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

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1 Introduction

2 The area of environmental data is attracting growing attention due to the important role it
3 plays in the management of marine areas. Indeed, recent observations made by
4 environmental activists engaged in ocean protection and working within the European
5 Commission highlight a major problem: the withholding of data by some government, thus
6 compromising informed decision-making for the conservation of marine ecosystems. The
7 lack of data provided to the European Commission, despite its crucial need for scientific
8 advice to shape evidence-based policies, reveals a major gap in data availability and
9 accessibility. Policies such as Directive 2008/56/EC¹ establishing the strategic framework for
10 the sea and Directive 2014/89/EU² for Marine Spatial Planning (MSP), show the importance
11 that governments place on the protection and sustainability of the marine ecosystem
12 (Guinan et al., 2021), which can only be guaranteed by access to high-quality data to guide
13 environmental policies in this evidence-based process. To support this ambition, European
14 Union (UE) member states are working on a set of criteria and standards for a more
15 consistent ecological status. To illustrate, this is achieved through a number of marine data
16 collection and sharing initiatives, such as the European Marine Observation and Data
17 Network (EMODnet) or the European Ocean Observing System (EuroGOOS), which aim to
18 promote access to and sharing of marine data and information, with a view to addressing
19 societal challenges related to marine space. All these initiatives are part of Directive
20 2007/2/EC (INSPIRE), which established a common infrastructure for spatial information.
21 But, on the one hand, EMODnet, for example, still requires to improve the coverage, quality,
22 and resolution of the data, as well as the consistency, harmonisation and interoperability of
23 the various accessible thematic areas (Martín Míguez et al., 2019). As it stands, EMODnet
24 results in data degradation in enabling European standardisation at similar scales, leading to
25 the loss of significant detail (Guinan et al., 2021). On the other hand, a strictly spatial
26 approach to data through visualization tools cannot take into account non-spatialized data,
27 despite the fact that this could minimize the risk of incomplete information (Holzhüter et al.,
28 2019), particularly when implementing marine planning policies. Directive 2014/89/EU places
29 data at the core of the MSP process, since EU member states must organize MSP on
30 'reliable', 'evidence-based' data, in short, 'the best available data'. In fact, MSP is, in theory,
31 an evidence-based process (MSP Data Study, 2016). This means that the success of MSP
32 is closely linked to the quality and availability of data (Stamoulis & Delevaux, 2015). While
33 some organizations are working on cross-border harmonisation (e.g. HELCOM-VASAB),
34 particularly in areas where maritime activities are densest, such as the Baltic Sea in Europe,
35 the main focus is on harmonizing spatial representations (Zaucha, 2014), particularly
36 through the production of homogeneous data. However, this does not yet apply to all areas
37 covered by Directive 2014/89/EU, which severely hampers the implementation of
38 transborder maritime plans, as each state defines its own indicators of good ecological
39 status (European MSP Platform, 2019) and its own interpretation of "the application of an
40 ecosystem-based approach will contribute to promote sustainable development and growth
41 of maritime and coastal economies and sustainable use of marine and coastal resources".
42 (Directive 2014/89/EU). Therefore, it seems necessary to study the data mobilized in the
43 MSP context to understand what are the potential challenges and limits to the application of
44 the European directive. To do so, we will examine the existing marine plans in Europe and
45 especially the data lifecycle to produce an evidence-based plan.

46
47 This study focuses on the data used for MSP, examined through its lifecycle
48 (collection/selection, processing, mapping...). In this article, the term lifecycle refers to the
49 genealogy of the data, from the production to the representation on a map. The lifecycle
50 consists of all the phases through which data pass from their creation through to their
51 deletion. Given the datafication of the world, data abundance and, above all quality, must be

¹ 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>

² 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>

52 interrogated at each stage of an MSP process (Holzhüter et al., 2019). It is also worth
53 examining the multiscale approach of European spatial planning in order to assess the
54 coordination of marine plans for a space that cannot be delimited in a fixed way, as is then
55 the case on maps. This study was carried out to understand what knowledge is produced by
56 these data, how, by whom, and why? As critical data studies have shown, answering these
57 questions will help to understand the power relationship that shapes planning.
58

59 The results of this study will greatly contribute to extend the existing literature on this subject
60 with a critical approach in order to document the following questions: Do the data created
61 and used in marine spatial plans capture the entanglements between human activities and
62 the marine environment? Our hypothesis is that if the data used do not enable us to assess
63 impacts and multidimensional relationships in marine environments, then they do not enable
64 us to satisfy the environmental protection goals required by the European directive. Unless,
65 as Batty (2022) argues, the data are used only downstream in the planning process. In that
66 case, data serve simply to justify political decisions. By validating or invalidating this
67 hypothesis, we will not only document the power-knowledge relationships that crystallize
68 through data, but also discuss their quality external and internal, as claimed by Devillers and
69 Jeansoulin (2005). To do so, we need to balance the notion of abundance when discussing
70 data and interrogating their spatial representation, especially in a marine case study,
71 because spatial boundaries are not static.

