Interim Report of the Working Group on Resilience and Marine Ecosystem Services (WGRMES)

19–20 November 2018

Vigo, Spain

ICES CIEM

International Council for
the Exploration of the Sea

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Contents

Executive summary

The Working Group on Resilience and Marine Ecosystem Services (WGRMES) meeting was held in Vigo, Spain, 19–20 November 2018, and attended by 14 participants representing 6 countries. The majority of the participants in the meeting came from the academia and research institutions.

WGRMES progressed on all Terms of Reference. A new Resilience Heuristic was developed by operationalizing resilience in social-ecological systems called "Operationalizing Resilience: Resistance, Recovery Time and Robustness for Decision-making". Policy recommendations were written for future assessment of marine and coastal ES (ToR A).

The WGRMES is reviewing existing projects and data collection exercises which provide information about natural capital accounting (NCA) and marine ecosystem services (e.g., Joint Research Centre, MAES reports). Establishing a sound method for NCA, with a strong focus on ecosystems and their services, is a key objective of the 7th EAP and of the EU Biodiversity Strategy to 2020. In Portugal, WGRMES developed a participatory mapping of marine ES in the "Parque Natural do Litoral Norte", a marine protected area (MPA) in the municipality of Esposende, Portugal, where there are zones with different levels of protection and restriction to human use. In addition to the biodiversity it hosts - and because of it - the park is also an important supplier of ecosystem services (ToR B).

The group created a co-production matrix globally by developing three tasks: a) an inventory of co-production examples in marine social-ecological systems; b) an international expert consultation; and c) the development of a local interviews program in key selected case studies (France, Portugal and the United Kingdom) under the H2020 GENIALG project (https://genialgproject.eu); (ToR C).

WGRMES have started developing the *Social Vulnerability Index* for coastal communities created by the NOAA for several case studies in the European Union (France, Portugal and Spain); (ToR D).

WGRMES members globally reviewed the role of MPAs in maintaining ecosystem services, identifying the key cultural services offered by MPAs (ToR E).

1   Administrative details

| **Working Group name** |
| Working Group on Resilience and Marine Ecosystem services (WGRMES) |
| **Year of Appointment within current cycle** |
| 2018 |
| **Reporting year within current cycle (1, 2 or 3)** |
| 1 |
| **Chair(s)** |
| Sebastian Villasante, Spain |
| Andrea Belgrano, Sweden |
| **Meeting dates** |
| 19–20 November 2018 |
| **Meeting venue** |
| Vigo, Spain |

2   Terms of Reference

ToR	Description	Background	[Science Plan codes](#)	Duration	Expected Deliverables
A	To undertake a literature search to assess the current data available to document the resilience of marine ecosystem services	Information and data on marine ES is scarce and not organized. Links to ICES Science Plan 1st, 2nd and 3rd thematic areas, and WGs described above	1.3; 2.4; 5.8	1 year	-Interim report -Global review paper: Key drivers for resilient small-scale fisheries. - Exploration of potential opportunities for collaboration with EU institutions and fishery organizations -Online repository with results from year (2015-2017)
B	To document the current approaches available in connection to multidimensional valuation of marine	Valuing marine ES is key for policy makers. Regional and local data is lacking in Europe. Links to ICES	4.3; 6.5; 7.1	2 years	-Interim report -Paper review on intrinsic, instrumental and relational values

	ecosystem services	Science Plan 1st and 2nd Thematic Areas; and WGs described above			of marine ES -Special Session at ASC 2018 -Special Session at PICES 2018 -Extended version of the online repository
C	To review the available information and to produce a document with the co-production of marine ES	Marine ES are co-produced by a mixture of natural capital andvarious forms of social, human, financial and technological capital. Human intervention in the co-creation of marine ES is a key driver in ES delivery,	4.1; 5.4; 7.7	2 years	-Interim report -Special Session at ASC 2019 -Special Session at AAA Conference 2019 -Global paper about co-production of marine ES -Special Issue "*Blue Growth under the Antrophocene*"
D	To work on the Special Issue entitled: "Tipping points and social transformations of marine ES"	Document critical changes which facilitate transformations of social groups. Links to ICES Science Plan 1st, 2nd and 3rd thematic areas, and WGs described above and below. Links to the Strategic Initiative on the Human Dimension	2.4; 5.1; 7.3	2 years	-Interim report -Global paper documenting social transformations of marine ES. -Special Session at ASC 2020 -Special Issue "*Tipping points and social transformations of marine ES*"
E	Governance and scenarios for sustainable marine ES	The role of institutions is key to develop assessments of best practices of integrated assessments of marine ES	6.3; 6.6; 7.6	3 years	-Interim report -Global paper on governance of

3 Summary of Work plan

Year 1	Review of existing frameworks, methodologies and tools to study socio-economic dimensions of marine ecosystem services
Year 2	Undestanding of ecological, economic, cultural, social drives of changes of marine ecosystem services
Year 3	Scenarios and policy recommendations for resilient trajectories of marine ecosystem services

4 List of Outcomes and Achievements of the WG in this delivery period

Publications

Scientific papers (key selected publications)

Grafton, Q. (including Villasante, S.) (2019) *Nature Sustainability* (accepted).

