Lower selectivity as a consequence of higher fuel costs? A simple bio-economic model and an application to the french *Nephrops* fishery in the bay of Biscay

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Introduction

« Technical measures » aimed at increasing selectivity = an important component of the standard fisheries management toolbox

Social benefits expected due to positive consequences on non-commercial and commercial species (biomass and age structure)

However, selectivity also generates costs because it decreases CPUE of marketable individuals

→ Balance between social benefits and costs depends on the level of effort

Plan of the presentation

1. Simplified bioeconomic model

2. Numerical application to the Nephrops fishery in the bay of Biscay

1. Simple bio-economic model and optimal equilibrium analysis:

Bio-economic model specifications

Only **one stock** exploited by an homogenous fleet
2 age groups 1 and 2

Constant Fishing mortality per age group
CPUE proportional to biomass: $F_i = q_i E$

Catchability for age 2=1
Catchability for age 1: $q_1 = 1 - s$
With s a technical parameter for selectivity:

- **s=1**: selective technique→ no joint production, catches of age 2 only
- **s=0** : non selective technique→ joint production
  Catchability for age 1 and 2 equal to 1
- **0<s<1** : imperfect selectivity

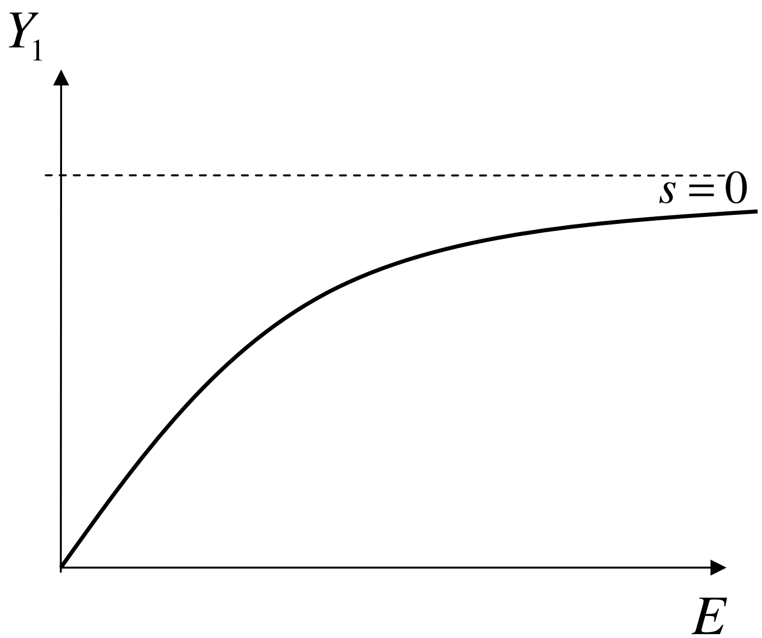
Exogenous Recruitment (1)

a>0: a parameter catching individual weight growth and natural mortality assumed to occur once at the beginning of the fishing season

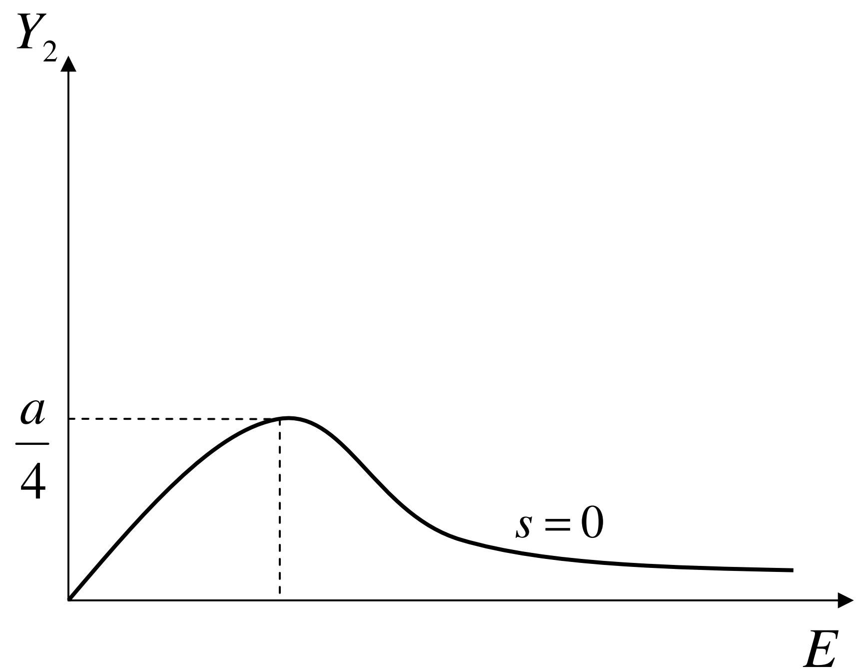
$ap_2 > p_1$ → if it is not fished, biomass value is higher at age 2 than at age 1 (otherwise non selective technique is optimal in any case)

