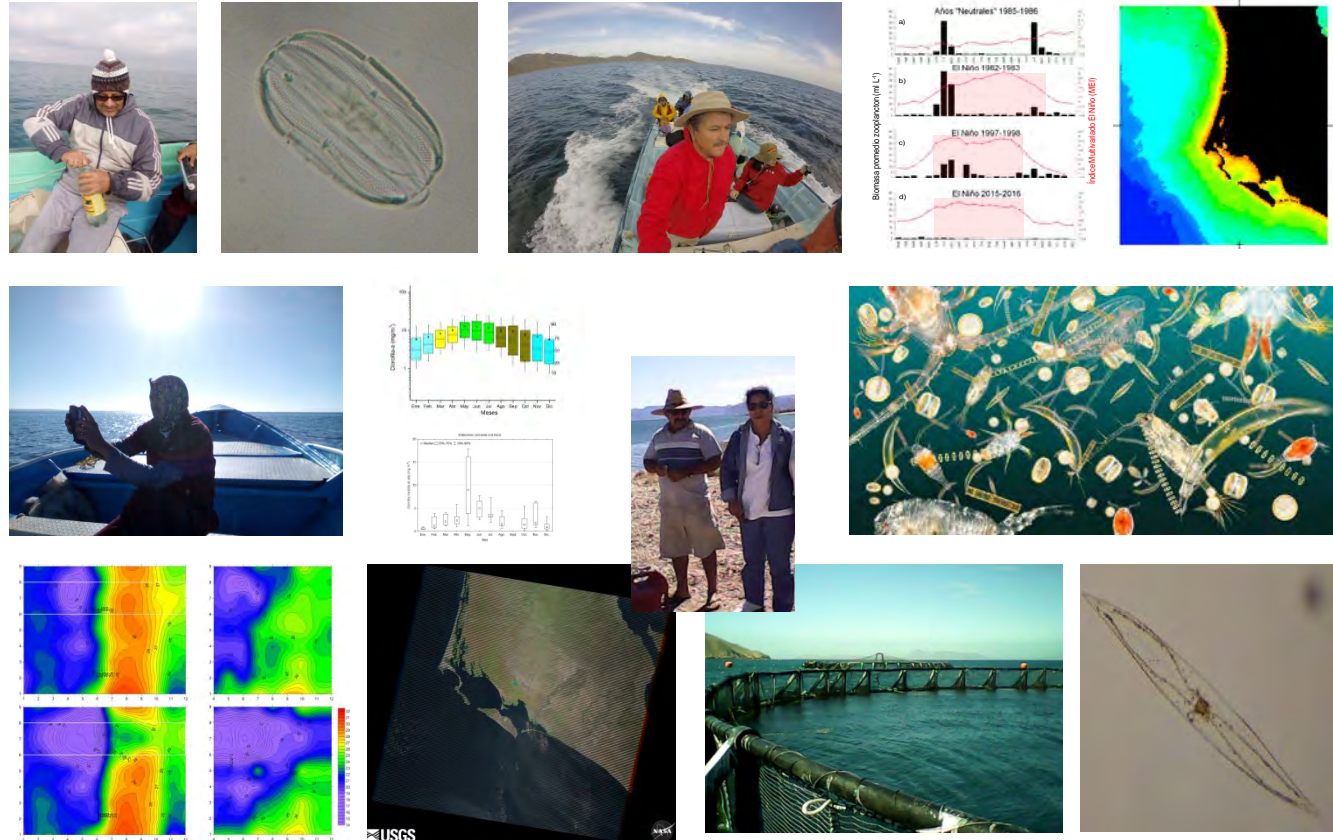


Impact of “The Blob” and “El Niño” warming phenomena in the SW Baja California peninsula: study case of Bahia Magdalena



María del Carmen Jiménez-Quiroz, Rafael Cervantes-Duarte, René Funes-Rodríguez, Sofía Alida Barón-Campis, Felipe de Jesús García-Romero, Sergio Hernández-Trujillo, David Uriel Hernández-Becerril, Rogelio González-Armas, Raúl Martell, Sergio Cerdeira-Estrada, José Ignacio Fernández-Méndez, Luis Vicente González-Ania, Mario Vásquez-Ortiz & Francisco Javier Barrón-Barraza.



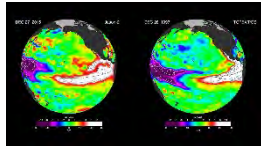
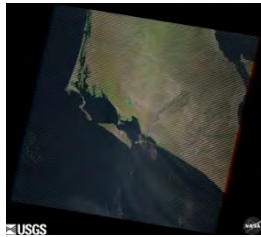
Bahía Magdalena

- The most important coastal lagoon of BCS
- Transitional zone: temperate-tropical
- High biological richness
- Fisheries and aquaculture uses
- Atypical warming since 2014

The Blob 2013/2015

El Niño 2015/16

2015-2017 The warmest years since 1880



Objective

To determine the effect of the atypical warming on environment (temperature, salinity, nutrients) and phyto and zooplankton communities

How the ecosystem resilience has been affected?



Topics

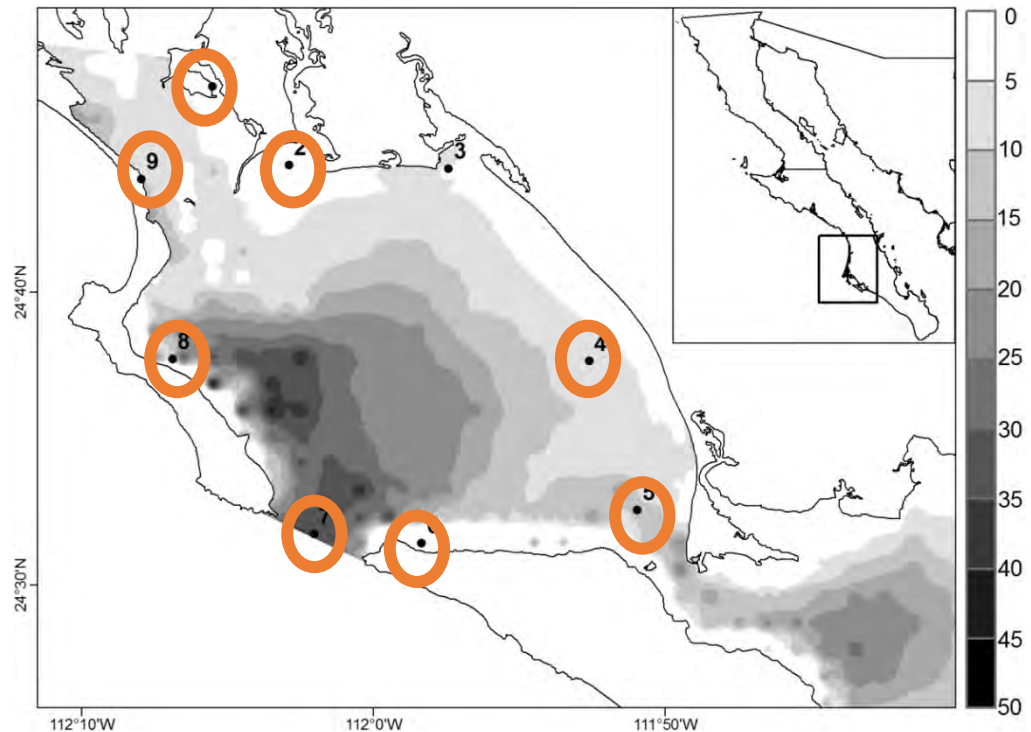
- NE Pacific characteristics
- Upwelling phenology
- Temperature, salinity and density
- Inorganic Nutrients
- Phytoplankton community structure
- Zooplankton biomass and mortality (2015)
- Ecosystem resilience