Sumaila, R., Villasante, S., Le Manach, F. (2019) Europe must avoid harmful subsidies to ensure healthy marine social-ecological ecosystems. *Nature* (in press).

Alice, N. *et al.* (2018) Assessing, quantifying and valuing the ecosystem services of coastal lagoons. *Journal for Nature Conservation* 10.1016/j.jnc.2018.02.009

Outeiro, L., Villasante, S., Oyarso, H. (2018) The interplay between fish farming and nature based tourism in Southern Chile: a perception approach. *Ecosystem Services* 32(A): 90-100.

Pita, P., Villasante, S. (2018) The building of a management system for marine recreational fisheries in Galicia. *Ocean and Coastal Management 165* 10.1016/j.ocecoaman.2018.12.027.

Pita, P. *et al.* (2018) Socioecological changes in data-poor S-fisheries: A hidden shellfisheries crisis in Galicia (NW Spain). *Marine Policy* doi.org/10.1016/j.marpol.2018.09.018.

Libralato, S. *et al.* (2018) Past, present and future of marine ecosystems and commercial fisheries in the Mediterranean and Black Sea under the Common Fisheries Policy. *Frontiers in Marine Science* doi:10.3389/fmars.2018.00299.

Special Issues in scientific journals

Topic Editor for Ecology and Society: Special Issue on *Managing local and global fisheries in the Anthropocene* (2018) (Topic Editor: Villasante S.)

Topic Editor for Frontiers of Marine Sciences: Special Issue on The Role of the Human Dimension in Marine Ecosystem Services Valuation (2018) (Topic Editors: Villasante S., Antelo, M.).

Topic Editor for Ocean and Coastal Management: Special Issue on The Fisheries Policy Reform for the development of Galician communities (2018) (Topic Editors: Villasante S., Pita, P., Antelo, M.)

Datasets

The **Social Transformation Dataset** provides a high-quality, descriptive, open-source information resource for the scientific community, ecosystem managers and the sectors related to the marine ecosystem (i.e. industrial and small-scale fisheries, aquaculture and canning industry). Our hypothesis is that crossing critical tipping points can lead to abrupt social transformations of marine social-ecological systems (SES), but avoiding those

thresholds can be possible by also promoting desirable social changes in marine SES. To test this hypothesis, this is the first attempt to standardise different complex and inter-connected drivers (e.g., environmental, institutional, economic and financial) in order to document empirical evidence of social transformations of marine ES. By documenting case studies with large social transformations, we will be able to better understand what are the social changes needed to avoid crossing tipping points and undesirable outcomes.

The Social Transformations of marine SES repository includes detailed and innovative information about the different human uses and impacts on the oceans and their drivers. It provides a high-quality, descriptive, open-source information resource for students, researchers, fisheries managers and representatives of the marine sectors (industrial and small-scale fisheries, aquaculture and the canned industry). The repository provides the basis for future inclusions of case studies, on topics such as small-scale fisheries, industrial fisheries and aquaculture.

The repository is the result of the ICES Science Fund project Social transformation of marine social-ecological systems. To date there has been no standardized data collection about the social transformation of marine social-ecological systems (SES). From a literature review made by members of the ICES Science Fund Project, key information on the most common variables was extracted which helped evaluating whether social transformations could be applied to marine SES. Data variables include, amongst other things, name of the authors, year of publication, objectives and key words of the papers, scale of the study, type of social transformation, drivers and scales of the social transformation, economic sectors affected; synergies and trade-offs identified, time scale and reversibility of the social transformation, and sources of evidence.

Another repository "*Marine and Coastal ecosystem services*" has been also created. The Cultural Marine Ecosystem Services Dataset includes information about cultural marine ES globally. This research is the first systematic contribution directly related to cultural services in the marine science. This work includes a new CES framework for practical application in the marine and coastal environment by managers and decision makers. In addition, the dataset provides an overview of the state of the art of marine and coastal CES research worldwide, it identifies key factors/variables to take into account in marine and coastal CES assessments, and it also analyses the main drivers of change in marine and coastal CES potentials, flows, and demands. The dataset is also including variables to gather information about the role of traditional knowledge in marine and coastal systems (IPBES, 2019).

5 Progress report on ToRs and workplan

5.1 ToR A) Review current data available to document the resilience of marine ES

A new Resilience Heuristic has been developed by members of the WGRMES by operationalizing resilience in social-ecological systems called "Operationalizing Resilience: Resistance, Recovery Time and Robustness for Decision-making". The Resilience Heuristic address the current lack of operationalization of resilience by: (1) reviewing how resilience is conceptualized and measured; (2) developing a Resilience Heuristic for resilience management of social-ecological systems; (3) contextualizing this Heuristic with an illustration in relation to marine fisheries; and (4) applying this Heuristic in wild capture fisheries (Grafton *et al.* 2019 -including Villasante, S.) *Nature*.

