Lessons from bright-spots for advancing knowledge exchange at the interface of marine science and policy

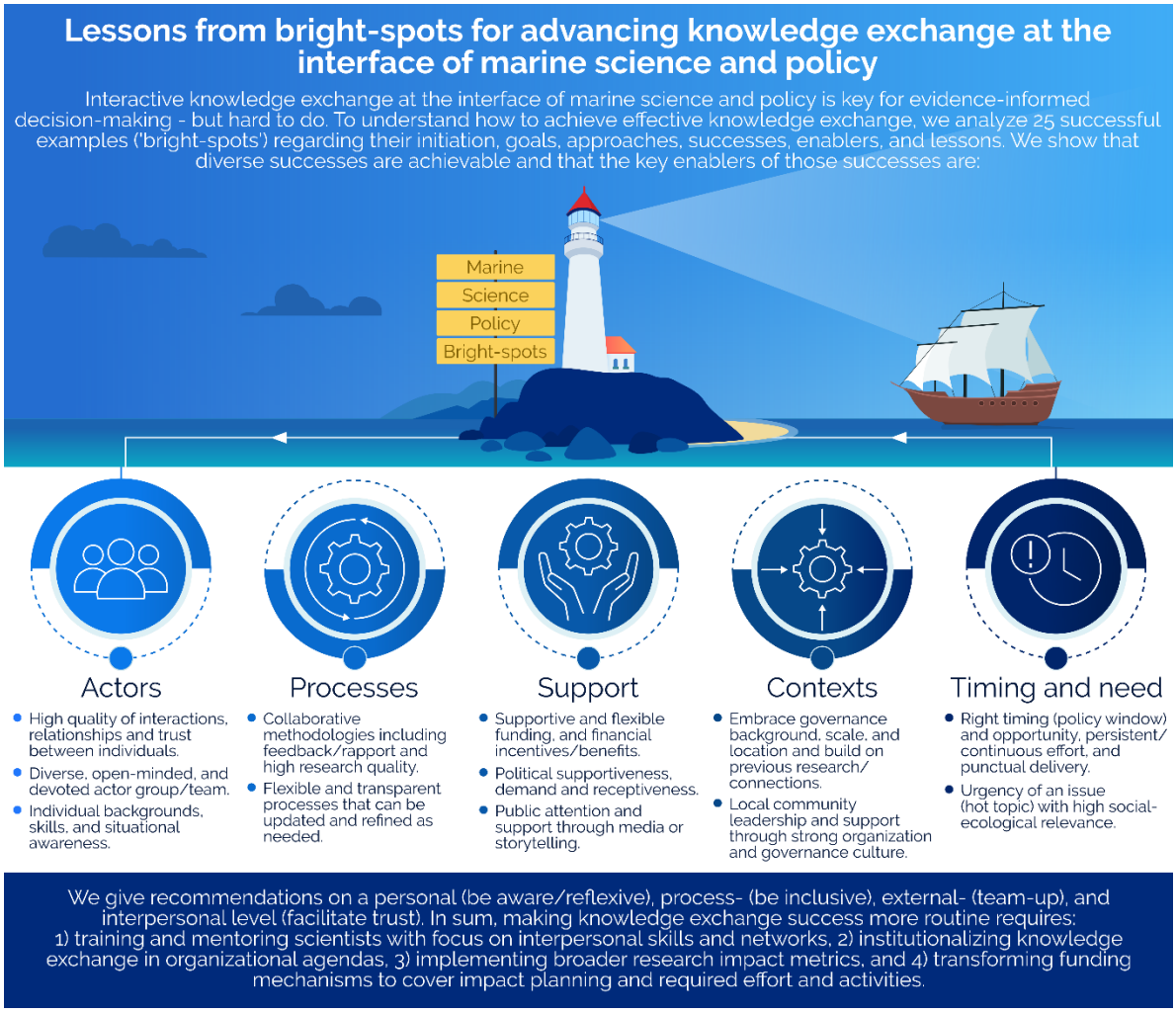
Denis B. Karcher[1*], Christopher Cvitanovic[1], Ingrid E. van Putten[2,3], Rebecca M. Colvin[4], Derek Armitage[5], Shankar Aswani[6], Marta Ballesteros[7], Natalie C. Ban[8], María José Barragán-Paladines[9], Angela Bednarek[10], Johann D. Bell[11,12], Cassandra M. Brooks[13], Tim M. Daw[14], Raquel de la Cruz-Modino[15], Tessa B. Francis[16], Elizabeth A. Fulton[2,3], Alistair J. Hobday[2,3], Draško Holcer[17,18], Charlotte Hudson[19], Tim C. Jennerjahn[20,21], Aimee Kinney[16], Maaike Knol-Kauffman[22], Marie F. Löf[23], Priscila F. M. Lopes[24], Peter C. Mackelworth[18,25], Abigail McQuatters-Gollop[26], Ella-Kari Muhl[5], Pita Neihapi[27], José J. Pascual-Fernández[15], Stephen M. Posner[28], Hens Runhaar[29], Keith Sainsbury[3], Gunnar Sander[30], Dirk J. Steenbergen[12], Paul M. Tuda[20], Elizabeth Whiteman[31], Jialin Zhang[20].

1: Australian National Centre for the Public Awareness of Science, Australian National University, Canberra, ACT, Australia
2: CSIRO, Oceans and Atmosphere, Hobart, Tasmania, Australia
3: Centre for Marine Socioecology, University of Tasmania, Hobart, Tasmania, Australia
4: Crawford School of Public Policy, Australian National University, ACT, Australia
5: School of Environment, Resources and Sustainability, University of Waterloo, Waterloo, ON N2L 3G1, Canada
6: Departments of Anthropology and Ichthyology and Fisheries Science (DIFS) Rhodes University, Grahamstown, South Africa
7: Fisheries Socioeconomic Department, Centro Tecnológico del Mar- Fundación CETMAR, Vigo, Spain
8: School of Environmental Studies, University of Victoria, Victoria, British Columbia, V8P 5C2, Canada
9: Charles Darwin Research Station, Charles Darwin Foundation, Galápagos, Ecuador
10: Evidence Project, Research and Science, The Pew Charitable Trusts, Washington, DC, United States
11: Center for Oceans, Conservation International, Arlington, VA, USA
12: Australian National Centre for Ocean Resources and Security, University of Wollongong, Wollongong, NSW, Australia
13: Department of Environmental Studies, University of Colorado Boulder, Boulder, CO, United States
14: Stockholm Resilience Centre, Stockholm University, Kräftriket 2B, SE-106 91 Stockholm, Sweden
15: Instituto de Investigación Social y Turismo, Universidad de La Laguna, San Cristóbal de La Laguna, Tenerife, Spain
16: Puget Sound Institute, University of Washington Tacoma, Tacoma, WA, USA
17: Croatian Natural History Museum, Zagreb, Croatia
18: Blue World Institute of Marine Research and Conservation, Veli Lošinj, Croatia
19: Lenfest Ocean Program, The Pew Charitable Trusts, Washington, DC, United States
20: Leibniz Centre for Tropical Marine Research, Fahrenheitstrasse 6, Bremen, Germany
21: Faculty of Geoscience, University of Bremen, Klagenfurter Strasse, Bremen, Germany
22: Norwegian College of Fishery Science, University of Tromsø - The Arctic University of Norway, 9037, Tromsø, Norway
23: Baltic Sea Centre, Stockholm University, Stockholm, Sweden
24: Fishing Ecology, Management and Economics Group, Department of Ecology, Universidade Federal do Rio Grande do Norte, Natal, Brazil
25: Institute for Tourism, Zagreb, Croatia
26: School of Biological and Marine Sciences, University of Plymouth, Drake Circus, Plymouth PL4 8AA, UK
27: Vanuatu Fisheries Department, Port Vila, Vanuatu.
28: Gund Institute for Environment, University of Vermont, Burlington, VT, 05405, USA

29: Copernicus Institute of Sustainable Development, Utrecht University, Princetonlaan 8a, CB Utrecht 3584, the Netherlands
30: Norwegian Institute for Water Research (NIVA), 0579 Oslo, Norway
31: California Ocean Science Trust, Sacramento, CA 95814, USA

*Corresponding author: Denis.Karcher@anu.edu.au

Graphical abstract



Abstract

Evidence-informed decision-making is in increasing demand given growing pressures on marine environments. A way to facilitate this is by knowledge exchange among marine scientists and decision-makers. While many barriers are reported in the literature, there are also examples whereby research has successfully informed marine decision-making (i.e., 'bright-spots'). Here, we identify and analyze 25 bright-spots from a wide range of marine fields, contexts, and locations to provide insights into how to improve knowledge exchange at the interface of marine science and policy. Through qualitative surveys we investigate what initiated the bright-spots, their goals, and approaches to knowledge exchange. We also seek to identify what outcomes/impacts have been achieved, the enablers of success,

and what lessons can be learnt to guide future knowledge exchange efforts. Results show that a diversity of approaches were used for knowledge exchange, from consultative engagement to genuine knowledge co-production. We show that diverse successes at the interface of marine science and policy are achievable and include impacts on policy, people, and governance. Such successes were enabled by factors related to the actors, processes, support, context, and timing. For example, the importance of involving diverse actors and managing positive relationships is a key lesson for success. However, enabling routine success will require: 1) transforming the ways in which we train scientists to include a greater focus on interpersonal skills, 2) institutionalizing and supporting knowledge exchange activities in organizational agendas, 3) conceptualizing and implementing broader research impact metrics, and 4) transforming funding mechanisms to focus on need-based interventions, impact planning, and an acknowledgement of the required time and effort that underpin knowledge exchange activities.

Keywords: Research impact; Marine environmental governance; Science-policy interface; Evidence-informed decision-making; Transdisciplinary research

1. Introduction

Navigating the challenges facing marine social-ecological systems (*cf.* Berkes, 2017; Berkes et al., 2003) in ways that are sustainable and equitable requires the accessibility and integration of existing and newly emerging scientific knowledge into decision-making processes (Addison et al., 2018; Alexander et al., 2020; Fisher et al., 2014; Pendleton et al., 2019; Sutherland et al., 2004). The accumulation of information alone, however, is not enough to solve the complex and dynamic challenges facing marine social-ecological systems. Rather, it is crucial to improve the translation of marine scientific knowledge into action (Buxton et al., 2021), for example, through improved knowledge exchange (hereafter 'KE') among science and policy actors (e.g., Cvitanovic et al., 2016).

KE is a relatively new concept within marine management. In its broadest sense it implies a two- or multi-directional process of knowledge sharing with mutual benefits and learnings to both scientists and decision-makers (Fazey et al., 2013). KE therefore seeks to move beyond traditional linear models of science communication, which positioned researchers as the 'providers' of knowledge and decision-makers as the 'users' of knowledge, by recognizing the interdependencies between them (reviewed by Cvitanovic et al., 2015a). Over the past decade numerous approaches to improving KE at the interface of marine science and decision-making have been identified, including the process of knowledge co-production (Chambers et al., 2021; Norström et al., 2020) and the utilization of boundary spanning individuals (Cvitanovic et al., 2017; Lomas, 2007) or organizations (Bednarek et al., 2018; Cvitanovic et al., 2018; Meyer et al., 2015). For the purpose of this paper, and to be inclusive of all KE processes, we define KE as the interchange of knowledge between research producers and users, spanning all

activities and processes of knowledge generation, sharing, storage, mobilization, translation, mediation and use (Best and Holmes, 2010; Cvitanovic et al., 2015a).

Despite growing recognition for the importance of KE, many barriers remain that limit the integration of marine science into policy and practice (Addison et al., 2015; Cvitanovic et al., 2015a). For example, barriers relate to the decision-making process itself (e.g., lack of time or expertise to search for, access and interpret scientific knowledge), cultural differences between science and policy (e.g., different 'languages'), institutional disincentives (e.g., publish or perish), and inadequate resources (time, money, capacity) (Cvitanovic et al., 2016, 2014; Rose et al., 2018; Walsh et al., 2019). Marine scientists often have the personal goal of impacting marine policy and management through their research, but few can report cases where they have achieved this (Cvitanovic et al., 2015b).

Clearly, there is still much to learn about how to effectively connect marine research with decision-makers and management. One step forward is by learning from 'bright-spots' - successful examples whereby marine science has informed policy and/or practice (Cvitanovic and Hobday, 2018). The importance of bright-spots as seeds of positive outcomes (cf. Bennett et al., 2016), as well as the meaning and diversity of impacts from successful KE are becoming increasingly studied and understood (Cooke et al., 2020; Cvitanovic et al., 2021a; Karcher et al., 2021). Broadly, impacts can be described as "changes in awareness, knowledge and understanding, ideas, attitudes and perceptions, and policy and practice" (Morton 2015, p.36). It can span individuals, groups, organizations, societies, and ecosystems but are a matter of the context-specific perceptions of intended beneficiaries, as well as others who might be disadvantaged (Cvitanovic et al., 2021a; Reed et al., 2021). However, what constitutes success can vary across projects and perspectives – and evaluation of KE is challenging (Jagannathan et al., 2020; Meagher et al., 2008; Pitt et al., 2018; Posner and Cvitanovic, 2019). Increasingly, there are calls to more specifically plan for and acknowledge less tangible social outcomes like changed mind-sets, strengthened relationships, or resolved conflicts (Karcher et al., 2021; Louder et al., 2021). Accordingly, for the purpose of this study we define KE success as knowledge becoming:

> "accessible, understandable, shared, and used, enabled by good knowledge exchange products, - processes, and social outcomes […], with the potential to contribute to changes in policy and demonstrable societal impact" (Karcher et al., 2021, p.214).

