"Translating ocean acidification into practical applications to support aquaculture and food sustainability"

Dr Silvana N.R. Birchenough

International Symposium on Ocean Acidification -Dialogues between scientists and stakeholders
28th October 2018.

Centre for Environment Fisheries & Aquaculture Science

OECD

musels
CENTER FOR THE STUDY OF MULTIPLE DRIVERS ON MARINE SOCIO-ECOLOGICAL SYSTEMS

CEAZA

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News

PLACID

BIOACID

German BioAcid (8yrs)

https://www.oceanacidification.de/category/video-en/?lang=en

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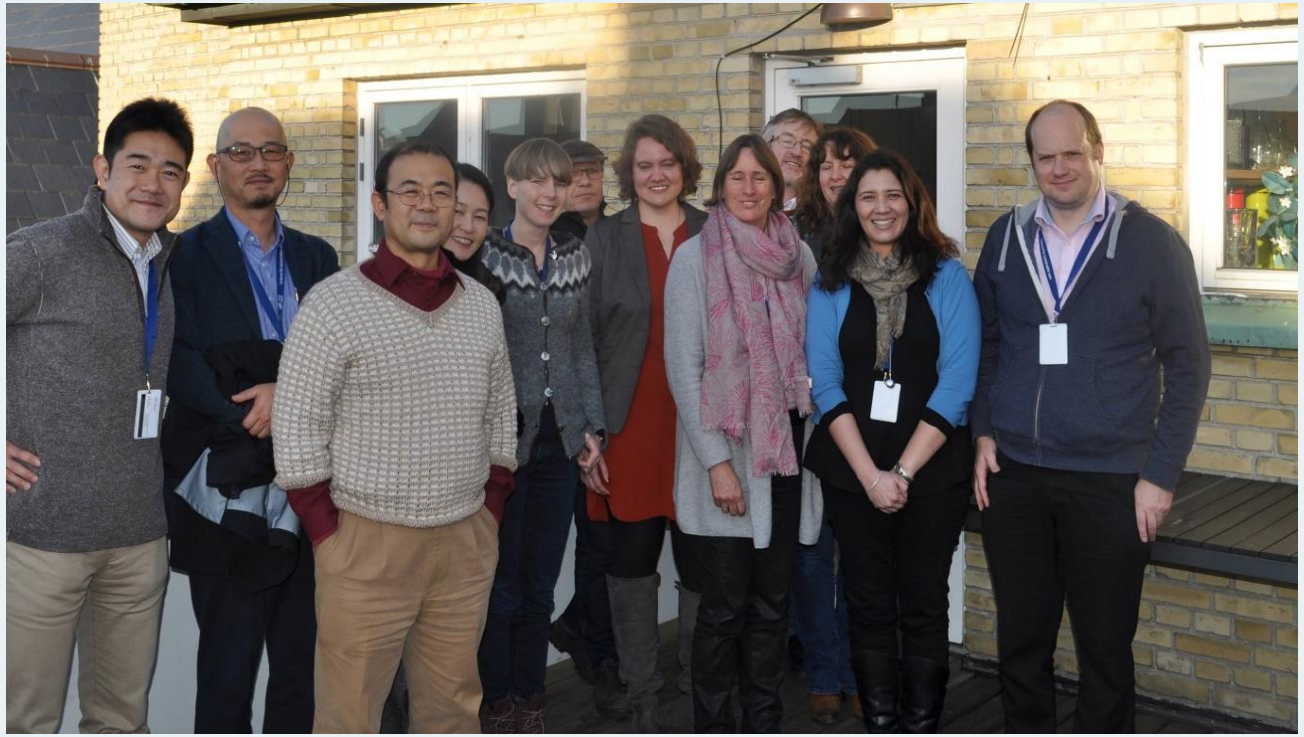
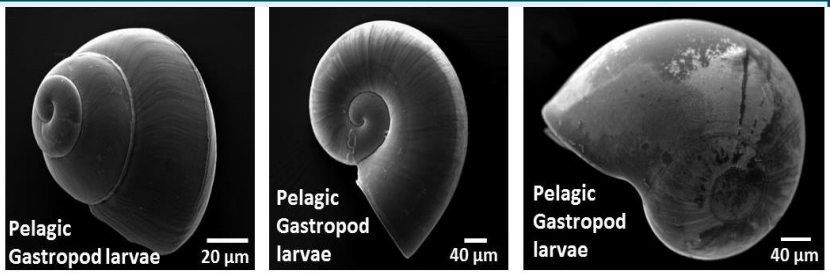
ICES/PICES ACIDUSE WK

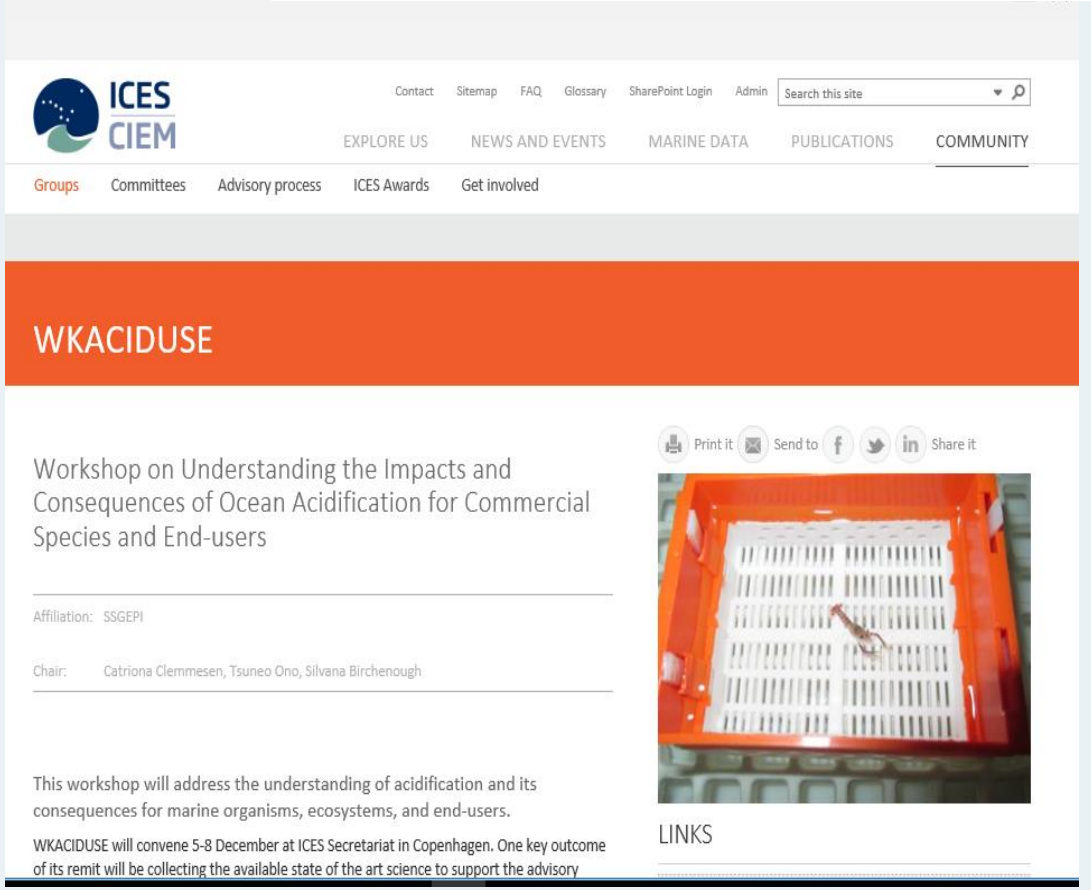
- 5-8th December 2016, at ICES;
- The workshop on understanding the impacts and consequences of ocean acidification for commercial species and end-users;
- Government, advisors, scientists and end-users.
- Discuss ways of translating science into applications.
- Follow up from the OSPAR/ICES SG
- The report is available:



ICES/PICES ACIDUSE WK



- Importance of monitoring practices;
- Develop a suite of suitable robust, sensitive, and OA-specific biological indicators,
- Pteropods, foraminifera are widely found but no a clear pH response;
- OA and multiple stressors on marine life and potential socio-economic implications;
- Saturation thresholds: Ωar and Ωca at which a species responds was different for plankton and fish. Saturation thresholds for marine species has not been fully characterised



UK/USA Workshop

- July 2016 in London and in West Mersea, Essex;
- Organised by Ocean Conservancy , USA;
- Aquaculture and end-users interested in understanding climate change effects on mussels, oysters and overall;

- USA- examples on oysters (Whiskey Creek)
- UK- still these examples are not felt in UK waters

- Several degrees of inshore variability

Newsroom

A VOICE FOR OUR OCEAN

American and British Shellfish Farmers Meet to Discuss the Threat of Ocean Acidification to Their Businesses

JUNE 29, 2016

(London- 29 June 2016) Today at the Friend's House in London, American and British shellfish farmers are meeting to begin developing responses to the growing threat of ocean acidification to their businesses and coastal communities. While Britain and the EU work to address the fallout from the Brexit referendum, an American delegation of farmers from four U.S. states (California, Washington, New York, and Virginia) and the non-governmental organization Ocean Conservancy, is initiating a dialogue on an international crisis of a different nature – environmental threats to the oysters, mussels, clams and crustaceans with their British counterparts, including shellfish farmers, scientists, and civil servants.

Ocean acidification is a change in seawater chemistry that is occurring as a result of carbon emissions being

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- The Global Leader In Aquaculture And Fish Farming News -

US, UK shellfish farmers swap concepts for battling ocean acidification impacts

A few years ago, Washington state lost 75 percent of its larvae to ocean acidification.

American and British shellfish farmers will meet Wednesday at the

Seaweed farming

House of Commons Science & Technology Committee

Defra response (18 July, 2017) to issues raised re the OA inquiry:

Science and Technology Committee
House of Commons London SW1A 0AA
Tel 020 7219 7126
http://www.parliament.uk/science

From Stephen Metcalfe MP, Chair

Thérèse Coffey MP
Parliamentary Under Secretary of State
Department for Environment, Food and Rural Affairs
Nobel House
17 Smith Square
London SW1P 3JR

26 April 2017

Dear Thérèse,

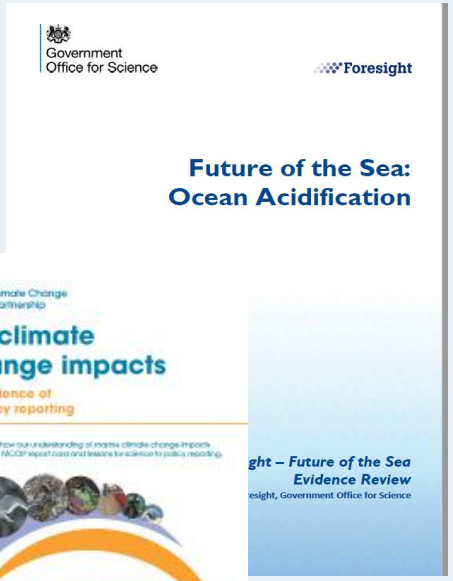
Ocean acidification

I am writing on behalf of the Science and Technology Committee about our recent inquiry into ocean acidification. We were grateful for your evidence to us last month and wanted to draw your attention to some of the key points from our inquiry, and highlight the follow up needed by Government.

Our inquiry highlighted the breadth and scale of work undertaken by marine scientists as part of the UK Ocean Acidification Research Programme (UKOA) that ran from 2010-2015. It is clear that the programme played an important role in advancing the general understanding of ocean acidification processes, as well as highlighting its specific implications for marine life, and human society, in the UK and beyond. We note that the future impacts of ocean acidification on shellfish and finfish fisheries remain highly uncertain[1] and ask that, when the results of the Defra and UKOA-funded PLACID programme (Placing Ocean Acidification in a wider Fisheries Context) have been analysed, Government outlines its conclusions to our successor Committee, together with plans for addressing PLACID's findings.

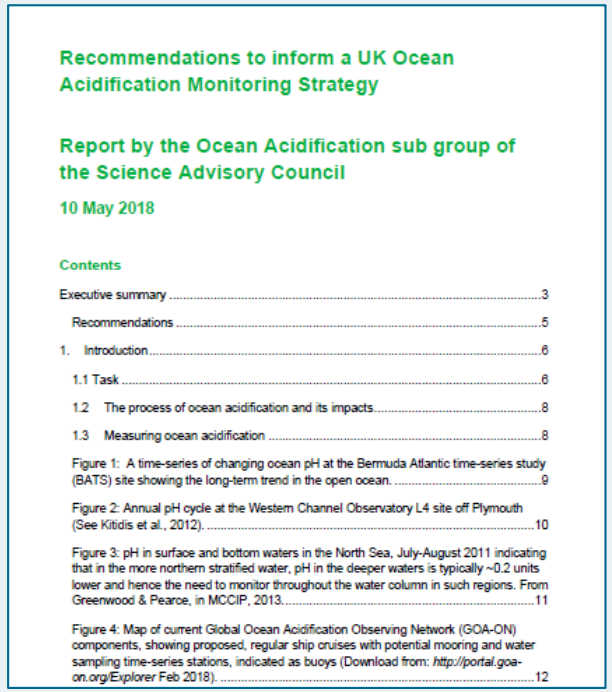
Research programmes such as PLACID enable the UK to develop, and cement, its

- Monitoring of UK waters
- Understanding of ocean acidification effects on commercial species
- OA effects over species and habitats of conservation importance
- Key gaps, so where should we target efforts…



Defra Ocean Acidification sub group of the Science Advisory Council (CSAC)

- UK national experts were tasked to compile advice;
- An advice document was drafted;
- Endorsed by Defra;
- Several recommendations to establish a UK network of monitoring stations for carbonate chemistry;
- Also ideas for sampling carbonate chemistry over OTs and SIDs.



