PRIFYSGOL
BANGOR
UNIVERSITY

East of Douglas Experimental Research Area: Five-Year Review

I.S.M. Bloor[1], M.J. Garratt[1], M. Coleman[1], P. F. Duncan[2] & S.R. Jenkins[1]

[1]Sustainable Fisheries and Aquaculture Group, School of Ocean Sciences, Bangor University; [2]Fisheries Division, Department of Environment, Food and Agriculture, Isle of Man Government

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

Contact: i.bloor@bangor.ac.uk

January 2022

To cite this report: Bloor, I.S.M., Garratt, M.J., Coleman, M, Duncan, P.F. and Jenkins, S.R. (2022). East of Douglas Experimental Research Area: Five-Year Review. Sustainable Fisheries and Aquaculture Report (IoM), Bangor University. pp. 13.

1 | Introduction

The East of Douglas Experimental Research Area (EDG ERA) was established as an experimental closed area for three years in July 2017. The ERA encompassed a region (~ 24 km^2) agreed with industry (Figure 1) where the queen scallop (*Aequipecten opercularis*) stock had recently declined. Prior to closure, there was little sign of natural improvement in the region over the preceeding years (i.e. 0 queen scallops per $100m^2$ in 2014, 2015 and 2016; source: R.V. Prince Madog survey Station 29) (Figure 6). The purpose of the EDG ERA was to assess the recovery of a depleted queen scallop ground during a three-year closure to demersal mobile gears.

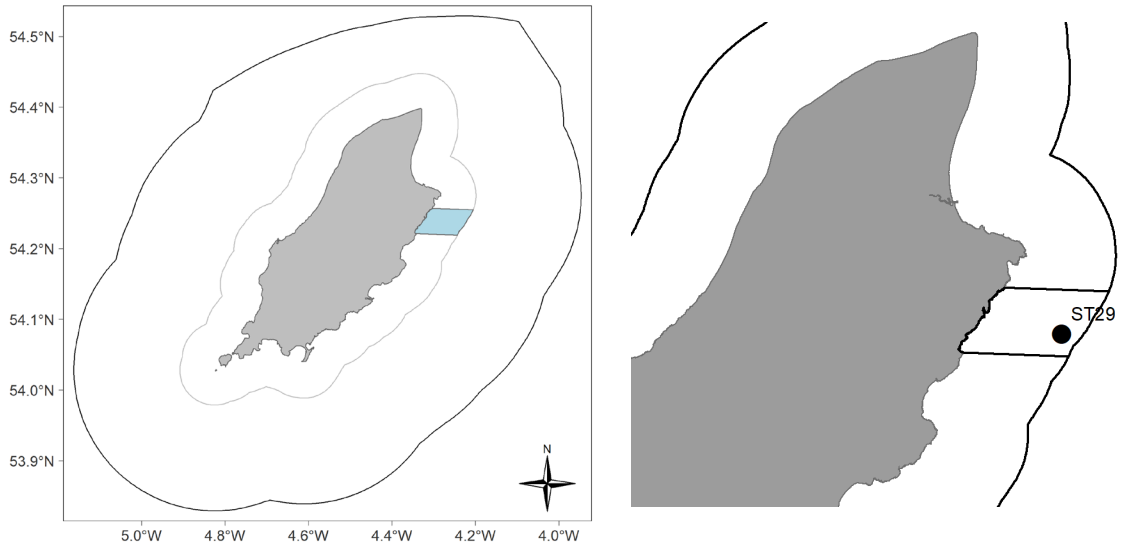

Figure 1: Location of EDG ERA (closed area highlighted in blue) on the east coast of the Isle of Man within the 0-3 nm limit (left); Location of Station 29 from the R.V. Prince Madog Survey within the EDGERA (Right).

Since 2017, the area has been monitored annually over the three years of closure during autumn (October-November) from the F.P.V. Barrule, including demersal fisheries surveys (beam trawl and dredge) and a drop-down camera habitat survey. Additionally, the annual R.V. Prince Madog dredge survey, which occurs in the spring, has sampled a station within the EDG ERA (Station 29; see Bloor & Jenkins, 2020 for further survey details).

An initial assessment of the experiment was expected after three years, but it was agreed to extend the trial further; however, due to Corona Virus restrictions and an inability to survey the area in 2020 the area remained closed. A further survey was completed in November 2021 onboard the F.P.V. Barrule, and was considered sufficient to complete the project and report on results, with a view to determination of its longer-term management.

2 | Methods

The EDG ERA survey design consisted of a grid of 80 sampling stations evenly distributed between four strata (inshore north; offshore north; inshore south and offshore south) to ensure consistent sampling across the entire ERA (Figure 2). The survey work consisted of:

- 16 random stations selected annually for beam trawling in 2017, 2018, 2019 and 2021 (4 stations in each strata)

- 8 fixed transects (A-H) (each transect running through 4 consecutive stations) were dredged in 2018, 2019 and 2021 (2 transects in each strata)
- Drop-down camera work was undertaken in 2018 and 2021 (10 stations in 2018 and 14 in 2021) to assess habitat and sediment

In addition, the GPS position of the vessel was logged every 30 seconds throughout the surveys.

