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The challenge of ocean acidification

what do we need to know?





# Q1: Why do we need to study ocean acidification?

# Q2: What is the cause of ocean acidification?



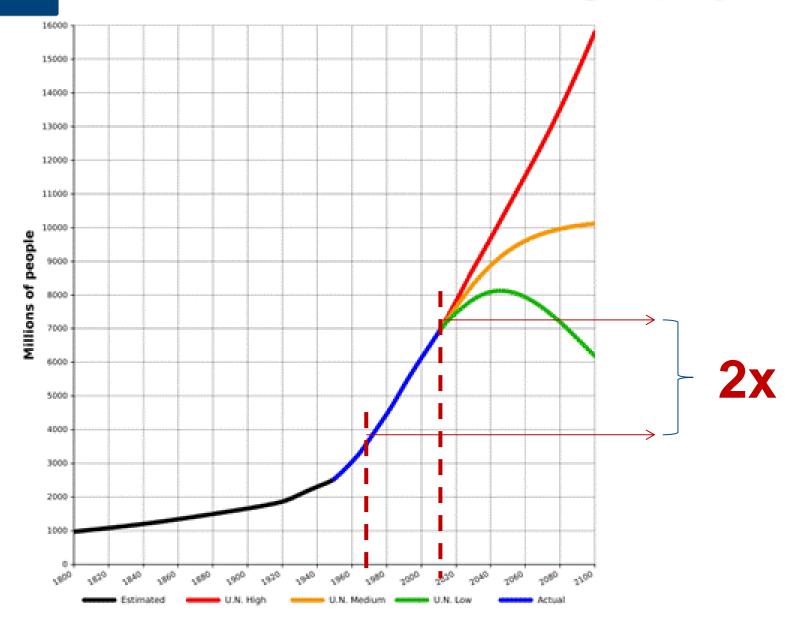
### Planet infected by humans



### Cause: human demography

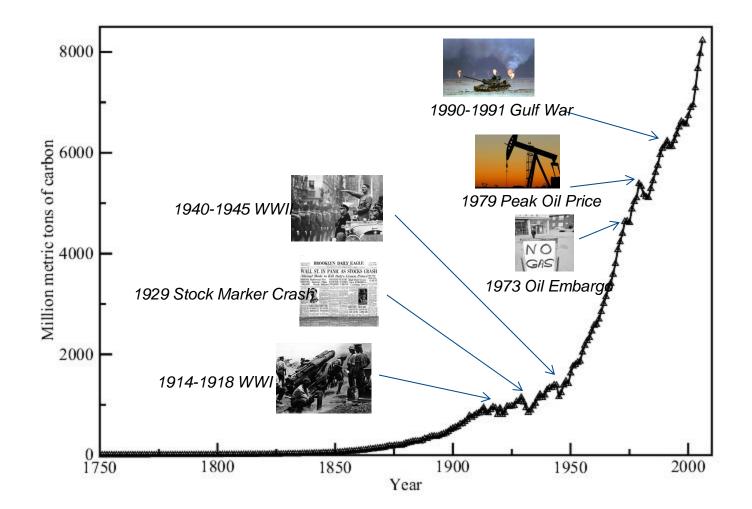
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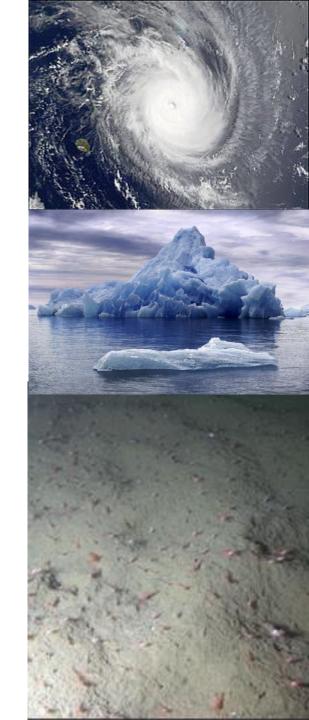
#### Global Fossil-Fuel CO, Emissions





