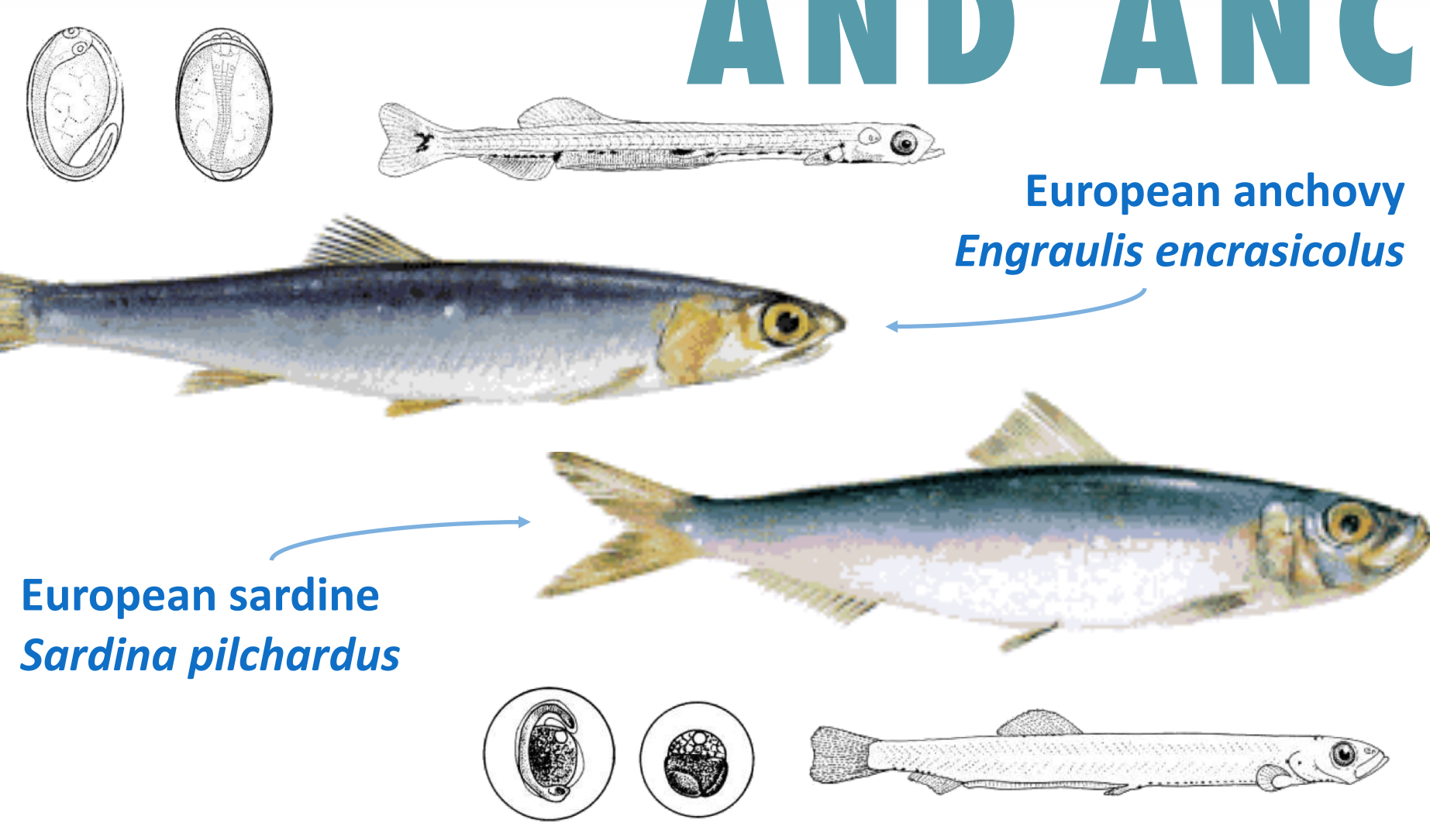


Review on

THE INFLUENCE OF ENVIRONMENTAL VARIABLES IN SARDINE AND ANCHOVY ECOLOGY IN THE MEDITERRANEAN SEA



OBJECTIVE

To **map** and **review** information of sardine and anchovy in the Mediterranean Sea and provide a general view of the most important **environmental factors** influencing their ecology.

