Inventory evaluation process

3-5 April 2023 | Abuja, Nigeria

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Institut Agro

Introduction - DEMERSTEM :

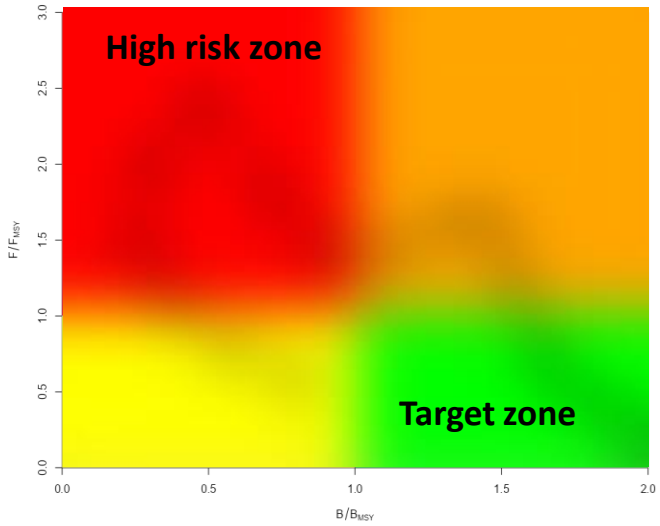
➔ Improve **knowledge** on **demersal** ecosystems and fisheries

➔ Contribute to stock assessment in data-moderate context (WP1)

➔ Present a review of the methods used

Introduction - Modelisation process

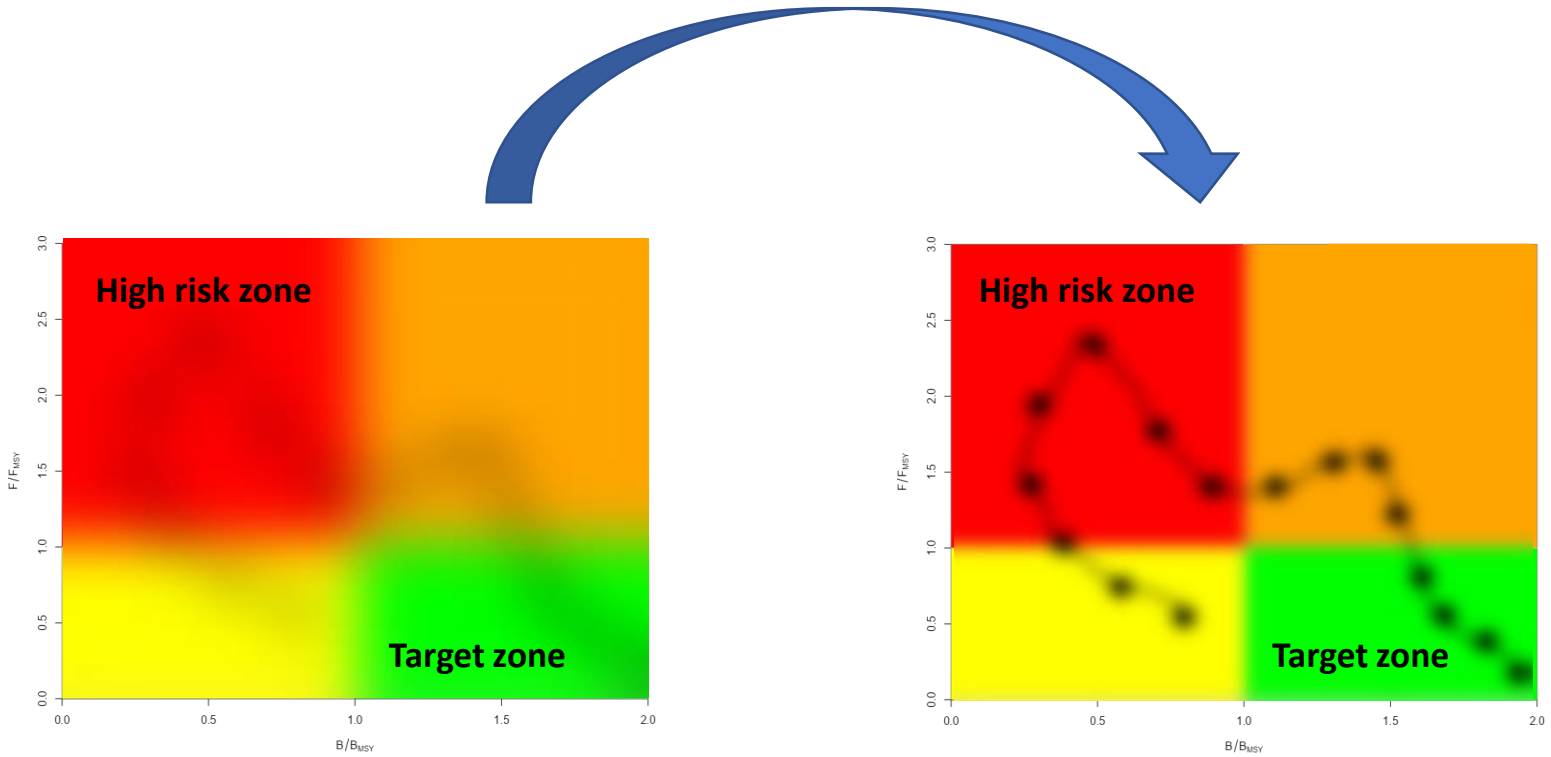
➔ Aims to a **better understanding** of a **complex** system



Introduction - Modelisation process

➔ Aims to a **better understanding** of a **complex** system

➔ Relies on more or less strong **assumptions** to get a picture of the **reality**

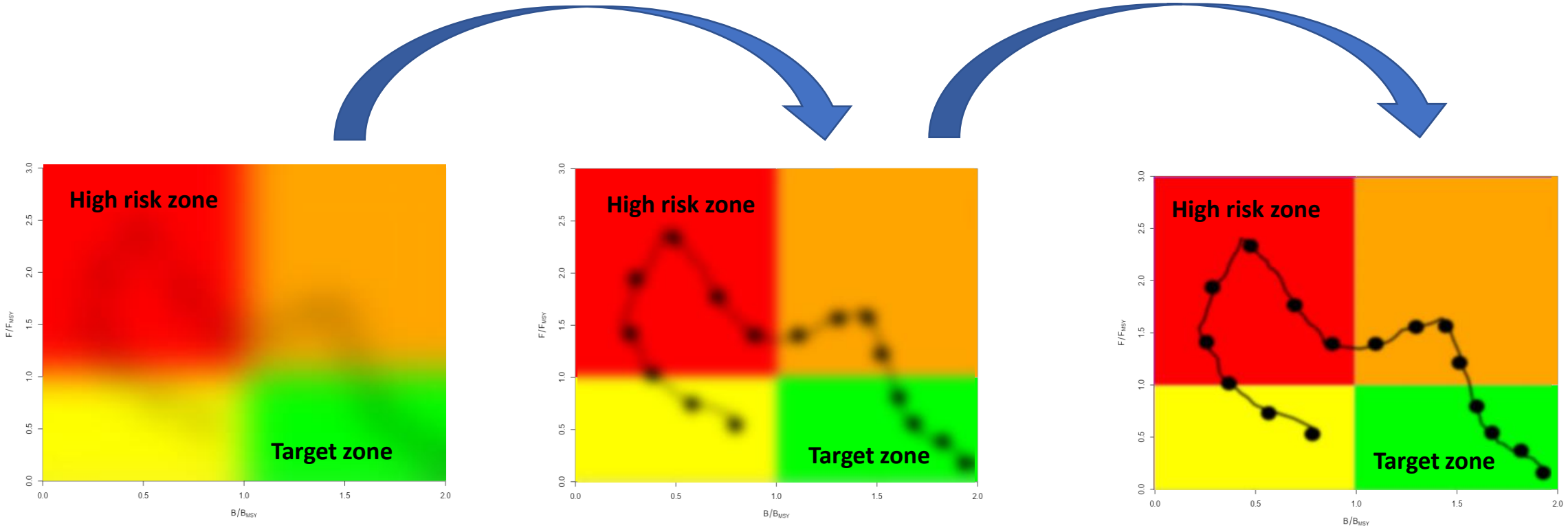


Introduction - Modelisation process

➔ Aims to a **better understanding** of a **complex** system

➔ Relies on more or less strong **assumptions** to get a picture of the **reality**

➔ Combining **complementary** approches leads to increase the **diagnostic reliability**



Introduction - Methods : Two main sets

- Production model
  - Pseudo-equilibrium
  - Dynamic in a Bayesian framework
- Length frequency based
  - Rectified pseudo-cohort analysis
  - Length based bayesian model

