

Review of proxies for Fmsy ranges for Iberian Peninsula stocks (Southern hake, megrims and white anglerfish)

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Robust linear regression equations based on North Sea and Baltic stocks provided a first guess for Fmsy ranges, upper and lower bounds for stocks in the SWW Ecoregion. The last two columns in the following table suggest the modifications suggested:

Stock	Fmsy	Fupper	Flower	F*upper	F*lower
Hake (south)	0.24	0.33	0.16	0.36	0.17
Hake (north)	0.27	0.37	0.18		
Horse Mackerel (South)	0.11	0.16	0.08		
Megrim IB&BoB	0.17	0.24	0.12	0.24	0.11
Sole BoB	0.26	0.36	0.17		
Blue whiting	0.3	0.41	0.2		
4 Spot Megrim 8C9A	0.17	0.24	0.12	0.19	0.08
Horse Mackerel (Western)	0.13	0.18	0.09		
White Anglerfish (south)	0.19	0.26	0.13		

Here we have extended the previous analysis considering now the population and fishing characteristics of these stocks. The approach is deterministic and risks have been considered acceptable if F upper do not drive the stock above Bpa in the long term. Otherwise, Fupper is replaced with the F that drives the stock to Bpa.

Southern hake (*Merluccius merluccius*)

Current Fmsy is 0.24 based on Fmax. Blim is 9 000 t. No more reference points have been set for this stock. Next table shows the current reference points for this stock

	Type	Value	Technical basis
MSY approach	MSY B _{trigger}	Not defined.	
	F _{MSY}	0.24	F _{max} (ICES,2010).
Precautionary approach	B _{lim}	9000 t	A biomass that produces a recruitment that is at or above average (WKSOUTH, ICES, 2014)
	B _{pa}	Not defined.	
	F _{lim}	Not defined.	
	F _{pa}	Not defined.	

The following analysis presents an alternative approach to test these figures as well as the risk of collapse. Simple deterministic equilibrium analysis based on yield per recruit, SSB and stock-recruitment plots was performed. The deterministic risk limit was defined as a Bpa= Blim * 1.4. (12 600 t). For equilibrium estimations recruitment was set as the geometric mean of years 1989-2013 (80.205 mill)

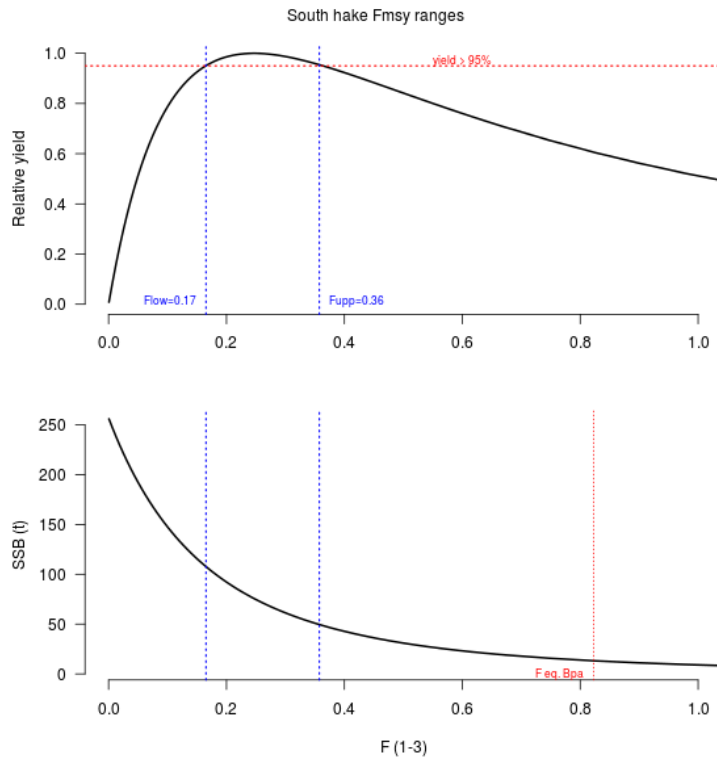


Figure 1.

