The West of Scotland case study: Status and further work

Report for the North Western Waters Advisory Council

Co-authors: Kare Nolde Nielsen, Paul Fernandes, Alain Baudron

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The purpose of the MareFrame project http://www.mareframe-fp7.org/ is to support an ecosystem-based approach to fisheries management. The co-creation approach of the MareFrame project envisages a close cooperation between stakeholders and researchers in order ensure quality and relevance of the project's outcomes. This approach invites stakeholders to contribute to problem definition as well as with concrete knowledge relevant for each of MareFrame's 7 case studies.

The project seeks to use existing and novel types of data in state of the art ecosystem models. These models will be used in conjunction with a framework for decision support to develop proposals for how to deal with specific problems in case studies require an ecosystem orientation.

The purpose of this note to is summarize the West of Scotland case study so far, to outline the coming work and to invite stakeholder contributions to the case study work.

Initial problem formulation at the Dublin meeting: whitefish recovery and long term economic optimum

The West of Scotland case study was launched in Dublin the 22.05.14. The stakeholders present at the meeting identified and ranked 13 management issues to be analyzed as part of the case study. The issues that were given particular priority relate to the biology and economics of recovery of whitefish: What would be required to recover cod and whiting stocks, giving consideration to seal predation and discards of these species, and the economic effects they may constitute as choke species? In addition, priority was given to the topic of long term economic optimum in the fisheries: What would represent FMMEYs for key commercial species in the area? In relation to that optimum, what would be the number of vessels within each fleet segment that would be able to achieve a reasonable level of profitability?

The ecosystems models

Background on the modelling approach

One of the novelties of the MareFrame project is that a minimum of two ecosystem models are to be applied on each case study to investigate the relevant management issues, contrary to the usual approach of one model per case study. Ecosystem models are designed to simulate whole ecosystems and are therefore very complex. They require a lot of data from various sources in order to be parameterised correctly, some of which are not always available. Thus, ecosystem models often rely on several assumptions. In addition, although ecosystem models are designed to capture the main dynamic processes they do not perfectly replicate reality as it is impossible to account for all the variability observed in the wild. As a result, ecosystem models are prone to criticism. By applying two or more ecosystem models on each case study, MareFrame aims at overcoming this criticism: if the similar observations are made based on the outputs from different models then conclusions can be drawn with more confidence.

The University of Aberdeen is the MareFrame participant in charge of the West of Scotland case study. The two ecosystems models to be applied on the West of Scotland case study are Ecopath with Ecosim (EwE) and FishSUMS. EwE is a foodweb ecosystem model in which the entire ecosystem is modelled by functional groups, each of which encompasses species with similar lifestyle and diet (Fig. 1). EwE is a widely recognised ecosystem model which has been employed to model numerous marine ecosystems throughout the world (Heymans *et al.*, 2011). FishSUMS is a length-based model in which part of the ecosystem (species of interest) are modelled in length stages throughout their life while the rest of the ecosystem is modelled as one entity (Fig. 2). FishSUMS has only been developed for the North Sea ecosystem where it focused on demersal species (Speirs *et al.*, 2010).