Complementarity of approaches

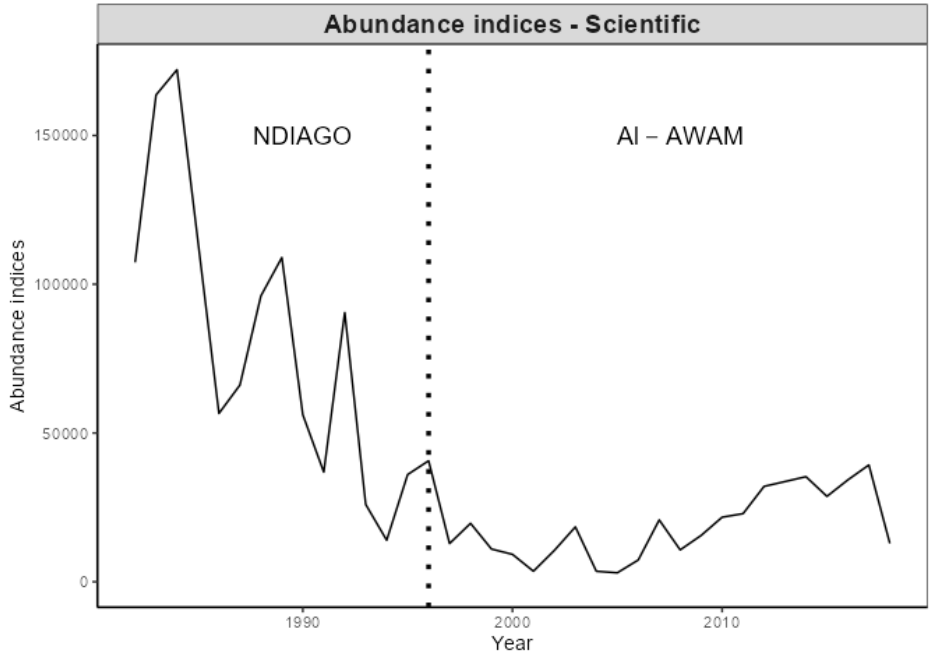
➔Different datasets and assumptions

1. Production model

1. Production model : Data

Abundance indices

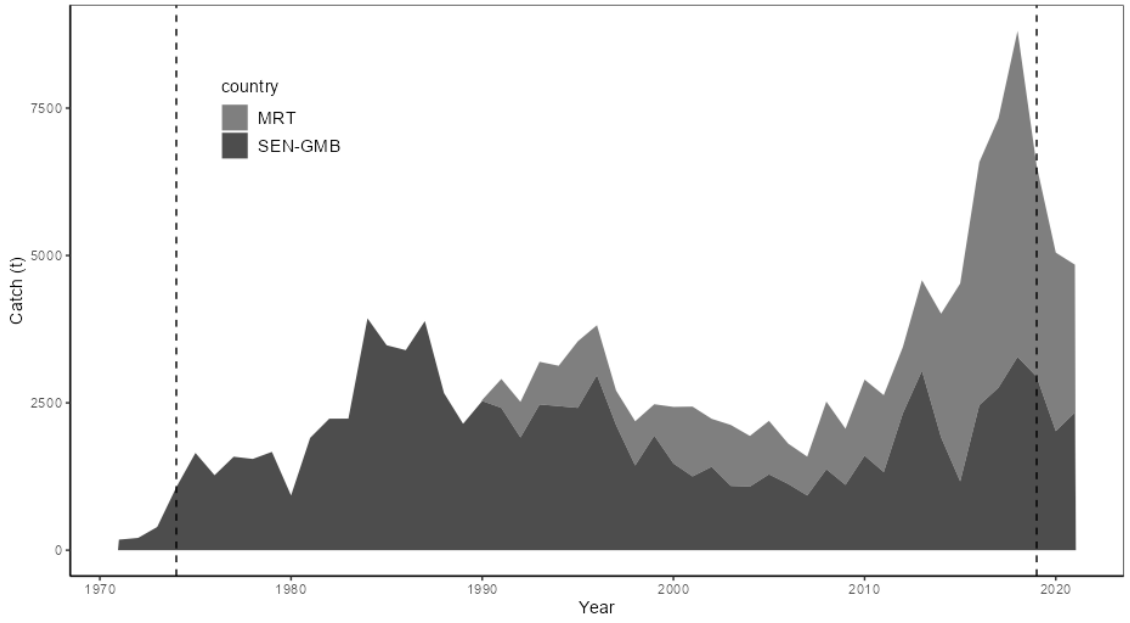
(Thiof – MRT)



➔ From scientific survey or CPUE

Catch

(Thiof – MRT/SEN/GMB : 1970-2021)



➔ From national fisheries information system

1. Production model : Model formulation

Equilibrium assumption :

Catch

$$Abundance = f(\boldsymbol{parameters}, Fishing\ effort)$$ ➔ pseudo-equilibrium model

$$Abundance = f(\boldsymbol{parameters}, Biomass)$$ ➔ dynamic model (biodyn)

1. Production model : Fitting process

Equilibrium assumption

$$Abundance = f(\boldsymbol{parameters}, Fishing\ effort)$$

$$IA_{pred} = \mathbf{a} \cdot \exp(-\mathbf{b} \cdot Effort)$$

1. Production model : Fitting process

Equilibrium assumption

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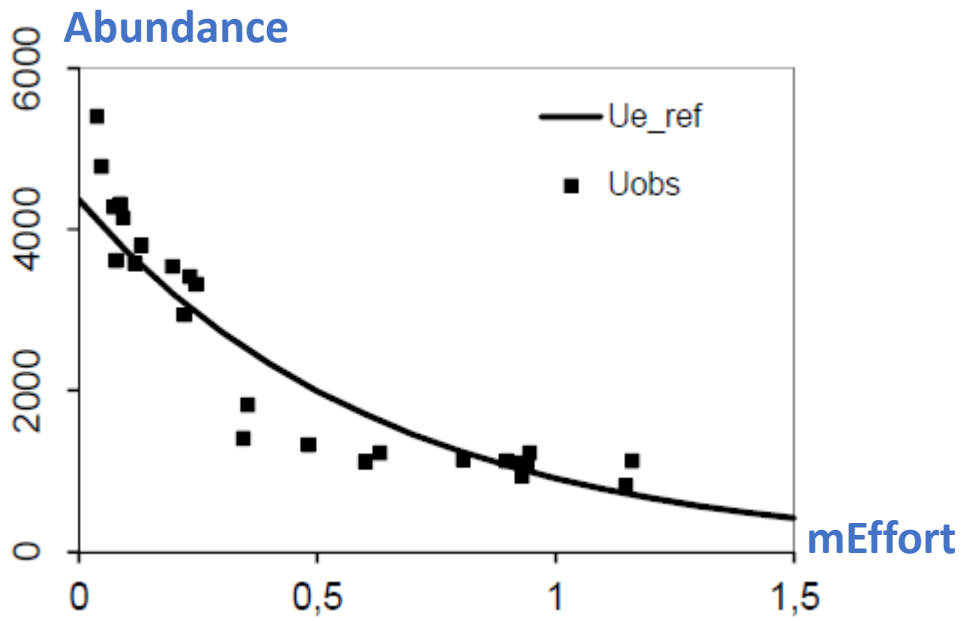
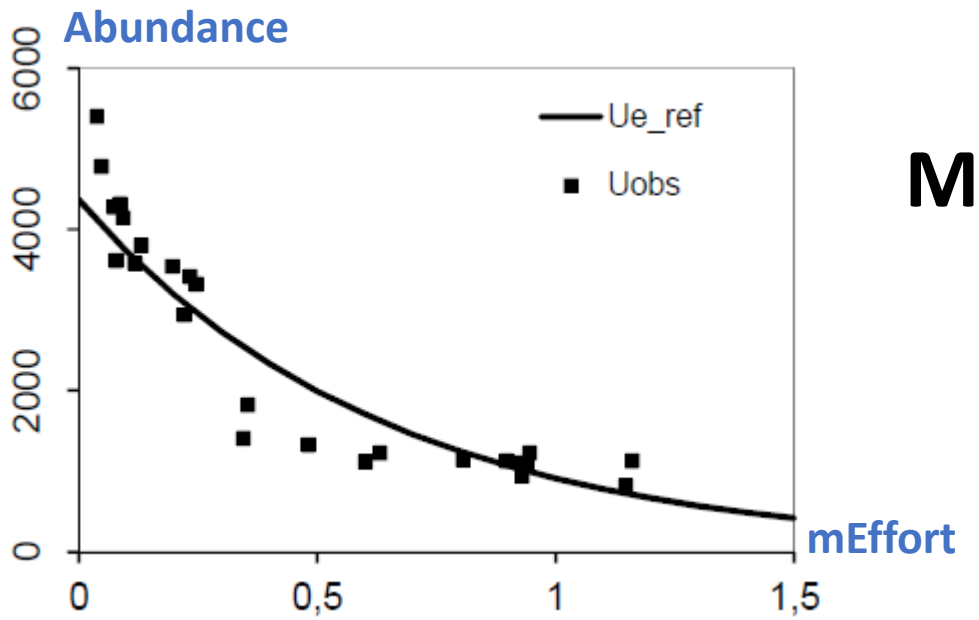


