Marine fish traits follow fast-slow continuum along coastal-offshore gradient

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Marine fish traits follow environmental gradients across European seas

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Introduction

One of the major goals in biogeography is describing and understanding species distributions. However, when focusing on species-environment relationships, one may miss the mechanistic understanding of what underlies these distributions. Therefore, trait-environment relationships are useful in explaining where species occur, since traits determine which environment a species can inhabit[1]. In this study, we apply this trait-based approach to Europe's marine fish communities.

Aims of this study

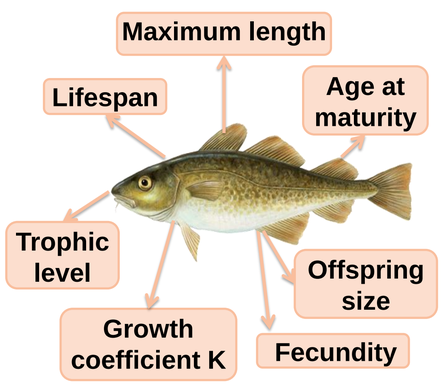
1) To identify key traits for marine fish that explain fish species distributions;
2) To identify the most important relationships between marine fish traits and the environment.

Data

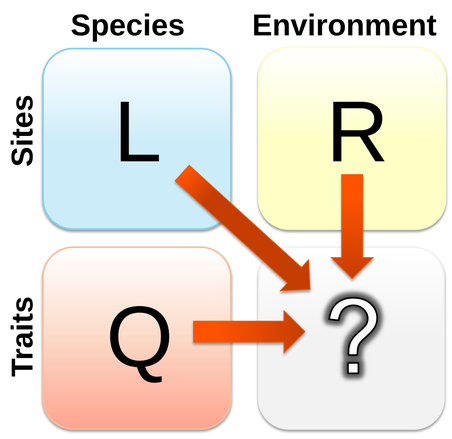
SITES & SPECIES:
~2200 sampling sites and ~250 species from scientific surveys done in the contintental shelf seas of Europe (combination of publicly available and institutional data).

ENVIRONMENT: depth, temperature, salinity, Chlorophyll (Chl) concentration, seasonal variability in temperature and monthly variability in Chl-concentration (NOAA; GlobColour).

TRAITS: 7 quantitative traits



Methods



- **RLQ analysis[2]**

Multivariate ordination approach combining all three datasets (R, L and Q). Gives a score to all data onto the same ordination axes.

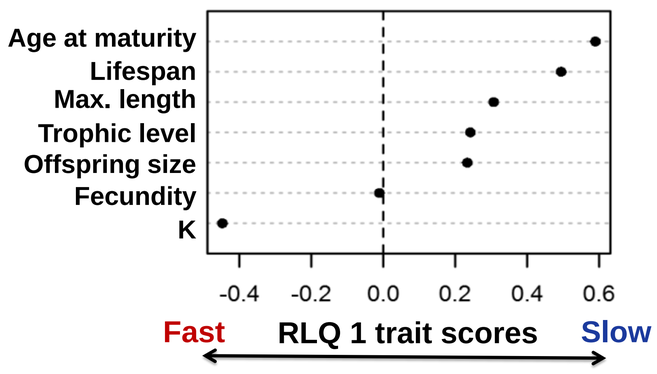
- **Fourth-corner analysis[2]**

Makes use of species distributions when testing for correlations between traits and environmental variables.

Results

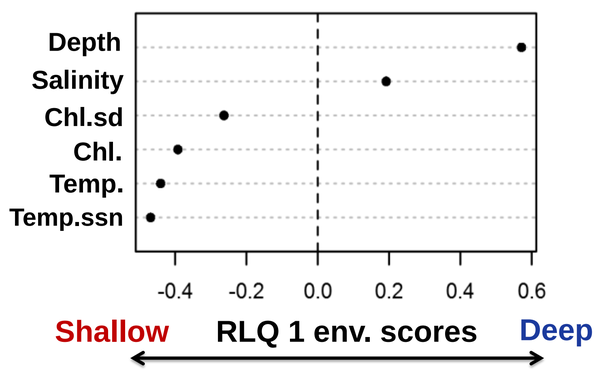
TRAITS

The first axis of the **RLQ analysis** (RLQ 1) explained 95% of the variation. In terms of traits, RLQ 1 represents a **fast-slow continuum**, mainly characterized by age at maturity, lifespan and the growth coefficient K.



