Isle of Man Queen Scallop 2024 Stock Survey Report

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May 2024

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Fisheries Report

Please cite as: Bloor, I.S.M, Coleman, M.T., Jenkins, S.R. (2024). Isle of Man Queen Scallop 2024 Stock Survey Report. Bangor University Sustainable Fisheries and Aquaculture Group, Fisheries Report, 38 pages.

Version Control: Final (Printed on 08/08/2025)

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1. Fishery Management:

Since 1969, fishing for queen scallops (*Aequipecten opercularis*) has occurred within the territorial waters of the Isle of Man. In 2023, 35 vessels were licenced to fish for queen scallops in Isle of Man waters. In Isle of Man waters, Manx vessels now fish exclusively for queen scallops using otter trawls. UK vessels also primarily employ this method, though a small number are permitted to use toothless dredges during October. In 2023, two UK vessels were licensed for the dredge fishery; however, as neither intended to participate, the dredge fishery remained closed for the season. Various management measures regulate the queen scallop fishery within Isle of Man territorial waters with those applicable during the 2023 queen scallop fishing season indicated in Table 1. Spatial management measures are indicated in Figure 1.

Table 1: Management measures for the Isle of Man queen scallop dredge fishery during the 2023 fishing season

Management measure	Applicable
Total allowable catch of 1142 t	Trawl
Total allowable catch of 58.3 t	Dredge
Weekly Catch Limit (WCL) 5460 kg per vessel	Trawl; General Territorial Sea; Weeks 1-7
Additional Exploratory WCL 2100 kg per vessel	Trawl; Point of Ayre;, W 1-7
Weekly Catch Limit (WCL) 7098 kg per vessel (30% ↑)	Trawl; General Territorial Sea; Weeks 8-18
Additional Exploratory WCL 2730 kg per vessel (30% ↑)	Trawl; Point of Ayre;, Weeks 8 - 18
Queenie conservation zone (dredging prohibited)	0 to 12 nm zone except dredge box
Temporary closed areas	TAR x3 and EDG ERA
Permanent closed areas (i.e. MNRs)	Within 0 to 3 nm zone
Minimum landing size (55 mm)	0 to 12 nm zone
Spawning protection closure (01/04 – 31/05)	0 to 12 nm zone
Irish Sea Closure (01/04 to 30/06)	Irish Sea
Daily Curfew (18:00 to 06:00)	0 to 12 nm zone
Weekend ban (fishing prohibited Saturday and Sunday)	0 to 12 nm zone
VMS required for all vessels	0 to 12 nm zone
Submission of EU logbook	0 to 12 nm zone
Submission of IoM daily catch return	0 to 12 nm zone
Under 221 kW (except Grandfather Rights)	0 to 12 nm zone
≤ 15.24 m vessel registered length	0 to 3 nm zone

The Fisheries Act 2012 and restrictive licencing conditions enable the implementation of these management measures.

Outside of the territorial sea, although a minimum landing size of 40 mm is enforced, the fishery is subject to very few additional management measures except a statutory 3-month closure (April, May and June) for ICES areas VIa and VIIa which came into effect in 2018 following two years of industry voluntary closures.

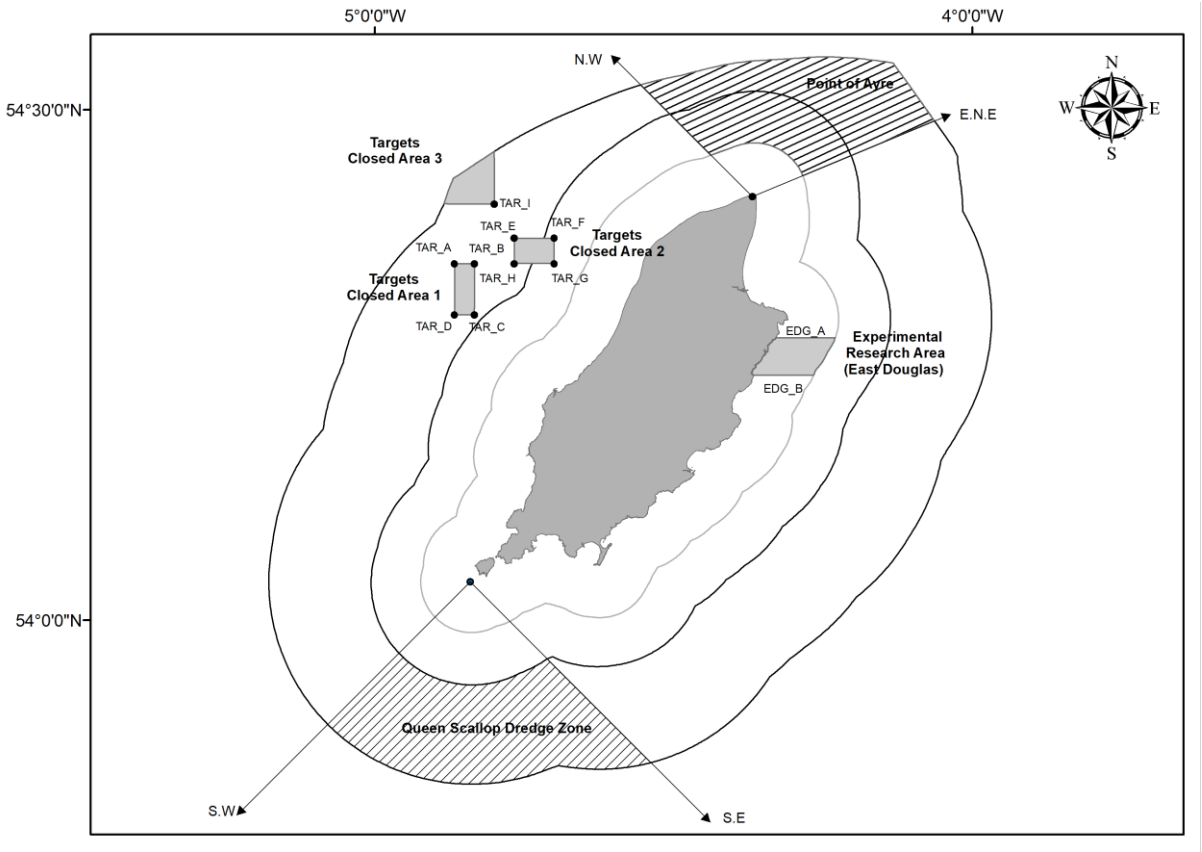

Figure 1: Map showing closed areas (grey boxes) and restricted/management areas (hashed boxes) for the 2023 queen scallop fishing season

2. Annual Landings and Fishing Effort:

2.1 Irish Sea

Annual landings of queen scallops from the Irish Sea (Area VIIa) over the period 1950 – 2020 (data lag of around 4 years) are shown in Figure 2 (ICES 2023a,b). In the early part of the Irish Sea fishery (1950 – 1973), boats from the Isle of Man recorded the majority of catch (> 75%), but between 1997 and 2020 the average annual Manx share declined to around 21%, with United Kingdom vessels (Scotland, England, Wales and Northern Ireland) landing the remaining proportion (~79%).

Landings over the last 15 years have shown high variation with a rapid increase from 2008 to a peak of over 20,000 t in 2011 (Figure 2). These unprecedented levels were maintained briefly before declining rapidly. Given the general lack of management of the wider Irish Sea stock and our limited knowledge of the impact of such high fishing rates such a significant increase in landings was of concern. Reported landings in 2020 for queen scallops from the Irish Sea were over 85% lower than landings recorded at the peak in 2011.

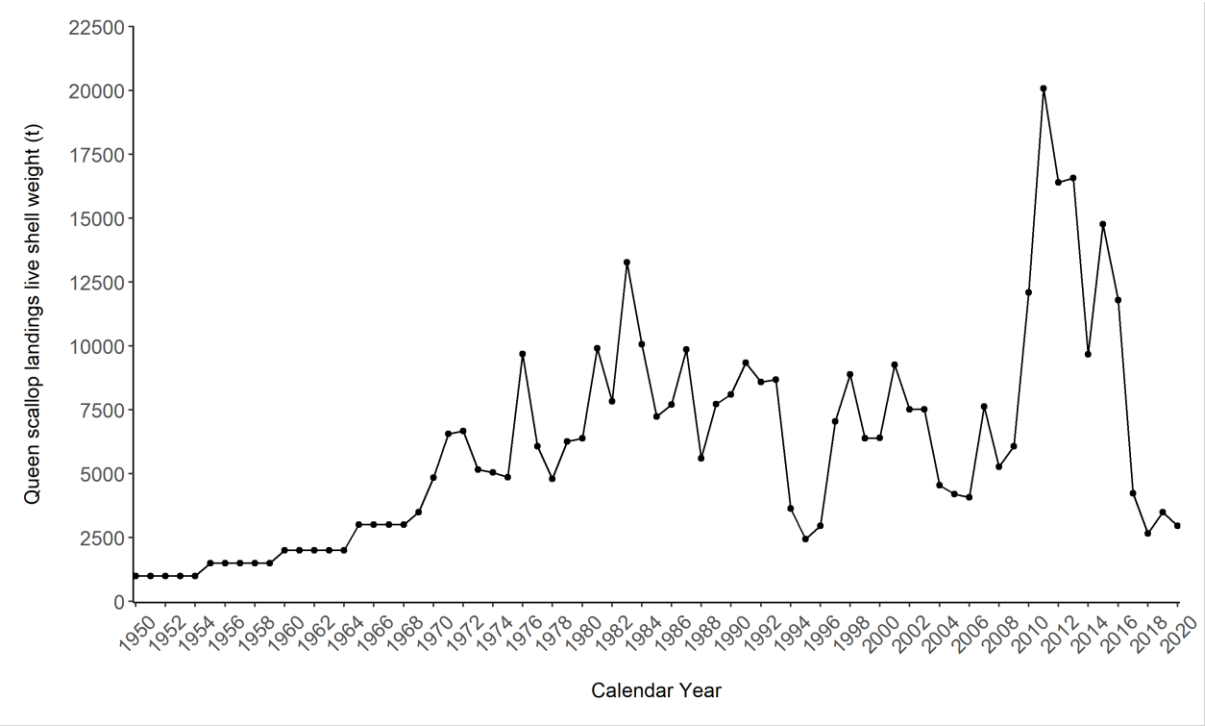

Figure 2: Annual live shell weight queen scallop landings (tonnes) from ICES Area VIIa for 1950 to 2020 using scallop landings from species Aequipecten opercularis (ICES 2023a,b).

2.2 ICES Rectangles 36E5, 37E5 and 38E5

The annual landings of queen scallops from ICES Rectangles 36E5, 37E5 and 38E5, which cover the main extent of the Isle of Man's territorial waters, show a similar pattern of landings to those from the wider Irish Sea (Area VIIa) over the period 2000 – 2020 (Figure 3). Landings increased rapidly from 2009 to 2011 tripling over that period from 5015 t in 2009 to 16957 t in 2011. This was followed by a large decline; in 2020 landings reached a low of only 920 t (Figure 3) which represented only 6% of the landings at the 2011 peak. In recent years, there has been a slight recovery (1872 t in 2021, 2365 t in 2022 and 3541 in 2023).

Landings by both dredge and trawl have declined dramatically since 2011 (Figure 4). The dredge fishery has seen a reduction in landings from a peak of 12570 t in 2011 to only 293 t in 2020 before increasing again to 2945 t by 2023. The trawl fishery has seen a reduction in landings from a peak of 4517 t in 2013 to 579 t in 2019 before increasing to 1056 t by 2022. In 2020 (Covid lockdown year) the trawl fishery had a higher proportion of landings than the dredge fishery for the first time in the time series, with almost 50 % of landings contributed by either gear in 2021. However, in 2023 dredge landings are again higher than trawl landings. Dredge landings in recent years (2022 and 2023) include additional landings of queen scallops as bycatch in the king scallop dredge fishery within the 12nm (5% of trip weight in 2022/2023 and 10% of trip weight in 2023/2024) (Figure 4).

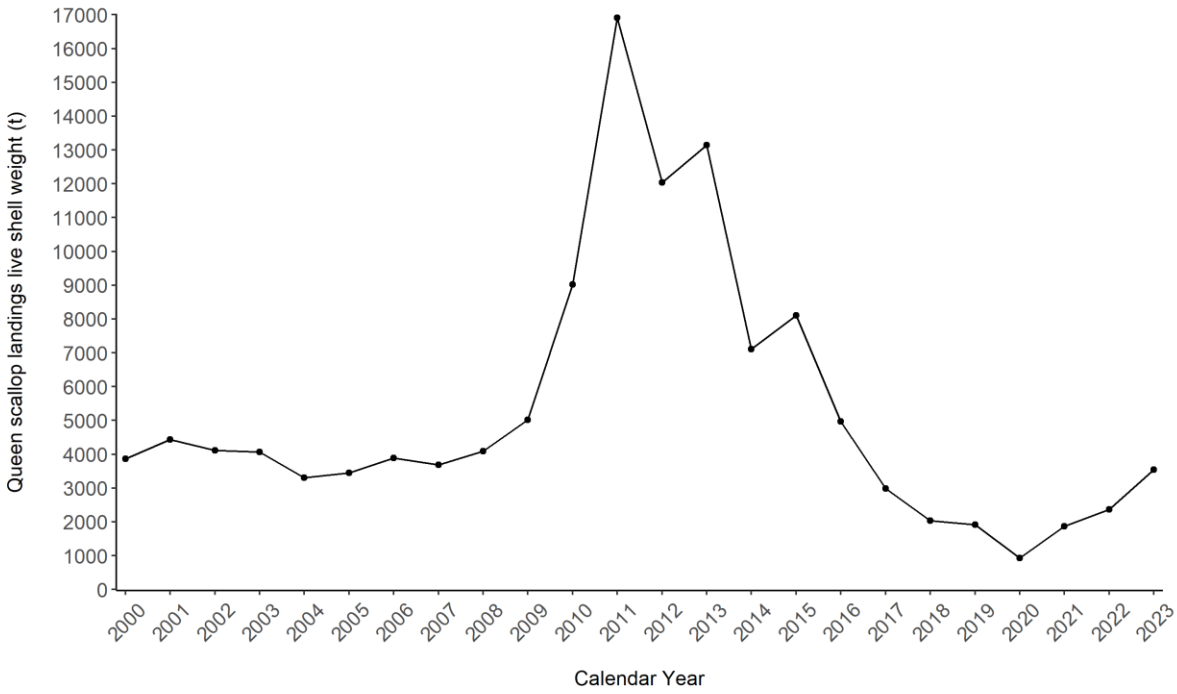

Figure 3: Annual live shell weight queen scallop landings (tonnes) from ICES Rectangles 36E5, 37E5 and 38E5 for 2000 to 2023 (Source: Paper logbook data DEFA and IFISH 2 Database).

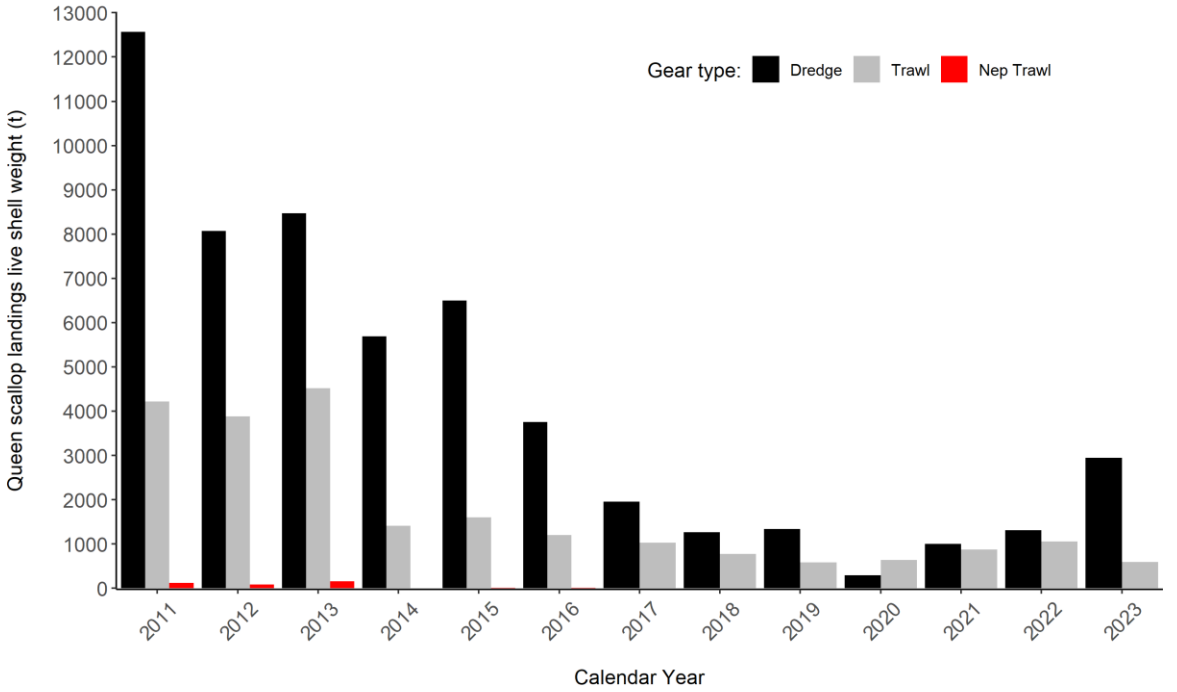

Figure 4: Annual live shell weight queen scallop landings (tonnes) from ICES Rectangles 36E5, 37E5 and 38E5 for 2011 to 2022 (Source: IFISH 2 Database) split by Gear type. Since the 2022/2023 fishing season for Isle of Man king scallops bycatch of queen scallops has been permitted (5% in 2022/2023 and 10% in 2023/2024).

