

EcoTroph (E.T.): a trophic-level based ecosystem approach

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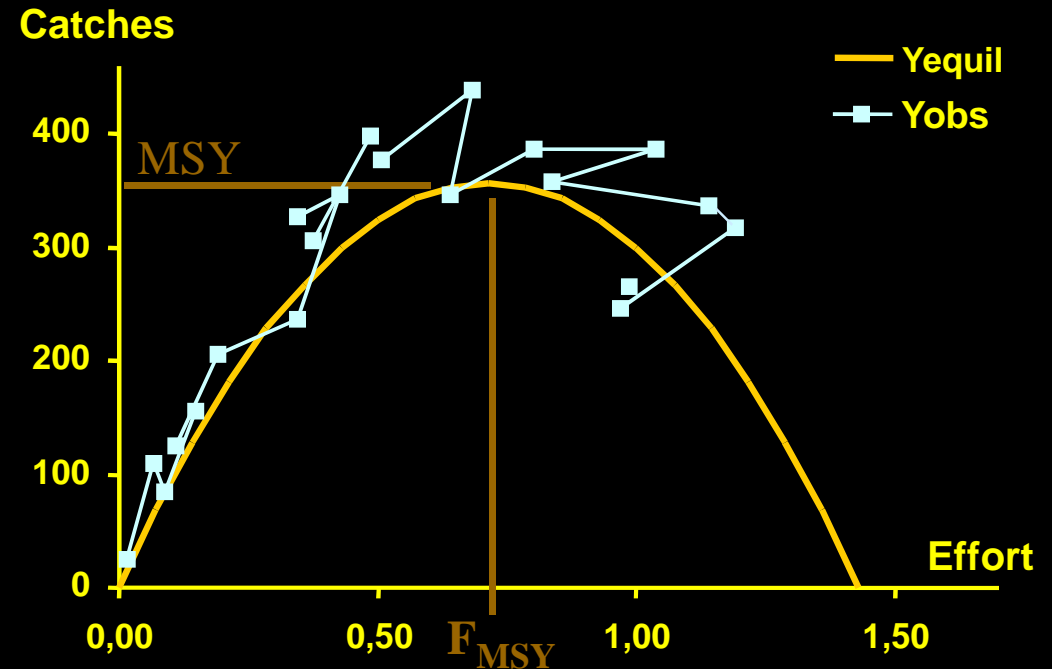


Introduction ...

Theoretical (generic) models of ecosystem functioning are needed for EAF

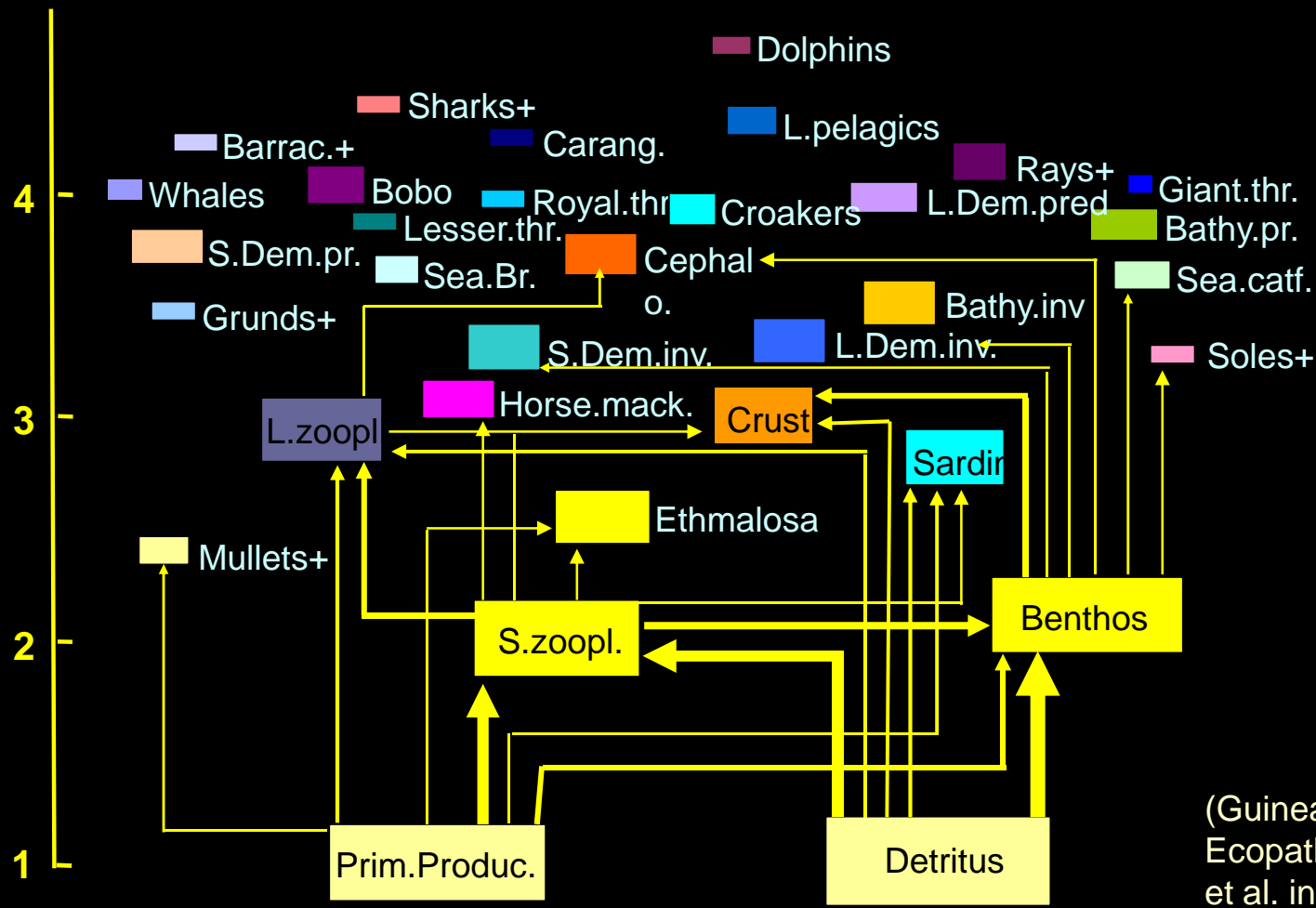
An example within single species approaches:
the Schaefer model

-> a theoretical and operational tool



Introduction ...

