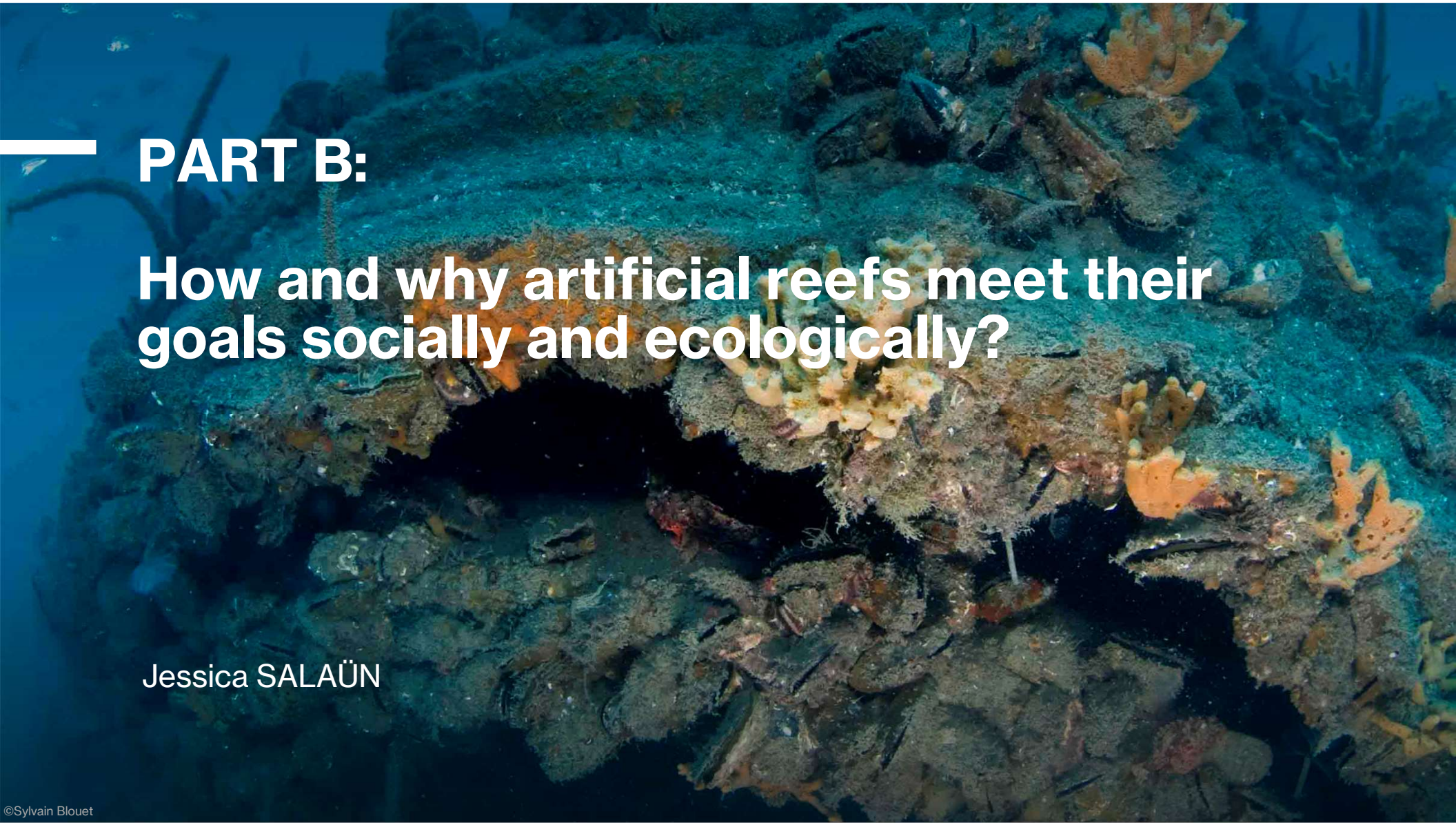


PART B:

How and why artificial reefs meet their goals socially and ecologically?

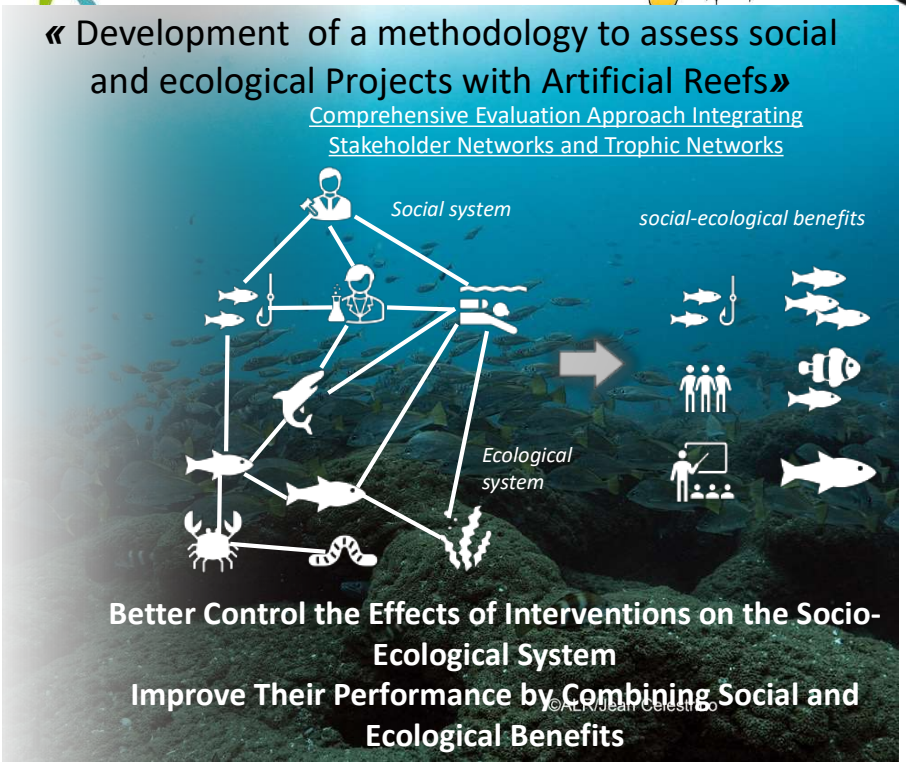
Jessica SALAÜN

Ph.D in Geography and spatial planning (March 2022) - Paul Valéry Montpellier 3 University
Geologist Engineer (2013) - Master 2 equivalent at Institut Polytechnique LaSalle Beauvais
Scientific divers certificate (Classe I B)

Ph.D student CIFRE (2019-2022)

