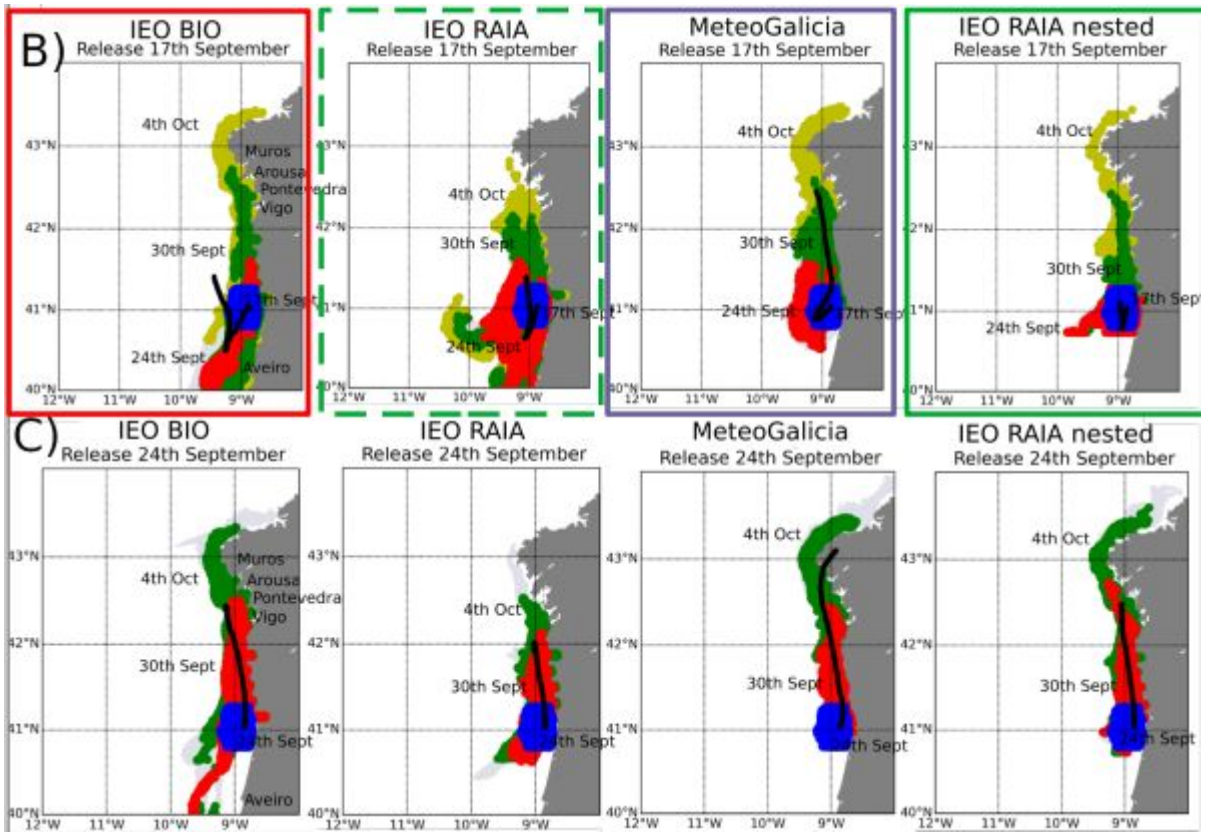
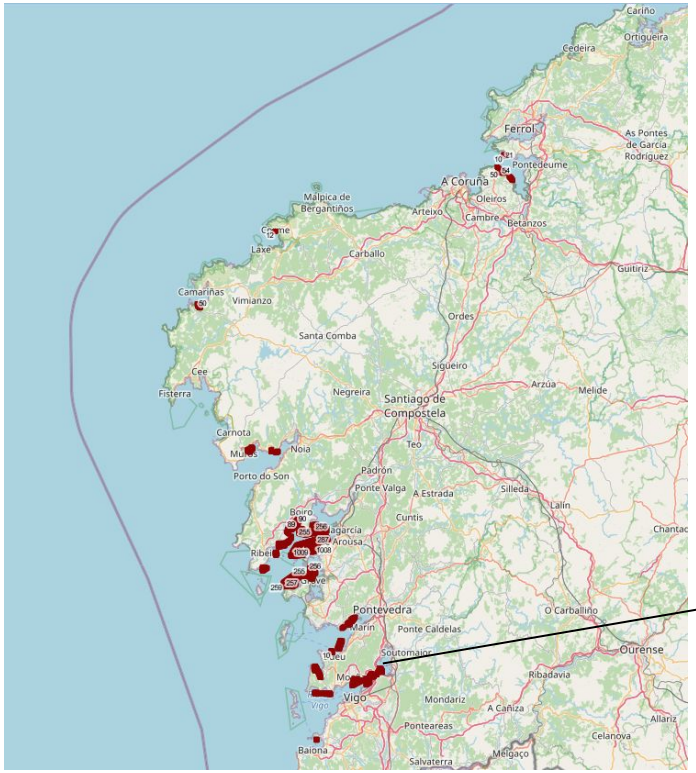
Early warning forecasts of harmful *Dinophysis* blooms in Galicia (NW Spain)

Manuel Ruiz-Villarreal, Luz García-García, Gonzalo González Nuevo, Francisco Rodríguez and Beatriz Reguera
Instituto Español de Oceanografía, IEO, CSIC





44 harvesting polygons
3387 mussel rafts
Weekly HAB monitoring

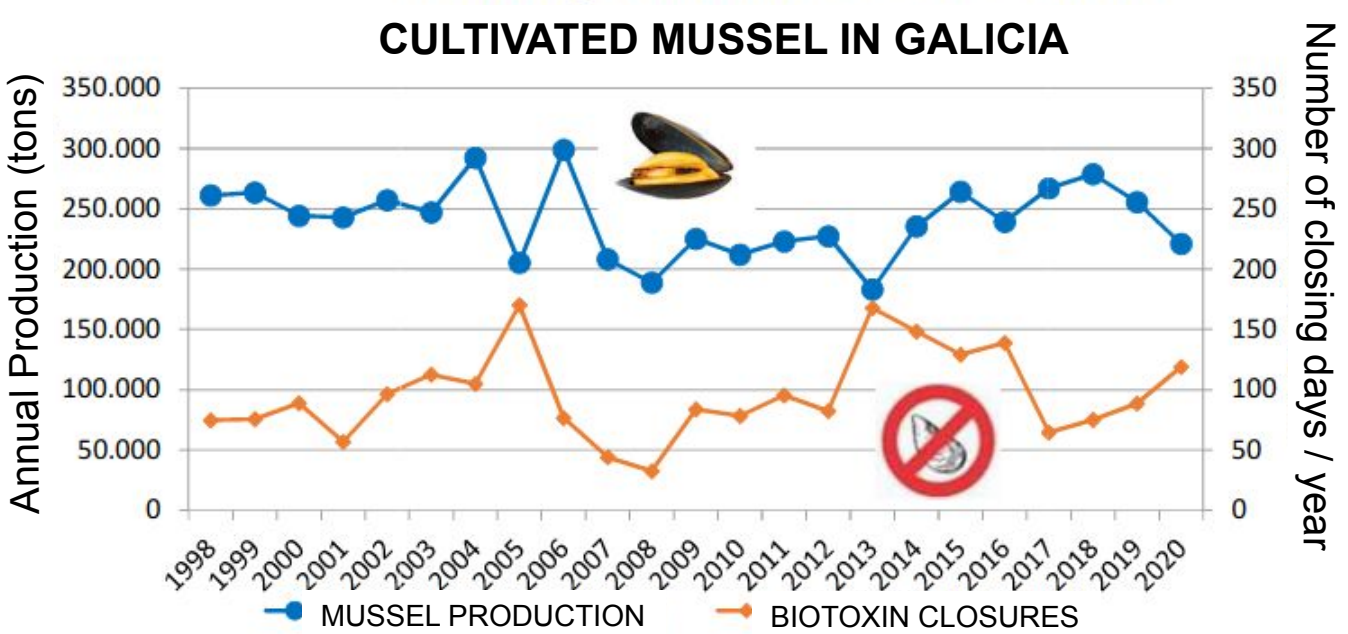
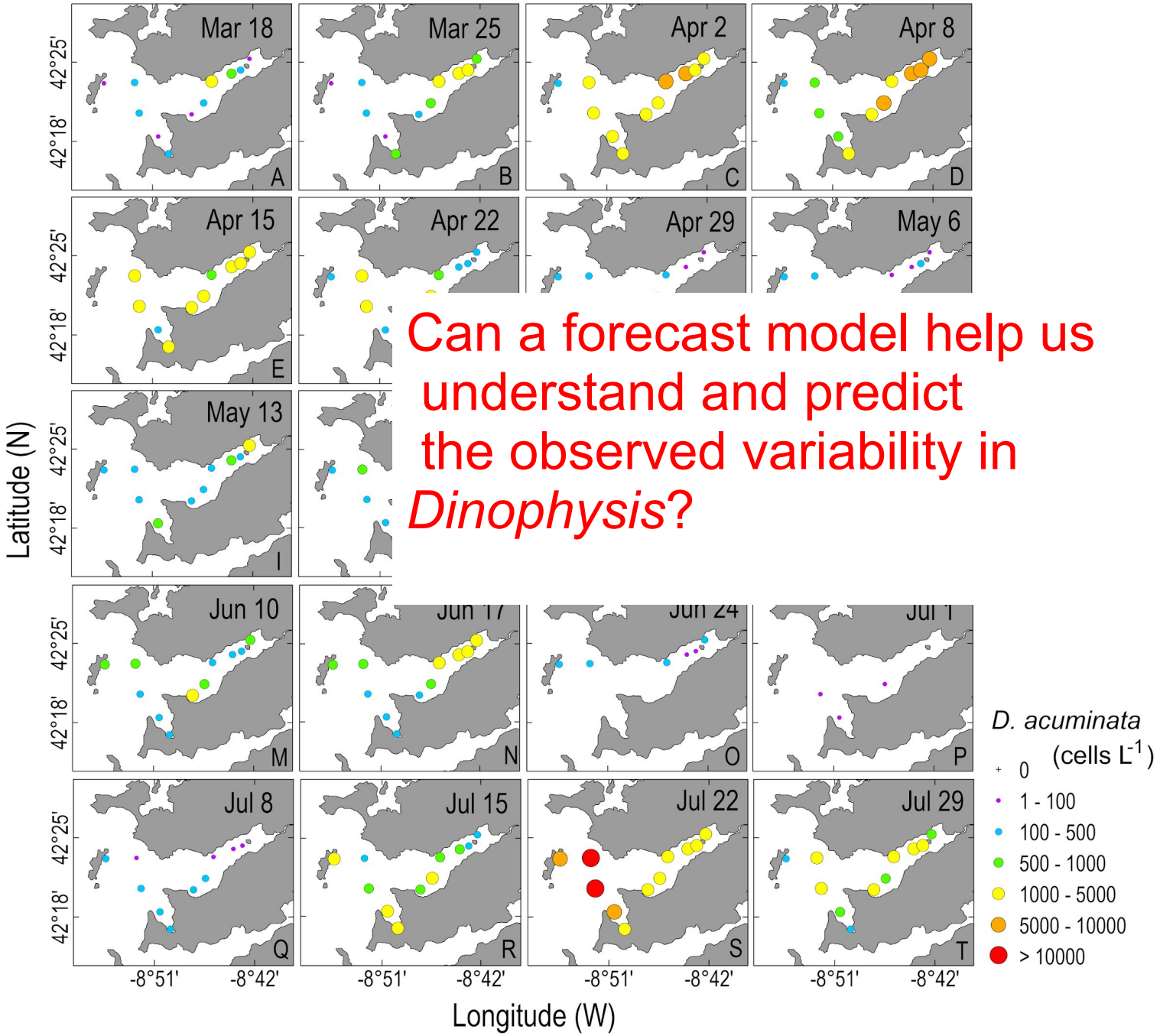
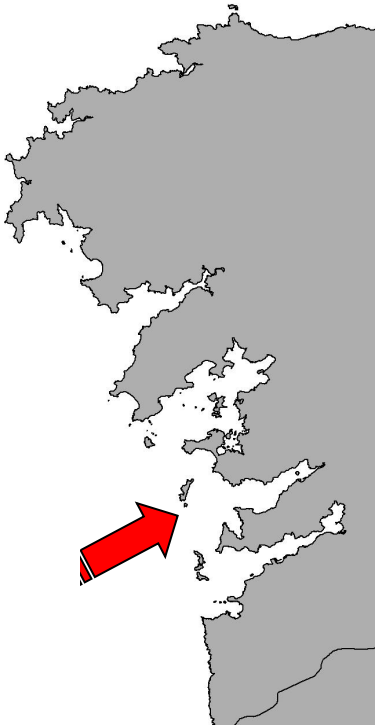


Figura 1. Producción anual de mexillón cultivado en Galicia (fonte: Conselleria do Mar).

