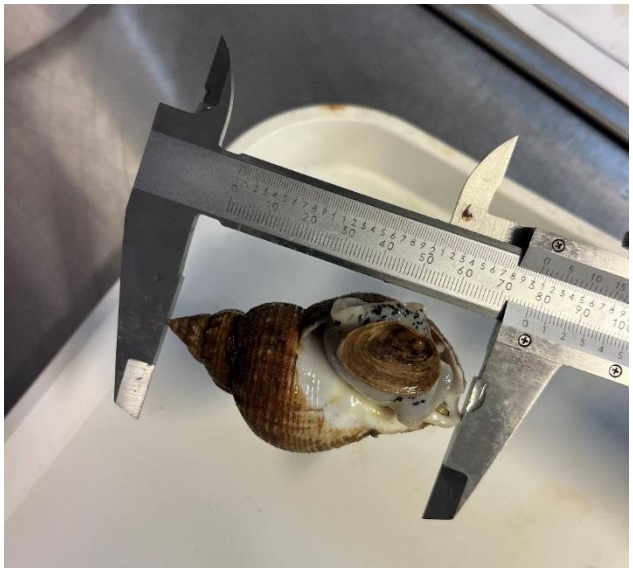
2024 Size-at-maturity study of Whelk (*Buccinum undatum)* within the North Western IFCA's District



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1. Background

1.1 The need to assess the NWIFCA's whelk MCRS

The Byelaw 4 – Potting Permit Byelaw (2019) came into force on the 6th of June 2022. The main purpose of the byelaw was to bring in unified management to the entirety of the NWIFCA District, in particular with regards to whelk, as the legacy CSFC Byelaw had unintentionally precluded whelk fishing in the northern half of the District's waters which NWIFCA wanted to rectify. This preclusion was due to the byelaw requiring all pots to have escape gaps for crabs, preventing the use of whelk pots within that portion of the District.

As part of the new byelaw, NWIFCA also sought to introduce an appropriate minimum conservation reference size (MCRS) for whelks. There was significant research evidence across the UK that the national MCRS of 45 mm was not providing enough protection to juvenile stocks, and therefore, required increasing. As a result, NWIFCA introduced an annual increase in the whelk MCRS from 55 mm to 65 mm to 75 mm each year from its inception in the Flexible permit Conditions of Byelaw 4.

Over the past two decades, whelks have become one of the UK's most economically important fisheries, as increasing demand from abroad, near year round availability of stock and low start-up costs make it a popular fishing option. Industry has expanded rapidly (In 2018, whelks made up nearly a quarter of all shellfish landed by ≤10 metre vessels (MMO 2018), with both the volumes and value of whelk increasing. Given the increasing pressures on the stock, it is important that a suitable MCRS is determined to help protect stocks.

1.2 Evidence in support of the original MCRS increase

The evidence for an increase in the MCRS for whelks in the NWIFCA District (which was originally the national MCRS of 45 mm) was provided at our Technical, Scientific and Byelaws Sub-Committee (TSB) meeting on the 5th of February 2019 in Agenda Item 8 (https://www.nw-ifca.gov.uk/app/uploads/Item-8-Report-to-TSB-Whelk-Management-Feb-2019VERSION-FOR-PUBLICATION-2.pdf) during the Byelaw 4 production stage.

The recommendation to increase the MCRS to 75mm at the time was based on the references provided in Annex A of this report. These sources detail the size of whelks across the UK and provide reasoning for the need to increase the MCRS in the NWIFCA District. In summary they provide evidence that:

1. Whelks reach maturity at different sizes across the UK, and show large variability over short geographical distances. Typically, stocks at higher latitudes mature at larger sizes.
2. The national MCRS of 45 mm does not provide enough protection to the majority of UK stocks.
3. Two of the studies contain whelks landed into Whitehaven (McIntyre et al. 2015, Lawler, 2013). The size at which 50% of these whelks were mature (the measure typically used to establish MCRS known as L_{50}) were 67.2mm and 69.5mm for females and 71.6mm and 74mm for males.
4. Other Irish Sea figures include samples from North Wales with a mixed L_{50} of 51.4mm (females from Menai Bridge) to 77.9mm (males from Nefyn) and samples from the Isle of Man with a mixed L_{50} of 63.9mm (females from the south of the island) to 73.1mm (males from the west of the island).

The Authority subsequently agreed to the proposed incremental increase in whelk MCRS from 55 mm to 65 mm to 75 mm each year from its inception.

1.3 Stakeholder concerns over the whelk MCRS

In 2023 four permit holders expressed their concern that the increase from 65mm to 75mm would negatively impact their activities and potentially make it uneconomical. The need for a more comprehensive dataset, and the outstanding concerns of fishers led to further research into the MCRS in the NWIFCA district.

1.4 NWIFCA whelk research to date

Previous sampling was undertaken by officers in 2019, 2020 and 2023 in attempts to determine whelk size-at-maturity in the District.

During these studies, samples were taken from 3 months of the year (March, April and August) in 2019, from 4 months in 2020 (February, May, June and July) and from 2 months in 2023 (October & December).

Samples for these studies were predominantly taken from the central part of the district, with corresponding ICES rectangles being: 37E6 (2023) and 36E6 (2019 and 2020). ICES rectangles shown in Figure 1.

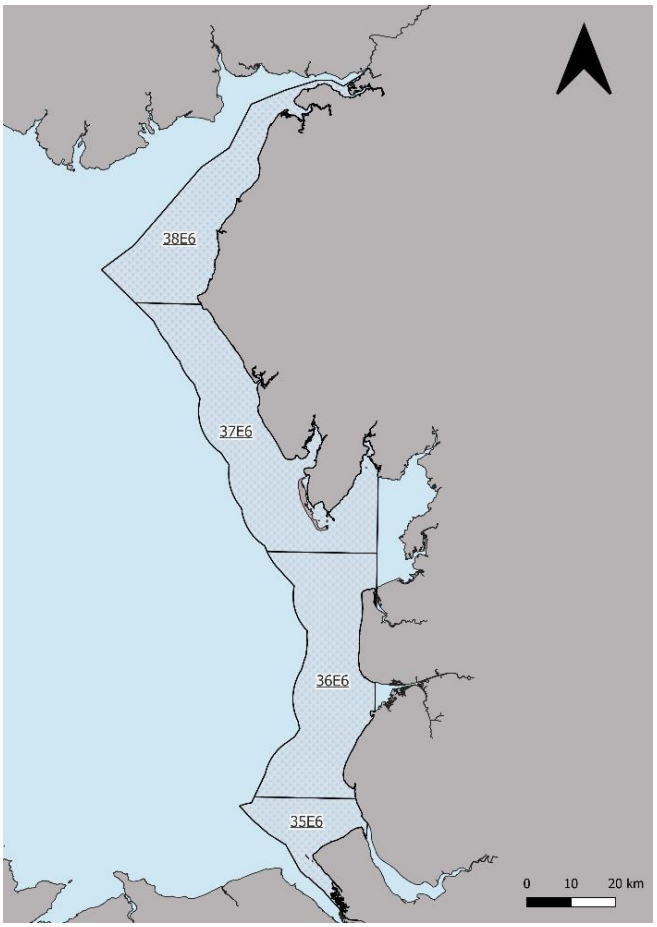


Figure 1. The locations of the four ICES rectangles (38E6, 37E6, 36E6 and 35E6) which samples have been collected from for NWIFCA whelk research to date.

