



Sardinella aurita key biological parameters variability under the effects of environmental changes

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Objectives

To determine how environmental
conditions SST and CUI
affect

S. aurita populations, their biology
reproductive condition and growth
parameters

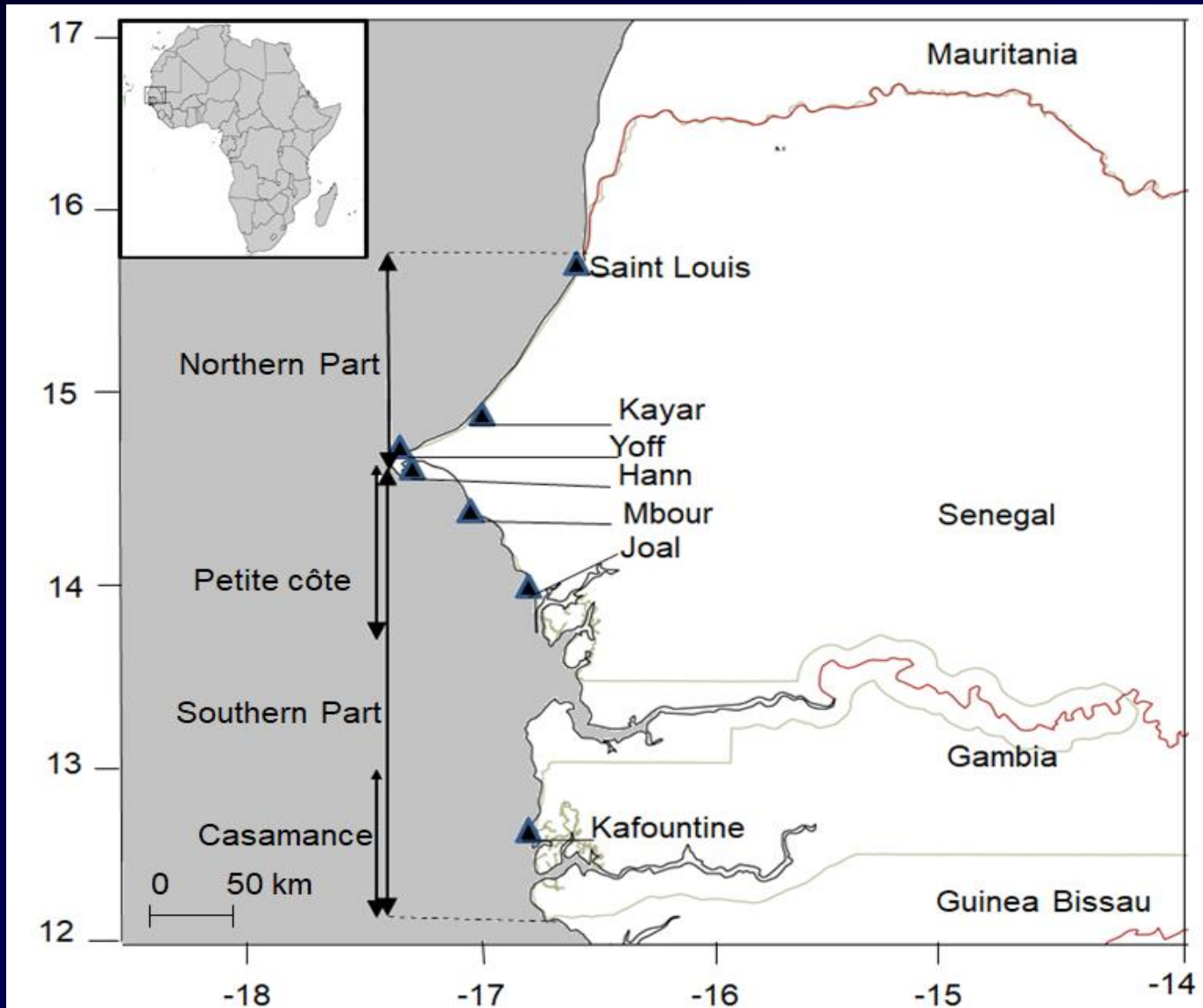
Environmental Change

In the eastern Atlantic; Do Climate change affect through SST and CUI on:

Growth parameters (L_{∞})

Reproductive parameters (K_n , L_{50} , GSI)