INTECMAR report on closures of mussel polygons 1998-2020. May 2021



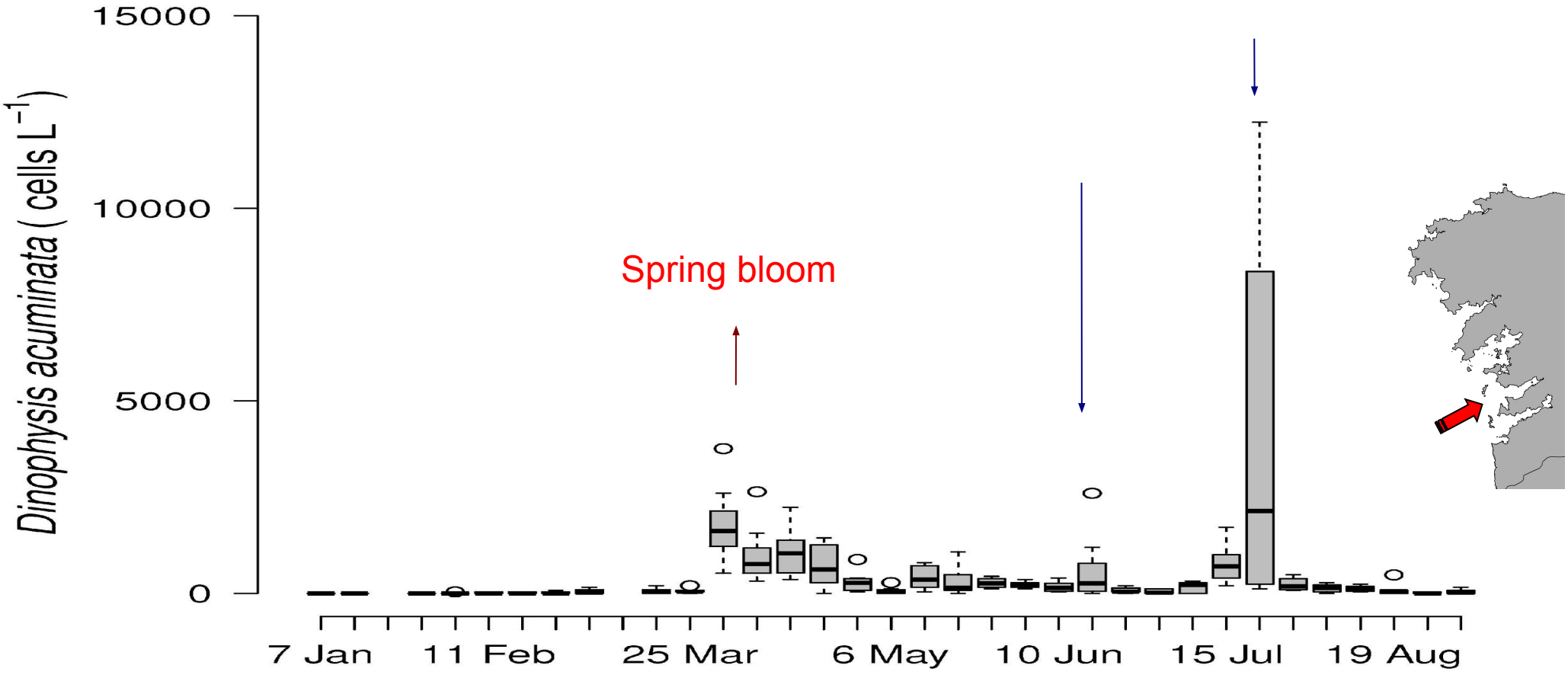
Can a forecast model help us understand and predict the observed variability in *Dinophysis*?

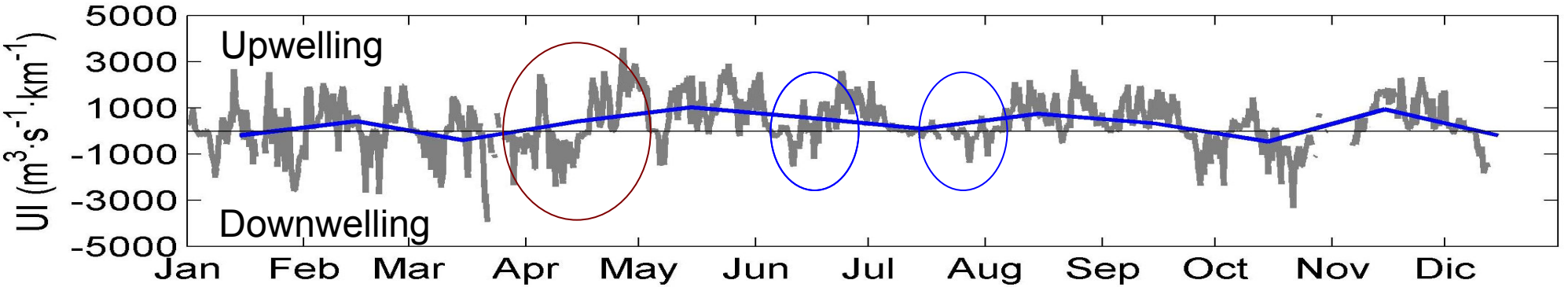


Ría de Pontevedra

Dinophysis acuminata concentrations in weekly monitoring stations
(Data from INTECMAR, Xunta de Galicia)

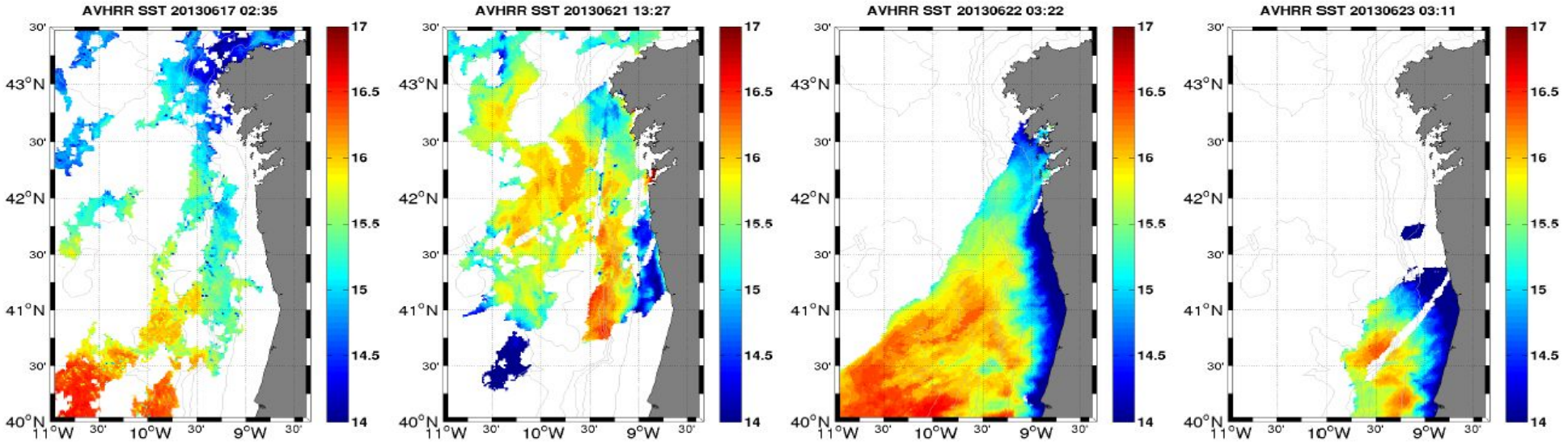
Spring-summer 2013: Temporal evolution of *D. Acuminata* concentrations and closures



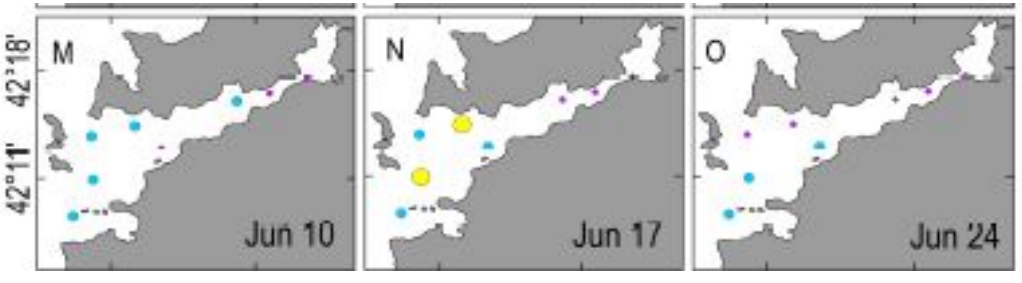


Spring 2013: variability in *D. acuminata* vs. variability in oceanographic conditions

