From ecosystem services to nature contribution to people: what is better for marine ecosystems?

Sebastian Villasante
University of Santiago de Compostela (Spain)
@sebvillasante
Email: sebastian.villasante@usc.es

Golfo Ártabro: Biodiversidade e Bienestar Humano

Oleiros, Mayo 22 2018

USC UNIVERSIDADE DE SANTIAGO DE COMPOSTELA

futurearth research for global sustainability

pecs Programme on Ecosystem Change and Society

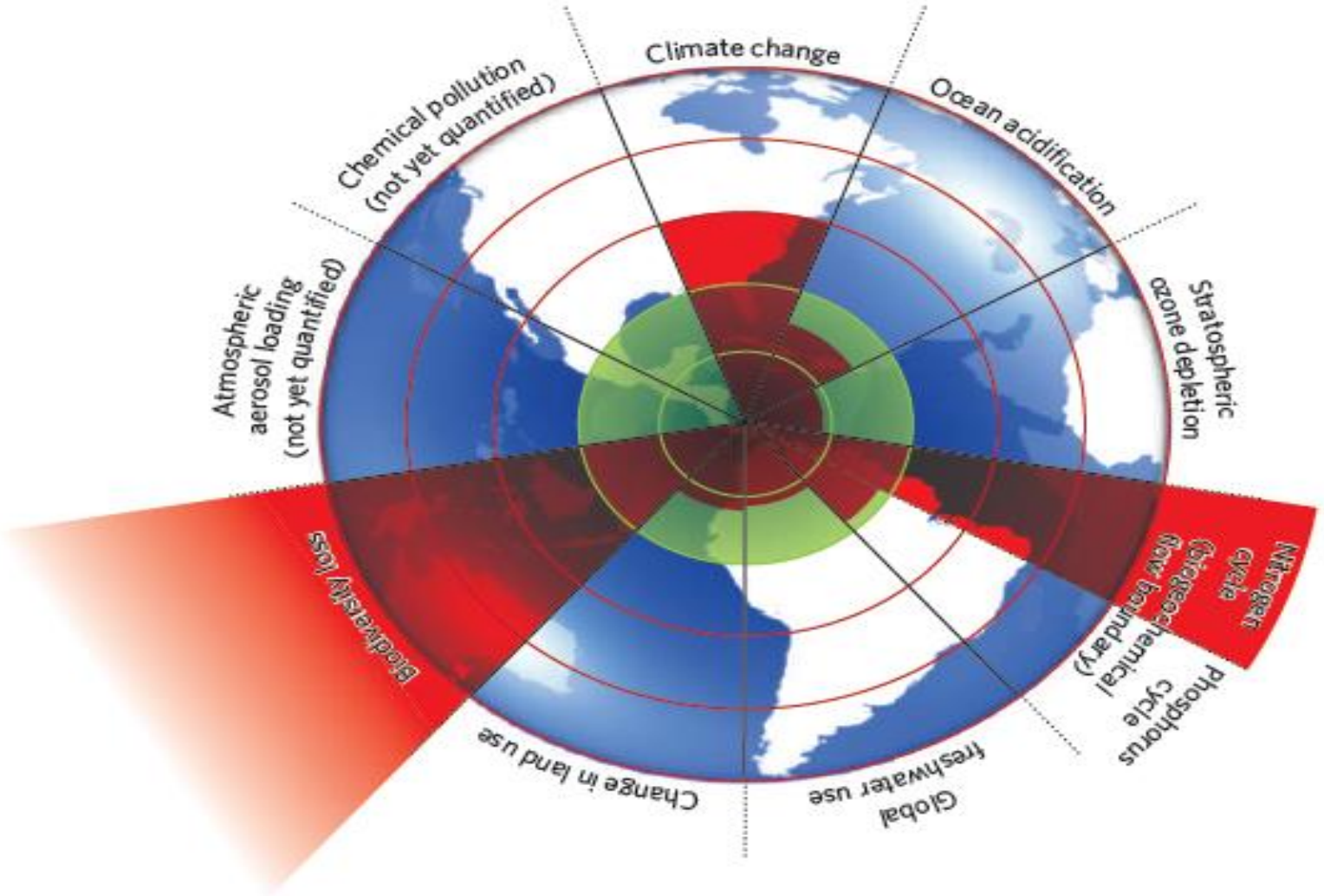
CAMPUS DO MAR

Outline of the talk

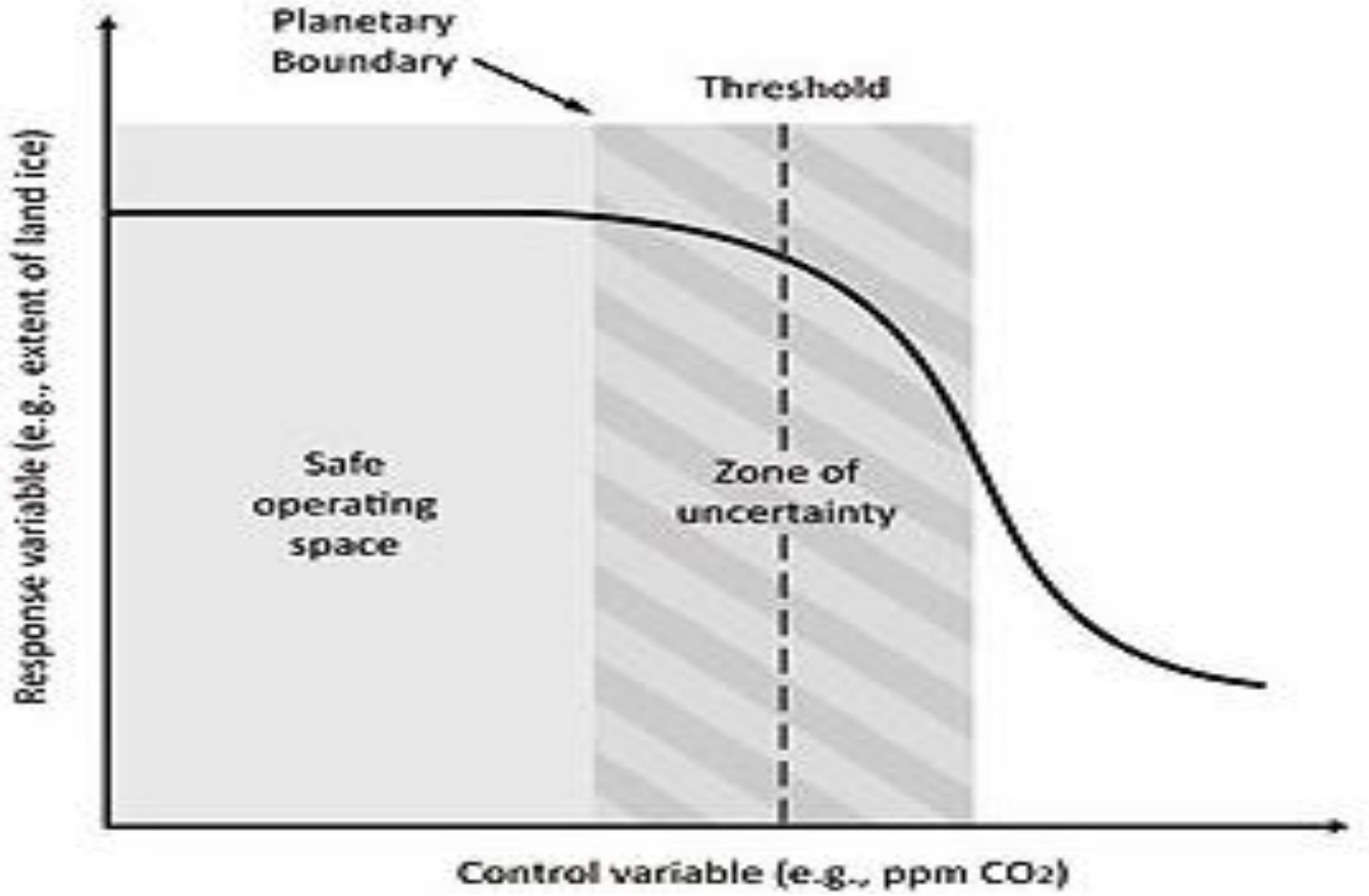
- Marine ecosystem services under anthropogenic pressures
- Key research gaps in marine ecosystem services
  - Co-production of marine ecosystem services
  - Empirical examples in Portugal and Spain
- Nature contribution to people
- Some lessons and future directions

