

# **Comunidades bentónicas en bahías del sector costero de la Región del Biobío**

**Dr. Eduardo Hernández Miranda**



# TEMARIO

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1. BAHÍAS EN LA REGIÓN DEL BIOBIO
2. PERTURBACIONES (DISTURBIOS)
3. EQUILIBRIO - NO EQUILIBRIO – RESILIENCIA
4. BIOINDICADORES GOLFO DE ARAUCO
5. 27F EN BAHÍA CONCEPCIÓN
6. HIPOXIA-27F-EL NIÑO EN BAHÍA COLIUMO
7. CONCLUSIONES Y REFLEXION FINAL

## PERTURBACIONES – (DISTURBANCES/DISTURBIOS)

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Cualquier evento **relativamente discreto en el espacio y tiempo** que altera la estructura de un sistema ecológico (i.e., poblaciones, comunidades o ecosistemas), ya sea afectando la densidad, biomasa, o distribución de la biota, cambiando la disponibilidad y distribución de los recursos o sustratos, o alterando el medioambiente físico.

Pickett, S. T. A., Wu, J. & Cadenasso, M. L. Patch Dynamics And The Ecology Of Disturbed Ground: A Framework For Synthesis. 707–722 (1999).

Wu, J. & Loucks, O. L. From Balance of Nature to Hierarchical Patch Dynamics: A Paradigm Shift in Ecology. *Q. Rev. Biol.* 70, 439–466 (1995).

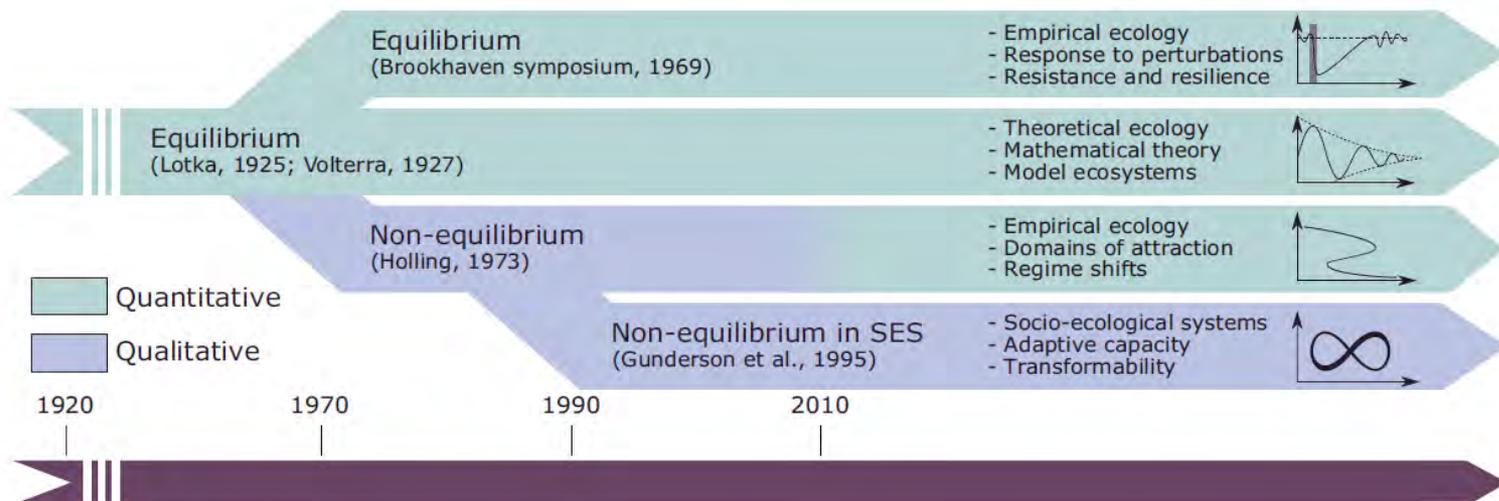
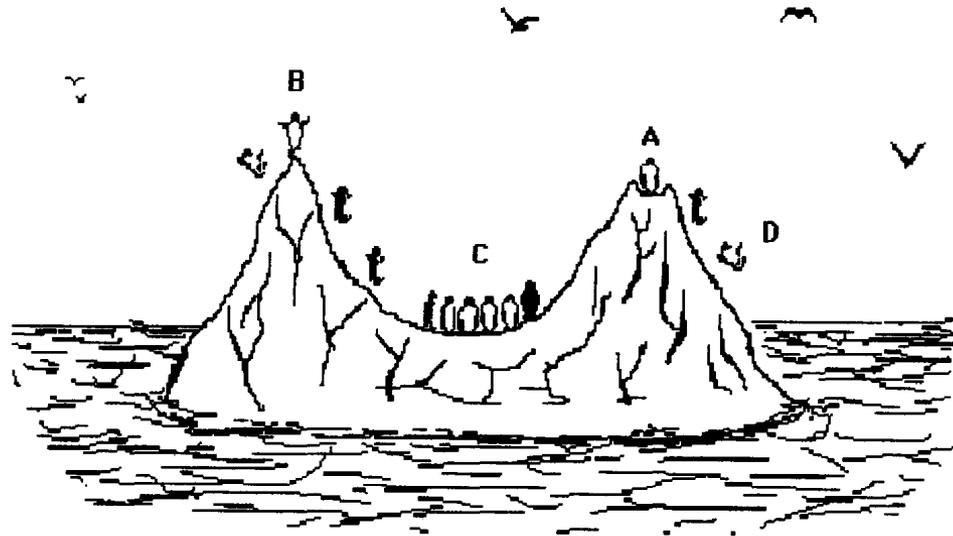
White, P. S. & Pickett, S. T. A. *Natural Disturbance and Patch Dynamics: An Introduction. The Ecology of Natural Disturbance and Patch Dynamics* (ACADEMIC PRESS, INC., 1985). doi:10.1016/B978-0-08-050495-7.50006-5.

Sousa, W. P. The Role of Disturbance in Natural Communities. *Annu. Rev. Ecol. Syst.* 15, 353–391 (1984).

**Equilibrio ecológico:** Un estado, observable, en el cual la composición y abundancia de las especies se mantiene relativamente **estable** por un **tiempo prolongado**.

# Perturbaciones - Estabilidad - Resiliencia

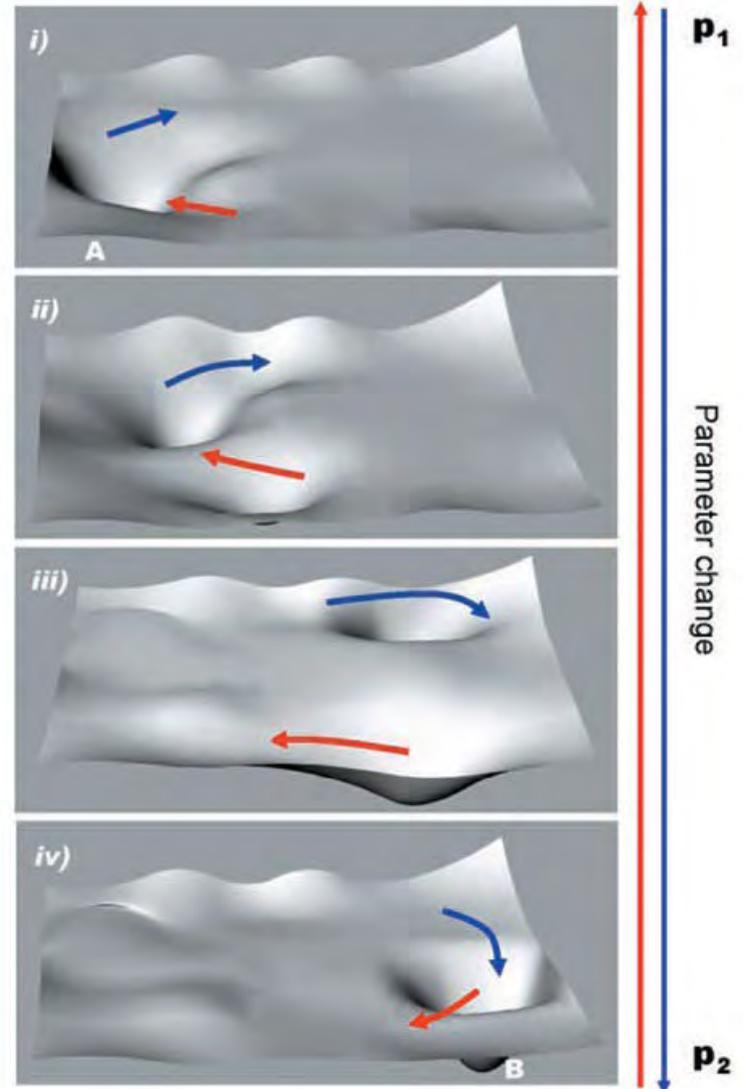
Lewontin, 1969. *Brookhaven Symposia in Biology*; 22: 13–24



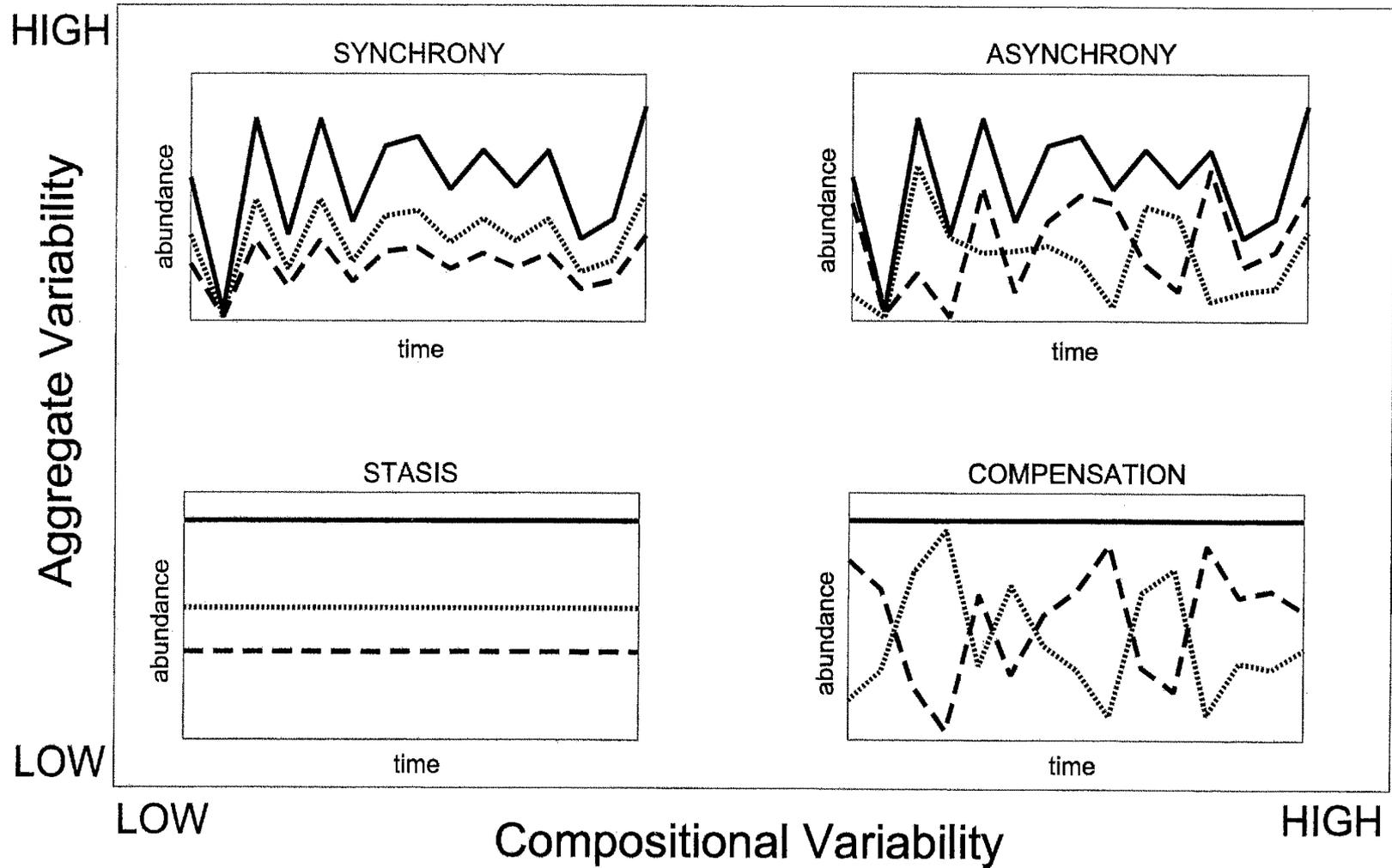
# Perturbaciones - Estabilidad - Resiliencia

