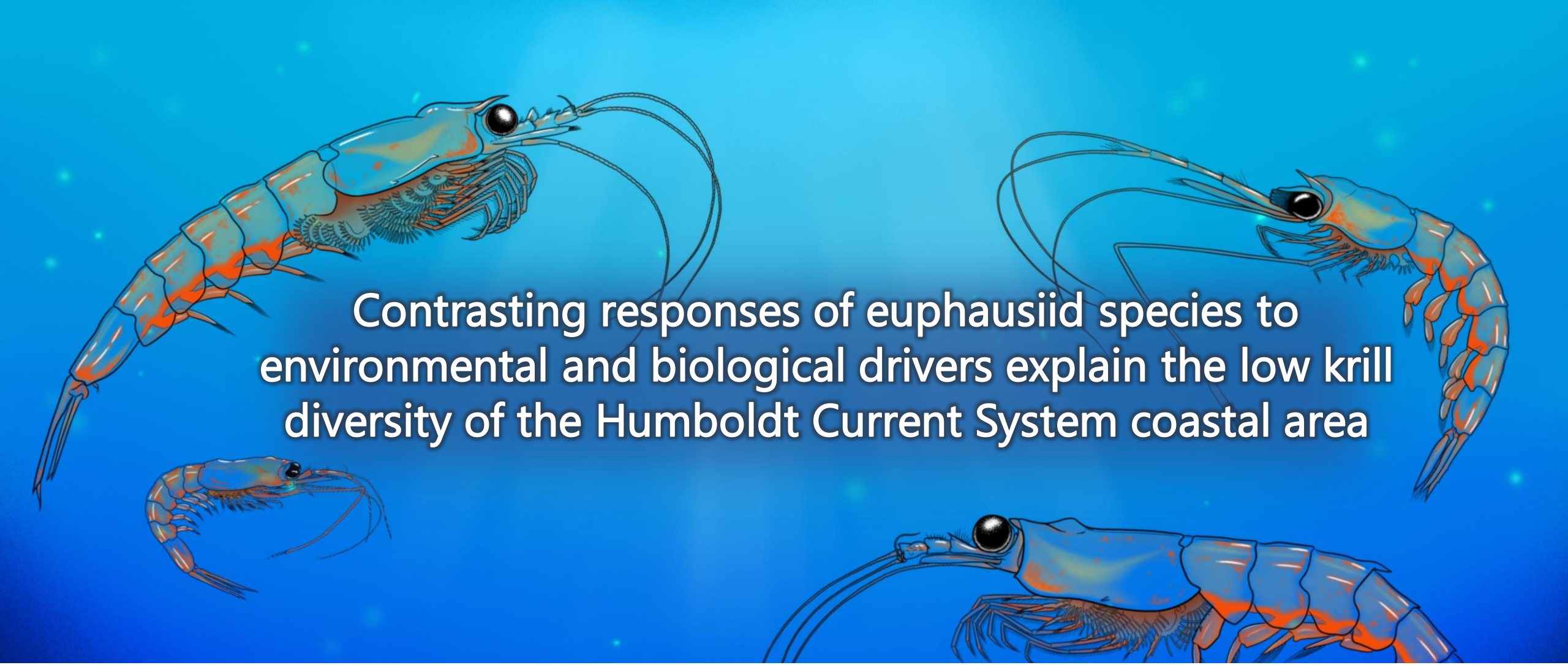


Contrasting responses of euphausiid species to environmental and biological drivers explain the low krill diversity of the Humboldt Current System coastal area

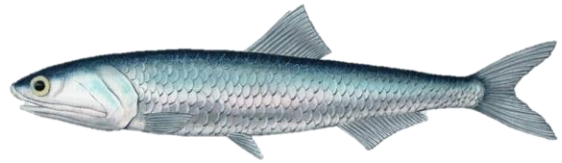
Macarena Díaz Astudillo, Ramiro Riquelme, Gonzalo Saldías, & Kim Bernard. 7th Zooplankton Production Symposium.

COPAS COASTAL
Centro de Investigación Oceanográfica en el Pacífico Sur-Oriental

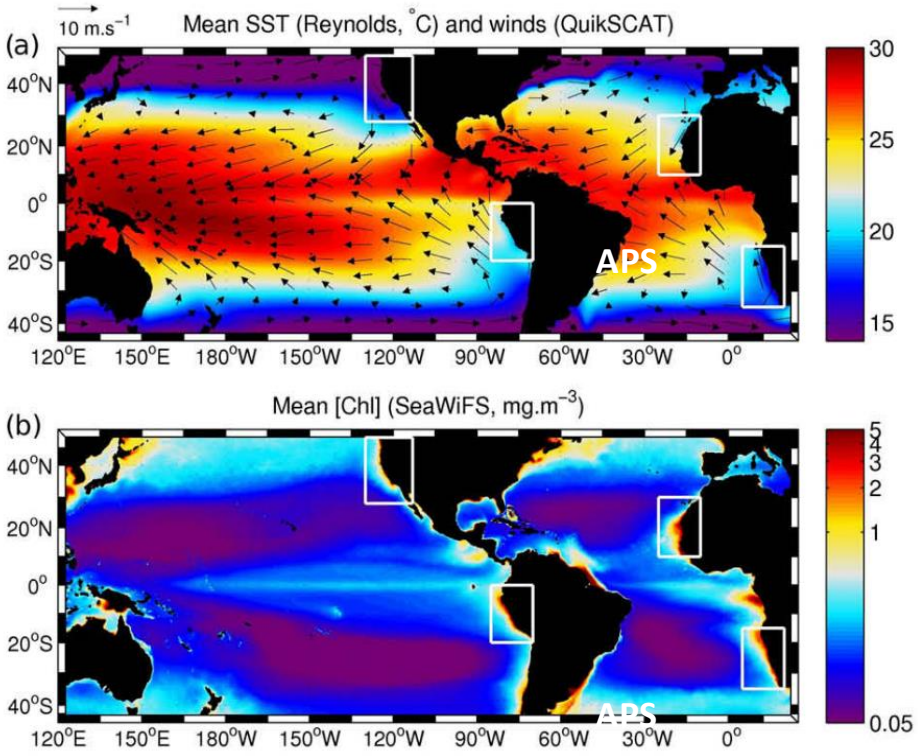
ICES-PICES 7th International Zooplankton Production Symposium
NEW HORIZONS
2021 2030 United Nations Decade of Ocean Science for Sustainable Development
17-22 March, 2024
Hobart, Tasmania
AUSTRALIA | #ZPS7

The Humboldt Current System

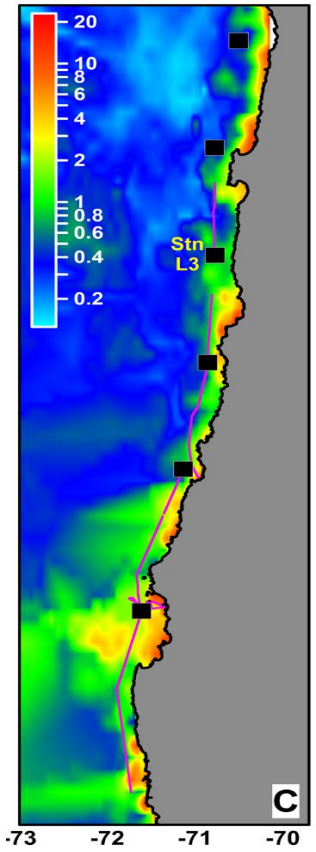
- Highly productive eastern boundary upwelling system (EBUS)
- Highest mono-specific fishery production wordlwide (Peruvian anchovy)
- Quasi-permanent oxygen minimum zone (OMZ)



