

# Stock Assessment of Dorado (*Coryphaena hippurus*) in the South Eastern Pacific Ocean



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... and many collaborators

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7<sup>th</sup> Meeting of the IATTC Scientific Advisory Meeting  
La Jolla, California (USA), 9-15 May 2016



# Outline

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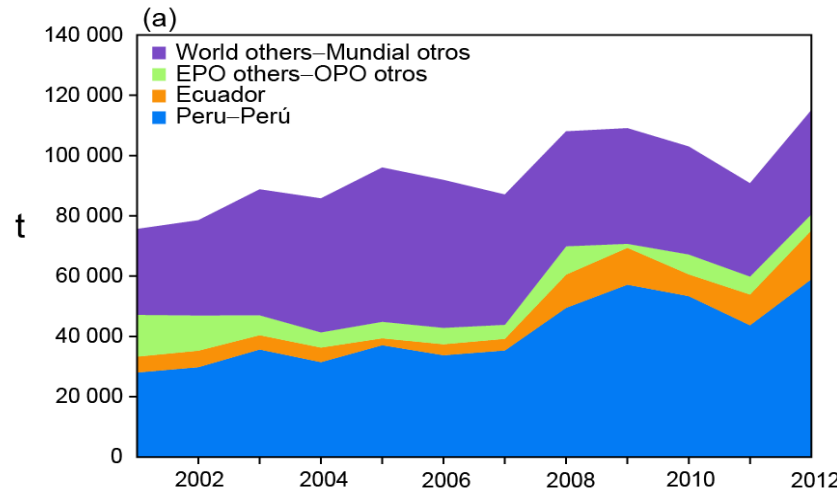
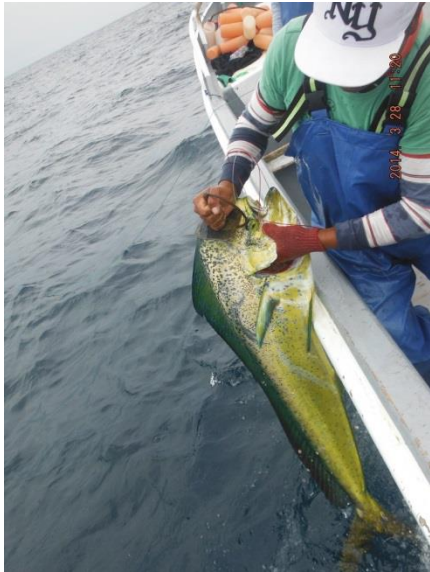


- Background
  - Dorado exploitation in the EPO
  - IATTC and dorado
- Exploratory stock assessment (base case model)
  - Fishery data
  - Model assumptions (biological and fishery process)
  - Model diagnostics (model fits)
  - Results (recruitment, biomass, fishing mortality)
  - Potential management tools (see Doc SAC-07-06a(ii) for exploratory management strategy evaluation MSE for dorado)
- Sensitivity analyses
- Summary conclusions



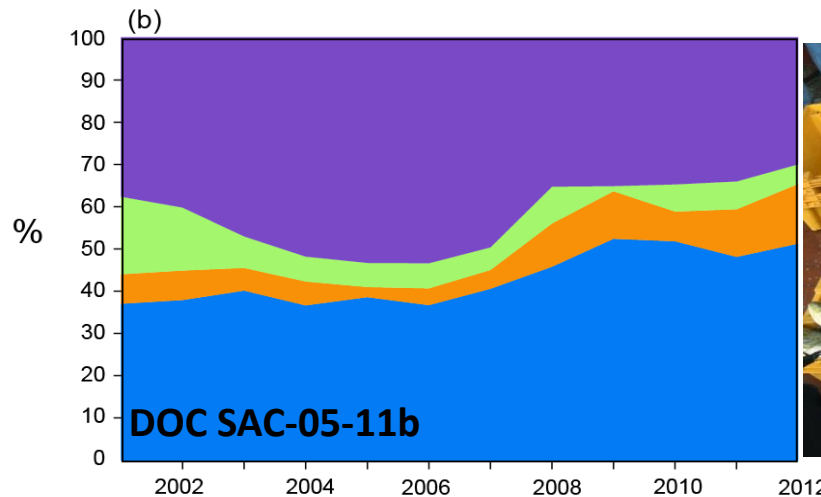
# Important source of livelihood

- Exploited by artisanal fisheries of EPO coastal States



← 71,000 MT on average (2008-2012)

47-70% of world's catch



Fuentes: FAO FishStat  
SRP-Ecuador, Anuarios Estadísticos de Pesca, Perú

# Growing interest in ecolabeling



- High value of dorado exports
- Certification require stock assessments (reference points and harvest control rules)
- Dorado is thought to be highly resilient to overfishing due to its high productivity
- But there are no stock assessments for dorado in the EPO



# 1<sup>st</sup> IATTC Meeting on Dorado



- Some coastal States requested collaborative research and guidance from staff on dorado stock assessment research
- Established collaborative research forum in the region
- Identified a large amount of biological and fishery data



# 2<sup>nd</sup> IATTC Meeting on Dorado



- Progress on two important questions
  - Stock structure assumptions
  - Which methodologies and indicators of stock status to use for dorado

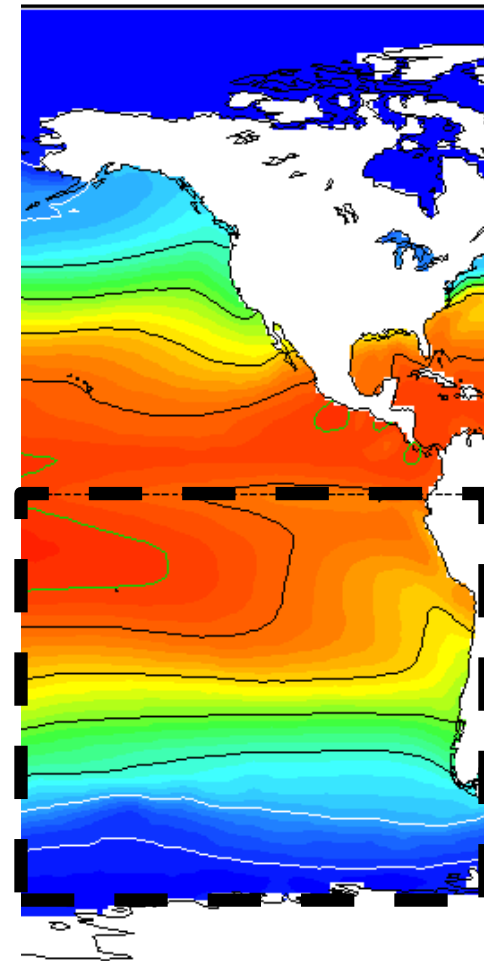


# Stock structure hypothesis

SST Climate: 01JAN



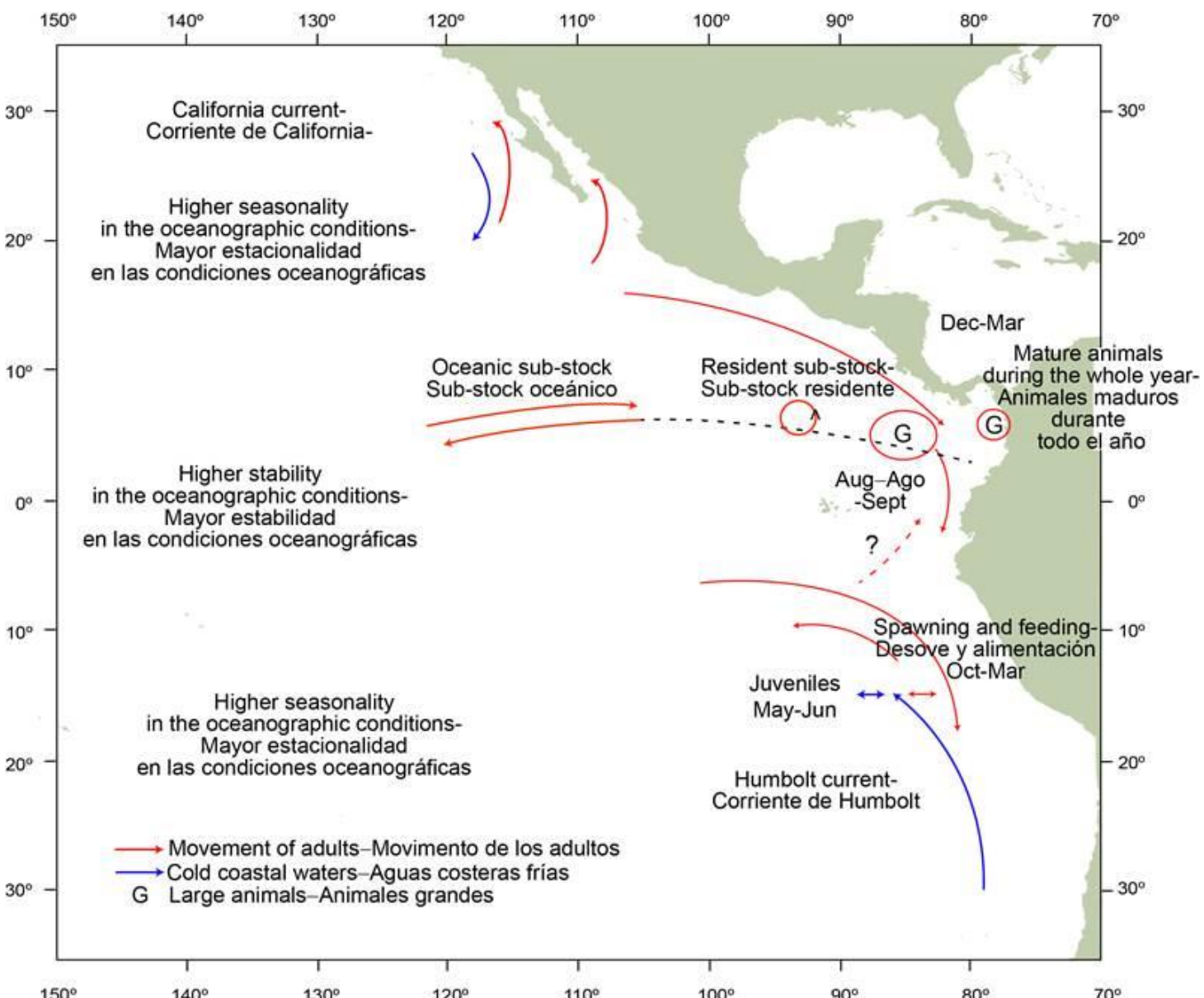
- Results from genetic studies are not conclusive
- Most data comes from Peruvian and Ecuadorian artisanal fisheries
- About 90% of catches are taken by Peruvian and Ecuadorian fisheries
- Exploratory Stock assessment for South EPO (*Stock Synthesis*)



