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Abstract

There is an increasing need to take into account a "mixed fisheries" approach in management, assessment and sampling of fish stocks. To do this effectively it is necessary for groups of fishing trips with homogeneous fishing patterns or tactics to be defined into métiers. Presented here is the result of an Irish case study analysis in applying multivariate statistics to declared logbook landings to define Irish fleet métiers operating in the Irish Sea. Established multivariate statistical procedures, a combination of factorial and cluster analysis, were applied to five variables; landing profile, vessel length category, gear, mesh size range and month. The investigation has shown this methodology to be a suitable tool in identifying métiers without prior assumptions and enabled data to be described from a multivariate statistical perspective providing useful and informative results.

In total twenty-two métiers were identified and defined from 2003 landings data, and a further 5 groups were formed to include trips which could not be assigned to a métier. Definitions were applied to 2003-2005 landings and effort data to examine their dynamics and stability. The dominant métier (in terms of effort and trips) contained high proportions of landed *Nephrops* taken by bottom otter trawlers using 70-89mm meshes. The effort in this métier was fairly stable over time. The greatest increases in effort and trip allocation occurred within métiers employing pots and traps for crustacean species. A small number of minor métiers (in terms of landings and effort) became obsolete over the three years examined. The effects of recent management measures are likely to have contributed to declines in the numbers of trips and effort in some métiers. For example, days-at-sea limited mobile gears, such as bottom otter trawls and beam trawls with ≥100mm mesh have declined. Such changes within métiers over recent years have contributed to a deeper understanding of fleet dynamics in the Irish Sea. This analysis has identified and highlighted a segment of polyvalent Irish fishing vessels, which move between several métiers within a year.

The definition of métiers can be used to enhance the Irish sampling program in the Irish Sea by developing a finer scale, métier based, stratification of sampling. This in turn, enables increased precision and robustness of national assessment data thus improving assessments and management advice. Defining métiers will prove advantageous in developing mixed fisheries assessments and advice.

Keywords:

Mixed fisheries, Irish Sea, Métiers, Fleet, Fisheries, Cod, Dynamics, Multivariate analysis

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1 Introduction

Fish stocks in European Community waters have traditionally been assessed and managed under the common fisheries policy (CFP) on a single species basis. The main management tools have been limitation of single species output (e.g. Minimum Landings Sizes) and input controls (e.g. total allowable catch (TAC) quotas, gear regulations and closed areas). There is an increasing realisation that this management system is ineffective and several key stocks have continued to decline and are now subject to stock specific recovery plans (e.g. cod). This has lead to the introduction of input controls such as days-at-sea in several areas, including the Irish Sea in addition to other management measures (closed areas, catch constraints). However, managing fishery inputs effectively requires a detailed knowledge of the multi-species interactions and the multi-fleet nature of fisheries. The introduction of these new input focused management measures may also trigger changes in the dynamics and stability of métiers. Effective management therefore requires an understanding of the complexity of the dynamics and the adaptability within operational fisheries (Holley & Marchal, 2004).

1.1 Mixed fisheries terminology

It is useful to reiterate the various scientific terms as they are used in relation to mixed fisheries. These are largely taken from those defined by the International Council for the Explortation of the Sea (ICES; 2003), with the addition of "gear grouping":

Term	**Definition**
Fleet	A physical group of vessels sharing similar characteristics in terms of technical features and/or major activity (e.g. the Irish otter trawler fleet < 55 feet in overall length, regardless of which species or species groups they are targeting)
Fishery	Group of vessel voyages targeting the same (assemblage of) species and/or stocks, using similar gear, during the same period of the year and within the same area (e.g. the *Nephrops*-directed otter trawl fishery in the Irish Sea).
Métier (also know as 'fishing tactic' or 'fishing strategy')	Homogeneous Subdivision of a fishery by vessel type (e.g. the *Nephrops*-directed otter trawl fishery in the Irish Sea by vessels < 55 feet).
Fishing unit	Common denomination for any grouping of voyages (i.e. fishery or métier) or vessels (i.e. fleet), and for any miscellaneous grouping of vessels and/or voyages that does not have the status of a fleet, fishery or métier. (e.g. the Clogherhead otter trawlers fishing in the Irish Sea)
Gear grouping	Current management unit for input controls, such as days-at-sea restrictions in the Annexes of various EC regulations. Typically this refers to a mesh size and gear type combination (trawl & seine, beam, gill nets, trammel nets or long-line). Through earlier regulations these also include species composition catch restrictions. An example would be "towed trawl or seine gears with cod-end mesh sizes of 70-99mm (with <80mm square mesh panel SMP) in VIIa". This gear grouping also carries a catch composition restriction of >30% *Nephrops*, <5% Cod and <20% Hake.

Within a fleet or fishery, various types of fishing operations impact the resource differently. For relevant advice and effective management, operations should be considered in métiers. A métier, as defined by the Study Group on the Development of Fishery-based Forecasts (SGDFF; ICES, 2003) is "a homogeneous sub-division of a fishery by vessel type". Also called 'fishing tactic' (Pelletier & Ferraris, 2000), or 'fishing strategy' (Holley & Marchal, 2004) in the literature. Formulation of métiers allows landings (and effort) to be allocated into "sensible" sized units reflecting the fishing activities within them (ICES, 2003).

The homogeneous nature of fishing strategies within a métier can provide more "accurate" catch per species and effort calculations for assessment, and effective partitioning of fishing mortality (Pelletier & Ferraris, 2000). Well-defined homogenous métiers create building blocks, which can be used at a national level to stratify sampling and discard programs. Defined métiers can also aid in assessing fleet/fishery dynamics (e.g. Ulrich & Anderson, 2004), and are becoming increasingly important in management strategy evaluations through simulation models (e.g. ISIS-Fish (Intogration of Spatial Information and Simulation of FISHeries): Drouineau et al., 2006, and Fisheries Libaraies in R (FLR): http://flr-project.org/doku.php).

1.2 Previous approaches to define métiers

Several approaches have been used to identify and define métiers. The main technique adopted, and recommended by the Study Group on the Development of Fishery-based Forecasts (SGDFF; ICES, 2003), is the use of quantitative multivariate analysis. Combinations of factorial and cluster analysis methods have frequently been applied to landings and effort data. Biseau and Gondeaux (1988) applied Principal Component Analysis (PCA) to two variables of French Celtic Sea data, contrasting two analyses to obtain métiers. Pelletier and Ferraris (2000) used a two-step process to identify métiers in Senegalese and Celtic Sea fisheries. For the former, a combination of PCA, Hierarchical Agglomerative Clustering (HAC) and Multiple Correspondence Analysis (MCA) were applied to landings and effort data based on individual trips. To the latter, a combination of PCA, HAC and Two-Way Correspondence Analysis (TWCA) were used to obtain métiers for French bottom trawlers.

SGDFF (ICES, 2003) proposed a three step open framework to identify métiers. This combined quantitative statistical analysis and ad hoc qualitative classification. Firstly, defining catch/landings profiles. Relationships between effort and vessel characteristics and landing profiles were then to be investigated, followed by hierarchical classification to obtain groupings. In a final step, métiers could be defined by combining these multivariate results with ad hoc knowledge of the fishery. The following SGDFF meeting (ICES, 2004) countries detailed preliminary analyses of fishing trip groupings (including fleets, fisheries, and métiers).

Ulrich and Anderson (2004) followed this three-step framework incorporating methodology used by Pelletier and Ferraris (2000), combined with expert knowledge to give realistic métiers for Danish fisheries. The same framework was followed by Holley and Marchal (2004), applying PCA and HAC to catch and effort data from the French North Atlantic offshore fleet.

Mahévas et al. (2004) did not follow the SGDFF framework, and only applied cluster analysis to observe annual variation from vessel characteristics. Similarly, Castro et al. (2004) and Castro and Punzón (2005) used non-hierarchical K-means cluster analysis to identify Spanish southern shelf and northern coastal trawl fleets. Whereas, PCA and clustering according to Wards algorithm were applied to the Basque trawl fleet (Santurtún et al., 2004), Spanish North East Atlantic trawl fisheries (Prellezo et al., 2005) and Basque trawl fisheries in 2005 (Garcia et al., 2006). However, Santurtún et al. (2004) stated that PCA was not essential to achieve the objectives of the study. More recently, Portuguese trawl (Silva & Cardador, 2006) and artisanal (Duarte & Cardador, 2006) fisheries were analysed in two studies using Partition Around Medoids cluster analyses (PAM), the consistency of which was assessed by the Silhouette coefficient (Si). Duarte and Cardador (2006), comment that additional information (in terms of location and gear) would be required to focus clusters and define métiers appropriately.

An alternative, qualitative, approach is through classification with subjective criteria. However, there are few published examples. Biseau (1998) used thresholds to classify species directed trips. Métiers were identified by target species obtained from (weight) proportions within trip landings and relative effort. Métiers have also been defined on the basis of expert knowledge from a combination of inputs such as gear, mesh size, and fishing area, however these are often not published (ICES, 2003). The disadvantage of this approach is the subjective nature of the criteria used and the dependency upon qualitative *a priori* knowledge of fisheries and fleets, which is not required for the above quantitative method. In the past, this has been the primary method of classification used in Ireland. For example the *Nephrops* métiers were identified as vessels using otter trawls with over 30% of the catch composition by weight consisting of *Nephrops* (ICES 2003).

1.3 The Irish Sea

The Irish Sea covers an area of around 58,000 sq km (23,000 sq miles) and has the form of a fairly shallow basin, with depths ranging from 20-100m over considerable areas, a deeper channel, exceeding 100m, extends north-south in the western part reaching a maximum depth of 315 m in Beauforts Dyke (Boelens et al., 1999). International landings from the Irish Sea have shown a declining trend since the 1970’s from over 100,000 t to less than 40,000 t in recent years. This has mainly been due to the decline in the herring stock and then large declines in biomass of cod and whiting (Marine Institute, 2006). Shellfish fisheries now account for over 50% of the total landings by weight, dominated by the significant *Nephrops* fishery.

1.4 Objectives

The objectives of this study were as follows:

- To utilise multivariate statistical techniques and criteria to identify and define métiers within the Irish Sea.
- To give a summary of the landings and effort for the métiers defined.
- To investigate the recent dynamics and stability within the métiers identified in response to management actions and fleet developments.
- To consider the utility of these analytical techniques for wider application to fisheries in Ireland and sampling strategies.

2 Materials and Methods

2.1 The Data

The study focused on the Irish Sea in order to keep the data set to a manageable size and relatively homogeneous nature. Data used for the analysis was confined to Irish Sea logbook data from the Integrated Fisheries Information System IFIS database, collected by the Sea Fisheries Protection Authority[1] and provided by the Department of Agriculture, Food and Fisheries[2]. All vessels 10 meters or above, fishing in European waters which are at sea on fishing voyages >24hrs are required to complete a daily logbook during each fishing trip as detailed by Article 6 of EEC Regulation No 2847/93 (EC 1993). For each trip, overall vessel length, gear type, mesh size, ICES area, landing date, and estimated species live weight (using national conversion factors) from the "landing declarations" were included in the analysis.

Data from 2003 to 2005 was available for analysis, consisting of 9259 trips by 232 vessels. Owning to the size of the data set, a reference year (2003) was chosen for analysis to identify and define métiers. This restricted the number of fishing trips to 3142. Analyses were performed with R Version 2.4.1 (http://www.r-project.org/) a computer language and environment which can be utilised for statistical analysis and graphical representation.

Data was subjected to initial quality control and assurance, prior to analysis to remove records unsuitable for analysis. Landed weight recorded as "mixed boxes" were removed and discounted from weight calculations. These records are excluded as the species compositions are unknown. This grouping accounts for an average of 0.2 % of total Irish landed weight. One trip recorded landings solely of mixed boxes, and was subsequently removed from analysis. A single trip occurred with multiple gears recorded. In this instance gear type was replaced with "multi" and the mesh size taken from the gear with the greatest associated landings.

2.2 Analysis/Typology of métiers

This investigation has adopted the SGDFF three-step framework (ICES, 2003) to identify métiers. The three-step process combines the use of quantitative multivariate statistical analysis of landings and effort data and qualitative expert knowledge. Therefore, no prior assumptions of the fishery are made, avoiding the inherent subjectivity of qualitative analysis. The first step in the framework uses multivariate analysis of landings data in relation to species composition to identify landings profiles (groups of species often associated). The second step investigates the relationships between trip variables (e.g. gear type, mesh size and vessel characteristics) and their identified landing profiles. The final step is to then define métiers, utilising results from the previous step combined with statistical assessment and expert knowledge to classify sensible and practical métiers.

The methodology applied here is based on that used by Pelletier and Ferraris (2000), and Ulrich and Anderson (2004). Species landed live weight proportions of total landed weight per trip were used as the basis for landing profiles. Landed live weight was obtained from landed weight multiplied by the appropriate raising factors for species and presentation. The species included in analyses were based on a landings threshold of greater than 0.1% of total Irish landings for all areas (three year average), thus removing the effect of 'less abundant' species.

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[1] http://www.sfpa.ie

[2] http://www.agriculture.gov.ie

Some individual species were grouped into “Species Categories” to reduce the impact of uncertain identification or variations in coding practices in the logbooks. The final species and species categories included in analyses are detailed along with average total landings in Table 1. Species contributing less than 0.1% to total landings were grouped as “Other” (Table 2). This category totalled 0.71% of landings, equating to average annual landings of 1734 t.

A non-normalised PCA, a form of factorial analysis, was run to give a reduced description of the dataset and analyse relationships between species. This technique reduces the dimensionality of the dataset and identifies combinations of variables (in this case species), which explain the greatest variation (Fowler et al., 2004). Variations in species weight proportions are accounted for, where greater weighting is given to dominant species. All factors were used as inputs for Hierarchical Agglomerative Cluster analysis (HAC) based on Euclidean distance and Ward’s algorithm (1963). This method creates successive clusters based on previously identified clusters, building a hierarchy from individuals until all trips are within a single group. Euclidean distance was used as each component of PCA is independent from the others, and the variance of which reflects its importance (Fowler et al., 2004). The appropriate number of clusters was estimated from the level at which the increase in the proportion of variance explained levelled off (via sums of squares and r^2 values), similar to that in Ulrich and Anderson (2004). The relevance and size of clusters was considered in formulating the final clusters. This results in well-separated, homogeneous clusters that can be related to the observed variables. The resultant, final clusters or “landing profiles” were then considered as categorical variables for input to the next stage.