3. Landings and Fishing Effort in Isle of Man waters:

A requirement of the queen scallop fishing licence In the Isle of Man is that Daily Catch Return forms (DCRs) are submitted through an electronic App by midnight on the day of fishing. This provides almost

real-time fisheries dependent data for the fishery for monitoring total allowable catches (TACs) and catch rates (i.e. landings per unit effort [LPUE]).

The 2023 Isle of Man queen scallop trawl fishery, for which 33 vessels were licenced, had a starting TAC of 1142 t (20% increase from 2022 harvest value). The trawl fishery opened on Monday 3rd July 2023 and closed on 31st October 2023. An initial weekly catch limit (WCL) of 5460 kg per vessel per week was implemented for the general territorial sea with an additional initial exploratory catch at Point of Ayre of 2100 kg per week per vessel (hatched area at PoA; Figure 1). In Week 8 the WCLs were increased by 30% to 7098 kg per vessel per week for the general territorial sea and 2730 kg per vessel per week for Point of Ayre. Total reported landings for the trawl fishery during the 2023 fishing season were ~ 607.73 t with 14 unique vessels reporting landings. The majority of landings for the 2023 season came from Targets (Table 2). In 2023 0 t was landed from the Ramsey Bay permit only fishery which has its own total allowable catch and 0 t was landed from Chickens as part of the dredge fishery in October 2023.

Table 2: Landings by ground for the 2023 queen scallop fishery (trawl and dredge; 0 t landed from dredge fishery)

Area	Landings (t)
IS9: Targets	409.2
IS15: East Douglas	126.0
IS6: Point of Ayre	69.6

Weekly LPUE, standardised to 35 kg bags per hour fished per 10 fathoms of net, are displayed for each of the main fishing grounds in Figure 5. Targets (TAR) (IS 9) had the highest LPUE across the season (median weekly LPUE values of ~ 8 – 15). The mean weekly LPUE for all other grounds was typically below ≤8 bags for Point of Ayre (POA) and East Douglas (EDG) (Figure 5).

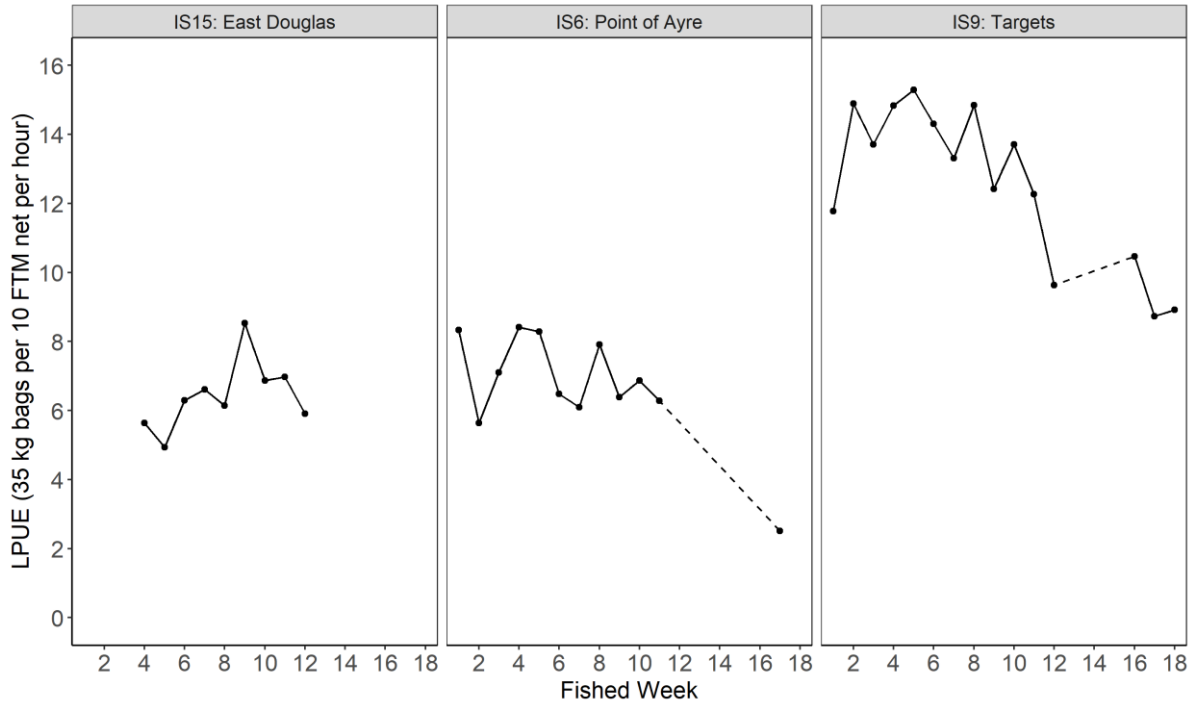

Figure 5: Mean queen scallop trawl LPUE (35 kg bags per hour fished per 10 fathom of net) for the 2023 queen scallop trawl fishing season displayed by week and main fished ground. Dashed line indicates weeks with no fishing recorded between fished weeks.

Landings per unit effort, standardised to 35 kg bags per hour fished per 10 fathoms of net, is displayed for each fishing season from 2014 to 2023 in Figure 6. The boxplot indicates that the median LPUE for the 2023 fishery was the third highest in the time series (Figure 6). Fishing within higher density restricted access areas at Chickens and Targets in 2021 and Targets in 2022 contributed significantly to increases in median LPUE in those fishing seasons (Figure 5).

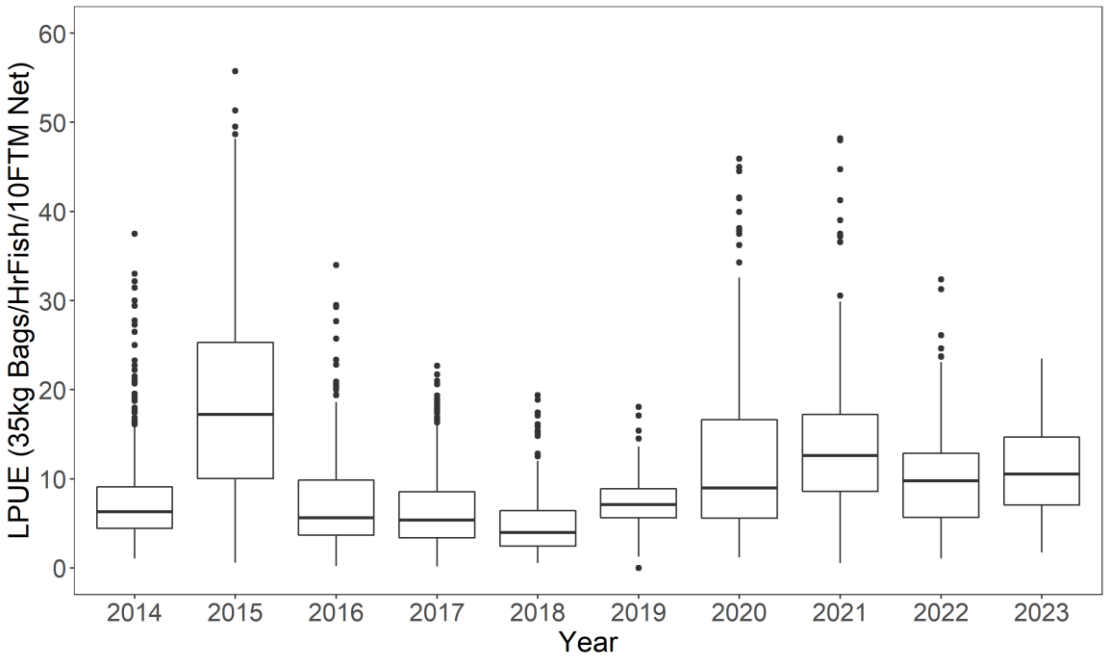

Figure 6: A boxplot of queen scallop trawl LPUE (35 kg bags per hour fished per 10 fathom of net) for all vessel trips by fishing season from 2014 to 2023.

The dredge fishery was allocated a sub TAC of ~58.3 t but as neither licenced dredge vessel expressed an interest in fishing this metier did not operate in 2023. Total reported landings for the dredge fishery during the 2023 season were 0 t with neither of the 2 licenced vessels fishing. Prior to 2021, LPUE for the dredge fishery had seen annual declines with the lowest value (based on a single trip) recorded in 2020 (Figure 7).

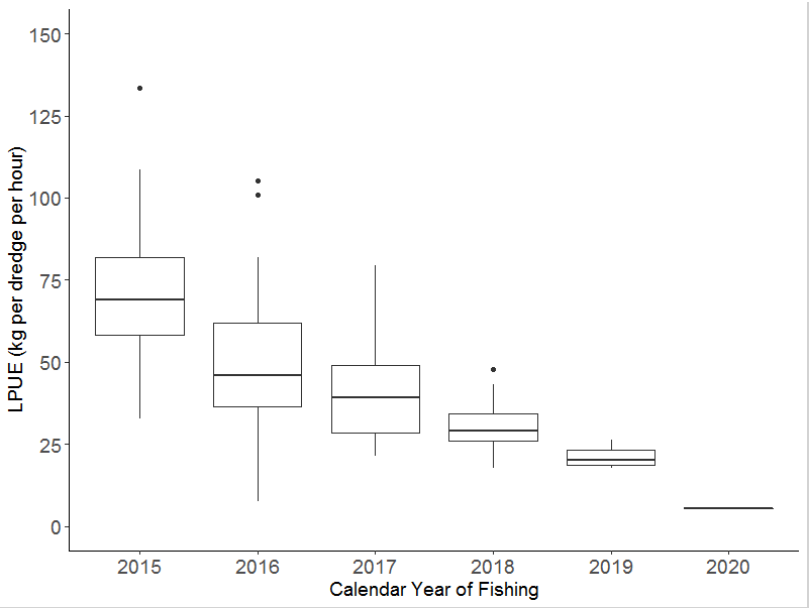

Figure 7: LPUE standardised to kg per dredge per hour for dredge vessels participating in the Isle of Man queen scallop dredge fishery which occurs within the dredge box located within the CHI fishing ground from 2015 to 2020 (note no landings reported in 2021, 2022 or 2023).

4. Scallop Surveys:

4.1 Background:

There are currently two annual scallop surveys undertaken within the Isle of Man's territorial waters:

1. **Long-term, medium resolution, fixed site survey:** This survey has been undertaken since 1992 and is currently completed on the R.V. Prince Madog. It is a medium resolution survey (~ 3nm between survey sites), conducted at fixed survey stations. There is a long-term data set associated with this survey which enables stock assessment to be undertaken along with provision of a time series for TAC calculation using the approach outlined by ICES for Category 3 data limited stocks (i.e. survey based methods approach). Unfortunately, due to the Coronavirus restrictions in place in both the IoM and the UK this survey could not be completed in April 2020 but data collection has continued since April 2021.

2. **Short-term, fine resolution, random stratified survey:** This is a new survey that was undertaken for the first time in June 2019. It is currently completed on two industry fishing vessels and sampling is coordinated by the MFPO with scientific support from Bangor University. It is a fine resolution survey (survey cells: 1 min (longitude) x 0.5 min (latitude)). The 2023 survey included the four main fishing grounds (East of Douglas [EDG], Chickens [CHI], Targets [TAR] and Point of Ayre [POA]), and further survey work was also undertaken at a transient ground at Bradda [BRA] and within the East of Douglas Experimental Research Area [EDGERA]which has been closed since July 2017.

The long-term survey data has been used annually to undertake a quantitative length-based stock assessment using the catch survey analysis (CSA) approach to estimate biomass. Following the recommendations of the scallop management board (SMB), the data has also been used to calculate the Total Allowable Catch (TAC) using the approach outlined by ICES for Category 3 data limited stocks. This approach requires a minimum time series of five years with the survey indices of the two most recent survey years summed and then divided by the sum of the survey indices from the three years prior. This ratio is then used to adjust the previous year's TAC up or down by a maximum of 20%. The

five-year time series of data is important in this calculation as stocks can be variable in any year and comparing one year against another doesn't incorporate trends in the data.

4.2 Prince Madog Annual Spring Survey:

4.2.1 Survey Methods:

Spring surveys of the Isle of Man's scallop populations have been undertaken annually since 1992 (Beukers-Stewart et al., 2003). The 2024 spring scallop survey was undertaken by the R.V. Prince Madog over 7 days from 8th – 14th April 2024 [additional survey days lost due to bad weather]. A total of 36 survey stations were sampled (Figure 8). The standard survey gear comprises of a set of four Newhaven dredges: two with 80 mm belly ring diameter and 9 teeth of 110 mm [king dredges] and two with 55 mm belly ring diameter and 10 teeth of 60 mm [queen dredges]. At each station, the dredges are towed at 2.5 knots for 20 minutes with the direction of the tow dependent on tidal state and current condition. For each tow the total biomass of king and queen scallops is recorded by dredge and a subsample of 90 queen scallops and 90 king scallops from each dredge are then weighed and measured (king scallops are also aged).

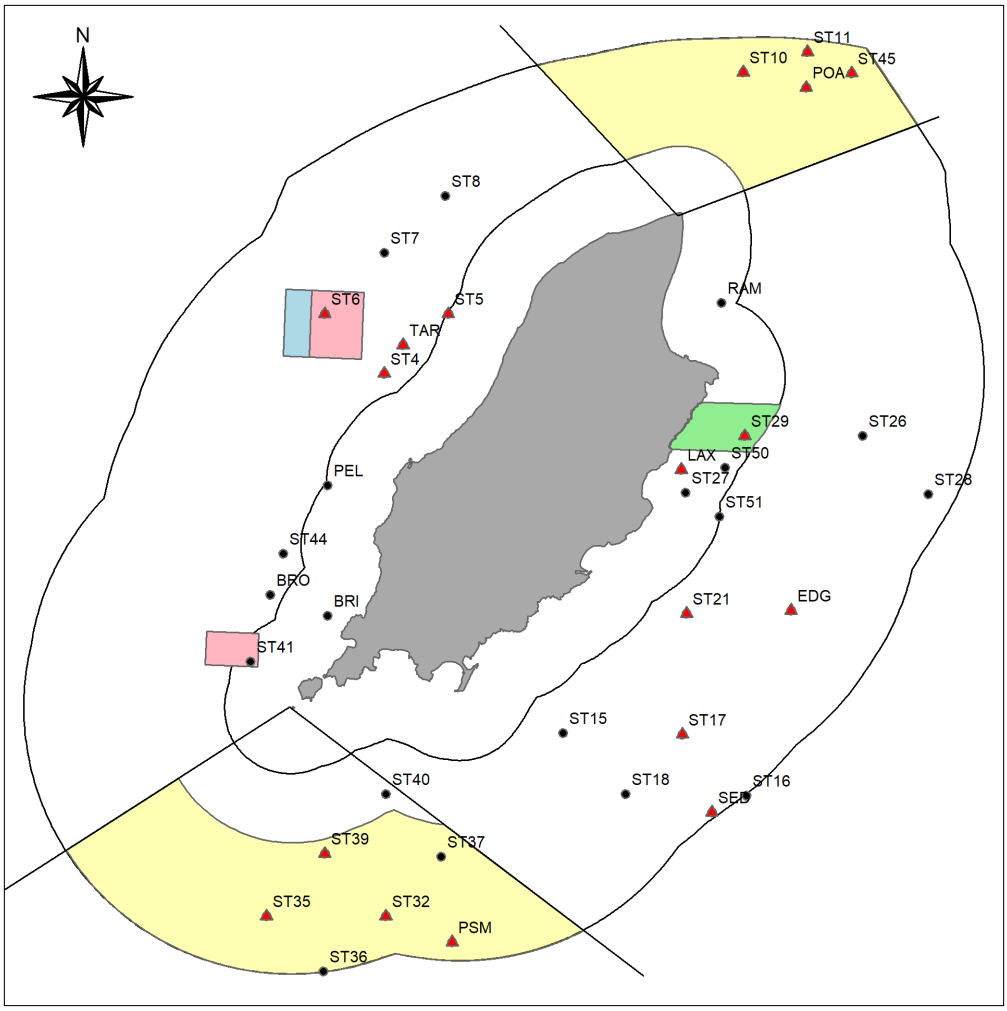

Figure 8: A map showing the location of all 2024 survey stations (red triangles = Stations used in stock assessment and survey abundance indices; black circles = Additional survey stations). During the 2023 queen scallop fishing season light pink boxes indicate areas with restricted management; light blue boxes indicate closed areas, the green box indicates the experimental research area at East Douglas closed since July 2017 to allow recovery and the yellow boxes indicate the queen scallop dredge zone in the south and the exploratory WCL zone in the north.

4.2.2 Size Frequency:

A frequency plot of queen scallop size data is presented in Figure 9 from samples measured at stock assessment stations (queen scallop dredge data only). In 2024, there is a well-defined peak in queen scallops from 52.5-62.5 mm (Figure 9). Queen scallops ≥ 55 mm represent post-recruits (i.e. queen scallops that are already at or above the minimum landing size (MLS) of 55 mm). Queen scallops ≥ 45 & < 55 mm represent recruits (i.e. queen scallops under MLS), some of which will be large enough to grow into the fishery during the upcoming fishing season. In 2024, the data also indicates a proportion of the sampled stock to be pre-recruits queen scallops (i.e. 15-45 mm), which are unlikely to grow into the fishery for the current 2024 fishing season. This cohort, and its spatial distribution, should be considered when looking at sustainable management over a > 1 year period and when discussing potential closures for areas containing high densities and proportions of queen scallop recruits.

