SPF FROM DIFFERENT ORIGIN SHARING AN AREA LIMIT OF THEIR LATITUDINAL DISTRIBUTION: DYNAMIC FACTORS FACILITATING HABITAT PARTITIONING

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Different SPF occupying a same area at the limit of their latitudinal distributions is not uncommon in many systems

Overlap in spatial, temporal and feeding habits occur, particularly in seasons of high biological production (spring, upwelling seasons, etc)… but..

What happens in seasons when food abundance goes down? (late autumn, winter)

Do some spp leave the area while others stay?

If they stay…

Do they compete for food?
Do they segregate spatially within the area? …horizontally? … vertically?
Do they partition the available food? … Based on what?
Are these behavioral responses similar between years?

To try to answer some of these questions we focussed on 3 SPF species present in northern Patagonia

1- we determined feeding and behavioral responses (gut contents, trophic positions (SI), gill rakers, horizontal and vertical distributions
2- we assessed the food field … during 4 years in the same season (Autumn)

Work in progress…

Species objective:

- Anchoveta (*Engraulis ringens*)
- Sardina común (*Strangomera bentincki*).. Sardine
- Sardina austral (*Sprattus fuegensis*)… Sprat

Where: Northern Patagonia (Pacific Ocean side)

When: Mid-late autumn (late April-May; 2019-2022)

Limited information available on feeding

Work in progress…

SAMPLING:

- **Food availability and environmental conditions**:
  - Zooplankton samples
  - Hydrography (CTD)
  - Seawater simples (Cholorhyll-a, POM (SI)
- **Adult fish:** biomass (acoustics), fish id tows.

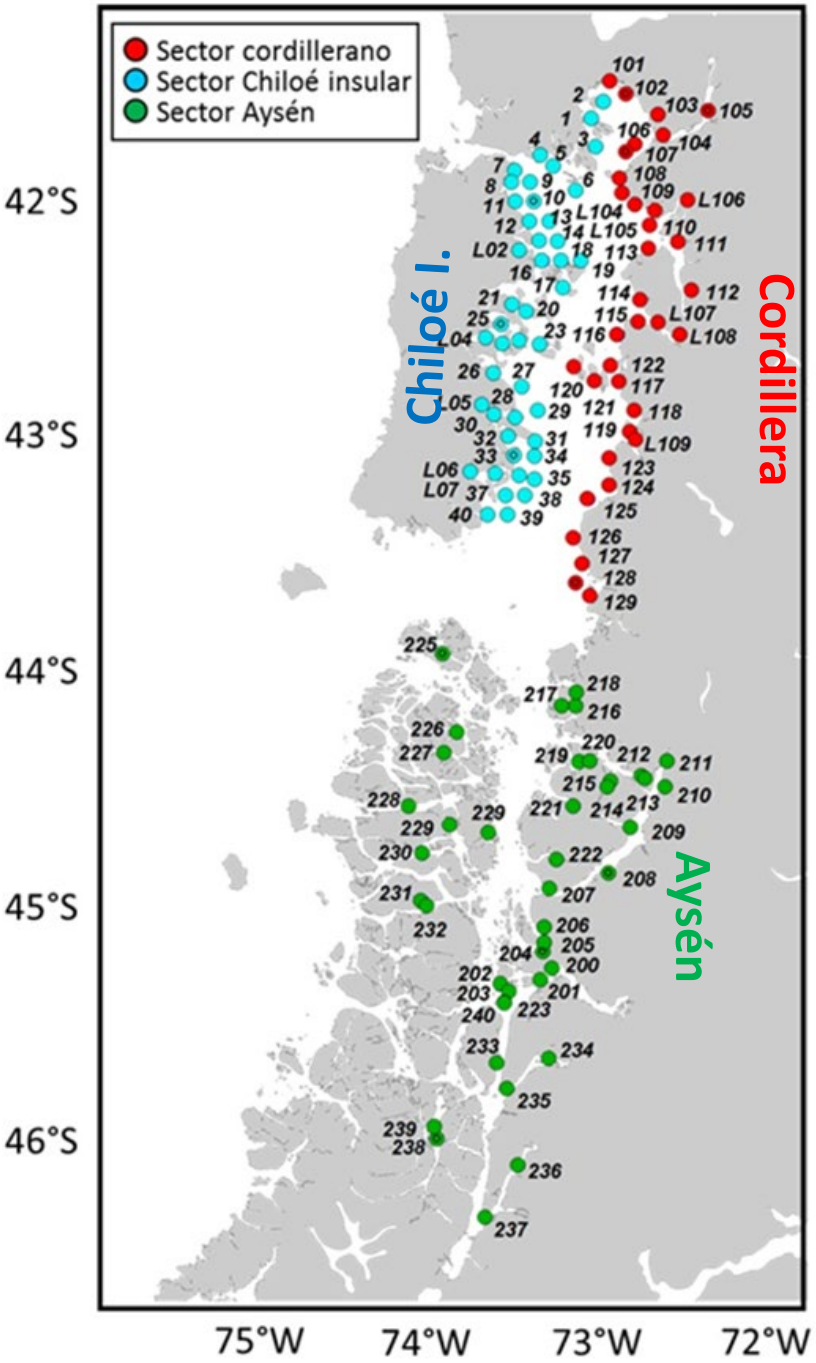
ANALYSES

Food field description:

- ❑ Zooplankton community indexes; taxonomic groups id, functional groups (herb. vs carn.; chitinous vs gelatinous), body size, ichtyoplankton.
- ❑ Stable isotopes (^{13}C, ^{15}N, trophic position, carbon origin (allochthoonous C vs. autochthonous C)

Adults:

- ❖ Standard biological measurements (TL, TW, Sx, IGS, CF)
- ❖ Gut content analyses (3 years)
- ❖ Stable isotopes (3 years)
- ❖ Gill rakers (1 year)
- ❖ Microplastics (1 year)



RESULTS

Autumn 2019

GUT CONTENTS

Index of relative numerical importance (RNI, %) of zooplankton preys in the guts of sardina austral, sardina común and anchoveta.