Recommendations to inform a UK Ocean Acidification Monitoring Strategy

Report by the Ocean Acidification sub group of the Science Advisory Council

10 May 2018

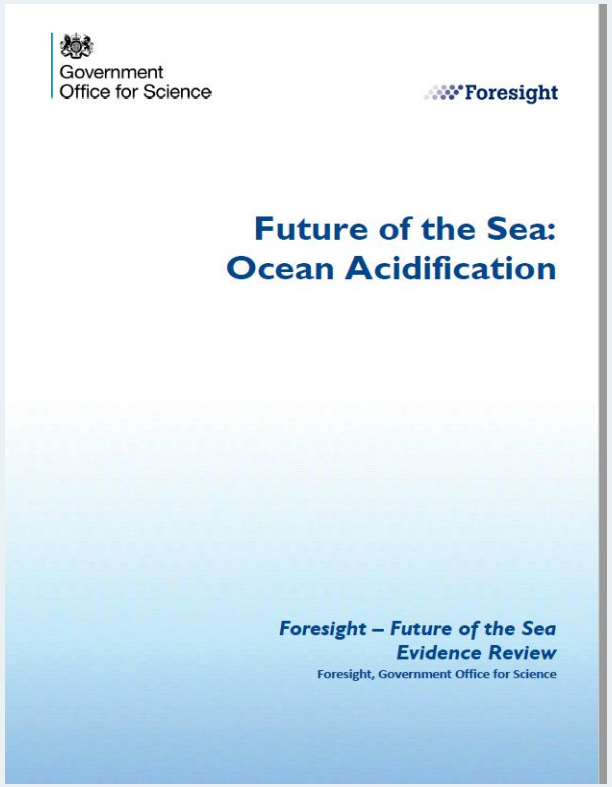
Contents

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/730461/defra-sac-oa-report-2018.pdf

UK science & advice

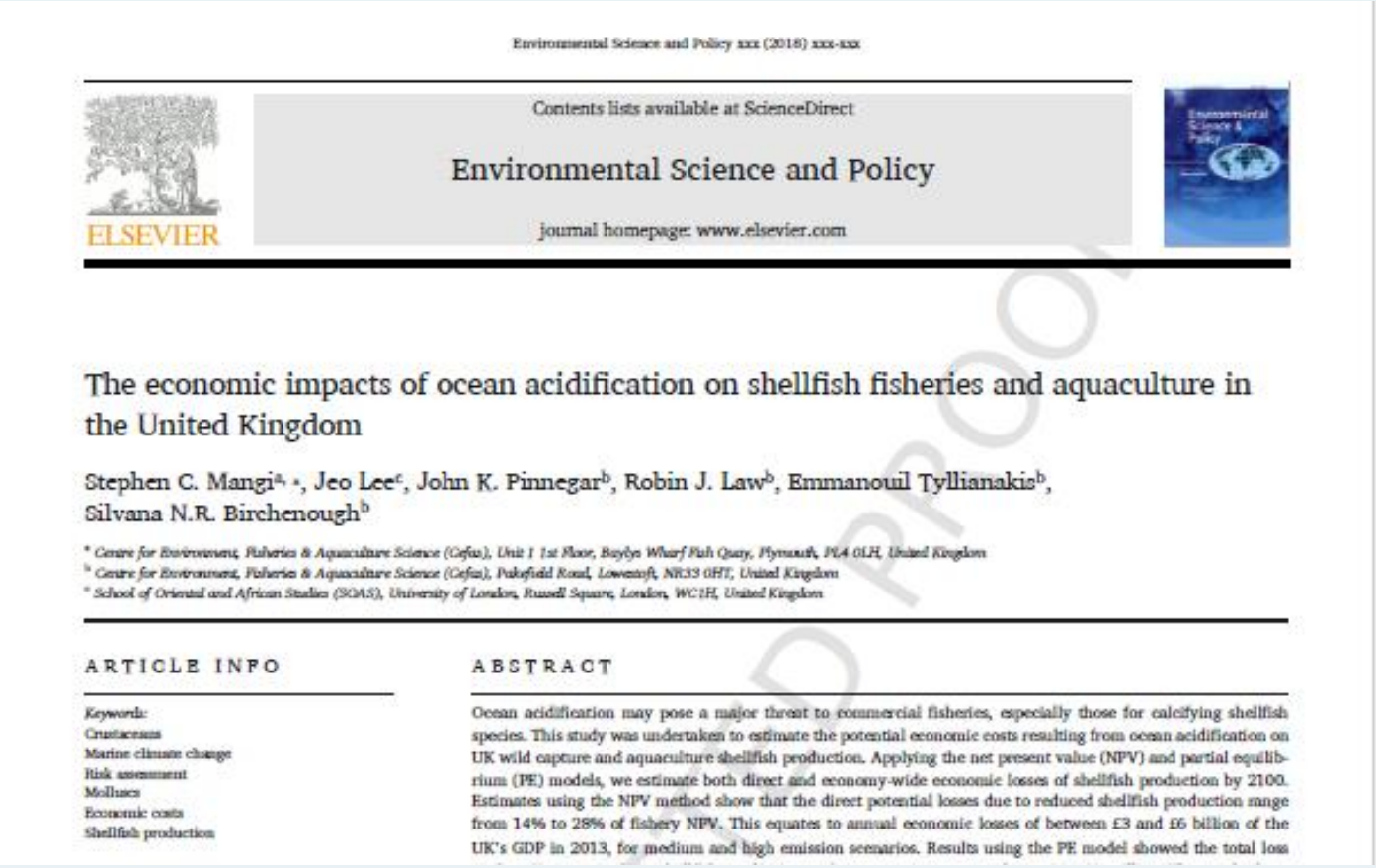
- Monitoring data conducted over the North Sea assessments have shown clear pH changes in shelf and coastal sites.
- Trends of pH variability are still uncertain and further work to disentangle the observed variability does require further investigation;
- Though the future impacts of ocean acidification on commercial fisheries are still uncertain, recent research has indicated that annual economic losses in the UK resulting from the effects of ocean acidification could reach US$ 97.1 million by 2100;
- The integrity of some UK species and habitats of conservation importance could be affected by future changes in pH and temperature;

These results are particularly important for UK shellfisheries and shellfish aquaculture, as these industries could be negatively affected. Therefore, future adaptations strategies may need to be considered to support these sectors.



Birchenough, SNR, Williamson, P and Turley, C (2017). Future of the sea: Ocean acidification.