However, more work is needed to understand the most promising pathways and the enabling factors to obtain such *successes*.

Learning from KE successes may help to build capacity for evidence-informed decision-making and equip scientists, decision-makers and practitioners with new ways of working together. Therefore, the aim of this study is to empirically identify, analyze and learn about improving KE from a broad range

of marine science-policy bright-spots across different scales and marine ecosystems. We do this by addressing the following questions:

i) What initiated the project/initiative and what were the goals?

ii) Which approaches to KE were used?

iii) What outcomes and impacts were achieved?

iv) What were the enablers of KE success?

v) What lessons can we draw from them to improve KE at the interface of marine science and policy?

2. Methods

2.1 Recruitment of research participants

The Human Ethics Committee (Protocol 2020/693) at the Australian National University approved this study prior to data collection. We identified international experts in the field of marine science-policy interactions from a systematic review of the academic literature (as reported in Karcher et al., 2021). There was no individual rationale for each expert or their case study, rather a systematic identification process with self-identification of policy- or context-specific success by respective case study leaders. The lead author team (DK, CC, IvP, RC) checked studies from that body of literature for relevance to the scope of the present study (i.e., marine case studies at the science-policy interface covering KE interactions). If study focus and lead author research focus/background aligned, we contacted the lead author of each study, otherwise a different author on the same publication was contacted.

We contacted identified experts and asked if they were able and willing to participate. If so, they were asked to fill out a text-based survey with open-ended questions (Supplementary Material 1) (following approaches described in Kelly et al., 2019; Norström et al., 2020). Because literature in the field of environmental science-policy connections is predominantly produced by organizations from Europe and North America (Karcher et al., 2021), we actively took steps to overcome existing publication bias (e.g., geographical). Specifically, we sought to achieve a more balanced representation of global experts by asking the initial participants to identify other experts in the field (snowballing) and stopped when case studies from all continents and oceans were identified and included in the study.

In total, we contacted 49 potential participants, 33 of whom participated in the survey (67%) and joined this paper as co-authors (for some case studies, there was more than one expert contributor). Most participants played the role of a researcher within their specified case study (n=14), followed by KE connector/organizer (n=13) (including knowledge broker, boundary organization employee), or advising expert (n=8). Some played more than one role and in five cases the identified experts were external to the KE process (e.g., involved as a policy analyst).

170

171 *2.2 Selecting bright-spots*

172 For the purpose of this study, we consider bright-spots to be situations when KE success (see
173 *Introduction*) was achieved *and* marine research has had an impact (be it instrumental or non-
174 instrumental) on policy and/or the practice of marine management (following Cvitanovic and Hobday,
175 2018). The included bright-spots were self-identified by the participants to account for individual
176 notions to the perception of success where those involved know what met their needs and ambitions
177 (Le Heron et al., 2021). We purposefully asked for bright-spots in which any research discipline
178 (spanning both the social and natural sciences) has had an impact on policy and/or practice. To be
179 considered for inclusion in this study, the bright-spots had to include actors from science and policy,
180 and some also included actors from other stakeholder groups (e.g., fishers, NGOs, civil-, or boundary
181 organizations). This process identified 25 bright-spots that span a wide range of ecological fields,
182 marine spaces and policy scales (Supplementary Table 1).

183

184 An information-oriented selection of maximum variation case studies was followed (Flyvbjerg, 2006).
185 The case study contexts and scales vary to generate diverse examples and lessons in the field. Most of
186 the bright-spots focused on coastal waters, followed by national waters/exclusive economic zones
187 (EEZs) as well as combinations of either coastal lands and waters, or coastal and offshore waters. Their
188 governance level was mostly national, followed by local, regional (i.e., sub-national or state-level), and
189 international (i.e., multi-national) (Figure 1). In cases where bright-spots involved multiple levels we
190 used the dominant level to characterize it for the purposes of further analysis. Among the 25 included
191 bright-spots, 20 were based on completed projects, and five were ongoing. As per the criteria for
192 inclusion in this study, projects that were still ongoing had to have already achieved some form of
193 demonstrable impact/success related to KE. The starting points of projects date back to the 1990s, but
194 the majority (n = 16) commenced in 2010 or after, most recently in 2019.

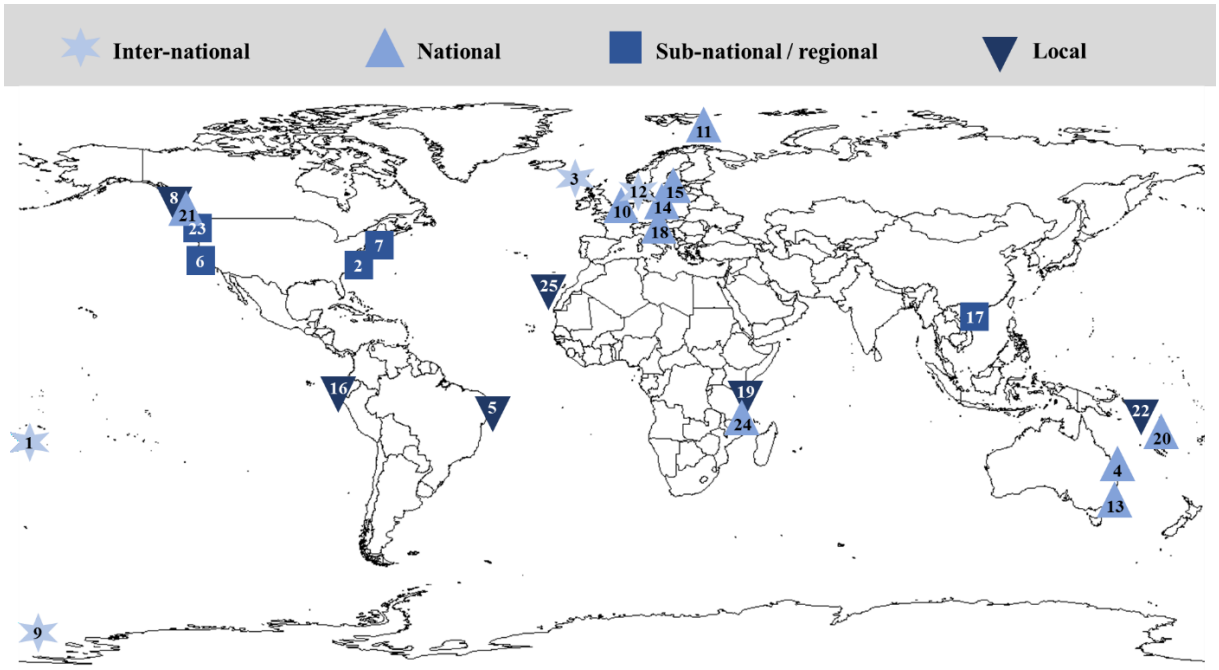


Figure 1: Global distribution of marine science-policy bright-spots analyzed through this study, with international (), national (), sub-national/regional (), and local () governance level. Numbers identify the bright-spots (see Supplementary Table 1).

2.3 Data analysis

Survey responses were analyzed using the qualitative data analysis software NVIVO 12. Following a grounded theory approach, *in vivo* inductive thematic coding was conducted for each research question with iterating theming of codes (Charmaz, 2008, 2006; Glaser and Strauss, 1967; Saldaña, 2015). The research questions embodied the starting points (i.e., broad themes like approaches, successes, enablers, recommendations) followed by an iterative, coding process within those themes. Hence, without additional pre-classification, the individual codes (using the participants' words) emerged directly from the data. As coding progressed, they were iteratively compared to existing codes to identify data-driven descriptive key themes (Blythe and Cvitanovic, 2020; Fleming and Vanclay, 2009; Saldaña, 2015).

To ensure inter- and intra-personal coding reliability, a randomly selected subset of three surveys was pilot-coded twice within four weeks by the lead author, as well as independently pilot-coded once by each for the four coordinating authors. We then met to discuss our individual codes and themes to identify overlap, and more importantly, points of divergence in our coding. Subsequently, three surveys were coded by two authors (DK, CC) and discussed to ensure coding reliability. A second cycle of coding was undertaken to find higher-level labels (i.e., broader categories), particularly for questions that had a lot of data themes. The data were reanalyzed following thematic coding to unravel coherent key themes (Saldaña, 2015). Emerging themes are reported in the results if they were raised by more than two bright-spots.

219
220 *2.4 Methodological limitations*
221 There are some methodological limitations associated with case study analysis that are important to
222 note. Even though case-study research is well recognized for its contribution to understanding complex
223 issues (see description of qualitative case-study research in Starman, 2013), the findings are not always
224 directly generalizable across contexts. Thus, in presenting the results we acknowledge that the interface
225 between marine science and decision-making varies between sectors, cultures, political systems, and
226 governance levels. Thus, whilst the lessons we present are purposefully drawn from diverse case studies
227 in diverse locations, settings, and levels to represent this range of contexts, they should be considered
228 as guidelines rather than directly applicable to each context. While biases may exist in self-identification
229 and self-reporting, this approach directly links to impact attainment in that impacts on policy or
230 management were shown to be directly related to how 'successful' participatory transdisciplinary
231 research is perceived (Steger et al., 2021). When discussing successes and their enablers within the
232 bright-spots, we always refer to KE success, not a specific conservation success or impact.
233
234
235 **3. Results**
236 The coding of survey responses resulted in 1,413 codes that were distributed across the main study
237 goals and grouped together as themes. Themes are presented in order of number of sources (bright-
238 spots, 'n') that mention the theme throughout the study. The frequency, which refers to the number of
239 times each theme was mentioned by the participants (i.e., number of references), is presented in
240 Supplementary Table 2.
241
242 *3.1 Bright-spot setting (initiation, goals, approaches)*
243 Data analysis revealed that the bright-spots had three main initiators or origins: i) policy demand (i.e.,
244 raised by policy processes or documents) (number of bright-spots (n) =12), ii) research actors (n=12),
245 and iii) third parties (n=11). Those third parties initiating the bright-spots were mostly funding agencies
246 (e.g., funding requirement), but also NGOs, boundary organizations, or local or Indigenous
247 communities.
248
249 The most common goals within the bright-spots were ambitions to impact policy (n=17, particularly in
250 national-level bright-spots) and create both scientifically and policy-relevant knowledge (n=15). Other
251 commonly reported goals included impact on governance (n=12), social outcomes (n=12), societal well-
252 being (n=9), and ecological well-being (n=8).
253
254 A diverse range of KE approaches was used across the 25 bright-spots, which were classified into three
255 overarching themes (Figure 2): (i) activities (n=25, i.e., specific actions such as events, meetings,

collecting relevant knowledge, and connecting/facilitating/convening people and organizations); (ii) strategies (n=24, i.e., broad concepts such as knowledge co-production, boundary work, and advisory bodies/agencies/assessments); and (iii) products used (n=14, e.g., policy briefs or meeting papers). It is important to highlight interactions among these three themes. Altogether, convergent, collaborative spaces were important and one participant explained that their events (i.e., workshops) were structured to first "*open [ ] up a 'divergence' in terms of views and knowledge, and [then] create [ ] 'convergence'*". A full list of approaches, strategies, and products can be found in Supplementary Table 2.

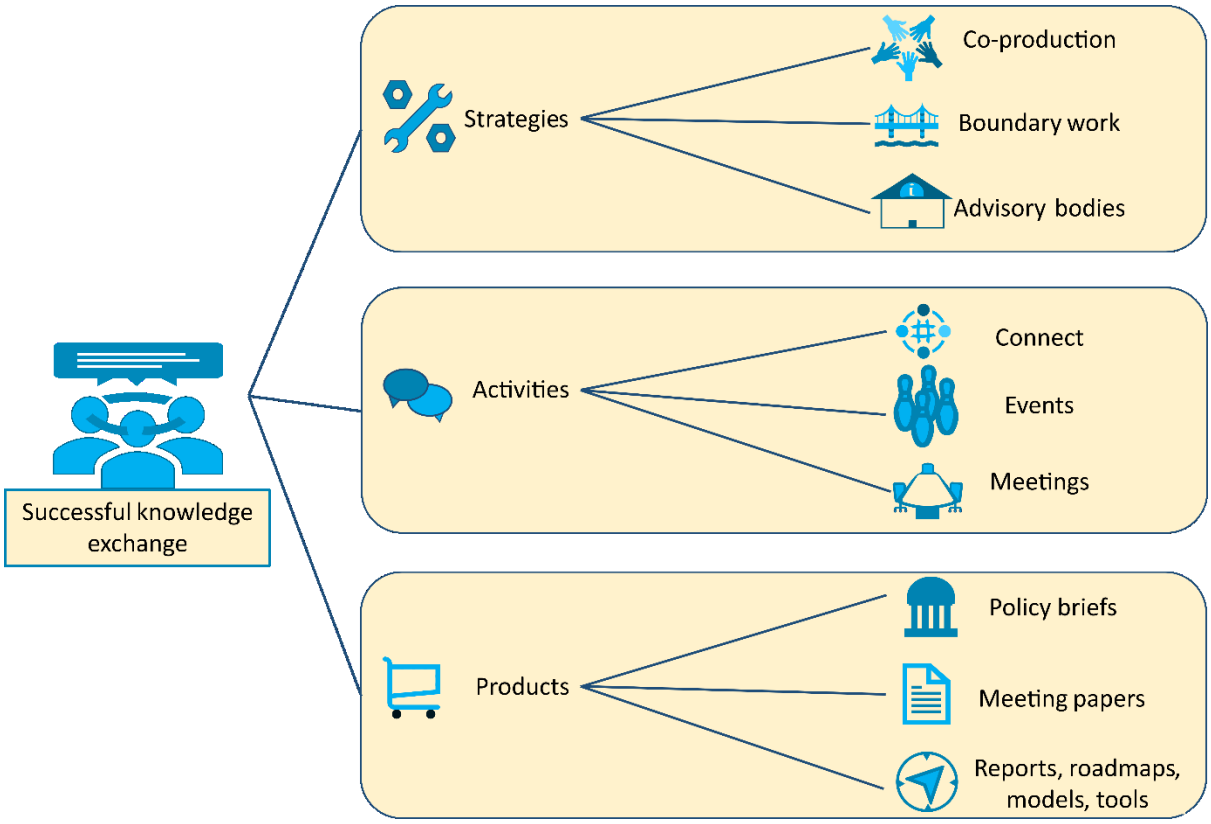


Figure 2: Summary of the key approaches (spanning the strategies used, activities undertaken, and products produced across the 25 analyzed case studies) to achieving successful knowledge exchange in bright-spots at the marine science-policy interface.

