PRIFYSGOL
BANGOR
UNIVERSITY

Annual Fisheries Science Report

2016

Fisheries and Conservation Science Group

School of Ocean Sciences

Annual Report for 2016

Isle of Man Fisheries Science

Fisheries & Conservation Science Group
Bangor University

PRIFYSGOL BANGOR UNIVERSITY

Isle of Man Government
Reiltys Ellan Vannin

Review of 2016 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 research contract.

The Isle of Man has a reputation within the UK for taking an innovative approach to managing its fisheries. My own experience of working with administrations elsewhere in the UK is the Isle of Man is much more responsive to changing dynamics in a fishery and much more willing to implement combinations of different management measures to improve the sustainability of its fisheries. This is well illustrated by the flexible approach to management of scallop beds through novel management measures such as rotational closures, bag limits and rights based access measures. For example, in the Ramsey Bay Marine Nature Reserve, the lease of a Fisheries Management Zone for scallop fishing has enabled local industry, scientists and Government to work together to create more efficient fishing harvest methods and increased profitability within this protected area. The last 12 months has seen a much greater focus on developing our science programme on pot gear fisheries. We have had excellent collaboration from the whelk sector in the Isle of Man and from AM Seafoods in Fleetwood who have returned monthly catches that will give us the first 12 month insight into the seasonality of the whelk fishery in relation to patterns of breeding and bycatch composition. We have spent much time developing and refining our on-board camera technology to measure the catches taken at sea. This means that we can integrate information on catch composition caught by fishermen on the ground. The use of cameras means that we can also gather evidence of bycatch and thus use it to build the evidence base necessary to exempt the Isle of Man static gears from the discards landing obligations. Later this year we will trial 'disruptive' light (LED) technology in the queen scallop trawl fishery to reduce the retention of fish in the scallop fishery. This work will be undertaken by two MSc students, sponsored by Young's Seafood, with the collaboration of the MFPO. This promises to be a very exciting project at the cutting edge of fishing technology. Hopefully as these different strands of science come together we will be able to maintain the Isle of Man at the forefront of sustainable use of natural resources.

CONTENTS

- *Sea Fisheries Research Priorities 2016—2021……..Pg. 1 & 2*
- *Annual spring scallop survey (8th—20th April 2015) …… .Pg. 3 & 4*
- *Queen scallop closed areas…….. ……..Pg. 4*
- *King Scallop Fishery Update (2016)……Pg. 5 & 6*
- *Ramsey Bay Fisheries Management Zone……Pg. 7*
- *Modelling Scallop Fishing Behaviour……Pg. 8*
- *Scallop Management Unit Identification……Pg. 8*
- *Queen scallop juvenile survey (2m beam trawl)……..Pg. 9*
- *Queen Scallop Fishery Update (2016)……..Pg. 10*
- *Stock Assessment Executive Summary for queen scallops……..Pg.11*
- *ICES Working Group Scallop Stock Assessment……Pg. 12*
- *Scallop Research Priorities for 2017……..Pg. 12*
- *Potting Sector Fisheries: Crab, Lobster and Whelk……..Pg. 13*
- *Update on Whelk Fishery……..Pg. 13-15*
- *Update on Lobster Fishery……Pg. 15-17*
- *Update on Crab Fishery……..Pg. 18*
- *Pot Fishery Research Priorities for 2017……Pg. 18*
- *Master's project: Brown Crab (summer 2016)……Pg.19*
- *Master's project: Whelk tagging (summer 2016)……..Pg.20*
- *Master's project: King scallops and Marine Reserved (summer 2016)……Pg.21-22*
- *Master's project: Benthic Habitat Mapping Ramsey Bay FMZ (summer 2016) ……Pg. 23-24*
- *PhD project: Modelling Fisher's behavior (2013 –2017)……..Pg. 25*
- *Protected Areas: Little Ness Horse Mussel Reef……Pg. 26*
- *Protected Areas: Baie ny Carrickey……Pg. 27*
- *Peer Reviewed Publications……Pg. 28*
- *Theses……Pg. 28*
- *Training……..Pg. 29*
- *Public Outreach……Pg. 29*
- *Awards……Pg. 29*
- *Meetings and Committees……Pg. 30*

Sea Fisheries Research Priorities 2016—2021:

The relationship between government, scientists and industry continues to evolve and change. In order to deliver the Isle of Man Government's 5 year sea fisheries strategy (Future Fisheries) a Sea Fisheries Strategy Working Group and three sub groups (Industry development, Fisheries and Marine Management and Sea Fisheries Products) were established in 2016 to implement this strategy.

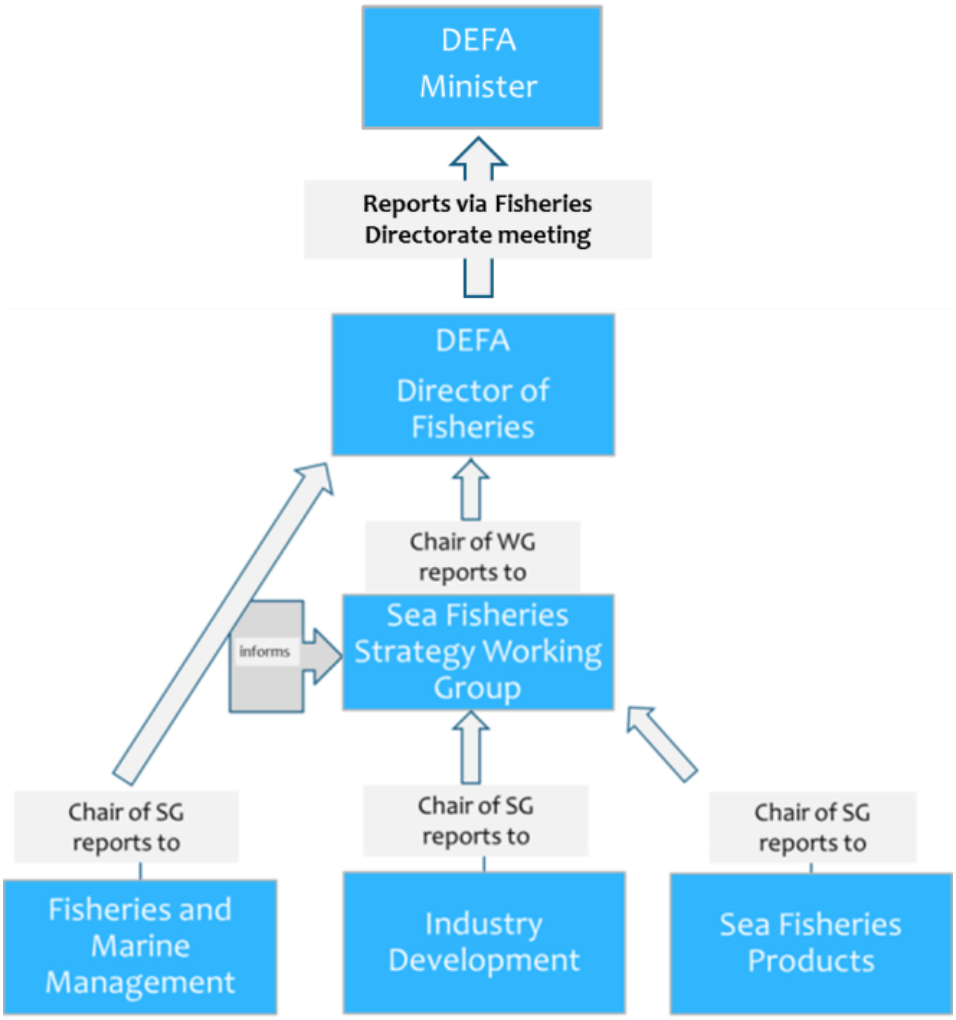


Figure 1: *A flow chart showing the reporting structure for the newly established Sea Fisheries Strategy Working Group and sub-groups. All groups report through the Director of Fisheries to the DEFA Minister.*

The aims of the working group and subgroups are:

- To work with the Department of Environment, Food and Agriculture (DEFA) to deliver 'Future Fisheries'.
- To prioritise specific action areas within the five priority themes as appropriate, and identify additional action areas which could help deliver the strategy.
- To progress specific action areas in relation to; e.g. scoping, feasibility assessment, project development, initiation and resourcing as appropriate, via the working group and subgroups.
- To provide feedback on the progress of specific action areas to the Director of Fisheries and DEFA Minister in the context of implementation and delivery of the sea fisheries strategy.

The five key themes identified within the Future Fisheries strategy are:

1. Managing sea fisheries
2. Safeguarding the marine environment
3. Developing our sea fisheries
4. Managing resources
5. Working with our customers

Each key theme has priority action areas within it, and these will be progressed by each of the sub-groups reporting to the overarching Working Group (Figure 1). This Working Group is headed by an independent chair (Graham Hall) and contains representatives from Industry, Government , Scientists, NGOs and other stakeholders. The chairs of the sub- groups are: Industry Development: David Beard (CEO of Manx Fish Producers Organisation); Fisheries & Marine Management: Karen McHarg (Director of Fisheries at DEFA); Sea Fisheries Products: Tim Croft (Island Seafare).

In 2017, the main focus of the Fisheries and Marine Management subgroup will be enforcement and sea fisheries licencing. The Industry Development subgroup has agreed its priorities to be:

- Safeguarding the long term viability of the Manx sea fisheries industry;
- Securing local industry viability and sustainability by appropriate management of fishing effort
- Developing and diversifying sustainable fisheries

The Sea Fisheries Products subgroup meanwhile will look at UNESCO branding of seafood products and the marketing of live product.

Bangor University scientists are members of three of the four groups which provide an excellent forum to work with industry, government and other stakeholders to prioritise areas of science and to develop new research ideas with an industry focus. Links with these groups will also enable us to review and revise our own 5 year scientific research plan to ensure that it stays in line with the research priorities within DEFA's sea fisheries strategy that will continue to evolve over the next five years.

The relationship between industry, science and Government continues to develop in areas of data collection as well. In 2016 Industry has taken a more active lead in the annual scallop survey undertaken within the Ramsey Bay Fisheries Management Zone. In April 2016 the survey was undertaken on an industry vessel with industry, government and Bangor University providing personnel to measure and count the catch onboard. In addition, industry is also taking on a more active role in collecting data on queen scallop recruitment in the territorial sea. A similar set up as with Ramsey Bay with the survey undertaken on an industry vessel and with industry, government and Bangor University providing personnel to measure and count the catch onboard proved successful. The aim is as Industry gains more experience in survey methods that it will take on full responsibility for these surveys from data collection right through to analysis, especially within the 0-3 nm limit.

Annual Scallop Survey (25th April—8th May, 2016)

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 within the stock assessment area. These results are used by the Queen Scallop Management Board to propose management measures for the fishery. For 2016, dredge cameras (Figure 2) were fitted and trialled for the first time on the survey to allow visual checks on the gear and gear efficiency in different habitats along with information on sediment and seabed type. In addition a multibeam and side-scan sonar survey of an area of horse mussel reef (Little Ness; see pg 25 for further details) was also conducted from the R.V. Prince Madog during several nights of the survey with the vessel operating a 24 hr schedule.

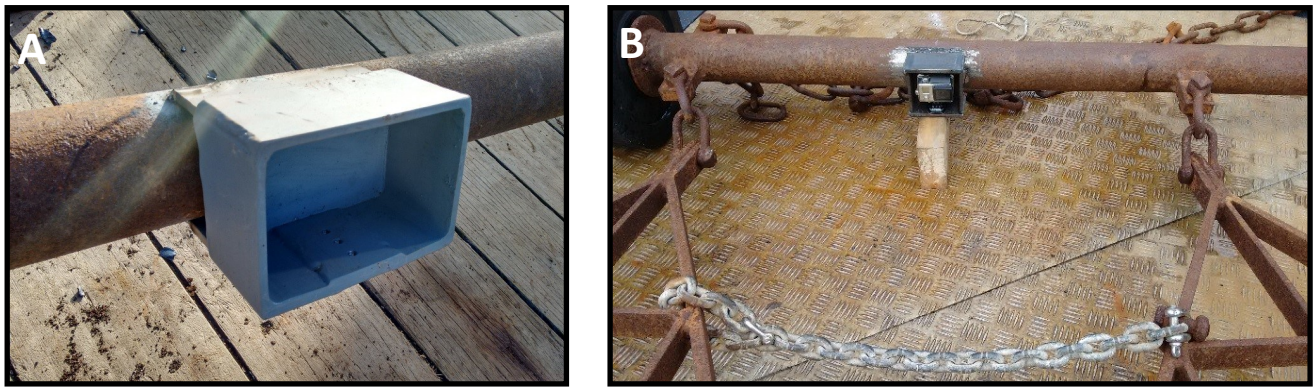


Figure 2: *a) A housing for a dredge camera was designed to prevent the camera (GoPro) from being damaged during dredging b) two housings were welded onto the dredge bar (one housing between two dredges) this enabled the cameras to record how each set of two dredges were working as well as giving a qualitative view of the seabed habitat.*

Survey: Despite a period of unsettled weather that prevented surveying on multiple days during the trip a total of 49 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 are currently being analysed by a Bangor University student to provide information on the spatial and temporal variation of maturity, spawning and growth in scallops.

Figure 3: *Bangor University Scientists a) working on deck of the R.V. Prince Madog to sort the contents of the four dredges into fish baskets, b) counting and measuring queen scallops in the wet laboratory of the R.V. Prince Madog.*

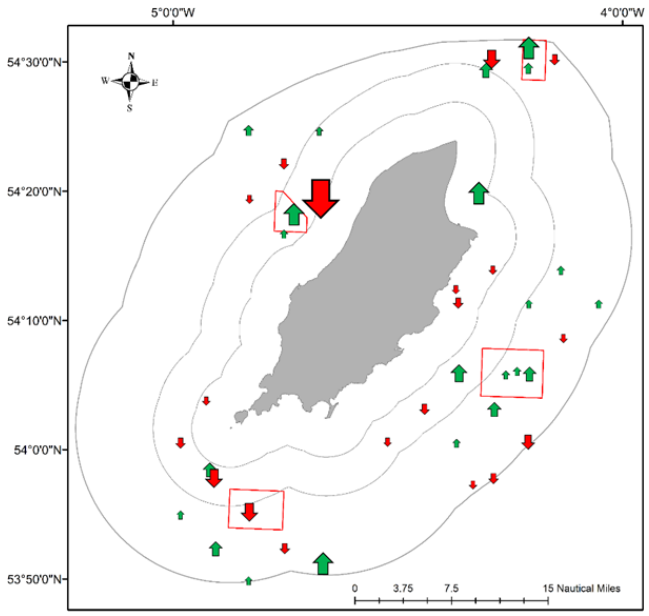


Figure 4: *Changes in Queen Scallop density (scallops per 100 m^2) from the 2015 and 2016 surveys. Red arrows indicate a decrease and green arrows in increase. Red boxes indicate the 2015 queen scallop closed areas. The size of the arrows is proportional to the change.*

Output: The results of the survey were presented in detail to the Queen Scallop Management Board at a meeting in June 2016. In addition, the Isle of Man *Aequipecten opercularis* fishery stock assessment 2016 Final Report is available for download from:

http://fisheries-conservation.bangor.ac.uk/iom/documents/66.pdf

In total eight scientists from Bangor University participated in the stock assessment survey together with volunteers from DEFA. In addition, three commercial fishermen from the MFPO also spent a day onboard the R.V. Prince Madog during the survey.