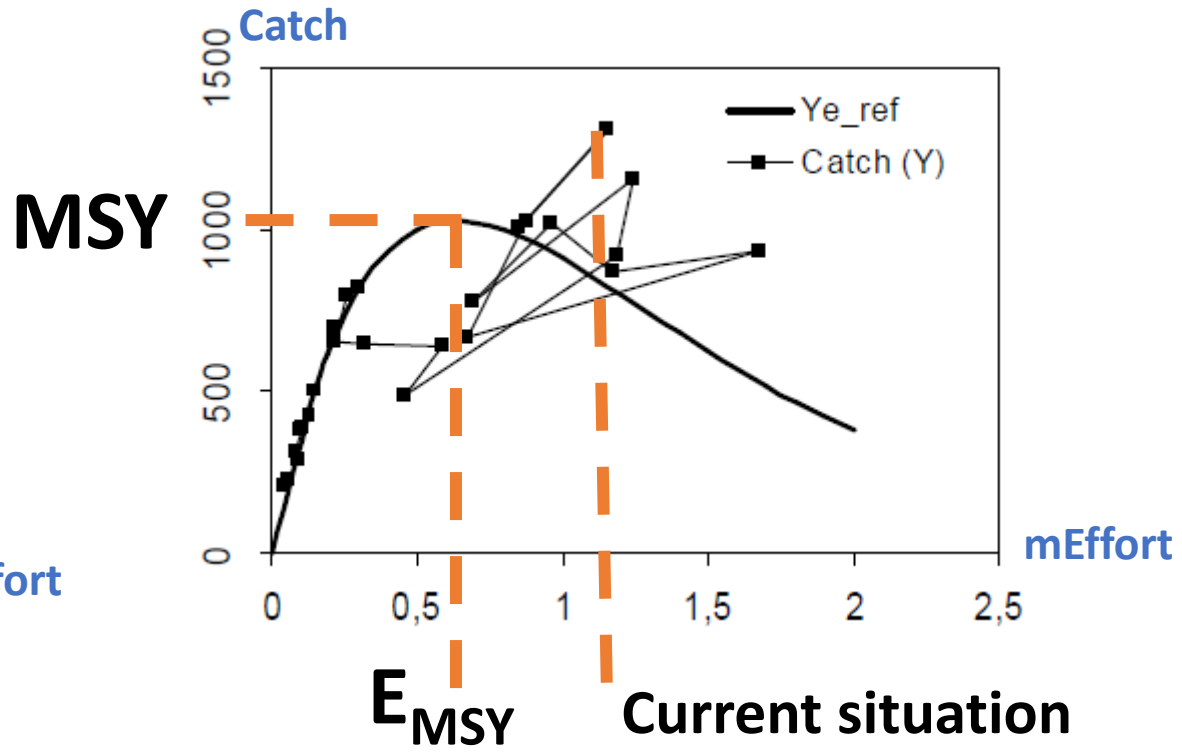
1. Production model : Fitting process

Equilibrium assumption

$IA_{pred} = a \cdot \exp(-b \cdot Effort)$

$Catch_{pred} = Effort \cdot IA_{pred}$





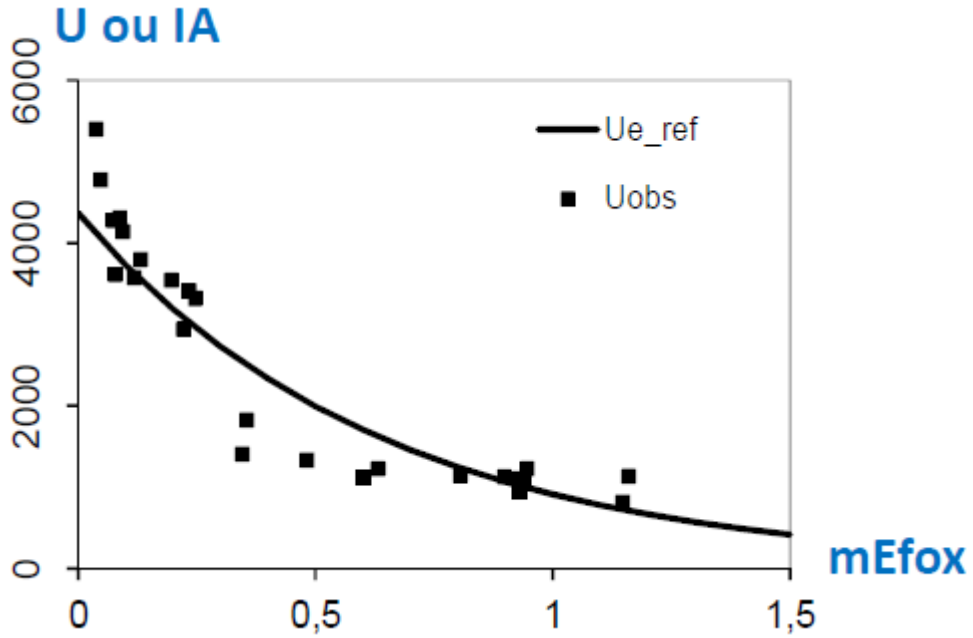
1.1 Production model : Pseudo-equilibrium model

$$IA = \mathbf{a} \cdot \exp(-\mathbf{b} \cdot \mathbf{E\_fox})$$

Observed abundance depends on previous years

$$Efox_t = \frac{3 \cdot Efox_t + (3-1) \cdot Efox_{t\_1} + \ldots + Efox_{t\_3}}{3 + (3-1) + \ldots + 1}$$

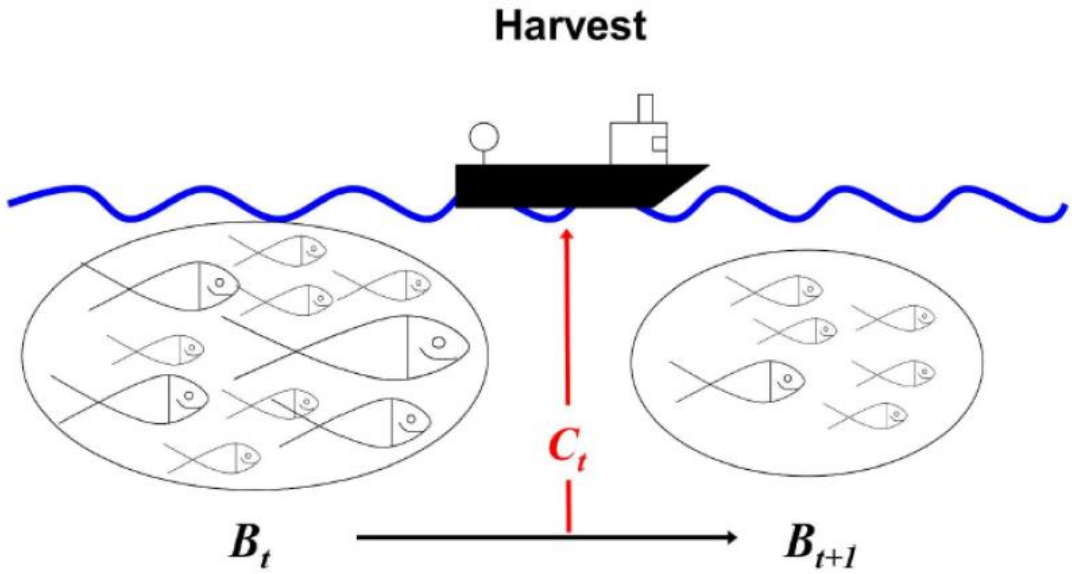
2 parameters :
a, b (and m)



1.2. Production model : Dynamic model in Bayesian framework

(Winker et al, 2018)

1.2. Production model : Dynamic model in Bayesian framework



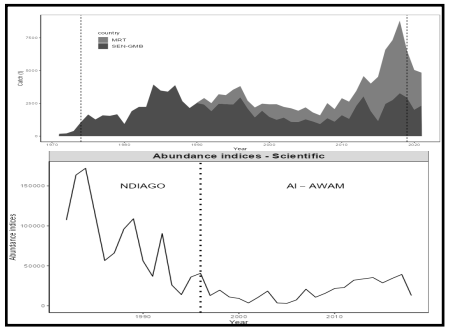
(Rivot, 2020)

$$\begin{cases} B_{t+1} = B_t + P_t - C_t \\ IA_t = f(\boldsymbol{parameters}, B_t) \end{cases}$$

4 parameters :
r, K, B_0, q (and m)

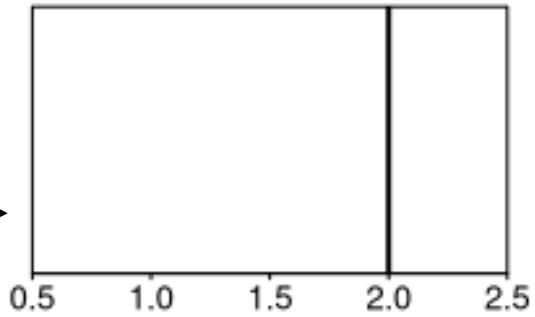
1.2. Production model : Dynamic model in Bayesian framework

Data



Fitting

Parameter estimation



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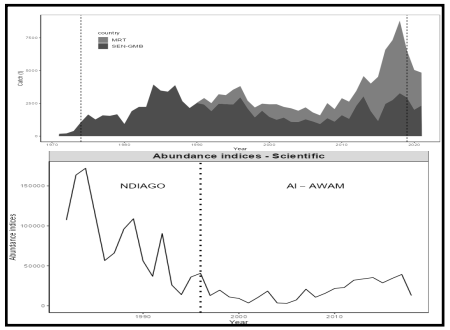
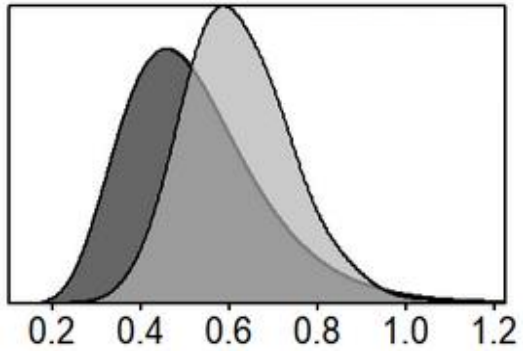
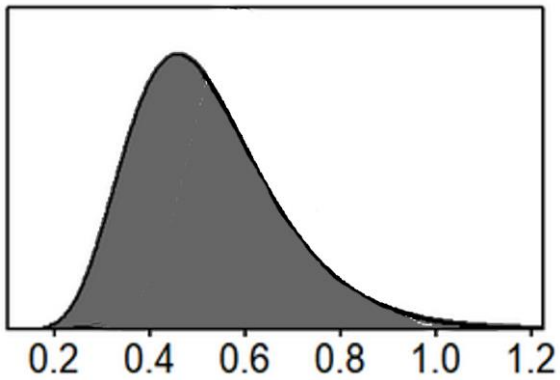


Bayesian Fitting

Parameter estimation





Expert knowledge on parameters

1.2. Production model : Dynamic model in Bayesian framework

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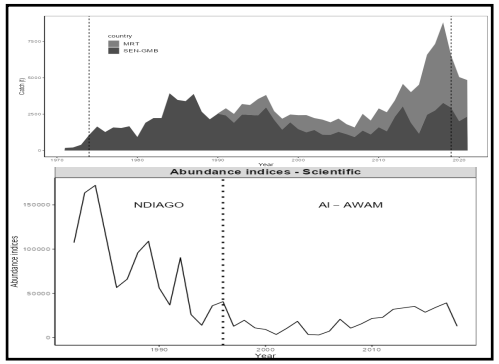

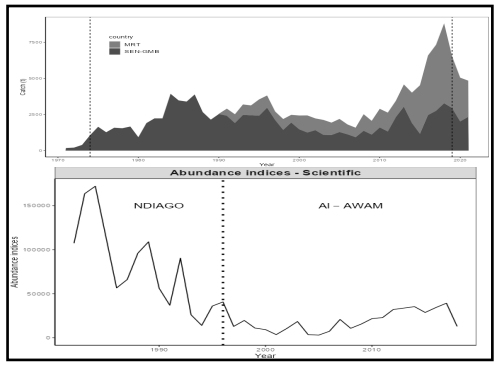

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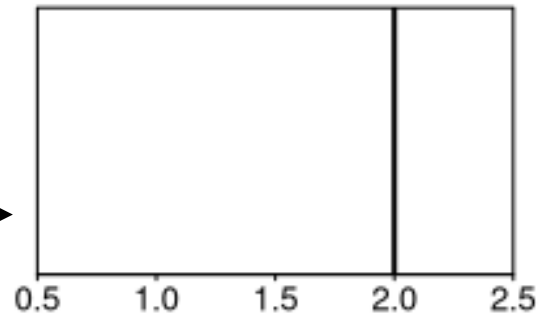
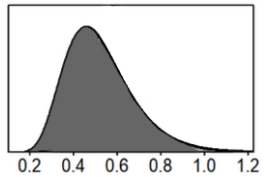
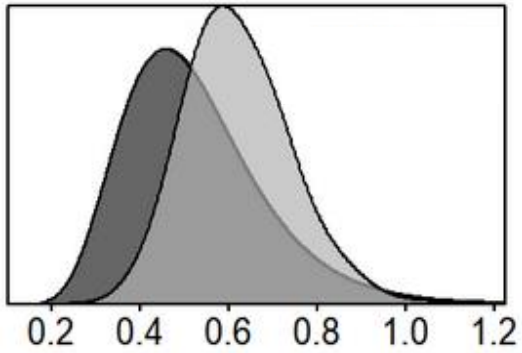


