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EwE linked stanza recruitment: A brief users' guide

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Compatible with Ecopath with Ecosim version 6.7 α1
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Contents

Scope and purpose

This document provides usage instructions of linked stanza recruitment in the Ecopath with Ecosim food web modelling approach (Christensen and Walters, 2004; Heymans et al., 2016). If you have any questions, find bugs, or see ways to expand on this functionality please contact us at ewedevteam@gmail.com.

This document was last updated January 2022 to EwE version 6.7.0.0 Alpha prerelease.

Acknowledgements

Linked stanza recruitment was implemented by Jeroen Steenbeek after an idea by Villy Christensen under project *EISA: Ecology and management of the invasive snow crab (https://www.akvaplan.niva.no/en/projects-networks/eisa/)*.

Summary

Occasionally, ecosystem modellers run into issues where gender-split populations need explicit modelling. This can occur when empirical data is only available for male or female specimens, or when males and females of key species have markedly different behaviours. We have made a small modification to the Ecopath with Ecosim (EwE) multi-stanza model (Christensen and Walters, 2004), that allows linking recruitment to ensure proportional spawning between two multi-stanza groups, and thus connecting two gender-split populations at their foundation.

Computations

At the first Ecosim and Ecospace time steps, a base scalar is calculated:

$$a_i = \frac{NAge1_i}{NAge1_j} \qquad \textit{Eq. 1}$$

where a is the scalar, *i* is a multi-stanza group whose recruitment is driven by multi-stanza group *j*, and *NAge1* is the number of individuals at age 1, e.g., the number of recruits, for multi-stanza groups *i* and *j*. This base scalar serves to maintain the ratio between the number of gender-spit recruits during the simulations.

For every consecutive time step, the number of multi-stanza group *i* recruits is then set as follows:

$$NAge1_i = a_i \times NAge1_j \qquad \textit{Eq. 2}$$

Changes to the EwE computations were minimal; the most challenging code changes were made in the Ecospace IBM model (Walters et al., 2010), where parallel computations was reorganized to ensure that multi-stanza recruitment is calculated in the correct order. Ecospace does not yet calculate recruitment success from spatial overlap of the gender-split stanza; this could be a future refinement if needed.

An example of the impact of linked recruitment is shown in Figure 1. Here, Ecosim is executed for a model that contains separate multi-stanza groups for male and female snow crab *Chionoecetes opilio*. Both multi-stanza groups consist of two life stages each: juveniles and adults. Only the male snow crabs are fished. The model contains no change in environment and fishing other than gradually intensifying effort of the snow crab fishery. Figure 1 shows three simulations: in the left panel, multi-stanza recruitment is not linked. In the middle panel, female recruitment is obtained from the male multi-stanza group. In the right panel, male recruitment is obtained from the female multi-stanza group.

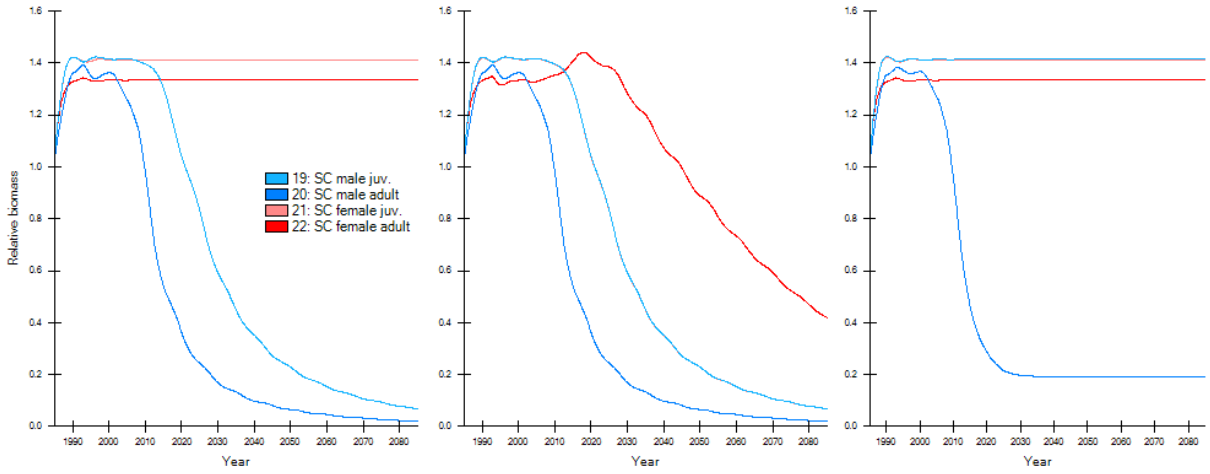

Figure 1 - Three Ecosim simulations with different recruitment linkage configurations for snow crab: no linked recruitment (Left), female recruitment linked to the fished males (Center), and fished male recruitment linked to non-fished females (Right). Note that both juvenile groups are identically parameterized in this specific case, and therefore their biomass estimates exactly overlap in the Center and Right plots.

Configuring linked stanza recruitment

First, define the male and female multi-stanza configurations in the “Define groups” interface (Figure 2).

