

# A bioenergetics approach to compare anchovy and sardine in the Bay of Biscay, from energy density data to a DEB model



ICES  
CIEM



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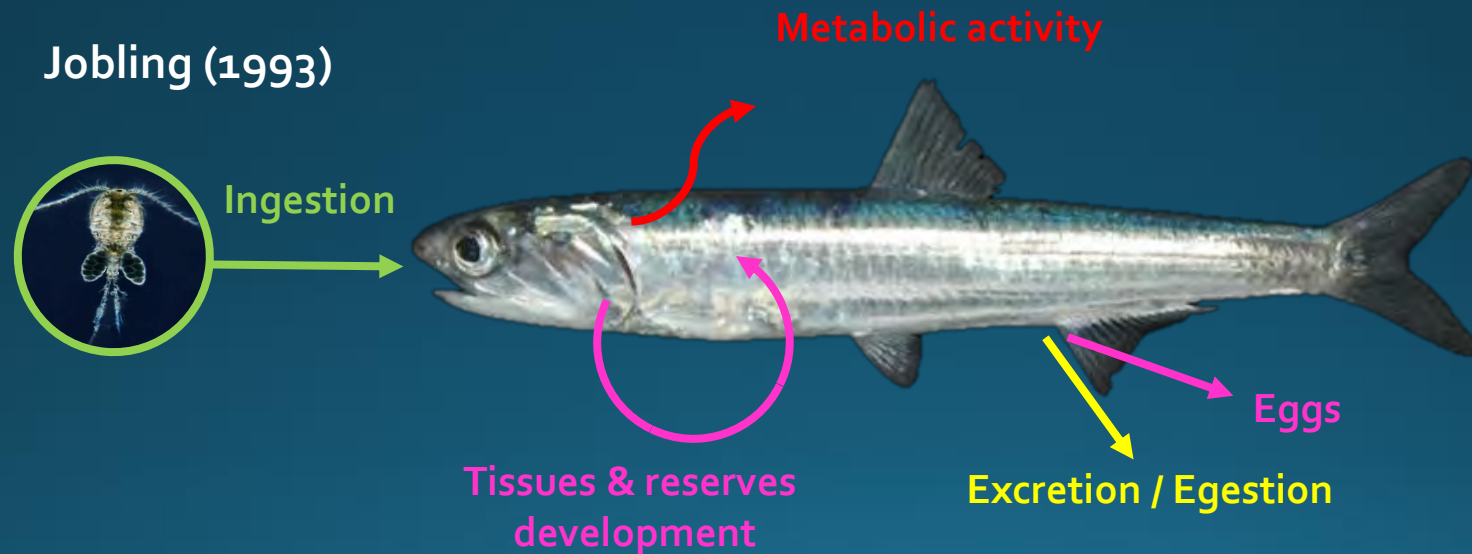


- 2 closely related species sharing the same ecosystems
- **BUT** sometimes contrasted population dynamics or spatial distribution
  - Trophic **Van der Lingen et al. 2006**
  - Temperature **Takasuka et al. 2007 & 2008**
  - Oxygen **Bertrand et al. 2011**
  - ...

Simultaneously integrate numerous processes at the individual scale

→ Physiology ?

→ ... or a more synthetic approach: « *the Bioenergetics* »

