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**Bycatch Survey- Isle of Man Queen Scallop Otter Trawl Fishery  
Summer 2014**

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**Report to the Isle of Man Government, Department of Environment, Food and Agriculture**

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**Final Report – March 2015**

To cite this report: Bloor, I.S.M., Dignan, S.P., Murray, L.G. and Kaiser, M.J. (2015). Bycatch Survey – Isle of Man Queen Scallop Otter Trawl Fishery Summer 2014. Fisheries & Conservation Report No. 67, Bangor University. pp. 14.

## 1. Background

As part of the Marine Stewardship Council (MSC) certification process there is a requirement to regularly monitor bycatch within the Isle of Man queen scallop trawl fishery. The first bycatch assessment for this fishery was completed by Duncan (2009) as part of the initial MSC assessment process. The results indicated that bycatch levels were relatively low, estimated at 3.36 % of weight relative to the total catch, when compared to other similar fisheries (e.g. Kelleher, 2005). As part of the continued assessment process a second bycatch assessment was undertaken by Boyle and Thompson (2012) which indicated that there had been an increase in the proportion of bycatch to total catch to around 6.8 %, but that levels were still relatively low compared with other similar fisheries (e.g. Kelleher, 2005). An additional important aspect of the 2012 bycatch survey was a comparison of bycatch survey data between industry collected data and data from an independent onboard observer programme that assessed the validity of self-reporting trials. The authors found that the majority (75 %) of self-reporting tows had levels of teleost biomass close to values found by observers. The results indicated that in general the self-reporting scheme was a successful method of gathering data on the amount and composition of bycatch in the Isle of Man queen scallop fishery and concluded that it would be an appropriate method for monitoring bycatch of the fishery in the future, especially if funding for observers was limited (Boyle and Thompson, 2012).

The current report analyses data from an ongoing collaborative program of bycatch monitoring with Bangor University, the Department for Environment, Food and Agriculture (DEFA) and the Manx Fisheries Producers Organisation (MFPO). This study re-assesses the composition of bycatch of the otter trawl queen scallop (*A. opercularis*) fishery in the Isle of Man during the 2014 fishing season. The results were also compared to the previous sampling surveys conducted by Duncan (2009) and Boyle and Thompson (2012).

## 2. Materials and Methods

### 2.1 Location of Activities

The general locations of the fishing grounds on which vessels were observed during the 2014 season are shown in Figure 1.

