DRIVERS OF DYNAMICS OF SMALL PELAGIC FISH RESOURCES
March 6-11, 2017
Victoria, Canada

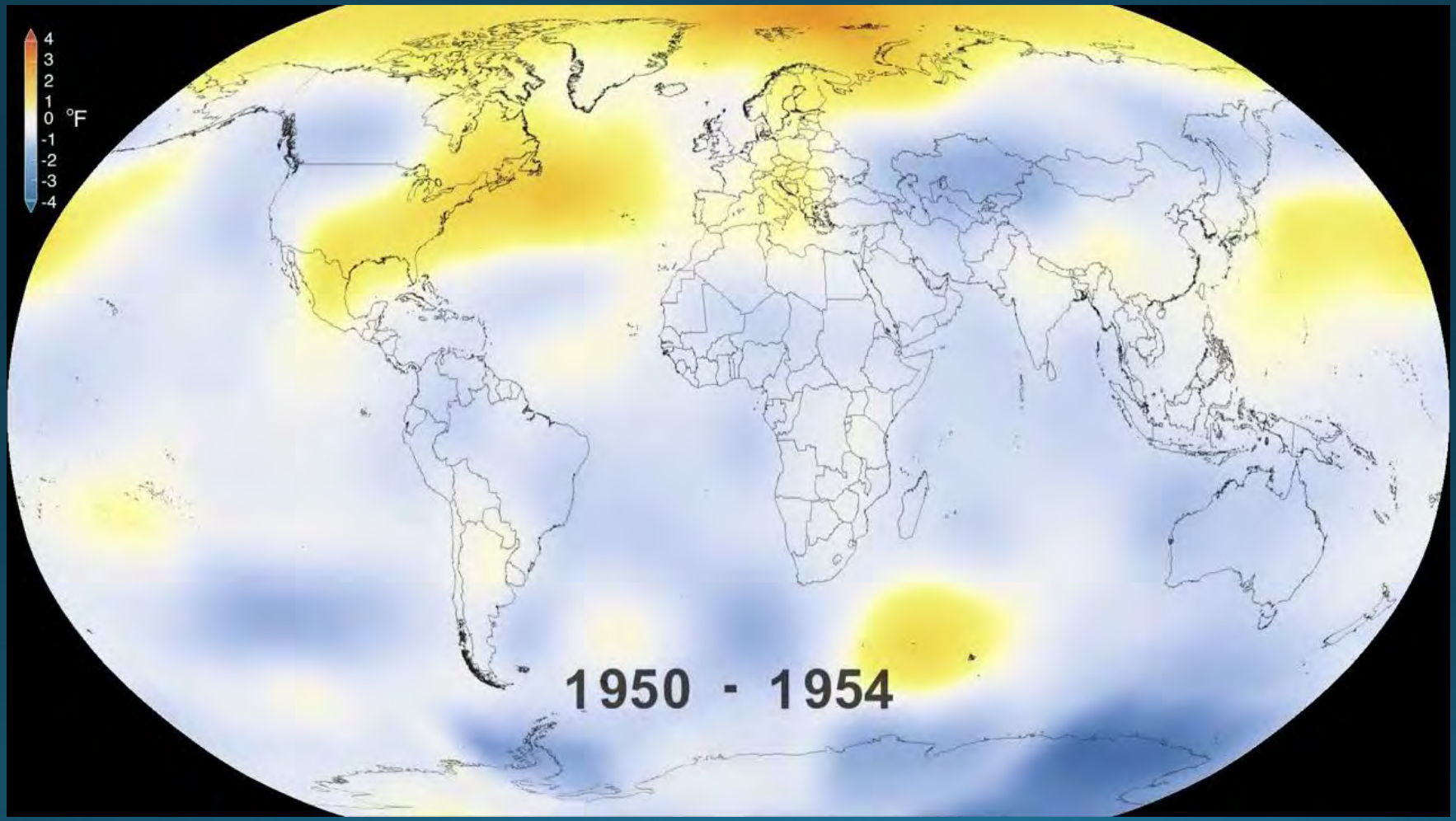
Past and future distribution of the Bay of Biscay anchovy in response of climate change

Maite Erauskin-Extramiana

Marine Research division, AZTI-Tecnalia, Sukarrieta (Spain)

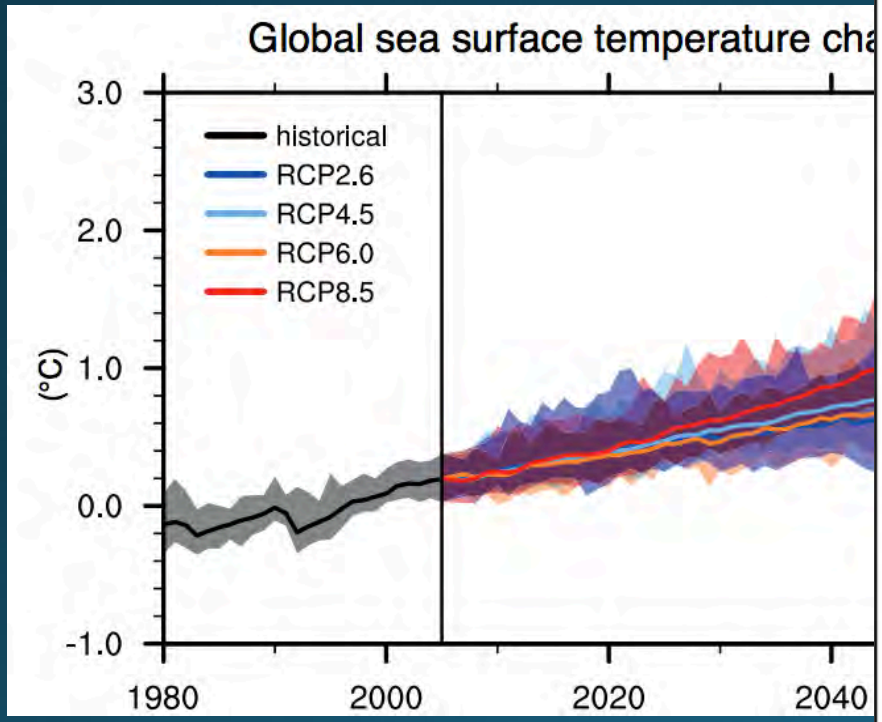
Chust G., Álvarez P., Arrizabalaga H., Ibaibarriaga L., Uriarte A., Cotano U., Santos M., Ferrer L. , Cabré A.

