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DTU Aqua
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Effects of future climate on physiology and egg production in Baltic Sea sprat

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BACKGROUND:

Sprat (*Sprattus sprattus*), a key species in Baltic Sea, has strong and seemingly unpredictable year-to-year variations in recruitment. These variations has been linked to the physical environment as a response to atmo-spheric forcing and longer term climate trends. Focus has been on the egg and larval stages but there may be an additional source of variation in how the egg production of the adults depends on the climate. Therefore, we aim at quantifying the temperature effects on growth and reproduction in Baltic Sea sprat under a future climate scenario.

METHOD:

The model setup includes three structure pools (Fig. 1, squares): Somatic tissue, reserves and gonads. Growth in the structure pools are determined by the fluxes: Intake and metabolism (Fig 1, circles) as well as the spawning period. Here we only focus on temperature effects, thus food availability is kept constant in both scenario runs.

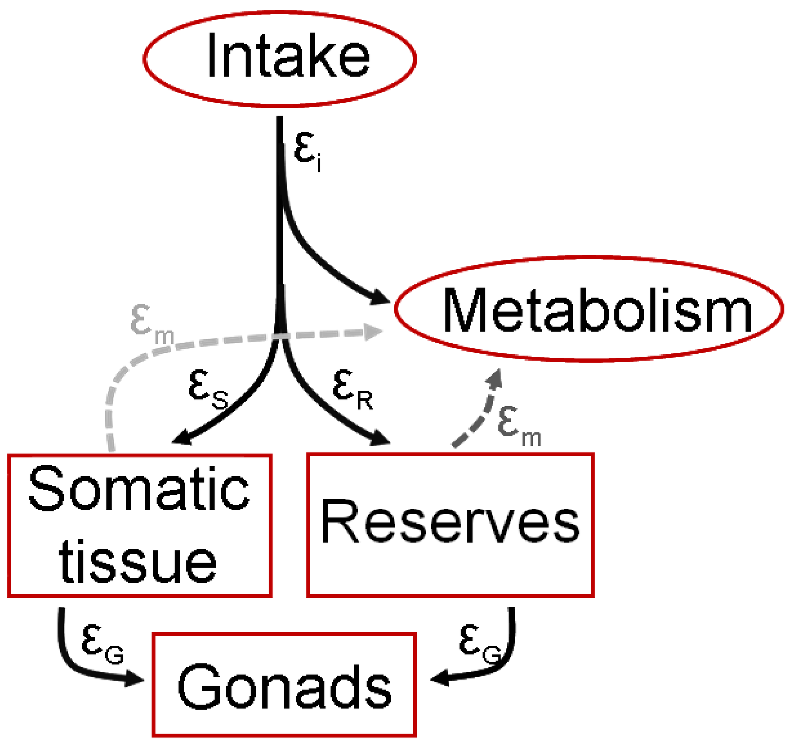

Figure 1: Schematic model setup. Squares are structure pools and circles are fluxes

We drive the model with temperature described by a cosine function. The function is based on position of sprat in the water column over the day and year, and temperature information based on hydrodynamic model simulations for the top layer (Fig. 2 diamonds) and bottom layer (Fig. 2 circles). We use a recent temperature scenario from 1960-1990 and a future scenario from 2070-2100.

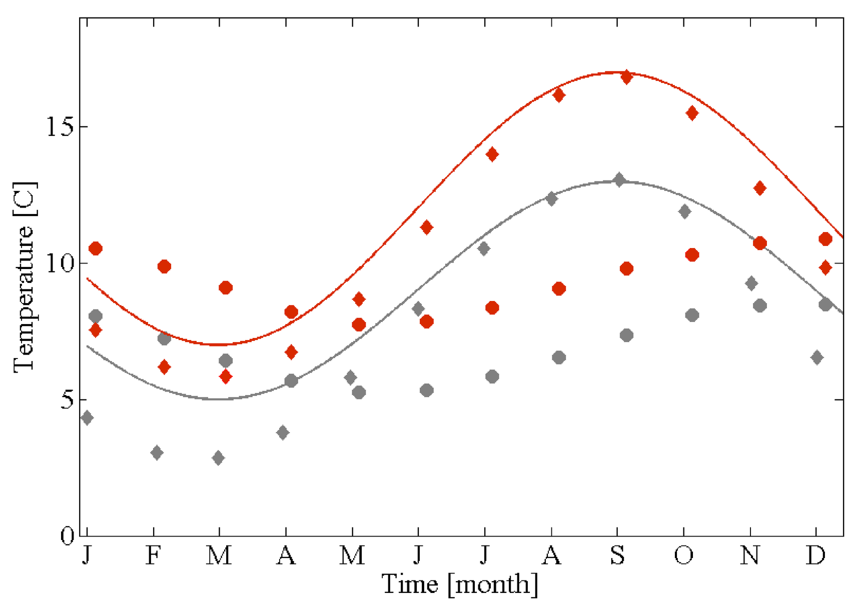

Figure 2: Climate. Temperature functions applied to the model with recent (grey line) and future scenarios (red line). Top and bottom layer temperatures are given in respectively diamonds and circles. Standard deviations are not included in figure.

