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Legally analysing and addressing the Effects of Ocean Acidification in a European Union law context through the lens of the ecosystem approach

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Abstract

Ocean Acidification (OA) continues to have an increasing impact on the marine waters of the European Union (EU). Nevertheless, there is no legal framework in place that addresses OA sufficiently enough to reduce or even halt it. Therefore, it has become necessary to consider possible avenues and legal instruments that can tackle the consequences of OA. As the current sectorial approach to marine management has been unsuccessful in addressing complex issues such as OA, this paper set out to explore how and if the Ecosystem Approach, with a particular focus on adaptive management could contribute to tackling the consequences of OA within the marine waters of the EU. Following a concept analysis of the Ecosystem Approach and a subsequent case study on the utilisation of MPAs in response to the effects of OA, it must be concluded that no clear legal answer can be given.

Table of Contents

List of Abbreviations

CBD	Convention on Biological Diversity
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CJEU	Court of Justice of the European Union
COP	Conference of the Parties
EEZ	Exclusive Economic Zone
EU	European Union
MPAs	Marine Protected Areas
MSFD	Marine Strategy Framework Directive
OA	Ocean Acidification
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
SACs	Special Areas of Conservation
SPAs	Special Protection Areas
TEU	Treaty on European Union
TFEU	Treaty on the Functioning of the European Union
UNCLOS	United Nations Convention on the Law of the Sea
UNFSA	United Nations Fish Stocks Agreement
UNGA	United Nations General Assembly
ICP	Open-Ended Informal Consultative Process on the Law of the Sea
WCN	World Charter for Nature
WFD	Water Framework Directive

1 Introduction

For the Eropean Union (EU), its maritime waters are of extreme importance. Estimates from 2019 determined that around 4.45 million people depend on the EU's marine waters for their livelihoods and especially the established sectors, such as marine living resources and shipbuilding, achieved a turnover amounting to a gross value of €183.9 billion.[1] Nevertheless, the EU's maritime waters offer and provide us with so much more. To determine how exactly ecosystems such as the marine waters of the EU benefit us humans and the value of such benefits, the concept of ecosystem services was developed. In fact, ecosystem services describe all the ways, both direct and indirect in which ecosystems help to achieve human well-being.[2] By framing the concept in such a way, it tries to reconcile our current problem of ecosystem overexploitation with our need to increase and maintain human well-being. In our economically focused world, this is done by considering each aspect of the world as assets, namely the people (human capital), the society (social capital), the economy (build capital) and ecosystems (natural capital) which in turn need to be balanced against each other.[3]

Following the ecosystem service typology established by the Economics of Ecosystems and Biodiversity initiative (TEEB), ecosystems provide a variety of different services such as the provision of food, water, medical resources, and raw materials (provisioning services). Moreover, they sustain genetic diversity and full life cycle development of migratory species (habitat services), as well as erosion prevention and the regulation of the air quality (regulating services). Finally, ecosystems also provide room for recreational purposes or cultural and artistic activities (cultural/amenity services).[4]

To exemplify the importance of marine ecosystems and their ecosystem services for the EU specifically, the Mediterranean Sea offers a good representative framework and appropriate scale.[5] In fact, even though the Mediterranean Sea is rather small, it consists of a variety of different habitats and accommodates a total of 7% of the world's marine biodiversity.[6] Some

[1] European Commission et al. 2022, p. VI.

[2] de Groot et al. 2010, p. 25.

[3] Costanza et al. 2014, p. 153.

[4] de Groot et al. 2010, p. 25–26.

[5] Bethoux et al. 1999, p. 133.

[6] Zunino et al. 2017, p. 87.

of the ecosystem services provided by the Mediterranean Sea include the protection of the coastlines, the regulation of the regional climate, as well as the provision of food through fisheries activities.[7] Nevertheless, the Mediterranean Sea is also exposed to an increasing number of environmental pressures, inflicted on it by its twenty-two riparian states, seven of which are EU Member States.[8] One such pressure of increasing significance and of particular interest to this paper is Ocean Acidification (OA).

For decades or even centuries, humans have emitted an increasing amount of CO_2 into the atmosphere as a side-effect of industrialisation and globalisation. However, this increase of CO_2-levels in the atmosphere is not only one of the causes of Climate Change but also affects the world's oceans through OA.[9] In fact, OA occurs due to an increase of hydrogen ions in the water column which in turn lead to a decrease in the ocean's pH levels thereby, turning the oceans more acidic. Hence, OA.[10]

The increase of hydrogen ions in the water columns takes place due to natures constant need to establish concentration equilibriums even between the earth's atmosphere and its oceans. Thus, the increase of atmospheric CO_2-levels, as mentioned above, lead to a subsequent dissolution of some of the CO_2 in the oceans where the CO_2 breaks into its chemical components, one of which are the hydrogen ions.[11] Besides these global drivers of OA there are also some drivers that influence the acidity of the ocean locally such as nutrient inputs, soil erosion and pollution.[12] Nevertheless, the real problem with OA is not that an exchange of CO_2 molecules between the ocean and the atmosphere occurs, but instead the current rate at which it does. Looking back in time, the current OA- rate has last been seen around 56 million years ago and was due to a large CO_2 injection.[13]

It is this accelerated rate of CO_2 dissolution that has scientists agree that OA will (adversely) affect marine ecosystems and its inhabitants, despite the persisting scientific

[7] ibid.

[8] ibid, p. 87.

[9] Baird et al. 2009, p. 459.

[10] Galdies et al. 2020, p. 2.

[11] Zunino et al. 2017, p. 87.

[12] Kelly et al. 2011, p. 1036.

[13] Galdies et al. 2020, p. 2.

uncertainties with regards to species-specific responses and the effect of mediating factors.[14] Especially, calcifying algae, corals and sea urchins have been predicted to suffer under the advance of OA, while fleshy algae might even benefit from such an advance.[15] The predictions become less certain when it comes to seagrass meadows, photosynthetic organisms and molluscs. As a matter of fact, some studies suggest that seagrass meadows will thrive under decreased pH-levels,[16] while other studies indicate that particularly the domestic seagrass species (Posidonia oceanica) will instead be hampered in its development.[17] For photosynthetic organisms and molluscs the effects of OA are even less clear and often dependent on the relevant sub-species. Mussels for example seem to be quite OA resistant while vermetids are predicted to suffer under increasing OA.[18]

Despite these remaining uncertainties, consensus seems to form that even small changes in the abundance and structure of these key species will inevitably affect the relevant ecosystem at large, as well as the ecosystem services it offers.[19] For example, a decrease in calcifying algae will also inhibit their role in carbon cycling and as habitat providers. Similarly, a decrease in corals and seagrass has been predicted to affect their role as e.g., feeding, nursing and development sites, thus impacting the fishing yields in the Mediterranean. Moreover, the role of both species as carbon sinks, recreational diving sites and coastal protection will also be inhibited by OA.[20]

Overall, this short excursion into ecology has shown that the predictions for EU marine waters, indicatively represented by the Mediterranean Sea, look rather grim if OA continues its rise in the European waters. Moreover, a decrease in the pH levels of the EU marine waters will inevitably affect all four groups of ecosystem services identified by the TEEB, thereby also

[14] Baird et al. 2009, p. 461; Zunino et al. 2017, p. 94; Zunino et al. 2019, p. 10.

[15] Zunino et al. 2017, p. 91–94.

[16] ibid, p. 92.

[17] Zunino et al. 2019, p. 6–8.

[18] Zunino et al. 2017, p. 93.

[19] Zunino et al. 2019, p. 2.

[20] ibid, p. 8–9.

affecting the benefits humans receive from these services.[21] As such the question arises how the EU should legally deal with OA and the consequences it will have for our daily lives.

In response, it must be highlighted that, regardless of the seriousness of the problem, OA has neither been properly addressed on the international or even regional level as a distinct issue from Climate Change, nor has a solution been found.[22] In fact, steps tackling OA and its consequences in the EU, have only been taken since the EU-funded research initiatives in 2008.[23] And although the EU has taken further action in recent years when it comes to Climate Change, these steps do not cover all aspects of OA.[24] Particularly, the ways in which the consequences of OA can be addressed, has not received a lot of attention within the EU, although such activities might help to further the resilience of ecosystems against OA and its impacts on marine waters. Resilience generally describes the ability of a system, either of ecological or social nature, to handle disturbances or change in a way that allows it to maintain its basic functioning and structure.[25] In line with that, especially Marine Protected Areas (MPAs) have been advanced as a possible tool to increase the resilience of ecosystems against stressors such as OA, thus facilitating the recovery process of OA impacted species.[26]

Besides the lack of OA specific action, marine management more generally, has also encountered some issues arising due to its sectorial focus.[27] In fact, many of the pressures faced by the oceans, including OA, have increased over time with no alleviation provided by marine management and environmental law in general. This might to some extend be due to the complex character of many of these current environmental problems which have been characterised as so-called wicked problems due to their unresolved and persistent nature.[28] The sectorial approach with its independent regulation of all the sectors and activities impacting the marine environment, currently in place, does not seem to be up to the challenge. Instead, an alternative has been developed with the so-called Ecosystem Approach. Contrary to the

[21] For the full typology see: de Groot et al. 2010, p. 25–26.

[22] Galdies et al. 2020, p. 2–3.

[23] ibid, p. 6.

[24] ibid.

[25] Kroeker et al. 2019, p. 118.

[26] ibid, p. 120–121.

[27] Curtin and Prellezo 2010, p. 821.

[28] O'Higgins et al. 2020, p. 4.

sectorial approach, the Ecosystem Approach recognises that the human activities occur within and depend on the surrounding ecological system. Within that more holistic framework it then identifies the existing problems as well as its underlying causes and the actors involved.[29] As such, the Ecosystem Approach generally aims at implementing an integrated, adaptive, and science-based conservation and management approach to natural resources and human activities.[30] At face value, the Ecosystem Approach thus seems to be better equipped to deal with complex issues such as OA. Therefore, this paper will explore if the Ecosystem Approach, with a particular focus on adaptive management, can contribute to tackling the consequences of OA within the marine waters of the EU, and if so, how. When considering possible ways of tackling the consequences of OA, the focus will be on MPAs as there already exists a strong legal framework for such activities within the EU. Moreover, this paper will limit itself to the EU's internal and territorial waters when considering the EU marine protection regime. Finally, the ambiguity surrounding the Ecosystem Approach makes it necessary to clarify the use of terminology employed in this paper. As such the paper will mainly use the term Ecosystem Approach, considering the term to be equivalent to the term 'ecosystem-based management' and 'ecosystem-based approach' as used in EU legislation.

In the following, section 2 will lay the groundwork in relation to the Ecosystem Approach by tracking the evolution of the Approach from its ecological roots to its current position within law (section 2.1). Section 2.2 will then continue within the same line of thought by investigating the Approach's legal role and status in international environmental law as well as by identifying its underlying characteristics. Together both sub-sections thus help with the conceptualisation of the Ecosystem Approach which will provide the overall framework within which adaptive management as one of the key principles of the Ecosystem Approach can be dissected. Afterwards, Section 3 will take a closer look at the implementation of the Ecosystem Approach and adaptive management within the EU legal order concerned with marine area

[29] ibid, p. 5.

[30] De Lucia 2018, p. 104; CBD Secretariat, "Ecosystem Approach Description" 2010 <https://www.cbd.int/ecosystem/description.shtml> (last accessed 10 February 2023).

protection. Thus, particular attention will be paid to the Habitats[31] and Birds Directives[32], the Water Framework Directive[33] (WFD) and the Marine Strategy Framework Directive[34] (MSFD) as they provide the main framework for MPAs within EU law. To tie everything together, section 4.1 will first take a closer look at the consequences of OA on EU marine waters, thus building on the short overview of the topic provided in the introduction. This is then followed by an analysis of MPAs, especially highlighting their role in addressing the effects of OA, as well as detailing their legal framework within the EU legal order (section 4.2). Finally, section 4.3 will consider the role adaptive management can play in tackling the consequences of OA through MPAs. Section 5 will end this paper with the conclusion.

A final consideration that must be made, before turning to the substantive sections of this paper, is the methodology. Firstly, the thesis will in fact apply multiple different methodologies. Especially Section 2 and 3 will be based on a normative legal concept analysis considering the Ecosystem Approach. The analysis will be mainly based on doctrinal legal research and will begin with an evolutionary approach to the Ecosystem Approach before identifying other important aspects of the concept. After the concept analysis, Section 4 will apply the identified normative concept of the Ecosystem Approach, more specifically adaptive management, as a descriptive case study, to MPAs aiming at addressing the consequences of OA within EU marine waters. Throughout the whole thesis it will be necessary to fall back on research in biology and chemistry to strengthen the legal arguments in an auxiliary manner.

Secondly, it is also important to highlight the distinction between soft law and hard law, as these distinctions become especially important when considering the role of the Ecosystem Approach within international and EU environmental law. Within the field of international law, hard law theoretically includes internationally binding legal instruments as they only come into

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[31] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [2003] OJ L206/7.

[32] Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (Codified version) [2009] OJ L20/7.

[33] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy [2000] OJ L327/1.

[34] Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) (Text with EEA relevance) [2008] OJ L164/19.

existence with the consent of states.[35] In fact, treaties are directly negotiated between the States involved and generally rely on their ratification to become legally binding.[36] Soft law instruments on the other hand are non-legally binding, thus including instruments such as guidelines, standards, or recommendations.[37] Often soft law instruments are used as interpretative sources for hard law.[38] This will become especially apparent when considering the role and conceptualisation of the Approach within the international conventions analysed in this paper (section 2.2.1). However, in reality, the distinction between hard and soft law is often not as clear cut. The difficulties of classifying legal sources along the lines of hard and soft law become particularly apparent when considering Article 38 of the ICJ Statute[39] which constitutes an authoritative list of legal sources. While treaties and customary law are generally considered as sources of hard law, the distinction becomes less clear for the other sources listed in the Article. General principles of law recognised by civilised nations seem to take a middle ground as they can be regarded both as soft law and hard law depending on the circumstances in which they are applied. Similarly, the decisions of international courts must be considered as hard law for the parties to the dispute and as soft law for any other state.[40] Finally, the teachings of highly qualified academics are generally soft law as they help with the interpretation of any international hard law obligations.[41]

Therefore, when considering the EU with its distinct legal order, it must be highlighted that similar to the international level, the EU level is faced with problems when it comes to the categorisation of its legal sources.[42] While the founding treaties, namely the Treaty on European Union[43] (TEU) and the Treaty on the Functioning of the European Union[44] (TFEU), can be

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[35] Maxim 2020 p. 113.

[36] ibid, p. 114.

[37] ibid.

[38] ibid, p. 115.

[39] Statute of the International Court of Justice (adopted 26 June 1945, in force 24 October 1945) US.TS 993.

[40] Maxim 2020 p. 124.

[41] Wolfrum, "Sources of International Law" 2011 <https://opil.ouplaw.com/display/10.1093/law:epil/9780199231690/law-9780199231690-e1471> (last accessed 16 May 2023).

[42] Maxim 2020 p. 122.

[43] Consolidated version of the Treaty on European Union [2012] OJ C326/13.

[44] Consolidated version of the Treaty on the Functioning of the European Union [2012] OJ C326/47.

regarded as hard law sources of law, due to their nature as international treaties, the line gets blurrier when considering the legal instruments adopted by the EU under the umbrella of its founding treaties. These include legal acts established in line with article 288 to 292 TFEU as well as an assortment of other more normative acts most of which can be categorised as soft law.[45] Of particular interest to this paper are the directives which according to article 288 TFEU are binding as to their result. Thus, it follows from the above line of argumentation that Directives must also be considered as hard law sources of law.

With these considerations in mind, it is now time to turn to the substantive issues of this paper. Thus, the following section will begin with an evolutionary description of the Ecosystem Approach from the ecological ecosystem concept to its inclusion within the legal order, before turning to the conceptualisation of the Ecosystem Approach with a particular focus on adaptive management.