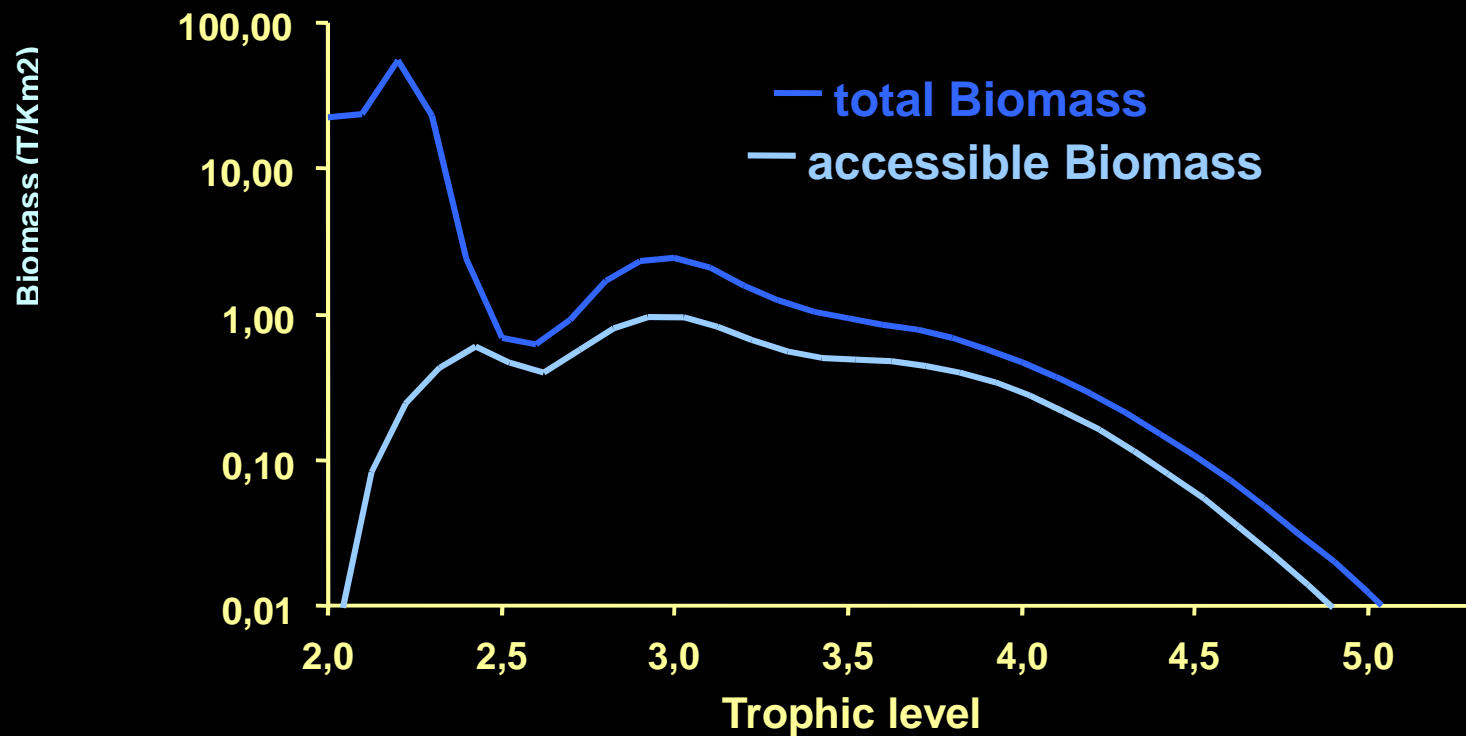
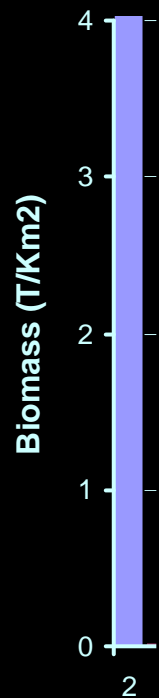
- The “usual” representation of ecosystem structure and functioning : Ecopath
 - ➔ a operational (data driven) tool



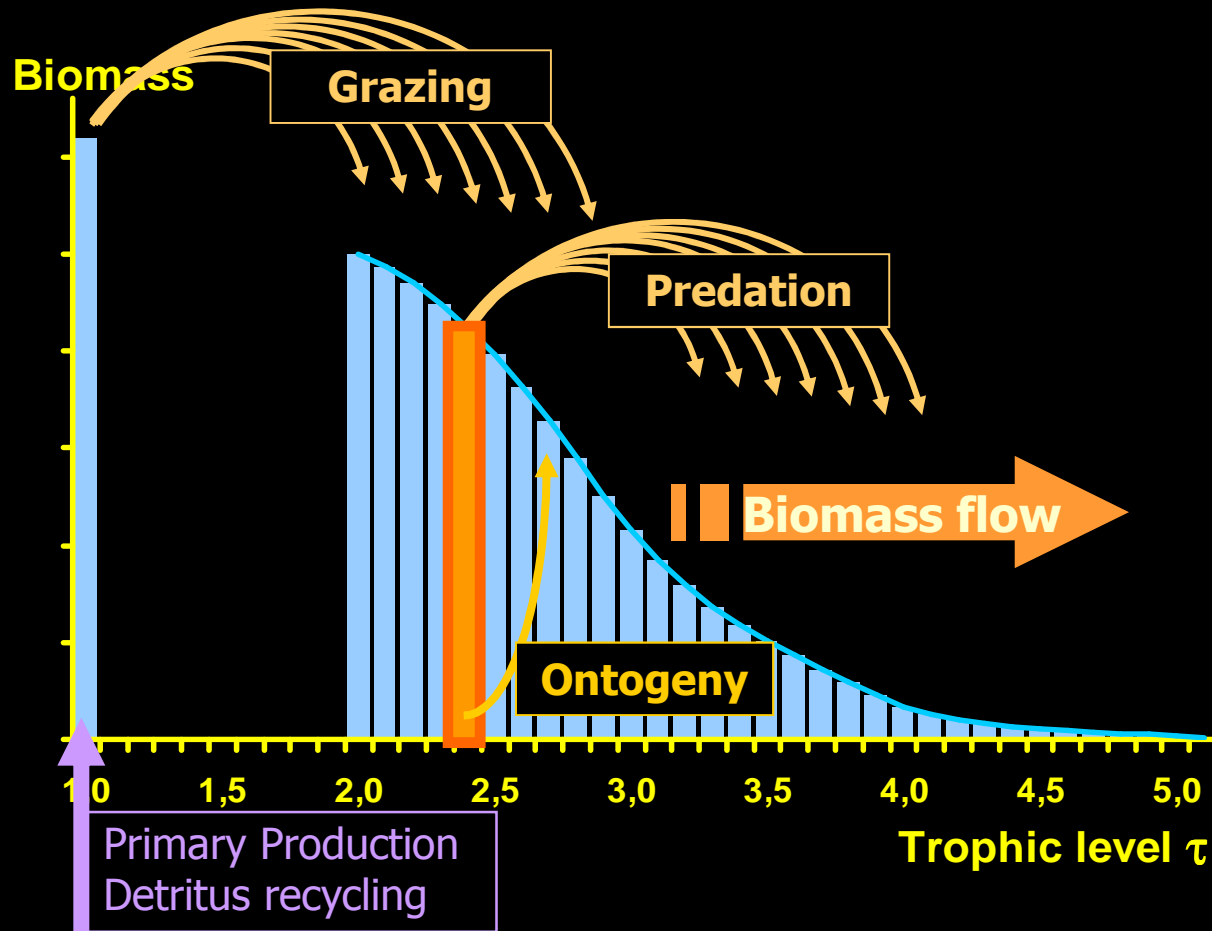
(Guinean ecosystem, Ecopath 2004, Gascuel et al. in press)

