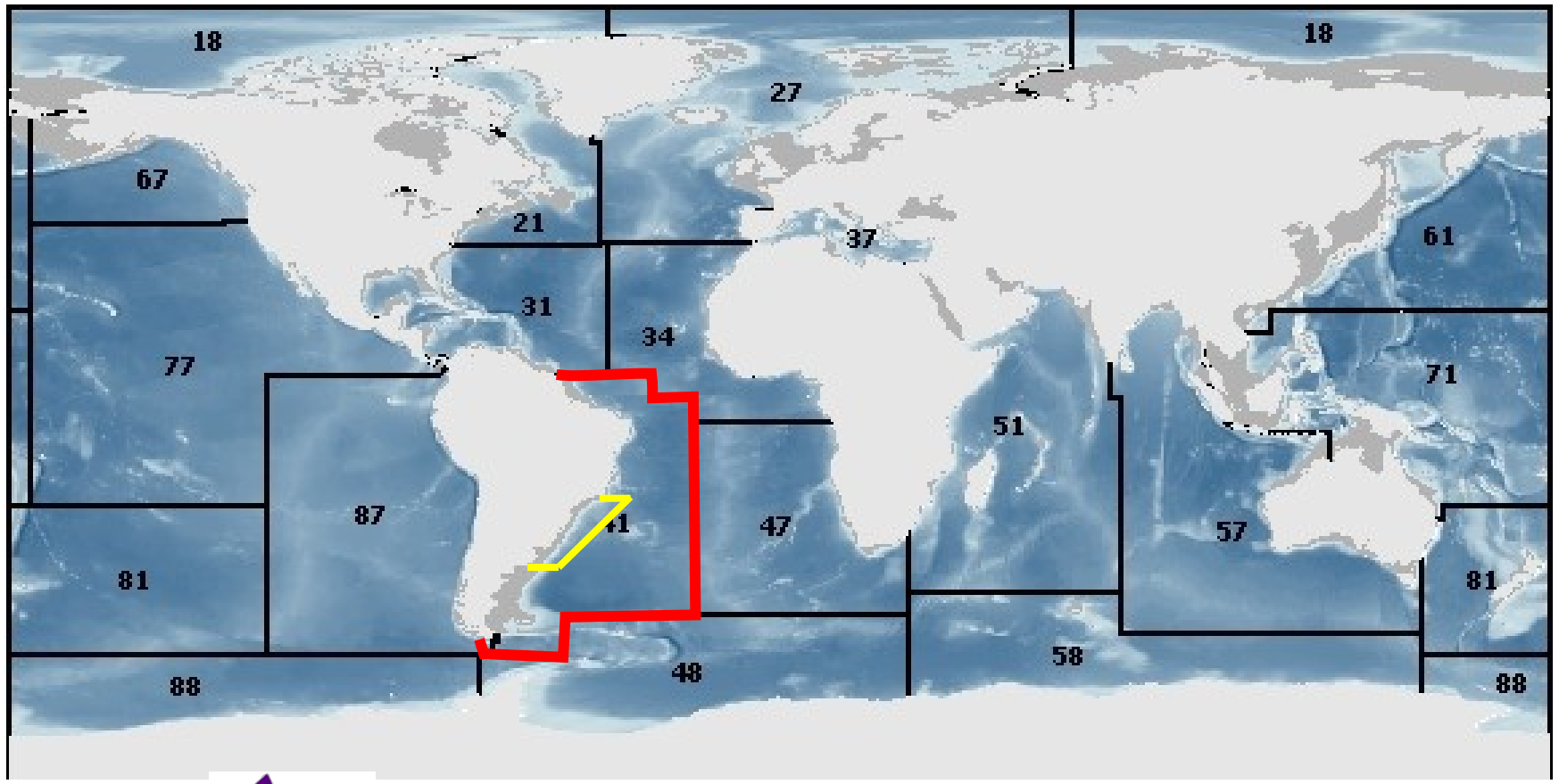
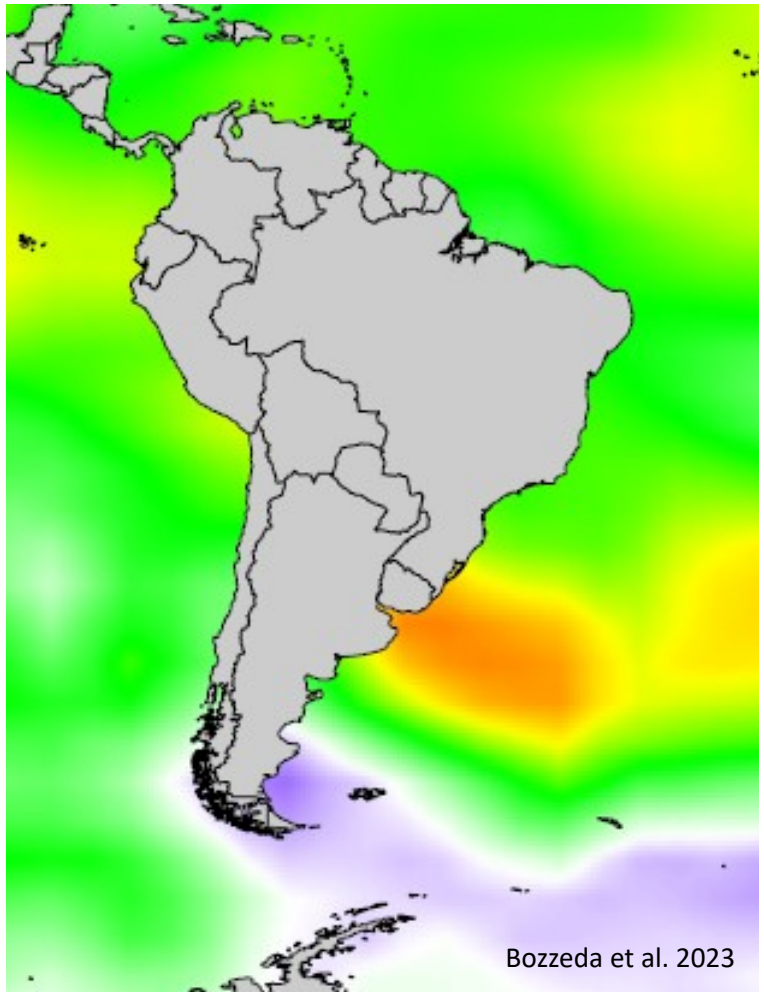
Integrating oceanography, fisheries, and governance for sustainable coastal and marine systems in the SW Atlantic



Omar Defeo
Uruguay

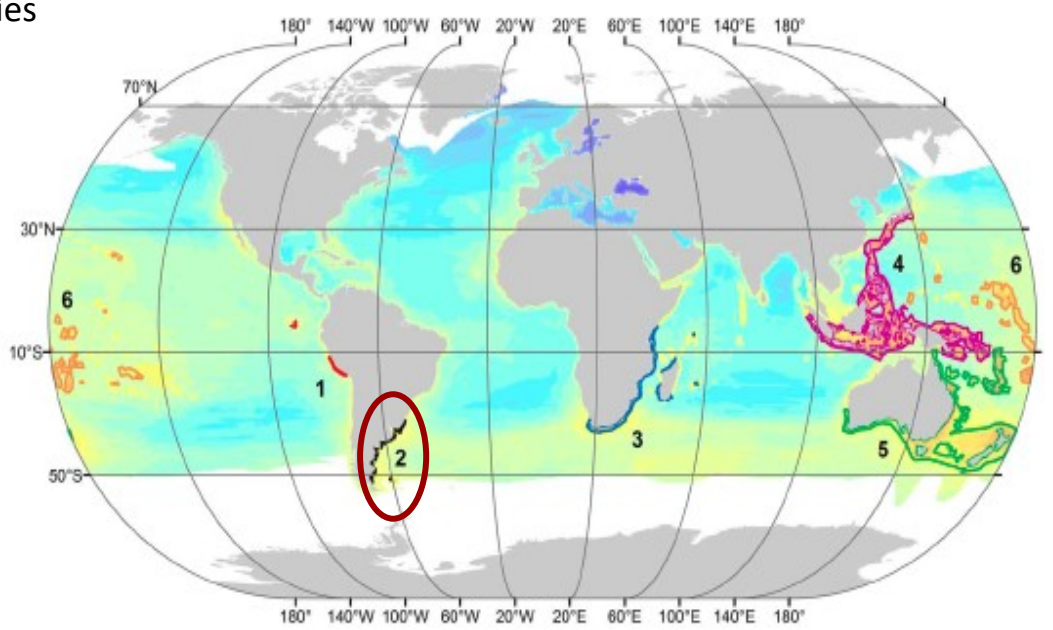
The SW Atlantic Ocean: a hotspot



Multiple lines of evidence & attribution

Long-term increase in:
Sea surface temperature
Sea level
Onshore winds (intensity and frequency)
Extreme events
Freshwater discharge /Rio de la Plata, Patos)
Coastal erosion

Effects on biodiversity
Mass mortalities
Tropicalization
Range shifts
Invasive species
Red tides



Three countries: Brazil, Uruguay and Argentina

- A biodiversity hotspot!!
- Shared industrial fisheries at risk
- Small-scale fisheries and livelihoods threatened
- Climate drivers affecting vulnerability of local communities

Atlantic SW: major fishing area

5°N-60°S: Brazil, Uruguay, Argentina

SW Atlantic (~23-40°S): high percentage of landings

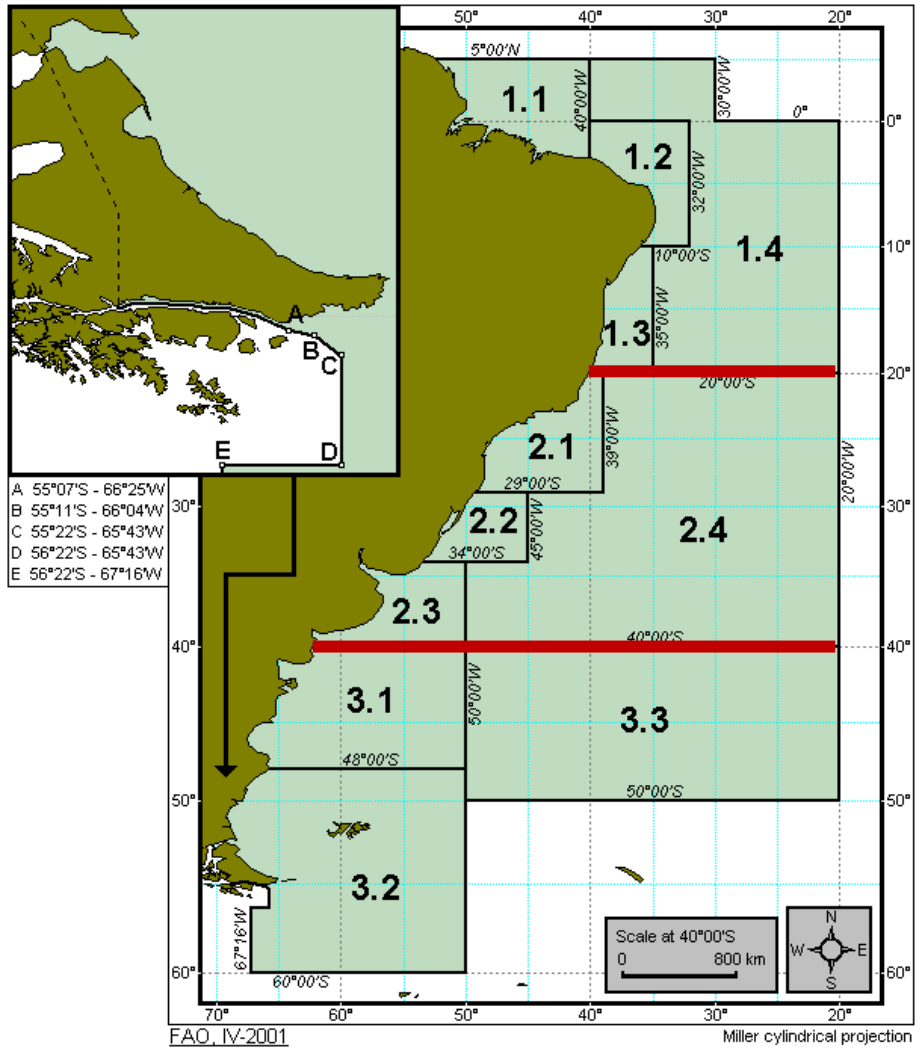
One of the most productive fishing areas worldwide