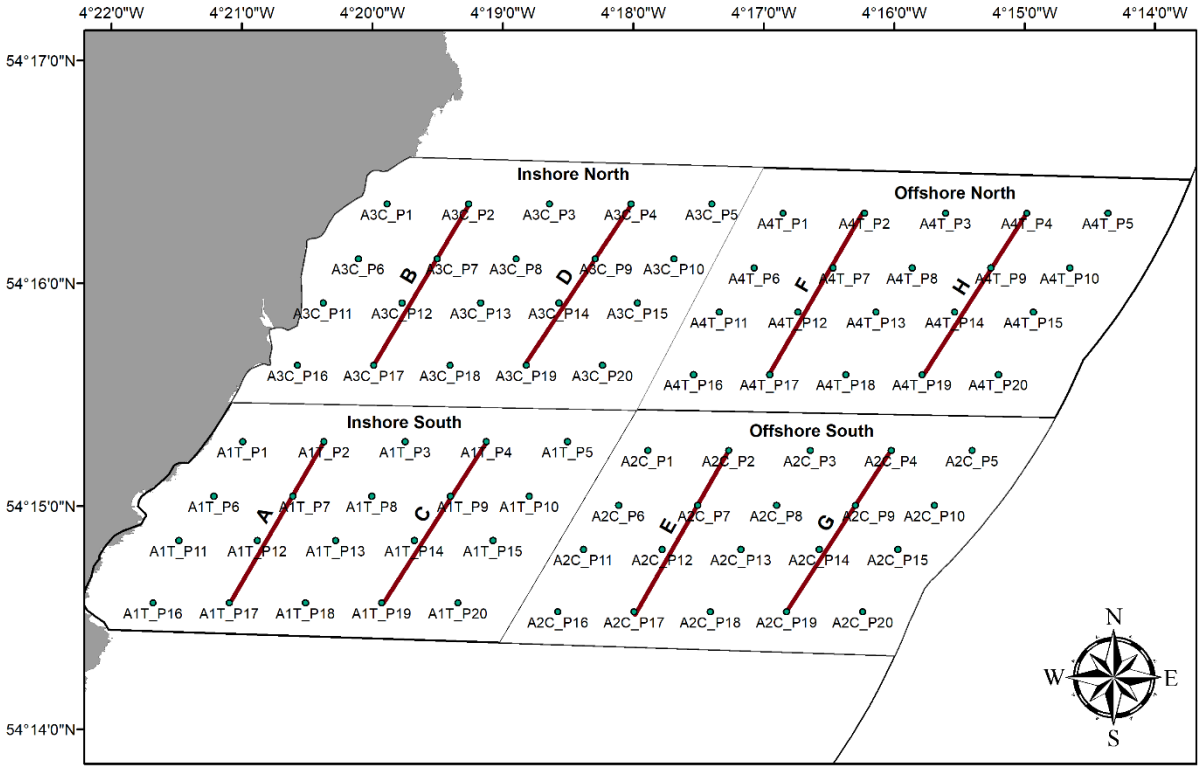

Figure 2: East of Douglas Experimental Research Area (EDG ERA) which is split into four survey strata (Inshore North, Inshore South, Offshore North and Offshore South). Sampling stations indicated by green circles (with station labels) and the eight fixed dredge transects are displayed (A-H) as red lines.

2.1 | Beam Trawl

Beam trawl surveys (2m beam) were conducted in October 2017, October 2018, November 2019 and November 2021 in order to monitor the epifaunal community in EDG ERA (queen scallops and bycatch). Each survey consisted of 16 x five-minute tows (1 – 1.5 knots) through 4 randomly-selected stations in each of the four strata. Queen scallops in each tow were counted and measured (shell height), and the remainder of the catch sorted into species and counted.

2.2 | Dredge

Dredge surveys were conducted in October 2018, November 2019 and November 2021 to sample king and queen scallops. Eight 20-minute tows (2.5 knots) were completed each year and in the same positions. Two king scallop dredges (K) and two queen scallop dredges (Q) were used in the following configuration: K, Q, Q, K. As before, queen scallops in each catch were counted and measured (shell height), and king scallops were also counted, measured (shell width), and aged using growth rings on the shells using a standard protocol.

2.3 | Drop-Down Camera

A drop-down camera habitat survey was completed in October 2018 and November 2021 in order to explore the seabed sediment and habitat type within the four survey strata of EDG ERA. Seabed substrate is an important factor in determining scallop densities (Kostylev et al., 2003; Howarth et al. 2011). Underwater lights and two GoPros collecting images (1 second^{-1}) and video footage were attached to a metal frame which was lowered by a cable to the seafloor, and the frame was moved at least three times per station. Images and footage was collected at between 10 and 14 stations sampled by the beam trawl.

2.5 | Data Analysis

Fisheries survey catch data were analysed separately by species (king and queen scallops) and by gear type (beam trawl and dredge). Temporal analysis across the five-year closure was undertaken to identify any changes/recovery in the area. Qualitative descriptive substrate categories (e.g. gravelly sand, clean sand etc.) were assigned to survey stations based on the drop-down camera stills and footage.

3 | Results

3.1 Queen Scallops

3.1.1 Size Frequency

Queen scallops were recorded in the survey from two gear types (2m beam trawl and queen scallop dredges). While the two gears showed similar trends in the size frequency of the sampled population, the 2m beam trawl sampled queen scallops more efficiently across the entire sampled size range (Figure 3) and so these data have been used for the analysis of this species within this report. In 2017 the majority of queen scallops sampled by the 2m beam trawl were under MLS indicating good recent recruitment but a lack of commercially harvestable queen scallops (i.e. ≥ 55 mm), due to poor recruitment in previous years and/or recruit over-fishing (i.e. scallops are harvested at high rates as soon as they reach 55 mm).

The progression of the queen scallop cohort recorded as under MLS in 2017 can then be seen in the 2018 and 2019 samples, with a peak in 2018 at around 45-55 mm (just under MLS) and a peak at around 55-65 mm (over MLS) in 2019. There is no survey data from 2020 as local coronavirus restrictions prevented data collection. The population sampled in 2021 shows three cohorts with peaks around 25 mm, 50 mm and 70 mm which indicates a healthier population structure with queen scallops of commercial fishable size in addition to two new recruitment cohorts under MLS, which will support the fishery in the next 2-3 years. Such recruitments typically provides a buffer for the fishery to annual recruitment variability, and would be considered a positive fisheries management outcome.