LAGAM (Geography laboratory), M2C et Paul Valéry Montpellier 3 University

- Social-ecological approach in order to assess coastal project with artificial reefs.
- Quantification of social-ecological benefits, suggesting monitoring indicators
- Sociological investigation by interviews of 134 stakeholders and network analysis
- Trophic network modelling
- Management of the scientific monitoring program of artificial reefs,
- Research and development of scientific project on artificial reef
- Outreach initiative and teaching on the functioning of coastal ecosystems

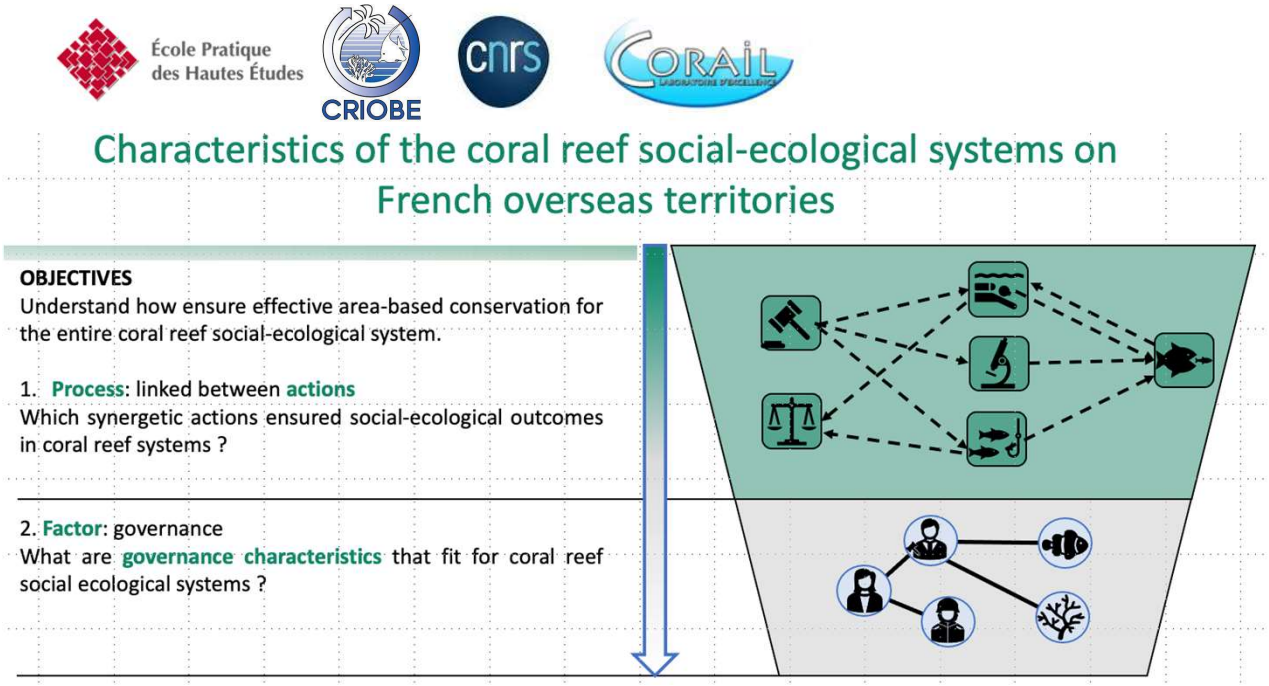


Ph.D in Geography and spatial planning (March 2022) - Paul Valéry Montpellier 3 University
Geologist Engineer (2013) - Master 2 equivalent at Institut Polytechnique LaSalle Beauvais
Scientific divers certificate (Classe I B)

Post-doc (2023-2024)

EPHE, Labex Corail, Criobe, CNRS

- Social-ecological system approach to ensure sustainable management of **MPA** on coral reef systems
- Characteristics of the coral reef social-ecological systems of french overseas territories
- Identifying mechanisms to set up enabling conditions and ensure effectiveness of conservation in coral reef system
- Sociological investigation by interviews of 87 stakeholders in French Polynesia



RECENT RESEARCH CONFIRM A SYSTEMIC APPROACH FOR AR SUCCESS

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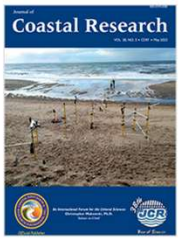

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RESEARCH ARTICLES | MAY 02 2022

Socio-Ecological Analysis to Assess the Success of Artificial Reef Projects

Jessica Salaün ; Sylvain Pioch; Jean-Claude Dauvin

Journal of Coastal Research (2022) 38 (3): 624–638.
https://doi.org/10.2112/JCOASTRES-D-21-00072.1 Article history

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ABSTRACT

Salaün, J.; Pioch, S., and Dauvin, J.-C., 2022. Socio-ecological analysis to assess the success of artificial reef projects. *Journal of Coastal Research,* 38(3), 624–638. Coconut Creek (Florida), ISSN 0749-0208.

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Article | Open access | Published: 17 August 2021

Successful artificial reefs depend on getting the context right due to complex socio-bio-economic interactions

Timothée Brochier, Patrice Brehmer, Adama Mbaye, Mamadou Diop, Naohiko Watanuki, Hiroaki Terashima, David Kaplan & Pierre Auger

FISH and FISHERIES

ORIGINAL ARTICLE | Open Access

Global synthesis of effects and feedbacks from artificial reefs on socioecological systems in recreational fisheries

Lisa Chong, Zachary A. Siders, Kai Lorenzen, Robert N. M. Ahrens, Edward V. Camp

First published: 22 December 2023 | https://doi.org/10.1111/faf.12809

I/ THE SOCIAL AND ECOLOGICAL GOALS OF ARTIFICIAL REEFS

The requirements for building AR projects lead to the identification of social and ecological interests

1-Requirements for the project

Social requirements:

- Authorization
- Financial support
- Scientific support
- Technical support
- Public acceptance
- Project manager

Ecological requirements:

- Protection and refuge
- Nursery habitat
- Fixing support
- Reproduction
- Feeding area

2-Stakeholders involved

Category of stakeholder	Type of stakeholder
Civil society	Commercial businesses
	Environmental organizations
	Leisure organizations
	Fishermen's organizations
	Non-profit organizations
	Unorganized individuals
Local authorities	Municipality
	Interlinked municipalities
	County
	Region
National authorities	Decentralized service
	Public institutions (Laboratories, research institutes, water agencies, chambers of commerce, marine parks)
	Agencies (Environment and marine)
International	European institutions
	Other countries
Marine Fauna and flora	Marine mammals, seabirds, fishs, benthic fauna, etc.