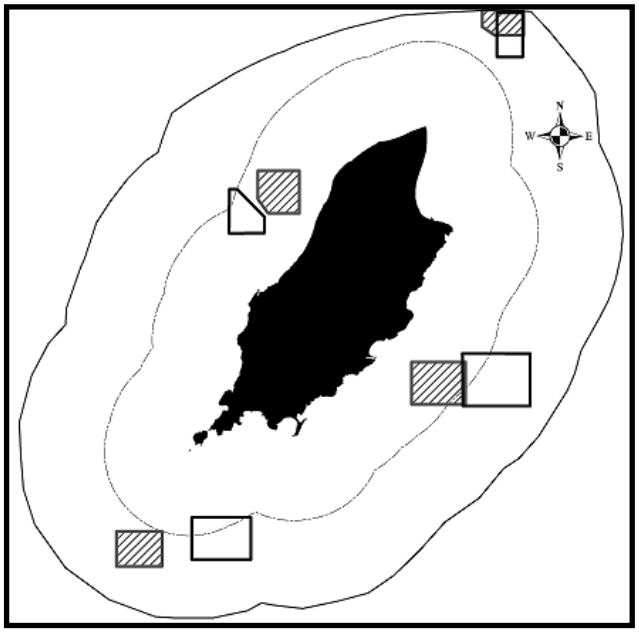


Figure 5: *A map shoring the changes in location of the four temporary closed areas for queen scallops for both 2015 (hollow boxes) and 2016 (hashed boxes).*

Queen Scallop Closed Areas (2016)

Following a meeting of the scientific steering committee scallop sub group four small areas that exhibited sufficiently high densities of post-recruits (queen scallops over 55 mm) or recruits (queen scallops under 55 mm) were closed for the 2016 queen scallop fishery.

Scallops release eggs and sperm into the water. For successful spawning to occur scallops need to be close enough together for these sperm and eggs to encounter each other. The purpose of these closures is to either protect areas of relatively high densities of post-recruit queen scallops around the Island to try and promote spawning success and/or to protect areas of relatively high densities of queen scallop recruits to reduce any negative impact from fisheries disturbance which may affect their growth or survival rates.

The siting, size and access of these closed areas are discussed by the scallop sub group before the start of each queen scallop fishing season to ensure optimal performance. As such the siting of these closures has changed from 2015 to 2016 (Figure 5).

King Scallop Fishery Update (2016)

The king scallop fishery remains the most valuable commercial fishery prosecuted within the Isle of Man's territorial waters (approx. £4m per annum at first sale (DEFA, 2016)). Prior to the 2016/2017 king scallop fishing season (season runs from 1st Nov^{year} to 31st May^{year+1}) any vessel with an engine power of less than or equal to 221 kW, or with an engine power above 221 kW but with sufficient track record or having fished for king scallops between 2008 and 2010, could obtain a licence to fish for king scallops within the territorial sea. As of 27th June 2016 a total of 156 vessels held a licence to fish for king scallops within the Isle of Man's territorial sea.

Landings of king scallops from ICES statistical rectangles 36E5, 37E5 and 38E5 (which cover the area of the territorial sea) have shown a general increasing trend since the 1992/1993 fishing season. Landings from the 2015/2016 season were lower than from the previous three fishing seasons (Figure 6A)

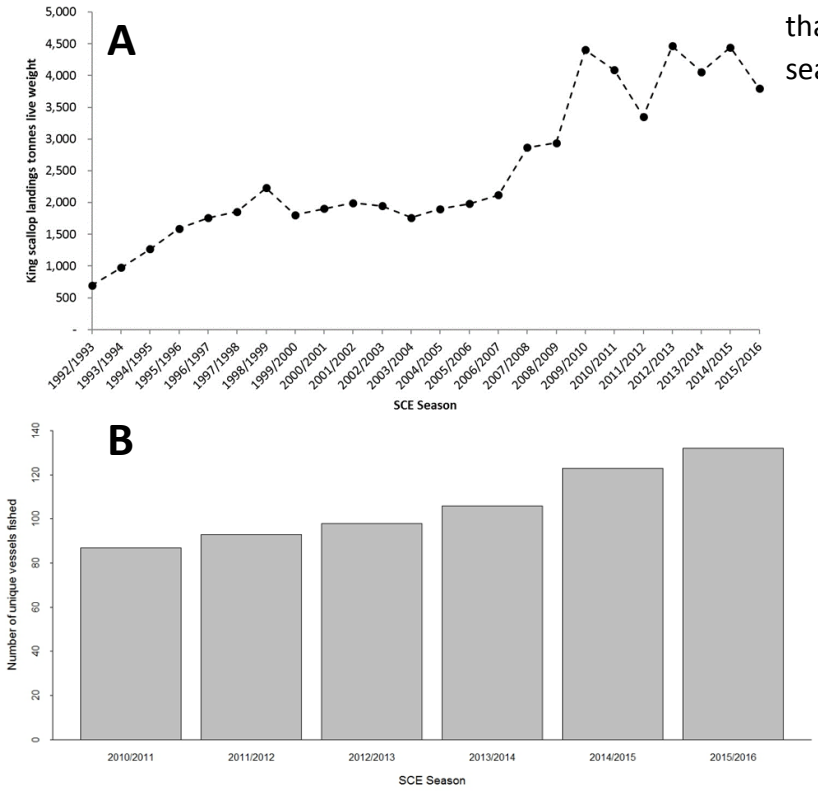


Figure 6: *A) Landings (live weight) of king scallops from 36, 37 & 38E5.; B) Number of unique vessels recorded as having fished for king scallops within ICES Rectangle 37E5. In both graphs the data are for fishing seasons (i.e. 1st Nov^{Year} to 31st May^{Year+1}). Data source: IFISH and Isle of Man Government, DEFA. N.B. This data includes all vessels fishing for king scallops and not only those vessels that are currently licenced to fish for king scallops within the Isle of Man's territorial sea.*

Using ICES Statistical Rectangle 37E5, as an indicator for the Isle of Man's territorial sea, analysis of the logbook data shows that there has been a year on year increase in the number of unique vessels fishing for king scallops since the 2010/2011 fishing season (Figure 6A). Although 156 vessels were licenced to fish for king scallops within the territorial sea (as of 27th June 2016) the number of those that had recorded landings of king scallops within ICES Statistical Rectangles 36E5, 37E5 and 38E5 for 2010/2011, 2011/2012, 2012/2013, 2013/2014, 2014/2015 and 2015/2016 was 74, 74. 84, 95, 110 and 122 respectively (as landings are only resolved to ICES Rectangle and not specifically to the territorial sea then some landings from these vessels may have come from outside Manx waters). Thus it is evident that whilst latent effort does exist within the fishery it has reduced in recent years due to annual increases in the number of licenced vessels that are prosecuting this fishery. However, under the current licencing requirements there is no means by which to restrict effort going forward as any UK vessel with ≤221 kW engine capacity is eligible to receive a licence provided it has a VMS and pays the licence fee. Consequently, vessels currently involved in other fisheries (e.g. *Nephrops*) could diversify into king scallop fishery if their target stock became depleted or if new regulations affecting their ability to efficiently prosecute other stocks were imposed.

Following concerns of increasing effort (e.g. number of vessels, kWdays) in the king scallop fishery and decreasing LPUE, a consultation was issued by DEFA (July 2016) to scope views on the king scallop fishery. A track record period was introduced which required a number of qualifying days (50 days for under 15 m boats and 26 days for over 15 m boats [due to a restriction in fishing as a result of Western Water days]). The management measures introduced ahead of the 2016/2017 king scallop fishing season are aimed at reducing the latent fishing capacity in the fleet, reducing current effort levels and ensuring the long term sustainability of the stock. For the 2016/2017 fishing season the number of licenced vessels has been reduced to 93. In addition the other outcome of the consultation was the introduction of a king scallop management board which will be implemented during the current season.

In addition to the management measures introduced in the 0 – 12 nm limit a second consultation on the 0 – 3 nm limit was issued in parallel following concerns of increasing king scallop effort within this area. Following the results of the consultation a zoned spatial model was introduced with restrictive licencing in the 0 – 3 nm limit for king scallops. In addition a series of conservation zones were also implemented within which mobile gear fishing for king and queen scallops was prohibited. Following the results of the consultation a reference period was chosen that covered the last 6 fishing seasons (2010/11 – 2015/2016 inclusive) within which a number of criteria were assessed. This analysis resulted in a reduction of vessels eligible to fish for king scallops in the 0 – 3 nm limit from 87 to 42 vessels. Not only will the reduction in licenced vessels within the 0 – 3 nm limit aim to reduce king scallop effort but the creation of Fisheries Management Zones within the 0 – 3 nm limit which will be leased to a newly formed association (headed by the MFPO) will require the formation of a Fisheries Management Plan for each zone which will work towards achieving sustainable king scallop fisheries.

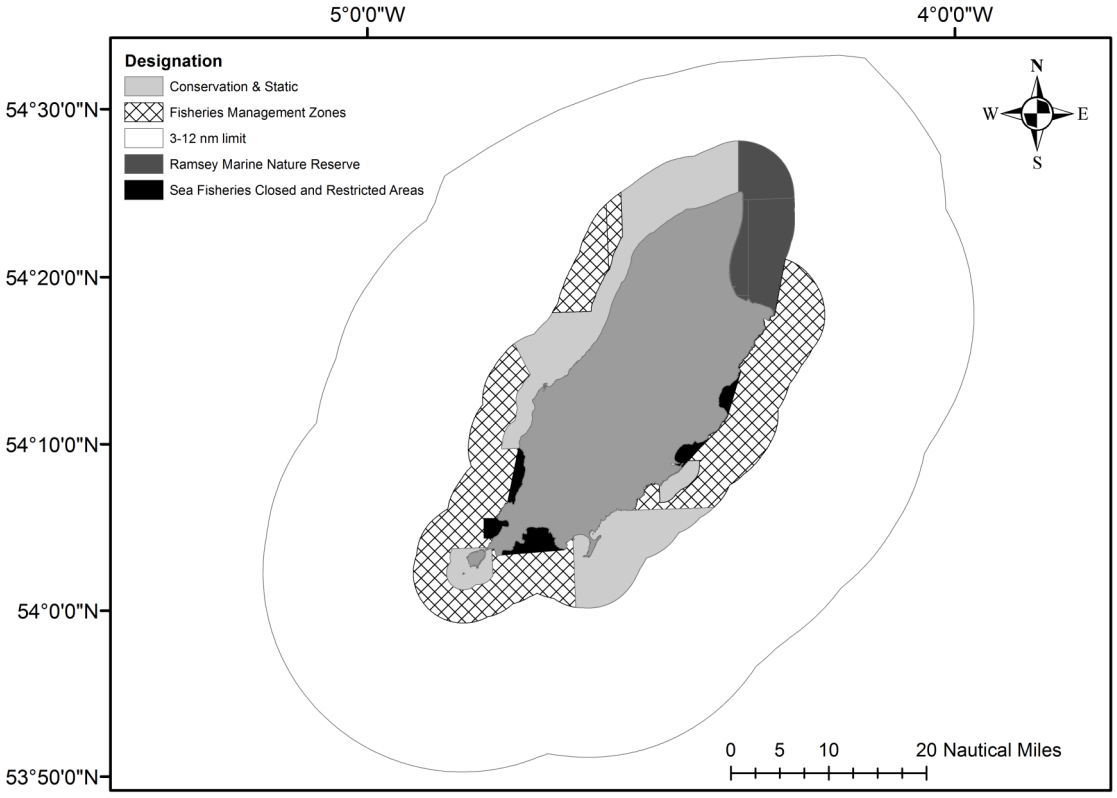


Figure 7: *A map showing the new spatial management zones for the 0—3 nm limit. Fiisheries Management Zones (FMZ) are marked with hatched symbols, Conservation zones are marked with solid light grey symbols and existing closed areas are in black with Ramsey Bay marked in dark grey.*

Ramsey Bay Fisheries Management Zone (2016)

On 13th – 14th April 2016 the MFPO, DEFA and Bangor undertook a joint survey of scallop stocks in Ramsey Bay onboard the F.V. Alena. Two replicate tows were undertaken in each of 13 Grid Squares (A4, A5, B4, B5, B8, B9, B10, C7, C8, C9, C10, D7, D8) and an average density of king scallops over MLS calculated for each Grid Square (scallops per 100 m^2).

The highest density areas from the April 2016 survey were identified as D7 where the density was 15.7 scallops per 100m^2 (> MLS) and the Garden Area (A4, A5, B4, B5) where the density ranged from 9.8 – 12.6 scallops per 100 m^2 (> MLS). D7 is a partial grid square and has had very minimal fishing activity in any of the three years, whilst the Garden Area has not been fished at all since the Bay was closed in 2009 (Figure 8). The relative changes in densities from the September 2015 and April 2016 surveys indicate that the largest decrease in densities occurred in the fished boxes of C8, C9 and C10 (Figure 8). Survey data from April 2016 showed a decline in king scallop density (number of king scallops > MLS per 100 m^2) from 6.9 to 2.1 scallops per 100m^2 for C8 and 5.8 to 2.6 scallops per 100m^2 in C9. The fishing intensity (number of GPS points per 0.0167 km^2) has largely been constrained within boxes C7, C8 and C9, although some fishing has occurred in B7, B8, B9 and D7. The highest density of fishing activity has however occurred within only two grid squares C8 and C9 (Figure 8). The average fleet LPUE for all vessels participating in the fishery has seen a year on year decrease from 1.39 x 40 kg bags per dredge per hour fished in 2013 to 0.82 x 40 kg bags per dredge per hour fished in 2015. The results of this survey work were presented to the MFPO so that they could make a decision on the management of the December 2016 fishery.

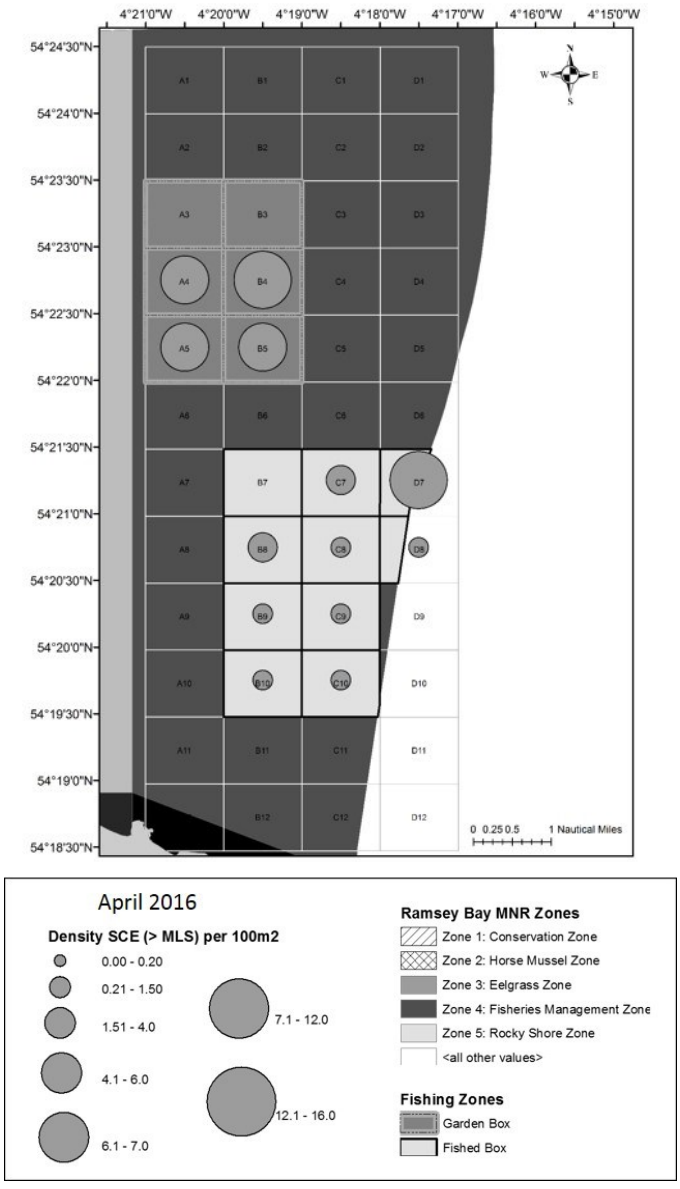


***Figure 8**: Survey Densities for April 2016*

Following a review of the April 2016 survey data the MFPO, who lease the seabed for harvesting king scallops, proposed a 15 % increase for the current seasons TAC from 2015 giving a total allowable catch of 43,400 kg (which equates to 1400 kg per boat or approximately 35 bags at 40 kg for each of the 30 MFPO scallop fishing vessels plus 1,400 kg fished for the MFPO to help pay for future surveys. In order to rest the fished areas the MFPO elected to target two new fishing areas within the Bay selecting two fishing zones: Area 1 (B7, C7 and D7) which runs East-West at the top of the current Fished Area and Area 2 (B3, B4, B5) which runs North-South and encompasses the offshore section of the Garden Area.