Our proposed Resilience Heuristic encompasses seven questions or steps in relation to a marine social-ecological system (and its boundaries) under consideration:

1) What is the object (system, system component, or interaction) whose resilience is being managed?

2) For whom (stakeholders) is resilience being managed?

3) What are the metrics of system performance for the identified stakeholders?

4) What are the viability (or safety) goals of the identified stakeholders (and associated metrics) for key system variables that allow a system to retain its identity?

5) What adverse events might threaten these viability goals?

6) How are the Three R's measured in relation to system performance and in response to adverse events?

7) What are expected net benefits, currently and over time and space, of resilience management actions?

Together: (i) the measurement of three distinct, but related, characteristics of social-ecological resilience and (ii) a Resilience Heuristic that includes seven questions linked to complementary management steps, provide practical, operational guidance to those who care about, and wish to manage for, system performance in an uncertain world. Graphically, the new Resilience Heuristic is shown in Figure 1.
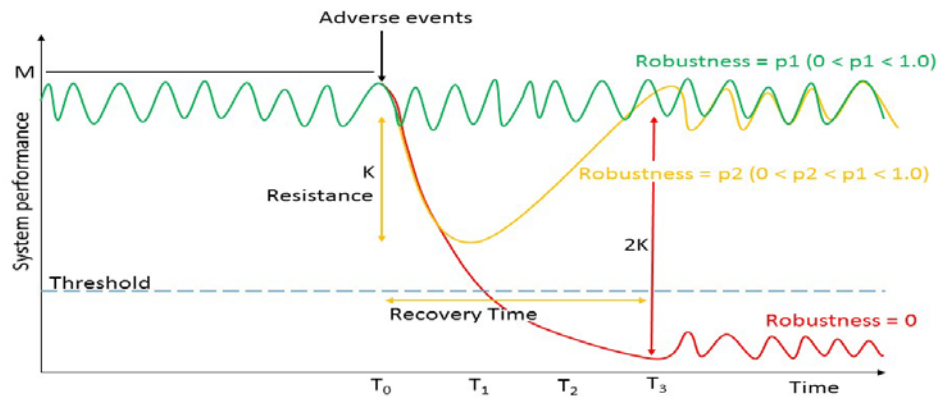
We illustrate the Three R's in Figure 1 and specify dimensionless (normalized) units (from 0 to 1.0) for resistance and recovery time (robustness is measured as a probability). For consistency across the Three R's, a higher value of our dimensionless measure of recovery time represents greater social-ecological resilience.

- *Resistance* – a system's ability to actively change while retaining its identity or to passively withstand a decline in system performance following one or more adverse events (Grafton *et al.* 2009).

- *Recovery Time* – a measure of the time it takes for a system to recover or to achieve a desired level of functionality or system performance following one or more adverse events (Pimm 1984); and

- *Robustness* - the probability of a system to stay functional, maintain its identity and *not* cross an undesirable (and possibly irreversible) threshold following one or more adverse events (Huizar *et al.* 2017).

Building on the insights of Carpenter *et al.* (2001, 777), Helfgott (2018) highlights that social-ecological resilience needs to be operationalized by identifying: (i) *for whom* (those affected by adverse events and management actions); *(ii) of what* (aspects of system performance of interest, including system boundaries); (iii) *to what* (adverse events that affect system performance); and (iv) *over what time frame* (short versus long-run, time to recover, etc.).

Figure 1 highlights possible policy implications of the Three R's for resilience management. System performance is measured on the vertical axis while the horizontal axis is time. System performance varies over time, within some desirable, viable or acceptable range, prior to T0 when a pulse or one-off adverse event occurs, but we observe that adversity may also include on-going and long-term influences (presses) on system performance (Donohue *et al.* 2016).

The threshold in Figure 1 represents a single and static critical transition (Béné and Doyen 2018) point beyond which the system may move to an irreversible state where previous levels of system performance (defined by M) cannot be restored. Thresholds may not always exist; but, when they do, they may be exogenous or endogenous such as the requirement profits always be positive, as determined by stakeholders or decision-makers.

For illustrative purposes only, Figure 1 includes three possible scenarios after T0. Scenario one is represented by the green trajectory where no adverse event is assumed to occur and, thus, there is no observable impact on system performance. In this case, social-ecological resilience is characterized by: a. Resistance, such that there is no observable decline in system performance, b. Recovery Time, system performance remains at M, and c. Robustness, is the probability $0 < p1 < 1.0$ of not crossing the threshold, and is unchanged.

5.2   ToR B) Assess approaches available for pluralistic valuation of marine ES

The WGRMES is reviewing existing projects and data collection exercises which provide information about natural capital accounting (NCA) and marine ecosystem services (e.g, Joint Research Centre, MAES reports). Establishing a sound method for NCA, with a strong focus on ecosystems and their services, is a key objective of the 7th EAP and of the EU Biodiversity Strategy to 2020.

The WGRMES is also reviewing scientific literature to document and assess the role of monetary and non-monetary (socio-cultural and traditional knowledge) valuation of marine ES for decision-makers to provide a pluralistic valuation of ES in connection with IPBES recommendations. By using several case studies from small-scale fisheries, industrial fisheries and IMTA system in EU countries (Norway, Portugal, Spain, Sweden).

