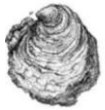
Regional workshop

"Human impacts on Mediterranean marine ecosystems and the economy“



Case studies on the North coast of the Mediterranean Sea

Luís Campos Rodrigues

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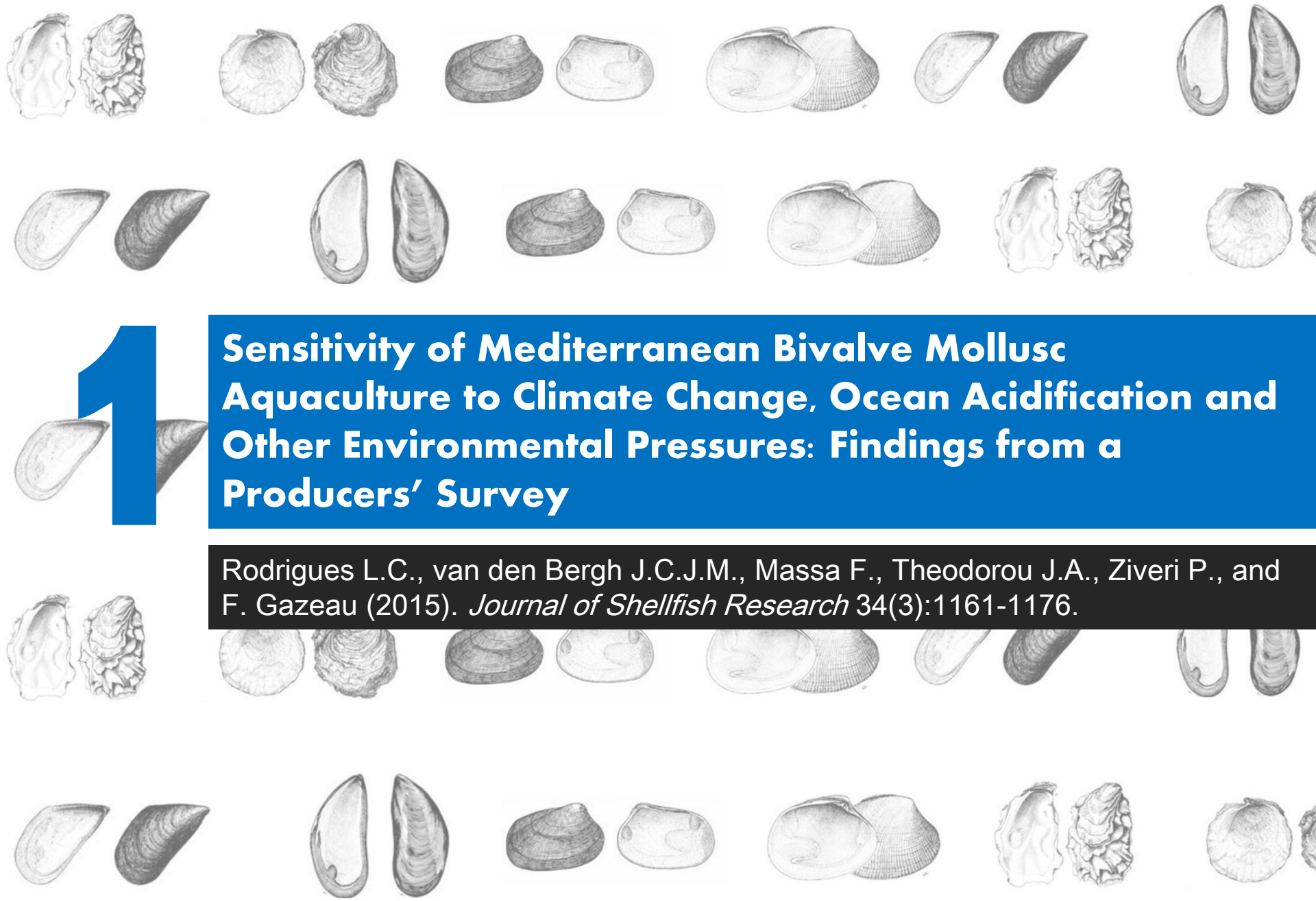
CONTEXT OF THE PRESENTATION

- EU MedSeA project (2011-2014).
- PhD thesis: Economics of ocean acidification and sea warming in the Mediterranean (2016).
- 3 case studies on the potential implications for bivalve mollusc aquaculture, scuba diving tourism, and MPAs.



1 Sensitivity of Mediterranean Bivalve Mollusc Aquaculture to Climate Change, Ocean Acidification and Other Environmental Pressures: Findings from a Producers' Survey

Rodrigues L.C., van den Bergh J.C.J.M., Massa F., Theodorou J.A., Ziveri P., and F. Gazeau (2015). *Journal of Shellfish Research* 34(3):1161-1176.

1 QUESTIONNAIRE STRUCTURE

- **Background information**

- Years of establishment
- Number of staff employed
- (…)

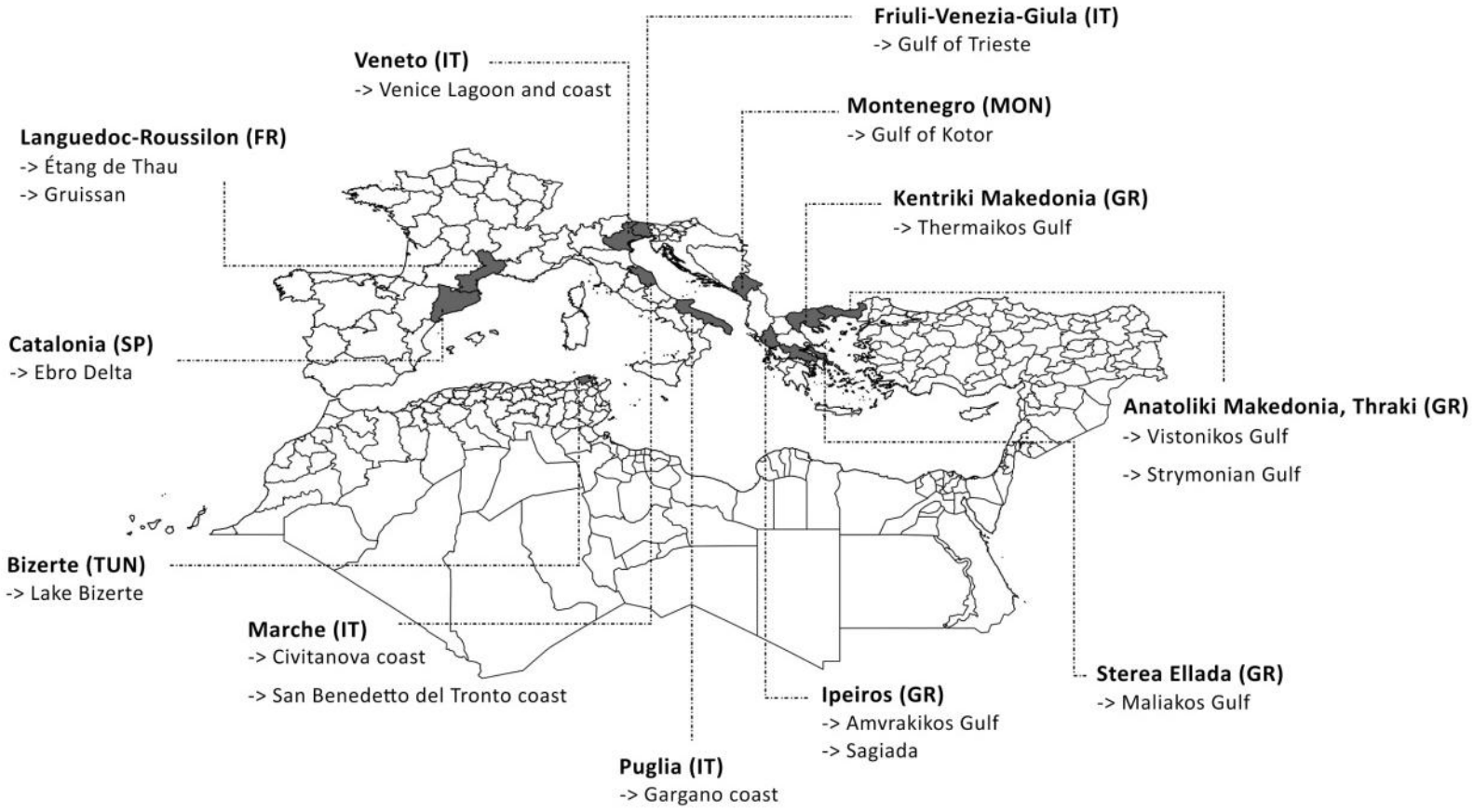
- **Mollusc production and markets**

- Total production
- Seed source
- (…)

