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# Ecosystem modelling in support of the MSFD Commercial fish/shell fish Descriptor

MEECE is an EU FP7 project which has developed regionally-focused ecosystem models. The new European Marine Strategy Framework Directive (MSFD) provides a transparent, legislative framework to apply an ecosystem-based approach to the management of human activities in the marine environment. The Directive aims to achieve 'Good Environmental Status' (GES) across Europe's regional seas by 2020. The MEECE Descriptor fact sheets highlight how MEECE science can be used in support of the MSFD.

**Commercially exploited fish and shellfish and the MSFD**


The Descriptor 3 definition for GES is: "Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock." Key criteria for measuring GES include the level of fishing pressure, the reproductive capacity of the stock and the age and size distribution of the assessed population.

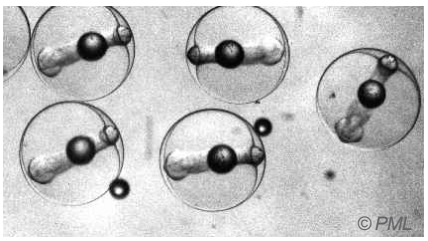
Fishing is the only driver explicitly considered as part of this descriptor and the only activity subject to tactical management at the appropriate scales of space and time. Other drivers such as climate, however, could become relevant and should be considered for the longer-term strategic management of fishing activities. At the scale of several decades, considerable and regionally-different changes in productivity can be expected due to climate or eutrophication which should be considered when setting management targets for this descriptor.

## How MEECE science can support this descriptor

Meeting the goals of the MSFD to achieve GES for commercial fish and shellfish needs integrative approaches to consider multiple drivers and biological interactions in each of the regional ecosystems. The simulation models developed and applied in MEECE provide tools for addressing these issues thereby allowing a shift from a conventional single stock perspective to a more holistic ecosystem based approach. This involves considering the short-term tactical management specific to this descriptor as well as in relation to all other MSFD descriptors, but also how this descriptor's objectives can be achieved in the longer-term.

To that end a suite of modelling tools have been identified, each targeting the major exploited fish resources in each of the MSFD regions. A diversity of approaches have been used ranging from foodweb and size structured models to Individual Based (IBM) and single- or multi-species stock assessment models. Several of these models can be coupled to models of the bottom of the food web, allowing the exploration of the impact of fishing pressures and other drivers.

One important exercise within MEECE has been the application of such models to explore the reference levels required for operationalizing the objectives/criteria for GES of this descriptor.



*From top to bottom: Purse Seine Fishing Vessel in the Adriatic Sea, cod eggs and mixed fish at the market.*

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## Science in support of policy

A healthy age and size structure is considered a key attribute that determines GES of commercial fish. However what constitutes this and how fisheries management could protect it remains unclear. To investigate this issue MEECE used simulations from a generic model where recruitment is driven by fish egg production, a variable which is more sensitive to variations in age structure than the traditionally used spawning stock biomass (SSB). These simulations were conducted to mimic populations of North Sea cod, plaice and herring.

Our results could not identify what a "healthy" age and size structure should look like as none of those explored exhibited unequivocally the key characteristic of a "healthy" stock, defined as providing a quick recovery once the adverse ecosystem conditions improve, or its impacts ceases.

However, by applying two selection patterns (Protect older fish versus Maximise biomass) and comparing the resulting trends with those resulting from the current selectivity (graph 1, top) we found that:

1. age structure was highly dependent on the selection pattern (graph 2), and to a lesser extent on the level of fishing mortality;
2. selection pattern determined the ability of fish stocks to withstand, and recover from, external perturbation;
3. selection pattern determined the output of the fishery suggesting management options of either balanced stable but relatively low yields versus strongly fluctuating high yields (graph 3 and 4).

**Therefore we propose to make the exploitation selection pattern for which clear management targets can be set as a more effective policy goal instead of the current "healthy age structure" formulation. Selection patterns would range from whether the preference is for stable but relatively low yields or for strongly fluctuating high yields.**

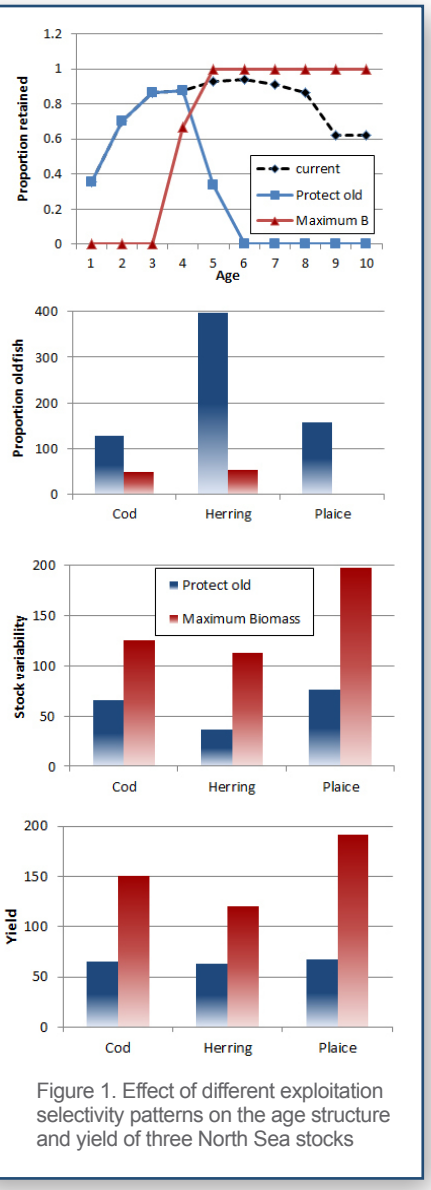


Figure 1. Effect of different exploitation selectivity patterns on the age structure and yield of three North Sea stocks

For the MSFD fisheries descriptor the proposal would be that it is reformulated into two "Pressure" criteria, fishing mortality and selection pattern, each with very specific targets. In addition two "State" criteria, Spawning Stock Biomass and age/size structure could be included. However, due to their known sensitivity to environmental variation and limited understanding of potential targets for age/size structure, these would be better placed as so-called "surveillance indicators", not directly influencing management but where any major change should be a stimulus to identify the causes and initiate remedial management action.

## Statement of confidence

The operating model used for the simulations was built to explicitly incorporate the age structure effect on the stock reproductive potential. This was done by representing reproductive potential using Total Egg Production, calculated using age-/size-dependent reproductive traits (fecundity, hatching probability for cod). The model also aimed at giving a realistic representation of the dynamics incorporating density-dependent growth.

MEECE Links

*The full suite of models developed in MEECE can be viewed through the Model Library with accompanying user guides. Outputs from the models applied across European regional seas during MEECE are available through our web based Model Atlas. This interactive website allows visitors to view and compare model projections per region for different variables affected by a range of scenarios including future climate and human induced drivers of change.*

www.meece.eu/Library.aspx | www.meeceatlas.eu

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