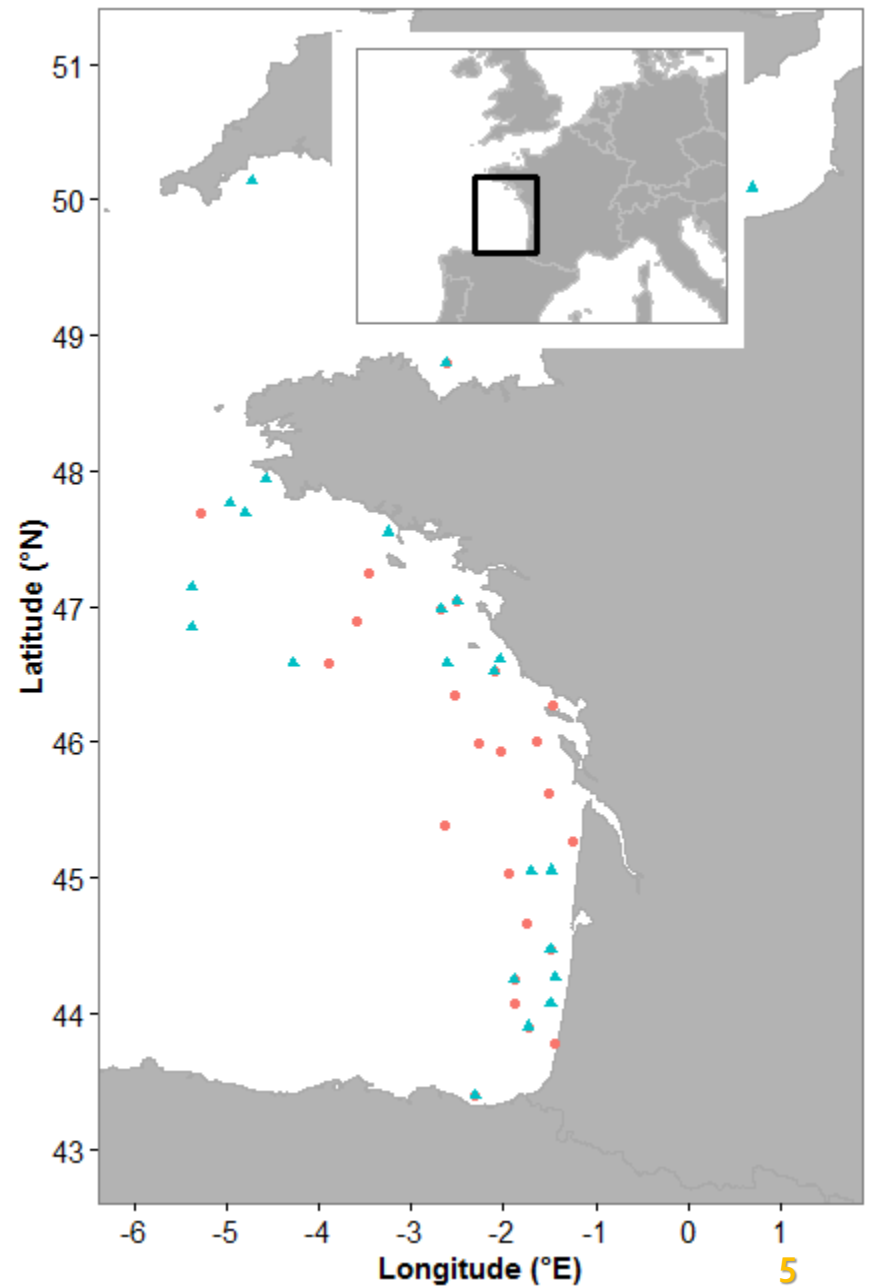


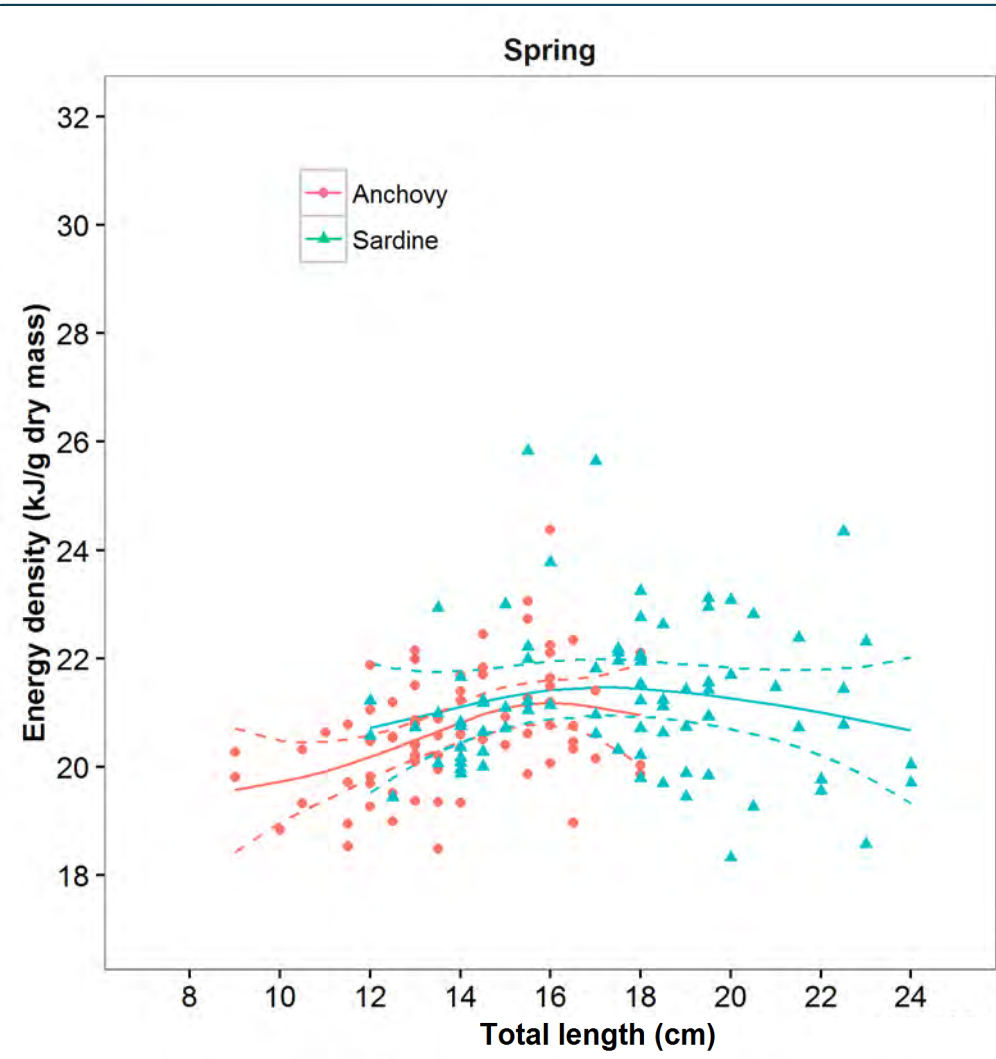
PhD: Compare biological & life history traits of anchovy and sardine in the Bay of Biscay. A bioenergetics approach

1. Data: **Energy Density**

2. Whole life cycle model: **Dynamic Energy Budget (DEB)**

- Energy density (ED) =  $\frac{Energy}{Mass}$  kJ/g
- Sampling in 2014 in the Bay of Biscay at 2 contrasted seasons  
Spring & autumn ~ min & max
- ~400 individual measurements of ED using a bomb calorimeter
- GAM model  
 $ED \sim f(size, season)$   
 $R^2 = 0.64$  (Anchovy)  $0.71$  (Sardine)