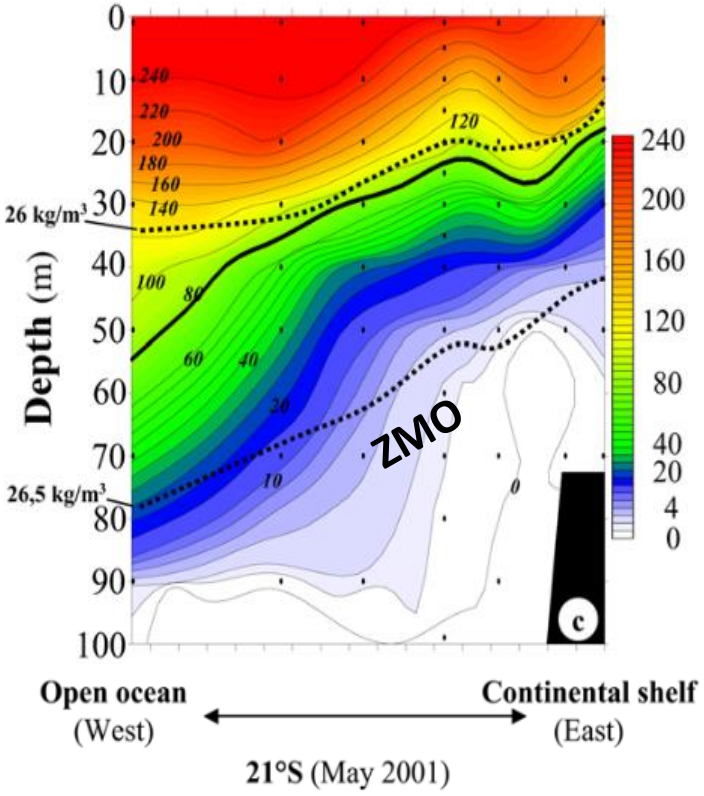
Engraulis ringens



Chávez & Messié 2009



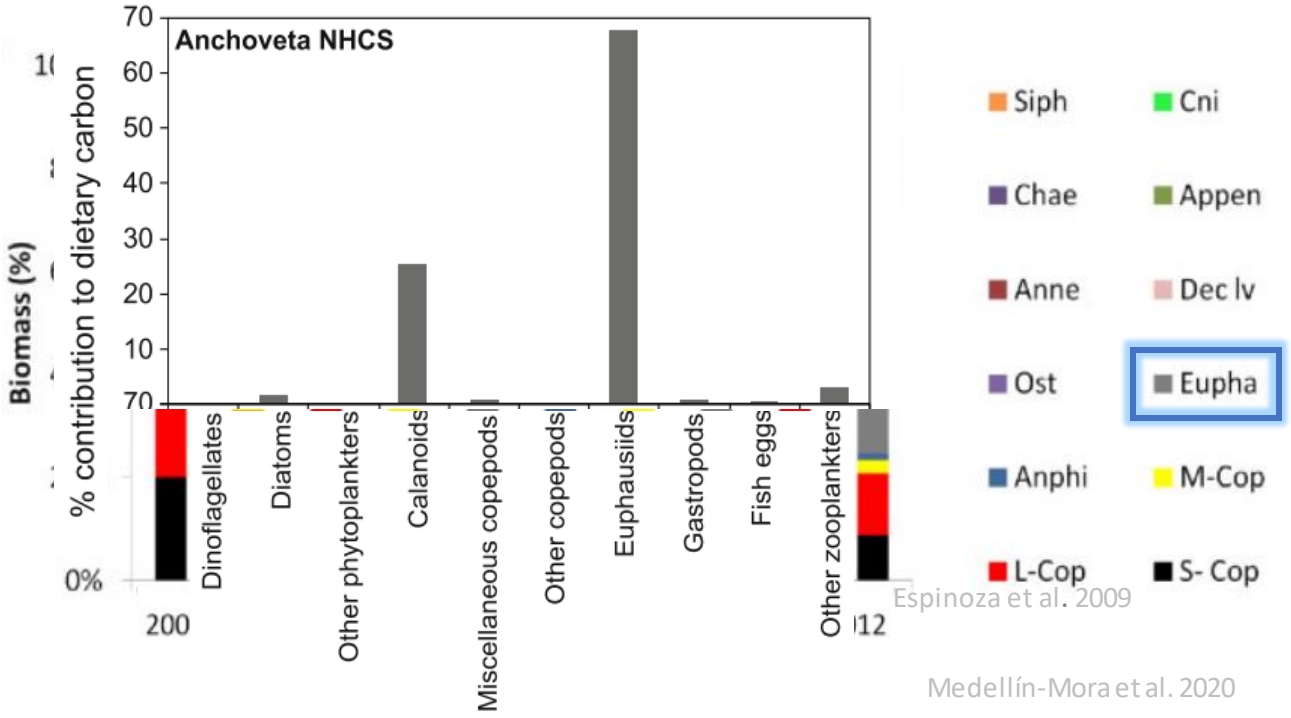
Riquelme-Bugueño et al. 2020



Paulmier et al. 2006

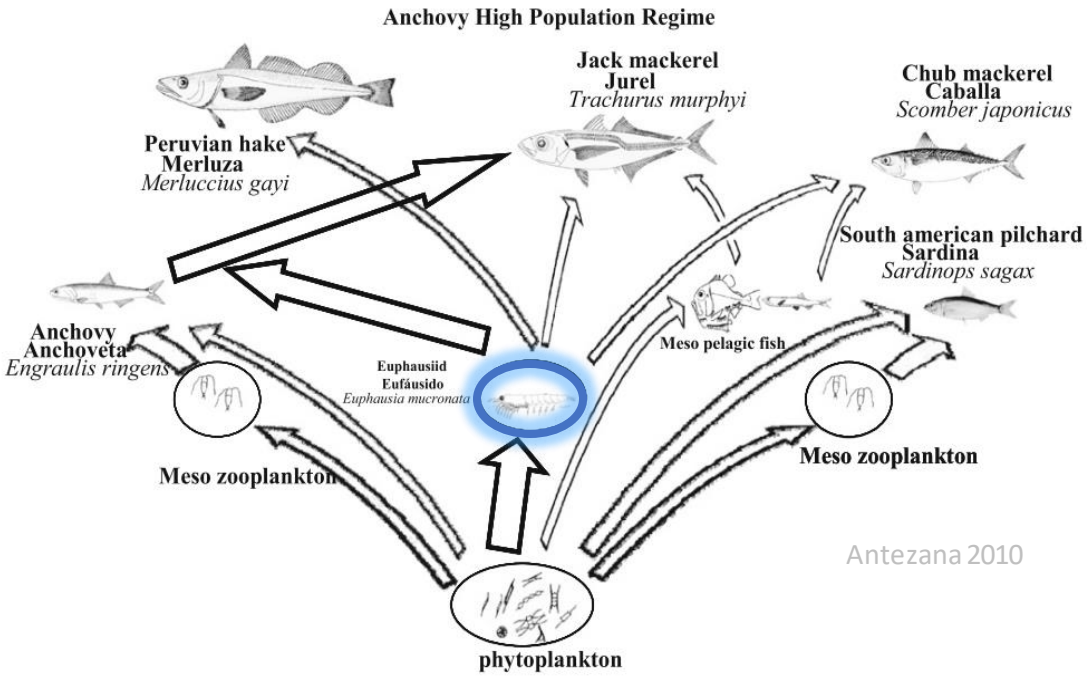
The role of krill in the HCS

- Significant contribution to total zooplankton biomass
- They are a key component of the food webs
- Many fisheries rely on krill