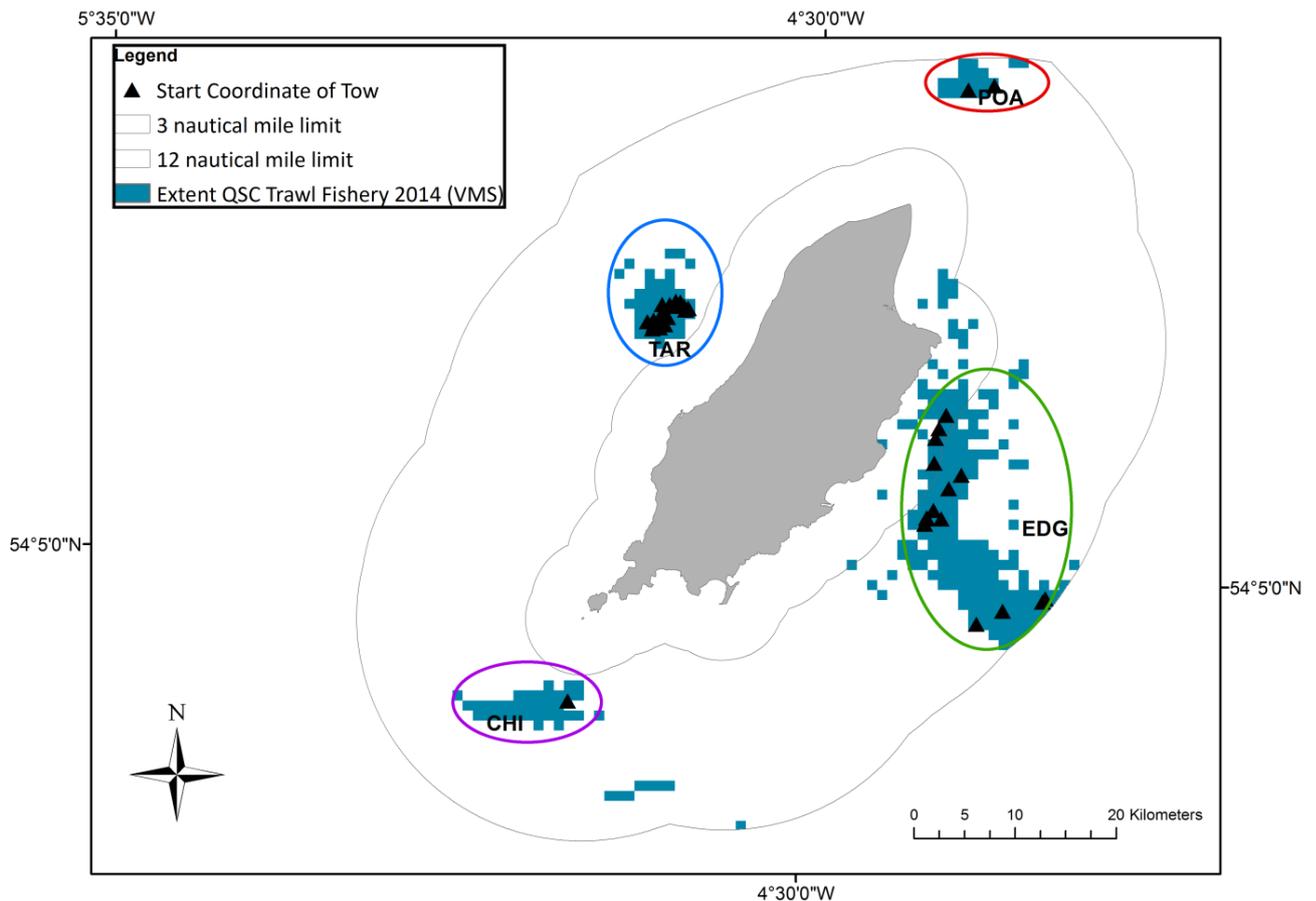


Figure 1: The extent of queen scallop trawl fishing activity from the 2014 season as plotted from VMS data (using only points at fishing speed) overlaid with the indicative locations of four of the main fishing grounds (POA = Point of Ayre, TAR = Targets, CHI = Chickens and EDG = East Douglas) and the start coordinates for 40 of the 46 tows sampled for bycatch (GPS data was not available for the remaining 6 tows).

### 2.2 Data collection

The 2014 Isle of Man queen scallop (*Aequipecten opercularis*) trawl fishery took place between 2<sup>nd</sup> July and 2<sup>nd</sup> October 2014. A total allowable catch (TAC) of 1,000 t was allocated and a total of 32 boats prosecuted the fishery. A total of 2776 tows were undertaken across the 5 main fishing grounds (Table 1). During the fishing season vessels were asked to self-report the quantity and variety of bycatch caught during a sample of tows. Bycatch was assessed as a component of a typical trawl during typical commercial operations. A total of 13 Manx vessels reporting bycatch from a total of 46 tows were part of the sampling scheme (covering approximately 1.65 % of fishing effort).

**Table 1: Tows undertaken within the Isle of Man territorial sea during the 2014 queen scallop trawl fishing season across the five main fishing grounds and the number of tows for which bycatch sampling was undertaken**

<b>Fishing Ground</b>	<b>Number of fished tows</b>	<b>Number of Sampled tows</b>
Chickens	320	1
East Douglas	1561	18
Point of Ayre	125	2
Ramsey	55	0
Targets	715	25
<b>Total</b>	<b>2776</b>	<b>46</b>

### 2.2.1 Vessel specific data:

Within the Isle of Man territorial sea queen scallop otter trawls are fairly standardised and only minor differences between the fishing gear and its operations (e.g. trawl net width of between 6 – 12 fathom, cod-end mesh size and use of tickler chains) exist among the vessels that participated within the survey and these were recorded for each vessel. Each skipper also had an onboard GPS logger and provided data on trawl duration (minutes), speed (knots), distance (nautical miles) and location (degrees, minutes and seconds of arc for latitude and longitude) for each sampled tow.

Using the methodology employed in both previous bycatch surveys (Duncan, 2009; Boyle and Thompson, 2012), the combination of data provided by each vessel on gear specification and individual tow by tow data was used to calculate the fishery-swept area per tow (i.e. the area of seabed covered by the net during each tow). The swept-area calculations were based on the method described by Courtney *et al.*, (2007):

$$\text{Area Swept (ha)} = \frac{F \times \text{NSF} \times D}{10,000}$$

Where F = footrope length (fathoms converted to meters), NSF = net spread factor (= 0.75 (Sterling, 2005)) and D = distance trawled (nm = 1852 m). Division by 10,000 provided a final swept area value expressed in hectares (ha = 10,000 m<sup>2</sup>) (to convert back to m<sup>2</sup>, multiply by 10,000). Using this formula, each tow, and its associated bycatch could be related to a specific area of seabed covered and correlated with individual catch quantities.

