Welsh whelk length-based indicator assessment

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Dr Natalie Hold, Charlotte Colvin, Professor Lewis Le Vay

Executive Summary

The annual survey of whelk in Welsh waters took place in September 2022. Five sites, distributed across Wales, were surveyed. These have been labelled regionally to allow some indication of geographical distribution, but port level data has been removed to protect commercially sensitive data. Size data for whelk along with four size-based stock status indicators and reference points were used to assess the status of stocks in Welsh waters. The assessment indicates:

1. 70% of the indicators assessed across Wales were classified as being in "good" status, with the remaining 30% classified as "poor" status.
2. There was variation across the sites, with some sites performing better than others, although no one site performed poor across all four indicators.
3. The primary factor in the poor status results was the fact that there are some whelk smaller than size at maturity being caught and retained by commercial riddles.
4. These results do not suggest a full 20% buffer on the Annual Catch Limit needs to be applied. However, with some poor results a lower buffer (10%) would be both proportional and precautionary given the short time series and remaining uncertainty in some of the data.
5. Welsh Government landings statistics, not presented here, do not suggest that the progression towards the Annual Catch Limit in 2022 has been too rapid by using 50 tonnes monthly catch limit and there is no concern regarding over-shooting the Annual Catch Limit. Therefore, there is no evidence to suggest this monthly cap needs to be altered.
6. Improvements to these annual surveys would be made with the inclusion of size data of whelk landings across the season (either monthly or quarterly).

Methods

This report summarises the status of the Welsh whelk stocks using size-based indicators and reference points. A full scientific report will be release in December 2022.

Data were collected during September 2022 using scientific whelk pots that are commercial pots adapted to capture smaller whelk (10mm drainage holes and smaller mesh size). Scientific pots were given to fishers fishing out of five ports spread across Wales (North East Wales, North Wales, North West Wales_a, North West Wales_b, South West Wales).
Whelks fished by these pots were counted, measured, weighed, and dissected in the laboratory, with maturity and age estimated. These data were combined with data from the same sites from 2020 and 2021, and then used to calculate the following biological parameters:

1. Size at 50% maturity (L_{mat})
2. The power parameter in the length weight relationship (wbeta)

Existing data from 2020 and 2021 was used to estimate growth of whelk at each site and the following parameters:

1. Asymptotic size (L_{inf})
2. Growth rate (k)

Mortality rate (M) was collected from the literature, as best available evidence:
Length density plots were constructed to show changes in length structure of whelk stocks over time.

Size Based Indicator reference points

A series of length-based indicators were calculated for each population/site surveyed. Some indicators are calculated using total catch and some using landings data. Currently there are no landings size-frequency data available, therefore we truncated the scientific datasets to >= to 60mm in total shell length and used only length data collected in 2022, to act as a proxy for landings size-frequency in 2022. The following parameters were then calculated (See Hold *et al* (2021) for formulae):

1. Optimum size for capture (L_{opt})
2. Mean size of the largest 5% of the catch ($L_{max5\%}$)
3. Proportion of "megaspawners" or greater than 10% larger than L_{opt} (P_{mega})
4. The shell length at the 25% percentile of the landings (L_{25})

Data on length of whelk, retained using a riddle on a commercial whelk boat (riddle width 27-28mm), was used to calculate the length at first capture (L_c) and the value at which scientific length data would be truncated to represent landings. This is the size that is considered the average size that the fishing gear selects for. This is calculated by carrying out a regression on the ascending curve of the riddled size frequency data. Lc is the shell size at which the regression line is 50% of the maximum size class frequency. This value was 60mm.

All calculations and models were carried out in the software R.

Indicator reference points

To allow assessment of the population, indicators, in terms of what a healthy size and age structure should look like, we utilised previously determined reference points (Table 1). See Hold *et al* (2021) for the references and evidence used to develop these.

Table 1: Reference points for the Welsh whelk stock.

Indicator	Green	Amber	Red
1: $L_{max5\%}$	$L_{max5\%} / L_{inf} > 0.8$	$L_{max5\%} / L_{inf} = 0.8$	$L_{max5\%} / L_{inf} < 0.8$
2: P_{mega}	$P_{mega} > 0.3$	$P_{mega} = 0.3$	$P_{mega} < 0.3$
3: $L_{25\%}$	$L_{25\%} / L_{MAT} > 1$	$L_{25\%} / L_{MAT} = 1$	$L_{25\%} / L_{MAT} < 1$
4: L_c	of $L_c / L_{MAT} > 1$	of $L_c / L_{MAT} = 1$	of $L_c / L_{MAT} < 1$

A site will be described "in poor status" if indicators are below reference points, satisfactory if they are equal to the reference points and good if they are over the reference point.