Welcome to the Anthropocene

Planetary boundaries



Crossing planetary boundaries: Transitions towards unpredictable consequences



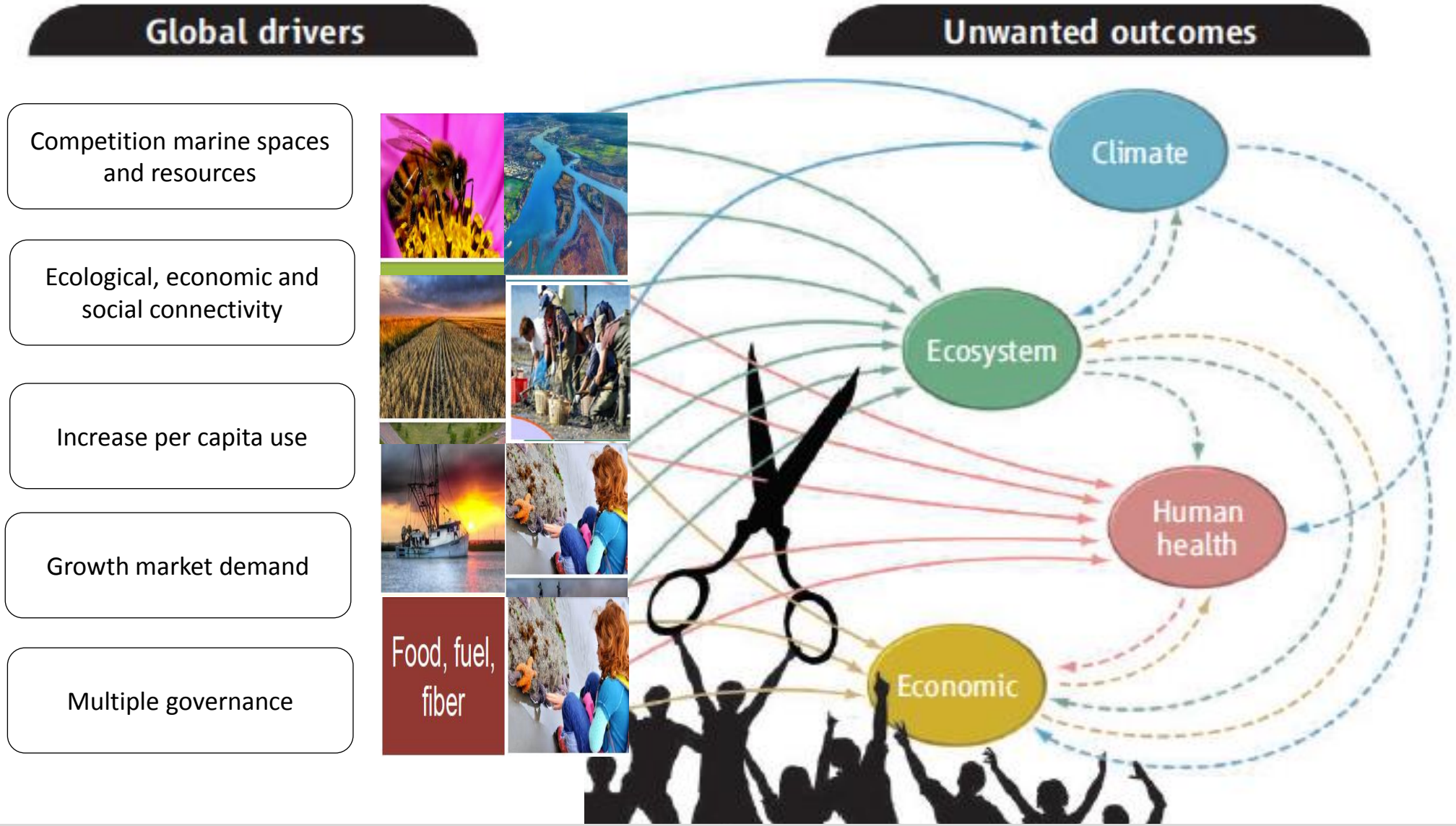
The role of the oceans for live on Earth and Human being

Carry out 50% primary production Earth

Supply 20% average intake animal protein to 3.1 billion people

Support the greatest biodiversity on the Planet

Social-ecological connectivity



Adapted from Walker et al. (2009) Science

Comparation ES classifications

Comparison of four of the main ecosystem services classification systems used worldwide and their differences and similarities.

	Costanza et al., 1997	Millennium Ecosystem Assessment, 2005	TEEB, 2010	CICES (v. 2017?)
Provisioning	Food production *(13)*	Food	Food	Biomass - Nutrition
	Water supply *(5)*	Fresh water	Water	Water
	Raw materials *(14)*	Fibre, etc.	Raw materials	Biomass - Fibre, energy & other materials
		Ornamental resources	Ornamental resources	
	Genetic resources *(15)*	Genetic resources	Genetic resources	
		Biochemicals and natural medicines	Medicinal resources	
	X	X	X	Biomass - Mechanical energy
Regulating & Habitat	Gas regulation *(1)*	Air quality regulation	Air purification	Mediation of gas- & air-flows
	Climate regulation *(2)*	Climate regulation	Climate regulation	Atmospheric composition & climate regulation
	Disturbance regulation (storm protection & flood control) *(3)*	Natural hazard regulation	Disturbance prevention or moderation	Mediation of air & liquid flows
	Water regulation (e.g. natural irrigation & drought prevention) *(4)*	Water regulation	Regulation of water flows	Mediation of liquid flows
	Waste treatment *(9)*	Water purification and waste treatment	Waste treatment (esp. water purification)	Mediation of waste, toxics, and other nuisances
	Erosion control & sediment retention *(8)*	Erosion regulation	Erosion prevention	Mediation of mass-flows
	Soil formation *(7)*	Soil formation *[supporting service]*	Maintaining soil fertility	Maintenance of soil formation and composition
	Pollination *(10)*	Pollination	Pollination	Life cycle maintenance (incl. pollination)
	Biological control *(11)*	Regulation of pests & human diseases	Biological control	Maintenance of pest- and disease-control
Supporting & Habitat	Nutrient cycling *(8)*	Nutrient cycling & photosynthesis, primary production	X	X
	Refugia (nursery, migration habitat) *(12)*	'Biodiversity'	Lifecycle maintenance (esp. nursery)	Life cycle maintenance, habitat, and gene pool protection
			Gene pool protection	
Cultural	Recreation (incl. eco-tourism & outdoor activities) *(16)*	Recreation & eco-tourism	Recreation & eco-tourism	Physical and experiential interactions
	Cultural (incl. aesthetic, artistic, spiritual, education, & science) *(17)*	Aesthetic values	Aesthetic information	
		Cultural diversity	Inspiration for culture, art, & design	
		Spiritual & religious values	Spiritual experience	Spiritual and/or emblematic interactions
		Knowledge systems	Information for cognitive development	Intellectual and representative interactions
		Educational values		


GLOBAL ECONOMY
...THESE SPECIES ARE UNPROFITABLE, SO THEY WILL BE LAID OFF.
CONSULT
UH... CAN EVERYTHING BE MEASURED IN MONEY?
YEAH, MAN... FOR EXAMPLE, IF IT WASN'T FOR US DUNG DECOMPOSERS, THE WORLD WOULD DROWN IN SHIT.
seppo.net