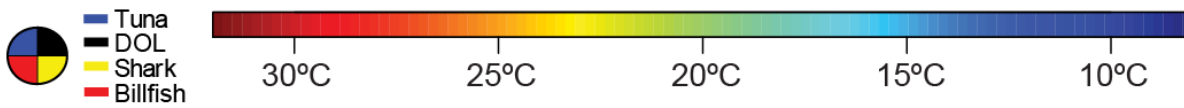
160W 120W 80W 40W



# Conceptual life-history model



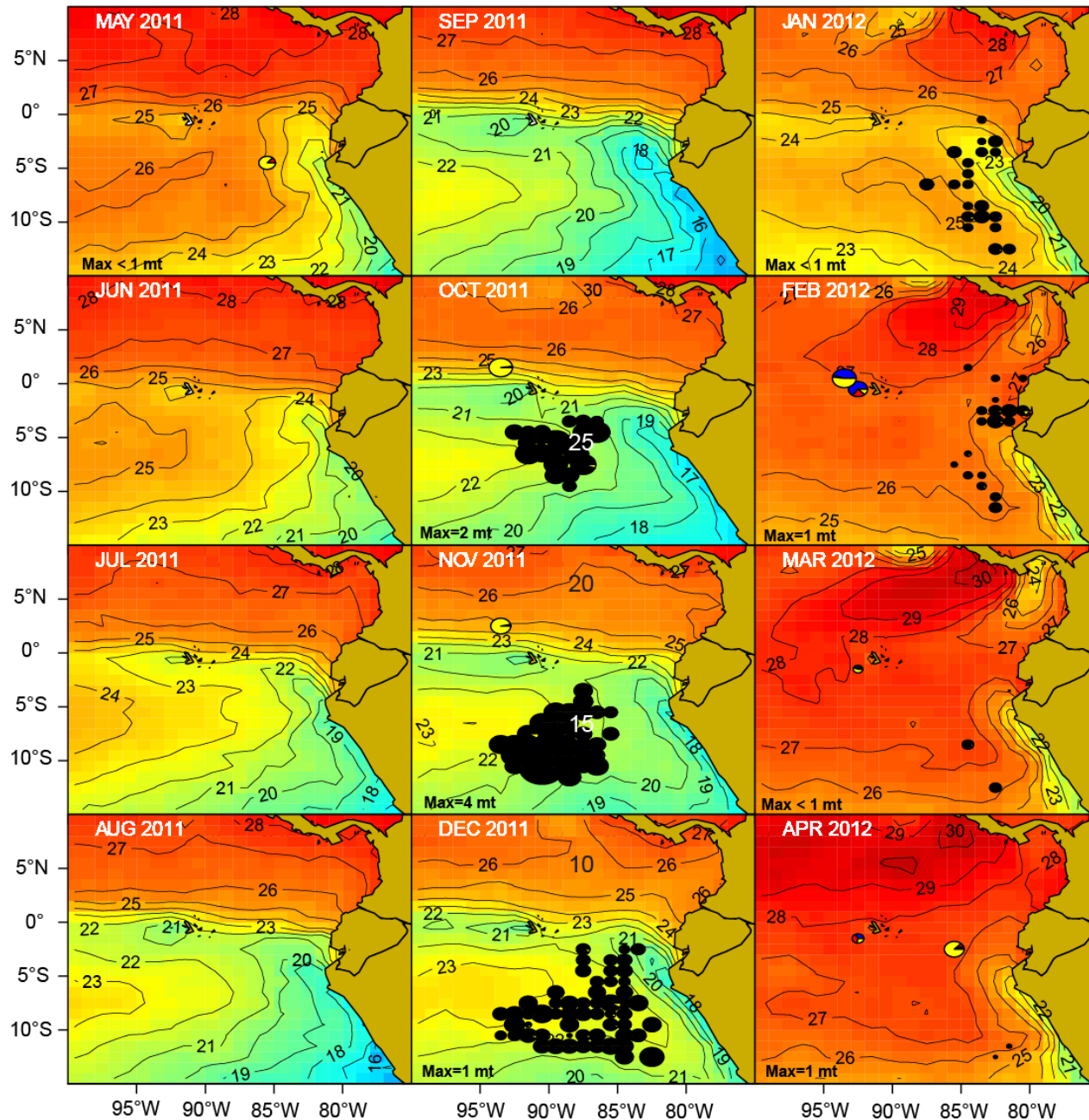




## Assumptions

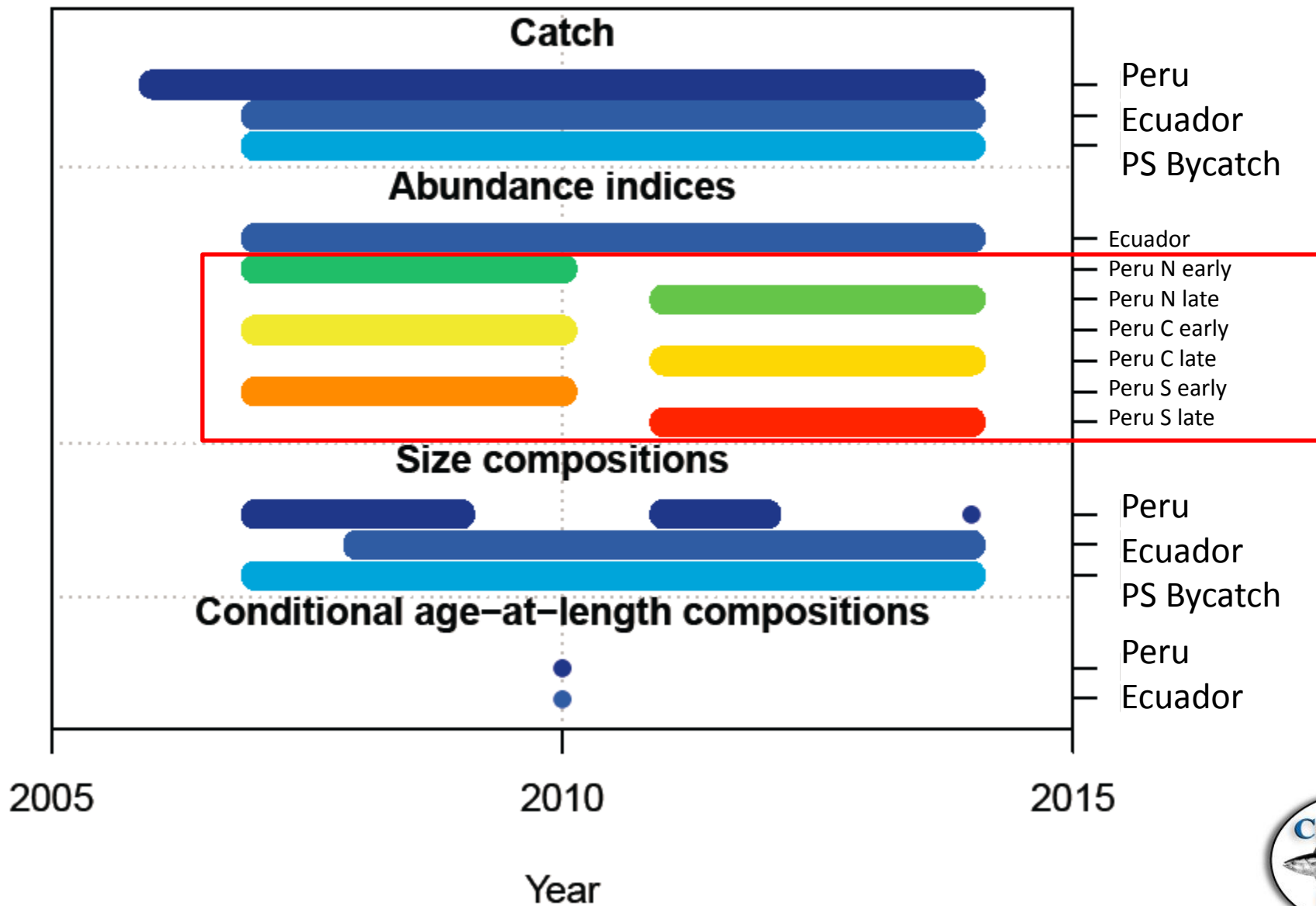


# Spatio-temporal dynamics



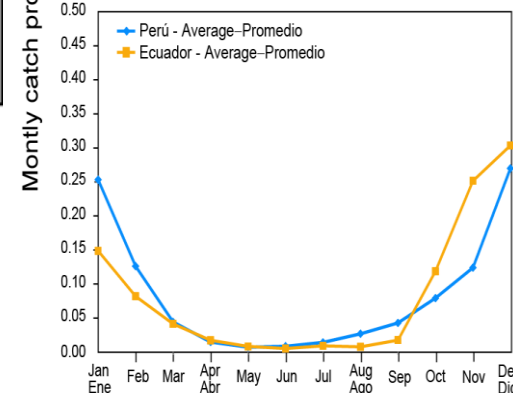
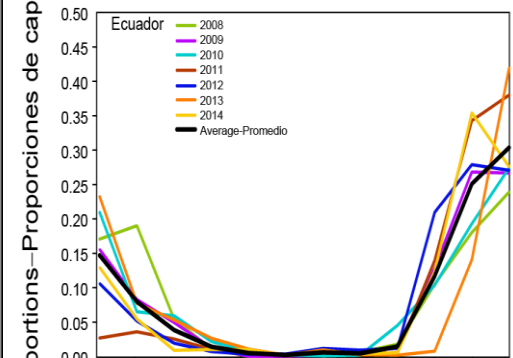
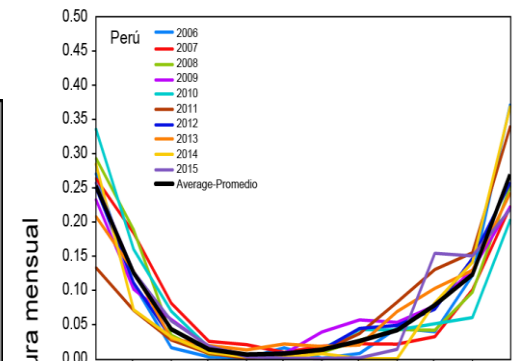
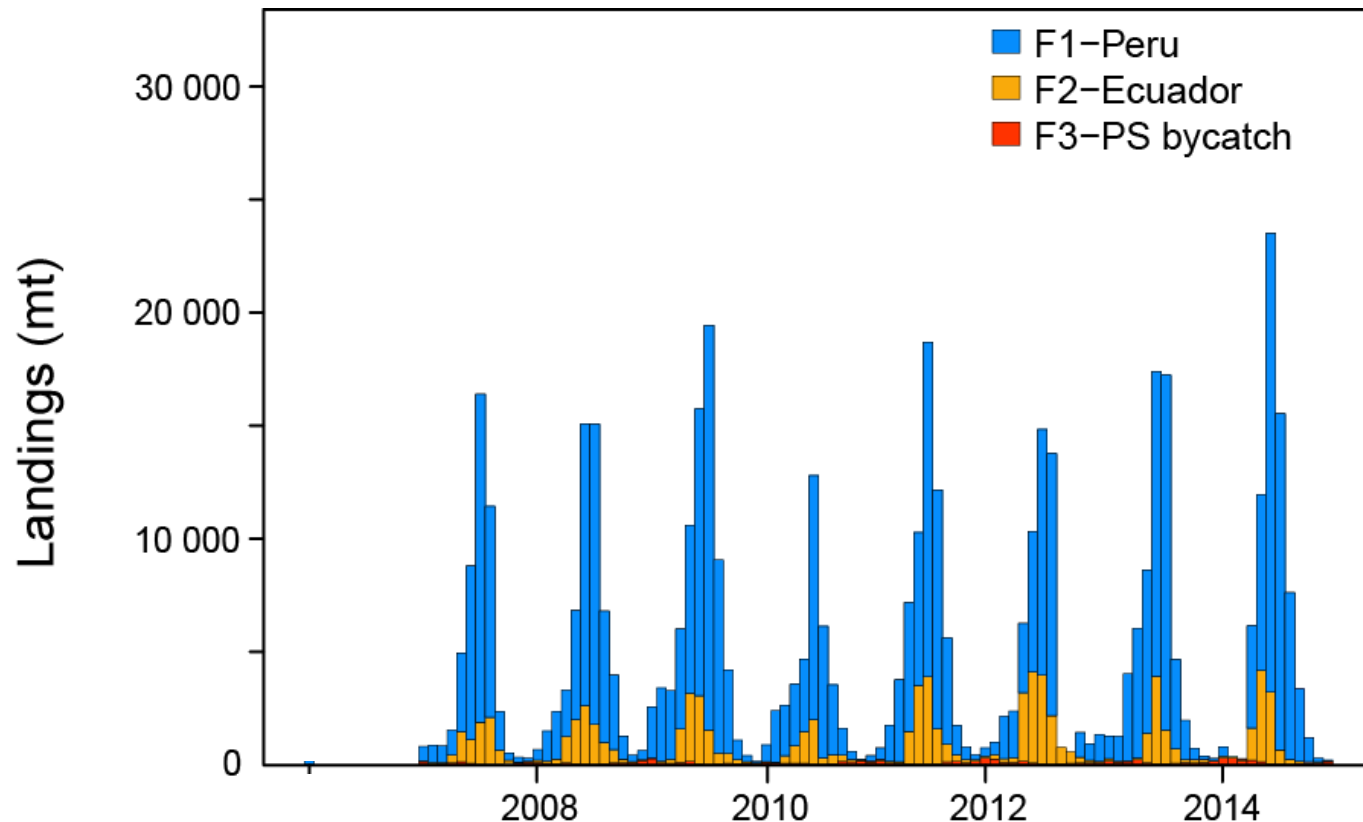
# Data sources in model