Ramos et al., Braz. Journ. Oce., 2011; Salaün et al. , JCR, 2021

3-Human and non-human interests

Social interest:

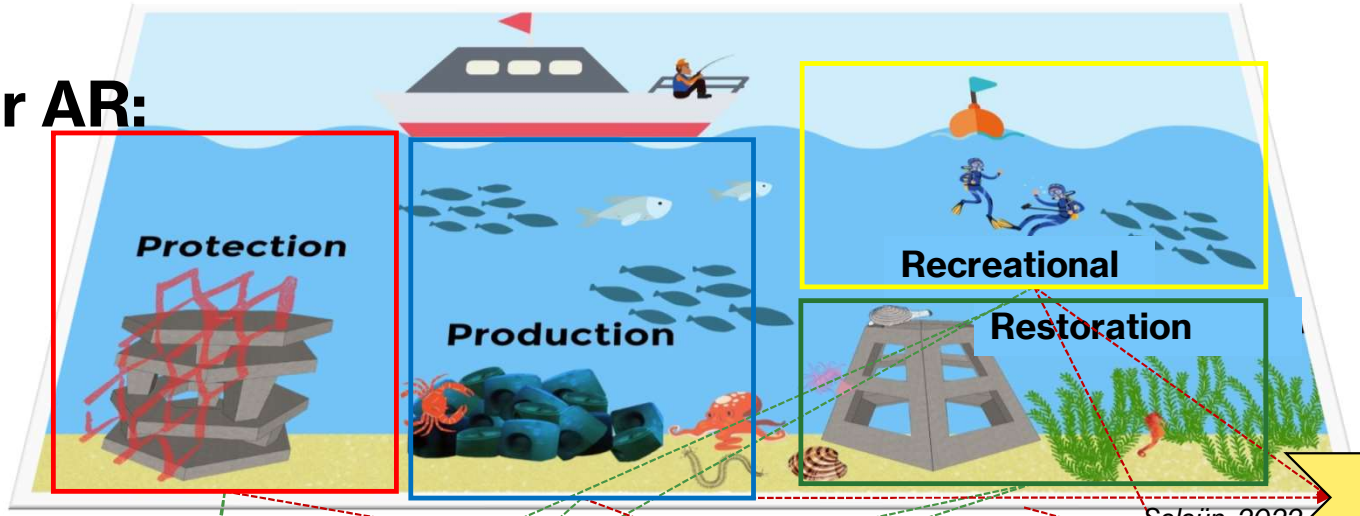
- Economic
- Cultural knowledge
- Human security
- Social connexion and relationship
- Local value

Ecological interest:

- Habitat
- Fauna abundance and richness
- Growth and reproduction of species

The social and ecological interests under the main goals of ARs

4 goals for AR:



Salaün, 2022

Ecological interest:

- Habitat
- Fauna abundance and richness
- Growth and reproduction of species

Social interest:

- Economic
- Cultural knowledge
- Human security
- Social connexion and relationship
- Local value

II/ ASSESSMENT: A KEY CORE POINT FOR MANAGERS

Why do an AR assessment and for whom?

Aims of assessment:

Determine whether or not the ARs **fulfilled their "intentional"** goals.

Assess the efficiency and impact of artificial reefs:

- Social & ecological
- Cost/effectiveness.

Targeted stakeholders:

- Decision makers,
- Environmental Agencies,
- Local Governments,
- users (fishing communities, tourism operators, etc.),
- marine biologists.

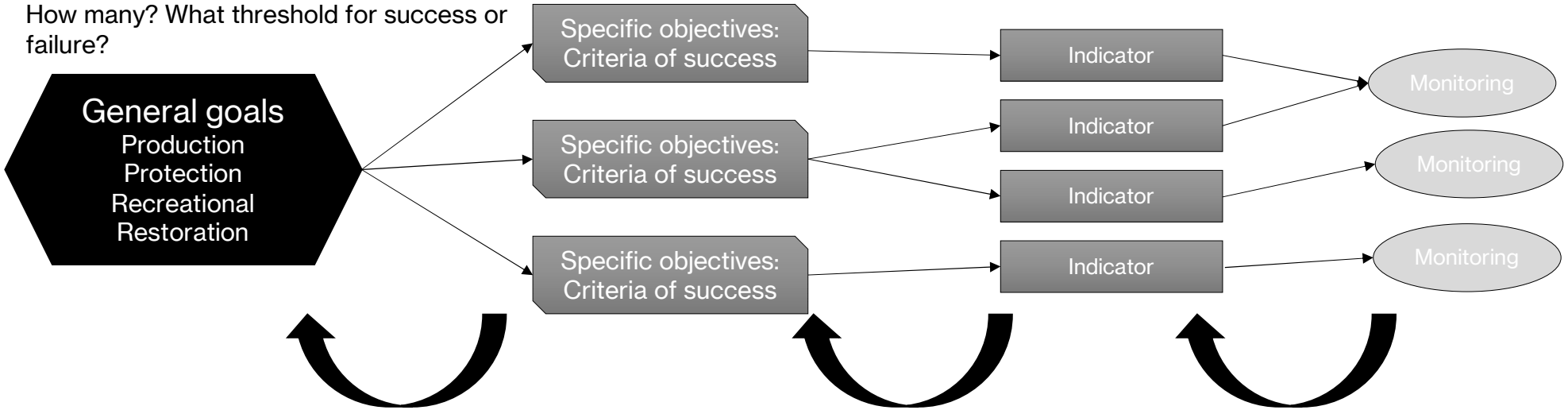
Assessment Framework: principles

1. Need to specify general goals:

Which species (commercial or non comm.) ?
Which social and ecological interest (economic, tourism, habitat)?
How many? What threshold for success or failure?

2. Choose indicators adapted to specific objectives:

3. Monitor and record the data:



4. Assess and validate success or failure:

Global assessment of ARs results

Compare the indicator value to the criteria of success

Analyze the results and calculate the indicators

Salaün, La mer, 2024 (Seaman & Jensen, CRC Press, Boca Raton, *2000; Claudet and Pelletier, Aquat. Living Resourc., 2004)*

Specific objectives
(depend of each stakeholders and their interests)

Specific objectives:

- **Example of ecological impact:** invasive species, pollution, topographic perturbation
- **Management decision:** conflict, compliance, etc.

Indicators:

- **Example of ecological indicators:** species diversity, abundance, and biomass around the artificial reef, etc.
- **Example of social indicators:** income, number of users, scientific insights, communication, etc.

Monitoring tools

Examples of existing guideline:

-FAO, 2015: « *Practical guidelines for the use of artificial reefs in the mediterranean and the black sea* » (Fabi et al., 2015)

-Southeast Florida Coral Reef Initiative, 2011: « *Guidelines and Management Practices for Artificial Reef Siting* », Use, Construction, and Anchoring in Southeast Florida (Lindberg, W.J. and W. Seaman (editors) 2011)

Ecological monitoring:

Fishing survey, Underwater Visual Census (diving), video survey, acoustic survey, etc.

