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

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## ► To cite this version:

Juliette Davret, Brice Trouillet. Recycling data for Marine Spatial Planning: A review of maritime plans in Europe. 2024. hal-04563075v2

**HAL Id: hal-04563075**

**<https://hal.science/hal-04563075v2>**

Preprint submitted on 13 Nov 2024

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

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## 6 7 **Introduction**

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 are still 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) are working to improve  
17 data access and sharing, but issues remain 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, so the information required for marine planning is often incomplete (Holzhüter et al.,  
21 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 any 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, so that evidence-based policies  
27 can be implemented for sustainable marine management.

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

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

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

<sup>2</sup> 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>

<sup>3</sup> 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>

49 details the results; section 4 discusses the entanglement of digital and data governance in  
50 marine planning, and section 5 is the conclusion.

51

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

53

### 54 1.1 Data integration and quality issues in MSP

55

56 Data harmonisation has been the focus of many recent studies and is often discussed in  
57 scientific publications as being an urgent necessity to fulfil MSP objectives (Ehler, 2008;  
58 Hattam et al., 2015; Holzhüter et al., 2019; MSP Data Study, 2016; Stamoulis & Delevaux,  
59 2015). Strain et al. (2006) suggested that spatial information plays a significant role in  
60 decision-making since it provides the geographical context for plans. Results reported by  
61 Holzhüter et al. (2019) and Schaefer & Barale (2011) suggest that the temporal dimension is  
62 also important for managing human activities at sea, since both the ecosystem and human  
63 activities are subject to seasonal shifts, and adjustments are therefore required to ensure  
64 compatibility. The three-dimensional aspect of marine space must also be taken into  
65 account, which further complicates the management of marine space and reinforces the  
66 importance of geographical information. It is also essential to consider the temporal  
67 dimension of activities at sea. In a 2014 paper, Shucksmith and Kelly reported on the limited  
68 implementation of spatial and temporal aspects of the dataset used for MSP.

69

70 In spite of these findings, the inclusion of spatial and temporal aspects in datasets remains  
71 limited in practice. Various studies have examined the data used in MSP and revealed  
72 significant gaps and disparities in the processing of data for planning purposes between  
73 countries (e.g. Shepperson et al., 2018; Trouillet, 2019, 2020). These studies reveal the  
74 growing importance of data in planning and reinforce the need to improve our understanding  
75 of how data is produced and used.

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

87 These studies on the data used for planning purposes are valuable as a snapshot of how  
88 data is used, but do not provide an understanding of the power-knowledge relationships at  
89 work in the data factory, and should therefore be extended. Batty (2022), for instance,  
90 reveals that (urban) planning is based only on data downstream of the process and not  
91 upstream, and encourages a change in this practice to fulfil planning requirements, which  
92 would suggest the need for a similar, more thorough investigation of this aspect as it relates  
93 to marine planning. Critical data studies have also shown that data processing is never  
94 neutral but influenced by a number of choices (Dalton & Thatcher, 2014; Kitchin, 2021). In  
95 terms of MSP, some of the critical data studies on which it is based focus on a single activity,  
96 indicating the influence of knowledge production and a missing layer (St. Martin & Hall-  
97 Arber, 2008). The absence of information relating to various specific activities is well  
98 documented in the literature (e.g. fishing, as studied by Leroy, 2018 and Trouillet, 2019).  
99 Some studies of data used in MSP have focused on environmental data (McGowan et al.,  
100 2013; Ryan et al., 2018; Weatherdon et al., 2015), questioning its quality and usage.  
101 Environmental data is of particular interest in terms of MSP goals, as it must enable  
102 'ecosystem and biodiversity conservation' (paragraph 1, Directive 2014/89/EU) and ensure  
103 that 'the collective pressure of all activities is kept within levels compatible with the

104 achievement of good environmental status, and that the capacity of marine ecosystems to  
105 respond to human-induced changes is not compromised, while contributing to the  
106 sustainable use of marine goods and services by present and future generations' (paragraph  
107 14, Directive 2014/89/EU). Data quality issues should be addressed by documenting the  
108 internal and external quality of data (Devilliers & Jeansoulin, 2006), which has so far eluded  
109 analyses of environmental data in planning. The 'internal' quality of data refers to its  
110 properties and characteristics, measured by the difference between the data that should be  
111 produced and the data that is actually produced. The 'external' quality is the alignment of  
112 data with usage needs, measured by the difference between the necessary or ideal data and  
113 the data that is actually produced. In addition to data quality, other studies have looked at  
114 the production of data more suited to the challenges faced by MSP and at data  
115 harmonisation (Dosell et al., 2021; Guinan et al., 2021; Holzhüter et al., 2019), but again,  
116 only a few examples are given, and these do not cover the whole range of issues potentially  
117 linked to data production for planning purposes.