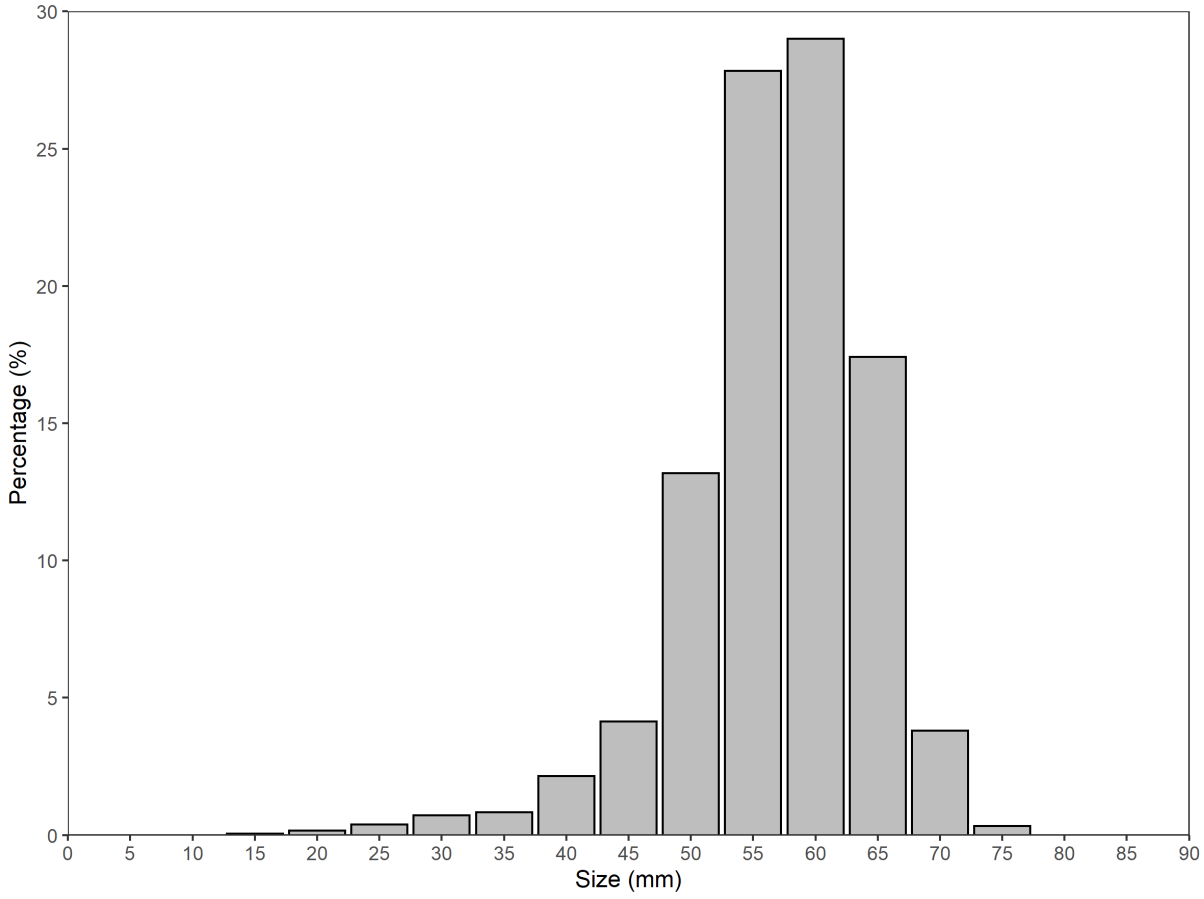

Figure 9: Queen Scallop size frequency plot for 2024 Prince Madog survey data for measured scallops. Data from stock assessment sites and queen scallop dredges only. Percentage under 55 mm = 17% (based on subsamples of n = 1814).

4.2.3 Density estimates:

The mean density (scallops per 100 m^2) of queen scallops from queen scallop dredges for all stations surveyed is displayed in Figure 10. The survey site with the highest density is POA (north coast; 92 queen scallops per 100m^2) (Figure 8).

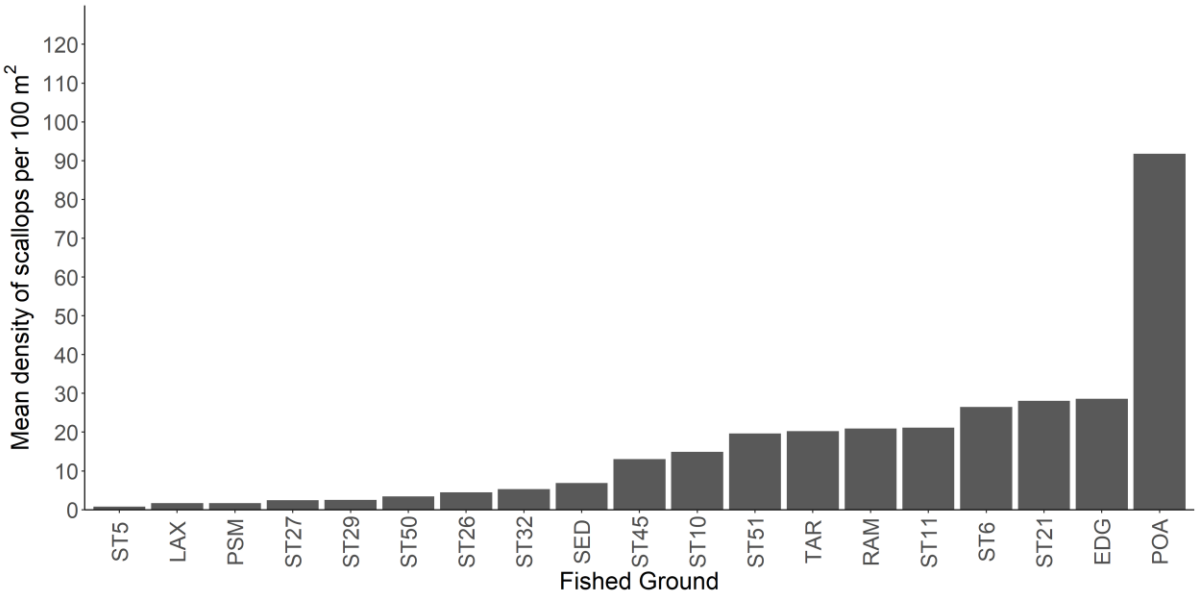

Figure 10: Average survey density (scallops per 100m^2) of queen Scallops from queen scallop dredges from all sites surveyed during the 2024 Prince Madog survey. For plotting purposes sites where QSC density was < 0.45 scallops per 100 m^2 are not displayed (see figure 9 for station locations)

Stations that have been sampled over at least three years and at which queen scallops are present (3, 4, 5, 6, 9, 10, 11, 13, 14, 17, 21, 22, 23, 24, 25, 29, 32, 35, 38, 39 and 45), in addition to the standard historical queen scallop survey stations (CHI, EDG, LAX, POA, PSM, SED and TAR), were included in the current stock assessment (Figure 8). Please note that the inclusion of stations was updated in 2022 to include or exclude relevant stations (Bloor et al., 2022). Since 2016 the model has been run at a smaller spatial scale using landings and survey data exclusive to the Isle of Man territorial sea.

The differences in mean survey density (scallops per 100 m^2) of queen scallops from queen scallop dredges between 2023 and 2024 are displayed for all stations used in the stock assessment in Figure 11. The highest density increases are on the north of the Island where densities have increased at POA by around 50 scallops per 100 m^2 respectively. The highest decreases in density were on the west and south of the Island where densities have decreased at TAR (west) by 78 and ST32 (south) by 54 scallops per 100 m^2.

Figure 11: Difference in average survey density (scallops per 100 m^2) of queen scallops from queen scallop dredges between 2023 and 2024. Red bars indicate decreases in scallop density from 2023 to 2024 and turquoise bars indicate increases in scallop density from 2023 to 2024.

4.2.4 Survey Abundance Indices:

The abundance index (derived from the survey data using the geometric mean of queen scallop densities) for recruits (scallops < 55 mm) is typically very variable but has been consistently low since 2011. The data for 2023 (132) was the highest recorded for recruits since 2009 and is above the long-term mean of 81 (Figure 12). In 2024 the recruit abundance index (45.7) has dropped again to similar low levels as seen across the low period 2011 – 2021 (Figure 12). As seen in Figure 14 POA was the only site with very high recruit densities around the island (i.e. over 10 queen scallops per 100m^2). The POA site also had a high density of post-recruits (Figure 15).

The abundance index for post-recruits (scallops ≥ 55 mm) had an increasing trend from 2007 to 2010, reaching the highest levels on record in 2010 (Figure 14). From 2012 to 2019 there has been a declining trend in post-recruit abundance (slight increase observed in 2016). The data for 2023 (285), although still below the long-term mean (~386), is the highest recorded for post-recruits since 2013 (Figure 13). The data for 2024 (204) shows a decline from 2023 but is still the 2nd highest value since 2014 (Figure 13).

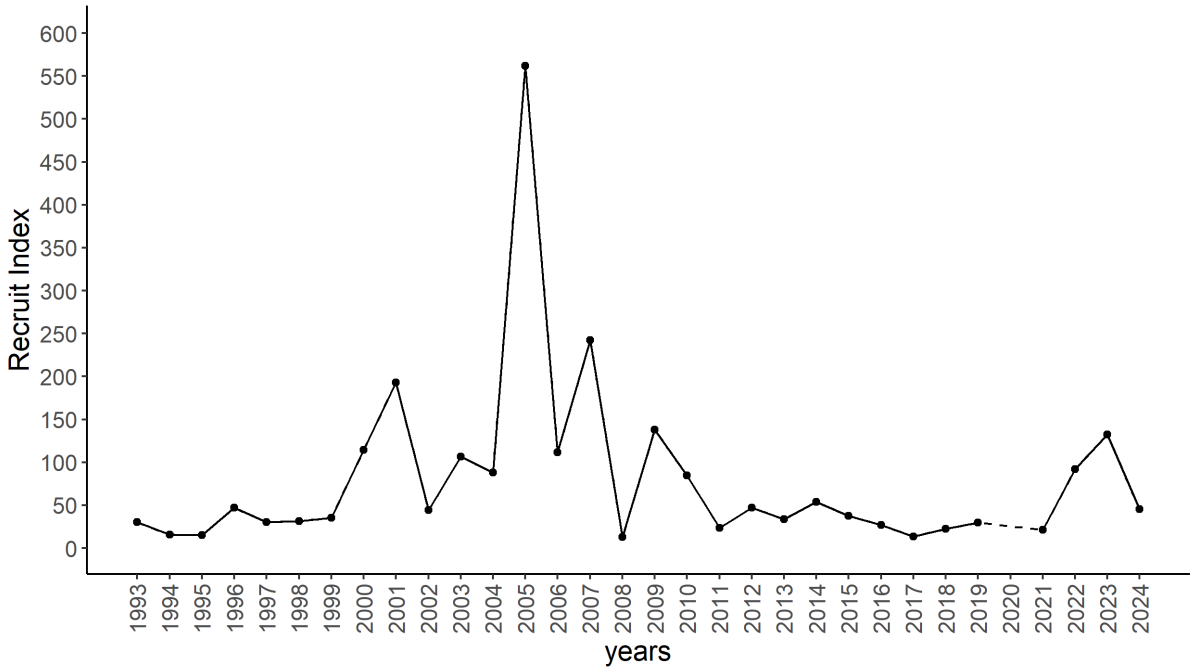

Figure 12: Abundance index (based on geometric mean) for recruits (under 55 mm) used in the catch survey analysis model. This is calculated using data from only the stations used in the stock assessment model. In order to calculate the geometric mean 0.01 was added to each site in order to account for zero data values. Dashed line represents missing values. Note that in 2005 there were only three historic sites surveyed of which one (LAX) had a very high density of recruits recorded which is driving the spike in that year.

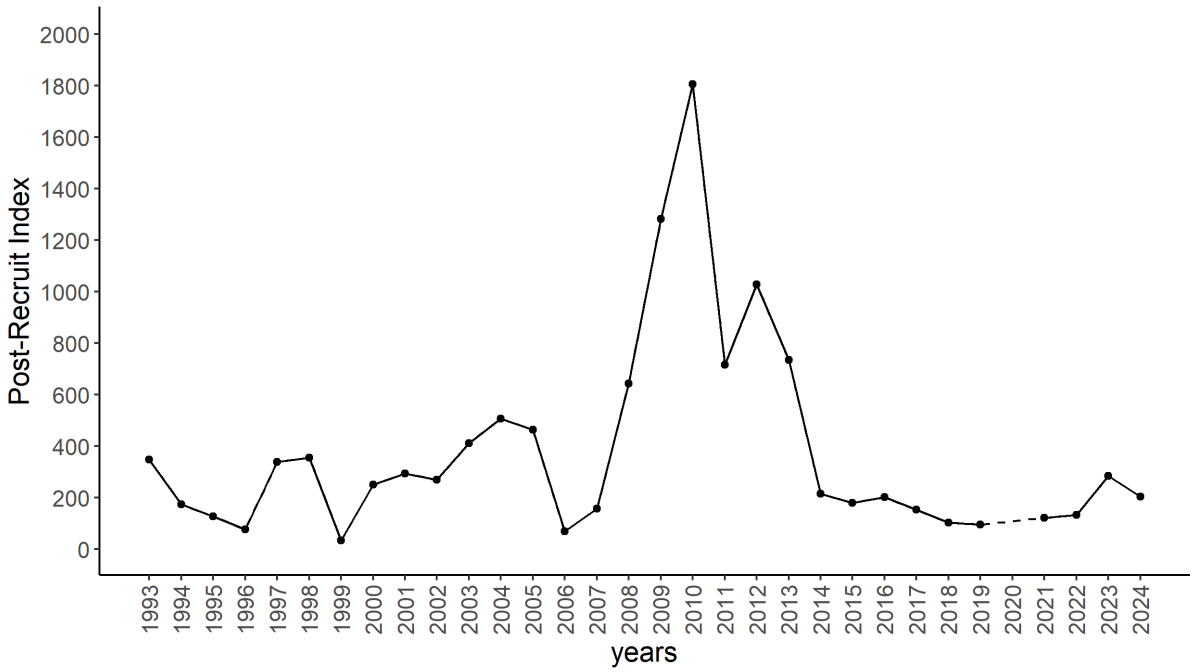

Figure 13: Abundance index (based on geometric mean) for post-recruits (over 55 mm) used in the catch survey analysis model. This is calculated using data from only the stations used in the stock assessment model. In order to calculate the geometric mean 0.01 was added to each site in order to account for zero data values. Dashed line represents missing values.

When viewed spatially and temporally by site over the time period of the survey, anomalies where exceptional densities of queen scallop recruits or post-recruits occur at a site in a given year can be identified.

The boxplots in Figure 14 indicate the typical ranges (box indicates inter-quartile range) of recruit density across years (1992 to 2024) for each site along with the median value (horizontal line). The red line indicates a density of 10 scallops per 100 m^2 that is above typical values and indicates a good recruitment event at that site within that year. The data for 2024 are plotted as blue points on the figure and indicate that the highest localised densities of queen scallops recruits are at POA on the north coast and ST6 on the west coast. It could be appropriate to consider separate management for the 2024 fishing season for the high density area at POA.

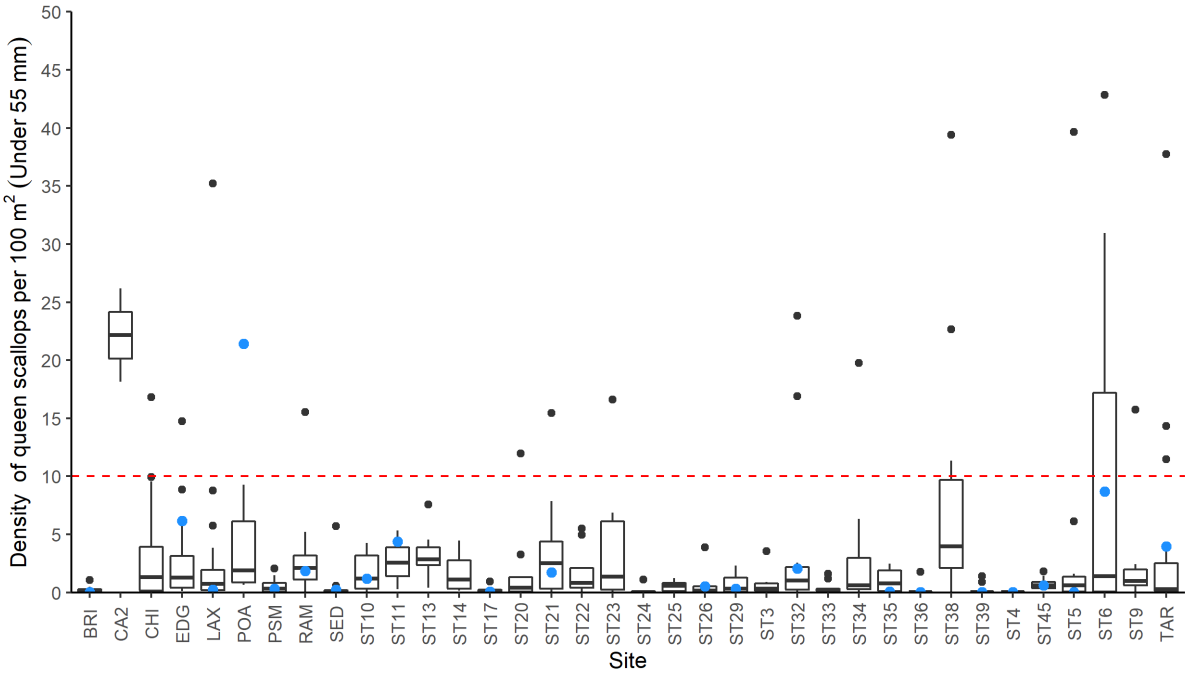

Figure 14: Boxplot of recruit (< 55 mm) queen scallop density per 100 m^2 for stations where queen scallops are typically present. Outliers over 10 (which appear as points above the red dashed line) are exceptional years of recruitment. The data includes all surveys from 1992 to 2024 and the blue points are the data from the current 2024 survey.

