



# Epidemiological approaches to deal with pathogens in the farmed salmon industry in Chile

Session: Empirical methods and modeling tools for predicting pest/pathogen outbreaks.

Aspen, 20 Aug. 2019

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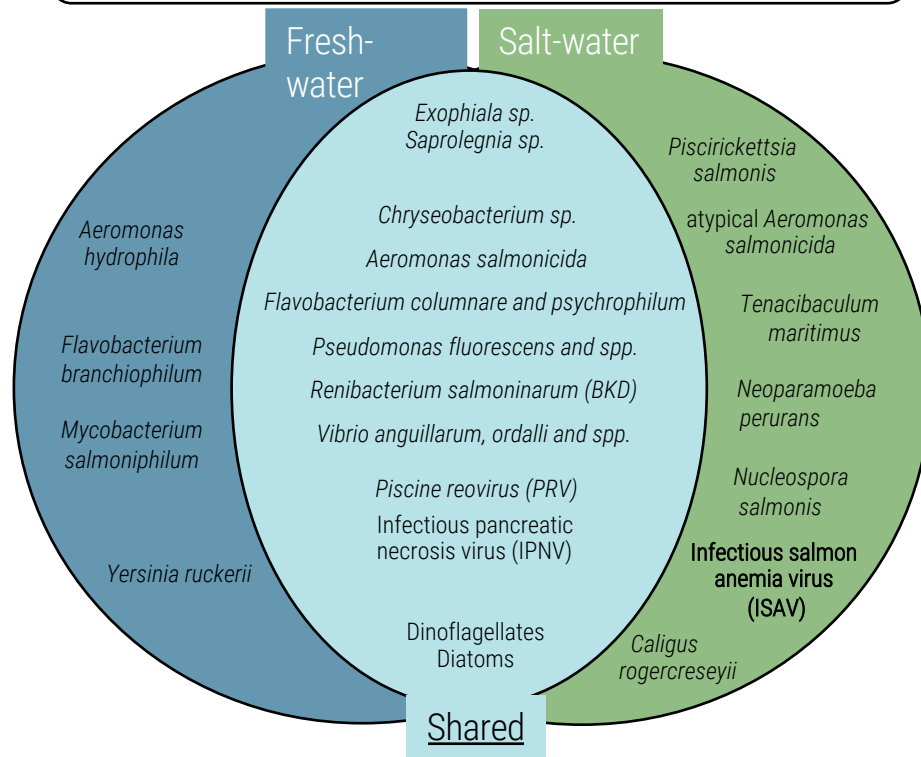
# Salmon farming

## Single vs a set of pathogens



27 organisms reported from farmed salmon in Chile

Source: Passive and Surveillance Reports in 2015, Sernapesca



### *Piscirickettsia salmonis*

- Highly endemic bacterium
- 50-90% of infectious mortality
- USD 700 million yearly cost
- Reason for large amount of antibiotics

### Sealice (*caligus rogercreseyii*)

- Worldwide ectoparasite
- Risk factor and vector
- USD 300 million yearly cost
- Reason for large amount of antiparasite bath treatments

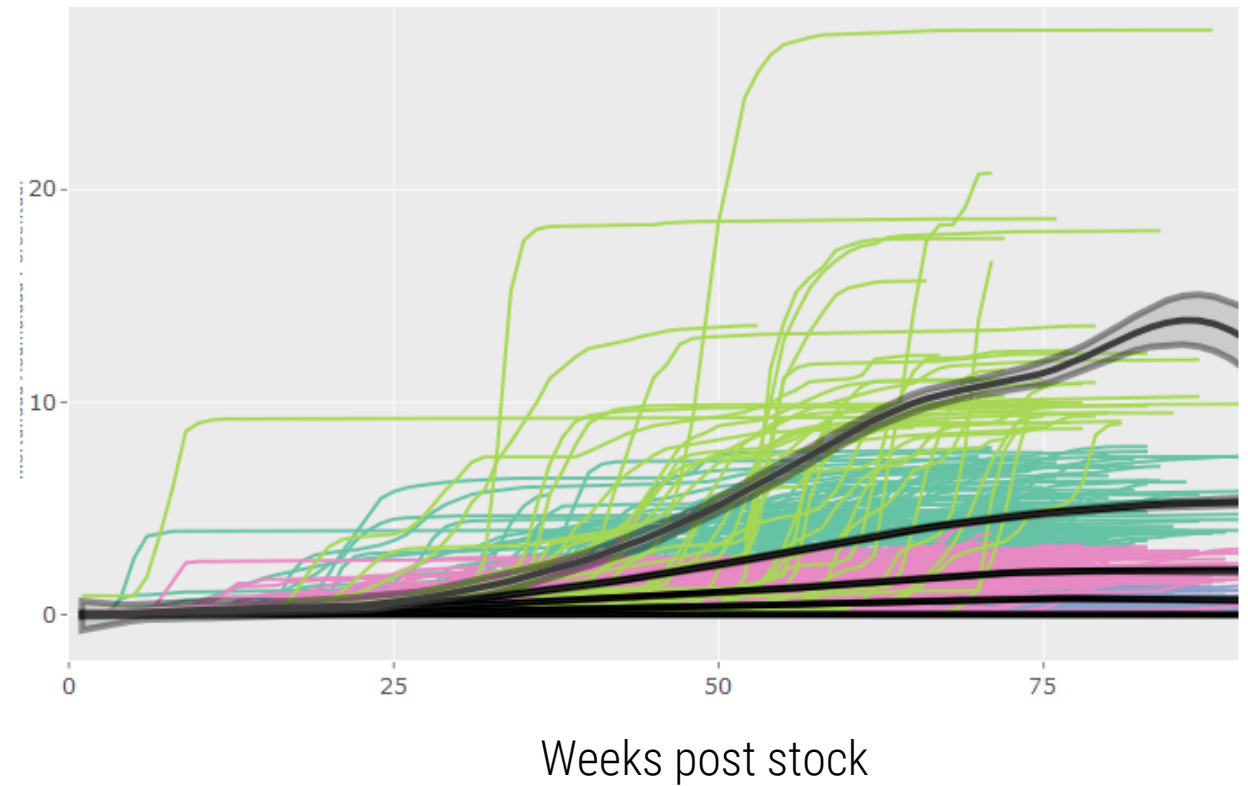
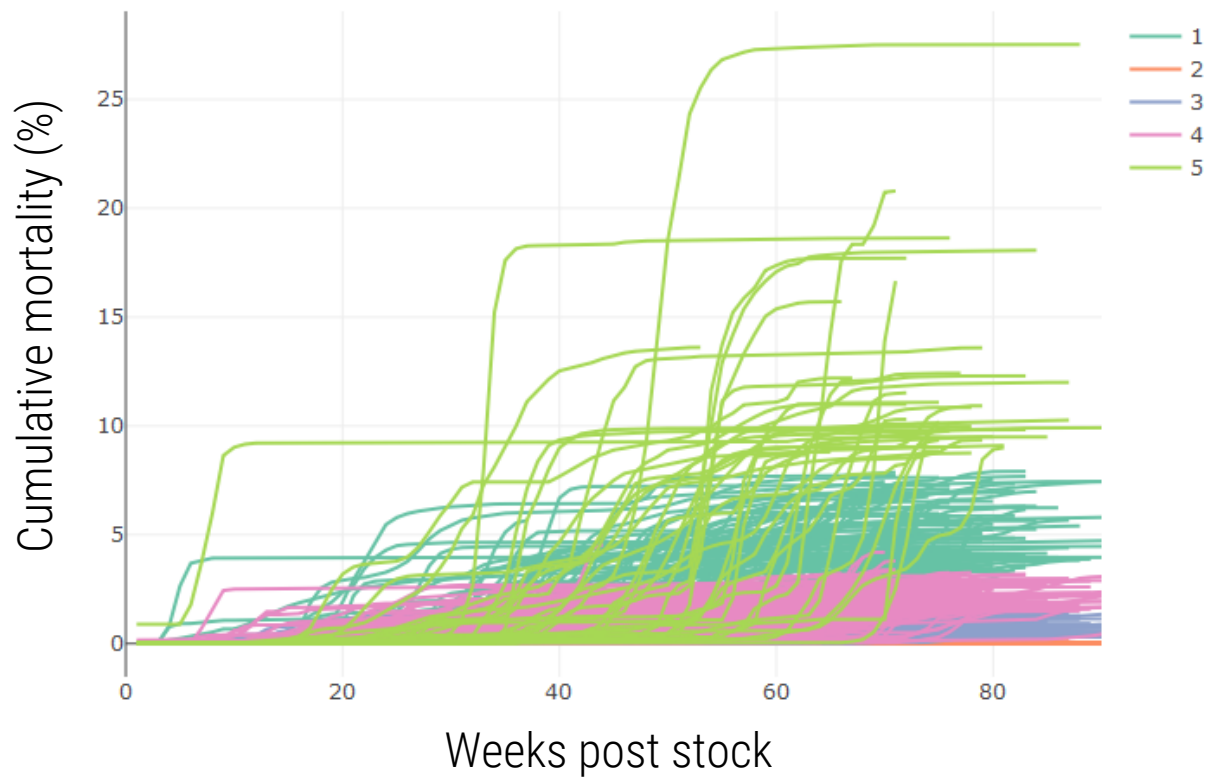