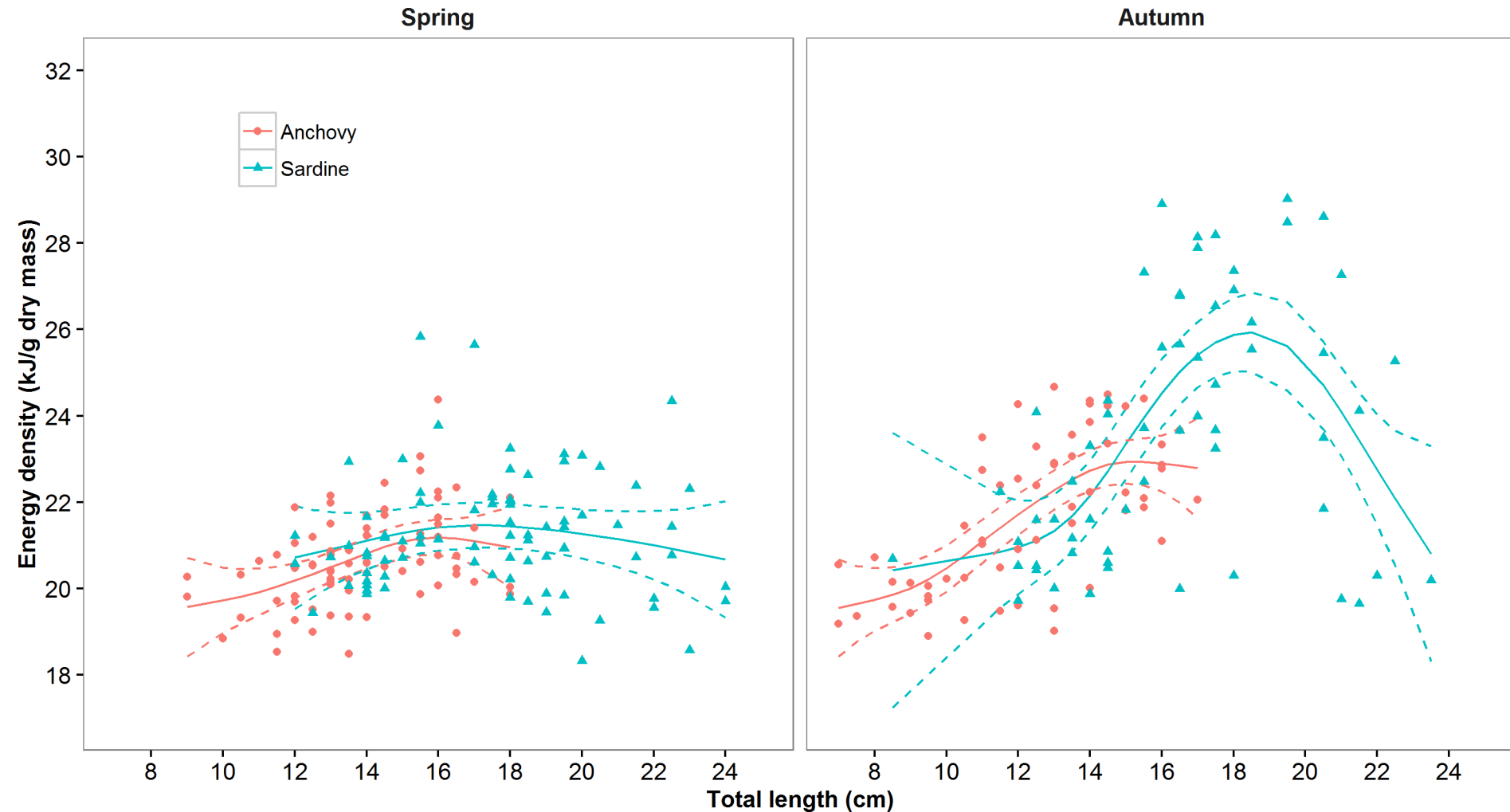


- **Spring:**

- ~ Same scaling of ED with size
- ~ Same ED minima in Spring
  - Energetic exhaustion in winter ?

## 2. Energy density

$$ED=f(\text{species, length, season})$$



- **Spring:**

- ~ Same scaling of ED with size
- ~ Same ED minima in Spring
  - Energetic exhaustion in winter?

- **Autumn:**

- ~ larger ED values for sardine
  - larger storage capacity
  - larger needs? → reproduction<sup>7</sup>

- $\neq$  storage capacity
- $\neq$  energetic needs
- ... in link with specific biological traits (size & spawning )

→ Need for a mechanistic & predictive tool: *The DEB*



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- $\neq$  energetic needs
- ... in link with specific biological traits (size & spawning )

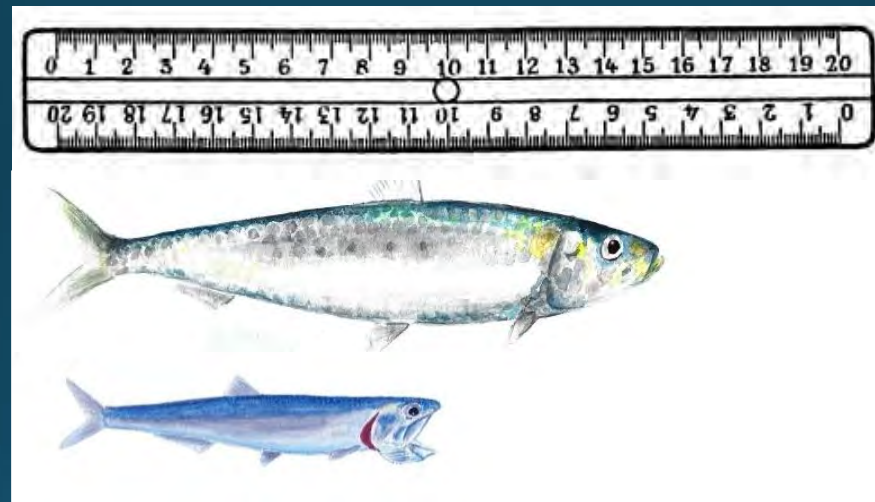
→ Need for a mechanistic & predictive tool: *The DEB*

- A calibration for both species in the BoB...
- ... using an approach by scenarios