3.2 Successes and impacts achieved in bright-spots

The successes most commonly identified were impacts on policy (n=22). Reported impacts on policy included production of management/policy documents, the new formation of protected areas, and informed decision-making processes. Impacts on people was the next most commonly identified theme (n=17), being relatively more common in regional-level case studies (Supplementary Table 3). Impacts on people included the expansion of social networks, relationships, trust, and mitigation of conflicts. It also included impact on individuals, for example, decision-makers (e.g., increased awareness and

understanding of available and needed science), stakeholders or resource-users (e.g., increased recognition of other perspectives and/or conflicts) and researchers (e.g., learning about opportunities and roles of science and decision-makers). Individual impacts also reached more personal aspects as "*researchers had increased interest, confidence, and motivation to further engage with policy-makers*".

Other successes commonly identified were impacts on governance (n=17, e.g., changed management processes, new monitoring/assessments, shift to ecosystem-based or community-based management) and 'relative' successes (n=15). The latter include projects that went further and faster than anticipated, hit their own goals, or achieved something for the first time (e.g., management break-through after stagnation). For example, participants said that the project met their objective "*in full but at a more rapid rate than expected*" or managed to "*push the boundaries from what was initially anticipated*".

3.3 Enablers, lessons, and recommendations from global bright-spots

Participants identified five key categories of enablers (Table 1, Figure 3): actors (n=23), processes (n=22), support (n=16), contexts (n=16), and timing and urgency (n=13). Furthermore, participants made statements on the lessons from their project. Those referred to the importance of recognizing and including diverse actors and knowledge types (n=11), considering time and effort (n=8), and the nature of boundary work (n=8).

Table 1: Coding structure of emerging themes distributed over the research questions of enablers, lessons, and recommendations. Listed are the number of bright-spots naming emerging themes (n) and brief descriptions of each theme.

Enablers	**n**	**Description**
Actors	23	
Interpersonal	18	The quality of interactions between people - relationships, bonds, and trust between individuals.
Actor group and openness	18	References made to the group of people as a whole - the team, team composition, devotion, and skillsets.
Personal	15	Characteristics, roles, backgrounds, and skills of individuals – facilitating role, commitment, reputation.
Understanding expertise, differences and restrictions	3	Referring to situational awareness regarding included actors – understanding roles, differences, and limitations.
Processes	22	
Methodological	20	Factors related to strategies and approaches as well as methodological inputs to the interaction (e.g., research quality, collaborative setting).
Process characteristics	8	The quality, flexibility, transparency, and relevance of the process.
Support	16	
Financial	11	Funding, financial support and flexibility, as well as financial incentives or benefits through the project/initiative.
Political	8	Broad (political) or specific (politician) supportiveness, demand, and receptiveness.
Public attention and support	6	Media attention, storytelling, celebrity support, (public) pressure, advocacy.
Organizational	5	Referring to organizations' institutionalized support, trainings, teaming-up and partnerships, but also their independence.

Contexts	16	
Background (e.g., governance system and level)	14	Embracing the political context, governance system, scale, location, global context, as well as research background and previous work.
Local community	7	Local leadership and support, community organization and governance culture, and homogenous cultural/religious identity.
Timing and urgency	13	
Timing and opportunity	10	Referring to both the right timing (policy window), momentum, and opportunity for achievements, as well as persistent, continuous effort and punctual delivery.
Topic, need, urgency	8	Urgency of the issue as a hot topic with high social-ecological relevance.
Lessons learnt		
Recognize and engage diverse actors and knowledge types	11	Legitimacy and inclusion matter, stakeholders and local people/communities should be engaged, as well as local, traditional, and experience-based knowledge.
Consider time and timing	8	Boundary work needs time, effort, resources, and the right timing.
Boundary work and context	8	Boundary work can be successful, but is often hidden, iterative, a sum of actions in a system of positive efforts and conditions.
Value people and relationships	6	References were made that it's all about relationships and bringing the right people together (i.e., human factors and investing in them).
Expect challenges along the way	5	Disruptions may occur, needs may change, research may be used for a political agenda or to delay action.
Accept that politics matters	4	Organizations have different mandates; different actors have different motivations; diplomacy and geopolitics matter.
Invest in trust and consistency	3	Trust is slow and difficult, it is individuals that build and break trust, and a clear and transparent policy process is key.
Focus beyond only science and policy	3	Focus on 'science' and 'policy' may be too narrow, society and public debate matter.
Governance context (different types of governance may work)	3	References were made that top-down approaches can or can't work (underlining context specificity).
Recommendations to others		
Personal	16	Recommendations to individuals, skills, roles, and behavior. For example, to be aware of perspectives and context, decision relevant, prepared, culturally & politically sensitive and supportive, humble, adaptive, flexible, and willing to compromise.
Process	12	Recommendations at process level, incl. strategies. For example, to install a truly collaborative interface with different societal actors and knowledge types & timely feedback loops among actors, empower locals, plan early, feasible, and target driven.
External	7	This includes recommendations to team-up with other organizations (incl. civil society organizations and advisory agencies) or boundary spanners, and train others.
Interpersonal	5	Relating to the interactions between individuals. This includes to facilitate trust, develop relationships, ask peers for feedback, network and socialize informally.

The recommendations from participants to others working at the marine science-policy interface fell into four distinct levels: i) personal level (n=16), ii) process level (n=12), iii) external level (n=7), and iv) interpersonal level (n=5). Key considerations for maximizing the likelihood of success at the interface of marine science and policy are summarized in Figure 4. Because both the scope and findings of enablers, lessons, and recommendations overlapped, they are combined here.

Figure 3: Summary of the factors that enabled KE success in the 25 marine science-policy bright-spots analyzed in this study.

3.3.1 Actors

The actor group (i.e., all the people who were involved in the KE project) was a commonly discussed enabler of successful KE. Recognizing and including diverse actors and knowledge sources (research-based knowledge, experience-based knowledge, local, and traditional knowledge) was an important success factor. This was particularly important in bright-spots that occurred at local governance level (Supplementary Table 3) with one participant stating: "*When they [local people] are involved in developing the solutions, and this solution may help improve their wellbeing, their support may demonstrate as the determinant factor.*"

Actor-focused enablers also included the openness of the individuals (i.e., to co-learning, to collaborate, and to try new approaches), as well as having a devoted/motivated group of people. Trust, building on pre-existing relationships, and the relationships built between actors themselves, were also found to be key enablers, as were individuals who can openly and constructively debate conflicts, or have personal bonds/friendships between actors. One participant stated: "*Often personal relationships are overlooked for conservation; however, this is probably what made the key connections possible.*" Study participants suggested actively and deliberately building and facilitating trust, developing relationships, and socializing informally: "*It's about developing relationships between decision makers and researchers that allow them to explore and produce solutions together.*" The study participants also reflected that it takes a long time to build trust, as one participant said: "*The trust generating processes needed to be*

complex to include all the interest groups involved. And in some cases the level of initial mistrust was high and the process of overcoming that took quite some time (i.e. years)."

At a personal level, actors' awareness of the diverse perspectives, roles and limitations was another enabler of successful KE. This included being aware of the motivations, goals, and restrictions (e.g., institutional limitations) of others, particularly of decision-makers, as well as being aware of one's own and science's role. This was emphasized by two participants who said that "*technical research is only one factor among many that decision-makers must consider*" and hence the "*key lesson is to respect the restrictions on the policy side, which were not always transparent to [them]*". Other personal recommendations included the need for scientists to focus on decision-relevant questions, to be prepared (e.g., for a policy window), culturally and politically sensitive, supportive, humble, adaptive, and flexible, as well as not to rush or push too much. The personal factors also referred to the involvement of key individual champions/facilitators with specific skills or backgrounds. For example, that someone "*was born and raised in a fishing community, and as a consequence had a deep understanding of the constraints linked to the establishment of protection measures for fishers*". Furthermore, it included individuals' personal drive, contribution, and reputation. One participant said that "*the most significant factor was the personal commitment (indeed voluntary work sometimes) of the people involved*". This suggests that a lack of institutionalization/resources (e.g., to cover the full workload) may also occur in bright-spots, but underlines the high individual commitment, "*interest and drive*" to contribute towards a bigger change.

3.3.2 Processes and support

Within this theme, methodological enablers were most commonly discussed. These included the process being co-developed, the availability of clear, credible, decision-relevant research ahead of management, mandates by, or close collaboration with, authorities and policy bodies, as well as use of specific products or creative strategies (e.g., science-policy speed-dating) to support KE efforts. Such enablers were particularly relevant to bright-spots at international and regional scales (Supplementary Table 3). Recommendations relating to the process included explicitly establishing a collaborative science-policy interface (i.e., open spaces and minds where projects can be co-developed among diverse actors), and having timely and strong feedback loops among project participants to enable shared learning and local community empowerment. This is well-illustrated by one researcher's recommendation to other researchers conducting KE projects (i.e., knowledge co-production): "*Make communities a part that is at least just as relevant as your own research agenda […] keep them in the loop, but always give them a voice*."

Data analysis also identified the need to 'start early' (acknowledging the time needed to establish collaborative research efforts with diverse stakeholders) and find the right policy windows, as well as

focusing on what is feasible (i.e., what policy impact is realistic). Additionally, high flexibility and adaptability were valued, as highlighted by this statement of a participant: "*We adapted as we went, went down new pathways and could not, on Day 1, have predicted or scoped the […] outputs that were ultimately developed. This flexibility was really important.*"

Other process- and support-related enablers included the need to 'team-up' (e.g., with other organizations, civil society groups, or NGOs), to train others (e.g., students, stakeholders), and use/assist local authorities or advisory agencies in producing policy-relevant advice. Regarding the latter, one participant stated that "*it is essential to work through the regional technical agencies that national policy makers look to for advice*". An additional layer of support referred to the political supportiveness that projects benefited from. First, it refers to political supportiveness: "*The direct interest and involvement of the political class in the project was a game-changer and helped navigate through.*" Second, this refers to organizational-level support and institutional architecture around KE, with one participant saying that it was particularly enabling to work "*in a university-based boundary organization, with close support from communicators and a journalist, and after a while, also policy analysts*". Ultimately, participants emphasized that KE is more than a relationship between only 'science' and 'policy'. This is reflected by one participant having experienced "*a reality where that line [between science and policy] is usually blurred and where these categories might be too narrow*" suggesting "*there may be value in downplaying the science-policy dichotomy*". As such, a clear finding is that successful KE projects between research and *policy* (see *Methods*) also meaningfully engage *society* as a whole.

3.3.3 Context

Context was also commonly identified as having played a key role in enabling successful KE. Firstly, this refers to social and political background ranging from crises, court sentences, and the history of resource management to being "*embedded in a long-term political process*" (be it locally or internationally). Context included local preconditions to the engagement of non-academic actors, or a broader public "*tradition for appreciating knowledge-based policies*". More broadly, one participant reflected that "*successful initiatives are built on or embedded within other successes and long-standing relationships, and that they are a part of a broader 'ecosystem of positive efforts'*". Additional lessons were articulated around the governance context and roles of politics - for example, that relationships and motivations may reflect organizational mandates. On top of that, a small spatial scale was stated supportive to KE. Within small spatial scale, a high level of local or traditional organization, leadership and governance culture supported successful KE (Supplementary Table 3).