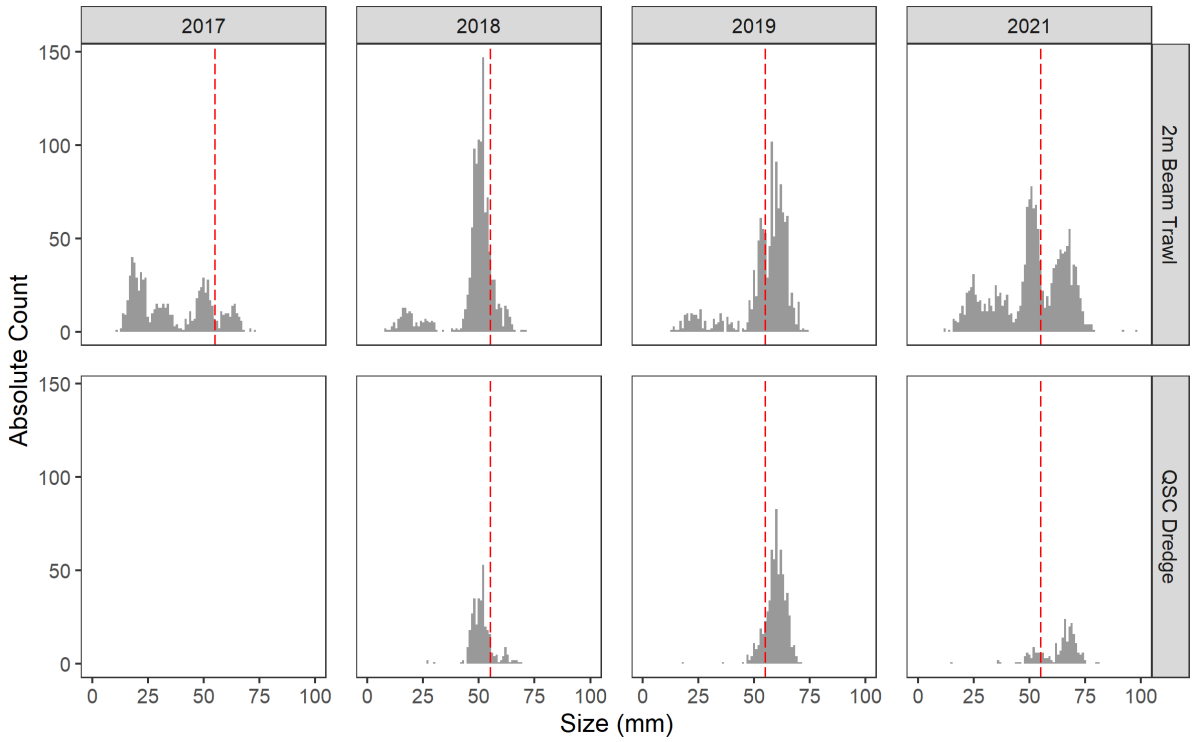

Figure 3: Queen scallops. Size-Frequency plot (by 1 mm increments) from 2m Beam Trawl (top row) and queen scallop dredges (bottom row) split by year (note: a dredge survey was not completed in 2017 and there was no survey undertaken in 2020 due to corona virus restrictions). Red dotted line indicates the minimum landing size for queen scallops within Isle of Man territorial waters (55 mm).

3.1.2 Density

There has been an increase in the mean density of queen scallop recorded within the EDG ERA over the five years of the closure with the mean density of queen scallops (any size) recorded as 9 ± 1.6 queen scallops per 100m^2 in 2017, 14 ± 2.3 in 2018, 16 ± 1.5 in 2019 and 21 ± 4.7 in 2021 (Figure 4).

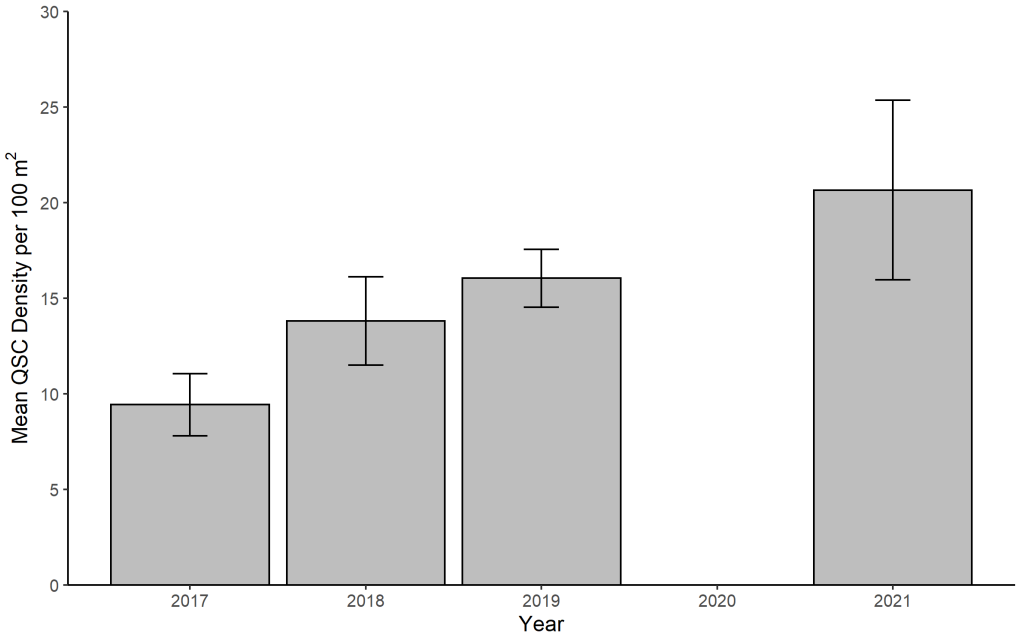

Figure 4: Queen scallop. Mean density (QSC per 100 m^2) by year from 2m beam trawl samples. Note: no survey completed in 2020 due to Corona virus restrictions. Black lines indicate the standard error for each year. Data includes queen scallops across all size ranges.