In Portugal, we developed a participatory mapping of marine ES in the "Parque Natural do Litoral Norte", a marine protected area (MPA) in the municipality of Esposende, Portugal, where there are zones with different levels of protection and restriction to human use. In addition to the biodiversity it hosts - and because of it - the park is also an important supplier of ecosystem services. Ecosystem services represent the contributions of nature to human well-being. They are therefore fundamental for providing benefits that people obtain from nature, be they social, cultural, or economic.

The ecosystem services provided by the habitats and species that exist in the Litoral Norte MPA are manifold. Habitats and species of the MPA are sources of food for human consumption, such as fish, bivalves, or crustaceans. Dunes and rocky reefs provide coastal protection safeguarding houses and agricultural fields from sea level rise. Estuaries and beaches are places with high landscape and symbolic values to people. Essentially, protecting biodiversity and its ecosystem services is protecting human well-being (Garcia Rodrigues *et al.* 2019).

To think about new strategies that safeguard both biodiversity and its contributions to human well-being we organised the workshop "Litoral Norte Natural Park: what futures?" in Esposende, on 17 and 18 January 2019. The objectives of the workshop were the following: a) to create ideal visions for the next 10 years of Litoral Norte MPA; b) to propose actions to achieve the idealised future visions; c) to spatially identify key habitats,

ecosystem services, threats and conflicts that occur in the MPA; d) to understand and discuss the diversity of perspectives and opinions on the present and future situation of Litoral Norte MPA. The workshop was structured around four themes that we considered vital for the future of the MPA, namely:

- biodiversity conservation;
- small-scale fisheries;
- tourism and recreational activities;
- governance and planning

Each topic was assigned to a working group made up of people with professional experience on the subject. The participants of the workshop were local fishers, tourism operators, representatives of the municipality council of Esposende, representatives of the national Institute for Nature Conservation, and researchers from both the natural and the social sciences of the universities of Aveiro, Porto, Santiago de Compostela, and from the Interdisciplinary Centre for Marine and Environmental Research (CIIMAR); (Garcia Rodrigues *et al.* 2019).
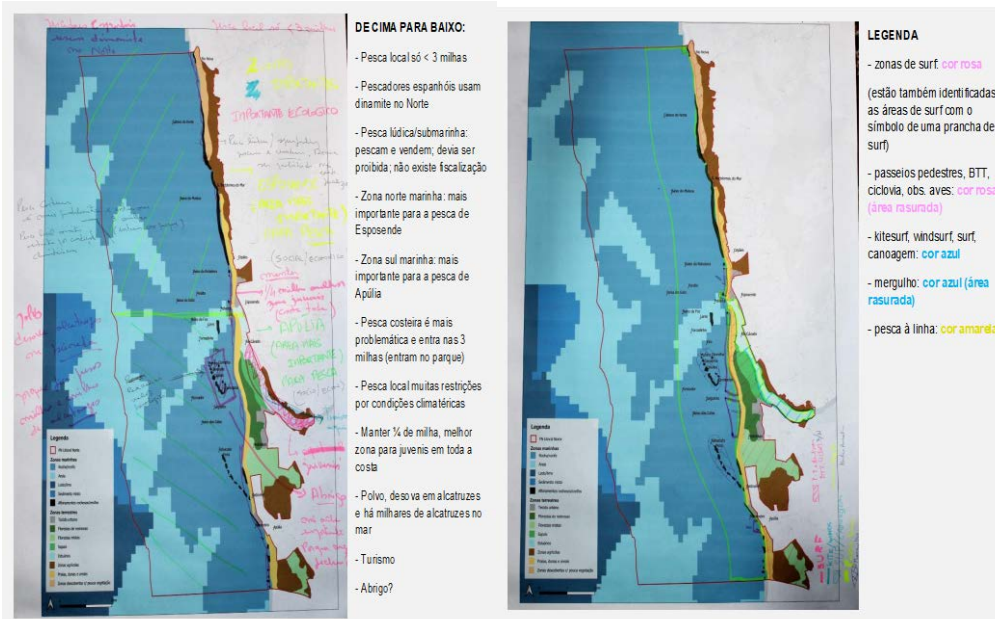
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Figure 2. Participatory spatial mapping of marine activities and ES in the Litoral Norte Natural Park (Portugal).