### 2.2.2 Bycatch assessment:

For the purposes of this survey the contents of the cod-end were deposited onto the deck of the fishing vessel. A sample (approximately ½ a scallop bag) was shovelled straight off the deck, for the purpose of analysing invertebrate bycatch and undersized queen scallops, and placed into a standard scallop bag (Sample 1). All visually obvious fish were then removed from the remaining haul and placed in a separate standard scallop bag (Sample 2). Both bags were labelled by the fishermen with the corresponding vessel name and tow number and returned to the processor for cold storage and subsequent analysis. Species identification was made with reference to the following sources: Campbell (1994), Hayward and Ryland (1995), and Hayward, Nelson-Smith and Shields (1996).

*Sample 1 (invertebrates):*

Organisms from Sample 1 were sorted by species and the total number of individuals recorded. A total weight for all individuals of each species was recorded, enabling an estimate of mean weight per individual to be made. Total weights were not recorded for frequently broken species, since weights were irrelevant (e.g. *Luidia cillaris*), or where the combined weight was less than the operational accurate range of the measuring apparatus (< 1 g).

*Sample 2 (fish and elasmobranchs):*

For commercial fish species, where small numbers (e.g. < 15) of individuals were present, individual weights and lengths were recorded. When relatively large numbers (e.g. > 15) were caught, the total numbers of individuals and their combined weight was recorded.

Individual specimens were weighed on a Salter kitchen scale to the nearest 1 g and measured on a standard fish-measuring board (0 - 55 cm range) to the nearest 1 mm. Round fish species were laid out on their lateral surface and measured from the snout to the tail tip. Dorso-ventrally flattened fish, e.g. anglerfish, rays, flatfish, were laid flat and measured from the snout to the tail tip.

2.2.3 Discard assessment (undersized queen scallops):

Prior to bagging, queen scallops were typically size selected using a rotating drum riddle with rings of fixed size (e.g. 55 to 65 mm) to allow either retention or escape of shells of a target size. Queen scallops, over the Minimum landing Size (MLS) of 55 mm, were then loaded into sacks, of approximately 35 kg each (volume equivalent to 1.5 standard fishing baskets) and the number of sacks per trawl, per day, was recorded.

Queen scallops under MLS, which passed through the riddle, were diverted into a chute, which returned the animals to sea. The proportion of the catch returned to sea was estimated per tow from Sample 1 which was obtained straight from the deck prior to sorting in the riddle. A random subsample of 90 queen scallops was measured for shell height to allow the proportion of undersized scallops in the sample to be recorded and subsequently used to estimate the total amount of discarded undersize queen scallops for each tow. That is, the quantity, in terms of number, volume (sacks or baskets), or approximate weight, of queen scallops both under and over MLS caught during each tow could be estimated.

In order to calculate the total bycatch as a proportion of the total catch including discarded queen scallops the following method was used:

1.  $QU_t = \left(\frac{QR_t}{QR_s}\right) * QU_s$
2.  $I_t = \left(\frac{QR_t}{QR_s}\right) * I_s$

Where  $QR$  = weight of retained queen scallops,  $QU$  = weight of discarded queen scallops and  $I$  = weight of invertebrate bycatch, with  $t$  indicating a tow and  $s$  indicating a subsample. The number of invertebrate individuals in the subsample was multiplied by the invertebrate weight proportion  $I_t/I_s$  to give an estimate of the number of individuals in the tow.

### 3. Results:

#### 3.1 General

Data presented represent the mean value and one standard deviation. For various reasons (including variations among vessels in the level of compliance with the standardised sampling protocol and issues with the misplacement of stored subsamples at the processors) comparable data was not collected for every tow, and therefore not all presented statistics comprise the same number of tows. The actual sample size,  $n$ , is provided in parentheses after each value.

#### 3.2 Survey details

Surveys were conducted between 26<sup>th</sup> August and 1<sup>st</sup> October 2014. Monthly survey day totals were; August = 3, September = 9 and October = 2. The survey involved 13 Manx vessels that collected data on a total of 14 fishing days, comprising 46 individual trawl tows. Due to catch limits and other factors, the number of tows per day varied from boat to boat and day to day (range 1 to 5 tows).

The most accurate series of comparisons can be made if we include only those tows for which complete data for all parameters is available ( $n = 30$ ). This enables a complete breakdown of the total weight on deck for each tow to be calculated.