Methods

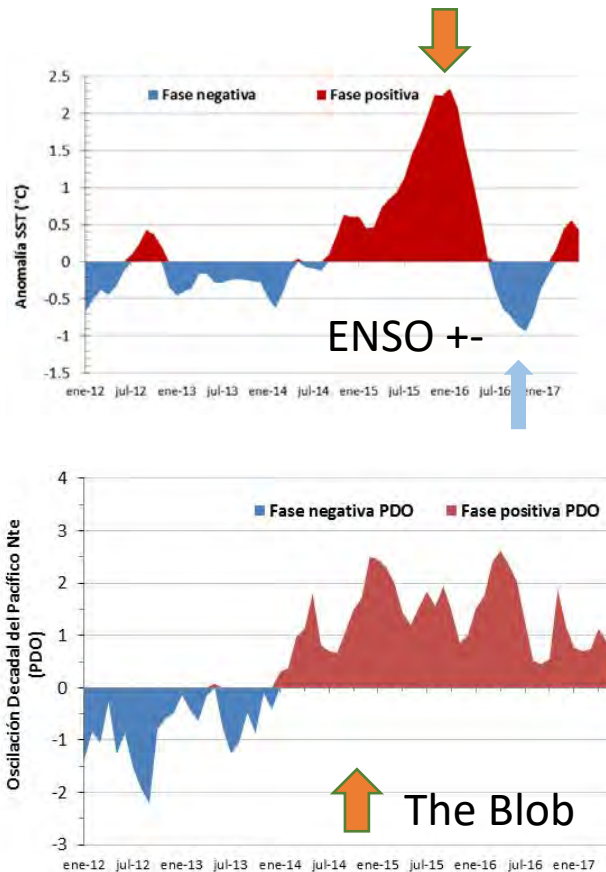
Samples collected during neap tides (1 day per month)

- Jan 2015 to Dec 2017
- CTD
- Inorganic Nutrients
- Chlorophyll-a
- Phytoplankton: Density, species richness and diversity index
- Zooplankton: biomass and mortality
- Fluorescence of chl a (MODIS-Aqua) daily composite imagery
- Cumulative Upwelling Index PFEL-NOAA

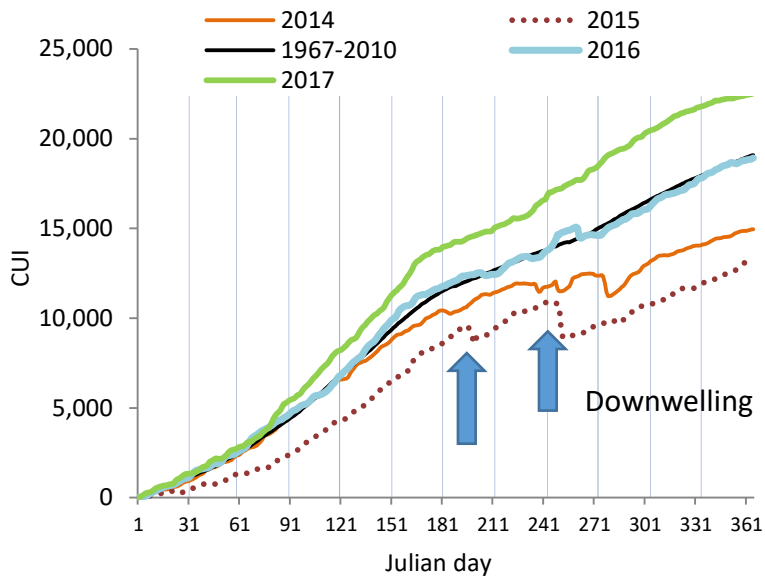
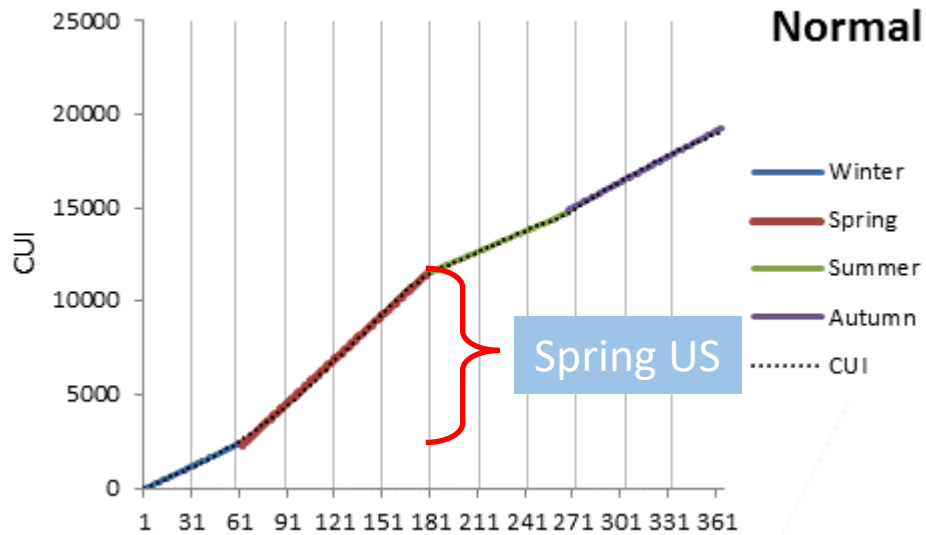


Sampling station

NE Pacific characteristics



- Warming since 2010
- *The Blob* Oct 2013- May 2015
- *El Niño* March 2015-May/June 2016
- *La Niña* Oct 2016- March 2017
- ENSO neutral April 2017- Oct 2017
- California current weaker than normal
- 2015-2017 -The three warmest years since 1880