Introduction

Small pelagic fish species such as sardine (*Sardina pilchardus*) and anchovy (*Engraulis encrasicolus*) are **essential elements** coupling the pelagic and the demersal environments¹. Their fluctuations modify the ecosystem structure and functioning.

In parallel with an overall increase of fishing effort, both species have experienced an increasing **overexploitation**².

Their populations are clearly influenced by **changes in the environment** by controlling food availability or influencing recruitment, growth and condition³. Their low position in the marine food web and a relatively short life-span, makes their populations strongly dependent on the environment, being excellent **bio-indicators of climate-driven changes**⁴.

Results & DISCUSSION

1. Scientific knowledge was more extensive for **anchovy** → 79,5% of the reports
2. **Adults** were the most studied life stage (59%), followed by juveniles, eggs and larvae
Life stages studied did not depend on the studied area, but there were differences between both species
3. Data was **heterogeneously distributed**:
 - i. Most studied areas were the Spanish coast, the Northern Adriatic and the Aegean Sea
 - ii. Information was scarce regarding the northern African waters
4. The preferred methods were **Generalized Additive Models** (58%), followed by correlation and regression analysis
The method used was not independent from the species and the life stage studied
5. Main dependent variables studied were **landings** and **catches** (28%), followed by abundance and presence
6. The dependent and the explanatory variables (Fig. 2) chosen did not depend on the species studied

Materials & Methods

- 🔍 Bibliographic search following the **PRISMA approach** (Fig. 1)
- 📄 Creation of a **database** with the information retrieved from the selected articles
- 📊 Testing of pair-wise potential dependences
 - ↳ **Crosstabulation** analysis and χ^2 test of independence
- 📈 Graphic **representation** of the effect of the selected variables for each Mediterranean area (Fig. 3)

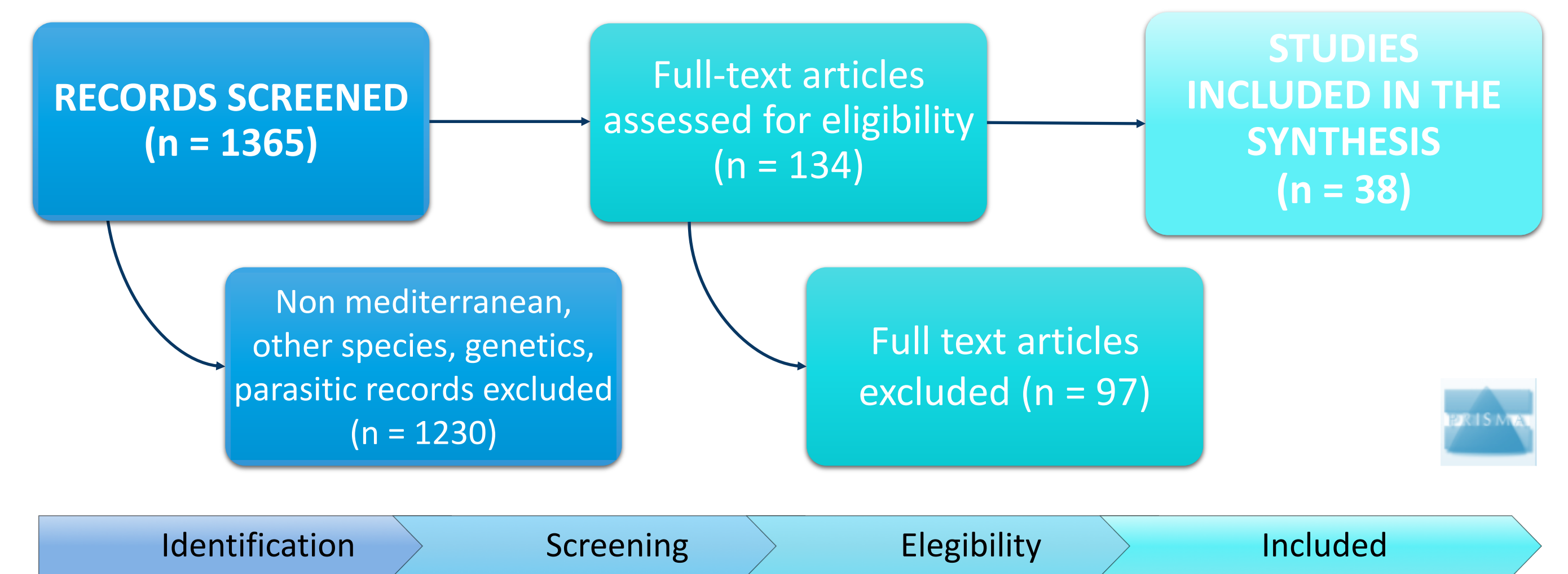


Figure 1. PRISMA flow diagram for literature search used in the systematic review.

