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Annual Fisheries Science Report

2017

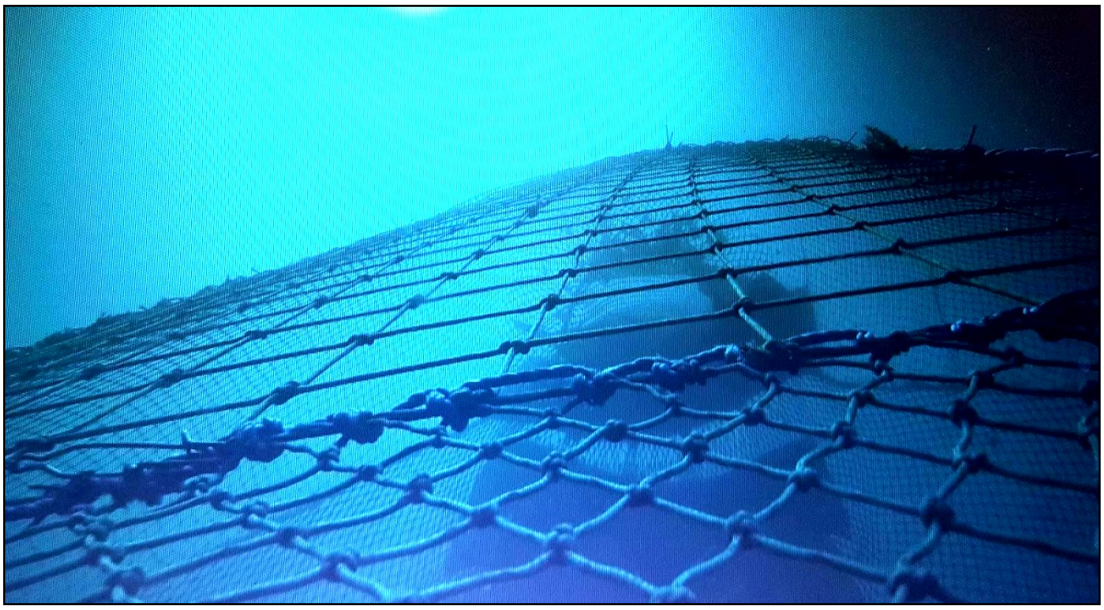
Fisheries and Conservation Science Group

School of Ocean Sciences

Annual Report for 2017

Isle of Man Fisheries Science

Fisheries & Conservation Science Group
Bangor University



PRIFYSGOL BANGOR UNIVERSITY

Isle of Man Government
Reiltys Ellan Vannin

Review of 2017 by Professor Michel Kaiser

Michel Kaiser is a Professor of Marine Conservation Ecology within the School of Ocean Sciences at Bangor University and is the academic and scientific lead for the Isle of Man

This is the tenth anniversary that Bangor University has had the privilege of providing fisheries science and advice to the Isle of Man Government. Hence it is with great pleasure that I reflect upon the achievements that have occurred over the last 12 months in moving Isle of Man fisheries towards greater sustainability. The level of collaboration between scientists, the fishing industry and the Government has reached a new high and is almost certainly unparalleled in the UK. We have achieved many firsts. The Isle of Man is now the only administration in Europe where formal analytical stock assessments are used to advise on appropriate management limits on scallop fishing activity – for both king and queen scallops. The allocation of fishing effort has been helped immensely by the clarity with which the chair of the scallop management board (Walter Crozier) has explained and interpreted the science for the members of the board. The introduction of the ICES protocols for adjusting movements in quota has provided the fishing industry with greater stability. The innovative use of an App and mobile technology to simplify catch return data capture has helped give the scientists, managers and industry up to date insights into quota uptake. The speed with which this data is captured is unprecedented in the UK and enables management to respond at timescales that are appropriate to the fishery. We also trialled LED lights on square mesh panels this year. The results were very exciting with 80% of haddock eliminated from the queen scallop net when the lights were attached to the square meshed panel. There were some teething issues with the square mesh panel, but these are certainly not insurmountable and an issue the fishing industry can fix given time.

Considerable advances have been made in the most data poor fisheries (crab, lobster and whelk). The initial trials with the pot logging devices has enabled us to calculate catch per unit effort data for the first time. This coupled with the Bluetooth enabled measuring boards has enabled fishermen to contribute to our understanding of the size structure of the catch. While many people talk about using data collecting by fishermen, often it is not used. However, given the quality of information collected with the technologies implemented on Manx vessels, this information is as good as any collected by scientists which releases my science team to focus on understanding what this data is telling us. The Isle of Man is the only location in the UK where a sentinel fleet of fishing vessels is collecting data using on-board cameras. While we still need to refine this technology with software development, we will have the first year round records of catches from the same vessels fishing the same locations. This data will gives us a unique insight into population structure and movement patterns in crab and lobster.

Two weeks ago, I taught on a fishermen/scientist course in Devon, a course we ran seven years ago in the Isle of Man. I look back and think this was a milestone for our collaboration with the Isle of Man which is now producing some very exciting innovations. One of the most exciting innovation is the Ramsay Bay fishery management area. This system is now so well managed that it out-performs protein production (beef, pig and eggs) on land in terms of its energy efficiency and its environmental performance (in terms of conservation benefits) by reducing the amount of fishing time spent in the area to harvest scallops. Nevertheless, not everything is perfect, and the Isle of Man scallop fisheries are still bearing the cost of weak management outside the territorial sea, where overfishing has greatly depleted queen scallop stocks and thereby limits recruitment into the Isle of Man. Thankfully, given the careful and evidence-based management imposed within Manx waters, the self-recruiting nature of the scallop beds around the island mean that a sustainable fishery can be maintained, but at lower levels than perhaps could be achieved if the Manx approach to management was applied more widely.

As ever, the scientific advances are only possible with the hard work of my team of Dr Isobel Bloor and Jack Emmerson who have been assisted by Claire Lambden during the last 12 months. I'm also grateful for the manner in which DEFA have helped and assisted my team, indeed I would say the achievements to date are only possible with the full collaboration of DEFA, my scientists and the willing fishermen who have helped or collaborated with us.

CONTENTS

Annual Scallop Survey (28th March—10th April, 2017)

Aim: The aim of the annual scallop survey is to assess the relative densities of king and queen scallops at a fixed set of stations within the Isle of Man's territorial sea. This allows a relative index (showing annual increases or decreases in scallop density) to be produced. The survey data also feeds into a stock assessment model to assess the abundance of queen scallops and king scallops within the stock assessment area. These results are used by the Scallop Management Board (SMB) to propose management measures for the king and queen scallop fisheries. For the 2017 survey a camera sledge with lasers attached was trialled to look at comparing the feasibility of counting and measuring scallops in camera tows compared to dredges (Figure 1).

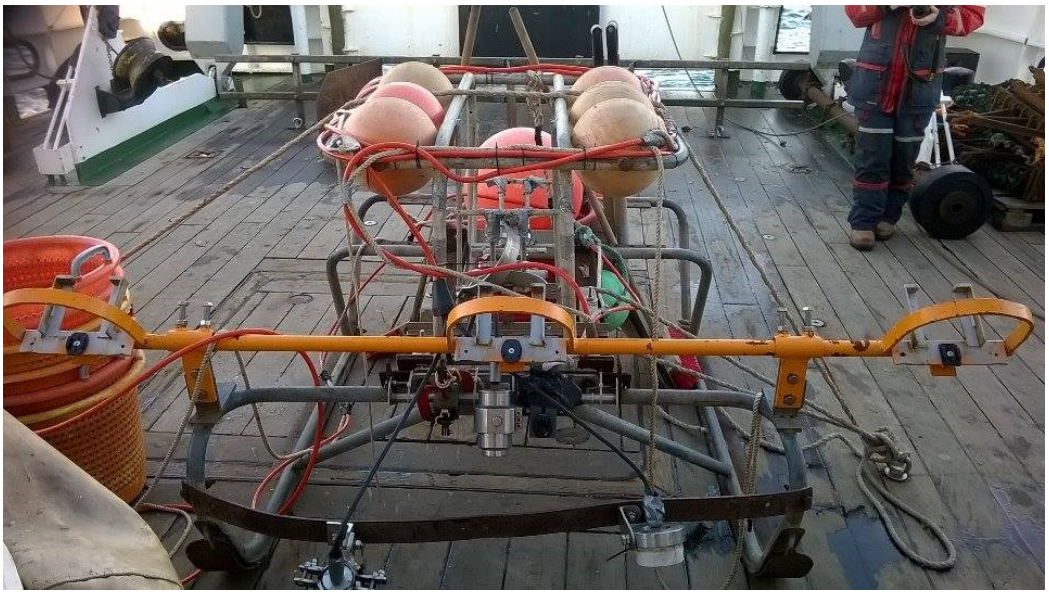


Figure 1: Photograph showing the camera sledge with laser bar attached. The laser bar allows three go pros to be attached to the sledge, each with a set of parallel lasers attached.

Survey: Despite a period of unsettled weather that prevented surveying on multiple days during the trip a total of 53 dredge stations were sampled around the Isle of Man. From each dredge a subsample of up to 90 king and queen scallops was measured and aged (king scallops only). In addition a total of 20 king and 20 queen scallops were also collected from each station and will be analysed in the laboratory to provide information on the spatial and temporal variation of maturity, spawning and growth of scallops around the Isle of Man.

Figure 2: Photographs showing the variation in catch during the survey from two stations around the Isle of Man.

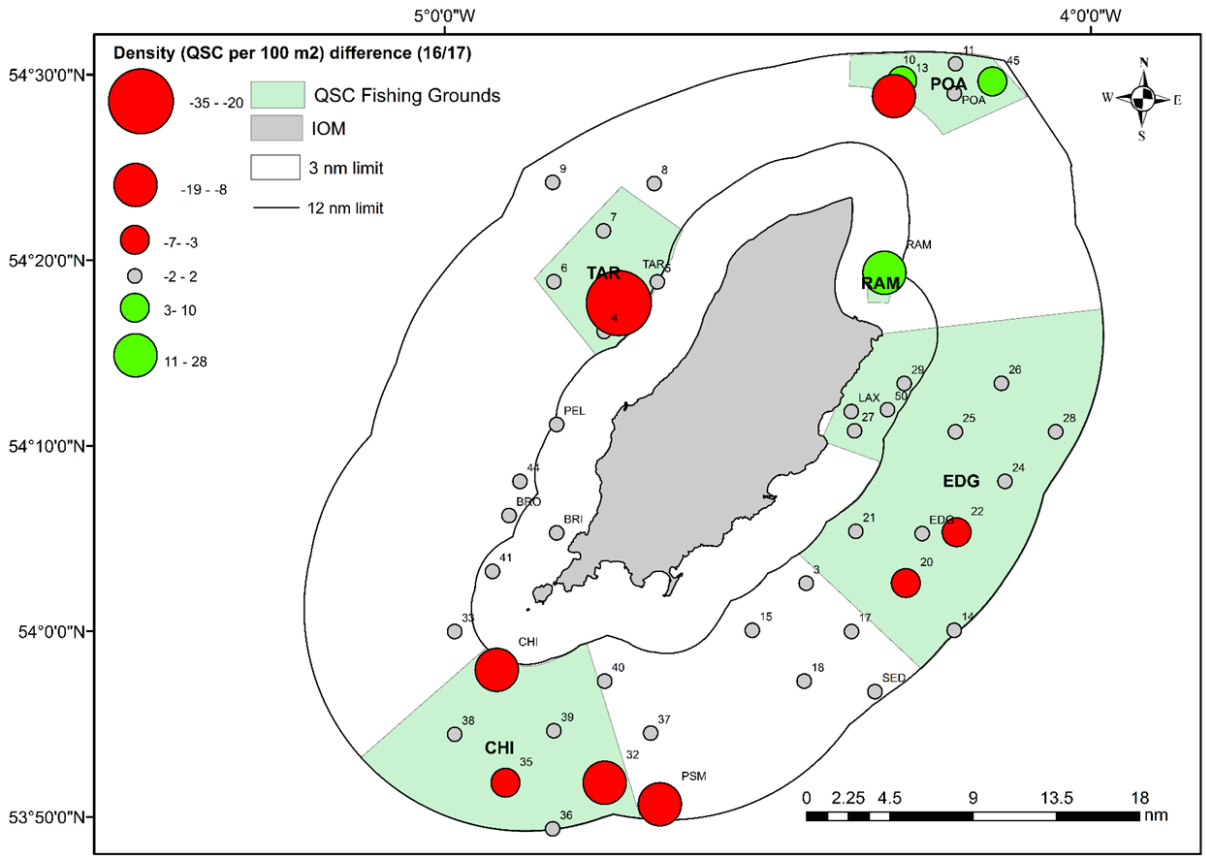


Figure 3: Changes in queen scallops densities within the Isle of Man's territorial sea based on differences in survey densities between 2016 and 2017. Red circles indicate decreases and green circles indicate increases (size indicates relative changes). Green areas roughly depict main queen scallop fishing areas.

East Douglas Experimental Research Area

An experimental research area (ERA) was established off the east coast during 2017. The specific location of the ERA was recommended by the SMB (Fig 4: Map). The purpose of the ERA is to trial artificial spat receptors as a means of increasing recruitment in the area. A baseline survey of queen scallops , was undertaken in October using a 2 m beam trawl. A total of 16 x 5 minute tows were undertaken. All bycatch from each tow was also analysed. A baseline dredge survey for scallops and a drop down camera survey for habitat will be completed in early 2018. A summary report on the baseline status will be published following these surveys. A successful 6 week trial deployment of a spat collector was also undertaken in the area ahead of a full fieldwork programme deploying spat collectors and artificial spat receptors (2018).

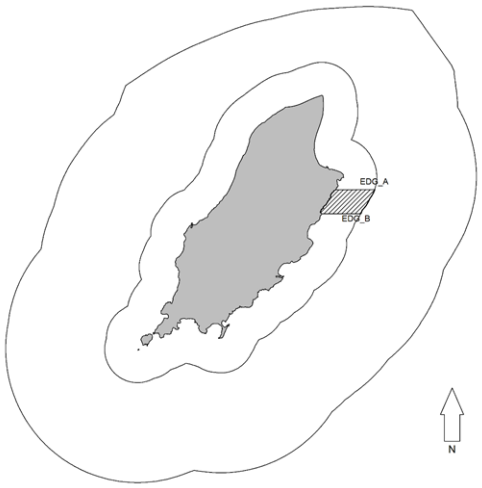


Figure 4: A map showing the location of the East Douglas Experimental Research Area and a photograph showing the example catch from a 5 minute beam trawl tow within the area.

King Scallop Fishery Update (2016/2017)

The king scallop fishery remains the most valuable commercial fishery prosecuted within the Isle of Man's territorial waters (approx. £7.4m per annum at first sale in 2016 (DEFA, 2017)). The Isle of Man's king scallop fishery is prosecuted from 1st November to 31st May by vessels using toothed, Newhaven, dredges. Management of the fishery differs between an inner 0 to 3 nautical mile zone, and an outer 3 to 12 nautical mile zone, with more stringent regulations in the inner zone. A total of 94 vessels from the Isle of Man, Wales, Scotland, England and Northern Ireland have licences to fish for king scallops in the Isle of Man's territorial sea 3- 12 nm limit and of those 42 vessels also have permits to fish for king scallops within the 0- 3 nm limit. Of the 94 vessels licenced to fish for king scallops during the 2016/17 fishing season 93 vessels reported landings of king scallops from within 36E5, 37E5 or 38E5.

The annual landings of king scallops from the ICES Rectangles 36E5, 37E5 and 38E5, which cover the main extent of the Isle of Man's territorial sea, show a very similar pattern of landings to those from the wider Irish Sea (Area VIIa) over the period 1992 – 2016. Landings increased rapidly from 2006 to 2009 almost doubling during that period from 2111t to 3971t. Annual landings have continued to increase since 2009 with an annual average of 4020t from 2010 – 2015 and a peak in 2016 of 5714t.

