

# knobi: AN R PACKAGE IMPLEMENTING KNOWN-BIOMASS PRODUCTION MODELS CONSIDERING ENVIRONMENTAL EFFECTS

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## Usefulness

KBPM input requires catch observations and **historical biomass series** derived from a prior model adjustment. Then, if we already have a model that defines the stock status, **what does this alternative provide?**

- Exploration of **Surplus Production (SP) evolution** and drivers affecting it.
- Diagnostic tool for **identifying stock collapse reasons**.
- Analysis of **environmental effects** over the SP.
- **Forecasting** considering different catch and environmental scenarios, for example the **Intergovernmental Panel on Climate Change scenarios** considering the different future climate change environmental projections.
- Estimation of **biological reference points (BRPs)** without a stock-recruitment relationship.

## Formulation

Known biomass production models (KBPMs) estimate the annual  $SP$  as

$$SP_t = \bar{B}_{t+1} - \bar{B}_t + C_t$$

being  $C_t$  the catch during the year  $t$  and  $\bar{B}_t = (B_{t+1} + B_t)/2$ , where  $B_t$  is the biomass at the beginning of year  $t$ . Then, the SP biomass relationship is fitted as

$$SP_t = \frac{r}{p} \bar{B}_t \left( 1 - \left( \frac{\bar{B}_t}{K} \right)^p \right) + \varepsilon_t,$$

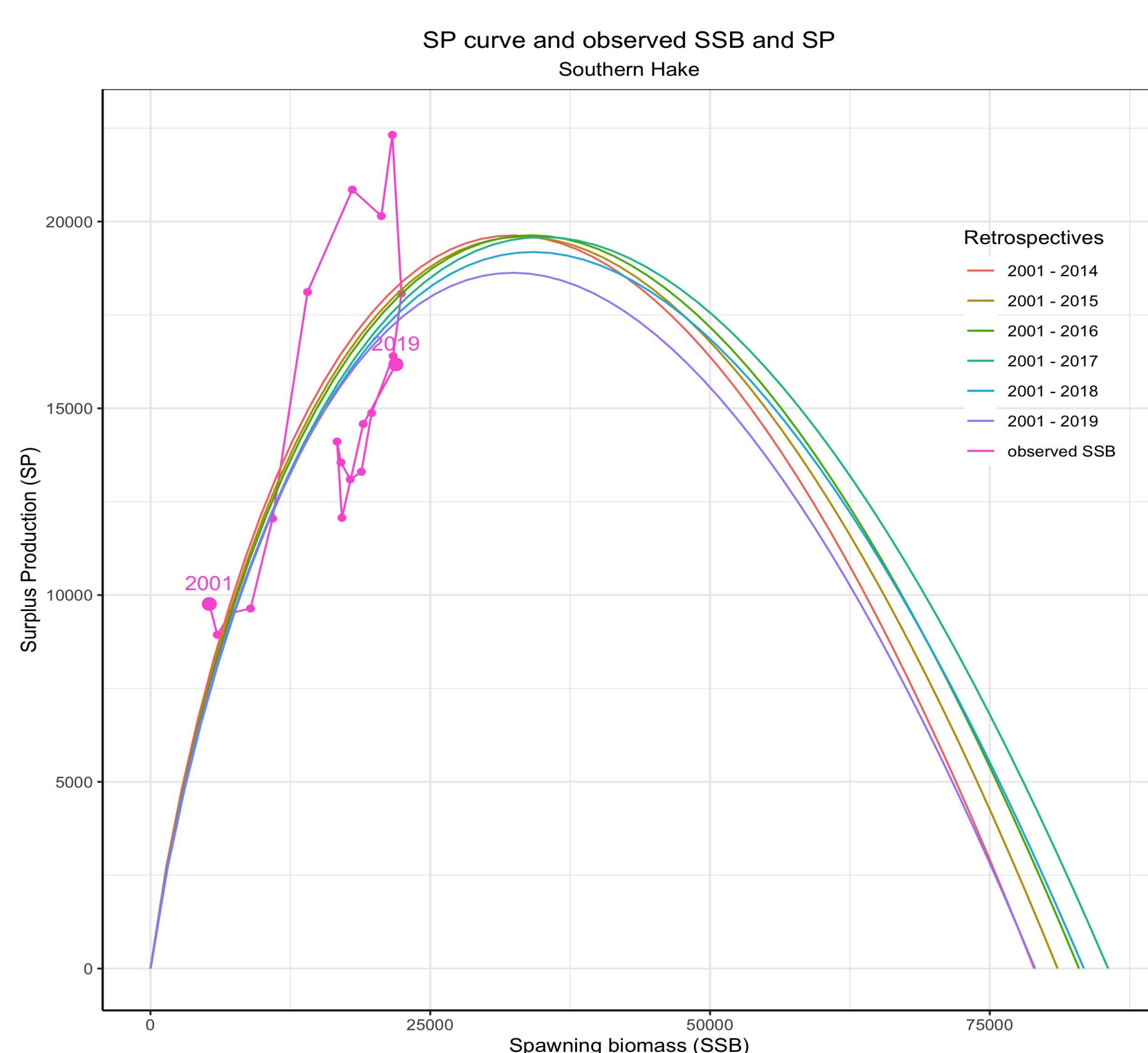
where  $r$ ,  $K$  and  $p$  are model parameters and  $\varepsilon_t$  are the  $t$ -th model residual.



