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The Isle of Man *Aequipecten opercularis* fishery stock assessment 2017

Short Report

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1.1 The fishery

A fishery for queen scallops, *Aequipecten opercularis*, has been prosecuted in and around the Isle of Man's territorial sea since the 1950s. Inside the territorial sea most Manx vessels now fish for queen scallops with otter trawls, while UK vessels continue to use both otter trawls and toothless dredges. The fishery within the territorial sea is governed by several management measures. For the 2016/2017 fishing season these included:

- Four temporary closed areas where fishing for scallops was prohibited (Figure 1).
- Queenie conservation zones where dredging for queen scallops was prohibited.
- Spawning protection closure (1st April to 31st May)
- Weekend ban
- Daily curfew (06:00 – 18:00)
- Weekly catch limits (maximum of 4200 kg for trawl and 10500 kg for dredge)
- Minimum landing size (55 mm)
- Limited TAC (1240 t)

These management measures were covered by the Fisheries Act 2012 and through restrictive licencing conditions.

Of the 48 vessels licenced to fish for queen scallops during the 2016/17 fishing season only 39 prosecuted the fishery.

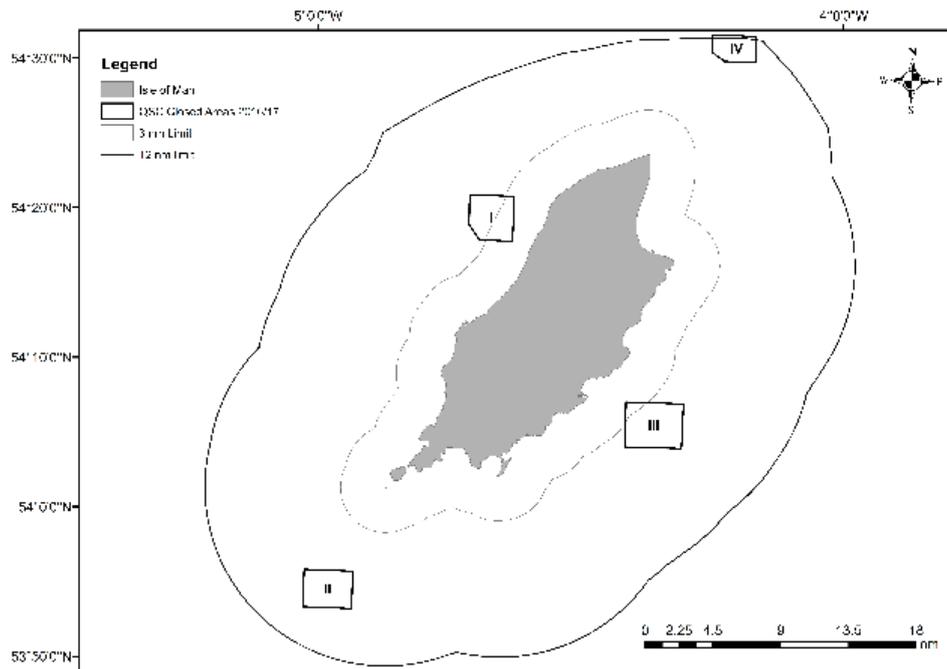


Figure 1: Four temporary queen scallop closed areas that were put in place for the 2016/2017 fishing season. All closed areas remained in place for the duration of the 2016/2017 king scallop fishing season

Outside of the territorial sea although a minimum landing size of 40 mm is enforced, the fishery is subject to very few additional management measures. However, in May 2016 industry implemented a voluntary closure for the first time in ICES areas VIa and VIIa to protect the fishery during one of its spawning periods.

1.2 Scallop surveys and abundance index

Spring surveys of the Isle of Man's scallop populations have been undertaken annually since 1992 (Beukers-Stewart *et al.*, 2003). The 2017 stock assessment survey was undertaken using the RV Prince Madog from 28th March – 10th April. Stations that have been sampled over at least two years (3, 4, 5, 9, 10, 14, 17, 20, 21, 22, 23, 24, 25, 32, 35, 36, 38, 39 and 45), in addition to the standard historical queen scallop survey stations (CHI, EDG, LAX, POA, PSM, RAM, SED and TAR), were included in the current stock assessment. Since 2016 the model has been run at a smaller spatial scale using landings and survey data exclusive to the Isle of Man territorial sea. All stations were surveyed using the protocol described by Hinz *et al.* (2009) and Murray *et al.* (2009).