Data sources

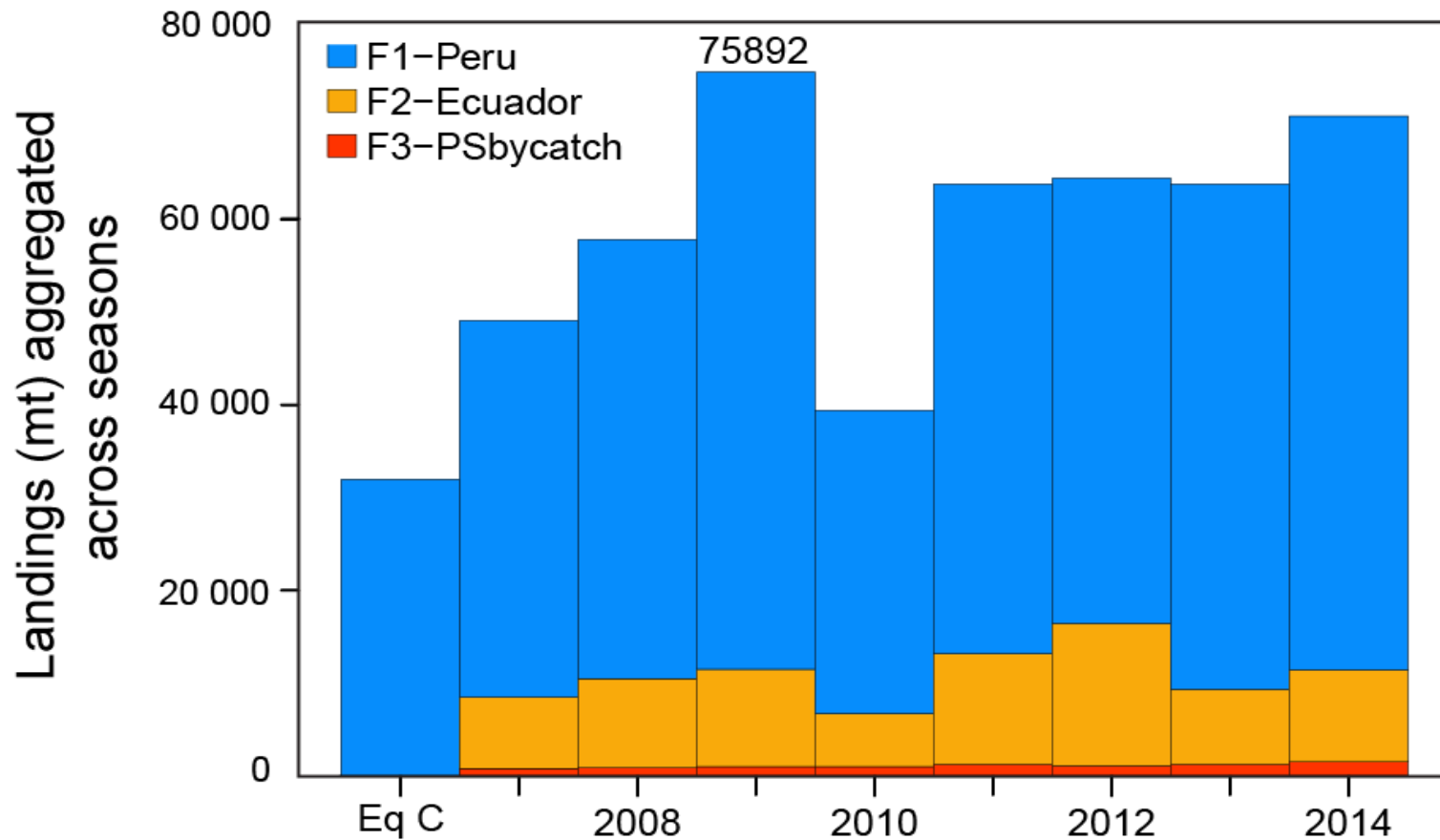


# Dorado monthly catches

Data sources

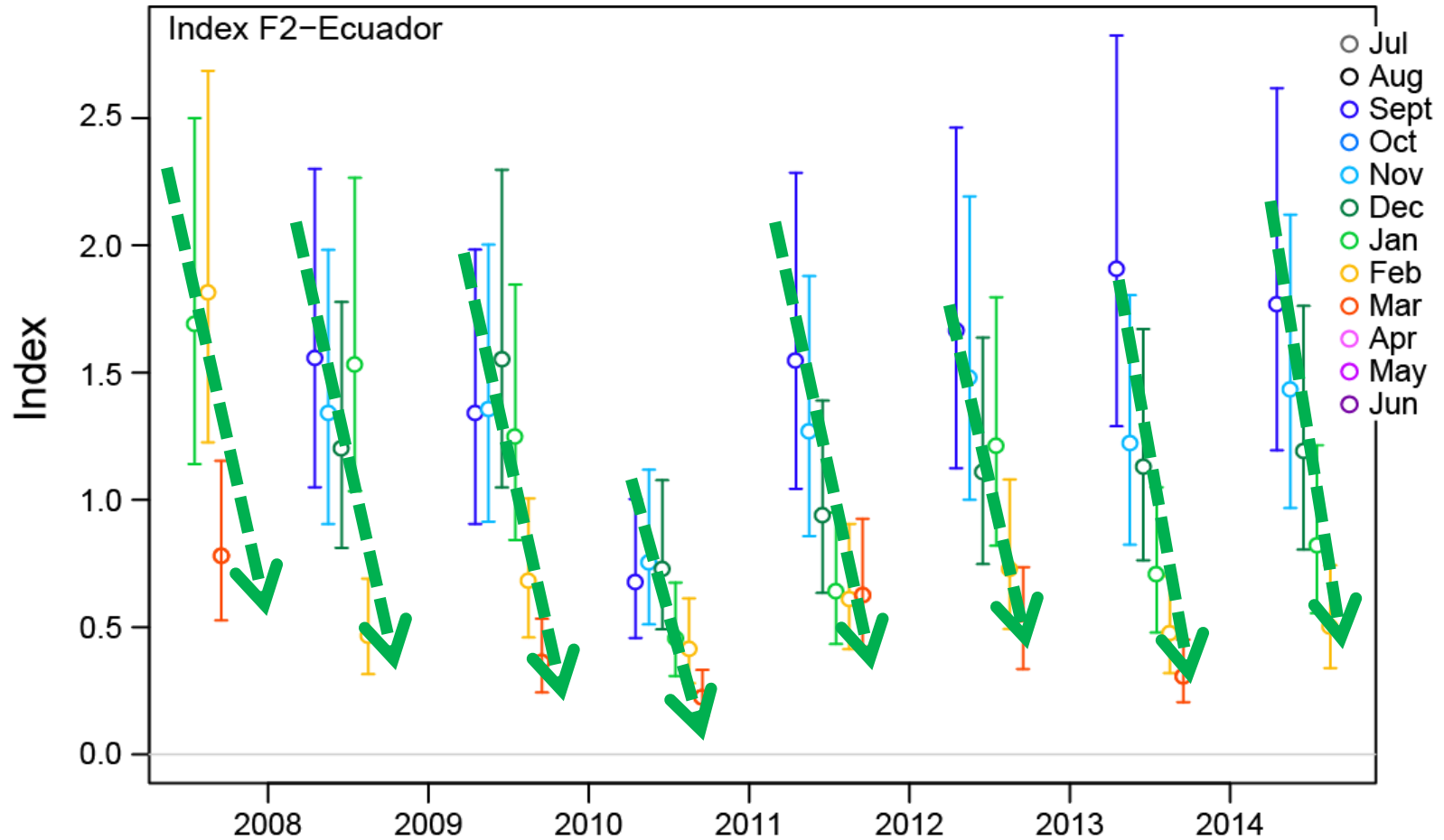


# Dorado annual catches



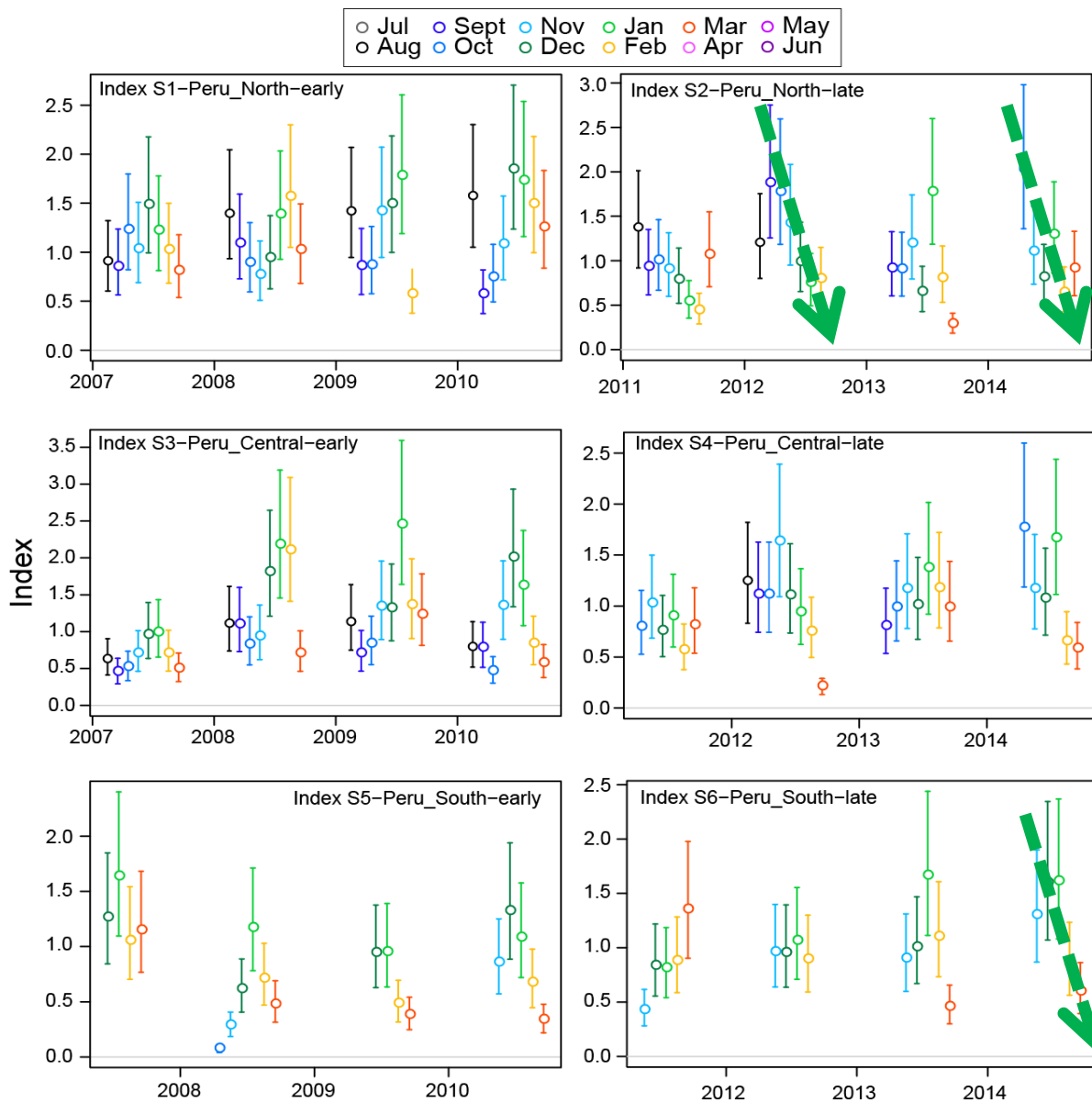
# Standardized CPUE - Ecuador

Data sources

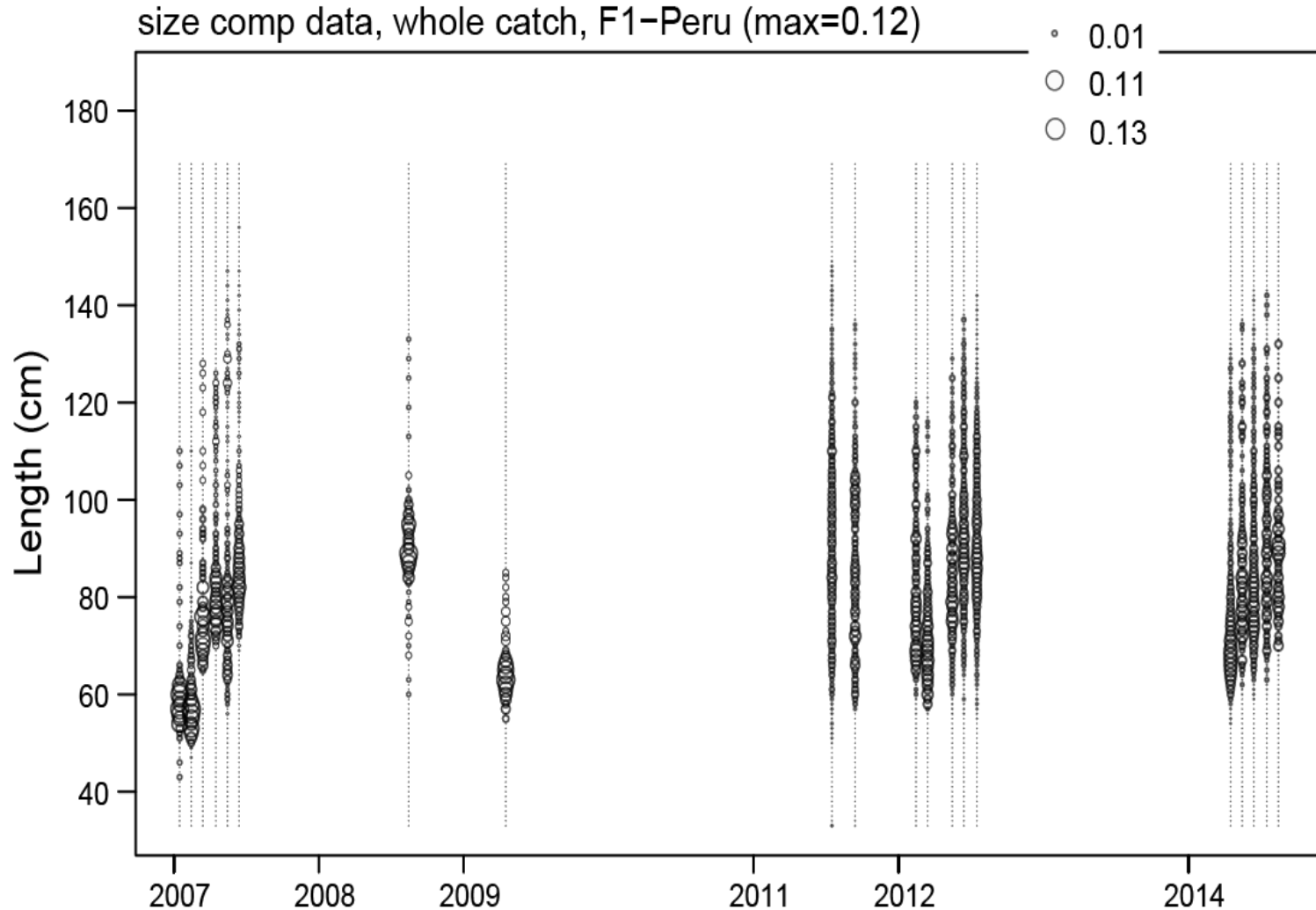




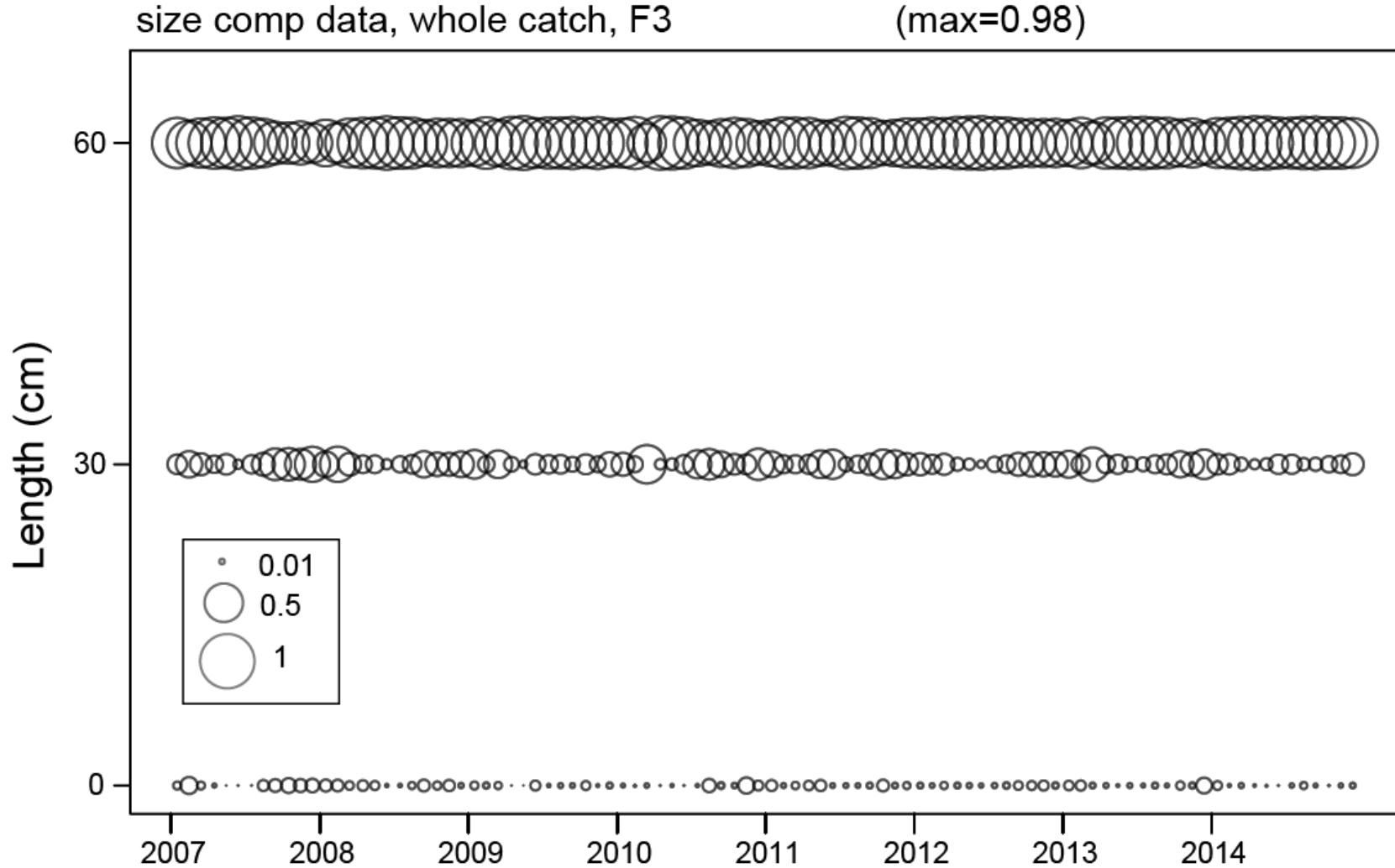
# Standardized CPUE - Peru



# Size composition data - Peru

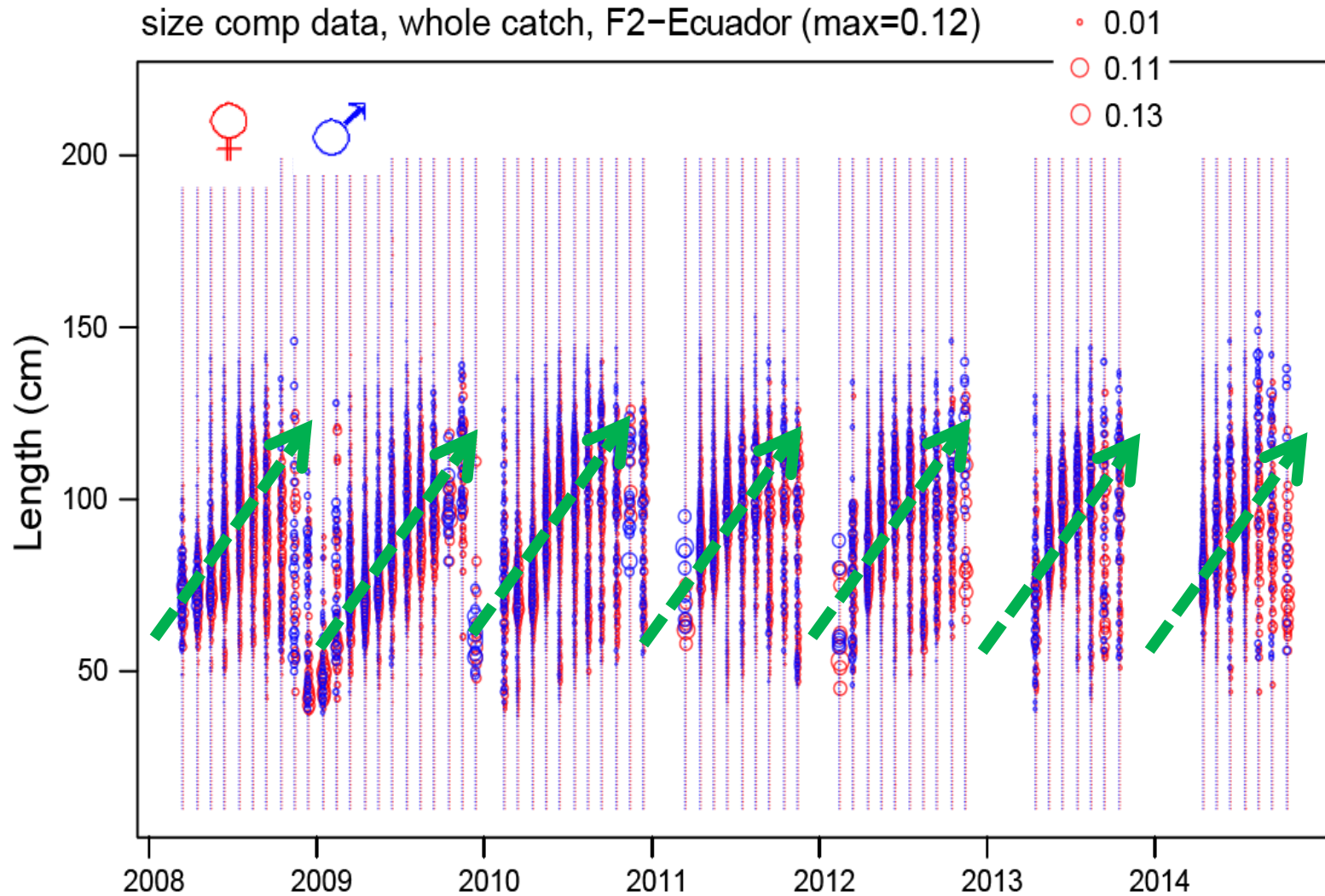


# Size composition data - IATTC



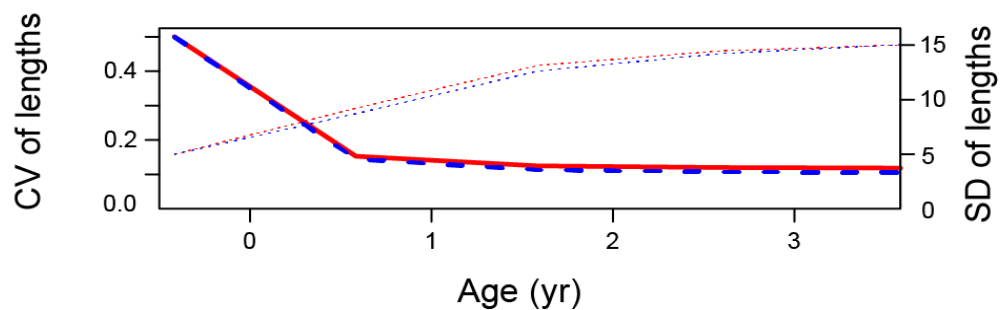
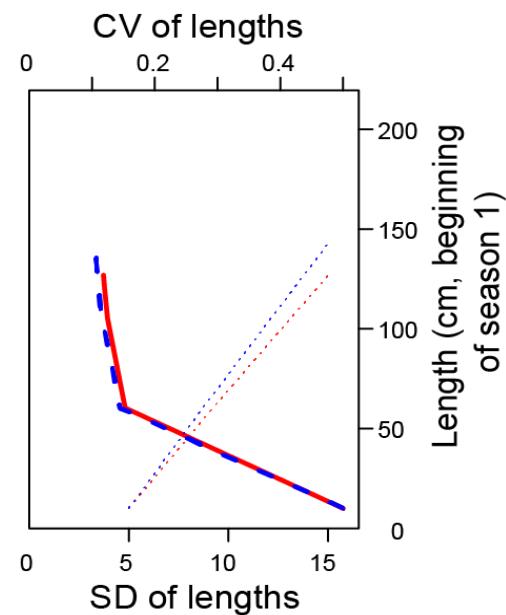
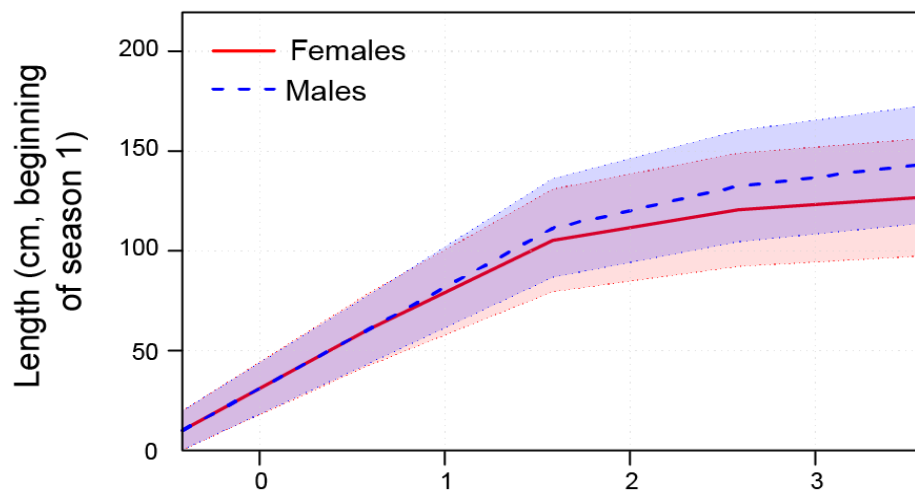