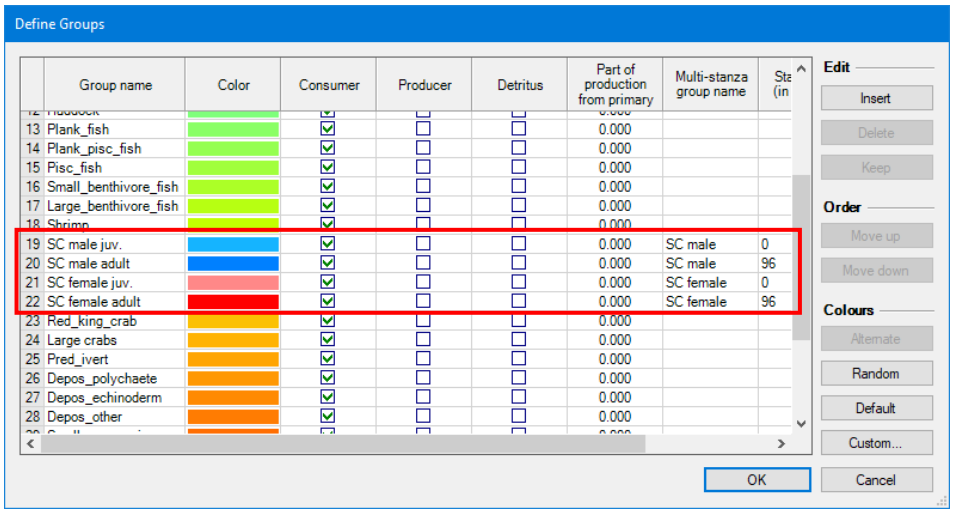

Figure 2 - Define gender-split multi-stanza groups

Second, configure the two gender-split multi-stanza groups in the “Edit multi-stanza” interface (not shown here).

Third, link recruitment in the “Edit multi-stanza” interface. In the figure below, female snow crab recruitment is linked to the males. A multi-stanza group whose recruitment is linked will have its recruitment calculations overwritten, and therefore the “Recruitment Power” parameter becomes inactive (Figure 3).

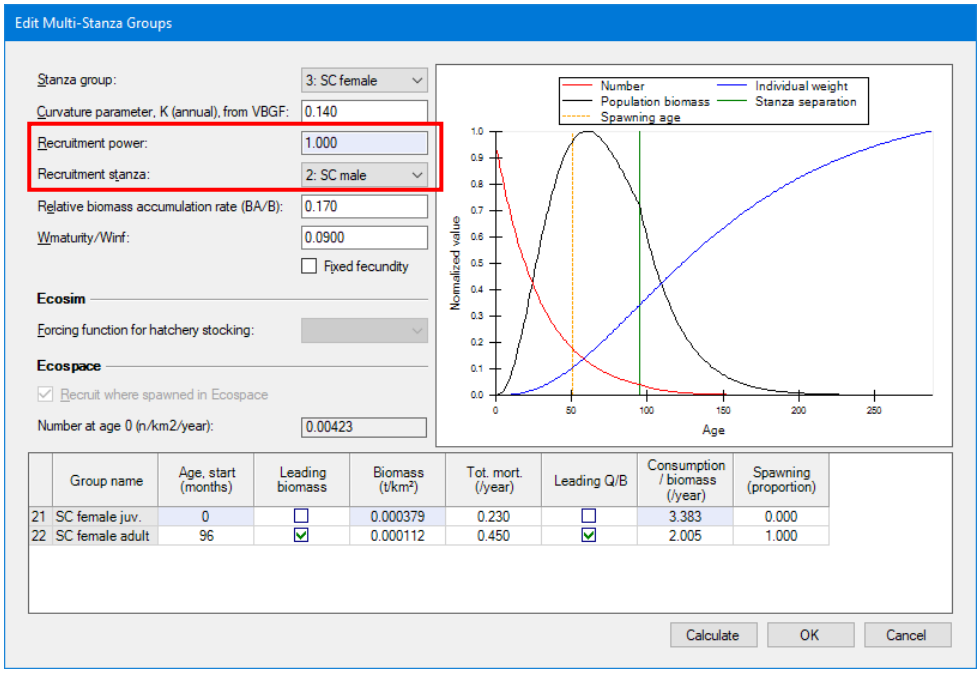

Figure 3 - Linking the recruitment of a multi-stanza configuration to another multi-stanza.

References

Christensen, V., Walters, C.J., 2004. Ecopath with Ecosim: methods, capabilities and limitations. Ecol. Model. 172, 109–139. https://doi.org/10.1016/j.ecolmodel.2003.09.003

Heymans, J.J., Coll, M., Link, J.S., Mackinson, S., Steenbeek, J., Christensen, V., 2016. Best practice in Ecopath with Ecosim food-web models for ecosystem-based management. Ecol. Model. 331, 173–184. https://doi.org/10.1016/j.ecolmodel.2015.12.007

Walters, C.J., Christensen, V., Walters, W., Rose, K.A., 2010. Representation of multistanza life histories in Ecospace models for spatial organization of ecosystem trophic interaction patterns. Bull. Mar. Sci. 86, 439–459.