Under pressure: Fisheries and climate change in a highly vulnerable marine ecosystem

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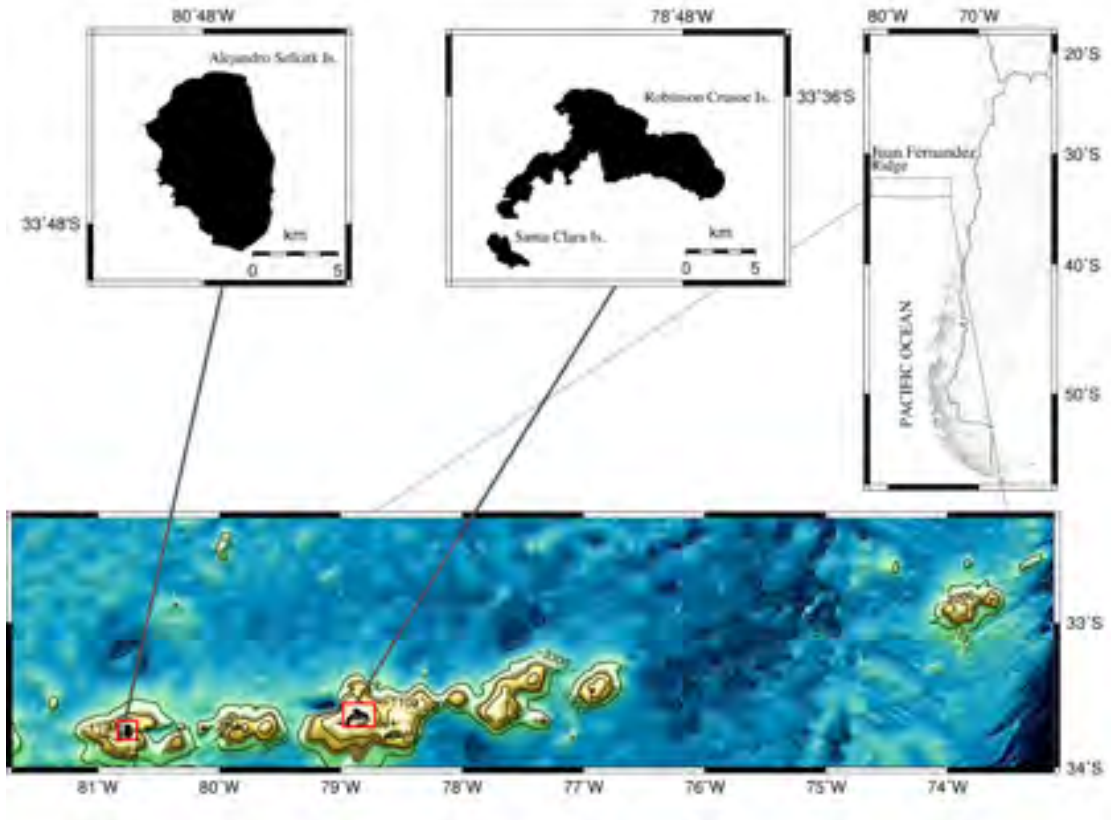
Juan Fernández Ridge Ecosystem

Location - Structure

- 1% Chilean Territory
- Approximately 97,166 km^2
- Juan Fernández Archipelago
  - 1000 inhabitants (aprox.)
  - Robinson Crusoe - Santa Clara
  - Selkirk

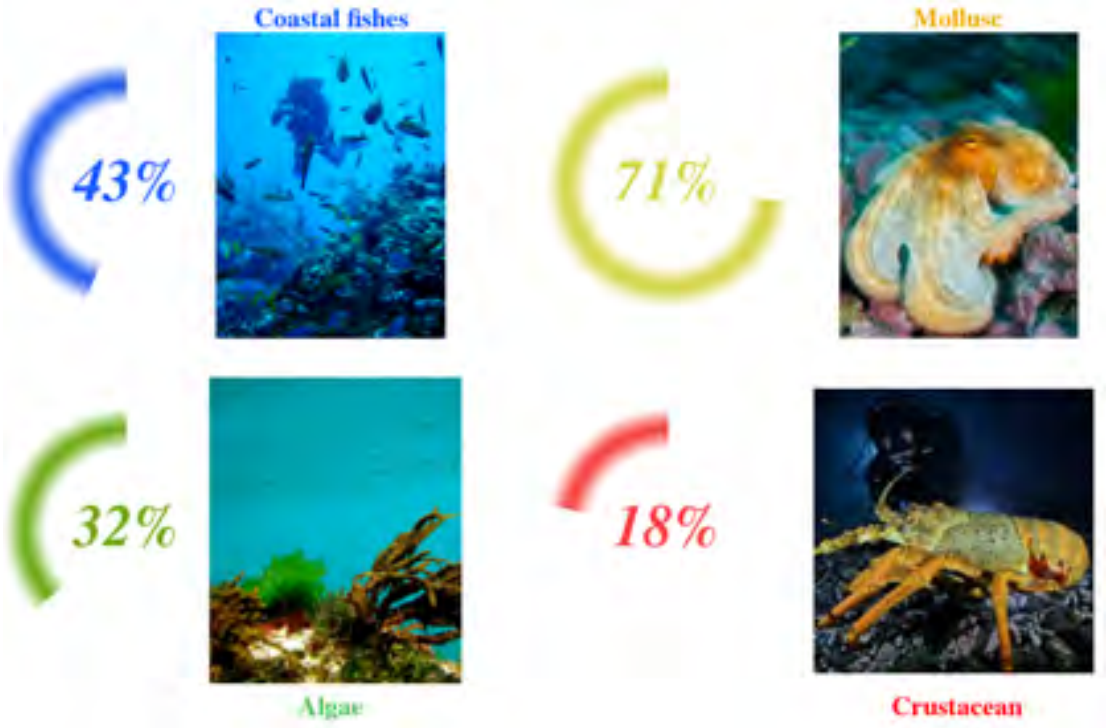


Juan Fernández Ridge Ecosystem

JFRE as a VME

- 80% of endemism
- 60% historical extinctions
- 59% threatened or rare species
- Biosphere Reserve (1977)
- Highest Conservation Priority Chile

Percentage of Marine Endemism

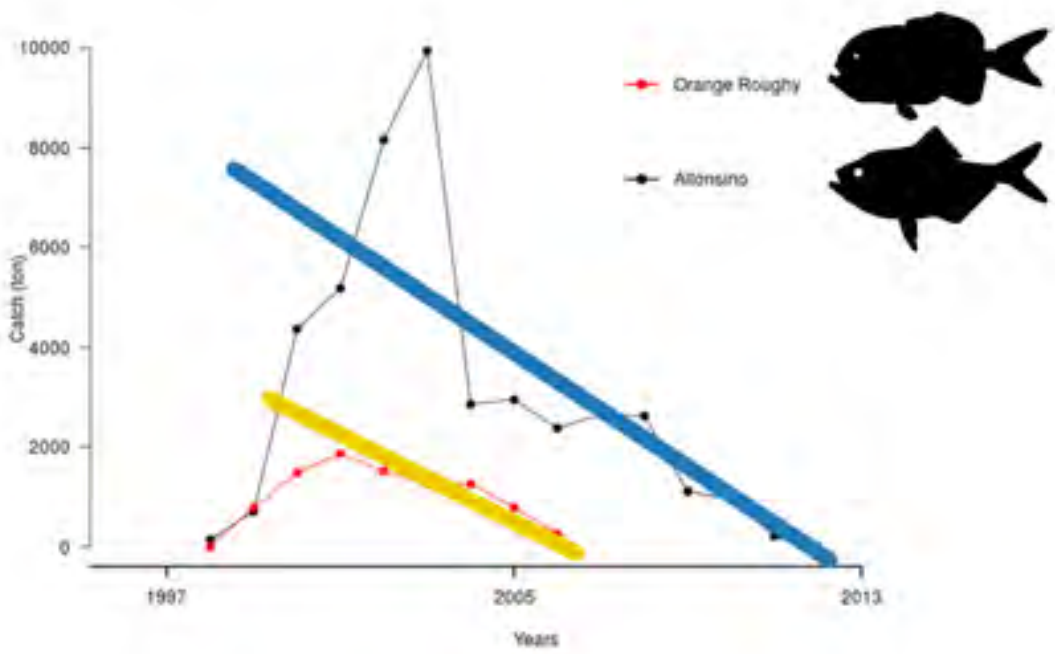


ECONOMY - **Fisheries**

THE INDUSTRIAL FLEET

THE HISTORY OF A FAILURE

- Trawling fisheries
- Boom-and-Bust fishery
- Both currently closed
  - 2006 Orange roughy
  - 2012 Alfonsino

