The Future of Offshore Carbon as a Marine Common Pool Resource:

Towards a Governance Framework

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Abstract

The threat represented by global climate change demands novel approaches to the management of the world's carbon resources to assist in climate mitigation attempts, including natural systems of carbon sequestration and storage. Following advancements in coastal "Blue Carbon", research suggests a similar approach could be extended to the carbon found in offshore sediments, referred to in this thesis as *Offshore Carbon* (OC). The thesis investigates if OC is a common pool resource and, if so, what is required to inform any future international governance framework(s) for this emerging resource. The research questions were investigated through semi-structured expert interviews, and an open-question survey informed by a purposely developed scenarios analysis. Following a thematic analysis of the findings, new insights were discovered on OC as an emerging, large-scale, common pool resource. The thesis makes three main contributions to the literature: 1) a conceptualisation of OC as a common-pool natural resource constitutive of three qualitatively different stages (*OC-Origin*, *OC-Migration*, and *OC-Destination*). The conceptual findings emphasise the need for more robust science to reduce the uncertainty around the anthropogenic effects on the OC system, alongside the need to further develop differing conceptions of OC's value, including economic values; 2) key components to inform a potential governance framework, including the need to integrate OC governance with existing international marine institutions, the importance of including every vested stakeholder from the outset, and the need and challenges of innovative monitoring; and 3) *Six Principles for Commons Governance* (derived from fisheries governance and management), applicable in part to OC, and *Four Scenarios* for OC. These conclusions help to move forward work on a potential contribution to climate change mitigation, building a firm foundation on which future research can be built to develop an efficient and effective governance of OC as an emerging common pool resource.

For my parents, Robin and Beverley Smith

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Abbreviations

BC	Blue Carbon
BCE	Blue Carbon Ecosystem
CC	Climate Change
CCP	Common Carbon Policy
CFP	Common Fisheries Policy
CPR	Common Pool Resource
DEFRA	Department of Environment, Food and Rural Affairs
DIC	Dissolved Inorganic Carbon
DOC	Dissolved Organic Carbon
EEZ	Exclusive Economic Zone
EOCI	European Offshore Carbon Initiative
EU	European Union
FQA	Fixed Quota Allocation
GBN	Global Business Network
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GOAP	Global Ocean Accounts Partnership
HELCOM	Helsinki Convention
ICES	International Council for the Exploration of the Sea
IFQ	Individual Fisheries Quota
IL	Intuitive Logics
IPCC	Intergovernmental Panel on Climate Change
ITQ	Individual Transferable Quota
MIDAS	Managing Impacts of Deep Sea Resource Exploration
MSP	Marine Spatial Planning
NDC	Nationally Determined Contributions
NGO	Non-governmental Organisation
NWES	Northwest European Shelf
OC	Offshore Carbon

OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
P	Participant
PES	Payment for Ecosystem Service
PIC	Particulate Inorganic Carbon
PO	Fish Producers Organisation
POC	Particulate Organic Carbon
REDD+	Reducing emissions from deforestation and forest degradation in developing countries
RQ	Research Question
SEEA	System of Environmental-Economic Accounting
SES	Social-Ecological System
SLR	Systematic Literature Review
SOIF	School of International Futures
TA	Thematic Analysis
TAC	Total Allowable Catch
TCA	Trade and Cooperation Act
UK	United Kingdom
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNFCCC	United Nations Framework Convention on Climate Change
ZSL	Zoological Society of London

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Chapter 1 |

Introduction

1.1 Introduction

According to the Intergovernmental Panel on Climate Change (IPCC), human activity has resulted in a general increase of global temperature by approximately 1^{o} Celsius compared to pre-industrial levels, with temperature increases expected to rise to 1.5^{o}-2 ^{o} between 2030 and 2052 (IPCC, 2018, 2021). The main driver of temperature increases has been the increased output of greenhouse gasses from anthropogenic sources such as industry and agriculture, especially the emission of carbon dioxide (CO_2) resulting from the widespread burning of fossil fuels and land use change. This has created an impetus for greater research into natural carbon-cycling systems with the potential for preventing further increases in temperature and drawing down historical emissions through both sequestering and storing CO_2 (Farrelly et al., 2013). In regard to this impetus, a United Nations (UN) report was published in 2009, building on previous global carbon-cycle research (Chmura et al., 2003; C M Duarte et al., 2004) arguing that coastal and marine ecosystems represent vast stores of carbon that are not sufficiently accounted for and are being lost at a rate higher than similar carbon stores found on land, such as forests (Nellemann et al., 2009). The report states that the destruction of these ecosystems has directly contributed to climate change (CC) by both releasing carbon into the atmosphere and oceans, and through the wasted opportunity that results from excluding such habitats from carbon sequestration and storage strategies. The authors of the report used the phrase “Blue Carbon” to refer to the carbon sequestration and storage provided by specific coastal ecosystems rich in plant biomass and nutrient-rich sediments: mangrove forests, seagrass meadows and estuarine salt marshes.

This research thesis has the overarching aim of exploring the possibility of extending the idea of mitigation inherent in *Blue Carbon*, with its conventional focus on coastal habitats, out to sea in the form of *Offshore Carbon*; the specific aim of the thesis is to inform the inception of a governance framework(s) for the emerging concept of *Offshore Carbon*. Put another way, it explores the possibility of incorporating the natural processes of carbon sequestration and storage in offshore marine habitats into human systems of governance and management for the purpose of CC mitigation. This thesis can therefore be considered a climate change thesis, but it is also a multi-disciplinary project which draws upon social science and marine governance as well as integrating these with knowledge from the fields of natural resource management, blue carbon and economics.

To pursue the thesis aim, three research questions were first derived from the literature and then explored through the application of social scientific methods. Thus, the thesis can be understood as a project of two halves: the exploration of the literature and subsequent derivation of the research questions forming the first half (chapters 2-5), with the answering of the research questions – utilising the methods of semi-structured interview, scenarios analysis, and open-question survey – forming the second half (chapters 6-10). Key to the thesis is the argument that offshore carbon is a common pool resource that will likely require international co-governance between national jurisdictions.

The research focus of this thesis, and the concept of offshore carbon, are presented in Section 1.2. The research design is outlined in Section 1.3, with the layout of the thesis in Section 1.4.

1.2 Offshore Carbon and the Call for a Governance Framework

As part of the United Nations Framework Convention on Climate Change (UNFCCC), each signatory nation state must declare their annual carbon budget – the total anthropogenic emissions, minus the removals by any carbon sinks (UNFCCC, 1992). The blue carbon concept has been essential to including coastal habitats in the established process of carbon accounting for nationally determined contributions (NDCs), set up through the Paris Agreement to facilitate the carbon budget obligations of signatory nations to the UNFCCC (A. Martin et al., 2016). There remains ongoing discussion however as to what counts as blue carbon (and therefore, to be included in the NDCs and other policy processes), given that there are other sources of vegetated carbon in the marine zone, besides the three conventional blue carbon ecosystems – mangrove, salt marsh, and seagrass (Christianson

et al., 2022; Crooks et al., 2018; Howard et al., 2023; Krause-Jensen et al., 2018; Lovelock & Duarte, 2019). The underlying biological and physical mechanism that facilitates the fixation, and eventual sequestration, of carbon in ecosystems is photosynthesis i.e., the underlying mechanism is plant-based. It is a logical avenue of further examination therefore to question whether the photosynthetic-based production of microalgae, the subsequent fixation of large amounts of carbon by this process across the world's oceans, and further subsequent burial of a portion of this carbon in seabed sediments via the biological carbon pump (alongside other key inputs), can be conceived in a similar vein to conventional coastal blue carbon (Graves et al., 2022; Legge et al., 2020; Luisetti et al., 2019).

Attempts have been made to account for the carbon stored in the seabed of the UK's Exclusive Economic Zone (EEZ) and the regional zone of Europe's northwest continental shelf, with an estimated 80-110 million tonnes of particulate organic carbon in the upper 10cm of the UK EEZ, and 60-190 million in the northwest European shelf (Diesing et al., 2017; Legge et al., 2020; Luisetti et al., 2019; Smeaton et al., 2021). The stock however is only one part of the equation.

The flow of carbon – the carbon while in a state of fixation, transportation, deposition, and burial – is also a crucial component of any conceived blue carbon system, but is particularly difficult to measure and attribute to an origin in the marine environment (Graves et al., 2022; Luisetti et al., 2019). It is from a carbon valuation and accounting perspective (Luisetti et al., 2020) that the need was identified for international governance frameworks for accounting marine sedimentary carbon stocks and flows (Christianson et al., 2022; Howard et al., 2023). Luisetti et al. (2020) argued that as the flows of carbon in the marine zone are transboundary and migratory, despite the stocks being stationary, then this (potentially) new form of blue carbon could be considered a common pool resource with repercussions for carbon accounting and CC mitigation considerations. As such, it would require at least a minimum level of international co-governance and a governance framework(s) to facilitate such. The idea of *Offshore Carbon* as a common pool resource is therefore a central theme in this thesis (see Chapter 2 and Chapter 5, Section 5.2.1).

1.2.1 Defining Offshore Carbon

To research and discuss the topic, a working definition and concept of the subject carbon sequestration and storage system was required to apply throughout the research. There are many possible ways to conceive the natural sequestration and storage of carbon that occurs at sea, and it has been conceived, and referred to in different ways in the literature, e.g.,

Sedimentary Carbon (Graves et al., 2022), *Seascape Carbon* (University of Exeter, 2021), and *Fish Carbon* (Lutz & Martin, 2014). The working definition used throughout this thesis is stated below. It follows a similar definition as that referred to as *Sedimentary Carbon* in the literature and is further explained and justified in Chapter 3:

> **Offshore Carbon (OC):** The natural process of organic carbon sequestration and storage that occurs in the offshore zone as a result of the processes of the biological carbon pump and the production of particulate organic carbon, alongside some terrestrial and coastal inputs [*Flow*], and the subsequent storage of a portion of the carbon generated within seabed sediments for the long term i.e., decades to millennia [*Stock*].

Another crucial term developed and used throughout the thesis is:

> **Offshore Carbon *Realisation*:** the hypothetical attempt to utilise the offshore carbon system, as defined above, as a tool of climate change mitigation i.e., to bring offshore carbon into a process of governance and management for the purpose of climate change mitigation.

Both these terms act as the essential subjects under investigation by this research thesis. OC is the subject natural resource/ecosystem-service/nature-based-solution, while an OC realisation refers more specifically to the idea of OC as a project requiring human systems of laws, policies, governance frameworks etc.

1.3 Research Design and Research Aims

To answer the research questions, an overall strategy of expert consultation was adopted. Data were collected in relation to populations of experts in fields that can be considered adjacent to OC, such as marine governance, environmental economics, and blue carbon. Specifically, the first method employed was the semi-structured interviewing of knowledge experts (mostly academic researchers). Following this, the data collected in the interviews were then used as the basis for a scenarios analysis in which four scenarios were created to help bring the concept of OC to life. Subsequently, a further group of knowledge experts were asked to complete an online open-question survey focussing on questions that arose in light of the interview data. The scenarios were utilised in combination with the survey to help participants conceive and think about OC, which was considered difficult due to OC's novelty and lack of existing examples of an OC governance.

Expert consultation provided the primary underlying strategy of research because of OC's novelty. As an emerging resource, OC does not *exist*, as such. There are no real-world OC policies, OC management strategies, OC regulations, OC institutions, OC specialists, or the like, that a social scientist could study and analyse. Instead, the purely theoretical concept – the *idea* that the offshore carbon system could, possibly, be governed for CC mitigation, and subsequent framework(s) for such – required an approach that utilised existing resources to facilitate research. One of the most accessible and intuitive resources at hand was the knowledge of experts who have spent considerable time studying, researching, and working in fields adjacent to OC. Fields including blue carbon, environmental economics, marine governance (and environmental governance in general), and natural resource management. Additionally, fish as a resource, and fishing as a governed activity, provided a useful, if imperfect, analogue to OC as a transboundary, common pool, marine resource. Thus, the focus on European fish resources and their common pool nature as the subject of research in Chapter 4.

