

# Comisión Interamericana del Atún Tropical Inter-American Tropical Tuna Commission



Use of diagnostic tools to understand integrated stock assessment models:  
the case of yellowfin tuna in the eastern Pacific Ocean

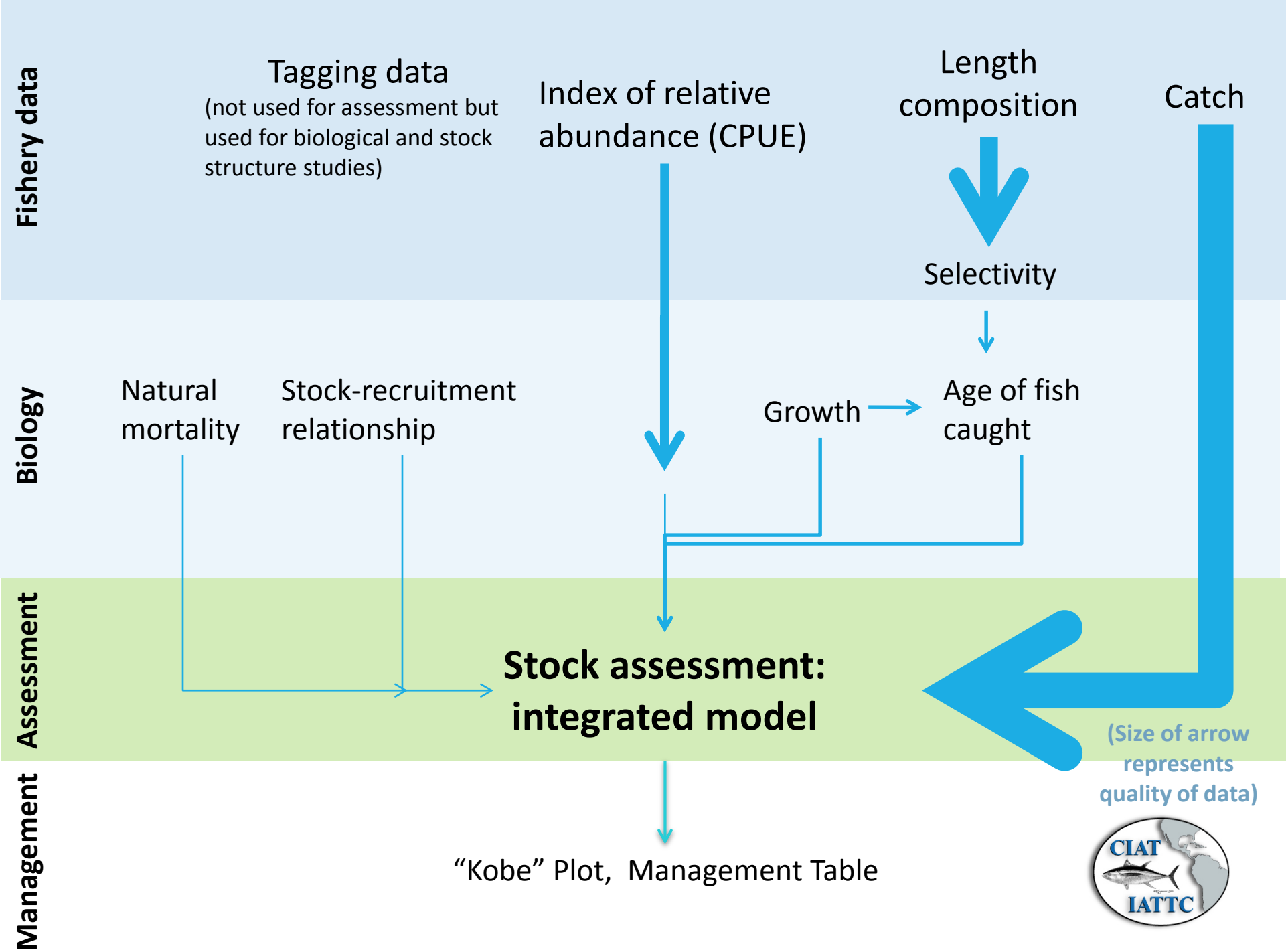
Carolina Minte-Vera,, Mark Maunder, Alexandre M. Aires-da-Silva

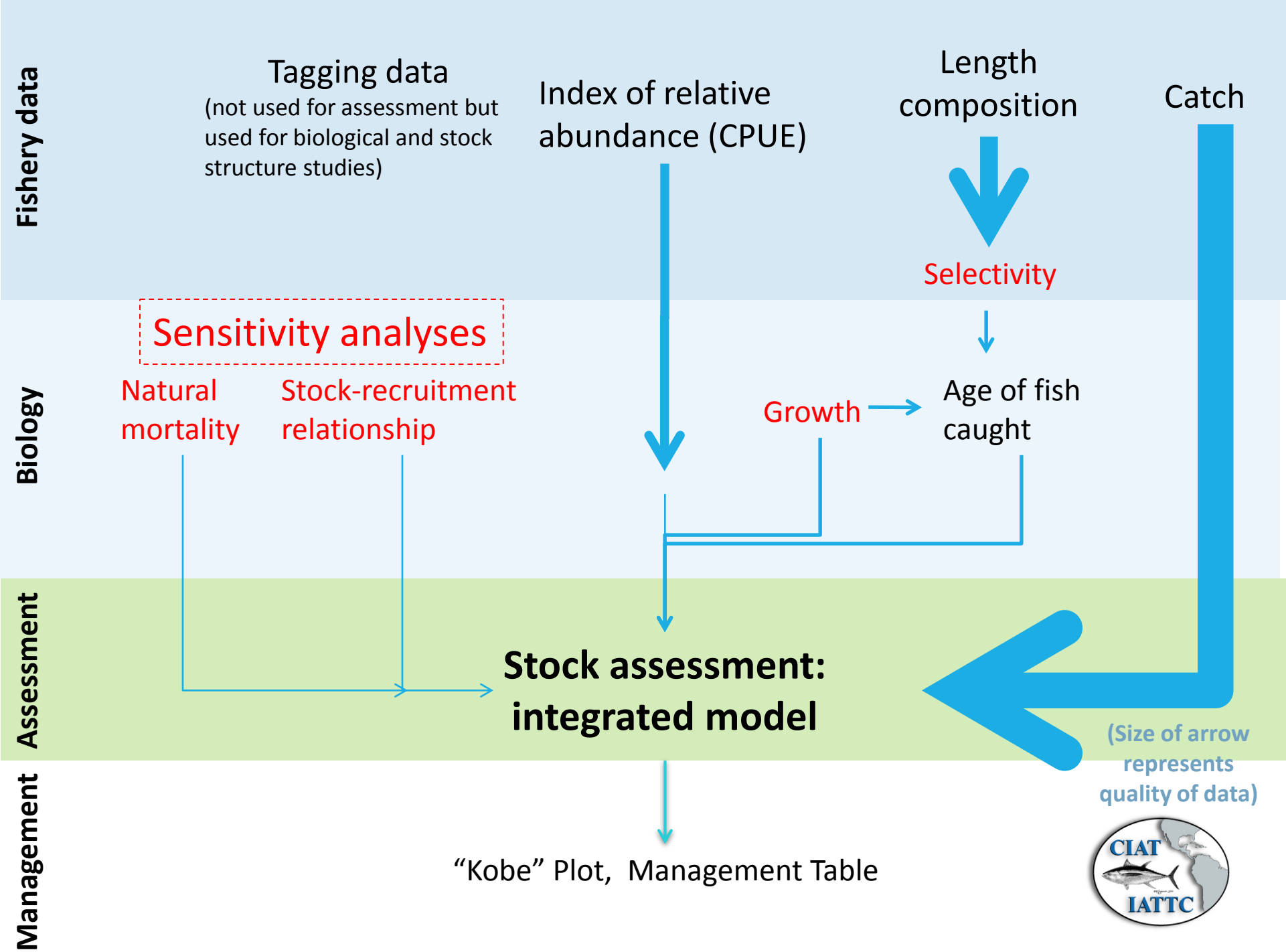
# MAIN GOAL

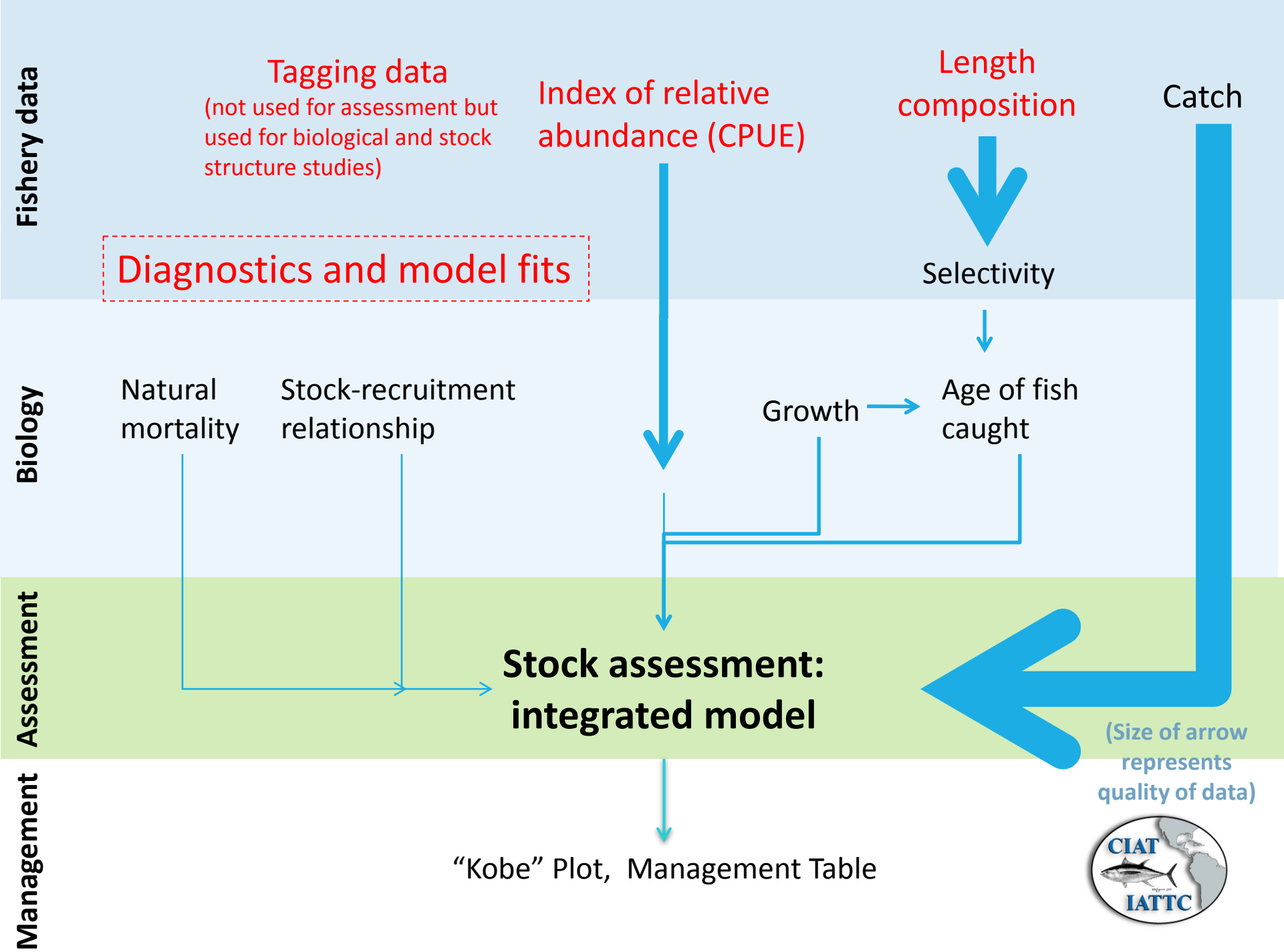
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**To investigate the ability the integrated assessment model to estimate abundance in for yellowfin tuna in the eastern Pacific Ocean (EPO).**