Impact of selectivity on catches

Age group 1

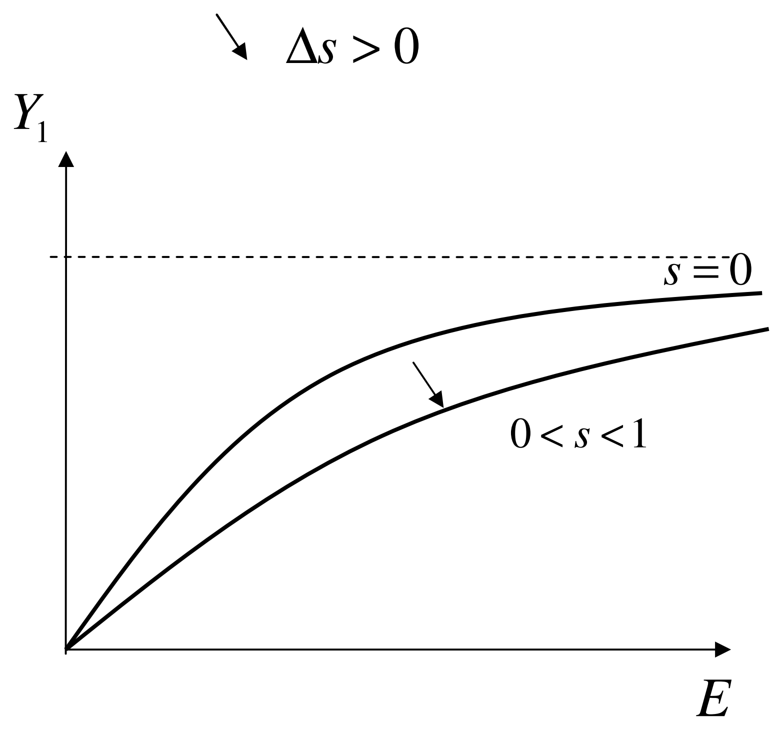


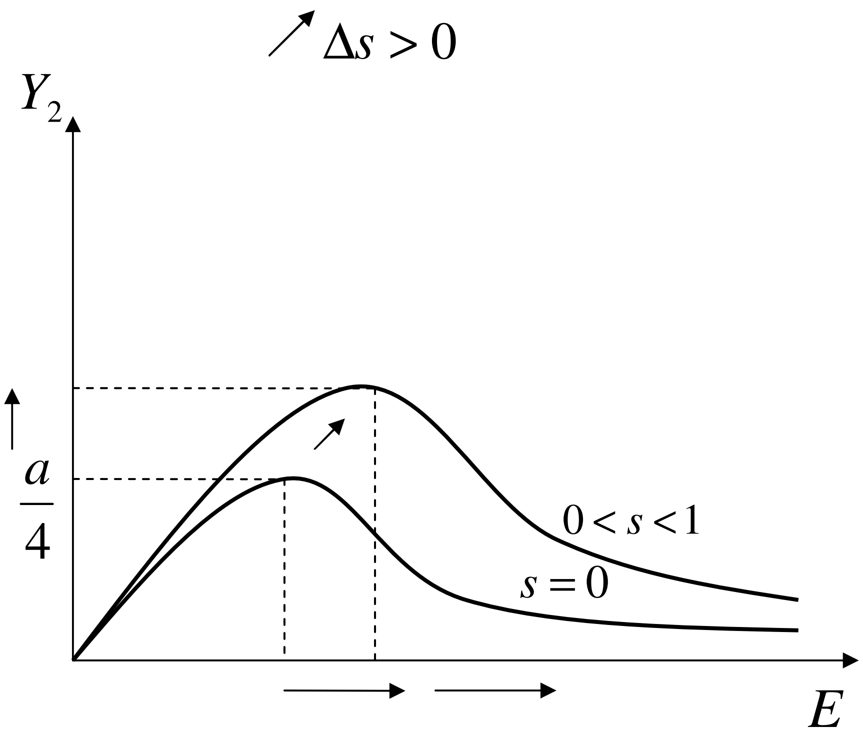
Age group 2



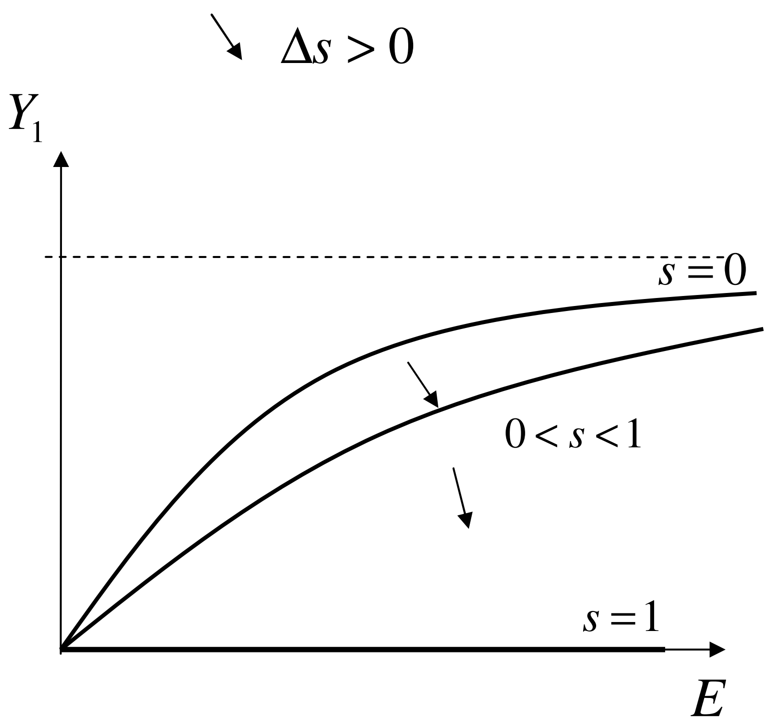
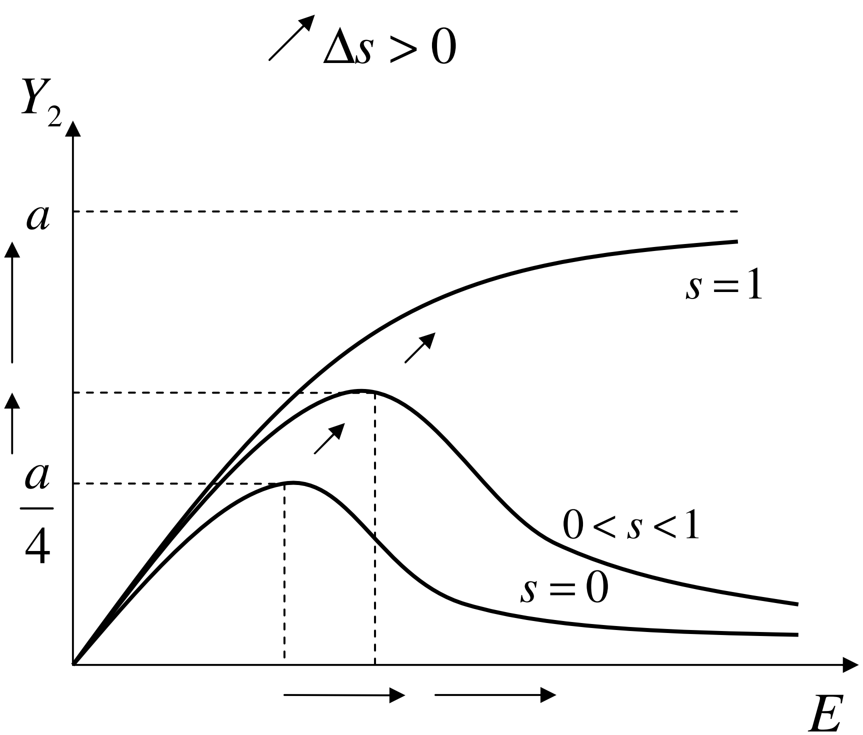
Impact of selectivity on catches