# Epidemiological approaches

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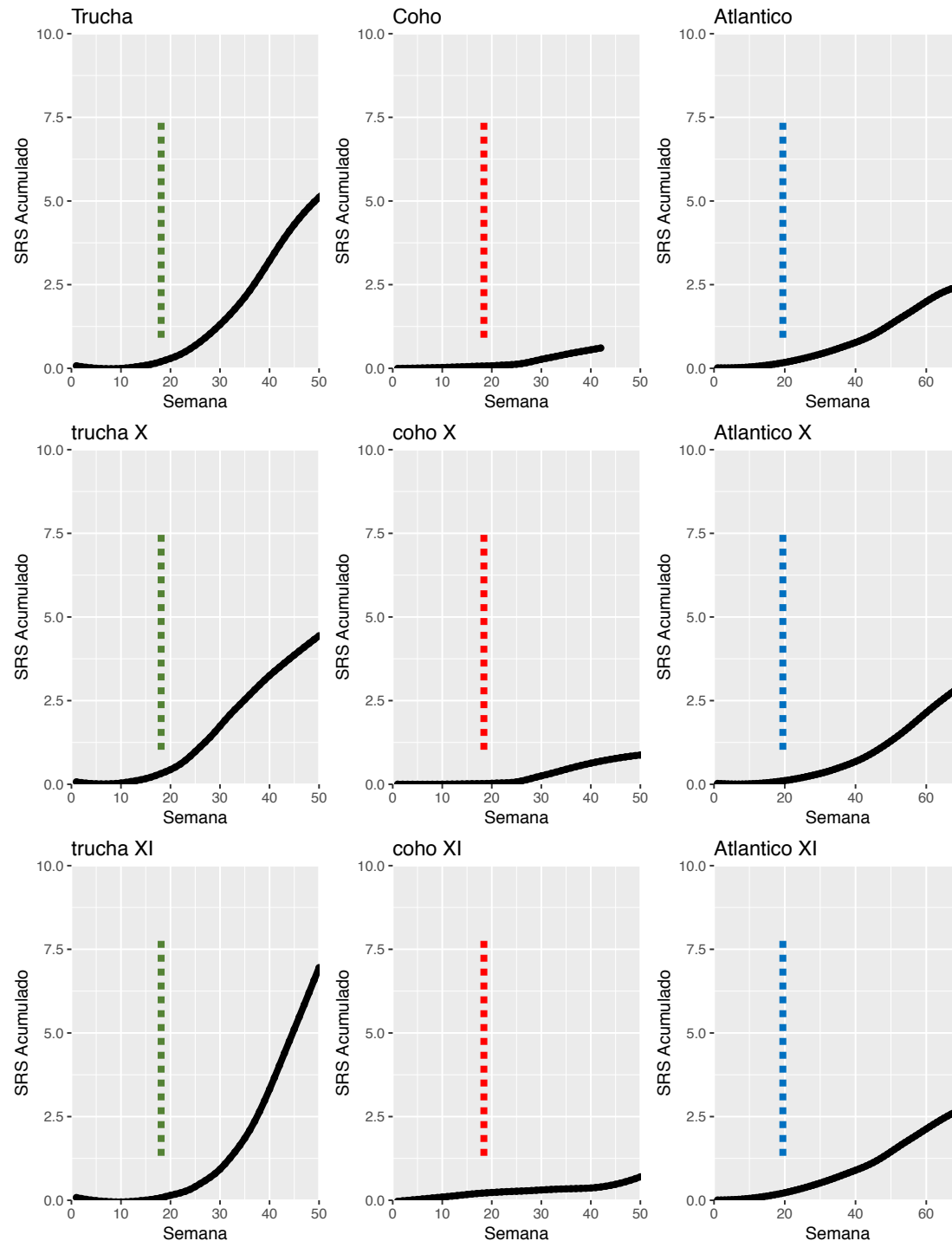
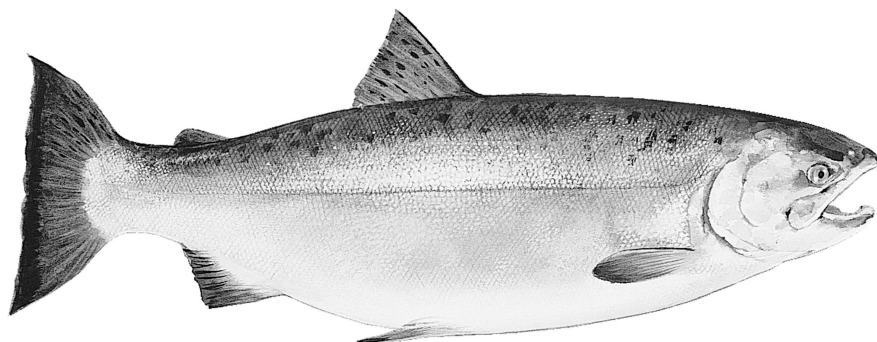
- **Baseline levels of mortalities attributable to pathogens**
  - Dynamic time warping (optimal alignment between time series data)
- **Identification of risk factors**
  - Mixed effects regression models
  - Occurrence
  - Magnitude
  - Time to onset of clinical signs
- **Early warning and detection systems**
  - Bayesian Belief Network
- **Spatial and spatio-temporal analysis**
  - Local cluster analysis
  - Endemic-epidemic modeling

# Baseline levels of mortality: *Piscirickettsiosis*



Pacific salmon is more resistant to:

- Sea lice infestations
- *Piscirickettsia salmonis*
- Infectious salmon anemia virus – ISAV