- **Environmental issues**

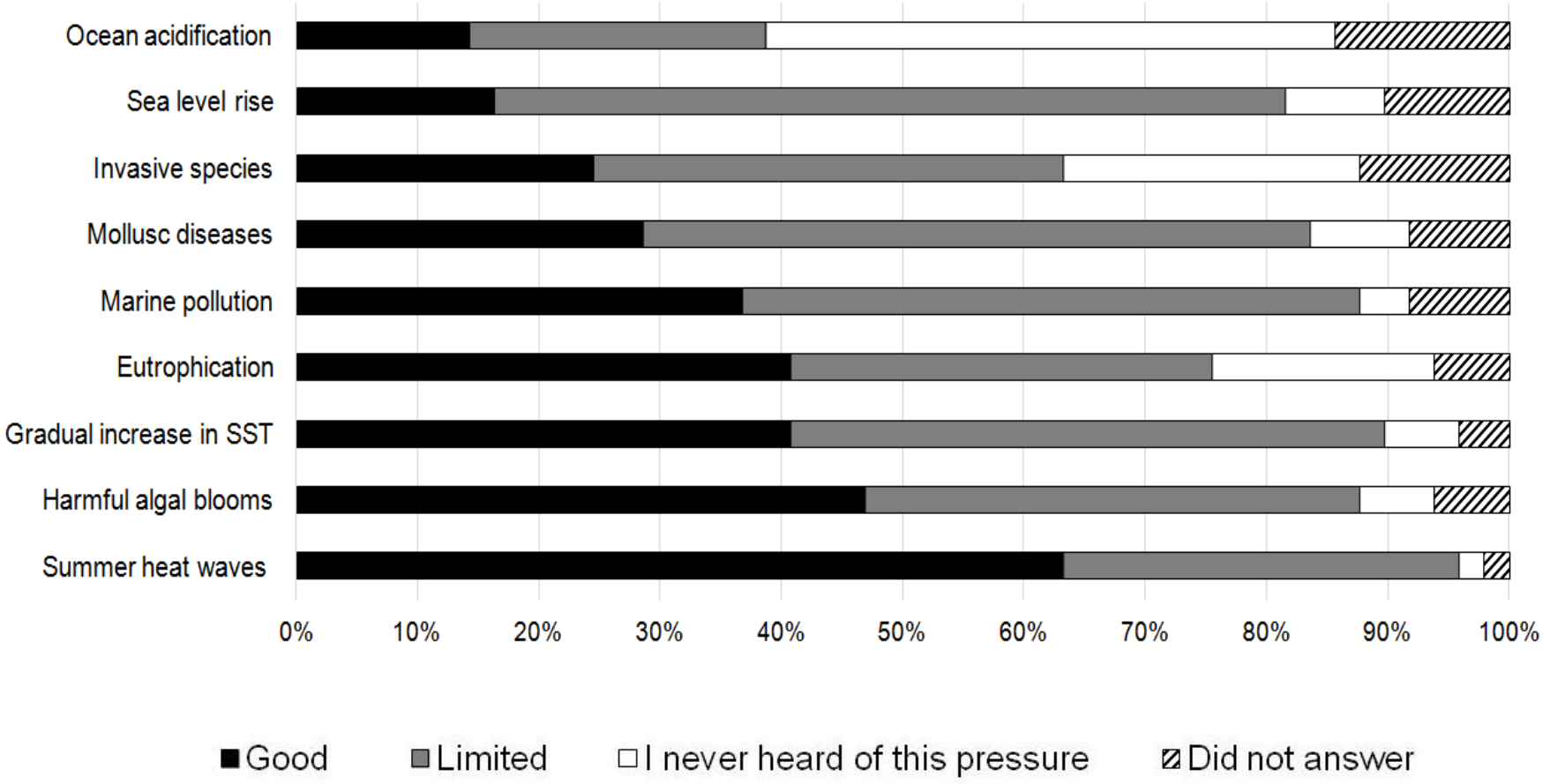
- Level of knowledge of environmental pressures
- Perception of threat
- Experience of past environmental impacts
- (…)

