Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission




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YELLOWFIN TUNA IN THE EASTERN PACIFIC OCEAN, 2019: benchmark assessment

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Outline

- Introduction
- Fishery definitions
- Data
- Assumptions
- Set of reference models
- Results
- Conclusions

Introduction: 2018-2020 - Workplan to improve the stock assessments of tropical tuna

- Included external reviews of the YFT and BET assessments
- Both external reviews suggested a variety of alternative models rather than a replacement for base case
- Change from “best assessment” to a risk analysis approach which considers multiple models and explicitly deals with uncertainty

Introduction: The staff's pragmatic risk analysis approach

Described in Maunder et al. 2020 (SAC-11- INF-F):

1. **Identify alternative hypotheses** (‘*states of nature*’) about the population dynamics of the stock that address the main issues in the assessments
   - YFT: SAC-11-J; BET: SAC-11 INF-F
2. **Implement stock assessment models representing alternative hypotheses**
   - **YFT: SAC-11-07**; BET: SAC-11-06
3. **Assign relative weights to each hypothesis (model)**
   - YFT: SAC-11 INF-J; BET: SAC-11 INF-F
4. **Compute combined probability distributions for management quantities using model relative weights**
   - SAC-11-08

Fishery definitions

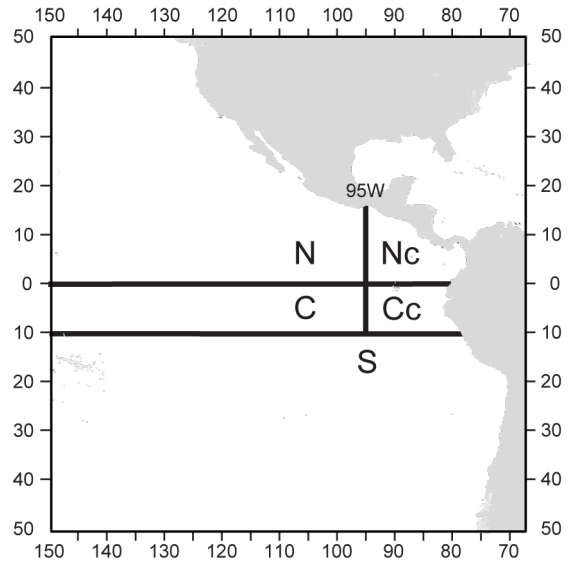
- “Areas-as-fleets” approach
- 38 fisheries defined by gear, set type, area and quarter
- Areas and quarters grouped by similarity in the length frequency
- Floating object and longline fisheries are separated by quarter and area

  (quarters 1 and 4, quarters 2 and 3)

Fishery definitions

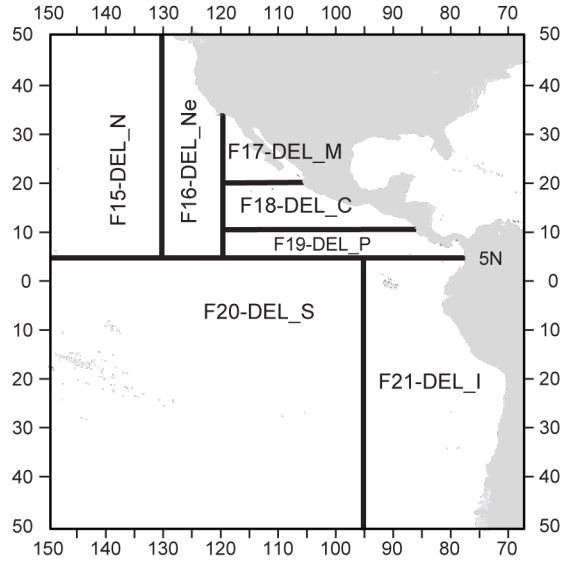
PS- OBJ

Purse-seine fisheries sets on floating objects (OBJ)



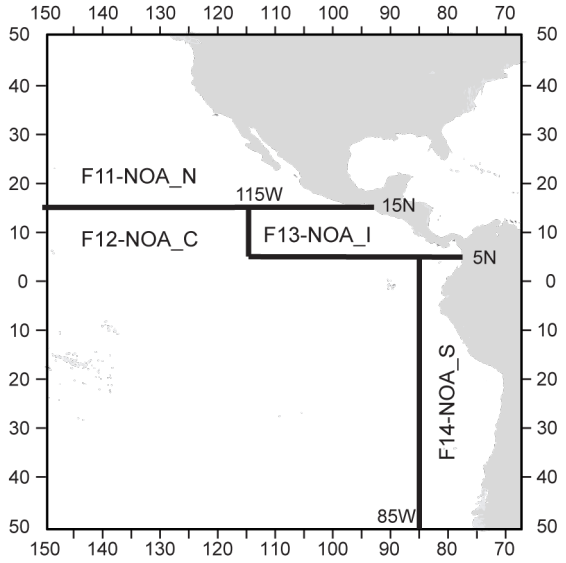
PS- DEL

Fisheries purse-seine sets around dolphins (DEL)



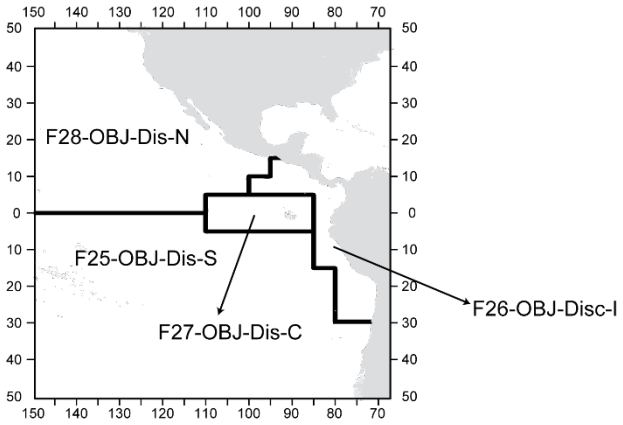
PS- NOA

Purse-seine fisheries sets unassociated (NOA)



