

Comisión Interamericana del Atún Tropical  
Inter-American Tropical Tuna Commission



POTENTIAL REFERENCE POINTS AND HARVEST CONTROL RULES FOR  
DORADO (*Coryphaena hippurus*) IN THE EASTERN PACIFIC OCEAN  
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SAC-10-11

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# IATTC and dorado: A Regional Collaborative Work

Three technical meetings during 2014-2016



**CIAT IATTC**  
**OSPESCA**  
Organización del Sector Pesquero y Acuicola del Istmo Centroamericano

**Asociación de Pescadores de Puerto Pedregal**

**WWF**

**CICIMAR-IPN**  
Instituto Nacional de Pesca

**MARVIVA**

**UNIVERSIDAD TECNOLÓGICA DE PANAMÁ**  
**UTP**  
1981

**FACULTAD DE CIENCIAS DEL MAR**  
**UMIP**  
2007

**Incopesca**  
Instituto Costarricense de Pesca y Acuicultura

**ARAP**  
Autoridad de los Recursos Acuáticos de Panamá

**CeDePesca**  
Centro Desarrollo y Pesca Sustentable  
Centre for Development and Sustainable Fisheries

**Dirección Normativa de la Pesca y Acuicultura Guatemala**

**PRODUCE**  
MINISTERIO DE LA PRODUCCIÓN

**INSTITUTO DEL MAR DEL PERU**  
CIENCIA Y TECNOLOGÍA

**UNIVERSIDAD CATOLICA DEL NORTE**  
CHILE

**IFOP**  
INSTITUTO DE FOMENTO PESQUERO



# Results from regional work

## 1. Exploratory stock assessment of dorado in the South EPO (Aires-da-Silva et al. 2016)

- 2007-2015 catches near MSY,  $F_{MSY}$  poorly defined (YPR curve was very flat)
- No assessment for the North EPO, no update of analyses since 2015

## 2. Exploratory MSE of dorado in the South EPO (Valero et al. 2016)

- Management in Peru and Ecuador (size limits and season closures) consistent with YPR

## 3. Monthly depletion estimator (Maunder et al. 2016)

- Alternative when lacking full assessments and if monthly CPUE and catches are available





# Reference Points and Harvest Control Rules

- **Reference Points:** Guidelines for management. Benchmarks against which the abundance of the stock, the fishing mortality rate or economic and social indicators can be measured to determine its status.
- **Harvest Control Rules:** specify **pre-agreed actions** to changes in the stock and/or environmental, economic factors relative to pre-established **reference points, or trends** in stock indicators.

# Reference Points and Harvest Control Rules

Indicator, or  
Stock assessment

“Stock”



Reference  
Points



Green Backlight  
(32-37.3 °C)  
normal



Keep on playing



Orange Backlight  
(37.3-38 °C)  
low fever



Hydration, bath

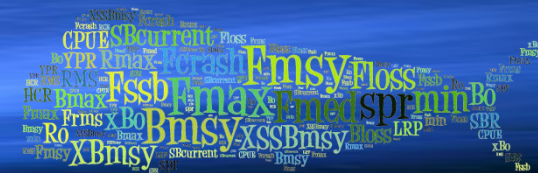


Red Backlight  
(>38 °C)  
high fever



Hospital

# Reference Points: metric and derivation



## Biomass reference points

Reference Point	Description	Pros	Cons	Target / limit
$XB_{MSY}$ $XSSB_{MSY}$	Ratio of Biomass, or spawning stock biomass (SSB), needed to produce MSY	Considers recruitment and growth overfishing	Difficult to estimate, sensitive to recruitment and selectivity	Either
$XB_0$ or $XSB_{current/F=0}$	Ratio of biomass stock relative to unfished...	Can be used for data poor stocks...	Unfished biomass estimates depend on...	Either
$B_{XR0}$ or $B_{XRMAX}$	Biomass expected to produce X fraction of...	Considers recruitment overfishing	Depends on current and historical recruitment estimates	Limit
$B_{MAX}$	Biomass when $F = F_{MAX}$ in equilibrium	Considers growth overfishing	Difficult ... when yield curve is flat topped...	Either
$B_{0.1}$	Biomass or spawning biomass produced when $F = F_{0.1}$	Considers growth overfishing, adjusts for flat topped YPR curve, adjusts somewhat for the stock-recruitment relationship	Difficult to estimate when the yield curve is flat topped Does not explicitly consider recruitment overfishing.	Either
$B_{loss}$	Minimum biomass (or SSB)	Considers recr... overfishing	Does not consider growth overfishing.	Limit