1 SURVEYED AREAS

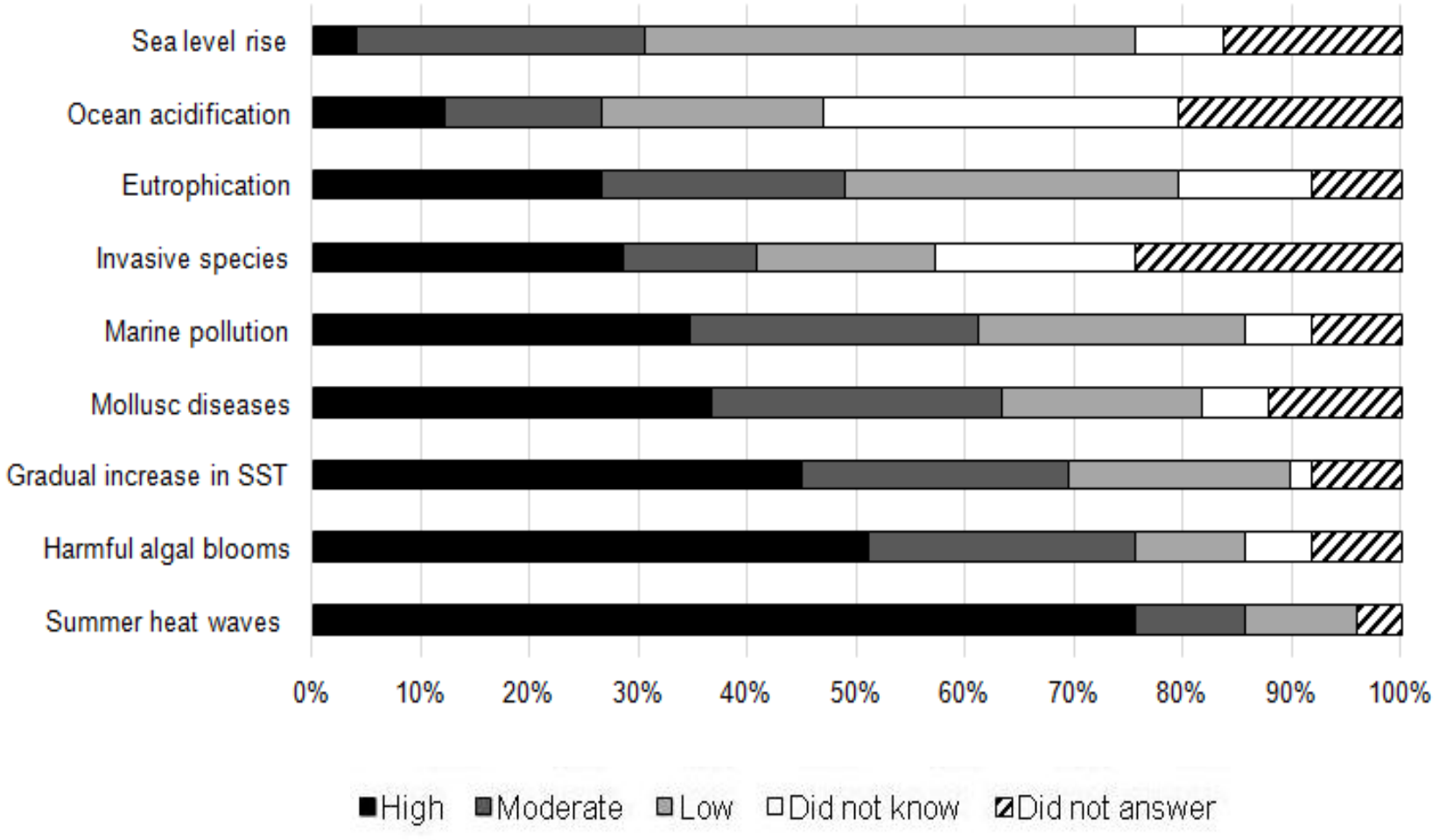


- 49 surveys from 6 Mediterranean countries, 12 coastal regions, 15 production sites.
- Representativeness: 4.1% of total Mediterranean mollusc aquaculture production.

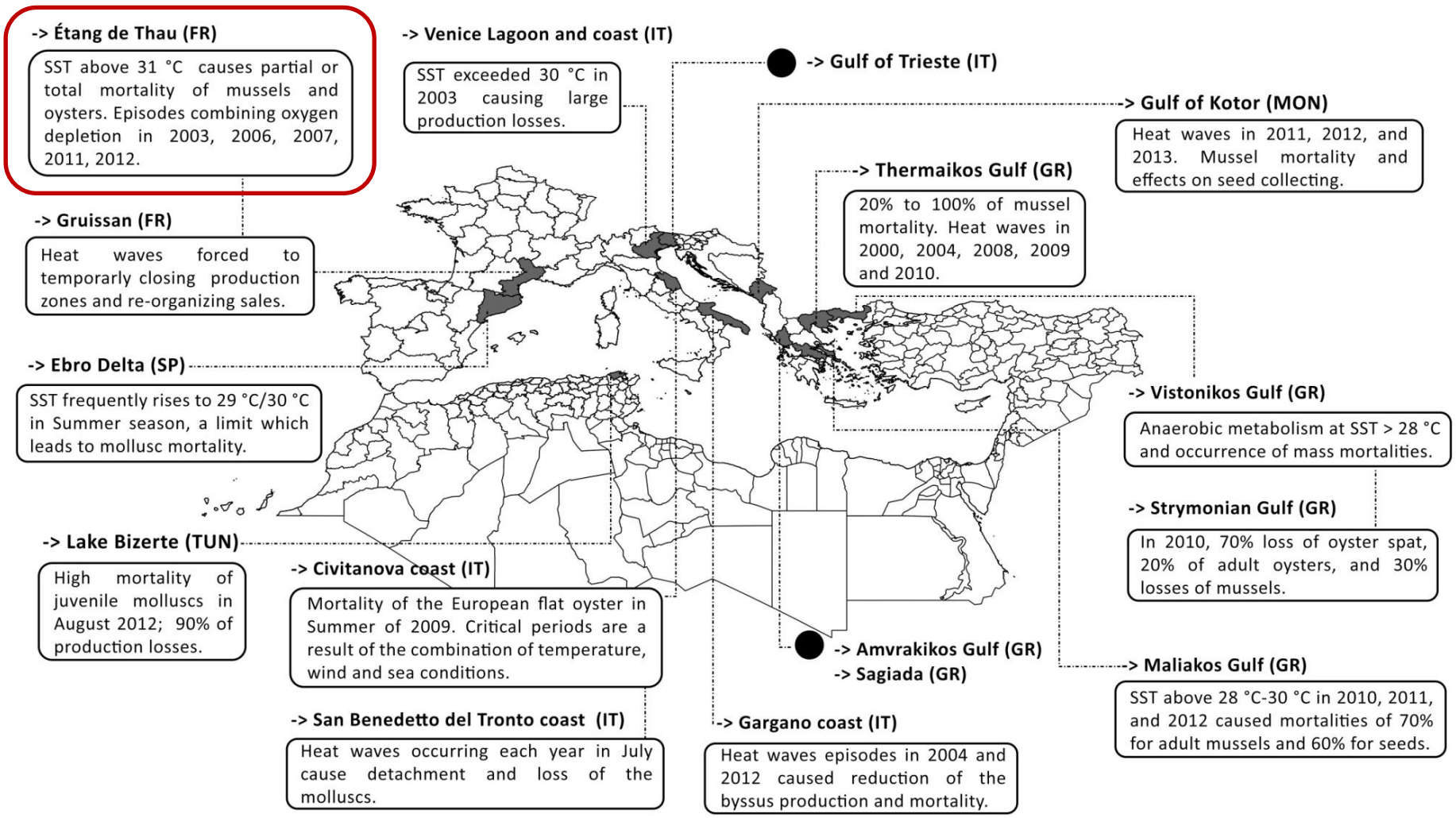
1 LEVEL OF KNOWLEDGE ABOUT ENVIRONMENTAL PRESSURES



1 LEVEL OF THREAT POSED BY ENVIRONMENTAL PRESSURES



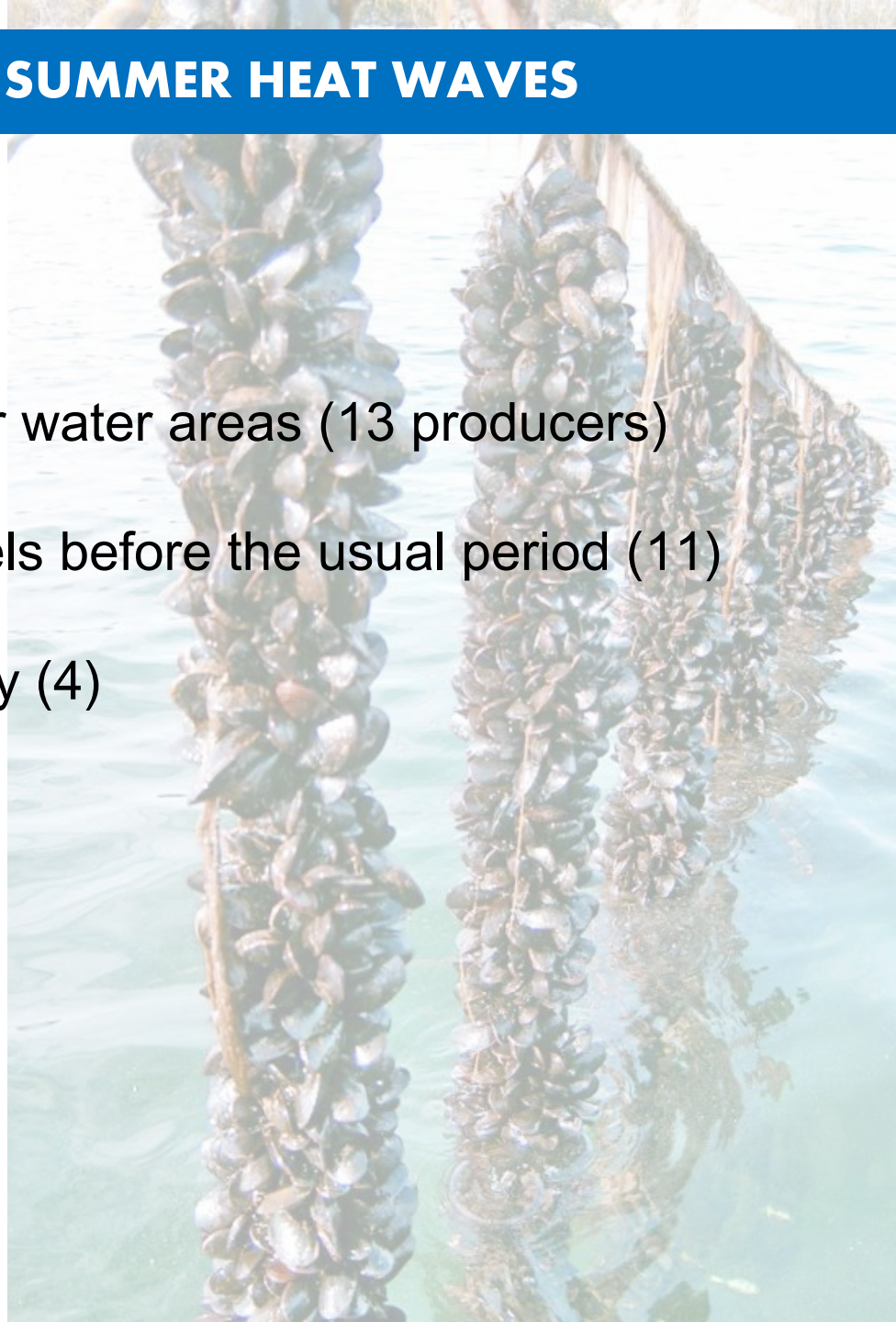
1 INFORMATION ON SUMMER HEAT WAVES EVENTS



