Fishing the food web: a bio-economic analysis of changes and drivers of change in fisheries of the Bay of Biscay

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I. Context – the “Fishing down the food web” debate

II. A case study: changes in fisheries production by French Fleets in the North-East Atlantic / Bay of Biscay

III. Key drivers
- Internal: (deficient) access regulations
- External:
  - Globalization of markets
  - Climate change

IV. Perspectives
Context: the «fishing down marine food webs» debate

- Key role of economic drivers, at least in some cases (e.g. case B below)?
- Environmental drivers?
- Economic consequences?

Total yearly catch for each 0.1 trophic-level increment indicated by the color bar on the right ($10^4$ kg yr$^{-1}$)

A - sequential collapse / replacement

The Scotian Shelf ecosystem: collapse of the cod fishery → decline in the herring fishery → growth of the northern prawn fishery

B - sequential addition

Patagonian Shelf ecosystem: catches for upper-trophic-level species (Argentinean hake) grew substantially / new fisheries for short-fim squid developed

Essington et al., 2006. PNAS
The case of fisheries production by French Fleets in the North-East Atlantic

Study period: 1973-2005
Two scales of analysis: landings by French fleets operating in
(i) the North-East Atlantic & (ii) the Bay of Biscay

Data
1. Official French landings data published in paper reports
2. Deflation of fish prices by consumption price index (base year 2005)
3. Compilation of bio-geographical descriptors of species landed (literature based): trophic level; maximum length, age and weight; growth rate; mean latitude and depth of area of distribution; ...

Focus on 57 fish species (50 % of French landings from the Bay of Biscay & 78% of French landings from the North-East Atlantic, in volume)

Steinmetz F., Thébaud O. et al., forthcoming. ALR
Average characteristics of landings

Av. trophic level

Mean latitude of area over which landed species are known to be distributed
Structure of landings

North-East Atlantic  Bay of Biscay

Trends in French landings of the three groups of species

<table>
<thead>
<tr>
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<th>Bay of Biscay</th>
<th>North-East Atlantic</th>
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<tbody>
<tr>
<td>Benthic fishes</td>
<td>**(-842 tons per year)</td>
<td></td>
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<tr>
<td>Demersal fishes</td>
<td></td>
<td>**(-3363 tons per year)</td>
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<tr>
<td>Pelagic fishes</td>
<td>**(+982 tons per year)</td>
<td>**(+2027 tons per year)</td>
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* (resp. **) : Indicates the significance to 5 % (resp. 1%) of the Mann-Kendall trend test; the Sen slope is indicated in the brackets.
Changes in the composition of landings – A synthetic representation

Bay of Biscay

First plane of a principal component analysis with landings_years as active variables, and species as observations.

The blue arrow follows the sequence according to which the composition of landings changed with time.
Projection of individual species - Bay of Biscay

size of marks = f(share in total landings)

« high price » species / « medium price » species / « low price species »
Indices of total volume / value of landings

North-East Atlantic:
- Decrease in landings since late 80ies
- Maximum value achieved in 1987;
- Drop in value by 40%+ since then; lower value today than in the 70ies

Bay of Biscay:
Increase in landings until 1994
Maximum value achieved in late 80ies
Drop in value by 45%+ in the last decade
Role of catch composition in value changes

→ 2002/1989 evolution of French fish landings from the Bay of Biscay:

~ 40% drop in value

Based on index number calculations:

Reduction in volumes of fish landed explains 58% of drop in total value

→ Drop in price of fish landed explains the rest

But 62% of the drop in average price of fish is due to increased proportion of low-priced species in landings
Three key drivers
Key driver 1 - A case of de facto open access:
→ incentives towards the increase of fishing capacity

O. Thébaud et al., 2005.

From 1973 to 2002:

Gross Registered Tonnage = - 44%

\[
\frac{\text{Landings (metric tons)}}{\text{GRT}} = + 53\%
\]
Key driver 2: Impacts of increased competition on markets for fish (all species)

→ Highest prices achieved in the late 1980ies
→ Market crisis in early 1990ies (due to external factors)
Key driver 3: Effects of the sea warming on the fish community structure

### Total fish abundance in the Bay of Biscay

**Shelf water temperature anomaly**
- +1.5°C since 1970
- Depth range: 0-50 m

**Total fish abundance**
- 100,000
- **Subtropical species**
- **Boreal species**
- **Temperate species**

Poulard & Blanchard, ICES JMS, 2005
Perspectives → Compare trends across ecological-economic systems: the Chaloupe project

- identify the main drivers of bio-economic changes in three systems over the past decades
- develop integrated models of key processes
- assess the viability of fisheries

Moroccan upwelling area
Temperate continental shelf of the Bay of Biscay
Amazonian continental shelf of the French Guyana

Thank you for your attention!

PROJET CHALOUPE

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