[45] ibid.

2 Framing the Ecosystem Approach

Although the Ecosystem Approach is intended to solve or at least decrease some of the issues left by the current sectorial approach to environmental law and marine management, the approach itself still leaves a lot of questions unanswered, including its definition or conceptualisation.[46] Therefore, the following section will consider the evolution of the Approach from a scientific concept to the current regulatory and management framework. To do so, this section will consider the Ecosystem Approach from a broader international law perspective and will only address the Approach from an EU perspective in section 3. Such a broader international perspective is necessary to understand the evolution of the Ecosystem Approach and assist its conceptualisation.

2.1 Development of the Ecosystem Approach through time

As hinted at in the introduction, the Ecosystem Approach has been introduced in response to the inadequacy of the sectorial approach to marine management and environmental law in general. The latter has been the predominant regulatory and management framework for centuries. In fact, it took until the 20th century for a slow shift in marine management to occur.[47] These changes seem to coincide with the development of the ecosystem concept and its integration into the legal sphere through the Ecosystem Approach. Therefore, the next sub-sections will in turn consider the development of the Ecosystem Approach beginning with the rise of the ecosystem concept in the natural sciences (section 2.1.1). This will then be followed by Section 2.1.2 which will continue with the role the ecosystem concept plays in a legal setting. Lastly, Section 2.1.3 will discuss the position of the Ecosystem Approach within law.

2.1.1 The Ecosystem concept in the natural sciences

The Ecosystem Approach finds its origin in the development of the term ‘ecosystem” itself. The term was first coined by the ecologist Arthur George Tansley in 1935 during the

[46] Bohman 2018, p. 86

[47] Tarlock 2008, p. 578.

early days of the science of ecology which goes back to the end of the 19th century.[48] Tansley wrote:

> "Though the organisms may claim our primary interest, when we are trying to think fundamentally we cannot separate them from their special environment, with which they form one physical system. It is the systems so formed which, from the point of view of the ecologist, are the basic units of nature on the face of the earth. Our natural human prejudices force us to consider the organisms (in the sense of the biologist) as the most important parts of these systems, but certainly the inorganic " factors" are also parts- there could be no systems without them, and there is constant interchange of the most various kinds within each system, not only between the organisms but between the organic and the inorganic. These ecosystems, as we may call them, are of the most various kinds and sizes."[49]

Thus, Tansley understood that organisms are connected to their surroundings and cannot be studied independently.[50] Moreover, he was already aware of the different scales an ecosystem can comprise of. All together his definition recognises the earlier focus of scientists and natural science in general on certain key species which still underlies the current sectorial approach to environmental law and marine management.

Following its first appearance in 1935, the term 'ecosystem' quickly became one of the central ideas of ecology and was picked up by numerous other scientists all attempting to further define the underlying concept.[51] One of them was E.P. Odum, who defined an ecosystem as an entity or unit comprising both of living organisms and non-living parts that work together to build a stable system. In this system a circular exchange of materials occurs between the two components.[52] Based on his definition he then developed a stability hypothesis which stipulates that ecosystems always strive towards stability. As he believed that such stability could easily be disrupted by humans, the main premise for nature protection during that time period was to

[48] ibid.

[49] Tansley 1935, p. 299.

[50] Suietnov 2021, p. 51.

[51] De Lucia 2015, p. 98.

[52] Suietnov 2021, p. 51.

set aside nature reserves which prohibited any human disturbances.[53] Moreover, by focusing on the effects humans can have on ecosystems, the hypothesis for the first time also linked the ecosystem concept to an anthropogenic perspective.[54] As such, Odum's stability hypothesis seems to mark the starting point of the distinction between the anthropogenic and ecocentric perspective on the Ecosystem Approach as discussed later on (see Section 2.1.3). Nevertheless, and despite its success at the time, it is important to note that Odum's stability hypothesis is no longer supported by the field of ecology. It has instead been replaced by the realisation that ecosystems are complex and dynamic structures which are naturally exposed to disturbances from both humans and nature itself.[55] It is thus no longer believed that nature is best protected by setting it aside, and by preventing human interferences. However, these new realisations have also highlighted the abundance of knowledge gaps that still surround the Ecosystem concept, thereby feeding into the general vagueness of the concept.[56]

One such source of ambiguity is the purpose of the ecosystem concept. In fact, the philosopher of ecology, Kevin deLaplante, identified no less than three different purposes that could be fulfilled by the ecosystem concept. First, the concept could be considered as an object, thus being characterised by the abiotic and biotic elements and their interplay within a particular area. Second, as a theory, the concept is concerned with the flow of energy and matter within its confines, thus trying to not only define but also explain both processes. Finally, as a method, the concept is concerned with its application in other scientific fields besides ecology. It is within this last purpose that the development of the Ecosystem Approach as a management and conservation strategy fits in.[57]

Another gap exists around the definition of the 'ecosystem' concept. Although current scientists generally regard ecosystems as comprising of all biotic factors, such as animals, plants and microorganisms that occur in a particular place characterised by shared abiotic factors (all chemical and physical influences), some deviations to this general definition have been

[53] Tarlock 2008, p. 578.

[54] ibid.

[55] ibid, p. 579.

[56] ibid.

[57] De Lucia 2015, p. 98; De Laplante 2005, p. 398–400.

introduced especially concerning marine ecosystems. Thus, the ecosystem concept is still lacking a clear, and especially uniform definition.[58]

Without such an unambiguous definition in place, the only way forward is thus to fall back on the general definition, describing an ecosystem as the sum of its abiotic and biotic factors. However, this definition remains purely descriptive, thus leaving much room for discussions.[59] Indeed, while this general definition allows for the inclusion of all types of ecosystems ranging from terrestrial to marine ecosystems, its functional attributes are not concrete enough to facilitate the identification and definition of a particular ecosystem. As a matter of fact, it neither helps with the drawing of accurate delimitations for an ecosystem nor truly supports the identification of the biotic and abiotic factors that make up the relevant ecosystem.[60] This could make it particularly difficult to establish MPAs for specific ecosystems which either require more protection from the consequences of OA or which already provide a refugium for species threatened by OA.

Due to all these uncertainties, some have argued that the 'ecosystem' concept is outdated and should be replaced by a new concept.[61] Indeed, the previous paragraphs can attest to the changes that both the ecosystem concept and the field of ecology in general have undergone over the past decades. Especially new knowledge has led to a fundamental change in the ideas and principles underlying the ecosystem concept, including its new featuring as a dynamic instead of stable system.[62] However, if these new realisations truly merit the introduction of a completely new concept is disputable. As it stands right now, the ecosystem concept has neither a uniform definition nor a clear purpose and conceptualisation. Nevertheless, the past decades have seen its inclusion into the legal sciences and regulatory and management strategies through frameworks such as the Ecosystem Approach (see section 2.1.3). Thus, replacing the current concept, will not only impact the natural sciences but also other fields such as law and policy, which have already begun to incorporate the term as a method. Instead, it seems more rational to continue with the use of the ecosystem concept for now, and in turn use the reserved energy

[58] Hatcher and Bradbury 2006, p. 207–208.

[59] Tarlock 2008, p. 576.

[60] Hatcher and Bradbury 2006, p. 209.

[61] Tarlock 2008, p. 579.

[62] ibid.

to further develop and clarify the current concept. Here, the lack of a definition, purpose, and conceptualisation might even be beneficial, as it leaves enough room to redefine the concept and adjust it to our modern believes.

In conclusion, ecosystems must therefore be regarded as highly complex, dynamic, and unpredictable systems which so far have escaped a clear and uniform definition and purpose.[63] In fact, the only definition widely used is rather general and descriptive, thus not facilitating its further use and practical application especially when it comes to the designation of MPAs for particular ecosystems. Moreover, regarding the concept's purpose, no less than three different purposes have been identified so far. While such vagueness and flexibility might be desirable from a natural science perspective, as it allows for the inclusion of all different kinds of ecosystems within the overarching concept, this does not hold true from a legal perspective. In fact, the flexibility of the general ecological definition seems to provide some difficulties for legal and policy instruments.[64] Therefore, the next section will take a closer look at the next step in the evolution of the Ecosystem Approach, namely the incorporation of the ecosystem concept into law.

2.1.2 The Ecosystem concept as part of the legal sciences

Following its first introduction into ecology in 1935, the 'ecosystem' concept slowly extended its reach into other scientific fields, thus laying the foundation for the concepts development into a method as identified by deLaplante (see section 2.1.1).[65] Especially the legal sciences and policy took an interest in the concept for their nature protection regimes, both on an international and domestic level.[66]

[63] DeFries and Nagendra 2017, p. 266.

[64] Hatcher and Bradbury 2006, p. 209.

[65] De Lucia 2015, p. 98; De Laplante 2005, p. 398–400.

[66] Tarlock 2008, p. 575.

In fact, the non-legally binding but authoritative Stockholm Declaration[67] acknowledged the importance of protecting and conserving ecosystems and its functions as early as 1972.[68] Even though the Declaration takes an anthropocentric perspective to the topic of ecosystem protection, it also signifies the first step towards the recognition of the legal importance of the ecosystem concept.[69] From there, the concept evolved over time, especially with the help of two soft-law instruments, namely the World Conservation Strategy[70] published 1980 and the World Charter for Nature[71] (WCN) from 1982, which both supported the concepts evolution to the Ecosystem Approach. The WCN can also be regarded as the starting point for a more ecocentric interpretation of the ecosystem concept as it acknowledged the need to protect nature in its own right.[72]

Nowadays, the ecosystem concept has been defined in Article 2 of the Convention on Biological Diversity[73] (CBD) which, provides an authoritative definition of the concept especially for the EU, where the Convention constitutes an integral part of the EU legal order.[74] According to the CBD, an ecosystem can be defined as "a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit"[75]. At face value, this legal definition is almost identical to the scientific definition provided above. Therefore, it can be argued that this definition is faced with the same problems of ambiguity than its scientific counterpart. Nevertheless, it must also be kept in mind that, there is a difference in weight given to the two versions of the concept in the different scientific fields. On the one hand, the ecosystem concept has become of great importance for many nature protection efforts within

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[67] Stockholm Declaration on the Human Environment, in Report of the United Nations Conference on the Human Environment (1972) UN Doc. A/CONF. 48/14, at 2 and Corr. 1.

[68] Suietnov 2021, p. 52–53.

[69] ibid, p. 52.

[70] World Conservation Strategy: living resource conservation for sustainable development (1980) UNEP(02)/C6.

[71] World Charter for Nature (1982) A/RES/37/7.

[72] Suietnov 2021, p. 56.

[73] Convention on Biological Diversity (adopted 5 June 1992, in force 29 December 1993) 1760 UNTS 79.

[74] Publications Office of the European Union, "International Agreements and the EU's External Competences" 2020 <https://eur-lex.europa.eu/EN/legal-content/summary/international-agreements-and-the-eu-s-external-competences.html> (last accessed 17 May 2023); Consolidated version of the Treaty on the Functioning of the European Union [2012] OJ C326/47, art. 216(2).

[75] Convention on Biological Diversity (adopted 5 June 1992, in force 29 December 1993) 1760 UNTS 79, art. 2(7).

ecology and the natural sciences more general. On the other hand, the legal version of the concept has proven less influential due to its general lack of recognition as the primary object of protection within international but also EU law.[76] In fact, if ecosystems are protected under environmental law, this is usually done to satisfy another objective than the protection of the ecosystem itself. One example of this is the protection of specific species or habitats within protected areas such as MPAs. Within these areas, ecosystems are generally considered as subunits and not as the main focus of the protection efforts.[77]Therefore, it must be concluded that there are no direct protection obligations for ecosystems within the field of international and EU law.

This seems to be at least partly due to the scientific vagueness and flexibility underlying the concept,[78] which in turn has made it difficult to derive explicit and substantive protection norms from the ecosystem concept. Instead, international law often resorted to the use of procedural rules such as the requirement for an environmental impact assessment, to facilitate ecosystem protection.[79] Furthermore, the ecosystem concept has been introduced into the environmental law regime rather late into its development. Thus, the basic principles and frameworks underlying this legal field had already formed before the introduction of this new concept.[80] Therefore, much is still aligned with the old sectorial approach to environmental law which in turn hampers the introduction of a more ecosystem focused regime.

Overall, it thus becomes apparent that the ecosystem concept is faced with many hurdles when it comes to its proper implementation into law. Not only is there no single international or EU legal regime that protects ecosystems in their own right, but the existing legal definition under the CBD is as vague as its scientific counterpart. This in turn leads to different legal annotations and normative interpretations of the concept.[81] Despite all these problems faced by the ecosystem concept, its introduction into the legal sphere nevertheless had a law-making

[76] Morgera 2023, p. 71.

[77] Tarlock 2008, p. 576–577, 584.

[78] Hatcher and Bradbury 2006, p. 209.

[79] Tarlock 2008, p. 591.

[80] ibid, p. 577.

[81] ibid, p. 576.

effect, as it allowed for the subsequent development of the Ecosystem Approach, as further discussed in the next sub-section.[82]

2.1.3 The Ecosystem Approach as a concept of law

After the slow and limited success of the ecosystem concept in international environmental law, it is surprising that it even came to the development of the Ecosystem Approach as a methodological conceptualisation of the former. However, the path seems to have been paved especially by the Ramsar Convention[83] and the Great Lakes Water Quality Agreement[84] between Canada and the United States of America. Both Conventions, although not directly stating it in their text, dedicated themselves to upholding the integrity of the ecosystems with which they were concerned.[85]

In turn, the first treaty that directly and universally implemented the Ecosystem Approach as a legal concept was the 1980 Convention for the Conservation of Antarctic Marine Living Resources[86] (CCAMLR).[87] The CCAMLR is a part of the Antarctic Treaty System, first established by the Antarctic Treaty[88] in 1959 and provides a model structure for the application of the Ecosystem Approach to the conservation of living natural resources.[89] Although the concept is not explicitly mentioned in the text of the treaty, the reliance of the Convention upon the Approach can nevertheless be deduced from its Article II(3)(b) which includes an indirect reference to the Ecosystem Approach.[90] In fact, this article requires that the effects on the ecosystem must be considered when managing and harvesting marine resources in the

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[82] Morgera 2023, p. 71–72.

[83] Convention on wetlands of international importance especially as waterfowl habitat (adopted 2 February 1971, in force 21 December 1975) UNTS 996/245.

[84] Agreement between the United States of America and Canada on the Great Lakes Water Quality (adopted 22 November 1978).

[85] Suietnov 2021, p. 58.

[86] Convention on the conservation of Antarctic marine living resources (adopted 20 May 1980, in force 07 April 1982) UNTS 1329/47.

[87] Kirk 2015, p. 40; Suietnov 2021, p. 68.

[88] 1959 Antarctic Treaty (adopted 01 December 1959, in force 23 June 1961) UNTS 402/71.

[89] Suietnov 2021, p. 67.

[90] Fabra and Gascón 2008, p. 574–575.

Antarctic.[91] Following this example, more and more environmental conventions implemented or acknowledged the importance of the Ecosystem Approach over time.[92] Similar developments can also be identified in EU law which is to be further discussed in section 3.

Nowadays, the CBD is one of the most prominent treaties following an Ecosystem Approach. Already at its second meeting, the CBD's Conference of the Parties (COP) declared the Ecosystem Approach to be the Convention's overarching framework of action, despite the lack of a clear acknowledgment of the Approach within the legal text of the treaty.[93] In turn, this endorsement only further increased the international popularity of the Approach leading to its subsequent consideration and implementation also into marine management.[94]

Based on this widespread endorsement, it might come as a surprise that the Ecosystem Approach suffers from similar problems as the underlying ecosystem concept when it comes to its definition. In fact, up until today, there is no uniform definition of the Ecosystem Approach.[95] Instead, it has only been possible to establish some communalities amongst the different definitions. First, definitions of the Ecosystem Approach generally highlight the complexity of an ecosystem, which in turn necessitates their management and/or protection. Second, the definitions often include different social and policy objectives which qualify the first part of the definition. It is then through these objectives that the focus of the definition is shifted or adjusted to the aims to be achieved.[96] However, especially this flexibility also stands in the way of a uniform definition and conceptualisation of the Ecosystem Approach. As it currently stands, different versions of the Ecosystem Approach have already developed, the Ecosystem Approach to Fisheries being one of them.[97]

Another factor that hampers the introduction of a uniform definition is the possibility to consider the Approach in light of two opposing worldviews, each with their own sets of

[91] "Related Agreements | Antarctic Treaty" <https://www.ats.aq/e/related.html> (last accessed 2 March 2023).