Symptoms

Global warming Catastrophic events Ice melting Sea level rise Hypoxia Salinity changes **Ocean acidification** 



# Ocean acidification is chemistry... CO, ... not conjecture

# $CO_2 + H_2O \longrightarrow H_2CO_3$

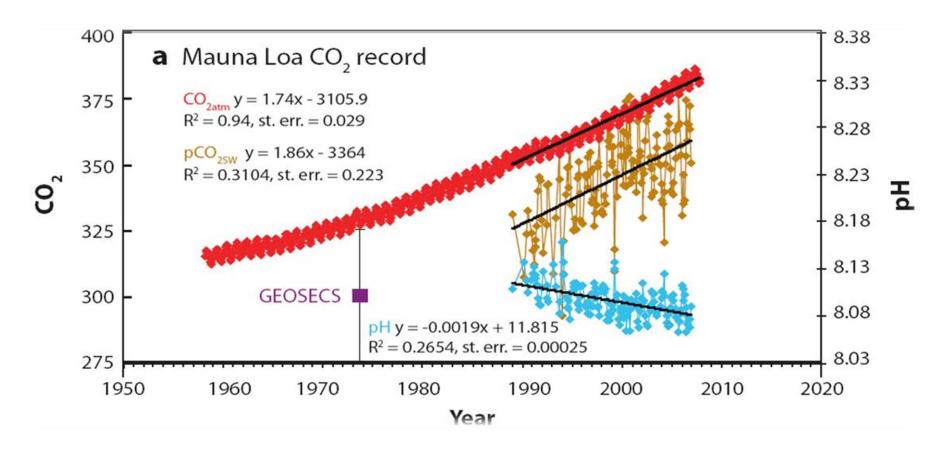
Carbon dioxide

Water

Carbonic acid

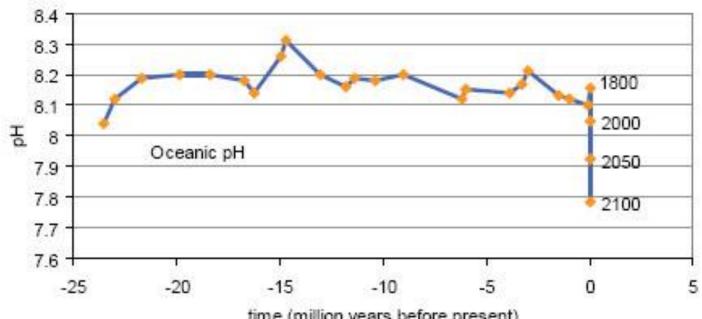


# Ocean acidification is happening now





### Fast and strong



time (million years before present)

Ocean 2x more acidic by 2100



#### Ocean acidification is a real, fast and directly related to our CO<sub>2</sub> emissions



## On the menu today

Ocean acidification

The problem

Challenges

Research strategy

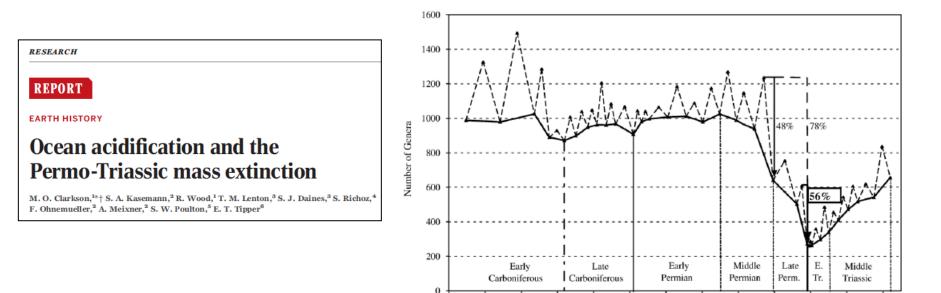
**Conclusion/Questions** 

#### Get ready for ocean acidification

- What is ocean acidification?
- Why shall we care?
- What do we need to know and what are the main challenges?
- The critical role of physiology a strategy to move forward
- Conclusion / Questions