The thesis addresses the following research questions:

1. What are the policy options for utilising offshore carbon for the purpose of climate change mitigation?

2. Who would be the relevant actors in offshore carbon governance?

3. How do the findings inform a governance framework(s) for offshore carbon?

The research questions were derived from a synthesis of the knowledge and key findings of the literature review chapters, as laid out and explained in Chapter 5. This included insights from a systematic literature review on the common pool nature of European fisheries resources in Chapter 4. The first two research questions were born from the paucity of research on OC governance as a concept. As this topic is so novel, there were foundational questions that needed to be addressed before work could begin on answering questions more directly pertaining to governance frameworks, which are not addressed to any depth in the literature. A crucial uncertainty hanging over an OC realisation lies in understanding how an OC system would be utilised in human action to mitigate climate change i.e., what policy intervention(s) will a governance framework be built around? Thus, research question 1. And as key components of any governance frameworks are the maps of responsibility and remit between various actors, better understanding the potential types of actors involved is fundamental, thus research question 2. Research question 3 then

focussed the thesis research on the overarching aim of informing a governance framework(s), building on the foundation of insights provided by asking the initial two research questions. All of the findings, from the systematic literature review in Chapter 4, the interviews in Chapter 7, and the combined scenarios-survey (Chapters 8-9) were used to answer research question (RQ) 3. Each question is broken down into underlying research aims and goals at the beginning of the relevant empirical chapters – RQs1 and 2 in Chapter 7, and RQ3 in Chapter 9. And each provides the main subheadings in discursive Chapter 10.

1.4 Thesis Overview

The thesis is comprised of ten chapters. As a result of the initial thesis remit addressing three wide-scoping topics – common pool resources, blue carbon, fisheries – there is no single literature review chapter. Instead, the literature review is split into various chapters that address the three central topics individually. These literature review chapters are then brought together, and their major points synthesised, in Chapter 5. After this, the thesis follows the standard PhD thesis structure: methods, empirical chapters, discussion and conclusion. I have structured each empirical chapter as if it were a standalone research paper – including explanations of the data collection processes, findings, and discussion – in order to discuss and review findings as the thesis progressed. This allowed preceding research to better inform the research that followed and ensured that each stage of the thesis was able to successfully build on what came before. For a diagrammatic understanding of the chapters and how they relate, see Figure 1.1.

Chapters 2 to 5 consider the literature, with Chapter 2 focussing on common pool resources, laying the theoretical foundations of the thesis, as well as discussing some of the major challenges that face common pool resources at scale. Chapter 3 explains the blue carbon concept and defines and explains the biophysical concepts underpinning the OC resource in relation to the literature, making the case for OC to be considered a form of blue carbon. Chapter 4 systematically reviews the literature on the UK leaving the European union in relation to the common pool nature of European fish resources. This was to derive lessons and insights into the nature of marine common pool resources that could potentially be applied to OC, the rationale being that fish and OC are similar as both are large-scale, marine, common pool resources. The findings in Chapter 4 are synthesised into Six Principles for large-scale commons governance which are subsequently referenced

throughout the rest of the thesis in relation to the findings. Chapter 4 is therefore a literature review chapter as well as an empirical chapter as it provides original findings and conclusions. Common pool resources, blue carbon, European fisheries: the subjects of the first three chapters of literature review are diverse and eclectic reflecting the nature of the topic – offshore carbon governance – as one that has many different aspects and is informed by many different fields. Its multi-disciplinarity is a key feature of OC governance as a topic of research. Chapter 5 brings together the disparate threads of the literature review chapters to make the case that OC be considered a common pool resource and identifies the research questions to inform the direction of the research.

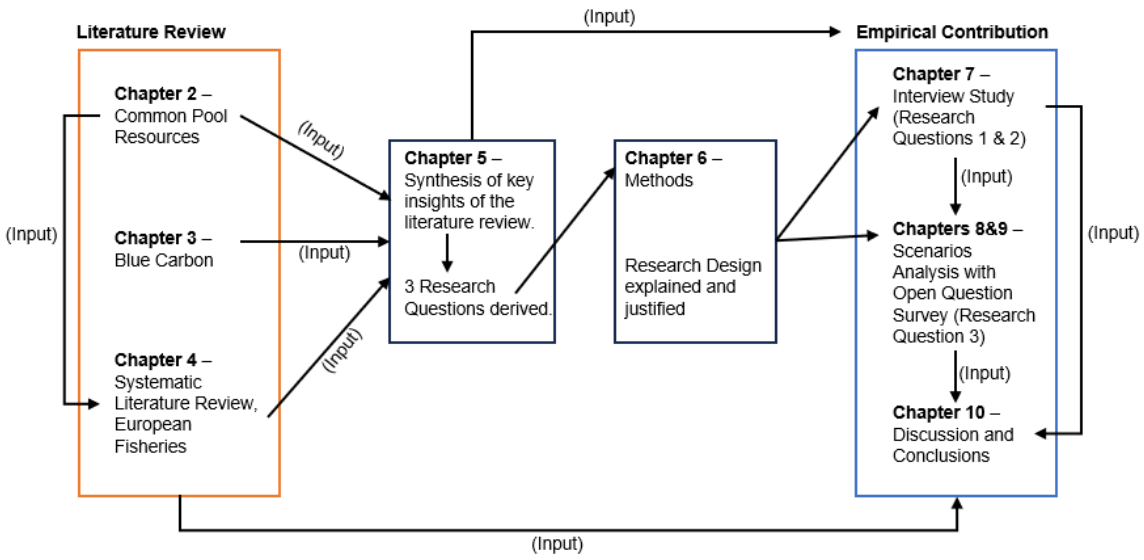


Figure 1.1 *The thesis chapter structure and how the chapters inform one another*.

Chapter 6 states, explains, and justifies the methodology of the applied research. It discusses the choice of interviews, scenarios analysis, and open-question survey, including the choice to utilise thematic analysis throughout the thesis. It does not, however, describe the *processes* by which each method was applied, these are instead explained within each empirical chapter, with supplementary material placed in the appendices.

Chapter 7 explains the process of qualitative interviewing that was conducted to answer research questions 1 and 2. In Chapter 8, four original scenarios were produced as derivatives of the interview data, the findings of the systematic literature review, and insights gained in the synthesis of the literature review in Chapter 5. Chapter 9 explains the process and results of surveying knowledge experts, utilising the scenarios from Chapter 8 as aides in the survey.

In Chapter 10, the findings of the research are brought together and discussed in relation to the research questions, the major contributions of the thesis are summarised, the limitations of the thesis research laid out, and the calls for further research are proposed.

Chapter 2 |

Common Pool Resources

2.1 Introduction

On the 16th of July 2015, representatives from the five nations bordering the Arctic Ocean (USA, Canada, Russia, Norway, Denmark) met in Oslo to sign the *'Declaration concerning the prevention of unregulated high seas fishing in the central Arctic Ocean',* (hereby the Declaration) (Shephard et al., 2016). The impetus for this declaration was scientific evidence that clearly demonstrates that the extent of sea ice cover in the Arctic Ocean, in both quality and quantity, has been steadily decreasing over the last few decades (Norris & McKinley, 2017; Stroeve & Notz, 2018). Less and less sea ice, even in winter, allows greater and greater access to parts of the Arctic Ocean that were previously cut-off (Brigham, 2016).

The retreat of the sea ice has brought about the potential for the utilisation of previously inaccessible marine resources in the *Central Arctic Ocean* - an area of high seas outside the jurisdiction of any sovereign state (as described under UNCLOS, the UN Convention on the Law of the Sea) (Evans, 2010). In 2017, the Declaration was extended to include four more nation states (China, Japan, South Korea and Iceland) and the European Union. The parties agreed to a 16 year abstention from any kind of fishing in the central Arctic to allow time to fill the substantial research gap surrounding the quality and quantity of the stocks as well as the best manner in which to govern them (Hoag, 2017).

The Declaration presents a rare example of international cooperation in the management of an emerging natural resource[1]. Even more notable is that this agreement was brought about in regard to the natural resource of fish in an area not under any country's jurisdiction. This is notable because fish, under these geopolitical conditions, have historically been overexploited due to a phenomena popularly referred to as *The Tragedy of the Commons* (Hardin, 1968). Fish, under these circumstances, are vulnerable to overexploitation because of their economic nature as a *common pool resource*. The following section explores the nature of common pool resources in an international context: their structure (Section 2.2), their link to the tragedy of the commons (2.3), and their development in the literature. Central to this is a discussion of the philosophical difference that has animated commons research in recent decades: the divide between what are known as "Leviathan solutions" and what can be generally described as "the commons" (Section 2.4). Elinor Ostrom, giving her name to the Ostrom School, is perhaps the most famous scholar of the commons and her work and contribution are set out in Section 2.5, followed by a look at the critique of the Ostrom School in 2.6. The issues that surround dealing with large scale common are then outlined and explored in Section 2.7, before a summary of the main points is provided in 2.8. The aim is to provide the necessary grounding in common pool resource studies crucial for a proper understanding of the topics under research in this thesis.

2.2 Defining Common Pool Resources

A common pool resource (CPR) is one that produces economic good(s) which are subsequently categorised as *rival* and *non-excludable*. Rivalry describes the nature of the resource (or consumption of the good produced by the resource) as depletable and finite e.g., if a fisherman fishes a shoal of mackerel onto their boat, that shoal is now no longer available for a *rival* fisher. Contrast this with the acquisition of a digital file such as digital music or software etc. (the economic good), the use of the download (consumption) by one person does not prevent or deplete the use of the download by another person nor does it prevent the other person from downloading a copy of the file for themselves; the digital download is non-rival. Excludability describes whether the resource (and the good it produces) can be "fenced-off" and controlled in such a way as to limit people's ability to access or consume the good e.g., an area of land can be fenced off, protected by property rights, and guarded so as to exclude certain users and allow others. Common pool resources

[1] Here, "emerging" refers to a resource that has never before been incorporated into a human system of appropriation.

then are resources which are difficult to bring under a regime of exclusion e.g., an oil field that lies beneath and between separate national borders. For a break-down of the relationship between rivalry and excludability, see Table 2.1.

Table 2.1 *The four categories of economic goods (adapted from Nitzan & Ueda, 2008)*

	Excludable	*Non-excludable*
Rival	**Private good** (e.g., house or land)	**Common-Pool good** (e.g., fishing ground)
Non-rival	**Toll or club good** (e.g., digital streaming service)	**Public good** (e.g., breathable atmosphere)

2.3 Tragedy of the Commons and Necessary Institutions

The nature of common pool resources as non-excludable often leads to resource exhaustion if left outside any mechanism of control because users are able to continue extracting/using/appropriating the resource without any deterrence. As long as there is a sustained demand for the good that exceeds the total amount of the good, or the ability of a renewable resource to regenerate, then resource users will continue to extract/use/appropriate the good in highly inefficient ways or until it is gone (Hardin, 1968; Harvey, 2005; Scott, 1955). One of the most famous stories of species extinction, the Mauritian Dodo, is an example of this: 17th century Dutch sailors hunted the Dodo without any processes or institutions controlling their consumption leading to the depletion of the resource beyond the Dodo's ability to reproduce (although this was exacerbated by invasive species' taste for Dodo eggs) (Turvey & Cheke, 2008). In the case of Central Arctic Fishing above, without the Declaration, the potential and emerging marine resources would be "free-game" for any interested parties with the ability to exploit them to such a degree that it could very likely create a race for the resource amongst the interested parties eventually leading to highly detrimental inefficiencies if not full resource exhaustion. This phenomenon, the *Tragedy of the Commons*, is one of the major issues that lies at the heart of natural resource management.

A dominant solution to this problem has been to change the nature of a CPR, where possible, to that of a private good i.e., to make the good excludable. "Privatised good" refers here to a rival good that has been excluded. However, this may not indicate private property, commonly thought of in regard to private goods. Here, "privatised" is taken to mean "when a rival good is made excludable" and it should be noted that privatisation is not the only option for dealing with the tragedy of the commons, as will be discussed. The resource is privatised through incorporation into some form of institution, often private property rights but also the issuing and enforcing of licences or declared agreements between relevant parties e.g., the Declaration above (Sweeney et al., 1974). For example, the privatisation can be realised through state control (e.g., state property) or through placing it in the market via private individuals, companies, organisations etc. The following section looks at the background and debates concerning these aspects.