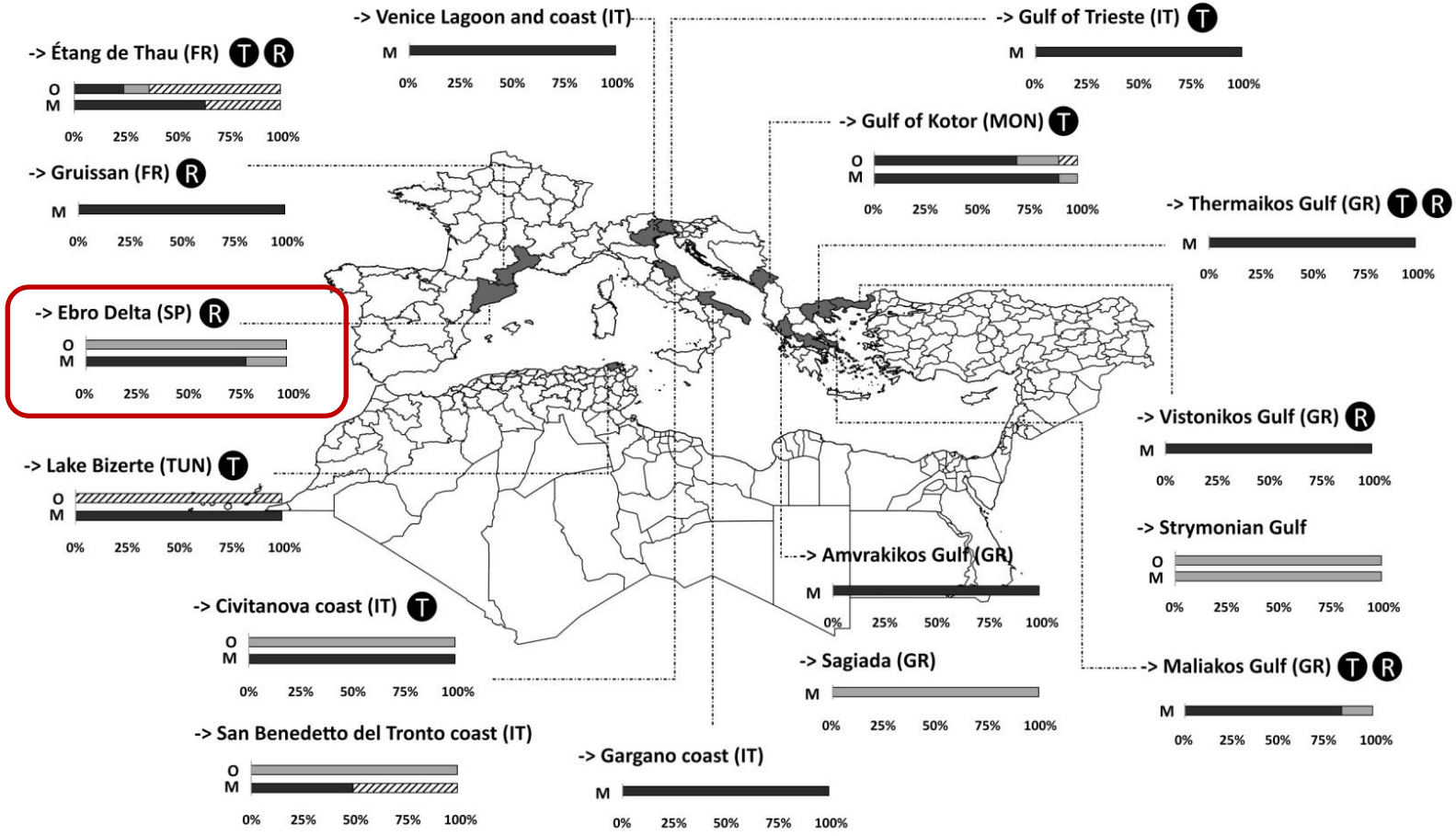
● No effects observed.

2 MEASURES TO RESPOND TO SUMMER HEAT WAVES

- Moving production to deeper water areas (13 producers)
- Collecting and selling mussels before the usual period (11)
- Hiring an insurance company (4)
- No action / no solution (5)
- Importing seeds (1)
- (...)



2 INFORMATION ON OCEAN ACIDIFICATION EFFECTS



Legend:

1. Seed recruitment source for mussels (M) and oysters (O) (%):

Natural environment near the production areas | Imported seeds from the natural environment | Hatchery

2. Observation of effects: R Decrease in seed recruitment T Decrease in shell thickness / resistance

1 CONCLUSIONS

- **High uncertainty and lack of knowledge** among producers regarding what OA could represent for the future of their sector.

- The **provision of more information about environmental pressures could be beneficial** for the mollusc sector in anticipating and adapting to such problems.