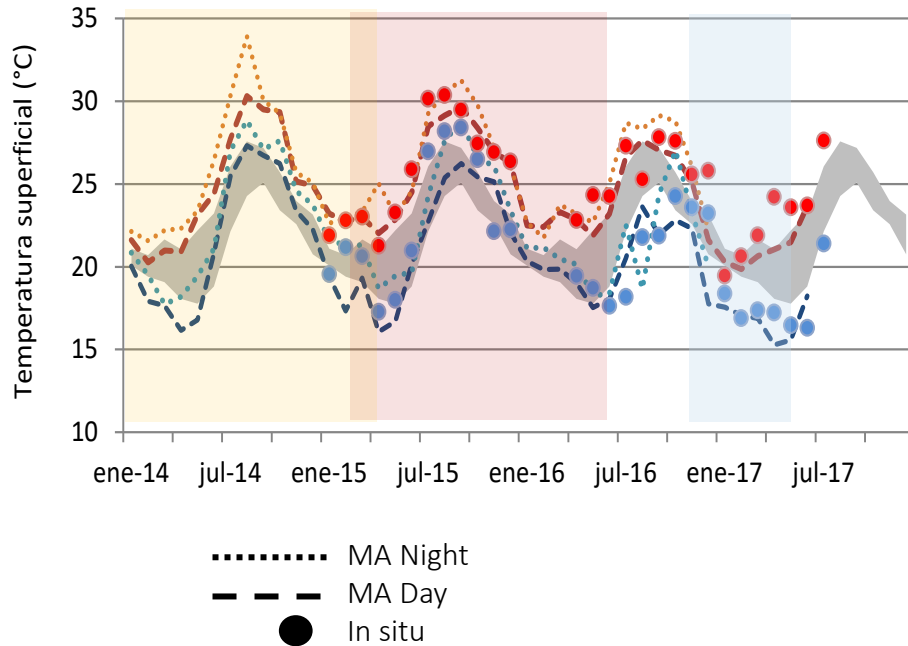


Upwelling phenology

Spring US	Days	UI>100 (days)
Normal (1967-2010)	1/March-28/June	55
2015	23/March-14/June	18
2016	02/March-15/June	31
2017	14/March-07/July	55

US Upwelling season

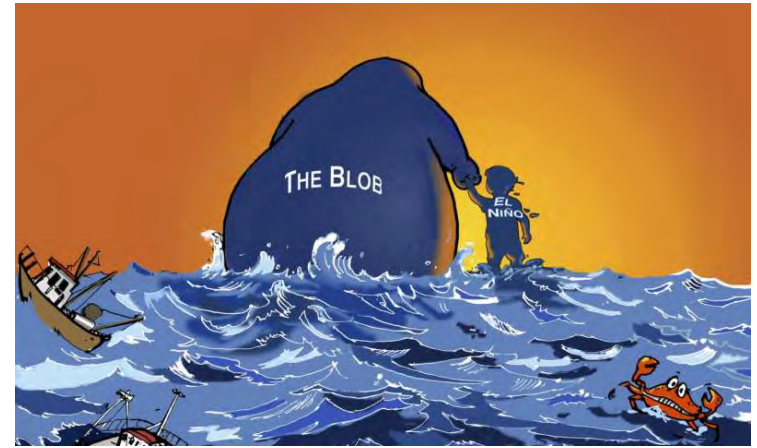
Satellite (monthly images) and *in situ* measures



T° MODIS Aqua night and day images

T° *in situ*

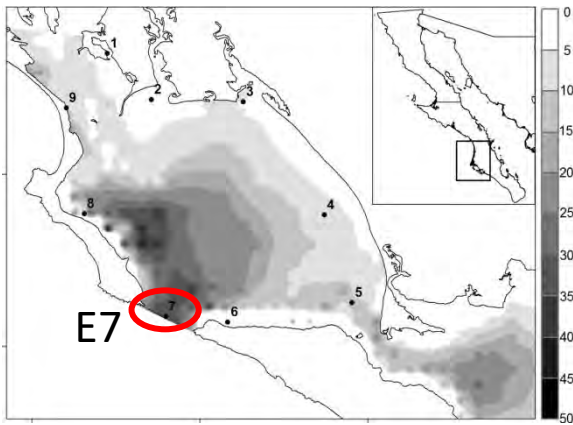
Monthly extreme values were compared with Lluç-Belda'1 (2000) data (grey stripe)



Temperature

2014 y 2015 Anomalies were between +2 y +5°C

2016 y 2017, values near to average, but the air temperature continues higher than normal.



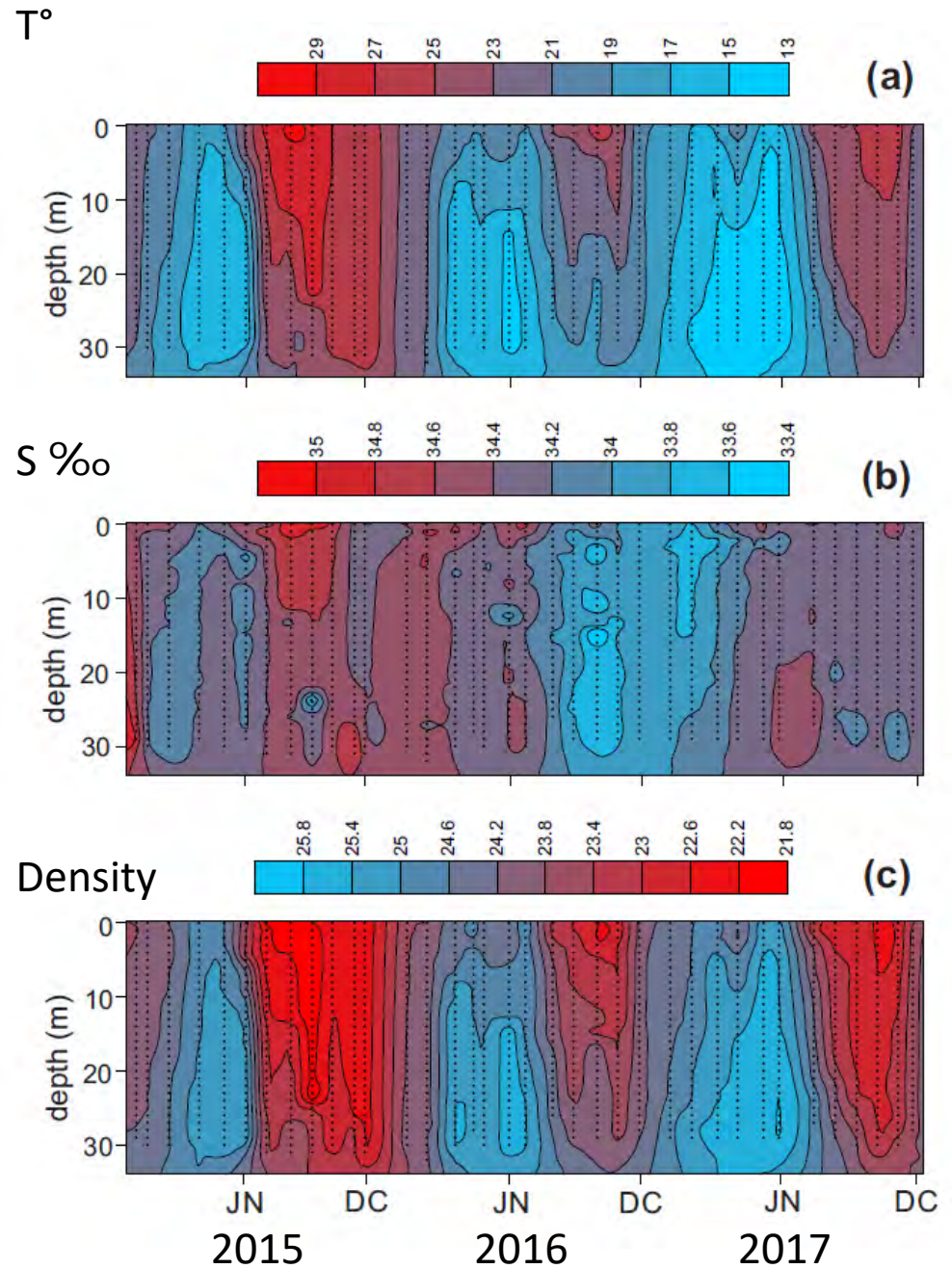
Temperature, salinity and density were measured at the lagoon mouth (E7)

