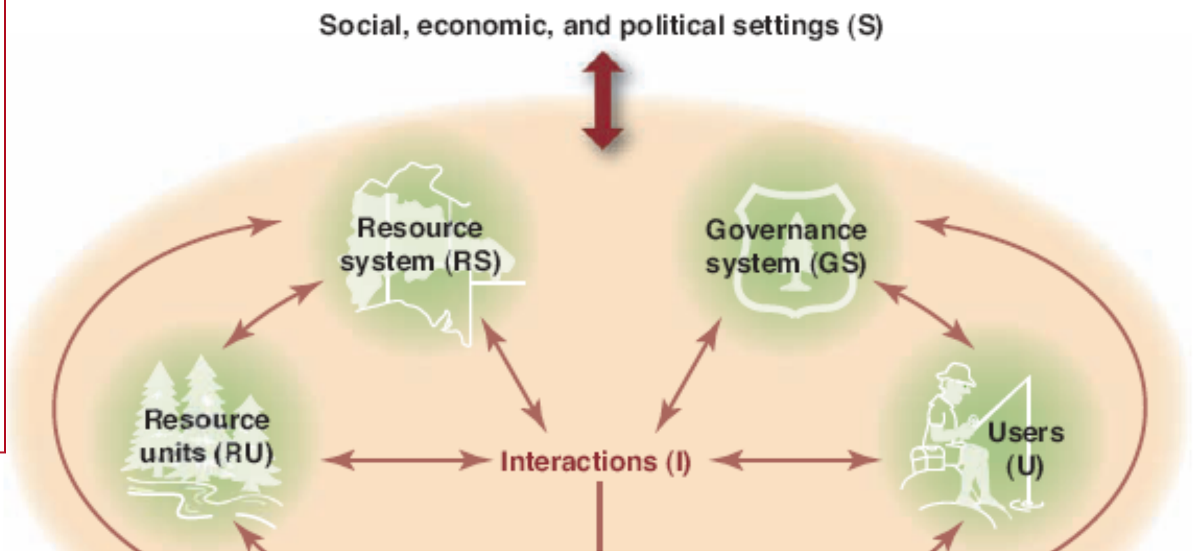
Impacts of climate, fisheries and governance in Latin American shellfishes

Omar Defeo - Uruguay

Social – ecological systems (SES)

1. Social and ecological systems are interconnected
2. Delimitation between social and ecological issues is arbitrary and artificial (Berkes & Folke 1998)



A major problem worldwide is the potential loss of fisheries, forests, and water resources. Understanding of the processes that lead to improvements in or deterioration of natural resources is limited, because scientific disciplines use different concepts and languages to describe and explain complex social-ecological systems (SESs). Without a common framework to organize findings, isolated knowledge does not cumulate. Until recently, accepted theory has assumed that resource users will never self-organize to maintain their resources and that governments must impose solutions. Research in multiple disciplines, however, has found that some government policies accelerate resource destruction, whereas some resource users have invested their time and energy to achieve sustainability. A general framework is used to identify 10 subsystem variables that affect the likelihood of self-organization in efforts to achieve a sustainable SES.

Ostrom 2009

SES

Critical core subsystems and second-level variables directed to address SES

Order of variables importance varies among studies

Table 1. Examples of second-level variables under first-level core subsystems (S, RS, GS, RU, U, I, O and ECO) in a framework for analyzing social-ecological systems. The framework does not list variables in an order of importance, because their importance varies in different studies. [Adapted from (*12*)]

Social, economic, and political settings (S)

S1 Economic development. S2 Demographic trends. S3 Political stability.
S4 Government resource policies. S5 Market incentives. S6 Media organization.

Resource systems (RS)	*Governance systems (GS)*
RS1 Sector (e.g., water, forests, pasture, fish)	GS1 Government organizations
RS2 Clarity of system boundaries	GS2 Nongovernment organizations
RS3 Size of resource system*	GS3 Network structure
RS4 Human-constructed facilities	GS4 Property-rights systems
RS5 Productivity of system*	GS5 Operational rules
RS6 Equilibrium properties	GS6 Collective-choice rules*
RS7 Predictability of system dynamics*	GS7 Constitutional rules
RS8 Storage characteristics	GS8 Monitoring and sanctioning processes
RS9 Location	
Resource units (RU)	*Users (U)*
RU1 Resource unit mobility*	U1 Number of users*
RU2 Growth or replacement rate	U2 Socioeconomic attributes of users
RU3 Interaction among resource units	U3 History of use
RU4 Economic value	U4 Location
RU5 Number of units	U5 Leadership/entrepreneurship*
RU6 Distinctive markings	U6 Norms/social capital*
RU7 Spatial and temporal distribution	U7 Knowledge of SES/mental models*
	U8 Importance of resource*
	U9 Technology used

Interactions (I) → outcomes (O)

I1 Harvesting levels of diverse users	O1 Social performance measures (e.g., efficiency, equity, accountability, sustainability)
I2 Information sharing among users	
I3 Deliberation processes	
I4 Conflicts among users	O2 Ecological performance measures (e.g., overharvested, resilience, bio-diversity, sustainability)
I5 Investment activities	
I6 Lobbying activities	
I7 Self-organizing activities	O3 Externalities to other SESs
I8 Networking activities	

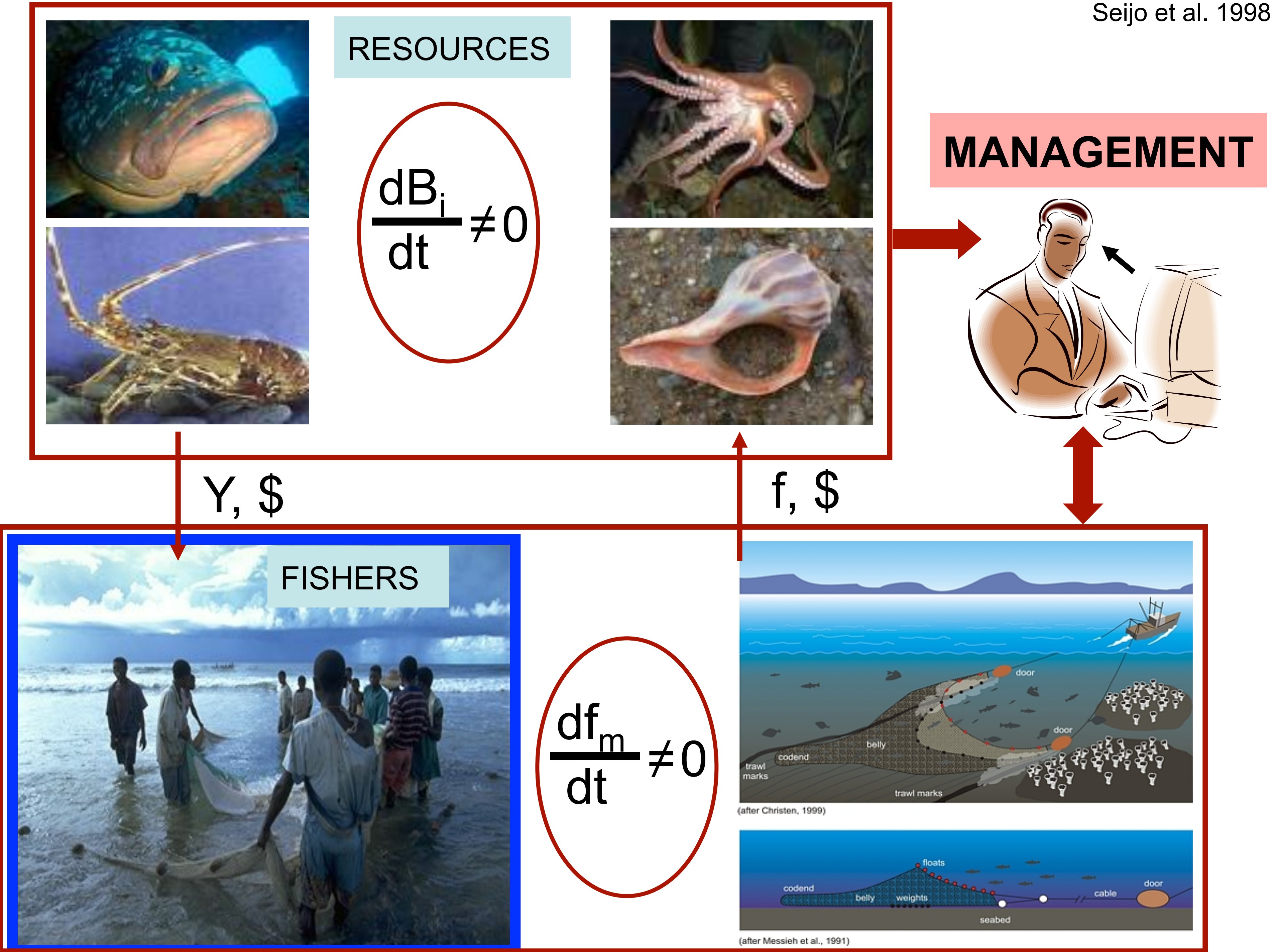
Related ecosystems (ECO)