Growth of scientific studies

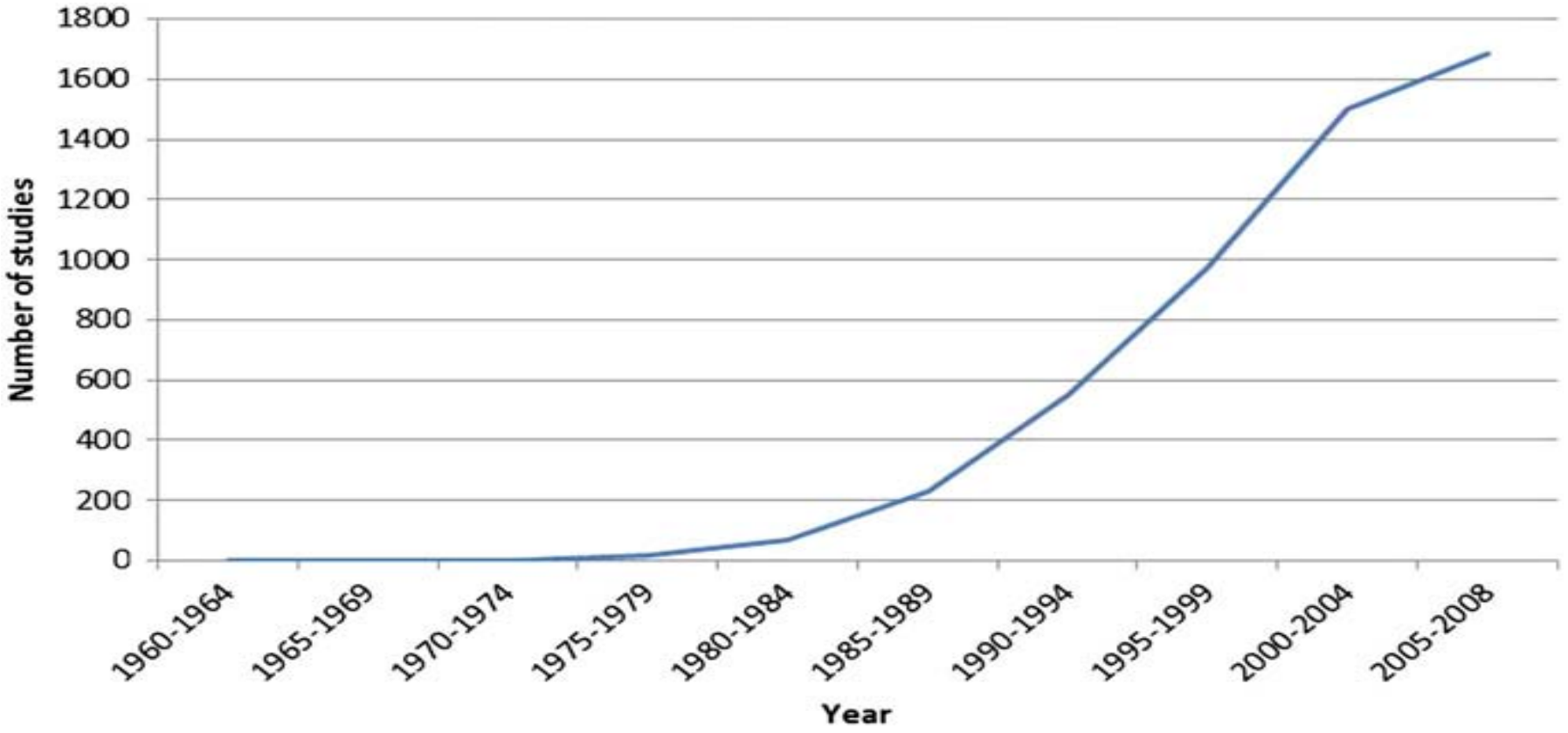
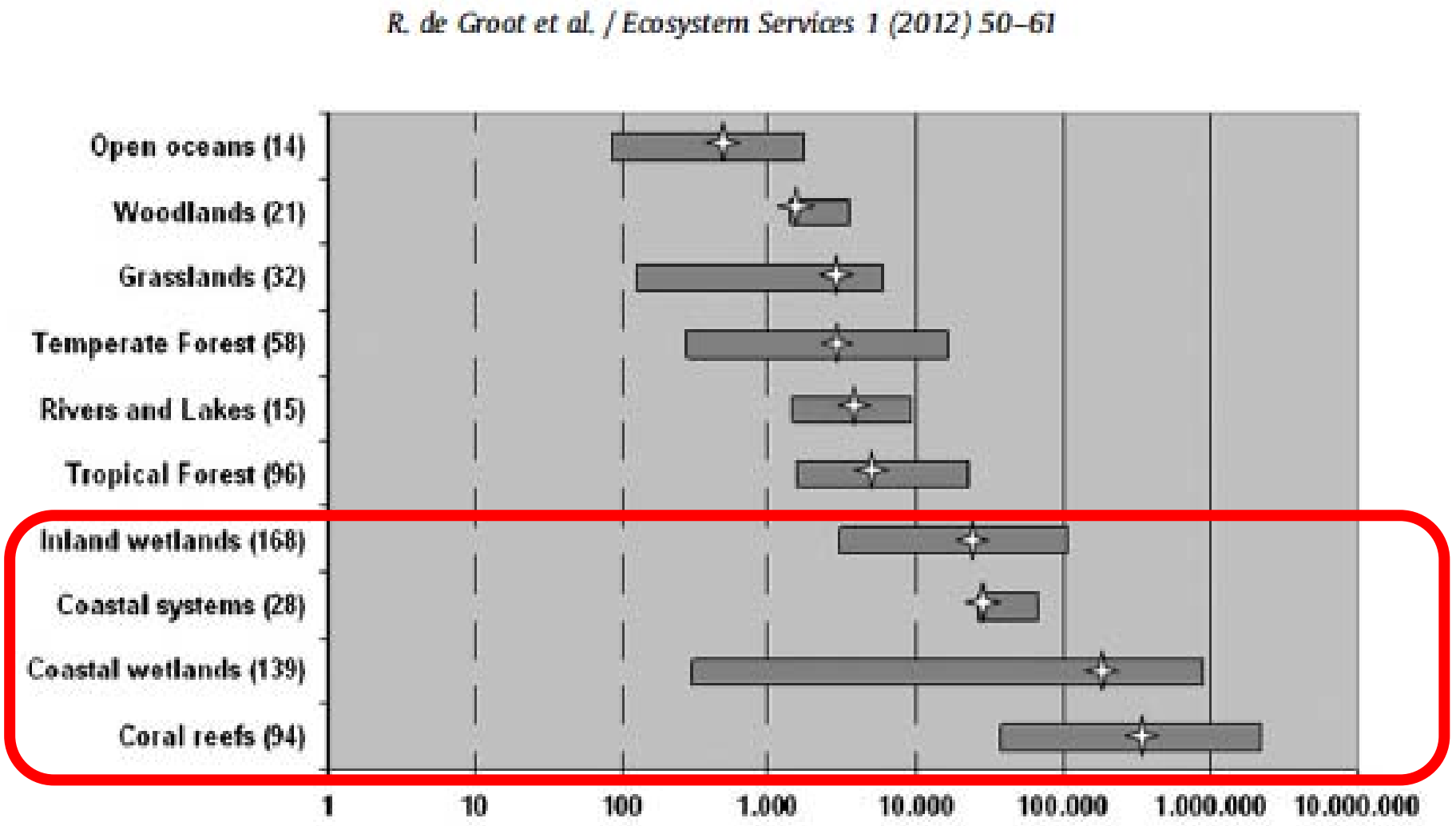


Fig. 1. Cumulative total of ecosystem services valuation studies sourced from EVRI from 1960 to 2008. Source: modified from Christie et al., 2008.

Oceans provide the highest economic benefits for humans



But marine systems experience an economic loss of $10.9 trillions/year

Biome	Area (e6ha)		Aggregate global flow value (trillions 2007$/yr)	
	1997	2011	1997	2011
Marine	**36,202**	**36,202**	**60.5**	**49.7**
Open ocean	33,2	33,2	21.9	21.9
Coastal	*3,102*	*3,102*	*38.6*	*27.7*
Estuaries	*180*	*180*	*5.2*	*5.2*
Seagreass/algae beds	*200*	*234*	*5.8*	*6.8*
Coral reefs	*62*	*28*	*21.7*	*9.9*
Shelf	2,66	2,66	5.9	5.9
Terrestrial	**15,323**	**15,323**	**84.5**	**75.1**
World	**51,625**	**51,625**	**145.0**	**124.8**

Costanza, R. et al. (2014) Global Environmental Change 26: 152-158.

Qué prioridades de investigación en SE?

Table 1
Final list of (unranked) research questions synthesized from research scanning exercises.
Source: Own elaboration based on survey results. Q1–Q35 denote research questions that were selected for the second phase of the survey.

Abbreviation	(***Topic***, question)
Wellbeing	***Linking ecosystem services and wellbeing***
Q1	How do human decisions and behaviors influence ES dynamics?
	What factors determine whether, how, and when the maintenance of biodiversity is key to sustain the flow of ES to society?
Q2	What are the effects of taxes, subsidies and environmental compensation on marine ES at local, regional, and international levels?
Q3	How can the ecosystem service approach aid marine spatial planning?
Q4	How to account for changes in natural resource conditions and social conditions jointly?
Function	***Ecosystem function***
	What are the main effects of changes (physical and chemical changes) in ocean conditions on the underlying dynamics that govern ecosystem structure and function?
	How can we best predict changes in species composition and communities' distribution that have the potential to alter ecosystem structure and function?
Q5	How can we ensure the resilience of natural capital that underpins ES flows?
Q6	What are the factors that underlie ecosystem production functions?
Q7	What are the effects of increasing anthropogenic pressures on the conservation of marine biodiversity and ecosystem functioning?
Metrics	***Metrics, indicators, thresholds***
	How can standardized indicators help to set policy and management objectives?
Q8	What information is critical for predicting tipping points?
Q9	What are the main indicators and benchmark values for measuring the capacity of an ecosystem to provide services, and what are the maximum sustainable use levels?
Q10	How to develop a set of indicators capable of reflecting ecosystem services state and trends, and approaching thresholds or tipping points by including the perceptions and views of stakeholders?
Q11	What are the best techniques and metrics for monitoring and valuing marine ES, and to construct policy-relevant indicators?
Trade-offs	***Trade-offs and synergies***
Q12	How do multiple ESs interact, and which are the processes of their interactions?
Q13	How can we track changes in ES supply and demand in response to policy or environmental drivers, and preferences of society?
Q14	How can we effectively determine synergies and trade-offs between multiple and alternative uses of ecosystems and their services?
	How can the analysis of trade-offs effectively account for interpersonal trade-offs among ES?
	How will the assumptions regarding different scenarios, management options or changing environments affect trade-offs among ES?