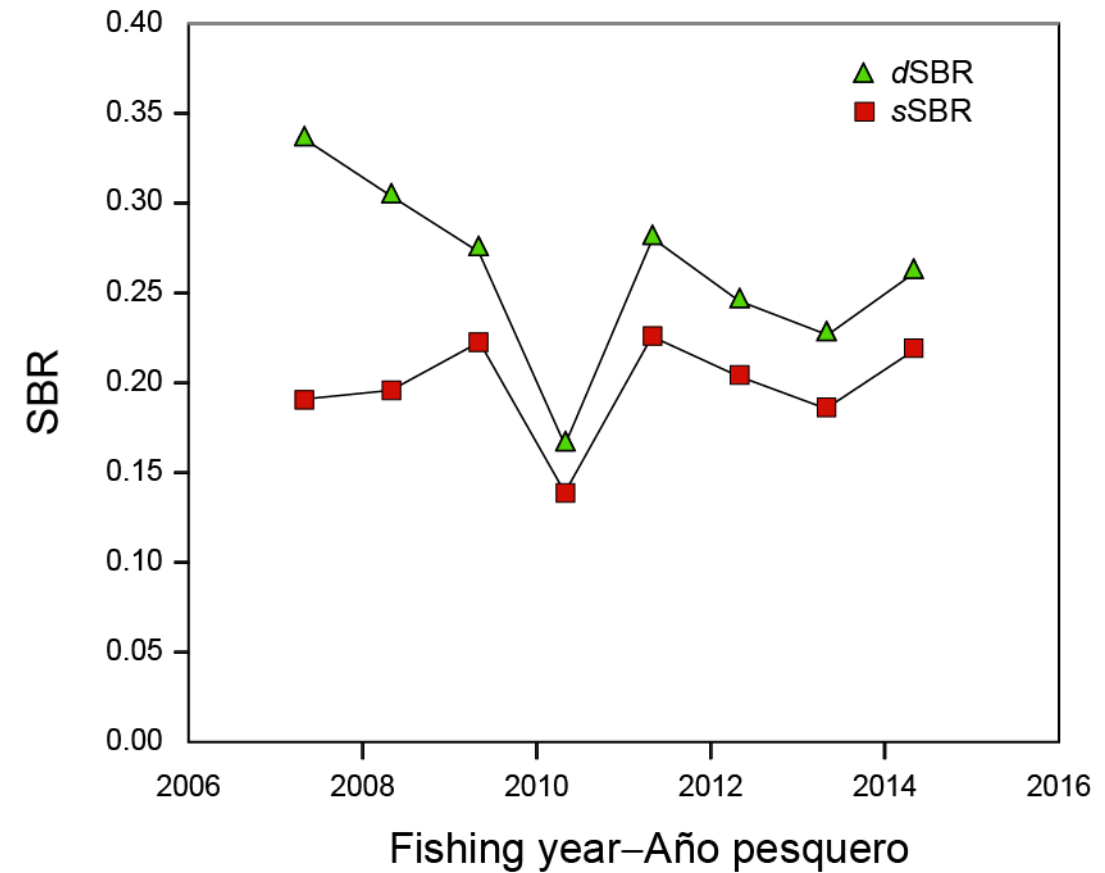
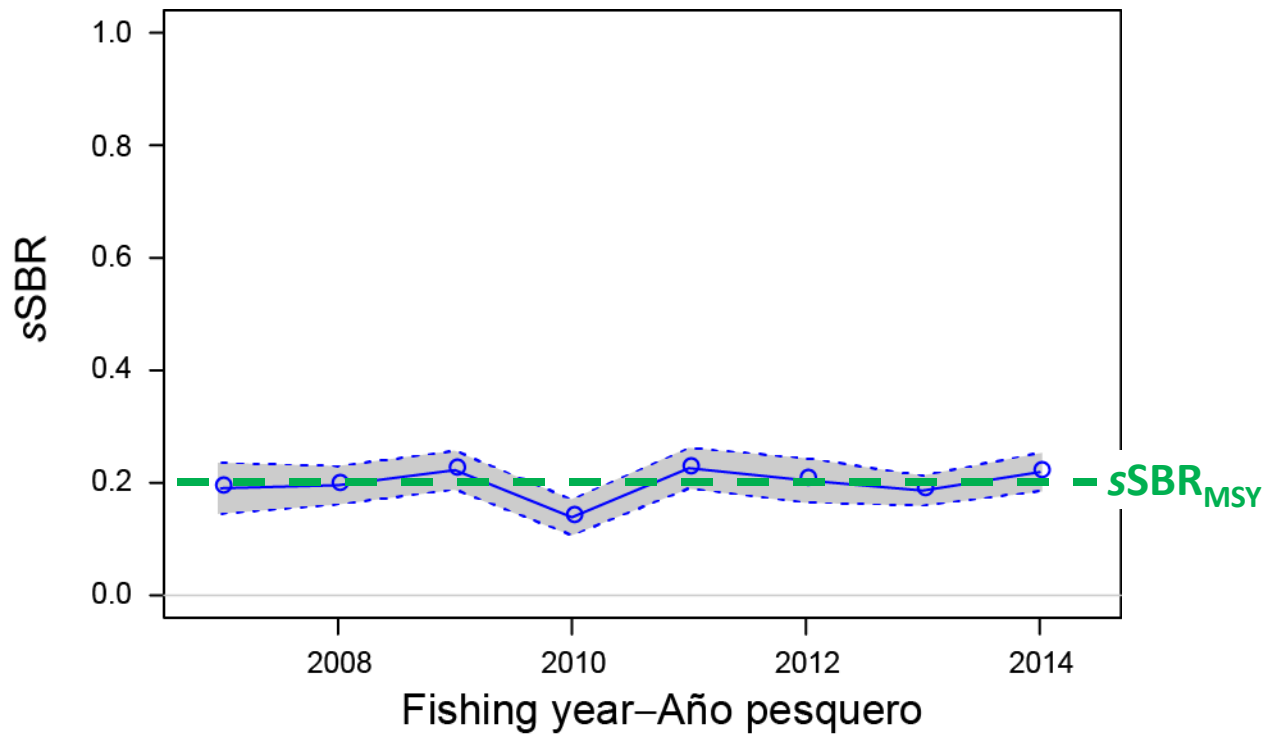
## Fishing mortality (F) reference points

Reference Point	Description	Pros	Cons	Target / limit
$F_{MSY}$	Fishing mortality rate that results in MSY on average	Considers recruitment and growth overfishing	Difficult to estimate when yield curve is flat	Either
$F_{MAX}$	Fishing mortality rate producing the maximum YPR	Considers growth overfishing; easy to calculate.	Does not consider rec. overfishing; Difficult if curve is flat topped	Limit
$F_{0.1}$	F at which slope of Y/R is 10% of value at origin	Consider growth overfishing; works if yield curve is flat	Does not explicitly consider recruitment overfishing.	Either
$F_{X\%}$ , $F_{X\%SPR}$	F that reduces SSB/R to a certain % of unfished	Considers recr. overfishing.	Does not consider growth overfishing	Either
$F_{MED}$	F that can be supported by estimated survival ...	Recr..overfishing; historical recruits...	Does not consider growth overfishing; depends on S/R...	Either
$F_{SSB-Min}$	F that prevents SSB from falling below the minimum observed SSB	Reference point for recruitment overfishing.	Risk-prone; sensitive to period for calculations No consideration of growth overfishing	Limit
$F_{loss}$	F expected to keep biomass at $B_{loss}$	Recruitment overfishing...	Risk-prone; no growth overfishing; depends on S/R knowledge...	Limit
$F_{crash}$	Lowest F that would make stock extinct...	Based on S/R	Risk-prone, allows the path to extinction	Limit
$F = X\%M$	F is set at a % of natural mortality	Can be used in data-poor situations	Uncertainty in estimation of M, possibly too high for longer-lived species.	Limit