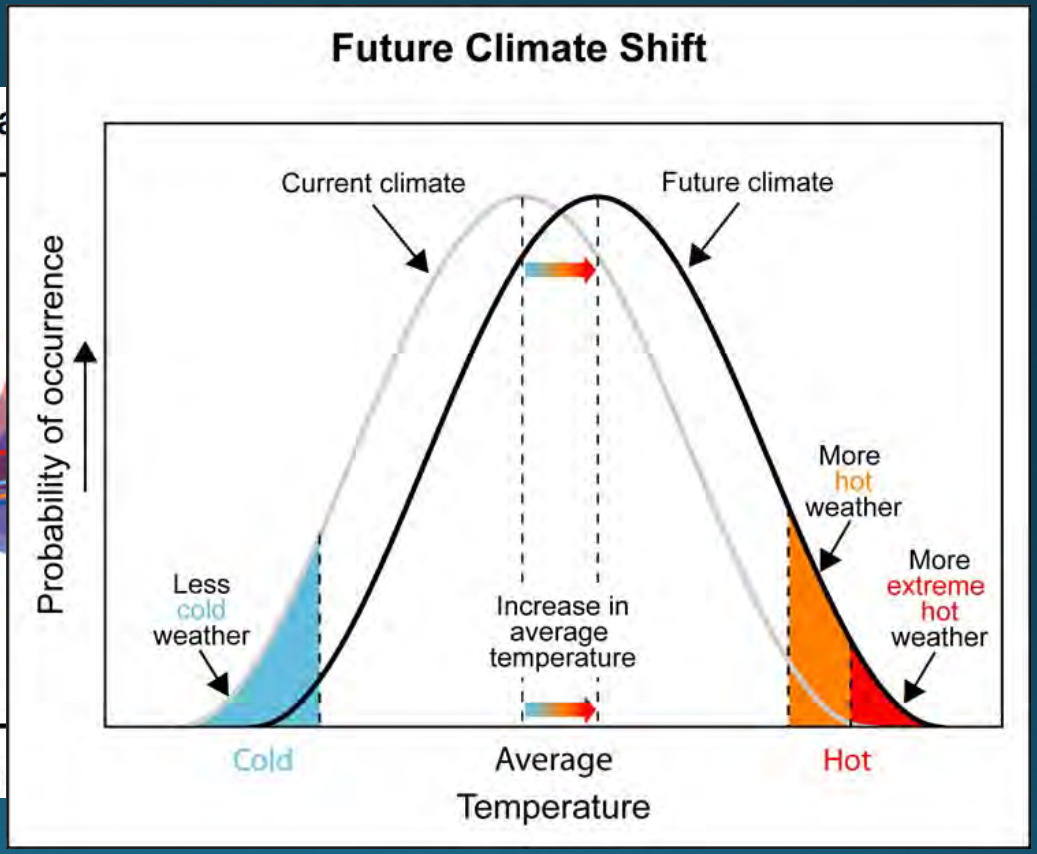
Global climate change

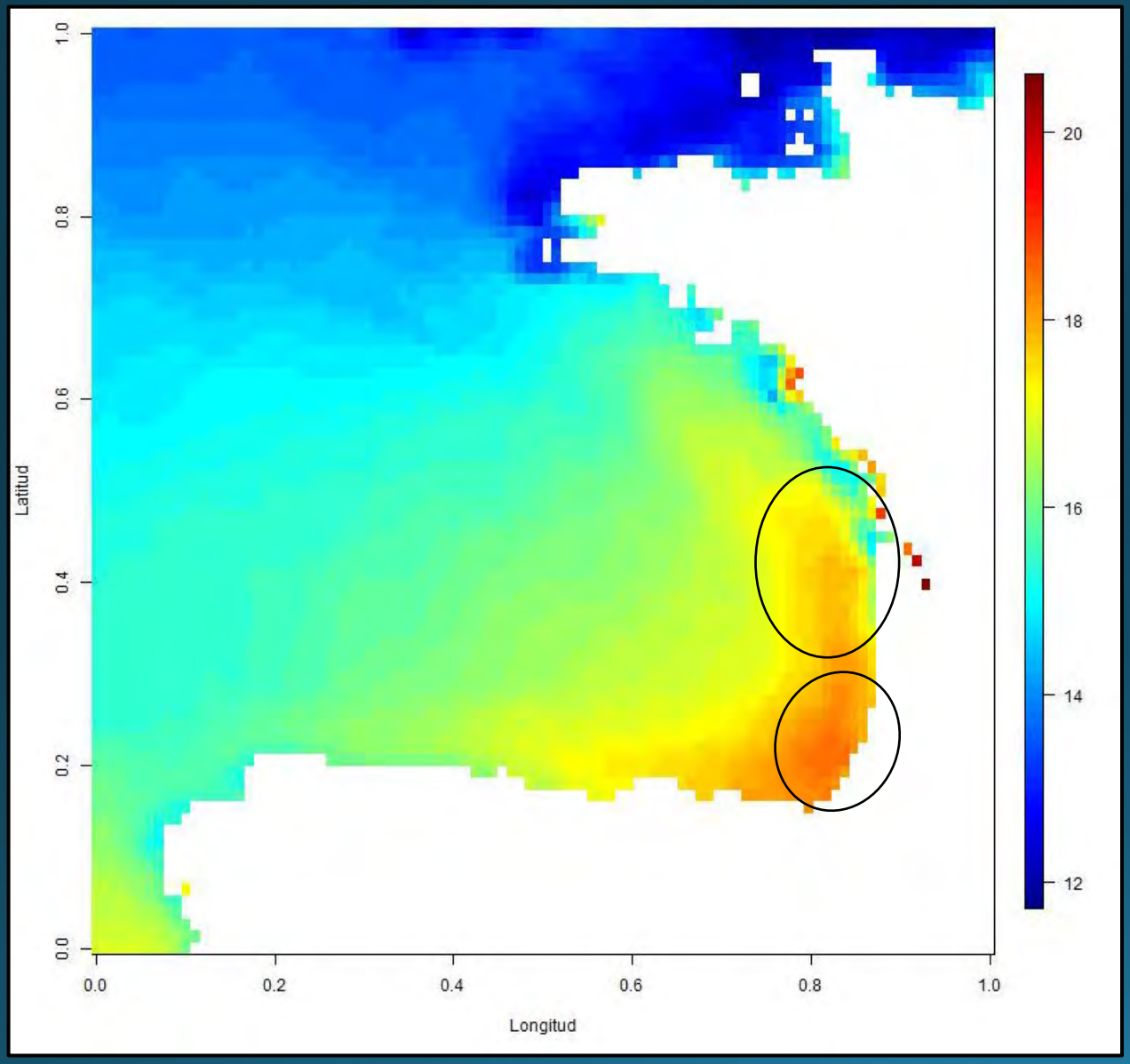


Atmospheric temperature change (1950-2014) –
NASA.gov Video

Global climate change






Latitud
Longitud
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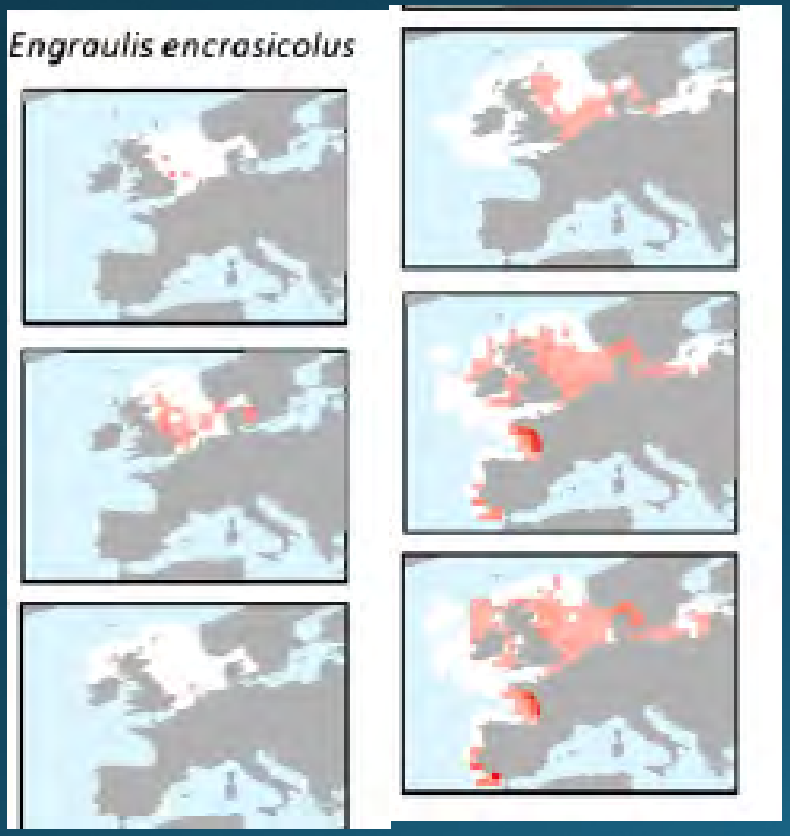
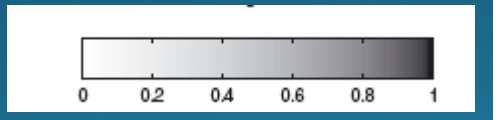
0.2
0.4
0.6
0.8
1.0
12
14
16
18
20