2.4 The Commons, Privatisation and Leviathan

A major fault line in commons studies lies at the philosophical level. The two general solutions to the commons problem mentioned previously – privatisation by market and state – are regarded as rather expansive and authoritative; implicating that the only solution is total, and ultimately coercive, control by some kind of central governing body or authority (Orr & Hill, 1978; Wirl, 1996). Indeed, this is the main argument in Garret Hardin's paper on the Tragedy of the Commons: the only logical answer to humanity's survival, given a finite amount of resources on the planet, is to allow some kind of authoritative control of fertility and the human birth rate so as not to surpass the planet's natural limits (Hardin, 1968). Hardin's work, alongside William Ophuls and Robert Heilbroner, argued that encroaching limitations to natural abundance require the need for what Hardin referred to as "mutual coercion mutually agreed upon" (Heilbroner, 1974; Ophuls & Boyan Jr, 1992). This line of argument has been established as grounded in the Hobbesian tradition of justifying expansive and powerful government as necessary for the proper functioning of civil society. Thomas Hobbes's argument stemmed from his use of the philosophical *state of nature*, a hypothetical and imagined existence, before the establishment of human societies and civilisation, in which he believed humanity would exist in a state of constant conflict and disorder: "*during the time men live without a common power to keep them all in awe, they are in that condition which is called warre"* (Tuck, 2002 [1651] p.88). His intention in writing his famous text, *Leviathan*, was to defend the tradition of monarchy during the English civil war by arguing that sufficient and correct

government of the "commonwealth" requires the arbiter of a sovereign to ensure it. By willingly entering into a relationship with the sovereign and their fellow countrymen, the citizens form the commonwealth by uniting into one body, the *Leviathan*. This was one of the key steps in the establishment of social contract theory, as David Hume would later describe, the social contract is "*enter'd into by all the members of the society to bestow stability on the possession of…external goods, and leave everyone in the peaceable enjoyment of what he may acquire by his fortune and industry*" (2003 [1739-41] p.348).

Following Plato's famous prescription for a class of ruling philosopher kings, Hobbes and Hume present the descriptive origins, as well as normative defenses, of the Leviathan itself – a powerful and encompassing state apparatus of institutions necessary to govern sufficiently, including the governing of "external goods" i.e., natural resources and their products. For Hobbes and Hume, a property right, for example, cannot exist without the arbiter of the state to hold individuals to the contract; Leviathan facilitates and makes possible privatisation. All resources come under the remit and ownership of the Leviathan – which often defaults to the (nation) state – which may be further alienated to become a privatised resource, made private only through the will of the sovereign (where the "sovereign" can be a monarch, a dictator or a public represented by a democratically elected government). The Leviathan approach is necessitated because the state is the only entity capable of providing the necessary administration and organising capabilities on society's expansive use of resources through the ultimate use of coercion and the state's monopoly on violence.

2.5 The Ostrom School

> "*Let me start with a provocative statement. You would not be reading this article if it were not for some of our ancestors learning how to undertake collective action to solve social dilemmas*." (Ostrom, 1998, p.1).

After hearing Garret Hardin give a lecture on the Tragedy of the Commons, the political scientist Elinor Ostrom felt compelled to question what she saw as dangerous excuse-making for authoritarianism. The process spurred her on to become the world's foremost commons scholar by questioning the necessity of Leviathan in all instances, with its focus on coercion, and the subsequent state/market binary in the context of the management of natural resources (Ostrom, 1990). She set out to discover and systematically analyse instances of common ownership whereby a natural resource is managed and owned by a

relatively small community under communally determined institutions, thereby proving that Leviathan approaches need not be necessary in all instances; that communities can organise collaboratively rather than coercively. She then worked to systematically determine what made some commons work and others fail. The following section is a non-comprehensive overview of her work, its legacy and surrounding debates in order to highlight important points and conclusions for this research thesis.

By addressing economic problems from the vantage of a political scientist, Ostrom was able to introduce different perspectives on commons issues that opened the door to a new wave of commons scholarship. Key to her work is a critique of the 1st generation rational-choice games and theoretical constructs of collective action, such as Nash equilibriums, the prisoner's dilemma, and coordination games (Gardner et al., 1990; Ostrom, 1998). These theories and matrices concluded that human interactions and behavior work along a logic and rationality of amoral self-interest in regard to collective action. That human beings make decisions following a logic of self-interest, referred to by Ostrom as the "Rational Egoist", was seen as reductive and overly simplistic (Ostrom, 2000). She helped prove, using numerous case studies around the world, that these theories did not hold-up under substantial empirical evidence to the contrary, including under newly contrived and more nuanced games of collective action (Ostrom, 1990, 2000). Systems of resource management built around mutual cooperation, rather than mutual coercion, with no need for Leviathan, were both theoretically possible as well as active and ongoing in instances around the world, at least at the relatively local and small scale that Ostrom studied. She further characterised these non-coercive systems of natural resource management – commons systems – as *complex adaptive systems* (following complex adaptive systems theory):

> *"In contrast to forms of organization that are the result of central direction, most self-organized groups – including locally organized fisheries, forests, grazing areas, and irrigation systems – are better viewed as complex adaptive systems. Complex adaptive systems are composed of a large number of active elements whose rich patterns of interactions produce emergent properties that are not easy to predict by analyzing the separate parts of a system."* (Ostrom, 1999, p. 38).

This "rich pattern of interactions" is one of the main aspects that Ostrom's work suggests should be addressed in order to substantiate and properly prove theories surrounding CPR problems in situ. Complex adaptive systems are characterised by attributes including self-organisation, emergence and differences of scale. In the context of commons systems, they have a number of important advantages, including: lower cost of enforcement; better

adaptation of rules and institutions to the local context; higher levels of trust between users; higher retention and use of local knowledge etc. Ostrom also recognized that the commons systems she and her colleagues studied included weaknesses such as: limited access to scientific data and expertise, the potential for corruption and tyrannies of some groups or individuals over others, and an inability to function properly at larger-scales (Ostrom, 1998). Building on top of complex adaptive systems, Ostrom and others developed the Social-Ecological Systems (SES) framework in order to help merge the study of ecological issues with social issues (Brondizio et al., 2009; Ostrom, 2008). As Ostrom explains, SESs are:

> "*Composed of multiple subsystems and internal variables within these subsystems at multiple levels…In a complex SES, subsystems such as a resource system (e.g., a coastal fishery), resource units (lobsters), users (fishers), and governance systems (organizations and rules that govern fishing on that coast) are relatively separable but interact to produce outcomes at the SES level, which in turn feed back to affect these subsystems and their components, as well other larger or smaller SESs"* (Ostrom, 2009, p.419)

The rationale behind SESs is that human and ecological systems are highly connected and dependent rather than two distinct spheres, so should therefore be studied and managed concomitantly. The main lessons from Ostrom's extensive body of work in regard to successful commons management were synthesized into eight institutional design principles (see Table 2.2. for a list of the principles).

A further key achievement of Ostrom's work was in creating the theoretical impetus for a 2nd generation of commons scholars to analyse successful commons and effectively critique the necessity of Leviathan and private property solutions, known as the Ostrom Workshop or the Bloomington School of Institutional Analysis. One of the main lessons derived from this work was that tragedy need not be inevitable if commons users are able to cultivate sufficient trust and reciprocity (Agrawal, 2014; Ostrom, 2003). This helped underpin the point that political systems are essentially human systems that require the ability of the humans within them to interact in a way that facilitates the maximisation of positive outcomes based on the ability to trust one another. As Agrawal points out, in the classic prisoner's dilemma, the prisoners cannot interact with one another but, supposing they could, it is possible and likely they would communicate to reach a solution i.e., collaborate (2014). Under such theoretical conditions, trust is the key factor between the two prisoners. The conclusion is that all resource management systems that rely on collaboration, rather than coercion, must facilitate and encourage trust between users. In a coercive system, trust

is instead forgone in favour of a coercion that reprimands any agents that deviate from the rules.

Table 2.2 *Eight Design Principles for commons management (McGinnis, 2011)*

(1) *Clear Boundaries*	The conceptual/legal extent of the resource area must be clearly defined alongside clear definitions of who has what access and to what extent i.e., well defined property rights
(2) *Congruence*	Rules should be defined relative to the particular needs of the local ecology and society and dictated by local resource users and people
(3) *Collective Choice*	The decision-making process should involve as many people as is feasible
(4) *Monitoring*	The management system requires robust monitoring preferably by people accountable to resource users/appropriators
(5) *Graduated Sanctions*	When deviation from the rules occurs, penalties must be graduated with increasing levels of penalty applied each time a rule is broken
(6) *Dispute Regulation*	Any conflict between users should be resolved and facilitated easily, simply and cheaply
(7) *Recognition*	The rules, and commons generally, must be recognized by higher powers and local authorities
(8) *Nested Enterprises*	Commons regimes should be nested within larger structures to facilitate cooperation across jurisdictions, as is often required with natural resources

Additionally, the Ostrom Workshop furthered work on *Polycentricity*, a theory of social-political structure that purports a model of multiple decision-centres that are largely, but not completely, autonomous within their specified remit but held together in a framework of overarching rules and institutions that are brought to bear when these individual centres need to interact and collaborate (Aligica & Tarko, 2012). Polycentricity therefore argues for as much local control as possible while keeping the autonomous units within a system of governance that facilitates cooperation on issues that require it. This can be conceptualized as the antithesis of Leviathan in which the powerful, hierarchical centre is instead split into a loose-fitting web of interconnecting but mostly autonomous nodes that interact through the web when required. Polycentric approaches are therefore particularly useful in regard to environmental governance, especially for natural resources that cross,

as they often do, multiple jurisdictions (McGinnis, 2011). This can be conceived as an attempt to scale-up the Ostrom ethos of local autonomy where possible to counteract the necessity of Leviathan/privatisation as solutions to the Tragedy.

Through questioning the assumptions of the times and using interdisciplinary methods of research, Elinor Ostrom was able to forward a sufficient and compelling critique of the necessity for Leviathan or a subsequent privatisation for effective management of commons. She did so by putting forward examples of real-life commons management systems – complex adaptive systems/SESs – that provided the insights necessary to synthesize the key lessons learned for successful commons management, the eight design principles. By opening up this debate she also made room for what would become a 2nd generation of commons scholars that would enhance these ideas further e.g., the importance of trust and reciprocity and Polycentricity. The following section will discuss this legacy, its critiques and the main issues in the commons to date.

2.6 Critique of Ostrom and the Development of Commons Studies

The original aim of Ostrom's work, and some of commons studies since, was to find a systematic way in which to manage natural resources sustainably and efficiently so as to avoid the tragedy of the commons without resorting to Leviathan solutions. However, it has been argued that this research on commons management has not been critical enough of other effects of commons systems beyond holding off the Tragedy. For example, Bingham Daniels (2007) addresses this in his thesis of "Tragic Institutions": even when a commons system manages to prevent the tragedy of the commons, it can be at the expense of a host of negative externalities, based on a privileging of the values of the current commons users who cannot possibly represent all of the potential uses of a commons. Daniels uses an example that some herdsmen may gain stability through institutional arrangements on a pasture but at the expense of local people who previously used that commons to fish in a stream that runs through the pasture or to relax and enjoy nature (Daniels, 2007). He argues that these values then become entrenched through the stability of the institutions in play and the privileging of those it favours, preventing the expression of any new emerging values or indeed emerging uses. Daniels's critique is useful in that it questions the stability of commons systems along temporal lines; a reminder that institutions must be managed *across time*, time in which values, needs and uses can and do change.

We can imagine Ostrom replying that the eight design principles allow for change through local collaboration and the accommodation of conflicting ideas and views, at least theoretically. But this is dependent on who exactly the system includes e.g., if the system also gives a voice to the local community, not just the herdsmen, then the system could conceivably be changed to accommodate the community's emerging values, otherwise the herdsmen will maintain the system that advantages them. The key lesson to be drawn then is that any system of governance will often privilege and empower certain people within that system and that effective management relies on being aware of who is privileged and how.

What emerges from the discussion around Ostrom's work is that the critiques are often based on the sheer complexity of these systems and the struggle to simplify them into systematic solutions. Ostrom herself acknowledged this, having anticipated the direction of travel for commons studies would be towards figuring out how to deal with complexity and contextual/situational factors in commons management (Laerhoven & Ostrom, 2007). Part of this complexity reaches to the initial formation of commons systems. As Cleaver argues (2000, 2002), they can often be the result of complex cultural and historical factors and practices built-up over time rather than through directly conscious rule-building that follows a collaborative logic. Cleaver's research led to further advances in the *Critical Institutionalism* approach which attempts to study commons institutions as more embedded phenomena with established privileging, complex histories and multiple purposes beyond immediately managing the resource (Cleaver & De Koning, 2015).

Quintana and Campbell present a comprehensive thematic review of the critiques of the commons to date (Quintana & Campbell, 2019). They allocate the likes of Daniels and Cleaver to the "Functional Critique" in which the commons scholars have focused too much on institutions such as property rights without looking closer at the context of these systems and their aims. Another major theme they identify is the "Apolitical Critique" in which traditional commons scholarship has not fully accounted for the political factors of a given commons situation, such as who benefits and how, similar to Daniels's critique above (Agrawal, 2003, 2014). This tendency has been to focus on systems of management as apolitical and objective systems brought about through a conscious logic, rather than highly politically embedded systems which affect, and are affected by, the politics of the local community and beyond. As Agrawal writes:

> "*Ultimately, power is not just what planning and management attempt to exclude. Rather, power and politics imbue the process of management thoroughly and unavoidably. Management is not just about providing technical solutions to*

> *objective problems of development and environmental conservation. It may be important to consider that these problems and their solutions may themselves be part of a political process*." (2003, p.258)

Agrawal's critique furthers the idea that management is not a matter of objectively deciding on the best course of action, determined through objective analysis and rational decision making. Instead, he makes the point that management is conducted by humans within human systems and therefore incorporates a high degree of agency and subjectivity – in which the people imbedded in these systems can inhabit multiple subjectivities at any one time.