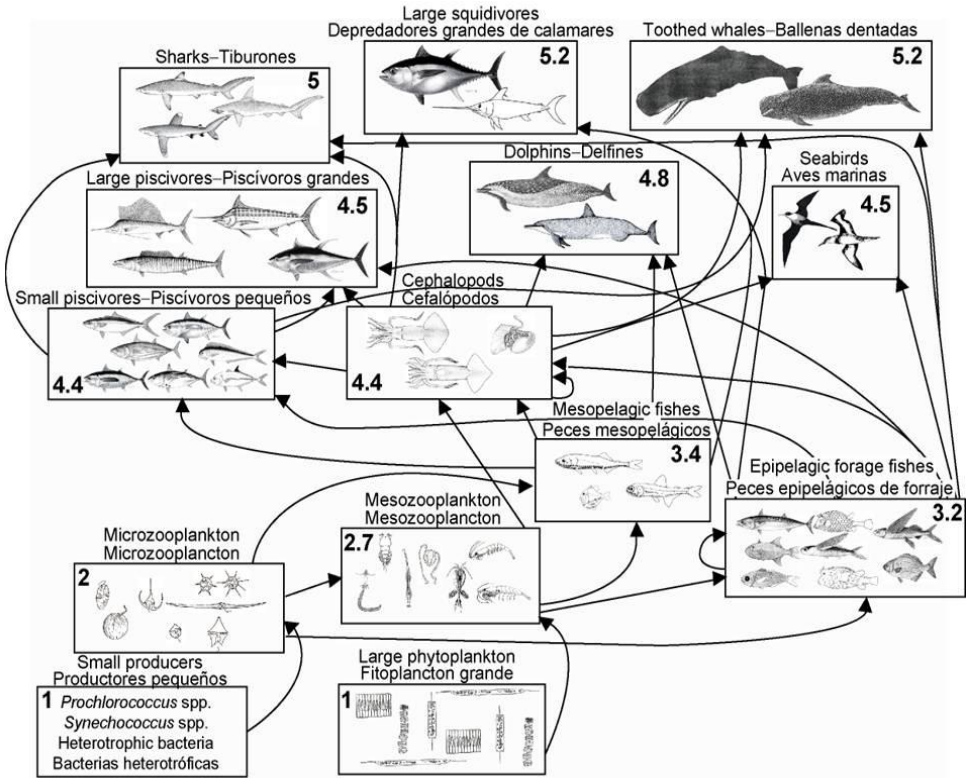

Figure 1: Schematic representation of the Ecopath with Ecosim foodweb full ecosystem model

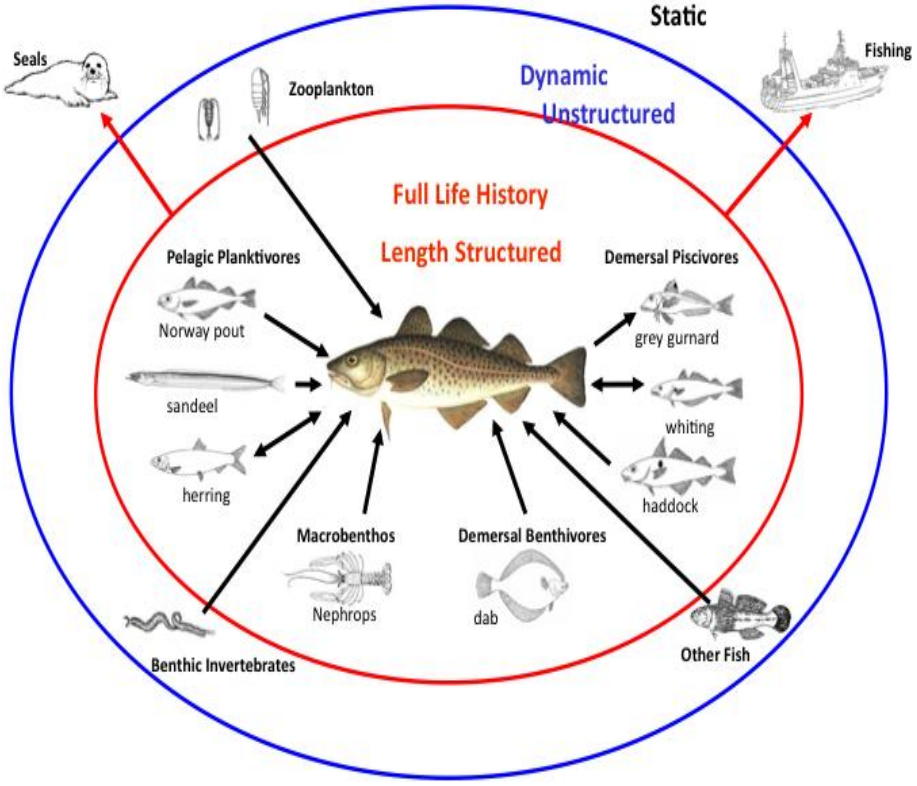

Figure 1: Schematic representation of the FishSUMS length-based partial ecosystem model

Progress to date

EwE has previously been developed for the West of Scotland ecosystem by Bailey *et al.* (2011). This model has very recently been updated by Alexander *et al.* (2014) who added a few species and published their work in September 2014. This latest version of the model luckily provides an advanced starting point for the West of Scotland case study. FishSUMS on the other hand will have to be built from scratch which will take a significant amount of time. The MareFrame deliverable 4.1 (D 4.1) due at the end of November 2014 will contain reports detailing the parameterisation of one ecosystem model for each of the case study considered in MareFrame. Due to this schedule, it has been decided that the parameterisation of EwE will be described in D 4.1 for the West of Scotland case study. The FishSUMS model will be developed throughout the MareFrame project. Both University of Aberdeen participants (Dr Paul Fernandes and Dr Alan Baudron) have previously used FishSUMS during the FP7 EcoFishMan project (http://www.ecofishman.com/). However, both participants have limited knowledge of EwE. As a result, Alan Baudron attended a 3 days course entitled "Ecosystem Based Management using Ecopath with Ecosim" held at the Scottish Association for Marine Sciences (SAMS) in Oban on the 15th-17th of July. This course provided Alan Baudron with the necessary skills to use Alexander *et al.*'s model and adjust it for MareFrame's purpose. Alan Baudron is currently writing the report describing the parameterisation of EwE's latest version for the West of Scotland. This report will be included in D 4.1 due to be delivered at the end of November.

