Using trophic spectra to detect shifts in ecosystem structure.

Application to N-W African demersal resources.

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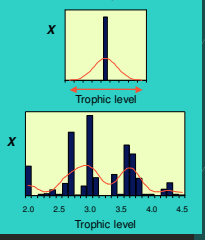
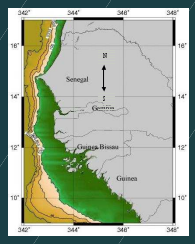
Recipe for a trophic spectrum

A trophic spectrum is a graphical representation of an ecological variable *X* (abundance, biomass, catch) distributed along "non-discrete" trophic levels.

1. Assign each species a mean trophic level (*TL*). Aggregate *X*-values by *TL* increments of 0.1
2. Smooth the *X*-distribution with a weighted moving average technique: *X*-values are spread along an empirical range of trophic levels
3. Plot the smoothed distribution *vs.* trophic levels

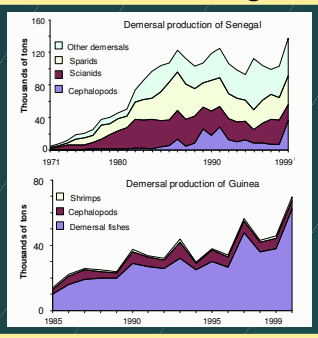


Senegal and Guinea: 2 countries with fast-growing fisheries



From pristine state to overexploitation

- Marine ecosystems are very productive in Senegal and Guinea and sustain important demersal fisheries that have rapidly developed in the last decades.
- At the same time, the collection of landing and survey data has been carried out. Thus, data collection extends from a period where stocks can be considered as unexploited to an overexploited situation.



From stock assessment to trophic level-based approach

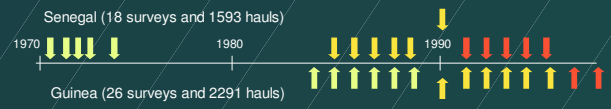
- Many monospecific assessments have been conducted on demersal species and conclude to their overexploitation.

We propose a complementary approach allowing to investigate fishing effects at the ecosystem scale

Using data series since the beginning of exploitation

Data

- For the two countries, surveys were conducted in order to improve current knowledge on the biology, distribution and abundance of all the species sampled by bottom trawl.



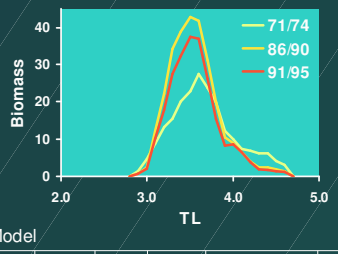
- Mean trophic levels for each species are extracted from the FishBase database and are assumed stable from year to year within the study area.

Method

- Based on scientific survey data, the Biomass Trophic Spectrum (BTS) describes the distribution of the demersal community biomass per trophic class (i.e., trophic levels with increments of 0.1).
- Biomass is estimated from the catch, considered as an index of abundance since no technical change affects the sampling procedure.
- Linear models (LMs) are used to investigate the annual variation of a BTS. The biomass by trophic class (B) is defined as the response variable and trophic classes (TC), year (Y), season (S), latitude classes (L) and bathymetric classes (Ba) are used as categorical factors.

Testing the shifts in the biomass trophic spectra

Biomass trophic spectra in Senegal



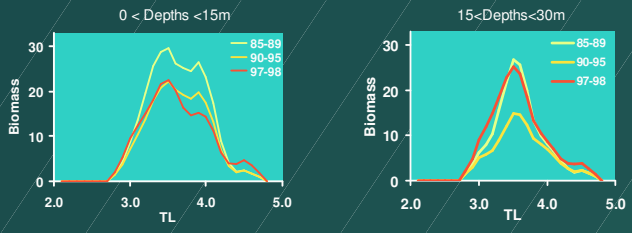
- Model

Variable	Source	d.f.	p	Residual deviance	% explained
B	Null			82.2	
	S	1	0.003	81.7	0.6
	TC	15	<0.00	20.1	75
	Y	2	<0.00	18.	4 2.1
	TC*Y	30	<0.00	12.8	6.8

The significant interaction between trophic class (*TC*) and year (*Y*) shows a change in the structure of the BTS since the beginning of the 70s ; the biomass decreases for upper trophic levels (4-4.5) and increases for the lower ones (3.2-3.6).

Total biomass remains constant. This evolution appears as a top-down effect and could traduce the ecosystem capacity to react to the increasing fishing pressure.

Biomass trophic spectra in Guinea



- Model

Variable	Source	d.f.	p	Residual deviance	% explained
B	Null			2443.5	
	L	2	<0.00	2432.6	0.4
	TC*Y*Ba	107	<0.00	663.6	72.3

The significant three-dimensional interaction effect shows that the temporal changes in the trophic spectra differ according to the bathymetric classes.

In lower depths, the biomass of the high trophic levels decreases during the whole period, while the biomass remains relatively stable for the lower trophic classes. No top-down effect is observed and the total biomass displays a 40% decrease.

In deeper waters, the structure of the BTS remains stable during the period. The total biomass shows some fluctuations without any clear trend.

The Senegalese and Guinean BTS show strong modifications occurring in demersal resources.

The evolution appears different in both ecosystems. In Senegal, total biomass has remained fairly constant since the 70s. This could characterize a top-down control, with a release of predation pressure by the highest trophic levels. In Guinea, the total biomass has strongly decreased in coastal waters. Biomass of lower trophic levels seems relatively constant, reflecting a weaker top-down effect and/or a wider range of exploited trophic levels.

In the context of such fast-growing fisheries, fishing pressure appears to be the main factor impacting the structure of both ecosystems.

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