Application of SPiCT to produce MSY advice for *Nephrops* Funcional Unit 31 (Cantabrian Sea)

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INTRODUCTION

Nephrops landings in FU 31 (ICES Division 8c, Cantabrian Sea) have decreased a 97% from 1988 to 2016. Due to the low catches, no analytical stock assessment has been conducted in this FU since the beginning of the 2000 decade; therefore ICES advice for this stock is on the basis of a data-limited approach since then. According to this approach, FU 31 is considered as category 3.1.4 stock (ICES, 2012) and it is assessed mainly by the analysis of the catch and LPUE series trends. Until 2018 there were no *Nephrops* discards in this FU, therefore catches were equivalent to landings (ICES, 2020). In the FU 31 trawl fleet trips that catch *Nephrops* there are hauls directed and not directed to *Nephrops*. ICES recommendation for this FU has been zero catch since 2002. Results of the assessment in 2016 indicated an extremely low abundance level in the division 8c (that includes FU 31 and FU 25) and a zero TAC was recommended for 8c in 2017, 2018 and 2019. Following this recommendation, the *Nephrops* TAC zero was established for that triennium (EU, 2017). The 2019 assessment obtained the same conclusions and the zero TAC was extended for 2020, 2021 and 2022 (EU, 2020).

ICES has planned a Benchmark Workshop on the application of SPiCT to produce MSY advice for selected stocks (WKMSYSPiCT) that will be held from 15th to 19th of February 2021. Previously, two preparatory meetings were planned. The first consisted in two SPiCT model learning sessions the 26th and 28th of October 2020. In these sessions the preliminary work with SPiCT carried out in FU 31 was presented and the group recommended only use the Demersales survey CPUE as biomass index for this stock. The second preparatory meeting, a Data evaluation meeting, will be held since 17th to 19th of November 2020. The last results obtained with SPiCT in FU 31 and the related work in progress are described in this working document.

METHODS

FU 31 *Nephrops* catch data has been collected on monthly basis by sex since 1983 by personnel on ports and also by data provided by the different ports authorities. Demersales bottom trawl survey has been carried out each year in October since 1983. Both activities were done by the Spanish Institute of Oceanography (IEO). There was no Demersales survey in 1987.

Study area

Figure 1 shows FU 31 location (ICES statistical rectangles 16E4-E7).

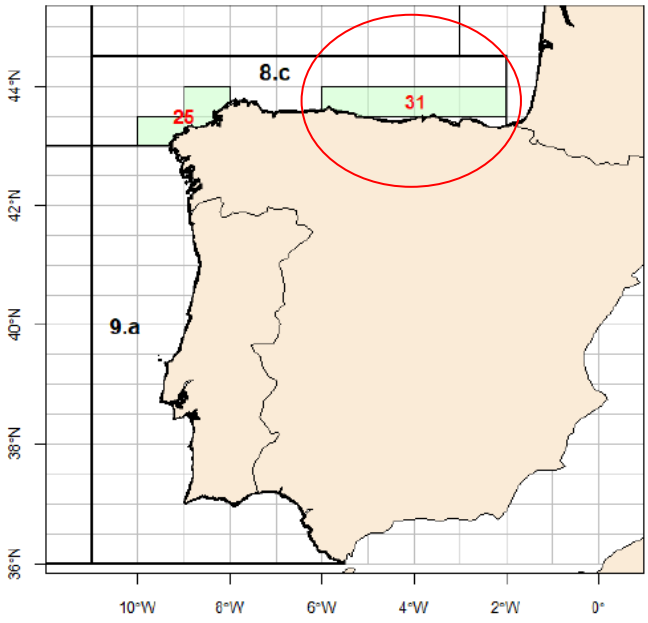


Figure 1. *Nephrops* Functional Unit 31 (Cantabrian Sea) in red. FU statistical rectangles in green.

RESULTS

After many trials with different periods of the *Nephrops* catch and CPUE time series and different combination of indices, one trial is presented in this document (Table 1).

Table 1.- SPiCT trial presented in this document.