# Structural risk

## Spatial distribution of salmon farms

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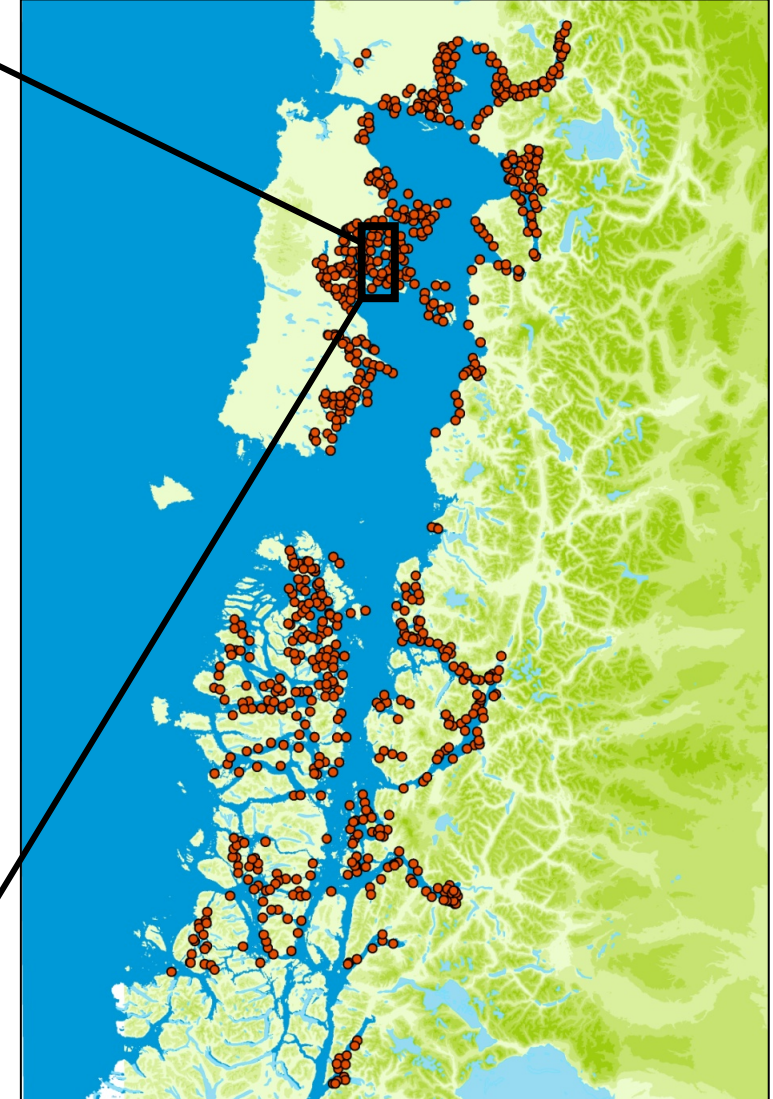
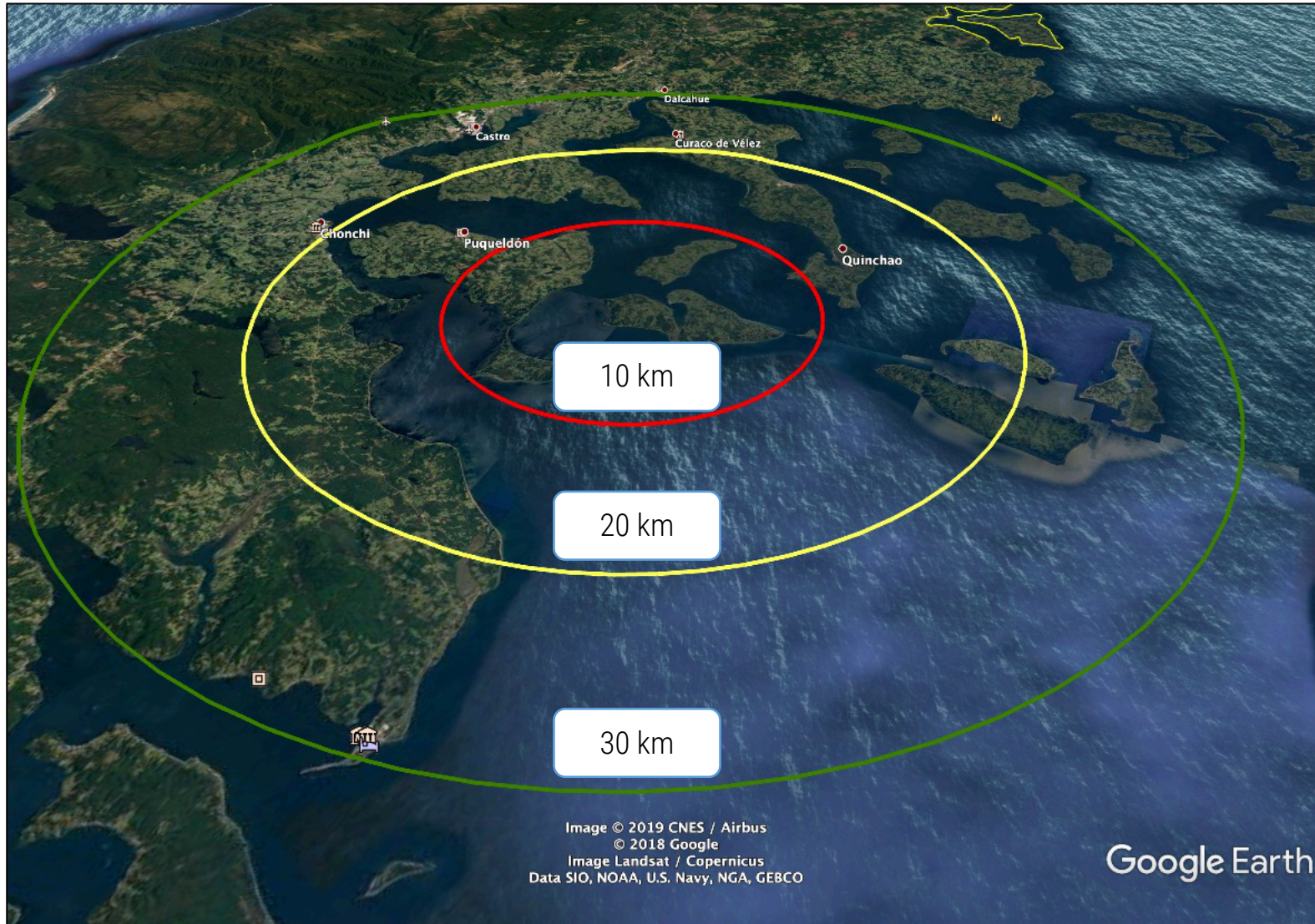


Pathogen	Critical distance (in km)	Reference
Infectious salmon anemia virus (ISAV)	7.5 – 15	Mardones et al., 2009
Sea lice	30	Kristoffersen et al., 2013
ISAV-sealice	12.7	Valdes-Donoso et al., 2013
Infectious pancreatic necrosis virus	10	Escobar-Dodero et al., 2019
<i>Piscirickettsia salmonis</i>	7.5 – 10	Rees et al., 2014

On average, spatial risk for a number of diseases ranges between 10 to 13 km.