Espinoza et al. 2009

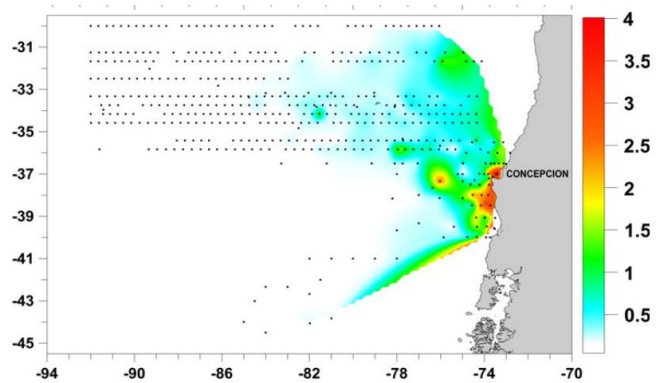
Medellín-Mora et al. 2020



Antezana 2010

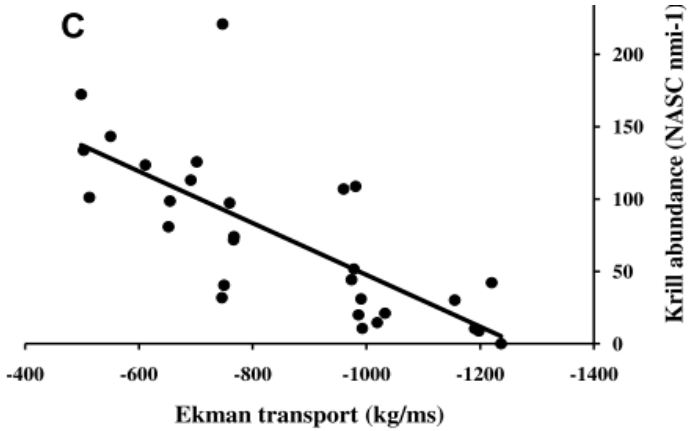
Main drivers of krill in EBUS

- Upwelling centers

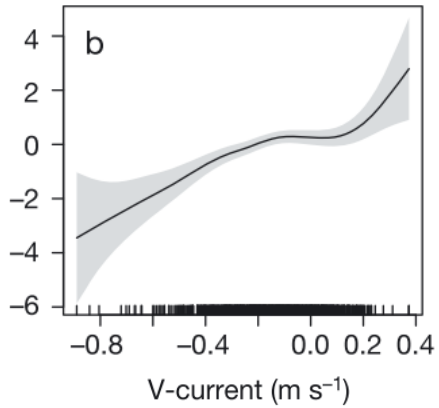


Riquelme-Bugueño et al. 2012, HCS

- Ekman transport

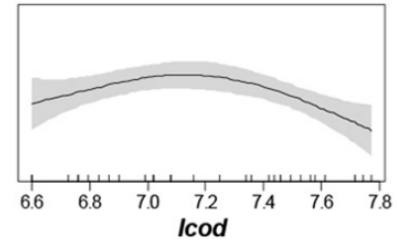


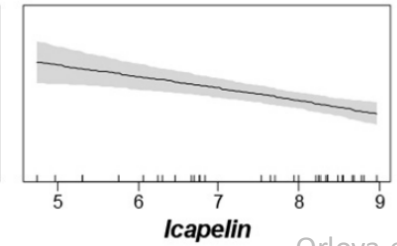
Santora et al. 2011, California Current System



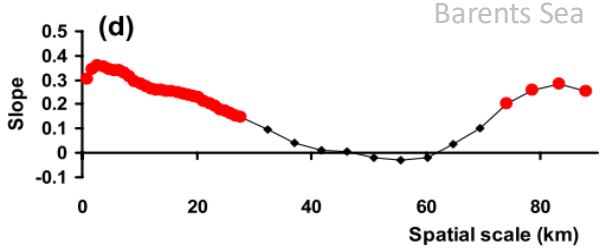
Dorman et al. 2015, CCS

- Temporal and spatial correlations with predators

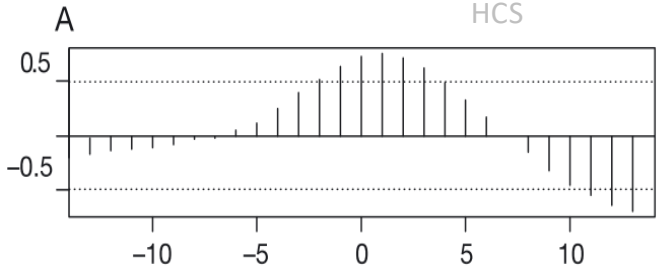




Orlova et al. 2015, Barents Sea



Bertrand et al. 2004, HCS



Ayón et al. 2011, HCS

Questions:

Up to this point, little was known about the composition and dynamics of krill communities in the highly productive, permanente-upwelling areas of the HCS (north of 30°S).

