

Cambios en las comunidades de macroalgas del Cantábrico y su relación con el cambio climático

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¿Qué son las macroalgas y cual es su importancia en los sistemas costeros?

¿Qué peculiaridades tiene la costa Cantábrica?

¿Qué cambios se han detectado recientemente en las comunidades dominadas por macroalgas en el Cantábrico?

¿Y en el futuro?



Costas rocosas:
Zonas intermareal y submareal

Macroalgas



Macroalgas



Ochrophyta
(*Clase* Phaeophyceae)
“Feofíceas”

Chlorophyta
“Clorofíceas”



Rhodophyta
“Rodofíceas”



Macroalgas



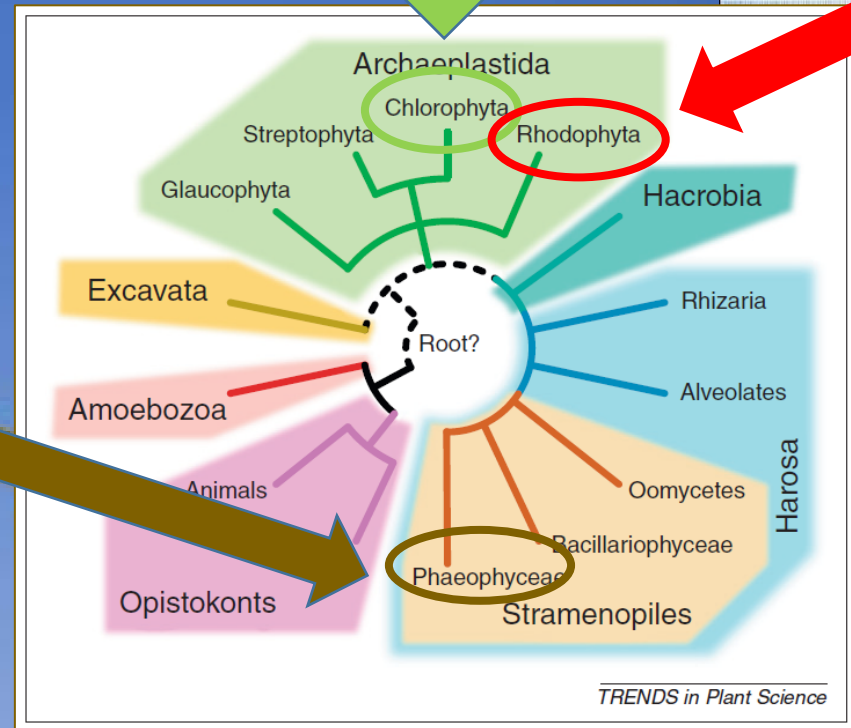
Chlorophyta
"Clorofíceas"

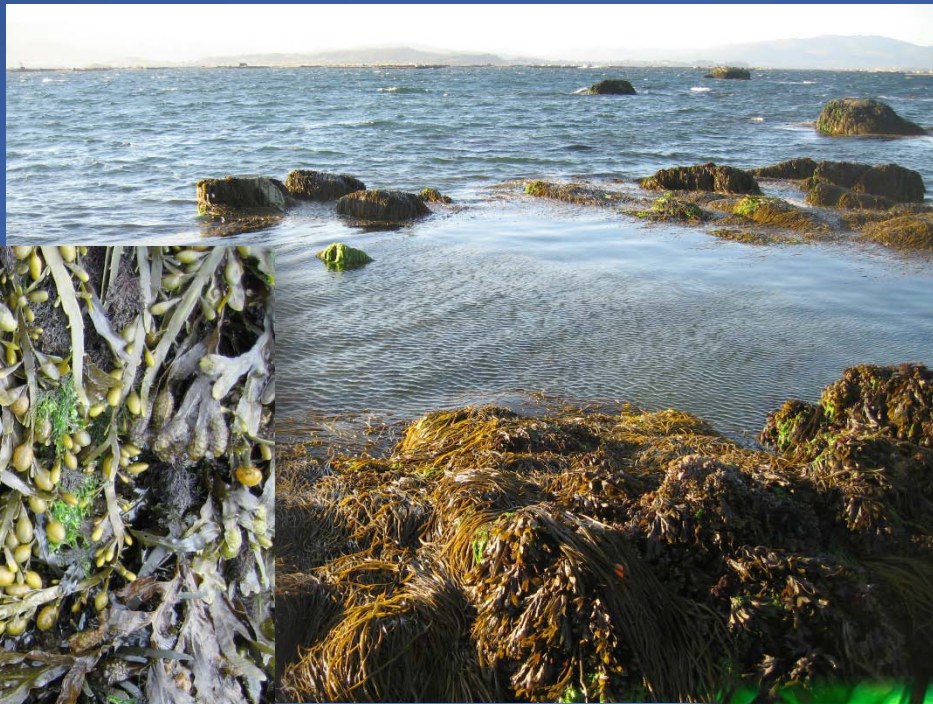


Rhodophyta
"Rodofíceas"



Ochrophyta
(Clase Phaeophyceae)
"Feofíceas"





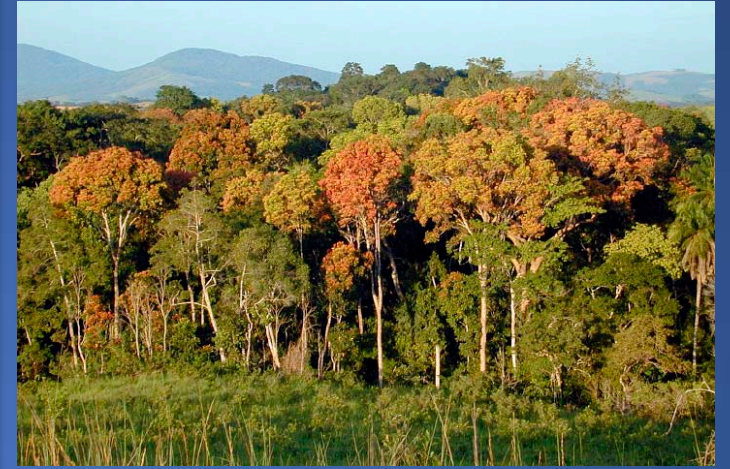
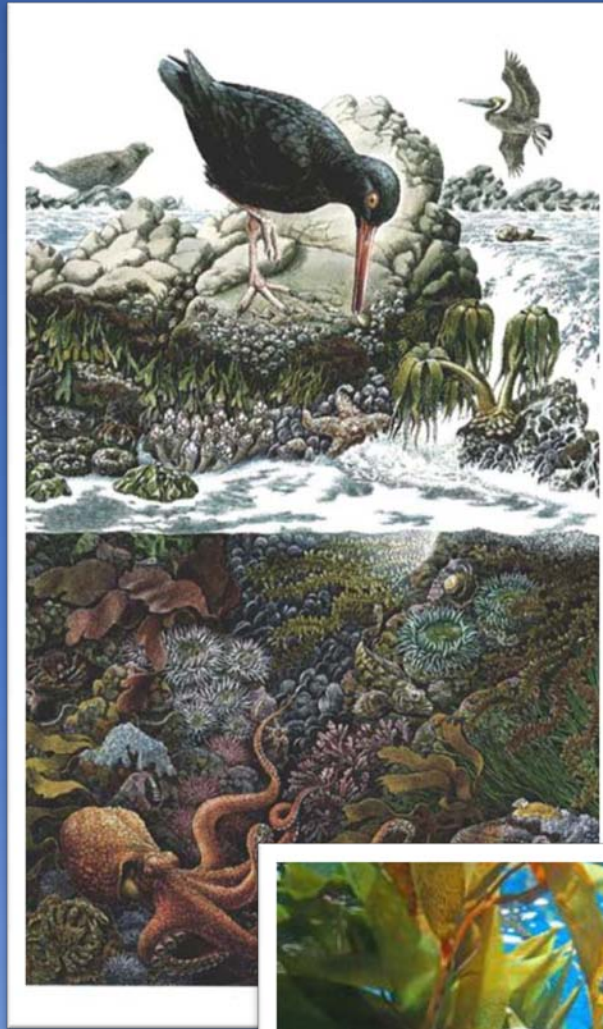
Macroalgas “formadoras de dosel”

Especies clave en los ecosistemas costeros



Macroalgas formadoras
de dosel

“Ingenieros autogénicos”



La costa Cantábrica: Información de la distribución de especies de macroalgas desde el siglo XIX

NOTE PRÉLIMINAIRE
SUR LES ALGUES MARINES DU GOLFE DE GASCOGNE
Par M. Camille SAUVAGEAU. (1897)

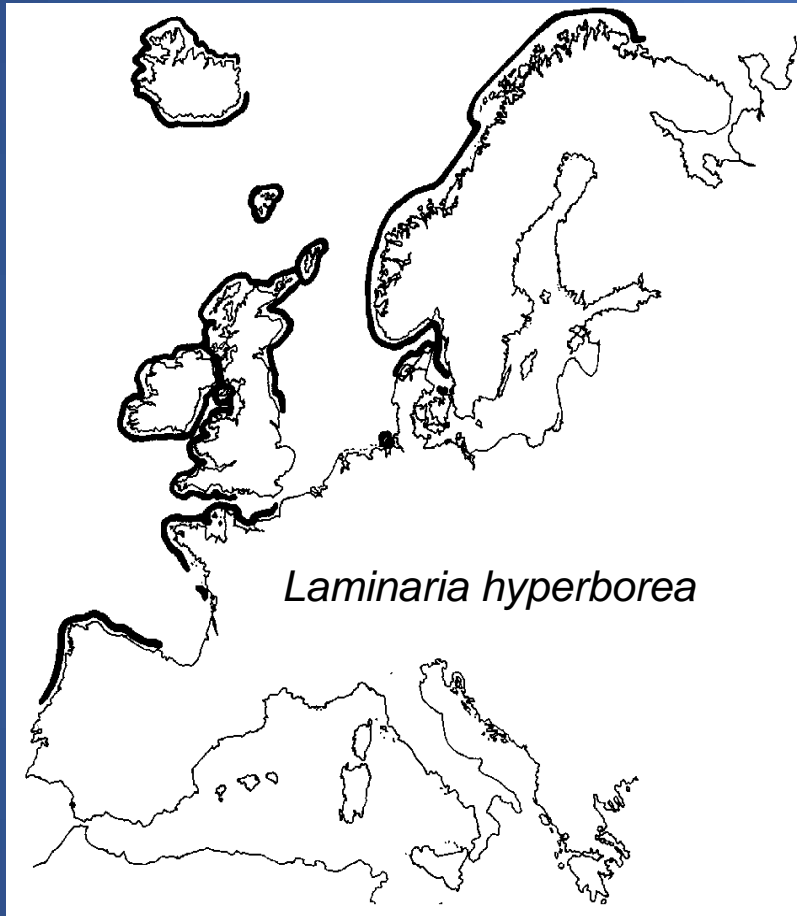
ANNALES DE L'INSTITUT OCÉANOGRAPHIQUE
Tome XL, pages 165 à 312.
29 Juin 1963.

LA DISTRIBUTION
DES PRINCIPAUX ORGANISMES INTERCOTIDAUX
NORD-IBÉRIQUES EN 1954-1955

PAR
E. FISCHER-PIETTE



La costa Cantábrica : Frontera biogeográfica



Saccharina latissima

Laminaria hyperborea

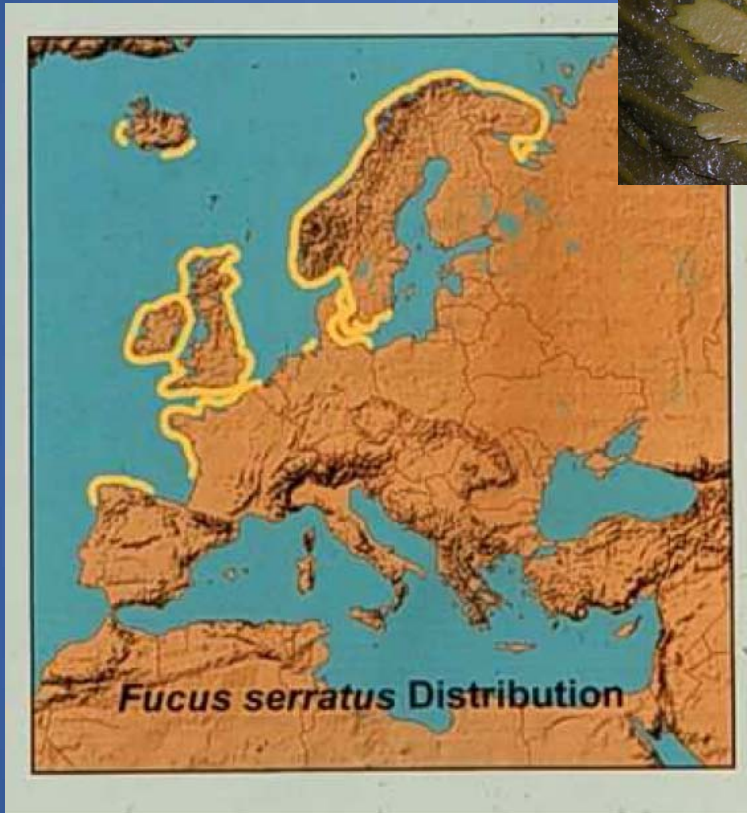


La costa Cantábrica : Frontera biogeográfica

Fucus serratus

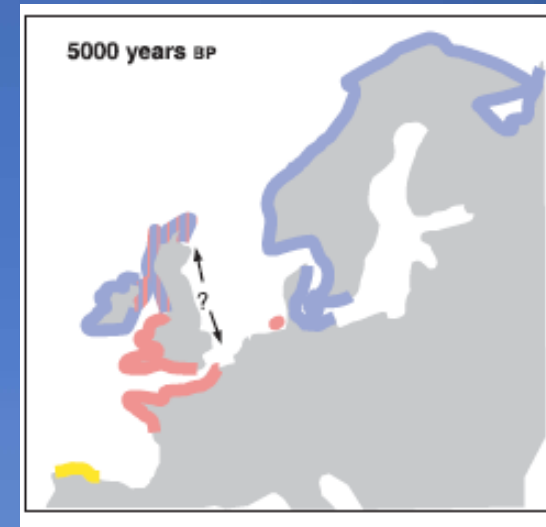
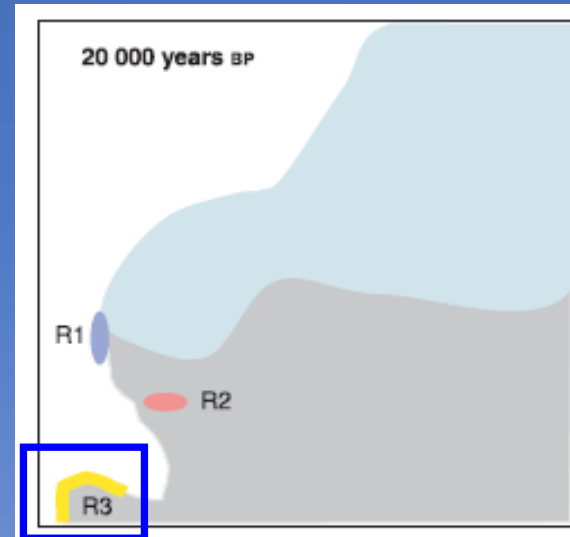
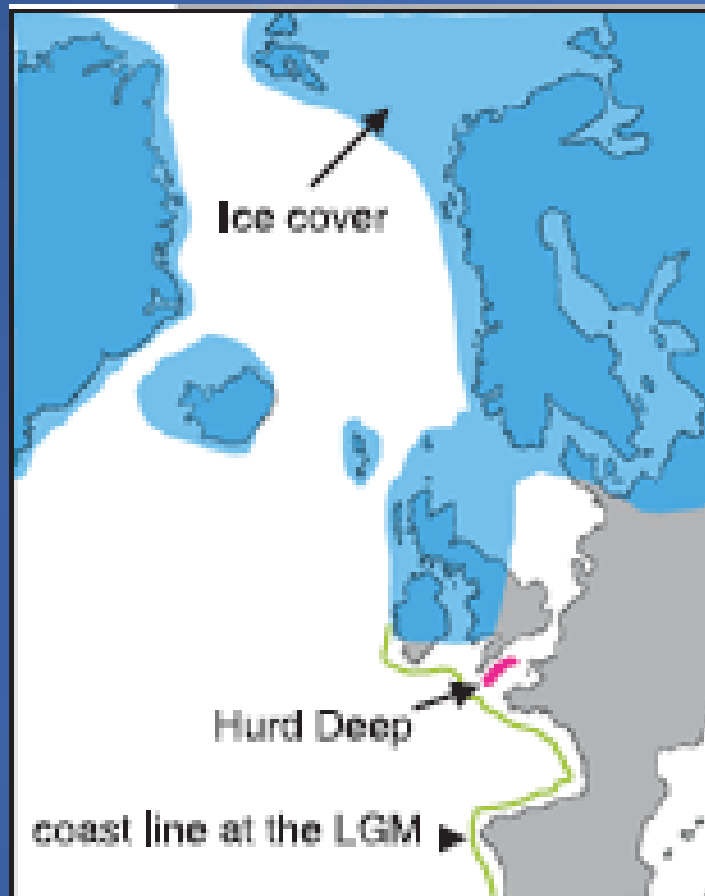