The workshop resulted in the to the following ecosystem services assessments:

- <u>presence of habitats and species</u>: all groups considered the whole area of the park important for habitats and species, especially rocky reefs and kelp forests in the marine zone, saltmarshes and reed beds in the estuarine zone, and hardwood forests in the terrestrial zone. Habitats and species of the MPA were considered by all groups important to the well-being of the local population by contributing directly or indirectly to the social, cultural and economic activity of the whole region;

- <u>opportunities for fishing</u>: groups highlighted the great importance of the whole marine area for the local fishing communities of Esposende and Apulia,

and for their culture and identity. Local consumers also benefit from local small-scale fisheries by having a source of fresh and nutritious fish in the region. It has been reported that local catches have remained stable in recent years, with a reduction in catches of some species, which, however, has been offset by increased catches of other species. Yet, given the lack of reliable information on local fisheries catches, the uncertainty associated with this assessment is high;

- coastal erosion control: groups emphasized the role of rock outcrops in the marine zone, dunes, pebble beaches, and possibly kelp forests in the dissipation of the energy of waves and tides. These habitats were considered important for the protection of houses and agricultural fields from sea level rise. Saltmarshes of Neiva and Cávado estuaries, as well as hardwood, mixed and resinous forests on land, were considered natural barriers to wind corridors, thus protecting the coastal fringe from the erosion caused by the wind. Interestingly, pebble beaches (beaches that have lost their sand in the last decades) are much as the consequence of coastal erosion, as they are now considered a system capable of protecting the coast from that same erosion;

- cultural heritage and local identity: there are numerous local heritage elements influenced by the sea and the coast of Litoral Norte MPA, which are very important for the local population and park visitors. Groups referred to the sargaceira costumes and their activity, local fishing communities, mills and masseiras of Apúlia, the pilgrimage of S. Bartolomeu do Mar, the Fort of S. João Batista, the wrecks that exist along the entire coast of park, among others. Some participants warned that masseiras have been losing their original characteristics due to sand removal from their slopes, with the purpose of increasing the agricultural area, or to extract sand for sale.

- opportunities for tourism and recreational activities: groups stressed the importance to the local economy of the conditions offered by the MPA for tourism and recreational activities. In the coastal zone, groups highlighted beach tourism, surfing and hiking. In the estuarine zone, groups emphasized kitesurfing, canoeing, bird watching and angler fishing, although the latter often occurs in forbidden areas of the estuary. In the marine zone, groups highlighted onboard recreational fishing and some recreational diving, and mentioned the potential the MPA has for cetacean watching. Groups pointed out that increasing coastal erosion in the park's beaches threaten the capacity that the area provides for beach tourism (Garcia Rodrigues *et al.* 2019).

5.3   ToR C) Review the available information about the co-production of marine ES

The WGRMES worked on the co-production mechanisms of marine ES. Co-production of ES has been described a how interactions between people and ecological systems that result in the provision of ES. We analysed five marine harvesting systems: two small-scale fisheries in Northern Portugal and three small-scale shellfisheries in Galicia. The harvesting system with the largest use of non-natural capital is intensive intertidal semi-aquaculture, as it uses all the forms of non-natural capital (human, social, manufactured, financial capital). The second most important activity using non-natural capital is the extensive semi-aquaculture which needs almost the same practices as intensive semi-aquaculture but at a lower intensity level, using all the forms of non-natural capital except financial capital. These preliminary results have been already published in Outeiro *et al.* (2017).

Based on these results, we are extending the co-production matrix globally by developing three tasks: a) an inventory of co-production examples in marine social-ecological systems, b) an international expert consultation, and c) the development of a local interviews program in key selected case studies (France, Portugal and the United Kingdom) under the H2020 GENIALG project (https://genialgproject.eu).

The inventory of co-production processes of marine ES globally is collecting case studies to better understand what experiences have been made, what lessons and conclusions have been drawn and what have been key issues for advancing collaboration/key challenges for further inclusion of the co-production of marine ES in integrated assessments of marine social-ecological systems. The inventory is going through existing documentation from international and national agencies, other authorities and research institutions that have documented information from current or finished research projects about and/or including the physical and cognitive types of co-production. We are comparing and contrast these diverse experiences through quantitative and qualitative and scientific analytical methods, as well as through qualitative, descriptive methods. The material gathered, and the synthesis conducted, will be shared by and discussed with a range of stakeholders in a workshop format.

Based on the existing evidence, we are mobilizing our international scientific networks (e.g., Future Earth, Ecosystem Services Partnership, etc.) through meetings with experts to synthesize existing knowledge associated with the co-production of marine ES in order to ensure that no key examples from the inventory is missing, and help us to extract insights and lessons from our international inventory.

We will also use the conceptual framework developed by Palomo *et al.* (2016) to conduct interviews and questionnaires with key stakeholders (e.g., fishers, enterprises, ONGs, policy makers) in Galicia (Spain) and Northern Portugal to study in deep the role of different forms of natural and non-capital in the ES delivery across a selected number of case studies. We are exploring the co-production pathways and their effects on ES quantity and quality, associated trade-offs, resilience and social equity. Co-production analysis at local scale will help to better identify the effects of co-production on the final distribution of ES, their benefits and costs. Such distribution of the costs of co-production

and the benefits of the resulting services is a key (often implicit) policy question that affects the equity of well-being in society.