Scallop management unit identification

One of the most important aspects of managing a fishery is to be able to understand the appropriate scale of the management unit or identity of the stock (e.g. the Irish Sea herring stock). In this respect, our understanding of appropriate management units has been limited to date and has relied on expert judgement. Work undertaken at Bangor University, led by Dr Natalie Hold & Dr Peter Robins, has used a combination of genetic and oceanographic modelling approaches to understand how different scallop beds are connected by oceanographic processes. Scallop larvae spend up to five weeks in the water column and have the potential to travel large distances in that time. However, gyres and fronts can restrict the movement of larvae to specific areas. The diagram below shows the extent to which different scallop beds are linked (black lines) by oceanographic processes and the amount of scallop larval retention (red bubbles, size = amount of retention) in an area. The figure shows that all locations around the Isle of Man are connected to each other with some linkage to Liverpool Bay which is a source of larvae. In addition there is quite a high level of retention of larvae in Manx waters. More importantly, the areas in southern Irish Sea are not connected to the northern half. This tells us that an appropriate management unit for scallop is the Northern Irish Sea with boundaries at the Northern Channel (between Northern Ireland and Scotland) and in the south across from Anglesey to Ireland.

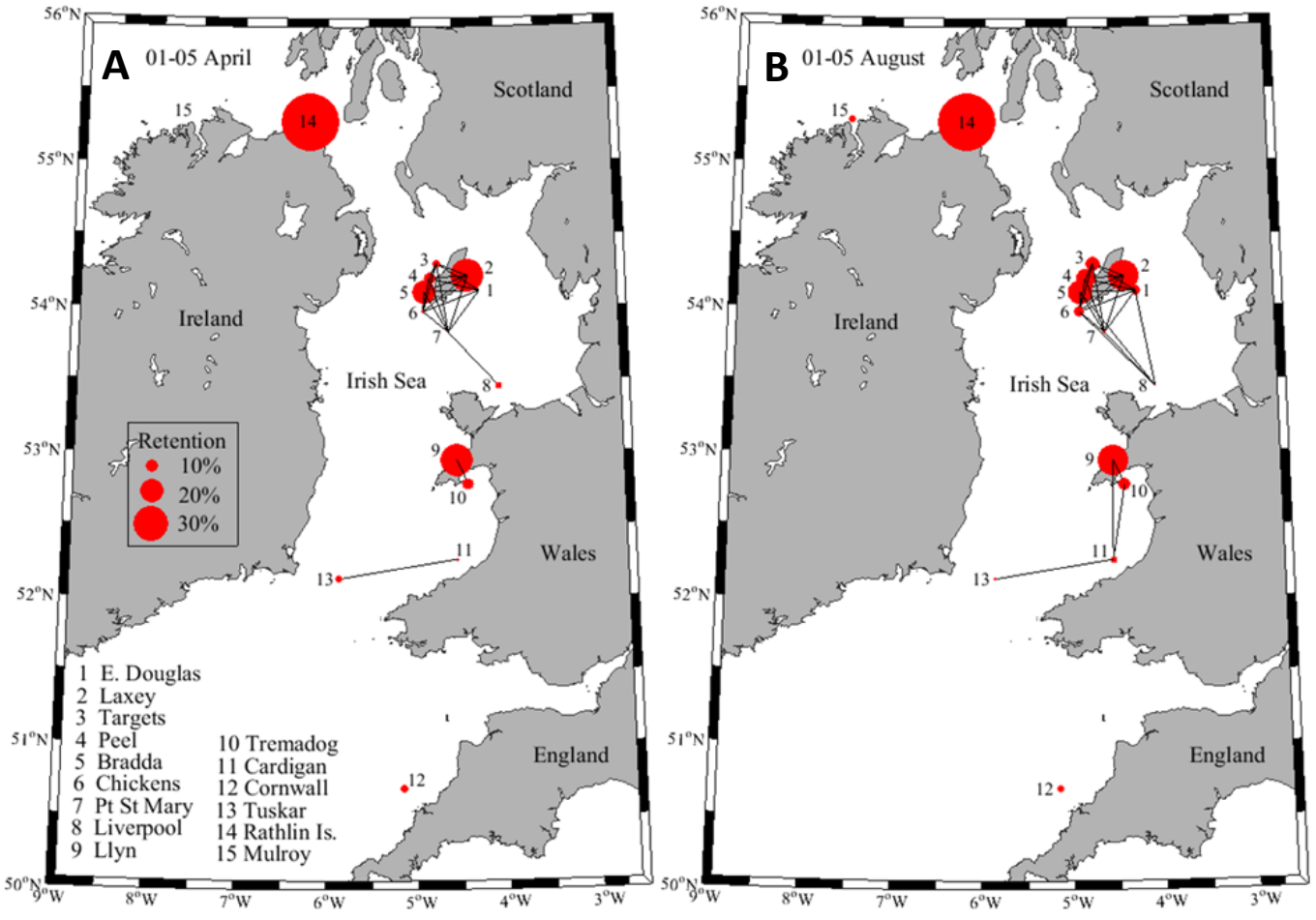


Figure 9: Simulated connectivity maps for scallop populations within the Irish Sea, based on 30—50 day post larval dispersion for larval release dates A) 1st—5th April and B) 1st—5th August . Red circles = larval retention; larger circles denote higher retention. Black links = larval connectivity between populations. Connectivity may be one-way or two ways. (Hold et al., in prep).

Queen Scallop Juvenile Survey (2m Beam Trawl)

Aim: The aim of this research is to optimise sampling of juvenile queen scallops (e.g. use of beam trawls) to more accurately understand and forecast recruitment and pre-recruitment processes. This data can be used to assess which areas around the Isle of Man may have high densities of post-recruit queen scallops in one or two years time. In addition the data will also be used to validate the data obtained from the dredge survey (which is not designed to catch undersized queen scallops). This survey was undertaken in collaboration with the MFPO. Two x 2 m beam trawls have been manufactured and set up in June/July 2016 by the MFPO using the net plans set out in Jennings et al., (1999). The standard beam trawl design is suitable for sampling epibenthic fauna on coarse substrates. A 4 mm knotless mesh liner is used in the cod end to retain smaller organisms. The survey was carried out over 3 days (August—September 2016) and sampled within three of the four main queen scallop fishing grounds (CHI, TAR, EDG). POA was not be surveyed due to the physical and environmental conditions that occur here that would risk damaging the survey equipment.

Methods: Two x 2 m beam trawl with 4 mm cod ends (Figure 10) were towed for 5 minutes at 1.5 knots. The contents of the trawl were emptied on to deck (with Port and Starboard trawls kept separately). A photograph of the catch was taken for each site before it was sorted for queen and king scallops. A subsample of 100 queen scallops were measured and any remaining queen scallops were counted.

Figure 10: A) One of the two 2 m beam trawls manufactured by the MFPO and paid for by DEFA for use in this study; B) An example of the catch from a single 5 minute tow.

Results: Preliminary observations from the data collected indicate that low numbers of recruits (under MLS) were found at the majority of stations sampled. However, one survey site on the west coast (just off the traditional fished area) and one site on the south coast (just off the traditional fished area) showed large quantities of recruits with a single size class of around 30—40 mm dominating the catch.

Future work: It is anticipated that this survey will be undertaken on an annual basis in June (ahead of the start of the queen scallop fishing season). Prior to the start of the next survey a preliminary trial will be undertaken with a lighter frame design compared to the current frame design to try and optimise sampling efficiency in softer sediments.

Output: A full analysis of the data from this survey is underway and the results will be made available once completed in a short report that will be published on the Fisheries and Conservation Science Group website: http://fisheries-conservation.bangor.ac.uk/iom/index.php.en

Queen Scallop Fishery update (2016)

Trawl Fishery:

- A TAC of 1012 tonnes was set for the 2016 Isle of Man trawl fishery. The fishery opened on 4th July 2016 and finished on 25th October 2016 with approximately 99.5 % of the TAC caught.
- Only 31 of the 40 licenced vessels that nominated to take part in the 2016 trawl fishery have prosecuted it. Of these, 24 vessels were from the IOM and 7 from the UK.
- A weekly catch limit per vessel of 4200 kg (120 x 35 kg bags) was set for Weeks 1 – 10 and subsequently reduced to 2800 kg (80 x 35 kg bags) for Weeks 11—16 and 1085 kg (31 x 35 kg bags) for Week 17.
- The average LPUE (kg per hour per m of net width) dropped from an island-wide average of 33.16 kg in 2015 to 14.02 kg in 2016.
- Average LPUE (standardised for net size and fishing time) for an example fishing ground is displayed for 2015 and 2016 below. The chart shows the decrease in LPUE that is apparent both within and between fishing seasons.

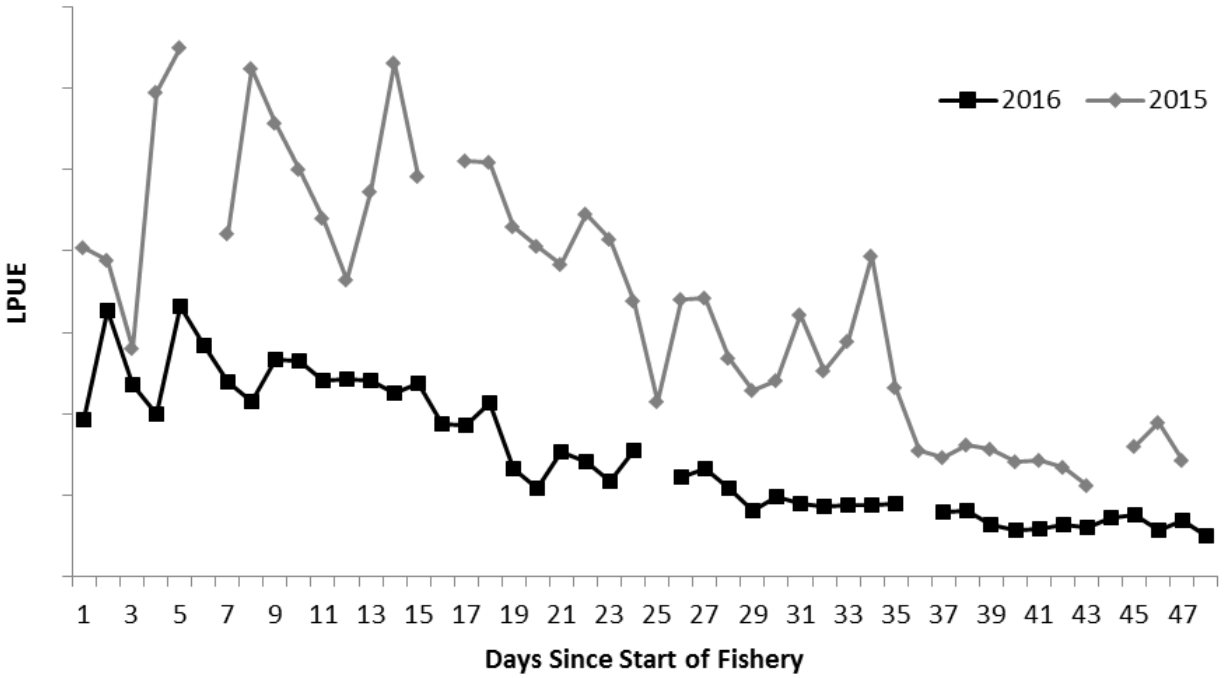


Figure 11: LPUE (standardised for net size and fishing time) for the Isle of Man queen scallop trawl fishery displayed for an example fishing ground within the Isle of Man's territorial sea showing the decrease in LPUE that is apparent both within and between fishing seasons.

Dredge Fishery:

- A TAC of 228 tonnes was set for the 2016 Isle of Man dredge fishery. The fishery opened on 1st October 2016 and finished on 26th October 2016 with approximately 96% of the TAC caught.
- A total of 8 out of the 9 licenced vessels that nominated to take part in the 2016 dredge fishery have prosecuted it. All 8 vessels were from the UK.
- A weekly catch limit per vessel of 10500 kg was set for Weeks 1 – 3 and subsequently reduced to 2625 kg for Weeks 4 onwards.

A 2016 stock assessment summary sheet (below) was produced and distributed along side the full report (Bloor, I.S.M., & Kaiser, M.J. (2016) The Isle of Man *Aequipecten opercularis* fishery stock assessment 2015. Fisheries and Conservation Report No. 66, Bangor University. pp.48.)

2016 Executive Summary: Queen scallop (*Aequipecten opercularis*) stock within the Isle of Man territorial sea

2016 Survey

From 25th April—8th May 2016 an annual survey of queen scallop stocks was undertaken in the Isle of Man's territorial sea aboard R.V. Prince Madog. A total of 49 survey stations were sampled by dredge (Fig 1) In addition, overnight multi-beam and side-scan sonar work was undertaken to map a horse mussel reef (*Modiolus modiolus*) at Little Ness.

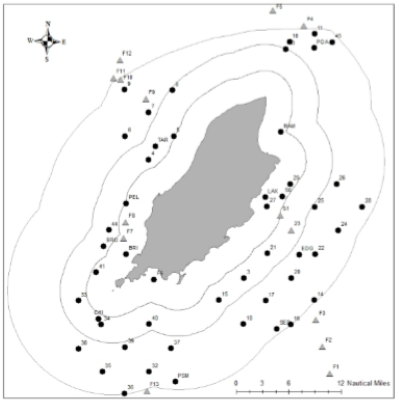


Fig 1. *Stations surveyed in 2016 (black circles surveyed; grey triangles not surveyed)*

2015/16 Fishery

In total 35 of the 47 licenced vessels took part in the queen scallop fishery in the territorial sea from July to October 2015 landing a total of 1,240t (Trawl fishery: 31 vessels; Dredge fishery: 12 vessels). Landings from outside the territorial sea added a further 6760t to the total landings for the wider stock unit (ICES Statistical Rectangles 36, 37 & 38 E5) for the 2015/2016 fishing season (1st June 2015 - 30th April 2016). The fishery inside the territorial sea was regulated with restricted licences, curfews and weekly bag limits and uptake was monitored with daily catch returns and GPS loggers. Four higher areas with relatively high densities of spawners were strategically closed around the island to try and promote improved recruitment to the fishery.