Study area



Material ~ Methods

- Growth data (July 2013 to June 2014):
 - ✓ von Bertalanffy growth parameters (K ; L_{∞});
 - ✓ Auximetric double logarithmic plot (ϕ').
- Reproduction data (1995 to 2011):
 - ✓ Condition factor (K_n);
 - ✓ Length at first sexual maturity (L_{50});
 - ✓ Gonado-somatic index (GSI).
- Landing data (1995-2014)
- Environmental parameters (1995 to 2014):
 - ✓ Coastal Upwelling Index (CUI);
 - ✓ Sea surface temperature (SST).
- Historical review in same geographic area and other tropical and Mediterranean environments for this species

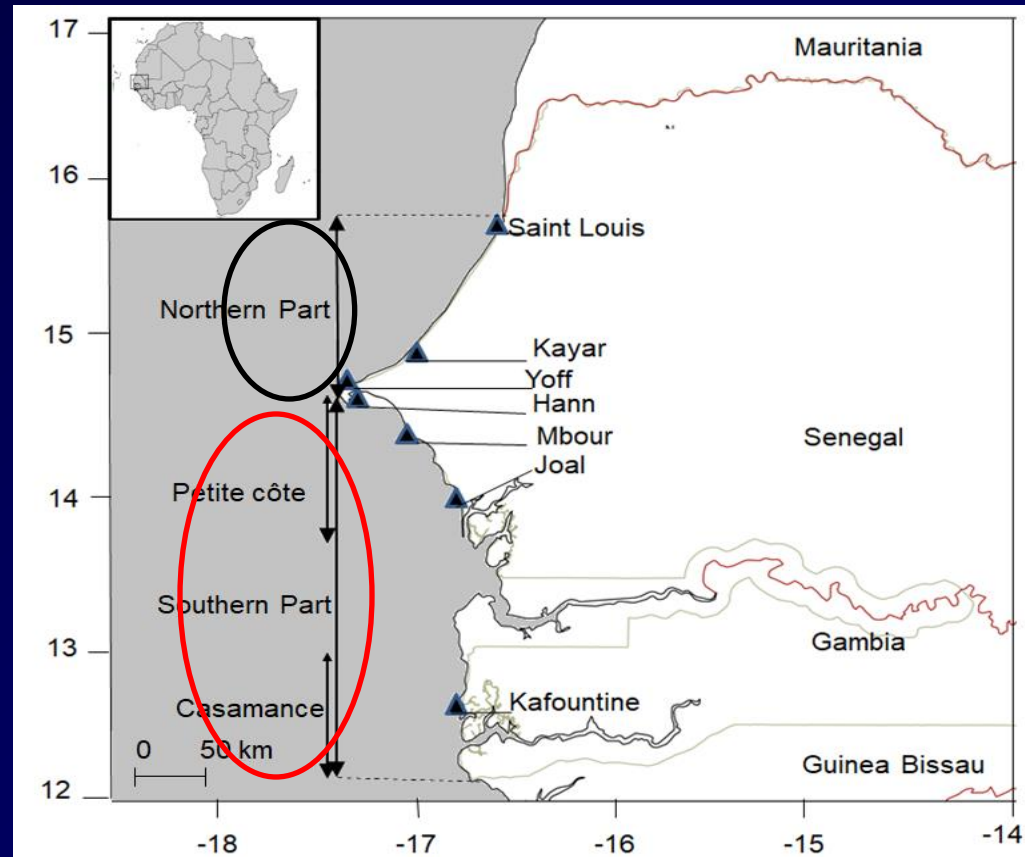
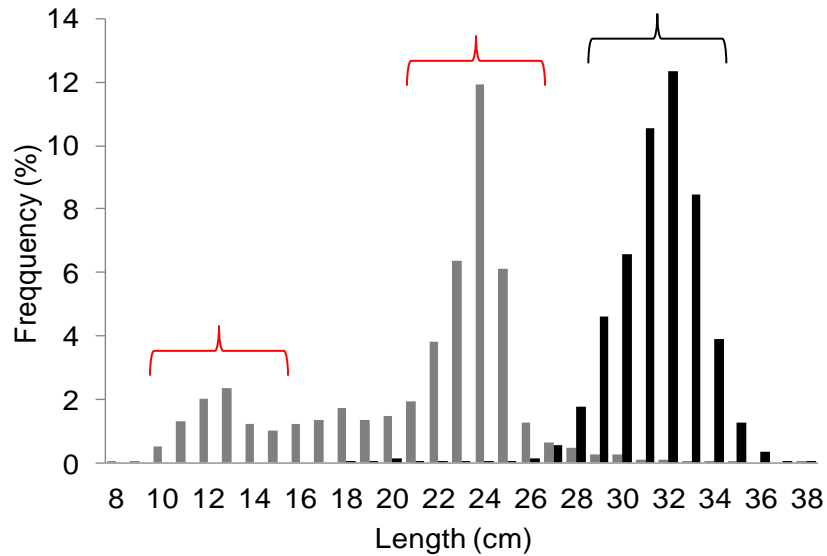
Growth parameters and natural mortality of *Sardinella aurita* estimated in Senegal and from Eastern and Western Central Atlantic as well as the Mediterranean Sea

