Using trophic spectra in an ecosystem individual-based simulator: impact of fishing.

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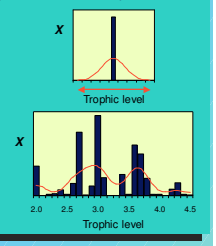
Recipe for a trophic spectrum

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

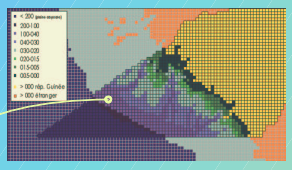
1. Assign each species a mean trophic level (*TL*). Aggregate *X*-values by *TL* increments of 0.1
2. Smooth the *X*-distribution with a weighted moving average technique: *X*-values are spread along an empirical range of trophic levels
3. Plot the smoothed distribution *vs.* trophic levels



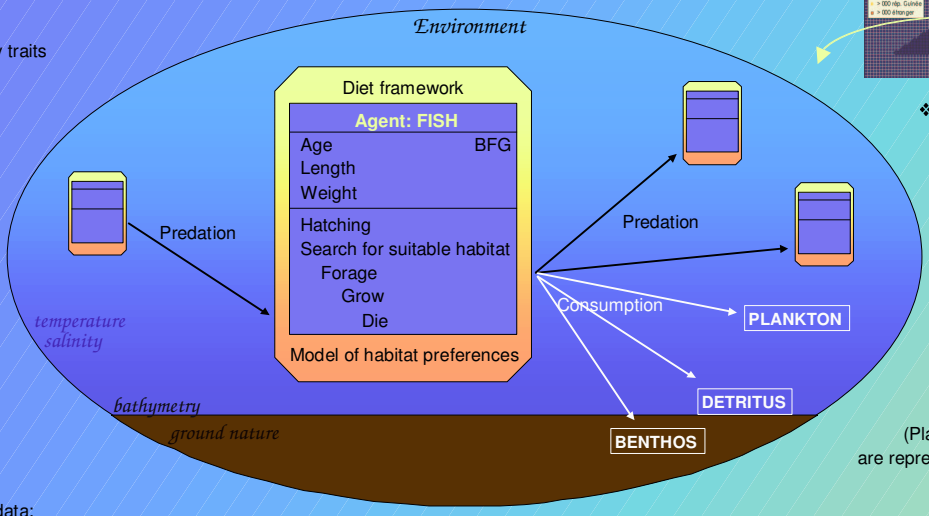
MOOVES*: an individual-based model of age- and size-structured communities dynamics applied to the ecosystem of Guinea

* MOOVES:Marine Object-Oriented Virtual Ecosystem Simulator

❖ The current study is conducted on 35 bio-functional groups (BFG). Each BFG comprises species that :
- share habitat
- share food resources
- have similar life-history traits



❖ Space is discretized into a geo-referenced grid



❖ The full life-cycle of fish is modelled by the way of autonomous agents.

❖ Resources at the bottom of the food web (Plankton, Detritus, Benthos) are represented as compartments.

❖ Origin of trophic level data:

✓ A theoretical food ration is defined for each fish through a consumption rate and its current weight.

✓ Diets are combinations of feeding on low-level compartments (P, D, B) and on other fish.

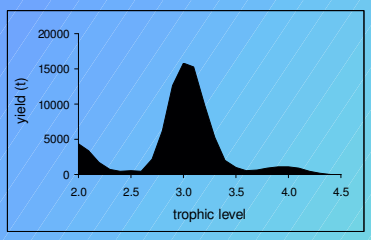
✓ Predation, whatever the prey taxonomic origin may be, is based on:
- predator-prey co-occurrence,
- appropriate predator-prey length-ratio.

Fish trophic level is an output of the model.

Studying the impact of fishery on the ecosystem using simulated Trophic Spectra

Scenario simulated: **intense exploitation** targeting **fish larger than a limit size** (total length > 19 cm), whatever their bio-functional group.

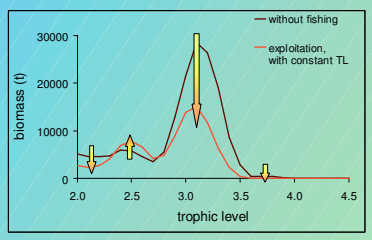
Catch Trophic Spectrum



- Mainly fished groups have a mean trophic level around 3.
- High catches on fish with TL around 2 highlight the « detritus-rich » characteristic of the Guinean ecosystem, where some large fish partly feed on detritus.

Biomass Trophic Spectra

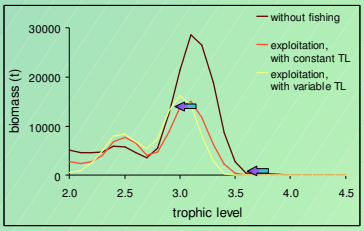
Trophic levels are fixed at their level « without fishing pressure »



The exploitation induces:
- a release of predators biomass and of targeted low-TL groups.
- an increase in the biomass of intermediate groups that are non-predated and non-targeted.

Biomass Trophic Spectra

Trophic levels are simulated in both pristine-state and exploited scenarios



The exploited trophic spectrum shifts back in its right side. This reveals a decrease in the trophic level of upper-web groups.

Changes in trophic spectra show not only the variation of the groups biomass, but also a change in their diet.

The combined use of the simulator MOOVES with trophic spectra allows to investigate the response of the ecosystem to exploitation. The tested scenario argues for the hypothesis that the trophic levels of upper-food web populations tend to decrease under fishing pressure. If confirmed, this hypothesis may indicate that the "fishing down marine food web" phenomenon is actually more pronounced than previously stated.

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