Expert knowledge on parameters





➔ Incorporates the idea of confidence

1.3. Production model : review

- Pseudo-equilibrium model :
  - Easier to handle
  - Quicker fitting process

- JABBA (dynamic in bayesian framework model) :
  - Incorporates confidence in outputs
  - Possibility to take into account several CPUE
  - Diagnosis tools for model selection are incorporated
  - More complex to handle

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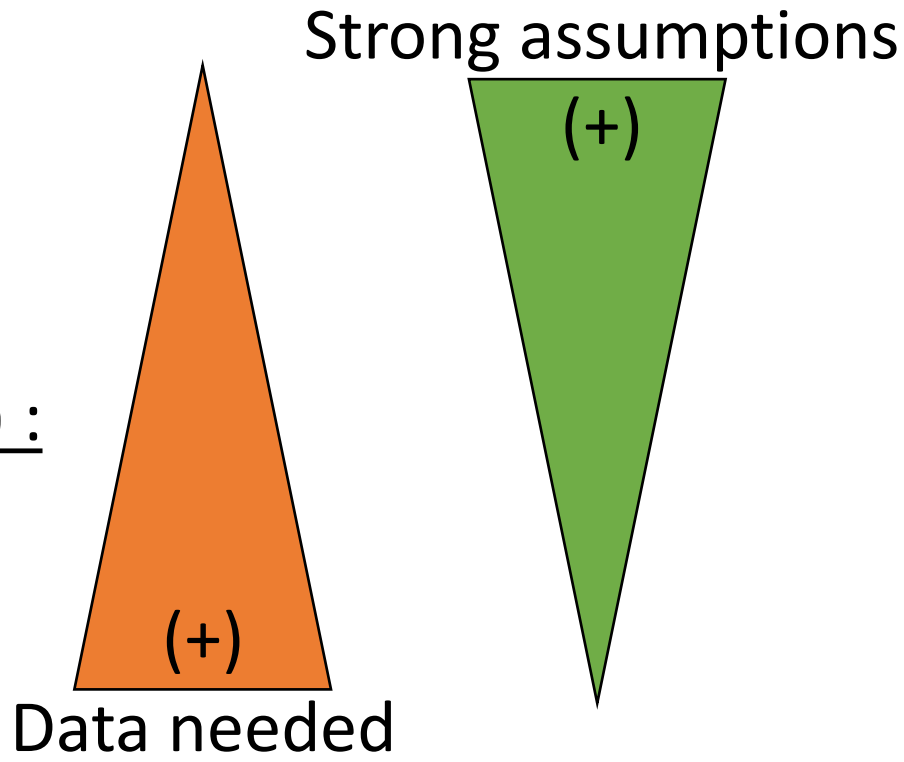


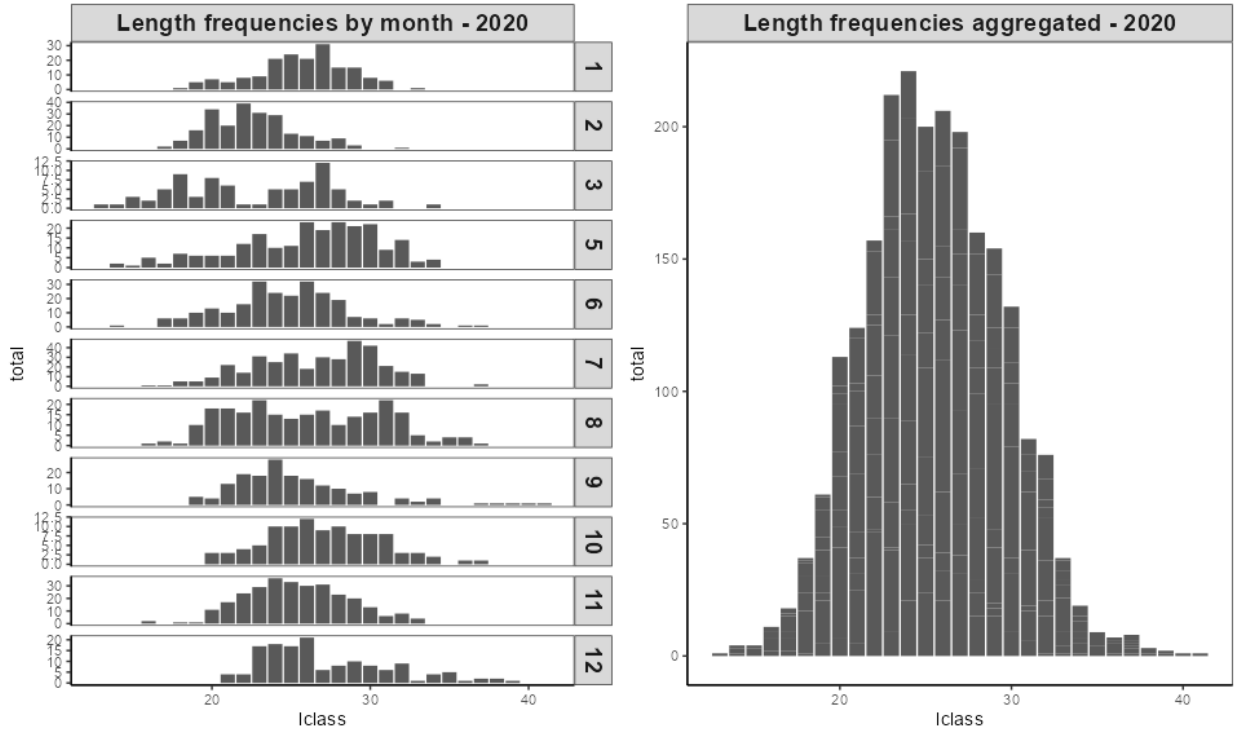
2. Length frequency based model

2.1. “Length-based Bayesian Biomass” estimator method (LBB)