The second step investigated relationships between landing profiles and four variables, in line with those recommended by SGDFF (ICES, 2003). These were: month (a proxy for season), gear type, mesh size range (based on groupings in Council Regulation (EC) No 850/98: EC, 1998), and over all vessel length based on the category outlined by the October 2005 North East Atlantic Rigonal Coordination Meeting report (Anon, 2005a). The relationships were investigated using MCA. This method is a type of factorial analysis, analogous to PCA but designed for use with categorical variables, such as those used here. A HAC was applied to the factorial coordinates obtained from the MCA, retaining all factorial axes following the same methodology as the first step. Here the aim was to obtain clusters of fishing trips based on the relationships between the five categorical variables (landing profile, month, gear type, mesh size, and vessel length). The number of clusters was again estimated using the proportion of variance explained and resulting clusters were described in their most accurate form.

In a final step, métiers were defined from the resulting clusters. Some clusters were pooled according to expert knowledge to avoid over complexity and excessive desegregation, whilst retaining important information on the structure of the dataset. Pooling was also required to maintain sufficient numbers of trips within each métier to preserve the integrity of future statistical analysis and avoid unrealistic sampling targets (Anon, 2005b).

3 Results

3.1 Landing profiles

PCA of species proportions by fishing trips was applied to 2003 trip data. The first four factorial axes, or components, predominate in explaining the variation within the dataset (cumulative 25%, Figure 1).

The main species features within the dataset were highlighted on a bi-plot of the first two factorial axes (Figure 2). A clear *Nephrops* profile is observed apparently disassociated with other species. Two further groups were observed but with greater species complexity. Firstly a combination of plaice, black sole and ray species, with possible associations with, or by-catches of, whiting, hake and haddock. The second is a mixture of cod, ling, pollack and saithe, with possible associations with, or by-catches of, megrim, witch, monkfish and lemon sole. A lack of species within the lower right quarter of the bi-plot indicates that no species are significantly negatively correlated to this second species grouping. The third and fourth axes (Figure 3) also depicted *Nephrops* as well separated from other species. Two other species groupings occurred on these two axes. Megrim associated with witch, and crab species associated with the “Other” grouping, which is likely to result from the presence of lobsters in this group.

Species composition of trips appears complex, indicated by the low variation explained by the first four PCA axes, thus requiring all factorial axes to be considered. For this reason, in addition to maintaining sufficient variation, all factorial axes were retained for HAC analysis. The primary HAC division (Figure 4) occurred separating those trips with few species, where typically only one has a high weight proportion, from those with more complex, mixed species compositions and several species with relatively higher weight proportions.

Choice of the appropriate number of clusters was made based on the level of variance within the dataset explained by clusters (from sums of squares and r^2 values). Little increase in the explained variance occurred after 33 clusters. This was therefore chosen as the appropriate number of clusters, explaining 78% of the variation. The number of trips per cluster varied considerably (from 1 to 1151) many of which contained less than 5% of all trips. Of these, only those considered to symbolise real target species (e.g. herring and sprat) were retained as landing profiles. The remainder were recombined with closely related clusters, i.e. the next nearest linked cluster on the dendrogram. This resulted in eleven clusters considered as landing profiles in the next step of analysis. The main species and number of trips in landing profiles are detailed in Table 3. Several landing profiles contained high proportions of a single species, for example herring, sprat or *Nephrops*. The latter of which formed the largest landing profile identified (37% of all trips).

3.2 Métier Identification and descriptions

To obtain groupings of similar trips with respect to key trip details a MCA was performed. Various preliminary MCA runs were carried out to determine the most appropriate variables and categories within them. The final input variables were: landing profiles (from previous step), gear type, month, mesh size, and vessel length. Table 4 details the final variables and their categories.

In order to investigate the relationships between variable sub-categories it is helpful to observe trip distribution in relation to each variable and subcategory through boxplots. Figure 5 details a boxplot representation of the link between the first (the most important) MCA axis and the categorical (trip) variables. The x-axis represents values from the first MCA axis, and each line corresponds to a fishing trip, with the greatest trip density to the left of the plot, i.e. the trips with the most similar values and thus, the most similar variable factors (trip characteristics). The plot shows that in the Irish Sea trips are dominated by vessels utilising bottom otter trawls (OTB), beam trawls (TBB), or Scottish seines (SSC) in conjunction with mesh sizes 70-79mm, 80-89mm and 100-119mm. These categories have high numbers of trips (are furthest to the left) with well defined inter-quartile ranges (i.e. narrow boxes). The majority of trips occur by vessels ranging between 12m and 24m in length. In terms of landing profiles, the following species (groups) are most common: *Nephrops* (L1), clean ray species (L7), plaice and ray (L8), ray and mixed species (L9), and whitefish and mixed species (L10). Month is the only variable where factors occur across the whole x-axis, indicating that overall, this is not an important variable in defining métiers. There is one group of trips separated from the main, to the right of the plot, which would indicate a specialised group. This group consists of trips with landing profiles L6 (crab and "other"), and cod, pollack, ling and saithe (L11), combined with vessels 10-12m in length, utilising static gillnets (GNS) with the <110mm and 110-219mm mesh ranges.

As with a PCA the each MCA axes explains a proportion of the variance. The bar chart of percentage variance explained (Figure 6) shows the first 4 axes predominate (24% of the variation) These four axes were all considered as relevant to illustrate the main relationships between categories.

The associations between the different variables are displayed in bi-plots of these four MCA axes. The first and second axes, i.e. the most important axes on which the greatest variation within the dataset is observed, are plotted in Figure 7. This plot highlights a clear separation of, and association between a group of trips in the upper right hand section of the plot. These trips are characterised by pair trawls (PTM and PTB) operating with small mesh trawls (32-54mm) targeting herring (L5). In addition, some association may occur between these typically "pelagic" characteristics, the 90-99mm mesh band and, to a lesser extent the 40-80m vessel length range. Although less distinguished than this first group, a number of trips also separate from the main towards the lower right area of the plot. These trips relate to the distinguished group in figure 5, showing the same vessel characteristics of between 10m and 12m in length, employing set gillnets and their associated mesh size ranges (<110mm and 110-<220mm) apparently targeting an assemblage of cod, pollack, ling and saithe (L11), along with crab and "other" (L6). In the second MCA bi-plot plotting axis three against axis four (Figure 8), the main trip separation is as on the previous plot, those with pelagic trip characteristics (upper right). The separation of trips characterised by gillnets is no longer visible, although two different groups are distinguishable. The first characterised by pots and traps (FPO), and dredges (DRB) targeting whelks (L2) and scallops (L3) without mesh size (upper left). The second, in the lower section, an association between beam trawls, their related small mesh range (80-89mm), and large vessel lengths (40-80m). There are no clear landing profiles associated with these trips, although some are likely to target ray and mixed species (L9) giving its reasonably close proximity.

All MCA factorial axes were retained for HAC due to the low level of variance explained by individual axes and to maintain a sufficient level of variation in the dataset. This grouped fishing trips into clusters displaying similar variable categories. At first separation (Figure 9), fishing trips utilising non-trawl gear (i.e. pots and traps, dredges, set gillnets and purse seines) were divided from those using trawls. Subsequent divisions successively separated relatively small groups from the main body of trips.

As with HAC for landing profiles, the appropriate number of clusters was decided based on the level of dataset variance explained by increasing numbers of clusters. Little increase in the explained variance occurred after 37 clusters, and subsequently chosen as the appropriate number of clusters, which explains 74% of the variation within the dataset. The number of trips within clusters was widespread, from 1 to 208 trips. Each cluster was fully described using the variable categories. Some clusters contained a single gear type, landing profile, and/or mesh size category. Several vessel length categories and months often occurred in each cluster. Clusters with low fishing trip numbers were recombined with closely related clusters, i.e. the next nearest linked cluster on the dendrogram unless considered to symbolise a true métier, such as dredges targeting “other” (in this case razor shells) comprising 20 fishing trips. *Nephrops* occurred in high proportions within twelve clusters, where trip related characteristics were similar across each, differing only by month. By-catch species compositions of these clusters were similar and many vessels occurring in one *Nephrops* cluster, also occurred in the majority of the others. For these reasons all clusters primarily containing trips with high *Nephrops* proportions were combined into a single métier. This resulted in 22 defined métiers for the Irish Sea. In addition, a number of groups were added to amass trips not qualifying for métiers. This included a group for trips utilising multiple mesh sizes, and for non-*Nephrops* OTB trips with no mesh size. As demersal trawling is the dominant fishing method in the Irish Sea, two groups were formed for this, divided by mesh size (large and small). The third class groups all remaining unallocated trips together. Each métier is defined in Table 5.

The importance of métiers varies greatly in terms of the number of trips. The largest of which, target *Nephrops* with 70-89mm bottom otter trawlers (MC1), accounting for 39.6% of the 2798 trips allocated to métiers. The smallest métier targeted a combination of cod, pollack, ling and saithe with 70-89mm mesh bottom otter trawls between January and June (11 trips; MC20). Of métier defined trips, ~50% were within three métiers. These are the *Nephrops* métier (MC1) already mentioned, whitefish and ray mixed OTB 70-89mm (7.4%; MC22) and the whelk métier (7.1%; MC6).

The number of species within each métier varies. Eleven métiers contain a single dominant species, defined as when 50-100% of each trip’s total landed weight comprises of a single species, with low proportions, generally <10%, of any other species. This includes the métiers defined by “Other”, identified as solely razor shells (100%; MC8), sprat (90%; MC15), whelk (85%; MC6), scallops (80%; MC9), *Nephrops* (50%; MC1) and ray species (50%; MCs2, 3, 4). The remaining métiers are defined by groups of species, such as cod, pollack, ling and saithe. In these more mixed métiers, with species each contributing between 20% and 40% of the trip’s total landed weight. In these métiers compositions vary between trips demonstrating the mixed nature of fisheries in the Irish Sea.

Many métiers use bottom otter trawling, indicating the importance of this gear in the Irish Sea. These divide into two main mesh size ranges, between 70-89mm and 100-119mm. No clear métiers were identified using 90-99mm mesh size range, implying they are rarely used here. The majority of other gears occur within one or two métiers with varying importance. Beam trawls however, occur within four métiers all of relatively low importance in terms of trips. The smallest vessel length category, 10-12m, has little association with trawling métiers, remaining primarily associated with static gears (i.e. gillnets and pots). Presumably related to a certain minimum level of power required to tow nets, which such small vessels may not have. In beam trawl métiers vessels are a minimum of 18m in length, again this is likely due to a minimum power requirement to tow this gear. Vessels 10-12m, have greater association with static gears (i.e. gillnets and pots).

3.3 Applying metiers to 2004 and 2005

The 2003 métier definitions were applied to fishing trips during 2004 and 2005 (Table 6) to observe their stability over time. Both the *Nephrops* (MC1), and whitefish and ray mixed (MC22) OTB 70-89mm métiers remained stable. Suggesting, these dominant métiers are well established, important fishing tactics in the Irish Sea. Two further, less important métiers remained relatively stable, dredging for "Other" (razor shells; MC8) and plaice and ray 80-89mm beam trawling (MC10). Implying these métiers are also well established. Small fluctuations may suggest an opportunistic behaviour fluctuating with species availability. The whelk pot and trap métier (MC6), which was one of the dominant métiers in 2003, has increased in importance by around 70%. The second pot and trap métier, targeting crabs and "other" (MC7), tripled since 2003 possibly reflecting increased reporting in logbooks by smaller vessels.

Over time, some métiers became irrelevant, particularly those with few trips in 2003. For example, the crab gillnetting métier (MC11) only occurred in 2003. This may have been a mis-specification of gear in the logbook, as the species composition is very similar to that of the crab and "other" pot and trap métier. Trip numbers declined in many of the larger mesh trawl métiers (≥100mm). A similar decline also occurred in métiers targeting cod, pollack, ling and saithe, particularly within the bottom otter trawl métiers. Declines may result from increasing effort and quota restrictions within the Irish Sea (ICES, 2006). Pair trawling for multiple pelagic species (primarily herring with some European pilchard and sprat; MC16) has increased whilst, single trawling for sprat alone (MC15) has declined, indicating a shift in pelagic fishing strategy. Sprat may not be available to target as a single species, or it may no longer be economically viable to target sprat alone in the Irish Sea. Vessels in this métier are likely to have moved to fishing elsewhere or to non pelagic métiers as they have not moved into the mixed pelagic métier, possibly due to quota restrictions for other pelagic species.

In 2004 the number of trips where mesh size was not recorded, increased greatly. Subsequently in 2005, this reduced to one trip. This improvement in 2005 may have resulted from improved logbook recording or logbook enforcement.

Based on trip allocations, the number of vessels within each métier were considered (Table 7). The *Nephrops* métier (MC1) contained the largest number of vessels, around 50. Four métiers contained on average, two vessels per year, including both large mesh beam trawl métiers (MCs3, 18). Dredging for razor shells (MC8) is a highly specialised, targeted métier, unlikely to be able to support great vessel numbers. Over all, Vessel numbers in important métiers appear relatively stable over the period. This demonstrates that the métiers are established groupings, with appropriate definitions.

Several métiers demonstrated declining vessel numbers, particularly the large mesh bottom otter trawl and beam trawl métiers, regardless of target species. This implies a shift away from the use of large mesh (≥100mm) trawls, a possible result of the greater effort (days at sea) restrictions for large mesh ranges. Vessel declines in large mesh beam trawl métiers were less pronounced than those in otter trawl métiers, as there were few beam trawl vessels operating in 2003. Conversely, there has been an increase in vessels of both otter trawl and beam trawl métiers using smaller mesh (70-89mm). For the two trawl based métiers targeting cod, pollack, ling and saithe, vessel numbers declined from, 14 in the large mesh (MC19), and 10 in the small mesh (MC20) métier in 2003 to just one or two vessels in 2005. Part of this may be linked to declining white fish trawl fisheries and restrictive days-at-sea. A less extreme decline was observed within gillnet métiers for the same species target group (MCs12, 13). Vessel increases occurred primarily within two métiers, mixed pelagic pair trawls (MC16) and small mesh bottom other trawls targeting whitefish, ray and mixed species (MC22). The second of which has shown the greatest increase, from 36 to 52 vessels over the three years.

