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First Interim Report of the Working Group on Integrating Ecological and Economic Models (WGIMM)

11–12 May 2015

Via WebEx conference call

ICES CIEM
International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

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Contents

Executive Summary

The Working Group on Integrating Ecological and Economic Models (WGIMM) met on 11–12 May 2015 via WebEx to work on the Terms of Reference and to discuss further work from 2015 to 2017. One specific issue was the challenge to organize physical meetings with the group. Besides exploring opportunities to meet aside other meetings to increase the opportunities for physical meetings the group also agreed that there is the need for more intersessional work.

The work on ToR a) was a continuation of the work performed over the last years on collecting information about coupled models and analysing them. The collection of models has grown to currently 26 analysed models. A short summary of the work is presented in Section 4. The group discussed the planning for the ICES ASC Session "Social, economic, and ecological impact assessment across marine sectors?" and continuing the preparation of the review paper "Evaluation of Integrated Ecological-Economic Models – Review and Challenges for Implementation" for presentation at the ASC session and subsequent submission to a peer reviewed journal.

The other ToRs were discussed in terms of how to approach the work envisaged. One specific topic was the discussion of what has led to the development of integrated models. A short summary of that discussion is presented in Section 5.

1 Administrative details

Working Group name

Working Group on Integrating Ecological and Economic Models (WGIMM)

Year of Appointment

2014

Reporting year within current cycle (1, 2 or 3)

1

Chair(s)

Eric Thunberg (USA)

F. Rasmus Nielsen (Denmark)

Jörn Schmidt (Germany)

Meeting venue

WebEx

Meeting dates

11 – 12 May 2015

2 Terms of Reference a) – f)

ToR	Description	Background	Science Plan topics addressed	Duration	Expected deliverables
a	Collect globally available coupled ecological-economic models and characterize them with respect to their applicability (academic, advice, evaluation)	Serves as the basis for further work of WGIMM and provides deliverables for the wider community		1st year, will be continued over all 3 yeras	Online Repository with explanation of the different models
b	Develop a framework for evaluation and comparison of these models	Models are a method to evaluate or explore specific hypotheses within systems and such need to fulfil the requirements of every other method of reproducibility		2nd year	White paper of good practice, manuscript for peer reviewed journal

c	Analyse the potential, capability and performance of the models and frameworks with respect to spatial and regional explicit bio-economic evaluation of fisheries management in context of marine spatial planning and broader cross sector marine management on regional basis	Fisheries is increasingly competing for space, especially in coastal areas, but also for the high seas marine spatial planning will become the basis for decision-making in future	3 years	White paper, manuscript for peer reviewed journal
d	Identify further the data and information required as well as expertise needed for integrated bio-economic modelling of fisheries and application of socio-economic evaluation methods on short and long-term basis enhancing the above	The models are increasingly data demanding and the collection and access needs to be harmonized. It will be of crucial importance with respect to limited resources to identify the data, which will be needed to feed the models and to serve as a sound scientific basis for decision-making	3 Years	White paper
e	Discuss how different stakeholder groups can be incorporated in the process of model development. These participatory processes will be of increasing importance to "answer the right questions" and to make these models usable beyond the academic sphere	This is also part of ToR a, but needs to be taken explicitly, because it will influence future developments	2nd year	Nested workshops with stakeholders

f	Develop innovative ways of communicating the increasingly complex results from these models to decision-makers, but also the wider public	A transparent communication of complex results is the basis to increase literacy of fisheries related issues both for decision-makers and the public		3rd year	Schemes for decision support systems

3 Summary of Work plan

Year 1	Repository set up, general White paper
Year 2	Workshops with stakholder involvement, peer reviewed publication, white paper on evaluation schemes
Year 3	Decision support schemes

4 Evaluation of Integrated Ecological–Economic Models – Review and Challenges for Implementation (ToR's a and b; the following is an extended abstract of the manuscript in preparation)

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4.1 Summary

In order to fulfil society's intensifying and diversifying needs while ensuring ecologically sustainable development, more effective marine spatial planning and broader-scope management of marine resources is necessary. Integrated ecological–economic models (IEEM) of marine systems are needed to evaluate potential management actions and understand, and anticipate ecological, economic, and social dynamics at a range of scales from local to national and regional. To make these models most effective, it is important to determine how model characteristics and methods of communicating results influence the nature of the advice that can be provided and the impact on decisions taken by managers. This paper presents a global review and comparative evaluation of IEEM applied to marine fisheries and marine ecosystem resources to identify the characteristics that determine their usefulness and effectiveness.