Froese et al, 2018

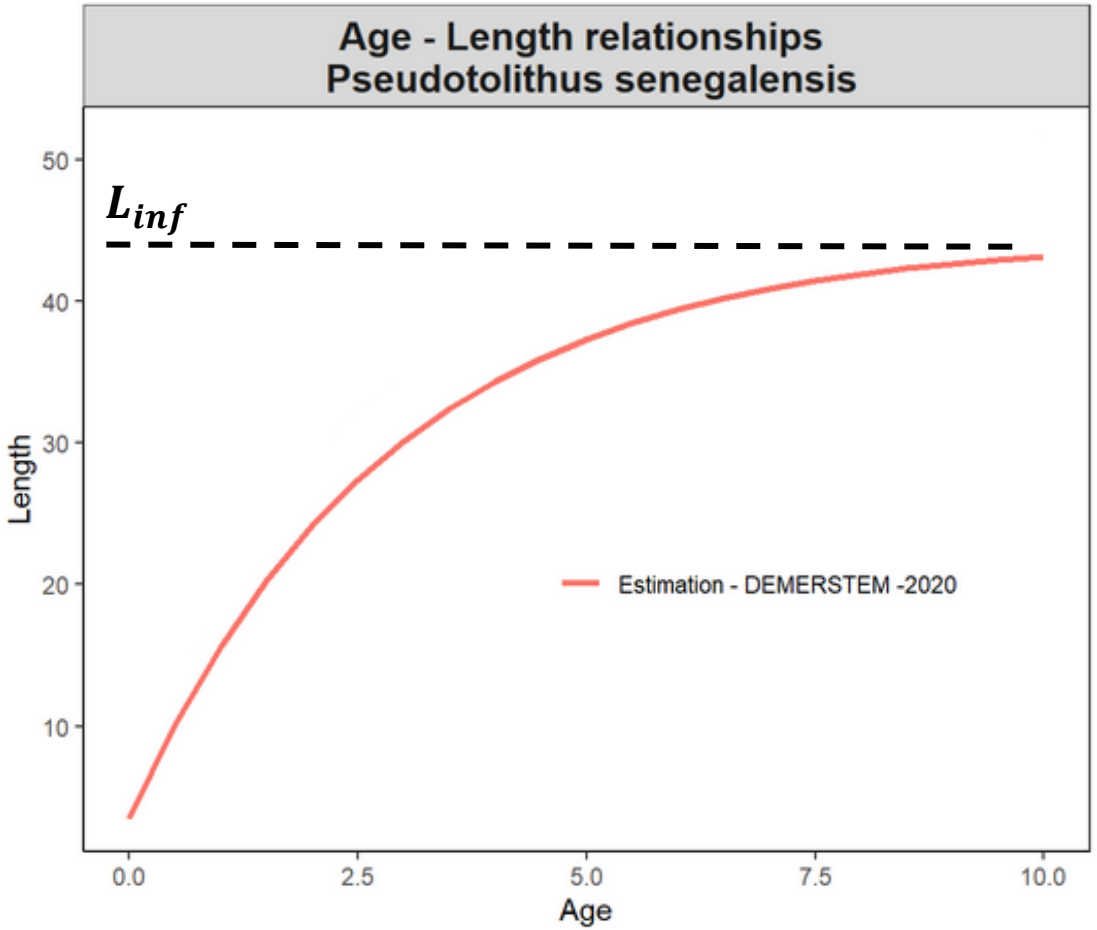
2.1. LBB - Data

- Length frequencies

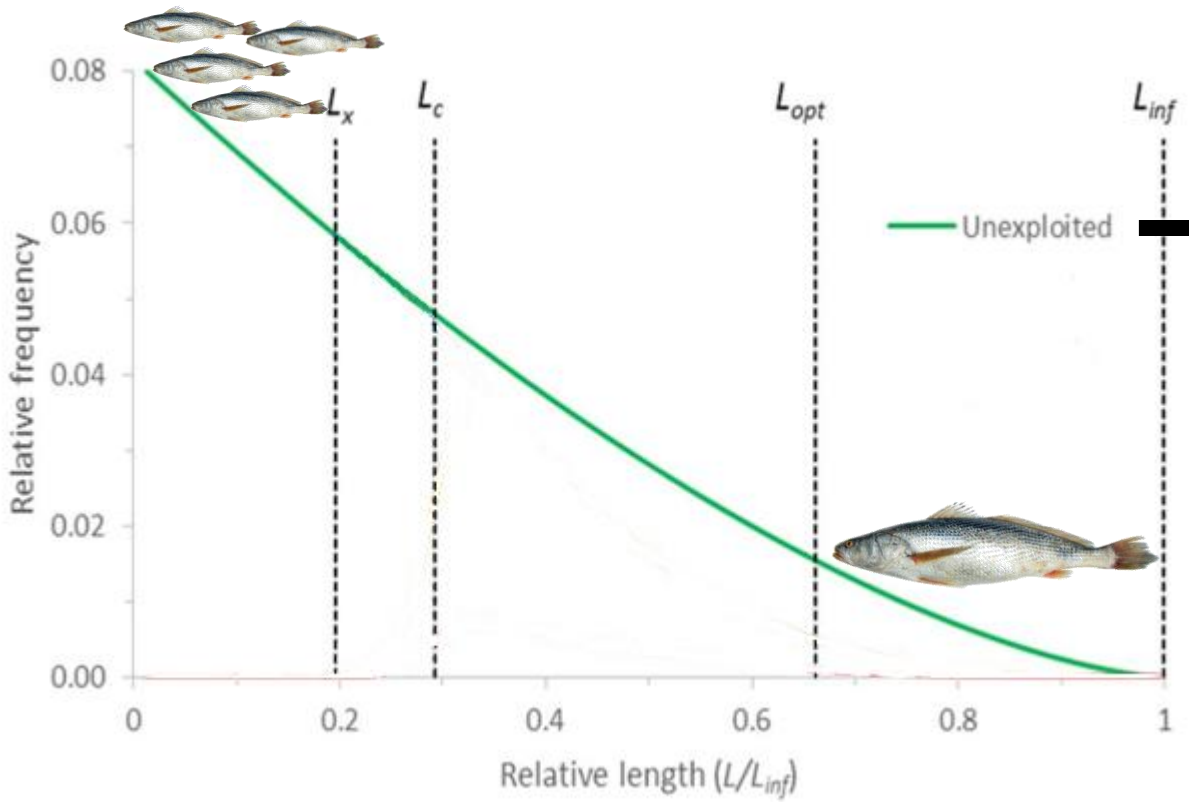


2.1. LBB - Data

- Length frequencies
- L_{inf} : Asymptotic length

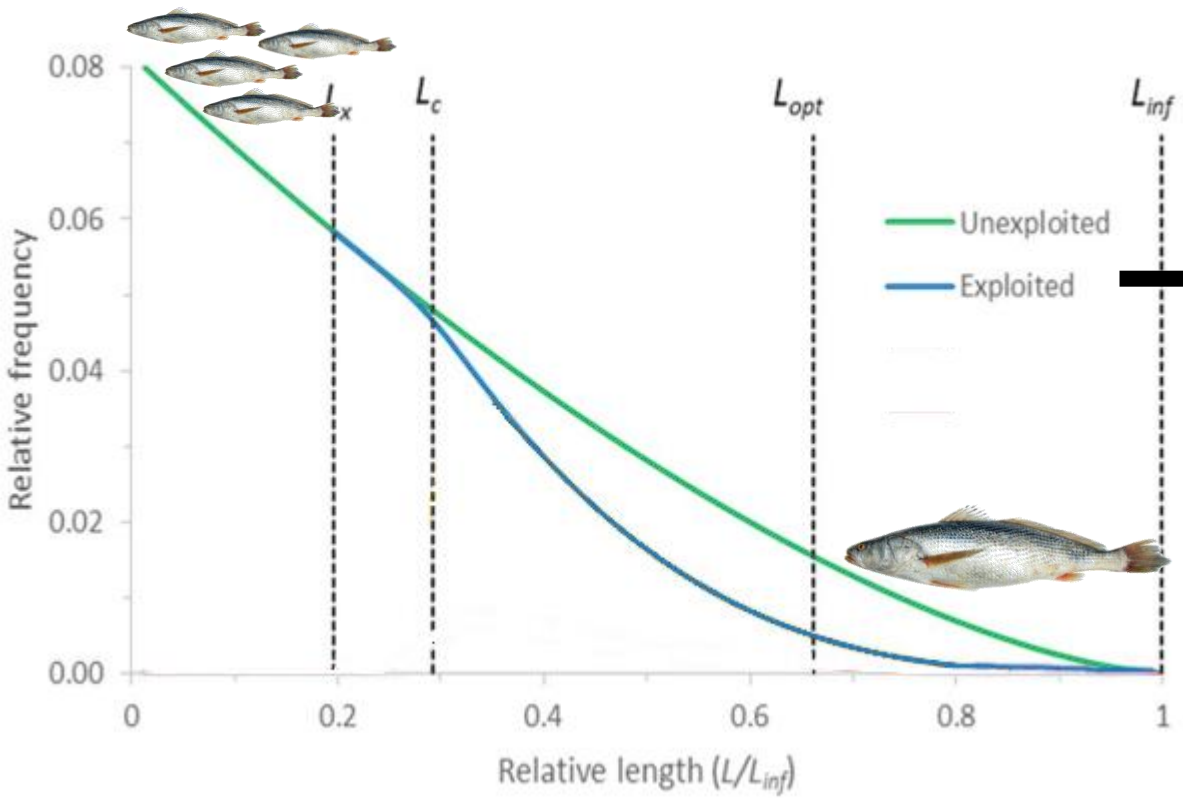


2.1. LBB - Theory



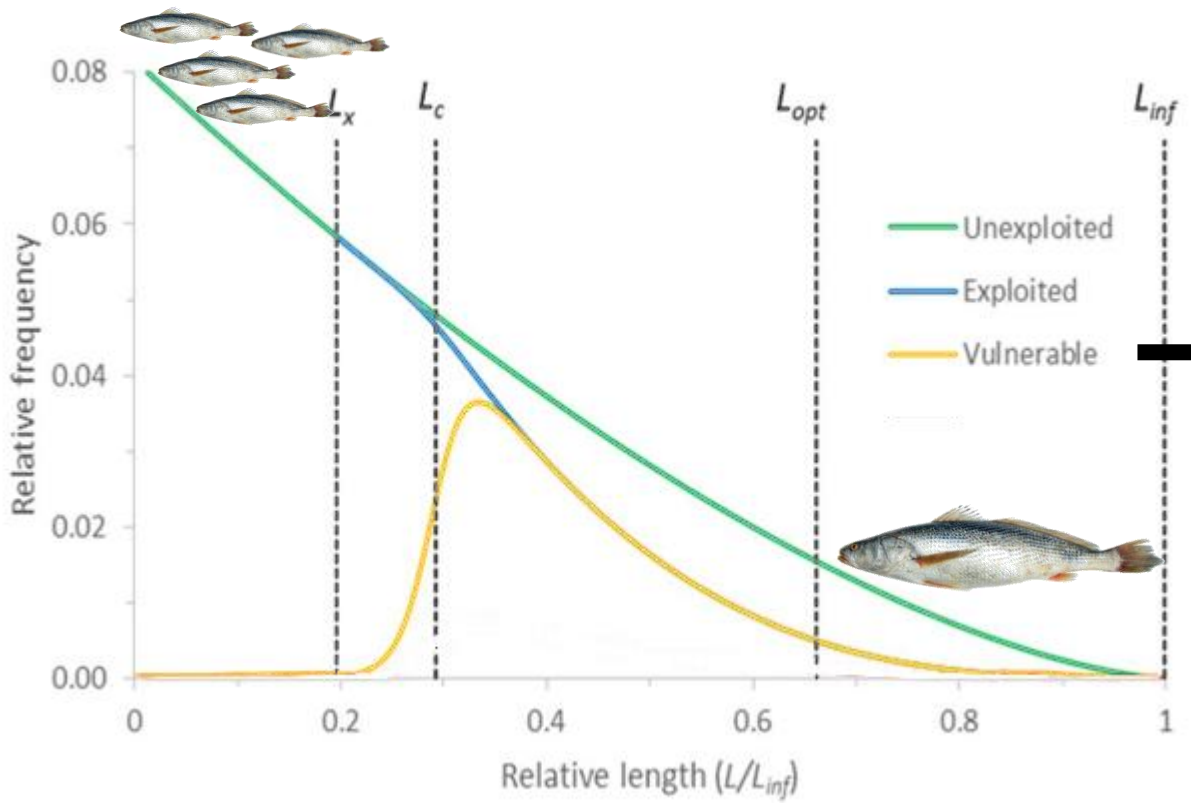
Natural Mortality : $\boldsymbol{M}$

2.1. LBB - Theory



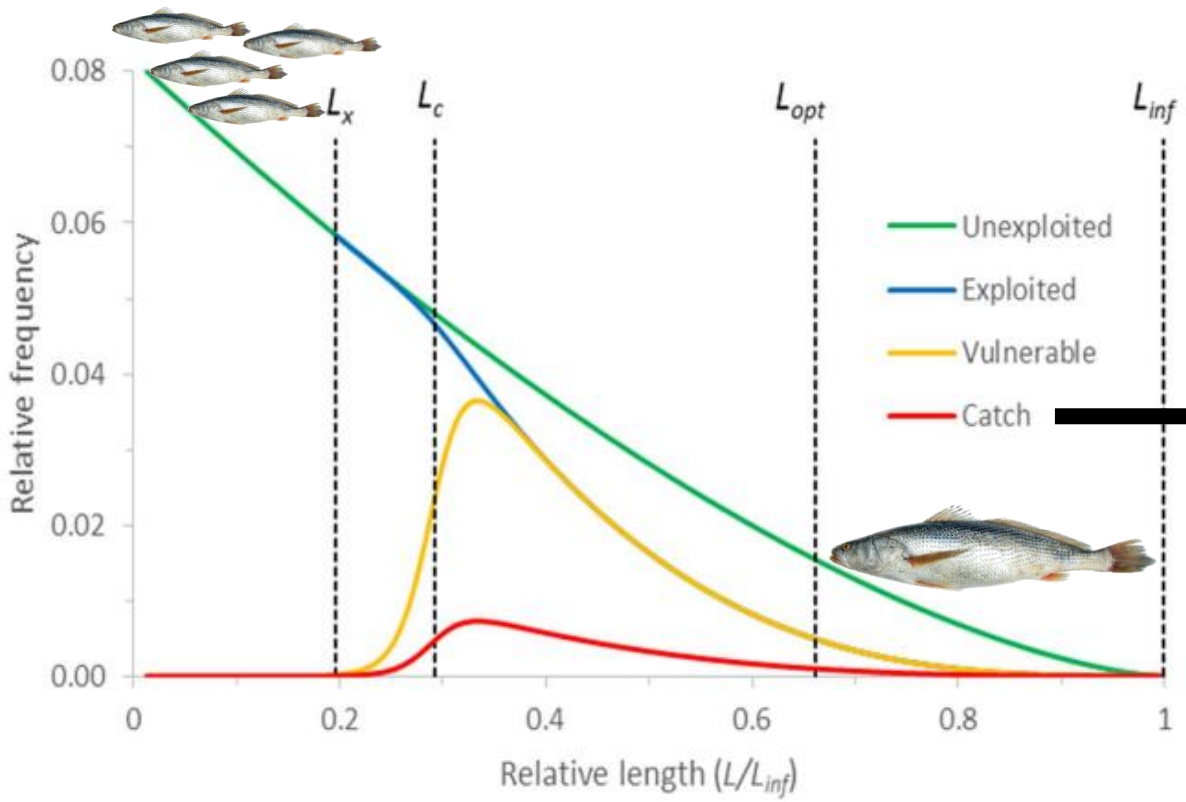
Natural and Fishing Mortality : $\boldsymbol{F + M}$

2.1. LBB - Theory



Gear Selectivity

2.1. LBB - Theory

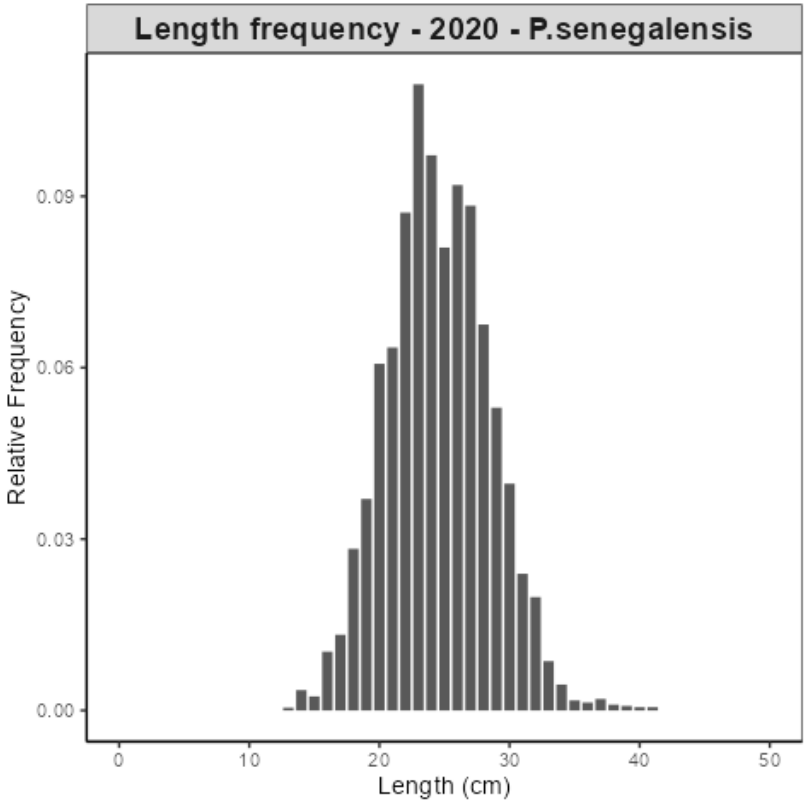