Country	Method	L_{∞}	L_{∞}	K	t_0	ϕ'	t_{\max}	M	References	
		FL	TL							
Western Central Atlantic										
Brazil	Scales	20.7	24.4	0.44	-0.39	2.42	6.42	0.46	Matsuura (1971)	
Brazil	Otoliths	19.6	23.0	0.72	-0.25	2.58	3.91	0.76	Saccardo et al. (1988)	
Brazil	Otoliths	23.2	27.5	0.55	-0.30	2.62	5.15	0.58	Cergole et al. (2002)	
Venezuela	NR	20.5	24.1	0.32	-0.55	2.27	8.82	0.34	Heald & Griffiths (1967)	
Venezuela	Length frequencies	22.5	26.6	1.26	-0.13	2.95	2.25	1.33	Mendoza et al. (1994)	
Venezuela	Length frequencies	27.3	32.6	0.66	-0.05	2.85	4.48	0.66	Barrios et al. (2010)	
Mediterranean										
Algeria	Length frequencies	29.3	35.0	0.24	-0.70	2.47	12.01	0.24	Bouaziz et al. (2001)	
Croatia	Length frequencies	28.6	34.2	0.36	-0.94	2.62	7.39	0.40	Mustać and Sinovčić (2012a)	
Egypt	NR	22.0	26.0	0.53	0.34	2.55	5.00	0.60	El-Maghraby et al. (1970)	
Greece	Scales	27.3	32.6	0.28	-0.57	2.47	10.14	0.29	Ananiades (1952)	
Greece	Scales	18.3	21.4	0.32	-0.55	2.17	8.82	0.34	Tsikliras et al. (2005)	
Israel	Length frequencies	26.1	31.1	0.25	-1.80	2.38	10.20	0.29	Ben Tuvia (1956)	
Spain	Length frequencies	23.2	27.5	0.45	-0.38	2.53	6.28	0.47	Navarro (1932)	
Tunisia	Otolith	26.3	31.3	0.24	-2.50	2.37	10.00	0.30	Gaamour et al. (2001)	
Eastern Central Atlantic										
Canary Islands	Length frequencies	34.6	41.5	0.31	-0.63	2.71	11.34	0.26	Navarro (1932)	
Congo	Length frequencies	31.0	37.0	0.69	-0.56	2.96	5.82	0.51	Rossignol (1955)	
Mauritania	Scales	34.6	41.6	0.26	-0.87	2.65	13.11	0.22	Chesheva (1998)	
Mauritania	Otoliths	31.0	37.0	0.39	1.46	2.72	9.15	0.32	Pascual-Alayón et al. (2008)	
Mauritania	Scales and Otoliths	32.9	39.4	0.32	-1.78	2.69	10.89	0.27	Pascual-Alayón et al. (2008)	
Mauritania	Otoliths	30.4	36.3	0.41	-0.94	2.72	6.38	0.47	Iglesias et al. (2009)	
Mauritania - Senegal	Scales	34.0	40.7	0.33	-0.60	2.74	10.81	0.27	Thuoc & Szypula (1973)	
Mauritania - Senegal	Scales	38.1	45.9	0.36	-0.69	2.87	9.91	0.30	Maxim and Maxim (1988)	
Mauritania - Senegal	Length frequencies and Scales	31.2	37.3	0.97	-0.21	3.12	4.58	0.65	Boëly et al. (1979)	
Senegal	Length frequencies	35.0	42.0	0.60	-0.24	3.02	4.75	0.63	Postel (1955)	
Senegal	Scales	35.0	42.1	0.28	-0.99	2.70	12.22	0.24	Krzepkowski (1982)	
Senegal	Length frequencies and Scales	30.6	36.5	1.21	-0.06	3.20	3.97	0.75	Boëly et al. (1982)	