The figure 1 shows the F lower and F upper bounds around Fmsy. This range was defined as the F figure below Fmsy that match the 95% yield and the F figure above Fmsy that match the same 95% yield. The risk of collapse associated with the upper bound (Fupp=0.36) was tested against the F driving to Bpa (0.82). The expected equilibrium SSB at Fupp is 49.6 Kt well over Bpa=12.6 Kt (Fig 2). Even in absence of a stochastic analysis which allows to estimate the risk of falling above Blim, the high differences between these figures suggest that fishing at Fupp (0.36) should not drive the stock outside safe limits.

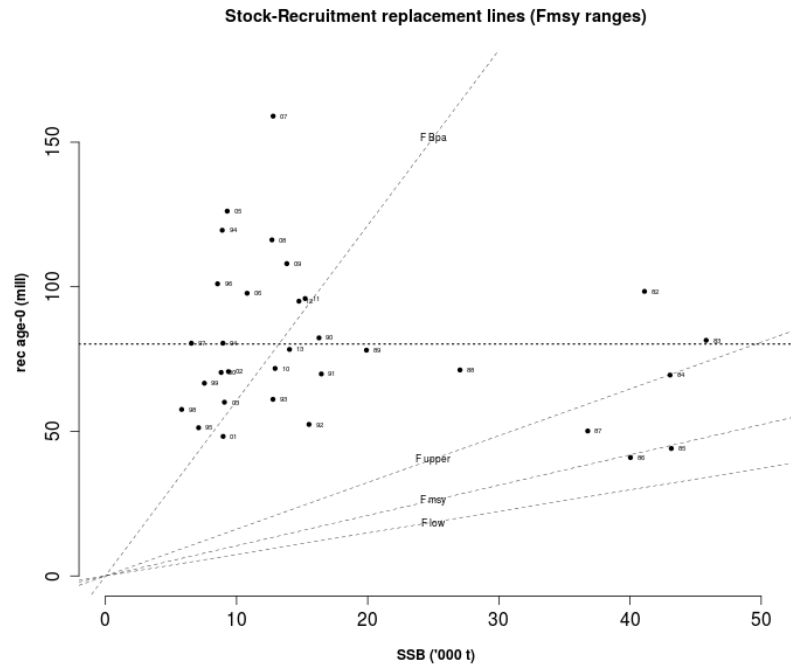


Figure 2.

Conclusion

The estimated figures [0.17-0.36] are similar than those estimated based on North Sea ranges [0.16-0.33]. Both alternatives are not in the risk area, far away from F driving to Bpa.

Four-spot megrim (*Lepidorhombus bosci*) and megrim (*L. whiffiagonis*)

BRP for both megrims stocks were defined during the Benchmark WKSOUTH 2014 and based on Fmax. These BRP are showed in next tables:

For Four-spot megrim:

	Type	Value	Technical basis
MSY Approach	MSY B _{trigger}	4600 t	default option; Bpa
	F _{MSY}	0.17	Fmax as FMSY proxy
Precautionary Approach	B _{lim}	3300 t	provisional reference point; Bloss in the 2014 benchmark assessment
	B _{pa}	4600 t	default option; 1.4 Blim
	F _{lim}		
	F _{pa}		

And for megrim:

	Type	Value	Technical basis
MSY Approach	MSY $B_{trigger}$	910 t	default option; 1.4 Blim
	F_{MSY}	0.17	Fmax as FMSY proxy
Precautionary Approach	B_{lim}	650 t	provisional reference point; just above Bloss in the 2014 benchmark assessment
	B_{pa}	910 t	default option; 1.4 Blim
	F_{lim}		
	F_{pa}		

In the present document, a simple deterministic equilibrium analysis based on yield per recruit, SSB and stock-recruitment plots was done to evaluate an alternative to this approach.

Figure 1 shows the F ranges for Fours-spot megrim. F lower and F upper are the values that intersect the curve up to 95 percent yield. F lower is 0.11 and F upper 0.24. For this stock, the upper limit is bellow the F which the Bpa would be achieved.

Figure 2 corresponds to Megrim. The ranges of this stock are 0.08 for the lower and 0.19 for the upper. In this stock, the upper limit had been matched with the F driving to Bpa, in order to avoid the risk of collapse. The upper F that matched the 95% yield would lead to a SSB value bellow the precautionary Bpa.