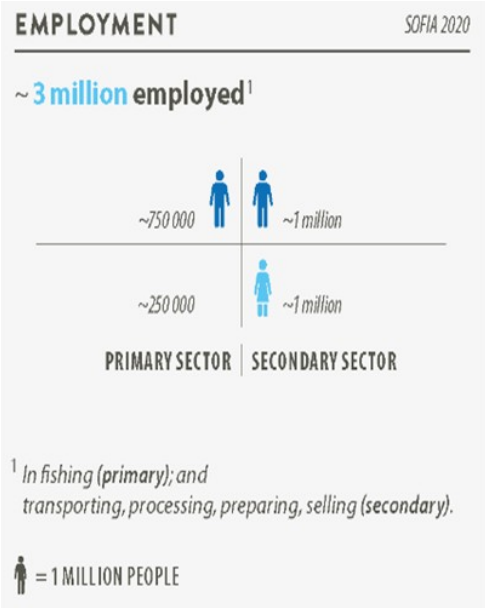
Unique oceanographic characteristics

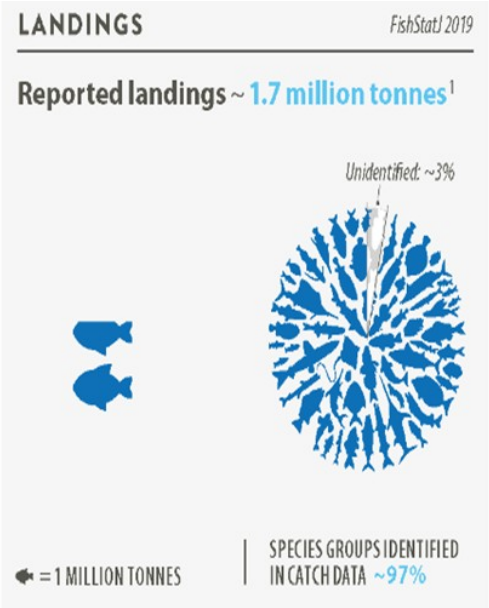
27,000 active vessels (18,000 non-motorized)

Artisanal, industrial, sequential fisheries

FAO Statistical Subareas





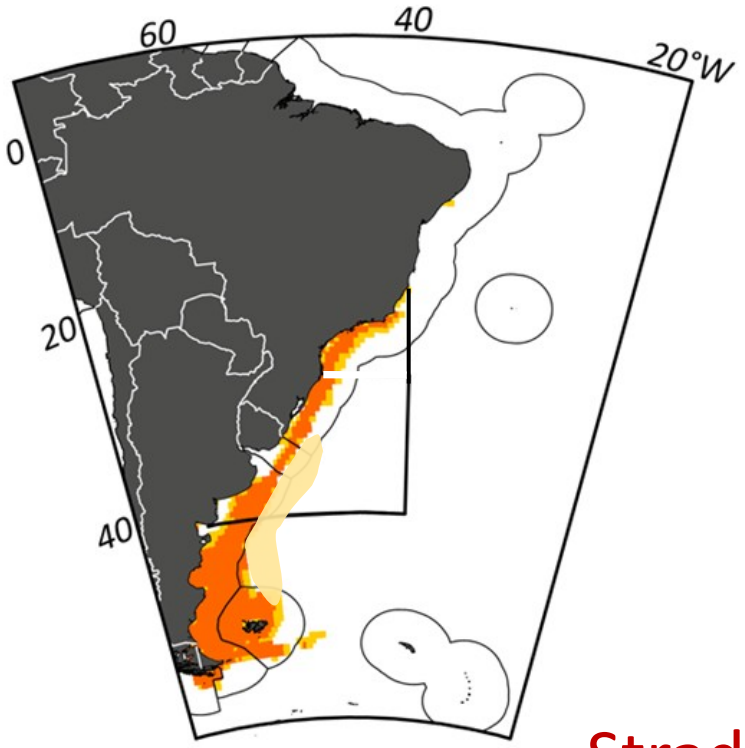




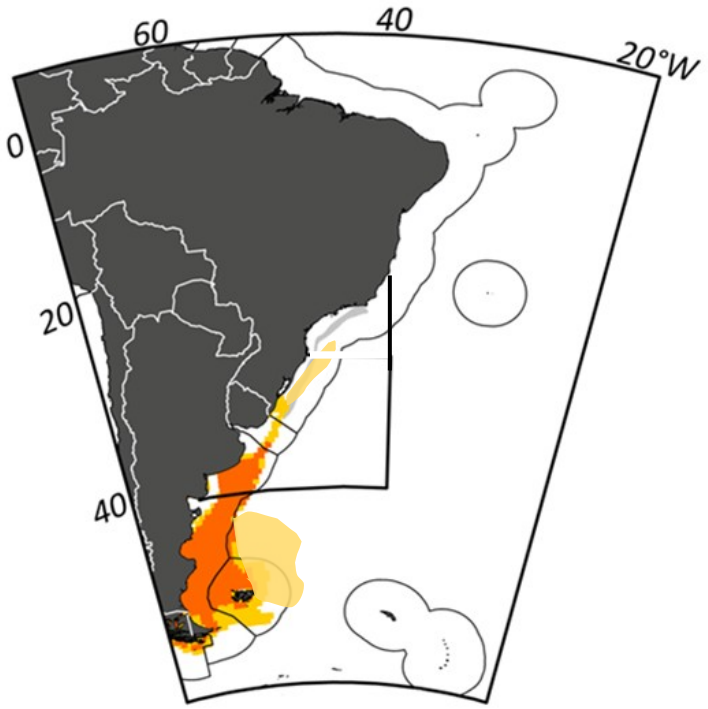
Defeo et al. 2025

Distribution range of main stocks

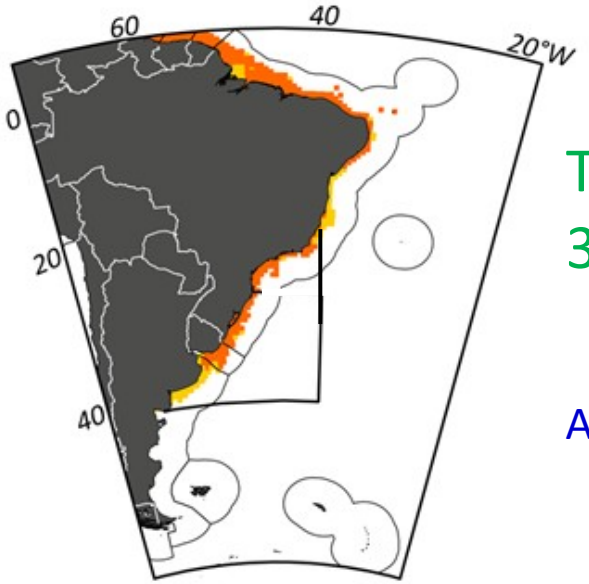
Argentine hake



Argentine shortfin squid



Whitemouth croaker



Transboundary:
3 countries

Argentine anchovy

Straddling: also in international waters

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Facing oceanographic, fisheries, and governance hotspots: Scientific evidence and policy implications from the southwest South Atlantic Ocean

Omar Defeo [a,*], Bárbara C. Franco [b,*], Alberto R. Piola [c,*], Claudio C. Buratti [d], Luis Gustavo Cardoso [e], Federico Cortés [d], Ignacio Gianelli [f], Micaela Giorgini [d], Gabriela Jorge-Romero [a], Diego Lercari [a], Erika Meerhoff [g], Leonardo Ortega [h], Jose Angel Alvarez Perez [i], Nicolás Prandoni [d], Rodrigo Sant'Ana [i]

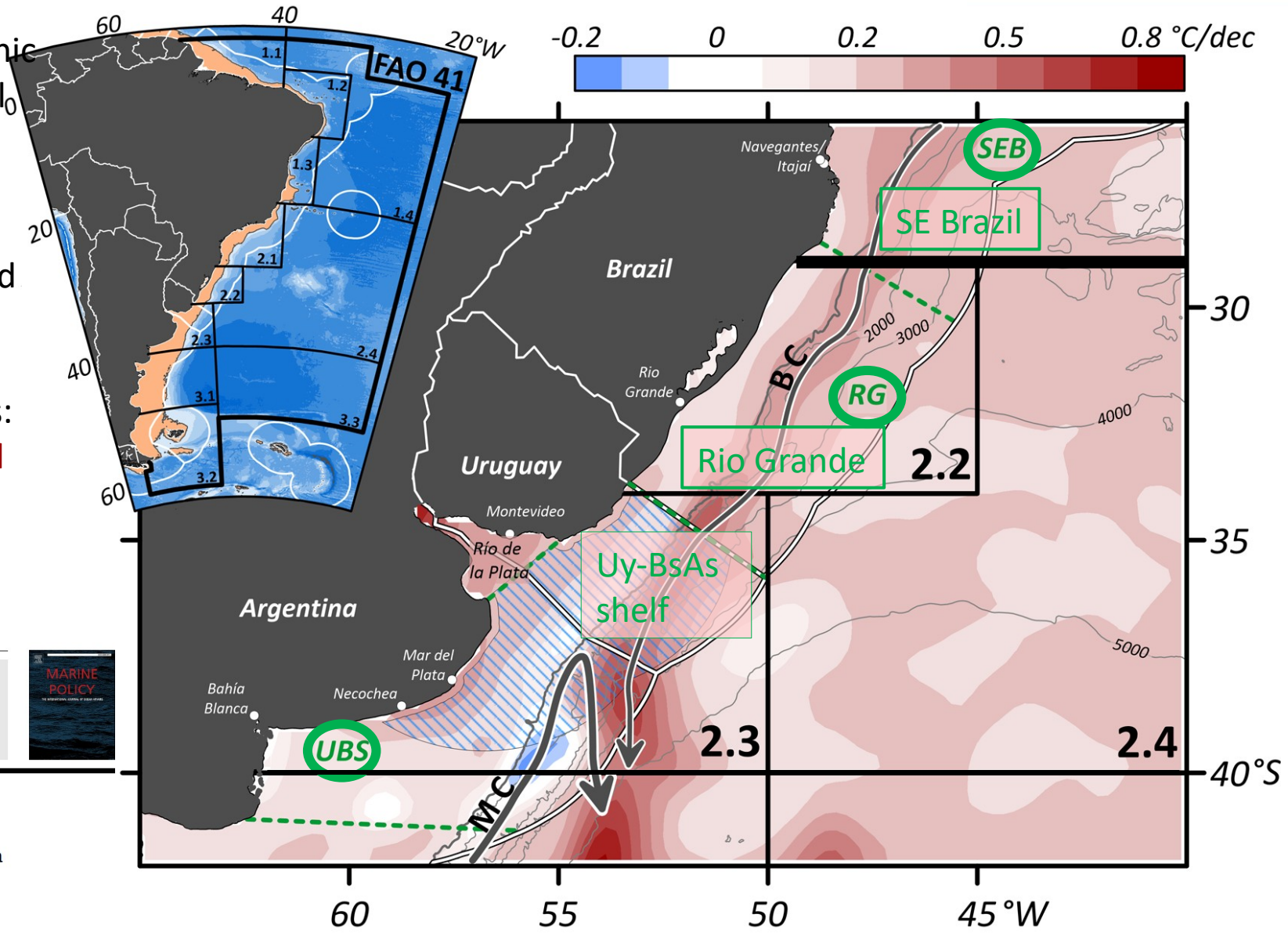
Tropicalization: increasing effects of climate change-related stressors acting simultaneously on fisheries productivity at large spatial scales

