Long-term stability in modelled zooplankton influx could uphold major fish spawning grounds on the Norwegian continental shelf

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Supplementary figure set

Here we present a supplementary figure set for three additional simulations, with reference to the figure set of the main article [Original, WUD Feb 4th]. The additional simulations have a uniform overwintering distribution as shown in figure S1 and are initiated with a fixed overwintering depth of 400 m, a fixed dry weight of 50 $\mu\text{g C}$, and three different wake-up days (WUD, start of simulation). Feb 4th [Uniform, WUD Feb 4th], Jan 20th [Uniform, WUD Jan 20th] and Feb 20th [Uniform, WUD Feb 20th]. In all simulations, individuals follow the same growth and behavioural patterns as described in the Materials and methods section.

Figure S1. Horizontal coverage of the uniform overwintering distribution of ca 70.000 particles in the Norwegian Sea (yellow). Silhouette of the evolved overwintering distribution from Hjøllø et al. (2012) can be seen in black. Defined borders to the North Sea (southern dashed line), the Norwegian continental shelf break (whole line) and the Barents Sea opening (northern dashed line) are denoted together with major spawning areas for Northeast Arctic cod (Lofoten) and Norwegian spring spawning herring (Møre).

Figure S2. The NAO winter-index (top panel left panel) , and the inter-annual variation (from 4 simulations) in total cross-shelf transport of calanus quantified by yearly anomaly z-scores 100 days after wake up day for the Barents Sea opening, the Norwegian shelf break and the North Sea cut-off border. Yellow line denote the 10 year simple moving average (n=42), and dashed lines are the upper and lower limits of the 80 % confidence intervals (CI). Years with extreme high or low anomalies (outside the 80 % CI) are indicated with a red or blue coloured dot, respectively.

Simulation/Area	Original, WUD Feb 4 th	Uniform, WUD Feb 4 th	Uniform, WUD Jan 20 th	Uniform, WUD Feb 20 th
Barents Sea	$R=0.83, p<0.001$	$R=0.79, p<0.001$	$R=0.82, p<0.001$	$R=0.83, p<0.001$
Norwegian shelf	R not significant	R not significant	$R=0.47, p=0.002$	R not significant
North Sea	$R=0.65, p<0.001$	$R=0.57, p<0.001$	$R=0.61, p<0.001$	$R=0.66, p<0.001$

Figure S3. Regression plots and lines between the 10 year moving average ($n=42$) of the NAO winter index and calanus cross shelf-transport anomaly z-scores for the Barents Sea, the Norwegian continental shelf and the North Sea. Results of regression analysis for the four different simulations shown in table.

Figure S4. Average number of calanus transported over time through the Barents Sea opening (top panel), over the Norwegian continental shelf break (centre panel), and across the North Sea cut-off border (bottom panel) in years with high (red lines) and low (blue lines) cross-shelf transport anomaly z-scores (see figure S2). Shaded areas denote standard deviation.

Figure S5. Location and abundance (colour scale, abundance) of particles transported across the eastern shelf boundaries after 100 days for all years (bottom axis). Superimposed (top axis) is depth contours (gray), coastlines (black), and the assigned border to the North Sea (southern dashed line) the continental shelf (whole line) and Barents Sea (northern dashed line). Areas with contrasting patterns in cross-shelf transport are marked with black and white bars with geographical names (Møre, Helgeland, Lofoten-Vesterålen and the Barents Sea).

Figure S6. Integrated overwintering distribution ((colour scale, abundance)) for all years for calanus that are transported from the Norwegian Sea and across the different shelf boundary areas (denoted with double red line). The shelf boundary areas are selected based on the latitudinal variation in modelled cross-shelf transport shown in figure 6, and indicate the Barents Sea (1st row), the Lofoten-Vesterålen area (2nd row), and Helgeland area (3rd row) and the Møre area (4th row).

References

Hjøllø, S.S., Huse, G., Skogen, M.D., and Melle, W. 2012. Modelling secondary production in the Norwegian Sea with a fully coupled physical/primary production/individual-based *Calanus finmarchicus* model system. *Marine Biology Research* 8(5-6): 508-526.