Impact of human activities on a multifunctional territory, Gironde estuary (France): a bioeconomic approach

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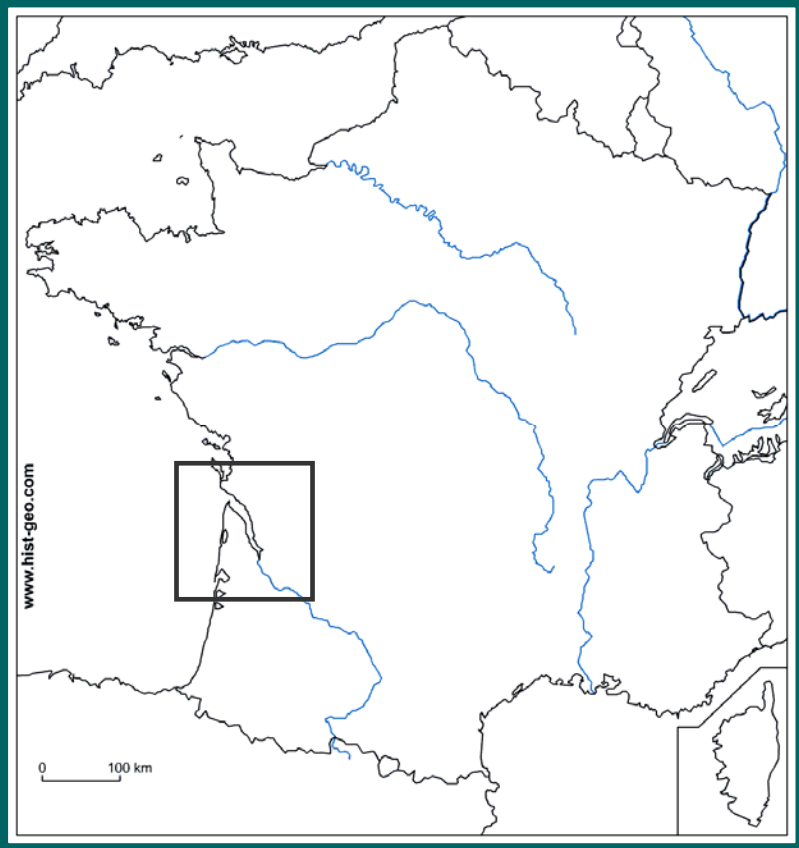
Gironde estuary