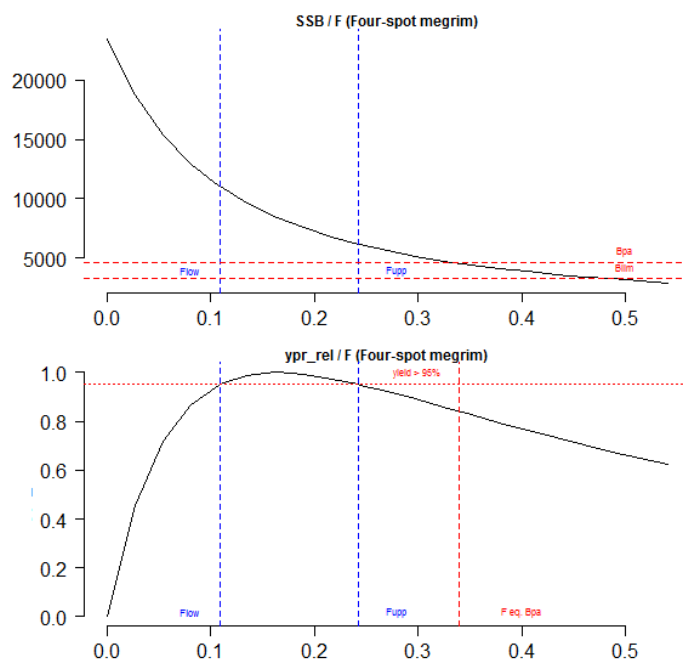


Figure 1.

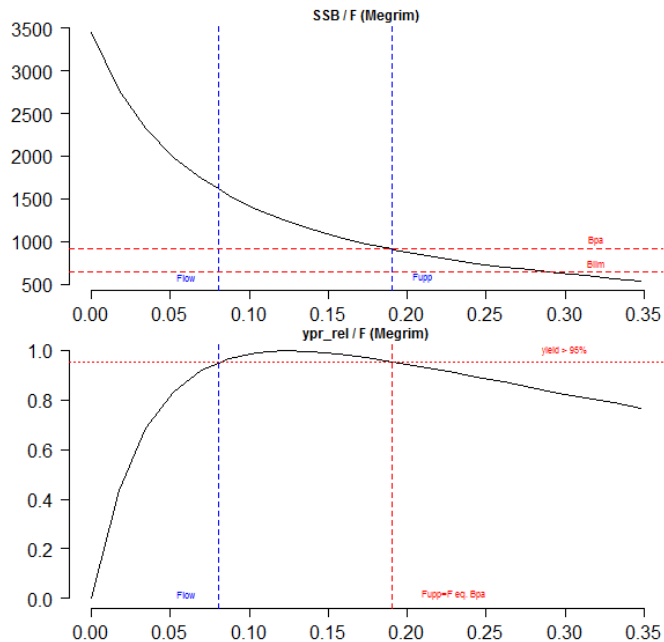


Figure 2.

Conclusion

The estimated ranges are similar to those proposed in the previous analysis for the Four-spot megrim and more restrictive in the case of Megrim.

stock	Fmsy	Upper	Lower
Four spot megrim	0.17	0.24	0.11
Megrim	0.17	0.19	0.08

White anglerfish (*Lophius piscatorius*) in Divisions 8c and 9a

Proxies of Fmsy ranges for anglerfish in 8c9a are proposed to account no more than a 5% reduction in long-term yield compared with MSY. For this stock, the current Fmsy value corresponds to its $F_{0.1}$ and no biomass reference points have been estimated.

Two determinist approaches were applied to provide proxies of Fmsy ranges:

Robust linear regression equations fitted for North Sea and Baltic stocks Fmsy upper and lower ranges (Jardim, 2015) were applied to predict values for white anglerfish. The values obtained were $F_{lower}=0.13$ and $F_{upper}=0.26$.

Yield per Recruit analysis. Based on YPR analysis a proxy for F_{MSY} was defined corresponding with $F_{0.1}$ value and it is currently used to provide annual advice. The fitted curve is clearly skewed to the right

that prevents from considering the F_{max} as F_{MSY} proxy and from estimating F_{msy} rangea using this approach.