Satellite SST



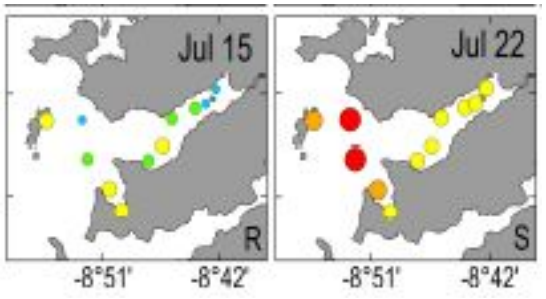
Model surface current and temperature

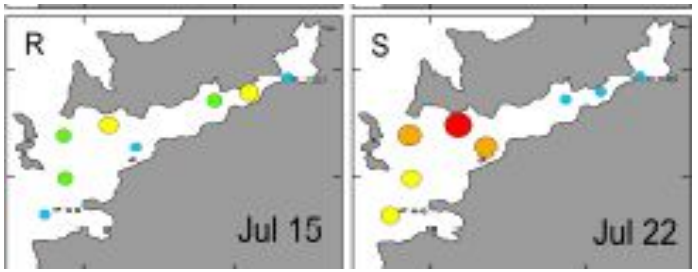


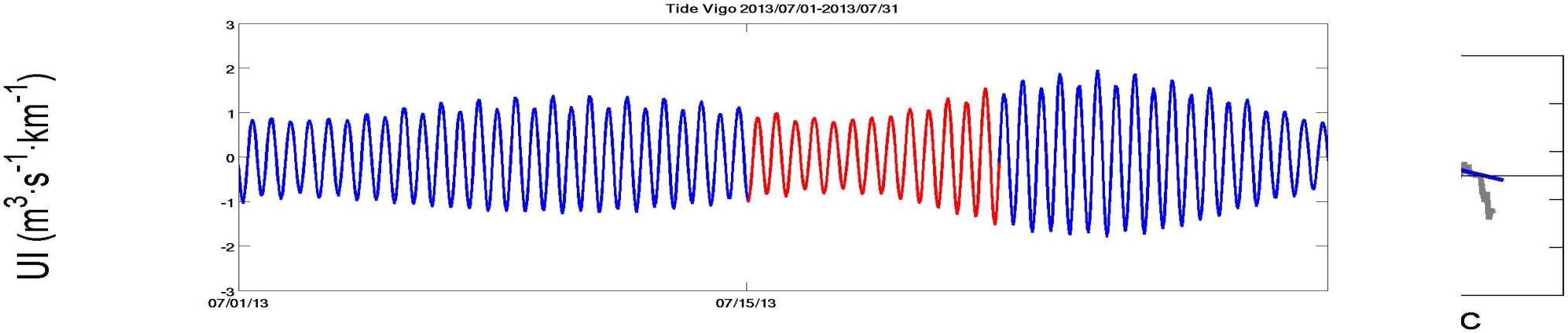
Diaz et al. 2017, PiO

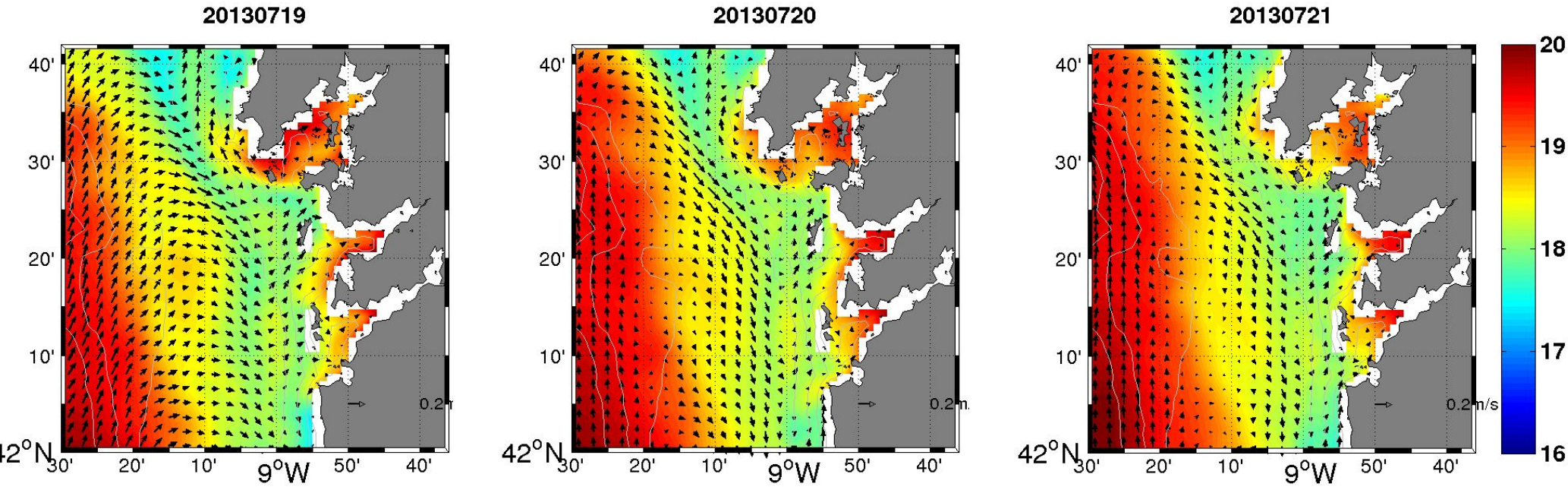
Upwelling pulse
Water renewal in the rias

Summer 2013: *D. acuminata* vs. variability in oceanographic conditions



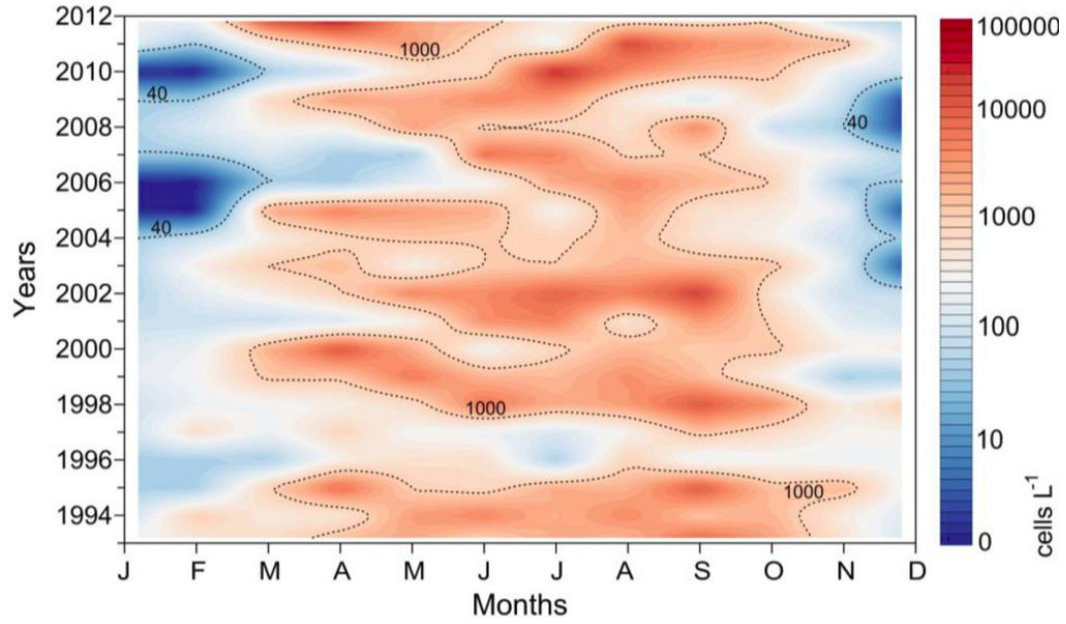


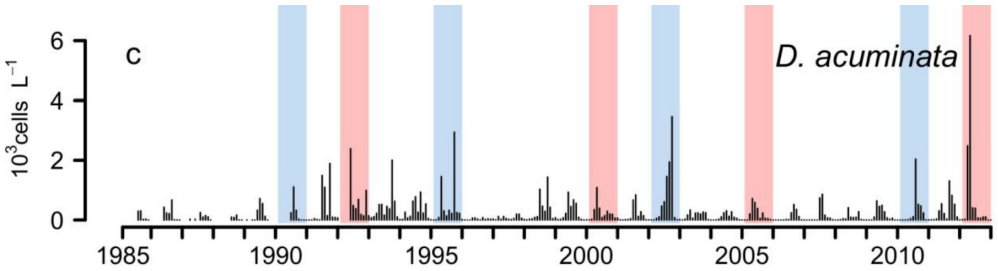




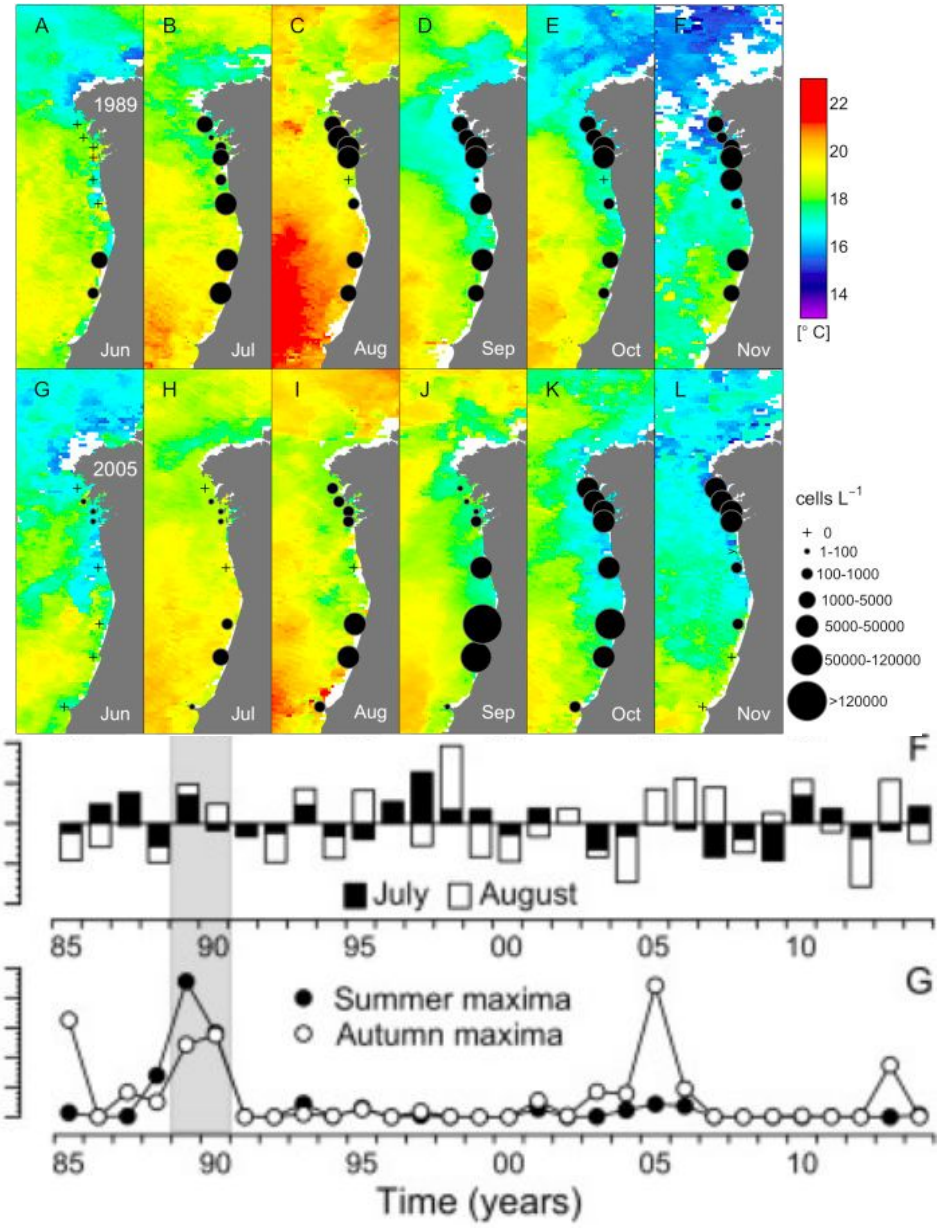
Dinophysis acuminata feeding on the marine ciliate *Myrionecta rubra* by extracting its cytoplasm through a peduncle. *Photo: Myung Gil Park*