Holling, 1973. *Annual Review of Ecology and Systematics*; 4: 1–23

Beisner et al., 2003. *Front Ecol Environ*; 1(7): 376–382



# SERIES DE TIEMPO ECOLOGICAS



# PERTURBACIONES ANTROPOGÉNICAS

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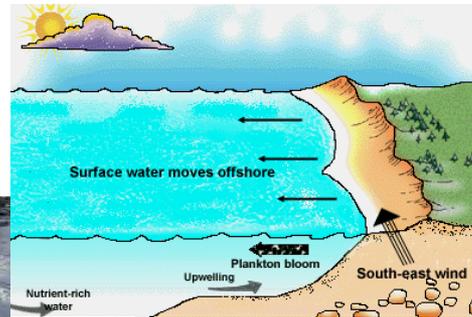
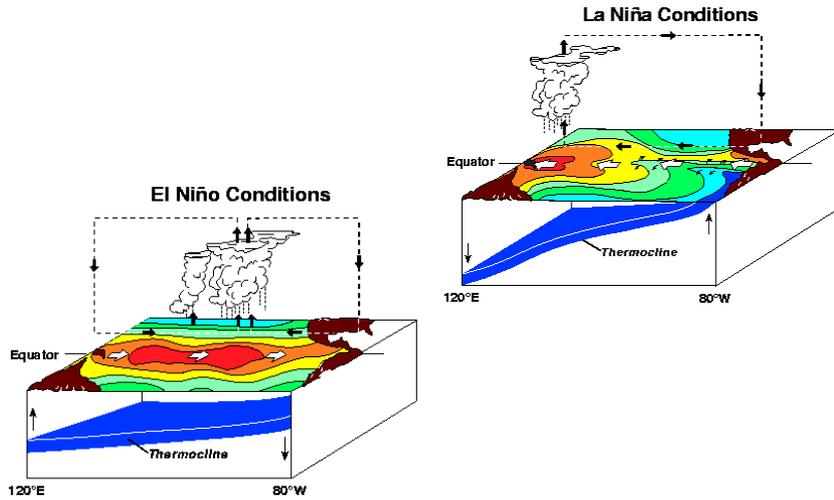
PUNTUALES



CONTINUAS



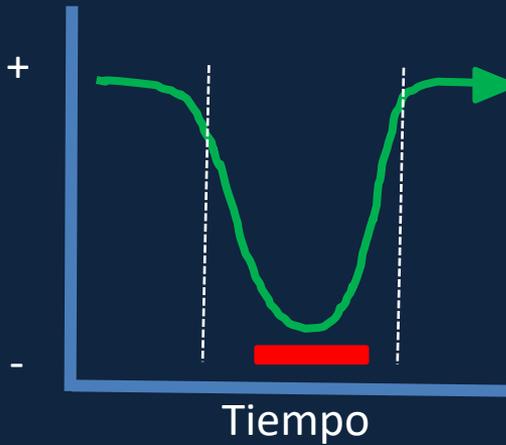
# PERTURBACIONES NATURALES



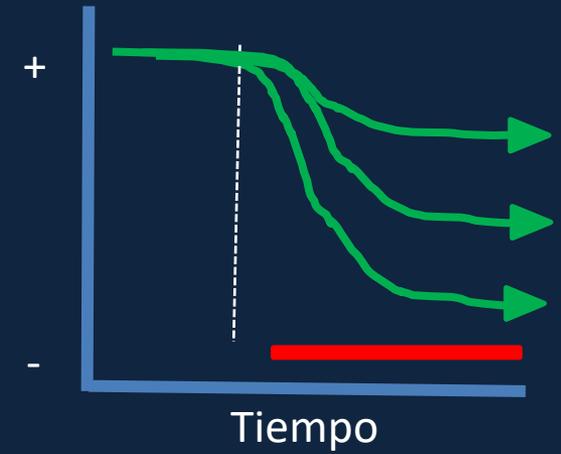
# RESPUESTAS DE LOS ORGANISMOS

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PUNTUALES



CONTINUAS



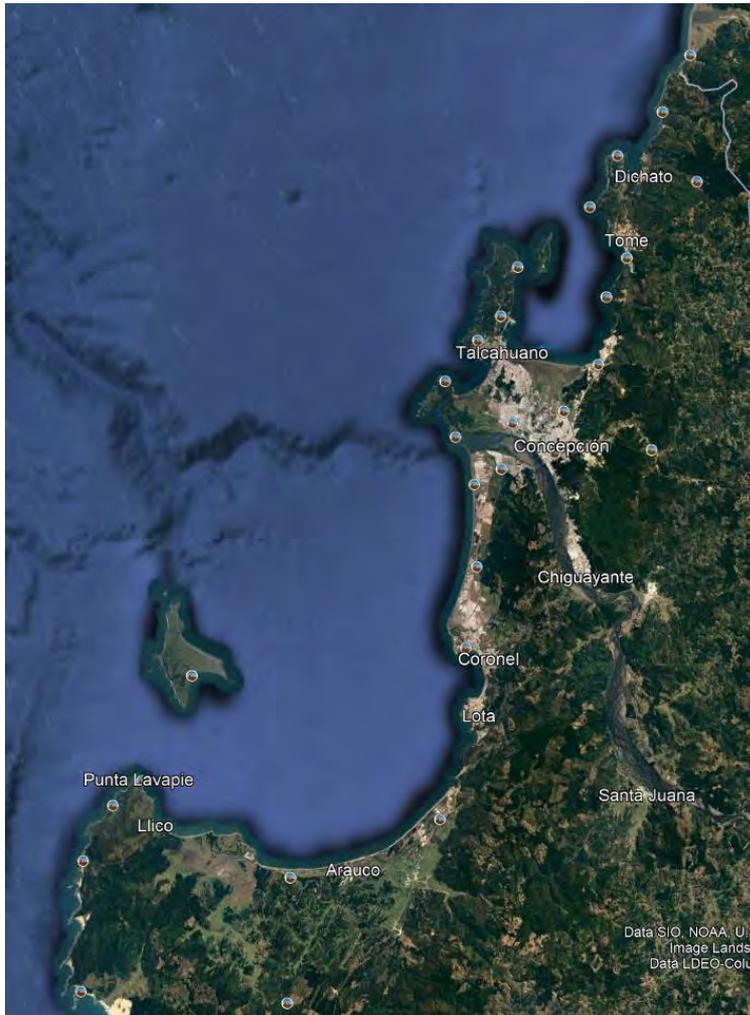
Perturbaciones - Estabilidad – Resiliencia





# Ecosistema de Bahías

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# Ecosistema de Bahías

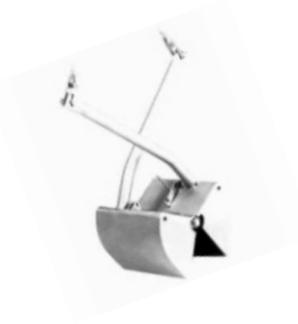
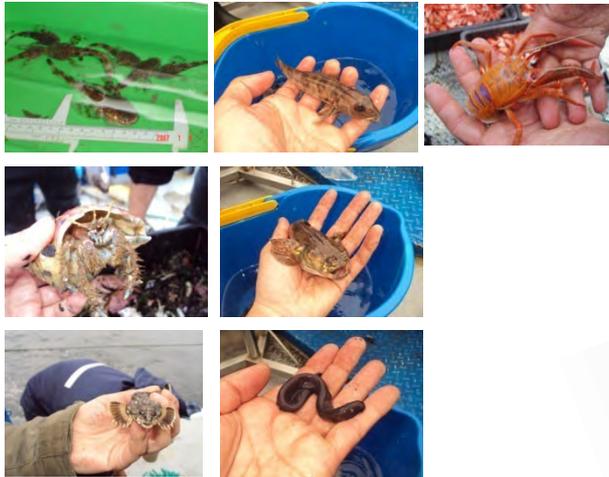
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# Modelos Ecológicos de Estudio



Rastra Aggazis: megafauna  
Draga van been: macrofauna



# Publicaciones



Marine Environmental Research 78 (2012) 1–14  
Contents lists available at ScienceDirect  
**Marine Environmental Research**  
Journal homepage: [www.elsevier.com/locate/marenvrev](http://www.elsevier.com/locate/marenvrev)

Spatio-temporal biodiversity of soft bottom macrofaunal assemblages in shallow coastal waters exposed to episodic hypoxic events  
Rodrigo Veas<sup>a,b</sup>, Eduardo Hernández-Miranda<sup>b,c</sup>, Renato A. Quiñones<sup>b,c,d</sup>, Franklin D. Carrasco<sup>e</sup>



Journal of Fish Biology (2010) 76, 1543–1564  
doi:10.1111/j.1095-8649.2010.02580.x. available online at [www.interscience.wiley.com](http://www.interscience.wiley.com)

A major fish stranding caused by a natural hypoxic event in a shallow bay of the eastern South Pacific Ocean  
E. HERNÁNDEZ-MIRANDA<sup>a,f</sup>, R. A. QUIÑONES<sup>a,g,h</sup>, G. AEDO<sup>g</sup>, A. VALENZUELA<sup>g</sup>, N. MERMIOUD<sup>g</sup>, C. ROMÁN<sup>g</sup> AND F. YAÑEZ<sup>g</sup>



Marine Environmental Research 130 (2017) 233–247  
Contents lists available at ScienceDirect  
**Marine Environmental Research**  
Journal homepage: [www.elsevier.com/locate/marenvrev](http://www.elsevier.com/locate/marenvrev)

Macrofaunal community structure in Bahía Concepción (Chile) before and after the 8.8 Mw Maule mega-earthquake and tsunami  
Paula J. Cárcamo<sup>a</sup>, Eduardo Hernández-Miranda<sup>a,b,c,e</sup>, Rodrigo Veas<sup>a,c</sup>, Renato A. Quiñones<sup>a,b,c</sup>



Marine Environmental Research 89 (2013) 9–20  
Contents lists available at ScienceDirect  
**Marine Environmental Research**  
Journal homepage: [www.elsevier.com/locate/marenvrev](http://www.elsevier.com/locate/marenvrev)

The influence of environmental factors on the abundance and recruitment of the sand crab *Emerita analoga* (Stimpson 1857): Source–sink dynamics?  
R. Veas<sup>a,b</sup>, E. Hernández-Miranda<sup>b,c</sup>, R.A. Quiñones<sup>a,b,c</sup>, E. Díaz-Cabrera<sup>b</sup>, J.M. Rojas<sup>d,e</sup>, I.M. Ferrás<sup>a,f</sup>

Revista de Biología Marina y Oceanografía  
Vol. 47, N°3: 475-487, diciembre 2012  
Article

The impact of a strong natural hypoxic event on the toadfish *Aphos porosus* in Coliumo Bay, south-central Chile  
Impacto de un fuerte evento de hipoxia natural sobre el bagre de mar *Aphos porosus* en Bahía Coliumo, centro-sur de Chile

Eduardo Hernández-Miranda<sup>1</sup>, Renato A. Quiñones<sup>1,2,3</sup>, Gustavo Aedo<sup>1</sup>, Ernesto Díaz-Cabrera<sup>1</sup> and José Cisterna<sup>1</sup>

**Ecology and Evolution** Open Access  
Dynamic relationships between body size, species richness, abundance, and energy use in a shallow marine epibenthic faunal community  
Fabio A. Labra<sup>1</sup>, Eduardo Hernández-Miranda<sup>2,3</sup> & Renato A. Quiñones<sup>2,3</sup>

Mar Biol (2014) 161:681–696  
DOI 10.1007/s00227-013-2370-x

ORIGINAL PAPER

Epibenthic macrofaunal community response after a mega-earthquake and tsunami in a shallow bay off central-south Chile

Eduardo Hernández-Miranda · José Cisterna · Ernesto Díaz-Cabrera · Rodrigo Veas · Renato A. Quiñones

Marine Biology (2020) 167:15  
<https://doi.org/10.1007/s00227-019-3625-y>

ORIGINAL PAPER

Assessing how body size affects the species-time relationship in a shallow marine benthic megafauna community exposed to a strong hypoxia disturbance

Fabio A. Labra<sup>1,2</sup> · Eduardo Hernández-Miranda<sup>3,4</sup> · Renato A. Quiñones<sup>3,4</sup>



Marine Environmental Research 79 (2012) 16–28  
Contents lists available at ScienceDirect  
**Marine Environmental Research**  
Journal homepage: [www.elsevier.com/locate/marenvrev](http://www.elsevier.com/locate/marenvrev)

Response of the epibenthic macrofaunal community to a strong upwelling-driven hypoxic event in a shallow bay of the southern Humboldt Current System  
Eduardo Hernández-Miranda<sup>a,c</sup>, Rodrigo Veas<sup>b</sup>, Fabio A. Labra<sup>c,d</sup>, Marco Salamanca<sup>a</sup>, Renato A. Quiñones<sup>a,b,c</sup>



RESEARCH ARTICLE  
Short-term alteration of biotic and abiotic components of the pelagic system in a shallow bay produced by a strong natural hypoxia event  
Eduardo Hernández-Miranda<sup>1,2</sup>, Rodrigo Veas<sup>1</sup>, Valeria Anabalon<sup>3</sup>, Renato A. Quiñones<sup>2,3</sup>

<sup>1</sup> Programa de Investigación Marina de Excelencia (PIME3), Facultad de Ciencias Naturales y Oceanográficas, Universidad de Concepción, Concepción, Chile, <sup>2</sup> Interdisciplinary Center for Aquaculture Research (ICAR), Casilla 160-C, Universidad de Concepción, Concepción, Chile, <sup>3</sup> Department of Oceanography, Casilla 160-C, Universidad de Concepción, Concepción, Chile  
\* [eduardo.hernandez@publico.cl](mailto:eduardo.hernandez@publico.cl)



NEW ZEALAND JOURNAL OF MARINE AND FRESHWATER RESEARCH, 2016  
<http://dx.doi.org/10.1080/00288330.2016.1206377>

RESEARCH ARTICLE

Spatial-temporal changes of the morphodynamic beach state before and after the 2010 mega-earthquake and tsunami along south-central Chile  
R Veas<sup>a,b</sup>, E Hernández-Miranda<sup>b,c</sup>, C Martínez<sup>d</sup>, D Lercari<sup>e</sup> and RA Quiñones<sup>a,b,c</sup>