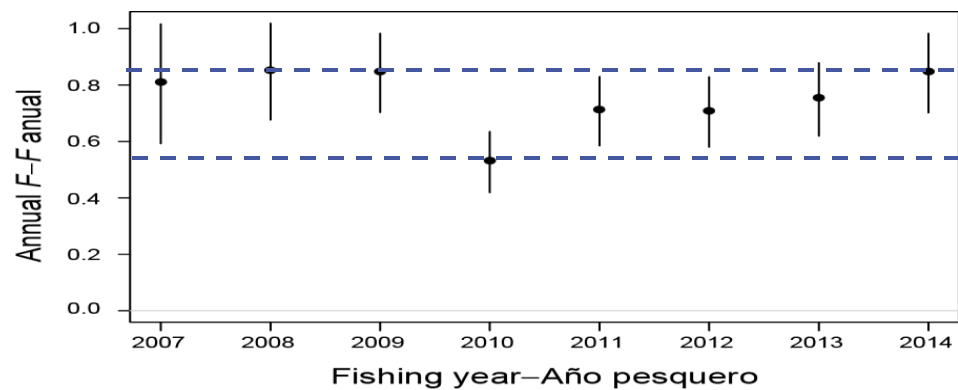
Valero, J. L., Aires-da-Silva, A., Maunder, M. 2019. Potential reference points and harvest control rules for dorado (*Coryphaena hippurus*) in the eastern Pacific Ocean. [SAC-10-11](#).

# Spawning Biomass Ratio (SBR) for South EPO dorado

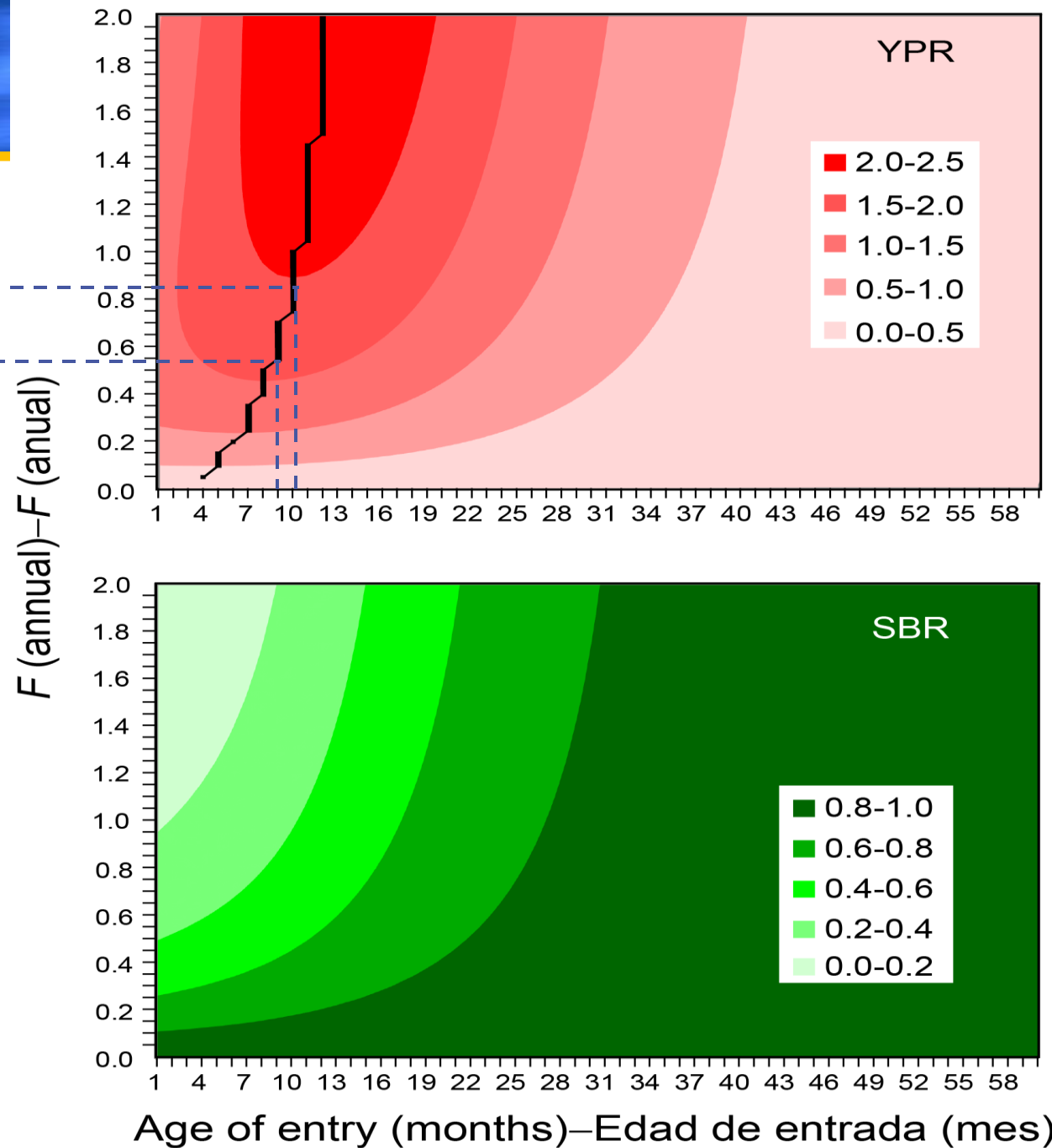
Estimated spawning biomass (2007-2014)  
around the level estimated to produce MSY