5.4   ToR D) Examine tipping points and social transformations of marine ES

Social vulnerability is a term describing how resilient a coastal community is when confronted by external stresses or drivers on human wealth and health. These stressors can range from natural or human-caused disasters to disease outbreaks. By reducing social coastal vulnerability, we can decrease both human suffering and economic losses to economic activities. Determining which of your group's assets are most likely to be affected by a climate threat can help your group decide where and how to start. One consideration in the decision is how close each asset may be to a *tipping point*—a point when incremental change in a system results in a new, irreversible response. Some people refer to tipping points as critical thresholds. Looming tipping points aren't the only factor groups need to consider when deciding which assets to protect, but the potential for a large change in the system can elevate the level of concern for those assets.

We have started to develop the *Social Vulnerability Index* in the European Union (EU). The SVI has been created by the NOAA and based on the requirements of the Data Collection Framework in the EU. We have stablished a regular and solid collaboration with the NOAA to apply the SVI in several coastal communities in the EU starting with the detailed analysis in France, Portugal and Spain. For example, in Galicia (NW Spain) we have already collected the following data:

- Fisheries data (1997–2017)
    - o   Official platform www.pescadegalicia.gal
    - o   Reported landings (volume and value) by auction markets ("*Lonjas*")
    - o   255 commercial species (fishes, crustaceans, mollusks)
    - o   Number of fishing vessels (length, tonnage and fishing power) by port
- Social data (1991-2017)
    - o   Official platform www.ige.eu
    - o   Selection of key variables by local experts (from 123 indicators)

Some of the key indicators for which we are collecting data are listed in Table 1:

Category	Variable	Definition	Data period
1. Population	N° people (female/male)	People living in coastal municipalities	1996-2017
2. Houses	N° houses residential use	Houses destined to be inhabited by one or several people	1996-2017
3. Rent household	Gross income/capita	Account balance of the secondary distribution of the income	1996-2017
4. Population studies illiterate	% population of primary, secondary and tertiary	Population of 16 years and older in family homes by type of studies	1996-2017
5. Labour force structure	(Un)employment by economic sector	(Un)employed population by the location of their work	2001-2017
6. Employment	N° employment in fisheries sector	Population of 16 years working fisheries sector	1991-2017
8. Private sector	N° companies in each economic sector	Companies by activity sector (fishing) and legal status (cooperatives …)	1997-2017

The empirical results of the SVI will help the European Commission and national governments to a) Provide empirical evidence of social vulnerability of fishing communities in the European Union, b) Analise of dynamic changes in contribution of fishing activities to coastal communities c) Understand how fisheries management tools can contribute to reduce social vulnerability of people, and d) Understand adaptive strategies developed by coastal communities to increase resilience over time.

Another progress of the ToR about tipping points and social transformations are the update of two repositories of information: The *Social Transformation* and the *"Marine and Coastal ecosystem services"* Datasets. Both repositories are described in detail above.

5.5   ToR E) Evaluate governance and scenarios for sustainable marine ES

In contemporary society, Marine Protected Areas (MPAs) are increasingly expected to justify their existence through the services that they provide to society. Current challenges for MPAs research, and implementation, include understanding the role of MPAs in maintaining ecosystem services, identifying the key cultural services offered by MPAs (Garcia Rodrigues *et al.* 2017). WGRMES is developing a global review of MPAs and their role to maintain marine ES.

The global review paper is identifying and analysing the status quo of marine ES research undertaken with regards to MPAs by critically reviewing current publication. We searched for scientific papers published in English between 1950-2018 period in the Web of Scopus, by using the following criteria: *"marine* OR *coast** OR *sea** OR *gulf* OR *bay* OR *ocean)* AND *"Ecosystem Service"* AND (*protect** OR *park** OR *reserve** OR *no-take* OR *sanctuar** OR *"conservation unit"* OR *biosphere"*. No geographical boundaries were stated in the selection criteria as preliminary test Searches included all articles published until our cut-off date of 31 December 2018. Members of the WGRMES screened 1695 scientific papers and finally selected 81 studies.

Before starting the data collection, we carried out a 'calibration' exercise to attain a uniform data collection procedure among co-authors. This consisted of reviewing a randomly selected publication that had been previously identified for quantitative synthesis.

Each co-author assessed this publication individually and subsequently the results were compared against each other. The outcome of the exercise resulted in our template for the data collection process (Figure 3).
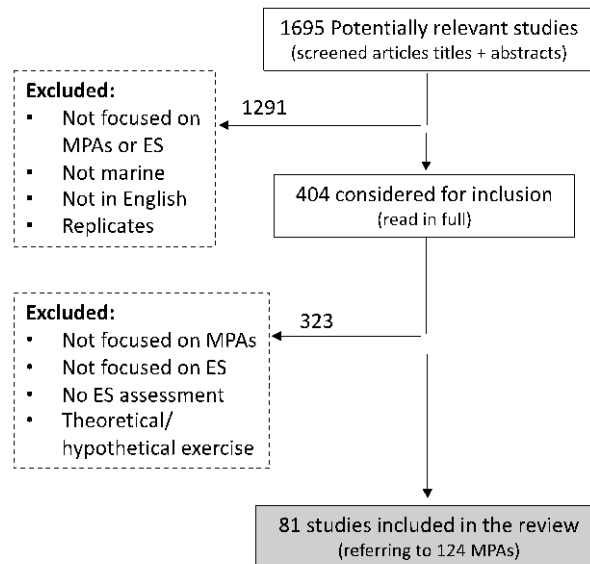

