Evidence of chronic trawling disturbance on bentho-demersal communities: insights from taxonomic and functional diversity

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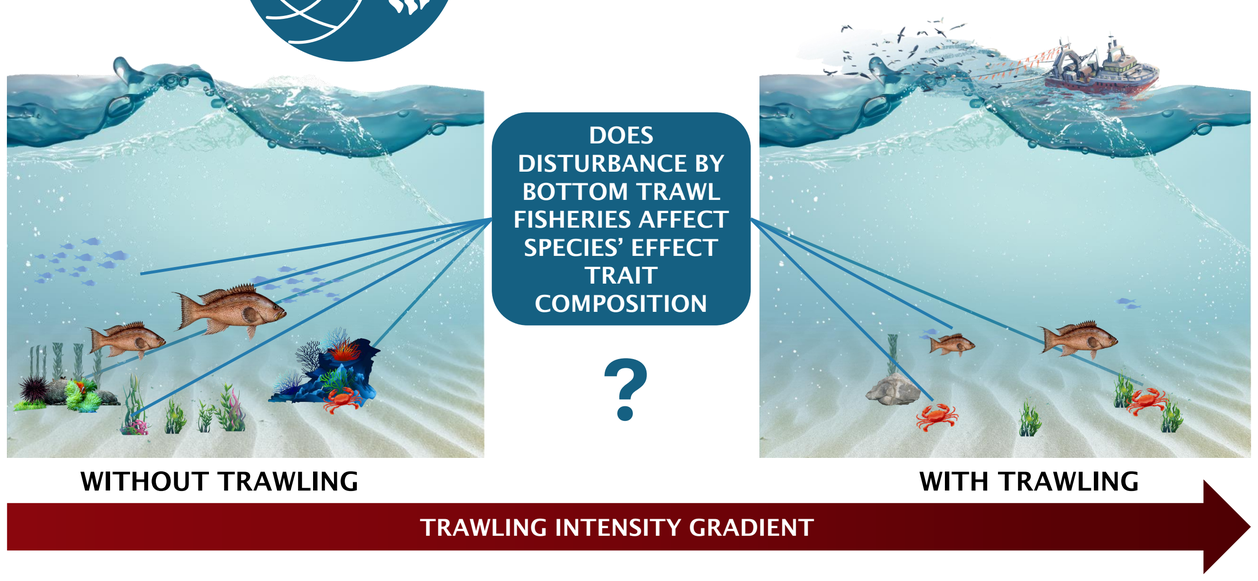
FRAMEWORK

Trawling is a widespread fishing activity, particularly on continental shelves, with **significant impacts on benthic communities**. It alters sediment composition and reduces species abundance, particularly affecting long-lived species with key ecological roles**. Chronic trawling shifts community structure**, favoring opportunistic species while harming others like suspension-feeders.

To fully understand these effects, ecosystem-based approaches are essential, including **trait-based analysis (TBA)**, which focuses on the functional roles of organisms. This study investigates **fishing disturbance impacts on bentho-demersal assemblages** between Sicily and Malta, utilizing both **taxonomic and functional traits** to analyze community responses to trawling and natural disturbances.