The critiques so far referenced concentrate on encouraging the wider commons community to be mindful of the many nuances – including political, social, historical etc., – that make up a social system such as a commons management system; that management systems must be thought of as existing across time and that the people who ultimately construct and operate the system be thought of as agents embedded in their own subjectivities. Alongside these more complexity-focused critiques run other critiques focused more on the background thinking and methodologies of common scholarship, such as (following Quintana & Campbell's thematic approach) the *normative critique* – the philosophical objection that commons studies do not engage in enough questioning of their background norms and underlying assumptions (Mansfield, 2004) – and the *methodological critique* – the objection that commons studies rely too heavily on the American Positivist School of political-scientific technique (Fabinyi et al., 2015; Johnson, 2004). The essential lesson of these critiques is to take a step back when studying a system and reflect on the underlying assumptions and methodologies in use as they are essential in fully understanding the drawn conclusions and their limitations.

Currently, the frontier of commons studies is focusing on developing these ideas further to help better understand the multiple complexities of common-pool resource systems (Quintana & Campbell, 2019). The literature that has been referenced so far centres on relatively small-scale, local-level commons systems. However, many common-pool resources, such as fish stocks and forests, are often so mobile or large that they exist across large and multiple jurisdictions, such as regions and countries, or even oceans and continents. Sometimes, as in the case of the Arctic fishery Declaration example referenced in Section 2.1, they exist outside of any national jurisdiction at all. These *Large-Scale commons* give rise to a number of challenges related to their size and the degree of political cooperation required to manage them. The next section discusses large-scale commons and issues arising from attempts to scale-up some of the key lessons of commons studies.

2.7 Large Scale Commons and the Scaling-Up Problem

For the purposes of definition, global commons are those resources which lie outside any country's jurisdiction e.g., central Arctic Ocean fish, while regional commons are those that lie within multiple countries' jurisdictions e.g., the Danube River basin or the North Sea. This section uses the term *Large-Scale Commons* to describe both regional and global commons and some national commons i.e., those that are found in more than one jurisdiction and/or can be regarded as being on a country/state-level of size.

Large-scale commons present different challenges to those of a more local-scale, tending to be far more difficult to manage. Stern (2011) and Ostrom et al. (1999) lay out the key differences:

(1) ***Geographic size*:** Large-scale commons encompass domains that can be as large as the earth's atmosphere or the entire ocean which are themselves complex chains of inter-linked commons systems.

(2) ***Population scales*:** the number of individual agents involved increases from tens to thousands for local commons to potentially millions and billions for large-scale.

(3) ***Individual disconnect*:** the results of agents' actions are not immediately evident as they would more likely be at the local level, so there is more of a disconnect between the resource user and the way the resource and other aspects change as a result of their use e.g., the effects of CO_2 emissions from one car journey are not as salient to the individual as the effects of overfishing their share of a small inshore fishery.

(4) ***Greater divergence of interests*:** the interests of a relatively small community that governs their irrigation system collectively will likely align in keyways that make collaboration easier and more likely, while at the large-scale the interests of the likes of a large CO_2 polluter will be highly divergent to that of, for example, indigenous hunters in the Arctic unable to maintain their traditional hunting practices due to sea ice melt.

(5) ***Plurality of views*:** plurality of views among the wide range of resource extractors and consumers means that there will be less common ground in ideology, politics, history, culture and economics. This can be a significant barrier to cooperation and can sometimes exacerbate commons problems by

encouraging different groups to compete rather than collaborate. Further to this is the tendency to require *unilateral* agreement in international negotiations making management difficult and slow to achieve as some states use this process to acquire advantage i.e., will not agree until they have received 'x'.

(6) ***Global-Scale systems*:** The complexity, non-renewable nature, unprecedented and difficult to measure changes, and a lack of relative analogues or proxies at the global level (there is only one Earth) make it much harder for large-scale commons to learn from experience and example as is often the case with local commons systems.

It is clear from the list above that large-scale commons have the same essential difficulties associated with rival and non-excludable goods in general but are much more challenging to address due to the extra complexity that comes with governing at such scales. Attempts to privatise such goods are also more challenging as private property rights and the systems that govern them are specific to their embedded jurisdiction which are unlikely to align completely, if at all, with neighbouring, or indeed global, jurisdictions. A Leviathan approach, involving various Leviathans in negotiation e.g., the European Union, is one of the few ways the problems of scale can be met, at least in theory. Examples of this include UNCLOS – the United Nations Convention on the Law of the Sea – and the aforementioned Declaration on fishing in the high Arctic i.e., unilaterally agreed institutions. However, there is no global authority for the various Leviathan jurisdictions in play to hold them all to account (there is nothing akin to a one-world government with a sufficient monopoly on violence). As such, states can often deviate from these arrangements without major penalty e.g., even as they follow the rules of UNCLOS for the most part, the treaty remains unratified by the US and China for both national-political and geopolitical reasons (Kogan, 2009).

What then about the third way of Ostrom-style cooperative commons management? Can the key lessons learned from the original, local-level case studies of the Ostrom workshop be scaled-up? There are those that have postulated they can be, even with the attendant difficulties (Dietz et al., 2003; Young, 1999). Stern states that the principles can be scaled-up if the principles are adapted to facilitate cooperation along the long and complex lines that reach from users to decision-makers (2011). He calls for an adaptive, ever-evolving system that includes: greater scientific analysis integrated into decision-making; as many people as possible be involved in framing the questions of the analysis with those higher up obliged to actively include lower-level users; and that the system be watched over by a

truly independent and impartial monitor that liaises at all levels, not just the higher, decision-making level.

In contrast, there are those who are pessimistic about a more commons-based approach to large-scale CPR problems, whether because states have a tendency to wait until a resource-scarcity issue becomes a matter for defence by which time it's too late (Matthew, 1999) or because of a general emphasis on extraction rather than conservation (Clancy, 1998). And there are those that are doubtful of the scaling-up potential because of the record on joint resource-use so far, citing the ineffectiveness of programmes like REDD+[2] to stem tropical deforestation and the continuing unsustainable depletion of major aquifers in China and India (Araral, 2014). From a record of general failure, the rather pessimistic conclusion to draw is that the complexities of CPR problems are too extensive to be solved along the collaborative lines of the Ostrom School.

However, complex problems are by definition difficult to solve, requiring various, often conflicting, inputs, and embedded in dynamic systems, such as an ecosystem, that require constant adaptation and review. But this does not mean there are no eventual solutions. The SES framework and Ostrom workshop are still active and evolving fields of study that may yet be able to yield theoretical and applicable solutions to these large-scale commons problems. One thing that is clear is that the sheer complexity and scale of large-scale commons present major difficulties in regards the sustainable management of both natural resources and the humans that use them. What is more, commons issues are not merely theoretical or bound to the confines of the Academy. They encompass the most pressing issues of the day including the climate emergency (the global commons of the atmosphere and oceans), overfishing and destruction of biodiversity, as well as the more anthropocentric issues such as the creation and management of digital data on social media and the internet.

2.8 Summary

This chapter introduces the reader to common pool resources, specifically: the strict definition as an economic good that is both rival and non-excludable; the susceptibility of

[2] REDD+ (*Reducing emissions from deforestation and forest degradation in developing countries),* is a forest protection scheme providing a framework to enhance forest-based ecosystem services in which developing nations receive performance-based payments for emissions reductions (Corbera & Schroeder, 2011).

CPRs to the tragedy of the commons; the subsequent reflex towards Leviathan solutions – the state/market binary; the challenge presented to Leviathan by the Ostrom School, SES approaches, and the general defence of the commons; and the problems associated with commons at large scales. Through ground-breaking research, the Ostrom School has contributed to synthesising key lessons regarding managing resources that can be said to be rival and non-excludable. These lessons include the eight design rules which maximise a local-sized commons' chances at succeeding, but also:

- the importance of trust which must be facilitated and expanded where possible.
- the potential of Polycentric methods of governance for facilitating sustainable natural resource management, and as a counter to Leviathan.
- that commons systems privilege certain users over others and should therefore be reviewed and updated to accommodate emerging views.
- that CPR systems should not bias the present over the future.
- that the subjectivities and agency of the commons users must be taken into account and properly understood.
- and that academic rigour, in the analysis and awareness of both methods used and the underlying philosophical norms in play, is key to reaching positive and instrumental conclusions.

At large scales, the picture is made far more complex by the attendant problems of management at such scales. Part of this research thesis is an attempt to analyse this large-scale complexity with the aim of offering useful insights into the problems of large-scale commons management, via the exploration of questions surrounding the hypothetical governance of offshore carbon. The particular large-scale issues that are of interest include: geographical size e.g., how states deal with a resource that extends over large areas; joint managing a resource system that incorporates the major complexities of entire ecosystems; and the manner in which various jurisdictions come to agreement on the appropriation of contested goods within the shared system. As such, the next chapter defines and explains Offshore – "blue" – Carbon as a large-scale, international CPR and subject of this thesis.

Chapter 3 |

Offshore Carbon as Blue Carbon

3.1 Introduction

This chapter introduces and discusses the literature on the concept of 'Blue' Carbon (hereby BC) to provide the foundational knowledge required to understand the focus and work carried out by this research thesis. First, an overview of the term Blue Carbon and its definition is provided (Section 3.2). Then, Offshore Carbon – as opposed to the coastal carbon represented by conventional BC ecosystems – is defined and explained (Section 3.3). This is followed, in Section 3.4, by an argument that certain aspects of carbon in the marine environment – namely particulate organic carbon, the process known as the "biological pump", and shelf sea sediments, which together I name *Offshore Carbon* (OC) – act together to represent a carbon sequestration and storage system that may be said to also meet the definition of BC, highlighting the subsequent potential for the governance and management of such systems for CC mitigation purposes.

3.2 What is Blue Carbon?

Blue carbon refers to ecosystems which facilitate carbon fluxes and storage via water-based (coastal and marine – 'blue') biological processes. Additionally, to be BC, these ecosystems need to be amenable to management and therefore have the potential to be applied as solutions to help mitigate against climate change (Crooks et al., 2018; Howard et al., 2023; IPCC, 2019, 2021). The original conception of BC applied only to the carbon

sequestered and stored in the highly vegetated coastal ecosystems of tidal mangrove forests, tidal salt marshes and inter-tidal/subtidal sea grass meadows (McLeod et al., 2011). Since then, the literature on BC has grown but the official definition has extended only slightly to include all tidal forests including fresh water forests alongside mangroves (Crooks et al., 2018). Beyond this, however, any other potential carbon sequestration and storage processes within the marine and coastal biosphere – such as macroalgae, tidal mudflats, or the processes further out to sea – remain outside this official definition and are ongoing subjects of research (Graves et al., 2022, Howard et al., 2023). The reason for this centres on BC's purpose: BC is a concept with the aim of producing management strategies that support ecosystems – and their embedded carbon sequestration and storage processes – to be conserved and managed for the primary purpose of part-mitigating CC through locking away carbon in sediments for the long term (more than 100 years) and generally reducing the presence of greenhouse gases (GHGs) in the atmosphere. An additional aim of BC is to facilitate other ecosystem services such as: reducing or even reversing biodiversity loss, reducing or reversing the loss of coastal flood protection, increasing the extent of fish nurseries, and to aid in the sustainable development of coastal communities. With such a specific yet wide remit BC's definition must remain relatively strict. According to Crooks et al. (2018), BC can be regarded as a conceptualisation for the purpose of constructing policy strategies. Therefore, if an ecosystem is difficult to bring into such a strategy, it is difficult to bring under the definition of BC. This is highlighted by the six key criteria for an ecosystem to be defined as BC; following Crooks et al. (2018), these are:

1. The carbon stored, or emission of greenhouse gases prevented, must be significant enough to affect climate.
2. The carbon stocks and fluxes in greenhouse gases must be measurable in spatial and temporal quantities.
3. Human actions must have an influence on the ability of the ecosystem to provide sequestration and storage.
4. The management of the ecosystem to reduce emissions or improve upon storage must be feasible.
5. That this management be introduced without resulting in harm to the environment or society.
6. That this management be able to integrate with already existing or developing international policy and other attempts to address climate change.

