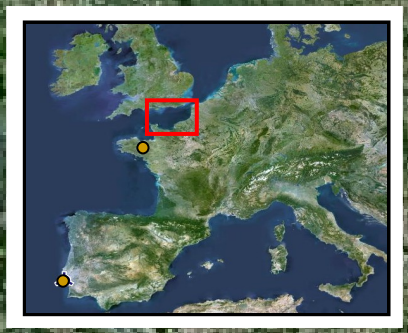
# Effect of nursery habitat destruction on flatfish population renewal

## Application to *Solea solea* in the Eastern Channel (Western Europe)

S. Rochette, E. Rivot, J. Morin, S. Mackinson,
P. Riou, O. Le Pape

Agrocampus Ouest, Rennes, France



# Outline

- Essential fish habitat
  - estuaries and coastal waters
  - notably for common sole
- Important human pressure
- What are the effects of human pressure on fish populations ?
- Evaluating consequences of habitat loss
  - Coupling Generalized Linear Models and Geographical Information System
  - Evaluate historical production

# Application in the eastern Channel

- Sole juveniles nurseries map
  - Coupling GLM and GIS

- > 150 years of transformation in the Seine estuary
  - Effects on juveniles biomass

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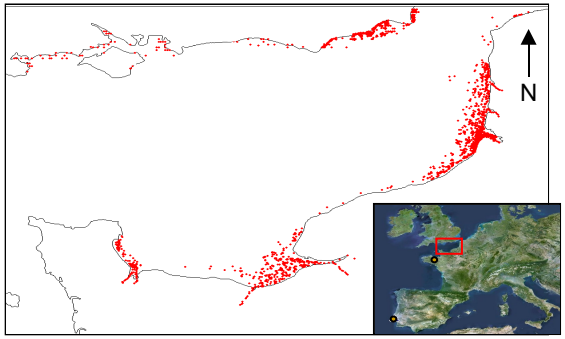
# Statistical model: data

- Trawl surveys in eastern Channel
  - From 1974 to 2007
  - French and English coasts
  - > 5000 trawl hauls in September
    - Factors : bathymetry, sediment structure, coordinates
  - 0-group and 1-group juveniles


# Statistical model: data




- Trawl surveys in eastern Channel
  - From 1974 to 2007
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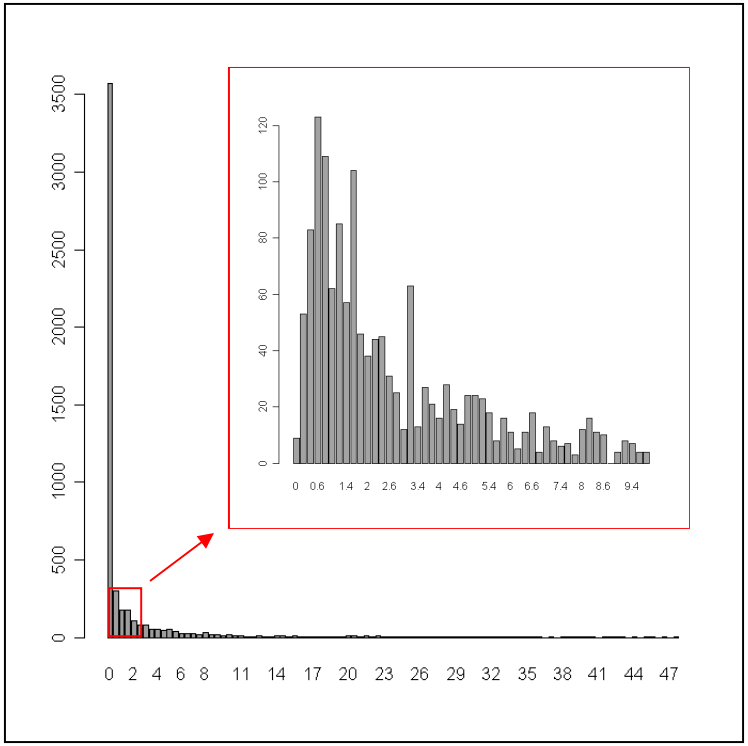
    - Factors : bathymetry, sediment structure, sector
  - **0-group** and 1-group juveniles

- Densities of sole in haul
  - Zero inflated data
  - Log normal distribution of positive values

⇒ Delta distribution model



# Statistical model

- Delta model
  - Known to work for sole nurseries *(Le Pape et al, 2003)*
  - Presence / absence : binomial distribution

$$YS_{0/1} \sim factor1 + factor2$$

  - Positive densities : log normal distribution

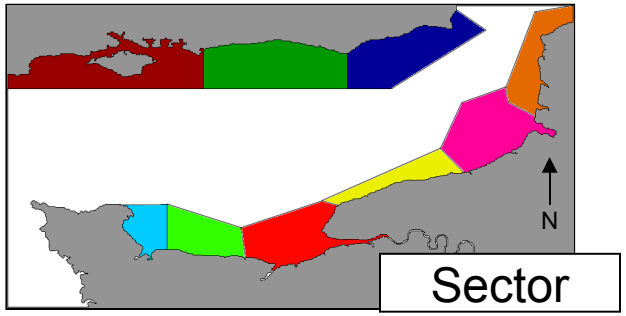
$$Log(YS_{+}) \sim factor1 + factor2$$

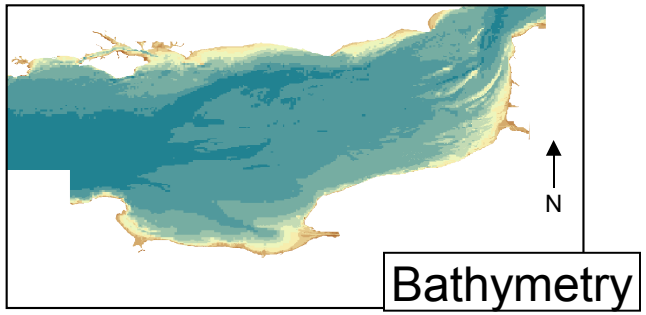
- Estimate habitat suitability by coupling

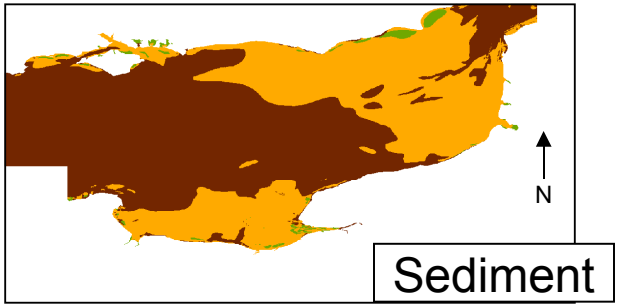
$$\hat{YS} = \hat{YS}_{0/1} \times e^{\hat{ln}(YS+)} \times e^{\frac{\sigma^2_{(ln(YS+))}}{2}}$$

# Habitat map

- Available maps
  - Sectors
  - Bathymetry
  - Sediment structure



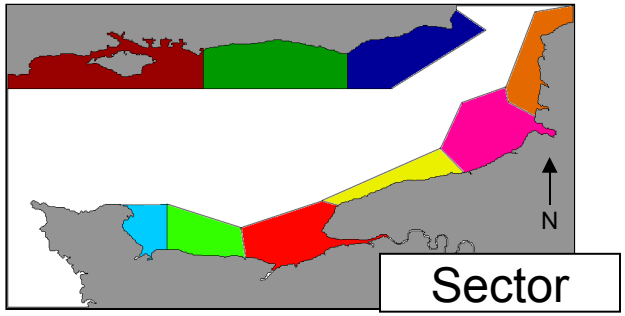



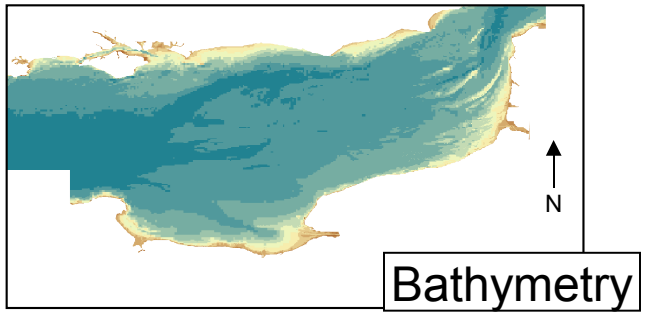



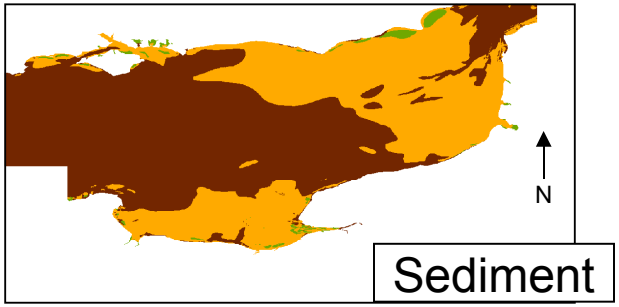
# Habitat map

- Available maps
  - Sectors
  - Bathymetry
  - Sediment structure

- Coupling GLM and GIS
  - Model: Bathymetry × Sediment × Sector
    - Density for an average year
  - GIS: Surface
  - Model × GIS
    - Number of fish: Abundance Indices
    - Contribution to the stock

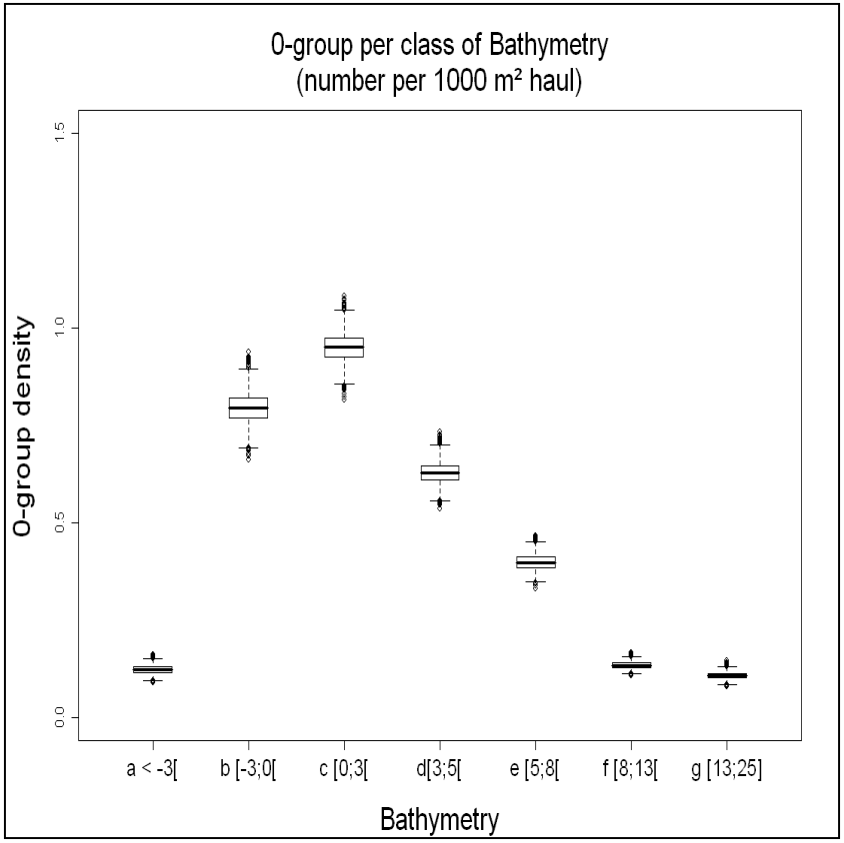


# Statistical model: results

- Effect of Bathymetry



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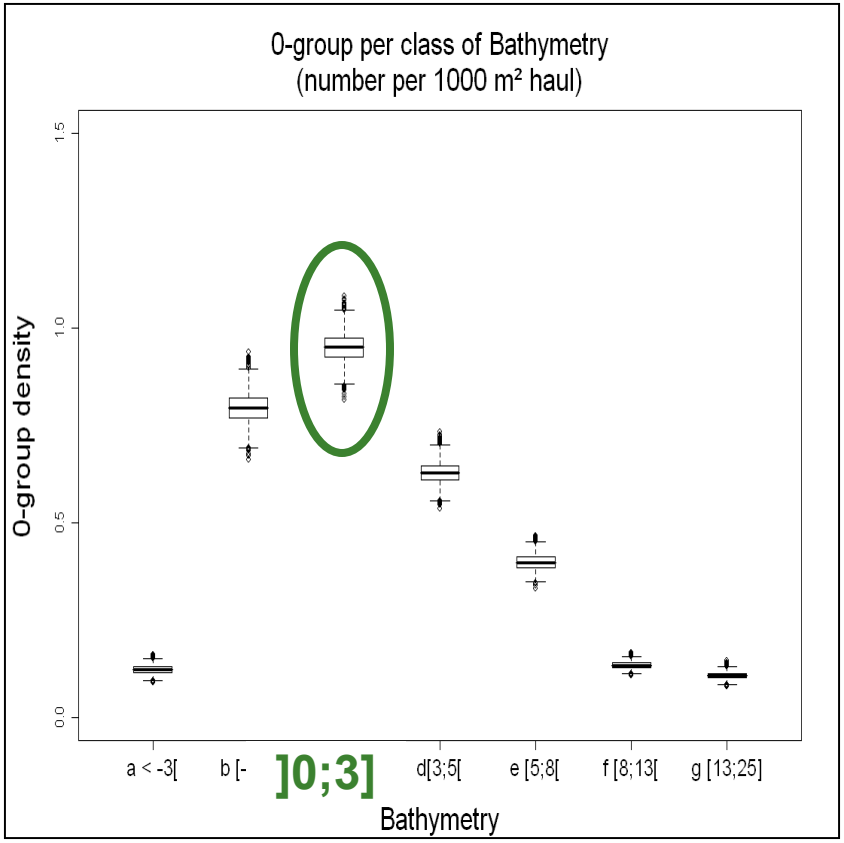

