Computing proportions at length (and by sex) from catches in a stratum

Tracey Fairweather, Doug Butterworth, Rebecca Rademeyer, Rob Leslie

The following formulae were applied to the *Merluccius capensis* and *M. paradoxus* length frequency data collected during Demersal Abundance Estimate Surveys.

Sex independent

Required $\tilde{P}_l$: the proportion of length group l within the stratum where $\sum_l \tilde{P}_l = 1$

Data

A total weight of W_t^L of large fish L is taken in trawl t.

A total weight of W_t^S of small fish S is taken in trawl t.

A total weight of W_t^A of all (i.e. not sorted by size) fish A is taken in trawl t.

A random subsample of weight w_t^L of large fish is taken and the length distribution of the fish measured yielding $n_{t,l}^L$ fish of length group l; w_t^S of small fish yields $n_{t,l}^S$ fish of length group l and w_t^A of all fish yields $n_{t,l}^A$ fish of length group l.

The estimated number of fish of length group l in the whole trawl is then given by:

$$N_{t,l} = n_{t,l}^L \frac{W_t^L}{w_t^L} + n_{t,l}^S \frac{W_t^S}{w_t^S} + n_{t,l}^A \frac{W_t^A}{w_t^A}$$

The proportion of fish in a trawl t of length group l is given by:

$P_{t,l} = N_{t,l} / N_t$ where $N_t = \sum_l N_{t,l}$

Then for the stratum as a whole, $\tilde{P}_l$ is given by:

$$\tilde{P}_l = \frac{\sum_t \alpha_{t,l} P_{t,l}}{\sum_t \alpha_{t,l}}$$

Where $\alpha_{t,l} = n_{t,l}$ unless $n_{t,l} \geq 100$ in which case $\alpha_{t,l} = 100$ and $\sum_t \alpha_{t,l}$ is the sum of these altered $n_{t,l}$ values.

Including sex information

For $l \leq 20$ (i.e. lengths to 20.99cm) $\tilde{P}_l^j$ is as above and refers to juveniles.

To split $\tilde{P}_l$ for $l > 20$ into males $\tilde{P}_l^m$ and females $\tilde{P}_l^f$, ignore FOG (Frill on Gill parasite which renders fish "unsexable") data, thus assuming that FOG fish have the same sex ratio as healthy fish.

Data

For trawl t in length group l we sex $m_{t,l,m}^L$ males and $m_{t,l,f}^L$ females from the large fish, and similarly $m_{t,l,m}^S$ males and $m_{t,l,f}^S$ females from the small fish as well as $m_{t,l,m}^A$ males and $m_{t,l,f}^A$ females from the all fish for $l > 20$.

Note: $\left.\begin{aligned} m_{t,l,m}^L + m_{t,l,f}^L &\leq n_{t,l}^L \\ m_{t,l,m}^S + m_{t,l,f}^S &\leq n_{t,l}^S \\ m_{t,l,m}^A + m_{t,l,f}^A &\leq n_{t,l}^A \end{aligned}\right\}$ because not every fish for which a length is measured is sexed.

The proportion of males in length group $l > 20$ in trawl t is estimated by:

$$q_{t,l}^m = \frac{m_{t,l,m}^L \frac{W_t^L}{w_t^L} + m_{t,l,m}^S \frac{W_t^S}{w_t^S} + m_{t,l,m}^A \frac{W_t^A}{w_t^A}}{\left(m_{t,l,m}^L + m_{t,l,f}^L\right)\frac{W_t^L}{w_t^L} + \left(m_{t,l,m}^S + m_{t,l,f}^S\right)\frac{W_t^S}{w_t^S} + \left(m_{t,l,m}^A + m_{t,l,f}^A\right)\frac{W_t^A}{w_t^A}}$$

For the stratum as a whole for $l > 20$ we split $\tilde{P}_l$ into male and female proportions using $q_{t,l}^m$ and $q_{t,l}^f$

Results

The results are too extensive to present in hard copy. They are presented in an associated excel file named 2009-DEM73_LF_propotions.xls.