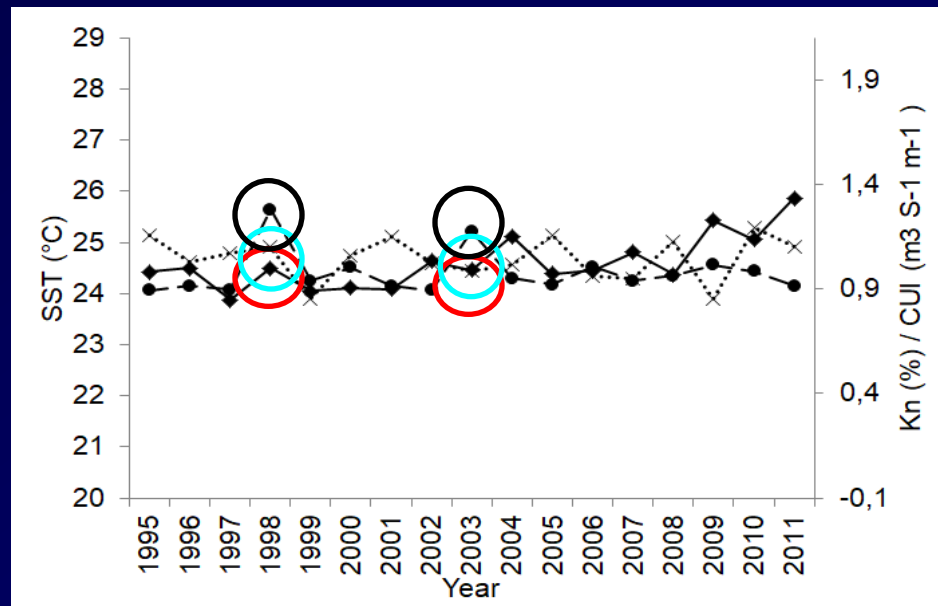
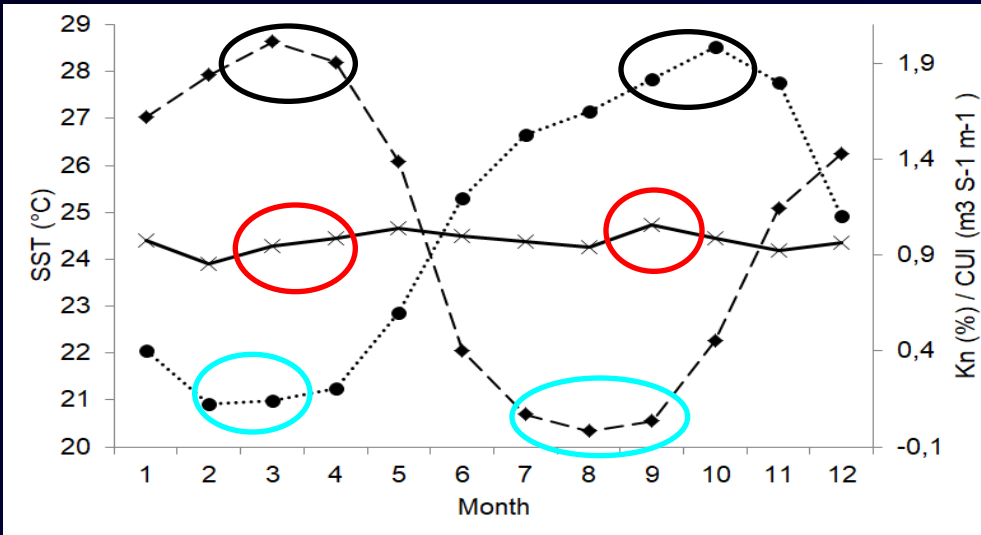
Reproductive parameters of *Sardinella aurita* in Senegal and from Eastern and Western Central Atlantic as well as the Mediterranean Sea