Seasonal landings of king scallops (1st November Year^{n} – 31st May Year^{n+1}) from ICES statistical rectangles 36E5, 37E5 and 38E5 have been relatively stable over the last six seasons (average 3961 t), although the last season (2016/2017) saw an increase to 4861 t. In addition to the increase in overall landings the temporal pattern of landings within the season differed from other seasons with a large spike in landings (> 2000t) during the first month of the 2016/2017 fishery while previous fishing seasons were more stable at ~1000t or less (Figure 5). A temporary daily bag limit of 1400 kg per vessel was therefore introduced in the territorial sea by DEFA on 15th November 2016 in an attempt to slow the overall catch rate of the fishery.

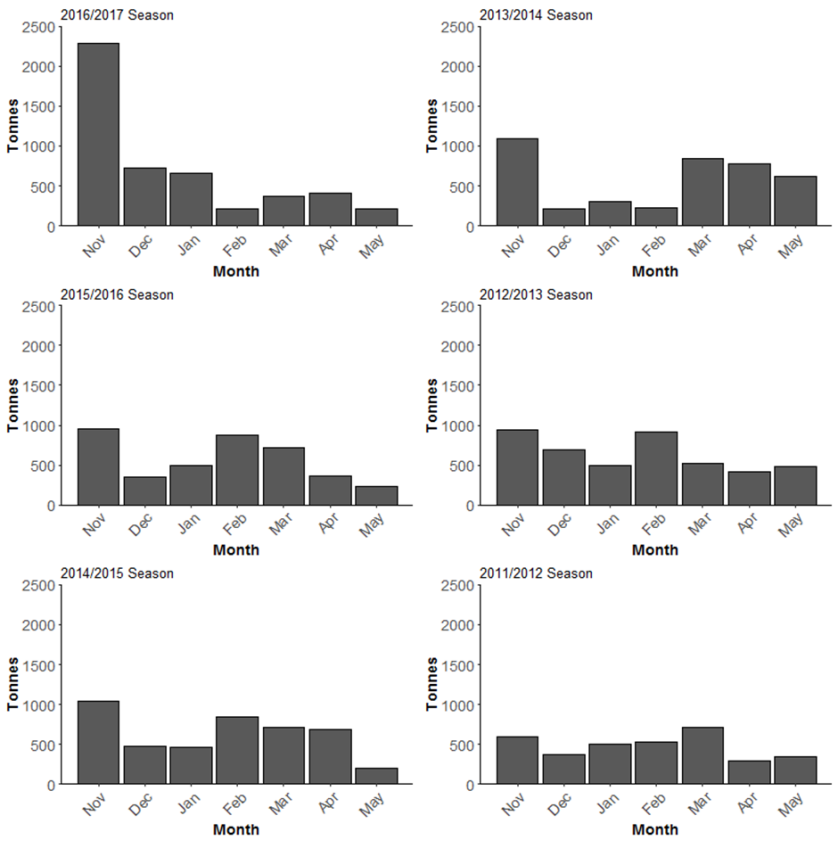


Figure 5: *King scallop landings (t) from 36E5, 37E5 and 38E5 by year and by month. Showing the relatively large increase in landings in the 2016/2017 season during the first month of the fishery (November).*

For the 2016/2017 king scallop fishing season four temporary closed areas were in place: located around the Island with one off each of the four coasts (Targets, Chickens, East Douglas and Point of Ayre).

King Scallop Stock Assessment Update

For the 2017/18 season, the king scallop fishery has for the first time been managed based on an agreed TAC. The TAC for 2017/18 was calculated using the data poor stock methods outlined by ICES (Method 3.2) and was based on the abundance index pending the peer review of the quantitative stock assessment methods. Method 3.2 outlined by ICES compares the values from the two most recent years of the abundance index with the values from the three preceding years. The TAC is then adjusted by the percentage difference of these two values taking into account the 20% uncertainty cap. As there is evidence of recruitment impairment and high fishing mortality (F) the 20% precautionary buffer was applied.

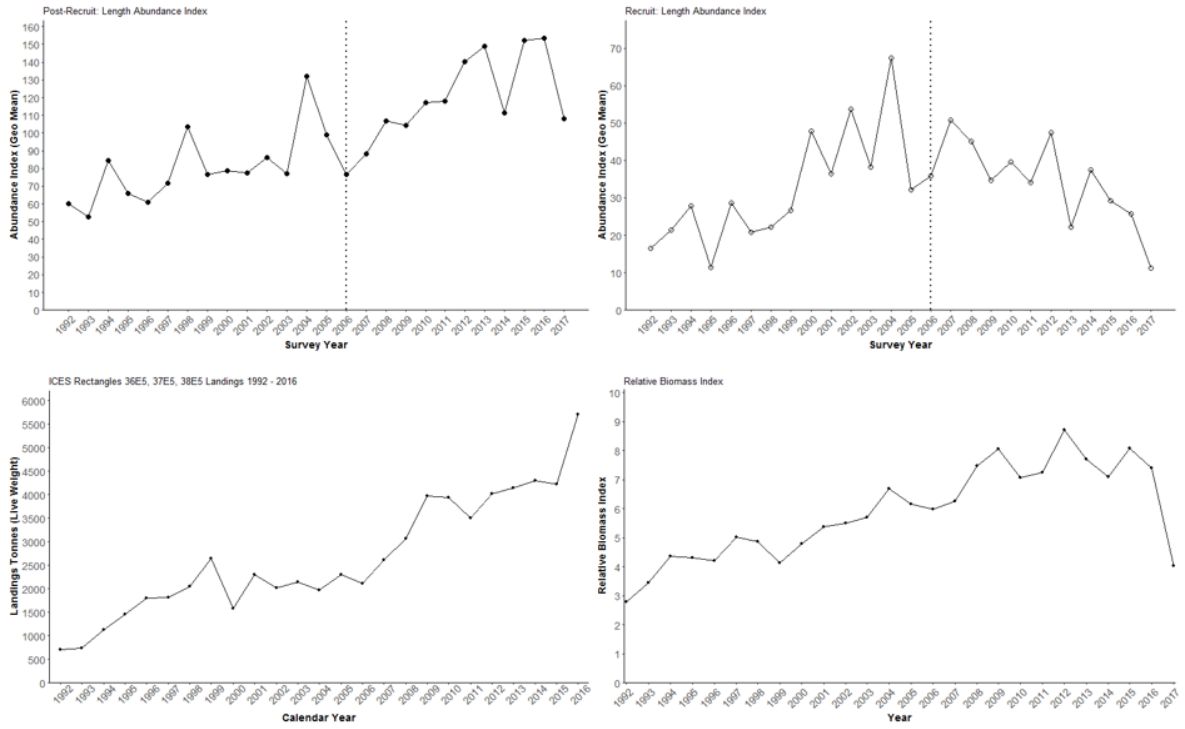


Figure 6: King scallops in ICES Rectangles 36E5, 37E5 and 38E5. Upper left, Post-Recruit abundance index from survey; Upper right, Recruit abundance index from survey; Lower left, landings from ICES Rectangles 36E5, 37E5 and 38E5 by calendar year; Lower right, Relative biomass index calculated using CSA v 4.3.

The length based abundance index for recruits (< 105 mm) declined in 2016 and decreased significantly in 2017. A similar decrease was evident for post-recruits (> 105 mm) in 2017 (Figure 6). The commercial catch continued to increase in 2016 (Figure 6). There was a decrease in the overall abundance index (all size scallops) in 2017 which is also observed in the estimates of biomass from both length (Figure 6) and age based stock assessments.

Previously no TAC has been set for the Isle of Man's king scallop fishery within the territorial sea. As a result, the SMB recommended that a proxy for the previous seasons catch advice was calculated from the average landings from the previous 5 fishing seasons (3708 t), with a proportion of landings from ICES Rectangles 36E5, 37E5 and 38E5 attributed to the territorial sea using VMS and landings data. The provisional catch advice for 2017/2018 king scallop fishery within the territorial sea is 2563 t (precautionary buffer applied). The actual TAC adopted by the SMB was 3203 t (no precautionary buffer applied). The calculation of the TAC for future fishing seasons will be based on the outputs of a quantitative stock assessment.

Commercial Market Sampling

In order to enable the commercial king scallop landings from within the Isle of Man's territorial sea to be split into age categories, to assist in stock assessment modelling, a monthly commercial market sampling scheme has been introduced. The initial scheme will run from November 2017 to May 2018 and the results will be reviewed prior to the start of the 2018 king scallop fishing season. The project is coordinated with assistance from the Manx Fish Producers Organisation, DEFA and Isle of Man Seafoods. The sampling schemes aims to target the main spatial fishing grounds which are largely

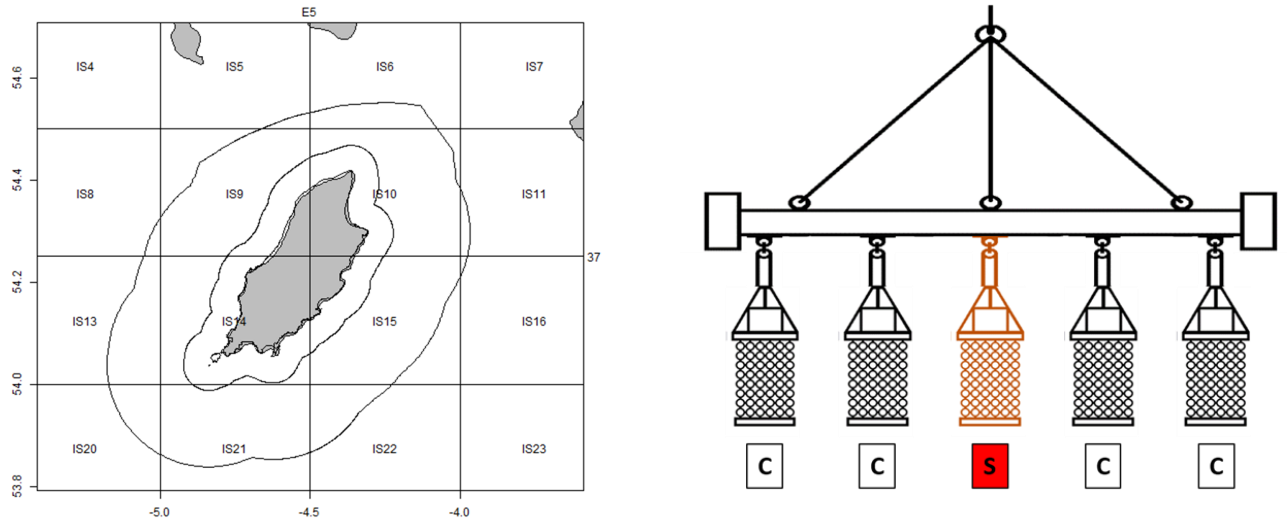


Figure 7: *Map showing IS Boxes and Diagram showing the placement of the standard dredge within the commercial set up*

covered by six IS Boxes (IS6, IS9, IS10, IS14, IS15 & IS 21). Weather permitting the scheme aims to achieve one commercial sampling event per fished IS Box per month during the king scallop fishing season. For each sampling event the MFPO identifies a vessel fishing within an IS Box and supplies the vessel with a standardised commercial king scallop dredge which they fit in the centre of their tow bar. Vessels tow for 60 minutes at ~ 2.5 knots. For each tow completed during that day the crew measure and record the size and number of scallops from within the dredge (using an electronic measuring board). This data allows the Catch Per Unit Effort and Size Frequency of the scallops to be compared both spatially and temporally. In addition, the vessel is supplied with 2 bags that are marked with a blue cross and a red cross. The red bag is filled with unsorted scallops of all size ranges straight from the deck while the blue bag is filled with sorted scallops over MLS. These two sample bags are landed to Isle of Man Seafoods and are analysed by Bangor University scientists for age, length and weight.

Figure 8: *Scientists analysing red bag samples (unsorted) and analysing blue bag samples (over MLS)*

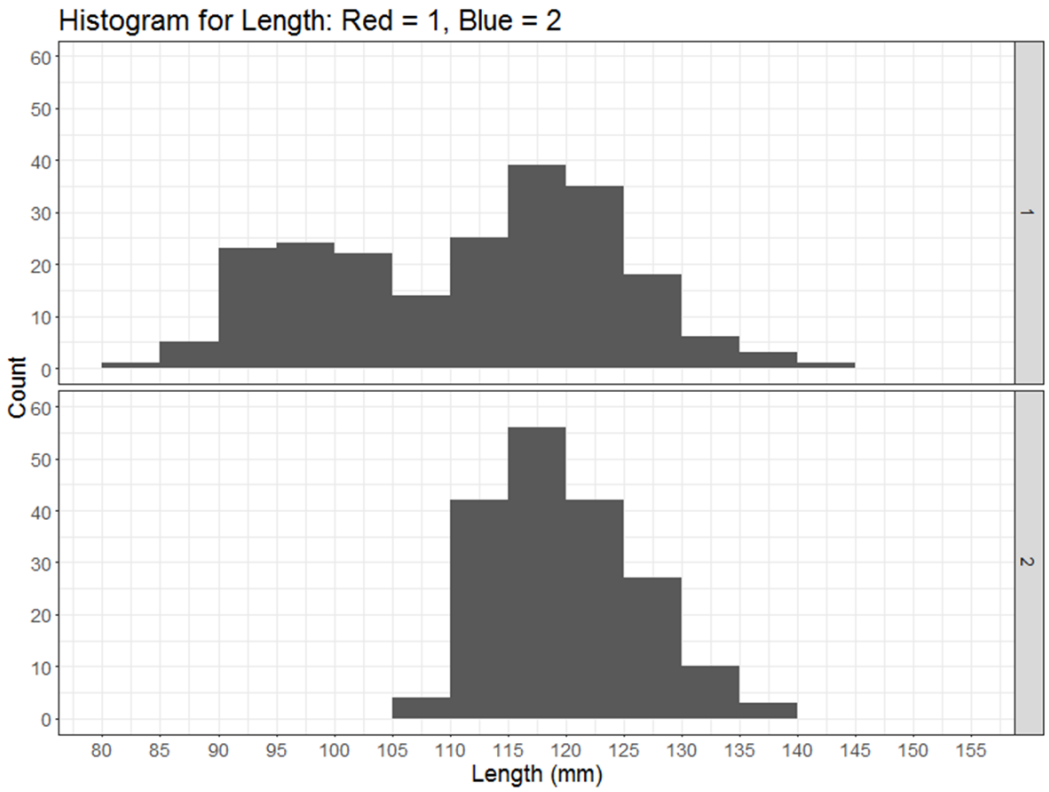


Figure 9: *Size frequency of ungraded (red bag) sample on the top graph and graded (blue bag) sample on the bottom graph. Both samples provide information on landings size-frequency while the ungraded sample provides additional information on discards.*

The two samples are able to provide information on both the size frequency of all caught scallops (catch) and retained scallops (landings) (Figure 9). A subsample of 20 scallops is retained for further analysis in the laboratory where information on growth increments, age, length, height, meat weight, gonad weight and gonad stage are recorded. Growth increments can be measured to look at the different growth rates spatially around the Island and also temporally among years. The maturity stage can also be assessed which will identify which months spawning events occur within each year.