	FU 31 Catch series (t)			Index: Scaled FU 31 Demersales trawl survey (kg/haul) 1983-2019
Trial 1	1983-2019	Males and females together	Annual	Males and females

Data

In Figure 2 the available series and the series that were used are shown. By recommendation from the WKMSYSPiCT learning sessions, only Demersales survey was used as index. CPUE series from Santander+Gijón+Avilés, from Gijón and Sentinel were not used they were too short.

Procedure

The survey index was scaled to mean 1 for better numerical stability, the number of iterations was increased to 1e6 and stronger priors were add (inp$priors$logbkfrac=c(0,1,1) , inp$priors$logn=c(log(2),0.5,1)) in order to obtain convergence and decrease the residuals problems.

The results of the function plotspict.ci(inp) are shown in Figure 3.

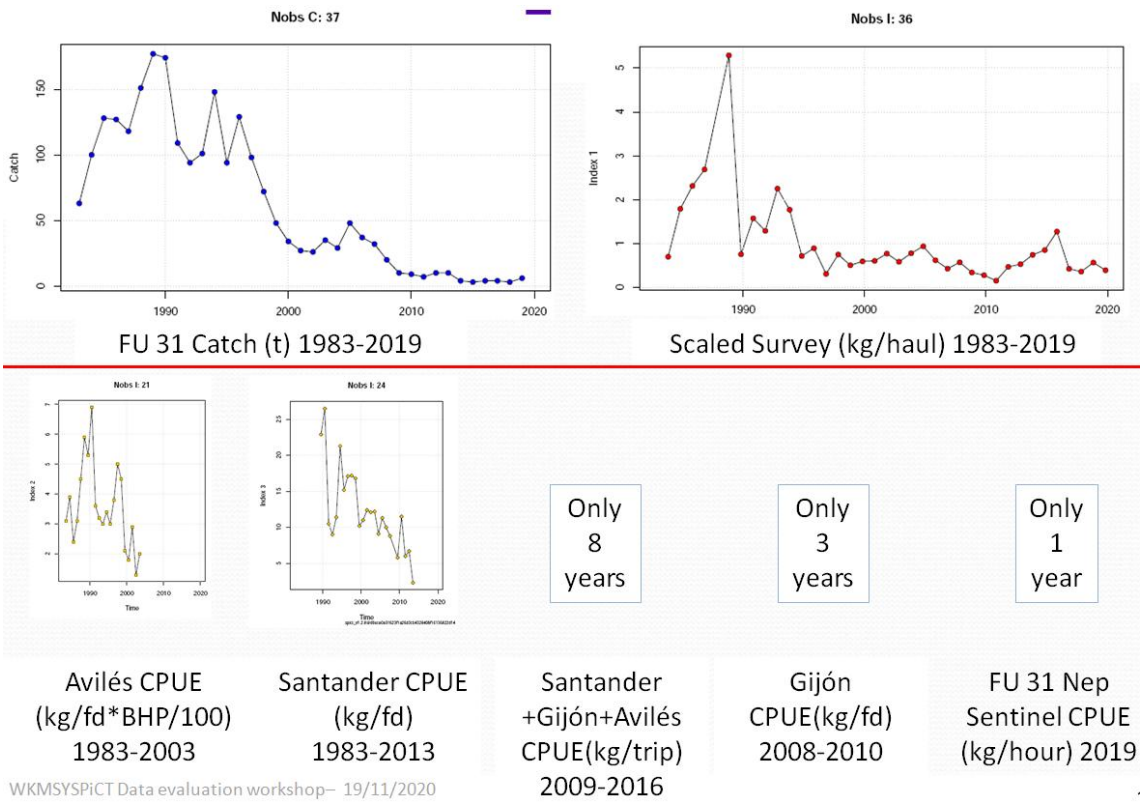


Figure 2.- FU 31 available time series.