Mesodinimum spp. bloom (upwelling) followed by conditions favorable for *D. acuminata* (relaxation, retention)
Variability in oceanographic conditions described in detail by the model (upwelling, relaxation, retention, advection, coupling with tides)



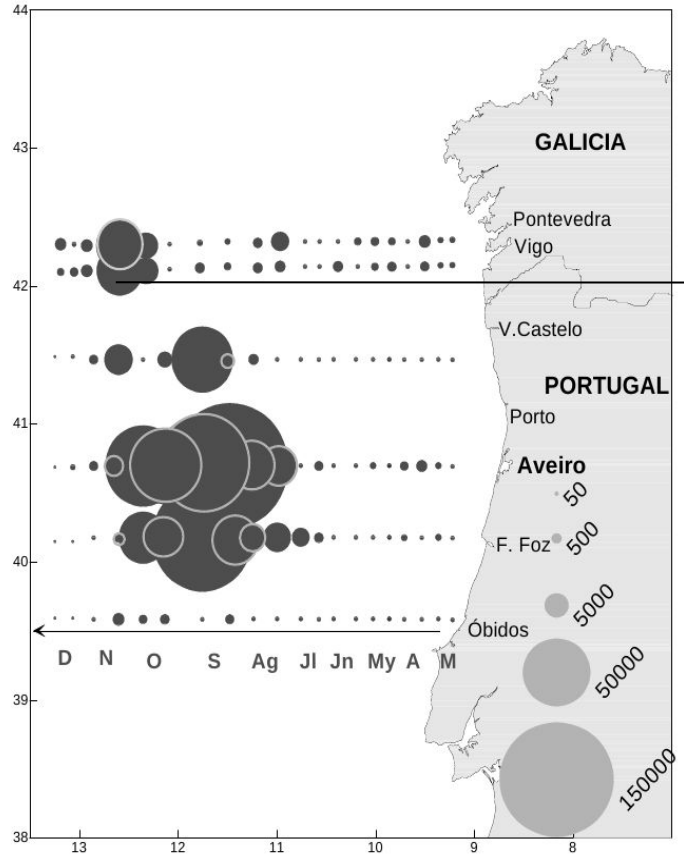


Dinophysis acuminata
Ria de Pontevedra 1985-2012
Diaz et al. 2013, Marine Drugs

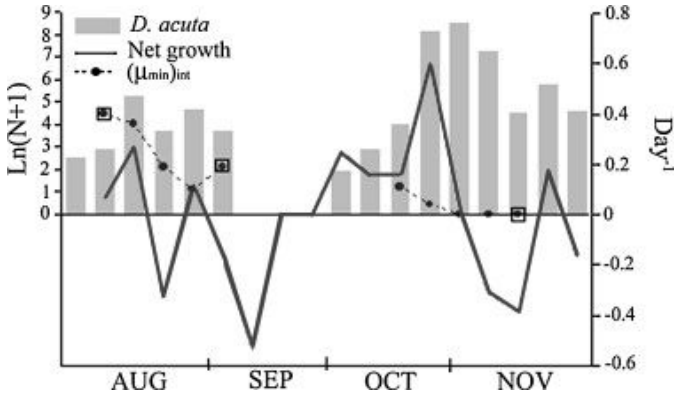


Dinophysis acuta
Ria de Pontevedra 1985-2015
Diaz et al. 2016, Harmful Algae

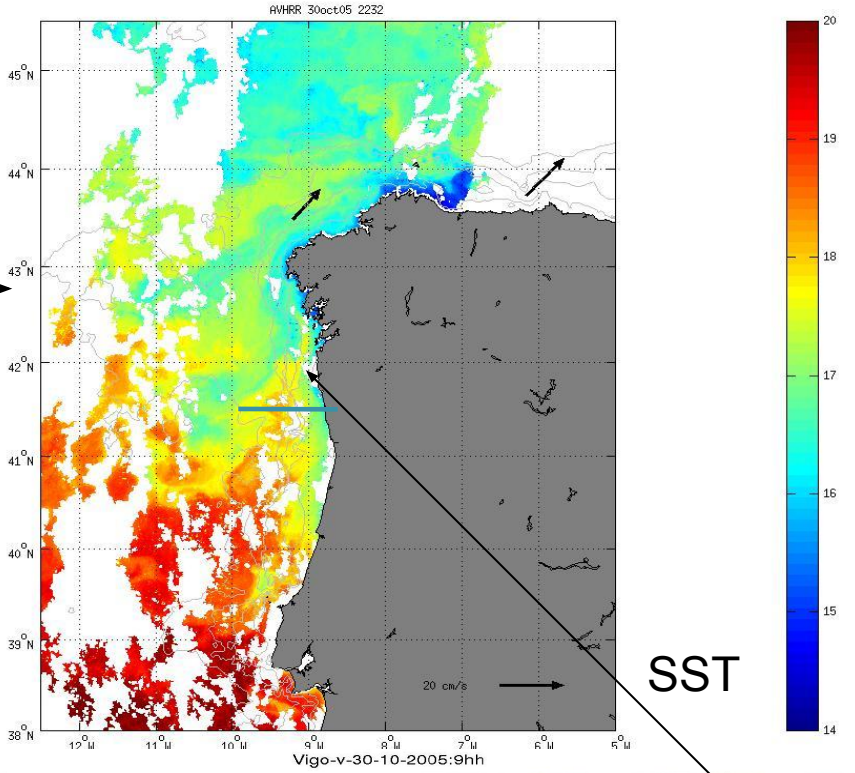
Northwards transport of *D. acuta* in autumn 2005

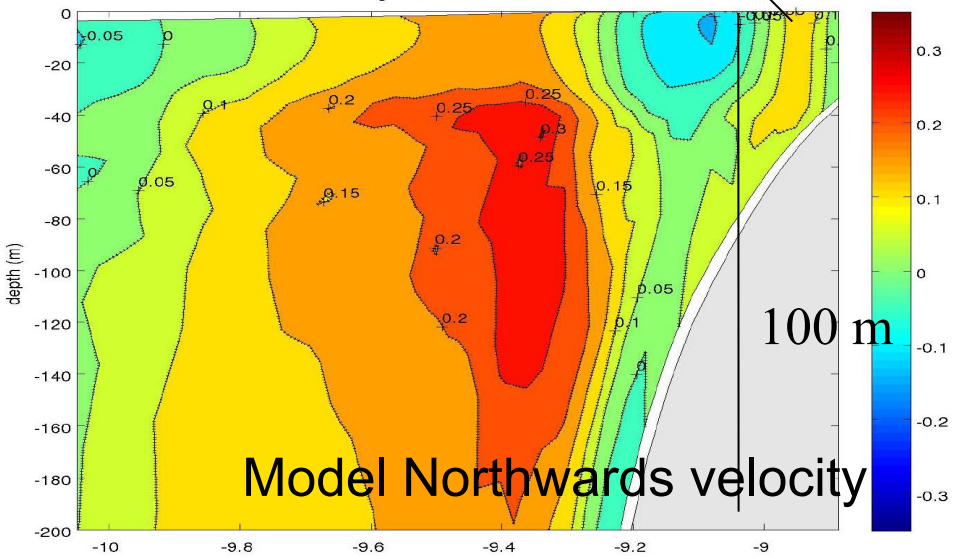


Dinophysis acuta weekly concentration



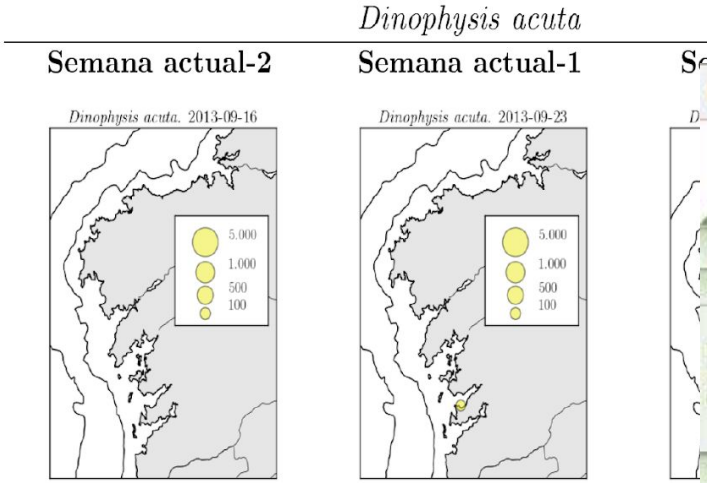
Escalera et al, Harmful Algae, 2009

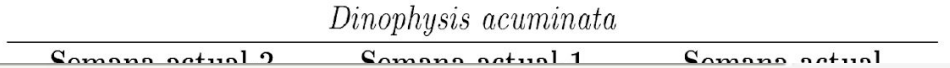




Ruiz-Villarreal et al., Harmful Algae, 2016

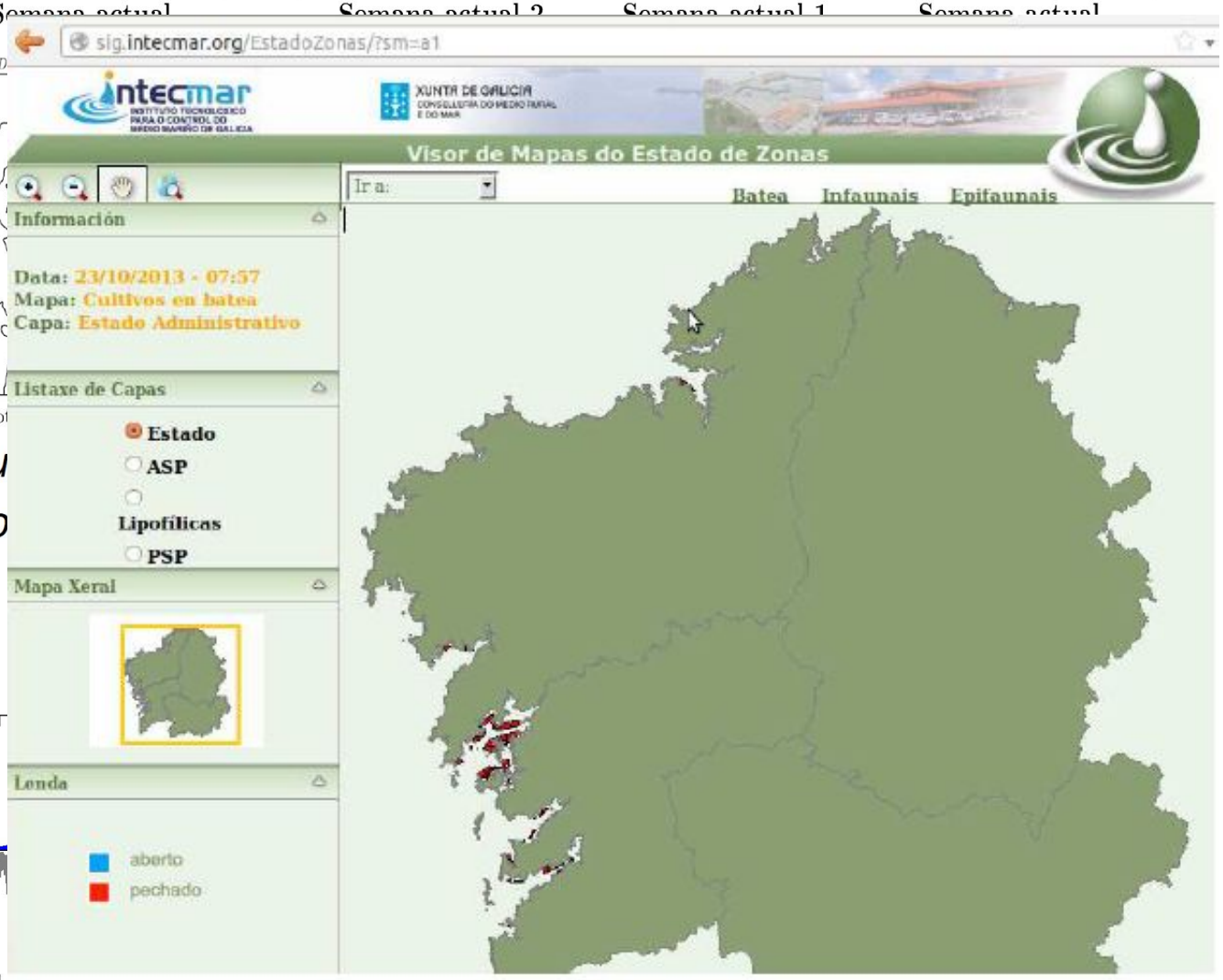
Autumn 2013: High *D. acuta* (and *D.acuminata*) concentrations (prolonged closures)

