Updated diagnostics in squid and cuttlefish stocks exploited by Northeast Atlantic French fishing fleets

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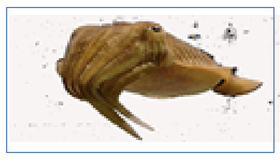
Introduction

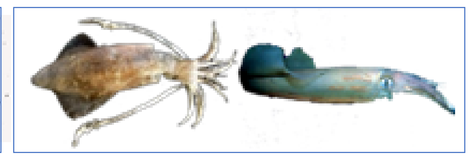
Stock assessment exercises were carried out in a number of Northeast Atlantic Cephalopod stocks in 2019-2020 within the Interreg project "Cephs&Chefs". Generalised surplus production models were fitted to time series of landings and biomass indices using the R package SPiCT.

We present here the update of such assessments in 4 stocks: loliginid squid and cuttlefish from the English Channel and from the Bay of Biscay. New diagnostics of stock status are compared to previous trends. In some previous model outputs uncertainty was so high that conclusions had to be taken with caution. The updated assessments enable the result of fishery exploitation that was continued without specific management measures to be examined.

The English Channel (ICES-divisions 27.7.d-e) and the Bay of Biscay (divisions 27.8.a-b-d) are the main fishing grounds for cuttlefish and loliginid squid in European waters with 2000-2020 average yields respectively 11,000T and 4,500T in cuttlefish and 3,600T / 1,800T in squid. English Channel resources are shared by France, UK, Belgium and Netherlands whereas Bay of Biscay stocks are fished by fishing fleets from France and Spain.
In both areas loliginid squid consist of two species *Loligo forbesii* and *Loligo vulgaris* which are not distinguished by fishermen or in fisheries statistics but which are distinguished in trawl survey data or in fish market sampling.

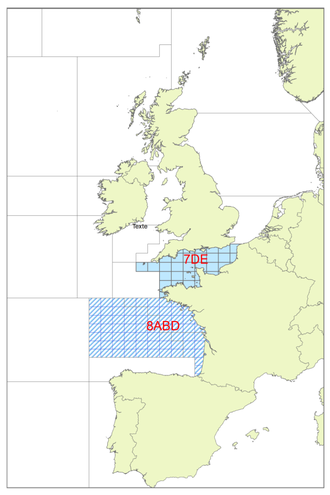
Materials and Methods





DATASETS:

Surplus production models are among the simples to use as they only require time series of total catch and of a biomass index.
Annual landings are compiled by groups of divisions within the ICES-WGCEPH Term of Reference A (fisheries status and trends) ;
Biomass indices are derived from French demersal trawlers catch and effort data standardized via the R package VAST (taking into account spatio-temporal changes in abundance and also differences in vessel engine power).
The assessment of Bay of Biscay loliginid squid stock was also carried out using EVHOE survey data to allow for comparisons with previous trials.



ASSESSMENT TOOL:

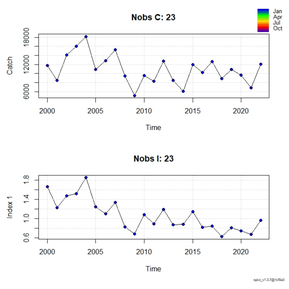
Generalised surplus production models were fitted with the R package SPiCT (v 1.3.7) with fixing priors on alpha and bêta to 1, and allowing the n for the shape of the production curve around the 1.478 as recommended by in the guidelines (Mildenberger et al., 2022).

Results

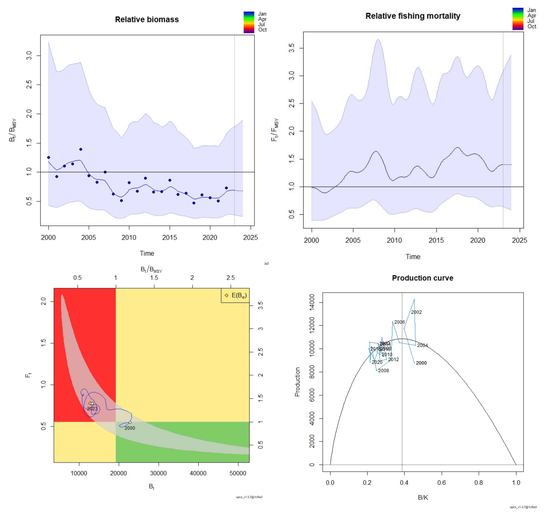
Cuttlefish (CTC)

