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# Recycling data for Marine Spatial Planning: A review of maritime plans in Europe

Juliette Davret, Brice Trouillet

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1 **Titre** : Recycling data for Marine Spatial Planning: A review of maritime plans in Europe

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3 **Auteurs** : Juliette Davret et Brice Trouillet

4  
5 **Affiliation** : Nantes Université, CNRS, LETG, UMR 6554, F-44000, Nantes, France

## 6 **Introduction**

7  
8 The management of marine areas is increasingly reliant on environmental data, but  
9 environmental activists have recently observed that data is being withheld by some  
10 governments<sup>1</sup>, which hampers evidence-based decision-making for the conservation of  
11 marine ecosystems. Despite European directives like 2008/56/EC<sup>2</sup>, establishing a strategic  
12 framework for the sea, and 2014/89/EU<sup>3</sup>, for marine spatial planning (MSP), which  
13 demonstrate the importance that governments place on the protection and sustainability of  
14 the marine ecosystem (Guinan et al., 2021), there remain gaps in the availability and  
15 accessibility of data. Initiatives such as the European Marine Observation and Data Network  
16 (EMODnet) and European Ocean Observing System (EuroGOOS) aim to improve data  
17 access and sharing, but issues are still present in terms of data coverage, quality and  
18 harmonisation (Martín Míguez et al., 2019).

19 Unfortunately, tools like EMODnet, which focus on spatial data, often overlook non-spatial  
20 data, meaning the information required for marine planning is often incomplete (Holzhüter et  
21 al., 2019). The MSP process requires 'reliable', 'evidence based' data, i.e. the 'best available  
22 data' (Directive 2014/89/EU), since it is, in theory, an evidence-based process (MSP Data  
23 Study, 2016). However, the inconsistency of ecological indicators between EU member  
24 states and the absence of cross-border harmonisation hinder effective implementation of  
25 MSP (Stamoulis & Delevaux, 2015). It is essential that these problems are addressed by  
26 analysing the data used in existing European marine plans, to allow evidence-based policies  
27 to be implemented for sustainable marine management.

28 This study focuses on the data used in MSP, as examined through planning documents. The  
29 data lifecycle is traced by studying the maps, sources and proposed analyses in the plans.  
30 For this article, the term 'lifecycle' refers to the genealogy of data, from production to  
31 representation on maps. Since datafication is now a widespread phenomenon, the quality  
32 and amount of data at each phase of the MSP process must be questioned (Holzhüter et al.,  
33 2019), to understand the knowledge produced by MSP data (who produces it, how it is  
34 produced and for what purpose) while analysing the power dynamics that influence planning.  
35 The hypothesis is that if the complex interaction between human activities and the marine  
36 environment cannot be captured by studying the data, it may not meet the environmental  
37 protection goals set by the European directive. However, if data is only used later in the  
38 planning process, it may merely serve to justify political decisions (Batty, 2022).

39 The study contributes to the critical literature on MSP by addressing the quality and  
40 relevance of the data used. It questions whether the data effectively represents the  
41 multidimensional relationships in marine environments and discusses unfixed spatial  
42 boundaries. This article is divided into five sections. Section 1 addresses gaps in the  
43 literature. Section 2 describes the methodology and offers a justification of the focus on  
44 European planning documents to carry out a comparative study based on the common  
45 requirements set out in Directive 2014/89/EU. An explanation is also given for the focus on  
46 environmental data in this paper rather than any other data available for MSPs. Section 3  
47 details the results. Section 4 discusses the entanglement of digital and data governance in  
48 marine planning, and section 5 is the conclusion.

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1 <https://bloomassociation.org/un-ete-meurtrier>

2 Directive establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive), 2008/56/EC (2008). <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008L0056>

3 Directive establishing a framework for maritime spatial planning (MSP Directive), n° 2014/89/EU (2014). <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014L0089>

## Section 1. Use of data in marine spatial planning: quantifying marine issues with data

### 1.1 Data integration and quality issues in MSP

Data harmonisation has been the focus of many recent studies and is often discussed in scientific publications as being an urgent necessity to fulfil MSP objectives (Ehler, 2008; Hattam et al., 2015; Holzhüter et al., 2019; MSP Data Study, 2016; Stamoulis & Delevaux, 2015). Strain et al. (2006) suggested that spatial information plays a significant role in decision-making since it provides the geographical context for plans. Results reported by Holzhüter et al. (2019) and Schaefer & Barale (2011) suggest that the temporal dimension is also important for managing human activities at sea, since both the ecosystem and human activities are subject to seasonal shifts and adjustments are therefore required to ensure compatibility. The three-dimensional aspect of marine space must also be taken into account, which further complicates the management of marine space and reinforces the importance of geographical information. It is also essential to consider the temporal dimension of activities at sea. In a 2014 paper, Shucksmith and Kelly reported on the limited implementation of spatial and temporal aspects of the dataset used for MSP. In spite of these findings, the inclusion of spatial and temporal aspects in datasets remains limited in practice. Various studies have examined the data used in MSP and revealed significant gaps and disparities in the processing of data for planning purposes between countries (e.g. Shepperson et al., 2018; Trouillet, 2019, 2020). These studies reveal the growing importance of data in planning and reinforce the need to improve our understanding of how data is produced and used.

The number of multinational projects involving MSP data studies has increased over the last five years, but few researchers have addressed the issue of the quality of the data used. UNESCO recently compiled a report of the marine environment in the Mediterranean based on a survey of the stakeholders involved, which highlights gaps in the data relating to various activities and spatial representations (UNESCO-IOC, 2021). The eMSP-NBSR project has also conducted a survey on the use of data and information to better understand the consistency and limitations of the data used in MSP for the Baltic Sea and Northern European countries, and discuss improvements to it (Lequesne and Souf, 2023). This survey reinforces the importance of data in planning. Both the UNESCO survey and the eMSP-NBSR project demonstrate that there are major disparities between countries in the way data is handled for planning purposes.