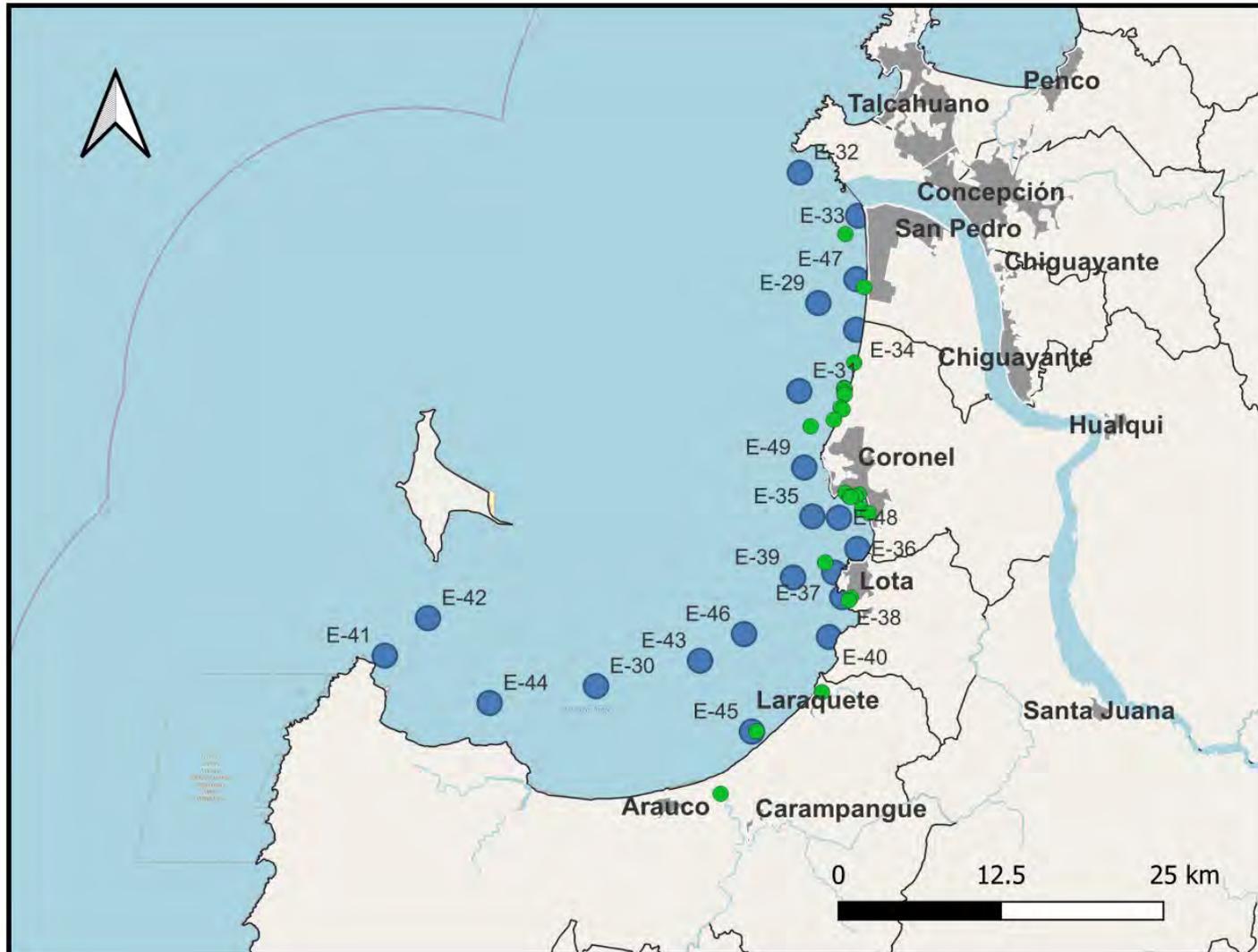


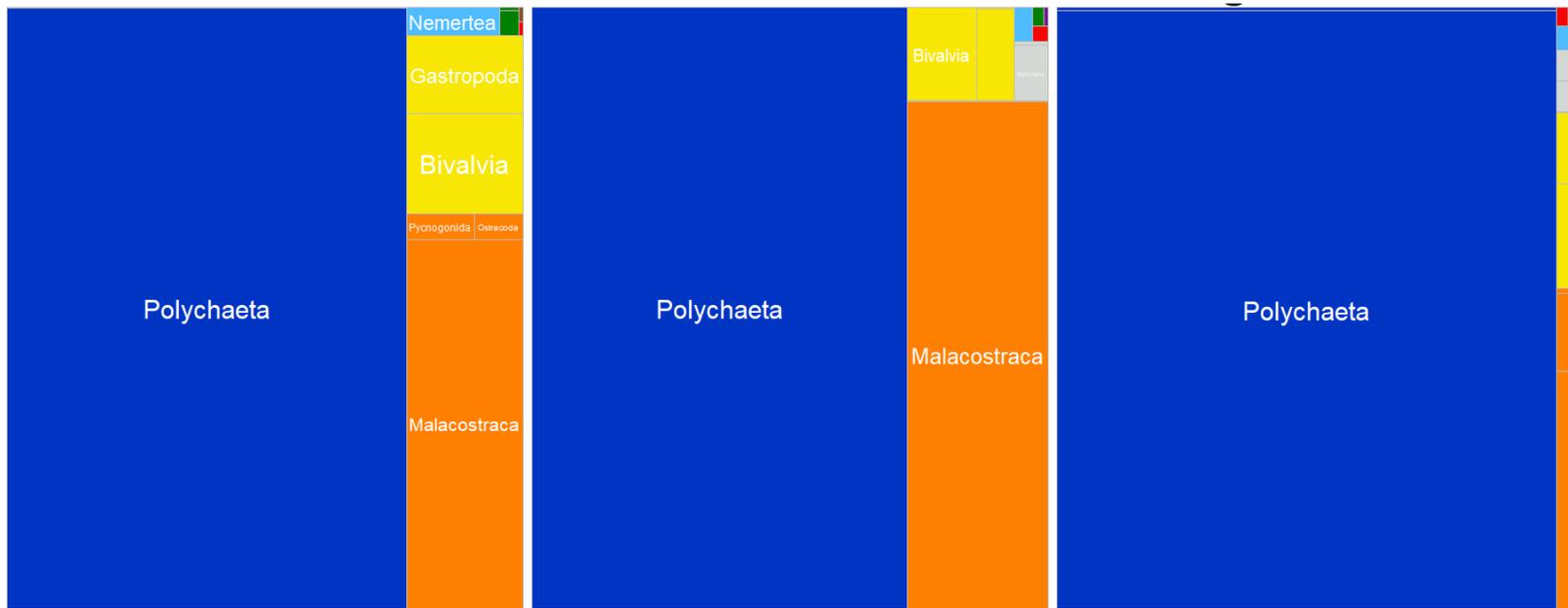
Marine Environmental Research 132 (2017) 168–176  
Contents lists available at ScienceDirect  
**Marine Environmental Research**  
Journal homepage: [www.elsevier.com/locate/marenvrev](http://www.elsevier.com/locate/marenvrev)

An estimate of the percentage of non-predatory dead variability in coastal zooplankton of the southern Humboldt Current System  
M.C. Krautz<sup>a,b</sup>, E. Hernández-Miranda<sup>a,b,c</sup>, R. Veas<sup>a,b</sup>, P. Bocaz<sup>a,b</sup>, P. Riquelme<sup>a,b</sup>, R.A. Quiñones<sup>a,b,c</sup>



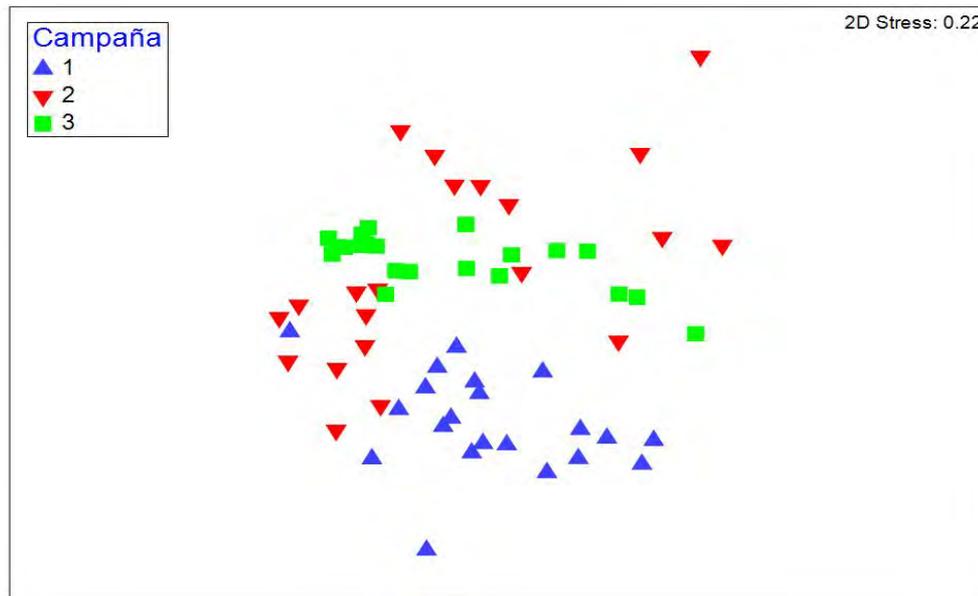
# Macrofauna Bentónica

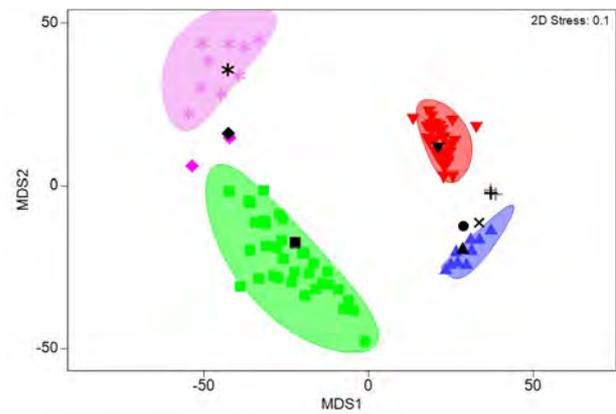
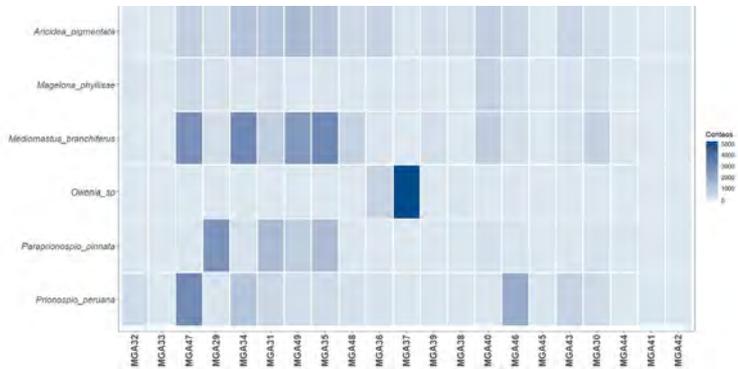
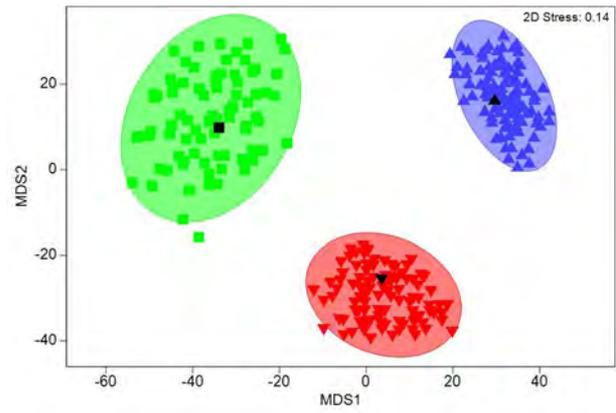
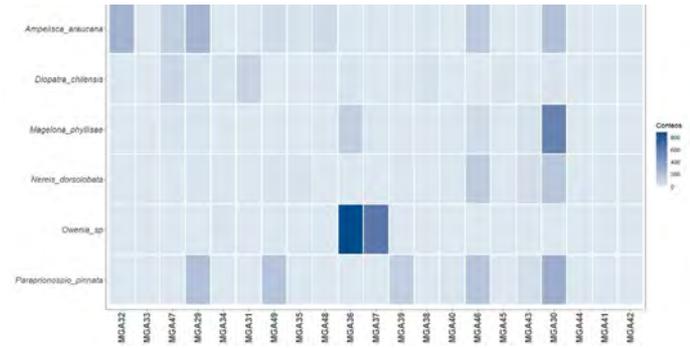
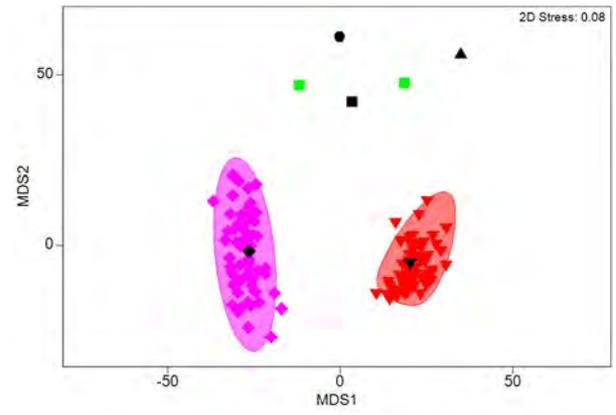
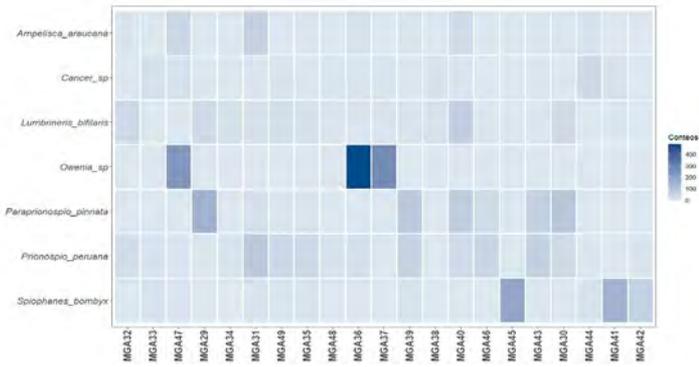


