Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission

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INTERIM LIMIT AND TARGET REFERENCE POINTS FOR TUNA, BILLFISH AND OTHER HIGHLY PRODUCTIVE FISHES IN THE EASTERN PACIFIC OCEAN

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Background

- MSY-based reference points only defined for yellowfin and bigeye tuna
- A proposal has been recently made for skipjack tuna
- Reference points are needed for all species associated with the EPO tuna fisheries
- Relevant information may not be available to reliably estimate reference points for all species
- Formal adoption of reference points can be time consuming
- Propose interim limit and target reference points that can be used for tuna, billfish and other highly productive fishes in the EPO.
- Based on the interim reference points currently used for bigeye and yellowfin and the assumption of a conservative value for the steepness (h = 0.75) of the Beverton-Holt stock-recruitment relationship

Calculating MSY

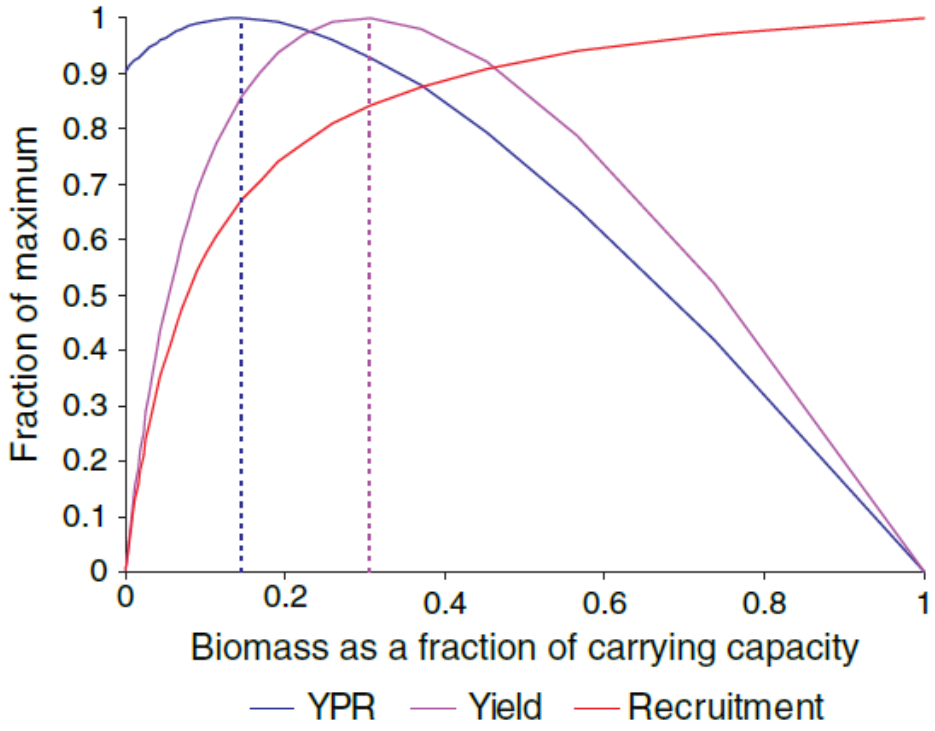


Figure 3 YPR, yield, and recruitment as a proportion of their maximum realized under equilibrium fishing mortality plotted against the equilibrium biomass as a fraction of the carrying capacity. The yield decreases faster than YPR at low biomass levels because the recruitment reduces as the biomass decreases.