These studies on the data used for planning purposes are valuable as a snapshot of how data is used, but do not provide an understanding of the power-knowledge relationships at work in the data production, and should therefore be extended. For instance, Batty (2022) reveals that (urban) planning is based only on downstream data processes and not upstream ones, and encourages a change in this practice to fulfil planning requirements, which would suggest the need for a similar, more thorough investigation of this aspect as it relates to marine planning. Critical data studies have also shown that data processing is never neutral but influenced by multiple choices from data collection to dissemination (Dalton & Thatcher, 2014; Kitchin, 2021). In terms of MSP, some of the critical data studies on which it is based focus on a single activity, indicating the influence of knowledge production and a 'missing layer' (i.e. a lack of data for certain marine activities which are therefore not taken into account when planning) (St. Martin & Hall-Arber, 2008). The absence of information relating to various specific activities is well documented in the literature (e.g. fishing, as studied by Leroy, 2018 and Trouillet, 2019). Some studies of data used in MSP have focused on environmental data (McGowan et al., 2013; Ryan et al., 2018; Weatherdon et al., 2015), questioning its quality and usage. Environmental data is of particular interest in terms of MSP goals, as it must enable 'ecosystem and biodiversity conservation' (paragraph 1, Directive 2014/89/EU) and ensure that "the collective pressure of all activities is kept within levels compatible with the achievement of good environmental status, and that the capacity of marine ecosystems to respond to human-induced changes is not compromised, while contributing to the sustainable use of marine goods and services by present and future

105 generations” (paragraph 14, Directive 2014/89/EU). Data quality issues should be addressed  
106 by documenting the internal and external quality of data (Devilliers & Jeansoulin, 2006),  
107 which has so far eluded analyses of environmental data in planning. The ‘internal’ quality of  
108 data refers to its properties and characteristics, measured by the difference between the  
109 data that should be produced and the data that is actually produced. The ‘external’ quality is  
110 the alignment of data with usage needs, measured by the difference between the necessary  
111 or ideal data, and the data that is actually produced. In addition to data quality, other studies  
112 have looked at the production of data more suited to the challenges faced by MSP and at  
113 data harmonisation (Dosell et al., 2021; Guinan et al., 2021; Holzhüter et al., 2019), but  
114 again, only limited examples are given, and these do not cover the whole range of issues  
115 potentially linked to data production for planning purposes.

## 117 **1.2 Intra-action as the foundation for ecosystem interconnection**

118 Academic research has focused on the ‘ecosystem-based’ approach promoted by the MSP  
119 directive (e.g. Domínguez-Tejo et al., 2016; Douvère, 2008; Douvère & Ehler, 2009; Gilliland  
120 & Laffoley, 2008), which in theory fulfils the need for a balanced approach between  
121 environmental conservation and the development of offshore activities. In practice,  
122 Domínguez-Tejo et al. (2016) point out in a comparative study that the relevant aspects are  
123 rarely considered in an ecosystem-based approach, in particular the assessment of human  
124 activity pressures, but also social values and non-market activities. Schwartz-Belkin and  
125 Portman (2023) provide a literature review specific to the ecosystem-based management  
126 approach and the challenges posed by limitations of the data available.

127 The authors identify geospatial technologies that can help navigate the challenges of MSP.  
128 The research for the present study extends to the environmental data used in MSP, through  
129 the concept of an ecosystem. We do this by exploring the theoretical framework of intra-  
130 action, as articulated by Barad (2007). This framework provides new insights to understand  
131 the term ‘ecosystem’ as the construction of environmental data layers and the dynamic  
132 relationships between human and non-human actors. Intra-action, as a concept, moves  
133 beyond the traditional view of interaction, where entities are assumed to pre-exist in their  
134 relationships. Instead, intra-action posits that entities emerge through specific engagements  
135 or ‘intra-actions’ – relations that enact their properties and boundaries.

136 Barad’s theory, grounded in quantum physics and philosophical inquiry, challenges the  
137 notion of independent relata (objects, entities or agents) that come into interaction. Instead,  
138 Barad argues that entities take on their properties through specific intra-actions. For  
139 example, in quantum experiments, particles like electrons do not pre-exist as entities with  
140 definite properties such as position or momentum. These properties emerge through  
141 measurement, with some attributes (e.g. position) becoming determinate while others (e.g.  
142 momentum) being excluded. This principle, known as complementarity, illustrates that  
143 properties are not intrinsic to particles but are enacted through their entanglements within  
144 experimental setups (Hollin et al., 2017). As Barad states, “Relata do not preexist relations;  
145 rather, relata-within-phenomena emerge through specific intra-actions.” (Barad, 2007, p.  
146 140). Applied to ecosystems, this principle suggests that the elements of an ecosystem  
147 (species, habitats, human activities, technologies, etc.) do not exist as static, isolated  
148 entities, but emerge through their dynamic relationships. This has profound implications for  
149 how we understand and manage marine systems under the MSP framework. Intra-action  
150 offers a theoretical lens to deepen our understanding of an ecosystem-based approach by  
151 emphasising the co-constitution of human and non-human actors. For instance, marine  
152 planning traditionally addresses human-environment interactions, such as the impact of  
153 fishing or offshore energy infrastructure on marine ecosystems. In contrast, intra-action  
154 highlights how these relationships actively shape the entities involved. A fishing vessel, for  
155 example, is not merely an external actor imposing pressure on fish populations. Instead, its  
156 practices, technologies, and impacts are co-constituted through its entanglement with the  
157 marine environment, regulatory frameworks, and societal needs.

158 In MSP, the aim of the ecosystem-based approach is to handle the various uses of marine  
159

160 space (fishing, energy, conservation, transport, etc.) in an integrated manner, while  
161 considering the underlying ecological interactions (e.g. the trophic relationships between  
162 species, ocean current movements and biogeochemical cycles). Intra-action complements  
163 this by adding a deeper theoretical dimension, emphasising that these elements and  
164 interactions are not pre-given, but are dynamically constituted through their relationships.  
165 Kaufmann and Leese (2021) introduce the concept of ‘information in-information’ to describe  
166 how environmental data emerges from the entanglements of human and non-human  
167 activities. This aligns with Barad’s agential realism, which insists that scientific practices,  
168 such as data collection and interpretation, actively participate in creating the phenomena  
169 they describe. Applying intra-action to marine planning enables a shift beyond the traditional  
170 conceptions of human-environment interaction and recognises how relationships between  
171 humans, nature and technology are intertwined (Lehman, 2016).

172  
173 Intra-action and the ecosystem-based approach converge in their recognition of the  
174 dynamic, interdependent relationships within marine systems. While the ecosystem-based  
175 approach emphasises interconnection, intra-action underscores the co-constitution and  
176 continuous flux of these relationships. This understanding enhances our ability to navigate  
177 with complexities of MSP, providing a robust framework for integrating human and ecological  
178 dimensions in a more holistic and adaptative manner. When applied to European MSP, it  
179 provides a basis of common environmental requirements for conducting a comparative  
180 study.

## 181 182 **Section 2: Materials and Methods**

183  
184 The method used for this research is a content analysis of the maritime plans in Europe. A  
185 comparative analysis of all the plans falling within the scope of Directive 2014/89/EU for the  
186 first MSP cycle was carried out. This method should be considered in the light of the  
187 theoretical framework developed - the intra-action approach - to understand how data is  
188 produced in the ecosystem-based system promoted by the European directive.