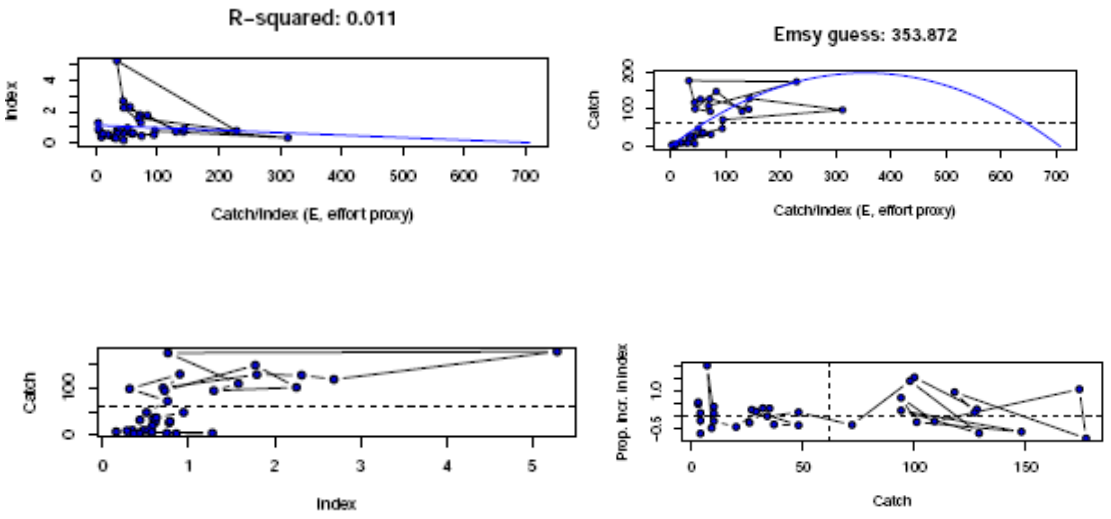


Figure 3.- Results of the function plotspict.ci(inp).

Table 2.- Results of the model.

	ANNUAL ♀+♂
CONVERGENCE	Convergence: 0 MSG: relative convergence (4)
K	2465 t
Bmsy	1183 t
Fmsy	0.02
MSY	22 t
B_2019.75	545 t
F_2019.75	0.01
B_2019.75/Bmsy	0.5
F_2019.75/Fmsy	0.6

The results of the model are shown in Table 2. In terms of reference points, present biomass is half of the Bmsy and present fishery mortality is 60% of Fmsy.