## 118 119 1.2 Intra-action as the foundation for ecosystem interconnection 120

121 Finally, academic research has focused on the 'ecosystem-based' approach promoted by  
122 Directive 2014/89/EC (e.g. Domínguez-Tejo et al., 2016; Douvère, 2008; Douvère & Ehler,  
123 2009; Gilliland & Laffoley, 2008), which in theory fulfils the need for a balanced approach  
124 between environmental conservation and development of offshore activities. In practice,  
125 Domínguez-Tejo et al. (2016) point out in a comparative study that the relevant aspects are  
126 rarely considered in an ecosystem-based approach, in particular the assessment of human  
127 activity pressures, but also social values and non-market activities. Schwartz-Belkin and  
128 Portman (2023) provide a literature review specific to the ecosystem-based management  
129 approach and the challenges posed by limitations of the data available. The authors identify  
130 geospatial technologies that can help navigate the challenges of MSP.  
131 The research for the present study extends to the environmental data used in MSP, through  
132 the concept of an ecosystem. The intra-action theory is a new conceptual framework for  
133 understanding how environmental data is constructed and the complex relationships  
134 between human and non-human actors and the environment; the intra-action theory is  
135 referred to in this article for a clearer understanding of the term 'ecosystem'. According to  
136 Barad (2007), intra-action, as applied to data, can be considered as recognising the  
137 interconnection between various entities involved in the production and use of data, and  
138 reflects how the environment is co-constructed in reality. This theory is explored through the  
139 concept of information in-formation (Kaufmann and Leese, 2021), which illustrates how new  
140 information is created from the entanglement of environmental and human activity data. For  
141 example, using the intra-action theory in marine planning enables a shift beyond the  
142 traditional conceptions of human-environment interaction and recognises how relationships  
143 between humans, nature and technology are intertwined (Lehman, 2016). In MSP, the aim of  
144 the ecosystem-based approach is to handle the various uses of marine space (fishing,  
145 energy, conservation, transport, etc.) in an integrated manner, while considering the  
146 underlying ecological interactions (e.g. the trophic relationships between species, ocean  
147 current movements and biogeochemical cycles). The concept of intra-action goes beyond  
148 the mere interconnection of elements by suggesting that these components cannot be  
149 understood in isolation but only through the dynamic relationships that shape them.  
150 Within the framework of intra-action, human and non-human actors (such as species,  
151 technological infrastructure and management policies) are seen as co-constituents of a  
152 network of relationships. This aligns with the ecosystem-based approach, which considers  
153 not only natural elements but also human practices and their impact on the marine  
154 ecosystem. In an ecosystem-based approach, for instance, the construction of an oil  
155 platform cannot be analysed solely in terms of the direct environmental impacts it has (e.g.  
156 pollution risk), but also through its interaction with surrounding ecosystems (changes in  
157 ocean currents, the effect it has on local species populations, etc.). Intra-action helps  
158 conceptualise this dynamic by emphasising that the platform's very existence is shaped by

159 its natural and human environment, and in turn shapes that environment.  
160 Intra-action and the ecosystem-based approach converge in their understanding of the  
161 dynamic relationships between elements within a system. While the ecosystem-based  
162 approach asserts the interdependence of natural and human components in marine  
163 systems, intra-action adds a deeper theoretical layer by emphasising that these relationships  
164 are co-constituted and constantly in flux, and that each actor both influences and is  
165 influenced by the others. This understanding enables a better grasp of the complexities of  
166 marine space governance in MSP by accounting for the multiple, evolving interactions.

167  
168 This framework offers a new understanding of governance processes and underlines the  
169 importance of taking into account the complex interactions between the different actors and  
170 factors involved in the production and use of environmental data. Ultimately, applying the  
171 intra-action theory allows us to recognise the complexity of human/non-human/environment  
172 interactions in MSP. This introduces a more holistic and integrated approach to the  
173 management of marine resources, incorporating all the social, economic and environmental  
174 elements involved in marine space. When applied to European MSP, it provides a basis of  
175 common environmental requirements for conducting a comparative study .