2 main differences: Size & Spawning

From anchovy to sardine: 2 sets of successive calibration scenarios

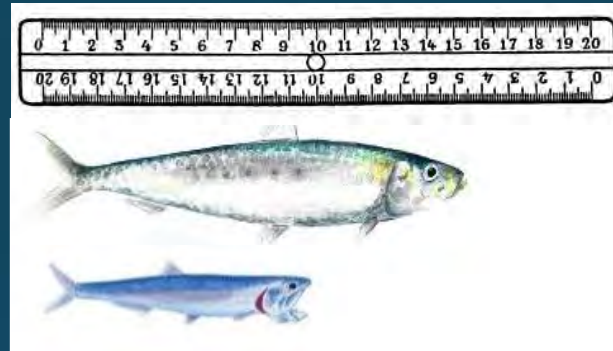
#### 1. Size



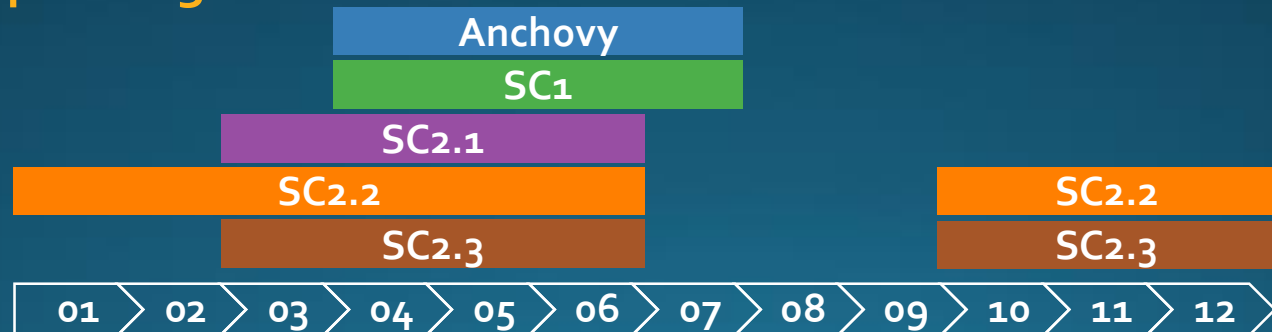
2 main differences: Size & spawning