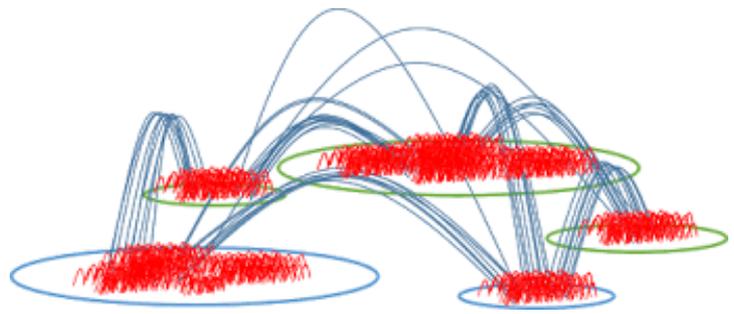
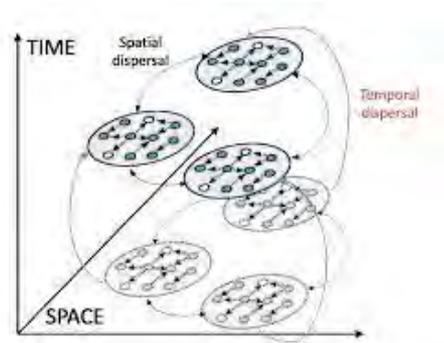
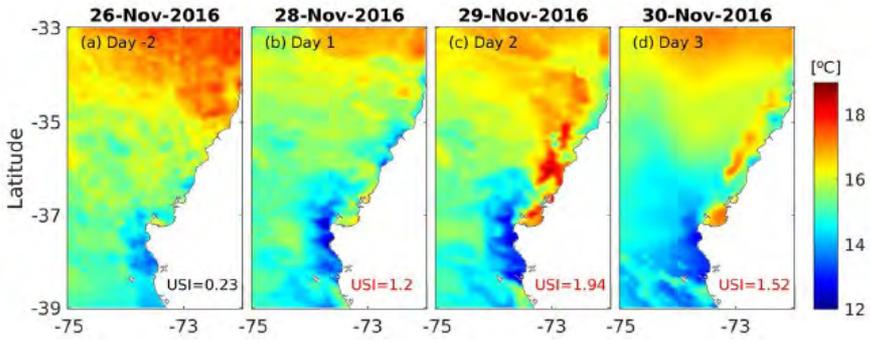
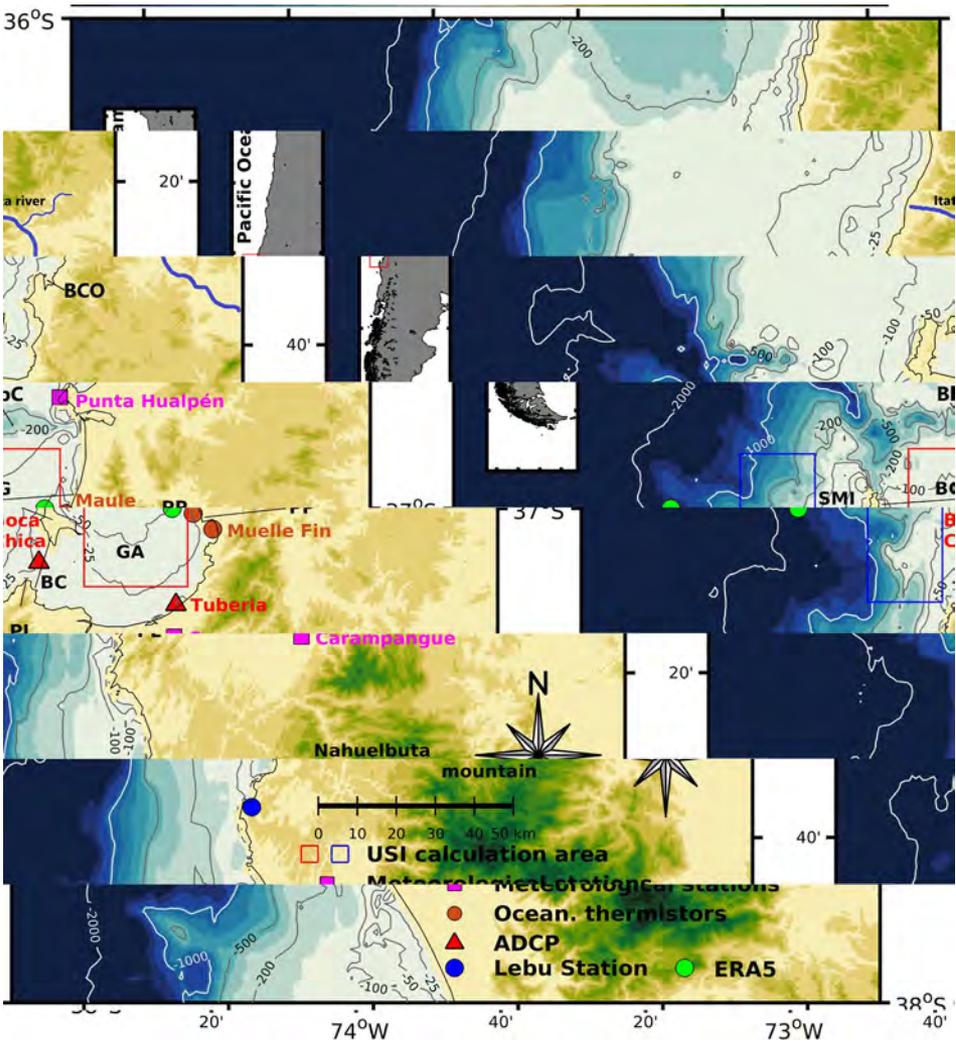


**Grupos Mayores**

<span style="color: blue;">■</span> Annelida	<span style="color: red;">■</span> Chordata	<span style="color: green;">■</span> Echinodermata	<span style="color: yellow;">■</span> Mollusca	<span style="color: brown;">■</span> Priapulida
<span style="color: orange;">■</span> Arthropoda	<span style="color: grey;">■</span> Cnidaria	<span style="color: purple;">■</span> Hemichordata	<span style="color: cyan;">■</span> Nemertea	







**JGR Oceans**

RESEARCH ARTICLE  
10.1029/2021JC017979

**Key Points:**  
 • Synoptic-scale atmospheric phenomena are directly related to the upwelling shadow events in the Gulf of Arauco.

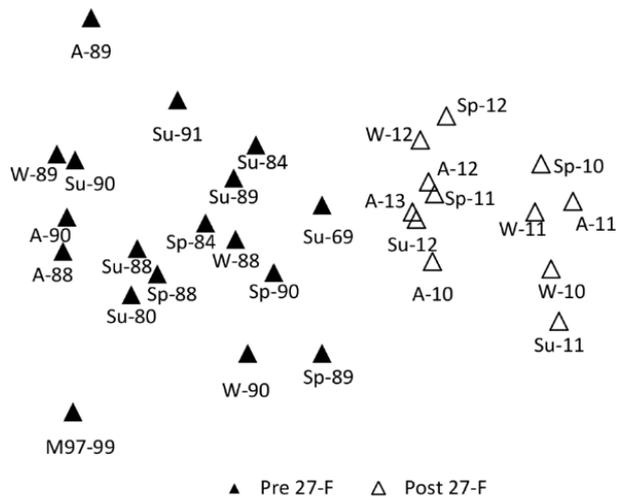
**Upwelling Shadows Driven by the Low-Level Jet Along the Subtropical West Coast of South America: Gulf of Arauco, Chile**

Piero Mardones<sup>1,2</sup>, Zeneida Wong<sup>1,3,4</sup>, Josse Contreras-Rojas<sup>1,3</sup>, Richard Muñoz<sup>1,2,5,6</sup>, Eduardo Hernández-Miranda<sup>1,4,5</sup>, and Marcus Sobarzo<sup>1,4,7</sup>

## MEGA TERREMOTO 8,8 (Febrero 27, 2010): Bahía Concepción



# Macrofauna



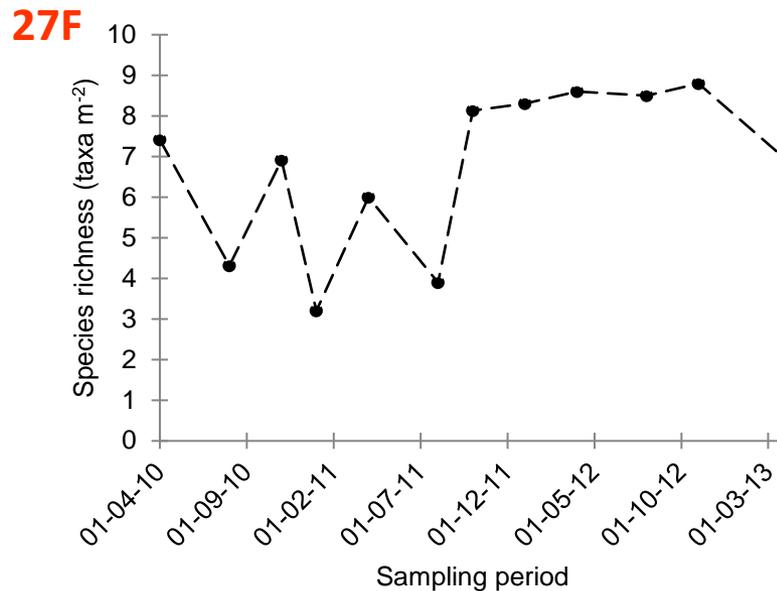
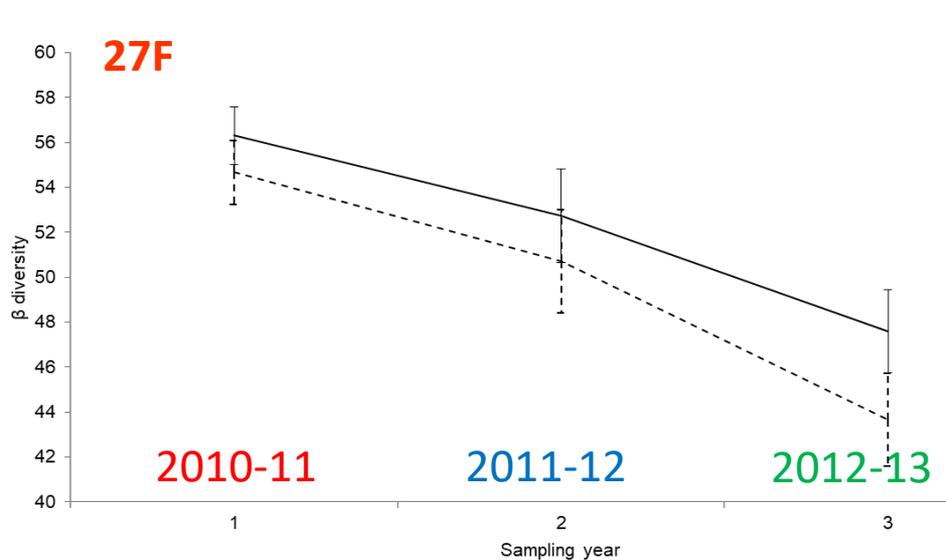
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 Paula J. Cárcamo<sup>a</sup>, Eduardo Hernández-Miranda<sup>a, b, c, \*</sup>, Rodrigo Veas<sup>a, c</sup>,  
 Renato A. Quiñones<sup>a, b, c</sup>

ELSEVIER

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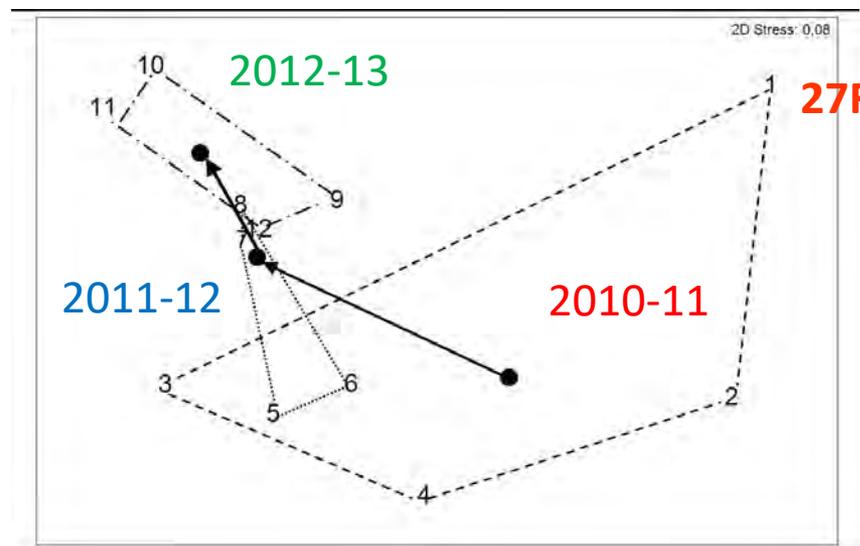
# Macrofauna