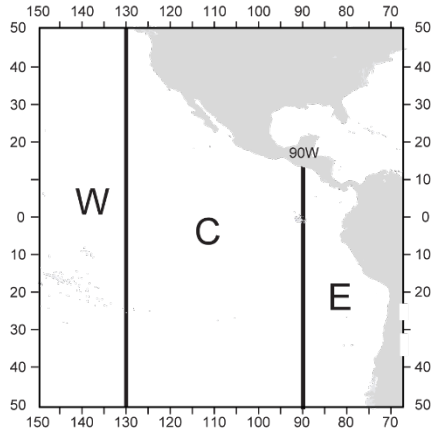
PS- Discards

Discard fisheries



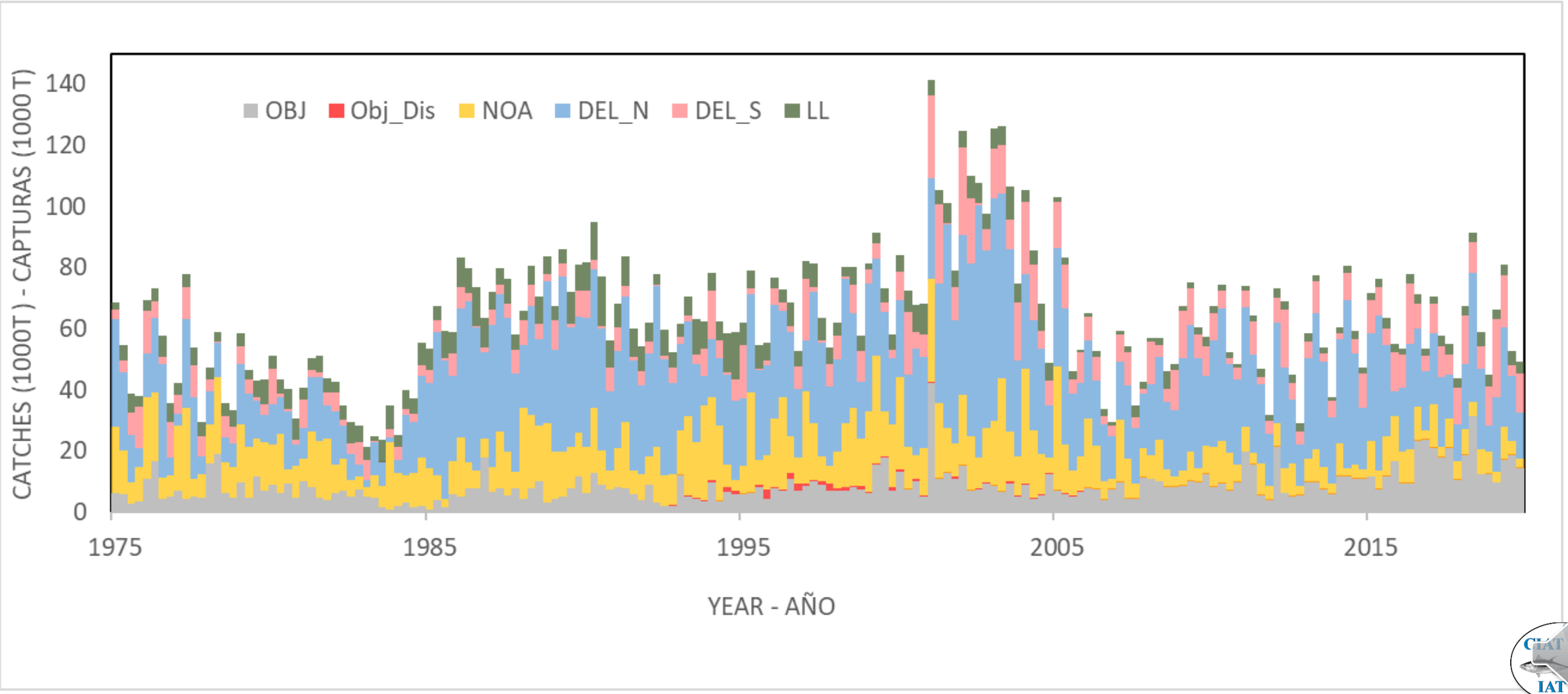
Longline

YFT longline fisheries

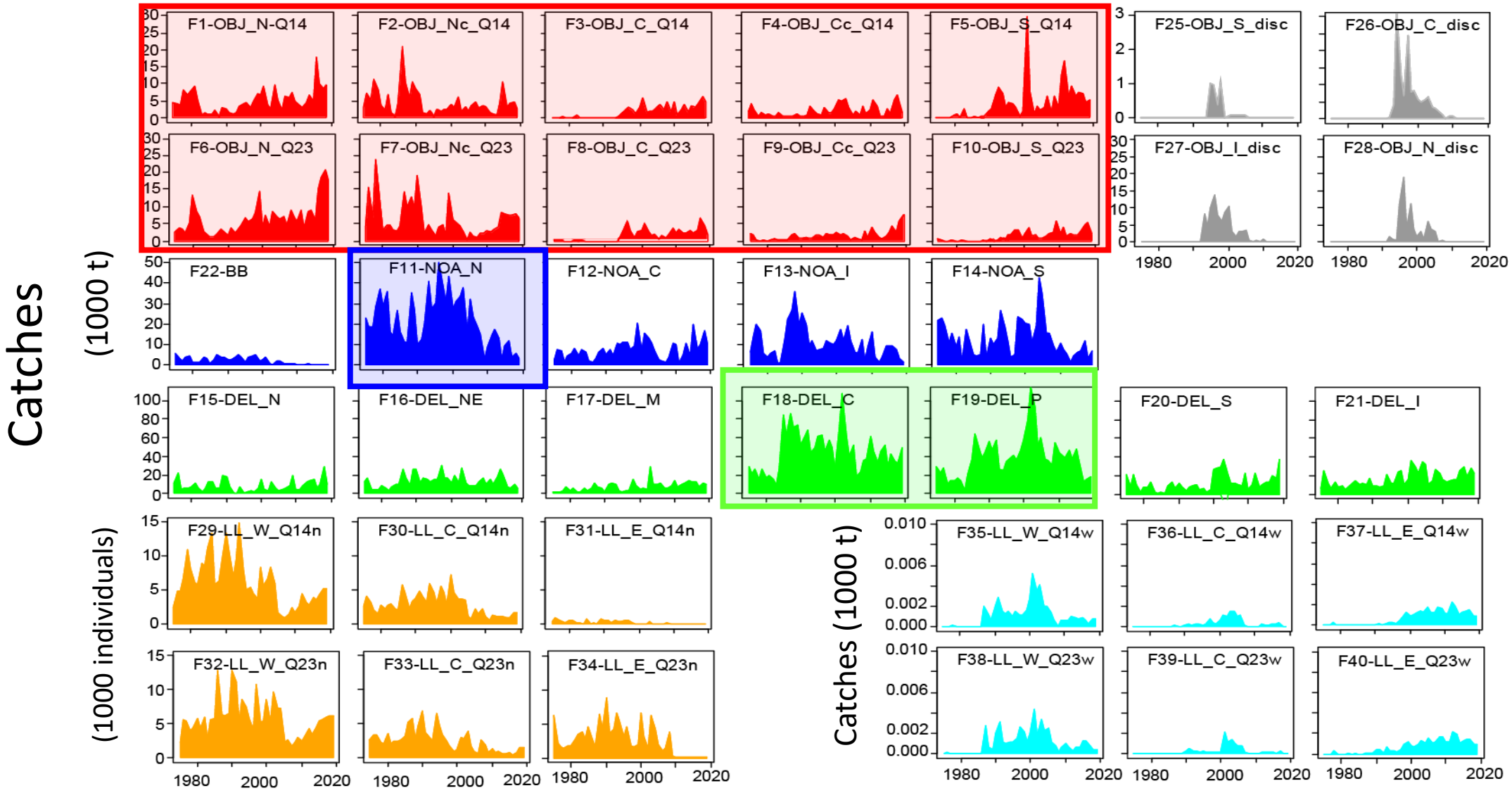


Data – catch (quarterly)

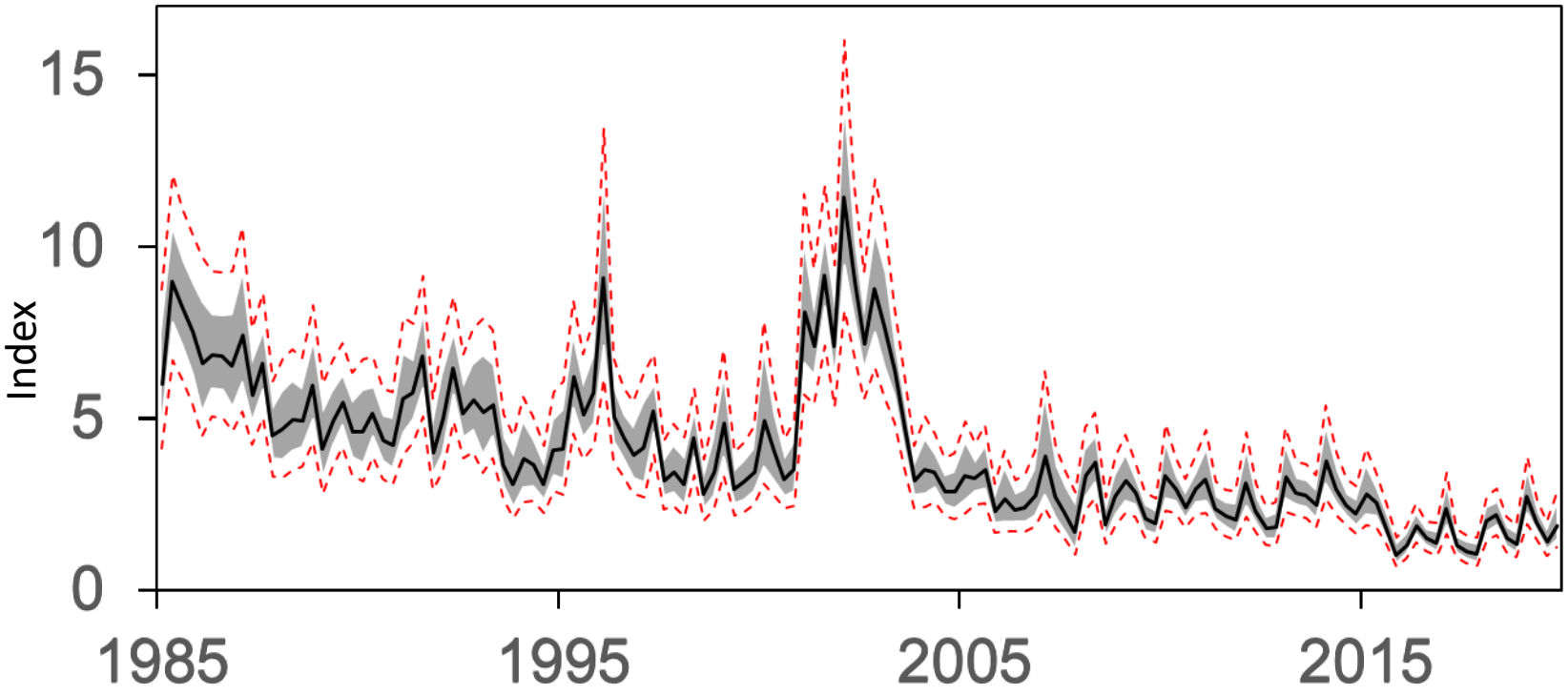
- **PS-DEL** (N and S) is the main fishery
- PS-OBJ has been increasing since 2015



Data – catch by fishery (annual)



Data - index of abundance



New model for <u>purse-seine index</u> of abundance:

- Standardized using a **spatiotemporal model** (VAST)
- Catch per day for vessels that fish mainly on purse-seine associated with dolphins

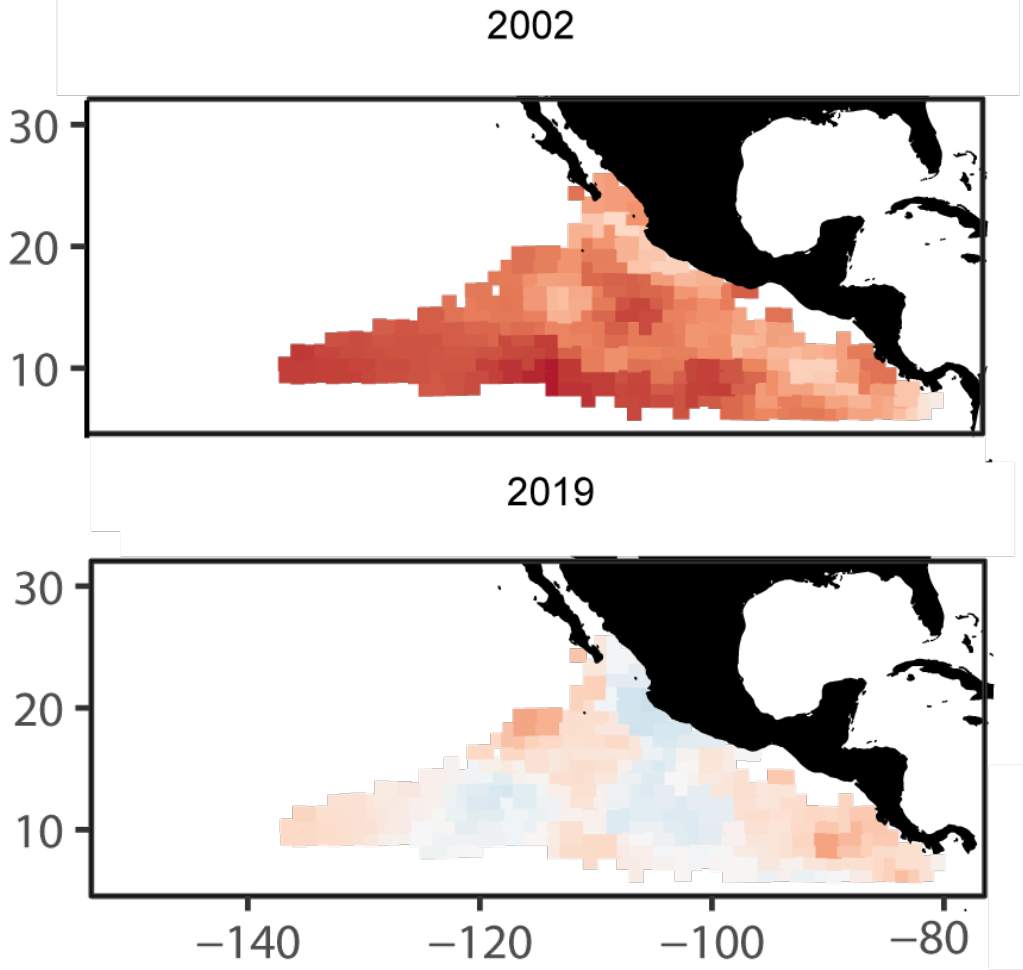
- Several hypotheses (Level 2A) of relationship between index and abundance:

Variability:

- Coefficient of variation (CV) from VAST model
- **Extra CV** added to average 0.15 over a range of years

“Survey”