The results from these studies were presented to the Authority at the TSB meeting on February 6th 2024. However, the data from these studies was insufficient to provide an MCRS recommendation, and suffered from limited confidence due to:

- **Limited geographic range** – No samples had been obtained from the northern and southern parts of the district. As the district whelk population is managed as a single stock unit, it is important that further samples are gathered from these areas.
- **Inconsistent sample timings** – Survey results were collected at inconsistent times of the year which can have effects on the size-at-maturity prediction. It is typically best to sample prior to the main spawning season as this is when most of the whelks will be visually showing their maturity. Consistent samples from autumn would assist in building confidence of the whelk size-at-maturity
- **Limited sample numbers –** In 2023 only 2 samples were obtained from a single area, 4 in 2020 and 3 in 2019. Samples were collected either from single areas, or at inconsistent times of the year which doesn't help to build an accurate L_{50} estimate and thus MCRS.

Due to the limited confidence in the previous research results, at the TSB meeting on the 6th February 2024 the current MCRS for whelk was frozen at 65mm until the 6th June 2025 to allow further evidence to demonstrate if an increase to 75mm was necessary. This study aims to fill those gaps, by collecting further data in 2024 from the full extent of the district over the main breeding season to be able to determine an accurate MCRS for whelk across the NWIFCA district.

2. Important considerations for determining MCRS for whelk

2.1 How is whelk MCRS typically determined

Figure 2. A variety of whelk gonads at different stages of maturity from the NWIFCA district.

The MCRS for whelk is typically set at its size-at-maturity.

The size-at-maturity for whelk is the size at which there is a 50% likelihood of it being mature. Researchers identify the maturity of whelks by gathering samples across the geographic range of interest and dissecting them.

Whelks show their maturity visually by the differing colour of their gonads (Figure 2).

2.2 Time of the year matters when sampling whelks

Whelks typically go through one reproductive event every year – in the UK this falls in Autumn, with the fishers subsequently seeing the laid eggs on the side of pots in winter (Figure 3).

Figure 3. Whelk eggs on the side of a whelk pot.

The time in the year that whelks are sampled for size-at-maturity is important. If they are sampled in the spring less individuals will be showing visual maturity because it is not close to the breeding season. In contrast, if whelks are sampled close to the breeding season in Autumn, the majority of those that are mature will be preparing to breed, and this will be visually obvious to researchers when dissected.

For this reason, academic studies often analyse samples collected prior to or during the breeding season (Emmerson *et al.,* 2018).

2.3 Geographic range is also important

In addition, whelks can demonstrate large differences in their size-at-maturity even over small spatial scales. Those in higher latitudes often demonstrate greater size-at-maturity, and those

in estuaries and warmer or shallower waters are seen to reach maturity at smaller sizes (Emmerson *et al.,* 2018).

For this reason, it is important to gain samples from across the District range. Whelk across NWIFCA may differ significantly in their size-at-maturity. As we manage as a single stock unit, it is important to obtain a representative sample so not to under, or overestimate, the MCRS.

2.4 Standardised sampling

As with any scientific survey, it is preferable that the samples are obtained in a similar manner so not to skew results. Soak times and methods of capture can influence the samples of whelk obtained.

3. Method

In autumn/winter of 2024, NWIFCA with the assistance of industry stakeholders initiated a second attempt at collecting samples from each of the four sub-rectangles in the NWIFCA District. The plan was for whelk samples to be provided by fishers once per month as part of their normal fishing activity from September to December from the district's main fishing grounds.

3.1 Sample Collection

We worked with three vessels (two fishing vessels and North West Protector) and permits were obtained to allow the two fishers who agreed to take part dispensation to land the total contents of one pot of unsorted whelks per month for the four month period. Along with the contents of one pot, fishers were also asked to provide the following data with each sample: date of pots set and hauled, latitude and longitude, bait type and soak time.

Samples were not able to be obtained for the entire four month duration directly by NWIFCA officers due to the main vessel being offline from October onwards.

Eleven samples of whelk were provided from across the district during the months of September to December. Samples were collected from the four ICES rectangles (35E6, 36E6, 37E6 & 38E6).

3.2 Dissection Methodology

Samples were defrosted before analysis and individuals were measured (total shell length; 0.1mm, minimum shell width; 0.1mm), and weighed (total wet weight; 0.01g). All individuals collected were removed from their shells, sexed, and dissected and assessed using standard Cefas methodology. Figure 4 provides pictures of the methodology.

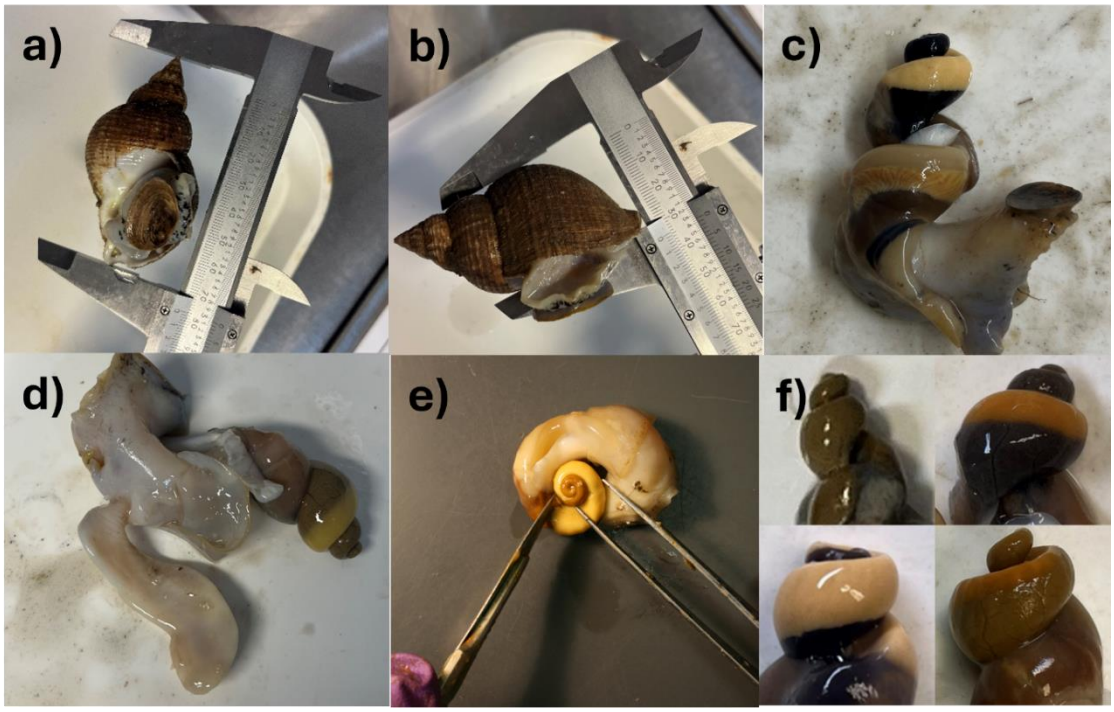


Figure 4. Images depicting the analysis of whelks in the lab. a) measuring shell length, b) measuring minimum shell width, c) removal of the body and gonads from the shell, d) measuring the penis if present, e) removal of the gonad and digestive whorl from the body, and f) the identification of maturity within each whelk.

The digestive gland and gonad are encapsulated in the same membrane and so are removed from the body and weighed together (Figure 5). As whelks prepare for reproduction, the difference between the gonad and the digestive gland becomes more apparent. Eggs stored in the female gonads are yellow and can be clearly identified by visual inspection. The proportion of the gonad/digestive gland made up of eggs gives a 'percent maturity' of an individual.