## 176 177 **Section 2: Materials and Methods**

178  
179 The method used for this research is a content analysis of the maritime plans in Europe. A  
180 comparative analysis of all the plans falling within the scope of Directive 2014/89/EU for the  
181 first MSP cycle was carried out. This method should be considered in the light of the  
182 theoretical framework developed - the intra-action approach - to understand how data is  
183 produced in the ecosystem-based system promoted by the European directive.

### 184 185 2.1 Indicators

186 Barad's theory (2007) was used to establish whether the data used is in line with the  
187 ecosystem-based approach required by Directive 2014/89/EU. In accordance with the  
188 findings of Barad (2007) and Kaufmann and Leese (2021), it was considered essential to  
189 carefully analyse the specifics of the relationships between data and its lifecycle, and to  
190 employ the concept of 'information in-information' (Kaufmann and Leese, 2021), to describe  
191 the entanglement of data in planning. Information in-information refers to a continuous process  
192 of formation and transformation of structures, whether biological, social or technological.  
193 Unlike a static conception of information where it is perceived as a fixed set of data, the  
194 concept of 'in-information' creates a dynamic that shapes and restructures systems. By  
195 applying the concept of 'in-information' to the MSP context, a holistic view of the processes  
196 that shape interactions between marine environments and human activities can be created  
197 to better understand how these systems are structured and adapt in space and time. This  
198 approach enables us to grasp the complexity of ecological dynamics and their relationships  
199 with social and economic dynamics. By exploring what it means to form information in the  
200 context of developing a policy for managing marine space, from an ecosystem-based  
201 perspective in particular, it should be possible to show how the interactions between data  
202 and humans generate knowledge and action.

203 The ecosystem-based approach involves integrated management of the ecosystems,  
204 including all their ecological components and interactions with human activities, while  
205 respecting the ecological limits of the system. One key aspect of the ecosystem-based  
206 approach in Europe is the integration of ecosystem services, i.e. the benefits that humans  
207 derive from ecosystems (resources such as fisheries, the regulation of ecological processes,  
208 support for basic ecological functions, the cultural and aesthetic value of ecosystems, etc.).  
209 In the context of MSP, the assessment and mapping of these services enables us to  
210 understand and visualise how marine ecosystems support critical socio-economic functions.  
211 Directive 2014/89/EU promotes an integrated cross-sectoral, cross-border approach. The  
212 use an ecosystem-based approach (paragraph 14) is intended to help promote the  
213 sustainable development and growth of marine and coastal economies and the sustainable

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

235  
 236 Documenting ecosystems and the parameters that influence them reveals the 'information  
 237 in-formation' where certain information, taken independently, would be interpreted differently.  
 238 The impact indicator approach facilitates the documentation of data entanglement as it is  
 239 produced by combining different types of data to assess the overall position. The study of  
 240 data production based on environmental data is of particular interest since this aspect of  
 241 offshore planning is indicated in the text of Directive 2014/89/EU. The method has been  
 242 used previously in comparative studies in Europe and beyond (e.g. Trouillet, 2020). Based  
 243 on this premise, three questions were determined with reference to the ecosystem-based  
 244 approach as framed by Directive 2014/89/EU:

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

248  
 249 By studying this in terms of the information available on European marine plans and  
 250 documenting how the data is used, documentation maps in particular, and by looking  
 251 specifically at the data used - which must facilitate fulfilment of the directive's objectives - the  
 252 aim is to understand which human or technical factors influence MSP. The three questions  
 253 developed by analysing the corpus were broken down into a number of indicators (Table 1):

254  
 255 Table 1. Indicators applied to European MSP initiatives  
 256

Question	Coding	Label	Comment	Indicator	Value	Explanation
Q1	I1	Ecosystem representation	Factual assessment of whether data is available to represent ecosystems	<b>Are ecosystem areas documented?</b>		
				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 new 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 new information on the maritime space.
				Yes, but it does not result in new 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

257

258 These four indicators were applied to the corpus by examining the maps of the marine plans,  
259 to enable documentation of the answers to the three main questions as factually as possible  
260 and draw general conclusions. This is one way of evaluating the data used for MSP but it is  
261 not intended to evaluate the effectiveness of the different approaches. There is no question,  
262 for example, as to whether the whole area is documented albeit with mediocre data, or  
263 whether only part of it is documented but with very good data. The objective is more general  
264 - to understand how ecosystems are qualified in the MSP.