SW Atlantic fisheries: research perspectives

Similar fisheries, shared stocks, oceanographic processes, socioeconomic drivers and faunal components

Short-term need: multidimensional assessment of ecological, socioeconomic and institutional drivers

Long-term and large-scale joint assessments: conservation, management and institutional implications



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Small-scale fisheries: social-ecological systems

Critical socio-economic importance: livelihoods for coastal communities

Commercial, recreational and subsistence fisheries coexist

Increasing overexploitation and extirpations

Cascade effects on ecosystems: biodiversity loss

Socioeconomic implications: unemployment, well-being





nature food

ANALYSIS

https://doi.org/10.1038/s43016-021-00363-0

Harnessing the diversity of small-scale actors is key to the future of aquatic food systems

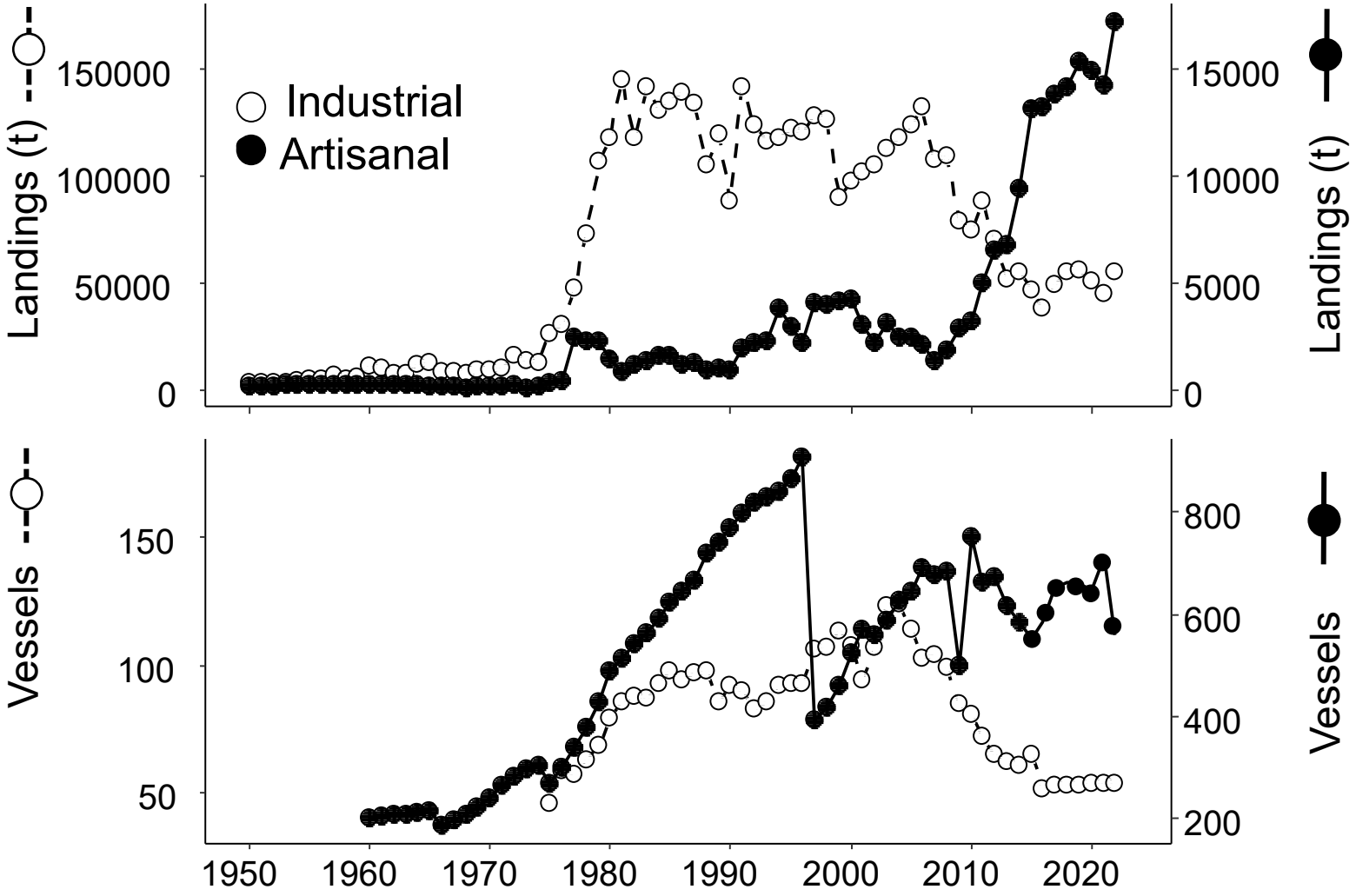
Short et al. 2021

The importance of small-scale fisheries

Uruguay: 70-year assessment

Small-scale fisheries: exponential increase in landings, from 3% to 25% of the total catch

Social-ecological systems (SES) assessed through 4 sustainability pillars: environmental, social, economic, and institutional







Bausero-Jorcin et al. 2025

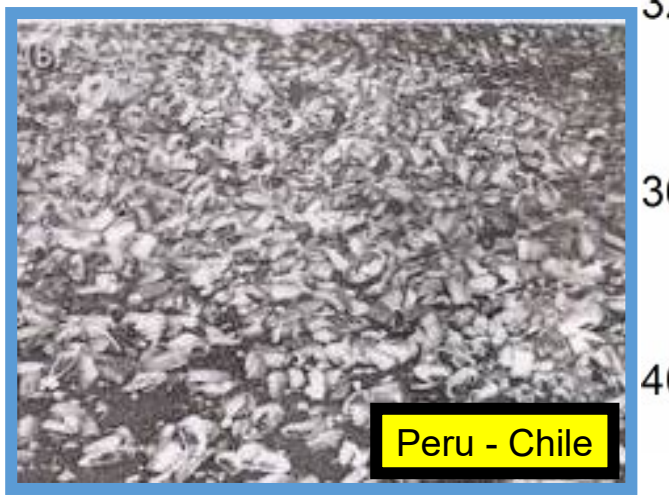
Climate change effects

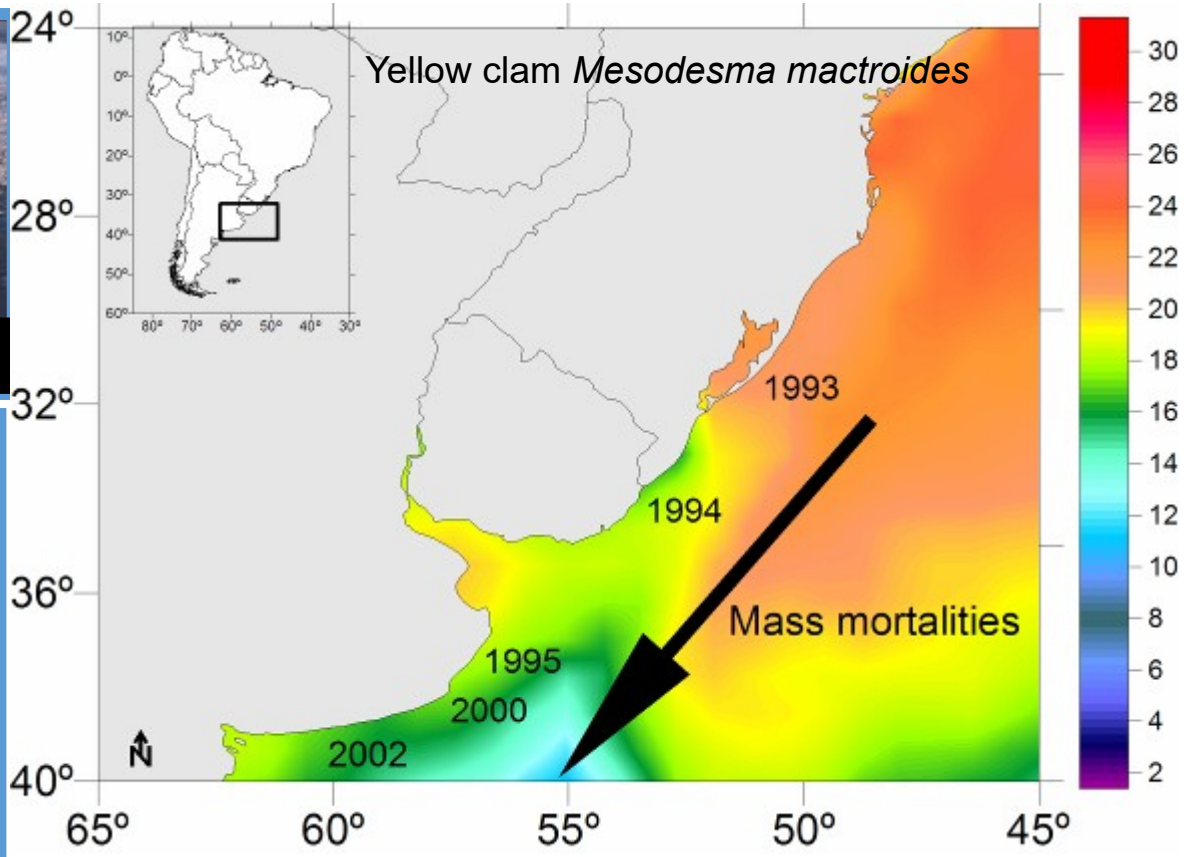
Mass mortalities of cold-water clams during the last 2 decades decimated populations throughout entire distribution range in the SW Atlantic:

1. Main factor: **temperature increase**
2. Social-ecological systems (SES): Fisheries and human livelihoods affected
3. Community structures and ecosystems drastically changed: **tropicalization**









Ortega et al. 2012, 2016, Franco et al. 2020, Gianelli et al. 2021, 2023, Defeo et al. 2018, 2021

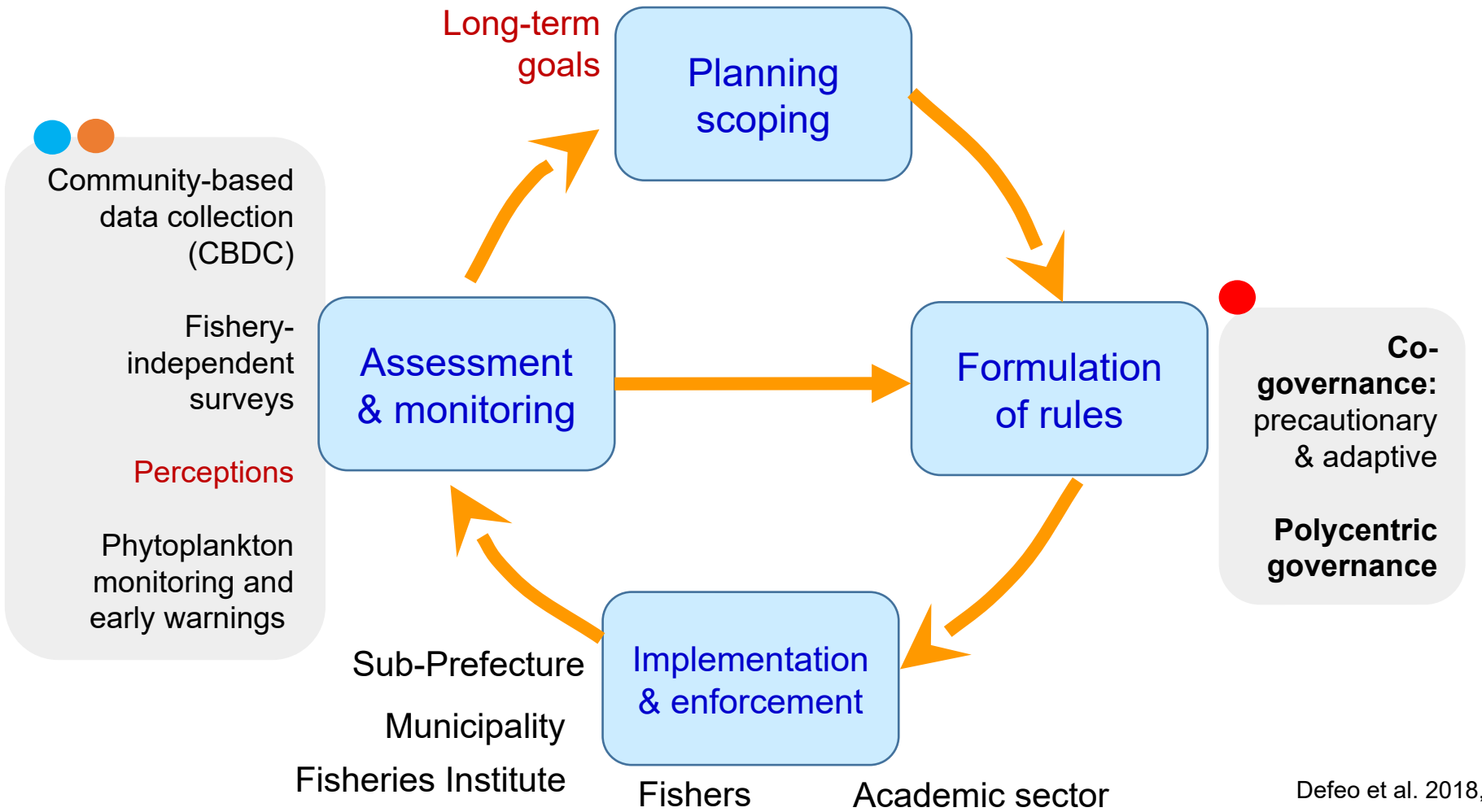
Adaptations to climate change: co-governance & adaptive management

- Governance
- Stock assessment & monitoring
- Harmful algal blooms
- Processing & marketing

Participatory planning and adaptation plans

Precautionary catch quotas
Fishing rights to local fishers
Redundancy in management measures
Market: quality over quantity
Early warnings: harmful algal blooms

Adaptation: social learning process integrating local and scientific knowledge



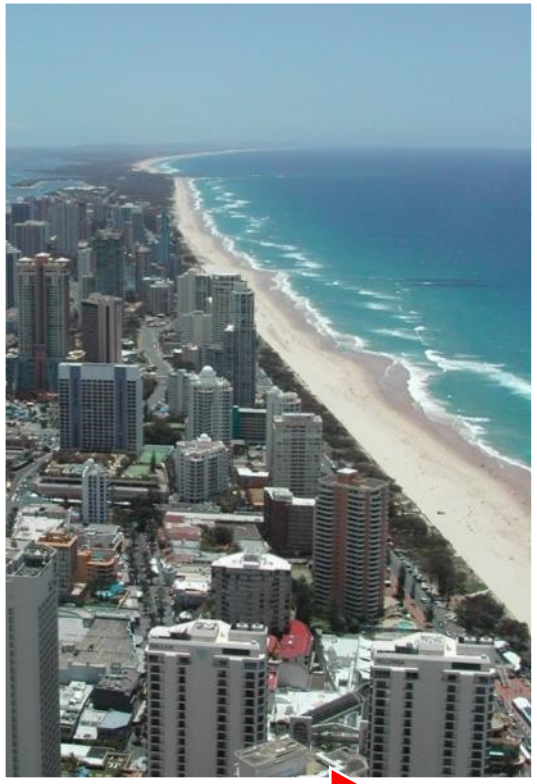
Defeo et al. 2018, 2021, Gianelli et al. 2021

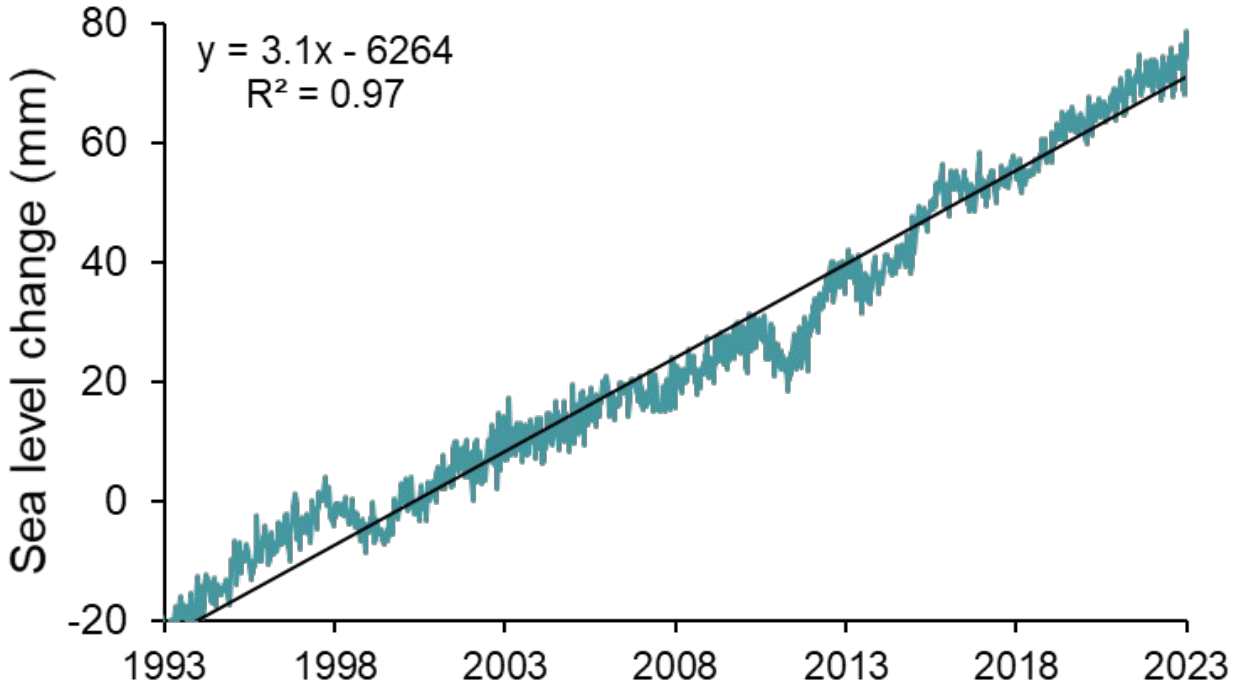
Conservation, management & governance of coastal ecosystems

- Coastal squeeze: beaches are caught between rising sea and expanding urbanization
- Retreat is not possible in most cases because of urban development
- Beach and dunes reduced/lost

Coastal recession driven by sea level rise could result in the extinction of almost half of the world's sandy beaches by the end of the century

Worldwide assessment: increasing impact of unplanned urbanization, including the SW Atlantic





COAST

Expanding urbanization

Coastal squeeze

Sea level rise

Bozzeda et al. 2023

Urbanization threatening coastal systems

90 beaches across Sao Paulo State (Brazil)

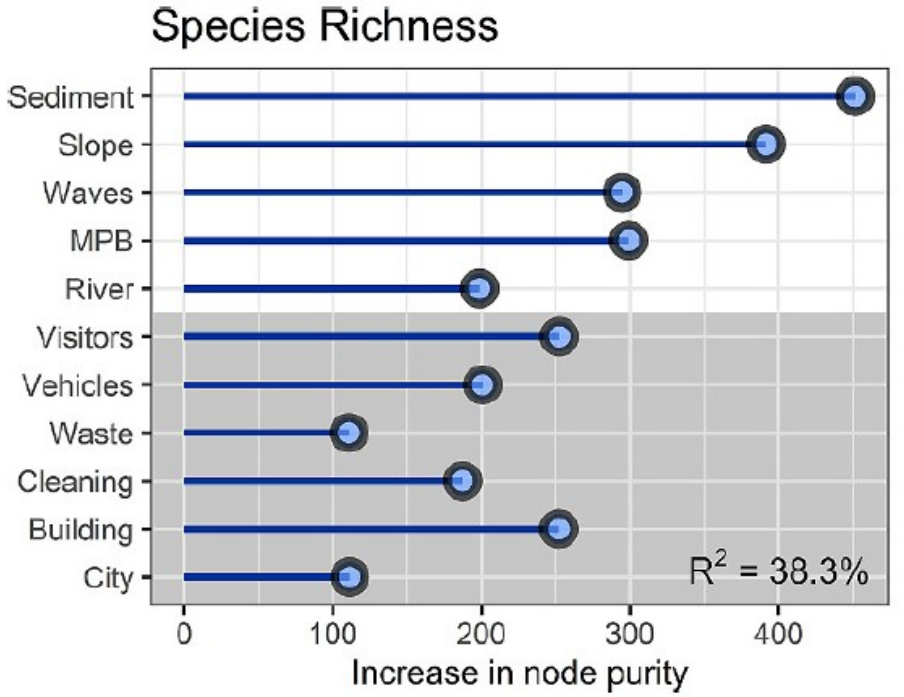
Spp richness and biomass negatively related with urbanization extent