3.3.4 Timing, urgency, and effort

Finally, time, timing, and opportunity were identified as important enablers. This is highlighted by one participant who said that "*a policy window facilitated state legislative action*" and another who explained "*[the project] came right at the time where poor conditions across all metrics (environment, economic and social) saw people willing to make a change to improve things*". The latter illustrates that the timeliness ('hot topic') of projects was often explained by local, strong dependence on marine resources threatened by poor ecological conditions. Findings also included the realization that successful KE takes a lot of time and invisible effort: "*Our experiences within a boundary organization suggest that the amount of time, resources and effort needed at the science-policy boundary are rarely recognized or given due credit.*"

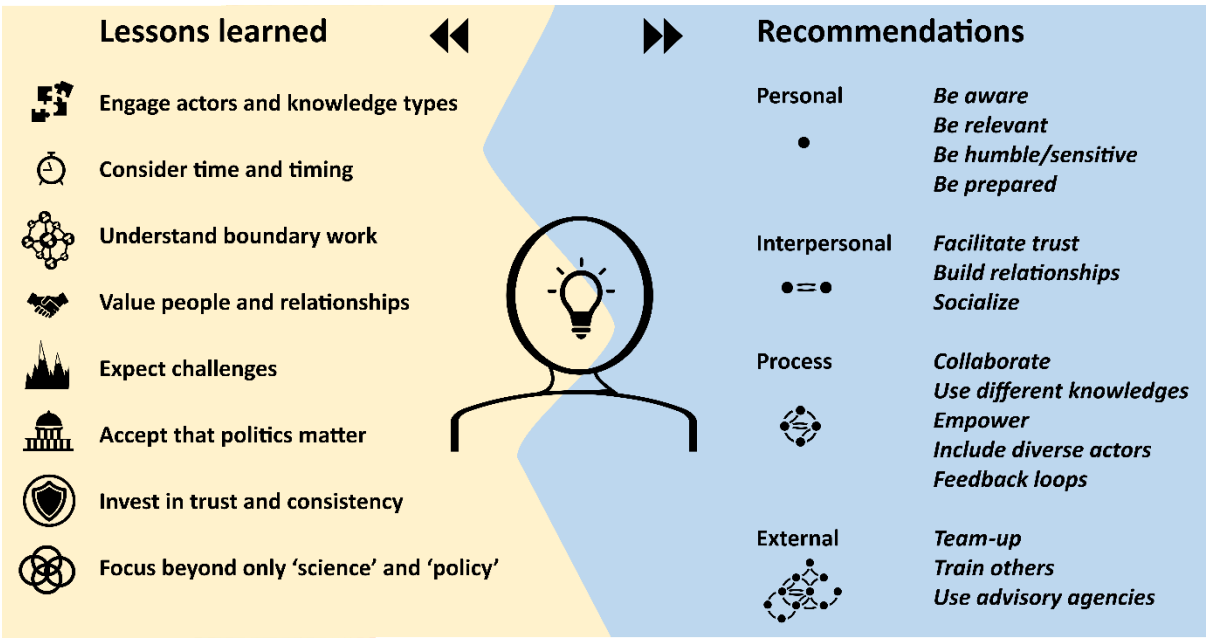


Figure 4: Lessons (left), and recommendations (right) from participants in marine science-policy bright-spots to other researchers and practitioners conducting knowledge exchange.

4. Discussion

4.1 Bright-spot setting (initiation, goals, approaches)

Within the 25 marine science-policy bright-spots analyzed in this study, most were initiated by policy demand, donors, local communities, or boundary organizations. This mirrors Steger et al. (2021, p.7) who found that "projects initiated by practitioners [incl. policy-makers] and/or other stakeholders had a larger proportion of high policy impact compared to projects initiated by researchers only". While it was beyond the scope of this study to determine the reasons for this, it could be that that academia is at times disconnected from policy-makers' needs, or that the non-research actors are more tightly and more timely connected to policy, ensuring relevance (Breckwoldt et al., 2021; Goldman and Pabari, 2021; Rose et al., 2020).

Relatedly, working with established advisory bodies or governmental agencies supported successful KE. The important role of advisory bodies and assessments, meaning the mandated generation, structuring, provision and debate of knowledge to inform decision-making on policy-relevant questions in a credible and legitimate manner (Adelle and Weiland, 2012; Deelstra et al., 2003; EEA, 2001; Hugé et al., 2011; UNEP and IOC/UNESCO, 2009), has long been known (e.g., Hoppe, 2010; Jasanoff, 1998; Soomai, 2017). Walsh et al. (2019) have also found formal collaborations with management organizations to be supportive to KE, because policy-makers find research conducted or commissioned by their own agency more relevant than external scientific research (British Academy, 2008). Designing agency-led projects with iterative elements between KE actors throughout the process may help ensure that needs are incorporated in the knowledge production to make the final results more policy-relevant and account for their experience-based knowledge that Sander (2018, p.114) called "traditional managerial knowledge".

The activities to achieve KE goals mirrored those commonly associated with boundary spanning and knowledge brokering (Bednarek et al., 2018; Lomas, 2007; Michaels, 2009). The most described strategy was knowledge co-production, an approach with a range of theoretical lenses (Bremer and Meisch, 2017) and practical modes (Chambers et al., 2021). The diversity of bright-spot approaches included many different co-production components at different points in time (co-designing, co-creating, co-writing, co-evaluating). What co-production processes have in common is helping political receptiveness and research uptake by being context-based, pluralistic, goal-orientated, interactive and benefiting from iterations among actors (Lemos and Morehouse, 2005; Norström et al., 2020).

4.2 Successes of KE

Results show that success at the interface of science and policy-making can be achieved, and that success comes in diverse forms and can be defined more broadly than traditionally conceptualized (supporting recent work by Cooke et al., 2020; Cvitanovic et al., 2021a; Karcher et al., 2021). Leaving bias from study selection criteria towards impact on policy/governance and comparison considerations aside, nearly 200 out of 326 references were made to other types of success. Among them were impacts on people (i.e., researchers and non-academic partners). For example, individual changes in knowledge or job satisfaction can occur (Cvitanovic et al., 2018; 2021a; Xavier et al., 2018) as well as individual learning and understanding of issues and uncertainties, or changes in attitude and practice of KE actors (Knapp et al., 2017; O'Connor et al., 2019). As a result, individuals may also have improved individual networks and reputation (Cvitanovic et al., 2021a), and ultimately gain more career opportunities (Hegger and Dieperink, 2015).

4.3 Enablers, lessons, and recommendations

Cvitanovic et al. (2016) identified three core capacities to enable KE, which are individual, institutional and financial capacities. In our study, factors related to people (i.e., interpersonal factors, actor group, individual enablers) were the most recurring enablers (throughout both individual and organizational KE endeavors). This refers to the actor group, its diversity, skillset, and devotion, corroborating findings by Cvitanovic et al. (2018) and Reed et al. (2014). Beyond that, understanding the expertise, motivations, and limitations of all actors was paramount, mirroring the literature (Brugger et al., 2016; Cvitanovic et al., 2016; Evans and Cvitanovic, 2018; Marshall et al., 2017). Our findings underline the pivotal roles of building and maintaining trust and long-term relationships (Balvanera et al., 2017; Cvitanovic et al., 2021b; Lacey et al., 2018; Newig et al., 2019; Tinch et al., 2018) suggesting that their attainment is of inherent value for KE. Hence, the findings suggest that trust is critical as both an input and an outcome of successful KE. This relates to the notion of social capital as a "set of values and relationships created by individuals in the past that can be drawn on in the present and future to facilitate overcoming social dilemmas" (Ahn and Ostrom, 2002, p.3). Our study participants indicated that KE particularly benefited from pre-existing relationships, which corroborates the value of history (e.g., individual experiences, social capital and trust) around KE (Hakkarainen et al., 2020; Karcher et al., in review).

A clear finding was that, even when (by study-selection) focusing on marine science-*policy* interfaces, many other *societal* actors and knowledge types, beyond the domains of 'science' and 'policy' were engaged in the bright-spots, mirroring a new knowledge-governance interface recently proposed by Turnhout et al. (2021). This highlights the value and need for strong collaboration between natural and social sciences and humanities for KE and marine management (Mazé et al., 2017; Nogueira et al., 2021; Singh et al., 2021). Social sciences, including anthropology, law, and economics, have important contributions, for example in giving advice on what type of policy instruments may affect people - whose activities affect the oceans (Lascoumes and Le Gales, 2007; Sander, 2018; van Putten et al., 2021). In that regard, experience-based knowledge by both decision-makers and stakeholders also needs to be considered (Fazey et al., 2006; Stephenson et al., 2016). Practically, this leads to recommendations to early and meaningfully involve diverse actors and knowledge systems (Hegger et al., 2012; Tengö et al., 2014; UNEP and IOC/UNESCO, 2009; Weichselgartner and Kasperson, 2010). It is well-known that participation and integration of local or traditional knowledge are beneficial to research, knowledge use in decision-making and management, and conservation success (Dawson et al., 2021; Loch and Riechers, 2021; McKenzie et al., 2014; Raymond et al., 2010). Particularly on a local level, participants often made the recommendation to meaningfully include diverse knowledge types and empower local communities. This also requires making local and traditional knowledge more visible and usable and pursuing social equity in and through marine conservation (Bennett et al., 2021).

Although not directly interrogated by the survey, the governance level of KE projects emerged in the analysis as an enabler and point of differentiation between projects (Supplementary Table 3). Despite the fact that particularly the national and sub-national levels are favorable for science-policy work (i.e., for public awareness and shaping the implementation of legislation, Jensen-Ryan and German, 2019), we showed successful KE projects at different levels. Regional bright-spots exhibited the most diverse success categories, although we acknowledge the non-representative sample. On the other hand, an international level may facilitate dealing with overarching issues that take longer to enter in the national policy agendas. Overall, the time and timing were important success factors, referring to the recommendation to proactively analyze and tackle emerging issues early-on (UNEP and IOC/UNESCO, 2009). Our findings corroborate Rose et al. (2020) in that KE is facilitated when evidence is synthesized and interpreted in a management-relevant way before a policy window opens, and that effectiveness increases when solutions are prepared ahead of time.

4.4 Limitations and future research opportunities

The study of bright-spots has high potential to inform how KE at the interface of marine science and decision-making can become more successful, but it also comes with methodological limitations. Firstly, as indicated in the *Methods* section, this case study cannot easily be generalized. It has to be considered that culture and openness are key to research use in policy-making (Court and Young, 2003; Goldman and Pabari, 2021), and that interactive engagement is a matter of cultures of participation (Reed et al., 2018). For project settings (e.g., initiation, strategies), we are unable to discern whether these co-exist with success or contribute to it. Therefore, in this study, we intended to look across very diverse case studies (i.e., breadth of data) to show commonalities despite the diversity of approaches and not to deep-dive into a specific case. Secondly, approaching bright-spots brings forth the limitations of binary approaches (success/not success) in that projects with other ambitions could be easily disregarded as a failure (*cf.* Giakoumi et al., 2018). To address this, we have transparently described the full study selection process including its ambition and have based it on participant-identified success

A track for future research on marine science-policy bright-spots could be analyzing the perceptions of more actors. Here, we mainly targeted well-connected, frequently-publishing researchers potentially missing out on experts immersed in a limited number of projects, but more deeply (many KE practitioners do not publish in academia). It also refers to non-academic actors involved in KE. Including them would ensure a more holistic presentation of perspectives beyond individual experiences of researchers, given that success, as well as the paths towards it, are a matter of perspective (Jacobs et al., 2005; Parker and Crona, 2012; Reed et al., 2021). KE work is only one of the contributors to changing policy, but there are many other actors and factors affecting it, making it hard to establish causality from KE initiatives (Ferguson et al., 2016). Moving forward also requires combining empirical bottom-up approaches and theoretical developments to understand how the factors for a successful

implementation of KE causally relate to each other. What are the critical factors, how can they be measured, what trade-offs may exist and how do they affect success? Ultimately, a better – more causal – understanding is needed on which success factors can be traced back to the institutional architecture supporting KE activities. Future studies should both consider the diversity of approaches in individual cases to engage more with specific contexts, but also develop broad indicator frameworks that allow achieving and assessing KE success across different cases and contexts.

5. Conclusions: Mainstreaming marine science-policy bright-spots

Having shown that diverse successes at the interface of marine science and decision-making can be achieved and enabled by the right people, methods, levels of funding, and timing, we would like to reflect on some of those themes, and what they mean in terms of making bright-spots the norm, not the outlier. First, we emphasize that positive examples of KE success exist across diverse governance levels and marine ecosystems. Accordingly, this work might motivate others to take the path of interactive KE, or as one participant phrased it: "*Do not be afraid of politicians; they do not bite. When they do, please direct them to bite the right place and remove barriers.*"

Second, our findings suggest that there is a need to diversify training opportunities to conduct KE well. Although society-relevant research is important and often appreciated, we acknowledge that interactive KE may not be everyone's ambition and is often not considered in research planning. It is also apparent that those interested need help to develop a broader set of 'soft' skills to engage in KE (Bednarek et al., 2018; Pietri et al., 2013). Different components have been described to improve capabilities and capacities for KE via organizations (e.g., universities). At a small scale, they include the formalization of transdisciplinary working groups (including real-life labs, Bergmann et al., 2021), supportive supervision, and KE mentorship (Andrews et al., 2020; Cvitanovic et al., 2015b; Lyall and Meagher, 2012). Such mentorship and supervision should not end with theoretical advice, but also include the introduction to existing networks and collaborations to both form the skills needed and some of the 'pre-existing relationships' supportive to future KE success. This also includes guidance for early and mid-career scientists to be connected to those with more established careers and networks. Furthermore, good communication skills can be cultivated by organizations and university programs. On a larger scale, this challenge can be addressed by courses (e.g., mainstreaming 'human dimensions' into biology/conservation courses), fellowships, internships, student-led activities, and partnerships between universities (Duchelle et al., 2009; Lyall and Meagher, 2012; Rozance et al., 2020).