L_{25} and L_c assess the conservation of smaller individuals in the site. $L_{max5\%}$ and P_{mega} assess the conservation of larger individuals in the site.

Results

Each site was assessed separately due to the spatial variation in biological input parameters. A complete description of parameter values will be provided in the full scientific report. These results are then pooled together and summarised for Welsh fisheries as a whole.

Length Frequency

Figure 1 shows the length density plots for the three whelk surveys and how these have changed over time. North has good recruitment coming through but a decrease in the size range associated with the fishery. There has been little change at northeast apart from some growth. Northwest_b seems reasonably stable over time, although 2022 does not have the small peak of large whelk seen previously. Northwest_a has a clear bi-modal distribution in 2022 with both larger/old cohorts and a smaller cohort coming through. The presence of a larger cohort is an improvement on previous samples. Southwest has had a broad range of

size classes in all three sampling periods. However, in 2021 there was a larger peak of the largest/oldest cohort compared to 2020 and 2022. South has only been surveyed once.
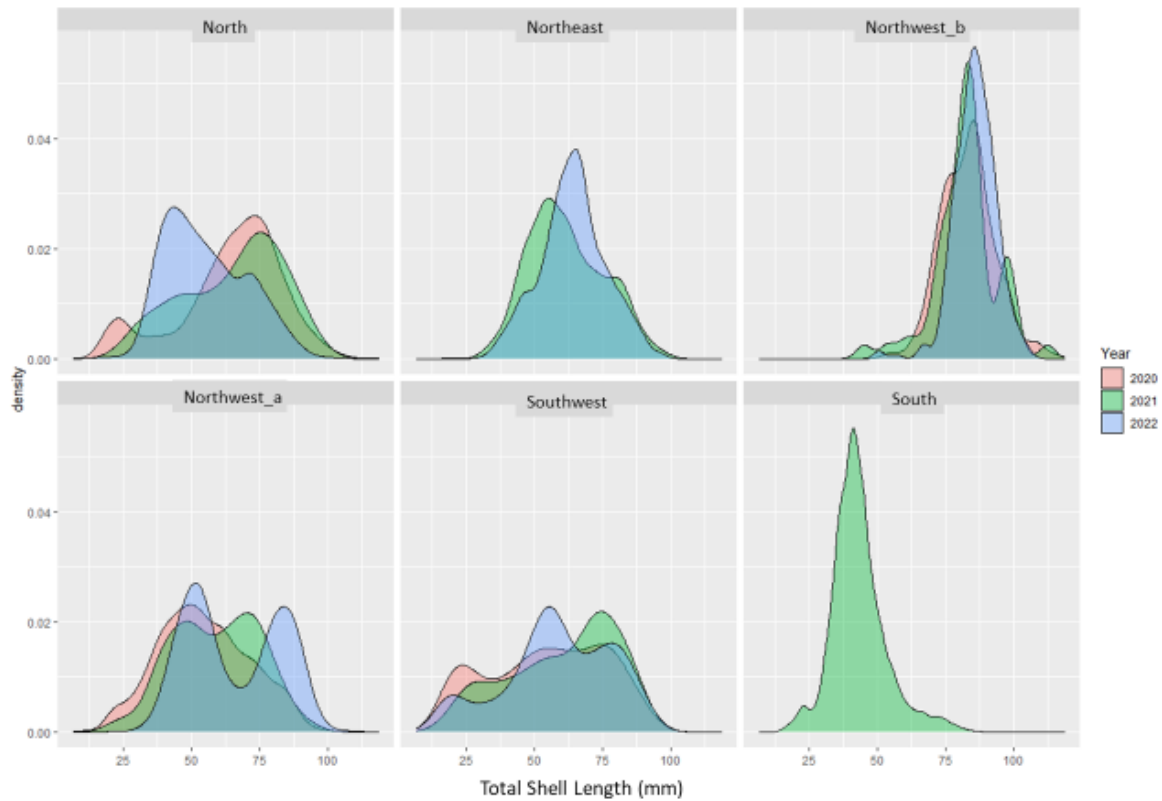

Figure 1: Length density plots for whelk across 6 sites in Wales with data collected over three survey periods (2020 = December 2020-May 2021; 2021 = December 2021 – May 2022; 2022 = September 2022). Plots 1 – 5 represent the sites assessed in September 2022. South has been included for reference but has not been assessed this year.

Indicators

Northeast Wales

Table 2: Indicator results for Northeast.