By using recently-proposed **diagnostic tools** that use different components of the data, and one **auxiliary model** to **better understand the integrated model** and **detect potential model misspecification**





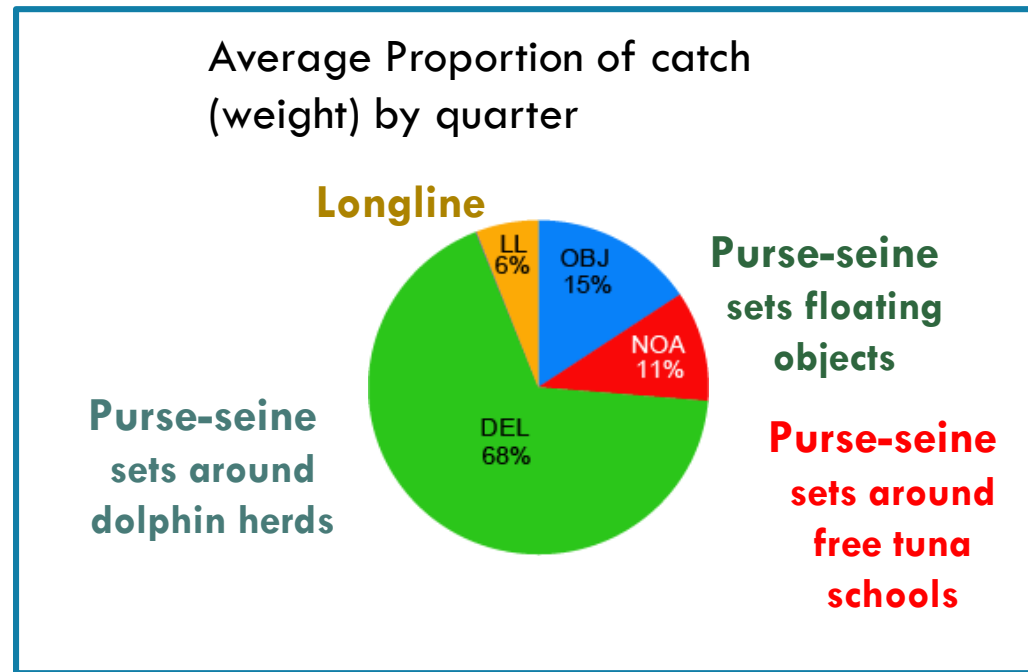


Diagnostics and model fits



## The assessment of yellowfin tuna the EPO

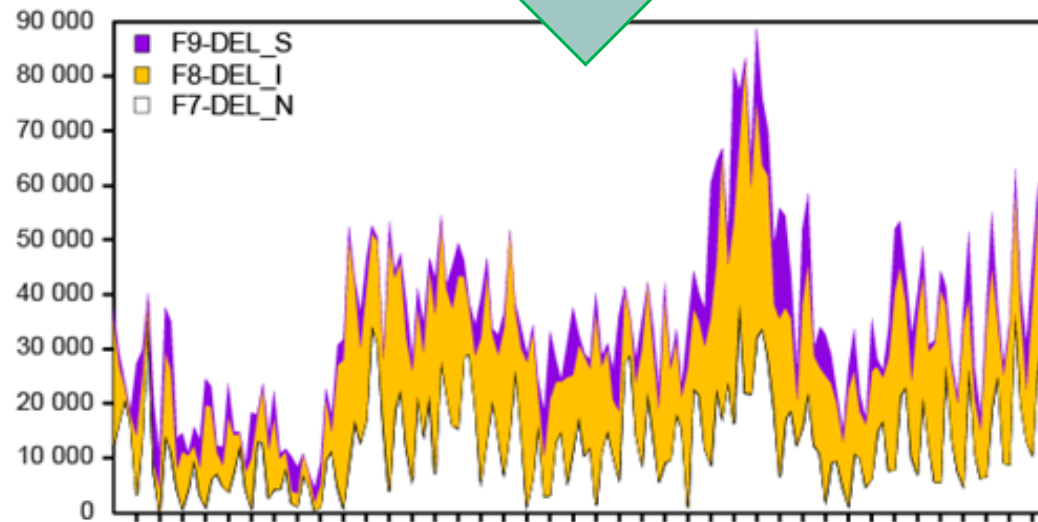
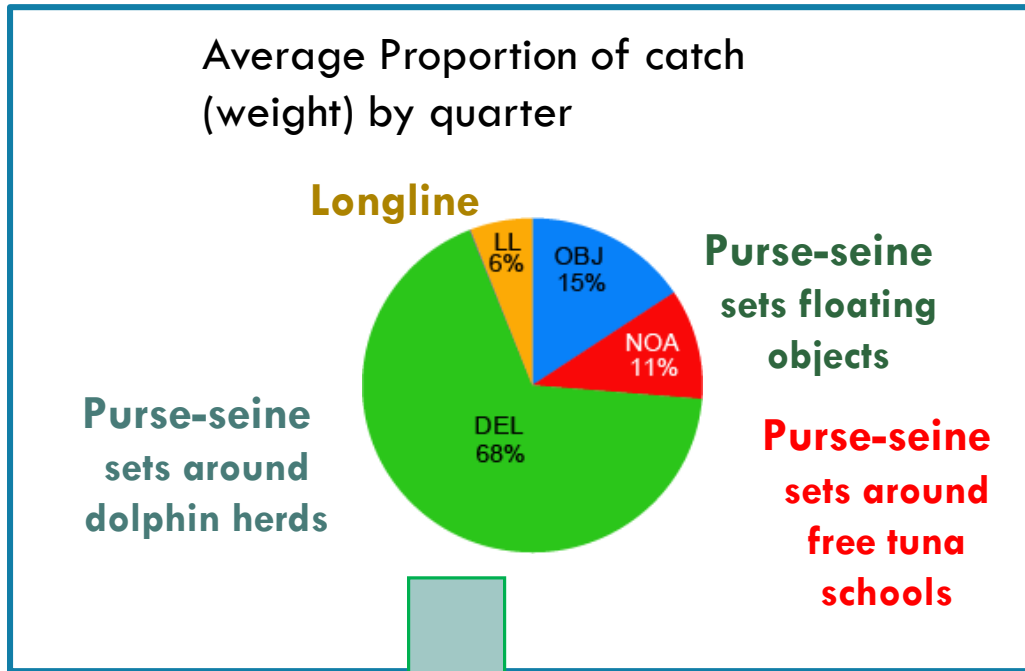
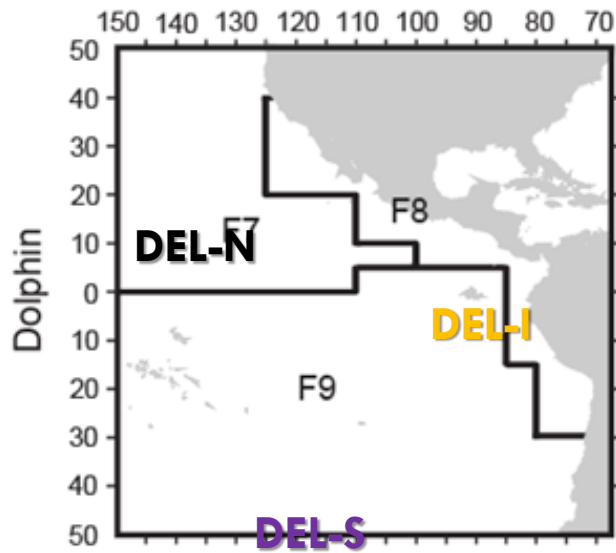
- Integrated statistical age-structured population dynamics model (Stock Synthesis)
- Conditioned on catches
- **Fit to:**
  - 5 indices of relative abundance (main index from longliners)
  - size-composition data
- **Assumes:**
  - one stock
  - Purse-seine fisheries by set type
  - 2 longline fisheries (one with asymptotic selectivity)
  - Richard growth curve ( $L_2=182$  cm)
  - Sex-specific natural mortality
  - Steepness  $h=1$
  - Recruitment  $CV = 0.6$
  - Temporal scale: quarter



# The assessment of yellowfin tuna the EPO

- Fisheries defined by gear (set type) and area of operation.
- Example:

Fishery definitions for DEL: Purse-seine sets around dolphin herds



# DIAGNOSTICS TOOLS FOR INTEGRATED MODELS

## PLUS ONE AUXILIARY ANALYSIS

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We used:

Likelihood profile on the scaling parameter

Age-structure production model – fit only to indices of relative abundance

Catch curve analysis – fit only to length-frequency data

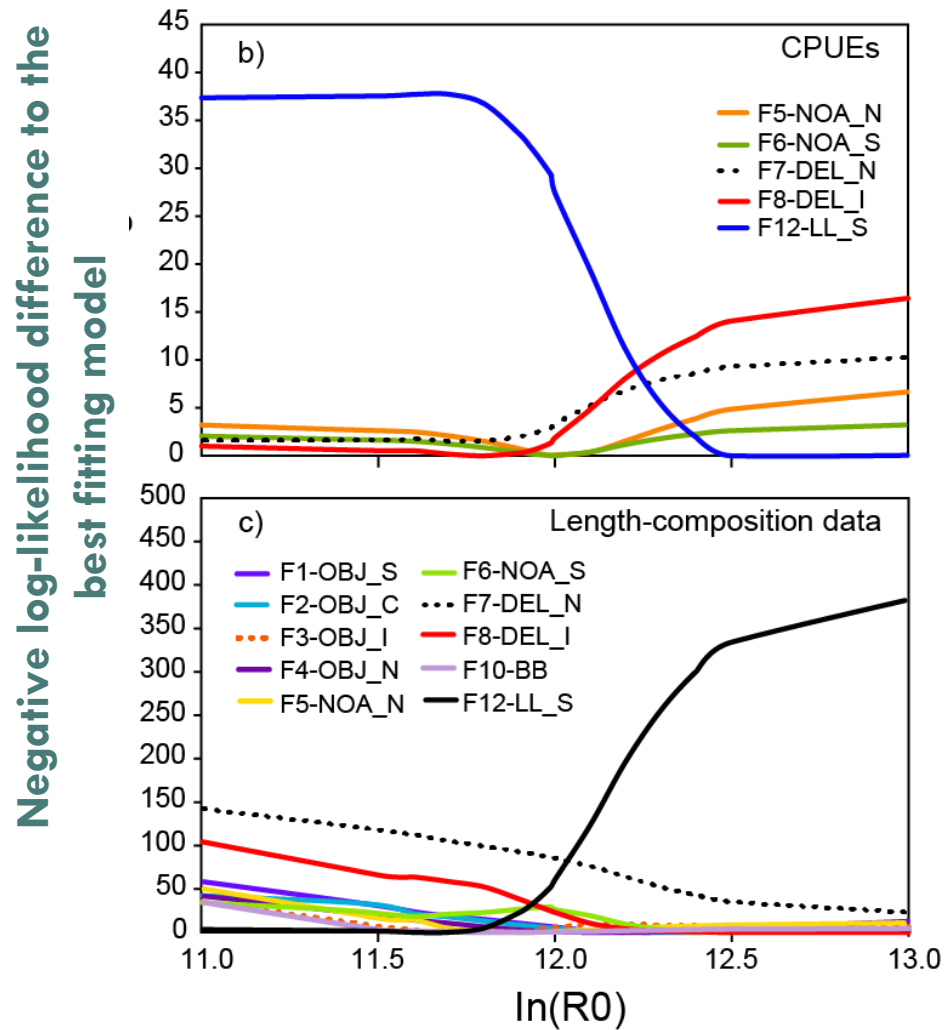
Depletion model - simplified population dynamics model, fit only to purse-seine CPUE





		Assessment and diagnostic models					
		Integrated Model IM	Age-structured Production Model ASPM	ASPMdev	ASPMfix	Catch-curve Model	Depletion Model
<b>Temporal scale</b>		Quarter	Quarter	Quarter	Quarter	Quarter	<b>Month</b>
<b>Data</b>							
	CPUEs	<b>yes</b>	<b>yes</b>	<b>yes</b>	<b>yes</b>	<b>no</b>	<b>yes</b>
	Size compositions	<b>yes</b>	<b>no</b>	<b>no</b>	<b>no</b>	<b>yes</b>	<b>no</b>
<b>Parameters</b>							
	Catchabilities	estimated	estimated	estimated	estimated	-	estimated
	Selectivities	estimated	<b>fixed at IM estimates</b>	<b>fixed at IM estimates</b>	<b>fixed at IM estimates</b>	estimated	-
	Virgin recruitment $\ln(R_0)$	estimated	estimated	estimated	estimated	estimated	-
	Initial conditions $(R_{init}, F_{init})$	estimated	estimated	estimated	estimated	estimated	-
	Recruitment deviations (recdev_early, rec_dev)	estimated	<b>0</b>	estimated	<b>fixed at IM estimates</b>	estimated	<b>One recruitment per year</b>

# In(R0) likelihood profile



R0 is the virgin recruitment (the parameter that gives the absolute scale of the integrated model)

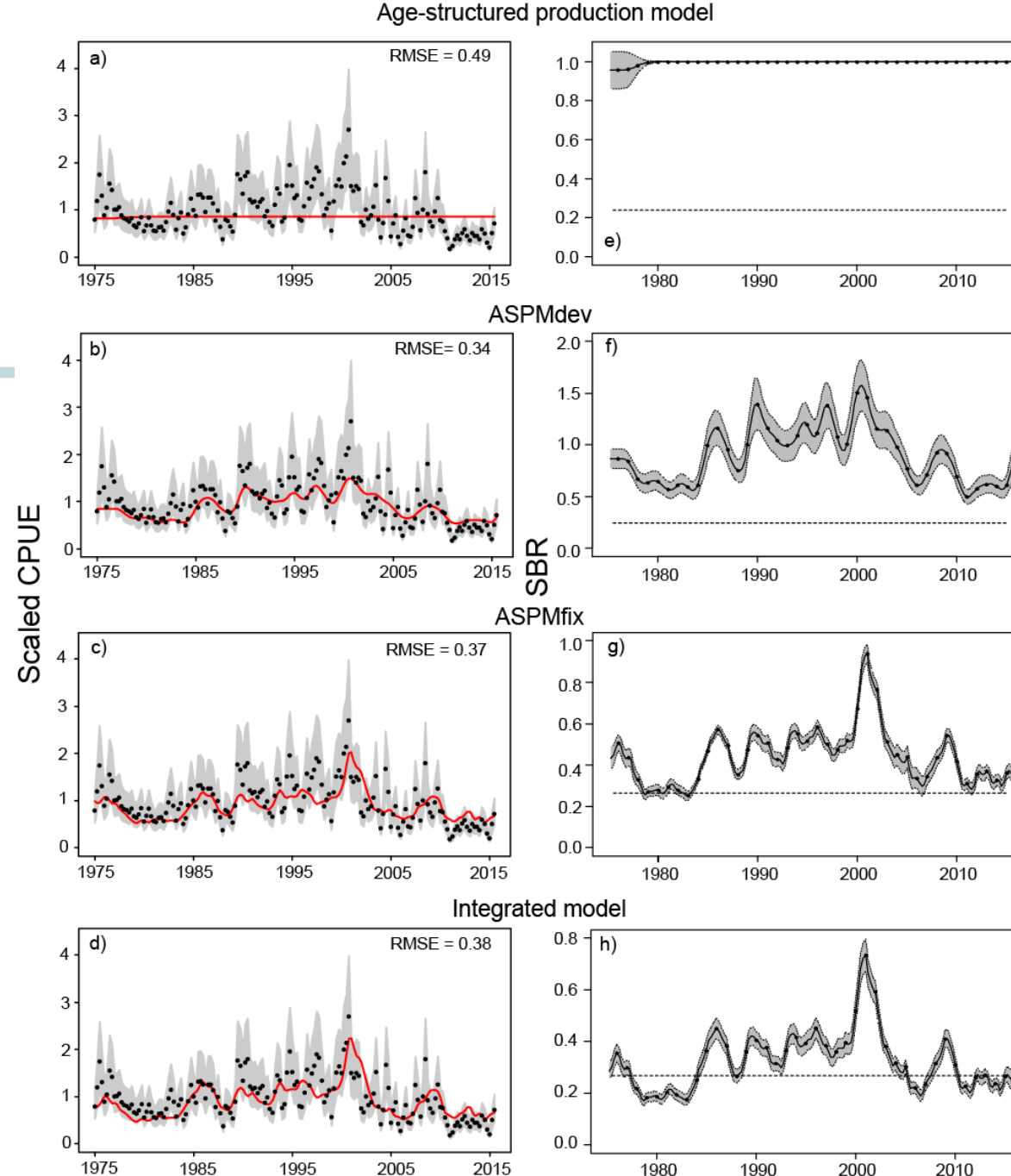
Contradictory signals about scale from different data types of the same fishery

Data from F12 LL-S seems to be the most influential one



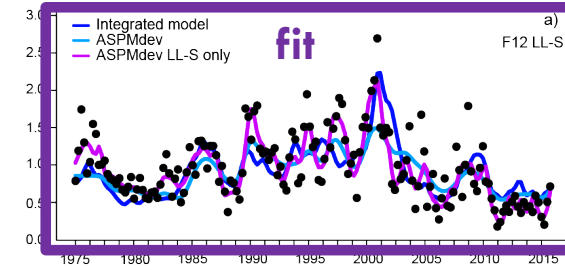
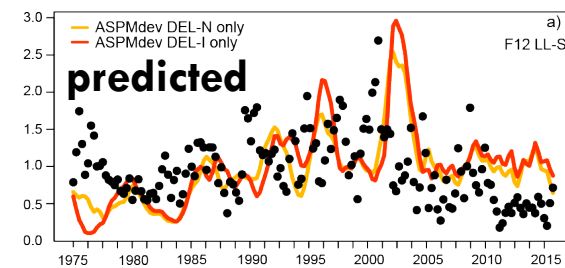
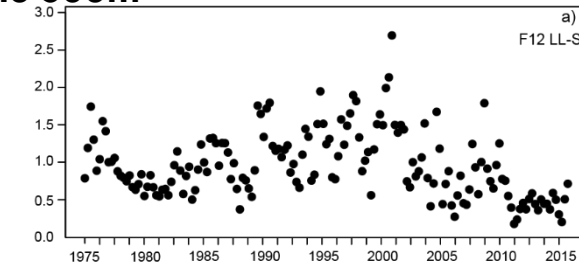
# AGE-STRUCTURED PRODUCTION MODEL

- The biomass dynamics trend cannot be captured (by ASPM)...
- ..unless the recruitment deviations are taken into account (by ASPMdev, ASPMfix)
- when several indices are used, ASPMdev can only approximate the relative scale

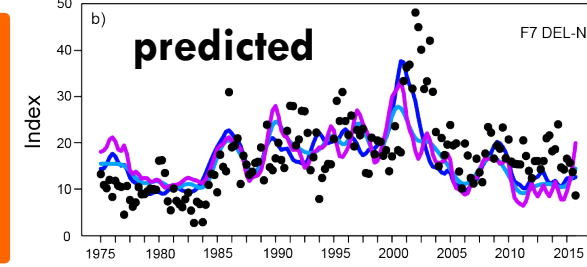
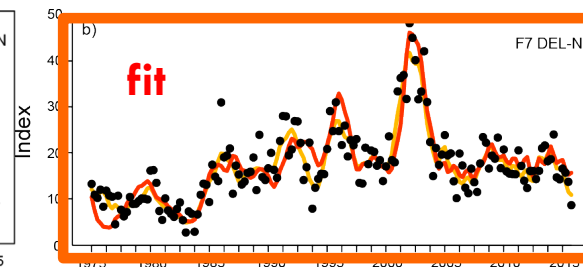
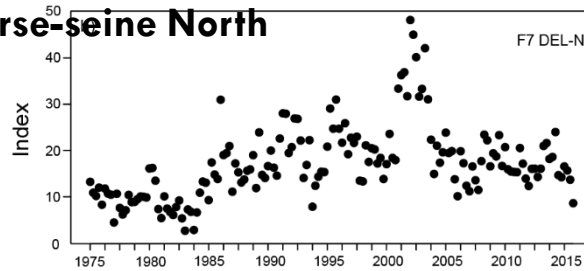