Social monitoring:

Questionnary, interviews, perception of stakeholders, economical monitoring, spatial identification (AIS), etc.

« Typical » assessments

- **Verifying Colonization and Development**:

Focus on fish community development and benthic fauna **colonization** (Folpp et al., 2011).

- **Comparing Habitat Quality:**

Assess if ARs offer habitat quality **comparable to natural reefs** (Page et al., 2007; Hallier and Gaertner, 2008).

- **Comparing Different AR**:

Determine which ARs **design characteristics** are most effective and provide the greatest environmental benefit (Dafforn et al., 2015; Firth et al., 2016).

Lack of holistic assessment: French example

What is done in the field ? *e.g.* for French Artificial Reefs

Monitoring	English Channel	Atlantic Ocean	Méditerranean sea
Structural integrity	100%	55%	59%
Hydrodynamic conditions	0%	22%	NA
Fish fauna (Abundance/Richness)	100%	55%	59%
Benthic invertebrates fauna (A/R)	66%	44%	NA
Commercial fauna (size, weight, number of species)	0%	33%	NA
Human activities	0%	22%	NA

NA : non sufficient available information

Salaün, PhD thesis, 2022

- **Average monitoring lasts 3 to 5 yrs**
- **30% of ARs** had not been monitored for the last 5 yrs (in 2022)
- The most frequent monitoring focuses on **fish communities and the structural integrity of ARs**

Assessment issues provide barriers to ARs social and ecological success

Assessment issues:

- Lack of social data (Milon et al., 2000; Ramos et al., 2007: Lee et al., 2018)
- Lack of clear and quantitative goal (Becker et al., 2018)
- Complexity of habitats (Vivier et al., 2021; Lee at al., 2018; Lima et al., 2020)

Social assessment

Social interest:

Not measured

- Economic
- Cultural knowledge
- Human security
- Social connexion and relationship
- Local value

Ecological assessment

Ecological interest:

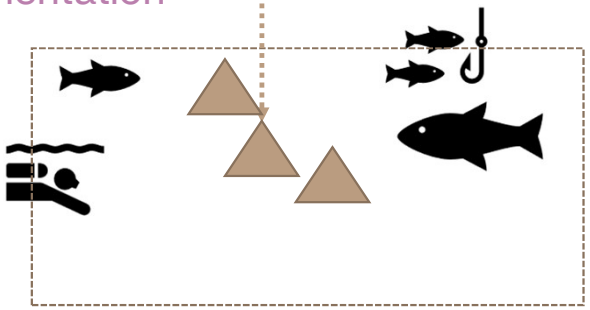
Partially measured

- Habitat
- Fauna abundance and richness
- Growth and reproduction of species

Why social and ecological assessments matter?

Interlinked dependencies:

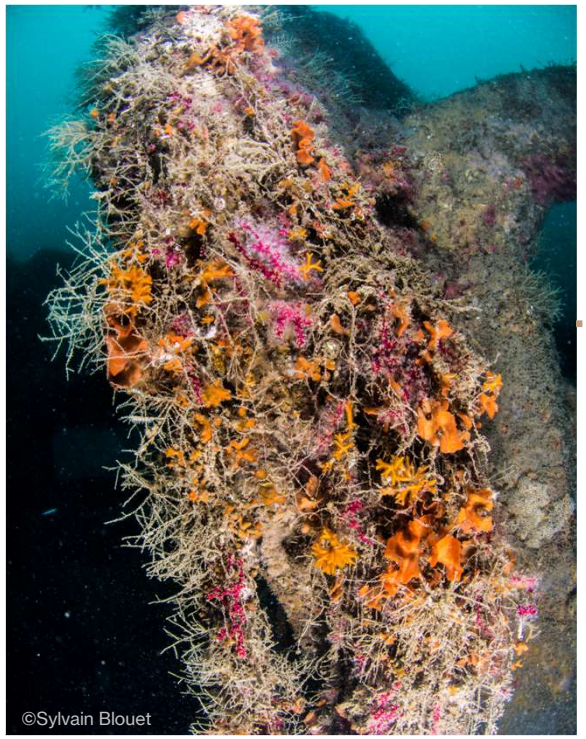
ARs Implementation



Why social and ecological assessments matter?

Interlinked dependencies:

ARs implementation



Support

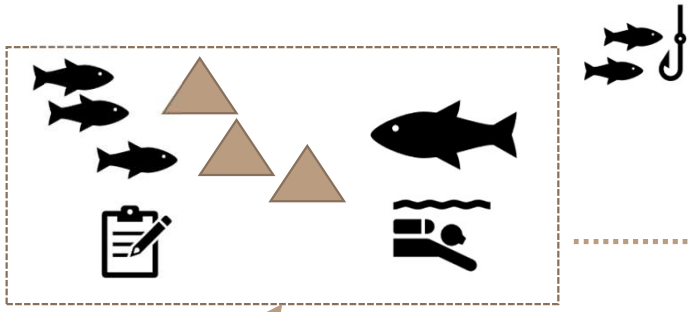
Ecological interest (outcomes expected):

- Habitat
- Fauna abundance and richness
- Growth and reproduction of species

Why social and ecological assessments matter?

Interlinked dependencies: a balanced between social and ecological benefit

ARs with no management



Increase

Ecological interest:

- Habitat
- Fauna abundance and richness
- Growth and reproduction of species

Affect

- Fisheries activities
- understanding of ecological functioning

Social interest:

- Economic
- Cultural knowledge
- Human security
- Social connexion and relationship
- Local value

Lead to

Social-ecological interactions:

- Economic activity
- Enhance Knowledge
- Ecological value

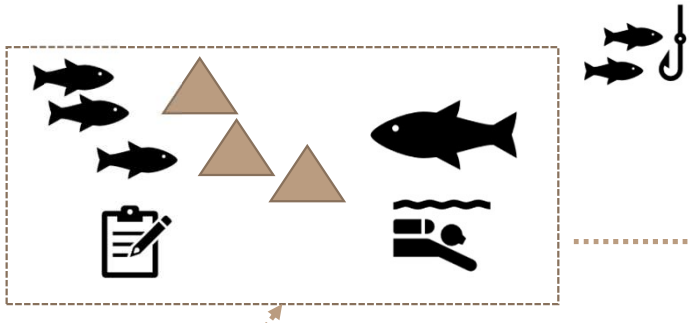
Support

Berkes et al., Cambridge University press, 1998; Ostrom, Cambridge University press 1990;Ostrom, Science, 2009

Why social and ecological assessments matter?