Age group 1	Age group 2



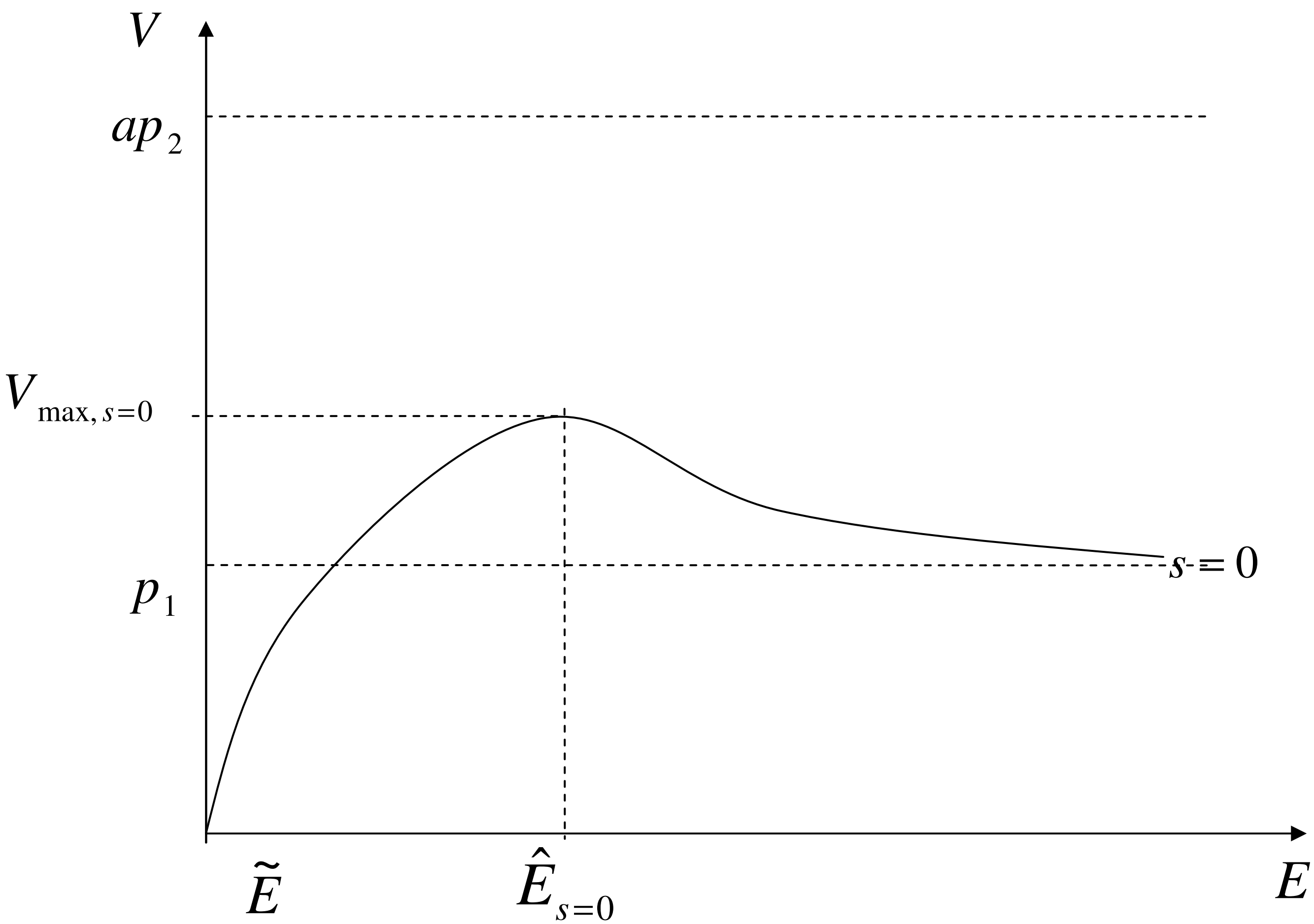


Impact of selectivity on catches

Age group 1	Age group 2
	

Impact of selectivity on landed value

$$V = p_1 Y_1 + p_2 Y_2$$



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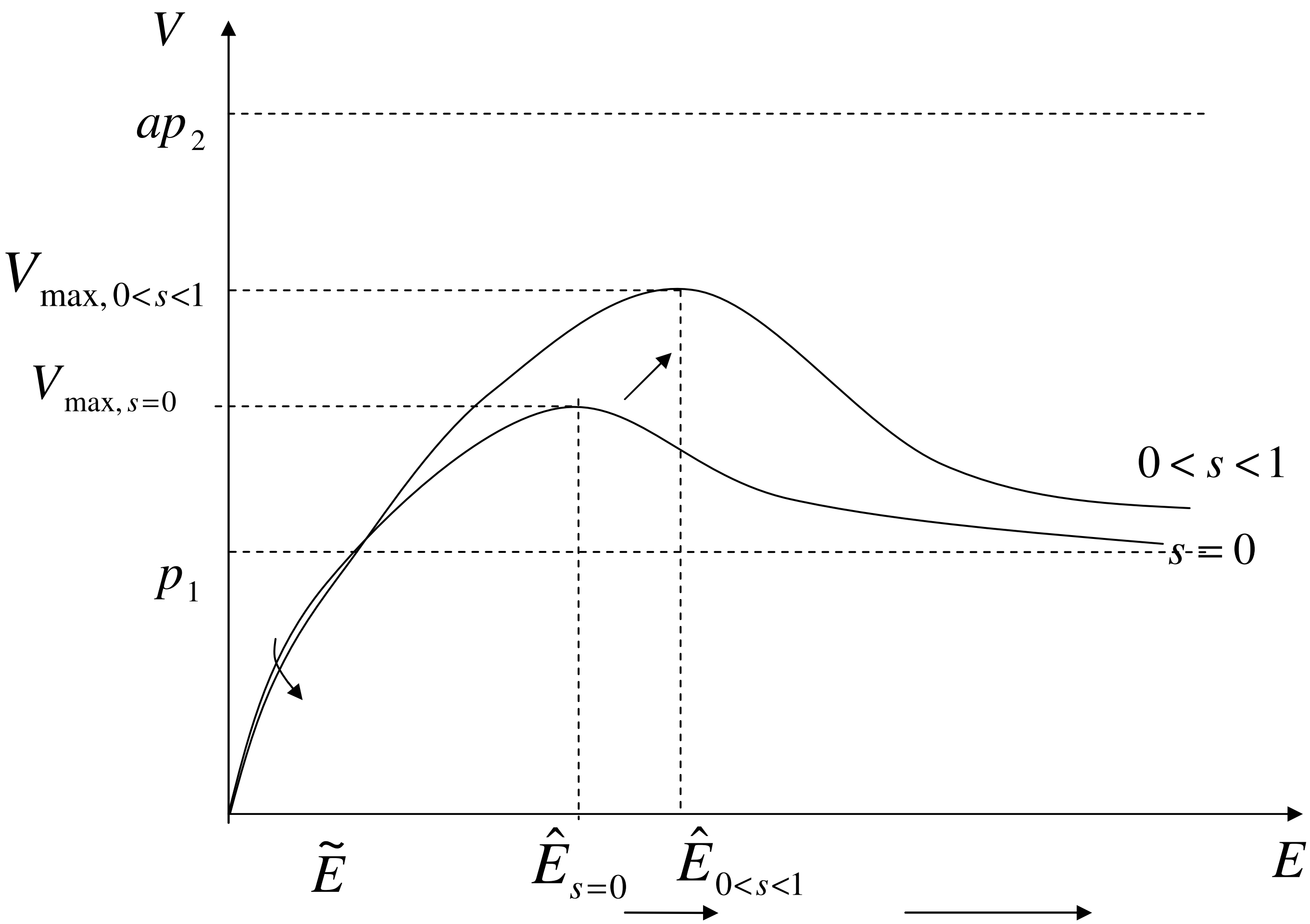