# Age-structured production model (with recruitment deviation estimated, one index)

## Longline South

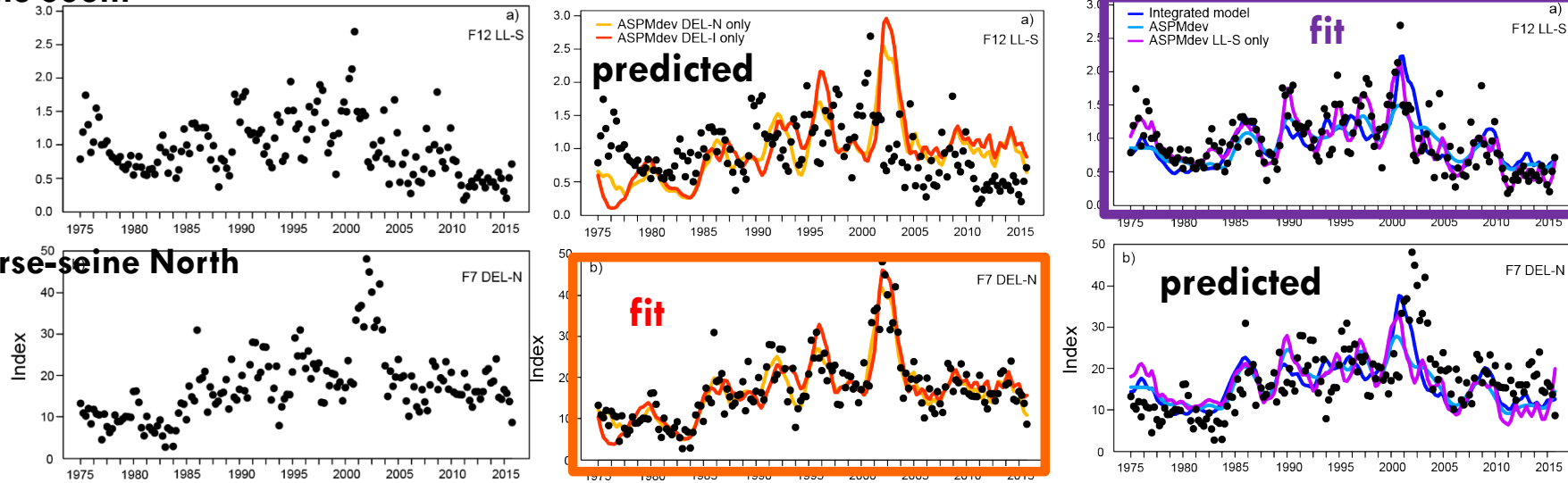


## DEL purse-seine North

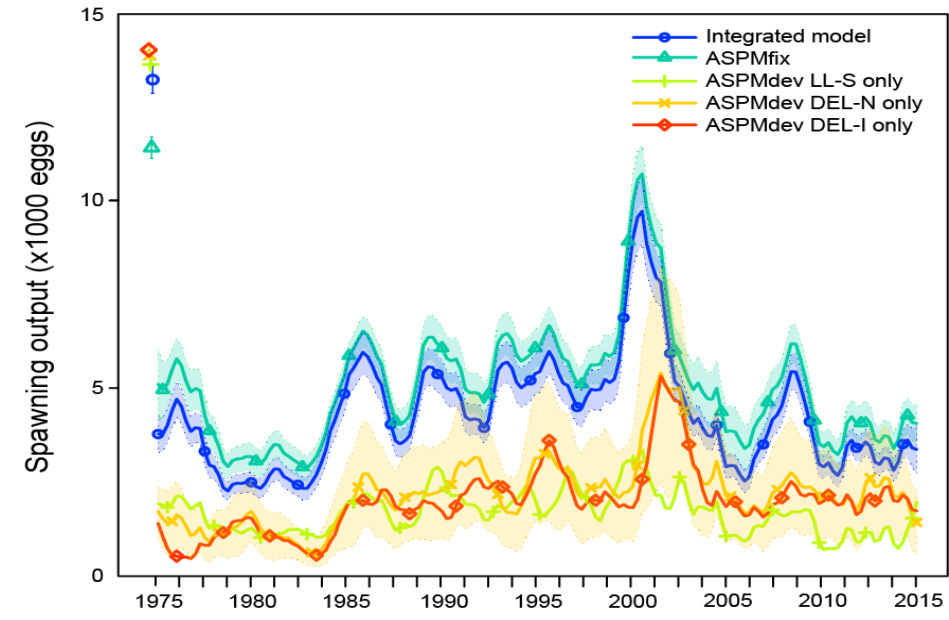


# Age-structured production model (with recruitment deviation estimated, one index)

## Longline South

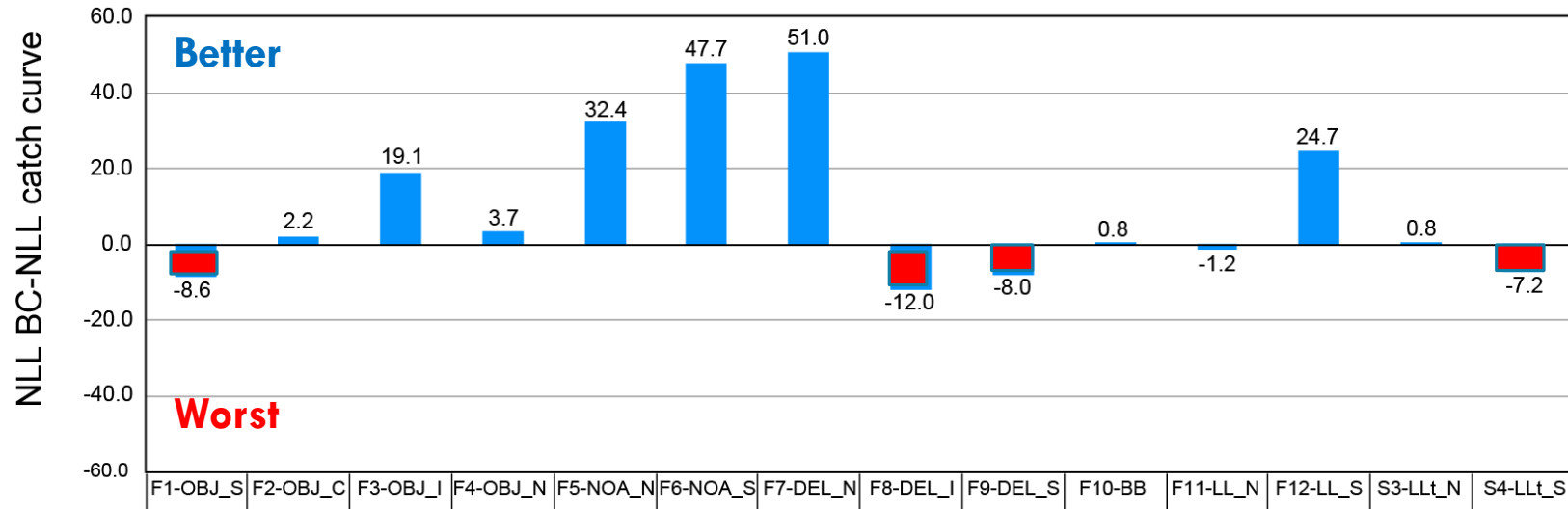


- Information on absolute scale can be extracted only with one index at a time (using ASPMdev)
- Indices do not match: indication of model misspecification -> spatial structure?
- The CPUEs need to be inspected for their ability to index the abundance (mainly LL index)



# Catch-curve model

Fits the length-composition data:

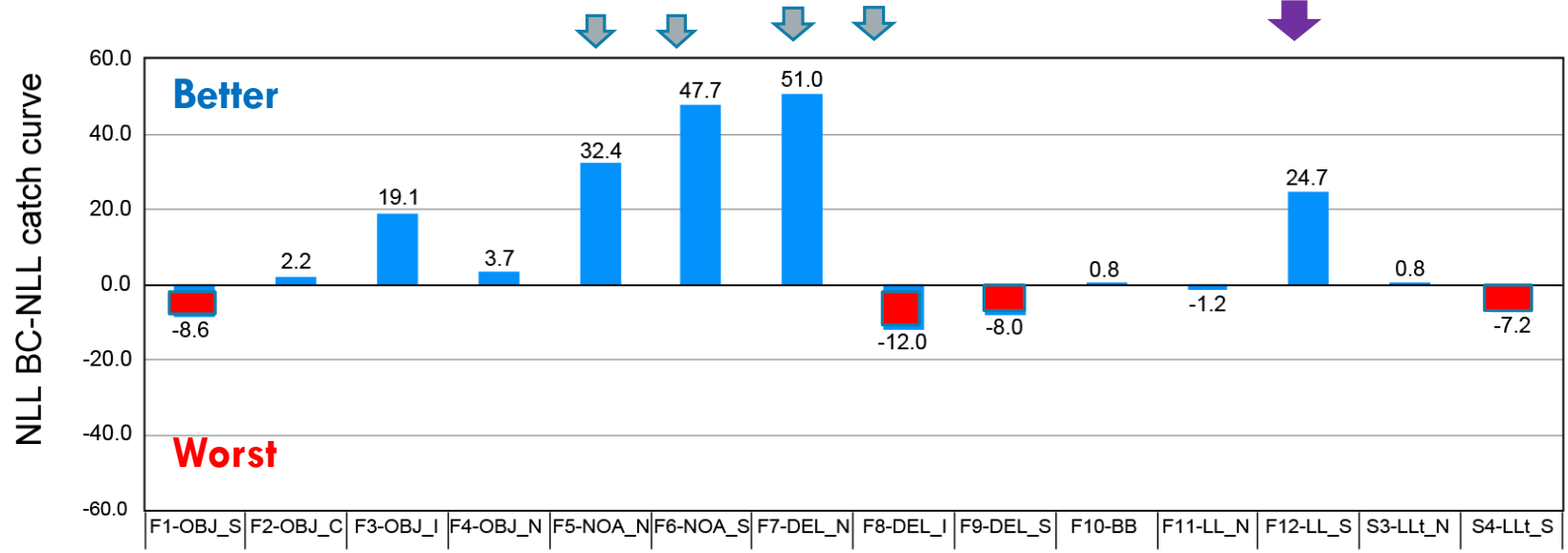


# Catch-curve model

Fits the length-composition data:

Corresponds to secondary index of relative abundance

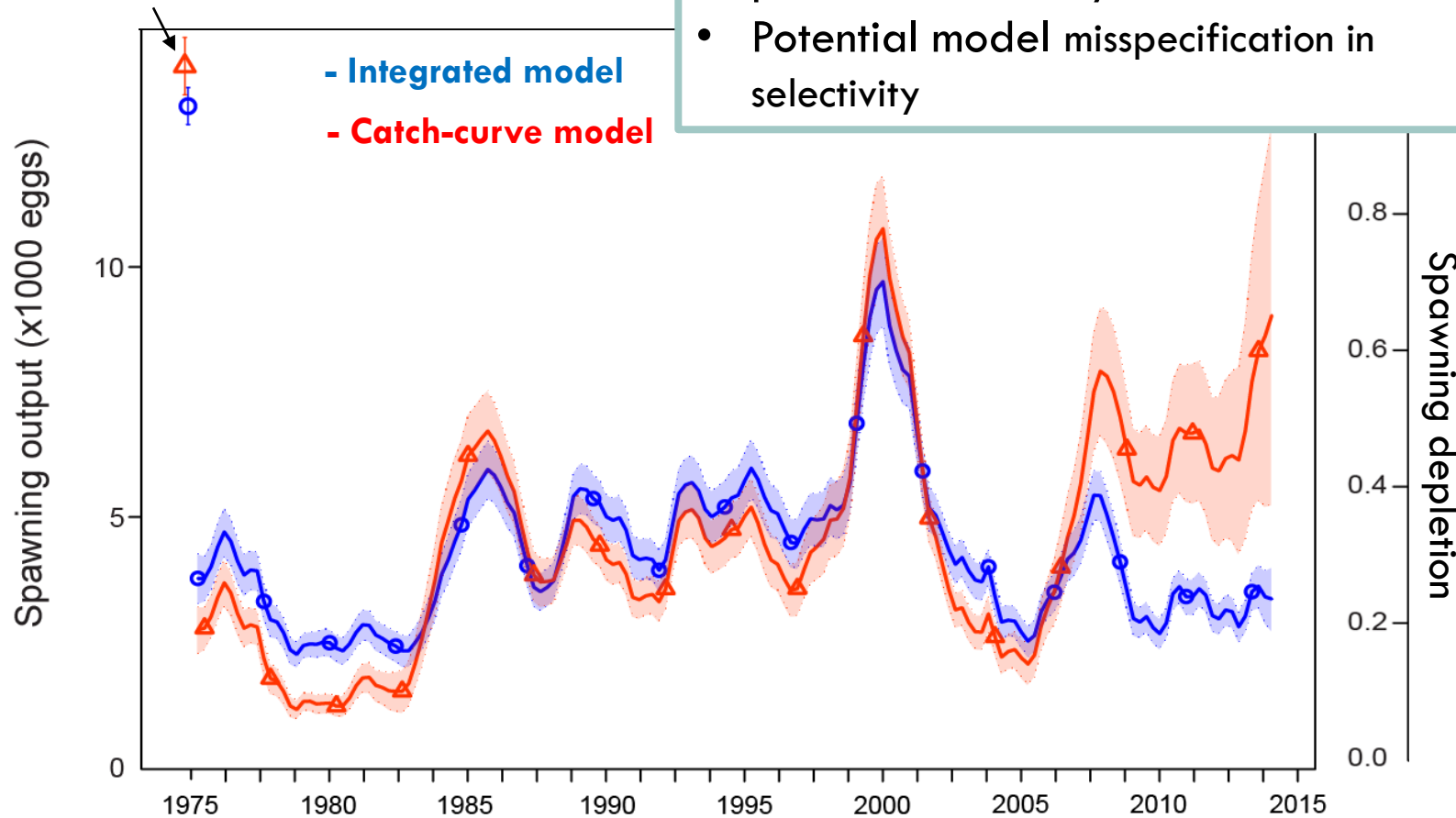
Corresponds to main index of relative abundance



# Catch-curve model: abundance



S0 Virgin spawning output



- CC match most the IM trajectory
- At the end of the series: increase of size in the longline fishery and some purse-seine fishery
- Potential model misspecification in selectivity



# Depletion model

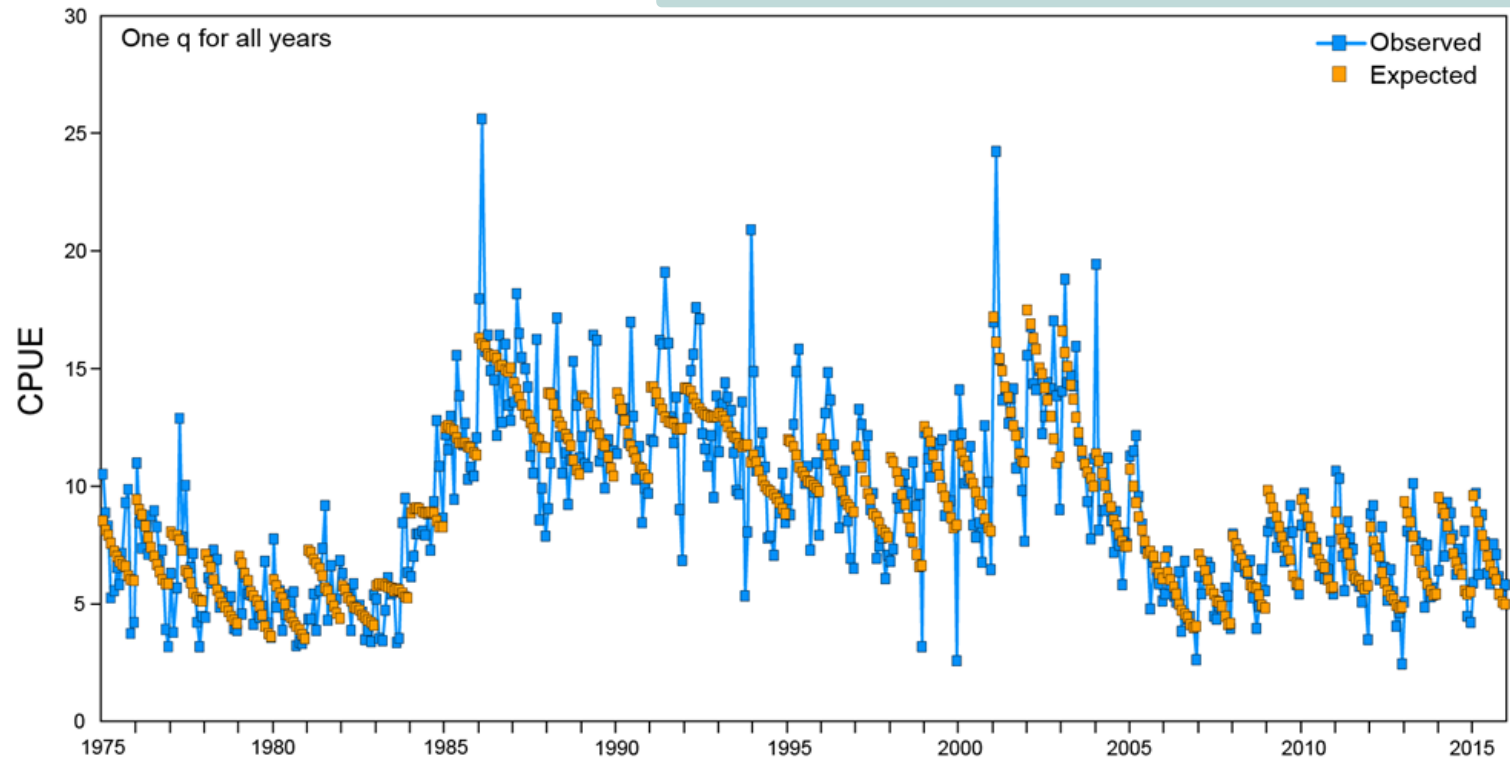
*Managing Data-Poor Fisheries: Case Studies, Models & Solutions* 1:251–258, 2010  
Copyright: California Sea Grant College Program 2010  
ISBN number 978-1-888691-23-8

## A Depletion Estimator for Within-Season Management of Yellowfin Tuna

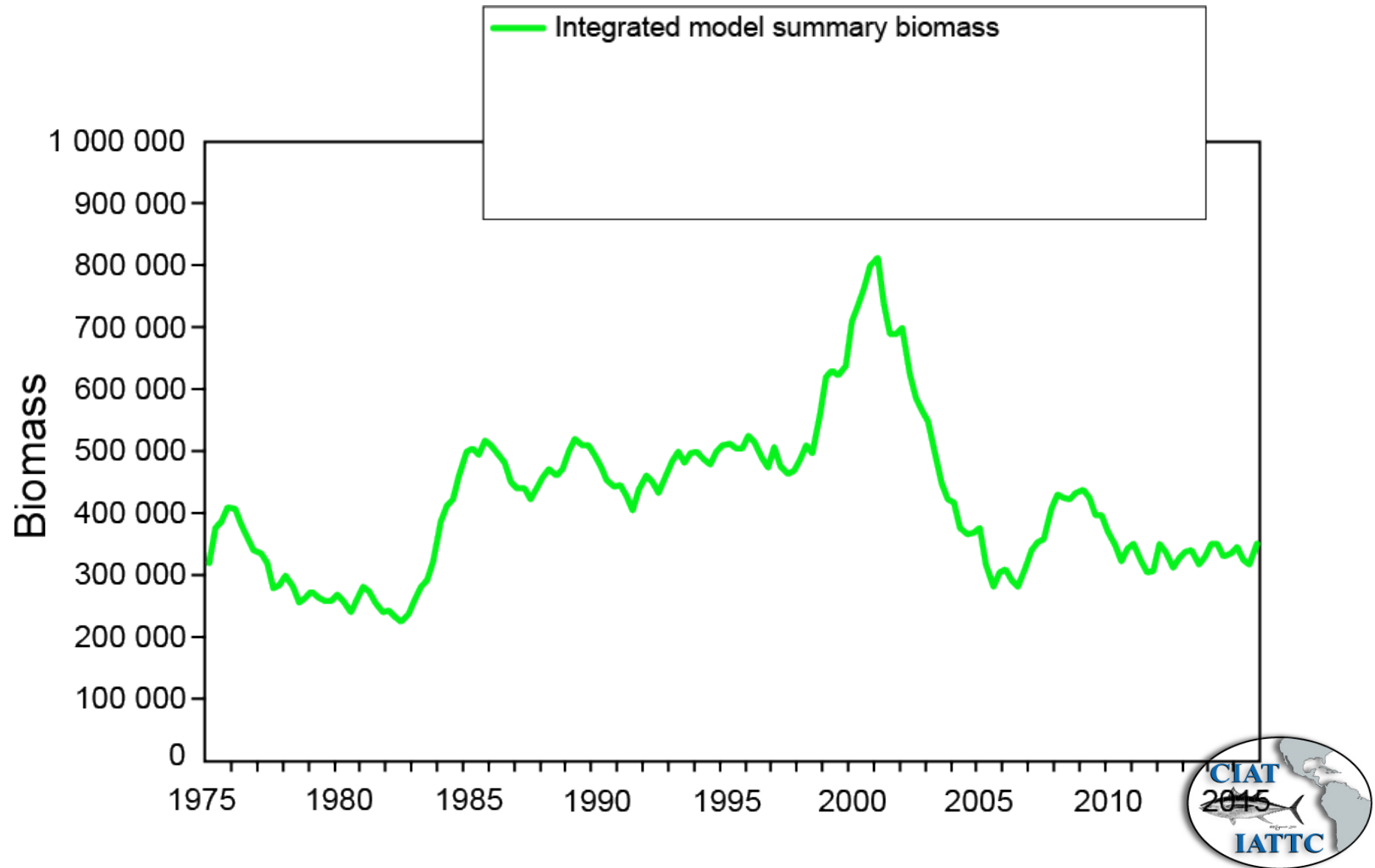
MARK N. MAUNDER

*Inter-American Tropical Tuna Commission,  
8604 La Jolla Shores Drive,  
La Jolla, CA, 92037-1508, USA  
mmaunder@iattc.org*

