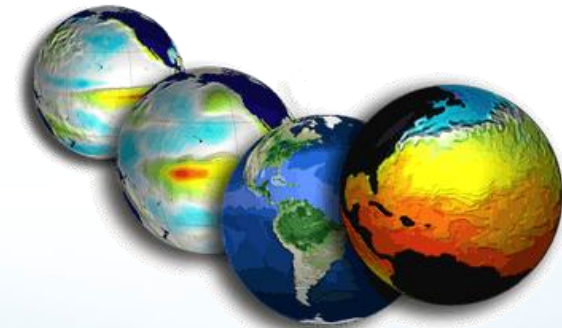


Cambio climático: Entendiendo los impactos en la acuicultura y descifrando sus desafíos



Felipe A. Briceño, PhD

Research Scientist

Norwegian Institute for Water Research (NIVA) Chile S.A.

www.nivachile.cl

November 29th 2016, Puerto Varas, Chile

NIVA

NIVA
Chile

PUERTO VARAS, 29 de noviembre
SANTIAGO, 1 y 2 de diciembre
FEEDNEWS
2016 
TIEMPOS PARA INNOVAR

1958

NIVA

Trondheim
Bergen
Grimstad
Hamar
Oslo
Solbergstrand

Akvaplan
*niva***NIVA**
Denmark

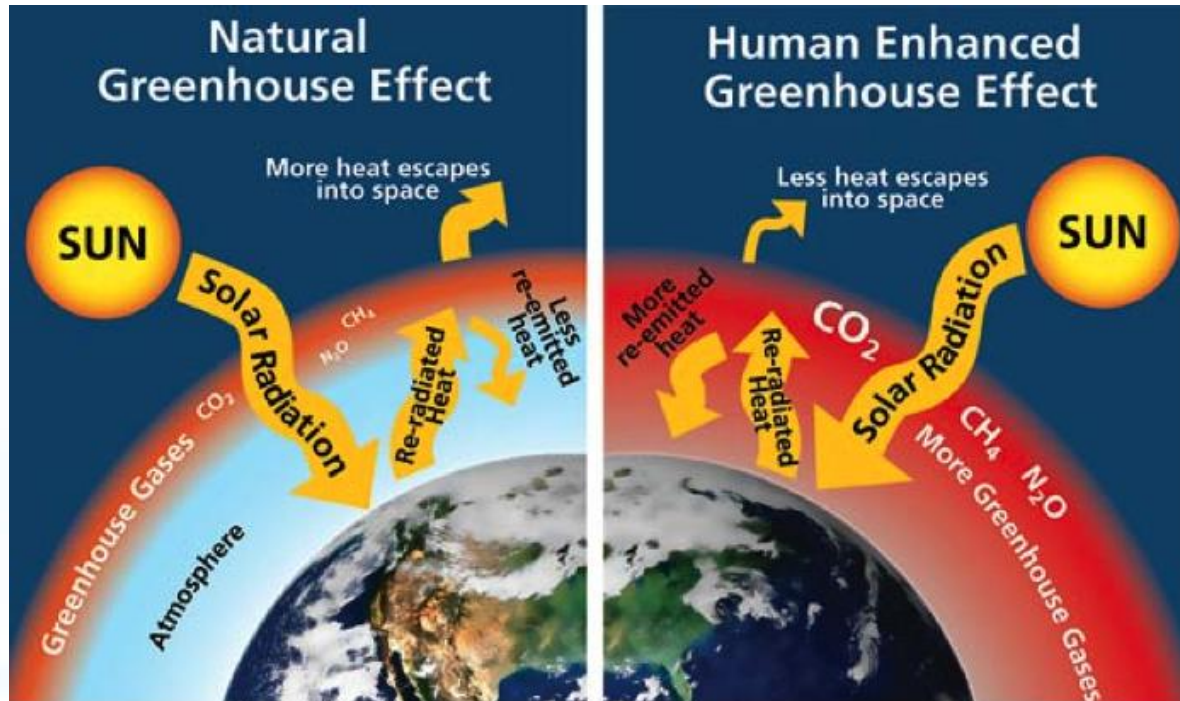
**NIVA Group: 230 employees
122 researchers**

NIVA
Chile

2008

Según la Convención Marco de las Naciones Unidas sobre el Cambio Climático (CMNUCC), Cambio climático (CC) se define como:

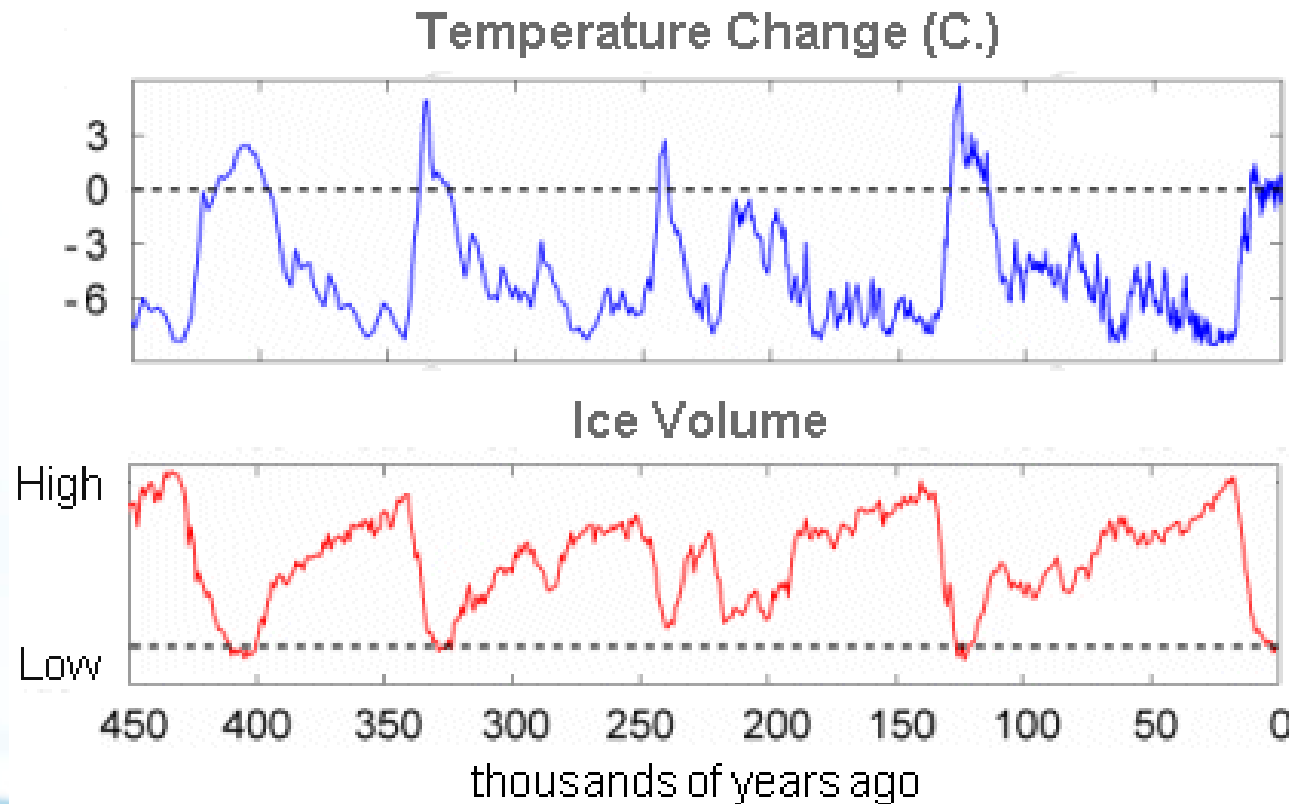
“Cambio de clima atribuido directa o indirectamente a la actividad humana que altera la composición de la atmósfera global y que se suma a la variabilidad natural del clima observada durante períodos de tiempo comparables”



<http://www.c2es.org/science-impacts/basics/kids>

Our changing climate

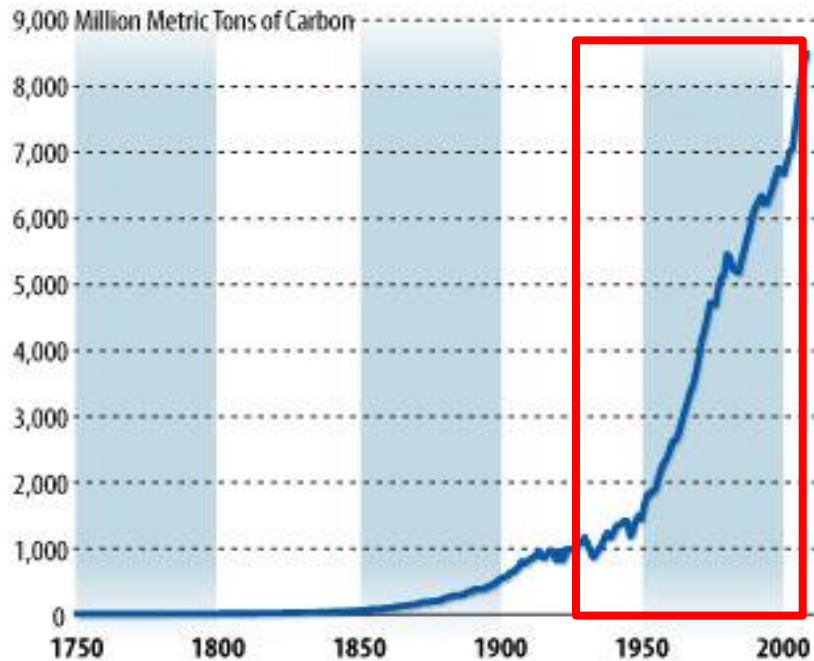
Climate has always been changing, e.g. several glaciations through the history of earth.



95% certainty that humans are the main cause of recent warming

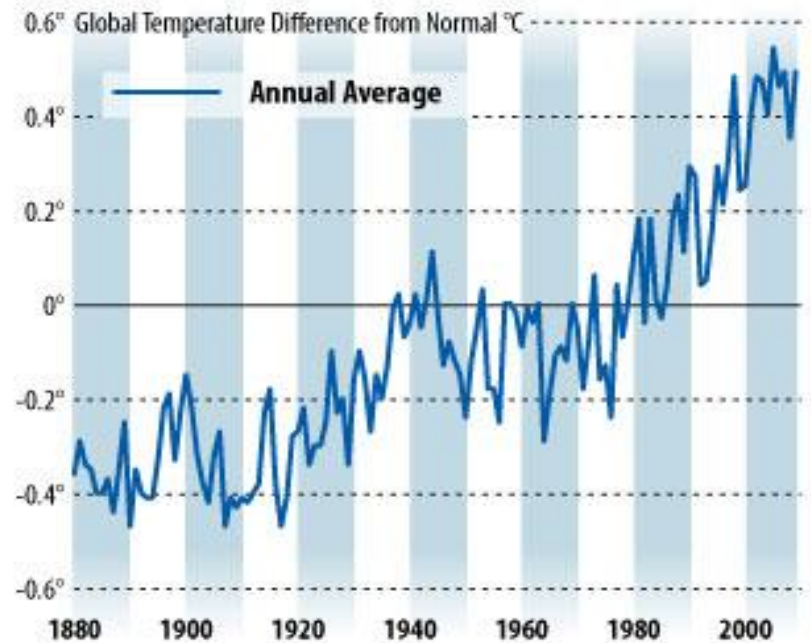


Carbon Dioxide Emissions Since 1750



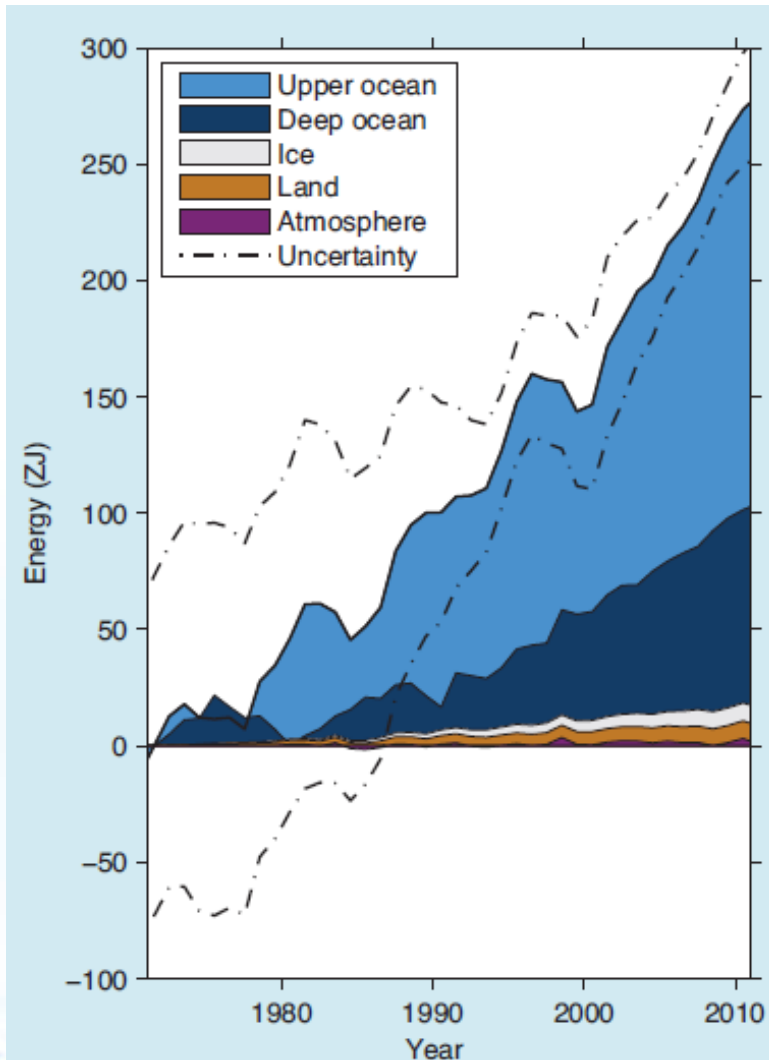
Data: Oak Ridge National Laboratory

Global Temperature Change Since 1880



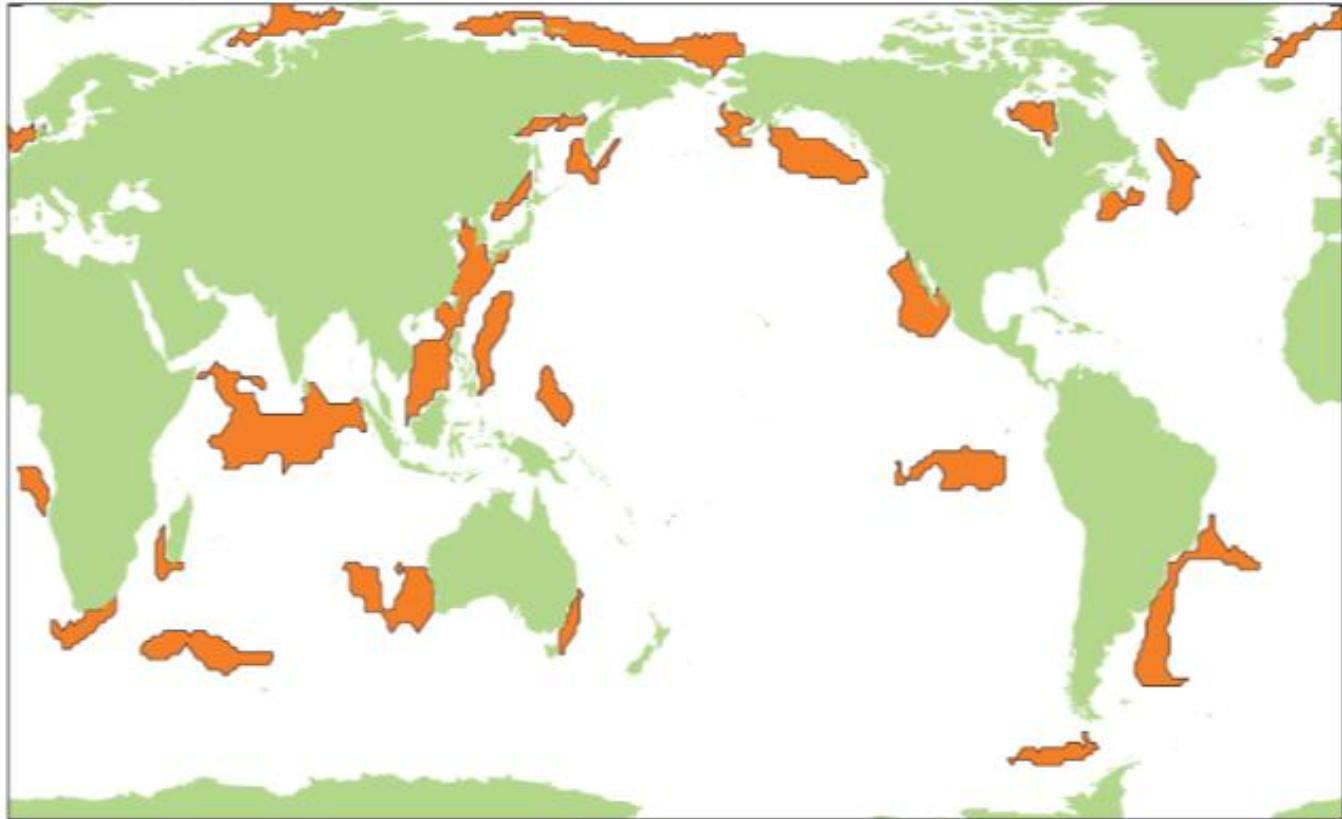
Data: NASA

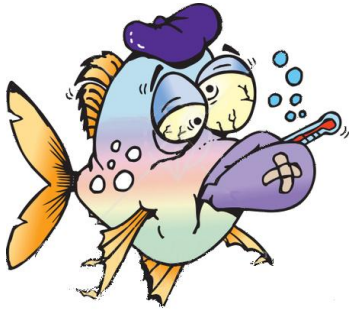
Global warming is mostly oceanic!!!!