Temperature: temperate and warm seasons

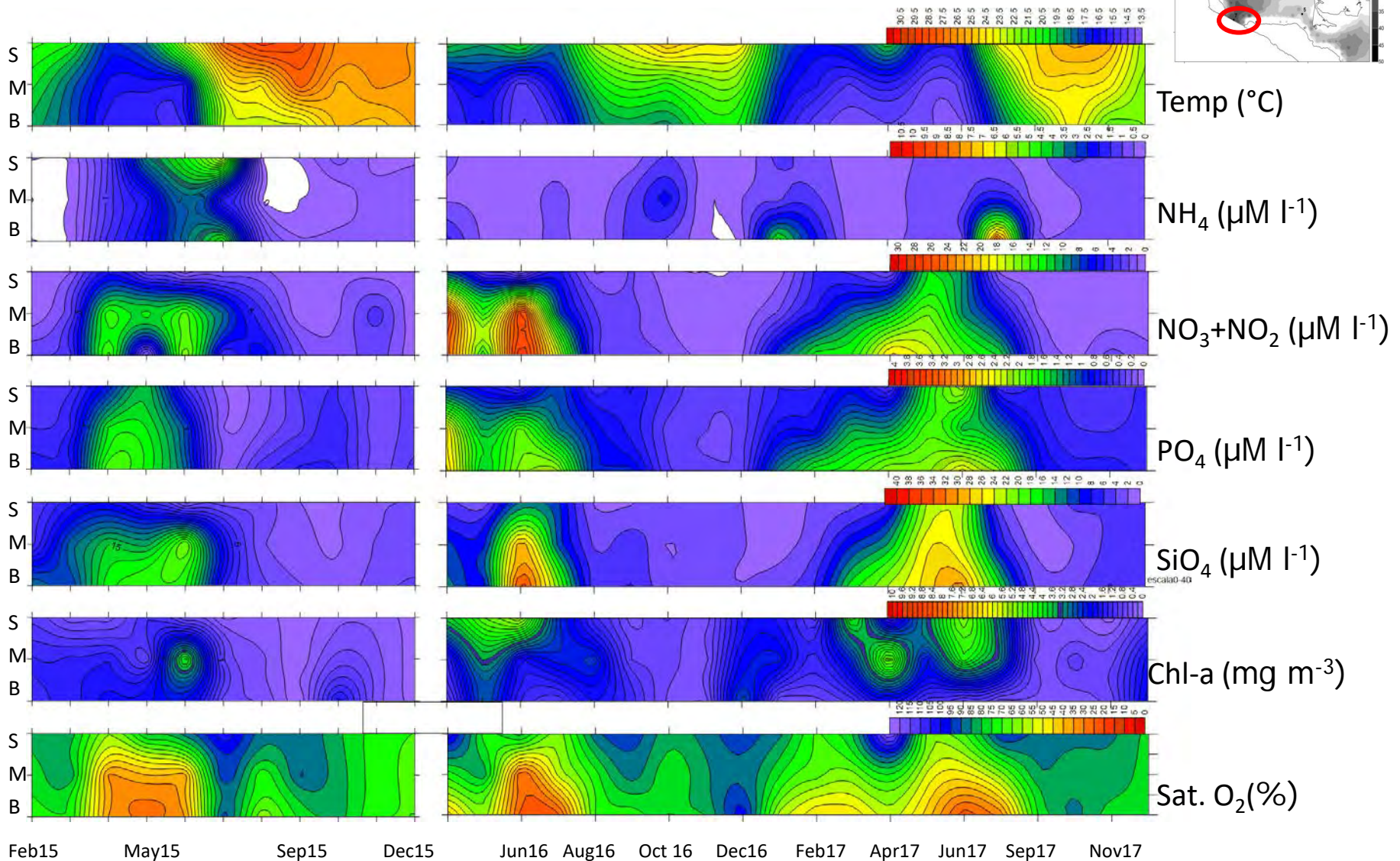
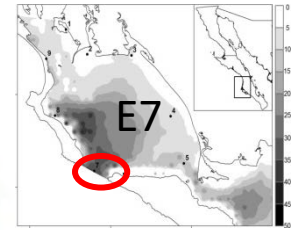
2015 > T° and $S \text{ ‰}$ (warm season); < Density

2016: < $S \text{ ‰}$ (warm season)

2017 < T° and > Density (temperate season)



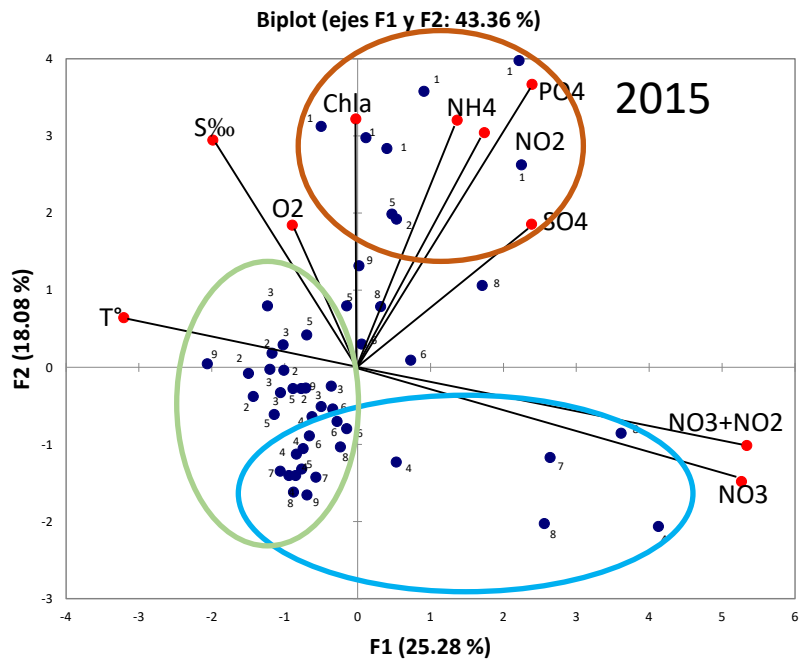
Sampling station 7 (lagoon mouth): Advection of subsurface water