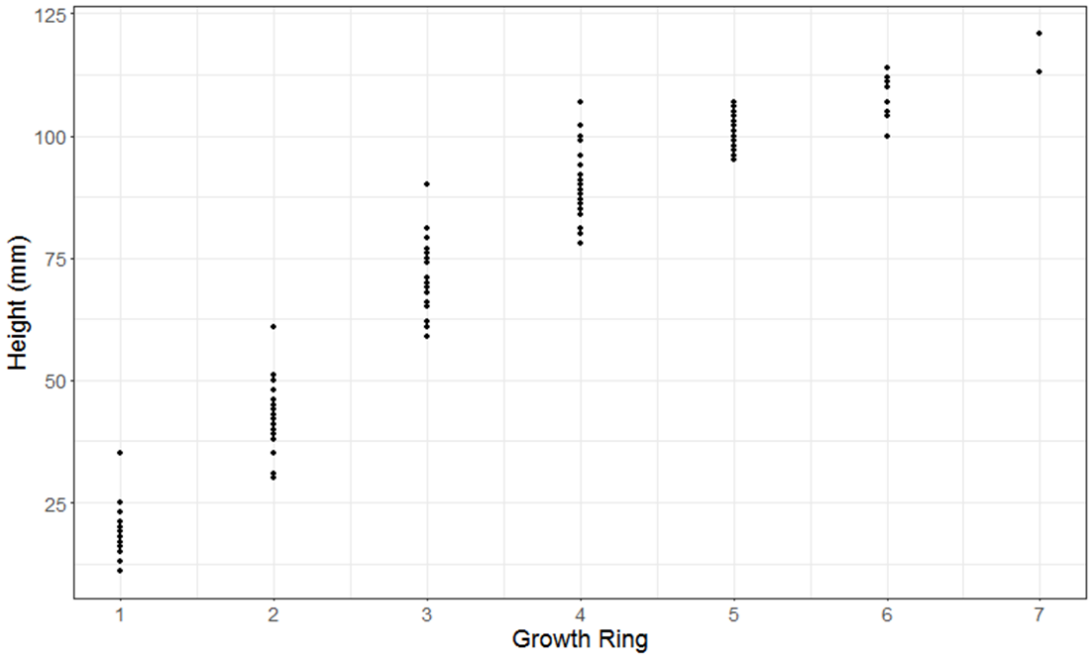


Figure 10: *Data on growth ring measurements which indicate the amount of growth between years. This data can be used to calculate von Bertalanffy growth rates among fishing grounds.*

Queen Scallop Trawl Fishery update (2017)

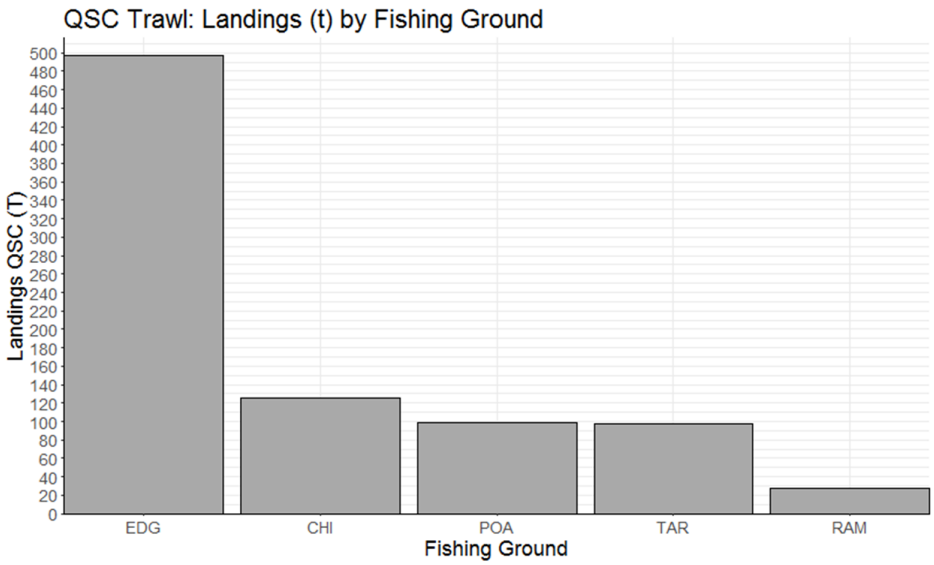


Figure 11: *Graph showing the landings (t) of queen scallops from each of the 5 main fishing grounds during the 2017 fishing season.*

For 2017 the quota for the queen scallop (QSC) trawl fishery within the Isle of Man's (IOM) territorial sea (TS) was set at 853 t of which 27 t was reserved for Ramsey Bay.

Trawl activity for QSC is permitted within all areas of the IOM TS excluding two closed areas: the Experimental Research Area East of Douglas and the Scallop Closed Area at Chickens.

A total of 38 licenced vessels were declared as trawl boats prior to the start of the fishing season entitling them to target QSC by trawl within the IOM TS. The trawl season opened on 3rd July 2017 and closed on 22nd September 2017. The initial weekly catch limit for trawl vessels was set at 3360 kg but this was reduced to 1400 kg on 9th September 2017 as the quota limit was reached.

Xx of the trawl vessels fished during the season with a maximum, of 31 unique vessels fishing in any one week. Total landings from Daily Catch Return forms submitted by the vessels approximated 845.5 t. The majority of effort and landings (~ 500 t) was focused East of Douglas (EDG), although later in the season the spatial extent of the fishery expanded to all the major fishing grounds (Figure 11).

LPUE by week across the whole fishery indicates a general pattern of depletion (although the QSC fishery that was prosecuted in the Ramsey Bay FMZ increased LPUE in Week 13) (Figure 12).

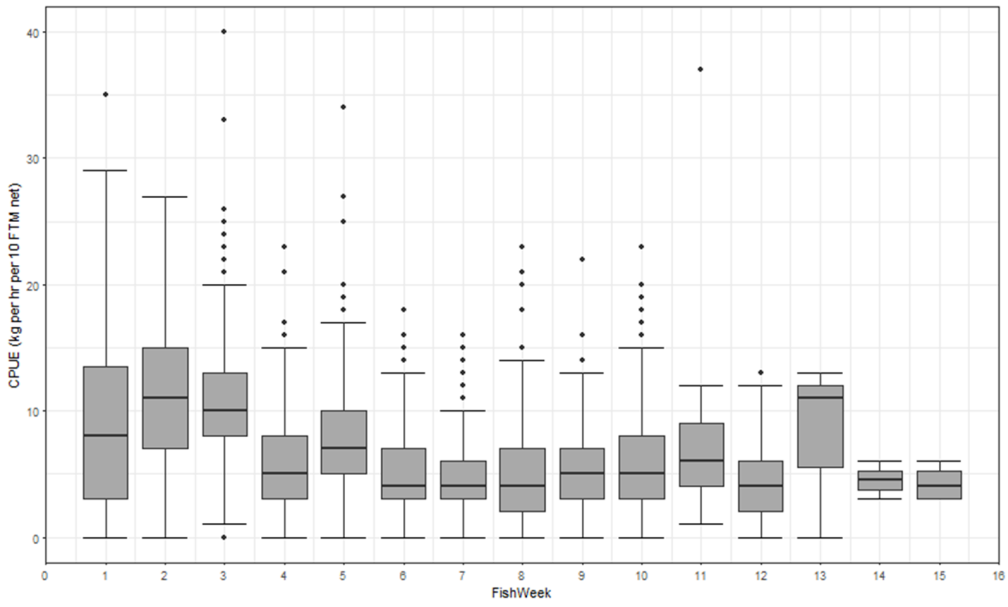


Figure 12: *Boxplot showing landings per unit effort (LPUE) in kg per hr per 10 fathom net by week across the fishing season.*

The box represents the inter-quartile range (i.e. the middle 50% of the data) and the horizontal line within the box represents the median.

The vertical line above the box illustrates the top 25% of the data (upper quartile) and the vertical line below the box illustrates the bottom 25% of the data (lower quartile).

Outliers are indicated by single points.

Queen Scallop Dredge Fishery update (2017)

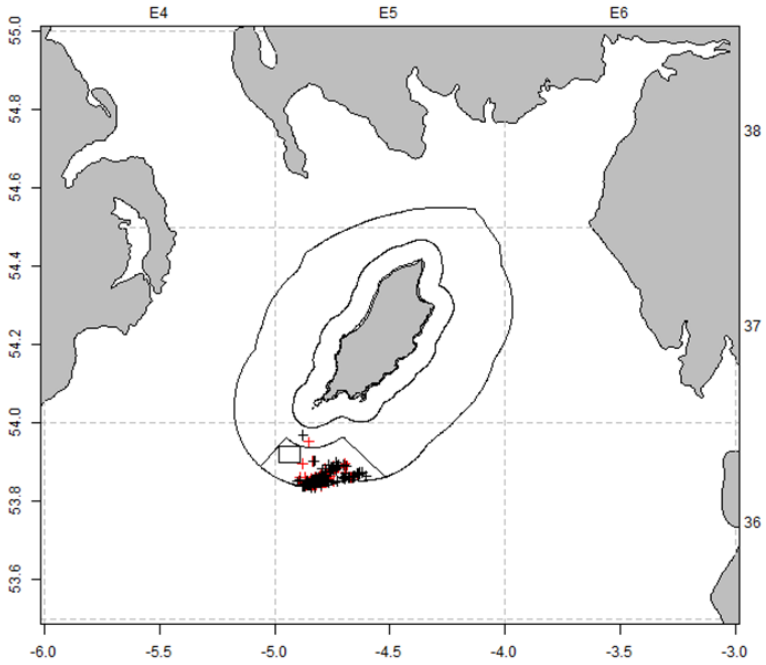


Figure 13: *Map of dredge box and 2017 QSC Dredge fishing activity*

For 2017 the quota for the queen scallop (QSC) dredge fishery within the Isle of Man's (IOM) territorial sea (TS) was set at 139 t.

Dredge activity for queen scallops within the IOM TS is currently restricted to a small dredge box (Figure 13) which is located to the South of the Island, within the Chickens fishing ground. Within the dredge box a small area in the north-west remained closed during the dredge season to protect juvenile queen scallops.

A total of 7 licenced vessels declared as dredge boats prior to the start of the fishing season entitling them to target QSC by dredge within the IOM TS. The dredge season opened on 2nd October 2017 and closed on 27th October 2017.

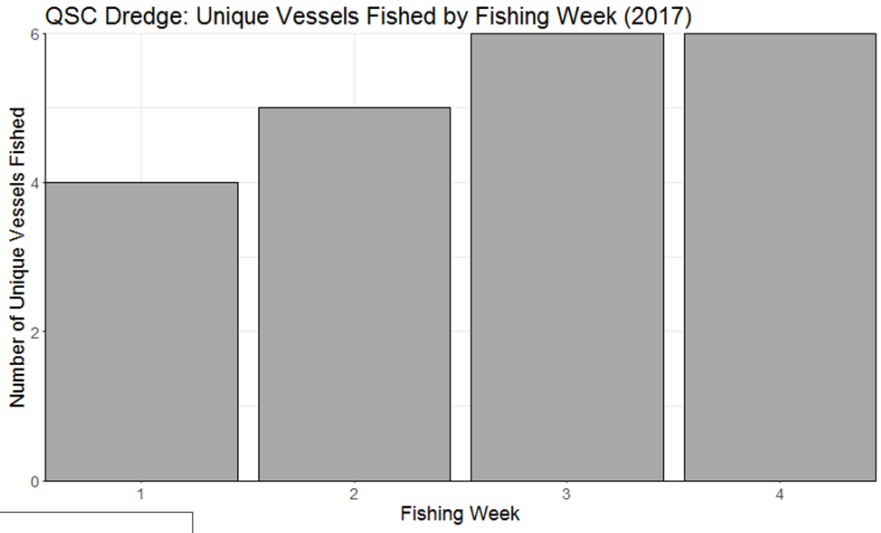


Figure 14: *Number of unique dredge boats targeting the fishery by week.*

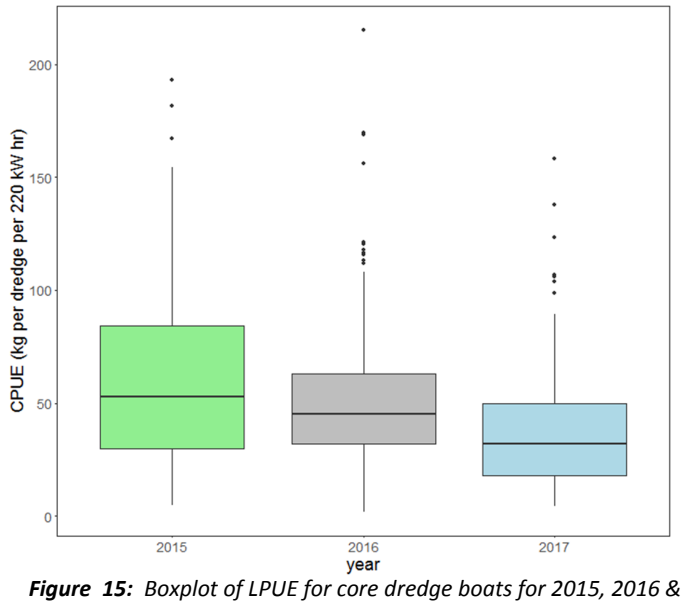


Figure 15: *Boxplot of LPUE for core dredge boats for 2015, 2016 & 2017*

The initial weekly catch limit for dredge vessels was set at 10500 kg and was reduced on 22nd October 2017 to 3000 kg as the quota limit was reached.

All 7 dredge vessels fished during the season with a maximum of 6 vessels fishing in any one week (Figure 14).

Total landings from Daily Catch Return forms

Queen Scallop Stock Assessment

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.

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 16). 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 .

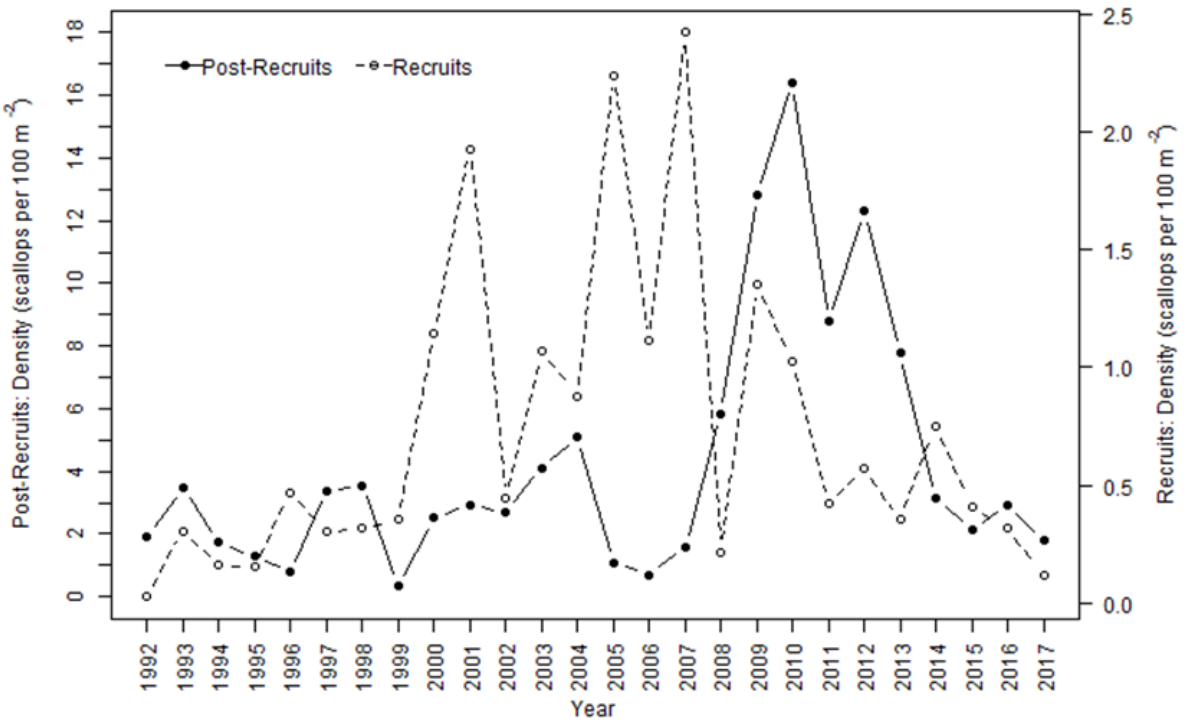


Figure 16: *Abundance indices (based on geometric mean) for recruits and post-recruits used in the catch survey analysis model. This is calculated using data from only the stations used in the 2017 stock assessment model. Zero data values have been treated as 0.01 in order to calculate the geometric mean.*

In 2016 (Jan to Dec) queen scallop landings from 36E5 and 37E5 were 4733t (Figure 17) 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).

