NWIFCA Technical Science and Byelaw Meeting 6th of February 2023: 10:00 a.m.	Agenda Item 9

WHELK MINIMUM CONSERVATION REFERENCE SIZE STUDY RESULTS

Purpose: To provide an update on the NWIFCA's research into the size-at-maturity of whelks in the District.

Recommendation:

1) Receive the report

2) The current MCRS for whelk be temporarily frozen at 65 mm until the 6th of June 2025 to allow officers to gather further evidence to demonstrate an increase in 75 mm is necessary. Without such evidence the intended increase to 75 mm will come into force as of 6th of June 2025 in accordance with the precautionary principle.

1. Background

1.1 The need to assess the 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.

The Flexible permit Conditions of Byelaw 4 stipulate an annual increase in the whelk MCRS from 55 mm to 65 mm to 75 mm each year from its inception.

1.2 Evidence in support of the 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 presented 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).

The recommendation to increase the MCRS to 75mm was based on the references provided in Annex 1 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:

- 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.
- The national MCRS of 45 mm does not provide enough protection to the majority of UK stocks.
- 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 L50) were 67.2mm and 69.5mm for females and 71.6mm and 74mm for males.

- Other Irish Sea figures include samples from North Wales with a mixed L50 of 51.4mm (females from Menai Bridge) to 77.9mm (males from Nefyn) and samples from the Isle of Man with a mixed L50 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 an incremental increase in whelk MCRS. However, since the introduction of the byelaw, members of industry have raised concern that the upper limit of this size might be too high for the stock, and detrimental to the fishery.

1.3 Stakeholder concerns over the whelk MCRS

Over the past year, four permit holders have expressed concern that the increase from 65 mm to 75 mm will negatively impact their activities and potentially make it uneconomical.

2. Important considerations for determining MCRS for whelk

2.2 How is whelk MCRS typically determined?

The MCRS for whelk is typically set at it's 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.

2.3 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 often seeing the laid eggs on the side of pots in winter.

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).

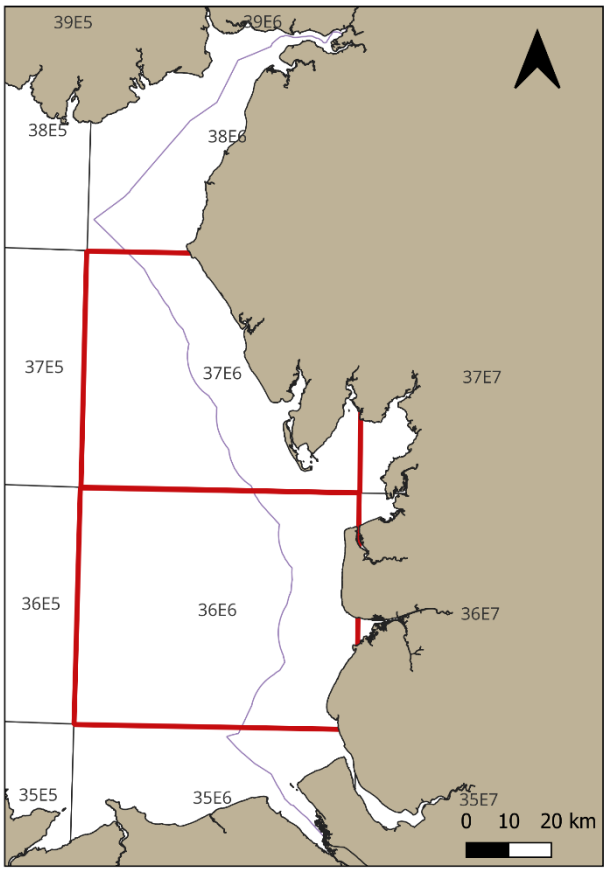
2.3 Geographic range is also important

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. NWIFCA Whelk Research to Date

Previous sampling was undertaken by officers in 2019 and 2020. Samples were taken from 4 months of the year (March, April, and August) in 2019, from 5 months in 2020 (February, May, June, and July) from 2 months in 2023 (October and December).

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

An overview of the sampling schedule, dissection and analysis methodology is provided in Annex 2 of this report.

Figure 1 (Left). The location of whelk samples obtained from across the District. The main sample areas have fallen within the southern portion of 37E6 and 36E6.