2016 Stock Assessment

The 2016 stock assessment was conducted using the CSA V.3.1.1 model and included Stations 3, 4, 5, 9, 10, 14, 17, 20, 21, 22, 23, 24, 25, 32, 35, 36, 38, 39 and 45 as well as historical stations (CHI, EDG, LAX, POA, PSM, RAM, SED and TAR). For the stock assessment unit (Isle of Man territorial sea):

- Landings had risen from 1,000t in 2014/15 to 1,240t in 2015/16 (Fig. 2).
- Median estimated biomass had fallen from **5328t** for the 2015/16 fishing season (80% confidence intervals of 3780t and 7749t) to **4678t** for the 2016/17 fishing season (80% confidence intervals of 3022t and 6928t) (Fig. 3).

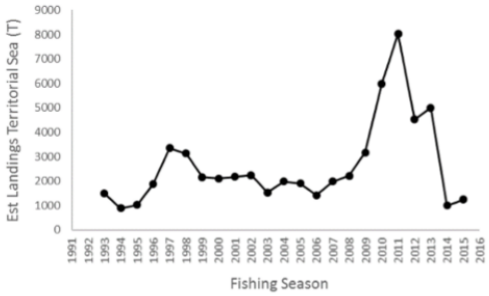


Fig. 2. *Summary of estimated total landings (t) from territorial sea.*

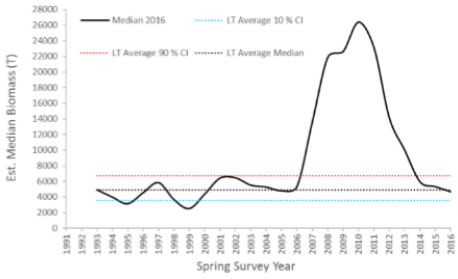


Fig. 3. *Estimated biomass for territorial sea. Dotted lines show historic long term average calculated using all data except 2007-2013, highlighting the extraordinary peak in biomass that occurred during that period.*

Advice for 2016

Estimated biomass for the territorial sea remains below the minimum threshold and so a scientifically advised TAC has not been recommended for the 2016/17 fishing season.

Biomass within the territorial sea has returned to around average historical levels (average 4873t: 1993-2006; 2014-2016) following increased management. Despite year on year fluctuations for that period the overall biomass trend remained relatively stable with an average of 1845t removed (range 886-3343t) (Fig. 2 and Fig. 3). Estimated biomass for 2016 is slightly down from 2015 (Fig. 3). As such, there is no scientific evidence that the stock can support any increase in the TAC from 2015 (e.g. 1240t). Furthermore should fishing occur a more precautionary approach for 2016/17, limiting biomass to 20-25% of the estimated median biomass (e.g. 935-1170t), is advised in order to try and further stabilise biomass.

It is also advised that a Pan-Irish Sea management plan is still urgently needed to develop and implement measures to substantially reduce fishing mortality within the wider stock. Following concerns raised by industry a one month voluntary closure of the queen scallop fishery (Areas VIa and VIIa) was enacted for 2016 to protect the stock during the spawning period.

ICES Working Group Scallop Stock Assessment

The fourth meeting of the ICES Scallop Working Group was held from 3rd – 7th October 2016 in Aberdeen, Scotland. A total of thirteen members from 8 international institutions attended the meeting which is chaired by Professor Kevin Stokesbury from the University of Massachusetts. The workshop focused on several key areas including: the identification and collation of evidence and information that can be used to draw boundary lines to delimit stock structures within the ICES areas; standardising ageing techniques for use in stock assessment models leading to an inter-laboratory ageing calibration assessment using samples from all the populations discussed; indirect impacts of scallop fishing on bycatch and discard mortality.

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 12: Scientists from eight international institutions representing France, Isle of Man, Wales, Iceland, Faroe Islands, Ireland, Northern Ireland, Scotland and England met at Marine Science laboratories in Aberdeen as part of the working group on scallop stock assessments which was chaired by Professor Kevin Stokesbury (USA)

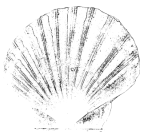
Scallop research priorities for 2017

- **Bycatch reduction in the queen scallop trawl fishery:**

⇒ Trial of disruptive technology for bycatch reduction (LED escape rings & SMPs)

- **King scallop stock assessment:**

⇒ April 2017



- **2017 Spring Scallop Survey:**

⇒ 28th March—10th April 2017 survey

⇒ Dredge camera improvement trials

⇒ Investigating the potential for sub-area assessments and quotas

- **Industry Beam Trawl Surveys:**

⇒ 3 day survey onboard F.V. Alena June 2017

⇒ Calculation of queen scallop juvenile abundance index

- **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 fishing industry is defined by vessels that use baited traps (pots) to capture target species. This traditional, environmentally benign method of fishing targets a number of shellfish species, including lobster, crab and whelk.

Since the start of the year, scientific staff and industry have been working together on a number of projects that aim to improve our understanding of these fisheries. Most fundamentally, industry has improved the detail at which it reports catch and effort data. With more confidence in the data, the management of these fisheries will become increasingly supported by a robust evidence base.

However, the improvements in logbook reporting only go so far in addressing the data gaps for whelk and crustacean fisheries. Bangor staff, with support from the scientific steering committees and the industry representatives, have aimed to address present and future data requirements by setting out on several ambitious projects.

Update on whelk fishery

Monitoring the whelk fishery throughout 2016 has been one of the focal points of Bangor staff based on the Isle of Man.

The landings and effort data from Isle of Man monthly logbooks indicates that the fishery has expanded significantly during recent years and, although productivity (LPUE) appears stable at current levels of fishing (fig 1.), the fishery may be at risk of being over-capitalised. Indeed, there was concern amongst all stakeholders during September when the productivity of the fishery declined below previously observed levels at that time of year. Furthermore, although overall landings have increased, peak catch rates during the summer fishery have not returned to a level observed in the data during 2014.

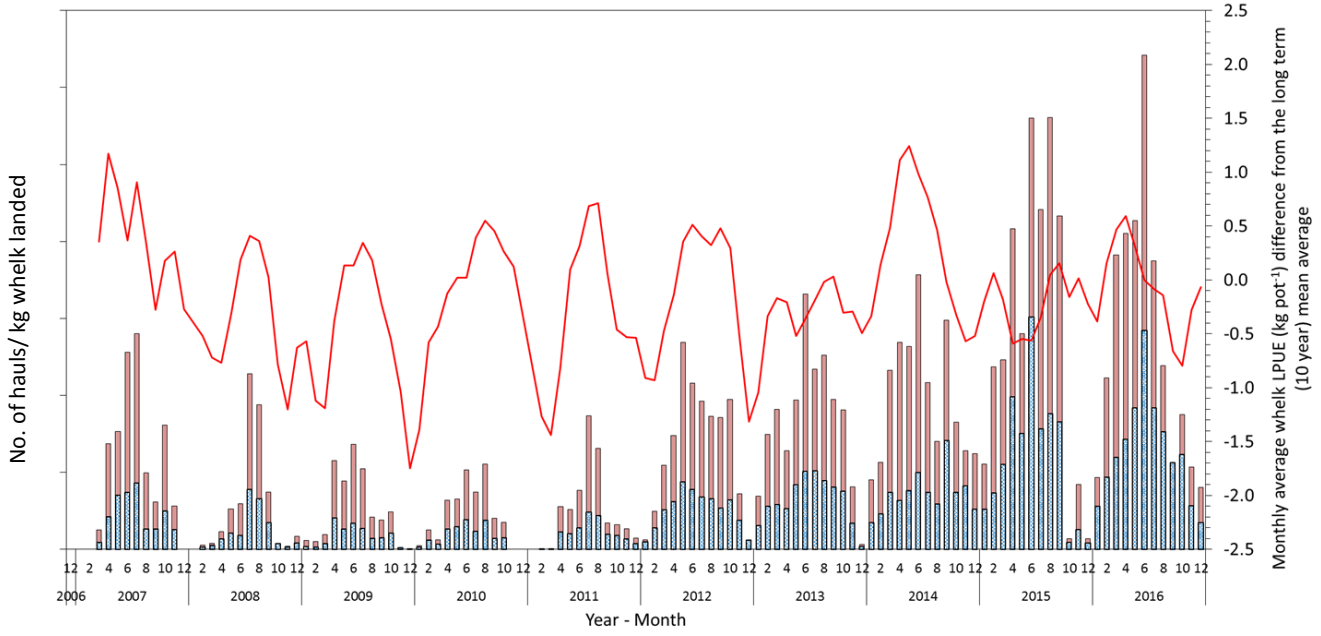


Figure 13: Recent trends in whelk (B. undatum) catch data supplied by Monthly Shellfish Activity Logbooks. Blue bar = effort (haul events). Red bar = Landings (kg). Red line = average daily LPUE.

Although the resolution of data has improved significantly during the past 12 months, industry and scientists are continuing to explore technological solutions to make further advances.

Whelk are known to exhibit variation in life-history traits that make localised populations vulnerable to depletion in the absence of appropriate management. Recognising their key role in creating a sustainable future for the fishery, industry members from the Isle of Man and the UK have supplied biological samples throughout the spatial extent of the fishery over the last 12 months (Figure 14).

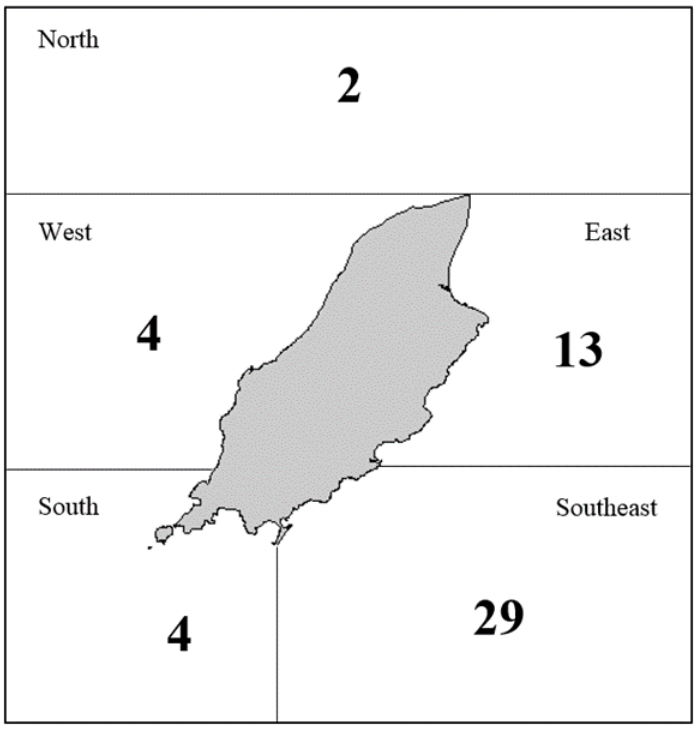


Figure 14: Sample locations analysed to date.

The dataset, which is pending completion with remaining samples set to undergo laboratory analysis in early 2017, creates a thorough and locally-relevant overview of the biological characteristics of the species. The data, once fully analysed, will detail:

- Functional size-at-maturity
- Morphological size-at-maturity
- Population structure (e.g. length distribution, sex ratio, etc.
- Nursery grounds
- Spawning seasons
- Growth rates (size-at-age)

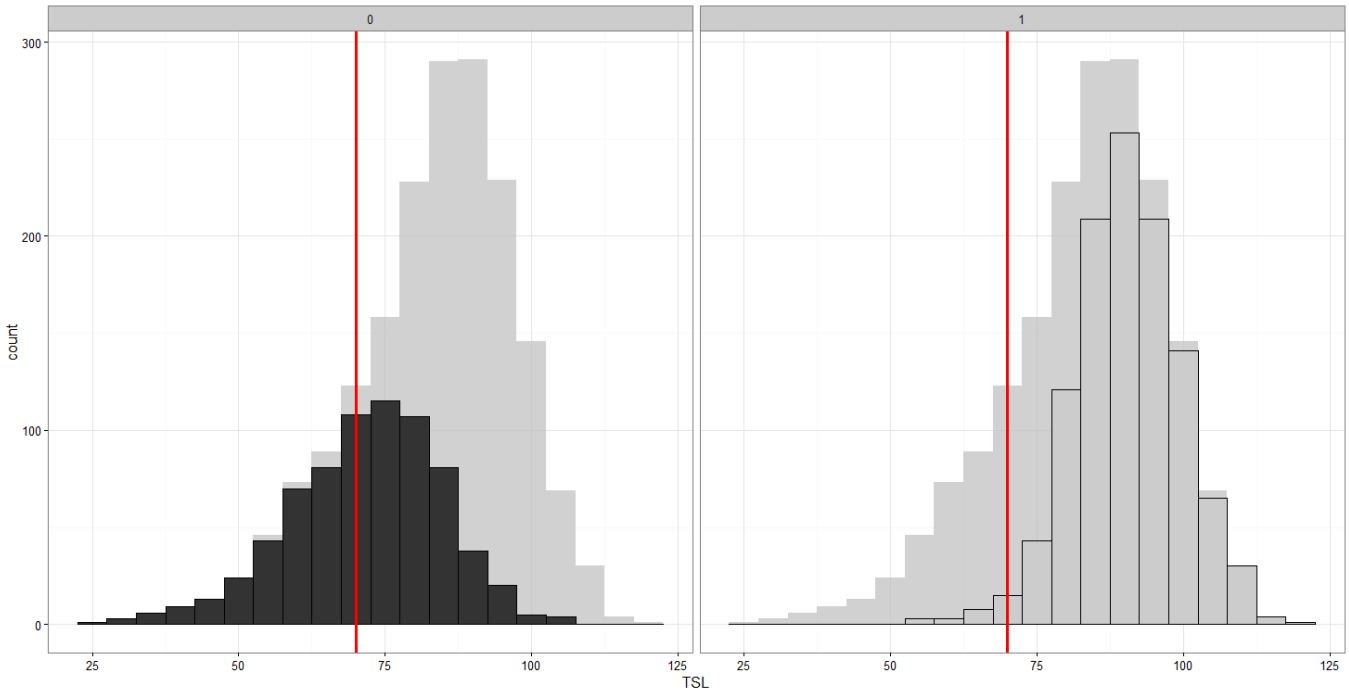


Figure 15: Size structure of immature (black) and mature (grey) whelk. Back drop represents overall population structure. Red line shows current minimum landing size.

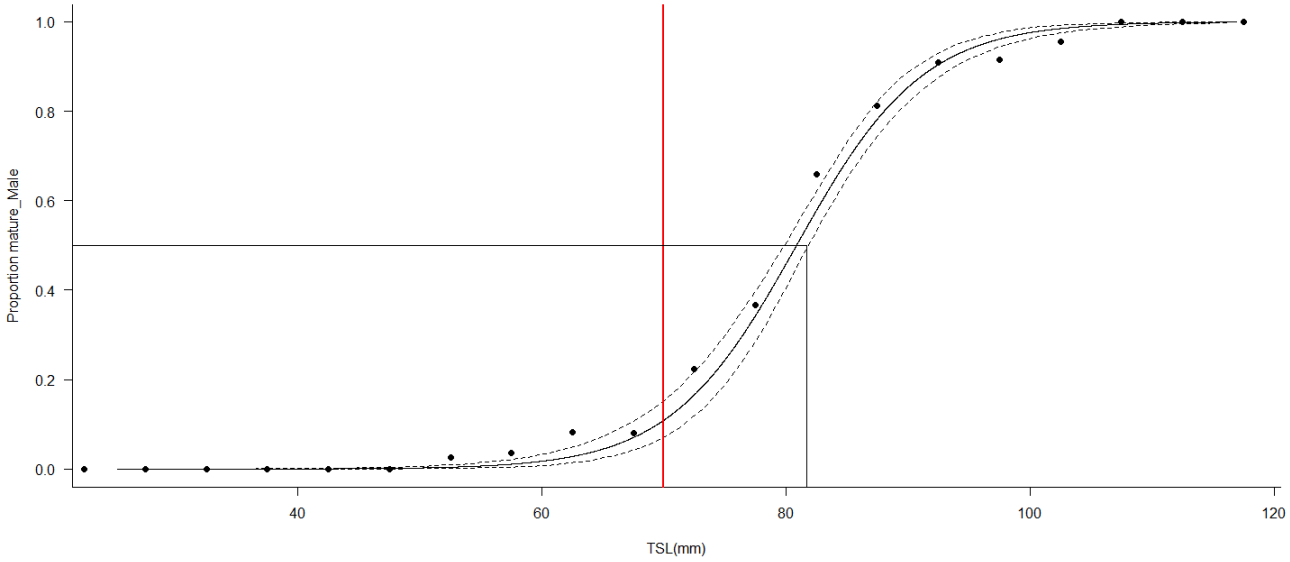
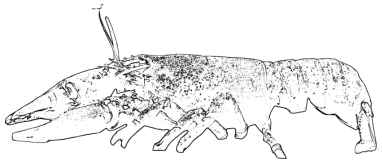


Figure 16: Functional maturity, L_{50}, of all individuals analysed (aggregated data). The red line indicates the current minimum landing size.