Rivero, S., Villasante, S. (2016) Marine Policy 66:104-113.

Qué prioridades de investigación en SE?

Drivers	***Drivers of change***
Q15	What are the main social, economic and institutional drivers of change in marine ES?
	How will changing ocean circulation patterns affect connectivity across marine ecosystems, and how this affects ecosystem structure, function and services?
	What are the effects of global change on marine biogeochemical cycles, and what are the impacts on regulating marine ES?
Q16	What effects will interactions between natural climate cycles and anthropogenic climate change have on marine ecosystem structure and function?
Q17	What are the drivers behind the loss of ES and how do they interact across scales?
Valuation	***Market and non-market valuation***
Q18	What are the most appropriate economic and social valuation methods for ES, including the role and perceptions of stakeholders?
	To what extend does the value of ES depend on biodiversity and/or human preferences?
Q19	How can people's values for different ES best be identified, measured, aggregated and used in decision-making?
	How could the loss of ES integrity be compensated into the estimates of economic costs done by the scientific community?
Q20	What are the key factors to meaningfully value marine ES, and what are the methods to measure them?
Risk	***Accounting for risk and uncertainty***
	What methods can be used to minimize uncertainty and risk prediction?
Q21	How can the complexity of social–ecological systems be incorporated into valuations and management of biodiversity, ES and natural resource use?
Q22	How should spatial and temporal features be incorporated into effective ES assessments, and which are their spatial and temporal determinants?
Q23	How can non-linearities and off-site effects of ES be identified and their minimized?
Q24	How do people's perceptions of risk, uncertainty and vulnerability influence their held values for ES, and how might these perceptions be measured in a way that generates data useful for decision-making?
Integration	***Integrating natural science, economics and social sciences into ES assessments***
	How can we identify major mismatches between natural and social science data/findings that inhibit a proper assessment of ES?
Q25	What is the importance of spatial connectivity between ecosystems and their beneficiaries, how do ES flow across land/seascape from ecosystems to people?
Q26	What approaches are best suited for stakeholder involvement in ES management and to minimize possible conflicts of interest?
Q27	How does social equity influence the access to ecosystem services and economic flows?
Q28	How can local and traditional knowledge be most effectively integrated into ES assessments?
Tools	***Decision support systems/tools, governance and management***
Q29	What are the best tools to inform management and policy decisions about marine ES?
	To what extent are international environmental policies and conventions driving the ES agenda?
Q30	How can different ES valuation methods be combined to provide the best information to support management and governance?
Q31	What kind of evidence on the value of ecosystem and associated ES do decision-makers need to improve their decisions, and how do these evidence needs vary across different institutions and in different decision-making contexts?
Q32	How governance systems or the lack of them affect ecosystem services sustainability?
Class	***ES classifications***
Q33	What ecosystem services framework is most suitable for integrated assessment of marine ES?
	How can we match the empirical assessments with theoretical classifications?
	Is there a "final" typology and classification of ES that covers all benefits human society derives from nature?
Q34	Are different classifications needed depending on the main goal of the ES assessment?
Q35	How can we overcome the inconsistencies in comparisons between studies and assessments derived from the use of multiple classifications?

Rivero, S., Villasante, S. (2016) Marine Policy 66:104-113.

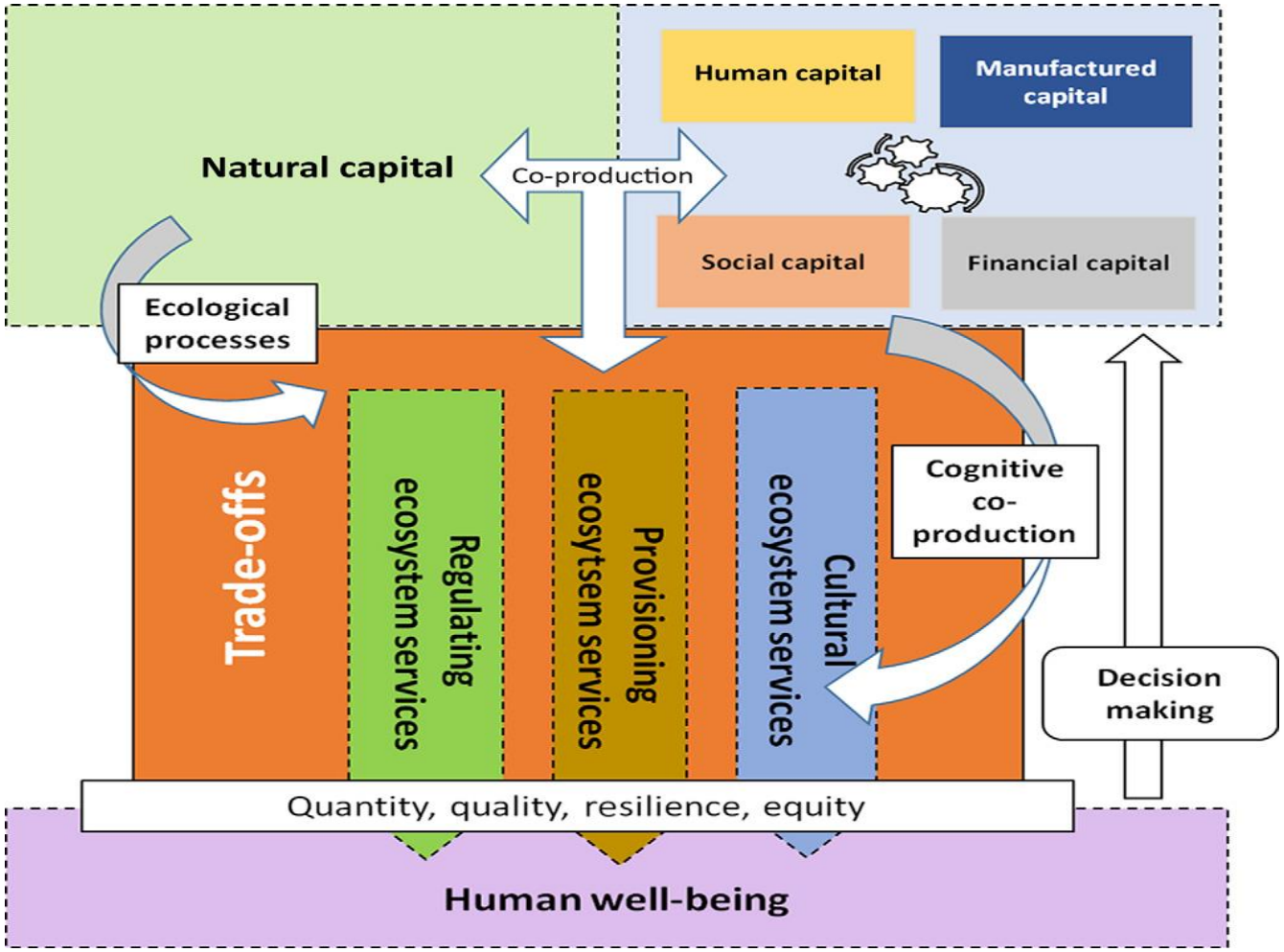
Key research gaps in marine ecosystem services research

1. Most scientific work is conceptual, with little empirical evidence of connections between disciplines (Levin et al. 2013)
2. Co-creation has been a fundamental driver in the supply of marine ES, but it is largely unknown (IPBES, 2018)
3. Research do not address synergies and trade-offs (Bennett et al. 2015)
4. Interactions of marine ES may be linear or non-linear, and may contain unexpected thresholds and tipping points (Carpenter et al. 2009; Hughes et al. 2013)
5. Most assessments address one ES only by focusing on isolated industries (e.g., fisheries) and sectorial approaches (Villasante et al. 2016)

Why co-production is key for marine ES research?

- As ecosystems are increasingly transformed by human intervention, co-production has become the norm rather than the exception
- MEA, IPBES and UN SDGs acknowledged that both ‘nature’ and other ‘anthropogenic assets’ jointly contribute to the provision of ecosystem services for human well-being
- Three –at least- reasons to pay due attention to co-production:
  - Combinations of different natural and human capital affect ES delivery, generating trade-offs in other ES
  - Resilience may be affected if co-production of ES diminishes biodiversity
  - Ecosystem services are not equally distributed among people

Conceptual framework integrating co-production into the assessment of ecosystem services



Palomo et al. (2016) Advances in Ecological Research

Database of co-production in marine ecosystem services

Villasante et al. (2018) Ecology and Society

Por qué realizar una evaluación de SE marinos en política y gestión costera?