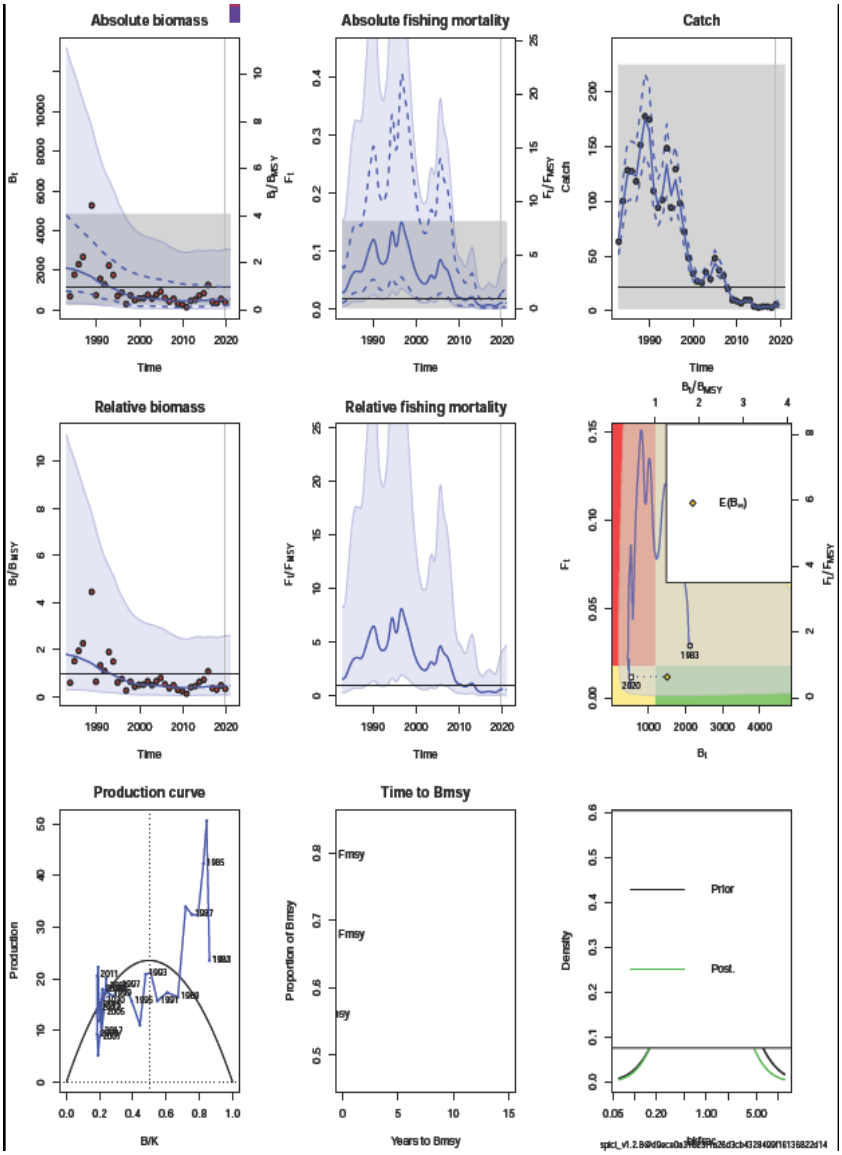


Figure 4.- Plots of the model.

The plots of the model identify 3 periods in the fishery (Figure 4). In the first period, there were high biomass and fishing mortality (yellow), in the second period there were low biomass and high fishing mortality (red), and in the last period there were very low biomass and fishing mortality (yellow).