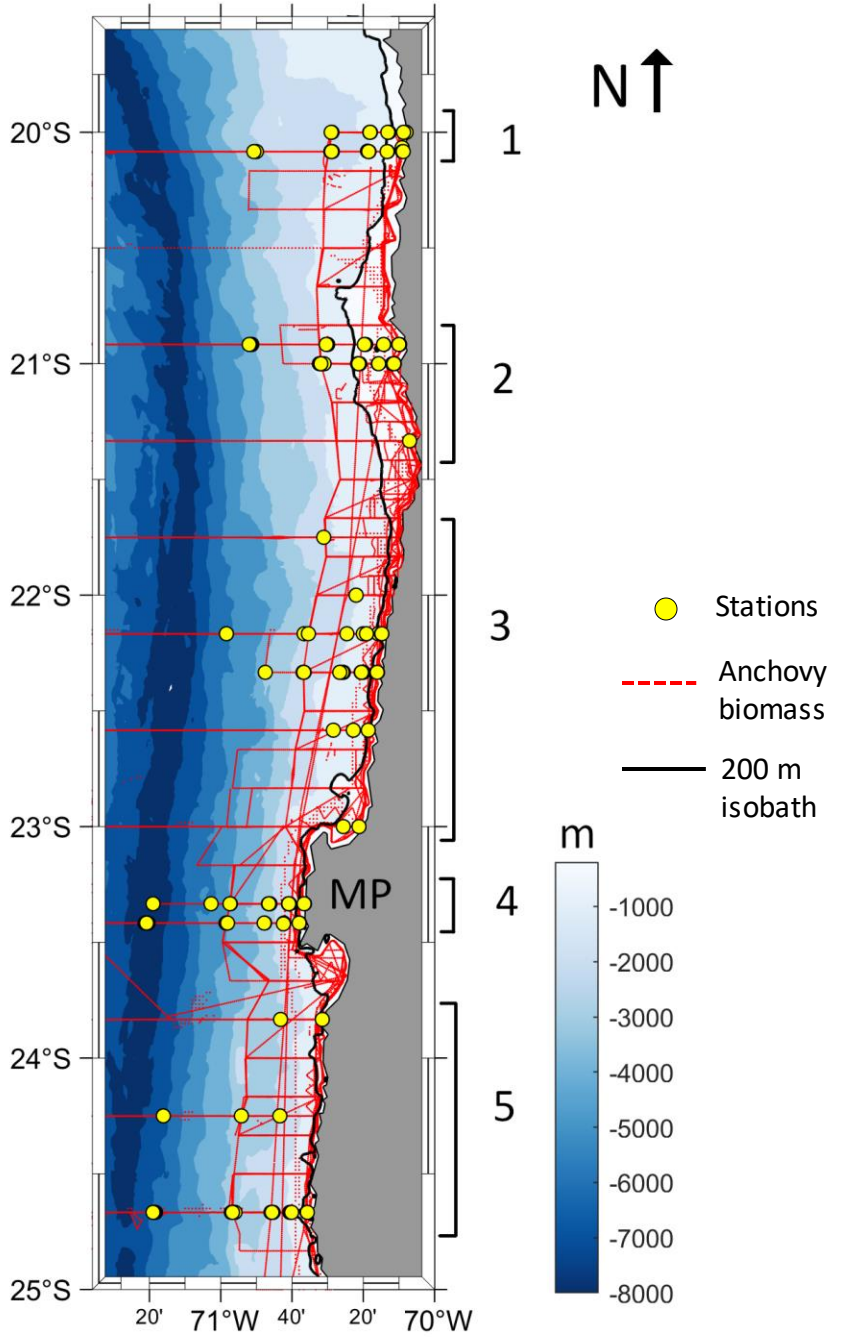
- How is the krill community of the permanent-upwelling area of the HCS composed?

- What are the main drivers of species distribution and abundance?

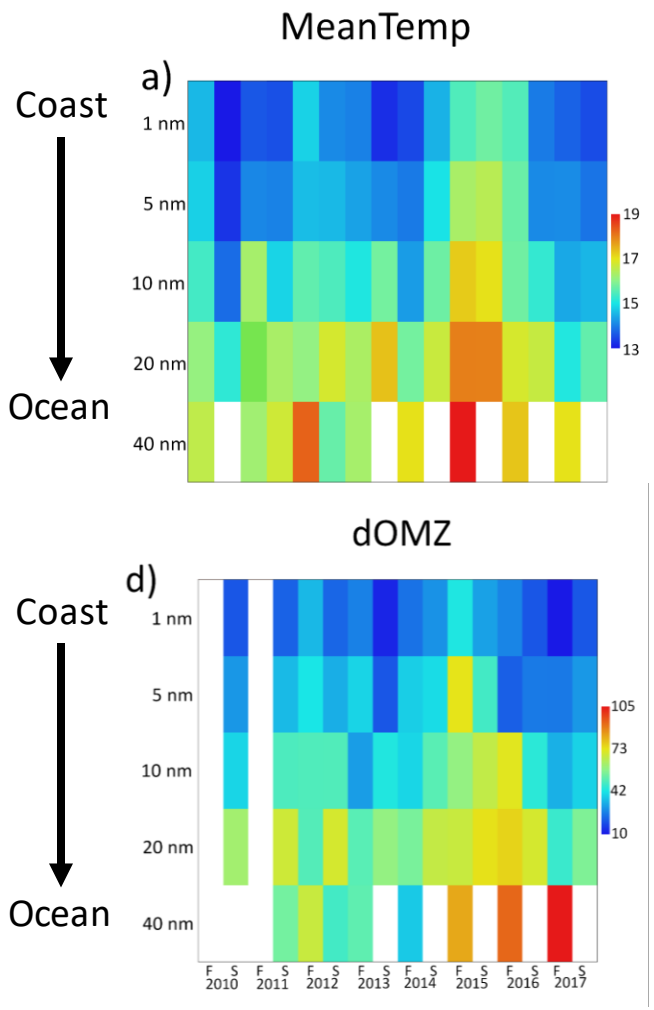
Study design

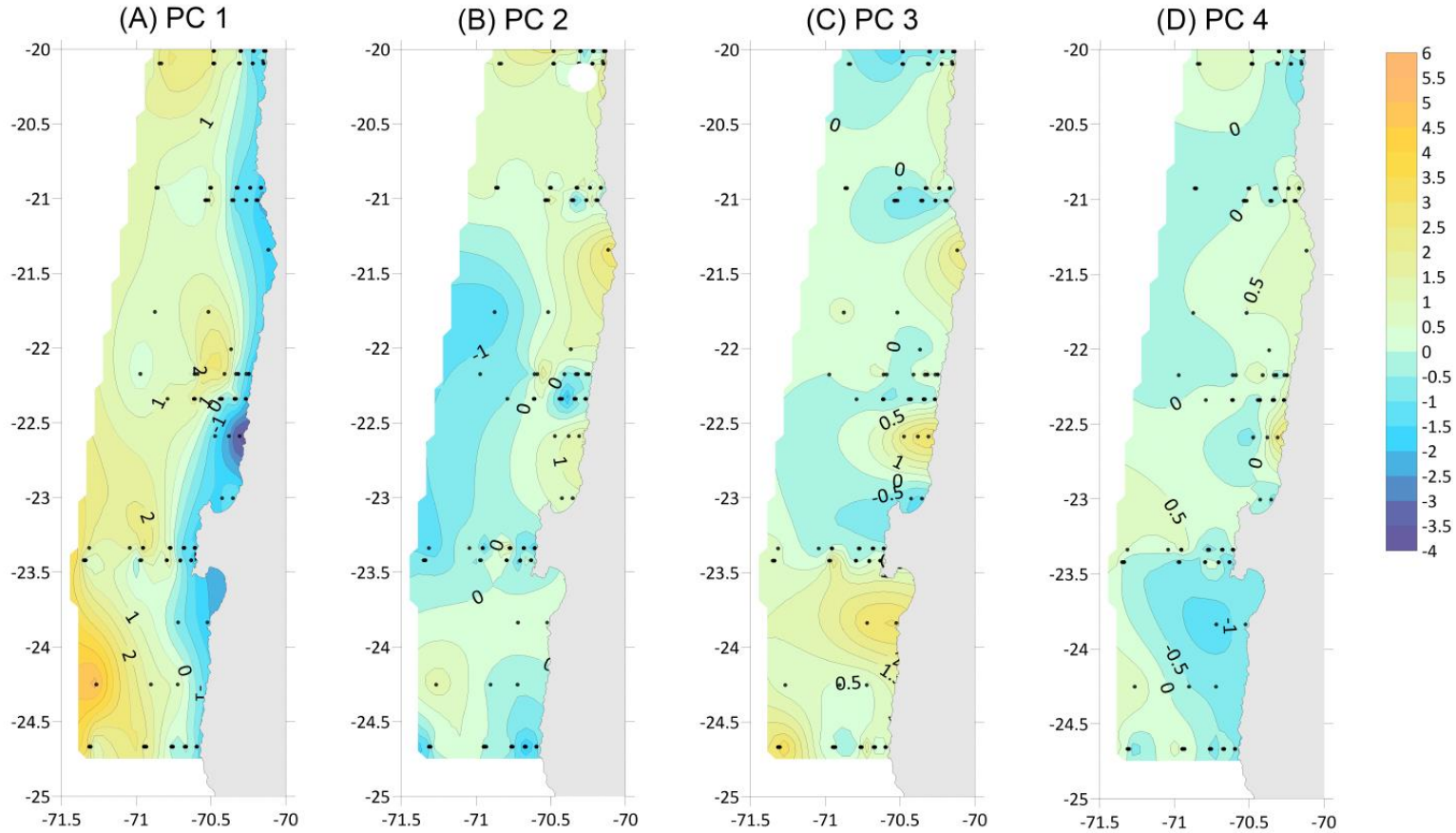
- Study area: northern Chile, permanent upwelling
- 16 bianual cruises
- Night zooplankton samples (100 m deep) with Bongo nets
- CTD-O casts
- Anchovy acoustic biomass (NASC) from EK-60 echosounder
- Satellite temperature (SST), Chl-a (SSC) and winds