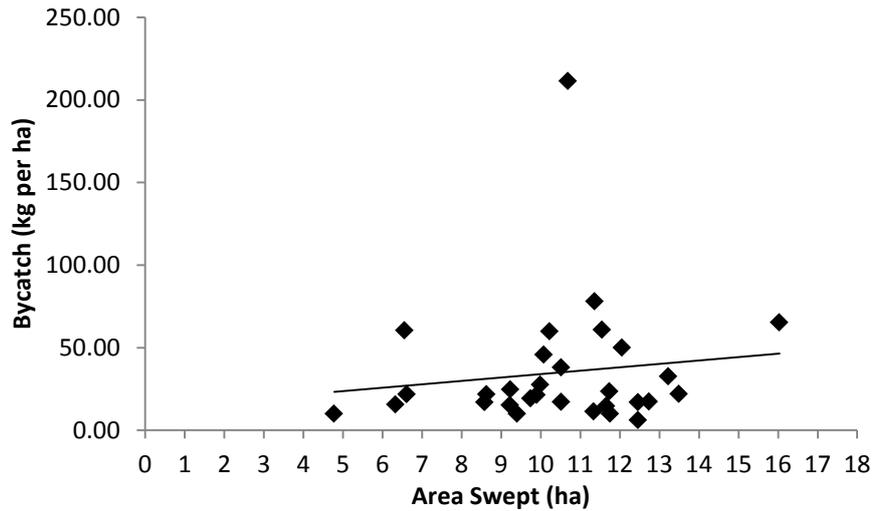
The mean distance covered per tow, in nautical miles, was  $4.09 \pm 0.67$  nm ( $n = 30$ ). The mean tow duration was  $95 \pm 16$  min ( $n = 30$ ) and the mean trawl speed was  $2.37 \pm 0.22$  knots ( $n = 30$ ). The trawl nets employed during the survey ranged from 6 – 12 fathoms in foot-rope length (10.97 – 21.94 m), the mode (most frequent) being a 10 fathom net (18.3 m). The mean swept area per tow was  $10.49 \pm 2.69$  ha ( $n = 30$ ) and the total swept area for the survey ( $n=30$ ) was 313 ha.

#### 3.3 Bycatch analysis

The total weight of bycatch (fish, elasmobranchs and cephalopods) for these 30 tows was 247.51 kg, which equates to a mean weight of bycatch of  $8.25 \pm 6.17$  kg per tow. The mean bycatch per hectare swept was  $0.83 \pm 0.61$  kg/ha ( $n = 30$ ). Therefore, for these complete tows, the mean proportion of bycatch represented  $2.68 \pm 1.75$  % of the commercially-landed queen scallop catch by weight.

The total weight of bycatch (fish, elasmobranchs, cephalopods and invertebrates) for these 30 tows was 1045.12 kg, which equates to a mean weight of bycatch of  $34.84 \pm 38.6$  kg per tow. The mean bycatch per hectare swept was  $3.39 \pm 3.65$  kg/ha ( $n = 30$ ). Therefore, for these complete tows, the mean proportion of bycatch represented  $10.4 \pm 8.62$  % of the commercially-landed queen scallop catch by weight.

There was no apparent linear relationship between the quantity of bycatch (kg) and swept area (ha) (Figure 2). For the purposes of best describing such interactions only those tows with complete data for both bycatch and tow parameters have been included ( $n = 30$ ). A linear trend line has been added for visual clarity, with the equation  $y = 2.0584X + 13.37$ , ( $r^2 = 0.016$ ,  $n = 30$ ).



**Figure 2: The relationship between swept area (ha) by trawl net and bycatch weight (kg) [fish, elasmobranchs and cephalopods] associated with the tow (n = 30). Linear trend line fitted to data, see text for line equation**

### 3.3.1 Fish

A total of 23 fish and cephalopod species were recorded during the survey, of which at least 7 (cod, angler fish, haddock, whiting, plaice, mackerel and sole) are quota species.

- Pogge (*A. cataphractus*)
- Red Gurnard (*A. cuculus*)
- Dragonet (*C. lyra*)
- Grey Gurnard (*E. gurnadus*)
- Cod (*G. morhua*)
- Ballan Wrasse (*L. bergylta*)
- Dab (*L. limanda*)
- Angler Fish (*L. piscatorius*)
- Haddock (*M. aeglefinus*)
- Whiting (*M. melangus*)
- Lemon Sole (*M. kitt*)
- Ling (*M. molva*)
- Squid (*Loligo* sp.)
- Norweigen topknot (*P. norvegicus*)
- Plaice (*P. platessa*)
- Octopus (*E. cirrhosa*)
- Mackerel (*S. scombrus*)
- Sole (*S. solea*)
- LS Sea-Scorpion (*T. bubalis*)
- Tub Gurnard (*T. lucerna*)
- Streaked Gurnard (*T. lastoviza*)
- Poor cod (*T. minutus*)
- John Dory (*Z. faber*)

### 3.3.2 Elasmobranch

A total of 8 elasmobranch species were recorded during the survey

- Starry Smooth hound (*M. asterias*)
- Smooth hound (*M. mustelus*)
- Blonde Ray (*R. brachyura*)
- Thornback Ray (*R. clavata*)
- Spotted Ray (*R. Montagu*)
- Cuckoo Ray (*R. naevus*)
- Small Spotted Cat Shark (*S. canicula*)
- Nursehound (*S. stellaris*)

### 3.3.3 Invertebrates

A total of 22 invertebrate species (not including cephalopods) were recorded during the survey, at least two of which the common whelk (*Buccinum undatum*) and king scallop (*Pecten maximus*), are species of commercial interest within the Isle of Man.