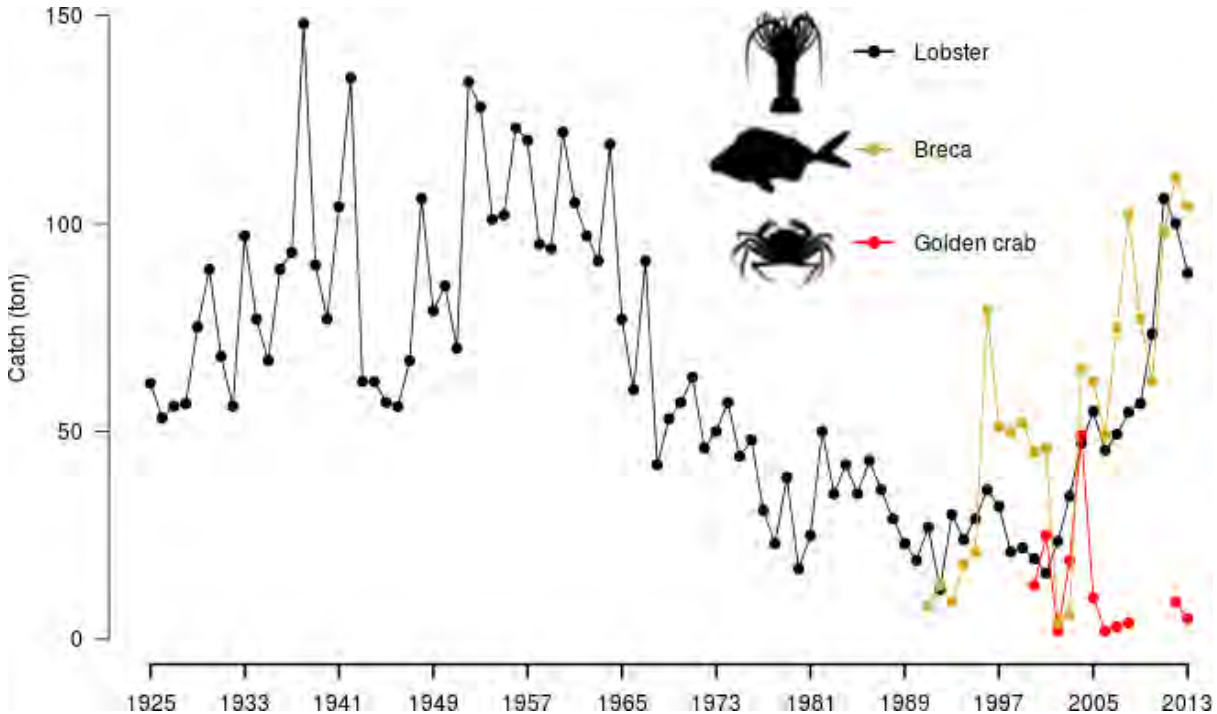


THE ARTISANAL FLEET

A FRAGILE SOCIO-ECONOMIC SYSTEM

- Tightly-knit fishing community
- Main economic income
  - 70% Lobster fishery
- Management
  - 3S type - Formal management
    - **S**ize - **S**ex - **S**eason
  - Internal code of conduct

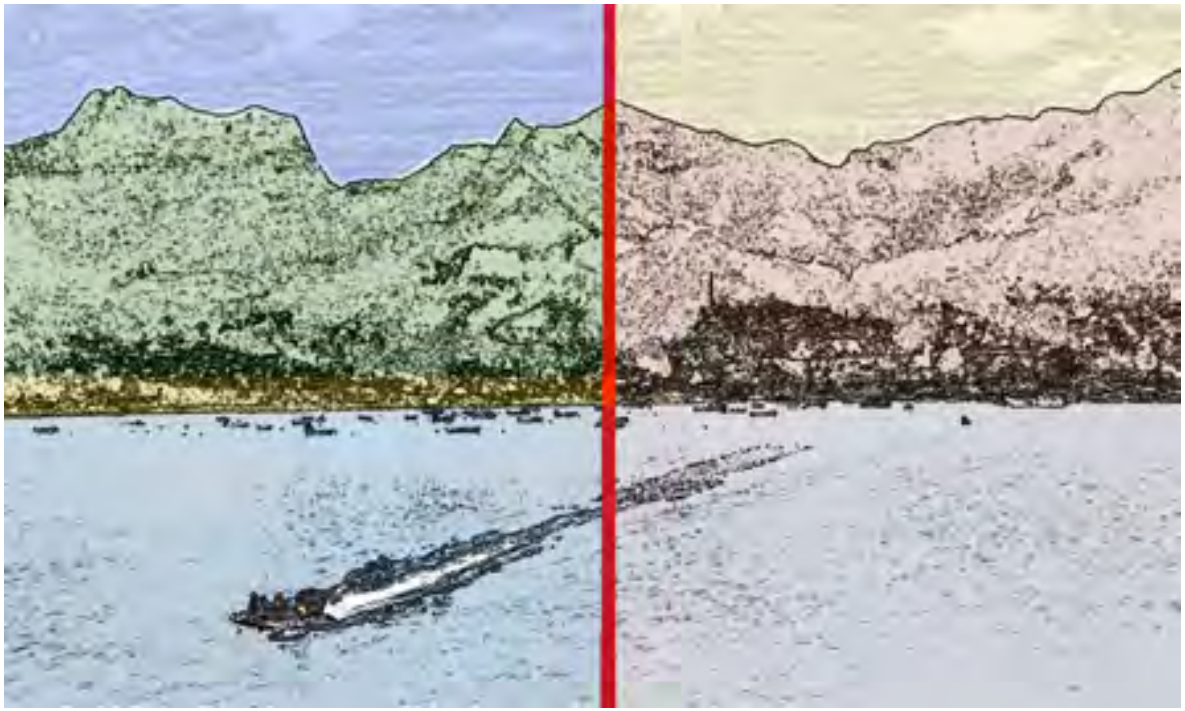
Likely future increase in fishing effort