(Red: most important ítems)

2019

TROPHIC DIVERSITY (H')

	Sardina austral			Sardina común			Anchoveta		
Total length	< 8	8-13,5	> 13,5	< 8	8-12	>12	< 8	8-11,5	> 11,5
Cordillera	1,142	0,703	1,215	0,671	0,834	-	-	1,107	0,948
Chiloé I.	1,009	1,162	1,173	0,428	0,731	-	-	-	-
Aysén	1,519	1,076	0,663	-	-	-	-	-	-
MEAN	**1,22**	**0,98**	**1,02**	**0,55**	**0,78**			**1,11**	**0,95**

S. austral: highest diet diversity ***S común: lowest diet diversity***

NUMERICAL IMPORTANCE INDEX (%F x %N)

	Presa	S austral (N=301)	S común (N=150)	Anchoveta (N=100)
1	Copépodos	46,27	52,34	43,64
2	Nauplius	12,55	7,74	8,95
3	Zoeas	4,39	1,64	3,36
4	Megalopas	0,29	0,00	0,07
5	Caliptopis	0,15	0,00	0,15
6	Furcilias	1,10	0,25	0,22
7	Eufáusidos	0,16	0,08	0,07
8	Misidáceos	0,98	0,00	0,00
9	Cladóceros	4,10	5,50	9,29
10	Ostrácodos	2,71	1,25	6,65
11	Apendicularias	10,89	12,94	13,10
12	Anfípodos	0,75	1,23	1,58
13	Isópodos	0,52	0,08	0,00
14	Cumáceos	0,22	0,00	0,22
15	Poliquetos	0,16	0,00	0,00
16	Larvas Cipris	0,43	0,85	3,24
17	Cifonautas	4,01	10,61	2,56
18	Huevos invertebrados	5,15	3,04	5,48
19	Microplancton	0,71	0,00	0,15
20	Huevos peces	3,82	2,06	0,59
21	Larvas peces	0,15	0,16	0,00
22	Nematodos	0,04	0,00	0,07
23	Quetognatos	0,00	0,08	0,00
24	Estomatópodos	0,00	0,08	0,30
25	Pterópodos	0,00	0,08	0,30
26	Ácaros	0,48	0,00	0,00
26	**TOTAL ITEMS**	**23**	**18**	**20**

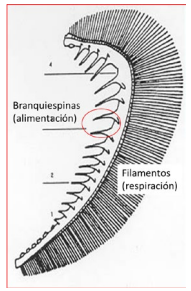
STABLE ISOTOPS

$\delta^{15}N$ and TROPHIC POSITION x SPECIES and SECTORS

Autumn 2019

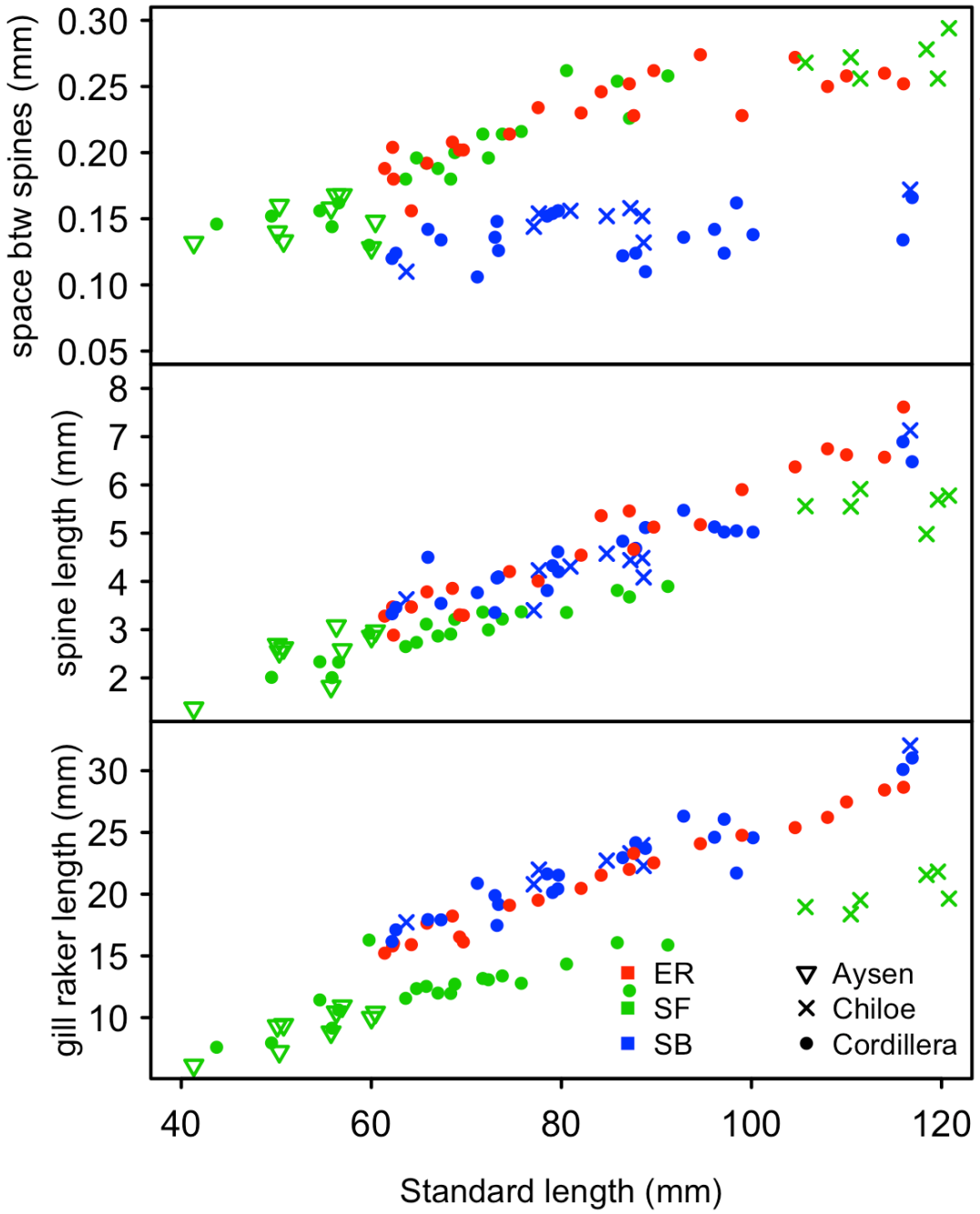
		$\delta^{15}N$				
Sector		**n**	**$\bar{x}$**	**SD**	**TP**	**SD**
Cordillera	Sardina austral	20	13,8	0,6	**3.0**	0,1
Chiloé I.	Sardina austral	20	13,8	0,4	**3,5**	0,1
Aysén	Sardina austral	20	14,3	0,4	**3,6**	0,1
Cordillera	Sardina común	20	13,9	0,2	**2,7**	0,1
Chiloé I.	Sardina común	10	13,5	0,5	**3,2**	0,1
Cordillera	Anchoveta	20	14,1	0,5	**3,0**	0,1

GILL RAKERS



Gill raker morphology for the three fish species (*E. ringens, S. fuegensis,* and *S. bentincki)* by standard length.