On average 79 (55%) of vessels operate within a single métier. Of the remaining vessels, 9 (on average) operated in more than 3 métiers. A single vessel operated in a maximum of 7 métiers in 2003. This reduced to 5 métiers in 2005. Many vessels targeting *Nephrops* also target other species such as rays, resulting in vessels belonging to multiple métiers. Some trawling vessels also report or utilise several mesh sizes, this is also true for gill netters. In addition, some bottom otter trawling vessels occurred within pot and trap métiers and/or gillnet métiers, demonstrating the polyvalent nature of vessels in the Irish Sea. Vessels beam trawling however, were shown to rarely change between gear types.

3.4 Landings and effort by métier

3.4.1 Landings

Once métiers have been defined it is useful gain an understanding as to how they contribute to total Irish landings of each species or stock in the Irish Sea. As with trip and vessel numbers, the total weight landed varies greatly (Table 8). The majority of métiers contain a variety of species, either as targets or as by-catch (considered here as <10% of total). Cod for example, is present to some extent in many métiers as by-catch but is a target species in other métiers (e.g. 12, 13, 19, 20), accounting for >10% of total landed weight. Very few métiers land less than three species. This strongly indicates the mixed nature of fishing activity in the Irish Sea, particularly trawling.

Total landings of the mixed pelagic pair trawl métier (MC16) exceed all other métiers, with landings in the order of 3,700 ton per year. The *Nephrops* métier (MC1) also accounts for large landings, at approximately 2,900 tons per year. Two further métiers have large total landings, although an order of magnitude less; scallop dredging (MC9) and whitefish, ray and mixed small mesh bottom otter trawling (MC22), each landing over 450 ton per year, on average.

Conversely, six métiers contribute less than an average of a hundred tons per year, excluding the crab directed gillnet métier. These métiers include razor shell dredging (MC8), where landings fluctuate at a low level. Although crab directed pot and trap métier (MC7) landings have increased, they too remain at a low level. The remainder of low average landings result from large declines over three years, between 85-100%, equating to several hundred ton. This applies to both the large mesh beam trawl métiers (MCs3, 18), cod, pollack, ling and saithe bottom otter trawl métiers (MCs19, 20), and the large mesh gillnet métier (MC13). The whitefish, ray and mixed bottom otter trawl métier (MC21) has also shown a steep decline in landings of around 90%, equating to a reduction of several hundred tonnes.

A major increase in landings within non-métier group A occurred during 2005 due to 4,800 ton of reported mussels, prior to 2005, no mussel landings were reported. This increase is likely to result from new legislation requiring mussel landings to be reported in the logbooks. In addition, high landings of non-métier grouped pelagic species occurred, as pelagic landings extended beyond the fourth and first quarters, stipulated by the mixed pelagic métier definition.

Métier percentage catch compositions (Table 8) are similar to the thresholds used to define the métiers, indicating few species occur in levels higher than those determined as the minimum threshold during the analysis. The catch composition of the cod, pollack, ling and saithe directed bottom otter trawl métiers (MCs19, 20) had high proportions of whiting although this species was not used to define the métier. The average percentage composition of *Nephrops* in trips allocated to the *Nephrops* métier (MC1) was 85%, well above the 50% qualification level for this métier (as derived from the MCA). This indicates a skewness high proportions of *Nephrops* (>85%), although there are also significant numbers of trips with a more mixed landings profile. Compositions also show the majority of métiers include species landed as by-catch, to varying extents. Within the *Nephrops* métier (MC1), five main species occur as by-catch, cod (3.9%), monkfish (2.2%), haddock (2.2%), plaice (1.8%), and ray (1.3%).

3.4.2 Effort

Fishing effort can be calculated in several ways and this can effect interpretation of the results. In this case effort is given as hours, giving the time spent actively fishing as recorded in the logbook, and days being the number of days in which a vessel carried out fishing activities. A third possible effort measure, days at sea, was not used. This is defined as the time a vessel leaves port to the time it returns, where every 24h period, or part thereof, is considered a day. However, as some vessels move between ICES areas during one trip, days-at-sea effort would cover multiple areas, resulting in an over estimation of effort.

In most métiers the relationship between hours and days is very similar. Two métier groups show a lower hours to days ratio. Pelagic directed métiers spend less time actively fishing each day, as these vessels can actively “hunt” for shoals of fish and target them directly. To a lesser extent, this is seen within pot and trap métiers, which can be set and left while the vessel returns to port. In the Irish Sea these two métiers, contribute relativly little effort compared to other métiers. All other métiers spend a far greater time actively fishing each day.

The greatest effort in days and hours fishing is expended by the *Nephrops* métier (MC1; Table 9). On average, a higher level of effort is directed to scallop dredging (MC9) and whitefish, and rays mixed small mesh bottom otter trawling (MC22) than to other métiers. A number of métiers account for relatively little effort in both days and hours fishing. Razor shell dredging (MC8) is a highly specialised, small métier, which is reflected in its very low effort contribution. The hours fishing deployed by pelagic métiers is very low. The mixed pelagic métier (MC16) however, contributes a greater amount in days fishing than the sprat métier (MC15), whose effort is in decline. Furthermore, the ray directed large mesh beam trawling métier (MC3), and cod, pollack, ling and saithe directed small mesh bottom otter trawl métier (MC20) contribute very little to overall effort in the Irish Sea, and both are in decline.

Some effort distribution changes occurred in the Irish Sea from 2003 to 2005. Although *Nephrops* directed effort (MC1) remained stable in both hours fishing and days fishing contributing on average 47% and 43% of the total, respectively (Table 9), several métiers show declining effort since 2003. Seven métiers contained less than 15 days fishing in 2005, all of which had declined over the period, although at varying rates. Ray directed large mesh beam trawls (MC3), and plaice and ray large mesh bottom otter trawls (MC5) showed reductions of over 200 days from 2005. Scallop dredging (MC9), although remaining a relevant métier in 2005, has shown a strong decline in fishing days, of over 200 since 2003, representing a relative decline of 46%. A proportion of this decline may be a result of recent decommissioning targeted at this métier. The greatest increase in effort was within the crab pot and trap métier (MC 7), representing a relative increase of 264%, to 200 fishing days in 2005. This is probably due to increased reporting rates as mentioned previously. However, this is not the only métier to show a large increase of fishing days, the ray directed small mesh bottom otter trawl métier (MC4) increased by over 200 days, a relative increase of 178%. Effort in fishing days is also increasing in the mixed pelagic (MC16) and the whelk pot and trap (MC6) métiers.

4 Discussion

Much is known about Irish fishing activities in the Irish Sea through a priori knowledge and ad hoc analysis. This investigation statistically defines métiers in a systematic way without prior assumptions. There are three major aspects of the study to discuss. Firstly, the utility of the statistical methods used to define métiers in the Irish Sea. Secondly, the distribution and stability of fishing activity and landing compositions. Thirdly, the utility of the defined métiers in a wider context. All discussion should be prefaced by the comment that this analysis is only as reliable as the input data. In this case study, logbook data is the primary data source and the lack of discard data, misreported landings and other data anomalies may have impacted the results obtained.

The combination of factorial analysis, clustering and expert knowledge were used to define métiers. These statistical methods have previously been used successfully to identify fleets, fisheries and métiers (e.g. Pelletier & Ferraris, 2000, Ulrich & Anderson, 2004 and Holley & Marchal, 2004). Neither technique requires prior assumptions on the distribution of variables, as their results simply describe what is within the dataset. Combined, these approaches firstly, generate linear factors producing axes where the greatest variation lies on the first axes, simplifying large data sets. Secondly, individuals are grouped into well separated homogeneous clusters, which can be related to the observed variables. Clustering makes the factorial axes and individual coordinates from the analysis easier to visualise and interpret. Here, cluster analysis had the added advantage that it allowed fishing trips with missing information, such as mesh size, to be grouped with other trips based on remaining variables so that missing information could be predicted. Trips where details may have been miss-recorded, such as pots and traps landing large quantities of herring can also be identified. Consequently, these techniques can be very useful in quality controlling logbook data sets.

There is debate in the literature on the most appropriate measure of species to use for landing profile analysis. There are two main measures: landed weight (e.g. Biseau, 1998; Pelletier & Ferraris, 2000; Holley & Marchal, 2004) and monetary value, taken from price-at-first-sale (e.g. Mahévas et al., 2004; Ulrich & Anderson, 2004). Value is preferred by SGDFF (ICES, 2003), considering it more likely to “reflect the real intentions of fishermen”, particularly for low weight high value species. Value may be misleading however, as it does not account for operating costs and is dependant on normal price fluctuations (Holley & Marchal, 2004). Species values fluctuate over time due to market constraints (Biseau, 1998) making métier definitions difficult to apply over several years. Here, weight was utilised since accurate landings values were not available at the time the analysis was carried out. It may be interesting to repeat the analysis at a later date to see if value makes a significant difference to the resulting métiers. However, it is unlikely that the signal in the dominant métiers would be changed significantly if landing values were used. Black sole may be a possible exception, due to low landed weights and high value per kilogram, resulting in an increased relative importance over weight based analysis.

It is agreed, as Biseau (1998) highlights, that métiers based on landings, either weight or value, include the inherent assumption that the intentions of fishers are revealed by landings. In other words, fishers catch the species that their effort was directed towards. However, it is not possible to know their intentions. Therefore, as with Biseau, a correlation between intention and landings is assumed. As there is a quota system in place fishers will participate in métiers for which they have available quota which are economically viable. A consequence of quota management is that species the fishers do not have quotas for may be misreported or discarded. This could undermine the analysis and subsequent métier definitions.

As in other studies, the multivariate techniques applied here have proved an extremely useful tool to identify métiers. Providing confirmation of the fisheries known, through a priori knowledge, to exist in the Irish Sea. It is noted here, and by other studies (such as Ulrich & Andersen, 2004, Pelletier & Ferraris, 2000, and ICES, 2003), that statistical techniques need to be supplemented by expert knowledge, through subjective choices, to truly define relevant and appropriate métiers. For example, in this analysis 12 clusters in which *Nephrops* had the greatest landings proportions were collapsed into a single métier.

The combined analyses identified gear type, mesh size and landing profile as particularly important variables in defining Irish Sea métiers. This is not surprising given gear type and mesh size combinations are able, to a certain extent, to select species or species groups. For example, mid-water trawling with small mesh sizes (<70) selecting for pelagic species. Vessel length and season (month) were seen to vary with métier, although were often not essential to the definition of a métier. An important finding, observed throughout the Irish Sea, is the targeting of different species groups with the same gear type and visa-versa. Therefore, métiers could not be defined solely by gear type or species, both were required. This was also found by Pelletier and Ferraris (2000), and Ulrich and Anderson (2004).

Métier importance varied with landed weight, days fishing effort or hours fishing effort. The mixed pelagic pair trawl métier (MC16) is a good example. This métier landed the greatest weight, yet contributed a relatively small amount of effort to the total fishing days and fishing hours within the Irish Sea. This highlights the importance of incorporating all available information (i.e. landed weight, numbers of trips and vessels, and effort measures) after analysis to determine appropriate, relevant, and realistic métiers.

Fishing is a dynamic industry, constantly evolving and adapting to changing conditions in market demand, resource availability, and management restrictions. This must be considered when examining métier stability. Métiers defined with 2003 data were applied to 2004 and 2005 logbook trips. Over this period, the variety of métiers declined with some becoming obsolete. Métiers which contain few trips and little effort are disappearing, leaving fewer, larger métiers, particularly obvious when observing effort distribution. It is likely four such métiers will soon become obsolete (MCs: 3, 18, 19, 20), each containing competitively low landings, for example <25 ton, with just one or two vessels and/or trips in 2005. Each of these is defined by a large mesh size, and/or directed towards cod, pollack, ling and saithe. It should be noted however, that it is possible for a couple of vessels to land relatively large weights and as such be viable métiers. The ray directed large mesh beam trawl métier (MC18) is a good example of this having contained 2 vessels carrying out 56 trips and landings around 330 ton in 2003. This can also be true for métiers targeting pelagic species where during a single trip several hundred tonnes or more may be landed. Métiers containing the greatest proportions of overall effort remained stable, with little variation in trip and vessel numbers, including the OTB métier targeting *Nephrops* (MC1). What is interesting is that the recent introduction of days-at-sea appears to have had little impact on the *Nephrops* métier, whilst an increase in effort was observed within the mixed whitefish métier using 70-99mm mesh size (MC22) together with significant effort decreases in the equivalent larger mesh métiers.

Several notable increases were observed over the period, firstly increasing trips within both whelk directed, and crab and “Other” directed pot and trap métiers (MC6 and MC7 respectively). However, vessel numbers within these métiers remained stable, suggesting vessels carried out (or reported) a greater number of trips. This may have occurred for several reasons such as a need to increase the time spent fishing to remain economically viable, or reduced activity within other métiers/areas due to reduced species availability, or management restrictions. Further investigation would be required to determine the exact cause however. Within the whitefish and ray mixed small mesh OTB métier (MC22) vessel numbers substantially increased. Trip numbers however, showed little increase. This suggests fewer trips per vessel than in 2003, and vessels are likely to have high participation within other métiers or fish in other ICES areas.

The mixed pelagic pair trawl métier (MC16) contributes the greatest landed weight in the Irish Sea. However, these landings are low compared to pelagic landings in other ICES areas and would not be considered of great importance to overall Irish pelagic landings. The west of Scotland (ICES VIa), for example, lands around 80,000 ton of pelagic species per year. In terms of overall effort contribution, this métier is small, with low days fishing activity, trip and vessel numbers, far below many other métiers. Therefore, although the landings for this métier are the highest in the Irish Sea, it could not be called the dominant métier in the area and is relatively minor in Irish pelagic fisheries as a whole.