These six criteria offer a useful guide as to what can be considered BC. Section 3.4 describes and discusses how these criteria relate to offshore carbon.

3.3 What is Offshore Carbon?

The three established BC ecosystems – mangroves, sea grasses, and salt marshes – remain the only such ecosystems that fit the current, official definition (Crooks et al., 2018; IPCC, 2019, 2021). However, there are other systems – pathways – within the marine and coastal zones that contain, store and sequester significant amounts of carbon that could potentially meet the definition of BC. Introduced in Chapter 1, this subheading explores the concept of *Offshore Carbon* (hereby OC).

With a conventional focus on coastal habitats, it has been an open question since the beginning of BC whether and how to include carbon sequestration and storage that occurs away from the coast (Lutz & Martin, 2014). Lutz and Martin's Grid-Arendal Report: *Fish Carbon: Exploring Marine Vertebrate Carbon Services* advocated the possibility of conceiving of the vertebrate marine biota of the world's oceans – termed *Fish Carbon* – as providing the ecosystem service of net carbon storage via a biological process. This acted as an initial example and attempt to extend the coastal focus of BC. This has inspired research into the topic, with the most famous concerning the *whale pump* – the carbon sequestration and storage ecosystem services provided specifically by the world's whale populations i.e., the whale pathway (Chami et al., 2019; Falciani et al., 2022)[3]. The language of "pathways" is useful in breaking-down the different potential processes in the wide-scoping and complex marine environment that could act to sequester carbon for the long term. In two recent papers, Christianson et al. (2022) and Howard et al. (2023) break down the different carbon pathways and categorise them into three broad groups: those that should definitely be included in the CC mitigation toolbox (conventional coastal BC habitats), those that have potential but struggle with problems associated with carbon accounting and uncertainty on mitigation potential (polar benthos, macroalgae, tidal mudflats, and shallow sea sedimentary carbon), and those currently with a high level of uncertainty (fish, whales and zooplankton). One of the examples of the potential pathways to be included – shelf sea sedimentary carbon – is a direct reference to what is referred to in this thesis as Offshore Carbon. Helping highlight the need to conduct further research into its potential for CC mitigation.

[3] It remains very questionable whether whale carbon is considerable enough to be considered a standalone BC pathway (Pearson et al., 2023).

There are a number of growing examples of research institutions engaging in researching the offshore sedimentary stock and its inputs, such as the University of Exeter's *Convex Seascape Survey* (looking to measure the carbon fluxes in the offshore zone and the influence human beings are having on the system – referring to their subject of study as *Seascape Carbon* (University of Exeter, 2021)). Also ongoing work in the United Kingdom centred on the *Centre for Environment, Fisheries and Aquaculture Science* (Cefas) concerning the aforementioned *Sedimentary Carbon* – the attempt to account for and potentially manage the carbon in shallow shelf seas (Diesing et al., 2017; Graves et al., 2022; Luisetti et al., 2019). And the *Environmental Defence Fund* in the United States which looks into different BC pathways such as macroalgae and the mesopelagic fisheries in the Pacific Ocean (Environmental Defense Fund, 2023). These examples demonstrate that this is a dynamic area of research, and there is widespread interest in filling the gaps highlighted in the Christianson et al. and Howard et al. papers.

But the language of individual pathways can also be reductive and unhelpful in so much as it creates differentiation in what is ultimately one large ocean-based carbon system in which all of the many pathways are interconnected, with all the different pathways in a process of constant carbon exchange. The rest of this section describes in more detail the physical carbon processes of the marine zone, according to the literature, following the concept of carbon "pumps", to help in understanding the foundational, physical aspects of offshore carbon as a subject of study and as a theorised natural resource.

3.3.1 The Marine Carbon Pools

Given the six criteria previously discussed, potential candidates for BC status are ecosystems within marine and/or coastal environments that fix, transfer and/or capture CO_2 to long-term storage in sediments, but which are also amenable to management i.e., can be affected by human actions (IPCC, 2019, 2021; Smale et al., 2018). As discussed, these potentially include certain pathways in marine ecosystems such as macroalgae (including kelp forests), the polar benthos, tidal mudflats, and sedimentary carbon. However, the forms in which carbon exists within marine environments can be broken down into more exacting categories, divided between two main aspects: whether the carbon in question is *dissolved* or *particulate*, and whether it is *organic* or *inorganic*. Carbon is considered *dissolved* if it is constituted within a body that can pass through a 0.2µm (micrometre) filter (Emerson & Hedges, 2008; Hedges & Keil, 1995). Particulate carbon is anything which contains carbon that is too big to pass through such a filter, from the carbon contained

within microscopic bacteria and biological waste to the carbon locked up in giant "particles" such as the bodies of large animals. The carbon is considered *organic* if it is or was contained within a living source (i.e., biogenic), with inorganic carbon primarily contained within four key compounds: carbon dioxide, carbonate, bicarbonate and carbonic acid (Emerson & Hedges, 2008). Therefore, the four categories, or pools, of offshore carbon are particulate organic carbon (POC), dissolved organic carbon (DOC), particulate inorganic carbon (PIC) and dissolved inorganic carbon (DIC). See Figure 3.1 for a breakdown of the composition of each of the four pools of carbon within the global marine environment, including the atmospheric pool for reference (measurements from Atwood et al., 2020; Friedlingstein et al., 2019). The four carbon pools are in constant flux with one another, exchanging carbon via various processes and at different rates. See Figure 3.2 for a diagrammatic understanding of the relationship and processes of exchange between the four pools (Holligan & Robertson, 1996; Honjo et al., 2014; D. Thornton, 2014).

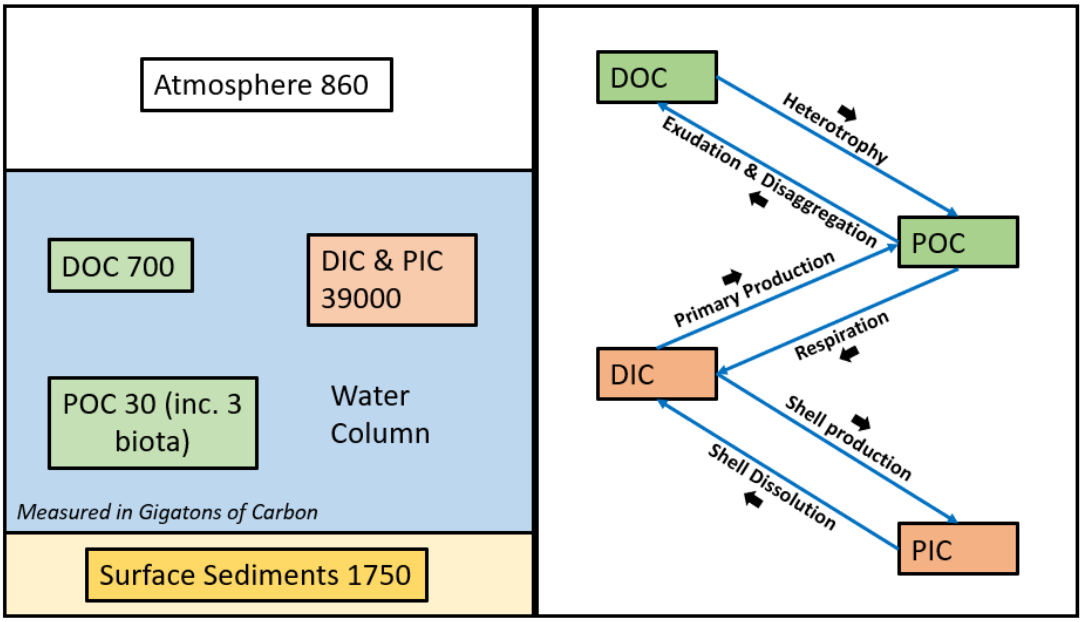


Figure 3.1 *[left] Composition of global carbon stores in ocean and atmosphere.*

Figure 3.2 *[right] The relationship of carbon exchange between the four offshore carbon pools.*

Through several processes, large amounts of marine carbon are eventually stored within the sediments on the seabed of both the deep-sea and shallow shelf seas, in which the carbon, if buried deep enough, is stored for centuries to millennia (Emerson & Hedges, 2008). When carbon sinks to the seabed it is either directly buried in the sediment, or living organisms in the benthic ecosystem either ingest and respire the carbon or bury it in the sediment through mixing processes known as bioturbation (Arístegui et al., 2005;

Middelburg, 2019; Middelburg, Duarte, & Gattuso, 2005). The burial of the carbon, however, is not simplistically fixed in a clean, one-way direction as a high degree of remineralisation occurs between the sediments and the water column (Middelburg et al., 2005). The process should therefore be conceived as a bridge between sediment and water column with carbon passing, through various processes, in both directions but at different rates, across the "bridge". The difference between what is stored and what is remineralised is the true measure of the carbon store.

There are many effects and processes that can disrupt the storage of the carbon in sediments. These include direct physical particle movement and perturbation created by bedform migration and other significant forces on the water column, biological processes such as infaunal movement, and human activity such as bottom trawling (Diesing et al., 2017). It is the carbon stored long term in such sediments that is the focus of this research thesis. However, storage is only one of the two key aspects of potential BC systems, the other is the fixation, transportation, deposition and burial – the *flow* of carbon (Arístegui et al., 2005; Middelburg, 2019; Middelburg, Duarte, & Gattuso, 2005). In the context of carbon away from the coast, the flow mostly occurs via processes conceived of as "pumps", involving the four carbon pools described above: the *biological pump*, the *solubility pump* and the *carbonate pump*. However, from what scientific evidence exists, the carbonate pump seems to releases more carbon into the atmosphere than it sequesters in sediments and the solubility pump is a complex global system for which the scientific community is unclear about the relationship between the component carbon pools within the pump and sediment storage (Atwood et al., 2020; Howard et al., 2017). As such, the focus of this research thesis will lie with the biological pump, although the other two are described as they form a part of the overall understanding of offshore carbon.

3.3.2 The Biological Pump

The biological pump is the name given to the series of biological processes that transport carbon from the atmosphere to seabed sediments (Volk & Hoffert, 1985). It acts as a natural conveyor beginning with the utilisation of dissolved atmospheric carbon (CO_2) at the sea surface in the biological production of POC that then descends to the seabed. The biological pump therefore transports carbon from the atmosphere and facilitates its storage within marine sediments. Phytoplankton at the sea surface utilise the carbon from dissolved atmospheric CO_2 (DIC) alongside other elements in the water column – nitrogen, phosphorous, and other trace elements – to photosynthesise new organic cells (proteins,

lipids and carbohydrates) (Fogg, 1991; Sigman & Hain, 2012). This phytoplanktonic uptake of carbon is the fixation stage and it is this part that moves the carbon from outside to inside the pump, from inorganic to organic. The phytoplankton form the basis of the marine trophic pyramid and are consumed by marine grazers (zooplankton) which in turn are consumed by small fauna which in turn are consumed up the pyramid ending with the megafauna and top predators (Honjo et al., 2008). At each stage of the trophic pyramid the carbon of the prey animal is converted into the body of the consuming animal, excreted as waste or lost as general organic detritus. This process, from primary phytoplankton production up the trophic pyramid, describes the production of POC in its various forms, from the carbon within a bacterium to that within the body of a blue whale.