### 189 190 **2.1 Indicators**

191  
192 Barad’s theory (2007) was applied to establish whether the data used is in line with the  
193 ecosystem-based approach required by the MSP directive. In accordance with the findings  
194 of Barad (2007) and Kaufmann and Leese (2021), it was considered essential to carefully  
195 analyse the specifics of the relationships between data and its lifecycle, and to employ the  
196 concept of ‘information in-information’ (Kaufmann and Leese, 2021), to describe the  
197 entanglement of data in planning. Information in-information refers to a continuous process of  
198 formation and transformation of structures, whether biological, social or technological. Unlike  
199 a static conception of information where it is perceived as a fixed set of data, the concept of  
200 ‘in-information’ creates a dynamic that shapes and restructures systems. By applying the  
201 concept of ‘in-information’ to the MSP context, a holistic view of the processes that shape  
202 interactions between marine environments and human activities can be created to better  
203 understand how these systems are structured and adapt in space and time. This approach  
204 enables us to grasp the complexity of ecological dynamics and their relationships with social  
205 and economic dynamics. By exploring what it means to form information in the context of  
206 developing a policy for managing marine space, from an ecosystem-based perspective in  
207 particular, it should be possible to show how the interactions between data and humans  
208 generate knowledge and action.

209 The ecosystem-based approach involves integrated management of the ecosystems,  
210 including all their ecological components and interactions with human activities, while  
211 respecting the ecological limits of the system. One key aspect of the ecosystem-based  
212 approach in Europe is the integration of ecosystem services, i.e. the benefits that humans  
213 derive from ecosystems (resources such as fisheries, the regulation of ecological processes,  
214 support for basic ecological functions, the cultural and aesthetic value of ecosystems, etc.).

215 In the context of MSP, the assessment and mapping of these services enables us to  
 216 understand and visualise how marine ecosystems support critical socio-economic functions.  
 217 Directive 2014/89/EU promotes an integrated cross-sectoral, cross-border approach. The  
 218 use of an ecosystem-based approach (paragraph 14) is intended to help promote the  
 219 sustainable development and growth of marine and coastal economies and the sustainable  
 220 use of marine and coastal resources. The MSP directive also mentions (paragraph 13) the  
 221 pressures on ecosystems and resources resulting from human activities, climate change and  
 222 natural risks. It encourages consideration of land-sea interactions and human and non-  
 223 human interactions (paragraph 16). The MSP should also take into account the temporal  
 224 aspect of activities and, in particular, any possible long-term variations (paragraph 19). To  
 225 this end, the governments responsible for implementing MSP must base their plans on  
 226 'reliable data [...] [and] use of the best available data and information by encouraging  
 227 relevant stakeholders to share information and [use] existing instruments and tools for data  
 228 collection' (paragraph 24). The approach used in this study is based primarily on three key  
 229 aspects: (1) knowledge of ecosystems and the variations they may undergo; (2) the  
 230 superposition of data to assess interactions; (3) the use of impact indicators derived from  
 231 this data. These three data evaluation points enable documentation of the interactions  
 232 between natural environments and between human and non-human aspects of marine  
 233 space. Analysing the diversity of available data should enable us to assess the potential  
 234 differences that exist in data production. However, there are significant challenges involved  
 235 in representing marine ecosystems in map form. While mapping species and habitats is a  
 236 relatively well-established practice, mapping ecosystems as a whole is more complex,  
 237 because it involves not just the biological composition of an area but also the interactions  
 238 between different biotic and abiotic components and their spatial-temporal dynamics. This  
 239 process is subjective because ecosystems are not static entities, they are in perpetual  
 240 reconfiguration, which makes cartographic representation less straightforward.

242 Documenting ecosystems and the parameters that influence them reveals the 'information  
 243 in-formation' where certain information, taken independently, would be interpreted differently.  
 244 The impact indicator approach facilitates the documentation of data entanglement as it is  
 245 produced by combining different types of data to assess the overall position. The study of  
 246 data production based on environmental data is of particular interest since this aspect of  
 247 offshore planning is indicated in the text of the MSP directive. The method has been used  
 248 previously in comparative studies in Europe and beyond (e.g. Trouillet, 2020). Based on this  
 249 premise, three questions were determined with reference to the ecosystem-based approach  
 250 as framed by MSP framework:

- 251 - Question 1 (Q1): What types of data are available to map ecosystems?
- 252 - Question 2 (Q2): Is there any data available on map entanglements (or intra-action)?
- 253 - Question 3 (Q3): Can the data produced support a multidimensional approach?

255 By studying this in terms of the information available on European marine plans and  
 256 documenting how the data is used, documentation maps in particular, and by looking  
 257 specifically at the data used - which must facilitate fulfilment of the directive's objectives - the  
 258 aim is to understand which human or technical factors influence MSP. The three questions  
 259 developed by analysing the corpus were broken down into a number of indicators (Table 1):

261 Table 1. Indicators applied to European MSP initiatives

Question	Coding	Label	Comment	Indicator	Value	Explanation
Q1	I1	Ecosystem representation	Factual assessment of whether data is available to represent	<b>Are ecosystem areas documented?</b>		

			ecosystems			
				Yes	2	The entire marine zone is documented
				Partially	1	Only certain areas are mentioned. Mostly, the plan consists of zoning, and some parts of the maritime area have no assigned zoning.
				No	0	No mention of ecosystems
Q2	I2	Data overlay	Creation of new information ('information information')	<b>Is there any data overlay?</b>		
				Yes, resulting in a new layer of information	2	Information is generated and displayed from data overlay. On the maps, a reference to the overlapping of two layers of data clearly appears as the result of a new layer of information on the maritime space.
				Yes, but it does not result in a new layer of information	1	Information from the overlay data is not mentioned. On the maps, the overlapping of various data can be seen but this does not result in a new interpretation or analysis of the maritime space. E.g. overlapping zoning on a map.
				No	0	No overlaying information. The maps do not overlay information; each layer is analysed independently of the others.
	I3	Indicator resulting from the combination of several data items	Highlighting the co-construction relationships (intra-action)	<b>Are there any indicators of impact on the marine area?</b>		
				Yes	2	An impact assessment is carried out for all activities presented in

						the document. This does not guarantee that it is complete, but it does include all the activities presented in the document.
				Partially	1	Impact indicator not established for all activities. Only some of the activities are taken into account in the impact assessment.
				No	0	There is no indication of impact assessment on the marine area
Q3	I4	Potential conflicts documented	Multidimensional approach to offshore activities	<b>Is a multidimensional approach to marine space documented ?</b>		
				Yes	2	The multidimensional approach concerns the entire marine area
				Partially	1	The multidimensional approach concerns only part of the marine area or some of the marine activities
				No	0	There is no multidimensional approach documented in the document

263  
264 The four indicators were applied to the corpus by analysing the maps of the marine plans.  
265 This approach aimed to document the answers to the three main questions as factually as  
266 possible and to draw general conclusions. While this method evaluated the data used for  
267 MSP, it does not assess the effectiveness of the various approaches. For instance, it does  
268 not question whether the entire area is documented, albeit with average-quality data, nor  
269 whether only a portion is documented but with high-quality data. The objective is broader: to  
270 understand how ecosystems are characterised within the MSP process.