Anchovy distribution variations

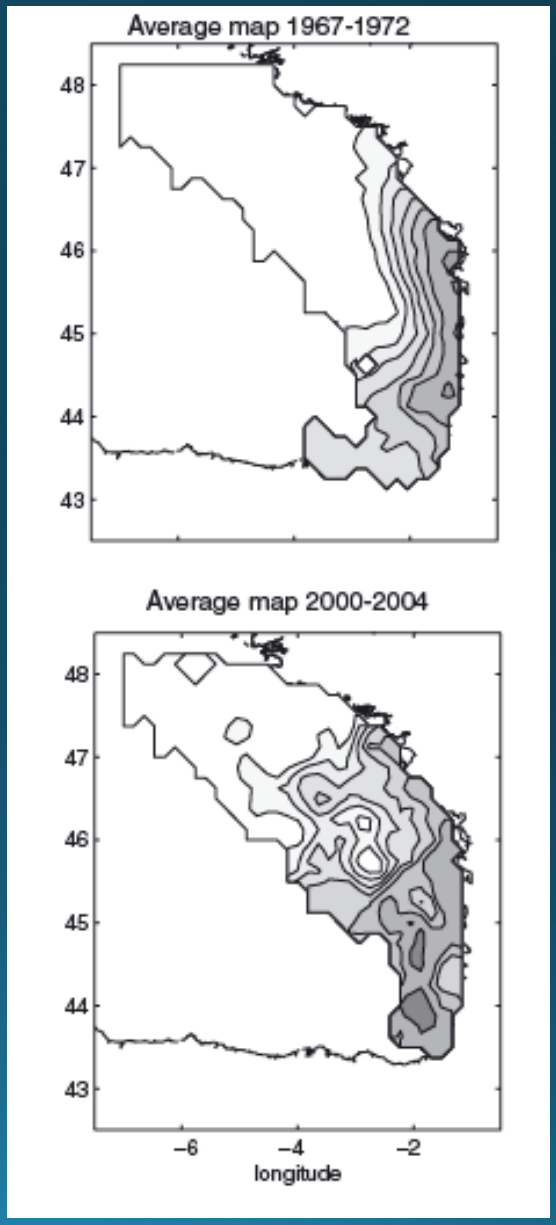


Fisheries-independent data from International Bottom Trawl Surveys (IBTS) between 1965 to 2012

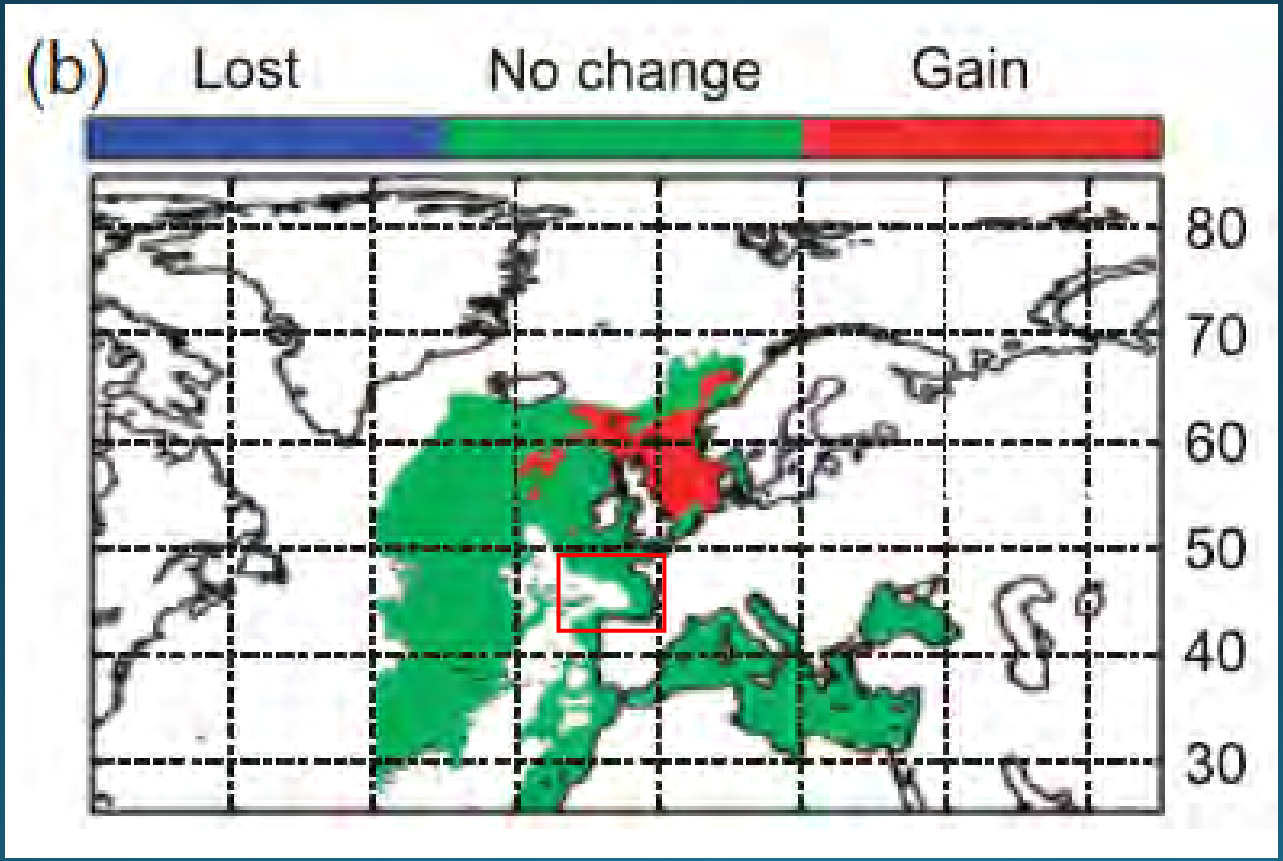
Montero-Serra *et al.*, (2015)



Bellier *et al.*, (2007)

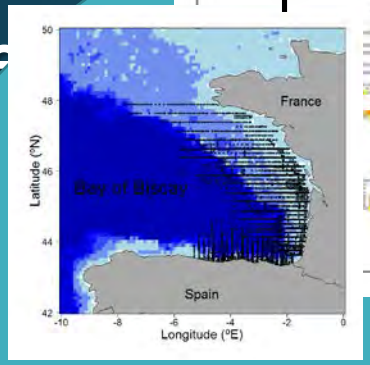


Anchovy distribution future projections

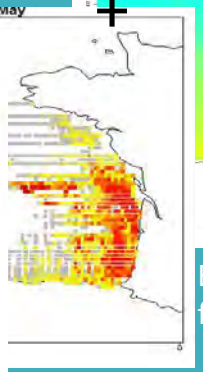


Lenoir *et al.*, (2011)

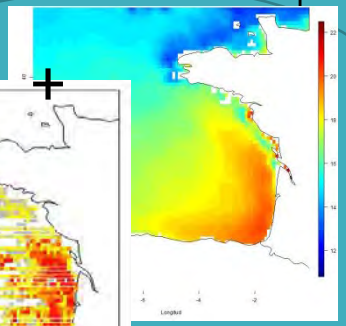
Objective



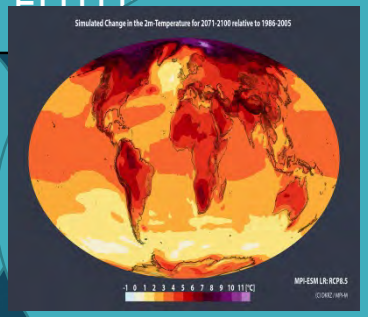
Sampling grid



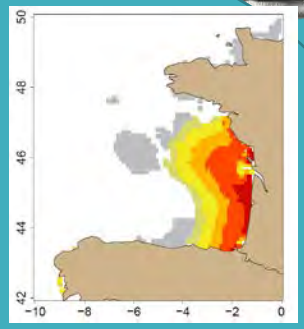
Observations



Environmental factors

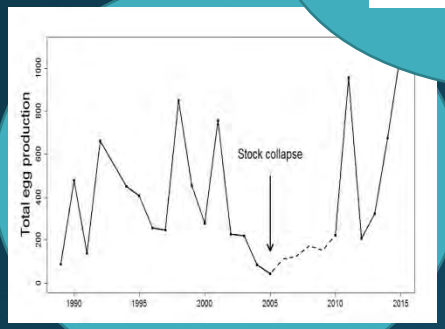


RCP8.5 climate change scenario



Anchovy eggs distribution

PAST



PRESENT

1 Spawning - peak
Spawning - CoG*

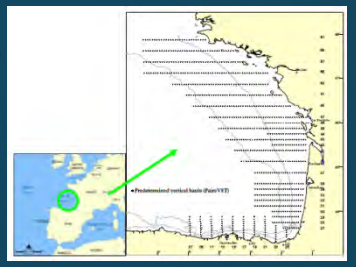
trends analysis

2 Current habitat modelling

3 Projections under RCP8.5 climate change scenario

*CoG → Population Center of Gravity

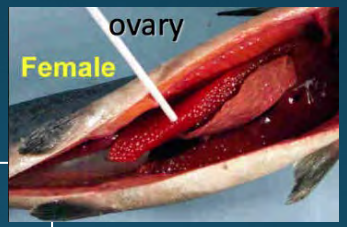
Peak of spawning period



BIOMAN (1990-2014) + ANEBIO (1987-2015)

