Enhancing Europe's marine ecosystem modelling capability for societal benefit

Marine ecosystem models are an important analytical approach to: integrate knowledge, data, and information; improve understanding on ecosystem functioning; and complement monitoring and observation efforts. They also offer the potential to predict the response of marine ecosystems to future scenarios and to support the implementation of ecosystem-based management of our seas and ocean.

There is no single model that can answer all policy questions. In each case the context, specific knowledge and scale need to be taken into account to design a model with the appropriate level of complexity. It is more practical to assemble several models in order to reach the full End-2-End spectrum. This requires a transdisciplinary approach and the inclusion of socio-economic drivers.
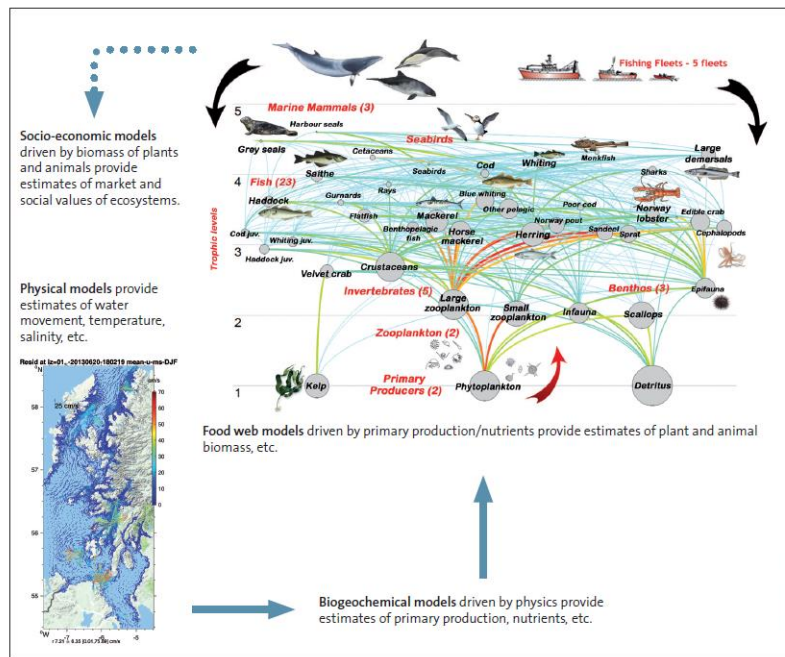

Figure 1 Example of the coupled model framework used for the West Coast of Scotland marine ecosystem (Serpetti et al., 2017). See Table 1 for examples and descriptions.

Key Recommendations and actions to strengthen marine ecosystem modelling capability include:

- *Link models to observations and data*. Develop models, or coupled models, that can incorporate the full spectrum of ocean data, including biodiversity from microbes to top predators. Ensure data assimilation centers (e.g. the Copernicus Marine Service, EMODnet, etc.) include all existing and emerging data streams. Use models more actively to design ocean observation networks;

- *Increase predictability through coordinated experiments and the ensemble approach.* Design and run coordinated model experiments, e.g. through a common funding scheme, to model uncertainty and increase model predictability. Further integrate model predictions, historic data and machine learning to generate sensitive adaptive modelling tools that are more representative of the complex interactions of evolving marine ecosystems;

- *Make marine ecosystem models more relevant to management and policy*. Increase the credibility of models by defining and communicating uncertainties. Couple ecosystem- and physico-chemical-models with socio-economic drivers to include the human dimension. Promote co-design between stakeholders and modellers;

- *Develop a shared knowledge platform for marine models and support the development of next generation models* for sharing information and capability on marine ecosystem models, building on European initiatives e.g. the pilot Blue Cloud, and the marine modelling framework and associated Network of Experts for ReDeveloping Models of the European Marine Environment;

- *Enhance trans-disciplinary connections and training opportunities.* Promote training that spans fundamental marine sciences, modelling and policy and develop an online shared knowledge training platform to connect marine ecosystem modellers, share opportunities and promote inter-disciplinarity.