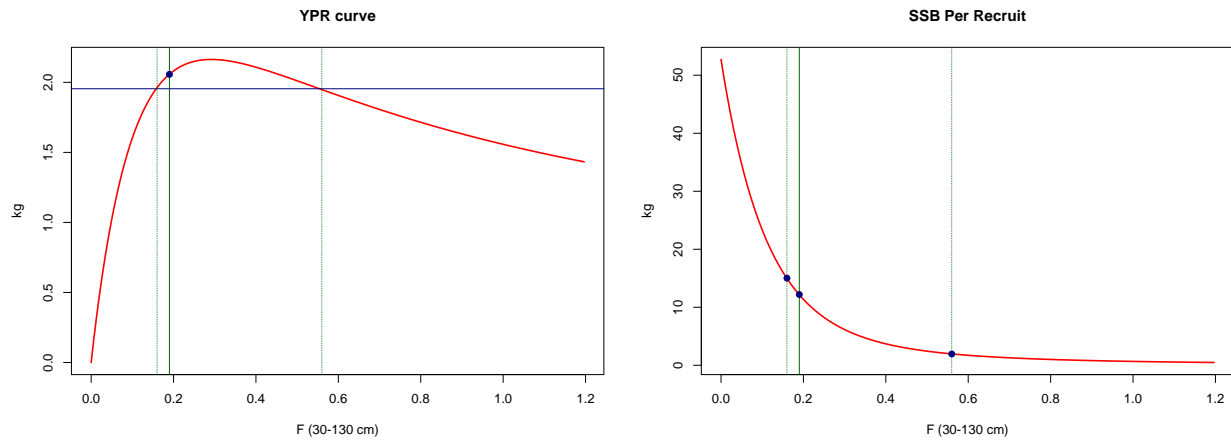


Figure 1. YPR curve by F_{bar} . Green lines $F_{0.1}$ estimate (solid) and range at 95% (dotted) of yield at $F_{0.1}$.

The YPR curve reached the maximum at 0.29 and the estimated F_{msy} ranges are $F_{lower}=0.19$ and $F_{upper}=0.46$. Due to the inability of biomass reference points for this stock the risk of collapse has not been analyzed. Taking into account the risk that the F_{upper} value leads the stock to low values of SSB this value will not be considered.

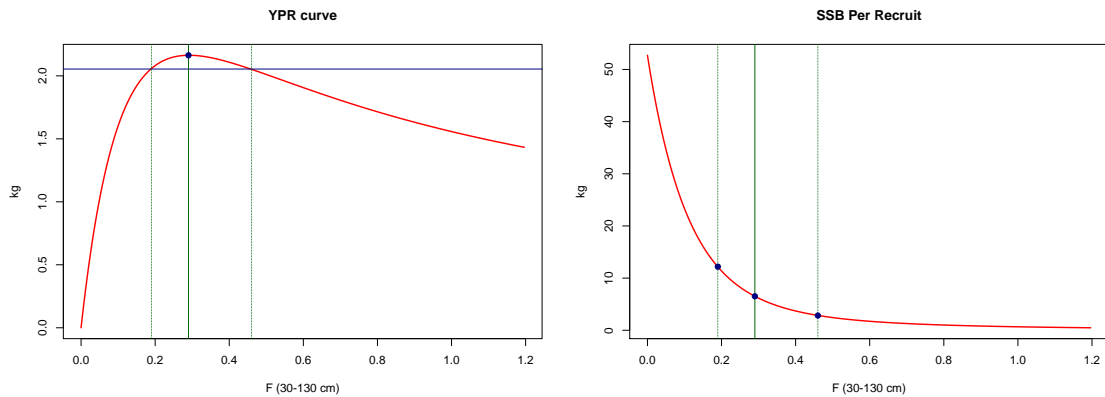


Figure 2. YPR fitted curve. Green lines F_{max} estimate (solid) and range at 95% (dotted) of yield at F_{max} .

Table 1. Proxies of F_{msy} ranges for white anglerfish 8c9a estimated by different approaches.

Approach	F_{msy}	MSY Flower	MSY Fupper
YPR analysis_ $F_{0.1}$	0.19	0.16	0.56
YPR analysis_ F_{max}	0.29	0.19	0.46
Robust linear regression	0.19	0.13	0.26

Conclusion:

The proxies of Fmsy ranges proposed for white anglerfish 8c9a are those estimated by robust linear regression equations: Flower=0.13 and Fupper =0.26.