1.) Data collection

2.) Gonadosomatic index (GSI) estimation

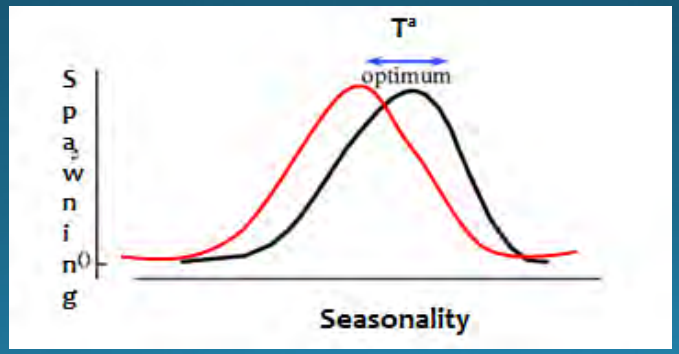


$$GSI = \frac{Gonad\ weight}{Body\ total\ weight}$$

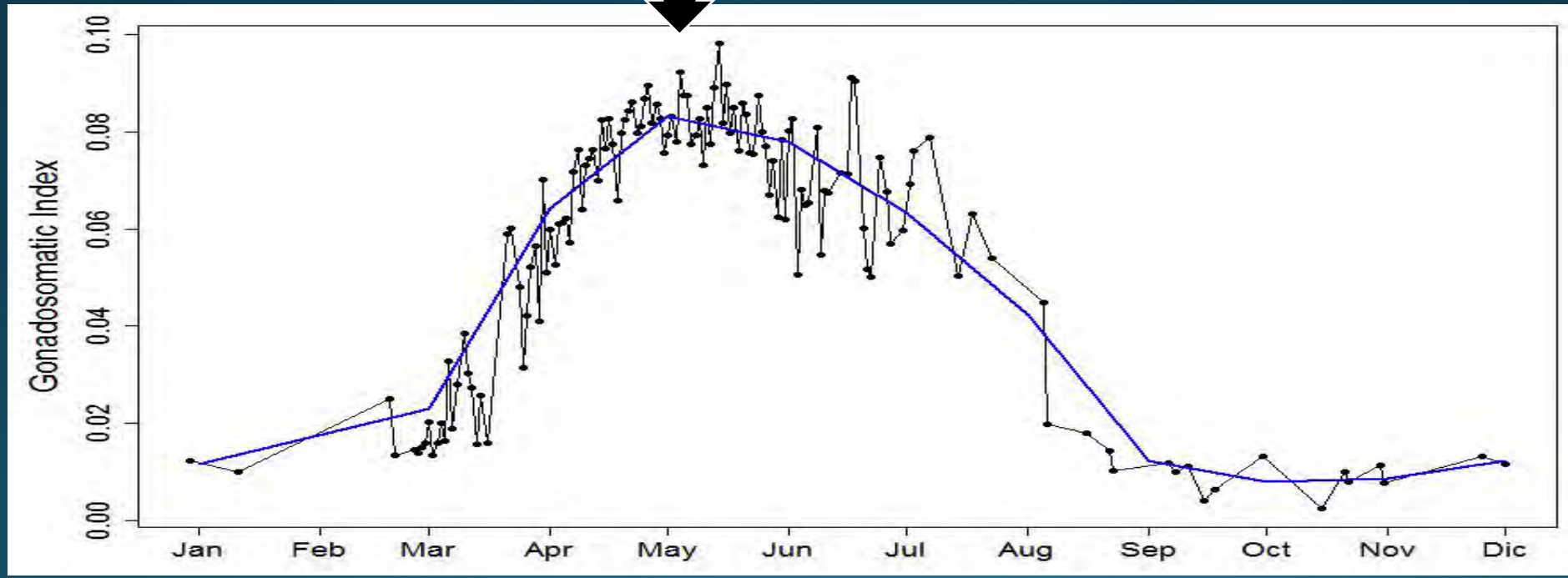
3.) Peak of spawning estimation

$$Spawning\ peak = \frac{\sum_m (GSI_m * m)}{\sum_m (GSI_m)}$$

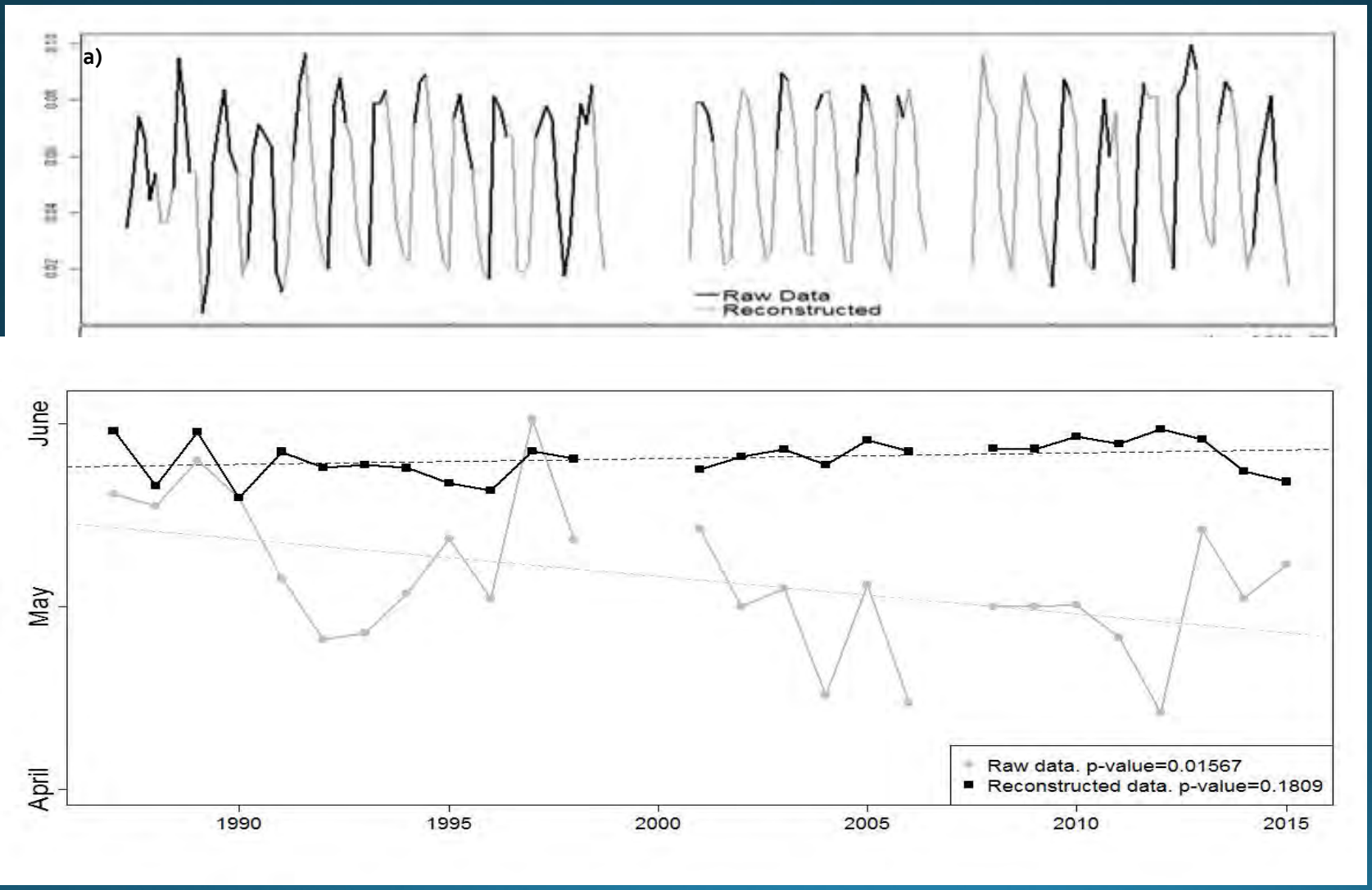
4.) Phenology changes?