# Size composition data - Ecuador



# Age and growth

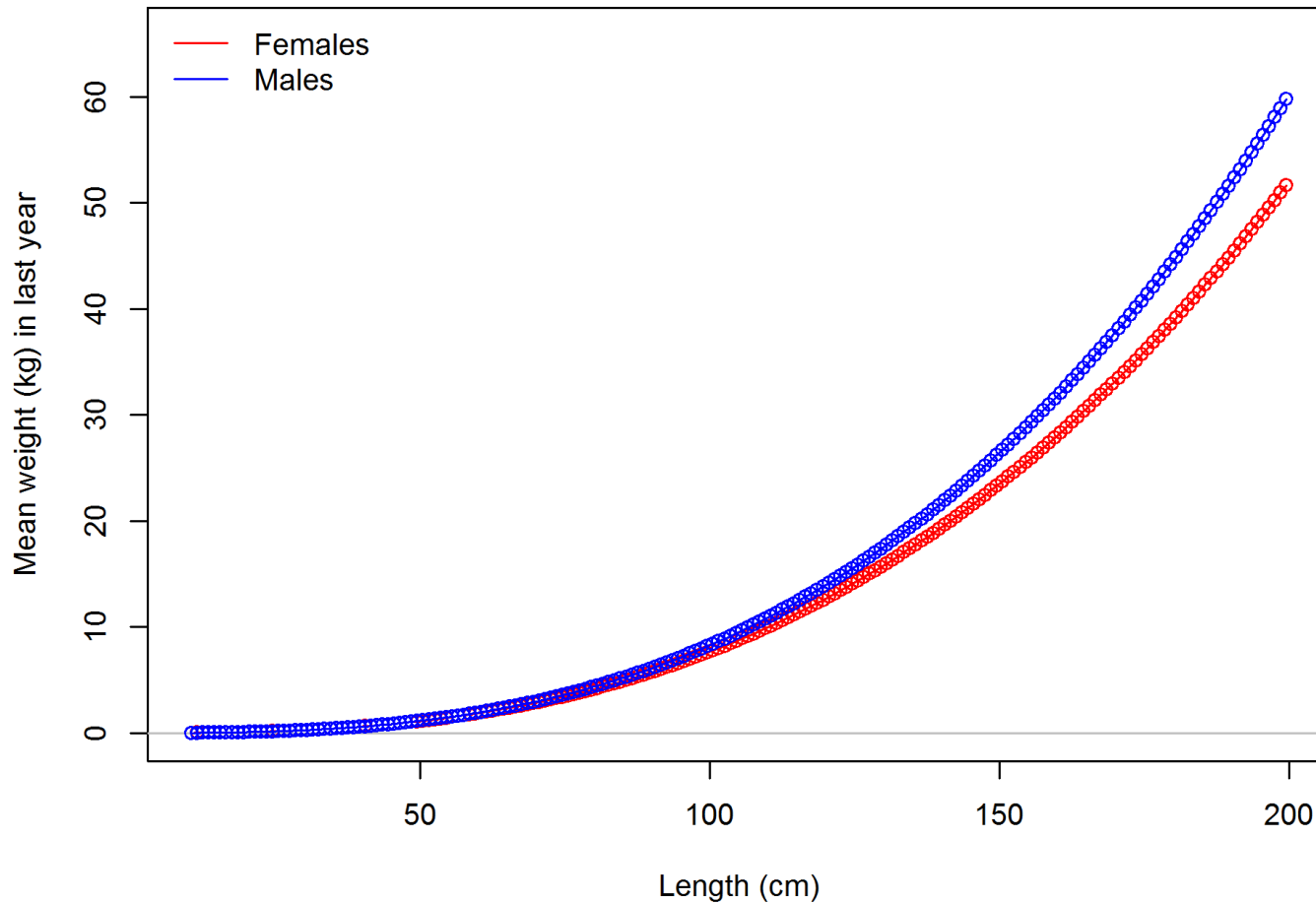
Model assumptions



# Biological processes

## Length-weight relationship

Model assumptions



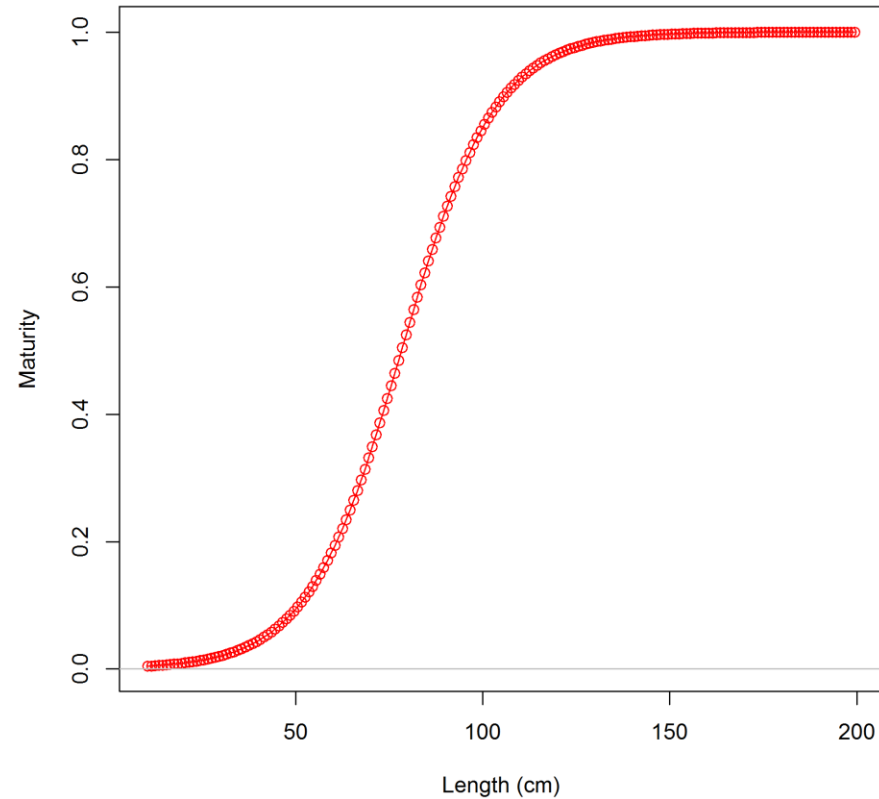
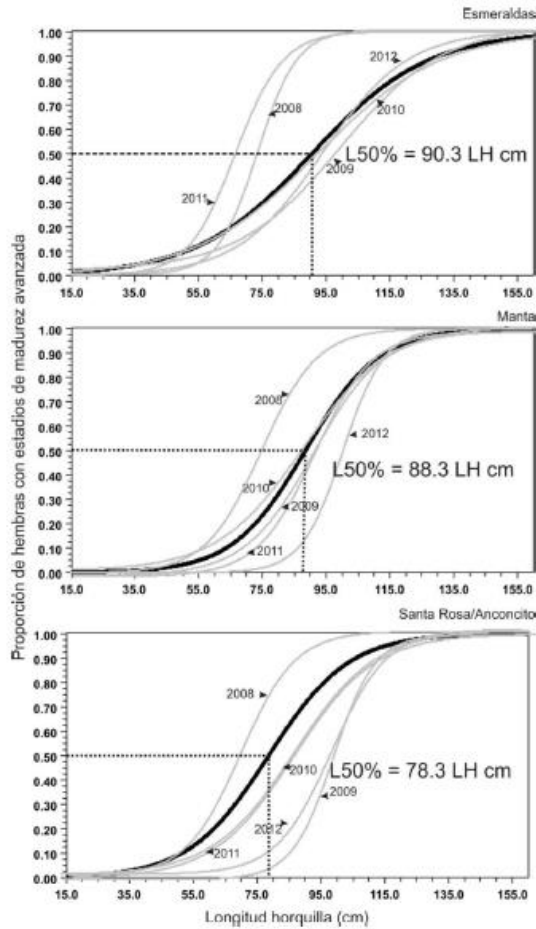
(Zúñiga-Flores (2014); Santa Rosa Anconcito)



# Biological processes

## Maturity ogive

Model assumptions



(Zúñiga-Flores (2014); Santa Rosa Anconcito)

Figura 25. Talla de primera madurez poblacional ( $L_{50}$ ) de las hembras por caleta y año, durante el periodo del 2008 al 2012.



# Biological processes

## Natural mortality ( $M$ )

Model assumptions



	Edad maxima o		Estimativa de M		Fuente de los datos de edad
	machos	hembras	machos	hembras	
Mexico Baja California Sur	2.51	1.68	1.7	2.5	Zúñiga (2009)
Ecuador Manta	3.5	3	1.2	1.4	Martinez-Ortiz & Zúñiga-Flores (2012)
Ecuador Esmeralda	3	3	1.4	1.4	Martinez-Ortiz & Zúñiga-Flores (2012)
Ecuador Santa Rosa	3	2.5	1.4	1.7	Martinez-Ortiz & Zúñiga-Flores (2012)
Peru	2.5	2.7	1.7	1.6	Goicochea (2012)

- Between  $0.43 \text{ yr}^{-1}$  (Zuniga, 2014) and  $2.5 \text{ yr}^{-1}$  (Hoening method, data from Zuniga, 2009)
- Estimates vary among sexes
- Base case model assumes  $M = 1 \text{ yr}^{-1}$

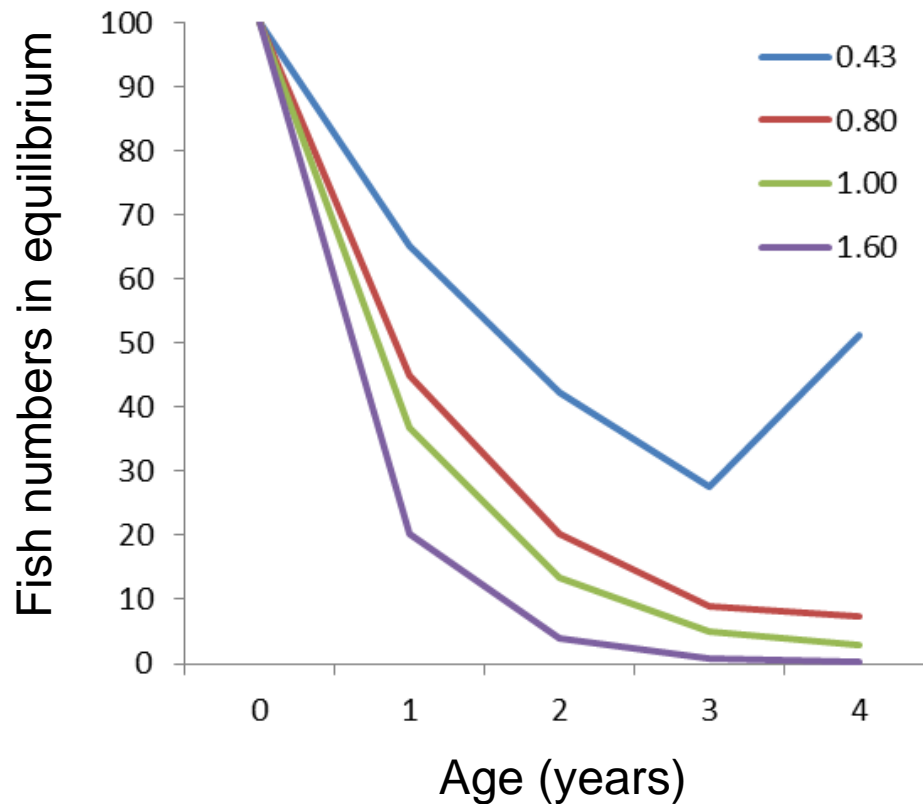
# Biological processes

## Natural mortality ( $M$ )

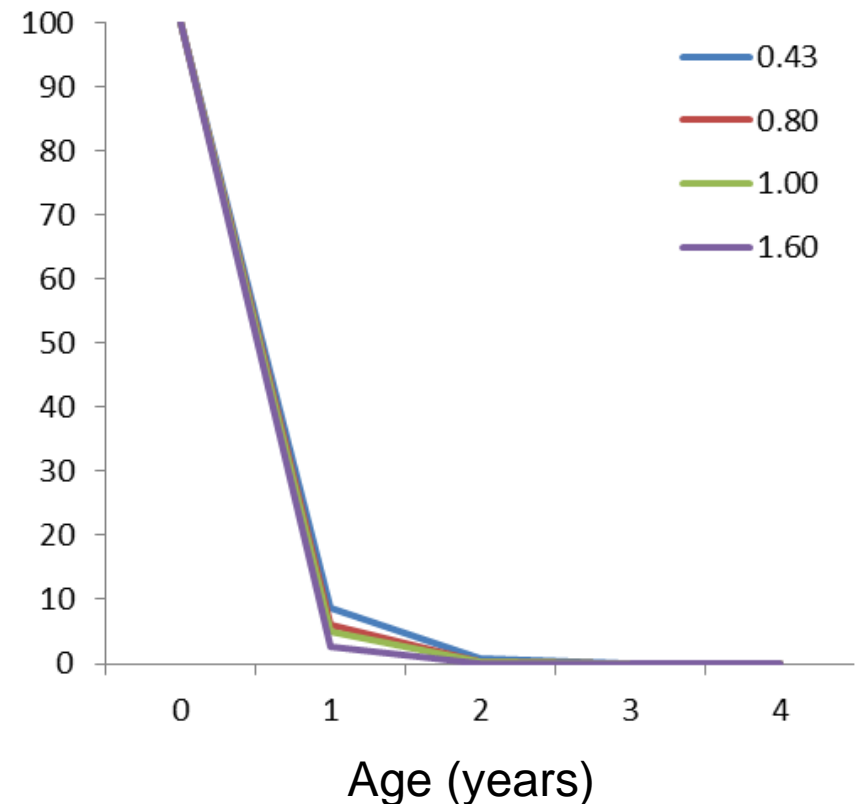
Model assumptions



$F = 0 \text{ yr}^{-1}$  (sin pesca)



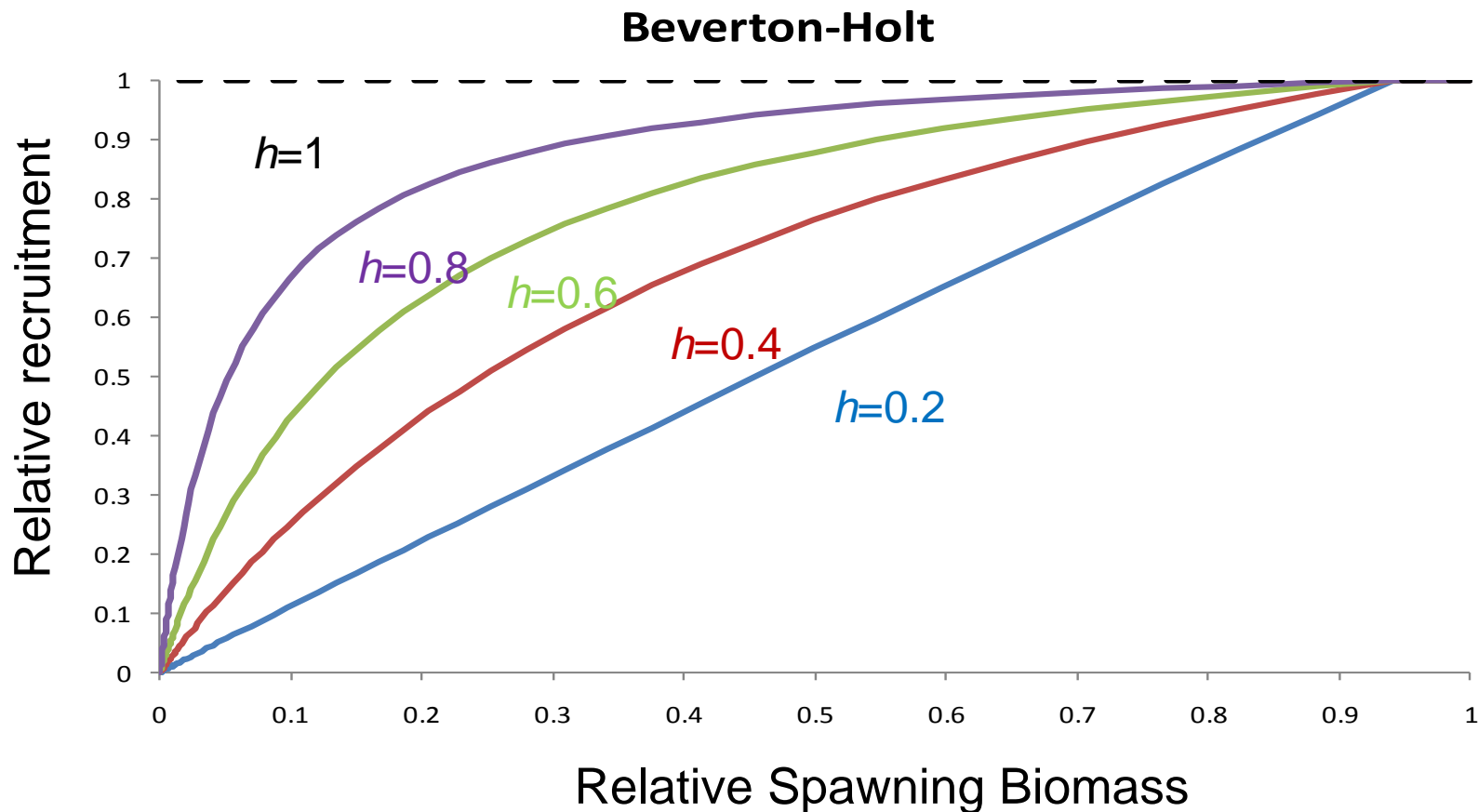
$F = 2 \text{ yr}^{-1}$



# Biological processes

## Stock-recruitment relationship

Model assumptions



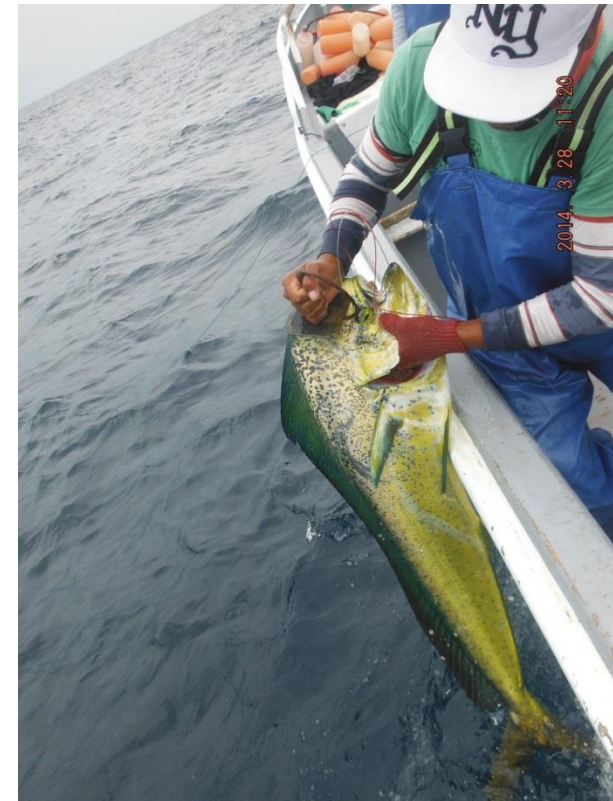
Base case assumes  $h=1$



# Fishery definitions



- 3 fisheries in model
  - F1 - Peru
  - F2 - Ecuador
  - F3 – Bycatch from tuna purse seine fisheries