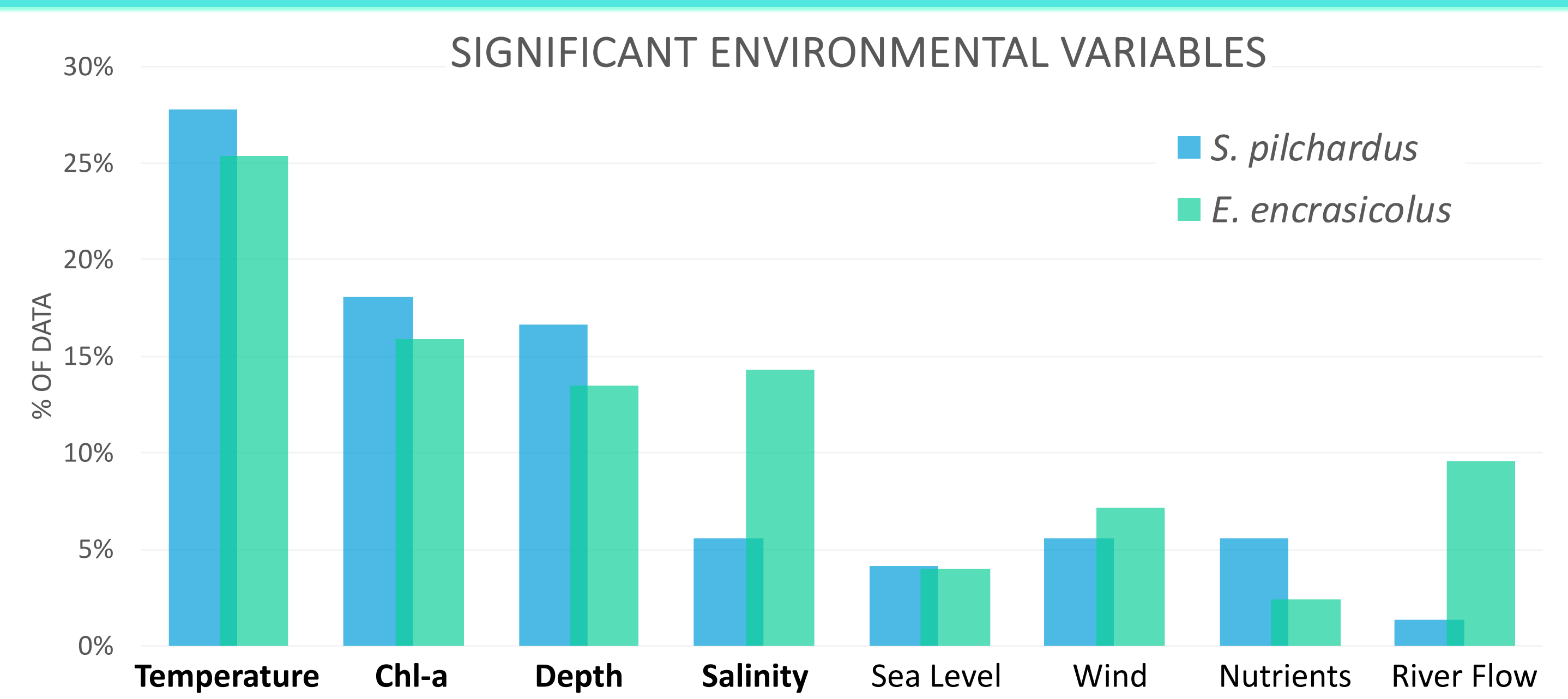


Figure 2. Explanatory variables significantly related to sardine and anchovy

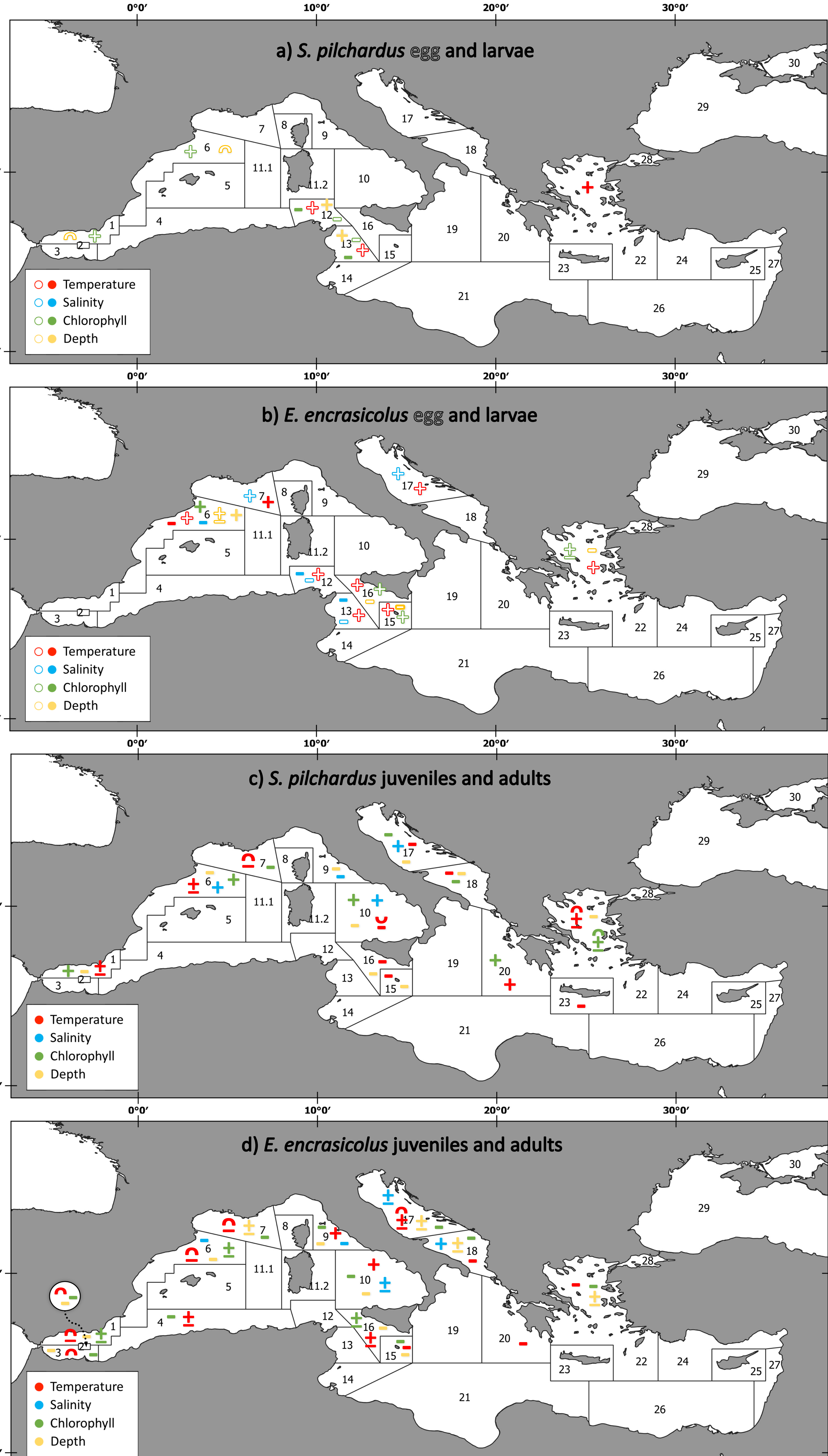
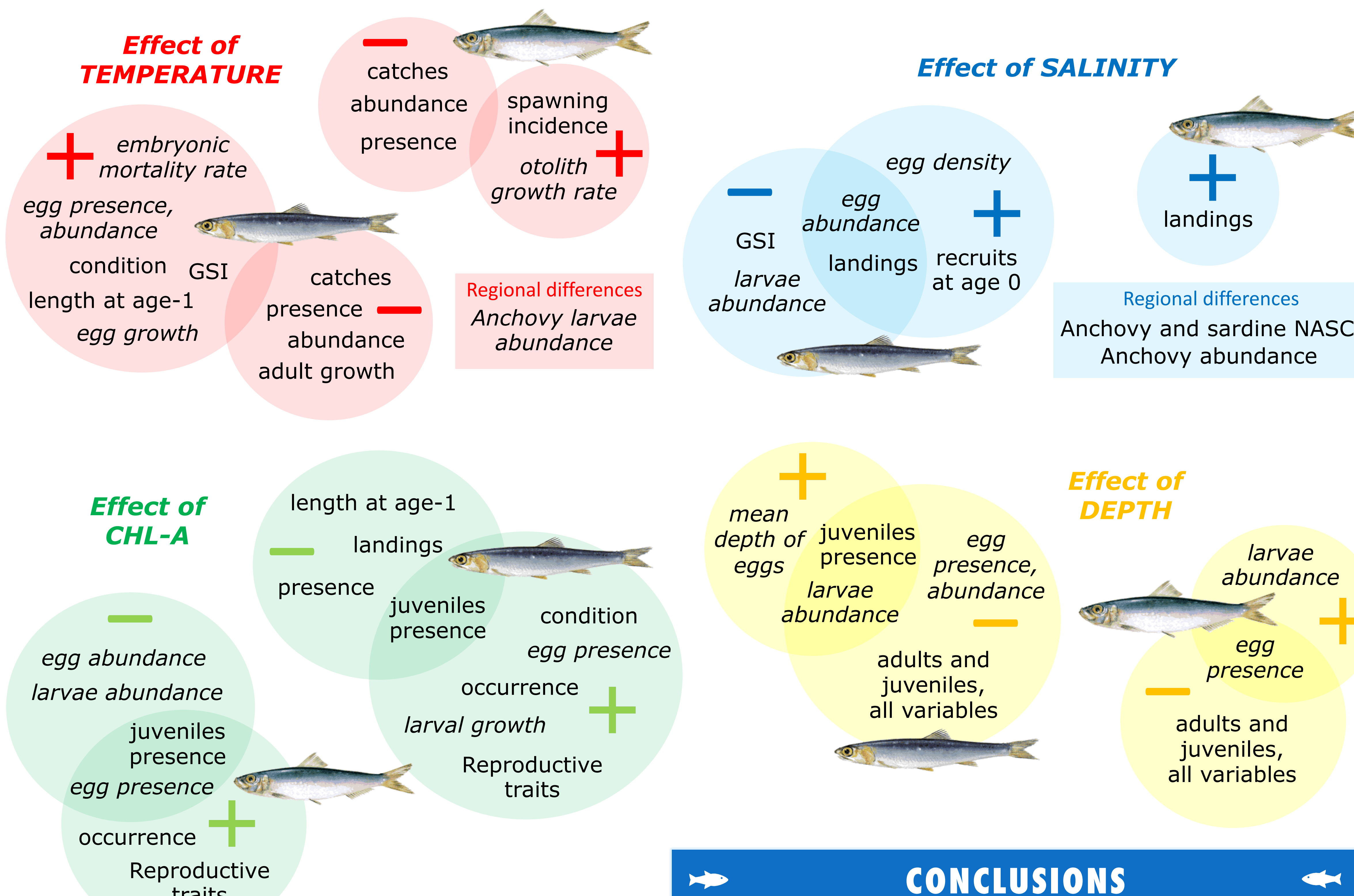


Figure 3. Representation of the environmental variables effect for each Mediterranean area (GSAs). Empty symbols in (a, b) for effect on eggs parameters, full symbols for larvae parameters.



CONCLUSIONS

FUTURE CONCERNS

1. Rising sea temperatures → **extended spawning seasons** that could result in an **overlapping** of both species.
2. Nutrient enrichment processes are slowed down → less primary production → fish **abundance decreases**.
3. **Regional differences** could be **accentuated** for anchovy larvae
4. Warmer waters at winter could enhance sardine larvae and juvenile growth, but if the optimum temperature is exceeded the effect will be negative.
5. Higher sea surface salinities could **benefit** sardine distribution in front of anchovies populations.

GAPS OF KNOWLEDGE

- **Lack of information** at the Eastern Mediterranean.
- More studies on the environment effect on **larvae and eggs** are needed, with particular attention on **sardine**.
- The effects of **sea level, wind, river flow** and **nutrients** were detected as significant, still few studies included them.
- Further **efforts needed** to make these results applicable to other areas of the Mediterranean.

Anchovy and sardine share their ecological niche but have different environmental requirements. With climate alterations and scarce resources, their populations could be **OVERLAPPED**