The geometric mean of queen scallop density was calculated across survey stations and was used to derive the abundance indices. This was precautionary and necessary to obtain meaningful stock assessment results. A failure to use the geometric mean which down-weights isolated high-density patches of scallops would increase the risk of over-estimating population size (Hutchings, 1996) and would provide a misleading over-optimistic estimate of scallop abundance.

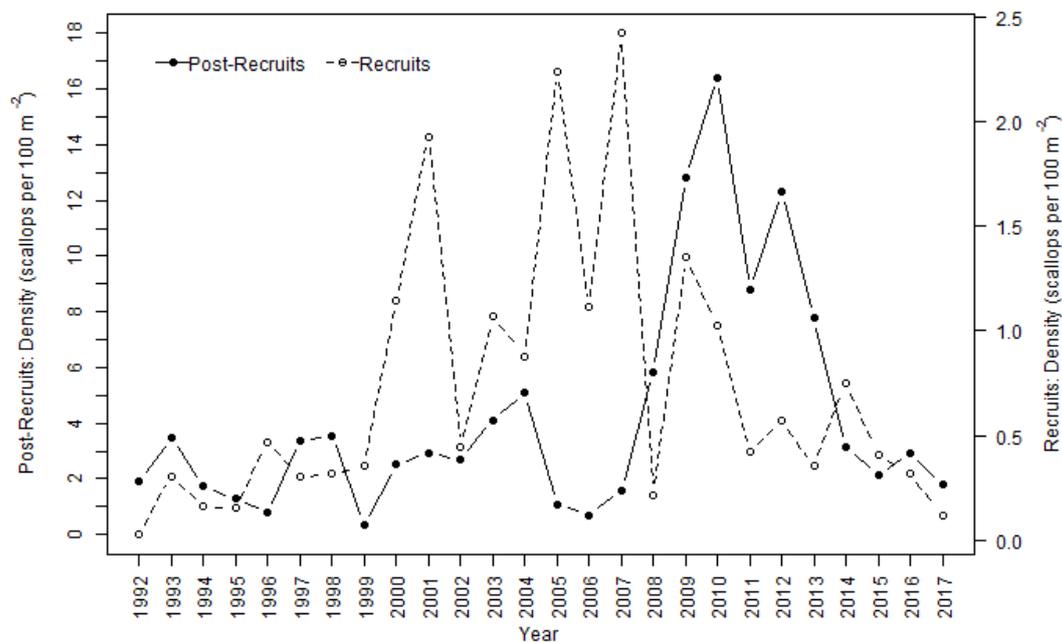


Figure 2: Abundance indices (based on geometric mean) for recruits and post-recruits used in the catch survey analysis model. This is calculated using data from only the stations used in the 2017 stock assessment model. Zero data values have been treated as 0.01 in order to calculate the geometric mean.

The abundance index shows a declining trend in the mean abundance of recruits (scallops < 55 mm) from 2009 to 2017 with slight increases observed in both 2012 and 2014 (Figure 2). From 2006 to 2010 there were year on year increases in the mean abundance of post-recruits (scallops ≥ 55 mm), reaching the highest levels on record in 2010. However, the mean abundance of post-recruits has shown a declining trend since 2010, recovering to a level similar to that recorded prior to 2007 (Figure 2).

One of the major issues for this fishery remains the continued lack of significant recruitment events within the territorial sea which is evident in the small number of pre-recruits observed within the annual survey (Figure 3).