Distribution of cod in the landings of each métier is of interest, given the poor state of the stock and the on going recovery plan. Over the three years, total cod landings by Irish vessels halved. However, cod is caught and landed in varying proportions by the majority of métiers and it continues to be a valuable component of the landings. For métiers where cod was identified as a defining species, proportionally cod contributed between 21.2% and 43% of the landed weight. Of non-target métiers cod is landed in proportions up to 7.2%. Six of which, contribute more than 5%, the threshold often used in days-at-sea management, below which a greater number of days can be applied for. In the *Nephrops* métier (MC1) for example, 3.9% of total average landings is cod. Overall, métiers where cod was a defined species contain a lower average annual landing of cod than in non-target métiers (124t to 208t). An additional 45t per year is landed by non-métier allocated trips. This implies that traditional cod targeting as part of the whitefish fishery is no longer significant although many métiers catch cod at low levels. Achieving the management object of reducing fishing mortality in cod needs to take into account the distribution of cod catches (and partial fishing mortality) across métiers.

The majority of métiers show little, or no, seasonal variation in landings pattern, occurring throughout the year. The two pelagic métiers however showed the greatest seasonality, occurring between October and March. Once these definitions were applied to 2004 and 2005 this seasonality appeared to break down, with landings throughout the year. The seasonality which does occur within these two métiers is driven by quota allocations and fishery restrictions. Once the fishery opens, vessels fish for these species until quotas are met, and the fishery closes. Seasonal variation in availability may also occur in métiers targeting cod, pollack, ling and saithe which primarily occur within the first two or three quarters. Cod catchability is known to vary throughout the year, traditionally fisheries occur within the first quarter (when cod aggregate to spawn), which may explain what is seen here. Plaice and ray directed trips did not occur in the first quarter, possibly showing reduced plaice availability, as other métiers directed toward ray species occur year round. Many flatfish species are known to display seasonal variation in availability. The *Nephrops* métier occurs throughout the year, although there is seasonal variability in landings. The variability is strongly linked to *Nephrops* emergence behaviour, largely determined by seasonal and tidal influences. In the Irish Sea highest catches occur in June, July and August. Whereas, catches in winter (November-January) are lower.

A section of Irish fishing vessels are multi-gear vessels indicating a polyvalent and flexible nature. In particular, bottom otter trawling vessels also employ static gear, such as pots or gillnets. Furthermore, vessels employ different mesh size combinations to exploit various different species mixes. These polyvalent vessels account for around 45% of vessels operating in the Irish Sea. Many vessels with trips in the *Nephrops* métier also carry out trips allocated to the various whitefish and ray métiers. There are several possible reasons for this. Fishers target a number of different species throughout the year, based on quota allocations and resource availability. It is also possible that, although a trip may be targeting *Nephrops*, proportions do not reach the defined threshold to be allocated to the *Nephrops* métier. A further possibility is that *Nephrops* trawlers switch to targeting gadoids when abundant, or when *Nephrops* are scarce. A similar tactic was described in the Celtic Sea by Biseau (1998) where French vessels reported targeting *Nephrops* during daylight and targeting gadoids at night, resulting in a mixed species métier classification. The number of métiers is declining, as is the maximum practiced by any single vessel from 7 in 2003 to 5 in 2005, the percentage of vessels belonging to multiple métiers however, remains unchanged. The majority of Irish fishing vessels specialise in a single métier (55%). Of these, dredging vessels appear to be the most specialised, remaining consistent in gear and target species. Within the Irish Sea two targets were identified, razor shells ("other"; MC8) and scallops (MC9).

A number of trips could not be allocated to a métier, and were subsequently divided into one of the four non-métier groupings. These accounted for, on average, 14% of annual effort in fishing days. These groups include gears not commonly utilised in the Irish Sea, trips with missing information which can not be placed into a métier by species composition and gear allocation rules and trips which may have miss-recorded information, such as pots and traps landing herring. These non-métier groupings can prove extremely useful, as it is here that developing métiers will emerge, and changes or expansions of defined métiers may be detected, such as the mixed pelagic métier indicating a shift toward year round fishing. On a final note, the numbers of trips where mesh size was not recorded varied on an annual basis, with a dramatic increase in 2004, declined to a single trip in 2005. The reason for the observed variation remains unclear.

Effective advice provision and management should be in a mixed fisheries context requiring métiers to be defined. The métiers defined here, as with the fishing tactics defined by Pelletier and Ferraris (2000), provide a method of partitioning Ireland's complex fleets and fisheries into more homogenous components, impacting the resource in a similar ways. Many of the Irish Sea métiers identified are defined by multiple species and land a variety of additional species in low proportions illustrating the mixed nature of fishing. Now appropriate métiers have been defined, their application in a wider context must be considered. This study has highlighted the need to account, not only for species interactions, but also for technical interactions of multi-fleet fisheries and the interactions between the two. This is illustrated by the need of both vessel and species characteristics to adequately define métiers. The complexity of métiers observed will inevitably provide challenges to effective advice provision and management. It may well be necessary to collapse defined métiers into larger groupings. With this in mind, these métiers have been defined in a way (i.e. by species group, gear and mesh size) that they can be recombined.

The analysis used landings post-stratification to determine métiers and their relative importance. This information can aid the construction of the national sampling programs. Indeed, the analysis could be extended to take into account the size structure of species in the landings, or better still the catches, of each métier. There are two types of sampling programmes: port sampling which collects length and age from landings, and discard sampling which is carried out on board to sample the whole catch. Each of these methods should compliment each other and with similar coverage. However, sampling programs are often resource limited and it would be unlikely that each of the métiers defined here could be sampled. Therefore, understanding the importance of the various métiers and stratifying sampling effort accordingly is vitally important in providing adequate, accurate and precise sampling. The defined métiers can be combined into larger groups to reach a compromise between realistically achievable sampling levels and retention of métier homogeneity. In the Irish Sea, the 22 métiers could be combined, into 8 key groups for example, *Nephrops* OTB, four demersal fish groups specified by the gear types OTB, beam trawl, Scottish seine, and gillnet, as well as pelagic trawl, shellfish dredge, and crustacean pot and trap groups. In this, the dominant métier (*Nephrops* OBT) remains unchanged, whilst less important métiers with similar characteristics can be combined. In relation to discard sampling in particular, although analysis is based on past landings, vessels can be grouped into one of the groups above using vessel track records and knowledge of real time vessel activity. It may also be necessary to confirm with the skipper the target métiers before sampling given that some vessels switch métiers.

Similarly to sampling, it is acknowledged that management of all 22 métiers would be both impractical, and in many cases inappropriate. Management can not necessarily be based at the vessel level as they have been shown to occur within more than one métier. Again a compromise is required, between métier homogeneity and realistic, practical management. It is possible to manage those métiers in which a large proportion of the fleet is active (such as *Nephrops* OTB). Remaining métiers can be combined into a more appropriate number of larger groupings with similar characteristics. Some specialised métiers can be easily managed separately (e.g. razor shell dredging). For effective métier based management for the more complex métiers factors such as gear type, catch composition, mesh size and in some cases season will need to be considered. Vessel track histories in combination with vessel quota allocations can be utilised in assigning vessels to appropriate métiers. Flexibility in the management framework would also be needed, to account for vessels changing activities throughout the year. Management could be structured quarterly, bi-monthly or monthly to accommodate this. One should also remember that fishing and the resource that they exploit are dynamic and métier structure should be constantly adapted to reflect this.

As stated above, those métiers of greatest importance and relevance may warrant separate management and advice. In the Irish Sea the *Nephrops* directed bottom otter trawling métier can be considered as the most important, accounting for a consistently large proportion of trips, vessels, effort, and landings. Combining this métier with others within the Irish Sea (e.g. OTB 70-99mm meshes) would severely compromise ones ability to manage this métier effectively. Within this métier *Nephrops* accounts for 85% of the landings. This is significantly greater than the 50% qualification level adopted for this analysis and the 30% landings composition required by regulation to permit the use of mesh sizes in the range 70-89 mm. Within this métier there are some more mixed trips where *Nephrops* proportions in the landings are between 50% and 80%. Given the satiability of the *Nephrops* stock and that other by-catch species such as cod and whiting are at low levels management efforts could focus on moving towards a single species *Nephrops* métier. This could be achieved with technical measures such as rigid grids, square mesh panels/cod-ends or separator panels which would reduce non-*Nephrops* by-catches. Limited quotas of non-*Nephrops* TAC species and less restrictive *Nephrops* TACs would further encourage a single species specialisation. Other key factors would also need to be considered when managing this *Nephrops* métier. Of particular importance is the high discard rates associated with the *Nephrops* métier and also the spatially discrete distribution of the *Nephrops* stock. The ultimate management objective might be to optimise the economic yield from the *Nephrops* stock whilst minimising effort and the impact of the fishery on the wider ecosystem.

5 Conclusions

This is the first Irish case study in applying multivariate statistics to define métiers. Despite some limitations (i.e. accuracy of logbook data and the lack of discards data) this investigation has shown the applied methodology is a suitable tool to identify métiers without prior assumptions. It has provided a useful and informative starting point for multivariate analysis of all Irish logbook data. Métier identification and definition will now begin across the whole of the Irish fleet and fisheries.

Overall 22 métiers were identified for Irish vessels ≥10m in the Irish Sea, and a further 5 groups were formed to include trips which could not be assigned to a métier due to lack of clear target species, “exploratory” trips, missing or miss-recorded information. Here the dominant métier contained high proportions of landed *Nephrops* taken by bottom otter trawlers using between 70mm and 89mm meshes, and has remained so in recent years. Changes within métiers over recent years have contributed to a deeper understanding of fleet dynamics in the Irish Sea, for example increasing effort and trip allocation to pot and trap fishing for crustacean species. The response of the fleet to recent management measures can also be identified. For example the declining trip and effort contributions by métiers defined by mobile gears, such as bottom otter trawls, and beam trawls with ≥100mm mesh where days-at-sea are most restrictive.

The métiers defined for the Irish Sea will enhance the Irish sampling program by ensuring that all the important métiers are sampled. This should lead to more appropriate sampling coverage and stratification resulting in improved precision of national assessment data. The métiers defined can potentially be used to manage fishing activity at an appropriate scale. For example the possibility of managing the *Nephrops* directed métier is discussed. Developing métier based management will require a new approach given the relatively complexity of the métiers defined and need for adaptive change over time.

Although this investigation provides relevant and useful insights to the fleet and fisheries dynamics in the Irish Sea, this is a relatively small area and has been a stepping stone in the definition of all Irish métiers. Its expansion spatially, temporally, and in resolution, will prove advantageous in gaining a greater understanding of the dynamics within the Irish fishing industry. In turn, this will result in more effective mixed fisheries advice which can be feed into the formulation of management plans to aid in the protection of vulnerable species whilst creating a context for sustainable exploitation.

Tables and Figures

Table 1. Species and "species groups" included in analysis with the average annual landings for all Irish vessels across all areas. Note landed weight is an annual average over the period 2003-2005.

Species Group	Scientific name(s)	Landed weight (ton)
Mackerel	*Scomber japonicus*	3,332.3
	Scomber scombrus	57,891.9
	Scomber spp	1.0
	Scombridae	54.2
	Scombroidei	1.8
Blue Whiting	*Micromesistius poutassou*	49,483.5
Horse Mackerel	*Trachurus spp*	18,322.8
	Trachurus trachurus	15,154.3
Herring	*Clupea harengus*	28,058.3
	Clupeidae	5,180.1
Sardinella	*Sardinella aurita*	20,207.5
Nephrops	*Nephrops norvegicus*	6,824.5
European Pilchard	*Sardina pilchardus*	6,139.0
Whiting	*Merlangius merlangus*	5,248.8
Sprat	*Clupeonella engrauliformis*	327.4
	Sprattus sprattus	4,288.2
Crab	*Cancer pagurus*	4,172.9
	Maja squinado	8.6
	Necora puber	5.4
Megrim	*Lepidorhombus spp.*	2,538.5
Ray	*Amblyraja radiata*	0.4
	Raja brachyura	1.9
	Raja montagui	1.2
	Raja spp	2,220.8
	Rajiformes	189.9
Haddock	*Melanogrammus aeglefinus*	2,398.0
Monkfish	*Lophius Piscatorius*	537.4
	Lophius spp	1,833.2
Scallop	*Aequipecten opercularis*	74.5
	Pecten maximus	1,727.3
	Pectinidae	1.6
Mussel	*Mytilus edulis*	1,712.7
Dogfish	*Scyliorhinidae*	12.8
	Scyliorhinus canicula	164.8
	Scyliorhinus spp	2.0
	Squalidae	89.6
	Squalidae, Scyliorhinidae	254.4
	Squaliformes	1.3
	Squalus acanthias	1,011.9
	Squalus spp	118.3
Cod	*Gadus morhua*	1,236.9
	Gadus spp	0.2

Table 1 continued.

Species Group	Scientific name(s)	Landed weight (ton)
Ling	*Molva molva*	1,082.2
	Molva spp	47.6
Hake	*Merluccius merluccius*	1,024.2
	Merluccius spp	0.1
	Urophycis tenuis	0.1
Pollack	*Pollachius pollachius*	919.8
Witch	*Glyptocephalus cynoglossus*	892.1
Cardinalfish	*Apogonidae spp.*	759.3
	Epigonus telescopus	65.0
Atlantic Spanish mackerel	*Scomberomorus maculatus*	782.0
Plaice	*Pleuronectes platessa*	629.1
Saithe	*Pollachius virens*	625.9
Tuna	*Euthynnus alletteratus*	13.6
	Katsuwonus pelamis	0.2
	Thunnini	120.9
	Thunnus alalunga	404.3
	Thunnus albacares	0.1
	Thunnus maccoyii	0.8
	Thunnus obesus	0.1
	Thunnus thynnus	1.5
Deepwater Shark	*Centrophorus granulosus*	5.3
	Centroscymnus coelolepis	472.2
	Dalatias licha	15.1
	Galeus melastomus	0.5
	Scymnodon ringens	1.7
Lemon Sole	*Microstomus kitt*	463.0
Boarfish	*Caproidae*	312.0
	Capros aper	140.8
John dory	*Zeidae*	0.3
	Zeus faber	368.2
Grenadier	*Coryphaenoides rupestris*	61.1
	Macrourus berglax	45.8
	Macrourus spp	222.4
	Nezumia aequalis	22.5
Squid	*Illex illecebrosus*	54.2
	Loliginidae, Ommastrephidae	147.7
	Loligo spp	119.5
	Loligo vulgaris	2.2
	Ommastrephidae	14.1
	Todarodes sagittatus	12.6
Conger eel	*Conger conger*	329.6
	Conger spp	3.7
Sole Black	*Solea solea*	285.0
Whelk	*Buccinum undatum*	272.9
Forkbeard	*Phycis blennoides*	255.6
	Phycis phycis	5.6

Table 2. Species and "species groups" included within the "other" category due to low abundance across all areas (each accounting for <0.1% of the total landings). Note landed weight is an annual average over the period 2003-2005.