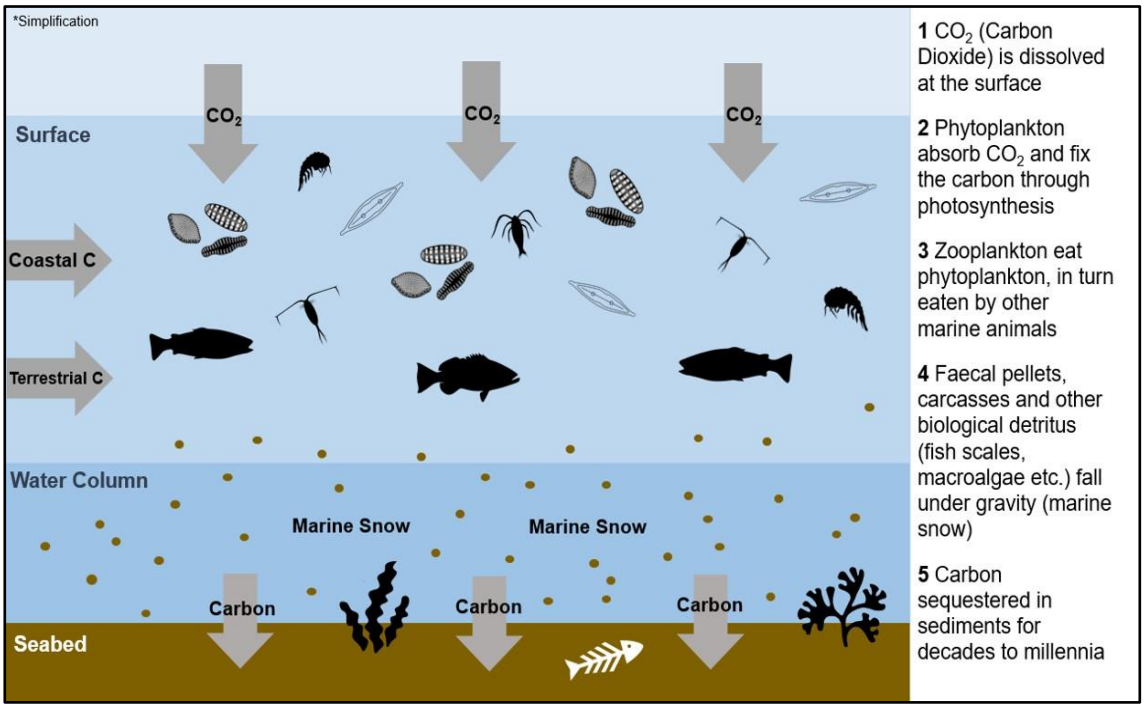


Figure 3.3 *The Biological Pump*

Other contributions to the POC pool include: organic detritus from terrestrial areas transported to the marine zone primarily by rivers, up to as much as one third of the carbon that is eventually buried in marine sediments on sea-shelf margins originates from terrestrial sources (Cartapanis et al., 2018); other sources of marine primary production, namely macroalgae that can dislodge, transport and break down into POC (McLeod et al., 2011); and the DOC pool also contributes via heterotrophy (the consumption of DOC by plankton) with some POC becoming DOC through simply disaggregating or exudation (the secretion of excess production by phytoplankton cells) (Thornton, 2014). POC eventually descends to the seabed either as dead cells, carcasses, excreted waste or general detritus

(e.g., loose fish scales), that collectively form aggregates of ubiquitous organic material named “marine snow” (Suzuki & Kato, 1953). Marine snow, and the carbon it contains, blankets the seabed of the deep ocean and shallow shelf seas, with a portion buried deep enough within the sediments to be considered stored for the long term at a net exchange rate of carbon from water to sediment of approximately 0.2 gigatons per year globally (Siegenthaler & Sarmiento, 1993). The biological pump is depicted pictorially in Figure 3.3.

3.3.3 The Solubility Pump

The solubility pump provides a similar function as the biological pump – it acts to transport carbon from the atmosphere into the ocean’s interior – through the production of DIC and the processes of oceanic thermohaline circulation (Raven & Falkowski, 1999). CO_2 is soluble in water and at the sea-surface to atmosphere interface CO_2 reacts with saltwater to form three compounds: carbonate, bicarbonate, and carbonic acid with some becoming aqueous carbon dioxide (Emerson & Hedges, 2008). These four compounds together form the DIC pool. The thermohaline circulatory system is the slow ocean-wide conveyor that circulates global ocean waters from the surface to the deep-sea and back (Raven & Falkowski, 1999). Sea water cools at different parts of the circulation (at the colder latitudes such as the Southern Ocean and the North Atlantic) causing the water to become more saline which makes it denser and heavier. The heavier, denser water sinks at these key places in the thermohaline system, with less dense water moving in to fill the space left behind (this is the movement that powers the system). This process transports surface water to depth which is drawn back up again at different points in the circulation system. Crucially, CO_2 dissolves in salt water at a higher rate in the colder conditions therefore allowing the thermohaline system to act as a pump that draws dissolved atmospheric CO_2 in the colder climates to lower depths, in turn transporting the DIC around the deep ocean via the conveyor effect of the system. As a result, the cooler, denser waters of the deep contain the majority of the global marine DIC, which itself constitutes the largest pool of “mobile/active” carbon (i.e., not stored away long term in sediments or the Earth’s crust) on the Earth’s surface at approximately 38,000 gigatons (Friedlingstein et al., 2019).

3.3.4 The Carbonate Pump

The PIC pool in the global oceans is the carbon found in biogenic calcium carbonate ($CaCO_3$) structures – the protective shells of certain phytoplankton and shellfish species

produced through fixing some of the dissolved carbonate within the DIC pool (Holligan & Robertson, 1996). PIC also forms a pump – the carbonate pump – that, due to the chemical nature of $CaCO_3$ and the overall alkaline nature of seawater, releases more carbon back into the atmosphere than it draws down, thereby acting against the net draw down of atmospheric carbon by the other two previously mentioned pumps (Holligan & Robertson, 1996).

The overall outcome of all carbon pumps, however, is a net exchange of carbon from the atmosphere to ocean of approximately 2.5 gigatons of carbon per year, an exchange that was historically the reverse but switched at the beginning of the industrial revolution as a result of the increase of anthropogenic carbon in the atmosphere (Friedlingstein et al., 2019; Siegenthaler Be & Sarmiento, 1993).

3.3.5 Offshore Carbon – Distribution

Much is still unknown as to the distribution of OC carbon stock across the global seabed, and stocks specific to individual Exclusive Economic Zones (EEZs) (Graves et al., 2022). The best estimates to date (Atwood et al., 2020; Diesing et al., 2017; Legge et al., 2020; Smeaton et al., 2021) suggest the following:

UK EEZ: (upper 10cms of the seabed)

Stock: 80 – 110 Million tonnes (POC)

Burial Rate: 11 Million tonnes CO_2 / yr

Northwest European Shelf: (upper 10cm)

Stock: 60 – 190 Million Tonnes

Burial Rate: 0 – 265 Million tonnes CO_2 / yr

Global Shelf (to 1m, excluding deep seabed):

Stock: 266,000 Million tonnes

3.4 Offshore Carbon as Blue Carbon

The processes described above – the carbon pumps – and the different pools of carbon in the offshore environment – DOC, POC, DIC, PIC – all contribute, in varying extents, to the net transportation of carbon from the atmosphere to long term storage in marine sediments. This entire global-marine system therefore represents a natural carbon sequestration and storage system. However, the focus of this thesis is the production and transport of POC via the biological pump rather than the other pools and pumps. The reasons for this are as follows (following Atwood et al., 2020; Howard et al., 2017; Legge et al., 2020):

- The extent of scientific knowledge on POC is further ahead than the other pools with relatively more known about POC-to-sediment storage, there is also strong evidence that significant POC stores exist. In contrast, there are still major gaps in scientific knowledge regarding, for instance, the manner DIC interacts with the seabed and contributes to carbon storage.
- POC, as undissolved matter, (eventually) blankets the seabed instead of being suspended in the water column, meaning the carbon (POC) within marine snow comes into direct contact and interaction with the benthic sediments. It is difficult to measure the extent to which the other pools do the same (Atwood et al., 2020).
- The solubility pump is a complex global system which makes it difficult to conceptualise as a sequestration system for the purposes of management (the underlying purpose of BC). Additionally, there are still gaps in our understanding of the way the pump interacts with sediments and centres on DIC, unlike POC which is linked to the biological pump.

As such, the relative contribution and nature of the biological pump/POC system allows such a system to be considered for status as a BC ecosystem within the definition of BC discussed above. This would allow the considerable storage and sequestration services provided by certain marine environments to be brought under policies of management to help mitigate global GHG emissions. For brevity, I name this system – POC/biological pump and sediment storage in shallow shelf seas – Offshore Carbon (OC). At the time of first writing this chapter – early 2020 – the research community had yet to decide on a name for the system I have described here. As such, I settled on the term *Offshore* Carbon to emphasise moving the focus away from the coast to the carbon out at sea. However, since then, a consensus in the literature appears to be settling on the term "sedimentary carbon"

to refer to a similarly conceived system (Graves et al., 2022; Howard et al., 2023). If this has been apparent in 2020, I would have considered referring to OC throughout the thesis as *sedimentary carbon* instead. This uncertainty on the name of the subject natural resource is proof of just how dynamic a research topic this is, developing and expanding rapidly even throughout the typical duration of a PhD project. The following section matches the OC conception against the six criteria for BC definition outlined in Section 3.2.

Criterion 1. (that the system sequesters levels of CO_2 significantly high enough to affect climate) is met by the POC system, as proven when compared to conventional BC storage. A localised example of this can be found in the UK where the carbon stock for the country's salt marshes is buried at an estimated rate of 37,000 t/yr (tons per year) but the rate is 109,000 t/yr for the sediments of the UK's section of the North West European shelf sea, which is primarily supplied via POC sequestration (Luisetti et al., 2019). It follows therefore that if the salt marshes of the UK are thought to meet criterion 1 then shallow shelf sea sediments certainly do so as well, in fact, the much higher level suggests that it is imperative that it be brought under similar management for similar purposes (notably, the burial rate for salt marshes is much higher than sea sediments *per square meter*, but salt marshes cover a much smaller area thereby sequester less in total over the course of a year).

Criterion 2. The previous points to prove criterion 1 in turn prove criterion 2 (that the carbon stocks be reasonably quantifiable and measurable), at least for the carbon storage in shallow shelf sea sediments. It is, however, much harder in the offshore environment than on the coast due to the inaccessibility of the underwater environment with a higher attendant financial cost, and the type of expertise required. It is much more difficult to measure deep-sea sediments due to practical difficulties with depth and the sheer scale of the global deep-sea floor, further complicated by potential problems of generalising any measurements.

More recently, alongside a greater emphasis on an ecosystem's amenability to management, the definition of BC more strictly includes the ability to prove that the given ecosystem is able to store fixed CO_2 *over the long term* (Howard et al., 2023; Lovelock & Duarte, 2019). This can be read as the standards for BC designation becoming more refined as the topic develops and begins to move from theoretical idea to practical application. OC is able to prove long term storage of fixed CO_2 via the application of standard methods of seabed sediment sampling and monitoring as highlighted in reference to the distribution data in Section 3.3.5 (Legge et al., 2020).

Criterion 3. (that there be significant human influence on ecosystem's ability to store carbon) is not as obvious as with conventional BC. However, an OC system can be significantly affected by human activity. The dominant effect, as with conventional BC, is various forms of destruction of the ecosystem as a result of human economic activity. In the case of seabed sediments, bottom trawling fishing fleets act to resuspend sediment and disrupt relevant processes (Oberle et al., 2016). This is especially problematic in shallow shelf seas as these seas are the most abundant in harvestable fish stocks with areas rich in POC deposits being the most productive and therefore the most heavily fished (Norse et al., 2012). Such disruption of the seabed releases carbon back into the water column, although it remains unclear how much of this released carbon is eventually respired back into the atmosphere (Epstein et al., 2021; Howard et al., 2023).

The OC flow system can also be affected. A significant amount of the POC in shallow shelf sea margins originate from terrestrial sources via rivers (estimated at up to a third of such POC stocks (Cartapanis et al., 2018)) that are influenced by human activity e.g., agricultural runoff, sewage, construction etc. It is conceivable that a range of different types of human activity on the coastal and marine zone could have a direct effect on POC levels in shelf sea sediments. For example, coastal development and economic activities can have a detrimental effect on levels of macroalgae production, a famous example is the destruction of eastern pacific kelp forests brought about by a series of processes that began with the hunting of sea otters for fur (the otters consume high levels of a sea urchin that in turn consume the holdfasts that attach the kelp to rocks, lower levels of otter led to higher levels or urchin and the subsequent felling of large areas of kelp) (Jessup et al., 2004). If human activity leads to less macroalgae (as can be imagined by other processes such as coastal construction and marine transport) then it leads to a subsequent depletion in levels of POC. It should be noted that this criterion is much easier to apply to an OC system that stores carbon in shallow shelf seas rather than the deep-sea. The deep-sea is not affected by human activity to nearly the same degree due to distance away from human settlement and the lack of disruption to the deep seabed by fishing, drilling etc.

Criterion 4. (the ecosystem must be amenable to management), is much harder to achieve for an OC system when compared to conventional BC. In the marine environment, water acts as a transport medium, and the resource system – the large ecosystem that contains the "biological pump" – is vast, complex and often crosses multiple jurisdictions. In contrast, the conventional BC ecosystems, although found in highly dynamic coastal zones, are relatively stationary with sedimentation occurring directly under the sequestering system (directly under the plants that fix the carbon from the atmosphere). Conventional BC

ecosystems therefore can be interpreted as “contained systems” in that the sequestration and storage is localised. This makes conventional BC relatively easy to institutionalise and manage and can be done in very similar ways that jurisdictions manage land. Marine resources, however, are very different due to the sheer scale and the manner in which such resources cross into other jurisdictions without clear boundaries as to which jurisdiction contributes and benefits from the wide-ranging system. Despite this, other mobile marine resources have been brought under feasible management, to various levels of success, with the prime example of fish stocks, and indeed, the management of marine pollution. Therefore, it follows that a similar form of management may be feasible for OC. It is worth stating that this criterion is far more applicable to shelf sea sediments rather than deep-sea sediments. Shelf seas are already institutionalised within the EEZs of the world’s coastal nations. The deep-sea often lies outside of national jurisdiction and is only institutionalised by some international treaties, such as UNCLOS – the United Nations Convention on the Law of the Seas – which states little about the management of marine seabed resources external to an EEZ, with some regulations relating to seabed mining (Töpfer et al., 2014).