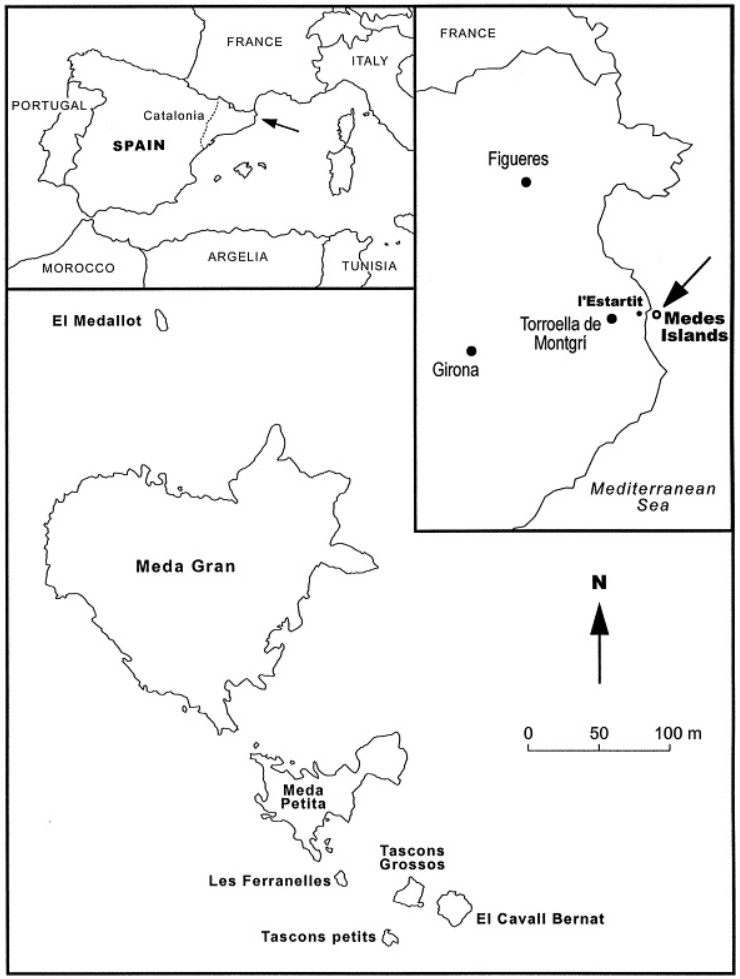
- **Summer heat waves have occurred in almost all production sites** in past years **with detrimental effects** on species.

- **Mollusc farms experiencing a decrease in seed recruitment** from natural environment near production sites in the future **may need to turn to other sources** such as hatcheries, meaning extra operational costs.

2 The Cost of Mediterranean Sea Warming and Acidification: A Choice Experiment among Scuba Divers at Medes Islands, Spain

Rodrigues L.C., van den Bergh J.C.J.M.., Loureiro M., Nunes P., and S. Rossi (2016). *Environmental and Resource Economics* 63, Issue 2: 289-311.

2 MEDES ISLANDS MARINE PROTECTED AREA (MPA)



Source: Mundet and Ribera (2001)

- Located in Catalonia (N-W Mediterranean).
- Study carried at L'Estartit (~3,230 inhabitants) in 2013.
- Annual tourism revenues associated with the MPA were >70% of local GDP in the last decade.
- 55,647 dives (2012).
- Main features: coralligenous, posidonia oceanic meadows, and species (e.g., gorgonians, grouper, eagle ray).

2 CHOICE EXPERIMENT (CE)

- Non-market valuation technique.

- Assess preferences of tourists regarding diving experiences under conditions of sea warming and OA characterized by changes in gorgonians and jellyfish species.

2 IDENTIFICATION OF ATTRIBUTES AND LEVELS

Attributes	Levels
Number of divers found on a diving trip	5; 15; 25
Underwater landscape	Hard bottoms with boulders, vertical walls, and caves/tunnels Hard bottoms with boulders and vertical walls Hard bottoms with boulders
Presence of Jellyfish species	Not present Abundance of non-stinging jellyfish species Abundance of stinging jellyfish species
Expected state of gorgonians (red coral, red gorgonian, white gorgonian)	All gorgonians are of good quality 50% of the gorgonians have disappeared due to climate change All gorgonians have disappeared due to climate change and ocean acidification
Price of the dive (includes boat trip, air and tank to dive, Medes Island tax, and dive insurance)	€30; €50; €70; €90; €110

2 DESIGN OF CHOICE SETS

Characteristics of the dive	Dive A	Dive B
Number of divers found on a diving trip	15	25
Underwater landscape	Hard bottoms with boulders and vertical walls	Hard bottoms with boulders
Presence of jellyfish species	Not present	Abundance of stinging jellyfish
Expected state of gorgonians (red coral, red gorgonian, white gorgonian)	All gorgonians are of good quality	All gorgonians have disappeared due to climate change and ocean acidification
Price of the dive (includes boat trip, air and tank to dive, Medes Island tax, and dive insurance)	€50	€30

Which diving experience do you prefer to undertake, A, B, or neither?

☐ Dive A ☐ Dive B ☐ Neither

2 QUESTIONNAIRE STRUCTURE

- General dive experience
- Past dive experience in Medes
- The choice experiment
- Socio-economic questions
- (…)

2 DESCRIPTIVE STATISTICS

- **390 valid surveys:** 6 choice sets/diver = 2,340 observations.
- Mainly **male divers** (80%).
- Mean monthly household **income close to €3,500**.
- Average of **12.6 years of experience with diving**.

2 ECONOMETRIC MODELS ASSESSING WELFARE CHANGES

REFERENCE DIVE	OTHER TYPES OF DIVE EXPERIENCES
5 divers	15 divers 25 divers
High geomorphology complexity	Medium complexity Low complexity
Non-presence of jellyfish	Abundance of non-stinging jellyfish Abundance of stinging jellyfish
All gorgonians are of good quality	50% have disappeared 100% have disappeared

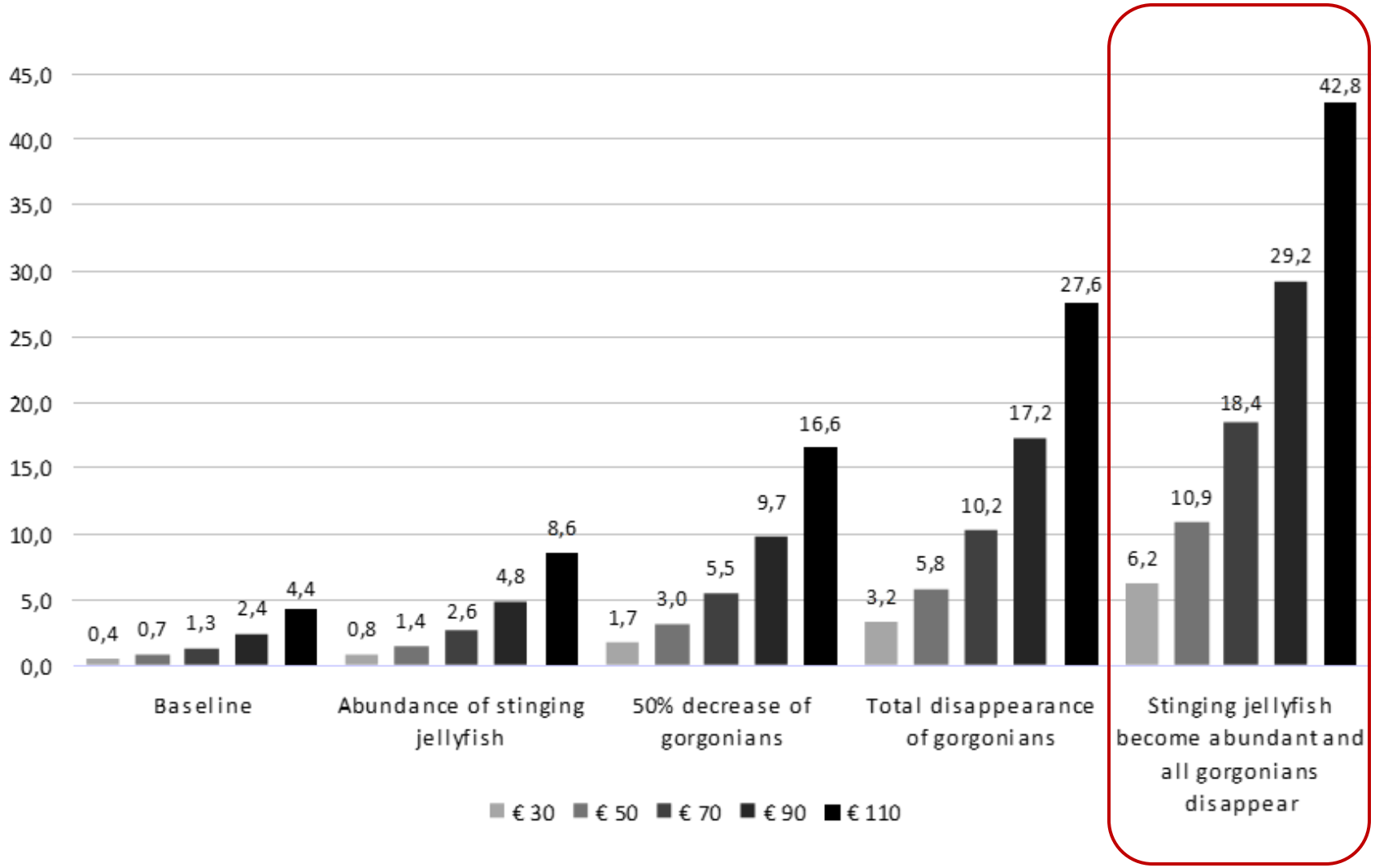
2 MEAN WELFARE COSTS FOR CHANGES IN ATTRIBUTE LEVELS