Multifunctional territory

Professional fishing

Recreational fishing

Agriculture

Dredging

Urban activity

Industrial activity

Biological and physical impacts have to be expressed in economic damage

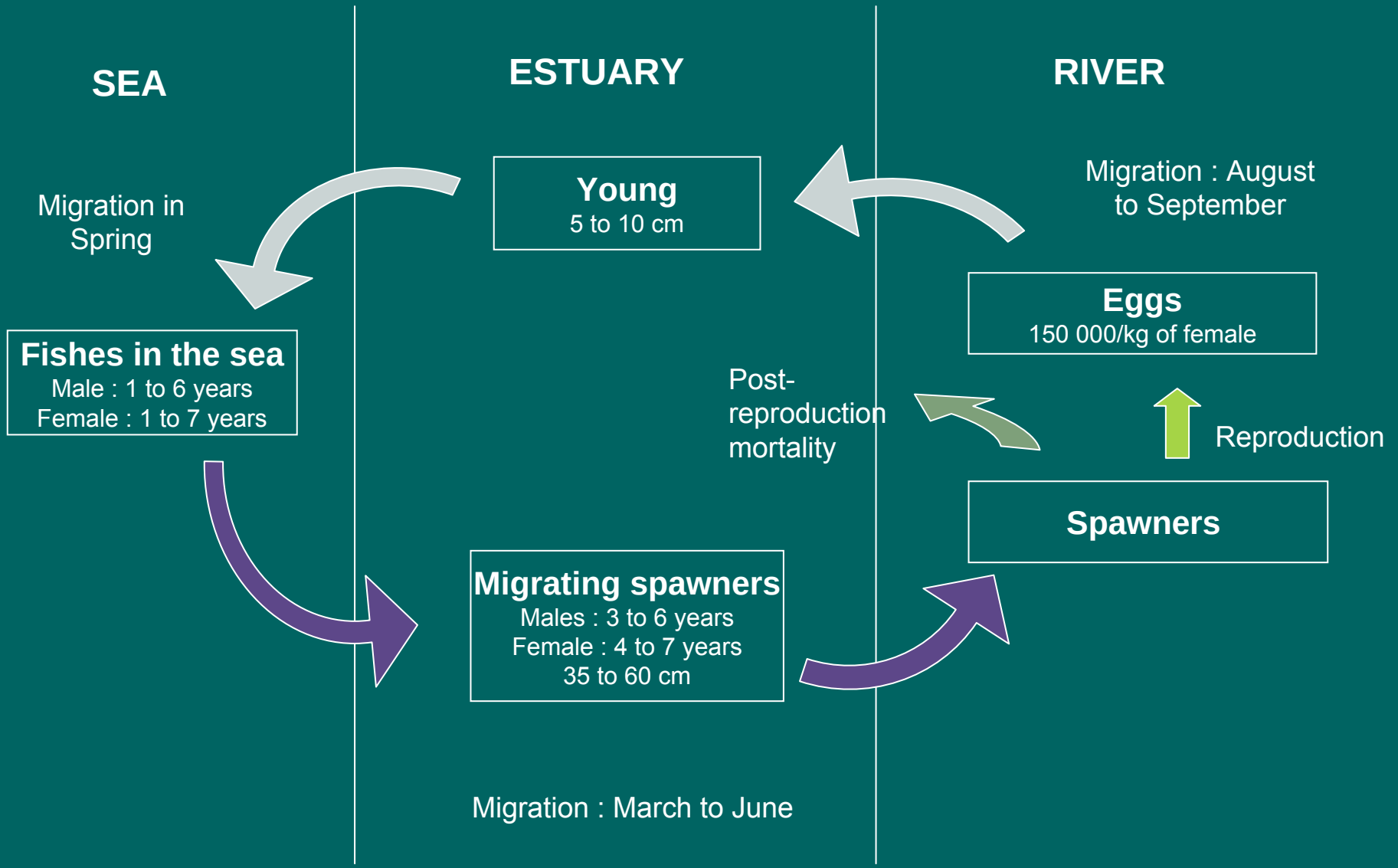
The model

- Estimating damage undergone by Gironde estuary as a whole
  - Complex
  - Don’t forget the interdependence of the impacts
- Halieutic resource taken as a witness of the impact
  - End of the trophic chain
  - Integrating the quality of the estuary

The model

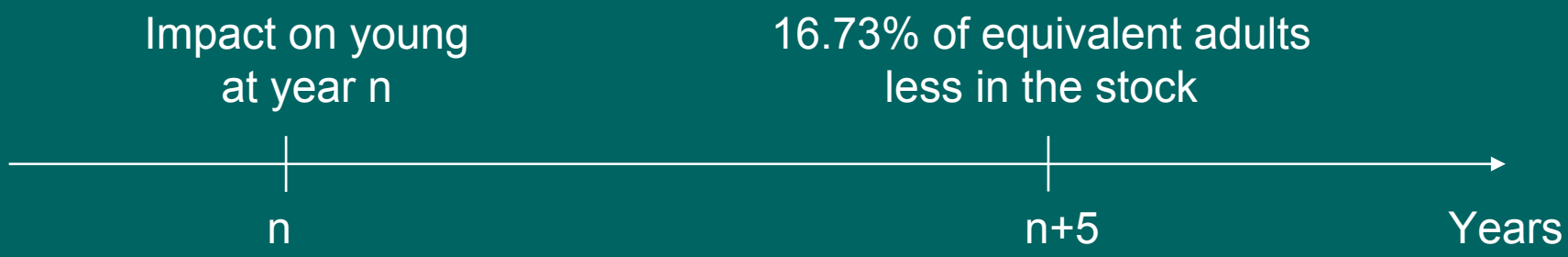
- Revealing the impact: loss of profits for commercial fishery
- Bioeconomic approach
- Two profits estimated:
  - Case « with impact »
  - Case « without impact »
- A migratory fish: Allis shad (*Alosa alosa*)