Symbols shape indicate the fish's region.



Anchoveta

Sardina austral

Sardina común

Autumn 2019

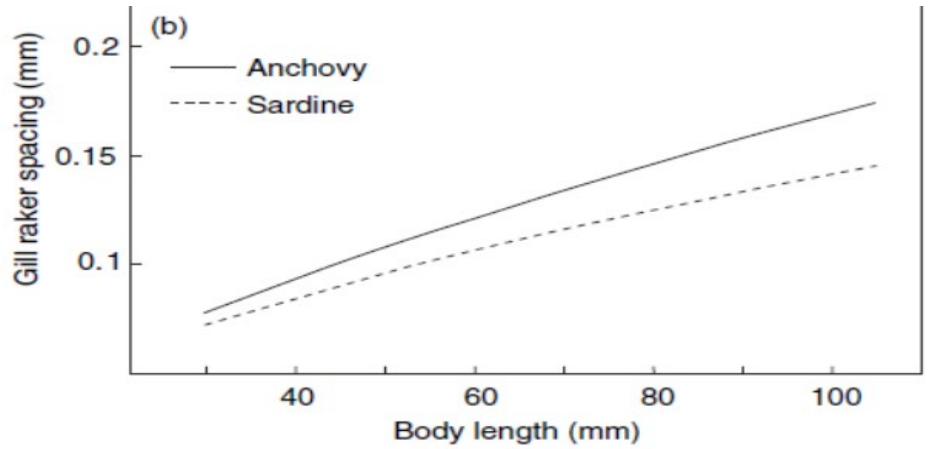
<u>Common sardine</u>: smallest space between gill rakers, indicative of smaller sized particles.

Probably feeds on small Copepods or other small herbivores

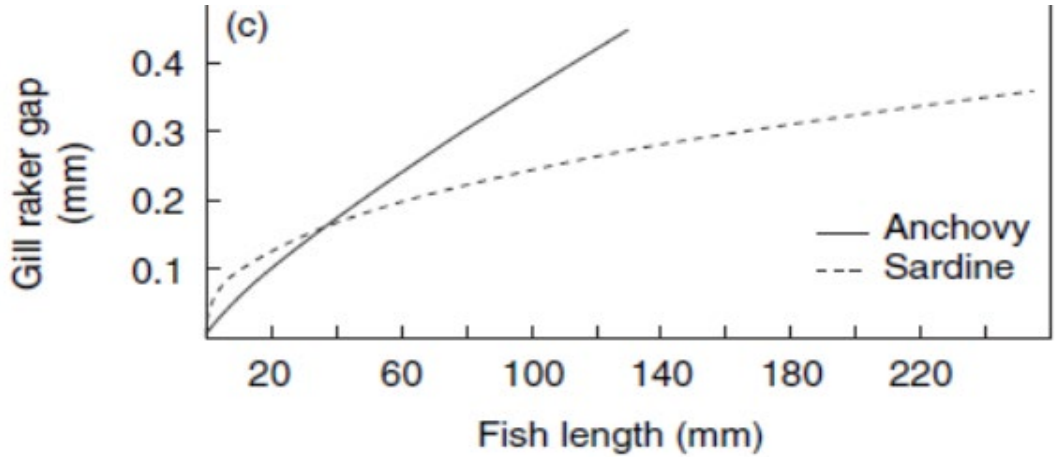
It coincides with a lower trophic position in the food web