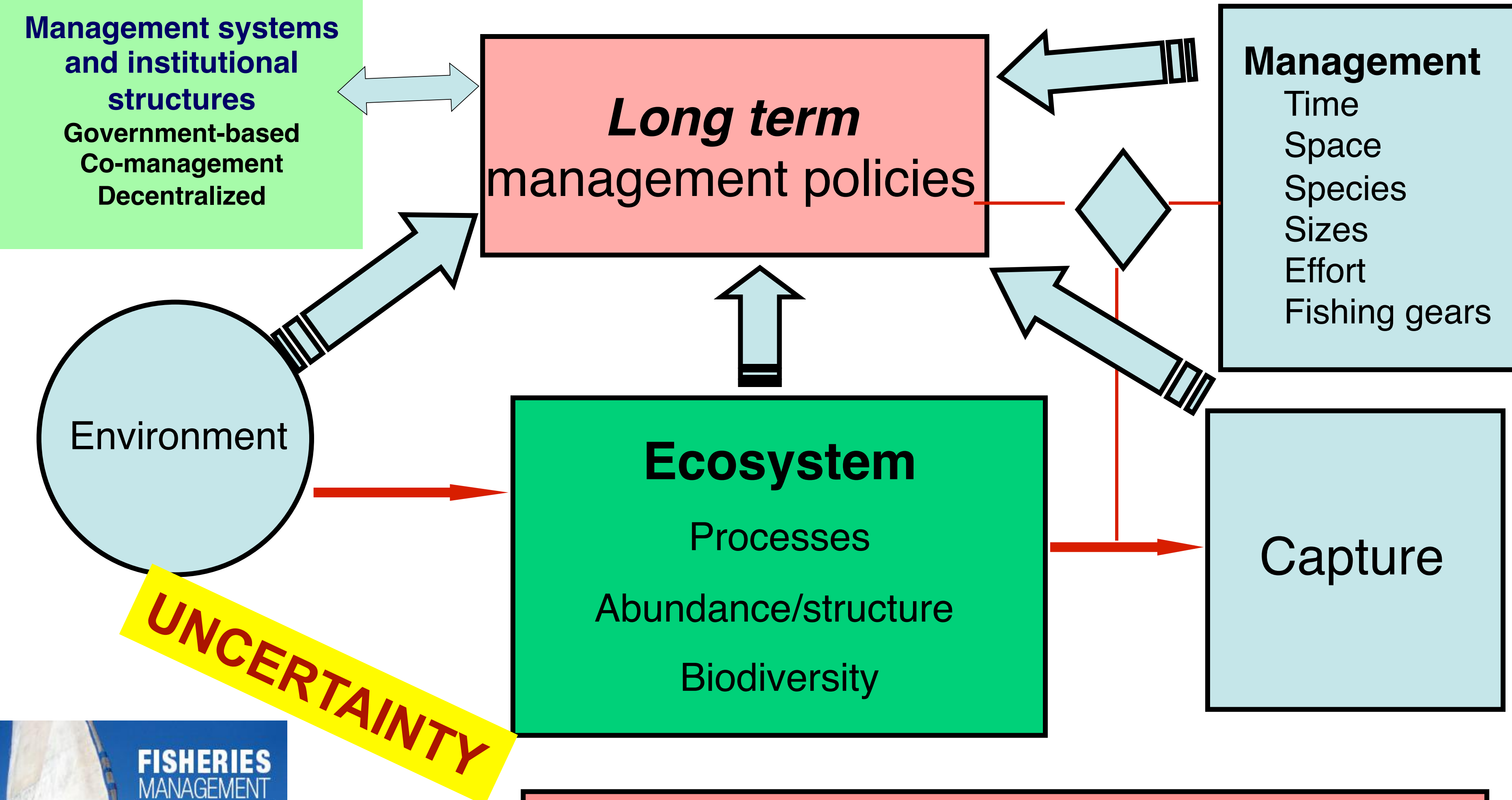
ECO1 Climate patterns. ECO2 Pollution patterns. ECO3 Flows into and out of focal SES.

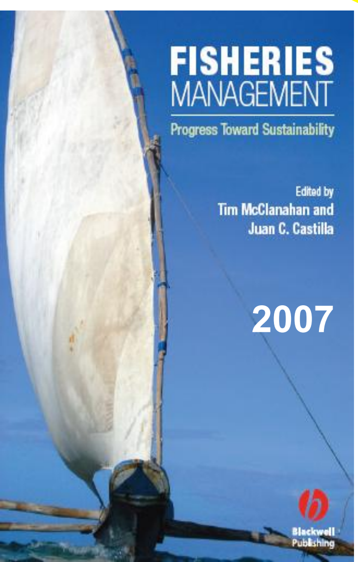
*Subset of variables found to be associated with self-organization.

Ostrom 2009

Seijo et al. 1998





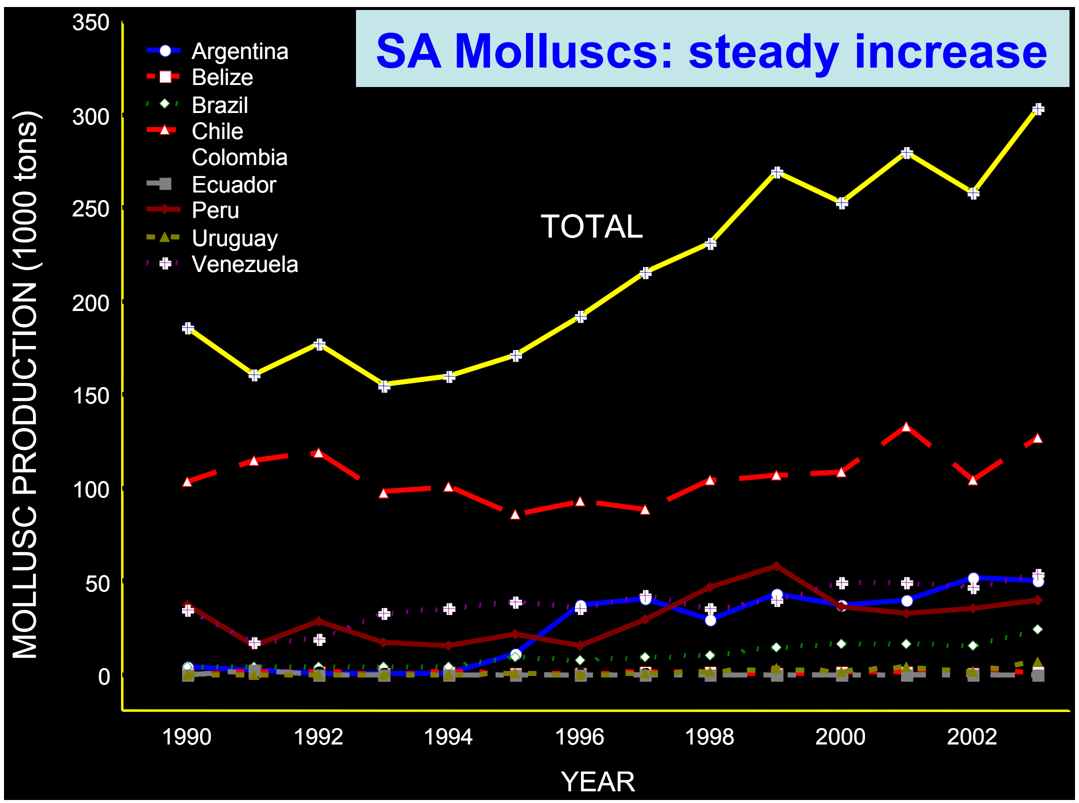


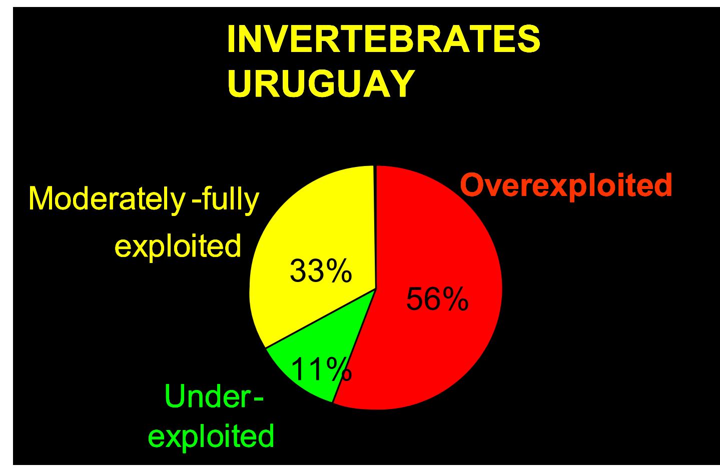
Fishery resources management needs the integration of its biology with socio-economic and institutional factors affecting fishers behaviour and managers

Defeo et al. 2007, McClanahan et al. 2009

Coastal Latin American shellfisheries

- Mostly artisanal and highly valued
- Open access: extended coasts imply costly MCS systems, poor enforcement
- Many are overexploited or just collapsed: historical population declines
- Fisheries/stock data poor or unavailable for diagnosis of condition
- Underemployment, income reduction and reduced access to marine food for subsistence





ALL INVERTEBRATES UNDER-EXPLOITED 18 YEARS AGO!!

Defeo et al. 2010

Coastal Latin American shellfisheries

- **Co-management**
  - Emerging as an institutional arrangement for sustaining harvests
  - Successful examples evaluated through sound science, are few and poorly disseminated

- **Sandy beach shellfisheries**
  - Co-management and area-based rights were successfully implemented
  - **Massive mortalities** decimated populations along entire ranges
  - Effects of **climate change** could swamp management measures?

Shellfish management in LA requires paradigm shifts, including:

- basic ecosystem principles
- fishery incentives
- implementation of resilient management systems and effective governance

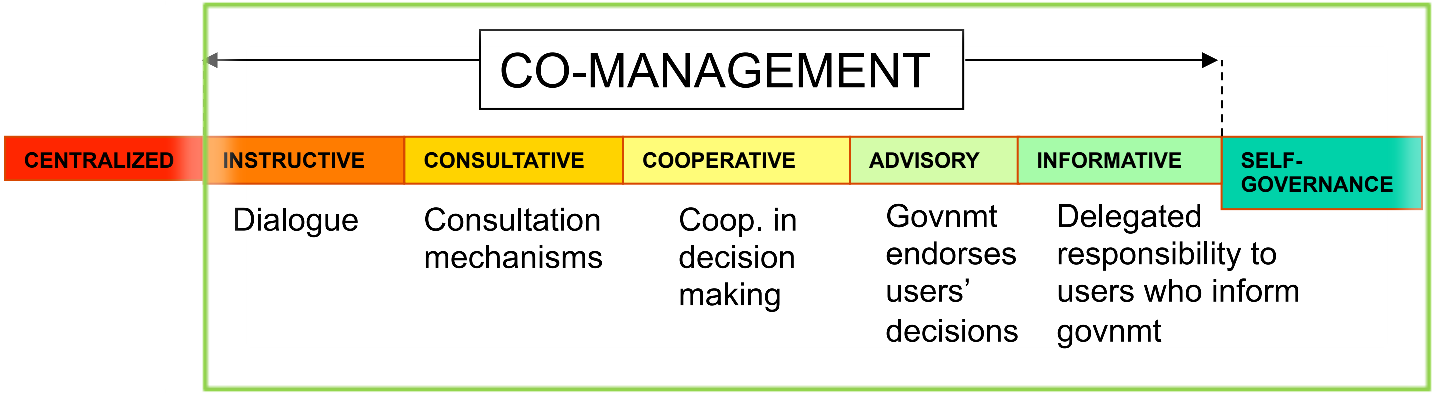
Main objectives

1. Assess and compare **co-management** regimes through performance indicators to provide shellfish management/ conservation solutions and to improve policy actions in LA

2. Evaluate long-term and large-scale effects of exploitation and climate in LA **sandy beach ecosystems** at different levels (populations, communities)

