Arni Magnusson

From: Jemery Day
Sent: Monday, 24 April, 2023 19:09
To: Arni Magnusson
Subject: Growth, M, maturity, movement and LW conversions: extracts from the YFT review

Growth:

The Panel **recommends** not basing the growth curve on an external estimate unless internal estimates are clearly implausible or an appropriate sampling approach to obtain representative population length-at-age data can be developed and implemented, or a growth curve is externally estimated using conditional age-at-length data.

There is evidence from both the otolith data and modes in the length- and weight-composition data that growth varies spatially.

Conflict was found between the growth increment data from tagging and the otolith data in the external analysis and between the otolith data and the modes in the length/weight composition data in the assessment. Further investigation and data collection is needed to determine the cause of these differences (e.g., spatial, selectivity, seasonal growth).

See Figure F.3a and F.3b in the report

Enhance the regular collection and aging of otolith data to use as conditional age-at-length data in the stock assessment to improve estimates of growth. These data should be collected broadly across the spatial range of the fishery and size classes.

The growth curve and sex-ratio-at-length vector are key inputs for calculating *M*-at-age.

The Panel endorsed the general approach for estimating *M*-at-age. This involves fitting a model that depends on empirical data on the sex-ratio at length, a growth curve, a base *M* for males, and assumptions on critical lengths and a multiplier that determines the linear decline in *M* for young ages to the base *M*, plus length at which female mortality begins to increase (Hoyle et al., 2009; Vincent et al., 2020b). The *M*-at-age vector is estimated outside of the stock assessment even though its calculation depends on growth. Thus, *M*-at-age is sensitive to the growth curve, which can ultimately impact biomass scaling.

Because calculation of both *M*-at-age and reproductive output at-age are based on estimates at length converted to age, they also depend strongly on length-at-age.

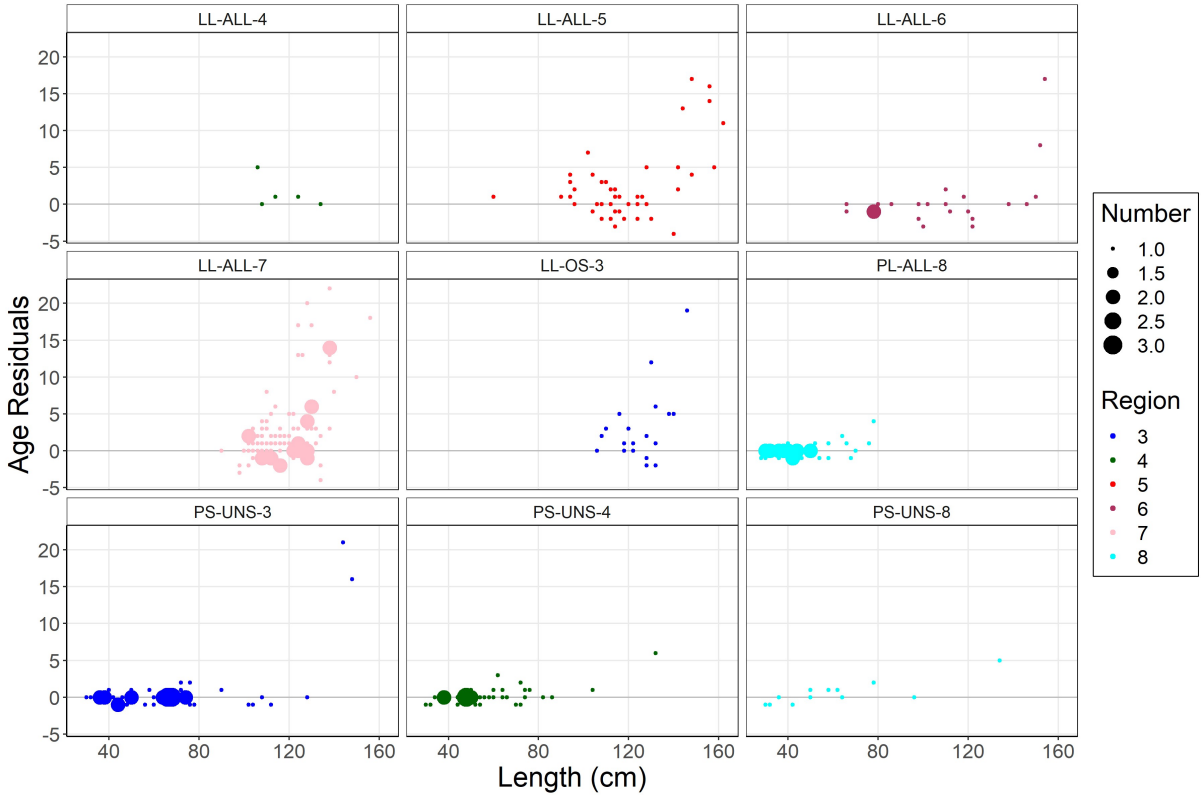

Figure F.3a. Conditional length-at-age residuals for the 2020 diagnostic model (coloured, sized by number).