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 Renato A. Quiñones <sup>a, b, c</sup>

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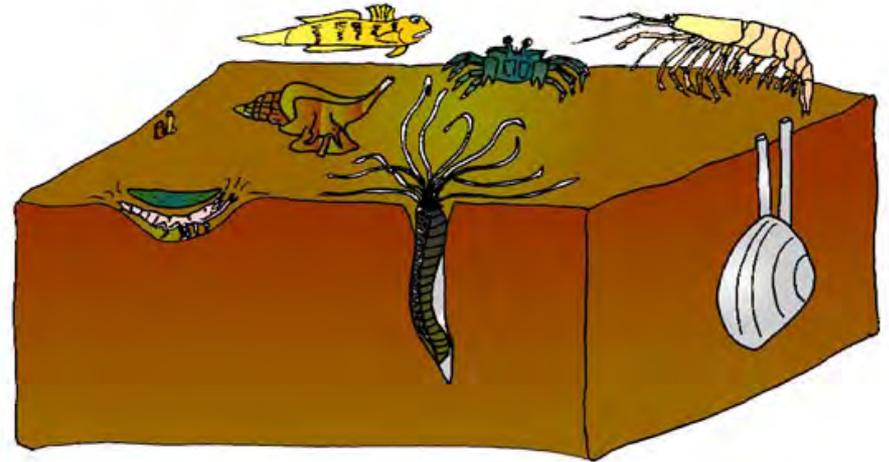


# Perturbaciones naturales

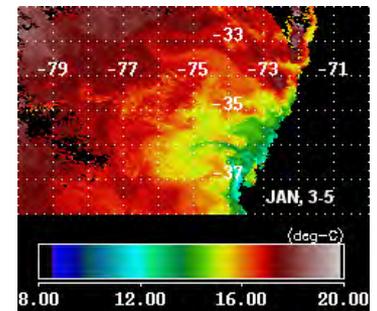
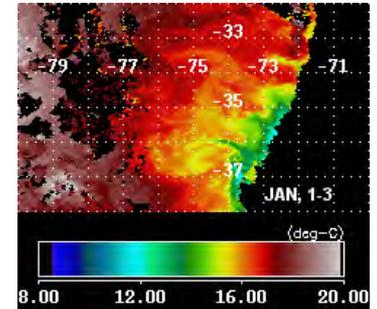
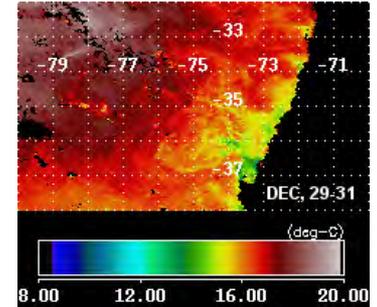
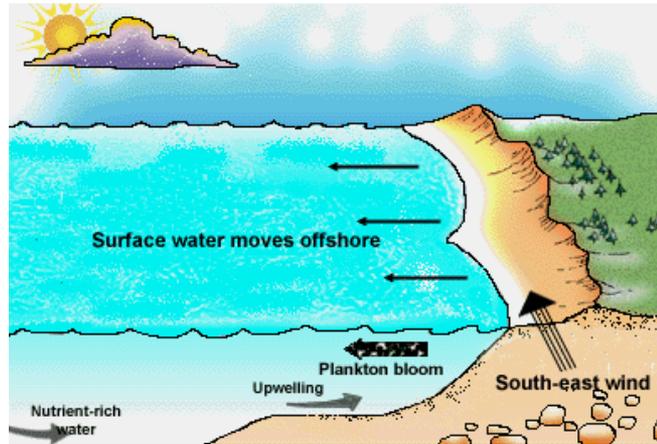
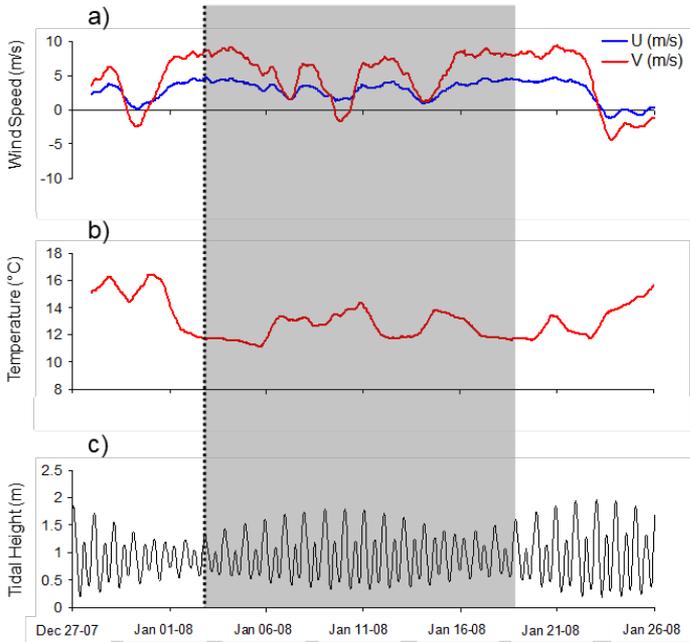


## Megafauna y Macrofauna

-  Hipoxia
-  8,8 Terremoto-Tsunami (27F)
-  Terremoto-Tsunami Japón (11m)
-  El Niño



# Hipoxia: enero 2008



**PLOS ONE**

RESEARCH ARTICLE

Short-term alteration of biotic and abiotic components of the pelagic system in a shallow bay produced by a strong natural hypoxia event

Eduardo Hernández-Miranda<sup>1,2\*</sup>, Rodrigo Vea<sup>1</sup>, Valeria Anabalón<sup>3</sup>, Renato A. Quiñones<sup>1,2,3</sup>

<sup>1</sup> Programa de Investigación Marina de Excelencia (PIMEX), Facultad de Ciencias Naturales y Oceanográficas, Universidad de Concepción, Concepción, Chile, <sup>2</sup> Interdisciplinary Center for Aquaculture Research (INCAR), Casilla 160-C, Universidad de Concepción, Concepción, Chile, <sup>3</sup> Department of Oceanography, Casilla 160-C, Universidad de Concepción, Concepción, Chile

\* [ehu@hazmex@uconce.cl](mailto:ehu@hazmex@uconce.cl)

Check for updates

# Hipoxia: enero 2008

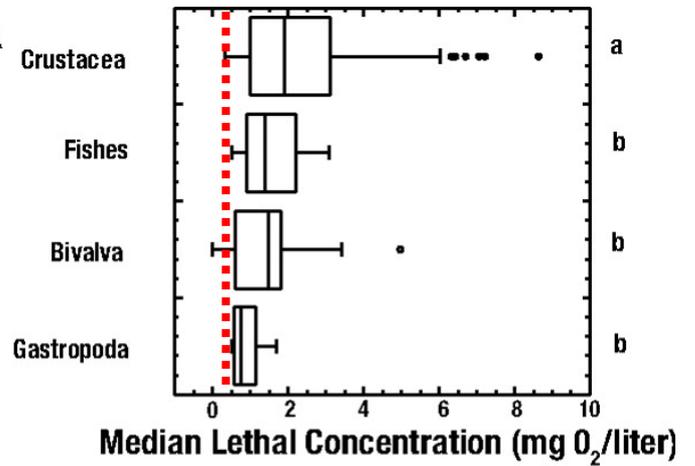
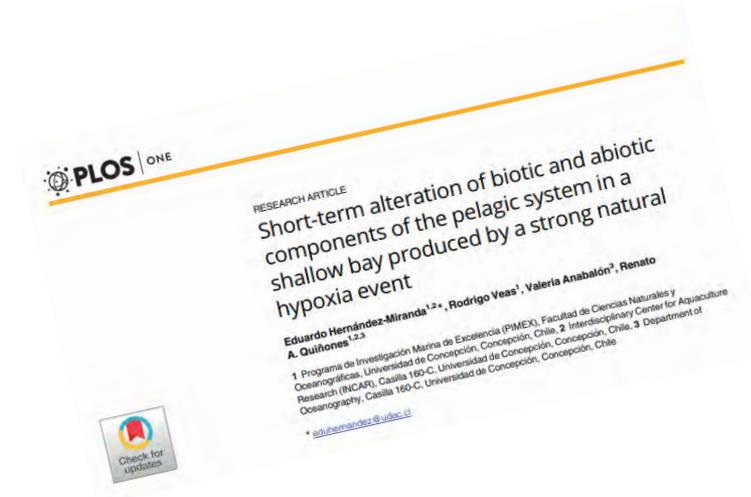


*Journal of Fish Biology* (2010) 76, 1543–1564  
doi:10.1111/j.1095-8649.2010.02580.x, available online at [www.interscience.wiley.com](http://www.interscience.wiley.com)

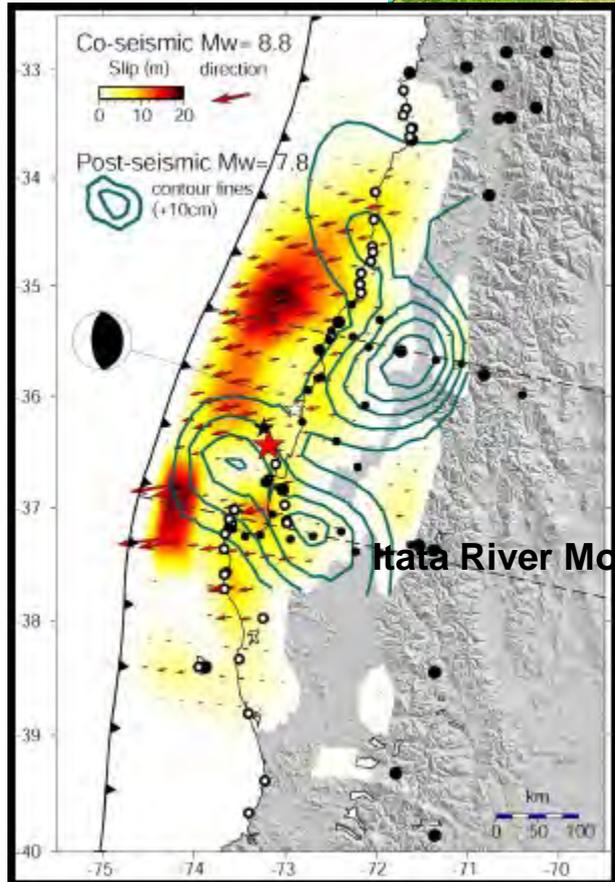
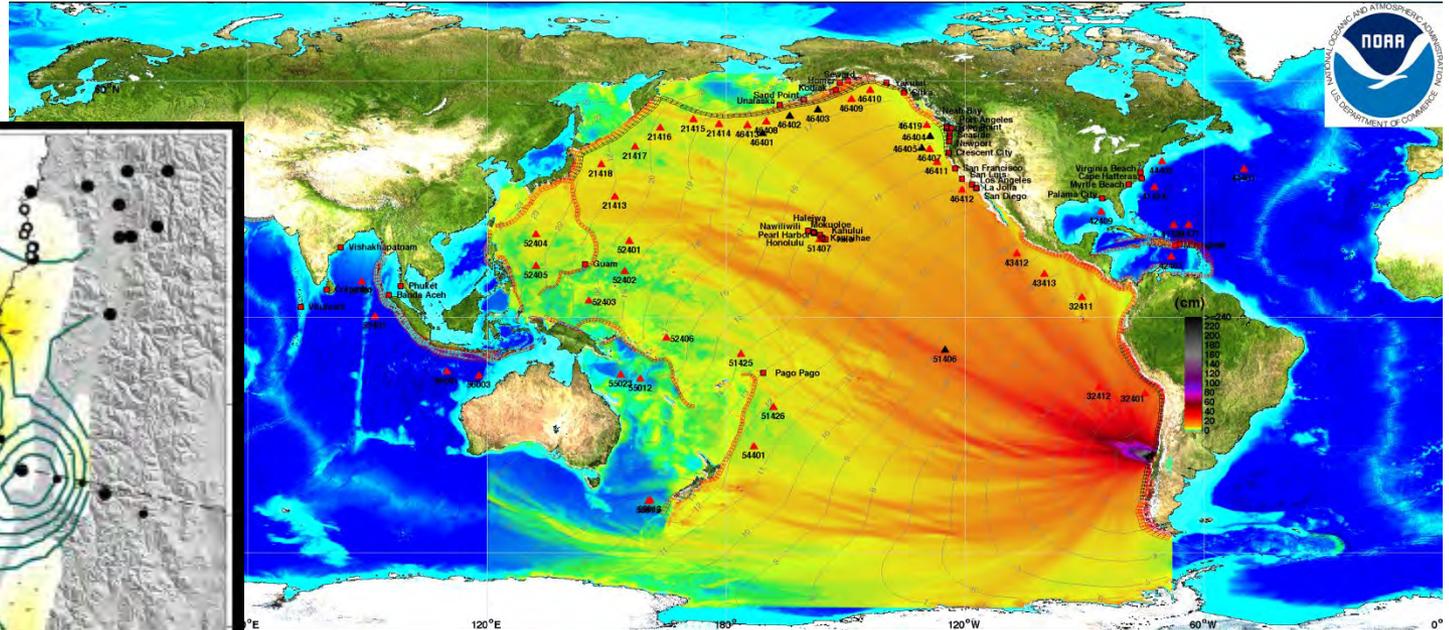
**A major fish stranding caused by a natural hypoxic event  
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E. HERNÁNDEZ-MIRANDA\*†, R. A. QUIÑONES\*†‡, G. AEDO‡,  
A. VALENZUELA‡, N. MERMOLD‡, C. ROMÁN‡ AND F. YAÑEZ‡