Country	Method	N	Month												Male L ₅₀	Female L ₅₀	a	b	SR	References	
			1	2	3	4	5	6	7	8	9	10	11	12							
Western Central Atlantic Ocean																					
Brazil	TL	250	*	*	*	*										NR	18.60	NR	NR	NR	Petermann and Schwingel (2016)
Venezuela	TL	92834	*	*	*								*	*		NR	19.70	1.0377	3.399	NR	Fréon et al. (1997)
Venezuela	TL	3736	*	*	*							*	*	*		NR	20.00	NR	NR	55.5	Gassman et al. (2008)
Mediterranean																					
Greece	TL	NR					*	*	*	*						14.00	15.00	NR	NR	NR	Ananiades (Ananiades, 1952)
Croatia	TL	2033						*	*	*						15.80	16.60	NR	NR	NR	Mustać and Sinovčić (2012b)
Greece	TL	19	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.0087	2.950	NR	Koutrakis and Tsikliras (2003)
Greece	TL	7942					*	*								15.50	16.80	NR	NR	50.5	Tsikliras and Antonopoulou (2006)
Tunisia	TL	918							*	*	*					14.10	15.20	NR	NR	NR	Gaamour et al. (2001)
Eastern Central Atlantic Ocean																					
Mauritania	FL	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.007940	3.227	NR	Lawal and Mylnikov (1988)
Mauritania	TL	3073						*	*	*	*					34.61	34.61	NR	NR	55.0	Wague and Mbodj (2002)
Senegal	TL	1334					*	*				*	*			NR	23.45	NR	NR	52.0	Conand (Conand, 1977)
Senegal	FL	2232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.000005	3.194	NR	Boëly (1982a)
Senegal	TL	9645		*	*	*	*					*	*			NR	21.59	NR	NR	55.0	Boëly (1982b)
Senegal	FL	2433	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.006392	3.274	NR	Fréon (1988)
Senegal	NR	NR		*	*	*	*	*				*	*	*		NR	NR	NR	NR	NR	Cury and Fontana (1988)
Senegal	TL	3947				*	*	*				*	*			27.66	30.98	0.000038	3.162	50.5	Goudiaby et al. (2008)
Senegal	TL	NR										*	*			21.10	26.55	0.000007	3.040	NR	Samba (Samba, 2011)
Senegal	TL	4397		*	*	*	*	*				*	*	*		24.82	25.72	0.000000	3.272	51.1	Present study