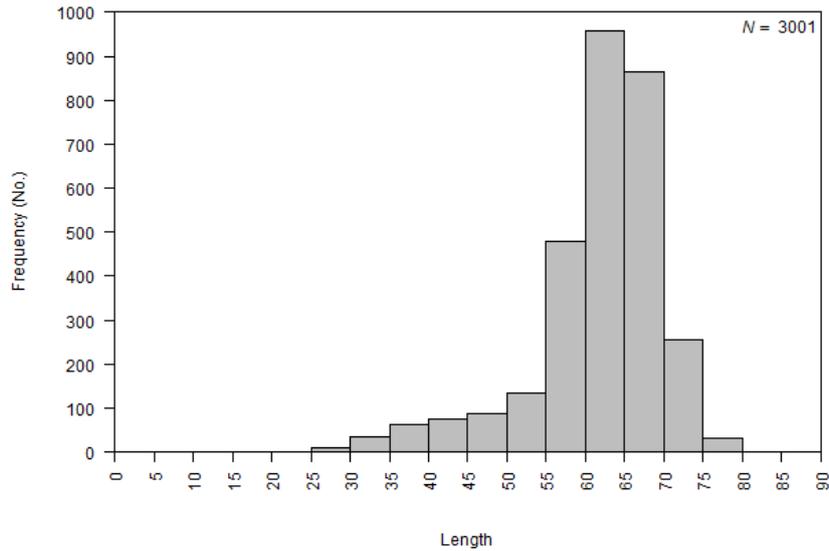


Figure 3: Length Frequency Histogram of queen scallops surveyed during the 2017 spring scallop survey. Combined data from all stations surveyed from queen scallop dredges only.

1.4 Landings and fishing effort

In 2016 (Jan to Dec) queen scallop landings from 36E5 and 37E5 were 4733t (Figure 4) with an additional 224t from 38E5. Of the total taken across these three ICES Rectangles 3751t (76%) was caught by dredgers and 1194t (24%) by otter trawlers (an additional 12t was taken with *Nephrops* trawls). Landings of queen scallops from within the territorial sea were approximately 1240t in 2016; this represents 25% of total landings from 36E5, 37E5 and 38E5 (Jan to Dec).

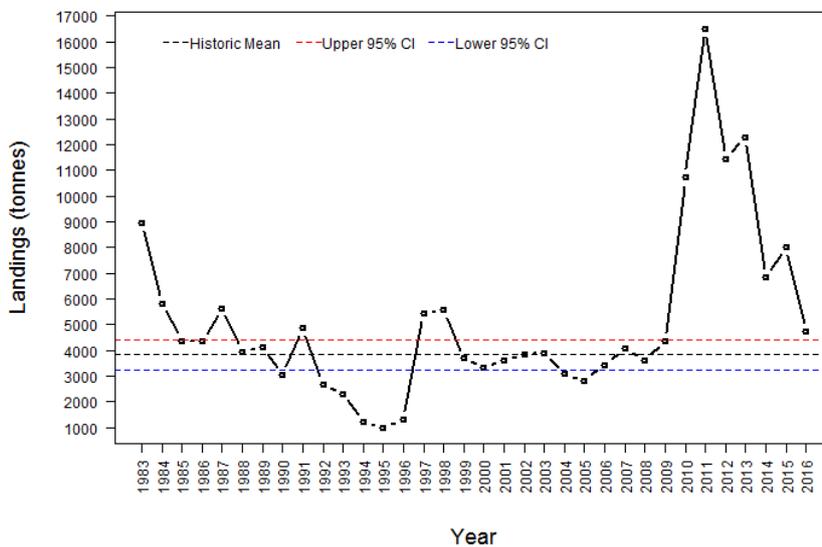


Figure 4: Landings (live weight) of queen scallops from ICES Statistical Rectangles 36E5 and 37E5 to the UK and Isle of Man. NB. Isle of Man landings before 1994 are total landings to the Isle of Man, which are likely to be predominantly from these two statistical rectangles. Data are for calendar years (i.e. from Jan to Dec). The long-term historic mean landings (1983 – 2009; before the peak) of 3865 t is displayed on the graph by a black dotted line and the upper and lower bounds of the 95% confidence interval for this value are displayed with blue and red dotted lines respectively. Data source: DEFA and IFISH.