- Dead man's fingers (*A. digitatum*)
- Saddle oyster (*Anomiidae Sp.*)
- Sea squirts (*Ascidian Sp.*)
- Common star fish (*A. rubens*)
- Common whelk (*B. undatum*)
- Common sun star (*C. papposus*)
- Edible sea urchin (*E. esculentus*)
- Bloody Henry Starfish (*H. oculata*)
- Scorpion Spider crab (*I. dorsettensis*)
- Seven armed starfish (*L. cillaris*)
- Spiny starfish (*M. glacialis*)
- Velvet swimming crab (*N. puber*)
- Nudibranch Spp.
- Common brittle star (*O. fragilis*)
- Serpent star (*O. ophiura*)
- Hermit crab (*P. bernhardus*)
- Hermit crab (*P. prideauxi*)
- King scallop (*P. maximus*)
- Green Sea Urchin (*P. milliaris*)
- Sponge Spp.
- Sponge Hermit Crab Sp.
- Swimming Crab Spp.

### 3.3.3 Commercial species

In order to look at the impact of bycatch from the queen scallop trawl fishery in terms of commercial species a separate analysis was undertaken using all tows for which the relevant data was provided (n = 36). A summary of the data from these tows is provided in Table 2.

**Table 2: A summary table of the survey data submitted during the self-reporting QSC trawl fishery survey conducted between 26<sup>th</sup> August and 1<sup>st</sup> October 2014) [POA = 2 tows; CHI = 1 tow; TAR = 24 tows; EDG = 9 tows]**

Number of useable survey tows	n = 36
Total associated QSC Landed (kg)	12372 kg
Total associated Fish & Cephalopod bycatch (kg)	174 kg
Total associated Elasmobranch bycatch (kg)	128 kg

The weight of commercial fish species caught within the bycatch survey (n = 36) is presented in Figure 3. This data has then been used to estimate the total weight of commercial species caught during the entire queen scallop trawl fishery (based on a TAC of 1,000 t) and is presented in Figure 4. The weights of all species caught within the bycatch survey (n = 36) are presented in Table 3.