SPACE BETWEEN GILL RAKERS

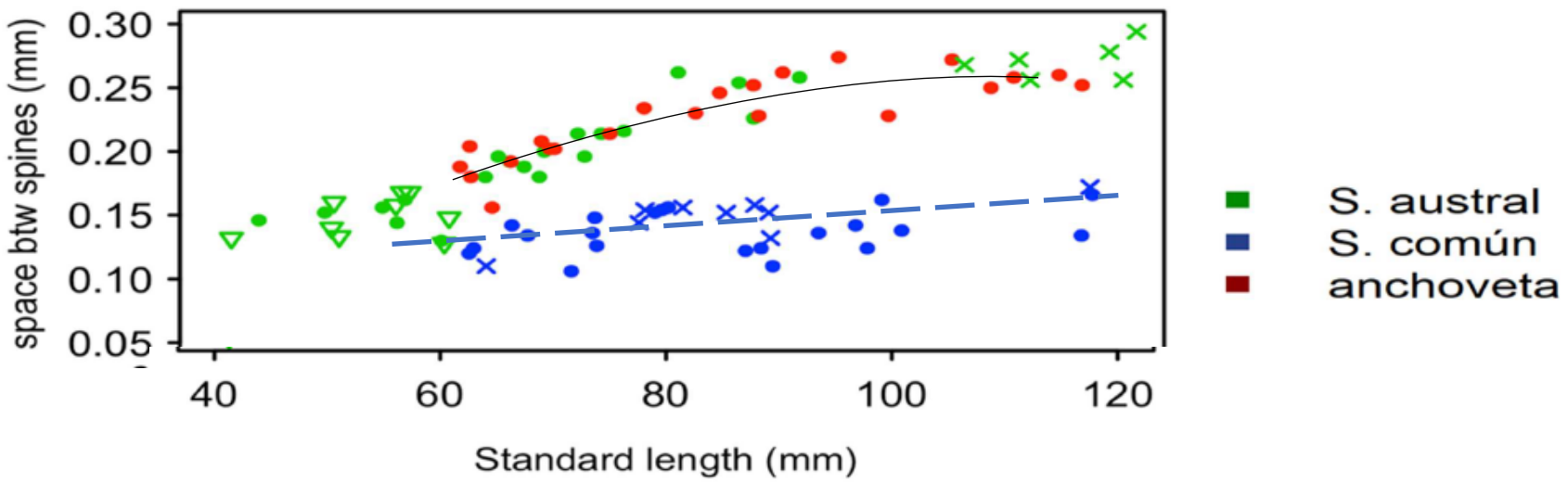
California Current



Benguela Current



This study



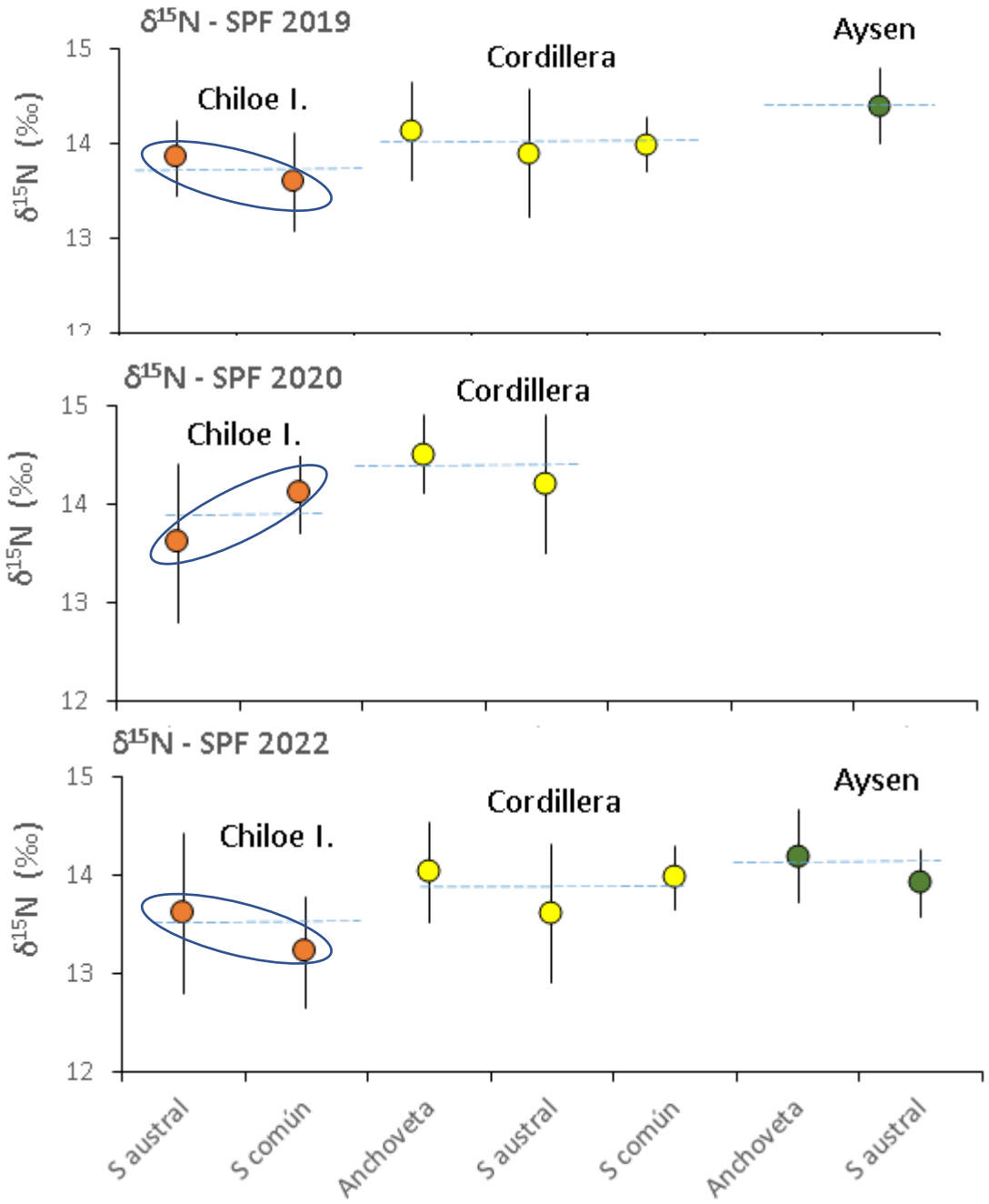