Climate Change
Expected changes in the JFRE

- Severe increase in aridity

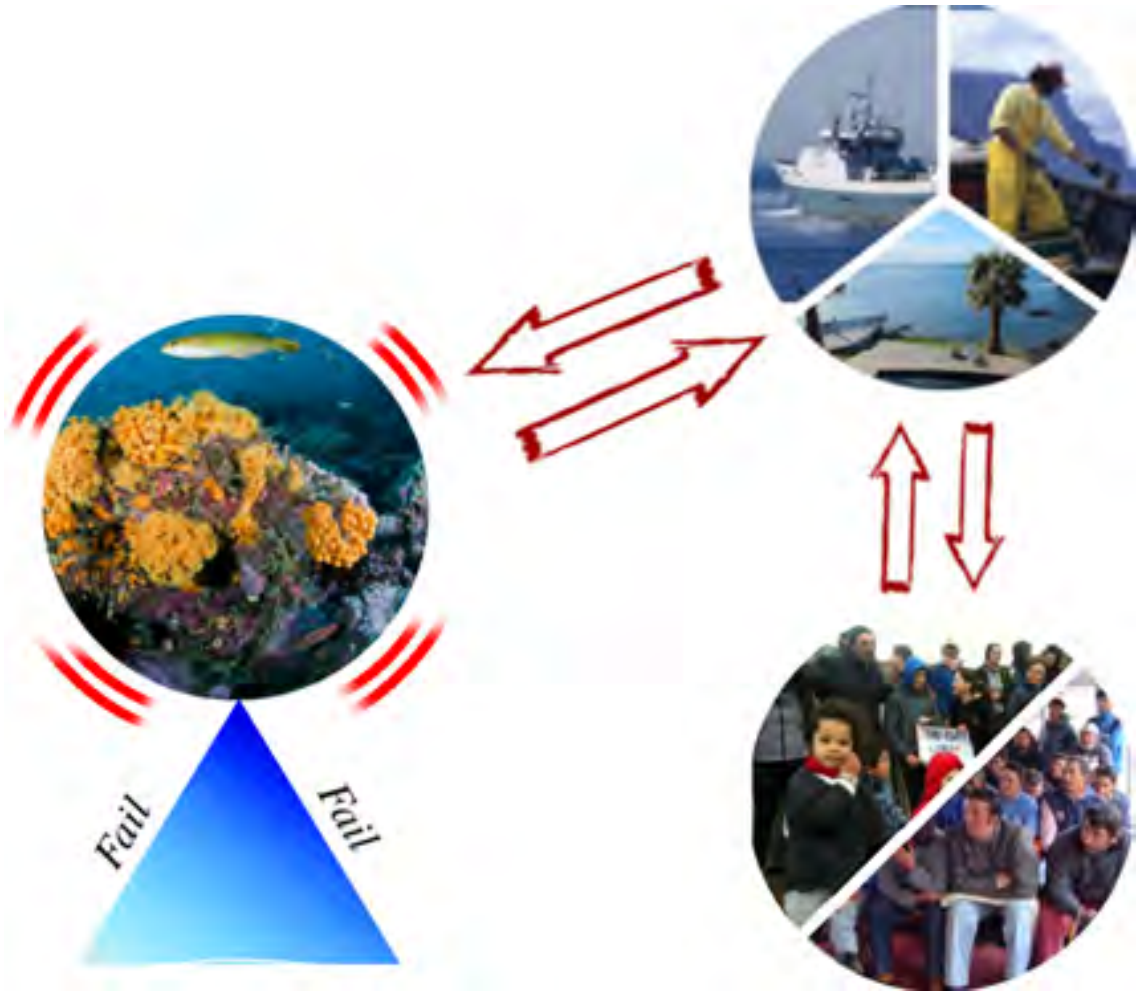
  Karnauskas *et al.* 2016
- Increase in seawater temperature



Climate Change

Impacts on resources

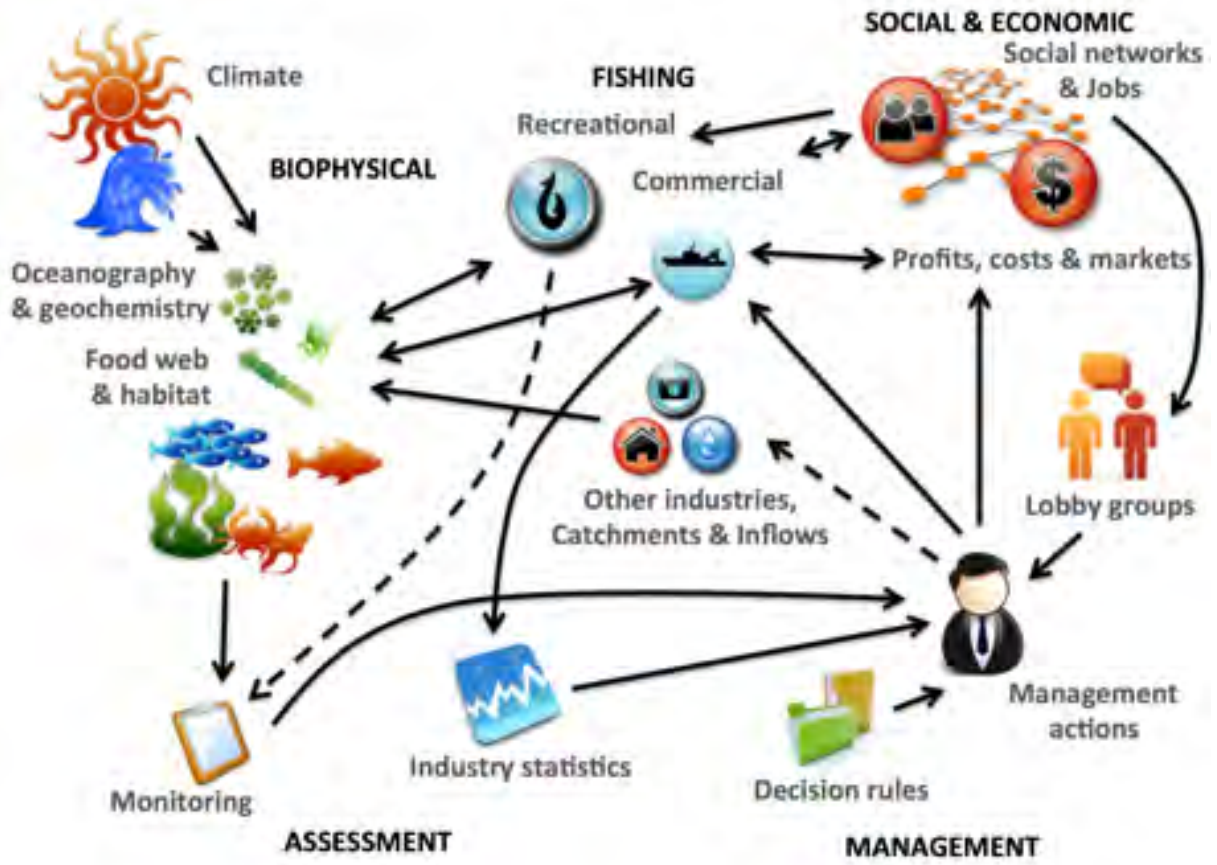
- Unknown impact on fisheries
- No fish - no food and no money
- Important management Problem
  - Fisheries
  - Political
  - Conservation
- Uncertain socio-ecological future