For 2016, queen scallop fishing effort (days spent fishing; dredge and trawl) within the three ICES rectangles 36E5, 37E5 and 38E5, indicates that days at sea decreased slightly from 2015 for UK

vessels (979 to 879 days in 2015 and 2016 respectively) whilst their corresponding landings decreased sharply (6595 to 3998 t in 2015 and 2016 respectively). For IOM vessels, days at sea increased slightly from 2015 (623 to 646 days in 2015 and 2016 respectively) whilst the corresponding landings decreased (1496 to 959 t in 2015 and 2016 respectively). For Manx vessels, most landings are trawl caught and originate from within the Isle of Man's territorial sea (where catch limits are in place). For UK vessels, most landings are dredge caught and originate from outside the territorial sea (where no catch limits are in place).

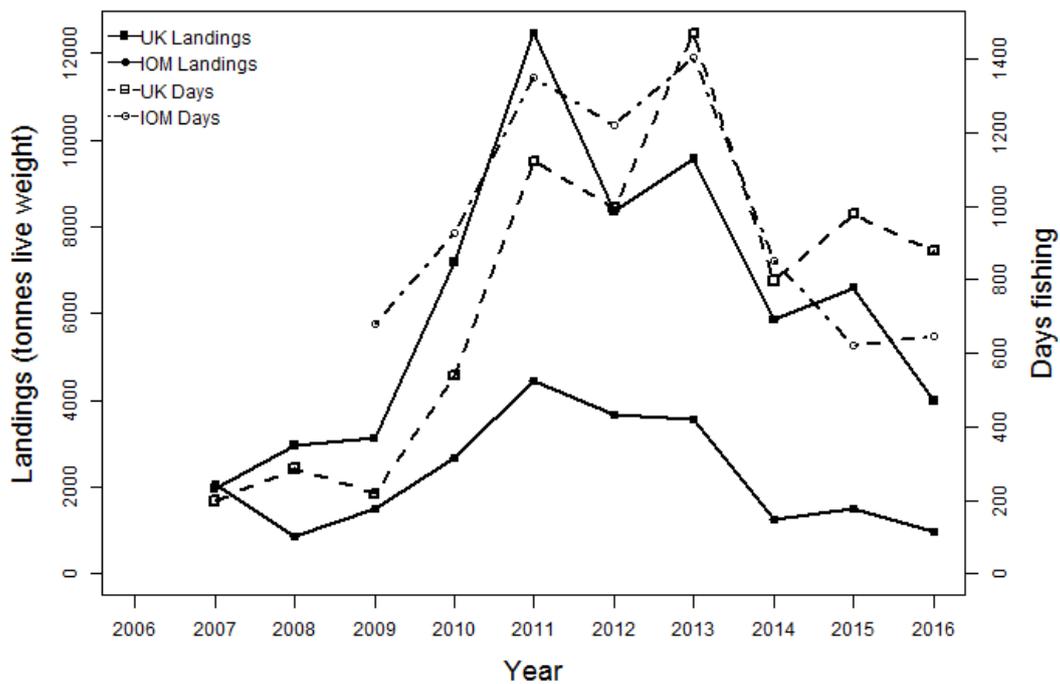


Figure 5: Landings from ICES statistical rectangles 36E5, 37E5 and 38E5 and days spent fishing for queen scallops by UK and IOM vessels. Days spent fishing by Isle of Man vessels are shown only from 2009 due to difficulty in accessing these data for earlier years. Data are derived from the iFISH database and are for calendar years (i.e. from Jan to Dec), rather than fishing years.

1.3 Stock assessment

The stock assessment was implemented using CSA v3.1.1 (NOAA, 2008). Data from the spring surveys was used since this is when temperature is lower and dredges are a more effective means of sampling queen scallops (Jenkins *et al.*, 2003), and before the main queen scallop fishing season.

