		
	18.58	27.56	<i>L.bud</i>		
	16.04	34.52	monkfish	75.54	55.40
	21.44	23.46	monkfish tails	4.66	1.24
	20.82	26.54	squid		
	21.94	25.20	pollack		
	23.78	27.42	whiting	6.00	5.20
	23.66	20.58	whiting (round)	1.68	
	22.36	25.28	spurdog		
	30.34	34.28	black sole	2.18	2.08
		24.66	lemon sole	0.62	0.58
		20.88	brill		
		21.62	witch		
		22.34	plaice	0.62	0.60
		22.62	ray		
		23.66	common skate		
		24.16	cuckoo ray		
		26.16	john dory		
		26.07	thornback ray		
		23.64	skate/ray		
		20.40	skate(wings)		
			cod		
subtotals	297.82	619.83	saithe		
Total		917.65	red gurnard		
			ling		
mean basket weight	21.27	24.79	turbot	0.68	0.64
			haddock	2.60	2.28
mean basket weight for haul		23.53	haddock (round)	0.48	
			hake	4.68	4.22
nephrops/fish ratio		2.32			
			totals	465.54	163.62