There is also a need for the institutionalization of KE within organizations. Our data does not allow statements on how innovative research solutions and KE processes were for organizational or non-research-initiated KE compared to 'only' science pushing. However, our research has shown that working at the science-policy interface in an organized manner – through advisory bodies, boundary

organizations, or NGOs – is conducive to KE success. This may require clearer institutional arrangements, relationships, and responsibilities (UNEP and IOC/UNESCO, 2009). To that end, resourcing, and institutional/cultural commitment to support relationship building and offering the time this takes are critical. Such resourcing and organizational support may need organizational re-examination of agendas, norms and constraints (Pearman and Cravens, 2022). The importance of human factors, people's skills and drive towards achieving success not only shows the role of interpersonal relationships but suggests that there is a shortage of formal, institutionalized KE arrangements. Research and funding organizations should consider KE as part of their mission, allocate required resources, positions, and recognize the value of KE work. From an organization's lens, this may include 'cross-learning' initiatives (e.g., workshops and/or residence type arrangements between academic and non-academic institutions to increase the understanding of each other's operating contexts) or transdisciplinary programs (e.g., EU COST program, https://www.cost.eu/). Currently, not only researchers but also practitioners in, for example, NGOs or boundary organizations, have to explicitly promote KE and justify its budgeting.

Trust and existing relationships are also key but the time and skills to build them are not usually captured by traditional metrics of research impact (i.e., publish or perish culture, citations, etc.). This is exemplified by institutional incentive structures and funding being the major barriers to KE, likely creating trade-offs between KE success and academic success (Shanley and López, 2009). We therefore call for a shift in the measures of science impact and institutional innovation (Cvitanovic et al., 2015b; Sellberg et al., 2021). Given the role of flexible and supportive funding, one pathway for change lies in the hands of funding bodies that can affect research, its planning, conduct, and impact (Arnott et al., 2020; Lyall et al., 2013; Trueblood et al., 2019). Accordingly, we encourage institutional changes in both research institutions (e.g., institutionalization of KE, training, science-society connections) and funders (e.g., through targeted impact planning, acknowledgement of time and resources needed for KE) to remove KE barriers, and create the conditions (including the right people, skills, and processes) required for bright-spots to become more common.

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Supplementary Material 1: Survey questions for data generation.

1. Please describe an example of a successful marine science-policy interaction (success defined as broadly as possible) that you have been involved in. Please include specific information on the location/ocean area, scope of the example [coastal land, territorial/ coastal waters, EEZ, high seas], topic/ecosystem, threat/problem, science bodies [university researchers, consultants, NGOs], policy bodies [local community-based managers, local policy makers, state agencies, national government, multinational treaty/organization, international], other actors [NGOs, stakeholders]).
2. What was your role in the example outlined above, and how did you come to be in this role?
3. What (and when) initiated the interaction between science and policy (policy demand, funding requirement, science outreach, joint knowledge production, personal motivations, etc.), and why?
4. What were the specific goal(s) of the science-policy interaction (i.e., what was the project hoping to achieve)? Did this goal change over time?
5. What strategies/approaches/process (or combination thereof) were used to connect and facilitate science-policy interactions in your case study (e.g., knowledge brokers, advisory board, boundary organization, co-production, events/meetings, co-management, etc.)? Why was this the selected approach?
6. In your example and your opinion, what constituted success(es) (please think as broadly as possible, e.g., impacts on policy, people, processes, ecosystems, species, society, etc.). Which of these were achieved?
7. What data/evidence did you collect (or in hindsight could you have collected) to demonstrate that success had been achieved in your example?
8. Of the success achieved, what conditions (i.e., the individual, organizational, social, political, material, technical, practical and financial elements required to reach the outcome) led to this project being a success? That is, what was in place that made it successful and which facilitating factors emerged spontaneously/unexpectedly?
9. Is there something that was special/unusual about this science-policy interaction that you have not previously experienced during your work at the interface of marine science and policy that you think made this example successful?
10. What are the key lessons (i.e., suggestions to other researchers) that you learnt through your example for attaining success at the interface of marine science and policy?
11. Considering the above questions and topic of this study, is there anything additional that you would like to tell us about your case study that is not covered above?

Supplementary Table 1: Project information on the 25 included marine science policy bright-spots.

ID	Title	Location/ scope	Dates	Some key achievements	References, further reading
1	Fish for food security in the Pacific Island region	Coastal and oceanic fisheries for domestic consumption in Pacific Island countries and territories Governance level: International	2008 - 2019	Regional Roadmap for Sustainable Pacific Fisheries endorsed by all Pacific Island Presidents and Prime Ministers. Implementation of adaptations and supporting policies. Strategy to sustain coastal fish habitats and coastal fish stocks. Awareness, realization of the issue.	Bell, J.D. et al. (2008). Importance of household income and expenditure surveys and censuses for management of coastal and freshwater fisheries. SPC Fisheries Newsletter 127, 34-39. SPC Policy Brief 1/2008, Fish and Food Security. Bell, J.D. et al. (2009). Planning the use of fish for food security in the Pacific. Marine Policy 33, 64-76. Bell, J.D. et al. (2015) Diversifying the use of tuna to improve food security and public health in Pacific Island countries and territories. Marine Policy 51, 584-591. Bell, J.D. et al. (2018). Adaptations to maintain the contributions of small-scale fisheries to food security in the Pacific Islands. Marine Policy 88, 303-314. Bell, J.D. et al. (2019). Realising the food security benefits of canned fish for Pacific Island countries. Marine Policy 100, 183-191 Regional Roadmap for Sustainable Pacific Fisheries (https://www.ffa.int/node/1569). https://pacificdata.org/data/dataset/oai-www-spc-int-ced24e95-7e0a-401a-9f0b-d79316c49cb0 A New Song for Coastal Fisheries – pathways to change. The Noumea Strategy (https://pacificdata.org/data/dataset/oai-www-spc-int-861e6395-7b00-4453-8b5a-b25923694cb9).
2	US fisheries management responses to interconnected ecological, social, and economic challenges of climate impacts	East coast USA Governance level: Regional, national	2017 - 2019	Elevated awareness and explored opportunities for policy/ management solutions. Mutual understanding, changes of minds. Built trust. Broader understanding of available expertise Understandings about specific decision contexts. Ability and confidence for further engagement with policy. Citation in NOAA federal technical memo.	The Mid-Atlantic Fishery Management Council (MAFMC). 2014. East coast climate change and fisheries governance workshop report. May 19-21. Washington, D.C. The Atlantic States Marine Fisheries Commission (ASMFC). 2018. Management, Policy and Science Strategies for Adapting Fisheries Management to Changes in Species Abundance and Distribution Resulting from Climate Change. Arlington, VA. Karp, M. A., J. Peterson, P. D. Lynch, and R. Griffis (editors). Accounting for Shifting Distributions and Changing Productivity in the Fishery Management Process: From Detection to Management Action. 2018. U.S. Dept. of Commerce, NOAA. NOAA Technical Memorandum NMFS-F/SPO-188, 37p. Pinsky, M.L., Reygondeau, G., Cadell, R., et al. 2018. Preparing ocean governance for species on the move. Science 360 (6394): 1189-1191. Lauren A. Rogers, Robert Griffin, Talia Young, Emma Fuller, Kevin St. Martin, Malin L. Pinsky. Shifting habitats expose fishing communities to risk under climate change. Nature Climate Change, 2019.
3	Pelagic plankton indicators for biodiversity and food webs	Pelagic waters of the North-Eastern Atlantic Ocean Governance level: National, international	2011 - ongoing	Impacts on policy. Indicators used in UK and OSPAR level policy assessments. Corroborating letter from OSPAR. Marine Strategy Part 3 Programme of Measures. Draft UK monitoring options proposal.	Capuzzo, E., Lynam, C.P., Barry, J., Stephens, D., Forster, R.M., Greenwood, N., McQuatters-Gollop, A., Silva, T., Sonja M. van Leeuwen and Engelhard, G.H., (2017). A decline in primary production in the North Sea over 25 years, associated with reductions in zooplankton abundance and fish stock recruitment. Global Change Biology, 24: e352-e364. OSPAR 2017 Intermediate Assessment Dickey-Collas, M., McQuatters-Gollop, A., Bresnan, E., Kraberg, A.C., Manderson, J.P., Nash, R.D.M., Otto, S.A., Sell, A.F., Tweddle, J.F. and Trenkel, V.M., (2017). Pelagic habitat: exploring the concept of good environmental status. ICES Journal of Marine Science, 74: 2333-2341. Bedford, J., Johns, D., Greenstreet, S. and McQuatters-Gollop, A., (2018). Plankton as prevailing conditions: a surveillance role for plankton indicators within the Marine Strategy Framework Directive. Marine Policy 89:109-115. McQuatters-Gollop, A., Atkinson, A., Aubert, A., Bedford, J., Best, M., Bresnan, E., Cook, K., Devlin, M., Gowen, R., Johns, D.G., Machairopoulou, M., Mellor, A., Ostle, C., Scherer, C. and Tett, P., (2019). Plankton lifeforms as a biodiversity indicator for regional-scale assessment of pelagic habitats for policy Ecological Indicators, 101: 913-925. Rombouts, I., Simon, N., Aubert, A., Cariou, T., Feunteun, E., Guérin, L., Hoebeke, M., McQuatters-Gollop, A., Rigaut-Jalabert, F. and Artigas, L.F., (2019). Changes in marine phytoplankton diversity: Assessment under the Marine Strategy Framework Directive. Ecological Indicators, 102: 265-277. Bedford, J., Ostle, C., Johns, D.G., Atkinson, A., Best, M., Bresnan, E., Machairopoulou, M., Graves, C.A., Devlin, M., Milligan, A., Pitois, S., Mellor, A., Tett, P. and McQuatters-Gollop, A., (2020). Lifeform indicators reveal large-scale shifts in plankton across the North-West European shelf. Global Change Biology. UK MSFD Assessment for pelagic habitats biodiversity indicators https://moat.cefas.co.uk/biodiversity-food-webs-and-marine-protected-areas/pelagic-habitats/)

					Corroborating letter from OSPAR (LoS Emily Corcoran OSPAR.pdf) Marine Strategy Part 3 Programme of Measures
4	By-catch management guidelines in Australian national sea's fisheries	Australian national waters Governance level: National	Until 2019	Guidelines being accepted by the policy side of government. Published and released without delay. Used for subsequent initiatives within the Commonwealth fisheries management agency.	https://www.agriculture.gov.au/fisheries/environment/bycatch/review Smith, A. D. M., S. D. C., M. Haddon, I. Knuckey, K. J. Sainsbury and S. Sloan (2014). Implementing harvest strategies in Australia: 5 years on. ICES Journal of Marine Science 71: 195–203. Punt, A. E., D. S. Butterworth, C. L. d. Moor, J. A. A. D. Oliveira and M. Haddon (2016). Management strategy evaluation: best practices. Fish and Fisheries 17: 303-334.
5	Science-based local octopus management under socio-economic well-being	Brazilian coastal waters and local fishing communities Governance level: Local	Over the last 4 – 5 years	Necessary conditions (trust, reliable partnerships, understanding of science) achieved to then achieve ecological and social impact. Fishers believed in success of their joint project.	Lopes, P. F., Andrade, L. C., Pennino, M. G., & Leite, T. S. (2021). The inter-annual fishing variability in Octopus insularis (Leite & Haimovici 2008) as a result of oceanographic factors. Fisheries Oceanography.
6	Ocean Acidification and Hypoxia at the US West coast	Nearshore waters West coast USA Governance level: Regional	2013-2016	Significant investment, policy action and new legislative mandates – particularly in California but also in Oregon and Washington. State agencies better equipped. Impact on the processes of ocean governance.	www.westcoastoah.org https://www.oceansciencetrust.org/impact-report/ https://www.sciencedirect.com/science/article/pii/S2212096315000133 https://www.oceansciencetrust.org/wp-content/uploads/2020/02/2020-OA-Progress-Report-to-OPC-.pdf
7	Ecosystem-based Atlantic menhaden management at the East coast USA based upon their role in the ecosystem	Coastal waters East coast USA Governance level: Regional	2013-2020	Atlantic States Marine Fisheries Commission (ASMFC) voted to adopt "ecological reference points" for Atlantic menhaden, based upon science supported by the Lenfest Ocean Program. Managers now able to set ecosystem-based catch limits for the menhaden fishery. Managers and stakeholders with greater confidence in how the models were performing.	https://www.lenfestocean.org/en/news-and-publications/cross-currents/2020/funding-the-research-to-jumpstart-ecosystem-approaches-in-fisheries-management https://www.lenfestocean.org/en/news-and-publications/cross-currents/2021/researchers-and-the-asfmc-cooperate-to-make-ecosystem-modeling-more-practical Chagaris, D., Drew, K., Schueller, A., Cieri, M., Brito, J., Buchheister, A. (2020) Ecological Reference Points for Atlantic Menhaden Established Using an Ecosystem Model of Intermediate Complexity. Frontiers in Marine Science. https://doi.org/10.3389/fmars.2020.606417 Drew, K., Cieri, M., Schueller, A.M., Buchheister, A., Chagaris, D., Nesslage, G., McNamee, J.E., Uphoff, J.H. (2021) Balancing Model Complexity, Data Requirements, and Management Objectives in Developing Ecological Reference Points for Atlantic Menhaden. Frontiers in Marine Science. https://doi.org/10.3389/fmars.2021.608059 Howell, D., Schueller, A.M., Bentley, J.W., Buchheister, A., Chagaris, D., Cieri, M., Drew, K., Lundy, M.G., Pedreschi, D., Reid, D.G., Townsend, H. (2021) Combining Ecosystem and Single-Species Modeling to Provide Ecosystem-Based Fisheries Management Advice Within Current Management Systems. Frontiers in Marine Science. https://doi.org/10.3389/fmars.2020.607831 Anstead, K., Drew, K., Chagaris, D., Cieri, M., Schueller, A.M., Mcnamee, J., Buchheister, A., Nesslage, G., Uphoff, J.H., Wilberg, M., Sharov, A., Dean, M., Brust, J., Celestino, M., Madsen, S., Murray, S., Appelman, M., Ballenger, J., Brito, J., Cosby, E., Craig, C., Flora, C., Gottschall, K., Latour, R.J., Leonard, E., Mroch, R., Newhard, J., Orner, D., Swanson, C., Tinsman, J., Houde, E.D., Miller, T.J., Townsend, H. (2021) The Path to an Ecosystem Approach for Forage Fish Management: a Case Study of Atlantic Menhaden. Frontiers in Marine Science. doi: 10.3389/fmars.2021.607657
8	Toward ecosystem-based management and governance of marine resources and Nation-to-	Gwaii Haanas National Park Reserve, a Haida Heritage Site on Canada's West coast	Ongoing	Enduring relationships. Enable the CHN (and Haida) to assess outcomes of fisheries that may be commercially and culturally important.	https://haidamarineplanning.com/wp-content/uploads/2019/07/Gina_Waadluxan_Kilguhlga_Land_Sea_People_Plan.pdf Muhl, E. K., Esteves Dias, A. C., & Armitage, D. (2020). Experiences with governance in three marine conservation zoning initiatives: Parameters for assessment and pathways forward. Frontiers in Marine Science, 7, 629. https://doi.org/10.3389/fmars.2020.00629