Assessing the impact of Climate Change in JFRE

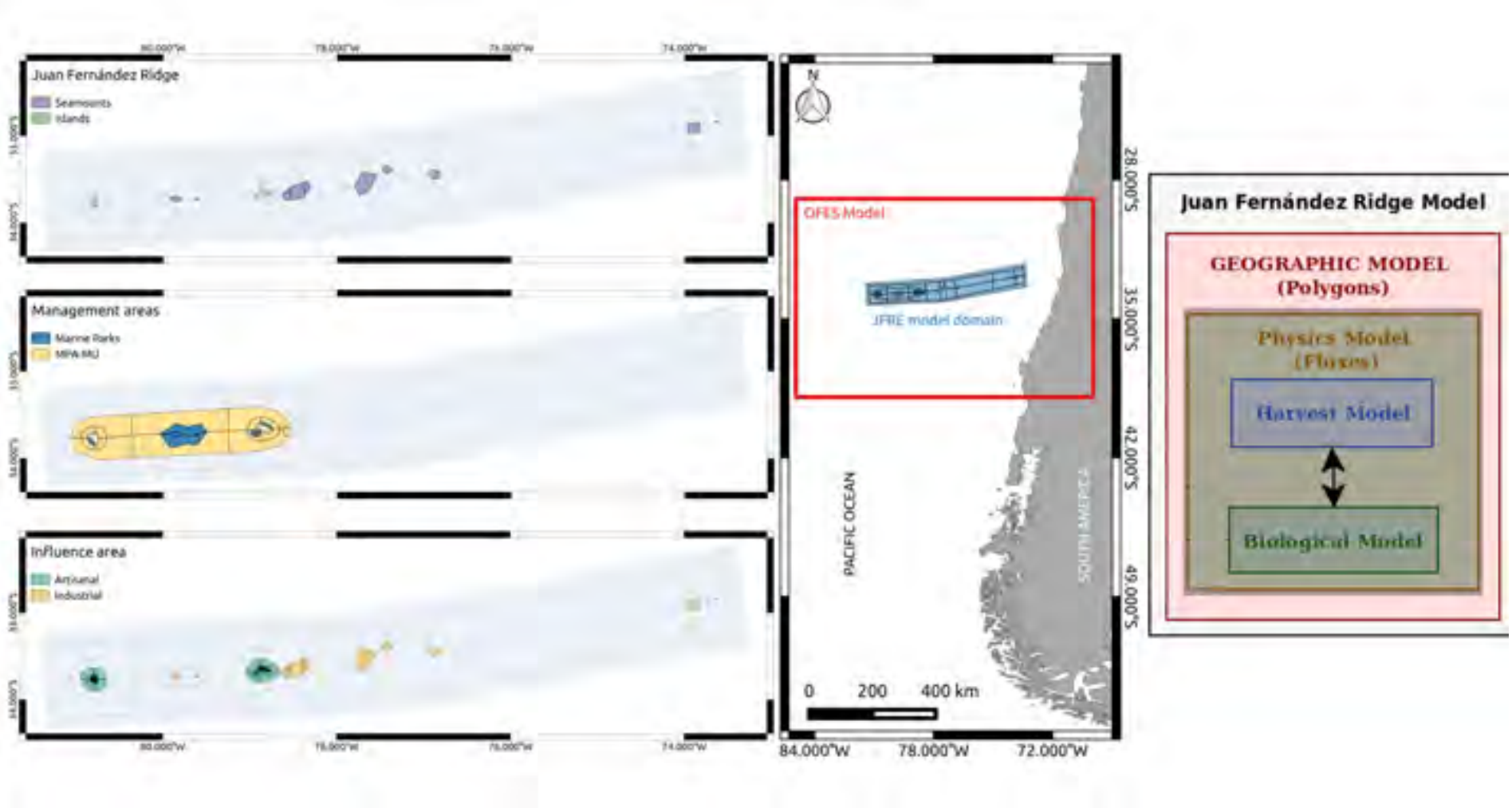
Atlantis - Short description

- Spatial explicit whole of ecosystem model
  - Physical drivers
    - Currents
    - Temperature
  - Bio-ecological processes
    - Growth
    - Reproduction
    - Trophic relation
  - Management and harvesting
    - Fishing mortality
    - Effort control
  - Social drivers
    - Revenues
    - Social impact



Assessing the impact of Climate Change

Configuration: JFRE Atlantis model



Assessing the impact of Climate Change

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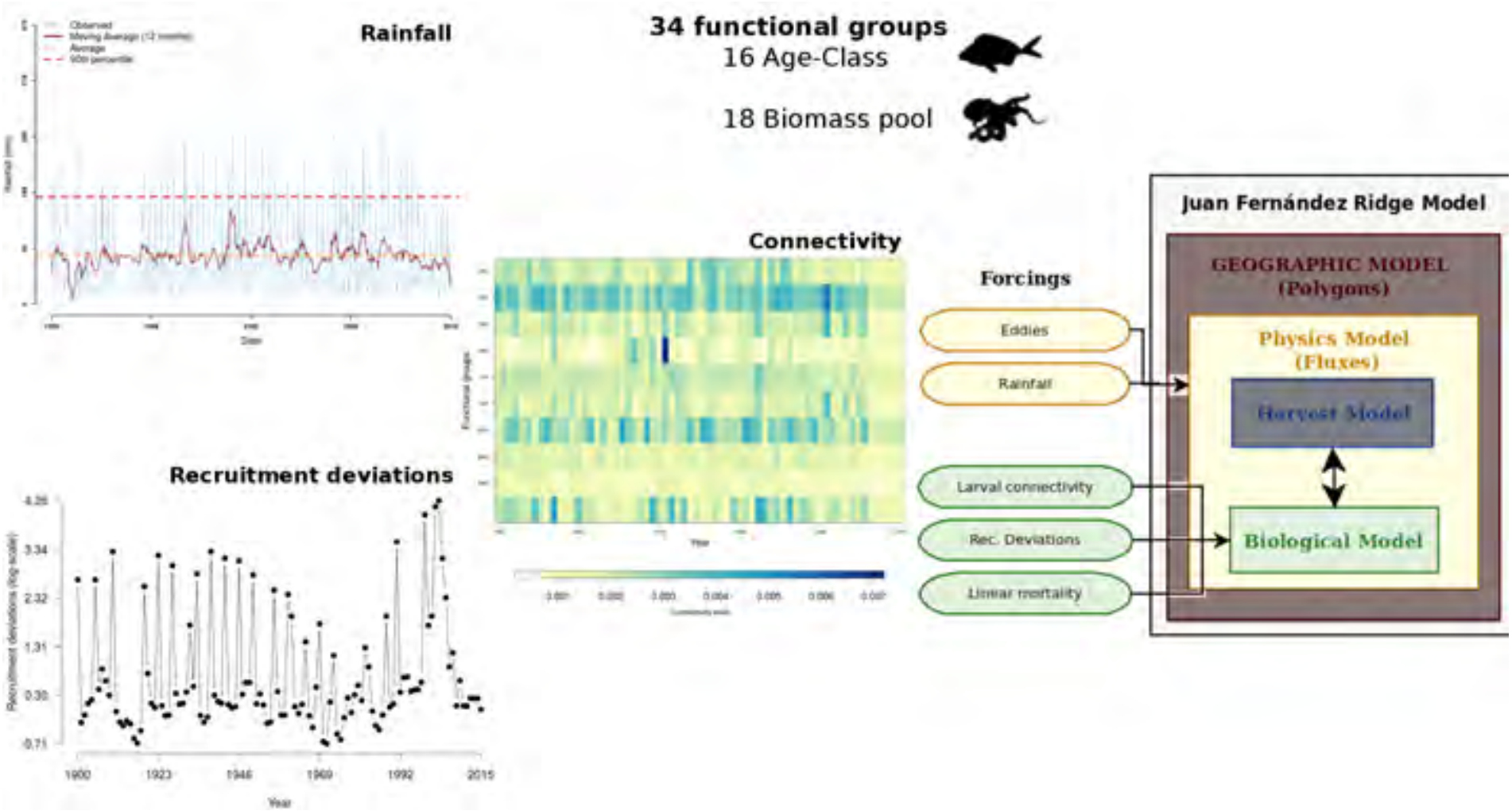