Allis shad

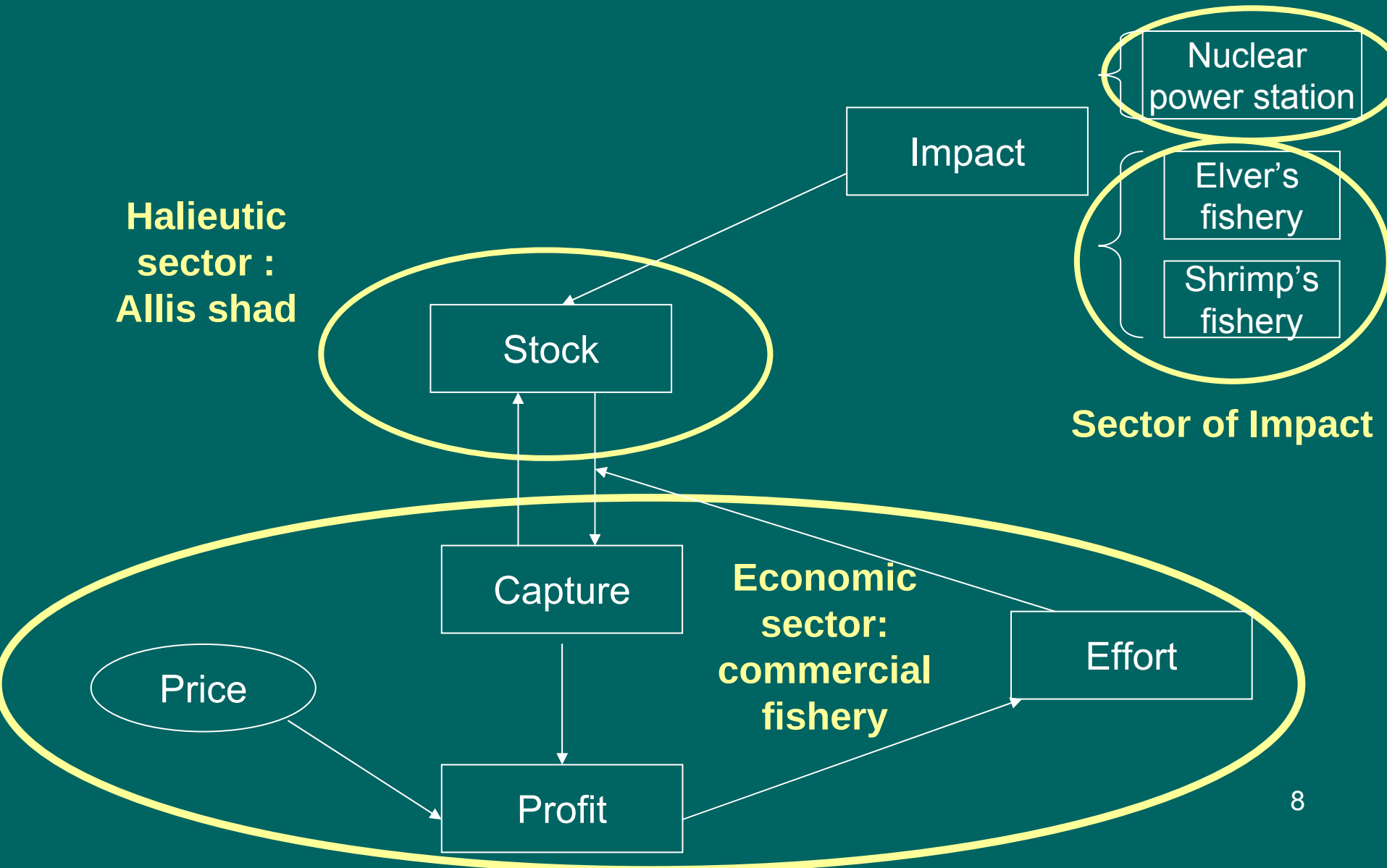

SEA
ESTUARY
RIVER
Migration in Spring
Young
5 to 10 cm
Migration : August to September
Eggs
150 000/kg of female
Fishes in the sea
Male : 1 to 6 years
Female : 1 to 7 years
Post-reproduction mortality
Reproduction
Spawners
Migrating spawners
Males : 3 to 6 years
Female : 4 to 7 years
35 to 60 cm
Migration : March to June

The impact

- Three human activities:
  - Nuclear power station of Blayais
  - Elver's fishery
  - Shrimp's fishery
- Impact on young but harvest of adult
- 5 years to become an adult and 16.73% of young become adults



Bioeconomic model



Bioeconomic model

- Maximisation: case “with impact”

$$\underset{\{E_t\}}{Max} \sum_{t=0}^{6} \rho^t \ (p_t Y_t - c_t E_t)$$

$$s.t. \quad B_{t+1} - B_t = F(B_t) - Y_t - \alpha_t B_t$$

$$0 \le E_t \le E_t^{\max}$$

- Y:Capture ; E: Fishing effort ; B: Biomass ; I=αB: Impact
- $Y = qEB$
- $\rho = \frac{1}{1+\delta}$
- F(B): Net growth function, Logistic function

Bioeconomic model

- Halieutic sector:
  - Carrying capacity: K
  - Intrinsic growth rate: r
  - Catchability rate: q
- Economic sector:
  - Cost function
  - Price function

Biological characteristics

- Two methods
  - Equilibrium method: $\dot{B} = 0$

$$Y = a\,E + b\,E^2$$

  - Non equilibrium surplus-production model: ASPIC

- Results:
  - r=0.298
  - q=7,27*10^{-5}
  - K=1,43*10^{7}

Economic characteristics

- Cost function:
  - Sailors

$$\ln IC = 10.75 + 1.01 \ln(average\ \ number\ of\ \ boats\ \ \ per\ \ \ fisherman)$$

  - River Professionals

$$\ln IC = 9.2 + 1.01 \ln(average\ \ number\ of\ \ boats\ \ \ per\ \ \ fisherman)$$