# Hipoxia: enero 2008



# MEGA TERREMOTO 8,8 (Febrero 27, 2010)



## Scienceexpress Report

### The 2010 $M_w$ 8.8 Maule Mega-Thrust Earthquake of Central Chile, Monitored by GPS

C. Vigny,<sup>1\*</sup> A. Socquet,<sup>2</sup> S. Peyrat,<sup>3</sup> J.-C. Ruegg,<sup>2</sup> M. Métois,<sup>1,2</sup> R. Madariaga,<sup>1</sup> S. Morvan,<sup>1</sup> M. Laucien,<sup>1</sup> R. Lacassin,<sup>2</sup> J. Campos,<sup>2</sup> D. Carrizo,<sup>4</sup> M. Bejar-Pizarro,<sup>2</sup> S. Barrientos,<sup>2,3</sup> R. Amijo,<sup>2</sup> C. Aranda,<sup>5</sup> M.-C. Valderas-Bermejo,<sup>6</sup> I. Ortega,<sup>6</sup> F. Boudoux,<sup>6</sup> S. Baize,<sup>7</sup> H. Lyon-Caen,<sup>1</sup> A. Pavez,<sup>3</sup> J. P. Vilotte,<sup>2</sup> M. Bevis,<sup>8</sup> B. Brooks,<sup>9</sup> R. Smalley,<sup>10</sup> H. Para,<sup>11</sup> J.-C. Baez,<sup>12</sup> M. Blanco,<sup>13</sup> S. Cimbaro,<sup>14</sup> E. Kendrick<sup>15</sup>

# MEGA TERREMOTO 8,8 (Febrero 27, 2010)

06:00 hrs.

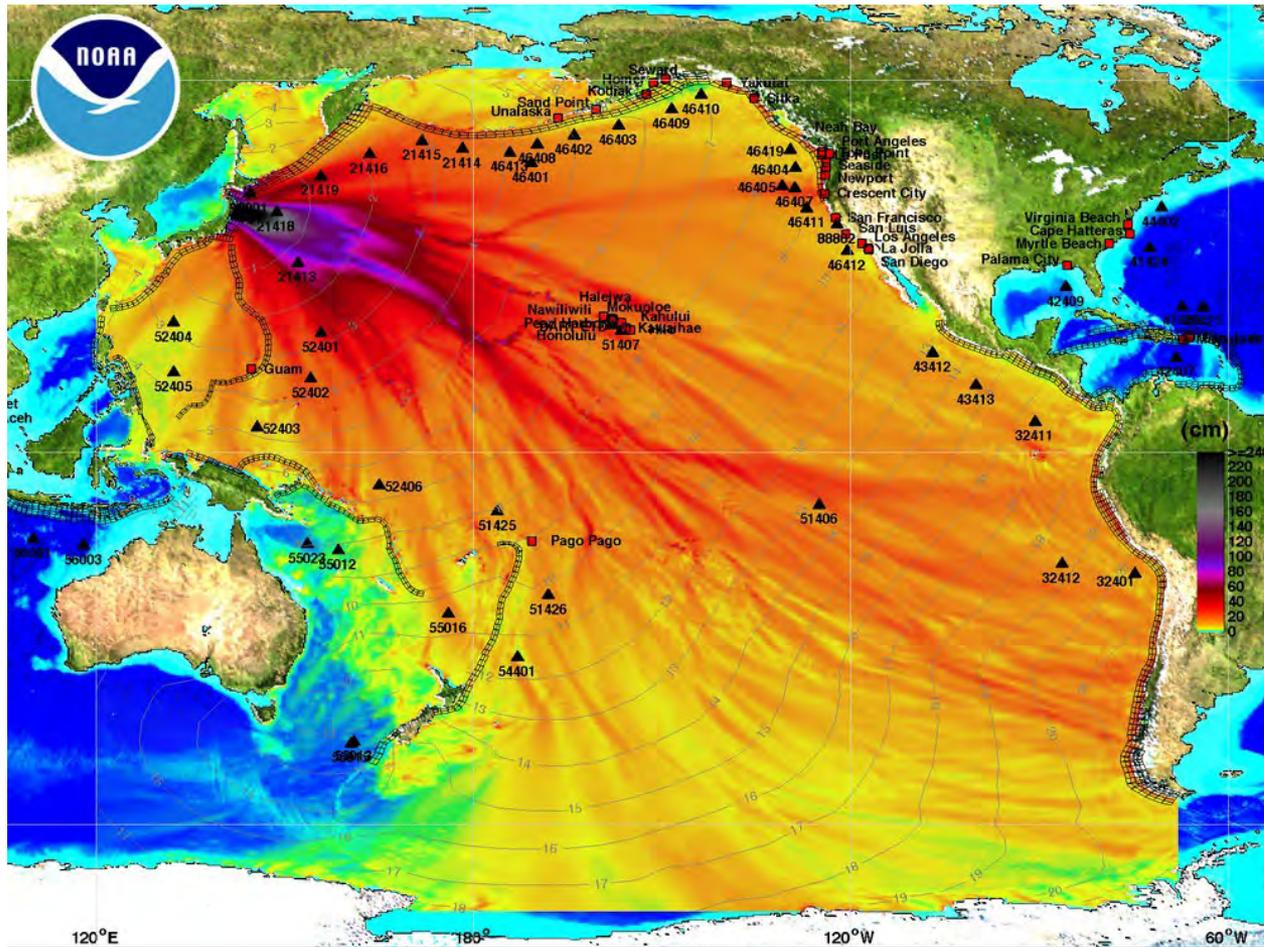


## MEGA TERREMOTO 8,8 (Febrero 27, 2010): Dichato



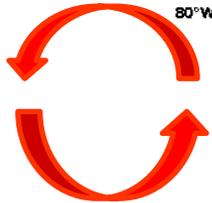
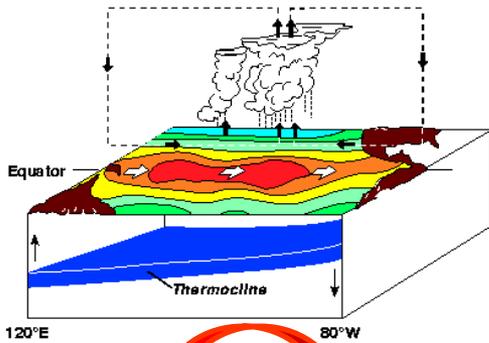
# MEGA TERREMOTO JAPON (Segundo Evento, Chile, Marzo 11, 2011)

23:14 hrs.

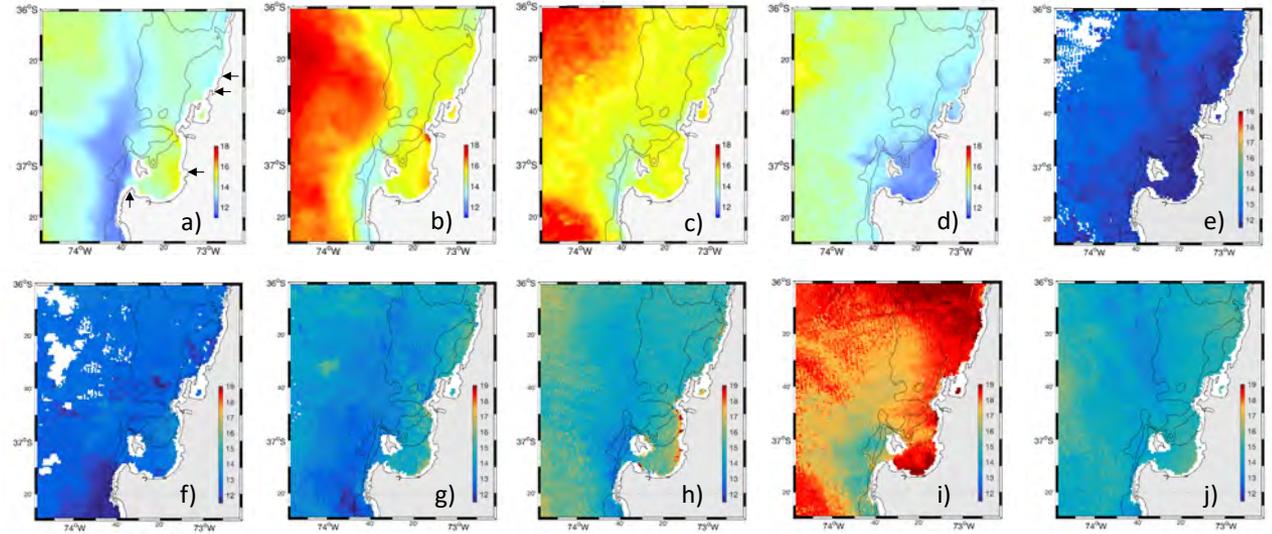
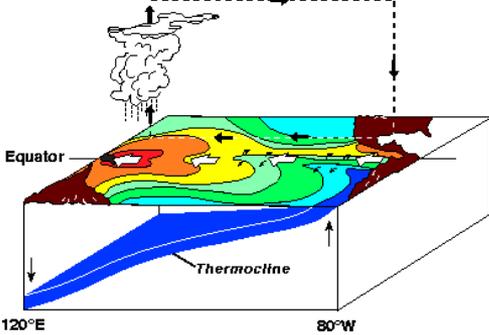