The stock assessment was implemented using CSA v3.1.1 (NOAA, 2008). Within the stock assessment unit (Isle of Man's territorial sea), the model output indicates that following five years of increasing

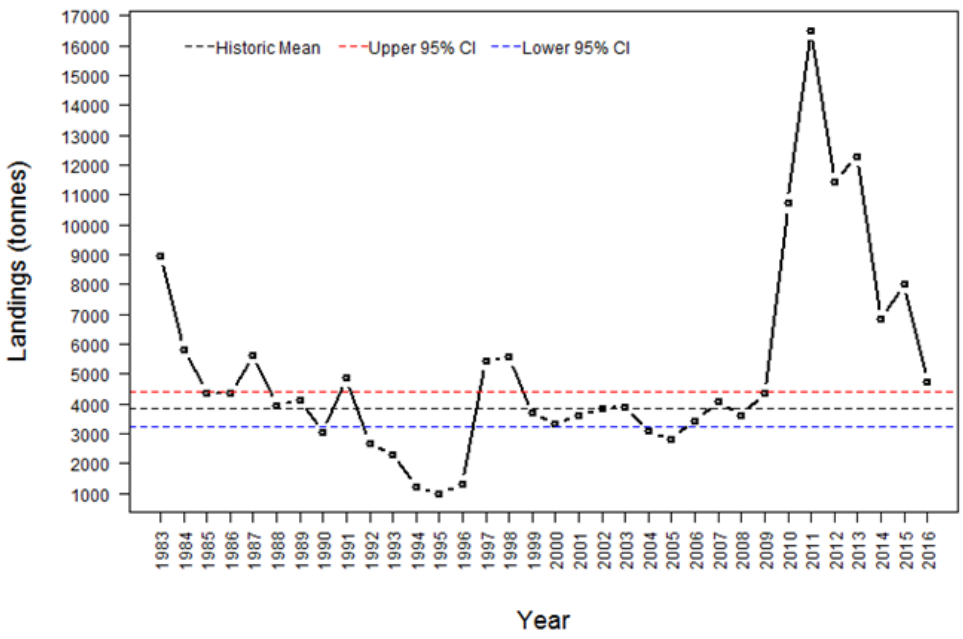


Figure 17: *Landings (live weight) of queen scallops from ICES Statistical Rectangles 36E5 and 37E5 to the UK and Isle of Man. NB. Isle of Man landings before 1994 are total landings to the Isle of Man, which are likely to be predominantly from these two statistical rectangles. Data are for calendar 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.*

biomass (2006-2010), total biomass has decreased during each of the subsequent seven years (2011–2017) (Figure 18). 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. 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). 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).

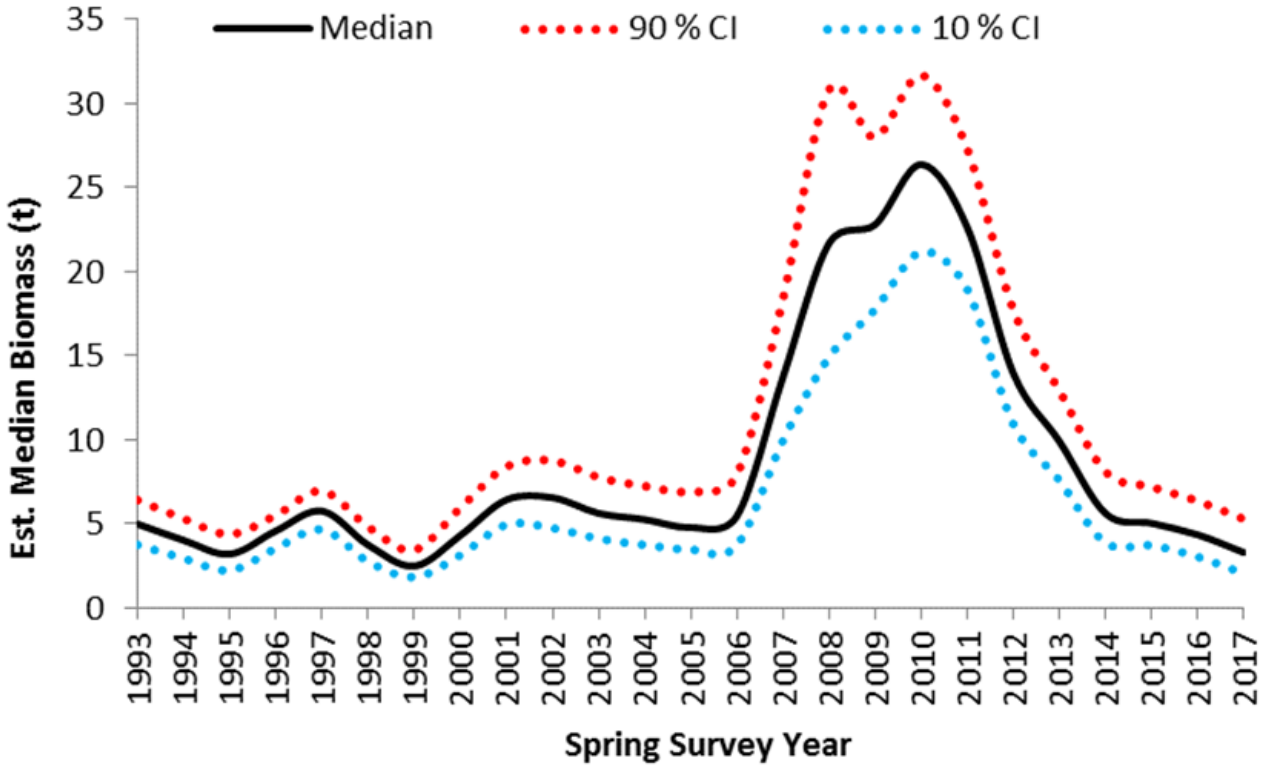


Figure 18: *Total estimated biomass for the stock assessment unit (Isle of Man territorial sea) bootstrap results.*

Ramsey Bay Fisheries Management Zone Survey

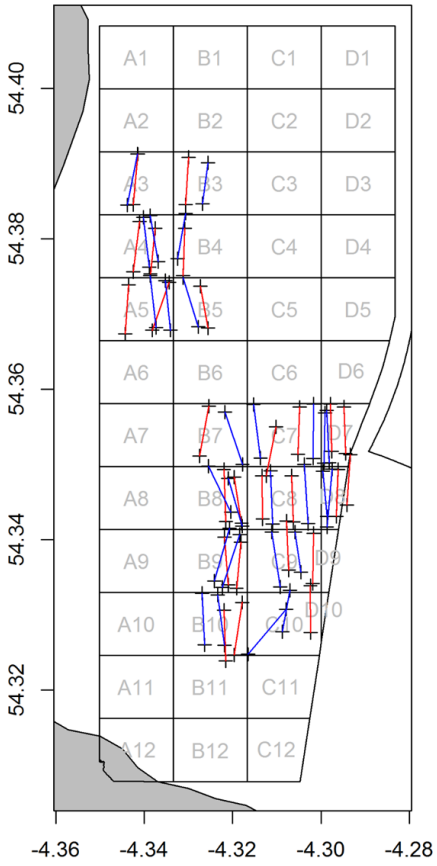


Figure 19: *Map of 2017 survey tows*

The Manx Fish Producers Organisation and Bangor University undertook the annual scallop survey for Ramsey Bay in March 2017. The survey was undertaken by two vessels (Our Sarah Jane and Two Girls) and took place over two days (20 - 21 March 2017). These vessels were chosen as they were similar in class and engine power. It was decided that several tows would be undertaken per fishable grid box (Figure 19) to account for variations in scallop densities within the boxes. Electronic measuring boards were used by the crew of the vessels to record the number and size range of king and queen scallops caught on each tow.

A total of 53 tows were undertaken with between 2—4 tows in a grid box (Figure 19). The analysis indicated that there was large differences both between the two vessels and among tows within the same box.

Figure 20: *Crew using the electronic measuring boards to measuring scallops in the Ramsey Bay.*

For the analysis an assumed dredge efficiency of 0.31 (based on data from CEFAS depletion studies for clean habitats) was used. The average density per fished box was calculated from the results of the survey (Figure 21). The MFPO agreed a TAC of 53.8 t for the December 2017 fishery with a quota allocation provided to each eligible member of the MFPO .

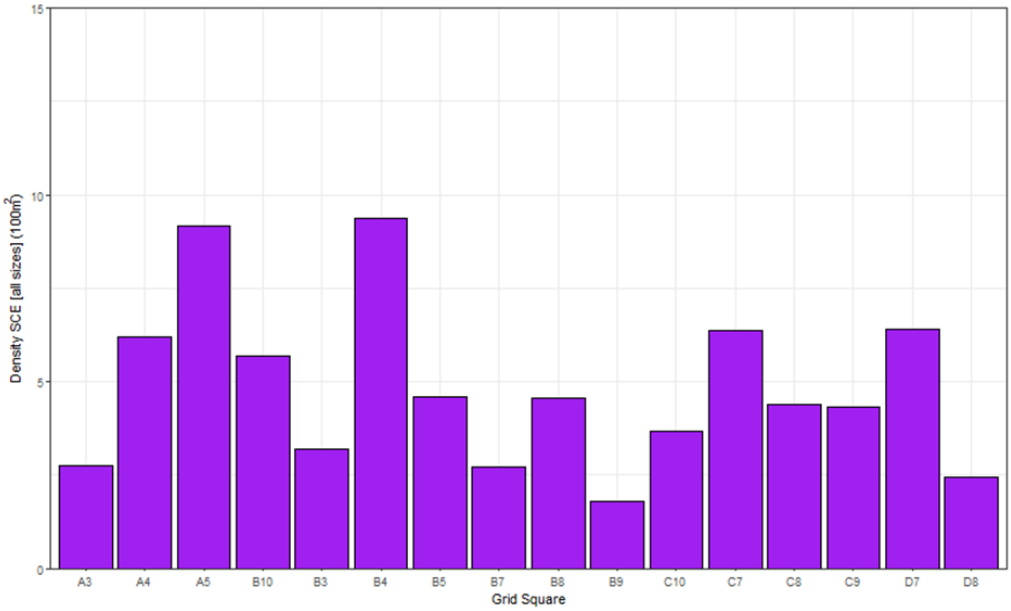


Figure 21: *Average density of king scallops per 100 m2 averaged across vessels and tows and presented by grid square for the 2017 survey.*

ICES Working Group Scallop Stock Assessment

The fifth meeting of the ICES Scallop Working Group was held from 10th – 12th October 2017 in Belfast, Northern Ireland. A total of fourteen members from 11 international institutions as well as an observer from the South-West Producers Organisation attended the meeting which is chaired by Professor Kevin Stokesbury from the University of Massachusetts. The workshop focused on several key areas including: Standardising ageing techniques for use in stock assessment models leading to an inter-laboratory ageing calibration assessment using samples from all the populations discussed; new scallop surveys and stock assessment methods and a review of existing stock assessments for scallops around the ICES area. The working group is moving towards a better understanding of the status of scallop stocks within the ICES areas. However, the growing need for global assessment of scallops is becoming increasingly apparent and the working group plans to use the Baie des Seines (English Channel) and the Isle of Man (Irish Sea) fisheries as case studies to explore this.

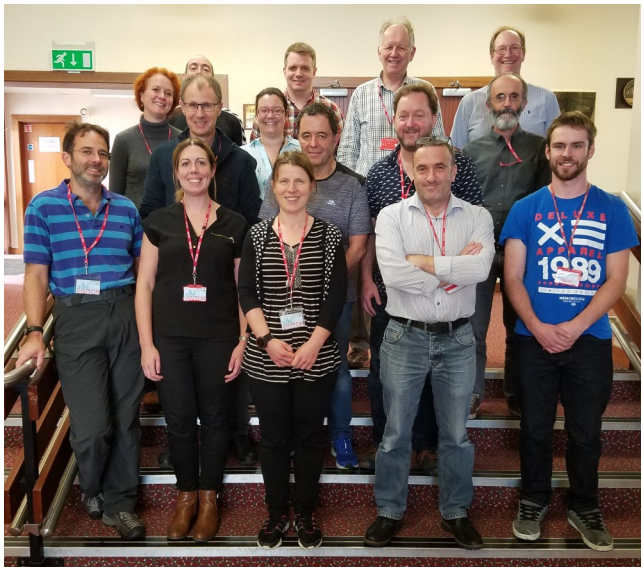


Figure 22: *Scientists from eleven international institutions representing France, Isle of Man, Wales, Iceland, Faroe Islands, Ireland, Northern Ireland, Scotland, Norway and England met at AFBI laboratories in Belfast as part of the working group on scallop stock assessments which was chaired by Professor Kevin Stokesbury (USA)*

Scallop research priorities for 2018

- **Queen Scallop fishery:**

⇒ Stock assessment (May 2018)

⇒ Review of dredge fishery

- **King scallop stock assessment:**

⇒ September 2018

- **Commercial Market Sampling Schemes:**

⇒ Red & Blue bags

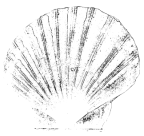
- **2018 Spring Scallop Survey:**

⇒ 4th —17th April 2018 survey

⇒ Laser survey trials for identifying scallops on the seabed

- **Economic assessment of the Ramsey Bay king scallop fishery:**

⇒ Manuscript submission for peer review publication



Potting sector fisheries: Crab, Lobster & Whelk

The potting sector of the Isle of Man fishing industry continues to work closely with scientific staff based on the island. The research priorities specific to the crab, lobster and whelk fisheries are addressing the issue that these stocks, much like elsewhere in Europe, are characterised as being 'data poor'. Consequentially, evidence-based management is difficult to implement and harvest strategies may not reflect stock abundance.

Nonetheless, collaborative efforts have resulted in improvements in the existing monitoring and management situation of static-gear fisheries. Understanding the interaction between static-gear fisheries and the biology of target and non-target species is vital for stock sustainability and the fisheries that they support.

Update on whelk fishery

The Isle of Man Government went to public consultation on the management of whelk fishing within the territorial sea during 2017. As an outcome of this process, a capped number of species-specific license were created and issued for the fishery in August. The consultation was supported by an evidence base document, which summaries data collected in a collaborative project that ran throughout 2016 and covered the principal fishing grounds within the Isle of Man territorial sea.

The consultation was the product of discussions held at the whelk industry group meetings, which functions as an effective stakeholder forum. The group continues to work closely and, with the species specific license in place, has a framework from which to move forward to sustainable management. Significant knowledge gaps remain on the biology of the species that must be established before routine stock assessment models are able to be performed. Further, landings and effort reporting mechanisms vary in quality according to vessel metier. A challenge for the coming year will be to bring all vessels into the same logbook scheme.