The data was then used to analyse the size-at-maturity. **Size-at-maturity is defined as the size at which a whelk is 50% likely to be mature.**

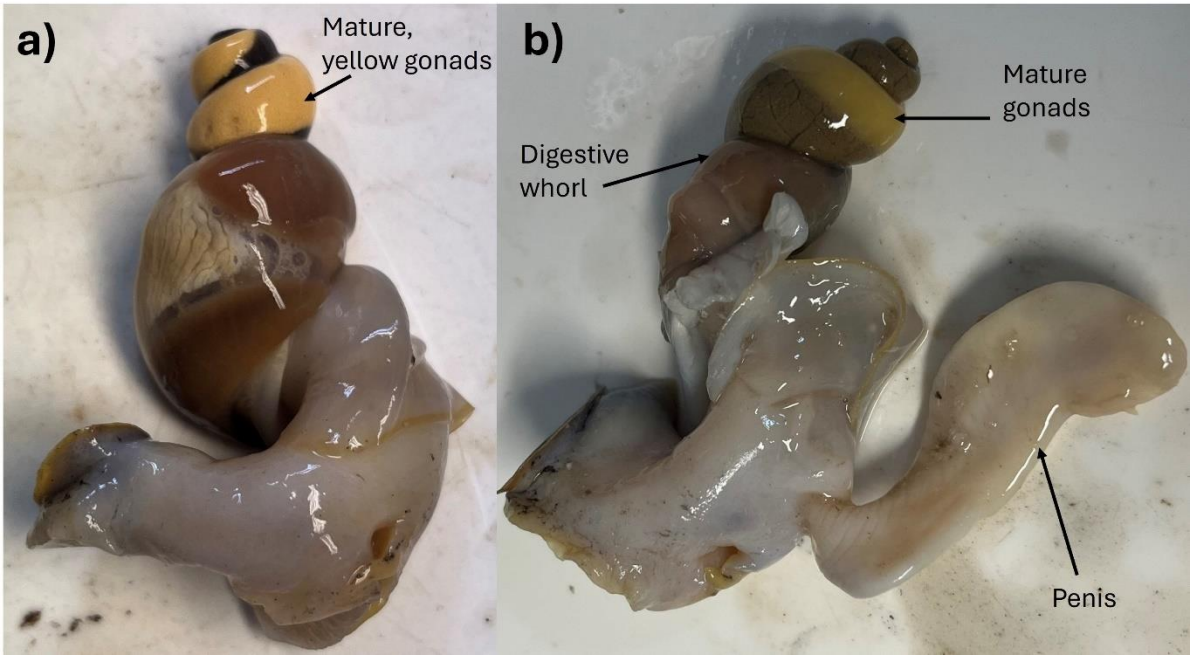


Figure 5. a) mature female whelk with gonads clearly differentiated from the digestive whorl, b) mature male, gonad differentiated from digestive whorl and penis fully developed.

3.3 Statistical Analysis

For calculating the size-at-maturity estimates (L_{50}) a logistic regression model was applied following the methodology detailed in Walker (2005). To do this, individuals were assigned a binary maturity factor (immature=0, mature=1) prior to analysis based on their visual maturity (Table 1). The formula for the logistic regression model is given below:

$$P = \left\{1 + e^{-ln(19)\left(\frac{L_i - L_{50}}{L_{95} - L_{50}}\right)}\right\}^{-1}$$

P is the proportion of the population that is mature at any given size (L_i), and L_{50} and L_{95} are the shell lengths at which 50% and 95% of the population are mature respectively.

In R, the logistic regression was carried out by means of a generalised linear model (GLM) with a specified binomial distribution and logit link function. Confidence intervals were calculated by bootstrapping the GLM (1000 runs of the model). The R code used for this analysis was adopted from Harry (2013) and previously used by Haig *et al.* (2015), Hollyman (2017) and Emmerson *et al.* (2017) in similar studies. Data were subset by sex and location, and maturity ogives estimated for each to see how these factors influenced L_{50} (the total shell length at which 50% of the population should be mature).

Table 1. Criteria for assigning binary maturity factors to the data from visual maturity measures.

Stage	Description		Binary factor
	Female	**Male**	
Immature	No visual differentiation between the gonad and the digestive gland	No visual differentiation between gonad and digestive gland.	**0**
Mature	>0% to 100% visual differentiation between the gonad and digestive gland.	>0% to 100% visual differentiation between the gonad and digestive gland.	**1**

4. Results

Overall eleven samples were collected across the district within the four ICES areas. A total of 1848 whelks were weighed and measured over the duration of the four months. From these 1848 whelks, 1277 were then dissected and maturity was successfully determined. The whelks were a mixture of both sexes and from all four sites.

4.1 Size-at-maturity estimates

When determining a suitable MCRS, it is important to look at:

1. The different size-at-maturity estimates for males and females to see if there is a significant difference between them, and whether an MCRS should be weighted in favour of the greater.
2. The size-at-maturity estimates for each location, to identify the range within the district
3. A total estimate of size-at-maturity including all sexes and locations – as the stock is managed as a single unit.

Size-at-maturity per ICES sub-rectangle and sex:

Table 2 summarises the size-at-maturity estimates for the whelks sampled in each ICES rectangle for all months sampled:

Table 2. The size-at-maturity results of 38E6, 37E6, 36E6 and 35E6 from the 2024 whelk survey.

Location	Gender	L_{50}
38E6	Female	73.3
	Male	62.3
	Combined	**68**
37E6	Female	55.5
	Male	56.3
	Combined	**56.1**
36E6	Female	71.5
	Male	66.8
	Combined	**68.7**
35E6	Female	66.9
	Male	61.1
	Combined	**65.1**

The results from Table 2 indicate that from the four ICES areas sampled 36E6 had the greatest combined size-at-maturity (L_{50}) for both males and females at 68.7mm. However, the greatest size-at-maturity was for females in 38E6 with an L_{50} of 73.3mm. Females consistently showed higher size-at-maturity estimates than males for most areas.

Combined size-at-maturity estimates are displayed on a map of the district in Figure 6. And the corresponding ogive figures are presented in Figure 7.