The oceans assimilate approximately 80% of the heat of the planet and about 30% of the CO₂.

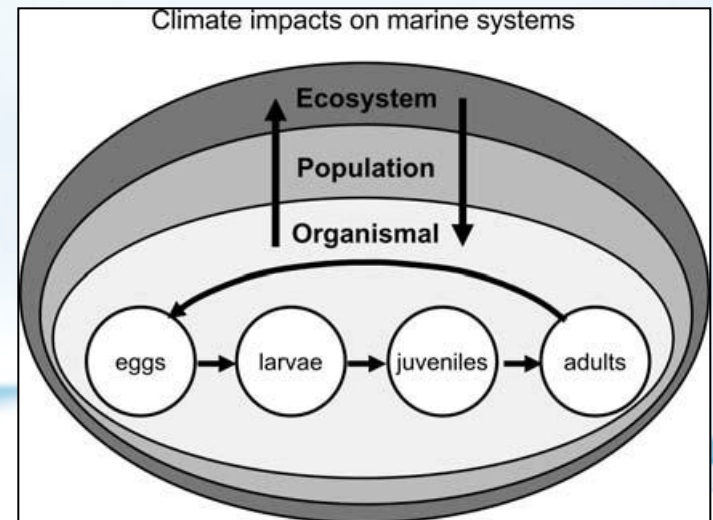
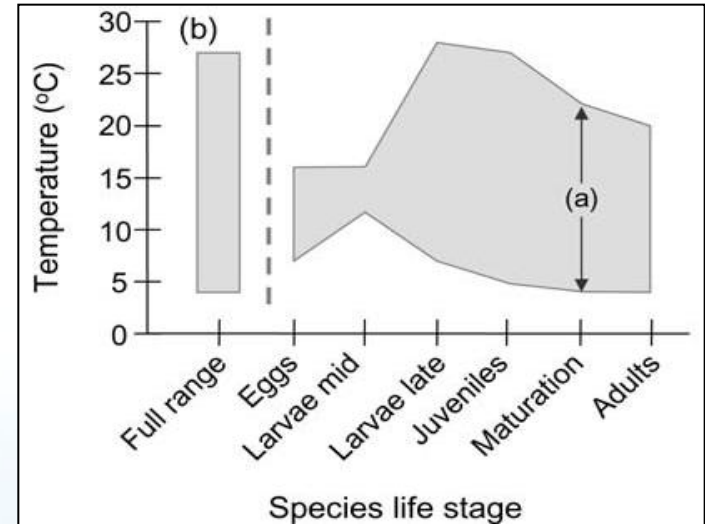
Ocean warming hotspots areas in the top 10% for rate of warming



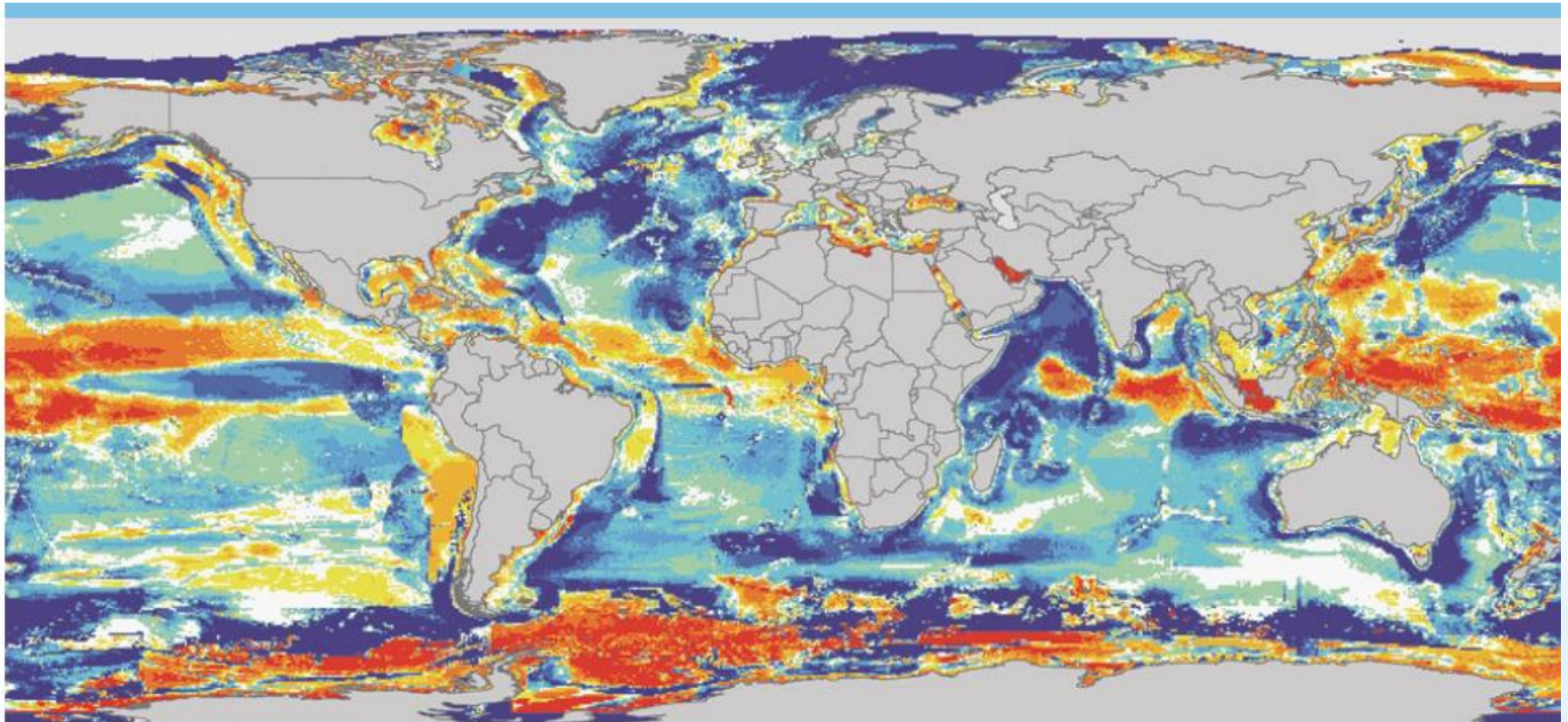


As waters warm:

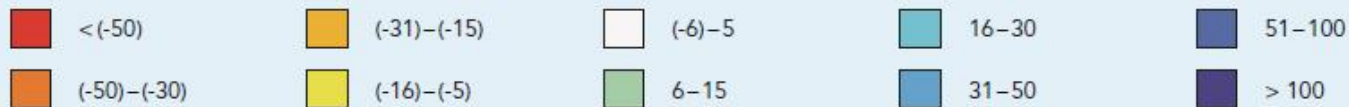
- There is less oxygen available
- Animals use more energy to breathe
- Greater stress on animals
- More stress makes animals more susceptible to disease
- Less energy available to reproduce

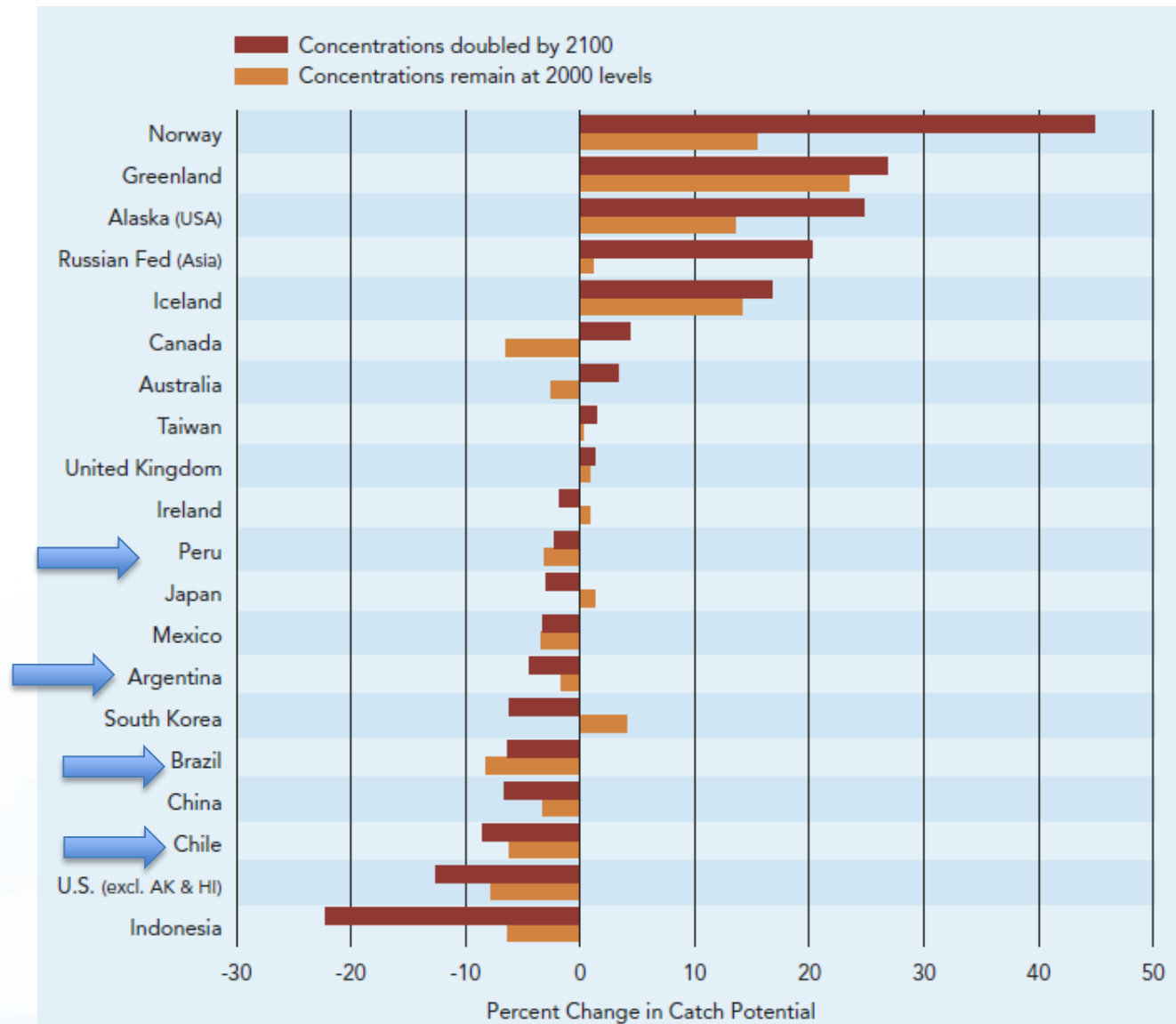


Global change in maximum fisheries catch potential from 2005 to 2055 under climate change scenario



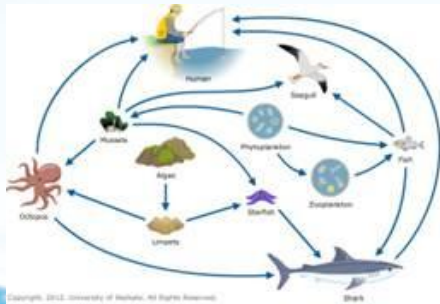
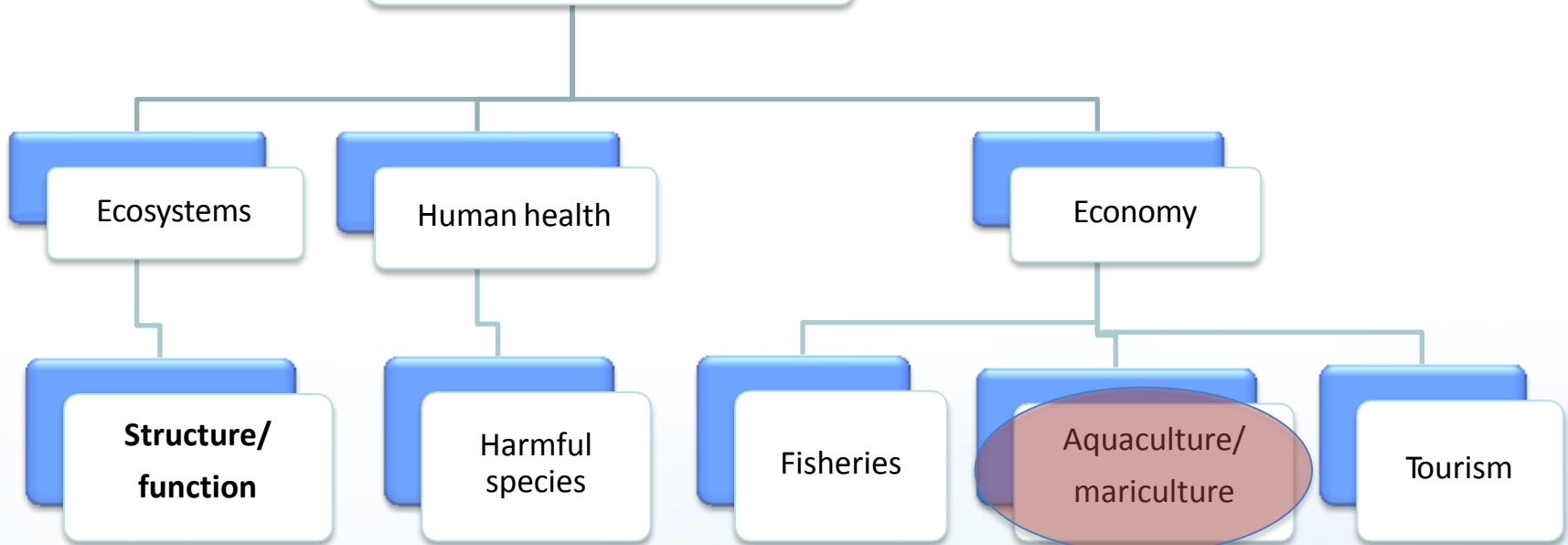
Change in Catch Potential (% relative to 2005)



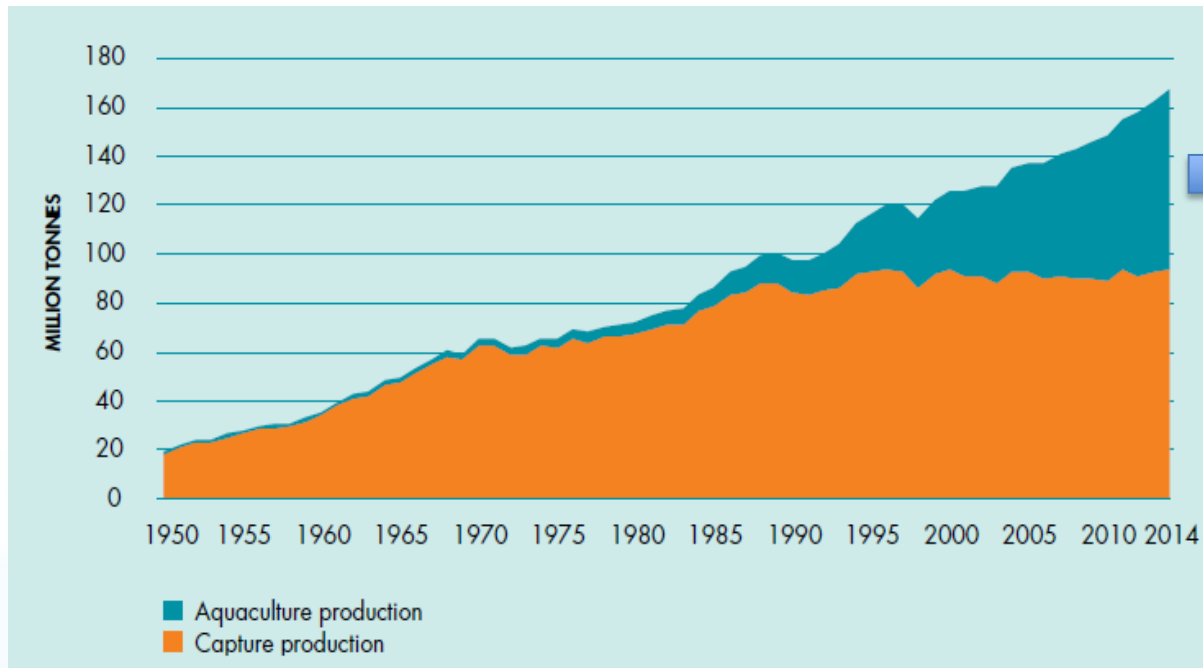


The two scenarios represent possible greenhouse gas emissions. In the first scenario, emissions continue to grow in their current trajectory and will double by 2100. The second scenario assumes that greenhouse gas concentrations remain constant at 2000 levels.