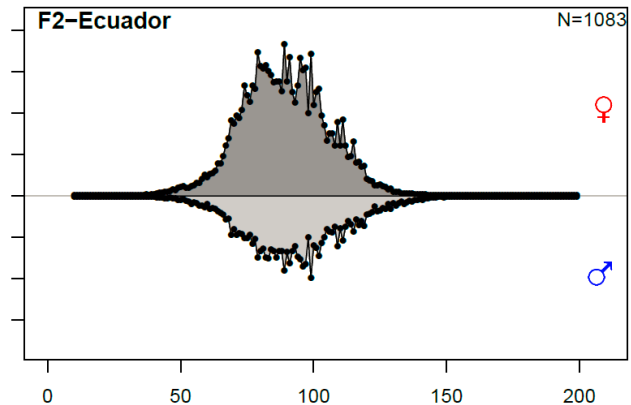




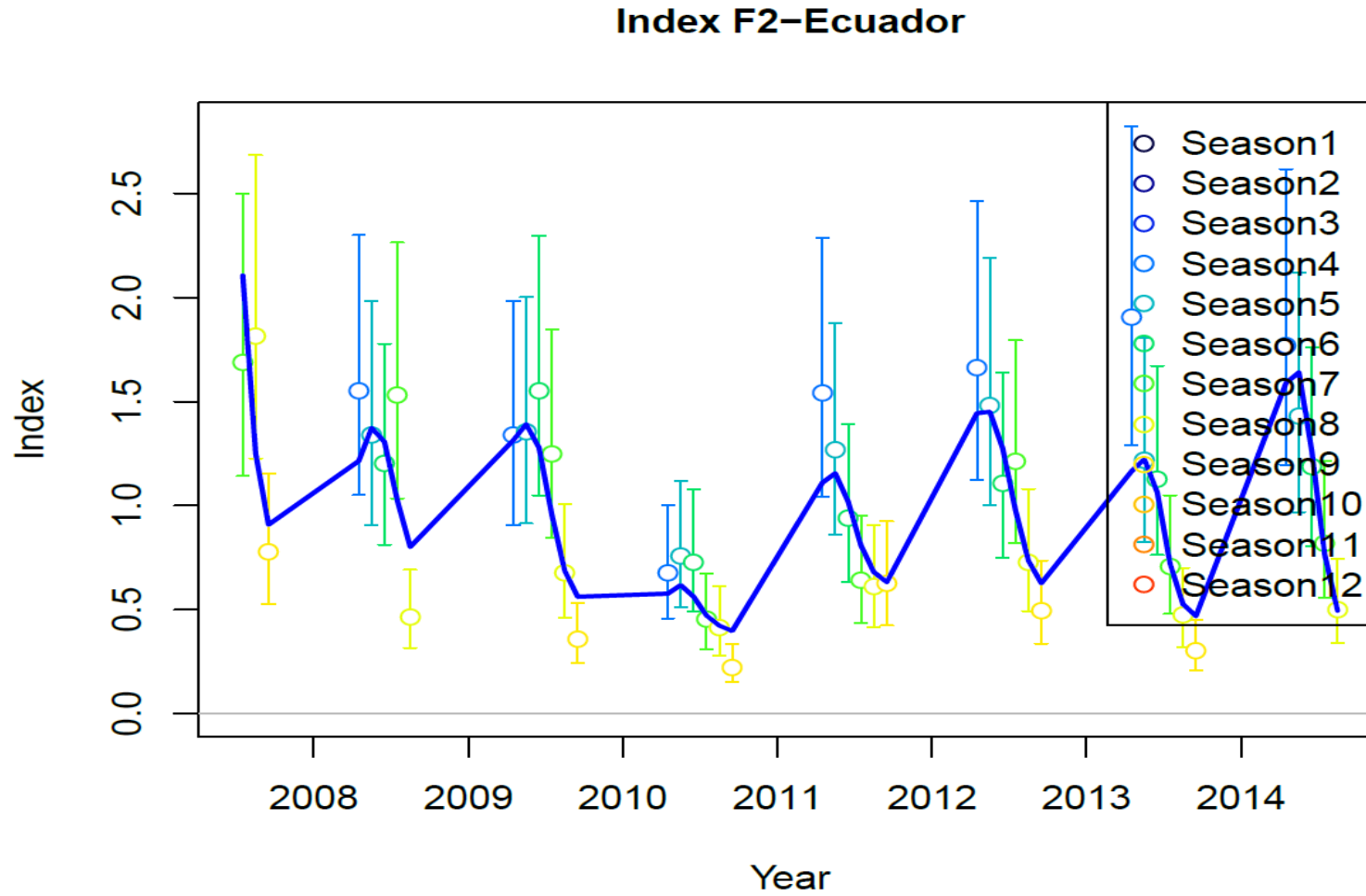
# Base case model



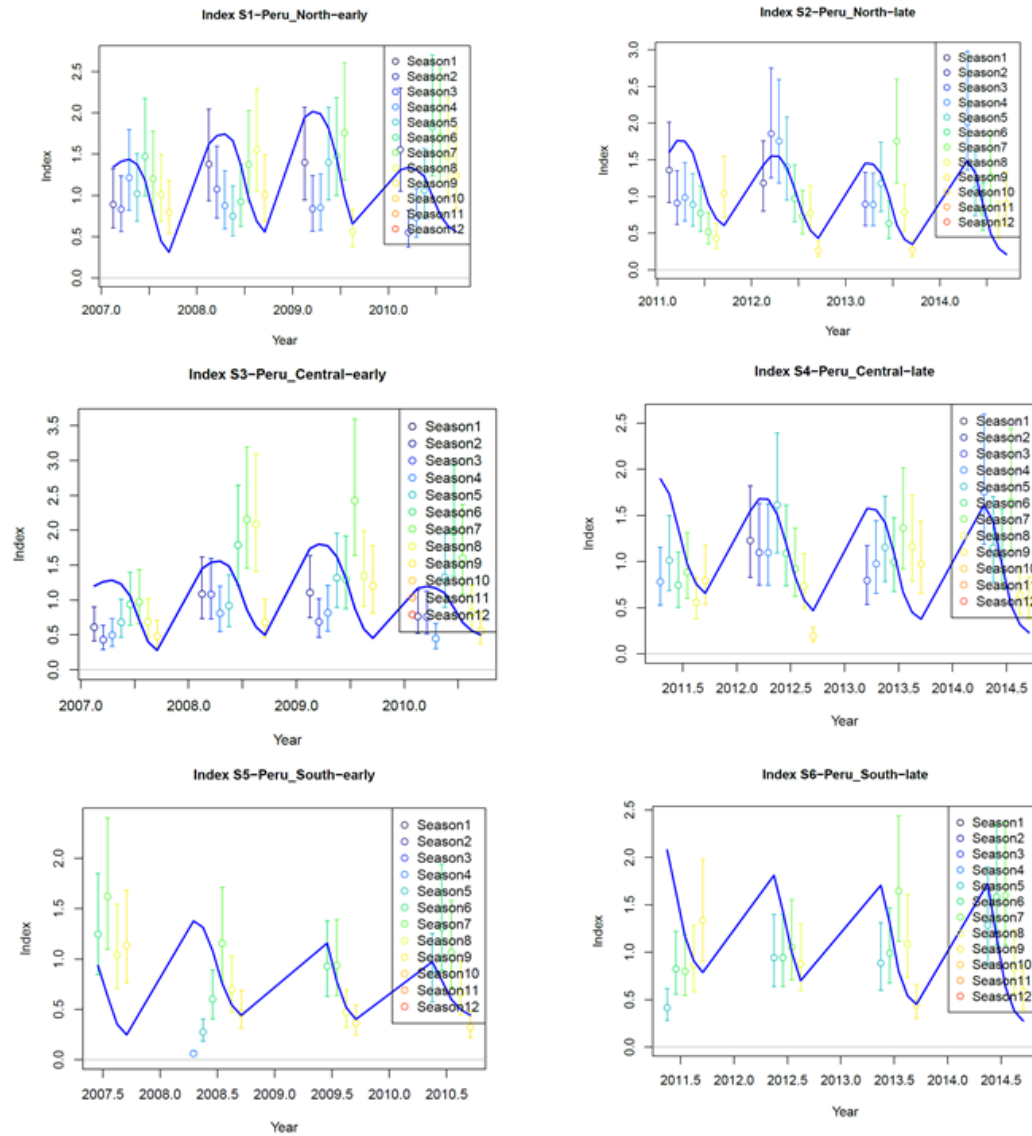
- Monthly time step
- Steepness of S-R relationship = 1
- Index of abundance: monthly CPUE Ecuador (CV=0.2)
- Catchability: time-varying (one  $Q$  parameter for each year)
- Selectivity for Peru and Ecuador
  - Asymptotic selectivity for females
  - Dome-shape selectivity for males
- Weighting of data sources
  - Down-weighted size composition data for all fisheries
  - Follow the “Francis approach”



# Model fit to CPUE data from Ecuador



# “Model fit” to CPUE data from Peru

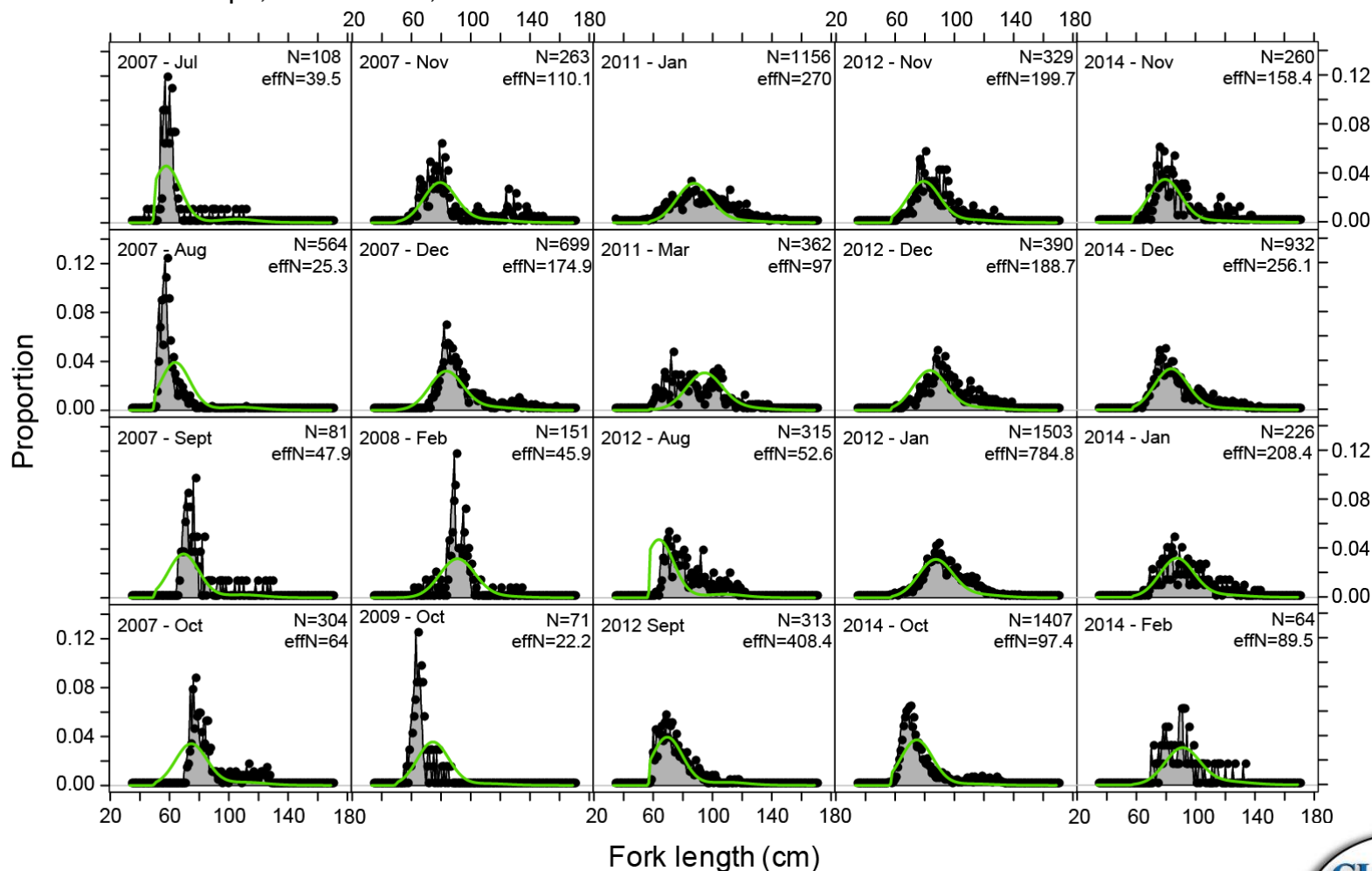


# Model fit to length composition data

Results



size comps, whole catch, F1-Peru



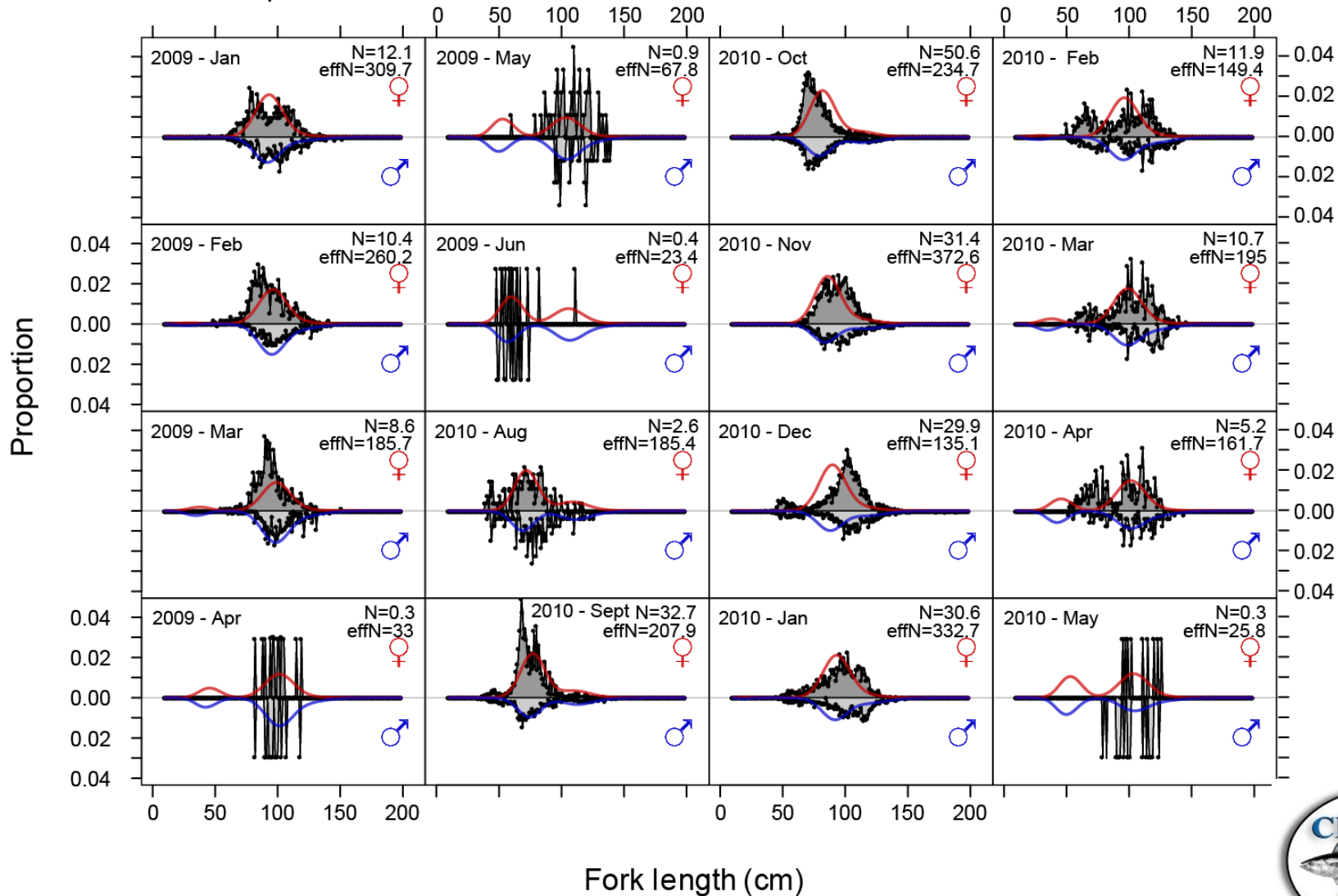
# Model fit to length composition data

## Ecuador

Results



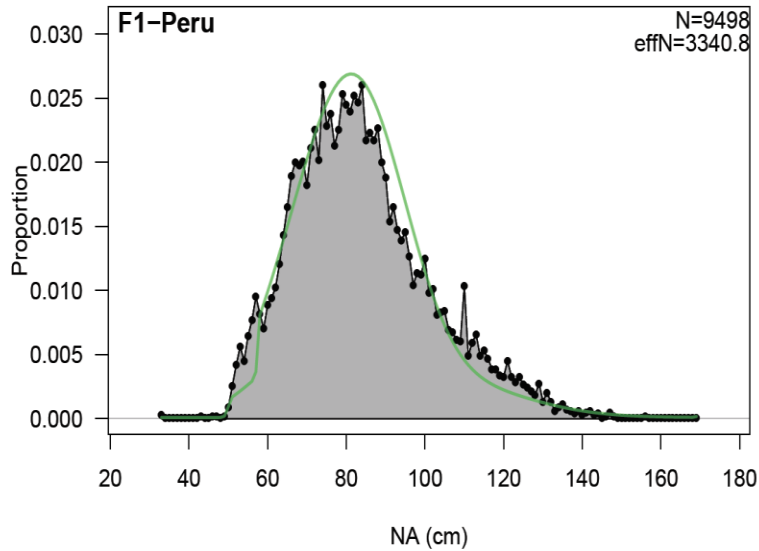
size comps, whole catch, F2-Ecuador



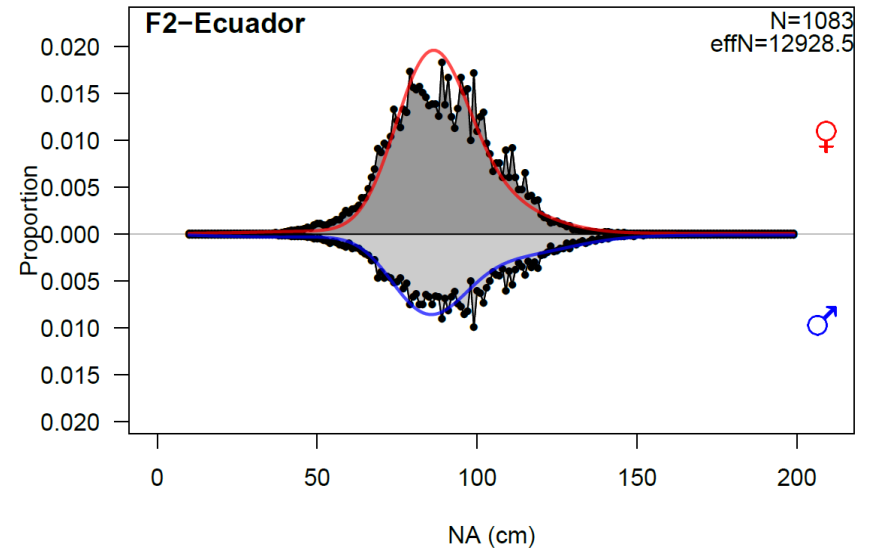
# Average model "fit" to size compositions