72 This article is organized as follows: Section 1 examines the literature gap to fill in. Section 2
73 presents the methodology and justifies the focus on European planning documents to carry
74 out a comparative study based on the common requirements set out in Directive
75 2014/89/EU. Of all the data available for MSPs, we will also explain why we have chosen to
76 focus on environmental data in this paper. In Section 3 we present the results. This is
77 followed by Section 4, which enables us to discuss the data lifecycle to understand planning
78 and conclude in Section 5.
79

80 **Section 1. The use of data in Marine Spatial Planning: How to frame marine challenges** 81 **with data?** 82

83 Data harmonization has become a major topic in recent studies; it is repeatedly discussed in
84 the scientific literature as an urgent need in order to meet the goals posed by MSP (Elher,
85 2008; Hattam et al., 2015; Holzhüter et al., 2019; MSP Data Study, 2016; Stamoulis &
86 Develaux, 2015). Strain et al. (2006) suggested that spatial information is recognized as a
87 decisive element in decision-making since it provides the geographical context for plans.
88 Results reported by Holzhüter et al. (2019) or Schaefer & Barale (2011) suggest that the
89 temporal dimension is also important for the management of human activities at sea, since
90 both ecosystems and human activities are subject to seasonal shifts, making it necessary to
91 adjust their compatibility. Marine space must also be taken into account in a three-
92 dimensional way, while including the temporal dimension, which makes the management of
93 marine space more complex and reinforces the decisive role of geographical information
94 relating to it. In their 2014 paper, Shucksmith and Kelly reported the limited implementation
95 of spatial and temporal aspects of the dataset used for MSP.
96

97 However, despite this acknowledgement, the actual integration of spatial and temporal
98 aspects into datasets remains limited. Various studies have been carried out to examine the
99 data used in MSP, revealing significant gaps and disparities between states in the
100 processing of data for planning purposes (e.g. Shepperson et al., 2018 ; Trouillet, 2019,
101 2020). These studies reveal the growing attention given to data in planning, but also
102 highlight the need to deepen our understanding of the power-knowledge dynamics involved
103 in the production and use of data.

104 Few researchers have addressed the question of data quality used in MSP. The last five
105 years have witnessed and increased the number of multinational projects involved in MSP
106 data studies. UNESCO has recently conducted an inventory of marine environment in the

107 Mediterranean, highlighting gaps in data according to activities or spatial representations
108 (UNESCO-IOC, 2021) on the basis of a survey completed by stakeholders in the
109 Mediterranean. The eMSP-NBSR project also supported the implementation of a survey on
110 the use of data and information to better understand consistency, limitations, and
111 improvements regarding the data used in MSP for the Baltic Sea and Northern European
112 countries (Lequesne and Souf, 2023). This survey reveals once again the attention paid to
113 data in planning. Both the UNESCO survey and the eMSP-NBSR project demonstrate that
114 there are major disparities between countries in the way data are handled for planning
115 purposes.

116 These studies on data used in planning need to be taken further since, although they are
117 valuable for taking a snapshot of how data is used, they do not provide an understanding of
118 the power-knowledge relationships at work in the data factory. Therefore, when Batty (2022)
119 reveals that (urban) planning is based on data only downstream and not upstream of the
120 process, and encourages a change in this practice to meet the challenges of planning, this
121 area needs to be deeply investigated in marine planning as well. Furthermore, critical data
122 studies have shown that data processing is never neutral and emanates from a multitude of
123 choices (Dalton & Thatcher, 2014; Kitchin, 2021). MSP has been invested by critical data
124 studies, and some of them focus on one activity, and thus reveal the production of
125 knowledge and the missing layer (St. Martin & Hall-Arber, 2008). In particular, the lack of
126 information relating to some specific activity is well documented in the literature (e.g., fishing
127 activity has been studied by Leroy, 2018 and Trouillet, 2019). Generally, studies of data
128 used in MSP often focus on environmental data (McGowan et al., 2013; Ryan et al., 2018;
129 Weatherdon et al., 2015) and question the quality and use. Environmental data are
130 particularly interesting in view of the MSP goals, as it must enable 'ecosystem and
131 biodiversity conservation' (paragraph 1, Directive 2014/89/EU) and ensure that "the
132 collective pressure of all activities is kept withing levels compatible with the achievement of
133 good environmental status and that the capacity of marine ecosystems to respond to human-
134 induced changes is not compromised, while contributing to the sustainable use of marine
135 goods and services by present and future generations" (paragraph 14, Directive
136 2014/89/EU). Data quality issues cannot be addressed without documenting the internal and
137 external quality of data (Devilliers & Jeansoulin, 2006), which has so far eluded analyses of
138 environmental data in planning. In addition to data quality, other studies have looked at the
139 production of data more suited to the challenges faced by MSP and at data harmonization
140 (Dosell et al., 2021; Guinan et al., 2021; Holzhüter et al., 2019), but again, only a few
141 examples are given, and these do not cover the full range of issues potentially linked to data
142 production for planning purposes.