Himanthalia elongata



La costa Cantábrica :

-Diferenciación genética de las poblaciones de macroalgas y otros organismos marinos



Fucus serratus

Hoarau et al 2007. *Molecular Ecology*



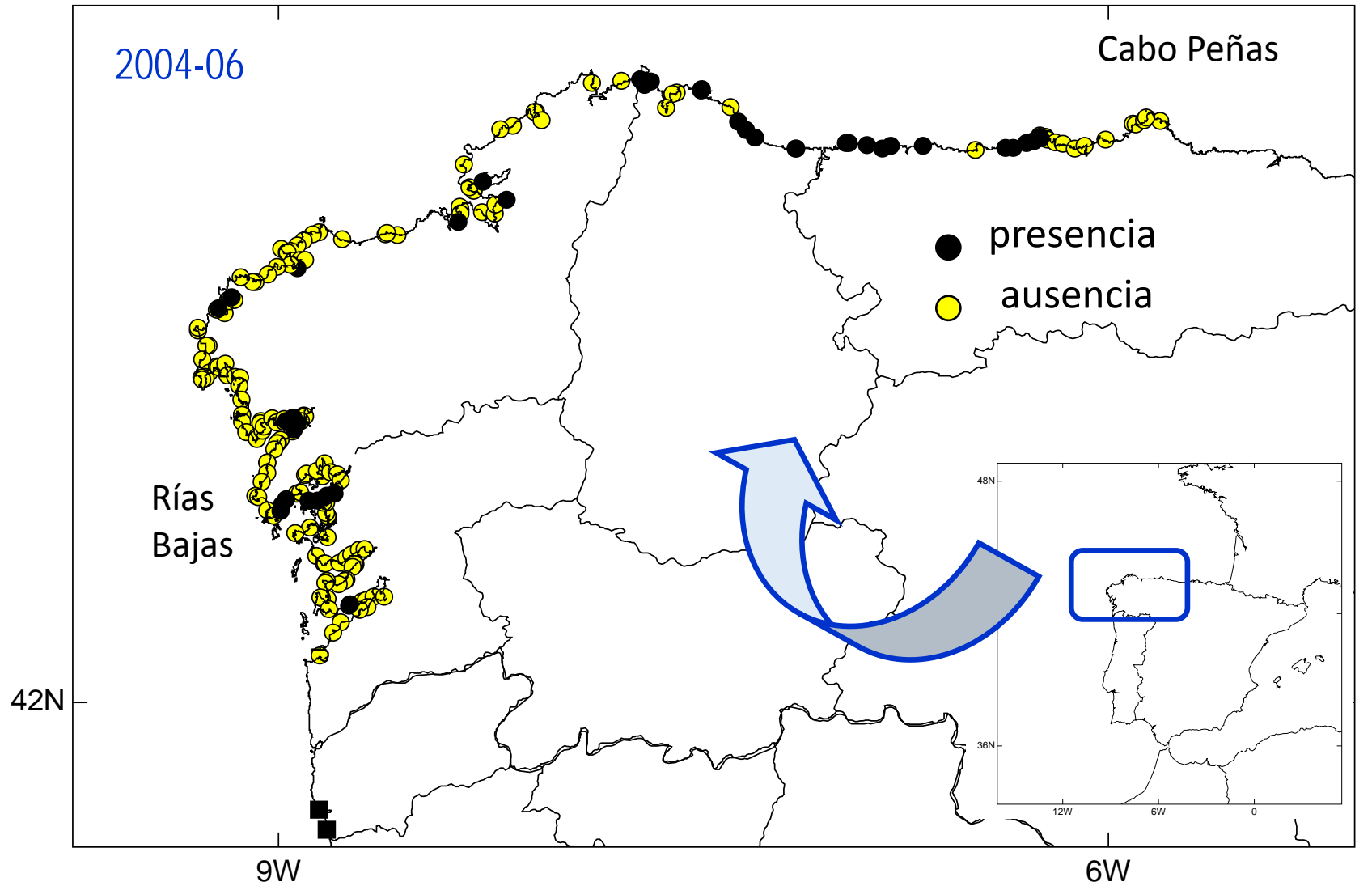
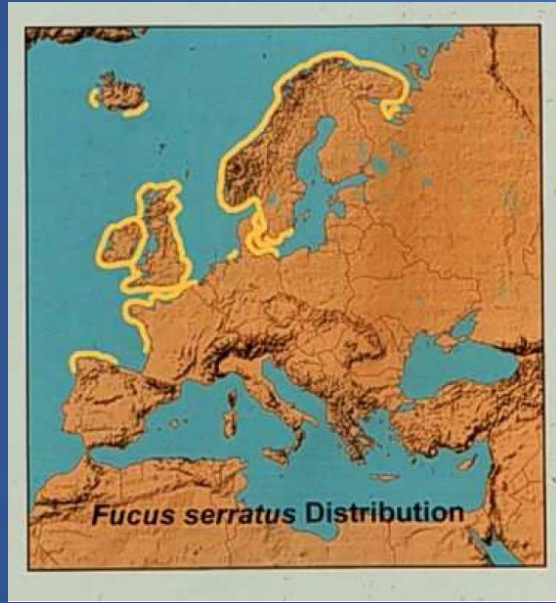
La costa Cantábrica : Diferenciación genética de las poblaciones de macroalgas y otros organismos marinos

Species	Description	Refugial location(s)	Reference
<i>Celleporella hyalina</i>	Bryozoan	Northwestern Iberia	Gómez et al. (2007)
<i>Chondrus crispus</i>	Seaweed	Northwestern Iberia	Provan & Maggs (2012)
<i>Fucus ceranoides</i>	Seaweed	Northern Iberia	Neiva et al. (2012)
<i>Littorina saxatilis</i>	Periwinkle	Northwestern Iberia	Doellmann et al. (2011)
<i>Monocelis lineate</i>	Microturbellarian	Northwestern Iberia	Casu et al. (2011)
<i>Nassarius nitidus</i>	Gastropod	Mediterranean / Northern Iberia	Albaina et al. (2012)
<i>Neomysis integer</i>	Mysid	Portugal	Remerie et al. (2009)
<i>Palmaria palmata</i>	Seaweed	Portugal	Provan et al. (2005)
<i>Pomatoschistus minutus</i>	Fish	Northwestern Iberia	Larmuseau et al. (2009)

Table 1. Northern North Atlantic species harbouring unique genetic variation in rear-edge populations.

Cambios recientes en la distribución y abundancia de varias especies de macroalgas en la Costa Cantábrica

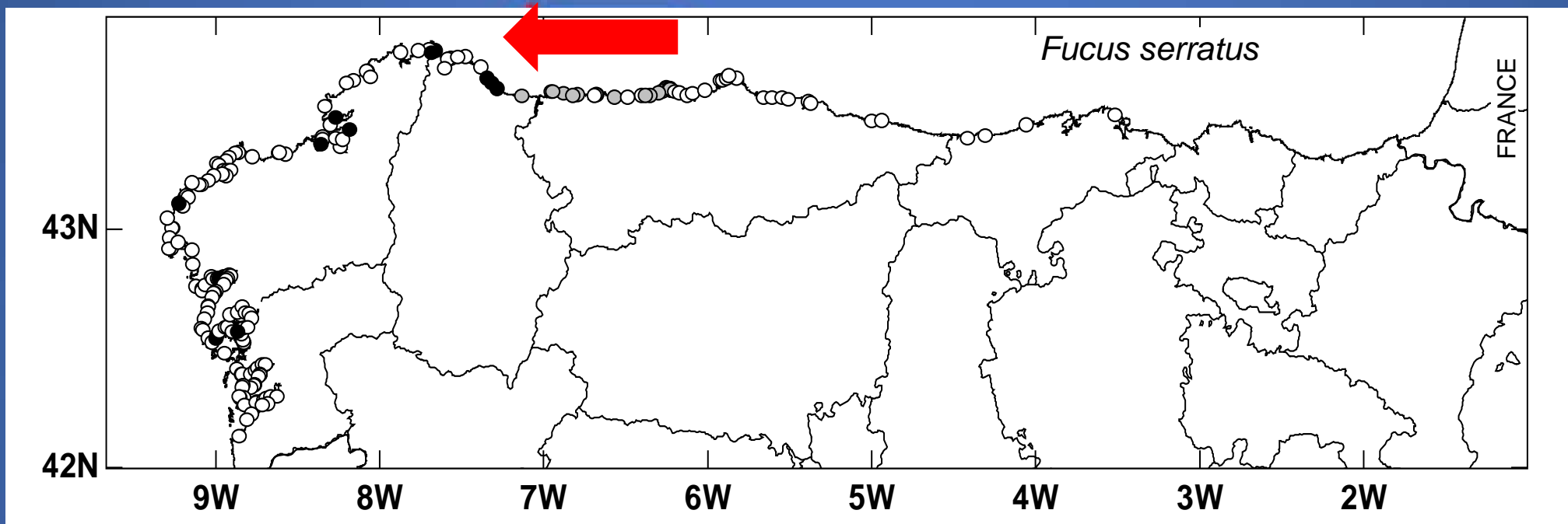
Fucus serratus



Fucus serratus

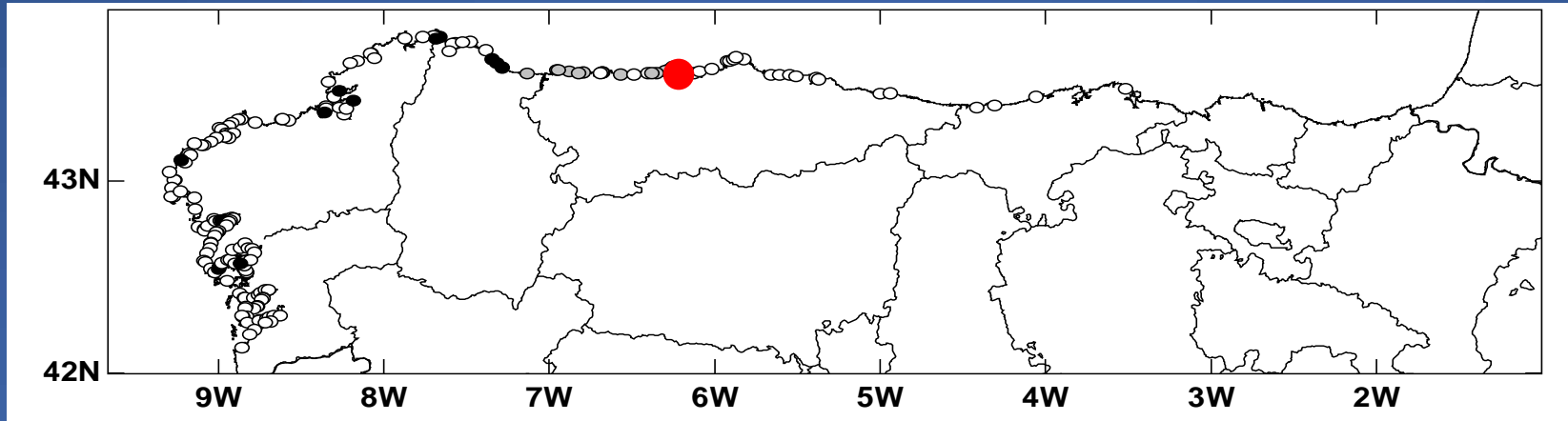
Cambio reciente y drástico en su abundancia y distribución en la costa cantábrica

De 2004-2006 a 2008-2009



Duarte et al. 2013. *Acta Oecologica*

Fucus serratus

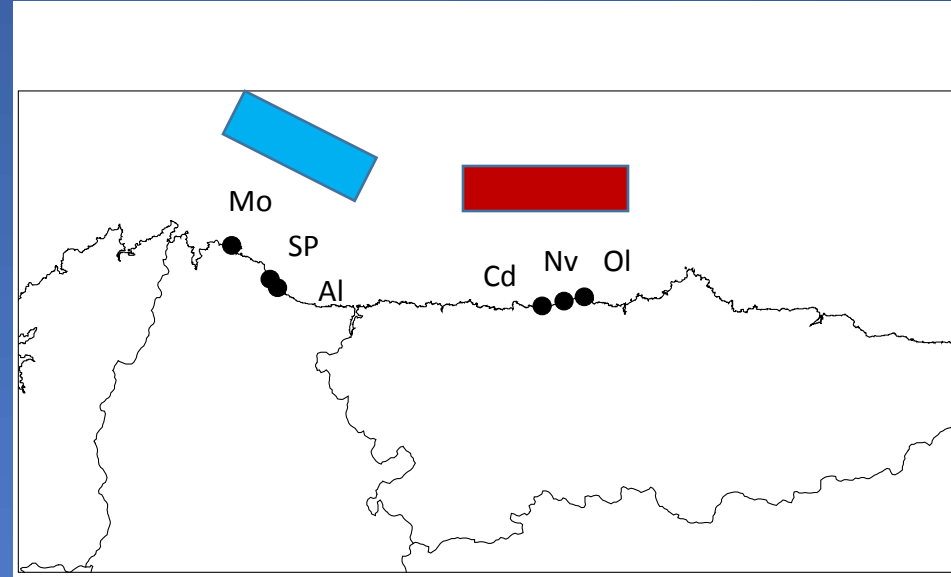
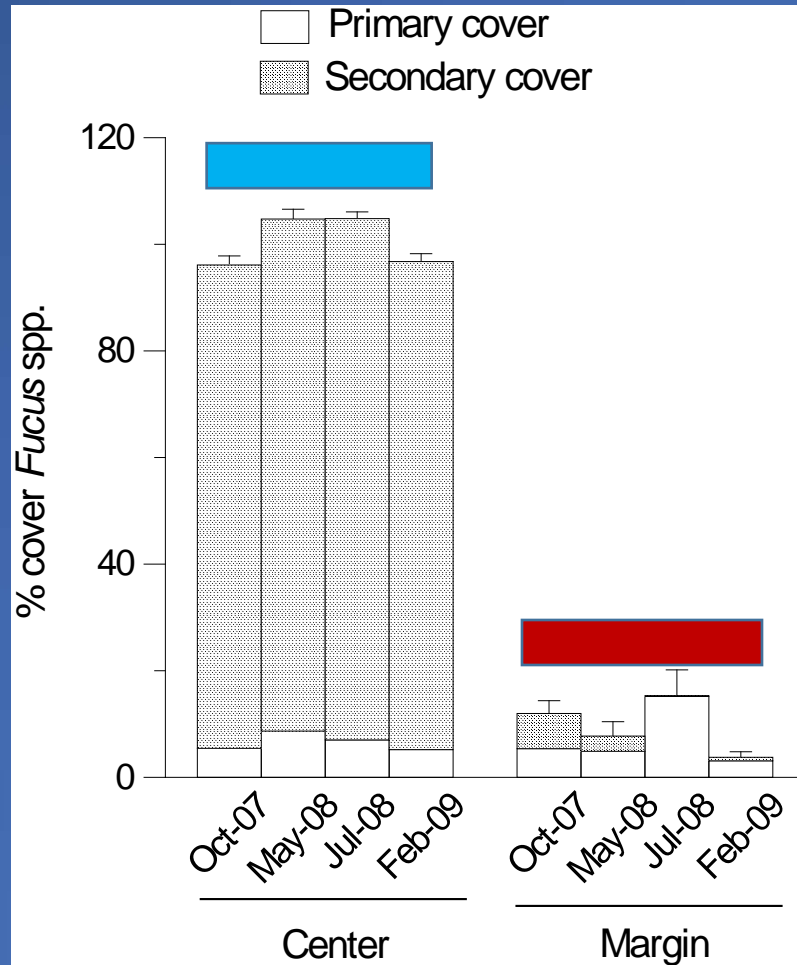