Impacts of marine changes in distribution



World capture fisheries and aquaculture production



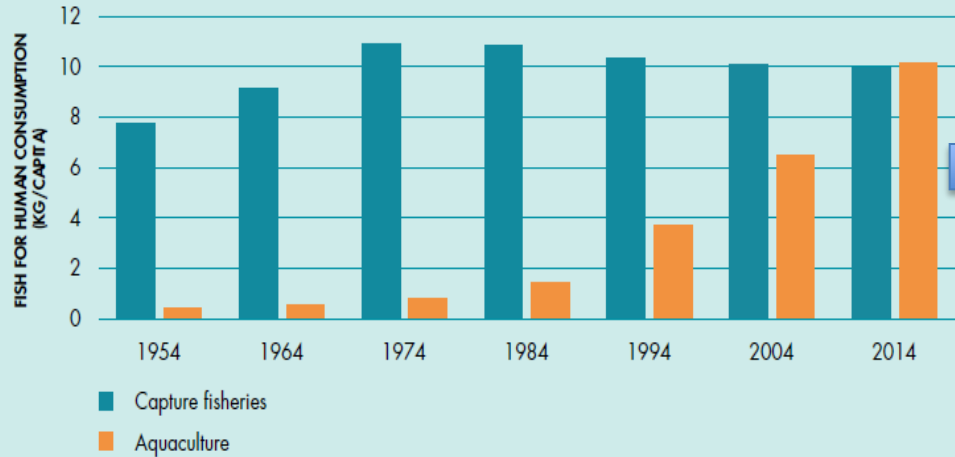
89% occurs in Asia,
mostly in tropical and
subtropical ecosystems

High vulnerability
under climate change!

The global output in 2014 from aquaculture:

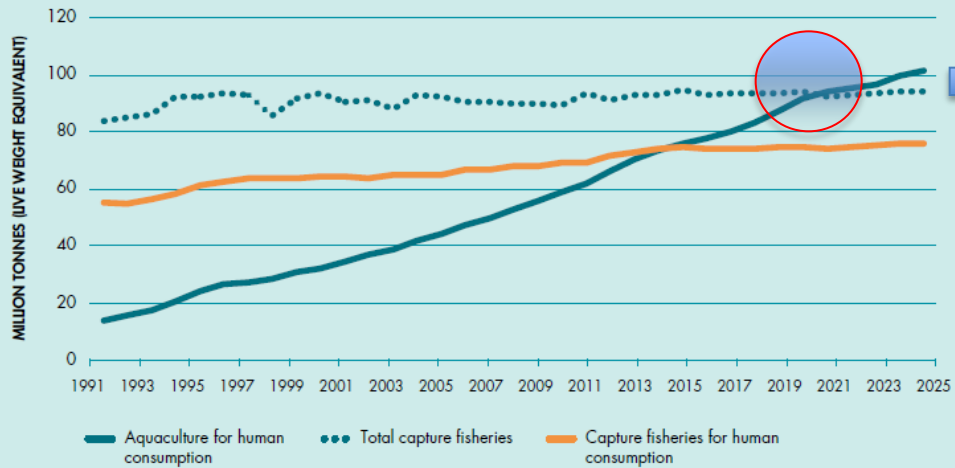
- Fish, molluscs, crustaceans and other aquatic animals= **74 million tonnes (USD 160.2 billion)**
- Cultured seaweed and other aquatic plants= **27.3 million tonnes (USD 5.6 billion)**

RELATIVE CONTRIBUTION OF AQUACULTURE AND CAPTURE FISHERIES TO FISH FOR HUMAN CONSUMPTION



Equally, fishery and aquaculture fish supply for human consumption

GLOBAL CAPTURE FISHERIES AND AQUACULTURE PRODUCTION TO 2025



Future challenges related to climatic variability for aquaculture production and sustainability

SOURCE: OECD and FAO.

Physical impacts of climate change on aquaculture

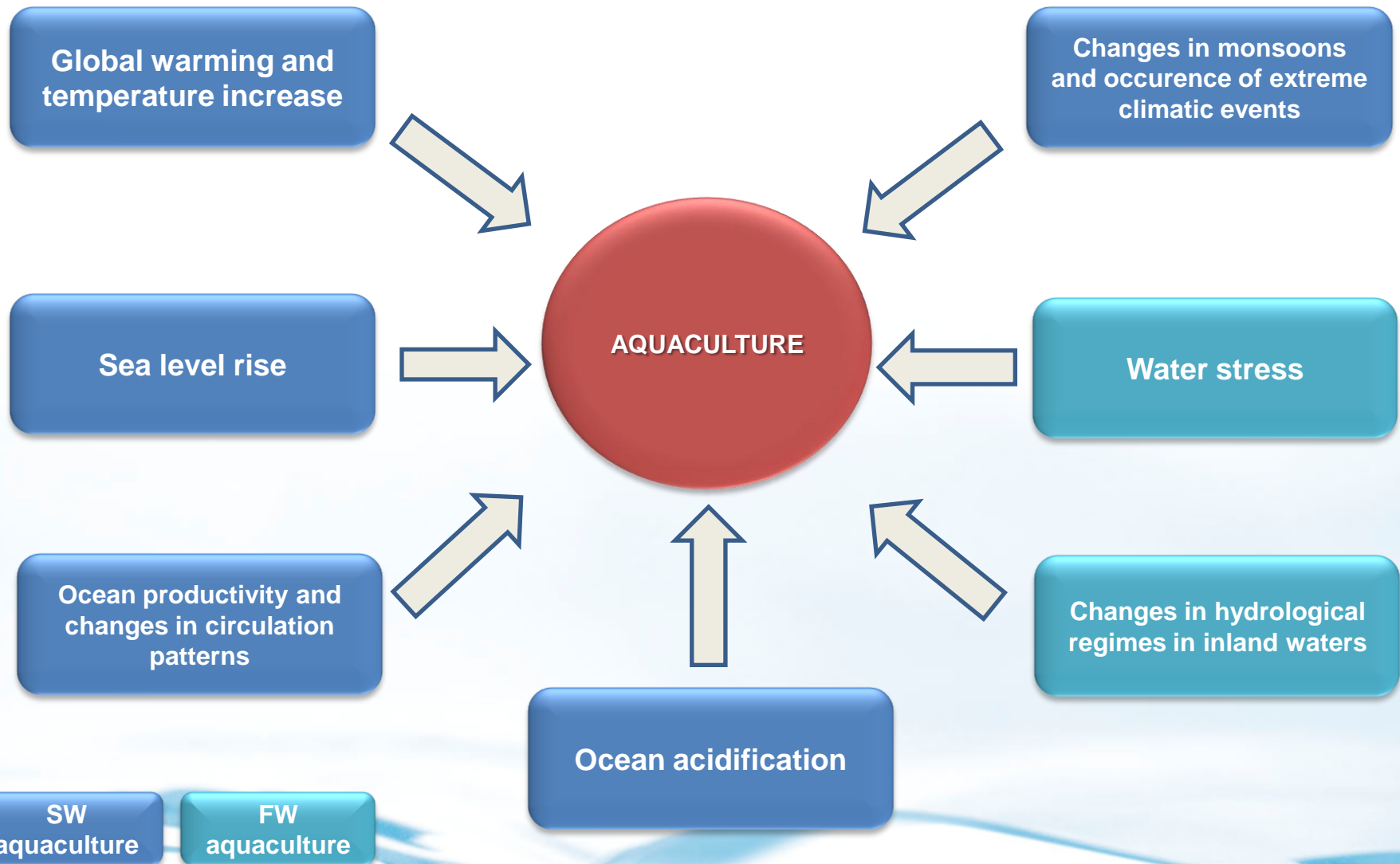
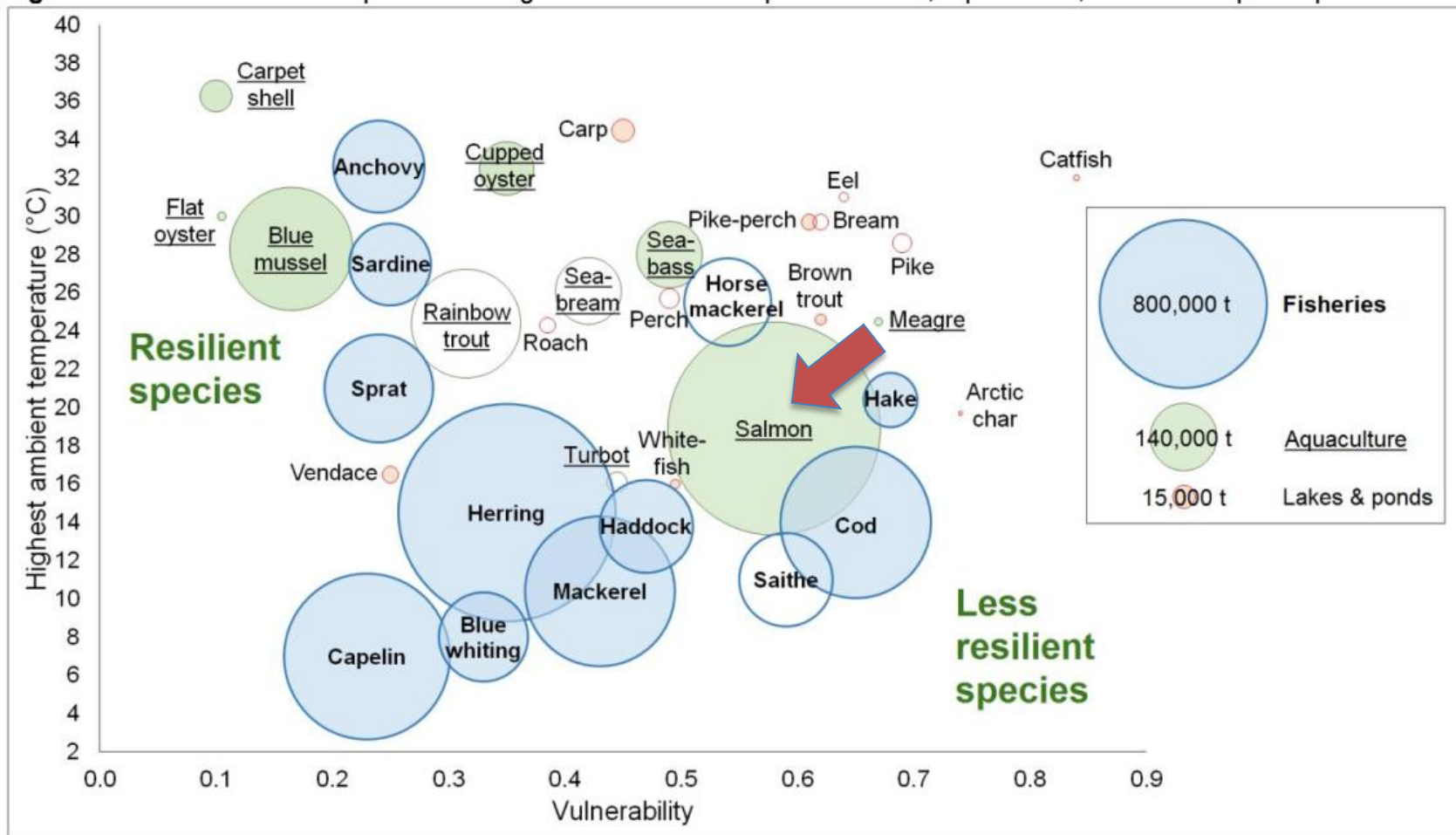


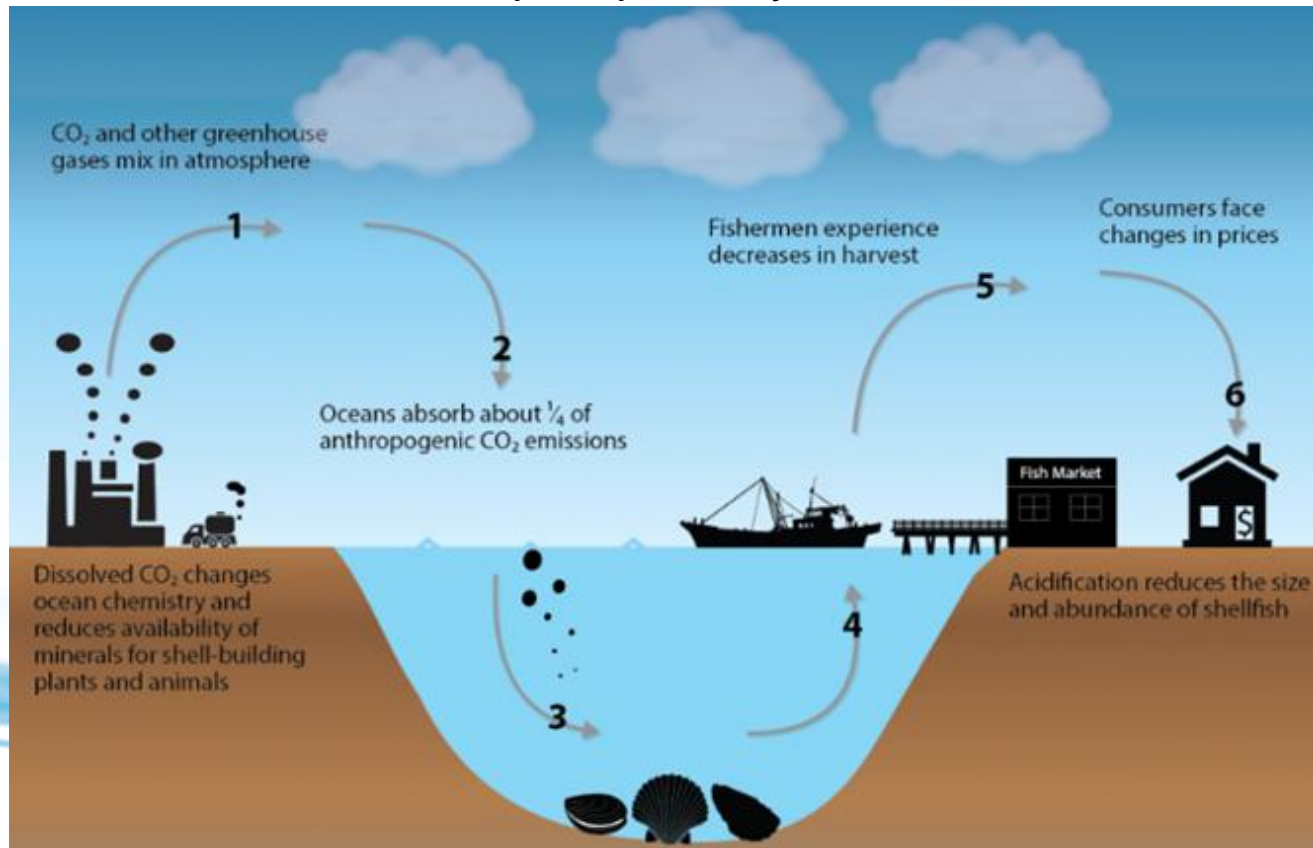
Figure 1.3c Resilience of the species with highest volume in European fisheries, aquaculture, and lakes & ponds production