# Statistical model: results

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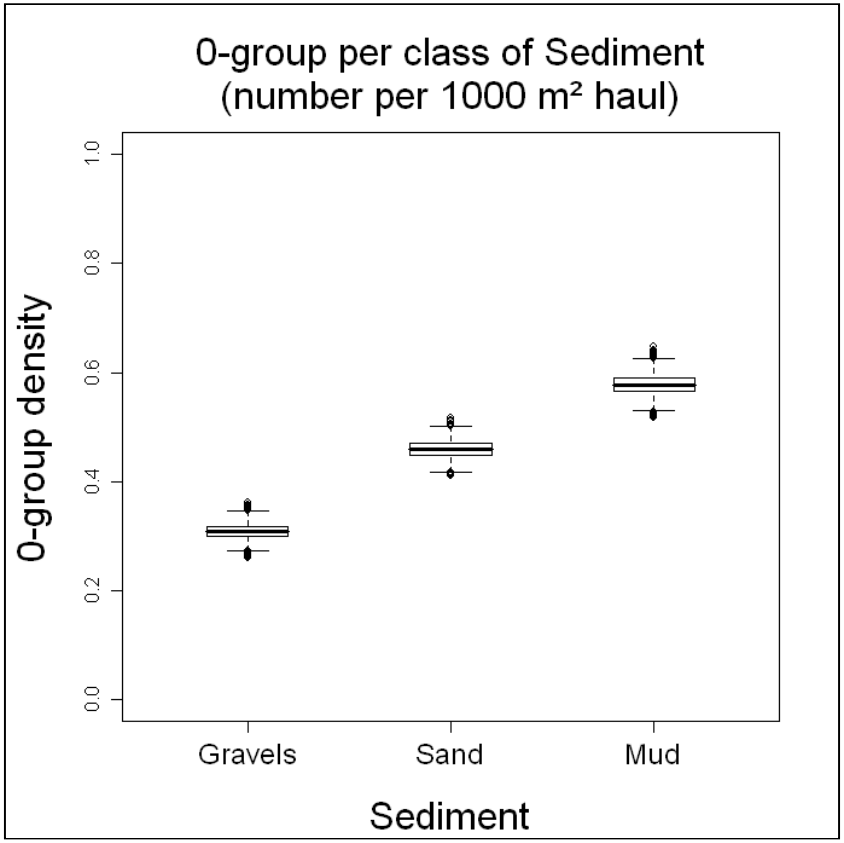
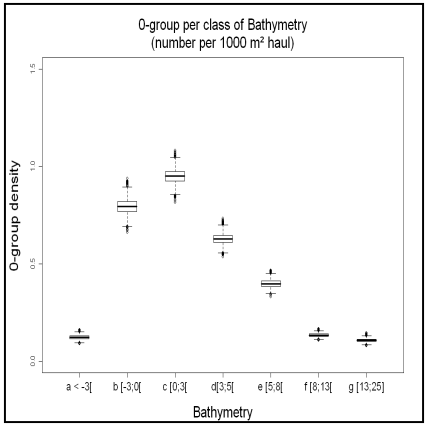
- Effect of sediment structure



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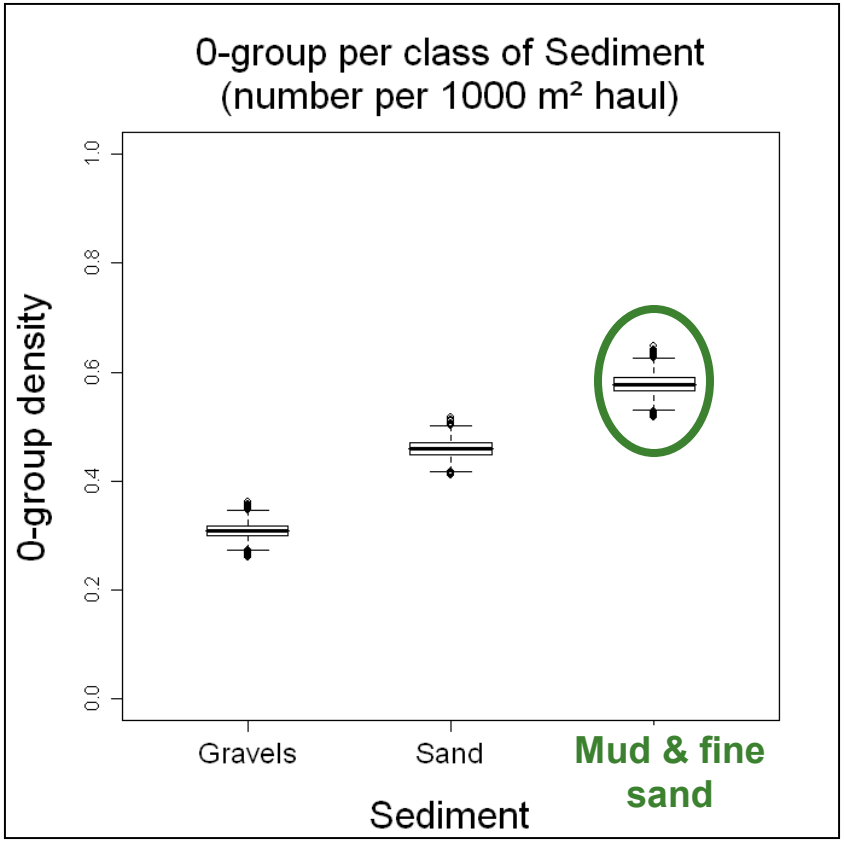
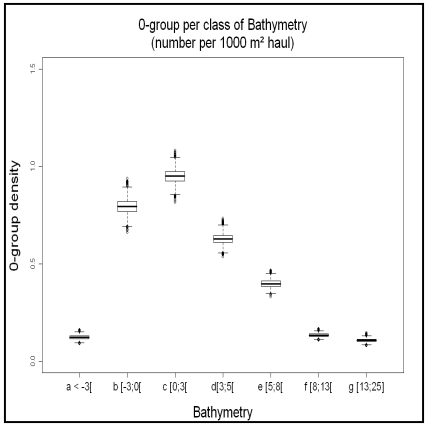
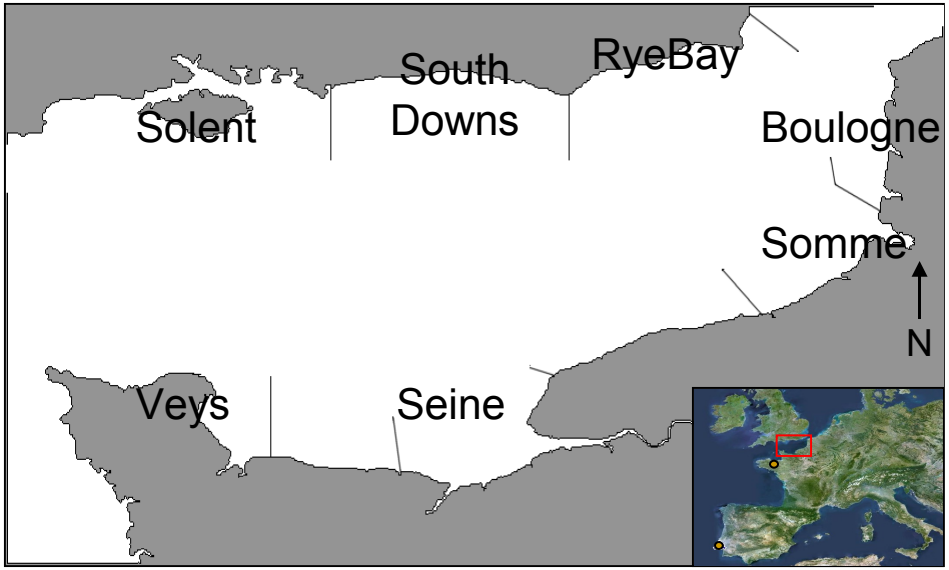
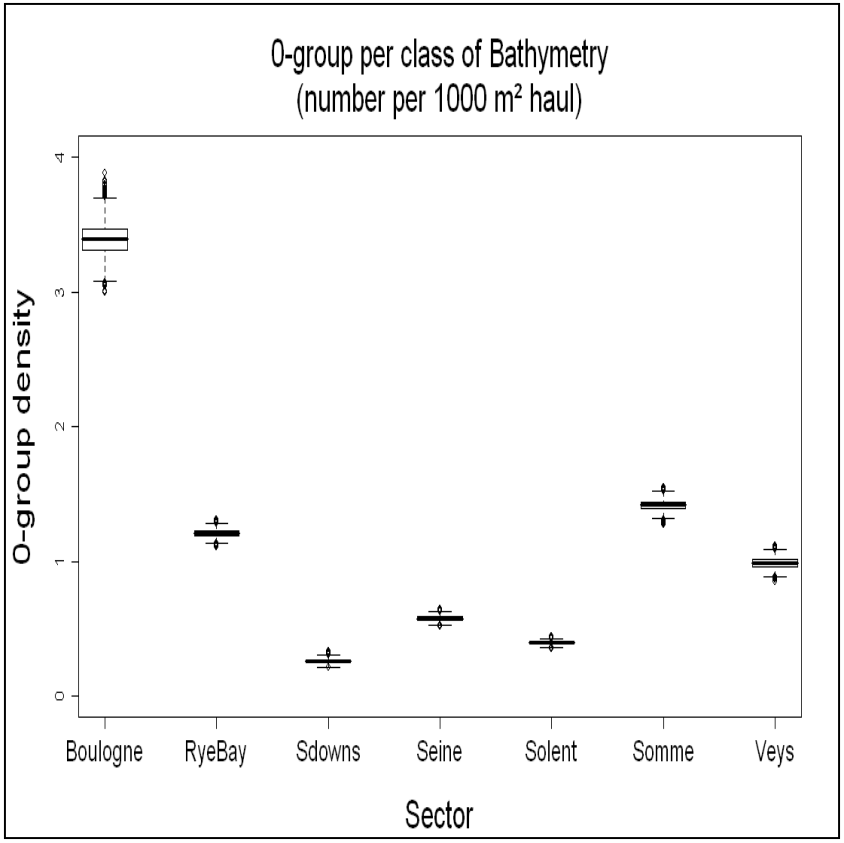


