# The Irish Sea data-enhancement project: comparison of self-sampling and national data-collection programmes-results and experiences 

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#### Abstract

The Irish Sea Data Enhancement Pilot (ISDEP) was initiated by the UK and Irish fishing sectors, with the objective of improving the precision of commercial catch data (landings and discards) from vessels engaged in demersal trawling in the Irish Sea (ICES Division $\mathrm{V} l \mathrm{la}$ ). The programme was supported by the Irish and UK Governments and managed by national laboratories. The experience of establishing and managing such a programme, including logistical, data-quality, and participation issues, is discussed. By contrasting with parallel national programmes, it is shown that the new data are robust and have improved precision. Experience has also shown that it is preferable to involve a few vessels in providing frequent samples, but that positive incentives are needed to maintain the participation.


Keywords: discards, Irish Sea, self-sampling.

## Introduction

There are many models of fisher self-sampling (FSS) or cooperative research in Europe and around the world (ICES, 2008). A major problem with industry self-sampling is that some scientists and managers consider the data provided by fishers not to have been collected in a sufficiently rigorous manner and potentially to be biased. There needs to be a shift in this attitude before the industry would be more willing to participate in self-sampling schemes. A basis for this paradigm shift is proper verification of the utility and quality of data from self-sampling schemes (ICES, 2008).

Measures under the Irish Sea cod (Gadus morhua) recovery programme have been in place since 2000 (Kelly et al., 2006). These measures initially included two closed areas in the eastern and western Irish Sea to provide the maximum possible protection during the spawning season and to maximize egg production of the existing stock. The closed areas were based on the putative spawning grounds at peak spawning time (14 February-30 April; ICES, 2003). Additional measures were adopted (Anon., 2000), banning various technical specifications of towed nets.

The stock appears to have shown little response to these measures (Kelly et al., 2006). Cod are taken as a bycatch in all demersal fisheries in the Irish Sea, and management measures aimed at cod have a direct impact on catch opportunities for other stocks caught in the same fishery. The 2005 ICES assessments for the Nephrops norvegicus (commercially the most important stock in the Irish Sea), haddock (Melanogrammus aeglefinus), and plaice (Pleuronectes platessa) stocks in the Irish Sea were favourable, yet the Commission proposed cuts of $11-15 \%$
because of the perilous state of cod (NWWRAC, 2005). The continued poor status of the cod stock, and its lack of response to management measures, further exacerbated by the inherent uncertainties in scientific assessments (ICES, 2007a), led to fishing opportunities for other stocks being adversely affected. The NWWRAC (North Western Waters Regional Advisory Council), in their opinion paper to the EC in 2005, highlighted the lack of reliable data as a significant issue causing uncertainty in the assessment, different perceptions of stock status, and impeding the ability to assess the effectiveness of cod-recovery measures. The NWWRAC and some national fishery organizations believed that it was necessary to address the problems repeatedly highlighted by ICES. The Irish Sea Industry Science Data Enhancement Project (ISDEP) was adopted to transform the reliability of the data available to scientists and hence ultimately to achieve better assessments, more trusted advice, and effective management measures (NWWRAC, 2006). The project was supported by the Irish and UK fishery administrations and scientific laboratories. To provide additional incentives, the national administrations obtained additional days-at-sea allocations for their vessels participating in the project, and in the UK, payments were made to vessels collecting samples.

The aim of this paper is to review the benefits and difficulties involved in establishing and running self-sampling programmes, using the ISDEP as a case study. Further, the data gained from ISDEP will be used to determine whether it is possible to supplement discard data collected by observers with self-sampling by fishers and to verify the utility and quality of the latter information. We compare the discard estimates from the Irish fishery
observer (FO) programme with FSS data provided by Irish fishing vessels engaged in the ISDEP programme.

## Methods

Extensive discussions with the fishing industry in 2007 resulted in the ISDEP project being implemented at the end of that year. At that time, the industry became more aware of the background and objectives of the project. To foster collaboration, vessels that had previously carried FOs were initially targeted for participation in the self-sampling scheme, and skippers interested in participating were given written instructions and diary sheets.