Assessing the impact of Climate Change

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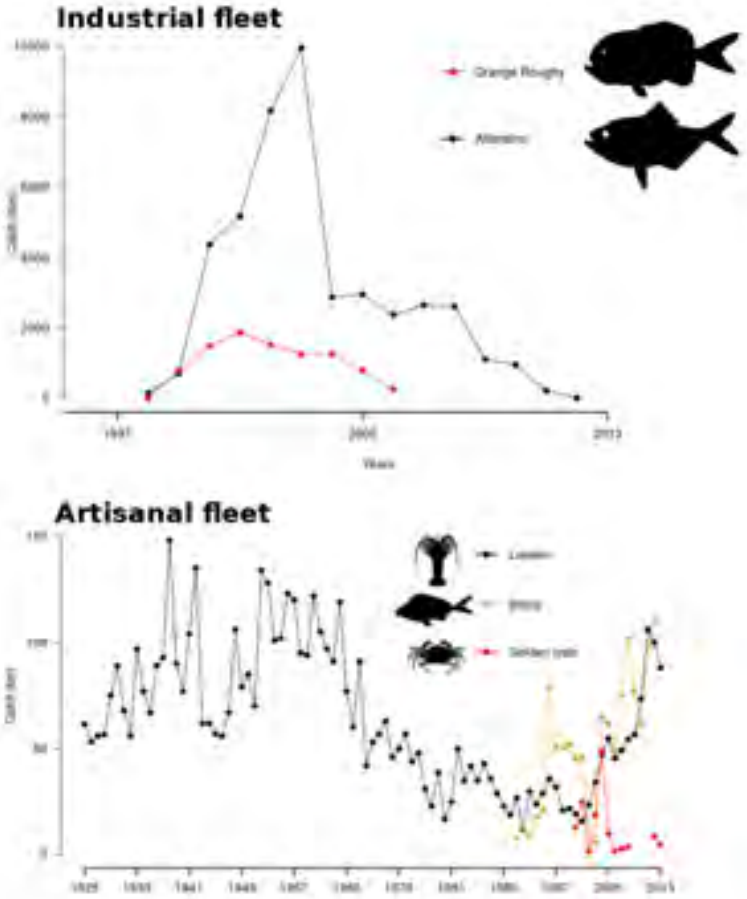
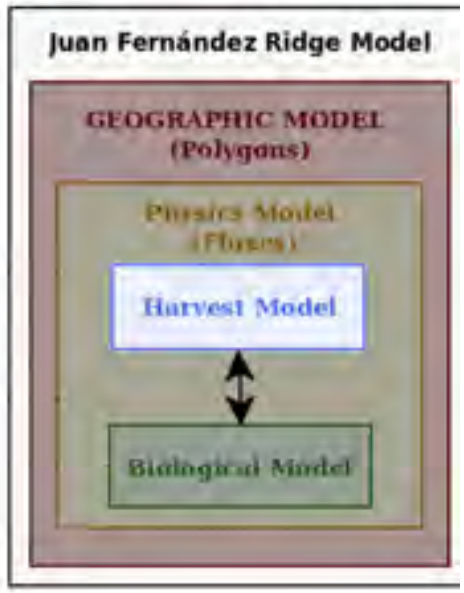
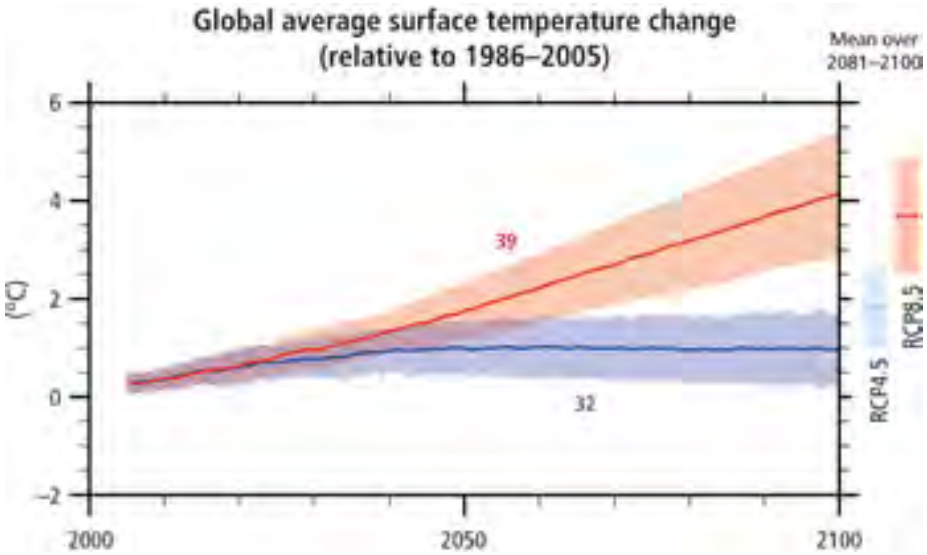
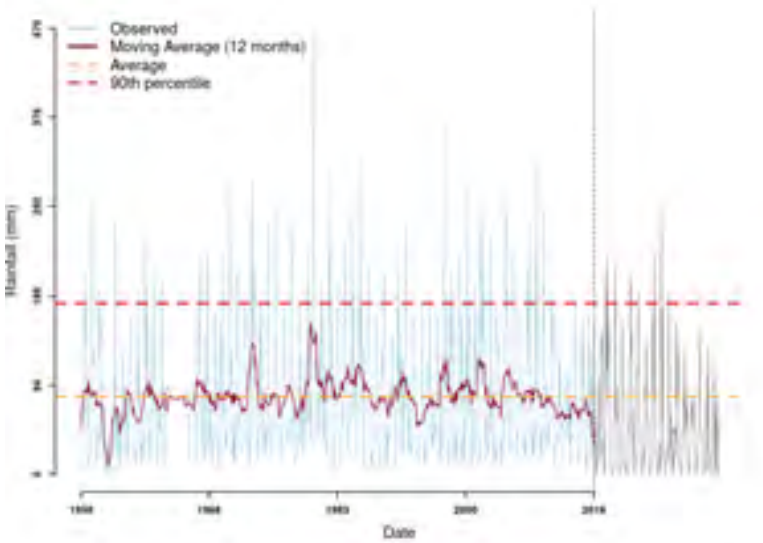




Including Climate Change

Scenarios - Projections 2050



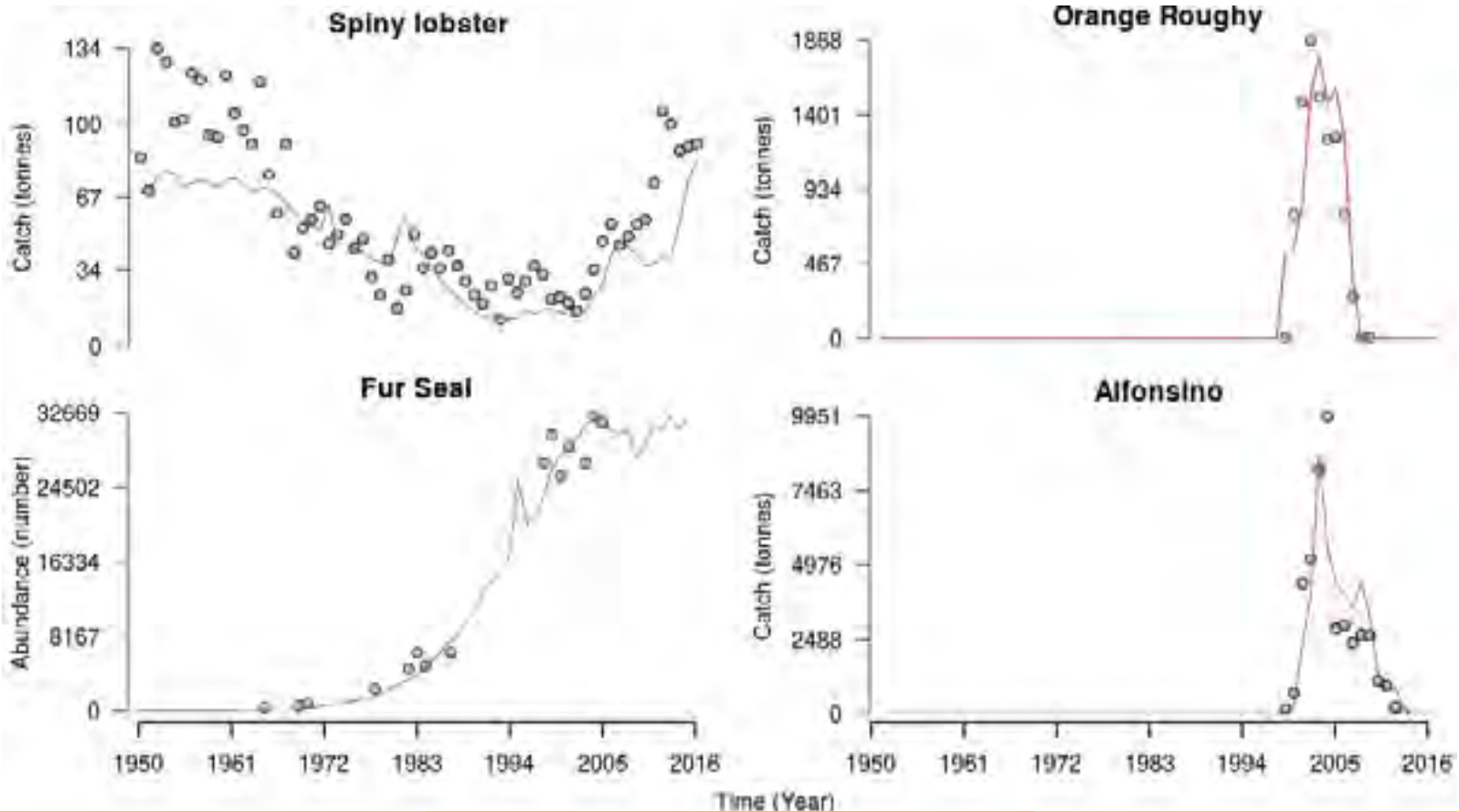


	Crustacean **C**		Finfish **F**	C. Change
Scenario	SPL	GCR		RCP 4.5&8.5
BAU	-	-	-	✓
50%↑ **C+F**	↑	↑	↑	✓
300%MIX	↓ 20%	↑	↑	✓

