COMPARING A RANGE OF MULTISPECIES MODELS BETWEEN AND ACROSS AREAS BY THE USE OF THE JACOBIAN MATRIX OF YIELD ON FISHING MORTALITY RATE

Authors By region:-. J. Pope, R. Thorpe, V. Bartolino, B. Bauer, J. Horbowy, N. Kulatska, E. Sturlasdottir, J. Ribeiro.

Introduction

The role of a Multispecies models is to compute the interactions between species. Even the simplest model is complex and difficult to understand. But $\frac{\partial Yield(i)}{\partial F(j)}$ 1is easy to compute by making runs with each F(j) increased in turn by 10%. It's results give a clearer picture of the interactions between species and can also be used to construct yield surfaces and compute approximate reference points.

1 {the Jacobian Matrix, where Yield(i) is the steady state yield of species i and F(j) is the status quo fishing mortality rate of species j}

These runs are easier to interpret if it assumed that the yield surface in the vicinity of the long term steady state at status quo mortalities can be approximated by the quadratic equation:

$$Yield(i) = F(i)\left(Ai + \sum_{all\ j} Bij.F(j)\right)$$

Noting that (all F(j)'s are relative to stuatus quo and that)

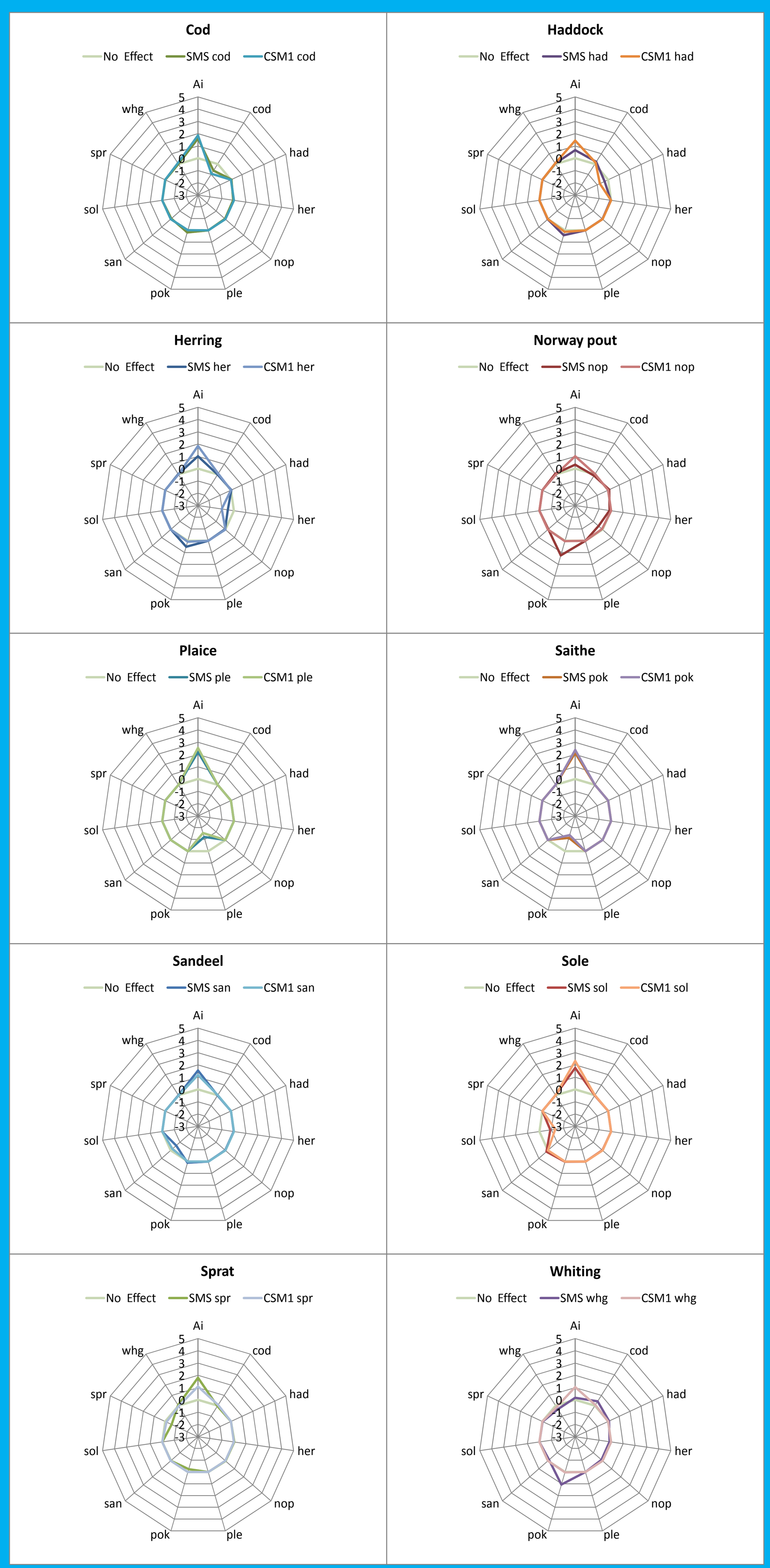
$$\frac{\partial yield(i)}{\partial F(i)} = Ai + Bii + \sum_{all\ j} Bij$$