The boxplots in Figure 15 indicate the typical ranges (box indicates inter-quartile range) of post-recruit density across years (1992 to 2024) for each site along with the median value (horizontal line). The red line indicates a density of 50 scallops per 100 m^2, which is above typical values and indicates an exceptional density of post-recruits at that site within that year. The data for 2024 is also plotted as blue points on the figure and indicates that the highest localised densities of fishable queen scallops is at POA on the north coast. It could be appropriate to consider separate management for the 2024 fishing season for this high density areas of post-recruits, especially as this area overlaps with the highest density of recruits.

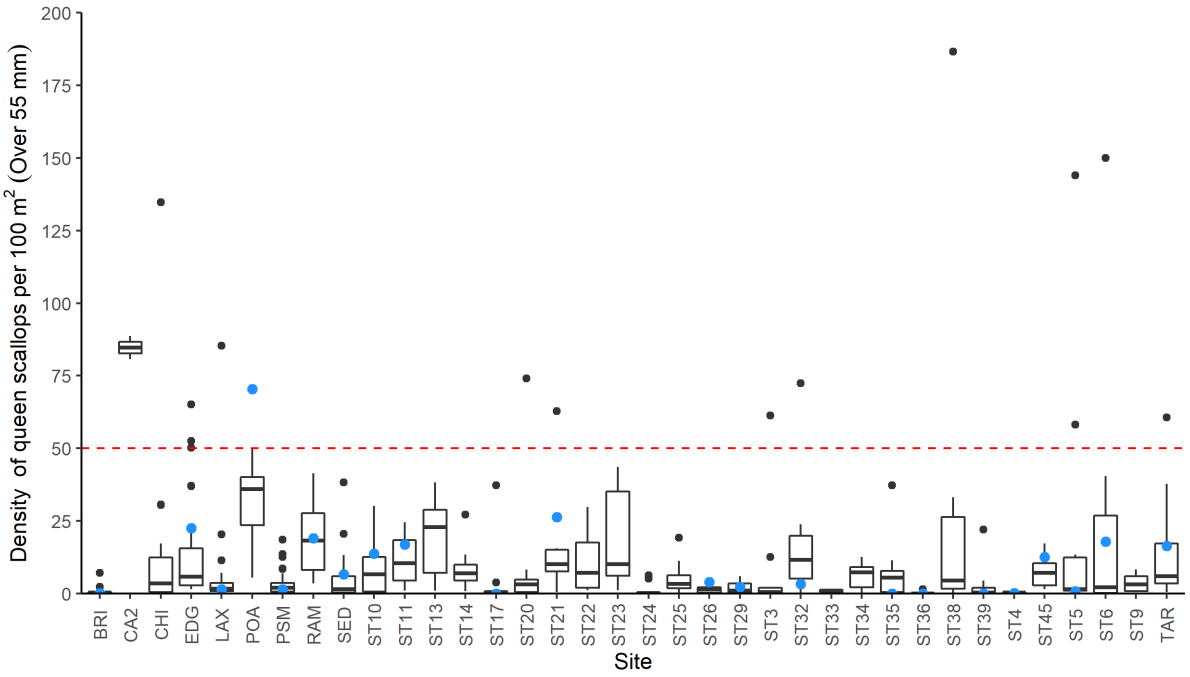

Figure 15: Boxplot of post-recruit (≥ 55 mm) queen scallop density per 100 m^2 for stations where queen scallops are typically present. Outliers over 50 (which appear as points above the red dashed line) are exceptional years of post-recruits. The data includes all surveys from 1992 to 2024 and the blue points are the data from the current 2024 survey.

4.2.5 Stock Assessment (CSA):

An annual assessment of the Isle of Man queen scallop stock has been undertaken since 2012 using the Catch-Survey Analysis (CSA) method, first developed by Collie and Sissenwine (1983). Further information on this method and the results from previous stock assessment are presented by Murray and Kaiser (2012a, 2012b), Murray (2013) and Bloor et al., (2014, 2015, 2016, 2017, 2018 and 2019). CSA has been advocated as a valuable method to support management advice where age data is not available (Mesnil, 2003). The CSA method estimates stock size using abundance indices and is generally well-suited to the data available for the Isle of Man's queen scallop fishery. Absolute estimates of stock size and fishing mortality derived from CSA are sensitive to input parameters, although trends over time are more robust to changes in these input parameters (Mesnil, 2003). The stock assessment was implemented using CSA v4.3 (NOAA, 2014). The timing of the survey in spring allows data collection before the main queen scallop fishing season and at a time of year when seawater temperatures mean dredges are a more effective means of sampling queen scallops (Jenkins *et al*., 2003).

Within the stock assessment unit (Isle of Man's territorial waters), the trend from the model output indicates that following five years of increasing biomass (2006-2010), total biomass has decreased during each of the subsequent eight years (2011–2018) before slight annual increases in each of the last 5 years (2019 – 2024) (2024: median estimated biomass of 6683 t) (Figure 17). *Note, that there is a missing year of survey data for 2020 in the input data.*

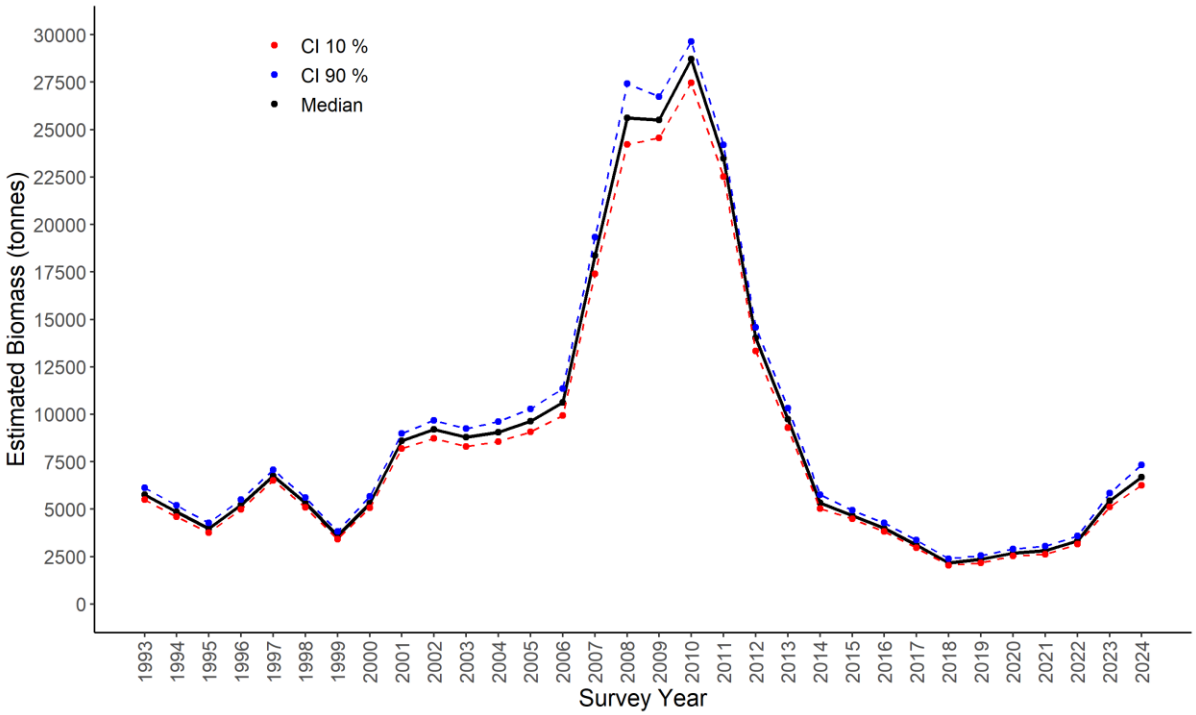

Figure 16: Estimated biomass (all scallop sizes) for the stock assessment unit (Isle of Man territorial waters) MCMC results from CSA Version 4.3.

Estimated biomass can be further subdivided into post-recruit (≥ 55 mm) and recruit (< 55 mm) biomass (Figure 17); for 2024 these values are 5721 t post-recruit and 957 t recruit. From this data, we can see that peaks in recruit biomass (i.e. 1996, 2001, 2007, 2009) are typically followed by peaks in the post-recruit biomass, with a 1-year lag (Figure 17). Following this pattern, the increase in recruit biomass in 2022 and 2023 has seen a subsequent increase in post-recruit biomass in 2023 and 2024 (Figure 17).

Figure 17: Estimated biomass for the stock assessment unit (Isle of Man territorial waters) MCMC results from CSA Version 4.3. The black line is for post-recruit (≥ 55 mm) biomass (left y-axis) and the grey line is for recruit (< 55 mm) biomass (right y-axis), please note different axes scales.

4.2.6 Trawl TAC calculation (based on the ICES Category 3 approach):

The Total Allowable Catch (TAC) advice for the Isle of Man queen scallop trawl fishery is based on the ICES Category 3 methodology for data-limited stocks (ICES 2012). This approach requires an index of abundance or biomass, typically derived from research vessel surveys, to assess recent trends in stock status. The method compares the mean survey index from the two most recent years (Index A) with the mean from the three preceding years (Index B). The ratio of Index A to Index B provides an indication of whether the TAC should be increased, decreased, or remain unchanged.

To ensure precaution in the face of uncertainty—particularly regarding how representative the survey index is of true stock status—ICES applies an "uncertainty cap" that limits annual changes in TAC to a maximum of ±20%. This helps avoid large inter-annual fluctuations in catch advice that could result from variability in survey data.

In 2020, no survey was conducted due to COVID-19 restrictions, creating a gap in the five-year time series. However, since survey data are available for both 2019 and 2021, and it is known that the industry survey index increased in 2020, the 2020 value has been estimated as the average of 2019 and 2021 for the purposes of TAC calculation.

For the 2024 season, the ICES Category 3 approach yields a recommended TAC of 726 tonnes for the queen scallop trawl fishery (**Error! Not a valid bookmark self-reference.**). This figure represents a 20% increase on 2023 landings, in line with the uncertainty cap. Although the calculated Index ratio suggests a near doubling of landings (1.99), the cap ensures that the increase remains within precautionary limits.

When interpreting this recommendation, the following points should be noted:

- The original TAC for the Isle of Man queen scallop fishery, which is adjusted each season, was not linked to biomass.

- The ICES protocol uses actual landings—rather than proposed TAC—as the basis for adjusting the following season's TAC.

Table 3: Queen scallops in Isle of Man territorial waters, TAC calculation for the trawl fishery based on ICES Category 3 approach for data limited stocks for 2024 advice (total abundance index i.e. scallops of all sizes). Average of 2021 and 2019 were used to calculate an index value for the missing survey year in 2020.

Index A (2024 & 2023)		333
Index B (2022-2020; no data for 2020)		167
Index ratio (A/B)		1.99
Uncertainty cap	Applied|	0.8
Landings from 2023 (trawl)		605 tonnes
Precautionary buffer	Not applied|	NA
Catch advice for 2024 (trawl)		726 tonnes
% advice change relative to prior season		+ 20 %

4.3 Industry Juvenile Spring Scallop Survey:

4.3.1 Survey Methods:

A survey for king and queen scallops was undertaken onboard two industry vessels (F.V. Benolas and F.V. Our Sarah Jane) from 24th May - 6th June 2024. Four main queen scallop fishing grounds, one transient bed and an Experimental Area at East Douglas (EDGERA) were surveyed (Table 4):

Table 4: Grounds surveyed during the 2024 industry scallop survey with ground type and number of survey tows detailed. EDGERA = East of Douglas Experimental Research Area (closed since July 2017). Not all tows are within queen scallop ground as king scallop grounds are surveyed at the same time.

Ground	Survey Tows	Type
Targets (TAR)	41	Permanent
Chickens (CHI)	37	Permanent
East of Douglas (EDG)	96	Permanent
Point of Ayre (POA)	10	Permanent
Bradda (BRA)	53	Transient
EDGERA	5	Closed

Survey areas were split into a fixed grid with a resolution of 1 min (longitude) x 0.5 min (latitude). Survey cells were sampled randomly within each ground strata (strata were defined predominately by depth) with approximately equal effort to ensure relatively even distribution of survey effort across the entire fished ground. Within each survey cell a 10 minute tow was undertaken at ~ 2.5 knots. Each vessel towed a 'standard survey dredge bar' and a 'juvenile survey dredge bar'. The standard bar had two King and two Queen dredges interspersed along the bar (Queen dredges had 10 teeth) while the juvenile bar was of the same design but using Queen dredges with 17 teeth and a mesh (60 mm) attached internally that when stretched into a fixed position resulted in a maximum mesh size of 38 mm. The catch from each dredge was counted and a subsample of up to ~ 90 kings and 90 queens were measured.

Data cleaning: During 'data cleaning' any scallops in the subsample that were recorded as queen scallops over 100 mm were assumed to be a measuring error and reset to a maximum size of 90 mm and the data adjusted accordingly. Discrepancies between the number reported on the tow sheet and the number sampled (where the whole dredge catch were measured) were altered to reflect the number measured.

Ground refinement: As the main survey grid was defined to include both king and queen scallop at each fishing ground the outer survey extent for each ground was further refined for queen scallops (Figure 18) using vessel monitoring system data (VMS) amalgamated from 2011 – 2019. To identify queen scallop fishing activity VMS data from the queen fishing season were filtered to only include vessels moving at fishing speed (i.e. 1.0-4.0 knots). In addition, depth and sediment profiles were also considered when refining each survey ground as well as skippers' survey comments.

Ground inclusion: POA and the transient bed at BRA were only surveyed for first time in 2020 (& POA was not surveyed in 2021). To keep the data constant only EDG, CHI and TAR are included in the main territorial sea analysis section. Each ground will be analysed individually later in the report.

Targeted Cells: In addition to the random Survey Cells described above, additional selected cells were surveyed in some areas on the basis of suitability for closed area or hotspot placement or exploratory fishing. These were excluded from the main analysis because these areas were chosen specifically because they were typically areas of known high queen scallop density (i.e. they were not a random selection of the particular fishing ground).

Data analysis: The geometric mean was used for data analysis due to the skewed (non-normal) distribution of the density data. In addition, the juvenile dredges appear to be more efficient for catching both post recruits (i.e. ≥ 55 mm) and recruits (i.e. < 55 mm) and so the analysis within this report focuses on that data set.

Survey timing: It should be noted that the 2019 survey was undertaken in June whilst the 2020 and 2022 surveys were undertaken in April, the 2021 survey in May and the 2023 and 2024 survey in May/June. Size data is presented here as a snapshot at the time of the survey and the data has not been adjusted for size increase due to growth between these periods.