Stock-Recruitment: saturating life history

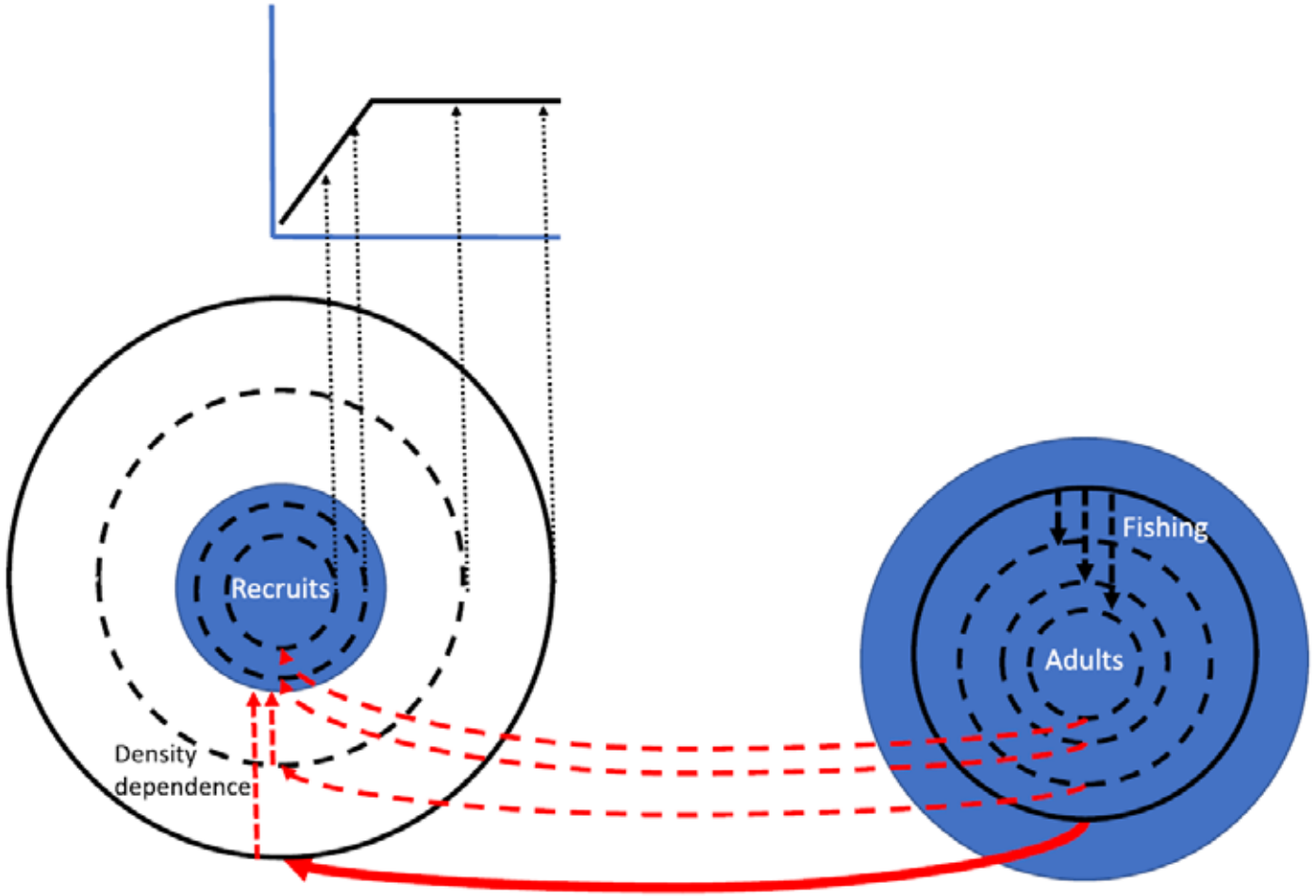
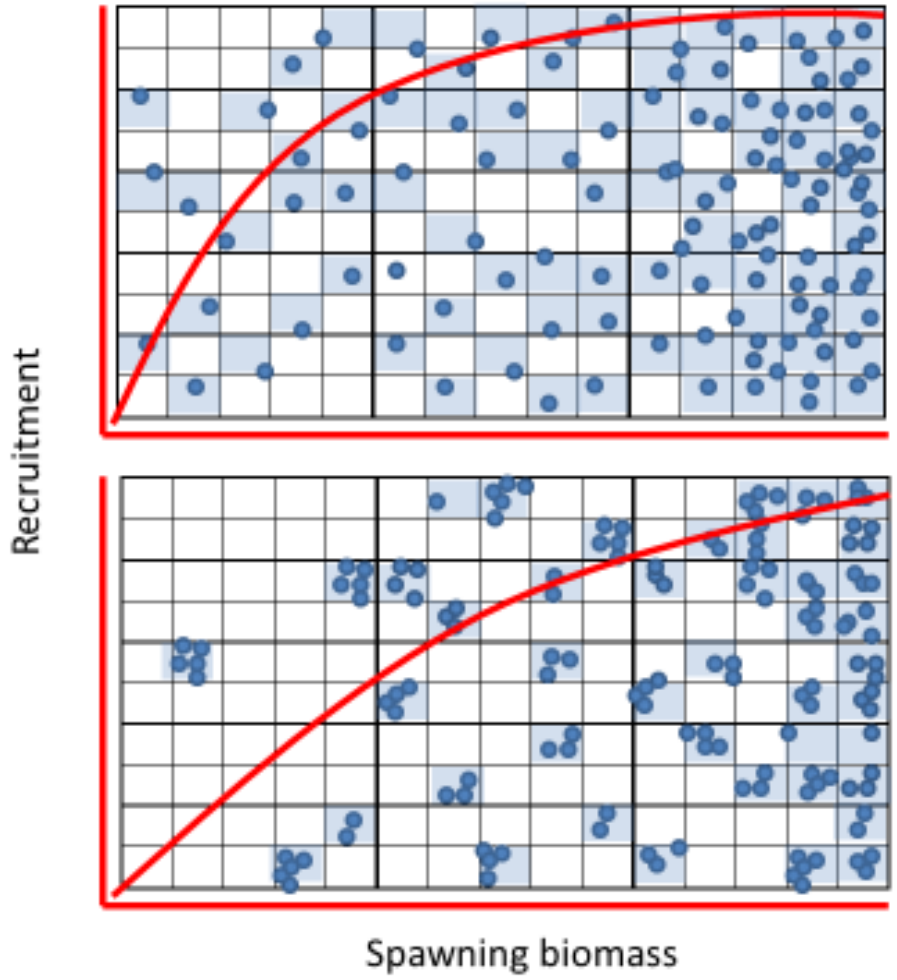