From anchovy to sardine: 2 sets of successive calibration scenarios

#### 1. Size

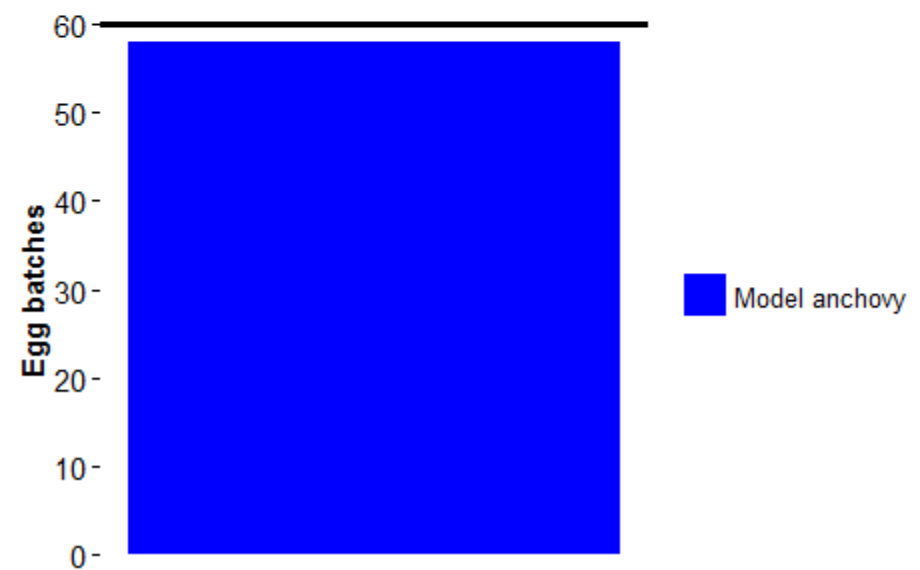
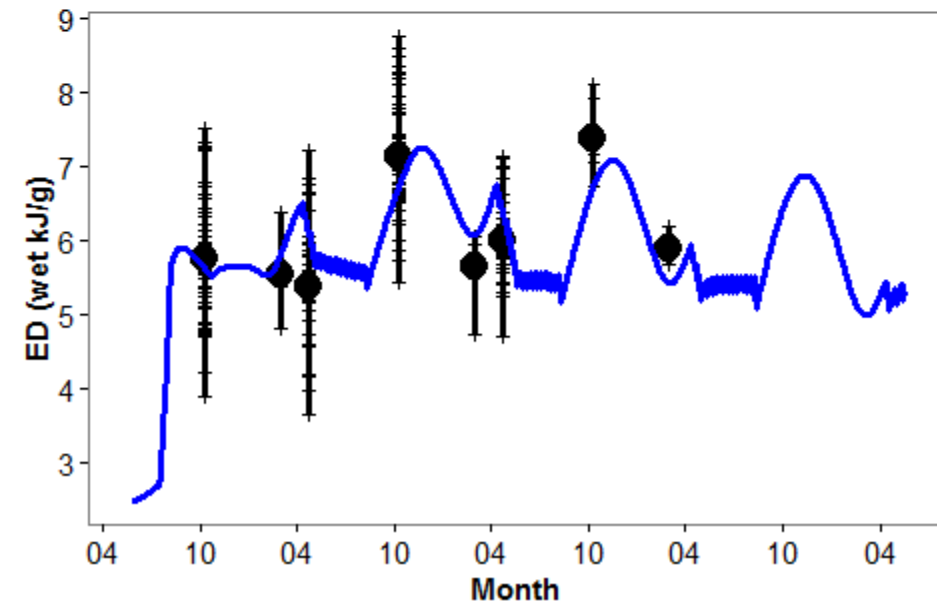
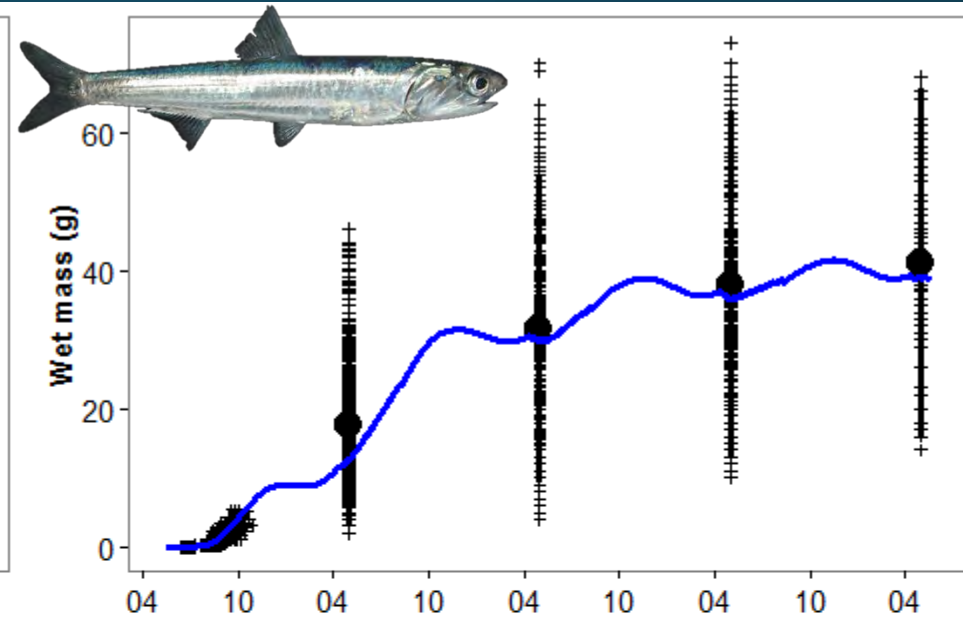
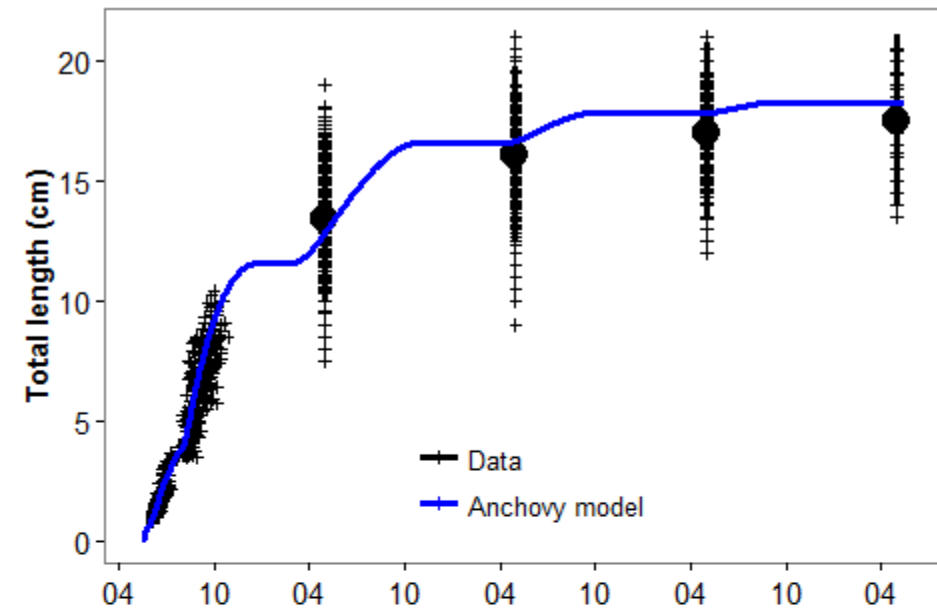