	Single dive *(€)*
Number of divers found on a diving trip[a]	
15 divers	Non statistically significant
25 divers	-24.87***
Underwater landscape[b]	
Hard bottoms with boulders and vertical walls	-25.68***
Hard bottoms with boulders	-44.57***
Presence of jellyfish species[c]	
Non-stinging jellyfish	6.95*
Stinging jellyfish	-26.17***
Expected state of gorgonians[d]	
Less 50% of gorgonians	-17.15***
All gorgonians have disappeared	-60.22***

Reference levels: [a] 5 divers; [b] hard bottoms with boulders, vertical walls, caves and tunnels; [c] non presence of jellyfish species; [d] all gorgonians are of good quality.

* ***, **, * indicate statistical significance at 1%, 5%, 10% level, respectively

2 REJECTION RATES FOR DIVING UNDER DIFFERENT SCENARIOS (%)



2 CONCLUSIONS

- **Total disappearance of gorgonians** was considered the **most disliked change**.

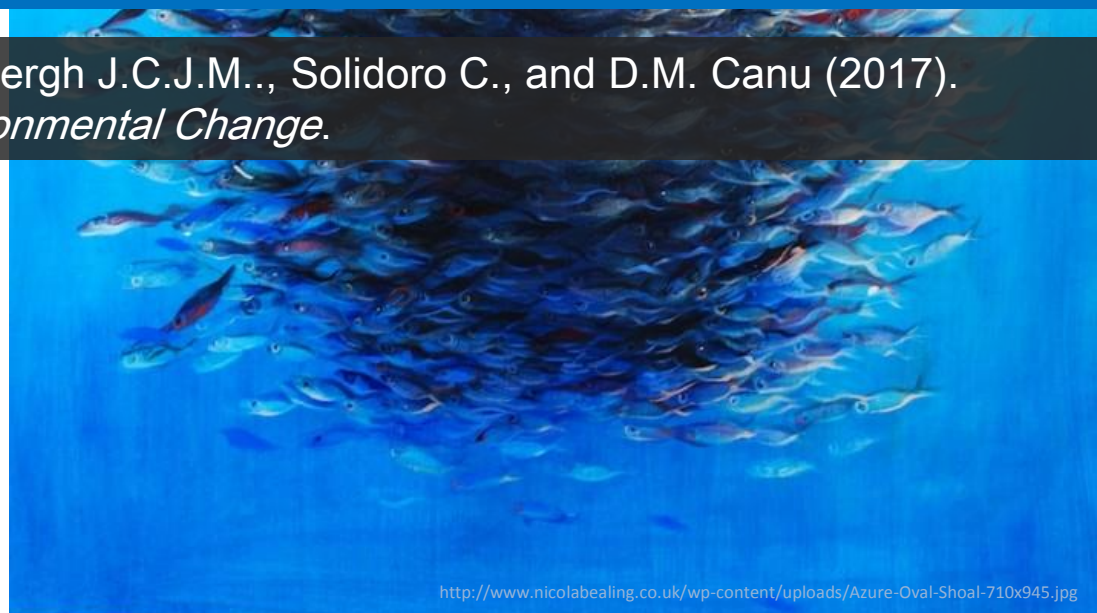
- **Jellyfish could be considered as repulsive/attractive** to divers, whenever they **present a risk of stinging or not**.

- **Economic costs** may involve **recreational welfare losses** for scuba divers, and a **reduction of tourism revenues** with possible effects for the local economy , and **management budgets of MPAs**.

- The **magnitude of estimated costs could be higher** if repercussions in the entire ecosystem are considered.

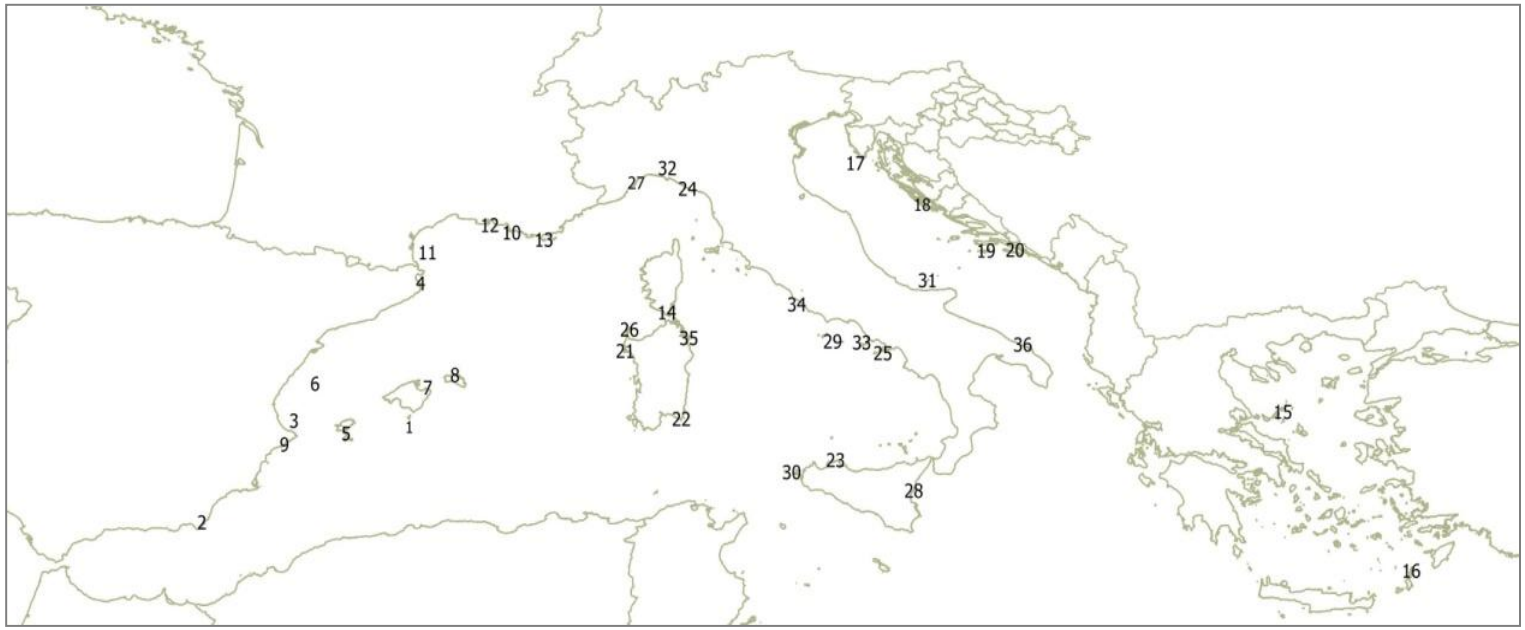
3 Value Transfer of Sea Warming and Acidification: An Economic-Ecological Impact Study of EU-Mediterranean MPAs