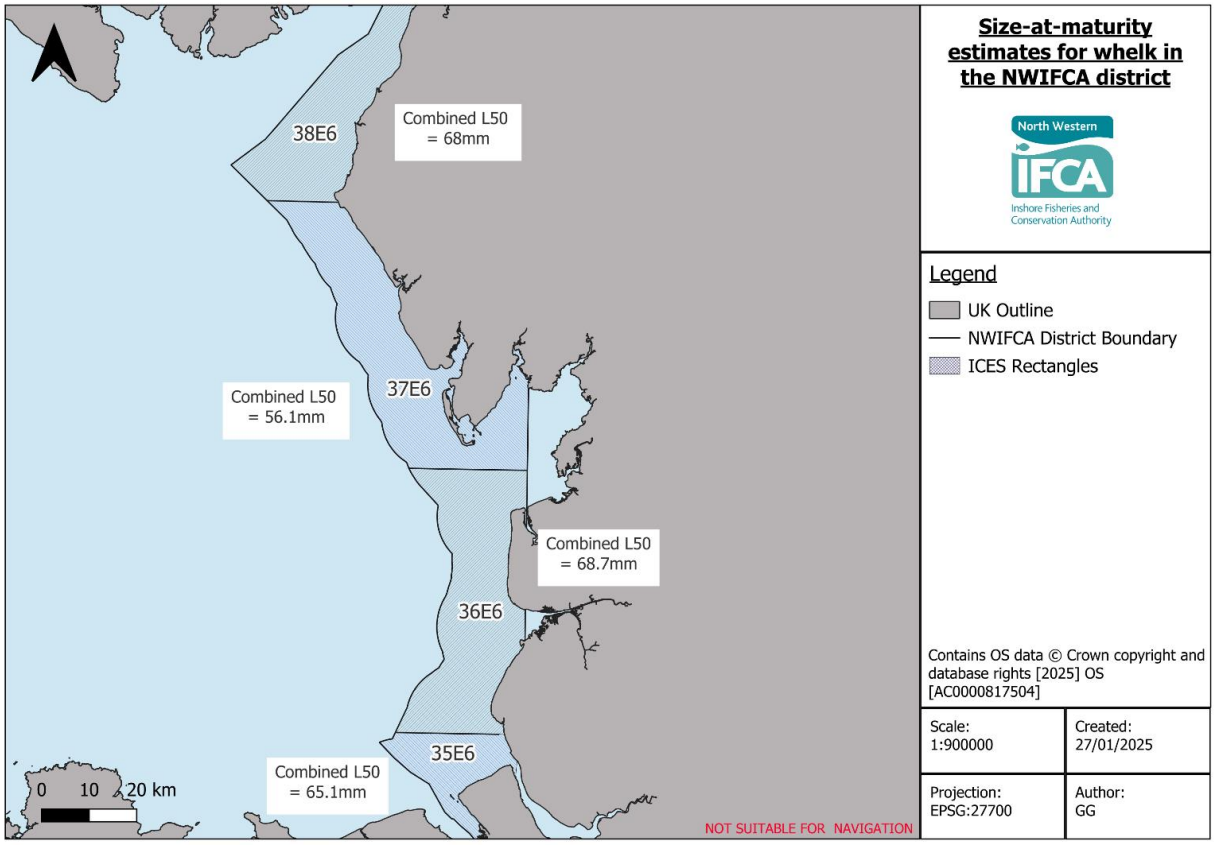


Figure 6. Map showing the whelk size-at-maturity (L_{50}) for each ICES rectangle sampled within the NWIFCA district. Each ICES rectangle shows the combined L_{50} result which includes both male and female whelks.

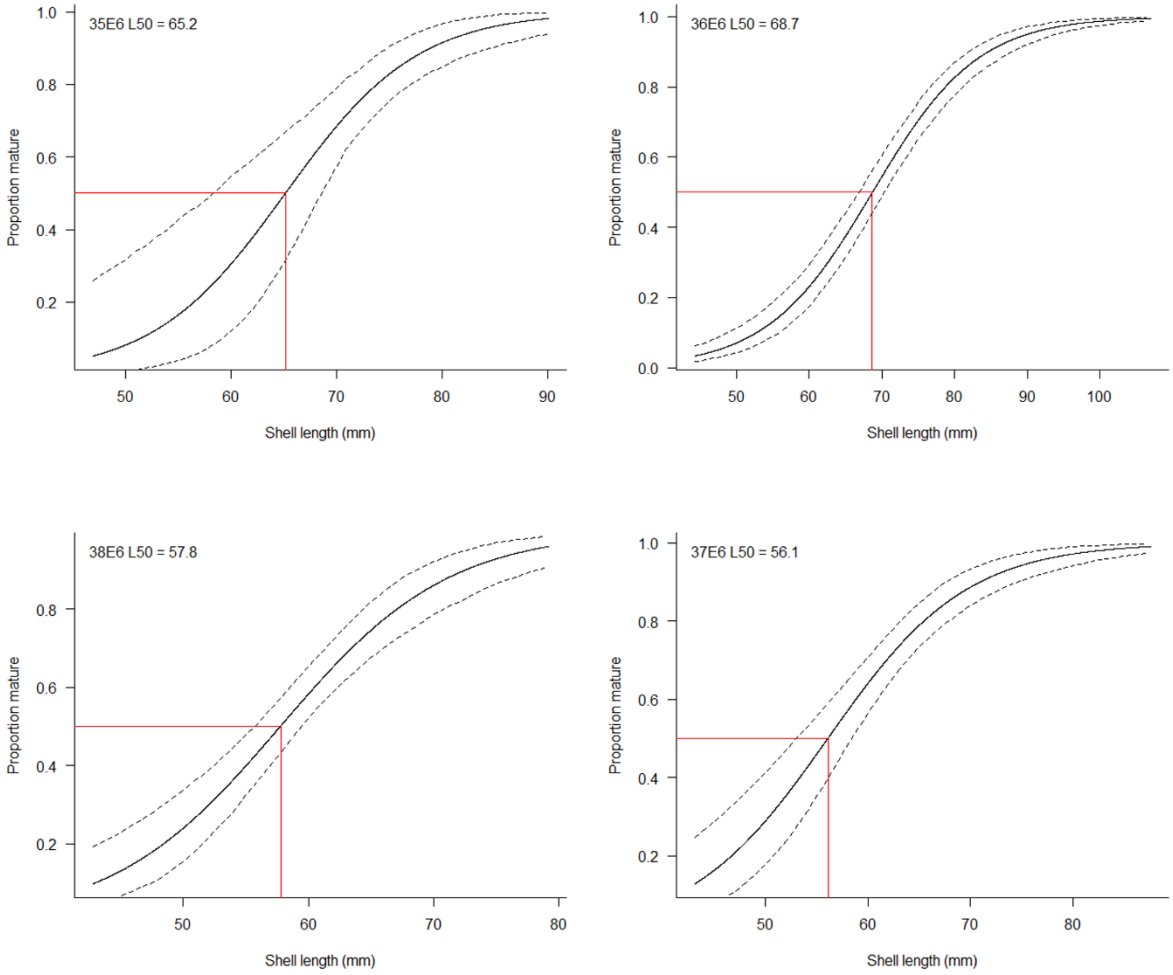


Figure 7. Maturity ogives for combined, male and female Buccinum undatum populations for samples taken across four ICES rectangles (35E6, 36E6, 37E6 & 38E6) within the NWIFCA district. The horizontal red line indicates 50% population maturity. The L_{50} is shown on the top left side of the figure. The upper and lower 95% confidence intervals are represented by the dotted lines.

It is important to note: samples from 35E6 show large confidence intervals at the base of the ogive curve. This is indicative of a large variance in the data. In particular, this sample suffered from whelks which once defrosted, lacked integrity and so were difficult to fully dissect. Only successfully dissected whelks were recorded, however the sample size was reduced and likely contributed to the lack of confidence in this data.

Similar data discrepancies were seen in samples for 38E6, where large variations on the size of whelk and their size-at-maturity estimates were observed. This resulted in the larger confidence limits around the lower and upper part of the size-at-maturity curve. Further data investigation showed that there were an unusual number of large, immature, males in this sample. Data was retained in this instance as it was not clear the cause and officers were conscious not to skew data.

size-at-maturity for the district as a whole:

As whelks are managed as a single stock unit within the District, it is important to calculate an size-at-maturity estimate for the full dataset.