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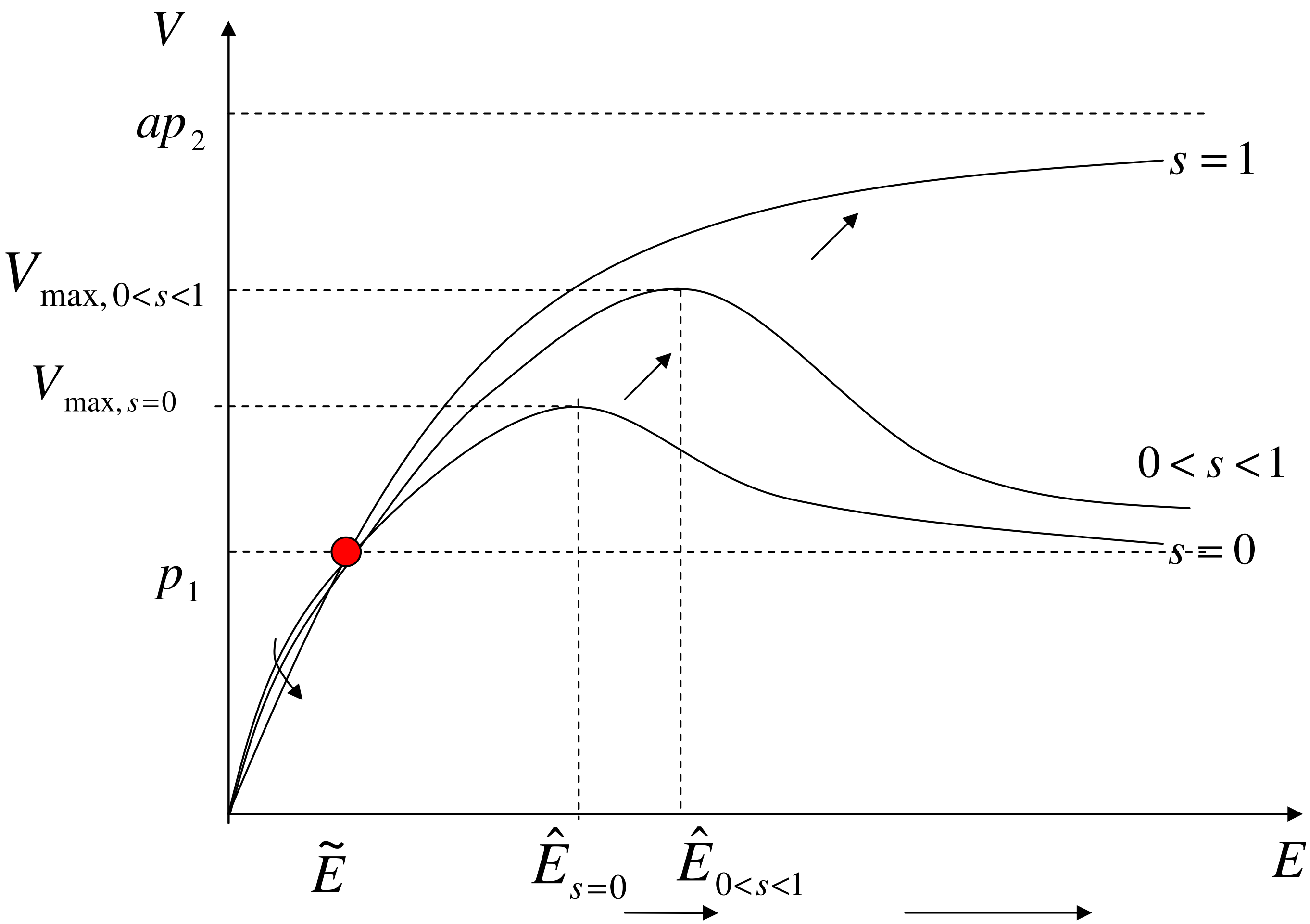
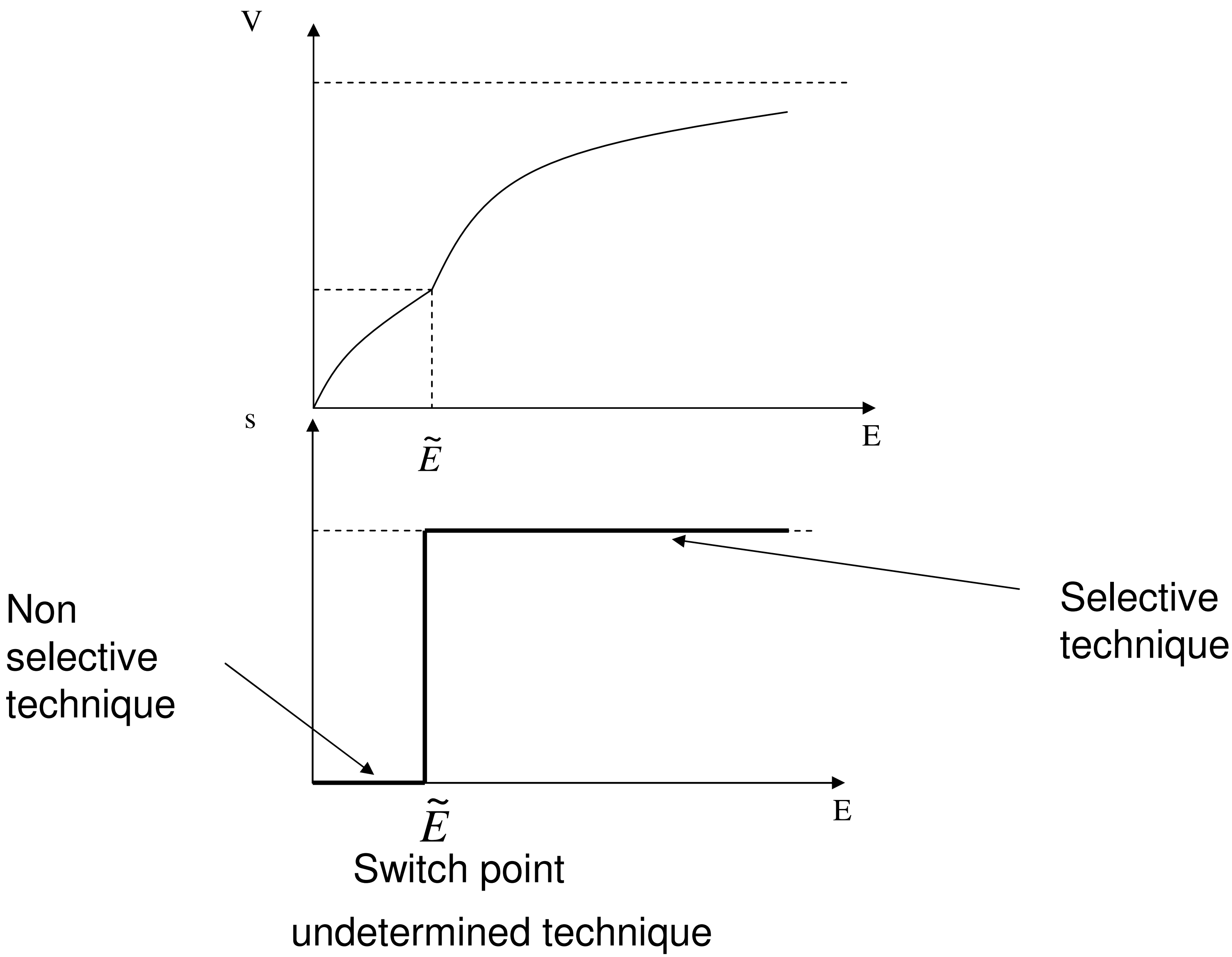