Fig. 8. Illustration of the effect of variation in spawning biomass (caused by fishing) on recruitment capacity for a stock limited by the carrying capacity (i.e., habitat) of recruits. See Fig. 6 for definitions. The dotted vertical up pointing arrows in the right of the figure map the recruitment onto the hockey stick stock-recruitment relationship.

Maunder, M.N. 2022. Stock-recruitment models from the viewpoint of density-dependent survival and the onset of strong density-dependence when a carrying capacity limit is reached. Fisheries Research 249, 106249.

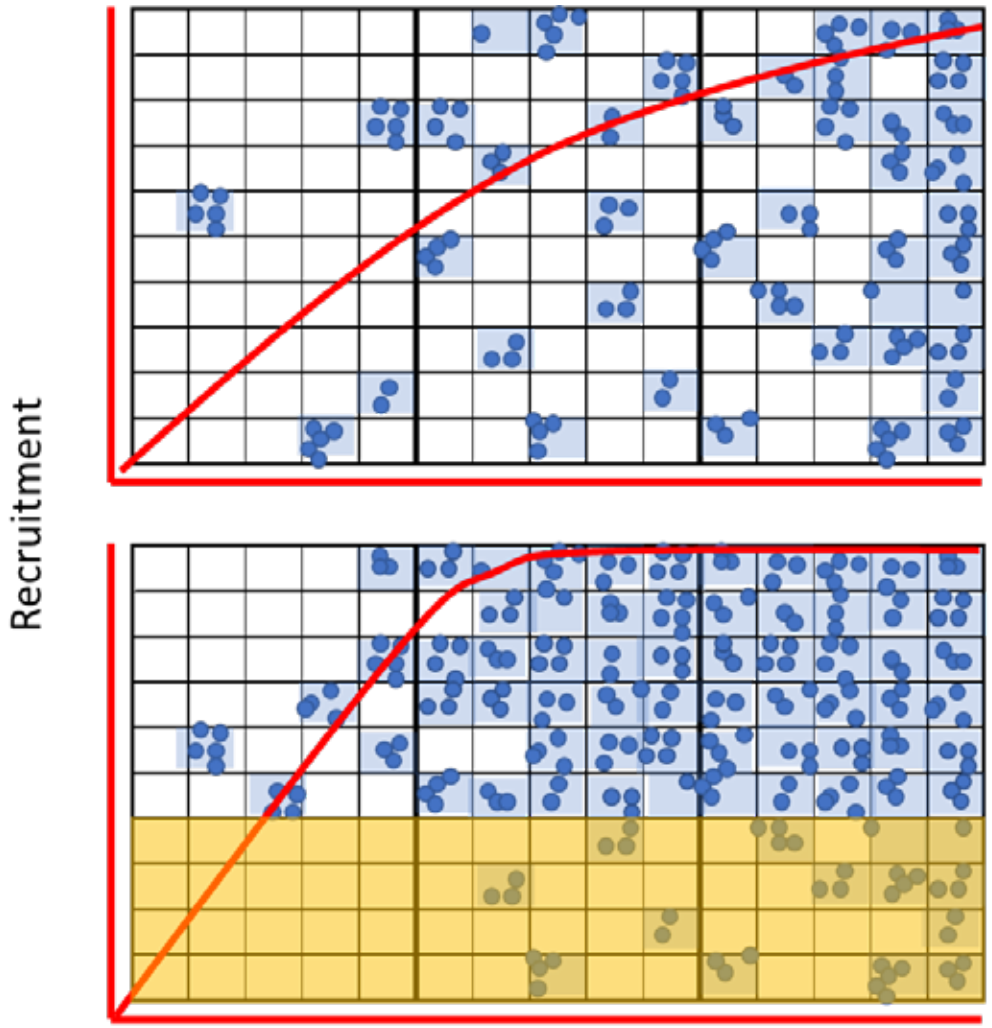
Stock-Recruitment: Spatio-temporal distribution

A stock–recruitment model for highly fecund species based on temporal and spatial extent of spawning



Maunder, M.N. and Deriso, B.R. (2013) A stock–recruitment model for highly fecund species based on temporal and spatial extent of spawning. Fisheries Research 146: 96–101.

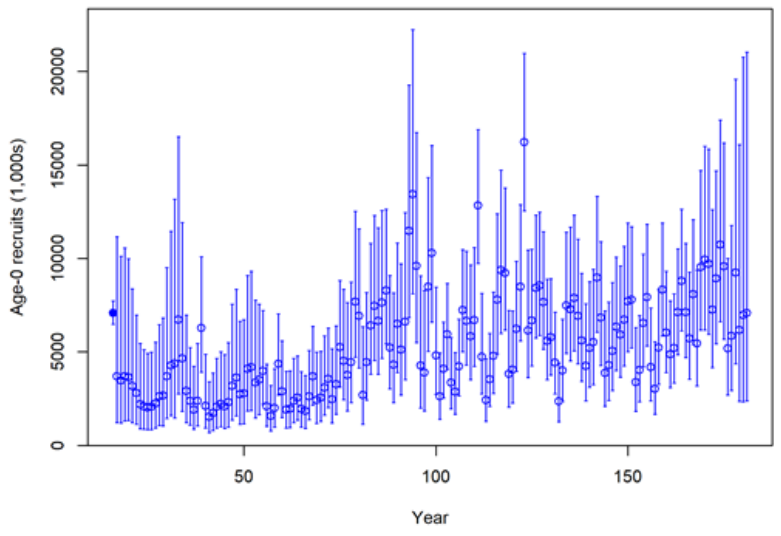
Stock-Recruitment: Spatio-temporal distribution