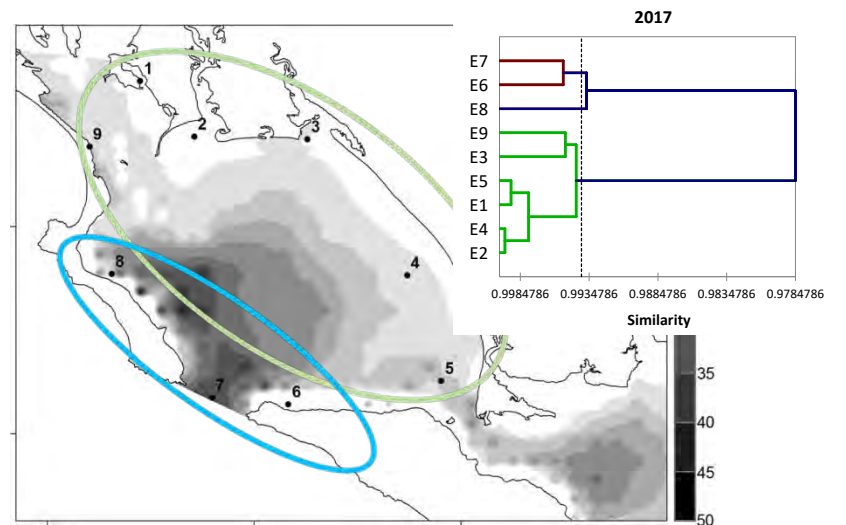
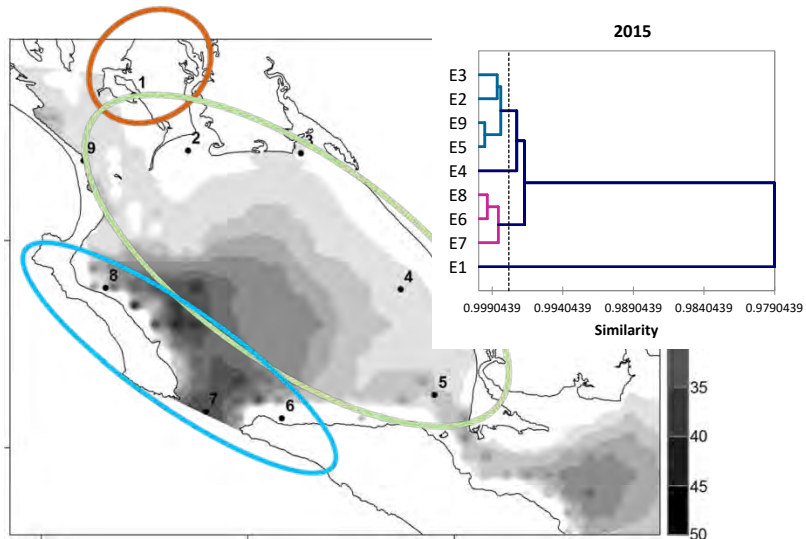
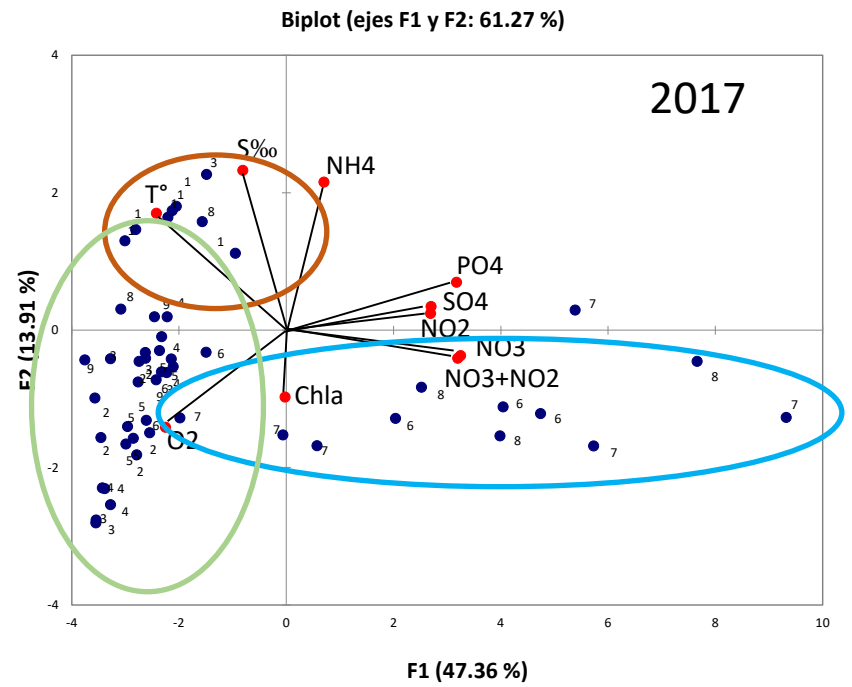
Upwelling

Upwelling

Upwelling



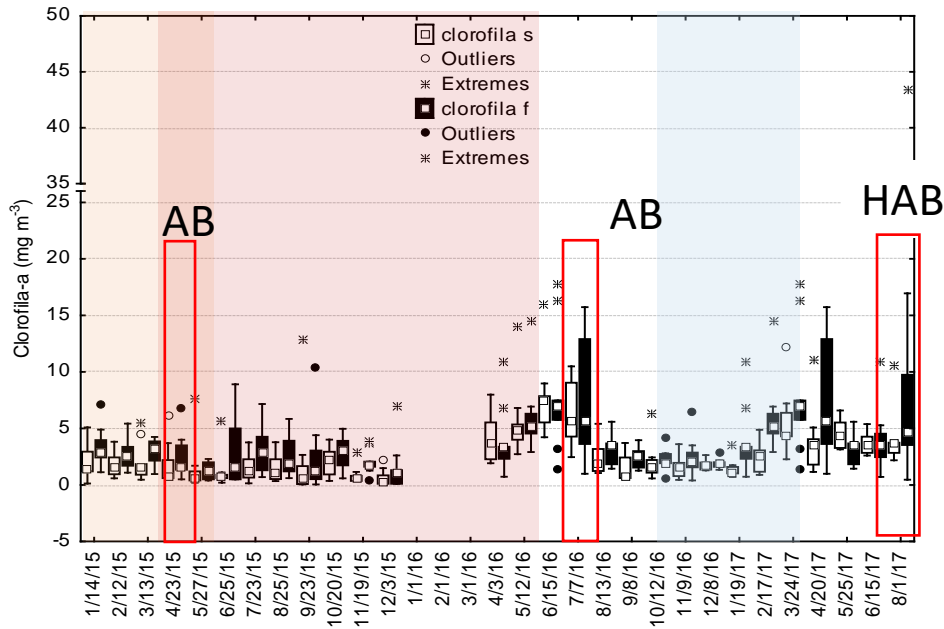
PCA



Cluster Analysis



2015-2017

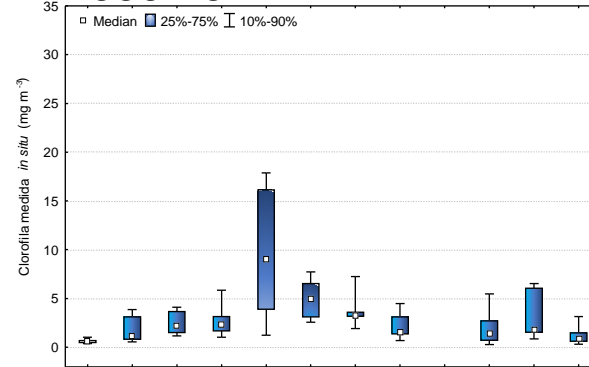


Chlorophyll-a

Abundance phyto/chla E6 $r^2=0.45$; $n=22$

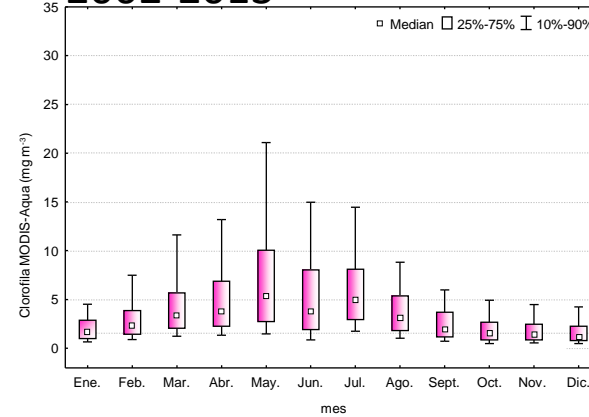
Seasonal pattern

2006-2011



In situ
CICIMAR

2002-2013



MODIS-
Aqua
CONABIO
SATMO

Est. CICIMAR Boca L1, M1 y M2

Fluorescence-chla

[chl_a < 4 mg m⁻³] (Blondeau-Patissier *et al.*, 2014)