# South EPO fishing mortality ( $F$ )

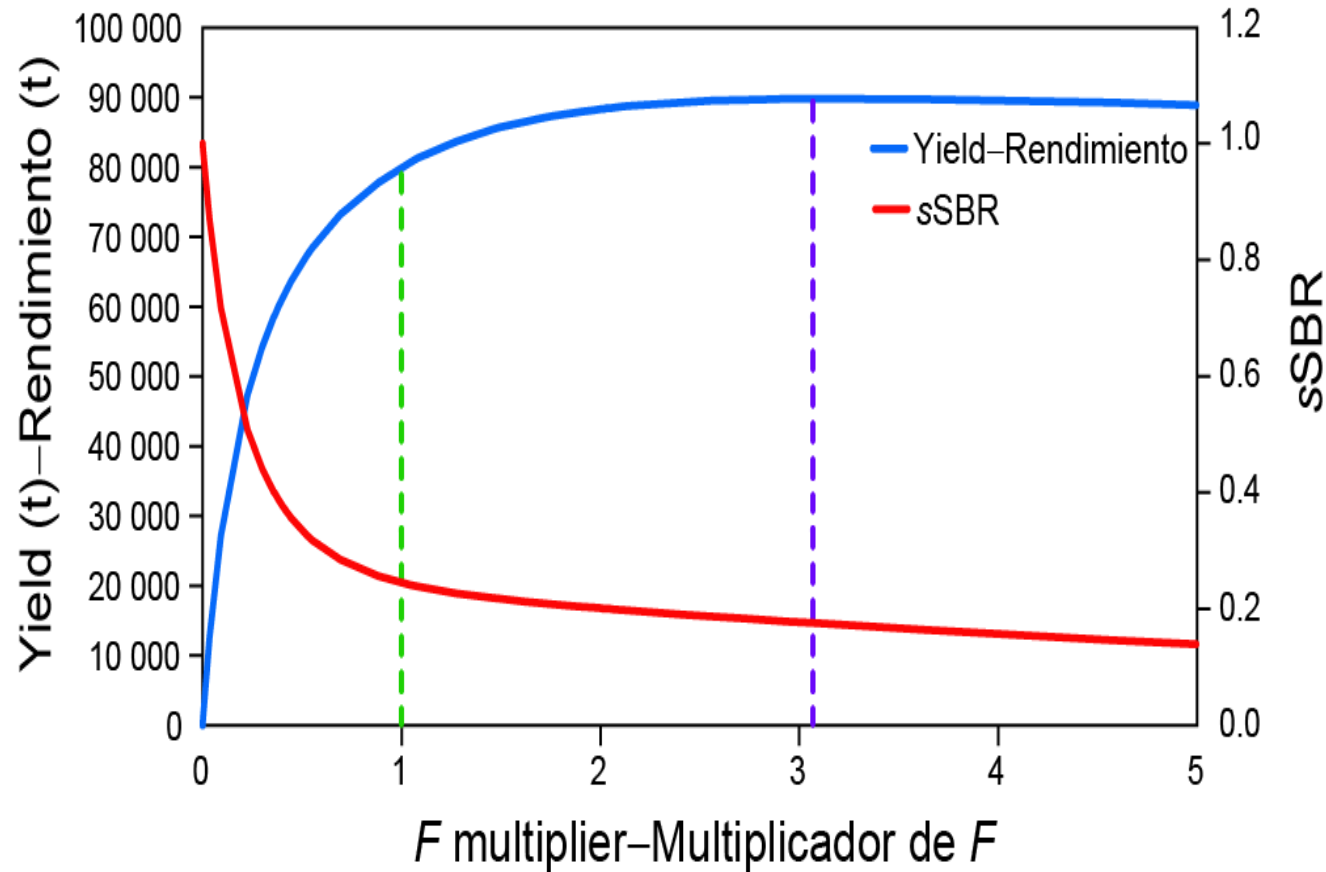


$F$  during 2007-2014 consistent with yield per recruit (YPR) given seasonal fishery closures in Peru and Ecuador





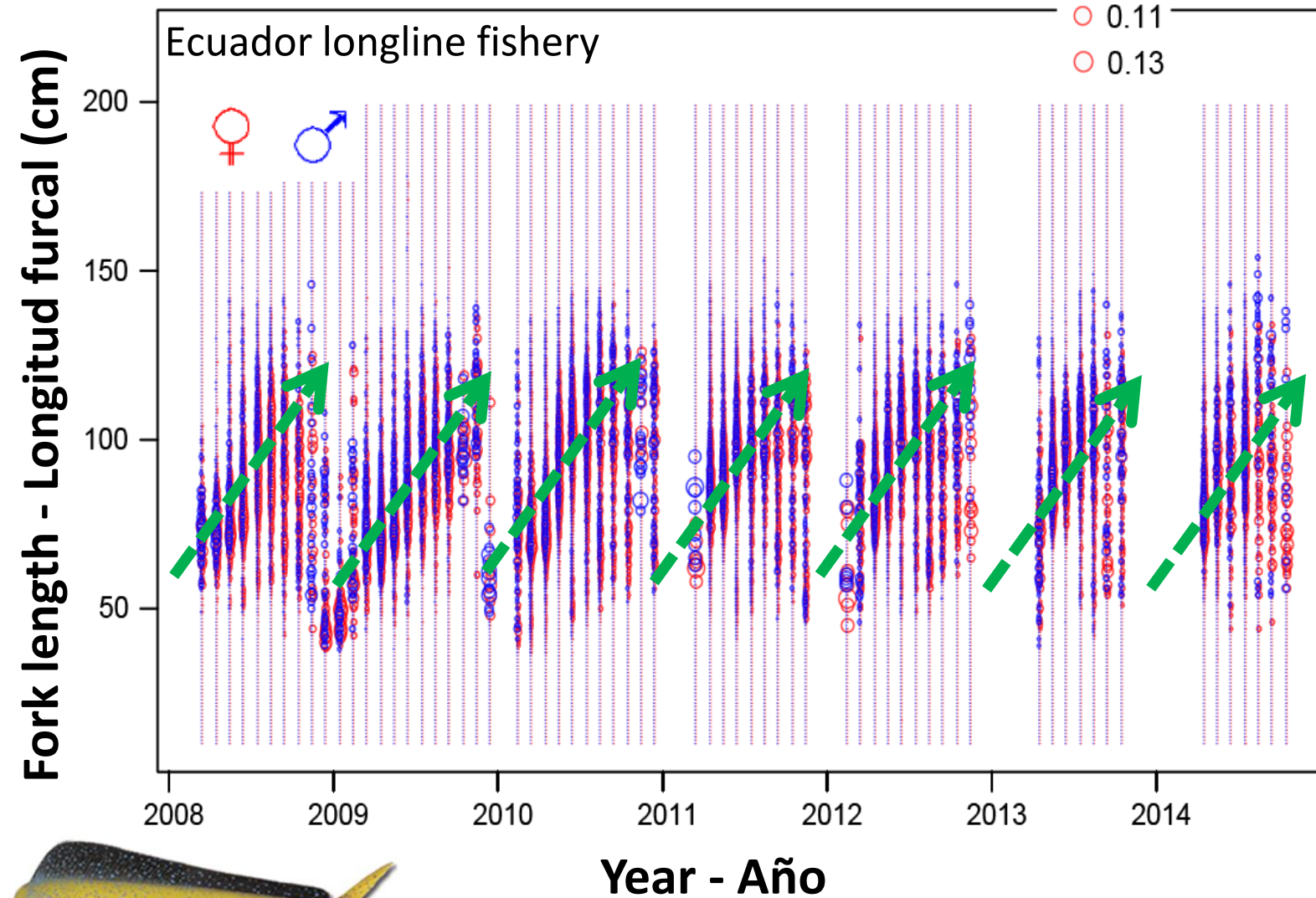
# Yield per recruit (YPR)