Recent work……



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The economic impacts of ocean acidification on shellfish fisheries and aquaculture in the United Kingdom

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ARTICLE INFO

Keywords:
Crustaceans
Marine climate change
Risk assessment
Molluscs
Economic costs
Shellfish production

ABSTRACT

Ocean acidification may pose a major threat to commercial fisheries, especially those for calcifying shellfish species. This study was undertaken to estimate the potential economic costs resulting from ocean acidification on UK wild capture and aquaculture shellfish production. Applying the net present value (NPV) and partial equilibrium (PE) models, we estimate both direct and economy-wide economic losses of shellfish production by 2100. Estimates using the NPV method show that the direct potential losses due to reduced shellfish production range from 14% to 28% of fishery NPV. This equates to annual economic losses of between £3 and £6 billion of the UK's GDP in 2013, for medium and high emission scenarios. Results using the PE model showed the total loss

- Applying the net present value (NPV) and partial equilibrium (PE) models;
- Estimations of direct and economy-wide economic losses of shellfish production by 2100;
- Estimates using the NPV method showed that the direct potential losses due to reduced shellfish production range from 14% to 28% of fishery (£3-£6 billion) of the UK's GDP in 2013, for medium and high emission scenarios
- Results using the PE model showed the total loss to the UK economy from shellfish production and consumption ranging from £23 - £88 million.

Centre for Environment Fisheries & Aquaculture Science

POSTER S3-P12

Cefas

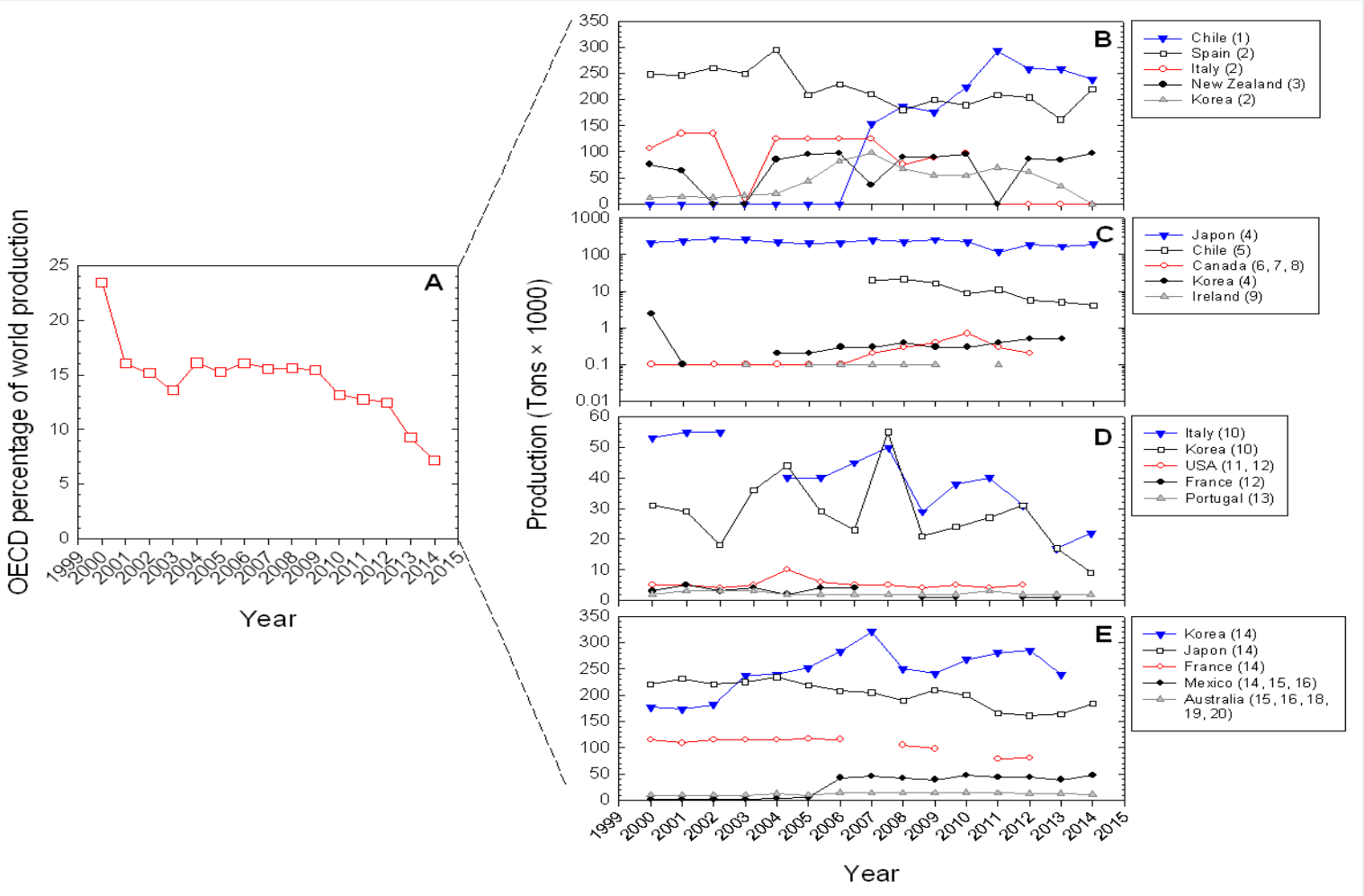
…So What?

- How end-users/industry will be affected by these changes;
- Are they aware of these changes (e.g. early warning/signals?)
- Are they industry prepared to deal with these changes…

Background

- Aquaculture is key to feed the increasing global population with high-quality nutritional components;
- Production has grown steadily over the past decades, and is now the fastest growing food production system worldwide;
- World's seafood production including fish (66.6 million tonnes), algae (23.8 tons/yr) and molluscs (15.1 tons/yr)}, a trend that may account for 60% of seafood by 2030;
- Multiple stressors effects (coastal areas)

Production and trends



(1) Mytilus chilensis, (2) Mytilus galloprovincialis, (3) Perna canaliculus, (4) Patinopecten yessoensi, (5) Argopecten purpuratus, (6) Patinopecten caurinus, (7) Placopecten magellanicus, (8) Argopecten irradians, (9) Pecten maximus, (10) Ruditapes philippinarum, (11) Mercenaria mercenaria, (12) Venerupis philippinaru, (13) Ruditapes decussatus, (14) Crassostrea gigas, (15) Crassostrea virginica, (16) Crassostrea corteziensis, (17) Sacostrea glomerata, (18) Sacostrea cucullata, (19) Ostrea angasi, (20) Striostria