265

## 266 2. 2 Corpus

267 Since the intention was to compare different marine plans, only plans drawn up in response  
268 to Directive 2014/89/EU were considered. A corpus of marine plans based on the scope of  
269 application for Directive 2014/89/EU was created in 2021 for this study. Plans were selected  
270 on the basis of the census carried out by the European Commission within the framework of  
271 the European MSP Platform<sup>4</sup>, an information and communication website designed to offer  
272 support to all EU member states in their implementation of MSP, which existed prior to 2022  
273 (details in Appendix 1). Directive 2014/89/EU required all EU coastal member states to draw  
274 up an intersectoral plan for their marine areas by 2021. The main advantage of this method  
275 is that the European directive calls for a certain homogenisation of plans with a view to  
276 meeting the requirements at least, which for the purposes of this study enabled the  
277 application of an analysis grid that should be compatible with the various plans. Conversely,  
278 the main limitation is that the plans cannot summarise all the documents produced as part of  
279 the planning exercise. Some elements may therefore have been overlooked in the present  
280 analysis.

281 The inclusion of the United Kingdom on the European MSP Platform and in this corpus is  
282 worth mentioning here, despite its withdrawal from the EU. The development plans for the

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

283 UK's seaboard formerly fell under the purview of Directive 2014/89/EU. Norway, on the  
284 other hand, is not a member of the EU and is not obligated to comply with the  
285 aforementioned directive. Nevertheless it complies with approximately 95% of EU directives  
286 through other European environmental policies, which raises pertinent questions as to why it  
287 is excluded from the corpus. To maintain coherence, the corpus is aligned with the European  
288 MSP Platform in its pre-2022 form, choosing to exclude Norway but include the United  
289 Kingdom in the analytical framework.

290 The corpus was made up of the most tangible elements of planning documentation, maps in  
291 particular, to identify the data used. In observing the planning documents, the maps  
292 contained in them were analysed with the aim of tracing them back to the data.  
293 Consequently, the corpus is made up of 38 planning documents from 23 countries (finalised  
294 or under development). Each country is responsible for developing its own marine plan;  
295 translating the marine plans drafted in different European languages was a laborious task,  
296 especially those containing graphic materials such as maps, where contextual understanding  
297 is crucial. Although it was theoretically possible to attempt translation, the results were often  
298 too imprecise to be reliable. This issue was compounded by the fact that many of the  
299 documents were in neither French nor English, including 19 plans from 12 countries,  
300 rendering them largely unintelligible. Consequently, the analysis grid has been used with 19  
301 marine plans from the 11 countries that were intelligible to us.

### 302 **Section 3: Results**

303  
304 This study is an in-depth examination of the operational component of MSP at a significant  
305 juncture, but is not intended to be exhaustive.

306 From the vast amount of documentation compiled, we have opted to provide a synthesis of  
307 the results in this section and include detailed listings in the appendices. The outline results  
308 of the analysis of 19 marine planning documents appear below (Table 2 and Appendix 2).  
309 These results focus solely on trends and overall proportions rather than a thorough statistical  
310 analysis, which would lack significance due to the limited number of MSPs involved:

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

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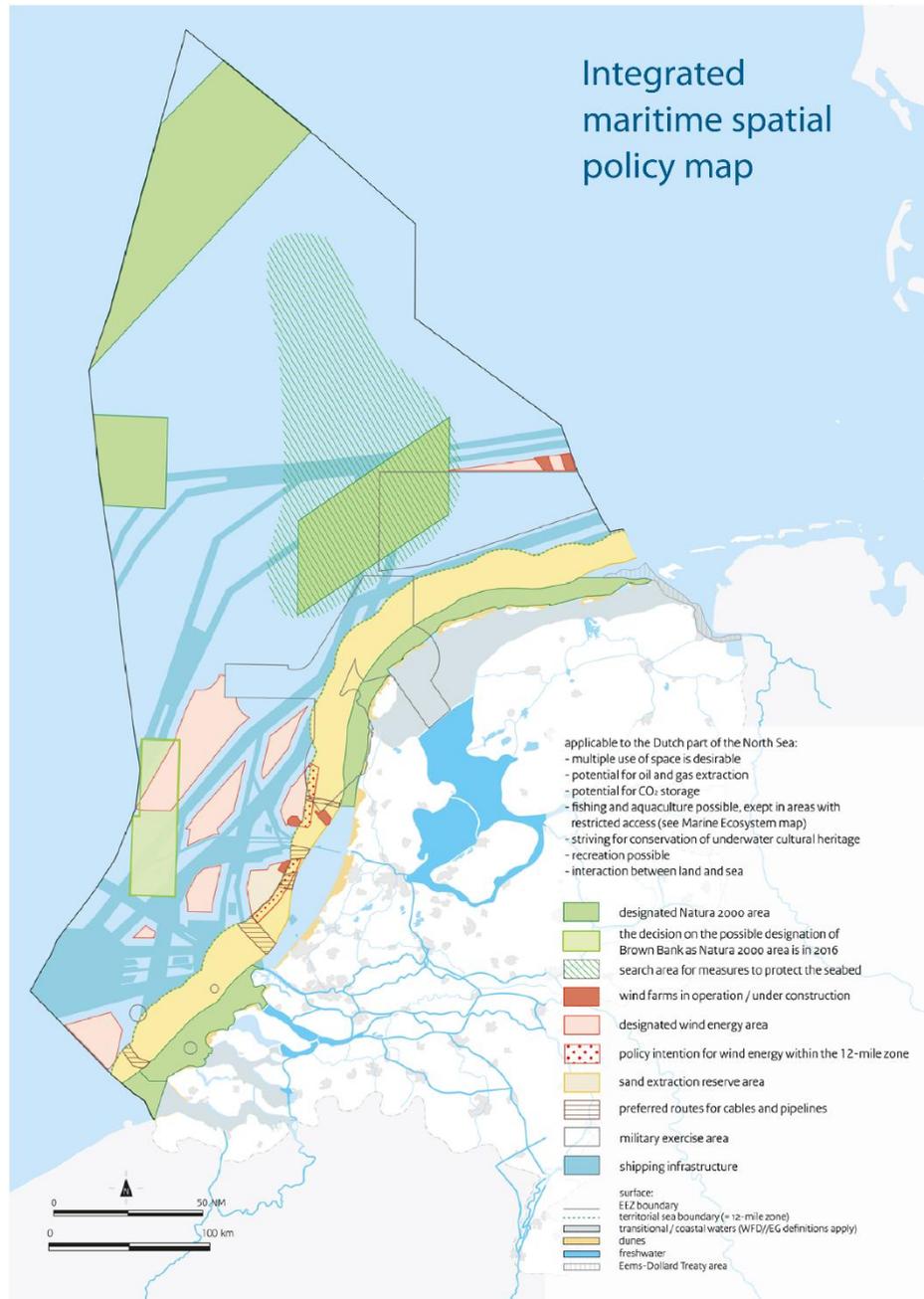


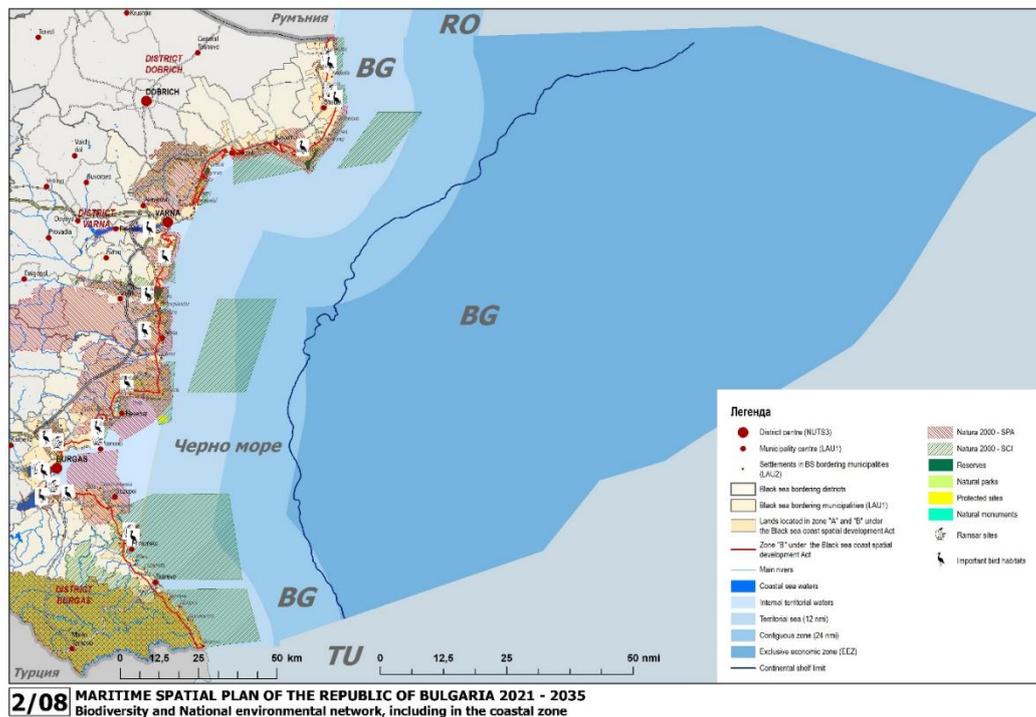
Figure 1. Netherlands Marine Spatial Plan