4.2 Introduction

There is a growing need for tools to evaluate policies and assess trade-offs in management of marine resources and provision of ecosystem services such as fishing, aquaculture, renewable energy, shipping, conservation, and recreation. To meet this need there has been increasing development of integrated ecological–economic models (IEEM) that include various disciplines such as fish ecology, fisheries economics and sociology. Fundamentally, an IEEM is a mathematical representation of ecological, economic and social systems based on linking components and parameters of each dimension. One of the potential benefits of IEEMs is that one can develop a better and more comprehensive understanding of the feedback effects between human activity, human structures and the ecosystem dynamics, which may help managers, avoid unintended consequences of management actions. However, increased complexity within each dimension and greater integration of the dimensions may also increase the difficulty of conditioning the models and understanding and communicating the results. We conducted a global review of IEEMs to provide potential users an overview of when and how IEEMs can be and have been used, and to identify the characteristics that determine their usefulness and effectiveness in fisheries advice. The review evaluates model design choices such as spatial and temporal scale, scope, level of complexity and realism, the ability to model uncertainty and stochastic process impact, and the type and robustness of advice that can be provided as well as the data and expertise needed to develop and parameterize IEEMs.

4.3 Material and methods

In order to perform the comparative evaluation of IEEMs we collected information from model developers on model characteristics and uses including: a) model scope, type, characteristics, development, and complexity; b) model dimensions and scales; c) model input, data, parameters, and functions; d) the model linking, coupling and level of integration of biological-economic-social components; e) model output indicators and model performance criteria (and robustness and risk assessment); f) model uses (generic or case specific; strategic or tactical); g) what makes the models informative and useful to policy-makers and stakeholders (user-friendliness, flexibility, complexity); h) what improves or impedes model acceptance and how can we best communicate model results; and i) the challenges and processes involved in model development and implementation. We established three model meta-analysis tools: a Model Evaluation Matrix, a Model Categorization and Descriptors Summary, and a Model Use and Trade-Off Summary. All model developers filling in the meta-analysis tools were involved in the review, which covers 26 different models.

4.4 Results and Discussion

Most models reviewed provide short-term (tactical) advice and medium term management strategy evaluation (MSE), while only some models (around 1/3) provides both short-term and medium term advice, as well as medium term MSE. Nearly all models can provide long-term strategic advice. Most models were classified as multispecies and mixed fisheries models having modules that also considered socio-economics in relation to fisheries. Only a few IEEM´s included biological interactions or trophic dynamics and interactions. The majority of models only operate with one geographical area and unit, i.e. they are not spatially explicit. Some models operate with several areas such as stock or ecosystem subareas or management and advisory subregions. With respect to the processes considered in the IEEM's most models incorporate dynamic processes, while only four were static models, and five included equilibrium processes. More than half of the models included both simulation and optimization models with respect to estimation of output parameters, while only two were exclusively optimization models. The rest were pure simulation models. For a bit less than half of the models analyses can only be performed by the developer. With the exception of two models, which may be operated with general expertise, for the remaining models, analysis could be performed by someone other than the developer but that specialized training or expertise would be required. Only three IEEM's were characterized as user friendly. The majority of models have been developed using open access software but a few have specific software requirements. Most IEEM's were characterized as flexible, and only about 1/5th of the models as specialised. Most models have high data needs also adding to complexity and need for higher-level expertise.

About 25% of the IEEM's have a high level of implementation (i.e. several cases of implementation and direct use in fisheries management advice). Similar proportions have a medium level of implementation in advice, low implementation or no implementation at all (i.e. only scientific development). For many of the implemented models the advice level they have targeted has been broader regional, ICES or EU, while only a few models have targeted only national advice. The latter models have typically been implemented in uni-jurisdictional systems like in North America and/or Australia. Concerning academic status and use, most of the IEEM's are published in scientific peer reviewed journals, however, only a few have frequent citations.