	Nation relationships at Gwaii Haanas National Park Reserve, a Haida Heritage Site	Governance level: Local		Continuation of that co-production orientation.	
9	The initiation, adoption and implementation of the Ross Sea region marine protected area (MPA)	Ross Sea, high seas in the Southern Ocean, Antarctica Governance level: International	Overall MPA process: late 2001 - 2016	The Ross Sea MPA was adopted, it was immediately a source of pride for CCAMLR Member States. Diplomatic win. CCAMLR States have learned from the experience.	'The Convention on the Conservation of Marine Living Resources'. 1980. Ainley, David. 2002. 'The Ross Sea, Antarctica, where all ecosystem processes still remain for study', CCAMLR WG-EMM-02/60. Ainley, David. 2004. 'Acquiring a "Base Datum of Normality" for a marine ecosystem: The Ross Sea, Antarctica.' WG-EMM-04/20. ASOC. 2009. "The Case for Special Protection of the Ross Sea." CCAMLR-XXVIII/BG/28 Ainley, David, Grant Ballard, and John B. Weller. 2010. 'Ross Sea Bioregionalization Part I ', CCAMLR WG-EMM-10/11. ASOC. 2010. "Scientists' Consensus Statement on Protection of the Ross Sea." In. Washington, D.C.: Antarctic and Southern Ocean Coalition. Ballard, Grant, Dennis Jongsomjit, and David Ainley. 2010. 'Ross Sea Bioregionalization Part II: Patterns of Co-occurrence of mesopredators in an intact Polar ocean ecosystem.' WG-EMM-10/12. Miller, D. 2011. 'Sustainable Management in the Southern Ocean: CCAMLR Science.' in PA Berkman, MA Lang, WH Walton and OR Young (eds.), Science Diplomacy: Antarctica Science, and the Governance of International Spaces (Smithsonian Institution Scholarly Press). Sharp, Ben R., and George M. Watters. 2011. "Marine Protected Area planning by New Zealand and the United States in the Ross Sea region. CCAMLR WS-MPA-11/25."AOA. 2012. "Antarctic Ocean Legacy: A Marine Reserve for the Ross Sea." In.: Antarctic Ocean Alliance. Young, Peter. 2012. "The Last Ocean." Documentary Film. FishEye Films. Weller, John. 2013. "The Last Ocean." Rizzoli Publishing. Brooks, Cassandra, L.B. Crowder, Lisa Curran, Robert Dunbar, David Ainley, Klaus Dodds, Kristina M. Gjerde, and Rashid Sumaila. 2016. 'Science-based management in decline in the Southern Ocean', Science, 354: 185-87. CCAMLR. 2016a. 'Conservation Measure 91-05, Ross Sea Region Marine Protected Area'. ———. 2016b. 'Report of the XXXV Meeting of the Commission'. Bloom, Evan. 2017. "Two key developments in Polar law and diplomacy: A new Arctic science agreement and establishment of the World's largest marine protected area in Antarctica's Ross Sea."In 10th Polar Law Symposium. Rovaniemi, Finland. Brooks, Cassandra. 2017. 'Policies for Managing the Global Commons: The case of marine protected areas in Antarctica', Stanford University. Brooks, C. M., L.B. Crowder, H. Osterblom, and Aaron L. Strong. 2019. 'Reaching consensus for conserving the global commons: The case of the Ross Sea, Antarctica', Conservation Letters.
10	Mediating multiple human uses of the Dutch Wadden Sea using social science	Dutch Wadden Sea Governance level: National	2008 - 2018	First time social scientists were invited to the table. Guide with action perspectives for policy makers and stakeholders. Direct use of scientific insights in decision-making. Building trust and relationships.	Runhaar, H. (2009), Putting SEA in context: A discourse perspective on how SEA contributes to decision-making, Environmental Impact Assessment Review, 29 (3), pp. 200-209. Runhaar, H. and K. van Nieuwaal (2010), Understanding the use of science in decision-making on cockle fisheries and gas mining in the Dutch Wadden Sea: putting the science-policy interface in a wider perspective, Environmental Science and Policy, 13 (3), pp. 239-248. 2016 special issue in Environmental Science and Policy (https://www.sciencedirect.com/journal/environmental-science-and-policy/vol/55/part/P3) Enst, W. van, H. Runhaar and P.P.J. Driessen (2016), Boundary organisations and their strategies: Three cases in the Wadden Sea, Environmental Science and Policy, 55 (1), pp. 416-423. Van Enst, W.I. (2018), Science–policy interfaces for enriched environmental decision-making: a research into the strategies of boundary work, illustrated by case-studies in the Dutch Wadden sea, PhD thesis, Utrecht University, Utrecht, the Netherlands. (https://dspace.library.uu.nl/handle/1874/358671) Runhaar, H., H.J. van der Windt and J.P.M. van Tatenhove (2016), Conclusions from the Environmental Science and Policy special issue on Organising productive science-policy interactions for sustainable coastal management. Lessons from the Wadden Sea, Environmental Science and Policy, 55 (1), pp. 467-471

11	Marine ecosystem governance in Barents Sea management	Barents Sea – Lofoten area in Norway Governance level: National	2002 - 2011	(Temporary) stabilization of a persistent conflict. Translation of ecological values (science) into planning regulations (policy), including the identification of valuable and vulnerable areas as a basis for spatial management Different agencies and institutions (ministries, directorates, and scientific bodies) were brought together in a new way. Trust-building between organizations.	Ministry of the Environment. (2006). Report No. 8 to the Storting (2005-2006) Integrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands. (8). Oslo. Knol, M. (2010a). Constructing knowledge gaps in Barents Sea management: how uncertainties become objects of risk. MAST, 9(1), 61-79. Knol, M. (2010b). Marine ecosystem governance in the making: Planning for petroleum activity in the Barents Sea-Lofoten area. (PhD Thesis), University of Tromsø, Tromsø. Knol, M. (2010c). Scientific advice in integrated ocean management: The process towards the Barents Sea plan. Marine Policy, 34(2), 252-260. doi:10.1016/j.marpol.2009.07.009 Knol, M. (2011). Mapping ocean governance: from ecological values to policy instrumentation. Journal of Environmental Planning and Management, 54(7), 979-995. doi:10.1080/09640568.2010.547686 Ministry of the Environment (2011). White Paper No. 10 (2010-2011): Update of the management plan for the marine environment of the Barents Sea-Lofoten area (in Norwegian). Blanchard, A., Hauge, K. H., Andersen, G., Fosså, J. H., Grøsvik, B. E., Handegard, N. O., . . . Vikebø, F. (2014). Harmful routines? Uncertainty in science and conflicting views on routine petroleum operations in Norway. Marine Policy, 43(0), 313-320. Hauge, K. H., Blanchard, A., Andersen, G., Boland, R., Grøsvik, B. E., Howell, D., . . . Vikebø, F. (2014). Inadequate risk assessments–A study on worst-case scenarios related to petroleum exploitation in the Lofoten area. Marine Policy, 44, 82-89. Kristoffersen, B., & Dale, B. (2017). Post Petroleum Security in Lofoten: How identity matters. Arctic Review, 5(2). Irish, O. (2018). Identifying ecological hotspots in the United States and Norway: Turning ecosystem-based management into practice? Marine Policy, 98, 65-76. Sander, G. (2018a). Against all odds? Implementing a policy for ecosystem-based management of the Barents Sea. Ocean & Coastal Management, 157, 111-123. Sander, G. (2018b). Ecosystem-based management in Canada and Norway: The importance of political leadership and effective decision-making for implementation. Ocean & Coastal Management, 163, 485-497.
12	Co-creating Ecosystem-based Fisheries Management Solutions	European Sea basins with different scopes Governance level: International	2014 - 2017	Reassessment of the utility of decision support tools for implementing an EBFM. Tensions made explicit for policy-makers. Policy advice based on better available science. Impacts on researchers. Impact on stakeholders. Awareness of the benefits and limitations. Generating a “safe space” for dialogue. Collaboration beyond the project remits.	Rincón, M. M., Mumford, J. D., Levontin, P., Leach, A. W., & Ruiz, J. (2016). The economic value of environmental data: a notional insurance scheme for the European anchovy. ICES Journal of Marine Science, 73(4), 1033-1041. https://doi.org/10.1093/icesjms/fsv268 Ruiz, J., Rincón, M. M., Castilla, D., Ramos, F., & del Hoyo, J. J. G. (2017). Biological and economic vulnerabilities of fixed TACs in small pelagics: An analysis of the European anchovy (Engraulis encrasicolus) in the Gulf ofCádiz. Marine Policy, 78, 171-180. https://doi.org/10.1016/j.marpol.2017.01.022 Roadmap for exploitation of MareFrame outputs within ICES, 2017. GFCM RoadMap, 2017. MareFrame North Sea Case Study Fact Sheet. Colloca, F., Scarcella, G., & Libralato, S. (2017). Recent trends and impacts of fisheries exploitation on Mediterranean stocks and ecosystems. Frontiers in Marine Science, 4, 244. https://www.frontiersin.org/articles/10.3389/fmars.2017.00244/full Sturludottir, E., Desjardins, C., Elvarsson, B., Fulton, E. A., Gorton, R., Logemann, K., & Stefansson, G. (2018). End-to-end model of Icelandic waters using the Atlantis framework: exploring system dynamics and model reliability. Fisheries Research, 207, 9-24. https://doi.org/10.1016/j.fishres.2018.05.026 Bauer, B., Horbowy, J., Rahikainen, M., Kulatska, N., Müller-Karulis, B., Tomczak, M. T., & Bartolino, V. (2019). Model uncertainty and simulated multispecies fisheries management advice in the Baltic Sea. PloS one, 14(1), e0211320. https://doi.org/10.1371/journal.pone.0211320 Pope, J. G., Hegland, T. J., Ballesteros, M., Nielsen, K. N., & Rahikainen, M. (2019). Steps to unlocking ecosystem based fisheries management: Towards displaying the N dimensional potato. Fisheries research, 209, 117-128. https://doi.org/10.1016/j.fishres.2018.07.023 T-ONS a swift transportable and user friendly integrative model of the North Sea for decision support https://doi.org/10.1016/j.fishres.2019.02.012 Nielsen, K. N., Baudron, A. R., Fallon, N. G., Fernandes, P. G., Rahikainen, M., & Aschan, M. (2019). Participatory planning and decision support for ecosystem based fisheries management of the west coast of Scotland. Fisheries Research, 211, 59-68. https://doi.org/10.1016/j.fishres.2018.10.020 https://digital.csic.es/bitstream/10261/176706/3/co_creation.pdf Advancing Ecosystem Based Fisheries Management. Journal Special Issue. Fisheries Research. https://www.sciencedirect.com/journal/fisheries-research/special-issue/103CX9S3P53