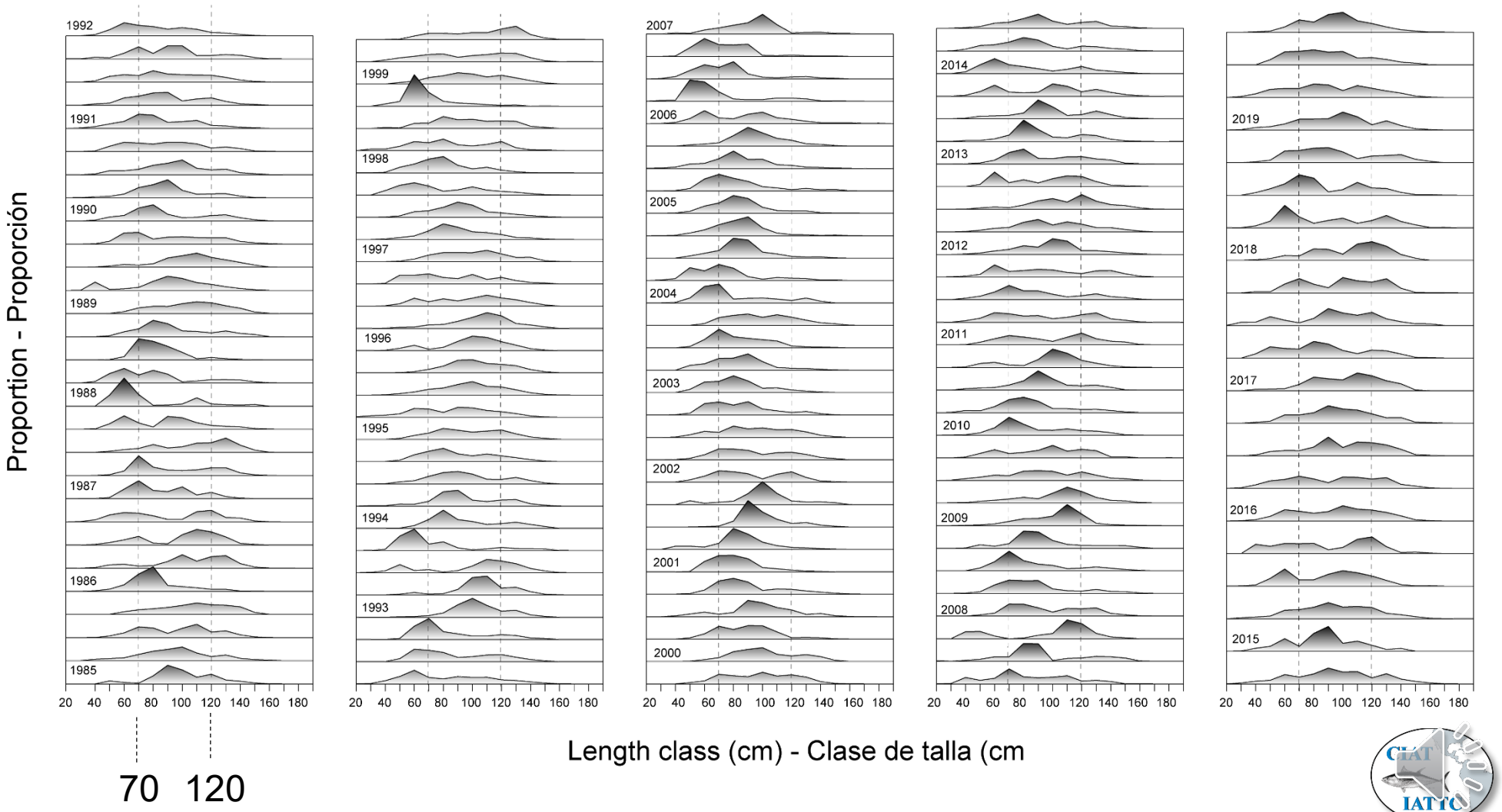
Quarter 1



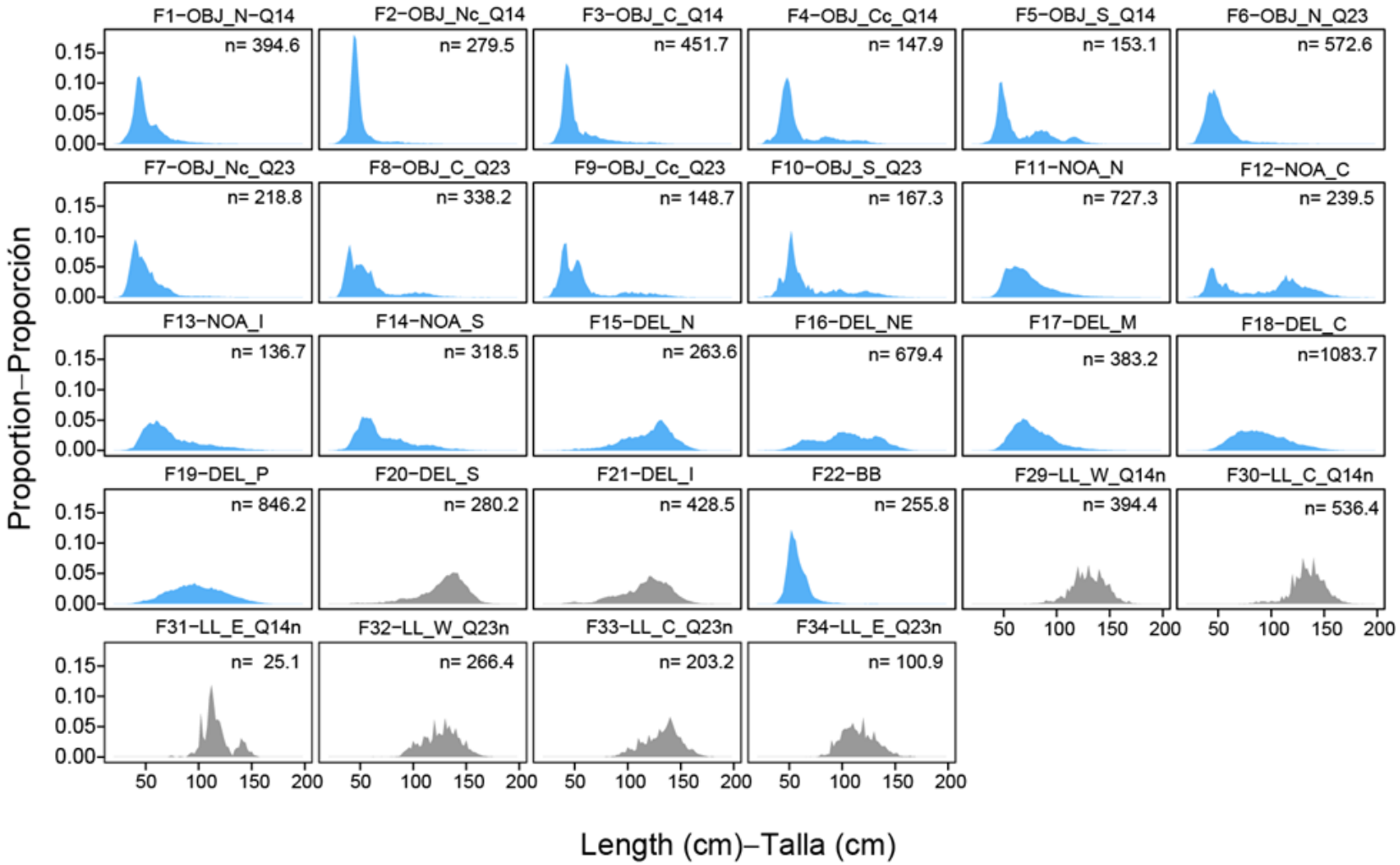
- The index focuses on the core area of the the catches (north of 5°N)
- In addition, includes only cells with 30 years or more
- In *Stock Synthesis* the abundance index is entered in the model as a “survey”, a fishery without catches but with associated size compositions
- It is not a real survey it is the standardized data of the purse-seine fleet

Data – standardized length frequencies

- Length frequencies associated with the index of abundance
- From port-sampling data
- Catch per day for DEL vessels
- Same selection criteria as for index
- Standardized using a **spatiotemporal model**