Species composition
Diversity índices
dbRDA
Hierarchical GAMs



Environmental setting

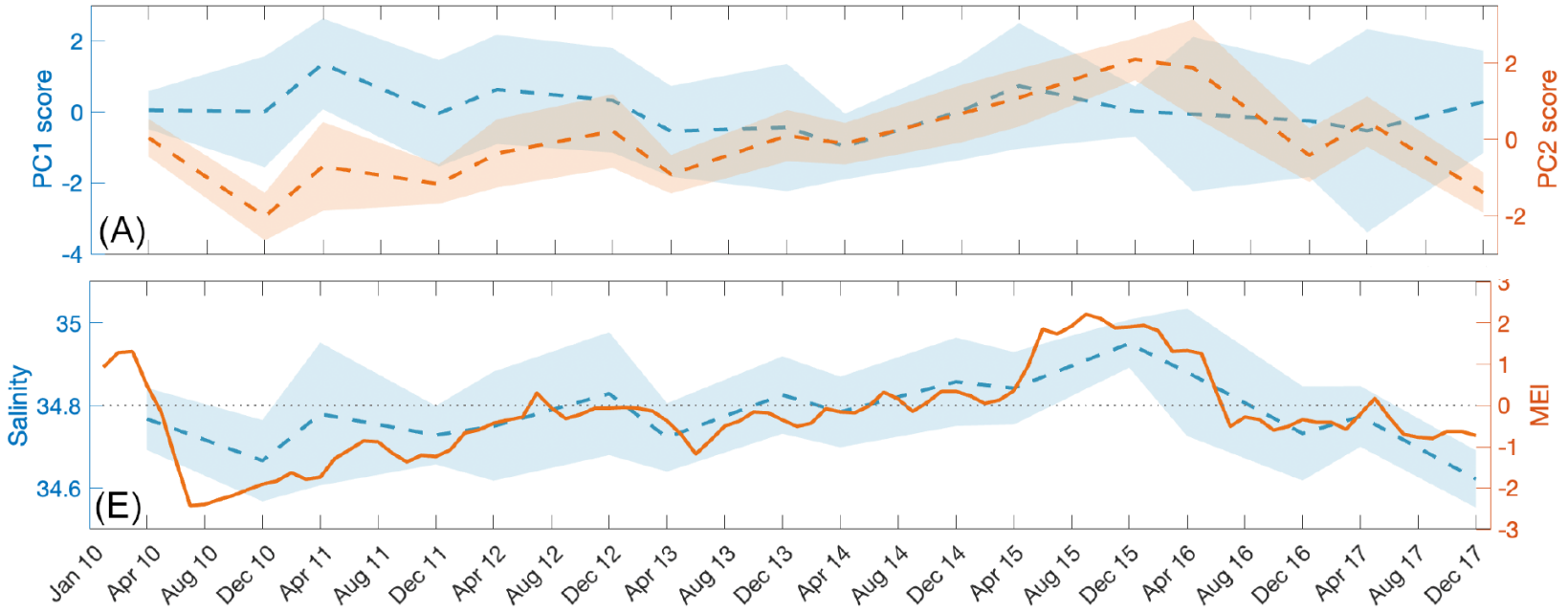




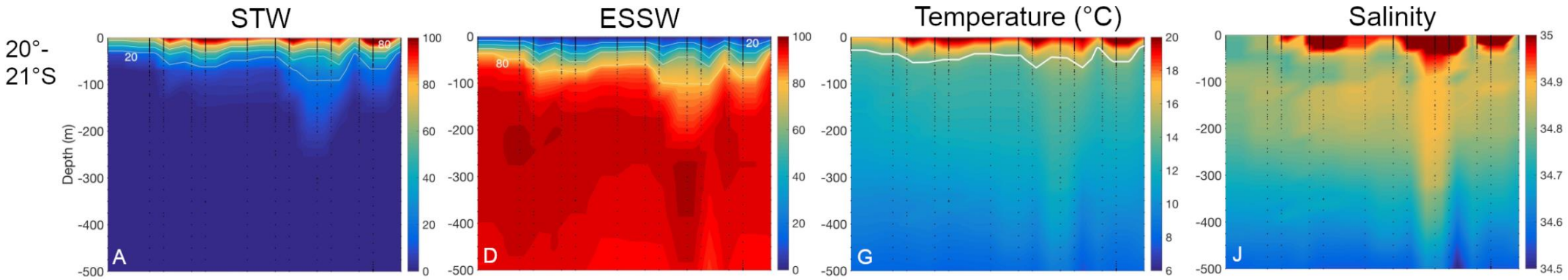
PC1 = 34%

Dissolved oxygen not shown because of high correlation with the depth of the OMZ

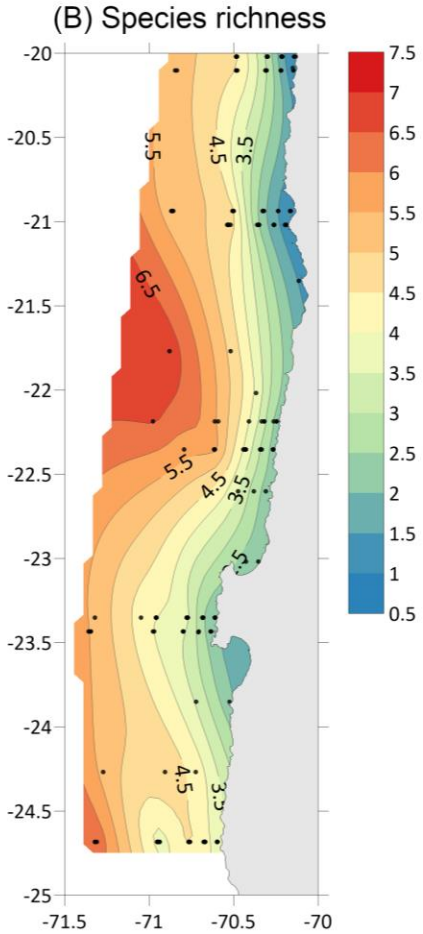
Environmental setting

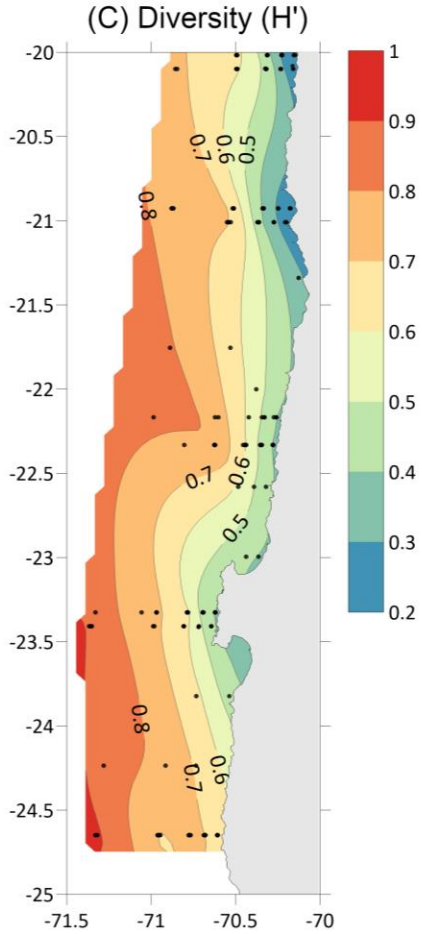


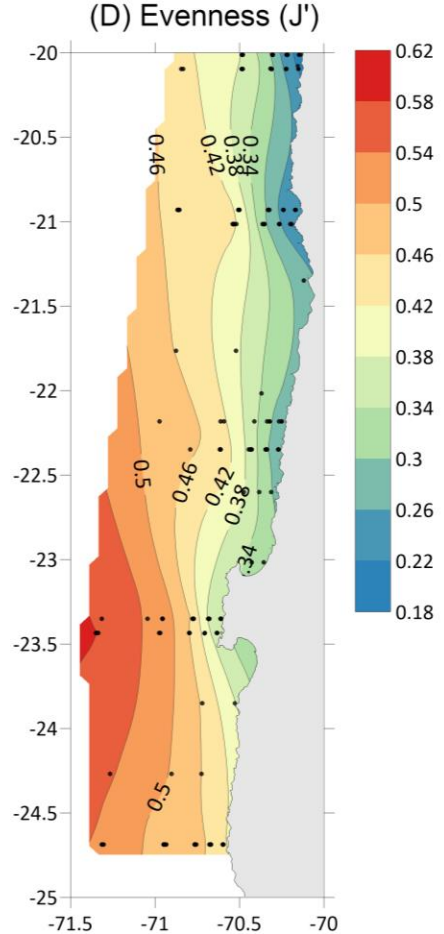
PC2 = 24%



Diversity and community composition







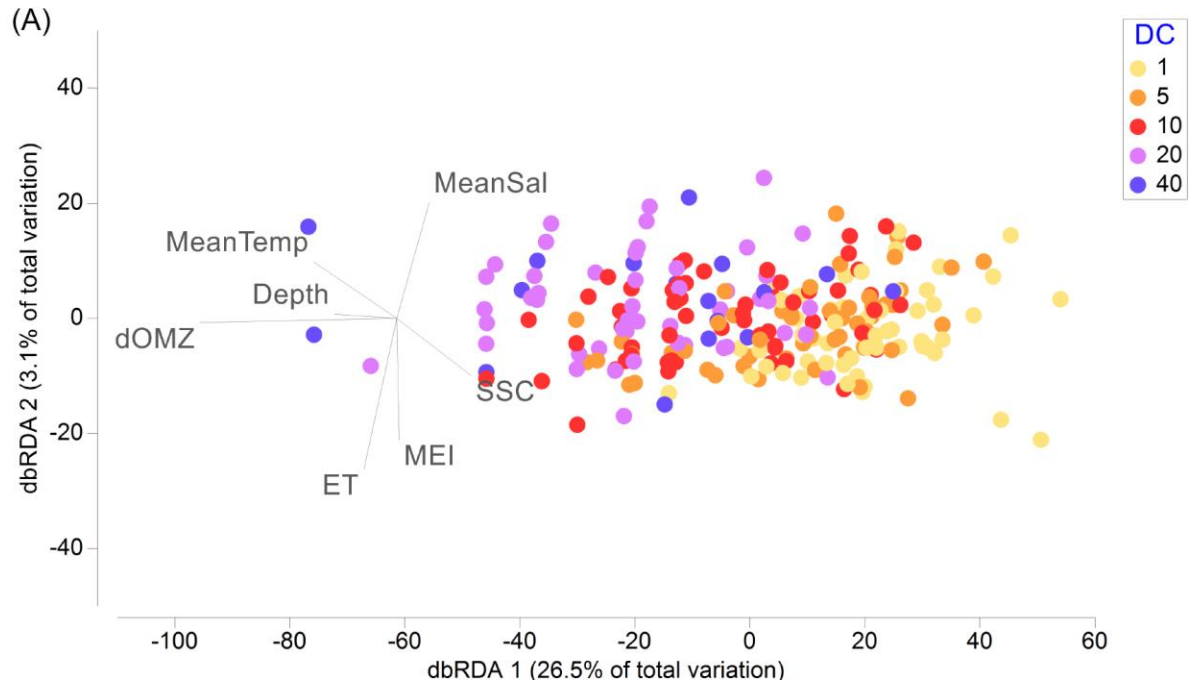
Euphausia mucronata 70%

Euphausia eximia 13%

Stylocheiron affine 10%

Hansarsia spp. 3%

Diversity and community composition



Variable	SS	Pseudo-F	p-value	% EVSM	*r* dbRDA 1	*r* dbRDA 2	*r* dbRDA 3
dOMZ	120420	80	**0.001**	25.7	-0.82	-0.02	0.11
MeanTemp	64650	37	**0.001**	13.8	-0.35	0.24	0.25
Depth	55905	31.4	**0.001**	11.9	-0.26	0.02	-0.02
SSC	38044	20.5	**0.001**	8.1	0.31	-0.24	0.28
ET	9561	4.8	**0.006**	2	-0.14	-0.63	0.15
MeanSal	8719	4.4	**0.002**	1.9	0.14	0.48	0.75
MEI	4618	2.3	0.061	<1	0.01	-0.51	0.51