## Sampling

Vessels that were willing to participate but had not previously been involved were joined by FOs who trained the crew in self-sampling. This ensured consistency of the information provided from all participants. Standardized forms and written sampling protocols were used; these included a trip form, containing information on gear type, mesh size, area fished, and ports of departure and return, and a haul form that requested information on the catch, discards, and landings, as well as providing the option to identify why particular elements of the catch were discarded.

A subset of vessels, in addition to the information outlined above, provided discard samples from certain hauls. The FSS technique had to be comparable with the FO programme, and easy for crews to perform safely and quickly, minimizing any interruption to their normal deck routine. A sample of $\sim 40 \mathrm{~kg}$, i.e. a standard fish box, was taken randomly from the discarded proportion while sorting the catch from each haul, tagged, and recorded on the diary sheet for the relevant haul, then processed by scientific staff on land to determine species and length compositions. When practicable, the landed catches were also examined by shore-based staff, and otoliths were taken from some species to augment other agesampling work in constructing species-specific age-length keys for assessment purposes.

## Data analysis

The total weight of discards per haul within a trip was estimated by subtracting the landing weight from the total catch estimated by eye by the skipper. For species $s$, discards were calculated in two steps: (i) the discarded length frequencies were transformed to weight $\left(d_{s}\right)$ by applying species-specific length-weight relationships (derived for commercial species from Coull et al., 1989, and Pereda and Perez, 1995, for all others), and (ii) they were subsequently raised to haul level $h\left(d_{h s}\right)$ by the ratio of total discards $\left(d_{h}\right)$ to the sample discard quantity ( $d_{\text {box }}$ ): $d_{h s}=d_{s} \times d_{h} / d_{\text {box }}$.

The results were then raised to trip and fleet levels, based on the number of hauls within a given trip and the number of trips per fleet. Analysis of variance (ANOVA) was used to compare the discard rates between gears, the difference in latitude and longitude at which vessels operating OTB (single-rig otter trawls) and TWR (twin-rig otter trawls) fished, and the variability of discard rates over latitude and longitude.

## Results

## Participation

In all, eight vessels took part in the project over a 2 -year period, returning diary sheets and landing samples at the end of each trip. Monthly participation levels varied during the project, and
there was a general decline in participation as the project continued.

The at-sea observer target under the EU Data Collection Regulation (EC No. 1639/2001) for the Irish National Programme called for 17 observer-days on vessels targeting Nephrops from the third quarter of 2007 to the second quarter of 2008. This sampling coverage represents $0.3 \%$ of the total effort in 2005 for the Irish otter-trawl fleets operating in ICES Division VIIa ( 5596 d). Under the enhanced programme, the aim had been to increase this level of sampling by around $50 \%$, but in the event an increase of $80 \%$ was achieved. However, it is important to note that many of the additional trips were conducted on vessels operating inshore, landing daily, and hence representing less effort in terms of sampling days than implied by the number of trips. Most of the enhanced coverage was during the last quarter of 2007 and the first quarter of 2008 , reflecting initial staffing limitations, and the end of additional funding in April 2008.

## Discard estimates

The overall area sampled on board OTB and TWR trawlers under the FO and FSS programmes was similar, although the distribution of the hauls sampled within the area differed, with more FSS data for the western part (Figure 1a and b). For each gear type, except beam trawls (TBB) and otter trawls, a similar number of trips was covered by FO and FSS sampling (Table 1). TBB vessels were not sampled by FSS, and OTB vessels were sampled more intensively. There is no significant difference between the gears regarding their discard rates ( $p=0.12$ ), but there is a significant difference in the position at which they fished ( $p<0.001$ ). Discard rates varied little with latitude $(p=0.07)$ and longitude $(p=0.7)$. The average monthly discard rate followed a similar pattern for both sampling methods ( $p=0.35$; Figure 2 ), with discard rates remaining constant over the annual cycle.

Of the 192 FSS trips sampled, 60 had partial, missing, or no data. These included $>200$ hauls of which about half had missing data. The most common problem was the omission of bulk-catch estimates ( $62 \%$ ), followed by hauls omitted, i.e. not recorded ( $25 \%$ ). Initially, the data quality in terms of data completeness was poor, but it improved over time, before deteriorating towards the end of the programme (Figure 3).