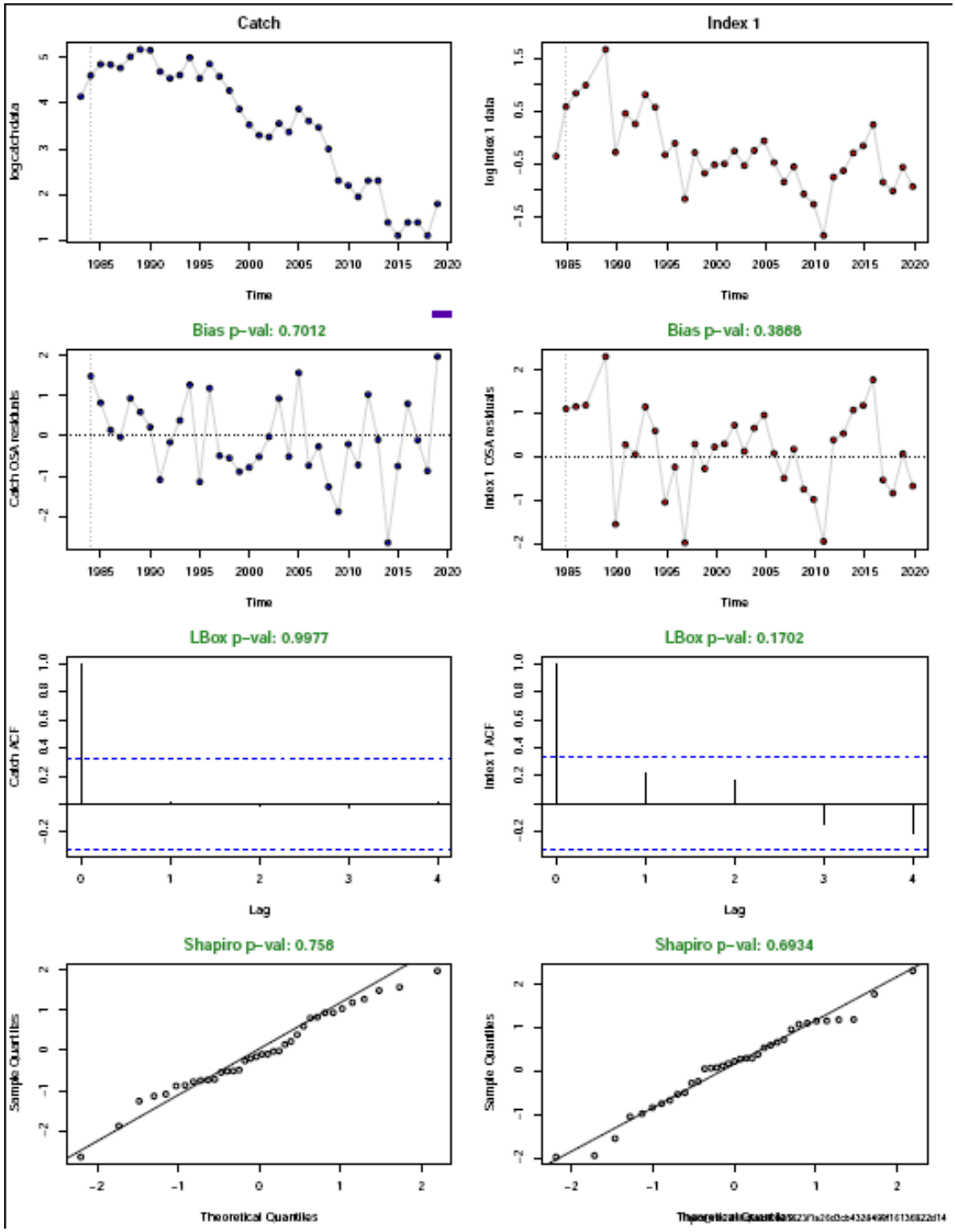


Figure 5.- Residual analysis of the models.