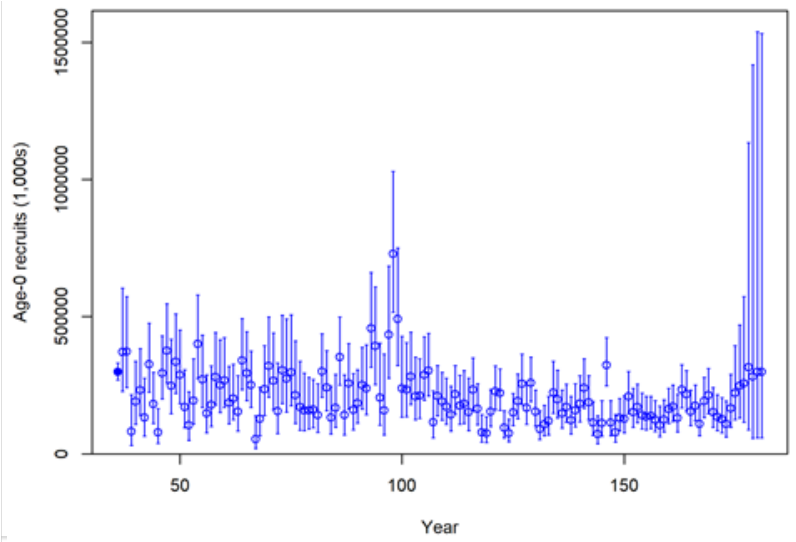
Unproductive habitat

Stock-Recruitment: BET, YFT, and PBF

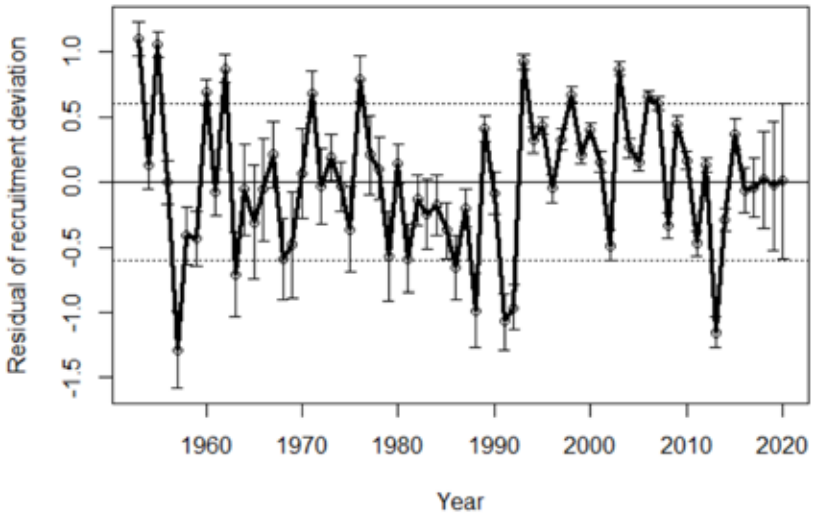
BET

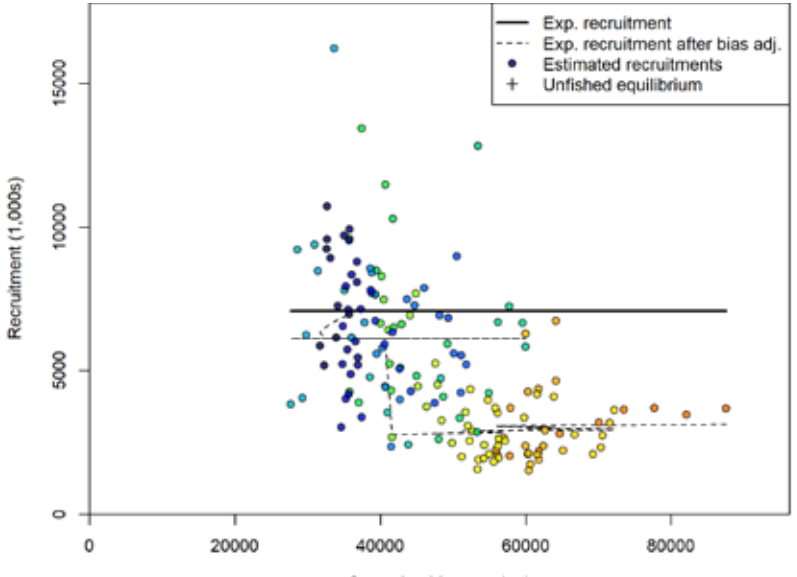