## Comparison of species-aggregated data

There were relatively low sampling proportions leading to high raising factors (and standard errors) in the FSS results (Table 1). This was due to the small number of hauls sampled within each FSS trip relative to the FO data (Table 1). To ascertain whether there was any difference between the data collected by FO and FSS, the aggregated (all species combined) discard rates by weight were compared. These were estimated by aggregating catches (landings and discard weights) across trips and species, for each gear type. For all three gear types, OTB, TWR, and Scottish Seine (SSC), the point discard estimates were broadly consistent between self-sampling and FO data (Table 1). The differences in discard rates between FO and FSS samples were tested using Fishers' F-test; they were not significantly different ( $p=0.08$ ).

The standard deviation is estimated from the spread of discard rates across trips and hauls. The variability of aggregated discard rates across trips was high for all gear types and sampling


Figure 1. (a) Location of hauls with associated discard rates (the size of the points is proportional to the discard rate) for vessels carrying FOs and (b) those operating FSS.
methods (Figure 4). The FSS discard estimates were generally higher than the FO estimates, although the two overlapped.

## Comparison of species-specific data

The species composition of discards was similar between sampling methods (Table 2). Five species made up most of the FO and FSS fish discards ( $80 \%$ by weight): whiting (Merlangius merlangus), haddock, grey gurnard (Eutrigla gurnardus), plaice, and dab (Limanda limanda). In terms of numbers of fish, whiting, haddock, and plaice were the most discarded species for both
sampling methods. Grey gurnard and dab dominated the bycatches by number. A $t$-test was used to compare the means between species, gears, and sampling type. No significant difference was found between the discarded numbers estimated by the two sampling methods. Discard rates by number could not be calculated because of a lack of landings samples from FSS samplers. For TWR, there were significant differences in the discard rates by weight for $\operatorname{cod}(p<0.001)$, haddock ( $p=0.01$ ), and plaice ( $p=0.03$ ) between sampling methods. The data presented for the seine gear are unreliable, however, because of the very small

Table 1. The number of trips sampled, discard sample boxes ( 40 kg ) brought ashore, the mean number of hauls sampled per trip, mean discard rates by weight aggregated across species, with standard deviations in parenthesis, and the associated coefficients of variation (CVs), and means and standard errors (s.e.) of the raising factor for discard samples to haul in the Irish fleet fishing in the Irish Sea, 2007-2009, by method and gear.

| Sampling method | Gear | Trips | Discard sample boxes | Mean hauls sampled per trip | Mean discard rates by weight | CV | Mean raising factor by trip (s.e) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| FO | OTB | 21 | 35 | 1.6 | 63.70 (16.38) | 0.25 | 12.33 (2.4) |
|  | SSC | 2 | 13 | 6.5 | 48.66 (23.80) | 0.48 | 10.10 (1.86) |
|  | TBB | 7 | 152 | 21 | - | - | 9.13 (0.85) |
|  | TWR | 13 | 114 | 8.7 | 53.56 (17.33) | 0.32 | 21.38 (1.91) |
|  | Total | 43 | 314 | 7.3 |  |  |  |
| FSS | OTB | 161 | 60 | 0.3 | 63.76 (19.23) | 0.30 | 22.57 (2.27) |
|  | SSC | 2 | 2 | 1 | 39.62 (41.88) | 1.05 | $12.99 \text { (3.59) }$ |
|  | TWR | 29 | 18 | 0.6 | 70.98 (12.84) | 0.18 | $25.70 \text { (2.8) }$ |
|  | Total | 192 | 80 | 0.4 |  |  |  |
| Combined FO and FSS | OTB | 182 | 95 | 0.5 | 63.75 (18.95) | 0.29 | 20.45 (1.91) |
|  | SSC | 4 | 15 | 3.7 | 47.53 (24.85) | 0.52 | 12.90 (3.59) |
|  | TWR | 42 | 132 | 3.1 | 63.36 (17.27) | 0.27 | 23.15 (1.61) |

OTB, single-rig otter trawl; SSC, Scottish seine; TBB, beam trawl; TWR twin-rig otter trawl.


Figure 2. Mean discard rate of all species combined from July 2007 to October 2009 for each sampling method. FO, fishery observer; FSS, fisher self-sampling.