Species Group	Scientific name(s)	Landed weight (ton)
Turbot	Psetta maxima	213.2
Orange roughy	Hoplostethus atlanticus	205.0
Redfish	Centroberyx affinis	186.5
	Sebastes mentella	15.6
	Sebastes Viviparus	4.6
Scabbardfish spp.	Aphanopus carbo	179.2
	Lepidopus caudatus	84.6
	Aphanopus intermedius	1.2
Bonito	Sarda sarda	117.8
Brill	Scopthalmus rhombus	103.6
Gurnard	Triglidae spp.	92.9
Scorpianfishes nei	NULL	76.0
Crab deepsea red	Chaecon affinis	69.0
Argentine	Argentina spp	65.5
Skates and Rays nei	Rajidae	59.0
	Raja nasuta	5.4
	Raja stellulata	0.9
	Myliobatidae	0.5
	Raja hyperborea	0.4
	Raja nidarosiensis	0.2
	Raja oxyrinchus	0.04
Tusk	Brosme brosme	45.0
Dab	Limanda limanda	30.5
Blue ling	Molva dypterygia	20.6
Flounder	Platichthys flesus	19.7
Codlings	Moridae	19.2
Pouting	Trisopterus luscus	19.2
Lobster	Homarus gammarus	16.1
Octopodidae family	Eledone spp	14.6
	Octopodidae	4.5
	Octopus vulgaris	2.9
Mora	Mora moro	13.1
Bluemouth	Heliocolenus dactyloptreus	12.5
Wolffish	Anarhichas lupus	11.3
	Anarhichas spp	7.3
Mackerel Shark spp.	Lamna nasus	10.6
	Lamnidae	0.4
	Lamniformes	0.02
Halibut	Hippoglossus hippoglossus	8.3
Mullet spp.	Mullus surmuletus	7.1
	Mugilidae	3.6
	Liza aurata	0.4
	Mullus spp	0.1
Tope shark	Galeorhinus galeus	5.7
Razor clam	Solenidae	5.6

Table 2 Continued.

Species Group	Scientific name(s)	Landed weight (ton)
Swordfish	Xiphias gladius	4.7
Alfonsino	Beryx splendens	4.2
Razor Shell	Ensis ensis	3.5
Gadiformes nei	Gadiformes	3.0
Spiny Lobster spp	Palinurus spp	2.6
	Palinuridae	0.9
	Palinurus elephas	0.2
Shrimp spp	Palaemonidae	2.3
	Crangon crangon	1.5
	Aristaeomorpha foliacea	0.1
	Crangon spp	0.1
Ocean perch	Sebastes marinus	2.1
Smoothhead spp.	Alepocephalus rostratus	2.1
	Alepocephalus bairdii	1.8
Smooth hound spp.	Mustelus spp	1.6
	Mustelus mustelus	0.7
	Triakidae	0.1
Rabbit Fish	Chimaera monstrosa	1.5
Greenland Halibut	Reinhardtius hippoglossoides	1.5
Cuttlefish spp.	Sepiidae, Sepiolidae	1.2
	Sepia officinalis	0.4
Oyster	Ostrea edulis	1.2
Nursehound	Scyliorhinus stellaris	0.9
Blue Shark	Prionace glauca	0.8
Garfish	Belone spp	0.6
Selachimorpha nei	Selachimorpha	0.5
Cockle	Dinocardium robustum	0.3
	Cerastoderma edule	0.1
Hairtail, Scabbardfish nei	Trichiuridae	0.3
Clam	Spisula solidissima	0.3
Norway pout	Trisopterus esmarkii	0.2
Pomfret	Brama brama	0.2
Sand gaper	Mya arenaria	0.1
Pelagic Shark	Alopias spp	0.1
Wreckfish	Polyprion americanus	0.002
Seabass	Dicentrarchus spp	0.001

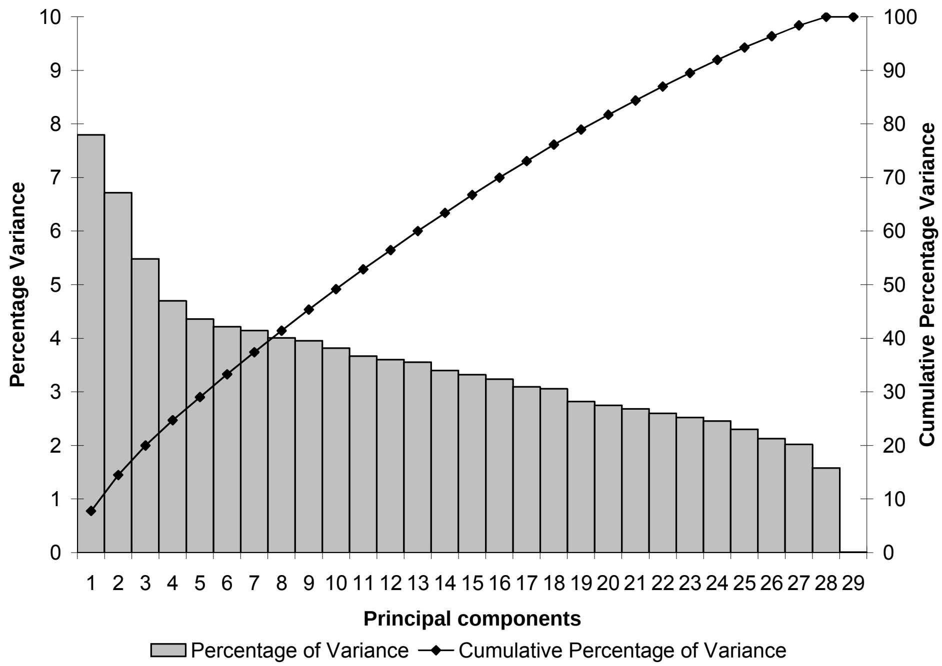

Figure 1. Percentage of the variance explained by each component and cumulative percentage variance from Principal Component Analysis of species proportions by trip in the Irish Sea, 2003.

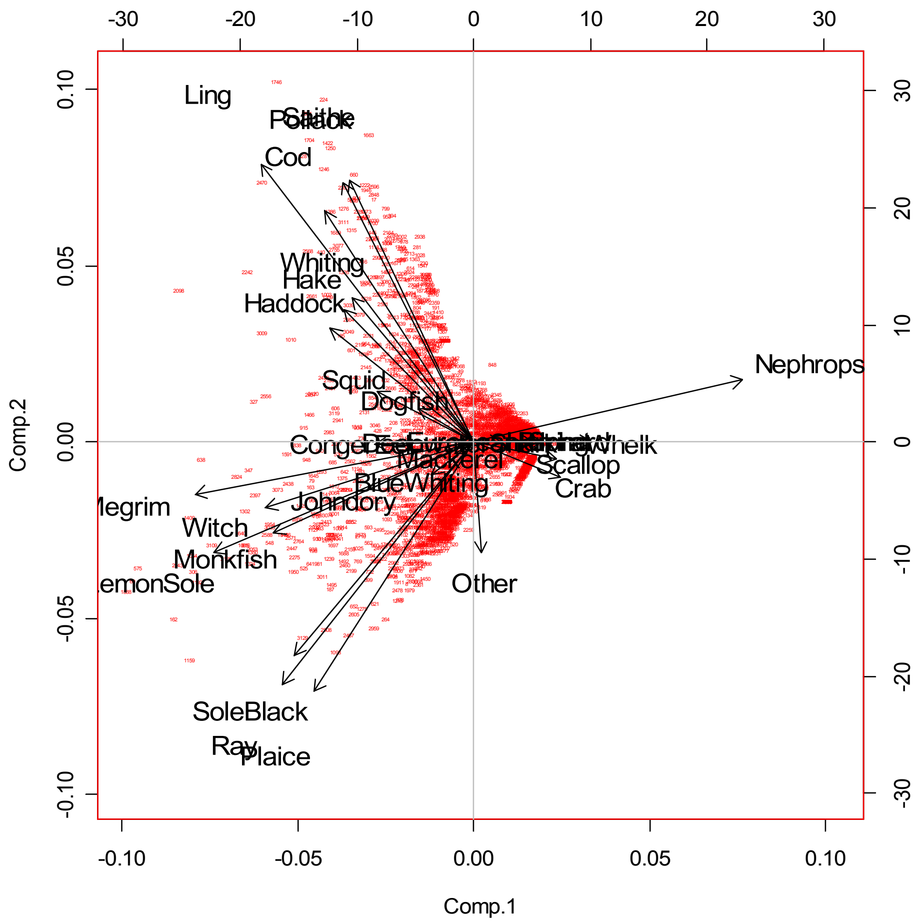

Figure 2. Bi-plot representation of the first two factorial axes from Principal Component Analysis of species proportions by trip within the Irish Sea, 2003. Fishing trips are represented by randomly assigned numbers. Three groups can be identified: 1) Cod, pollack, ling, and saithe in the top left area, 2) *Nephrops* in the top right, 3) Black sole, plaice and ray species in the bottom left.

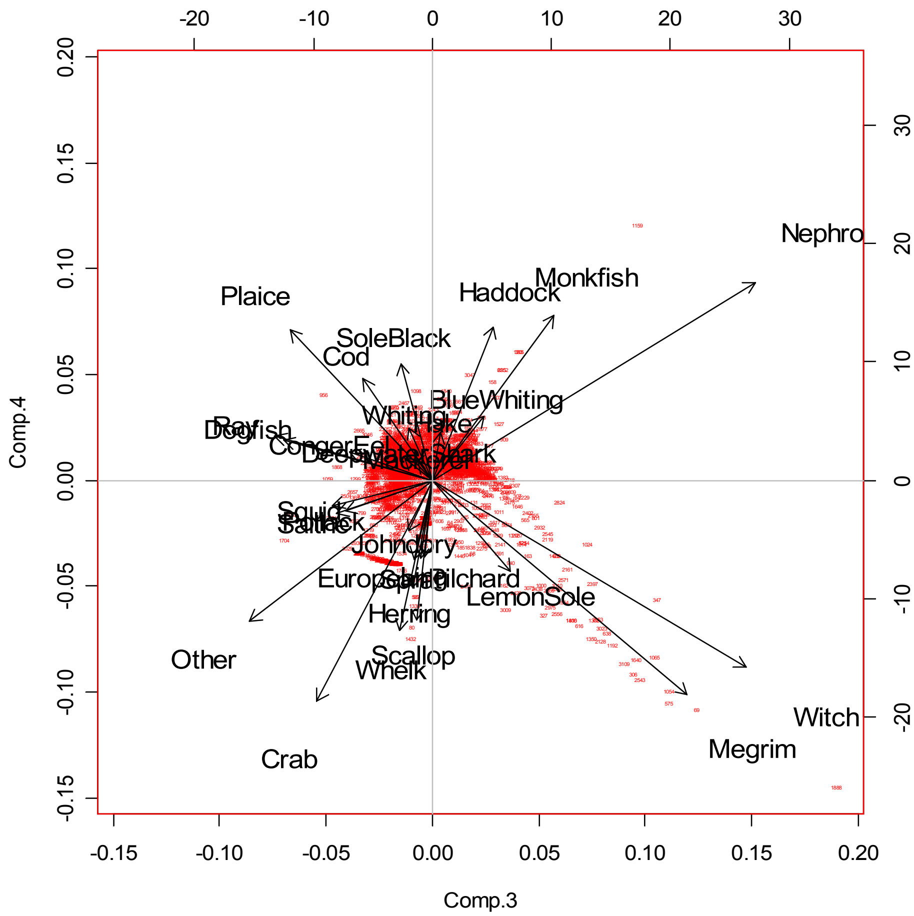

Figure 3. Bi-plot representation of the third and fourth factorial axes from Principal Component Analysis of species proportions by trip within the Irish Sea, 2003. Fishing trips are represented by randomly assigned numbers. Four groups can be identified consisting primarily of: 1) Plaice in the top left area, 2) *Nephrops* in the top right, 3) crab and the "other" grouping in the bottom left, 4) Witch and megrim in the bottom right.