Peak of spawning period

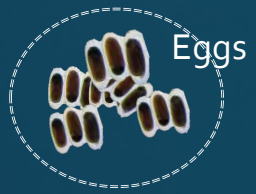


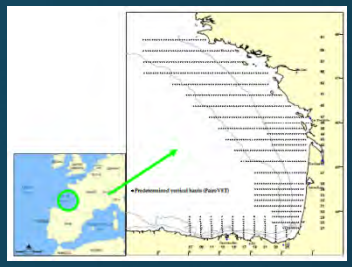
Peak spawning period



Spawning reconstruction model

1.) Data collection





BIOMAN (1989-2015)

2.) General additive models (GAM-s):

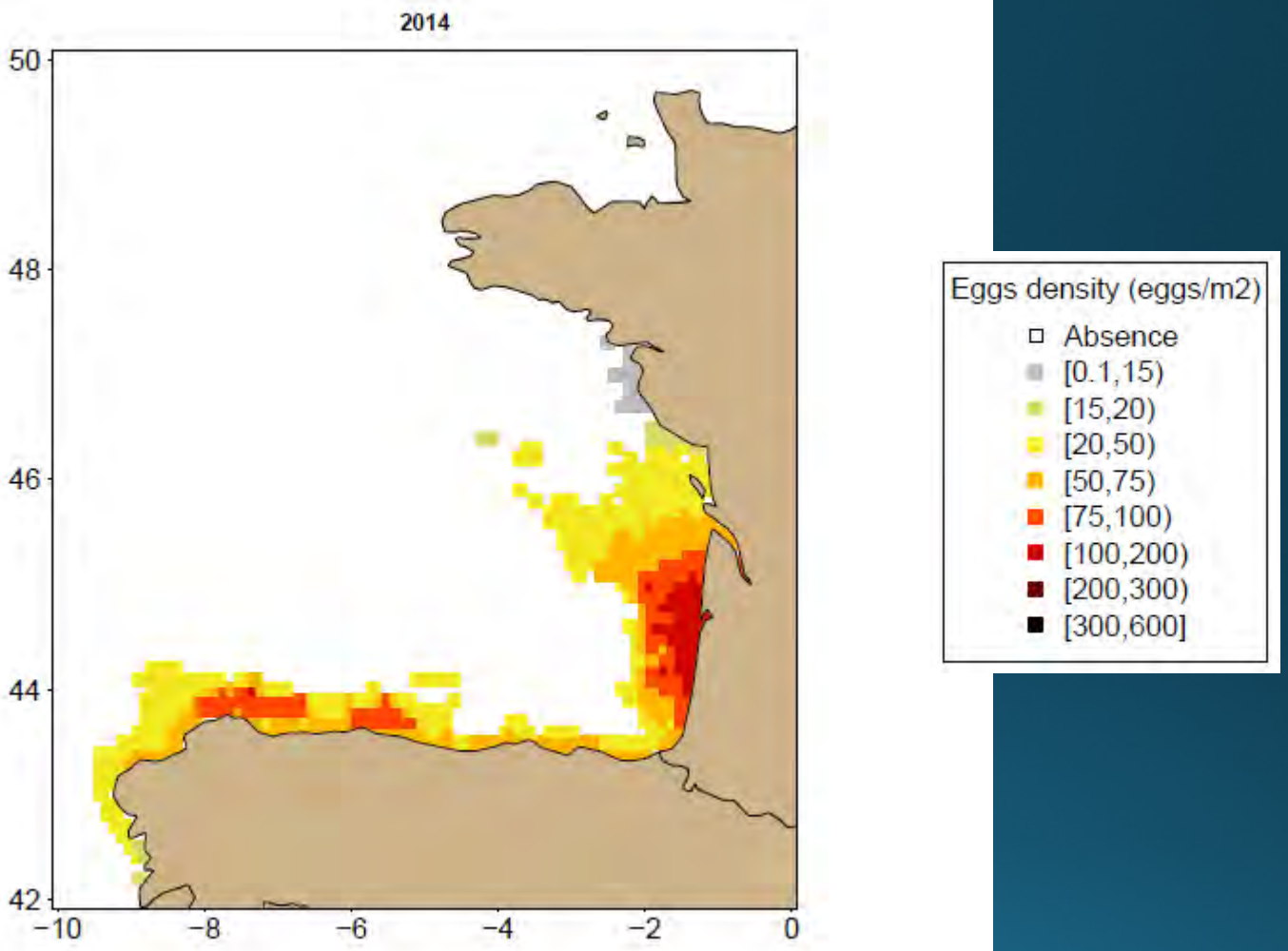
eggs observations (PA* / ED) + Spatio-temporal variables

*PA = Presence/Absence

ED = Egg Density (abundance)

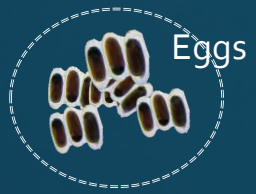
Spatial:
- Latitude
- Log(Bathymetry)

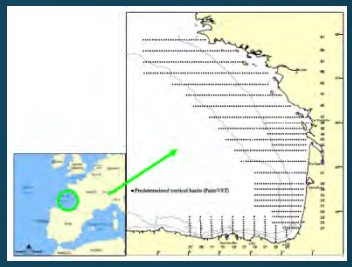
Temporal:
- Year


2014
50
48
46
44
42
−10
−8
−6
−4
−2
0
Eggs density (eggs/m2)
Absence
[0.1,15)
[15,20)
[20,50)
[50,75)
[75,100)
[100,200)
[200,300)
[300,600]

Spawning reconstruction model

1.) Data collection





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Spatial:
- Latitude
- Log(Bathymetry)

Temporal:
- Year

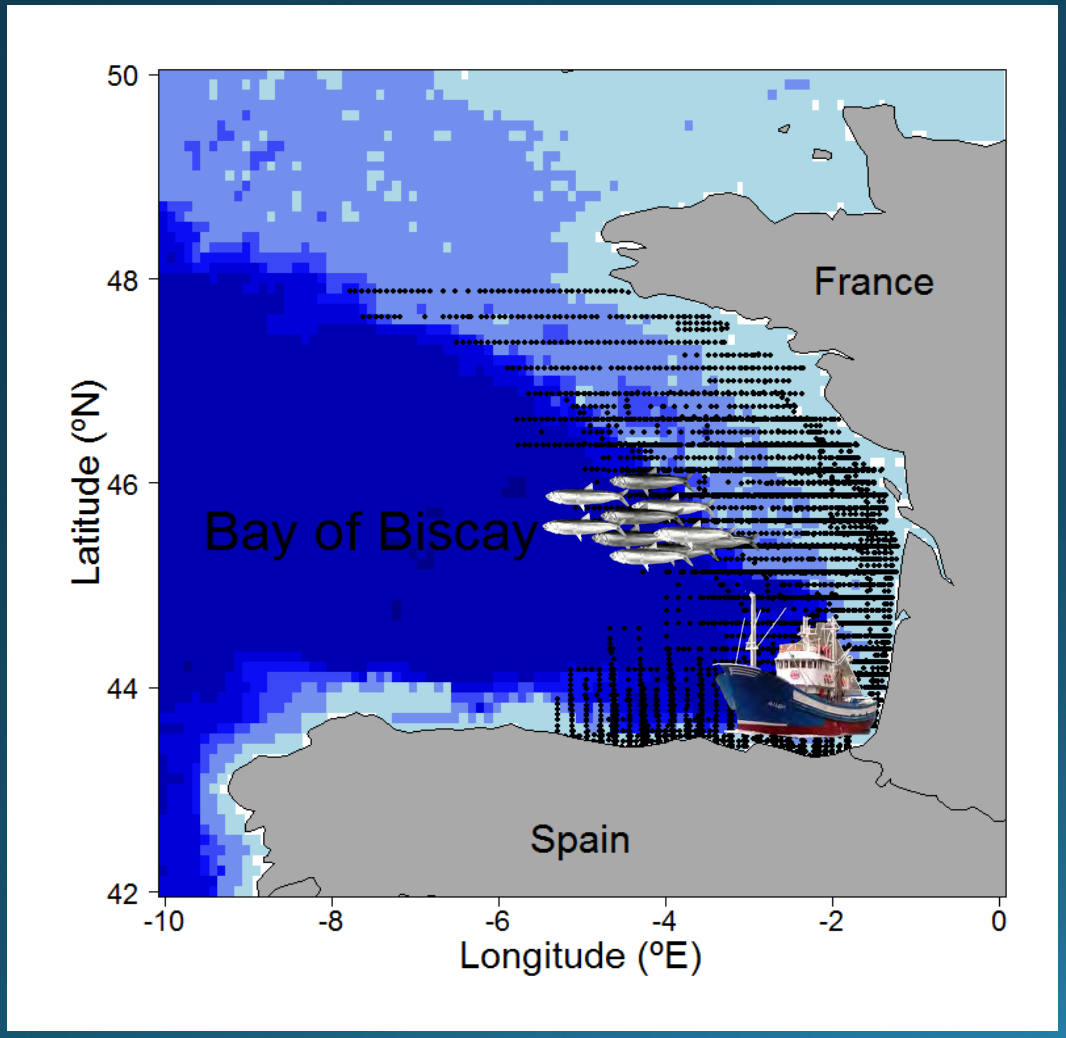
3.) Population Center of Gravity estimation