Source: OECD

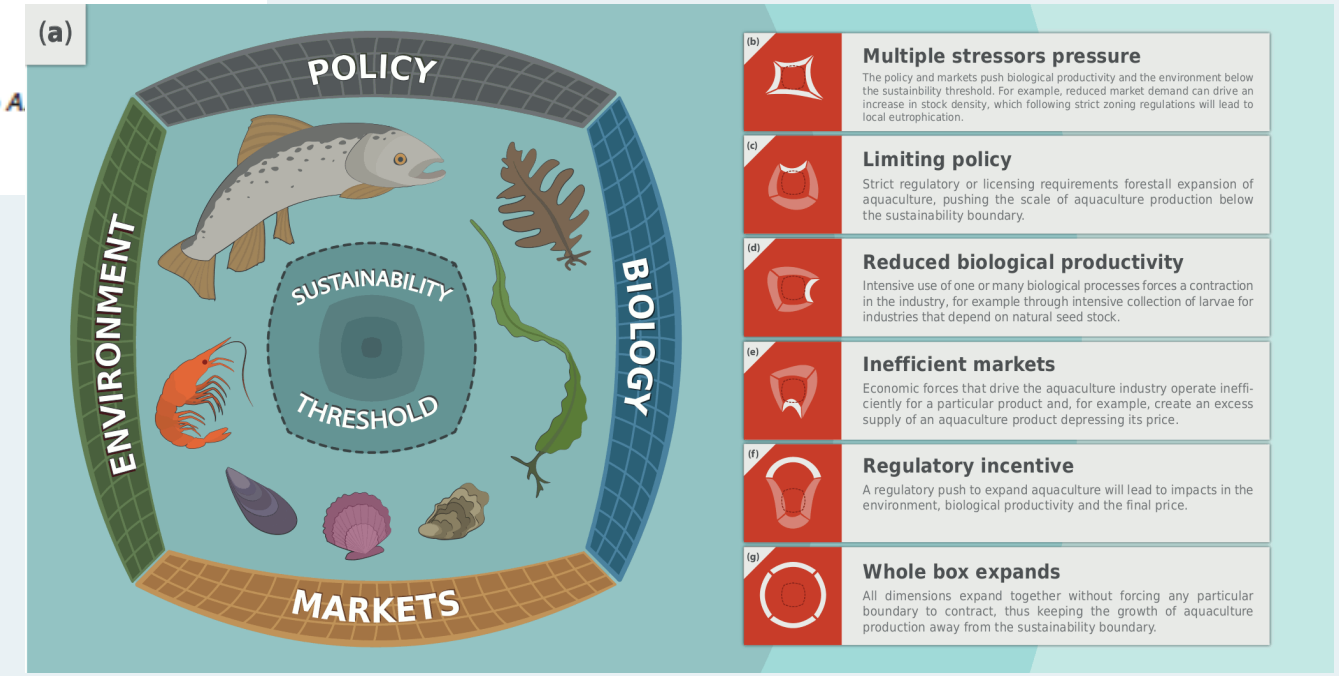
frontiers in Marine Science

PERSPECTIVE
published: 26 January 2017
doi: 10.3389/fmars.2017.00015

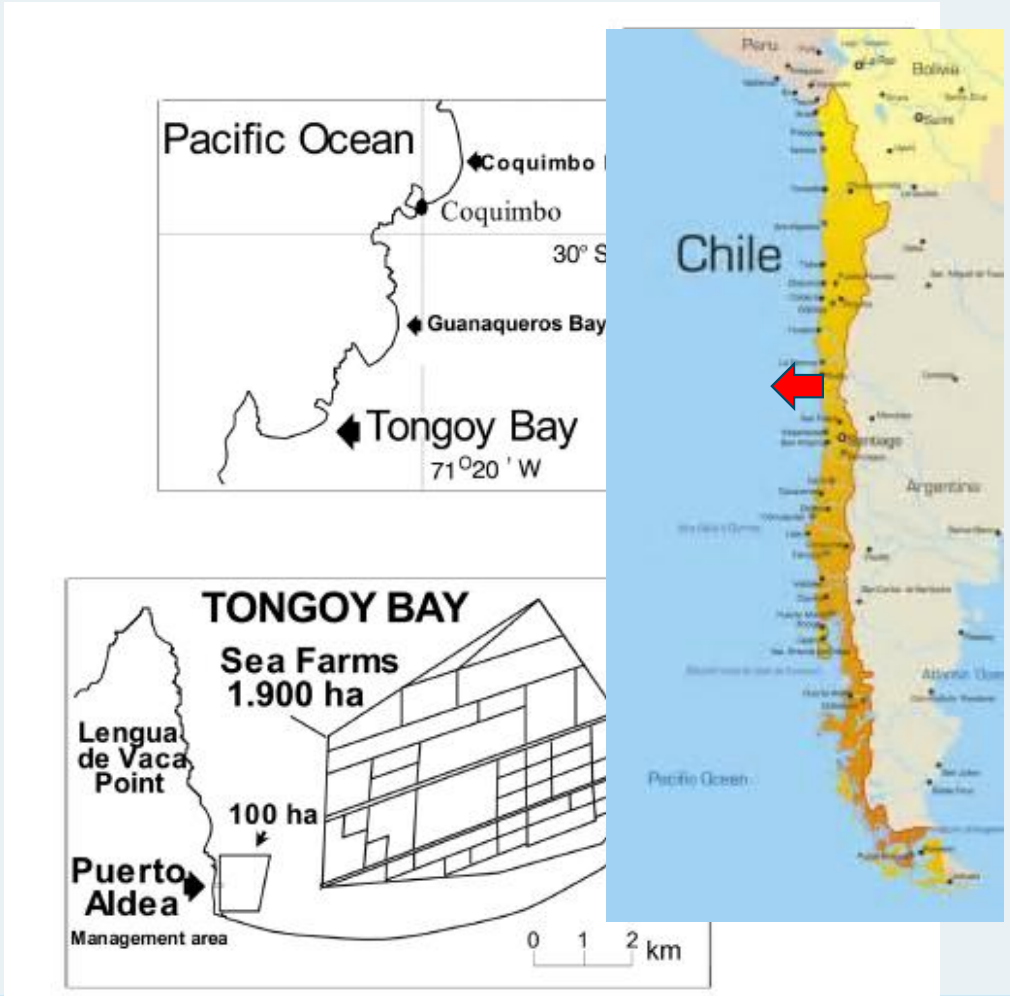
Dynamic Interactions among Boundaries and the Expansion of Sustainable Aquaculture

Bernardo R. Broitman[1], Benjamin S. Halpern[2], Stefan Gelcich[3], Marco A. Cristian A. Vargas[5], Felipe Vásquez-Lavín[6], Stephen Widdicombe[7] and Silvana N. R. Birchenough[8]*

- Conceptual framework ;
- Support growth and development;
- 4 areas: environment, biology, policy and markets;
- This work helped to generate scenarios;