METHODS

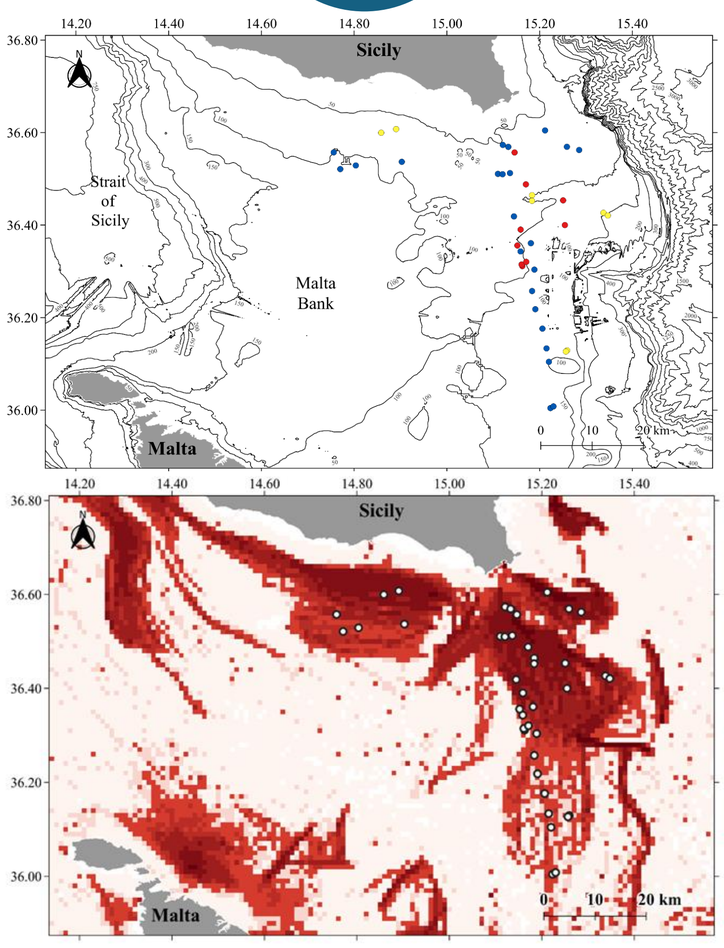


Figure 1 Fishing intensity raster map expressed as **Swept Area Ratio (SAR)** of the study area obtained from analysis of Global Fishing Watch AIS data. Dots represents hauls sampled during the surveys.

The study area encompasses the continental shelf between Malta and Sicily, part of the Malta bank, featuring sandy and muddy sediments and moderate to strong currents. Fishing surveys from 2019 to 2022 were conducted using otter trawlers to assess the impact of trawling on bentho-demersal communities.

Data on fishing intensity and environmental variables were collected and analyzed using **taxonomic** and **functional diversity indices**, with statistical models evaluating the effects of trawling and natural factors on community composition and structure.

Variables accounted:

- Fishing intensity (SAR; years) from Automatic Identification System (AIS) data
- Bathymetry (m)
- Bottom temperature (°C)
- Bottom dissolved oxygen (mmol/L)
- Chlorophyll-a concentration at the sea bottom (mg/m^3)
- Seabed shear stress due to the currents (N/m^2)
- Seabed slope (°C)

Taxonomic response indices:

- Species abundance
- Species richness
- Shannon-Wiener's index
- Simpson's index
- Pielou's evenness

Functional response indices:

- Community weighted-mean
- Functional richness
- Functional evenness
- Functional divergence
- Functional dispersion
- Rao'sindex

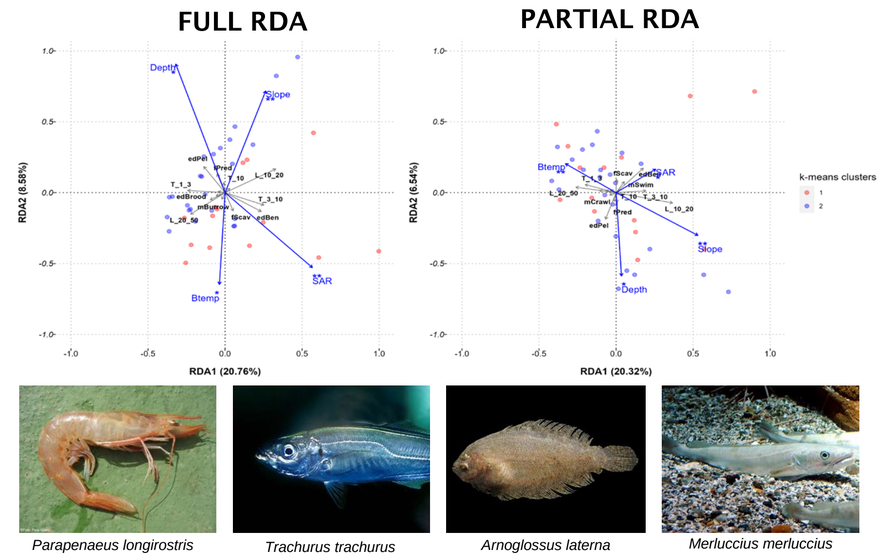
Diversity indices → Univariate approach (linear regression)