Model skill assessment

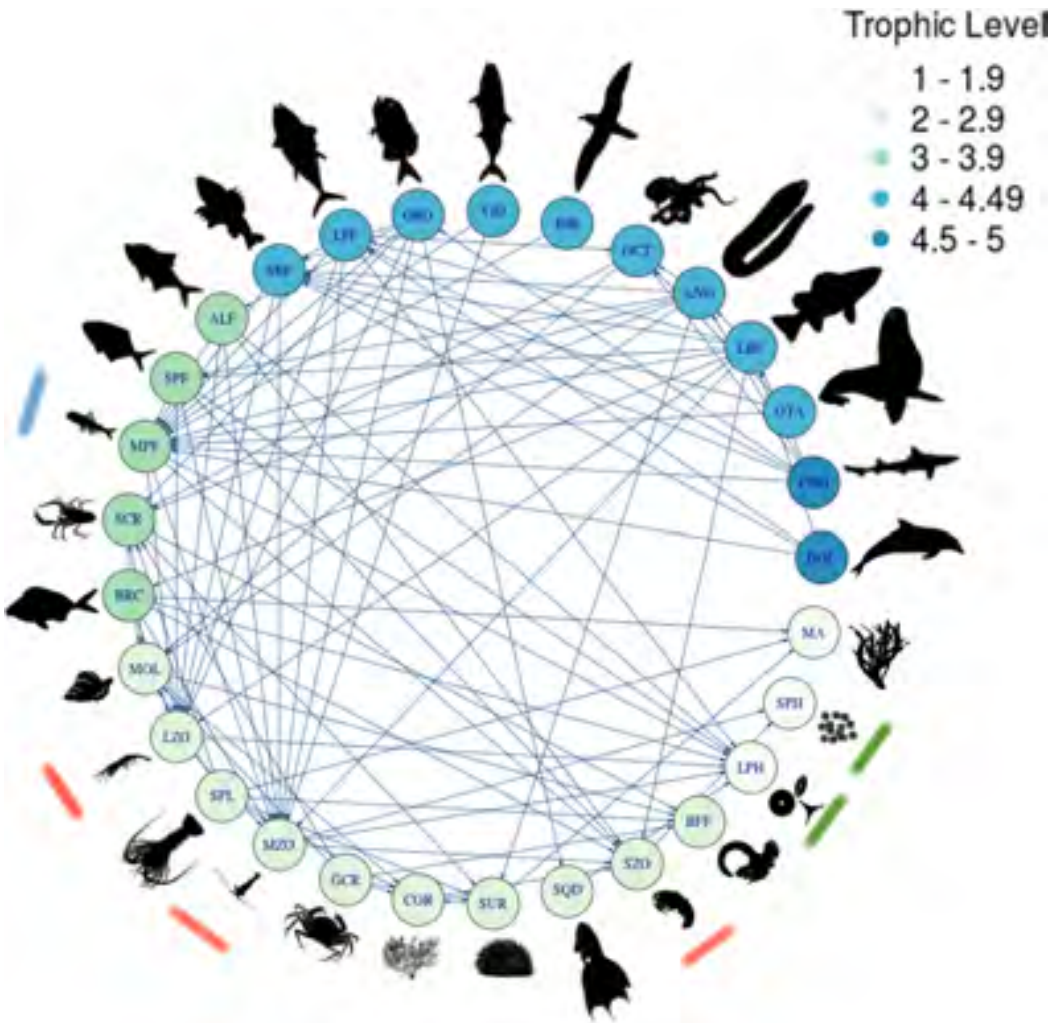
Stats

Model Efficiency ∼1
Correlation ∼0.9



TROPHIC LEVELS

JFRE SIMULATED AVERAGE FOOD-WEB



- Highly dependent on local primary production
- The major component of the food web:
  - phytoplankton
  - zooplankton
  - mesopelagic fishes