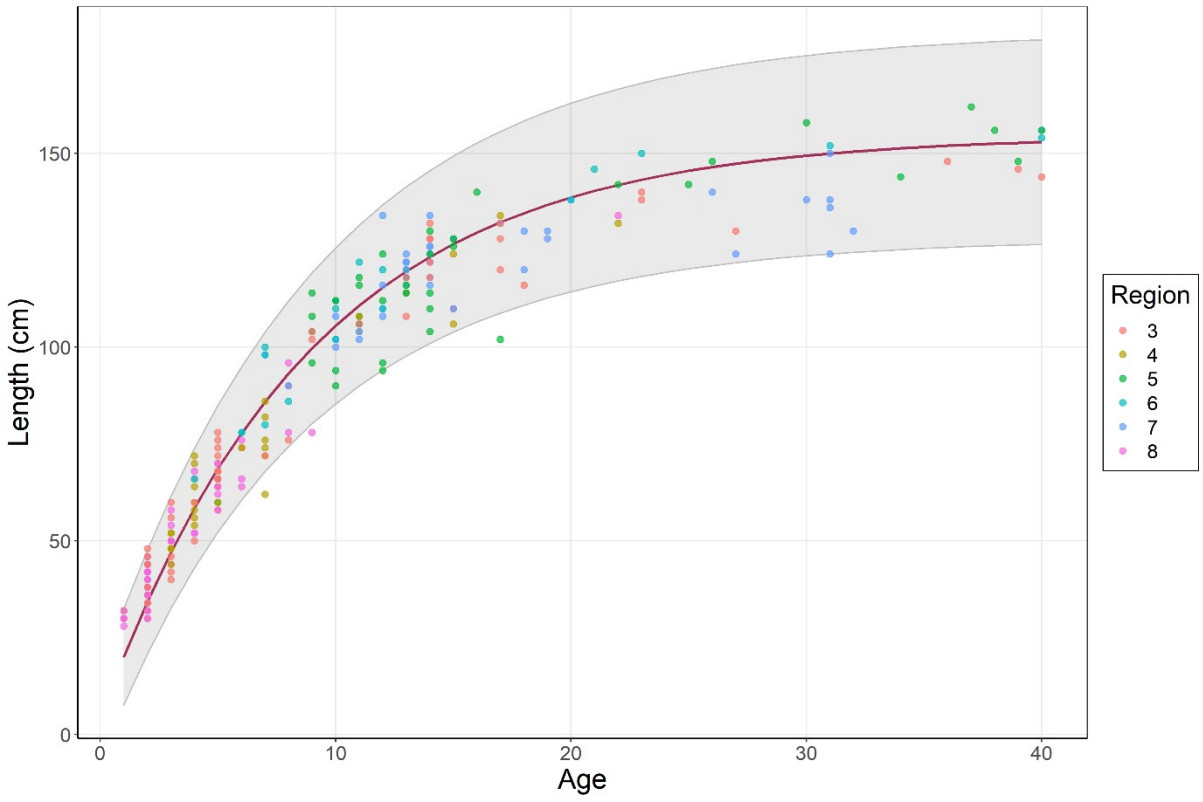

Figure F.3b. Growth curve with 95% confidence interval for the 2020 diagnostic model.

Natural mortality

Major changes from the 2017 to the 2020 diagnostic models included: a) reproductive output-at-age and natural mortality-at-age were modified to use a different sex ratio-at-age vector based on updated sex ratio-at-length data and an updated growth curve

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The *M*-at-age vector is estimated outside of the stock assessment even though its calculation depends on growth. Thus, *M*-at-age is sensitive to the growth curve, which can ultimately impact biomass scaling. However, until MULTIFAN-CL can be extended to calculate *M*-at-age from sex ratio-at-length internally, the current approach is the most appropriate
The Panel **recommends** continuing the current approach with the base *M* for the Hoyle et al. (2009) method set to 0.2 quarter^{-1} but including alternative values for base *M* in the uncertainty grid. The range of base *M* values could be determined using a likelihood profile or the bounds from Hoyle et al. (2023), but for now there is no basis to set this value other than to the default of 0.2 quarter^{-1}.

The review identified the value of base natural mortality and the assumptions regarding the regional structure and the number of fisheries as additional key dimensions of uncertainty.

Maturity/reproductive biology

Reproductive output-at-age was determined for the 2020 assessment by first computing reproductive output at length from maturity-at-length, fecundity-at-length, and the sex-ratio-at-length.
Unlike the 2017 assessment, where the reproductive output-at-length was converted to -at-age externally, the newer version of MFCL used in the 2020 assessment made this conversion within the model using the specified growth curve (external or internally estimated growth from conditional age-at-length data).
Assumptions about maturity do not affect the process of fitting the model (the stock-recruitment relationship is included with a weak penalty so it does not influence the results) but directly determine spawning potential, which is used to calculate reference point values.

Figure F.2 shows sensitivity to maturity-at-age vector between 2017 and 2020

Movement

There is a possibility that movement differs between adults and juveniles. Future work should look at releases and recaptures by size groups to identify any differences. Age-specific movement should be investigated in the assessment either by fixing movement to zero for adults or estimating age-specific movement. The assessment report notes that an alternative hypothesis is that spatial differences in growth are currently mis-specified, and the models are attempting to compensate for this through the resulting movement and abundance patterns.
A fine-scale movement model would be useful for defining the time it takes for tagged animals to fully mix into the population within a region and experience the same probability of recapture as untagged fish in the region.

Future research: Examine the releases and recaptures by size groups to identify any differences in movement rate between ages.

Diagnostics to determine what is informing movement, or at least determine if movement is counter to the tagging data. This might involve running the model with and without movement (or cutting the movement in half for all areas) and determining which likelihood functions are impacted.

Length-weight conversions

the conversion factor from gilled and gutted to whole weight, which is based on 100 fish

Re-analyze the length-weight data (e.g., by conversion type and season) for use in quantifying the extent of variation in weight-composition due to error about the length-weight relationship.

Collection of additional information on the conversion from processed to whole weight is needed to improve the relationship and also allow inclusion of the additional variation in weight-at-age for fitting weight composition data

ciao

Jemery