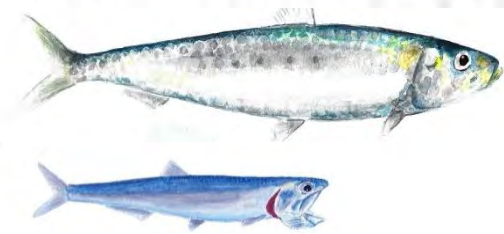
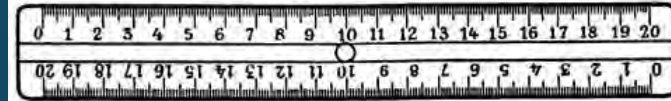
#### 2. Size + Spawning



# 3. Bioenergetics modelling: DEB

Model fit

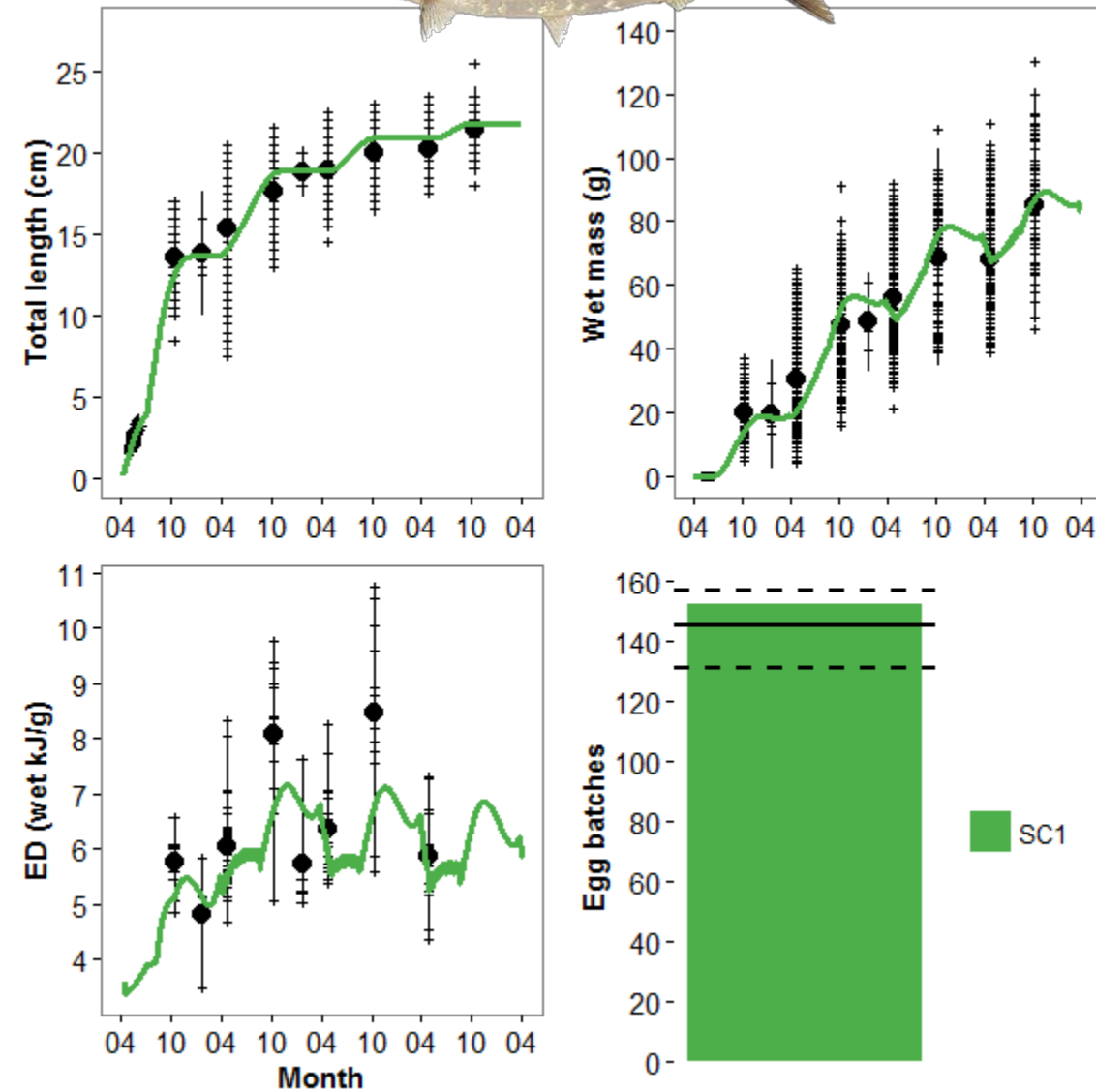


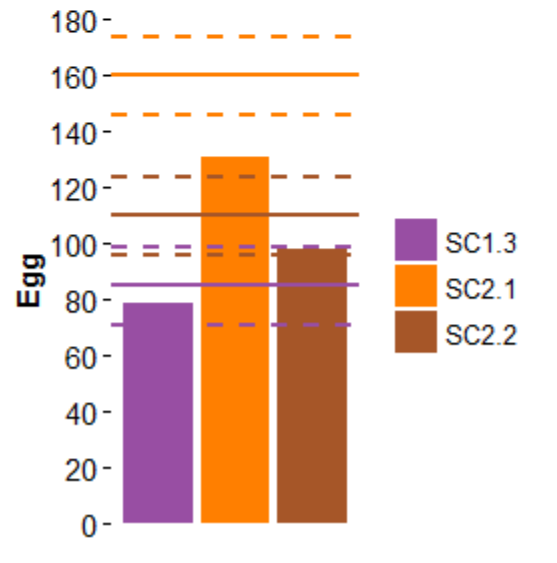
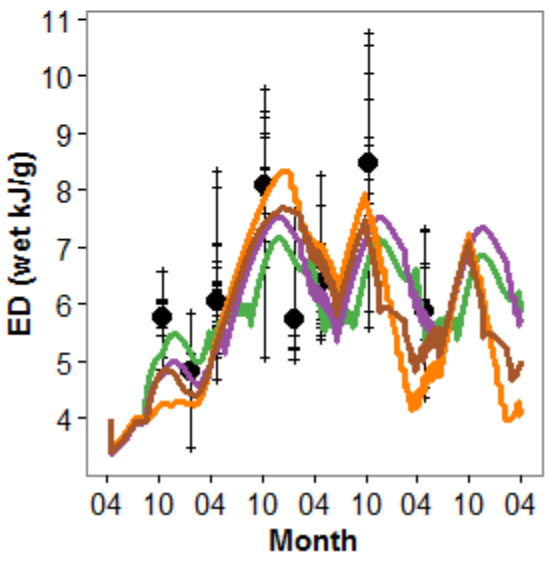
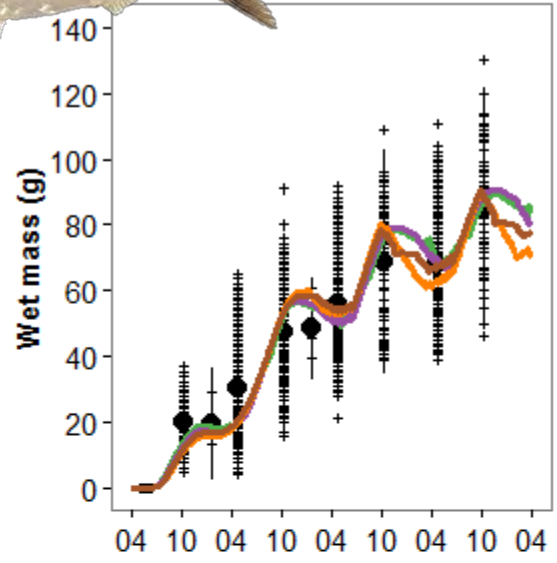
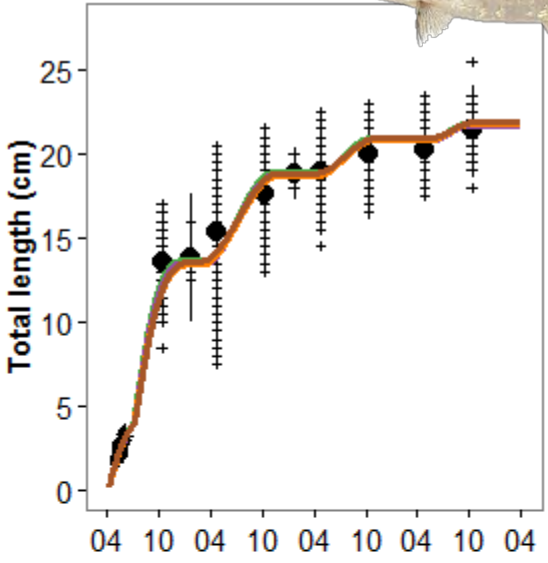
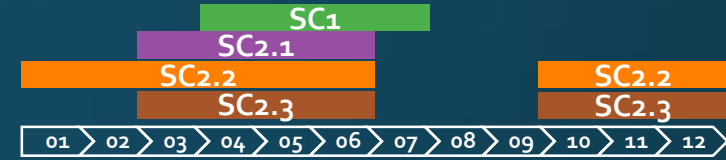