Figure 3. Flowchart of stages of identification of studies in the review
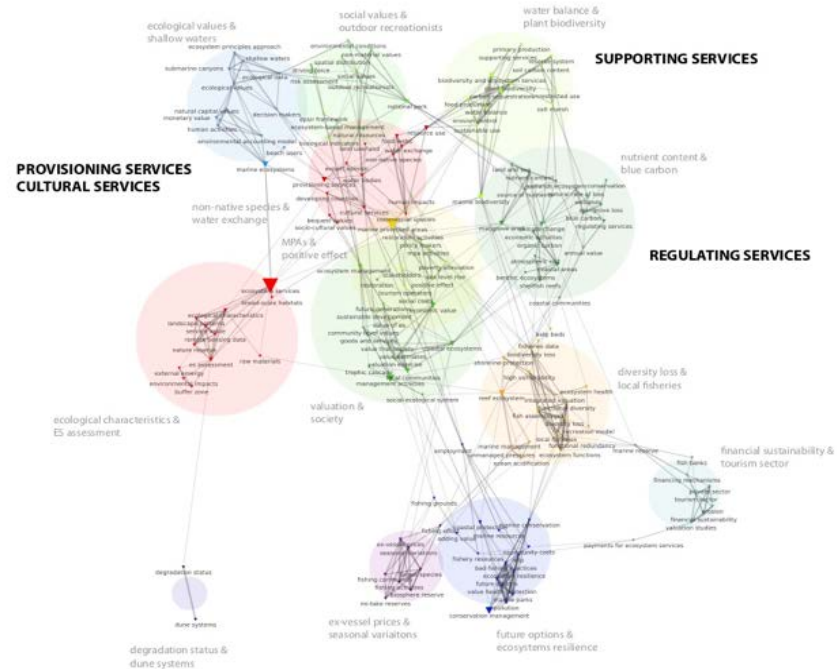
Source: authors' results.

	VARIABLE	DESCRIPTION
Information paper	Title	Title of the paper
	Keyword	Keywords in the paper
	Year of publication	Year of publication
	1st author affiliation	1st author affiliation as specified in the paper
	Type of article	Empirical, conceptual, revision
	Dimension	Environmental, economic, social, mixed
	Type of analysis	Quantitative, qualitative, mapping, mixed
	Scale	Local, regional, national, European, other
	Country	Identify the country of the study area
Marine Protected Area	Name	Official of the Marine Protected Area
	Location	Area, municipality, region
	Type of PA	National park, reserve, etc.
	Year of implementation	Year of the creation of the area
	Area (ha or km2)	Area (in ha or Km) - please mention unit
	Type of habitat	mangrove, coral reefs, beach, delta, dunes, other (specify)
	Spatial information	Yes - there is spatial information about the MPA; No - there is no spatial information
	Spatial reference	Official (if any) link to the area
Management of MPA	Success or not	Degree of success (if mentioned in the paper)
	Reasons for success	Leadership of local people, strong institutions, participation of stakeholders, other (specificy)
	Activitites *in*side the PA	Artisanal fisheries, coastal fisheries, recreational fisheries, aquaculture, ecotourism, other (specify)
	Activities *outside* the PA	Artisanal fisheries, coastal fisheries, recreational fisheries, aquaculture, ecotourism, other (specify)
	Fisheries Management system	co-management, ITQs, quota, etc.
MPA Governance	Level of governance	private, local, regional, other (specify)
	Stakeholders' involvement	Low, medium, high
	Existing conflicts (trade-offs)	Yes: there are conflicts within the MPA; No: no conflicts are identified
	Actors of conflicts	Identify the groups in conflict
	Source of conflicts	Identify the reasons for conflict
Ecosystem Services	ES Classification	Millenium Ecosystem Assessment (MEA) | TEEB | CICES | Other (specify)
	Type of ES (provisioning, regulating, supporting and cultural)	Count how many provisioning ES are mentioned
	Trade-off between ES	Count how many provisioning ES are assessed

Source: authors' results.

The variables used to investigate the role of MPAs in their capacity to sustain marine ES and select the final list of papers to review are listed in Table 2. Based on the selection of these variables, we developed a cluster analysis by using selected terms to link different type of marine ES.