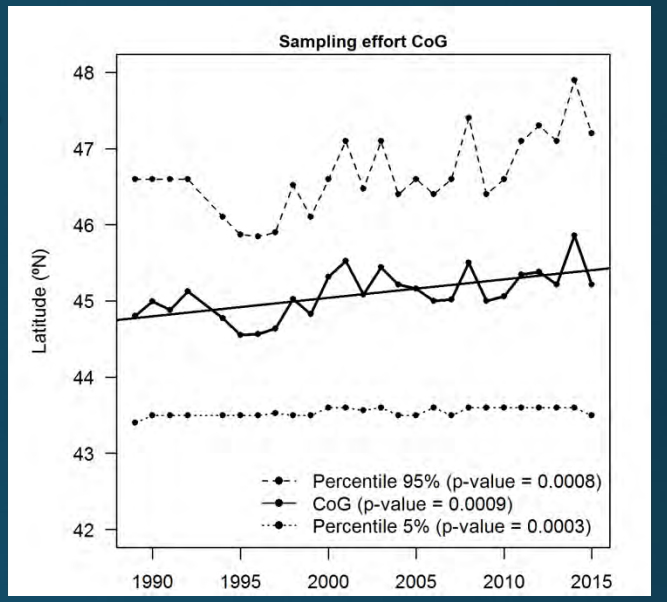
- Geographical point that describes a center-point of the region's population

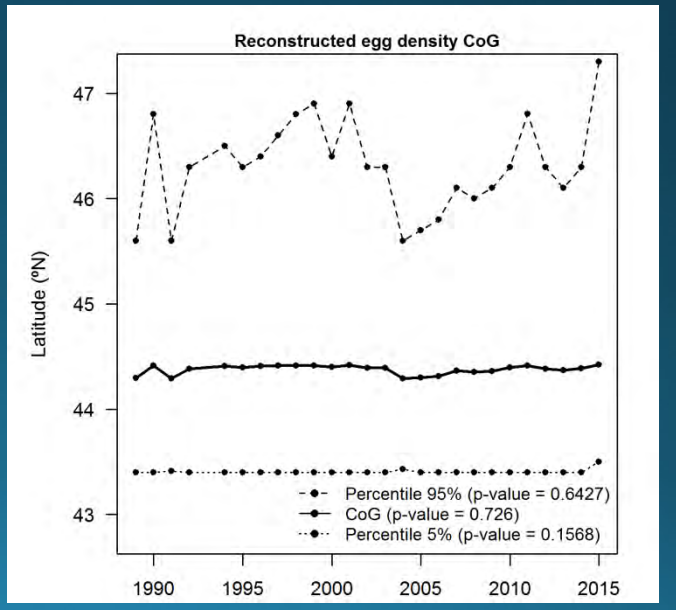
4.) Correlation: CoG and variation drivers