- Price function:

$$\ln(Allis\ \ shad\ \ \ price) = -0.18 \ln(catch) + 1.38 \ln(lamprey\ \ price) - 0.21 \ln(elver\ \ price)$$

- Discount rate: 0,05

Results (1)

- The profits are estimated on periods
  - 1987-1993 for nuclear power station,
  - 1990-1993 for shrimp's fishery
  - 1990-1992 for elver's fishery
- We assume $5000 \leq E \leq 10000$
- Profits in the case "with impact" are lower than profits in the case "without impact"

Results (2)

Sum of actualised profits with price function from 1987 to 1993 (in euros):

	Profits with impact	Profits without impact	Difference	Average difference
Nuclear thermal power station	477 733	1 684 543	-1 206 811	-172 402

Sum of actualised profits with price function from 1990 to 1993 (in euros):

	Profits with impact	Profits without impact	Difference	Average difference
Shrimp fishery	892 688	1 045 190	-152 502	-38 125

Sum of actualised profits with price function from 1990 to 1992 (in euros):

	Profits with impact	Profits without impact	Difference	Average difference
Elver fishery	793 239	881 124	-87 885	-29 295

Sensibility

- Carrying capacity: few consequences
- Intrinsic rate of growth of stock: an increase of 10% increases the profits about 22% and increases the economic impact about 11%
- Catchability rate: a decrease of 10% increases the profits and increases the economic impact about 6%
- A discount rate of 0.1 (instead of 0.05) decreases the profits about 13% and decreases the economic impact about 10%

Conclusion

- Loss of profit for Allis shad's commercial fishery due to three human activities
- Other species
- Other human activities