# Last ocean acidification event: the third extinction



Millions of Years Ago

(280)

(270)

(260)

(250)

(290)

(Knoll et al. 2007)

(240)

(230)

#### Extinction of 92% of all marine species

(350)

(340)

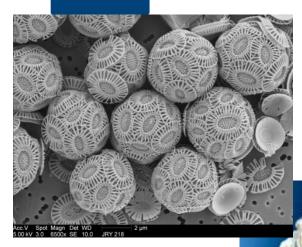
(330)

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(310)

(300)

### Challenge marine ecosystems



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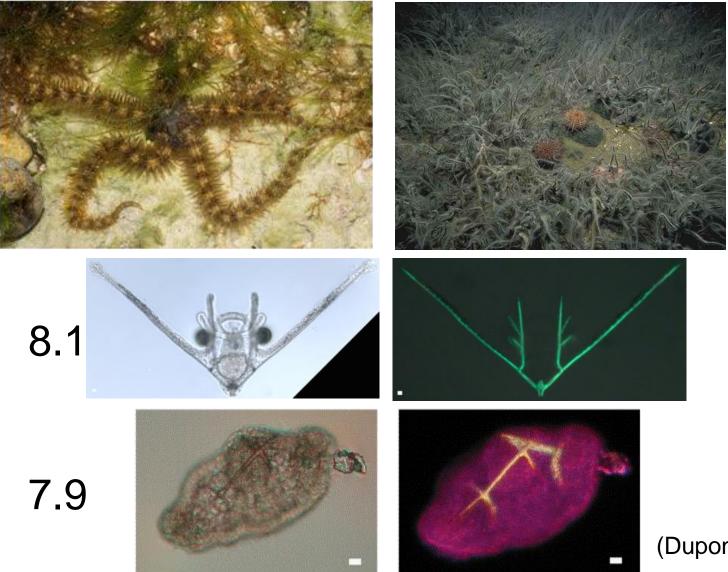


50% of marine animals threaten by ocean acidification

(Wittmann & Pörtner 2013)



#### Can lead to species extinction



(Dupont et al. 2008)



### It is already happening



#### Impact aquaculture and industry



### Q3: What can we do?

# Q4: What do we need to address this challenge?



### What can we do?



Fight?

Flight?

or nothing?

- NOTHING: Face to the consequences
- FIGHT: Mitigation Work on the cause (decrease CO<sub>2</sub>)
- FLIGHT: Adaptation Work on the symptoms (buy some time)



## A problem of scale

#### **GLOBAL** challenges



# **GLOBAL** options: $\bigcirc$ CO<sub>2</sub>

#### **GLOBAL/LOCAL** data



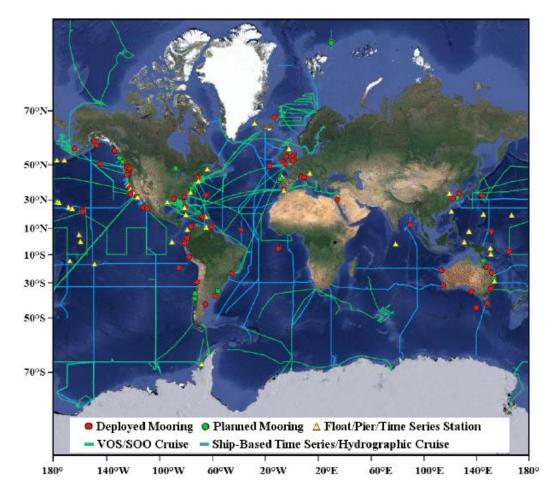
# Scientists are "virtually certain" that ocean acidification will lead to dramatic consequences

CEAN





# Global Observatory Network for ocean acidification



Existing: red Planned: green

#### ©Jan Newton



Ocean Acidification International Coordination Centre

OA-ICC

#### Ocean Acidification International Coordination Centre (OA-ICC)

Communicating, promoting and facilitating global actions in a changing ocean world