Interlinked dependencies:

ARs with no management



Increase

Ecological interest:

- Habitat
- Fauna abundance and richness
- Growth and reproduction of species

Affect

- **Illegal fisheries**
- **Less understanding of ecological functioning**

Social interest:

- Economic
- Cultural knowledge
- Human security
- Social connexion and relationship
- Local value

Lead to

Not measure or negative

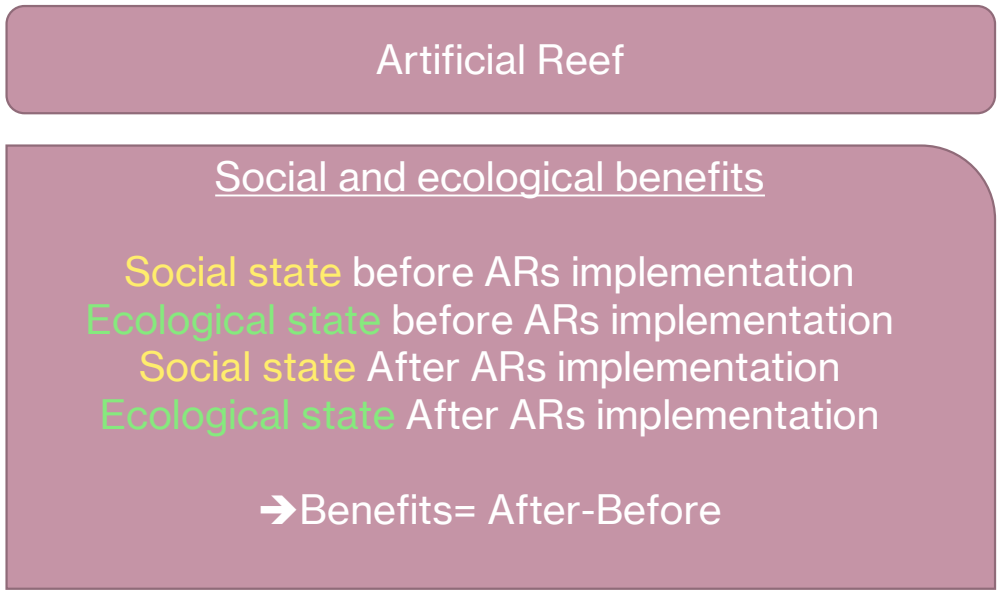
Social-ecological interactions:

- Economic activity
- Enhance Knowledge
- Ecological value

Provide

Using before/after comparison in assessment process

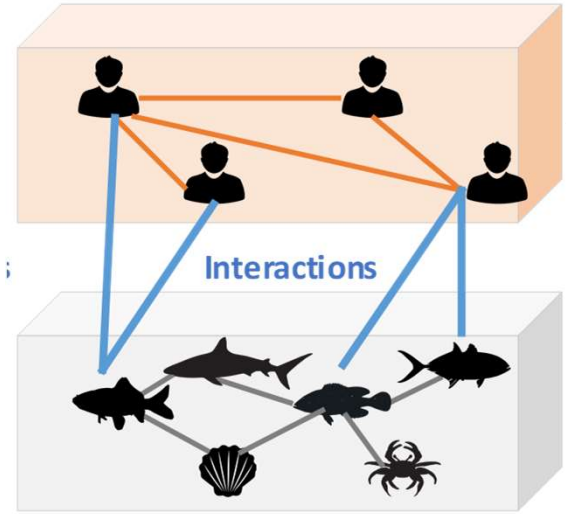
Inspired from « Rapid assessment Method » notation:
Score indicator, assessed before and after (MERCI-e; Pioch et al., 2018)



https://icriforum.org/new-report-methodology-for-scaling-mitigation-and-compensatory-measures-in-tropical-marine-ecosystems/

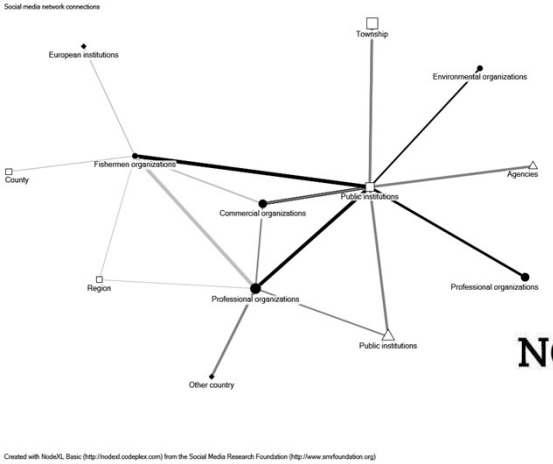
Assessing symetricaly the social and ecological system with network analysis

ARs social-ecological system:



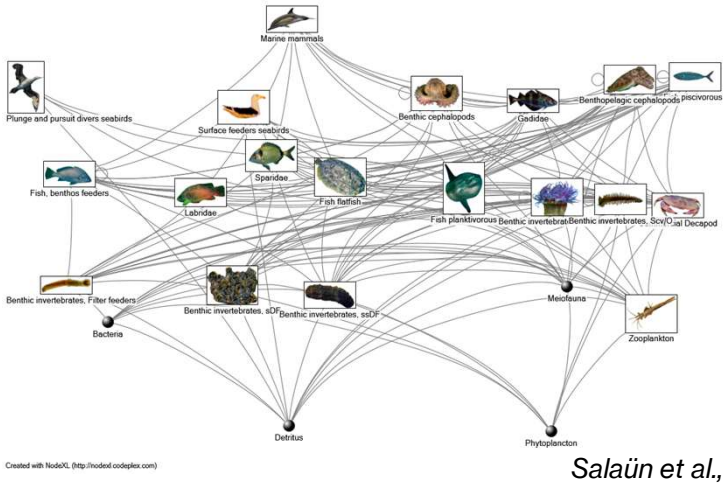
Example of networks:

Social Network Analysis
(Wasserman and Faust, 1994)



NODEXL

Ecological Network Analysis
(Polovina, 1984; Christensen et Pauly, 1992)