3.1 Study results

Table 1 summarises the size-at-maturity estimates for the whelks sampled in their respective years:

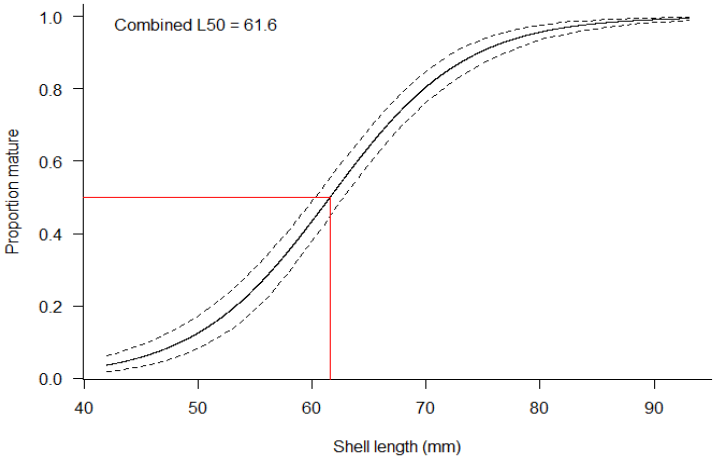
Table 1. The size-at-maturity results of the 2019, 2020 and 2023 whelk surveys.

Year	Location	Gender	L50
2019	36E6	Female	61.6
		Male	62
		Combined	**61.6**
2020	36E6	Female	59.7
		Male	61.2
		Combined	**60.4**
2023	36E6	Female	59.2
		Male	62.4
		Combined	**61**

Results from the three sample studies demonstrate that whelks from the central part of the NWIFCA District reach size-at-maturity (L50) at around 61 mm in length. The corresponding ogive figures are presented in figure 2.

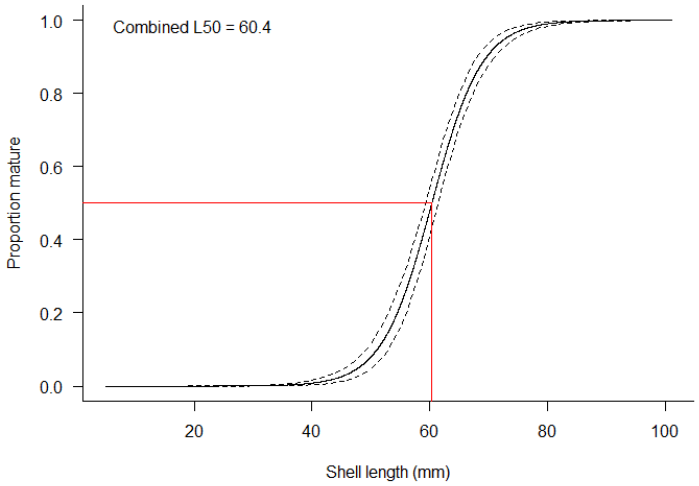
A) ICES Rectangle 36E6 (March, April, and August) 2019 Study

Combined = 61.6 mm



B) ICES Rectangle 36E6 (February, May, June, and July) 2020 Study

Combined = 60.4 mm



C) ICES Rectangle 37E6 (October and December) 2023 Study

Combined = 61 mm

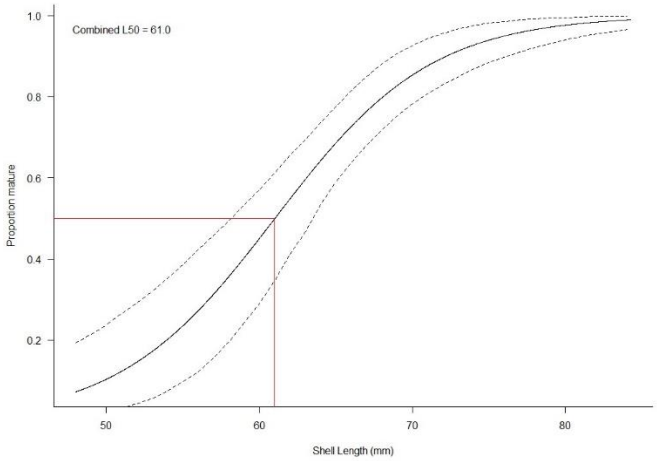


Figure 2. Maturity ogives for combined (male and female) *Buccinum undatum* populations for samples taken from A) ICES rectangle 36E6 for 2019, B) ICES rectangle 36E6 for 2020 and C) ICES rectangle 37E6 for 2023. The horizontal line indicates 50% population maturity. The L_{50} is shown on the plot by the figure. The upper and lower 95% confidence intervals are represented by the dotted lines.

4. The need for further study

The current results provide limited confidence due to the following reasons:

1) Limited geographic range.

No samples have been obtained or assessed from the Northern part of the District. Research indicates that it is likely the whelks in the northern part of the District will reach maturity at a larger size. As the District whelk population is managed as a single stock unit, it is important that further samples are gathered from these areas.