### SC1 : Size

- Correct size & weight predictions
- Underestimate ED variability

*Sardine* ≠ « big anchovy »





SC1 : "Spring anchovy"

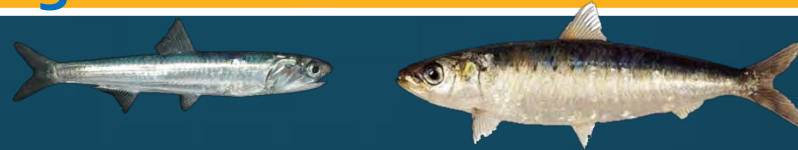
SC2 : Size & Spawning

SC2.1 : Spring

SC2.2 : From autumn to spring

SC2.3 : Spring & autumn

- Size & weight predictions  $\approx$
- Better ED predictions



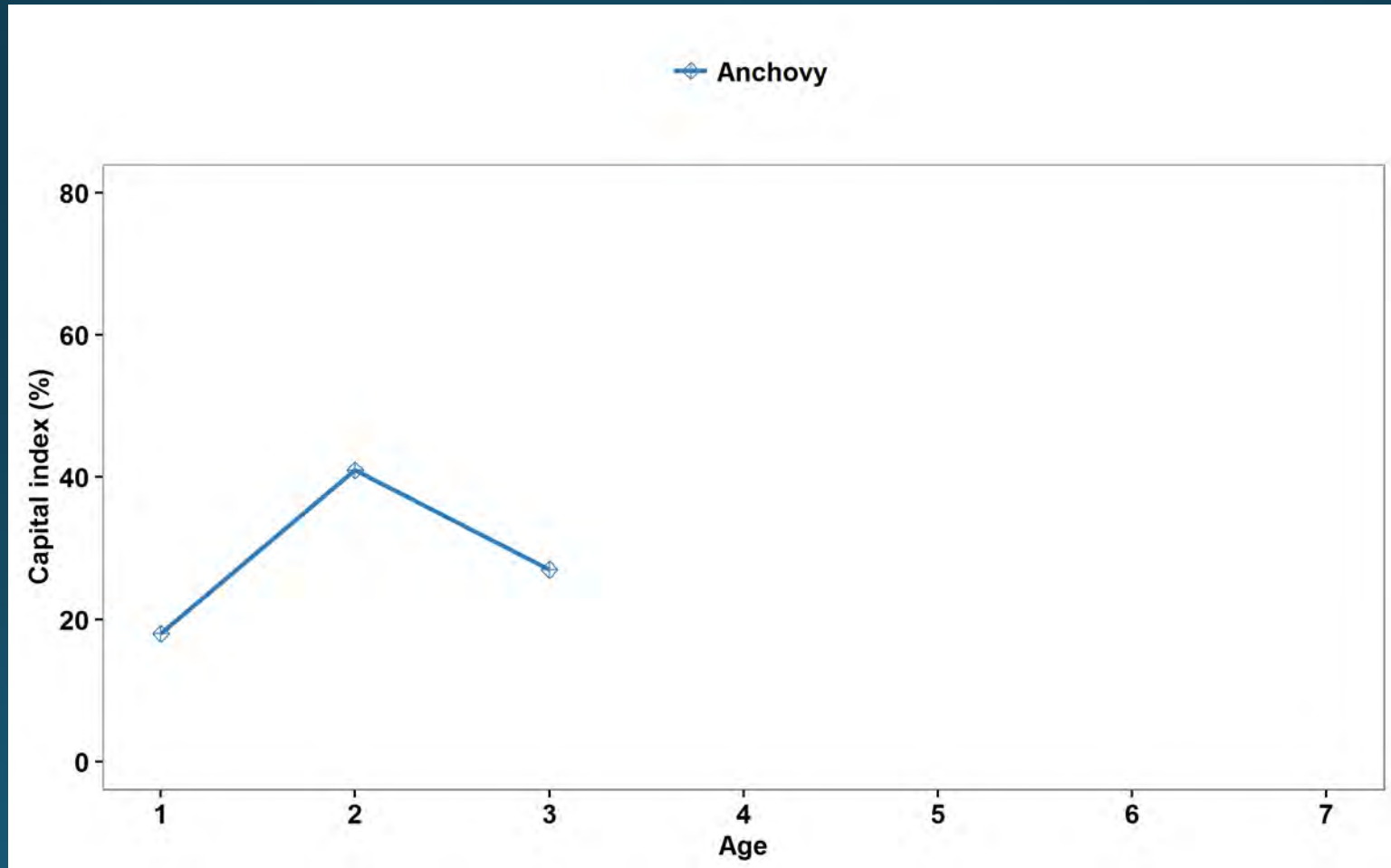
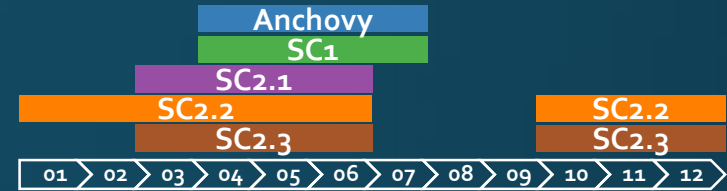
Parameter	Anchovy	Sardine SC2.1
$K$	0.71	0.58
$[E_m]$	1815	2346
$p_{Am}$	884	1060
$[p_M]$	158	118