SS= sum of squares

% EVSM= porcentage of explained variance in single-term linear model

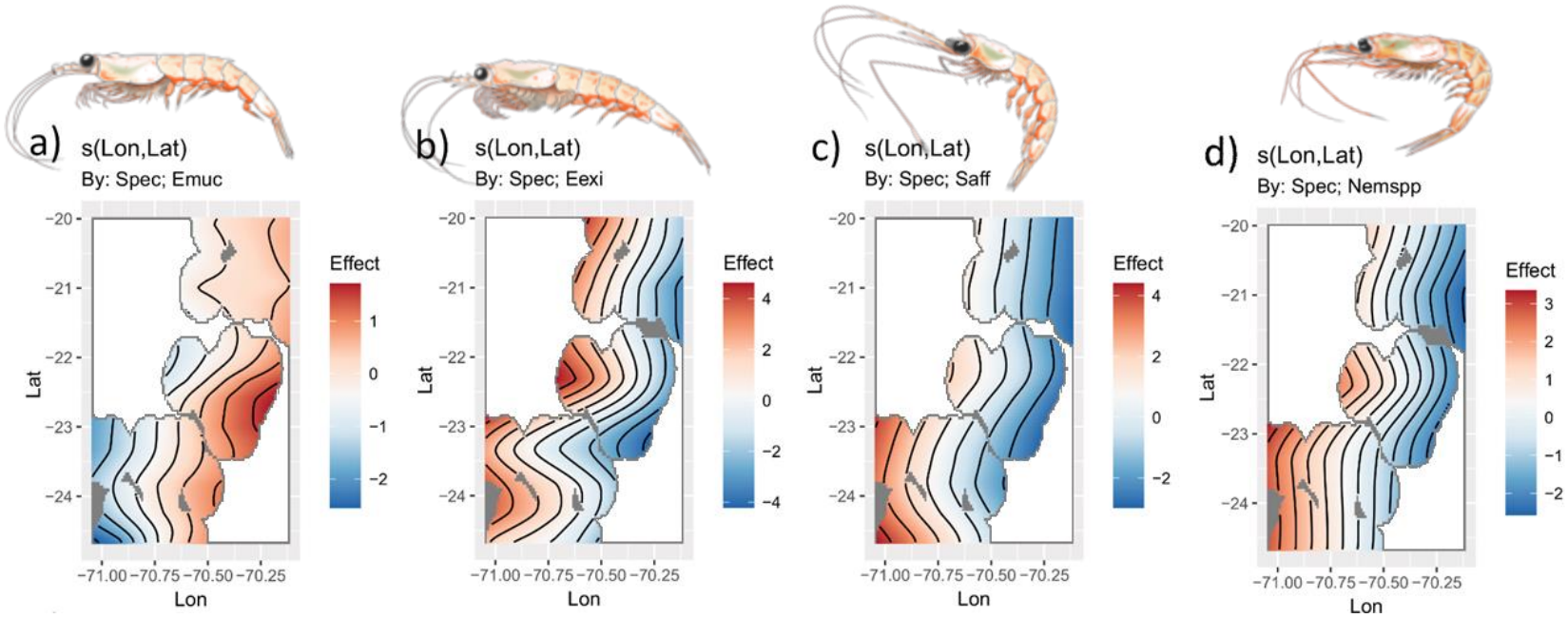
r = multiple partial correlation coefficient

Species-specific drivers – HGAM models

- The best and final model included 5 predictors
- The variables with higher explanatory power were the dOMZ and temperature

Model	*Terms*	*Dev. Expl. (%)*	*AIC*	*Δ AIC*
Full model	Lat/Lon, Sal*, Temp, dOMZ, E_T, SSC*, Anchovy	56	3316.65	7.25
Spatial	Lat/Lon	39.7	3474.53	165.13
dOMZ	dOMZ	42.4	3391.97	82.57
Temp	Temp	29.3	3350.00	40.60
Final model	**Lat/Lon, Temp, dOMZ, E_T, Anchovy**	**55.3**	**3309.40**	**0.00**