Update on lobster fishery

The lobster fishery, unlike the whelk fishery, has been well established on the Isle of Man for decades. The trends in fishing productivity show characteristic seasonal peaks and troughs; however, the long term average is stable and indicative of a healthy fishery that can be sustained into the future.

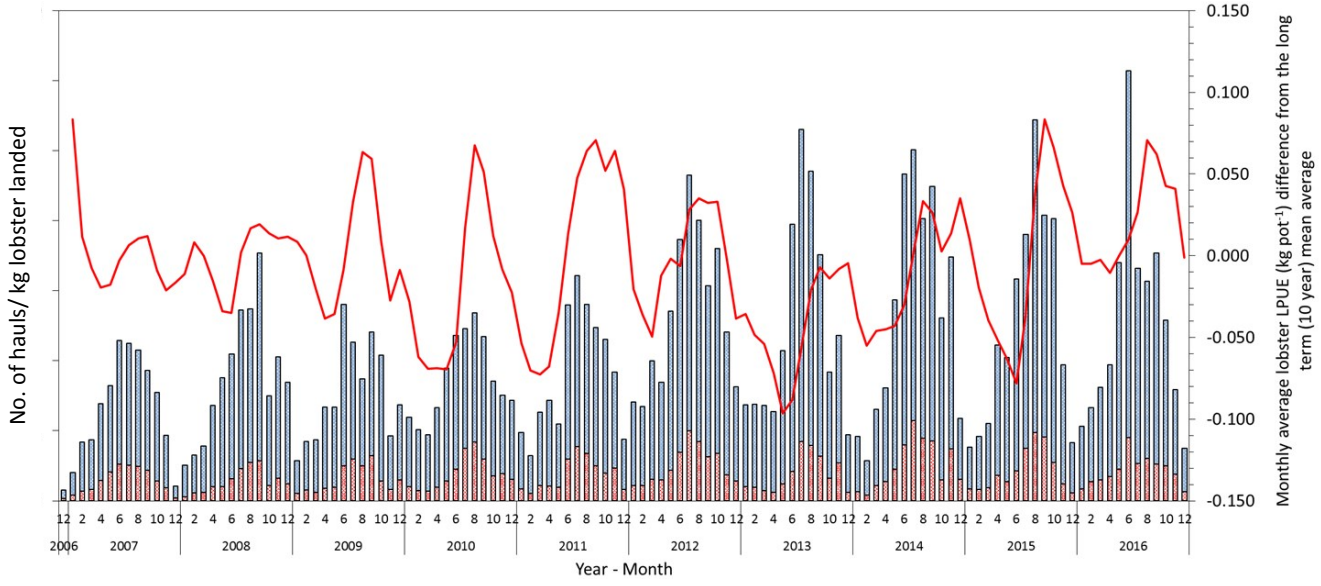


Figure 17: Recent trends in lobster (H. gammarus) catch data supplied by Monthly Shellfish Activity Logbooks. Blue bar = effort (haul events). Red bar = Landings (kg). Red line = average daily LPUE.

Bangor University will be establishing innovative research programmes beginning in 2017 to verify the sustainability of this fishery and build upon the progress made during 2016, which is outlined below.

On-board cameras

Inshore fisheries throughout Europe tend to be data deficient. The crustacean fisheries targeting lobster and crab in the Isle of Man are no exception, despite the recent improvements in logbook data.

The spatial distribution of fishing effort is assumed mainly to occur within the 0-1 mile area; however, in order to properly inform spatial management in the 0-3 and indeed in the 3-12 nm, an evidence base of fishing activity is necessary. Furthermore, the structure of the population is captured only through infrequent field-surveys. Trends in recruitment, reproduction and discards need to be understood on a finer spatial and temporal scale moving forward.

Figure 18: A parallel paired laser onboard FV Shelgeyr, Port St Mary.

By working closely with members of the static-gear industry and technicians based at the School of Ocean Sciences in Menai Bridge, our scientists have designed on-board cameras that will capture high-resolution data. During the trial process, having taken the feedback from both commercial fisherman and field-researchers, we have re-designed the units. They now include:

- External power supply
- User controlled on/off switch
- Parallel-paired lasers (for accurate size measurement)
- Integrated GPS system

We have manufactured 7 units and intend to have 5 of them operating on-board Manx fishing boats

Lobster Tagging

Thanks to funding from the charity "Sea-changers", the Baie Ny Carrickey Crustacean Fishery Management Association (BNCCFMA), with support from Bangor University staff, was able to undertake exciting new research that involves tagging up to 1500 lobsters in the Baie Ny Carrickey Closed Area.

The data collected will identify any seasonal patterns in movement, whether this is linked to spawning migrations and if the closed area is creating any spill-over benefits to surrounding lobster grounds.

The field work element of the project is being undertaken by Guy Sutton, owner of Auk CT25, and began in August 2016. Analysis of the dataset has already led to some interesting finds; such as several lobsters having increased by ~ 10 mm (CL) in a single moult (from 82 mm in September to 93 mm in November).

As the BNCCFMA continues to run the project into 2017, it is expected that the data will improve our understanding of:

- Lobster home-ranges
- Seasonal & spawning migrations
- Growth rates & moulting periods

Figure 19: Lobster tagging in the Baie ny Carrickey closed area. Picture credit: Guy Sutton (Auk, CT25).

Lobster Genetics

Although the tagging data collected thus far suggests that lobster occupy discrete *home-ranges*, their life-cycle includes the release of larvae into the water column, i.e a planktonic phase. The dispersal of millions of larvae into the water column renders individuals vulnerable to high levels of predation during a period thought to last 5 – 10 weeks. However; the movement of genetic material via ocean currents is likely to result in populations *mixing* over large geographic areas. Whilst genetic mixing over large spatial scales is often thought to afford resilience to local populations, it also means that management of the species as a resource should also be integrated.

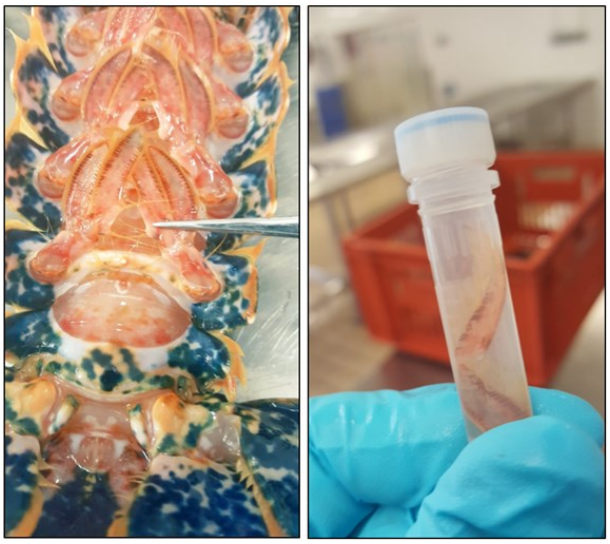


Figure 20: p**leopod samples being taken from lobsters for genetic analysis.**

For this reason, Bangor staff supplied genetic samples (pleopods stored in ethanol) from 60 lobsters to a study being undertaken Exeter University. The Manx genetic samples are to be compared to others from in the Irish Sea region and elsewhere in the UK.

Update on crab fishery

Recent trends in catches continue to indicate a healthy edible crab fishery in Isle of Man waters. Despite the summer peak in LPUE not reaching a level observed in previous years, landings remained high into the autumn. Indeed, total catches for 2016 to the end of October were 20% greater than during the same period in the previous year. We will improve the understanding of this fishery through the use of on-board cameras and tagging studies during 2017.

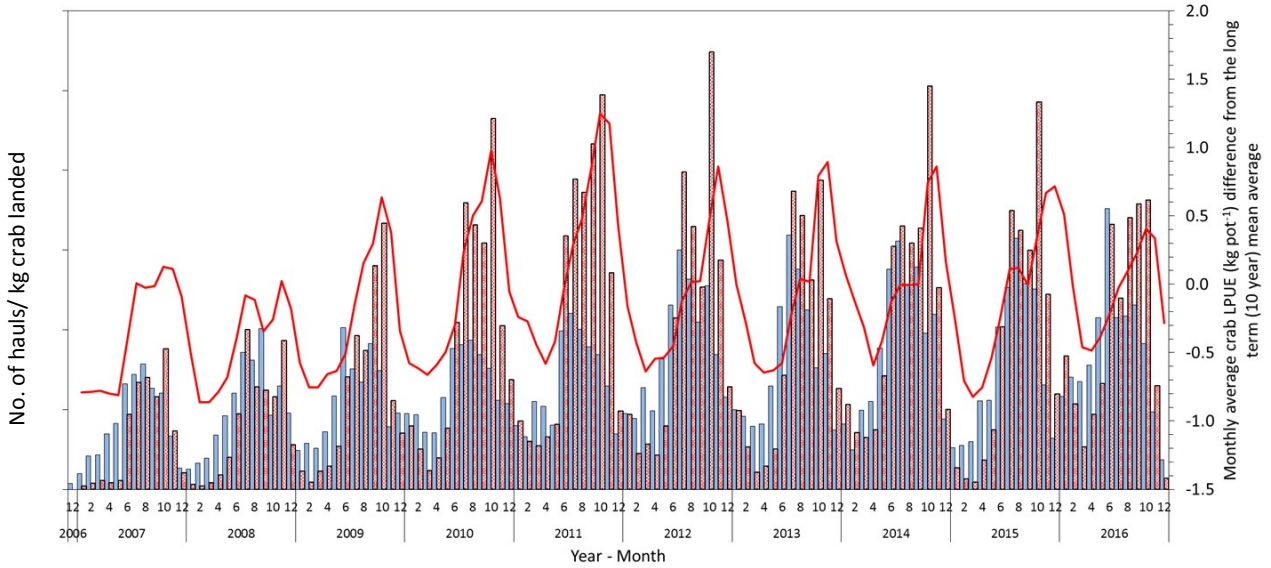


Figure 21: Recent trends in crab (C. pagurus) catch data supplied by Monthly Shellfish Activity Logbooks. Blue bar = effort (haul events). Red bar = Landings (kg). Red line = average daily LPUE.

Pot fishery research priorities for 2017

- **Sea trials of 2nd generation onboard camera systems:**

⇒ Deploy on-board cameras on a sentinel fleet to monitor crab and lobster fisheries

⇒ Collect, analyse and present data acquired through the systems.

- **Whelk fishery-dependent data returns:**

⇒ Test novel monitoring technology with industry (electronic deck-loggers that collect environmental data as well as catch data).

⇒ Using this data, explore stock assessment options with the whelk sub-group.

- **Whelk monthly pot sampling scheme:**

⇒ Process the remaining whelk pot-samples from the 2016 monitoring programme.

⇒ Process the whelk statolith samples for size-at-age data.

- **Lobster tagging study:**

⇒ Review the mark-recapture data in the Baie ny Carrickey tagging experiment.

- **Assess suitability of current MLS for all pot fisheries**

⇒ Explore cost-benefits of any alterations to the MLS

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 2016 we had four 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: ASSESSING THE ISLE OF MAN'S BROWN CRAB, *CANCER PAGURUS*, FISHERY: DOES HEAVY METAL CONTAMINATION HAVE A LINK WITH SHELL DISEASE SYNDROME?

Student: Zachary Radford
Universities: Bangor University
Dates: June 2016– September 2016
Supervisors: Kevin Kennington, Jack Emmerson, Isobel Bloor & Stuart Jenkins

Shell disease syndrome is prevalent in several *C. pagurus* fisheries in the British Isles, including the Manx fishery; although, very little is known about the causative agent or environmental factors driving shell disease in *C. pagurus*. In 2012, the prevalence of shell disease in the Manx fishery was 24.4% and the average infection severity was 2.1%. Coincidentally, Manx waters are subject to extensive heavy metal contamination, which has been linked to reduced immunocapabilities in crustaceans. Metal contamination in the brown meat of *C. pagurus* is currently unregulated under European legislation, which has led to foreign food standards agencies embargoing *C. pagurus* imports from areas of the British Isles. This study investigated the link between heavy metal contamination in the brown meat of C. pagurus and the prevalence and severity of shell disease, along with temporal and spatial variance in shell disease intensities. Furthermore, the biodynamics of metal concentrations in *C. pagurus* brown meat were investigated. The overall prevalence (40.3%) and severity (3.9% ± 0.41) of shell disease found in this study was double that found in 2012. No significant link between metal contamination and shell disease was detected, although there was a trend toward lower metal concentrations in uninfected *C. pagurus*. The concentration of several metals, specifically arsenic (14.93mg/kg ± 0.75) and cadmium (3.47mg/kg ± 0.48), were found in high concentrations within the brown meat of *C. pagurus*, with cadmium concentrations almost seven times greater than European limits for crustacean white meat.

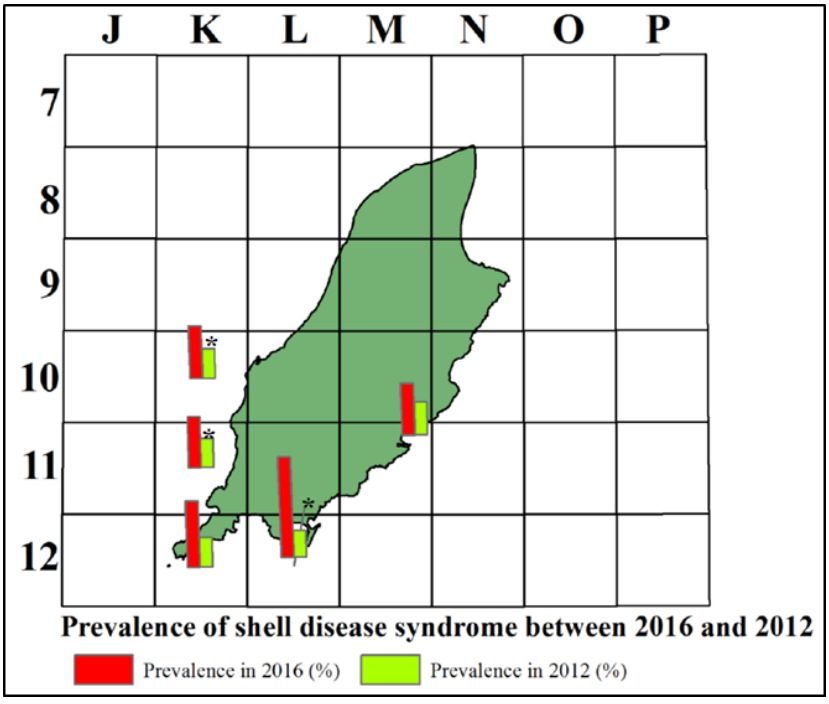


*Figure 22: Variation in shell disease syndrome prevalence in the Isle of Man's brown crab (Cancer pagurus) population between 2012 and 2016. Map shows the Port Erin Marine Laboratory grid squares overlaid onto an Isle of Man base map. 2012 data was provided by King et al., (2014). * indicates a statistically significant difference.*

Thank you to all the pot fishermen for their assistance without which this research would not have been possible

Title: THE ABUNDANCE, MOVEMENT AND POPULATION CHARACTERISTICS OF COMMON WHELK, *BUCCINUM UNDATUM*, IN AN AREA UNDER CONSIDERATION FOR AN OFFSHORE WINDFARM DEVELOPMENT IN THE TERRITORIAL WATERS OF THE ISLE OF MAN.