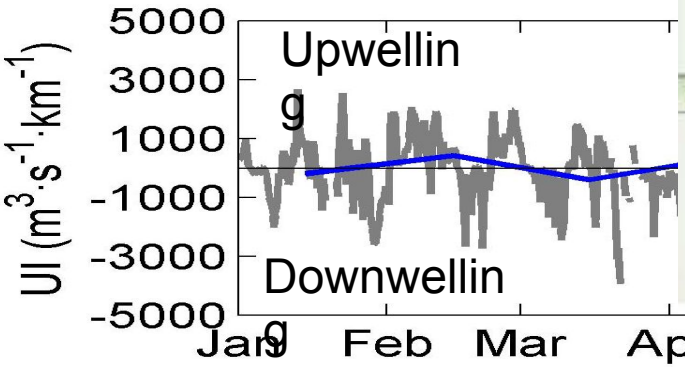




*Os datos de concentración de especies tóxicas (en células/l) son obt

Figure 12: Cell counts of D. Acu monitoring cruises of the two Intecmar)





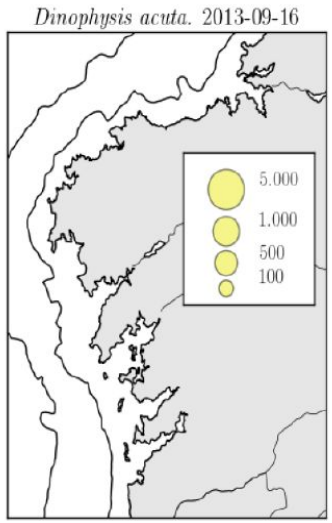
Autumn 2013: Dynophysis acuta and Along-shore transport

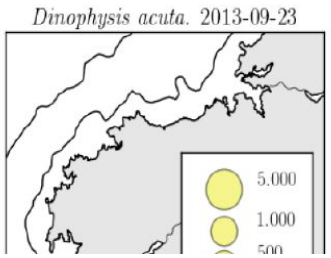
PILOT BULLETIN

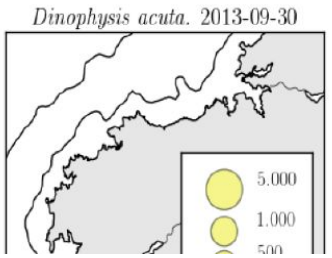
ASIMUTH

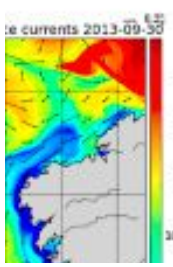
1. Models: surface temperature and currents. Shelf circulation

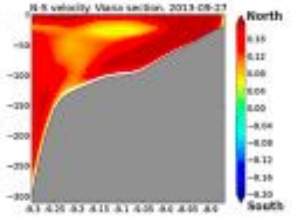
2013/09/27 (0d) 2013/09/28 (1d) 2013/09/29 (2d) 2013/09/30 (3d)

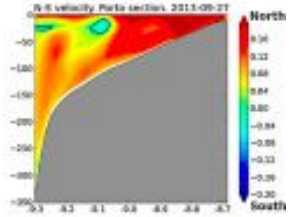


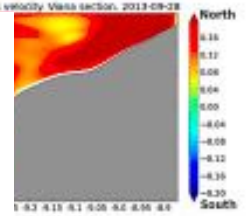


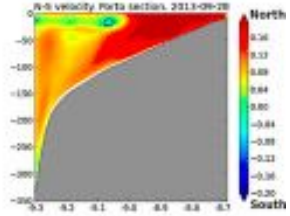


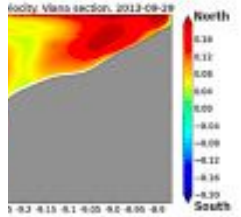


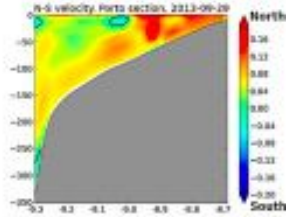


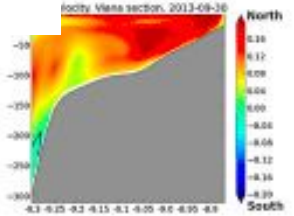


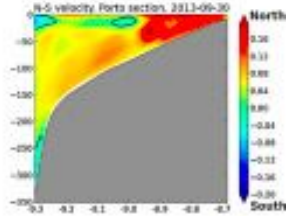




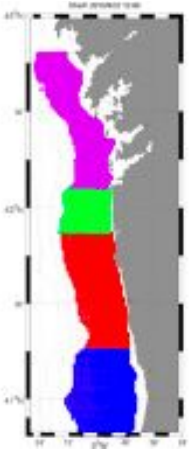


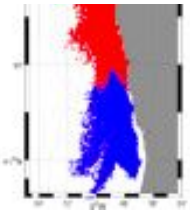


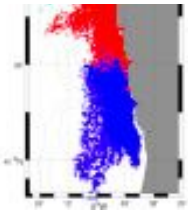


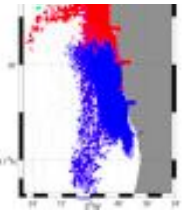


During autumn *D. acuta blooms*, forecasts of along and across-shore transport are a tool for predicting the risk of closures of harvesting areas









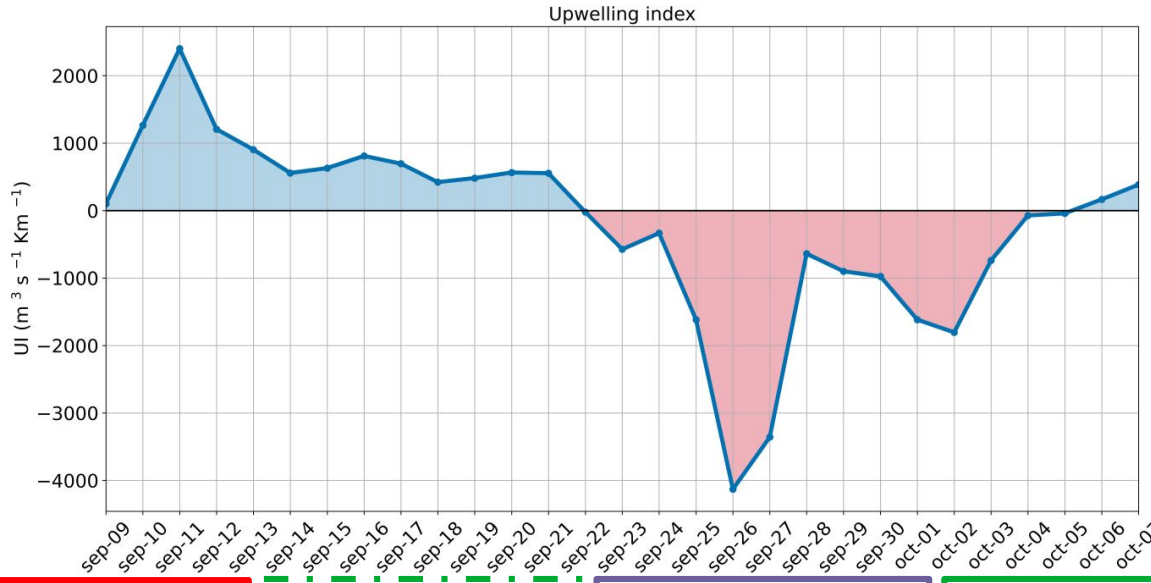
100m

Viana

Porto

Ruiz-Villarreal et al. 2016 Harmful Algae

A)