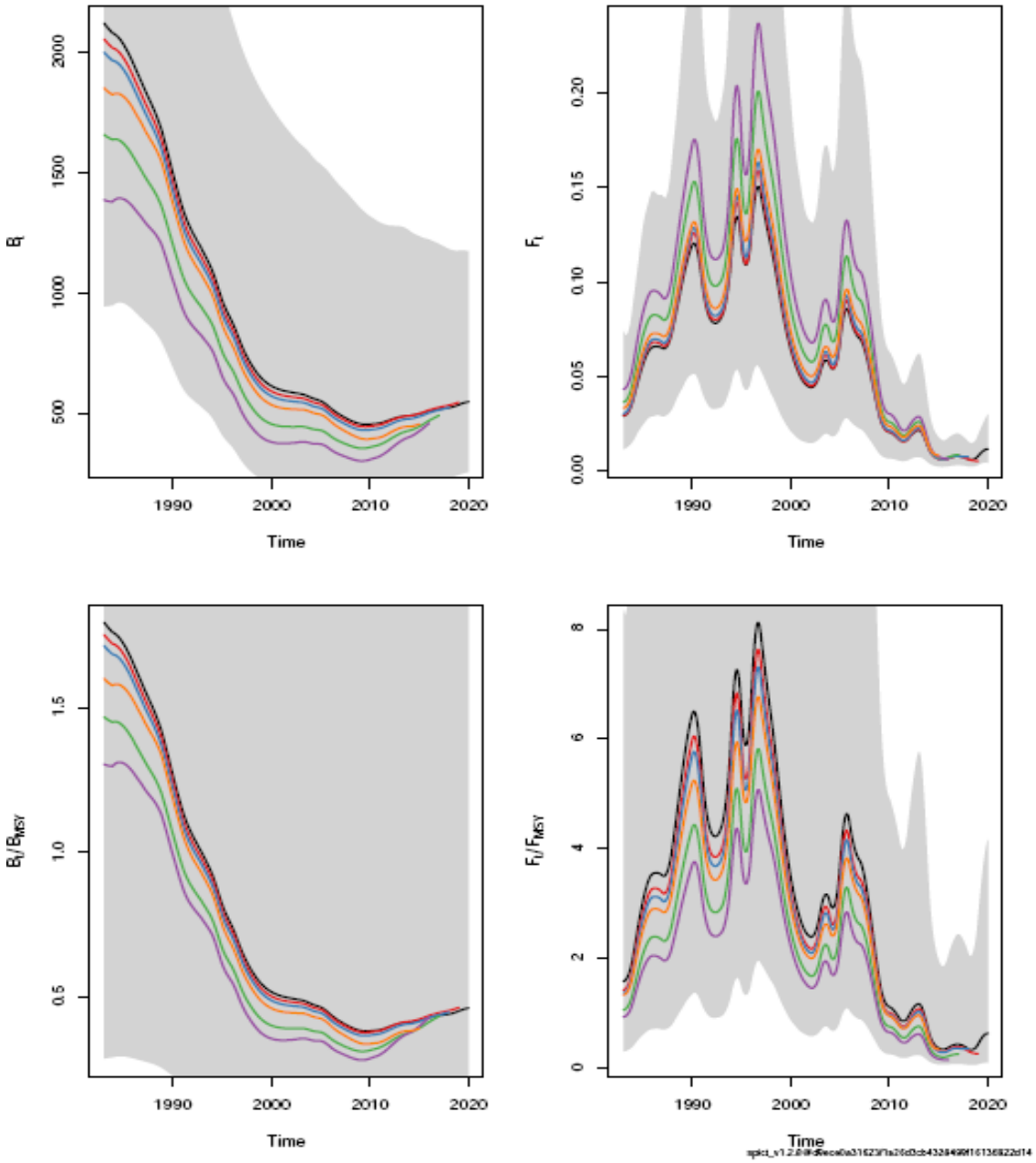


Figure 6.- Retrospective analysis of the model.

Table 3.- Models checklist.

	ANNUAL ♀+♂
1.- Convergence *resoptconvergence*	0
2.- Variance parameters finite *all(is.finite(res$sd))*	TRUE
3.- No assumptions violation	See plot
4.- Retro convergence	See plot
5.- Realistic production curve *calc.bmsyk(res)*	0.50
6.- Sensitivity to initial values *res$ckeck.ini$resmat*	NULL
7.- BBmsy, FFmsy IC *calc.om(res)*	2 in both cases

The residual analysis and the retrospective analysis of the model are shown in Figure 5 and 6 respectively and the checklist in Table 3. The model checklist does not present big problems.

DISCUSSION

The FU 31 survey index time series has two marked periods, until 1993 and since 1994, which could arise certain doubts about this index.

A catch decrease in the middle nineties has also observed in the *Nephrops* divisions 9a and in the total 8c and in the FU 25 (Figure 7), the FU 25 is the other FU of division 8c.

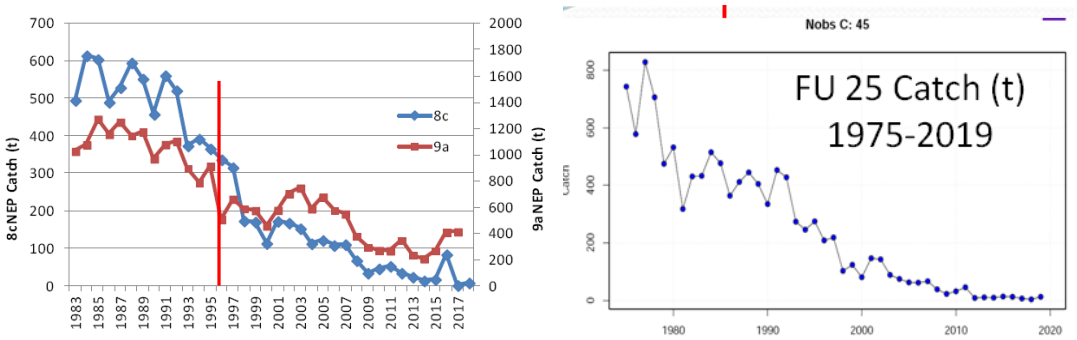


Figure 7. Divisions 8c and 9a (left) and FU 25 (right) landings time series.

Respect of the own survey index, the number and distribution of the survey hauls in FU 31 were similar in both periods (Figure 8; ICES, 2020).