$$and\ \frac{\partial yield(i)}{\partial F(j)} = Bij\ where\ i \neq j.$$

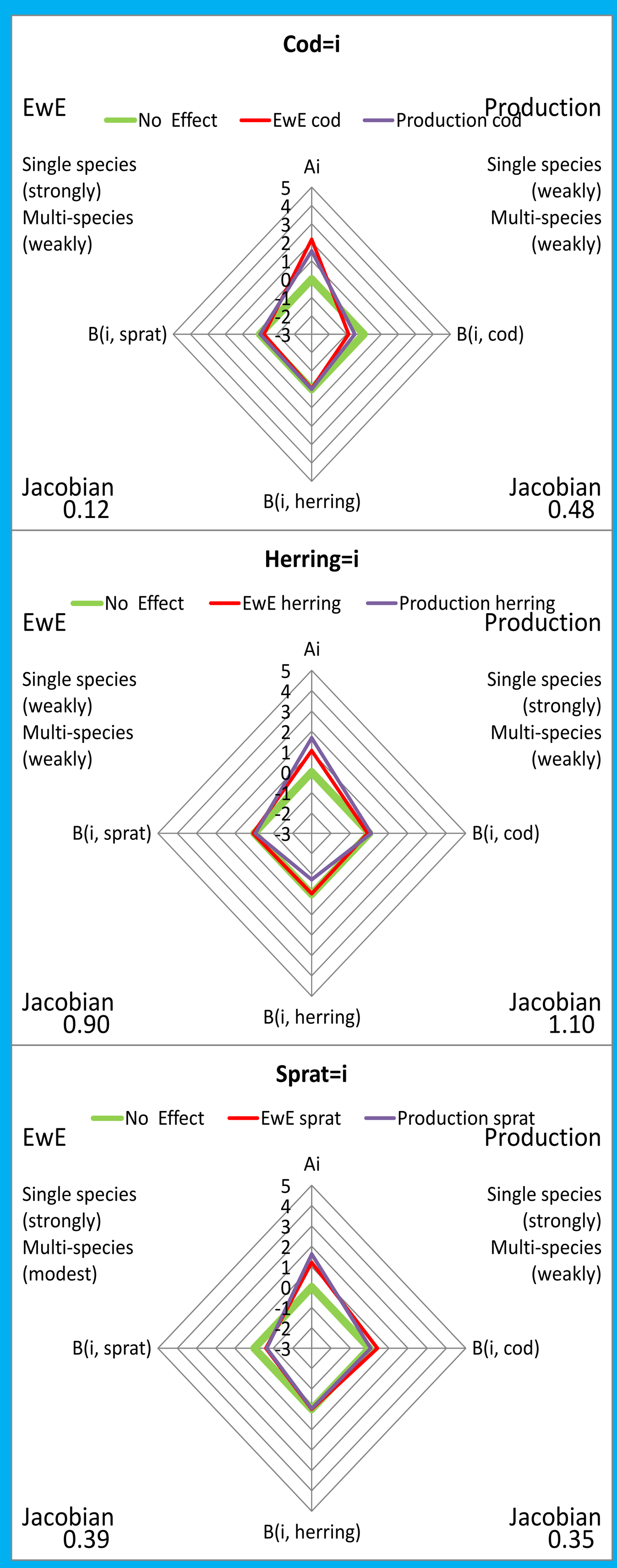
Ai and the Bij may thus be estimated from the factorial set of runs of a model about status quo. They may then be used to compute the Jacobian Matrix. Moreover, the constants Ai is the rate of increase of the exploitable biomass while the Bij are the rates that its growth is affected by each F(j) as these modify the biomass of other species. Thus, these constants have clear biological meaning. They can also be used to construct yield surfaces or estimate notional reference points such as MSMSY or the MS Nash equilibria. Sadly, there is insufficient room for these here!