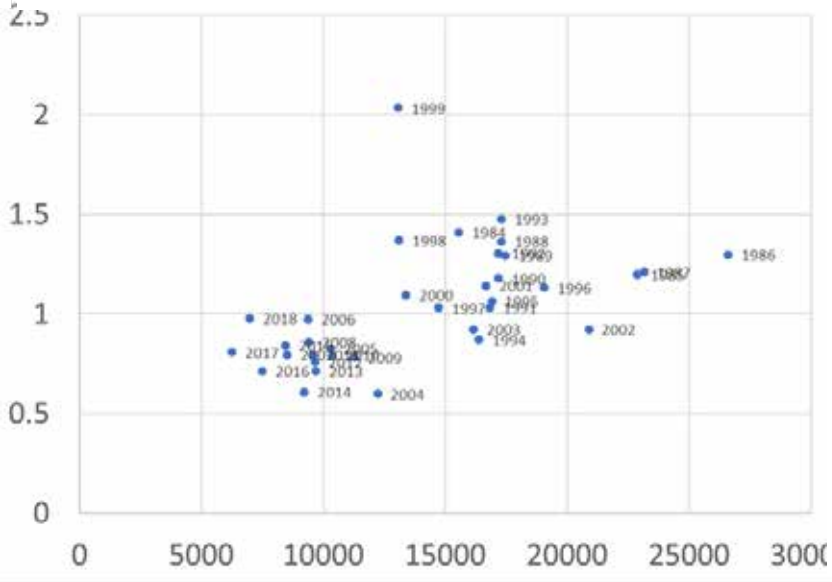
YFT

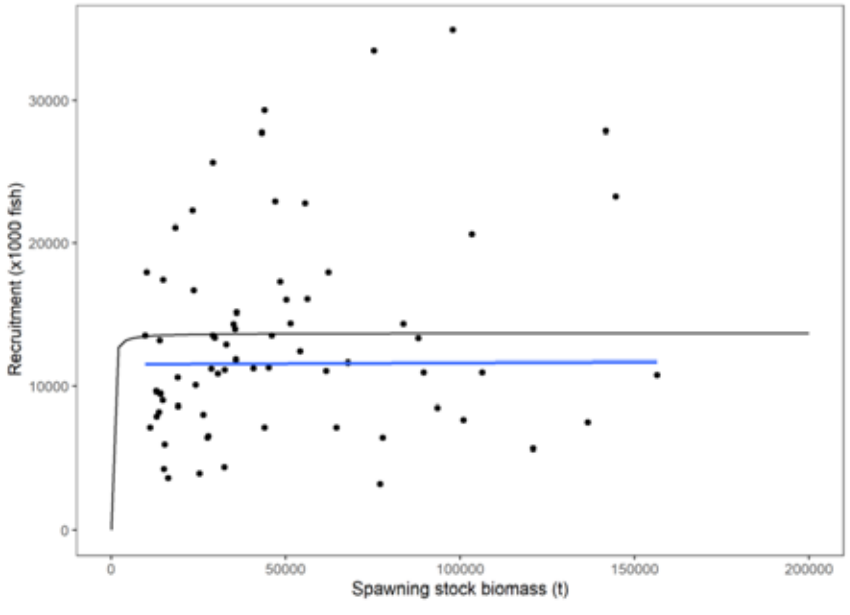


PBF









Selectivity

Table 1 Estimates of MSY and associated quantities for yellowfin tuna in the EPO using different fishing methods.