# Evento El Niño (2015-2016)

### El Niño Conditions

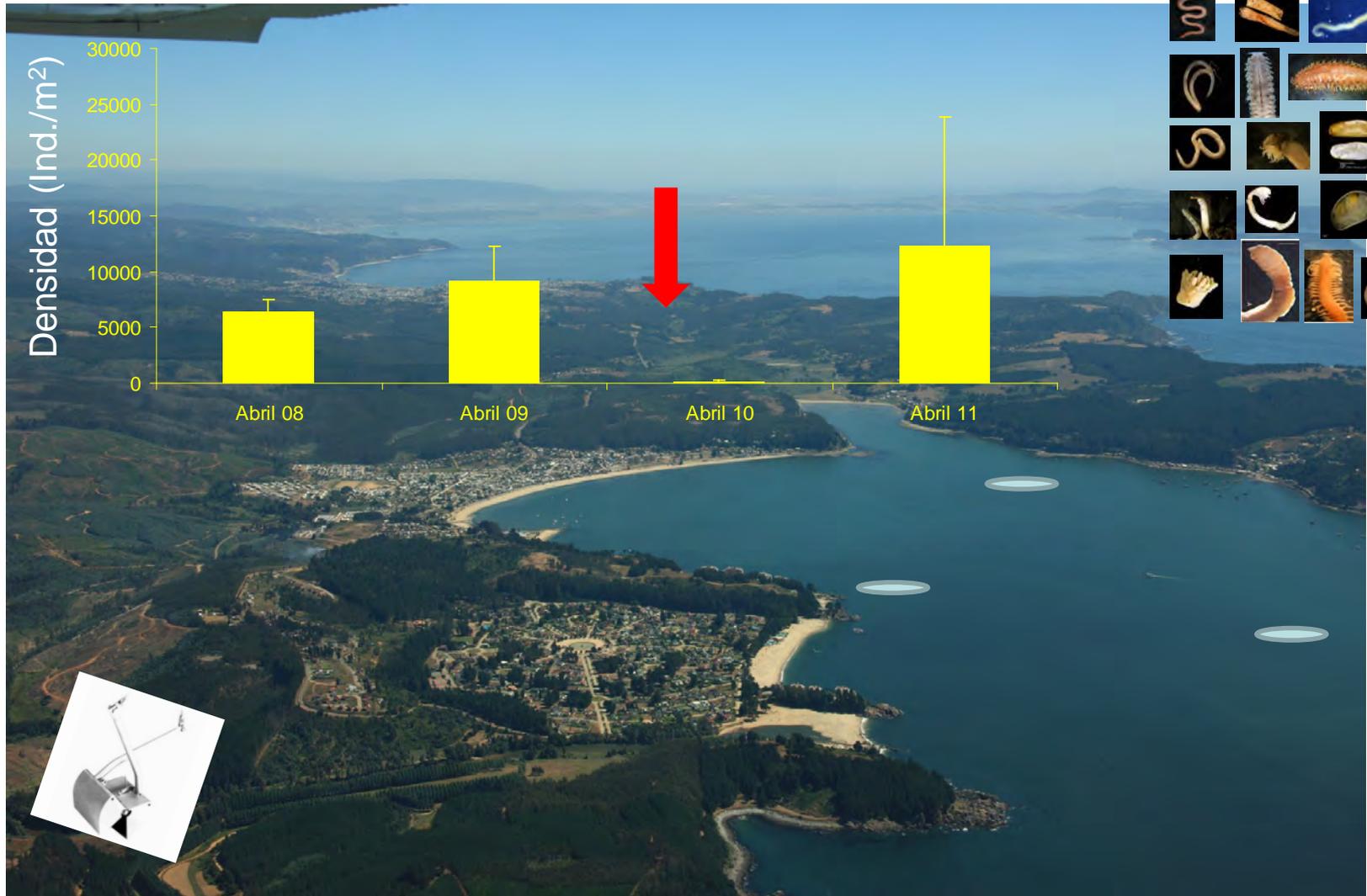


### La Niña Conditions

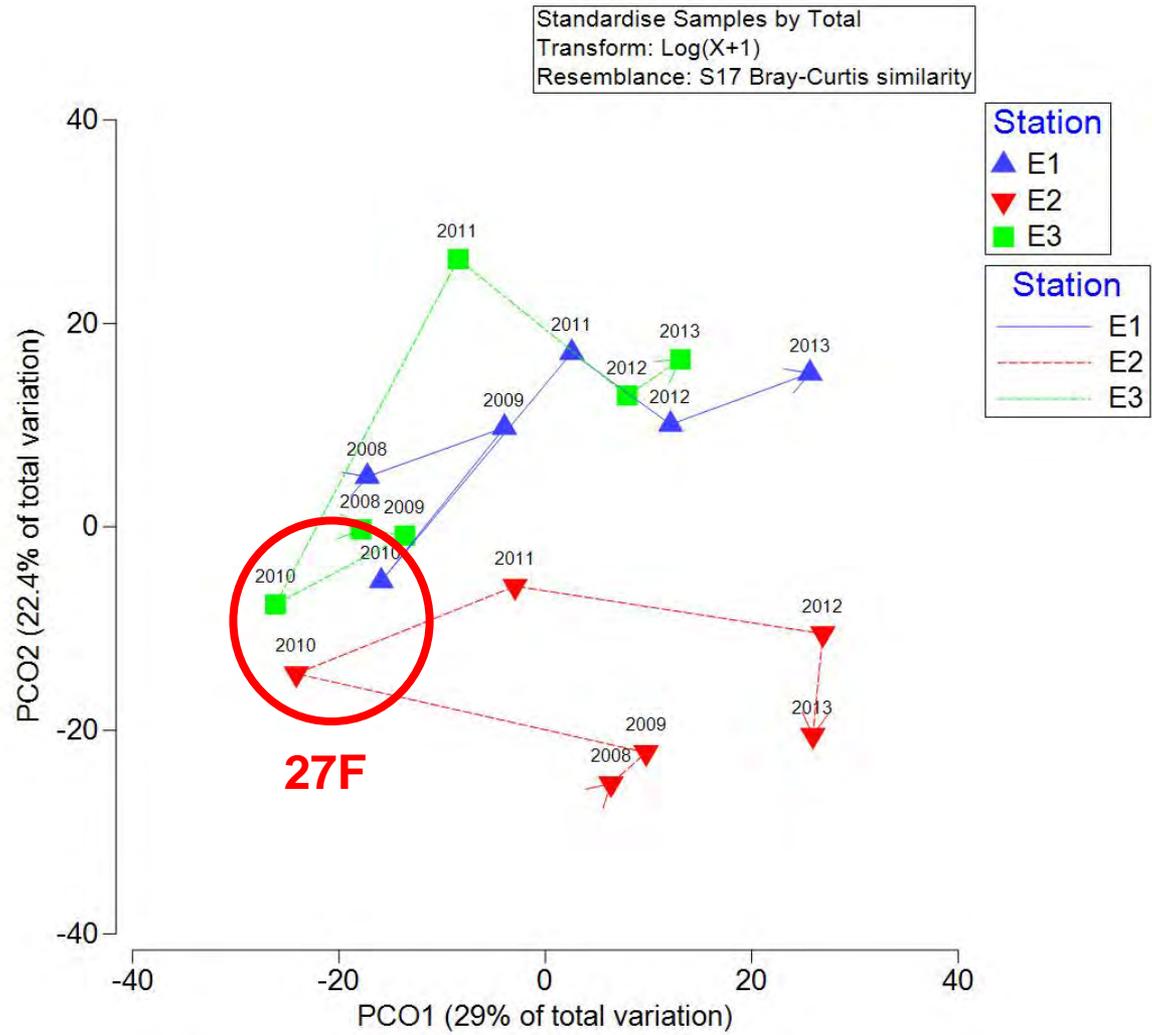


Journal cover for *Marine Environmental Research*. The cover includes the Elsevier logo, the journal title, and the article title: "An estimate of the percentage of non-predatory dead variability in coastal zooplankton of the southern Humboldt Current System". The authors listed are M.C. Krautz<sup>a,b</sup>, E. Hernández-Miranda<sup>a,b,c,e</sup>, R. Veas<sup>a,b</sup>, P. Bocaz<sup>a,b</sup>, P. Riquelme<sup>a,b</sup>, and R.A. Quíñones<sup>a,b,c</sup>. The journal homepage is [www.elsevier.com/locate/marenvres](http://www.elsevier.com/locate/marenvres). The cover also features the CrossMark logo and a small image of a wave.

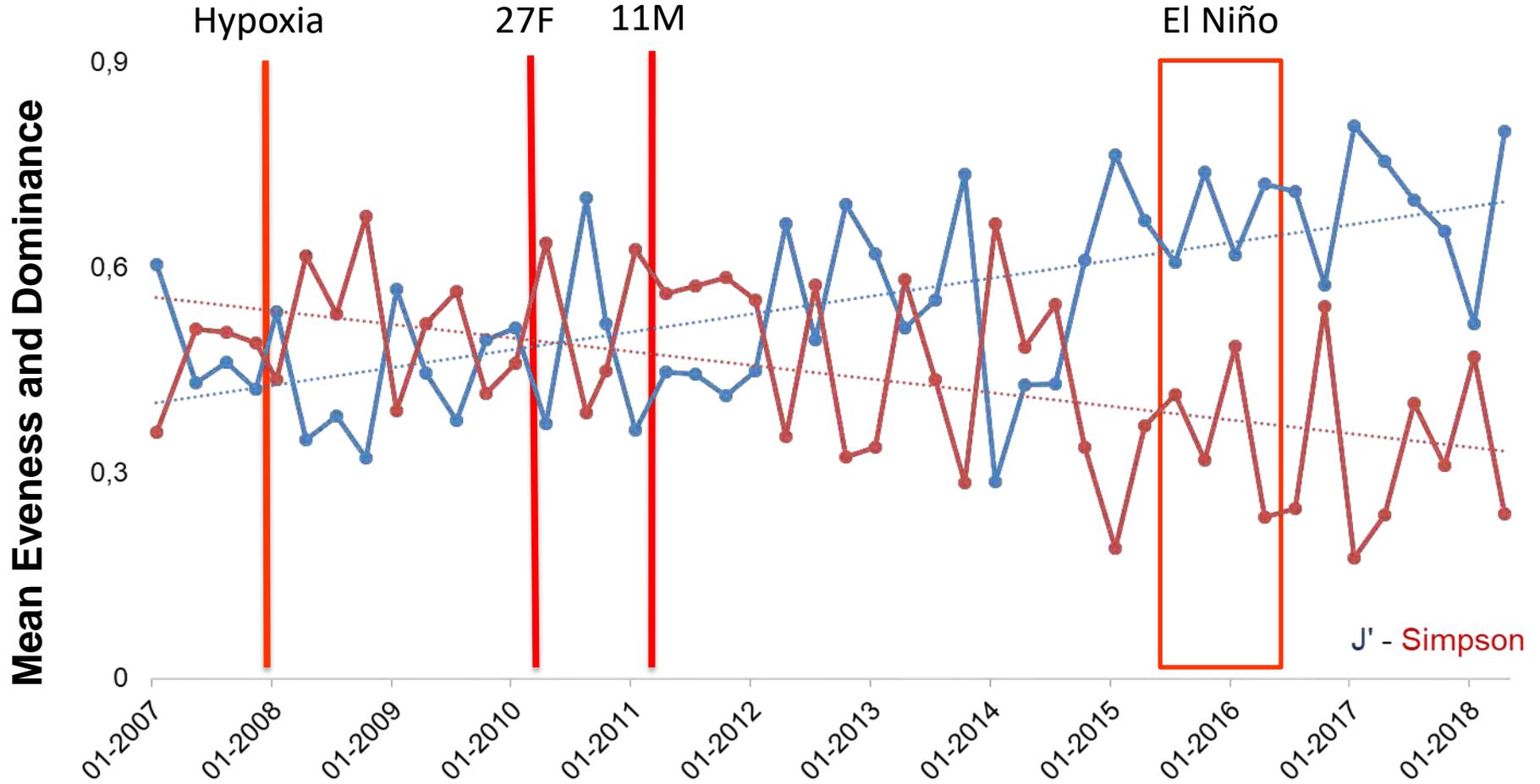
# Macrofauna



# Macrofauna



# Megafauna

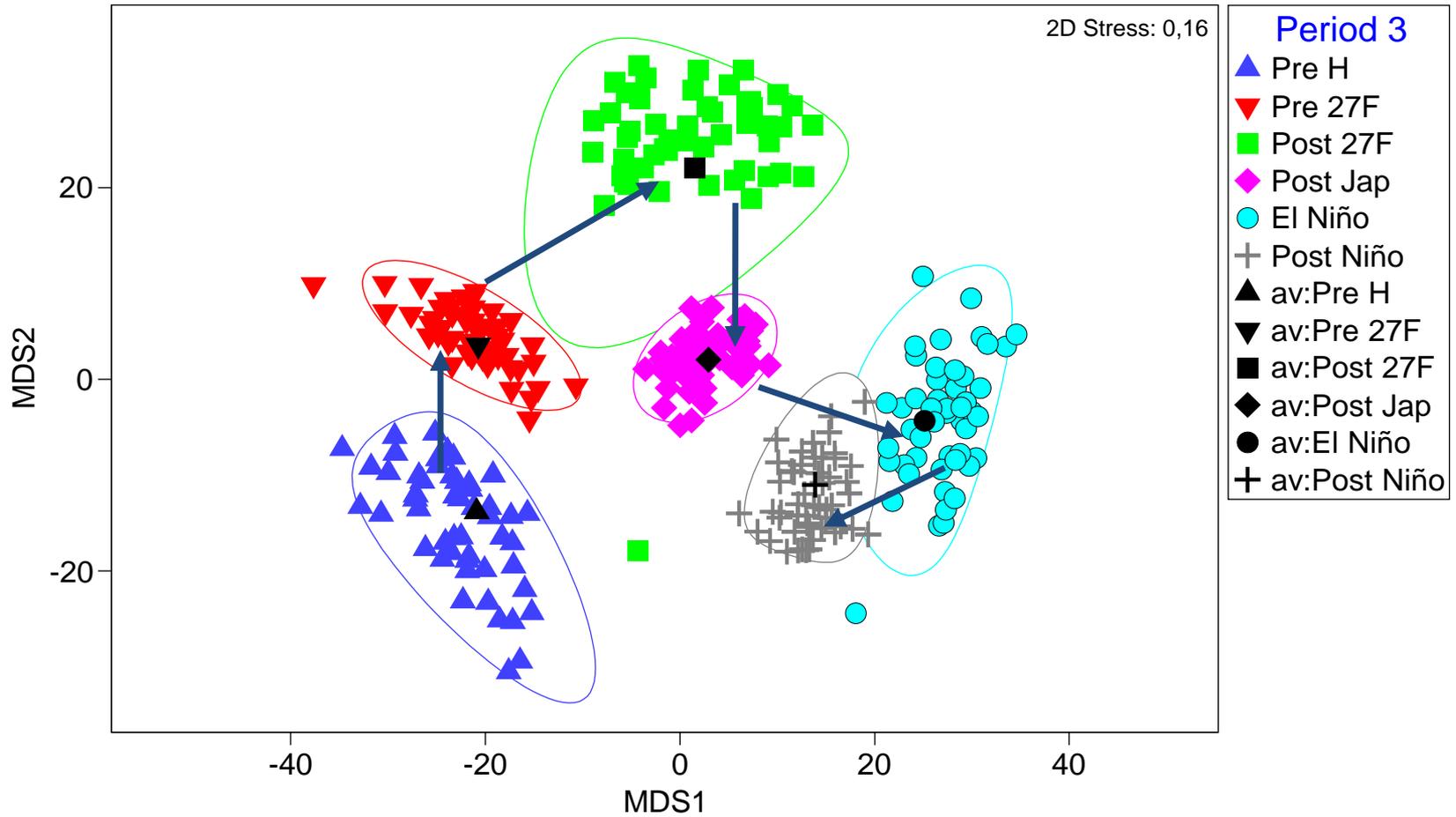


# Megafauna

## Metric MDS

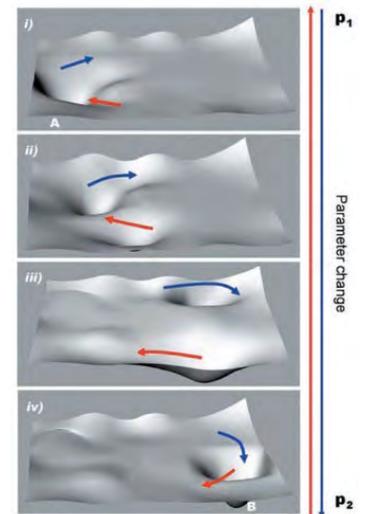
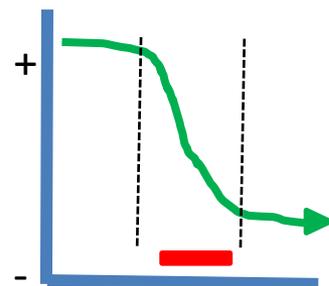
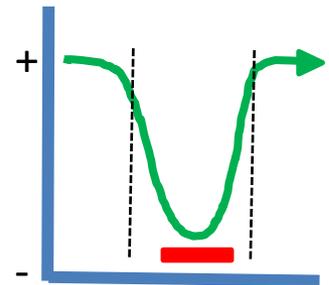
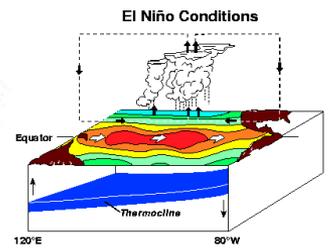
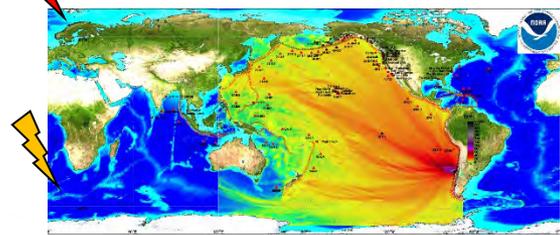
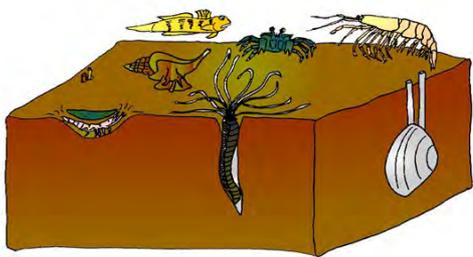
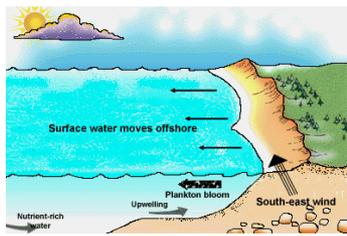
Transform: Fourth root  
Resemblance: S17 Bray-Curtis similarity