For illustrative purposes, the preliminary results of the literature review are shown in Figure 3. The results show that the proximity of nodes indicate a stronger relationships between the different marine ES (Figure 3a).
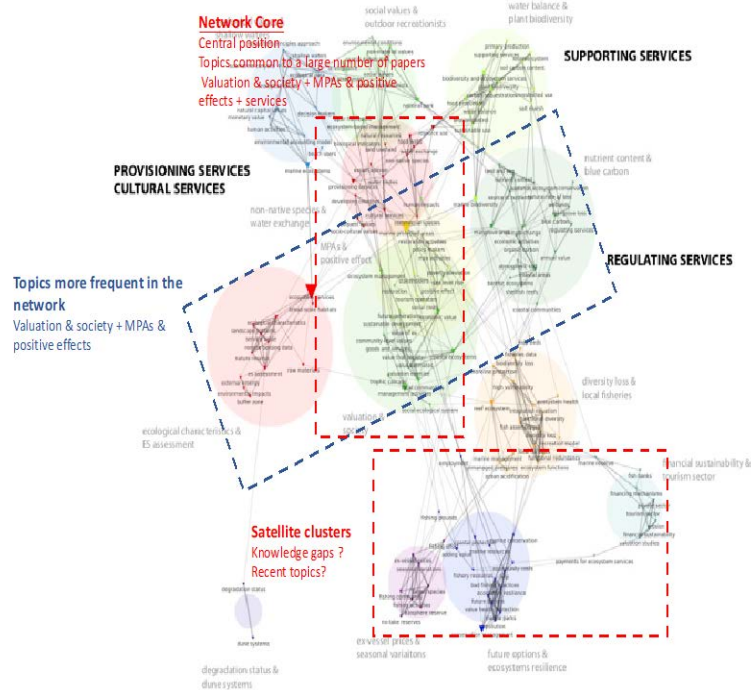
A)

B)

Figure 3. Global cluster analysis of marine ecosystem services in Protected Areas: A) Cluster analysis of marine ES and terms, B) topics more frequently used by scientific papers.

Source: Authors' results.

The bigger nodes also indicate the higher frequency of the terms used in each of the scientific paper. Also, the larger clusters of terms suggest a higher mention of them by the authors. The most cited terms were "valuation", "society", "ecological characteristics", and "ecosystem assessment" (Figure 3b).

In addition, WGRMES members are also working on case studies within Europe and elsewhere by combining social network analysis and social media (e.g., Instagram and Twitter), to assess the role of cultural marine ecosystem services in Natural Protected Areas in the following sites:

- the National Park of Illas Atlánticas in Galicia (Spain)
- NE Spanish Mediterranean (Spain)
- Arrabida Marine Park (Portugal)
- Berlengas National Park (Portugal)
- Galapagos (Ecuador) Islands
- The Great Barrier Reef (Australia)

The results of this research will be submitted to a scientific journal during 2019.

6   Changes/ Edits/ Additions to ToRs

Not required.

7   Cooperation with other WGs

WGRMES have stablished cooperation with the ICES WGECON and WGSOCIAL to generate synergies during this 3-year period. S. Villasante made a presentation at the WGECON meeting (Paris, France, 11–14 June 2019) and the WGs will be working together on the following topics:

- WGRMES–WGECON: Sharing economic information about the data collection from different case studies related to marine and coastal ES from H2020 and national projects initiatives, and datasets.
- WGRMES–WGSOCIAL: Sharing economic information about the data collection from different case studies related to marine and coastal ES from H2020 and national projects initiatives, and datasets.

Science highlights

The following PhD thesis on marine ES are currently under developing and/or (co)supervising by WGRMES members to be defended during 2019:

- Garcia Rodrigues, J. Human wellbeing in a changing marine social-ecological system: A participatory analysis using the ecosystem services framework. Co-supervisors: Villasante, S., Sousa Pinto, I. University of Santiago de Compostela (Spain).
- Custodio, M. Integration of halophytes production to promote coastal aquaculture eco-intensification. Co-supervisors: Lillebo, A., Calado, R., Villasante, S. University of Aveiro (Portugal).

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Villasante, S. Pita, P., Himes-Cornell, A., Colburn, L., Macho, G., Kaspersky, S. Social vulnerability of Galician (NW Spain) fishing communities, ICES Working Group on Social Indicators, June 25-29nd 2018, Rome, Italy.

Next meeting

The WGRMES 2020 meeting will be held in Brest, France, 10-12 June.

Annex 1: List of participants

NAME	INSTITUTE	COUNTRY	EMAIL
Azevedo, I.	CIIMAR	Portugal	mazevedo@ipma.pt
Belgrano, A.	SLU	Sweden	andrea.belgrano@slu.se
Burgués, I.	CIIMAR	Portugal	iburgues@bio.puc.cl
Cabecinha, E.	University of Tras Montes	Portugal	edna@utad.pt
de Juan, S.	IMEDEA	Spain	sjmohan@bio.puc.cl
Liu, Y.	SINTEF	Norway	yajie.liu@uit.no
Macho, G.	University of Vigo	Spain	gmachor@gmail.com
Murillas, A.	AZTI	Spain	amurillas@azti.es
Ojea, E.	University of Vigo	Spain	elenaojea@uvigo.es
Pita, P.	University of Santiago de Compostela	Spain	ppitaorduna@gmail.com
Queiroga, H.	University of Aveiro	Portugal	henrique.queiroga@ua.pt
Ramos, S.	CIIMAR	Portugal	ssramos@ciimar.up.pt
Verutes, G.	Stanford University	USA	gverutes@gmail.com
Villasante, S.	University of Santiago de Compostela	Spain	sebastian.villasante@usc.es