143 Finally, academic research has focused on the 'ecosystem-based' approach promoted by
144 Directive 2014/89/EC (e.g. Domínguez-Tejo et al., 2016; Douvere, 2008; Douvere & Ehler,
145 2009; Gilliland & Laffoley, 2008), which in theory meets the need for a balanced approach
146 between offshore activities development and environmental conservation. In practice,
147 Domínguez-Tejo et al. (2016) points out, using a comparative study, the relevant
148 characteristics of applying an ecosystem-based approach are rarely present, in particular the
149 assessment of human activities pressures, but also social values or non-market activities.

150 Considering the above-mentioned issues, it is necessary to pursue further reflections
151 through the study of the environmental data production in MSP, in particular through the
152 notion of an ecosystem. To better understand the meaning of an ecosystem, in this paper,
153 we will refer to the intra-action theory to offer an innovative conceptual framework for
154 understanding the construction of environmental data and the complex relationships
155 between humans, non-human actors and their environment. According to Barad (2007) and
156 applied to data, intra-action can be considered as recognizing the interconnection between
157 various entities involved in the production and use of data, and this approach highlights the
158 co-construction of environmental reality. We will explore this theory through the concept of
159 information in-formation (Kaufmann and Leese, 2021), which allows us to understand the
160 creation of new information through the entanglement of environmental and human activities
161 data. For example, the use of intra-action theory to marine planning makes it possible to

162 move beyond traditional conceptions of human-environment interaction and recognize the
163 intertwined nature of relationships between human being, nature, and technology (Lehman,
164 2016). This framework offers a new understanding of governance processes and underlines
165 the importance of taking into account the complex interactions between the different actors
166 and factors involved in the production and use of environmental data. Ultimately, applying
167 intra-action theory allows us to recognise the complexity of interactions of human/non-
168 human/environment interactions in MSP. This leads to a more holistic and integrated
169 approach to the management of marine resources, taking into account various social,
170 economic, and environmental dimensions involved in marine space. By applying it to the
171 case of European MSP, this ensures a basis of common environmental requirements for
172 conducting a comparative study.

173 **Section 2 : Materials and Methods**

174
175
176 The method used in this research is a content analysis of the maritime plans in Europe.
177 More specifically we used a comparative perspective to analyze all the plans that fall within
178 the scope of Directive 2014/89/EU for the first MSP cycle. This methodological proposal
179 must be mobilized in the light of the theoretical framework developed and particularly
180 through the intra-action approach to understand the production of data in an ecosystem
181 approach promoted by the European directive.

182
183 To establish whether the data used are aligned with the ecosystem approach mentioned in
184 Directive 2014/89/EU, Barad (2007) theory is used. Indeed, based on Barad (2007) and
185 Kaufmann and Leese (2021) research, we understand the importance of carefully analyze
186 the specifics of the relationships between data and its lifecycle. For this reason, we use the
187 concept of 'information in-information' (Kaufmann and Leese, 2021), to describe the
188 entanglement of data in planning. By exploring what it means to form information in a policy
189 context for managing marine space, particularly from an ecosystem-based policy
190 perspective, it should be possible to show how interactions between data and humans
191 generate knowledge and action.

192 Directive 2014/89/EU promotes a cross-sectoral integrated and cross-border approach. The
193 application of an ecosystem-based approach (paragraph 14) is intended to help promote the
194 sustainable development and growth of marine and coastal economies, as well as the
195 sustainable use of marine and coastal resources. The directive also mentions (paragraph
196 13) the pressures on ecosystems and resources resulting from human activities, climate
197 change, and natural risks. Encourages consideration of land-sea interactions, as well as
198 human and non-human interactions (paragraph 16). MSP also needs to take into account
199 the temporal aspect of activities and, in particular, possible long-term variations (paragraph
200 19). To this end, states implementing MSP must base their plans on "reliable data [...] [and]
201 use of the best available data and information by encouraging relevant stakeholders to share
202 information and [use] existing instruments and tools for data collection" (paragraph 24). Our
203 approach is mainly based on three key aspects: (1) knowledge of ecosystems and the
204 variations they may undergo; (2) the superposition of data to assess interactions; (3) the use
205 of impact indicators derived from these data. These three points of data evaluation will make
206 it possible to document interactions between natural environments, as well as between
207 human and non-human aspects of marine space. Analysis of the diversity of available data
208 should enable us to assess the potential differences that exist in data production. By
209 documenting ecosystems and the parameters that influence them, it is possible to see the
210 'information in-information' if certain information, taken independently, has a different meaning
211 when put together. The impact indicator approach helps to document data entanglement
212 since it results from the combination of several data to assess an overall state. Given
213 Directive 2014/89/EU, the study of data production through environmental data is particularly
214 interesting, since this aspect of offshore planning is relatively circumscribed by the text of the
215 directive. This method has been already used in previous comparative studies, at the