MODIS-Aqua; Giovanni-NASA

Res. 4 km, monthly composites

2014-2017

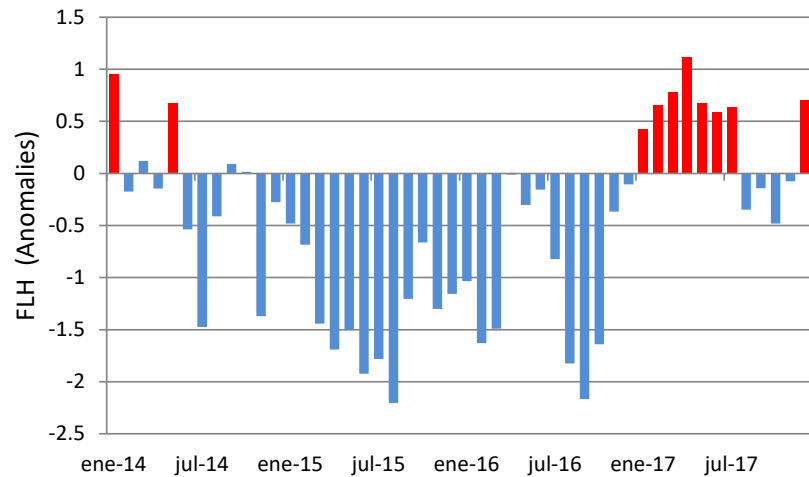
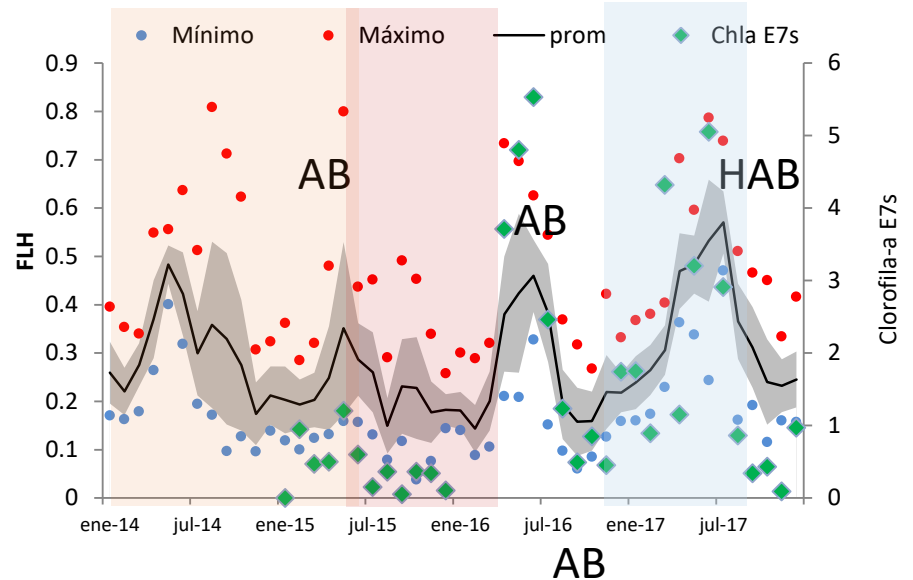
Negative anomalies

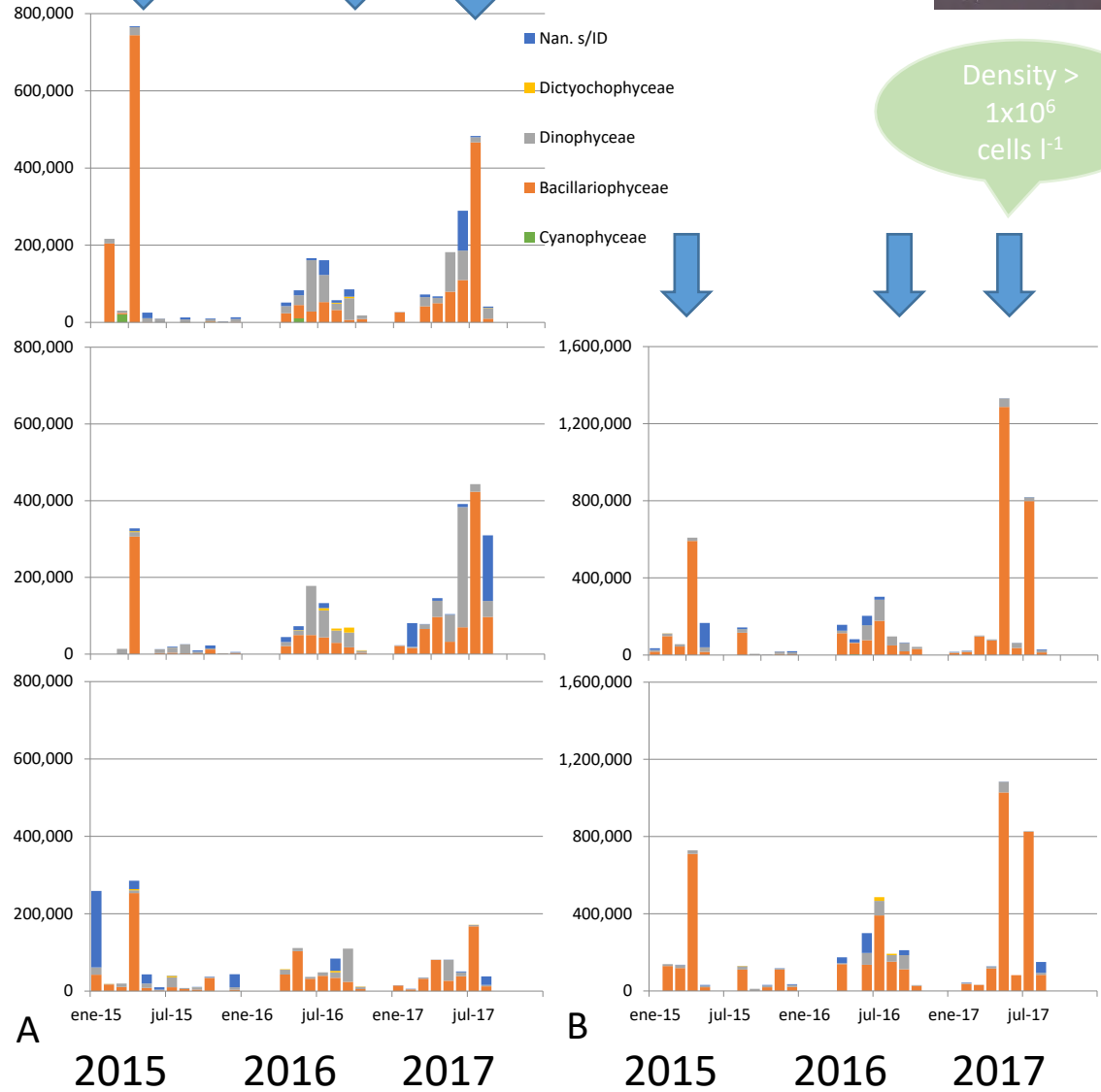
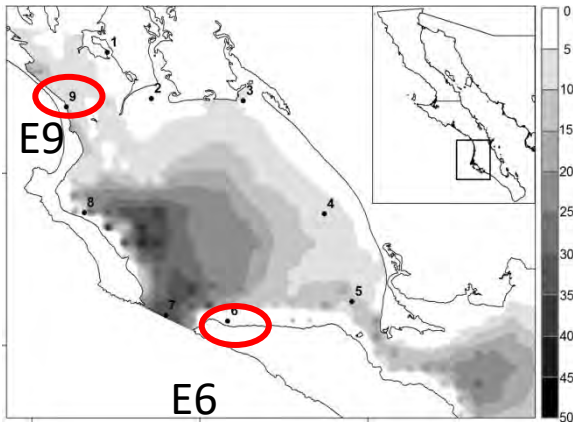
Seasonal pattern varied among years