Agosto 2004

Agosto 2007

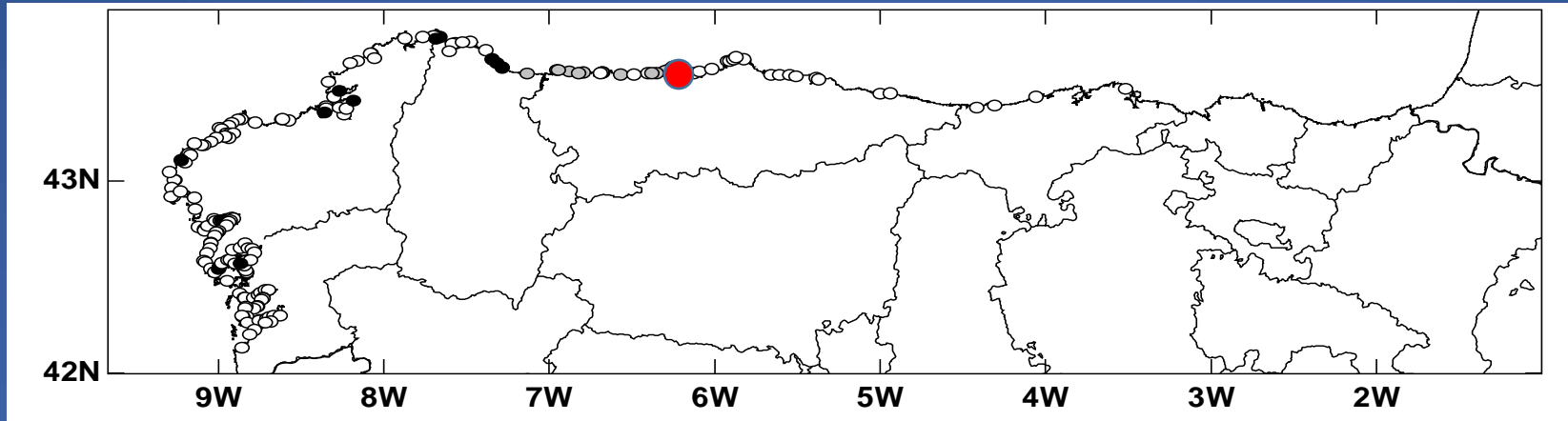


Fucus serratus



Abundancia de *Fucus serratus* en la costa de Lugo (azul) y la costa occidental asturiana (rojo) entre 2007 y 2009