Lina Hansson OA-ICC Project Officer

Michel Warnau OA-ICC Programme Manager

IAEA Environment Laboratories International Atomic Energy Agency Principality of Monaco iaea.org/ocean-acidification news-oceanacidification-icc.org

©Lina Hanssor



## Mitigation: We know what to do



#### Demography



#### CO<sub>2</sub> emissions

## WHY NO MORE ACTIONS???

## KEN CALDEIRA

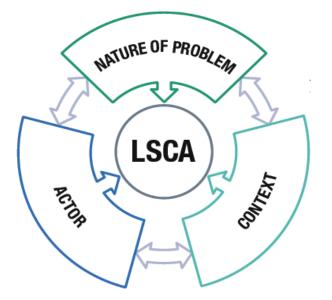
on Inquiring Minds

"People have to sacrifice a little bit of their short term self interest to help the world be a better place for the long term. And how you get people to do that, I think, is the most important research that can be done."



#### **CENTRE FOR COLLECTIVE ACTION RESEARCH**





Social dilemna:

Action, acceptance and compliance linked to psychological factors, values, beliefs, norms, policyspecific beliefs, freedom, fairness, effectiveness, personal outcome, trust and reciprocity, etc.

## Need to be ocean literate



### A failure to communicate



Tim Minchin

The idea that (...) the science of anthropogenic global warming is controversial is a powerful indicator of the extent of our failure to communicate.



### A failure to communicate

... and

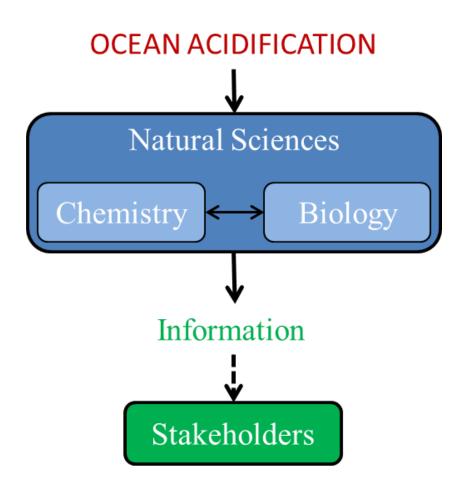
nerds

## Scientists are sometime poor communicators...





## A need for a new strategy



# Information

[e.g. OA major threat]

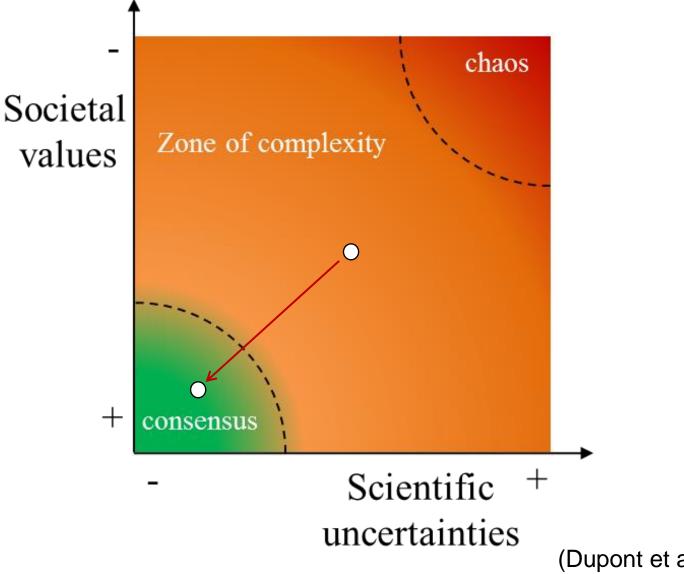


[e.g. cut carbon dioxide emission]

#### Science supply paradigm



### A science based on values



(Dupont et al. 2014)