EcoTroph: an other view on ecosystems

- Changing the view, using TLs as the x-axis
 - Taking into account the within group variability of TLs
 - Forgetting species or groups: the trophic spectrum



EcoTroph: an other view on ecosystems



- A continuous representation of the biomass distribution, according to trophic level τ

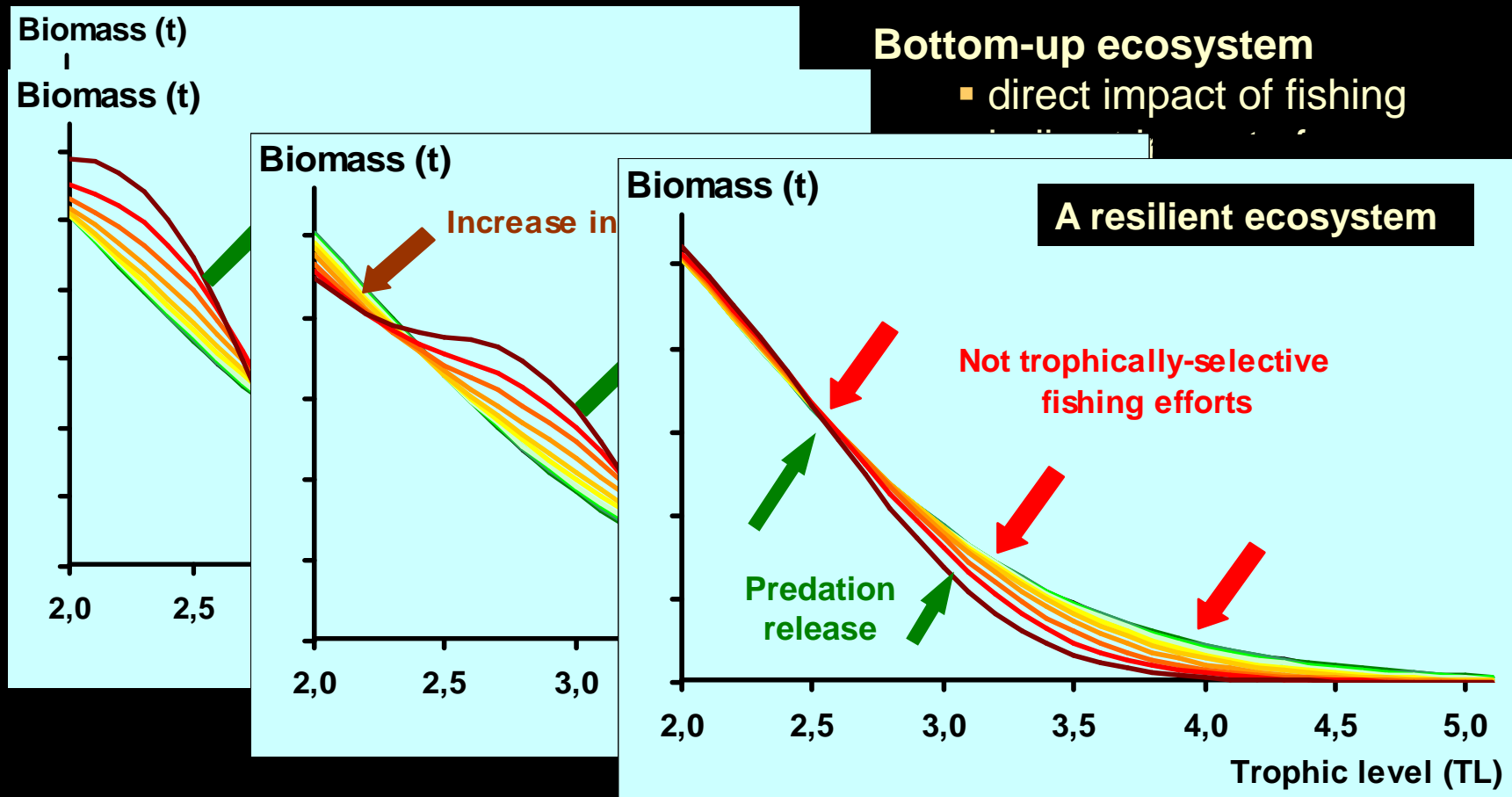
-> the Biomass Trophic spectrum

- The ecosystem functioning: a flow of biomass trough trophic levels

EcoTroph: a model of the biomass trophic spectrum ($B\tau$), based on equations issued from physic's flux

EcoTroph: theoretical simulations (Gascuel and Pauly 2009)

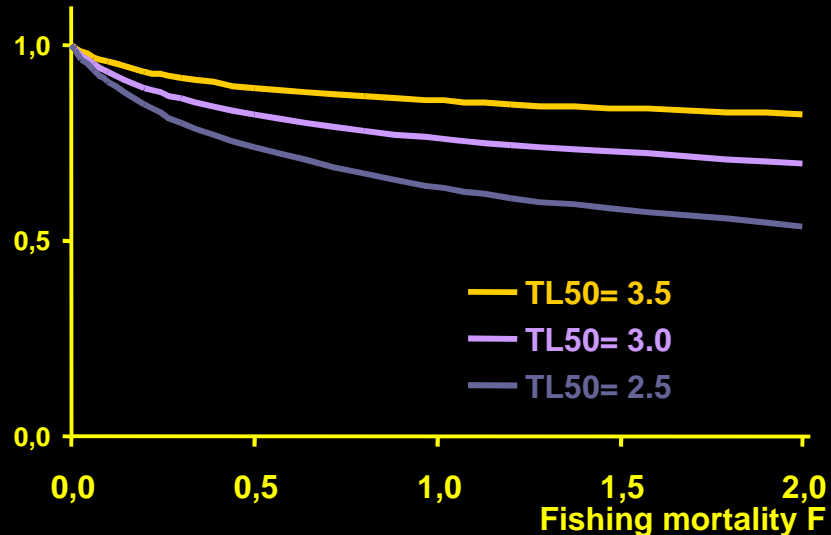
- Theoretical result: Fishing impact on biomass flow and kinetic affects the biomass



EcoTroph: theoretical simulations

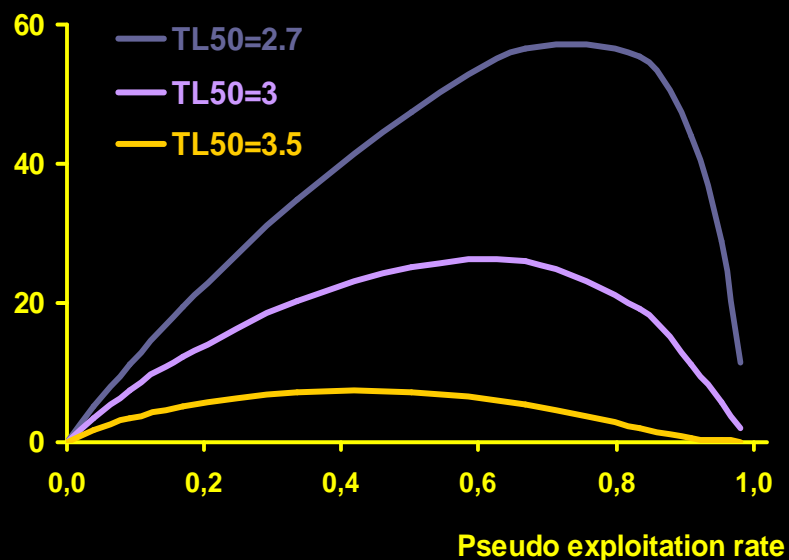
(Gascuel and Pauly 2009)

Relative biomass



- Ecosystem biomass decreases with exploitation
- This decrease is stronger when the trophic level of first catch TL₅₀ is low
- Top-down controls, low trophic efficiency and fast flow kinetics increase resilience
- ...