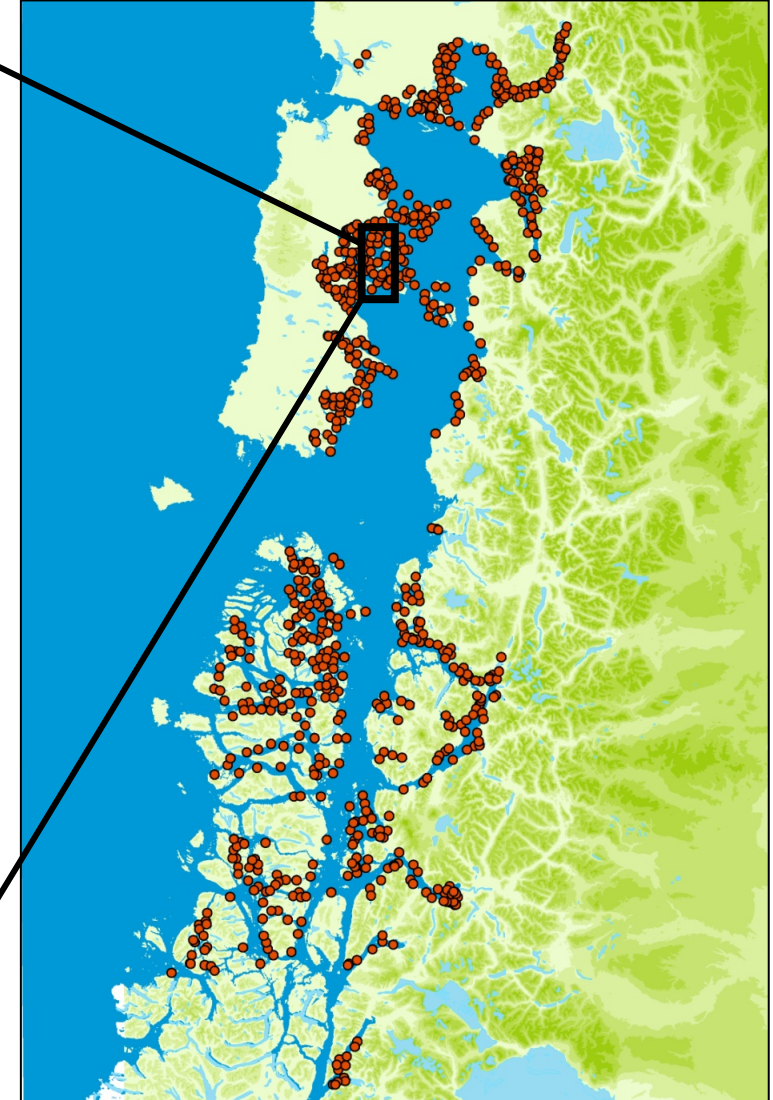
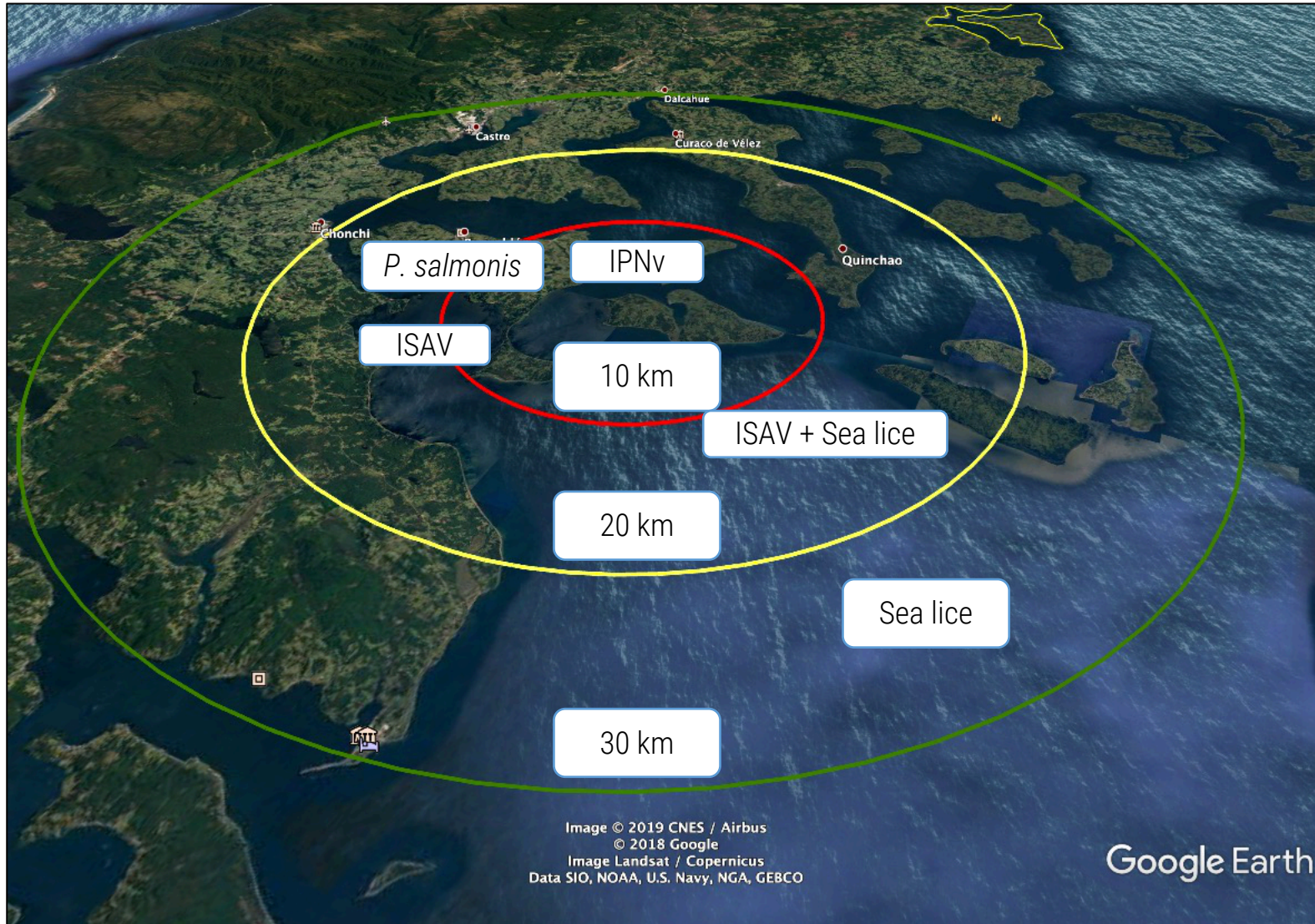
# Structural risk