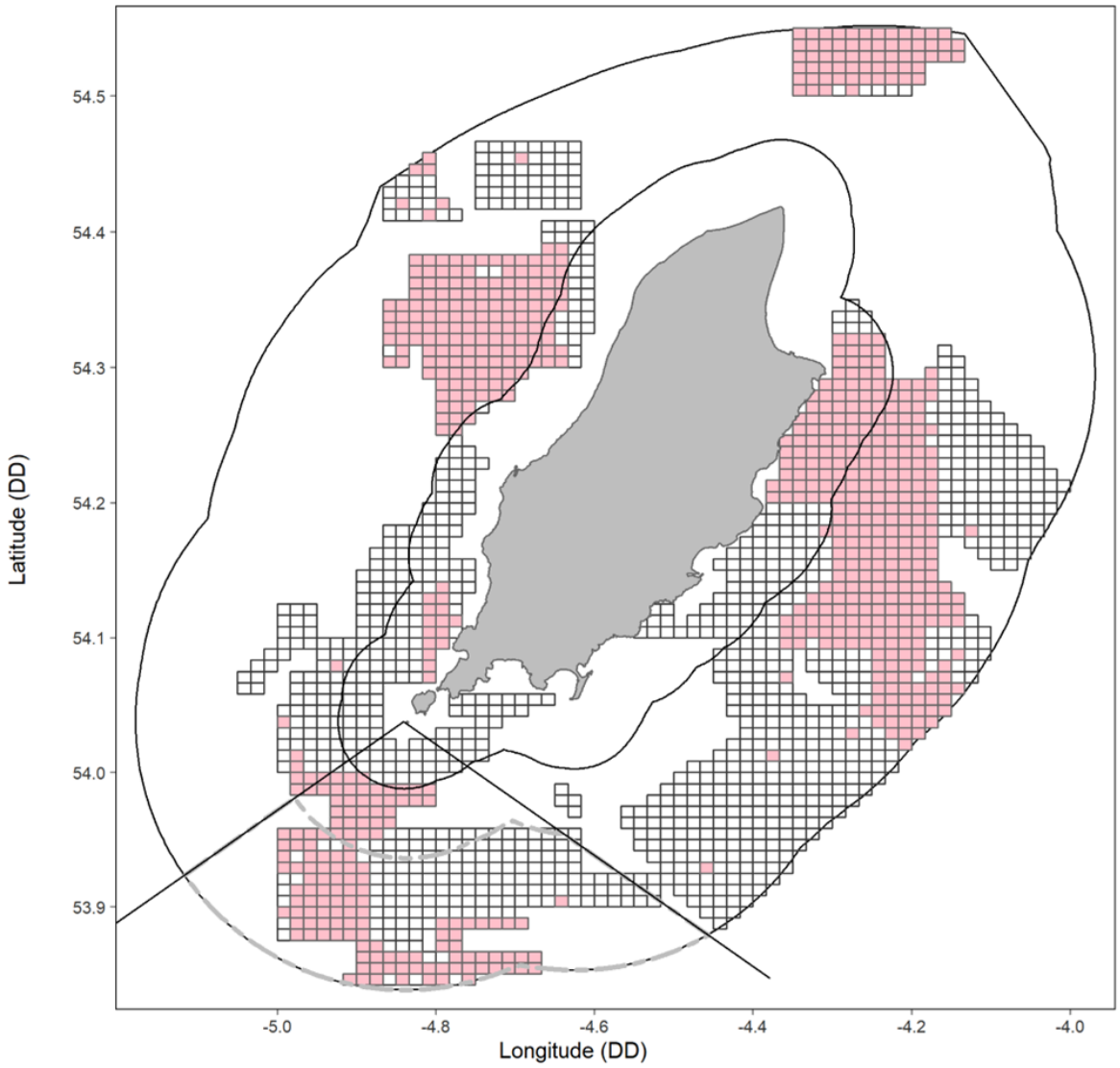

Figure 18: Current extent of the industry scallop survey grid with survey cells defined as queen scallop area highlighted in pink

4.3.2 Size frequency and Density estimates:

4.3.2.1 Territorial Waters:

A size frequency plot of queen scallop size data is presented in Figure 19 from samples measured at all industry scallop survey stations (queen scallop dredge data only) within the main TS grounds of EDG, CHI and TAR. Scallops > 55 mm represent post-recruits (queen scallops that are already at the minimum landing size (MLS) of 55 mm). Scallops < 55 mm represent recruits (queen scallops under MLS), some of which will be large enough to grow into the fishery during the upcoming fishing season (i.e. > 45 mm) and some which will not reach MLS until next year's fishery (i.e. <45 mm).

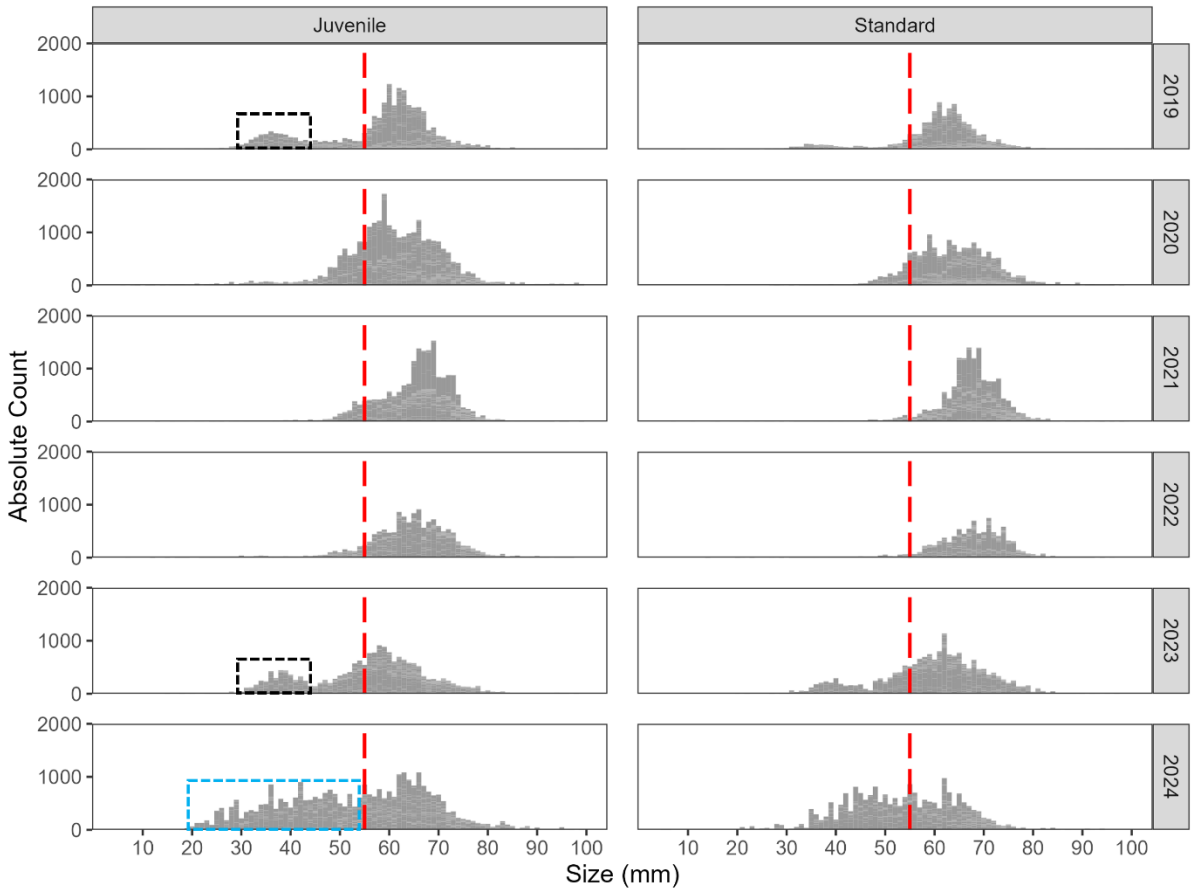

Figure 19: Size frequency distribution (by 1 mm size bin) of absolute counts of queen scallops displayed by year and dredge type (red dotted line indicates the MLS of 55 mm) for survey cells at East of Douglas, Targets and Chickens combined (targeted survey cells excluded). The absolute count is calculated by using a scalar (i.e. the ratio of total observed to subsampled counts) to scale the size frequency distributions. The black dotted boxes in 2019 and 2023 highlights a new recruitment peak (i.e. queenies of ~ 25 – 45 mm) indicating new recruitment coming through from that year (i.e. these queen scallops are 1 year old). The blue box in 2024 highlights a protracted recruitment with potentially multiple overlapping cohorts of recruitment. Note recruitment peak absence in 2020, 2021 and 2022.

Both 2019 and 2023 indicate a well-defined peak in recruiting queen scallops in the juvenile dredge data. In 2019, this peak was focused in two key areas at Chickens and Targets whilst in 2023 the peak is focused predominately at Targets (Figure 19, Figure 20 and **Error! Reference source not found.**). In 2024 the recruitment peak was protracted with potentially multiple overlapping cohorts of recruitment Figure 19. These recruitment peaks are an important consideration when looking at sustainable management over a > 1 year period.

Figure 20 and Figure 21 shows the spatial distribution of recruitment (i.e. under 55 mm) and harvestable (i.e. over 55 mm) queen scallops respectively around Isle of Man territorial waters for 2024. For recruits the majority of higher densities are focused on the west coast in the Targets fishing ground. For harvestable queen scallops there were good densities recorded at Targets, South East Douglas and Point of Ayre.

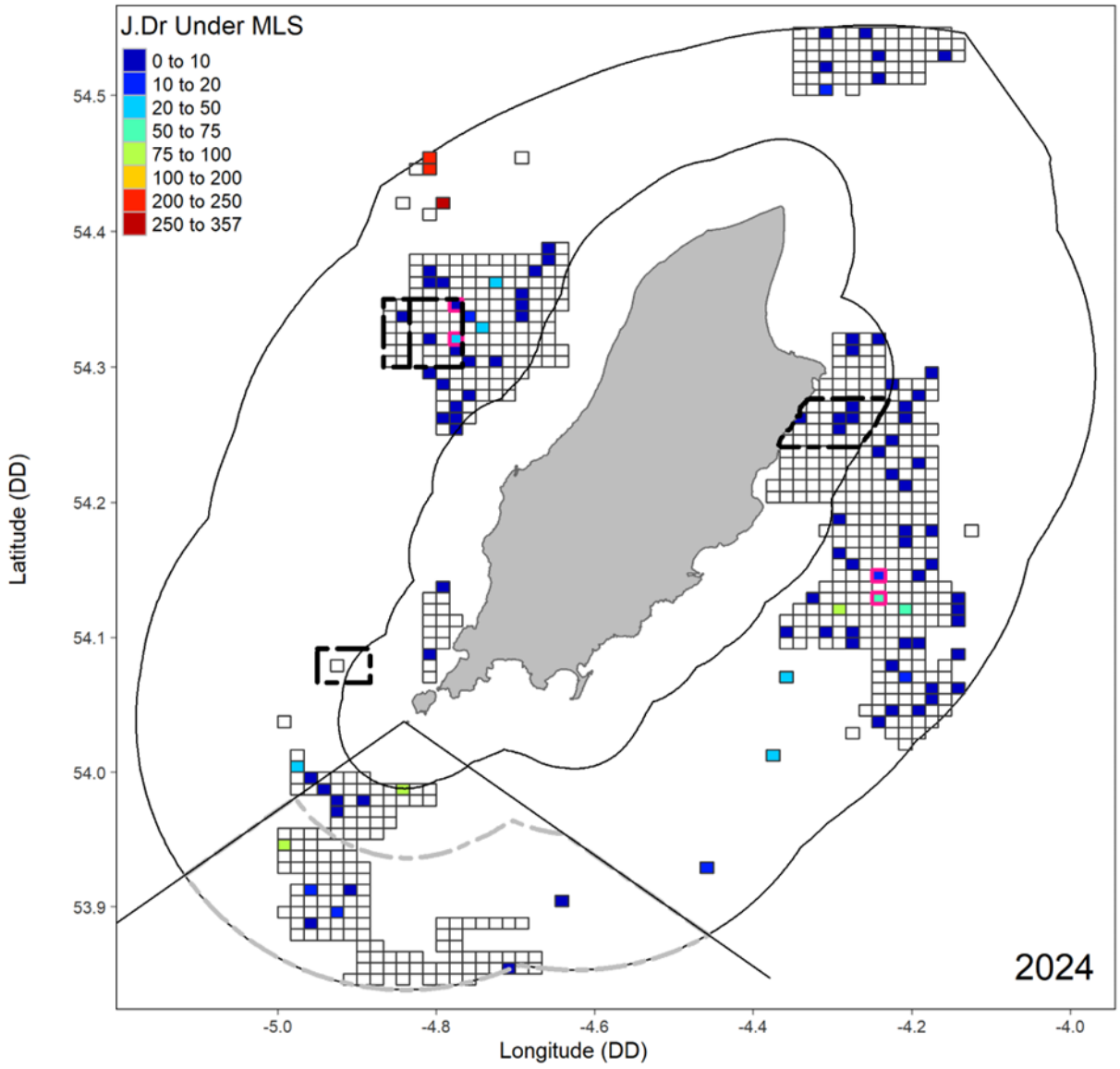

*Figure 20: Maps illustrating the survey densities for queen scallops **under** MLS from juvenile dredges for 2024. The pink cell borders indicate cells that were part of an additional targeted survey. The black dashed boxes indicate closed or managed areas for the 2023 queen scallop fishery and the 2023/2024 king scallop fishery. The grey dashed line and solid black lines indicate the queen scallop dredge zone.*

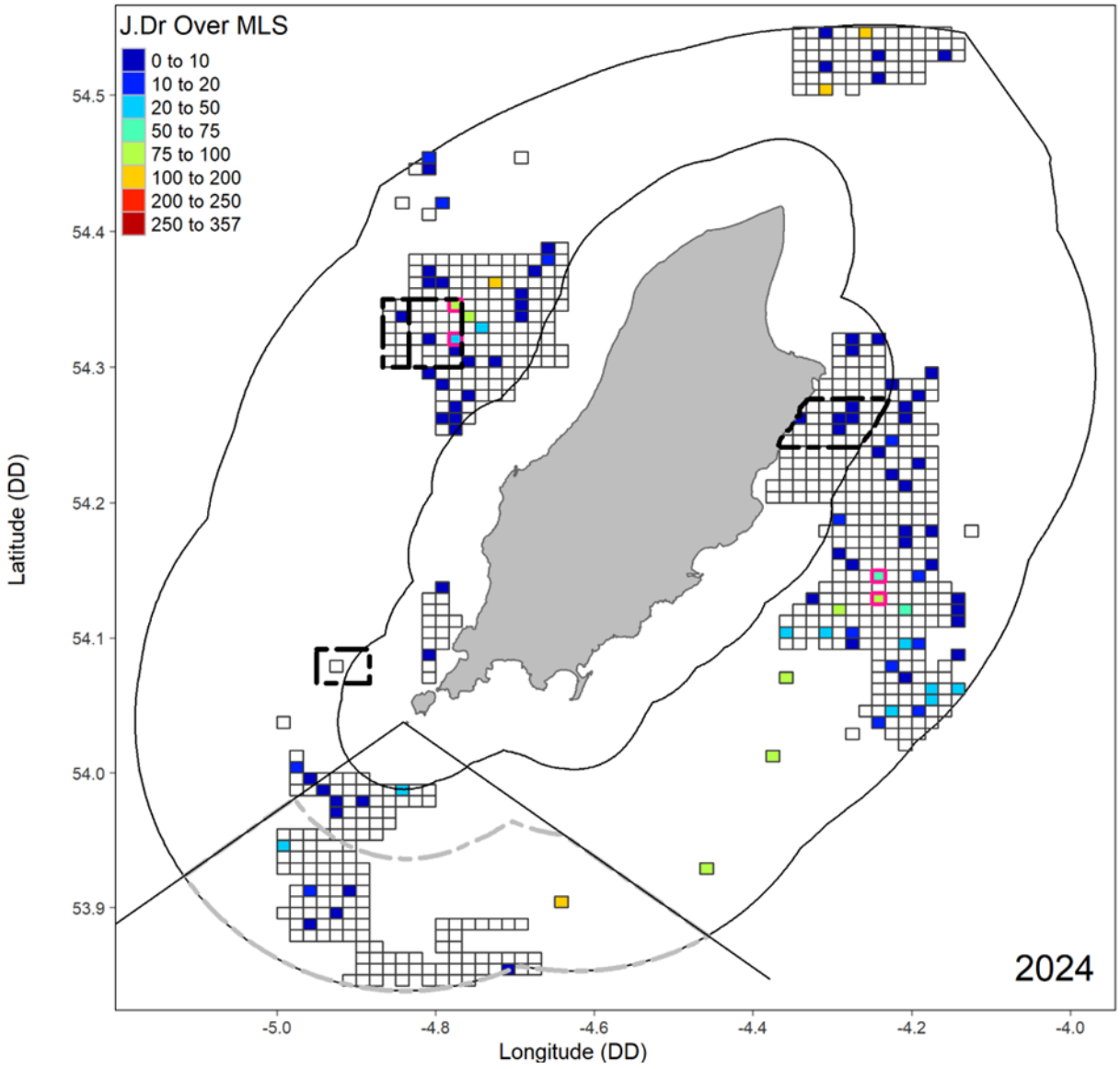

*Figure 21: Maps illustrating the survey densities for queen scallops **over** MLS from juvenile dredges for 2024. The pink cell borders indicate cells that were part of an additional targeted survey. The black dashed boxes indicate closed or managed areas for the 2023 queen scallop fishery and the 2023/2024 king scallop fishery. The grey dashed line and solid black lines indicate the queen scallop dredge zone.*

4.3.2.2 Fishing Grounds:

4.3.3.2.1 Targets:

Targets supported the highest quantity of landings from the 2023 fishing season (409.2 t; ~68 % of total landings). The size frequency distribution of scallops at Targets indicates that 2024 is the first year, since the survey began in 2019, with higher levels of recruits (i.e. under 55 mm) than harvestable scallops (i.e. over 55 mm) (Figure 22). For recruits (under 55 mm) the 2024 data indicates that the highest levels of recruitment are located near to the 12 nm line (Figure 23). For post-recruits (over 55 mm) the 2024 data also indicates that the higher densities are concentrated in the centre of the main fishing ground (Figure 24).