Upwelling index
UI (m 3 s −1 Km −1)
2000
1000
0
−1000
−2000
−3000
−4000
sep-09
sep-10
sep-11
sep-12
sep-13
sep-14
sep-15
sep-16
sep-17
sep-18
sep-19
sep-20
sep-21
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sep-23
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sep-26
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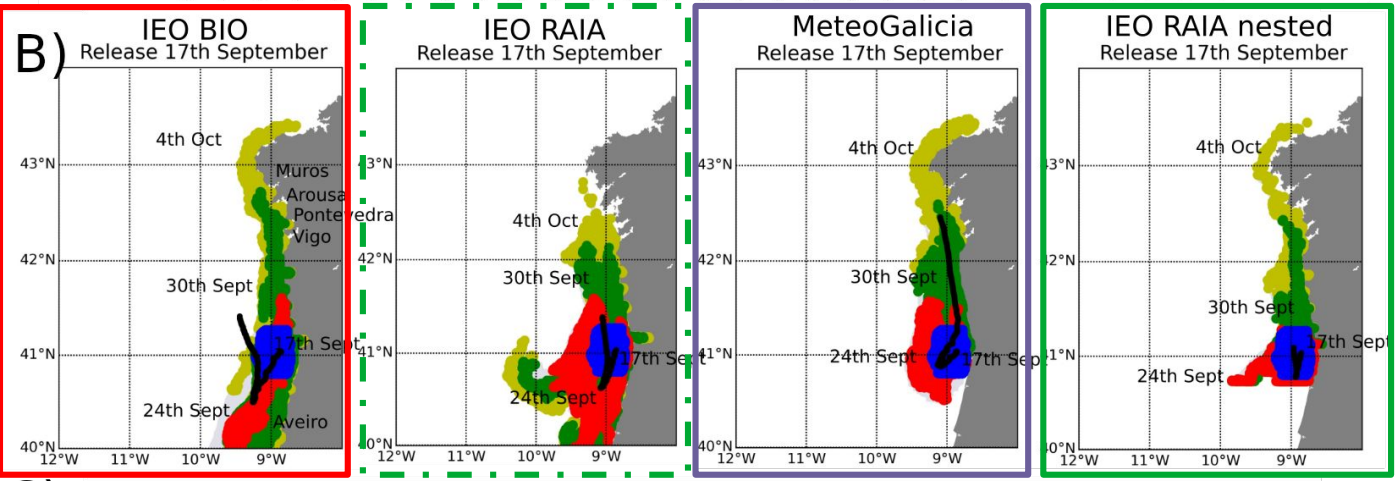
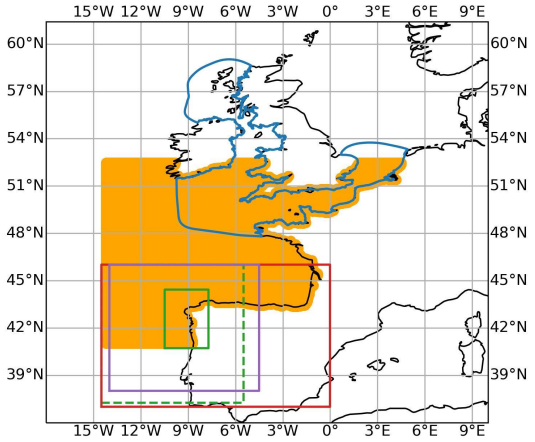
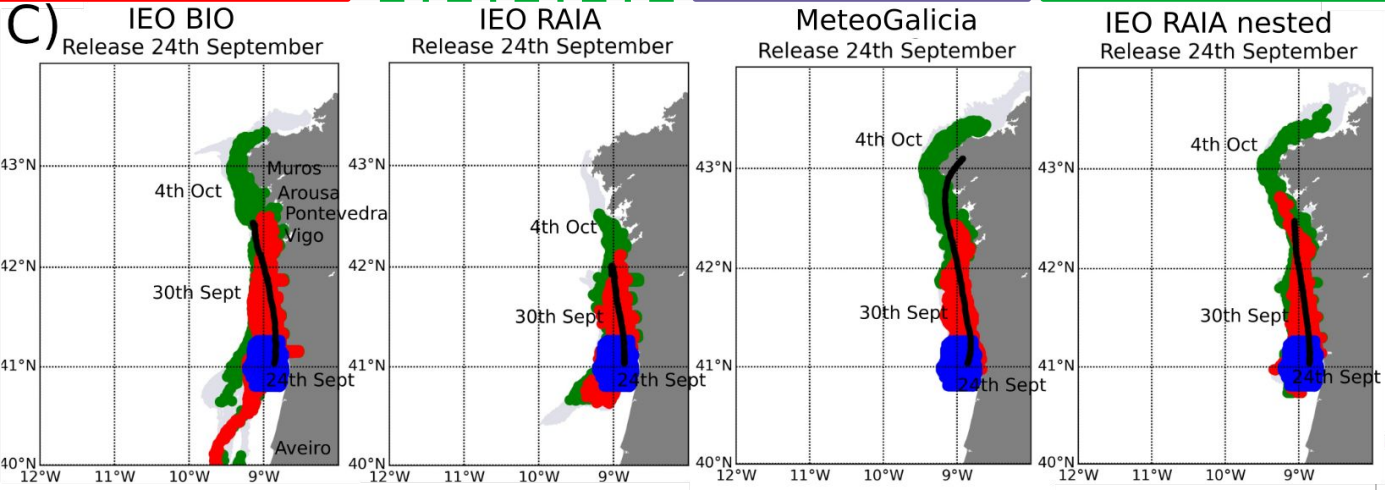
oct-07

B)


IEO BIO
Release 17th September
IEO RAIA
Release 17th September
MeteoGalicia
Release 17th September
IEO RAIA nested
Release 17th September
4th Oct
30th Sept
24th Sept
17th Sept
Muros
Arousa
Pontevedra
Vigo
Aveiro
43°N
42°N
41°N
40°N
12°W
11°W
10°W
9°W


15°W 12°W 9°W 6°W 3°W 0° 3°E 6°E 9°E
60°N
57°N
54°N
51°N
48°N
45°N
42°N
39°N

C)


IEO BIO
Release 24th September
IEO RAIA
Release 24th September
MeteoGalicia
Release 24th September
IEO RAIA nested
Release 24th September
4th Oct
30th Sept
24th Sept
Muros
Arousa
Pontevedra
Vigo
Aveiro
43°N
42°N
41°N
40°N
12°W
11°W
10°W
9°W

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Short Communication

Are red tides affecting economically the commercialization of the Galician (NW Spain) mussel farming?

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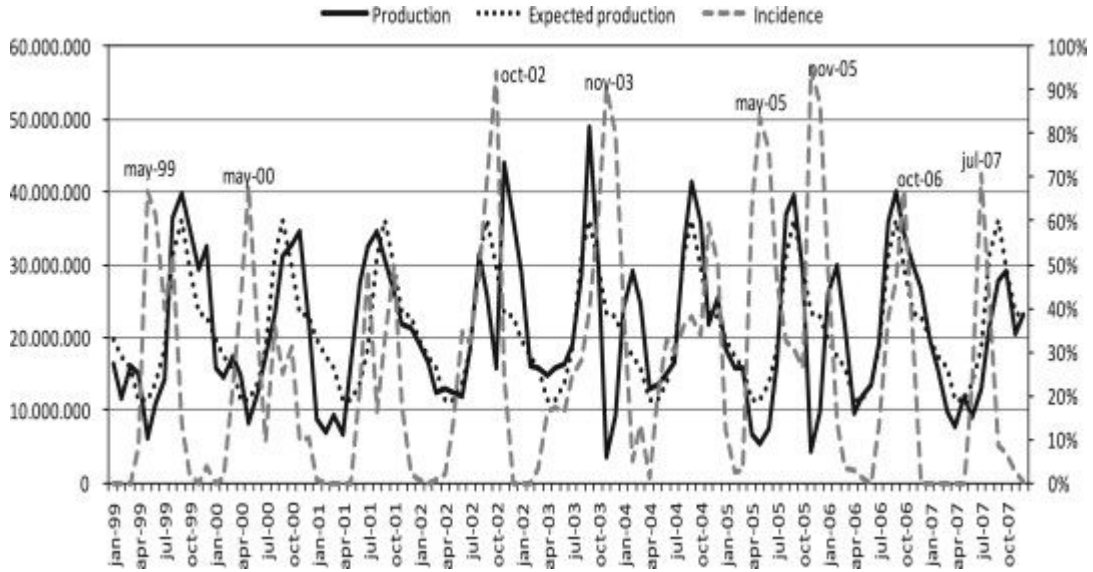
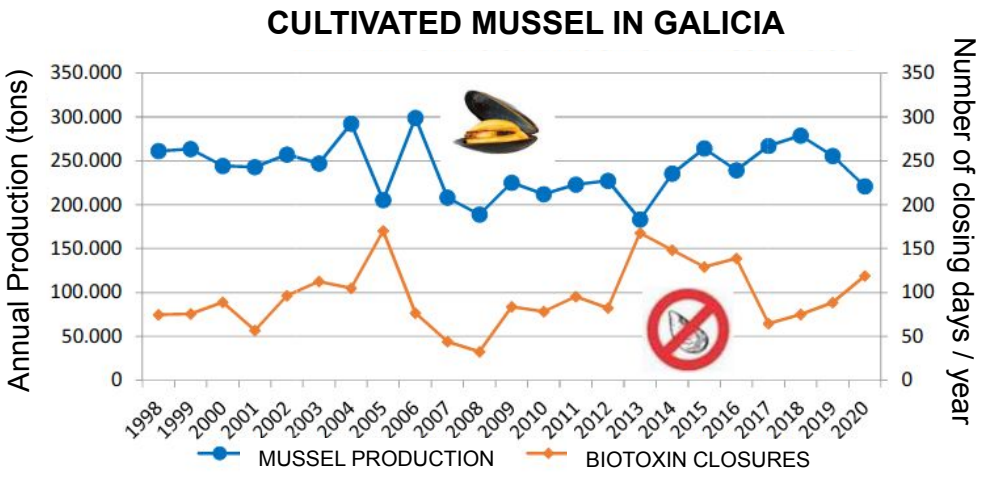
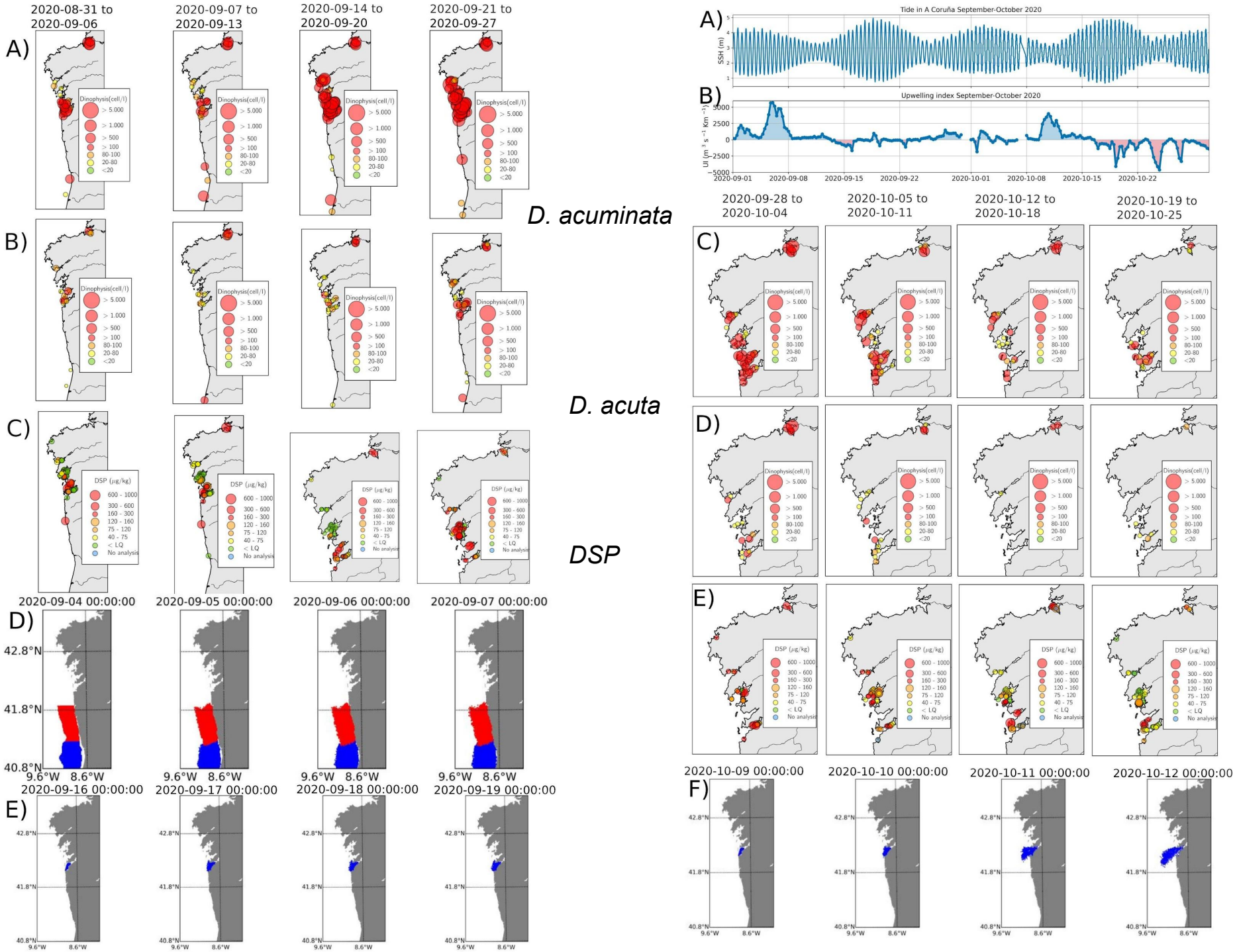
ABSTRACT

Harmful algal blooms (HABs), more specifically red tides, are among the most critical environmental factors affecting mussel cultivation in Galicia (NW Spain), and they often have been blamed for economic losses for producers. This statement is based on the correlation between days of closure of the production areas and unsold product. The present article shows that such a statement is not always correct, at least in the case of Galician mussel farming, because red tides only cause losses to producers under specific circumstances that arise from the impossibility of placing their product in the market. In addition, this article reveals the importance of finding organizational solutions within the framework of the production sector to counteract the impact of this type of phenomenon.

