DEVELOPING AN *FLR* OPERATIONAL MODEL FOR EVALUATION OF FISHERIES MANAGEMENT STRATEGIES: AN APPLICATION TO HAKE FISHERY

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Abstract
An operational population model for hake developed in *FLR* framework of the *R* language under the EFIMAS project is presented. Two effort restriction scenarios were tested (10% and 20% reduction of fishing mortality F). The response of the hake fishery in these two management measures was evaluated for a 10-year projection period.
Keywords : Aegean Sea, Demersal, Models, Population Dynamics, Fisheries.

Hake is one of the main target species of several multi-species Mediterranean fisheries and especially of the bottom trawlers exploiting the continental slope. On the basis of the available data most of the hake stocks in the Mediterranean are either fully exploited or overexploited. In most of the cases a decreasing trend in individual lengths of the hake caught and in the catches per unit of effort of the trawlers can be observed. Fisheries management in the Mediterranean is based mainly on technical measures and control effort regimes i.e. a minimum landing size of 20 cm, a prohibition of bottom trawling within three miles of the coast or in depths less than 50 m (whatever comes first), a 40 mm minimum mesh-size of bottom trawls cod-end and a control capacity regime, i.e. limitation on national fleets' horsepower and gross tonnage.

In the Aegean Sea, hake is one of the main target species of the demersal trawl fishery and around to 300 vessels are currently involved into this fishery having an annual hake production of about 3000 t. Demersal trawlers operate from October 1 to May 31 exploiting the continental shelf and the upper part of the continental slope from 30 to 400 m [1].

Under the framework of EU EFIMAS *(Operational evaluation tools for fisheries management options)* project two management measures and corresponding strategies will be evaluated in the light of potential future increase of hake biomass using either effort or technical measures. The first will deal with effort restrictions, e.g. reduction of fishing mortality F, closed seasons, etc. The scenario will evaluate the trade-offs between effort, fishing intensity and stock status when limiting the trawling intensity to certain bounds (e.g. a single percentage cut off F / Effort, a closed fishing season). It is more than likely that the effect of these bounds on age composition of the stock and thus on interannual catches and yields, in the short term, will be dependent on the initial status of the stock. The second scenario will explore the impact of management regulations addressing specific technical measures, e.g. gear selectivity measures such as mesh type (e.g. knotted or not), on catchability dynamics.Gear selectivity will be evaluated against two scenarios, i.e. 40 mm cod-ends with and without knots. It is anticipated that the above analyses and scenarios testing will highlight if effort- or selectivity-based management is preferable for demersal trawl fisheries of hake.

A population model for hake fishery in the Aegean Sea was developed using the *FLR* (Fisheries Science in *R*) framework of the *R* language [2] in order to estimate future catches. First results are presented here from the application of the operational model to 2004 data of catch at age, weight at age, VPA derived estimates of F-at-age and recruitment. Stochasticity was incorporated in the operational model by introducing random variability in the recruitment values.

Two effort restriction scenarios were tested: one with a single 10% and another with a single 20% cut off F in the following year (2005). Under the assumption of constant catchability these F cuts may well reflect analogous reduction in effort E. The response of the hake fishery in these two management measures was evaluated for a 10-year projection period (Figure 1). Under fixed management rules the catch of the hake fishery remains relatively stable. A 10% cut in the fishing mortality F results in a 6% reduction in that year's catch (2005). However, the fishery soon (2006) returns to the previous level of exploitation and catches gradually increase in the following years (up to 10%). A 20% reduction in F induces a 13% decrease in the following year's catch. Hereafter the catches increase and level at higher values (17.5%) compared to the base and 10% case studies.

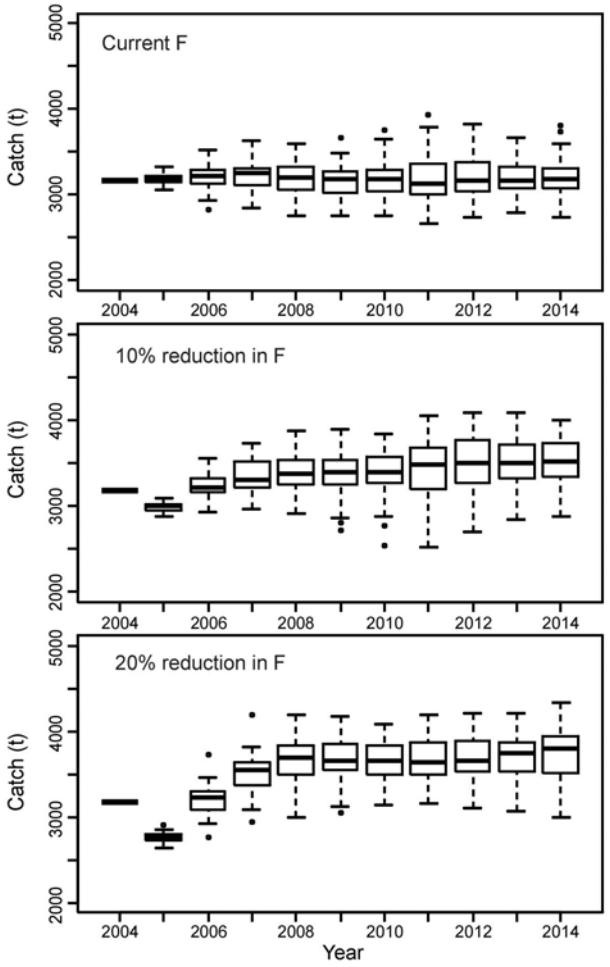

Fig. 1. Simulation results of operational model applied to hake catches in the Aegean Sea (2004). Projection period: 10 years. Scenarios with the current F, 10% and 20% reduction of current F.

References

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