STABLE ISOTOPS

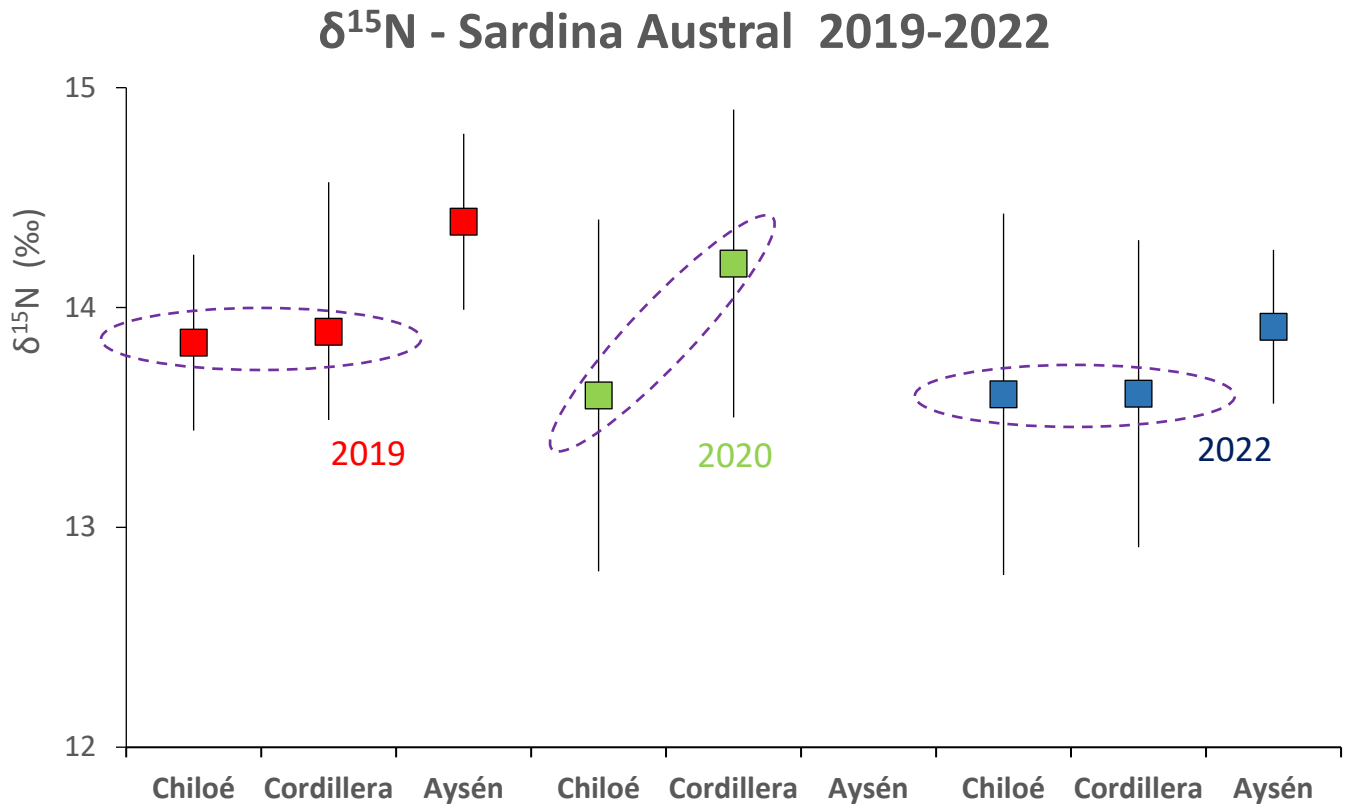
Is there a inter-annual pattern in terms $\delta^{15}N$ in SPF tissues (trophic positions) at different locations?