Differences with chl_a patterns probably were due to species composition

AB: Algae bloom

HAB: Harmful algae bloom





Algae Blooms

2015: *Eucampia zodiacus*

2016: *Ditylum brightwellii*,
Nitzschia sp., *Cylindrotheca closterium*

2017: *Rhizosolenia* sp., *Guinardia* sp. HAB: gill damages of *S. lalandi* juveniles

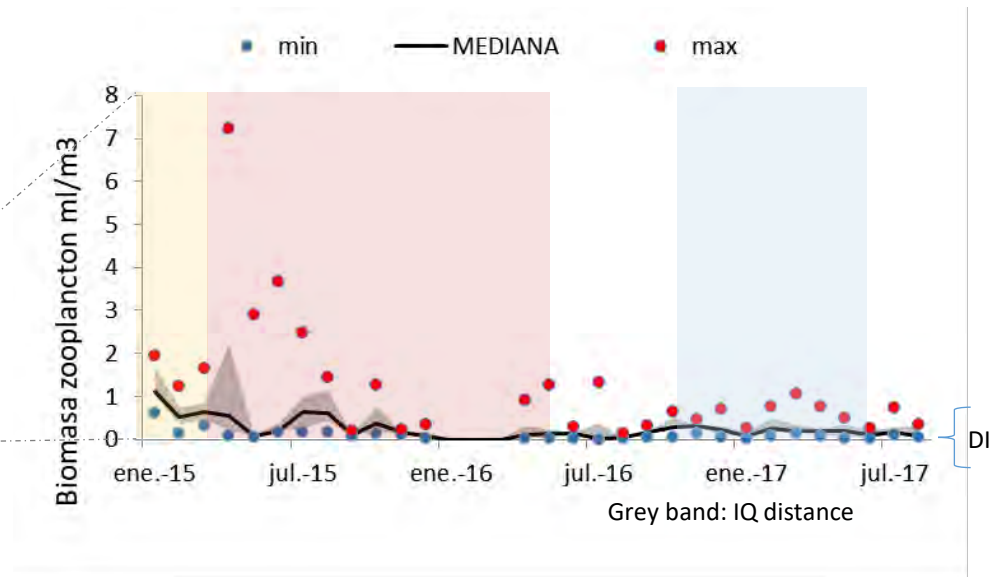
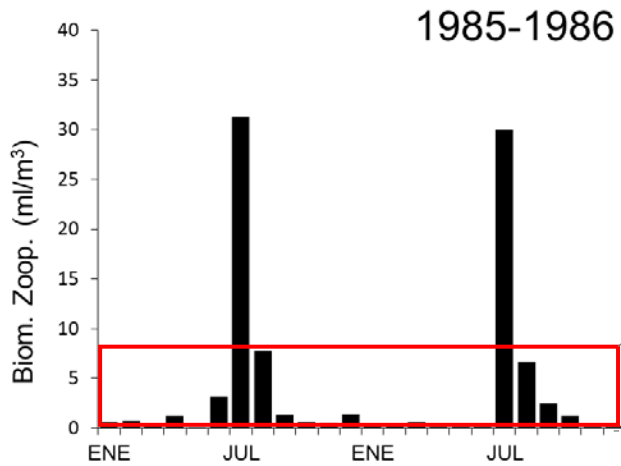
Shannon-Weiner Index 1-3

2015: > July

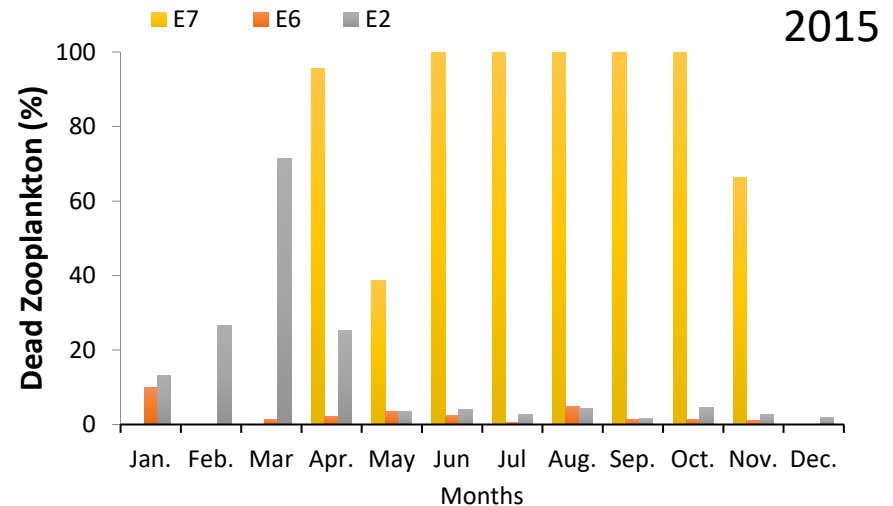
2016: > July, depth intermediate

2017: > April, July, surface

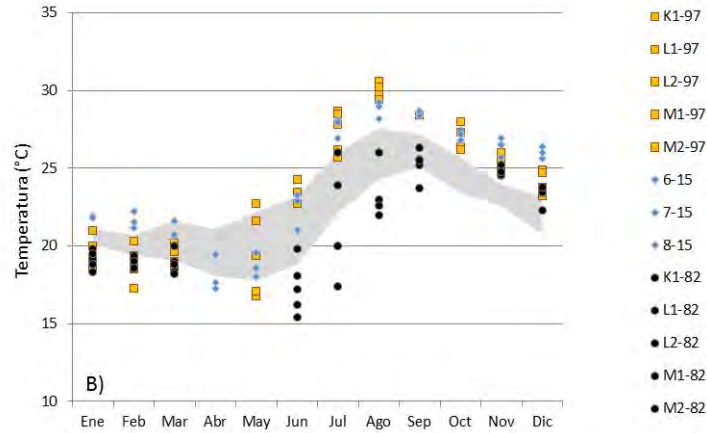
Zooplankton biomass and mortality (2015)