Ecopath with Ecosim

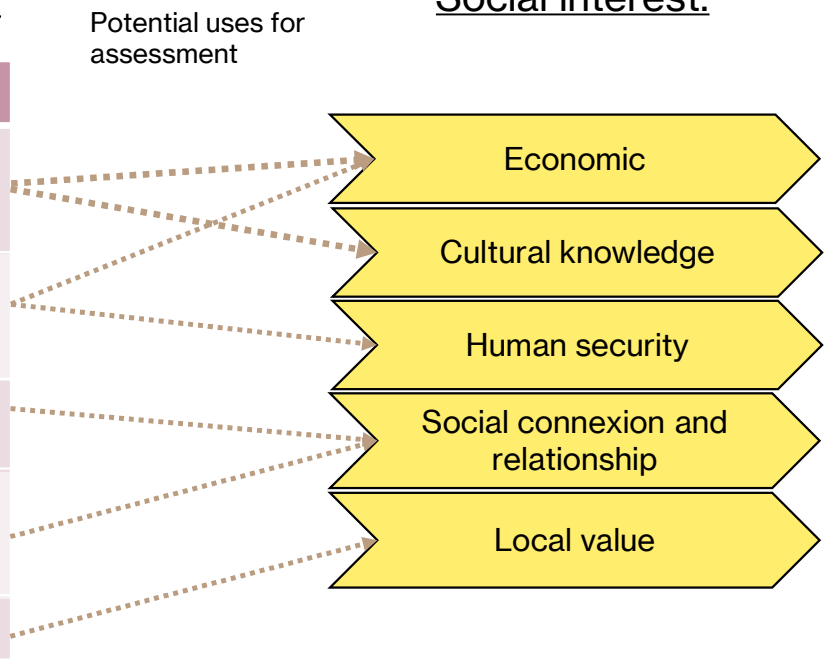
Salaün et al., Vie et milieu, 2020

Provide useful metrics related to social stakeholders interests

Example of indicators providing by social network analysis:

Social indicator	Description
Flux Density	Measure the number of interactions (monetary, information, technical, involvement, skills)
Node Density	Measure the number of stakeholders (civil society, Local authorities, National authorities, International)
Density	Measure of the connectivity of a global network
Degree centrality	Represents the interconnection of network nodes, corresponding to the nodes' relation activities
Betweeness centrality	Identify the key node of the system

Burt, Oxf. Univ. Press, 2005; Salaün et al., IGI 2022



Provide useful metrics related to ecological stakeholders interests

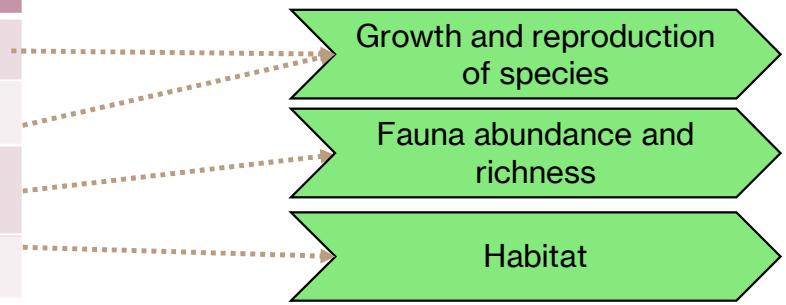
Example of indicators providing by ecological network analysis:

Trophic network	Description
Total System Throughput	Sum of all the flows in the system
Ascendency	Growth of the system
System Omnivory	Trophic interaction among different Trophic Level
Recycling index	Fraction of energy recyled in the system

Nogues et al., Ecological Indicators,2021; Raoux et al., Regional studies in Marine Science, 2024

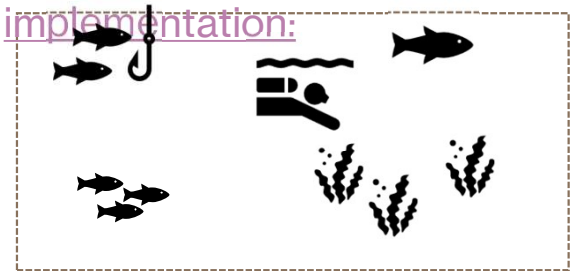
Potential uses for assessment

Ecological interest:



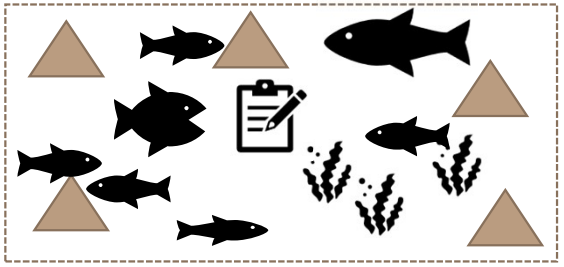
Example of assessment process

Area before AR implementation:



Management choices:

Area after AR implementation:



Outside the area

Scores before AR implementation (0 to 1)

Social	score
Information density	0,1
Number of fishermen (inside the area)	0,43

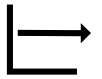
Ecological	score
Total System Throughput	0,34
System Omnivory	0,51

Score after AR implementation (0 to 1)