Criterion 5. (BC programmes should do no harm to society and environment) is a relatively contentious criterion at the best of times as it requires the often subjective judgement as to what constitutes harm and opens up questions when certain goods conflict (e.g., economic good of a shrimp farm vs the environmental good of conserving a mangrove forest). The main potential conflict that can be anticipated in the management of offshore carbon, especially in highly productive shallow seas, lies in the economic and social fallout from the limiting of fishing activity, alongside other potential conflicts e.g., oil and gas drilling and exploration, marine energy infrastructure etc. Positive externalities can also be anticipated such as a potential increase in fish stocks by allowing no-go areas of high production, allowing fish space and time to grow and breed, alongside the global benefit attributed to managing carbon stores and lowering levels of GHGs. The economic, social and environmental effects of a potential OC programme would ultimately need to be explored but can be seen as analogous to the effects already considered in regards to marine conservation (Tisdell, 2005), as well as similar to those already faced in conventional BC ecosystems.

Criterion 6. (amalgamation into existing global and regional programmes of carbon management) is not only feasible within a hypothetical OC system, it is a necessity. As previously stated, the nature of the system as international, crossing multiple jurisdictions and involving many different groups, means any such OC programme would have to start from an initial international management context. As for existing agreements, such as the

UNFCCC programmes, integration could be challenging due to the already mentioned differences between terrestrial and marine resources:

> "*One particular challenge facing potential BCEs* [Blue Carbon Ecosystems] *in open-water is the lack of an appropriate policy context. Policies developed under the UNFCCC under recent decades are focused on stable and spatially fixed carbon pools, and clear ownership of the resource. Trying to integrate open-water potential BCEs into these policies will likely be challenging"* (Crooks et al., 2018, p. 5)

Saying that something is challenging is not the same as saying it is not feasible. Because the conception of OC as a natural resource is novel there are questions that need to be explored and discussed, and this thesis is an attempt to do so. However, again, analogous marine resources, such as fish, are also managed internationally with international treaties and programmes (e.g., the European Union's Common Fisheries Policy), providing examples of how a potential OC programme could be constructed and implemented within existing and new forms of international institutions, policies and agreements. The above points on how OC meets the definition of BC are summarised in Table 3.1.

Table 3.1 *A summary of how OC, so defined, meets the criteria for BC definition, following(Crooks et al., 2018)*

Criterion	**How the criterion applies to offshore carbon**
1 - that the system sequesters levels of CO_2 significantly high enough to affect climate	Shallow shelf sea sediments, although not as dense in carbon as conventional BC, hold large quantities of carbon spread across a much greater area. This is Illustrated by a localised comparison: the UK's salt marshes bury carbon at an estimated rate of 37,000 t/yr (tons per year) but the rate stands at 109,000 t/yr for the sediments of the UK's section of the North West European shallow shelf sea, which is primarily supplied via POC sequestration (Luisetti et al., 2019). It follows therefore that if the salt marshes of the UK are thought to meet criterion 1 then shallow shelf sea sediments certainly do so as well.
2 - that the carbon stocks be reasonably quantifiable and measurable	This criterion is proven by the likes of the above example, measurements may be more impractical to collect but similar methods can be employed. This demonstrates that long term storage of fixed CO_2 can be proven for OC, using established methods.
3 - that there be significant human influence on	Sediment storage is affected by human action, primarily bottom trawling but also oil and gas drilling and marine infrastructure/construction. These disruptions disturb the stored carbon back into the water column and, partially, back to the

ecosystem's ability to store carbon	atmosphere. It is conceivable that a range of different types of human activity on the coastal and marine zone could have a direct effect on POC levels (processes of flow) in shelf seas, including such things as agricultural runoff, construction, sewage, fishing etc.
4 - that management must be feasible	Harder to achieve in the offshore zone due to the scale and manner in which water acts as a transport medium. Contrast with conventional BC which is terrestrial (on the coast, so already managed and institutionalised) and easier to contain and institutionalise. Marine resources can be highly mobile and can move throughout various jurisdictions which makes it more difficult. However, not impossible e.g., fish are a mobile marine resource often joint managed by various jurisdictions. Feasibility is something that requires further research.
5 – that the BC programmes should do no harm to society and environment	This criterion is highly subjective but offshore carbon faces largely the same problems as conventional BC – potential conflicts with economic interests. The main potential conflict, especially in highly productive shallow seas, lies in the economic and social fallout from the limiting of fishing activity, alongside other potential conflicts e.g., oil drilling and exploration, marine energy infrastructure, seabed mining etc. Positive externalities can also be anticipated such as a potential increase in fish stocks resulting from no-go areas for BC sediment preservation.
6 - amalgamation into existing global and regional programmes of carbon management	Not just applicable to offshore carbon but a necessary component due to the internationally shared nature of offshore carbon systems.

Following the above discussion of OC against the criteria for BC definition, it is the case that an OC system, and the subsequent storage of carbon in shelf sea sediments, does meet the criteria for BC definition. However, this is tentative and dependent on answering key questions, such as: what form would such an OC programme of management take? What subsequent economic and social conflicts would arise? How would such a programme be constructed and implemented given its international nature? How would the difficult marine-based complexities (as opposed to terrestrial) be dealt with?

3.5 Summary

Over the last fifteen years or so, there has been a race to integrate natural coastal systems of carbon sequestration and storage into programmes of management and conservation for

the purpose of CC mitigation. The conceptualisation of these ecosystems as “blue carbon” has allowed for attempts to better manage their potential to store and sequester GHGs. As a result, there exists the impetus to extend the definition and purpose of the BC initiative to other forms of marine carbon sequestration and storage. Beyond the coast, the offshore environment contains four of the largest pools of carbon on the Earth’s surface – POC, DOC, PIC, DIC – that, facilitated by the biological and solubility pumps, are responsible for sequestering and storing significant amounts of carbon in seabed sediments as long-term carbon storage. In particular, the POC pool and the biological pump are the major drivers of this sequestration and storage most amenable to management. It is therefore possible, and potentially very beneficial, to bring sedimentary stocks and the POC/Biological-pump input that feeds them (OC) under the definition of BC. When checked against the six criteria for BC definition, it is clear the OC conception is correct and meets the definition of BC if attendant practical questions surrounding implementation in the difficult offshore zone can be answered.

Chapter 4 |

Common Pool Fisheries Governance in a Post-Brexit Europe: A Systematic Literature Review

4.1 Introduction

This chapter explores, in the form of a systematic literature review, the disruption caused to European fisheries by the United Kingdom's (UK) exit from the European Union (EU) and the EU-wide Common Fisheries Policy (CFP). This aspect of fisheries governance was examined to derive lessons surrounding the management of a blue common pool resource (CPR) and was used to inform the direction of travel for the proceeding research.

The rationale is that EU fisheries are, for the most part, highly mixed and transboundary meaning they are particularly common pool in nature, requiring a high degree of shared management and cooperation. European Seas also share an offshore carbon resource system that crosses multiple countries and jurisdictions, storing carbon within the shelf-sea sediments of the North Sea, Irish Sea etc., arguably available for potential distribution between the various international interests. Here there is a clear similarity with European fish resources. The UK's territorial waters contain a large proportion of the EU's fish stocks, so, it was hypothesised that as the country left the CFP, the literature that explored the presumed and subsequent disruption would contain valuable insights and knowledge regarding the management of a blue CPR generally that could perhaps be applied to offshore carbon specifically. Leaving the CFP and establishing a new system necessarily requires evaluation of the previous arrangement and an analysis of how best to move

forward with a new one. Such an evaluation, it was predicted, would contain valuable insights for potential shared-management agreements on offshore carbon.

The chapter begins by providing the background on international marine resource ownership, the European and UK fisheries systems, and the UK's exit from the EU (Section 4.2). This is followed by an explanation of the systematic review methodology (4.3), the findings (4.4), and a subsequent discussion focussing on how the findings relate to the governance of marine CPRs in a general sense (4.5). These data are then synthesised into six key principles for marine CPR governance in Section 4.6 and subsequently carried over into the next chapter to inform the subject of OC and the proceeding research. The chosen literature has a UK bias with most selected documents having been written by UK academics and researchers for primarily UK audiences. This is due to the English language component placed as part of the literature selection but also as a result of the fact that it is the UK that is leaving and setting up a new fisheries arrangement, naturally this has energised UK researchers more than researchers elsewhere.

Importantly, the material reviewed for this chapter spans from 2016, when the Brexit vote occurred, to Summer 2020, the point in time the review was conducted. This means the review was conducted while the UK was in the process of leaving the EU and negotiating a new fisheries settlement with European neighbours. At that point, there was still much uncertainty as to how the new fisheries system, and new fisheries relationships, would be conceived. The key findings from this review continue to be relevant to understanding common pool resource governance and are still pertinent in light of later developments, including the UK finalising a fisheries governance settlement after leaving the EU. The manner in which the new fisheries relationships and systems were settled was added as a 2023 update in Section 4.2.5.

4.2 Context

Here, necessary background for understanding the context of this systematic review is provided. I describe the historical foundations of the European and UK fisheries systems; the common fisheries policy; the UK's fisheries system; the UK's exit from the EU; the approach the UK Government took to the fisheries negotiations which were ongoing at the time the review was conducted; and the manner in which negotiations were finalised after the review was finished i.e., the fisheries settlement after the UK had left the EU.

4.2.1 Exclusive Economic Zones and Historical Enclosure

In 1962, with the purpose of developing fishing access and rights in the North Sea beyond *The North Sea Fishers Convention* of 1882, the UK invited various European neighbours to agree to a new set of rules governing North Sea fishing (Fisheries Convention, 1964). *The London Fisheries Convention* (1964) was a successful attempt to bring more of the free seas under the control of adjacent coastal states by declaring exclusive fishing rights for its fishers in a belt around its coastline measured at twelve nautical miles. However, part of the agreement included the compromise that foreign vessels could negotiate fishing rights if said foreign fishers could prove they had fished in the relevant waters within a 1953-62 reference period, with access granted only within the six to twelve nautical mile zone (Fisheries Convention, 1964). The impetus for the London Convention was the twin effects of a large increase in the world's population in the mid-twentieth century (creating larger and more globally connected markets for fish) alongside advances in fishing technology resulting in an increase in fishing effort with greater pressure on European fish stocks and more competition among fishermen. The consequence was a small but growing demand to enclose the fish stocks, an historically free and open resource, within a prism of rules, rights, and regulations. The London Convention was the first meaningful steps in this regard. It was followed by global negotiations throughout the 1970s, culminating in the *United Nations Convention on the Law of the Sea* (UNCLOS) in 1982. UNCLOS designates exclusive rights over the biological and mineral resources found within a (up to) two hundred nautical mile zone of sea adjacent to nation sates' coastlines, called the Exclusive Economic Zone (EEZ) (United Nations, 1982). This revolutionised global fishing in so much as it changed the manner in which governments, publics and actors in the fish economy conceived of the fish resource: as something that was no longer free and accessible to anyone with the means and impetus to catch it, but instead a national resource – a limited pool of available asset that required distribution among various competing interests. Importantly, under articles 62 of UNCLOS, nation states are obliged to offer access to any excess fish stock to neighbouring countries if the owning country does not have the capacity to fish that stock fully. In other words, the stocks, under international law, should be utilised to their full potential by allowing access to neighbouring fishing effort, especially if the neighbouring state(s) has historically fished said stock (United Nations, 1982).

4.2.2 The Common Fisheries Policy and UK Fishing

The Common Fisheries Policy (1970) is the overarching policy that governs all fishing sectors across the European Union. The EU is responsible for setting European-wide regulations and distributing fishing opportunities, as well as negotiating with third parties on quota sharing of shared stocks (i.e., fish stocks in which the fish are known to migrate between various countries' EEZs) and access to foreign stocks (European Commission, 2020). For the purposes of fishing, the EU regards the EEZs of each member state as one complete EEZ. All fish stocks within this EEZ (including those that border with neighbouring countries) are distributed to the member states based on a system of *historical right*, also referred to as *relative stability*. Under relative stability, each member is allocated a fixed percentage share of the various different stocks based on historical fishing patterns. The period of 1973-79 was used as the reference period for the fixing of the percentage share allocated to each member state (European Commission, 2020). Much of the famous antipathy towards the CFP among UK fishermen stems from the belief that they, in retrospect, did not receive a fair allocation of the fixed percentage of stocks relative to how much of the stocks are caught and maintained in the UK section of the EU EEZ (Harte et al., 2019).