To guide design and implement IEEM´s efficiently it seems necessary to formulate specific management requests both with respect to ecological sustainability and economic efficiency. It is also necessary to consider how and when strategic advice moves into tactical advice, i.e. in what precise advisory context the IEEM's are supposed to develop and be used? It seems necessary to establish adequate governance structures under which relevant stakeholders and model developer experts can work together in implementing the IEEM´s. It is important to involve model developers and advanced users with cross-disciplinary expertise covering both biological and socio-economic disciplines to develop, adapt and apply the models for advice, as well as assure financing.

5 Question: What has driven the development of integrated models?

In Australia, co-management systems were already in place, mainly organized by gear type, long before strategic modelling has even started. Integrated models were developed mainly for strategic use and medium to long-term planning. Nevertheless simpler bio-economic models have been and are still in use for tactical management purpose, e.g. for setting catches according to the MEY objective. Most of these models (e.g. ss3) are also still single species models. Participatory management is a legal requirement and it came into force, because a political party had took it into its agenda and brought it finally forward and into action. There is a huge political will to put the Ecosystem Based Approach into practice, just because the ministry for the environment has been more powerful than other ministries. However, in Australia, the spatial competition is not that large and thus MSP as a process has not played a big part in this.

In Australia, most fisheries could be considered data poor, because either no data are available or the few data that is available is from such a short timespan that it cannot be used in standard assessment models. Thus, a large toolbox of different model approaches exists and also multiple information streams into the system and simulation models have been developed and used extensively to explore these data poor situations and to answer "what-if" questions.

The above might prove the fact that a top–down approach seems necessary, i.e. managers need to state that they want a regionalized approach and participatory management, to initiate the development and especially use of integrated models in assessment and advice. Such a regionalized approach might be more difficult in Europe with the Lisbon Treaty prohibiting strong regionalization in Europe. One of the few exceptions might be the Advisory Councils (ACs) and regional management plans, which come closest to the situation in Australia. From a fisheries perspective many problems are also located in the biological realm rather than looking into social and economic situations (drivers).

However, even if you have a regional management structure, you still need trust in the science from all affected people. The question arises how participatory are participatory structures in reality. If you do not have trust, integrated models are of no use. The question is how to build-up trust into science? Either trust comes with our work, developing models and showing that results reflect true developments or trust comes with time and continued collaboration. The way forward would be to build-up participatory governance developing trust in the process, trust in the science and trust in the data over time.

A good way to get general insights can be to perform a comparative analysis of case studies to investigate the process of integrated model development and to analyse process and governance structures, which led to the development of integrated models (from tactical to strategic). Examples could also include aquaculture, integrated coastal zone management, water quality and even networks on land as well like water rights (e.g. COMAS community in developing agent-based models). This topic could also provide the basis for collaboration with WGIPEM and could be the topic of a dedicated workshop.

6 Next meetings (Interim reports only)

The time and venue of the next meeting is not yet known.

Annex 1: List of participants

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Annex 2: Agenda

I. Meeting objectives and introductions

II. Progress report on ICES ASC Session
    a. number of papers and titles (if available)
    b. preliminary ideas on session design

III. Continuation of review paper preparation
    a. Review paper outline (See Annex 1)
        i. Does this reflect current objectives?
        ii. Revise as needed
    b. Review status of model collections (Model Evaluation Matrices and Model Overview Tables)
        i. Is the current collection representative?
            1. Geography
            2. Level of complexity
            3. Level of integration (social, economic, ecological)
            4. Dimension/scale (multispecies/multifleet/multi-users)
    c. Develop model performance criteria
        i. How do we measure performance characteristics for reporting purposes?
            1. Model type
            2. Characteristics
            3. Complexity
            4. Dimensions
                a. Space/Time
                b. Scale
                c. Inputs and outputs
                d. Biological/Social/Economic
            5. Coupling
            6. Use/Implementation

IV. Discuss whether/how to integrate fishery connections to the rest of the economy in the review paper in the broader context of marine spatial planning
    a. General aspects to be considered
    b. Linking to broader scale cross sector and socio-economic models
    c. Planning for WGIMM ToR c