MERVEX
Modeling and Evaluation of Exploited Resources

IMPRESS

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA

CSIC
Consejo Superior de Investigaciones Científicas

Surplus Production Models: a practical review of recent approaches

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Iberian Symposium on Modeling and Assessment of Fishery Resources

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- **(3) catch and CPUE (catch per unit effort), or other fishery-independent biomass index, based methods.**

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SPMs model the temporal evolution of the aggregated biomass (targeted by fishing) by combining the general effects of growth, recruitment and mortality **(all aspects of production) into a single production function.**

That is, SPMs estimate the **changes in the biomass as a function of the biomass of the previous year, the surplus production in biomass and the catches.** For this reason the SPMs are also known as **Biomass Dynamics Models**.

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A problem in SPMs appears when the data is too homogeneous, more precisely, **if the catch and effort information is available only for a limited range of biomass levels**.

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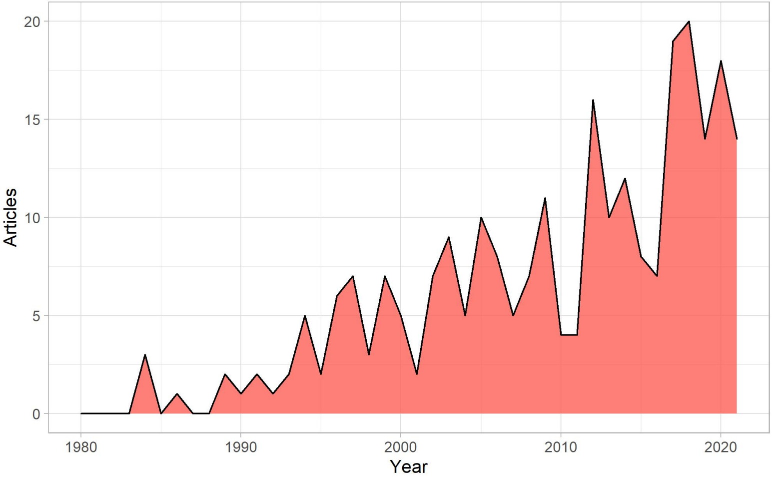

Figure 1: *Annual scientific production. Numbers of articles related to SPMs published each year. Information derived from SCOPUS database search.*

SPMs general overview

SPMs general structure (discrete form) relates directly to Russell's [1] formulation of the stock dynamics

$$B_{t+1} = B_t + f(B_t) - C_t$$

where B_{t+1} is the stock biomass at the end of year t or the beginning of year $t+1$, B_t is the stock biomass at the start of year t, C_t is the biomass caught during year t and $f(B_t)$ is the production of biomass function.

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The population dynamics equation is linked to the reality through the relation between the catches and the stock (set E_t the effort associated to the catch C_t)

$$\hat{I}_t = C_t/E_t = qB_t$$

where I_t is an index of relative abundance for year t, notation ˆ denotes an estimated value and q is the catchability coefficient, which scales the modelled stock biomass to match the trends in catch rates.

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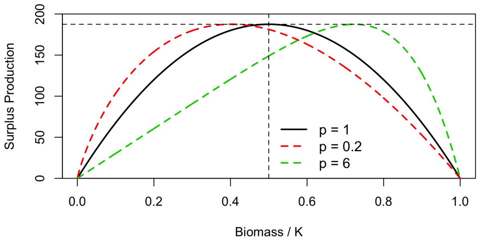

Figure 2: *Influence of the parameter p on the discrete Pella–Tomlinson version of SPM. When p = 1, the equation is equivalent to the Schaefer model, and thus has a symmetrical production curve around 0.5.*

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Recent proposals provide estimators that combine both forms of error.

Most relevant SPMs

The SPM research carried out in the last years has provided a **huge collection of different SPMs implementation**; then, in practice, **it can be difficult to decide which one of them is best suited for assessing a particular stock.**

- ASPIC (A Surplus-Production Model Incorporating Covariates) by Prager (1992, 1994) [3] [4].

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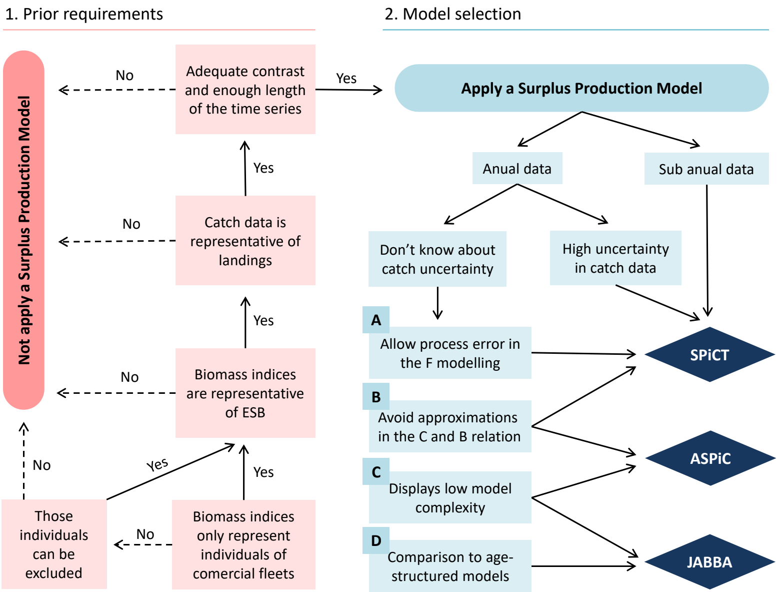
Most relevant SPMs

	ASPIC	SPiCT	JABBA
R package	`connectASPIC`	`spict`	`JABBA`
Type of formulation	Continuous-time	Continuous-time	Discrete-time
C_t observation error	✗	✓	✗
I_t observation error	✓	✓	✓
B_t process error	✗	✓	✓
F_t process error	✗	✓	✗
F_t seasonal patterns	✗	✓	✗
Projections	✓	✓	✓

Table 1: *Summarizing the main features of three SPMs: ASPIC, SPiCT and JABBA. The properties recapped are: inclusion of observation error of both catches and biomass indices, incorporation of dynamics in both biomass and fisheries and involvement of a seasonal fisheries dynamics component. Finally, inclusion of projection functions related to fisheries management in the corresponding* `R` *package is also discussed. Note that ✓means that the particular SPM fulfills the corresponding property, whereas ✗represents the opposite situation.*

Conclusions



Thanks for your attention!

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Acknowledgments

The authors thank the financial support of the project IMPRESS (RTI2018-099868-B-I00) project, ERDF, Ministry of Science, Innovation and Universities - State Research Agency, and also of GAIN (Xunta de Galicia), GRC MERVEX (nº IN607-A 2018-4).