## 271 272 **2.2 Corpus** 273

274 Since the intention was to compare different marine plans, only plans drawn up in response  
275 to the MSP directive were considered. A corpus of marine plans based on the scope of this  
276 framework was created in 2021 for this study. Plans were selected on the basis of the  
277 census carried out by the European Commission within the framework of the European MSP  
278 Platform<sup>4</sup>, an information and communication website designed to offer support to all EU  
279 member states in their implementation of MSP, which existed prior to 2022 (details in  
280 Appendix 1). The MSP directive required all EU coastal member states to draw up an  
281 intersectoral plan for their marine areas by 2021. The main advantage of this method is that  
282 the MSP directive calls for a certain homogenisation of plans with a view to meeting the

<sup>4</sup> <https://maritime-spatial-planning.test.ec.europa.eu/>



283 requirements at least, which for the purposes of this study enabled the application of an  
284 analysis grid that should be compatible with the various plans. Conversely, the main  
285 limitation is that the plans cannot summarise all the documents produced as part of the  
286 planning exercise. Some elements may therefore have been overlooked in the present  
287 analysis.

288 The inclusion of the United Kingdom on the European MSP Platform and in this corpus is  
289 worth mentioning here, despite its withdrawal from the EU. The development plans for the  
290 UK's seaboard formerly fell under the purview of the MSP directive. Norway, on the other  
291 hand, is not a member of the EU and is not obligated to comply with the aforementioned  
292 directive. Nevertheless it complies with approximately 95% of EU directives through other  
293 European environmental policies, which raises pertinent questions as to why it is excluded  
294 from the corpus. To maintain coherence, the corpus is aligned with the European MSP  
295 Platform in its pre-2022 form, choosing to exclude Norway but include the United Kingdom in  
296 the analytical framework.

297 The corpus was made up of the most tangible elements of planning documentation, maps in  
298 particular, to identify the data used. In observing the planning documents, the maps  
299 contained in them were analysed with the aim of tracing them back to the data.

300 Consequently, the corpus is made up of 38 planning documents from 23 countries (finalised  
301 or under development). Each country is responsible for developing its own marine plan;  
302 translating the marine plans drafted in different European languages was a laborious task,  
303 especially those containing graphic materials such as maps, where contextual understanding  
304 is crucial. Although it was theoretically possible to attempt translation, the results were often  
305 too imprecise to be reliable, particularly in the case of automated translation, as many of the  
306 documents were neither in French nor in English. This applied to 19 plans from 12 countries,  
307 making their content difficult to interpret accurately. Consequently, the analysis grid has  
308 been used with 19 marine plans from the 11 countries that were intelligible to us.

309

### 310 **Section 3: Results**

311

312 This study is an in-depth examination of the operational component of MSP at a significant  
313 juncture, but is not intended to be exhaustive.

314 From the vast amount of documentation compiled, we have opted to provide a synthesis of  
315 the results in this section and include detailed listings in the appendices. The outline results  
316 of the analysis of 19 marine planning documents appear below (Table 2 and Appendix 2).

317 These results focus solely on trends and overall proportions rather than a thorough statistical  
318 analysis, which would lack significance due to the limited number of MSPs involved:

319

- 320 • Indicator I1: Marine ecosystems are documented for the entire planning area for 8 of  
321 the 19 MSP initiatives and are partially documented in 11 MSP initiatives in the maps  
322 published, notably the ones corresponding to protection zones.

323

324 For clarity, the result is illustrated with examples. All the plans and maps mentioned in the  
325 results section are detailed in Appendices 1 and 2. A comparison of the marine ecosystem  
326 mapping data for Ireland and the Netherlands revealed significant disparities. Ireland  
327 benefits from the support of exhaustive coverage of its exclusive economic zone, as  
328 illustrated on the associated geoportal (<https://atlas.marine.ie>) used to produce the maps.  
329 The online atlas also revealed the diversity and richness of the available datasets, ranging  
330 from biodiversity to climate change and environmental monitoring. In the Netherlands, on the  
331 other hand, only areas of ecological interest were mapped in the environmental part of the  
332 MSP, Natura 2000 in particular (Fig.1). Closer observation reveals that this data was not  
333 specifically produced for planning purposes but taken from other management projects.