Submerged zones: most impacted by human activities

Substantial proportion of threatened beaches in densely populated areas: design and implementation of adaptive measures

Management and conservation should consider dunes, beaches and surf zones as a unit

Plastic pollution & litter transcend MPA boundaries: need to treat causes rather than symptoms



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Ocean and Coastal Management

journal homepage: www.elsevier.com/locate/ocecoaman

Evaluation of the effects of urbanization and environmental features on sandy beach macrobenthos highlights the importance of submerged zones

Guilherme N. Corte [a,b,*], Helio H. Checon [a,c], Yasmina Shah Esmaeili [d], Omar Defeo [e], Alexander Turra [a]

[a] Instituto Oceanográfico, Universidade de São Paulo (USP), CEP 05508-120 São Paulo, São Paulo, Brazil

Beyond "paper parks": integrating marine fauna into Brazilian protected area management

Helio H. Checon [a,*], Beatriz P. Cunha [a], Yasmina Shah Esmaeili [c], A. Cecília Z. Amaral [a], Omar Defeo [b], Guilherme N. Corte [c]

Corte et al. 2022, Costa et al. 2020, 2022, Checon et al. 2025, Barros et al. 2025, Arueira et al., 2025

Winds of hope: Brazil- Uruguay collaboration

- Linking oceanography, fisheries, and governance for sustainability: social-ecological fit
- Four sustainability pillars: environmental, social, economic, institutional
- Multi-scale adaptive and participatory approaches to connect science & management
- Transboundary and straddling stocks: shared science, shared solutions
- Small-scale fisheries: SES, drivers of change, mixed methods, ethnoecology
- Coastal systems: assessing human impacts and fostering sustainable solutions
- Regional cooperation to foster adaptive, sustainable SES

Winds of hope: Brazil- Uruguay collaboration

Integrating oceanography, fisheries, and governance to strengthen sustainable coastal and marine systems in the SW Atlantic

Multidisciplinary perspective to link oceanography, ecosystem integrity, fisheries, and governance performance: 4 sustainability pillars

Adaptive and participatory governance integrating the four sustainability pillars: environmental, social, economic, and institutional

Joint assessments of transboundary and straddling stocks to address climate-driven shifts in productivity and species distribution.

Small-scale fisheries as social-ecological systems, linking oceanography, governance, and community resilience

Science–policy co-design to build adaptive and resilient social-ecological systems under climate change.

Social-ecological fit: Shared policy goals and transboundary cooperation to manage straddling stocks beyond geopolitical boundaries, to capture the processes and mechanisms operating in the ocean

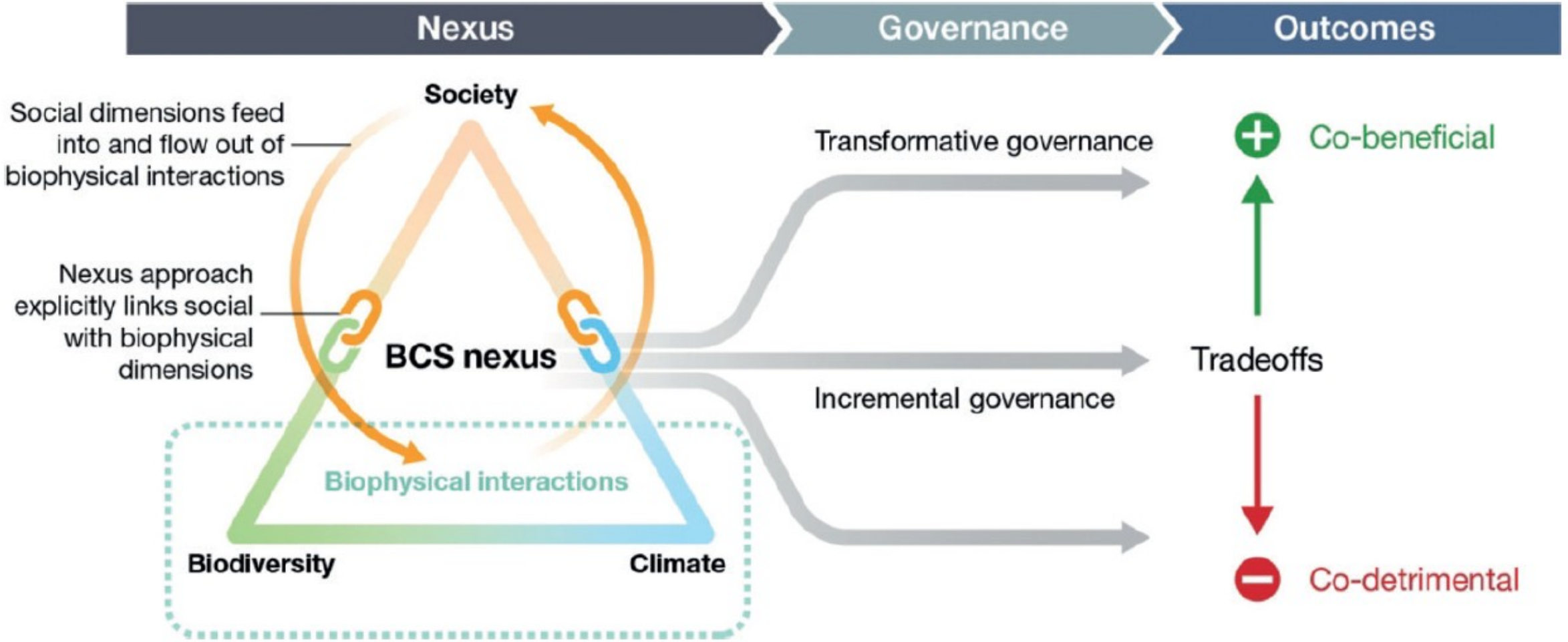
Dynamic and adaptive governance frameworks to align ecological, social, economic, and institutional scales.

A regional window of opportunity to foster joint research, improve stock assessments, and co-create sustainable blue economies across the SW Atlantic.

Ecological, social, economic and institutional dimensions: interdisciplinary and participatory long-term approaches

Governing for Transformative Change across the Biodiversity–Climate–Society Nexus

UNAI PASCUAL, PAMELA D. MCELWEE, SARAH E. DIAMOND, HIEN T. NGO, XUEMEI BAI, WILLIAM W. L. CHEUNG, MICHELLE LIM, NADJA STEINER, JOHN AGARD, CAMILA I. DONATTI, CARLOS M. DUARTE, RIK LEEMANS, SHUNSUKE MANAGI, ALINY P. F. PIRES, VICTORIA REYES-GARCÍA, CHRISTOPHER TRISOS, ROBERT J. SCHOLES, AND HANS-OTTO PÖRTNER



Fisheries and climate change in the SWAO: priority action areas

Needs

Coordination and cooperation among countries
Long-term scientific programs and common policy goals
Ways to communicate science at the local, national and regional levels

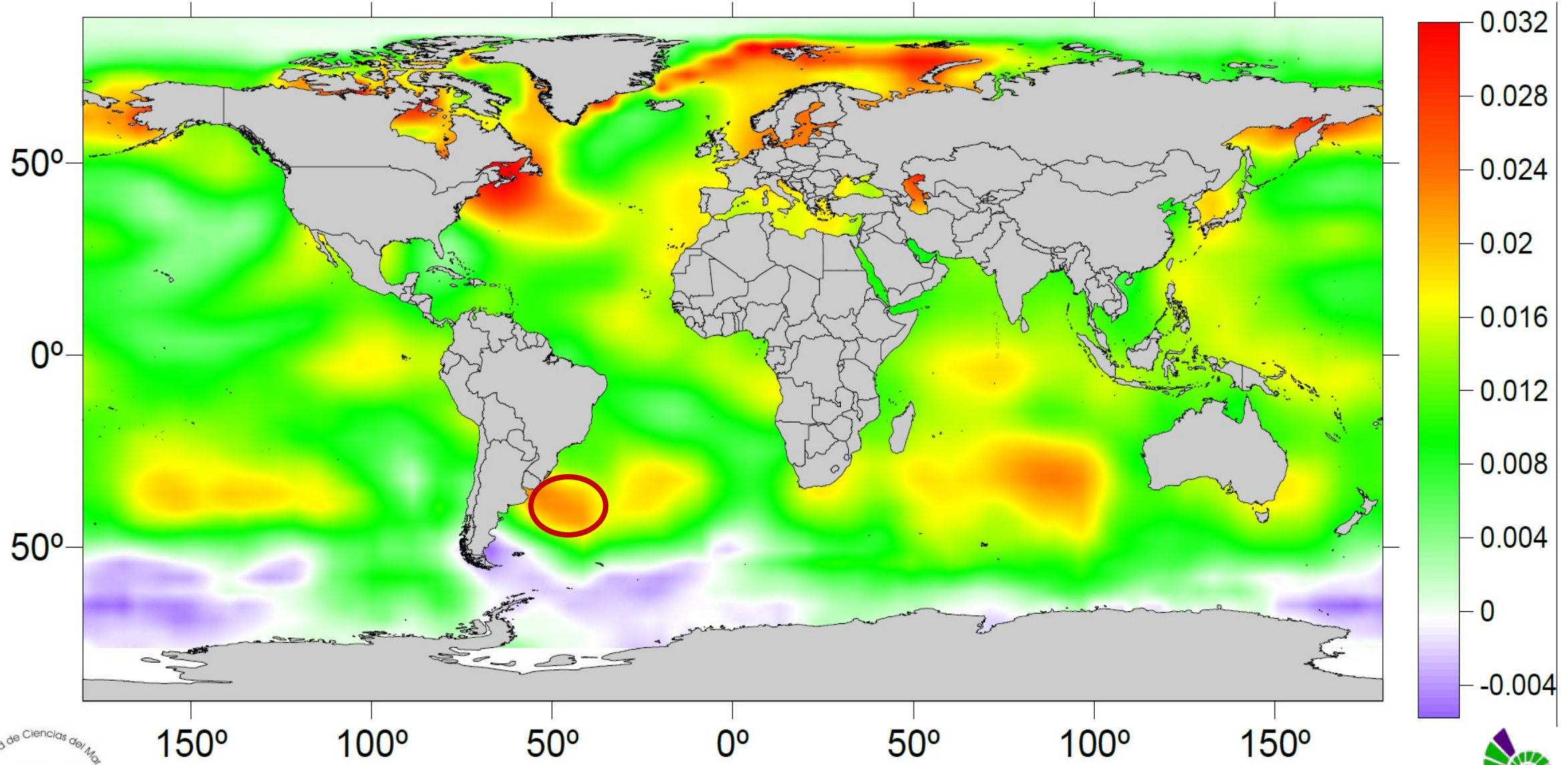


Strengthening the science-policy interface

1. Interdisciplinary research and networks for CC assessment and adaptation
2. Multi-level governance improvements for CC adaptation
3. Strengthening of national adaptation plans
4. Social dimensions at the core of adaptation strategies
5. Targeted approaches for fisheries comanagement
6. Development of innovative technologies (early warning systems)
7. Translational science: a platform for communicating CC science