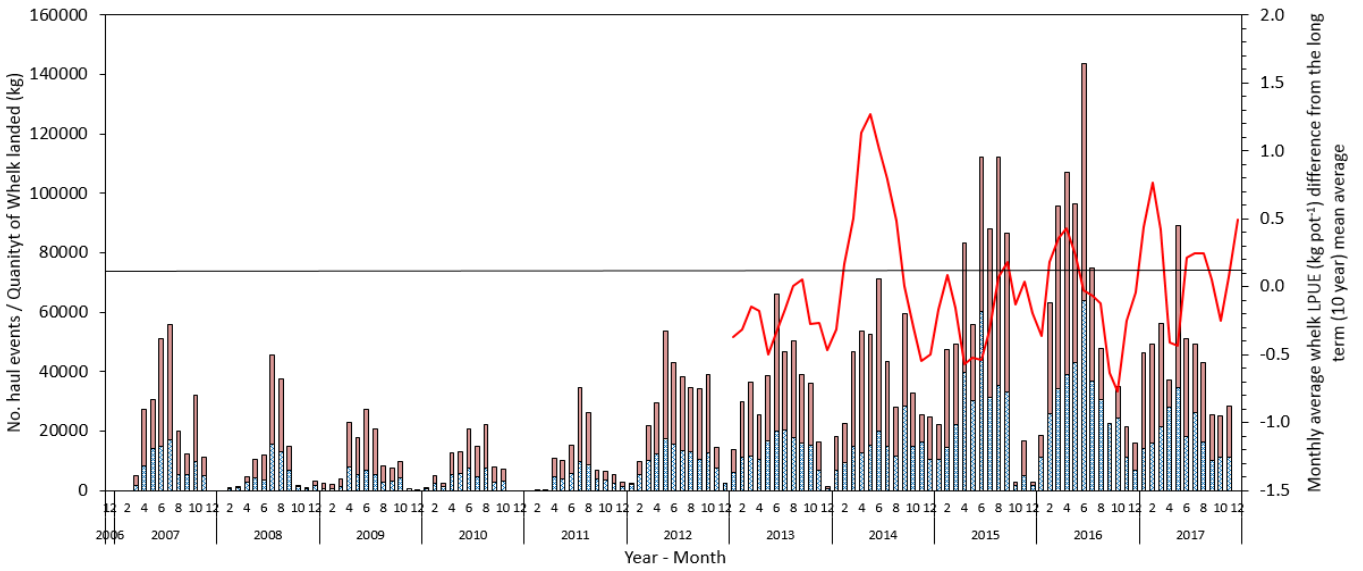
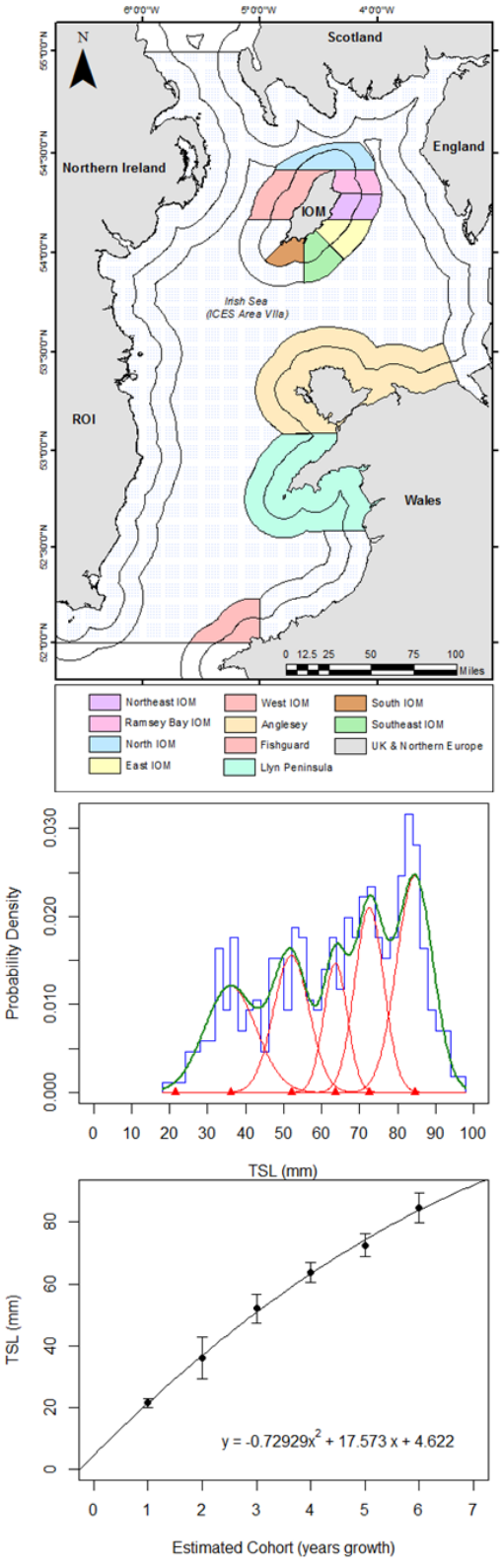


Figure 23: *Whelk (B. undatum) catch data supplied by Monthly Shellfish Activity Logbooks. Blue bar = effort (haul events). Red bar = Landings (kg). Red line = average daily LPUE difference from the recent average (0.0).*

Nonetheless, where landings and effort data is available, the average landings-per-unit-effort (LPUE) calculated suggests that the fishery within the Isle of Man territorial sea is stable, despite landings in 2017 having decreased since 2016 (Figure 26). The data presented in Figure 23 does not account for larger vessels that operate both within and outside of the Isle of Man territorial waters, which likely account for a significant proportion of stock biomass removal. It is therefore essential that during 2018, all vessel begin to use a common logbook system.



The fishery-dependent data collected using pot-samples throughout 2016 (as well as samples collected elsewhere in the Irish Sea) have now been analysed and the main findings have been submitted to the journal of Fisheries Research for peer review.

The main findings include:

- The population structure (total shell length; TSL) varies significantly around the island, with the average size of animals being above MLS (70 mm TSL) in some areas and below in others.
- Functional maturity (L_{50}) also varies around the island, but is above the MLS in all but one area to the North of the island.
- Spawning (egg laying) occurs in late winter and early spring, after which females enter pots in greater abundance to replenish energy reserves and develop ovaries, which reach their maximum gonadosomatic index (GSI) value in late summer and early autumn.
- Data indicates that whelk are slow-growing and, on average, recruit into the fishery 5 years after hatching. This data will be further validated with statolith analysis in 2018 (below).

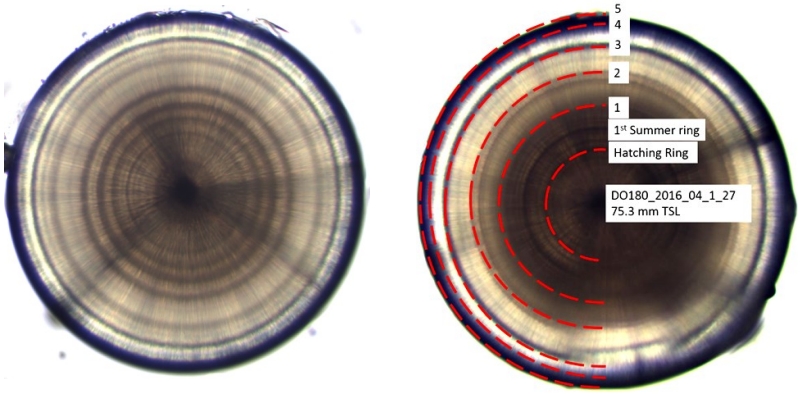
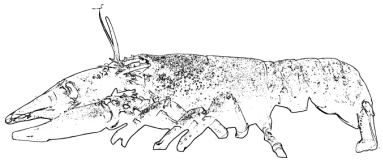
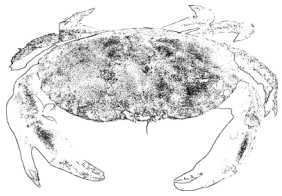


Figure 24: *Top left: A map showing the study areas of the whelk sampling research. Bottom left: the estimated size-at-age relationship according to a mixed-modal cohort analysis. Above: an example of statolith images, with the annual growth rings highlighted on the right.*





Update on crab & lobster fisheries

Both the crab and lobster fisheries have continued to display seasonality in landings and effort. Landings per unit effort (LPUE) data are observed to be variable through the year, with clear peaks during the summer. LPUE for the Isle of Man territorial sea shows that, over the past 5 years, both fisheries are yielding LPUE at historical levels (Figure 25). In the absence of stock assessments, LPUE remains the most useful index of estimating stock abundance.

The logbook data provided by the crab and lobster fleets, which largely target both species, indicates that stocks are in good health. Nonetheless, the knowledge gaps that prevent stock assessment models from being conducted need to be addressed and innovative research undertaken in 2017, in collaboration with several inshore static-gear vessels, has made useful advances in how to better monitor population structure, reproductive patterns and recruitment.

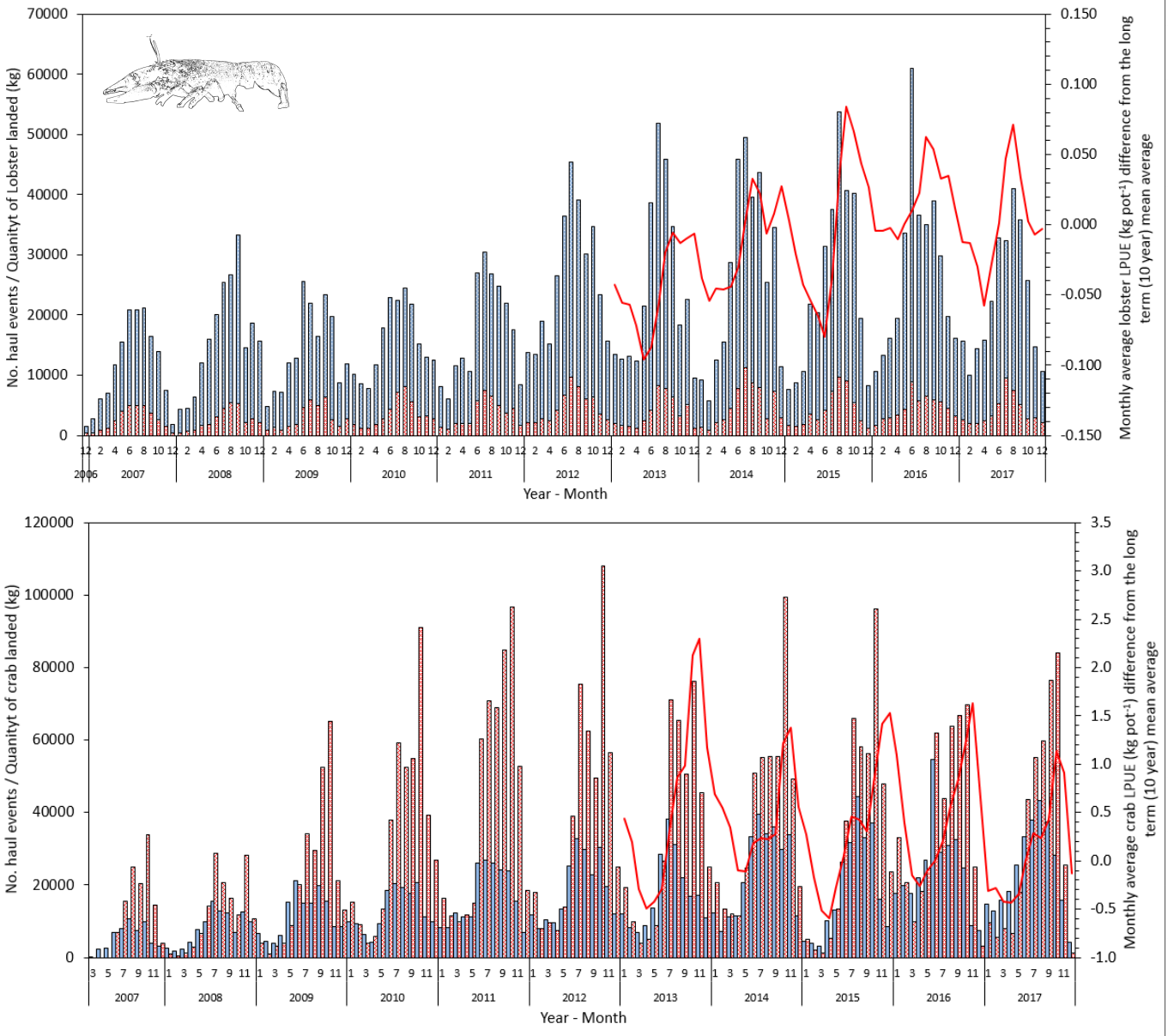


Figure 25: *Recent trends in lobster (H. gammarus) and crab (C. pagurus) catch data supplied by Monthly Shellfish Activity Logbooks. Blue bar = effort (haul events). Red bar = Landings (kg). Red line = average daily LPUE deviation from the 5-year average.*

On-board cameras

In order to capture more biological and catch data in the crab and lobster fisheries, without the need to have a scientific officer onboard during commercial operations, Bangor University has been developing onboard cameras both in the Isle of Man and Wales. The latest generation of cameras (3rd Gen.) were given to three inshore potting vessels in early 2016.

The trial used fisheries-dependent sampling (i.e the fishermen operated the cameras themselves and subsampled their daily catch). The aim was to assess the benefits and limitations of deploying this technology in a sentinel fleet of boats. The video data collected by fishermen was supplemented in calibration trials, which has been evaluated by an MSc student (see Pg. 21—22).

Figure 26: *A parallel paired laser onboard FV Shelgeyr, Port St Mary.*

Lobster Tagging update

A lobster tagging project was established in the Baie ny Carrickey closed area in late 2016 and has been running successfully through 2017.

The research aims to collect data on the movement of lobsters within the bay, reproductive patterns and also growth rates, as the tags are retained through several moults and can last several years.

The tagging is ongoing, but some interesting results are already being observed in the data collected to date. 270 lobsters have been tagged by commercial fisherman Guy Sutton (Auk CT25), who had recaptured ~20% of those released.

10 individuals have been recaptured that have moulted, with the data collected showing that growth increments (measured as Carapace Length) is in excess of 10%.

70% of the lobsters that were recaptured were within 100 m of their release location after months of being ‘at large’. 16% of recaptures showed lobster movements greater than 500 m.

The project is being expanded spatially through 2018. The data will provide useful insight on the biology of lobster populations as well as being useful for management purposes.

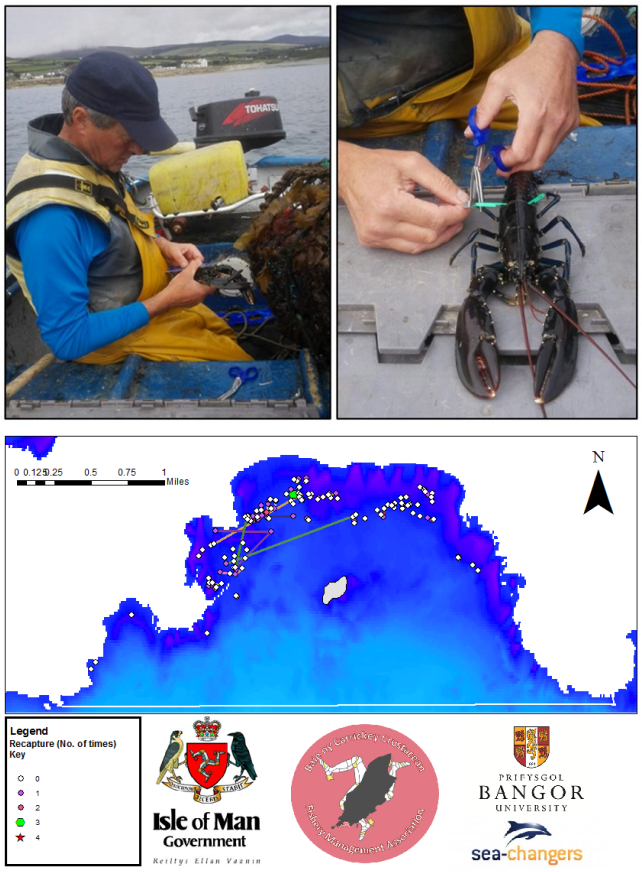


Figure 27: Above; Lobster tagging in the Baie ny Carrickey closed area. Picture credit: Guy Sutton (Auk, CT25). Below; The movement data collected, projected on a virtual map of Baie ny Carrickey.

Zebra-Tech monitoring equipment

With 40% grant funding from DEFA (Agriculture & Fisheries Grant Scheme), the MFPO has purchased several pieces of Zebra-Tech equipment, including a deck-logger, 10 wet-tags and two electronic measuring boards. The deck-logger was loaded with an "app" designed by Zebra-Tech with input from Bangor University.