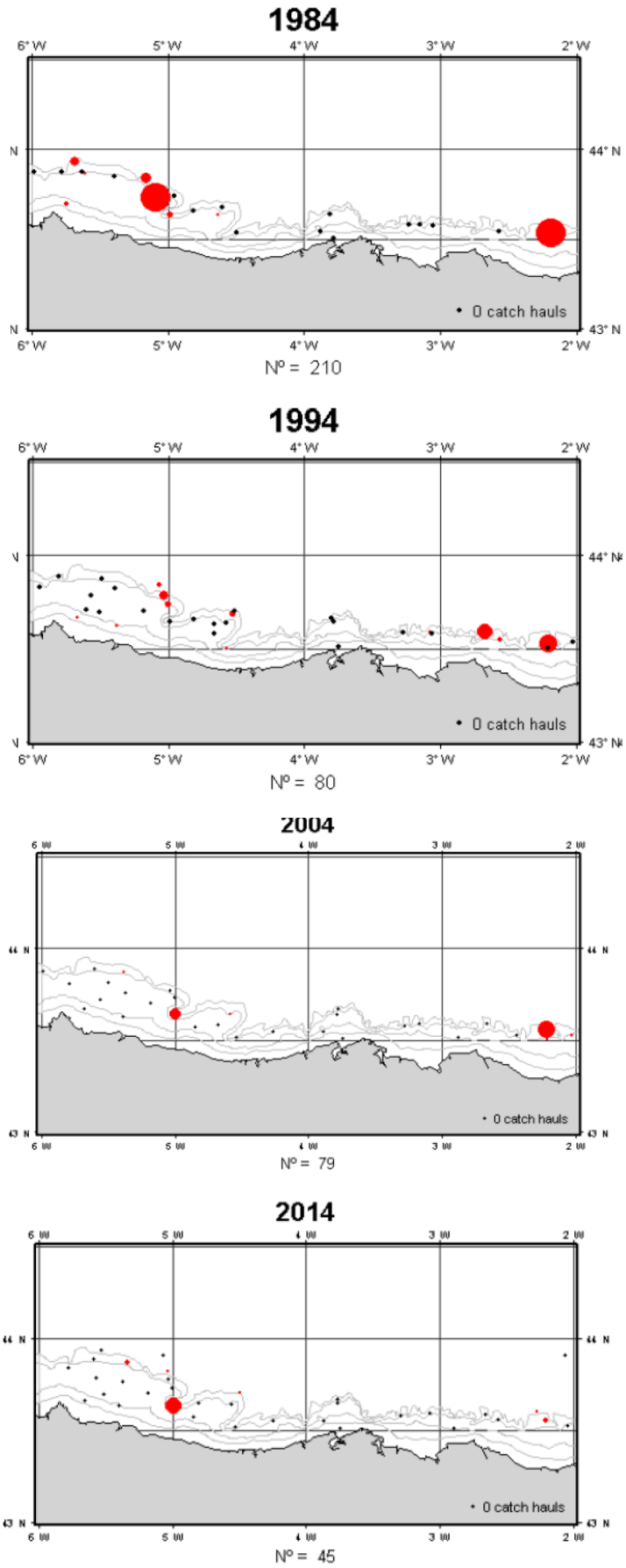


Figure 8.- Demersales survey hauls in FU 31. Red points: hauls with *Nephrops* catches. Black points: hauls with no presence of *Nephrops*.

The information provided by the maps (Figure 8; available each year maps in Figures 12.2.4abc in ICES, 2020) seems compatible with the survey index two periods.

The work in the future should be in the line of explore the annual model by sex and monthly and quarterly models for males and females together and separately. It could be interesting carry out models by sex because, unlike females, males are out of the burrows most of the time and could be more vulnerable to the fish activity. In fact, the fall in the catch in the middle nineties in FU 31 coincides with the years with the lowest percentage of males in FU 31 in the Demersales survey (Figure 9).