1. Aumento actividades humanas y conflictos:

Pesca artesanal, pesca recreativa, acuicultura, Actividades recreativas, transporte marítimo, conservación marina

2. Complejidad políticas y gobernanza multinivel:

EU Marine Strategy Framework Directive; EU Maritime Strategy; EU CFP; Spanish/Galician Act 2009; Energy policy & legislation etc.

3. Diversidad de organizaciones:

Xunta de Galicia, Campus Do*Mar, Cofradías de Pescadores (63), entramado productivo marino …

Barreras uso de evaluación de SE en política y gestión

- Limitación métodos de valoración de SE
- Pobre entendimiento de flujos de SE
- Confusión en uso de terminología
- Expectativas no satisfechas
- Especificidad espacial y temporal
- Costos elevados relevamiento información
- Marcos regulatorios poco flexibles
- Limitada aplicación con evidencia empírica

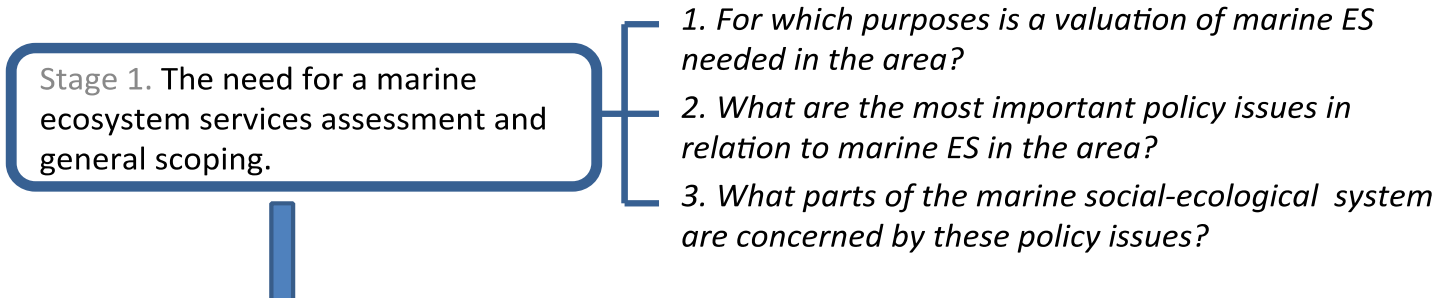
Diseño Estrategia Marina de SE en Galicia

- Cumplimiento de MSFD, CFP 2020
- Tres objetivos:
  - Evaluación integrada de ecosistemas de las rías
  - Conciencia importancia medio marino bienestar humano y prosperidad económica
  - Asegurar participación stakeholders y cooperación científica interdisciplinar
- Campus Do*Mar – facilitador proceso
  - Conformación de grupos de trabajo (ambiental, económico-social, institucional)
  - Evaluación inicial – revisión objetivos (2015-2018)
  - Evaluación final (2018-2020)
  - Comité Seguimiento (USC-Natural Capital Project) –
  - 8 Tesis doctorales en curso

Diseño Estrategia Marina de SE en Galicia

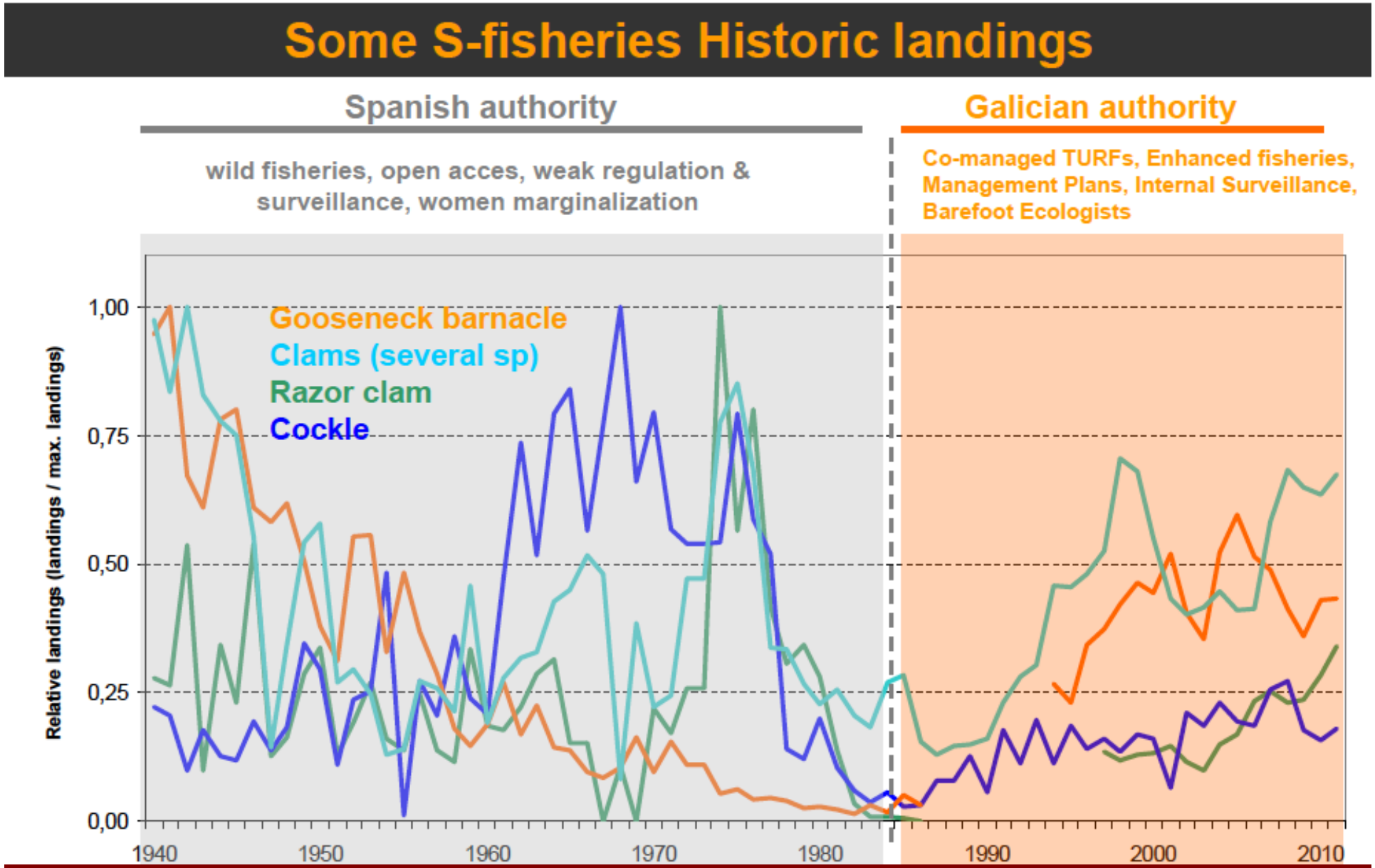
- Evaluación integrada de SE
  - Cartografía de hábitats de interés comunitario 92/43/CE
  - Identificación de servicios ecosistémicos
  - Selección de actividades económicas
- Repositorio de información disponible
  - Cartografía de hábitats
  - Identificación de servicios ecosistémicos
  - Selección de actividades económicas
- Participación de stakeholders:
  - I Workshop (5 zonas ecogeográficas)
    - Presentación proyecto
    - Mapeo de presiones
    - Mapeo de sinergias y trade-offs
    - Cuestionarios para colecta de vacíos de información

The Triage Approach



Pendleton L., R. Mongruel, N.Beaumont, T. Hooper, M. Charles. A Triage Approach to Improve the Relevance of Marine Ecosystem Services Assessments. Marine Ecology Progress Series (MEPS) 530:183-193. 2015

1. Evaluación de SE de provisión



Villasante, S. et al. (2016) In Pauly, D., Zeller, D. Atlas of the Oceans, Inland Press, USA

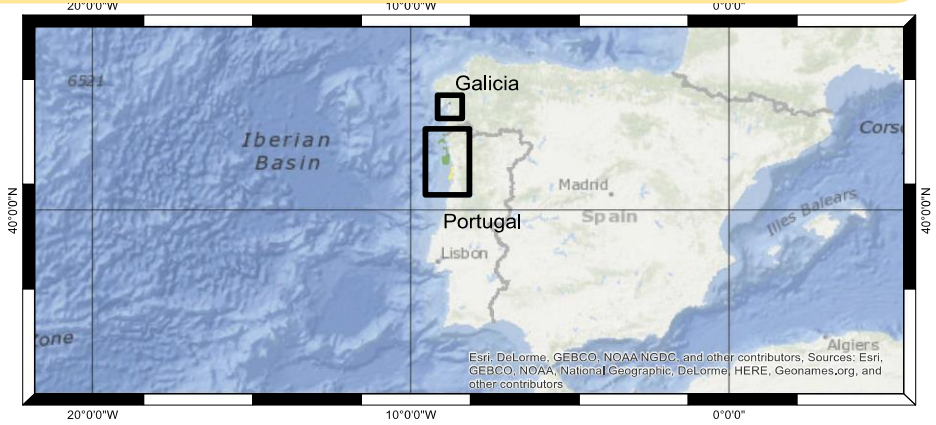
Empirical evidence of co-production in marine ecosystem services

