Proposal for biomass and fishing mortality limit reference points based on reductions in recruitment

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IATTC

Limit Reference Points: Background

- Triggering an LRP should not mean that the species has a high risk of biological extinction: an appropriate response would be a reduction in fishing mortality rather than the closure of the whole fishery. (Punt and Smith 2001)
- If an LRP is appropriately set, the probability of triggering it should be low, but clearly not zero.
- A fish stock or fishery is expected to approach or fluctuate around a TRP, and to have a very low probability (*e.g*. less than 10%) of exceeding an LRP (Sainsbury 2008).
- LRPs have been traditionally set on biological grounds to protect a stock from serious, slowly reversible, or irreversible fishing impacts, which include recruitment overfishing and genetic modification (Sainsbury 2008).
- In practical terms, this generally means determining the effect of exploitation on recruitment, typically through evaluating the stock-recruitment relationship.

Limit Reference Points: Applicability to IATTC

- The IATTC staff has historically based its conservation recommendations on an informal decision rule that is based on adjusting effort to correspond to the fishing mortality (F) corresponding to the maximum sustainable yield (MSY; FMSY), implying that FMSY is a TRP.
- The use of FMSY as a LRP is unreasonable, particularly if the required probability of exceeding the LRP is very low

Limit Reference Points: Main Considerations

- Four main points should be kept in mind when developing LRPs:
- 1) given that management is implemented to achieve the TRP, there should be a very low, but not zero, probability of exceeding the LRP;
- 2) the LRP should be based on biological grounds to protect a stock from serious, slowly reversible or irreversible fishing impacts;
- 3) the TRPs will often be at, or close to, MSY-related quantities; and
- 4) the decision about which LRPs are appropriate should be made in the context of the management action to be applied if the limit is exceeded.

Proposed limit reference points

- Based on the predicted reduction in recruitment compared to virgin recruitment
- Practical implementation for biomass and fishing mortality LRPs
  - Using a conservative steepness value for the Beverton-Holt stock-recruitment relationship.

Reduction in Recruitment Based LRP

$$P(BH(d,h) < x\%R_0) > \pi$$

Symbol	Description
P	Probability
π	The critical value for the probability that recruitment will fall below $x\%R_0$
$x\%R_0$	fraction of the recruitment expected in unexploited conditions
$BH()$	Beverton-Holt stock-recruitment relationship
$d = S/S_0$	depletion level
h	Steepness (the proportion of the recruitment from an unfished stock obtained when the spawning biomass is 20% of the virgin (unexploited) spawning biomass)

Reduction in Recruitment Based LRP

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Uncertainty

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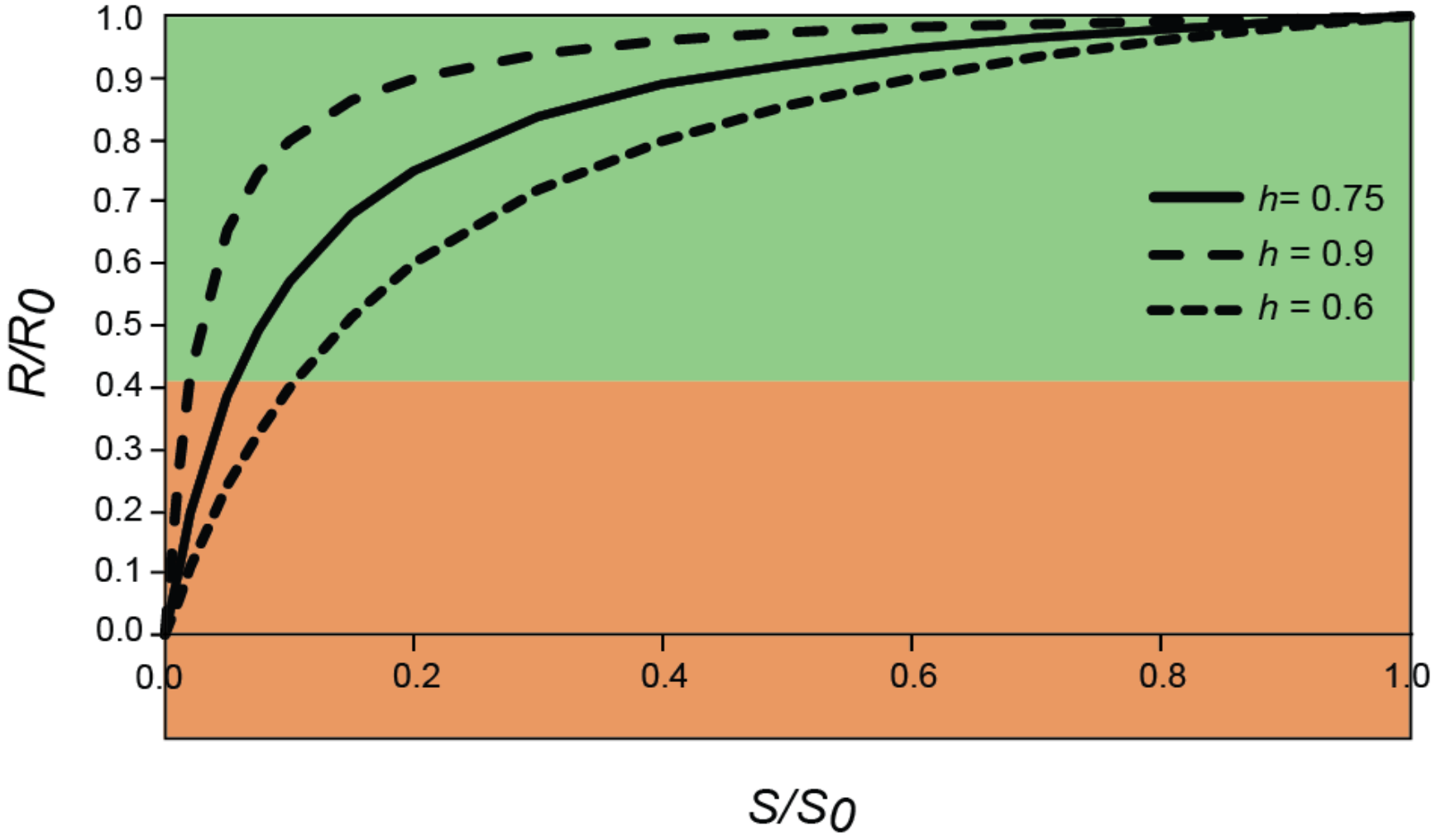
Practical implementation for biomass and fishing mortality LRPs