Spatial variance in queen scallop density across the area is high within years. The 2021 survey recorded the highest station densities of queen scallops over the total survey period (2017 – 2021) at up to 60 queen scallops per 100m^2. For 2021 densities for the whole EDG ERA ranged from 0 – 60 queen scallops per 100m^2, with the highest densities occuring in the Offshore North (NE) and Inshore South (SW) strata of the closure specifically (Figure 5).

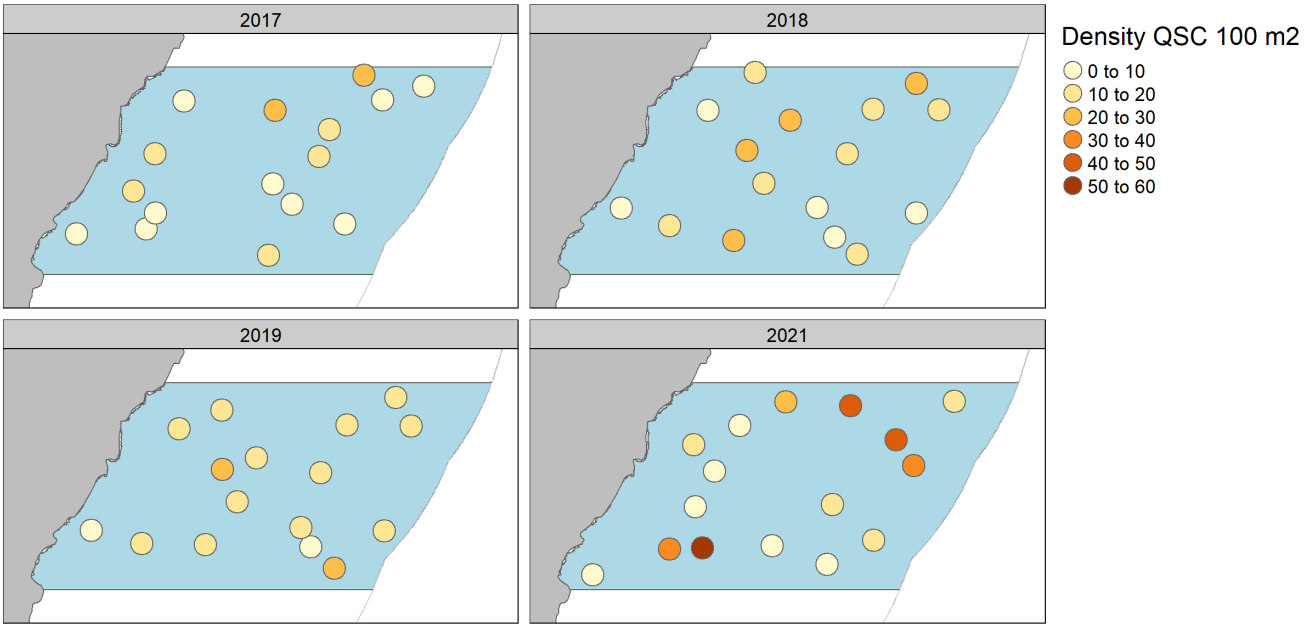

Figure 5: Queen scallop. Spatial variance of density (QSC per 100 m^2) from 2m beam trawl samples displayed by survey station and by year. Note: no survey completed in 2020 due to Corona virus restrictions. Data includes queen scallops across all size ranges. Blue polygon represents the extent of the EDG ERA closed area.

In addition to the data collected as part of a targeted survey in the EDG ERA, the annual scallop stock survey, undertaken by the R.V. Prince Madog has a station within the ERA (Station 29) which has been monitored annually since 2012 and has also indicated annual increases in queen scallop densities since the closure in 2017 (Figure 6).

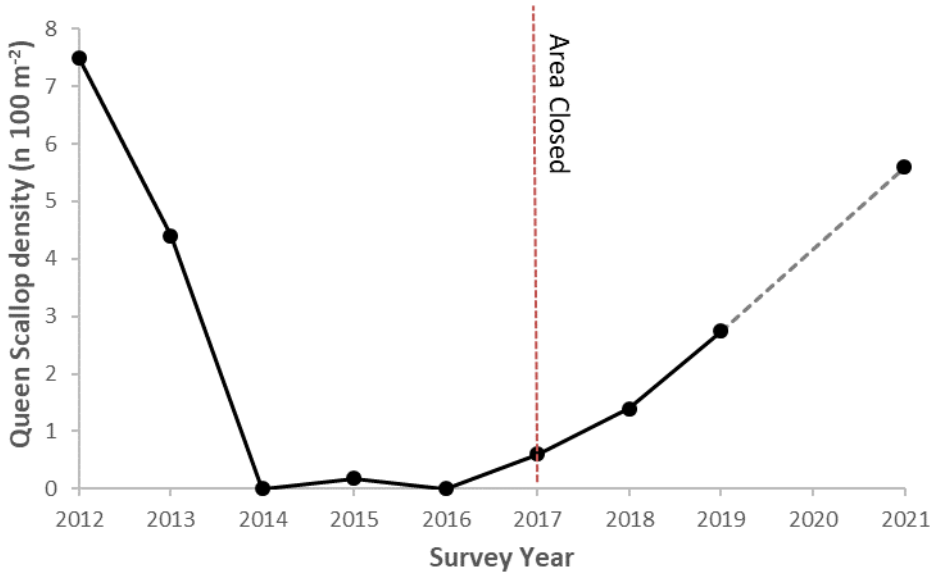

Figure 6: Queen scallop. Mean density (QSC per 100m^2) in EDG ERA from dredge surveys (queen scallops from queen scallop dredges) Source: Prince Madog stock assessment Station 29.