Other work carried to date by the University of Aberdeen includes deliverable 4.2 (D 4.2) which provides a common structure to report the results obtained with the different ecosystem models employed in MareFrame. Such common structure is needed in order to efficiently assess management strategies which are modelled with different ecosystem models which vary in type (food web model, size- or age-based model, individual-based model), are built differently, rely on different assumptions, and will consequently return different outputs. One of the main outcomes of D 4.2 is a list of indicators which can be derived from the outputs of each model employed in MareFrame. These common indicators will form the basis for comparing the performance of management strategies simulated with different models. D 4.2 was submitted by University of Aberdeen to the MareFrame project leaders for approval on 13th October 2014 and should be available from the MareFrame website in the next few days. The list of common indicators is given in Appendix 2.

Next steps for modelling approaches

The latest version of EwE published by Alexander *el al.* (2014) is parameterised until 2008. The next step upon completion of D 4.1 will be to update the parameterisation of the model until 2013. This will involve obtaining the required data (biomass estimates from scientific survey, diet composition, fishing fleet composition and effort, etc.) for the 2009-2013 period, re-run the mass balance approach from Ecopath, and parameterise Ecosim so that the model outputs match the time series of historical data, indicating the ability of the model to simulate the processes occurring in the wild. This update of EwE should be completed by spring 2015.

When updating the parameterisation of the model additional species can be added should they be required, for example, to investigate choke species issues. Upon identification of the main management issues to be considered for the West of Scotland case study, additional processes needed to investigate particular management issues such as trawling impact on seabed can also be added at this stage if possible.

On the long term, future steps will involve developing and implementing the FishSUMS model for the West of Scotland. It is likely that the feedback gathered when developing the EwE model will be useful when building the FishSUMS model.

Input needed from NWWAC

At this stage, it would be helpful to obtain feedback on the following:

- List of common indicators (Appendix 2): What do stakeholders think of these indicators? Are they relevant to measure management efficiency? What other indicator/measure would you like to see?
- Are choke species an issue in West of Scotland, and if so, which species would you like to be investigated?
- Rank the management issues mentioned during the kick off meeting (Appendix 1) in order of priority: which ones MUST be investigated within the MareFrame project?

Further case study work

In the coming time Stakeholders and case study researchers need to elaborate the case study in different respects:

- Selection and further specification of management problem: Due to the high number of case studies in MareFrame, the project will not have the capacity to address all the management issues that were identified by Stakeholders in Dublin. Preferably, a single problem (or set of interrelated problems) should be chosen for the case study for decision support.
- What policies and specific policy objectives have a bearing on the problem and must be met by a management proposal?
- Which indicators should be used?
- How to model the problem context? Will required data be available? Ideally, the problems should be identified by stakeholders based on their relevance. However, it must also be practically possible to conduct research in support of the identified problems. Hence, a common ground between problems and research possibilities must be ensured.
- Candidate measures to solve the problem should be identified. This is important so that the ecosystem model, to the extent possible, can be tailor made to be relevant for evaluating likely outcomes and effectiveness and of these measures.

Planned project work within the next 12 months and beyond

November 2014: Skype meeting with stakeholders to elaborate problem scope and ensure correspondence with ecosystem model and data capacities. If you would like to participate in this meeting, send an email to Kåre Nolde Nielsen or Alex Rodriguez. Written suggestions are also welcome (see contact info below).

9-12 December 2014: Annual project meeting (this year in Aberdeen). Review progress and problems in the overall project. Get feedback from stakeholders and external advisors. Ensure coordination between project partners.

Spring 2015: Further work on modeling the problem, identifying constraints (e.g. GES criteria that might apply, e.g. that stocks needs to be > MSY) as well as concrete opportunities. What represents minimum appropriate profits in the industry? Can conflicts with other interests be anticipated? Are there possibilities to reduce the chokes species problem by way of quota swaps? Etc. Please let us know if you have suggestions for management measures and strategies!