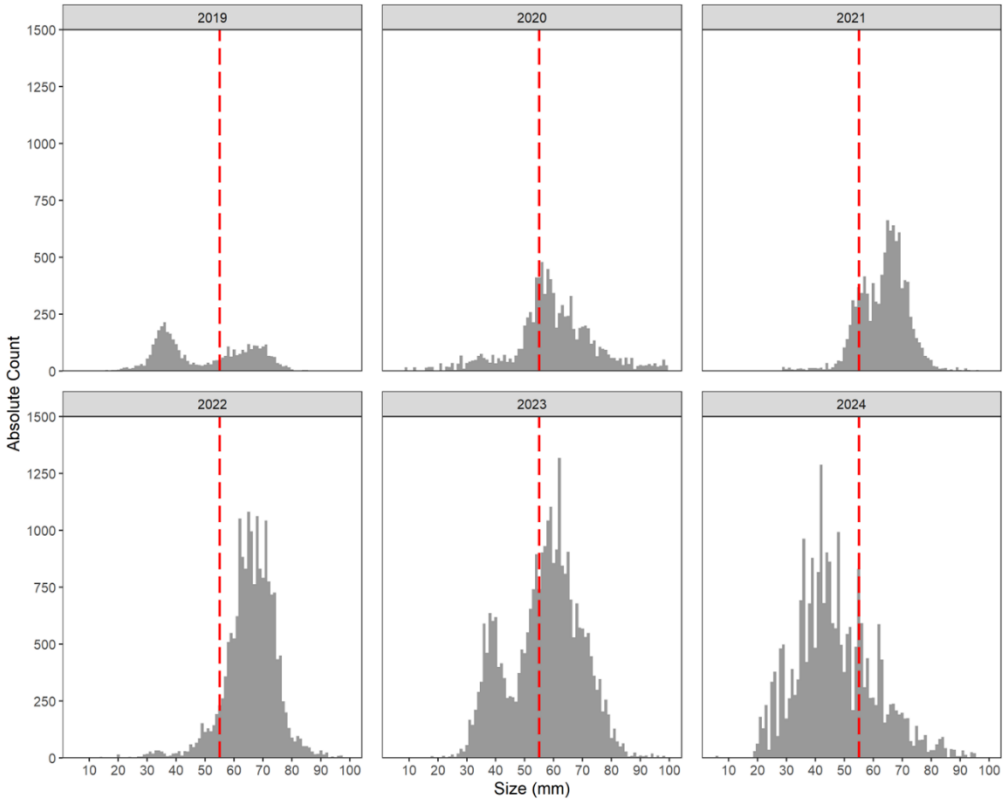

Figure 22: Size density histogram of absolute counts of queen scallops displayed by survey year for Targets (red dotted line indicates the MLS of 55 mm). Excludes targeted survey cells.

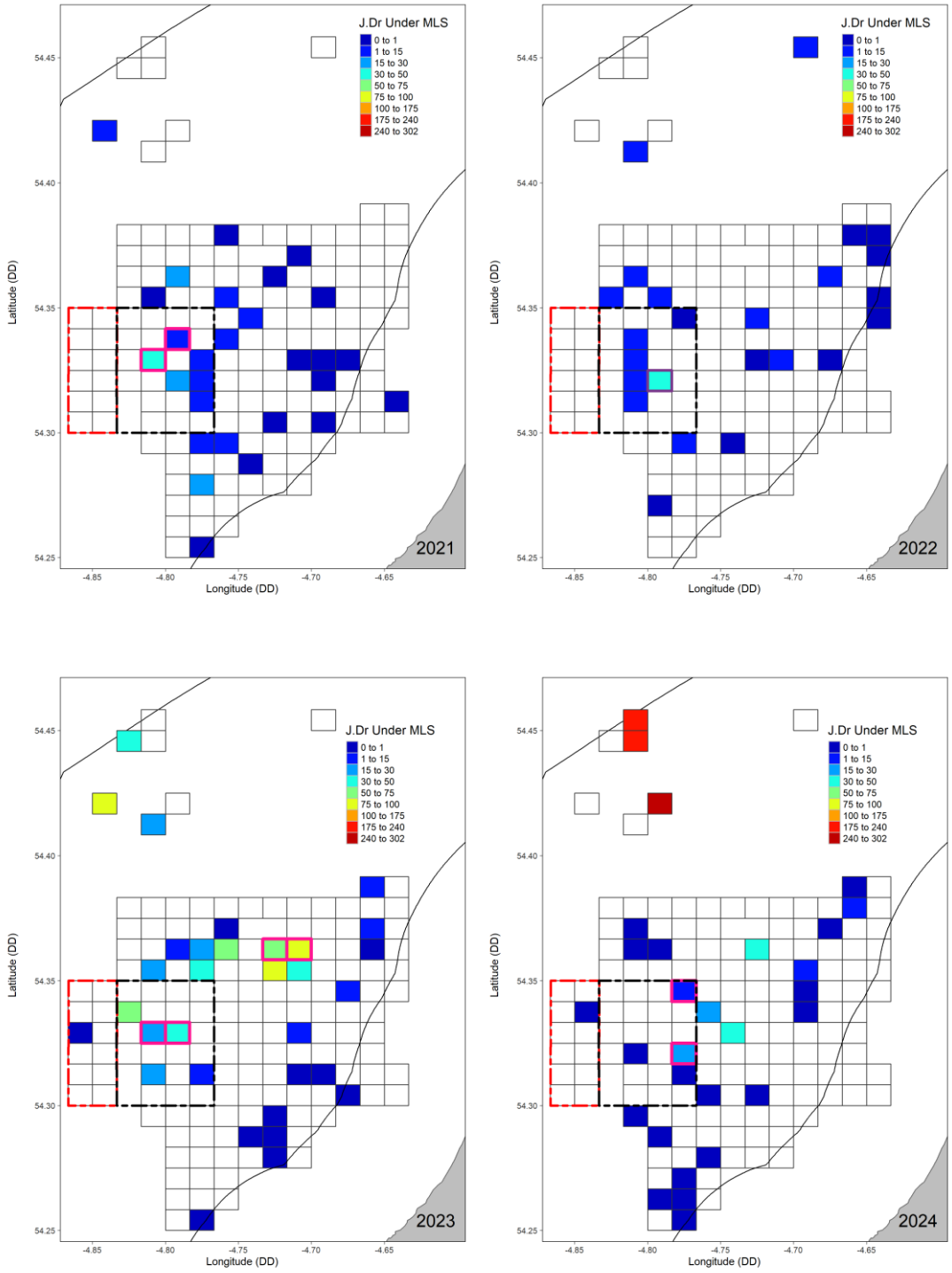

*Figure 23: Maps illustrating the survey densities for queen scallops **under** MLS from juvenile dredges for 2021 to 2024 at Targets (West coast). The red box indicates the areas closed and black box indicates areas with restricted access to scallop fishing in 2023. Pink borders indicate cells that were part of an additional targeted survey and are not included in the main analysis for the TS, or for individual fishing areas (although they are used in the closed area or hotspot analysis).*

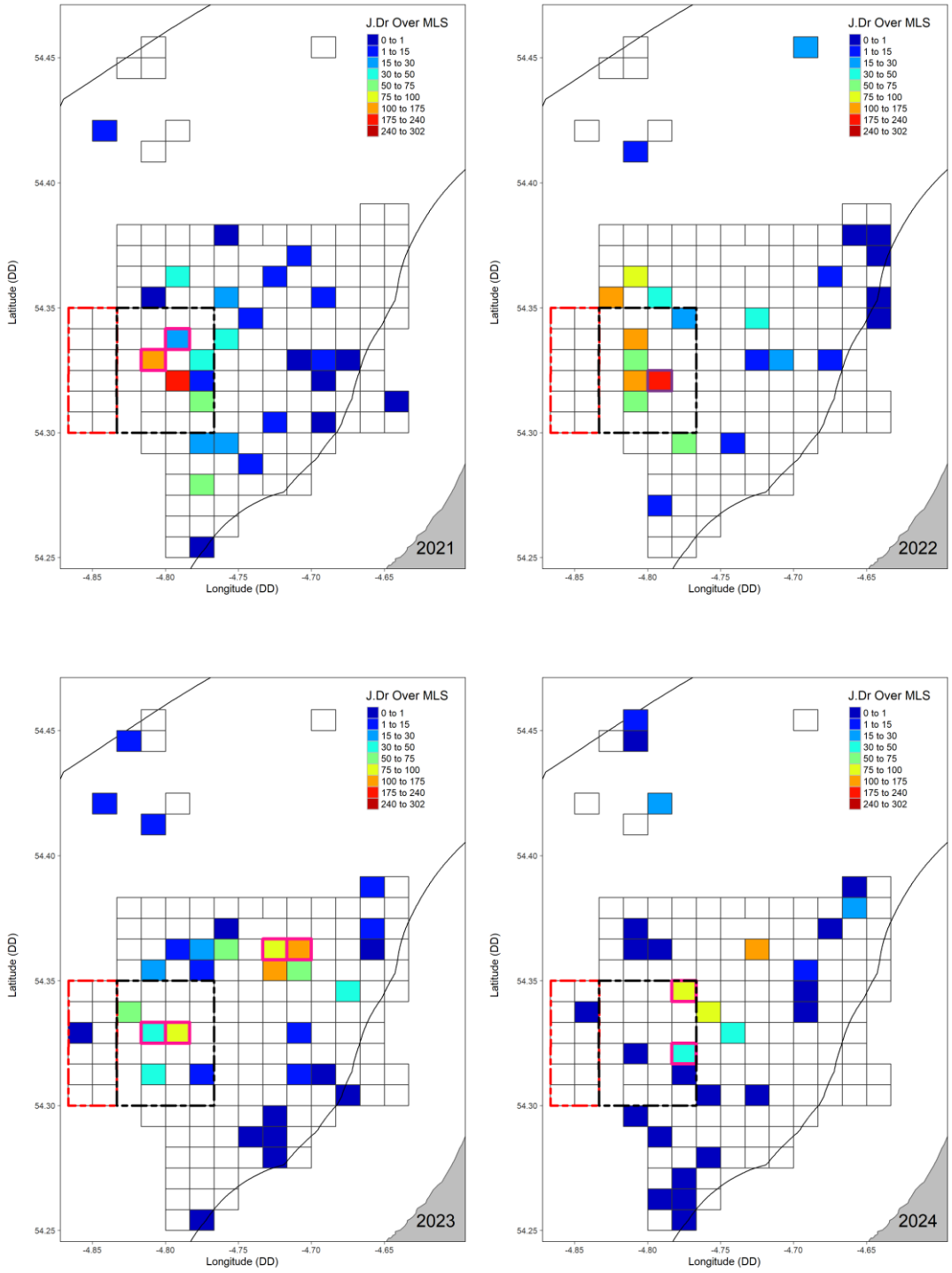

*Figure 24: Maps illustrating the survey densities for queen scallops **over** MLS from juvenile dredges for 2021 to 2024 at Targets (West coast). The red box indicates the areas closed and black box indicates areas with restricted access to scallop fishing in 2023. Pink borders indicate cells that were part of an additional targeted survey and are not included in the main analysis for the TS, or for individual fishing areas (although they are used in the closed area or hotspot analysis).*

The locations of potential closed areas for the 2024 fishing season to protect recruits from fishing activity are indicated by solid black boxes in Figure 25. By focusing on queen scallops under 45 mm (i.e. scallops unlikely to recruit to the fishery until the 2025 fishing season) one potential location can be identified for closure during the 2024 fishing season to protect these pre-recruit (i.e. scallops under

45 mm) scallops (solid black line box in Figure 25). The western closed area (dashed red line box in Figure 25) is in muddy ground and the intention from the SMB is that this area should continue to remain closed as it is an area where recruitment of queen scallops is common but the sizes and yield are typically low and therefore not of commercial value.

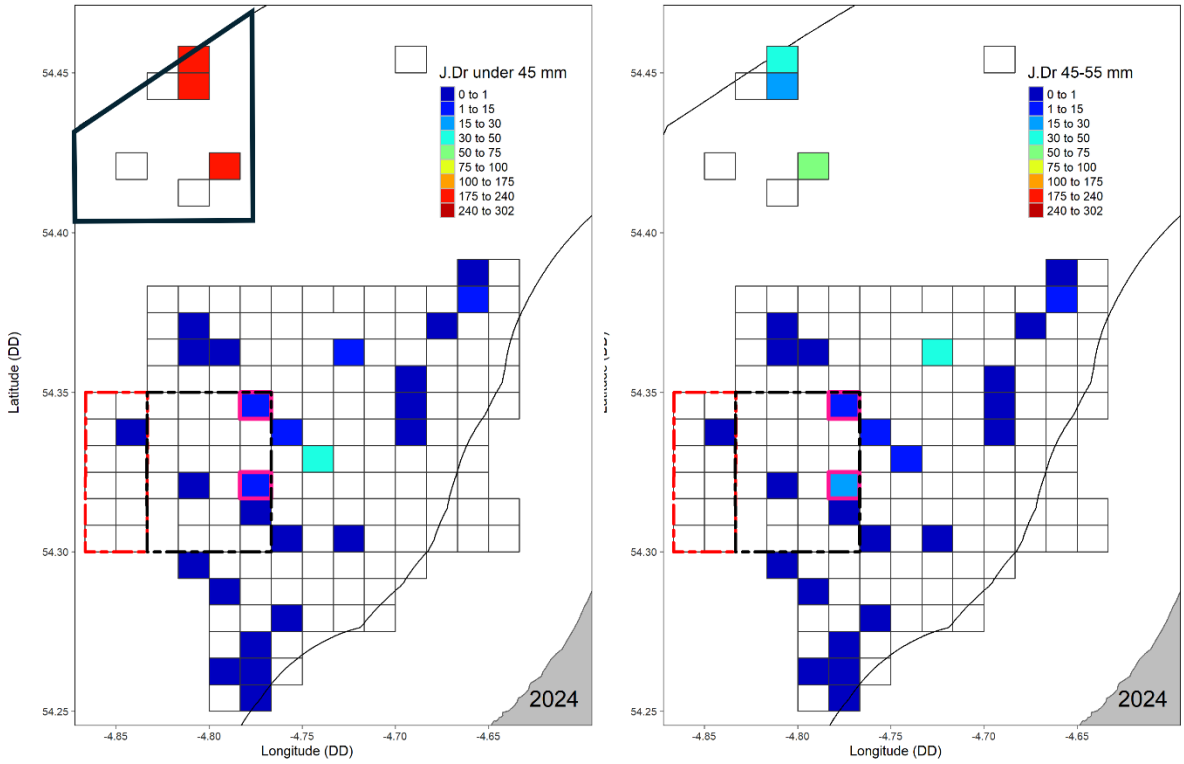

Figure 25: Maps indicating the split of queen scallops at TAR in 2024 which are under 45 mm (Left) and between 45 and 55 mm (Right). Queen scallops under 45 mm are not likely to be harvestable until the 2025 queen scallop fishing season. Black boxes (solid lines) indicate suggested closures to protect queen scallops under 45 mm during the 2024 fishing season. Black box (dashed line) indicates restricted area for 2023 fishing season and red boxes (dashed lines) indicate closed areas for 2023 fishing season.

4.3.3.2.2 Chickens:

There were no landings from Chickens during the 2023 fishing season. The size frequency distribution of scallops at Chickens indicates that 2024 is more positive for both recruits (i.e. under 55 mm) and harvestable queen scallops (i.e. over 55 mm) compared to the previous two survey years (i.e. 2022 and 2023; Figure 26). For recruits (under 55 mm) and post-recruits (over 55 mm) the 2024 data indicates pockets of densities across the fishing area (Figure 27 and Figure 28).

Given the lack of substantial areas of queen scallop recruits recorded within the Chickens fishing ground there are no recommendations for discrete closed areas to protect high densities of recruit or post recruit queen scallops.

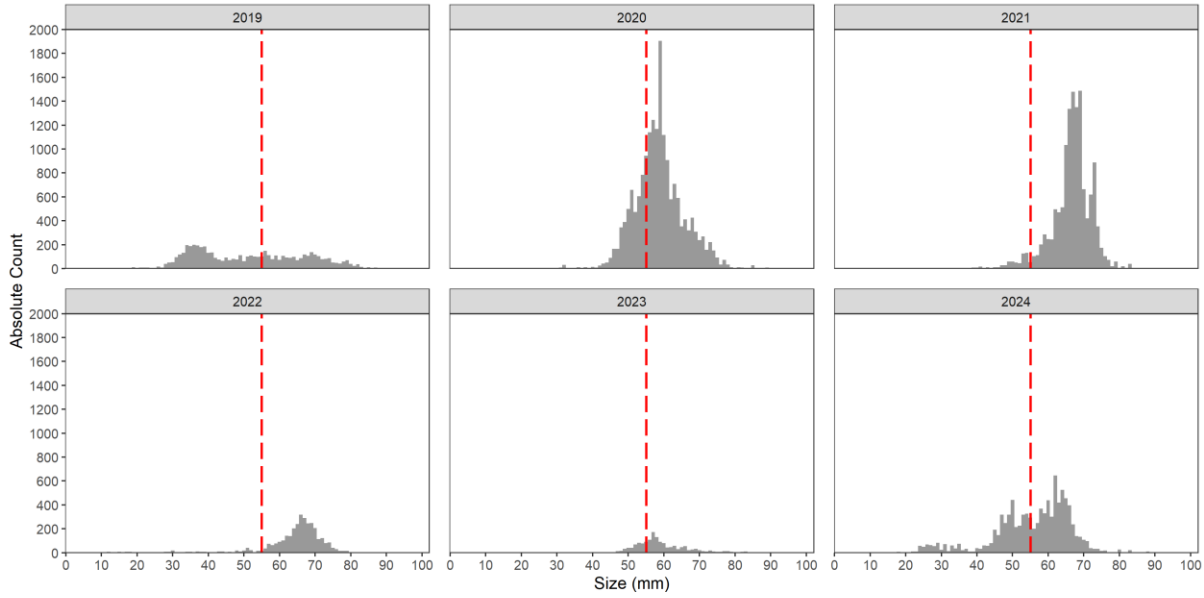

Figure 26: Size density histogram of absolute counts of queen scallops displayed by survey year for Chickens (red dotted line indicates the MLS of 55 mm). Excludes targeted survey cells.

