

# Using trophic spectra to identify habitat-related trophic signatures of coral reef fish assemblages

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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.

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

## Trophic structure of fish assemblages as ecosystem indicator

Coral reef fish cover a wide range of trophic levels. For this reason, the trophic structure of fish assemblages may provide relevant **indications on the trophic state of the underlying ecosystem**. We propose to describe the trophic structure of reef fish communities using **fish abundance distributed along trophic levels**.



### Application to the South-west lagoon of New Caledonia

Since the late 80's, an extensive survey of reef fish assemblages was conducted by IRD in the South-west lagoon of New Caledonia. This large data set allows to test the indicator function of **abundance trophic spectra** (see the recipe) by the search of :

- a typical shape related to typical environmental conditions
- a deviation in a typical shape in response to fishing pressure

## Methodology

Fish abundance was estimated using underwater visual censuses. In total, **578 species were surveyed in 360 sampling stations**.

We estimated for each fish species a trophic level from local gut content analyses and FishBase information.

Fish abundances were aggregated by trophic level, allowing to estimate a **trophic spectrum of fish abundance for each sampling unit**.

For various sets of sampling units, we calculated the **geometric mean** of abundance of each trophic level. A **confidence interval of the mean** was estimated using a bootstrap procedure.

## 1 Searching for habitat-related trophic signatures

Sampling stations are grouped according to three types of reef habitat defined in various locations of the SW lagoon:

- **Fringing reefs** along the mainland coast
- **Inner lagoon reefs**
- **Barrier reefs**

Since total abundance exhibits strong differences between the three habitats, each mean trophic spectrum is plotted using **relative abundance** per trophic level.

**Trophic spectra of the fringing reefs** are all characterised by 1 peak of abundance for TL ranked from 2.5 (omnivores) to 3 (zooplankton feeders).

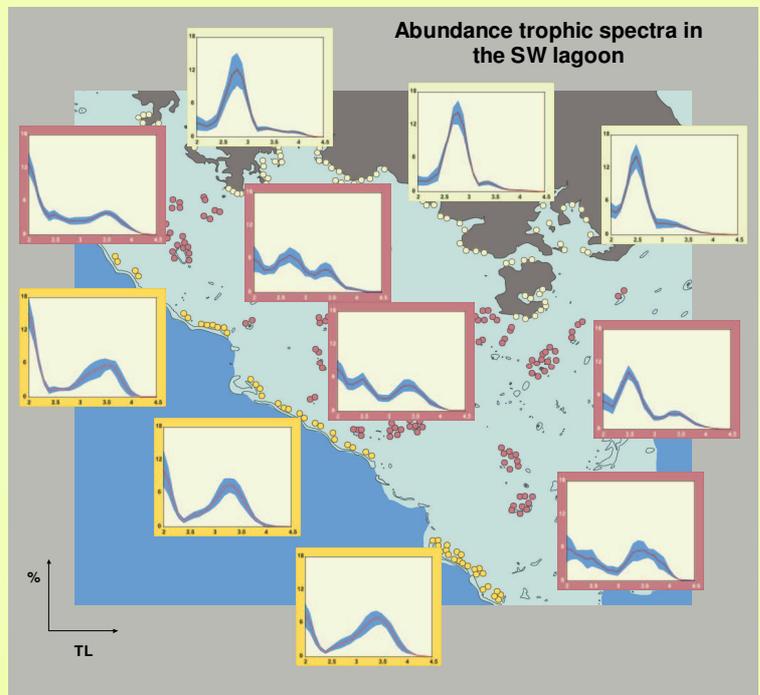
**Trophic spectra of the barrier reefs** are all characterised by 2 peaks of abundance. Herbivores (TL = 2) and carnivores of mobile invertebrates (TL between 3.2 and 3.6) dominate fish abundance.

**Trophic spectra of the inner lagoon reefs** exhibit an intermediate shape following the distance to the mainland coast.

### Abundance trophic spectra shows:

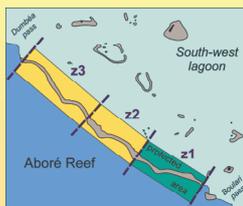
- significant differences in their shape according to habitat type
- a consistent shape for a given habitat in various locations.

➔ **Identification of standard trophic signatures related to the three habitats defined in the SW lagoon.**

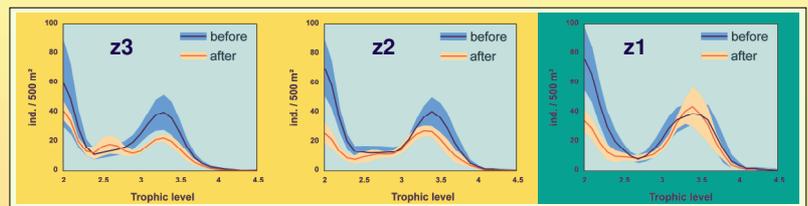


## 2 Searching for fishing effects on the trophic signatures in a marine protected area (MPA)

Aboré Reef is a **MPA** located on the barrier reef of the SW lagoon. In 1993, two reef sections (z2 & z3) were opened to fishing. Fishing effect was investigated using a **BACI** approach (Before-After-Control-Impact).



The fished zones experienced a **decrease in abundance of all trophic levels** 2 years after exploitation started. In the same time, abundance of predators of mobile invertebrates (TL ranked from 3.2 to 3.6) did not change in the protected section, reflecting a **"MPA effect"**.



Abundance trophic spectra provide easy-understood pictures of the trophic structure of coral reef fish assemblages in the SW lagoon.

They define consistent habitat-related trophic signatures reflecting food web characteristics of the underlying biocenose.

They allow to summarise the trophic structure of highly diversified assemblages, and may be able to detect disturbance effects on the fish community structure.

For these reasons they are potential candidates for community-based indicators on coral reefs.



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