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CERES storyline - European hake in the Mediterranean

Will European hake be effected from climate change?

European hake (*Merluccius merluccius*) is found throughout the Mediterranean Sea, and is a common catch in all commercial demersal fisheries. Exploited since historical times, it has been concluded by the General Fisheries Commission for the Mediterranean that stocks are declining and are over-exploited in some regions.

For the Aegean Sea hake, a recent study suggested that both fishing mortality (F) and spawning stock biomass (SSB) may be outside optimal levels. As a result, a national multi-annual management plan targeting fisheries exploiting the hake stock has been put in place since 2014. Our goal in CERES is to determine the potential impact of climate change, not only on hake historical production but also distribution, fecundity, growth, maturity, recruitment, and natural mortality. Of particular interest is to identify the exact point in time when this climatic driven regime shift may have occurred and which environmental factor was the key driver behind this change.

How vulnerable is hake to climate change?

It has been documented that during the 80's West Mediterranean hake stocks have undergone drastic changes, consistent with hydroclimatic variability. It is now suggested that the combined effect of fisheries, environment and stock internal dynamics can increase the dependency of the hake populations on the recruitment variability, which is largely climate driven.

What is the economic value of this fishery?

Hake is an important commercial species in the small scale fisheries sector, as well as the industrial bottom trawl fleet, reaching as much as 10% of total catches. Given the low profitability of the Greek Aegean fleet and the inability for an increase in capital investment to become more competitive, efficient and productive, any climate related change that will affect hake yields may pose a serious threat to the viability of the fishing sector.

What are the challenges?

Hake related information is associated with significant knowledge gaps, being no exception from the rule governing Greek fisheries. The lack of sufficient time series of stock related data, due to the discontinuous implementation of the Fisheries Data Collection Programme, hindered any efforts to analytically assess the status of the stocks. Valuable descriptors of population status such as age structure, biomass levels, spawning stock biomass, fishing mortality, recruitment variability, spatio-temporal distribution, fecundity, growth and maturity are either partial or lacking completely. The only available long-term datasets are the official landings provided by national statistics which date back to the 60's.

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Inferring on these data was deemed the only option within reach. However, projecting the impact of climate change on hake production based on these data is expected to be accompanied by a great deal of uncertainty.

What is the working program in CERES?

The modeling approach will go along the following steps:

- Review the physiological limits of the species to multiple stressors.
- Investigate trends and relationships of landings and environmental indices time series
- Select which environmental indices to include (check for multi-colinearity)
- Identify if and when changes have occurred in the 'system' (Aegean demersal marine biota - e.g. hake stock) through application of:
  - » Principal Component Analysis (PCA)
  - » Chronological Clustering (CC)
  - » Sequential Regime Shift Detector (STARS)
  - » Non-linear Threshold Generalized Additive Models
- The aforementioned models, will be applied in parallel, with the intention to confirm in more than one ways if a climatic driven regime shift has occurred and which environmental factor was the key driver behind this change.
- Project future changes in distribution and productivity under various climate scenarios, through life cycle and mechanistic models.
- Provide spatially-explicit bio-economic estimates of climate-driven changes in the fishery and the resources (bio-economic model).

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