Fucus serratus

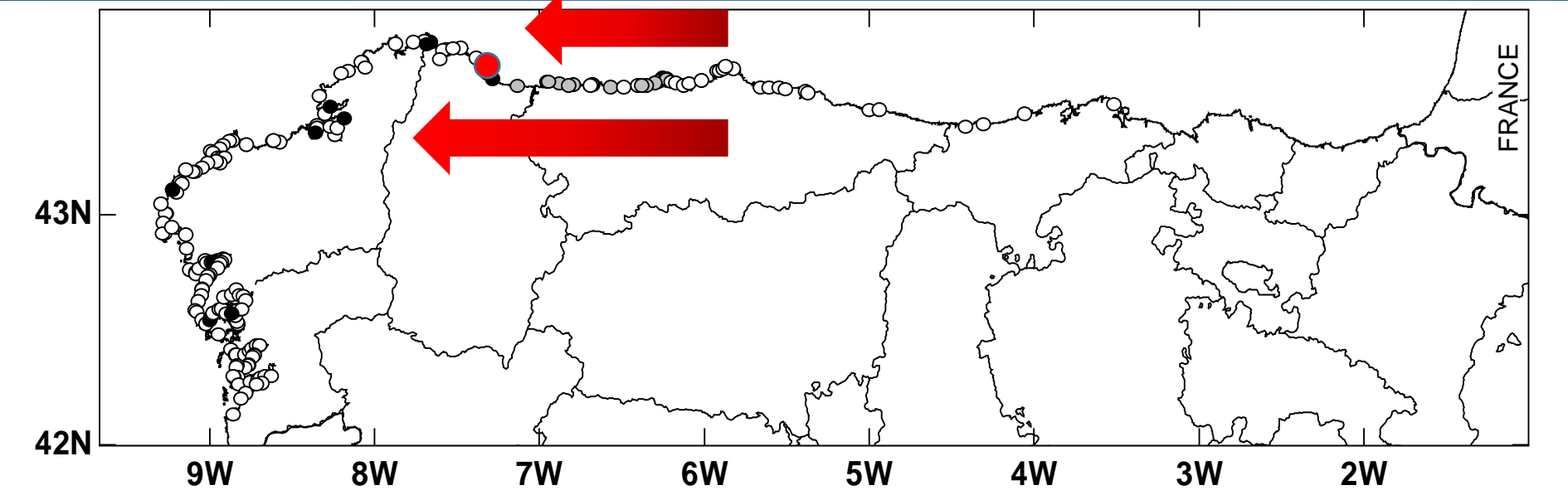


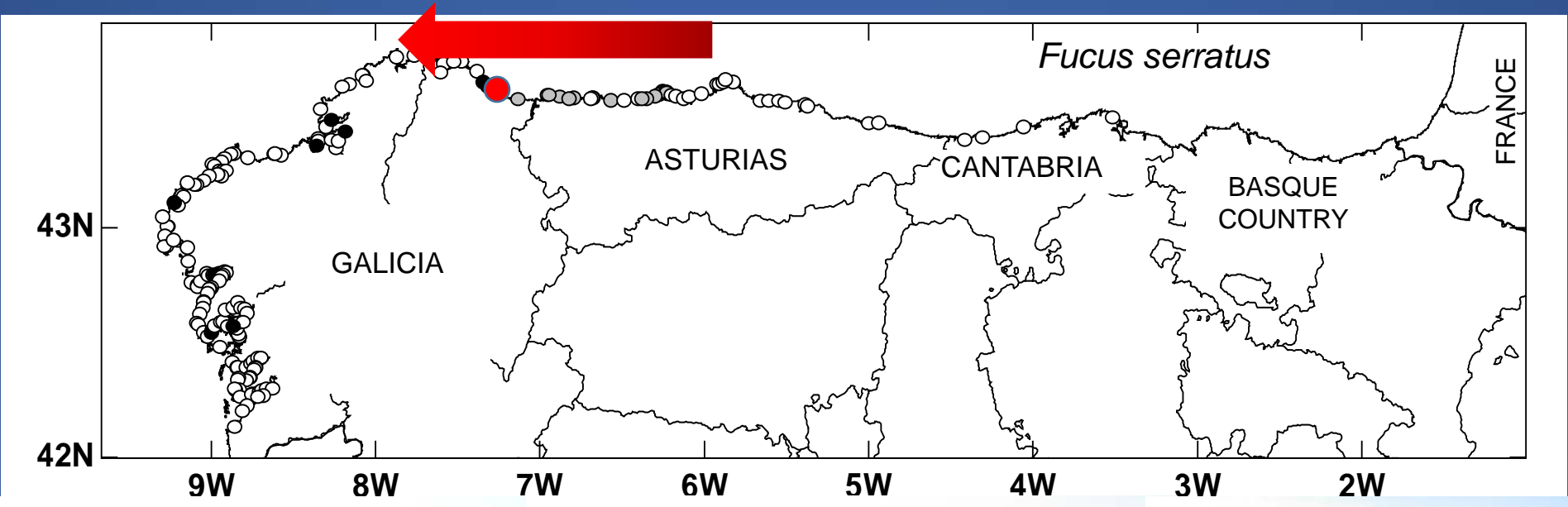
2004

2014



Fucus serratus





2007



2015



2016



2007



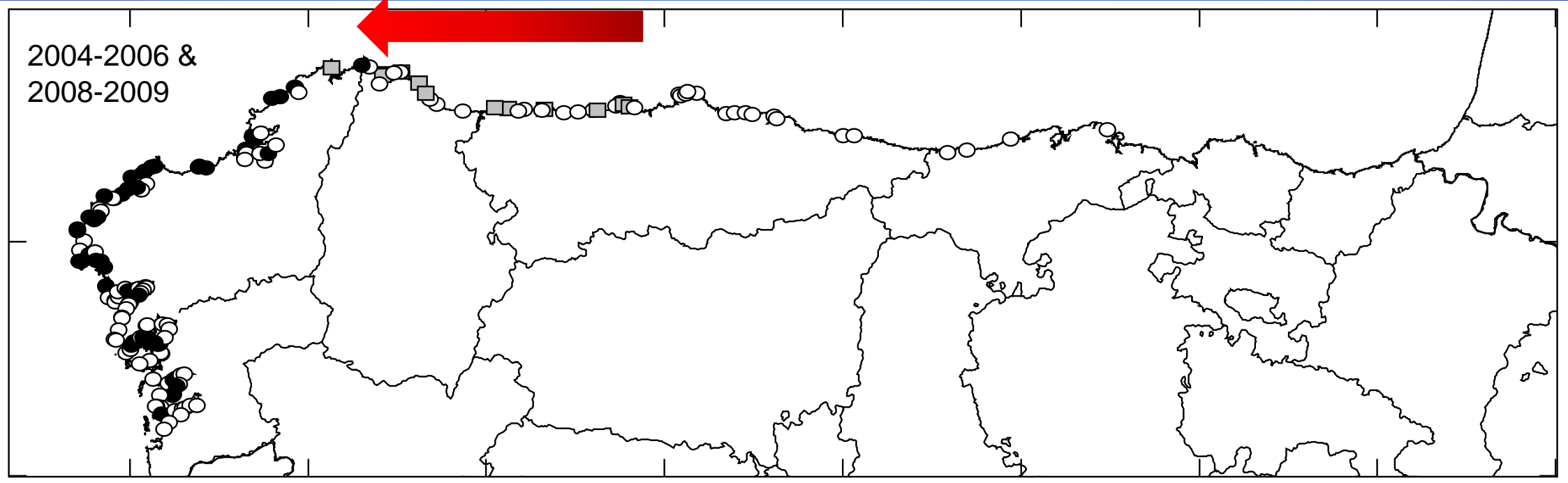
2015



2016



Himanthalia elongata



Fucus vesiculosus

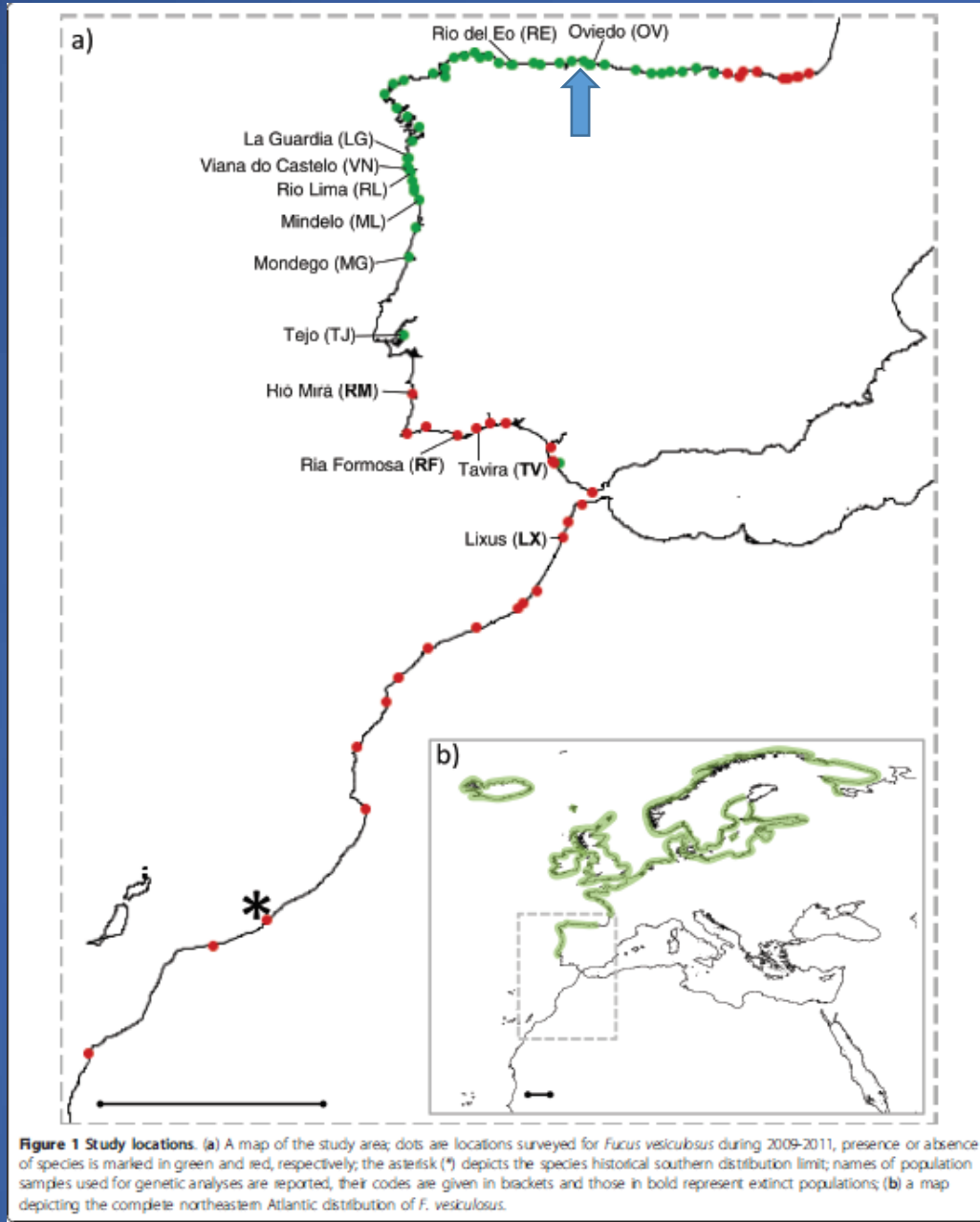
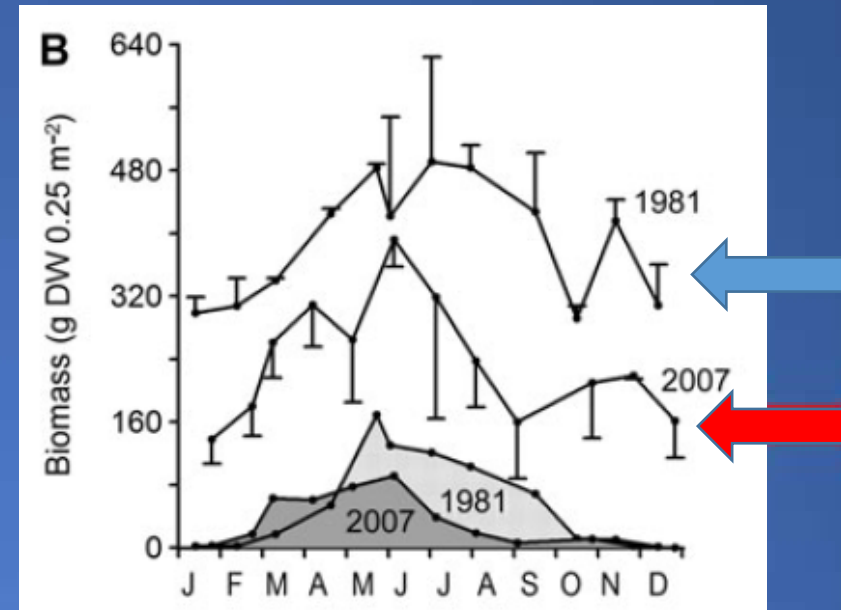
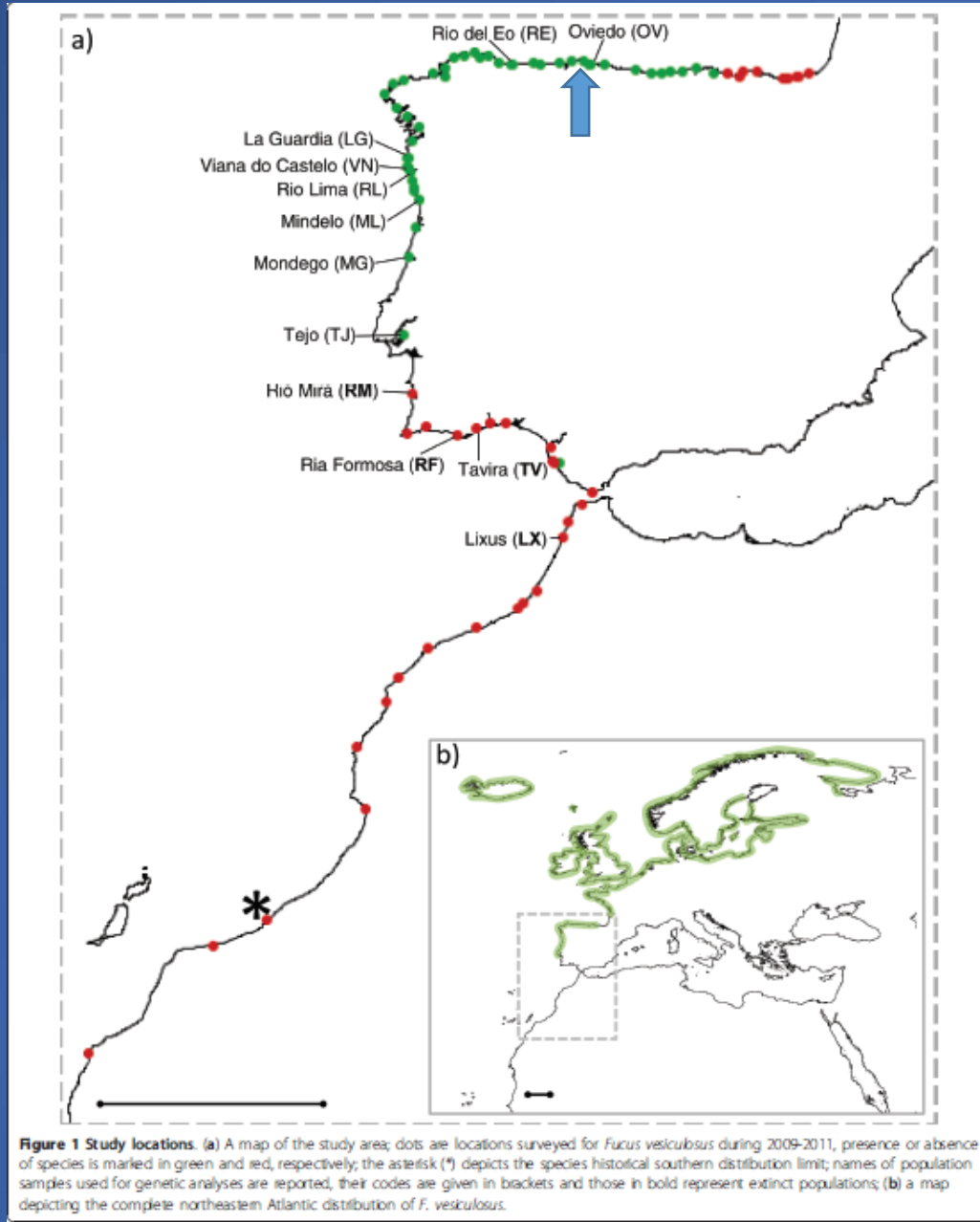


Figure 1 Study locations. (a) A map of the study area; dots are locations surveyed for *Fucus vesiculosus* during 2009-2011, presence or absence of species is marked in green and red, respectively; the asterisk (*) depicts the species historical southern distribution limit; names of population samples used for genetic analyses are reported, their codes are given in brackets and those in bold represent extinct populations; (b) a map depicting the complete northeastern Atlantic distribution of *F. vesiculosus*.



Fucus vesiculosus



Lamela-Silvarrey et al 2012. *Botanica Marina*



Nicastro et al 2013. *BMC Biology*

Laminariales y Tilopteridales

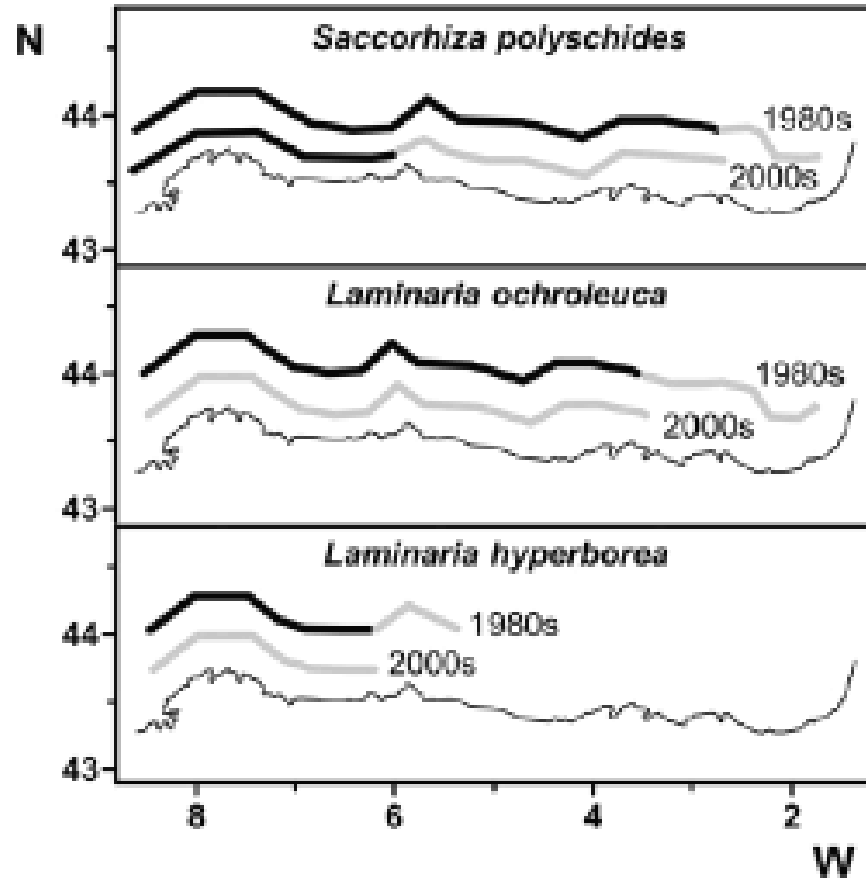


Fig. 2. North coast of Spain: kelp distribution maps in the 1980s and 2000s. Dense populations (dark) and small patches or isolated individuals (grey) are indicated.

Fernández. 2011. *European Journal of Phycology*

Laminariales y Tilopteridales

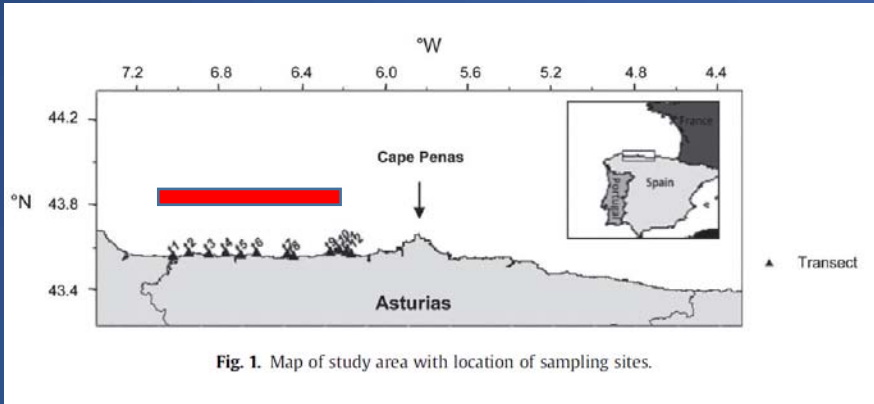


Table 2

Main macroalgal taxa west of Cape Penas in the late early 1990s century and the past decade in the shallow subtidal, classified by vertical zonation. Biogeographic distribution is indicated as northern, cold temperate (no); southern, warm temperate (so); cosmopolitan (co) or alien (al). Information on pigment content is indicated as ochrophyta (ochr); chloryphyta (chl); rhodoficea (rhodo). Species indicated in bold where identified as dominant. (+) Indicates an increase of the taxa abundance, (-) indicates a decrease of the taxa abundance.

1992	2009
Canopy	
<i>Cystoseira baccata</i> (so) (ochr)	<i>Cystoseira baccata</i> (so) (ochr)
(-) <i>Desmarestia ligulata</i> (so) (ochr)	<i>Desmarestia ligulata</i> (so) (ochr)
(-) <i>Desmarestia aculeata</i> (no) (ochr)	<i>Saccorhiza polyschides</i> (so) (ochr)
(-) <i>Halidrys siliquosa</i> (no) (ochr)	* <i>Laminaria ochroleuca</i> is present, but only in juvenile form, not forming canopy
(-) <i>Laminaria ochroleuca</i> (so) (ochr)	
(-) <i>Laminaria hyperborea</i> (no) (ochr)	
<i>Saccorhiza poyschides</i> (so) (ochr)	
Understory	
(-) <i>Calliblepharis ciliata</i> (so) (rhodo)	(+) <i>Asparagopsis armata</i> (al) (rhodo)
(-) <i>Corallina</i> spp. (so) (rhodo)	<i>Corallina</i> spp. (so) (rhodo)
(-) <i>Chondrus crispus</i> (no) (rhodo)	(+) <i>Codium</i> spp. (so) (chloro)
(-) <i>Dictyopteris polypodioides</i> (so) (ochro)	(+) <i>Cladophora</i> spp. (co) (chloro)
(-) <i>Dilsea carnosa</i> (no) (rhodo)	(+) <i>Dictyota dichotoma</i> (so) (ochro)
<i>Gelidium corneum</i> (so) (rhodo)	(+) <i>Gelidium corneum</i> (so) (rhodo)
(-) <i>Polyides rotundus</i> (no) (rhodo)	(+) <i>Stypocaulon scoparium</i> (so) (ochro)
(-) <i>Pterosiphonia complanata</i> (so) (rhodo)	(+) <i>Jania squamata</i> (so) (rhodo)
<i>Plocamium cartilagineum</i> (so) (rhodo)	<i>Plocamium cartilagineum</i> (so) (rhodo)
	(+) <i>Sphaerococcus coronopifolius</i> (so) (rhodo)
<i>Ulva</i> spp. (co) (chloro)	<i>Ulva</i> spp. (co) (chloro)



Laminariales y Tlopteridales

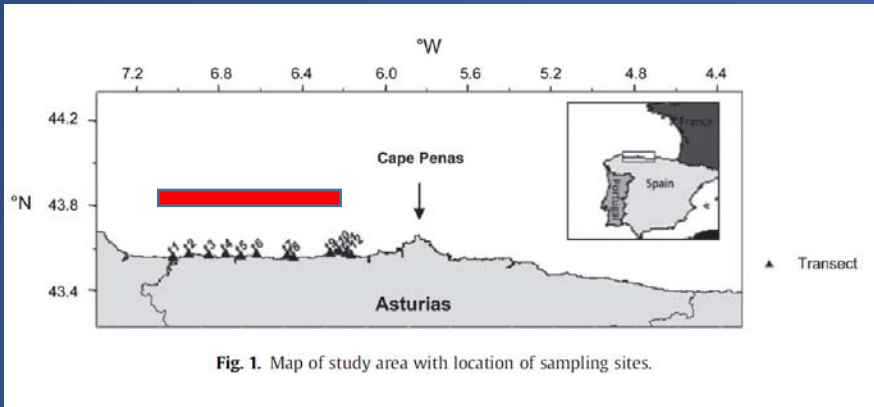
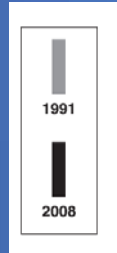
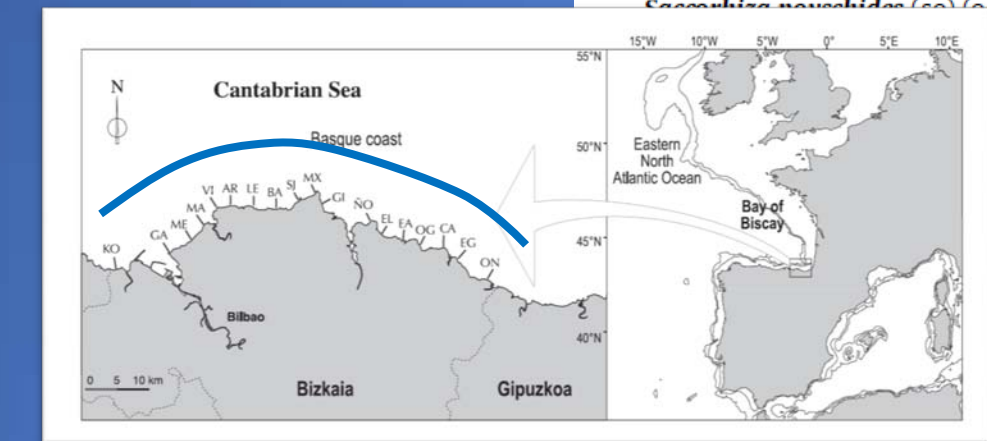
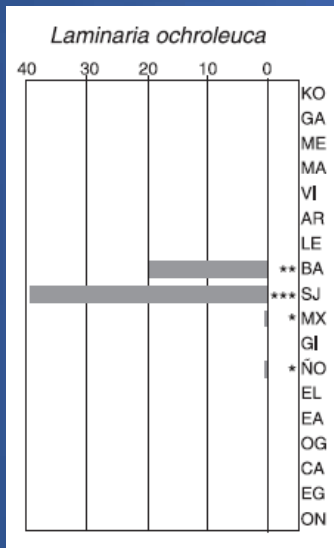