The deck-logger, which acts as an onboard logbook computer, is used by the skipper to record catch (kg) and effort (pots lifted), and automatically pairs the data with an accurate GPS signal.

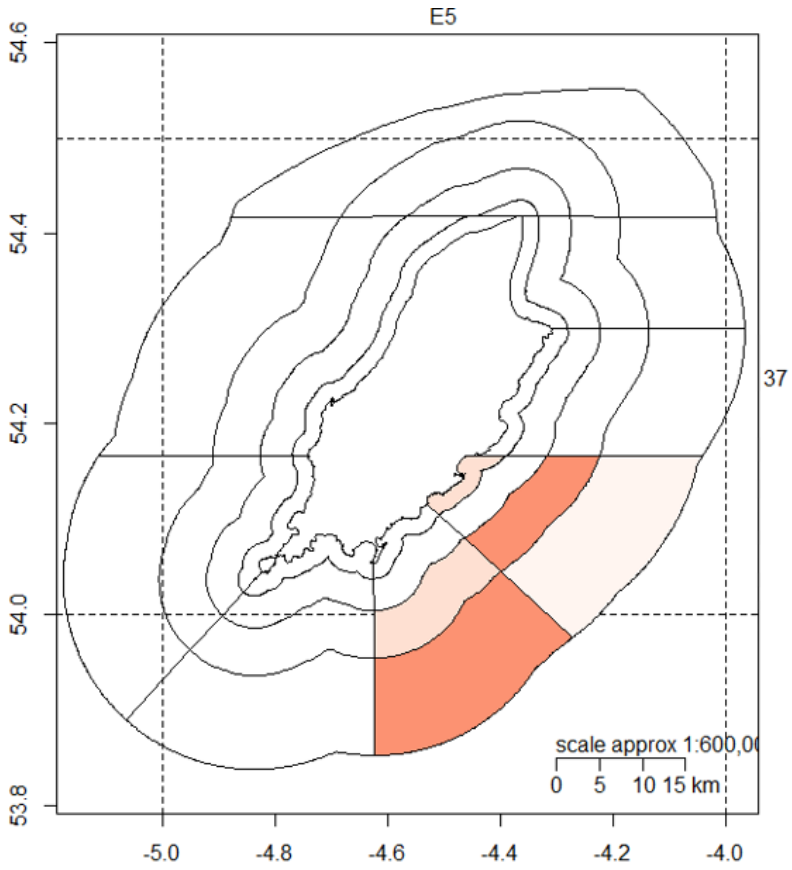
The wet-tags, which are attached to pots, record soak-time, average bottom depth temperature and depth. When the pot is hauled, it communicates this data wirelessly to the decklogger. The deck logger then stores this data and matches it to the catch data that the skipper entered. Presently, the data is offloaded via USB, however 4G submissions to a secure account are going to be trialled in 2018.

The electronic measuring boards have been utilised effectively by the MFPO in the organisations own data collection programme. The wet tags and decklogger have been trialled onboard a local static gear boat from July through to October, during which time Bangor scientists were able to modify and adapt the firmware so that it captured sufficient information for analysis, whilst also making it user-friendly and efficient for the skipper. The firmware went through several modifications and is now set up to capture data from all three static-gear fisheries; whelk, crab and lobster.

The page on the right displays some of the outputs that were created from the 2017 trial, which is due to be expanded again in 2018 to include more vessels that operate around the island in all three pot fisheries.

Figure 28: *Above: the Zebra-tech deck logger. Below: Wet-tag. Images taken from www.zebra-tech.co.nz*

Figure 29: *Above: The purchased decklogger being used in trials to record catch and effort data onboard a Manx whelk boat. Left: MFPO scallops survey using the electronic measuring board.*



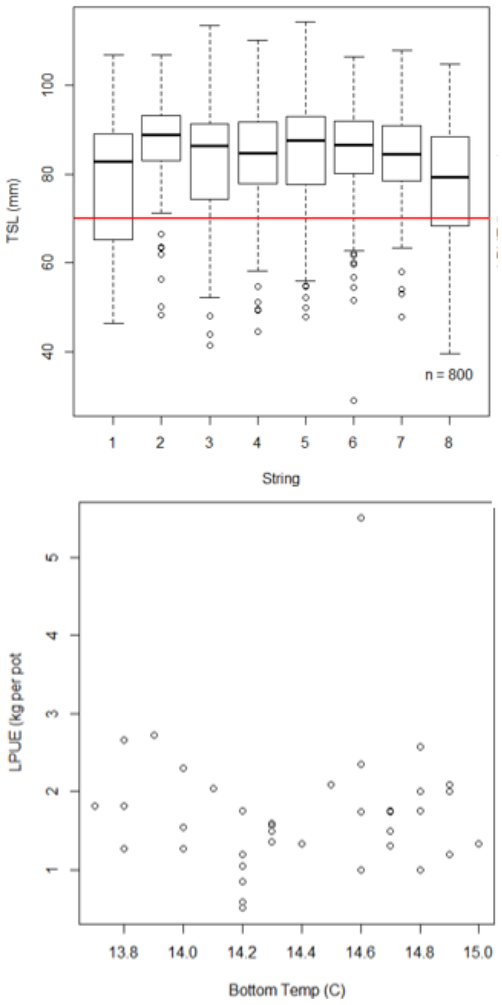


Figure 30: *Above: An example of how spatial data could be presented to help monitor fishing effort and total catch in separate fishing grounds. Top-right: the variation in the size-distribution of whelk (B. undatum) catch relative to the MLS (red line) in a single days fishing. Right:: Environmental data (sea bottom temperature) and the relationship this may have with LPUE.*

Pot fishery research priorities for 2018

- **Whelk statolith analysis: size-at-age relationship**

⇒ Whelk samples that have been dissected are prepared for statolith extraction. Imaging the statoliths and imaging them is a priority to determining a size-at-age relationship.

- **Electronic reporting for static-gear fisheries**

⇒ Develop an app so that all pot fisheries are reporting daily to the same data standard, irrespective of metier.

- **Zebra-tech equipment (sentinel fleet project)**

⇒ Continue trialling the zebra-tech equipment and refining the software component of the technology, so that it can be used in multiple fisheries (including mobile gear)

- **Expand the lobster-tagging project**

- **Contribute to crab & lobster fishery review**

Bangor University and DEFA placement student (12 months):

I am a second year BSc Applied Marine Biology student at Bangor University, I moved to the Isle of Man in June 2017 to complete a 12-month placement between my second and third year of University based at DEFA. The first project I was involved in was the queen scallop bycatch trials which took place over the summer of 2017. For this project I spent around 9 days at sea with other students aboard two queen scallop fishing boats, we collected measured and identified the fish bycatch caught in the otter trawls. This field work was part of a MSc thesis trailing modified nets as a method to reduce the quota fish species caught as bycatch. I learnt a great deal about the industry whilst working on the fishing boats. After this survey was completed I started working in the lab to dissect the fish and identify any individuals that we were unsure of whilst at sea.

I have also been involved with Inland fisheries since working at DEFA, they completed several electrofishing surveys over the summer to assess the populations of younger fish in rivers around the island. I was involved with netting the fish and moving them to holding buckets. Since completing these surveys, I have also assisted with the brood-stock surveys which took place in November 2017. This survey targeted the adult fish in order to collect a number of male and female Salmon to be placed in a hatchery. The first survey I was involved in was completed on Sulby river and we managed to remove 3 female (hen fish) these fish were moved to the hatchery in a large tank on the back of a pickup. Due to the lack of male fish (cockfish) the survey would have to be revisited in the next few days. The next brood-stock survey I was involved in was on Laxey river and instead of helping with netting I instead drove the pickup for the day. The 3rd and final survey I was involved in was back in the Sulby river and we managed to recover 2 male salmon and another female meaning a total of 2 male and 4 female fish were recovered. I was able to see some large fish up close during this survey and gain experience in an electrofishing survey.

The enforcement vessel F.P.V Barrule is used to carry out several different surveys for the fisheries team. I was involved in one of these projects which focused on the possibility of using artificial spat receptors to encourage scallop spat to settle, the survey consisted of 16 x 5 minute tows using a beam trawl and then the placement of a trial spat collector. The bycatch from each tow was identified and counted and any queen scallops caught were measured. This survey gave me more time at sea and improved my species knowledge and how to identify them.

I have also spent a lot of time working in the lab since starting my placement, I am now able to carry out the monthly king scallop dissections alone and have also been assisting with whelk dissection and the removal and mounting of statoliths under a microscope.

I am in the process of applying for funding to complete my own project over the summer of 2018, this project will focus on alternative bait formats in the whelk industry to try and relieve the pressure on brown crab which is currently the most popular bait used. I am excited at the prospect of being able to complete my own small research project and I hope that I am able to learn half as much as I have in the past 6 months. Being involved in so many different projects I am learning a huge amount about the industry I hope to build a career in. I have also met some incredible people and grown as a person. My time at DEFA has been invaluable and I still have 6 months left to learn! I would recommend this placement to any future students, there's nowhere quite like the Isle of Man!

Figure 31: *Large sea trout caught during the broodstock surveys*

Figure 32: *Malcolm and Brian carrying out an electrofishing survey*

Figure 33: *A cod from the queenie bycatch trials being dissected*

Figure 34: *A curled octopus caught in the spat survey*

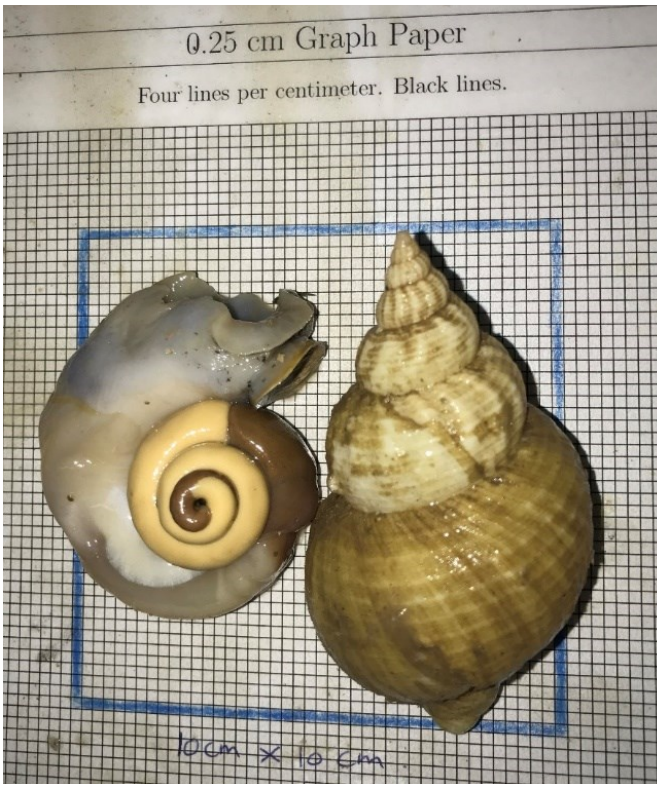


Figure 35: *A common whelk dissected in the labs*

Each year we have the opportunity to add value to the current contract by submitting MSc project proposals for Bangor University students to select. In 2017 we had three students on-island undertaking MSc project research for 7 weeks during the summer. This additional research was self-funded by the Bangor University project students who provide a valuable additional resource to the Isle of Man .

TITLE: EVALUATING THE POTENTIAL OF USING PARALLEL-PAIRED LASERS IN ON-BOARD CAMERA SYSTEMS FOR FISHERIES-DEPENDENT DATA CAPTURE IN THE ISLE OF MAN CRUSTACEAN FISHERY

Student: Siân Morgan
Universities: Bangor University
Dates: June 2017– November 2017
Supervisors: Michel Kaiser, Isobel Bloor & Jack Emmerson

Abstract

Most crustacean fisheries are data poor, relying exclusively on either intermittent observer or landings data to perform stock assessments. As a result, there is inadequate data to inform management advice so as to ensure the sustainable exploitation of crab (*C. pagurus*) and lobster (*H. gammarus*) resources. A growing burden of evidence collection, in the form of increasing European Union legislation, combined with diminishing public resources has led to the need to consider Electronic Monitoring (EM) solutions as an alternative to traditional data collection methods, to fill data deficits. The present study was a proof of concept and demonstrated possible applications for data collected using parallel-paired lasers in on-board camera systems in the Isle of Man Crustacean Fishery. Data derived from footage recorded by the cameras was found to provide information on the damaged component of the *C. pagurus* catch, the sex ratio of *C. pagurus* and the size frequencies of both *C. pagurus* and *H. gammarus*, comparable in accuracy to that collected by an observer in situ, indicating that the cameras can be used to monitor these aspects of the fishery.

The magnitude of error attributable to measuring the size of both species remotely from stills rather than in situ was within an acceptable tolerance, sufficient to detect growth increments in both species (*C. pagurus*: median=0.05mm; *H. gammarus*: median= -0.13mm, with an inter quartile range of ±1.2mm for both species). However, all analysts will need to collect data to validate their own calibration models before measuring animals from stills taken using the cameras. The Isle of Man provides a unique opportunity for this data collection method to be implemented at a national level in order to create a comprehensive evidence base for management. A five-month fishery-dependent data collection program demonstrated the ability of the cameras to increase the spatial and temporal coverage of the data collected on the fishery, relative to current data collection methods.

Figure 36: *Camera units installed on inshore vessels in the Isle of Man.*

Methods and Results

Housed in a waterproof box, these camera unites are made of off-the-shelf electronics; a Nextbase dash-cam with integrated GPS and two Odiforce 5mW red lasers spaced approximately 50 mm apart. The power supply is an external battery that lasts for several days and can be recharged using mains supply. The units were mounted on bespoke brackets after consultation with the skippers and crew of the vessels involved in the trial (Figure 36).

Using the lasers as a reference scale (Figure 37), the cameras were calibrated by Bangor scientists and students as slight variations in the setup of each unit could result in different estimation relationships (i.e the pattern between the 'real' and 'predicted' data, Figure 37).

The relationships that were modelled in the calibration process were then applied to the fisheries-dependent data that was collected at sea during commercial operations. Fishers would present the dorsal and ventral sides of each animal caught within a subsample of their normal fishing operation.

A total of 2,203 crabs and 831 lobsters were sampled by fishers during the 5 month period. Several issues were identified that resulted in a 'rejection' of the still images that were extracted from the video footage, such as over-exposure from sunlight and the features (i.e carapaces) of the animals being obscured. Further, analysis was able to show how the cameras should be designed to be used at an optimum height (approx. 1m) to minimise error. However, the trial showed that the technology is both accurate and precise enough to capture biological data.

Further developments in hardware (improved definition and camera quality) and software (auto-recognition and identification of species)(could result in a cost-effective method for capturing fisheries data.