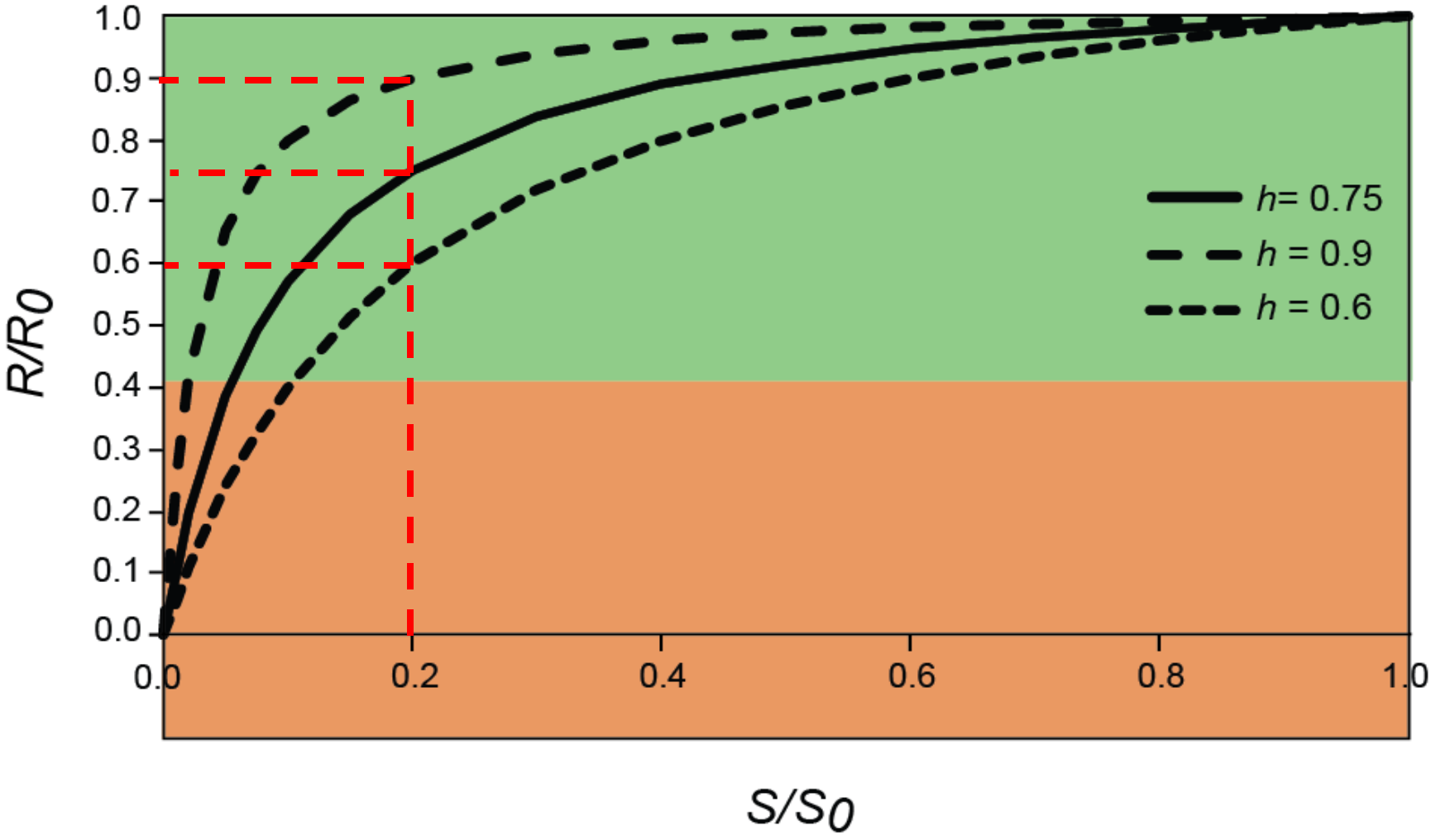
- The x%R_0 reference point ($r = R/R_0$) can be converted into a biomass reference point based on the depletion level ($d = S/S_0$)
- A conservative value of h ensures that if the reference point is triggered there is a low probability that recruitment < x%R_0
- A fishing mortality reference point can be determined by finding the equilibrium fishing mortality corresponding to the depletion level
- Use 50%R0 (r = 0.5) as the definition of the reference point