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(-) <i>Desmarestia aculeata</i> (no) (ochr)	<i>Saccorhiza polyschides</i> (so) (ochr)
(-) <i>Halidrys siliquosa</i> (no) (ochr)	* <i>Laminaria ochroleuca</i> is present, but only in juvenile form, not forming canopy
(-) <i>Laminaria ochroleuca</i> (so) (ochr)	
(-) <i>Laminaria hyperborea</i> (no) (ochr)	
<i>Saccorhiza polyschides</i> (so) (ochr)	
(-) <i>Ulva</i> spp. (co) (chloro)	(+) <i>Asparagopsis armata</i> (al) (rhodo)
(-) <i>Ulva</i> spp. (co) (chloro)	(rhodo)
(-) <i>Ulva</i> spp. (co) (chloro)	(rhodo)
(-) <i>Ulva</i> spp. (co) (chloro)	(+) <i>Corallina</i> spp. (so) (rhodo)
(-) <i>Ulva</i> spp. (co) (chloro)	(+) <i>Codium</i> spp. (so) (chloro)
(-) <i>Ulva</i> spp. (co) (chloro)	(+) <i>Cladophora</i> spp. (co) (chloro)
(-) <i>Ulva</i> spp. (co) (chloro)	(+) <i>Dictyota dichotoma</i> (so) (ochro)
(-) <i>Ulva</i> spp. (co) (chloro)	(+) <i>Gelidium corneum</i> (so) (rhodo)
(-) <i>Ulva</i> spp. (co) (chloro)	(+) <i>Stypocaulon scoparium</i> (so) (ochro)
(-) <i>Ulva</i> spp. (co) (chloro)	(+) <i>Jania squamata</i> (so) (rhodo)
(-) <i>Ulva</i> spp. (co) (chloro)	<i>Plocamium cartilagineum</i> (so) (rhodo)
(-) <i>Ulva</i> spp. (co) (chloro)	(+) <i>Sphaerococcus coronopifolius</i> (so) (rhodo)
(-) <i>Ulva</i> spp. (co) (chloro)	<i>Ulva</i> spp. (co) (chloro)



Díez et al. 2012. *Estuarine and Coastal Shelf Science*

Voerman et al 2012. *Marine Environmental Research*

Especies calcáreas articuladas

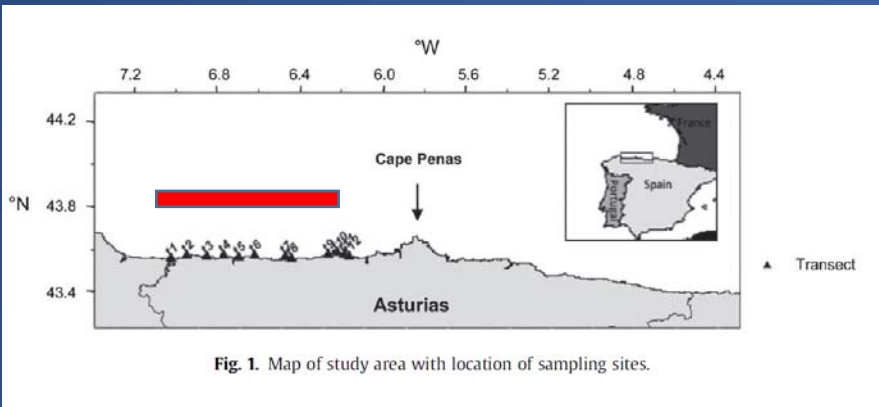


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(-) <i>Desmarestia aculeata</i> (no) (ochr)	<i>Saccorhiza polyschides</i> (so) (ochr)
(-) <i>Halidrys siliquosa</i> (no) (ochr)	* <i>Laminaria ochroleuca</i> (so) (ochr)
(-) <i>Laminaria ochroleuca</i> (so) (ochr)	but only in juveniles
(-) <i>Laminaria hyperborea</i> (no) (ochr)	forming canopy
<i>Saccorhiza polyschides</i> (so) (ochr)	
Understory	
(-) <i>Calliblepharis ciliata</i> (so) (rhodo)	(+) <i>Asparagopsis armata</i> (so) (rhodo)
(-) <i>Corallina</i> spp. (so) (rhodo)	(rhodo)
(-) <i>Chondrus crispus</i> (no) (rhodo)	<i>Corallina</i> spp. (so) (rhodo)
(-) <i>Dictyopteris polypodioides</i> (so) (ochro)	(+) <i>Codium</i> spp. (so) (ochro)
(-) <i>Dilsea carnosa</i> (no) (rhodo)	(+) <i>Cladophora</i> spp. (so) (ochro)
<i>Gelidium corneum</i> (so) (rhodo)	(+) <i>Dictyota dichotoma</i> (so) (ochro)
(-) <i>Polyides rotundus</i> (no) (rhodo)	(+) <i>Gelidium corneum</i> (so) (rhodo)
(-) <i>Pterosiphonia complanata</i> (so) (rhodo)	(+) <i>Stypocaulon scoparium</i> (so) (ochro)
<i>Plocamium cartilagineum</i> (so) (rhodo)	(+) <i>Jania squamata</i> (so) (rhodo)
<i>Ulva</i> spp. (co) (chloro)	<i>Plocamium cartilagineum</i> (so) (rhodo)
	(+) <i>Sphaerococcus coronopifolius</i> (so) (rhodo)
	<i>Ulva</i> spp. (co) (chloro)



Especies calcáreas articuladas

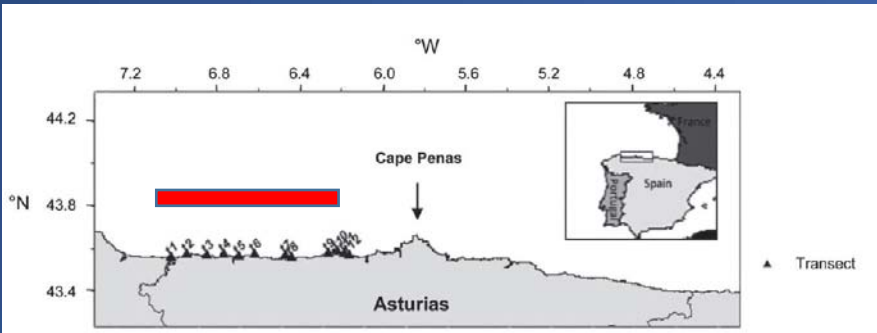
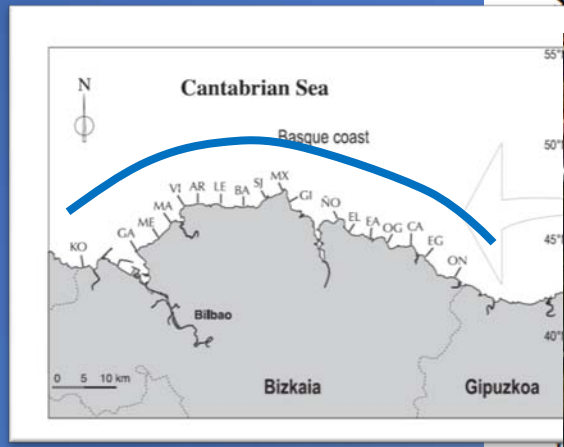
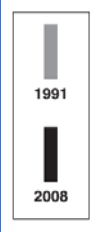
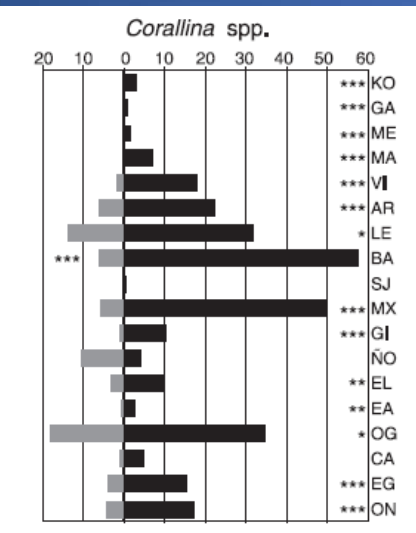
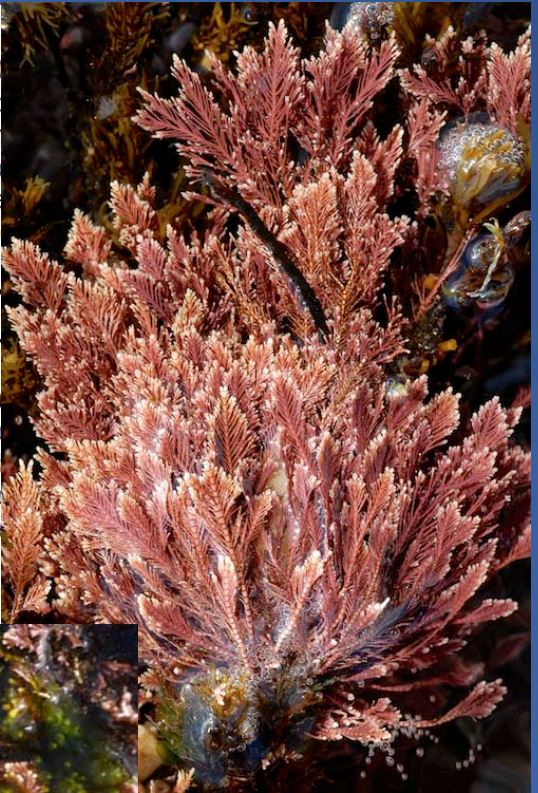


Fig. 1. Map of study area with location of sampling sites.

Table 2
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(-) <i>Desmarestia ligulata</i> (so) (ochr)	<i>Desmarestia ligulata</i> (so) (ochr)
(-) <i>Desmarestia aculeata</i> (no) (ochr)	<i>Saccorhiza polyschides</i> (so) (ochr)
(-) <i>Halidrys siliquosa</i> (no) (ochr)	* <i>Laminaria ochroleuca</i> (so) (ochr)
(-) <i>Laminaria ochroleuca</i> (so) (ochr)	but only in juvenile stages
(-) <i>Laminaria hyperborea</i> (no) (ochr)	forming canopy
<i>Saccorhiza novschides</i> (so) (ochr)	



(ochr)
(odo)
(ochr)
(o)
(rhodo)
s

Díez et al. 2012. *Estuarine and Coastal Shelf Science*

Voerman et al 2012. *Marine Environmental Research*

Especies invasoras

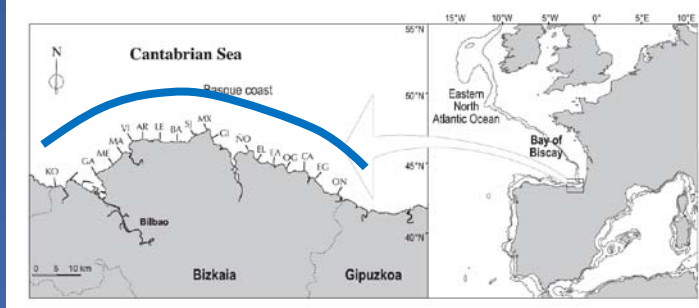
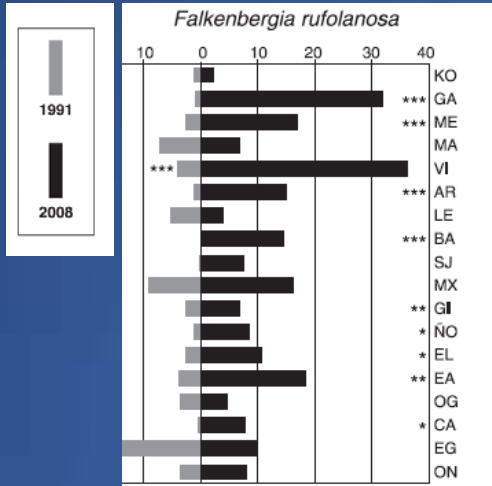


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(-) <i>Desmarestia aculeata</i> (no) (ochr)	<i>Saccorhiza polyschides</i> (so) (ochr)
(-) <i>Halidrys siliquosa</i> (no) (ochr)	* <i>Laminaria ochroleuca</i> is present, but only in juvenile form, not forming canopy
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<i>Laminaria hyperborea</i> (no) (ochr)	
<i>Saccorhiza polyschides</i> (so) (ochr)	
Understorey	
<i>Calliblepharis ciliata</i> (so) (rhodo)	(+) <i>Asparagopsis armata</i> (al) (rhodo)
<i>Corallina</i> spp. (so) (rhodo)	<i>Corallina</i> spp. (so) (rhodo)
<i>Chondrus crispus</i> (no) (rhodo)	(+) <i>Codium</i> spp. (so) (chloro)
<i>Dictyopectis polypodioides</i> (so) (ochro)	(+) <i>Cladophora</i> spp. (co) (chloro)
<i>Dilsea carnosa</i> (no) (rhodo)	(+) <i>Dictyota dichotoma</i> (so) (ochro)
<i>Codium corneum</i> (so) (rhodo)	(+) <i>Gelidium corneum</i> (so) (rhodo)
<i>Polyides rotundus</i> (no) (rhodo)	(+) <i>Stypocaulon scoparium</i> (so) (ochro)
<i>Pterosiphonia complanata</i> (so) (rhodo)	(+) <i>Jania squamata</i> (so) (rhodo)
<i>Plocamium cartilagineum</i> (so) (rhodo)	<i>Plocamium cartilagineum</i> (so) (rhodo)
<i>Ulva</i> spp. (co) (chloro)	(+) <i>Sphaerococcus coronopifolius</i> (so) (rhodo)
	<i>Ulva</i> spp. (co) (chloro)

Chondrus crispus y Gelidium corneum

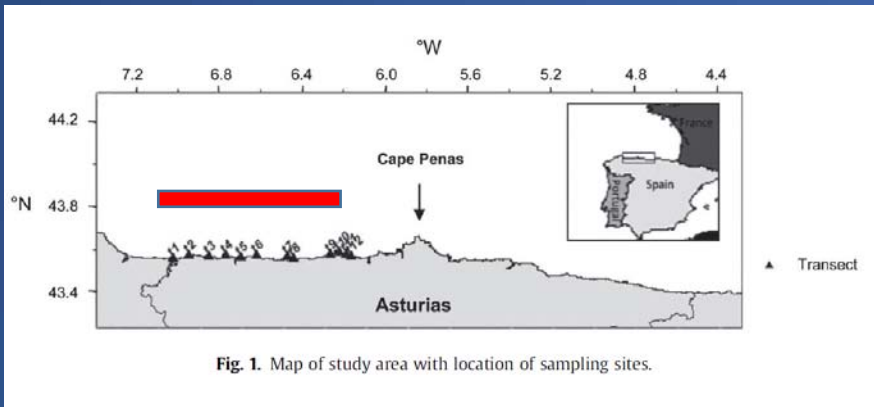


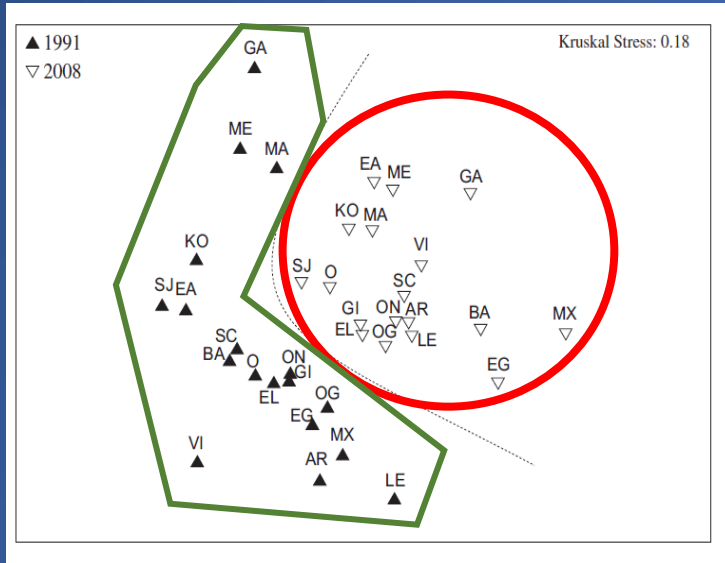
Table 2

Main macroalgal taxa west of Cape Penas in the late early 1990s century and the past decade in the shallow subtidal, classified by vertical zonation. Biogeographic distribution is indicated as northern, cold temperate (no); southern, warm temperate (so); cosmopolitan (co) or alien (al). Information on pigment content is indicated as ochrophyta (ochr); chloryphyta (chl); rhodoficea (rhodo). Species indicated in bold where identified as dominant. (+) Indicates an increase of the taxa abundance, (-) indicates a decrease of the taxa abundance.