July 2015: Decision support workshop (Stakeholders and researchers). Purpose: To map the problem in greater detail, explore involved trade-offs, and to identify relevant scenarios. Detailed scenarios should represent proposed solutions to the problem, and they will be "tested" after the meeting. Comparisons of the scenarios will be used as basis in a draft "management proposal". Due consideration will also be given to the governance context that any proposal would need to fit into. E.g. Could the proposal be proposed as a "Joint Recommendation" by member states to the Commission? If so, who would be behind the proposal? Have the interests of other affected parties been appropriately considered?

July 2015: Further elaboration of problem, models and the first drafts of a management proposal. Later on, the drafts will be evaluated together with the models and decision support approaches they resulted from. This will be the basis for further development of models, decision support tools, which subsequently will be used to develop a final management plan proposal by the end of the project. The MareFrame project will continue until 01.01.17.

More information and contact

If you have comments suggestions or would like to know more about the case study or the MareFrame project in general, please contact:

Alex Rodriguez (NWWAC Secretariat – general queries from stakeholders)

Paul Fernandes / Alan Baudron (University of Aberdeen - Ecosystem model development)

Kåre Nolde Nielsen (University of Tromsø - planning and decision support)

Case study contacts:

Name	Role	@mail	skype	phone
Paul Fernandes	WP4 case leader	fernandespg@abdn.ac.uk		
Alan Baudron	WP4 researcher	alan.baudron@abdn.ac.uk		
Jane Sandell	Stakeholder, NWWAC – SFO	jane.sandell@scottishfishermen.co.uk		
Mike Park	Stakeholder, NWWAC – SWFPA NWWAC SWFPA	mike@swfpa.com	mike@swfpa.com	
Bertie Armstrong	NWWAC Chair – SFF Stakeholder	barmstrong@sff.co.uk		
Alex Rodriguez	NWWAC Secretariat	rodriguez@bim.ie	alexandre_rodriguez	+353 (0) 87 3141387
Kåre Nielsen	WP6 case leader	Kare.nolde.nielsen@uit.no;	kaarenolde	+47 776 44480

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Appendix 1: Management issues identified by stakeholders during the West of Scotland case study launch meeting

i. What would be required to recover the cod stock?
ii. What would be required to recover the whiting stock?
iii. What is the impact of seal predation?
iv. What is the optimum (economic) balance between the prawn and whitefish fisheries?
v. What is F_{MMEY} (the fishing mortality associated with the multispecies maximum economic yield)?
vi. How to include the data-poor stocks?
vii. How to measure the impact of deep-water fishing?.
viii. Study the effect of alternative selectivities in the main fisheries.
ix. Consider sub-regional effects (Clyde vs Minch vs Offshore).
x. Can the model estimate the optimum fleet size? Although it is not clear what the "optimum" might be (economic or social). Perhaps best to consider the maximum fleet size for all vessels to be making a minimum amount of earnings before interest, tax, depreciation and amortisation (EBITDA); and have the option to estimate the n number of vessels that would make the x amount EBITDA.
xi. To simulate the scenario of "black discards" (discards occurring at sea, assuming compliance).
xii. To simulate the effect of choke species (cod on the west coast): when would the fishery close? What are the likely losses (revenue, EBITDA)?
xiii. What would a recreational fishery look like in the west of Scotland?

Appendix 2: List of common indicators to be used to compare management strategies simulated with different ecosystem models, as defined in Deliverable 4.2

- Trends in biomass: do all species in the ecosystem reach a stable and sustainable status (% of species stabilised at the end of simulation)
- Abundance trends of functionally important species/groups
- Trends in landings: is economic sustainability achieved
- Fishing revenues: using mean price/kg
- Fishing mortality (species specific)
- Catch to biomass ratio
- Number of overfished stocks (assessed stock only)
- Proportion in weight of large species
- Number of species with significant landings (Gascuel *et al.*, 2014): landings higher than a minimum level (to be set for all models/ecosystem to be compared)
- Shannon's diversity index (Shannon, 1948): biodiversity index based on the proportion of species in the landings
- Mean Maximum Length (MML) (ICES, 2009): based on maximum asymptotic length L_∞ from Fishbase (www.fishbase.org) and the weight (biomass) of species
- Mean Trophic Level (MTL) (Pauly *et al.*, 1998): based on the mean trophic level from Fishbase (www.fishbase.org) and the weight (biomass) of species
- Marine Trophic Index (MTI) (Pauly and Watson, 2005): MTL of predatory fish i.e. species with a trophic level of 3.25 or higher
- Pelagic to demersal ratio: indicator of nutrient input and quality of benthic habitat (de Leiva Moreno *et al.*, 2000)