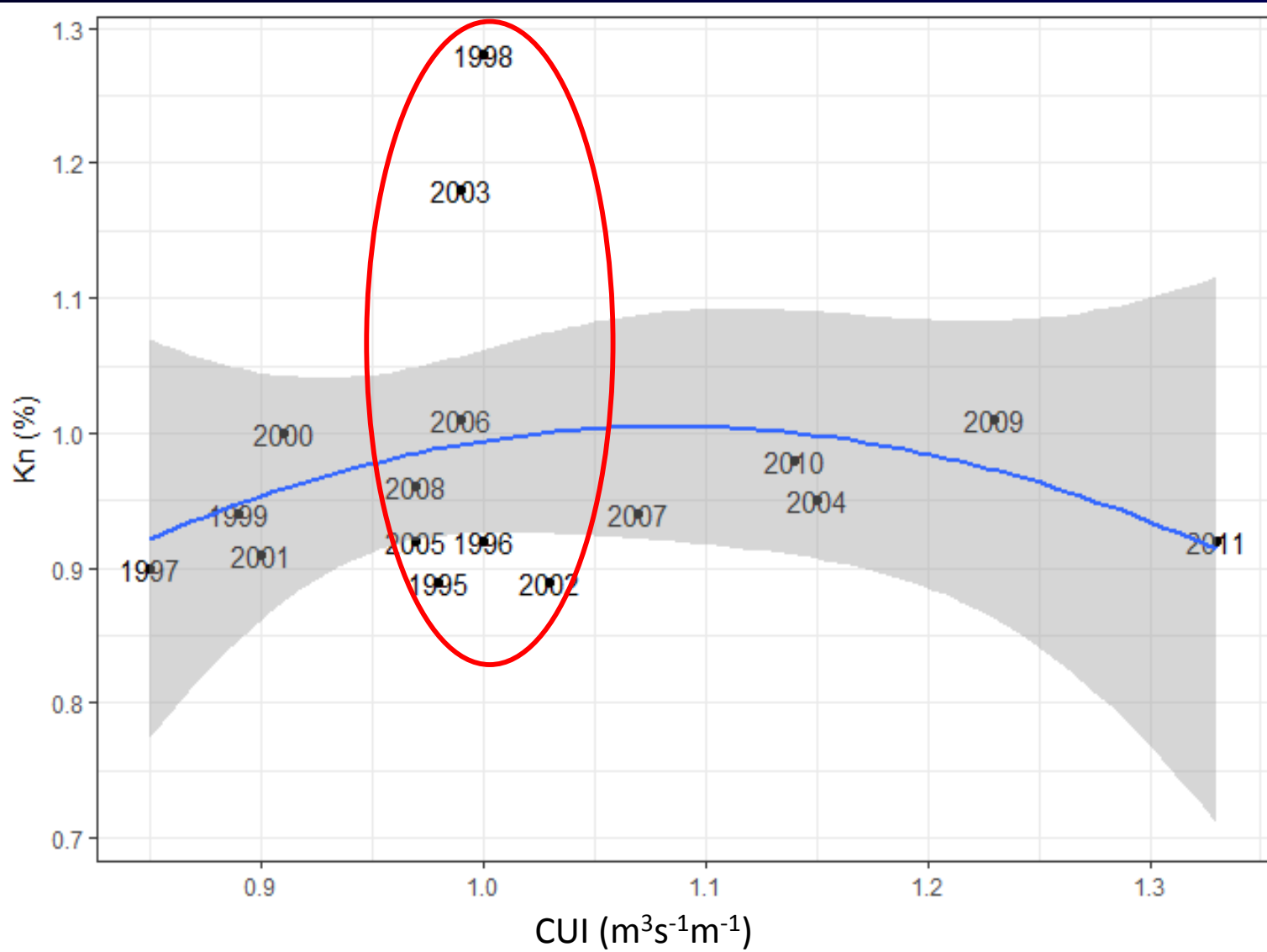
Fish Size spectra



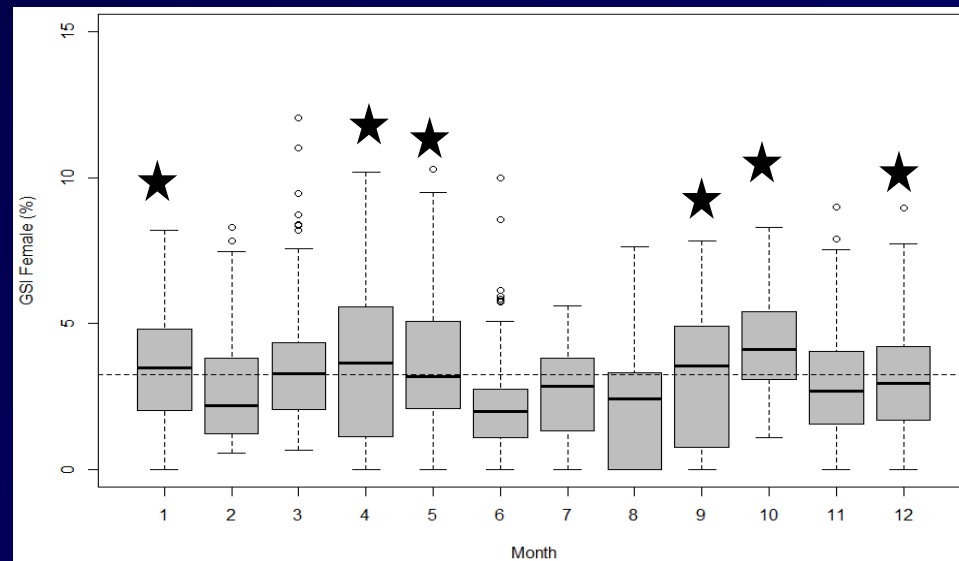
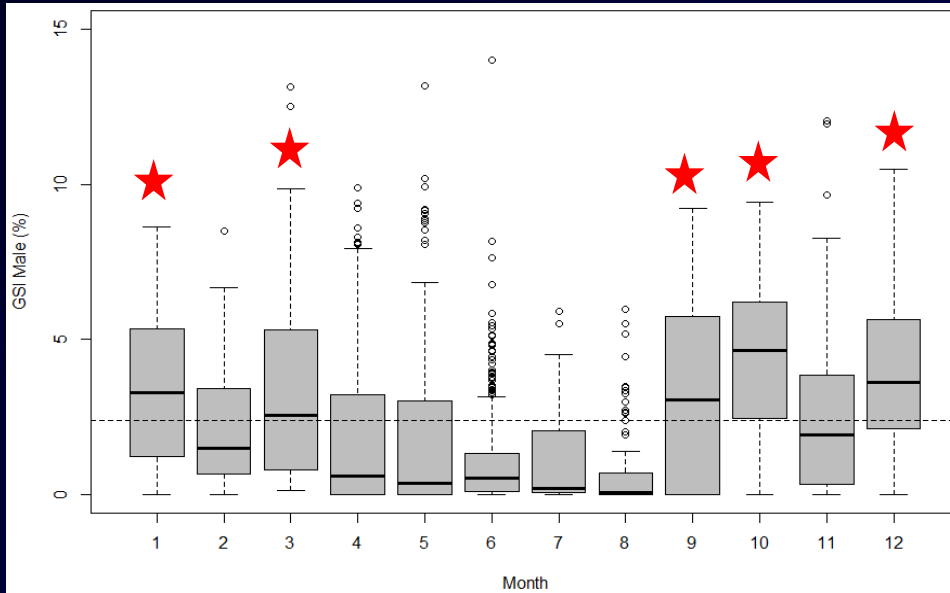
Temporal variability of Kn and environmental parameters