# Go local: Bohuslan, a seafood paradize



<u>Hypothesis</u>: By targetting values, we'll attract more attention





# Can you taste ocean acidification?



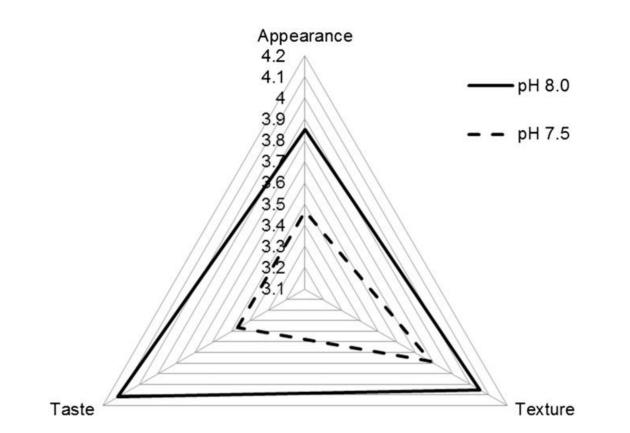
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Journal of Shellfish Research, Vol. 33, No. 3, 857-861, 2014.

#### FIRST EVIDENCE OF ALTERED SENSORY QUALITY IN A SHELLFISH EXPOSED TO DECREASED pH RELEVANT TO OCEAN ACIDIFICATION

#### SAM DUPONT,<sup>1</sup>\* EMILIE HALL,<sup>2</sup> PIERO CALOSI<sup>2,3</sup> AND BENGT LUNDVE<sup>4</sup>

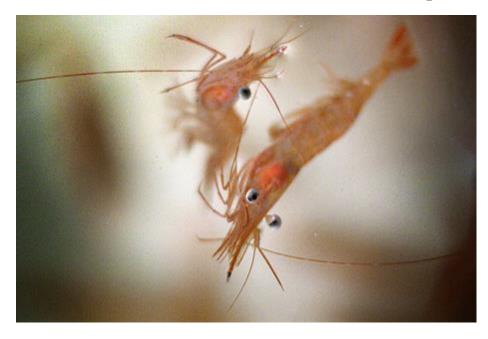
<sup>1</sup>Department of Biological and Environmental Sciences, University of Gothenburg, 566 Kristineberg, Fiskebäckskil 45178, Sweden; <sup>2</sup>School of Marine Science and Engineering, Plymouth University, Plymouth PL4 8AA, UK; <sup>3</sup>Département de Biologie, Chimie et Géographie, Université du Québec à Rimouski, Rimouski QC G5L 3A1, Canada; <sup>4</sup>The Sven Lovén Centre for Marine Sciences–Kristineberg, University of Gothenburg, 566 Kristineberg, Fiskebäckskil 45178, Sweden





## A timely press release

# Ocean acidification can alter the taste of shrimps



Ocean acidification is often referred as the silent storm because you can't see it, you can't hear it, and you can't smell it, but our research suggests that you just may be able to taste it



CÔMPASS

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### Scientific impact

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News > Climate > Less tasty shrimp, thanks to climate change

#### SCIENCESHOT



## Stimulate research: - Chile

USA

Less tasty shrimp, thanks to climate change



Climate change won't just harm marine life—it could also affect how it tastes. A new study finds that as oceans become more acidic—thanks





# A popular impact Daily Mail NPK LAVANGUARDIA

#### Los Angeles Times

	生命科学 医学科学 化学科学 工程材料 作	料  信息科学  地球科学  數理科学			
论文	首页 新闻 博客 群组 院士 人才 会	议   论 文   基 金   科 著   小白鼠			

作者: Sam Dupont 来源: 《贝类研究杂志》 发布时间: 2015/1/8 14:41:19

#### 法择字号: 醌 翻 题

#### 气候变化让虾美味受损



气候变化不只会损害海洋生物的生活,还会影响它们的味道。一项新的研究发现,由于海洋会吸收 二氧化碳,海洋酸度在不断增加,从而导致海虾味道变酸。研究人员把数百只中国毛虾(Pandalus borealis,如图)放入目前的酸度(pH值为8)或预设的2100年海洋酸度(pH值为7.5)的盛水容器中。 水温为11摄氏度, 这是海虾正常情况下可以适应的高温段。

#### Через сто лет креветки станут невкусными

текст: Анна Говорова/Ірбох ли



Группа ученых из Великобритании, Канады и Швеции пришла к выводу, что в будущем (к 2100 году) креветки станут менее вкусными. Причиной ухудшения их вкусовых качеств, считают авторы, станет глобальное потепление климата и повышение уровня кислотности Мирового океана.