Fishing method	MSY	S/S_0	Effort multiplier
Current mixture	248	0.23	1.19
Longline	425	0.26	66.47
Dolphin associated	337	0.26	3.06
Free-swimming schools	199	0.14	4.72
Floating objects	144	0.13	7.60

The effort multiplier is the proportion of the current effort for that fishing method that is required to produce MSY if no other methods are used.

Maunder, M.N. 2002. The relationship between fishing methods, fisheries management and the estimation of MSY. Fish and Fisheries, 3: 251-260.

S_{MSY}/S_0 for BET and YFT

TABLE 1. Ranges of S_{MSY}/S_0 estimated in the bigeye (SAC-11-06, Table 7) and yellowfin (SAC-11-07, table 8) stock assessments.
TABLA 1. Rangos de S_{RMS}/S_0 estimados en las evaluaciones de las poblaciones de patudo (SAC-11-06, Tabla 7) y aleta amarilla (SAC-11-07, Tabla 8).

Steepness (*h*)	Bigeye	Yellowfin
1.0	0.20 – 0.24	0.23 – 0.32
0.9	0.25 – 0.27	0.28 – 0.35
0.8	0.28 – 0.30	0.32 – 0.37
0.7	0.31 – 0.32	0.35 – 0.40

Around 0.3

Proposed reference points

Target Reference Point: defined as 0.3 of the dynamic unfished spawning biomass (S_0 or B_0) or the spawning biomass that maximizes yield under current relative age specific fishing mortality when the spawner-recruitment relationship follows the Beverton-Holt function with an assumed steepness (h) of 0.75, whichever is largest. The fishing mortality (F) target reference point is the value of F that, under equilibrium conditions, maintains the spawning biomass at the biomass target reference point.