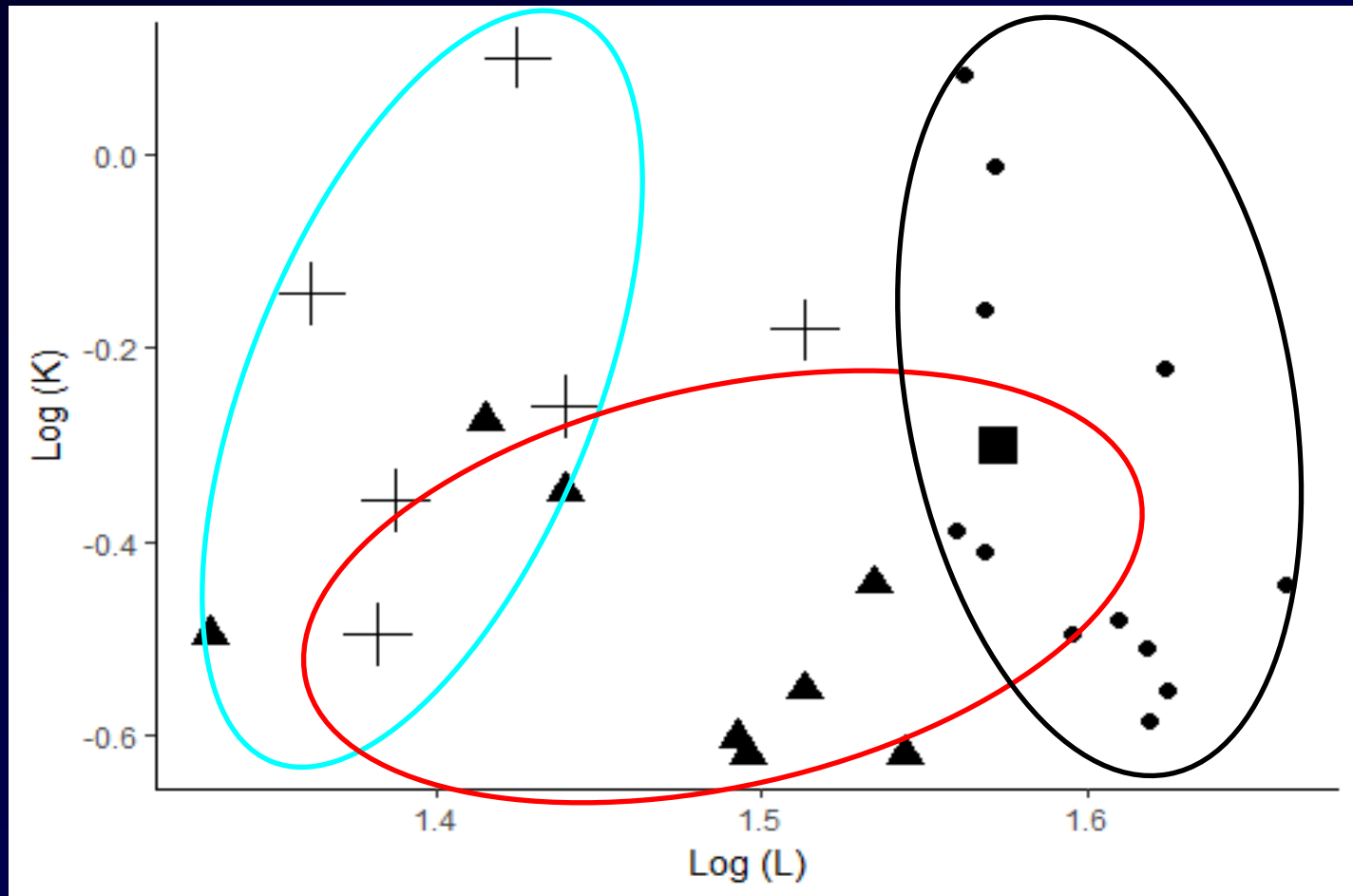
Temporal variability of Kn and CUI



GSI variabilities



Auximetric plot



Reproductive parameters

Country	Method	N	Month												Male	Female	a	b	SR	References		
			1	2	3	4	5	6	7	8	9	10	11	12	L ₅₀	L ₅₀						
Western Central Atlantic Ocean																						
Brazil	TL	250	*	*	*	*									*	*	NR	18.60	NR	NR	NR	Petermann and Schwingel (2016)
Venezuela	TL	92834	*	*	*										*	*	NR	19.70	1.0377	3.399	NR	Fréon et al. (1997)
Venezuela	TL	3736	*	*	*										*	*	NR	20.00	NR	NR	55.5	Gassman et al. (2008)
Mediterranean																						
Greece	TL	NR					*	*	*	*							14.00	15.00	NR	NR	NR	Ananiades (Ananiades, 1952)
Croatia	TL	2033						*	*	*							15.80	16.60	NR	NR	NR	Mustać and Sinovčić (2012b)
Greece	TL	19	NR	NR	NR	NR	N	N	N	N	N	N	N	NR	NR	NR	NR	NR	0.0087	2.950	NR	Koutrakis and Tsikliras (2003)
Greece	TL	7942					*	*									15.50	16.80	NR	NR	50.5	Tsikliras and Antonopoulou (2006)
Tunisia	TL	918						*	*	*							14.10	15.20	NR	NR	NR	Gaamour et al. (2001)
Eastern Central Atlantic Ocean																						
Mauritania	FL	NR	NR	NR	NR	NR	N	N	N	N	N	N	N	NR	NR	NR	0.007940	3.227	NR	NR	NR	Lawal and Mylnikov (1988)
Mauritania	TL	3073						*	*	*	*						34.61	34.61	NR	NR	55.0	Wague and Mbodj (2002)
Senegal	TL	1334					*	*				*	*				NR	23.45	NR	NR	52.0	Conand (Conand, 1977)
Senegal	FL	2232	NR	NR	NR	NR	N	N	N	N	N	N	N	NR	NR	NR	0.000005	3.194	NR	NR	NR	Boëly (1982a)
Senegal	TL	9645		*	*	*	*					*	*				NR	21.59	NR	NR	55.0	Boëly (1982b)
Senegal	FL	2433	NR	NR	NR	NR	N	N	N	N	N	N	N	NR	NR	NR	0.006392	3.274	NR	NR	NR	Fréon (1988)
Senegal	NR	NR		*	*	*	*	*				*	*	*	NR	NR	NR	NR	NR	NR	NR	Cury and Fontana (1988)
Senegal	TL	3947				*	*	*				*	*		27.66	30.98	0.000038	3.162	50.5	NR	Goudiaby et al. (2008)	
Senegal	TL	NR										*	*		21.10	26.55	0.000007	3.040	NR	NR	Samba (Samba, 2011)	