Student: Edward Bolger
Universities: Bangor University
Dates: June 2016– September 2016
Supervisors: Jack Emmerson, Isobel Bloor & Michel Kaiser

The abundance, movement and population characteristics of commercially exploited common whelk, *Buccinum undatum* (L.), were investigated in an area under consideration for an offshore windfarm development in the territorial waters of the Isle of Man, from June – July 2016. A Lincoln-Peterson mark-recapture survey, using tags with unique identification codes, to estimate abundance and movement, was carried out in 3 x 1km^2 sample areas within the windfarm area. In total, 2722 *B. undatum* were tagged and released. Recapture rates were variable, with an overall recapture rate of 1.62%. The mark-recapture survey produced a population abundance estimate of 0.20 individuals m^{-2} and an average movement speed of 9.13 m day^{-1}. Using the abundance estimate produced, it was then possible to estimate the value of the *B. undatum* stock within the windfarm AFL..

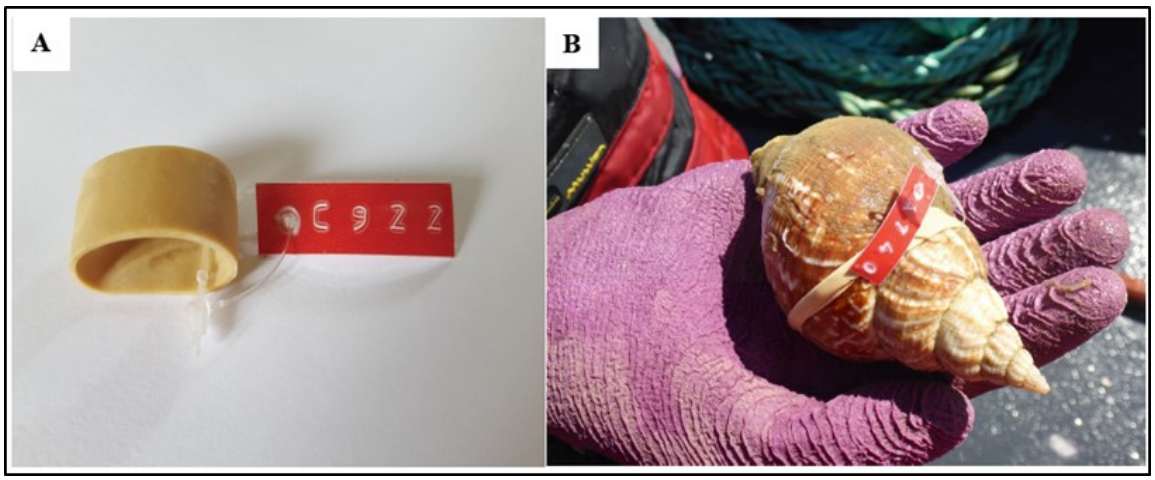


Figure 23: The tagging method used during the study (Bolger, 2016).

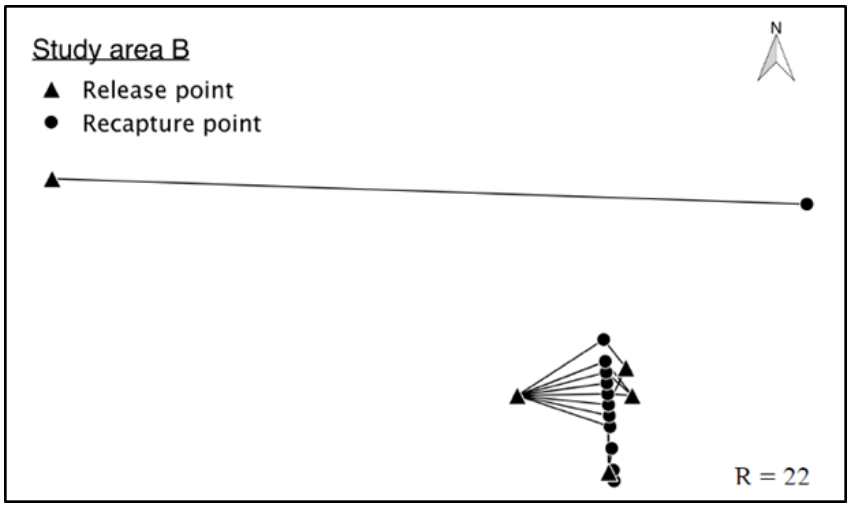


Figure 24: An example of the spatial analysis conducted (triangles represent the release locations from FPV Barrule, cirlces represent the recapture locations onboard FV Boy Shayne).

Thank you to Jon-Joe Skillen and the crew of Boy Shayne for their assistance without which this whelk tagging research would not have been possible .

TITLE: ASSESSING KING SCALLOP (*PECTEN MAXIMUS*) ASSOCIATION WITH THE BENTHIC ECOSYSTEM WITHIN ISLE OF MAN MARINE RESERVES.

Student: Chyanna Allison
Universities: Bangor University
Dates: June 2016 – September 2016
Supervisors: Isobel Bloor, Jack Emmerson & Michel Kaiser

In 2009 DEFA established two scallop replenishment zones in Niarbyl (west coast) and Laxey (east coast). These areas were closed to mobile fishing gear and reseeded with juvenile king scallops to try and rebuild depleted scallop stocks. The aim of this research was to investigate the benthic environment within these two closed areas with a focus on identifying sensitive habitats (e.g. maerl) and to quantify the current densities of scallop populations . This will provide DEFA with important information on which to base future environmental management decisions of these marine reserves.

The seabed within these two marine reserves was surveyed between 13th and 25th June 2016 using a video sledge towed from the F.P.V. Barrule. The video sledge comprises a live video feed, a mounted camera with flash, a high resolution GoPro Hero 3 and two underwater lights on the front (Figure x). A total of 6 one hour video transects (split into 36 ten minute transect segments) were completed in Laxey Bay and 27 ten minute video transects completed in Niarbyl Bay. Stills images were also taken every 10 seconds during the video transects. Stills images were assessed for quality prior to analysis and any images that were affected by visibility or image quality were removed from the dataset. Habitat type was determined using a 12 point superimposed grid, at each grid cross point the substrate of the image was identified and recorded allowing a percentage cover for each substrate type to be estimated for each stills image. The video data was then analysed to estimate scallop density and provide habitat verification for the stills images. Biotope maps were generated in ArcGIS using two different approaches (JNCC biotopes and cluster analysis). A total of 236 species were identified from the still images and video footage.

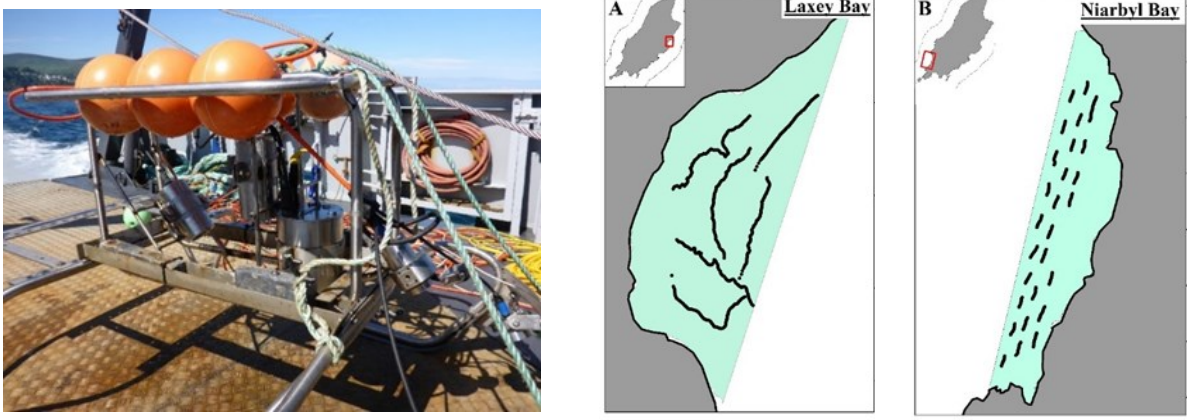


Figure 25: Towed video sledge comprising a stills camera and flash, a live video feed with lights and a mounted GoPro and maps indicating the location of video transects within both Laxey Bay (A) and Niarbyl Bay (B).

In 2009 Laxey Bay, which covers an area of approximately 4 km^2 was closed to mobile fishing and subsequently reseeded with 100,000 juvenile scallops (1 – 2 year olds) from Mulroy Bay Scallop Farm, Ireland, in an attempt to replenish the native stock (Kennington, 2009). Despite this reseeding event, scallop densities within the bay have remained low with only 22 scallops observed from the video footage collected in June 2016. These scallops were concentrated in the centre of the bay at depths of approximately 15 m within substrate comprising of maerl and gravel.

Analysis of the video and stills data found that Laxey Bay contained three main substrate types (sand, maerl and seagrass). Both maerl and seagrass are Biodiversity Action Plan habitats and are protected under the Habitats Directive.

In 2009 Niarbyl Bay, which covers an area of approximately 6 km^2, was also closed to mobile fishing and subsequently reseeded with over 100,000 wild caught scallops (dominant cohort was 3 year olds) taken from fishing grounds on the west coast of the Isle of Man (Kennington, 2009). The number of king scallops observed from the video footage collected in June 2016 was greater than in Laxey with 123 scallops which were dispersed across a large proportion of the Bay. Scallops tended to be concentrated in areas where depths were over 10 m and the substrate was coarse. Eleven juvenile scallops were also observed in Niarbyl typically in harder, rocky habitats with high biodiversity.

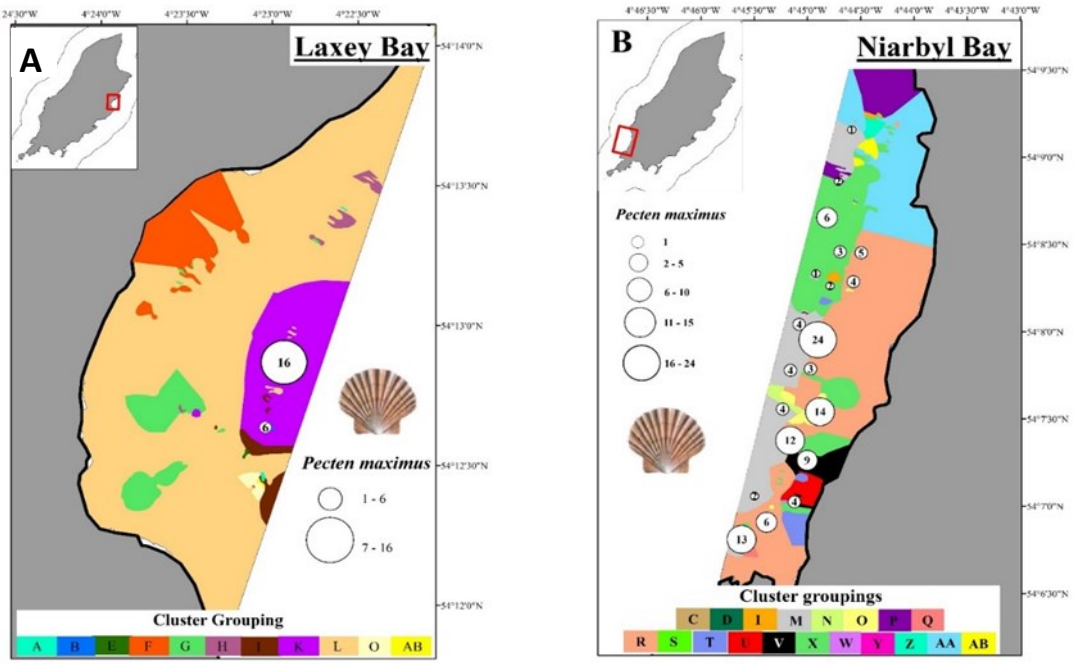


Figure 26:: King scallop abundance superimposed onto the biotope maps created for A) Laxey Bay and B) Niarbyl Bay. Please see final thesis for a key and explanation of each cluster grouping.

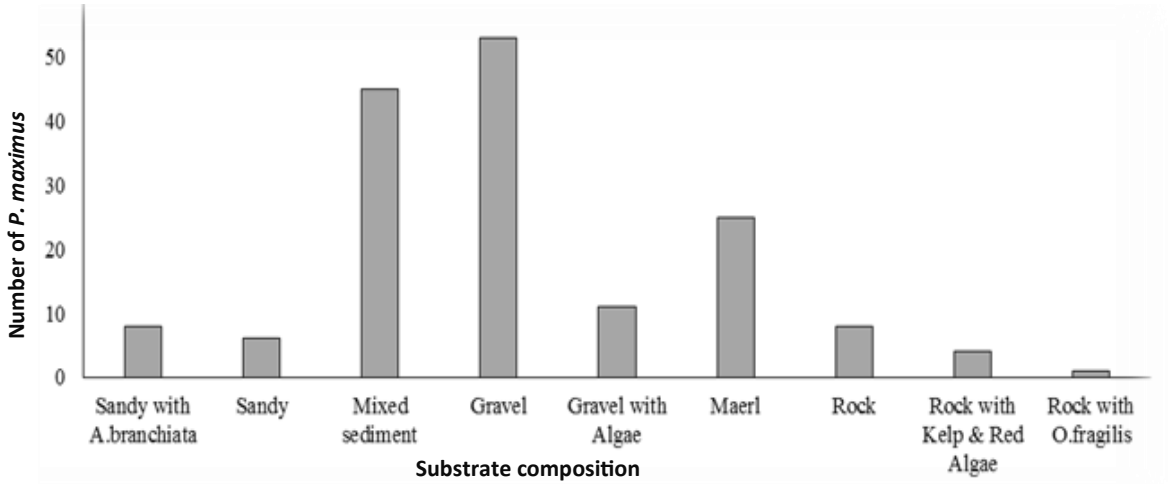


Figure 27: The abundance of king scallops within each substrate type (data pooled for Laxey and Niarbyl)

Output: The results of this research were presented to staff at DEFA during a lunchtime symposium. In addition a copy of the final thesis for this project can be requested from i.bloor@bangor.ac.uk

TITLE: BENTHIC HABITAT MAPPING RAMSEY BAY MARINE NATURE RESERVE

Student: Nicola Dempster
Universities: Bangor University
Dates: June 2016 – September 2016
Supervisors: Isobel Bloor, Jack Emmerson & Michel Kaiser

Ramsey Bay Marine Nature Reserve (MNR) is situated off the northeast coast of the Isle of Man and covers an area of approximately 94.5 km^2. Sampling took place over 4 days in June and July 2016 onboard the F.V. Barrule. At each sample location the video sledge was deployed with the GoPro cam era on video setting and a stills camera taking a still picture every 10 seconds. Following cleaning of the data, stills images were processed in Image J, with percentage cover recorded for substrate, flora and sessile fauna using a point sampling grid (Figure x). A total of 48 grid squares were sampled using the video sledge in Ramsey Bay (41 within the FMZ, 4 within the CZ and 3 outside the MNR). A total of 10 still images and 10 minutes of video were analysed per grid square.