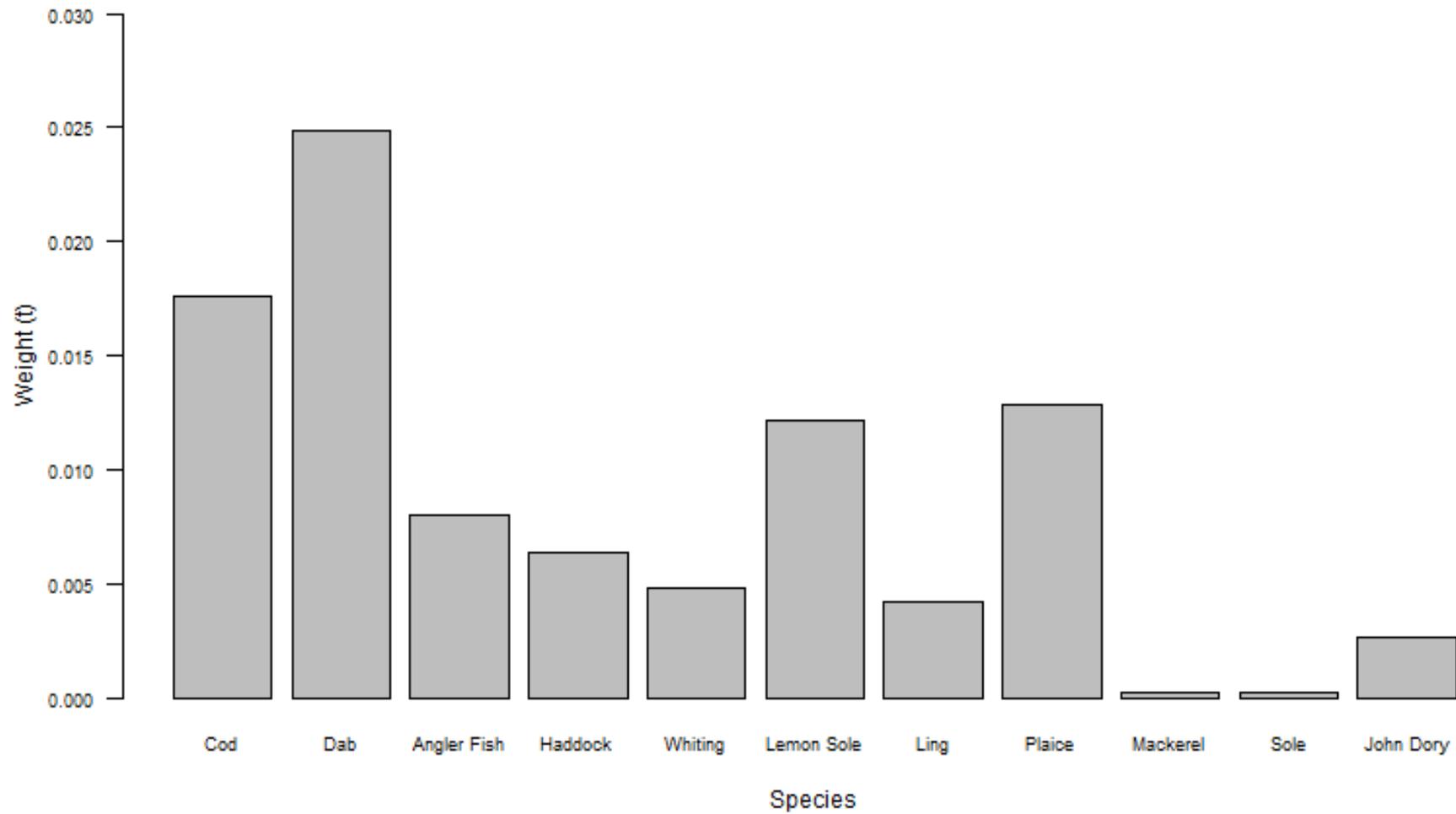


Figure 3: Total weight in tonnes of all commercial fish species caught during the industry self-reporting bycatch survey (n = 36 tows)

