Whelk Size of Maturity and Seasonality of Spawning Methodology

Equipment
Laptop
Scales (0.1g accuracy)
Callipers
Magnifying lens with light
Scalpel, forceps, gloves

Rationale
The objective of this study is to determine the size of maturity (SOM) for whelks in the Devon & Severn IFCA District, and to establish when spawning occurs for each sex. This will inform management decisions for the whelk fishery.

Size of maturity
Defrost whelk samples the night before analysis.

From each sample a size stratified sub-sample is selected for analysis. This consists of five whelks of each sex, for each of the following size categories; 40-45mm, 45-50mm, 50-55mm, 55-60mm, 60-65mm, 65-70mm, 70-75mm, 75-80mm, and ≥80mm.

The following measurements are collected for each whelk: total weight; shell height (from the apex to the end of the siphonal canal); minimum shell width (the width from the ventral aperture side to dorsal side); maximum shell width (widest part of the shell, either side of the aperture) (Figure 1).

Figure 1 a) Measuring shell height, b) Measuring minimum width, c) Measuring maximum width.

Individual whelks are removed from their shells using forceps and the following biometric data was collected: shell weight; visceral weight; sex; maturity status (according to Table 1) (Examples presented in Figure 2); digestive gland weight; gonad weight (if applicable).

Table 1 Maturity stage key by sex (Lawler, 2013)

Maturity Stage	Male	Female
Immature	No differentiation of digestive gland	No differentiation of digestive gland
Maturing	Some differentiation of digestive gland, restricted to dorsal and anterior edge	Some differentiation of digestive gland, restricted to dorsal edge
Mature	Presence of a mature testis (typically brick red in colour and thicker than 2mm in depth)	Presence of a mature ovary (typically yellow in colour and thicker than 4mm in depth)

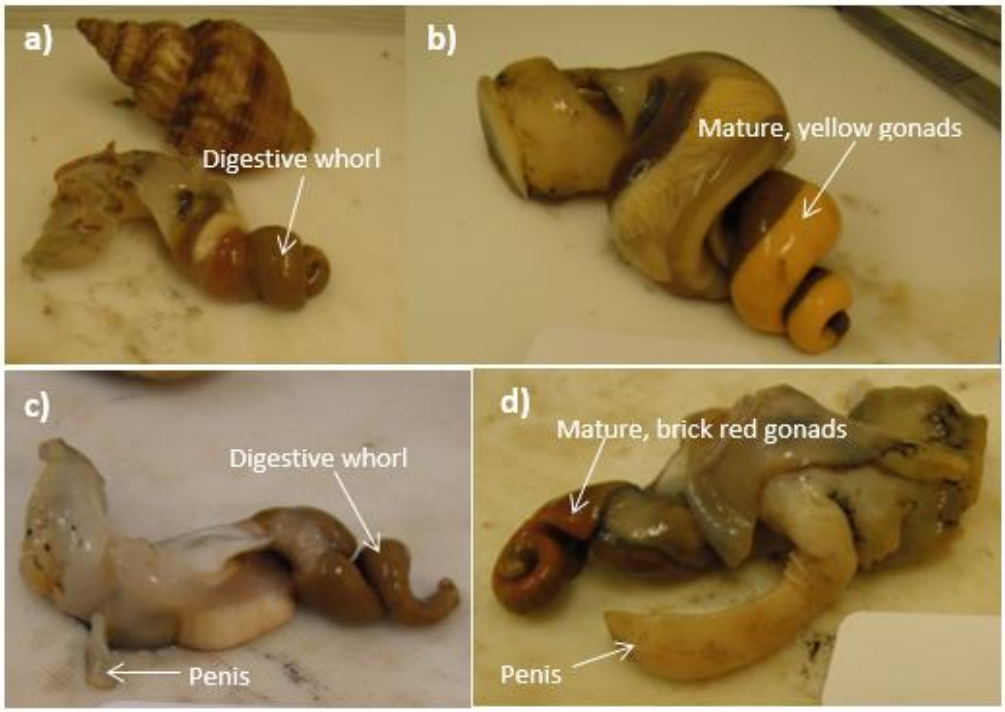

Figure 2 a) Immature female: no differentiation between digestive whorl and gonad. b) Mature female: gonad clearly differentiated from digestive whorl. c) Immature male: no differentiation between gonad and digestive whorl, undeveloped penis. d) Mature male: gonad differentiated from digestive whorl, penis fully developed.

The size of maturity (SOM) is the size at which 50% of the population is mature, or when the probability of a whelk being mature is 0.5. Whelks are classed as either mature or immature and the probability of a whelk being sexually mature by shell length (for each sex, and each site separately) is modelled using binomial logistic regression analysis using the "glm" function within the R statistical modelling software (R Development Core Team, 2013). The results are plotted onto a maturity ogive, using an R-script adapted from Harry et al. (2013), to report the SOM and 95% confidence intervals.

The Pearson's correlation between shell length and shell "minimum-width" is assessed using the "cor" function in R, to determine if there is a relationship between shell height and shell width.

The size of maturity calculations are repeated using the shell "minimum-width" measurement instead of shell length, to determine if a width based Minimum Size would be viable.

Seasonality of the reproductive cycle

Using the biometric data collected (detailed in section 4.1) from the mature whelks only, gonad size indices (gonad weight standardised to digestive whorl weight) are plotted for each month. Separate plots are created for each sex and each site. These plots show how the gonad size increases as it matures and when the size declines after copulation/spawning.

References

Harry, A.V., Tobin, A.J., Simpfendorfer, C.A. (2013) Age, growth, and reproductive biology of the spot-tail shark, *Carcharhinus sorrah*, and the Australian blacktip shark, *C. tilstoni*, from the Great Barrier Reef World Heritage Area, north-eastern Australia. Marine and Freshwater Research. 64(4), 277-293.

Lawler, A. (2013) (Cefas) Determination of the Size of Maturity of the Whelk *Buccinum undatum* in English waters – Defra project MF0231

R Core Team (2013). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.