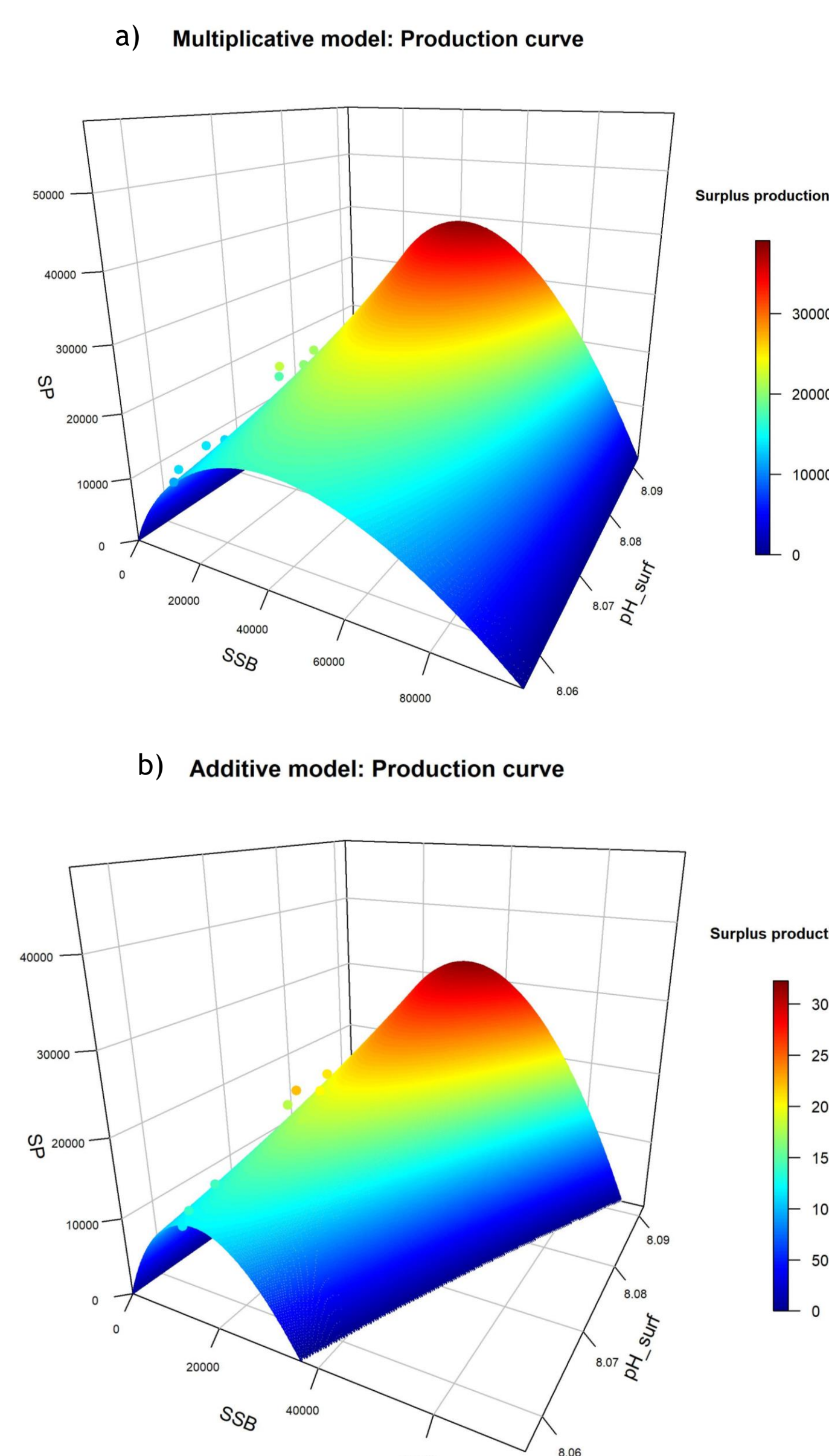
## knobi package



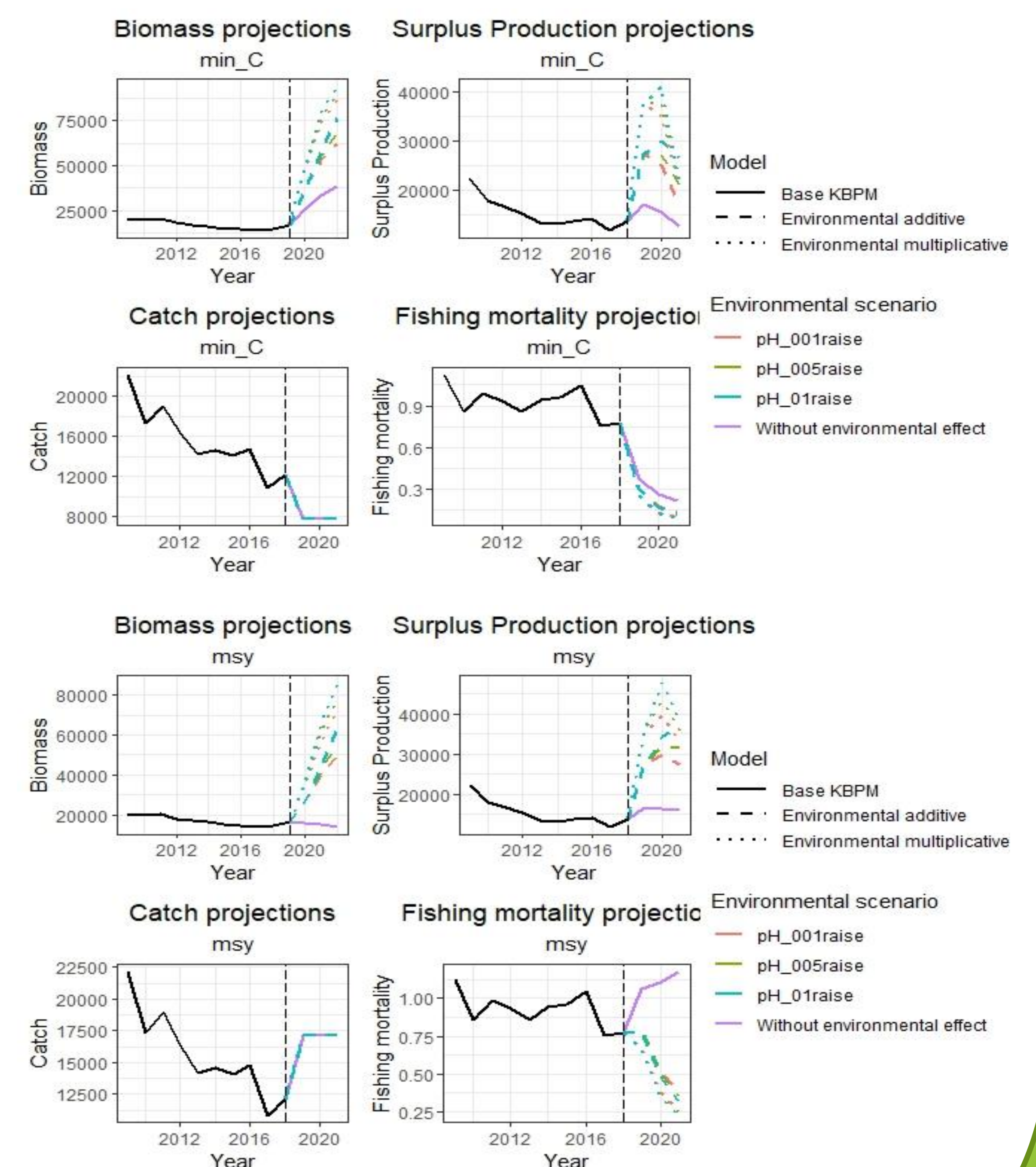
The *knobi* functions perform: (1) the KBPM model **fitting** with the **BRPs** estimation (2) the **retrospective analysis**, (3) the analysis of **environmental effects** on the SP and (4) the population and fishery dynamics **projections**.



**Fig 1:** KBPM retrospective analysis for the southern stock of European hake (*Merluccius merluccius*) in the International Council for the Exploration of the Sea (divisions 8.c and 9.a).



**Fig 2:** Surplus production curve for southern European hake stock depending on the values of pH ( $pH_{surf}$ ) covariable for a) multiplicative KBPM model; b) additive KBPM model.



**Fig 3:** Biomass and SP projections for southern European hake stock depending on future values for pH and catch levels.

## Conclusions

*knobi* is a **user-friendly** R package that provides a simple and powerful tool to explore KBPM applications and is expected to be **useful for the scientific community**. **Clear advices** for a correct use of the package and full illustrative examples are given in the **help pages and vignettes**.

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