Within the stock assessment unit (Isle of Man's territorial sea), the model output indicates that following five years of increasing biomass (2006-2010), total biomass has decreased during each of the subsequent seven years (2011-2017) (Figure 6). As landings exceeded surplus production in each of these seven years a corresponding decline in biomass is evident for 2011 to 2016. Abundance of recruits and post-recruits have both shown a general downward trend since 2009 and 2011 respectively.

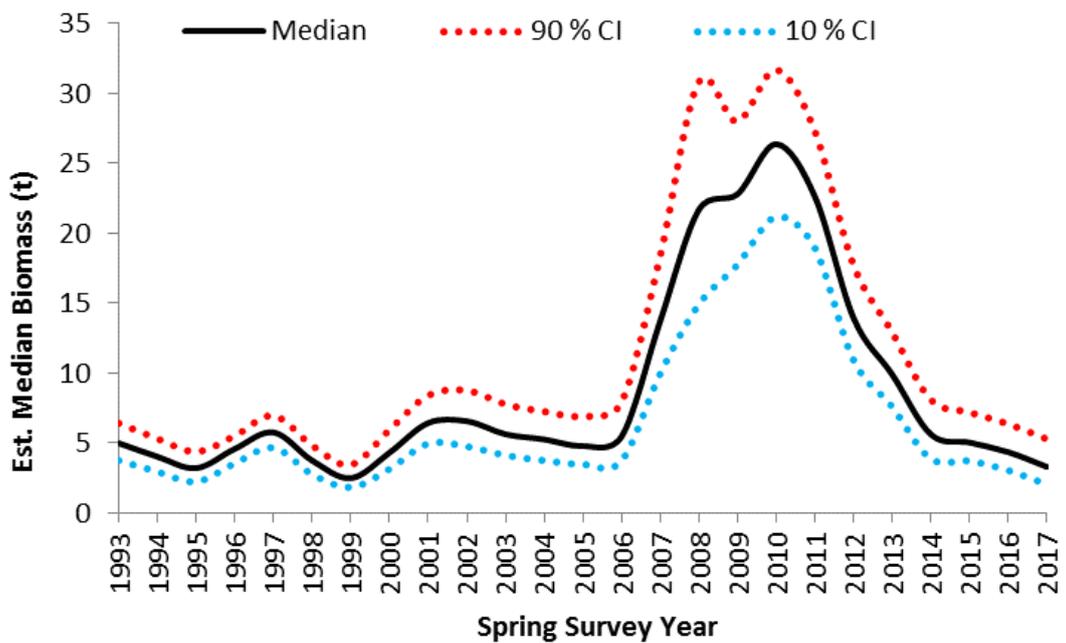


Figure 6: Total estimated biomass for the stock assessment unit (Isle of Man territorial sea) bootstrap results.

Whilst the biomass of the whole stock has declined annually since 2011, densities vary significantly among the five main fishing grounds: East Douglas (EDG), Chickens (CHI), Targets (TAR), Ramsey (RAM) and Point of Ayre (POA) (Figure 7 and Table 1). In addition, due to the aggregating nature of queen scallops some areas of relatively high densities are evident within each of these fishing grounds (on the east and west coasts the highest densities are within closed areas). The 2016 survey indicated that the highest density fishing ground was Targets on the west coast, where 51% of landings originated from during the 2016/2017 fishing season. The queen scallops within this area were predominantly large post-recruits (60–75 mm). The 2017 survey indicates that Point of Ayre on the north coast and Ramsey Bay on the north-east coast are the highest density fishing grounds (Table 1).

The average density of queen scallops (of all sizes caught) per 100 m² among fishing grounds around the Isle of Man can be seen in Table 1 for both 2016 and 2017 surveys. In 2016 the fishing grounds to the north and west of the Island (TAR and POA) had the highest densities of queen scallops per 100 m² (17 and 21 queen scallops per 100 m² respectively) whilst fishing grounds to the east of the Island (EDG) had the lowest density (5 queen scallops per 100 m²) (Table 1). For 2017 there was a large decrease in scallop density on the west and south coasts of the Island (reduced from 21 to 8 queen scallops per 100 m² at TAR and from 11 to 6 queen scallops per 100 m² at CHI) following a relatively large proportion of the total landings from the territorial sea (623 and 408 t respectively) originating from these grounds during the 2016 fishery (Table 1). On the north coast and east coast of the Island densities were maintained (18 and 4 queen scallops per 100 m² respectively) following a relatively small proportion of total landings from the territorial sea (51 and 137 t respectively) originating from these grounds during the 2016 fishery (Table 1). In addition, a large increase in density was observed on the north-east coast (RAM) following no fishing activity in 2016 (Figure 7) (increase from 13 to 41 queen scallops per 100 m²).