[92] Suietnov 2021, p. 80.

[93] ibid, p. 48.

[94] Long R. D. et al. 2015, p. 54.

[95] ibid.

[96] ibid.

[97] ibid.

values.[98] First, and as the name suggests, anthropocentrism finds its foundation in a focus on humans and their technical world.[99] Based on this, the Ecosystem Approach must be regarded as a means to achieve optimal resource use for humans.[100] Thus, from this perspective the main aim of the approach is to maintain global consumption and production patterns by securing a continuous resource base and addressing the negative effects the patterns might invoke.[101]

In turn, ecocentrism is deeply rooted in philosophy, ecology, and ethics.[102] From this perspective, the Ecosystem Approach should instead be used to first and foremost protect the relevant ecosystem, as well as its components and functions.[103] In its most extreme form, this might be done by considering ecosystems and humans on equal footing, thus requiring a complete paradigm shift with regards to the relationship between humans and nature. If such as shift would occur, nature would need to acquire the same legal rights and obligations as humans, thus requiring legal personality.[104] In turn, the Ecosystem Approach could then be used as the process to facilitate the consolidation of these two types of agents, both the human and non-human one.[105]

However, as such a step would require a complete paradigm shift of our current legal systems including the EU, this change is not likely to happen within the coming years. Therefore, it seems best to strike a balance between the two opposing worldviews, thereby situating the current understanding of the Ecosystem Approach somewhere in the middle. This could be done through formulations that acknowledge humans as part of nature, as well as highlight the need to protect ecosystems.[106] With all these factors impeding the development of a clear and uniform definition of the Ecosystem Approach, the next sub-section will map out the current legal role and status of the Approach within international environmental law. Furthermore, without a uniform definition another avenue of conceptualising the Ecosystem Approach must

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[98] De Lucia 2015, p. 99.

[99] ibid.

[100] ibid.

[101] ibid, p. 104.

[102] ibid, p. 99.

[103] ibid, p. 99–100.

[104] ibid, p. 105.

[105] ibid, p. 105–106.

[106] ibid, p. 116.

be found. Therefore, the next sub-section will also develop an understanding of the Ecosystem Approach by identifying its key principles.

2.2 Conceptualising the Ecosystem Approach as a legal concept for marine management

After providing the historical and conceptual evolution from the ecosystem concept to the Ecosystem Approach, it is now time to dive deeper into the Ecosystem Approach as a legal concept. Thus, after providing an overview of the legal status of the Ecosystem Approach under international environmental law, this paper will proceed with identifying the key principles underlying the concept, before taking a closer look at one principle, namely adaptive management, which is a particular focus of this paper. In turn, some additional details on the other key principles can be found in the Appendix.

2.2.1 The role and legal status of the Ecosystem Approach in international environmental law

As established above, the Ecosystem Approach has become increasingly prominent in international law. Nowadays, it has been implemented into many different legal instruments, both by being directly mentioned within the legal text of the relevant instrument, and through indirect references. Nevertheless, these inclusions do not seem to have helped with the overall conceptualisation of the approach. Therefore, the clarification of the role and legal status of the Ecosystem Approach in international law must be used to set the scene for another possible avenue of conceptualisation, as explored in section 2.2.2 and 2.2.3.

Beginning with the relationship between the United Nations Convention on the Law of the Sea[107] (UNCLOS) and the Ecosystem Approach, it becomes apparent that its role within the Convention is still unclear. On the one hand, it has been argued that it was never the intention of UNCLOS to implement the Ecosystem Approach. Therefore, it is based on the

[107] United Nations Convention on the Law of the Sea (adopted 10 December 1982, in force 16 November 1994) UNTS 397, 21 ILM 1261.

principle of maximum sustainable yield which focuses on the protection of key species and does not take into consideration the ecosystem as a whole. Moreover, the zonal approach employed by UNCLOS, which divides the Oceans into different zones based on jurisdictional concerns, goes against the idea of the Ecosystem Approach which would require the division of the ocean based on ecological criteria instead.[108]

On the other hand, some academics regard UNCLOS as the adequate legal framework for the implementation and use of the Ecosystem Approach for maritime activities. Such argumentation is further strengthened by, Articles 61-67 and Article 119 UNCLOS which can be regarded as requiring the application of the Ecosystem Approach to fisheries management. In fact, all these articles read together not only demand interdependent species management, but also the preservation and protection of marine living resources and the marine environment as a whole.[109] Finally, Article 194(5) UNCLOS specifically mentions ecosystems by requiring the protection and preservation of fragile ecosystems. Together with Article 192 UNCLOS, and following the reasoning of the South China Sea Case, it can thus be argued that the Ecosystem Approach at least informs the interpretation of the treaty obligations laid down in both Articles.[110]

Despite its disputed role within UNCLOS itself, some development has occurred towards the Ecosystem Approach within two of its implementing agreements. Firstly, the Fish Stocks Agreement[111] (UNFSA) indirectly incorporates the Approach into its legal text. Under Article 5(e) UNFSA, the state parties are required to consider target species within the ecosystem they occur in, to protect species dependant on them.[112] This provision also applies

[108] Suietnov 2021, p. 62.

[109] ibid, p. 61.

[110] South China Sea Arbitration, Philippines v China, Award, PCA Case No 2013-19, ICGJ 495 (PCA 2016), 12th July 2016, Permanent Court of Arbitration [PCA], para. 941.

[111] Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (adopted 4 August 1995, in force 11 December 2001) A/CONF.164/37.

[112] ibid, art. 5(e).

to areas within national jurisdiction.[113] Secondly, the BBNJ Agreement[114] as published on the 4th March 2023, even includes a direct reference to the Ecosystem Approach under Article 5(e) BBNJ Agreement. This direct reference to the principle further highlights the increased importance of the Approach. In fact, the BBNJ agreement will be the first international maritime Convention that directly and explicitly refers to the Ecosystem Approach.

All in all, the role and legal status of the Ecosystem Approach within UNCLOS remains ambiguous. While some provisions seem to require the implementation and use of the Ecosystem Approach under UNCLOS, other provisions might hinder such processes. Nevertheless, UNCLOS has also been considered as a living instrument which develops over time. Hence, the increased recognition of the Ecosystem Approach within its implementing agreements seems to indicate that UNCLOS, as a framework convention, does consider the Ecosystem Approach to be an important concept of current international environmental law.

Another important international Convention for the management of marine waters is the CBD. In fact, the CBD can be considered as the main forum for the development of the Ecosystem Approach. In 1995, the CBD COP formally accepted the Ecosystem Approach as a concept of law.[115] Additionally, the COP also declared the Approach to be the overarching framework of action, based on which the CBD tries to achieve its objectives.[116]

From there, the Ecosystem Approach was mainly developed in principles and guidelines under the auspice of the CBD. In fact, the most detailed definition and the most prominent underlying principles of the Approach can be found in the so-called Malawi principles,[117] which were adopted by the CBD COP in 1998. These principles although not legally binding, have a great representative value as they are regarded as an authoritative source for the interpretation of the concept. As such, these principles can also be used to conceptualise and define the Ecosystem Approach as laid down in other treaties, based on Article 32 of the Vienna Convention on the

[113] Diz 2023, p. 130.

[114] Draft Agreement under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (adopted 3 March 2023).

[115] Bohman 2018, p. 85.

[116] UNEP (1995) UNEP/CBD/COP/2/19, p. 55.

[117] UNEP (1998) UNEP/CBD/COP/4/Inf.9, p. 7-10.

law of treaties[118].[119] Overall, it thus follows from the CBD that the Ecosystem Approach must at least be considered as a concept of law which has been conceptualised mostly by soft law. Interestingly, within international law, the CBD also provides parts of the legal obligation to introduce protected areas such as MPAs.[120]

Finally, a last perspective on this matter must be included, namely the views of relevant scientists and academics. In line with that, the Approach has received support from scientific panels and policy makers, such as the Open-Ended Informal Consultative Process on the Law of the Sea (ICP) which informs the United Nations General Assembly (UNGA) for its annual debate on the law of the sea.[121] The inclusion of the Approach as one of the topics of the ICP has led to its increased profile within the subsequent UNGA resolution.[122] Moreover, academics like James Harrison (2017) already consider the Ecosystem Approach to be a key principle of international environmental law.[123] However, with regards to that, it must be remembered that there is a difference between a principle of international law and the so-called 'general principles of law recognised by civilised nations'[124]. Just because the Ecosystem Approach has been considered as a key principle of environmental law, such classification does not entail its automatic acceptance as a general principle of law recognised by civilised nations. Thus, the Ecosystem Approach cannot yet derive a legal status from its proposed status as a legal principle.[125] In line with that, it is also important to note that the Approach has been developed mostly through soft law instruments such as the CBD COP Decisions V/6[126]. Overall, it must thus be concluded that the legal status of the Ecosystem Approach within international environmental law is that of a legal concept, from which no direct legal consequences can be drawn. Nevertheless, it can still be argued that the Ecosystem Approach plays an important role

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[118] Vienna Convention on the Law of Treaties (adopted 23 May 1969, in force 27 January 1880) UNTS 1155/331.

[119] Bohman 2018, p. 85–86.

[120] Czybulka and Bosecke 2006, p. 34.

[121] Harrison 2017, p. 295; Gelcich et al. 2018, p. 41.

[122] Harrison 2017, p. 295.

[123] ibid, p. 304.

[124] Statute of the International Court of Justice (adopted 26 June 1945, in force 24 October 1945) US.TS 993, art. 38.

[125] Winter 2017, p. 592.

[126] UNEP (2000) UNEP/CBD/COP/5/23, Decision V/6.

within international environmental law, as it is included in an increasing number of legal instruments, such as the BBNJ Agreement. In turn, this might even lead to a paradigm shift of the overall regulatory framework, away from the anthropocentric and sectoral approach towards a more ecocentric framework.

2.2.2 The key principles – another attempt of conceptualising the Approach

The Ecosystem Approach, by some regarded as the starting point of a paradigm shift in environmental law towards a more ecocentric legal framework, does in fact introduce and collect several (new) ecological principles and strategies into environmental law and policy.[127] Falling back on the issue that no uniform definition of the Ecosystem Approach can currently be provided, it becomes necessary to characterise the Approach based on these principles and strategies instead. However, some issues might arise here as well. In fact, when it comes to naming the principles underlying the Ecosystem Approach, it quickly becomes clear that the scientific literature again lacks consensus on the topic. One of the most prominent attempts to fill this gap, besides the Malawi principles under the CBD, is the study by Rachel D. Long et al. (2015) which conducted a frequency analysis of the principles underlying the Ecosystem Approach in academic literature. Building on this work undertaken by Rachel D. Long et al., this paper considers the fifteen key principles identified during the frequency analysis as the defining characteristics of the Ecosystem Approach as they provide a comprehensive understanding of the Approach.[128] In line with that, it is important to understand that despite being presented as separate characteristics of the Ecosystem Approach, all these principles complement each other in one way or another, thus they are all interconnected.

The fifteen key principles identified by Rachel D. Long and her colleagues include: (1) consider ecosystem connections, (2) appropriate spatial and temporal scales, (3) adaptive management, (4) use of scientific knowledge, (5) stakeholder involvement, (6) integrated management, (7) sustainability, (8) account for dynamic nature of ecosystems, (9) ecological integrity and biodiversity, (10) recognise coupled social-ecological systems, (11) decisions reflect societal choice, (12) distinct boundaries, (13) interdisciplinarity, (14) appropriate monitoring, (15)

[127] De Lucia 2018, p. 104.

[128] Long R. D. et al. 2015, p. 57.

acknowledge uncertainty[129].[130] As the main focus of this paper is the key principle of adaptive management, a slightly more detailed account of all fifteen key principles can be found in a table in the Appendix, while the remainder of this section will be exclusively dedicated to adaptive management and its main aims. These include appropriate monitoring, the use of scientific knowledge and the necessity to acknowledge uncertainty, which interestingly are also key principles of the Ecosystem Approach in their own right.

Although stakeholder involvement is another main aim of adaptive management and the Ecosystem Approach in general, its exclusion from this analysis is deliberate as it signifies the next step in the implementation of adaptive management. The focus of adaptive management is on continuous learning.[131] As such, monitoring strategies, the use of scientific knowledge and the acceptance of persistent uncertainty provide the framework into which adaptive management must be incorporated to achieve such goal. Stakeholder involvement on the other hand, must be regarded as a source of knowledge and learning and can thus only be implemented when the framework provided by the other principles is in place.

2.2.3 Taking a closer look at adaptive management

After identifying the defining characteristics of the Ecosystem Approach in the form of fifteen key principles, the next step will be to take a closer look at the principle of adaptive management, as it is not only the particular focus of this paper, but arguably also an important aspect in the management of MPAs (see section 4.3).[132]

When now taking a closer look at adaptive management, it must be highlighted that this management strategy incorporates both substantive and procedural aspects. From the substantive side of adaptive management, the focus is generally on diversified goals including ecological, social, and economic considerations, which are embedded in flexible legal tools

[129] This principle must be considered to be inherently linked to the precautionary principle despite the classification of Rachel D. Long and colleagues to the contrary. Such interpretation is also supported by one of the studies underlying the frequency analysis; See: Arkema et al. 2006, p. 527.

[130] Long R. D. et al. 2015, p. 57.

[131] Soininen and Platjouw 2018, p. 22–23.

[132] Kroeker et al. 2019, p. 121–122.

such as principles or standards. In turn, these tools provide enough room for discretion to adapt the management strategies to changes in circumstances or new scientific knowledge.[133]

However, this only works if the diversified goals themselves are clear and specific thus allowing for a proper assessment of their implementation into specific management strategies. Additionally, the goals must be legally binding or at least paired with rules on their implementation, and timeframes for their achievement must be set.[134] To ensure that the goals are diverse and specific enough one can either rely on a narrow scope for the goal setting with a single focus on environmental aspects paired with an exemption regime based on economic and social considerations, or one has to introduce a broader scope from the beginning including environmental, social and economic goals.[135] Finally, the achievement of the goals must be safeguarded through non-compliance mechanisms.[136]

Procedurally, the focus of adaptive management should be on learning. Hence, adaptive management is built around a constant learning cycle that aims at reducing scientific uncertainty and includes the collection of new scientific knowledge and monitoring processes which are paired with the application of subsequent feedback loops. These feedback loops help with the implementation of the new information and ensure quick responses to ineffective management.[137] Therefore, adaptive management requires close cooperation between science and law.[138] When now combining these two perspectives, adaptive management is thus characterised by a circular process which requires (1) the defining of the problem and diversified goals and objectives (2) the determination of reference baselines for the relevant ecosystems (3) the identification and implementation of management actions (4) the monitoring and evaluation of the management progress and ecosystem responses.[139] The circularity is especially visible when considering these steps as a circle where the monitoring and the evaluation of the management strategy can be used as a feedback loop for the action

[133] Soininen and Platjouw 2018, p. 22.

[134] Soininen and Platjouw 2018, p. 27–28.

[135] ibid, p. 26.

[136] ibid, p. 27–28.

[137] ibid, p. 22–23 and 26–27.

[138] Piet et al. 2020, p. 25.