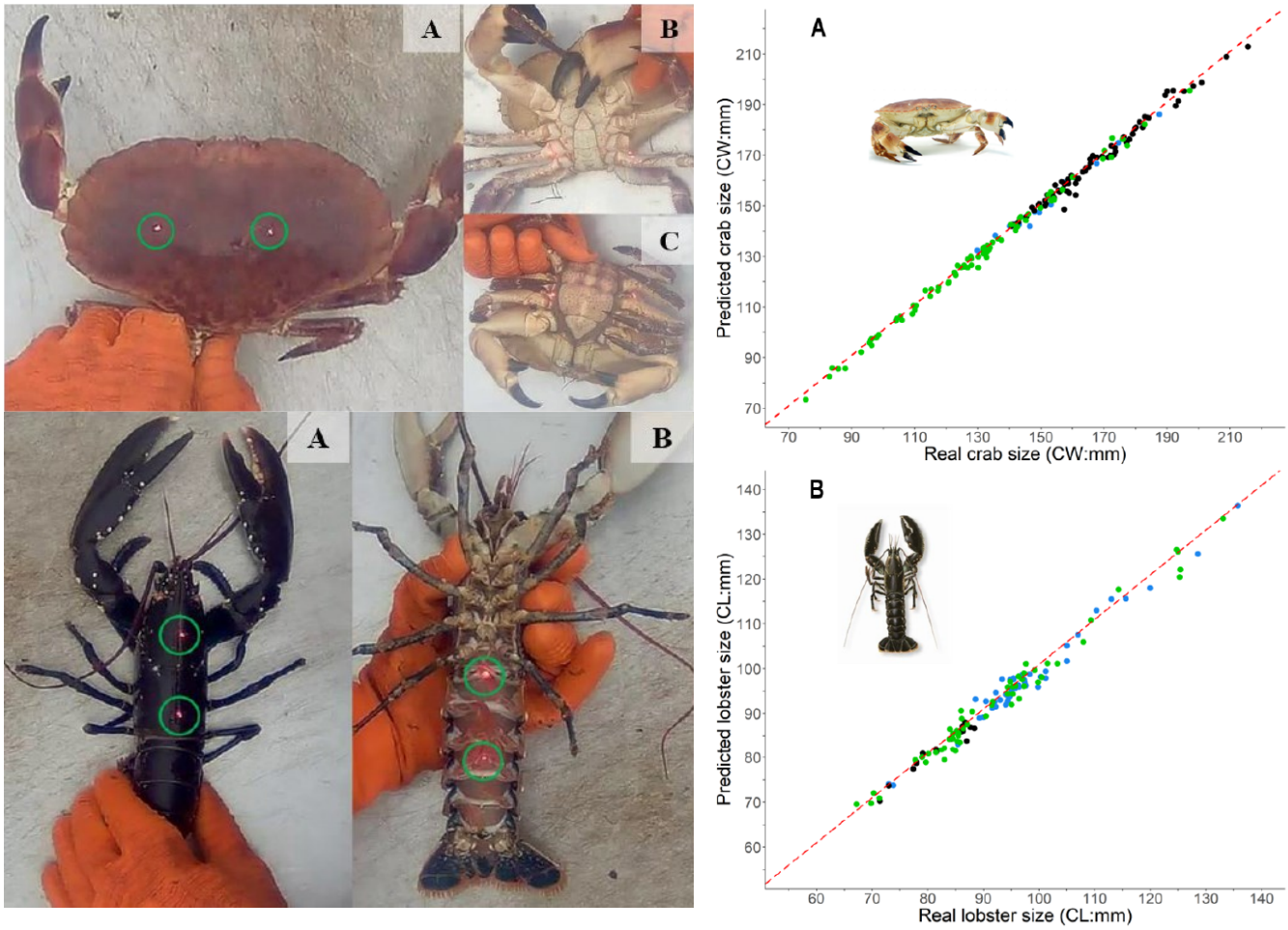


Figure 37: *Parallel lasers on lobster and crabs which are used to measure and graphs showing predicted vs real size for both species*

TITLE: **DISRUPTIVE TECHNOLOGY TRIALS TO REDUCE BYCATCH IN THE ISLE OF MAN QUEEN SCALLOP TRAWL FISHERY**

Students: Lucy Southworth and Frances Ratcliffe
Universities: Bangor University
Dates: June 2017– September 2017
Supervisors: Isobel Bloor, Jack Emmerson & Michel Kaiser

In the Isle of Man queen scallop (QSC) fishery, quota bycatch species such as haddock, cod and whiting have the potential to *choke* the fishery once the EU *landings obligation* is enforced in 2019. This study provides evidence that disruptive technology can help reduce bycatch species whilst maintaining catches of target species (QSC).

Study aims/objectives

This commercial trial evaluated the effectiveness of a square mesh panel (SMP), with and without artificial white lights attached, to reduce bycatch while maintaining QSC catch in comparison to a conventional all diamond mesh otter trawl. The SMP is designed to provide escape gaps for fish to swim through, as square mesh remains open when fishing, as opposed to traditional diamond mesh which closes under load. The lights were attached to the SMP to try and increase escapement of fish. Light is known to influence fish behaviour and may help individuals to detect and subsequently swim through the panel, either by attraction towards the lights which are attached to the panel, or simply by increasing visibility of the SMP through illumination.

Experimental design

Trials were carried out during daylight hours over a total of 11 days, from 19th June to 10th August 2017. The study consisted of a paired tow design, whereby two commercial fishing vessels of similar size, engine power and fishing ability (F.V Our Sarah Jane 13.98m, 187kW and; F.V Two Girls 13.88m, 216.24KW) towed parallel to one another, with one vessel operating a control net and the other operating a treatment net:

- Control net: conventional all diamond mesh otter trawl (85mm mesh size).
- Treatment net 1 (SMP): conventional all diamond mesh otter trawl (85mm mesh size) fitted with a 20 x 12 SMP (300mm stretched mesh) situated 1.8m posterior of the headline and 0.5m anterior of the codend.
- Treatment net 2(SMP + lights): conventional all diamond mesh otter trawl (85mm mesh size) fitted with a 20 x 12 SMP (300mm stretched mesh), with six LED constant white lights attached to the panel.

Two configurations of SMP were utilised in the trial, as the original 20x12 mesh panel incurred damages during commercial fishing operations, as the increase in target catch changed the geometry of the net, causing the net to chafe on the seabed. Therefore, the panel was reduced to a 20x8 mesh panel which alleviated damages to the net. The study was conducted in three different fishing grounds within the Isle of Man territorial sea (Figure 38):

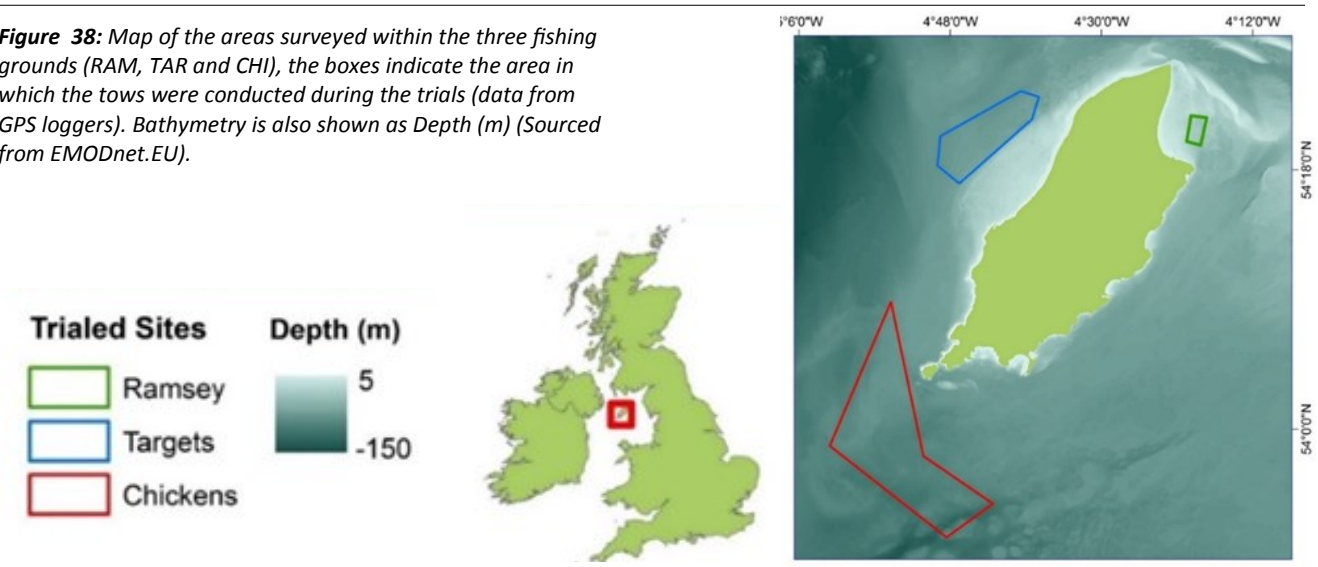


Figure 38: *Map of the areas surveyed within the three fishing grounds (RAM, TAR and CHI), the boxes indicate the area in which the tows were conducted during the trials (data from GPS loggers). Bathymetry is also shown as Depth (m) (Sourced from EMODnet.EU).*

Sampling design

A total of 70 paired tows were conducted randomly under normal commercial practice at constant speeds of ~2.2 knots, with a tow duration of 60 minutes at TAR and CHI and 30 minutes in RAM (reduced due to spatial constraints). After each tow the bycatch species were identified, counted, measured and EU quota species were identified, counted, measured and EU quota species were taken ashore to ascertain length~weight relationships. A subsample of 100 queen scallops from the unsorted catch were measured for size-distribution analysis and once riddled the number of marketable QSC bags were recorded. Environmental parameters that could have influenced the fishing selectivity of the devices were also recorded per tow including water depth, turbidity, ambient light levels, cloud cover and sea state, along with spatial records (GPS). The catch composition of the paired control and treatment nets were standardised per unit area and were compared to evaluate the relative difference in catch of the two treatment trawls compared to the control, assessing bycatch species along with marketable and undersized QSC catch.

Results

Queen scallop

Analyses conducted on the marketable QSC catch utilised data from RAM and CHI only due to consistent riddling occurring at these sites. The analyses indicated that although there was a slight reduction observed in target catch, overall the catch of QSC were not significantly reduced. In RAM the SMP net incurred no significant reductions of QSC (no tows were conducted with the SMP + lights nets at this site) (linear regression P=0.92). While at CHI no significant reductions in catch of QSC were detected in either treatment nets (linear regressions SMP: P=0.61; SMP+L: P=0.22).

Bycatch species

Shallow water depths:

At RAM, shallow depths (14-17 m) with high ambient light levels, no significant change in catch was observed between the control and treatment nets for any of the species caught.

Medium water depths:

At TAR, medium depths (29-40m) with high ambient light levels, whiting catch per hectare was found to significantly reduce by 82% (P=0.008) when fished by the SMP net, the addition of lights to the panel had no additional influence on the reduction of whiting with reductions of 77% (P=0.003) .

Haddock saw similar reductions when fished with the SMP and SMP + lights nets, although the average reduction of 0.26 individuals per hectare (63.41%) in the SMP net was non-significant, the SMP + lights net significantly reduced haddock by an average of 0.23 individuals per hectare by 55% (P=0.02). However, no reductions of cod bycatch were observed in either treatment, with no significant differences in catch in the SMP or the SMP + lights compared to the control net (P=0.38, P= 0.41). This response could be attributed to the swimming physiology of these fish species, as studies have reported that cod tend to remain low in the net, while whiting and haddock rise up in the net and actively locate the escape gaps.

Deeper water depths:

At CHI, deeper depth (45-95m) with low ambient light levels, the treatment nets exhibited mixed effects. The SMP + lights significantly reduced bycatch of lesser spotted catshark by 48% (P= 0.04), flatfish by 26% (P=0.002) and haddock by 44% (P=0.001). Contrastingly, the SMP net caused unexpected increases of haddock catch by 47% (P= 0.04). Water depth was found to have a significant influence on the effectiveness of the SMP and SMP+ lights to reduce bycatch of haddock (GLM P=0.004, P=0.002).

This study has revealed that the SMP has the potential to reduce bycatch rates of species such as haddock and whiting in depths where ambient light levels are high enough for the fish to detect the escape panel. While in deeper waters the SMP alone may increase bycatch of haddock, the addition of lights may alter the behavioural response of fish enabling bycatch species to detect the SMP and escape through it in very low light levels.

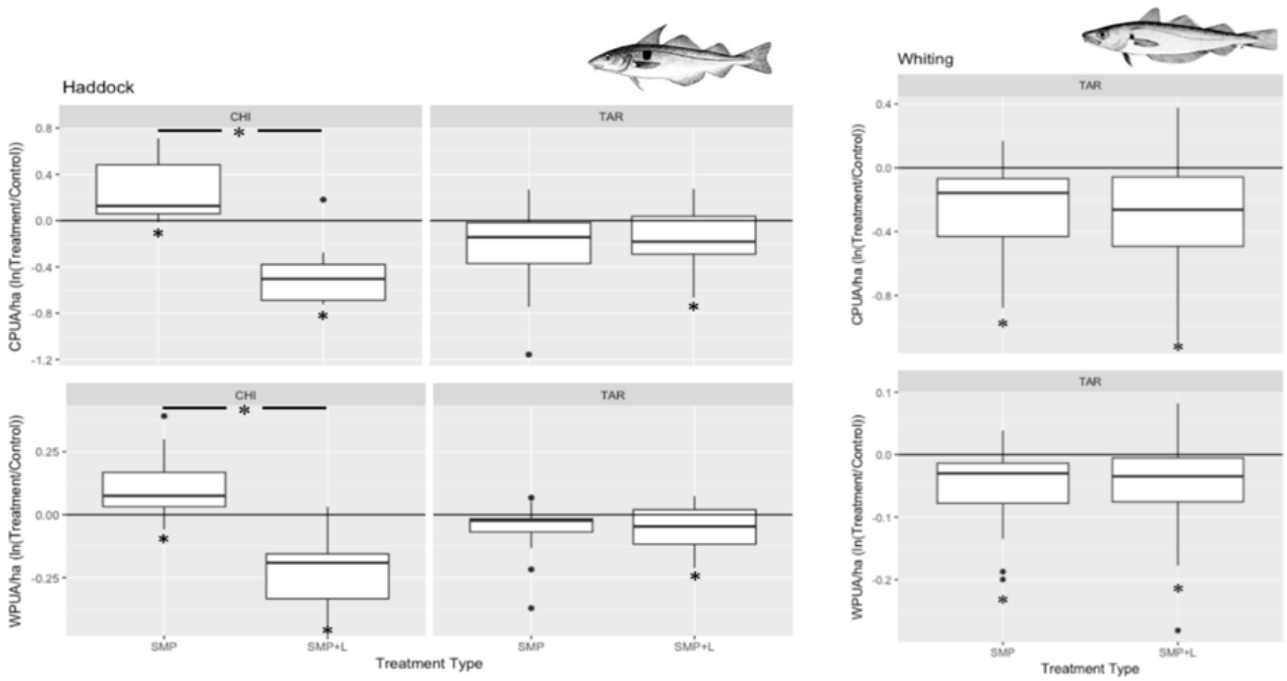


Figure 39: *The relative catch in per unit area (CPUA, top) and weight per unit area (WPUA, bottom) per hectare of haddock and whiting caught in the paired tows, with treatments SMP and SMP + Lights (CHI and TAR). Median is indicated by the horizontal line, error bars indicate the 95% confidence intervals and dots represent outliers.* above the boxes = indicate a significant difference (P<0.005) between the two treatments. * below the boxes = a significant difference in catch in a single treatment.*

Output: The results of this research were presented by the MFPO to NWWAC technical measures meeting Irish Sea (28 November 2017, Dublin) .In addition a copy of the final theses for this project can be requested from i.bloor@bangor.ac.uk

JRC ISPRA Stock Assessment Internship

Following successful application and acceptance for a special internship programme Bangor University scientists travelled from the Isle of Man to the JRC in Italy in September to spend a week working with scientists at the European Commission Joint Research Centre (JRC). Scientists at JRC have developed a quantitative statistical catch-at-age stock assessment model which uses an 'R' based statistical package called 'a4a' (assessment for all).

The short internship provides the opportunity for researchers to learn the a4a/FLR tools developed and maintained by JRC while working on developing analyses which are relevant for their own stocks. The internship format makes use of a dedicated and close working environment to maximise the learning opportunities and to foster scientific collaborations.

The objectives of the internship was to run the a4a stock assessment model for king scallop stock and forecast difference management scenarios based on different Total Allowable Catch regimes (TACs) and recruitment success. During the internship the stock assessment model was fitted to the king scallop stock using tailored submodels for Fishing Mortality and Catchability. A set of non-conventional assumptions were required to explain the population and fisheries dynamics of scallops. Namely the dependency of recruitment on laral drift and the fleet's operation impacts on the seabed, which can impair the settlement of larvae and future recruitment.