Even with the possibility of shifting production to the months adjacent to the closure periods, the greatest impact occurs when high rates of incidence are prolonged throughout the last four months of the year. It is noteworthy that the harvest is directed for factory production from August to November and it is aimed mostly for fresh production in December, which is the period in which the highest prices of the year are reached. The consequence of this selling cycle for mussel producers is that while the canned industry has the capacity to adapt the production chain to the availability of raw materials, the fresh market could loss a market position during times of large sales (i.e., Christmas holidays).






A)
2020-08-31 to 2020-09-06
2020-09-07 to 2020-09-13
2020-09-14 to 2020-09-20
2020-09-21 to 2020-09-27
Dinophysis(cell/l)
> 5.000
> 1.000
> 500
> 100
80-100
20-80
<20
D. acuminata
B)
D. acuta
C)
DSP (µg/kg)
600 - 1000
300 - 600
160 - 300
120 - 160
75 - 120
40 - 75
< LQ
No analysis
DSP
2020-09-04 00:00:00
2020-09-05 00:00:00
2020-09-06 00:00:00
2020-09-07 00:00:00
D)
42.8°N
41.8°N
40.8°N
9.6°W
8.6°W
2020-09-16 00:00:00
2020-09-17 00:00:00
2020-09-18 00:00:00
2020-09-19 00:00:00
E)
Tide in A Coruña September-October 2020
A)
SSH (m)
Upwelling index September-October 2020
B)
UI (m^3 s^{-1} Km^{-1})
2020-09-01
2020-09-08
2020-09-15
2020-09-22
2020-10-01
2020-10-08
2020-10-15
2020-10-22
2020-09-28 to 2020-10-04
2020-10-05 to 2020-10-11
2020-10-12 to 2020-10-18
2020-10-19 to 2020-10-25
C)
D)
E)
2020-10-09 00:00:00
2020-10-10 00:00:00
2020-10-11 00:00:00
2020-10-12 00:00:00
F)

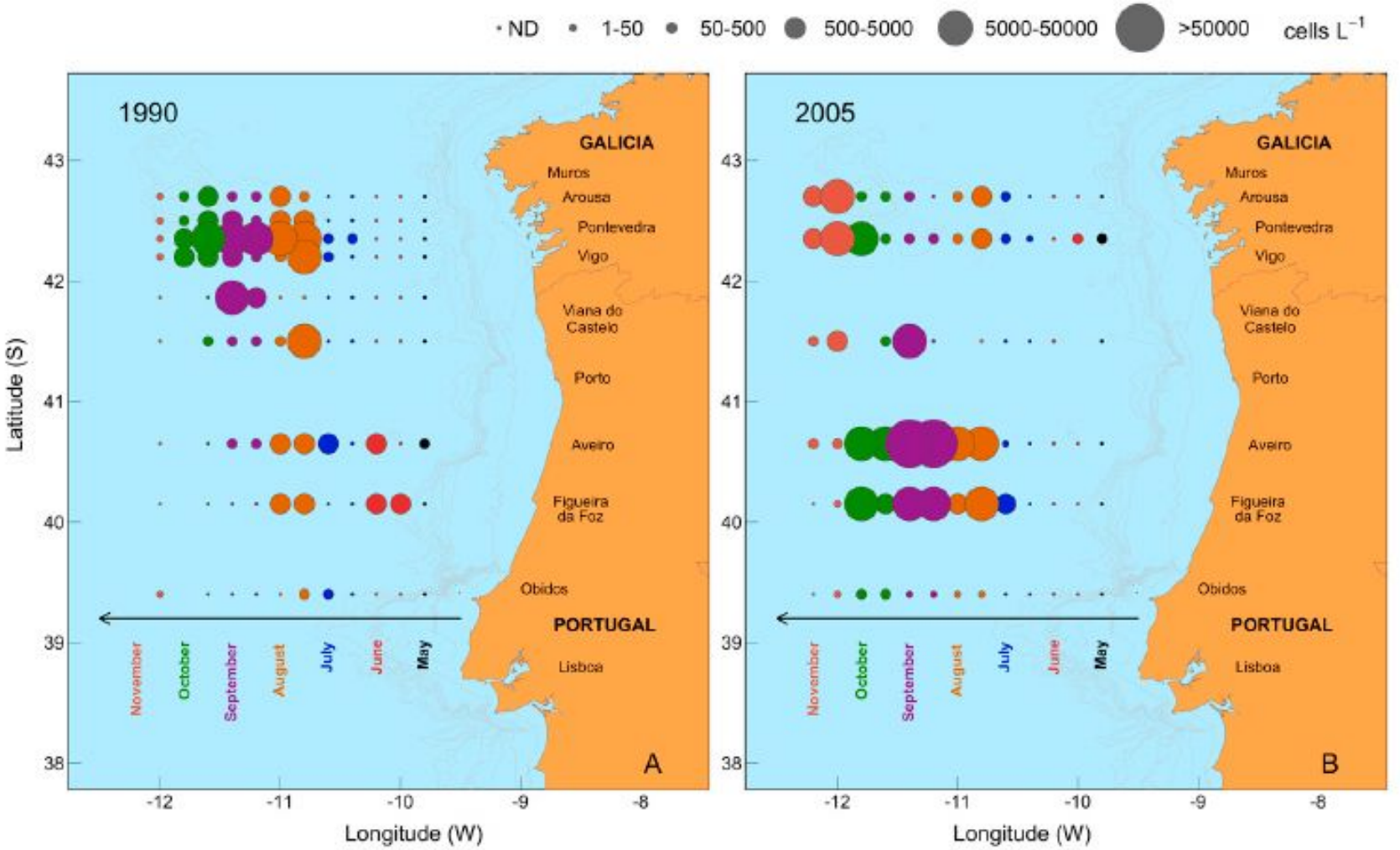


Figure 9. Seasonal variability, from June to November, of *D. acuta* cell maxima at monitoring sites in Galicia and northern Portugal in 1990 (**A**) and 2005 (**B**). Isobaths are shown in gray. The 2005 map is

toxins

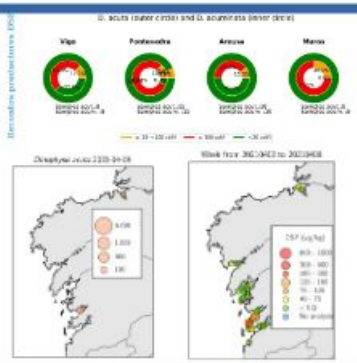
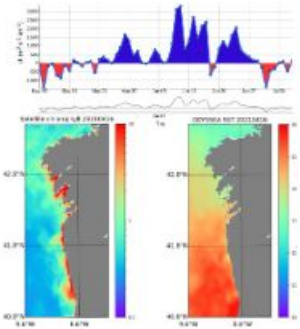
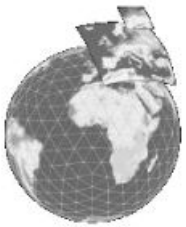
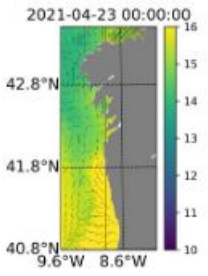
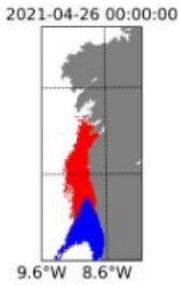
MDPI

Article

Mesoscale Dynamics and Niche Segregation of Two *Dinophysis* Species in Galician-Portuguese Coastal Waters

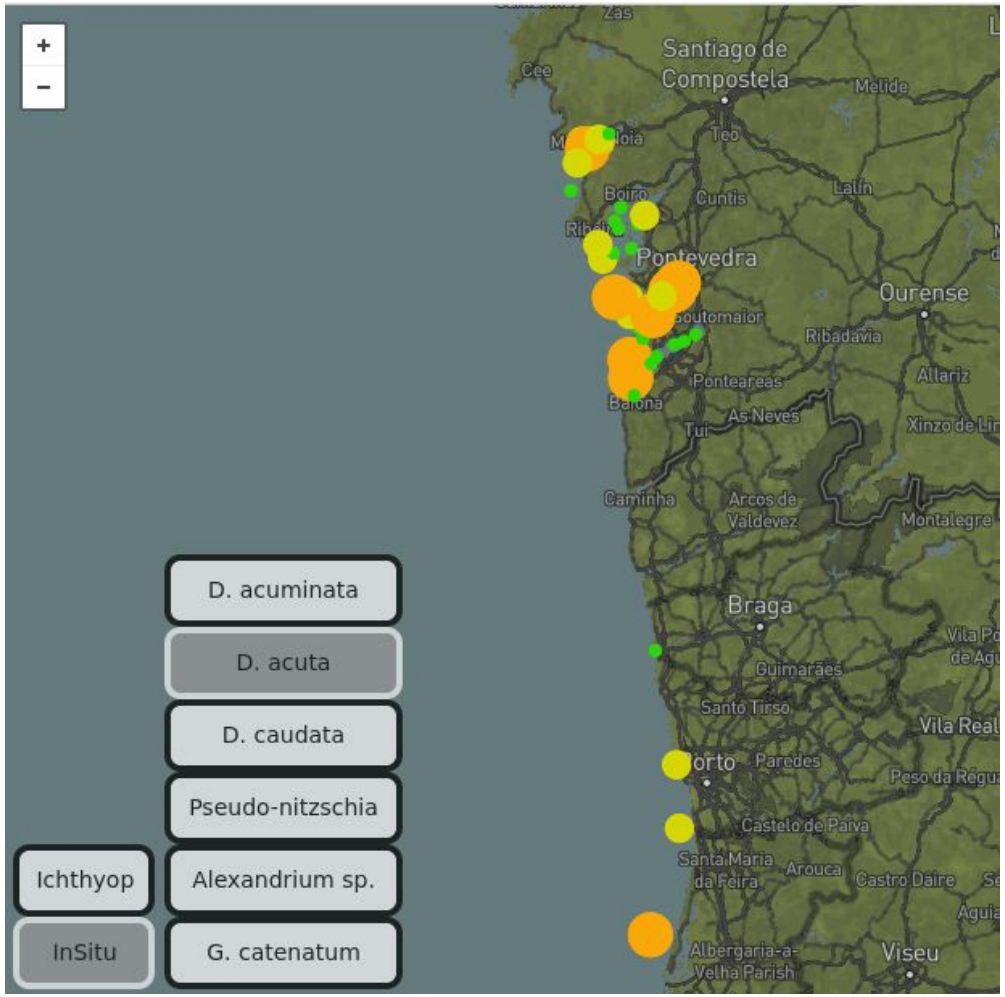
Patricio A. Díaz [1,2,*], Beatriz Reguera [1], Teresa Moita [3,4], Isabel Bravo [1], Manuel Ruiz-Villarreal [5] and Santiago Fraga [1]