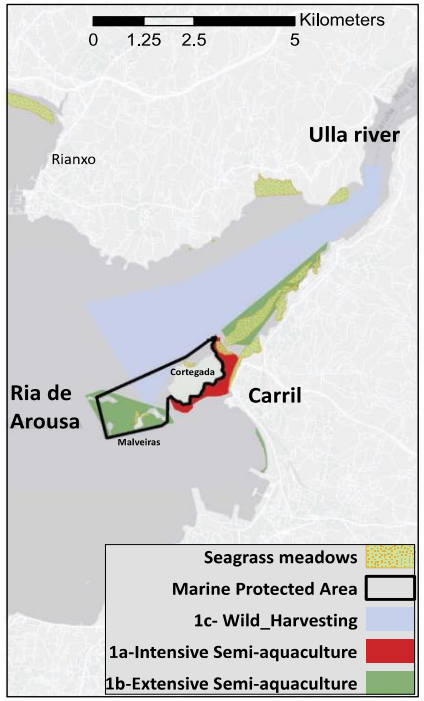
- Study areas (Ría de Arousa and Northern Portugal) share socioeconomic and cultural features
- Sequential step-wise analysis including three steps:

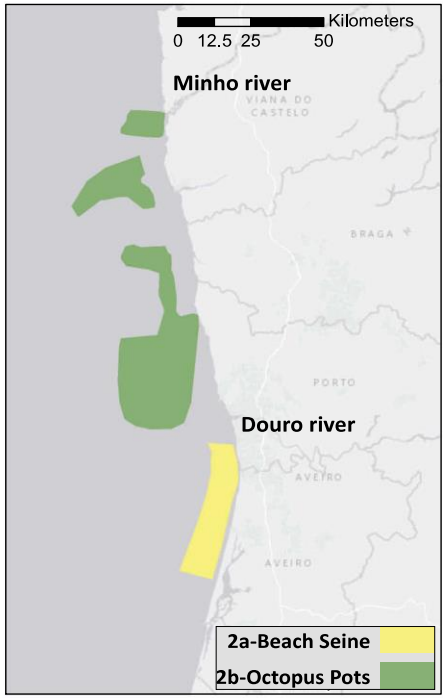
  1) Inventory: case studies in Europe for studying co-production in small-scale fisheries based on discussions during the ICES WG meeting RMES

  2) Matrix: collect information on co-production and ES delivery from regional databases, published papers and long-term research experience

  3) Comparative analysis: scale of co-production, and co-production level and ES trade-offs with special attention to the property regime







Outeiro et al. (2017) International Journal of Biodiversity Science, Ecosystem Services & Management 13:3:35-50

Management, property regime and social-ecological characteristics in Galicia (NW Spain) and Northern Portugal

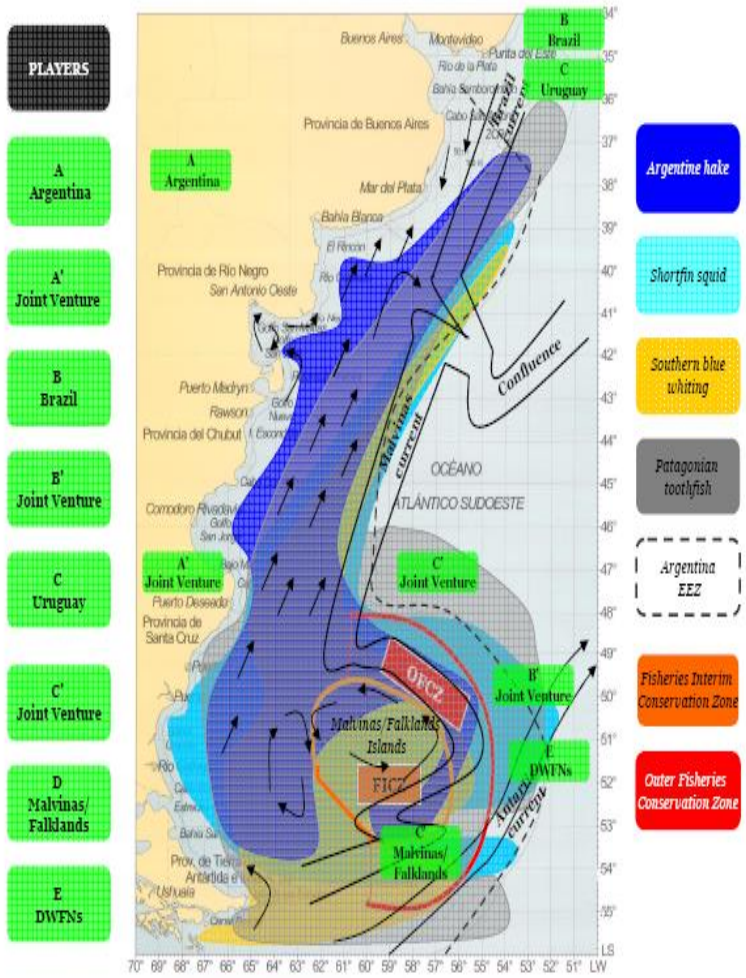
	Galicia	Galicia	Portugal
Case studies	**Intensive semi-aquaculture ("Parque cultivo")**	**Wild harvesting ("Libre marisqueo")**	**Octopus pots ("Alcatruz")**
Ecosystem type	Interdital/estuary	Interdital and subtidal/estuary	Coastal/marine
Property regime	Concession individuals/private	User rights with quota	Common property rights/quota based
Management	Individual decision-making/market driven	Collective decision making with technical support	Collective decision making
Management actors	Owners	Shellfishers, guild biologist, regional government	Ministry of the Sea, DG Natural Resources, Maritime Services and Safety, research institutions, fishers' associations
Management activities	Surveillance	Monitoring, control and surveillance	Monitoring, control and surveillance
Gears	Rakes and hoes	Rakes with long pole	Pots
Total area (km2)	1	6	n/a
Nº fishing units	656	300	50
Gender	Male and female	Only males	Mainly males

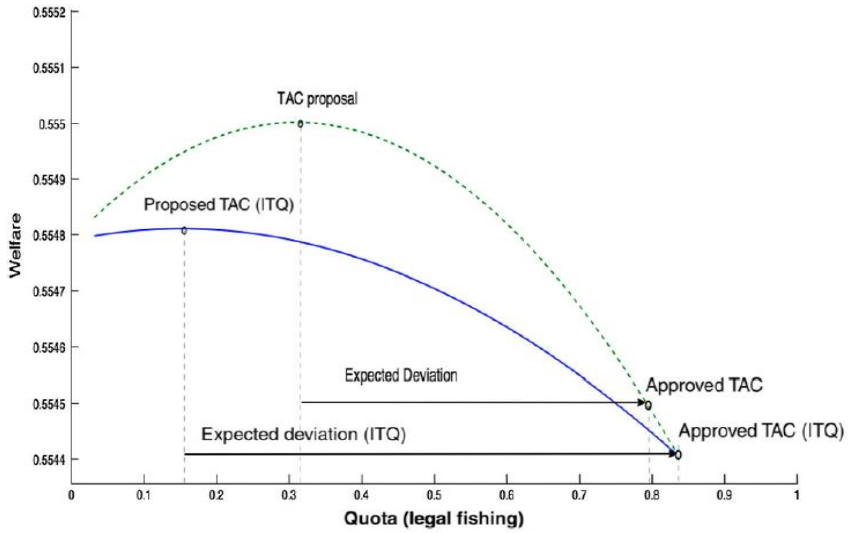
Disaggregated non-natural capital use and co-production of marine ecosystem (dis)services in Galicia (NW Spain) and Northern Portugal

	Galicia	Galicia	Portugal
Case studies	**Intensive semi-aquaculture ("Parque cultivo")**	**Wild harvesting ("Libre marisqueo")**	**Octopus pots ("Alcatruz")**
Property regime	Concession individuals	Common pool resource	Common pool resource
Target species	Bivalves (clams, cockles)	Bivalves (clams, cockles)	Common octopus
Benefits	Food, employment, tourism, identity	Food, employment, tourism, identity	Food, employment, tourism, identity, social relations
Human capital	LEK and skills, high intensity rearing, plowing, predators and algae removal, manual and mechanical harvest	LEK and skills	LEK and skills
Social capital	Collective surveillance	Gear restriction, quota based, collective surveillance	Gear restriction, minimum size
Manufactured capital	Boats and rakes	Boats and rakes	Vessels, pots
Financial capital	Lease of plots, seed hatcheries	May apply buy boats	May apply buy boats
Level of co-production	High-intensive	Low	Medium
Ecosystem disservice	Regulating, risk of pests	Unknown	Adverse climate/sea conditions; predation by other spp; unsuitable water temperature and salinity