## Spatial distribution of salmon farms



# Structural risk

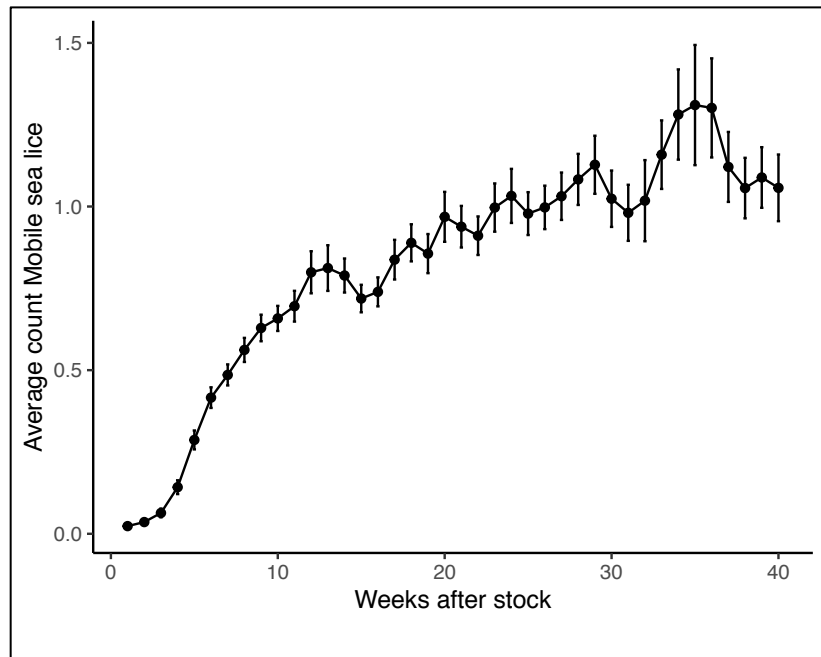
## Spatial distribution of salmon farms



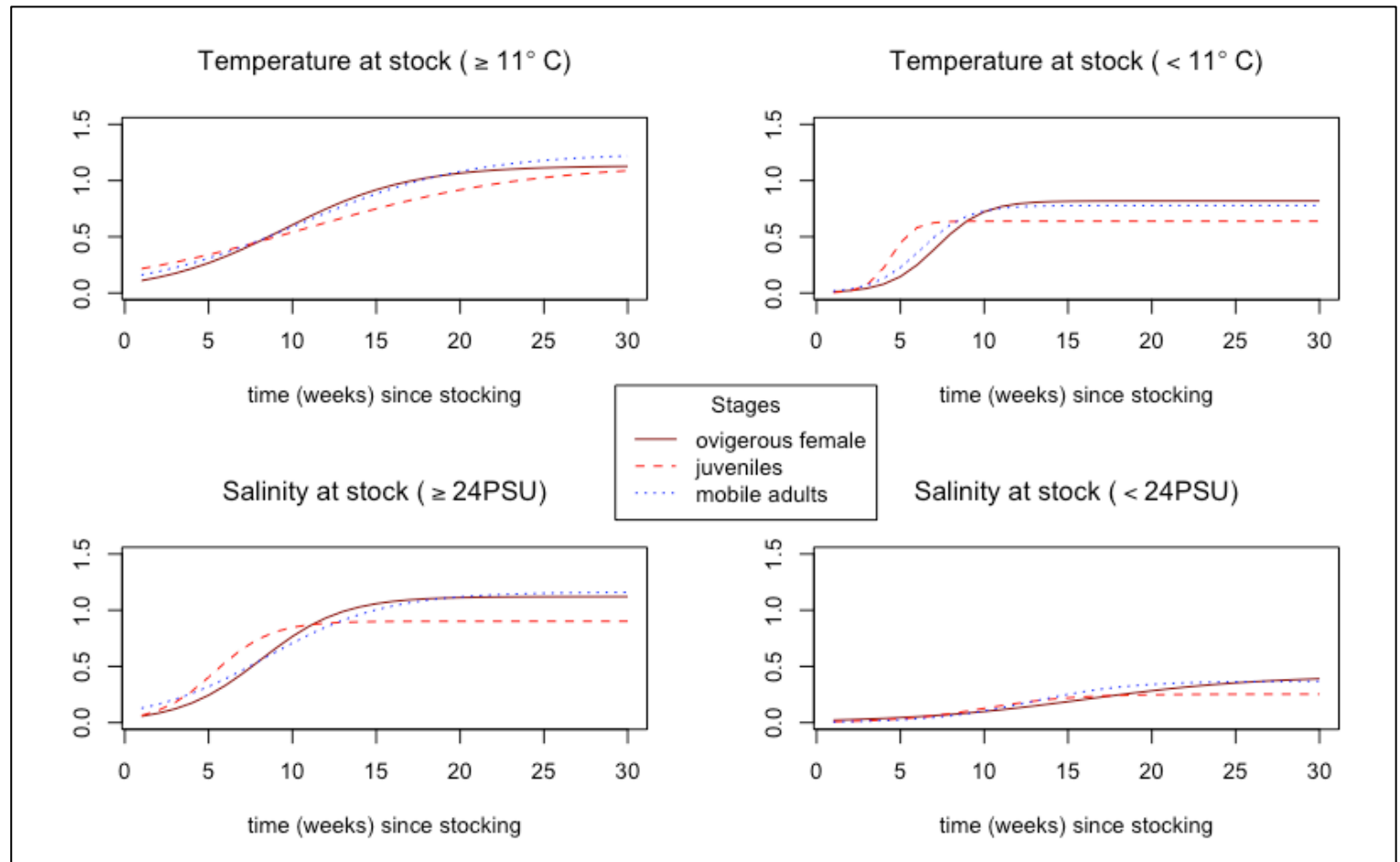
# Early characterization of sea lice infestation

## *288 Atlantic salmon production cycles (2014-2016)*

Observed sea lice counts



Fitted by logistic function

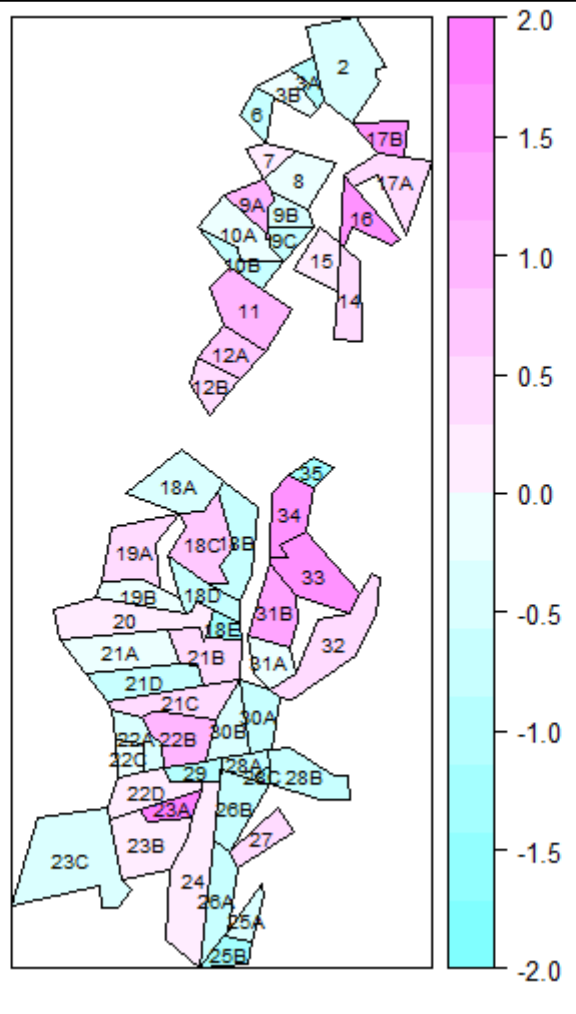


# Endemic-epidemic modeling of sea lice

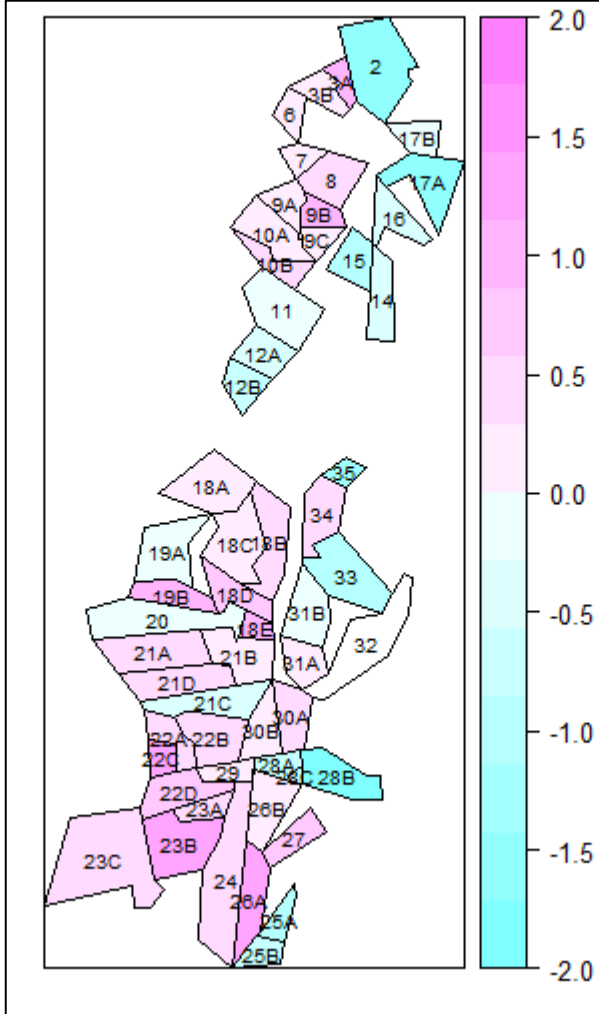
## Decomposition of disease counting at area levels