3.2 King Scallops

3.2.1 Size Frequency

King scallops have been recorded in the survey from two dredge types (king and queen scallop dredges). King scallop dredges are reflective of commercial catch (i.e. targeting scallops ≥ 110 mm) whilst queen scallop dredges are also used to better sample pre-recruit catch (i.e. scallops ≤ 110 mm). In 2018, although the majority of king scallops sampled were over MLS (Figure 7) there is also a peak of scallops under MLS (~ 80-100 mm). In 2019 the size distribution of scallops was relatively even across 80-150 mm whilst in 2021 the spread was skewed towards scallops ≥ 110 mm.

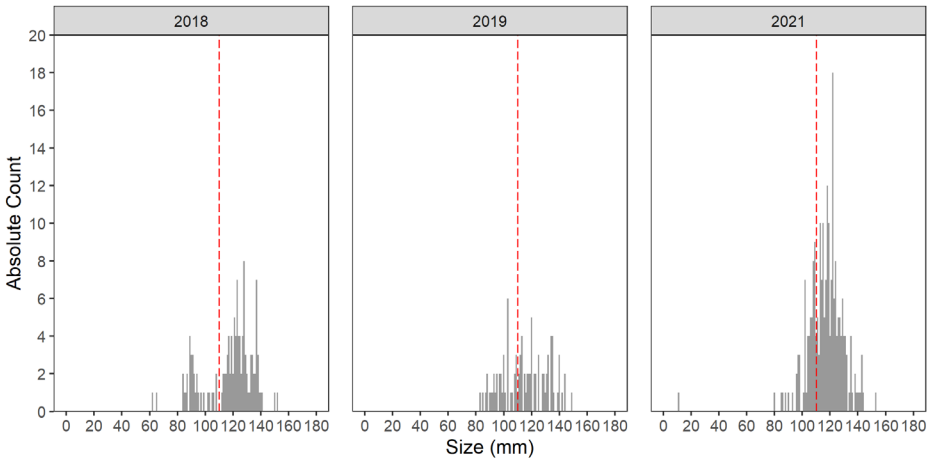

Figure 7: King scallop. Size-Frequency plot (by 1 mm) from king and queen scallop dredges combined and split by year (note: dredge survey was not completed in 2017 and there was no survey undertaken in 2020 due to corona virus restrictions). Red dotted line indicates the minimum landing size for king scallops within Isle of Man territorial waters (110 mm).

3.2.2 Density

There has been an increase in the mean density of king scallops recorded within the EDG ERA over the five years of closure with the mean density recorded as 0.31 ± 0.07 king scallops per 100m^2 in 2018, 0.25 ± 0.06 in 2019 and 1.08 ± 0.25 in 2021.

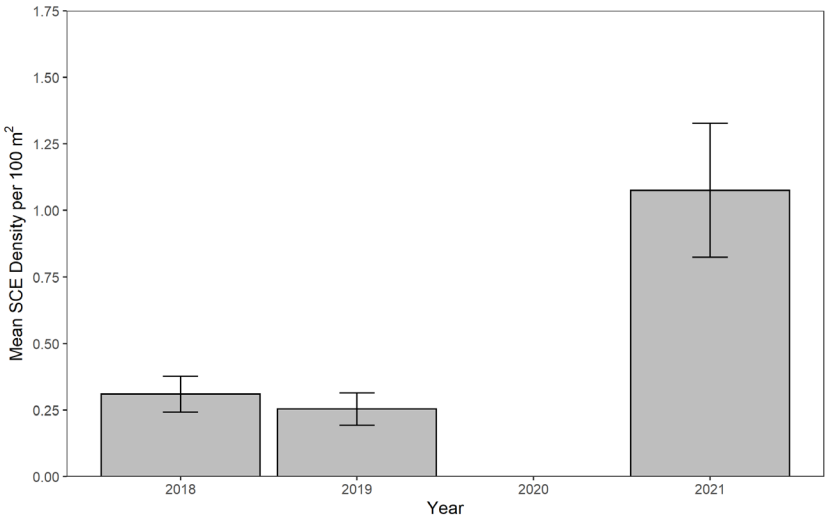

Figure 8: King scallop. Mean density (SCE per 100 m^2) by year from king scallop dredge samples. Note: no dredge survey completed in 2017 and no survey completed at all in 2020 due to Corona virus restrictions. Black lines indicate the standard error for each year. Data includes king scallops across all size ranges.

Spatial variance in king scallop density across the area is high within years and the 2021 survey recorded high densities of king scallops within the Inshore North and Inshore South strata of the closure specifically, with values for the whole EDG ERA ranging from 0 – 2.5 king scallops per 100m^2 in 2021.