1 – Assessment of marine and coastal ecosystem services

- Economic valuation and restoration of ecosystem services
- Game theory, public policies and management tools (industrial fisheries, tourism)





Villasante et al. 2014. In Maskin, Barret, Mäler. Oxford University Press. Da Rocha et al. 2013. AMBIO; Stefanski-Villasante. 2015. Ecosystem services

2. Mapeo espacial de SE marinos

- Sinergias y trade-offs entre ES y actividades (pesca, acuicultura, pesca recreativa)

- **Servicios ecosistémicos = beneficios (económicos o no) que las personas obtienen de la naturaleza**
- *Servicios de provisión* - bienes como alimento;
- *Servicios de regulación* - estabilizar el clima, protección calidad de agua, moderación riesgo de enfermedades;
- *Servicios culturales* - recreacionales, educacionales, espirituales, y
- *Servicios de soporte* - apoya a todos los anteriores, e.g. fotosíntesis, ciclo de nutrientes, preservación de opciones futuras

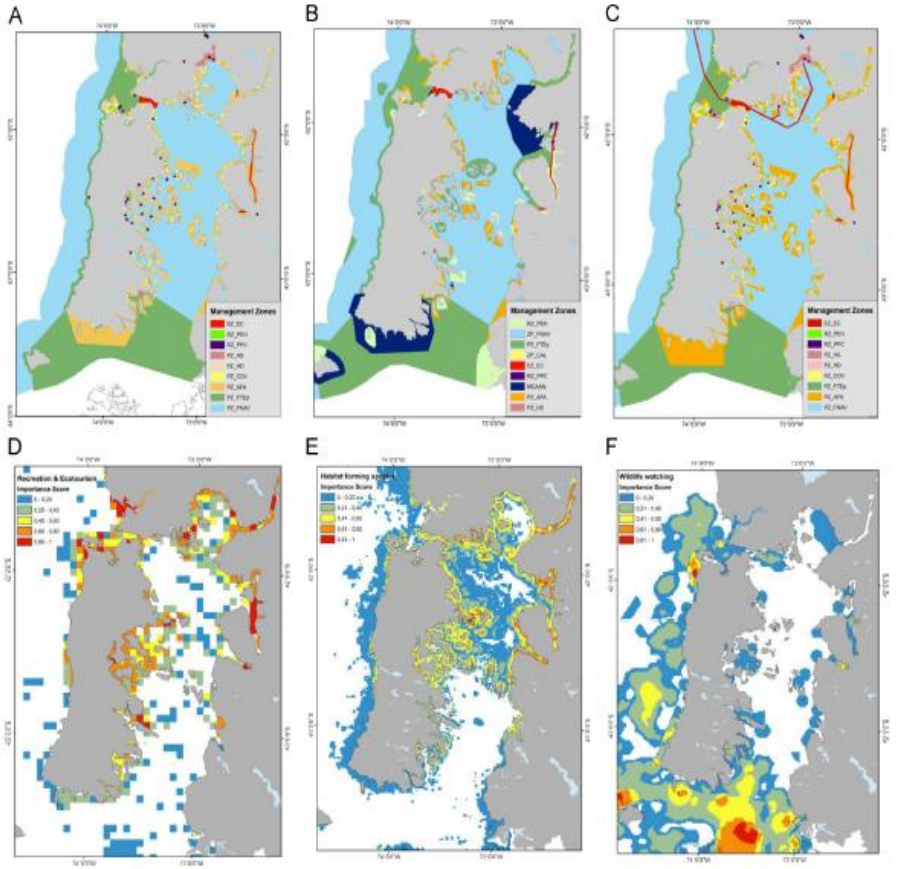


Fig. 5. Management areas for the scenario under analysis and the spatial distribution of the ecosystem services: (a) management zoning for the current scenario, (b) management zoning for the environmental conservation–indigenous development scenario, (c) management zoning for the industrial development scenario, (d) spatial distribution of the recreation and ecotourism, (e) spatial distribution of the habitat forming species, and (f) spatial distribution of the wildlife watching. Source: own elaboration from InVEST overlap marine model.

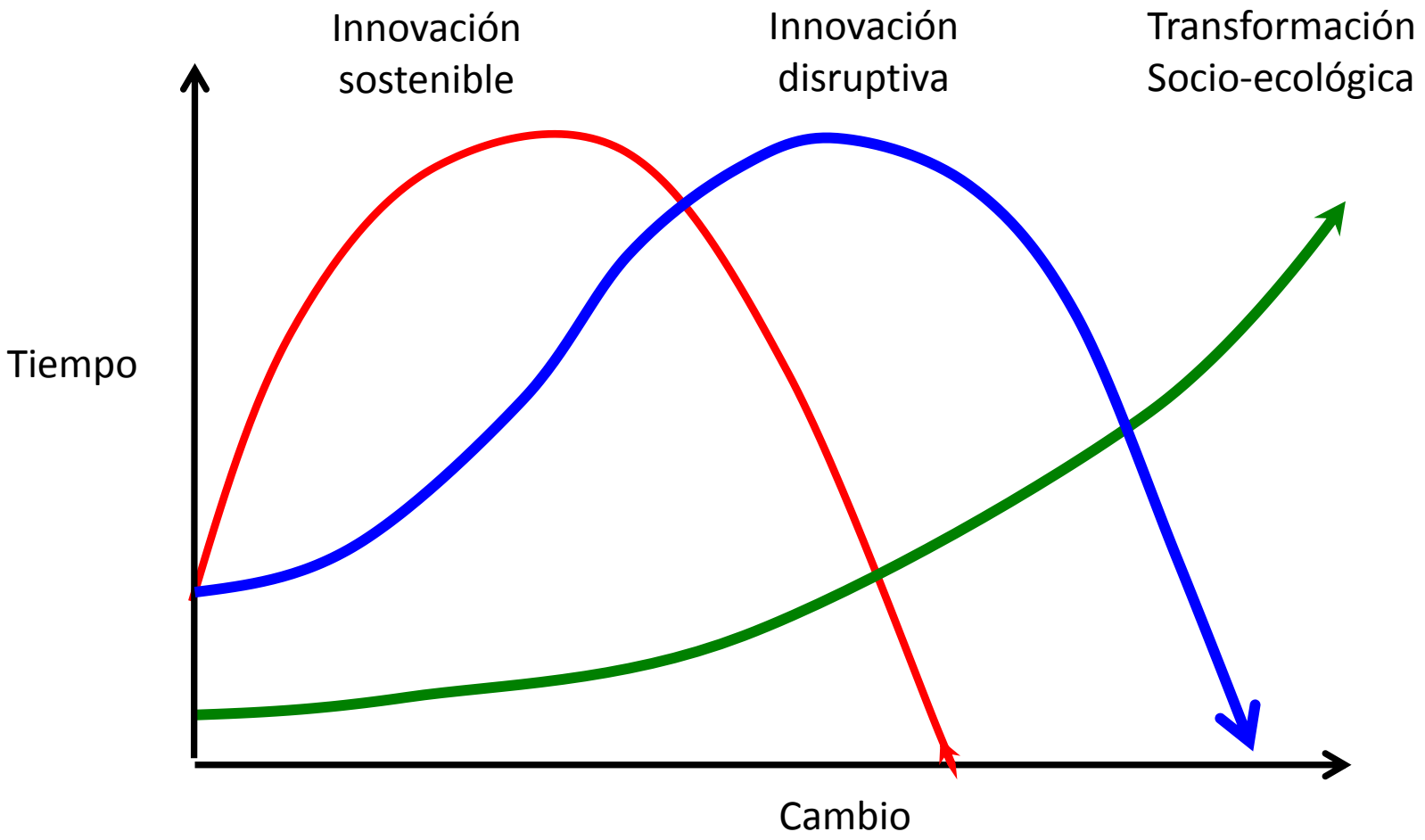
Outeiro-Villasante. 2015. Ecosystem Services.