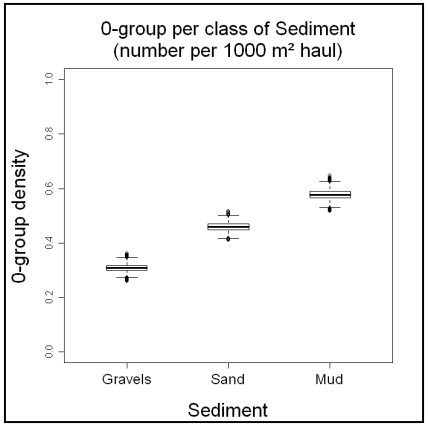



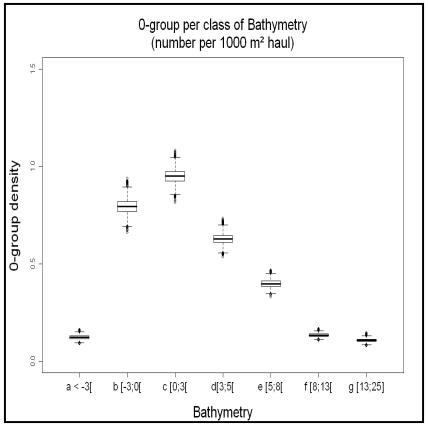
# Statistical model: results

- Effect of Bathymetry
- Effect of sediment structure
- Sector effect



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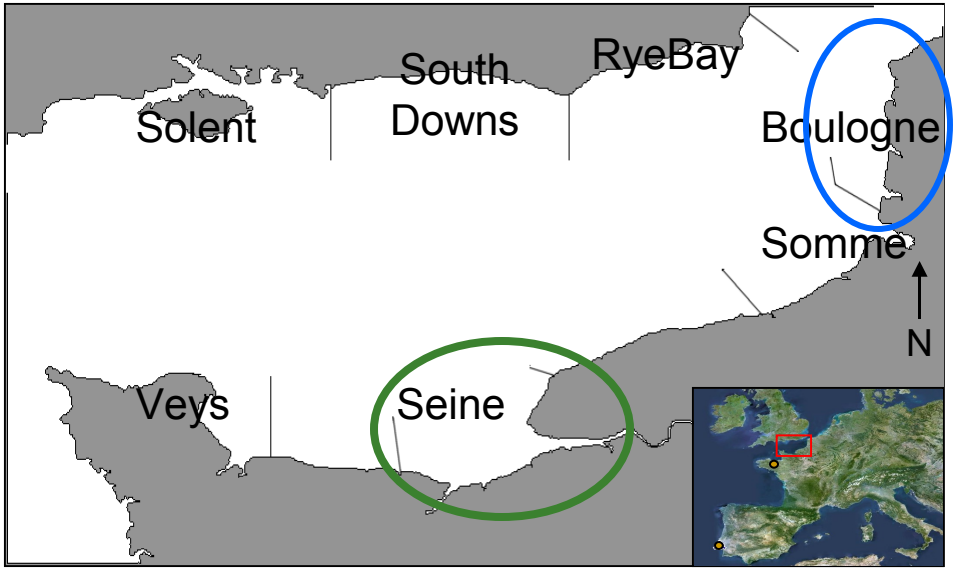
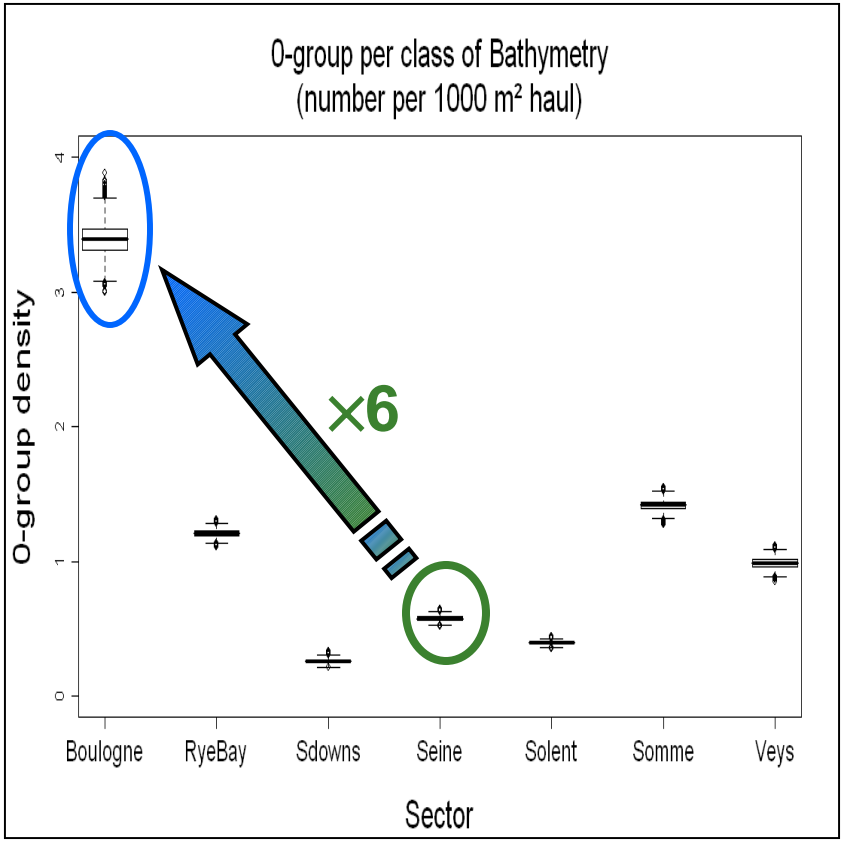
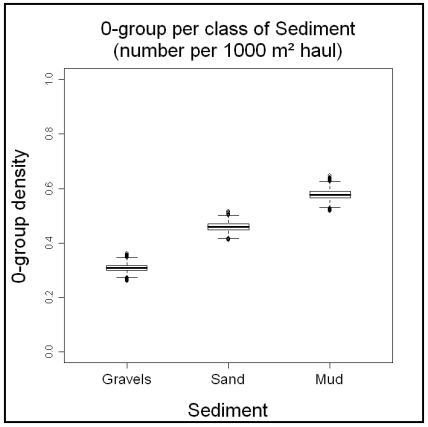
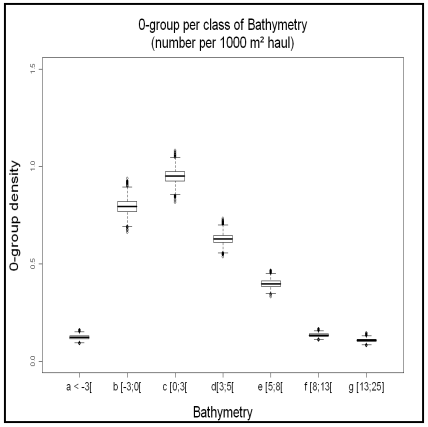


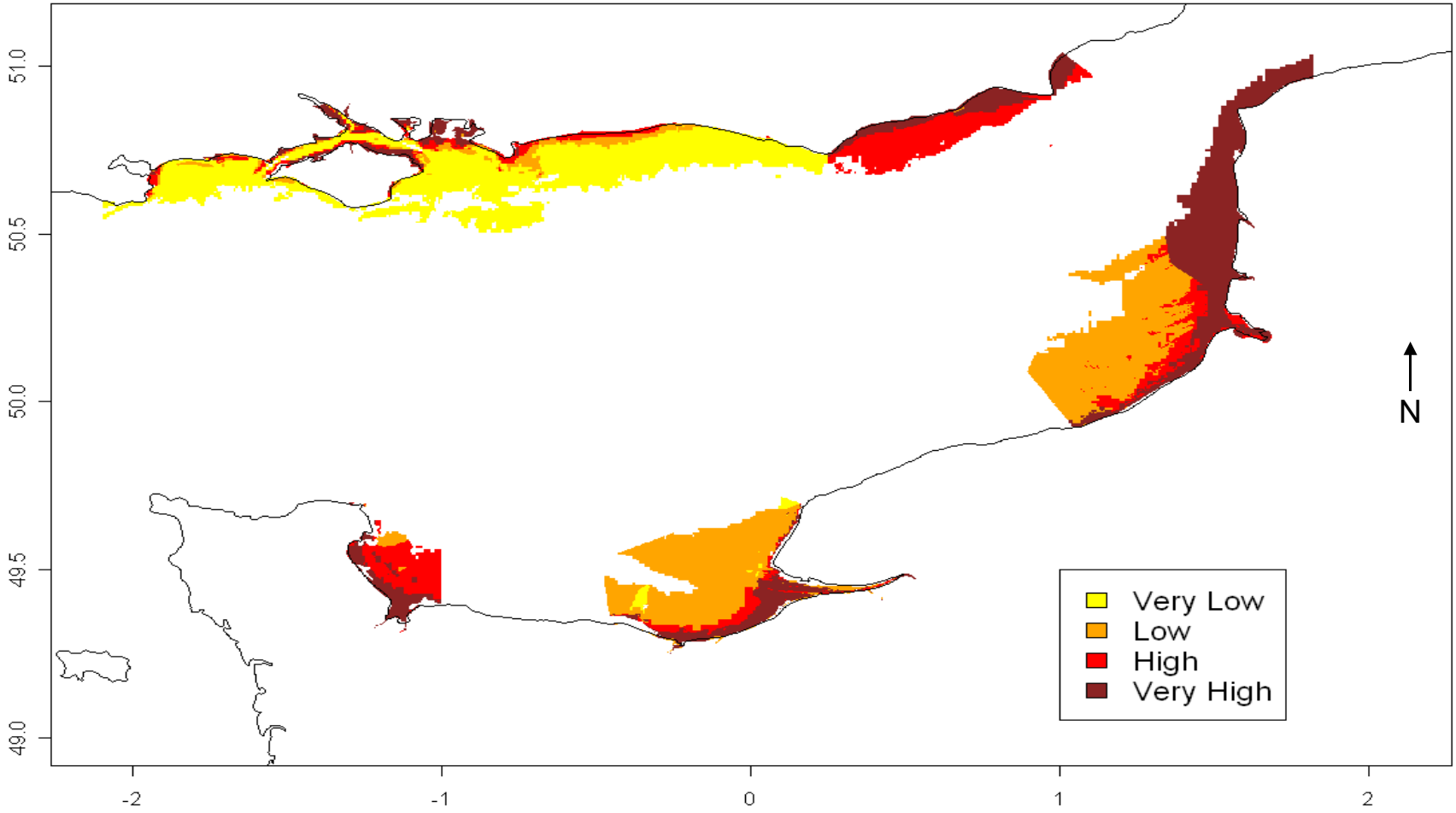



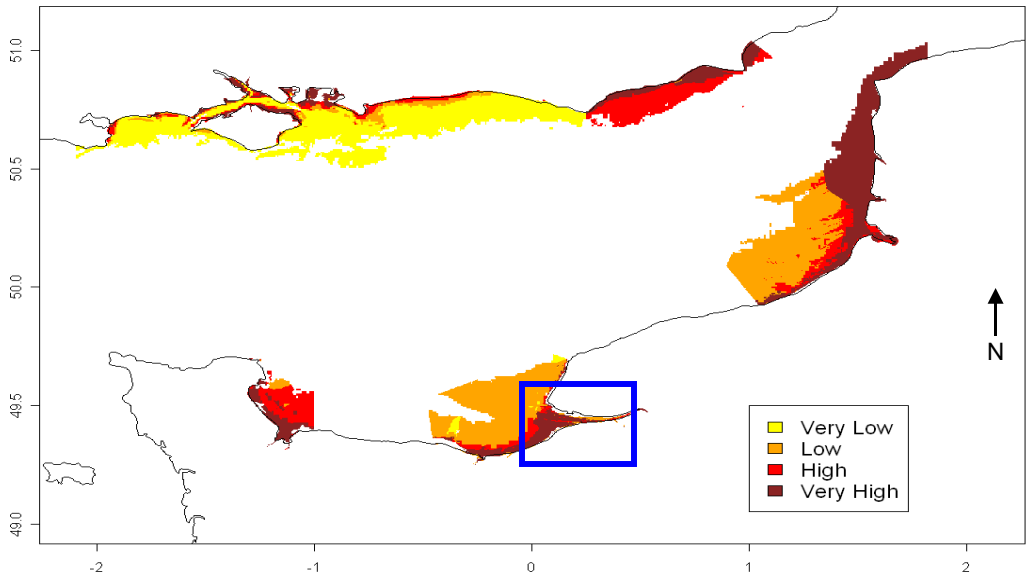



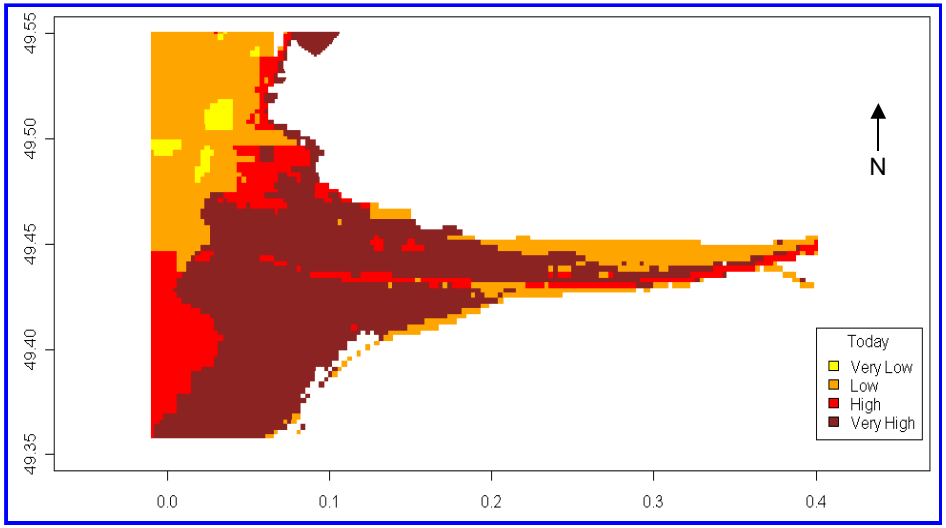
# Habitat map: present situation

- Distribution map for 0-group
- Update of existing model *(Riou et al., 2001)*



# Focus on the Seine estuary



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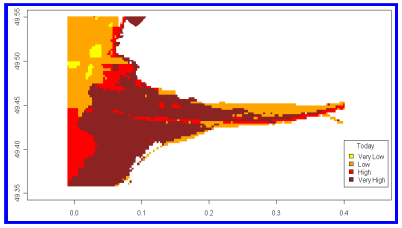
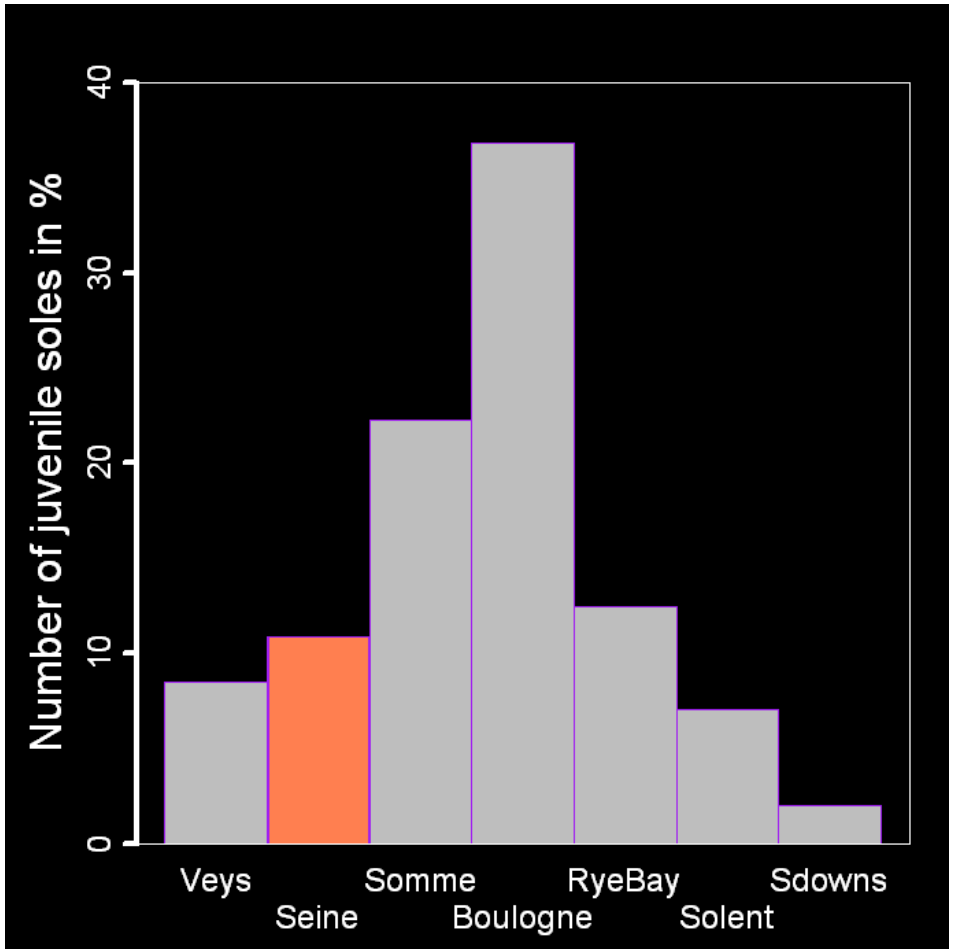