$$d = \frac{0.2r(1-h)}{0.8h - r(h-0.2)}$$

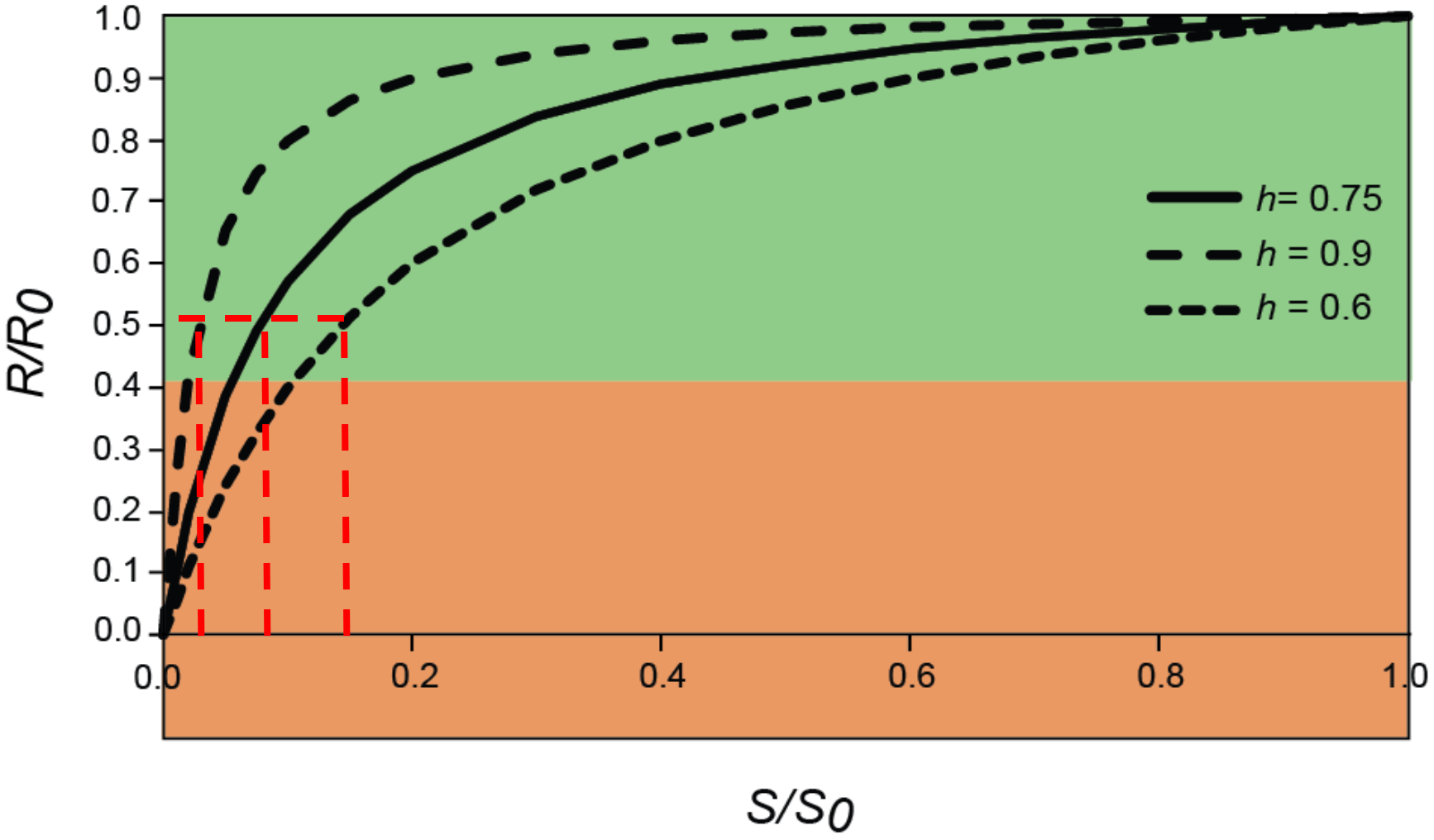
Reduction in recruitment for different values of steepness



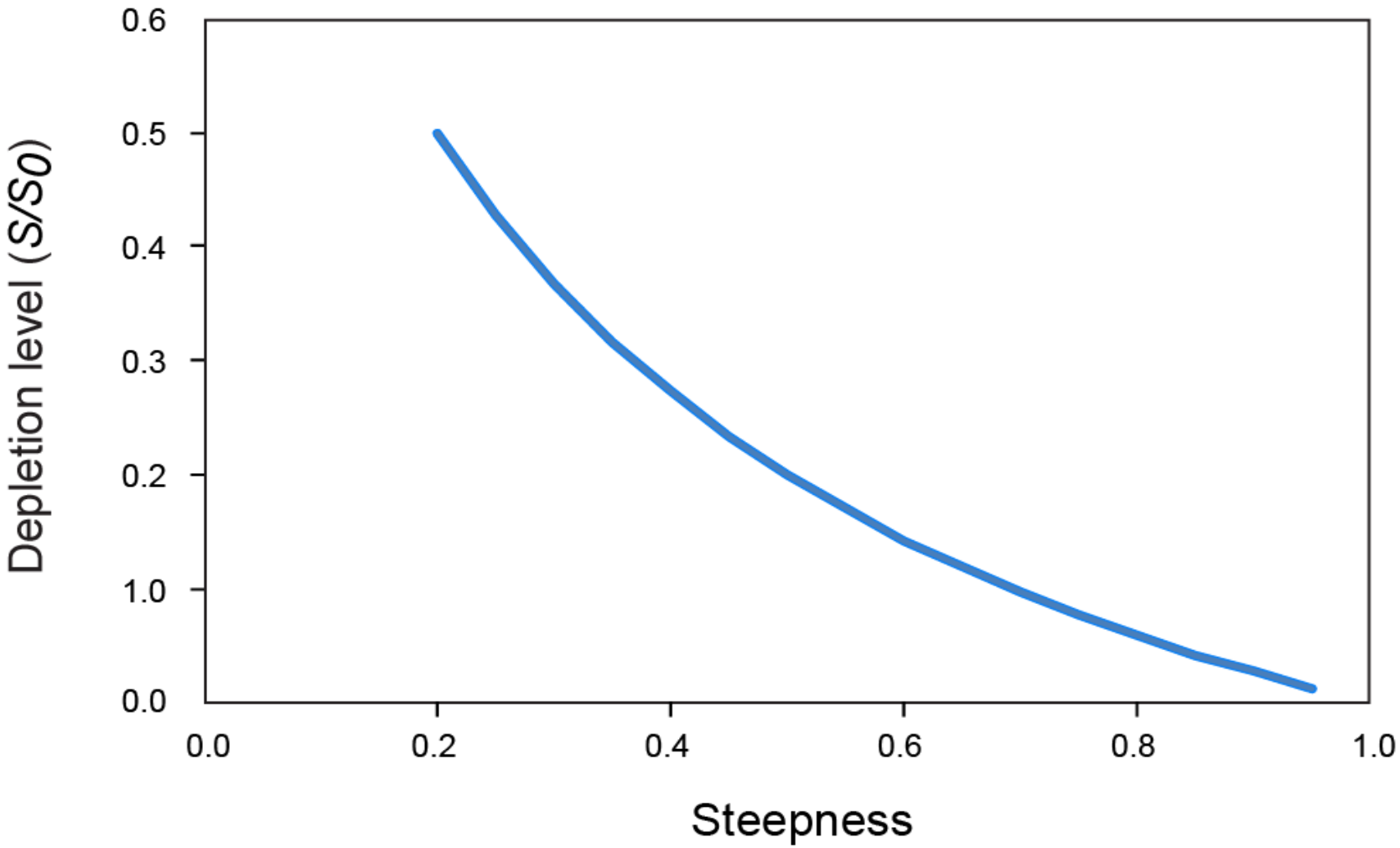
Reduction in recruitment for different values of steepness