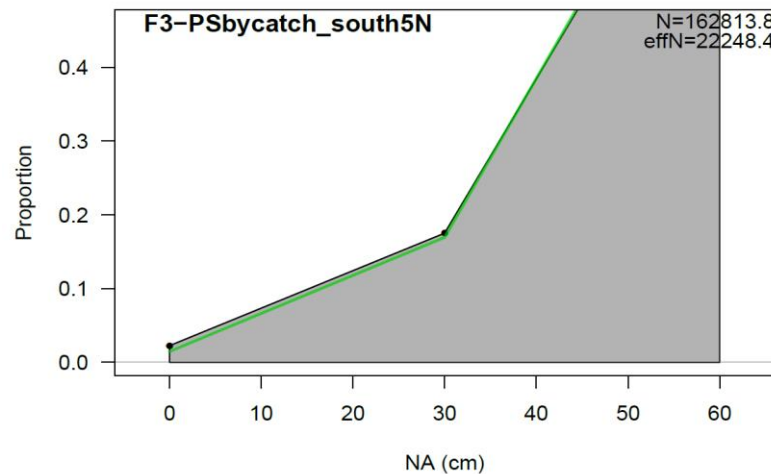
size comps, whole catch, aggregated across time by fleet



size comps, whole catch, aggregated across time by fleet

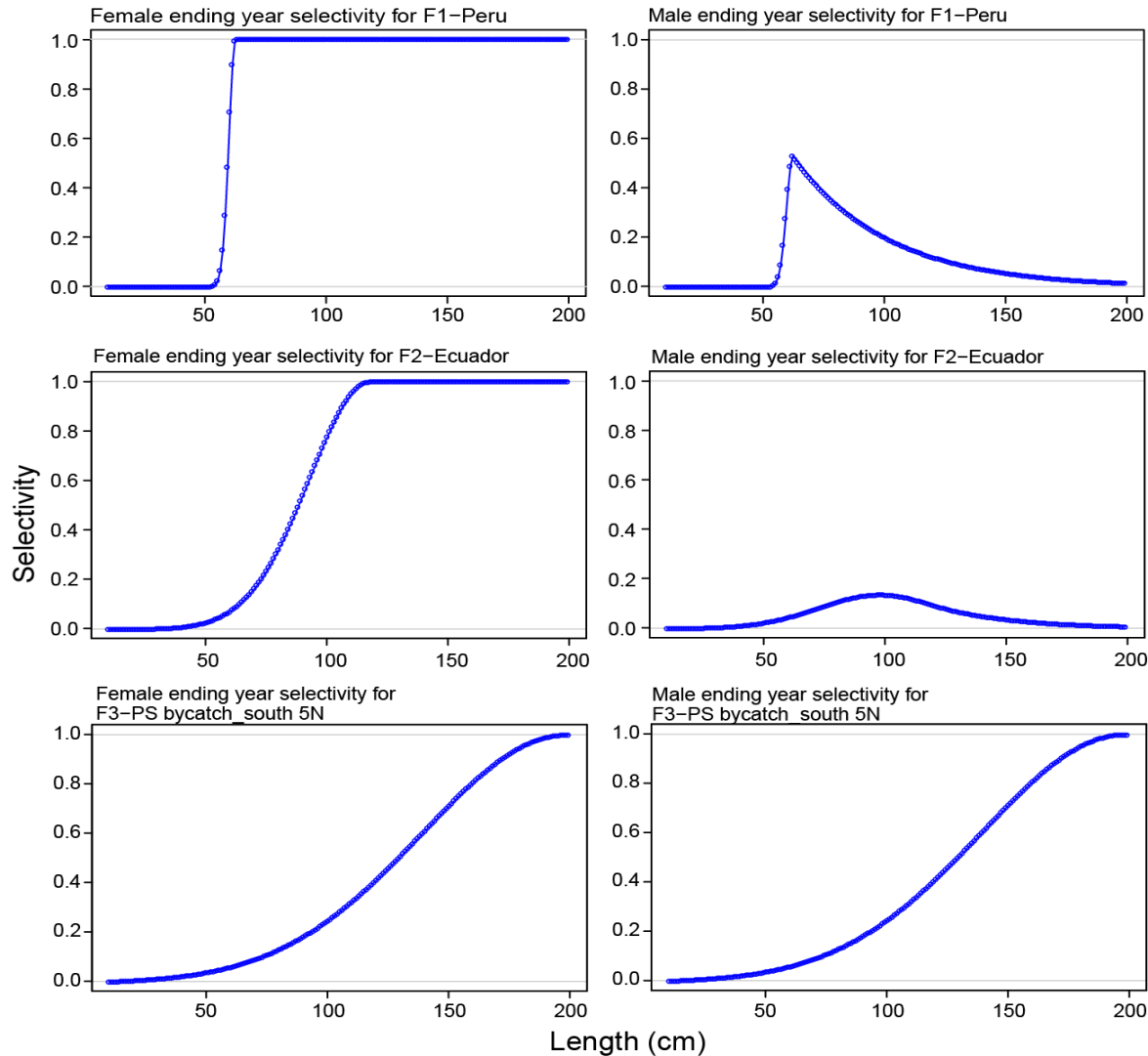


size comps, whole catch, aggregated across time by fleet

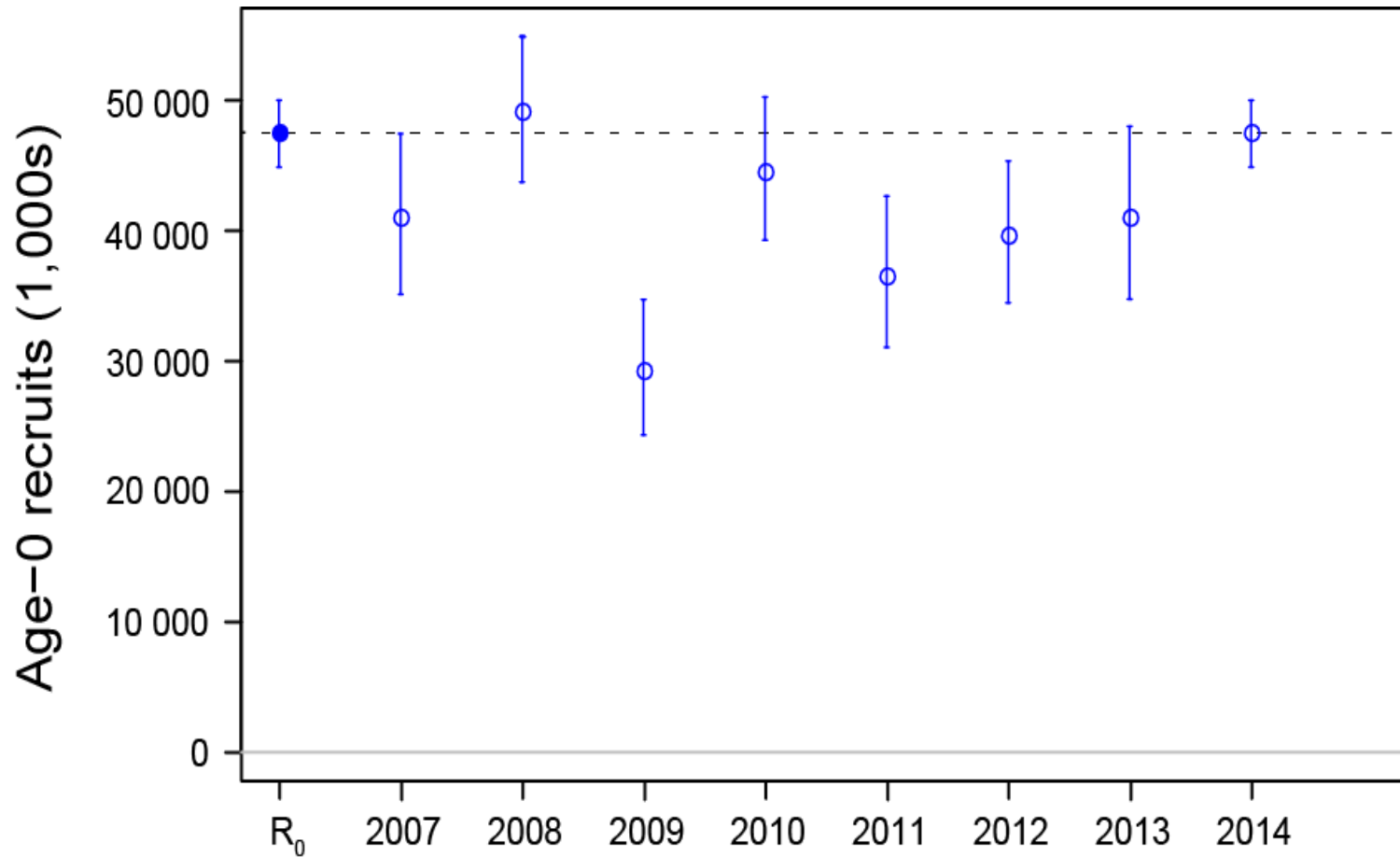


# Size selectivity

Results