Elements of the Galician HAB Early Warning Bulletin

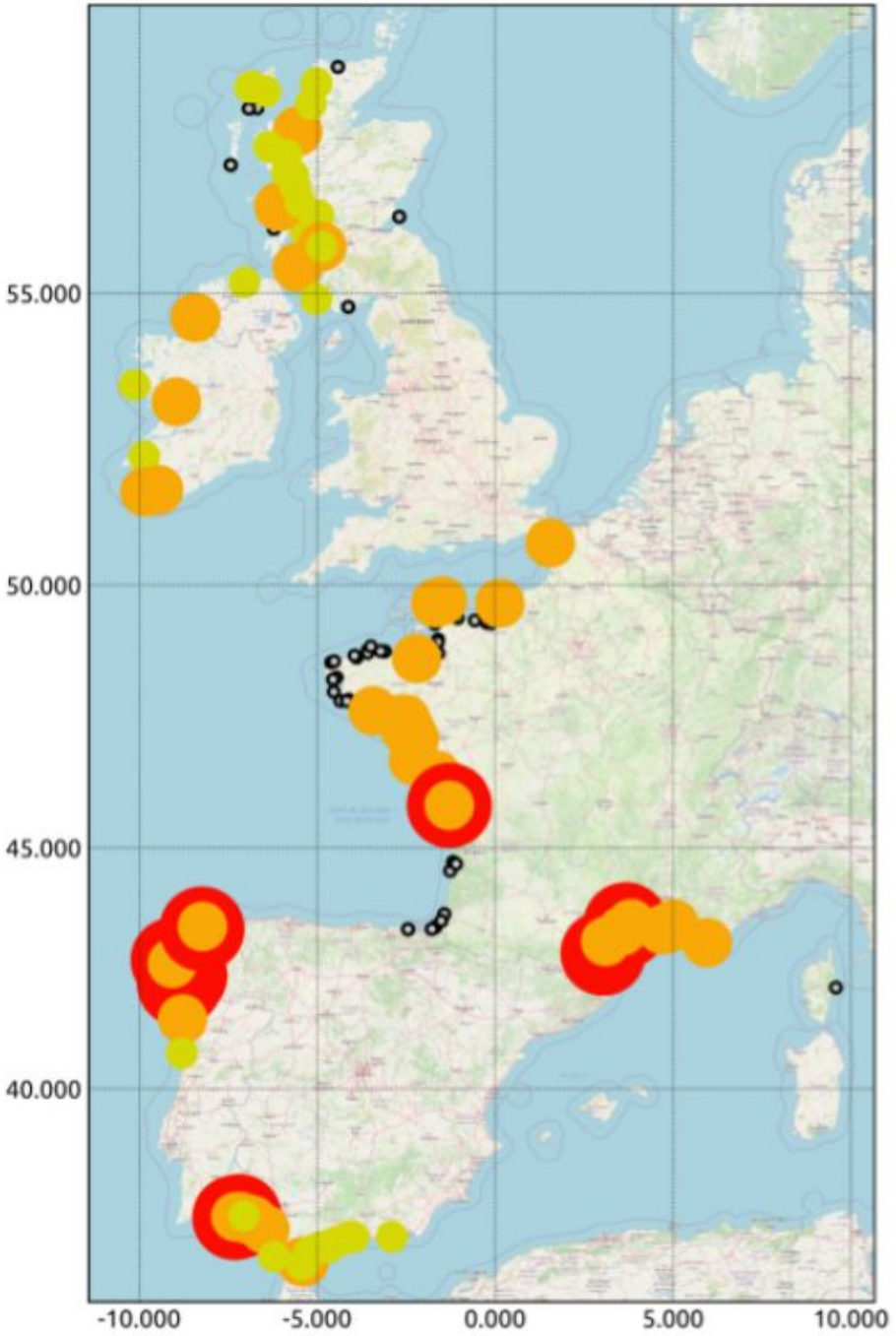
	Data	Sources	Processing	HAB Bulletin
In Situ	 HAB Cells HAB Toxines	Intecmar – Instituto Tecnoloxico para o Control do Medio Marino de Galicia	python PostgreSQL	
Observacional	 Upwelling Index SST Chlorophyll	Instituto Español de Oceanografía Copernicus Marine Service	python PostgreSQL python	
Models	 Temperature and Currents Shelf Circulation	meteogalicia Regional Ocean Modeling System ROMS Research Community Instituto Español de Oceanografía Instituto Español de Oceanografía	python python	 

In situ Data Processing

Server Services Client



Dinophysis acuta September 2020



Dinophysis acuminata September 2020

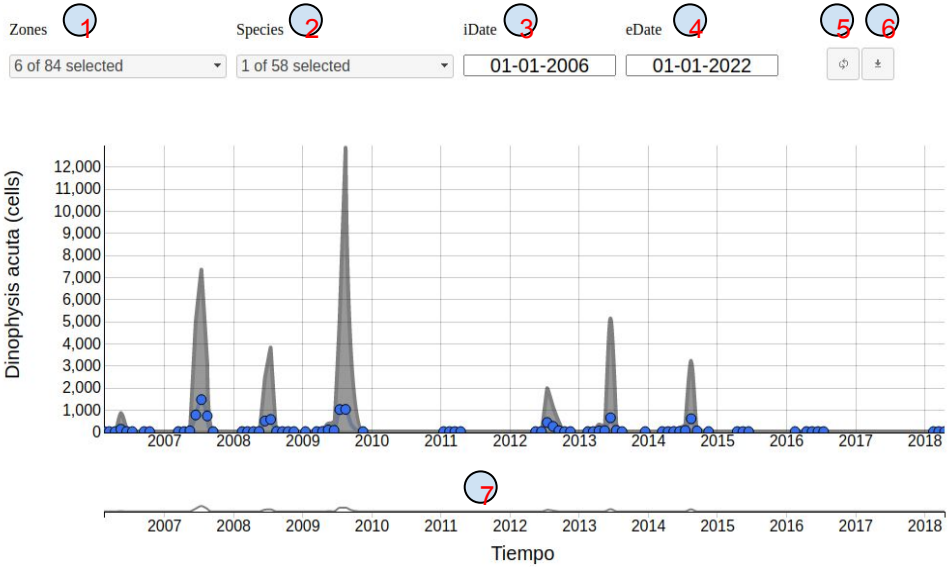


Figure 3: Screen caption of the time series plot service.

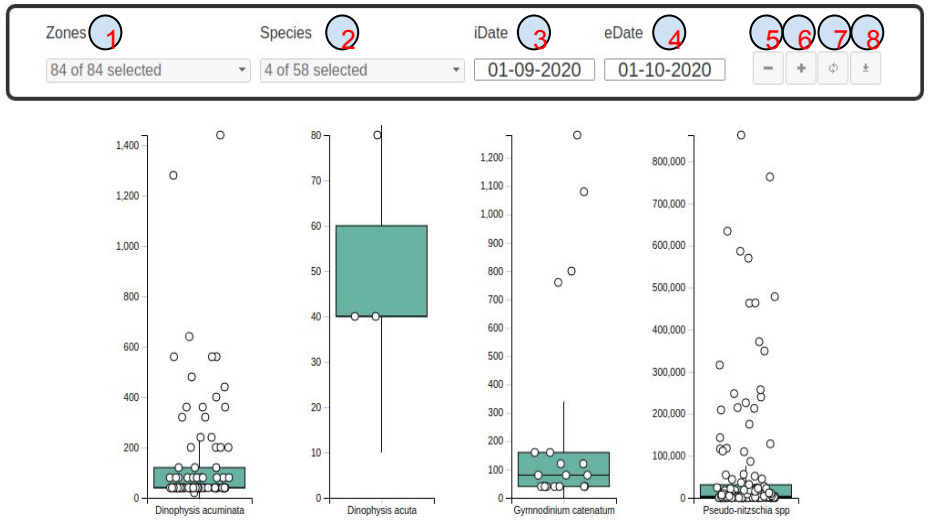


Figure 5: Screenshot of the hab species data summary web service.

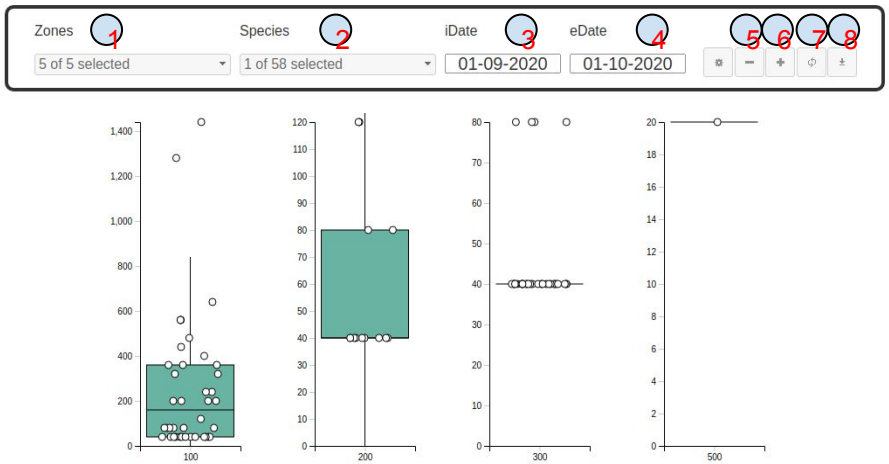


Figure 6: Screenshot of the zone data summary web service

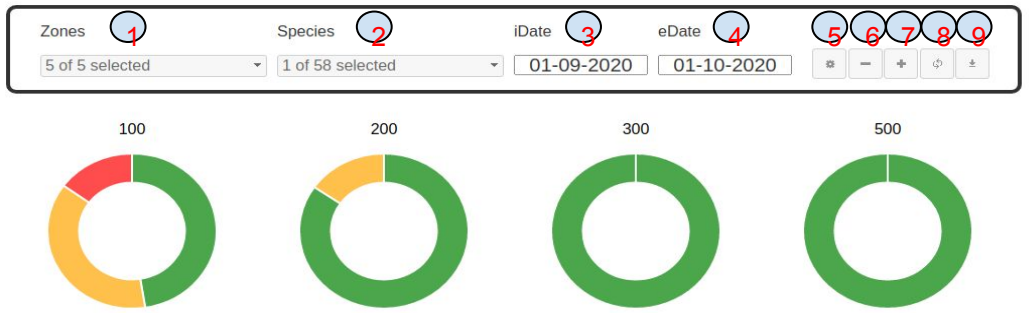


Figure 7: Screenshot of the "state of the zones" web service.

Conclusions

Lagrangian-hydrodynamical coupled simulations provide predictions of favorable conditions of along-shore advection, exchanges between rías or flows in and out of the rías, and this is useful for characterising *Dinophysis* spp. transport.

HAB alert and evaluation of the forecast rely on the measurements of HAB monitoring systems. In areas like Galicia and N Portugal where transnational alongshore transport can be relevant, transboundary exchange of information between different HAB monitoring systems is