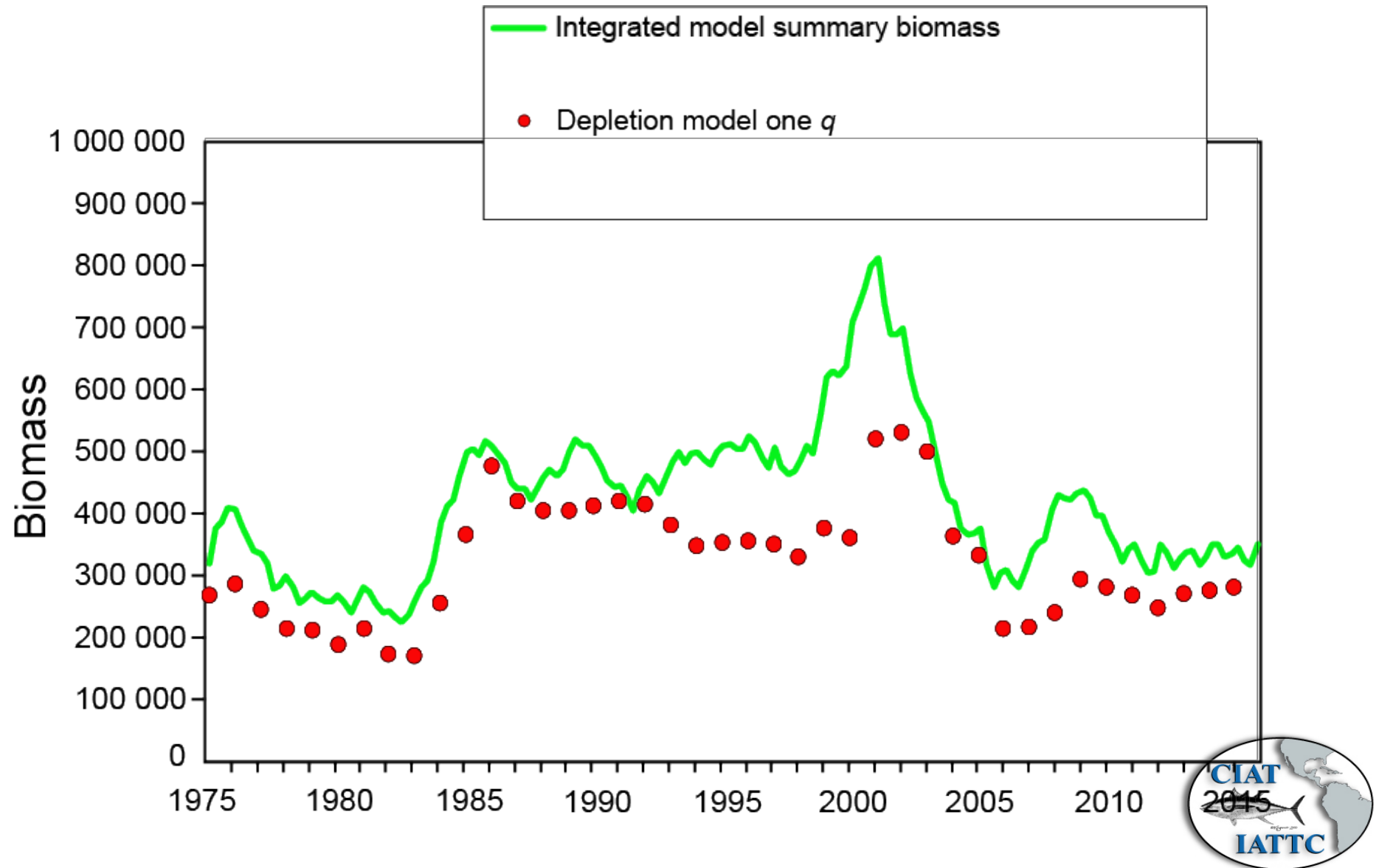
- Good fit to the purse-seine CPUE data
- Monthly time scale seems a good match for the stock