Envelope : landed value as a function of the effort, assuming optimal technique



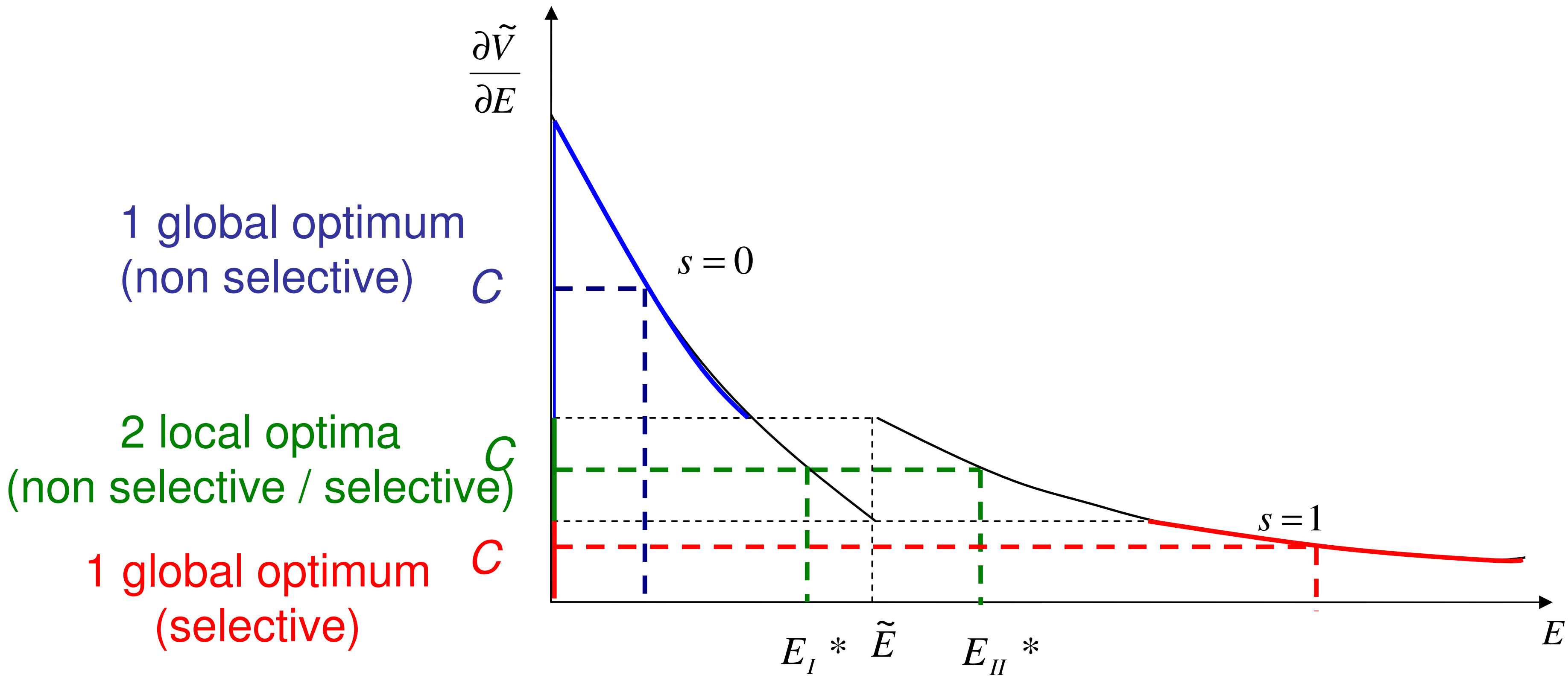
Optimal equilibrium of the fishery: optimum effort and selectivity