334

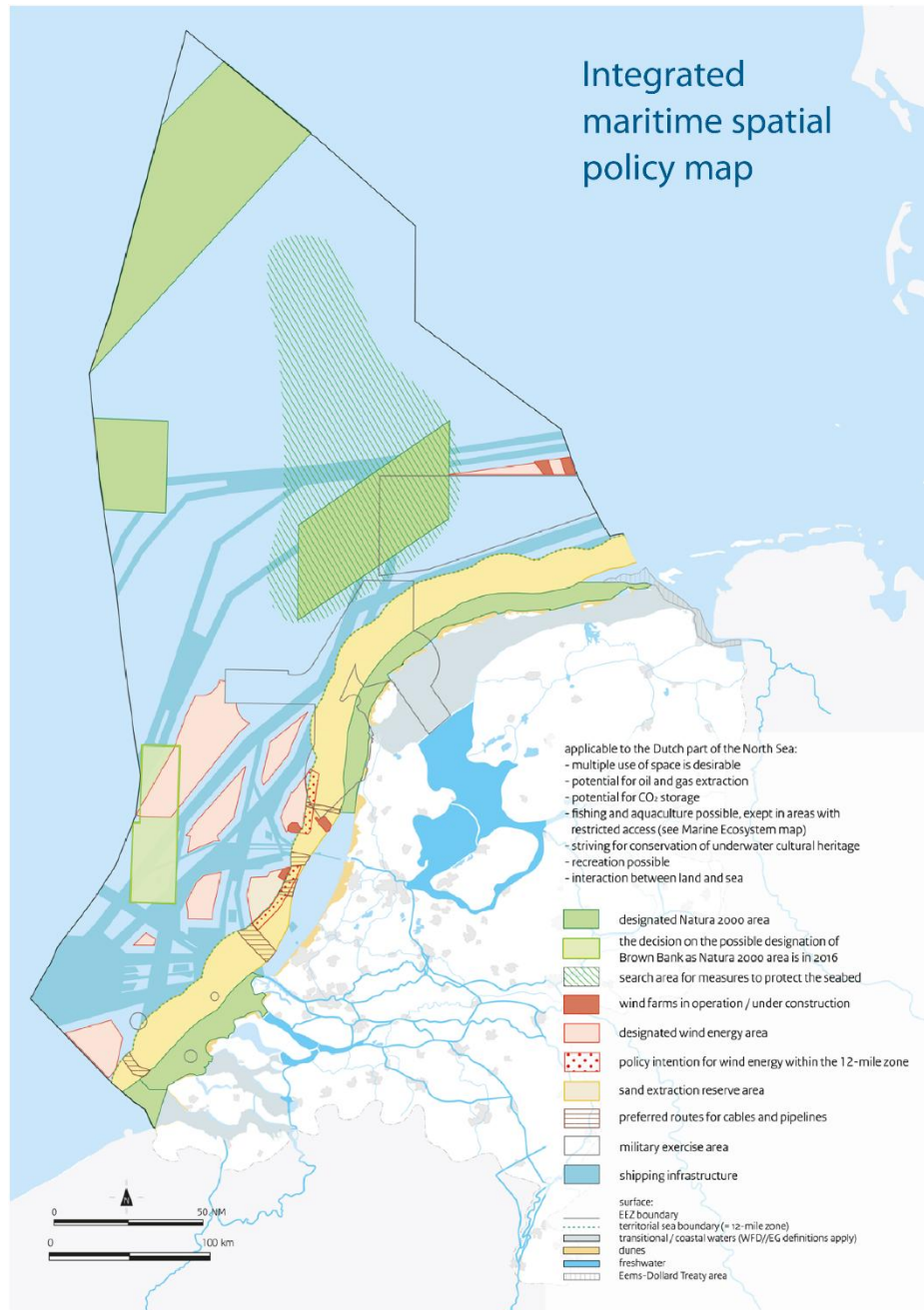


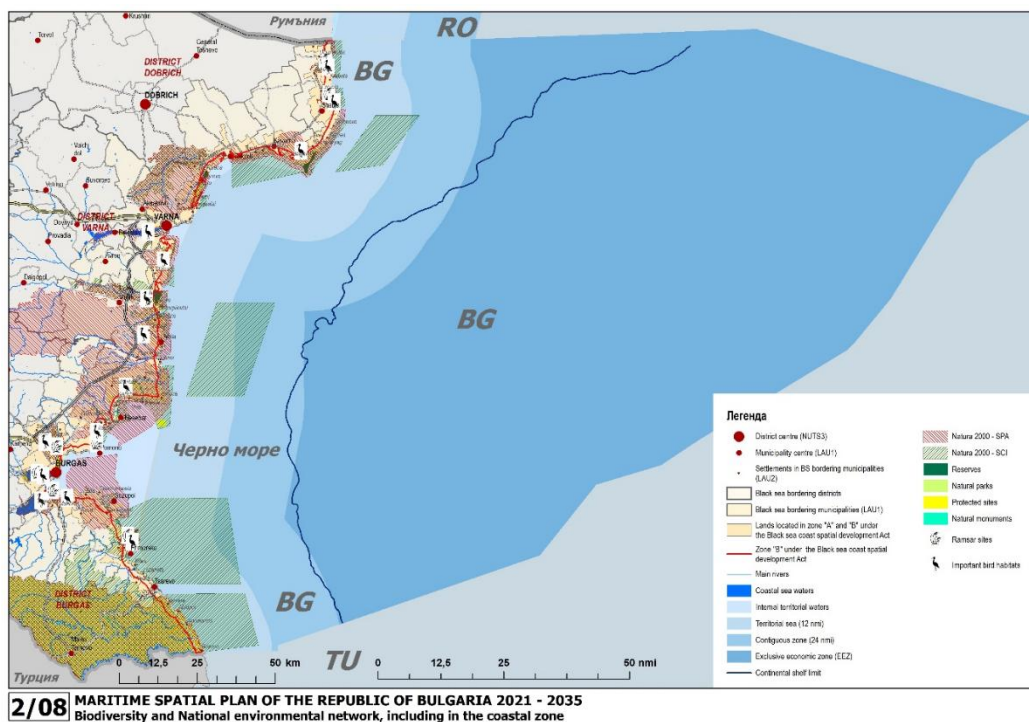
Figure 1. Netherlands' integrated maritime spatial policy map

Looking closely at the data sources, it is clear for both Ireland and the Netherlands that the data comes from various government bodies, not necessarily produced for planning purposes and often taken from other projects and recycled for MSP purposes. It is also important to note that access to metadata, which is essential for understanding how data is produced, is often hindered by a lack of translation or an uneven multilingual implementation, limiting its usability for the authors of this paper. This situation was particularly challenging for understanding the choices and processes involved in the production and representation of data.

- Indicator I2: in 9 of the 19 MSP initiatives, the plans use a combination of data related to ecosystems and human activities to generate new information as the basis for an ecosystem-based approach. In 10 MSP initiatives, the use of data related to

351 ecosystems and human activities only resulted in a graphical overlay of information  
352 and did not generate any new information.

353  
354 Taking Bulgaria as an example to explain this result, the data made available to document  
355 ecosystems was treated as zoning. The map in the MSP document shows an overlay of  
356 certain zonings but does not result in any new information (Fig. 2).  
357



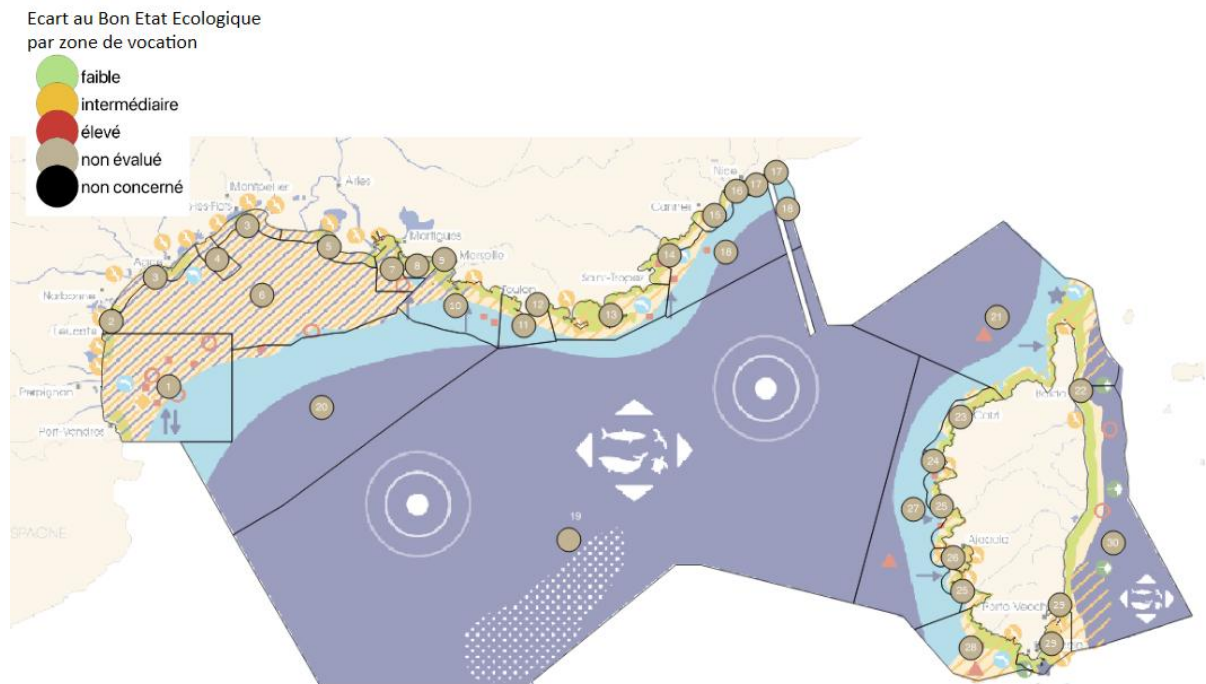
358  
359 Figure 2. Map of the Bulgaria Marine Spatial Plan  
360