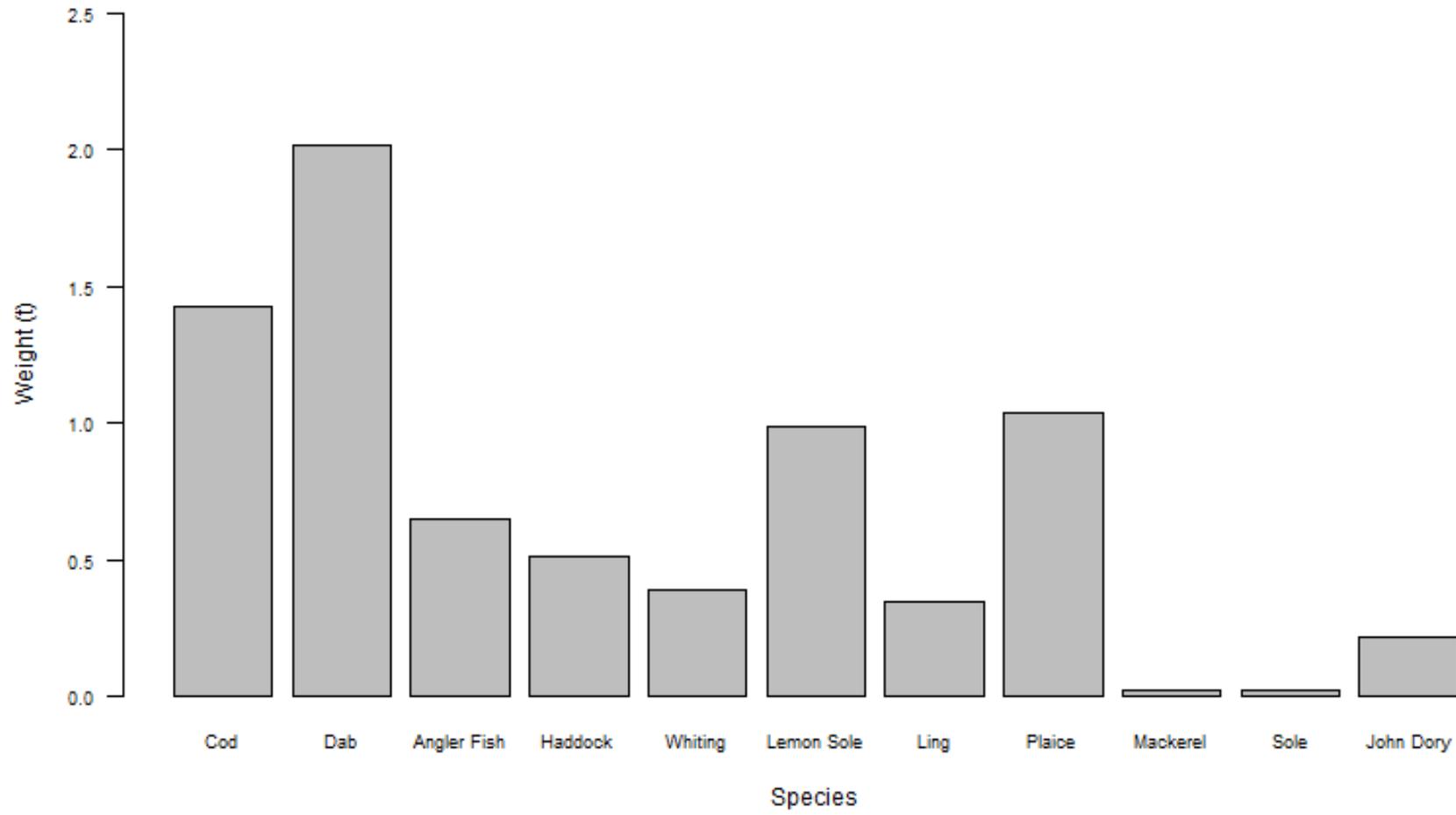


Figure 4: Estimated weight of commercial fish species caught by the trawl fleet from within the territorial sea during the 2014 fishing season based on 1,000 t of landed QSC

**Table 3: Weights of fish, elasmobranch and cephalopod species caught and landed during the industry self-reporting bycatch survey of QSC trawl fishery within the Isle of Man Territorial Sea (n = 36 tows)**

	<b>Weight (kg)</b>
<i>Agonus cataphractus</i>	0.035
<i>Aspitrigla cuculus</i>	35.89
<i>Callionymus lyra</i>	1.252
<i>Eledone cirrhosa</i>	0.659
<i>Eutriglia gurnadus</i>	5.754
<i>Gadhus morhua</i>	17.61
<i>Labrus bergylta</i>	0.88
<i>Limanda limanda</i>	25.116
<i>Loligo Sp.</i>	4.773
<i>Lophius piscatorius</i>	8.023
<i>Melanogrammus aeglefinus</i>	6.36
<i>Merlangius melangus</i>	4.798
<i>Microstomus kitt</i>	12.184
<i>Molva molva</i>	4.241
<i>Mustelus asterias</i>	5.966
<i>Mustelus mustelus</i>	0.964
<i>Phrynorhombus norvegicus</i>	0.029
<i>Pleuronectes platessa</i>	12.834
<i>Raja brachyura</i>	3.014
<i>Raja clavata</i>	2.583
<i>Raja Montagui</i>	2.083
<i>Raja naevus</i>	3.467
<i>Scomber scombrus</i>	0.264
<i>Scyliorhinus canicula</i>	94.759
<i>Scyliorhinus stellaris</i>	15.008
<i>Solea solea</i>	0.249
<i>Taurulus bubalis</i>	0.246
<i>Triglia lucerna</i>	28.927
<i>Trigloporus lastoviza</i>	0.921
<i>Trisopterus minutus</i>	0.712
<i>Zeus faber</i>	2.681

### 3.4 Discard analysis

A total of 305 bags of commercial-size queen scallops were harvested for the 30 tows, representing a total weight of approximately 10,675 kg (at 35 kg per bag). This was the equivalent of  $10.16 \pm 6.94$  bags of commercial size queen scallops (350 kg) for each of these 'complete' tows.

Similarly, for this same series of trawls (n = 30), the mean undersize queen scallop discard rate was  $36.47 \pm 11.84$  %, the equivalent of 88 bags in total, or  $2.94 \pm 2.32$  bags per tow. Applying the same weight per bag conversion (35 kg), this is the equivalent of 3095 kg in total, or 103 kg of discarded queen scallops per tow.

### 3.5 Proportion of bycatch

If we calculate the bycatch weight as a proportion of the weight of **landed queen scallops**, we obtain:

$$1045.12[\mathbf{A}] / 10675[\mathbf{B}] * 100 = 9.8 \% \text{ bycatch by weight of landed queen scallops}$$

If we recalculate the bycatch weight as a proportion of the **total weight landed on deck before sorting**, we obtain:

$$1045.12[\mathbf{A}] / (10675[\mathbf{B}] + 3095[\mathbf{C}] + 1045.12[\mathbf{A}]) * 100 = 7.1 \% \text{ bycatch by total weight}$$

Where A = the total weight of bycatch, B = the total weight of landed queen scallops, C = Total weight of discarded queen scallops

## **4. Discussion**

Two previous bycatch studies by Duncan (2009) and Boyle and Thompson (2012) have been undertaken as part of the MSC certification and continued monitoring process and the current study continues that work. It is instructive to compare the results of the three surveys, insofar as is possible (Table 4).