Catch



- MSEY
- Exploiting low trophic levels leads to higher catches and higher ecosystem F_{MSEY}
- ...but it induces strong biomass depletion and severe over-fishing for top predators

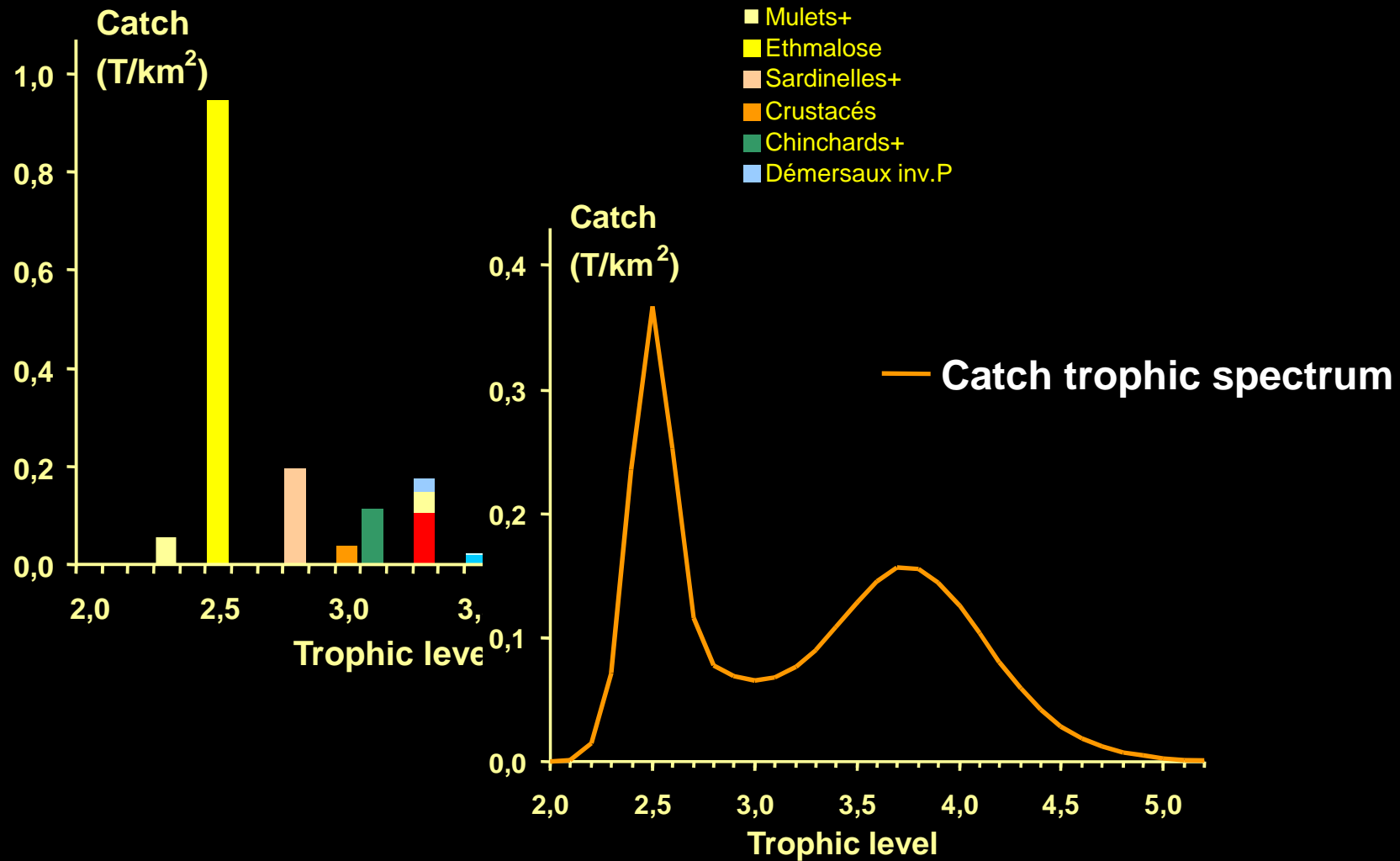
The Guinean case study as an example: input data

Catch per group ...

	Captures (tonnes)		Niveau trophique
	p.artis.	p.indus.	
Raies+	503	1 043	3,97
Requins+	307	110	4,31
Grands Pélagiques	1 062	2 980	4,21
Chinchards+	0	4 939	3,13
Ethmalose	40 645	0	2,53
Sardinelles+	2 476	5 953	2,85
Bobo	8 203	2 958	3,92
Bars+	3 200	2 557	3,92
Petit capitaine	101	3 244	3,88
	