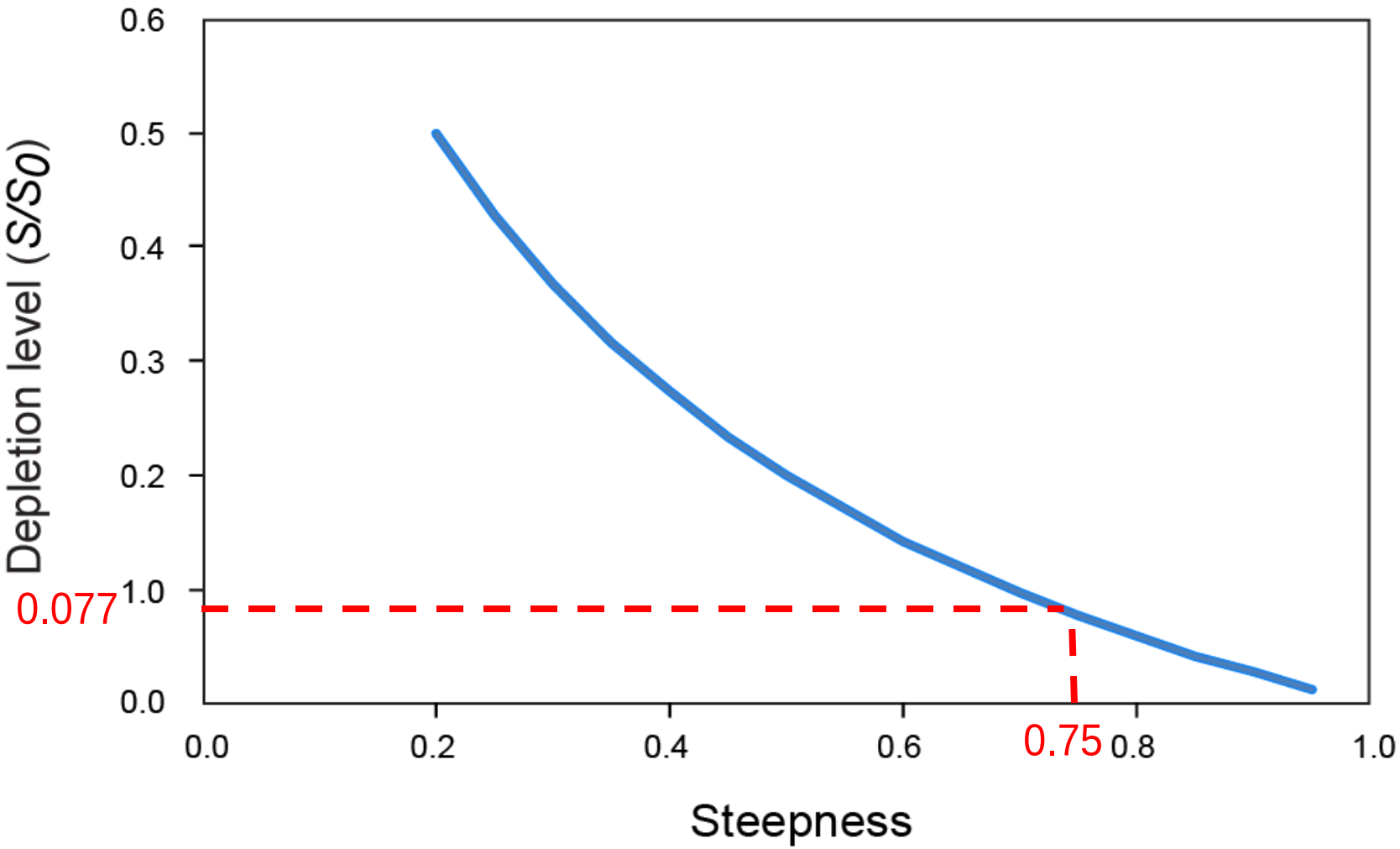
Reduction in recruitment for different values of steepness