Effort and selectivity maximizing the rent: $\Pi = V - CE$

Assuming breakeven point $C > p_2 a + p_1$

E* is given by $\dfrac{\partial \Pi}{\partial E} = 0 \Rightarrow \dfrac{\partial \tilde{V}}{\partial E} = C$

According to cost level:



Difference of rent between non selective technique and selective technique $\Pi_I * - \Pi_{II} *$: increasing function of fishing cost C

→ $\Pi_I * - \Pi_{II} *$ is negative and then positive when C rises

There is a value of fishing cost $\tilde{C}$ such that:

$$\Pi_I * - \Pi_{II} * = 0$$

and

$$C > \tilde{C} \Rightarrow \Pi_I * - \Pi_{II} * > 0$$

Global optimum is obtained with non selective technique

$$C < \tilde{C} \Rightarrow \Pi_I * - \Pi_{II} * < 0$$

Global optimum is obtained with the selective technique

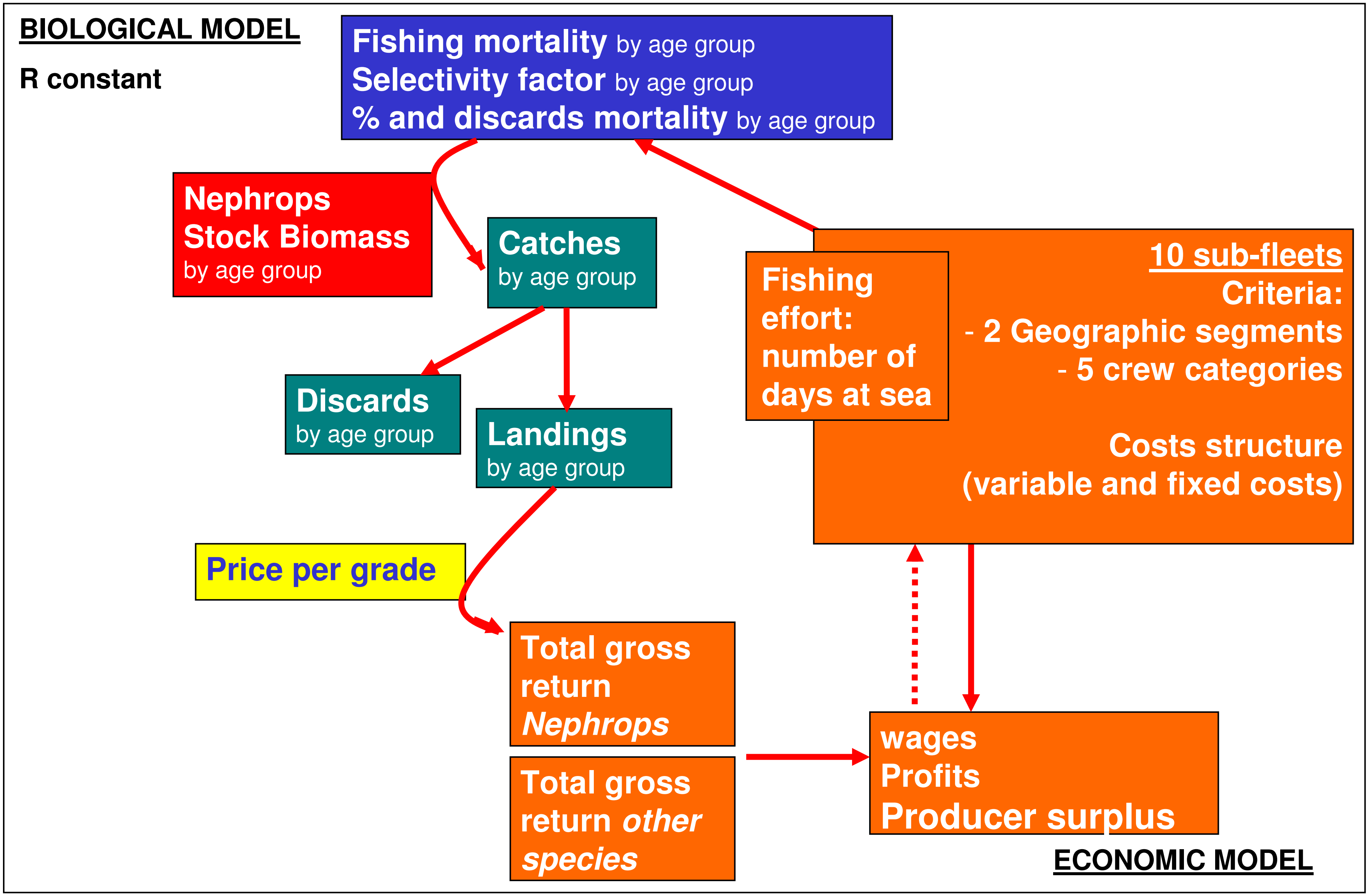
Conclusion: High fishing costs are a challenge to selectivity

2. Application to the *Nephrops* fishery in the bay of Biscay

250 trawlers operating in the bay of biscay and targeting Nephrops most of the year

Nephrops gross return: 30 millions euros
Total gross return: 80 millions euros

High levels of by-catches and discards
60% of the Nephrops in number are discarded



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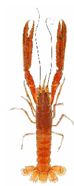
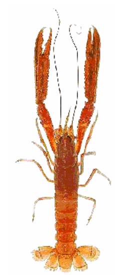
Selectivity measures tested

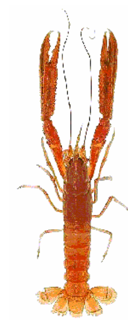
statu quo	Sel 1	Sel 2	Sel 3	Sel 4	Sel 5 (alternative gear)