Jacobian Components

NORTH SEA

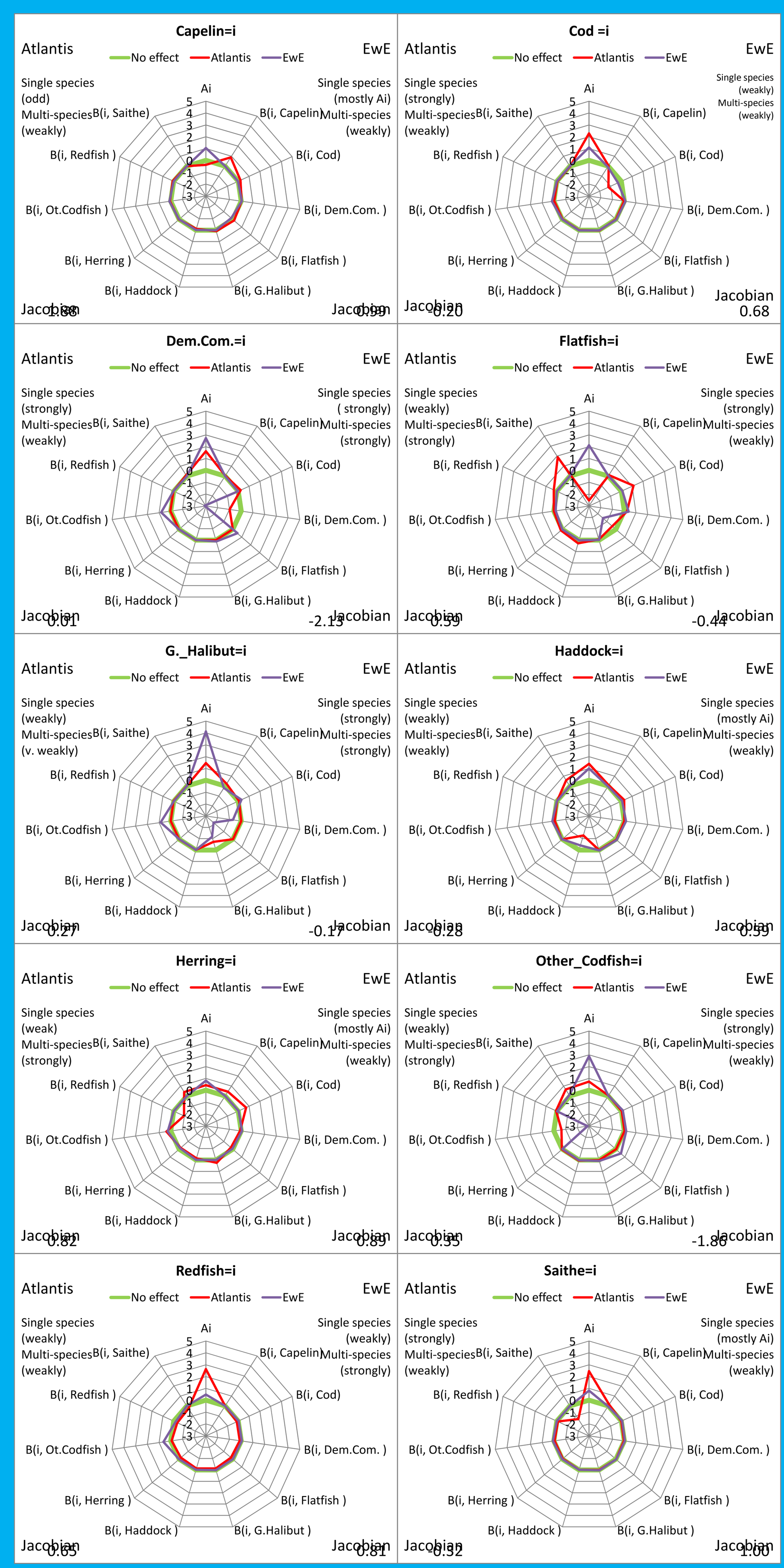


BALTIC SEA



Note that theNo Effect lines are the zero contour

ICELAND SEAS



DISCUSSION

SMS and CSM1 were used to model 10 species in the North Sea. Both are top down models. CSM1 following SMS's approach. Detailed comments are shown on the radar plots for each species as are the Jacobian B(i, i) component for that species' fishery for both models. Plaice, saithe and sole are modelled as single species in both models. Of the rest it is noticeable that the single species terms (i.e. Ai and B(i,i) and the multispecies terms B(i,j) typical tend to be stronger for SMS than for CSM1; perhaps, because the latter lacks a S/R relationship. Multispecies effects for SMS most often come from saithe. Despite the differences the Jacobian B(i, i) term for each model shown at the bottom corners of each plot agree on 8 occasions on a common direction for advantageous change in species' fishing mortality rate. It will be interesting to see how an update to CSM1 compares if a S/R relationship is included.

Results from an EwE and a Production model are shown here for the Baltic Sea. Results from a Gadget model with 4 species will also become available. EwE is a bottom up model but the Production model is more a top down model. As with the North Sea detailed comments and the Jacobian(i, i) are shown in the plots for both models. For all species the single species terms (i.e. Ai and B(i,i) are typically