216 European level or beyond (e.g., Trouillet, 2020). On this basis, we define three questions
 217 with reference to the ecosystem approach as framed by Directive 2014/89/EU:
 218 - Question 1 (Q1): What types of data are available to map ecosystems?
 219 - Question 2 (Q2): Are data available to map entanglements (or intra-action)?
 220 - Question 3 (Q3): Can the data produced support a multidimensional approach?

221
 222 By studying this from the information available on European marine plans and documenting
 223 how they mobilize data, particularly the cartographic part of the documents, and by looking
 224 specifically at the data used and which must enable the directive to be met, the aim is to
 225 understand which (f)actors (technical or human) influence maritime spatial planning. The
 226 three questions that we seek to answer by analyzing our corpus, are broken down into
 227 several indicators (Tab.1):

228
 229 Table 1. Indicators applied to European MSP initiatives
 230

Questions	Indicators	Labels (<i>and comments</i>)
Q1	I1	Ecosystem representation <i>Factual assessment of whether data are available to represent ecosystems.</i>
Q2	I2	Data overlay <i>Creation of new information ('information in-information')</i>
	I3	Indicator resulting from the combination of several data items <i>Highlighting co-construction relationships (intra-action)</i>
Q3	I4	Potential conflicts documented <i>Multidimensional approach to offshore activities</i>

231
 232 These four indicators will be applied to our corpus and should enable us to document the
 233 answers to the three main questions as factually as possible, in order to draw general
 234 conclusions.

235
 236 **Corpus**

237 Because we were interested in comparing different marine plans, we considered only plans
 238 under Directive 2014/89/EU. Based on the scope of application of Directive 2014/89/EU, we
 239 built up a corpus of marine plans back in 2021. The plans were selected on the basis of the
 240 census carried out by the European Commission within the framework of the European MSP
 241 Platform³ before 2022, which is an information and communication website designed to offer
 242 support to all EU member states in the implementation of MSP (see details in Appendix 1).
 243 Directive 2014/89/EU requires all EU coastal member states to have an intersectoral plan for
 244 their marine area by 2021. The principal advantage of this method is that the European
 245 directive calls for a certain homogenization of plans, at least with a view to meeting the
 246 requirements, which enables us to apply an analysis grid that should be compatible from one
 247 plan to another. Conversely, the main limitation is that the plans cannot summarize all the
 248 documents produced as part of the planning exercise. It is therefore likely that some
 249 elements will be overlooked in this analysis. Based on the European MSP Platform, the
 250 inclusion of the United Kingdom within this corpus deserves attention, despite its departure
 251 from the EU. Previously, the development plans for its seafronts fell under the purview of
 252 Directive 2014/89/EU. In particular, Norway, although not part of the EU and thus not
 253 obligated to comply with the aforementioned directive, adheres to approximately 95% of EU
 254 directives through other European environmental policies. This raises pertinent concerns
 255 regarding its exclusion from the corpus. To maintain coherence, we align with the corpus
 256 outlined by the European MSP Platform before 2022, choosing to exclude Norway but
 257 include the United Kingdom in our analytical framework from the corpus. For the sake of

³ <https://maritime-spatial-planning.test.ec.europa.eu/>

258 consistency, we have decided to follow the corpus proposed by the European MSP Platform
259 and not to include Norway but to include the United Kingdom in our analysis.
260 In order to analyze the most tangible planning materials, we build up our corpus with
261 planning documents, in particular maps, to identify the dataset that are mobilized, and thus
262 understand how they are produced. So, when we look at planning documents, we analyze
263 the maps they contain, with the aim of tracing them back to the data. Consequently, the
264 corpus is made up of 38 planning documents (under development or finalized) in 23
265 countries. Each country is responsible for developing its own marine plan. Therefore, it is
266 necessary to extract plans that are not in French or English and therefore unintelligible to us,
267 which brings us to 19 plans spread over 11 countries. Our analysis grid will be applied to 19
268 marine plans.