$$C_{Li} = N_{Li} \; S_{Li}$$

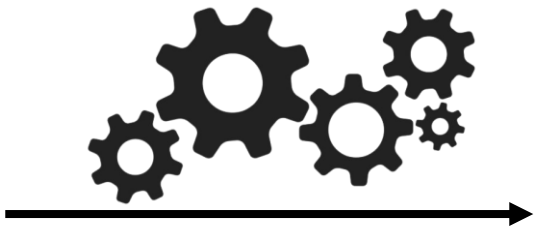
$$C_{Li} = \mathrm{f}(\boldsymbol{parameters})$$

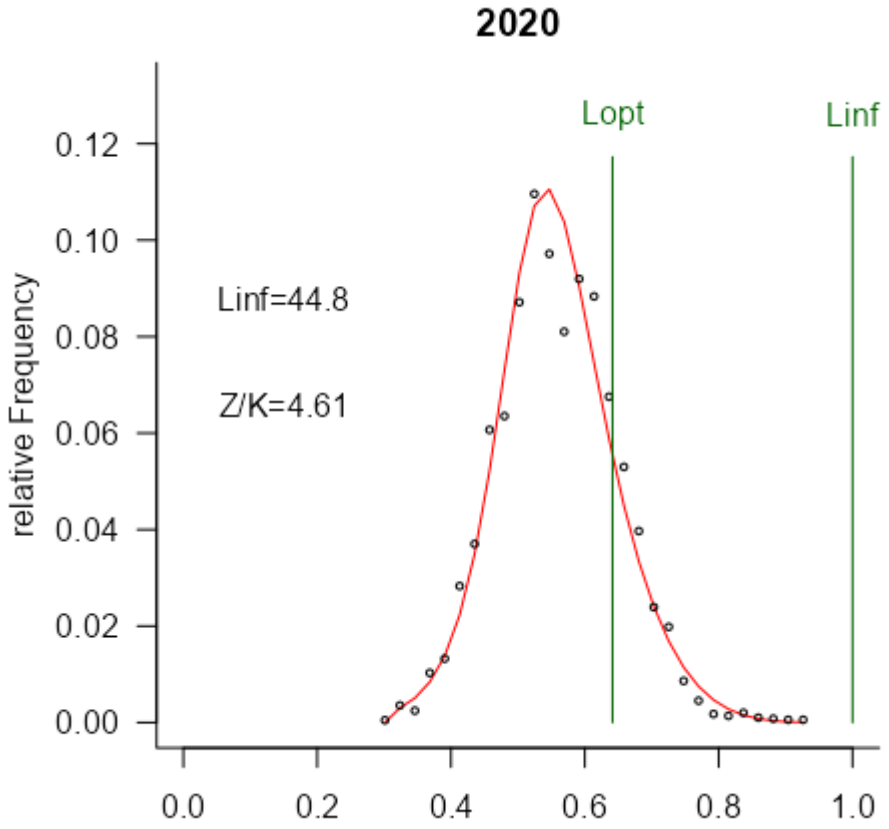
2.1. LBB – Fitting process

Data



LBB





2.1. LBB - Theory

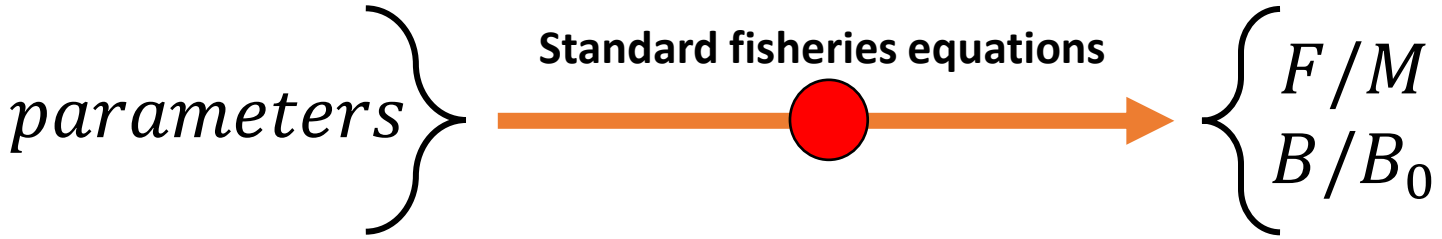
Bayesian framework : Estimate simultaneously parameters

6 parameters :
$M, F, K, Lc, L_{inf}, \alpha$

$parameters$ }

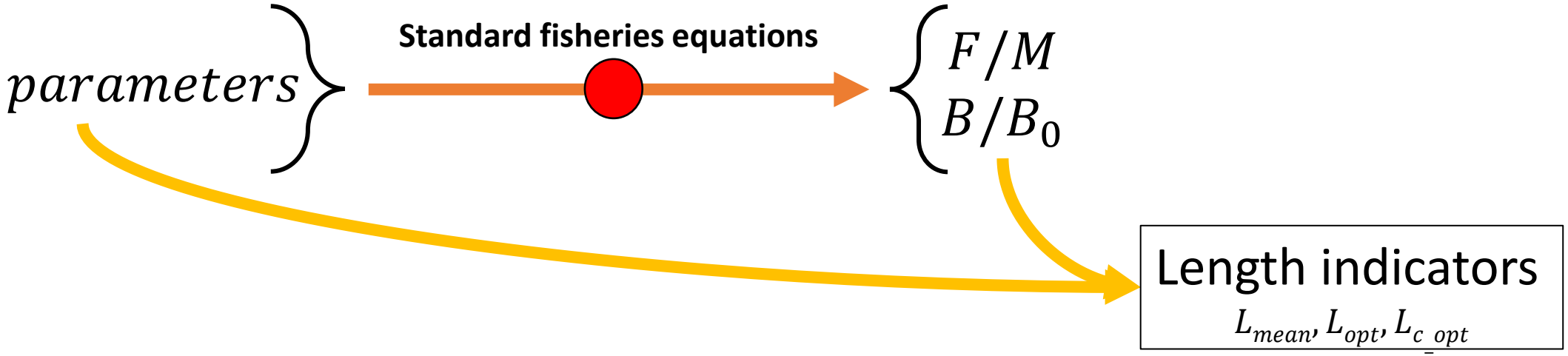
2.1. LBB - Theory

Bayesian framework : Estimate simultaneously parameters
Estimate stock status parameters