In total 117 taxa were identified from the still images and video, with 24 algae, 7 hydroids, 1 hydroid/ bryozoan mix and 81 other faunal taxa. Biodiversity Action Plan (BAP) priority species were relatively rare in the areas sampled in Ramsey Bay. The horse mussel, *Modiolus modiolus*, was only seen in 6 grid squares, and was generally found at low densities, averaging 2.13 individuals per 1 minute of tow. However, in grid square D5 densities were much greater, with an average of 68.50 individuals per 1 minute tow. In the case of maerl, the proportion of dead nodules tended to be greater than that of living nodules, with an average of 5.38 % cover in still images for living maerl compared to 8.28 % for dead maerl. The maerl species found in Ramsey Bay is suggested to be of the species *Phymatolithon calcerum* (Veale et al., 1998). Seagrass was not seen in any still images or videos. A brittlestar bed was found in the south east corner of the FMZ, and extended outside the protected area. This was made up predominantly of *Ophiothrix fragilis*, with small numbers of *Ophiothrix nigra* present.

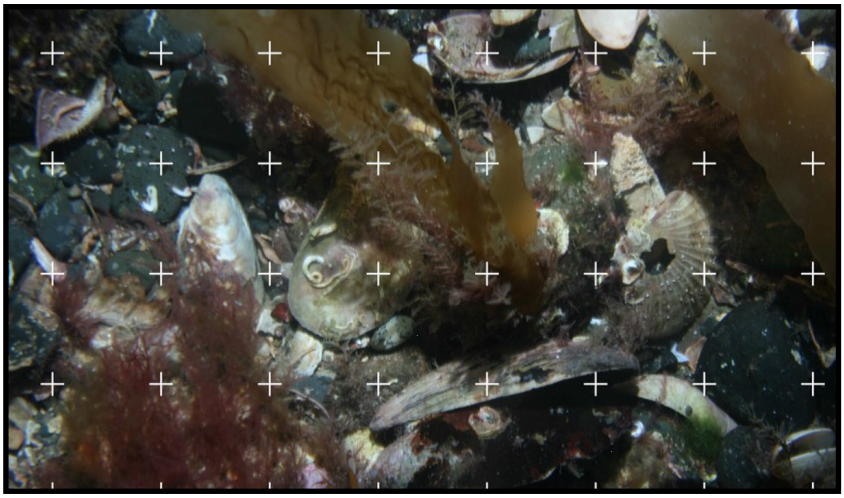


Figure 28: Example of the point sampling grid system used to determine species percentage cover. Substrate, flora or sessile fauna found at each of the 40 crosses were identified, with each point on the grid representing 2.5 % cover.

The abundance and distribution of king (*Pecten maximus*) and queen (*Aequipecten opercularis*) scallops varied across Ramsey Bay. In total 335 king scallops and 564 queen scallops were observed across all the video tows. The abundance of both king (61%) and queen (88%) scallops were greatest within the 'Fishing Ground' area of the FMZ (Figure 30) and differed among biotopes.

Output: A copy of the final thesis for this project will be available in early 2017 and can be requested from i.bloor@bangor.ac.uk

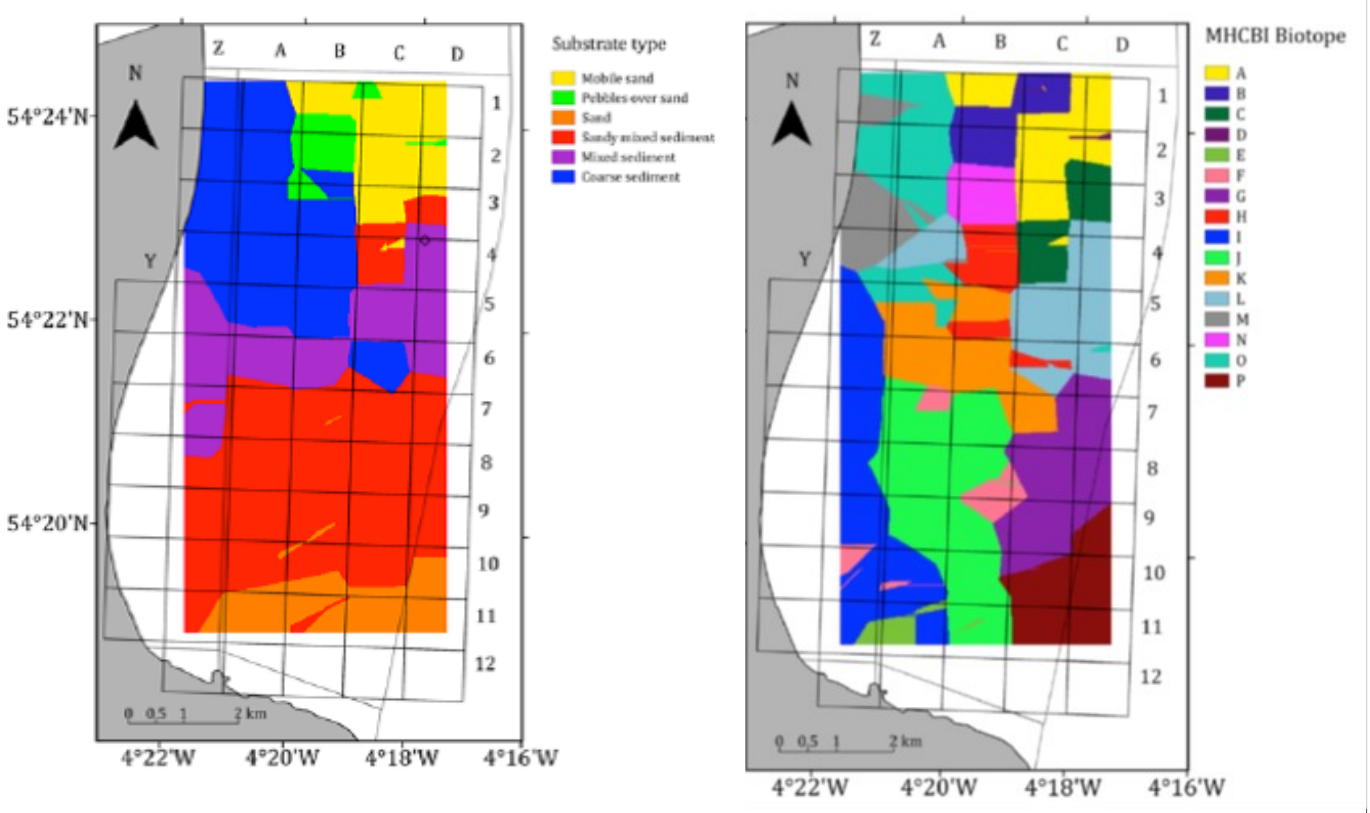


Figure 29: Biotope map showing the MHBCBI classifications. Please see final thesis for a description of each MHCBI Biotopes

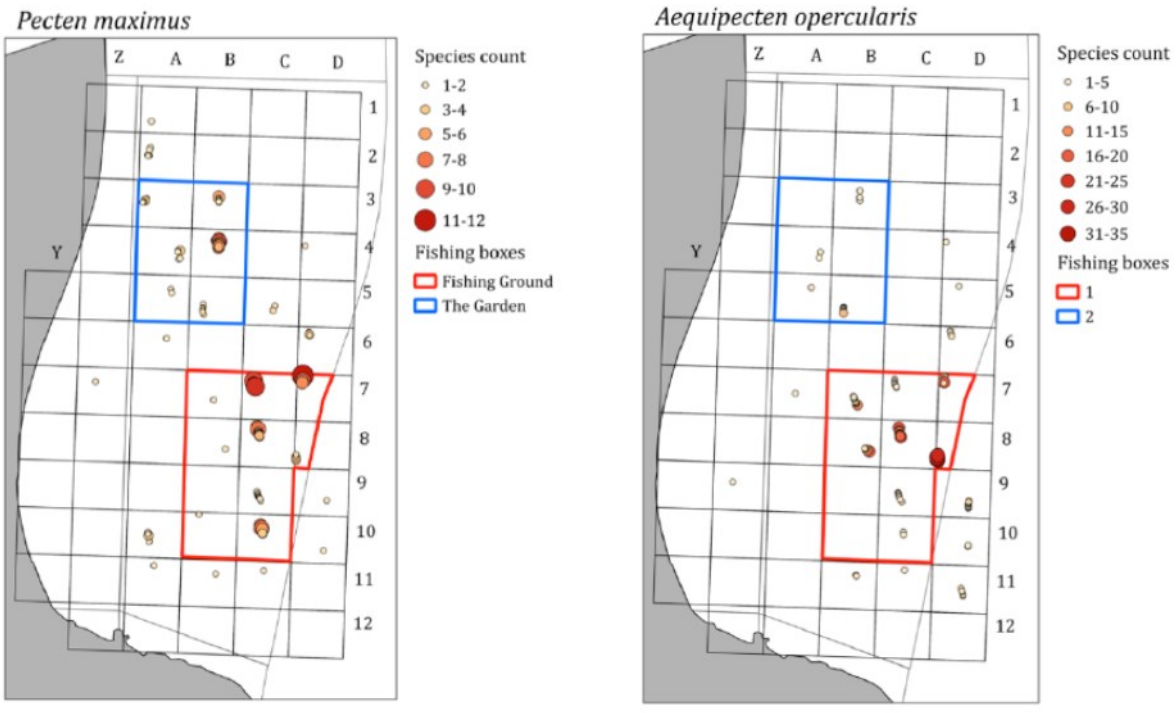


Figure 30: The distribution of the king (Pecten maximus) and queen (Aequipecten opercularis) scallops in Ramsey Bay.

TITLE: A SPATIALLY DYNAMIC MODEL TO ENGAGE FISHERS IN EVALUATING MANAGEMENT STRATEGIES IN THE ISLE OF MAN SCALLOP FISHERY

Student: Jenny Shepperson (PhD Student)
Universities: Bangor University & Centre for Environment, Fisheries and Aquaculture Science
Dates: 2013– 2017
Supervisors: Michel Kaiser, Lee Murray, Steven Mackinson & Ewen Bell

Fishermen often complain that scientists do not seek their input when we devise mathematical models to simulate the consequences of different management approaches and changes in natural environmental parameters such as storminess. Jenny Shepperson is nearing the end of her PhD funded jointly by Bangor University and CEFAS. Several years ago Jenny spent several weeks in the Isle of Man interviewing fishermen to understand why they chose to fish in different scallop grounds and what modified the decision to fish (e.g. weather, scallop condition, distance from port etc). Jenny linked the responses given by the fishermen to an analysis that showed that there are several different 'fishing strategies' used by fishermen on the Isle of Man fishery. More importantly Jenny was able to validate her findings by linking them to vessel monitoring data and logbook landings. What this showed is that questionnaire responses from fishermen give reliable results that reflect reality and underscores the importance and utility of seeking input from fishermen at the outset of any modelling exercise. Once the research is complete we will be able to model scenarios such what is likely to happen is the number of vessels fishing in Manx waters were to increase or decrease. In a climate change context we might be able investigate the consequences of increasing the number of rough days during the scallop season.

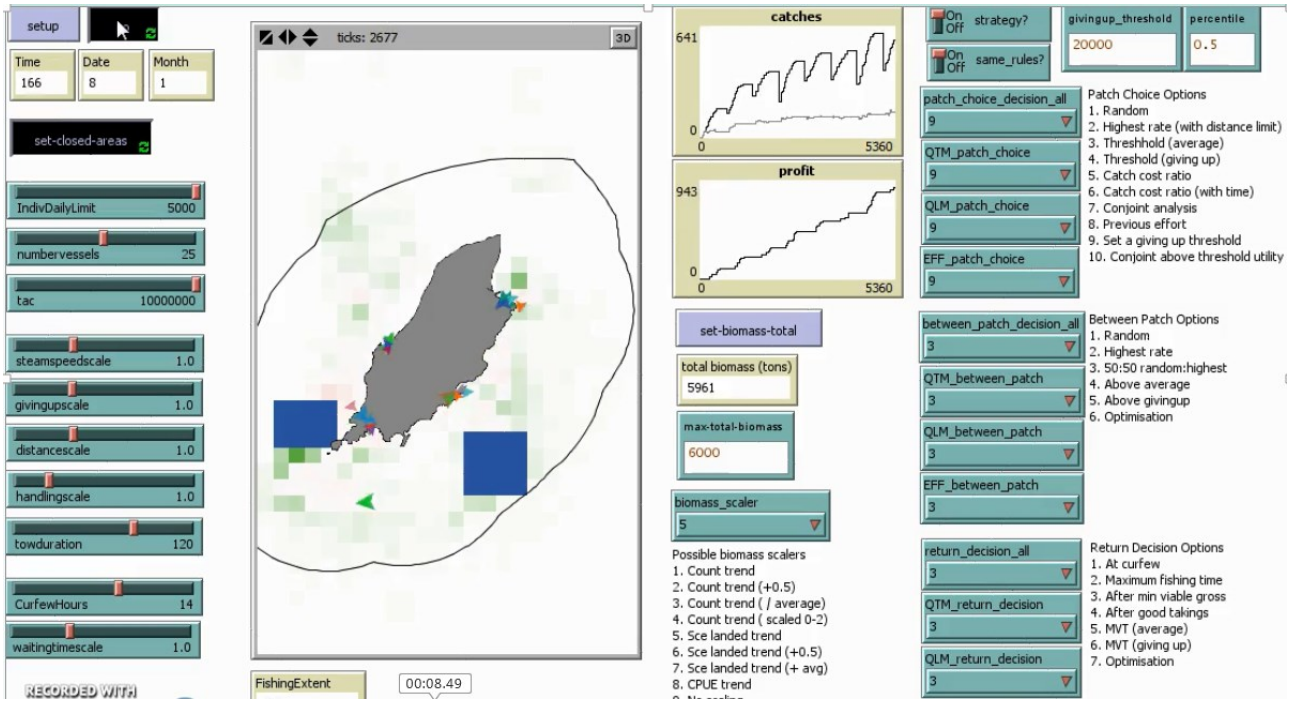


Figure 31: An example of the Individual Based Model interface developed to show predicted fishermen's behaviours under different management conditions based on behavioural rules (taken from questionnaire date). The blue boxes on the map indicate closed areas, the arrow heads represent fishing vessels and the green squares represent densities of scallops.

Protected Areas:

Little Ness Horse Mussel Reef

A survey to identify an important area of horse mussel reef within the Isle of Man territorial sea was undertaken by Bangor University and DEFA. On the 25th & 29th April 2016 the R.V. Prince Madog undertook survey work on the ground known as 'Little Ness' in the South-East of the Island. DEFA provided a 10 km^2 survey box (5 km x 1.8 km) that covered the area of interest. The vessel utilised multi-beam (Reson 7125 at 400 KHz) and side-scan sonar (CMAX CM2 at 325 KHz) technology to identify important conservation features such as horse mussel beds. For the multibeam the entire area survey box was covered with line spacing ranging from 120 – 140 m. For the side-scan sonar four equispaced lines were completed within the supplied survey box with towing occurring at an altidude of 3 – 10 m (total range coverage of 200 m) above the seabed at approximately 3 knots.

The data was filtered, cleaned and processed by staff from SEACAMS at Bangor University. In terms of the macro scale features the most notable features were two outcrops of bedrock (blue polygons) encompassing an area of 0.25 km^2 which form part of the north east ridge. The remainder of the ridge comprises two smooth banks (red polygons) and areas of raised platform structures that have dimpled texture (yellow polygons).