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 limited or not available in a language that the authors of this paper understand. 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 ecosystems and human activities only resulted in a graphical overlay of information and did not generate any new information.

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



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Figure 2. Bulgaria Marine Spatial Plan

Source: MOEW, EEA, NCRD

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

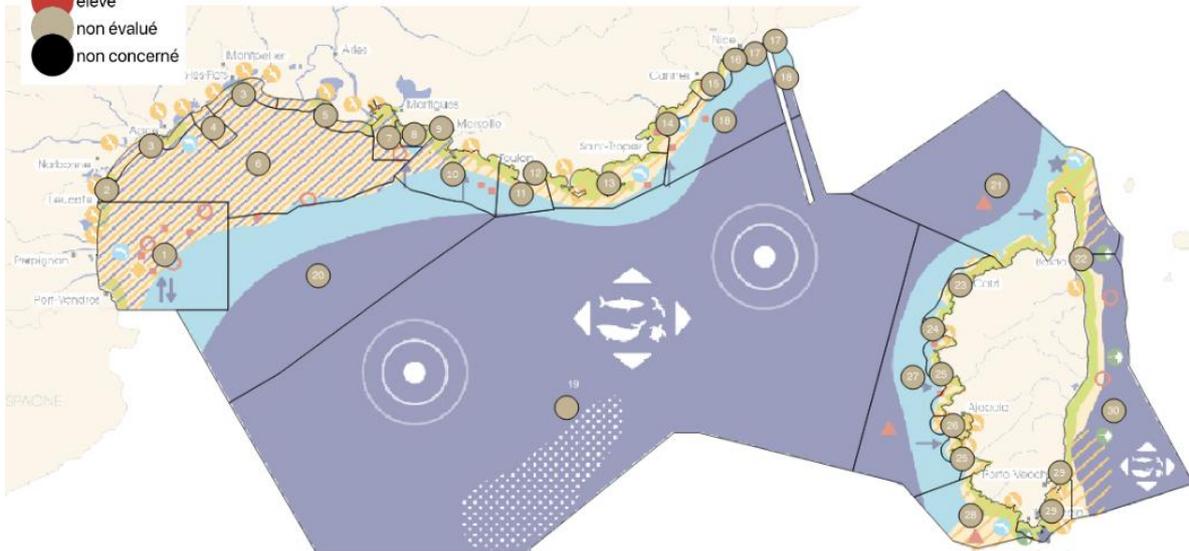
- Indicator I3: in 8 of the 19 MSP initiatives, the choice of an ecosystem-based approach led to the creation of map-based impact indicators between data on natural ecosystems and human activities. In 11 MSP initiatives, the document did not establish impact indicators cartographically.

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375

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

## ENJEU MAMMIFERES MARINS ET TORTUES

Ecart au Bon Etat Ecologique  
par zone de vocation



Source des données : évaluation environnementale du programme d'actions du DSF réalisée par Epices  
Fond de carte : Enjeux écologiques en Méditerranée occidentale produite par l'AFB, 2018  
Système de coordonnées : WGS84 / Pseudo Mercator  
Edition : 01/2021, Epices

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



As highlighted in Table 2, our analysis of 19 MSP documents from around Europe reveals that an ecosystem-based approach to marine spaces is often incomplete, particularly in terms of mapping. From the data shown in Table 2, it is apparent that given the multidimensional nature of marine space, a wide range of data is required (such as spatial sea bottom and surface data, temporal data, etc.). However, these requirements are likely to

402 encounter limitation in terms of techniques, knowledge, tools or the media used to transcribe  
403 them.

