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Conference Abstract

Temporal variability in zooplankton community structure and functioning in the eLTER site Promontory of Portofino: 20 years of sampling and models

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Abstract

Zooplankton plays a crucial role in marine ecosystems by mediating trophic interactions, recycling nutrients, and attenuating carbon flux via the biological pump. Understanding zooplankton community structure and functioning is key to predicting ecosystem responses to environmental change and global carbon cycling.

The eLTER network provides long-term ecological data to disentangle natural variability from directional environmental change. Here we analysed a 20-year (2003-2022) time-series of zooplankton abundance and community composition data (Povero et al. 2024) from the pelagic compartment of the eLTER site Promontory of Portofino (eLTER-IT15-001-M), station Punta Faro (44° 17.750' N; 9° 13.050' E) (Fig. 1). Our analysis aimed to: 1) assess changes in zooplankton community composition over time, 2) identify common trends across taxonomic descriptors, and 3) investigate the influence of environmental variables.

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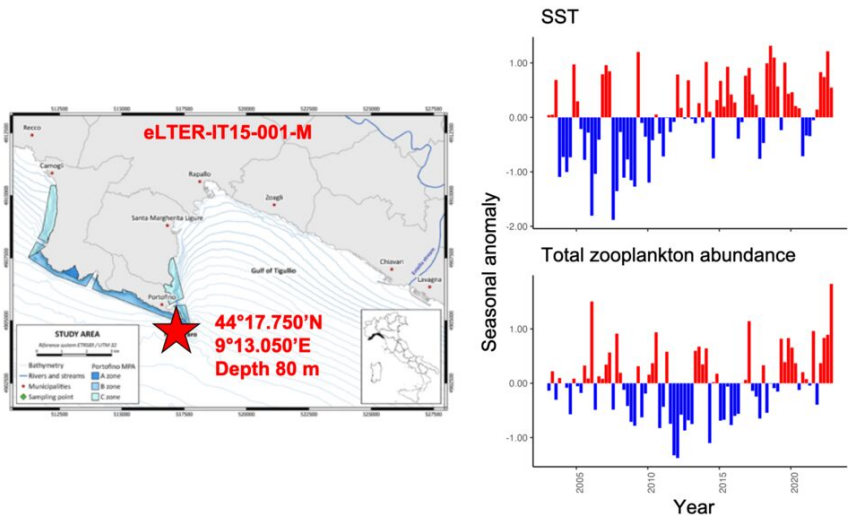

Figure 1. doi

Map of eLTER site Promontory of Portofino and bar charts of seasonal anomalies for Sea Surface Temperature (SST) and Total zooplankton abundance.

To explain observed patterns, we combined time-series analysis with two complementary modelling approaches. An Ecopath model was use to compare community structure and functioning between early (2003-2005) and later (2018-2019) periods (Vassallo et al. 2022). Stable isotope mixing models based on carbon isotope fingerprints of amino acids (Larsen et al. 2013) estimated the proportional contributions of distinct production sources (i.e., marine autotrophs, heterotrophic bacteria, and terrestrially-derived organic matter).

Our results revealed strong seasonal cycles and long-term changes in environmental variables, accompanied by shifts in zooplankton abundance and community composition. Total mesozooplankton and copepod abundance increased since 2019, particularly in summer and autumn (Fig. 1). Species richness increased from 2009, while the Simpson index declined, indicating a more even distribution of individuals across taxa. These trends were accompanied by increased contributions of carnivorous (*Corycaeus* spp.) and detritivorous (*Oncaea* spp.) copepods, other typically carnivorous groups (Chaetognatha), and gelatinous suspension-feeders (Thaliacea). In parallel, we observed decreased contributions of typically herbivorous (e.g., *Calocalanus styliremis*, *Euterpina acutifrons*, *Paracalanus nanus*, *Clausocalanus parapergens*) and small copepods (*Oithona. nana*), Appendicularia, and meroplankton. Zooplankton variability modestly correlated with environmental changes, including positive temperature seasonal anomalies since 2012 and increased oligotrophy.

Our findings suggest a transition from a herbivore-dominated food web towards a system increasingly supported by detrital and microbial processes. The Ecopath model indicated increased consumption on detritus and heterotrophs (Fig. 2; Vassallo et al. 2022). Isotope models estimated highest proportional contributions from marine autotrophs but increased contributions from microbial secondary production to summer zooplankton, especially bacterivores and detritivores (Fig. 2). Thus, while stability in the role of zooplankton of capturing newly fixed carbon and exporting it to depth is confirmed, at least at the study site, these shifts may reflect the ecosystem's capability to reorganise under changing environmental conditions, potentially at the cost of reduced energy transfer efficiency and higher metabolic demands.

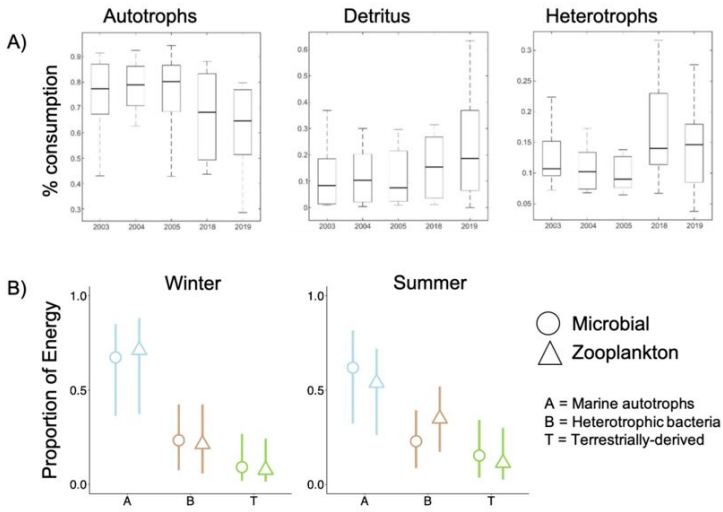

Figure 2. doi

A) Percent consumption on autotrophs, detritus and heterotrophs by zooplankton predicted by the Ecopath ecosystem model in years 2003-2005 and 2018-2019; B) Proportion of energy derived by marine autotrophs, heterotrophic bacteria, and terrestrially-derived organic matter in microbial and zooplankton mixture samples in summer and winter estimated by the isotope mixing model.

Keywords

Long-Term Ecological Research, Time-series, Zooplankton, ecosystem models, Ecopath, stable isotopes, fingerprinting

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Conflicts of interest

The authors have declared that no competing interests exist.

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