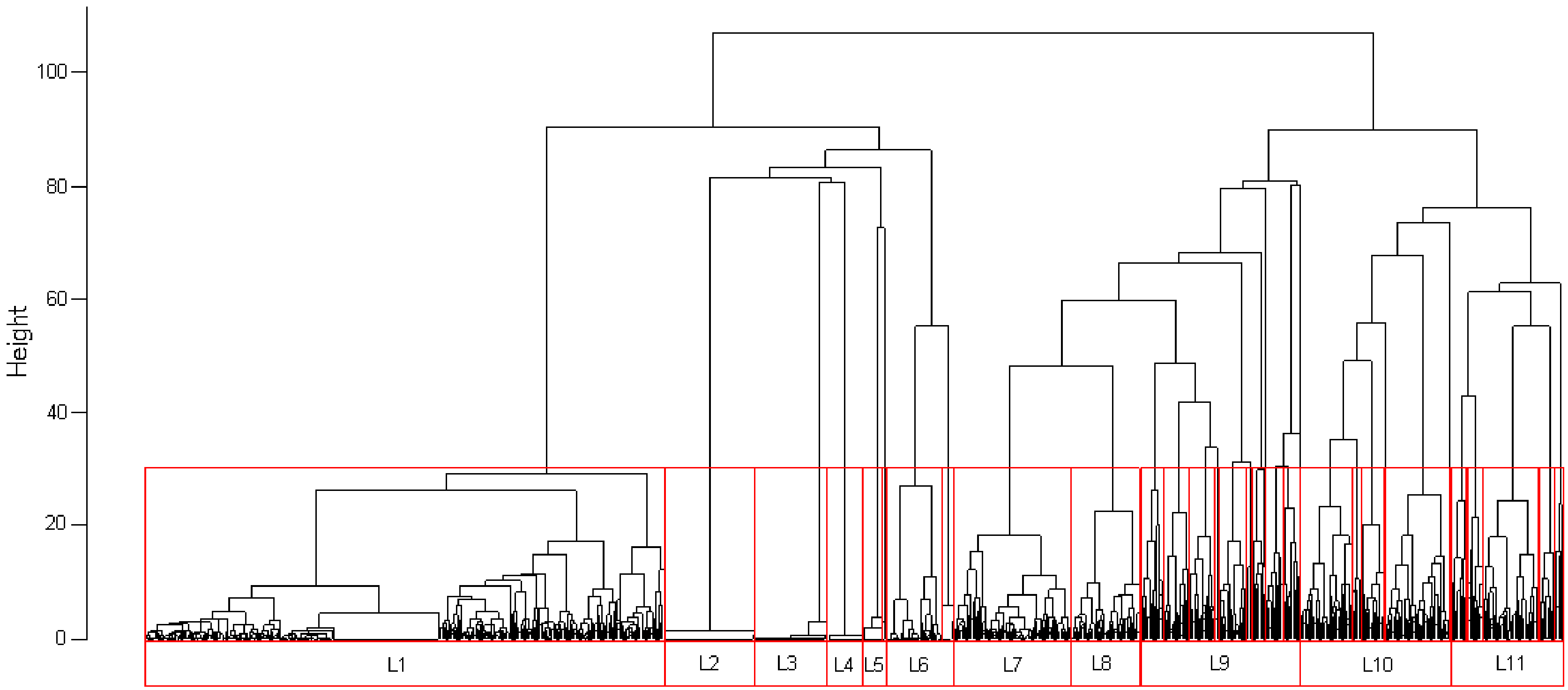

Figure 4. Hierarchical Agglomerative Cluster analysis tree based on factorial coordinates from the Principal Component analysis of species proportions by trip within the Irish Sea, 2003. The red boxes indicate the 33 clusters obtained where the percentage of variance explained levelled off, explaining 78% of the variation within the dataset. How clusters relate to landing profiles is specified by the prefix L, and detailed in Table 3.

Table 3. Landing profiles resulting from clustering of coordinates from Principal Component Analysis of species proportions by trip in the Irish Sea, 2003. Details are provided of the species or species group with the highest proportion in each profile, and number of trips within each profile.

Landing Profile	Main Species	Number of fishing trips
1	*Nephrops*	1151
2	Whelk	199
3	Scallop	163
4	Sprat	76
5	Herring	52
6	Crab, "other" category species	152
7	Ray species	260
8	Plaice, ray species	151
9	Ray species, monkfish, megrim, witch, lemon sole, black sole	356
10	haddock, whiting, cod, dogfish, pollack	331
11	Cod, pollack, ling and saithe	251

Table 4. Details of the final variable groupings used in Multiple Correspondence Analysis. i) Gear type and mesh size based on Council regulation 51/2006 Annex IIA, and ii) length based on the recommendations of the Regional Co-ordination Meeting of the North East Atlantic (2005).

i)

Gear Grouping	**Specific Gear Types**	**Mesh range**
Dredges	DRB - Dredges, DRH - Hand dredges used on board a vessel	none
Pots and Traps	FPO - Pots	none
Gillnets	GND - Gillnets (Drift), GNS - Gillnets (Set)	<110, ≥110 to <220, ≥220
Trammel nets	GTN - Combined trammel and gillnets, GTR - Trammel Nets	none
Longlines	LHP - Hooks and lines Hand lines and pole lines (hand operated), LLD - Longlines (Drift), LLS - Longlines (Set), LTL - Troll lines	none
No gear recorded	NO - No gear, NULL	none
Trawls - Pelagic and Demersal	OTB - Bottom Otter Trawls, OTM - Mid-water Otter Trawls, PS - Purse Seines, PTB - Bottom Pair Trawls, PTM - Mid-water Pair Trawls, SDN - Danish Seines (anchor), SPR - Pair seines, SSC Scottish Seines (Fly-dragging)	≥16 to <32, 32-54*, 55-69*, ≥70 to <90, ≥90 to <100, ≥100 to <120, ≥120
Beam Trawls	TBB - Beam Trawls	≥80 to <90, ≥90 to <100, ≥100 to <120, ≥120
Multiple gear	Multiple gear groups recorded within a single trip.	Mesh size category of the gear group with greatest employment adopted

* Note that 32 to 69mm mesh sizes are not considered in Annex IIA of council regulation 51/2006

ii)

Length*
10-12
12-15
15-18
18-24
24-40
40-80
> 80

* Note vessels under 10 meters have not been included in analysis

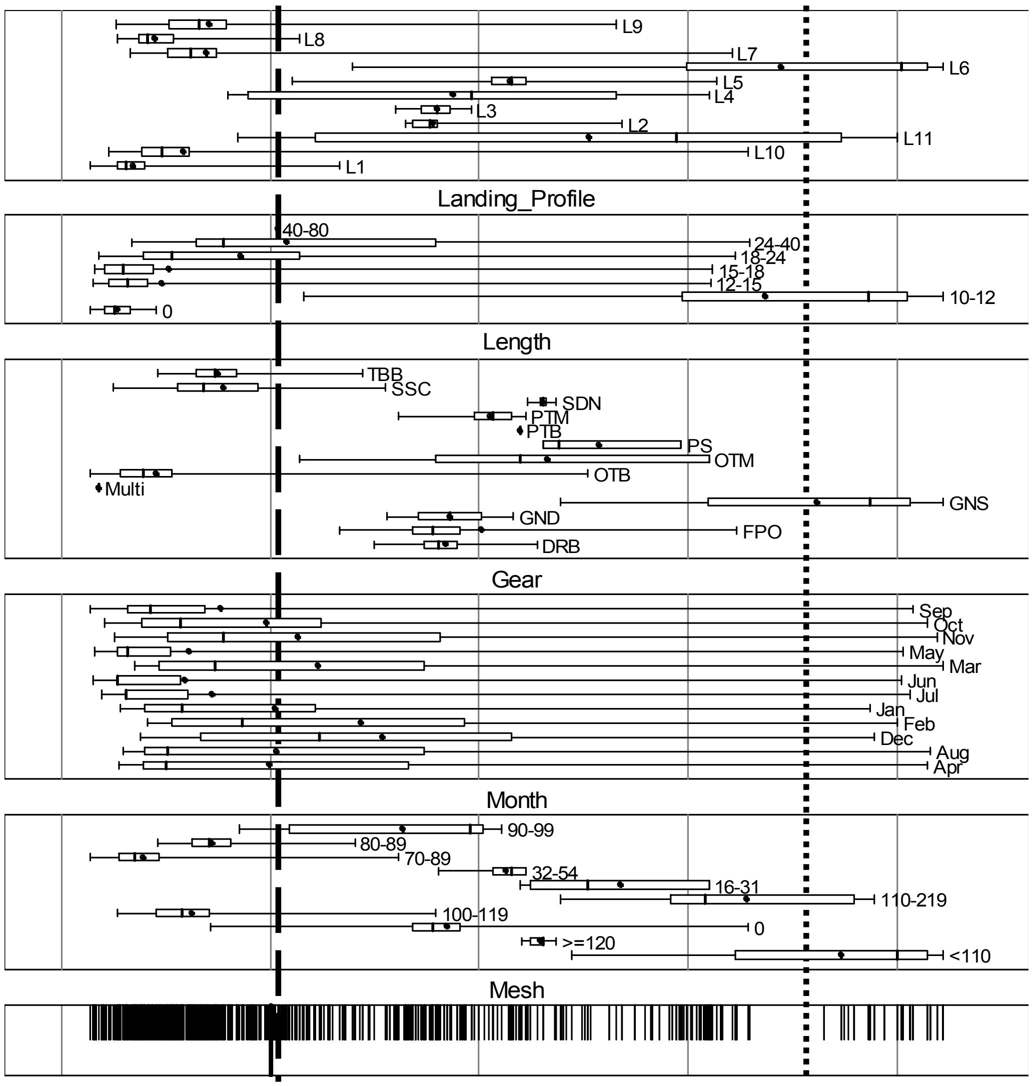

Figure 5. Boxplot representation of the link between the first (the most important) Multiple Correspondence Analysis (MCA) axis and the categorical (trip) variables. The x-axis represents values from the first MCA axis, and each line corresponds to a fishing trip, with the greatest trip density to the left of the plot, i.e. the trips with the most similar values and thus, the most similar variable factors (trip characteristics). Factors (characteristics) with boxes to the left of the long dash line dominate in the Irish Sea. This includes landing profiles 9, 8, 7, 10 and 1, vessel lengths 12-15m, 15-18m, 18-24m, , gear types TBB, SSC, and OTB, and mesh sizes 70-79, 80-89mm 100-119. Month is the only variable where factors occur across the whole x-axis, indicating that this is not a specific variable. Trips to the right of the short dash line, separated from the main, suggest a specialised group, consisting landing profiles 6 and 11, vessels 10-12m in length, GNS gear, <110mm and 110-219mm mesh ranges.

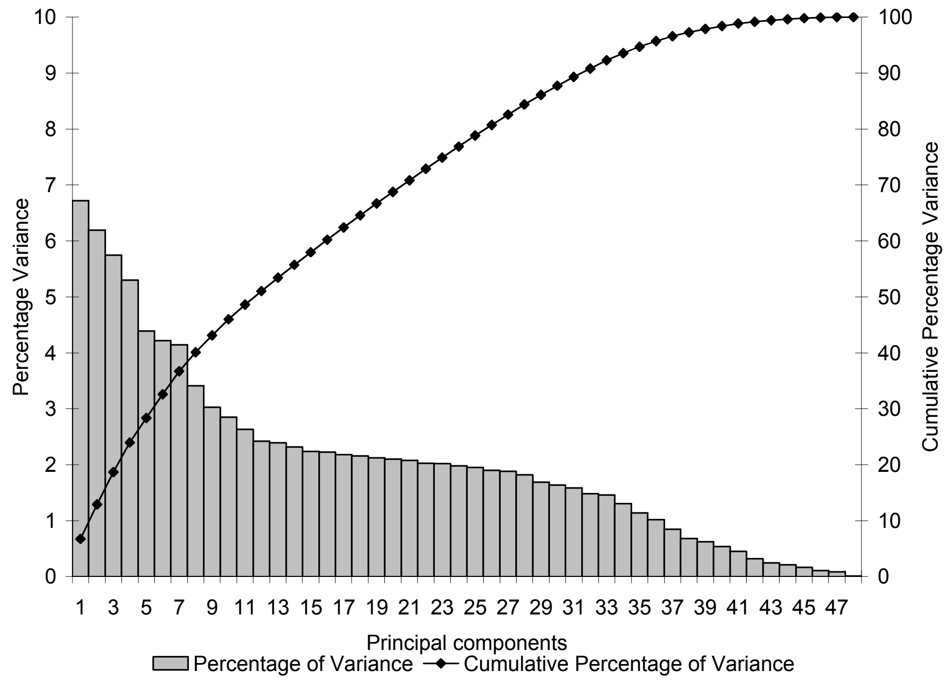

Figure 6. Percentage of the variance explained by each component and the cumulative percentage variance from Multiple Correspondence Analysis of the five descriptive variables chosen to define Métiers in the Irish Sea, 2003.

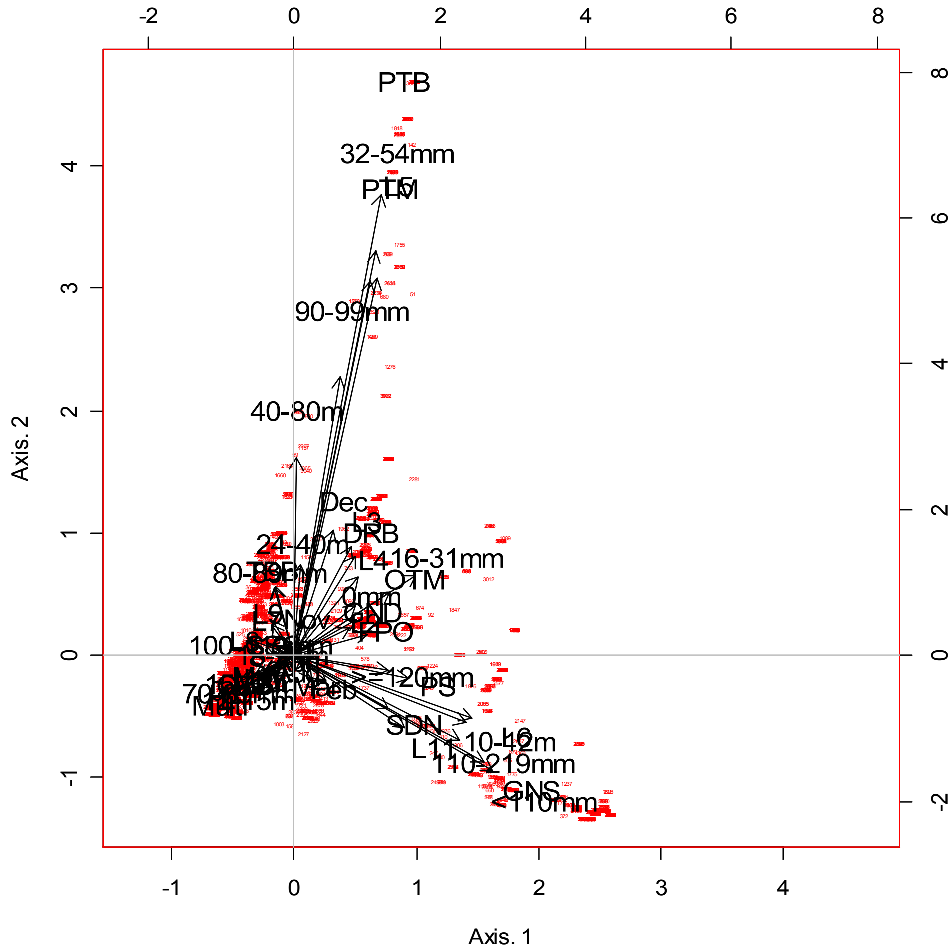

Figure 7. Bi-plot representation of the first and second axes from Multiple Correspondence Analysis of the five descriptive variables chosen to define métiers in the Irish Sea, 2003. Fishing trips are represented by randomly assigned numbers. Legend key: mesh size ranges are denoted by ending in “mm”, vessel length ranges by ending in “m”. Months are given by a three letter code as are all bar “Multi” in the gear codes. Landing profiles are as follows: L1 Nephrops, L2 whelk, L3 scallop, L4 sprat, L5 herring, L6 crab & “other”, L7 ray, L8 plaice & ray, L9 mixed ray, L10 mixed whitefish, and L11 cod, pollack, ling & saithe. Two main groupings can be observed: 1) pair trawls utilising small meshes (32-54mm) targeting herring, 2) small vessels (10-12m length) targeting CPLS with set gillnets of both large (110-<220mm) and small (<110mm) meshes.