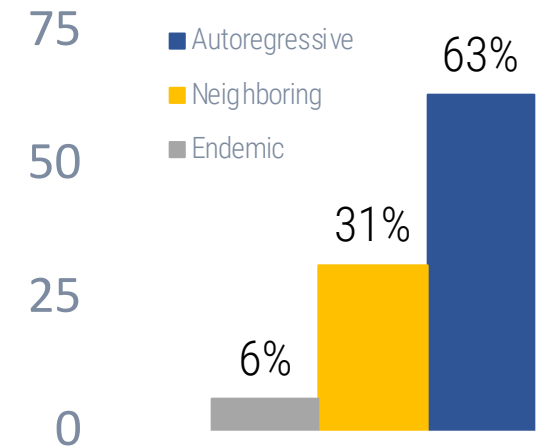
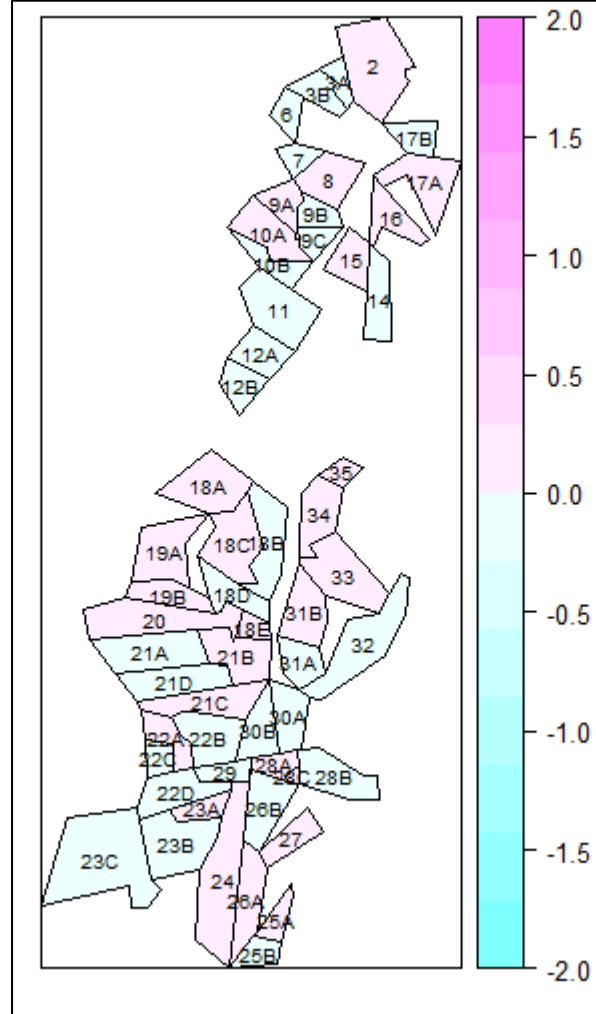
Autoregressive



Neighboring



Endemic





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# Summary

## Main drivers for salmon diseases

- Distance between farms (spatial planning)
- Number of fish at the farm (profit)
- Water temperature and salinity (climate?)
- Salmon species (market driven)
  - Atlantic salmon > rainbow trout > Pacific salmon
- Smolt quality (fresh water management)
- Complexity of pathogens and interactions

# Acknowledgments



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- Collaborative network



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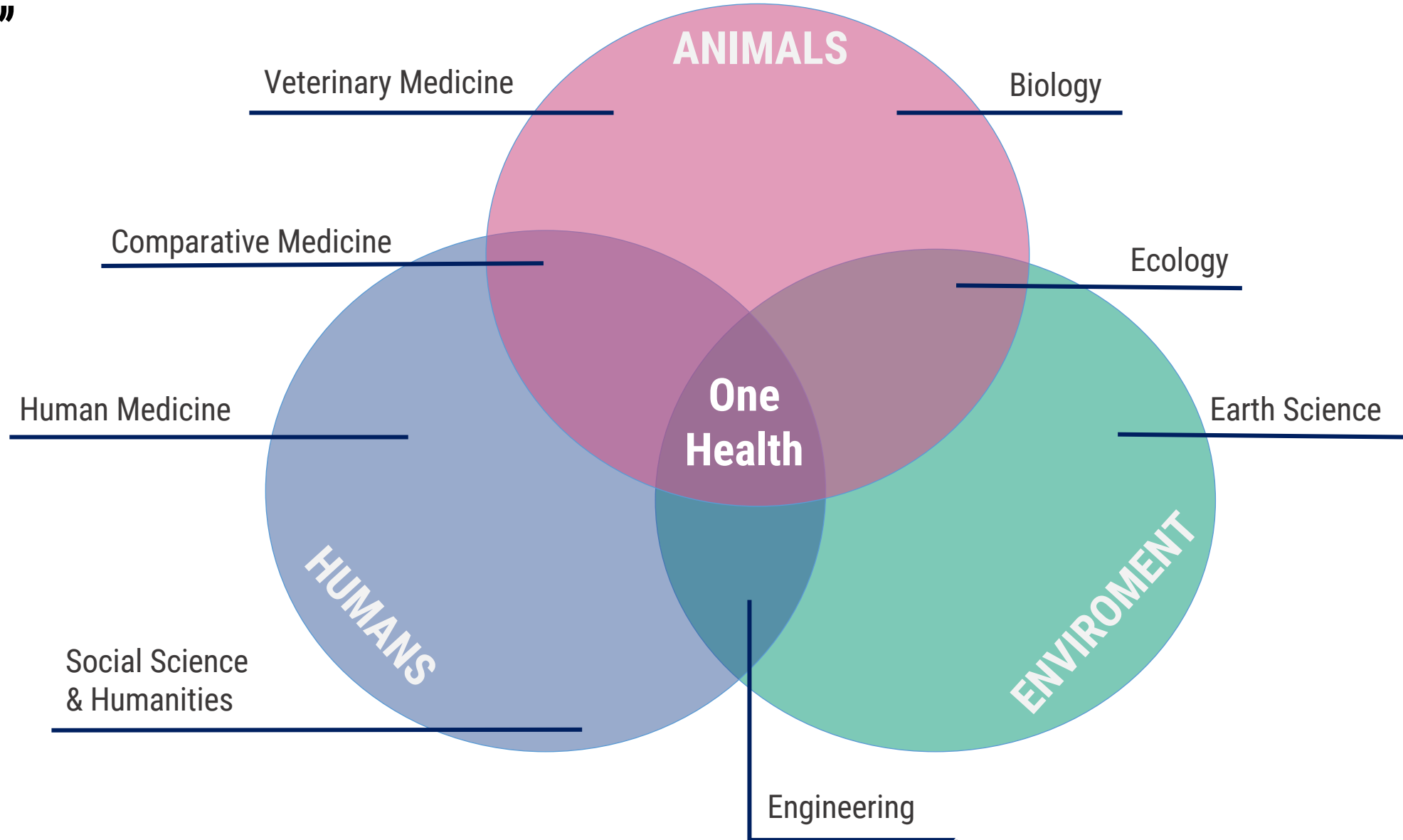