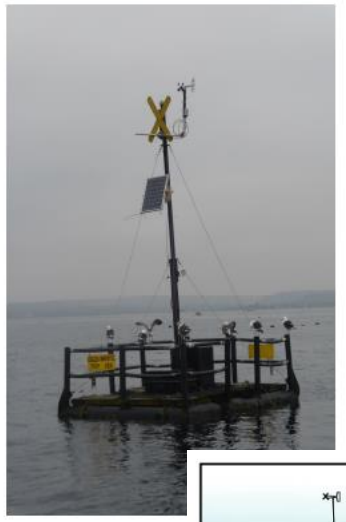


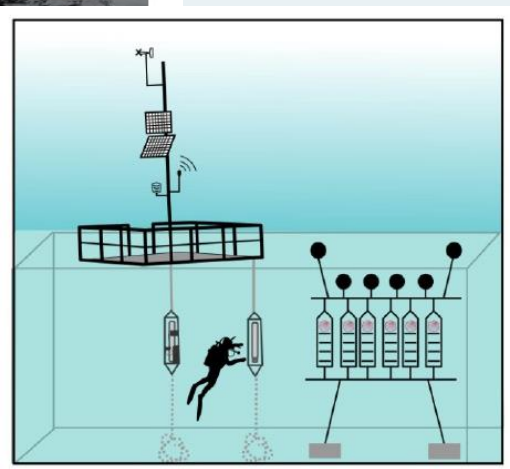
Study area: Bahia de Tongoy

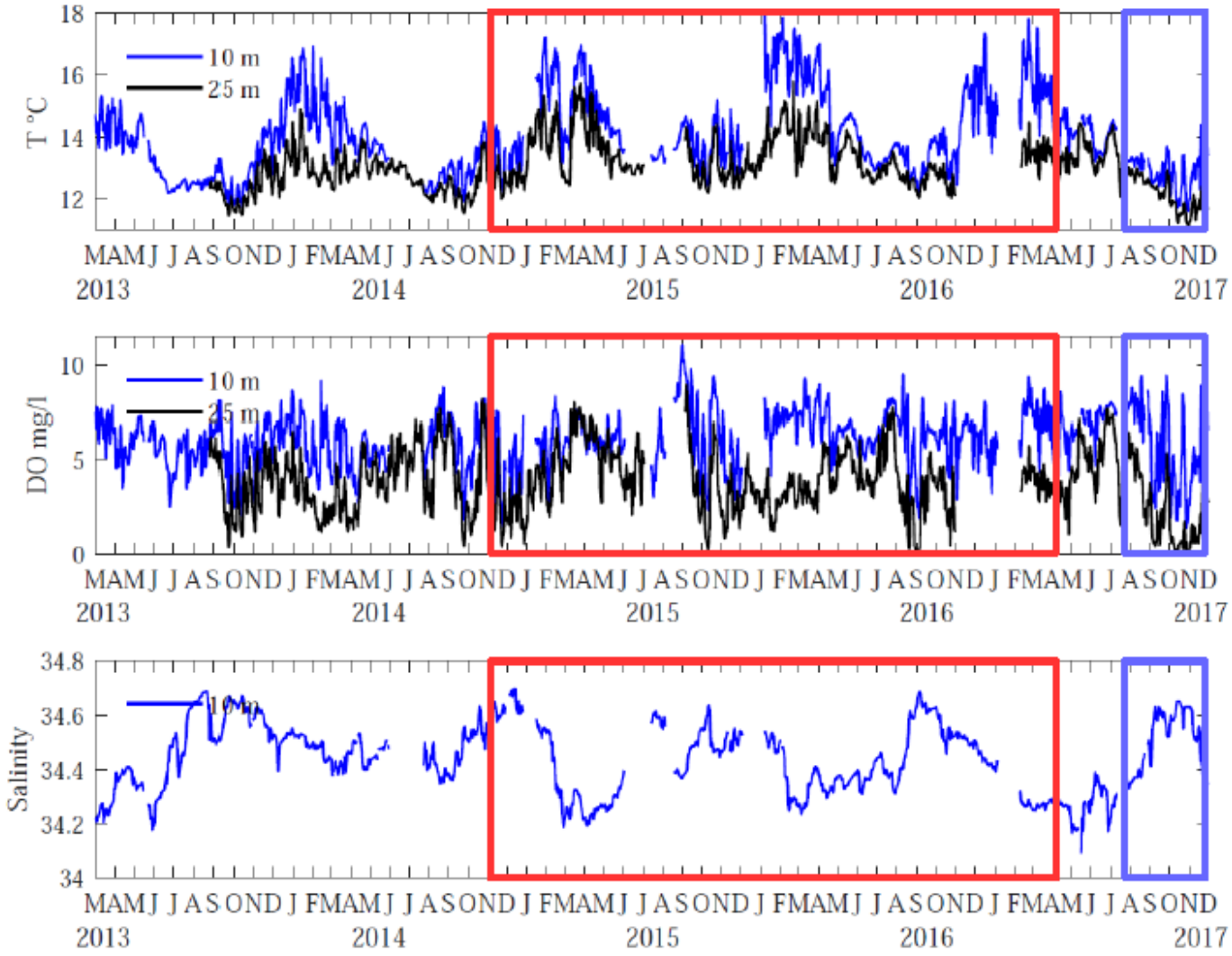


Monitoring local conditions

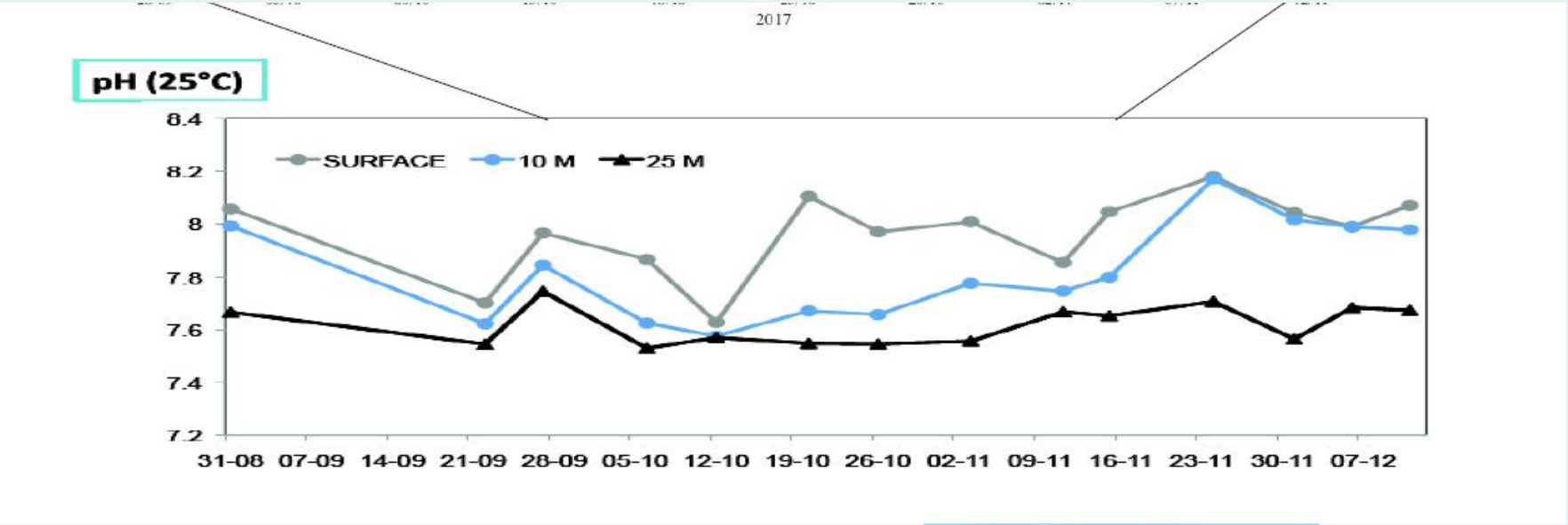
- Local variability and changes





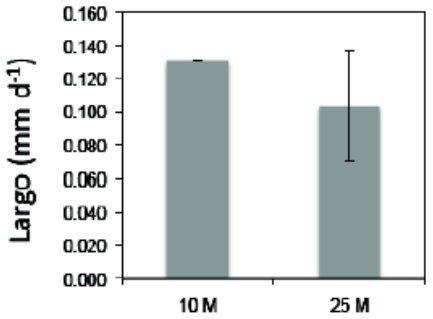


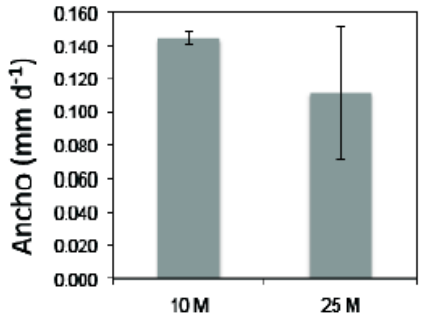
http://www.ceazamet.cl/index.php?pag=mod_estacion&e_cod=BTG


2017
pH (25°C)
8.4
8.2
8
7.8
7.6
7.4
7.2
SURFACE
10 M
25 M
31-08
07-09
14-09
21-09
28-09
05-10
12-10
19-10
26-10
02-11
09-11
16-11
23-11
30-11