Figure 3. Percentage of data incompleteness (missing catch estimates, haul position not recorded, no landings recorded, haul time not recorded, depth shot not recorded, haul recorded as foul, haul dates not in sequence, no fishing diary received, and missing hauls) over the period July 2007-September 2009 of the Irish FSS programme in the Irish Sea.
these practical considerations, it was decided to have a two-tier approach, the upper tier requiring fewer resources than the lower. The lower tier aimed to collect data on total discards and catches at haul and trip levels, and although this did not include the species composition of discards, it did provide important data on the variability in total discard rates. For the upper sampling tier, it was intended to arrange that some vessels $(\sim 20 \%)$ in the participating fleets would provide biological samples of the discards from individual hauls, for later examination onshore. However, because of the limited participation in the programme, all eight vessels participating provided samples, some continuously and others periodically.

Fishing activity, particularly in winter, can be variable, depending on weather conditions and fishing opportunities (exhaustion of national quota). This made it difficult to obtain samples from enough corresponding trips with FSS and FOs. The short duration of the project also contributed to a lack of balance in sampling. The full temporal and spatial pattern of the fishery was not covered. Nevertheless, we still achieved a substantial enhancement above the FO targets, and an improved view of discarding behaviour.

Initially, there was enthusiasm among industry representatives, but less from the skippers. To maintain momentum, there clearly


Figure 4. Box plots of discard rates aggregated across species and gear types, presented by (a) sampling method, and (b) gear. The horizontal line indicates the median, and the box encompasses the interquartile range. The whiskers extend to the most extreme datapoint which is no more than 1.5 times the interquartile range from the box; points beyond these are outliers. FO, fishery observer; FSS, fisher self-sampling; OTB, single-rig otter trawlers; TWR, twin-rig otter trawlers.

Table 2. Mean percentage discard rate by weight and the mean numbers of fish discarded per haul with standard deviations in parenthesis by gear type, sampling method, and species.

| Gear | Species | FOs (\% weight) | FSS (\% weight) | $p$ (t-test) | d.f. | FOs (numbers) | FSS (numbers) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| OTB | Anglerfish | 3.0 (11.2) | 2.4 (15.6) | 0.16 | 53 | 0 (2.5) | 0 (0.8) |
|  | Cod | 3.9 (9.7) | 17.6 (39.3) | 0.09 | 28 | 1 (3.1) | 1 (5.7) |
|  | Haddock | 70.5 (31.7) | 51.8 (47.8) | 0.37 | 69 | 754 (612.9) | 279 (2 204) |
|  | Plaice | 74.5 (31.9) | 42.5 (47.6) | $<0.001$ | 113 | 549 (736.5) | 323 (953) |
|  | Whiting | 88.3 (32.1) | 100.0 (0.0) | 0.07 | 49 | 2870 (2903.2) | 1337 (5 825) |
| SSC | Anglerfish | 33.3 (57.7) | - | - | - | (2 | - |
|  | Cod | 0.0 | - | - | - | - | - |
|  | Haddock | 34.3 (38.5) | 70.8 (42.5) | 0.14 | 5 | 3674 (2 086.6) | 1180 (4541) |
|  | Plaice | 49.5 (12.7 | 100.0 (0) | 0.05 | 2 | 98 (483.4) | 269 (106.6) |
|  | Whiting | 99.3 (1.0) | 100.0 (0) | - | - | 3 (233.7) | 78 (4.0) |
| TWR | Anglerfish | 29.3 (44.1) | 5.4 (22.9) | 0.05 | 28 | 1 (10.3) | 2 (3.2) |
|  | Cod | 25.1 (38.5) | 13.6 (35.1) | $<0.001$ | 9 | 9 (19.2) | 5 (23.4) |
|  | Haddock | 72.1 (33.1) | 38.4 (47.2) | 0.01 | 31 | 166 (537.7) | 216 (318.9) |
|  | Plaice | 79.7 (25.6) | 54.8 (46.0) | 0.03 | 29 | 783 (942.5) | 299 (1 410) |
|  | Whiting | 99.9 (0.2) | 88.9 (33.3) | 0.17 | 18 | 1401 (3793.1) | 1721 (2702) |