Northeast			
Conservation of Juveniles			
Indicator	Value	Limit	Status
L25	1.03	1	Good
Lc	0.97	1	Poor
Conservation of large individuals			
Lmax5%/Linf	0.97	0.8	Good
Pmega	0.34	0.3	Good

The site shows a mixture in the indicators related to the conservation of smaller individuals at the site. Whilst most of the sizes of "landable" whelk were above the size at maturity, the selectivity of an average commercial riddle is below the size at maturity. The indicators showed good status of conservation of larger individuals at the site

North Wales

Table 3: Indicator results for North.

North			
Conservation of Juveniles			
Indicator	Value	Limit	Status
L25	1.01	1	Good
Lc	0.93	1	Poor
Conservation of large individuals			
Lmax5%/Linf	0.82	0.80	Good
Pmega	0.13	0.30	Poor

This site shows a mixture of poor and good status. The majority of the "landable" catch are above the size at maturity, but the selectivity of an average commercial riddle is below the size at maturity of this site. There is a good proportion of large animals at the site, although this falls short of the indicator for having a third of the "landable" catch classified as "mega spawners"

Table 4: Indicator results for Northwest_a.

Northwest_a			
Conservation of Juveniles			
Indicator	Value	Limit	Status
L25	1.15	1	Good
Lc	0.92	1	Poor
Conservation of large individuals			
Lmax5%/Linf	1.03	0.80	Good
Pmega	0.30	0.30	Good

The majority of the "landable" catch are above the size at maturity, but the selectivity of an average commercial riddle is below the size at maturity of this site. There are good numbers of large adults in the "landable" catch.

Northwest Wales b

Table 5: Indicator results for Northwest_b. Please note, there are large confidence intervals around the size at maturity estimate for this site due to a lack of small samples.

Northwest_b			
Conservation of Juveniles			
Indicator	Value	Limit	Status
L25	1.47	1	Good
Lc	1.08	1	Good
Conservation of large individuals			
Lmax5%	0.95	0.8	Good
Pmega	0.78	0.3	Good

Whilst there is some uncertainty in the biological parameters at this site, it appears from preliminary results that the site is in good status across all indicators.

Southwest Wales

Table 6: Indicator results for Southwest

Southwest			
Conservation of Juveniles			
Indicator	Value	Limit	Status
L25	1.06	1	Good
Lc	0.93	1	Poor
Conservation of large individuals			
Lmax5%	0.85	0.8	Good
Pmega	0.17	TBD	Poor

This site shows a mixture of poor and good status. The majority of the "landable" catch are above the size at maturity, but the selectivity of an average commercial riddle is below the size at maturity of this site. There is a good proportion of large animals at the site, although this falls short of the indicator for having a third of the "landable" catch classified as "mega spawners"

Pan-Wales Assessment and advice

Figure 2 shows a visual assessment of the whelk stocks across Wales. Approximately 70% of the indicators assessed point to whelk stocks being in good status, with 30% assessed as poor. These data are based biological parameters from three years of survey data. Due to natural variation in growth of whelk, in response to environmental variables such as temperature, more than one year of biological data should be used to calculate the biological parameters and reference points (preferably 4–5-year timeseries). The size frequency data used for these assessments should be derived from landings data representative of the fishery across the season. We only had access to size frequency data from the survey and as such is representative of the size frequency of the populations in September, more than halfway through the fishing season. It is likely that these data will reflect a more exploited situation than data from across the whole season. A key factor in the poor status results is the use of an empirical length-at-first-capture calculation, which shows that riddling was not 100% accurate at excluding whelks below the MLS. This decrease in the Lc from 65 mm to 60mm has resulted in poorer outcomes for some assessments. Further work is planned to assess the riddling procedure and spacings as well as the survival of riddled and returned whelk and the potential for improving the selectivity of whelk retained by riddling.
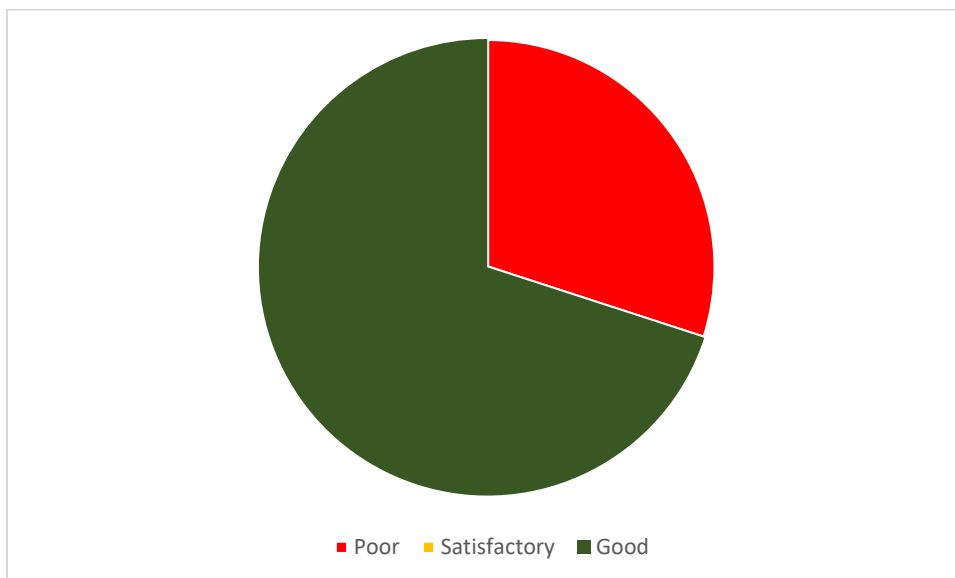
Figure 1 the proportion of whelk size-based indicators that suggest sites are either in poor, satisfactory or good status in Welsh waters.