Age 2
6.3 cm

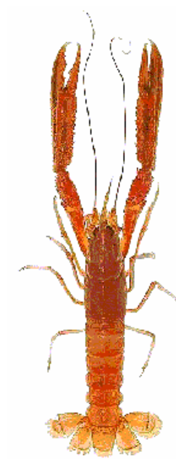


Age 3
8.8 cm
MLS



Age 4
10.4 cm

Age 5
11.8 cm

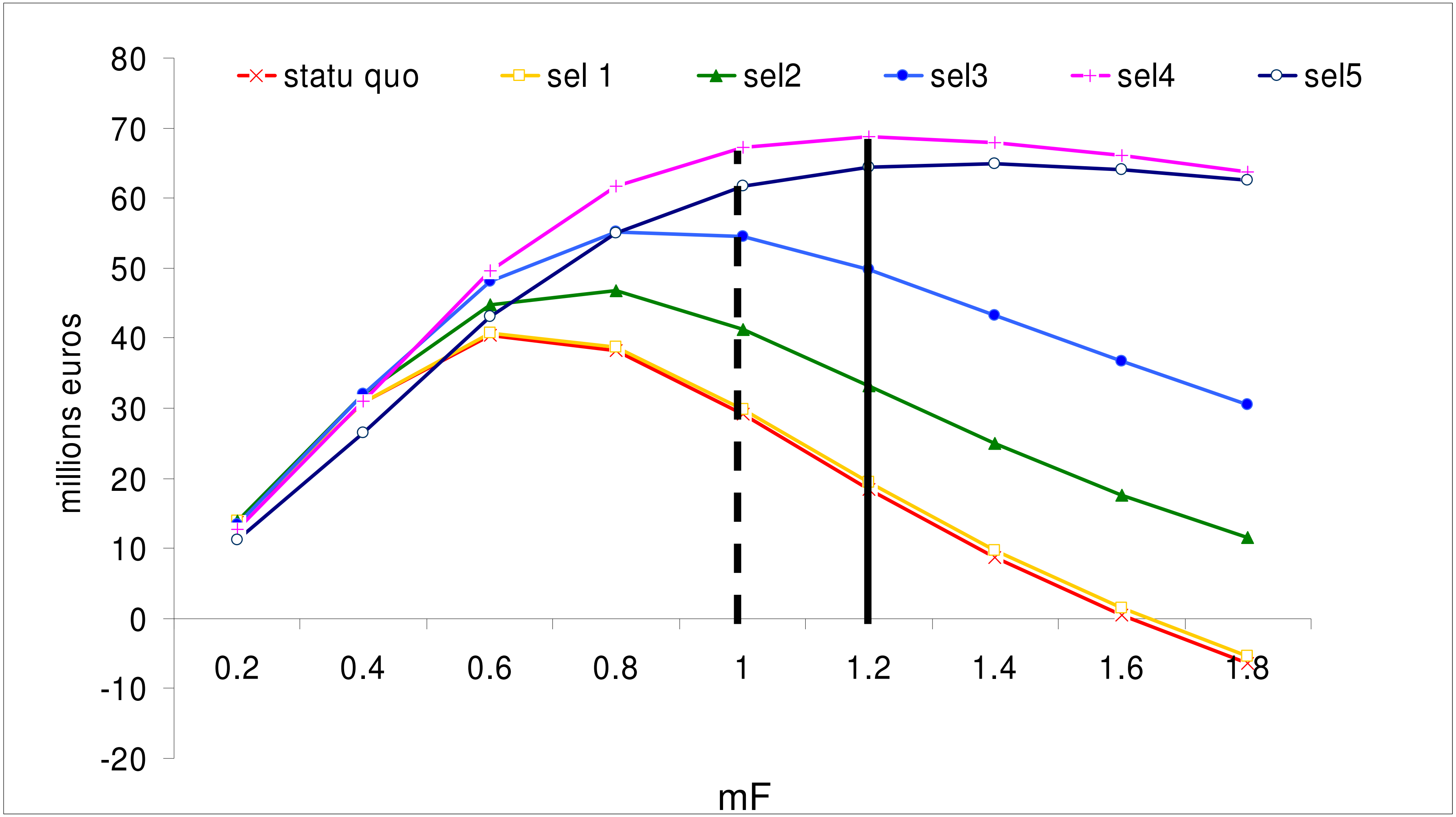


Age 6
13.1 cm

→ Analysis of the potential impacts of these scenarios on the producer surplus at equilibrium for several levels of effort modeled as a variation of a mF

According to the current fishing effort level :