Social	score
Information density	0,2
Number of fishermen (inside the area)	0,1

Ecological	score
Total System Throughput	0,41
System Omnivory	0,51

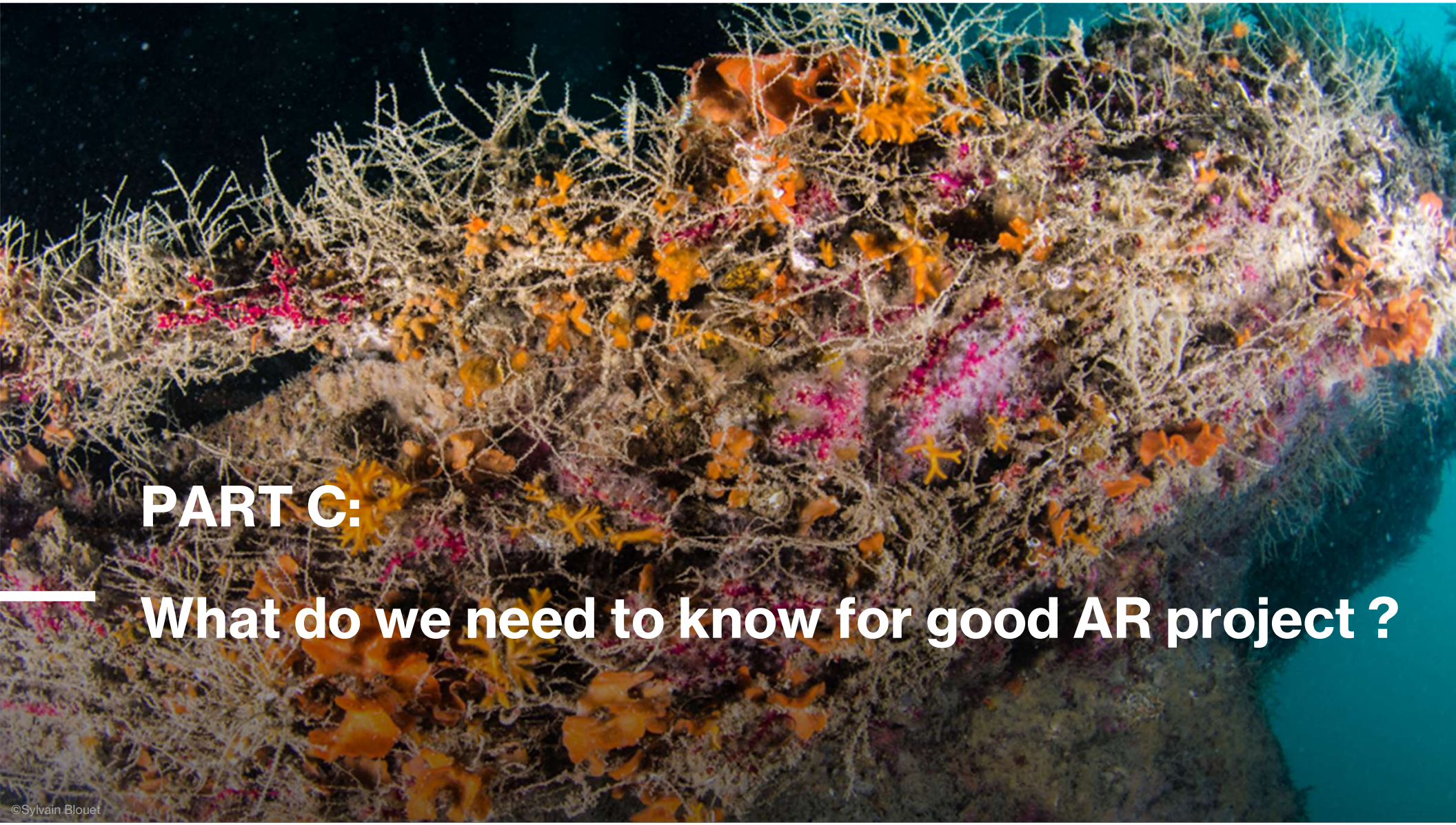
Trend



Further research to improve the assessment process

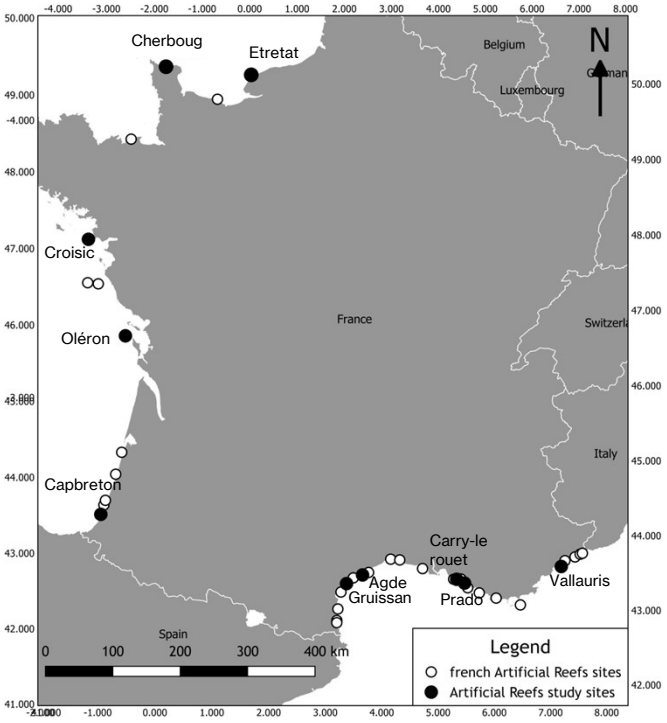
To apply this kind of social-ecological process, there is a need to select rapid indicator (RAM):

- 1/2 day to fulfill
- Costless / rapid to obtain
- Easy to score for trained people (not level of PhD/expert+++)


PART C:
What do we need to know for good AR project ?
©Sylvain Blouet

Assessment of 10 french ARs projects

All **ecological scores** are **positive** showing the ARs capacity to provide functional habitat.



Salaün, PhD thesis,2022

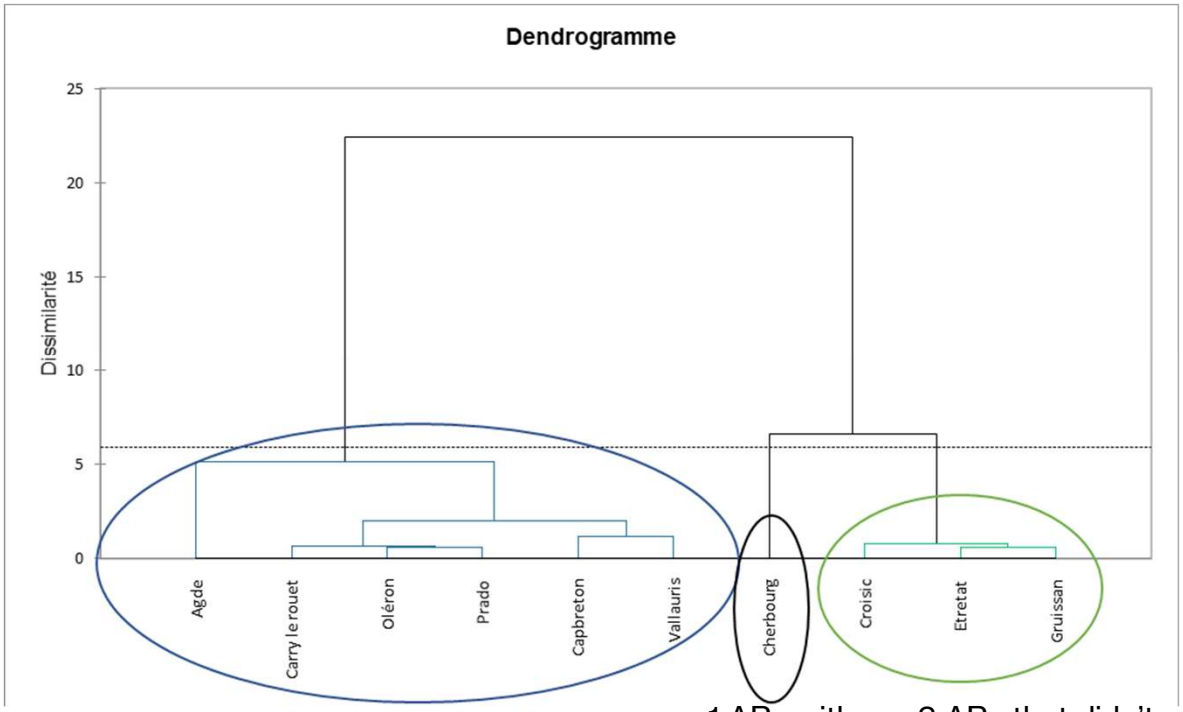
Example of indicators used:

- **Biomass** (score:0 for a decrease; 0.5 if it's stable; 1 for an increase)
- **Ecological function** such as feeding area (score:0 absence; 0.5 presence but not specific to study area; 1: presence in the area)
- **Scientific monitoring** (score: 0 no data; 0.5 if data >5yr; 1 if data <5yr).