- The single large estuary of the zone
- But ~10% contribution to the stock



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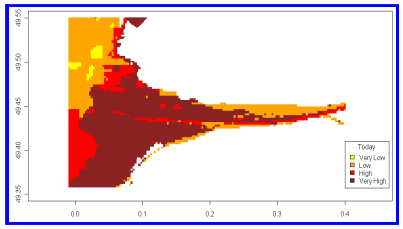


- The single large estuary of the zone
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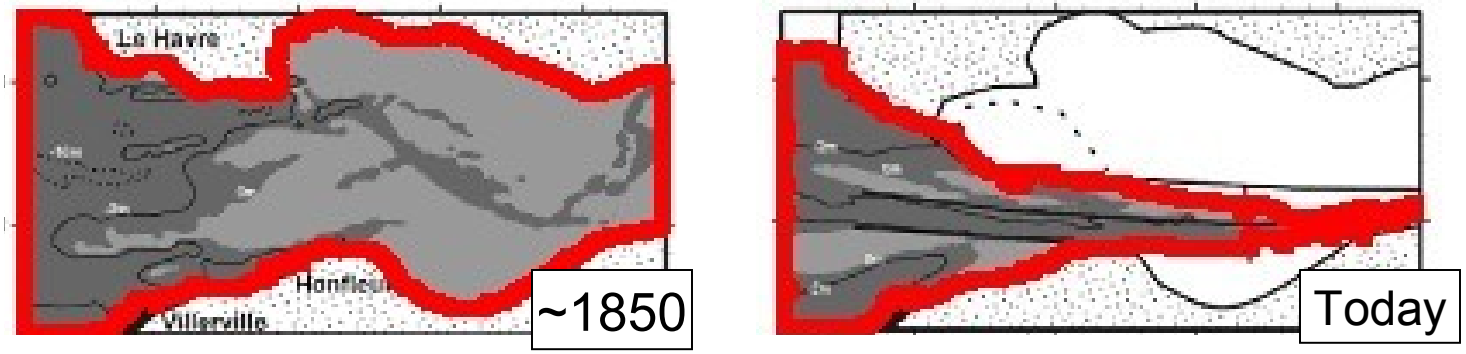
- Pieces of Explanation
  - ↘ 33% of surface, ↘ 75% of fine sediment in 150 years




*(Delsinne, 2005)*

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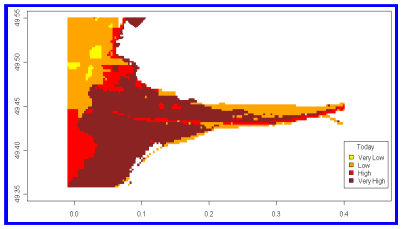

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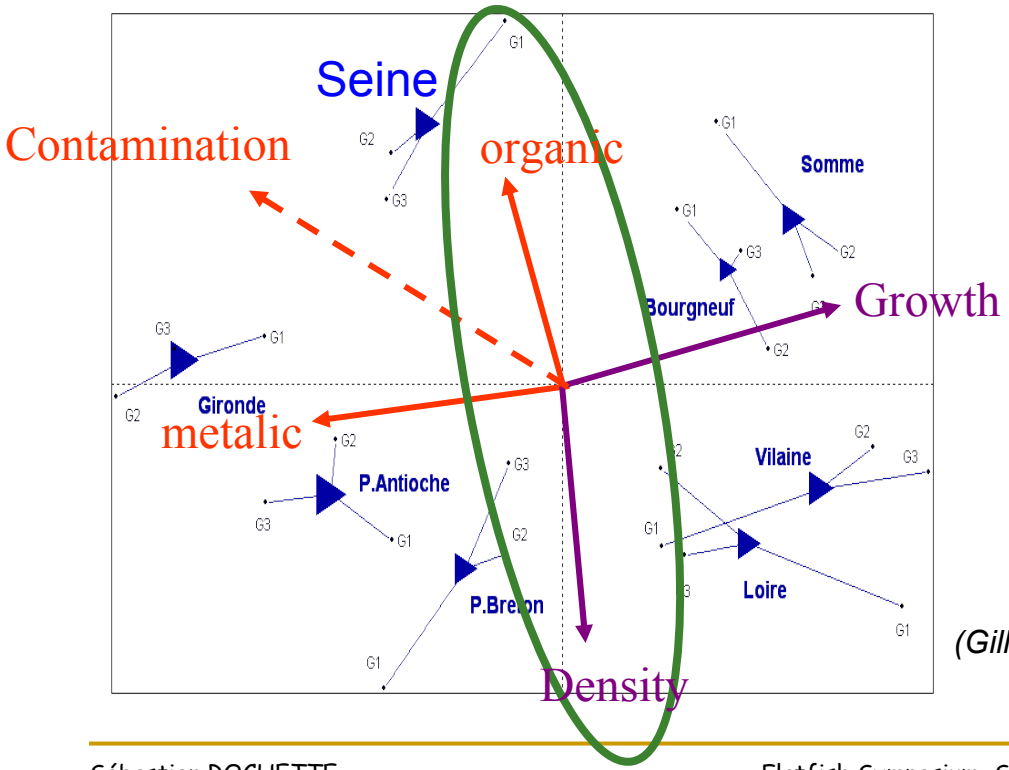
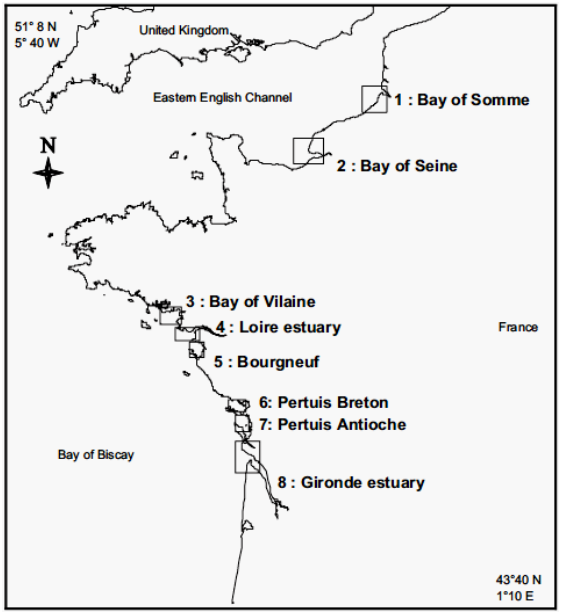



*(Gilliers et al., 2006)*



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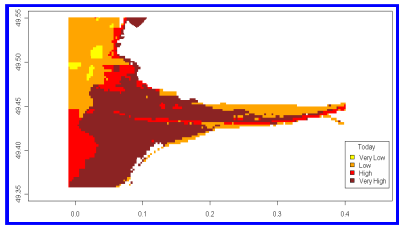

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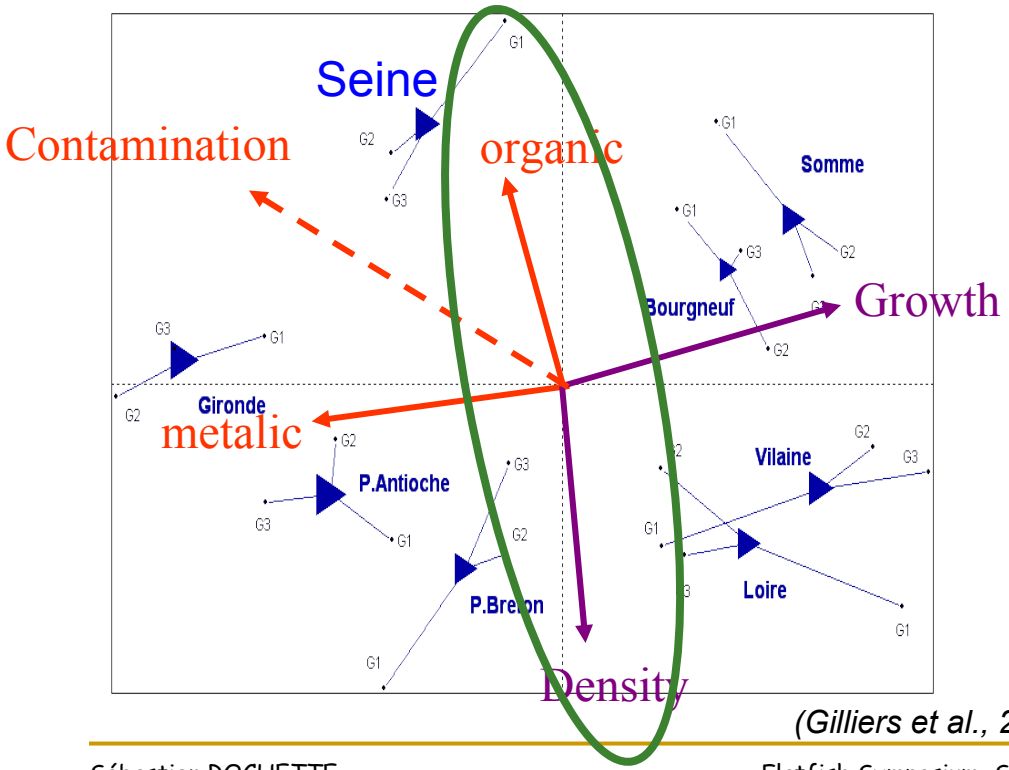


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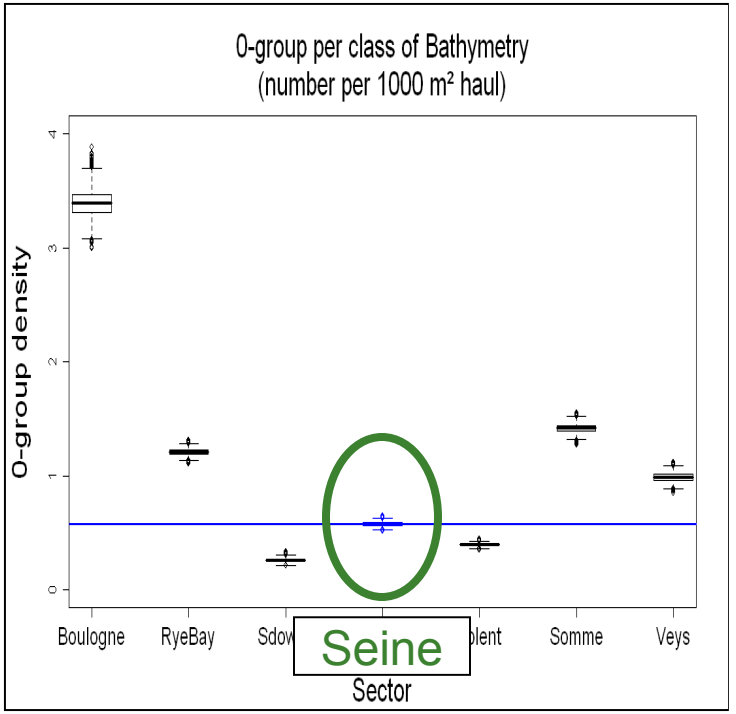
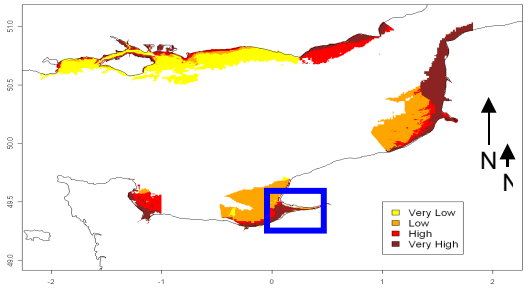


# Application in the eastern Channel

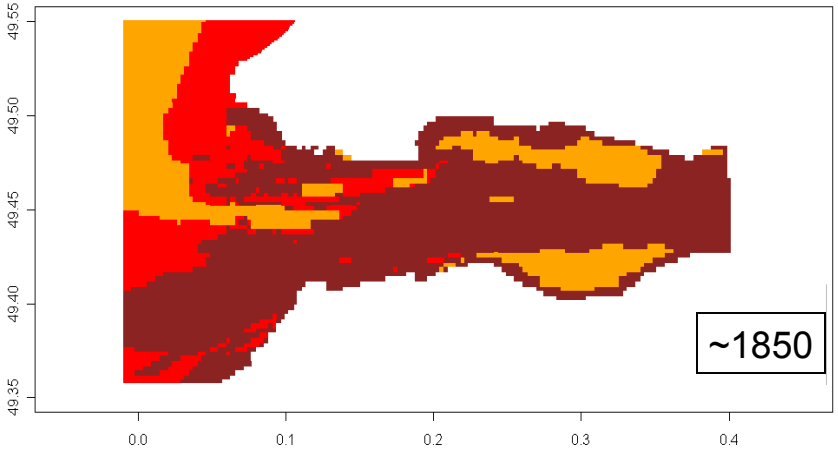
- Sole juveniles nurseries map
  - Coupling GLM and GIS