269 **Section 3 : Results**

270
271
272 The study presented in this paper offers an in-depth examination of a crucial moment in the
273 operational component of MSP, but does not aim to be exhaustive.
274 Given the sum of compiled elements, we have opted to provide a synthesis of the results in
275 this section, while reserving detailed listings for the Appendices. The analysis of 19 marine
276 planning documents (Table 2 and Appendix 2) yielded the following outline results – focusing
277 solely on trends and overall proportions, rather than conducting a statistical analysis, which
278 would lack significance due to the limited number of MSPs included:

- 279
280 • Indicator I1: Marine ecosystems are documented for the entire planning area of 8 out
281 of 19 MSP initiatives and are partially documented, particularly when they correspond
282 to protection zones, in 11 MSP initiatives in the maps published.

283
284 To be more explicit, we decided to illustrate our result with some examples. All plans and
285 maps mentioned in the results section are detailed in our Appendices 1 and 2. A comparison
286 of marine ecosystem mapping data for Ireland and the Netherlands reveals significant
287 disparities. Ireland benefits from the support of exhaustive coverage of its exclusive
288 economic zone, as illustrated in the associated geoportal (<https://atlas.marine.ie>) used to
289 produce maps. In addition, consultation of the online atlas reveals the diversity and richness
290 of available datasets, ranging from biodiversity to climate change and environmental
291 monitoring. However, in the Netherlands, only areas of ecological interest, in particular
292 Natura 2000, are mapped in the environmental part of the MSP. Closer observation reveals
293 that these data are not specifically produced for planning purposes, but are derived from
294 other management projects.

295 Looking closely at data production, it is clear that, both for Ireland and the Netherlands, the
296 data come from various government bodies and are neither necessarily produced for
297 planning purposes, but are often derived from other projects and recycled for MSP.
298 It is also important to note that access to metadata, which is essential for understanding how
299 data are produced, is often limited or not available in a language that the authors of this
300 paper understood, as is it in Denmark, where, surprisingly, the metadata are only available in
301 Danish. This situation is particularly challenging when it comes to understanding the choices
302 and processes involved in the production and representation of data.

- 303
304 • Indicator I2: In 9 of 19 MSP initiatives, the plans use a combination of data related to
305 ecosystems and human activities to generate new information to guide an
306 ecosystem-based approach. In 10 MSP initiatives, the use of data related to
307 ecosystems and human activities only results in the overlaying of information
308 graphically, but does not generate any new information.

309
310 To understand this result, we can, for example, use the case of Bulgaria, where the data
311 made available to document ecosystems are treated as zoning. On the map proposed in the
312 MSP document, there is an overlay of certain zonings, but this does not result in any new

313 information. The map is mainly descriptive and the lack of information resulting from the
 314 overlapping of zones illustrates the difficulty of taking into account all the dimensions of
 315 marine areas. Also, in this case, one possible explanation for this could be the lack of
 316 information on the overlaying zones due to missing datasets, but it can also be the result of
 317 representation choices. As we cannot access the metadata as we are performing this
 318 analysis, because the document has not yet been finalized, no significant correlation can be
 319 noted.

320

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

325

326 To illustrate this indicator, we can use the example of the French Mediterranean coast,
 327 where local authorities chose to employ an independent consulting firm to set up a system
 328 for assessing the impact of activities affecting the marine environment. The approach used is
 329 detailed in the appendix of the planning document, but concerning the data creation, it
 330 derives from the use of a scale for assessing impacts in relation to the actions set out in the
 331 plan. This impact assessment method shows its limitations when data are not complete or
 332 available. For example, according to the MSP document notes, in the case of marine
 333 mammals in the Mediterranean Sea, the distribution is not well known by the national
 334 institute for biodiversity (named *Office Français de la Biodiversité*), which provided data for
 335 MSP. The lack of available datasets means that it is not possible to assess the impact
 336 quantitatively. In this case, the lack of information means that no indicators can be mapped.

337

- 338 • Indicator I4: Finally, the 19 MSP initiatives provide partial multidimensional mapping,
 339 either because not all human activities are included, or marine biological areas are
 340 missing, or one of the multidimensional variables of maritime space is absent (e.g.
 341 depth or time variable).

342

343 To illustrate this indicator, we use the case of Wales, where data is used for MSP provided
 344 by the state and collected on an one-off basis. Besides, most of the data comes from the
 345 Marine and Coastal Access Act 2009. Once again, for this last indicator, it is difficult to know
 346 whether all the multidimensional aspects of marine space are not accessible due to the lack
 347 of specific data creation, processing, representation choices, or technological limitations of
 348 geoportals associated with marine plans (Davret et al., 2024).