4 PILLARS

Fisheries in the SW Atlantic hotspot: addressing emerging challenges



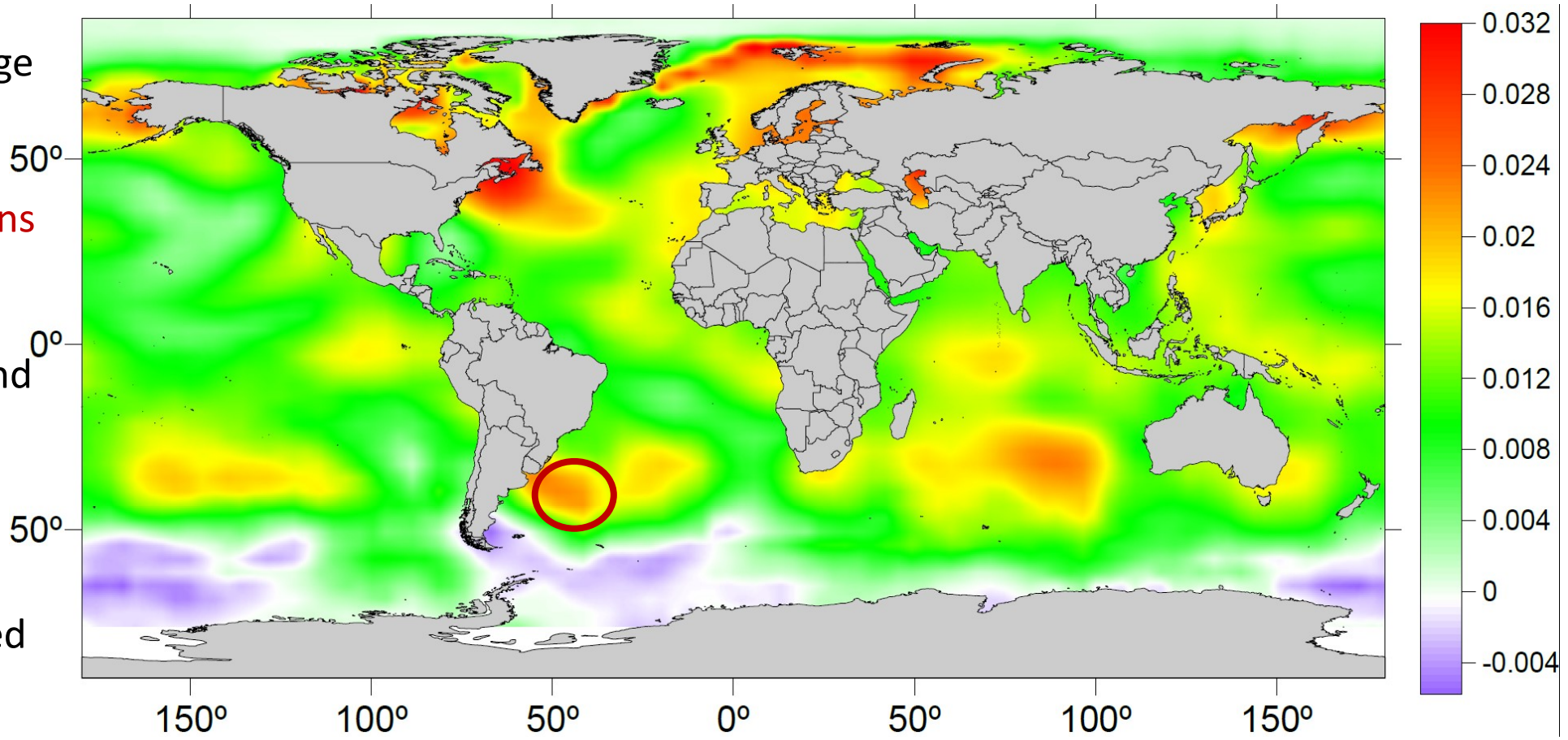
Omar Defeo
Uruguay

Climate change: warming hotspots

Warming hotspots: warming occurs at several times the average global rate of warming

Climate change threatens fisheries, disrupting ecosystems, altering species distributions, and impacting livelihoods

Multinational collaboration is needed and should be supported by sound science and robust institutions at appropriate scales



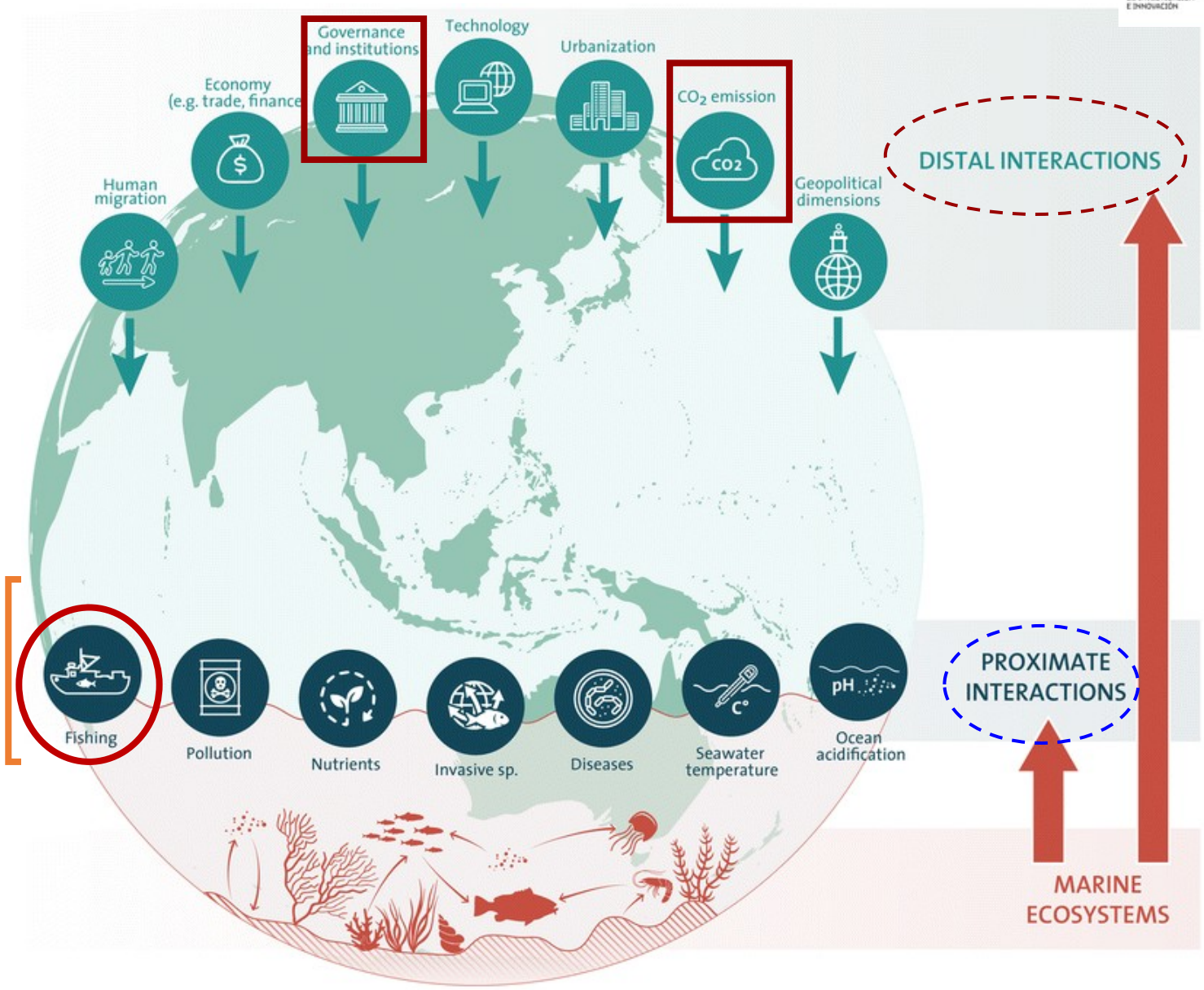
Drivers of change in fisheries as social-ecological systems

Socioeconomic activities and human-induced biophysical changes interact and impact ecosystem services

Proximate interactions embedded in a broader socioeconomic context, operating and interacting at different scales

Indirect distal interactions add dimensionality and complexity to the system

Multiple exposure, synergic interactions: press and pulse disturbances



Osterblom et al. 2017, Defeo & Vasconcellos 2020

Climate change and fisheries: tropicalization

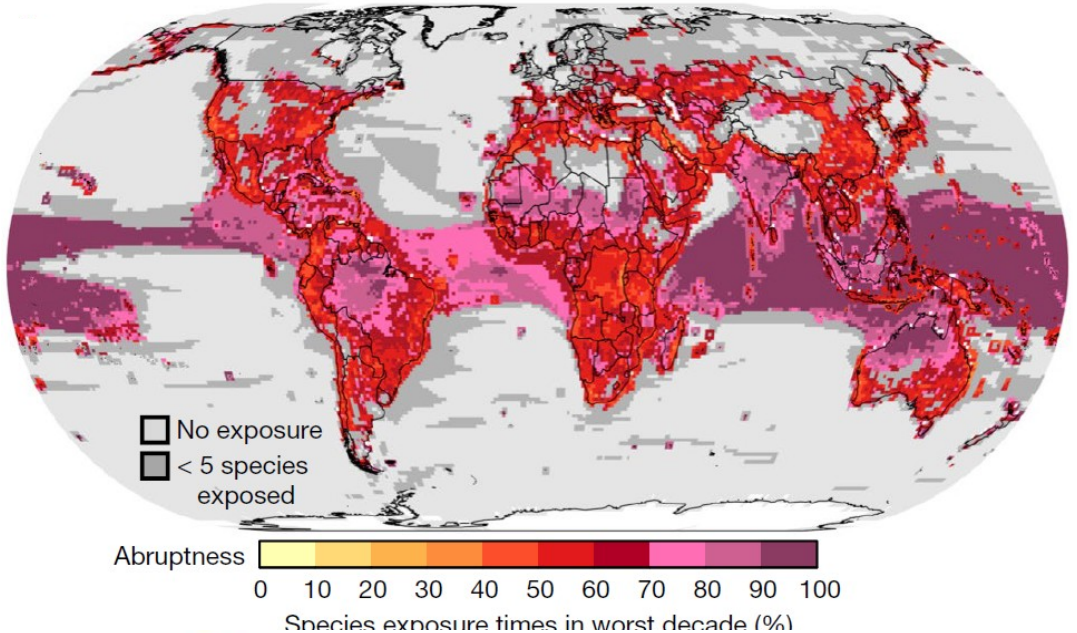
Species richness increases towards the tropics