During the 3 years analyzed:

* SPF in Chiloé show the lowest $\delta^{15}N$ values, followed by SPF in Cordillera and then Aysén (highest)

But,
* When comparing between years (Chiloé), some species switch in terms of higher/lower $\delta^{15}N$ content.





SA… while in some years they show similar ^{15}N contents between locations (Chiloé-Cordillera), in other years this values are different (2020)

Autumn 2020

GUT CONTENTS

TROPHIC DIVERSITY (H')

	Sardina austral		Sardina común		Anchoveta	
Total length	8-13,5cm	> 13,5cm	8-12cm	>12cm	8-11,5cm	> 11,5cm
Cordillerano	1,21 →	1,46	-	-	1,01 →	1,06
Chiloé i	0,35 →	0,81	0,86 →	1,10	-	-

S. austral gut contents differ in diversity in different locations…
(*plastic* feeding behavior)

Diet may change as fish develop: + diversity at larger sizes…

NUMERICAL IMPORTANCE INDEX (%F x %N)

		S austral	S común	Anchoveta
		Cord + Ch	Ch.	Cord.
		296	50	214
	Ítems-presa	IIN	IIN	IIN
1	Copépodos	49,14	20,52	43,94
2	Nauplius	3,8	0,65	4,54
3	Zoeas	1,6	0	2,07
4	Caliptopis	0	0	0,06
5	Furcilias	0,73	0	0,24
6	Eufáusidos	2,1	0	1,46
7	Misidáceos	0	0	0,18
8	Cladóceros	4,36	0	3,21
9	Ostrácodos	3,13	20,88	3,43
10	Quetognatos	2,34	0	5,27
11	Apendicularias	21,19	53,3	22,9
12	Anfípodos	2,03	0	1,63
13	Isópodos	0,08	0	0,54
14	Cumáceos	0,15	0	0,18
15	Larvas Cipris	0,08	0	0,3
16	Larvas Cifonautas	2,99	0	3,77
17	Huevos invertebrados	1,37	1,93	3,49
18	Pterópodos	0	0	1,07
19	Microplancton	0,36	0	0,54
20	Huevos peces	0,59	0,65	0,66
21	Ácaros	0,61	0	0,06
22	Nematodos	3,34	2,06	0,47

Do trophic positions also change along with body size increases?

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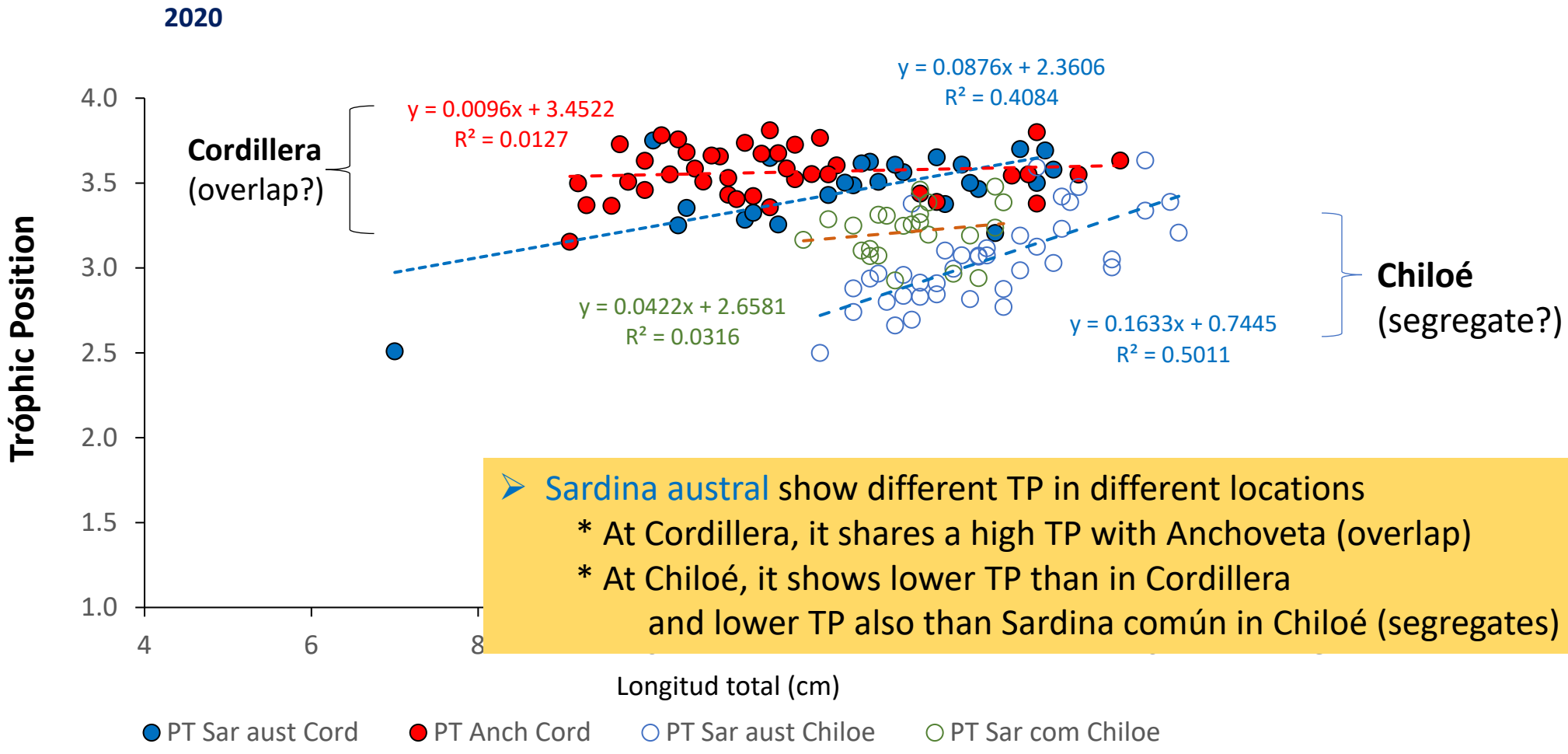