Table 1: A Comparison of the average survey densities (QSC per 100 m²) per fishing ground for 2016 and 2017 to show increases and decreases across fishing grounds. Landings from each fishing ground are also displayed for the 2016 fishing season (dredge and trawl).

Ground	Landings 2016	Average Survey Density 2016 QSC per 100 m ²	Average Survey Density 2017 QSC per 100 m ²
EDG	137 t	5	4
CHI	408 t	11	6
TAR	623 t	21	8
POA	51 t	17	18
RAM	0 t	13	41

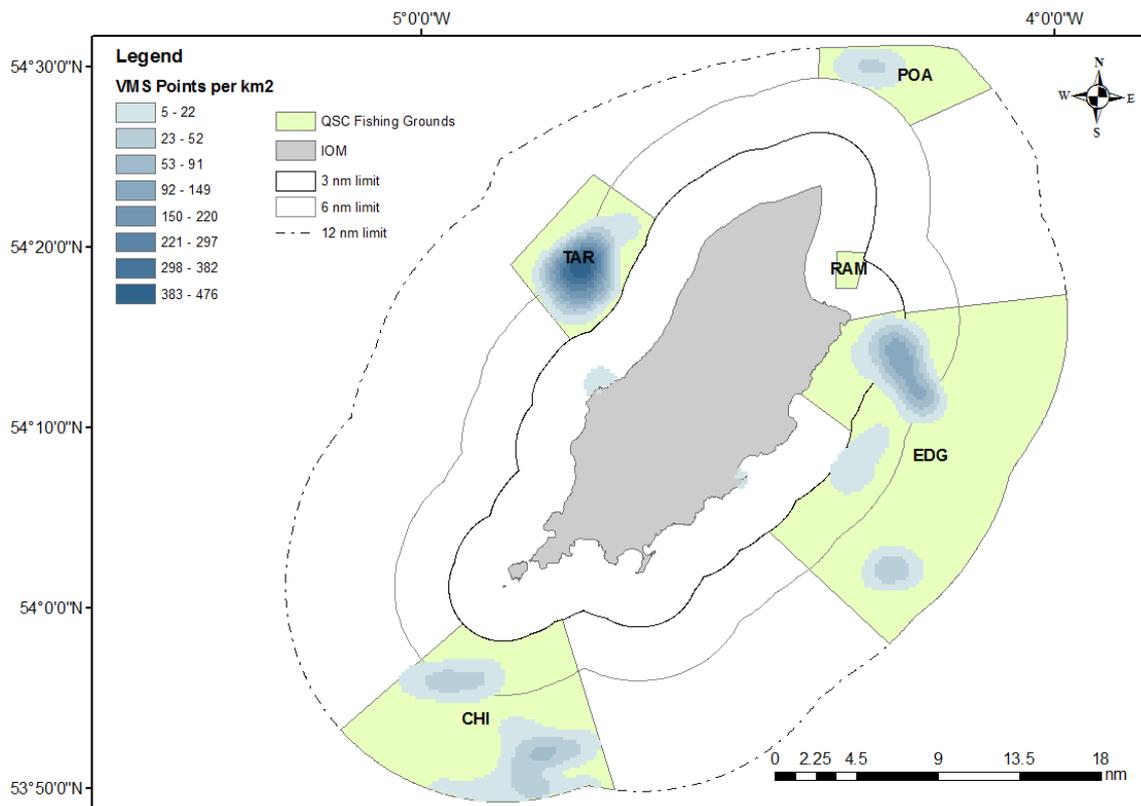


Figure 7: Map showing the approximate extents of the four main queen scallop fishing grounds known as EDG (East Douglas), CHI (Chickens), TAR (Targets) and POA (Point of Ayre). The fishing activity (represented by VMS point density) for the 2016/2017 Queen Scallop fishing season (dredge and trawl) within these sites is also displayed on the map.