RESULTS:

The model is able to reproduce the general pattern of growth and reserve dynamics of sprat (Fig. 3, full lines) compared to data (Fig. 3, circles). The individual has reduced size with age under future climate, which is due to reductions in the somatic tissue (Fig. 3 dotted lines). Reserve pools are depleted faster under future climate compared to the recent climate due to higher winter temperatures.

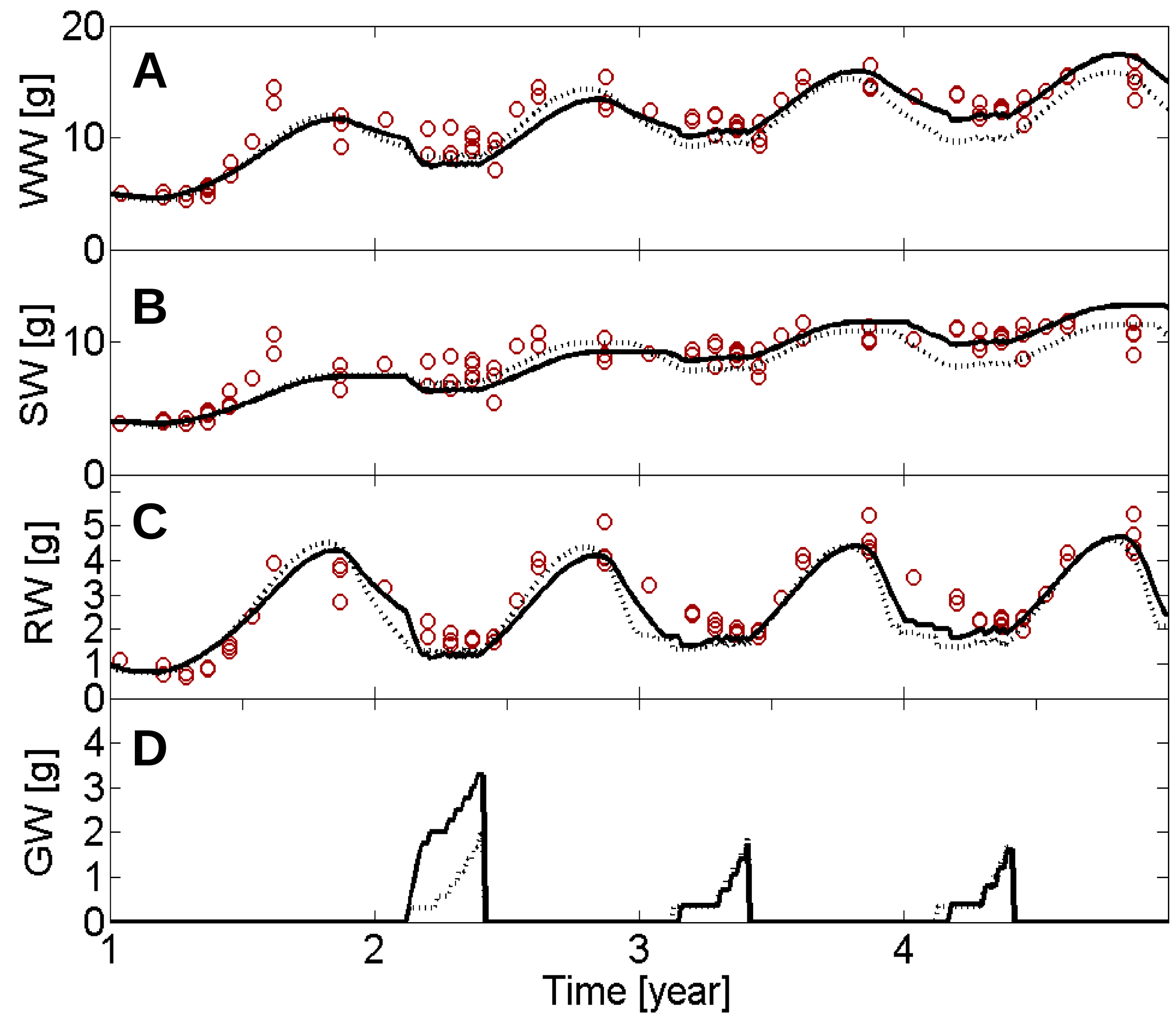

Figure 3: Growth dynamics and climate. Model simulations with recent climate forcing (full line) and future climate forcing (dotted line) along with validation data (circles). Panel A gives total weight, panel B is somatic tissue, panel C is reserve weight and panel D is gonad weight.