07-12

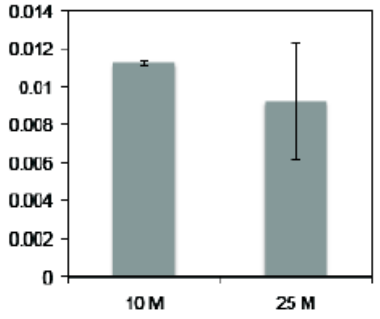
Parameters measured

Growth

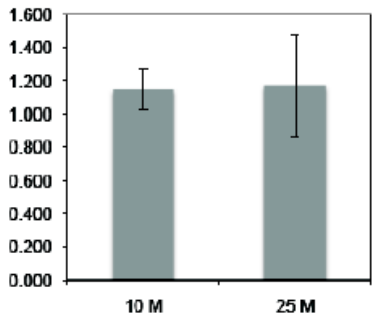




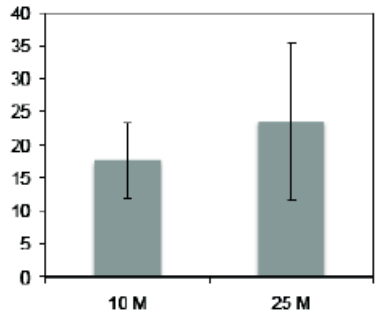
Calcification (gd-1)



Metabolic activity (mgO2h-1g-1)



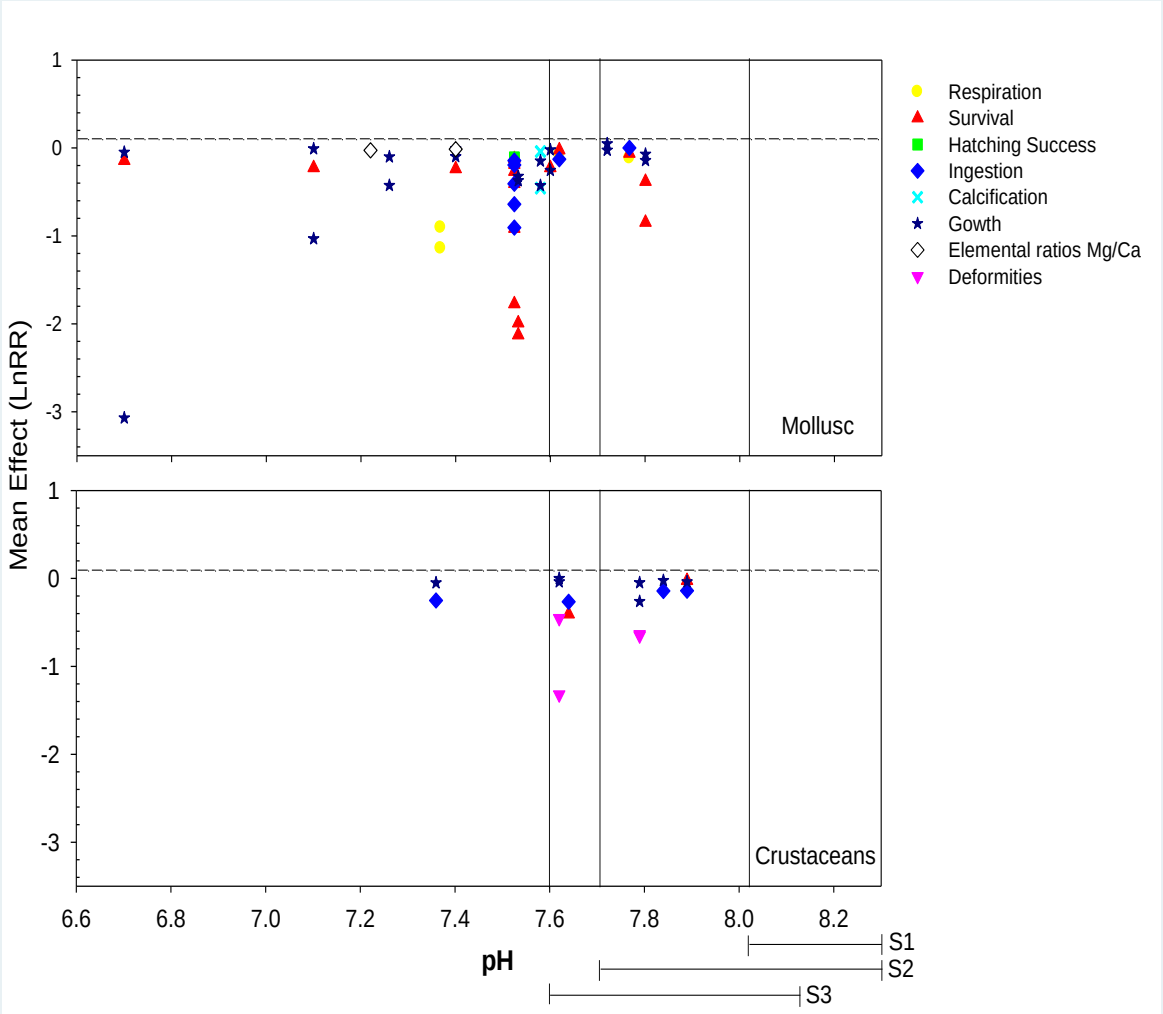
Mortality %



End-users: industry

- Stakeholder workshops;
- Evaluations of OA/climate effects on commercial species;
- Realistic scenarios for adaption;
- Economic implications some of these changes will modify these areas;
- Current options and future ideas to support these areas.