TROPHIC LEVELS

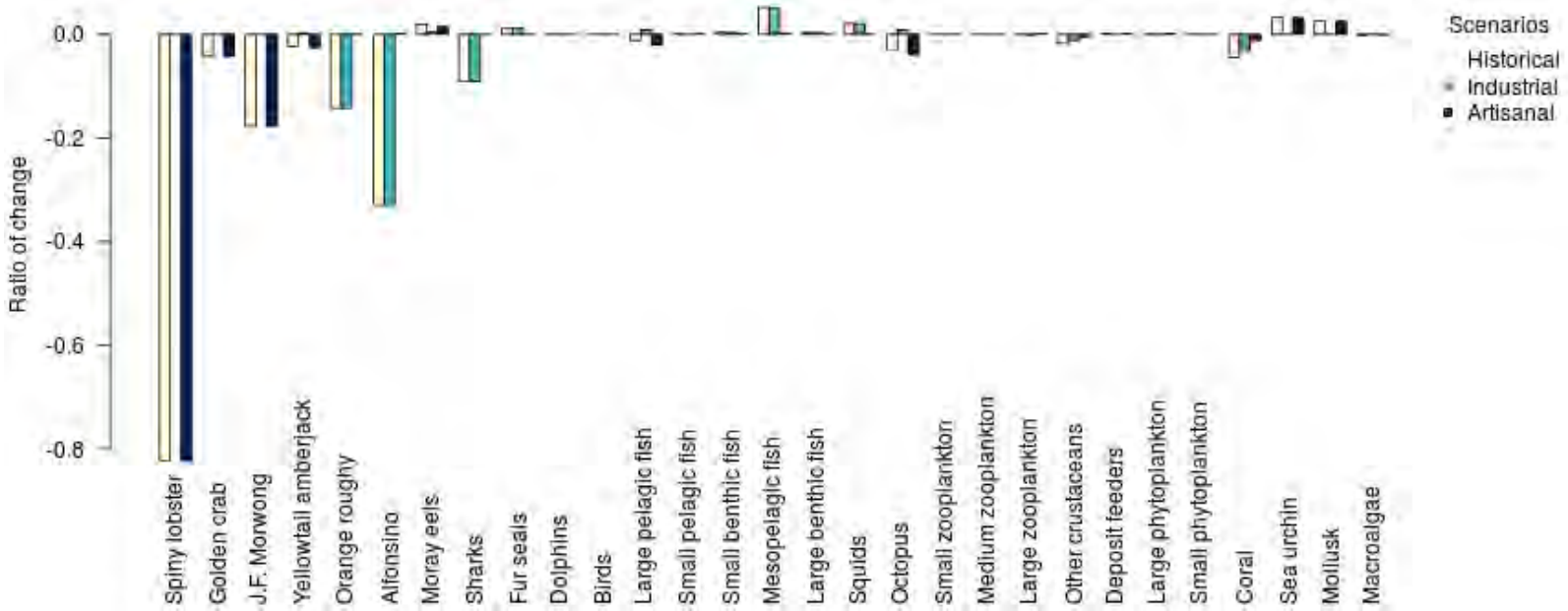
HINDCAST MODEL

ARTISANAL

- High impact on Lobster
- Almost no impact on Finfish
- Increase on sea urchin

INDUSTRIAL

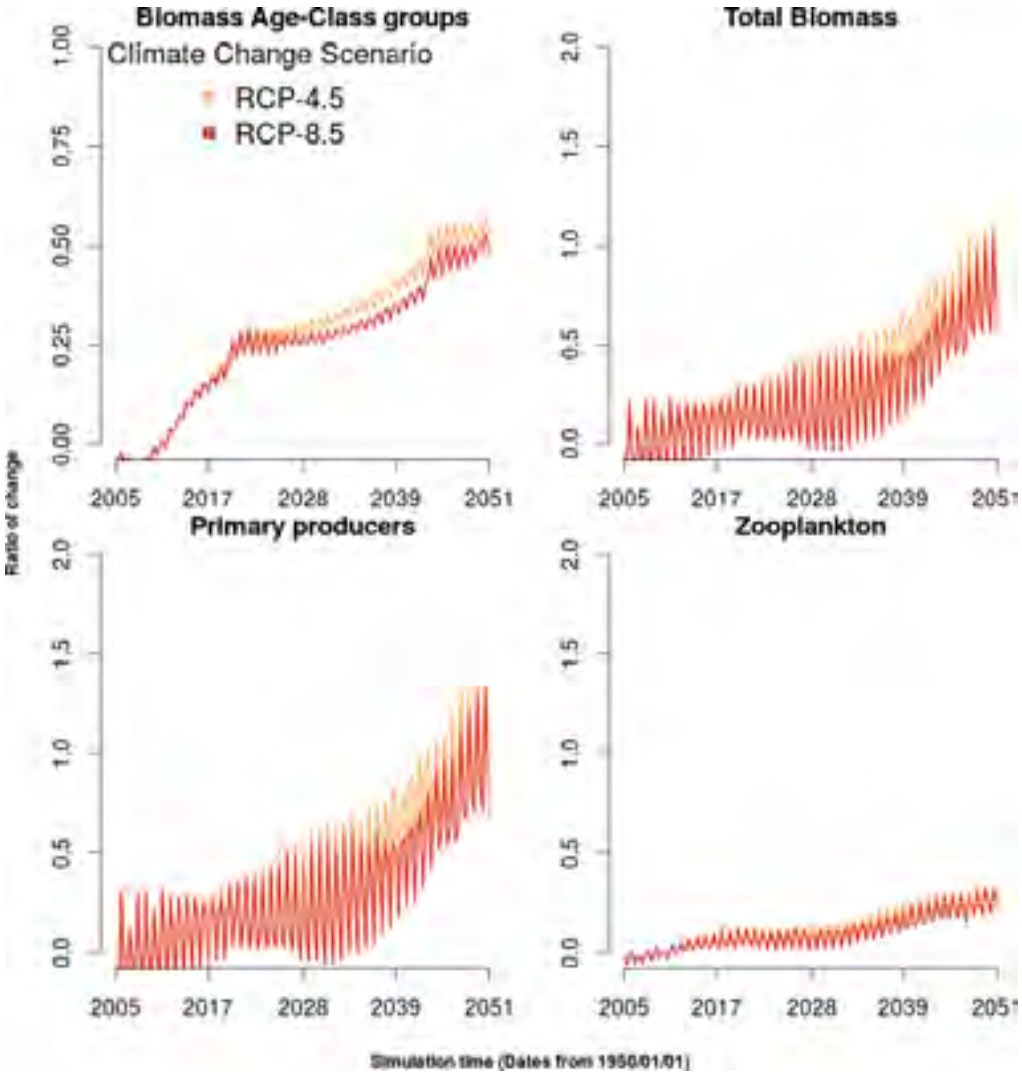
- High impact on Alfonsino
- Big impact on bycatch
- Impact highly localize



Time Series Projections

Changes through time - since 2011

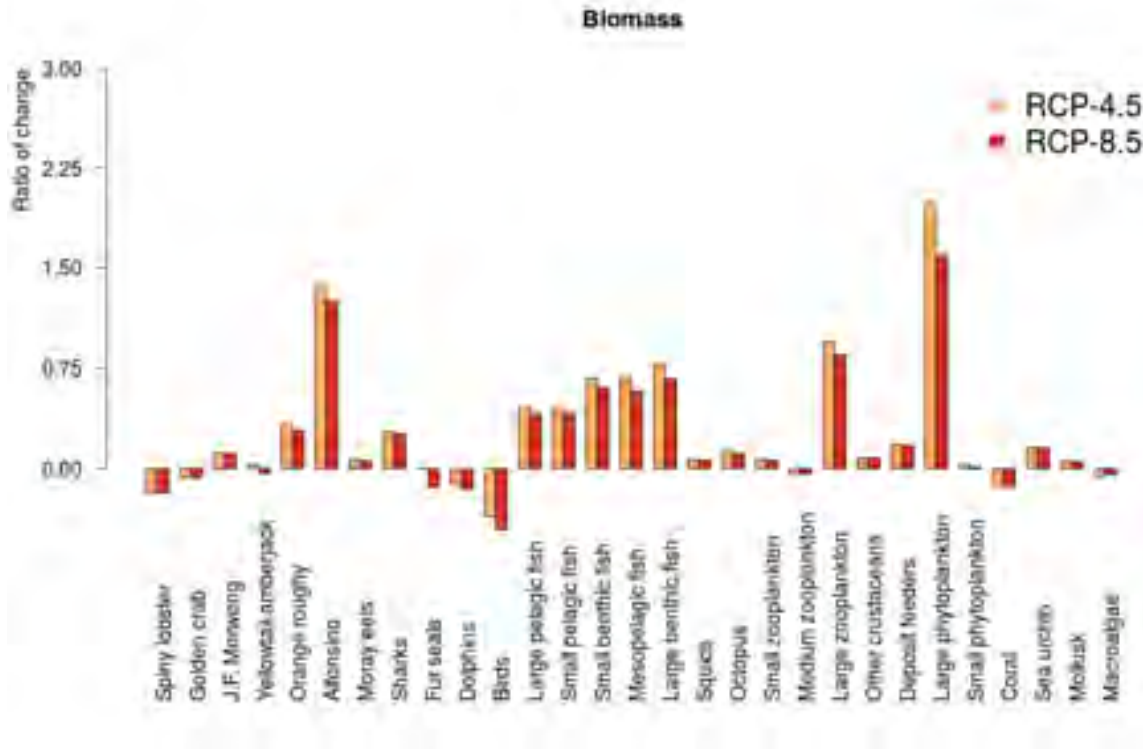
- High Difference compared to 2011
- RCP 4.5 biggest impact
- Highest impact on primary producers



COMPARE BY FUNCTIONAL GROUPS

AVERAGE CHANGE (2005 - 2011) & (2040 - 2050)

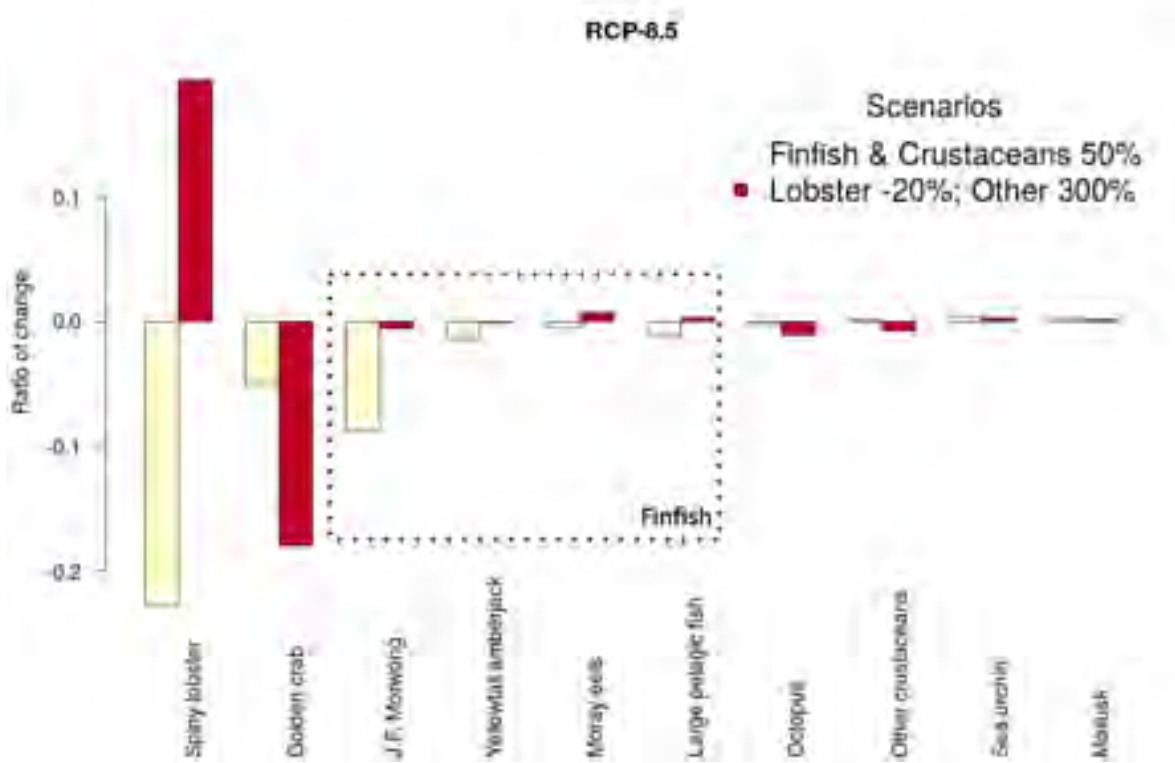
- RCP 4.5 biggest change
- Mayor impact on large phytoplankton
- Escalated effect
- Low effect on crustaceans