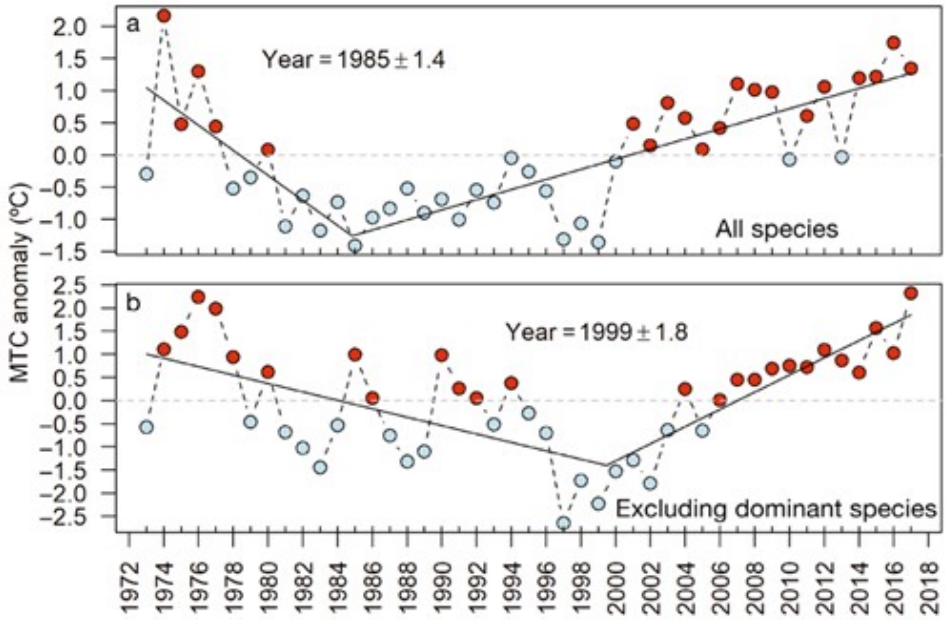
Global warming causes a pronounced dip in marine species richness around the equator

Impacts on ecosystems and fisheries

Tropical species in temperate regions: tropicalization, 40 years of scientific surveys

Weakness: existing policy/governance frameworks poorly equipped for this challenge





nature ecology & evolution
ARTICLES
https://doi.org/10.1038/s41559-022-01812-0
Check for updates

A global horizon scan of issues impacting marine and coastal biodiversity conservation

Chaudhary et al. 2021, Herbert-read et al. 2022

Gianelli et al. 2019, 2021, 2023

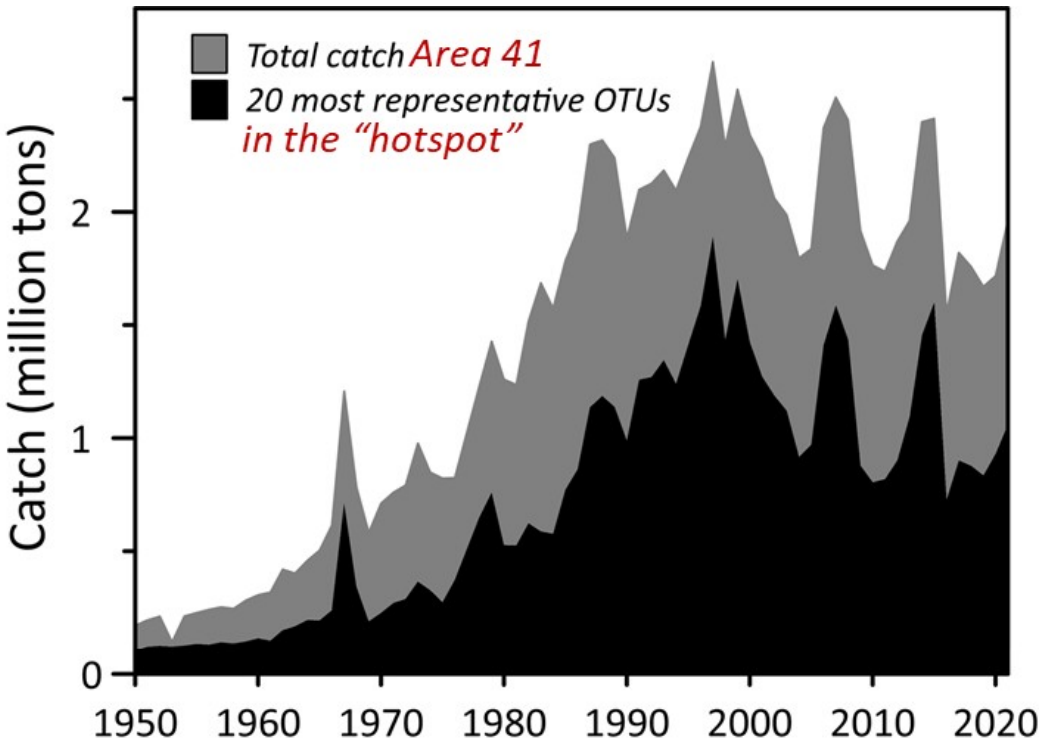
Fisheries: long-term trends Area 41

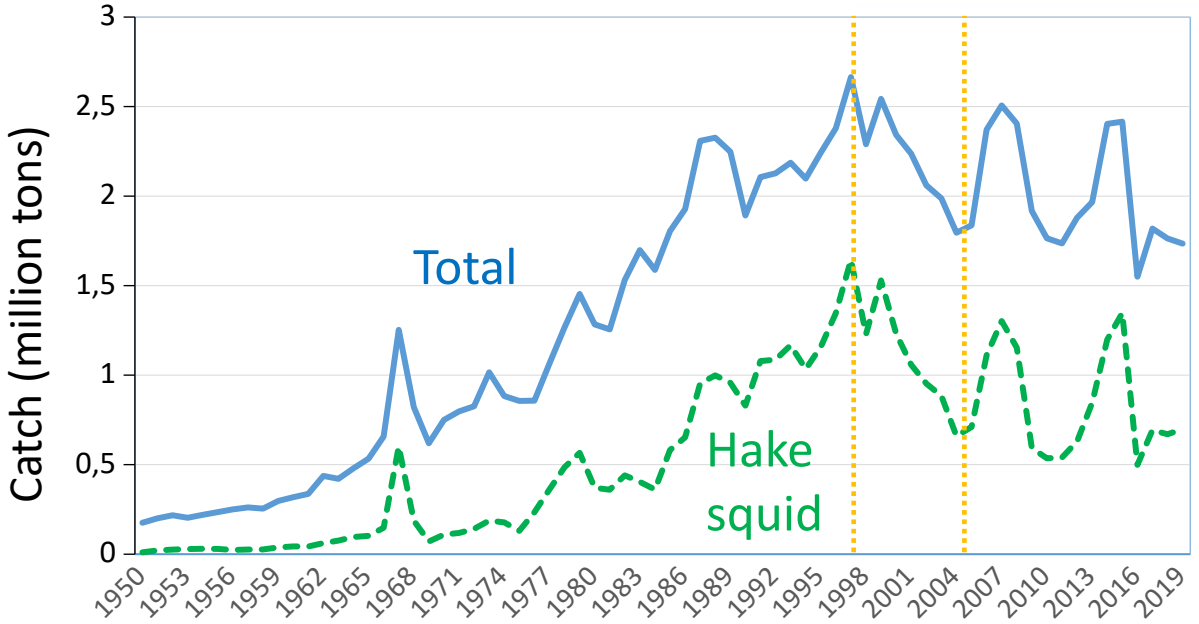
1950-1997: initial phase of expansion followed by sustained growth in landings