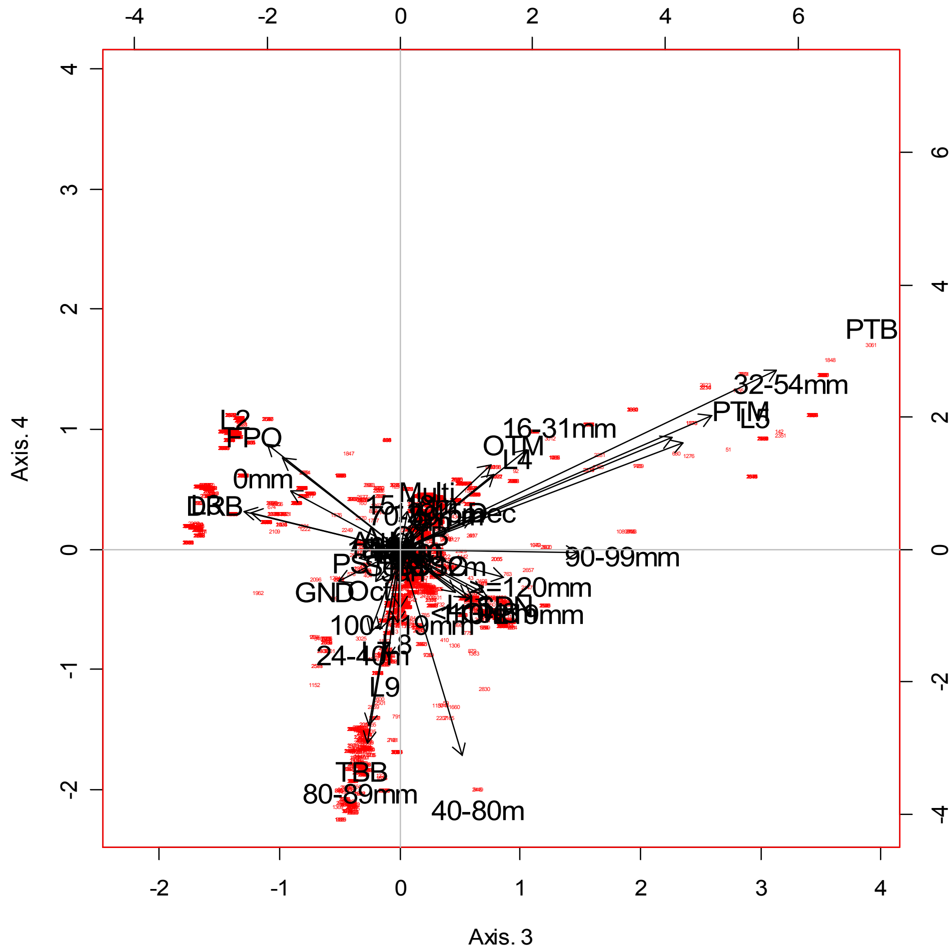

Figure 8. Bi-plot representation of the third and fourth axes from Multiple Correspondence Analysis of the five descriptive variables chosen to define métiers in the Irish Sea, 2003. Fishing trips are represented by randomly assigned numbers. Legend key: Mesh size ranges are denoted by ending in "mm", vessel length ranges by ending in "m". Months are given by a three letter code as are all bar "Multi" in the gear codes. Landing profiles are as follows: L1 Nephrops, L2 whelk, L3 scallop, L4 sprat, L5 herring, L6 crab & "other", L7 ray, L8 plaice & ray, L9 mixed ray, L10 mixed whitefish, and L11 cod, pollack, ling & saithe Many of the trips are centred on this plot. One main grouping occurs, as on the first and second axes, pelagic pair trawls. A further two groups are observed: 1) those gear types where mesh size is discounted; pots and traps targeting whelks, and dredges targeting scallops in the top left area, 2) beam trawls with 80-<90mm meshes, with no clear target species.

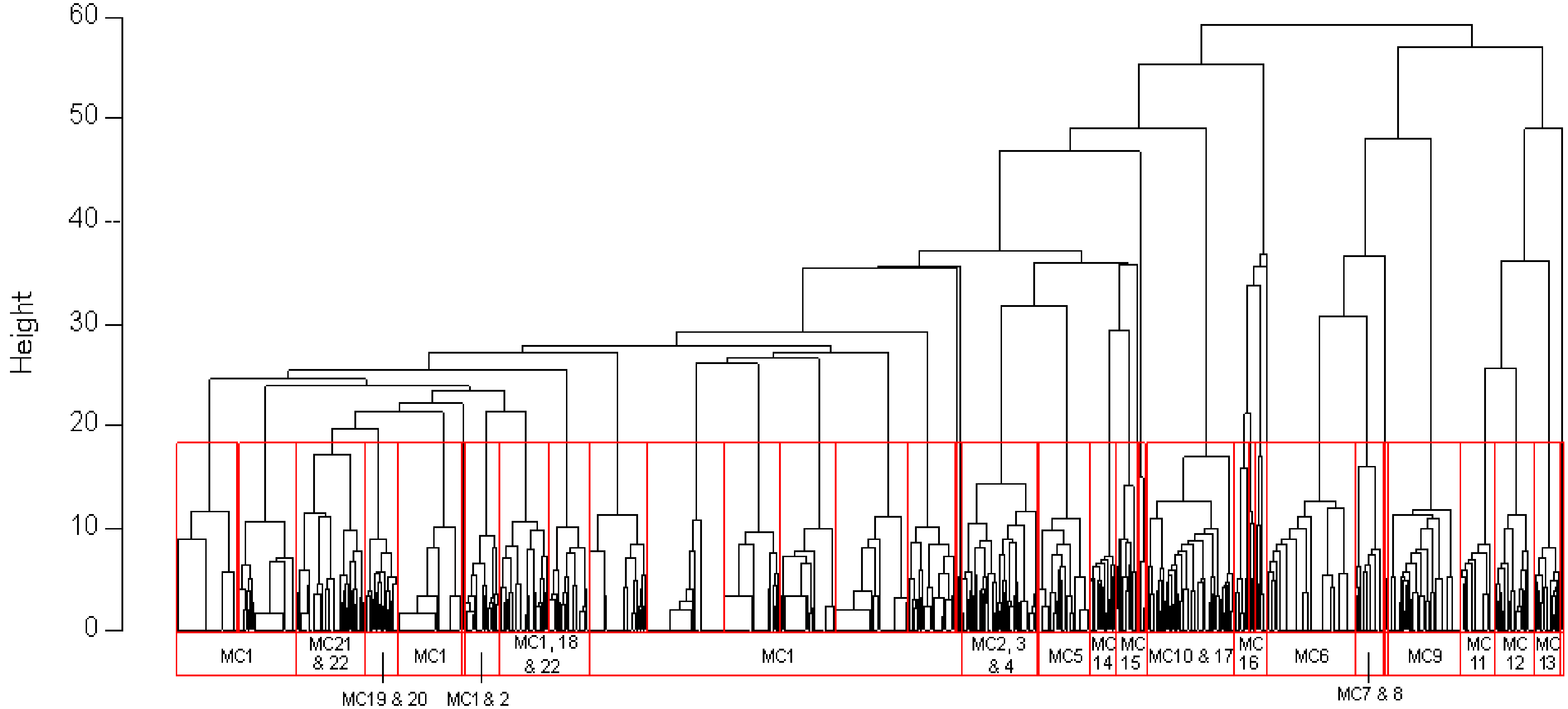

Figure 9. Hierarchical Agglomerative Cluster analysis tree based on factorial coordinates from Multiple Correspondence Analysis of the five descriptive variables chosen to define métiers within the Irish Sea, 2003. The red boxes indicate the 37 clusters obtained where the percentage of variance explained levelled off, explaining 74% of the variation within the dataset. How clusters relate to métiers is specified by the prefix MC (Métier Code), and detailed in Table 5.

Table 5. Métier definitions for Irish vessels in the Irish Sea, 2003. The table details the métier code, name and the conditions of each métier in relation to species composition, quarter, gear, vessel length and mesh size ranges.

Metier ID Code	Short Metier Name	Metier Name	Gear Type	Vessel Length Range (m)	Mesh Size Range (mm)	Quarter	Primary Species	Species Composition	
								Lower Species Threshold	Special Conditions
1	Nephrops OTB	Nephrops OTB 12-40m 70-<90mm	OTB	12-40m	70-<90	All	*Nephrops*	≥50% *Nephrops*	
2	Ray Large OTB	Ray AllQ OTB 15-40m 100-<120mm	OTB	15-40m	100-<120	All	Ray species	≥50% Ray Spp.	<35% Plaice
3	Ray Large TBB	Ray AllQ TBB 18-40m 100-<120mm	TBB	18-40m	100-<120	All	Ray species	≥55% Ray Spp.	
4	Ray Small OTB	Ray AllQ OTB 10-24m 70-<90mm	OTB	10-24m	70-<90	All	Ray species	≥50% Ray Spp.	<35% Plaice
5	Plaice & Ray OTB	Plaice and Ray Q2-4 OTB 15-24m 100-<120mm	OTB	15-24m	100-<120	2,3,4	Plaice & Ray species	≥35% Plaice Or, ≥40% Ray Spp.	<50% Cod &, <50% Ray Spp. <30% Haddock
6	Whelk FPO	Whelk AllQ FPO 10-24m	FPO	10-24m		All	Whelk	≥85% Whelk	
7	Crab FPO	Crab (& Other) AllQ FPO 10-12m	FPO	10-12m		All	Crab & " Other"	Or, ≥40% Crab Spp. ≥50% Other	No other species l&ed
8	Razor Shell DRB	"Other" - Razor Shell Q3-4 DRB 18-24m	DRB	18-24m		3,4	"Other" (Razor Shell)	100% "Other"	
9	Scallop DRB	Scallop AllQ DRB 18-40m	DRB	18-40m		All	Scallop	≥80% Scallop	
10	Plaice & Ray TBB	Plaice and Ray Q2-4 TBB 18-40m 80-<90mm	TBB	18-40m	80-<90	2,3,4	Plaice and Ray species	Or, ≥25% Plaice ≥45% Ray Spp.	with <20% Cod, Monkfish, Black Sole & <10% All other species with <20% Cod, Monkfish, Black Sole
11	Crab GNS	Crab and "Other" AllQ GNS 10-12m <110mm	GNS	10-12m	<110	All	Crab & "Other"	Or, ≥50% Crab Spp. ≥50% "Other"	No other species l&ed
12	CPLS Small GNS	Cod, Pollack, Ling and Saith Q1-3 GNS 10-40m <110mm	GNS	10-40m	<110	1,2,3	Cod, Pollack, Ling & Saith	≥30% Cod Or, ≥30% Pollack ≥30% Ling ≥30% Saith	If <30%, ≥25% cod + ≥5% of one other cod, pollack, ling or saithe ≥25% Pollack ≥20% Ling ≥20% Saith
13	CPLS Large GNS	Cod, Pollack, Ling and Saithe AllQ GNS 10-24m 110-<220mm	GNS	10-24m	110-<220	All	Cod, Pollack, Ling & Saithe	≥30% Cod Or, ≥30% Pollack ≥30% Ling ≥30% Saith	If <30%, ≥25% cod + ≥5% of one other cod, pollack, ling or saithe ≥25% Pollack ≥20% Ling ≥20% Saith
14	Mixed White SSC	Mixed Whitefish AllQ SSC 12-40m	SSC	12-40m	Any	All	Whitefish species	≥30% Cod ≥30% Haddock Or, ≥30% Whiting ≥30% Pollack ≥30% Dogfish	
15	Single Sprat	Sprat Q4 Single Trawl 10-24m <100mm	Single Trawl	10-24m	<100	4	Sprat	≥90% Sprat	
16	Mixed Pelagic Pair	Pelagic Q4-1 Pair Trawl 15-40m	Pair Trawl	15-40m		4,1	Pelagic species	≥90% Sprat Or, ≥60% Herring ≥50% European Pilchard	
17	RFMix Small TBB	Ray, Flatfish, Mixed AllQ TBB 18-24m 80-<90mm	TBB	18-24m	80-<90	All	Ray & Flatfish species	≥30% Ray Spp. ≥35% Monkfish Or, ≥30% Witch ≥10% Black Sole ≥10% Lemon Sole ≥10% Megrim	&, <45% Ray Spp. <25% Plaice

Table 5 continued. Métier definitions for Irish vessels in the Irish Sea, 2003. The table details the métier code, name and the conditions of each métier in relation to species composition, quarter, gear, vessel length and mesh size ranges