Literature review



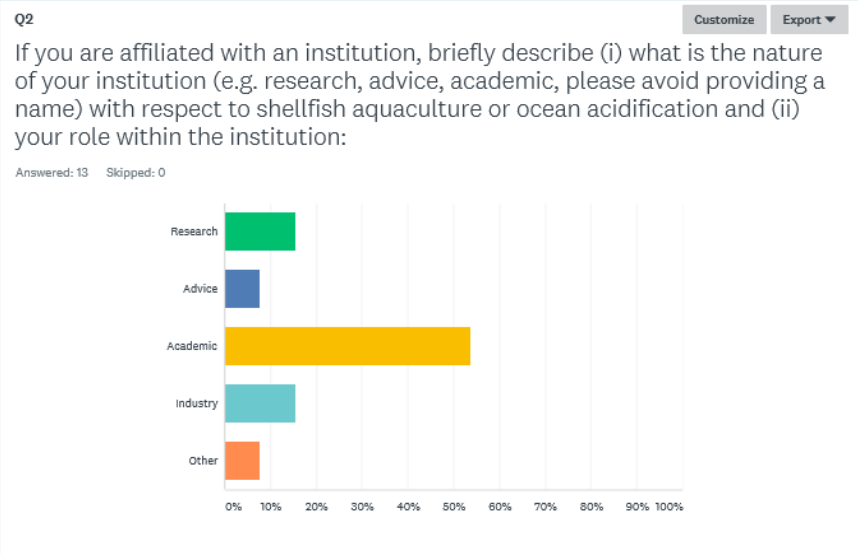
- Literature review was conducted to assess experimental responses to OA;
- Several endpoints (respiration, survival calcification, growth, Mg/Ca, deformities;
- Molluscs and crustaceans were analysed;
- Mean effects was used;
- Overall pH levels 8.0-8.2, 7.6-8.1 and 7.6-8.1
- Methodology used by Kroeker et al (2013), Ramajo et al., (2016)

Next steps: questions

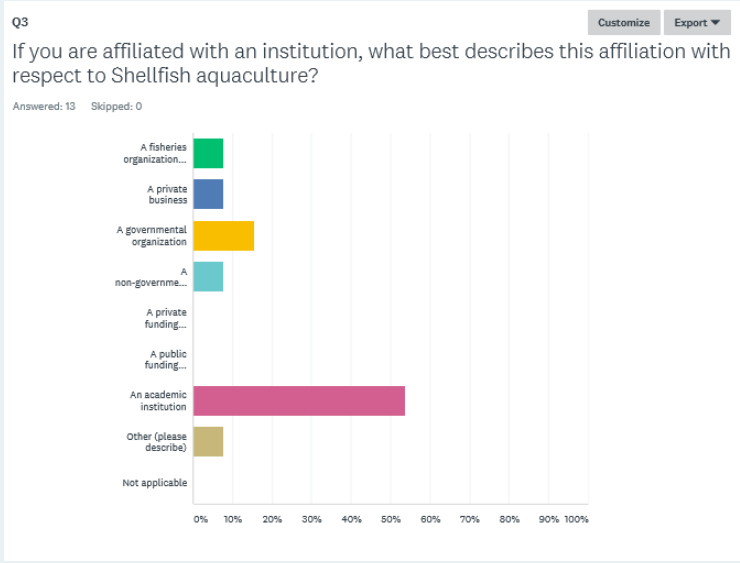
Questionnaires and workshops to ground-through potential adaption options:

1. Survey Monkey was used as a tool gain fast return of information;
2. 8 questions were developed to assess preferences/feasibility;
3. Results were gathered over a period of 3 months;

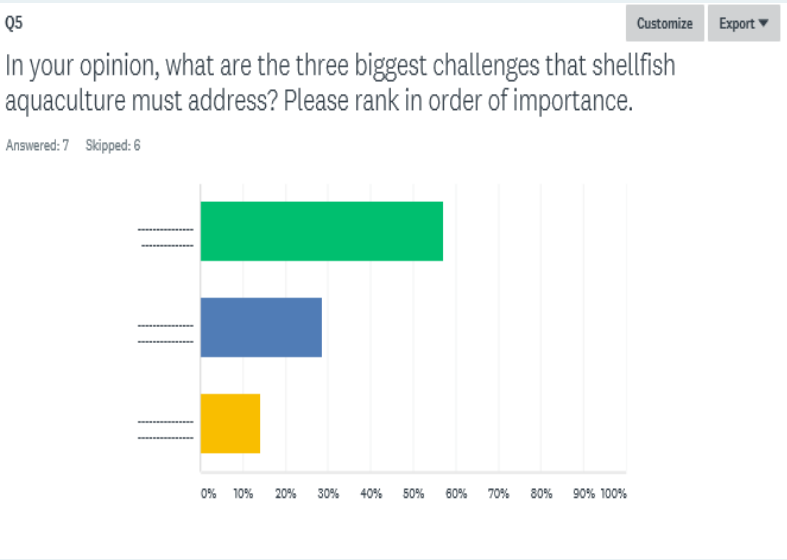
Background



Interests



Challenges



1. Marketing and trade - production keeps rising. Can demand fulfil these needs

2. Obtaining new farm permits. A real barrier to entry for new or expanding growers.

3. Environmental factors, in which OA could become a concern, at least to hatcheries. Temperature increase, pollution from various sources

Seed availability challenge in some areas (small hatcheries).

Summary

- Bottom- up approach (local changes and options)
- Opportunity to work with local end-users;
- Provide ideas to support monitoring, early warning signals and dedicated biological action;
- Consider further local issues (e.g. expansion of aquaculture concerns, production of seeds);
- Clear and tangible socio-ecological scenarios to support end-users for shellfish adaption

Acknowledgments

- *Centro De Studios Avanzados de Zona Arida (CEAZA)*

- *Valeska San Martin (Universidad de Concepcion)*
- *Invertect colleagues*
- *Many questionnaire respondents*

- ***Development and Cooperation-OECD fellowship entitled:*** *"Optimising* science, technology and innovation for studying ocean acidification effects on commercial species (Ostiones)" (Theme II MANAGING RISKS IN A CONNECTED WORLD). June-August 2017, at CEAZA, Coquimbo, Chile.

Questions?

Thank you…

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