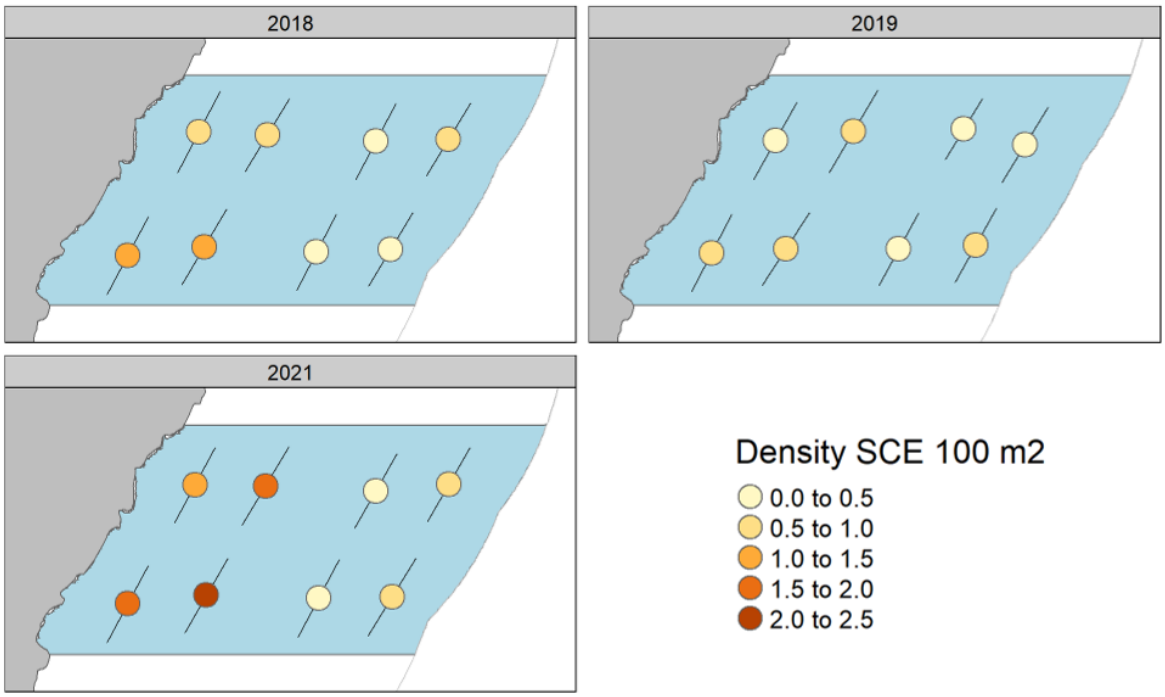

Figure 9: King scallop. Spatial variance of density (SCE per 100 m^2) from king scallop dredge samples displayed by survey station and by year. Note: The dredge survey was added to the survey methodology for the first time in 2018 and no survey was undertaken in 2020 due to Corona virus restrictions. Data includes king scallops across all size ranges. Blue polygon represents the extent of the EDG ERA closed area. The black lines indicate full dredge tow and the circles represent the midpoint (displaying the density of scallops per tow).

3.3 Bycatch

Bycatch community composition varied between years with increases in Species Richness from 2017 – 2019 followed by a slight drop in 2021 (Figure 10).

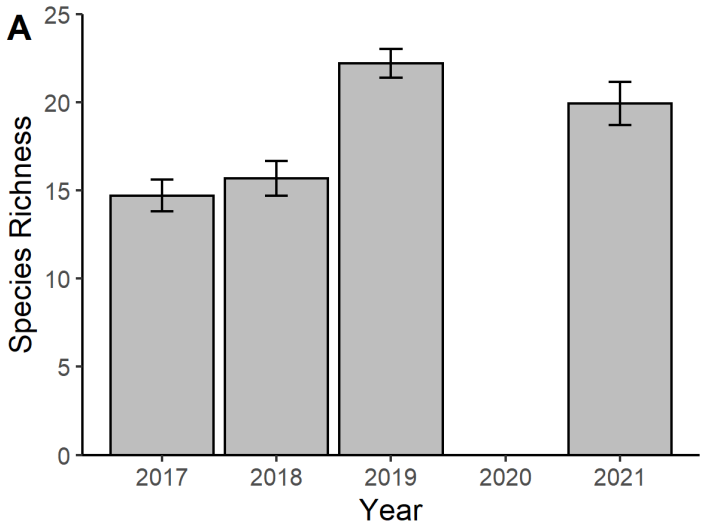

Figure 10: Mean Bycatch Species Richness (i.e. number of unique species) from 2m beam trawl.

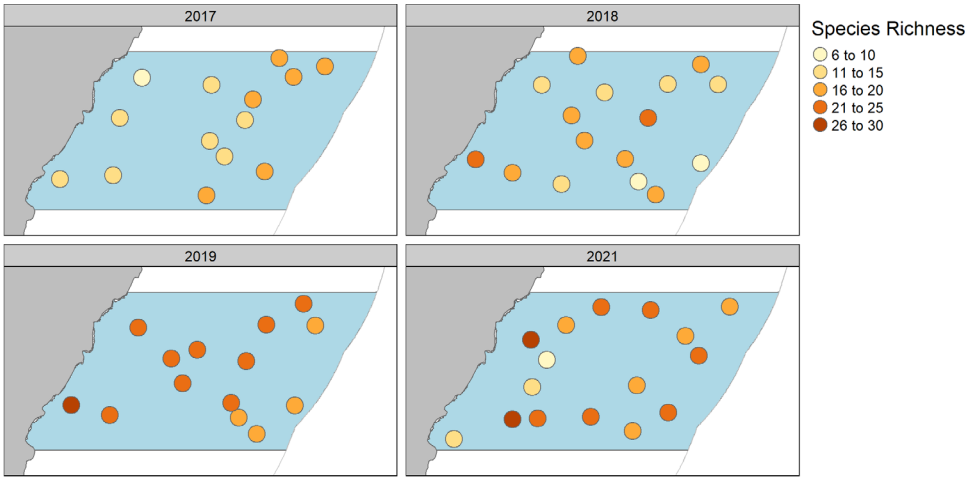

Figure 11: Bycatch. Spatial variance of species richness (i.e. number of different species) from 2m beam trawl samples displayed by survey station and by year. Note: no survey completed in 2020 due to Corona virus restrictions. Blue polygon represents the extent of the EDG ERA closed area. The circles represent the midpoint of each tow (displaying the number of species per tow in the legend).