3. Develop a **LA network of shellfish conservation** to:
   a. identify and promote science-based solutions for LA shellfishes
   b. raise awareness on the increasing effects of climate change on shellfishes

Objective 1: co-management



Arrangement where responsibility for resource management is shared between the government and user groups

Collective management of fishery resources under a set of universal conditions is more likely to attain sustainable outcomes than top-down approaches

However, general and multidisciplinary diagnoses of co-management regimes are lacking

1. Global examination of LA **co-managed fisheries** in a wide range of social, economic and ecological settings

2. **Long-term performance** of selected **shellfish** co-managed fisheries using a BA-CI approach

Global review - Variable coding

Resource

Defined boundaries
Type of resource
Mobility

Users

Cohesion
Leadership
Self-enforcement
Influence in Market
Tradition

Governance

Legislative framework
Long-term management
Global quotas; Catch shares
Spatial Management
Protected areas; MCS

Outcomes

Fishery Status; Sustainable Catches
Increase in Abundance
Increase in CPUE
Increase in Price
Increase in Social Welfare
Community Empowerment
Add-on Conservation Benefits

SUCCESS SCORE 0-8

After Ostrom 2009, *Science*

Gutierrez, Hilborn, Defeo (in prep)

Co-management in Latin America: some results

By data available		%
	None	45
	Any	55
	Catch	50
	CPUE	36
	Abundance	11
	Unit Prices	23

By data used for assessment		%
0	**None/NM**	21
1	Interviews	21
2	Fishery-dependent	28
3	Fishery-independent	0
1,2		17
1,3		0
2,3		7
1,2,3	All	7
Total		*100*

45% showed no data supporting their conclusions

21% did not use (or not mentioned to use) any data to support their conclusions

59% used some quantitative data (not necessarily long-term series)

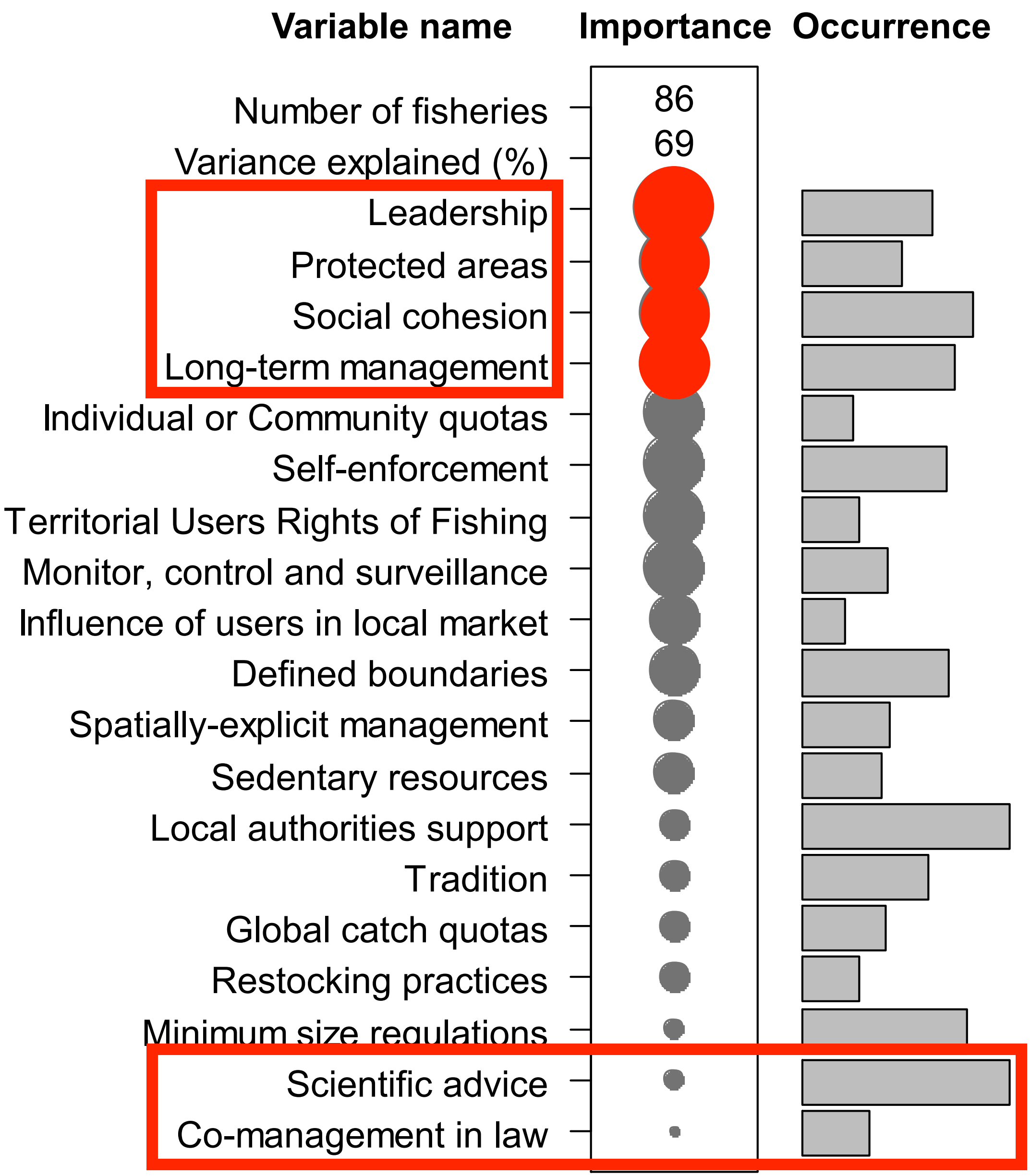
N (to date) = 42

Documents = 252

Attributes = 19

Indicators of success = 8

Attributes' importance



Methods

Regression Trees - **Random Forests:**

- Response variable: Success Score
- Covariates: 19 Co-M attributes

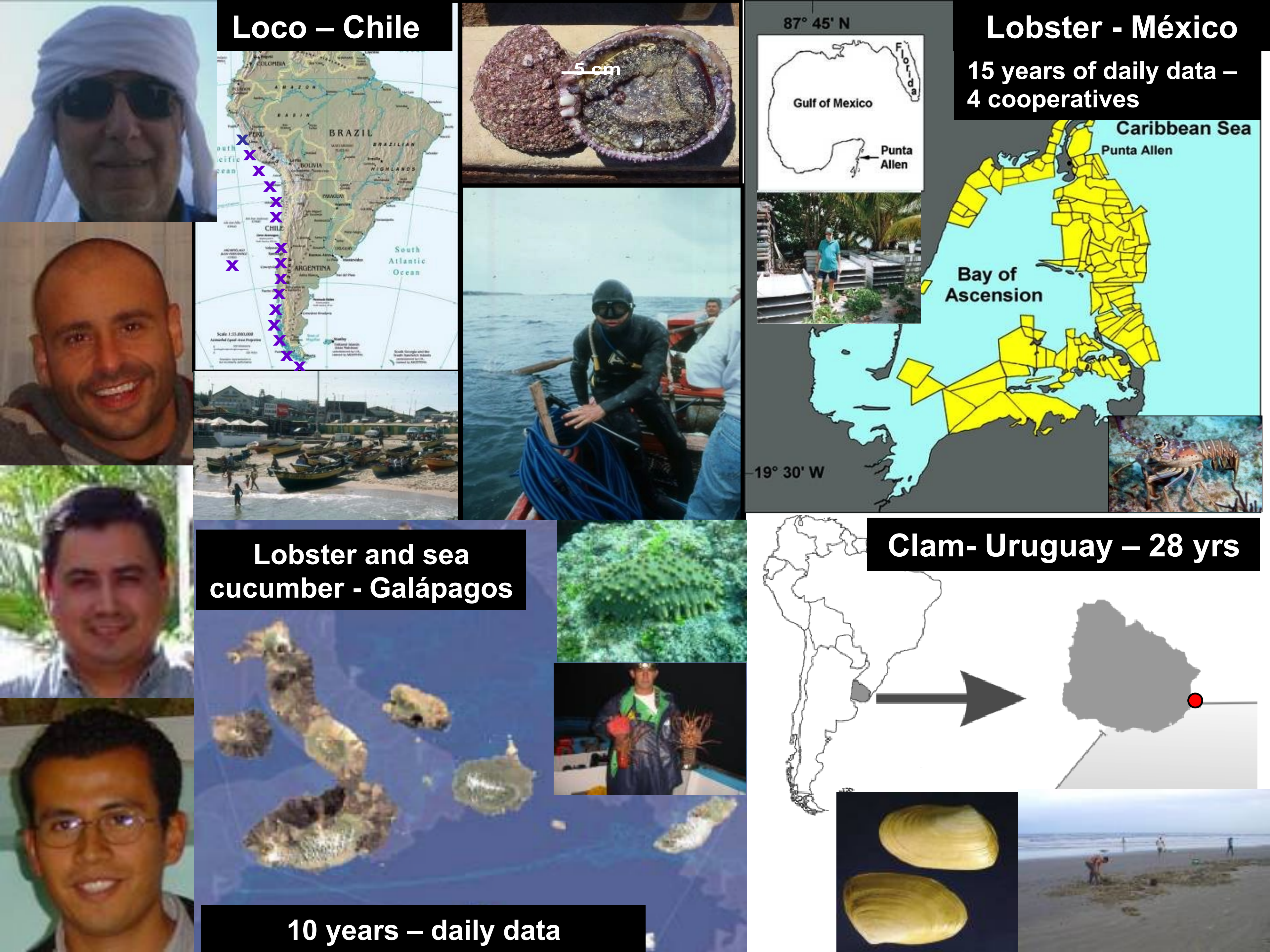
Results

Leadership and **social cohesion** most important users' attributes

Protected areas and **long-term management plans** as governance keys for success, followed by **catch shares**