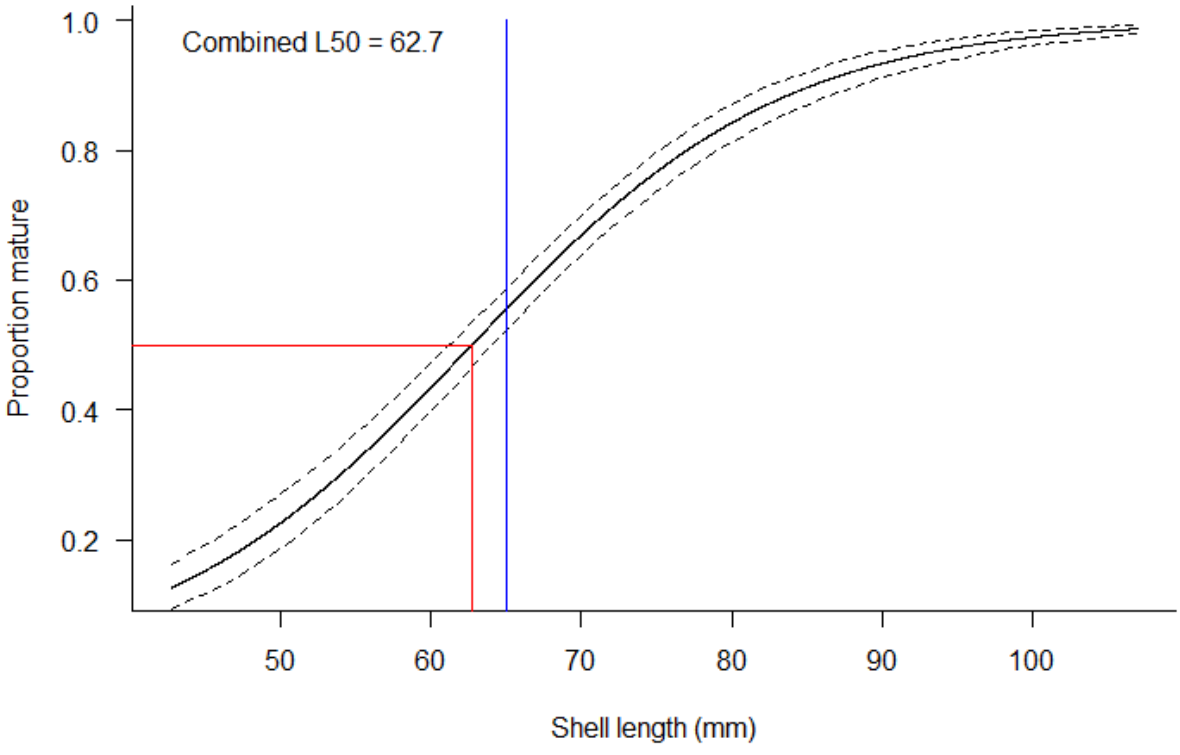
Table 3 shows that from all samples, across the full district, female whelks reach sexual maturity at 65.8mm and males at 60.2mm, with a combined L_{50} of 62.7mm. The corresponding ogive figures are presented in Figure 8.

Table 3. The size-at-maturity results for the NWIFCA district.

Gender	**L_{50}**
Female	65.8
Male	60.2
Combined	62.7

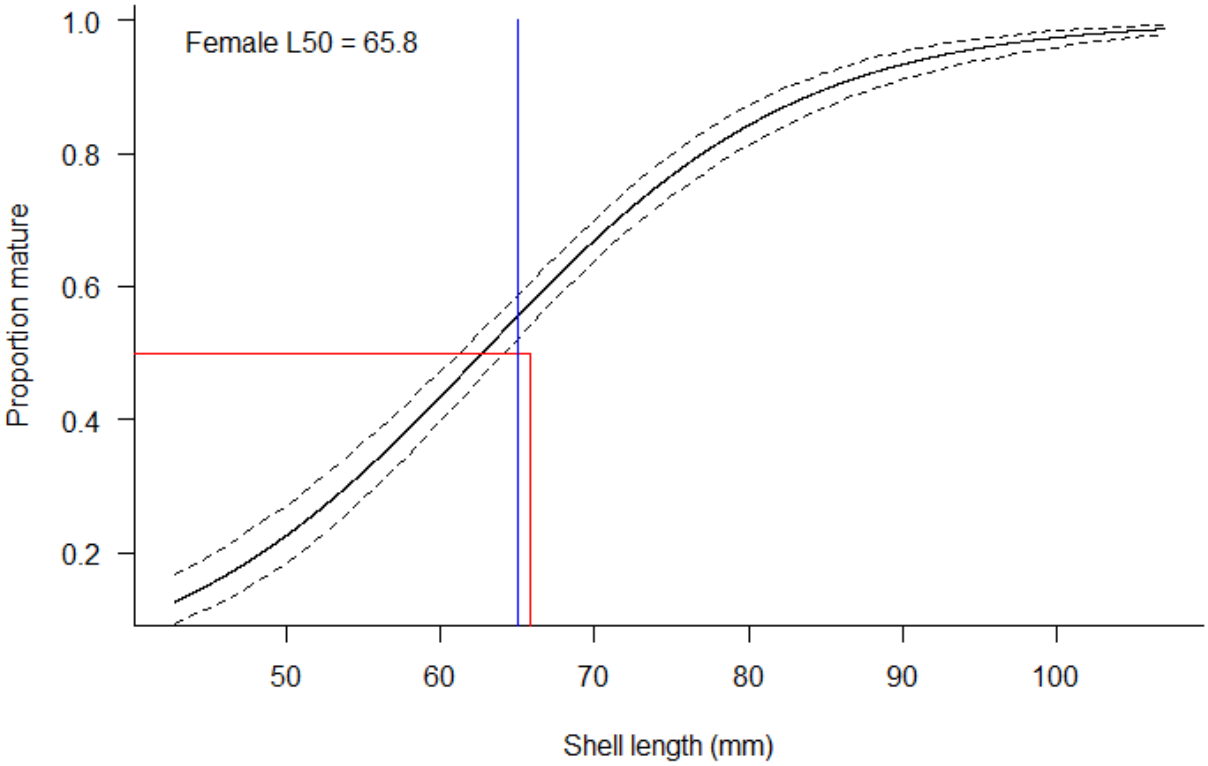
A) Combined L50 from 2024 Study

Combined = 62.7mm



A) Female L50 from 2024 study

Female = 65.8mm



B) Male L50 from 2024 study

Male = 60.2mm

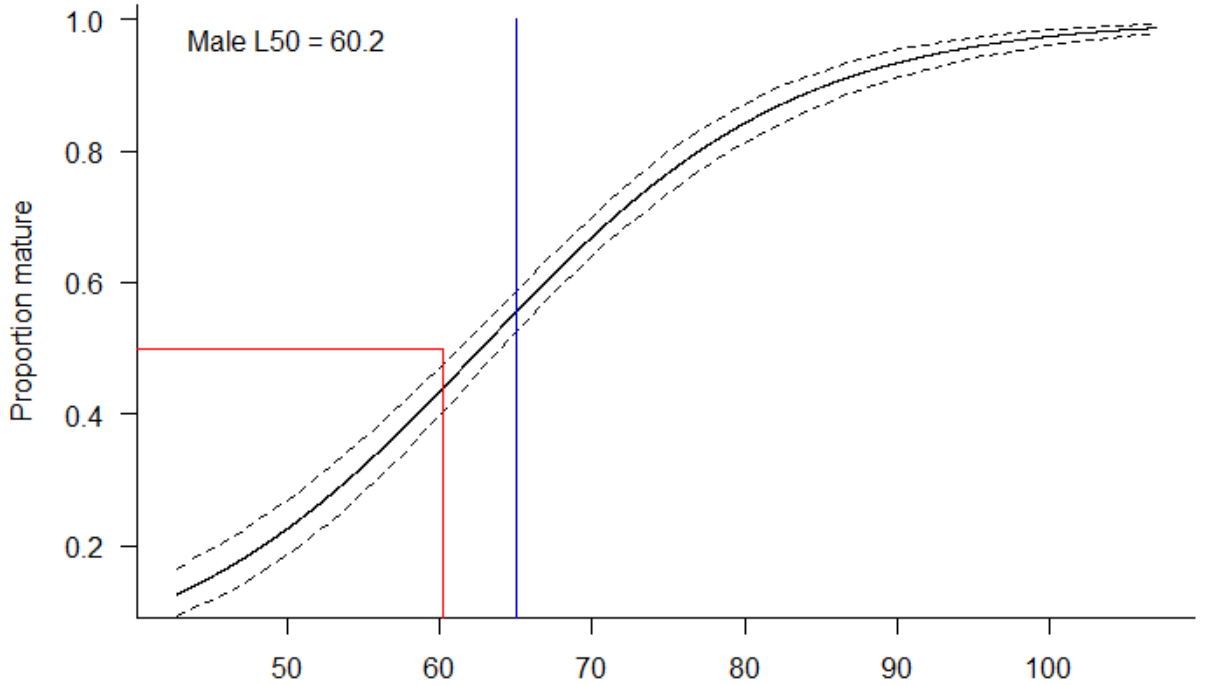


Figure 8. Maturity ogives for combined, male and female Buccinum undatum populations for samples taken across four ICES rectangles (35E6, 36E6, 37E6 & 38E6) within the NWIFCA district. The horizontal red line indicates 50% population maturity. The L_{50} is shown on the top left side of the figure. The upper and lower 95% confidence intervals are represented by the dotted lines. The horizontal blue line indicates 65mm.