Electronic data collection for scallop fisheries

In order to monitor the TAC that has been set for the 2017/2018 king scallop fishing season a trial is currently underway for an electronic data reporting scheme. Fishermen have been set up with an Electronic App (Nest Forms) that they can use on their mobile phone, tablet or web browser to submit their daily catch returns. So far the scheme is working well and the majority of scallop vessels are now submitting electronically.

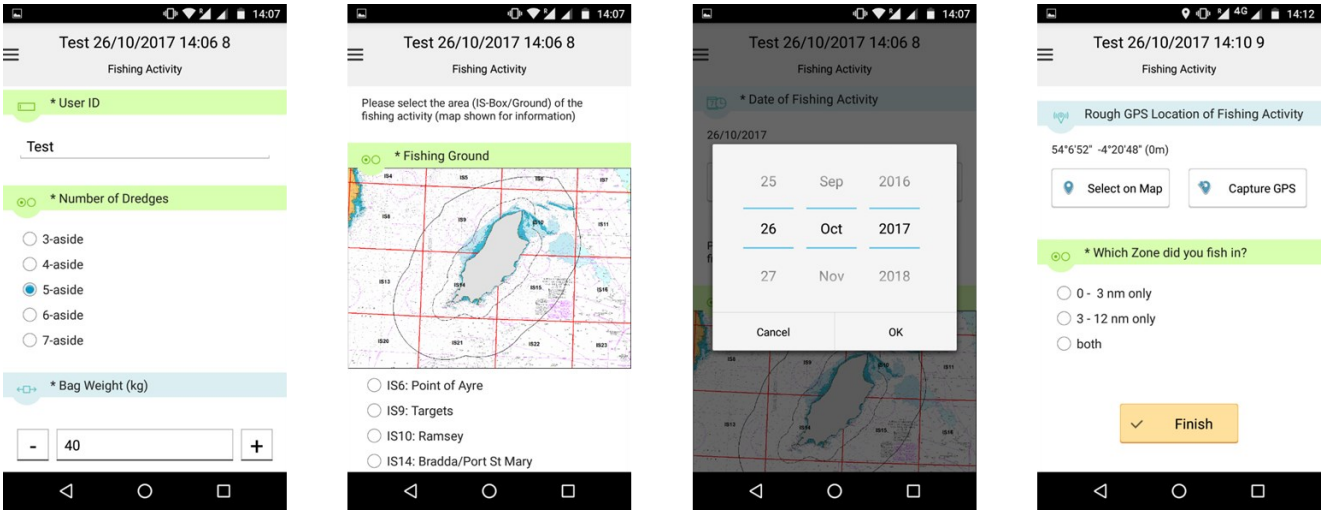


Figure 40: *Screen shots of the electronic reporting app for King Scallops which fishermen can use of their phone or tablets*

Festival of the Sea (22nd—23rd July 2017)

The Festival of the Sea was an educational event and a celebration of all things marine-related to help celebrate the island's marine conservation and heritage. The event was held from 22nd—23rd July 2017 in Port Erin with the goal of introducing local people to some of the key habitats found around the island (eel grass, horse mussels, maerl and kelp) to the public. Several organisations had displays at the event including DEFA. Bangor University student and staff volunteers helped out at the DEFA display over the two day event. One of the aims of the display was to provide insight into some of the Bangor University MSc student projects that had been run over the summer in cooperation with the Manx Fish Producers Organisation. One project that people were keen to find out more about was the trialling of modified nets with and without additional lights in the queenie fishery as a method to reduce the bycatch of quota fish species caught in the net. This project drew lots of public attention especially the large queen scallop otter trawl net that was suspended from the ceiling of the tent to show how queen scallops are caught by Isle of Man vessels. In addition, a range of GoPro footage from the trials which showed how the fish can escape through the square mesh panel in the net was also very popular. The other student project was the use of onboard cameras to collect data on brown crab, this project used two laser points at a set distance to measure the carapace length of the crabs and eliminate the need for a person to be on board the boat. As well as the project displays there were lots of arts and crafts happening in the tent, with kids colouring in the different habitats and creating all kinds of sea dwelling creatures with pipe cleaners. Alongside the DEFA tent the Manx Wildlife Trust had a "touch tank" setup with lots of different animals from the surrounding area; lobsters, crabs, starfish and fish to name a few. This tent drew big crowds and lots of kids who were desperate to see the animals up close. The whole event was a big success and a lot of visitors attended the fisheries related displays within the DEFA tent. It was a great way to engage directly with the public about local Isle of Man fisheries and the conservation measures that the industry are taking to safeguard the sustainability of local fisheries and their associated ecosystems.

Figure 41: *Small scale replica of a queen scallop otter trawl net*

Figure 42: *Fisheries displays at the DEFA tent*

Manx Fun Palace—Exploring Ramsey Bay (7th October 2017)

The Manx Fun Palace was the first event of this kind to take place on the Isle of Man. The event is intended to be a pop up university to creatively engage and educate the whole community in the marine science and conservation that is taking place on our doorstep. The theme of the fun palace was 'Exploring Ramsey Bay' and the event took place in Ramsey town hall on Saturday 7th October 2017. The event was all about exploring Ramsey Bay marine nature reserve and raising awareness of its importance. There were several stalls at this event with the focus being arts and crafts ranging from decorating cakes with maerl to writing poems about the marine life in the bay. Bangor University student (Claire Lambden) put together a montage of video footage that has been taken on scientific surveys over the last couple of years. The footage highlighted the variety and types of habitats and species that are found within the bay. The footage was very popular with the public with many people not having seen Ramsey Bay from this underwater view before and Claire spent the day onhand to help people identify the many key habitats (e.g. maerl, kelp, brittlestar beds and horse mussels) as well as the many species (e.g. fish, scallops and crustaceans) and to answer any questions about these amazing underwater habitats. Local marine themed art from schools was displayed and a large marine themed tunnel was also decorated with the student's creations. The event ran all day with several workshops and talks run by scientists and artists, it was a big success and we spoke to many members of the public about the importance of the bay.

Figure. 43: *Volunteers who helped at the Ramsey Bay fun palace.*

Figure. 44: *Marine themed tunnel decorated with student's artwork.*

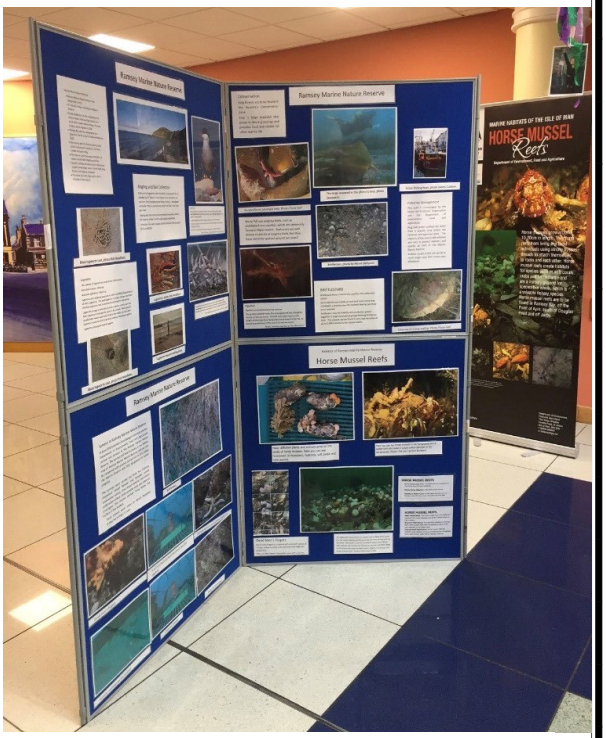


Figure. 45: *A display board at the Ramsey Bay fun palace.*

During 2017 the Isle of Man research team (staff and students) have communicated the findings of the scientific work undertaken to interested stakeholders. These communications include advisory reports to the Isle of Man Government, peer reviewed publications in scientific journals, presentations at international conferences and during attendance at national and international committees, working groups and meetings.

Publications:

- Emmerson, J.A., Haig, J.A., Robson, G., Hinz, H., LeVay, L. and Kaiser, M.J. (2017). Size-selective fishing of *Palaemon serratus* (Decapoda, Palaemonidae) in Wales, UK: implications of sexual dimorphism and reproductive biology for fisheries management and conservation. Journal of the Marine Biological Association of the United Kingdom. 97(6). Pp. 1223-1232
- Ondes, F., Emmerson, J.A., Kaiser, M.J., Murray, L.G. and Kennington, K. (2017). The catch characteristics and population structure of the brown crab (*Cancer pagurus*) fishery in the Isle of Man, Irish Sea. Journal of the Marine Biological Association of the United Kingdom. Pp 1—15.

Presentations:

- Bloor, I., Dignan, S., Emmerson, J., Beard, D., Gell, F., Duncan, P., Kennington, K., McHarg, K., Cunningham, S. and Kaiser, M.J. Can Rights-Based Management Improve the Environmental and Economic Performance of a Scallop Fishery?. 21st International Pectinid Workshop, Portland, Maine, April 2017.
- Bloor, I., and Kaiser, M. Isle of Man King Scallop Fishery and Stock Assessment: 2017 Update. ICES Working Group Scallop Stock Assessment, 10th - 12th October 2017, AFBI, Belfast.
- Bloor, I., and Kaiser, M. Isle of Man Queen Scallop Fishery and Stock Assessment: 2017 Update. ICES Working Group Scallop Stock Assessment, 10th - 12th October 2017, AFBI, Belfast.
- Emmerson, J.A. and Kaiser, M.J. Innovation in data-capture techniques for static-gear fisheries. North West Waters Advisory Committee—Crab subgroup. Dublin, Ireland. 14th Sep. 2017.

Theses:

- Dempster, N. (2017). Assessing Scallop, *Pecten maximus*, association with the benthic ecosystem within two Isle of Man Marine Reserves. MSc Thesis, Bangor University.
- Ratcliffe, F.C. (2017). Trialling innovative disruptive technology for fish bycatch reduction in the Isle of Man queen scallop (*Aequipecten opercularis)* fishery, using square mesh panels and artificial light. MSc Thesis, Bangor University.
- Southworth, L. (2017). Trialling innovative disruptive technology to reduce bycatch in the Isle of Man queen scallop (*Aequipecten opercularis*) trawl fishery. MSc Thesis, Bangor University.
- Morgan, S. (2017). Evaluating the potential of using parallel-paired lasers in on-board camera systems for fisheries-dependent data capture in the Isle of Man crustacean fishery. MSc Thesis, Bangor University.

Public outreach :

- Baccalaureate project work with King Williams Student August 2017.
- IOM Fish News: Newsletter of Bangor University Isle of Man Fisheries, Issue 05, November 2017.
- Manx Fun Palace—Exploring Ramsey Bay. 7th October 2017
- Festival of the sea—Port Erin, 22nd—23rd July 2017

Training events:

- International Council for Exploration of the Seas (ICES) Stock Assessment Training Course, 5th—9th June 2017, Copenhagen (attended by I. Bloor).
- Joint Research Council, European Union, FLR and A4A internship, 4th—9th September, Ispra, Italy (attended by I. Bloor and J. Emmerson).
- Whelk statolith workshop, School of Ocean Sciences, Bangor University. 16th—28th Oct (attended by J. Emmerson)

Awards :

- Dennis Crisp Endowment Fund (£500) travel award to attend the Shellfish Association of Great Britain annual conference. May 2017.

Meetings and Committees:

- Whelk Industry Meeting, 13th February 2017,DEFA
- Ramsey Bay Marine Nature Reserve Meeting, 13th February 2017 at Ramsey Town Hall
- Ramsey Bay Marine Nature Reserve Committee Meeting, 27th February 2017
- 21st International Pectinid Workshop, 19th - 25th April 2017, Portland, Maine
- Whelk Industry Meeting, 2nd May 2017, DEFA
- Fisheries and Marine Management sub-group, 11th May 2017, DEFA
- 1st SMB meeting 17th May 2017, DEFA
- Scallop Subgroup Meeting (Closed Areas), 22nd May 2017, The Hub, Peel
- Whelk Industry Meeting, 13th June 2017, DEFA
- 2nd SMB meeting 10th August 2017, DEFA
- International Council for Exploration of the Seas (ICES) Working Group on Scallop Stock Assessment, Belfast, N. Ireland, 10^{th} – 12^{th} October 2017 (Attended by Dr. Isobel Bloor).
- 3rd SMB meeting 14th December 2017, DEFA

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www.facebook.com/fisheriesconservation

Twitter:
@Fisheriesbangor

Bangor University's Fisheries and Conservation Science Group has undertaken research for the Isle of Man's Department of Environment, Food and Agriculture since 2007. The research focuses on achieving sustainable and economically viable fisheries within an ecosystem context. We are assessing scallop, crustacean and mollusc stocks and quantifying bycatch, as well as focusing on the ecosystem through habitat surveys and studies examining the impacts of different fishing gears. We also use state of the art techniques utilising fishery -dependent data to understand how the Island's scallop fisheries are exploited and how their management can be improved.

The work is funded by the Isle of Man's Department of Environment, Food and Agriculture

Professor Michel Kaiser:

After completing a PhD at Bangor University I worked for CEFAS for eight years and since then have continued to develop my research interests in understanding how fishing affects marine ecosystems and how we can better manage our use of natural resources. To achieve this I have examined the efficacy of using Marine Protected Areas as management tools, the socio-economic impact of different approaches to fisheries management, and the development of an evidence-based approach to conservation. Recently I have been engaged in fishermen-scientist workshops to encourage dialogue and learning. Public duties include an appointment to the board of Seafish and also to the board of the Joint Nature Conservation Committee. I have published over 135 peer reviewed papers and have authored or edited 5 books and write articles for the popular press.

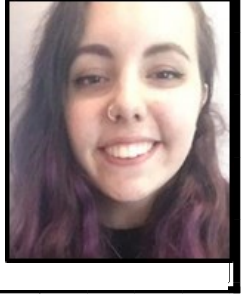
Dr Isobel Bloor:

After graduating from Queen Mary's University of London with an MSc in Marine Ecology and Environmental management, I worked as a marine ecologist at a small independent marine consultancy managing the impacts of marine related projects. I then worked on a cross-Channel EU project on cephalopod ecology and completed my PhD in conjunction with the Marine Biological Association and the Marine Institute, University of Plymouth on Cephalopod ecology, movement and behaviour. My research has been predominately fisheries and field-work based working directly with inshore potting fishermen, undertaking acoustic and data storage tagging studies and completing *in situ* scuba surveys of spawning grounds. I also have experience in developing presence-only and presence-absence species distribution models. My current role as a postdoctoral fisheries scientist on the Isle of Man involves developing and undertaking stock assessments and providing the science necessary to assist the government in managing the scallop, lobster and crab fisheries.

Jack Emmerson:

I am a fisheries scientist focussing principally on the interaction between commercial static-gear fisheries in the Irish Sea and the biology of the shellfish resources they depend upon. I gained my BSc and MSc degrees at York University and have worked as a shellfish research scientist for the Holderness Fishing Industry Group, Orkney Sustainable Fisheries and the Cardigan Bay Fisherman's Society. I am part of the Fisheries and Conservation Science group at Bangor University and am based on the Isle of Man within the Department for Environment, Food & Agriculture. I am leading on research related to the biology and life-history of lobster (*H. gammarus*), edible crab (*C. pagurus*) and whelk (*B. undatum*) and am contracted to supply evidence to inform sustainable management of static-gear fisheries within the Isle of Man territorial waters, whilst working towards a part-time PhD "*Sustainable static-gear fisheries in the Irish Sea*".

Claire Lambden:



I am a second year BSc Applied Marine Biology student at Bangor University, I moved to the Isle of Man in June 2017 to complete a 12-month placement based at DEFA. In my first 6 months I have been involved in a wide range of projects from queenie bycatch trials to electrofishing/brood stock surveys. In addition to fieldwork I have undertaken lots of laboratory work, completing dissections and microscope analysis. I have a keen interest in the management of fisheries on the Isle of Man and in the summer of 2018, I hope to undertake my own project into bait alternatives in the whelk fishery.