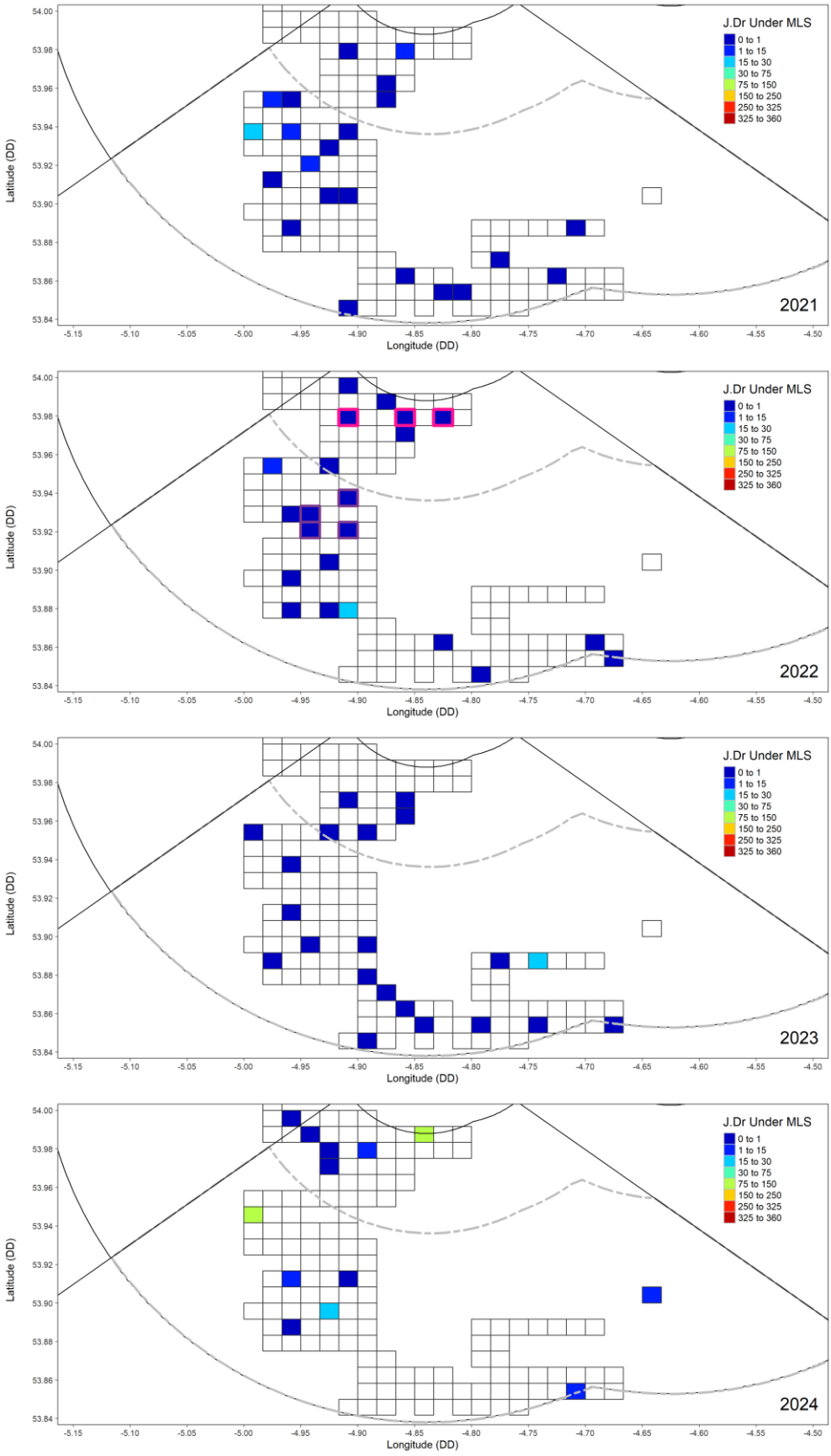

*Figure 27: Maps illustrating the survey densities for queen scallops **under** MLS from juvenile dredges for 2021 to 2024 at Chickens (South coast). Pink borders indicate cells that were part of an additional targeted survey and are not included in the main analysis for the TS, or for individual fishing areas (although they are used in the closed area or hotspot analysis). Purple borders indicate cells missing size data. The grey dashed lines indicate the area within which queen scallop dredging can occur.*

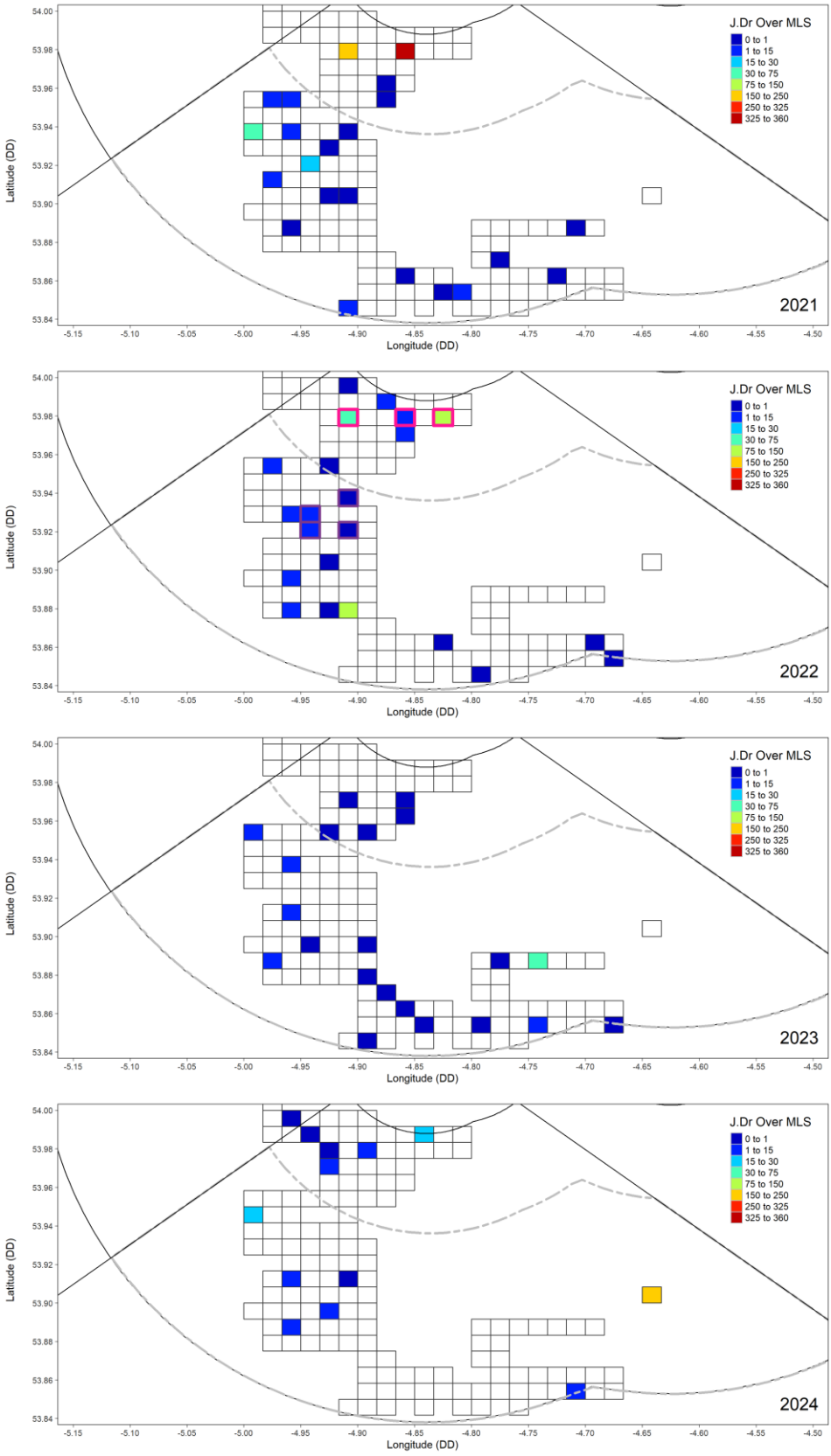

*Figure 28: Maps illustrating the survey densities for queen scallops **over** MLS from juvenile dredges for 2021 to 2024 at Chickens (South coast). Pink borders indicate cells that were part of an additional targeted survey and are not included in the main analysis for the TS, or for individual fishing areas (although they are used in the closed area or hotspot analysis). Purple borders indicate cells missing size data. The grey dashed lines indicate the area within which queen scallop dredging can occur.*

4.3.3.2.3 East of Douglas & East Douglas Experimental Research Area (ERA):

East of Douglas supported the second highest quantity of landings during the 2023 fishing season (126.0 t; ~21 % of total landings). The size frequency distribution of scallops at East of Douglas indicates that 2024 had a relatively equal spread of post-recruits (i.e. over 55 mm) and recruits (i.e. under 55 mm) (Figure 29, Figure 30). The last good recruitment at East of Douglas must have been before the start of the survey in 2019 given the high level of post-recruits recorded in that first survey year) (Figure 29).

Given the higher densities of queen scallop recruitment mirrored the densities of harvestable queen scallops within the East of Douglas fishing ground there are no recommendations for discrete closed areas to protect high densities of recruit queen scallops.

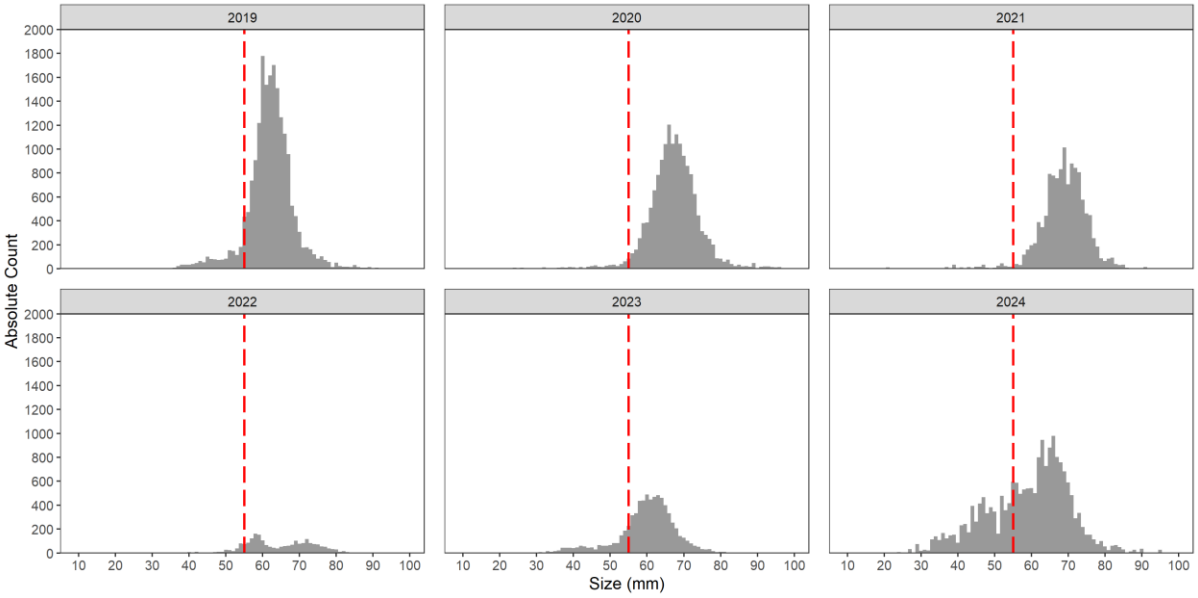

Figure 29: Size density histogram of absolute counts of queen scallops displayed by survey year for East Douglas (red dotted line indicates the MLS of 55 mm). Excludes targeted survey cells.

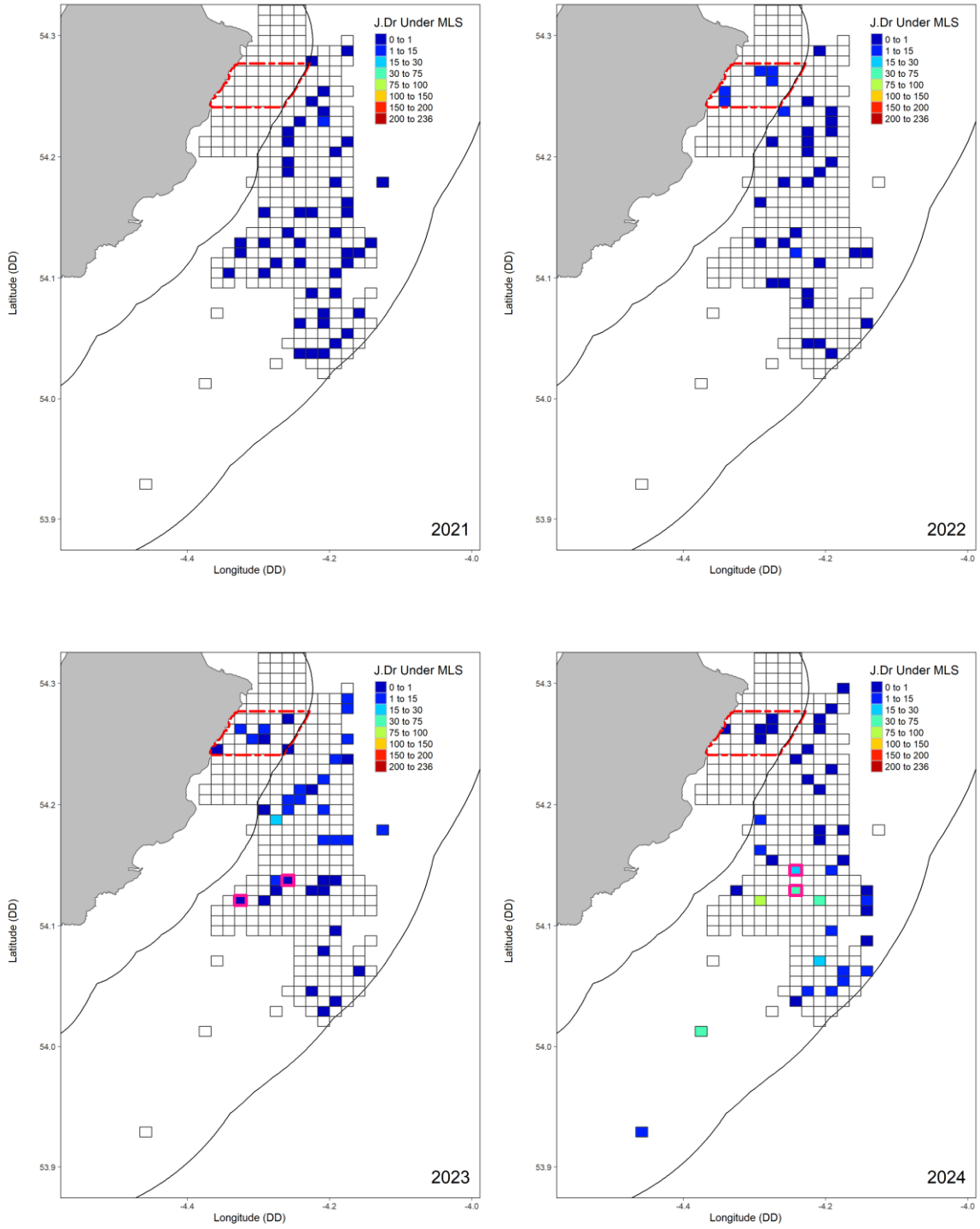

*Figure 30: Maps illustrating the survey densities for queen scallops **under** MLS from juvenile dredges for 2021 to 2024 at East Douglas (East coast). Pink borders indicate cells that were part of an additional targeted survey and are not included in the main analysis for the TS, or for individual fishing areas (although they are used in the closed area or hotspot analysis. The red dashed box indicates the East Douglas Experimental Research Area.*