3. Co-Diseño de escenarios plausibles de futuro

- *"Escapar al pasado" – "evitar futuro no deseado"*
- Tipología de escenarios
  - Globales – apoyo *policy-makers*, débil implementación
  - Participativos – tensión actores, datos, monitoreo
  - Radicales – Antropoceno, biosfera
- Escenario participativo
  - Cuantificación espacialmente explícita actividades
  - Evaluación participativa dinámicas actuales
  - Co-diseño de escenarios de futuro

- Hanapach, J. et al. (2015) Ecology and Society
- Nieto-Romero, M. et al. (2016) Land Use Policy

3. Co-Diseño de escenarios plausibles de futuro



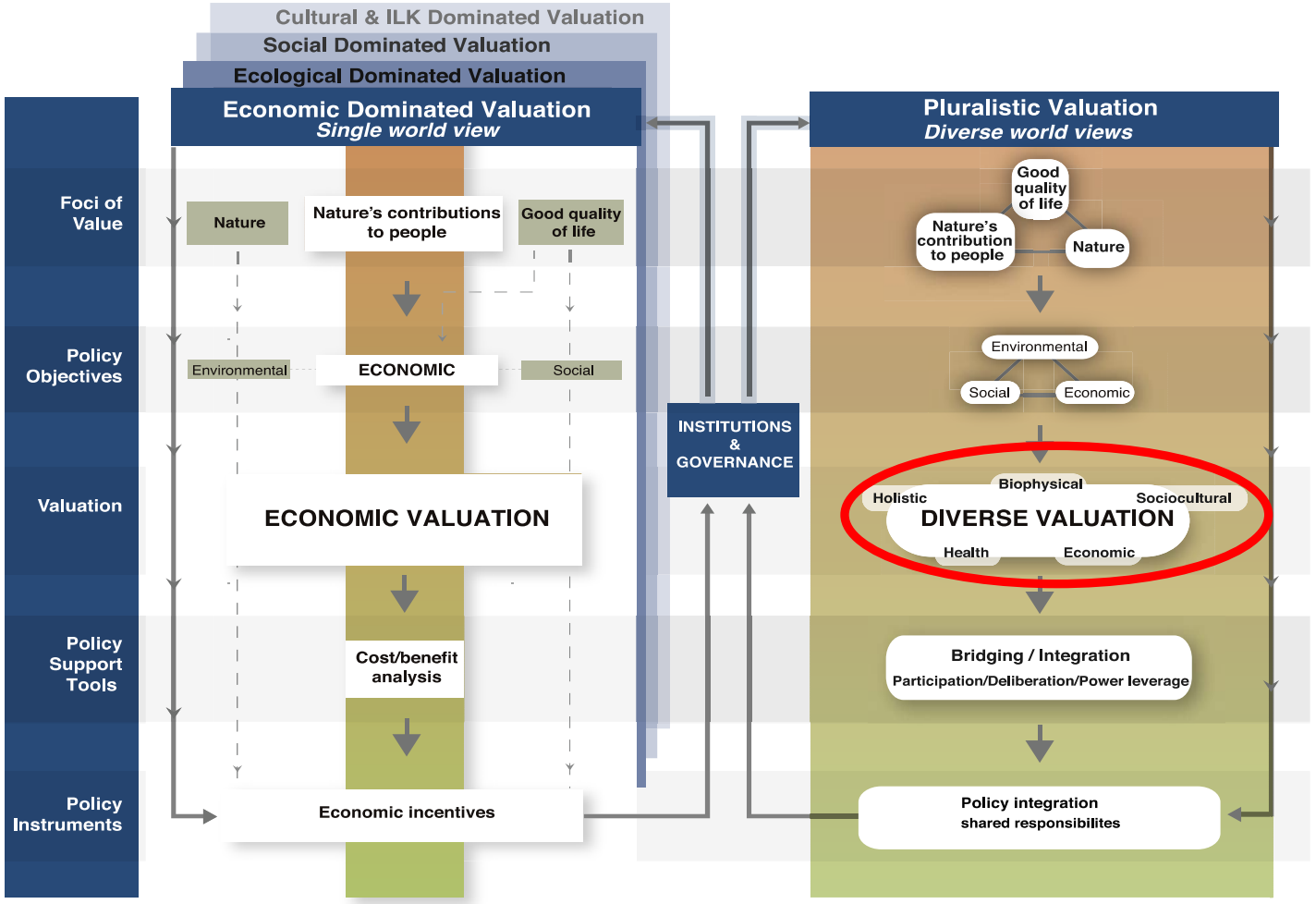
Peterson, G. (2016) Chapter 5 - IPBES Model and Scenario Report

Assessing nature's contributions to people

Recognizing culture, and diverse sources of knowledge, can improve assessments

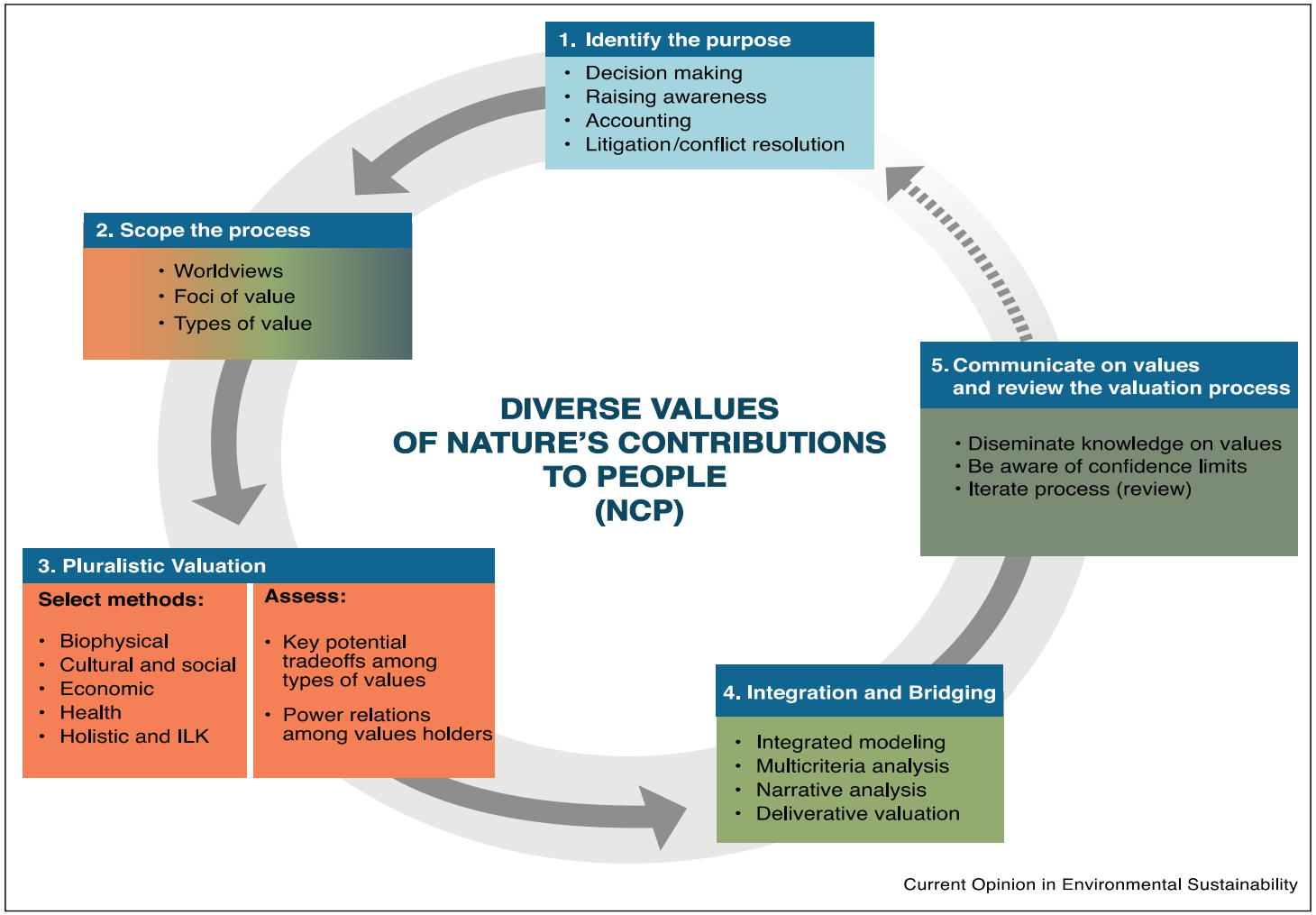
IPBES: Not just commodities!

Conceptual framework for marine ecosystem services research (Pascual et al. 2017)



Current Opinion in Environmental Sustainability

IPBES: Not just commodities!



The IPBES approach for assessing values and conducting valuation studies. Orange and green colours in step 2 indicate that the scoping applies to methods for both valuation and integrating/bridging diverse values (boxes 3 and 4).

Gracias!

sebastian.villasante@usc.es
@sebvillasante

USC UNIVERSIDADE DE SANTIAGO DE COMPOSTELA

CAMPUS DO MAR
KNOWLEDGE IN DEPTH