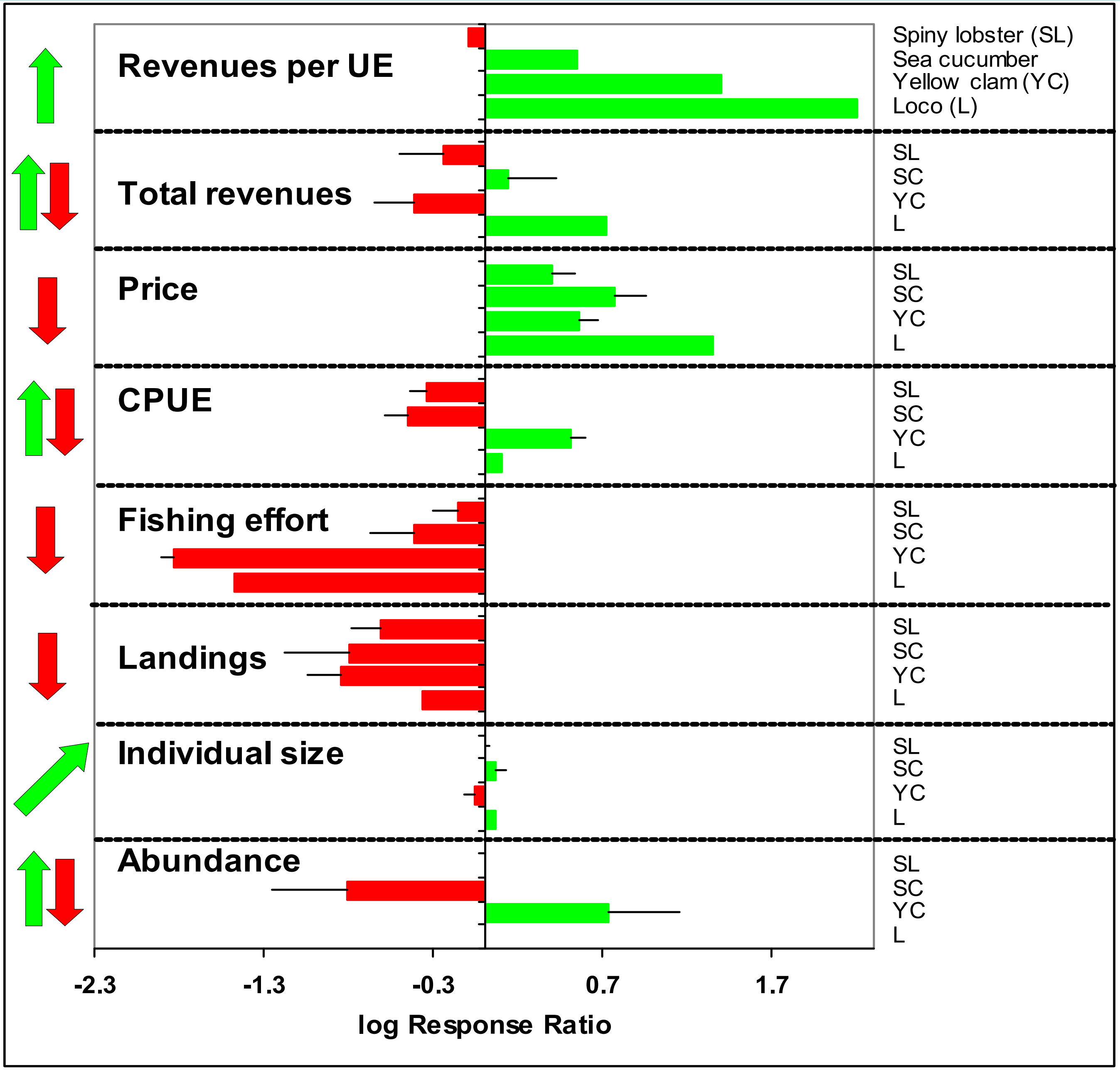
Scientific advice and **legislative framework** least important

Gutierrez, Hilborn, Defeo (in prep)



Loco – Chile
COLOMBIA
PERU
BRAZIL
BOLIVIA
CHILE
ARGENTINA
South Atlantic Ocean
5 cm
Lobster - México
15 years of daily data – 4 cooperatives
87° 45' N
Florida
Gulf of Mexico
Punta Allen
Caribbean Sea
Punta Allen
Bay of Ascension
19° 30' W
Lobster and sea cucumber - Galápagos
10 years – daily data
Clam- Uruguay – 28 yrs

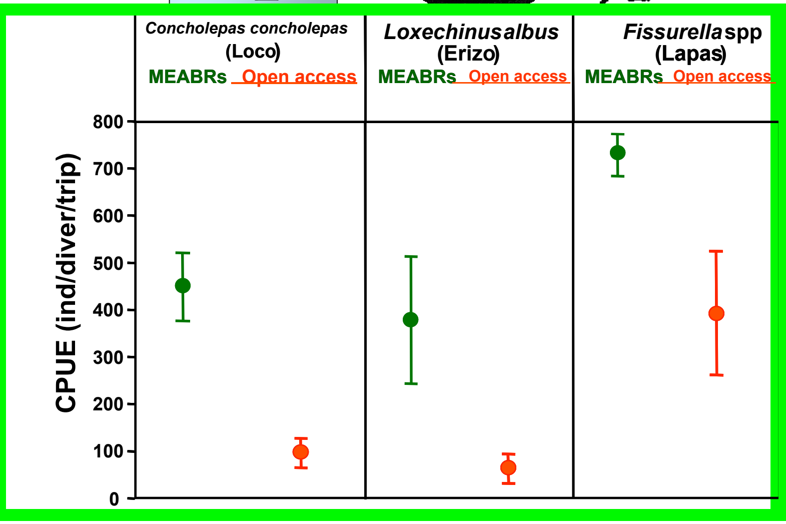
Co-management impact: response ratios

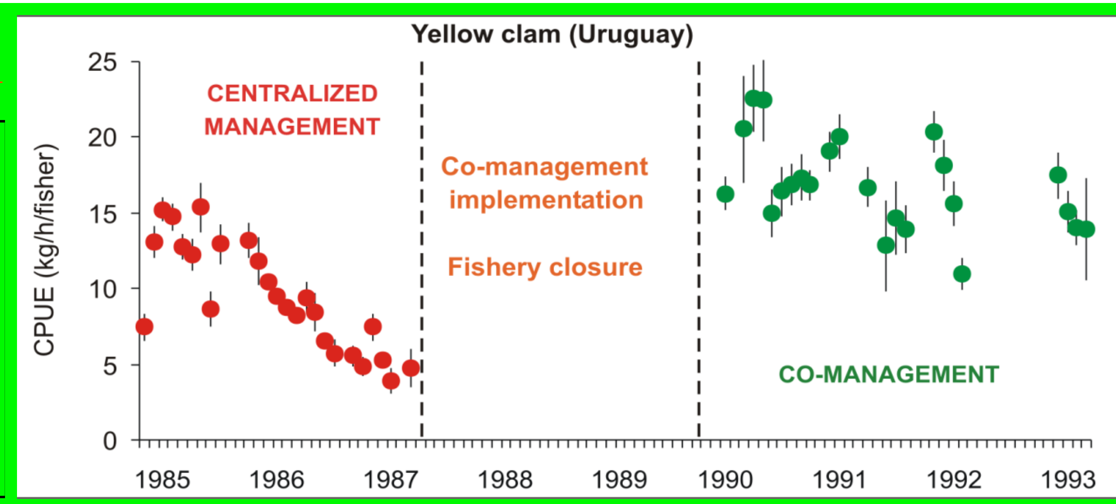


Defeo et al. (in prep.)

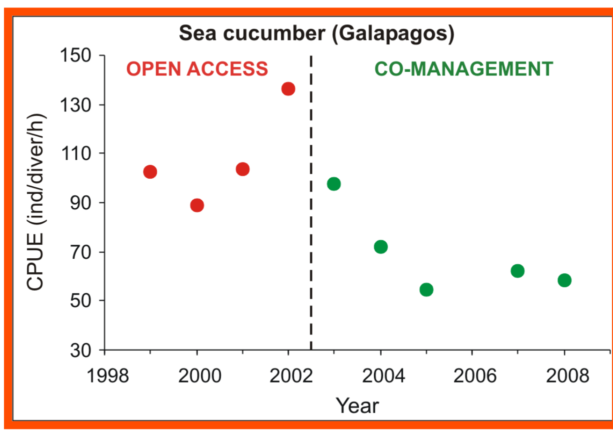
Impact of co-management: CPUE – abundance "BA-CI"

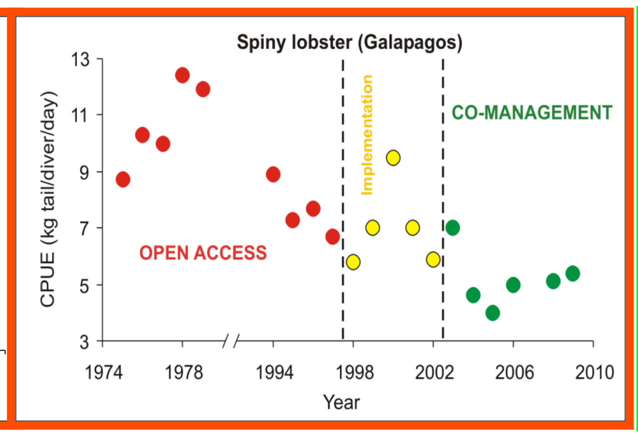
Long term: CPUE

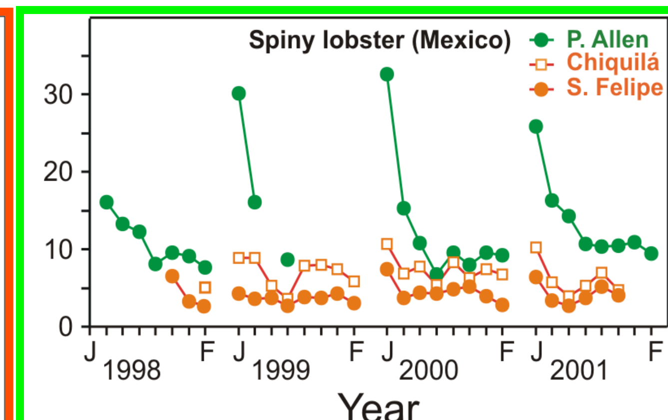




Chile, Mexico, Uruguay: SUCCESS ➔ Abundance and CPUE higher during co-management phase







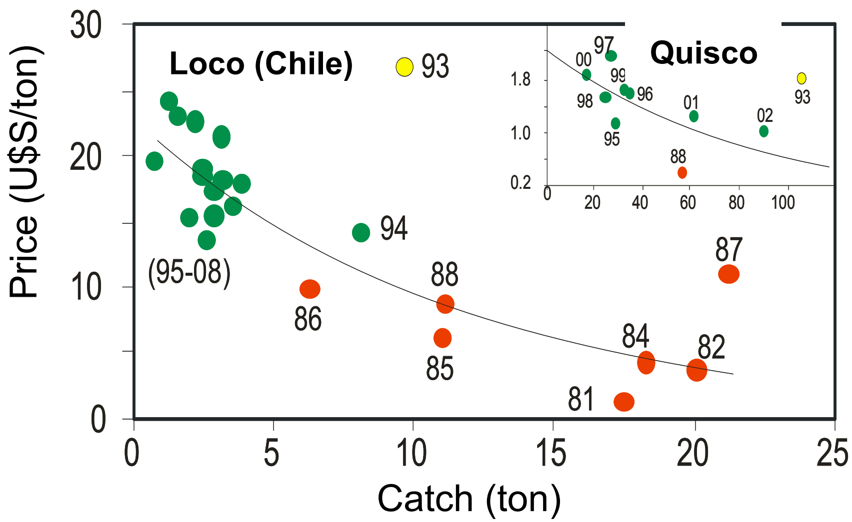
Galapagos: FAILURE ➔ Abundance and CPUE lower during co-management phase