Metier ID Code	Short Metier Name	Metier Name	Gear Type	Vessel Length Range (m)	Mesh Size Range (mm)	Quarter	Primary Species	Species Composition	
								Lower Species Threshold	Special Conditions
18	RFMix Large TBB	Ray, Flatfish, Mixed AllQ TBB 18-40m 100-<120mm	TBB	18-40m	100-<120	All	Ray & Flatfish species	Or, ≥30% Ray Spp. ≥35% Monkfish ≥25% Plaice ≥10% Black Sole	<55% Ray Spp.
19	CPLS Large OTB	Cod, Pollack, Ling and Saithe Q1-3 OTB 15-40m 100-<120mm	OTB	15-40m	100-<120	1,2,3	Cod, Pollack, Ling & Saithe	Or, ≥35% Cod ≥30% Pollack ≥25% Saithe	&, < 40% Ray Spp. <40% Whiting <35% Plaice
20	CPLS Small OTB	Cod, Pollack, Ling and Saithe Q1-2 OTB 12-40m 70-<90mm	OTB	12-40m	70-<90	1,2	Cod, Pollack, Ling & Saithe	Or, ≥35% Cod ≥40% Pollack ≥25% Ling	&, < 40% Ray Spp. <40% Whiting <50% Nephrops
21	WRMix Large OTB	Whitefish and Ray Mixed Group AllQ OTB 15-40m 100-<120mm	OTB	15-40m	100-<120	All	Whitefish & Ray species	Or, ≥30% Whiting ≥25% Haddock ≥30% Monkfish ≥30% Cod ≥30% Ray Spp. ≥20% Black Sole ≥30% Plaice ≥20% Lemon Sole ≥40% Dogfish ≥30% Nephrops	&, <40% Ray Spp. <35% Cod <35% Plaice <30% Pollack
22	WRM Small OTB	Whitefish and Ray Mixed Group AllQ OTB 10-40m 70-<90mm	OTB	10-40m	70-<90	All	Whitefish & Ray species	Or, ≥30% Whiting ≥25% Haddock ≥30% Plaice ≥30% Monkfish ≥20% Black Sole ≥30% Cod ≥30% Ray Spp. ≥20% Lemon Sole ≥25% Nephrops	&, <50% Ray Spp. <35% Cod <50% Nephrops <40% Pollack
A	Non-Demersal Trawl	Mixed Species AllQ non-demersal trawl gear	Non-demersal trawl	Any	Any	All	Not Specified	Any trip not employing a demersal trawl unallocated to a defined metier	
B	Small Demersal Trawl	Mixed Species AllQ Demersal Trawl <100mm	Demersal trawl	Any	<100	All	Not Specified	Any trip employing a demersal trawl with less than 100mm mesh unallocated to a defined metier	
C	Large Demersal Trawl	Mixed Species AllQ Demersal Trawl ≥100mm	Demersal Trawl	Any	≥100	All	Not Specified	Any trip employing a demersal trawl with a mesh greater than 99mm unallocated to a defined metier	
Multi	Multiple gears per trip								
Zero	Non-Nephrops Directed Zero Mesh Trawls				0		Not Nephrops		

Table 6. Number of fishing trips within each métier defined for the Irish Sea during 2003, 2004 and 2005. Also, detailing the 5 non-métier groups containing trips not assigned to a métier.

Metier Code	Metier Name	Fishing trips		
		2003	2004	2005
1	Nephrops OTB 12-40m 70-<90mm	1107	1201	1153
2	Ray AllQ OTB 15-40m 100-<120mm	130	73	58
3	Ray AllQ TBB 18-40m 100-<120mm	56	2	2
4	Ray AllQ OTB 10-24m 70-<90mm	48	124	130
5	Plaice and Ray Q2-4 OTB 15-24m 100-<120mm	114	15	6
6	Whelk AllQ FPO 10-24m	199	163	343
7	Crab (& Other) AllQ FPO 10-12m	47	116	177
8	"Other" - Razor Shell Q3-4 DRB 18-24m	20	1	29
9	Scallop AllQ DRB 18-40m	163	168	98
10	Plaice and Ray Q2-4 TBB 18-40m 80-<90mm	90	37	94
11	Crab and "Other" AllQ GNS 10-12m <110mm	78		
12	Cod, Pollack, Ling and Saith Q1-3 GNS 10-40m <110mm	86	52	40
13	Cod, Pollack, Ling and Saithe AllQ GNS 10-24m 110-<220mm	50	33	5
14	Mixed Whitefish AllQ SSC 12-40m	43	40	21
15	Sprat Q4 Single Trawl 10-24m <100mm	52		3
16	Pelagic Q4-1 Pair Trawl 15-40m	58	178	155
17	Ray, Flatfish, Mixed AllQ TBB 18-24m 80-<90mm	65	41	45
18	Ray, Flatfish, Mixed AllQ TBB 18-40m 100-<120mm	22	3	2
19	Cod, Pollack, Ling and Saithe Q1-3 OTB 15-40m 100-<120mm	46	11	1
20	Cod, Pollack, Ling and Saithe Q1-2 OTB 12-40m 70-<90mm	11	10	2
21	Whitefish and Ray Mixed Group AllQ OTB 15-40m 100-<120mm	107	34	13
22	Whitefish and Ray Mixed Group AllQ OTB 10-40m 70-<90mm	206	172	222
A	Mixed Species AllQ non-demersal trawl gear	79	238	218
B	Mixed Species AllQ Demersal Trawl <100mm	168	170	233
C	Mixed Species AllQ Demersal Trawl ≥100mm	55	41	16
Multi	Multiple gears per trip	1		
Zero	Non-Nephrops Directed Zero Mesh Trawls	41	126	1
	Total trips per year	3142	3049	3067

Table 7. Number of vessels within each defined métier for the Irish Sea during 2003, 2004 and 2005. Also, detailing the 5 non-métier groups containing vessels whose trips were not assigned to a métier.

Metier Code	Metier Name	Vessels per metier		
		2003	2004	2005
1	Nephrops OTB 12-40m 70-<90mm	57	49	52
2	Ray AllQ OTB 15-40m 100-<120mm	12	9	6
3	Ray AllQ TBB 18-40m 100-<120mm	2	2	1
4	Ray AllQ OTB 10-24m 70-<90mm	12	20	16
5	Plaice and Ray Q2-4 OTB 15-24m 100-<120mm	10	4	4
6	Whelk AllQ FPO 10-24m	6	4	7
7	Crab (& Other) AllQ FPO 10-12m	4	3	6
8	"Other" - Razor Shell Q3-4 DRB 18-24m	2	1	2
9	Scallop AllQ DRB 18-40m	18	16	9
10	Plaice and Ray Q2-4 TBB 18-40m 80-<90mm	8	6	11
11	Crab and "Other" AllQ GNS 10-12m <110mm	2		
12	Cod, Pollack, Ling and Saithe Q1-3 GNS 10-40m <110mm	17	13	8
13	Cod, Pollack, Ling and Saithe AllQ GNS 10-24m 110-<220mm	8	5	3
14	Mixed Whitefish AllQ SSC 12-40m	10	4	4
15	Sprat Q4 Single Trawl 10-24m <100mm	7		3
16	Pelagic Q4-1 Pair Trawl 15-40m	13	18	23
17	Ray, Flatfish, Mixed AllQ TBB 18-24m 80-<90mm	6	8	11
18	Ray, Flatfish, Mixed AllQ TBB 18-40m 100-<120mm	3	2	1
19	Cod, Pollack, Ling and Saithe Q1-3 OTB 15-40m 100-<120mm	14	3	1
20	Cod, Pollack, Ling and Saithe Q1-2 OTB 12-40m 70-<90mm	10	5	2
21	Whitefish and Ray Mixed Group AllQ OTB 15-40m 100-<120mm	23	8	8
22	Whitefish and Ray Mixed Group AllQ OTB 10-40m 70-<90mm	36	46	52
A	Mixed Species AllQ non-demersal trawl gear	21	33	24
B	Mixed Species AllQ Demersal Trawl <100mm	34	40	43
C	Mixed Species AllQ Demersal Trawl ≥100mm	18	13	5
Multi	Multiple gears per trip	1		
Zero	Non-Nephrops Directed Zero Mesh Trawls	7	20	1
	Number of vessels operating in metiers	157	138	130

Table 8. Species catch composition of defined métiers as an average percentage of landings, with total average métier landings (2003-2005).

	Average, per metier, species percentage landed live weight, 2003-2005																					
Metier Code	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Blue Whiting																	0.0					
Cod	3.9	5.0	5.9	3.1	4.5	0.0	0.0			2.9		43.0	33.6	3.0			5.6	7.2	21.9	21.2	5.8	6.1
Conger eel	0.1	1.4	0.0	0.9	0.2		0.0			0.0			0.0				0.2	0.4	0.7		0.4	0.5
Crab	0.0					0.1	91.8				95.8						0.1					0.2
Deepwater Shark				0.0	0.1																	
Dogfish	0.1	1.4		1.4	5.4					0.3		5.9	2.9	10.0			1.0		5.7	7.6	12.4	3.6
European Pilchard																4.7						
Haddock	2.2	1.6	0.6	1.6	2.0					0.8		3.3	4.4	27.0			4.9	1.9	3.8	8.0	7.0	8.4
Hake	0.4	0.0	0.2	0.1	0.1					0.2		4.2	7.3	1.2			0.9	0.3	0.8	0.6	0.6	0.9
Herring												0.0			0.2	85.4			0.2		0.1	0.0
Horse Mackerel																0.4						
John dory	0.1	0.0	0.0	0.5	0.1					0.2		1.0		0.2		0.0	0.1	0.2	0.4	0.7	0.1	0.7
Lemon Sole	0.2	0.2	0.6	0.5	1.8					1.5		0.3		1.2			3.8	2.2	1.3	1.8	2.1	1.4
Ling	0.7	0.1	0.4	0.2			0.0			0.3		6.9	9.2	1.0			2.7	0.8	3.0	3.0	2.1	2.1
Mackerel	0.0											0.0							0.2	0.2	0.1	0.2
Megrim	0.1		0.1	0.1					0.0	1.1		1.0	0.5	1.1			6.3	2.2	0.3	0.4	0.3	0.6
Monkfish	2.2	1.8	4.2	2.4	1.7				0.1	6.3		2.6	4.5	1.0			13.2	7.8	1.7	1.5	1.6	4.4
Mussel																						
Nephrops	84.6	0.1		1.3	0.8					0.1			0.0	0.6			0.7	0.1	0.3	11.9	5.5	16.2
Other	0.7	1.7	1.2	2.2	4.3	0.0	8.1	100.0	0.0	3.0	4.2	0.5	0.7	3.3			5.8	5.1	0.5	0.4	0.9	2.7
Plaice	1.8	8.2	5.9	8.0	50.5	0.0	0.0		0.0	17.9		0.0		5.3			11.7	19.7	1.3	1.0	4.9	6.7
Pollack	0.4	1.3	0.7	0.6	0.7	0.0				0.2		18.7	22.6	4.3			0.8	1.7	7.1	5.6	2.7	2.8
Ray	1.3	75.4	74.3	74.4	26.1		0.0		0.1	58.2		0.7	0.2	3.6			16.2	39.1	7.3	5.3	9.7	10.5
Saithe	0.1	0.1		0.3						0.0		8.7	8.8	0.4					3.9	0.5	2.9	0.7
Scallop	0.0	0.4	0.1	0.2	0.8				99.8	0.5				0.2			6.4	0.4			0.4	0.0
Sole Black	0.2	0.6	4.6	1.0	0.3				0.0	5.9		0.0	0.0				13.7	8.3	0.5	0.2	0.2	0.8
Sprat															99.8	9.4						
Squid	0.0	0.1	1.3	0.4	0.1					0.1				1.6				0.1	1.9	0.5	2.6	0.8
Whelk						99.8																
Whiting	0.3	0.4		0.6	0.5					0.0		3.0	4.0	34.8		0.1	0.8	1.5	37.0	29.6	37.4	28.4
Witch	0.7	0.1		0.3						0.6		0.1	1.4	0.2			4.9	1.1	0.1	0.1	0.3	1.3
Average, per metier, landed live weight, 2003-2005 (ton)	2,927.6	213.3	123.2	229.6	89.2	236.1	26.1	8.0	458.5	269.7	7.8	148.8	80.2	113.7	189.7	3,720.6	145.4	32.6	99.3	37.1	209.0	474.9

Table 9. Detailing effort in fishing days (left) and fishing hours (right) within each of the 22 Irish Sea métiers during 2003, 2004 and 2005. Each table also details effort in each of the 5 non-métier groups containing trips not assigned to a métier.

	Time Fishing (days)				
Metier Code	**2003**	**2004**	**2005**	**Total**	**Average**
1	3,097	3,303	3,201	9,601	3,200
2	335	185	181	701	234
3	248	8	10	266	89
4	126	345	351	822	274
5	258	40	14	312	104
6	223	170	374	767	256
7	55	116	200	371	124
8	24	1	29	54	18
9	528	594	285	1,407	469
10	416	142	383	941	314
11	90			90	90
12	137	104	72	313	104
13	94	78	9	181	60
14	89	74	47	210	70
15	72		5	77	39
16	72	190	161	423	141
17	272	173	129	574	191
18	88	8	9	105	35
19	119	15	1	135	45
20	27	11	2	40	13
21	229	78	34	341	114
22	443	387	554	1,384	461
A	136	532	306	974	325
B	444	512	577	1,533	511
C	117	78	25	220	73
Multi	5			5	5
Zero	97	358	1	456	152
Grand Total	7,841	7,502	6,960	22,303	

	Time Fishing (h)				
Metier Code	**2003**	**2004**	**2005**	**Total**	**Average**
1	46,395	49,381	47,723	143,498	47,833
2	4,974	2,733	2,621	10,328	3,443
3	3,244	77	205	3,526	1,175
4	1,602	5,030	5,026	11,658	3,886
5	3,808	559	155	4,522	1,507
6	1,844	1,305	3,656	6,804	2,268
7	369	616	1,198	2,183	728
8	267	12	464	743	248
9	7,013	8,194	4,351	19,558	6,519
10	6,503	2,541	6,525	15,568	5,189
11	583			583	583
12	1,545	1,317	693	3,555	1,185
13	1,200	916	96	2,212	737
14	846	680	430	1,956	652
15	175		3	178	89
16	235	427	309	971	324
17	3,625	3,151	2,174	8,950	2,983
18	1,143	117	161	1,421	474
19	1,805	156	10	1,971	657
20	371	64	15	450	150
21	3,172	1,034	474	4,679	1,560
22	6,279	5,623	7,820	19,723	6,574
A	1,611	5,636	4,056	11,304	3,768
B	5,807	8,254	9,247	23,309	7,770
C	1,345	919	251	2,515	838
Multi	80			80	80
Zero	1,026	5,559	2	6,587	2,196
Grand Total	106,864	104,301	97,665	308,830	

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