TOTAL	71 551	50 032	

The Guinean case study as an example: input data

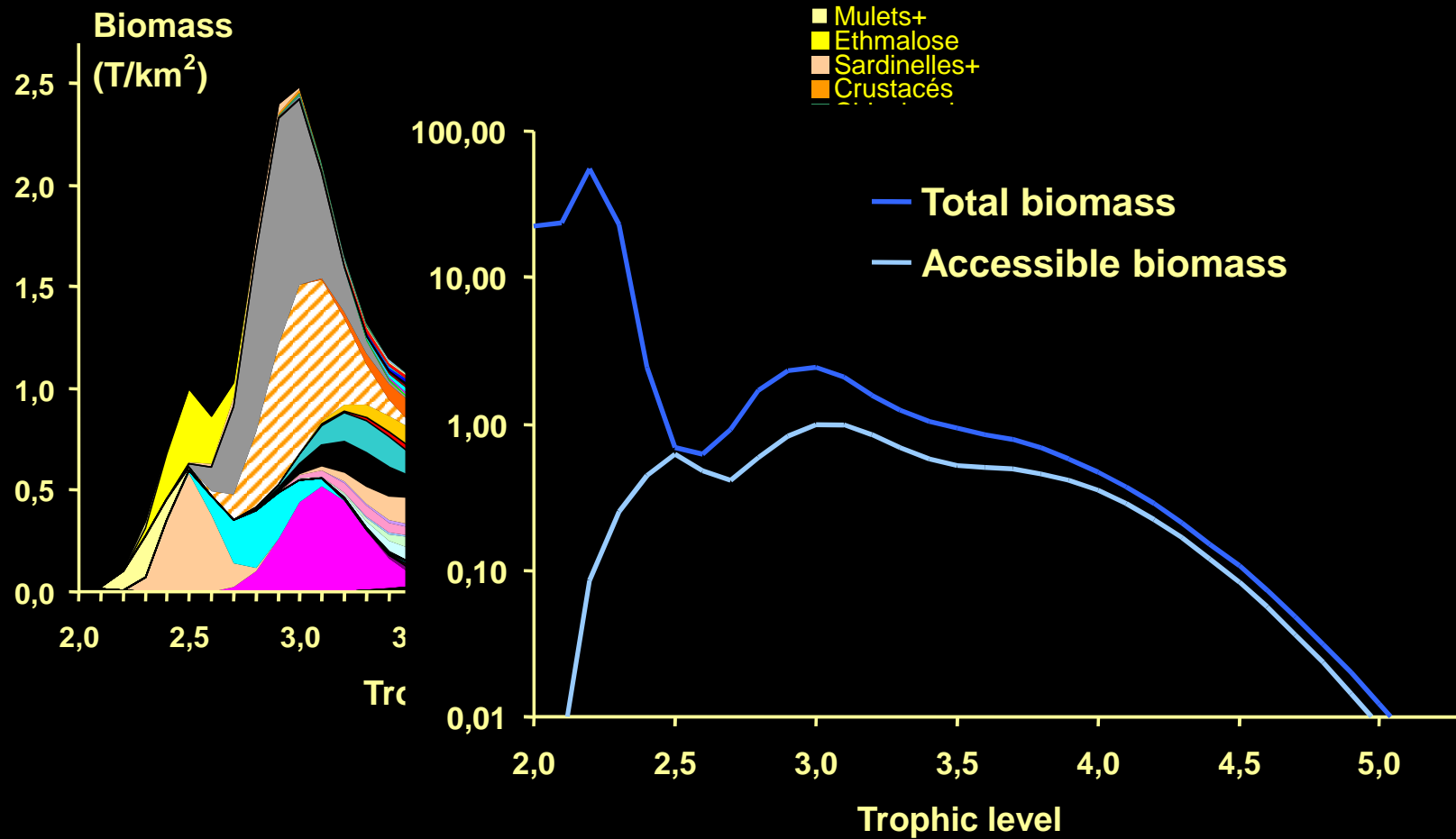
Catch per group ...



The Guinean case study as an example: input data

Biomass trophic spectrum

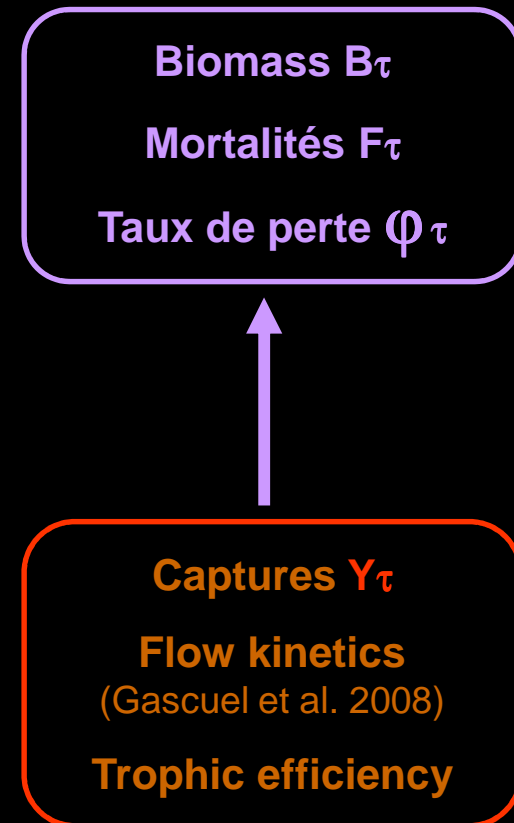
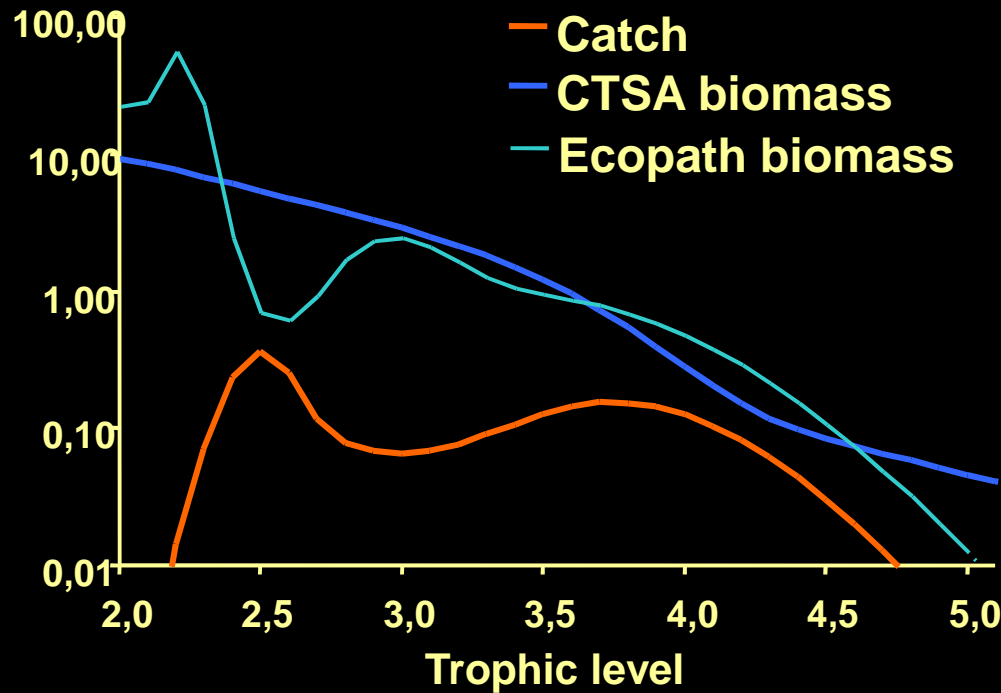
1. Based on an Ecopath model...