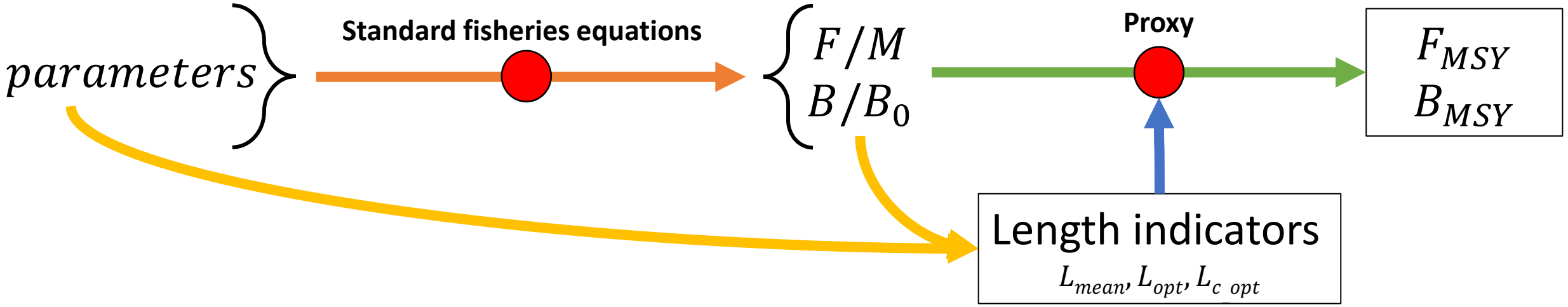
2.1. LBB - Theory

Bayesian framework : Estimate simultaneously parameters
Estimate stock status parameters and length indicators



2.1. LBB - Theory

Bayesian framework : Estimate simultaneously parameters
Estimate stock status parameters and length indicators
Estimate **proxies** for stock assessment



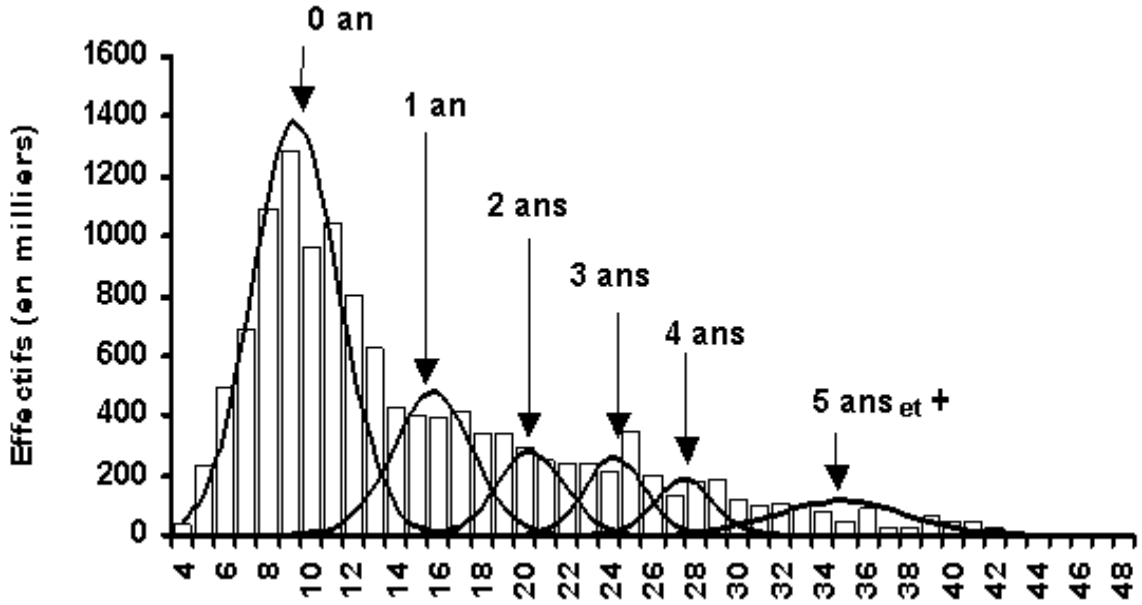
2.2. Rectified pseudo-cohort

2.2. Rectified pseudo-cohort : Prerequisite

From length frequencies to catch-at-age

➔ Polymodal decomposition

- Necessitate growth law



Sidibé et al, 2002

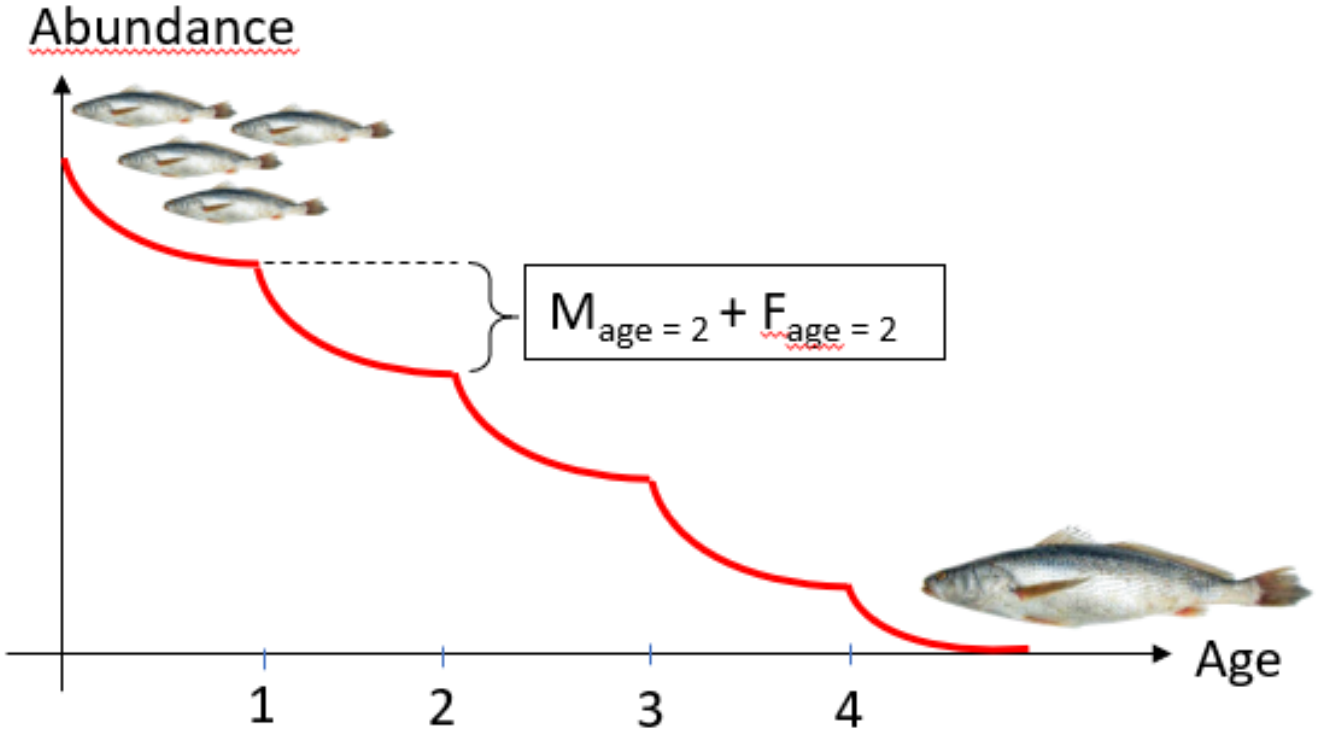
2.2. Rectified pseudo-cohort : Data

- Catch-at-age (in number)
- Effort for each year
- Recruitment index of each year
- Natural Mortality (Lorenzen, 2021)

Age	Catch
0	160 000
1	2 000 000
…	…
8	220 000
9	100 000
10	15 000

Year	Relative Effort	Relative Recruitment
2011	0.8	1.15
2012	0.75	1.1
…	…	…
2018	0.96	1.03
2019	0.93	1.2
2020	1	1

2.2. Rectified pseudo-cohort : Theory

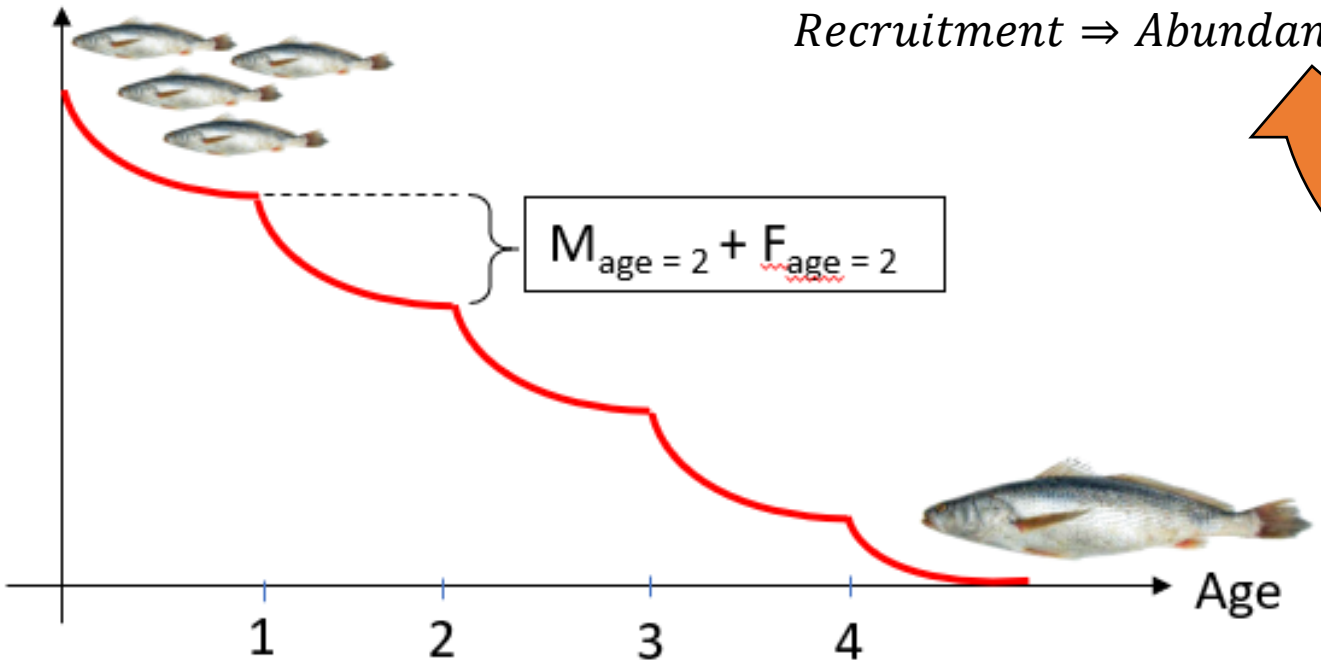


?