361 The map is mainly descriptive and the lack of information resulting from the overlapping of  
362 zones illustrates the difficulty of incorporating all the dimensions of marine areas. One  
363 explanation for this could be the lack of information on the overlaid zones due to missing  
364 datasets, but may also be the result of representation choices. Since we were not able to  
365 access the metadata when this analysis was carried out (the document was not finalised at  
366 that time), no significant correlation can be noted.  
367

- 368 • Indicator I3: in 8 of the 19 MSP initiatives, the choice of an ecosystem-based  
369 approach led to the creation of map-based impact indicators between data on natural  
370 ecosystems and human activities. In 11 MSP initiatives, the document did not  
371 establish impact indicators cartographically.  
372

373 The French Mediterranean coast is a good example of this indicator, where local authorities  
374 employed an independent consulting firm to devise a system for assessing the impact of  
375 marine activities. The approach used is detailed in the appendix to the planning document;  
376 data creation is determined from the scale used to assess impacts in relation to the actions  
377 set out in the plan. This impact assessment method is limited since some data was  
378 incomplete or unavailable. According to the MSP document notes, for example, little is  
379 known about the distribution of marine mammals in the Mediterranean by the *Office Français*  
380 *de la Biodiversité* (French National Institute for Biodiversity), which provided the data for  
381 MSP. The lack of available datasets means the impact cannot be assessed quantitatively. In  
382 this case, the lack of information means that no indicators can be mapped (Fig. 3).  
383

## ENJEU MAMMIFERES MARINS ET TORTUES



Source des données : évaluation environnementale du programme d'actions du DSF réalisée par Epices  
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Figure 3. Environmental impact assessment on Mediterranean marine mammals

- Indicator I4: the 19 MSP initiatives can provide only partial multidimensional mapping, for various reasons: not all human activities are included; certain marine biological areas are missing; one of the multidimensional variables of maritime space is absent (e.g. depth or time variable).

Wales is used to illustrate this indicator. The MSP data was supplied by the government for a specific purpose, most of it having been produced for the Marine and Coastal Access Act 2009. Once again, it is unclear whether comprehensive multidimensional aspects of the marine space are unavailable due to a lack of specific data creation, processing, representation choices, or the technological limitations of the geoportals associated with marine plans (Davret et al., 2023).

Table 2. Results of 19 MSP initiatives analysis (details in Appendix 2)

Country	Plan Area	I1	I2	I3	I4
Finland	EEZ	●	●	●	●
Ireland	EEZ	●	●	●	●
Latvia	EEZ	●	●	●	●
France	Mediterranean sea	●	●	●	●
France	Easter English Channel – North Sea	●	●	●	●
France	North Atlantic – Western English Channel	●	●	●	●
France	South Atlantic	●	●	●	●
Bulgaria	EEZ	●	●	●	●
United Kingdom	East England	●	●		●
United Kingdom	Northern Ireland	●	●		●
United Kingdom	Scotland	●	●		●
United Kingdom	South England	●	●		●
United Kingdom	Wales	●	●		●
Germany	Baltic Sea	●	●		●
Germany	North Sea	●	●		●
Belgium	EEZ	●	●		●
Denmark	EEZ	●	●		●
Malta	EEZ	●	●		●
Netherlands	EEZ	●	●		●

●	Yes
●	Partially
	No

401  
402 As highlighted in Table 2, our analysis of 19 MSP documents from around Europe reveals  
403 that an ecosystem-based approach to marine spaces is often incomplete, particularly in  
404 terms of mapping. From the data shown in Table 2, it is apparent that given the  
405 multidimensional nature of marine space, a wide range of data is required (such as spatial  
406 sea bottom and surface data, temporal data, etc.). However, these requirements are likely to  
407 encounter limitations in terms of techniques, knowledge, tools or the media used to  
408 transcribe them.

409 Table 2, which answers our three main questions, demonstrates that:

- 410
- 411 • (Q1) Plans with detailed ecosystem mapping tend to use data that highlights the
  - 412 spatial variability of ecosystems, while those with partial mapping often use
  - 413 fragmented data, including zoning data;
  - 414 • (Q2) Plans that incorporate data overlay to generate new information generally
  - 415 provide mapped impact indicators, unlike maps that overlay data without creating
  - 416 new information;
  - 417 • (Q3) Data manipulated and used in the plans we examined does not allow for a
  - 418 completely multidimensional approach, and the limitations inherent to this problem,
  - 419 such as technological constraints, data production, processing and representation
  - 420 choice, often remain unidentified.

421

422 In general, these results indicate that there are gaps in ecosystem-based approaches,  
423 particularly in terms of mapping. Although marine ecosystems are documented  
424 comprehensively in some plans, others are only partially documented, underscoring the  
425 disparities between MSPs. While some initiatives effectively integrate data from ecosystems  
426 and human activities to generate new information and impact indicators, others simply  
427 overlay data without creating any meaningful new insights. Data limitations and technological  
428 constraints often impede a comprehensive multidimensional approach to MSP, emphasising  
429 the need to improve data accessibility, comprehensiveness and integration for more effective  
430 marine planning.

431 This result highlights the differences in availability and nature of the environmental data used  
432 in different European countries, and the challenges associated with understanding data  
433 production in the context of maritime planning.

434

## 435 **Section 4: Discussion**

436

437 This study examines a variety of aspects relevant to MSP, focusing on the analysis of data  
438 used in the planning process. This reinforces the intra-action theory and demonstrates the  
439 benefit of examining the data lifecycle in critical data studies to better understand how  
440 marine space is governed. A lack of data transparency or completeness reveals the limits of  
441 evidence-based governance policies.

442

### 443 **4.1 Examining data quality through map-making**

444

445 Interestingly, the results of our analysis of the data approach to marine planning reveal that,  
446 beyond the factual responses to the indicators, the majority of data was produced by  
447 government agencies responsible for previous management projects and rarely for planning  
448 purposes specifically, as observed from the sources and year of creation attributed to the  
449 data used in the plans we analysed.

450 It is clear that data production analysis is highly dependent on information processing,  
451 representation and dissemination choices. In the absence of systematic and intelligible  
452 access to all metadata, it is difficult to distinguish particular stages of the data lifecycle.

453 These findings raise questions about the quality and completeness of the data used to  
454 achieve the ambitious objectives of the ecosystem-based approach.

455 The results reinforce the need to reflect on the analysis and evaluation of data, from any pre-  
456 processing carried out to decisions on how to present it for specific purposes such as  
457 planning.