1992	2009
Canopy	
Cystoseira baccata (so) (ochr)	Cystoseira baccata (so) (ochr)
(-) <i>Desmarestia ligulata</i> (so) (ochr)	<i>Desmarestia ligulata</i> (so) (ochr)
(-) <i>Desmarestia aculeata</i> (no) (ochr)	Saccorhiza poyschides (so) (ochr)
(-) <i>Halidrys siliquosa</i> (no) (ochr)	* <i>Laminaria hyperborea</i> (no) (ochr)
(-) <i>Laminaria ochroleuca</i> (so) (ochr)	but dominant in 2009
(-) <i>Laminaria hyperborea</i> (no) (ochr)	form
Saccorhiza poyschides (so) (ochr)	
Understory	
(-) <i>Calliblepharis ciliata</i> (so) (rhodo)	(+) <i>Calliblepharis ciliata</i> (so) (rhodo)
(-) <i>Corallina</i> spp. (so) (rhodo)	(rhodo)
(-) Chondrus crispus (no) (rhodo)	Chondrus crispus (no) (rhodo)
(-) <i>Dictyopterus polypodioides</i> (so) (ochro)	(+) <i>Dictyopterus polypodioides</i> (so) (ochro)
(-) <i>Dilsea carnosa</i> (no) (rhodo)	(+) <i>Cladophora</i> spp. (co) (chloro)
<i>Gelidium corneum</i> (so) (rhodo)	(+) Dictyota dichotoma (so) (ochro)
(-) <i>Polyides rotundus</i> (no) (rhodo)	(+) Gelidium corneum (so) (rhodo)
(-) <i>Pterosiphonia complanata</i> (so) (rhodo)	(+) <i>Stypocaulon scoparium</i> (so) (ochro)
<i>Plocamium cartilagineum</i> (so) (rhodo)	(+) Jania squamata (so) (rhodo)
<i>Ulva</i> spp. (co) (chloro)	<i>Plocamium cartilagineum</i> (so) (rhodo)
	(+) <i>Sphaerococcus coronopifolius</i> (so) (rhodo)
	<i>Ulva</i> spp. (co) (chloro)



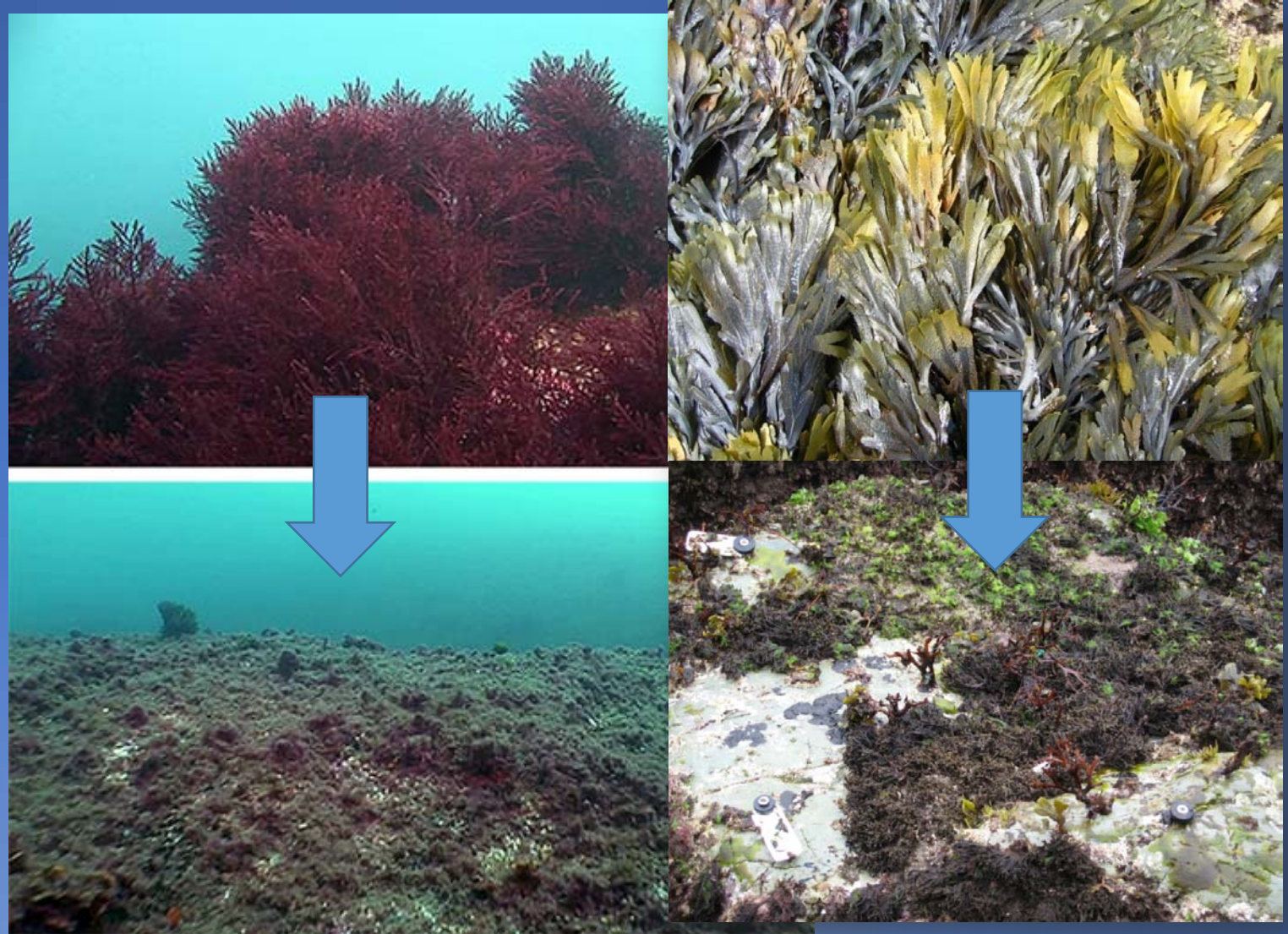
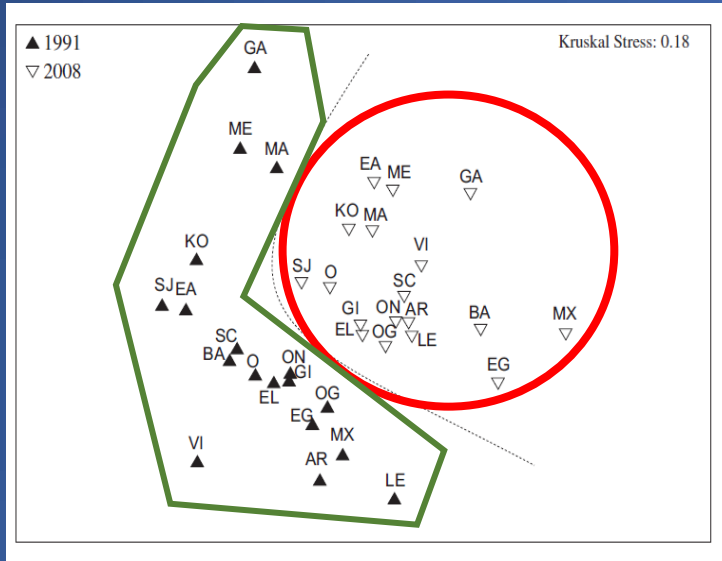
Re-estructuración de las comunidades



Díez *et al.* 2012.

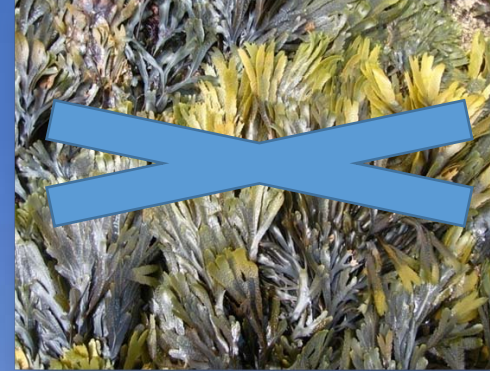
Estuarine and Coastal Shelf Science

Re-estructuración de las comunidades



Díez *et al.* 2012.
Estuarine and Coastal Shelf Science

Efectos en la red trófica



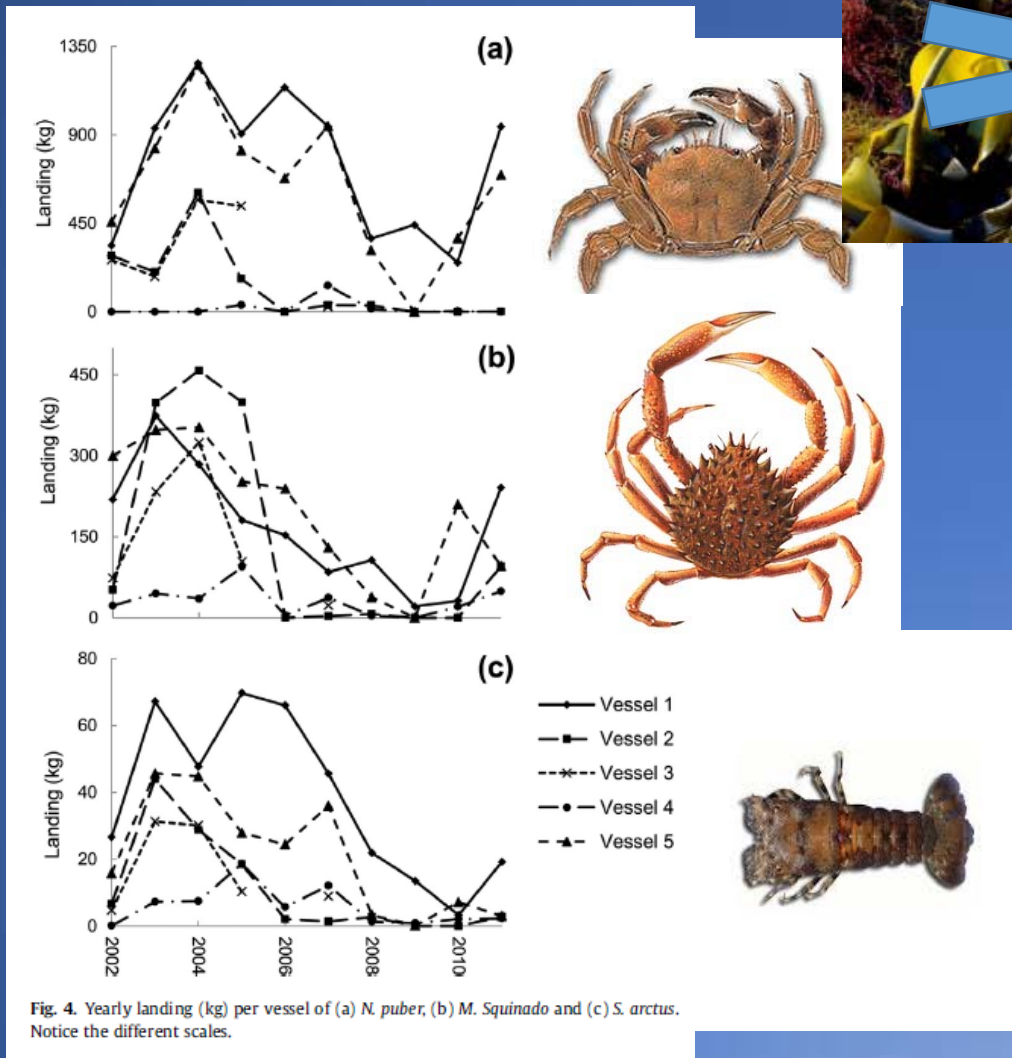
Posición trófica
más baja de
consumidores



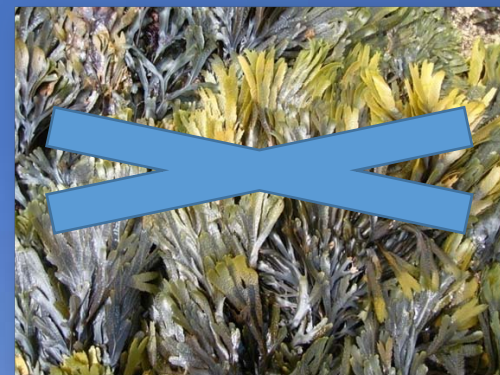
Pirimela denticulata

Duarte et al. 2015. *MEPS*

Efectos en la red trófica



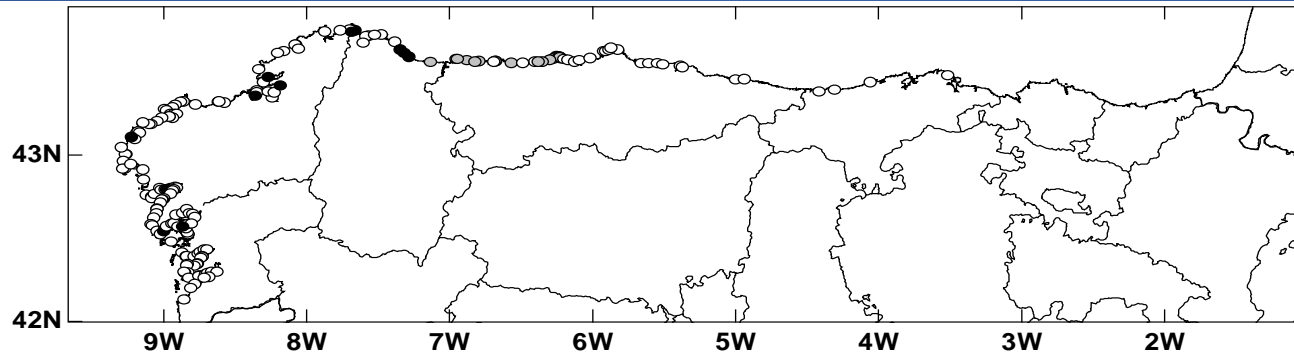
Posición trófica
más baja de
consumidores