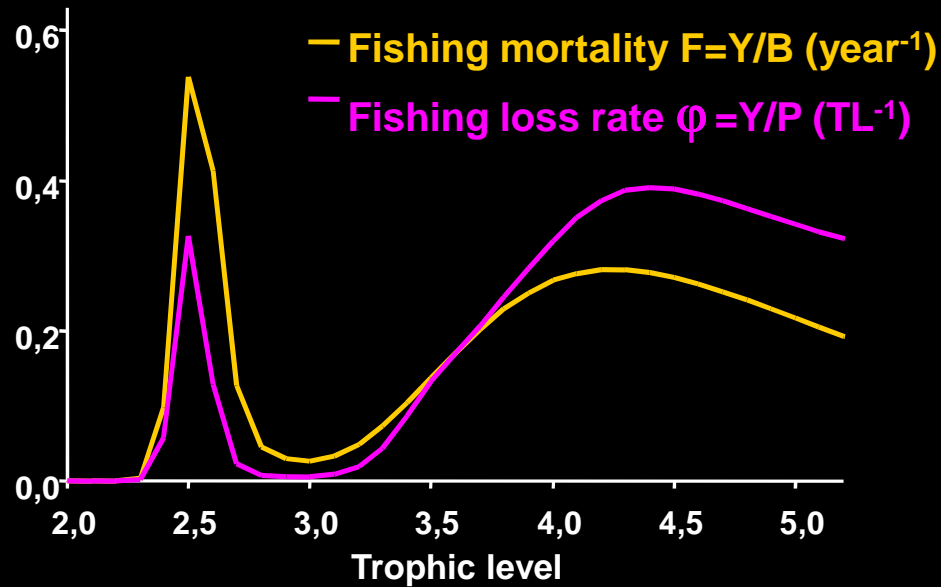
The Guinean case study as an example: input data

Biomass trophic spectrum

2. ... or based on a Catch Trophic Spectrum Analysis (CTSA)



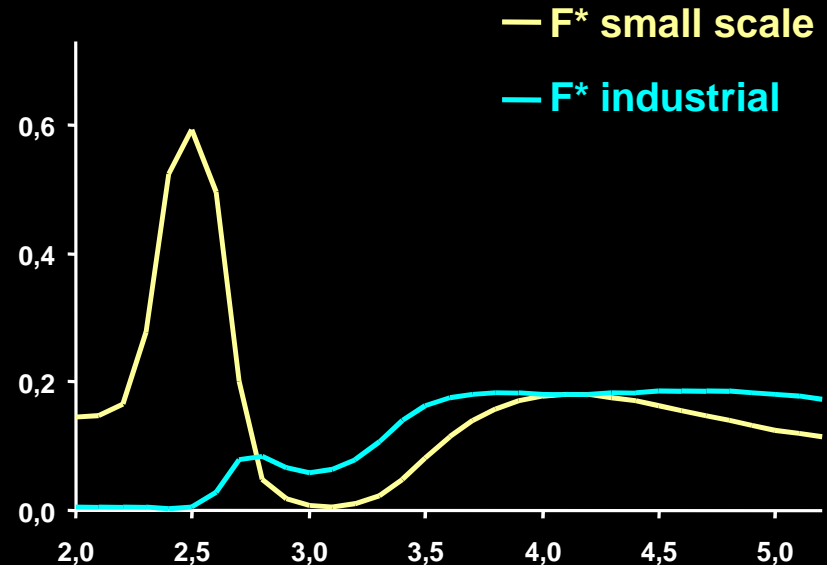
The Guinean case study as an example: fishing patterns



F : targeted levels

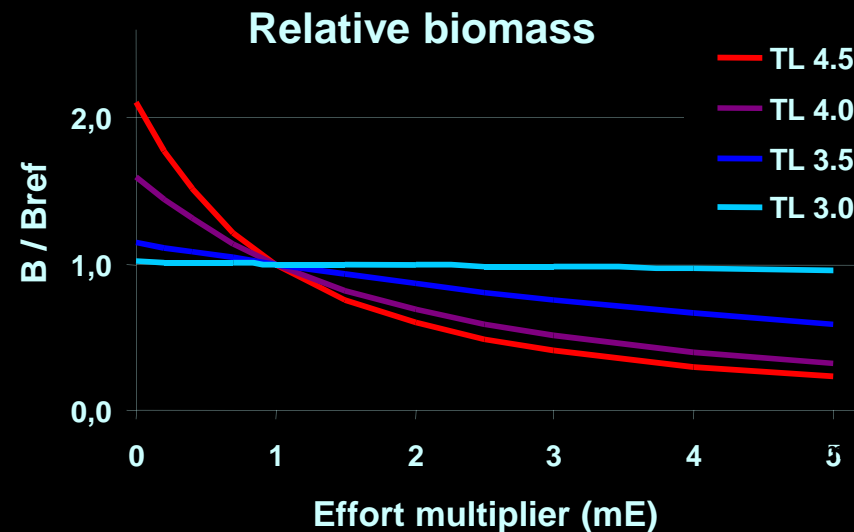
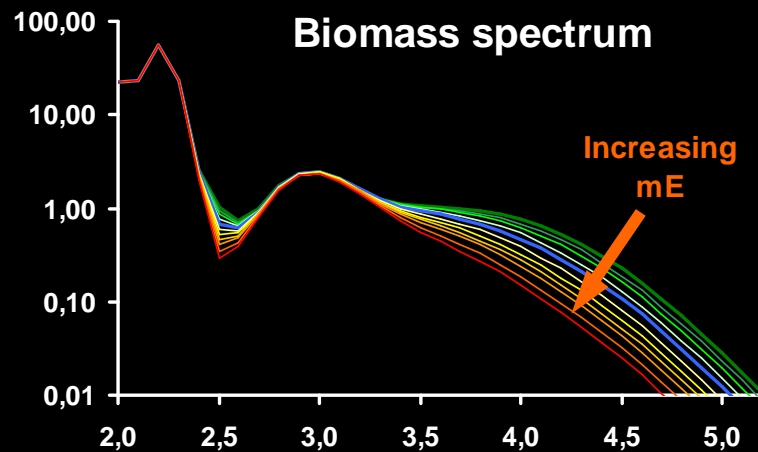
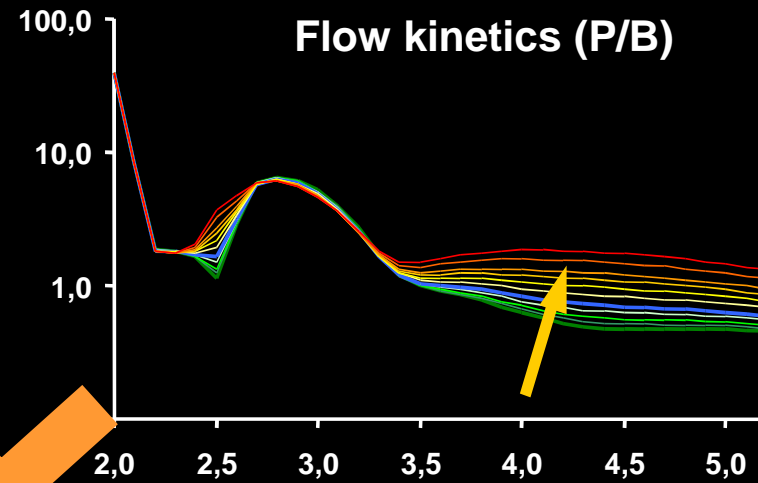
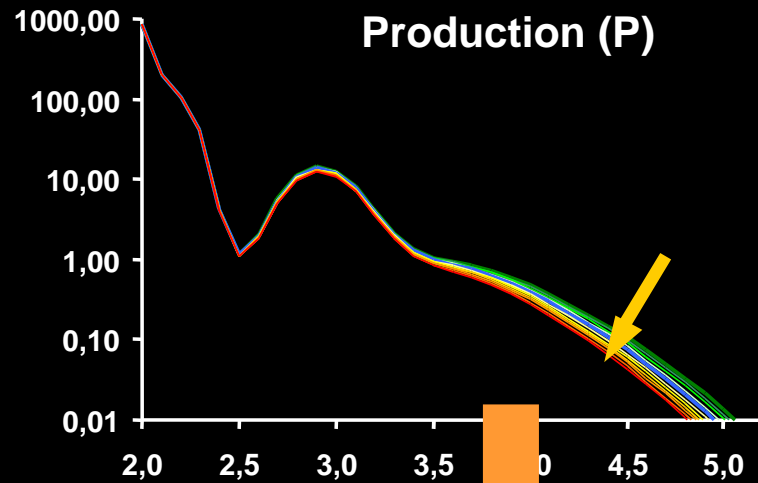
φ : impacted levels