- Sea Surface Temperature
- Density-dependence dynamics

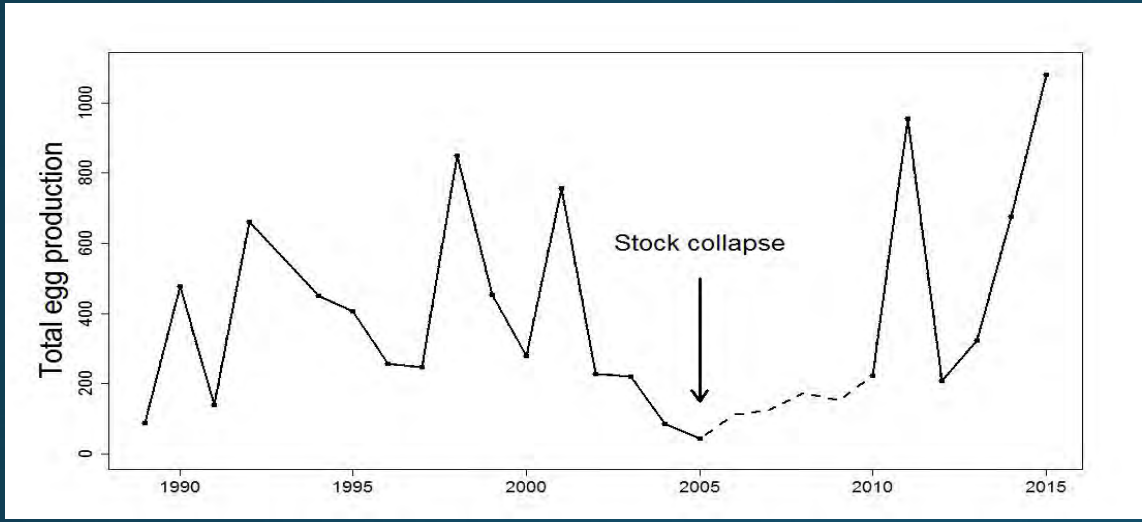
Spawning distribution variations

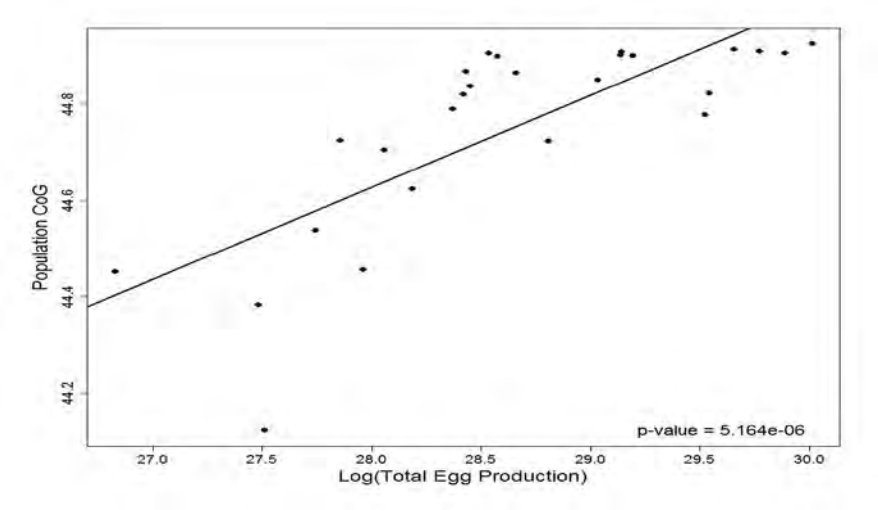






Spawning distribution variations

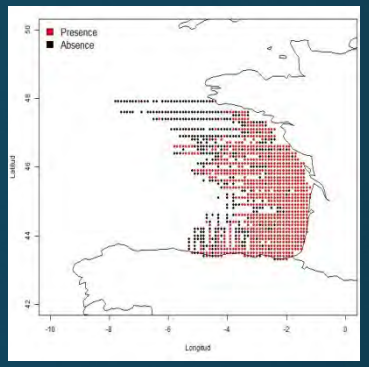




Spawning habitat modelling

Habitat modelling

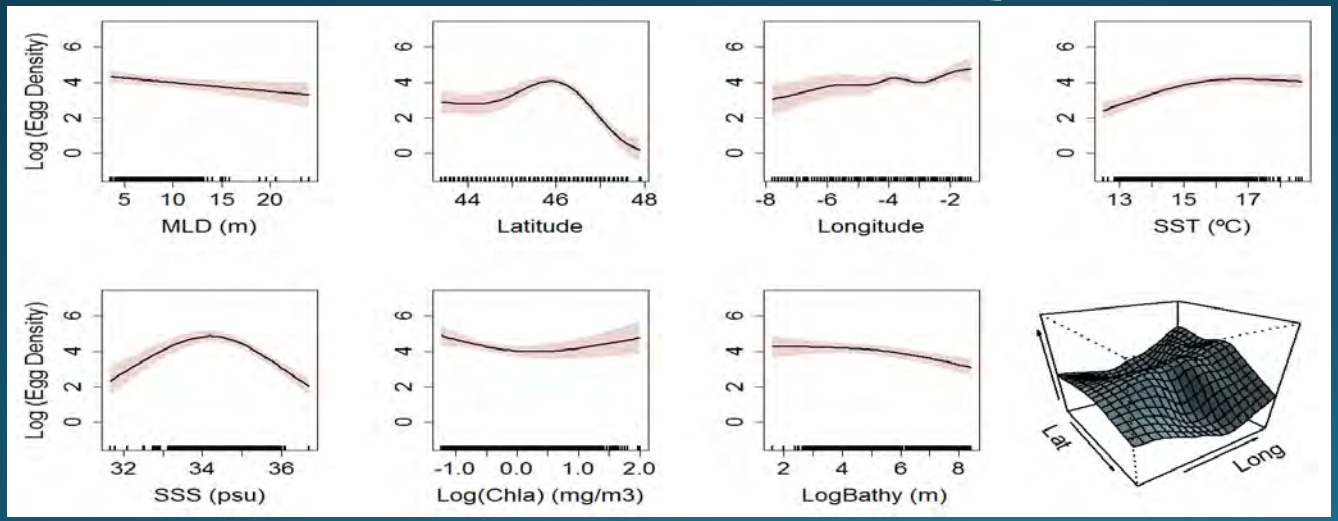
1.) Data standardization (0.1ºx0.1º resolution)



BIOMAN (1989-2015)

2.)Model: eggs observations (PA / ED) + environmental variables

- SST
- SSS
- MLD
- Log(Bathymetry)
- Log(Chlorophyl-a)
- Lat, Long

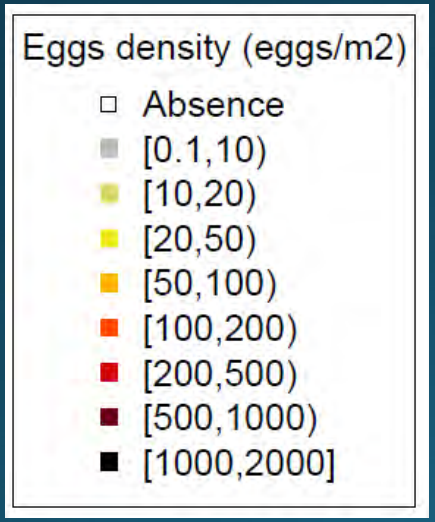


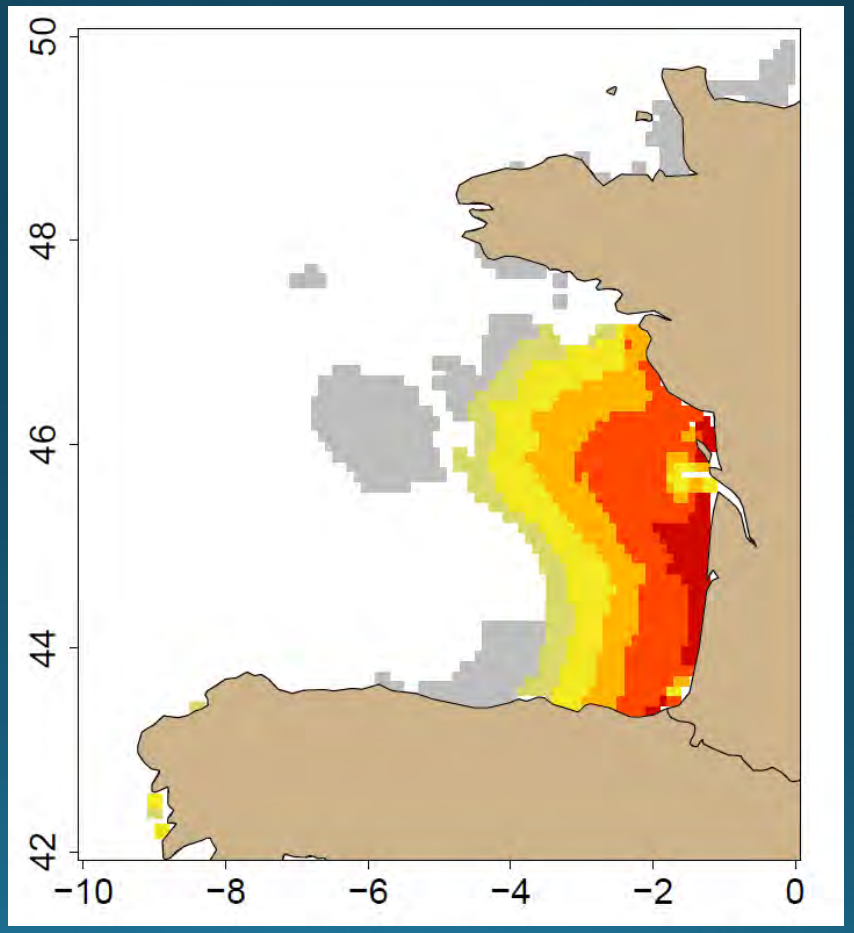
3.) Extrapolation to all the Bay of Biscay

Spawning habitat modelling

Present
(2006-2020)

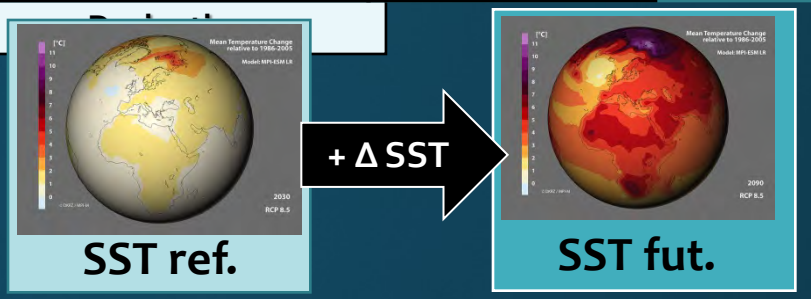
Dev. Expl.
- PA: 48%
- ED: 58%





gam<- gam(LogEP ~ s(Lat, Long) + s(SST, k=3) + s(SSS, k=3) + MLD + s(LogChla, k=3) + s(LogBathy, k=3), family=gaussian)

Future projections



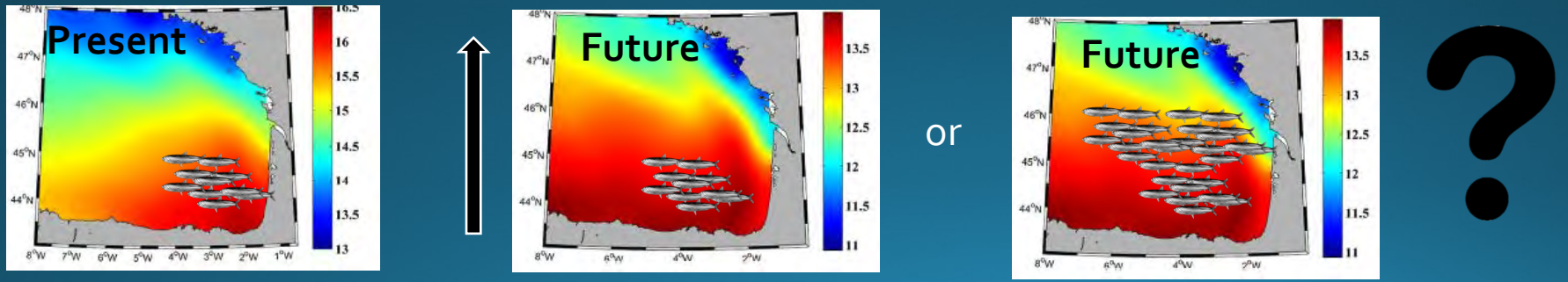
1.) Estimate changes for the future

RCP8.5 (936 CO_2 ppm)

- Mid-of-the-century (2040-2055)
- End-of-the-century (2080-2099)

Mid-of-the-century (2040-2059)			End-of-the-century (2080-2099)		
SST (ºC)	SSS (psu)	MLD (m)	SST (ºC)	SSS (psu)	MLD (m)
0.52±0.28	-0.30±0.13	-7.48±8.31	1.51±0.71	-0.57±0.35	-12.40±12.84