Ocean acidification (OA)

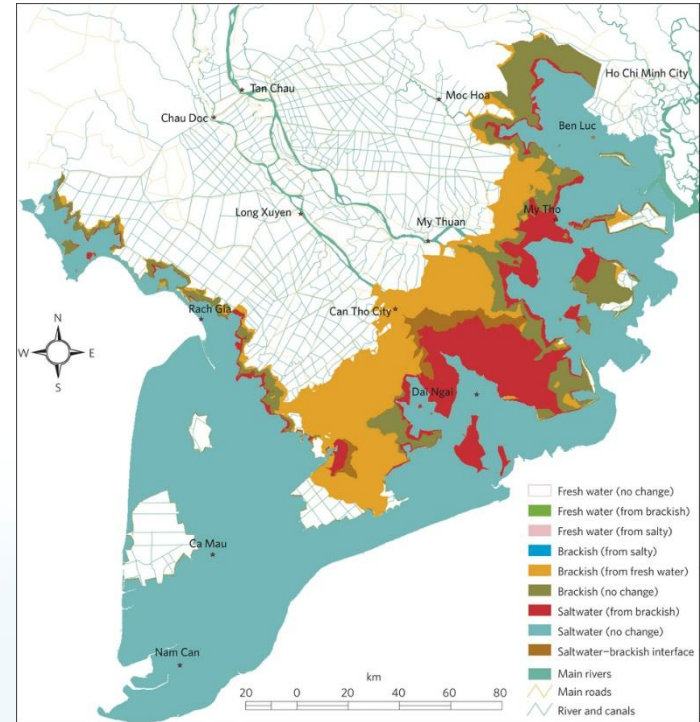
- Shellfish are considered among the most vulnerable organisms in a more acidic ocean due to their reliance on calcium carbonate (CaCO_3) shell.
- Physiological challenges to compensate for low pH by upregulating calcification internally, impacting growth, reproduction and other processes.

OA impact pathway for shellfish



Sea level rise

- Shrimp/finfish farming in the Mekong delta as case study.
- Physiological challenges for shrimp species.
- Upstream translocation of aquaculture facilities.
- Impacts on rice culture.

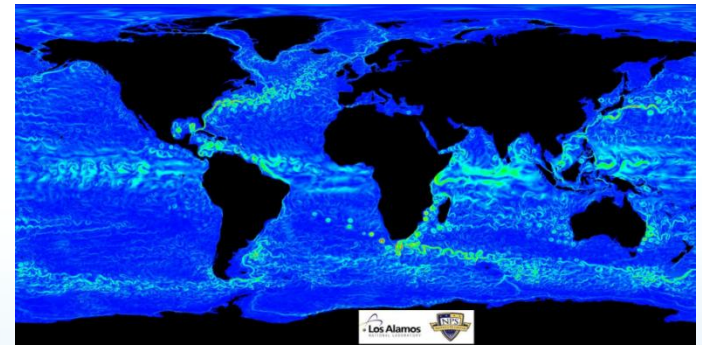


Mekong delta, Vietnam



Changes in ocean productivity and circulation patterns

- Aquaculture can be affected by changes in nutrient supply due to changed vertical stability and exchange.
- Harm algal blooms (HABs) and jellyfish blooms can increase due to ocean warming.
- Changes in runoff patterns also increase nutrient supply to coastal areas.



Changes in monsoon patterns and occurrence of extreme events

- **Impacts on aquaculture:**
 - Physical destruction of facilities.
 - Loss of stocks.
 - Scape of cultured exotic species.
 - Spread of diseases.



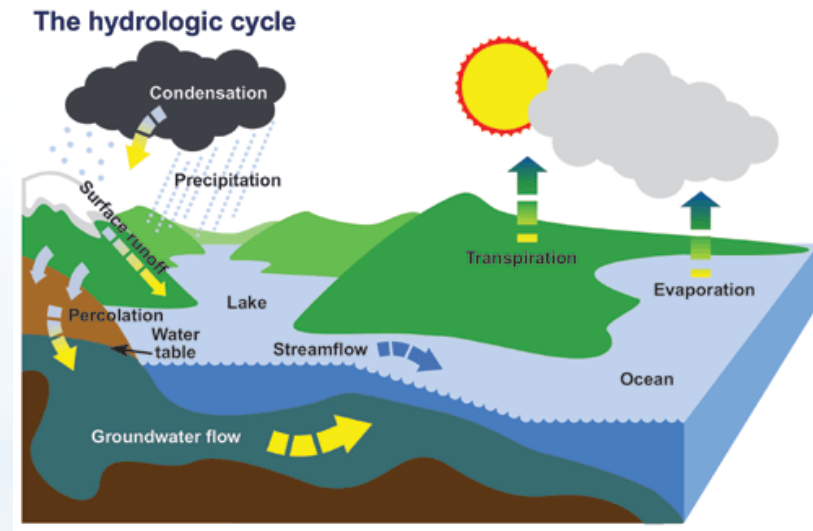
Damaged inshore cages after a typhoon in China



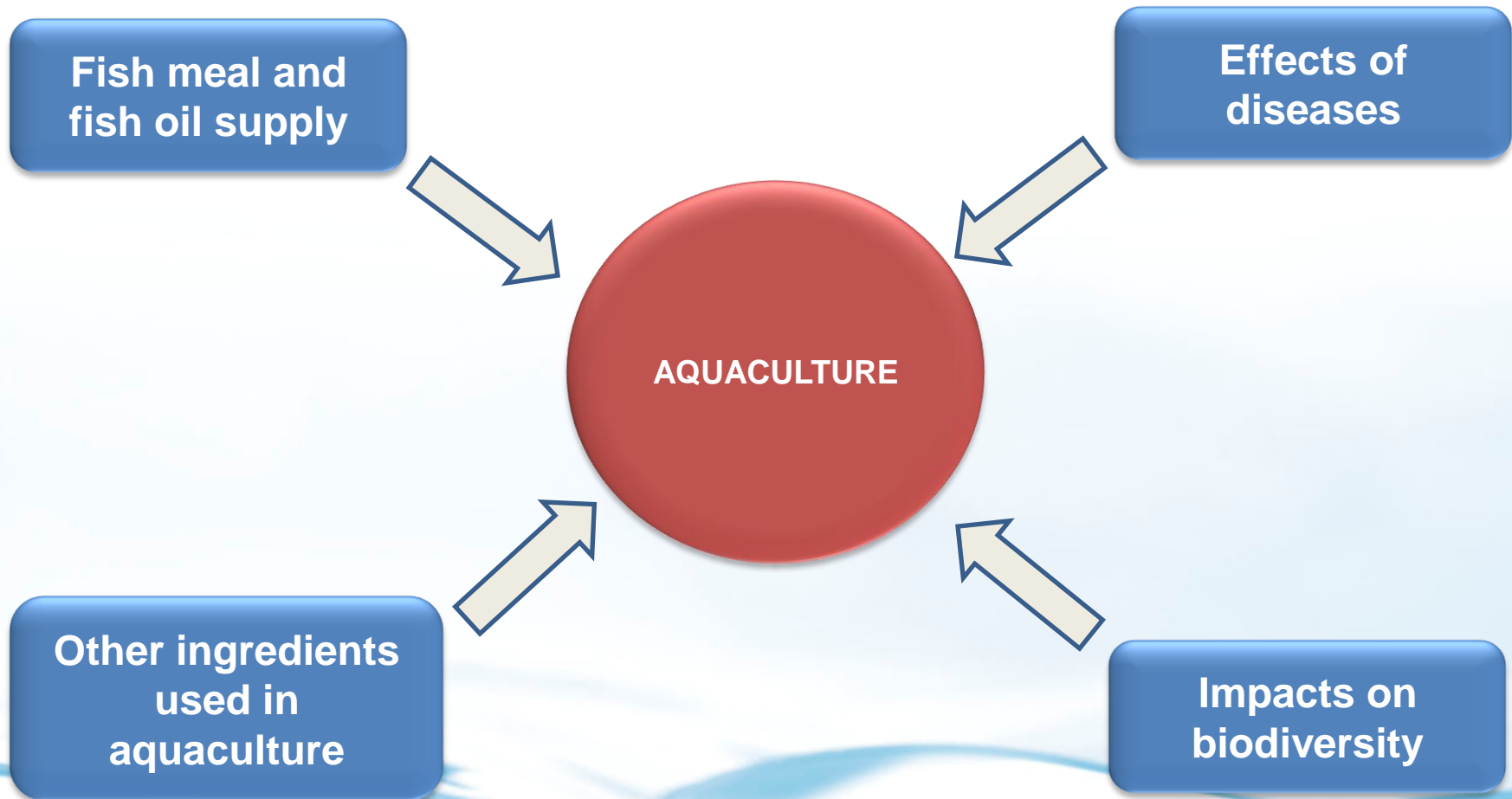
Open salmon pen after post-tropical storm Arthur, Nova Scotia, Canada

Water stress and changes in hydrological regimes in inland waters

- Changes in water quantity and quality for freshwater and brackish water aquaculture.
- Saline intrusion and changes in precipitation patterns.
- Gross changes in habitats where extensive aquaculture occurs (e.g. wetlands).
- Saline intrusion and physiological and reproductive challenges of species.
- Intensive farming such as salmon farming can be highly impacted given high demands of water quality and quantity.

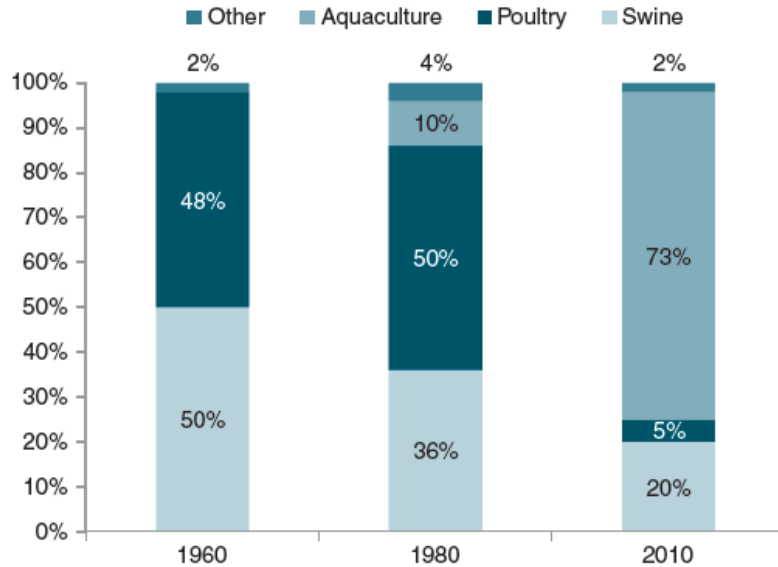


Indirect impacts of Climate Change on world aquaculture

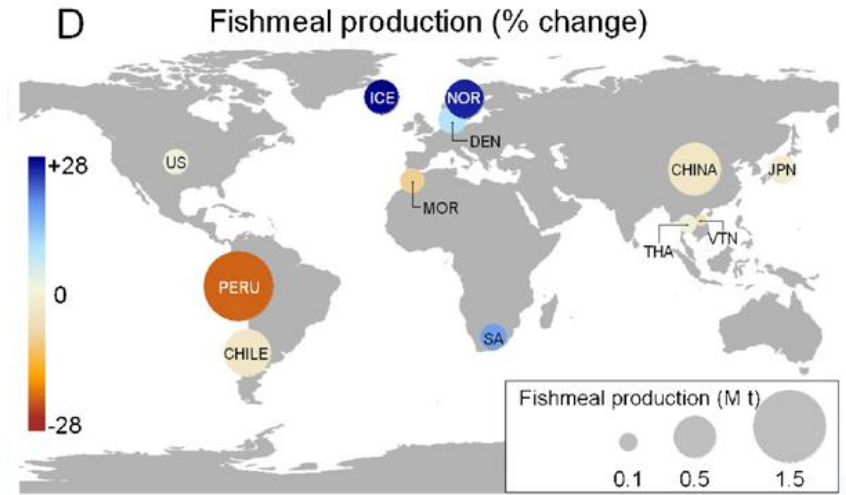


- The importance of aquaculture as user of fishmeal has grown substantially as a result of the industry's rapid growth since the 1980s

FIGURE 1.5: Global Fishmeal Use

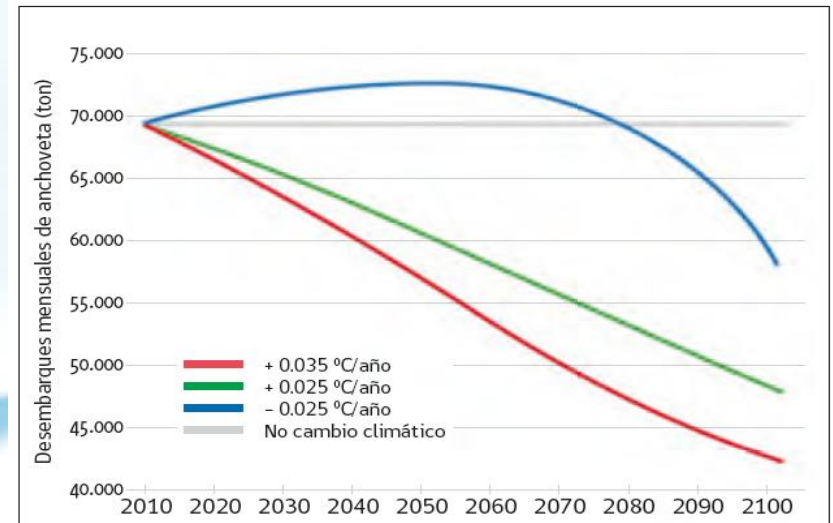


Source: Shepherd 2012.