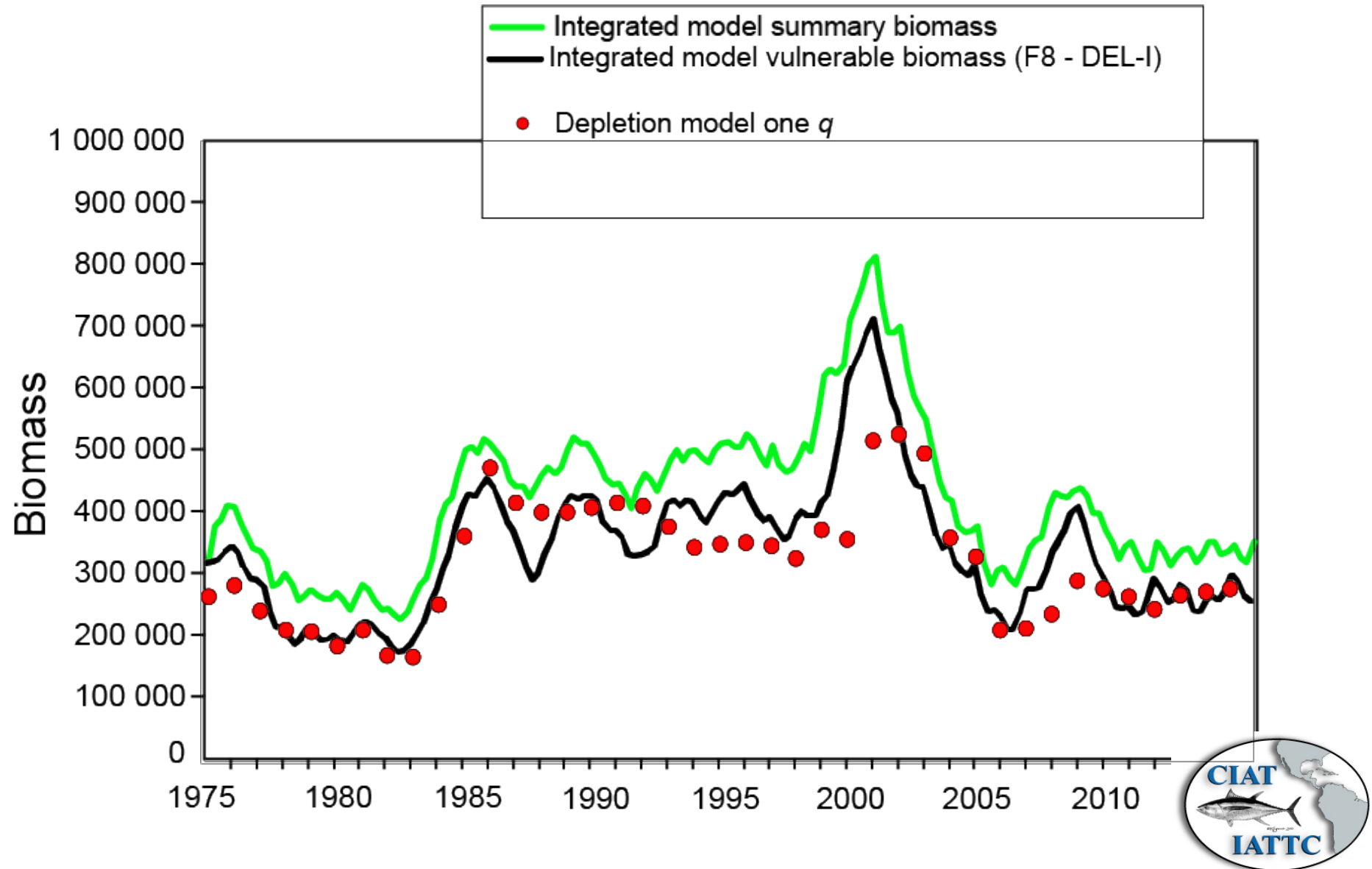
# Depletion model



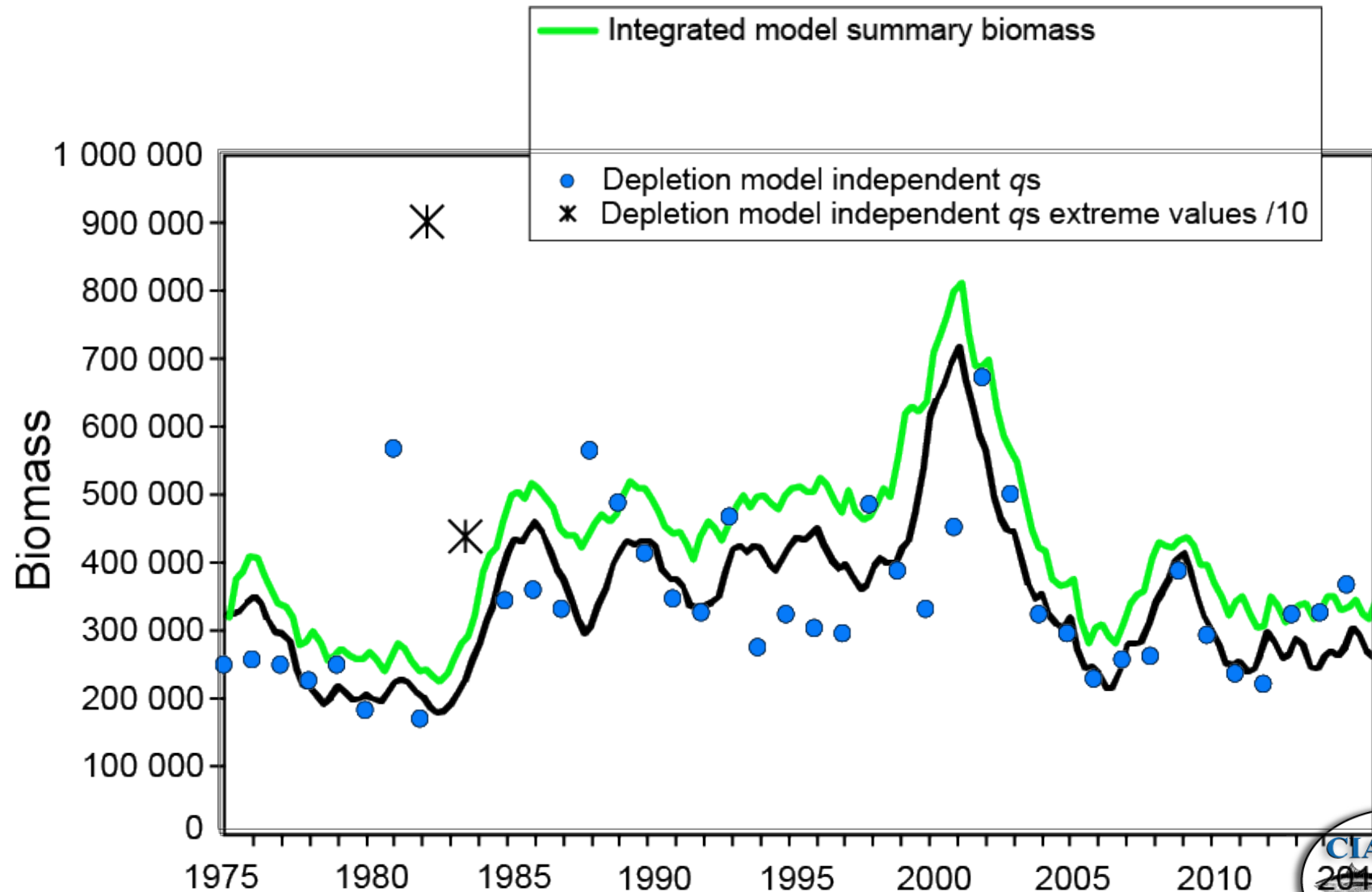
# Depletion model



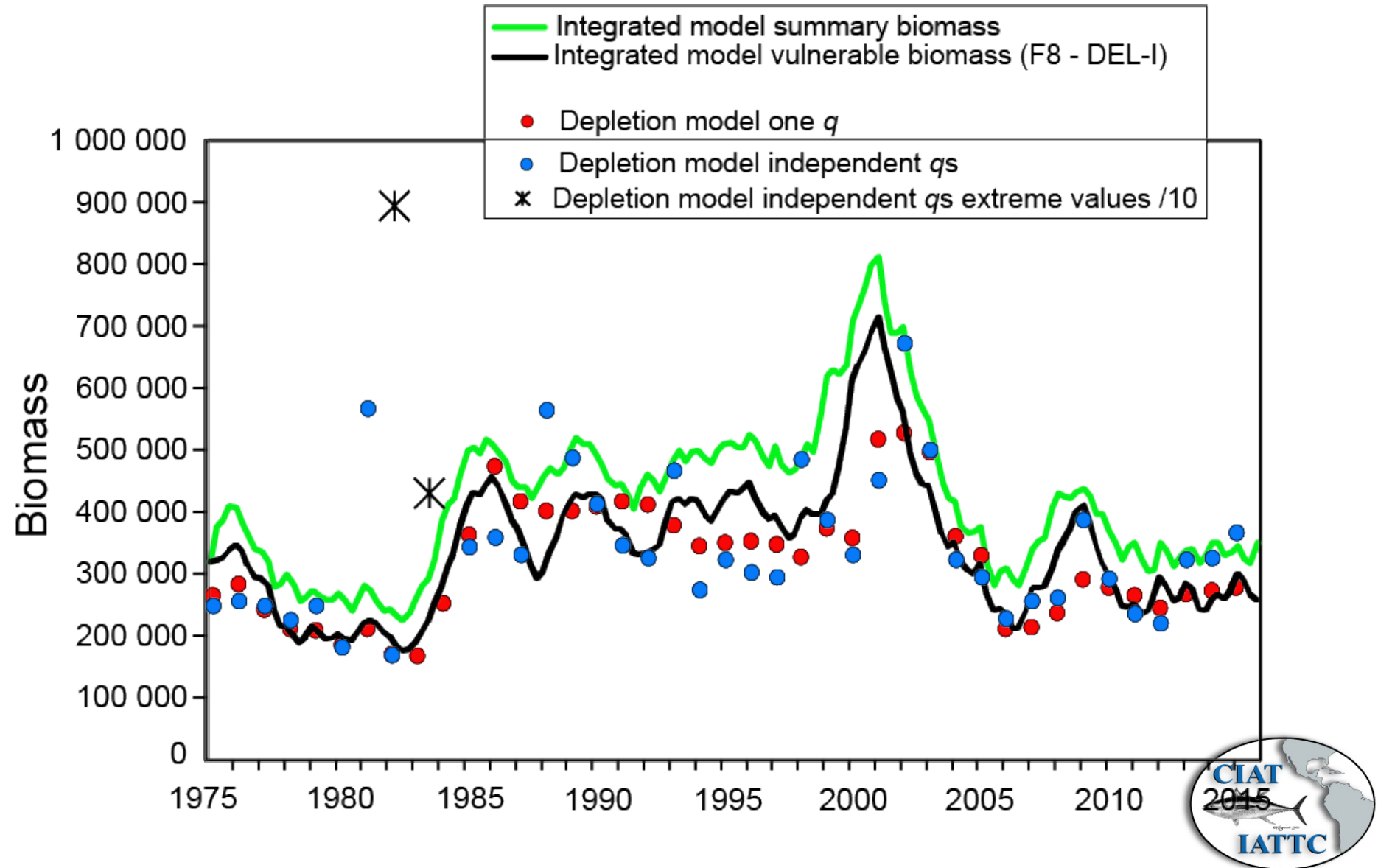
# Depletion model



# Depletion model

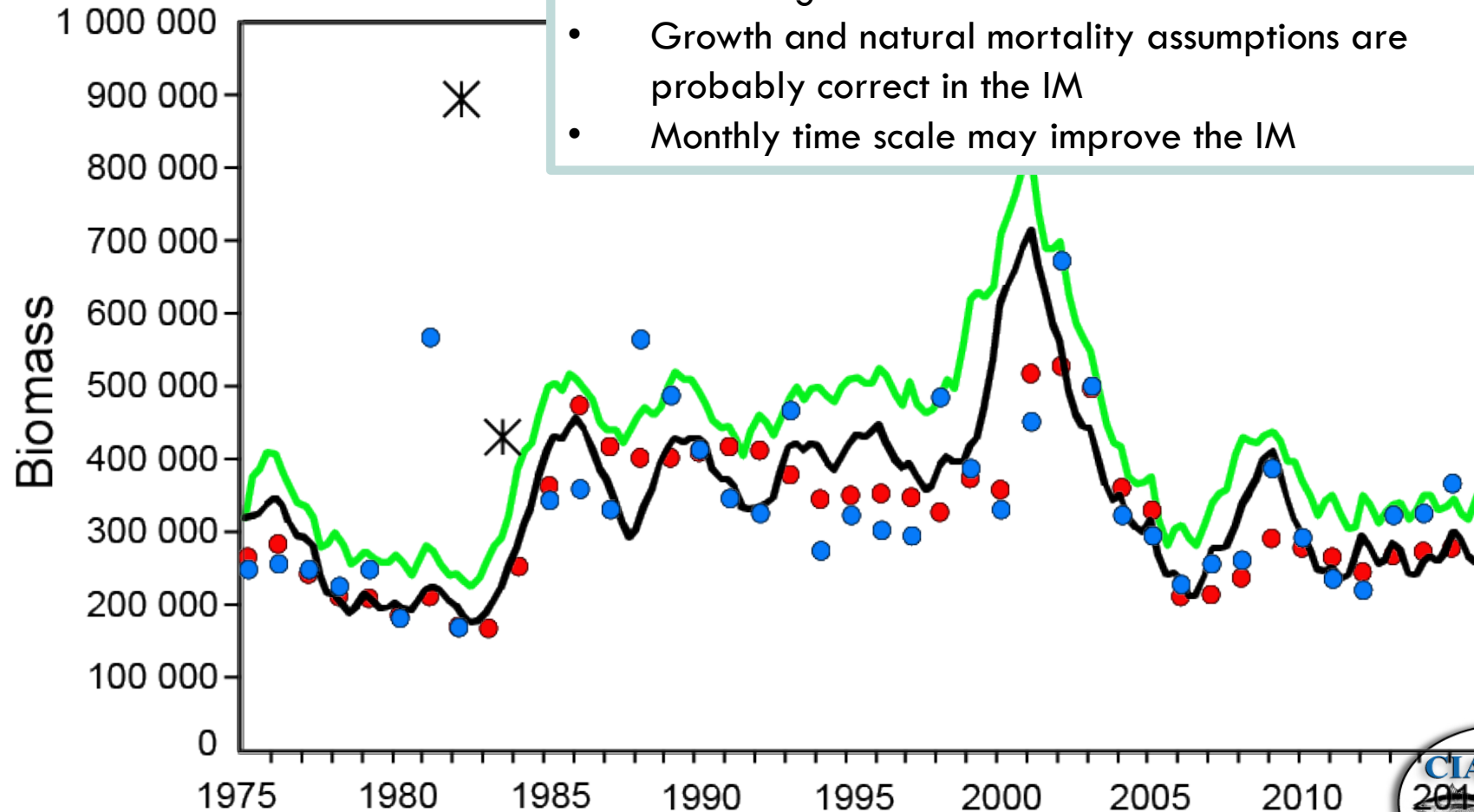


# Depletion model



# Depletion model

- Depletion models estimate of the absolute abundance coincides with the integrated model, increasing the confidence on the IM
- Growth and natural mortality assumptions are probably correct in the IM
- Monthly time scale may improve the IM

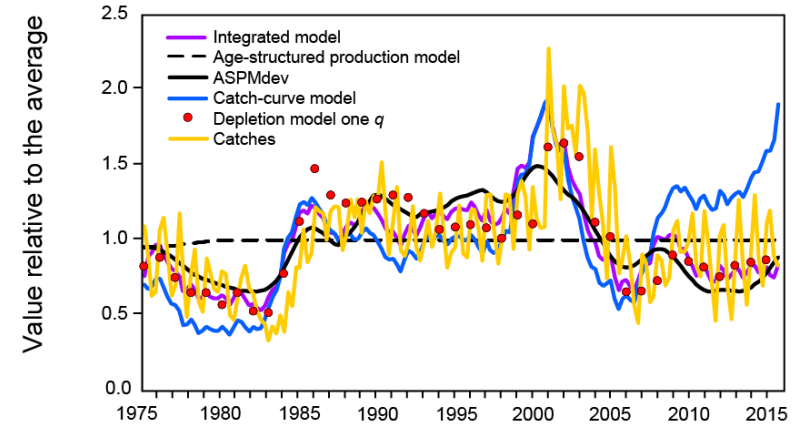


# Conclusions

Estimating abundance of YFT in the EPO

- Absolute abundance:
  - **Cannot be estimated when the five indices of relative abundance are fit** to the age-structure production model (ASPM) even when recruitment deviations are estimated (ASPMdev)
  - The **signal comes several data sources**: e.g. length-frequency data, and CPUE indices on monthly scale
  - Its is **driven by temporal changes in productivity** (recruitment)
- Relative abundance:
  - **Captured by ASPMdev**, but not by ASPM, effect of fishing needs to be measured **after accounting for productivity variations**

## Relative abundance



Diagnostics

Need to be used in combination to understand the whole picture:

**Ln(R0) profile model**

indicated the existence of model misspecification

large weight of length-frequency data in the IM  
the

**Catch-curve model**

misspecification in selectivity

not a problem because the indices constrained results

**Depletion**

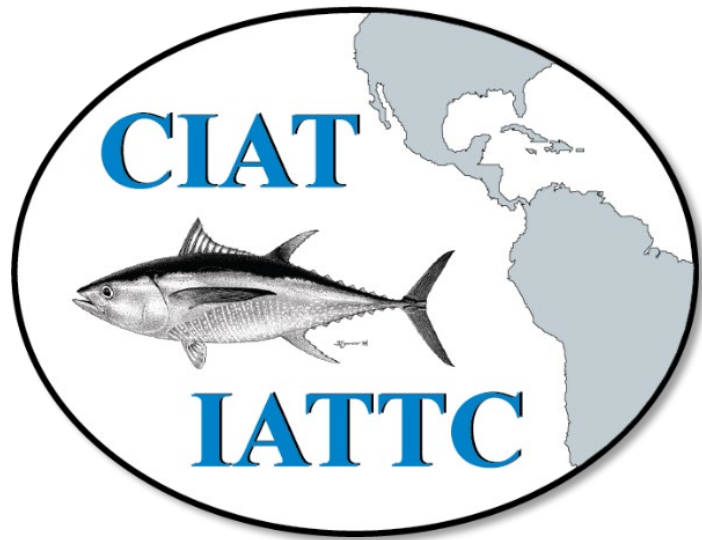
growth and  $M$  probably correct

Take-home

msn

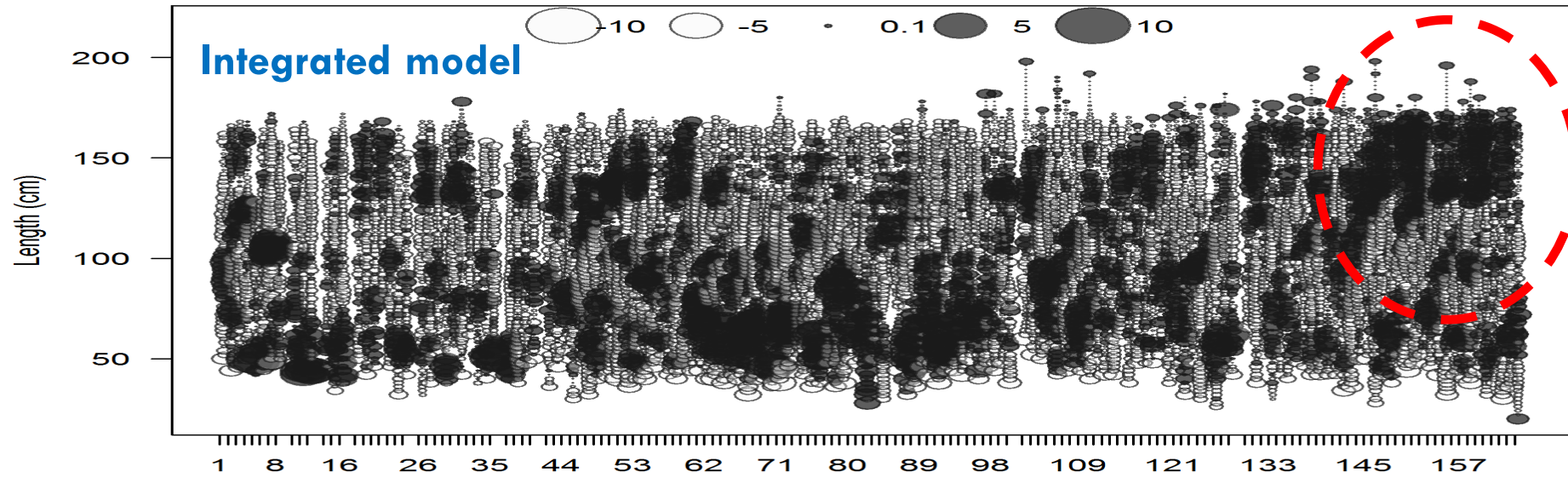
Integrated model should be “dissected” using diagnostic tools and auxiliary analyses



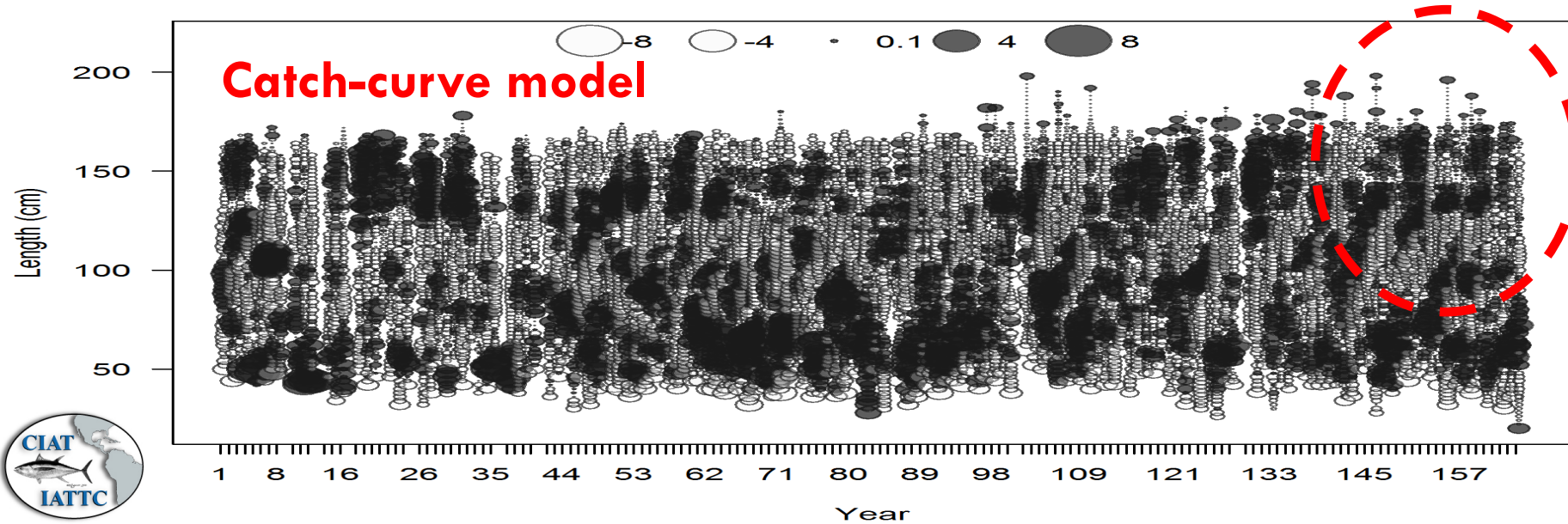


# **EXTRAS SLIDES**

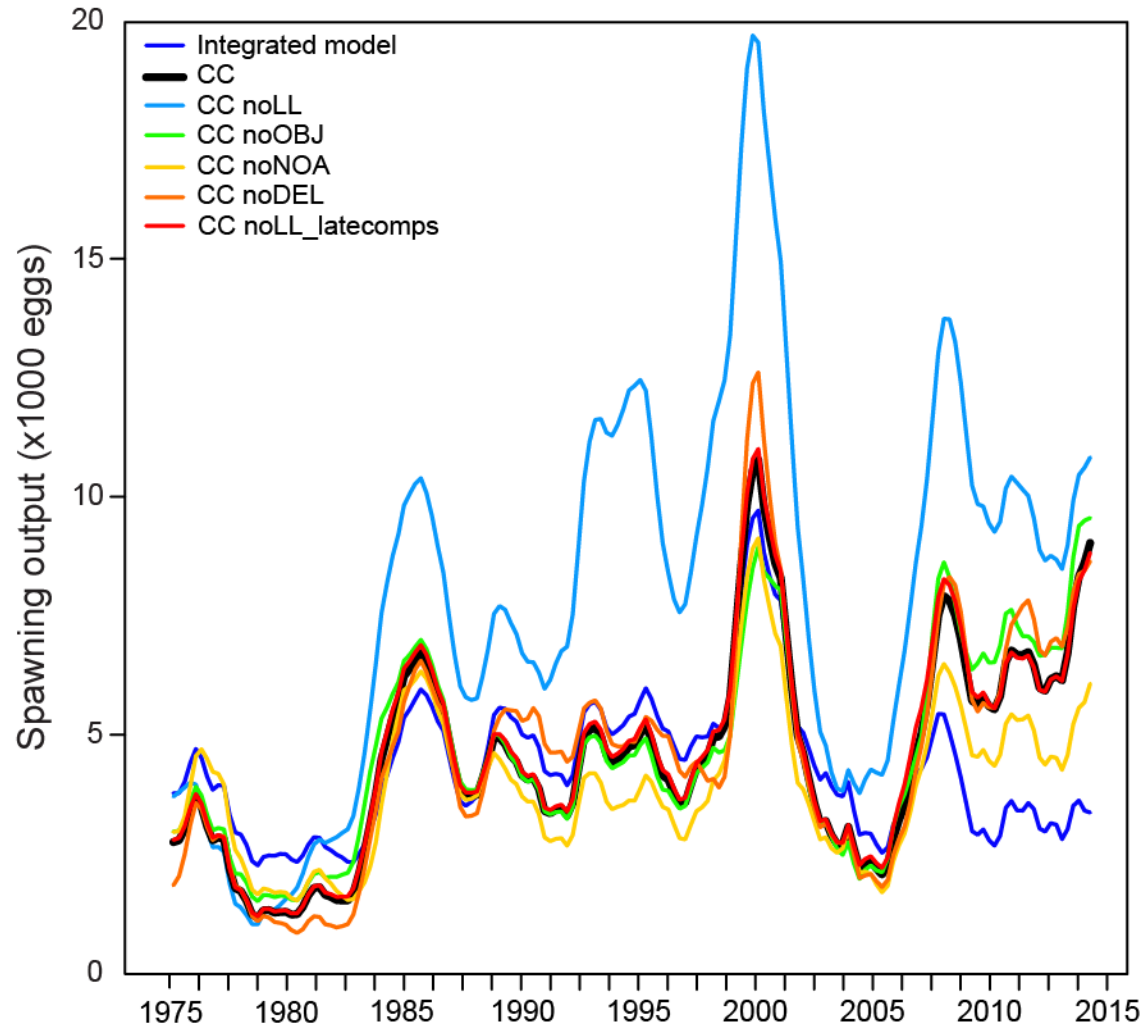
Pearson residuals, whole catch, F7-DEL\_N (max=6.67)



Pearson residuals, whole catch, F7-DEL\_N (max=6.42)



# Catch-curve model: sensitivity to data sets



Results are extremely sensitive to longline length-frequency data (fishery F12 LL-S, asymptotic selectivity, main index of relative abundance)

This was also indicated by the  $\ln(R_0)$  profile



# Outline

- Key uncertainties
- Background on general
- Evidence for spatial stru
- Conclusions

## Main goal

and ocean biogeography

To investigate the ability the integrated assessment model to estimate abundance in for yellowfin tuna in the eastern Pacific Ocean (EPO).

By using recently-proposed **diagnostic tools** that use different components of the data, and one **auxiliary model** to **better understand the integrated model** and **detect potential model misspecification**