The $t$-test compares the two sampling methods by weight. OTB, single-rig otter trawl; SSC, Scottish seine; TBB, beam trawl; TWR, twin-rig otter trawl.
needs to be active and regular support from Producer Organizations and industry leaders for such cooperative work to be successful (Johnson and van Densen, 2007). Managing industry expectations and clearly stating the objectives before undertaking such work is critical, to limit participation fatigue and to avoid future misunderstandings. The industry perception is often that simply providing additional data will result in better fishing opportunities, but it needs to be made clear that that may not be realized in practice. The inclusion of such data in formal analytical assessments is a lengthy process, often beyond the expectations of the industry, and the eventual quotas may be worse, not better. This is important, because any future decrease in fishing opportunities could result in fisher views that their participation made the industry situation worse, with their data having been "used against them". Although more and better data are needed to improve the precision of scientific advice, to the benefit of all stakeholders, these perceptions could have negative consequences for existing or future sampling schemes, unless the purpose of data collection is clearly stated at the outset. The key objective of our
project was to provide true catch data, covering both discards and landings. Although additional samples of the discarded portion of the catch were provided, insufficient samples of the landed portion of the catch were examined to undertake a formal analysis to compare the landed part of the catch with the raised estimates that include discards.

Some initial problems with data recording were encountered, but over time these were resolved through direct contact with individual skippers. Data flow improved quickly over time, before deteriorating at the end of the programme, mostly because some skippers failed to complete their diaries. Some noted that the additional paperwork caused too much work. Automating as much of the data collection as possible was suggested, e.g. through the use of electronic data-logging systems.

The mean discard rate from FSS data was higher than from FO results, although the difference was not statistically significant. However, when considering discard rates by species, the discard rates for FSS were lower for most species for TWR and variable for OTB.


Figure 5. Average percentage catch composition of the five most important species commercially by sampler and gear. FSS, fisher self-sampling; FO, fishery observer; OTB, single-rig otter trawlers; TWR, twin-rig otter trawlers.

## Conclusions

There were a few disadvantages in the self-sampling programme. The financial support ended after just 6 months. During that period, project needs had to be sourced and project coordinators and officers recruited and trained.

The ISDEP was conducted as a voluntary programme, but most of the skippers who participated did so for the benefit of receiving payments for the prawn-catch sample. Also, skippers seemed to be more interested in the possibility of their vessels being chartered for fishery surveys. The extra days-at-sea allowance was not that attractive, and it seems that financial and/or quota benefits would have been much stronger incentives to participate. Also, the apparently simple task of contacting vessels to arrange the collection of diaries and samples was often impossible, owing to the lack of mobile satellite phone coverage.

The primary benefit of this case study was in the increased quantity of discard data obtained. The ISDEP was also found to be an efficient, cost-effective means of collecting data on the commercial fishery. However, one should not underestimate the resources required to manage such programmes, or the problems associated with collecting samples. In particular, such programmes often suffer from participation fatigue. Initial enthusiasm is
insufficient on its own; skippers and crews need to have access to adequate training in how to collect samples and complete the necessary auxiliary paperwork. Whereas initial participation may be high, this period is also associated with the highest level of deficiencies in terms of missing auxiliary data. The second phase of the programme suffered from a decline in participation. Managing industry expectations is an important aspect of work of this nature, particularly if the provision of samples is purely on a voluntary basis or without meaningful incentive. In the case presented here, additional fishing effort allocations were made available, but because effort limits at the time were not constraining normal activity, they did not provide a strong enough incentive to maintain participation. Moreover, there is a general mismatch between short-term expectations of the industry and the more medium-term delivery from the scientific process. There is also a tendency for industry to expect that participation in voluntary programmes will result in a positive outcome in the form of increased fishing opportunities, which may not necessarily transpire. It is therefore important to clarify the objectives and what may realistically be expected from industry participation.

According to an ICES workshop on using fishers to sample catches (ICES, 2007b), the purpose of a self-sampling programme
is to improve stock assessments. Here, the improvement was less a question of precision (which is purely a scientific measure) or accuracy (which is often difficult to quantify), but more that the assessments could provide a common perception of what is in the sea. It is the greater involvement of fishers in the assessment process that is the ultimate benefit of self-sampling programmes.

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