8 shrimp taste acidification × +										
+ https://www	.google.no/sea	rch?q=shrim	p+taste+acidifi	cation&ie=u	itf-8&oe=utf	-88tgws_rd=	cr&ei=_9XQVJqQM	lij1aq7IgrAN	⊽ C'	8 × shrii
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Ungefär 87 100 resultat (0,39 sekunder)

Ocean acidification can alter the taste of shrimps - University ... science.gu.se/.../ocean-acidification-can-alter-the-t ... • Översätt den här sidan Ocean acidification can alter the taste of shrimps. News: Dec 29, 2014. A recent scientific study published in the Journal of Shellfish Research demonstrates that .

#### Study shows rising ocean acidification likely to cause shrimp ... phys.org > Biology > Ecology - Översätt den här sidan

\*\*\*\* Betyg: 3,7 - 14 röster 23 dec. 2014 - All of the shrimp were cooked by professional chefs and fed to volunteer shrimp lovers who rated the shrimp on how well they tasted.

Ocean acidification affects the flavour of shellfish, study ... www.dailymail.co.uk/.../Climate-change-leave-pra... - Översätt den här sidan 22 dec. 2014 - Climate change will leave a sour taste in our mouths - literally: Study ... Biologists put shrimp into tanks of sea water with pH 8 and pH 7.5 levels .

Tasting Ocean Acidification | Ocean Currents blog.oceanconservancy.org/.../tasting-ocean-acidif... \* Översätt den här sidan 15 jan. 2015 - Ocean acidification didn't affect texture at all, but it significantly hurt the shrimps' appearance and taste scores. Shrimp raised under regular

bad-tasting shrimp - Los Angeles Times www.latimes.com/.../la-fi-mh-badtasting-shrimp-2... 
Versätt den här sidan



# You talk the talk, do you walk the walk?

#### This information attracts interests but Does it drive changes?





#### (tested in Summer 2015)



## A problem of scale

#### **GLOBAL** challenges



#### **GLOBAL** options: $\downarrow CO_2$

#### **GLOBAL/LOCAL** data

#### LOCAL challenges

#### LOCAL options

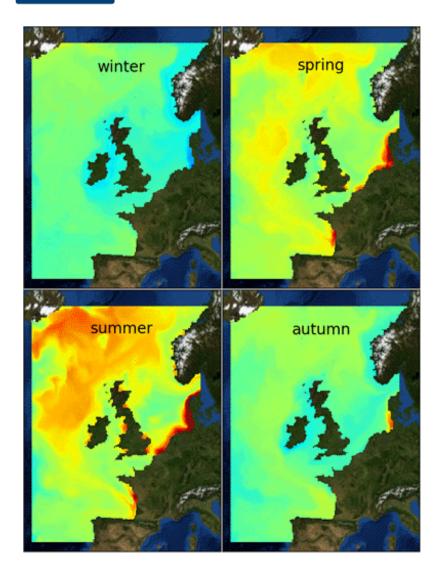
[management, adaptation, etc.]

LOCAL data





## Projections



## to better manage the future



# Biology is always the bottleneck

- Local scenarios
- Local variability
- Local stressors and other modulating factors
- Ecological interactions
- Evolution
- *Etc*.