349

350 **Table 2 summarizes the results following analysis of 19 MSP initiatives (see details in**
 351 **Appendix 2).**

352

Coding	Value	Indicators	Comment	Count
I1		Are ecosystems areas documented ?		
	2	Yes	The entire marine zone is documented	8
	1	Partially	Only certain areas are mentioned	11
	0	No	No mention of ecosystems	0
I2		Is there data overlay ?		
	2	Yes, resulting in new information	Information is generated and displayed from data overlay	9
	1	Yes, but it does not result in a new information	Information from the overlay data is not mentioned	10
	0	No	No overlaying of information	0

I3		Are there indicators of impact on the marine area?		
	2	Yes		8
	1	Partially	Impact indicator not established for all activities	0
	0	No		11
I4		Is a multidimensional approach to marine space documented?		
	2	Yes		0
	1	Partially	The multidimensional approach concerns only part of the marine area or part of marine activities	19
	0	No		0

353

354 As highlighted in Table 2, our analysis of 19 MSP documents around Europe reveals that an
 355 ecosystem-based approach to marine spaces is often incomplete, particularly when it comes
 356 to mapping. From the data shown in Table 2, it is apparent that given the multidimensional
 357 nature of marine space, a wide range of data is required (such as spatial sea bottom and
 358 surface data, temporal data, etc.). However, these requirements are likely to encounter
 359 limitations in terms of techniques, knowledge, tools, or mediums used to transcribe them.
 360 Table 2, which answers our three main questions, demonstrates the following:

361

- 362 • (Q1) Plans with detailed ecosystem mapping tend to use data that highlight the
 363 spatial variability of ecosystems, while those with partial mapping often use
 364 fragmented data, including zoning data.
- 365 • (Q2) Plans that incorporate data overlay to generate new information generally
 366 provide mapped impact indicators, unlike maps that overlay data without creating
 367 new information.
- 368 • (Q3) Data manipulated and used in plans examined do not allow for a complete
 369 multidimensional approach, and the limitations inherent in this problem, such as
 370 technological constraints, data production, processing, and representation choice,
 371 often remain unidentified.

372

373 In general, these results indicate gaps in ecosystem-based approaches, particularly in terms
 374 of mapping. Although some plans comprehensively document marine ecosystems, others
 375 present partial documentation, highlighting disparities between MSPs. While some initiatives
 376 effectively integrate data from ecosystems and human activities to generate new information
 377 and impact indicators, others simply overlay data without creating meaningful new insights.
 378 Data limitations and technological constraints often impede a comprehensive
 379 multidimensional approach in MSPs, highlighting the need to improve data accessibility,
 380 comprehensiveness, and integration for more effective marine planning.

381 This result highlights the differences in the availability and nature of environmental data
 382 between European countries, as well as the challenges associated with understanding data
 383 production in the context of maritime planning.

384

385 **Section 4 : Discussion**

386

387 Our paper examines a variety of facets pertinent to MSP, focusing on the analysis of data
 388 used in the planning process. Our study offers valuable information to reflect on the quality
 389 and completeness in MSP. Then we delve into the intra-action theory and we demonstrate
 390 the interest of doing research on the data lifecycle align with critical data studies to better
 391 understand governance of marine space.

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4.1 Examining data quality through map-making

Interestingly, the results reveal that beyond the factual responses to the indicators, analysis of the data approach to marine planning reveals that the majority of data is produced by the State for previous management project, but rarely specifically for planning purposes, as can be observed from the sources and creation year of the data used in the plans analyzed.

It is clear that data production analysis is closely related to information processing, representation, and dissemination choices. In the absence of systematic and intelligible access to all metadata, it is difficult to distinguish each stage of the data lifecycle. These findings raise questions about the quality and completeness of the data used to achieve the ambitious objectives of the ecosystem-based approach.

The results reinforce the need to reflect on the analysis and evaluation of data, from any pre-processing carried out to the representation choice for a specific purpose like planning.

The results of the plan review reveal significant gaps in ecosystem mapping: ecosystem mapping is often partial (in 11 cases of 19), the combination of information does not lead to new information (in 10 cases of 19), or the multidimensional approach is flawed (in all cases) based on our indicators. This weakness is often the result of technical constraints, data availability, or conscious or unconscious political choices. These findings highlight the limits of the 'evidence' available to guide planning decisions in the so-called evidence-based planning.

Critical studies are used to discuss the relationships between decision-making and data. Thus, as Gregg (2015) points out when speaking of the 'spectacle of data', data visualisation can be a 'fantasy of command and control through seeing' (p. 1) by delivering an ordered and prescriptive vision of space. In fact, MSP maps can be used as a tool of governance and power. Maps are not neutral representations of reality, but are shaped by political choices and specific interests. Consequently, maps can hide or marginalize certain claims or used for marine space, while favoring others (Bridge et al., 2013). McCarthy & Thatcher (2019) point out in this respect that it is mostly collective claims and informal use that are missing from maps due to lack of data. Finally, two ways of assessing the effect that maps and, by extension, the data used in maps, can have on the public stand out: (1) following Li (2014), Scott (1998) or Wood & Fels (1992) maps are a tool or power in themselves, or (2) maps do nothing in themselves but depend on how people use them (Fogelman & Bassett, 2017 ; Kitchin & Dodge, 2007, 2014). In line with McCarthy & Thatcher (2019) and Kitchin & Dodge (2007), we argue that maps are dependent on the social network in which they act and evolve, but also strongly constrained by the data and geotechnologies used.