- $F_{MAX}$  is about 3X of  $F$  in 2016 but poorly determined (flat yield curve)
- $F_{0.1}$  would be more appropriate



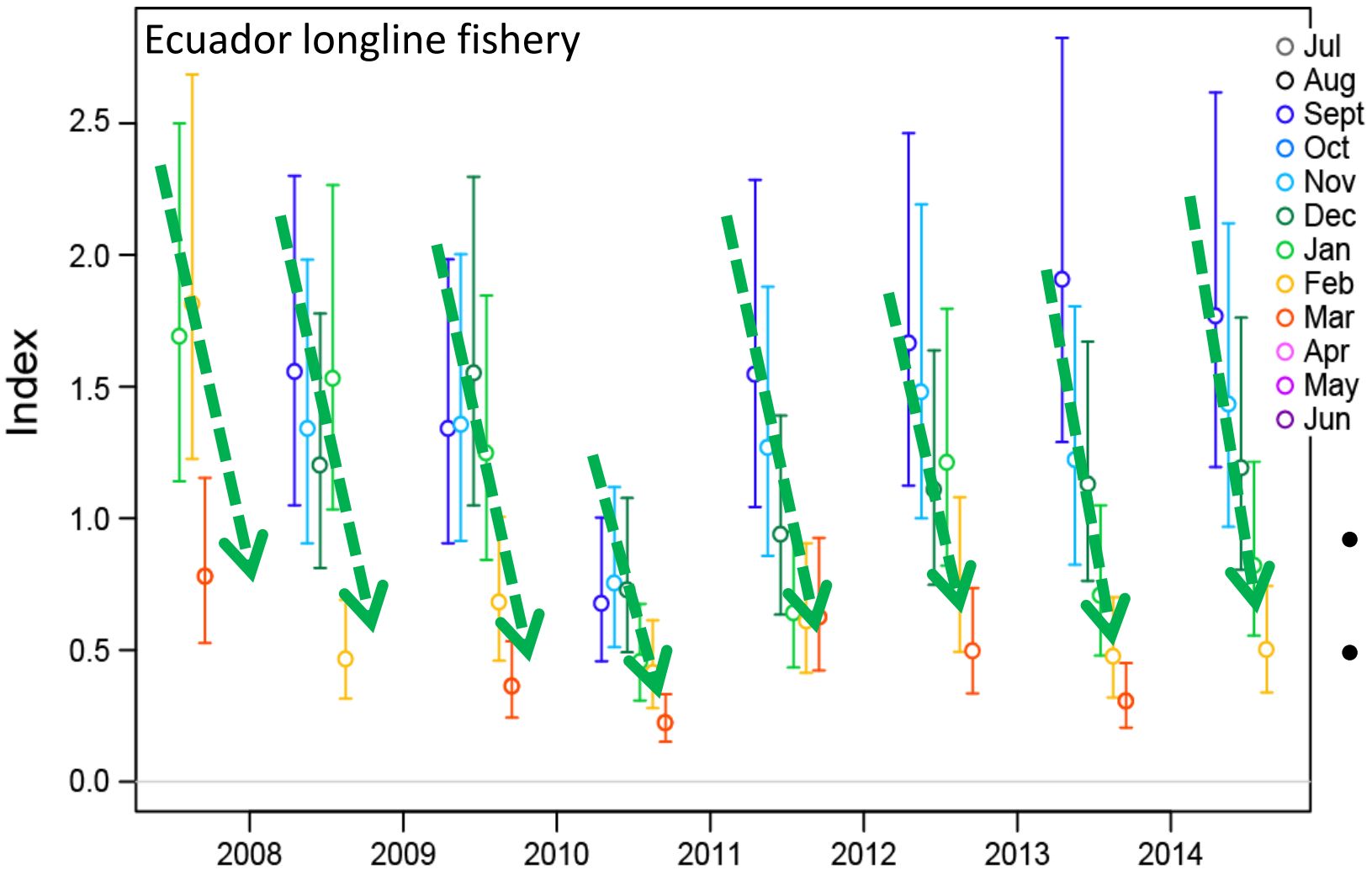
# Empirical reference points: Fish size



- Fishery targets mainly a single cohort per year
- Fish size not straightforward as potential reference point