					Pope, J. G., Hegland, T. J., Ballesteros, M., Nielsen, K. N., & Rahikainen, M. (2019). Steps to unlocking ecosystem based fisheries management: Towards displaying the N dimensional potato. Fisheries research, 209, 117-128. https://doi.org/10.1016/j.fishres.2018.07.023
13	Future options for the Australian federally managed fisheries, particularly the Southern and Eastern Scalefish and Shark Fishery (SESSF)	Across south eastern Australia Governance level: National	2007	National buy-back of fishing vessels/licenses. Policy process to elaborate and expand the use of harvest strategies. Change in policy. Change in management approaches. More sustainable footing in terms of improved biomasses for species and habitats in the ecosystem. Fishery was reduced. More profitable basis.	Smith, A. D. M. et al. Experience in implementing harvest strategies in Australia's south-eastern fisheries. Fisheries Research 94, 373–379 (2008).Fulton, E. A., Smith, A. D. M., Smith, D. C. & Johnson, P. An Integrated Approach Is Needed for Ecosystem Based Fisheries Management: Insights from Ecosystem-Level Management Strategy Evaluation. PLoS ONE 9, e84242 (2014). Smith, A. D. M. et al. Implementing harvest strategies in Australia: 5 years on. ICES Journal of Marine Science 71, 195–203 (2014).
14	Limiting microplastic pollution in the marine environment	Mainly Sweden, partly EU Governance level: National, international	2014-2019	The organization's work contributed to the following achievements: National ban for microplastics in rinse-off personal care products. European Chemicals Agency proposed a wide-ranging restriction on microplastics in products placed on the EU/EEA market. Increased awareness about microplastics pollution in Sweden and at the EU level. Changes in formulas in personal care products where microplastics were excluded.	https://www.su.se/ostersjocentrum/english/baltic-eye/great-media-interest-in-baltic-eyes-new-data-on-microplastic-1.233461 https://balticeye.org/en/pollutants/swedish-ban-on-microplastics-in-cosmetics/ https://www.su.se/ostersjocentrum/english/about-us https://balticeye.org/en/search/?query=microplastics
15	Eutrophication in the Baltic Sea	Sweden and Baltic Sea Governance level: National, international	2016-2020	Politicians agreed to meet with scientists and listen to their research and arguments. Politicians changed their opinions and adjusted party politics. National agency (Swedish Agency for Marine and Water Management) more nuanced in this matter. Members of the European Parliament were updated on latest science on eutrophication in relation to the reform of the regulation for trade with organic fertilisers and the reform of the Common Agricultural Policy.	https://balticeye.org/en/eutrophication/policy-brief-internal-load/ https://balticeye.org/en/eutrophication/faq-internal-load/

16	Mediation between wildlife tourism and humpback whale well-being	Machalilla National Park, Ecuador Governance level: Local	1998-2006	Served for local authorities to take informed decisions. Capacity building. 'Whale Watching' Reglamento for Machalilla was signed by three Ministries at the time: Environment, Tourism and Defense. Legitimate interaction between scientists and local community members.	Alava, J.J., M.J. Barragán, C.Castro, R. Carvajal. (2005). A Note on Stranding and Entanglements of Humpback Whales (Megaptera novaeangliae) in Ecuador. Journal of Cetacean Research and Management, 7(2):163-168. Alava, J.J., M.J. Barragán and J. Denkinger (2012). Humpback Whales (Megaptera novaeangliae) and the bycatch problem in a breeding ground off coastal Ecuador: A Critical Overview and Recommendations. Ocean and Coastal Management, 57:34-43. Alava, J.J., Tatar, B., Barragan-Paladines, M.J., Castro, C., Rosero, P., Denkinger, J., Jiménez, P., Carvajal, R., Samaniego, J. (2017) Mitigating Cetacean Bycatch in Coastal Ecuador: Governance Challenges of Small-scale Fisheries. Marine Policy. DOI 10.1016/j.marpol.2017.05.025 Barragán-Paladines, M.J. (2017) Small-Scale Fisheries versus Whale-watching Tourism: The Story of Puerto López. Environment & Society Portal, Arcadia. Spring 2017, no. 3. Rachel Carson Center for Environment and Society. http://www.environmentandsociety.org/arcadia/small-scale-fisheries-versus-whale-watching-tourism-story-puertolopez
17	Tackling environmental change Issues of China's coastal Aquatic Systems at the Science-Society Interface	Hainan Island, China. South China Sea Governance level: Regional	Since 2017, ongoing	Achieved its own goals. Built new networks. Engaged different stakeholder groups. It seems some of the regulations the Hainan provincial environment agency is facing have been influenced by previous policy recommendations.	http://ecoloc.leibniz-zmt.de/ http://ecoloc.leibniz-zmt.de/wp-content/uploads/2020/10/2020_03_Sustaining-Chinas-Coastal-Resources_Policy-Brief_English.pdf http://ecoloc.leibniz-zmt.de/outcome/fact-sheets/ Zhang, J., Wang, D. R., Jennerjahn, T., & Dsikowitzky, L. (2013). Land–sea interactions at the east coast of Hainan Island, South China Sea: a synthesis. Continental Shelf Research, 57, 132-142.
18	Bottlenose dolphin conservation in the Cres-Lošinj SCI	Cres-Lošinj. Croatian Waters Governance level: National	1999-2013	Partial policy success. Sites are in place. Increased awareness. Increased support of local communities to engage with the idea of conservation and nature-based tourism.	Mackelworth, P. & Carić, H. (2010). Gatekeepers of Island Communities - Exploring the Pillars of Sustainable Development. Environment, Development and Sustainability, 12(4): 463-480; http://www.springerlink.com/content/t846616r15n36rk2/ Mackelworth, P., Holcer, D., Jovanović, J. & Fortuna, C. (2011). Marine conservation and accession, the future for the Croatian Adriatic. Environmental Management, 47(4): 644-655; http://www.springerlink.com/content/l5037u55746738w6/ Mackelworth, P. & Holcer, D. (2011). The Cres-Lošinj Special Marine Reserve – governance analysis. Pages 206- 222 in PJS Jones, W Qiu and EM De Santo (Eds) Governing Marine Protected Areas: getting the balance right – Volume 2. Technical Report to Marine & Coastal Ecosystems Branch, UNEP, Nairobi. ISBN: 978-92-807-3159-0; http://www.mpag.info/mpag-final-technical-report-vol2.pdf Becker, E., Pavlovic, A., Nemet, S. & Mackelworth, P. (2013). Legal Issues Concerning the Cres-Lošinj Marine Habitat and Protected Area Legislation in Croatia. Environs, UC Davis, Environmental Law and Policy Journal 37(1): 1-24. www.environs.law.ucdavis.edu/issues/37/1/Becker.pdf Mackelworth, P., Holcer, D. & Fortuna, C.M. (2013). Unbalanced governance: the Cres-Lošinj Special Marine Reserve, a missed conservation opportunity. Marine Policy, 41: 126–133: http://www.sciencedirect.com/science/article/pii/S0308597X12002588 Pleslić, G., Rako. N., Mackelworth, P., Wiemann, A., Holcer, D. & Fortuna, C. (2013). The abundance of common bottlenose dolphins (Tursiops truncatus) in the former marine protected area of the Cres-Lošinj Archipelago. Aquatic Conservation: Marine and Freshwater Ecosystems: DOI: 10.1002/aqc.2416. http://onlinelibrary.wiley.com/doi/10.1002/aqc.2416/abstract Rako, N., Picciulin, M., Fortuna, C.M., Nimak-Wood, M., Mackelworth, P., Pleslić, G., Holcer, D., Wiemann, A., Sebastianutto, L. & Vilibić, I. (2013). Leisure boating noise as a trigger for the displacement of the bottlenose dolphins of the Cres-Lošinj archipelago (northern Adriatic Sea, Croatia). Marine Pollution Bulletin, 68(1–2): 77–84. http://www.sciencedirect.com/science/article/pii/S0025326X12006030 Batel, A., Basta, J. & Mackelworth, P. (2014). Valuing visitor willingness to pay for marine conservation – the case of the proposed Cres-Lošinj Marine Protected Area, Croatia. Ocean and Coastal Management, 95: 72-80. http://www.sciencedirect.com/science/article/pii/S096456911400091X Gaspari, S., Holcer, D., Mackelworth, P., Fortuna, C., Frantzis, A., Genov, T., Vighi, M., Natali, C., Rako, N., Banchi, E., Chelazzi, G. and Ciofi, C. (2015). Population genetic structure of common bottlenose dolphins (Tursiops truncatus) in the Adriatic Sea and contiguous regions: implications for international conservation. Aquatic Conserv: Mar. Freshw. Ecosyst., 25: 212–222. doi: 10.1002/aqc.2415.

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19	Use of and impacts on a coral reef and seagrass ecosystem: Participatory modelling of wellbeing trade-offs in a coastal fisheries system	Coastal Kenya Governance level: Local	2010-2012	Changed mindsets. Broader systems understanding amongst participants. New understanding of long-standing conflicts and social dynamics. Impact on their work activities. Developed trust. Collaborative beach management unit.	www.tinyurl.com/pmowtick Daw, T.M., Coulthard, S., Cheung, W.W.L., Brown, K., Abunge, C., Galafassi, D., Peterson, G.D., McClanahan, T.R., Omukoto, J.O., Munyi, L., 2015. Evaluating taboo trade-offs in ecosystems services and human well-being. PNAS 112, 6949–6954. https://doi.org/10.1073/pnas.1414900112 Galafassi, D., Daw, T., Munyi, L., Brown, K., Barnaud, C., Fazey, I., 2017. Learning about social-ecological trade-offs. Ecology and Society 22. https://doi.org/10.5751/ES-08920-220102 http://www.espa.ac.uk/files/espa/Participatory%20tools%20and%20processes%20from%20Pmowtick.pdf
20	CBFM development in Vanuatu	Coastal fisheries Vanuatu Governance level: National	Since 2014	Active adaptive management practices in communities, e.g. increased number in recognized Tabu areas across Vanuatu's coastal zone, community monitoring. Institutional collaborations/linkages. Policy changes.	Tavue, R. B., Neihapi, P., Cohen, P. J., Raubani, J. and Bertram, I. (2016). What influences the form that community-based fisheries management takes in Vanuatu? SPC Traditional Marine Resource Management and Knowledge Information Bulletin 37(November2016): 22-34. Raubani, J., Eriksson, H., Neihapi, P. T., Baereleo, R. T., Amos, M., Pakoa, K., Gereva, S., Nimoho, G. and Andrew, N. (2017). Past experiences and the refinement of Vanuatu's model for supporting community-based fisheries management. SPC Traditional Marine Resource Management and Knowledge Information Bulletin 38(June 2017): 3-13. Kleiber, D., Cohen, P. J., Teioli, H., Siota, F., Delisle, A., Lawless, S., Steenbergen, D. J., Gomese, C., Tavue, R. B., Vachette, A., Neihapi, P., Sokach, A., Li, O., Wraith, L., Koran, D., Campbell, B. T., Rooti, Vanguna, T., Wate, J. T., Boso, D., Duarte, A., Batalofo, M., Andrew, N., Sukulu, M., Saeni-Oeta, J., Sutcliffe, S., Eriksson, H., Newton, J. and McDougall, C. (2019). Gender-inclusive facilitation for community-based marine resource management. SPC Women in Fisheries Information Bulletin 30(September): 34-39. Neihapi et al. 2019 'Twisting and spinning' theatre into coastal fisheries management: Informing and engaging communities to address challenges Raising awareness Vanuatu Department of Fisheries, 2019, Vanuatu National Roadmap for Coastal Fisheries: 2019–2030, Port Vila Vanuatu Andrew et al. 2020 Developing participatory monitoring of community fisheries in Kiribati and Vanuatu Eriksson et al. 2020 A new angle on coastal fisheries development in the Pacific Sami, A., Neihapi, P., Koran, D., Ephraim, R., Malverus, V., Sokach, A., Joy, L., Li, O. and Steenbergen, D. J. (2020). A novel participatory catch monitoring approach: The Vanuatu experience. SPC Fisheries Newsletter May-August(162). Gereva, S., D. J. Steenbergen, P. Neihapi, R. Ephraim, V. Malverus, A. Sami and D. Koran (2021). "Reflecting on four years of community-based fisheries management development in Vanuatu " SPC Fisheries Newsletter 165(May-August): 55-67. Steenbergen, D. J., A. M. Song and N. Andrew (2021). "A theory of scaling for community-based fisheries management." Ambio, 10.1007/s13280-021-01563-5.
21	Protecting bays of high importance to coastal Indigenous peoples, and the Dungeness crabs therein	Central coast of British Columbia, Canada Governance level: National.	2007-2021	Bays closed under Canadian law. Started co-managing the fishery with the First Nations.	Ban, N. C., L. Eckert, M. Mcgreer, and A. Frid. 2017. Indigenous knowledge as data for modern fishery management: a case study of Dungeness crab in Pacific Canada. Ecosystem Health and Sustainability 3:1379887. https://thenarwhal.ca/bc-first-nations-dfo-dungeness-crab-decision/ https://coastalfirstnations.ca/protecting-dungeness-crab-on-bcs-central-coast/ https://www.ccira.ca/wp-content/uploads/2019/04/CCIRA-newsletter-10-v01.60-web.pdf
22	Roviana Conservation	Coastal Western	1997-2012	Kozou MPA sustained crises.	Aswani, S., and Ruddle, K. 2013. The design of realistic hybrid marine resource management programs in Oceania. Pacific Science 67:461–476.