Bycatch surveys for the Isle of Man queen scallop trawl fishery have been undertaken in 3 years (2009, 2012 and 2014). The 2009 survey (Duncan, 2009) was undertaken by onboard observers and at slightly different survey sites than 2012 and 2014 surveys and therefore may not be directly comparable. However the 2012 and 2014 bycatch surveys were conducted across the main queen scallop trawl fishing grounds and used a similar partial self-reporting methodology (where the fishermen collected and landed the catch to shore for analysis by scientists) and thus should be comparable.

The results (Table 4) indicate that the quantity of commercially landable (i.e.  $\geq 55$  mm) queen scallops (kg) caught per hectare (ha) had declined from 87 kg (2009) to 64 kg (2012) to 34 kg (2014). In order to avoid any bias from the restrictions on catch imposed by bag limits, only tows where the total catch limit was not exceeded were included in the analysis. In addition, the discard rate of undersized queen scallops has conversely increased from 21 % (2009) to 31 % (2012) to 36 % (2014).

In terms of bycatch the associated quantities in kg per ha have been variable among years however the proportion of bycatch relative to the total quantity of catch (e.g. everything that is brought onto deck) has increased from 3.4 % (2009) to 6.8 % (2012) to 7.1 % (2014). However, the actual quantity of bycatch (kg per ha) was less in 2014 (3.39 kg per ha) than in 2009 (4.79 kg per ha) but the corresponding total quantities of queen scallops (retained and discarded) was also less in 2014 (45 kg per ha) than in 2009 (108 kg per ha) which means that the relative proportion of bycatch is actually higher in 2014 than 2009.

Looking towards the introduction of the discard ban which is coming into effect gradually from January 2015, the Manx Fish Producers Organisation (MFPO) would require enough quota to cover the quantities of any quota species caught as bycatch (e.g. cod, angler fish, plaice etc.) in order for the fishery to continue, therefore it is important that such bycatch studies continue to be conducted

every two years in order to monitor changes in the bycatch composition not only for the purposes of MSC certification but also to inform the MFPO about quota needs going forward.

**Table 4: Comparison of results of tow characteristics and bycatch components from Duncan (2009), Boyle and Thompson (2012) and the current study. Figures are means and one standard error, where available**

	<b>2009</b>	<b>2012</b>	<b>2014</b>	<b>Units</b>
<b>Duration of tow</b>	69.75 ± 2.10	91.9 ± 1.78	95 ± 2.96	minutes
<b>Length of tow</b>	5445 ± 194	7677 ± 161	9075 ± 228	meters
<b>Swept area of tow</b>	7.46 ± 0.004	11.20 ± 0.28	10.49 ± 0.43	hectares
<b>Total queenies</b>	108.26	91.7	44.69	kg per hectare
<b>Landed queenies</b>	87.45 ± 4.51	63.9 ± 2.8	34.82 ± 44	kg per hectare
<b>Total bycatch</b>	4.79 ± 0.36	6.69 ± 0.53	3.39 ± 0.66	kg per hectare
<b>Teleost bycatch</b>	2.07	1.26 ± 0.10	0.48 ± 0.07	kg per hectare
<b>Elasmobranch bycatch</b>	1.55	1.71 ± 0.16	0.35 ± 0.07	kg per hectare
<b>Invertebrate bycatch</b>	1.17	3.72 ± 0.27	2.56 ± 0.67	kg per hectare
<b>Total bycatch % of landed queenies</b>	4	10.46	9.8	%
<b>Total bycatch % of total catch brought on deck</b>	3.36	6.80	7.1	%

## 5. Conclusions

The survey data indicates that:

- In 2014 the quantity of queen scallops (CPUE and total landings for the fishery) had reduced relative to both 2012 and 2009.
- Bycatch (kg per ha) was lower in 2014 compared to 2009 and 2012; however as a result of lower CPUE (kg per ha) of queen scallops in 2014 the proportion of bycatch relative to the total catch brought on deck had actually increased relative to 2009 and 2012.

Whilst bycatch levels as a proportion of the total catch have increased, this study confirms that bycatch levels in the Isle of Man queen scallop otter trawl fishery continue to remain low or equal relative to other similar fisheries (e.g. Dredge fishery 28.3 %; Demersal finfish trawl 9.6 % weighted average discard rate bycatch; Kelleher (2005)).

The MSC certification for the Isle of Man queen scallop trawl fishery is currently suspended due to low stock levels. It is therefore important that both landings of the target species (queen scallops) and of associated bycatch continue to be closely monitored to ensure that any significant changes to the bycatch or community composition are observed.

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