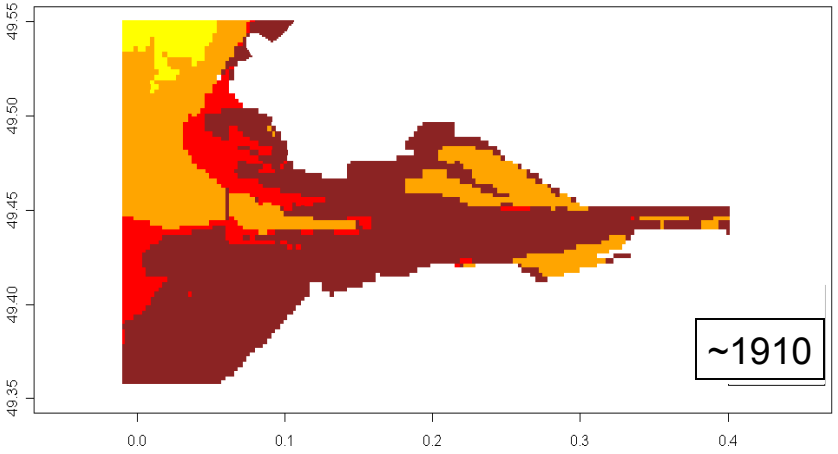
- > 150 years of transformation in the Seine estuary
  - Effects on juveniles biomass

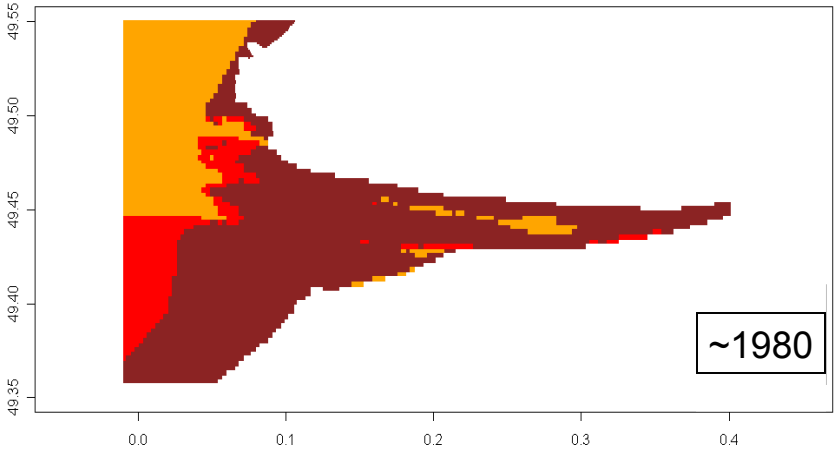
# Historical maps

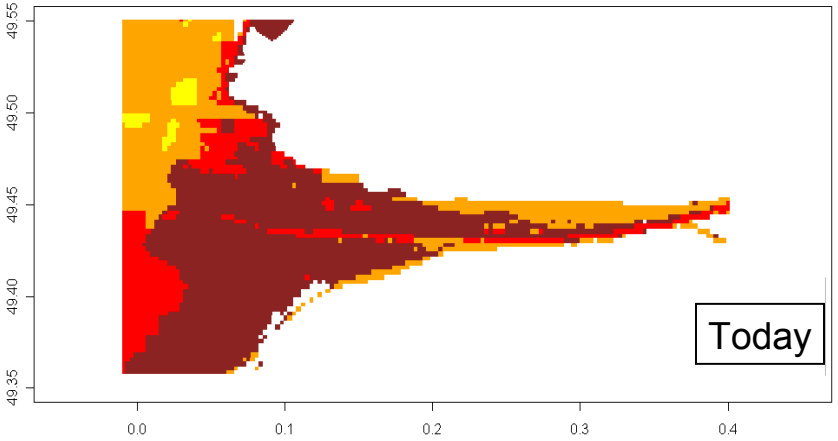



- Considering Seine quality same as nowadays
  - "Seine" sector effect from the delta model