In addition, the proportion of recruits and post-recruits at each station also varies around the Island. Whilst at some fishing grounds sites (e.g. CHI & EDG) were composed almost entirely of post-recruits (over 55 mm) other fishing grounds (e.g. POA & TAR) did show signs of new recruitment (i.e. queen scallops between 25 – 54 mm).

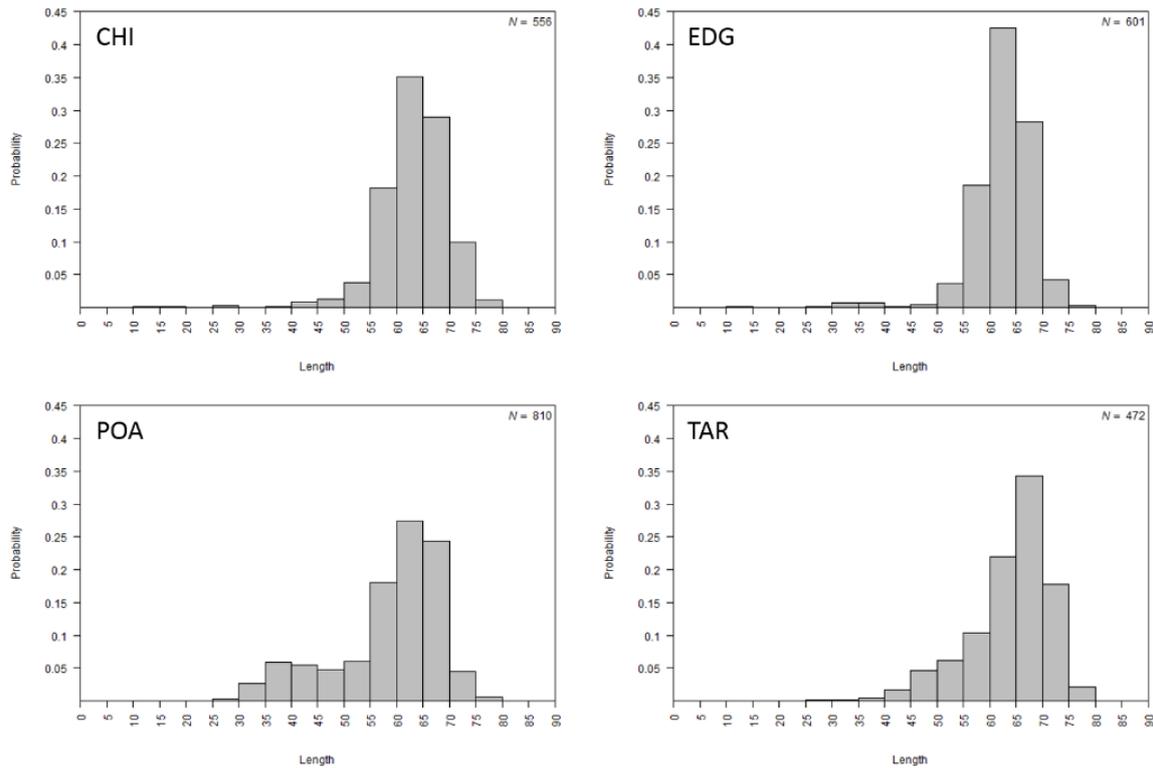


Figure 8: Length probability Histogram of queen scallops surveyed during the 2017 spring scallop survey. Data presented by fishing ground using samples from queen scallop dredges only.