Abundance composition → Multivariate approach (redundancy analysis)

SCAN ME

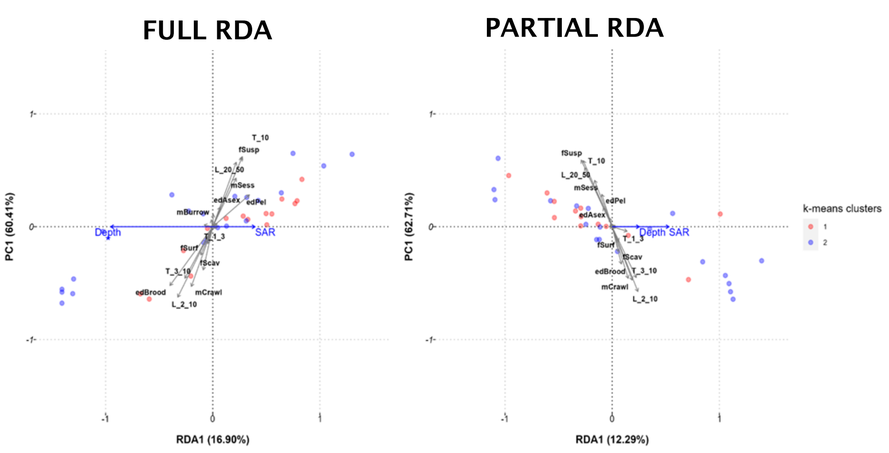
RESULTS

- **Fishing intensity showed a gradient from the coastline to offshore, with higher concentrations along the eastern continental shelf** with high trawling pressure (SAR from 0.36 to 37.37, averaging 9.86 ± 7.60 S.D.).
- Depth and fishing intensity were significantly correlated, with depth increasing and fishing intensity decreasing towards the south.
- **Fishing intensity negatively affected demersal biomass.**
- **Bottom temperature positively influenced both demersal and benthic densities.**
- Taxonomic diversity is higher for demersal component while functional diversity is higher for the benthic component.
- Taxonomic diversity was primarily influenced by chlorophyll-a concentration, while functional diversity was poorly influenced by bottom temperature, chlorophyll-a and shear stress.



Dominance (traits):
- **Size**: 10-20cm
- **Longevity**: 3-10 years
- **Egg development**: pelagic eggs
- **Mobility**: Swimming
- **Feeding mode**: Predators

Figure 2 & 3 Ordination of demersal (up) and benthic (down) CWMs of each traits modalities along the two main axes of Redundancy Analysis (RDA) triplot. RDA triplot of the model accounting stewpwise selected variables (Full RDA) and partial RDA accounting spatial coordinates (LAT and LONG) as conditioning factor.



Dominance (traits):
- **Size**: 2-10 cm
- **Longevity**: 3-10 years
- **Egg development**: pelagic eggs/brooding
- **Mobility**: Crawling/Sessile
- **Feeding mode**: Scavenger/Suspension feeder

Colored dots represent the clusters obtained from a k-means classification according the variables associated to the hauls. Significance level of the p-value : * p<0.05, ** p<0.01, *** p<0.001.

KEY MESSAGES

Disturbance by bottom trawl fisheries leads to community homogenization, selecting for traits more compliant with trawling impacts.

The bentho-demersal community across a highly exploited fishing ground reflects both chronic fishing pressure and bathymetric variation.

Local coastal heterogeneity and fishing secondary effects (e.g. sediment resuspension, preys' availability) may create more niches for species enhancing diversity.

Alcyonium palmatum

Pennatula phosphorea

Munida rugosa

Premio tesi di Laurea

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