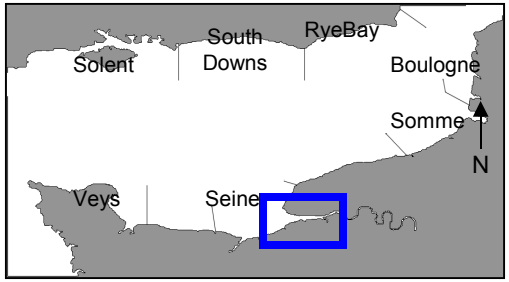



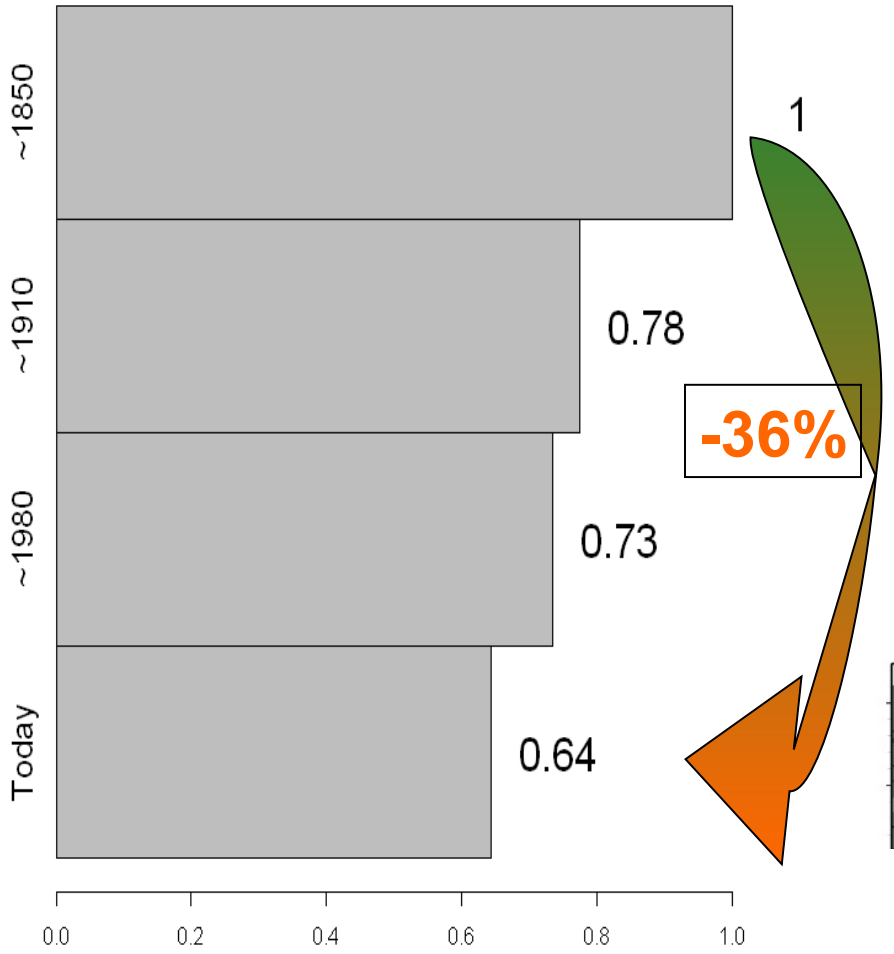



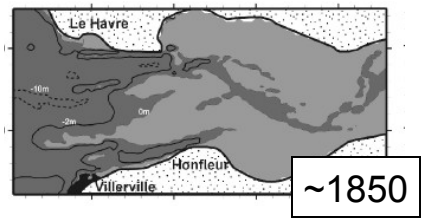



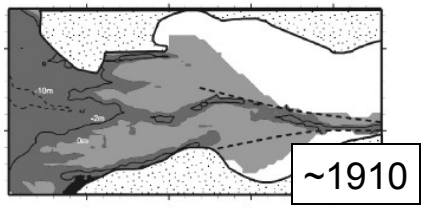
# Abundance index

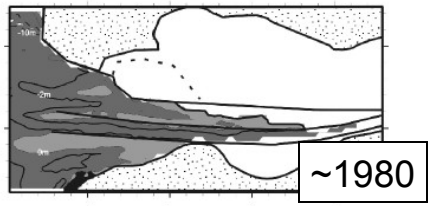
- 38% of Seine production lost

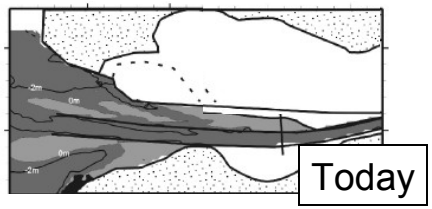


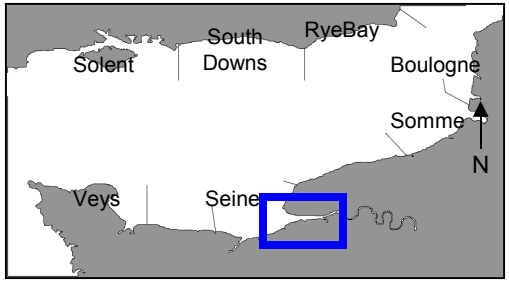



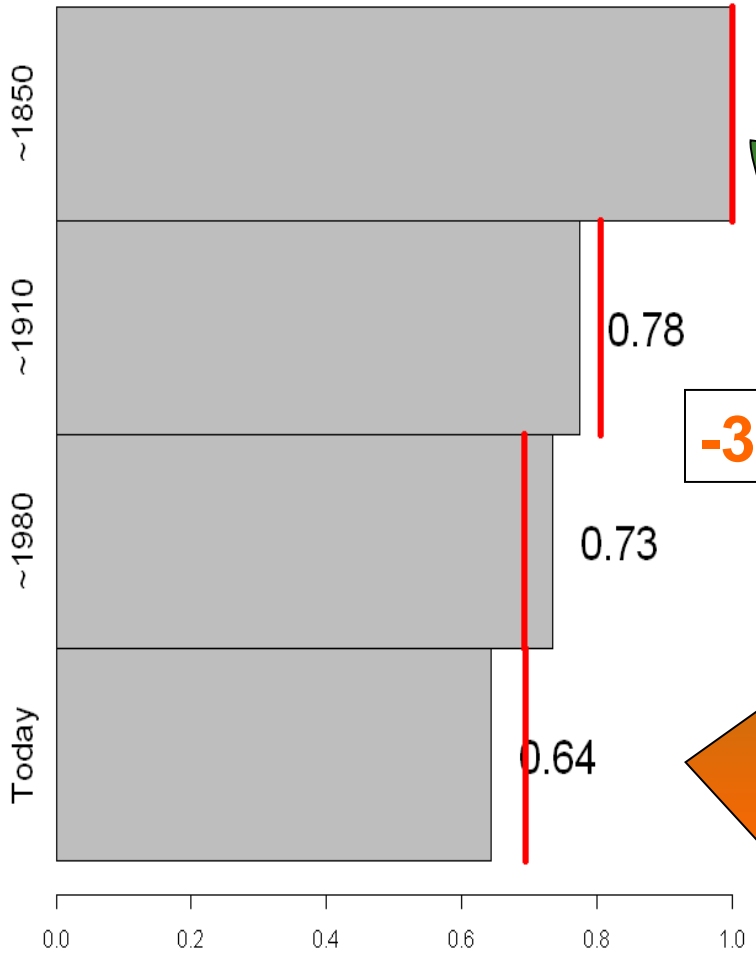




*(Maps: Delsinne, 2005)*

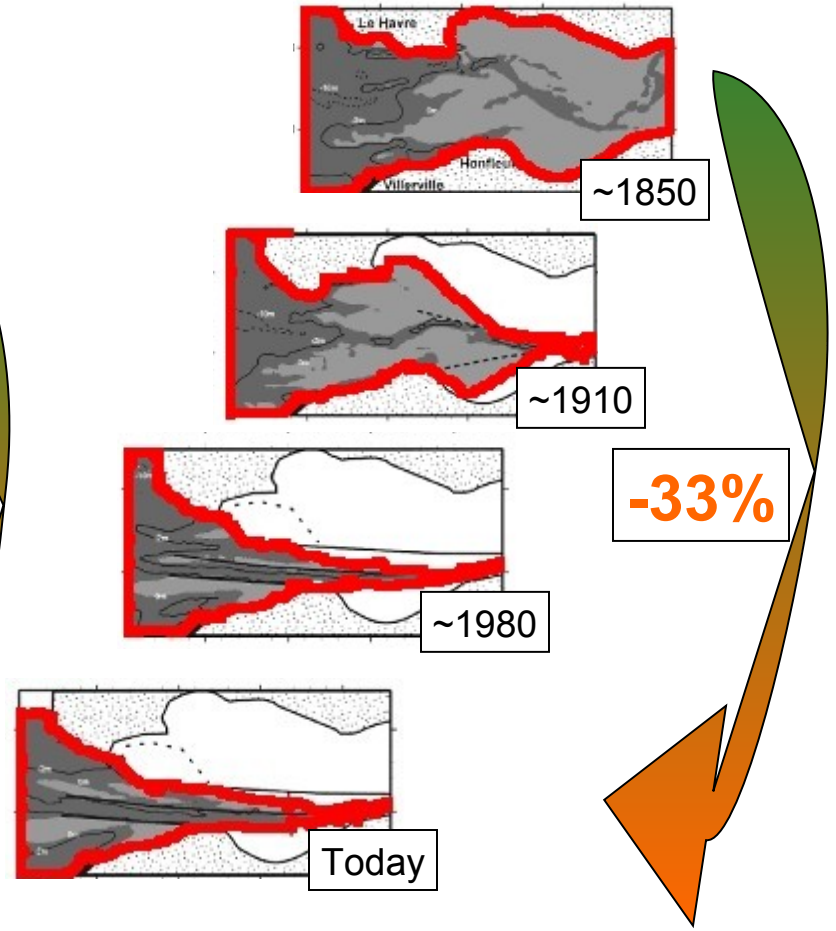
# Abundance index

- 38% of Seine production lost
  - 33% of surface lost



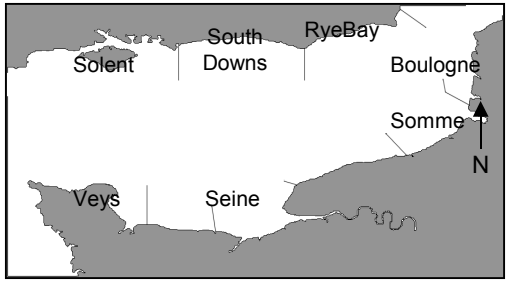

-36%

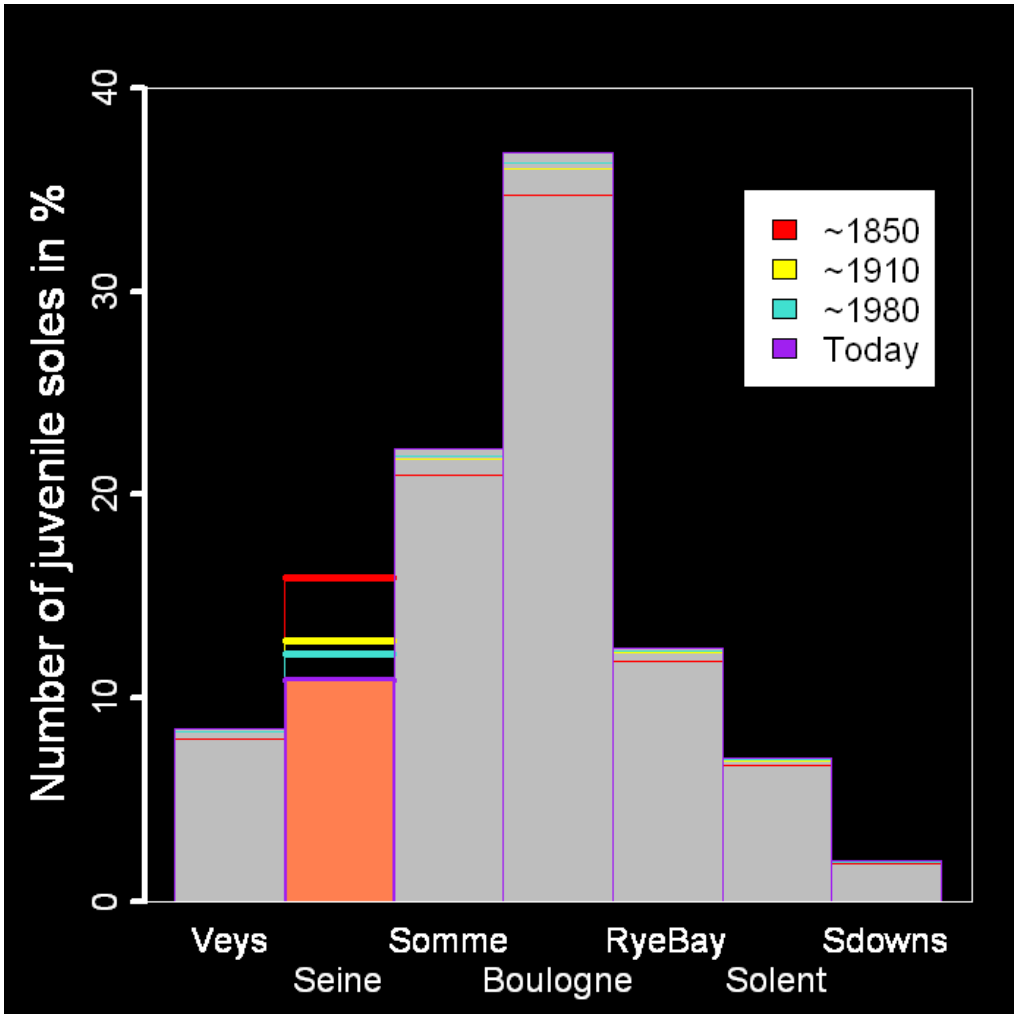



-33%

*(Maps: Delsinne, 2005)*

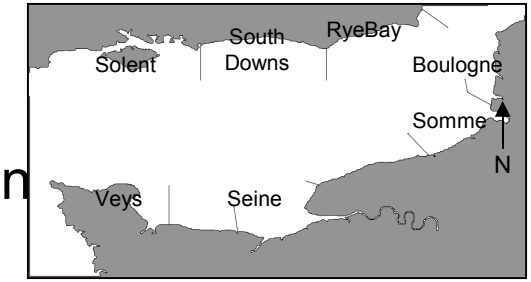
# Contribution to the stock

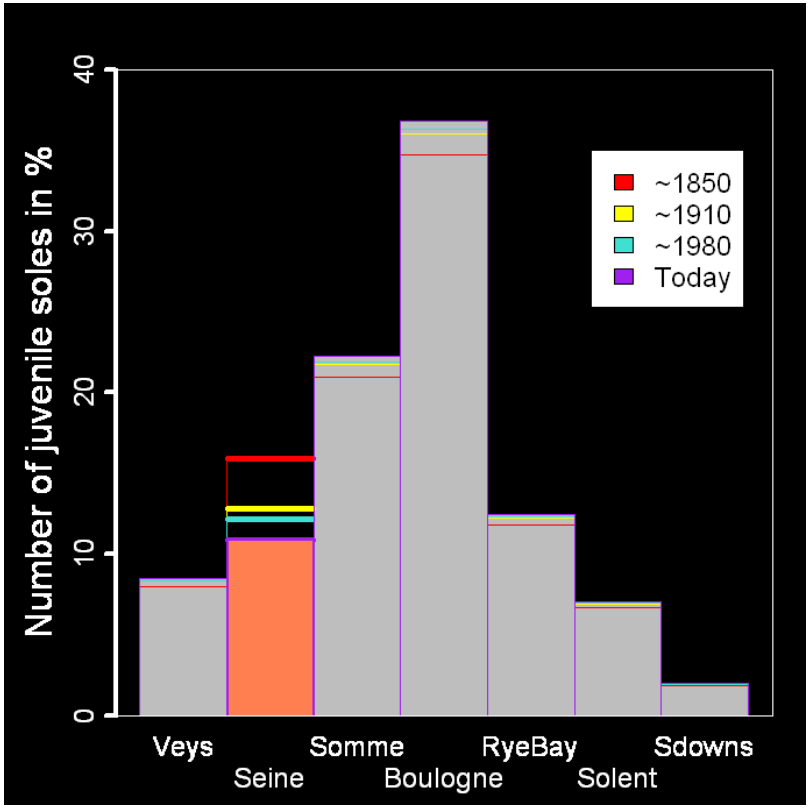


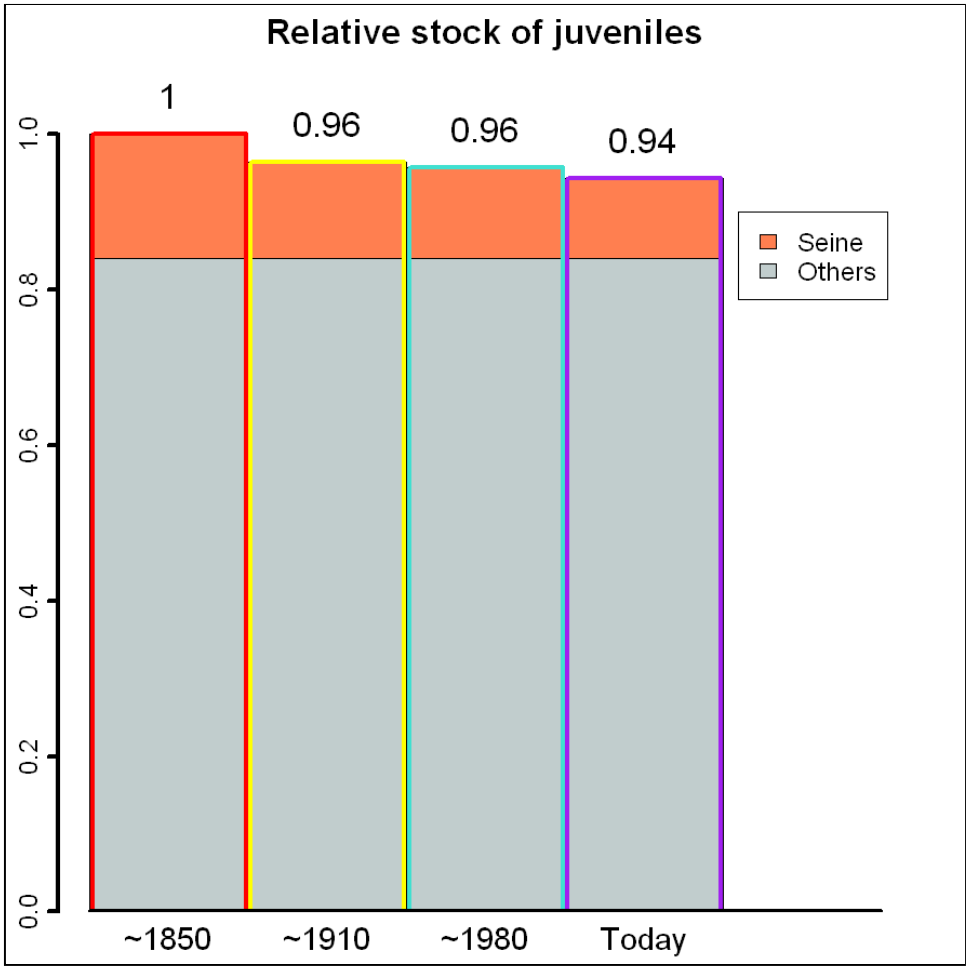



# Total stock of juveniles

- Loss of 6% of total 0-group juveniles population

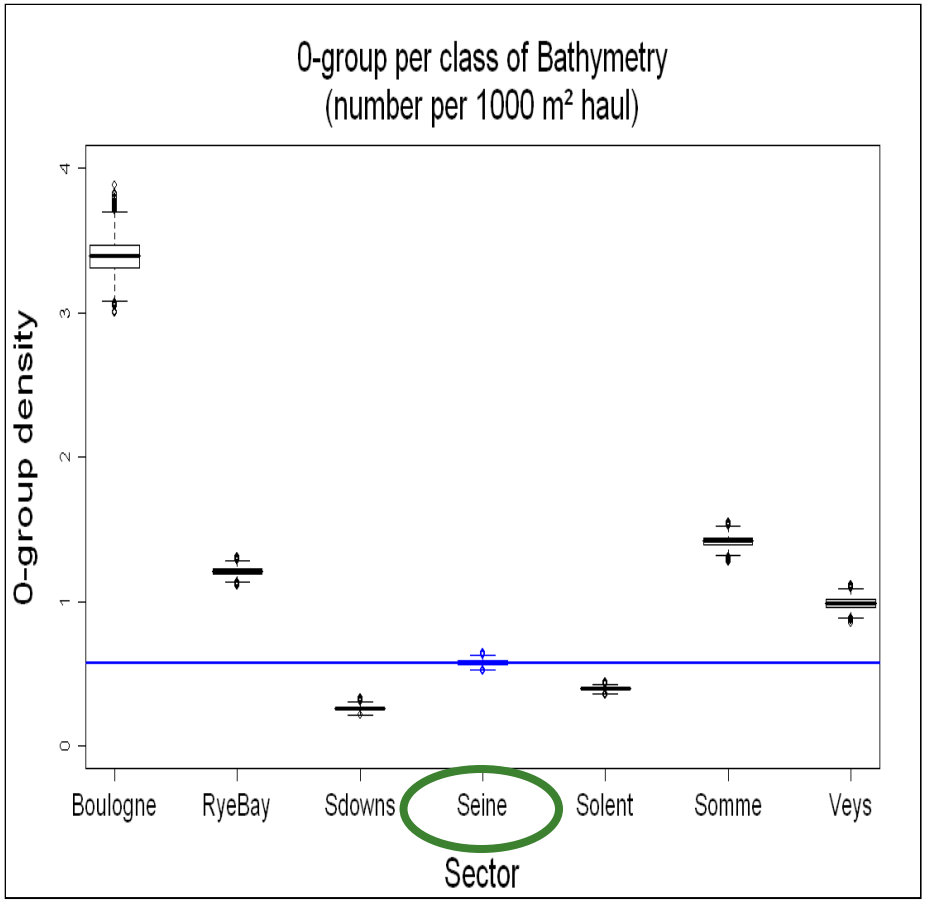


# What if the Seine was an average sector ?

- Low sector effect
  - Low quality
  - Low larval supply



# What if the Seine was an average sector ?

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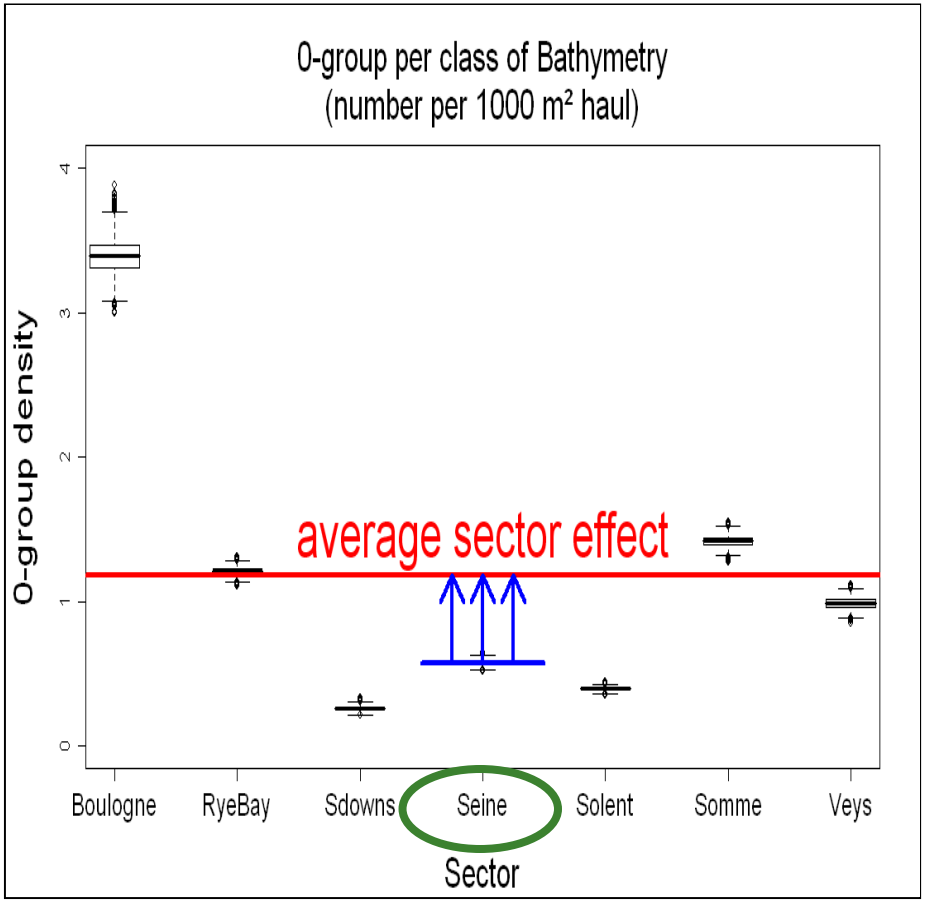
⇒ Seine with an average sector effect in the 1850s