The blue line on the graphs in Figure 8 indicate the current MCRS management measure of 65mm. Anything to the left of this line will be returned and protected, anything to the right will be retained under current management. It demonstrates that the current 65 mm is likely providing some protection to juvenile whelks, though potentially is insufficient to protect female whelks given their size-at-maturity estimate of 65.8mm. In addition, considering the full breadth of the District, it is important to consider that some areas had size-at-maturity estimates over the 65mm, with females even higher at 70+mm (see Table 2).

4.2 Size frequency results

In addition to investigating the size-at-maturity estimates, it is useful to see the size frequency distributions of whelk in the district. This shows the range and number of whelks that are potentially 'typical' for a particular area of the district (Table 4).

Table 4. Summary statistics for whelk total shell length sampled in each area of the district

Area	n	Mean length (mm)	SD	Min length (mm)	Max length (mm)
35E6	269	75.6	7.9	41.82	90.83
36E6	699	78.0	12.0	44.32	106.9
37E6	263	64.9	8.4	43.09	87.55
38E6	611	61.8	9.2	42.8	100.2
All	1842	70.4	12.5	41.8	106.9

These can change dependent on the time of year and during the breeding season, however, it is useful to show what a typical catch might consist of, and by extension, how different management measures might affect the volumes of whelk retained.

Figures 9 and 10 show the size frequency of whelks caught in the 4 ICES sub-rectangles of the NWIFCA District.

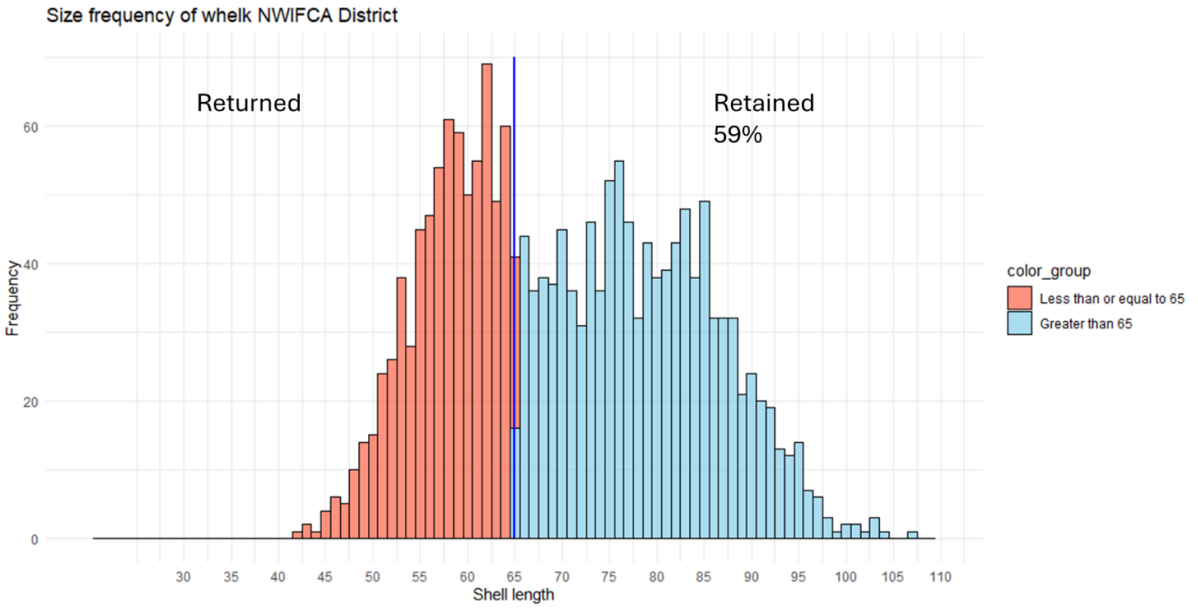
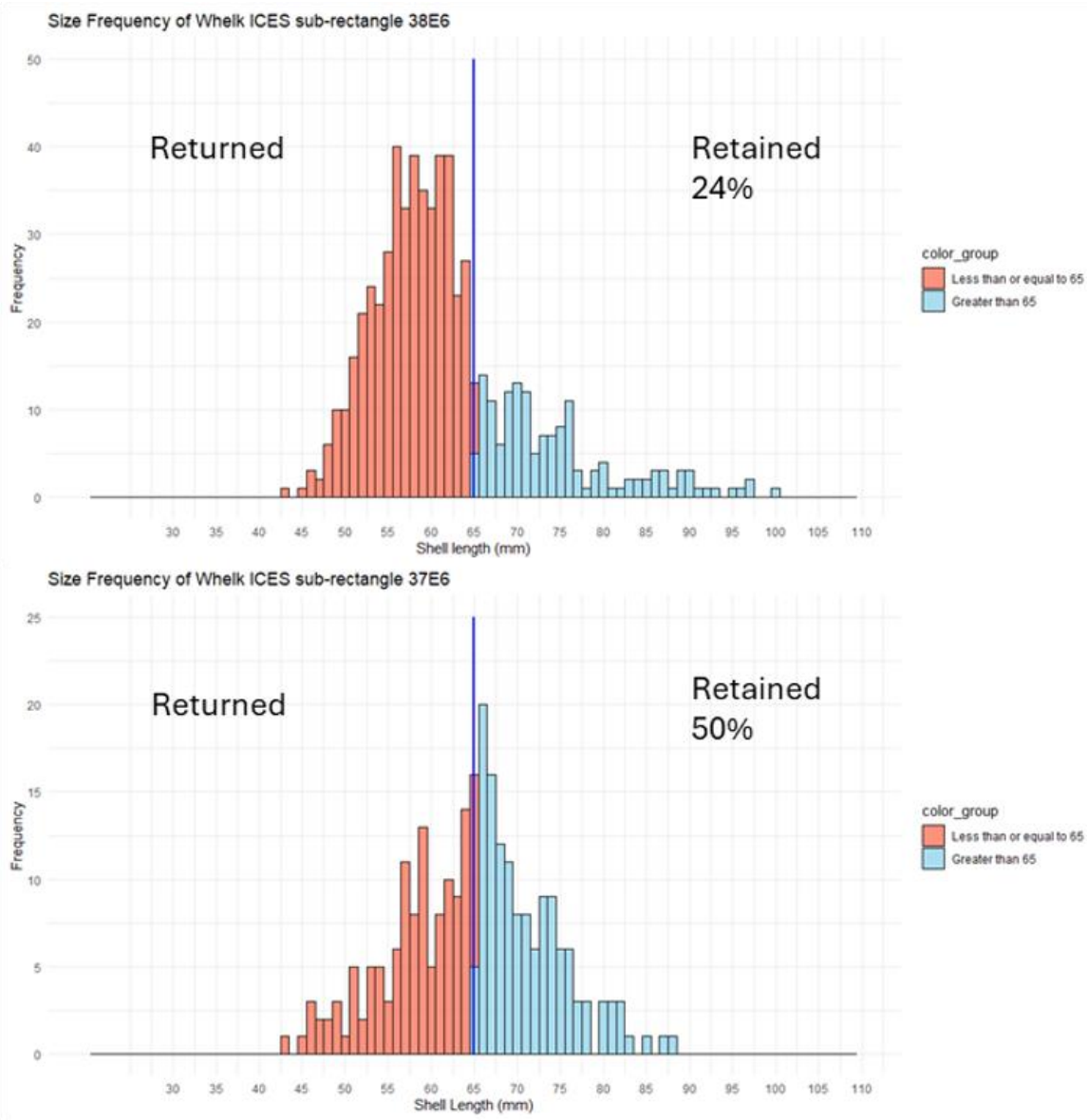


Figure 9. Histogram showing the size frequency for whelks sampled across the whole NWIFCA district. The x-axis represents the shell length in mm, while the y-axis indicates the number of whelks in each size class. The top right corner shows the percentage of whelks retained with a 65mm MCRS. The horizontal blue line indicates 65mm.