We see a reduction in the number of eggs produced in the first spawning season under the warmer future climate (Fig. 4A). In the coming spawning seasons production is equal. The future climate gives a reduction in the expected lifetime reproductive output of ~20% (Fig. 4B).

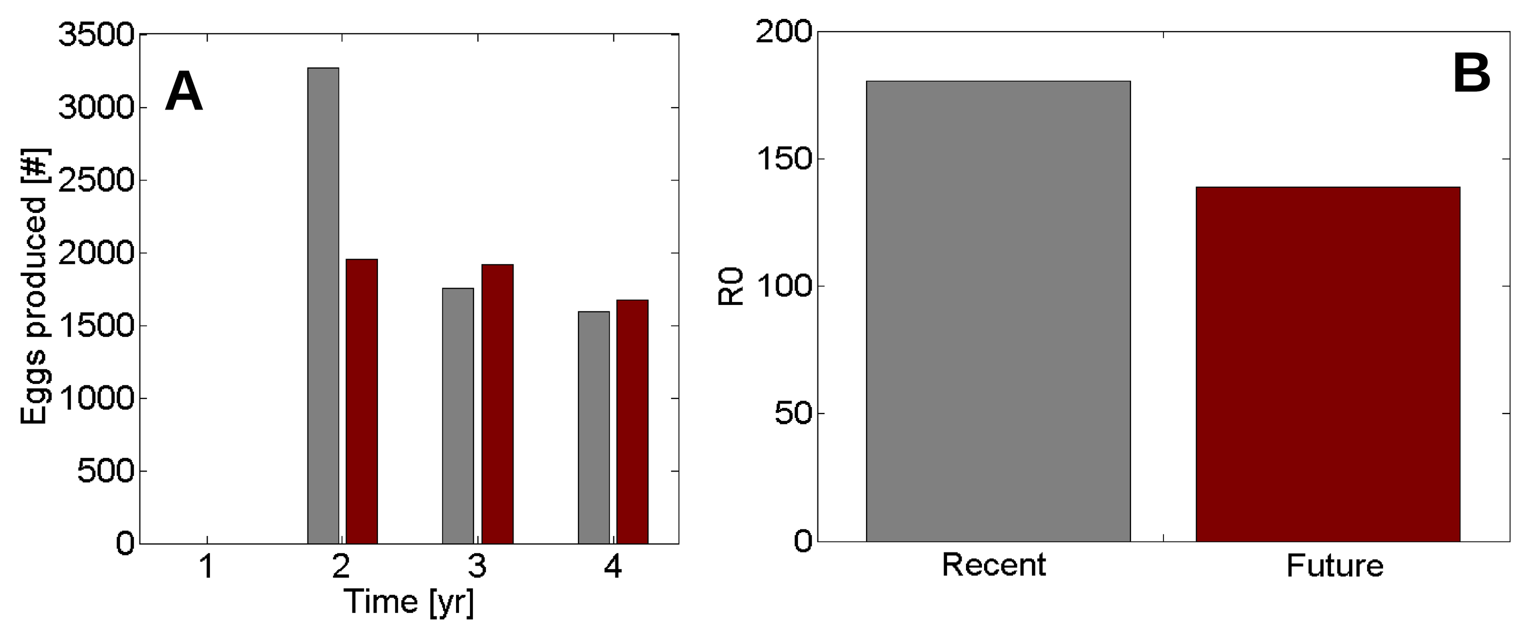

Figure 4: Reproduction and climate. Panel A shows individual egg production under recent (grey bars) and future climate (red bars). Panel B gives expected lifetime reproductive output under recent (grey bars) and future climate (red bars).

CONCLUSIONS:

We see that raised bioenergetic costs during warmer future climate will reduce the size and reproductive outcome in Baltic sprat. Further we see a reduction in the expected lifetime reproductive output when assuming that there are no changes in mortalities with the higher temperatures in 2070-2100.