[139] Ruhl 2005, p. 34.

plans and programmes which can then be adjusted or changed if they are deemed ineffective.[140] Thus, adaptive management is also closely linked to the collection and the reporting of scientific knowledge.

With this general framework of adaptive management in place, it is now time to turn to the importance of the three main aims of adaptive management within the framework of the Ecosystem Approach as identified above, namely appropriate monitoring, the use of scientific knowledge and the necessity to acknowledge uncertainty. In theory, all three features also seem to be of particular importance for the management of MPAs used for tackling the consequences of OA as addressed in section 4.3.

Beginning with the implementation of appropriate monitoring, it is especially important to understand that monitoring can be both active and passive. On the one hand, active monitoring entails active learning. Hence, management decisions are taken to decrease any uncertainties surrounding the management area.[141] Additionally, it is especially through active monitoring that the effectiveness of management measures can be assessed and amended if necessary.[142] Passive monitoring on the other hand, focuses on achieving optimal decision making, and the learning needed to improve the management is only an additional benefit. Overall, which type of monitoring is used depends on the management strategy used by the relevant authority.[143]

Second, it must be highlighted that the scientific knowledge about ecosystems has increased over the past decades. Nevertheless, there are still many knowledge gaps especially when considering marine ecosystems and their management.[144] One example of this links back to other key principles of the Ecosystem Approach. In fact, there is still a pertaining lack of knowledge surrounding the setting of adequate management scales and boundary setting, as well as ecosystem connectivity and its dynamic nature.[145] Moreover, scientists still encounter difficulties with regards to predicting the effects of human actions on ecosystems.[146] Therefore,

[140] Arkema et al. 2006, p. 529.

[141] Garmestani and Allen 2008, p. 1044.

[142] Ban et al. 2012, p. 267.

[143] Garmestani and Allen 2008, p. 1044.

[144] Curtin and Prellezo 2010, p. 823.

[145] Piet et al. 2020, p. 25.

[146] Arkema et al. 2006, p. 529.

adaptive management should facilitate the implementation of new scientific knowledge into existing management strategies as soon as it arises. This ensures that changes and new developments within the social ecological systems are taken into consideration as part of the ecosystem management strategies. [147] Furthermore, the implementation of adaptive management itself requires the accumulation of knowledge from different scientific backgrounds, thus scientists from different disciplines must be involved in the process.[148]

Finally, adaptive management also acknowledges the existence of persistent uncertainty surrounding ecosystems in general and even more so with regards to marine ecosystems.[149] In environmental law, uncertainty is inherently linked to the precautionary approach, thus requiring more precaution, the less is known about a certain situation or activity.[150] Therefore, another connection must be drawn between the acknowledgment of uncertainty and the use of scientific knowledge. Underlying the principle of acknowledging uncertainty, is the premise that scientific knowledge will never be absolute, thus following a continued learning process. In line with that, ecosystem management under the Ecosystem Approach should be flexible.[151] One way of doing that is by developing different policy options for each issue at hand. If it then becomes clear that the chosen policy strategy does not work properly, or has lost its effectiveness, other policy options are immediately ready to be implemented instead.[152]

Overall, adaptive management thus follows a circular management strategy which incorporates all these previously mentioned aims to ensure that current knowledge gaps and uncertainties surrounding the relevant ecosystem are filled as quickly as possible, and that newly available information is used timely to advance the management strategy. By working in a circular fashion, adaptive management also implements new management laws and policies, monitors their application and effectiveness, and finally adjusts or changes the regulations if they do not lead to the desired results. However, it has also been argued by some that especially the implementation of adaptive management might be limited by the framework provided for by the current legal systems. In fact, our legal systems are generally regarded as rather static, with

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[147] Soininen and Platjouw 2018, p. 25.

[148] ibid, p. 22–23.

[149] Curtin and Prellezo 2010, p. 823.

[150] ibid.

[151] Curtin and Prellezo 2010, p. 823.

[152] Garmestani and Allen 2008, p. 1050.

principles such as the rule of law and legal certainty gatekeeping the way to more flexibility.[153] Nonetheless, the real gap between adaptive management and these key legal principles might not be as big as often proclaimed by the academic literature. In line with that, it must be highlighted that there are two sides to the rule of law. While the rule of law formally requires foreseeability and specific rules, its procedural side is less stringent. Thus, as long as the procedural rules are followed, the substantive aspect underlying the rule of law can bear some uncertainty.[154] Moreover, the principle of legal certainty not only requires the necessary checks on the judiciary and administration, but it also ensures that the legitimate expectations of the actors involved are upheld. Furthermore, it can be used as a tool to induce social-ecological change towards more sustainability. Especially in this capacity, legal certainty provides the necessary stability and legal force to foster change according to new scientific knowledge.[155] Thus, although it is true that adaptive management sometimes clashes with the principle of legal certainty, there can also be situations when adaptive management relies on legal certainty to achieve its goals and objectives.[156]

In conclusion, adaptive management is thus a direct response to the precautionary approach and the characteristics of an ecosystem such as its dynamic nature.[157] Moreover, while many argue that the current laws stand in the way of a more adaptive management strategy for marine management, there is actually some evidence that the law is more flexible than it has been believed to be. As such it seems to be well equipped to support adaptive ecosystem management.[158]

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[153] Bohman 2018, p. 83–84.

[154] Soininen and Platjouw 2018, p. 29.

[155] ibid, p. 25.

[156] ibid, p. 24.

[157] Curtin and Prellezo 2010, p. 828.

[158] Cosens et al. 2017, p. 9.

3 The Ecosystem Approach in the European Union Legal Order concerned with marine protection

After its general conceptualisation in Section 2, it is now time to turn to the implementation of the Ecosystem Approach and adaptive management within the legal order of the EU concerned with the protection of marine waters.

In general, it has been possible to observe a great difference between the international, regional, and national level when it comes to the implementation of the Ecosystem Approach.[159] In fact, as the advancement of the concept mainly occurred at the international level, national and regional implementation has often been promoted far less.[160] However, the EU, as a regional institution, might be regarded as an exception to that. Contrary to the general lack of regional implementation, the EU has dedicated itself to the Ecosystem Approach for a long time already, arguably due to their heavy reliance on the ecosystem services provided by the aquatic ecosystems under their jurisdiction.[161] In fact, the EU openly committed itself to the implementation of the Ecosystem Approach already in 2002 at the World Summit on Sustainable Development.[162]

Therefore, the next sub-sections will provide an overview of the implementation status of the Ecosystem Approach within the EU legal order, first in general (section 3.1), and then section 3.2 will take a closer look at the EU marine protection regime relevant for MPAs, namely the Habitats Directive, the Birds Directive, the WFD and the MSFD.

3.1 The Ecosystem Approach within the European Union legal order

Although the Ecosystem Approach also underlies important policy instruments such as the European Biodiversity Strategies, the main focus of this paper is its legal framework because these instruments provide for binding obligations for the Member States. In line with

[159] Link and Browman 2017, p. 379.

[160] Gelcich et al. 2018, p. 45.

[161] Soininen and Platjouw 2018, p. 17.

[162] Long R. 2012, p. 460.

that, it must first be highlighted that the Ecosystem Approach does not have an explicit treaty basis in the EU Founding Treaties. Nevertheless, especially Article 11 and 191 TFEU have been argued to support the implementation of the Ecosystem Approach within the framework of the founding Treaties.[163] While Article 11 TFEU requires the integration of environmental protection considerations into EU policies and other activities, Article 191 TFEU lists a number of objectives which EU environmental policies should advance.[164] These objectives together, but especially the first and fourth objective, seem to facilitate the implementation of the Ecosystem Approach within the TFEU. Objectives one and four are concerned with maintaining the quality of the environment and requiring that the EU advances measures internationally that can help with environmental problems of a regional or international scale. In turn, this argumentation is even further strengthened by the other sub-paragraphs of Article 191, which require the attainment of a high level of protection and the consideration of important environmental principles, the consideration of scientific, social, and economic factors and the responsibility to cooperate internationally with other states and organisations.[165] Most of these aspects are also considered important aspects underlying the Ecosystem Approach.

Another relevant factor is the fact that the EU possesses legal personality, which allows the EU to enter into international agreements in their own right.[166] As environmental concerns are part of the competences shared between the EU and its Member States,[167] both are parties to treaties such as the CBD. Hence, it is not only the Member States that are members to many of the international conventions concerned with environmental protection but also the EU as a separate entity. In turn, the agreements entered into by the EU must be considered as an integral part of EU law which necessitates the implementation of these international rights and obligations into EU laws and policies.[168] As shown above the Ecosystem Approach has received an increasing amount of international attention and has been proclaimed the

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[163] O'Hagan 2020, p. 357; Long R. 2012, p. 460.

[164] O'Hagan 2020, p. 357; Long R. 2012, p. 459.

[165] Long R. 2012, p. 428–432.

[166] Consolidated version of the Treaty on European Union [2012] OJ C326/13, art. 47; Consolidated version of the Treaty on the Functioning of the European Union [2012] OJ C326/47, art. 216.

[167] Consolidated version of the Treaty on the Functioning of the European Union [2012] OJ C326/47, art. 4.

[168] Publications Office of the European Union, "International Agreements and the EU's External Competences" 2020 <https://eur-lex.europa.eu/EN/legal-content/summary/international-agreements-and-the-eu-s-external-competences.html> accessed 17 May 2023.

overarching framework for more than one international legal instrument. Therefore, the EU and its Member States are under a legal obligation to integrate the Ecosystem Approach into their legal and policy frameworks from more than one direction. Thus, the Ecosystem Approach has been introduced and implemented into the EU, through a top-down process that led to the inclusion of the Approach into different policy acts and directives.[169]

Nevertheless, the current structure and focus of the EU's legal order is not completely in line with the Ecosystem Approach. Especially due to the division of competences within the EU, some of the objectives and goals advanced by EU legal and policy instruments hinder the proper implementation of the Ecosystem Approach especially when it comes to MPAs.[170] One primary example of this, is the tension between the Common Fisheries Policy and the Habitats and Birds Directive in relation to protected areas. In fact, Member States are not allowed to limit fishing around a Natura 2000 site if this could impact the fishing fleets of other Member States. Thus, such actions can only be taken on the EU level.[171] Another factor limiting the implementation of the Ecosystem Approach within the EU is the fact that the EU lacks appropriate enforcement and compliance mechanisms to ensure the proper implementation of the Ecosystem Approach.[172]

Overall, it is thus possible to argue that the TFEU as part of the Founding Treaties, at least implicitly supports the Ecosystem Approach and its implementation into the EU legal order especially by providing the framework for its incorporation into the relevant EU secondary laws.[173] With this, the EU also showcases a high level of commitment to the implementation of the Ecosystem Approach into its legal order, despite the identified limitations standing in the way of its proper implementation. In fact, some of the environmental directives relevant for the EU marine protection either directly refer to the Ecosystem Approach or have been argued to acknowledge it more indirectly.[174] The next sub-section will thus take a closer look at each EU

[169] O'Hagan 2020, p. 357

[170] ibid, p. 369.

[171] Langlet 2022, p. 83–84.

[172] Long R. 2012, p. 483.

[173] ibid, p. 460.

[174] ibid, p. 482–483.

marine protection instrument included in this paper before considering their relationship with the Ecosystem Approach and adaptive management.

3.2 The role of the Ecosystem Approach within relevant EU secondary law

When it comes to the role of the Ecosystem Approach within EU secondary law, the focus of this paper will be on the Birds and Habitats Directive, as well as the WFD and the MSFD as these acts provide the legal basis for the establishment of MPAs within the EU marine waters as detailed in section 4.2. 2.. Therefore, the following sections will briefly introduce each of the Directives aim and main processes before identifying the role of the Ecosystem Approach and adaptive management within all of them.

3.2.1 The Birds and Habitats Directive

The Birds and Habitats Directives, adopted 1979 and 1992 respectively, have a great influence on the protection of terrestrial ecosystems especially through their so-called Natura 2000 network. However, the geographical scope of both directives also extends into the marine ecosystems within the jurisdiction of the EU Member States. In fact, the Court of Justice of the European Union (CJEU) acknowledged in its ruling against the United Kingdom from 2005,[175] that the Habitats Directive is not only applicable to the territorial waters of the Member States, but also to their respective Exclusive Economic Zone (EEZ) and continental shelf. Along these lines, the Commission and Council had already agreed beforehand that both Directives must extend their protection to the Member State's EEZs to be properly effective.[176] Therefore, it is more or less surprising that only 8% of the EU's marine area are protected under the Natura 2000 network compared to the 18% of their terrestrial counterparts.[177] One reason for the low number of MPAs seems to be the small number of marine habitat types and species protected

[175] C-6/04 Commission v. United Kingdom, para. 117.

[176] European Commission 2007, p. 8.

[177] COM(2020) 380 final, p. 4.

under the Annexes of both Habitats and Birds Directive.[178] Another aspect might be that the habitats of most marine species are considerably larger than of terrestrial species. As such they are more likely to be transboundary in nature which complicates their designation even further.[179]

With regards to their aims, the Birds Directive focuses on the protection of all Birds naturally occurring in the EU,[180] while the Habitats Directive has a more limited scope. In fact, the Habitats Directive only protects species and habitats that are included in its Annex I and II.[181] Nevertheless, the two directives together establish the so-called Natura 2000 network of protected areas across the entire territory of the EU for the species and habitats that require special protection.[182] Natura 2000 sites established under the two directives are extensively protected under Article 6 of the Habitats Directive as further discussed in section 4.2.2.[183] However, one aspect of the protection regime under Article 6 Habitats Directive that must already be mentioned here, is the fact that the environmental assessment required by that Article still finds its origins in the command-and-control approach underlying many environmental regulations.[184] As such, the appropriate assessment required by Article 6 Habitats Directive, requires an ex ante assessment of the possible significant effects of an anticipated plan or project on the relevant Natura 2000 site. Moreover, the plan and project can then only be implemented if there are no significant effects or if appropriate mitigation measures are implemented together

[178] Bastmeijer 2018, p. 199.

[179] O'Hagan 2020, p. 359–360.

[180] Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (Codified version) [2009] OJ L20/7, art. 1.

[181] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [2003] OJ L206/7, art. 3(1).

[182] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [2003] OJ L206/7, art. 3(1); Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (Codified version) [2009] OJ L20/7, 4(1).

[183] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [2003] OJ L206/7, art. 6; Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (Codified version) [2009] OJ L20/7, art. 7.

[184] Le Lièvre 2019, p. 495

with the plan and project. The assessment does not envision subsequent assessments after the plan or project was implemented.[185]

When it comes to the objectives of the two directives, the Habitats Directive strives to achieve the favourable conservation status of the species and habitats protected under the Directive. Additionally, the Habitats Directive also requires that measures taken under the Directive consider relevant economic, social, and cultural aspects and take into account regional and local differences. [186] Furthermore, the protection measures taken by Member States can be of both legal and administrative nature.[187]

In turn, the Birds Directive requires that measures taken under its auspice maintain European wild bird species at an appropriate level which has to be determined based on scientific, economic, cultural, recreational and ecological considerations.[188] Thus, the objectives of the two Directives are quite similar and can be easily aligned.[189] In fact, the EU Commission reasoned that the concept of 'favourable conservation status' as introduced by the Habitats Directive might also be applied to the Birds Directive. This can be implied from Article 2 of the Birds Directive.[190]

With regards to the relationship between the Nature Directives and the Ecosystem Approach, it is important to note that neither refer to the Ecosystem Approach directly. This is not surprising as the Birds Directive was adopted even before the Ecosystem Approach was

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[185] ibid.

[186] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [2003] OJ L206/7, art. 2(2) and (3).

[187] Czybulka and Bosecke 2006, p. 34.

[188] Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (Codified version) [2009] OJ L20/7, art. 2.

[189] "Links between the Marine Strategy Framework Directive (MSFD 2008/56/EC) and the Nature Directives (Birds Directive 2009/147/EEC (BD) and Habitats Directive 92/43/EEC (HD)). Interactions, overlaps and potential areas for closer coordination" 2012, para 15.