## Building the bride



**GLOBAL** options:  $\downarrow$  CO<sub>2</sub>

**GLOBAL/LOCAL** data



**LOCAL** options [management, adaptation, etc.]

LOCAL data







Ocean Acidification International **Coordination Centre** 

Re-evaluation of the literature to develop a mechanistic model (+ post-doc, WG)

**Global Ocean Acidification Observing Network** 





The Ocean in a High-CO, World

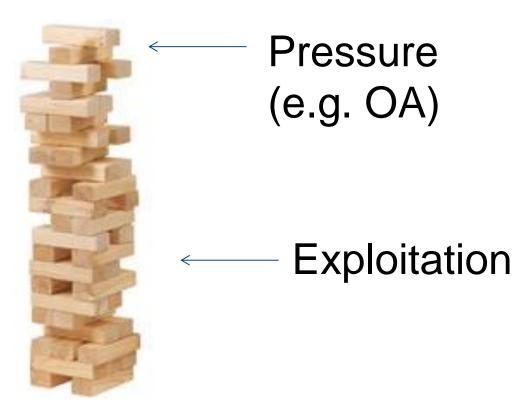
cean Acidification An international science symposium series



## Playing jenga with the ocean



#### Healthy ecosystem





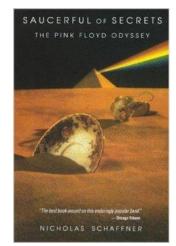
## Adaptation: Buy some time

"I am still convinced that a lot of it was acidbased. It may have happened without, but it probably would have taken longer."

- Change practices (e.g. aquaculture)
- Make ecosystem more resilients (e.g. MPA)
- Decrease other sources of stress (e.g. pollution)
- Select resilient strains
- Protect hot spots









#### Success story



### 2005 crash of oyster industry



## A viral story



@ Andrew Dickson



## Policy response





## Solution implemented

Monitoring / Research

Larval production in Hawaii



Treating water

Selection of resilient strains





### It's not too late...





WWI

2015

## But it's time

Living Blue Planet Report

Species, habitats and human well-being

NEARLY 3 BILLION PEOPLE RELY ON FISH AS A MAJOR SOURCE OF **PROTEIN.** OVERALL, FISHERIES AND AQUACULTURE ASSURE THE LIVELIHOODS OF 10-12 PER CENT OF THE WORLD'S POPULATION. 60 PER CENT OF THE WORLD'S POPULATION LIVES WITHIN 100KM OF THE COAST. MARINE VERTEBRATE POPULATIONS DECLINED 49 PER CENT BETWEEN 1970 AND 2012. POPULATIONS OF FISH SPECIES UTILIZED BY HUMANS HAVE FALLEN BY HALF, WITH SOME OF THE MOST IMPORTANT SPECIES EXPERIENCING EVEN GREATER DECLINES. AROUND ONE IN FOUR SPECIES OF SHARKS. RAYS AND SKATES IS NOW THREATENED WITH EXTINCTION. DUE PRIMARILY TO OVERFISHING. TROPICAL REEFS HAVE LOST MORE THAN HALF THEIR REEF-BUILDING CORALS OVER THE LAST 30 YEARS. WORLDWIDE, NEARLY 20 PER CENT OF MANGROVE COVER WAS LOST BETWEEN 1980 AND 2005. 29 PER CENT OF MARINE FISHERIES ARE OVERFISHED. IF CURRENT RATES OF TEMPERATURE RISE CONTINUE, THE OCEAN WILL BECOME TOO WARM FOR CORAL REEFS BY 2050. SEABED MINING LICENCES COVER 1.2 MILLION SQUARE KILOMETRES OF OCEAN FLOOR. MORE THAN 5 **NXYGEN-DEPI FTED DEAD 70NES ARE GROWING** RUN-OFF THE OCEAN GENERATES ECONOMIC BENEFITS WORTH AT LEAST US\$2.5 TRILLION PER YEAR. JUST 3.4 PER CENT OF THE OCEAN IS PROTECTED, AND ONLY PART OF THIS IS EFFECTIVELY MANAGED. INCREASING MARINE PROTECTED AREA COVERAGE TO 30 PER CENT COULD GENERATE UP TO US\$920 BILLION BETWEEN 2015 AND 2050.



## Q1: Why do we need to study ocean acidification?

Need solutions (mitigation, adaptation)

Need better information

Think carefully of your question