Data – size composition



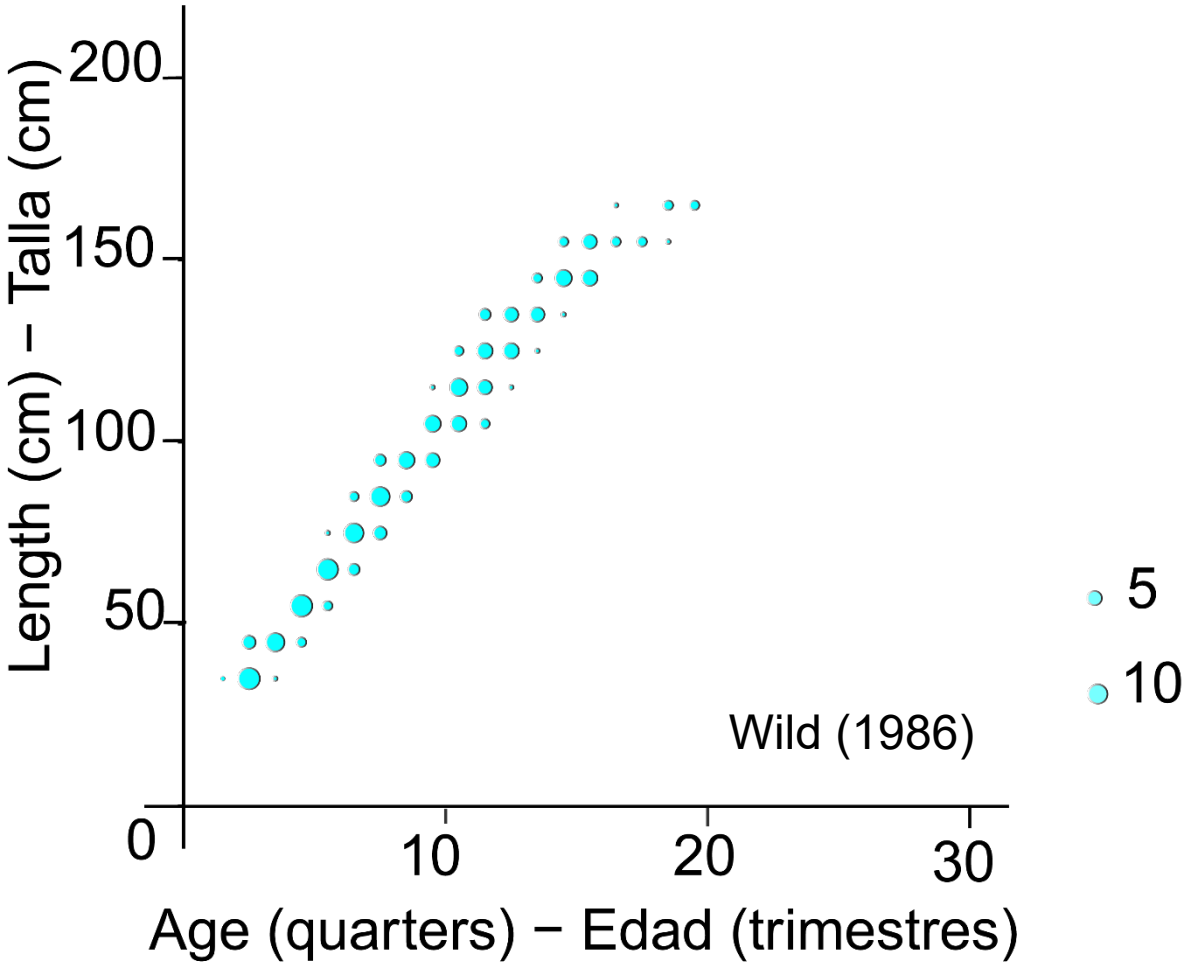
Models are

fit

not fit

to this data

Data – conditional age at length

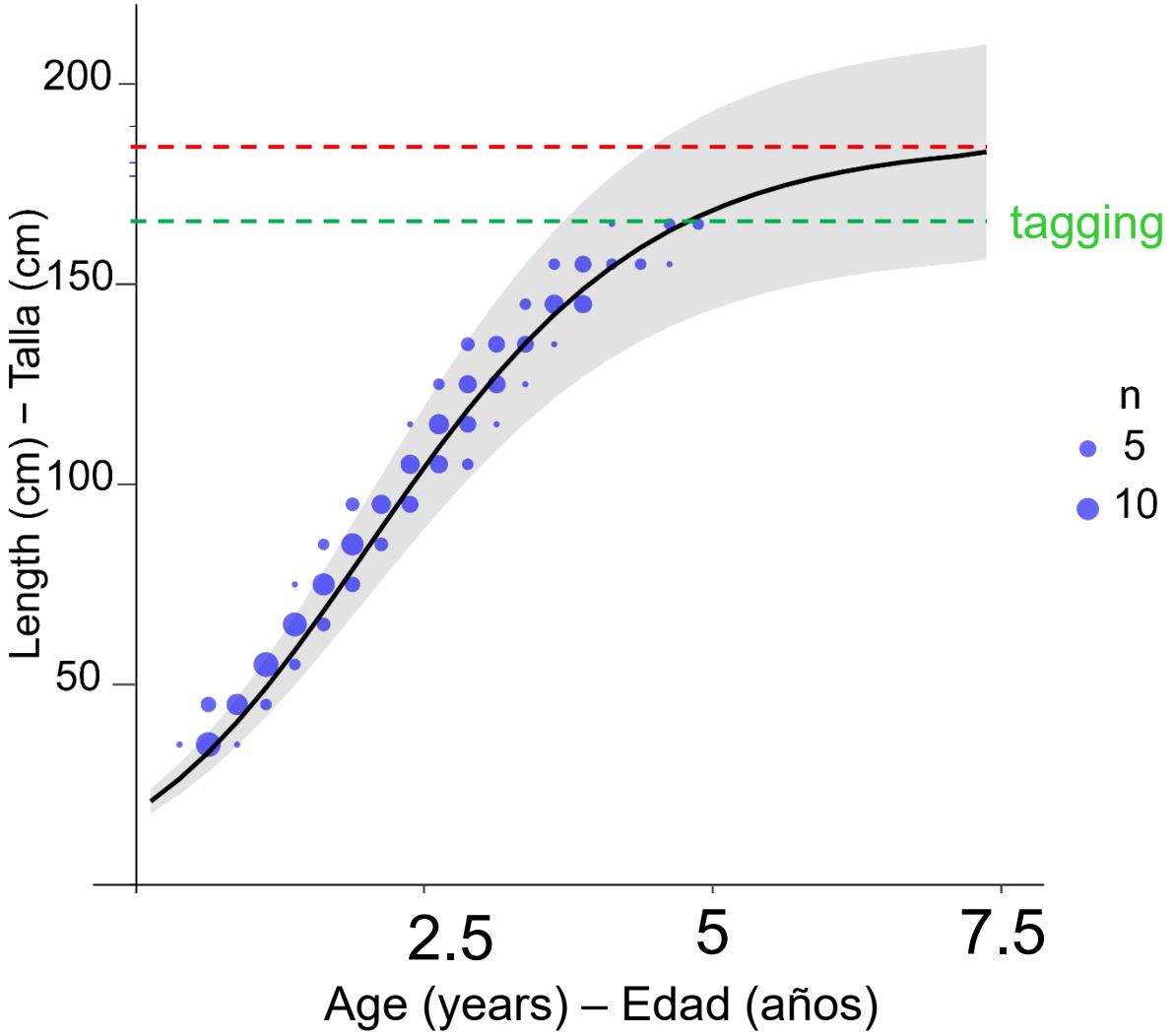


- Daily increments (validated)
- Included when estimating growth
- Up to about **170 cm** (142.5 females, 167.9 males)
- Up to **4 years old** (3.5 females, 4.8 males)
- 1975-1977 (assumed from 1985 F18-DEL-C)

Model assumptions - general

- Based on Stock Synthesis (v3.30.15), an integrated age-structured assessment model
- Model 1984-2019 with a quarterly time step
- The maximum population age bin is 29 quarters
- The Francis method is used to weight composition data (some further downweighted to 0.5 Francis weights)

Model assumptions - growth



Fixed growth assumption:

- L_2 = 182 (Maunder and Aires-da-Silva , 2009)

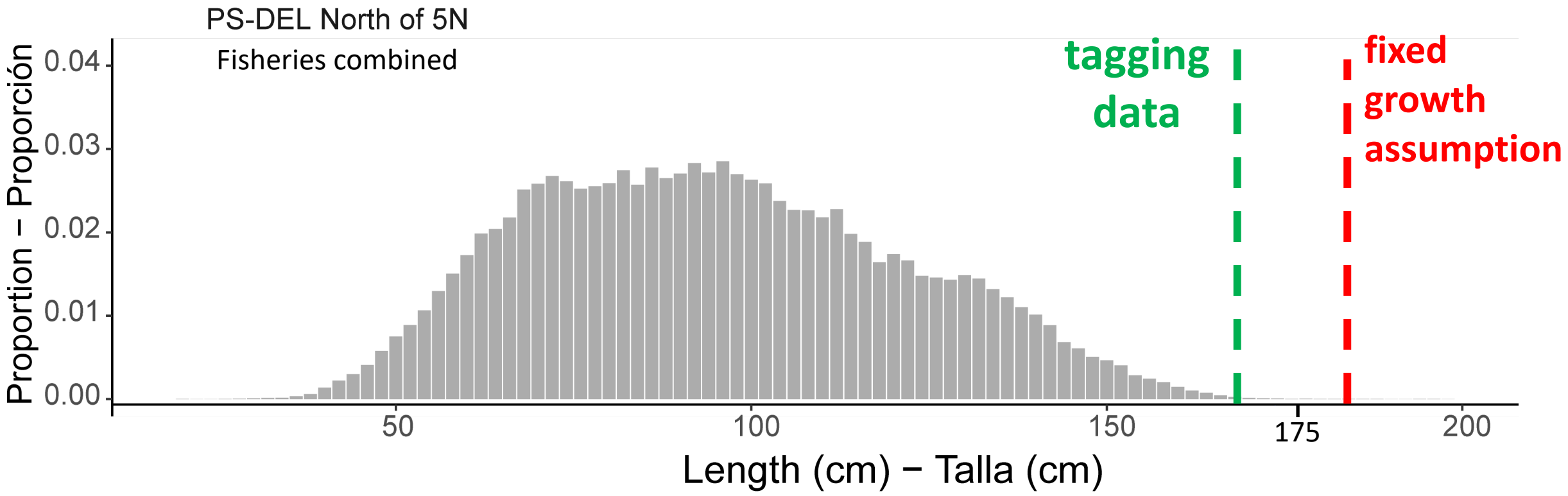
Limited tagging data:

- 167.3 average size of 4+ years at liberty (n=3)
- 163.3 average size of 3+ years at liberty (n=6)

Estimate growth in some models

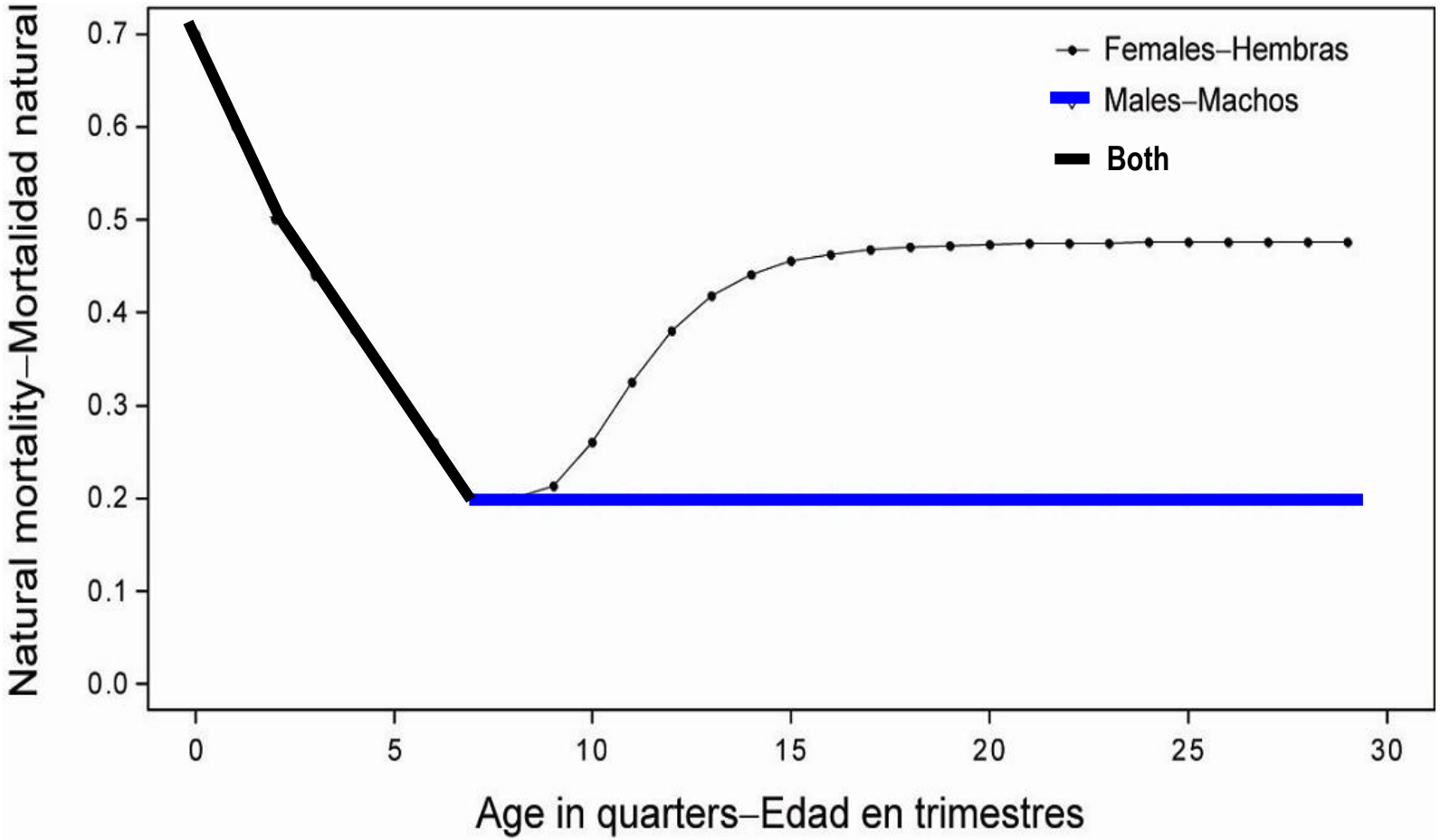
CV length at age = 7.5%

Model assumptions: growth (length distributions)



Model assumptions - Natural mortality (M)