- **K (Kappa)**: energy allocation between growth & spawning  
→ sardine allocate more energy to spawning
- $[E_m]$ : Maximum storage capacity  
→ larger for sardine
- $p_{Am}$  &  $[p_M]$ : assimilation & maintenance rates  
→ « waste to hurry » : short life cycle **Kooijman 2013**  
→ more pronounced for anchovy

Indeterminate spawning: « Capital » & « Income »

- Anchovy ~ « Income spawner »

Somarakis et al. 2004

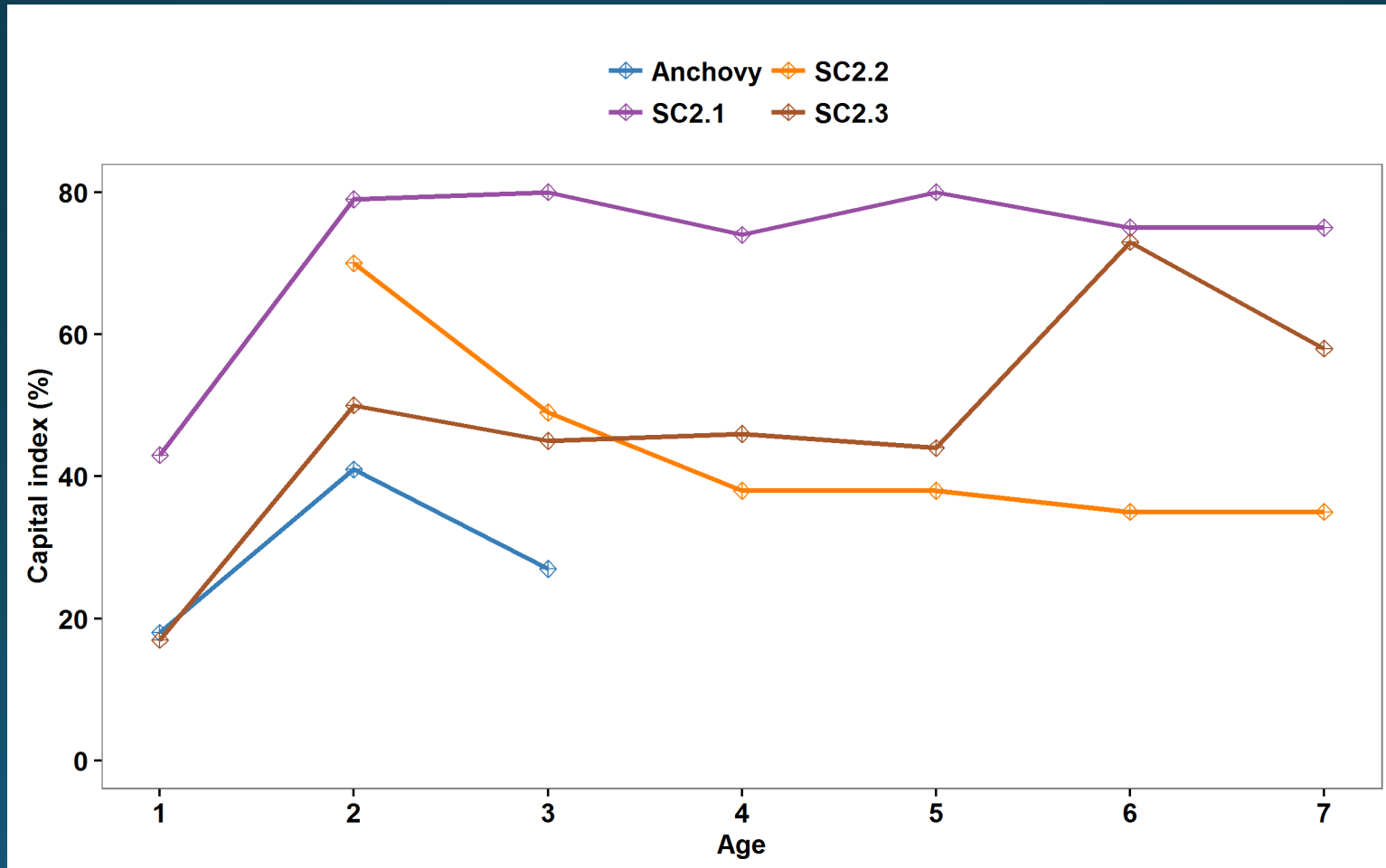
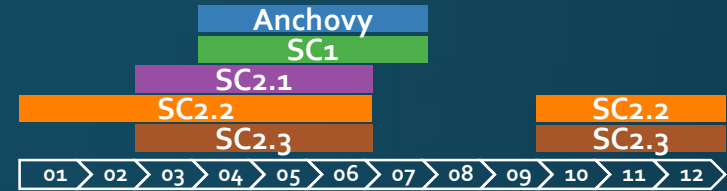




Indeterminate spawning: « Capital » & « Income »

- Sardine ~ « Capital spawner »

Ganias et al. 2007





- Bioenergetics & Spawning strategies strongly associated
- Operational model
  - To test the sensitivity of both species to environmental conditions
  - To be incorporated in End to End models

*For more information*

**Gatti et al. 2017**, Comparing biological traits of anchovy and sardine in the Bay of Biscay: a modelling approach with the Dynamic Energy Budget.



*Thank you !*

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