Rodrigues L.C., van den Bergh J.C.J.M.., Solidoro C., and D.M. Canu (2017). Submitted to *Global Environmental Change*.



http://www.nicolabealing.co.uk/wp-content/uploads/Azure-Oval-Shoal-710x945.jpg

3 POLICY SITES



Criteria of similarity:

1) EU- Med MPAs

2) MPAs w/ gorgonians

3) MPAs w/ scuba diving

Sample:

36 MPAs

(31% of EU-Med MPAs)

Italy: 16

Spain: 9

France: 5

Croatia: 4

Greece: 2

3 QUESTIONNAIRE STRUCTURE

- **Background information**

- Years of establishment
- Area of the MPA
- (…)

- **Scuba diving sector**

- Number of dives/year
- Existence of a scuba dive fee
- (…)

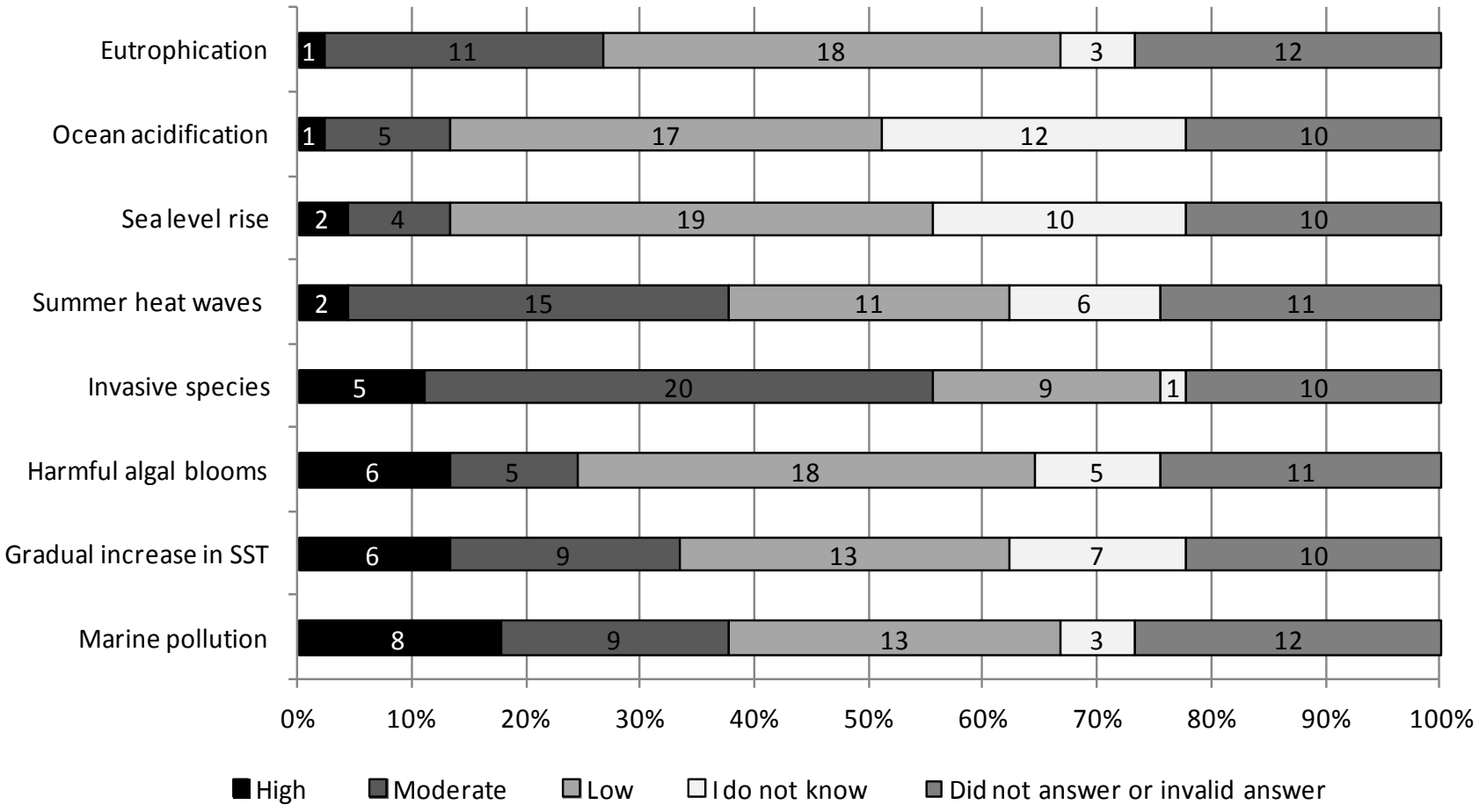
- **Environmental issues**

- Perception of threat
- Monitoring of seawater chemistry components

3 MAIN CHARACTERISTICS OF THE POLICY SITES

- Total marine surface **area of 5,656.7 km^2**.
- Total of **543,051 dives made in a year** (Calanques, France - 125,000).
- **15 MPAs had scuba dive fees**.
- **SST was the most monitored component** (17 MPAs), followed by pH (9), and alkalinity (6).