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- Funding from:

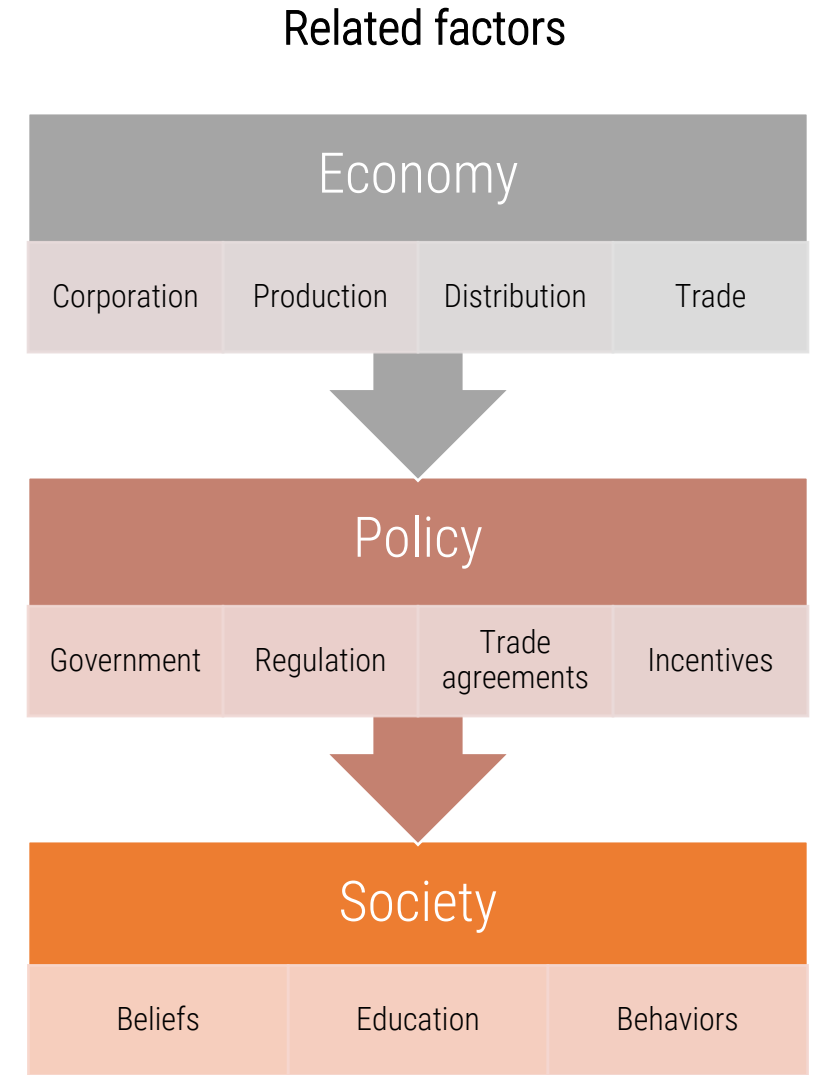
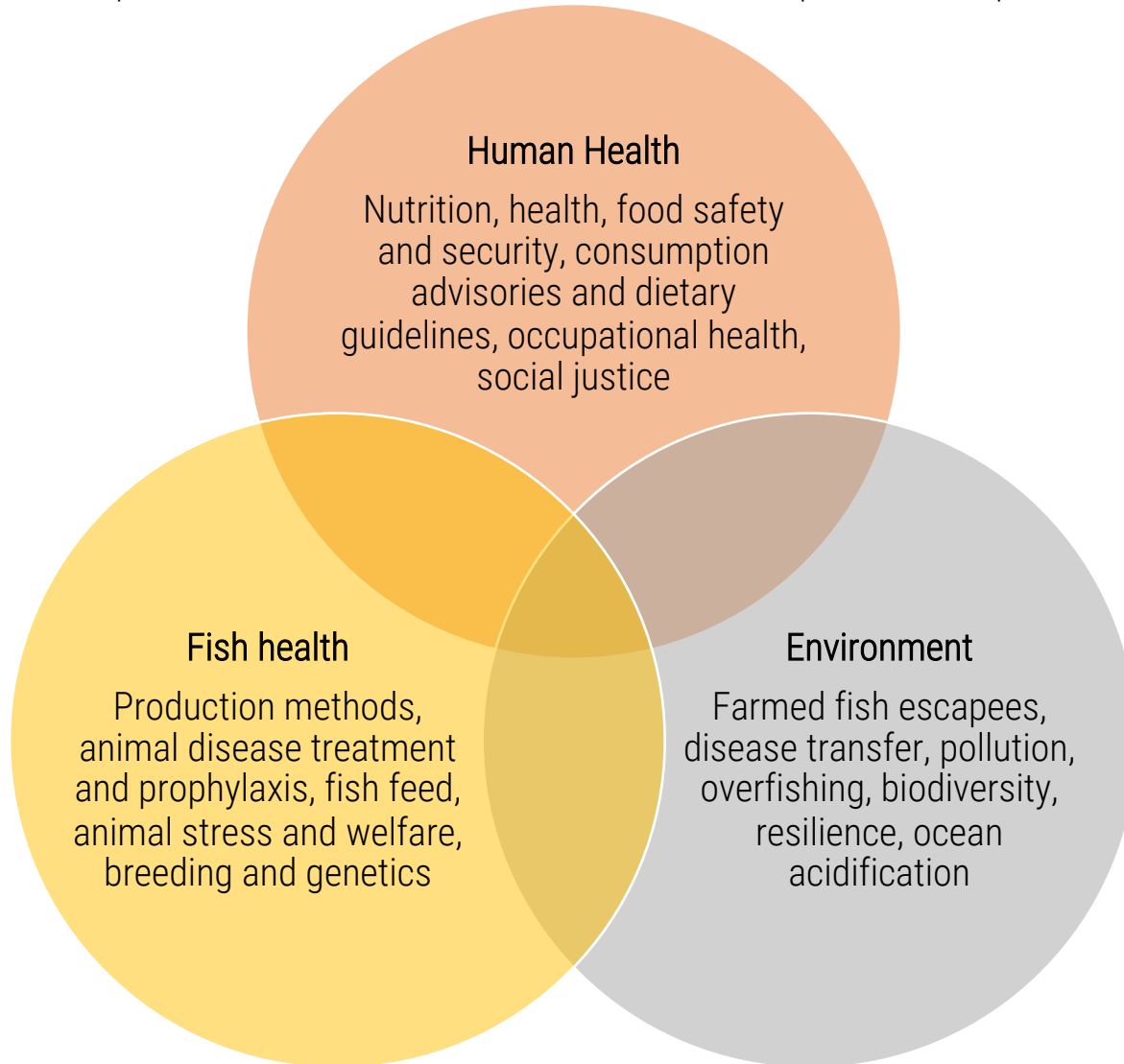