[190] European Commission (2008) "Guidance document on hunting under Council Directive 79/409/EEC on the conservation of wild birds "The Birds Directive.", p. 20.

first recognised in the CCAMLR Convention in 1980 and the Habitats Directive was adopted before the CBD mainstreamed the Approach through its COP V/6 decision in 1995.[191]

The Habitats Directive does mention the term 'ecosystem' once within its Annex III concerned with providing the criteria necessary for identifying protection sites of Community interest.[192] Besides that, the EU Commission has highlighted in multiple policy documents, that the Natura 2000 framework was never meant to be based on the Ecosystem Approach.[193] Nevertheless, the Commission also acknowledged that the Approach must be considered as being in line with the goals of the Habitats and Birds Directive, namely the attainment of favourable conservation status.[194] Therefore, it seems to be possible to utilise the Natura 2000 framework established by the Birds and Habitats Directive to help along the implementation of the Ecosystem Approach within the EU marine protection regime.[195] However, there are also some hurdles standing in the way of the proper utilisation of the Natura 2000 regime for the Ecosystem Approach. One such hurdle arises out of the structure of EU law itself. In fact, EU law does not allow fishing activities to be limited under the Nature protection regime unless such limitations are authorised under EU fisheries law. This can lead to considerable tension within MPAs as established under the Natura 2000 regime.[196] This hurdle arises especially due to the division of competences within the EU.

With regards to the principle of adaptive management, it should not come as a surprise that both directives do not actively implement it either. In fact, the two Directives seem to follow a direct regulation approach which aims at finding solutions for linear problems. Thus, the environmental assessment made under the Habitats and Birds Directives, especially for the Natura 2000 sites, follows a static approach that relies on ex ante predications of environmental risks which are then addressed with the help of anticipated measures.[197] Nevertheless, the two

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[191] Le Lièvre 2019, p. 495

[192] Bastmeijer 2018, p. 200.

[193] "Links between the Marine Strategy Framework Directive (MSFD 2008/56/EC) and the Nature Directives (Birds Directive 2009/147/EEC (BD) and Habitats Directive 92/43/EEC (HD)). Interactions, overlaps and potential areas for closer coordination" 2012, para 41.

[194] European Commission 2007, p. 11.

[195] Bastmeijer 2018, p. 201.

[196] Long R. 2012, p. 471.

[197] Le Lièvre 2019, p. 495.

Directives can still facilitate the implementation of the four characteristics of adaptive management.[198] Especially, the reporting obligation under both Directives,[199] as well as the monitoring and research obligations under the Habitats Directive can facilitate the information and data collection necessary for adaptive management.[200]

Overall, it must thus be concluded that the Birds and Habitats Directive are oriented towards the Ecosystem Approach and can facilitate the implementation of the Ecosystem Approach and adaptive management within the EU legal order especially through their role in establishing the Natura 2000 network.[201] Nevertheless, the two Directives cannot be argued to implement the Ecosystem Approach or adaptive management, as both Directives follow a more static and ex ante approach to area protection. Finally, the utilisation of the Natura 2000 network for the Ecosystem approach is also limited by the structure and division of competences within EU law itself.

3.2.2 The Water Framework Directive

The WFD, adopted 2000, is mostly concerned with the protection of fresh waters, like groundwaters and inland-surface waters. However, the interconnectedness of water bodies also makes it necessary to consider transitional and coastal waters.[202] The Directive defines coastal waters as including both the Member State's internal waters as well as a limited strip of their territorial waters,[203] thus, justifying its inclusion in this analysis.[204] The Directive tries to achieve its aims of good water quality (good ecological status), the protection of (aquatic)

[198] Rouillard et al 2018, Electronic supplementary material.

[199] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [2003] OJ L206/7, art 17; Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (Codified version) [2009] OJ L20/7, art. 12.

[200] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [2003] OJ L206/7, art. 11 and 18.

[201] Long R. 2012, p. 482.

[202] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy [2000] OJ L327/1, art. 1.

[203] ibid, art. 2(7).

[204] Bohman 2018, p. 89–90.

ecosystems and the sustainable use of the relevant water bodies throughout the EU, mainly through the procedural obligation of implementing so-called River Basin Management Plans and Programmes.[205] Moreover, the goals of the WFD have a narrow focus on ecological considerations, which requires the inclusion of economic and social considerations through an exception system in Article 4(4)-(7) WFD.[206] The connection of the goals to the exception system seems to provide Member States with enough discretion to adapt their management to new scientific knowledge. Additionally, the legal nature of the Directive, which is only binding as to the results to be achieved, allows the Member States enough room to choose how to achieve the goals of the WFD.[207]

With regards to the River Basin Management Plans and Programmes, it is first necessary to identify the relevant River Basin Districts within the territory of each Member State and designate the relevant authority for its management. Each Member State must then draw up plans and programmes to ensure that the environmental objectives identified in Article 4 WFD are attained.[208] The procedure for the adoption of the plans and programmes is detailed in Article 11 and 13 WFD.[209] Additionally, the identified river basin districts must be further subdivided, first into either coastal waters, transitional waters, rivers or lakes, based on their overarching characteristics and must then be broken down into even smaller units, so-called water bodies, based on their water type. The further downscaling is necessary for the identification of the appropriate management scale as required by the Ecosystem Approach.[210] However, one could also argue that, in reality, this process is rather used the other way around, namely from the identification of the different water bodies to the different water types and finally to the designation of the relevant river basin district.

Moreover, the WFD also requires that Member States ensure that adequate monitoring processes are established as part of their management plans and programmes to safeguard a continuous assessment of the water status. Furthermore, the monitoring is connected to review

[205] Soininen and Platjouw 2018, p. 32.

[206] ibid, p. 46.

[207] Consolidated version of the Treaty on the Functioning of the European Union [2012] OJ C326/47, art. 288.

[208] Article 4(1)(a) WFD includes legally binding obligations according to Case C-461/13 Bund für Umwelt und Naturschutz Deutschland e.V. v Bundesrepublik Deutschland.

[209] Bohman 2018, p. 89–90.

[210] Westholm 2018, p. 123–124.

processes which ensure that the management is re-evaluated and adjusted, if the environmental objectives laid down in Article 4 of the WFD are under threat of failing or deteriorating.[211] With the help of these processes the WFD tries to prevent any degradation of the Member State's surface and groundwater sources.[212] Moreover, the achievement of the obligations under this directive are monitored by the Commission which can bring a case to the CJEU in case of an alleged infringement.[213] Finally, the WFD also includes some provisions relevant for MPAs, most importantly Article 4, 6 and 8 which will be considered more closely in section 4.2.2.

Finally, the WFD was supposed to achieve its environmental objectives especially its goal of good ecological status, by 2015.[214] However, the Commission discovered in 2019 that less than half of all the water bodies in the EU have a good status. According to the EU, the main reason for the low success of the Directive is however not the structure and framework provided by the Directive itself, but instead issues such as its slow implementation by the Member States.[215] Moreover, as a framework directive, the WFD is also required to consider measures and actions taken under other directives especially within its programme of measures. Mentioned Directives relevant for this paper are the Birds Directive and the Habitats Directive.[216]

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[211] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy [2000] OJ L327/1, art. 11(5) and (8), 5(2), 4(7)(b), 13(7) See: Soininen and Platjouw 2018, p. 34.

[212] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy [2000] OJ L327/1, art. 4(1)(a)(i) and 4(1)(b)(i).

[213] Consolidated version of the Treaty on European Union [2012] OJ C326/13, art. 17; Consolidated version of the Treaty on the Functioning of the European Union [2012] OJ C326/47, art. 258, See: Soininen and Platjouw 2018, p. 34.

[214] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy [2000] OJ L327/1, art. 4; Soininen and Platjouw 2018, p. 31.

[215] "Water - Environment - European Commission" <https://ec.europa.eu/environment/water/fitness_check_of_the_eu_water_legislation/index_en.htm> (last accessed 4 April 2023).

[216] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy [2000] OJ L327/1, art. 10 and annex VI.

When now considering the relationship between the WFD and the Ecosystem Approach, it becomes clear that the WFD does not directly mention the Approach in its text.[217] Nevertheless, it has been argued that by following an adaptive management approach, the WFD is nevertheless implementing the Ecosystem Approach. Especially, the flexibility offered by the fact that the WFD is a framework directive, ensures that the EU Member States can attain their goals in an adaptive and ecosystem focused manner.[218] Moreover, the structure and processes outlined above clearly showcase that the WFD implements the four characteristics of adaptive management. Not only has the WFD diverse aims and objectives that try to address the issues of decreasing water quality and quantity with a particular focus on pollution control,[219] but the directive also requires the implementation of action plans and programmes that must be monitored and re-evaluated regularly.[220] Therefore, it can be concluded that the WFD implicitly implements the Ecosystem Approach together with adaptive management.

3.2.3 The Marine Strategy Framework Directive

The second aquatic directive to be adopted by the EU was the MSFD (2008) which is conceptually similar to the WFD.[221] Geographically, the MSFD also compliments the WFD, as it covers the water seaside from the baseline, while the WFD is more concerned with the territorial and internal waters.[222] The aim of the Directive was to ensure that the marine waters of the EU would have a good environmental status (GES) by the year 2020.[223] GES is defined within the MSFD as a state in which the water bodies are ecologically diverse, clean, healthy, and productive. Moreover, the marine waters are meant to be sustainably used, thus sustaining

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[217] Bohman 2018, p. 95.

[218] ibid, p. 91.

[219] "Water Framework Directive" <https://environment.ec.europa.eu/topics/water/water-framework-directive_en> (last accessed 21 May 2023).

[220] Soininen and Platjouw 2018, p. 34.

[221] Long R. 2012, p. 463–464.

[222] Bohman 2018, p. 90.

[223] Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) (Text with EEA relevance) [2008] OJ L164/19, art. 1(1).

them for future generations.[224] To help with the achievement of the GES, the Directive provides 11 qualitative descriptors in its Annex I and the Commission further advanced these with a Decision[225]. As part of this decision, the Commission broke the 11 descriptors further down into 29 criteria and 56 'indicators' to facilitate the assessment of GES.[226] These considerations highlight that similar to the WFD, the MSFD also focuses on ecological goals and includes other considerations through its exemption processes.[227] One issue with the goals under the MSFD is the extensive discretion they provide to the Member States, thus limiting their legal status. In fact, it is not clear if these goals are even legally binding.[228]

Similar to the WFD, the MSFD requires the adoption of Marine Strategies to be prepared by the Member States for marine waters under their jurisdiction or sovereignty. These Strategies must consider and include the current state of the marine environment, as well as well-defined environmental targets which must be backed up by so-called programmes of measures, detailing how the targets will be met. Furthermore, they must include an elaboration of the regional GES as well as monitoring and review strategies according to Article 11 and 17 MSFD.[229] With regards to the programmes of measures, Article 13(4) MSFD is of particular intertest for this paper as it highlights the importance of MPAs. Therefore, this Article will be considered further in section 4.2.2.. Finally, it must be highlighted that according to Article 23 of the Directive, the EU Commission is required to review and possibly amend the MSFD this year. Preparations for this process have already started in 2021 with a combined roadmap/inception impact assessment.[230]

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[224] ibid, art. 3(5).

[225] Commission Decision (EU) 2017/848 of 17 May 2017 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision 2010/477/EU (Text with EEA relevance.) [2017] OJ L125/43.

[226] Berg et al. 2015, p. 18.

[227] Soininen and Platjouw 2018, p. 46. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) (Text with EEA relevance) [2008] OJ L164/19, art. 14.

[228] Soininen and Platjouw 2018, p. 37–38.

[229] O'Hagan 2020, p. 361.

[230] "Law - The Review of the Directive - Environment - European Commission" <https://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/review_of_the_directive.htm> (last accessed 30 March 2023).

When considering the role of the Ecosystem Approach within the MSFD, it must be highlighted that this Directive is the only one of the four directives analysed in this paper, that explicitly commits itself to the Ecosystem Approach in Article 1(3) MSFD. The article requires the application of the Approach to the Marine Strategies of the Member States. Additionally, adaptive management is also explicitly mentioned in Article 3(5) MSFD which requires the application of adaptive management, as a part of the Ecosystem Approach, to achieve GES.

Nevertheless, the definition of the Ecosystem Approach within the Directive is still rather broad and lacks the detail to facilitate its further implementation. In fact, the Member States enjoy a wide discretion when it comes to the implementation of the Approach and its objectives, thereby leading to some divergence between the Member States.[231] This is especially highlighted by the fact that the directive only sets out clear procedural obligations. The substantive obligations are less clear and thus leave much room for interpretation and divergence.[232] Additionally, the definition takes a rather anthropocentric perspective as it focuses on ensuring the continued availability of marine ecosystem services and focuses on the management of human activities.[233] In turn, adaptive management is again clearly implemented into the processes of the Directive through its main characteristics. As such, its inclusion in the MSFD should also supports the overall attainment of the Approach within the MSFD. Nevertheless, issues might arise with the lack of legally binding goals underlying the MSFD, which will hamper the enforcement of these goals and adaptive management in general.[234]

Overall, the MSFD seems to take the leading role in the implementation of the Ecosystem Approach within the EU legal instruments concerned with MPAs. Not only does it provide for the only definition of an Ecosystem Approach within the legal instruments considered in this paper, but the explicit reference to the Ecosystem Approach within the legal text of the MSFD also indicates that the implementation of the Approach within EU law is intended to occur especially under the umbrella of the MSFD and its goal of achieving GES.[235]

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[231] O'Hagan 2020, p. 367–368.

[232] Soininen and Platjouw 2018, p. 47.

[233] De Lucia 2018, p. 111.

[234] Soininen and Platjouw 2018, p. 37.

[235] Platjouw 2016, p. 53; Long R. 2012, p. 483.

Following this analysis, the next section will now shift the focus back to the consequences of OA, before taking a closer look at the scientific role MPAs can play in tackling the consequences of OA. Afterwards, it will then be necessary to consider the EU legal framework for MPAs provided by the four directives discussed in this section. Finally, section 4.3 will identify in how far adaptive management can facilitate the use of MPAs as a response to the consequences of OA.

4 Facing the consequences of Ocean Acidification and the role of adaptive management

After the previous chapters have extensively focused on the Ecosystem Approach, its conceptualisation, and its implementation within the EU legal order, this chapter will shift the focus back to the issue of OA and will only subsequently answer the question of what role adaptive management can play in facing the consequences of OA. Thus, this chapter will begin by expanding on the information provided by the introduction concerning the effects and consequences of OA on marine ecosystems and their inhabitants. Following that, section 4.2 will highlight the ways in which MPAs can be utilised as a legal response to the effects of OA. In doing so, section 4.2 will first provide for the scientific background on MPAs and their effectiveness before detailing the legal framework for MPAs within the EU legal order on marine protection. Finally, section 4.3 will try to identify the role adaptive management, can play in addressing the consequences of OA through MPAs.

4.1 The consequences of Ocean Acidification

Beginning where the introduction left off, it must be highlighted again that the current OA-rate has not been seen for around 56 million years. As such, the issue with OA is not that the ocean and the atmosphere exchange CO_2 molecules but rather the significant rate at which such exchange currently occurs.[236] It is in fact this rush in the increase of CO_2 molecules within marine waters that makes scientists agree that OA will negatively impact marine ecosystems and species.[237]

Many studies have indeed confirmed such suspicions and especially calcifying species such as corals, sea urchins and calcifying algae seem to be most clearly impacted by OA. In addition to that some indications exist that domestic seagrass species might also be affected by decreasing pH-levels.[238] Moreover, the current OSPAR quality status report 2023[239] identified the negative effect of OA on commercially important species such as oysters, lobsters, and mussels.

[236] Galdies et al. 2020, p. 2.

[237] Baird et al. 2009, p. 461; Zunino et al. 2017, p. 94; Zunino et al. 2019, p. 10.

