An Input-Output/System Dynamics approach to ecological-economic modeling:

Interrelations between natural capital stock and economic growth

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Objectives

- Build a model by linking an **Input-output (I-O) table** to a **System Dynamics (SD) model** in order to **capture the complexity** of an ecological-economic system
- Apply the model to **the Seine Estuary**, France
- For this paper, **policy implications** for the restoration of the estuary are **NOT** the main focus
  - (we will address these in the next step)

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Motivation

- We need **modeling techniques** which can **capture the complexity** of an ecological-economic system.
- **Environmentally Extended I-O**
  - Captures detailed economic structures, but **not dynamics**
    - Constant technical coefficients; Lack of feedback loops
- **SD(a computer-aided approach to solving a system of nonlinear first-order differential equations)**
  - Captures nonlinear dynamics and feedback loops, **but not detailed (disaggregated) economic structures**
- It is technically possible to **integrate I-O and SD**.
  - SD can be synchronized with SAP, Oracle, Microsoft Excel, GIS, etc.

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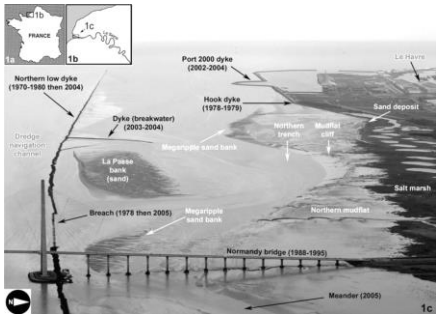
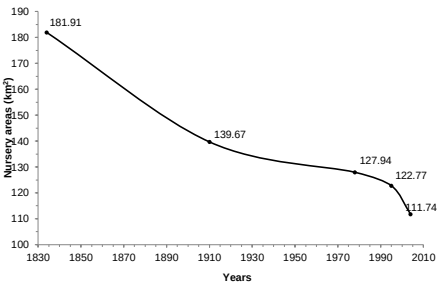
Study Area: The Seine Estuary

- The nursery area for sole has been **decreasing due to economic activities** (Rochette et al, 2010; Culliviez et al, 2008).



Nursery habitats have been continually destroyed since 1834 by the construction of dykes and harbour extensions for maritime transport, and by the Normandy bridge.

Source: Cullivies (2008).



Evolution of nursery areas of the internal part of the Seine estuary

Source: Rochette, S.

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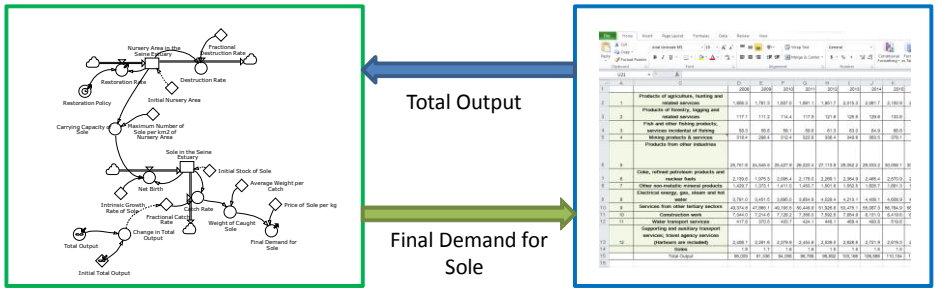
The Schematic Model

- SD on Powersim® is synchronized with I-O on Excel®.

Ecological System
(SD on Powersim)

Economic System
(I-O on Excel)



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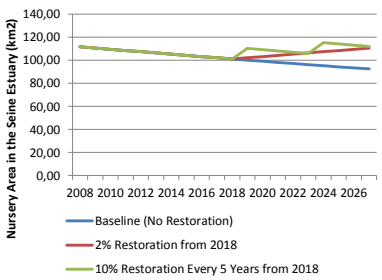
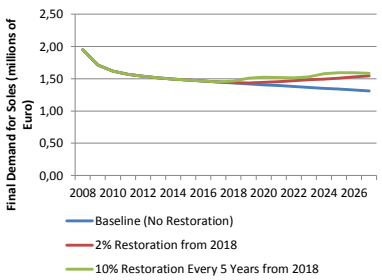
Simulation Results

- **Preliminary results** with three scenarios.
- Need to use **optimization techniques** to elicit practical policy implications.

Nursery area in the Seine Estuary



Final demand for sole



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Future Research Directions

- **Feedback loops**
  - E.g., impacts of economic activities on the destruction of the nursery
- **Delays**
  - E.g., dike construction impacts linger for several years (Culliviez, 2009)
- **Ecological System**
  - Need to sophisticate the model structure of the ecological system
- **Data Collection**
  - Collect “soft data” through, for example, expert meetings
- **Optimal Restoration Policies under Uncertainties**
  - SD offers optimization techniques for analytically unsolvable models

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