	Foundation on Kozou multiple zones MPA to protect mangrove related invertebrates	Solomon Islands Governance level: Local.		The Ministry of the Environment considered MPA legislation which was later enacted. Direct economic benefit from the MPA. Almost total compliance by local stakeholders.	Aswani, S., S. Albert, and M. Love. 2017. One size does not fit all: Critical insights for effective community-based resource management in Melanesia. Marine Policy 81:381-391. DOI: 10.1016/j.marpol.2017.03.041 Aswani, S. 2017. Customary management as TURFs: social challenges and opportunities. Mote Symposium invited paper in Bulletin of Marine Science 93(1): 3–12. http://dx.doi.org/10.5343/bms.2015.1084 Aswani, S. 2019. Indigenous polycentric and nested customary sea tenure (CST) institutions: A Solomon Islands case study. In Governing Renewable Natural Resources: Theories and Frameworks, ed. Nunan, F. Abingdon: Routledge. pp 129-144. ISBN number is 9780367146702.
23	Puget Sound coastal protection and armour	Coasts of Washington state, USA Governance level: Regional	2011-2019	Continuous and ongoing work. Policy changes. Incentive programs. Changed homeowner perceptions of shoreline management. Deficiencies in the regulatory review and approval process were addressed. Informed development of a regional recovery plan.	Whitman, T. and S. Hawkins. 2014. *The Impacts of Shoreline Armoring on Beach Spawning Forage Fish Habitat in San Juan County.* Friends of the San Juans. Friday Harbor, WA. Whitman, T., D. Penttila, K. Krueger, P. Dionne, K. Pierce, Jr. and T. Quinn. 2014. *Tidal Elevation of Surf Smelt Spawn Habitat Study for San Juan County, Washington*. Friends of the San Juans, Salish Sea Biological, and WDFW. Friday Harbor, WA. Dionne, P.E., H. Faulkner, W. Dezan, K. Barnhart, S. Key, and T. Quinn. 2015. *Tracking and Monitoring of Marine Shoreline Stabilization Permits Final Report.* Habitat Program, Washington Department of Fish and Wildlife, Olympia, WA. Kinney, A., T. Francis, and J. Rice. 2015. Analysis of Effective Regulation and Stewardship Findings: A Review of Puget Sound Marine and Nearshore Grant Program Results, Part 1. Puget Sound Institute. Tacoma, WA. https://www.eopugetsound.org/articles/review-puget-sound- marine-and-nearshore-grant-program-results-part-1 Kinney, A., T. Francis, and J. Rice. 2016. Synthesis of 2011-2014 Results and Key Recommendations for Future Recovery Efforts: Final Analysis Report for the Puget Sound Marine and Nearshore Grant Program. Puget Sound Institute. Tacoma, WA. https://www.eopugetsound.org/articles/puget-sound-marine-and-nearshore-grant-program-results-final-analysis-report Dethier, M.N., W.W. Raymond, A.N. McBride, J.D. Toft, J.R. Cordell, A.S. Ogston, S.M. Heerhartz, and H.D. Barry. 2016. Multiscale impacts of armoring on Salish Sea shorelines: Evidence for cumulative and threshold effects. *Estuarine, Coastal, and Shelf Science* 175:106-117. https://www.sciencedirect.com/science/article/pii/S0272771416301007 Habitat Strategic Initiative. 2018. Narrative. Shoreline Armoring Implementation Strategy. Washington Department of Fish and Wildlife and Washington Department of Natural Resources. https://pspwa.box.com/v/PublicIS-ShoreArmoring Kinney, A., A. Sweetser, and T. Francis. 2019. Analysis of 2016-2019 Regulatory Effectiveness Investments: Addendum to the Part 1 Report. Puget Sound Institute. Tacoma, WA. https://www.pugetsoundinstitute.org/wp-content/uploads/2021/08/2019_Part-1-Addendum.pdf Kinney, A. and T. Francis. 2019. Analysis of 2016-2019 Shoreline Armoring Investments: A Review of Marine and Nearshore Grant Program Results, Part 4. Puget Sound Institute. Tacoma, WA. https://www.pugetsoundinstitute.org/wp-content/uploads/2021/08/2019_Part-4-Analysis-Report_shoreline-armoring.pdf
24	FIDEA, fishing data East Africa and practical fisheries management decisions	Tanzania, Zanzibar, and Mozambique Governance level: National.	Since 2019	Support the capacity of the fisheries management institutions. Bringing together both managers and researchers involved in fisheries research and management. Impact on the processes. Harmonising fisheries data collection.	Tuda, P. Strong participation from wio scientists in stock assessment training. Workshop report. https://meerwissen.org/fileadmin/content/images/partnership-projects/fidea/FIDEA_WIOMSA_article.pdf
25	Governance analysis applied to the process of creating marine protected areas (GOBAMP) Challenges for the governance of sustainable artisanal	Coastal waters of El Hierro, Canary Islands, Spain Governance level: Local.	2010-2020	Traditional uses maintained with different levels of regulation. Improving sea-based economic activities. Fishing activity better than in most of the fishing communities. Assessments of the state of conservation of the ecosystem are positive.	Galván Tudela, A. (1990). 'Pescar en grupo': De los azares ambientales a los factores institucionales (La Restinga, El Hierro). Eres (Serie de Antropología), 2:-39-60. Pascual Fernández, J. J., Batista Medina, J. A., & De la Cruz Modino, R. (2005). Reservas marinas, participación y desarrollo sostenible: ejemplos desde Canarias. In J. Pascual Fernández & D. Florido del Corral (Eds.), ¿Protegiendo los recursos? Áreas protegidas, poblaciones locales y sostenibilidad (Vol. VIII, pp. 45-62). Sevilla: Fundación El Monte, FAAEE, Asociación Andaluza de Antropología. Pascual-Fernández, J. J., & De la Cruz Modino, R. (2005). Mujeres, reservas marinas y estrategias de diversificación en las poblaciones litorales: el caso de los restaurantes de pescado. In K. Frangoudes & J. J. Pascual-Fernández (Eds.), AKTEA Conference: Women in Fisheries and aquaculture: lessons from the past, current actions and ambitions for the future (pp. 247-262). La Laguna, Tenerife: Asociación Canaria de Antropología.

	fisheries: creating synergies with marine conservation and tourism (GOBAMP II).			Recovery of the ecosystem after unforeseen disturbance.	Jentoft, S., Chuenpagdee, R., & Pascual-Fernandez, J. J. (2011). What are MPAs for: On goal formation and displacement. Ocean & Coastal Management, 54, 75-83. doi:10.1016/j.ocecoaman.2010.10.024 De la Cruz Modino, R. (2012). Turismo, pesca y gestión de recursos. Aportaciones desde La Restinga y L'Estartit. Madrid: Ministerio de Educación, Cultura y Deporte. Jentoft, S., Pascual-Fernandez, J., De la Cruz Modino, R., Gonzalez-Ramallal, M., & Chuenpagdee, R. (2012). What Stakeholders Think About Marine Protected Areas: Case Studies from Spain. Human Ecology, 40(2), 185-197. doi:10.1007/s10745-012-9459-6 De la Cruz Modino R., Pascual-Fernández J.J. (2013) Marine Protected Areas in the Canary Islands – Improving Their Governability. In: Bavinck M., Chuenpagdee R., Jentoft S., Kooiman J. (eds) Governability of Fisheries and Aquaculture. MARE Publication Series, vol 7. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-6107-0_12 Ordoñez García, P. (2015). El buceo en el entorno de La Restinga (El Hierro): elementos ambientales, socioeconómicos y de gobernanza. La Laguna, Tenerife: Universidad de La Laguna, Master Thesis in Marine Biology, supervisors Jose Pascual-Fernández y Raquel de la Cruz Modino. Pascual Fernández, J. J., Chinea Mederos, I., & De la Cruz Modino, R. (2015). Marine Protected Areas, Small-Scale Commercial Versus Recreational Fishers: Governability Challenges in the Canary Islands, Spain. In S. Jentoft & R. Chuenpagdee (Eds.), Interactive governance for small-scale fisheries: Global reflections (pp. 397-412). Dordrecht: Springer. Pascual-Fernández, J. J., De la Cruz Modino, R., Chuenpagdee, R., & Jentoft, S. (2018). Synergy as strategy: learning from La Restinga, Canary Islands. Maritime studies, 17, 85-99. doi:10.1007/s40152-018-0091-y

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1068 Supplementary Table 2: Themes emerging from inductive coding to the research questions of the
1069 initiation, goals, approaches, successes, enablers, lessons, and recommendations of the bright-spot
1070 examples (via survey participants, respectively).

Initiation (Agency, starting point)	**Bright-spots**	**References**
Policy pull	12	18
Research push	12	16
Third party	11	16
Goals		
Impact on policy	17	33
Create relevant knowledge	15	34
Impact on governance (-process or management)	12	26
Social outcomes	12	25
Societal well-being	9	12
Ecological	8	12
Provide knowledge to actors	4	5
Approaches		
Activities, actions	25	220
Connect diverse actors	19	52
Events	17	42
Meetings	17	33
Collate relevant knowledge	14	17
Conversations and dialogue	11	16
Public-facing efforts	10	19
Disseminate, communicate	10	18
Translate, synthesize	6	7
Weigh alternatives and priorities	5	8
Pre-engagement	3	5
Strategies, concepts	24	109
Co-production	18	44
Boundary work	17	30
Advisory boards, working groups or agencies	16	31
Products	14	30
Successes/Impacts on		
Policy	22	78
People	17	73
Governance (management, processes)	17	31
Reflective or comparative	15	24
Process quality	12	16
Research, knowledge base	11	25
Society	9	27
Organizations or agencies	9	15
Creation of new products	7	12
Environment	7	10
Financial	3	7

Enablers		
Actors	23	129
Interpersonal	18	51
Actor group and openness	18	38
Personal	15	35
Understanding expertise, differences and restrictions	3	5
Processes	22	60
Methodological	20	48
Process characteristics	8	12
Support	16	68
Financial	11	15
Political	8	19
Public	6	24
Organizational	5	10
Contexts	16	61
Background	14	36
Local community	7	24
Timing and urgency	13	32
Timing and opportunity	10	18
Topic, need, urgency	8	14
Lessons learnt		
Recognize and engage those to be involved	11	16
Consider time and timing	8	10
Boundary work and context	8	8
Value people and relationships	6	9
Expect challenges along the way	5	5
Accept that politics matters	4	6
Invest in trust and consistency	3	6
Focus beyond only science and policy	3	4
Governance context	3	3
Recommendations to others		
Personal	16	34
Process	12	35
External	7	13
Interpersonal	5	13

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1074 Supplementary Table 3: Emerging goals, successes, and enablers. Total number of sources (i.e., bright-
1075 spots) and number of references are given (grey), as well as the fractions of sources referencing the
1076 themes within the 4 international, 10 national, 5 regional, and 6 local marine science-policy bright-
1077 spots.

	Total #sources	(N=25) #ref	International N=4	National N=10	Regional N=5	Local N=6
Goals						
Impact on policy	17	33	50%	90%	40%	67%
Create relevant knowledge	15	34	75%	40%	80%	67%
Impact on governance (process, management)	12	26	50%	40%	60%	50%
Social outcomes	12	25	50%	50%	60%	33%
Societal well-being	9	12	50%	30%	0%	67%
Ecological	8	12	0%	30%	40%	50%
Provide knowledge to actors	4	5	0%	30%	20%	0%
Successes/Impacts on						
Policy	22	78	100%	90%	100%	67%
People	17	73	50%	60%	100%	67%
Governance (management, process, approach)	17	31	50%	70%	60%	83%
Reflexive or comparative	15	24	75%	50%	80%	50%
Process	12	16	50%	40%	80%	33%
Research, knowledge	11	25	50%	40%	80%	17%
Society	9	27	0%	40%	20%	67%
Organizations or agencies	9	15	50%	50%	40%	0%
Products	7	12	75%	10%	40%	17%
Environment	7	10	50%	10%	20%	50%
Financial	3	7	0%	0%	60%	0%
Impact on industry	1	2	0%	10%	0%	0%
Enablers						
Actors	23	129	75%	100%	80%	100%
Interpersonal	18	51	50%	80%	40%	100%
Actor group and openness	18	38	75%	100%	60%	33%
Personal	15	35	50%	70%	20%	83%
Understand differences/restrictions	3	5	25%	10%	0%	17%
Processes	19	44	100%	80%	100%	83%
Methodological	15	32	100%	70%	100%	67%
Process characteristics	8	12	25%	30%	40%	33%
Support	15	44	50%	60%	100%	50%
Financial	11	15	25%	50%	60%	33%
Political	8	19	25%	40%	40%	17%
Public attention and support	6	24	25%	20%	40%	17%
Organizational	5	10	0%	40%	0%	17%
Contexts	19	77	25%	70%	60%	83%
Background	14	36	25%	60%	60%	67%
Local community	7	24	0%	20%	0%	83%
Timing and urgency	15	56	75%	70%	40%	17%
Timing and opportunity	10	18	25%	70%	40%	0%

Topic, need, urgency	8	14	50%	30%	40%	17%

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