[238] Zunino et al. 2017, p. 91–94; Zunino et al. 2019, p. 6–8.

[239] McGovern et al. 2023.

Furthermore, the report clarified that the way in which a species responds to OA does not only differ between species but also depends on factors such as their gender, population type, life history stage and their surroundings including their relevant habitat types and their adaptiveness to local conditions.[240] Finally, recent studies have also shown that non-climate factors such as pollution might also further influence the biological responses of species to OA.[241]

Overall, it is thus especially the calcifying organisms that suffer under OA as it hampers their calcification processes leading to thinner or less stable shells and coral skeletons when the water becomes too corrosive.[242] Additionally, marine species in general invest a great amount of energy into the balancing of their pH homeostasis which influences the functioning of their enzymes. Increases in OA thus also lead to increases in the energy used to maintain pH homeostasis within marine organisms. This energy is then missing for other important regulatory processes within these organisms.[243]

In turn, changes in these key species have been predicted to impact marine ecosystems at large, as well as the ecosystem services they provide. In fact, changes or decreases in metabolically intense coastal habitats such as seagrass meadows and coral reefs have been shown to impact local pH-levels and variability.[244] Therefore, it has become necessary to consider how we could handle such consequences of OA.[245] One important aspect in that regard is the fact that while OA is a global issue, management strategies that try to deal with its consequences are generally local or regional efforts.[246] Thus, it is understandable that at least for the near future, any strategies concerned with the alleviation of OA consequences will first and foremost rely on existing management strategies,[247] such as the introduction of MPAs as discussed further below.

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[240] McGovern et al. 2023, section 5 (key messages).

[241] ibid.

[242] Baird et al. 2009, p. 461.; McGovern et al. 2023, section 5.1.

[243] McGovern et al. 2023, section 5.1.

[244] Duarte et al. 2013, p. 229.

[245] Zunino et al. 2019, p. 2.

[246] Kroeker et al. 2019, p. 117.

[247] ibid.

4.2 Marine Protected Areas – A legal response to the consequences of Ocean Acidification?

As was highlighted in the introduction, OA is of increasing and persistent environmental significance. Nevertheless, from a legal and regulatory perspective not much direct action has been undertaken to address the issue.[248] As such, this chapter will begin from the premise that from a current standpoint, international and regional efforts will not be enough to substantially decrease or even halt OA. Instead, it will become necessary to develop and consider relevant measures that can address the consequences of OA. The following sub-sections will thus focus on one such possible response, namely the introduction of MPAs.

4.2.1 The role of Marine Protected Areas in addressing the effects of Ocean Acidification

Worldwide the coverage of marine and coastal areas under protection is just below 10% (8.16%) with around 18,444 areas designated as protected areas globally.[249] Although this might seem like a lot, when regarded alone, the percentage of protected areas within terrestrial landscapes and inland waters is almost double that of marine and coastal areas with 15.8% and 267,081 protected areas globally.[250] Nevertheless, especially MPAs have been recognised as an important player, in the fight against climate change and OA.[251]

MPAs can generally be described as spatially defined areas that aim at preventing the harvesting or disturbance of species for the sake of whom the protected areas were defined. Additionally, MPAs can be combined into networks if some kind of coordination exists between the different areas of protection.[252] Thus, it can be concluded that, the main management strategy of MPAs is the spatial delimitation of an area which can then be used to protect a particular species or habitat from a certain pressure such as fishing or shipping.[253] However, on top of that MPAs

[248] Galdies et al. 2020, p. 2–3.

[249] CBD/COP/15/INF/3 2022, p. 1.

[250] ibid.

[251] Kroeker et al. 2019, p. 122.

[252] ibid, p. 118.

[253] ibid, p. 122.

can potentially also facilitate the protection of certain areas or species from more modern pressures such as (the effects of) OA. Nevertheless, and despite the potential usefulness of MPAs against decreasing pH-levels, little scientific research exists with regards to the effectiveness of MPAs in that regard. This can to some extend be linked back to a persistent lack of widespread monitoring which identifies the real time effects of MPAs in the fight against OA.[254]

Nonetheless, some general effects of MPAs have been identified or at least theorised. One such effect might be the promotion and increase of the population size. In turn, species with a larger population size seem to be less likely to go extinct as they have a wider variety of genetic material including more resistant genotypes.[255] More specific to calcifying species such as corals, is the fact that MPAs might not only increase their population density but in turn also their fertilisation success, leading to a further increase in population size that might even extend beyond the borders of the MPAs due to the high connectivity of marine ecosystems.[256] Additionally, MPAs might also positively impact the mean size of individual specimens within a species and increase the overall diversity of marine species within the area. This in turn has been suggested to increase the resilience of ecosystems against disturbances mainly due to niche overlaps between species. In fact, these overlaps are more likely in species rich environments as the chances are higher that there are two or more species with the same or similar functions which allows them to substitute each other in case of disturbances.[257] Within a similar line of argumentation, MPAs might also ensure the existence of intact food webs which in turn increases the resilience of the ecosystem to change and disturbances.[258] Finally, MPAs might even indirectly mediate some of the biogeochemical changes occurring due to OA by protecting macrophyte species such as seagrass, which decrease CO_2 levels locally through their high photosynthesis productivity.[259] Thereby, MPAs might then provide for local 'pH-heavens' which showcase a lower level of OA than surrounding waters. These heavens might in turn

[254] ibid, p. 118.

[255] ibid, p. 118–119.

[256] ibid, p. 118–119 and 123.

[257] ibid, p. 119.

[258] ibid.

[259] Christianson et al. 2022, p. 5.

provide for habitats and nursing grounds for other species.[260] Nevertheless, these benefits of MPAs are even less researched than the ones previously mentioned.[261]

While the previous paragraphs have highlighted the benefits of utilising MPAs against decreasing pH-levels, there are also some considerations or even limitations that must be taken into account. First of all, it must be recognised that the effectiveness of MPAs in decreasing the consequences of OA not only depend on the local OA rate but also on the rate at which ecosystems and organisms can adapt to these changes. Hence, the management measures taken must be aligned to the local conditions and vulnerabilities of the species involved.[262]

In line with that, it is important to consider the criteria and characteristics that are used to designate an MPA. In fact, not all MPAs are equally effective against the effects of OA. For example, if the target species or habitat protected by the MPAs are actually highly sensitive to OA changes, this might lead to low levels of OA resilience within that MPA.[263] MPAs can thus be used in two different ways to tackle the consequences of OA. First, they can be established to increase OA resilience by protecting species such as sea grass that decreases the level of available CO_2 in the water. Secondly, MPAs can also be designated to protect OA sensitive species such as corals and mussels. Based on these considerations, it might be necessary to (re)consider which species should be used as target species for MPAs in acidic marine regions as these two types of MPAs logically also seem to require different management and conservation strategies.

Additionally, MPAs have often been designated not so much on the basis of biological and ecological considerations but instead based on more anthropocentric and social considerations such as human use.[264] However, especially as an OA response, MPA management must include an acknowledgment of the cumulative multi-stressor environment currently impacting the marine waters. [265] Furthermore, the effectiveness of MPAs can also be limited by implementation and enforcement issues and by the overall time needed to establish resilience

[260] Turner et al. 2021, p. 449–450.

[261] Kroeker et al. 2019, p. 120.

[262] McGovern et al. 2023, section 6.3.

[263] Kroeker et al. 2019, p. 121.

[264] Hatcher and Bradbury 2006, p. 224.

[265] McGovern et al. 2023, section 6.3.

within an MPA.[266] Finally, there is often a the lack of appropriate monitoring programmes, which not only record the MPAs' performance in achieving their goals but also make it possible to adapt their management strategies if necessary.[267]

All in all, MPAs thus seem to provide or at least promise to provide many different benefits in the fight against OA, amongst them an increase in population and mean size, and stabilisations of habitats and food webs. Thus, as a response to OA and its effects, MPAs should especially focus on re-establishing and increasing the resilience of protected area and connected marine ecosystems as well as on protecting sensitive species.[268] In turn, the main hurdle to the success of MPAs seem to be of administrative and regulatory nature, including issues with implementation, enforcement, and local adaptiveness.

4.2.2 The legal framework for Marine Protected Areas within the European Union legal order on marine protection.

Now that the scientific importance of MPAs as a tool against the effects of OA has been highlighted and the true barrier to their effectiveness has been identified as being of administrative and regulatory nature, it is time to consider the legal framework of the EU for MPAs and their utilisation for OA. In line with that, it must be highlighted again that area protection in the EU is generally regulated by the Birds and Habitats Directive. However, when it comes to MPAs, this legal framework is further supplemented especially by the WFD and the MSFD.[269] As such, it is not surprising that only around 75% of the EU's MPAs fall under the umbrella of the Natura 2000 regime.[270] Moreover, this fragmentation of the legal framework also necessitates the repeated consideration of the geographical scope of each Directive. Only afterwards will it be possible to identify the specific role each of them plays for the regulation of MPAs within the EU.

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[266] Kroeker et al. 2019, p. 123

[267] ibid; Hatcher and Bradbury 2006, p. 206; Geist and Hawkins 2016, p. 952.

[268] Geist and Hawkins 2016, p. 952.

[269] Jones-Walters and Čivić 2013, p. 123.

[270] European Commission 2022, p. 2.

Therefore, and although it was confirmed by the CJEU and the EU Commission together with the EU Council that both Directives apply to the territorial waters and the EEZ of all Member States and that the reach of the Habitats Directive even extends to the continental shelf,[271] it must also be highlighted that both Directives actually have a rather limited scope of application as they only apply to areas where protected species or habitats actually occur and not to the identified maritime zones, as a whole.[272] In turn, the WFD and the MSFD together have a similar geographical scope. While the WFD only applies to marine waters to a limited extend, namely only within 1 nautical mile from the baseline, the MSFD has a more extensive scope covering not only the marine waters up until the territorial waters, but also the EEZ of Member States. As such, the geographical scopes of the Nature Directives almost completely overlap with the two Framework Directives. Only the extension of the Habitats Directive into the EEZ is not mirrored by the WFD and the MSFD. With these considerations in mind, it is now time to take a closer look at each Directive in turn, considering their role in the establishment and maintenance of MPAs.

First, it must be remembered that the Birds and Habitats Directive together establish the so-called Natura 2000 network, which includes two different protection types. These two types are the Special Areas of Conservation (SACs) and the Special Protection Areas (SPAs) to be established under the Habitats Directive and the Birds Directive respectively.[273] In fact, area protection is one of the main objectives through which both Directives try to achieve their aim of species and habitats conservation. While the Birds Directive requires the designation of SPAs for all migratory birds and other threatened bird species, the Habitats Directive requires the designation of SACs for particular habitats and species listed in Annex I and II of the Directive.[274] By establishing these area protection measures the two Directives implement the obligations of the Berne Convention, the Ramsar Convention and Article 8(a) of the CBD.[275]

It is already here that a possible issue might arise when it comes to the utilisation of the Natura 2000 network as an OA response strategy. In fact, not many OA relevant species and habitats

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[271] C-6/04 Commission v. United Kingdom, para. 117; European Commission 2007, p. 8.

[272] Zampoukas et al. 2013, p. 350.

[273] Czybulka and Bosecke 2006, p. 34.

[274] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [2003] OJ L206/7, art. 3.

[275] Czybulka and Bosecke 2006, p. 34.

seem to be included in the relevant Annexes of the two directives. OA sensitive species such as Lophelia pertusa reefs, oysters (Ostrea edulis) as well as maerl beds and mussels (Mytilus edulis) are not considered as species requiring protection under the Natura 2000 network.[276] Moreover, as of now, no marine water plants are included in Annex II of the Habitats Directive which focuses exclusively on marine animals. As such, marine plant species are excluded from the area protection regime under the Nature Directives despite the importance of some species in the fight against OA.[277] Nevertheless, some remedy can be found in the habitat protection regime under the Habitats Directive. In fact, Annex I of the Habitats Directive includes habitat types such as Posidonia beds and reefs which have been identified as important players in the OA process and its alleviation. The Directive thus requires the establishment of MPAs for these types of habitats. All in all, the usefulness of the Natura 2000 network in addressing the consequences of OA is thus restricted by the limited inclusion of OA relevant species and habitats in the respective Annexes of the Birds and Habitats Directive.

Nevertheless, for the species that are included in the Natura 2000 protection regime, a relatively high level of protection is ensured. However, before addressing this aspect in more detail below, it is necessary to take a quick look at the aim of the two Directives again, as well as the designation process that needs to be followed to establish protected areas within the Natura 2000 framework.

As briefly mentioned in section 3.2.1 the aim of both directives is the conservation of the respective species or habitats under their protection.[278] To achieve that, Article 2 Habitats Directive, requires that any measures taken under the Directive must ensure the maintenance or restoration of the favourable conservation status of the habitats and species under protection. Moreover, the measures must consider the cultural, social, and economic aspects as well as

[276] Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (Codified version) [2009] OJ L20/7, Annex I; Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [2003] OJ L206/7, Annex I and II.

[277] Czybulka and Bosecke 2006, p. 34.

[278] Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (Codified version) [2009] OJ L20/7, art. 1; Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [2003] OJ L206/7, art. 2(1).

regional or local peculiarities.[279] Again, as mentioned in section 3.2.1, the EU Commission considers the concept of 'favourable conservation status' to be indirectly applicable to the Birds Directive as well through Article 2 Birds Directive.[280]As such, the stringency level of the measures to be taken under the two Directives seems to be relatively equal. Moreover, to ensure that this level of protection is maintained Article 11 Habitats Directive requires continuous monitoring which is also an important feature of adaptive management.[281]

When now turning to the designation of the sites to be protected under either of the two directives, the general focus is on natural criteria. In fact, the Birds Directive requires the identification of the 'most suitable' protection areas within the EU to ensure the conservation of the relevant bird species on land and at sea.[282] The suitability is only based on ornithological factors, namely the presence of Annex I birds, together with an additional focus on wetland habitats if present.[283] In turn, under the Habitats Directive, the identification process is more elaborate as it dedicates a whole Annex (Annex III) to the designation of protected areas. According to Article 4 Habitats Directive, Member States shall use the procedure laid down in Annex III to come up with a list of protection sites including either a protected habitat or species. Annex III is solely based on geographical, ecological, and natural considerations. In fact, the CJEU has clarified that factors such as economic, cultural, or social considerations as well as regional and local differences may not be part of the selection process for protected areas under the Habitats Directive.[284] Interestingly, Article 4(1) Habitats Directive includes a specific qualifier for aquatic species with an extensively big habitat. In these cases, protected areas shall only be designated if there are identifiable areas within the Union territory that

[279] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [2003] OJ L206/7, art. 2(2) and (3).

[280] European Commission (2008), p. 20.

[281] Czybulka and Bosecke 2006, p. 38.

[282] Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (Codified version) [2009] OJ L20/7, art. 4(1) and (2).

[283] C-355/90 Commission of the European Communities v Kingdom of Spain, para. 26.

[284] C-371/98 First Corporate Shipping, para. 25.

provide for the physical or biological characteristics needed by the relevant species for their life or reproduction.[285]

Based on these descriptions, at least one aspect must be highlighted that is of special concern for MPAs aiming at tackling the consequences of OA. Although both directives rely on nature and ecological considerations for the designation of MPAs in general, a closer look must be taken at the site assessment criteria under the Habitats Directive. As mentioned above, Annex III of the Directive requires the inclusion of certain considerations when designating protected areas under the Directive. Of particular interest for OA is the fact that for the designation of habitat protection areas, the Member States must consider the functions, structure, and degree of conservation of the relevant habitat as well as any available options for restauration. It is here that, Member States can and should consider the effects of OA on the relevant habitat.[286] Similar considerations must also be taken by Member States when designating protected areas for species. In fact, here Member States must take into account the conservation status of the habitat, features relevant for the protected species and possible restauration options.[287] Therefore, it can be concluded that MPAs under the Natura 2000 network generally do not fall victim to the issue that MPAs are often designated on the basis of anthropocentric considerations. Instead, the EU seems to put a lot of emphasis on the fact that Natura 2000 sites must be designated on the basis of natural and ecological considerations. Additionally, the designation process under Annex III of the Habitats Directive also seems to leave enough space for relevant OA considerations to be taken into account when identifying a new protection site.