Table 1: Ten most common bycatch species in EDG ERA from beam trawl surveys in October 2017, October 2018, November 2019 and November 2021. Note: no survey completed in 2020 due to Corona virus restrictions.

Species
Common brittle star (*Ophiothrix fragilis*)
Green sea urchin (*Psammechinus miliaris*)
Serpent star (*Ophiura ophiura*)
Cloaked hermit crab (*Pagurus prideaux*)
Serpent's table brittle star (*Ophiura albida*)
Hermit crab (*Pagurus bernhardus*)
Common starfish (*Asterias rubens*)
Black brittle star (*Ophiocomina nigra*)
Common dragonet (*Callionymus lyra*)
Dead man's fingers (*Alcyonium digitatum*)

3.4 | Drop-Down Camera (Substrate Type)

Three broad substrate types were classified from the 2018 drop-down camera footage: gravelly-sand, mixed-sand and clean-sand (Appendix A). Stations classed as gravelly-sand contained the highest mean density of queen scallops (Figure 12) and king scallops.

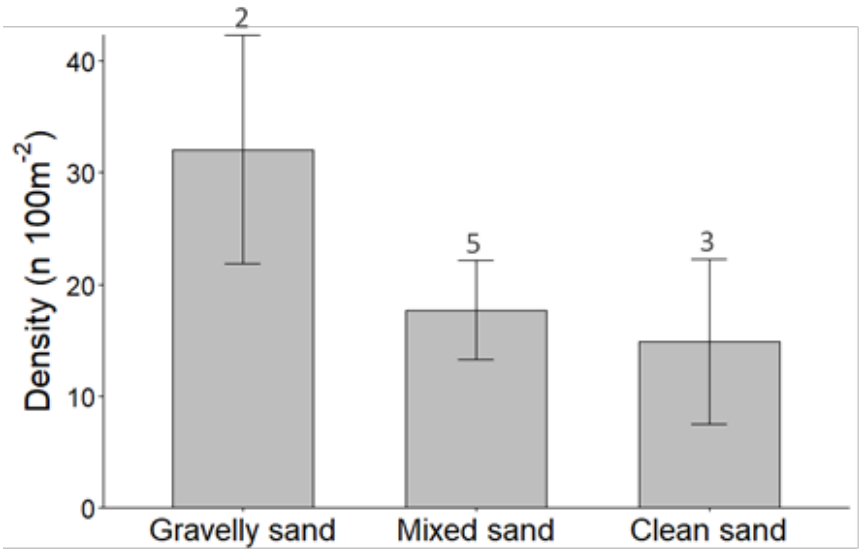

Figure 12: Substrate:Scallop Associations. Mean (± S.E.) density of queen scallops by sediment type, calculated using 2018 beam trawl data for corresponding survey stations. Number of stations in each category noted above error bars.

4 | Conclusion and recommendations

There have been improvements in both king and queen scallop density across the EDG ERA from 2017 – 2021, assumed to be as a result of restricted fishing, benthic recovery and natural recruitment processes. Within the EDG ERA there were large spatial variations between individual catches (reflected in large standard error bars on plots of mean scallop densities) with discrete patches of high densities. This is typically a common observation in scallop surveys throughout the territorial sea, and elsewhere. The highest densities at individual sites occurred in 2021. Drop-down camera surveys of the habitat/sediment within the EDG ERA indicate that there are three broad substrate types on survey stations: gravelly sand, mixed sand and clean sand (Appendix A). Spatial variability in scallop densities can be partially related to variation in seabed substrate with queen and king scallop densities in the EDG ERA both typically higher in areas of gravelly sand (substrate data collected in 2018 and 2021). Currently we only have habitat information for 23 stations (36%) within the EDG ERA; and so further drop-down camera work should be completed to provide a complete record of the distribution of substrate types in the area, and enable further analysis

The EDG ERA has now been closed for five years and will be reviewed by the Isle of Man Scallop Management Board during 2022.

The key points and recommendations from this report are as follows:

- The area was initially closed as an experimental trial area for three years to monitor recovery of a depleted queen scallop ground. The area has remained closed for five years due to coronavirus restrictions and the inability to survey the ground in 2020.
- Natural recovery of the area has been demonstrated for queen scallops, in terms of densities, from both the RV. Prince Madog dredge data (Figure 6) and from the EDG ERA 2m beam trawl data (Figure 4) between 2017 and 2021. As is typical for queen scallops, densities vary in terms of spatial distribution across the EDG ERA and may be related to sediment composition, with the highest densities occurring in 2021 and at sampled stations known to be gravelly sand rather than clean sand. The size structure of the queen scallop population has also improved

during the closure with the 2021 population structure indicating a more even distribution (spread) from pre-recruits through to recruits and post-recruits (Figure 3).