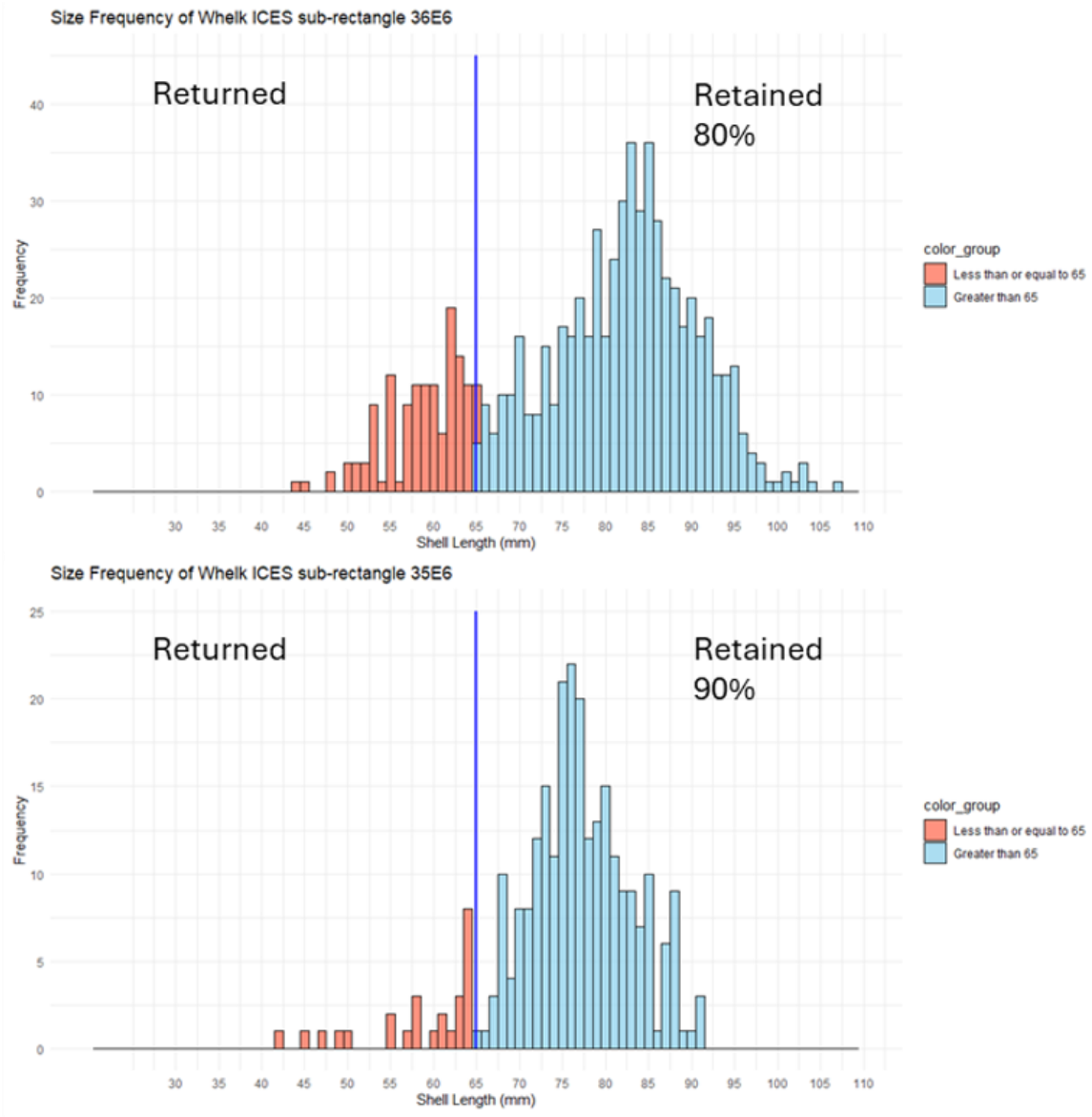


Figure 10. Histograms showing the size frequency for whelks samples taken from each of the four ICES rectangles (Top to bottom: 38E6, 37E6, 36E6 & 35E6) within the NWIFCA district. The x-axis represents the shell length in mm, while the y-axis indicates the number of whelks in each size class. The top right corner of each graph shows the percentage of whelks retained with a 65mm MCRS. The horizontal blue line indicates 65mm.

The blue line on the graphs in Figure 9 and 10 indicate the current MCRS management measure of 65mm. Anything to the left of this line (in red) will be returned and protected, anything to the right (in blue) will be retained under current management. The variation between the proportion of catch retained between the different areas is considerable.

It is again, important to note, that only one sample for 35E6 was obtained, which will limit the confidence in this data. Only the samples from 37E6 demonstrate normal distribution, this may be due to the large numbers of whelks obtained and analysed from this area in comparison to some of the others.

5. Important considerations and limitations

The aim of this current study was to gather further evidence to demonstrate if an increase in MCRS to 75 mm was necessary. From the results provided NWIFCA can say that the MCRS for whelk does not need to increase to 75mm.

Although the current results from this study provide much more confidence than previous data collected (2023,2020 and 2019) there is still further research to be done due to the following reasons:

Limitation	Reasoning	Future Recommendations
Limited sample numbers	Data analysis of 38E6 showed that out of the three samples collected from this area, two provided relatively similar estimates, whereas one was significantly higher at around 75+mm. This result could be caused by a number of different factors.	More research into 38E6 is recommended as this is the first time it has been sampled and so we would benefit from more data being collected for this area and for continued monitoring as this will help provide further confidence of the whelk size-at-maturity for that area, and help us to inform decisions on future management.
Data inconsistencies or skew	Nearly all whelks in the 37E6 October sample were mature, and there was not a great enough spread of sizes to allow the model to develop an accurate maturity model. This skewed data may have lowered the overall maturity estimate for 37E6 given that areas to the south gave a higher size-at-maturity estimate. Other samples for 37E6 showed L_{50} results of 60.4mm and 69.3mm, proving that Octobers sample pulled the combined L_{50} for 37E6 down to 56.1mm.	More consistent sampling would have allowed us to determine whether these were anomalous results or not. Without this, they have been included in the full analysis to avoid accidental bias.
	Further investigation into 38E6s sample with a higher L_{50} revealed that there was a number of large, immature male whelks in this particular sample. These whelks had small reproductive organs relative to others of a same size and gender. A possible suggestion is these whelks could have been suffering from some form of parasite which affected their development, though uncommon, is not unheard of, and has been studied by cefas in more depth with regards to the possible causes.	
Potential error identifying maturity during the breeding season	A problem that can be had during the breeding season is that it can be difficult to tell the difference between a spent whelk (recently copulated/spawned) and an immature whelk. Therefore, some whelks might be falsely classed as immature.	This can be reduced with a larger sample size.

6. Options analysis

The following section explores the potential management options with regards to the NWIFCA whelk MCRS.