English Channel (7DE)

Over-exploited & overfished

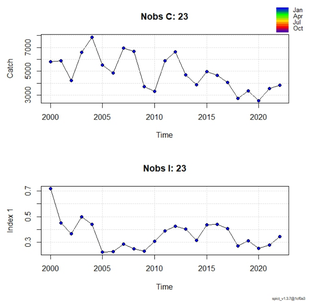


2000-2022 fitted models

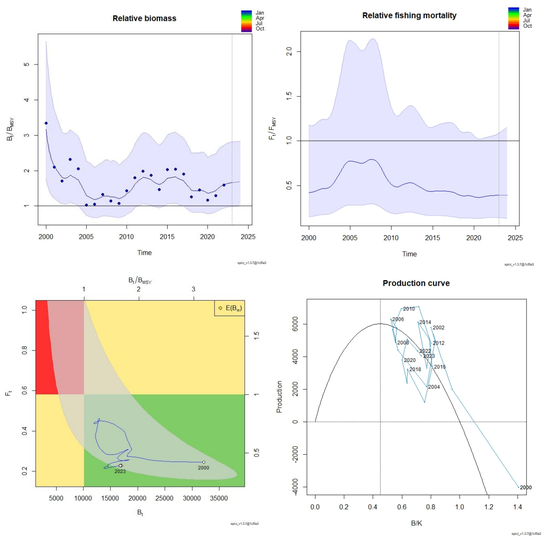


Bay of Biscay (8ABD)

Not over-exploited or overfished



2000-2022 fitted models



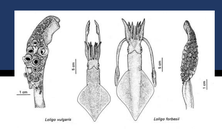
2020 (previous diagnostics)

		estimate	cilow	ciupp	log.est
CTC.7de					
Catch_2020: 9,661 tons	B_{2020}/B_{MSY}	1.77	0.37	8.35	0.57
	F_{2020}/F_{MSY}	0.39	0.11	1.42	-0.94
	MSY_s	13,573	6,262	29,420	9.52
CTL.8abd					
Catch_2020: 2,549 tons	B_{2020}/B_{MSY}	1.45	0.87	2.44	0.37
	F_{2020}/F_{MSY}	0.51	0.15	1.69	-0.67
	MSY_s	5,255	3,231	8,546	8.57

2022 (updated diagnostics)

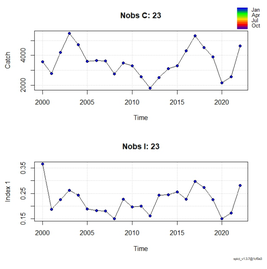
		estimate	cilow	ciupp	log.est
CTC.7de	**VAST index**				
Catch_2022: 12,055 tons	B_{2022}/B_{MSY}	0.69	0.27	1.78	-0.37
	F_{2022}/F_{MSY}	1.40	0.64	3.06	0.34
	MSY_s	10,728	8,229	13,986	9.28
CTL.8abd	**VAST index**				
Catch_2022: 3,832 tons	B_{2022}/B_{MSY}	1.66	0.98	2.81	0.51
	F_{2022}/F_{MSY}	0.39	0.14	1.08	-0.94
	MSY_s	5,878	3,544	9,749	-0.02

Long-finned squid (SQZ)

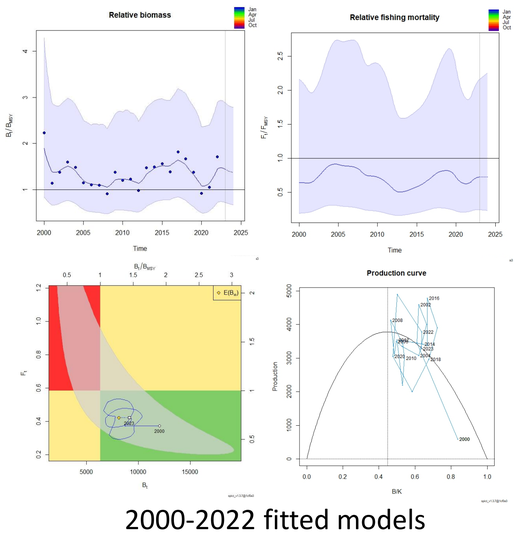


English Channel (7DE)