When now turning back to the level of protection afforded to protected areas under the Habitats and Birds Directives, it must be highlighted that both SACs and SPAs generally fall under the same protection regime under Article 6(2) to (4) Habitats Directive.[288] Nevertheless, it is also part of settled case law that areas that should have been classified as SPAs but were

[285] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [2003] OJ L206/7, art 4(1).

[286] ibid, Annex III (A)(c).

[287] ibid, Annex III (B)(b).

[288] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [2003] OJ L206/7, art. 7.

not, still receive protection under Article 4(4) BD, which is even stricter than the protection given to classified SACs and SPAs under Article 6(2) to (4) Habitats Directive.[289]

Under the Habitats Directive it is especially Article 6(2) Habitats Directive, that determines the level of protection to be achieved within the Natura 2000 network. In fact, the Article requires that all appropriate steps must be taken to prevent the significant deterioration and disturbance of the species and habitats under protection, measured in relation to the Directive's objectives.[290] Here, the command-and-control approach of the Habitats Directive becomes visible again.

In turn, article 4(3) and (4) Habitats Directive provide further details on how to handle any plan or project that might significantly impact the protected area without being connected to it. One requirement laid down in these paragraphs is that the plans or projects must be subjected to an appropriate assessment. Although the Directive does not specify what exactly falls under 'plans or projects', the CJEU has given the word 'project' a wide connotation. Therefore, activities such as fishing can also fall under the assessment requirement under Article 4(3) and (4) Habitats Directive.[291] In case of a negative assessment paragraph (4) provides for some overriding justifications that might allow the continuation of the project or plan at hand. Stricter rules apply to sites that were established for priority habitats and species.[292]

Overall, both Nature Directives thus provide for an elaborate protection regime for protected areas, including MPAs. However, one particular point of tension with regards to the use of the Natura 2000 network in addressing the consequences of OA, links back to the fact that only a limited number of OA relevant species and habitats are actually included in the protection regime provided by the Birds and Habitats Directive. This in turn limits the overall relevance of the Natura 2000 network in responding to the consequences of OA. Especially through the focus on sea grass which is considered a priority habitat under the Habitats Directive, the current Natura 2000 framework seems to, intentionally or not, focus on OA resilience building

[289] C-374/98, Commission v France, para. 47 and 57.

[290] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [2003] OJ L206/7, art. 6(2).

[291] C-127/02 - Waddenvereniging and Vogelsbeschermingvereniging, para. 25-27.

[292] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [2003] OJ L206/7, art. 4(4)(2).

and not so much on protecting OA sensitive species against the effects of OA. Therefore, it must be concluded that the Natura 2000 network can only utilise its full potential in the fight against OA, if the Annexes of the Birds and Habitats Directive were to be amended to include more OA relevant species and Habitats. However, such an amendment procedure is not planned for the next years and thus it will be necessary to work with the framework already in existence today. This framework includes besides the Habitats and Birds Directive also the WFD and the MSFD which will be discussed in more detail below.

Beginning with the WFD, it is important to understand that the Directive applies to two types of MPAs. Firstly, Member States can decide to apply the WFD to nationally designated MPAs, if they require a particular focus on the achievement of good water quality, in order to ensure the protection of the habitats or species for which they were designated.[293] Regarding OA relevant MPAs, it is thus possible for Member States to nationally protect species that either facilitate the marine OA resilience or which are sensitive to OA. Within these areas the relevant goals and objectives of the WFD to achieve good ecological status must then be used to also ensure the protection of the relevant species. Secondly and most importantly, the WFD applies to aquatic Natura 2000 sites.[294] In line with that, the River Basin Management Plans must include details on monitoring networks for protected areas under Article 8 and Annex V, as well as a list of environmental objectives established for protected areas under Article 4.[295] To fulfil these objectives, the programmes of measures established by each Member State, must at least include all the measures required for Natura 2000 networks under the Habitats and Birds Directive.[296] Thus, the WFD does not change any of the obligations that Member States have under the Habitats and Birds Directive but instead establishes a common basis between them to facilitates the implementation of the measures required under all three directives into Natura 2000 sites.[297]

To see in how far the WFD can facilitate the utilisation of MPAs used to respond to OA it must be checked in how far the goals and objectives of the WFD address OA and its consequences.

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[293] DG Environment 2011, p. 10.

[294] ibid.

[295] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy [2000] OJ L327/1, Annex VII.

[296] Ibid, art. 11.

[297] DG Environment 2011, p. 11.

Here, it must be highlighted that the assessment of the ecological status of coastal waters under the WFD requires the consideration of relevant physico-chemical elements. Arguably, the elements most relevant for OA are the oxygen and nutrient conditions of the water, as they indirectly contribute to the effects of OA on the water.[298] Thus, to ensure the usefulness of the MPAs as OA responses, it must be ensured under the WFD that these elements of the good ecological status are maintained or restored to a good level especially within the relevant MPAs.

As the WFD is so closely connected to the two Nature Directives, Article 4 WFD also tries to resolve any possible conflict between the Union instruments and their objectives for protected areas. While Article 4(1)(c) WFD highlights that the objectives and standards laid down in the WFD must be achieved in protected areas no later than 15 years after the Directive entered into force, unless different timeframes have been specified under the more specific Union legislation under which the protected area was established, Article 4(2) WFD clarifies that more stringent regulations prevail over less stringent objectives under the WFD, thus ensuring a high level of protection especially for protected areas.[299]

Finally, to ensure that all relevant MPAs are considered and protected under the WFD, the Directive also requires from the Member States to establish a register for protected areas. It must include any protected areas designated under other EU legislations and located within the geographical scope of the WFD.[300] Annex IV further details which protected areas must be included and both types of MPAs as identified above must be included. The mapping of the protected areas shall then be included in the River Basin Management Plans established under the Directive and Annex VII.

Overall, the WFD thus facilitates the utilisation of MPAs responding to OA, by ensuring that any protected areas established by Union instruments such as the Habitats and Birds Directive or national legislation are considered in the management programmes under the WFD, and that the relevant goals and objectives under the Directive are achieved under these MPAs as well. Moreover, the WFD limits the areas of conflict between the different legal acts concerned with area protection within marine waters by clearly establishing their relationship.

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[298] Kroeker et al. 2019, p. 120.

[299] Janauer et al. 2015, p. 17.

[300] ibid., art. 6.

As the second water related framework Directive to be established, the MSFD also pays close attention to MPAs and their usefulness in achieving the Directive's overall aim of GES. Under Article 13(4) MSFD, the Directive clearly states that spatial protection measures must be one part of the programmes of measures that must be implemented by Member States to achieve GES within their marine regions or subregions. In turn, the protected areas must then be used to establish coherent MPA networks that ensure biodiversity within the ecosystems concerned.

Similar to the WFD, the MSFD applies to Natura 2000 sites as established under the Habitats Directive and the Birds Directive. However, in addition to that, the MSFD also applies to MPAs established under regional or international agreements such as OSPAR[301]. With this obligation, the MSFD pays particular attention to the establishment of a network of MPAs across the EU and across the different protection regimes.[302] Furthermore, the MSFD also required that the information concerning MPAs within the marine regions and subregions of the EU must have been made public by 2013.[303]

As the establishment of MPAs within the MSFD is again required to ensure the attainment of the overall aim of the Directive, namely, to achieve GES, it is again necessary to check the relevance of GES for OA. It has been argued that quality descriptor 7 is the most important descriptor for OA within Annex I of the MSFD.[304] This descriptor is concerned with hydrographical conditions of the water body which are not allowed to permanently impact the relevant marine ecosystem. Arguably, descriptor 1 and 5, concerned with the maintenance of biological diversity and the reduction of anthropocentric eutrophication also seem to be relevant for the fight against OA as both have at least an indirect effect on OA. Therefore, it must be argued that MPAs included under the area protection measures under Article 13(4) MSFD,

[301] Convention for the Protection of the Marine Environment of the North-East Atlantic (adopted 22 September 1992, in force 25 March 1998) UNTS 2354/67, 32 ILM 1069.

[302] Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) (Text with EEA relevance) [2008] OJ L164/19, art. 13(6).

[303] ibid, art. 6.

[304] Galdies et al. 2020, p. 2.

must facilitate the attainment of GES with a particular focus on descriptor 1, 5 and 7 to ensure that OA and its effects on the marine waters of the EU are limited.

All in all, it can thus be concluded that the Habitats and Birds Directives provide the main legal framework for MPAs when it comes to the achievement of species and habitat protection goals. In turn, the WFD and the MSFD seem to use MPAs more as a tool to achieve their overall goals of good ecological status and GES. Therefore, the ways in which the MPAs can be utilised against the effects of OA differ a bit between the two pathways used by the four Directives. The focus within the Natura 2000 network seems to be on protecting OA relevant species although this approach is hampered by the limited inclusion of relevant species and the overall focus on utilising the network for OA resilience building.

The WFD and MSFD on the other hand, seem to use MPAs mainly as a tool to achieve their overall quality standards. In line with that, both directives are limited in their application of MPAs to the consequences of OA through the unclear status of OA within their assessment processes for establishing GES and good ecological status. While this paper has highlighted some possible descriptors and elements under which the problem of OA could fall, these are so far only speculations and further research is required for determining the actual place of OA within the two directives. Additionally, it must be remembered that it is mainly the Natura 2000 network as established by the Habitats and Birds Directive that underlies the area protection efforts under the WFD and the MSFD. Hence, the issues identified with regards to the Natura 2000 framework, necessarily also underlie many of the protected areas utilised under the WFD and the MSFD.

4.3 The role of adaptive management in addressing the consequences of Ocean Acidification through Marine protected areas.

MPAs are often considered to be one of the best developed marine management strategies.[305] In line with that, the design and general function of MPAs have been widely researched and developed.[306] Nevertheless, there are also some issues that are still unresolved.

[305] Hatcher and Bradbury 2006, p. 224.

[306] ibid.

These include especially the measuring of the actual effectiveness of the MPAs in achieving their goals, as well as their usefulness in addressing complex issues such as climate change or OA.[307] It has thus been argued that it is the current regulatory framework in place that hampers the assessment and utilisation of MPAs in both ways. With the rise of the Ecosystem Approach as analysed in this paper, the question thus arises if the Ecosystem Approach and more particular adaptive management can fill these gaps and provide a better management framework for MPAs used to respond to the consequences of OA. A particular focus here should be on the three aims of adaptive management, namely appropriate monitoring, the use of scientific knowledge and the necessity to acknowledge uncertainty.

With regards to that, especially three issues must be highlighted. First, the previous sub-sections have showcased that not enough scientific data exists about the actual effectiveness of MPAs in response to OA. Therefore, most of the information available in this regard is speculative. To change that, and to be able to assess the effectiveness of MPAs for OA resilience building long-term, (OA) monitoring must be achieved within the marine waters of the EU.[308]

In line with that adaptive management, if properly applied, can not only facilitate the monitoring of the actual effectiveness of MPAs in achieving their goals of biodiversity protection and as refugia against climate change and OA,[309] but it can also enhance the functioning and design of MPAs thereby making them more OA responsive.[310] Therefore, the aim of appropriate monitoring as required by adaptive management can contribute to the necessary assessments undertaken to determine in how far and how MPAs actually contribute to tackling the consequences of OA. Additionally, the monitoring can also provide information on how ecosystems inside and outside MPAs interact.[311]

Second, another aspect linked to the above is the fact the there is still a persistent lack of knowledge surrounding the effects of OA on the marine waters and its inhabitants. Not only does there seem to be a difference in OA responses between species but also between different genders and population types. Moreover, the relevant life stage of the specimen as well as the

[307] ibid; Kroeker et al. 2019, p. 117.

[308] Kroeker et al. 2019, p. 117.

[309] Curtin and Prellezo 2010, p. 826; Hatcher and Bradbury 2006, p. 224.

[310] Kroeker et al. 2019, p. 122.

[311] ibid, p. 122.

habitats surrounding it, influence how OA effects a species or an individual within that species.[312] This in turn, stands in the way of an effective utilisation of MPAs against the effects of OA, as MPAs can only be designed properly if it is at least partially known to the regulator how OA effects the species or habitats the MPA tries to protect.

Adaptive management could facilitate this process through its aim to use scientific knowledge. The circular processes through which it is applied can ensure that new scientific data is incorporated into the management strategies with each management cycle.

Finally, the lack of appropriate monitoring and scientific knowledge surrounding the effects of OA has overall led to a great amount of uncertainty within the management process of MPAs responding to the consequences of OA. By implementing the first two aims of adaptive management, namely acknowledging uncertainty and implementing scientific knowledge, adaptive management addressed at least some parts of the uncertainty resulting from the complex issue of OA and the dynamic nature of the ecosystem itself.[313]

Overall, the inclusion of adaptive management into the management of MPAs established as responses to the consequences of OA, seem to not only facilitate the monitoring of the actual effectiveness of MPAs in achieving their goals of biodiversity protection and as refugia against climate change and OA,[314] but it can also enhance the functioning and design of MPAs thereby making them more OA responsive.[315] Lastly, adaptive management also seems to facilitate the collection of scientific data, thus actively contributing to a decrease in the persisting knowledge gaps surrounding OA, its consequences on marine waters, and the effectiveness of MPAs as a response to that.

[312] McGovern et al. 2023, section 5 (key messages).

[313] Long R. D. et al. 2015, p. 59.

[314] Curtin and Prellezo 2010, p. 826; Hatcher and Bradbury 2006, p. 224.

[315] Kroeker et al. 2019, p. 122.

5 Concluding remarks

As identified throughout this paper, OA has severe consequences for the marine environment of the EU. Not only does it affect key species such as corals and calcifying algae, but it also impacts the marine ecosystems and their services at large. As such it is surprising that, there have been no direct legal actions addressing OA on an international or regional level. Instead, it has become necessary to consider possible avenues that can contribute to tackling the consequences of OA. One such strategy introduced in this paper are MPAs, which have their legal framework within the EU under the Habitats and Birds Directives, together with the WFD and the MSFD.

However, when it comes to the marine management and regulation of complex issues such as OA, another issue has appeared on the horizon, namely the ineffectiveness of the prevailing sectorial approach to marine management which regulates all the sectors and activities impacting the marine environment separately. Over the past decades, more and more voices were raised demanding another way of marine management. In response, the Ecosystem Approach was developed which promises a more integrated, adaptive, and holistic approach to environmental law and management. Nevertheless, as of today, the Ecosystem Approach is faced with its own set of problems and issues, most importantly the lack of a clear definition or conceptualisation. It is against this backdrop that this paper raised the question if the Ecosystem Approach, with a particular focus on adaptive management, can legally contribute to tackling the consequences of OA within the marine waters of the EU, and if so how.

In response to this question, it must first be highlighted that the lack of a clear definition and conceptualisation currently impedes the proper implementation and use of the approach within environmental law. Without either, the Approach is just an empty shell lacking any legal force or implications. Therefore, this paper had to do a concept analysis to identify a uniform definition or conceptualisation, before taking a closer look at the approach within EU law and the role the Approach can play in tackling the consequences of OA.

In line with that, section 2.1 followed the development of the Ecosystem Approach through time and scientific fields. This analysis identified the lack of a clear definition as one problem that seems to have followed the Approach from the beginning. In fact, not even the ecosystem concept which must be regarded as the conceptual origin of the Approach has a clear and uniform definition that can be utilised to conceptualise the Ecosystem Approach. The only

definitions available for the ecosystem concept in ecology and law are too vague to base explicit and substantive protection norms on it. Therefore, it is especially surprising that the legal method of the ecosystem concept, in the form of the Ecosystem Approach even developed.