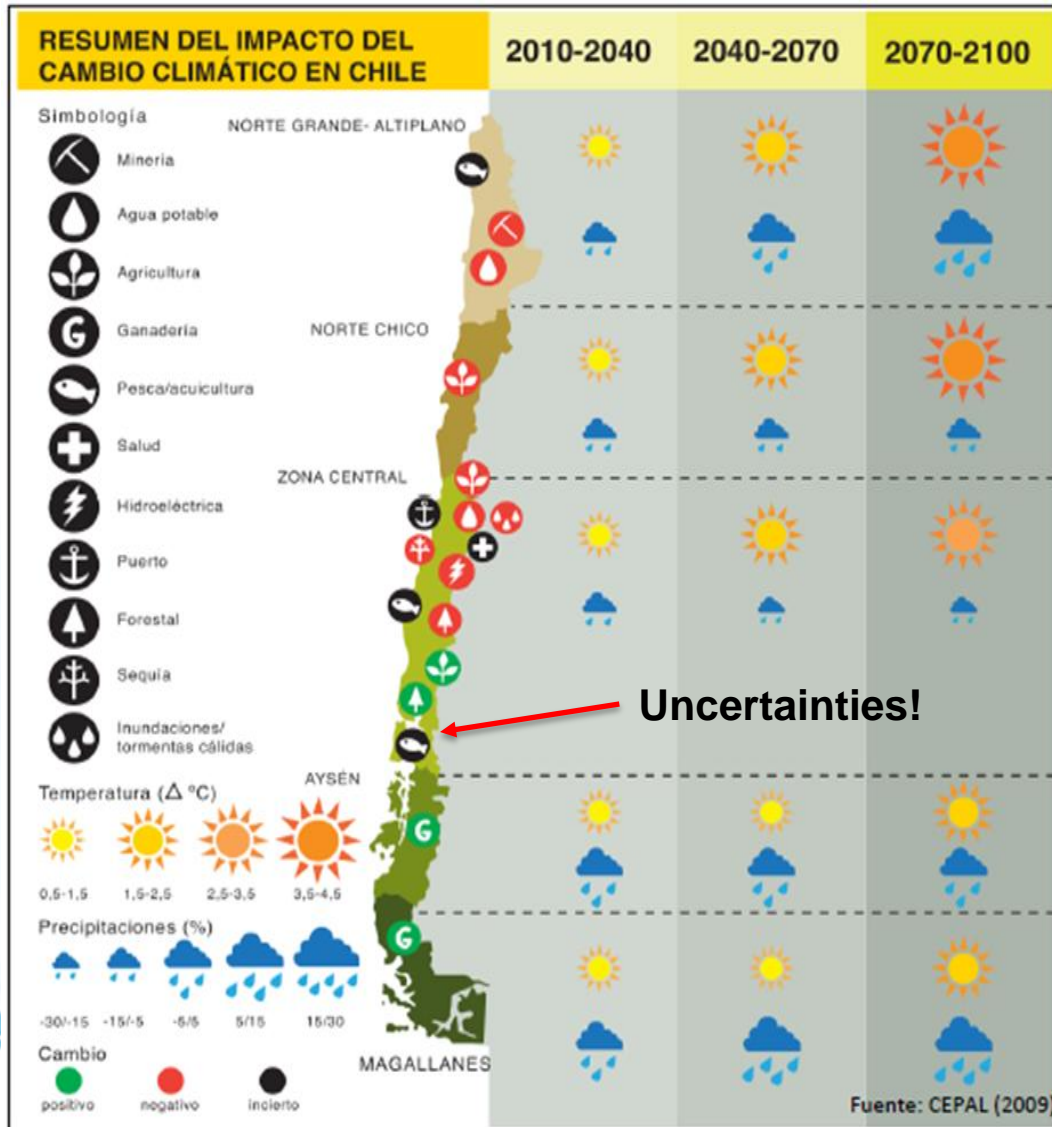
Merino et al., 2012

Projections of anchovy landings in northern Chile under climate change scenarios (Yañez et al., 2014)



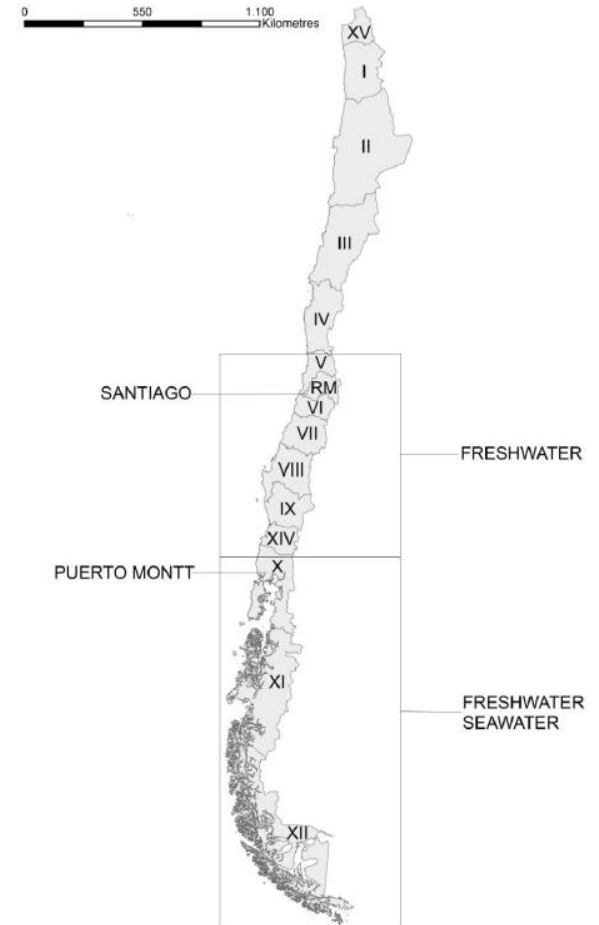
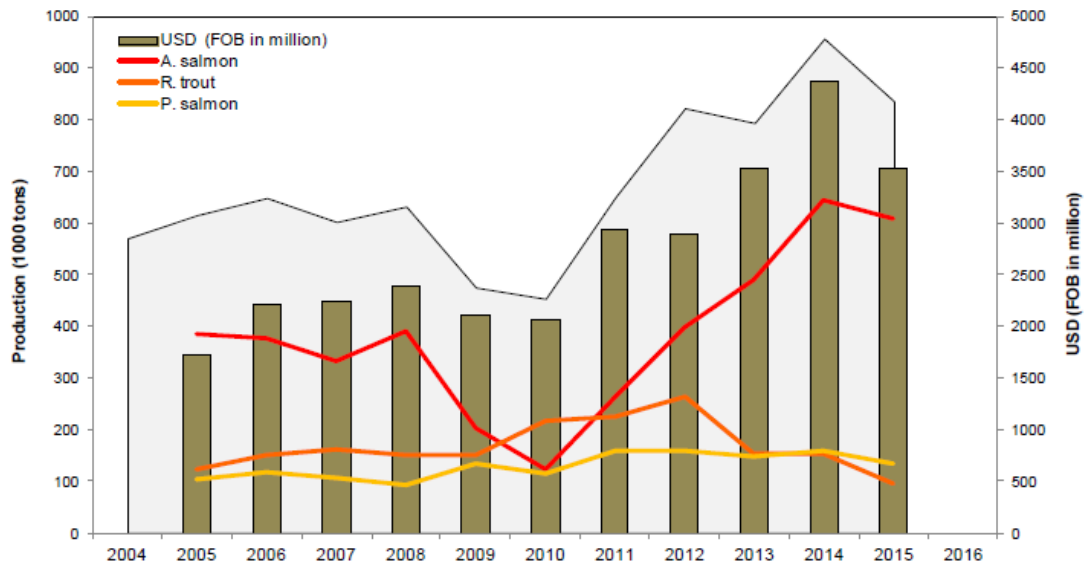
Climate change and Chilean economic resources

- Potential impacts of climate change on Chilean fisheries and aquaculture are related to interannual variability of ENSO and Pacific Decadal Oscillation (PDO)
- There are important gaps in knowledge on how fishery and aquaculture may respond and cope under climate change in Chile.
- There is an urgent need for research, R&D and multidisciplinary groups for tackling major issues of climate change on Chilean aquatic resources

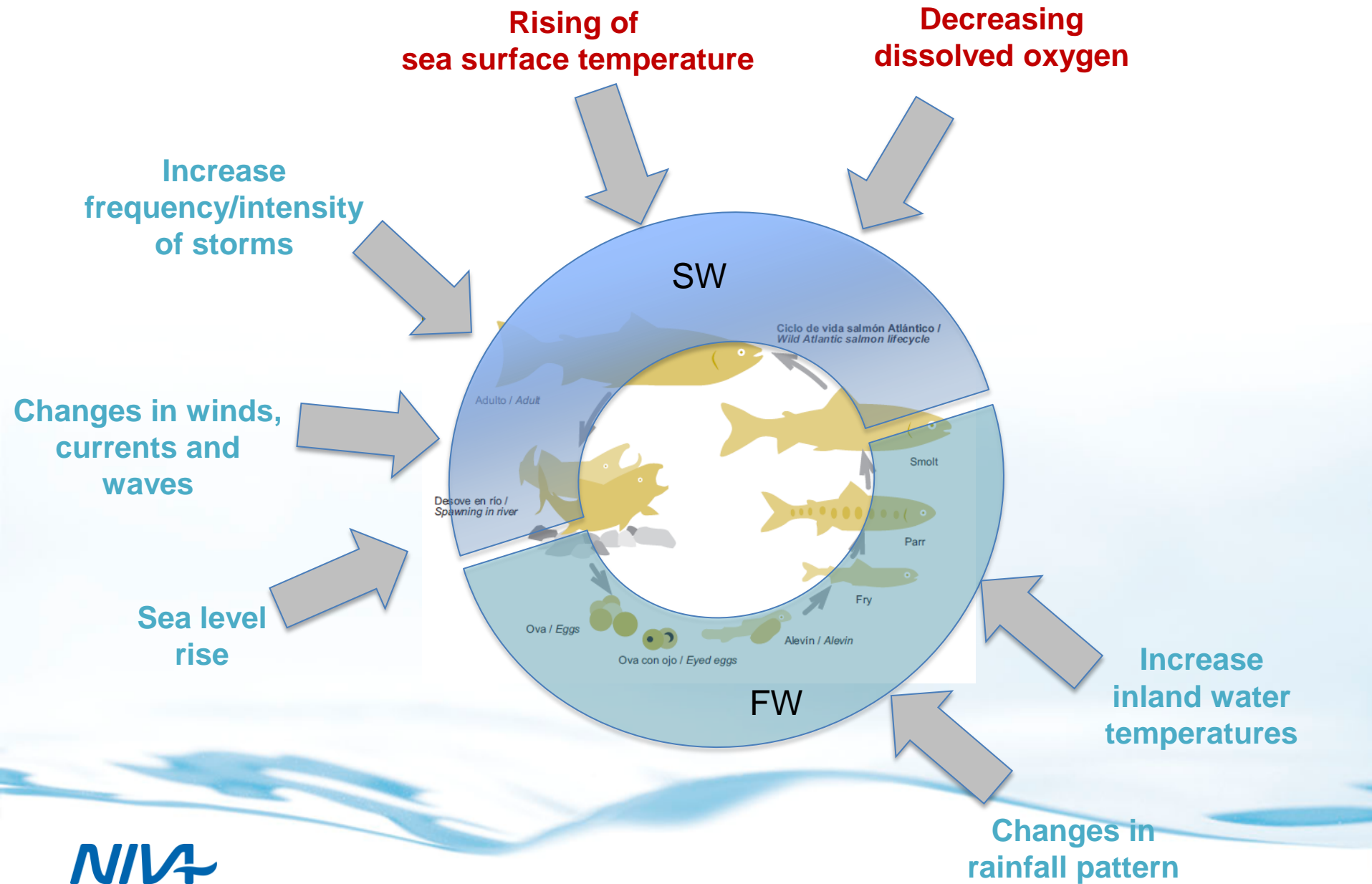


Chilean salmon farming as a case study

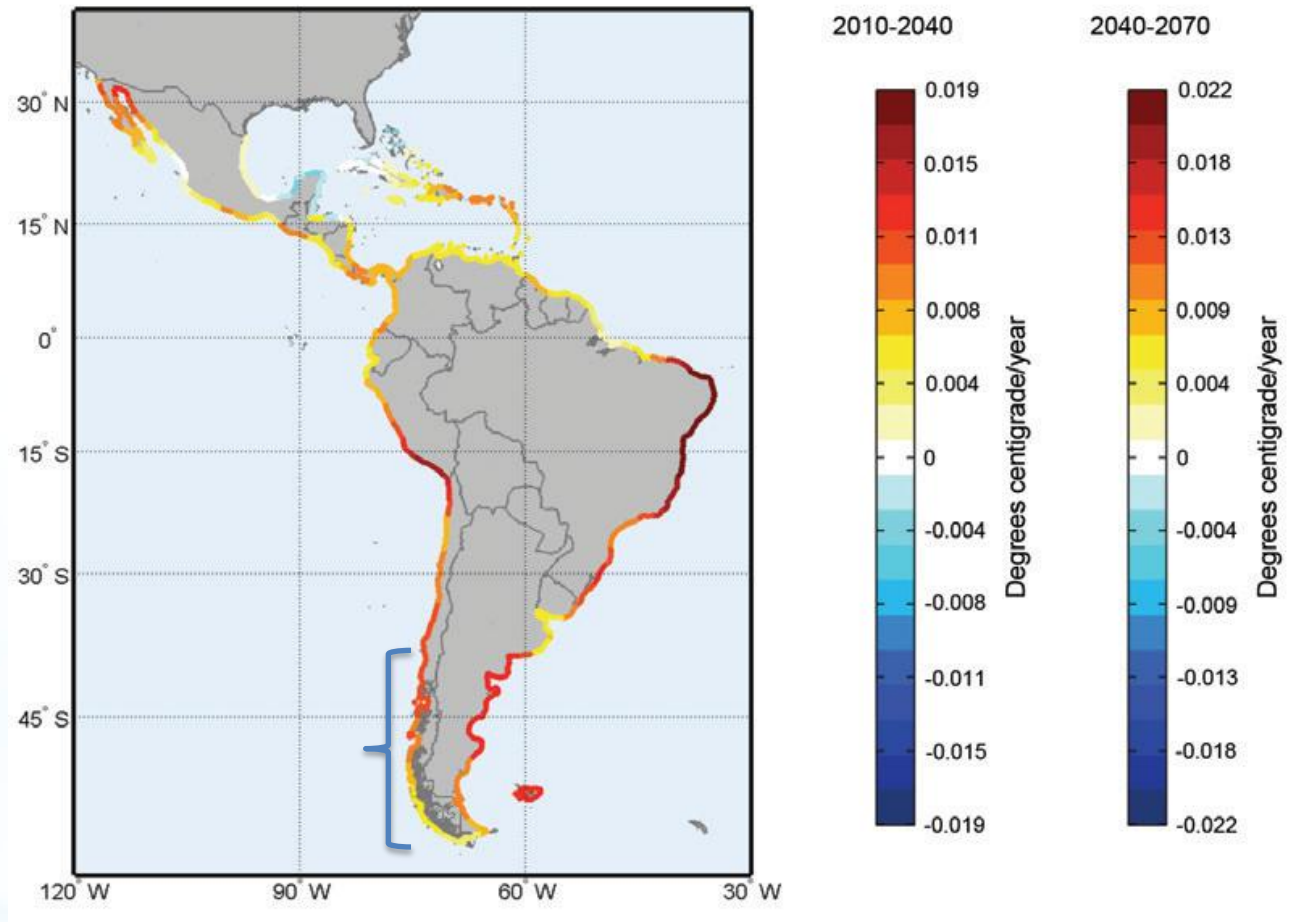
Production by species and FOB (USD)