The data from the side scan sonar and multibeam obtained by the R.V. Prince Madog will be provided to a consultant on the Isle of Man together with a series of ground truthing images and videos obtained by the F.P.V. Barrule to enable the location of any horse mussel reef within the survey box to be identified.

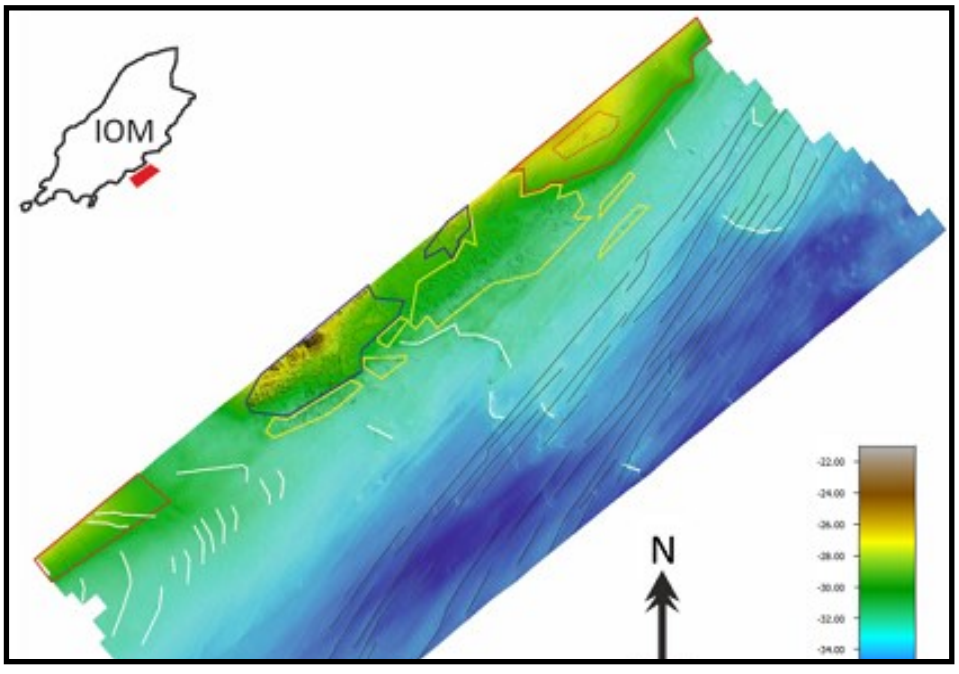


Figure 32: Little Ness: The multi beam echo sounder derived bathymetry for the site with an interpretation of the seabed sedimentary and geological features superimposed. The polygons represent different groups of features and are described in the text (Rowlands et al., 2016).

Output: To obtain a copy of the full report please email i.bloor@bangor.ac.uk : Rowlands, SJ., Walker-Springett, G., Powell, B. and Kaiser, M.J. (2016) "Bathymetric Survey of 'Little Ness' horse mussel reef and surrounding sea bed: Acquisition, Processing and Interpretation Report.

Baie ny Carrickey (BnC) Closed Area

The scientific trial within the Baie ny Carrickey closed area came to a conclusion in November and was subsequently extended for a further three years. The consequences of effort (total number of pots) restrictions, along with the increases in minimum-landing-size for both crab and lobster (135 mm and 90 mm respectively), requires a greater time-series of data to be fully understood. However, from the existing data, Bangor scientists were able to present trends in landings-per-unit-effort (shown below) that suggest the fishery is responding positively to the management measures. The full scientific report is available on the Isle of Man Fisheries sections of the Fisheries & Conservation Science Group website (report No. 65).

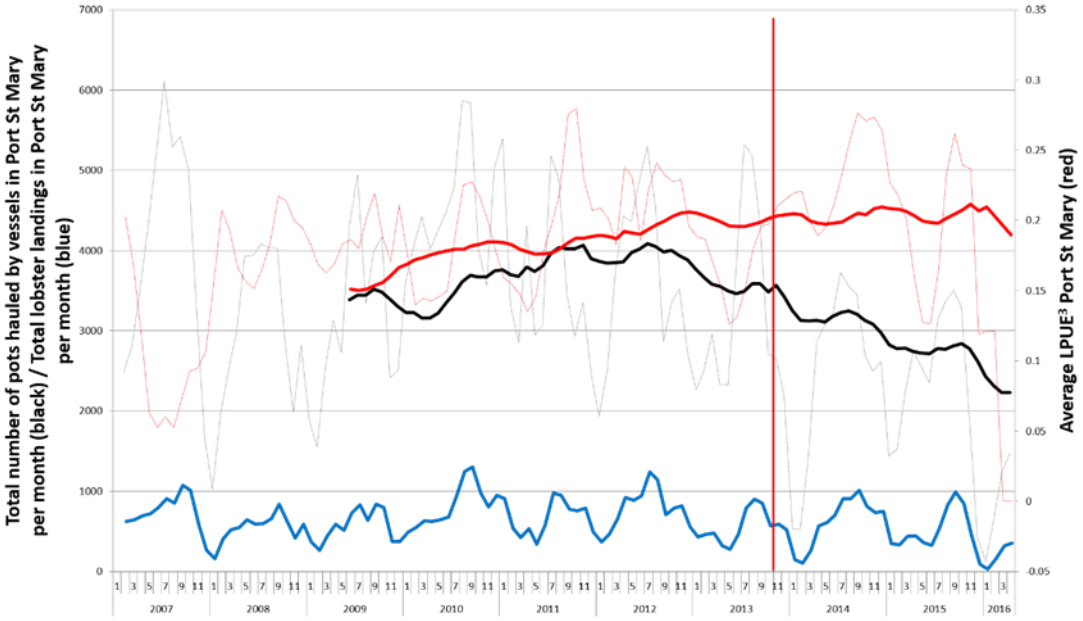


Figure 33: ***Landings (blue), effort (black) and landings-per-unit-effort (red) trends for vessels landing into Port St Mary. Data source: Monthly Shellfish Activity Logbook (DEFA).*** *2016).*

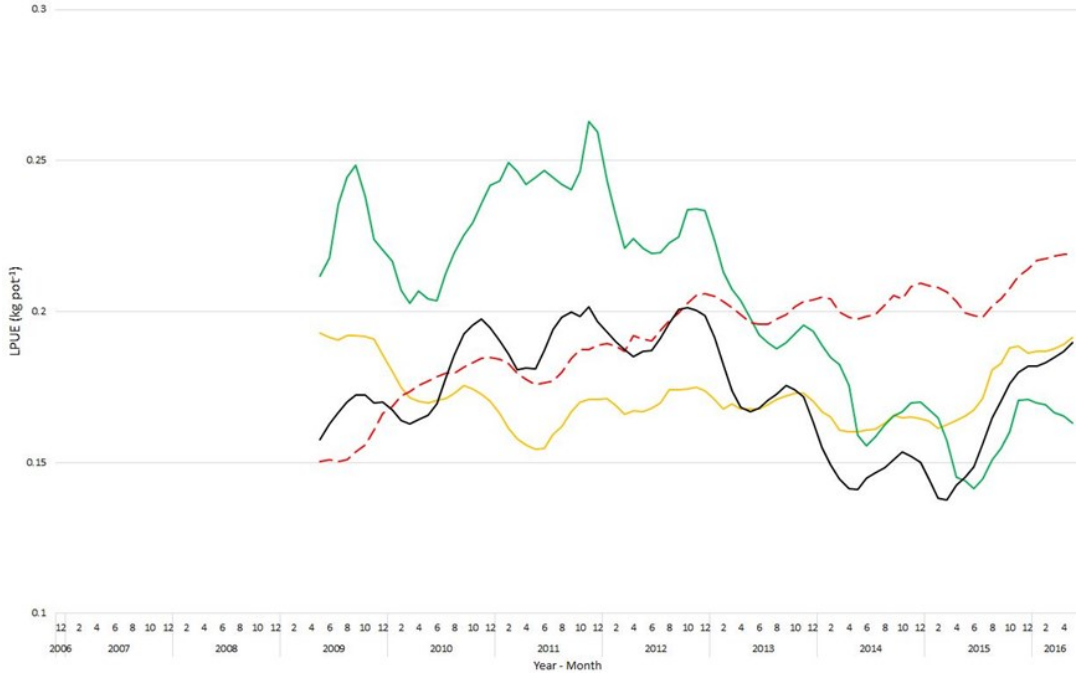


Figure 34: **Landings-per-unit-effort by port of landing (Red-dashed line represents Port St Mary / Baie ny Carrickey).**

During 2016 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.,** Haig, J.A., Robson, G., Hinz, H., Le Vay, L. and **Kaiser, M.J.** (2016). 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. DOI: 10.1017/S0025315416000722.

- **Bloor, I.S.M.** (2016). The current and changing role of physico-chemical factors and cues in the embryonic and early life stage development of the common cuttlefish (*Sepia officinalis*). Special issue, Cuttlefish Development: Biology of Early Life Stages in *Sepia officinalis.* Vie et Milieu, Volume 66 (1): 81—95.

- **Shepperson, J.,** Lambert, G., **Murray, L.G.,** Mackinson, S., Bell, E. & **Kaiser, M.J.** (2016). Use of a choice-based survey approach to characterise fishing behaviour in a scallop fishery. Environmental Modelling and Software, Volume 86 (1): 116-130.

- Haig, J.A., Bakke, S., Bell, M.C., **Bloor, I.S.M.,** Cohen, M., Coleman, M., **Dignan, S.P., Kaiser, M.J.,** Pantin, J.R., Roach, M., Salomonsen, H. and Tully, O. (2016). Reproductive traits and factors affecting the size at maturity of *Cancer pagurus* across Northern Europe. ICES Journal of Marine Science. DOI: 10.1093/icesjms/fsw081.

- Szostek, C.L., **Murray, L.G.,** Bell, E., Lambert, G. and **Kaiser, M.J.** (2017). Regional variation in bycatches associated with king scallop (*Pecten maximus*) dredge fisheries. Marine Environmental Research Vol. 123: 1—13.

- **Öndes, F**, **Kaiser, M.J.** and **Murray, L.G.** (2016). Quantification of the indirect effects of scallop dredge fisheries on a brown crab fishery. Marine Environmental Research. Vol 119: 136—143.

- **Öndes, F**, **Kaiser, M.J.**, **Murray, L.G.** and Torres, G.(2016). Reproductive Ecology, Fecundity and Elemental Composition of Eggs in Brown Crab (*Cancer pagurus*) in the Isle of Man. Journal of Shellfish Research.Vol. 35(2): 539-547.

Theses:

- Radford, Z. 2016. Assessing the Isle of Man's brown crab, *Cancer pagurus*, fishery: Does heavy metal contamination have a link with shell disease syndrome? MSc Thesis, Bangor University. 94 pp.
- Bolger, E. 2016. The abundance, movement and population characteristics of common whelk, *Buccinum undatum* (L.), in an area under consideration for an offshore windfarm development in the territorial waters of the Isle of Man. MSc Thesis, Bangor University. 59 pp.
- Allison, C. 2016. Assessing Scallop, *Pecten maximus*, association with the benthic ecosystem within two Isle of Man Marine Reserves. MSc Thesis, Bangor University.
- Dempster, N. In press. Assessing Scallop, *Pecten maximus*, association with the benthic ecosystem within two Isle of Man Marine Reserves. MSc Thesis, Bangor University.

Training events:

- SeaFish Training: Basic Fire Fighting and Prevention Certificate, Whitby, 14th January 2016 (Attended by Jack Emmerson)
- SeaFish Training: Basic First Aid Certificate, Whitby, 14th January 2016 (Attended by Jack Emmerson)
- Seafarer medical certificate (ENG1): 20th January 2016 (Attended by: Jack Emmerson and Isobel Bloor)
- RNLI: Casualty Care for Lifeboat Crews Certificate, Isle of Man, 9th March 2016 (Attended by: Jack Emmerson)
- RNLI: Elementary First Aid Certificate, Isle of Man, 10th March 2016 (Attended by: Jack Emmerson)
- Royal Yachting Association: Marine Radio (Short Range Certificate, Isle of Man, 16-17th April 2016 (Attended by: Jack Emmerson and Isobel Bloor).
- RNLI: Crew Course (including basic Fire-fighting course), Poole, 30th March 2016 (Attended by Jack Emmerson)

Awards :

- Marine Conservation Society Wakefield Memorial Award (February 2016): Jack Emmerson awarded P1 Marine Foundation National Student Award for his project 'Sustainable static-gear fisheries in the Irish Sea'.
- Baie Ny Carrickey Crustacean Fisheries Management Association (June 2016): Guy Sutton awarded £1,000 from Sea-Changers to fund a project that will tag 2000 lobsters in the Baie ny Carrickey closed area to enable more effective local management measures, such as increased MLS of lobsters and population forecasting.

Public outreach :

- Baccalaureate project work with King Williams Student August 2016.
- IOM Fish News: Newsletter of Bangor University Isle of Man Fisheries, Issue 04, August 2016.

Meetings and Committees:

- International Council for Exploration of the Seas (ICES) Working Group on Scallop Stock Assessment, Aberdeen, Scotland, 3rd – 7th October 2016 (Attended by Dr. Isobel Bloor).
- International Council for Exploration of the Seas (ICES) Working Group on Crab and Lobster, Aberdeen, Scotland, 31st October – 4th November (Attended by Jack Emmerson).
- Sea Fisheries Strategy Working Group- Scientific representatives; Meetings attended:

⇒ Tuesday 27th July 2016 (19:00 – 21:00)

⇒ Wednesday 14th December 2016 (18:00 – 20:00)

- Fisheries and Marine Management sub-group- Scientific representatives; Meetings attended:

⇒ Wednesday 17th August 2016 (10:00 – 12:00)

⇒ Monday 31st October 2016 (14:30 – 16:30)

- Industry Development Subgroup - Scientific representatives; Meetings attended:

⇒ Tuesday 13th December 2016 (18:30 – 21:00)

- Queen Scallop Management Board (QMB) – Scientific Advisors; Meetings attended:

⇒ Wednesday 1st June 2016 (Kirkcudbright, Scotland)

⇒ Wednesday 1st August 2016 (Isle of Man)

⇒ Monday 26th September 2016 (Isle of Man)

- Baie ny Carrickey Management Advisory Committee – Scientific Advisors; Meetings attended:

⇒ Tuesday 23rd February 2016 (19:00 – 21:00)

⇒ Thursday 2nd June 2016 (19:00 – 21:00)

⇒ Thursday 22nd September 2016 (19:00 – 21:00)

- Scientific Steering Committee: Scallop Subgroup – Scientific Advisors; Meetings attended:

⇒ Friday 28th October 2016 (11:00 – 13:00)

- Scientific Steering Committee: Whelk Subgroup – Scientific Advisors; Meetings attended:

⇒ Monday 3rd October 2016 (17:00 – 19:00)

- Marine Stewardship Council Annual Audit (queen scallop trawl fishery)

⇒ 27th & 28th July 2016

Bangor University

Fisheries and Conservation Science Group

Phone: 0044(1624)685840
Email: i.bloor@bangor.ac.uk
j.emmerson@bangor.ac.uk
michel.kaiser@bangor.ac.uk

Website: http://fisheries-conservation.bangor.ac.uk

Facebook: https://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**

Isle of Man Staff: Bangor University

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. More 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 3 year 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, undertaking the first electronic tagging field study of the common cuttlefish (*Sepia officinalis*) in the field. 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 within the territorial sea.

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*".