Based on this analysis it then became necessary to look for other ways of conceptualising the Ecosystem Approach. Thus, after identifying the legal status of the approach within international law, namely as a legal framework and concept of action which is mainly developed through soft law instruments under the CBD, it became clear that the best way of defining and conceptualising the Ecosystem Approach is through its key principles. While an attempt at this had been made through the Malawi principles under the auspice of the CBD, this paper decided to instead base its further analysis on, the frequency analysis undertaken by Rachel D. Long et al. as the analysis provided a more comprehensive understanding and well-rounded basis for the identification of the Approach's key principles. In fact, the study by Rachel D. Long et al. identified fifteen key principles, including adaptive management, which were then used by this paper as the defining features of the Ecosystem Approach. In line with that, it was thus possible to establish a conceptual framework for the Approach without a uniform definition in place.

As the particular focus of the Ecosystem Approach within this paper is on adaptive management, it then became necessary to take a more detailed look at the underlying characteristics and aims of the strategy. This analysis particularly highlighted the circular management strategy utilised by adaptive management which includes (1) the defining of the problem and diversified goals and objectives (2) the determination of reference baselines for the relevant ecosystems (3) the identification and implementation of management actions and lastly (4) the monitoring and evaluation of the management progress and ecosystem responses. Additionally, adaptive management also seems to include at least three main aims namely, appropriate monitoring, the use of scientific knowledge and the necessity to acknowledge uncertainty.

Based on this overall conceptualisation of the Ecosystem Approach and adaptive management it was then possible to analyse in how far both concepts were implemented into the legal order of the EU and the EU law instruments concerned with MPAs. Interestingly, the EU legal order offered more room for the Approach than anticipated. Not only can it be argued that the founding treaties of the EU, in particular Article 11 and Article 191 TFEU, facilitate the

implementation of the Ecosystem Approach into EU law and policy in a top-down manner, but the Approach also plays a role within some of the relevant EU secondary laws.

The two directives that directly implement the Ecosystem Approach and adaptive management are the WFD and the MSFD. While the WFD implements the Ecosystem Approach implicitly by following an adaptive management approach, the MSFD follows a more direct route by explicitly mentioning both concepts within its text. In fact, the Member States are required to follow the Ecosystem Approach within their Marine Strategies and the aim of GES must be achieved through adaptive management. Overall, the MSFD thus seems to take the leading role in the process of implementing the Ecosystem Approach and adaptive management into EU secondary law concerned with marine management.

This conclusion was only strengthened by the analysis of the Habitats and Birds Directive and their relationship with the Ecosystem Approach and adaptive management. In fact, the Habitats and Birds Directives are only oriented towards the Ecosystem Approach and adaptive management, as neither Directive actually implements the two concepts. Instead, both Directives follow a more direct and ex ante approach to habitat and species protection which stands in stark contrast to adaptive management under the Ecosystem Approach. Nevertheless, both directives still allow for regular monitoring, reporting, and the collection of scientific research which can help with the data and information collection necessary for adaptive management. Therefore, it had to be concluded that both Directives only play a facilitative role for the implementation of the Ecosystem Approach and adaptive management into EU secondary law.

With the conceptualisation of the Ecosystem Approach within the EU thus concluded it is necessary to turn back to the descriptive case study on OA and the role MPAs can play in tackling its consequences. Here it is important to mention that only limited research exists with regards to the actual effectiveness of MPAs against the consequences of OA. Nevertheless, the studies that do exist highlight and theorise that MPAs can lead to increases in the mean sizes and population sizes of species, as well as ensure the stabilisation of habitats and food webs. As such, the main factors standing in the way of utilising MPAs against the effects of OA do seem to be of scientific and legal nature. In fact, especially within the Habitats and Birds Directive the issue arises that not enough OA relevant species are protected by the habitat and species protection regime established by the two Directives. Thus, the Natura 2000 framework under both directives cannot utilise its full potential against OA. In turn, to make the two

directives more OA responsive a review and adjustment of the species and habitats protected under the two Directives would have to occur. However, as the two Directives and especially their Annexes are not up for a review anytime soon, this issue will probably stay unaddressed for a bit longer. Nevertheless, for the OA relevant species that are protected under the Habitats and Birds Directives, such as sea grass, the protection level is rather stringent which in turn facilitates their use against OA. Finally, it must also be highlighted that under the current protection regime, the Natura 2000 network seems to be focused on OA resilience building and less on the protection of OA sensitive species.

When now turning to the two aquatic framework directives (WFD and MSFD), it must be highlighted that both mainly utilise MPAs to achieve their quality objectives of good ecological status and GES. In line with that, the two Directives require from the Member States that MPAs are used as a measure to facilitate the achievement of their quality objectives. Thus, the OA relevance of MPAs under these two directives takes a different perspective than the nature directives. In fact, these two Directives seem to be less focused on protecting particular species from the consequences of OA and instead focus on water quality and the functioning of the marine environmental as a whole, when faced with OA.

After all these considerations, the answer to the question if the Ecosystem Approach with a particular focus on adaptive management can legally contribute to tackling the consequences of OA within the marine waters of the European Union, and if so how, is thus that it depends mainly on two factors: (1) in how far OA is, or can be, incorporated into the legal frameworks provided by the Directives (2) in how far the relevant protection regimes implement the ecosystem approach and adaptive management.

Based on these two factors, it can be concluded that the legal regime concerned with species and habitats protection as advanced by the Habitats and Birds Directive only protects a limited number of OA relevant species and focuses mainly on OA resilience building. Therefore, the first factor is only fulfilled to a limited extend. With regards to the second factor, it must be highlighted that both Directives do not implement the Ecosystem Approach or adaptive management. Instead, their focus on a direct and ex ante management approach makes it almost impossible to implement the Ecosystem Approach and adaptive management into their processes. Overall, it must thus be concluded that within the Natura 2000 framework itself the Ecosystem Approach and adaptive management cannot contribute to the tackling of the OA consequences within the EU marine waters. The only way forward, would be a complete

paradigm shift within the Habitats and Birds Directives, away from their direct and ex ante management approach to a more ecosystem-based approach. This, however, would require a review of both Directives which although desirable (also in connection with making the Annexes more OA responsive), is unlikely to occur within the foreseeable future as no such review is planned on the EU level.

With regards to the other two Directives, namely the WFD and the MSFD, it must be highlighted again that both Directives utilise MPAs to achieve their overall goals of good ecological status and GES. Due to this focus on the quality objectives within the utilisation of MPAs under the two directives, it must first be considered, in how far OA fits into these quality objectives in line with the first factor. However, here a lot of legal and scientific uncertainty remains. While some qualitative descriptors under the MSFD and some quality elements under the WFD seem to have some relevance for OA and its consequences on the EU marine waters, further guidance from the EU level seems to be necessary to definitively assess this issue. Therefore, it must be concluded that the protection offered to MPAs under the WFD and the MSFD does seem to have at least some OA relevance, although further research is necessary to determine the actual role and status of OA within the two Directives.

Finally, with regards to the second factor it must be highlighted that both Directives implement the Ecosystem Approach and adaptive management into their processes. In fact, both Directives use the Ecosystem Approach and adaptive management to facilitate the achievement of their quality objectives (GES and good ecological status). Overall, the answer to the research question, with regards to the WFD and the MSFD, is thus, that the Ecosystem Approach and adaptive management can contribute to the tackling of the OA consequences especially through the Directives' processes aimed at achieving good ecological status and GES respectively. As these processes are not only based on the Ecosystem Approach and adaptive management, but also seem to include some OA relevant considerations, it is possible to utilise these processes for OA responsive MPAs as soon as the status of OA within the MSFD and WFD is determined. Especially, adaptive management can then be used under these two Directives to ensure that new scientific knowledge about OA is included into the management processes in a timely manner and that continuous OA monitoring is achieved. This in turn will provide information about the effectiveness of MPAs in response to the consequences of OA and will also decrease some of the uncertainties still surrounding OA, its consequences, and the utilisation of MPAs as a response mechanism.

All in all, the contribution of the Ecosystem Approach and adaptive management to the possibility of addressing OA consequences through MPAs within the EU marine waters thus depends on the protection regime, with the Habitats and Birds Directive on one side and the WFD and MSFD on the other.

Recommendations for future research

The constraints imposed on this paper especially with regards to research time and overall length of the paper, have made it necessary to cut substantial parts of the initial research aim. In fact, this paper initially set out to consider the legal contributions of the Ecosystem Approach as a whole, to tackling the consequences of OA. However, with the identification of the fifteen defining principles of the Ecosystem Approach, this task became impossible, at least for this research project. Nevertheless, by focusing on only one of the key principles, namely adaptive management the true contributions that the Ecosystem Approach can make to the regulation of OA and its consequences was not uncovered. Therefore, it would be interesting to do such a more extensive analysis in the future. Additionally, it seems necessary to also consider other possible avenues of addressing the consequences of OA besides MPAs. A particular focus could for example be on the role of nutrient input into marine waters and their reduction efforts within the EU, as these inputs have been recognised as substantial stressors on marine waters that can increase the effects of OA especially on a local level. Finally, it also seems to be necessary to do an in-depth analysis of the role of OA within the GES and good ecological status processes under the MSFD and the WFD, to have a better understanding of how OA fits into these processes.

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Appendix

Overview of the key principles of the Ecosystem Approach

Classification	Principles	Description
Ecosystem considerations	Appropriate Spatial & Temporal Scales	Management should occur at the lowest appropriate scale both temporally and spatially, thus requiring decentralised ecosystem management.[316] The choice of scale will have a direct effect on the application and use of the applicable laws and regulations.[317] ➢ Finding the right scale promises to increase the effectiveness, efficiency.[318] ➢ Bridging organisations should facilitate proper information exchange between the different scales (link to the principle of stakeholder involvement).[319] ➢ The determination of 'appropriate' depends on the circumstances. No uniform definition is possible due to the ecosystem complexity and land-sea interactions.[320]
	Ecosystem Connectivity	The principle refers to the complexity of ecosystems thus highlighting the need to incorporate considerations concerning the relationship between the different parts of an ecosystem.[321]
	Distinct Boundaries	From a legal and management perspective it is necessary to define the boundaries of an ecosystem to enable the management of the relevant ecosystem at the appropriate scale.[322]

[316] CBD, "Ecosystem Approach // Principles" 2007 <https://www.cbd.int/ecosystem/principles.shtml> (last accessed 9 March 2023).
[317] Westholm 2018, p. 120.
[318] Garmestani and Allen 2008, p. 1048.
[319] ibid, p. 1049; CBD, "Ecosystem Approach // Principles" 2007 <https://www.cbd.int/ecosystem/principles.shtml> (last accessed 9 March 2023)..
[320] Westholm 2018, p. 118.
[321] Arkema et al. 2006, p. 527.
[322] ibid, p. 527.

		➢ Boundaries, however, can take many different forms, namely geopolitical, ecological, and managerial.[323] ➢ In some cases, a mismatch can occur between the boarders drawn by the social and natural sciences which requires close cooperation between both.[324]	
	Dynamic Nature of Ecosystems	Ecosystems are no longer regarded as stable systems but instead as dynamic.[325] ➢ Ecosystem changes are thus natural and unavoidable.	
Management Considerations	<u>Adaptive Management</u>	Adaptive management is focused on a circular management style and can take different forms across the substantive and procedural level.[326] ➢ Substantively the focus is generally on introducing diversified goals, while procedurally the focus is on learning.[327] ➢ The main aims are the use of scientific knowledge, appropriate monitoring, stakeholder involvement and the acknowledgement of uncertainty (also key principles of the Ecosystem Approach in their own right)	
		Use of scientific knowledge	Marine management and regulation are still surrounded by many knowledge gaps, which hinders both processes.[328] ➢ This can only be remedied if new scientific knowledge is promptly implemented into existing management strategies.[329]

[323] Curtin and Prellezo 2010, p. 823.
[324] Barnes and McFadden 2008, p. 390.
[325] Tarlock 2008, p. 579.
[326] Soininen and Platjouw 2018, p. 22; Berg et al. 2015, p. 19.
[327] Soininen and Platjouw 2018, p. 22–23.
[328] Curtin and Prellezo 2010, p. 823.
[329] Soininen and Platjouw 2018, p. 25.

		Appropriate monitoring	Monitoring can be active or passive. Which type is used depends on the relevant authority.[330] ➢ Active: focuses on active learning ➢ Passive: focuses on achieving optimal learning
		Stakeholder involvement	Proper stakeholder involvement is very important for adaptive management. ➢ Stakeholder involvement can increase the effectiveness and resilience of management plans and strategies.[331] ➢ Continuous involvement throughout the management process facilitates stakeholder commitment and generally decreases the need for monitoring and enforcement procedures.[332] ➢ Facilitates the implementation of new scientific knowledge.[333]
		Acknowledging uncertainty	Uncertainty is closely linked to the precautionary principle, thus the less is known about a situation, the more precaution is required.[334] ➢ The principle of acknowledging uncertainty is also inherently linked to the premise that scientific knowledge will never be absolute thus requiring for flexible management.[335]

[330] Garmestani and Allen 2008, p. 1044.
[331] Arkema et al. 2006, p. 529.
[332] Curtin and Prellezo 2010, p. 824.
[333] ibid; Bohman, p. 94.
[334] Curtin and Prellezo 2010, p. 823.
[335] ibid.

	Integrated management	Instead of following the sectorial approach, it has been recognised that a more integrated approach might be beneficial (e.g., through marine spatial planning) ➢ It is thus necessary to identify all human activities occurring on marine waters and regulate them in a way that they have the least cumulative effects on the marine aquatic environment. This recognises that none of the activities impact the marine ecosystems in a vacuum.[336] ➢ The other key principles underlying adaptive management also underly this management strategy together with the principle of sustainable development.[337]
Interdisciplinary Considerations	Interdisciplinarity	Management following the Ecosystem Approach must be based on the knowledge of different disciplines, the most prominent being sociology, economics, and ecology.[338]
	Recognising coupled social-ecological systems	The concept of a social-ecological system connects ecological systems consisting of ecosystems, their components, functions, and services, which all aim towards biodiversity, with social systems focusing on society and human wellbeing.[339] ➢ In a social-ecological system, the ecological system is considered as the supply side for ecosystem services which ensure that the demand-side, namely the social system can maintain human-wellbeing.[340] ➢ The social system influences the ecological system through the pressures human activities impose on ecosystems and their components.[341] As such humans and their activities must be considered as an integral part of ecosystem management.

[336] ibid, p. 826.
[337] ibid.
[338] Arkema et al. 2006, p. 527.
[339] Piet et al. 2020, p. 23.
[340] ibid.
[341] ibid.

	Decisions reflect societal choice	Ecosystems are valued differently depending on the stakeholders considered. Thus, societal choices should always be a part of ecosystem considerations, to ensure that the ecosystem in itself is protected as well as to safeguard the intrinsic values given to it by each group of stakeholders.[342]
	Sustainability	Sustainability emphasises the need to consider not only current generations but also future ones when advancing societal and economic development. Additionally, it requires that action is taken against the current inequality between developed and developing countries.[343]
	Ecological integrity and biodiversity	By requiring the protection of both ecosystem integrity and biodiversity under the Ecosystem Approach, it is ensured that all aspects of nature are considered and protected. **Ecological integrity**: By focusing on the ecological integrity of an ecosystem, the ecosystem approach aims at maintaining and ensuring the proper functioning of the ecosystem and its structure. To do so, it is also necessary to consider the health of an ecosystem.[344] **Biodiversity**: Ecosystems provide the spatial unit for biodiversity protection.[345]

[342] CBD, "Ecosystem Approach // Principles" 2007 <https://www.cbd.int/ecosystem/principles.shtml> (last accessed 9 March 2023).
[343] World Commission on Environment and Development 1987, p. 41-42.
[344] De Lucia 2018, p. 105.
[345] Tarlock 2008, p. 581.