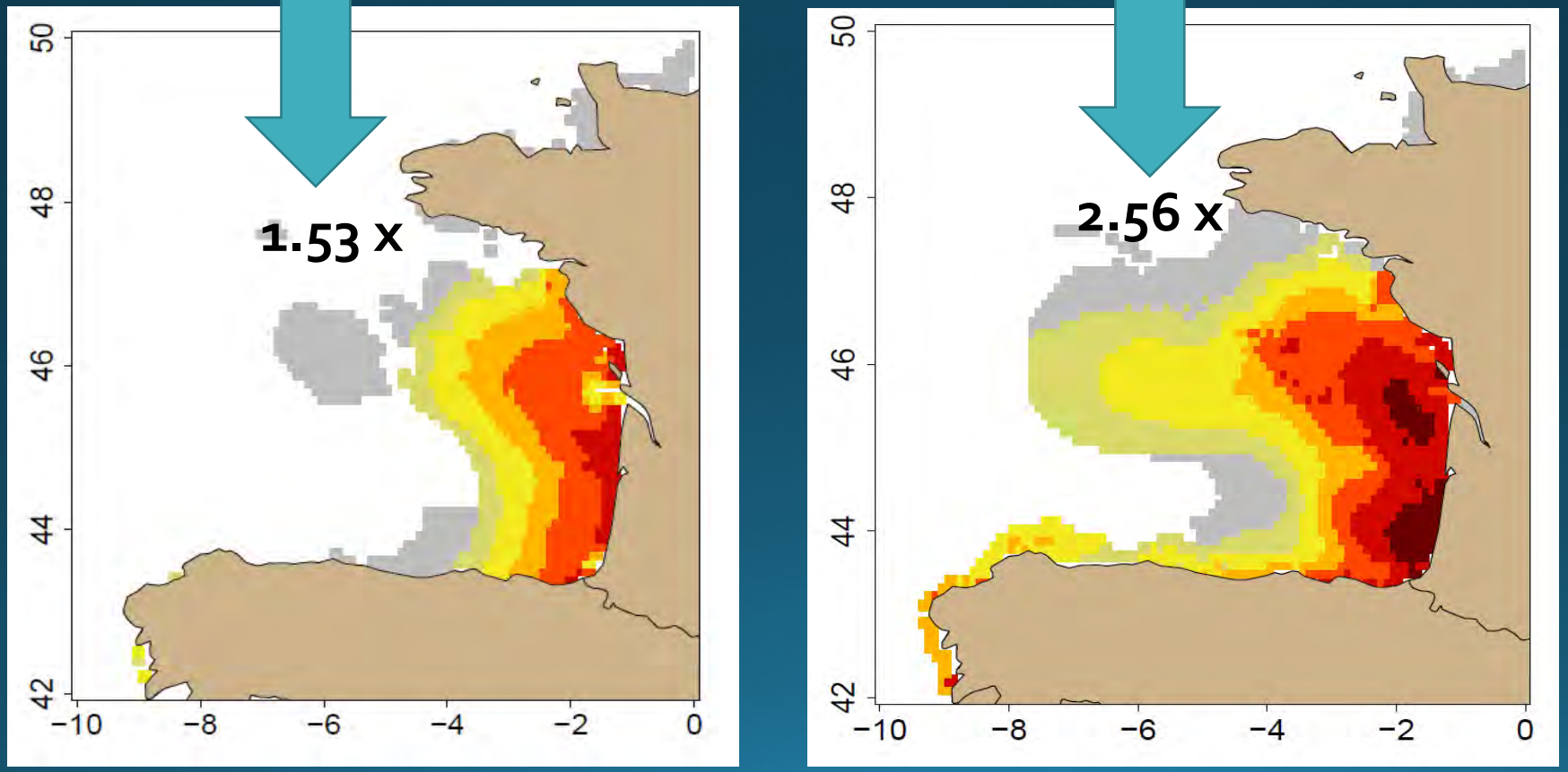
2.) Model + future environmental conditions



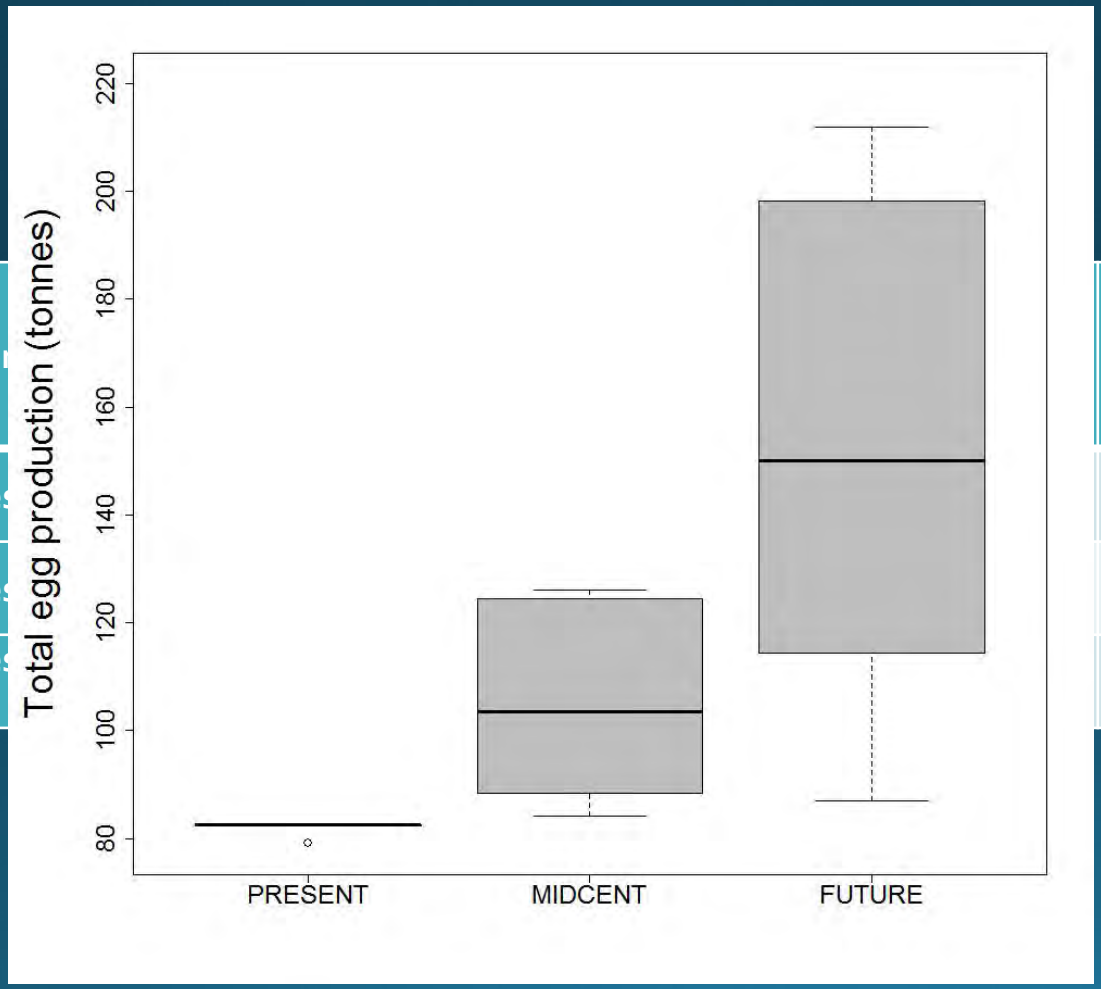
Spawning distribution future projections

Mid-century
(2040-2055)

End-of-century
(2080-2099)



Spawning distribution future projections



Total egg pr		Change →Midcent	Change →Future
All variables		1.53 x	2.56 x
All variables		1.51 x	2.40 x
All variables LogBathy		1.33 x	2.20 x

Conclusions

Past

- No phenological changes (1987-2015)
- No population CoG shift (1989-2015)
- Population CoG variations highly correlated with density-dependent dynamics

Present

- Our model explained 58.1% of the total deviance
- Spawning is closely related to river plumes (Adour, Gironde)

Future

- ++ effects for BB anchovy spawning
- Increase 1.5 and 2.5 times (mid-century / end-of-the-century)

ICES
CIEM

DRIVERS OF DYNAMICS OF SMALL PELAGIC FISH RESOURCES

March 6-11, 2017
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PICES

Thank you very much!

Chust G., Álvarez P., Arrizabalaga H., Ibaibarriaga L., Uriarte A., Cotano U., Santos M., Ferrer L. , Cabré A.

azti tecnalia