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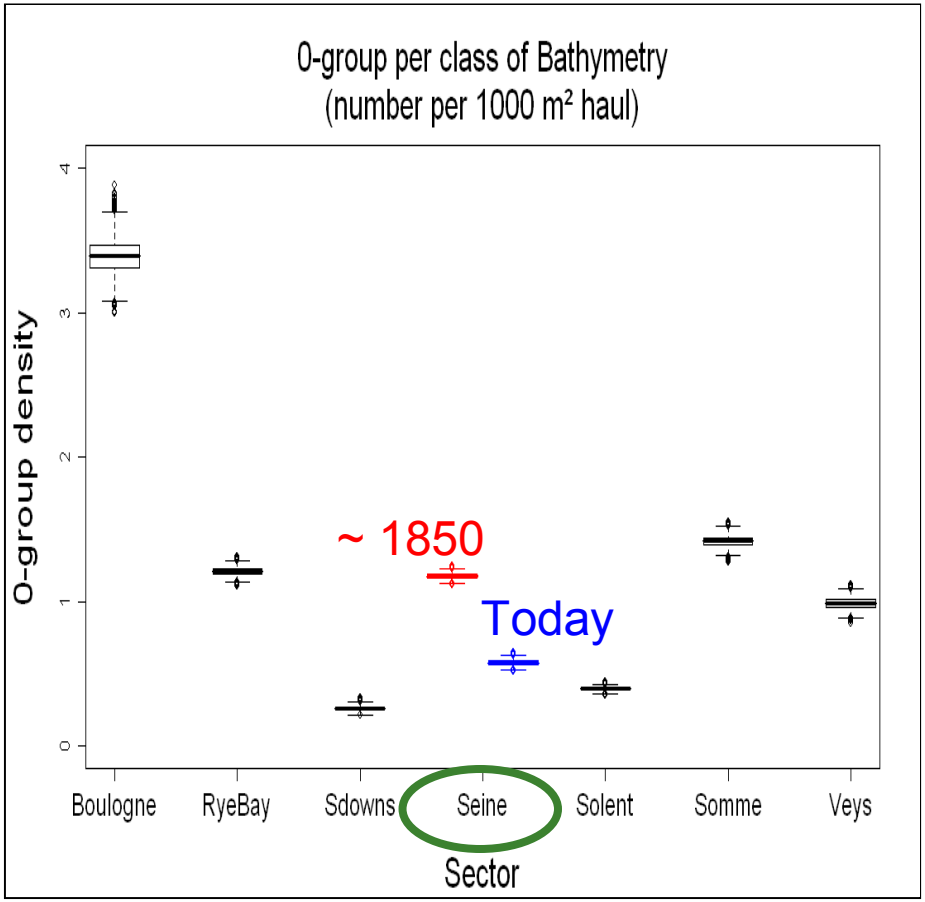

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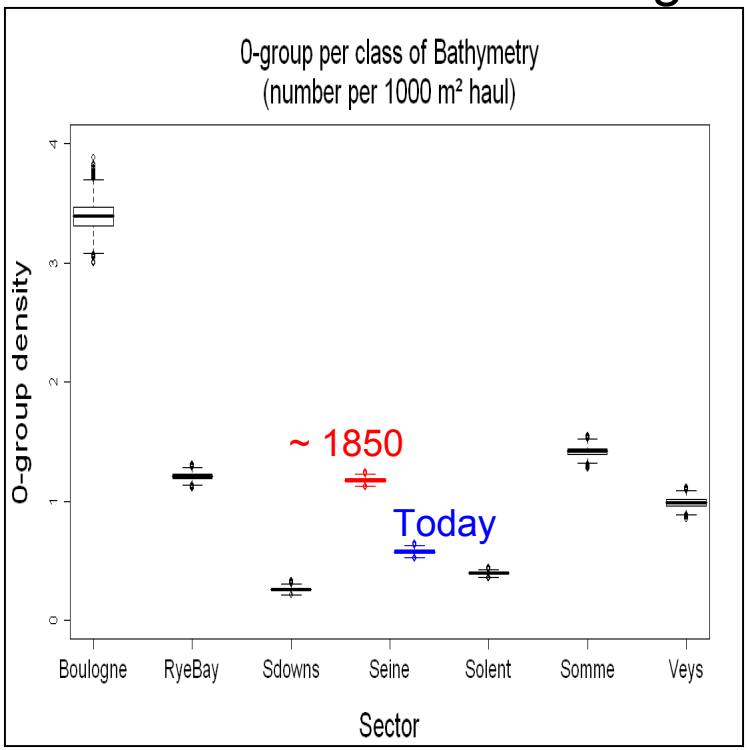


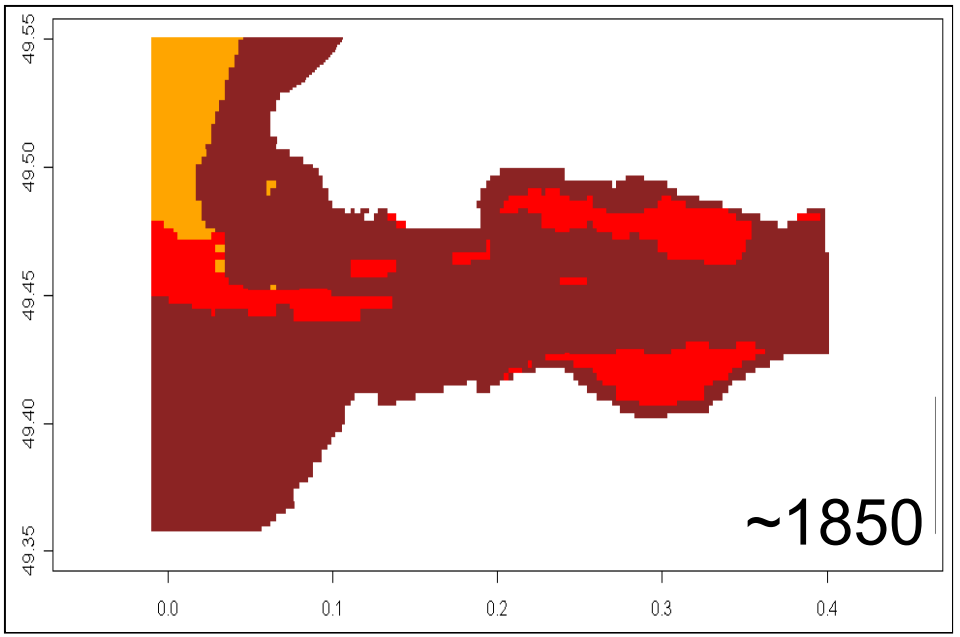


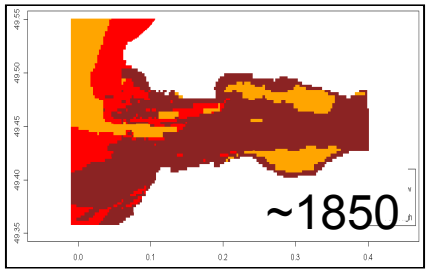

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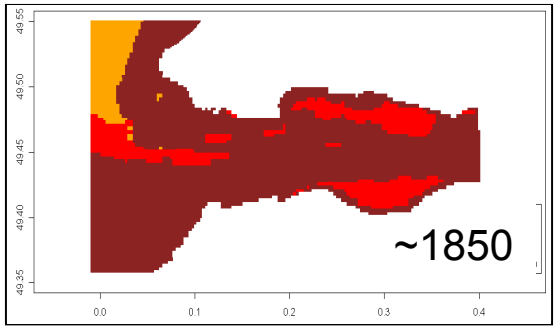
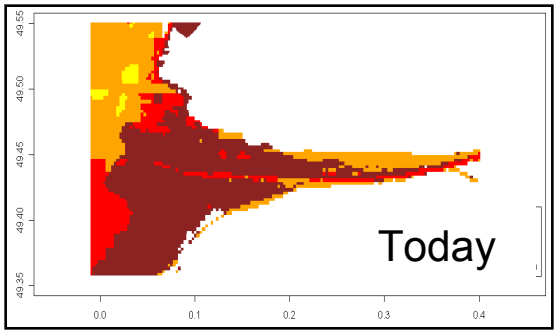
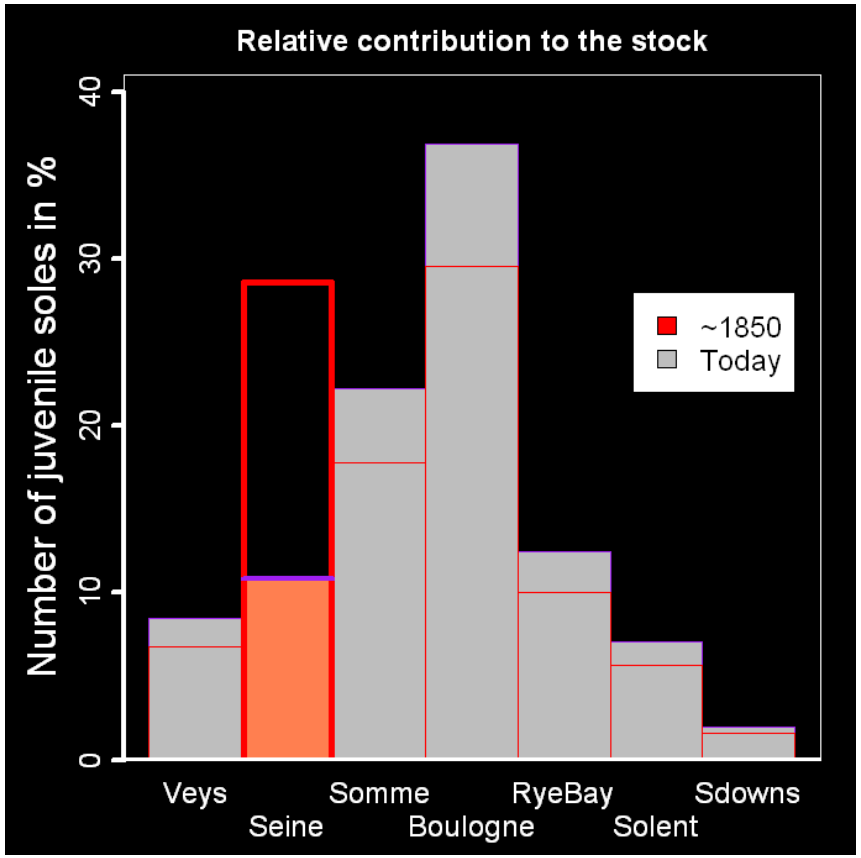
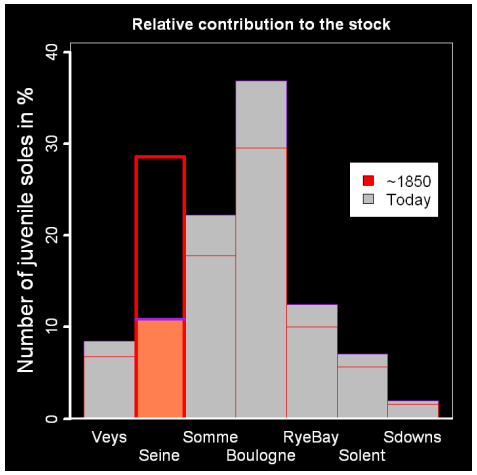