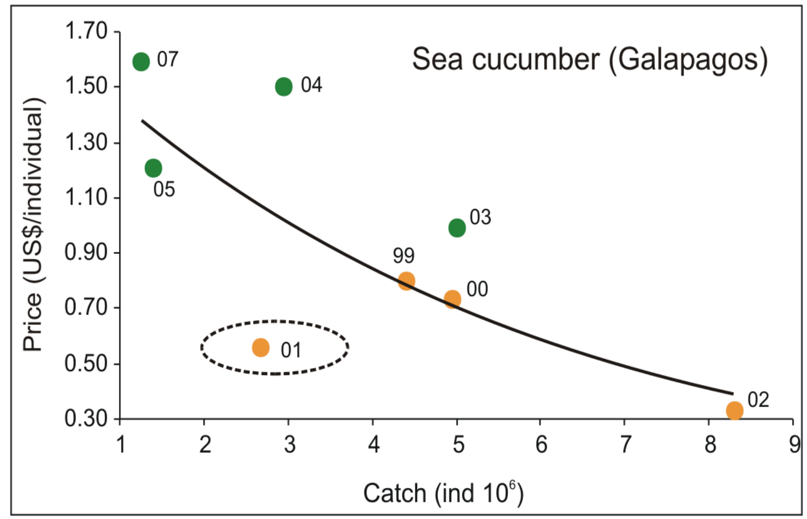
Defeo et al. (in prep.)

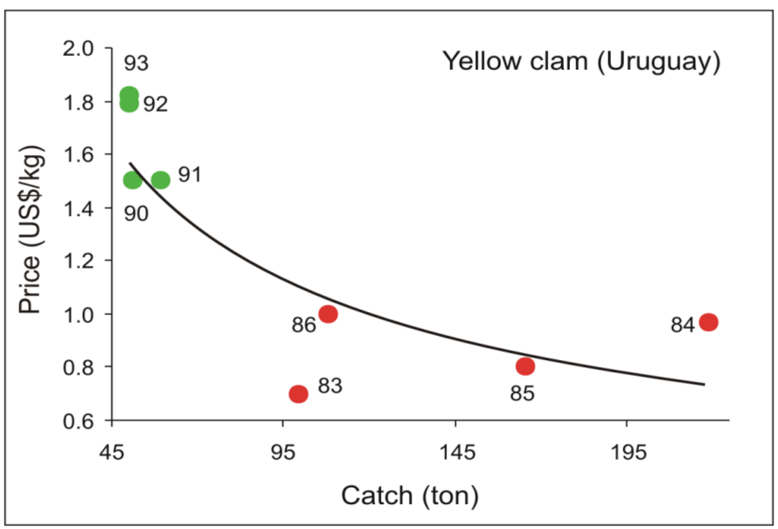
Demand curves: same trend but very different meaning

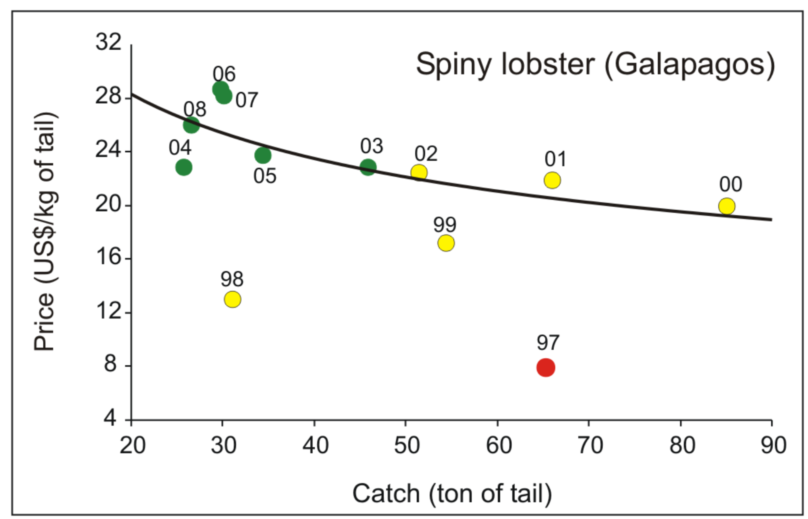
Chile –Uruguay: increasing prices at low catches but high abundance, resulting from the management framework

Galapagos: increasing prices at low abundance and CPUE levels: bioeconomic indicator of overexploitation ➔ Anthropogenic Allee Effect



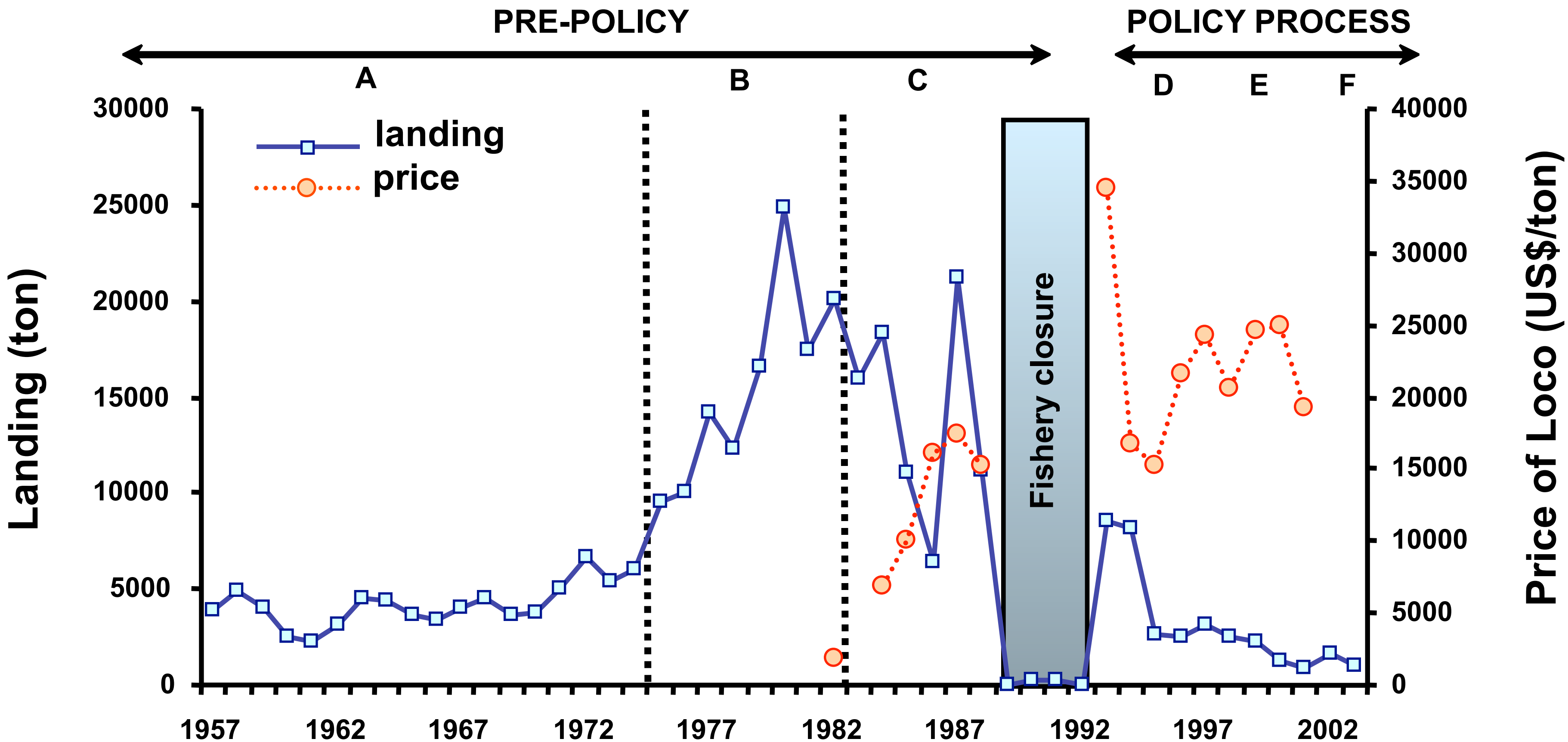






CHILE
"Loco" *Concholepas concholepas*

17-yr sustainable management of "loco" (1993-2010)



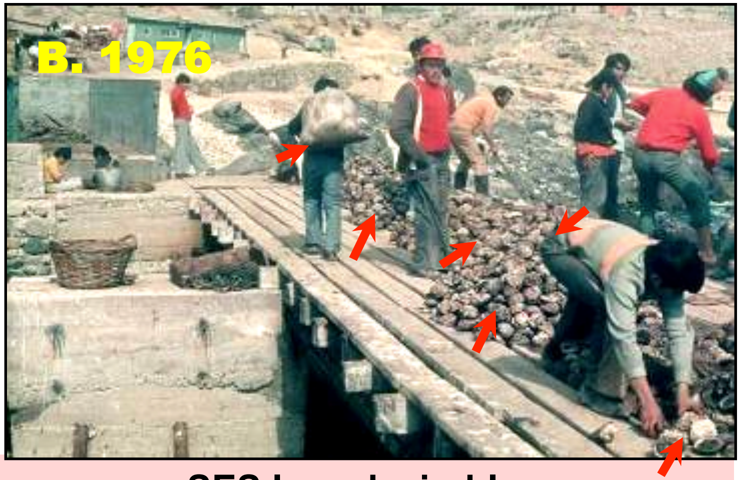
Catches reached similar levels to development phase of the fishery, whereas the price paid per ton of loco significantly increased during the period of management areas MEABR

Defeo & Castilla (2005)

SOCIAL – ECOLOGICAL SYSTEM: ALTERNATIVE STATES

Castilla et al. 2010

OPEN ACCESS



SES less desirable

1) Overexploitation
2) Individualistic behavior
3) Poor MCS system
4) Biodiversity loss (mussel monoculture)