- Sardina austral show different TP in different locations
  - * At Cordillera, it shares a high TP with Anchoveta (overlap)
  - * At Chiloé, it shows lower TP than in Cordillera and lower TP also than Sardina común in Chiloé (segregates)

Why a different feeding behavoiur in different áreas?

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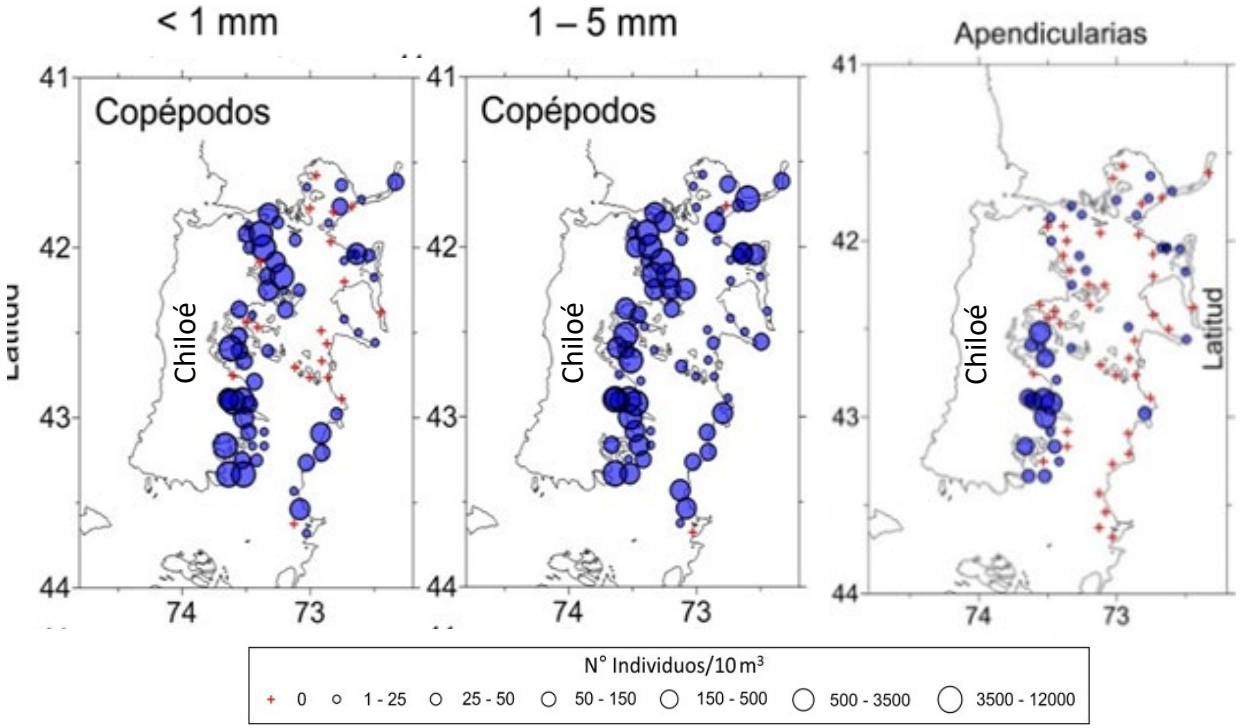
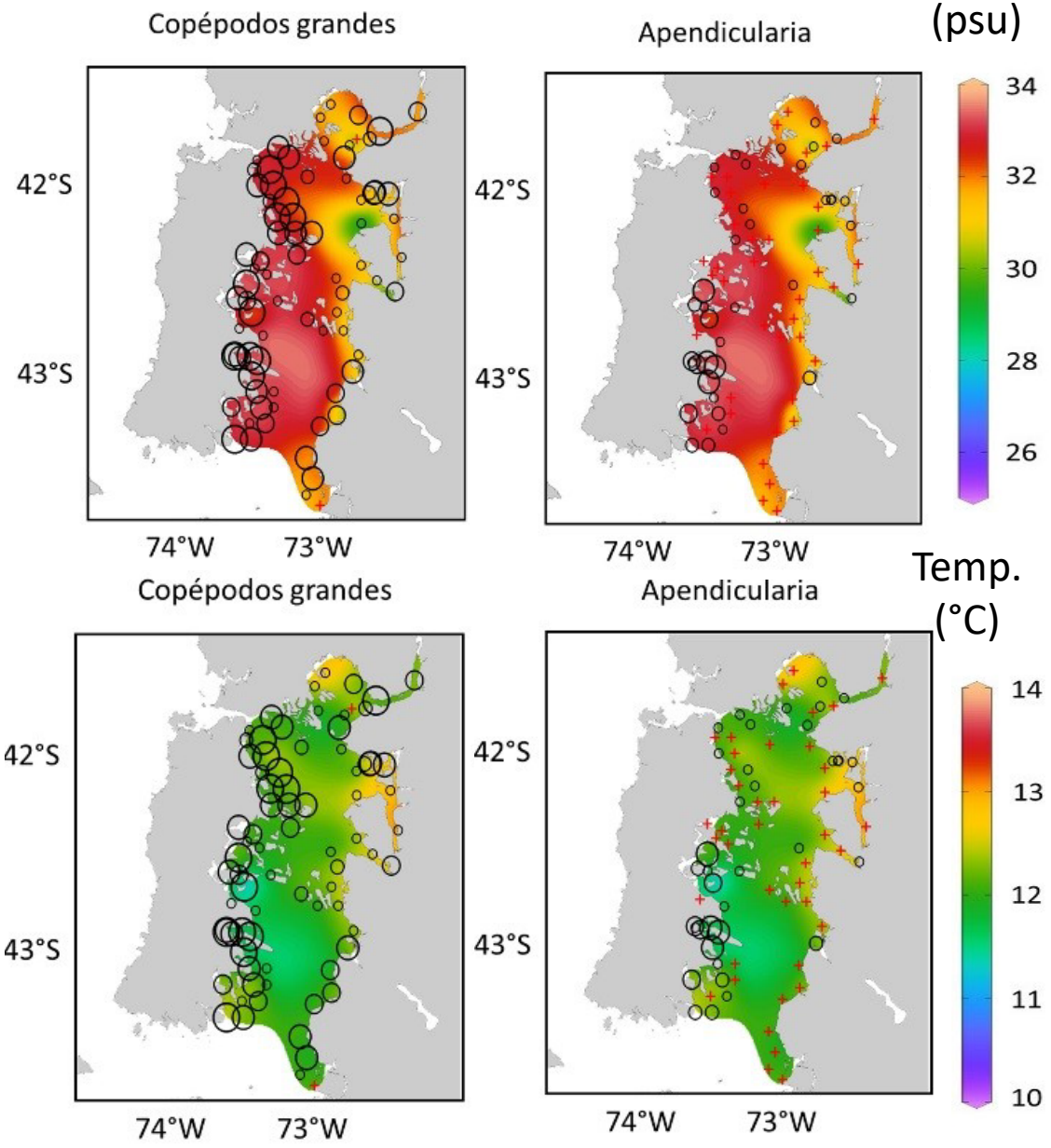
Is there anything about the environment that differ among locations?