At equilibrium scenario 4 is the most profitable to the fishery



Producer surplus at equilibrium

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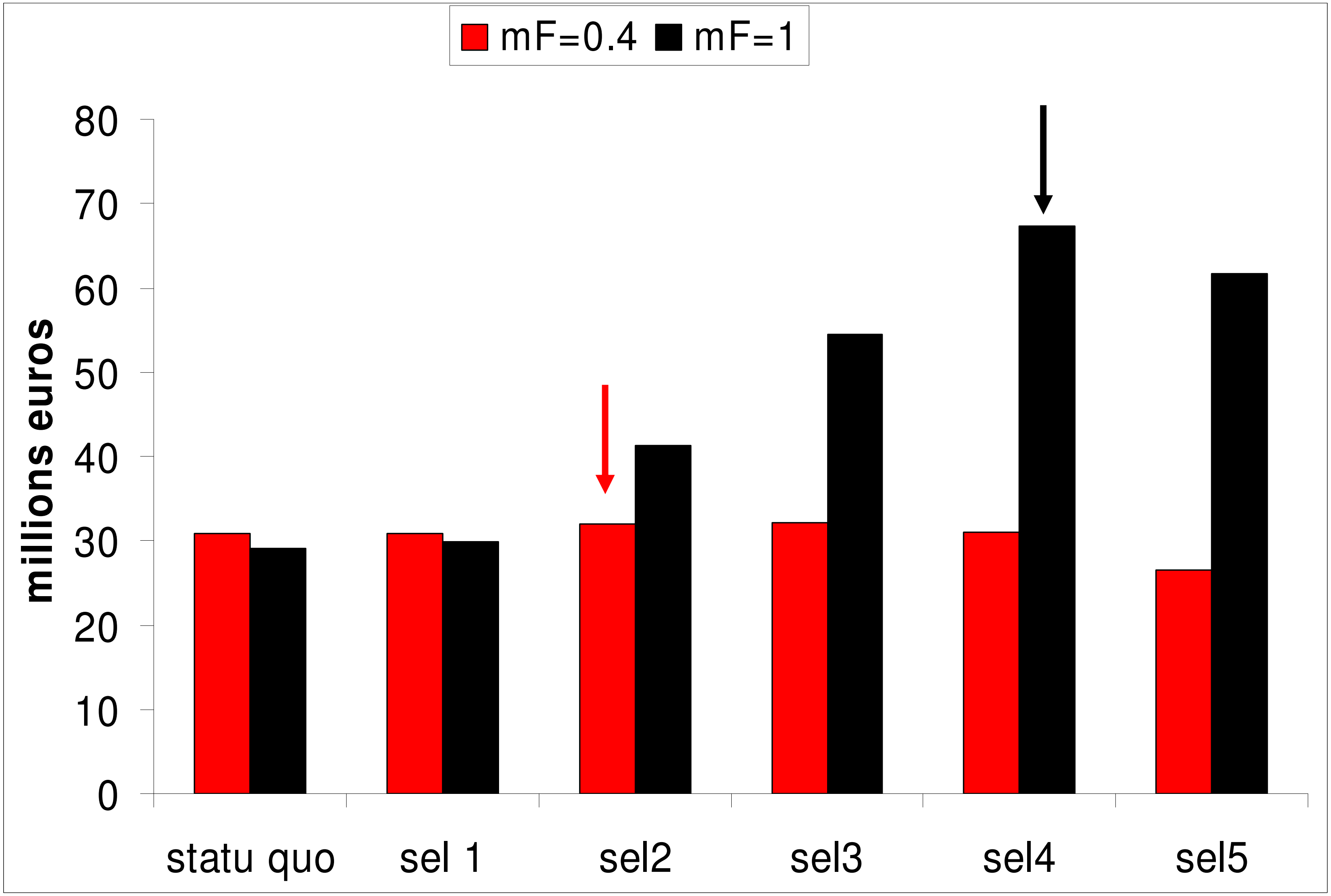
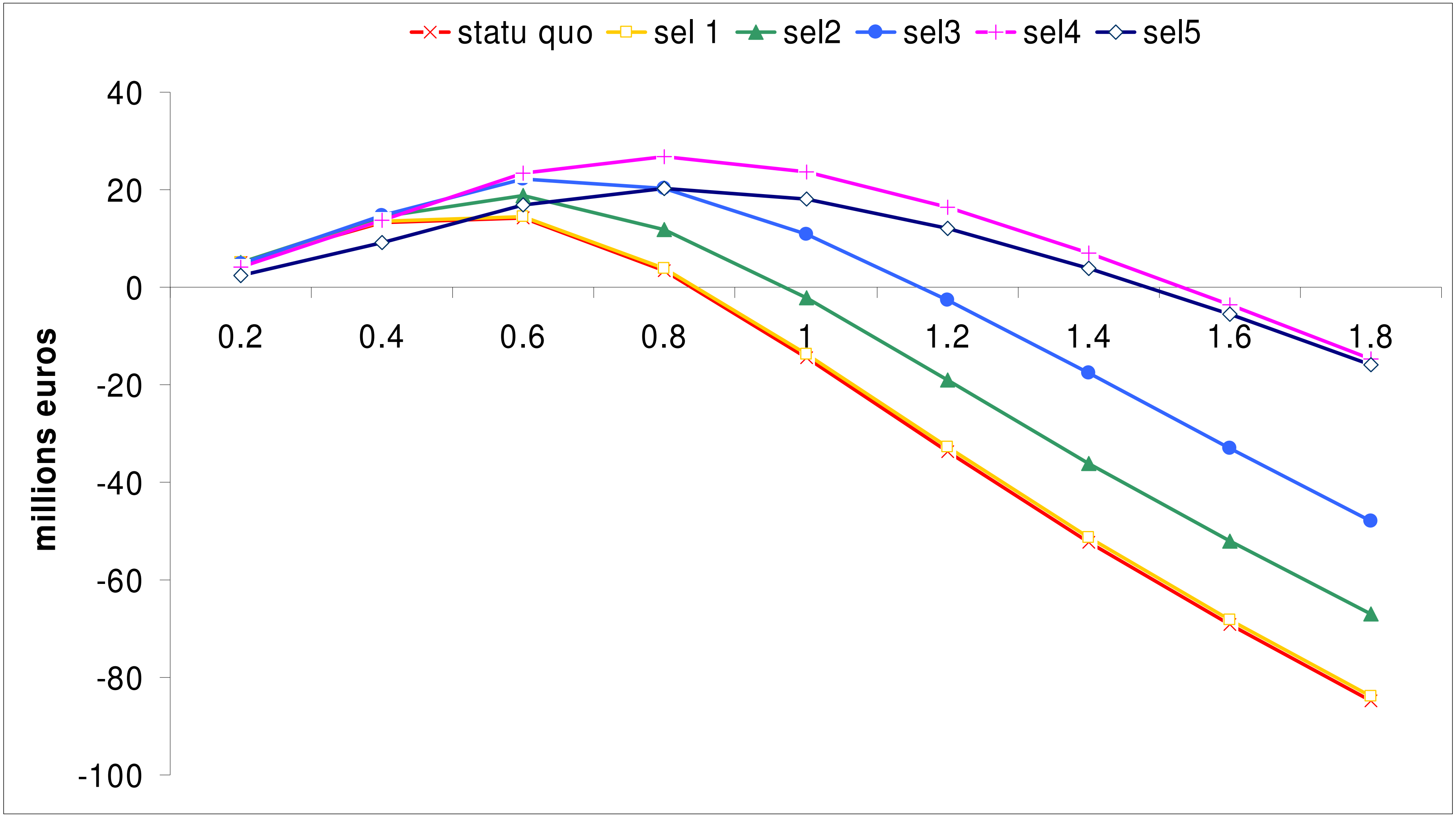
Optimal selectivity and effort



Scenarios statu quo and sel 1 are technically inefficient (discards)

By simulating an important increase in fuel costs (*5) we show that optimal effort decreases from 1.2 to 0.8, scenario 4 remains optimal, very high costs of effort are required to reach the switch point



Producer surplus at equilibrium

Concluding Remarks

- Increasing costs of the fishing effort would conduce fishermen to reduce their effort and to adopt a non selective technique

- Application to the Nephrops fishery shows however that very high costs of effort are required to reach the switch point, selective scenario still generates the highest social benefits when fuel costs*5

- It was however not implemented by the Nephrops trawlers

- Due to mutual negative externalities, individual and social benefit of selectivity are not the same

→ free riders temptations raise from non observable selectivity

- A gear change like pot adoption instead of trawling could enable
  - to increase selectivity and to make it observable
  - to reduce fishing costs