Fishing pattern per fleet



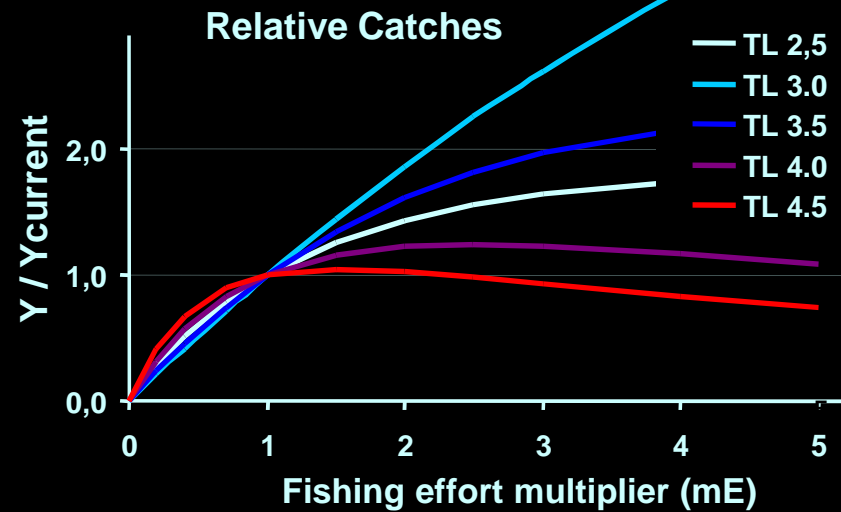
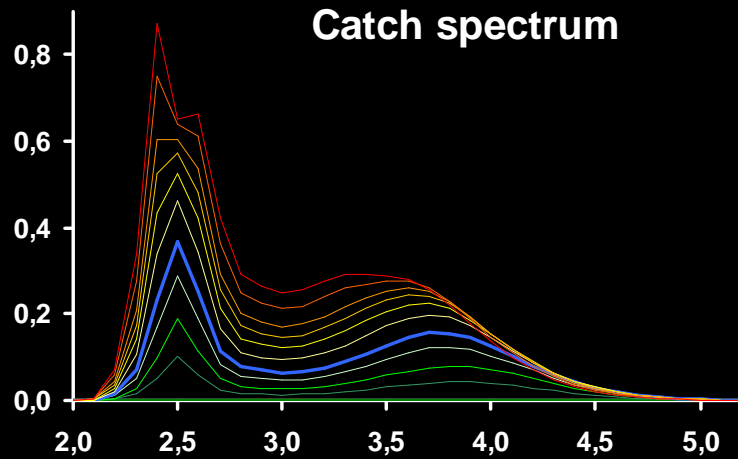
Simulation of changes in the fishing effort (multipliers $mE = 0$ to 5)

Fishing impact on the biomass of the ecosystem

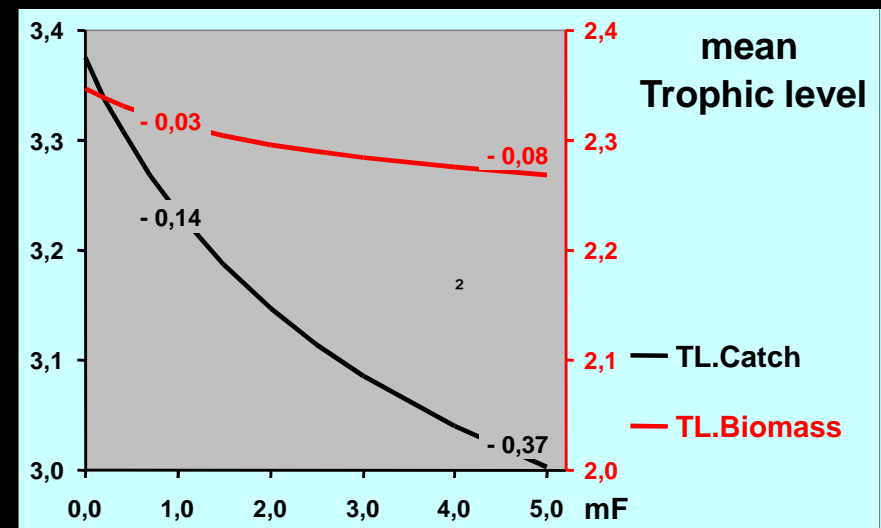
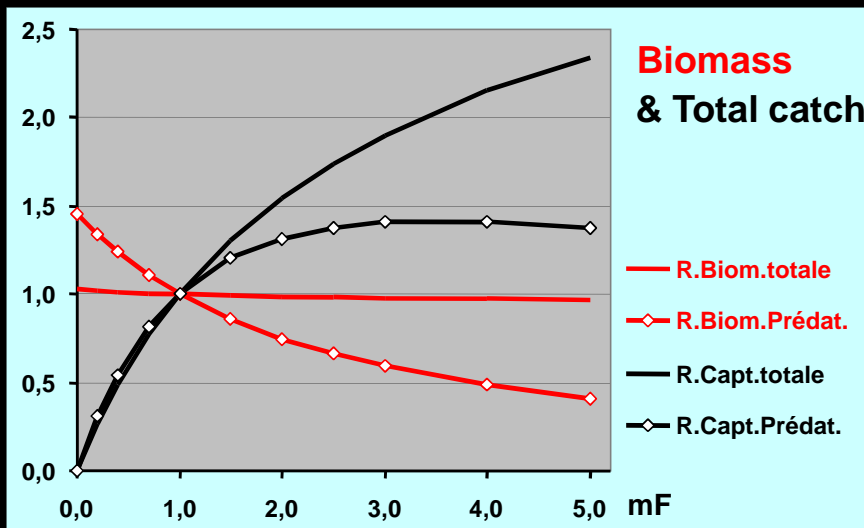


Simulation of changes in the fishing effort (multipliers $mE = 0$ to 5)