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

405

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

416

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

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

429

## 430 **Section 4: Discussion**

431

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

437

### 438 **4.1 Examining data quality through map-making**

439

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

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

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

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

453 The results from the review of plans reveal significant gaps in ecosystem mapping: based on  
454 our indicators, ecosystem mapping is often partial (11 cases out of 19); the combination of  
455 information does not lead to new information (10 cases out of 19); the multidimensional

456 approach is flawed (all cases). This weakness is often the result of technical constraints,  
457 poor data availability and conscious or unconscious political choices. The findings highlight  
458 the limits of the 'evidence' available to guide planning decisions in 'evidence-based'  
459 planning.

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

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

479 The thing that stands out overall is that the ecosystem-based approach advocated and  
480 expected by MSP is based on data collected for the purpose, i.e. collected on an ad-hoc  
481 basis, not intended to incorporate all the parameters needed to represent the marine space  
482 (the temporal or seasonal dimension, for example), and not data collected automatically on a  
483 regular basis (e.g. fishing activity, which appears as automatically-collected data), which is  
484 not produced with planning in mind. High-frequency and automated data is often collected  
485 for monitoring purposes, not management purposes (Said & Trouillet, 2020), which means  
486 that planning decisions are made without the benefit of data created specifically to meet their  
487 needs and subsequently justified with pre-existing data.

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

496 There are clear discrepancies between MSP requirements and the data actually used, as  
497 evidenced by the results (Q1), revealing that ecosystems are only partially documented in 11  
498 out of 19 cases. Evidence-based planning requires a meticulous approach to produce  
499 adequate data to address spatial management challenges, which is not the case, according  
500 to our results. This would suggest that the limitations of bioeconomic data which fails to  
501 capture the complexity of socio-spatial relationships, such as leisure activities, should be  
502 acknowledged. The results of this study reveal inconsistencies between MSP requirements  
503 and the data used, as illustrated in the Maltese and Danish MSPs, where zoning plans do  
504 not fully capture the true environmental situation. It is also important to be aware of potential  
505 biases related to data collection (Trouillet, 2019), especially the 'internal' and 'external'  
506 quality of the data (David & Fasquel, 1997; Devillers & Jeansoulin, 2006). External data  
507 quality depends on its suitability for the project requirements, as defined by Wang and  
508 Strong (1996), and in this respect the MSP data is hampered by gaps on two levels: (1) the  
509 time constraint imposed for production of the first plans (Directive 2014/89/EU in place in  
510 2014 for implementation by 2021 at the latest), which is the focus of this paper; (2) not all

511 sea activities are monitored in a way that is conducive to data generation, referred to by St.  
512 Martin & Hall-Arber (2008) as the 'missing layer' with particular reference to activities such  
513 as small-scale fishing and the social, cultural, and sentimental aspects of marine space. This  
514 aspect of planning has recently been the subject of other studies (e.g. Flannery et al., 2022;  
515 Gee et al., 2017; Ntona & Schröder, 2020; Pennino et al., 2021), demonstrating the  
516 incompleteness of planning approaches that fail to mention these aspects of marine areas.  
517 Despite the importance of non-spatial data, as highlighted by Shucksmith and Kelly (2014),  
518 the academic literature often focuses on spatial data. This gap underscores the need for a  
519 more holistic approach to data collection and use in planning.

## 520 521 **4.2 Reading MSP through intra-action theory**

522  
523 This article illustrates several important aspects of ecosystem-based planning. First, the  
524 inconsistency in marine plans both across borders and within national boundaries. This  
525 divergence between national policies and the absence of harmonisation between regional  
526 plans is indicative of the challenges attached to establishing a coherent management plan  
527 for marine ecosystems. One example is the discrepancy between the MSPs for Belgium and  
528 the North French Coast, which share a border. The vocation of the French side of the border  
529 is to promote shipping, fishing, harbours and offshore energy, while that of Belgium is to  
530 create a large marine protection zone that does not continue on the French side and ends  
531 abruptly where the two EEZs meet. Discontinuities such as these are a problem but are also  
532 indicative of the autonomy and responsibility of different countries.