Salmon farming as a case study

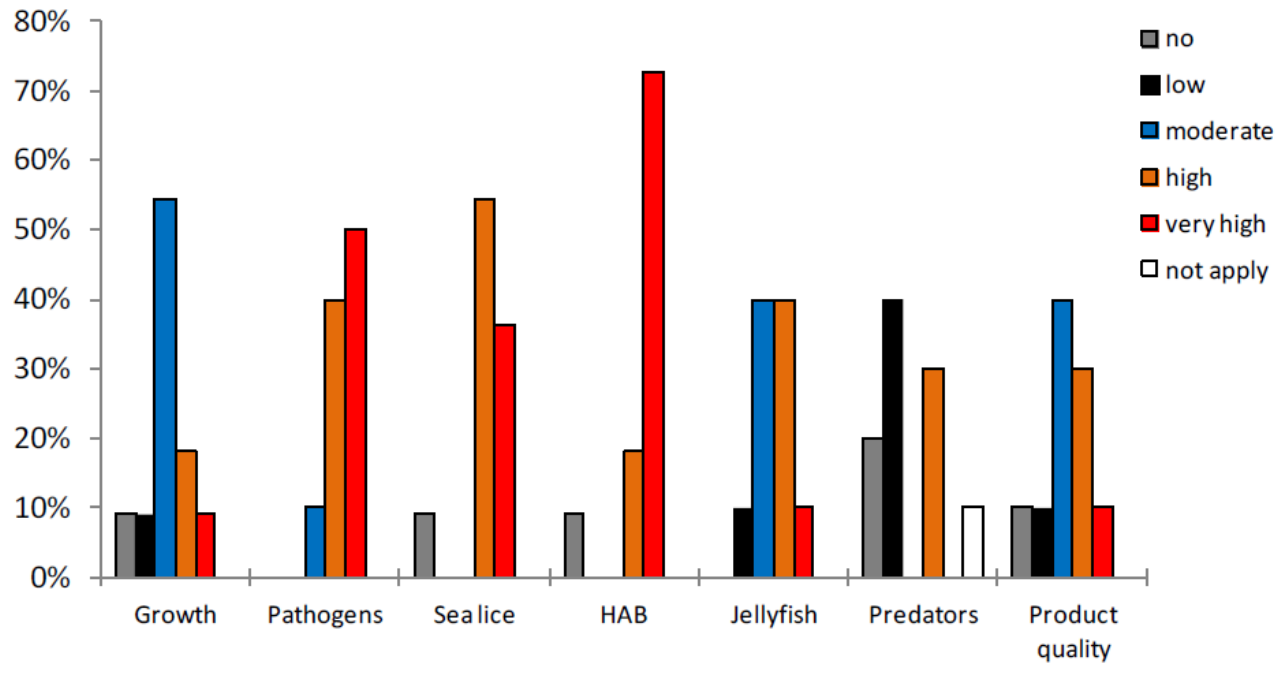


Mean sea surface temperature projections

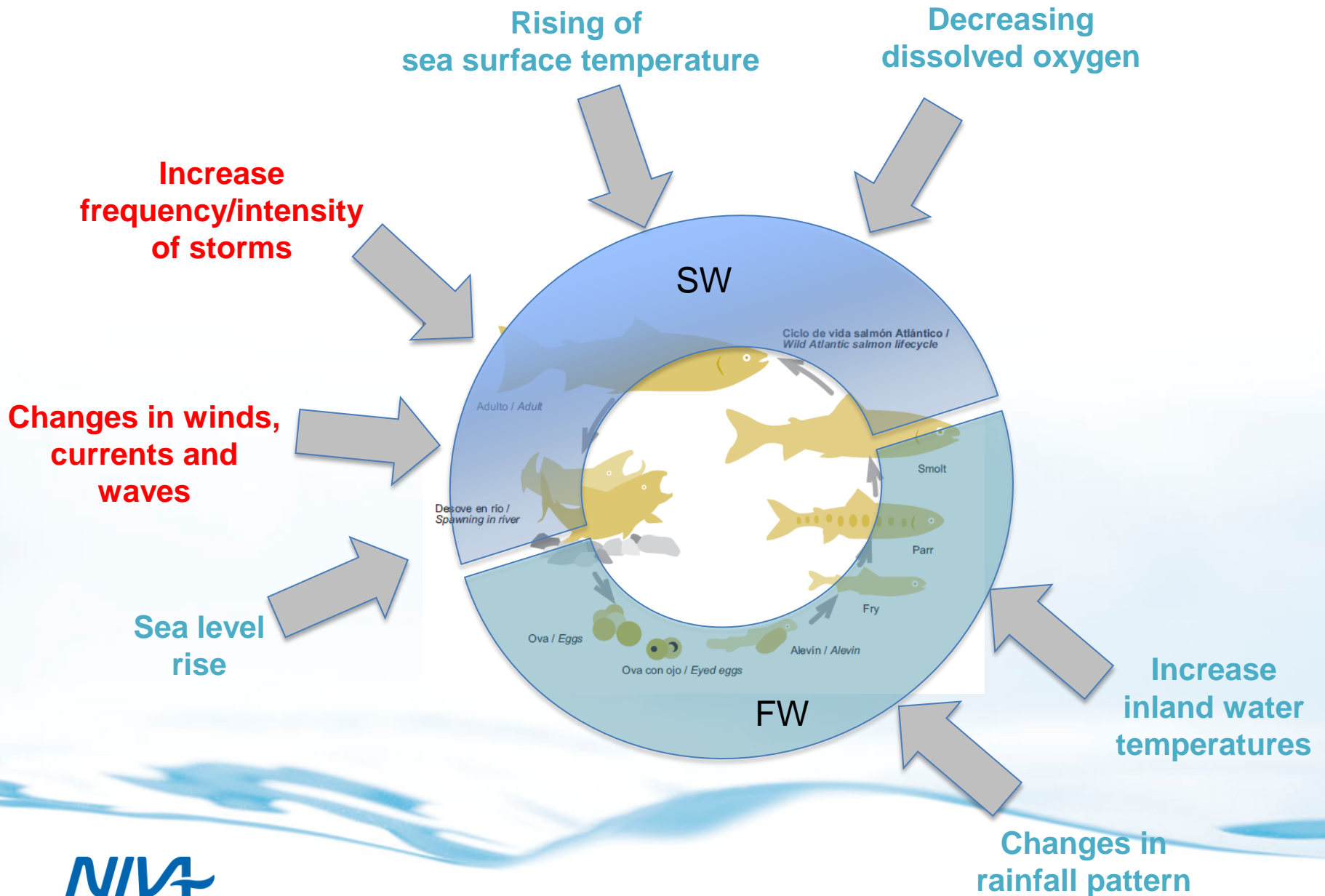


Perception of salmon farmers on climate change in Chile

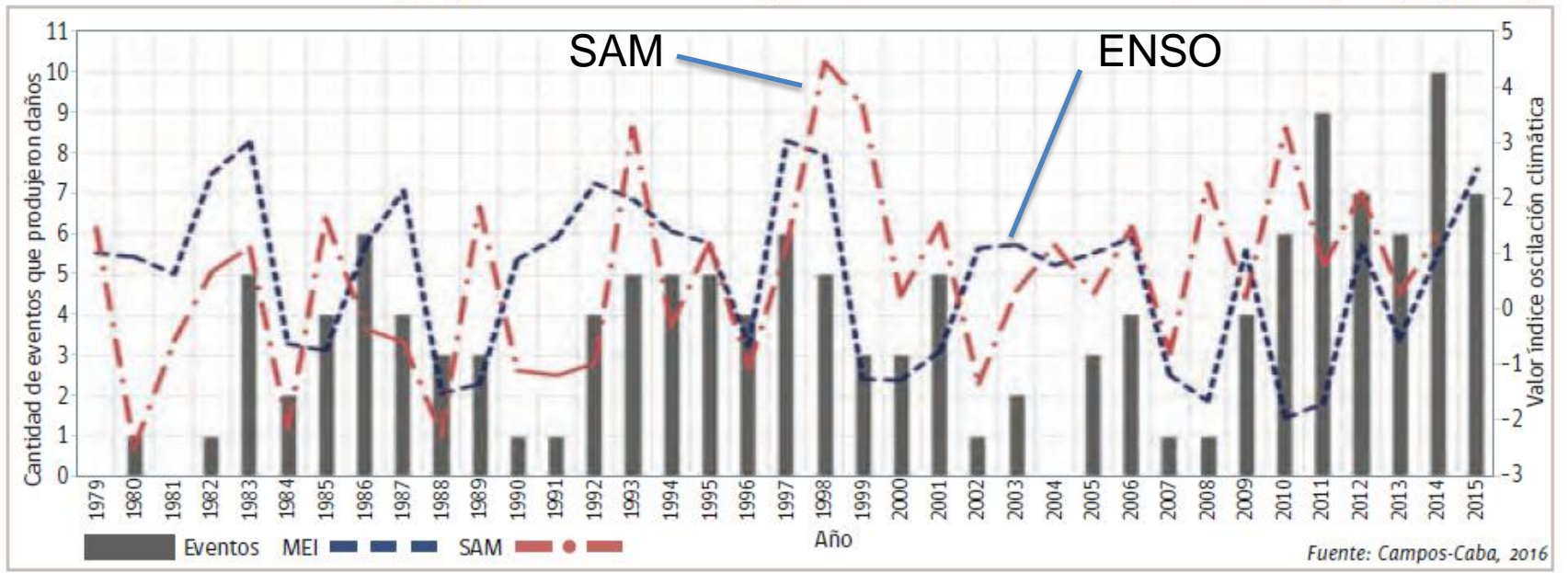
Impact of increasing water temperature on farming and production factors (seawater in on-growing sites):



Salmon farming as a case study

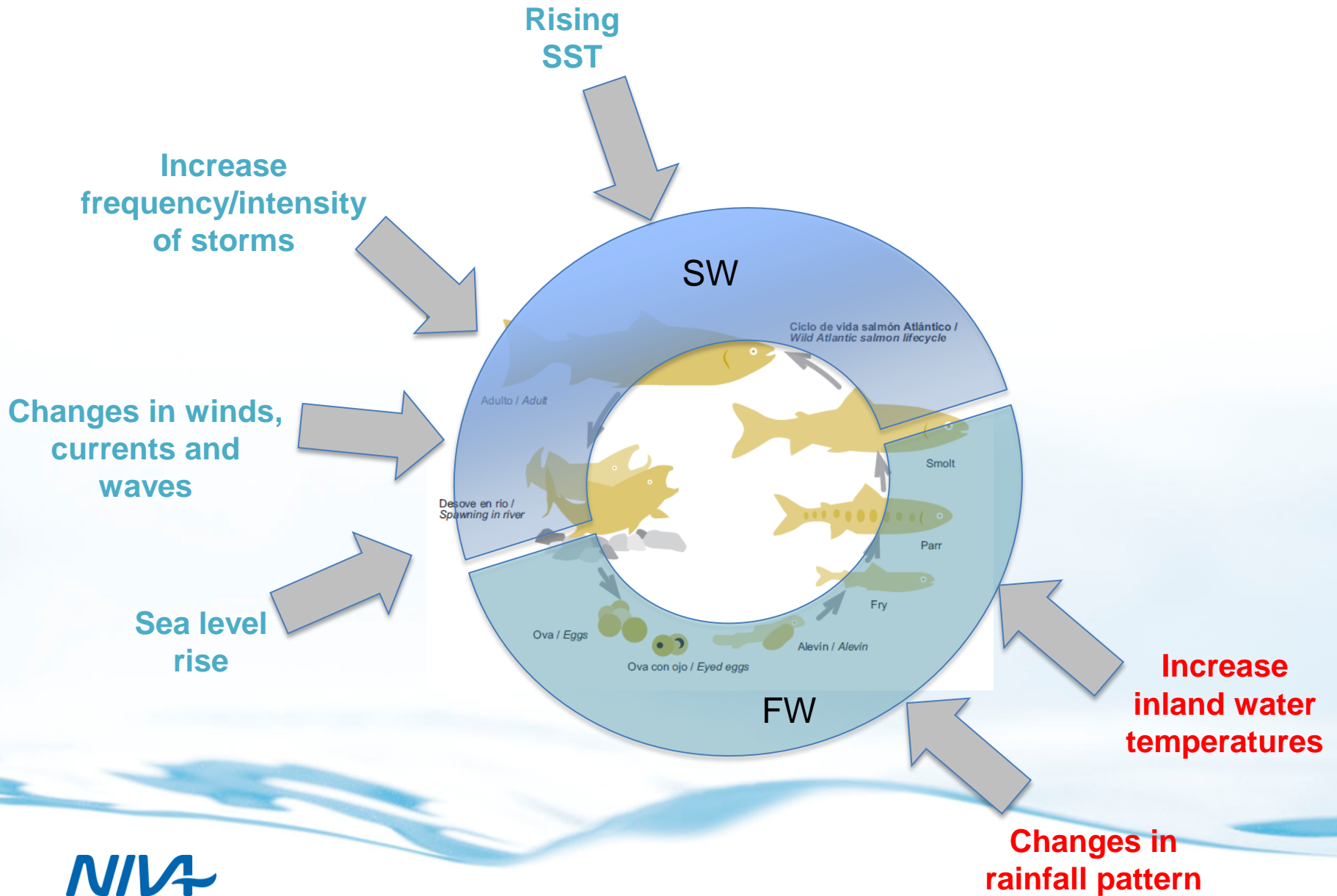


Annual frequency of storm surges resulting in impacts and damages throughout the Chilean coast (1979-2015)