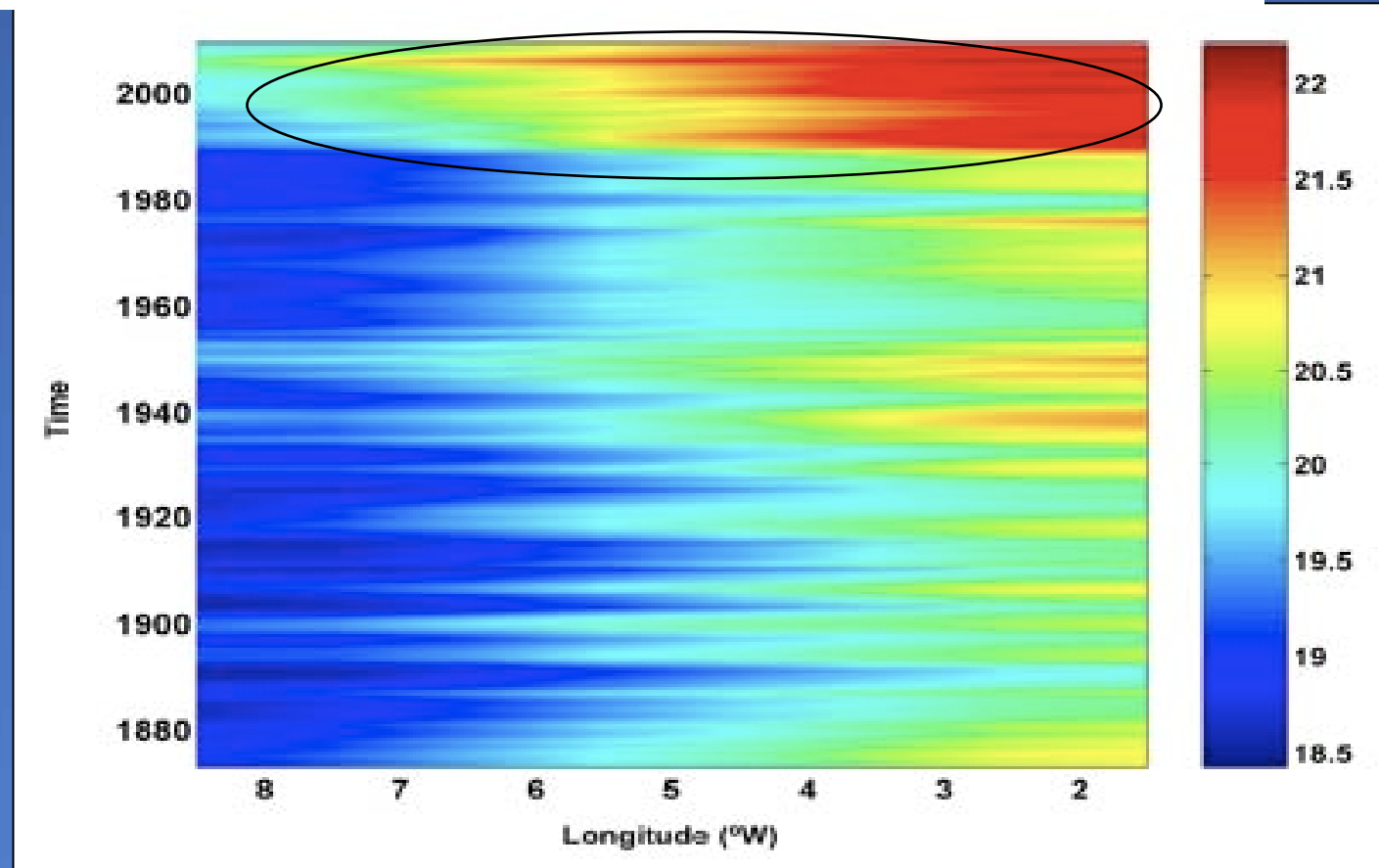
Pirimela denticulata

Duarte et al. 2015. *MEPS*

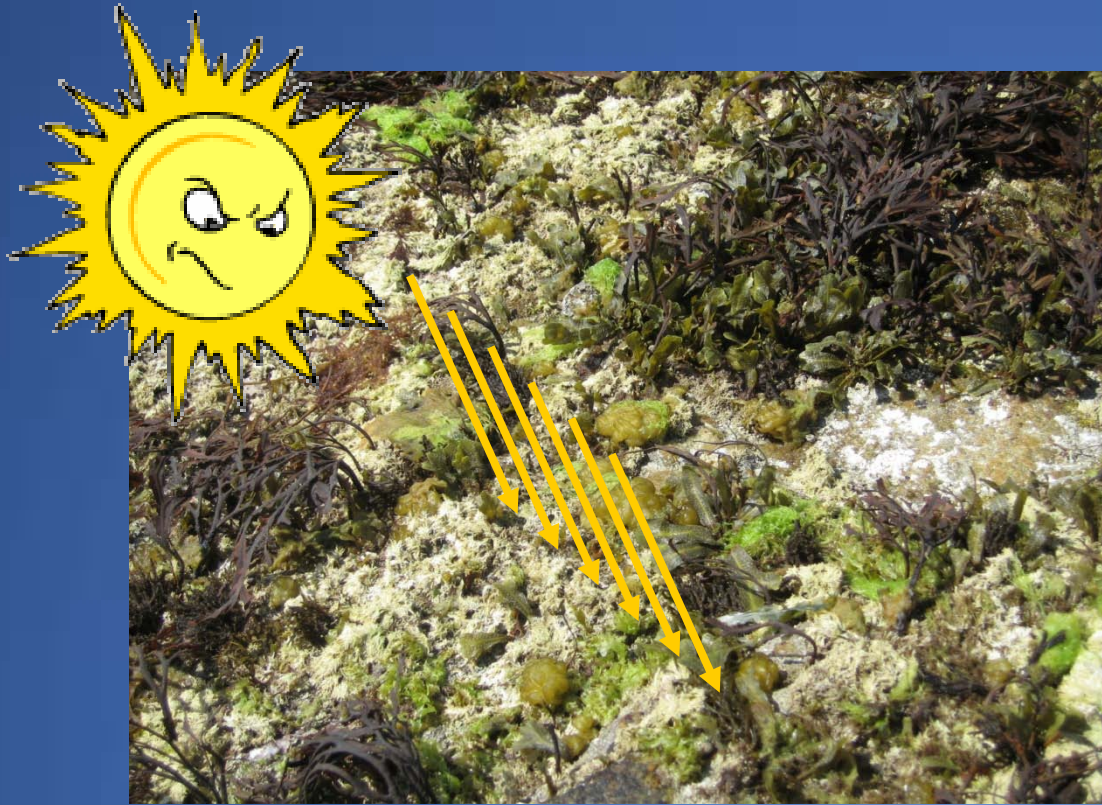
¿Causas?



Claro incremento en la temperatura superficial del agua



¿Causas?



**Especies intermareales:
Estrés durante periodos de
emersión**

(temperatura del aire, baja
humedad, radiación solar..)

Efectos aditivos para *F.serratus*

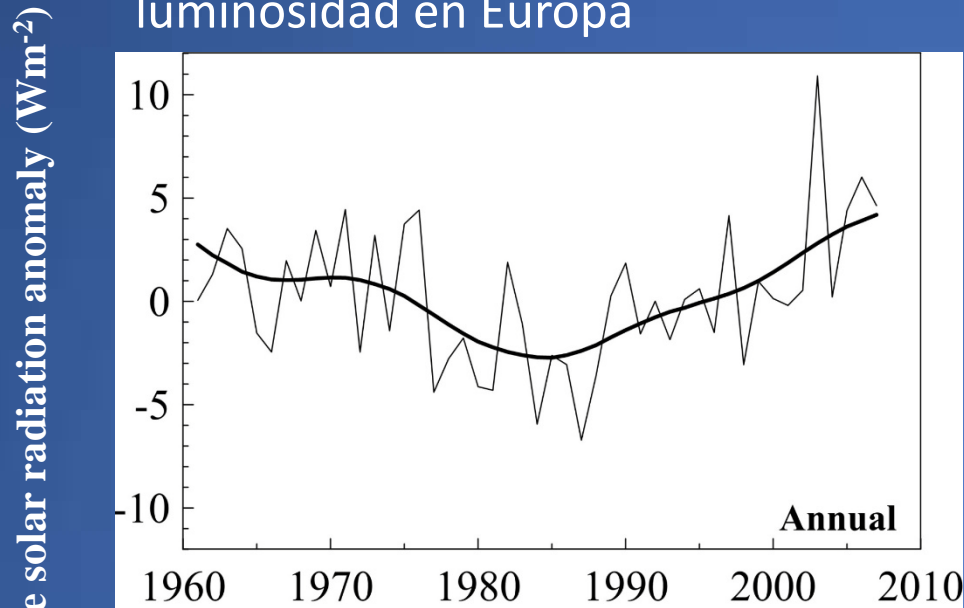
Martínez et al., 2012. Oecologia

Reducción en la intensidad de los afloramientos costeros

Llope et al 2006. *Journal of Geophysical Research*

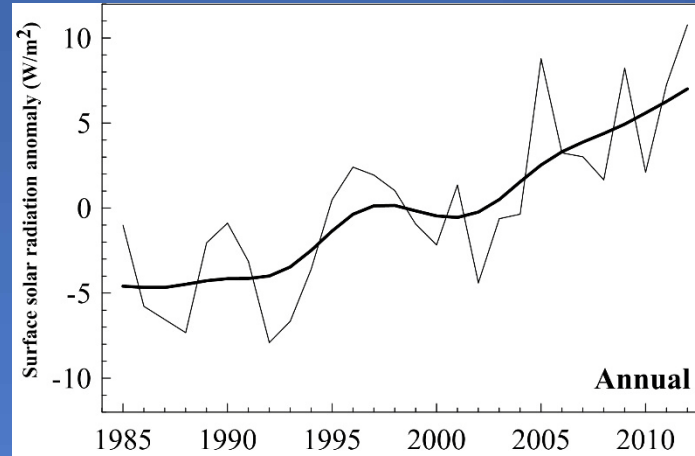
¿Causas? Incremento de la radiación solar

Periodos de oscurecimiento y luminosidad en Europa



Sanchez-Lorenzo *et al.*, 2013.
Global and Planetary Change

En España

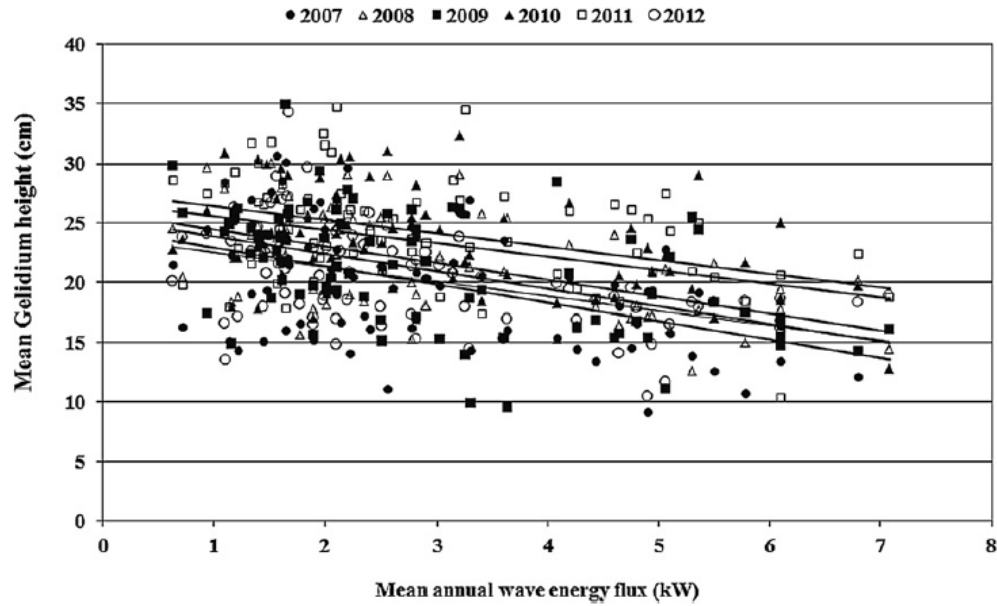


Efectos negativos de alta radiación solar en *Gelidium corneum*

Quintano *et al* 2013. *Journal of Sea Research*

¿Causas?

Incremento de oleaje



Relacion entre el tamaño de los talos de *Gelidium corneum* y la altura de las olas



Borja et al 2013. *Ocean and Coastal Management*

¿Causas?

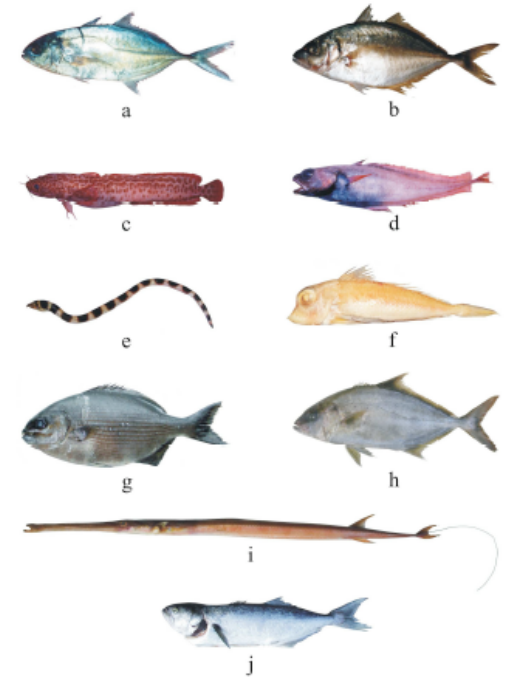
Herbivorismo



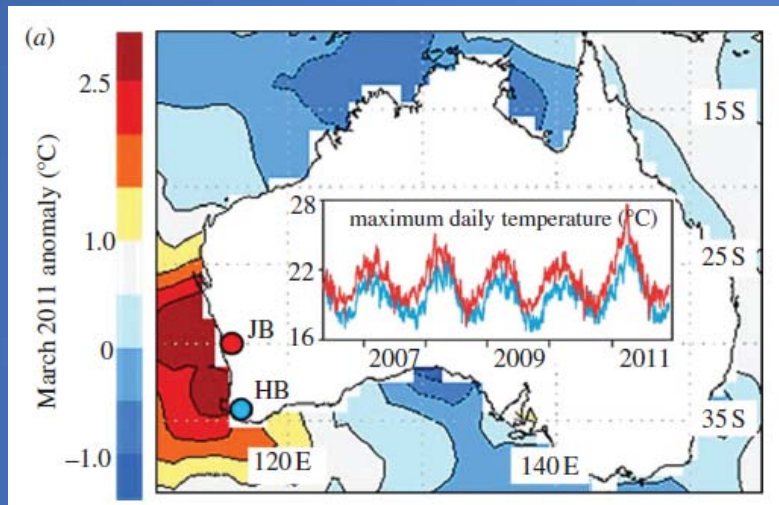
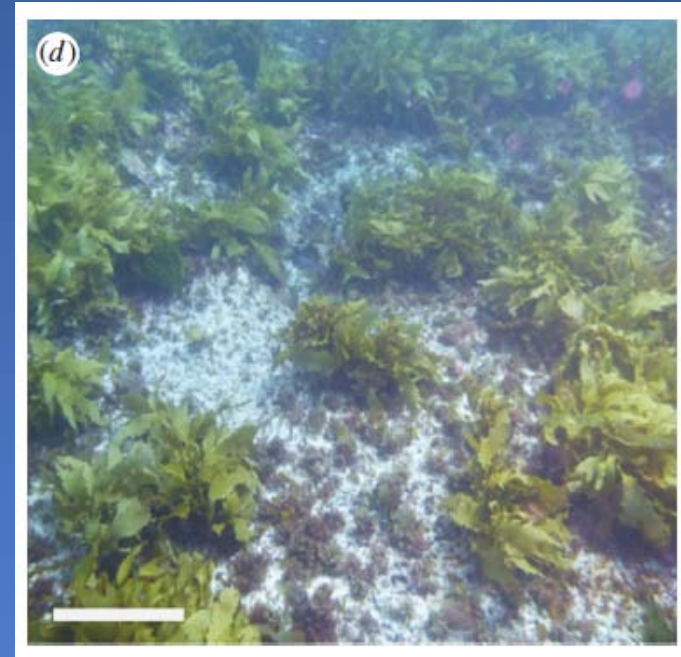
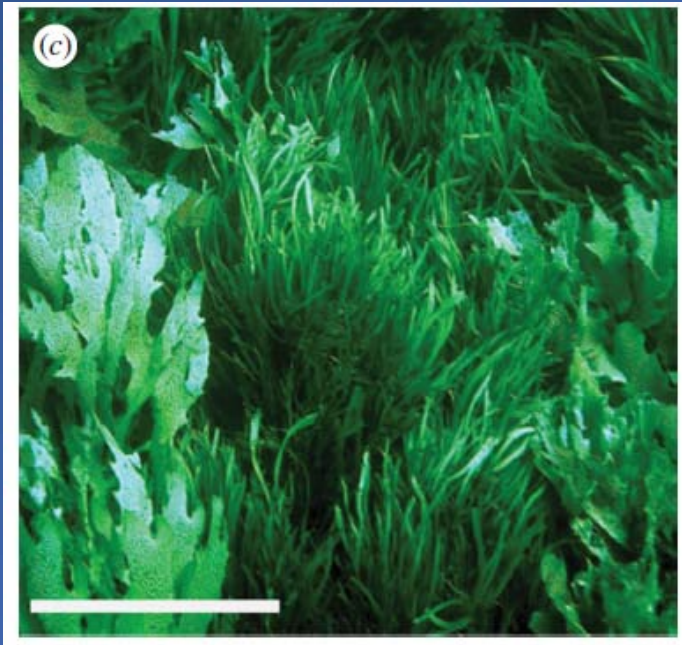
J. Mar. Biol. Ass. U.K. (2002), **82**, 877–880
Printed in the United Kingdom

Occurrence of tropical affinity fish in Galician waters, north-west Spain

R. Bañón*, J.L. del Río†, C. Piñeiro† and M. Casas†



Caranx crysos (a), *Pseudocaranx dentex* (b), *Gaidropsarus granti* (c), *Physiculus dalwigkii* (d), *Pisodonophis semicinctus* (e), *Lepidotrigla dieuzeidei* (f), *Kyphosus sectator* (g), *Seriola rivoliana* (h), *Fistularia petimba* (i), *Pomatomus saltatrix* (j)



Smale and Wernberg 2013. Proc. R. Soc. B. Biol.Sci.