Although the expected finding was to be able to trace the data lifecycle in planning, this study showed the difficulty of accessing the metadata. This was particularly the case because the planning process was still underway when we carried out this study and not all the planning geoportals were available, for example.

Altogether, what particularly stands out is that the ecosystem-based approach advocated and expected by MSP is based on data collected on a one-off basis, for example, data collected on an irregular basis and not containing all the parameters needed to represent the marine space (i.e., temporal or seasonal dimension is often absent), or data collected at high frequency and automatically (i.e., fishing activity is often represented with automatically collected data), but which have not been produced with planning in mind. High-frequency and automated data are often monitoring data, not management data (Said & Trouillet, 2020). This means that planning decisions are made without relying on the creation of specific data to meet their needs but are then justified by preexisting data. Our findings provide support for Batty (2018, 2022) theory that raised the same issue for urban planning, deploring the fact that planning is based on downstream rather than upstream data.

The mismatch between MSP needs and the data used is highlighted in our results (Q1), which show that ecosystems are partially documented in 11 of 19 cases. Evidence-based planning requires a meticulous approach to produce adequate data to address spatial management challenges, which is not the case, according to our results. This implies

447 recognizing the limitations of bioeconomic data which do not capture the complexity of socio-
448 spatial relationships, such as for leisure activity. Our results reveal inconsistencies between
449 needs and data used in MSP, illustrated, for example, in Malta or Denmark MSP, where
450 zoning plans do not fully capture environmental reality. Furthermore, it is crucial to anticipate
451 potential biases related to data collection (Trouillet, 2019), particularly taking into account the
452 'internal' and 'external' quality of data (David & Fasquel, 1997; Devillers & Jeansoulin, 2006).
453 External data quality depends on its suitability for the project's need, as defined by Wang
454 and Strong (1996). However, MSP is facing data gaps based on two aspects: (1) time
455 constraints imposed for the production of the first plans (Directive 2014/89/EU in place in
456 2014 for the plan implementation by 2021 at the latest), which are the focus of this paper,
457 and (2) not all sea activities are monitored in a way that allows data to be generated, which
458 is what St. Martin & Hall-Arber (2008) call 'the missing layer', particularly for activities such
459 as small-scale fishing and for social, cultural, and sentimental aspects of marine space.
460 Indeed, this aspect of planning has recently been the subject of studies (see, for example,
461 Flannery et al., 2022; Gee et al., 2017; Ntona & Schröder, 2020; Pennino et al., 2021)
462 demonstrating the incompleteness of planning approaches that fail to mention these aspects
463 of marine areas. Despite the importance of non-spatial data, as highlighted by Shucksmith
464 and Kelly (2014), the academic literature often focuses on spatial data. This gap
465 underscores the need for a more holistic approach to data collection and use in planning.
466

467 **4.2 Reading MSP through intra-action theory**

468
469 This article illustrates several crucial aspects of ecosystem-based planning. Firstly, it reveals
470 an inconsistency both across borders and within national boundaries with regard to marine
471 plans. This divergence between national policies and the lack of harmonization between
472 regional plans underscores the challenges faced in seeking a coherent management of
473 marine ecosystems. For example, MSP for the French North Coast, placed side by side with
474 Belgium, reveals a major contradiction, since the vocation of the French side border is to
475 promote shipping, fishing, harbor, and offshore energy. On the other hand, the Belgian
476 border creates a large marine protection zone that has no continuity on the French side and
477 therefore comes to an abrupt halt between the two EEZs. Secondly, our findings point to a
478 disparity in the data used to develop the MSP. Although some plans effectively integrate
479 different data sources to generate new information, others simply overlay data without
480 creating significant new knowledge (Q2). In fact, 9 out of 19 cases use data overlay to
481 generate new information. However, 10 plans out of 19 use a data overlay without creating
482 new information from this combination. This cumulative use of data underlines the
483 importance of considering not only the availability of data but also its interpretation and
484 integration for an integrated understanding of marine space. Thirdly, the ecosystem-based
485 approach to MSP reveals complex interactions between data, human and non-human
486 actors, and the resulting policies. Such mutual relationships result in the notion of intra-
487 action, which underlines the constant dynamics that exist between the different elements of
488 marine systems. Indeed, only 8 out of 19 plans provide a mapped assessment of impacts,
489 although these plans are based on available data, which, as we point out in the first part of
490 this discussion, are highly dependent on the quality and processing of the data.
491 These results provide support for Kaufmann and Leese (2021) concept of information in-
492 formation to understand the data lifecycle and the numerous trajectories that data can take,
493 depending on its 'interactions' and 'intra-action' with human and nonhuman actors as
494 theorized by Barad (2007). The notion of 'intra-action' is particularly interesting when thinking
495 about MSP, because unlike 'interaction', it is defined by a constant dynamic movement that
496 acts mutually between components of a system. Therefore, when planning for the multiuse
497 of marine space, each element becomes linked to another, and it is difficult to understand
498 the inner relationship between the 'node' of activity. In fact, this notion seems particularly
499 well suited to dynamic and mobile spaces such as marine space. This discussion highlights
500 the importance of rethinking data collection, analysis, and use practices in MSP to promote
501 fairer and more transparent governance. According to McCarthy & Thatcher (2019), critical