458 The results from the review of plans reveal significant gaps in ecosystem mapping: based on  
459 our indicators, ecosystem mapping is often partial (11 cases out of 19); the combination of  
460 information does not lead to new information (10 cases out of 19); the multidimensional  
461 approach is flawed (all cases). This weakness is often the result of technical constraints,  
462 poor data availability and conscious or unconscious political choices. The findings highlight  
463 the limits of the 'evidence' available to guide planning decisions in 'evidence-based'  
464 planning.

465 Critical studies are used to discuss the relationships between decision-making and data. As  
466 Gregg (2015) points out in reference to the 'spectacle of data', data visualisation can be a  
467 'fantasy of command and control through seeing' (p. 1) by delivering an ordered and  
468 prescriptive vision of space. MSP maps can actually be an effective tool of governance and  
469 power. They are not neutral representations of reality, but shaped by political choices and  
470 specific interests. Consequently, maps can hide or marginalise certain claims when used for  
471 marine space, while favouring others (Bridge et al., 2013). Similarly, McCarthy & Thatcher  
472 (2019) point out that it is mostly collective claims and informal use that are missing from  
473 maps due to lack of data. Finally, two ways of assessing the effect that maps and, by  
474 extension, the data used in maps, can have on the public stand out: (1) according to Li  
475 (2014), Scott (1998) and Wood & Fels (1992), maps are a tool or power in themselves, or (2)  
476 maps do nothing in themselves; it depends on how people use them (Fogelman & Bassett,  
477 2017; Kitchin & Dodge, 2007, 2014). In line with McCarthy & Thatcher (2019) and Kitchin &  
478 Dodge (2007), we argue that maps are dependent on the social network in which they  
479 operate and where they evolve, but are also heavily constrained by the data and  
480 geotechnologies used.

481 The desired outcome was to trace the lifecycle of the data used for planning, but difficulties  
482 were encountered in accessing the metadata, mainly because the planning process was still  
483 underway at the time and not all the planning geoportals were available.

484 The thing that stands out overall is that the ecosystem-based approach advocated and  
485 expected by MSP is based on data collected for the purpose, i.e. collected on an ad-hoc

486 basis, not intended to incorporate all the parameters needed to represent the marine space  
487 (the temporal or seasonal dimension, for example), and not data collected automatically on a  
488 regular basis (e.g. fishing activity, which appears as automatically-collected data) , which is  
489 not produced with planning in mind. High-frequency and automated data is often collected  
490 for monitoring purposes, not management purposes (Said & Trouillet, 2020), which means  
491 that planning decisions are made without the benefit of data created specifically to meet their  
492 needs and subsequently justified with pre-existing data.

493 This article does not suggest that data recycling is inherently positive or negative; on the  
494 contrary, it acknowledges the existence of data recycling in marine planning and goes on to  
495 discuss the limits of this recycling with particular reference to the use of management data,  
496 which serves a different purpose to that of planning. While it is unrealistic to expect all the  
497 data to be high quality, it is nevertheless counter-productive to use management data (e.g.  
498 fish stock data) to plan activities. Our findings tend to support the theory put forward by Batty  
499 (2018, 2022), which raises the same issue for urban planning, deploring the fact that  
500 planning is based on downstream data rather than upstream data.

501 There are clear discrepancies between MSP requirements and the data actually used, as  
502 evidenced by the results (Q1), revealing that ecosystems are only partially documented in 11  
503 out of 19 cases. Evidence-based planning requires a meticulous approach to produce  
504 adequate data to address spatial management challenges, which is not the case, according  
505 to our results. This would suggest that the limitations of bioeconomic data which fails to  
506 capture the complexity of socio-spatial relationships, such as leisure activities, should be  
507 acknowledged. The results of this study reveal inconsistencies between MSP requirements  
508 and the data used, as illustrated in the Maltese and Danish MSPs, where zoning plans do  
509 not fully capture the true environmental situation. It is also important to be aware of potential  
510 biases related to data collection (Trouillet, 2019), especially the 'internal' and 'external'  
511 quality of the data (David & Fasquel, 1997; Devillers & Jeansoulin, 2006). External data  
512 quality depends on its suitability for the project requirements, as defined by Wang and  
513 Strong (1996), and in this respect the MSP data is hampered by gaps on two levels: (1) the  
514 time constraint imposed for production of the first plans (Directive 2014/89/EU in place in  
515 2014 for implementation by 2021 at the latest), which is the focus of this paper; (2) not all  
516 sea activities are monitored in a way that is conducive to data generation, referred to by St.  
517 Martin & Hall-Arber (2008) as the 'missing layer' with particular reference to activities such  
518 as small-scale fishing and the social, cultural, and sentimental aspects of marine space. This  
519 aspect of planning has recently been the subject of other studies (e.g. Flannery et al., 2022;  
520 Gee et al., 2017; Ntona & Schröder, 2020; Pennino et al., 2021), demonstrating the  
521 incompleteness of planning approaches that fail to mention these aspects of marine areas.  
522 Despite the importance of non-spatial data, as highlighted by Shucksmith and Kelly (2014),  
523 the academic literature often focuses on spatial data. This gap underscores the need for a  
524 more holistic approach to data collection and use in planning.

525  
526 Within the context of an ecosystem-based approach, it is important to highlight the limitations  
527 of this approach. Ecosystem mapping, as typically interpreted in MSP, cannot fully capture  
528 the complex and dynamic relationships that underpin marine ecosystems. The ecological  
529 interactions between species are rarely comprehensively integrated into the datasets used  
530 for marine planning, making any attempt at ecosystem mapping inherently partial and  
531 incomplete. The challenge lies in the very nature of the ecosystem-based approach, which  
532 aims to integrate a broad range of dimensions, but in practice is constrained by the difficulty  
533 of obtaining sufficiently comprehensive data to represent the complexity of ecological  
534 interactions. Therefore, the concept of an ecosystem-based approach, in its strictest sense,  
535 should be reconsidered to focus on more specific representations, such as habitat or species  
536 mapping, while acknowledging that the full complexity of marine ecosystems exceeds what  
537 can be spatially represented with current data. This suggests that the ecosystem-based  
538 concept in MSP should be redefined to emphasise more tangible and measurable  
539 relationships between different elements, while being realistic about the limitations of  
540 available data.

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## 4.2 Reading MSP through intra-action theory

This article illustrates several important aspects of ecosystem-based planning. First, the inconsistency in marine plans both across borders and within national boundaries. This divergence between national policies and the absence of harmonisation between regional plans is indicative of the challenges attached to establishing a coherent management plan for marine ecosystems. One example is the discrepancy between the MSPs of Belgium and the North French Coast, which share a border. The vocation of the French side of the border is to promote shipping, fishing, harbours and offshore energy, while that of Belgium is to create a large marine protection zone that does not continue on the French side and ends abruptly where the two EEZs meet. Discontinuities such as these are a problem but are also indicative of the autonomy and responsibility of different countries.