Global Change Biology (2014) 20, 3300–3312, doi: 10.1111/gcb.12619

RESEARCH REVIEW

Identifying the interacting roles of stressors in driving the global loss of canopy-forming to mat-forming algae in marine ecosystems

ELISABETH M. A. STRAIN^{1,2}, RUSSELL J. THOMSON², FIORENZA MICHELI³,
FRANCESCO P. MANCUSO¹ and LAURA AIROLDI¹

PROCEEDINGS THE ROYAL **B** | BIOLOGICAL
OF SOCIETY | SCIENCES

The tropicalization of temperate marine ecosystems: climate-mediated changes in herbivory and community phase shifts

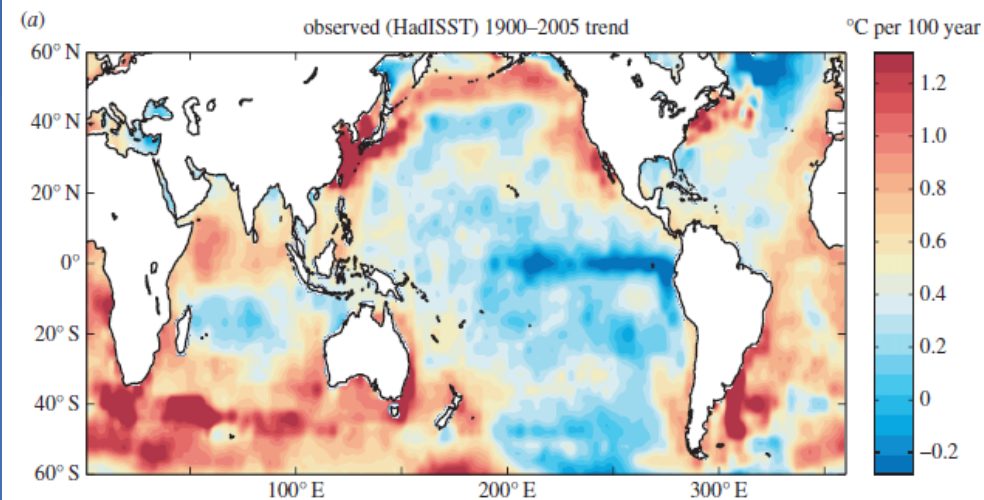
Adriana Vergés, Peter D. Steinberg, Mark E. Hay, Alistair G. B. Poore, Alexandra H. Campbell, Enric Ballesteros, Kenneth L. Heck, Jr, David J. Booth, Melinda A. Coleman, David A. Feary, Will Figueira, Tim Langlois, Ezequiel M. Marzinelli, Toni Mizerek, Peter J. Mumby, Yohei Nakamura, Moninya Roughan, Erik van Sebille, Alex Sen Gupta, Dan A. Smale, Fiona Tomas, Thomas Wernberg and Shaun K. Wilson

Proc. R. Soc. B 2014 **281**, 20140846, published 9 July 2014

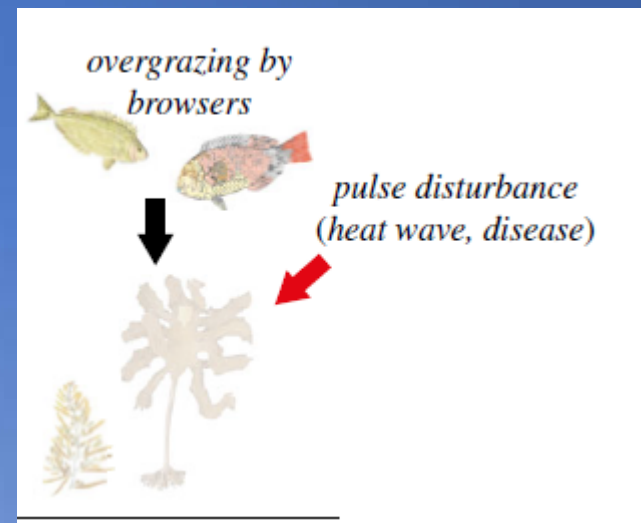
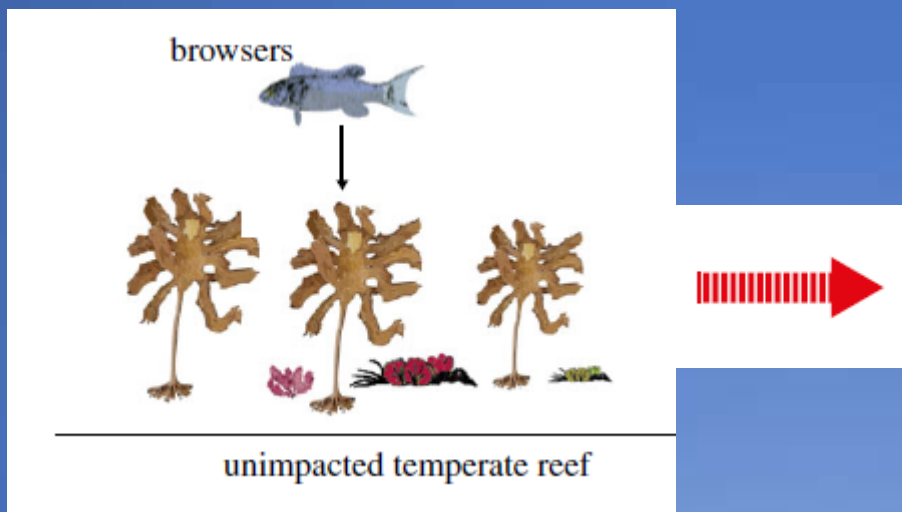
1990's

Tosa Bay (Southern Japan)

January 2013



Vergés et al 2014. Proc. R. Soc. B. Biol.Sci.

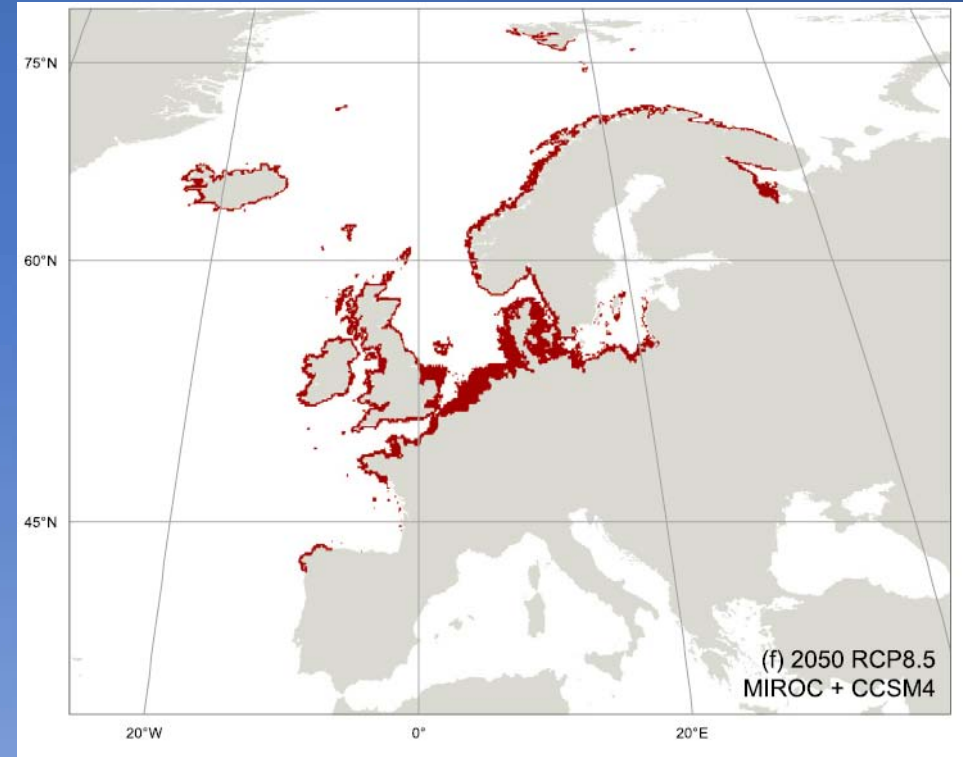
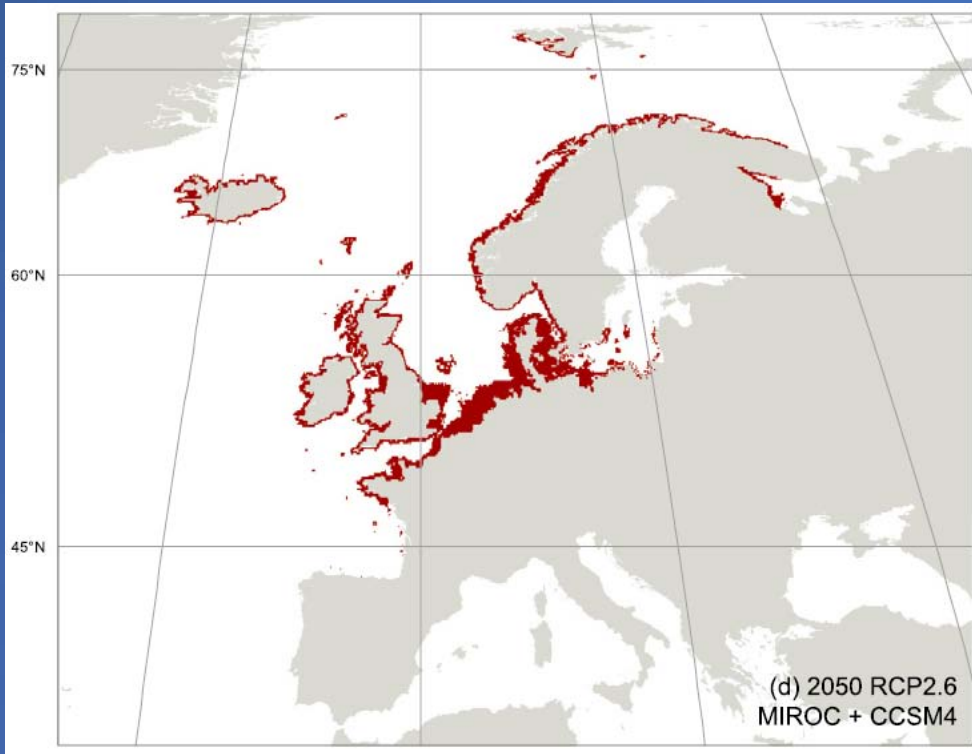


Vergés et al 2014. *Proc. R. Soc. B. Biol.Sci.*

Futuro próximo. Predicciones

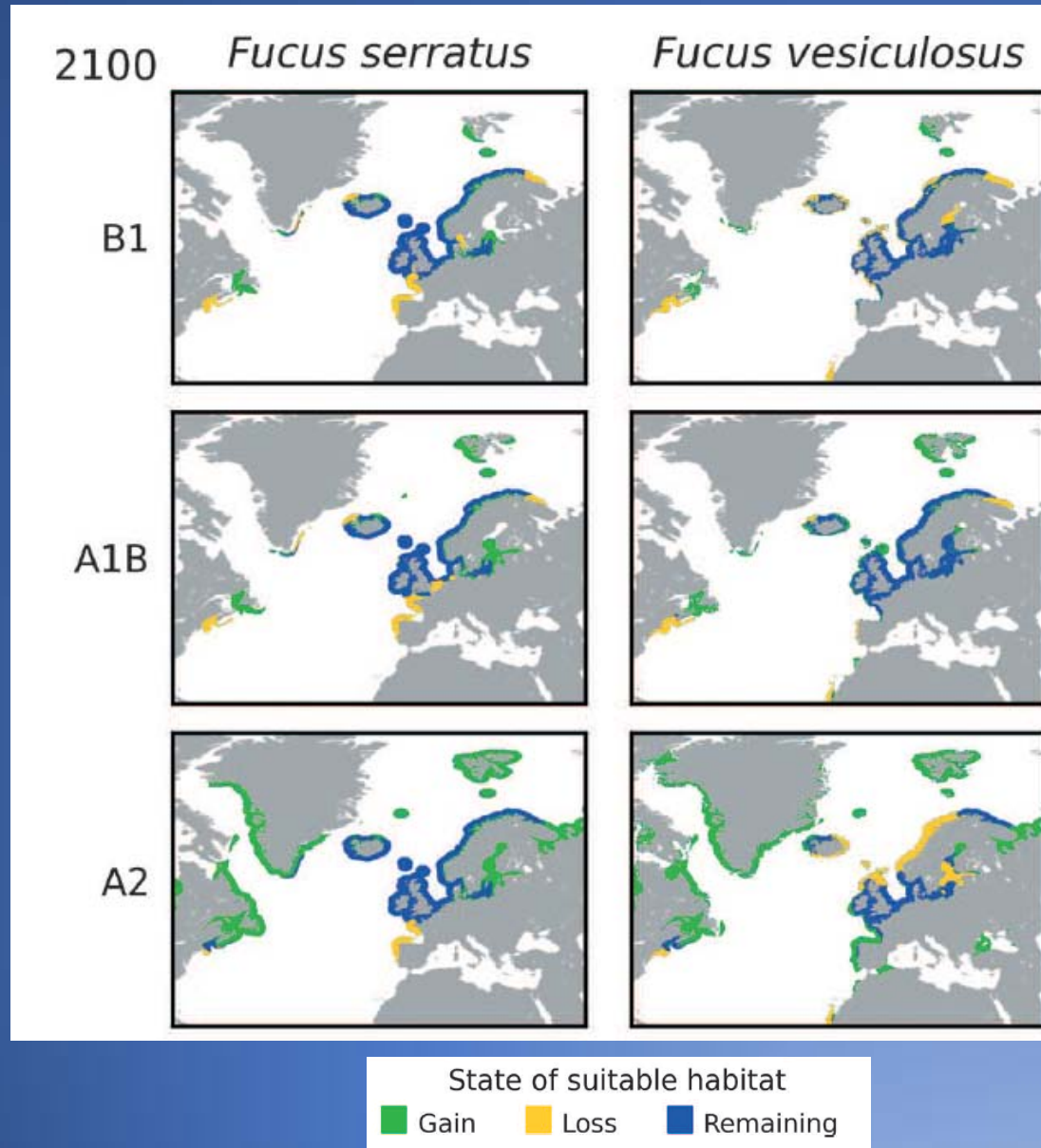
Predicciones

Laminaria hyperborea en 2050



Assis et al 2016. *Marine Environmental Research*

Predicciones



Jueterbock et al 2013. *Ecology and Evolution*

Necesidad de seguimientos a largo plazo y con una metodología común