MEABRs

SES desirable

- Sustainable exploitation
- Collective management
- Self-enforcement and efficient MCS
- High diversity

THE MODEL:

RATIONAL MANAGEMENT AND CONSERVATION through MULTI-LEVEL ZONING

MEABRs: great success

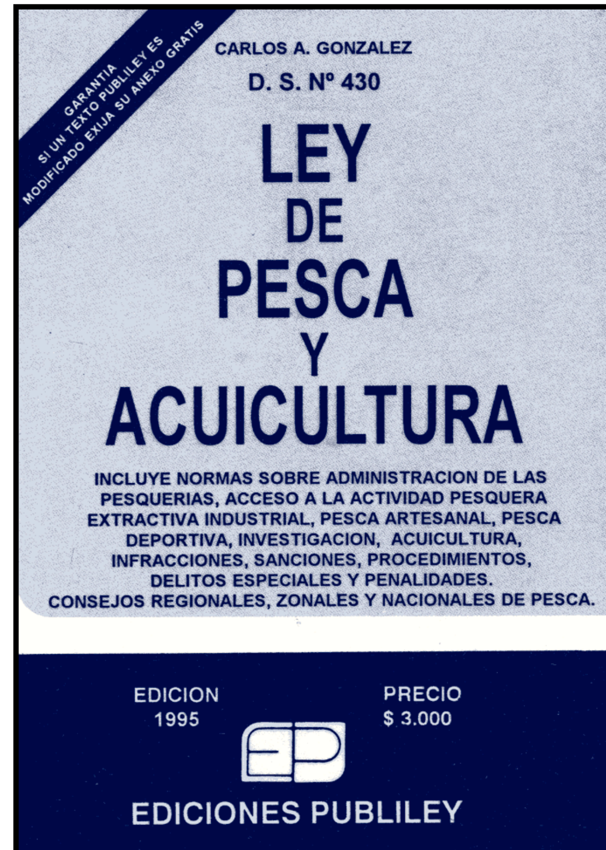
Solicited: > 1200
Approved = 707
Operative: 301

Each MEABR has *ca*. 1 - 4 km^2 and totally accounts for *ca*. 1100 km^2

Castilla 2000, 2010, Defeo & Castilla 2005, Castilla et al. 2007, 2009

CHILE: some keys for success

CHILEAN FISHERY AND AQUACULTURE LAW # 18,892 (1991)



Coastal strip of 5 nautical miles for exclusive use of artisanal fishers: macroscale zoning

TURFS: "Management and Exploitation Areas for Benthic Resources" (MEABRs) only for well-organized fisher associations (artisanal fishers)

Management redundancy: closures, legal sizes, TAC for each community that could be reallocated to e.g. families within the community

Marine reserves: conservation PLUS management

Official registration of artisanal fishers

Well-organized fisher groups with strong leadership

Government, users (and scientists) co-operate in decision making

MEXICO: keys for success

Well-defined territorial permit

High geographic isolation: self-help approach to community development

Grounds inheritable and transferable within the community

High enforcement levels

Reference Points strictly followed (e.g., quotas and legal sizes)

Strict community rules: penalties and self-policing strategies

Legal individual sizes and weights: quality over quantity

"Work, respect and trust: strength of the alliance"

Castilla & Defeo 2001, Defeo & Castilla 2005

Spiny lobster, Punta Allen (México): Internal Rules of the Cooperative

Articles	Purpose of each article or issue it deals with
# 1-7	Declaration of purpose of the internal rules (A1), obligation of every fisher to know them (A2), penalties for fishers who do not attend the General Assembly (GA) meetings (A3, A4) ways to justify the absence in GA meetings (A5), media to announcement of meetings (A6) and frequency of meetings (A7).
# 8	Duties and obligations of cooperative directors and commissioners to accomplish their tasks, setting the penalties (fines and lose of administrative positions) for non-compliance
# 9	On duties and obligations of the cooperative accountant to attend the various meetings and its full availability to provide the needed support.
# 10	Defines procedures for the payment of fines, who is in charge of collection of payments, penalties if somebody reacts agressively.
# 11	Penalties for cooperative members who (a) sell lobster outside to the cooperative and (b), fish lobster during the closed season. In both cases, the fisher will be ejected of the cooperative, losing all their rights and properties: campos, boat, motor and pending payments in the previous season. This property is transferred to the cooperative.
# 12	It is mandatory for fishers to mark properly the borders defining the limits of their campos.
# 13	Set penalties to fishers for using nets, traps, in fishing grounds or campos belonging to other fishers. The fisher invading a campo automatically loses the fishing gear used, which becomes property of the fisher possessing the right over the invaded campo.
# 14	Forbids the deployment of stationary nets (silk or monophilament) in the bay.
# 15	Sets penalties for fishers diving for lobsters in campos of other fishers having artificial habitats, located in either the back-reef or fore-reef: the fisher loses his fishing equipment: boat, motor and artificial habitats.
# 16	Sets fines to fishers throwing fish waste or lobster heads on campos or the beach of the town (specific limits are cited).
# 17	Fisher who hire as partners or helpers somebody who was expelled from the cooperative in the past; the first offence is a fine. The second offence results in loss of the rights to harvest lobster during the current season.
# 18	The cooperative allows only students of fishing technical schools to catch lobsters as helpers of a fisher belonging to the cooperative. They must have the proper identification to show to cooperative officers. In the contrary Article 17 applies.
# 19	Fishers who invite a parent to fish must notify the surveillance commission to get the proper permission.
# 20	Diving for lobsters is forbidden for all fishers who do not possess campos adjacent to the fore-reef, as there are a great number of ovigerous lobsters in this area.
# 21	Fishers in possession of sub-legal size lobsters in his boat or elsewhere will pay a fine, rated at $10/kg.
# 22	Fishers in possession of lobster tails showing remains of egg-mass are fired.
# 23	Fishers in possession of live egg-bearing lobsters must return them to the sea (or pay a fine).

GALAPAGOS: When co-management and laws are not enough…

Management regulations and co-management included in law

Annual assessments required by law

However:

Lack of management framework

No long-term management policy

No TURFs allocation

No individual quotas

Weak group cohesion

No leadership

Leaders unreliable to fishers

Weak enforcement

Illegal fishing by community members!!! during closed seasons and non-commercial sizes

This has caused erratic management practices that are impacting negatively exploited stocks, the health of the Galápagos marine ecosystem and the fisher communities

Objective 2: sandy beaches, massive mortalities & climate

1. Sandy beaches comprise ~70% of open-ocean coasts and have high socioeconomic value
2. Highly vulnerable to climate change
3. Omission of beach ecosystems from assessments of anthropogenic impacts
4. Scarce information on ecological impacts of climate change on this land-sea margin ecosystem

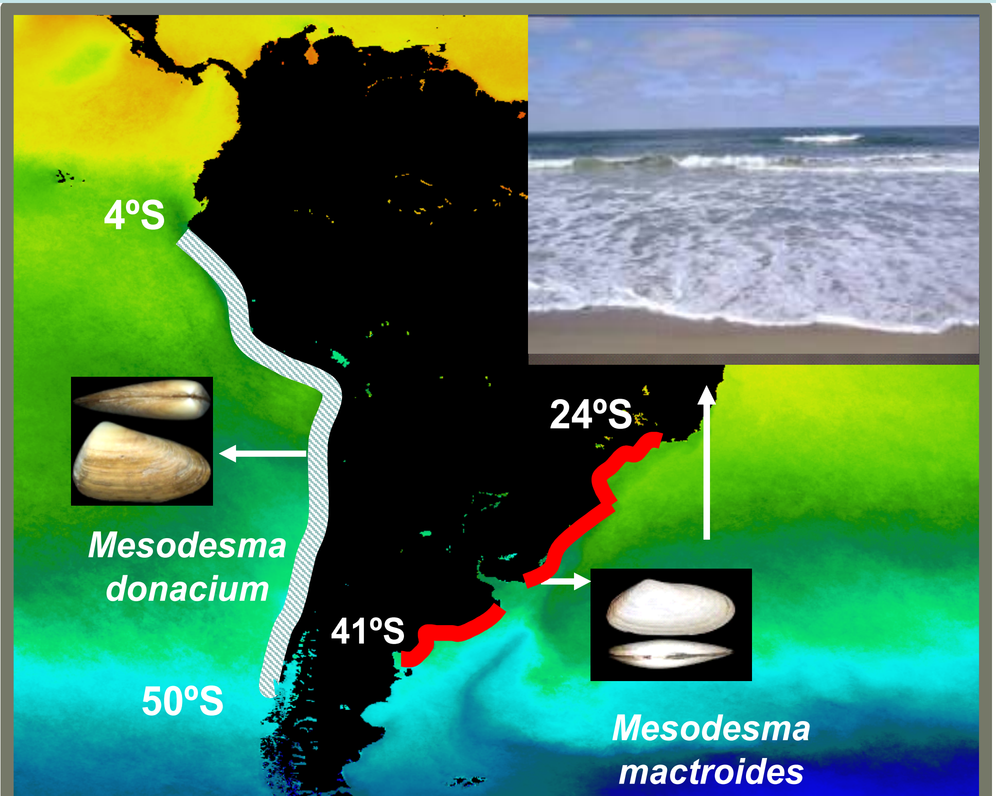
Defeo et al. 2009, Dugan et al. 2010 - Science

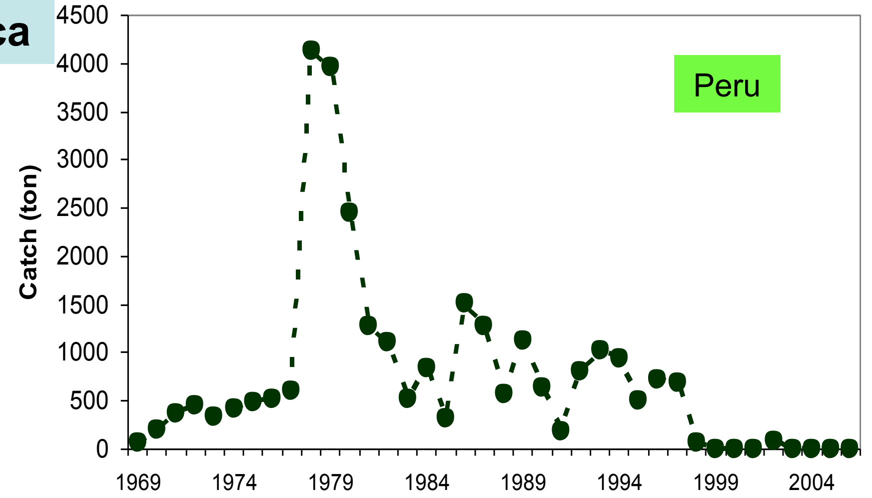
ACTIVITIES:

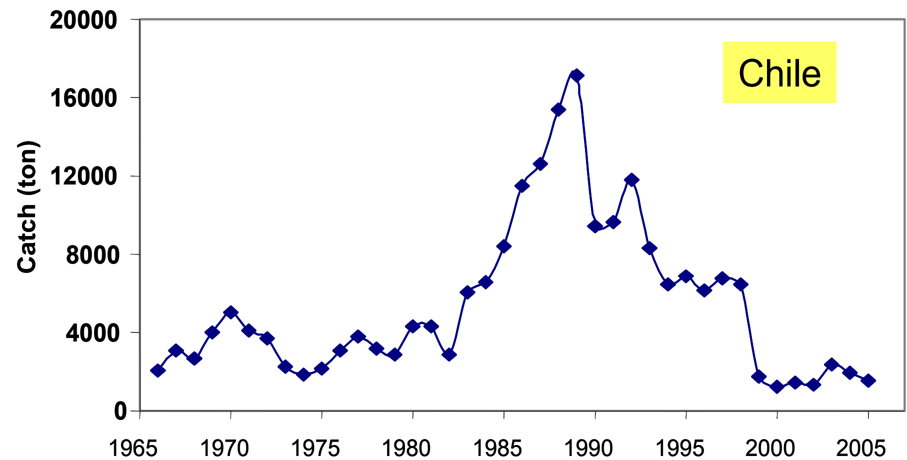
1. Collate and process long-term (30 yrs) and large-scale ecological, fishery and oceanographic information for Atlantic and Pacific shellfishes of South America throughout their entire distribution ranges
2. Assess the relative importance of exploitation and CC in explaining resource variability
3. Identify and promote potential actions for adaptive mitigation strategies to climatic variability for the fishers community

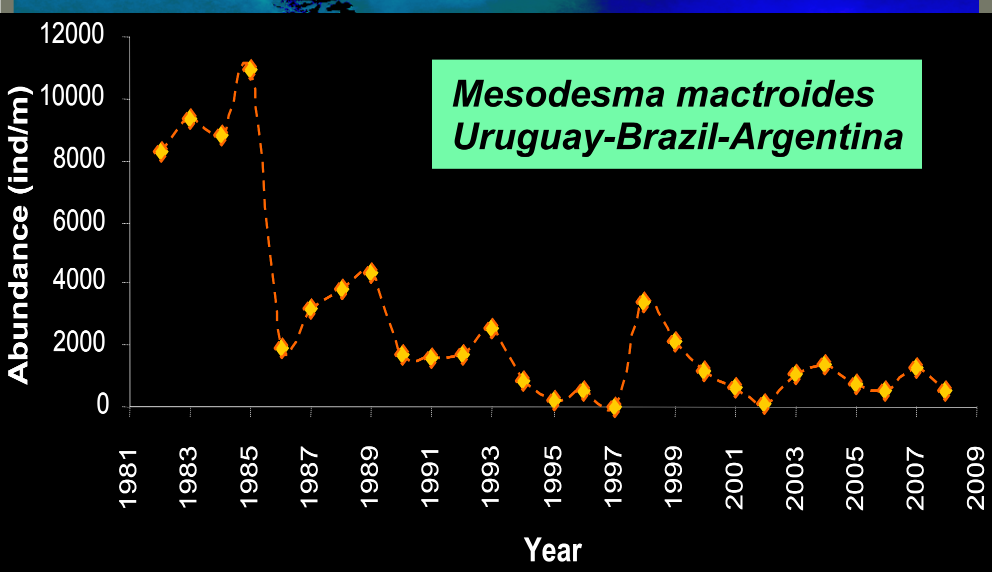



Clam *Mesodesma* – Pacific – Atlantic South America







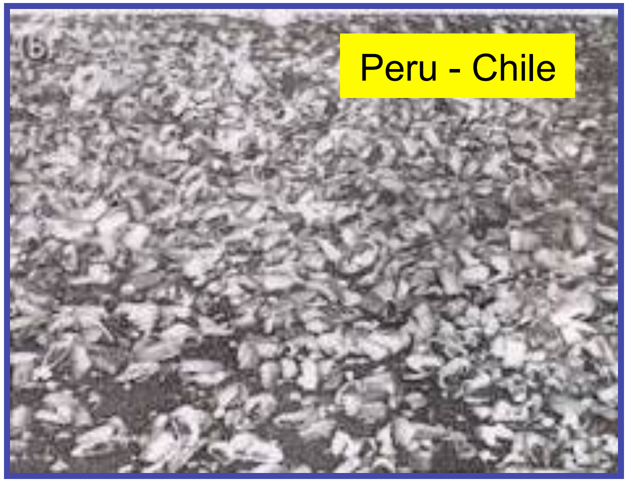


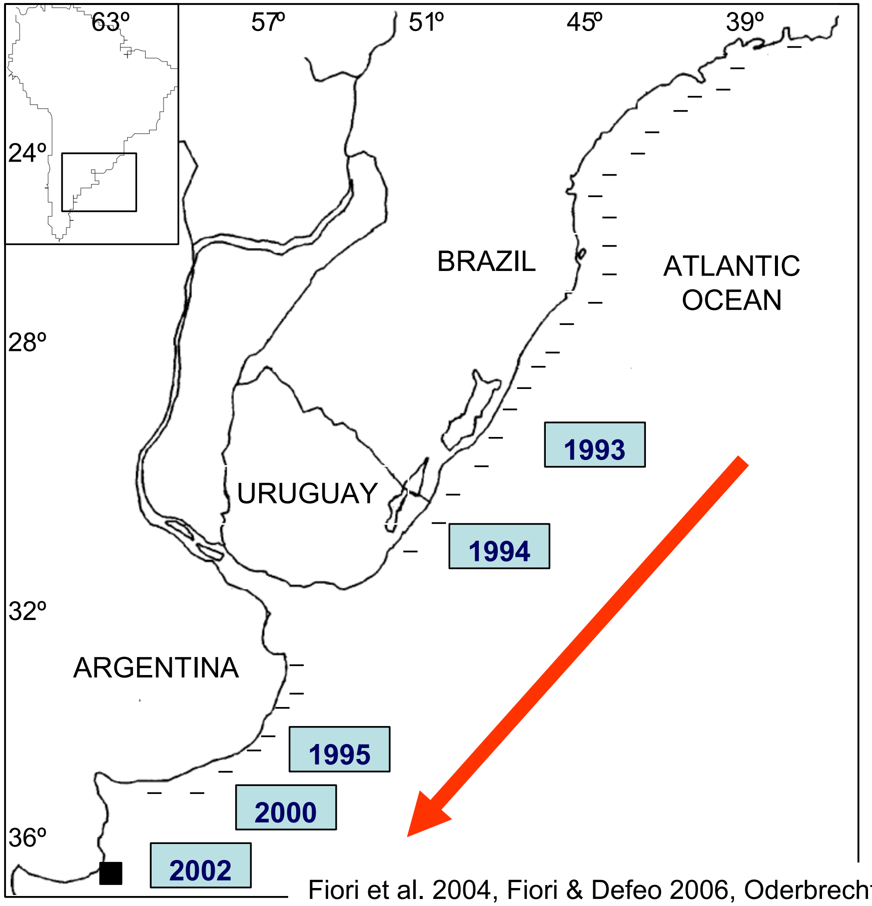
Almost collapsed, despite solid management strategies (area-based + co-management) that succeed in other benthic fisheries (e.g., Chile, Uruguay)

Cumulative effects of fishing and climate?

Massive mortalities during the last 2 decades decimated clam populations throughout entire distribution ranges in the Atlantic and Pacific:

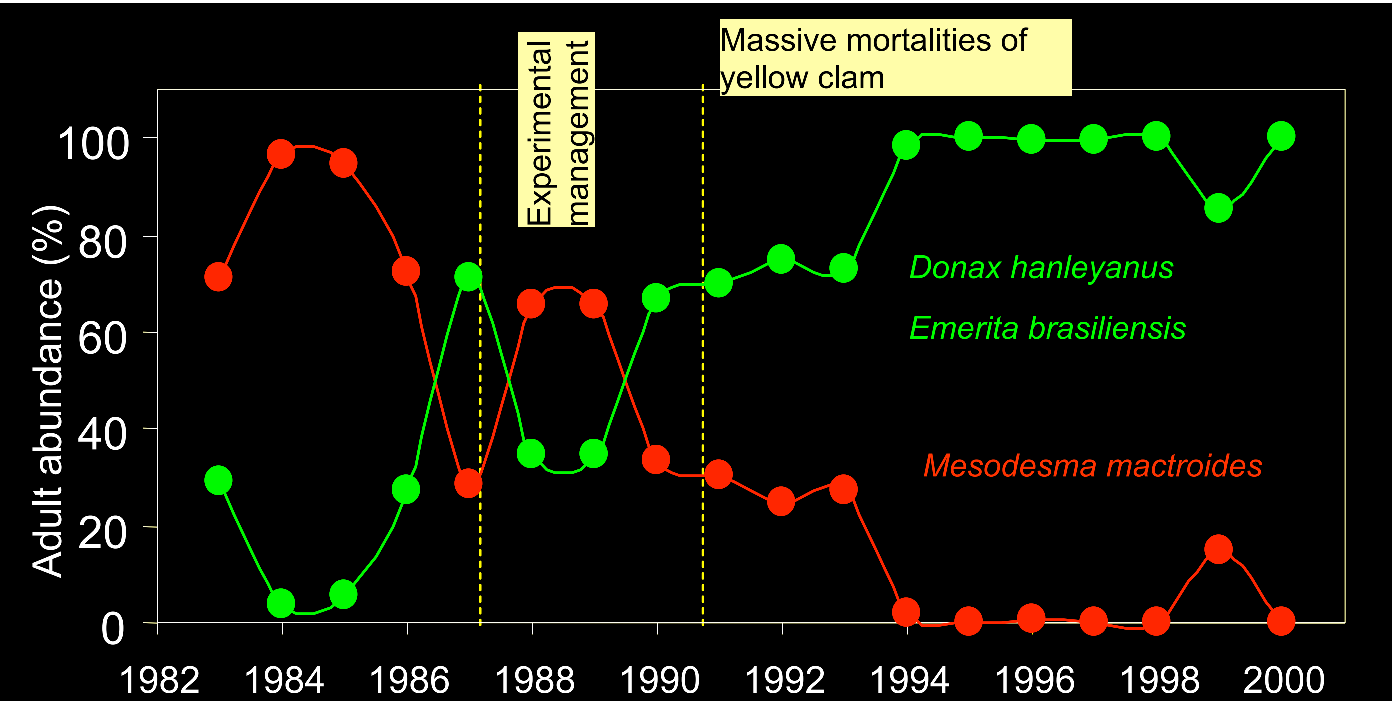
1. Artisanal fisheries and human livelihoods affected
2. Community structures and ecosystems drastically changed
3. Possible causes: fishing PLUS **temperature increase**, algal blooms, diseases