- Low Bio-volume of biomass
- Seasonal pattern on 2016 and 2017
- 2015: 100 % Zooplankton dead at lagoon mouth

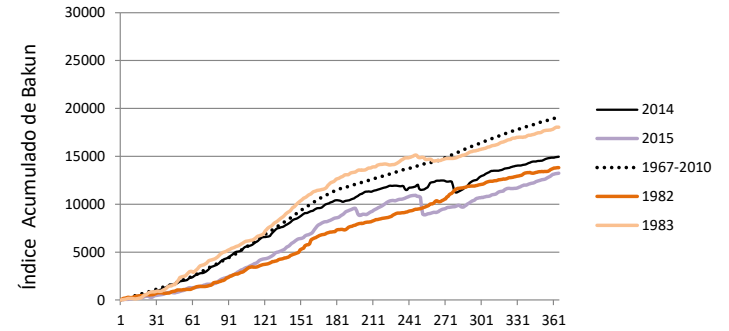


Near to mouth

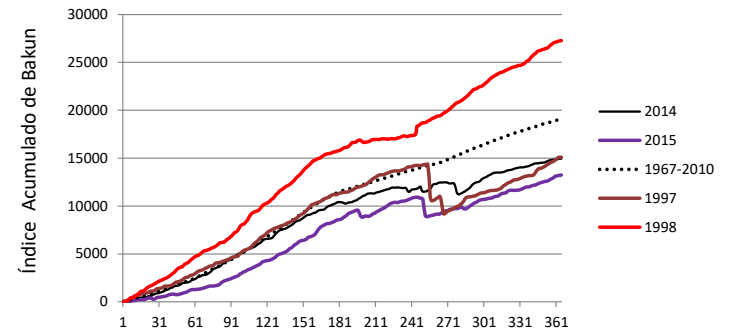


2015 (warmer during winter and autumn)

Temperature and Upwelling



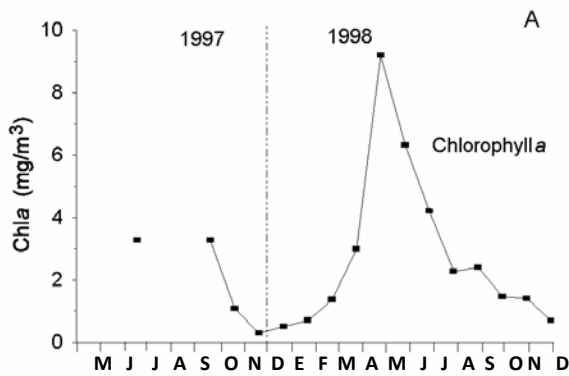
Weak Upwelling on 1982; they intensified since 4th week of April 1983 (PDO > 1)



Weak Upwelling since Aug ust 1997 Strong Upwelling 1998 (<PDO since March)

What happened on 1982 & 1997?

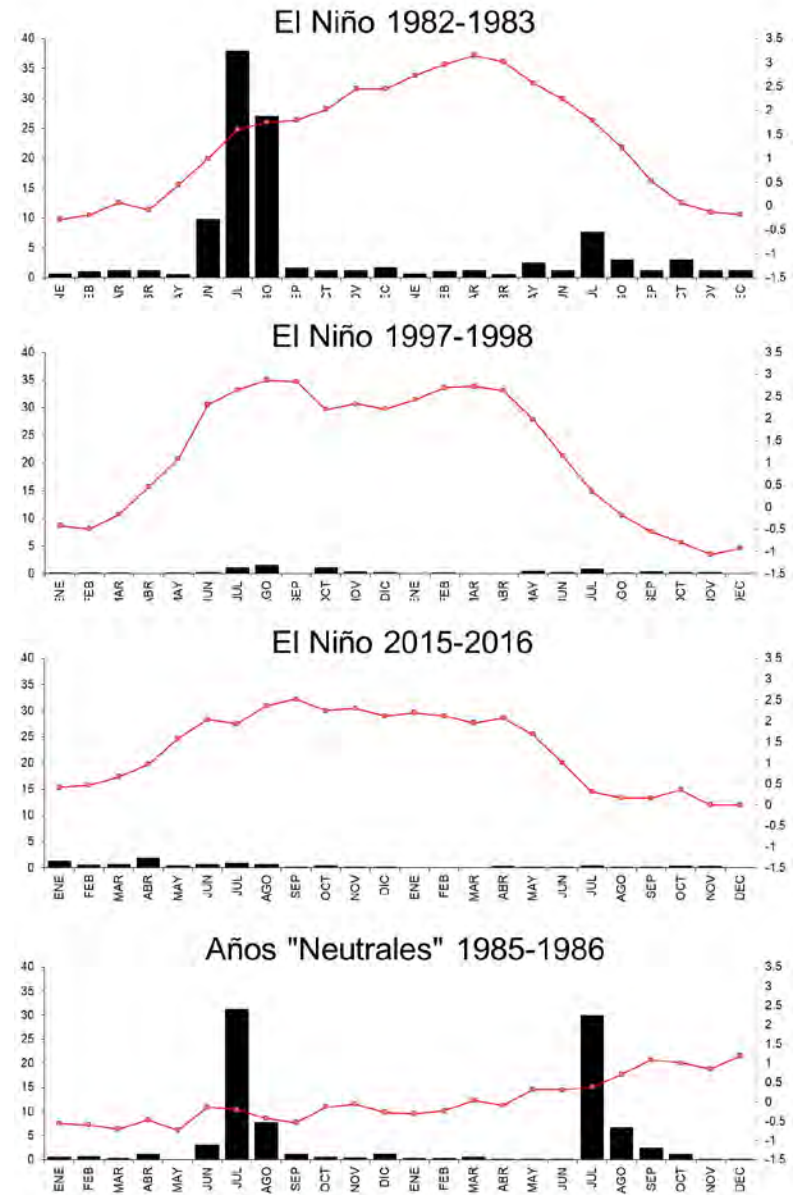
Chlorophyll-a



Zooplankton

Biomass diminished abruptly
1997/98 and 2015/16
Seasonal pattern on 1997, scarce
biomass
2015: Change of seasonal pattern

Zooplankton biomass



Conclusions

2015

Upwelling weaker than normal , then less nutrients

Disruption of seasonal patterns (abiotic, phyto, zooplankton)

Phytoplankton species adapted to high temperatures and scarce nutrients

(*E. zodiacus*)

Dominance of dinoflagellate during summer

Low zooplankton biomass, dead zooplankton on mouth of lagoon

2016

Seasonal patterns of T° , S%, nutrients and Chla returned to normality

Phytoplankton species adapted to high temperatures

Dominance of dinoflagellate during summer

Low zooplankton biomass

2017

Upwelling stronger than normal

HAB; Dominance of diatoms during summer

Low zooplankton biomass

Winter and Autumn 2015 warmer than 1982/83 and 1997/98

Weaker upwellings since 2014 than during other El Niño

Mil gracias!!!

- For your attention and to:
- Baja Seas, specially to Oc. Roberto Flores, Don Jorge Gámez, Don Lupe and all members of the staff
- Ph D Araceli Aviles, MC Ma. del Carmen Leticia Suarez and MC Victor Laurencez for their unconditional support
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