# Empirical reference points: CPUE

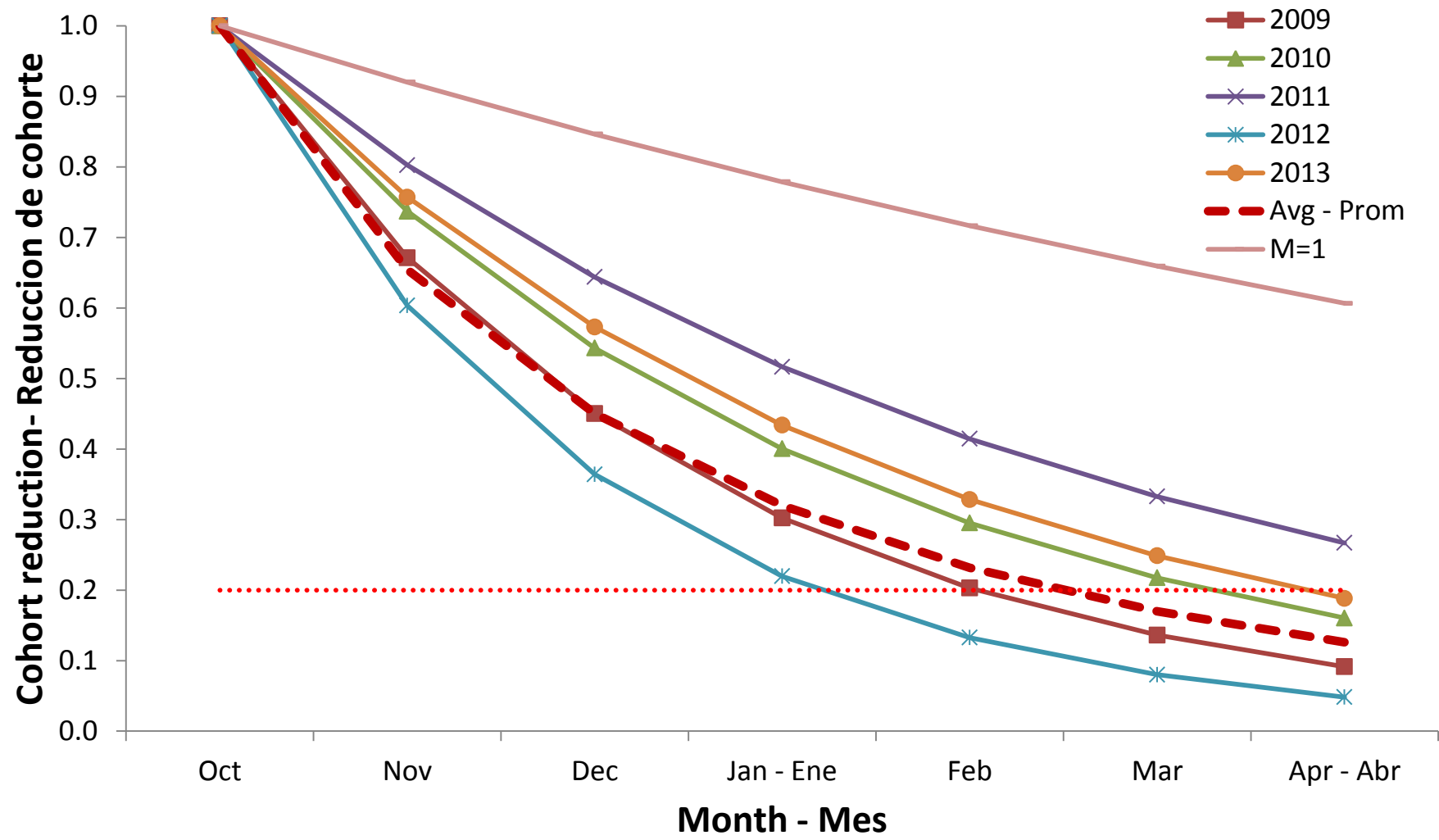


- Strong seasonality in CPUE
- Promising for potential derivation of reference points