Catch simulation



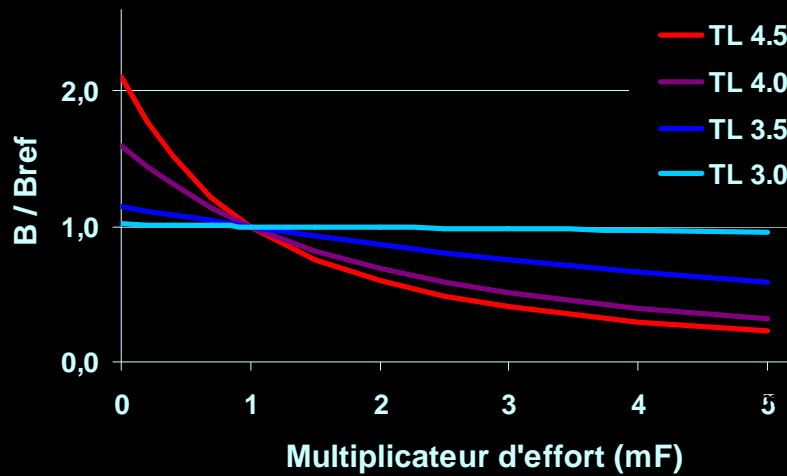
Global diagnosis



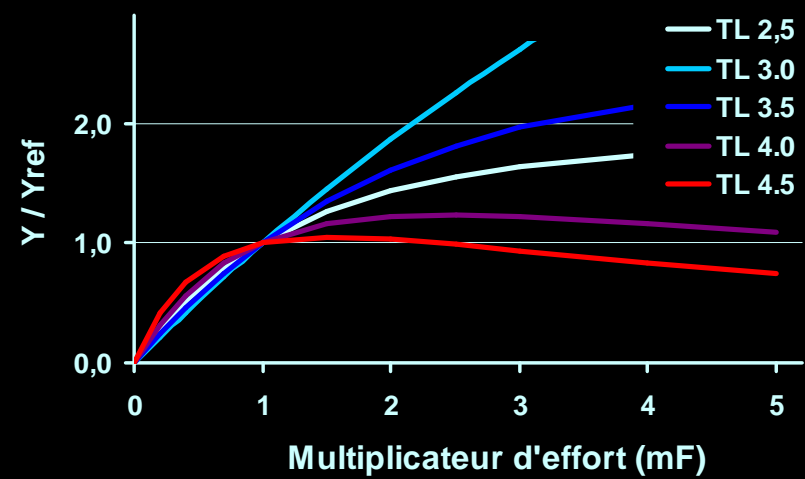
The CTSA: sensitivity

From Ecopath

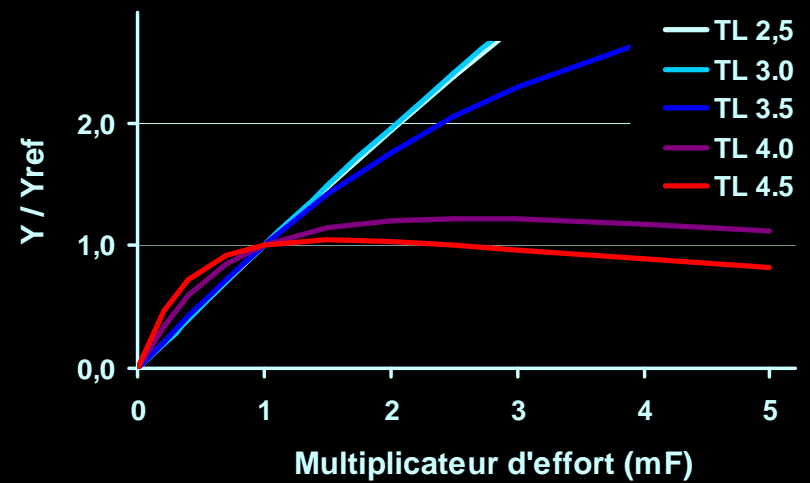
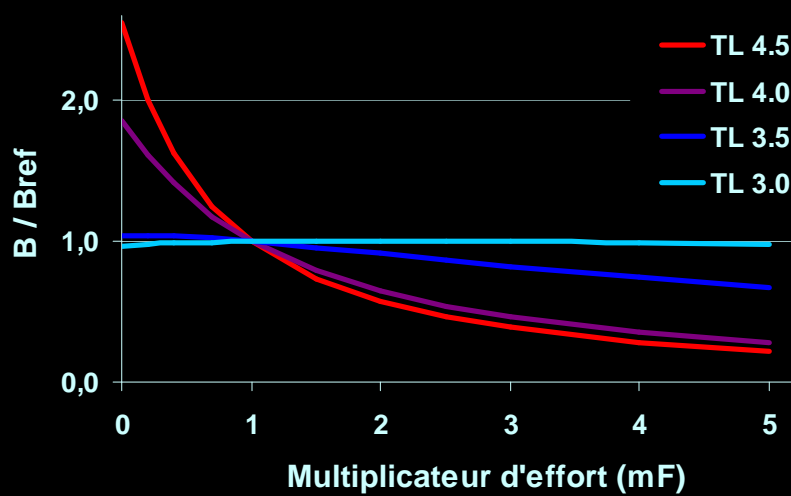
Relative biomass



Relative Catch



From CTSA



Conclusion: key points

1. The marine ecosystems functioning could be represented / studied (reduced ?) as a **continuous trophic flow**, from low to upper trophic levels
2. The EcoTroph model is based on very simple assumptions:
 - The biomass flow decreases with trophic levels (according to the **trophic efficiency**)
 - The **speed of the flow** is faster in low trophic levels
 - **Top-down control**: flow kinetics depend on predators abundance
3. The model leads to a **consistent representation** ... of almost all we already know (yield, biomass, ... FDMFW, cascades, resilience,...) ...
4. ... and appears a **useful tool for diagnosis of fishing impact in specific case studies.**

Conclusion: key points

5. **EcoTroph input parameters are calculated as functions of TL (leading to a strong decrease in the number of parameters required) ... the ultimate stage in the use of the TL metric**

6. **EcoTroph can be used as a stand-alone application (especially in data-poor environment) or based on an Ecopath model**
 - **A simplified (and useful) picture of ecosystem functioning**
 - **Available as a plug-in of EwE version 6**

Thank you

- **Main EcoTroph references**

Gascuel, 2005 – The trophic-level based model (*Ecological modelling*, **189**: 315-332)... **first version**

Gascuel, Morissette, Palomares, Christensen, 2008 - Trophic **flow kinetics** in marine ecosystems: toward a theoretical approach to ecosystem functioning (*Ecological Modelling*, **217**: 33-47)

Gascuel, Pauly, 2009 - EcoTroph: modelling marine ecosystem functioning and impact of fishing (*Ecological Modelling*, in press. [doi:10.1016/j.ecolmodel.2009.07.031]) ...**theoretical aspects**

Gascuel, Guénette, Pauly, 2008 (and in review)- The trophic-level based ecosystem modelling approach: Theoretical overview and practical uses. (ICES-ASC CM 2008 / F:18. Submitted to ICES JMS) ...**an overview**

Gascuel D., Tremblay-Boyer L., Pauly D., 2009 - EcoTroph (ET): a trophic-level based software for assessing the impacts of fishing on aquatic ecosystems. *Fisheries Centre Research Reports*, 17(1), 83 p. ... **A user guide - www.fisheries.ubc.ca/node/366**