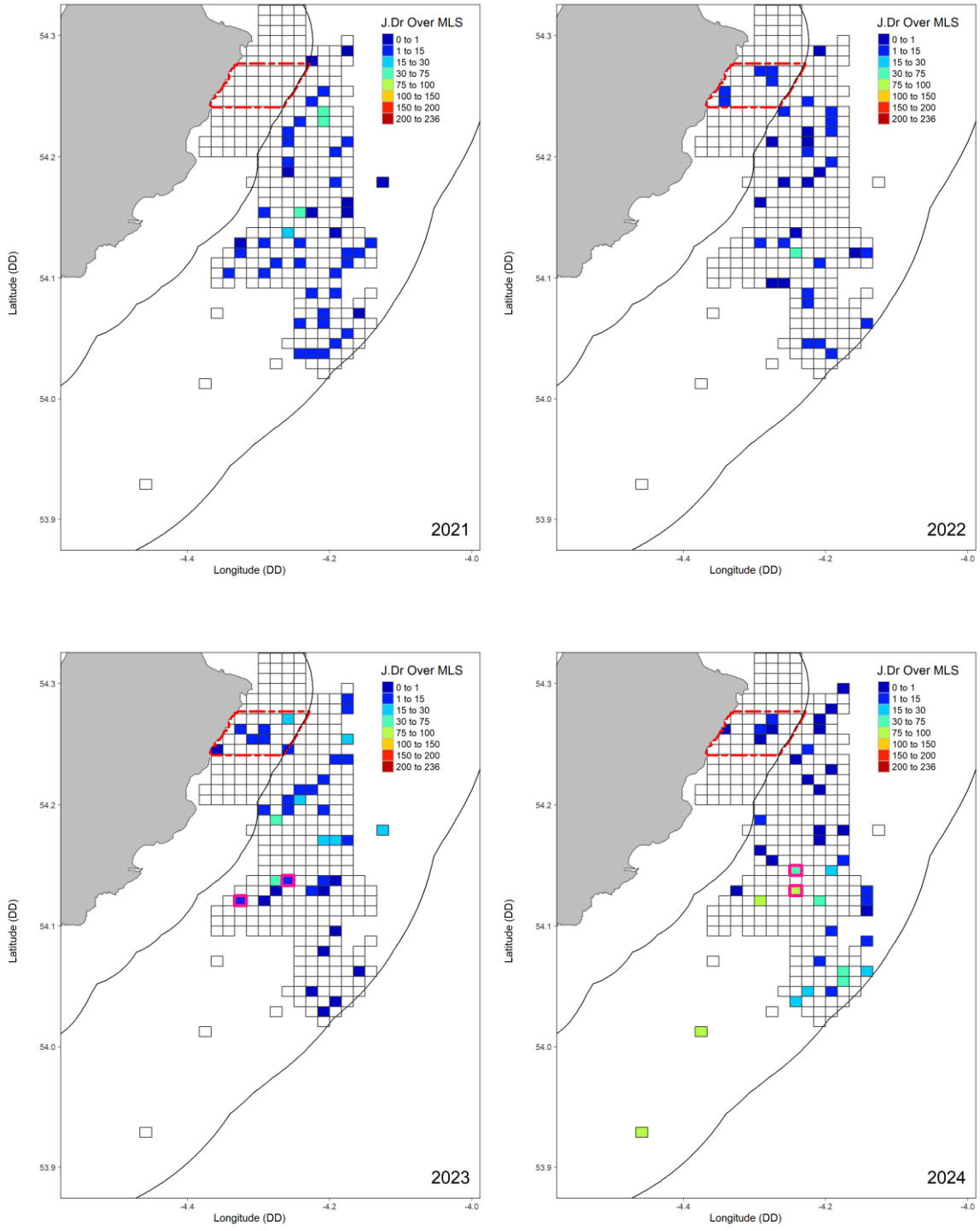

*Figure 31: Maps illustrating the survey densities for queen scallops **over** MLS from juvenile dredges for 2021 to 2024 at East Douglas (East coast). Pink borders indicate cells that were part of an additional targeted survey and are not included in the main analysis for the TS, or for individual fishing areas (although they are used in the closed area or hotspot analysis. The red dashed box indicates the East Douglas Experimental Research Area.*

4.3.3.2.4 Point of Ayre:

Point of Ayre had a separate 'exploratory' weekly catch limit initially of 2100 kg per vessel before increasing by 30% to 2730 kg pr vessel from Week 8 of the 2023 fishing season and supported the

third highest quantity of landings for the season (69.6 t; ~12 % of total landings). The size frequency distribution of scallops at Point of Ayre indicates that 2024 had lower levels of recruits (i.e. under 55 mm) than in 2023 with a larger proportion of harvestable queen scallops (i.e. over 55 mm) (Figure 32). For both recruits (i.e. under 55 mm) and post-recruits (i.e. over 55 mm), the 2024 data indicates that densities are more spatially discrete compared to the previous 2023 survey (Figure 33 and Figure 34).

Given the small area of the fishing ground at Point of Ayre there are no recommendations for discrete closed areas to protect high densities of recruit queen scallops.

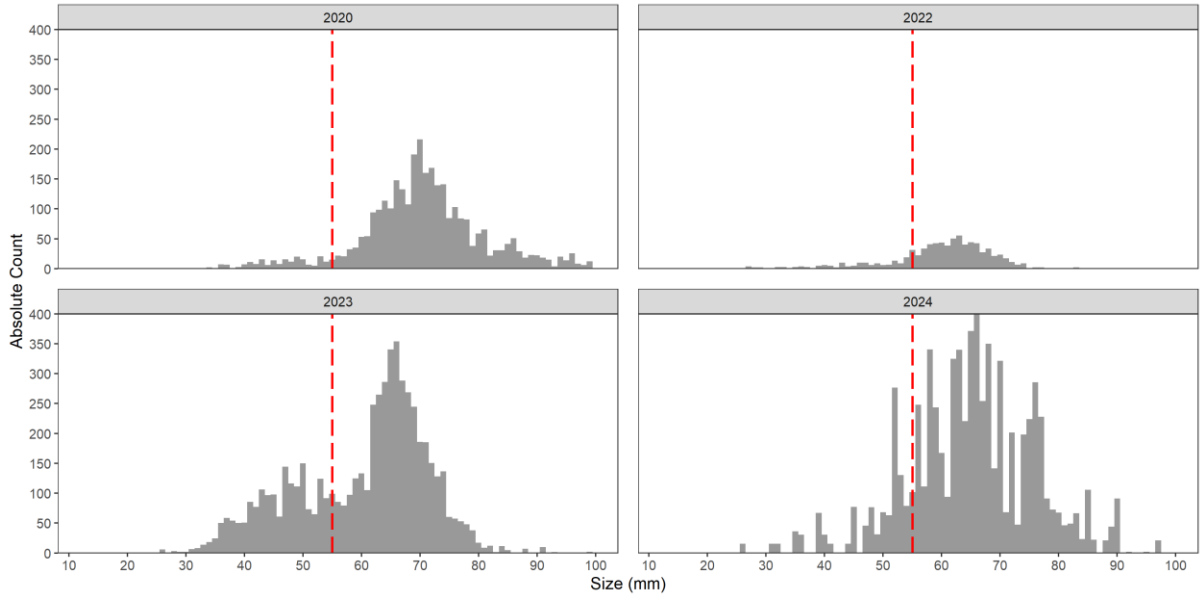

Figure 32: Size density histogram of absolute counts of queen scallops displayed by survey year for Point of Ayre (red dotted line indicates the MLS of 55 mm). Excludes targeted survey cells.

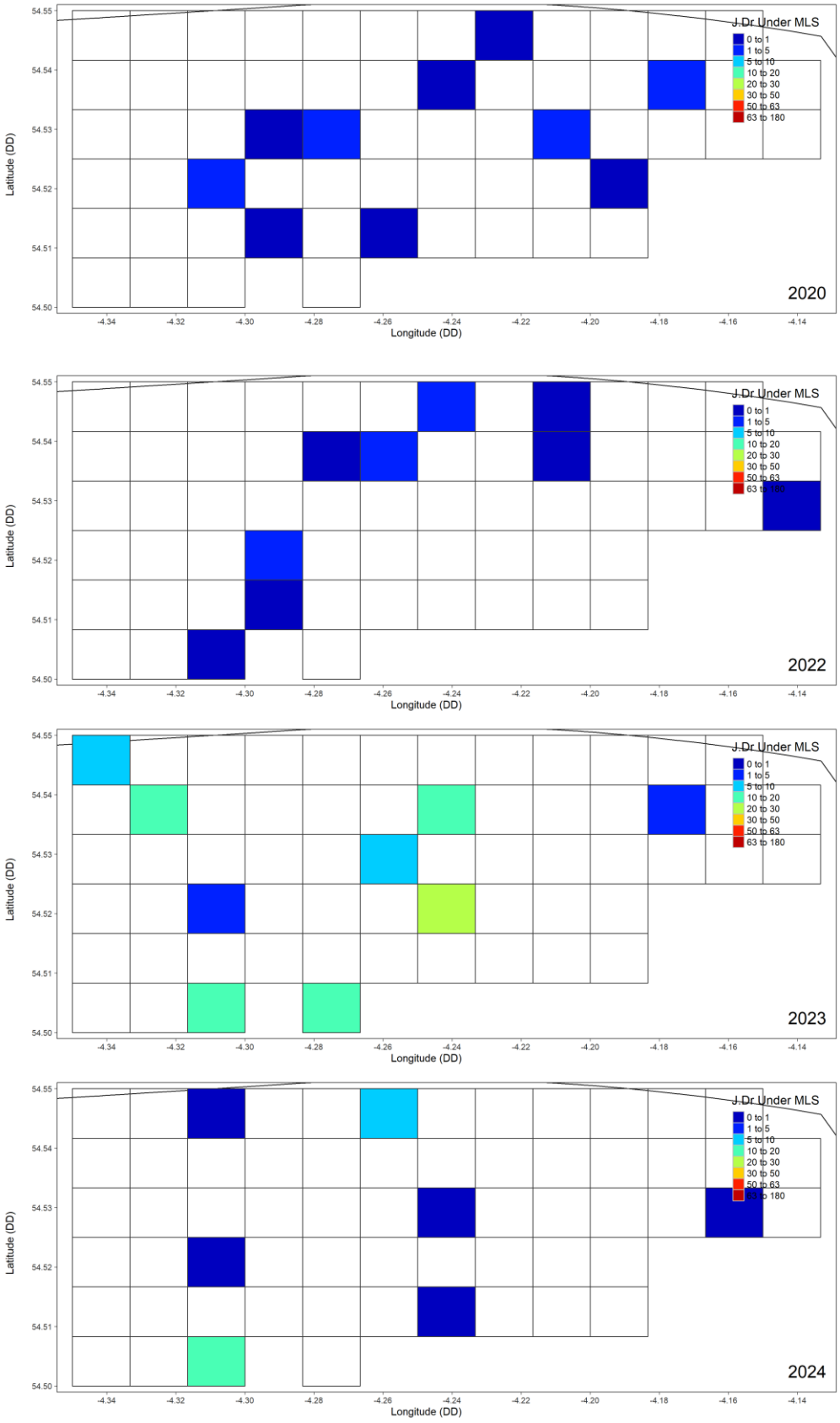

*Figure 33: Maps illustrating the survey densities for queen scallops **under** MLS from juvenile dredges for 2020 to 2024 (not surveyed in 2021) at Point of Ayre (North coast).*

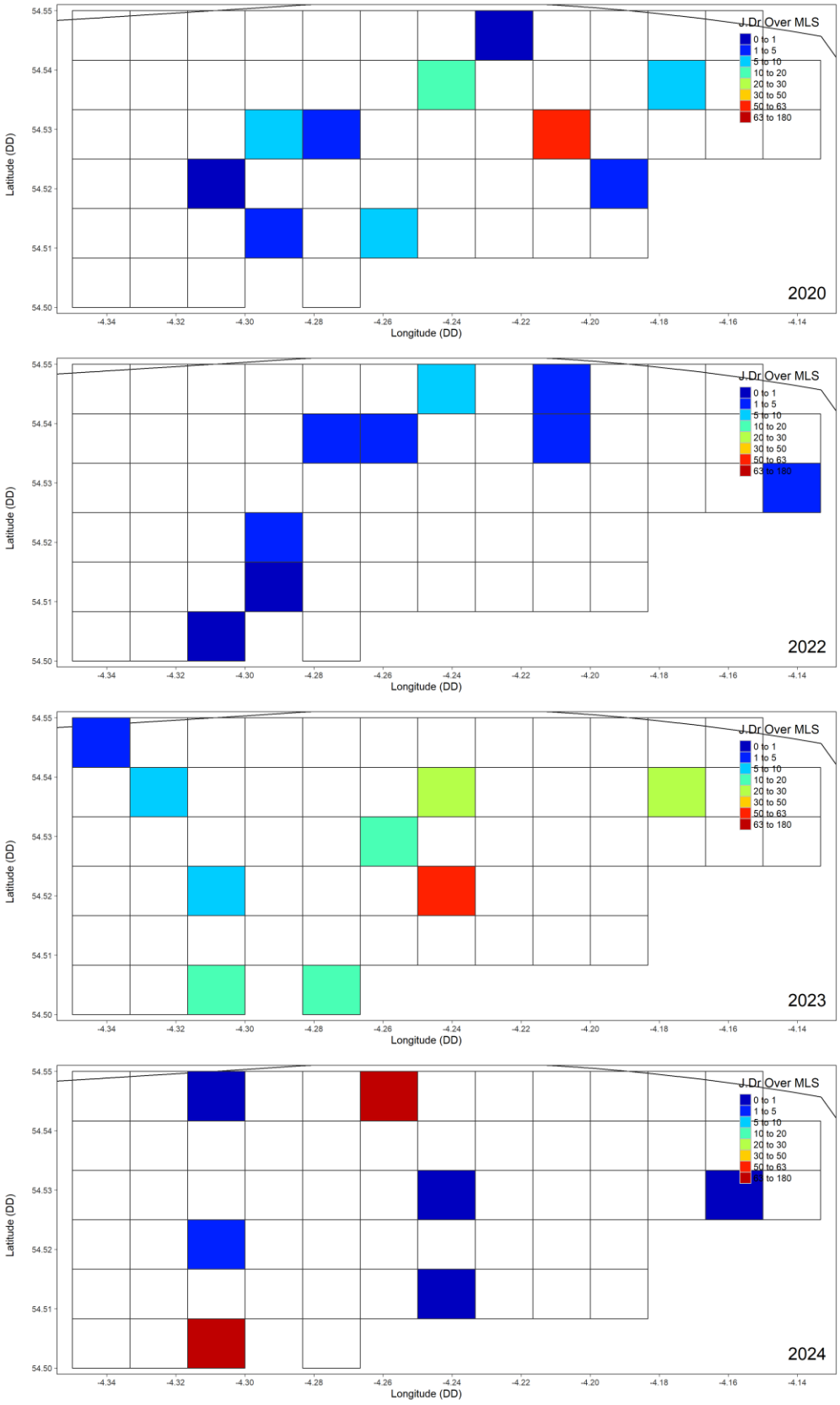

*Figure 34: Maps illustrating the survey densities for queen scallops **over** MLS from juvenile dredges for 2020 to 2024 (not surveyed in 2021) at Point of Ayre (North coast).*

5. Summary:

Survey summaries:

At the territorial sea level, the 2024 scientific survey shows a slight decrease in both the recruit (under 55 mm) and post-recruit (over 55 mm) indices. The CSA stock assessment however indicates a slight increase in the estimated biomass for 2024 which is likely driven by both a strong recruitment signal in 2023 (biomass is estimated to have increased for post-recruits and decreased for recruits) and increases in average weight of recruits and post-recruits for 2024 compared to 2023.

The spatial distribution of queen scallops remains highly variable across the territorial sea. The west coast fishing ground at Targets (TAR) continues to be the most productive area, accounting for approximately 68% of total landings in 2023. The industry survey identified this ground as a key hotspot particularly for recruits where a spatial closure should be considered. The presence of multiple overlapping cohorts of recruits in 2024 further highlights the importance of this area for future stock sustainability.

The Point of Ayre (POA) on the north coast supported the third highest landings in 2023 and was notable for having the highest recruit densities recorded in the scientific survey. High densities of post-recruits were also observed, although these were more spatially discrete than in the previous year. Despite the strong survey results, the small size of the fishing ground limits the feasibility of implementing spatial closures.

The East of Douglas (EDG) ground, located on the east coast, supported the second highest landings in 2023, contributing around 21% of the total. However, survey data from this area indicated only moderate densities of both size classes, with some variability between stations. No discrete closures are proposed outside of the already closed experimental research area (ERA).

Chickens (CHI) on the south coast also showed low densities of both recruits and post-recruits in both surveys, with only isolated pockets of higher abundance. No landings were reported from this ground in 2023, and no closures are currently recommended due to the lack of substantial aggregations.

Overall, the 2024 data reinforce the importance of spatially explicit management. Spatial analysis from both the scientific and industry surveys highlights significant heterogeneity in stock distribution. While total biomass is increasing, the spatial variability in recruit and post-recruit indices suggest that a single TAC applied across the territorial sea may not adequately reflect localised stock dynamics. Continued use of fine-scale closures, particularly at Targets, and adaptive management based on real-time LPUE and survey data are recommended to ensure the long-term sustainability of the fishery.

Recommendations

The latest survey results indicated a continued increase in stock abundance such that following the ICES Category 3 approach for setting TACs for data limited stocks a 20% increase in fishing opportunities relative to last year's landings is recommended (i.e. 762 t).

Using the harvest rule proposed for sustainable fishing mortality as part of the MSC certification in 2011 (20% of the estimated post-recruit biomass) would give a biomass linked TAC for the 2024 fishing season of 1144 t, rather higher than the ICES Category 3 approach.

Taken together, these two approaches provide a range of scientifically informed options for setting the 2024 TAC. The ICES Category 3 method offers a precautionary lower bound, while the biomass-linked CSA assessment provides an upper bound based on proposed sustainable fishing mortality. Therefore, a TAC range of **762–1,144 tonnes** is recommended for consideration in the 2024 management decision-making process.

Recommendations for the management approach for the 2024 queen scallop fishing season are as follows:

- TAC of a between 762 – 1144 t
- Separate management for high-density hotspots should be considered (i.e. closure of high-density area of pre-recruits at Targets for the 2024 fishing season).
- Regular monitoring and triggered reviews of all fishing areas throughout the fishing season in terms of LPUE thresholds and total catch.
- Development of a long-term management plan for queen scallops within the Isle of Man and wider Irish Sea (including development of future Harvest Control Rules and a review of the appropriate scale for setting TACs (i.e. Territorial Sea or fishing ground level) as well as the future of the dredge fishery).

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