Limit reference point

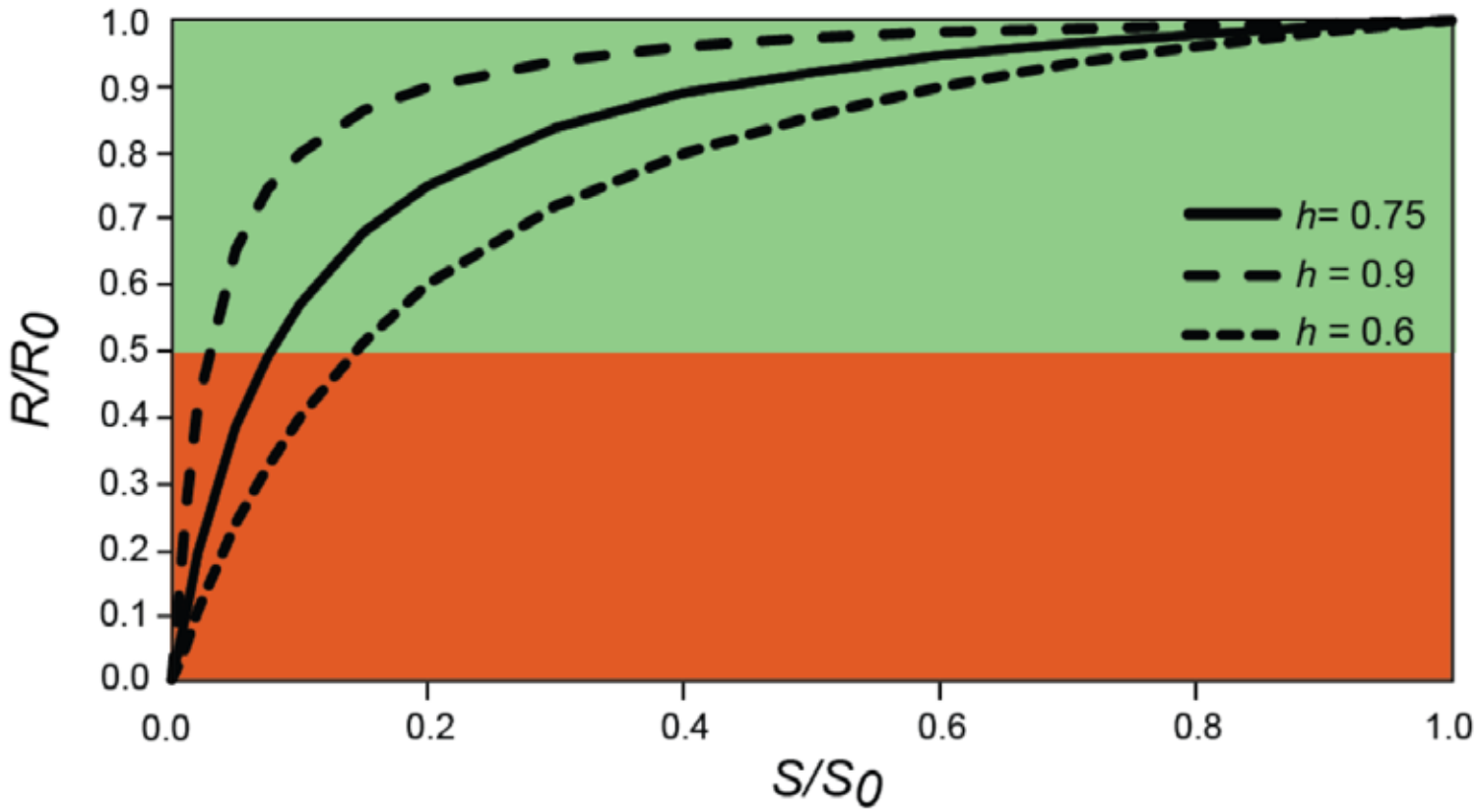


FIGURE 1. The Beverton-Holt stock-recruitment relationship with three different values for steepness (h). The orange area represents recruitment below the LRP definition of $0.5R_0$.
FIGURA 1. La relación población-reclutamiento de Beverton-Holt con tres valores diferentes de inclinación (h). La zona naranja representa reclutamiento inferior a la definición del PRL de $0.5R_0$.

Maunder, M.N. and Deriso, R.B. 2014. Proposal for biomass and fishing mortality limit reference points based on reduction in recruitment. IATTC Stock Assessment Report 15, 193–206.

Proposed reference points

Limit Reference Point: defined as the spawning biomass that produces 50% of the virgin recruitment (R_0) when the spawner-recruitment relationship follows the Beverton-Holt function with an assumed steepness (h) of 0.75. The spawning biomass at the limit reference point is equal to 0.077 of the equilibrium unfished spawning biomass (S_0 or B_0). The fishing mortality (F) limit reference point is the value of F that, under equilibrium conditions, maintains the spawning biomass at the biomass limit reference point.

Applications: SKJ

- MSY (h = 0.1) occurs at very high or infinite F
- $S_{MSY}/S_0 = 0.15$
- $S_{target} = 0.3S_0$
- $S_{limit} = 0.077S_0$

Applications: South-EPO Swordfish

Model	SMSY/S0
H1	0.263
1	0.244
2	0.242
3	0.244
4	0.244
Average	0.247

- S_{MSY}/S_0 = 0.24-0.26
- $S_{target} = 0.3S_0$
- $S_{limit} = 0.077S_0$

Proposed reference points

Limit Reference Point: defined as the spawning biomass that produces 50% of the virgin recruitment (R_0) when the spawner-recruitment relationship follows the Beverton-Holt function with an assumed steepness (h) of 0.75. The spawning biomass at the limit reference point is equal to 0.077 of the equilibrium unfished spawning biomass (S_0 or B_0). The fishing mortality (F) limit reference point is the value of F that, under equilibrium conditions, maintains the spawning biomass at the biomass limit reference point.

Target Reference Point: defined as 0.3 of the dynamic unfished spawning biomass (S_0 or B_0) or the spawning biomass that maximizes yield under current relative age specific fishing mortality when the spawner-recruitment relationship follows the Beverton-Holt function with an assumed steepness (h) of 0.75, whichever is largest. The fishing mortality (F) target reference point is the value of F that, under equilibrium conditions, maintains the spawning biomass at the biomass target reference point.

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