Not over-exploited or overfished

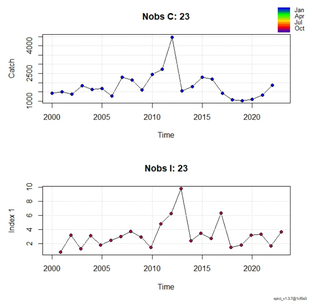


2000-2022 fitted models

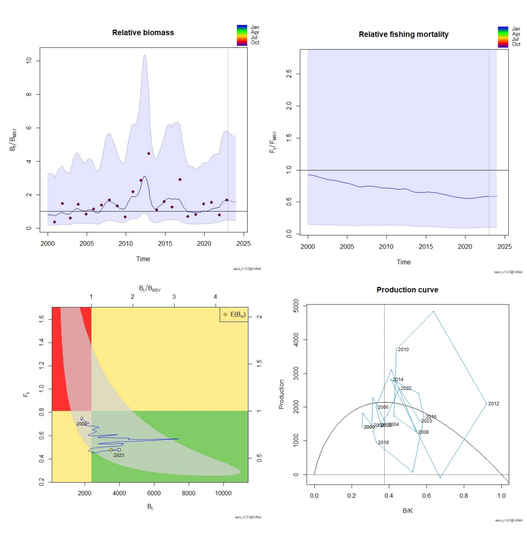


Bay of Biscay (8ABD)

Not over-exploited or overfished



2000-2022 fitted models



2020 (previous diagnostics)

		estimate	cilow	ciupp	log.est
SQZ.7de					
Catch_2020: 2,159 tons	B_{2020}/B_{MSY}	1.01	0.56	1.81	-0.1
	F_{2020}/F_{MSY}	1.18	0.71	1.98	0.16
	MSY_s	3,518	3,035	4,078	8.17
SQZ.8abd	**indice EVHOE *pour Loligo vulgaris***				
Catch_2020: 1,092 tons	B_{2020}/B_{MSY}	0.37	0.14	0.99	-0.99
	F_{2020}/F_{MSY}	1.56	0.69	3.54	0.45
	MSY_s	1,603	1,042	2,468	7.38

2022 (updated diagnostics)

		estimate	cilow	ciupp	log.est
SQZ.7de	**VAST index**				
Catch_2022: 4,628 tons	B_{2022}/B_{MSY}	1.45	0.73	2.89	0.37
	F_{2022}/F_{MSY}	0.72	0.24	2.15	-0.33
	MSY_s	3,703	2,440	5,618	8.22
SQZ.8abd	**EVHOE index Mixed species**				
Catch_2022: 1,862 tons	B_{2022}/B_{MSY}	1.65	0.42	6.41	0.50
	F_{2022}/F_{MSY}	0.59	0.09	3.77	-0.53
	MSY_s	1,934	1,090	3,432	7.57

Conclusions

- **In spite of large confidence limits models converged and provide updated diagnostics**
- **Change in the stock status of English Channel cuttlefish seems to be related to the set of abundance indices used in 2000 (replaced by VAST index in 2022)**
- **English Channel squid could be split in 2 stocks since divisions 7D and 7E tend to host the bulk of *Loligo vulgaris* (7D) and *Loligo forbesii* (7E)**
- **Data-limited models cross validation is required (Anderson, 2016) in order to provide models that would strengthen stock assessment conclusions. SPiCT outputs should be compared to other assessment tools (JABBA, Cmsy) in order to confirm diagnostics and BRPs**
- **In very short living species like cephalopods the concept of removing the maximum sustainable surplus from a stable population is questionable (Roa-Ureta et al. 2021)**

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