Due to the caveats associated with the data analysed in this report, and the large degree of differing size-a-maturity estimates, a clear MCRS recommendation for the full stock was difficult to determine. Therefore, three potential options were explored, and a SWOT analysis undertaken. The SWOT analysis details the relative strengths, weaknesses, opportunities and threats each option offers. These options are presented below.

MCRS alone is not a stand-alone management tool to and all options should be considered in addition to other management tools such as: pot limitations, permit limitations and seasonal closures.

Option 1. Increase to 75 mm (as detailed in Byelaw 4 Flexible Permit Conditions)

Option 2. Retain at 65 mm – with a view to re-asses in the next 3 years

Option 3. Increase to 68 mm - with a view to re-asses in the next 3 years

Option 1

Increase the MCRS to 75 mm as stipulated in the NWIFCA Byelw 4 flexible permit conditions.

Strengths: Provides full protection to district stock, including the large females identified in 38E6 and 36E6.

Weaknesses: The data is subject to limitations. This increase is excessive given that much of the stocks size-at-maturity falls below this. In the district as a whole, less than 38% of catch would be retained, and in some areas, less than 10%.

Opportunites: Limited

Threats: Increasing to 75 mm would significantly impact the fishery, as it would likely become uneconomical for fishers.

Recommendation: Not recommended

Option 2

Retain the 65 mm MCRS with a commitment to review in 3 years time

Strengths: It provides protection to much of the district stock as a whole. It strikes a compromise between stock retained percentages in the upper and lower part of the district. Many fishers are already familiar with this MCRS and will have gear set up to facilitate the retaining of 65mm+ whelk.

Weaknesses: It is still not enough to protect the larger females identified in the northern part of the district. The data has caveats which need to be explored.

Opportunites: Additional fishers who have so far limited their activity in the fishery due to concern over the increase to 75 mm may start to re-enter the fishery. This would allow us to get a better understanding of the effort levels the stock faces, and open up potential additional avenues for data collection and monitoring. If we identify the key fishing grounds, we could look to review the MCRS in 3 years-time to assess its appropriateness, and whether it needs to be weighted in favour of particularly highly targeted areas.

Threats: We still do not know the pressure on the stock, or have clear stock assessment data. If a review shows an increase it needed later on, this may be unpopular with members of industry

Recommendation: **Recommended**

Option 3

Increase the MCRS to 68 mm

Strengths: It provides further protection to vulnerable female stock in areas of the district, and provides protection for nearly all areas combined estimates. It does not significantly drop the percentage retained for the whole district significantly (>53% of catch could be retained under a 68mm MCRS)

Weaknesses: Given the uncertainties and inconsistencies in the data, it is difficult to confidently propose this measure. The increase would still further reduce the percentage retained in some areas of the district

Opportunites: Additional fishers who have so far limited their activity in the fishery due to concern over the increase to 75 mm may start to re-enter the fishery. This would allow us to get a better understanding of the effort levels the stock faces, and open up potential additional avenues for data collection and monitoring.

Threats: It is unknown how stakeholders view this proposal, and if new data collected does not support this, a further change could prove difficult for industry relations.

Recommendation: **Not recommended at this time**

7. Recommendation

In 2024, NWIFCA with the assistance of stakeholders obtained a more comprehensive and geographically distributed range of samples than has been previously achieved. This data has assisted in building a picture of the size-at-maturity estimates size distribution of the region's whelk stocks.

The large difference in size-at maturity highlights a common difficulty in managing whelk fisheries even over small spatial scales. Sample sites several kilometers apart show size-at-maturity estimates that are 10+mm different. The application of different management measures on such a small spatial scale is impractical for enforcement purposes and, therefore, stock is managed as a single unit across the NWIFCA district.

On the balance of data presented here, NWIFCA recommend the MCRS for whelks is set at 65mm, with the commitment to review this in a minimum of 3 years (option 2, see section 6).

The justification for setting the MCRS at 65 mm is as follows:

- **The overall size-at-maturity estimate for whelks in the district 62.7 mm**. However, it is important to protect the most vulnerable stock where possible, and so the current 65 mm MCRS provides a balance between providing protection to a greater proportion of females, while fully protecting males. It provides protection for large proportions of stock in 35E6 and 37E6 (location of a main fishing ground).
- Based on size-frequency estimates, 65 mm would allow for around 59% of catch to be retained.
- All whelks sampled across the region reached size-at-maturity below 75 mm.

The justification for undertaking a 3 year review is as follows:

- **There is still significant inconsistencies in the data set (see section 5)** despite obtaining a broad range of samples from across the district, samples were still inconsistent. Samples were not obtained every month for each area, and the limited data makes it difficult to identify anomalous results, and have confidence in the size-at-maturity estimates.
- **There are significant regional differences in size-at-maturity across the differences** – the MCRS may still be too low to protect spawning stock in areas 38E6 and 36E6. the greatest size at maturity for females was 73.3mm, and the lowest was 55.5 mm. It is important to protect vulnerable stock, and it is still possible the 65mm is not protecting vulnerable juveniles in certain areas of the district. It is not clear as yet where the greater part of the fishing effort is being concentrated, and it may be possible

with more data, to determine whether management should be weighted in favour of those stocks which are more heavily targeted. In addition, other management tools can be used in conjunction with the MCRS which will assist in limiting effort and targeting of vulnerable stocks such as pot limitations and seasonal closures need to be explored.

- Continued monitoring of the stocks size-at-maturity is recommended to be able to detect the presence of recruitment overfishing and the effectiveness of the 65 mm MCRS
- Given the above points and the data presented here, an increase to 68 mm could be a future option for management, should the additional data on the fishery support this.

8. Conclusion and next steps

Regulatory bodies such as NWIFCA must achieve a balance between the practicality of management, life-history parameters of the population, fishing intensity, and the local fleet dynamics, when determining management measures that aim to ensure the sustainability of a fishery. Despite the increasing volume of research being undertaken, the whelk fishery is still considered data poor and stock assessments are not available for much of the UK. The results presented here demonstrate the importance of understanding the life-history of whelks in determining effective management and setting an MCRS, however, they also highlight the difficulties in determining an effective MCRS over even small geographic ranges, and obtaining accurate and reliable datasets on these fisheries.

Future work, in addition to the continued monitoring of the MCRS is required as follows:

Stock assessments:

The lack of a baseline stock assessment means it is difficult to determine whether the current levels of fishing are high enough to cause long-term depletion of stock or a reduction in size-at-maturity due to recruitment overfishing. It is, therefore, critical that data on the fleets catch per unit effort (CPUE) is obtained, and a stock assessment carried out. Using MCRS as the sole tool for management would likely require further increase. Such a measure is often unpopular with fishermen given the immediate drop in yield and increased effort they may incur. Limiting effort by introduction of limited permits and pot limits are simple to enforce and have been demonstrated in other districts to contribute to successful management. However, further research is needed to a) identify a baseline stock level, and b) identify if the current pot limitations are appropriate.

Effort limitation:

Closed seasons and pot limitations can be explored as a measure to protect stock. Closed have also been used in other shellfish fisheries as a measure of catch limitation and protection of breeding stock. Knowledge of the whelk spawning season and growth rates as presented here could also be used to determine the timing of a closed season that protects first year spawning stock and increases the number of individuals reproducing at least once before removal.

Many of the under 10m fishers in the NWIFCA district target a variety of commercial species in addition to whelk, the relative contribution of these to their landings and income fluctuate dependent on the season, availability and price. Future analysis of CPUE data could look to identify the influence of socio-economic and alternative species availability on whelk fishing effort in the district.

We propose officers develop a 2025/26 whelk research plan to continue building our understanding of the districts fishery and achieving sustainable management.

9. Acknowledgements

We would like to thank the skippers and their crews involved with the collection of the whelk samples as without the co-operation of the whelk fishers this study would not have been possible.

Annex A

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