- Natural recovery of the area has also been demonstrated for king scallops, in terms of densities, from the EDG ERA dredge data between 2018 and 2021. As with queen scallops, this is also typical for king scallops, with densities varying in terms of spatial distribution across the EDG ERA and may be related to sediment composition, with the highest densities occurring in 2021 and at sampled stations known to be gravelly-sand rather than clean-sand.
- This ERA has demonstrated that natural recovery of queen, and king scallops, by closure of a ground to fishing effort for a period of 3-5 years is possible; consistent with other trials within the territorial sea, and could be used as a template for other depleted areas around the Island.
- The ERA could be reopened to fishing as the area has fulfilled its primary purpose of monitoring natural recovery of queen scallop stocks. However, given the patchy spatial nature of king and queen scallop densities within the area it is unlikely to support high-fishing pressure or landings. As such, and consistent with the strategic planning and sustainability objectives of Manx fisheries, this area should initially be managed as a restricted input/and/or output control area so as to ensure fishing effort and harvesting rates remain within precautionary limits. In this way, both long-term stock-improvement and economic benefits of the trial may be realised.
- The ERA now supports multiple cohorts of queen scallops. Fishing pressure should additionally be managed to prevent high mortality of undersized individuals in order that this ground can continue to support sustainable levels of fishing in future seasons. This includes limits on fishing pressure that might negatively impact the seabed and/or benthic structures that support ongoing successful recruitment of scallops.
- Although not the primary objective of this study, the closure has provided interesting and useful data on post-fishing recovery of biodiversity, pre-and post-closure baseline data, which may be used in the management of the island's marine protected areas.
- The 2021 camera survey also provided an opportunity to assess a recently-discovered eel grass (*Zostera marina*) bed in the furthest western part of the EDG ERA. The presence of this protected species, with significance for fisheries and biodiversity enhancement and blue carbon value, should be considered within the future management plan for the area, noting that its scallop-harvest value is minimal.

5 | References

Bloor, I.S.M and Jenkins, S.R. (2021). Isle of Man Queen Scallop 2021 Stock Survey Report. Bangor University, Sustainable Fisheries and Aquaculture Group, Fisheries Report. Pg39.

Howarth, L. M., Wood, H. L., Turner, A. P., & Beukers-Stewart, B. D. (2011). Complex habitat boosts scallop recruitment in a fully protected marine reserve. *Marine Biology*, *158*(8), 1767-1780.

Kostylev, V. E., Courtney, R. C., Robert, G., & Todd, B. J. (2003). Stock evaluation of giant scallop (*Placopecten magellanicus*) using high-resolution acoustics for seabed mapping. *Fisheries Research*, *60*(2-3), 479-492.

6 | Appendix A

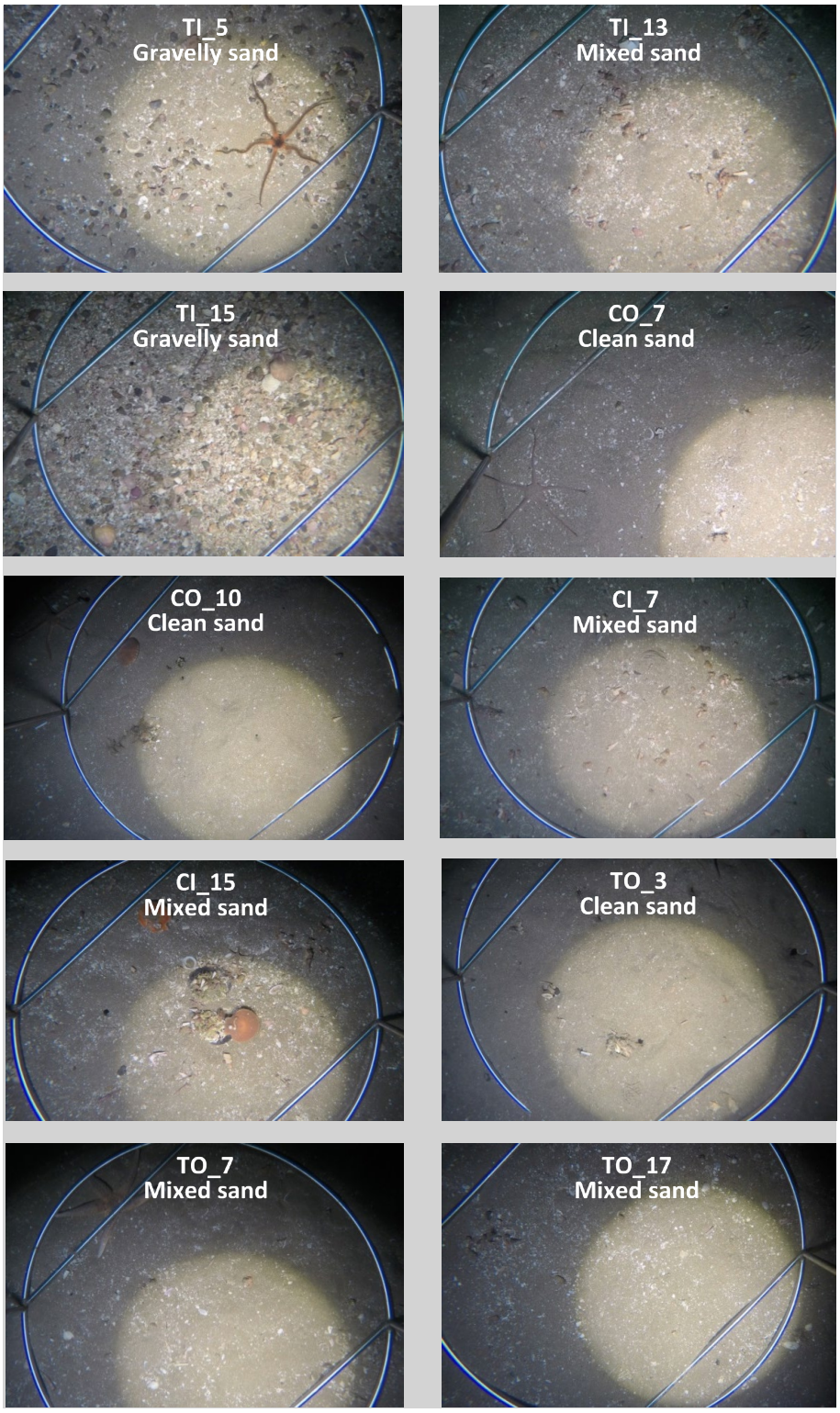

Figure 13: Sediment types qualitatively classified at the 10 survey stations that were sampled during the drop-down camera survey in October 2018.