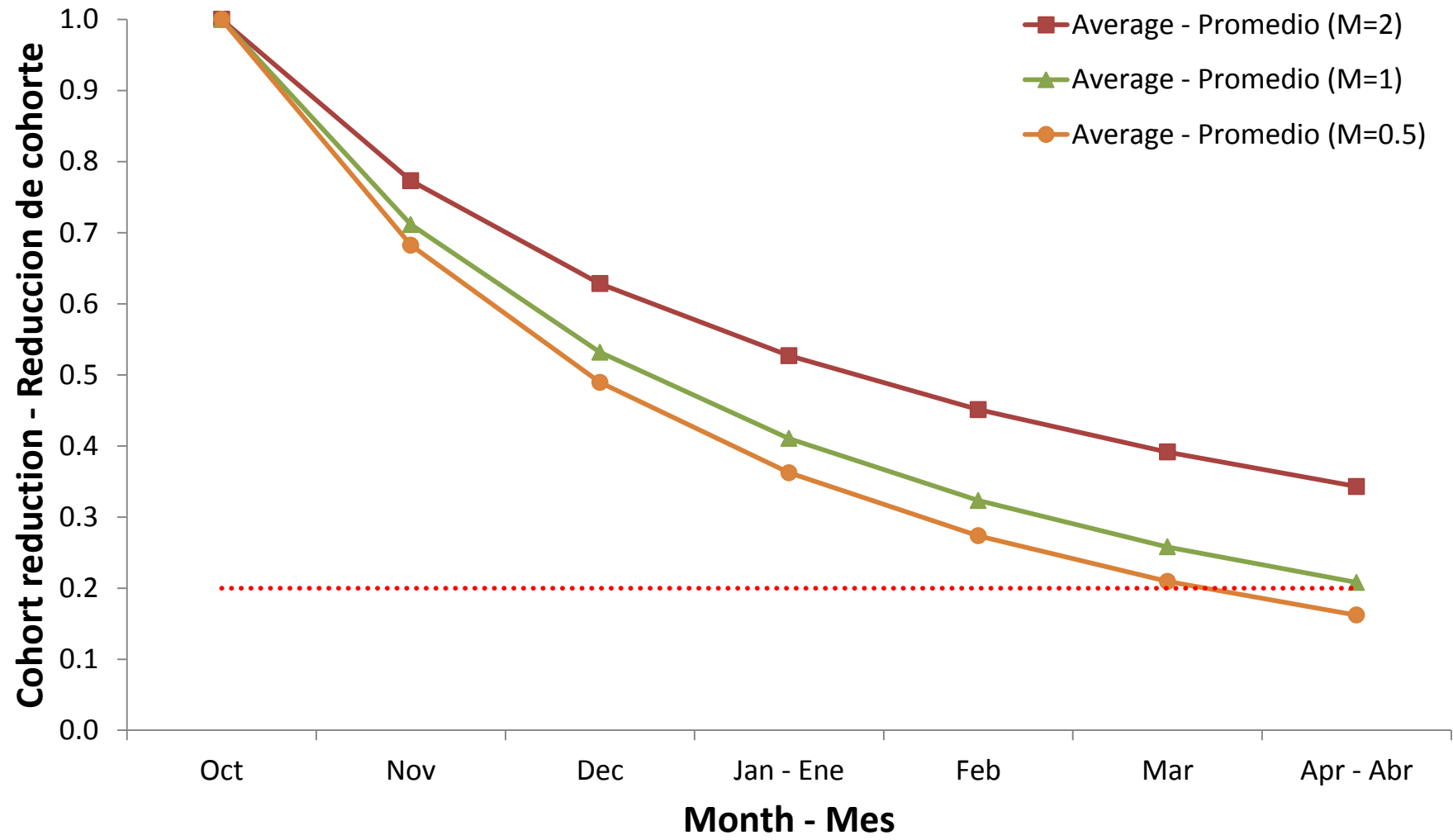




# Empirical reference points: CPUE



# Empirical reference points: CPUE relative to unfished



# Target and Limit reference points, Harvest Control Rules

- EPO Tropical tunas Target RPs on  $B_{MSY}$  and  $F_{MSY}$ , regular assessments.
- No explicit statement about MSY as objective in dorado national plans.
- S. EPO MSY estimates (2015 assessment)  $B_{MSY}/B_0 = 0.20$  : Update? Frequency?
- If YPR basis for Target RPs, better to use  $F_{0.1}$  given flat yield curve.
- Empirical RPs based on historical percentiles of relative CPUE monthly declines.
- Limit RPs for EPO Tropical tunas based on reduced recruitment ( $7.7\%B_0$ ).

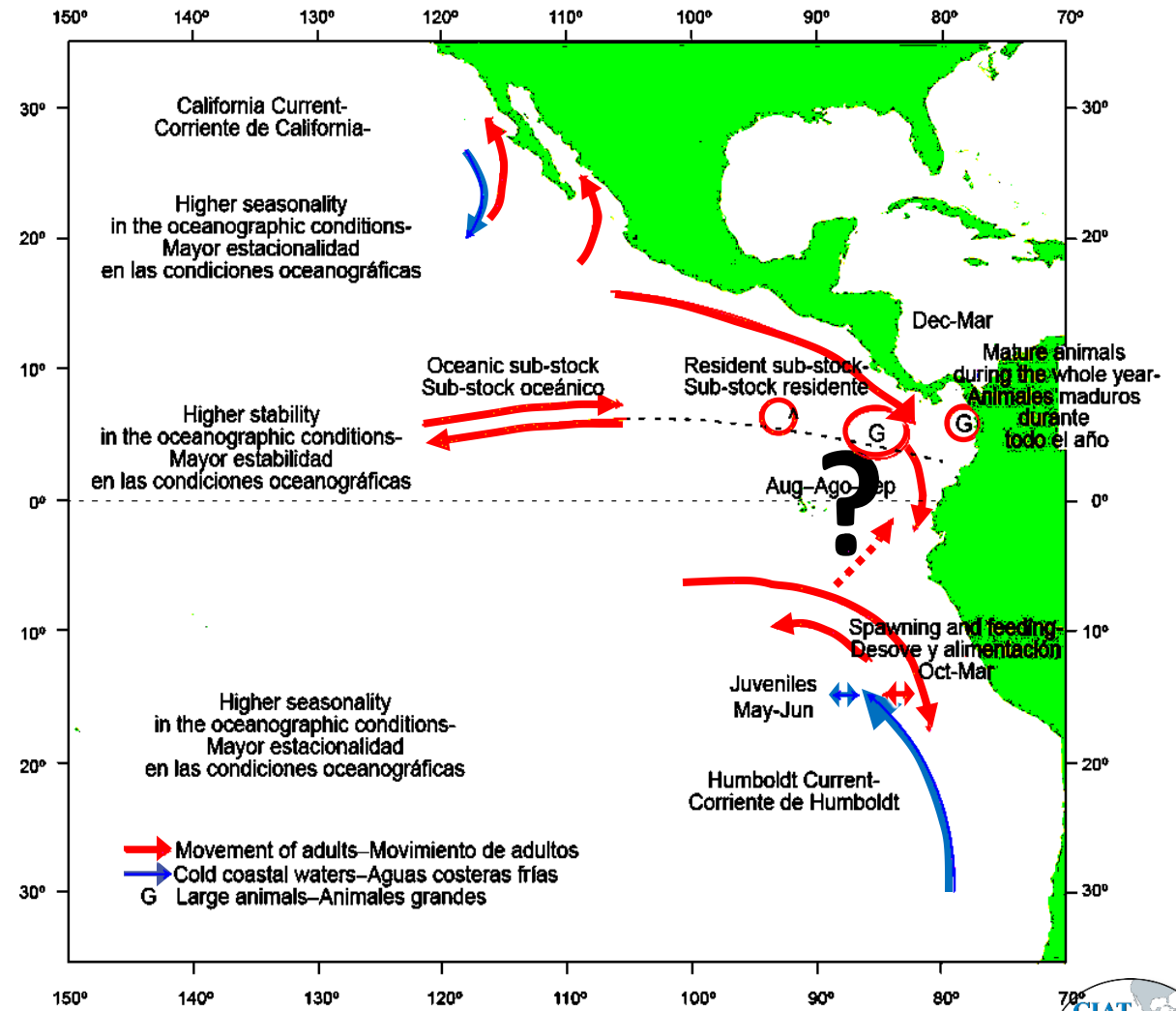




# Discussion

## Dorado stock structure in the EPO

- Conceptual model, but still unclear
- Connectivity South and North EPO?



# Discussion



## **Geographic scope, frequency of assessments**

- Exploratory assessment only for South EPO, using data through 2014
- Dorado almost an annual species, status and RPs would need frequent updates
- Alternatives (e.g. empirical approaches, size limits, closures)

## **Geographic scope of management**

- EPO tropical tunas managed regionally with reference points and HCRs (IATTC)
- Dorado managed nationally. Ongoing bilateral meetings (Ecuador and Peru) unclear whether they will include discussions on reference points and HCRs.