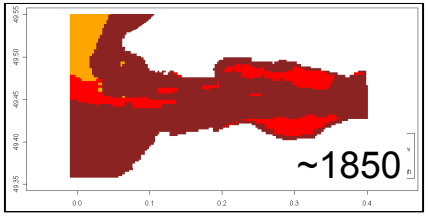



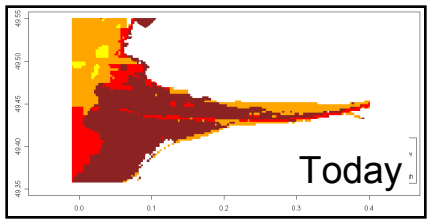



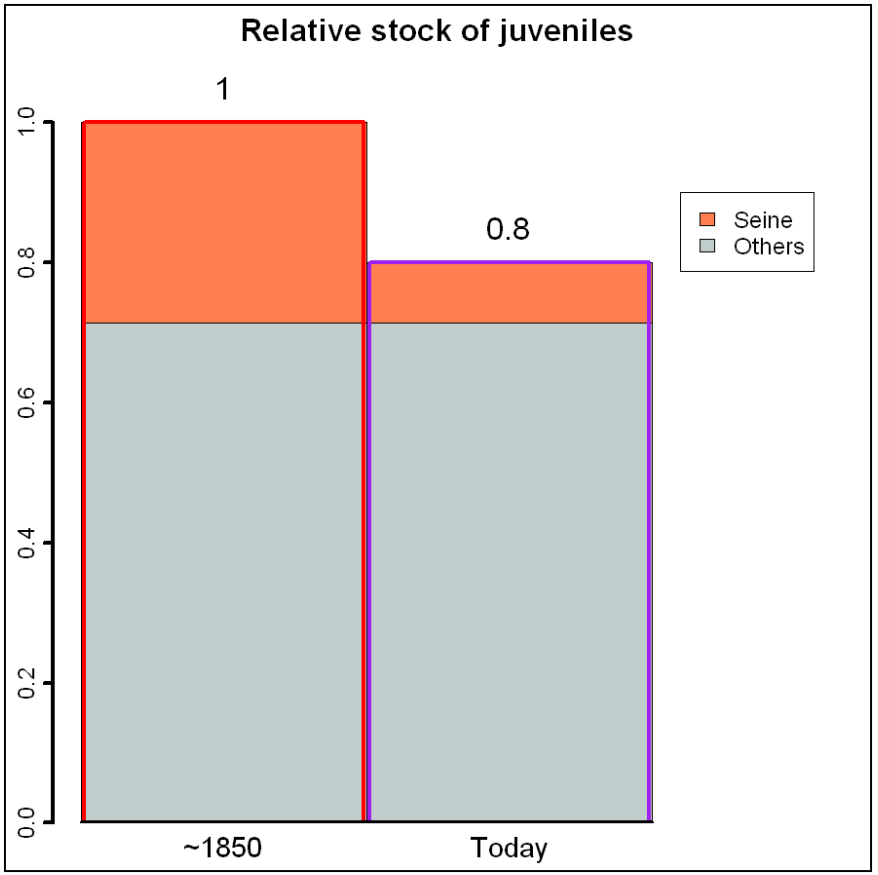
# What if the Seine was an average sector ?

- Seine with an average sector effect in the 1850s
- Loss of 20% of total 0-group juveniles population



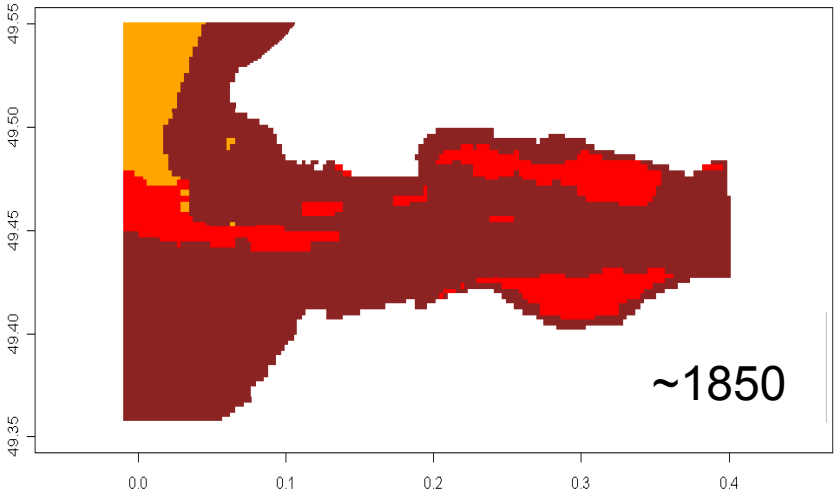



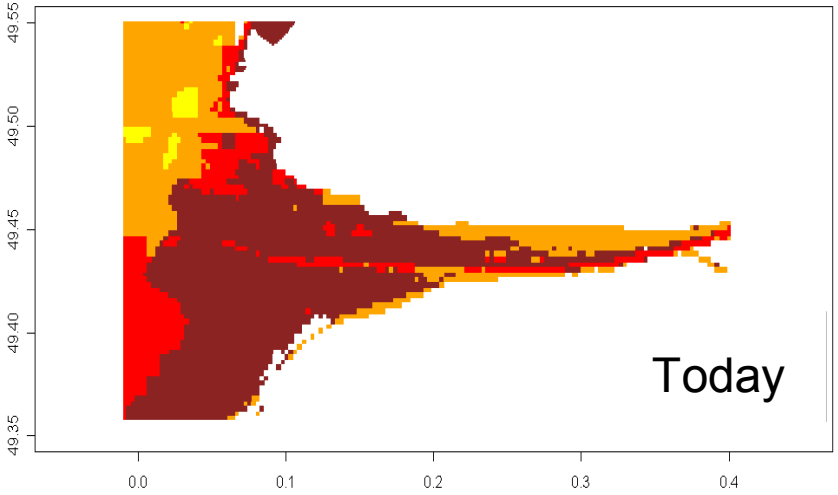



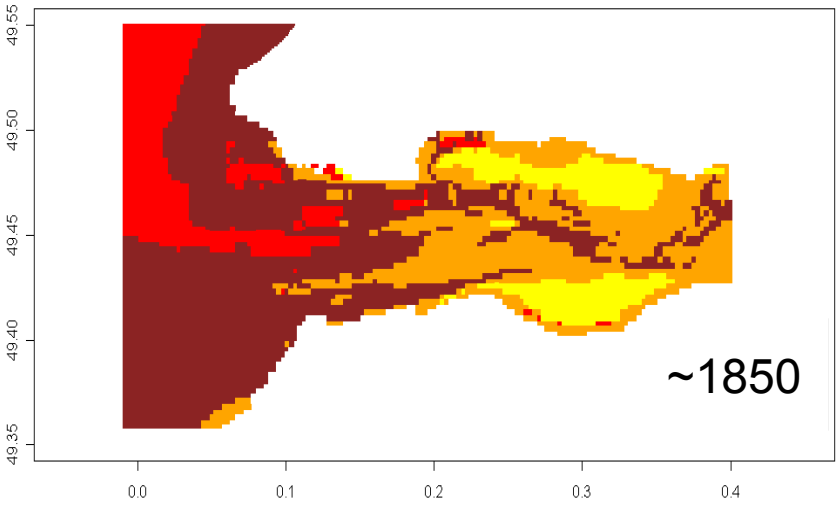
# What about 1-year group ?

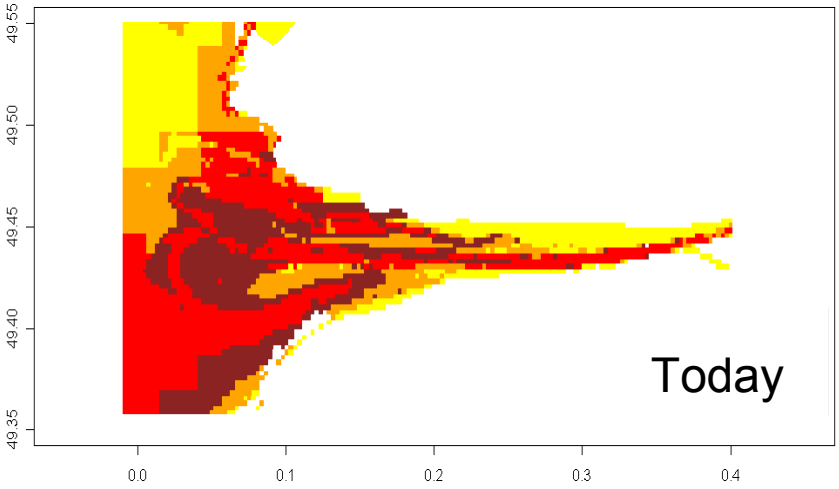
- 0-year group



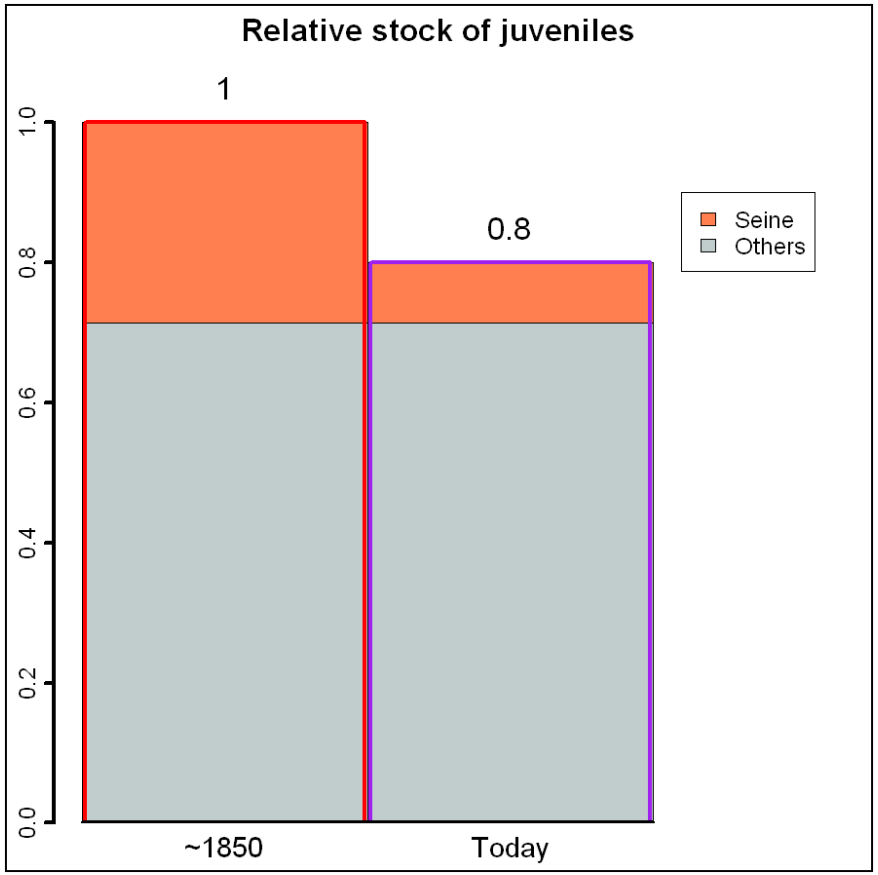

- 1-year group



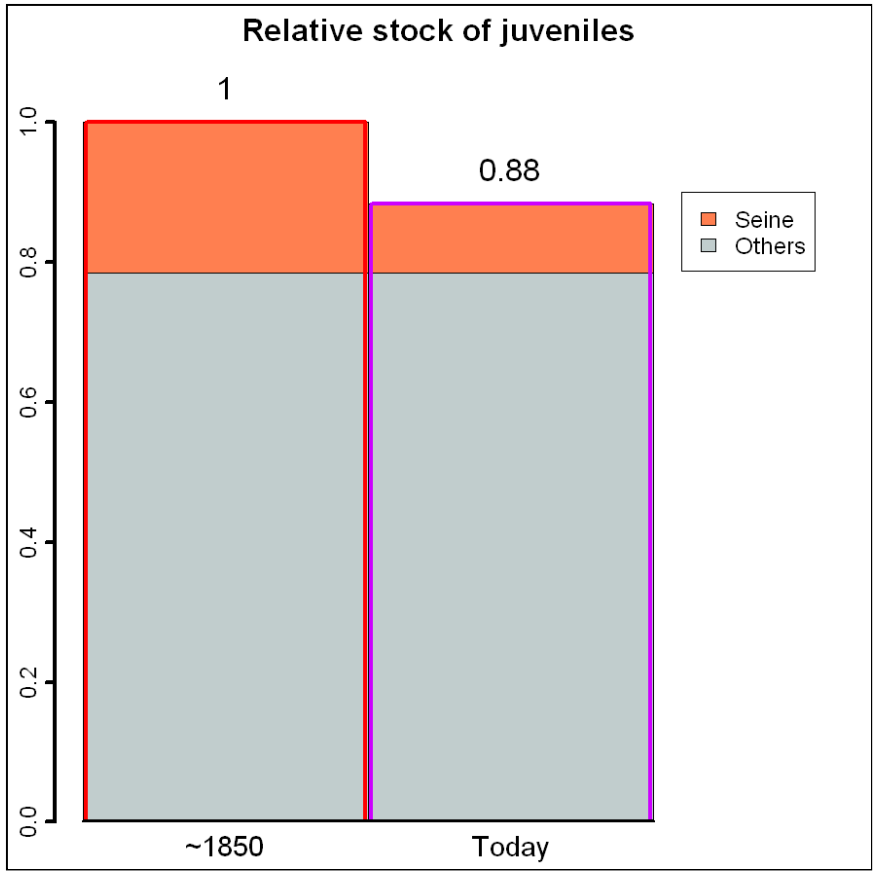



# What about 1-year group ?

- 0-year group
- Loss of 20% of total 0-group juveniles population




- 1-year group
- Loss of 12% of total 1-group juveniles population



# Conclusion

- Assumptions:
  - Average year
  - No change in other sectors
  - No change of soles behavior

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    - Today: 10% contribution in eastern Channel
    - During the last 150 years :
      - 33% surface decrease
      - ↘ 36% potential nursery in the Seine estuary
  - Eastern Channel population
    - From 6% (Same quality) to 20% (average effect) decrease of total 0-group juvenile population

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      - 33% surface decrease
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    - From 6% (Same quality) to 20% (average effect) decrease of total 0-group juvenile population

- Perspectives:
  - Juveniles = critical stage
  - Effect on adult population
    - Compared to mortality
    - Considering water quality

# Thanks for attention