502 data studies are essential to understand governance. Firstly, because critical data studies
503 make it possible to break the 'hidden technocracy' (Obermeyer, 1995), in particular by
504 providing access to decision-making methods through geotechnologies or by understanding
505 which data are included and excluded from the process. This again brings us to the notion of
506 intra-action, where the entanglement of different components is a prior condition, rather than
507 the results of action. In line with this, Lupton (2016) argues that it is equally difficult to
508 understand the entanglement between data and society, since data act on society and
509 society acts on data through various assemblages (Kaufmann & Leese, 2021).

510
511 Finally, our paper shows the importance of understanding the data lifecycle and its impact on
512 decision-making. Considering the limited number of plans analyzed, more research is
513 needed to carefully analyze power-knowledge relations and study the various journeys of a
514 dataset to better understand their role in the policy-making process and marine space
515 governance. Furthermore, the lack of undigitized datasets (Gautreau, 2021) and social
516 dimensions (Cornu et al., 2014 ; Gee et al., 2017) in MSP raises questions about the
517 representativeness and inclusiveness of planning, especially in developing countries where
518 greater attention is even more required (Trouillet et al., 2023).

519 **Section 5. Conclusion**

520
521
522 This paper has demonstrated that the ecosystem-based approach expected in MSP relies
523 heavily on fragmented data, which is often incomplete and lacks essential parameters such
524 as the temporal dimension. Data collected at high frequency and automatically is used, but
525 often distorted from its original purpose to meet planning need, raising concerns about its
526 relevance. Our research has highlighted that the absence of data specifically designed for
527 planning purposes leads to gaps in multidimensional plans, especially when it comes to
528 marine space, limiting their effectiveness. Technical constraints, data availability, and
529 political choices influence planning results, particularly with regard to ecosystem mapping
530 and the illustration of marine activities. Biases in the use of data and its mapping raise
531 questions about governance and information justice, highlighting the importance of a critical
532 approach to data and considering its use in the decision-making process for marine
533 planning. Also, by seeing things from a different angle, data could be a lever for including
534 stakeholders in participation. Despite this, today, data exclude (collection, processing,
535 interpretation...) more than they include stakeholders.

536 The Europe-wide examination which in theory should enable us to obtain a common
537 framework from Directive 2014/89/Eu in order to be able to compare data factory for each
538 plan, turned out in practice to be limited by the lack of intelligibility of the non-English-
539 speaking plans and the limitations of access to the databases. Despite limitations due to the
540 limited number of plans analyzes and the difficulty of following the data lifecycle through the
541 marine plan, we believe our work helps to highlight the different strategies used to develop
542 an ecosystem approach.

543 In this paper, we have highlighted the crucial role of data in marine planning, revealing that it
544 is not only a tool for visualizing state interest and economic visions of marine spaces, but
545 also a means by which these interest and visions are shapes because data are difficult to
546 access and, therefore, not easily questioned (McCarthy and Thatcher, 2019). These findings
547 underscore that, contrary to the ideal of an 'evidence-based' approach, MSP seems to be
548 driven more by political decisions justified *a posteriori* by the available data (Batty, 2022) and
549 validate our hypothesis based on the analysis of the first round of MSP. In addition, data
550 deserts are hidden or at least not explained, and processing algorithms are not explained or
551 justified, let alone discussed.

552 More research should investigate the map making of MSP such as those used to translate
553 the MSP into visual form in Europe. But once the map has been produced, it is already too
554 late to question the information and, above all, the data. This suggests the need to develop
555 upstream research to understand the relationships between states, technologies, and MSP

556 in order to open up the mapping process, since this is one of the main action drivers for
557 states that implement a marine plan.

558

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565

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