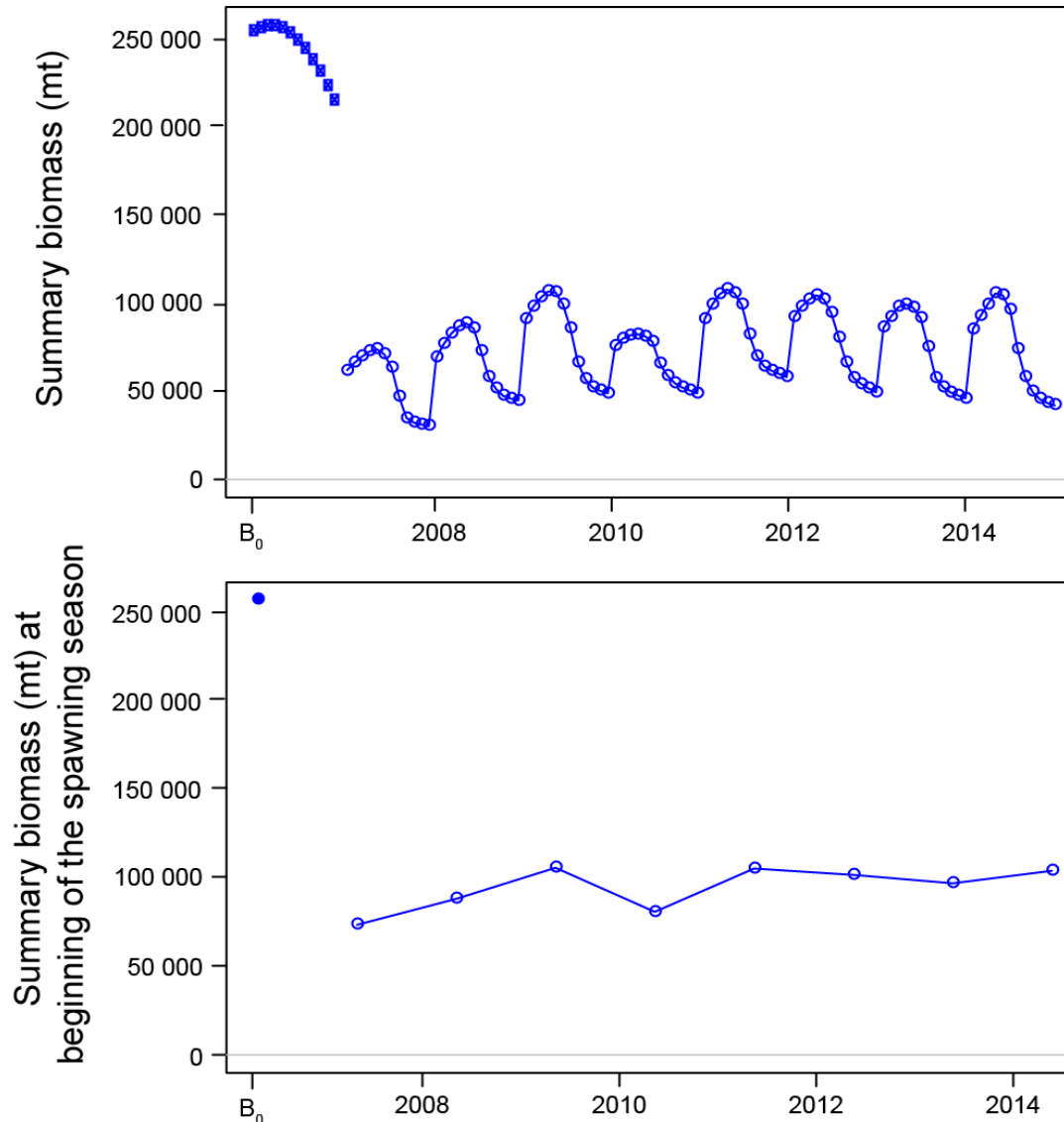


# Annual recruitment



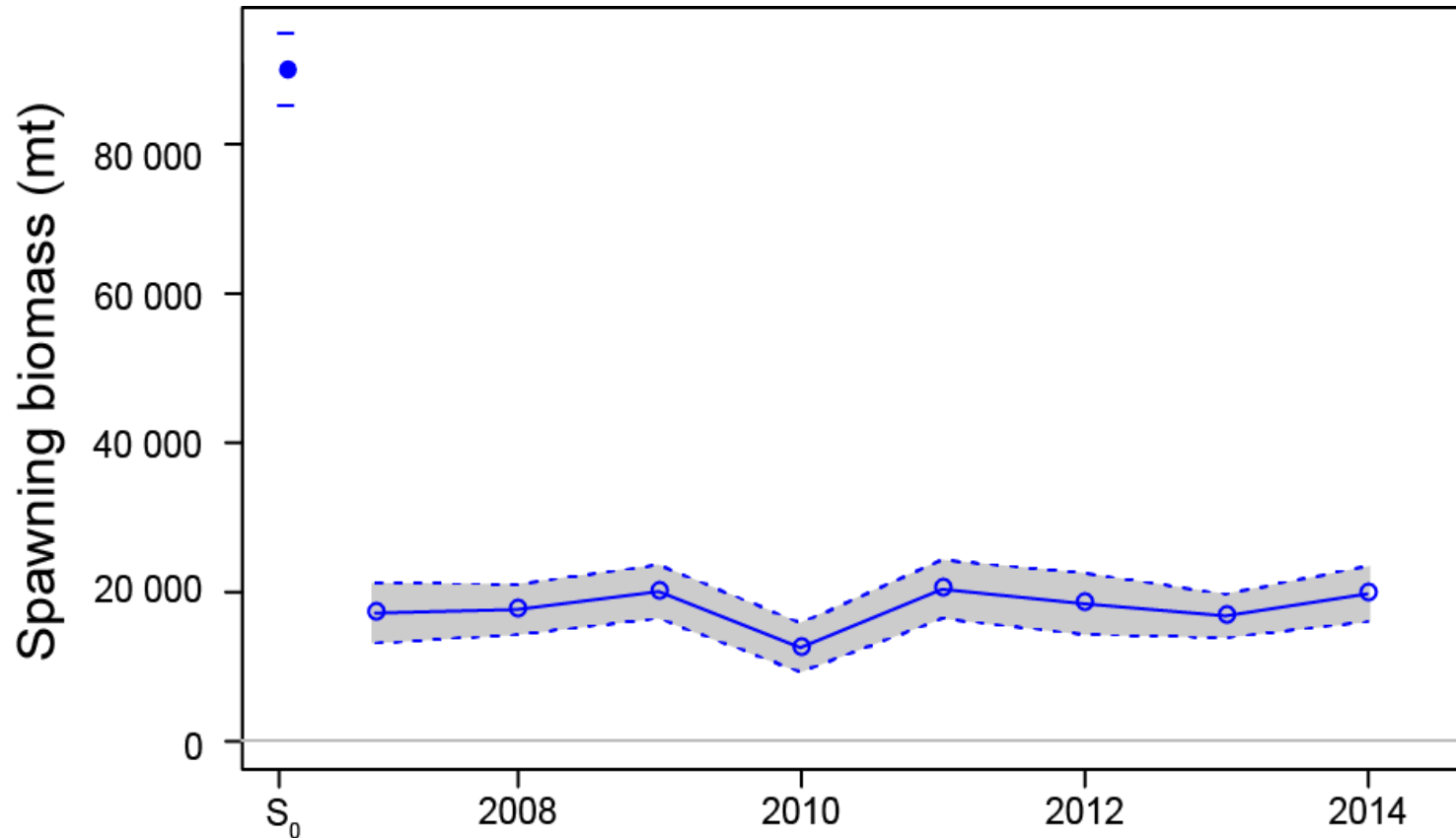


# Summary biomass

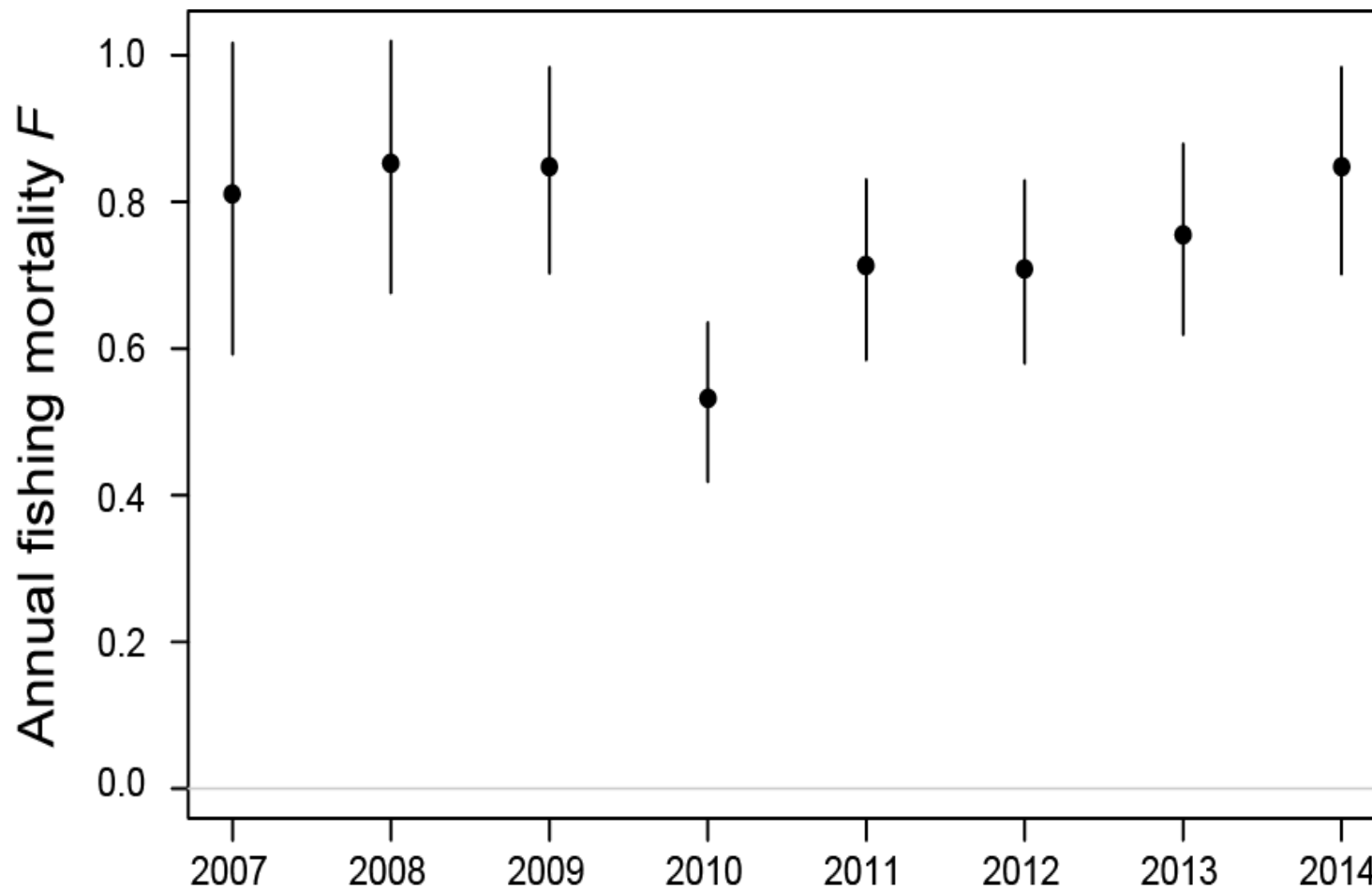


# Spawning biomass

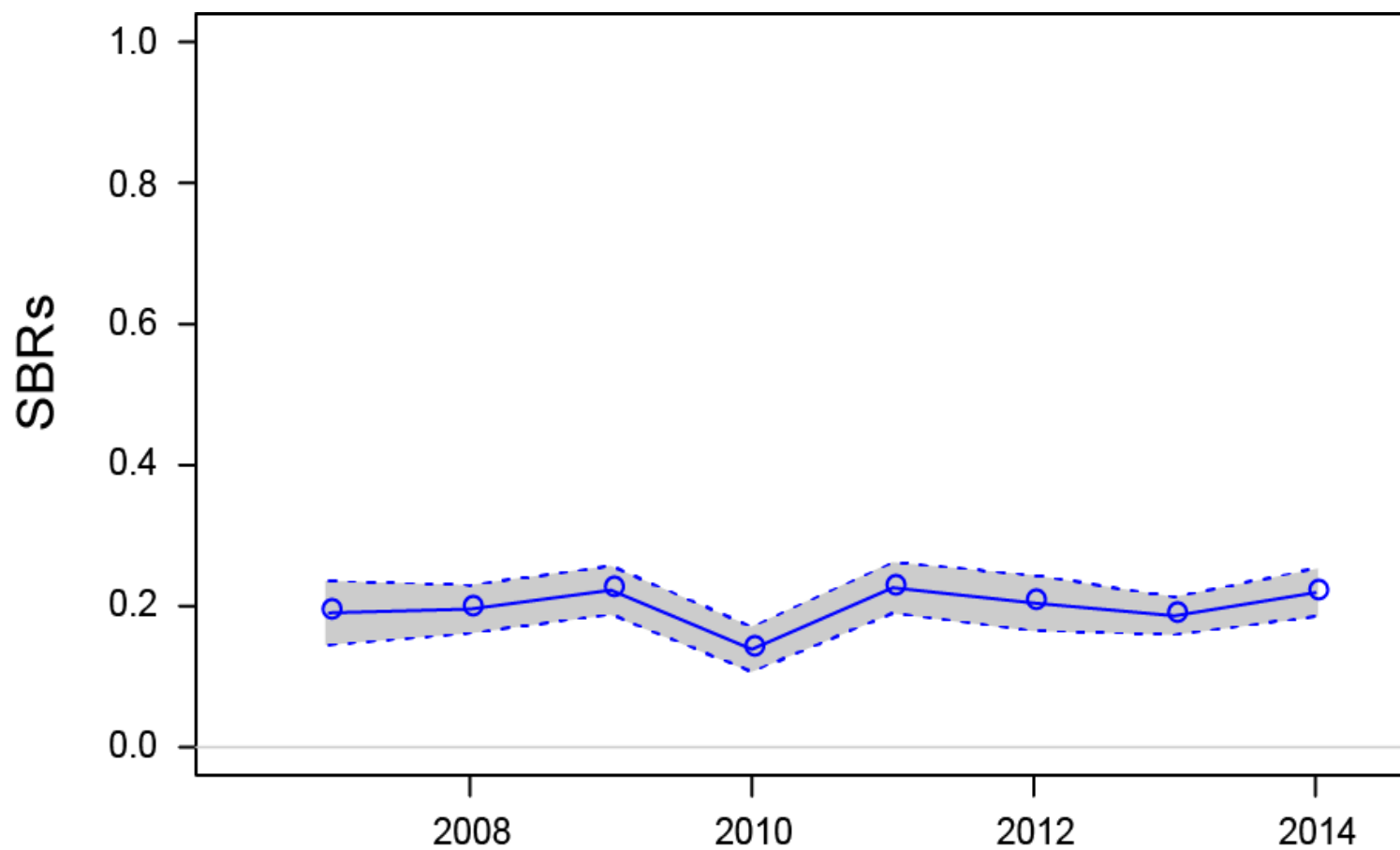
Results



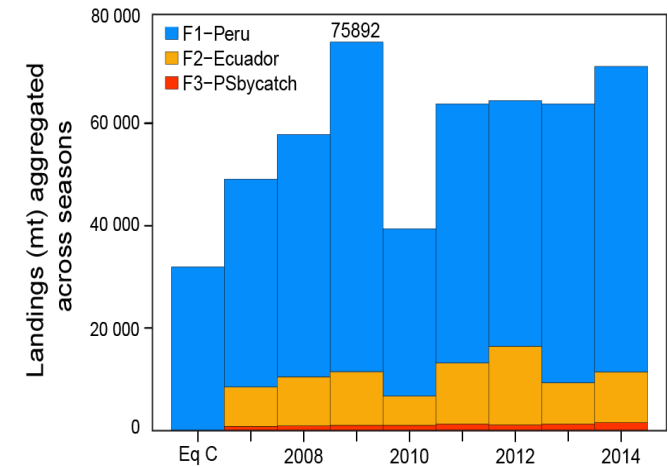
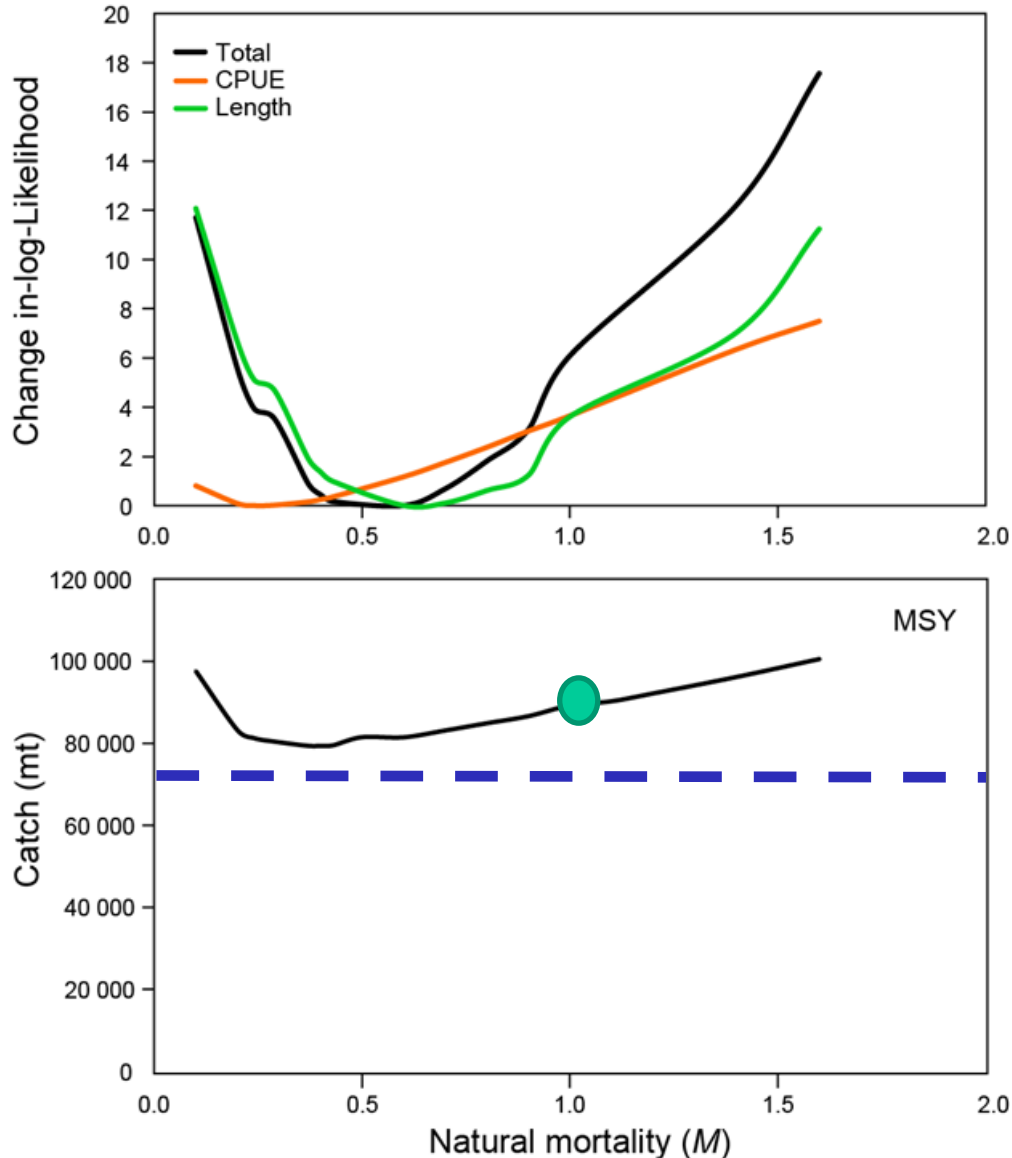
# Fishing mortality ( $F$ )