Uncertainties

There remain several sources of uncertainty in the data and assessments:

1. Natural mortality parameter (M). This value is important in fisheries assessments but is notoriously difficult to estimate. We have utilised and average value from the published and peer reviewed literature. Future work to design and implement a survey to estimate this value more accurately may offer more certainty. We also plan to carry out a sensitivity analysis of the indicator assessment to understand how the indicator reference point may change with variation in this parameter.
2. Confidence intervals around the size at maturity estimate for Northwest_b are large. This is due to the fact that the specific site surveyed seems to be a population dominated by adults, with very few juveniles present, resulting in a sample missing the lower size range in the maturity ogive. We plan to find a nearby location to sample for juveniles/smaller adults.
3. Landings size-frequency data have been approximated from survey data, by truncating the size data at the length at first capture (60 mm TSL). This may introduce several uncertainties: the frequency distribution is limited both spatially (fishers will fish a range of whelk sites across the season) and temporally (these analyses represent the status in September not across the whole season). Regular landings size frequency data are needed for these assessments.

Whilst uncertainty in data needs to be taken into account with regards to the level of precaution taken within fisheries management, these uncertainties do not nullify the outputs which still provide useful data on the status of whelk stocks in Wales.

Fisheries management measures, in the form of increased MLS in 2019 and 2020 and an annual catch limit in 2022, have been recently introduced. With a time to maturity of approximately 4 years, the impact of these measures on the stocks are still to be fully realised, with the potential for the indicators and stock status to improve further in response. At the time of the present surveys, there is variability in the status of the indicators across Wales, with some sites performing better than others. In general, the indicators for conservation status of smaller adults and juveniles were less favourable than indicators assessing the status of larger animals in the stock. This suggests that there is potentially some exploitation of whelk before they are mature, but that there is a high proportion of old, large individuals (in line with Marine Strategy Framework Directive, descriptor 3). There could be a few explanations for the indicators being poor for the conservation of smaller stocks. Firstly, the fishery is exploiting animals smaller than the size at maturity as indicated by the L_c indicator. Secondly, a large recruitment event could skew the size frequency towards smaller individuals; this is not necessarily a bad situation (in fact it could be a good thing) so long as there are still large individuals in the stock and there is adequate protection of these smaller animals until they are able to spawn. Finally, if the majority of the landings are small (i.e., the

larger sizes are missing from the stock) then the L_{25} indicator is likely to be poor. Overall, the poor status of juveniles is likely to be driven primarily by the Lc being lower than the size at maturity, which is probably a function of the selectivity of the riddle rather than the MLS. Overall, the stocks are considered in good status for the conservation of larger animals.

There is still some uncertainty in the data, especially the size frequency of landings. This combined with some poor indicator status suggests that there should be some caution in the management decisions regarding Welsh whelk stocks. While there is no evidence of a need for a full 20% buffer (i.e. there are 70% good status indicators), a precautionary approach would suggest that some buffer on the catches should be applied. It is suggested that a lower buffer (perhaps 10%) should be considered in setting the Annual Catch Limit for the 2023 fishing season. There is currently no evidence to suggest that the 50-tonne annual catch limit needs to be changed, as the progression towards the annual catch limit in the 2022 season has not overshot the predicted cumulative catch curve (Welsh Government landings data).

References

Hold, N., Colvin, C., Delargy, A. and Le Vay, L (2021). The use of catch limits in the management of whelk in the Welsh Zone. A Bangor University Sustainable Fisheries and Aquaculture Group Report for Welsh Government.