larger than the multispecies terms B(i,j). Hence, both models depict a weakly multi-species system. The Jacobian(i, i) term shown at the bottom corners of each plot broadly agree between models and suggest that yields would increase with more fishing mortality on all 3 stocks. It will be interesting to see if the Gadget model gives this same message!

Atlantis and EwE were used to model 10 species groups in the Iceland Seas. Both are bottom up models. Detailed comments are shown on the radar plots for each species as are the Jacobian component for that species' fishery for both models. It is noticeable that the relative strength of single species terms (i.e. Ai and B(i,i) and of multispecies terms B(i,j) typical differ between models for each species. Moreover, The Jacobian (i, i) term shown at the bottom corners of each plot only agree on 4 occasions on a common direction for advantageous change in species' fishing mortality rate. Thus there would seem to be quite large differences in how these two models interpret species interactions in the Iceland Seas. This suggests a need to investigate how interactions arise in the two different models.

Across all three areas it is clear that differences between models are potentially a major source of error.

Understanding these differences is a major research task!

NRC (EUROPE) LTD. FUNDING THE SCIENCE HABIT

MareFrame

THIS PROJECT WAS FUNDED BY THE EU UNDER THE SEVENTH FRAME WORK PROGRAMME

SEVENTH FRAMEWORK PROGRAMME