2D Stress: 0,16



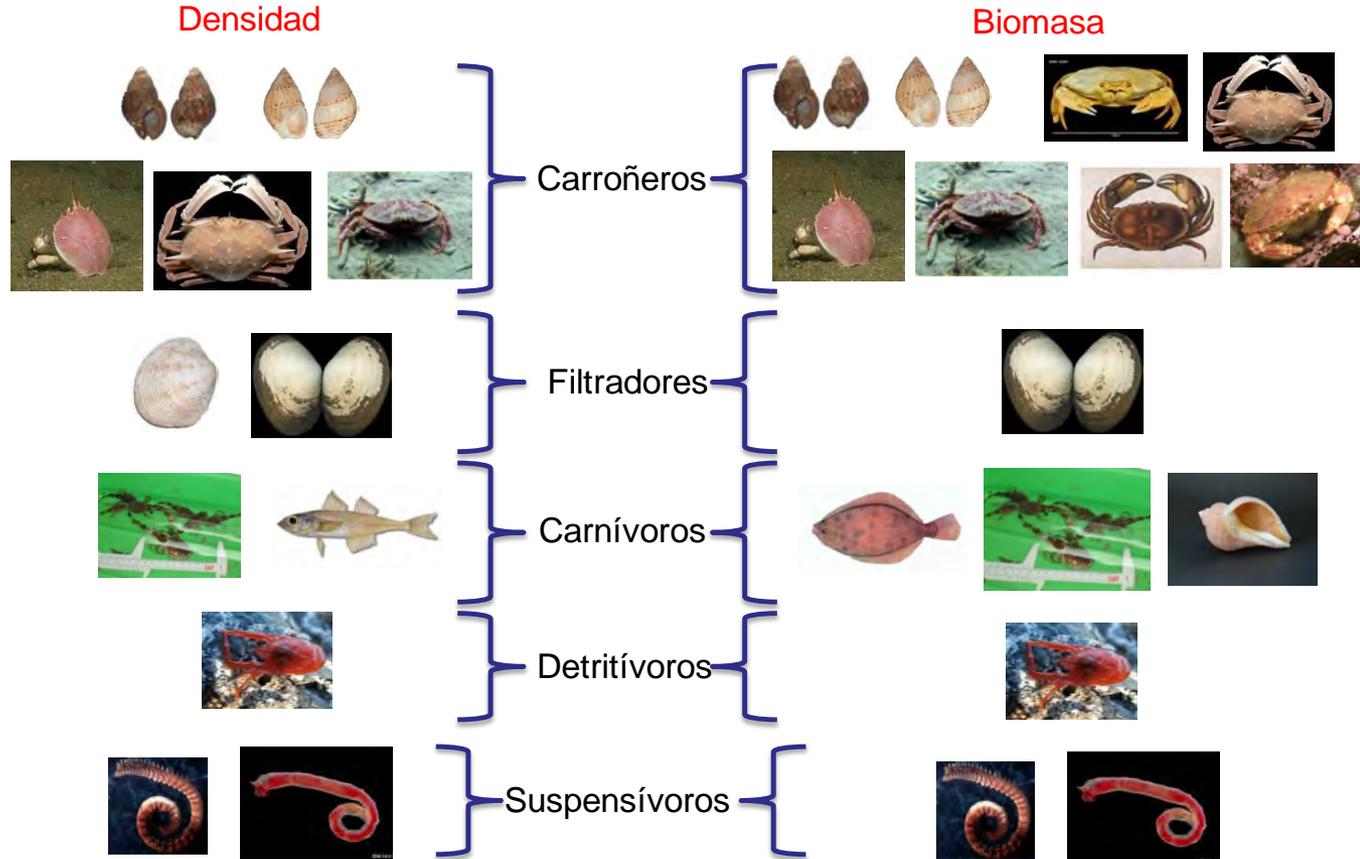
# Perturbaciones naturales

Jan-07 Jan-08 Jan-09 Jan-10 Jan-11 Jan-12 Jan-13 Jan-14 Jan-15 Jan-16 Jan-17 Jan-18



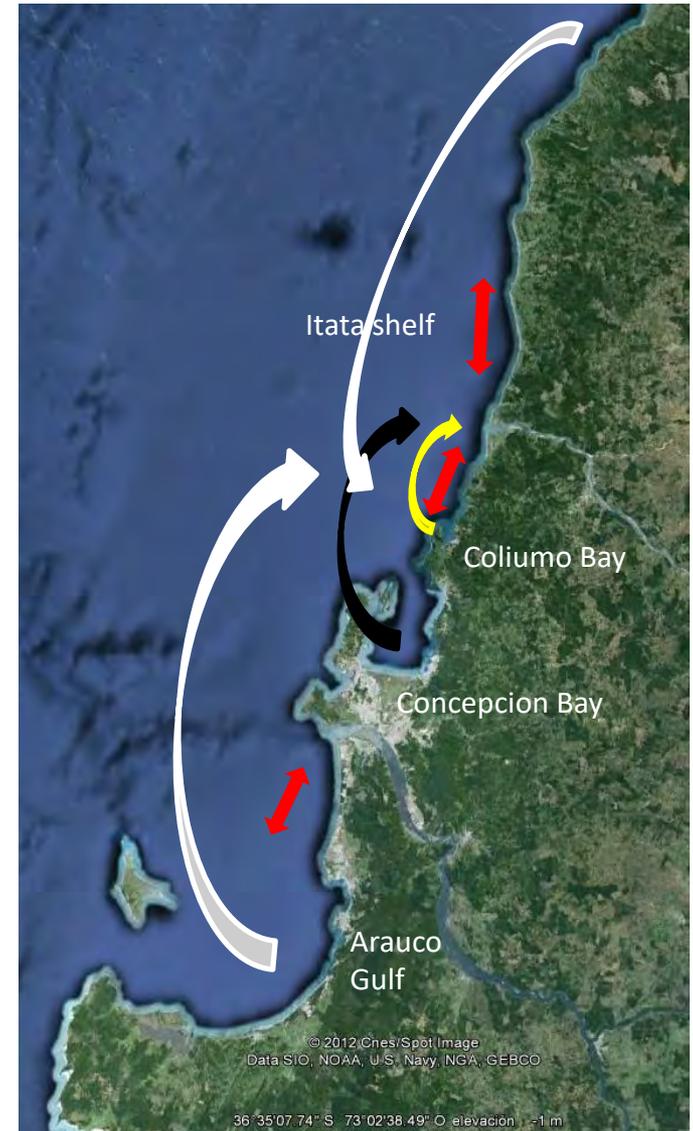
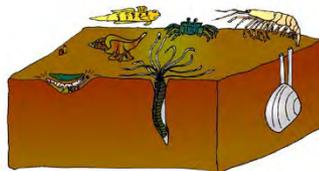
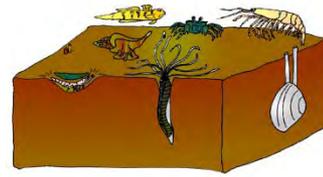
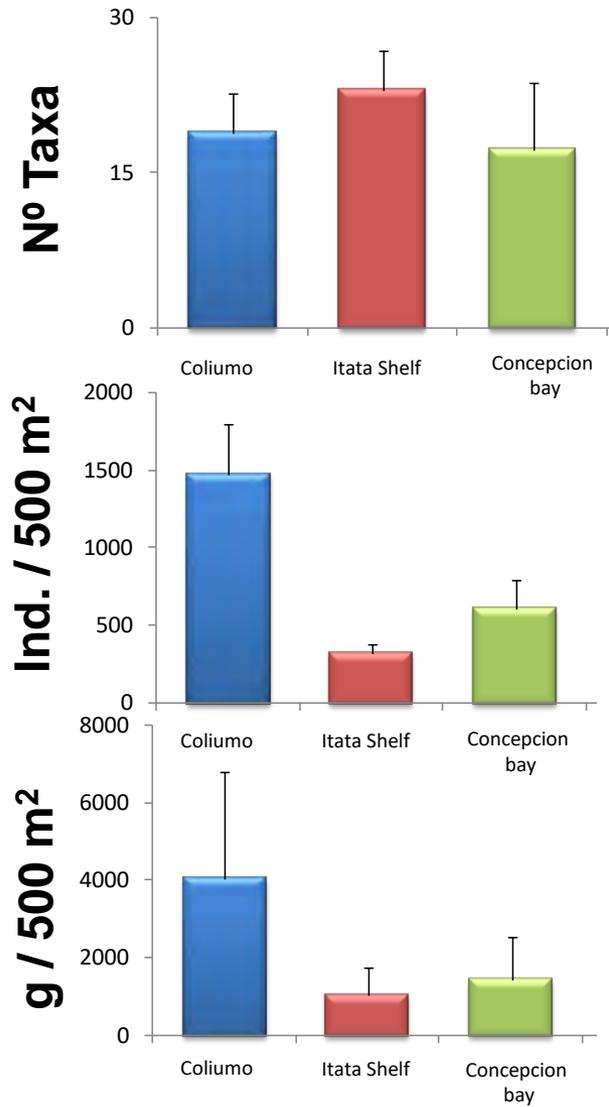
# Atributos ecológicos: Grupos funcionales

(Hernández-Miranda et al. 2012 MERE)



 Rol en el funcionamiento ecosistémico 

# Atributos ecológicos: Escala espacial



## Conclusiones generales

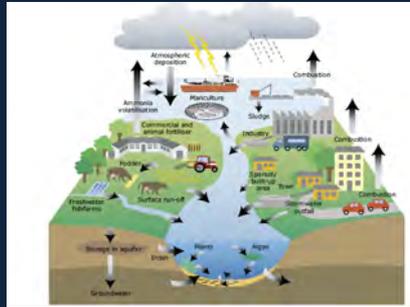
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- ✓ Existe evidencia empírica de la presencia de EEA en la comunidad bentónica de Bahía Coliumo.
- ✓ La alta resiliencia ecológica ante perturbaciones de origen natural podría estar relacionada a un alto nivel de transporte y dispersión larval + grupos funcionales.
- ✓ Perturbaciones naturales son capaces de determinar la dinámica/trayectoria inter-anual de las comunidades hasta escalas de decenas de kilómetros.
- ✓ La estacionalidad reproductiva actuaría como fuerza antagónica a las perturbaciones naturales. Mecanismo de estabilidad y resiliencia ecológica.
- ✓ Las series de tiempo ecológicas nos ayudan a comprender el funcionamiento de los ecosistemas y nos permitirían identificar cambios producto de perturbaciones antropogénicas. **Hay que sostenerlas y fomentarlas ¡¡¡¡¡**

**Ambiente cambiante.....?**

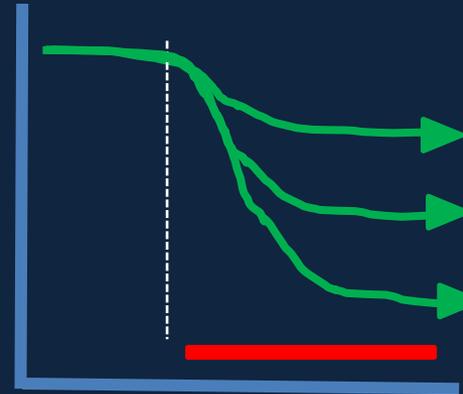


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**CONTINUAS**



Tiempo



**Predicciones...**

Ante el aumento de zonas de hipoxia (i.e. zonas muertas) en los océanos, ya sea por origen natural (i.e. surgencias) o antropogénico (i.e. acuicultura, aguas servidas o actividad industrial), la existencia/mantención de áreas extensas (i.e. decenas de kilómetros) con comunidades con atributos similares (i.e. AMPs), serviría como un buffer natural, favoreciendo la diversidad, resiliencia, productividad y sustentabilidad de los ecosistemas marinos costeros.

**Las bahías juegan un rol central !!!**