## **Data availability across time and space**

- Ecuador and Peru have enough data for integrated stock assessments
- Where data are limited, monthly CPUE approaches are feasible
- Need for better data streamlining given dorado fast dynamics

# Discussion

## Reference Points and HCRs vs. current and alternative management systems

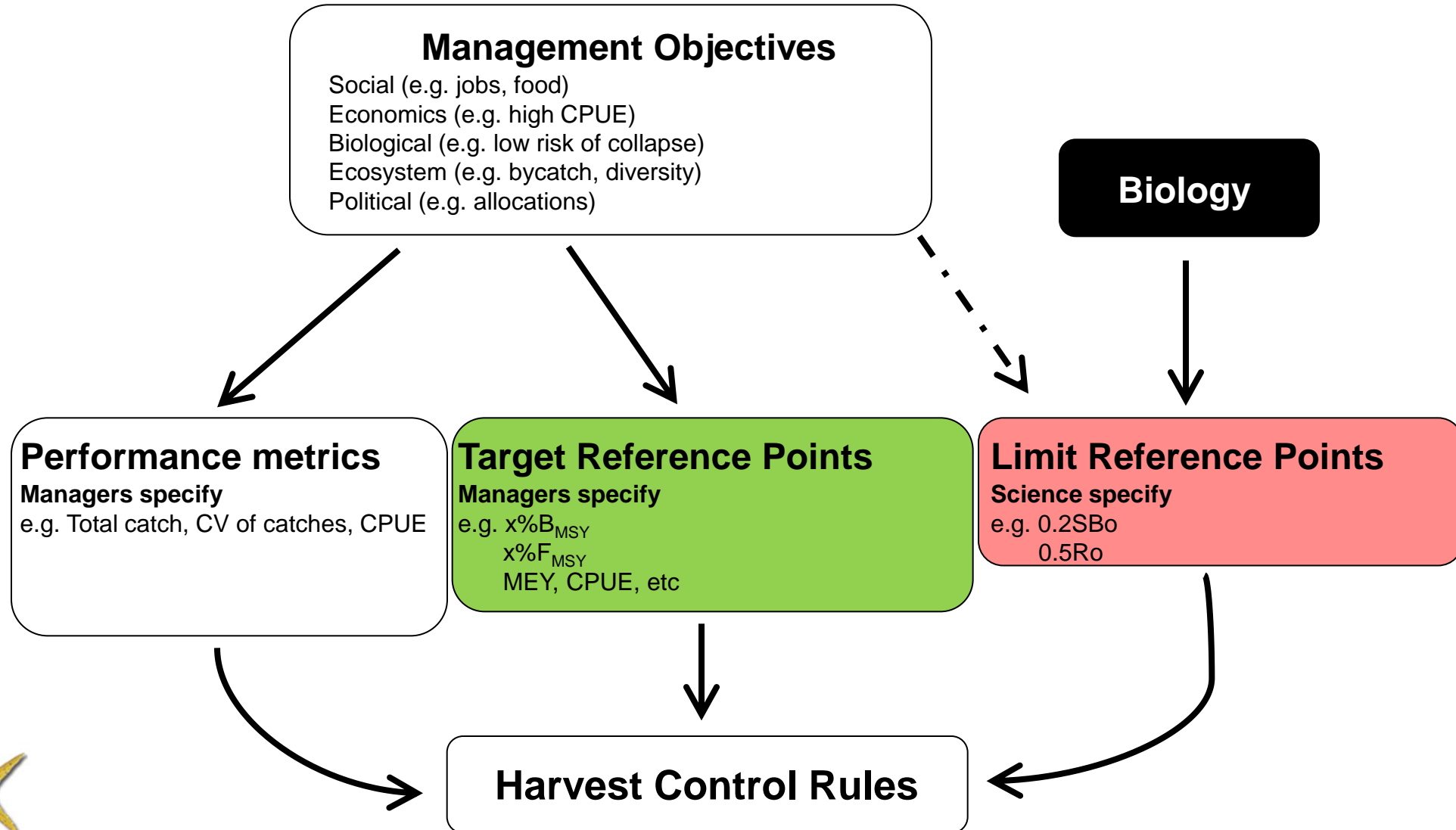
- Management measures for EPO dorado vary greatly (from none in some countries to commercial bans in others).
- Ecuador and Peru measures (minimum size limits and seasonal closures) are consistent with YPR, performed well vs. simulated alternatives while maintaining the stock slightly above levels estimated to produce MSY.
- Pros, cons and feasibility of adopting reference points and HCRs, in terms of both the increasing need for regular analyses (assessments or indicators) and of implementing management changes, are still not clear.





# Discussion

## Reference Points and HCR as part of a Harvest Strategy

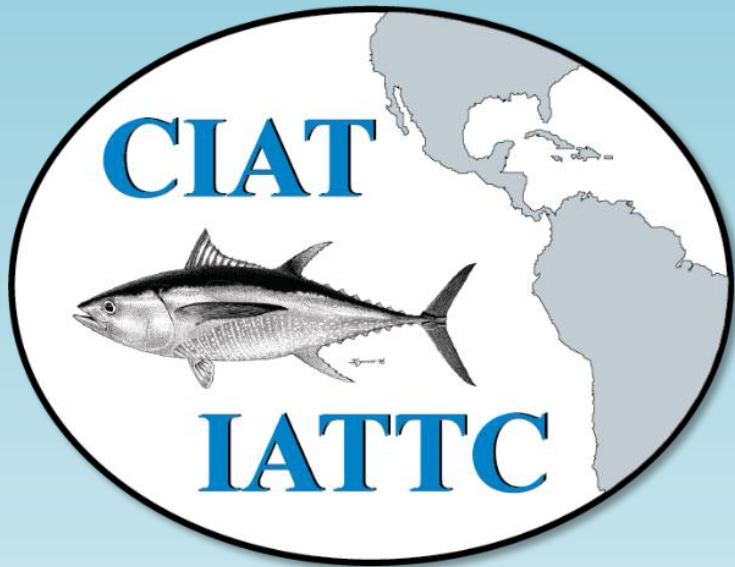


# Discussion

## Reference Points, HCRs and alternative components of a Harvest Strategy

- **HARVEST STRATEGY:** Combination of monitoring, stock status evaluation, harvest control rule (with or without RPs) and management actions designed to achieve **fisheries objectives**.
- The emphasis of harvest strategy elements varies by fishery, their historical context (e.g. developing, stable, rebuilding) and the level of monitoring, available analyses and management systems. **Overemphasis on reference points can be detrimental** to other aspects a developing harvest strategy.
- RPs and HCRs cannot be properly evaluated without specific management objectives, data collection, analyses, treatment of uncertainty and other components of a harvest strategy.
- Development and success of HCRs and RPs benefit from the **involvement of all stakeholders** in the management planning stage.





¿Preguntas – Questions?