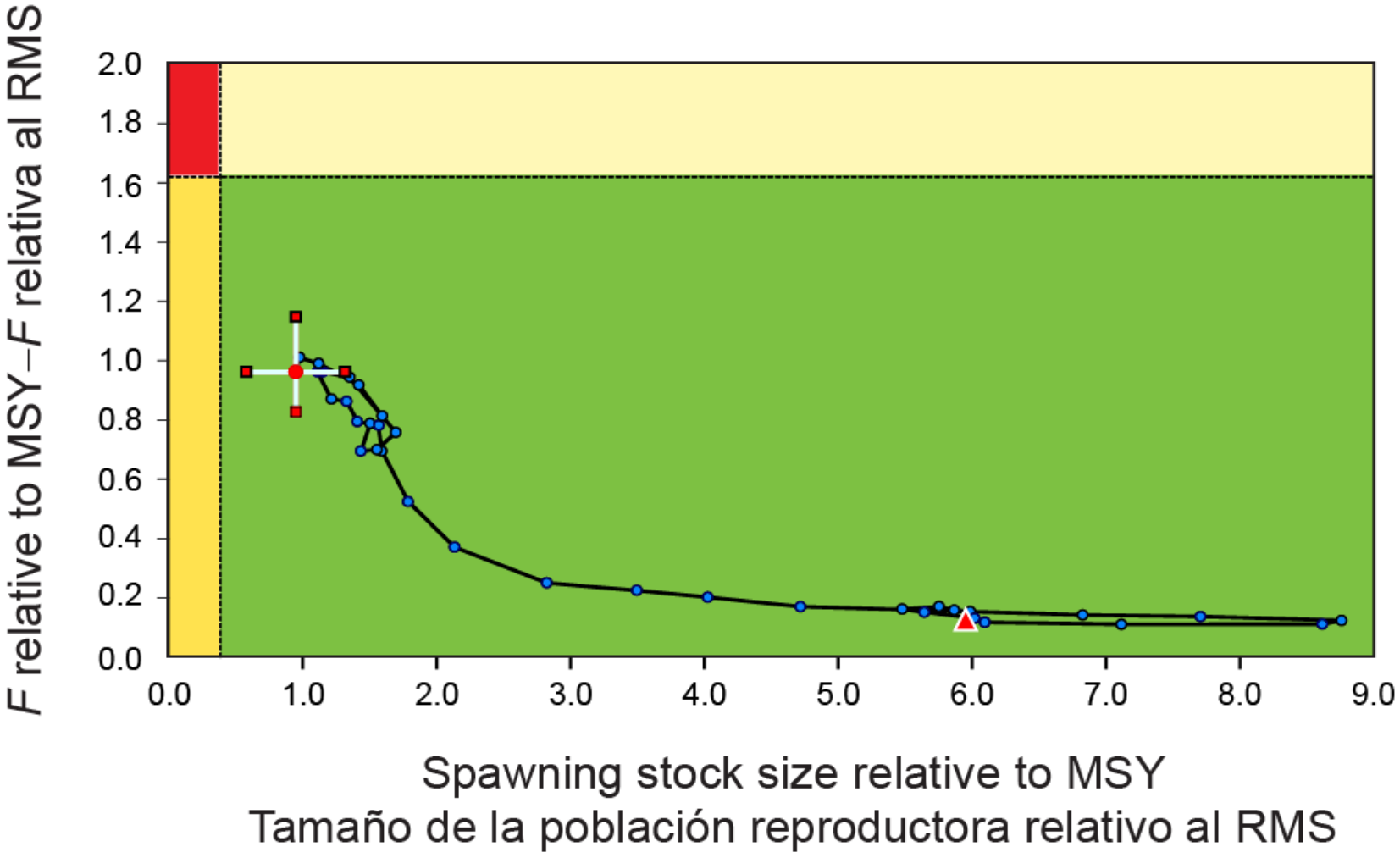
Biomass LRP for 50%R0



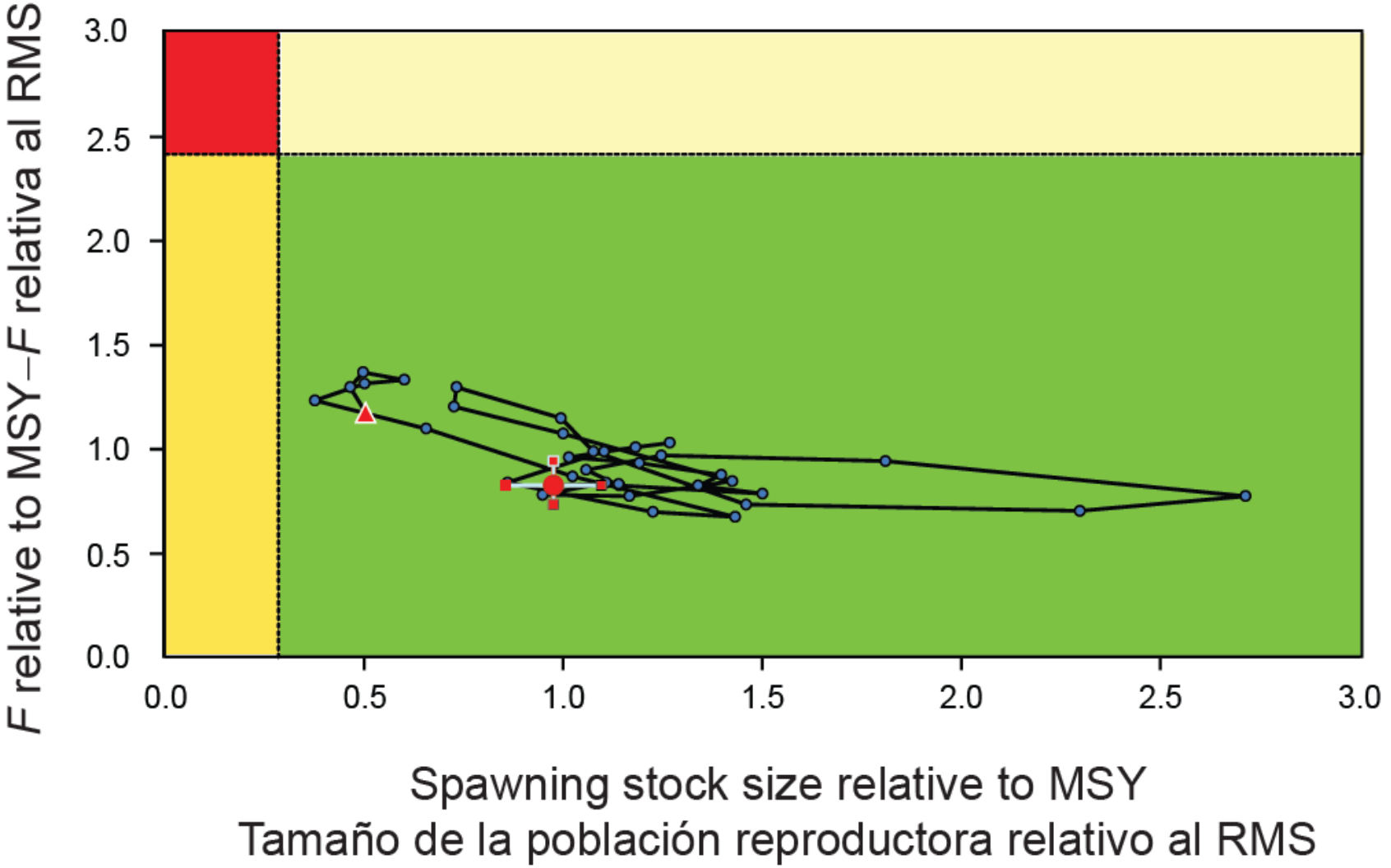
Biomass LRP for 50%R0



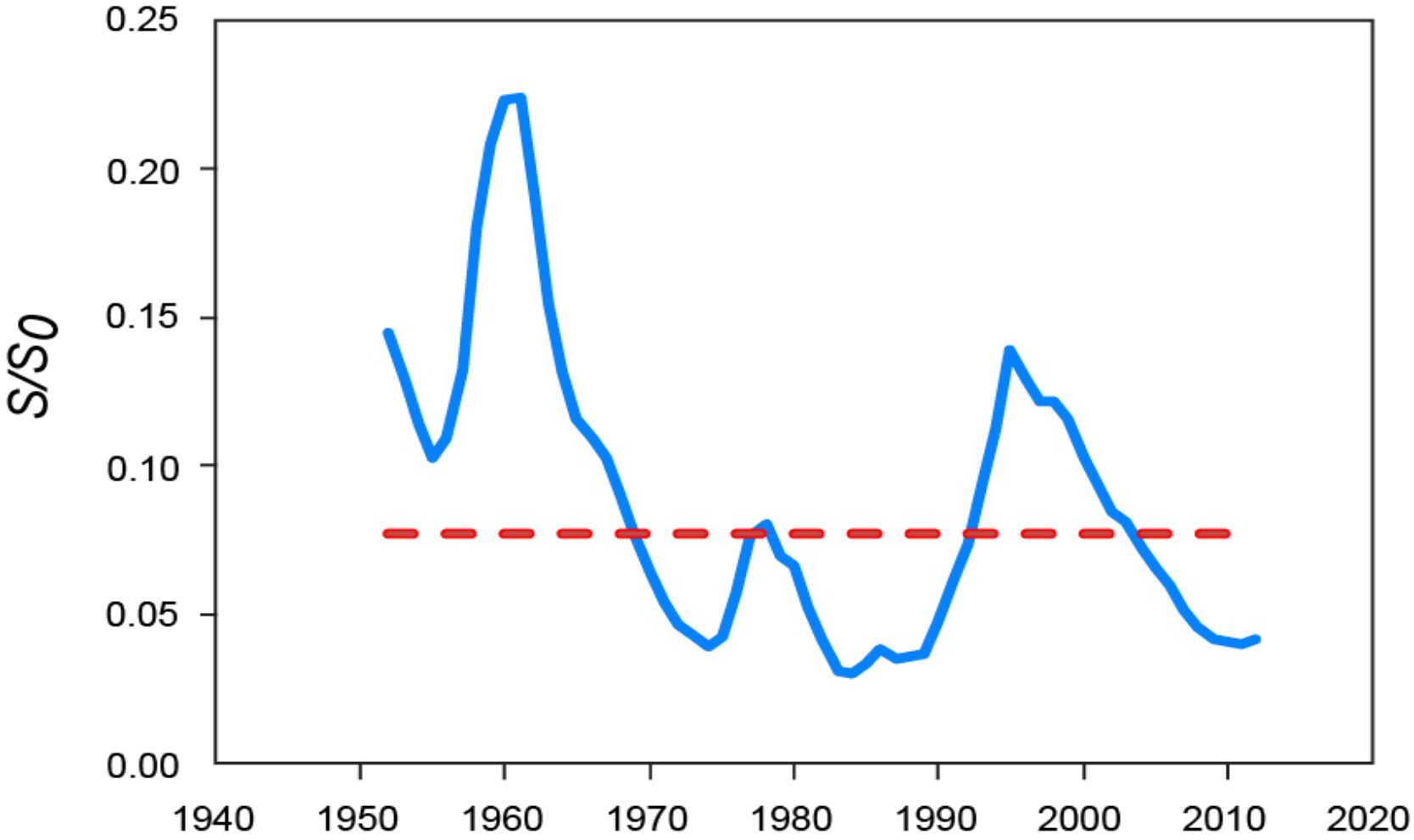
Bigeye tuna


F relative to MSY–F relativa al RMS
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
Spawning stock size relative to MSY
Tamaño de la población reproductora relativo al RMS