3 LEVEL OF THREAT POSED BY ENVIRONMENTAL PRESSURES (Nº; %)



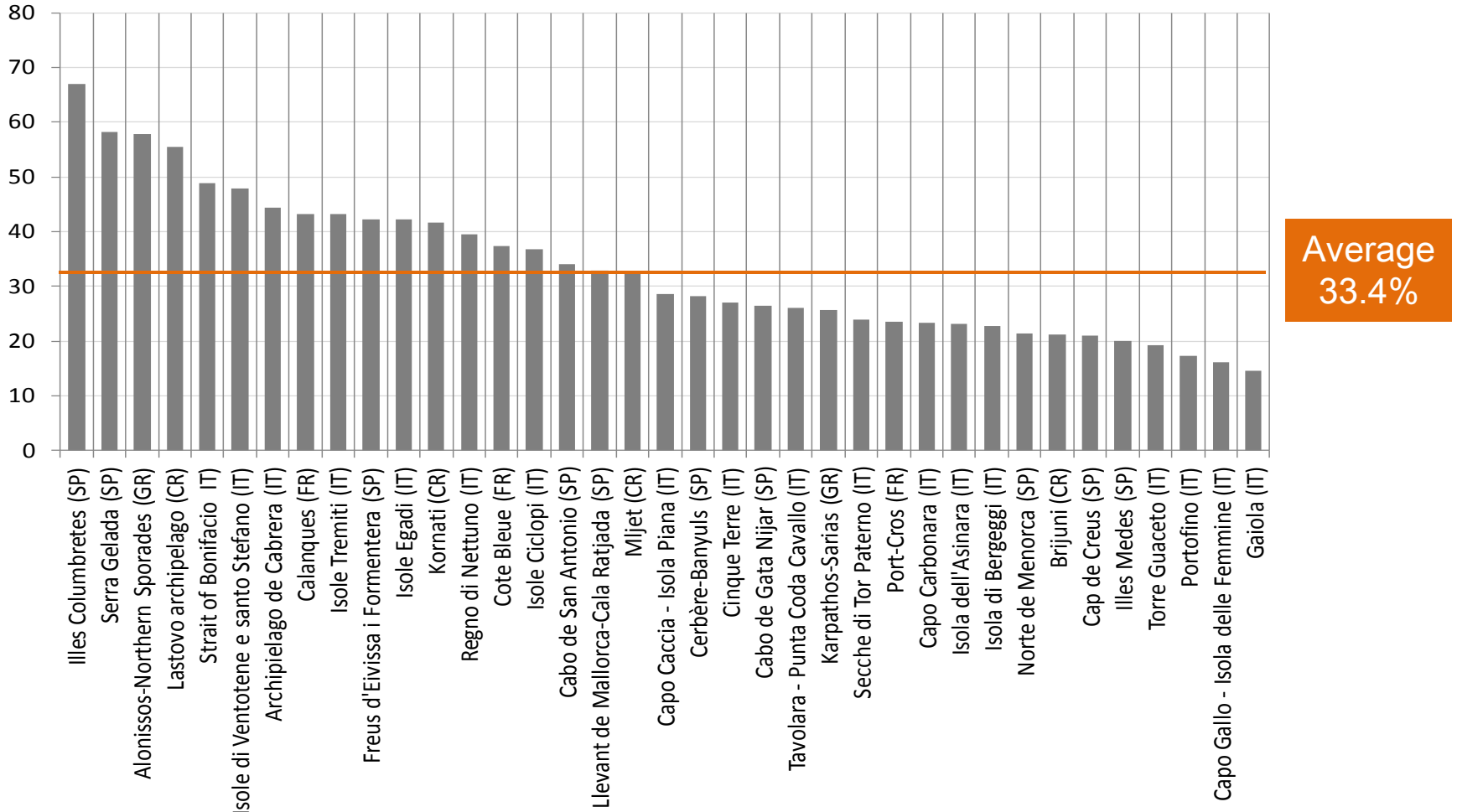
3 ECOLOGICAL MODEL OF CORALLIGENOUS SUITABILITY

- Based on 17 environmental factors that may constrain growth and survival of the coralligenous (Martin et al. 2014): bathymetry, temperature, salinity, nutrient concentration, pH, etc.

- Based on IPCC RCP 8.5 and ‘Deep Blue’ land use scenarios.

- Assesses likely changes in suitability between near past (2001-2010) and medium-term future (2041-2050).

3 LIKELIHOOD OF HABITAT UNSUITABILITY (2041-2050; %)



3 EXAMPLE OF A COST CATEGORY ASSESSED IN THE STUDY

- **Tourism revenue losses**

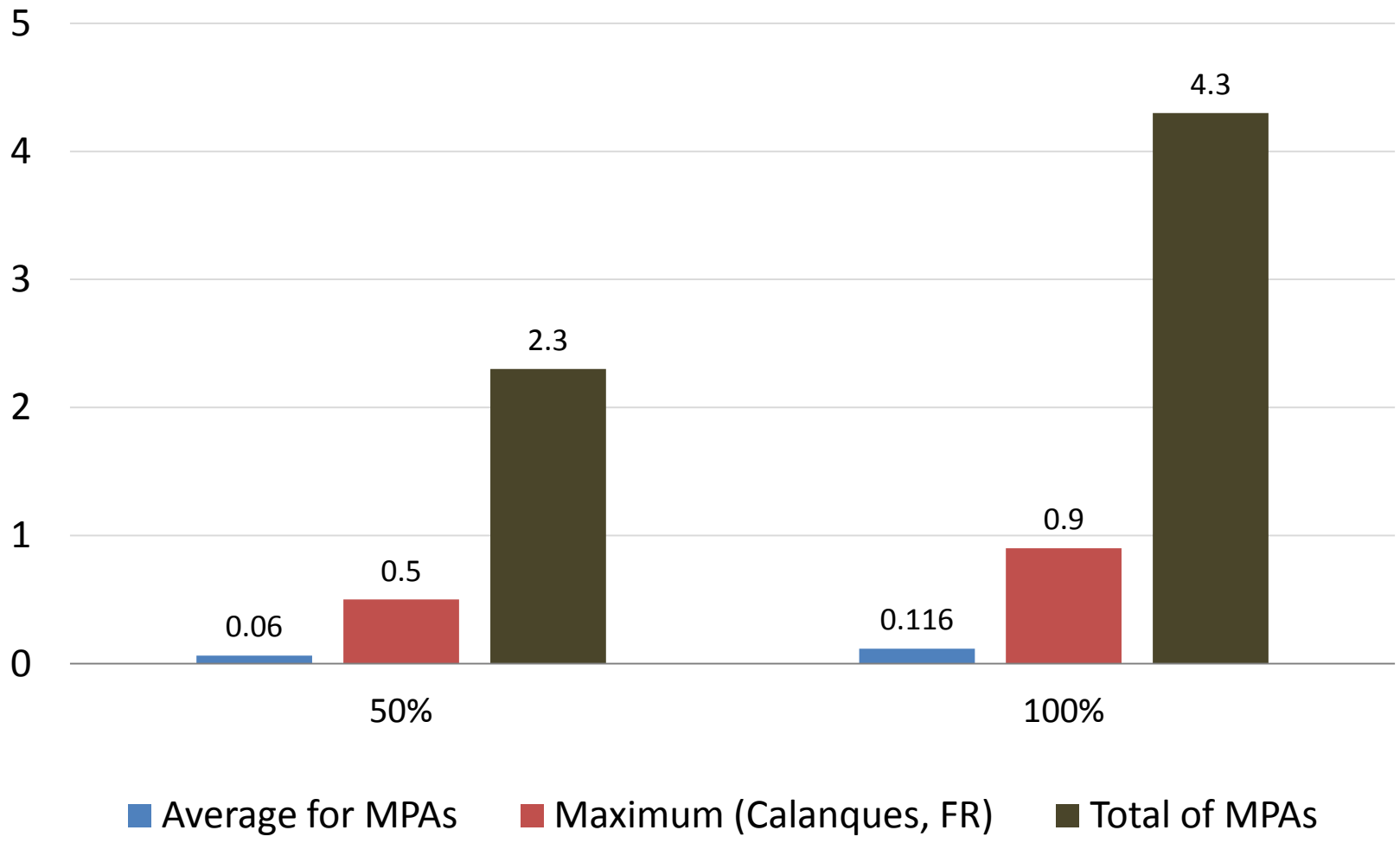
- Choice probabilities for rejecting to dive with a 50% and 100% decrease in gorgonians.

Price of a dive (€)	**Rejection rate (%)**
70	5.5% - 10.2%

Basic cost estimates

- Rejection rate multiplied by total dives made in a year in MPAs.
- Estimated value of dives not ocurring.

3 TOURISM REVENUE LOSSES (Million €) – Basic cost estimates (2014)



3 CONCLUSIONS

- **OA is considered** as a **low threat**, and there is a high **uncertainty about how to classify this pressur**e in terms of threat.

- Potential **lack of knowledge by MPA managers about seawater conditions** may be counterproductive for the development of adaptation actions.

- A majority of MPAs is **likely to experience a decrease in coralligenous suitability**.

- **Various MPAs** that may be vulnerable to sea warming and OA **were not assessed**, meaning that **estimates could represent a lower bound to the impact** of both pressures.

Other key insights

CHALLENGES OF SOCIO-ECONOMIC ANALYSIS

- Addressing uncertainty about effects of these pressures on species, habitats and ecological processes.
- Understanding the synergetic effects of multiple environmental pressures.
- The difficulty of deriving subsequent economic impacts.
- Uncertainty about effective adaptation of ecosystems and economic sectors to future ocean conditions.

REFLECTIONS FROM BEHIND THE RESEARCH SCENES

To value or not to value?

Iconic vs (non)-iconic species

Other social sciences coming into the analysis?

Sectors assessed are also contributing to the problem!

Interests and conflicts between diferent stakeholders

short vs medium/long-term

Thank you for your attention!

Luís Campos Rodrigues | lcampos@ent.cat