Food availability



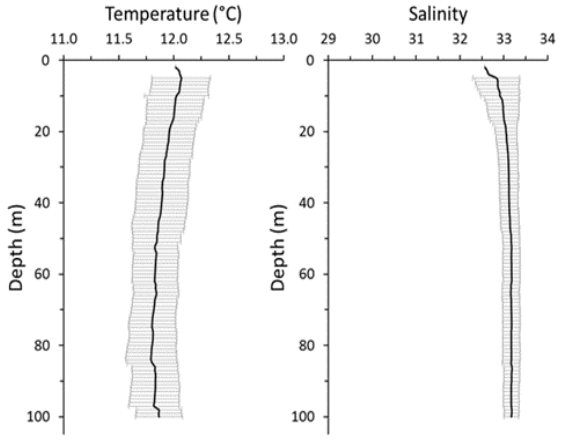
Herbivores (copepods, apendicularians) more abundant in Chiloé than Cordillera …
…coincident with lower TP of SPF in Chiloé compared with Cordillera

Hydrography + food availability



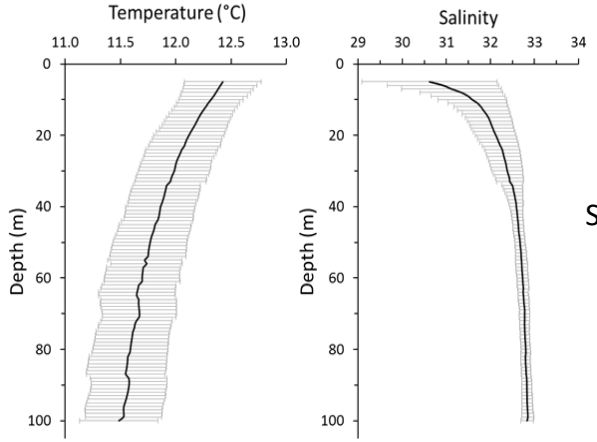
WATER COLUMN CHARACTERISTICS

CHILOE



Well mixed water column

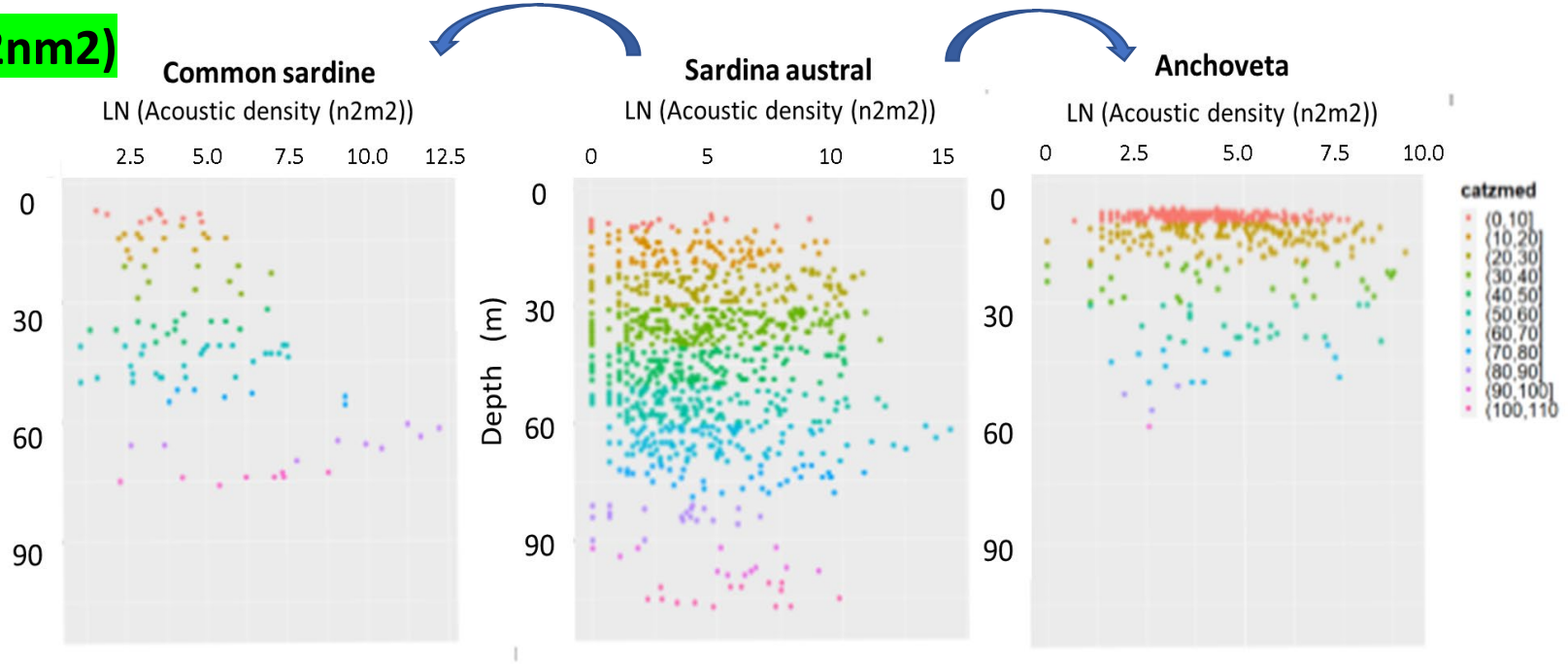
CORDILLERA



Stratified water column

Are there differences in vertical distributions among SPF species?

Acoustic density (m2nm2)



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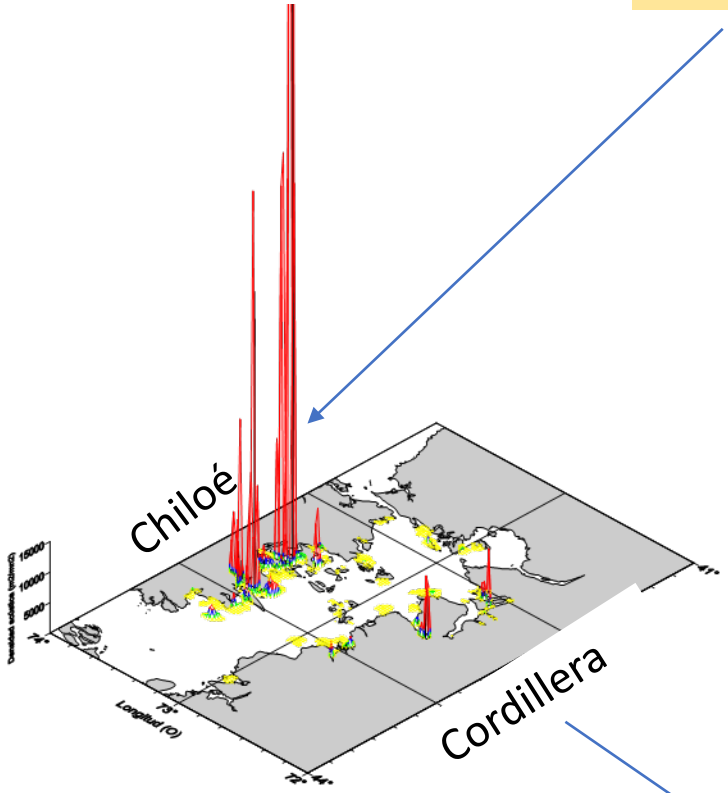
Horizontal distributions among SPF species

Acoustic density (m2nm2)

In areas of high food availability (Chiloé; copepods), SPF show higher abundances, and SA + SC partition the available food (size, taxa, diversity) and this results in different trophic positions between them.

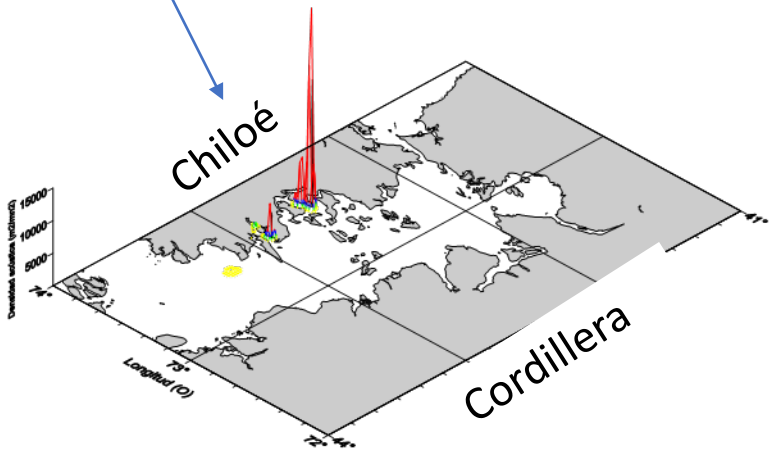
Sardina austral

Adults > 13,5 cm



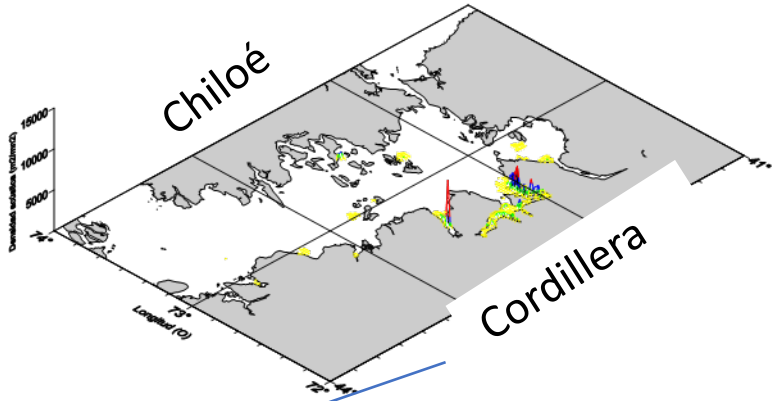
Sardina común

Adults >=11.5 cm



Anchoveta

Adults >11,5 cm



In areas of low food availability (Cordillera), SPF occur in low abundance, SA + AN share the scarce food available, resultings in similar trophic positions, higher than SPF in Chiloé.

THANKS

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