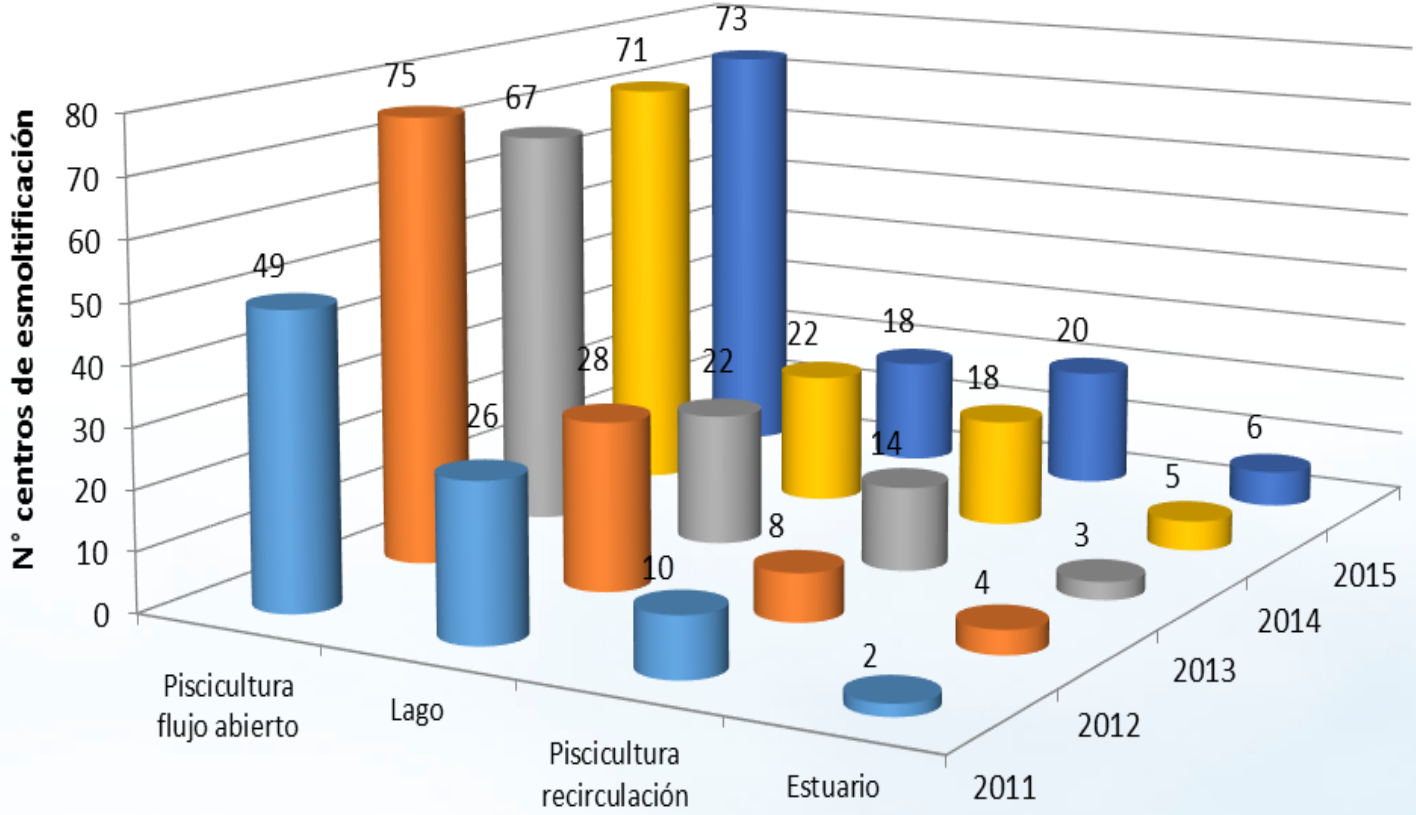


SAM : Southern Annular Mode

Salmon farming as a case study

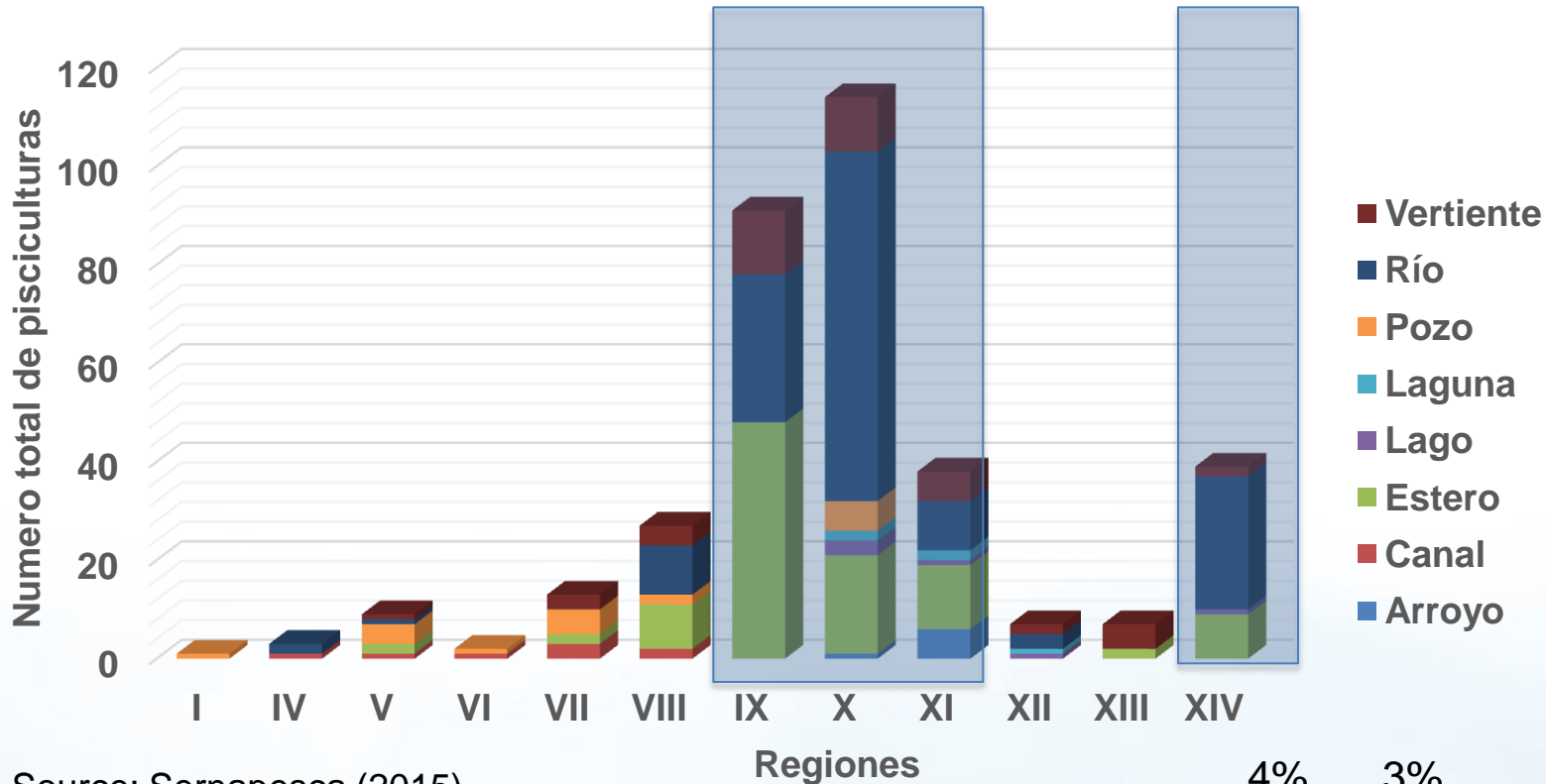


FW production systems for smoltification in Chile



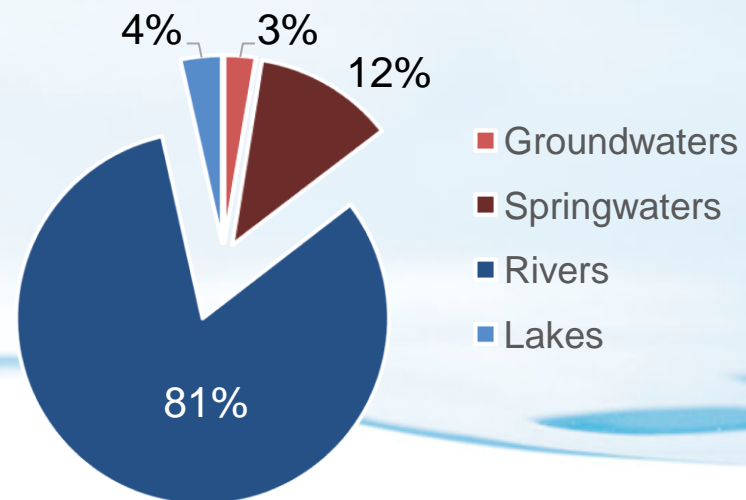
High dependency on water quantity/quality

National trends in FW inlets of land-based facilities

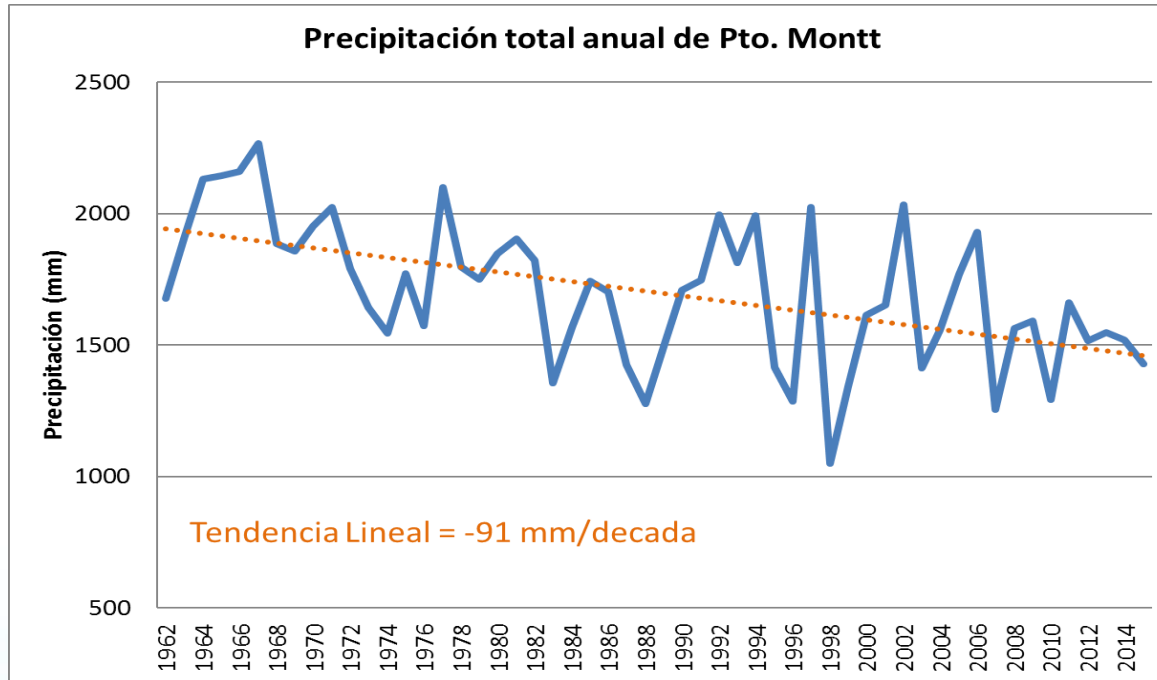


Source: Sernapesca (2015)

Total FW facilities registered until June 2015: 316



Current changes that we are facing...



Tendencias de la DMC

Tendencia	
Anal	-90 mm/decada
Invierno	-31 mm/decada
Primavera	-21 mm/decada
Verano	-23 mm/decada
Otoño	-20 mm/decada

Fuente: Claudia Villarroel, DMC

emol Nacional
Santiago, Jueves 20 de octubre del 2016 | Actualizado 12:20

Inicio Noticias Economía Deportes Espectáculos Tendencias Autos Servicios

36°C

Chile | Mundo | Tecnología | Educación | Documentos | Multimedia |

Buscar

Puerto Montt vivió el junio más seco de los últimos 65 años: 71% de déficit de agua caída

Experta de la Dirección de Meteorología dijo que se trata de un récord histórico y que no existen precedentes de este fenómeno desde 1950.

08 de Julio de 2016 | 08:27 | Emol

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biobiochile.cl

Inicio Nacional Internacional Economía Deportes Tendencias

Nacional

Miércoles 15 junio de 2016 | Publicado a las 17:20 - Actualizado a las 18:30

Imágenes muestran el desolador panorama del lago Llanquihue por la falta de lluvias

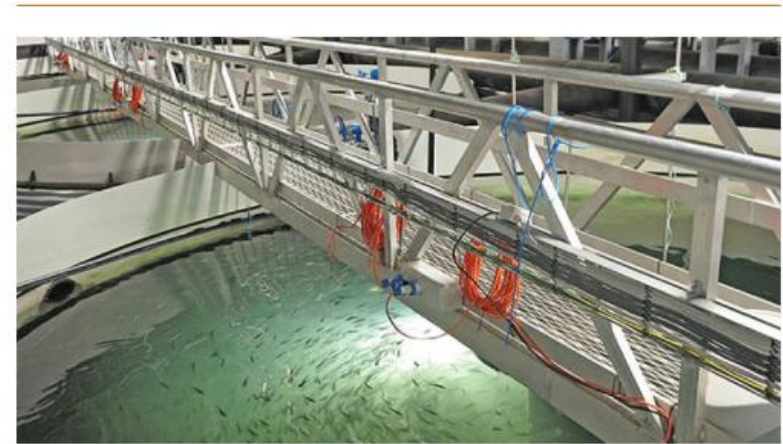
Diego Barria | RBB

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URL Corta: <http://rbb.cl/eceu>

Hydric deficit and FW land-based facilities in Chilean salmon farming

- There are uncertainties on how current changes in rainfall patterns may affect FW production in Chile.
- Facing challenges in terms of water quantity and quality
- The risk associated with water quality/quantity changes by current hydric deficit can be also dependant on farming conditions (biomass, flow rates, biomass/flow ratio)

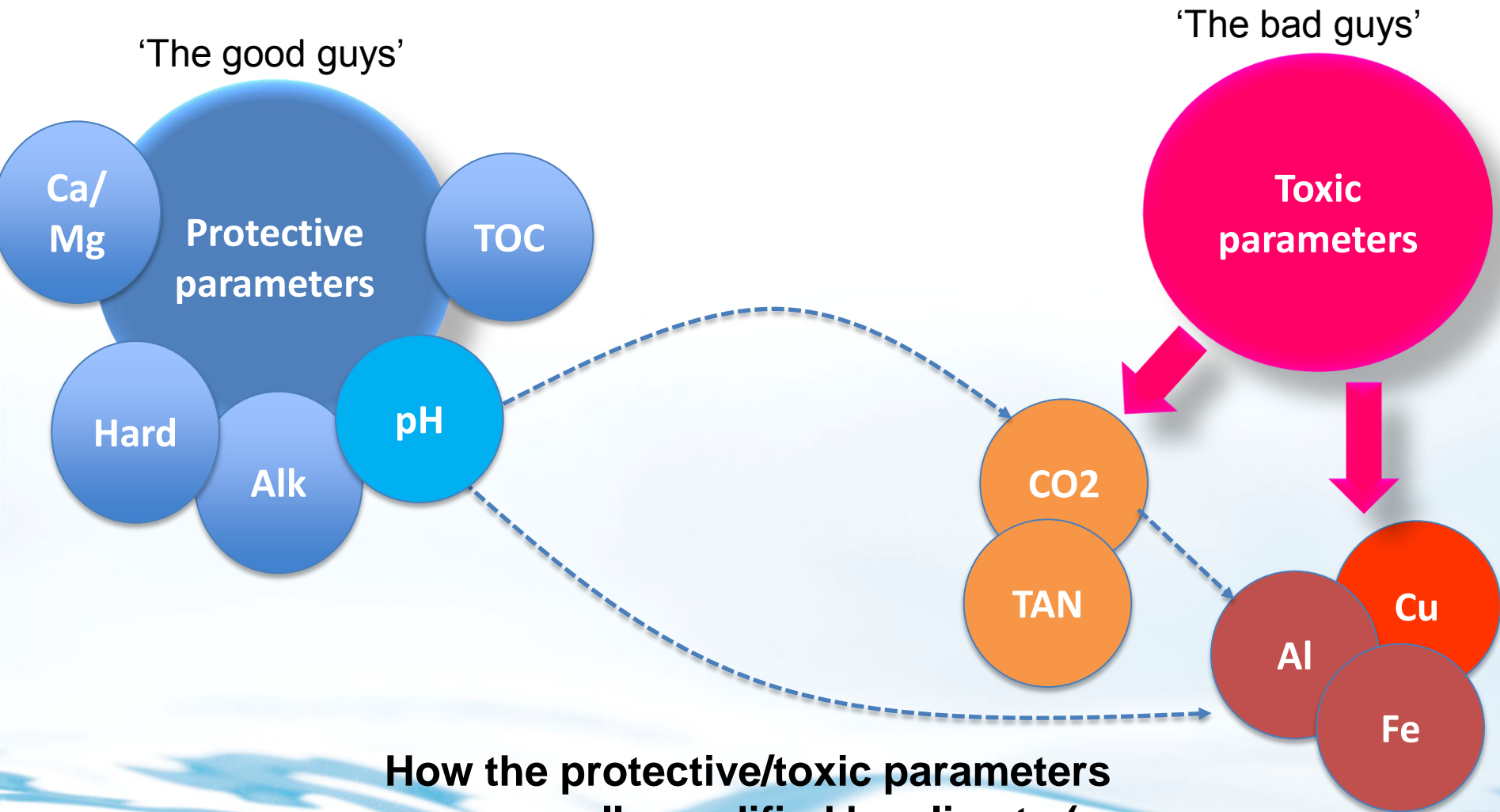


Déficit hídrico preocupa a la industria salmonicultora

Chile: La escasa agua caída en la zona y un escenario de mucha incertidumbre en el pronóstico meteorológico, ha generado preocupación en los salmonicultores, ya que la sequía no sólo puede reducir la cantidad de agua que abastecen las pisciculturas, sino también su calidad.

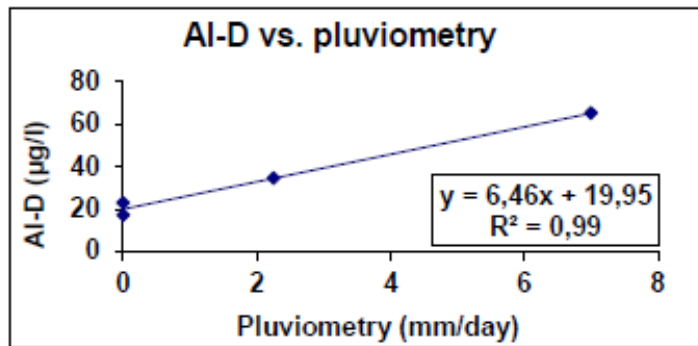
Autor: Patricio Feest

Water quality and fish welfare

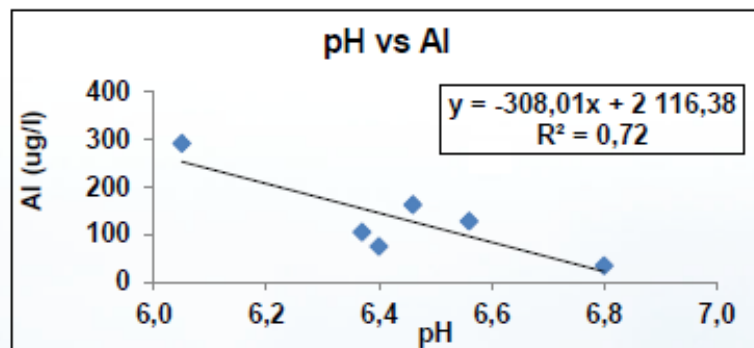


How the protective/toxic parameters are seasonally modified by climate (e.g rainfall)?