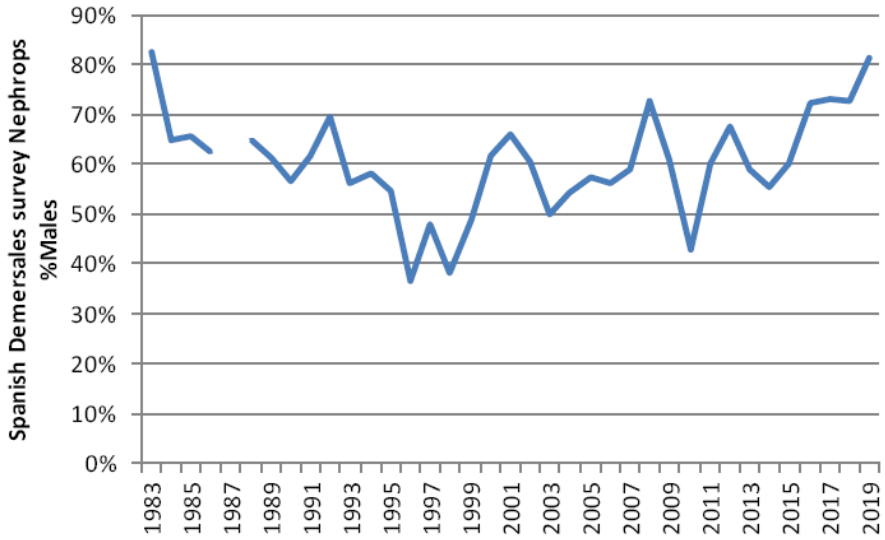


Figure 9. FU 31 Demersales survey catch proportion of males (WGBIE 2020).

It could be suitable use different time units (annual, mont, quarter) since *Nephrops* yields use to be very different depending on the month of the year (e.g. ICES, 2018). It should be discussed if it would be suitable to analyse the time series from the point of view of a shift regime, but maybe this could affect only to the MSY but not to K. Other possibility would be work with the shortened series.

WK RECOMMENDATIONS TOWARDS THE FEBRUARY MEETING

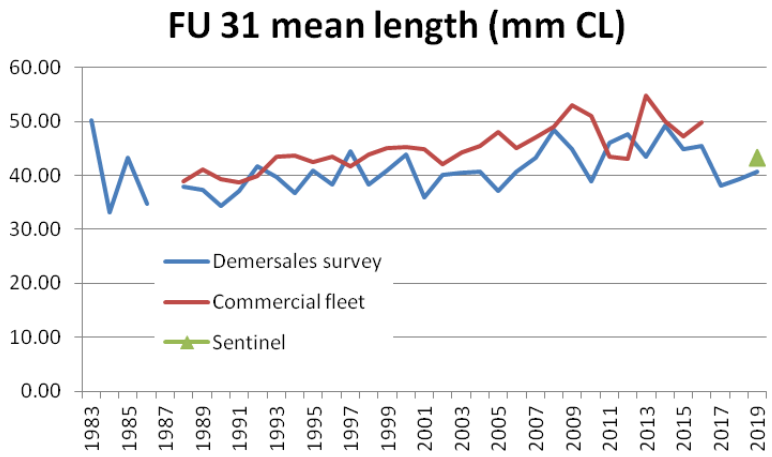
A) Data – Survey index:

- Check strange values in the first years of the time series, there has been differences in the sampling design? Has the gear change? Is the number and distributions of hauls similar? Are the maxima correct?

- Does the survey index take into account the swept area?

- Check the procedure to calculate Demersales survey index

- Show mean sizes of the survey and the fishery:



B) Data – SPiCT analysis:

- Carry out the forecast.

- Log SD of biomass in relation to recruitment bias?

- In the plots of the survey nep yield by haul and year there are few hauls with lot of nephrops and many hauls with nothing. Bas model? (spatial model). In few hauls all the nephrops catch.

- Discussion about use the whole time series or only since 1997.

- Discussion about use priors or not in MSY? Standard deviation is very large.

REFERENCES

EU. 2017. Reglamento (UE) 2017/127 del Consejo de 20 de enero de 2017, por el que se establecen, para 2017, las posibilidades de pesca para determinadas poblaciones y grupos de poblaciones de peces, aplicables en aguas de la Unión y, en el caso de los buques pesqueros de la Unión, en determinadas aguas no pertenecientes a la Unión (DOUEL 24 de 28.1.2017).

EU. 2020. REGLAMENTO (UE) 2020/123 DEL CONSEJO de 27 de enero de 2020 por el que se establecen para 2020 las posibilidades de pesca para determinadas poblaciones y grupos de poblaciones de peces, aplicables en aguas de la Unión y, en el caso de los buques pesqueros de la Unión, en determinadas aguas no pertenecientes a la Unión. 30.1.2020. L 25/1-156.

ICES. 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM 68. 42 pp.

ICES. 2018. ICES Special Request Advice. Bay of Biscay and the Iberian Waters Ecoregion. Published 9 February 2018. DOI: 10.178995 (ices.pub.3967).

ICES. 2020. Report of the Working Group for the Bay of Biscay and Iberian waters Ecoregion (WGBIE).