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Life history traits determine the shape and response to environmental conditions of a coastal community targeted by a Small-Scale Fishery

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The understanding and prediction of the structure of marine communities from the environmental conditions they experience is a crucial yet elusive question in marine ecology. However, trait-based approaches in several fields have helped to understand the mechanisms underlying community assembly. Small-Scale Fisheries (SSFs) usually target coastal communities where a variety of species compose the catch. We used time series of standardized abundance for ten finfish species caught by the coastal NW Spain SSFs during 1999–2013 to test whether life history traits (LHTs) can explain community responses to environmental fluctuations. Time series were ordered using a principal component analysis. Species with smaller L-infinity and higher growth rate coefficient tended to have the highest relationship with the main trend found for the community. Moreover, those species were on average more variable and showed a stronger positive association with sea surface temperature over the preceding year. These results concur with ecological theory providing evidence that species with contrasting life histories perform differently to environmental conditions in an exploited fish community. This study provides support to the fact that on board collection of data helps to understand fish assemblage variation in SSFs.

Introduction

Small-scale fisheries (SSFs) are usually under-attended despite being a large contributor to global catches, and of relevance for local economies and society. SSFs usually target coastal fish communities that are subjected to a variety of human impacts (contamination, habitat degradation, fishing effort) and affected by multiple local environmental changes. It has been suggested that life history correlates with species' response to heterogeneous human impacts (Ferreti at al. 2013) due to differences in vulnerability (Jennings et al. 1999). Life histories with shorter reproductive lifespans lead to greater instability in population size (Jennings et al. 1998). So, predicting vulnerability and likely responses to exploitation and abiotic processes is of interest for conservationists and fishery managers. The objective of this study was to investigate the degree of importance of life history traits on the fate of several species' abundance targeted by a SSF and their relationship with environmental conditions.

Material and Methods

Biological data: Sampling was undertaken off the Galician coast (NW Spain), between the mouth of the Eo River (43° 32′ N to 7°01′W) and the Miño River estuary (41° 50′ N to 9°40′W), comprising ICES Divisions IXa and VIIIc. LHTs data: species-specific information of L-infinity (Linf, cm) and K (1/y) were compiled from available literature from closest populations. Averages for these LHTs were computed when more than one parameter were available. Environmental data: data on sea surface temperature (SST, in °C) available at weekly 1° latitude × 1° longitude grid resolution were obtained from the NOAA Earth System Research Laboratory (http://www.esrl.noaa.gov/psd/). Upwelling intensity (-QX, in m3/s·km) was computed in a 2° × 2° cell centered at 43°N, 11°W and data were obtained from http://www.indicedeafloramiento.ieo.es/.
Time series of standardized catch and effort data for ten finfish species during 1999–2013 (Otero et al. 2015) were pooled to obtain trend and coefficient of variation for each species' index of abundance.

Principal Component Analysis (PCA) was applied to the matrix of indices in order to reduce dimensions in the data set and infer potential clustering among the species' abundances. Each abundance index was correlated with an annual one-year lagged time series of Qx and SST. Finally, all this information characterized individually each index of abundance and was correlated with the matrix of life history traits using ordinary least squares and standardized major axis (SMA) regression. All analyses and treatment of data were performed using R.

Results and Discussion

We did not found a clear association between the species' time trends and coefficient of variation with the life history traits, however, species with larger L-infinity and slower growth rates tended to be less variable. In addition, species with larger positive loadings on the first PC had smaller L-infinity and larger growth rates. Finally, no clear pattern was found between traits and response to upwelling strength, however, species that had higher positive association with one-yr lagged SST tended to have smaller L-infinity (Fig. 1) and larger growth rates.

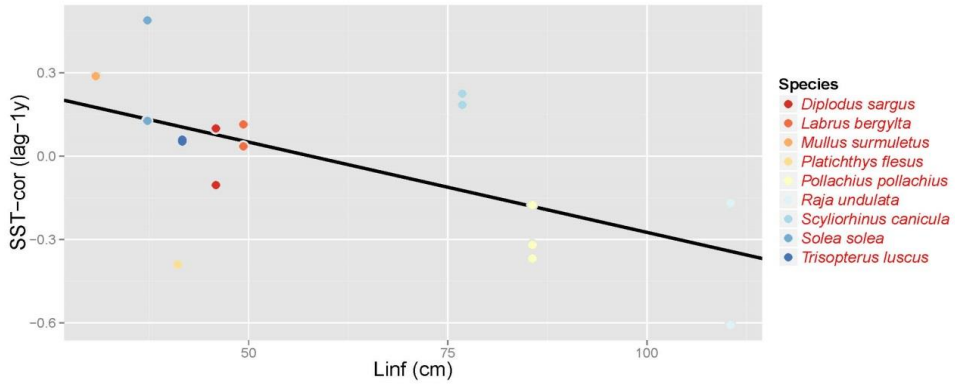

Figure 1. Relationships of sea surface temperature index correlations with species life history traits Linf.

Life history characteristics might be a mechanism for explaining community assembly and responses to environmental conditions, and theory predicts that life histories determine species' response to exploitation (Jennings et al. 1998; Levin et al. 2006). Preliminary results presented here concur with ecological theory and observations. We found that species with smaller life span seemed to cluster together and had stronger relationship with temperature. Thus, the present study suggest that both environmental factors, temperature-driven, and LHTs play a significant role in stock dynamic of exploited populations (Juan-Jordá et al. 2015), even at a local scale in coastal fish communities.

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