# A relatively new concept “One Health”



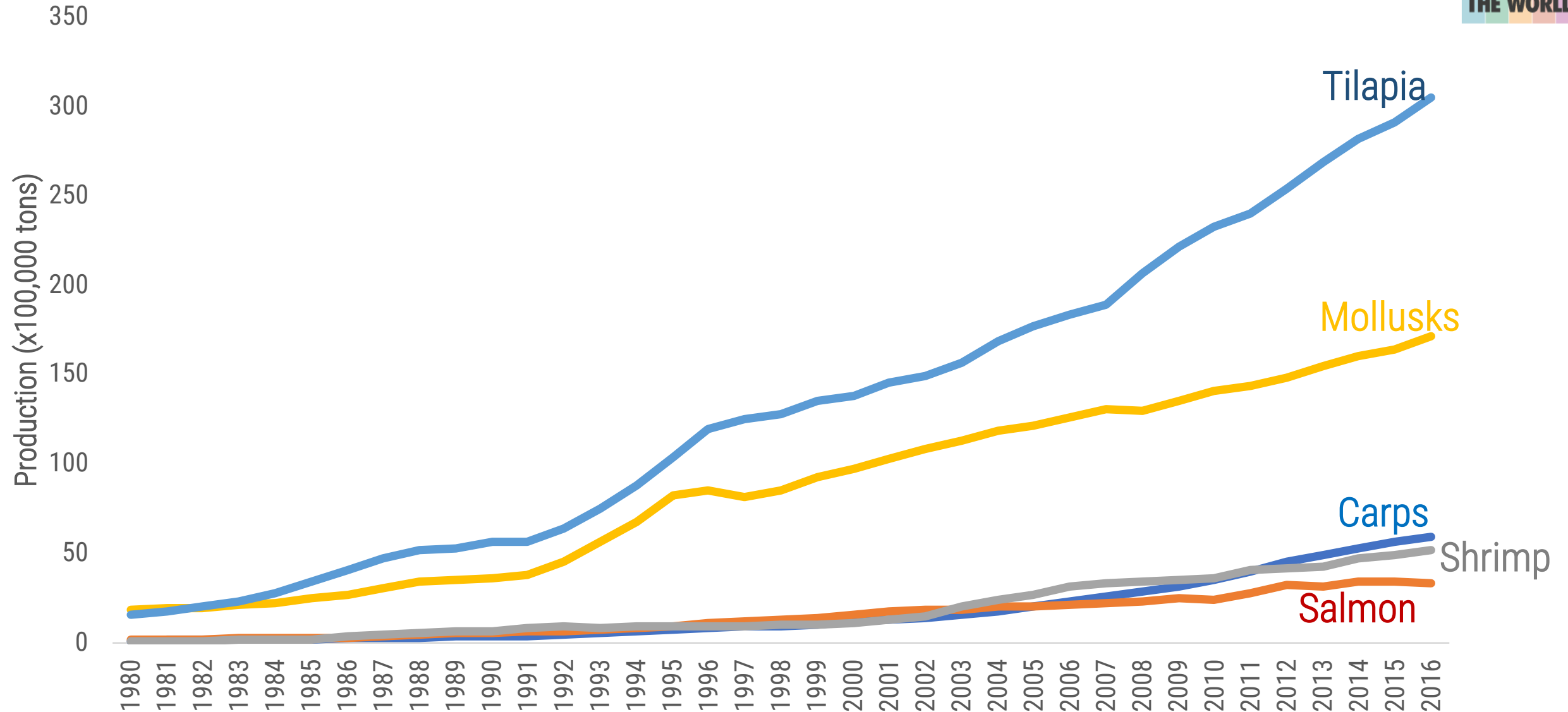
# Key topics of One Health and Aquaculture

Adapted from Gormaz et al., 2014. Public Health Perspectives on Aquaculture



# Global Aquaculture Production (1980-2016)

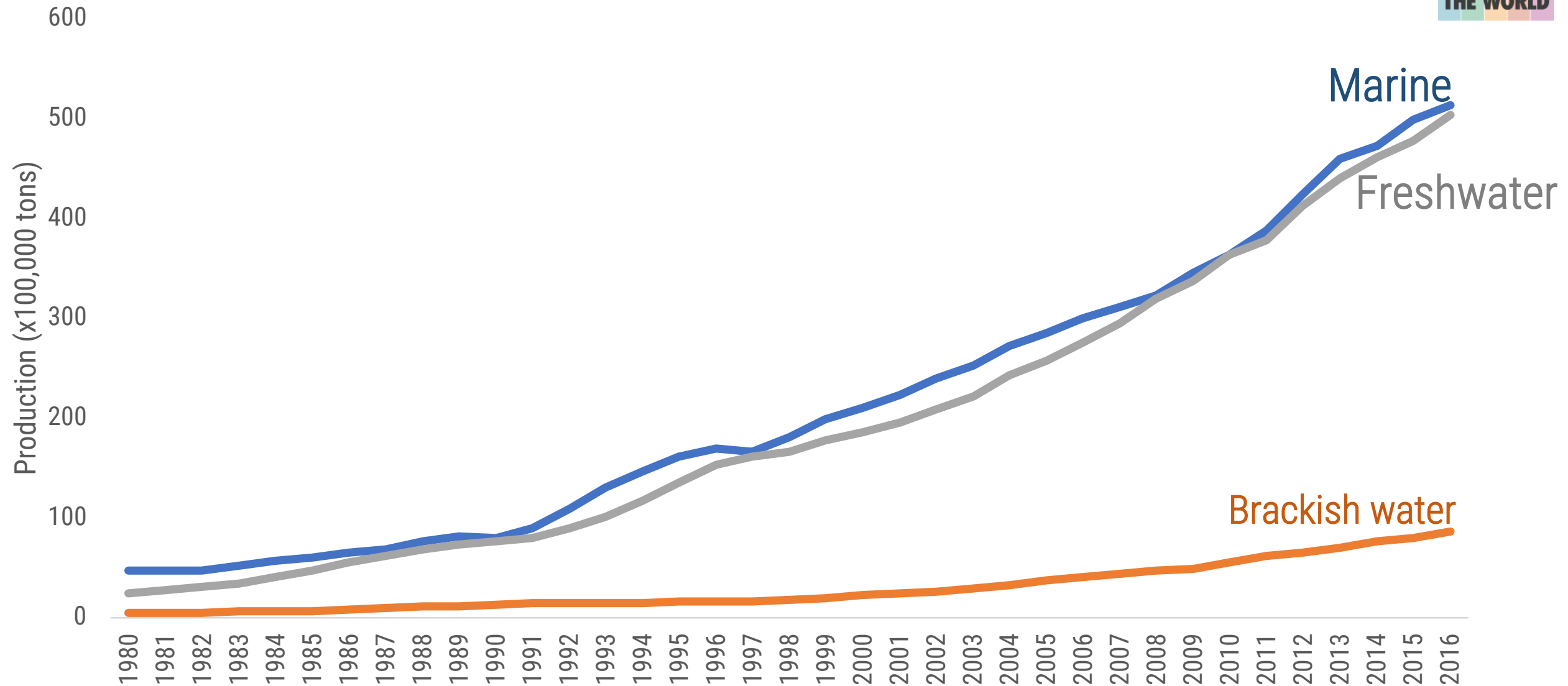
## Selected Species



Source: FAO, Fisheries and Aquaculture Department  
<http://www.fao.org/fishery/en>

# Global Aquaculture Production (1980-2016)

## Culture environment



Source: FAO, Fisheries and Aquaculture Department  
<http://www.fao.org/fishery/en>