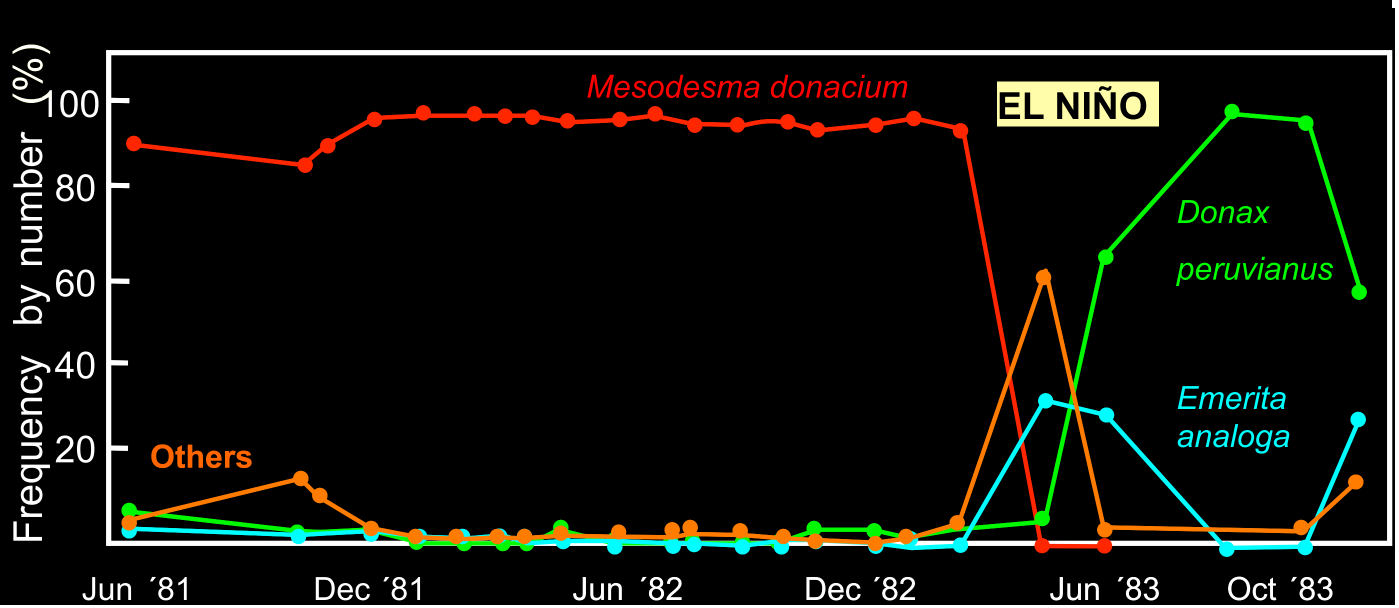
Fiori et al. 2004, Fiori & Defeo 2006, Oderbrecht et al 2009

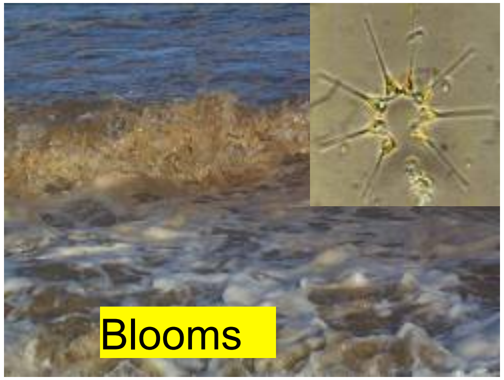
Sandy beaches, shellfisheries and climate



Changes being assessed:

1. Increasing SST
2. Phytoplankton biomass, composition and intensity of blooms
3. Benthic community structure
4. Population abundance
5. Persistence of invasive species
6. Range shifts





Objective 3: Latin American network

FUTURE ACTIVITIES & EXPECTED OUTCOMES:

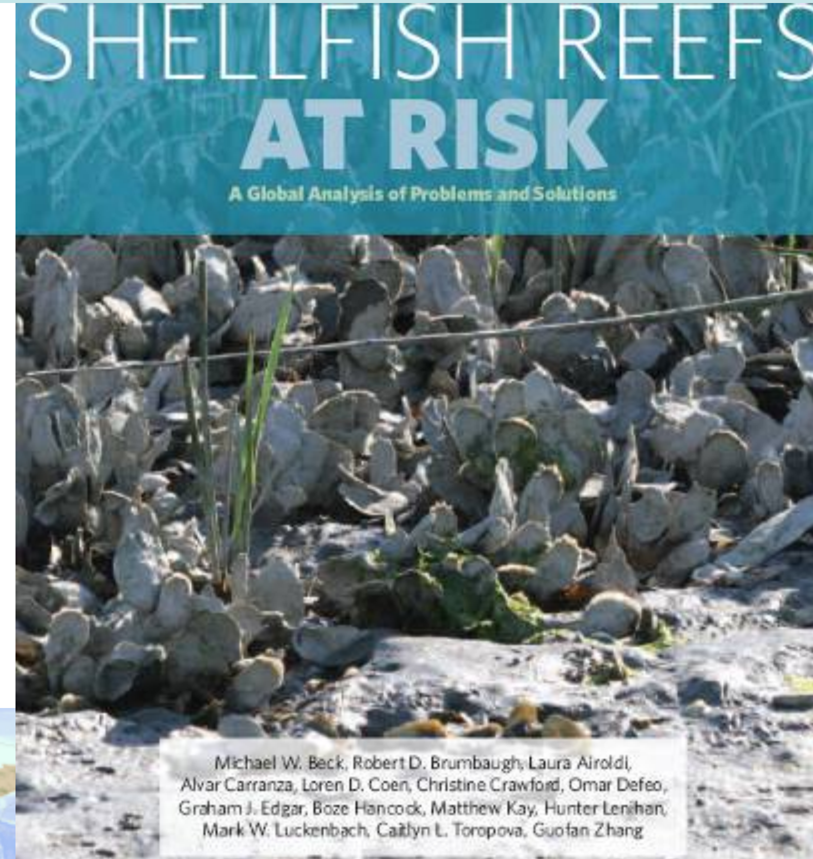
1. 2 LA workshops on shellfish conservation & management

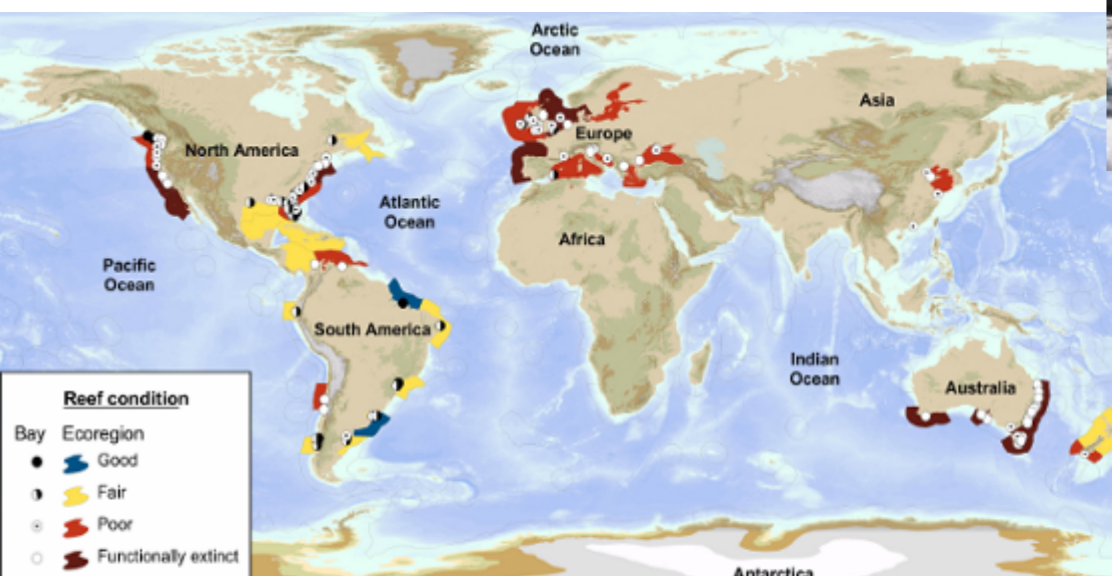
2. Booklets:
   a. Best practices and guidelines for shellfish management and conservation

   b. Key tools for C&M (MPAs) and management/ governance (co-management, area-based rights and catch shares)

   c. Climate-driven changes in shellfish

3. Book: case studies in LA





Beck et al. 2011 - Bioscience

Objective 3: Latin American network
Outcomes so far (2009-2010)

Rev Fish Biol Fisheries
DOI 10.1007/s11160-009-9108-3

RESEARCH PAPER

Linking fisheries management and conservation in bioengineering species: the case of South American mussels (Mytilidae)

Alvar Carranza · Omar Defeo · Mike Beck · Juan Carlos Castilla

Mar Biol
DOI 10.1007/s00227-009-1224-z

ORIGINAL PAPER

Latitudinal gradients in species richness for South American Mytilidae and Ostreidae: can alternative hypotheses be evaluated by a correlative approach?

Alvar Carranza · Omar Defeo · Juan Carlos Castilla · Thiago Fernando L. V. B. Rangel

AQUATIC CONSERVATION: MARINE AND FRESHWATER ECOSYSTEMS
Aquatic Conserv: Mar. Freshw. Ecosyst. (2008)
Published online in Wiley InterScience
(www.interscience.wiley.com) DOI: 10.1002/aqc.993

Diversity, conservation status and threats to native oysters (Ostreidae) around the Atlantic and Caribbean coasts of South America

ALVAR CARRANZA[a,*], OMAR DEFEO[a] and MIKE BECK[b]


¿QUE ES EL CO-MANEJO?
OBJETIVOS:

Navigating transformations in governance of Chilean marine coastal resources

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