1998-2004: decreasing trends

2005-2022: fluctuating pattern in 2 million tons

40% of stocks OVERFISHED

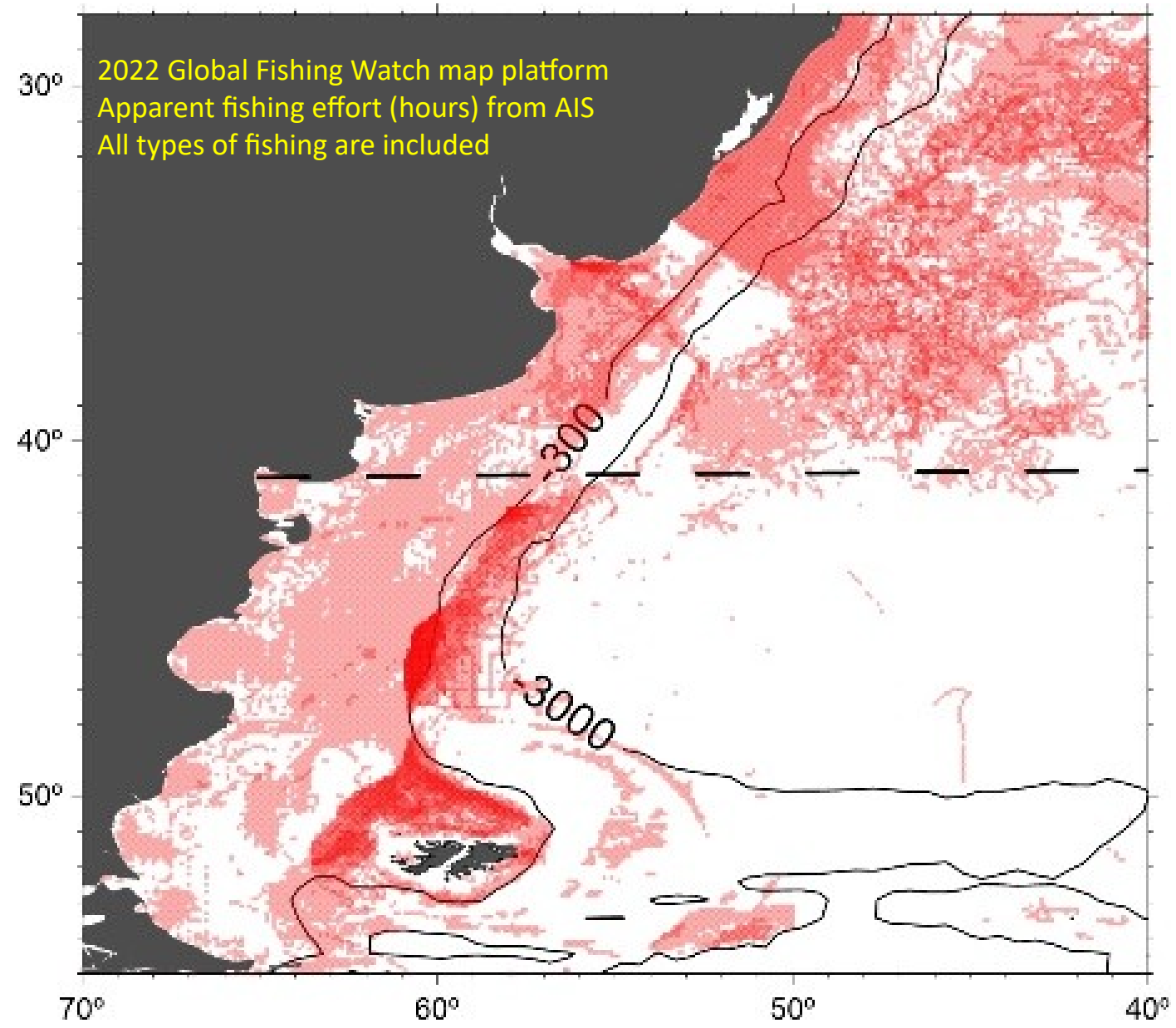


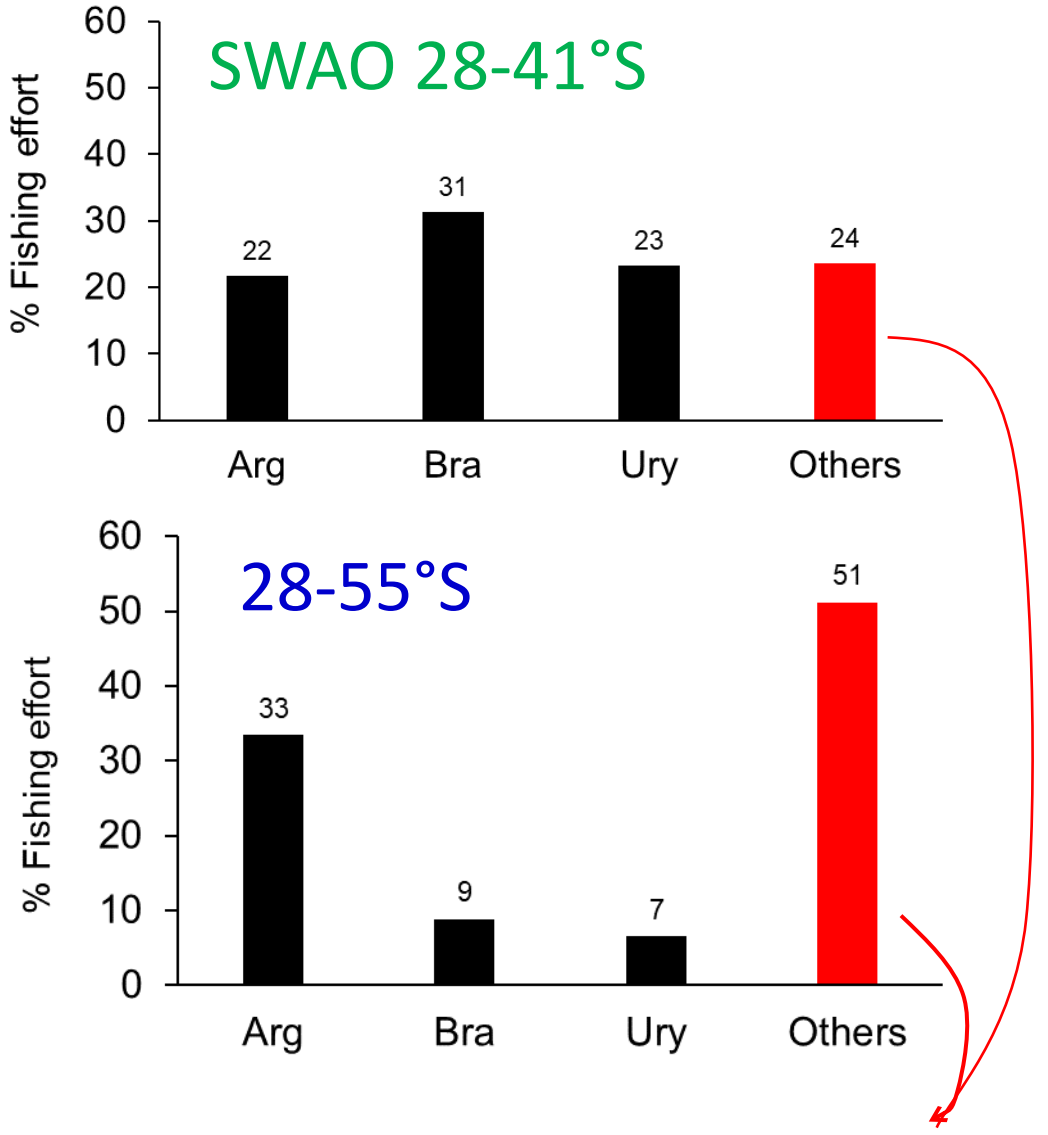


2 species with 40% of landings: Argentine hake *Merluccius hubssi* & calamar *Illex argentinus*

Important percentage of the catches in the main area of influence of the hotspot (28-41°S)

Fishing activity in the SWAO: governance?





Targets: several species managed in the SWAO

Social-ecological and institutional (mis)fit

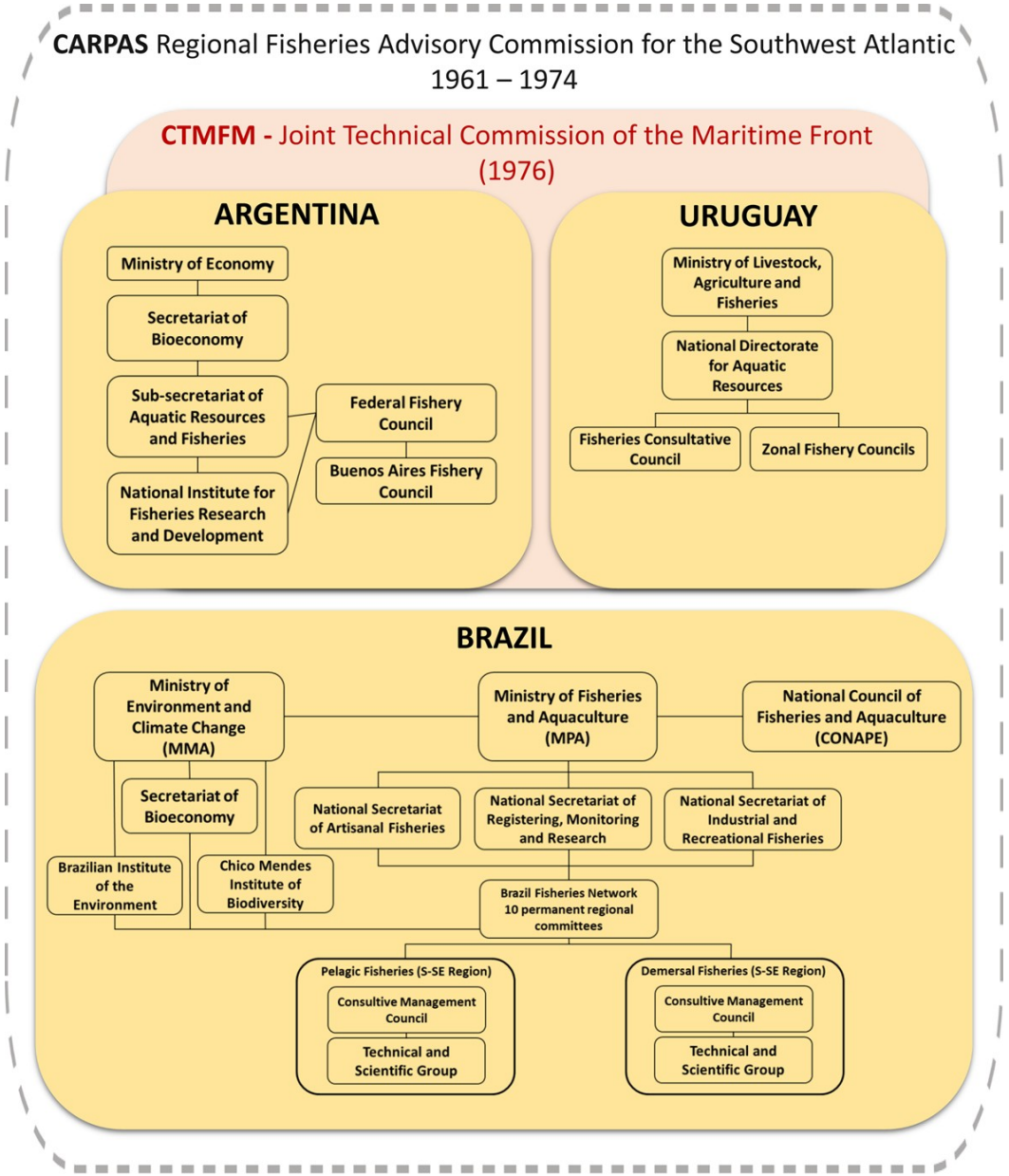
1. Increasing effects of climate change-related stressors acting simultaneously fisheries productivity at large spatial scales

2. Lack of management autonomy due to international fleets in open seas and loss of sovereignty caused by illegal fishing

3. Incongruence between ecological and management scales, aggravated by an institutional misfit

4. **Short-term need**: multidimensional congruence among social-ecological, management, and institutional settings

5. Participatory approaches and collaborative efforts are needed



Winds of hope: participatory assessment of stock status

Regional Workshops with plenary discussions:
Assessment of stock status

Consultation

Official invitations by FAO
Identification of experts
Introduction to the process
Informal meetings
Direct consultation



Planning and scoping

Fact sheet proposal
Dissemination & discussion
Feedback by FAO staff
Feedback by countries
Spreadsheet proposal

Overview of the literature

National reports
NGOs
Primary papers: SCOPUS, Google Scholar
Discussion with colleagues

Stock categorization

Suggestions by countries

Independent assessment by FAO

FAO

Defeo et al. 2025

Human impacts in coastal systems: urbanization

Global meta-analysis: 150 beaches with BACI designs

Interactions between multiple human disturbances and beach morphodynamics shape macroinvertebrate populations: Cumulative Harshness Hypothesis

Higher sensitivity of macroinvertebrates to human disturbances in harsh reflective beaches

LIFE HISTORIES: Supralittoral families responded more negatively to local urbanization

Intertidal organisms with planktonic larvae more affected by urbanization at the largest spatial scales (metapopulations)

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journal homepage: www.elsevier.com/locate/jenvman

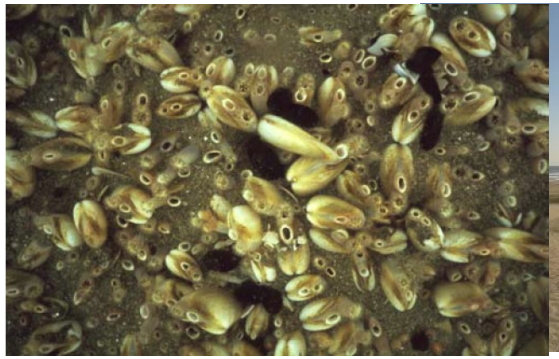
Cumulative stressors impact macrofauna differentially according to sandy beach type: A meta-analysis

Costa et al. 2022,

Social-ecological traps and regime shifts

Before 1980's

Andreoni Canal, Uruguay






After






Biodiversity loss
Fishers unemployment
Decreasing revenues

Erosion
Habitat loss & unsuitability

Damaged infrastructure
Unemployment

Tourism affected
Loss of scenic views

40 years of quantitative data

Before-After, BACI & gradient analyses

Social-ecological trap: *'situations when feedbacks between social and ecological systems lead toward an undesirable state that may be difficult or impossible to reverse'*

Kittinger et al. 2013

Interacting drivers at different spatial and temporal scales

Jorge-Romero et al. 2019. 2022, Defeo & Elliott 2021