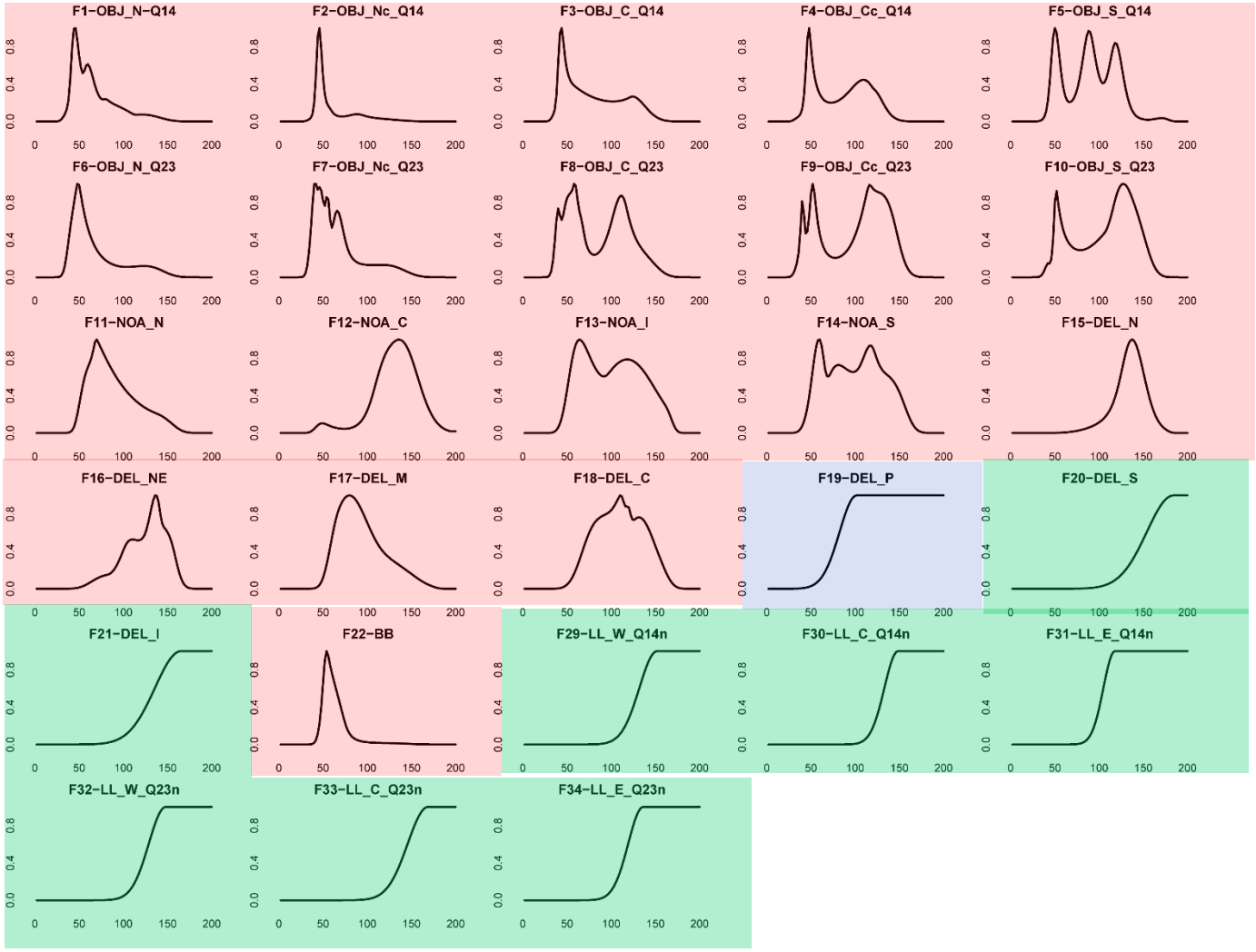
Age-specific and sex specific M



Model assumptions - recruitment

- Beverton-Holt stock-recruit relationship
- Recruitment is quarterly
- No autocorrelation in recruit deviates
- Recruitment variability (σ_R) equal to 1 (quarterly)
- Bias adjustment follows Methot and Taylor (2011)
- Reference models: four hypotheses about steepness of the stock-recruitment curve (h) are assumed: 1.0, 0.9, 0.8, 0.7

Model assumptions - selectivity



- Most fisheries have dome-shaped selectivity modeled with splines

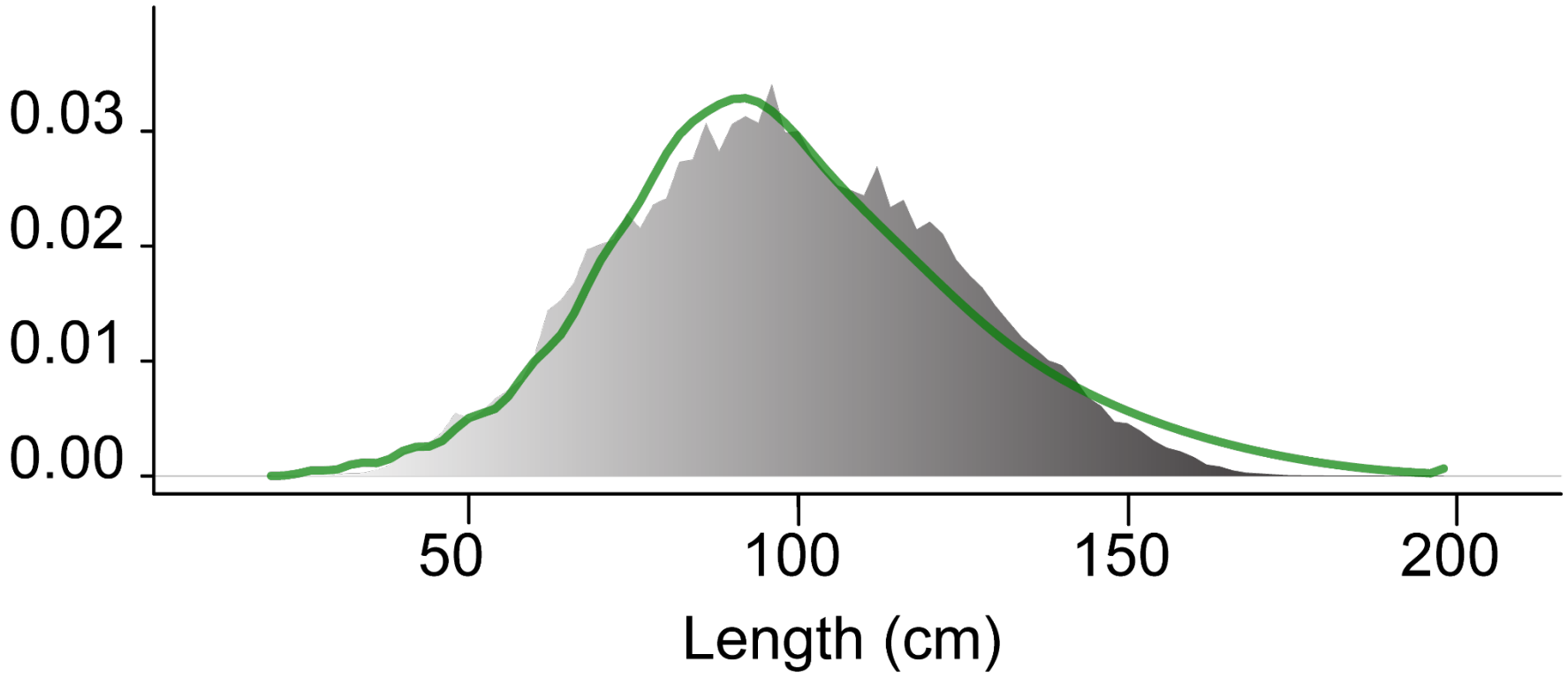
F19-DEL-P fishery:

- **asymptotic or dome-shape**

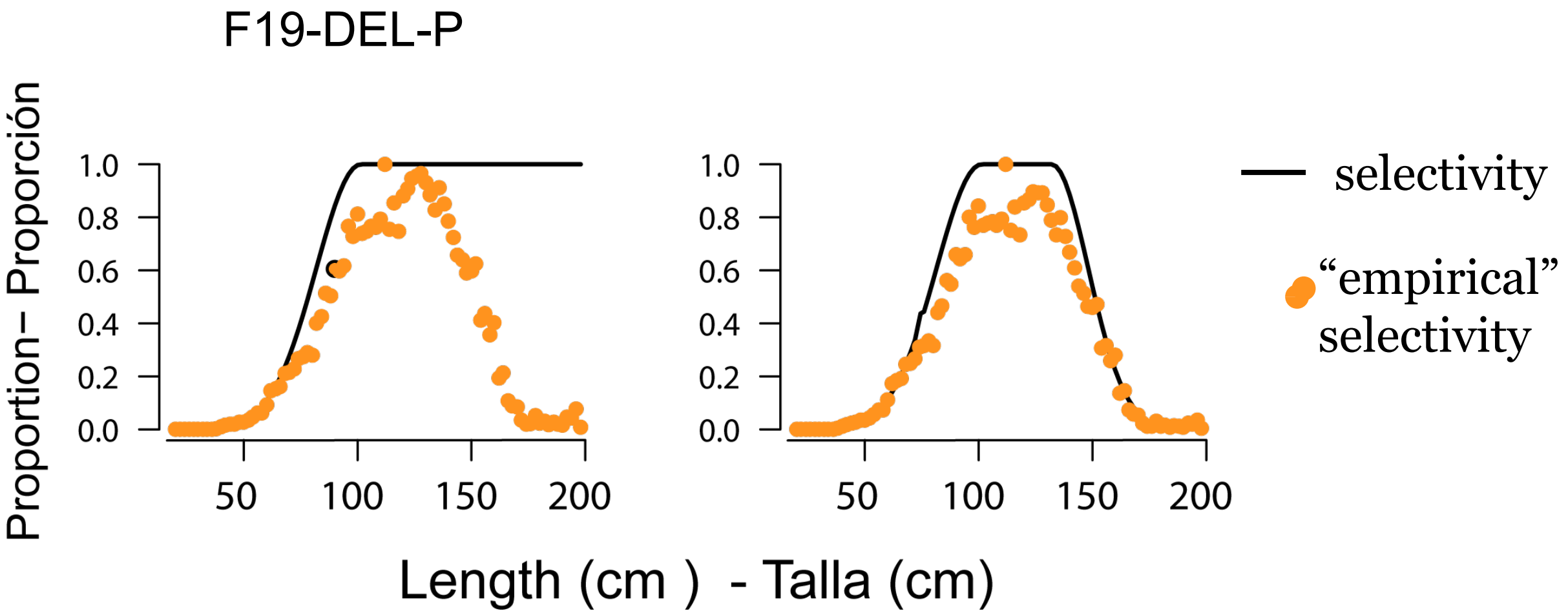
- Longline fisheries and purse-seine DEL south of 5N - asymptotic selectivity (not estimated)