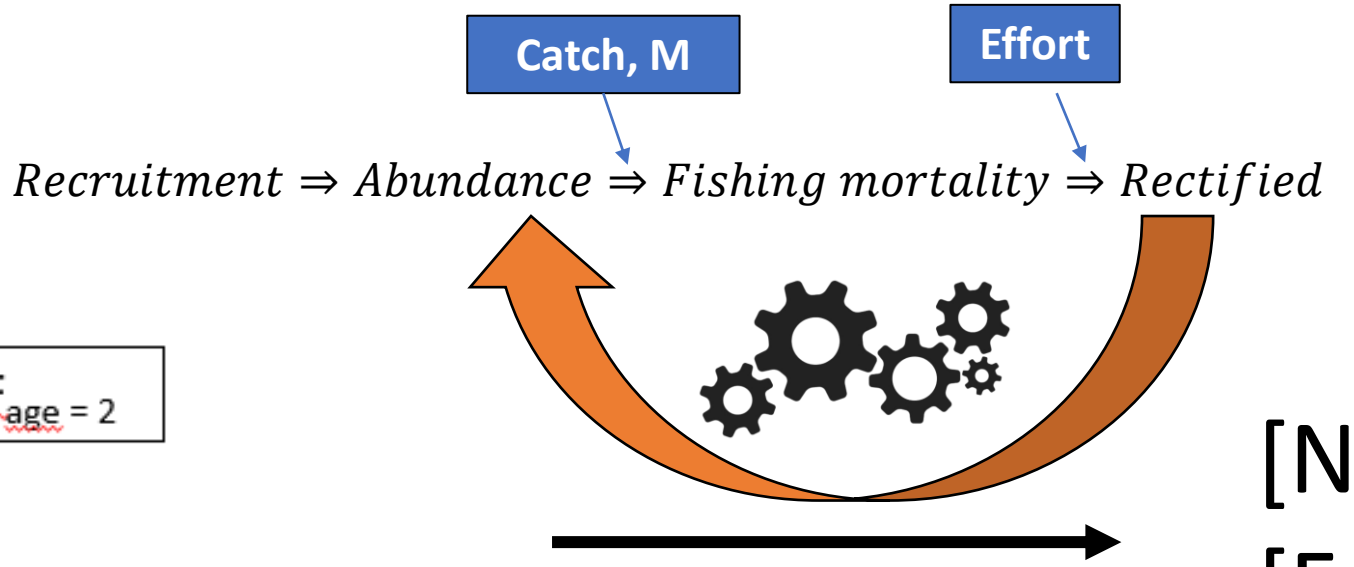
$[N_{age}]$

$[F_{age}]$

2.2. Rectified pseudo-cohort : Theory



Standard fisheries equations



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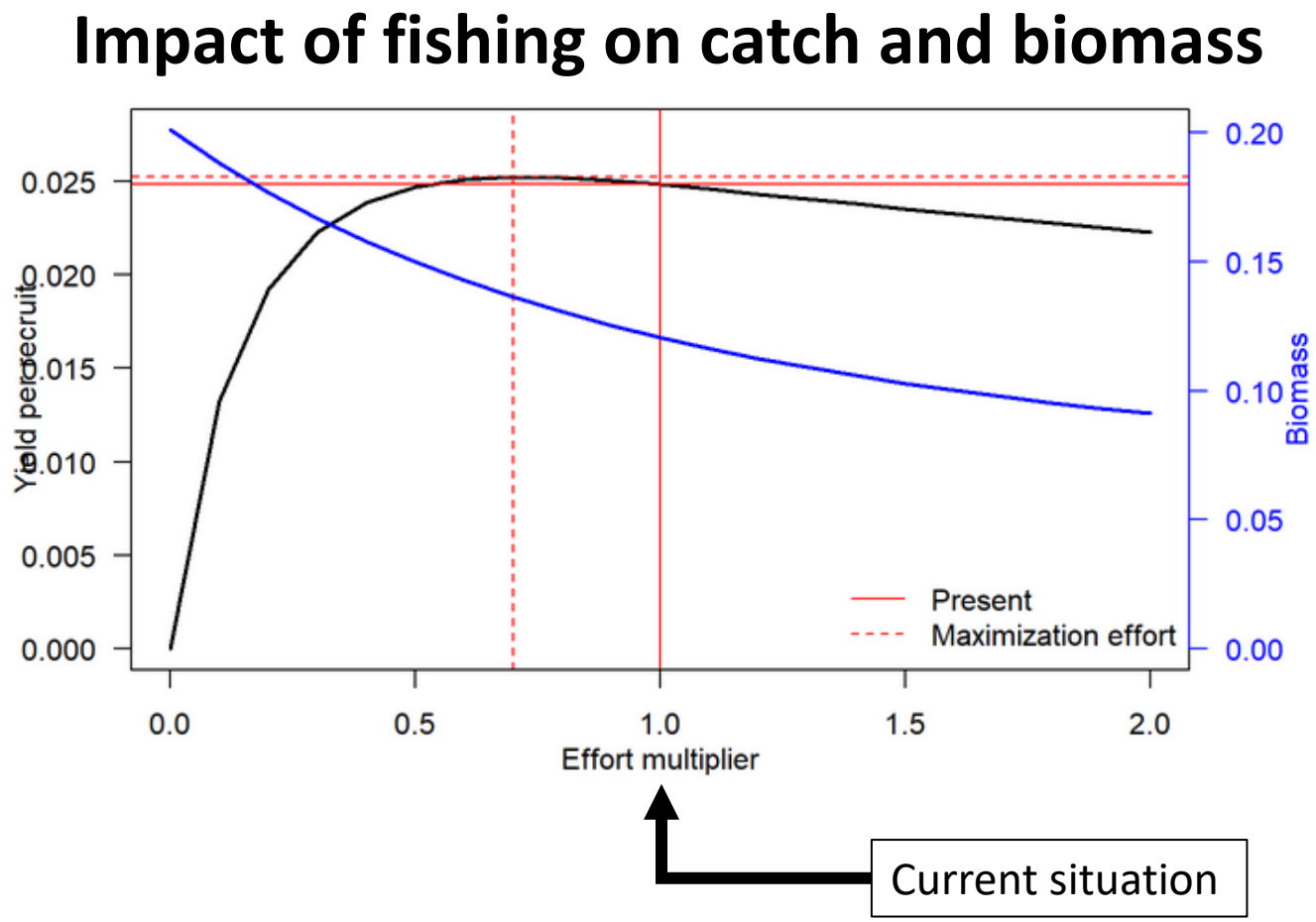
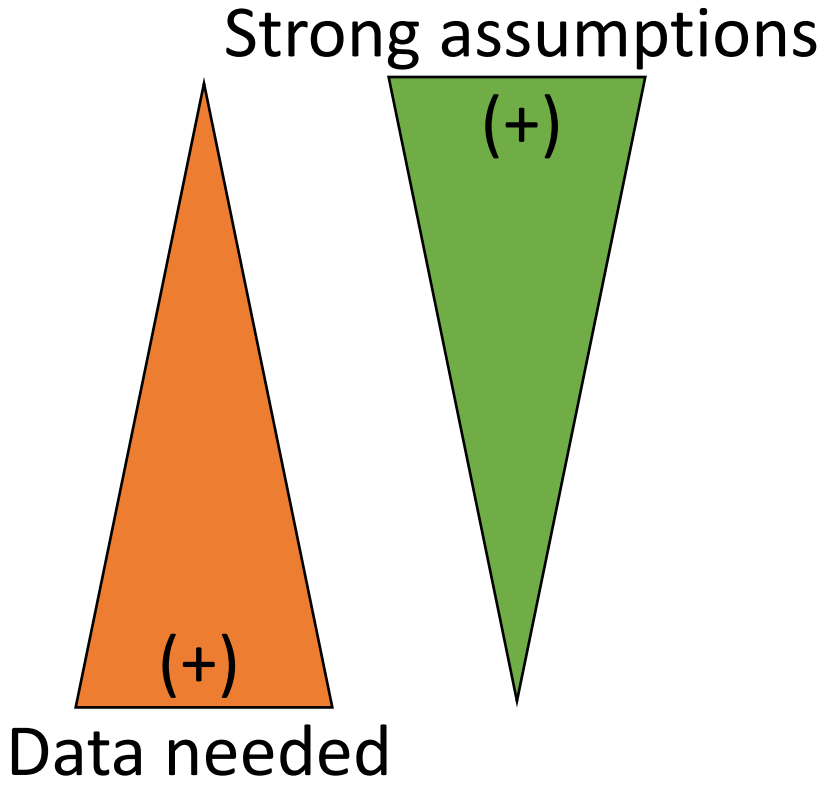


2.3. Length based model: review

- LBB :
  - Easy to handle method
  - Rely on strong hypothesis (Effort and Recruitment constant)

- Rectified pseudo-cohort :
  - Necessitate catch-at-age data
  - Take into account variations in Effort and Recruitment
  - More complex to handle



Conclusion - Review of the methods used

Methods \ Data		Catch	CPUE / AI	Priors (r and K)	Length - frequency	Growth parameters (Linf, K, t0…)	Effort	Natural Mortality
Production model	Pseudo-eq							
	JABBA							
Length-based model	LBB							
	Pseudo-cohort							

Necessary data

Optionnal data

Conclusion - Review of the methods used

Methods \ Characteristics		Model complexity	Data specificities	Managment tools for
Production model	Pseudo-eq	Simple	Long time series for Catch and IA	Fishing effort
	JABBA	Powerfull		
Length-based model	LBB	Simple	• LF representativity • Availability of catch at length and growth curve	• Fishing effort • Size selectivity
	Pseudo-cohort	Powerfull		

Thank you
Merci