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

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

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

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

561 As McCarthy & Thatcher (2019) point out, critical data studies are essential to understand  
562 governance because they help to unveil the 'hidden technocracy' (Obermeyer, 1995). In this  
563 regard, digital ecologies reveal the ethical and political implications of technological choices  
564 and the data systems underlying environmental governance, highlighting which aspects are  
565 included or excluded in the decision-making process. With digital ecology we can view digital

566 entanglement as a precondition for intra-actions between data and actors, both human and  
567 non-human. This aligns with Lupton's (2016) view that it is difficult to understand the  
568 entanglement between data and society, as data acts on society and, conversely, society  
569 acts on data through various assemblages (Kaufmann & Leese, 2021). This perspective  
570 sheds light on new ways of approaching marine space governance, promoting more  
571 equitable and transparent governance by using data critically within the framework of digital  
572 ecologies. Our approach introduces a new perspective to the data lifecycle, which is  
573 traditionally viewed through the different phases of the data - from production to deletion. It is  
574 essential to also consider the lifecycle in the context of entanglement with both human and  
575 non-human factors.

576  
577 Finally, this study reveals the importance of understanding the data used and its impact on  
578 decision-making. The number of plans analysed for this study was limited; more research is  
579 needed for a thorough analysis of power-knowledge relationships and consideration of the  
580 varied journeys of datasets to better understand their role in the policy-making process and  
581 marine space governance. The absence of undigitised datasets (Gautreau, 2021) and social  
582 dimensions (Cornu et al., 2014; Gee et al., 2017) in MSP raises questions about how  
583 representative and inclusive planning can be, especially in developing countries where even  
584 greater attention is required (Trouillet et al., 2023).

## 585 **Section 5. Conclusion**

586  
587  
588 This study demonstrates that the ecosystem-based approach expected for MSP relies on  
589 fragmented and often incomplete data, lacking critical parameters such as the temporal  
590 dimension. Data that is collected on a regular, automated basis is often repurposed to fit  
591 planning needs in ways that distort its original intent, raising serious concerns about its  
592 validity. Our research reveals that where data is not explicitly designed for planning, it results  
593 in significant gaps in multidimensional plans, particularly in the marine context, which limits  
594 their overall effectiveness. The plans are shaped by technical constraints, data availability  
595 and political choices in terms of ecosystem mapping and the representation of marine  
596 activities. These biases in data use and mapping underscore critical issues of governance  
597 and information justice, highlighting the need for a more critical approach to data and its role  
598 in decision-making for marine planning. The current lifecycle of data from collection through  
599 interpretation to deletion tends to exclude stakeholders, which is a major issue for the  
600 inclusivity and legitimacy required for MSP, but by changing the approach to data, it could  
601 become a powerful tool for encouraging stakeholder participation.

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

612 This paper highlights the crucial role that data plays in marine planning, revealing that it is  
613 not just a way of viewing government engagement with marine space and economic visions  
614 for it, but also a means by which the engagement and visions are shaped, because data is  
615 subject to restricted access and therefore not easily questioned (McCarthy and Thatcher,  
616 2019). The findings reveal that, contrary to the ideal of an 'evidence-based' approach, MSP  
617 seems to be driven more by political decisions justified *a posteriori* than by the data available  
618 (Batty, 2022), since the data available or used may be only partial. However, the plans are  
619 still needed. This validates our hypothesis based on analysis of the first round of MSP. In

620 addition, data deserts are hidden or at least not explained, and the processing algorithms  
621 are not explained or justified, let alone discussed.  
622 More research is needed to investigate the production of maps for MSP, such as those used  
623 to translate the MSP into visual form in Europe. Once a map has been produced, it is  
624 already too late to question the information, and above all the data. This suggests a need to  
625 develop upstream research to understand the relationships between states, technologies,  
626 and MSP to facilitate thorough investigation of the mapping process, which is one of the  
627 main action drivers for governments that implement marine spatial plans.  
628

### 629 **Acknowledgements**

630 This paper is supported by a doctoral grant from Nantes University and the Pays de la Loire  
631 Region. JD and BT contributed to the conception of the research; JD and BT provided  
632 insight and context to support interpretation of results; JD led the writing of the paper, data  
633 collection, and analysis; all co-authors contributed to the preparation, editing and refining of  
634 the paper. The co-authors would like to thank the reviewers for their help in improving the  
635 manuscript. JD revised the manuscript. The final manuscript has been approved by all the  
636 authors.  
637

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