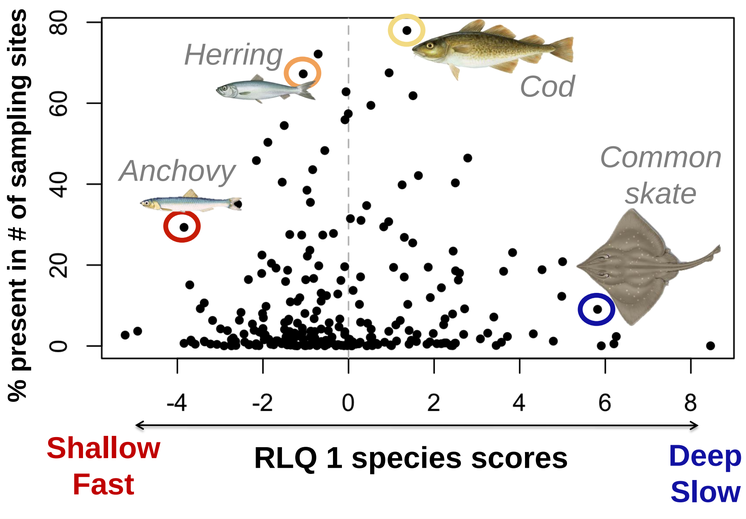
ENVIRONMENT

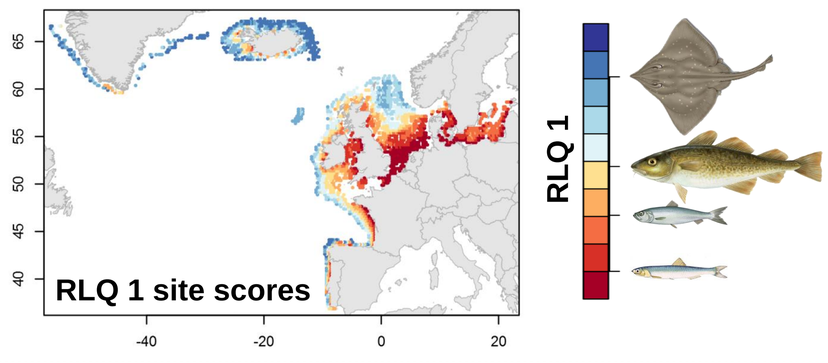
RLQ 1 represents a **depth gradient**, along which also vary: temperature (Temp.), seasonal variability in temperature (Temp.ssn), chlorophyll concentration (Chl) and seasonal variability in Chl (Chl.sd).



SPECIES

RLQ 1 identified **specialist species** having typical fast or slow life histories, e.g. anchovy and common skate. **Generalist species**, e.g. Atlantic cod and Atlantic herring, were not strongly characterized by RLQ 1 in terms of their traits and distribution. This indicates that the trait values they have allow them to inhabit a wide range of environments. Indeed, the most common species (i.e. that were present at most sampling sites) were generalist species, whereas typical specialist species were less abundant.

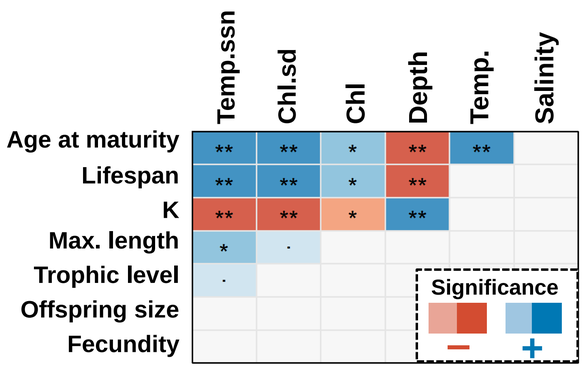




SAMPLING SITES

The RLQ 1 scores of the sampling sites follow a **coastal-to-offshore gradient**, thereby corresponding to the depth gradient that was found to be an important determinant for fish species distributions.

The **fourth-corner analysis** confirmed the importance of the three traits that characterize the fast-slow continuum as well as depth as an important environ-mental variable.The analysis also revealed significant relationships of the fast-slow traits with temperature and with the variability in temperature and Chl-concentration.



Conclusions

We demonstrated that marine fish species can be characterized according to their traits along a fast-slow continuum. Traits in particular related to growth and maturity are key for explaining fish species distributions. The trait continuum is strongly determined by a depth gradient. Along this gradient, other factors vary, such as temperature, productivity and seasonality, which help in explaining species distributions and the structure of marine fish communities.

References

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2. Dray, S. *et al.* Combining the fourth-corner and the RLQ methods for assessing trait responses to environmental variation. *Ecology* 95, 14–21 (2014).

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