CUMULATIVE EFFECT

BASE-SCENARIO BAU

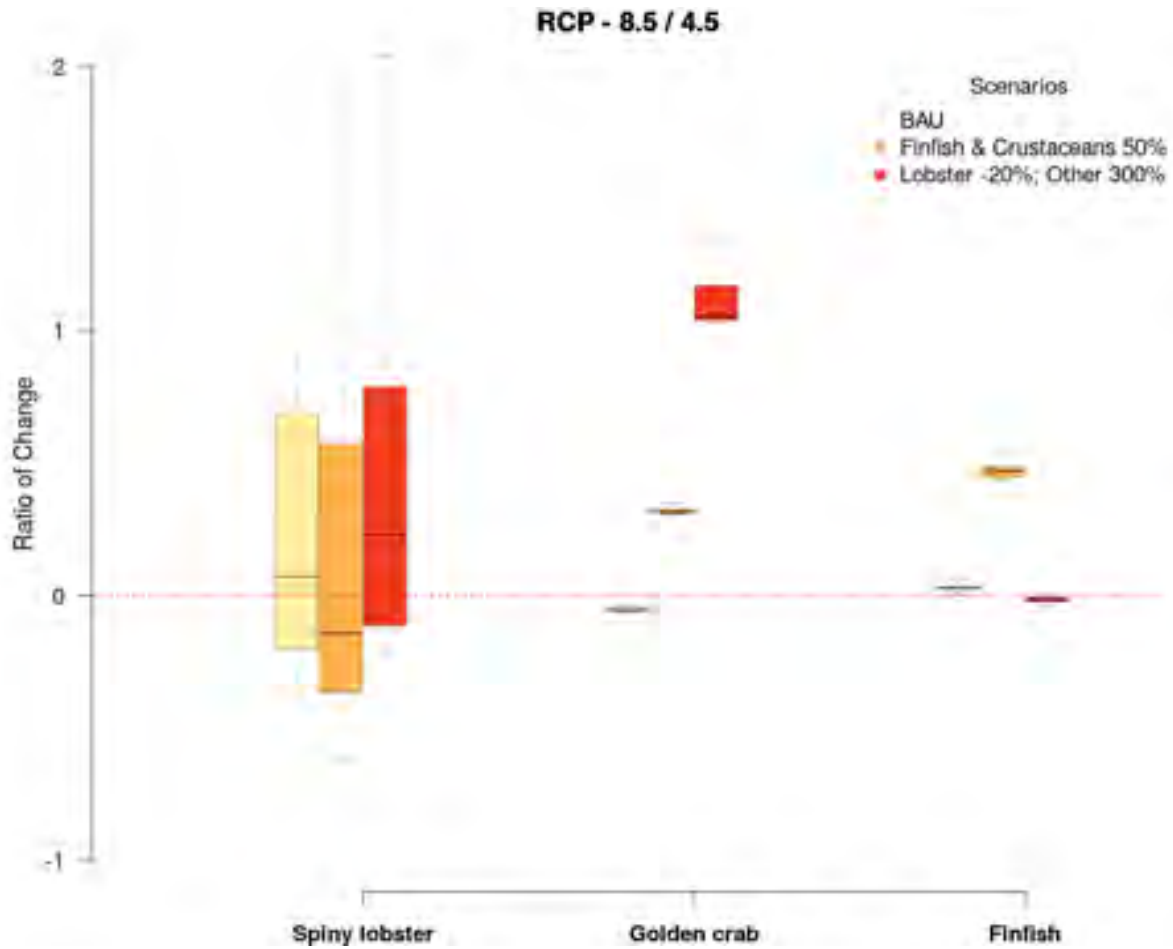
- RCP 8.5 & 4.5 similar
- 50% Increase All
  - ↓ Spiny lobster, golden crab and JF morwong biomass
- Mix (-20% lobster)
  - ↑ Spiny lobster biomass
  - ↓ Golden crab biomass



Compare Bar-plots

Projected Catch in the long run

- RCP 8.5 & 4.5 similar
- BAU
  - ↑ small increase in all the catches
- 50% Both
  - ↓ Spiny lobster
  - ↑ Other Species
- MIX (-20% lobster)
  - ↑ Spiny Lobster
    Golden Crab



Conclusion

Projected Catch in the long run

- Controlled by primary production
- Low impact from the artisanal fisheries
- Increase in the sea urchin population
- The ecosystem is not at optimal dynamical state

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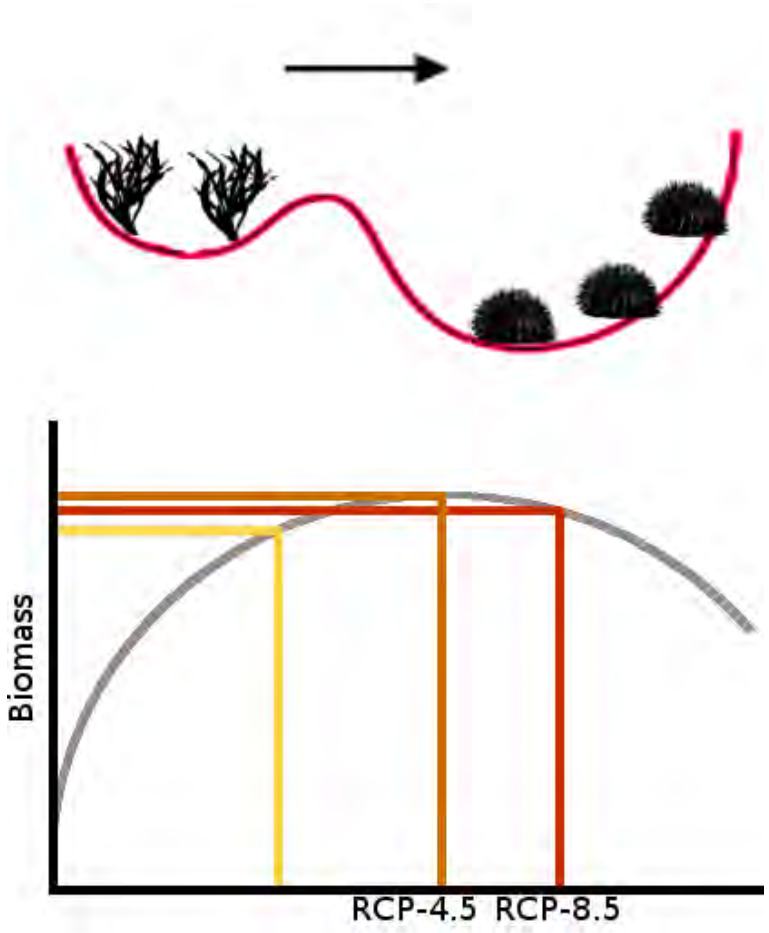

THOUGHTS FOR THE FUTURE

ALWAYS ABOUT DATA

Biology

- Biomass
- Recruitment
- Energetic costs

Modelling

- Bio-energetic
- Integrating CC stressors

Management

- New meassures
- Foster diversification

In Chile today, nobody can seriously think about the future or development without addressing the environmental dimension. But not as a slogan, but with concrete actions, with participation, with public-private collaboration, hand in hand with society and science, looking at the world (*Michelle Bachelet (Former President of Chile) during the signing of the Decree on the Creation of Marine Protected Areas in the Juan Fernandez Ridge Ecosystem*.

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