Second, the findings point to a disparity in the data used to develop the MSPs. The integration of data from different sources is achieved effectively in some plans to generate new information, but in others the data is simply overlaid without creating any significant new knowledge (Q2). In 9 out of 19 cases new information is created from data overlay, but in 10 of the 19 plans no new information is created by combining the data. This cumulative use of data underlines the importance of considering not only the availability of data but also its interpretation and integration to gain an overall understanding of marine space.

Third, the ecosystem-based approach to MSP reveals complex interactions between data, human and non-human actors and the resulting policies. These mutual relationships result in the notion of intra-action, which underlines the constant dynamics that exist between the different elements of marine systems. Only 8 out of 19 plans provide a mapped assessment of impacts, although these plans are based on available data, which, as mentioned above, is highly dependent on quality and processing.

These results tend to support the Kaufmann and Leese (2021) concept of information information to understand the data lifecycle and the numerous trajectories that data can take, depending on its interactions and intra-action with human and non-human actors, as theorised by Barad (2007). The notion of intra-action is especially significant in relation to MSP, because unlike interaction it is defined by a constant dynamic movement that acts mutually between the components of a system. When planning the multiuse of marine space, therefore, each element becomes linked to another and the inner relationship between the 'node' of activity is difficult to understand. This notion seems particularly relevant for dynamic and mobile spaces such as marine space.

In this context, the concept of digital ecology (Turnbull et al., 2023) adds another layer to the discussion. Digital ecology enables an alternative concept of governance operations and the interactions between data, digital technologies and ecological systems. It views data as the co-constituent elements of a network of entangled interactions, where the collection and analysis of data and its use in MSP are no longer perceived as a neutral or purely technocratic process.

As McCarthy & Thatcher (2019) point out, critical data studies are essential to understand governance because they help to unveil the 'hidden technocracy' (Obermeyer, 1995). In this regard, digital ecologies reveal the ethical and political implications of technological choices and the data systems underlying environmental governance, highlighting which aspects are included or excluded in the decision-making process. With digital ecology we can view digital entanglement as a precondition for intra-actions between data and actors, both human and non-human. This aligns with Lupton's (2016) view that it is difficult to understand the entanglement between data and society, as data acts on society and, conversely, society acts on data through various assemblages (Kaufmann & Leese, 2021). This perspective sheds light on new ways of approaching marine space governance, promoting more equitable and transparent governance by using data critically within the framework of digital ecologies. Our approach introduces a new perspective to the data lifecycle, which is traditionally viewed through the different phases of the data - from production to deletion. It is



595 essential to also consider the lifecycle in the context of entanglement with both human and  
596 non-human factors.

597

598 Finally, this study reveals the importance of understanding the data used and its impact on  
599 decision-making. The number of plans analysed for this study was limited; more research is  
600 needed for a thorough analysis of power-knowledge relationships and consideration of the  
601 varied journeys of datasets to better understand their role in the policy-making process and  
602 marine space governance. The absence of undigitised datasets (Gautreau, 2021) and social  
603 dimensions (Cornu et al., 2014; Gee et al., 2017) in MSP raises questions about how  
604 representative and inclusive planning can be, especially in developing countries where even  
605 greater attention is required (Trouillet et al., 2023).

606

## 607 **Section 5. Conclusion**

608

609 This study demonstrates that the ecosystem-based approach expected for MSP relies on  
610 fragmented and often incomplete data, lacking critical parameters such as the temporal  
611 dimension. Data that is collected on a regular, automated basis is often repurposed to fit  
612 planning needs in ways that distort its original intent, raising serious concerns about its  
613 validity. Our research reveals that where data is not explicitly designed for planning, it results  
614 in significant gaps in multidimensional plans, particularly in the marine context, which limits  
615 their overall effectiveness. While the MSP directive calls for the use of the 'best available  
616 data', our findings indicate that the notion of 'availability' often translates into a reliance on  
617 recycled or repurposed datasets that were not originally intended for MSP. As a result, plans  
618 are shaped by technical constraints, data availability, and political choices in terms of  
619 ecosystem mapping and the representation of marine activities.

620 These biases in data use and mapping underscore critical issues of governance and  
621 information justice, highlighting the need for a more nuanced approach to data and its role in  
622 decision-making for marine planning. Specifically, while the use of the best available data is  
623 a pragmatic and necessary starting point, our analysis suggests that it is not always  
624 sufficient to address the complexity and multidimensionality of MSP. This underscores a  
625 clear need to produce data specifically tailored for planning purposes, ensuring that it better  
626 supports multidimensional objectives and reduces the risks of exclusion or  
627 misrepresentation.

628 The current lifecycle of data, from production through interpretation to deletion, tends to  
629 exclude stakeholders, which is a major issue for the inclusivity and legitimacy required for  
630 MSP. By rethinking the way data is produced and integrated into planning processes, it  
631 could become a powerful tool not only for improving the technical quality of plans but also for  
632 fostering stakeholder participation and enhancing the overall legitimacy of MSP initiatives.

633 This Europe-wide examination that should have produced a common framework from  
634 Directive 2014/89/EU to compare data production for the different plans, was in practice  
635 limited by inability to interpret the plans not written in English and limited access to  
636 databases. Despite the limitations - the restricted number of plans analysed and the  
637 difficulties in tracing the data lifecycle via the marine plan - we believe this work has  
638 contributed by highlighting the various strategies used to develop an ecosystem-based  
639 approach. The conclusions are also limited by having targeted only plans devised in the  
640 European context, where there is a certain degree of homogenisation in spite of the findings;  
641 the results may well have been different if the study had been carried out at international  
642 level.

643 This paper underscores the crucial role that data plays in marine planning, revealing that it is  
644 not just a way of viewing government engagement with marine space and economic visions  
645 for it, but also a means by which the engagement and visions are shaped, because data is  
646 subject to restricted access and therefore not easily questioned (McCarthy and Thatcher,  
647 2019). The findings reveal that, contrary to the ideal of an 'evidence-based' approach, MSP  
648 seems to be driven more by political decisions justified *a posteriori* than by the data available  
649 (Batty, 2022), since the data available or used may be only partial. However, the plans are

650 still needed. This validates our hypothesis based on analysis of the first round of MSP. In  
651 addition, data deserts are hidden or at least not explained, and the processing algorithms  
652 are not explained or justified, let alone discussed.  
653 More research is needed to investigate the production of maps for MSP, such as those used  
654 to translate the MSP into visual form in Europe. Once a map has been produced, it is  
655 already too late to question the information, and above all the data. However, in practice,  
656 spatialising information often helps assess whether the data is adequate or not. This  
657 suggests a need to develop upstream research to understand the relationships between  
658 states, technologies, and MSP to facilitate thorough investigation of the mapping process,  
659 which is one of the main action drivers for governments that implement marine spatial plans.

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