Senegal	TL	4397	*	*	*	*	*				*	*	*		24.82	25.72	0.00000347	3.272	51.1	NR	NR	Present study

Conclusion I/IV

- Three main modal size classes exist among *S. aurita* inhabiting Senegal coastal waters
 - > **adults mainly inhabit northern coastal waters, while juveniles**
 - > **young breeders (<25 cm) are concentrated off the southern coast.**
- The growth parameters and asymptotic length for a same short life species
 - > **higher in the most productive area**

Conclusion II/IV

- The length-weight relationship parameters calculated for *S. aurita* caught in the Eastern Central Atlantic (Mauritania and Senegal) are similar in values to those calculated for fish in the Western Central Atlantic (off Venezuela);
- Variations in K_n suggest that males and females adopt a similar energy intake strategy during gonad maturation and spawning in that K_n reaches its maximum value the month before the beginning of spawning (May or September).

Conclusion III/IV

- Peak spawning corresponds to periods of low sea surface temperature (February or March, depending on the year).
 - *Sardinella aurita* adopts a specific growth and reproductive strategy that is a reaction to specific environmental cues
 - The primary spawning period for *S. aurita* occurs in times of high zooplankton abundance (during upwelling) and in places the most favourable to development of its early life stages
- > Demographic strategy allows *S. aurita* to adapt its abundance to fluctuations in food availability

Conclusion IV/IV

**Under the effect of multiple stressors
mainly fishing pressure and climate change**

→ Growth parameters (L_{∞})

→ Maximum size reported (13 % in 20 years)

--> Reproduction periods

**Nevertheless, surprisingly the size at first maturity
for *S. aurita* does not vary in the Canary Current
LME**

THANKS!!!