Results for 3 sites:

AR Sites	Ecological Score before ARs	Ecological Score after ARs	Ecological Benefit score	Trend
Etretat	0.50	0.68	0.18	↗
Cherbourg	0.62	0.90	0.28	↗
Capbreton	0.72	0.77	0.05	→

Using social score to differenciate 10 ARs area efficiency



6 ARs area that provide plural social benefit

1 ARs with single benefit

3 ARs that didn't provide any social benefits

Salaün, PhD thesis, 2022

Blind side of a single ecological assessment

▶ With only ecological indicators: all AR seem to be sucessful

▶ Using **social scores to differenciate** ARs efficiency make it clear that 3 failed and 1 ensured just one social outcome

Example of risks if ARs project failed socially:

- Conflict between users
- Decrease of fundings
- Negative influence on other projects

The analysis of which social indicator are low before/after, can help to shift management trajectories to **enhance holistic efficiency**.

Factors identified in AR projects

Social efficiency VS No social efficiency

Social efficiency	No social efficiency
High number of stakeholders involved in artificial reef projects	Few stakeholders involved
High number of interactions between stakeholders and with resources	Lack of control (monitoring and surveillance)
Governance ensures restriction of users	Weak interactions between stakeholders and the resource system
Governance planning integrated into territorial planning	

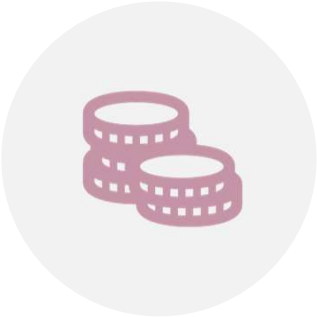
Step by step to a highly efficient « Dream » Project

1. CO-CONSTRUCTION WITH EXPERTS FOR SOCIAL ACCEPTANCE

2. AGREEMENT ON SPECIFIC SOCIAL AND ECOLOGICAL OBJECTIVES

Initiation stage

Step by step to a highly efficient « Dream » Project



3.PLANNING AND BUDGETING FOR MANAGEMENT

4.SELECTION OF A MANAGER AND THEIR RESPONSIBILITIES

Implementation stage

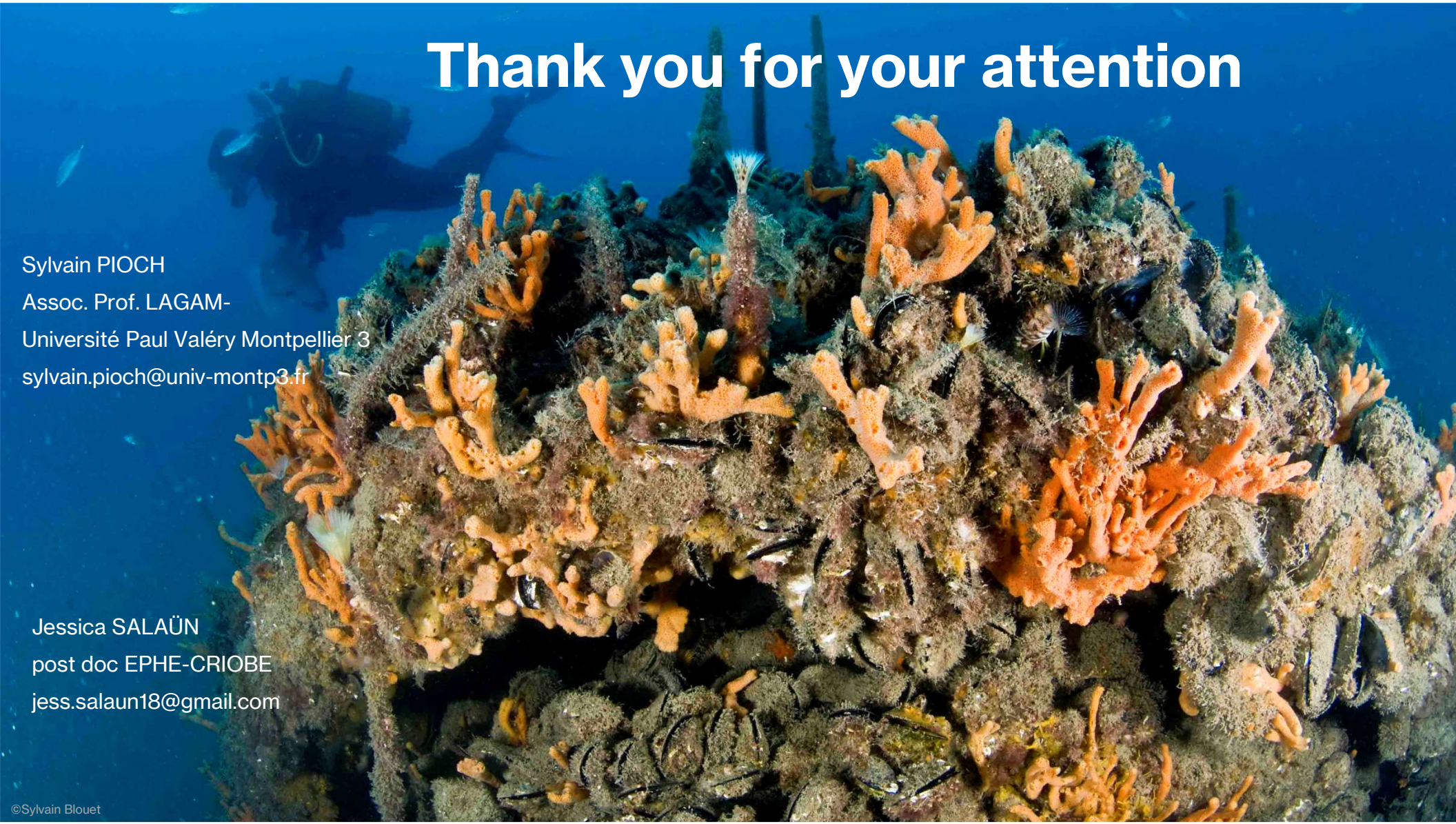
Step by step to a highly efficient « Dream » Project

5. LONG-TERM SOCIO-ECOLOGICAL MONITORING

6. PUBLIC COMMUNICATION AND EDUCATION

Management stage

Thank you for your attention



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