Model assumptions - selectivity

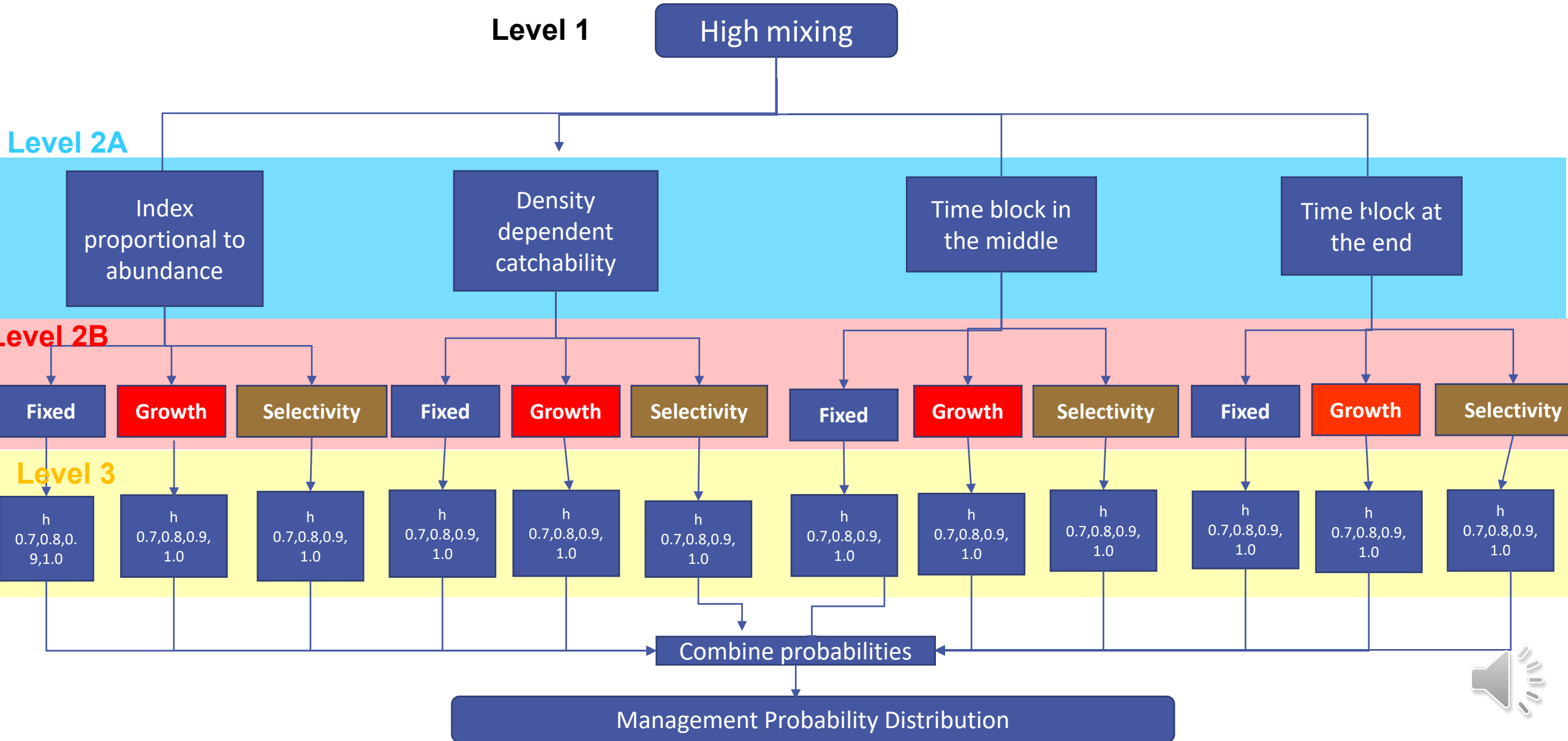
Why the F19-DEL-P has either asymptotic selectivity or dome-shape?



Selectivity



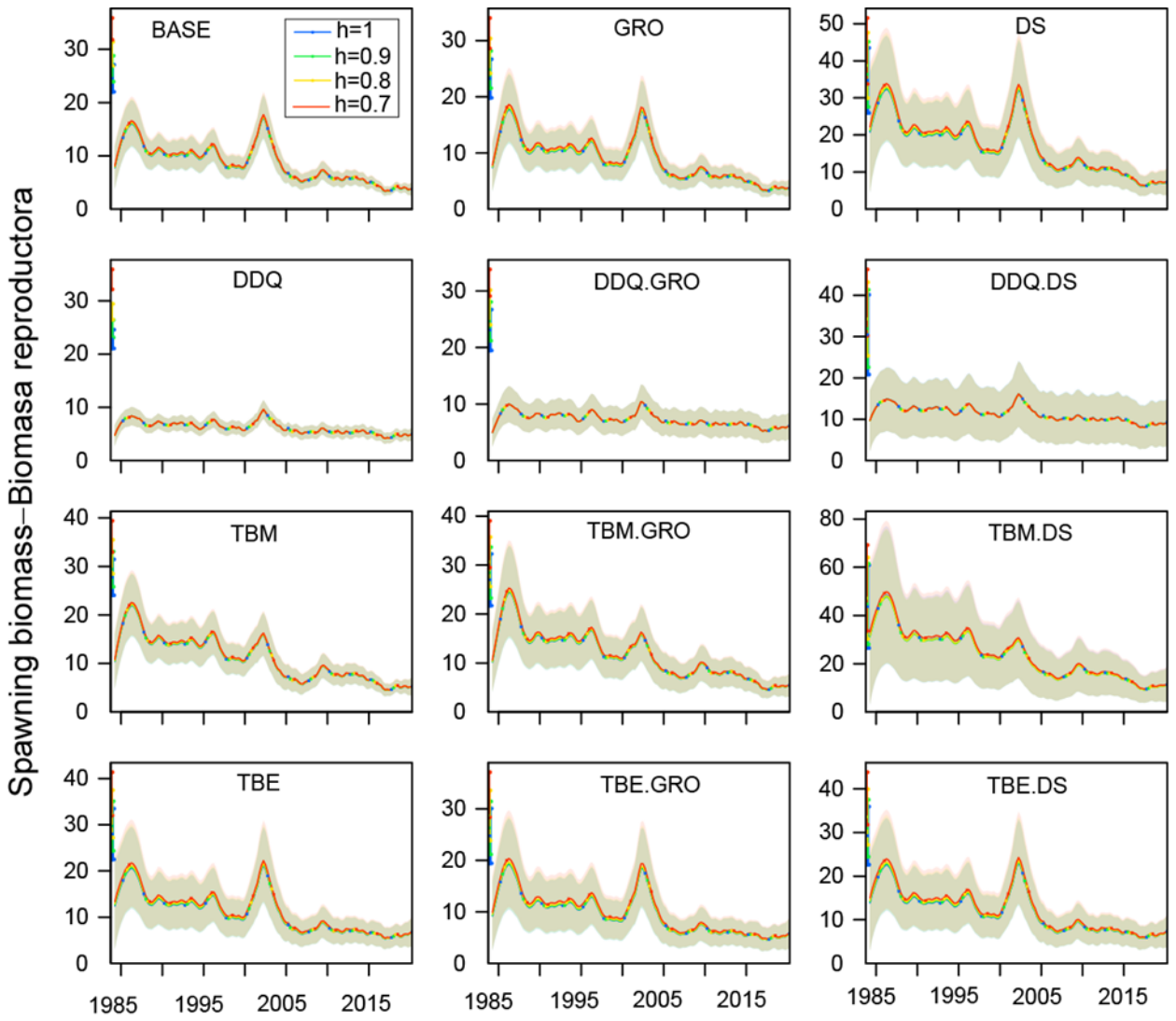
Hypotheses flow chart for yellowfin



Set of reference models

Model	Description
Level 2A Hypotheses: relationship between index and population (+ changes in selectivity)	
Proportional (BASE)	• Index proportional to abundance
Density dependence (DDQ)	• Index non-linearly related to biomass, parameter estimated
Time block middle (TBM)	• Block in index catchability 2001.Q1-2003.Q2 • Block in selectivity 2002.Q3-2007.Q3 for index, F18-DEL-C, F19-DEL-P
Time block end (TBE)	• Block in index catchability 2015 on • Block in selectivity of F19-DEL-P
Level 2B hypotheses: fit to length frequency	
Fixed (BASE)	• Fixed growth and selectivity asymptotic for fleet F19-DEL_P
Estimate growth (GRO)	• Eastimate growth and selectivity asymptotic for fleet F19-DEL_P
Estimate selectivity (DS)	• Fixed growth and selectivity for fleet F19-DEL_P is estimated as dome-shaped

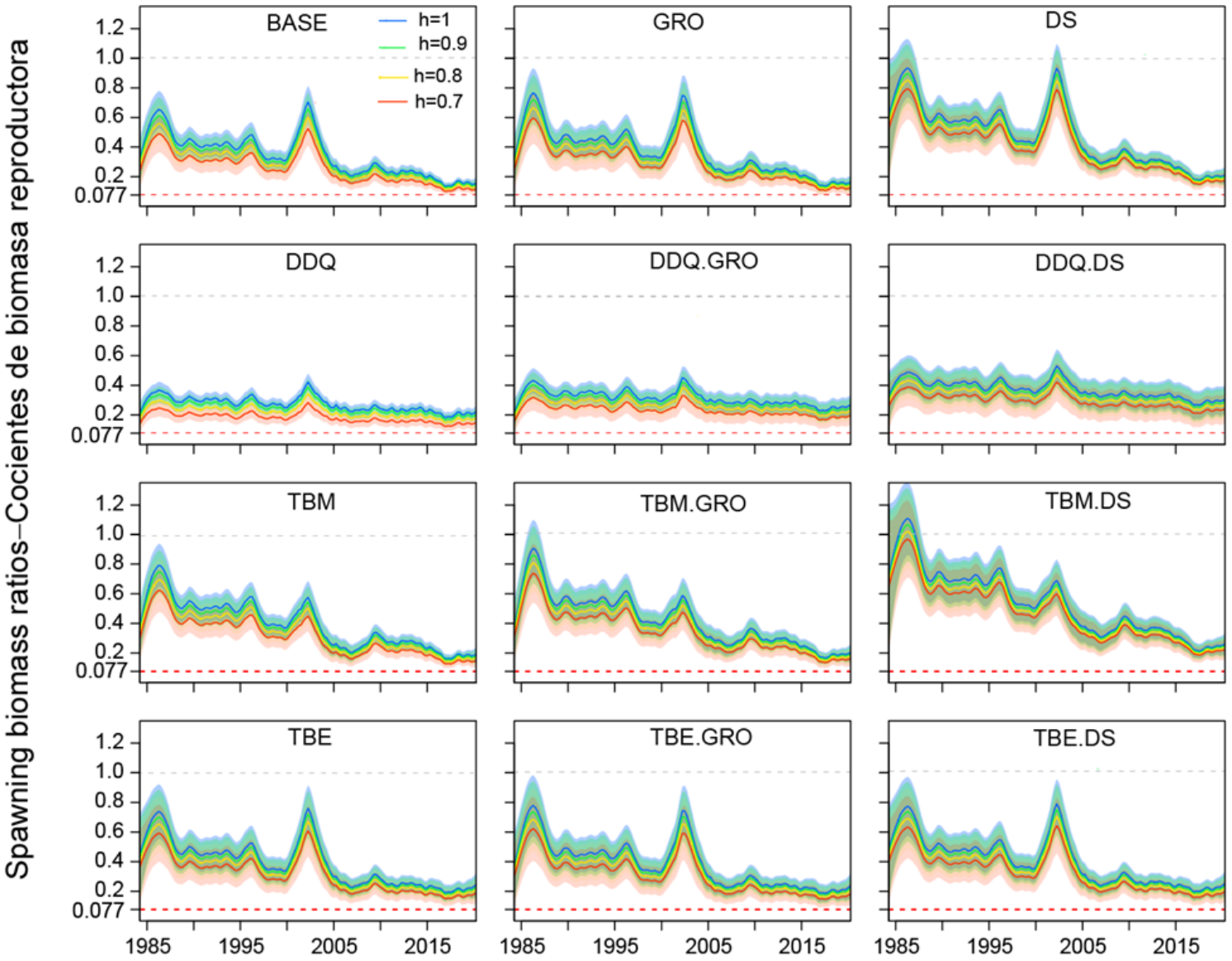
Results – spawning output



All models:

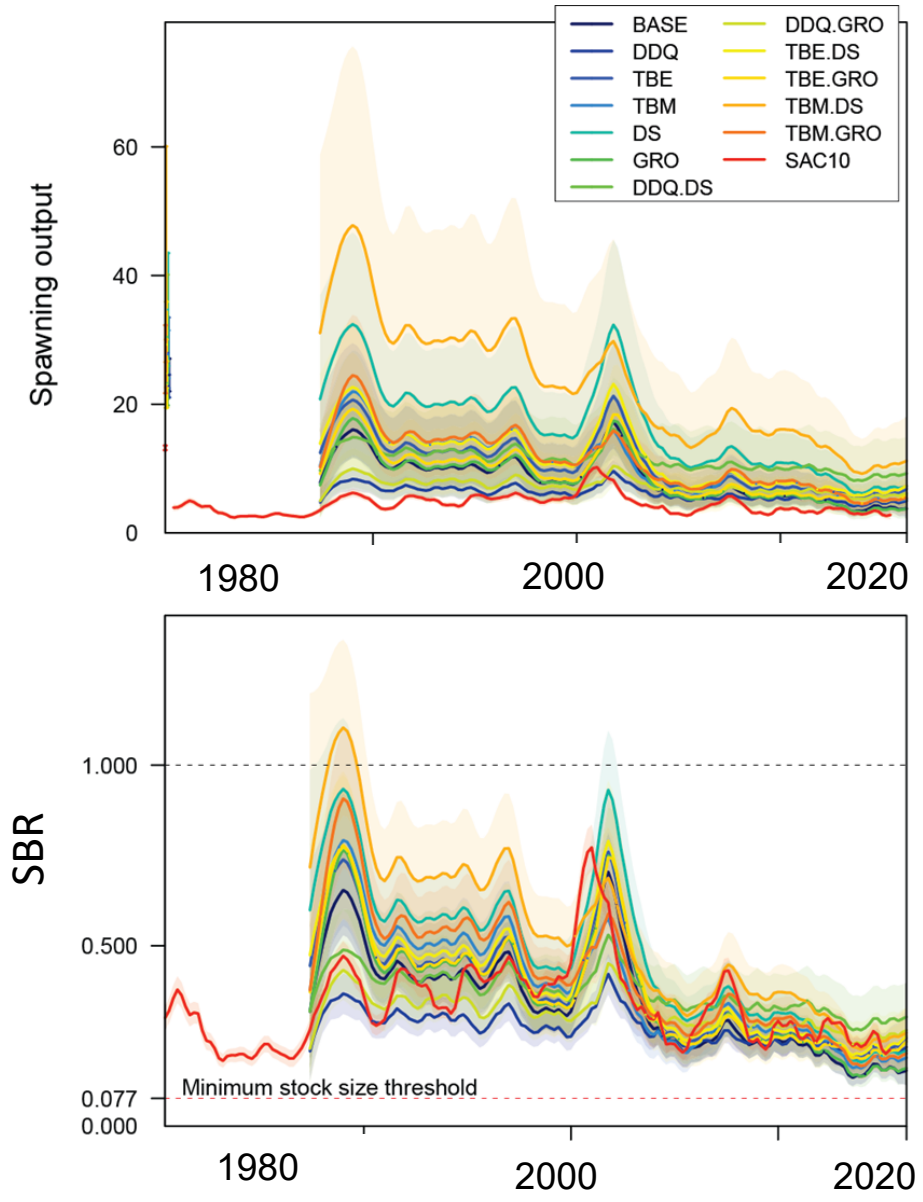
- Spawning “biomass” not affected by the steepness of the stock-recruitment curve
- Virgin spawning biomass larger for smaller steepness

Results – spawning biomass ratio (SBR)



- SBR sensitive to steepness:
  - h=0.7 more depleted
  - h=1 less depleted
- Density-dependent models: more stable SBR series
- Time-block in the middle models: largest population declines

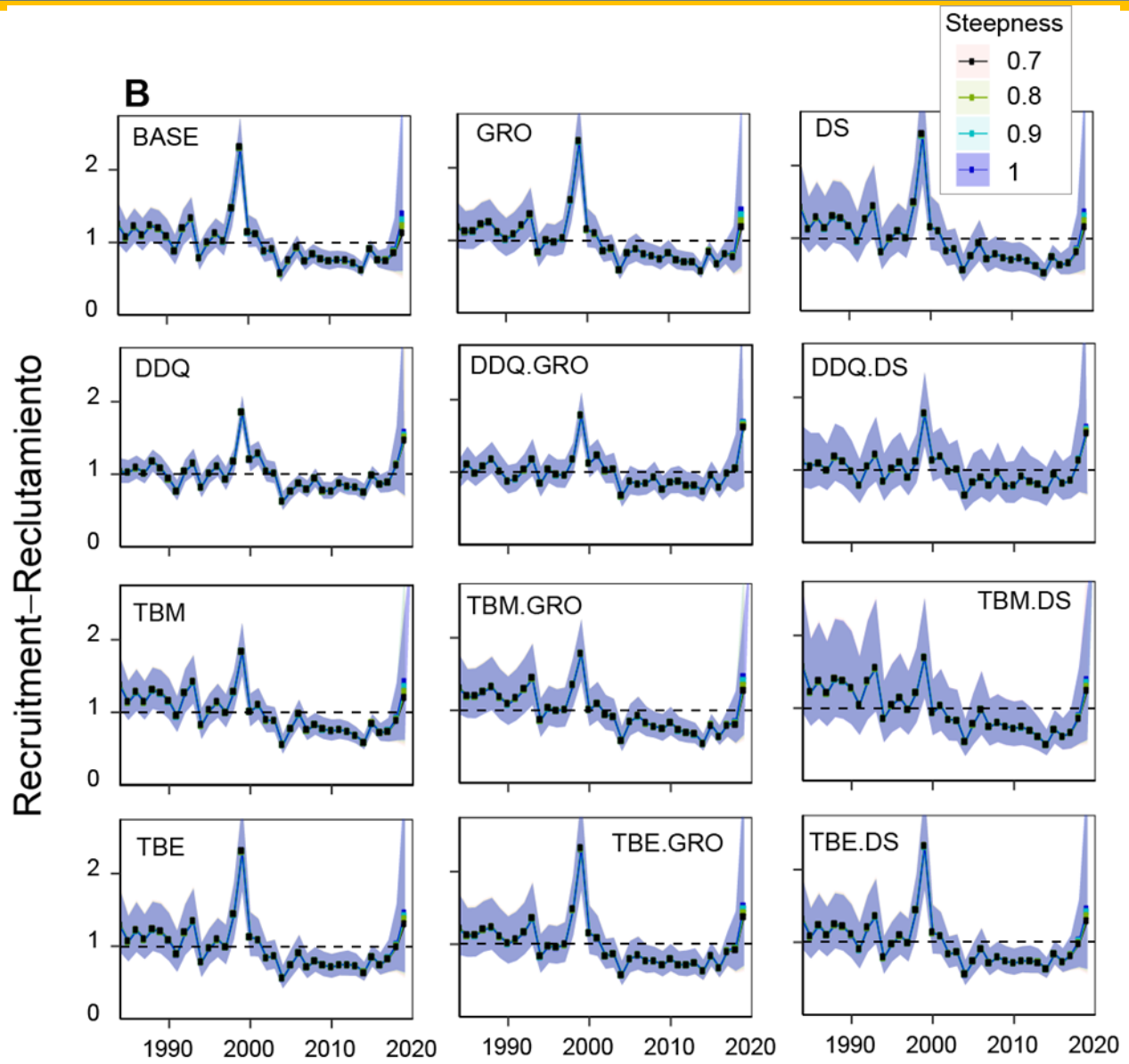
Results – spawning biomass ratio



Comparison previous assessment (SAC10) with h=1 models:

- Twelve reference models have larger uncertainty
- SBR of previous assessment (SAC10) more variable

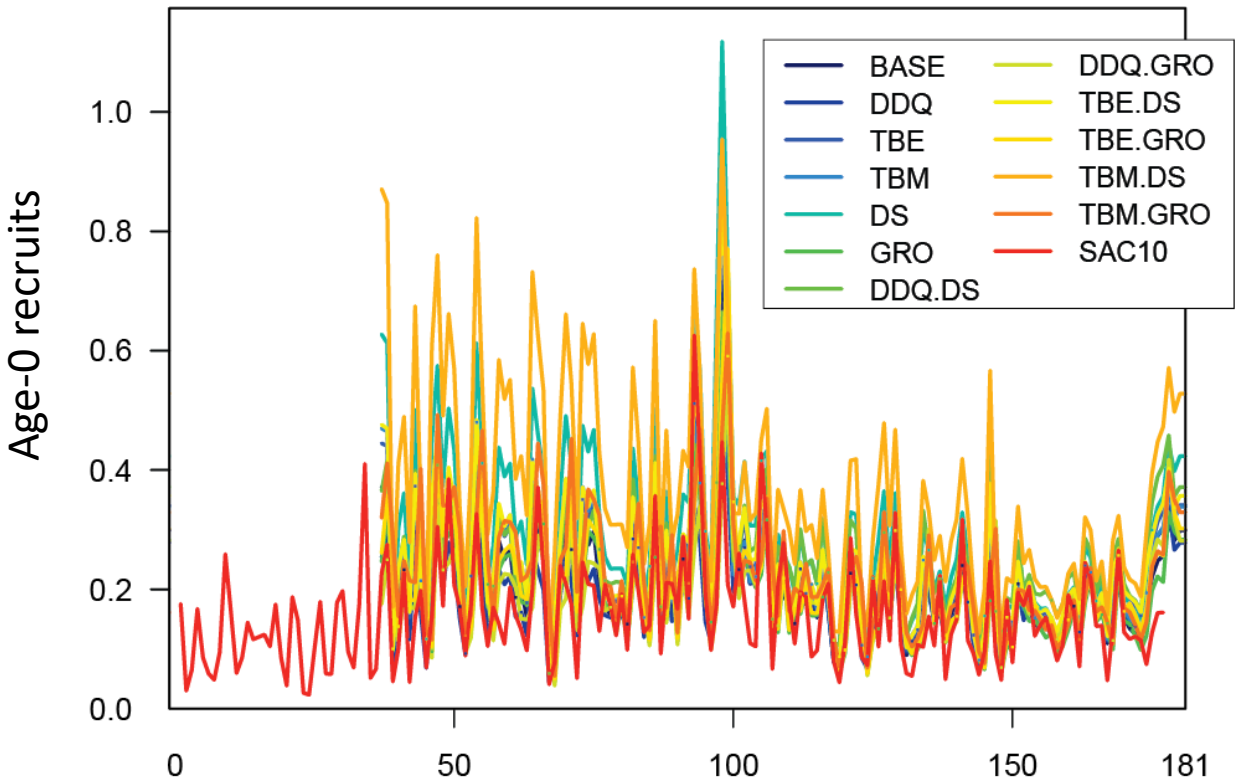
Results - relative annual recruitment



All models:

- Not sensitive to steepness
- below average recruitment since 2003
- Recent recruitment very uncertain

Results - recruitment

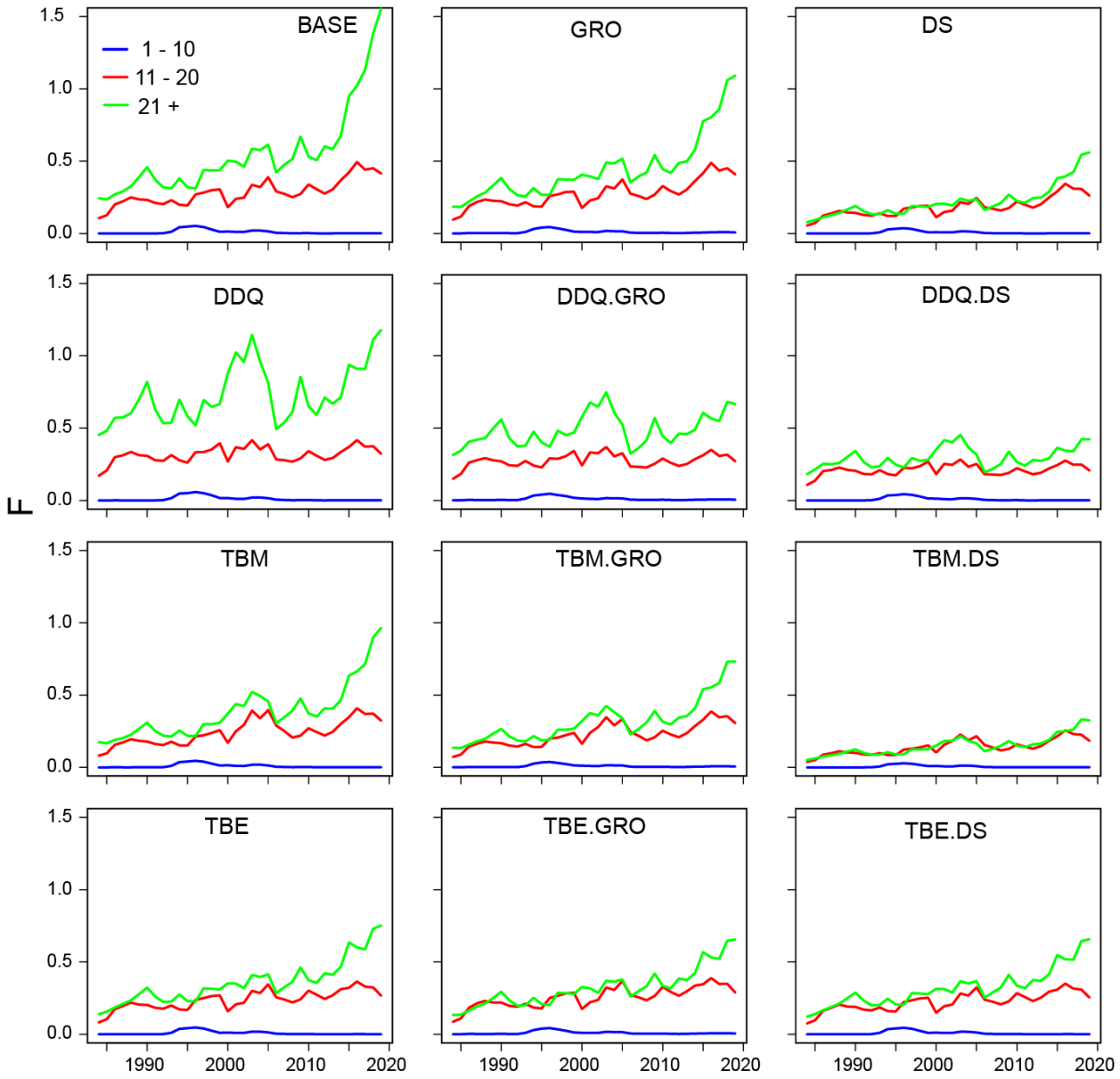


Comparison previous assessment (SAC10)

with steepnes h=1 models:

- Twelve reference models have larger estimate of recruitment

Results – annual fishing mortality



- Highest *F* on fish aged 21+ quarters

  followed by fish aged 11 to 20 quarters

- Lowest F on youngest fish

- Increase of F over time

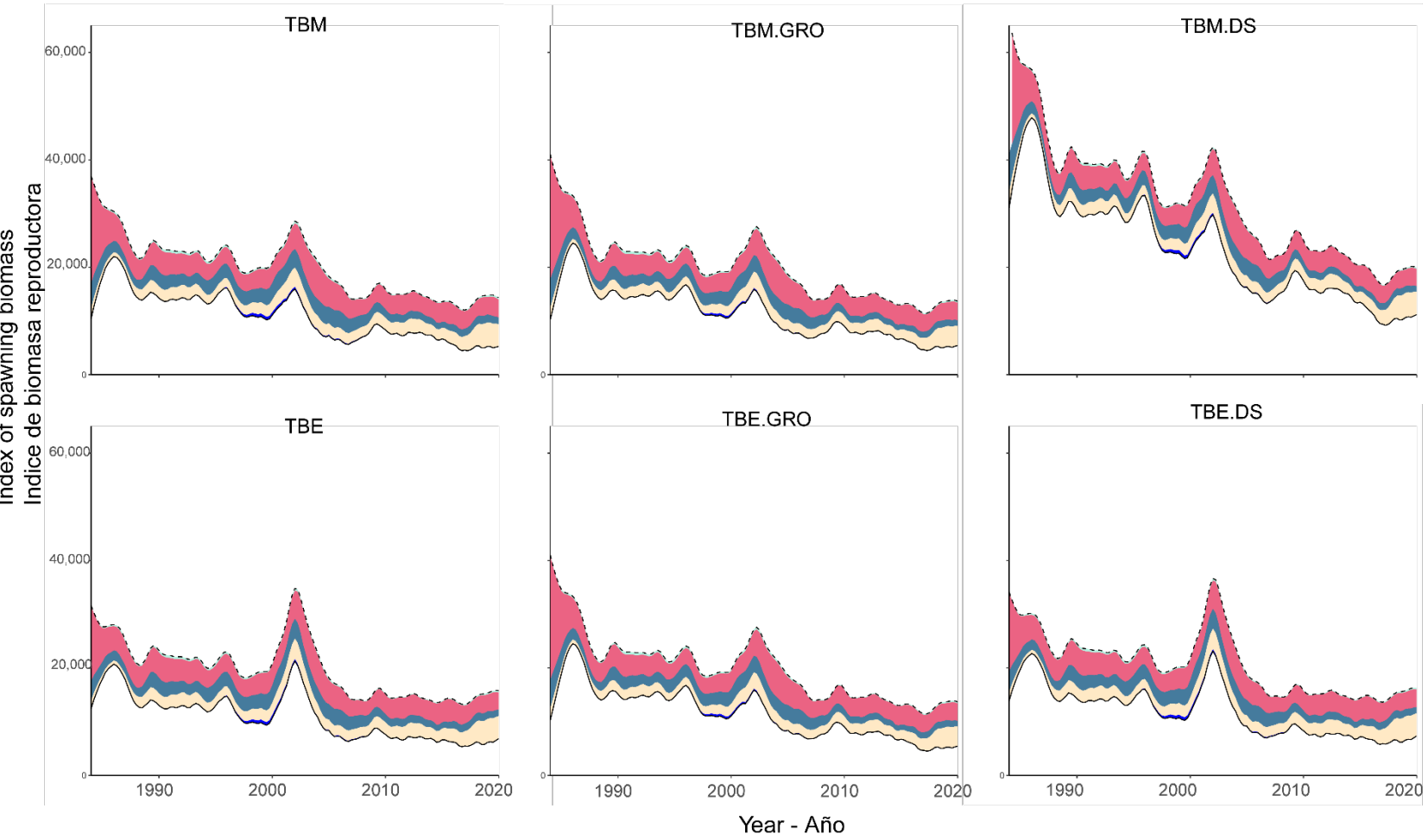
- Fixed growth have the highest *F* for age

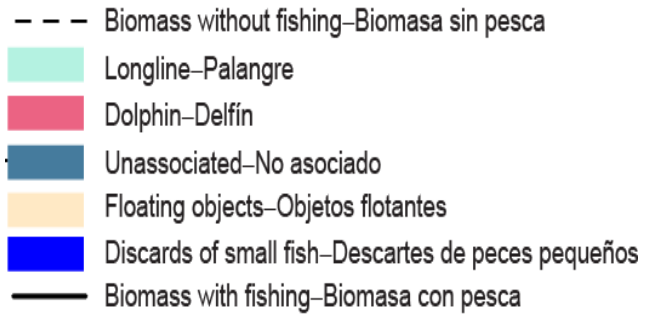
  21+ fish

- Time blocks influence the F trajectories

Results – fishery impact plot

h =1





- The **smallest** impacts:
  - Sorting discard from floating objects
  - Longline
- The **largest** impacts:
  - Overall dolphin associated purse-seine fisheries
  - Floating object impact increasing in recent years and are the largest in 2019

Conclusion

Previous benchmark assessment:

- One base-case model with an assumed steepness of 1.0
- Management advice based on point estimate
- In 2019 the assessment was rejected by the staff, the model was oversensitive to the inclusion of the longline index of abundance

This benchmark assessment:

- Embrace uncertainty
- An index of abundance based on the purse-seine fisheries associated with dolphins was adopted
- Several hypotheses about the population dynamics of yellowfin tuna were proposed and modeled
- The hypotheses were generated within a hierarchical framework, the broadest level was related to spatial structure
- Is centered on the core area of the catches
- Four assumed steepness (0.7, 0.8, 0.9, 1.0) X 12 configurations to better fit the data = 48 models

Next step in the risk analysis approach

Described in Maunder et al. 2020 (SAC-11- INF-F):

1. **Identify alternative hypotheses** (‘*states of nature*’) about the population dynamics of the stock that address the main issues in the assessments
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Thank you