Proceedings of the 2018 Winter Simulation Conference
M. Rabe, A. A. Juan, N. Mustafee, A. Skoogh, S. Jain, and B. Johansson, eds.

METHODS, MODELERS AND FISHERIES SCIENTISTS - BUILDING BRIDGES

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ABSTRACT

In recent years the stock dynamic of Eastern Baltic Cod (EBC), an ecologically and commercially valuable species, has undergone unexpected changes. This development has prompted the need for simulation models to aid in providing good scientific advice for management strategies. However, a strong scientific connect between the advancing modeling and simulation methods and the domain scientist equipped with intimate knowledge of the Baltic and EBC has not yet been established. Therefore, for any modeling and simulation effort in this domain to have an impact, bridging this gap is vital. Hence, points like choice of best modeling approach and understandable notation such as rule-based or even graphical ones are explored. Managing the complexity of the domain is supported by a component based approach in development together with successive systematic validation. Here progress and future work of reducing the gap for a simulation model on EBC are discussed.

1 INTRODUCTION

Fisheries scientists working in departmental research are tasked with providing scientific advice for management decisions concerning fish stocks. This involves a rigid yearly schedule of collecting and evaluating survey data in combination with ongoing basic research in reaction to emerging questions. Predictive models, mostly statistical macro models, are used for the evaluation of survey data. To aid basic research an increasing number of simulation models are developed an these encompass all types of models. The majority of such simulation models are developed by "hybrid-scientist" or "specialists", meaning scientists, who have either an interdisciplinary background or a strong aptitude for the field they have not been formally educated in. This situation causes a scientific disconnect between ever advancing methods and tools, and the domain scientist equipped with both formal and empirical knowledge of the ecosystem or relevant subsystem. Some of the issues which can result from this disconnect have been identified in the following paragraph.

State of the art modeling methods and tools often require a mathematically inclined user and are unintelligible to scientists whose expertise lies else where. This regularly leads to models which can not be utilized without engaging the "specialist". On the methods side those tools that are readily used by domain scientists, as well as their need for a graphical user interface (GUI) are often dismissed since these tools are usually not state of the art and producing GUI's brings no scientific advances to the methods scientists. On the domain scientists side the daily operations in departmental research limit time and energy available for continuing education in emerging methods. Therefore, new tools are often left exclusively to the "specialists", which severely limits the throughput of knowledge and expertise in the modeling and the simulation process. In this situation, where models are developed by the "specialists" without an ongoing dialog between the modeler and the scientists familiar with the domain aspects, a great opportunity for hypothesis development and deepening of understanding on both sides is squandered.

2 APPROACH

Choosing the right type of model: Large statistical macro models used for predictive purposes dominate the work of fisheries scientists and there is an inclination to use statistical models as the tool of choice. Informing domain scientists about the different options and their possible application is trivial but vital. In the case of the EBC an individual based model (IBM) illuminating several system levels was identified as the appropriate method (Pierce et al. 2017).

Put more generally, the approach was to offer consultation about different types of models and choose based on the properties required to address the research question.

Ensuring a comprehensible formalization: The historic alternative to statical models in fisheries science are systems of coupled differential equations. These are not accessible to people who are not continuously involved with this formalism. Formalizing the processes of interest for the EBC in single readable rules and providing a “don’t care, don’t write” syntax allows the model to remain readable to domain scientists. Put more generally, the approach was to use domain specific languages with formalisms that enable as much readability as possible (Pierce et al. 2017).

Profiting from the process: At its best, the process of developing a formalized simulation model can inform the scientific discourse, deepen understanding of relevant processes and provide rigor to formerly vague concepts. However, for this to take place an intimate involvement in the process of modeling and/or validation is essential. To support this successive composition of submodels and reuse of validation experiments (Pierce et al. 2018) was used to aid in benefiting from the process.

Put more generally, a “divide and conquer” approach was used to tackle the formalization of a multi-faceted complex system. By working with sets of submodels when formalizing processes within the different subdomains, deep involvement is facilitated by allowing focus on one submodel/aspect.

Making it comfortable: Departmental research is structured around the needs of the respective remit of the institute in question. This means that there is little time for the acquisition of new skills. Therefore, any tool that is already known or provides intuitive access is at an instant advantage. To this end a GUI for the modeling language used in this project as well as an R-Package, allowing domain scientist to run simulations from R as a tool they are accustomed to, are being developed.

Put more generally, the aim is to accommodate the needs, requirements and habits of domain scientists by developing, among other things, access via a known tool and a graphical user interface.

Keeping track: At the point were the model becomes sufficiently complex to be useful for simulation studies the amount of input data, underlying hypothesis and decisions made can become difficult to track, here a formal framework allowing for extensive documentation can aid in keeping an expanding model transparent and useful. Therefore, refining and exploiting provenance approaches in modeling and simulation, such as ODD+P (Reinhardt, Ruscheinski, and Uhrmacher 2018), will be part of future work.

Put more generally, the approach for future development will be to ensure and support extensive documentation by refining and exploiting provenance approaches.

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