For the area of the territorial sea the median biomass for 2017 is lower than for 2016 (Table 2) and is estimated as 3292t (with a 10% and 90% confidence interval range of 2083t to 5269t, respectively). At these low biomass levels the fishery is likely to be heavily dependent on annual recruitment success to allow biomass levels to increase. For scallops a direct relationship has yet to be found between spawning stock biomass and recruitment for scallops so it is likely that biomass levels do not act in isolation to determine stock levels but rather that it is one of multiple factors that have threshold limits that affect stock biomass including:

- Spatial variation in local densities of spawning individuals (e.g. Allee effect) which impact spawning success
- The physical impact of fishing on the benthic habitats utilised by scallop larvae during settlement
- The impact of fishing outside the territorial sea which may impact larval supply into the territorial sea and
- The impact of ambient environmental factors (e.g. water temperature and chlorophyll levels)

These factors may interact to determine the success of annual recruitment to the stock. Identifying a single reference point that incorporates the correct combination of these factors will be difficult and may take many years. Therefore, the combination of low total biomass and the removal of a high proportion of biomass must continue to be interpreted as a high risk strategy for the fishery and one that will sustain only low annual landings (Table 2).

Table 2: A comparison of scientific advice and actual TAC/landings (2010-2017). Landings here are represented seasonally (1st June to 31st May); BM = biomass. [*The recommended scientific TAC was proposed for two ICES squares (36E5 and 37E5), historically around 50% of landings have come from within the territorial sea and 50% from outside the territorial sea, therefore a TAC of 5000t for both ICES rectangles equates to a TAC of 2500t for the territorial sea]. NB. Data for 2016/2017 season are available until 17th April only.

	Territorial Sea					36E5, 37E5 & 38E5
Year	Estimated BM	Scientifically advised TAC (territorial sea)*	TAC of 20 % of Biomass	Actual TAC (territorial sea)	Estimated BM Removed (%)	Additional landings
2012/2013	14167t	2500t	-	3500 – 4000t	28%	6425t
2013/2014	10000t	2500t	-	5000t	50%	7631t
2014/2015	5952t	0t	-	1000t	16%	5561t
2015/2016	5328t	0t	-	1240t	23%	6374t
2016/2017	4678t	0t	935 t	1240t	27%	2940t
2017/2018	3292t	0t	660 t	TBD	TBD	TBD

2. Conclusions

- The estimated median biomass for 2017 (3292t) is lower than 2016 (approx 30% decrease).
- There is no scientific evidence that the stock is able to support a continued TAC of 1240 t. Each year the fishery has taken more than the scientific advice biomass has declined. In order to promote the earliest return of the stock to above the minimum biomass limit it is recommended that no fishing occurs within the stock assessment unit.
- Should fishing occur for socio-economic purposes a more precautionary approach to 2016/2017 is advised for the 2017/18 fishing season, limiting biomass removal within the territorial sea to 20% or less of the estimated median biomass (e.g. 660t or less) is advised in order to try and further stabilise biomass declines and/or promote an increase in biomass.
- Spatial management of the fishery is advised to reduce the risk of high density areas being depleted by more than 20% of the commercially exploitable biomass.
- Biomass depletion has rendered the fishery heavily dependent on annual recruitment. Management promoting successful spawning and recruitment using closed areas is essential.
- Low abundance of recruits at several survey stations has required plans to increase sampling effort of juvenile queen scallop to be developed. An annual beam trawl survey (which better targets recruits) will be undertaken across the territorial sea led by Industry.
- In 2016, landings within the territorial sea remained low as a result of restrictive management measures (1240t). Landings in the remainder of 36, 37 & 38E5, which covers the wider area of the biological stock and which is not subject to restricted management measures, saw a significant reduction in 2016 (2940t).
- Following a decline in stock status in 2014, and an estimated biomass below the level at which recruitment is considered to be impaired; the Isle of Man Queen Scallop trawl fishery withdrew from the MSC certification process in December 2016.
- The Irish Sea queen scallop fishery should be managed as a single biological stock with advice provided based on data collected across the Irish Sea. It is vital that work continues towards achieving a collaborative management approach for queen scallop stocks within the Irish Sea.

3. References

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