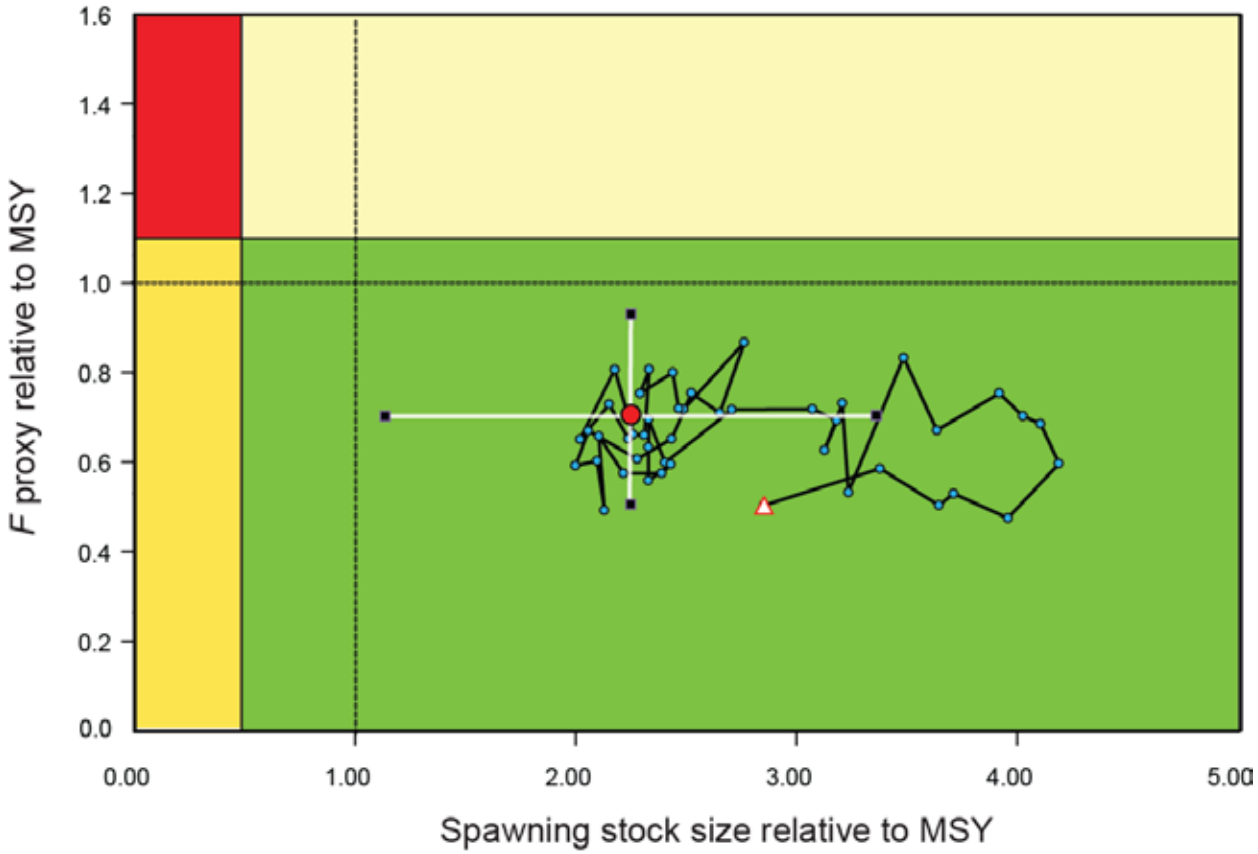
Yellowfin tuna



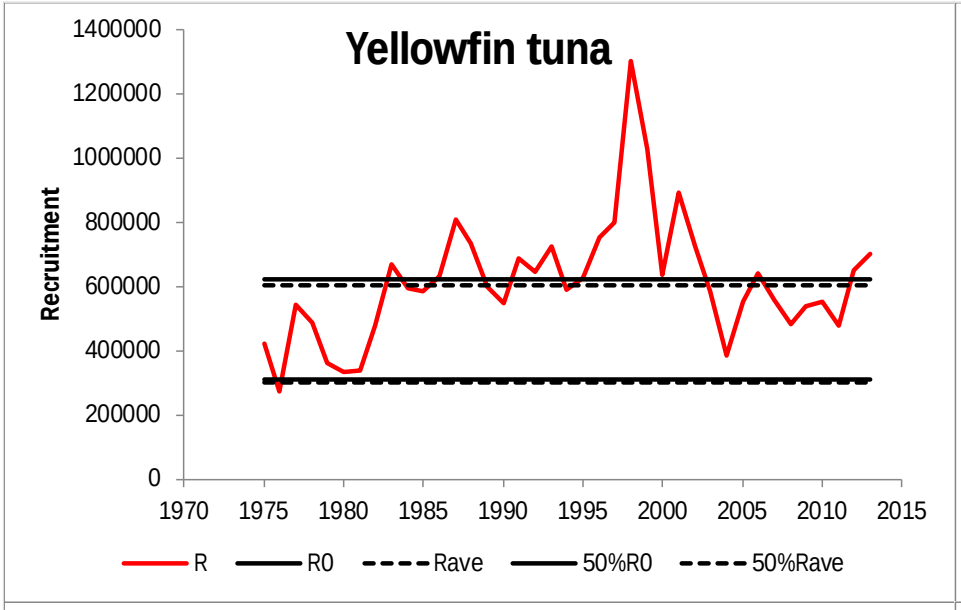
North Pacific bluefin tuna

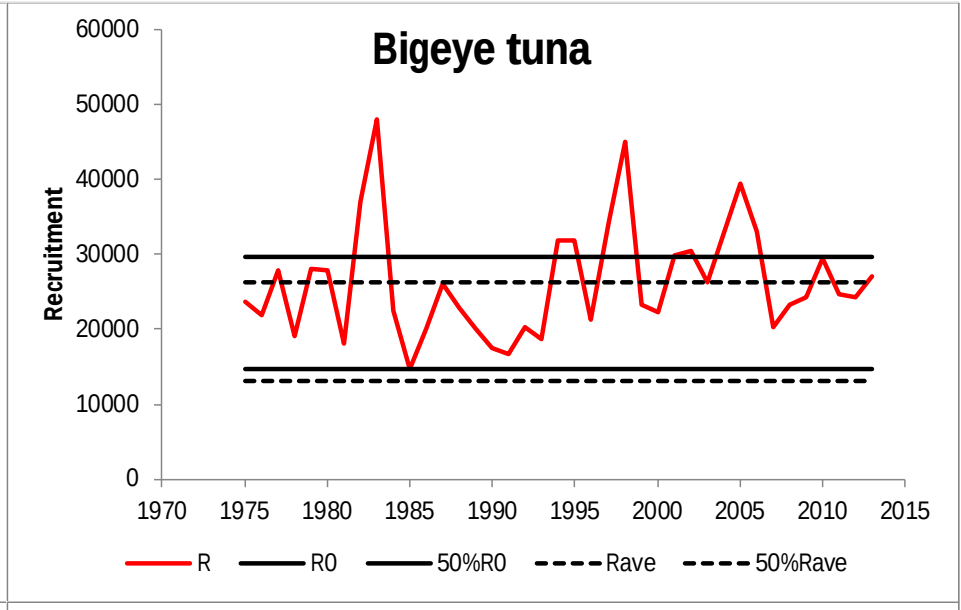


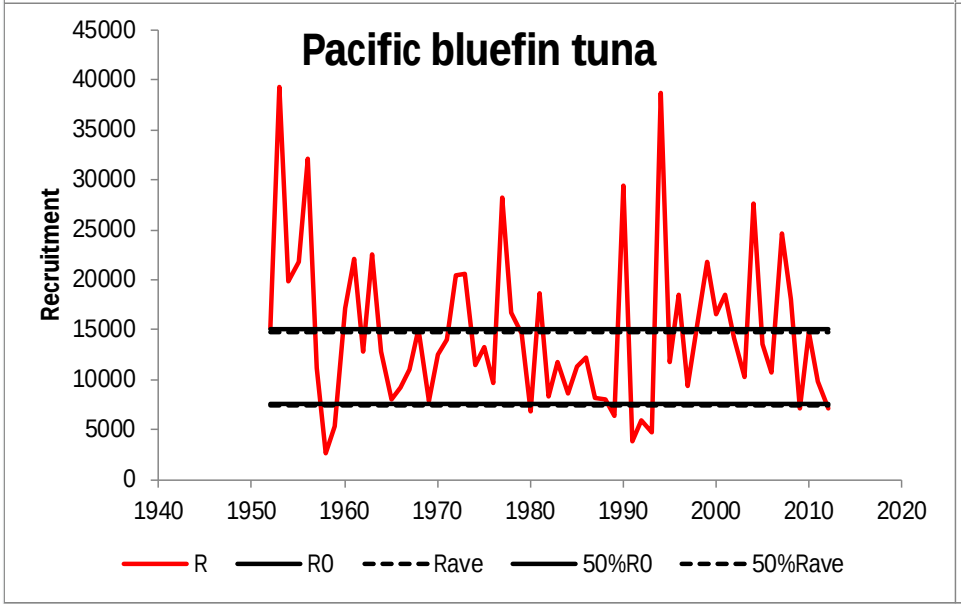
North Pacific Albacore

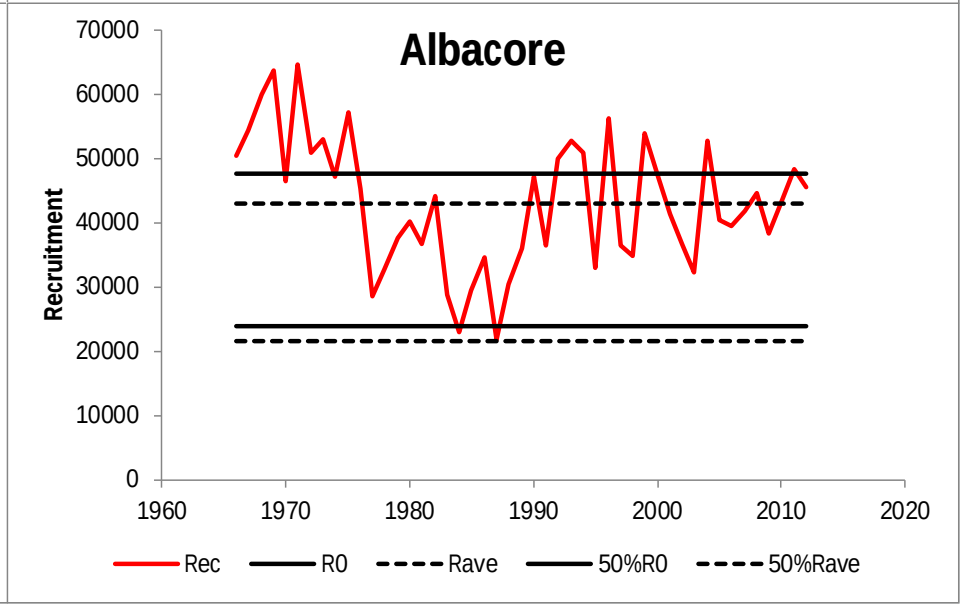


F proxy computed as (1-(SPR[year]/SPR[virgin]))









Victors request

Discussion

- Arbitrary 50%R0
- Semi-arbitrary steepness level
- Depletion based on base case or conservative steepness
- F based on base case or conservative steepness
- Dynamic depletion infers dynamic R_0
- What actions if LRPs exceeded?
- Evaluate with MSE