- The spatial term was significant for all taxa

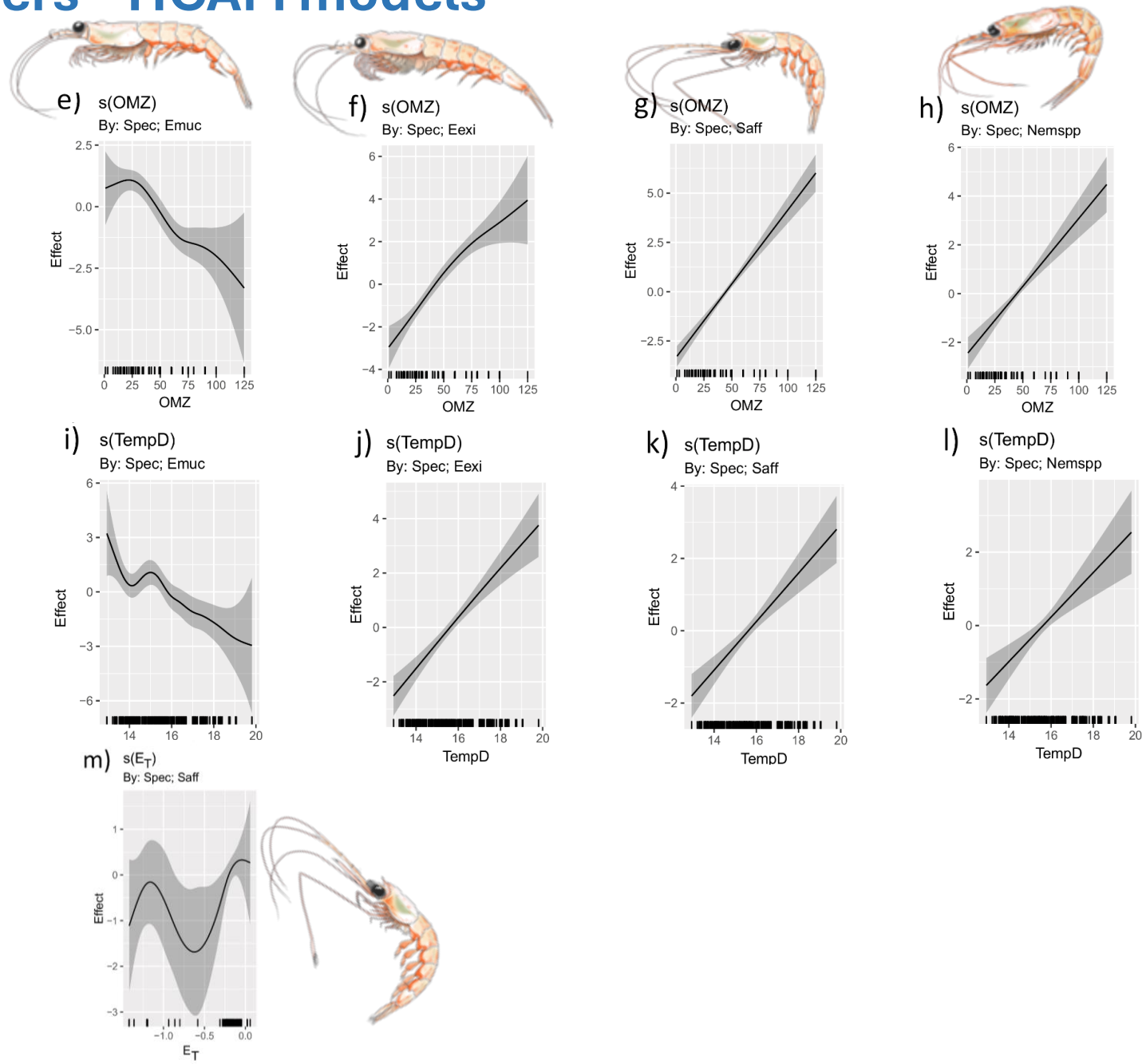


FiMS DOI: 10.3389/fmars.2022.979984

Species-specific drivers – HGAM models

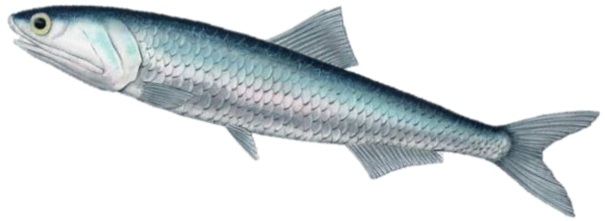
- The effects of the dOMZ and temperature on *E. mucronata* were opposed as to the other taxa

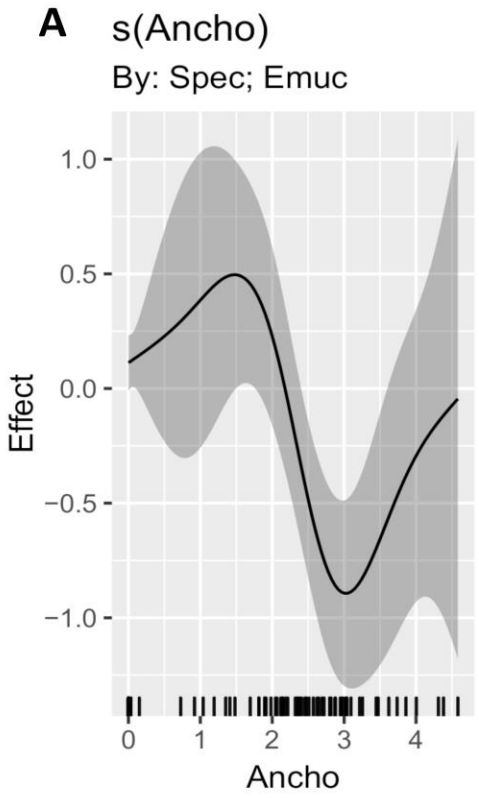
- The Ekman transport showed a non-linear effect on *S. affine* abundances

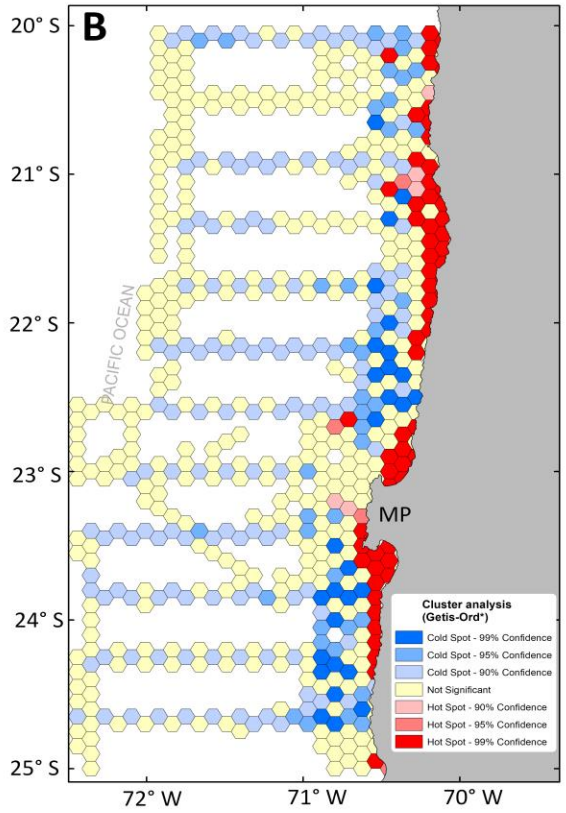


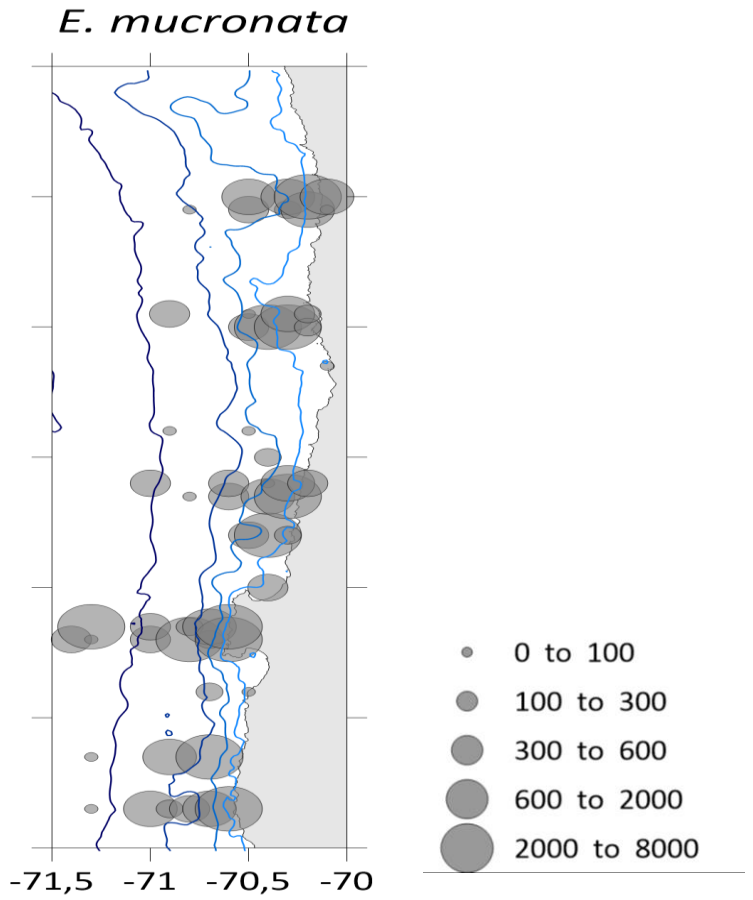
Species-specific drivers – HGAM models

- Negative non-linear effect on *E. mucronata*
- Shared habitat (as previously proposed by Peruvian studies)
- Local top-down effect?









Conclusions

1. The cross-shore gradients in temperature and dissolved oxygen caused by upwelling dynamics represent the main mode of environmental variability in this ecosystem.

1. This mode agrees with the spatial pattern observed in community diversity and is the main driver of community composition.

2. *E. mucronata,* the endemic and numerically dominant species, was the only one with higher modelled and observed abundances under upwelling conditions.

3. The lack of an effect of Chl-a is a novel finding in this ecosystem and could suggest that krill communities in this area are not limited by food.

4. Krill interactions with the Peruvian anchovy should be further investigated to prove or discard local top-down control.

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Thank you for your attention.

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