# Spawning biomass ratio (SBR)

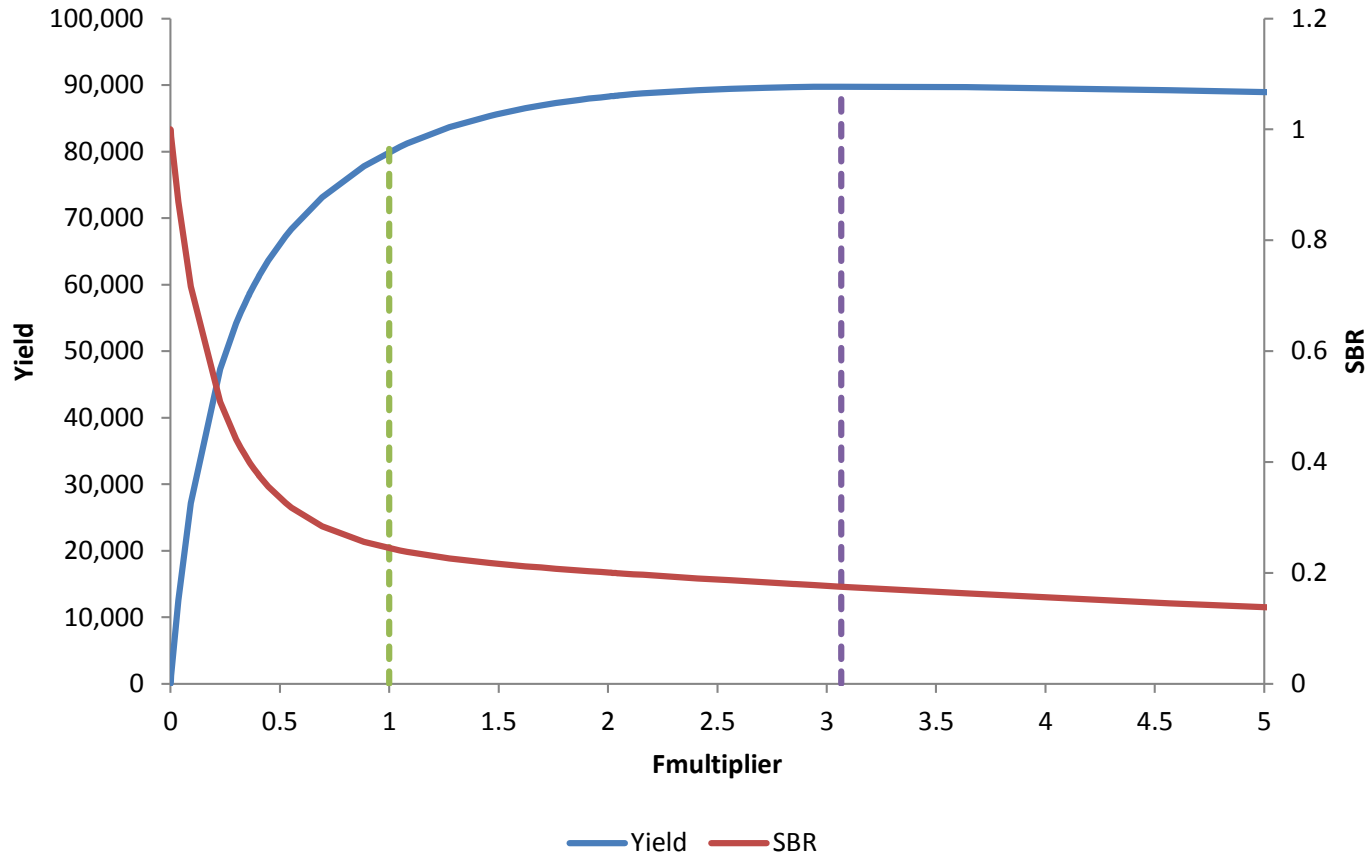


# Maximum sustainable yield (MSY) and M



# YPR

Results

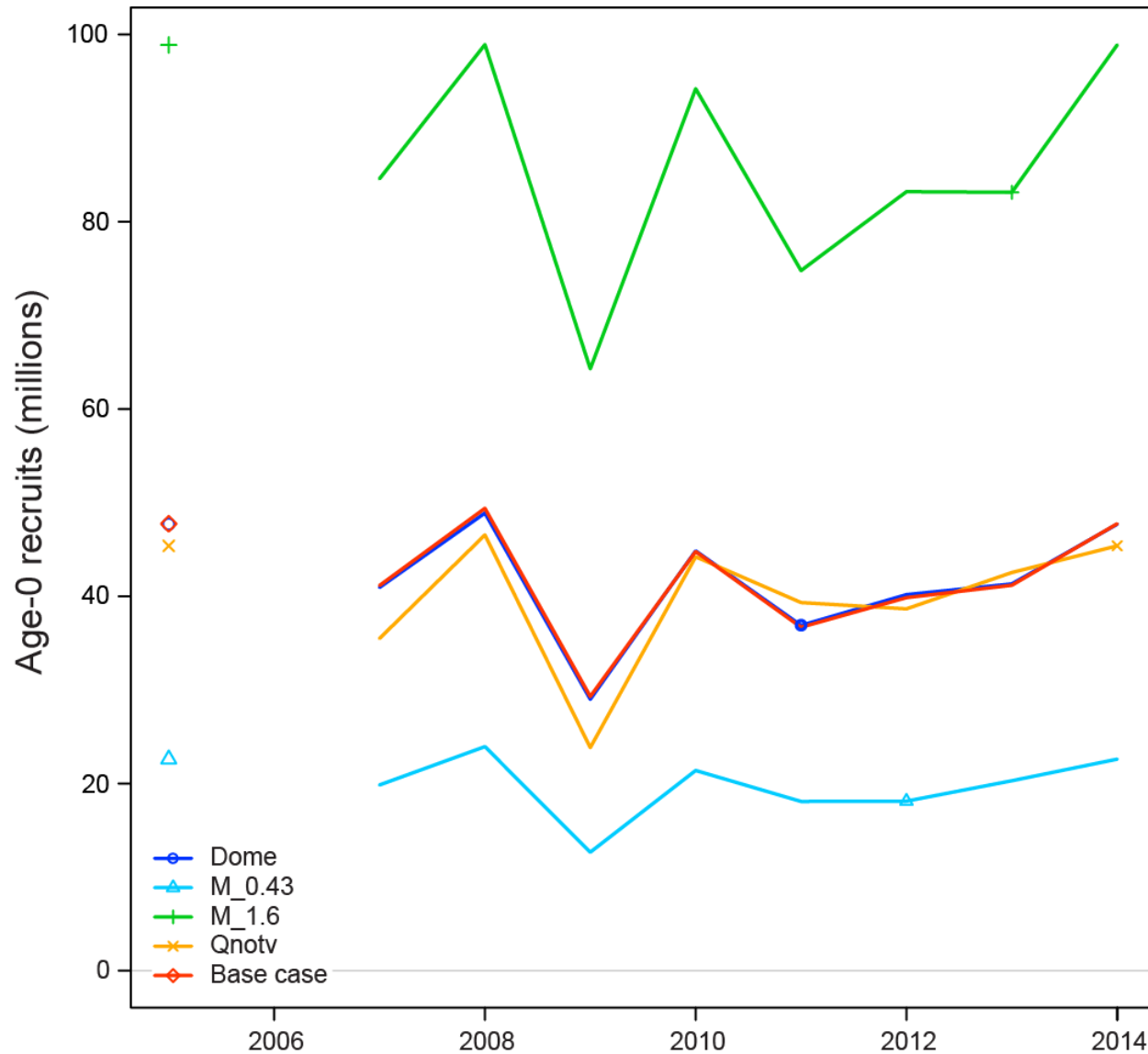


See Doc SAC-07-06a(ii) for exploratory management strategy evaluation (YPR, size limits, discard mortality and seasonal closures)



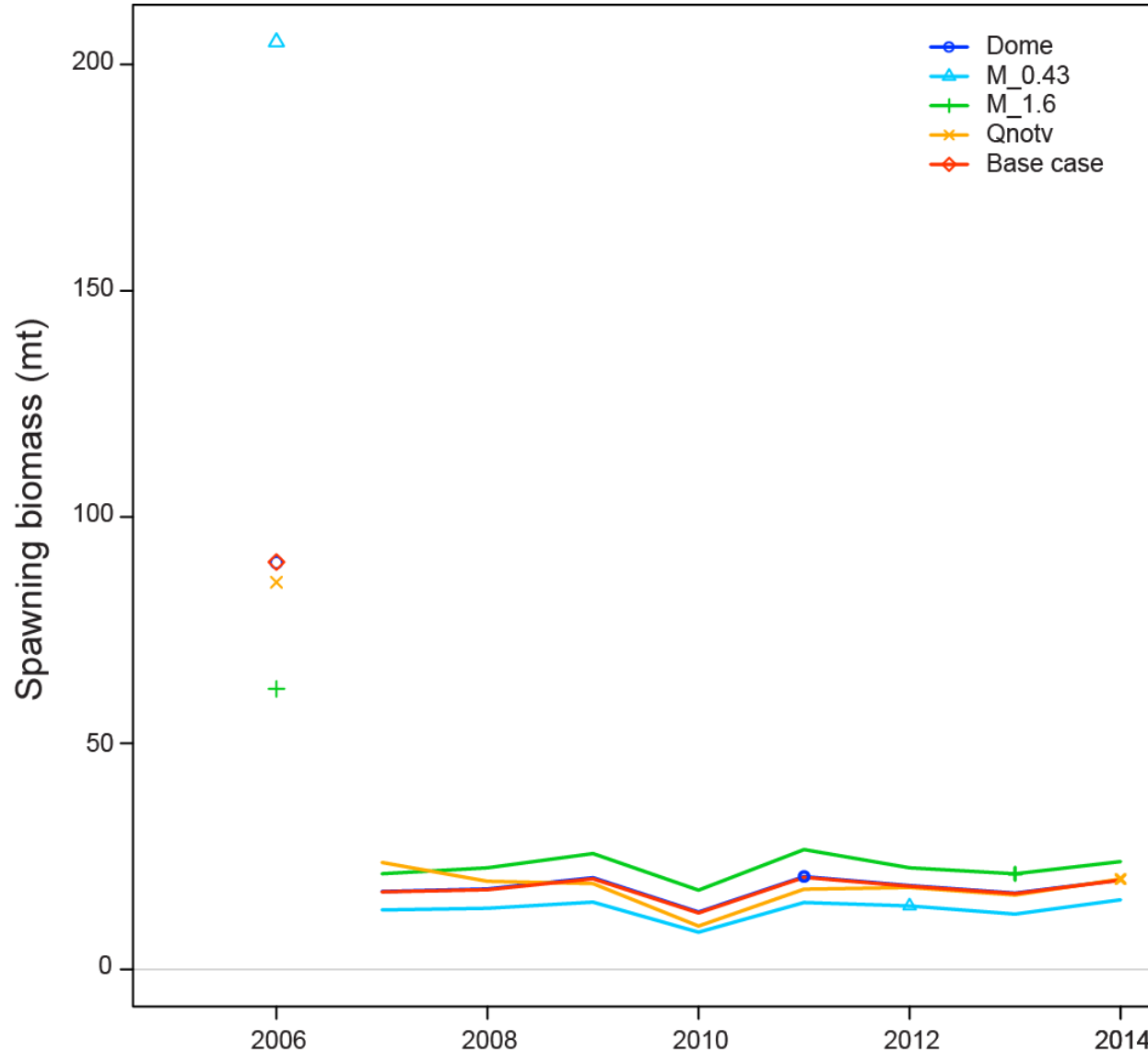
# Recruitment

Sensitivities



# Spawning biomass

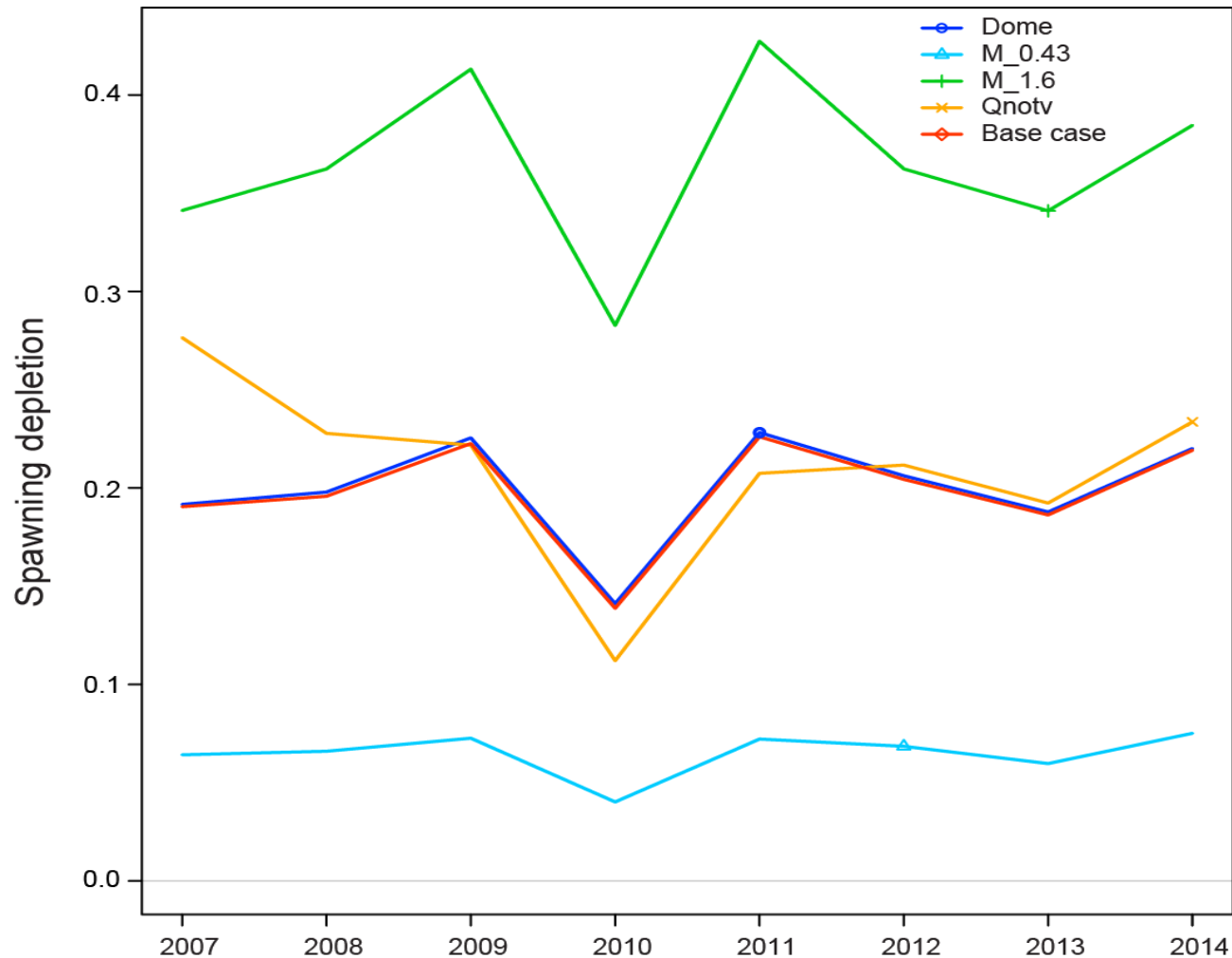
Sensitivities





# Spawning biomass ratio (SBR)

Sensitivities



# Summary

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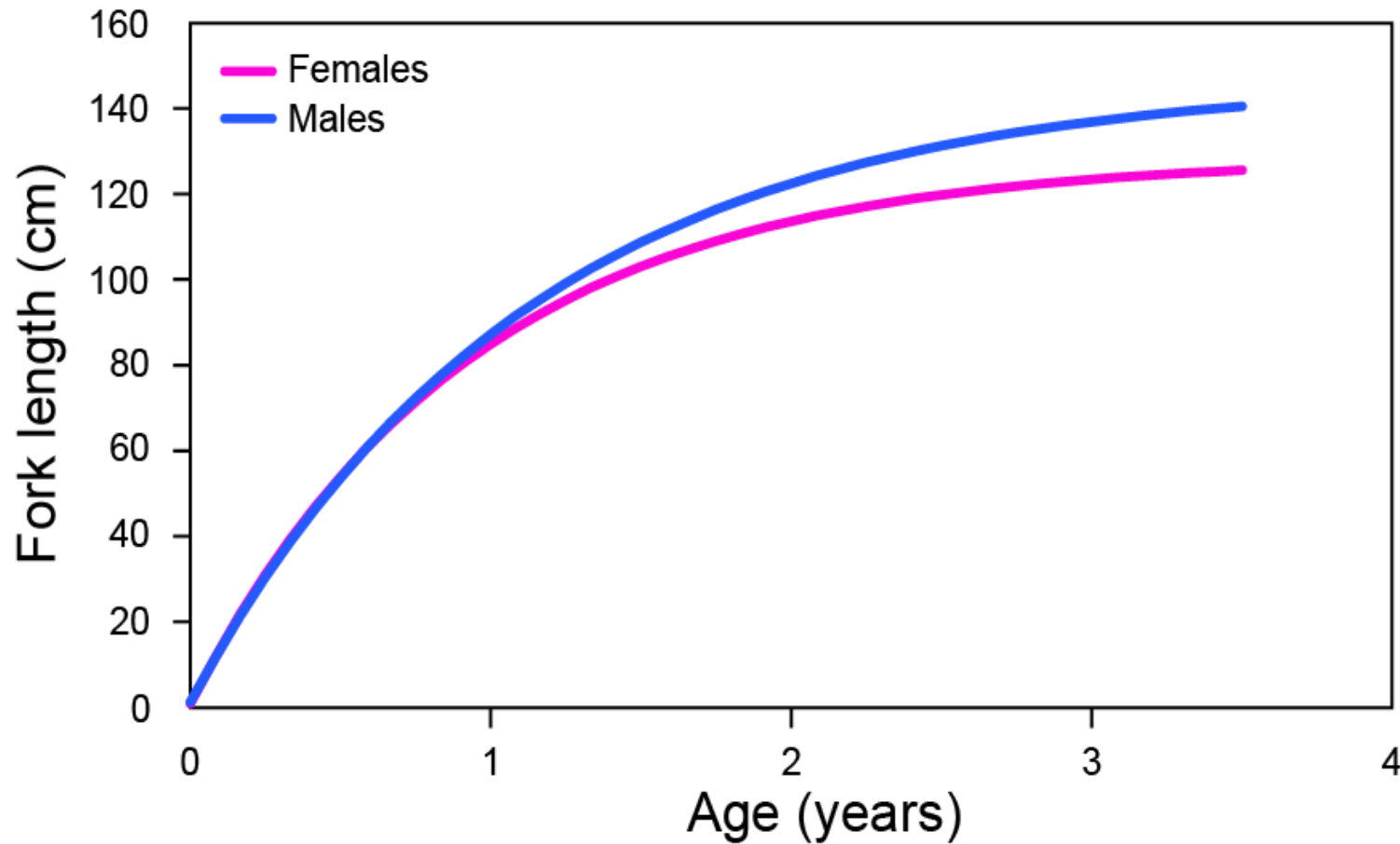
- There is very strong seasonality in the population dynamics of dorado
- *Stock Synthesis* shows potential to be used as a stock assessment tool for dorado
- See Doc SAC-07-06a(ii) for exploratory management strategy evaluation (YPR, size limits, discard mortality and seasonal closures)

# Questions?



# Age and growth

Data sources

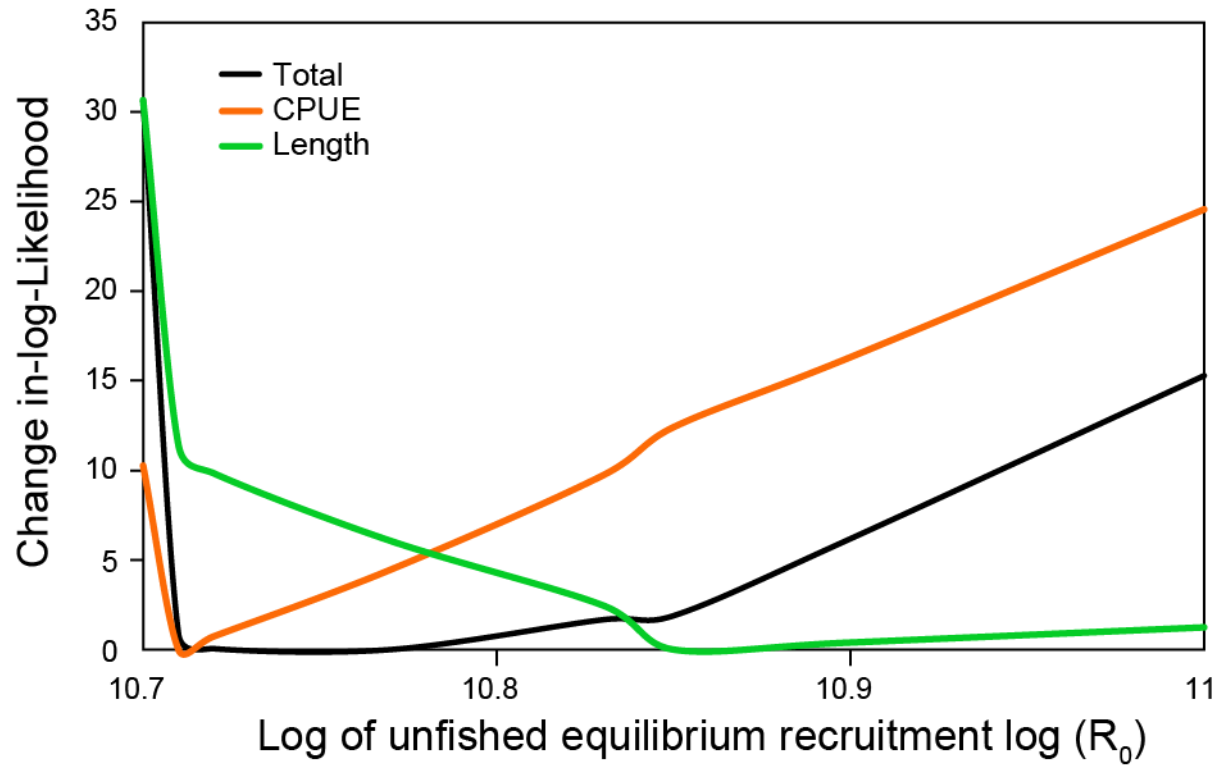


Based on Goicochea et al. (2012)





# R0 profile



# SBR