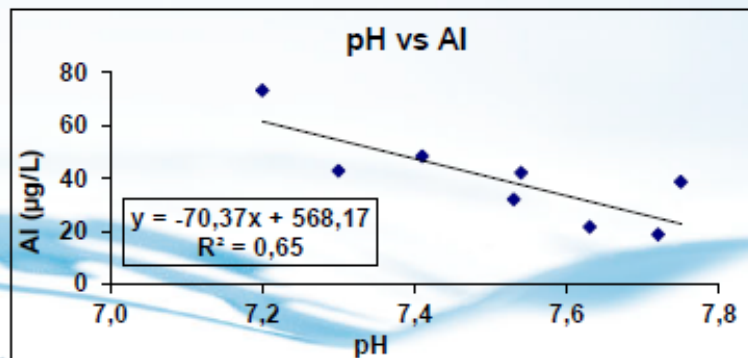
Effects of floods in rivers of Southern Chile.



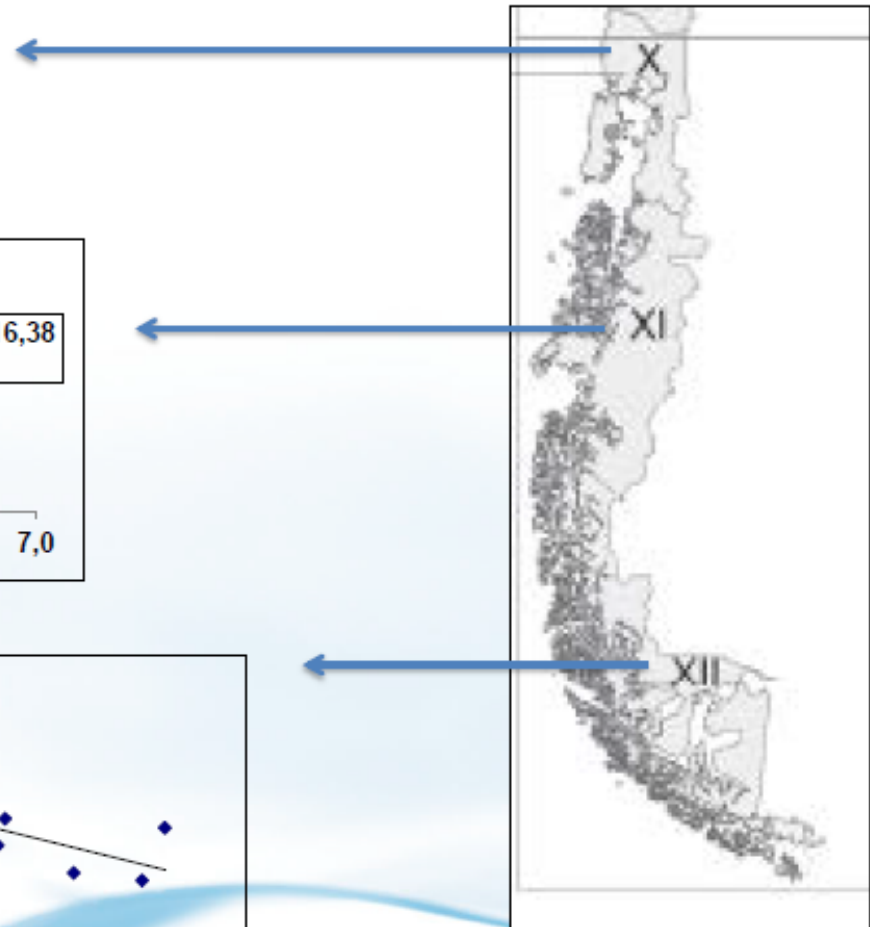
Source: River. Región: X.



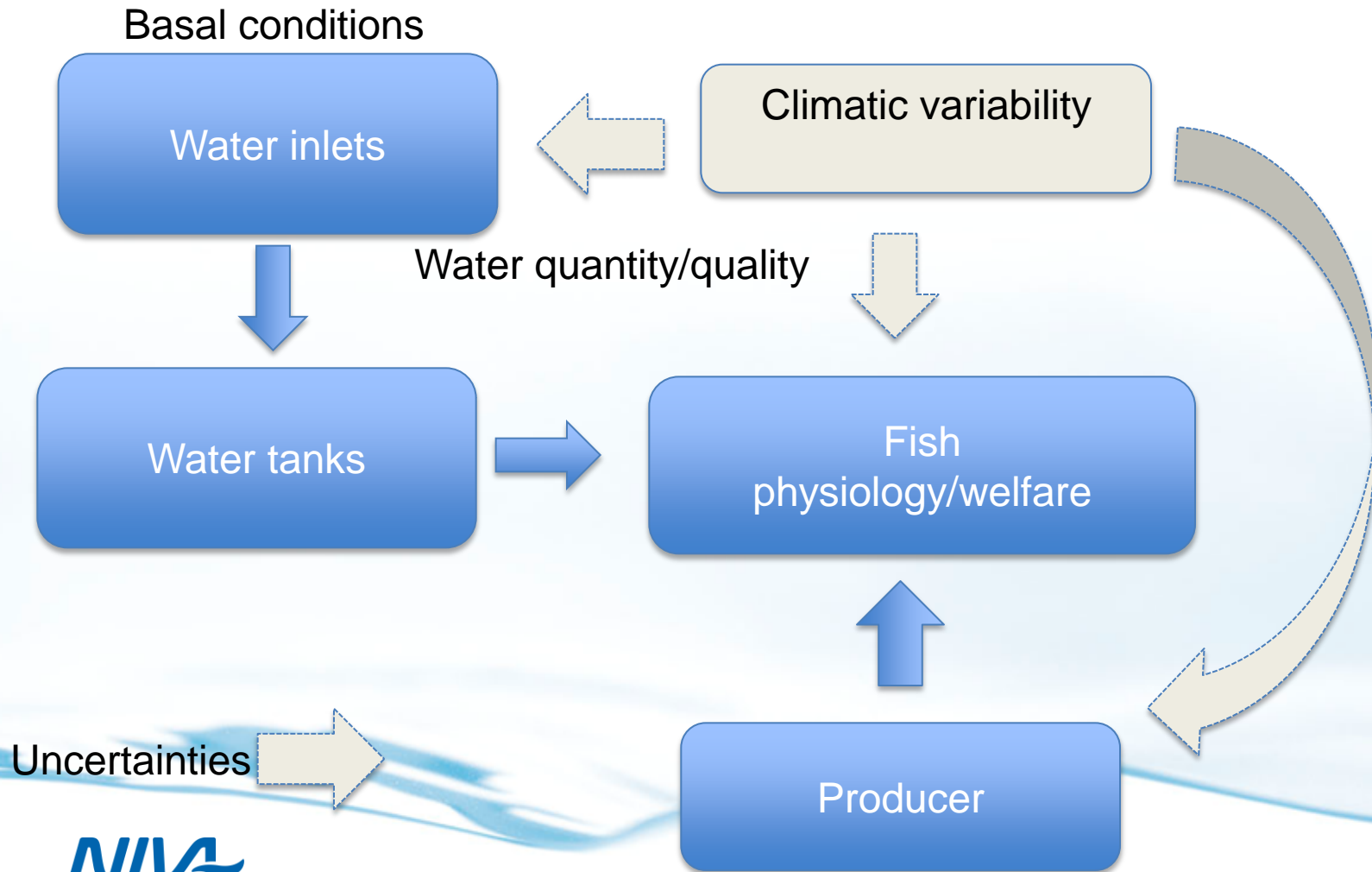
Source: River. Región: XI.



Source: River. Región: XII.



An integrative model (environment – fish- producer)



Adaptation to Climate Change



What is adaptation?

Process to enhance, develop, and implement strategies to moderate, increase the resilience, and take advantage of the consequences of climatic events.

Adaptation is the principal way to deal with the unavoidable impacts of Climate Change.



Manage risks – minimise losses and maximise opportunities

Factors to consider when developing adaptation options

- How different groups of stakeholders (or jurisdictions) weight objectives.
- Conflict which may act as barriers to implement adaptation actions.

1. Maximise wellbeing of communities

2. Maximise economic performance

3. Ensure environmental and ecosystem values

4. Strengthen management and governance

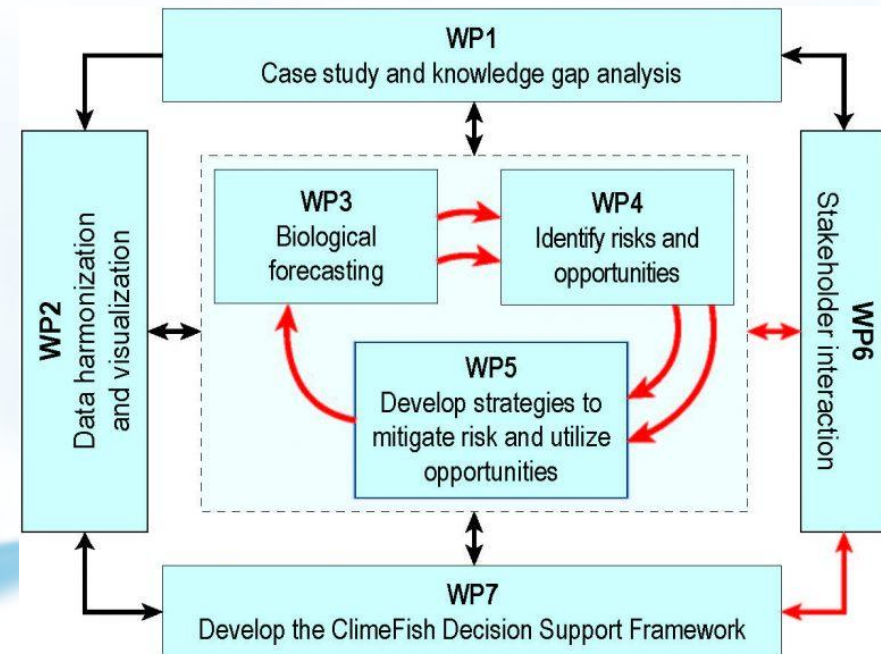
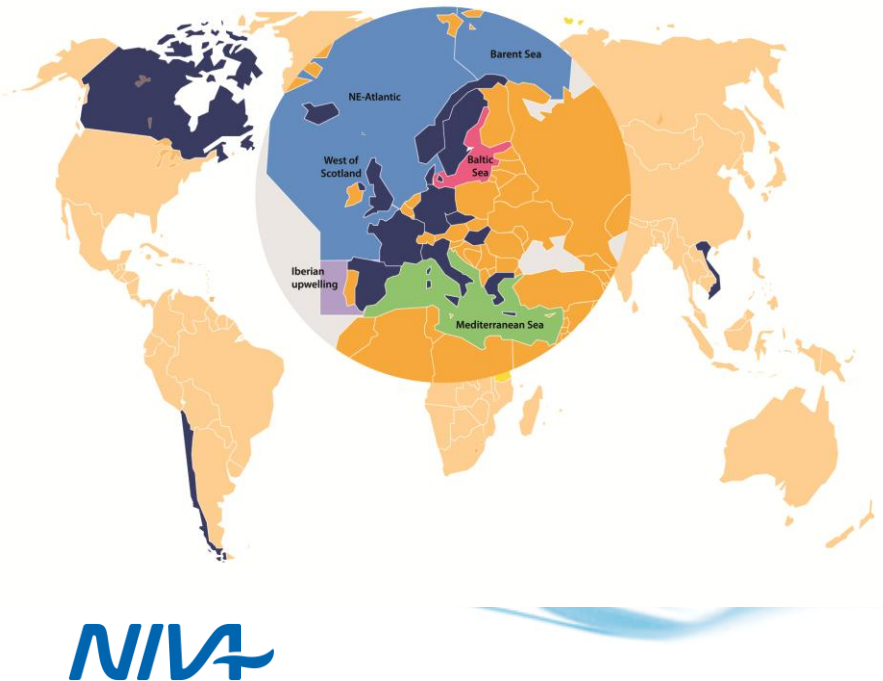
- Identifying weighted management objectives
 - Objectives determined through workshops (managers, industry, scientists).
 - Relative importance established with port-workshop survey Analytical Hierarchy Process.

Examples of adaptation in aquaculture – ClimeFish Project

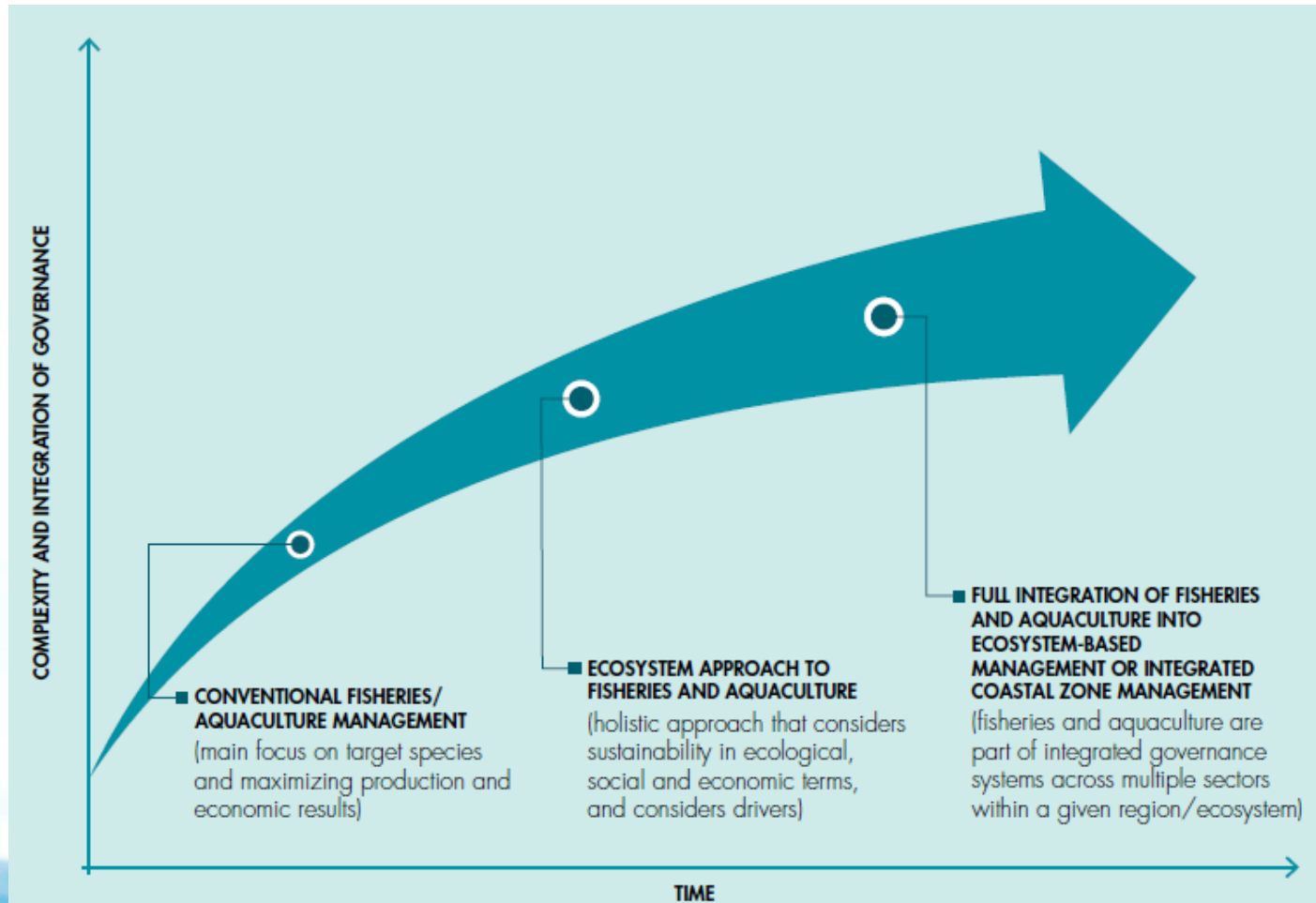
(www.climefish.eu)



Co-creating a decision support framework to ensure sustainable fish production in Europe under climate change



Evolution from conventional fisheries and aquaculture management to cross-sectorial integrated approaches



Muchas gracias!