2) Inconsistent sample timings

Samples taken at different times of the year can have slight effects on the SOM prediction. It is typically best to sample prior to the main spawning season as this is when most mature whelks will be visually showing their maturity. The survey results presented here were collected at inconsistent times of the year. Consistent samples from autumn would assist in building the confidence of whelk SOM.

3) Limited sample numbers

In 2023, only 2 samples were obtained from a single area of the District. In 2020 and 2019, 3 and 4 samples were obtained respectively, and at inconsistent times of the year. This does not represent the District whelk population from which to build an accurate L50 estimate and thus MCRS. Samples from the northern and southern areas must be obtained to provide further confidence. This is indicated in the figure 2 graphs by the wide confidence limits represented by the dotted lines, and the low numbers of small whelk present in samples.

Further data is needed from the full extent of the District over the main breeding season (at a minimum) to be able to determine an accurate MCRS for whelk across the NWIFCA District.

5. Recommendation

Taking into consideration the concern of fishers regarding the increase from 65mm to 75 mm, and the limited confidence in the results of the current whelk studies, officers make the following recommendation to the Authority:

Recommendation: The current MCRS for whelk be temporarily frozen at 65 mm until the 6th of June 2025 to allow officers to gather further evidence to demonstrate an increase in 75 mm is necessary. NWIFCA officers will work to obtain the evidence before the June 6th 2025. Without such evidence the intended increase to 75 mm will come into force as of 6th of June 2025 in accordance with the precautionary principle.

NWIFCA is now better placed to obtain samples for this research this coming Autumn due to availability of the vessel and propose to undertake a further sample schedule in 2024. Officers will also develop a stakeholder engagement strategy to encourage further participation with industry members.

Annex 1

References

- Management recommendations for English non-quota fisheries: Common whelk. Blue Marine Foundation. Final Report. 16th July 2018
- McIntyre R, Lawler A, Masefield R (2015) Size of maturity of the common whelk, Buccinum undatum: Is the minimum landing size in England too low? Fish Res 162: 53–57. doi:10.1016/j.fishres.2014.10.003
- Lawler A (2013) Determination of the size of maturity of the whelk Buccinum undatum in English waters − Defra Project MF0231
- Hollyman, P. R. (2017). Age, growth and reproductive assessment of the whelk, Buccinum undatum, in coastal shelf seas. Bangor University.
- Emmerson, J.A Haig, I.S.M. Bloor, M.J. Kaiser. (2018). The complexities and challenges of conserving common whelk (Buccinum undatum L.) fishery resources: Spatio-temporal study of variable population demographics within an environmental context

Annex 2.

Overview of NWIFCA Whelk Research study 2023

Sampling schedule overview

A new sampling schedule for determining the size-at-maturity for whelks was developed for the summer of 2023.

The plan was for whelk samples to be provided by fishers once per month as part of their normal fishing activity from May to September from the main fishing grounds. Four fishers initially agreed to take part, however, due to other commitments, limited targeting of whelk or loss of contact, only one vessel was able to provide us with samples. Samples were not able to be obtained directly by officers due to the main vessel being offline during this period.

Three samples of whelk were provided from the center of the District from October to December.

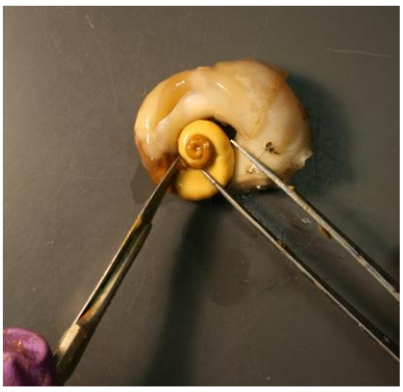
Additional data was also available from samples collected in 2019 and 2020. The results of these are also presented.

Methodology

In both studies, samples were defrosted before analysis and individuals were measured (total shell length; 0.1mm, maximum 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 1 provides pictures of the methodology.

a)Measuring Shell length

b)Removal of whelk body from shell



c)Assessing maturity

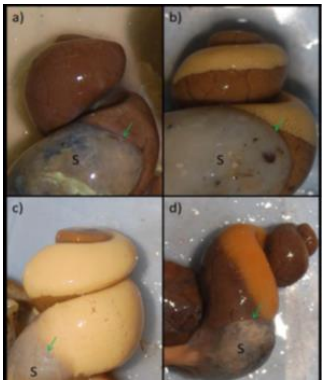


Figure 1. Images depicting the analysis of whelks in the lab, from a) measuring shell length, b) removal of the body and gonads from the shall, and c) the identification of maturity within each whelk.

The digestive gland and gonad are encapsulated in the same membrane and so are removed from the body and weighed together (Fig.1.c). 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.**

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 (Tab.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**