Each year, a total allowable catch (TAC) is calculated for each stock with the relative percentage of this quota given to each member state based on their fixed allocation (European Commission, 2018). (European Commission, 2018). Once each government has received its share of quota, it is then the decision of each member how it subsequently allocates the national share among its various fishing interests. Within the UK context, the four countries of the UK each have devolved responsibility over fishing and are each allocated a share of the national quota relative to the number of licenced vessels under that administration (Scottish Government, 2020b). Each administration then subsequently distributes the quota to fish Producers Organisations (POs), membership organisations that normally represent a certain type of fishing or a specific region. Once a PO has the quota, it then distributes it to its members based on the fixed quota allocation (FQA) system which acts along the same lines as relative stability – a fixed reference period between 1994-96 was chosen in which the catch record applied to each licence was recorded and fixed as a percentage share (Hatcher & Read, 2001). Vessels less than ten feet in length are managed directly by the relevant administration (e.g., the Scottish Government) and are allocated fishing rights separately to the FQA system (typically monthly catch limits enforced through the management of licenses) (Scottish Government, 2020a).

4.2.3 Brexit: The UK's Exit from the European Union

In 2016, the UK held a referendum on continued membership of the EU resulting in a 52% majority in favour of leaving, an outcome popularly known as 'Brexit' (Electoral Commission, 2016). Since then, the UK government has been involved in a highly politicised and frenetic process of leaving the trading bloc in which the country has wrapped many of its legal process and institutions, not least the entire fishing industry under the CFP. The UK fishing sector has been one of the most ardently anti-EU with stories of fishing industry dissatisfaction widespread in the media (M. Gray, 1998; Spiering, 2004). This is due to an almost ubiquitous disappointment with the CFP among much of the catch side of the sector: a University of Aberdeen report conducted in the lead up to the vote found 92% of 114 vessel-owning fishermen were of the position that leaving the EU would be better for their businesses (McAngus, 2018). The flipside is widespread apprehension in the fish processing (onshore) component of the sector that would, alongside aquaculture, be largely disadvantaged by the introduction of trade tariffs and cumbersome bureaucracy, as most seafood processed in the UK is exported to the EU (Garrett, 2016). The same report found that the main source of grievance among fishermen was the requirement that fishing rights be pooled with the rest of the EU and access be non-negotiable (as mentioned above, this has its roots in the perception that the UK does not have a fair share of the total EU stocks relative to the importance of UK waters within the collective EU EEZ).

In June 2020, when the review was undertaken, the UK and EU governments were in the final round of negotiations on trade and shared resources, such as fish, with a current stalemate on fishing negotiations. This was due to the adoption of maximalist positions in which both sides were seeking completely opposite outcomes with no offers of compromise (Boffey, 2020). The desired outcome of the EU was the status quo with the UK looking to renegotiate almost every aspect of shared fishing rights and access. The primary change most UK fishers wanted to see was the introduction of *zonal attachment* for shared stocks with the EU, which is the method currently used to negotiate shared stocks between Norway and the EU (B.D Stewart & O'Leary, 2017). Zonal attachment works by calculating the approximate time a stock, at an agreed age (normally at the "fishable" stage i.e., not juvenile), spends in the various EEZs over a year, with a subsequent allocation based on this time frame (Hannesson, 2013). It is popular with UK fishers as they perceive it to be the best way to apply a "fair" share to UK fishers based on the prevalence of stocks in UK waters.

An additional conflict that raised its head at the time of writing was internal to the UK. The EU held policy competency over 153 areas that would be considered under the competency of the devolved UK administrations (The Scottish and Welsh Governments, and the Northern Irish Assembly) once returned to the UK (e.g., farming and fishing). Of the 153 competencies, the UK government stated its intention to retain 24 of them, including fisheries management (The Blue Marine Foundation, 2018). A 2012 concordant allocated competency for fishing to the devolved administrations, with English fishing administered by the UK government. This set the scene for a conflict between the devolved administrations and the UK government, with the politically opposed Scottish government particularly aggrieved by the idea of not obtaining full fisheries competence as Scotland is home to the bulk of the UK fishing industry in terms of both landings and money value (McAngus et al., 2019).

4.2.4 UK Government Intentions During Negotiations 2016-2020

Between the 2016 vote affirming the UK's exit from the EU, and the initial completion of this systematic review chapter, the UK government published documents that laid out its intentions for negotiating fishing as it left the EU. This section provides a summary of the key points that were found in the relevant literature published by the government at the time: The 'Sustainable Fisheries for Future Generations' white paper (DEFRA, 2018), the Fisheries Bill 2017-2019 (Ares, 2019b), and a briefing report, 'Fisheries and Brexit' (Ares, 2019a).

- The UK will leave the common fisheries policy and become an "independent coastal state". As part of this, it will leave both the CFP and the London Convention.
- The UK will continue to abide by the United Nations Convention on the Law of the Sea (UNCLOS) and aims to fully follow the obligations regarding the sharing of surplus stock and other commitments laid out in the convention.
- New powers over the distribution of fishing opportunities and the exclusion of vessels from UK waters have been outlined in the Fisheries Bill.

- In the case of a "no deal Brexit"[4], EU vessels would be immediately excluded from UK waters and vice versa. The UK will be forced to enforce its maritime borders and negotiate yearly deals on shared stocks.
- The white paper states that the UK position on fishing will be founded on sustainability, based on a principle of maximum sustainable yield.
- The UK is to maintain the quota system as it is for existing quota but will research alternative ways to manage new fishing opportunities obtained upon leaving the CFP, with the intention of replacing the FQA system with one described as fairer and more scientific.
- Future fishing opportunities should be based on a principle of zonal attachment.

4.2.5 Finalised UK Government Position 2020-2023

Following completion of this systematic review in 2020, the UK left the European Union and settled on a new agreement for fisheries via the *Trade and Cooperation Act* (TCA) bill in late 2020, which came into force in early 2021 (European Commission, 2021). Although now fully independent of the EU, with separate agreements with other neighbouring coastal states, the UK has retained most EU laws and regulations regarding fisheries as a result of the EU Withdrawal Act 2018 (Stewart et al., 2022). Although capacity now exists to deviate from these rules, they have yet to be acted upon by the UK Government. Even if a UK Government wished to deviate drastically, the TCA bill states that it must be done in cooperation with the EU, not unilaterally, due to the interconnectedness of the fish resource. Additionally, the quota allocations are established by the TCA bill, meaning they are fixed and not negotiated yearly, contrasting with the rhetoric of a no deal Brexit (they will come under review in 2026). As a result, the UK has secured increases in quota share when compared to pre-Brexit levels: this was in 63 of the 105 stocks under negotiation, representing a 135,000 tonne increase in potential landings, further representing an approximate £124 million annually of projected actual landings (Stewart et al., 2022). However, this increase was mostly concentrated in just three species: Western mackerel, North Sea herring, and North Sea sole. Leading to concerns that the changes have favoured very specific fisheries at the expense of others that rely on quick access to the EU market, such as the bivalve (mussels, oysters, scallops etc.) fisheries. The UK now has full control of access to its waters within the overarching rules set out by UNCLOS. There is an agreed

[4] "No deal Brexit": the phrase that was popularly given to the notion that the UK would exit from the EU without an agreed settlement between the two parties as the result of political failure to reach agreement.

transition period built into the TCA to 2026 during which access to foreign vessels is commensurate with the level of UK-Waters quota held by that foreign state.

4.3 Methodology

A systematic literature review was conducted to discover in which ways the common pool resource aspect of fisheries governance had been addressed by the literature, directly or indirectly, since the UK voted to leave the European Union. The review followed the standard systematic review method (Booth et al., 2012; Collaboration for Environmental Evidence, 2013; Jesson et al., 2011; Ridley, 2008), beginning with the following review question:

Review Question: *How is the common pool nature of European fisheries being addressed in the context of the UK's ongoing exit from the European Union?*

The search databases used were: *Scopus, Web of Science, Google Scholar, Science Direct, ProQuest*, and various government websites such as the UK government website. The search was conducted in April 2020 with some later searches conducted in late May 2020 (the result of these searches and the process of search are outlined in more detail in Appendix 1). The databases were chosen as a result of their dominance as the major search engines for the more general topics that the review considers, these include: fisheries science, marine governance, political ecology, law, geography, anthropology, economics etc. In contrast to, say, medical science in which case medical science specific databases, such as *Pubmed* and *MEDLINE,* would be more appropriate. The key search terms were 'Brexit', 'fisheries' (including 'fish' and 'fishing'), 'common pool resource', 'marine governance', and 'common fisheries policy'. Additionally, governmental websites (gov.uk, gov.scot. gov.wales, openAIRE and Europa) were included to discover relevant grey literature. After a systematic search of these scholarly databases, forty eight documents (peer reviewed journals, government reports etc.) were identified as meeting the remit for further consideration under the exclusion/inclusion criteria set out below.

The inclusion/exclusion criteria state that the document:

- should be published in English or have an English language abstract available.
- should address European fisheries.
- should address the UK's exit from the European Union i.e., "Brexit".
- say something about the common pool nature of the fish resource.

The first three criteria are relatively easy to assess from title and abstract which is why the initial number of documents to be assessed under exclusion/inclusion was only forty eight. The search terms delivered a high number of hits on each database, but it was, for the most part, clear whether a document met the initial criteria. For example, whether a document referred to "Brexit" in a meaningful way was always stated in the abstract, and in most cases the title, no document was found that referred to "Brexit" in an indirect way or in a way deemed not explicit. However, once assessed by all these criteria, of the forty eight documents which met the first three criteria, thirty seven documents remained in the final overall collection. For a break-down of the search process, see Figure 4.1.

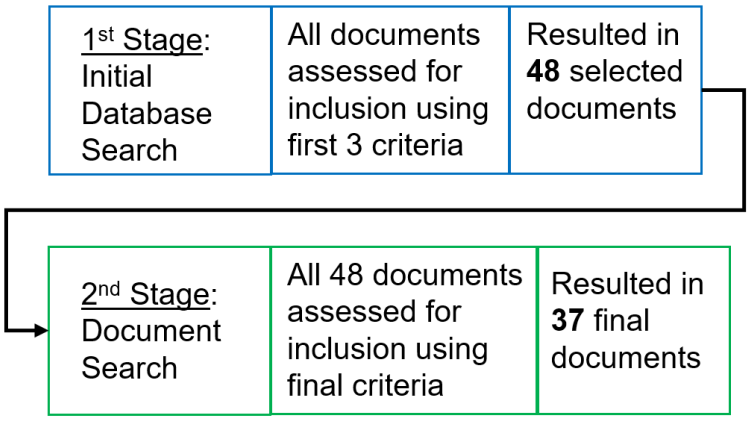


Figure 4.1 *Document Search Process*

As such, most documents that were excluded from the selected forty eight, as part of the exclusion/inclusion process, did not meet the last criterion on the list which required a closer reading to assess, accounting for most of the eleven excluded documents. Whether a document touched on the common pool nature of the resource was quite often not explicit. In contrast to "Brexit" or fisheries, the common pool nature could be discussed within a document without key words such as "commons" or "common pool" being used. Some authors may not have been aware they were even discussing something that could be deemed a commons issue. This is the justification for the ambiguous phrasing "say something" in the last criterion: the criterion required a subjective judgement by myself to assess whether a given document (a) addressed the common pool nature of fish in the first place, and subsequently (b) to such a degree it could be deemed relevant to the purposes of the study relative to the review question.

The thirty seven final documents were then sorted according to the categories of 'author(s)', 'title', 'publication', 'grey literature' etc. For a table of the selected documents, please see Table A.1 in Appendix 1. As the "Brexit" vote was confirmed in 2016, all the chosen documents were published between 2016 and 2020 with the database searches limited to these years. 22 of the documents were peer-reviewed articles with fifteen considered grey literature (mostly parliamentary and policy reports, alongside five 'academic blogs' – online briefs on subjects not published in a journal). The analysis of the selected literature was conducted qualitatively as no quantitative method was deemed appropriate given the wide and qualitative scope of the review question. This was conducted using a thematic analysis by reading the documents to initially ascertain the major themes (talking points addressed by the authors) and categorising key points from each document into each of these main themes. The main themes form the subheadings found in the findings section (4.4), these are: Access, Fishing Rights, and Devolution - Internal Governance of the UK. There were two more initial themes – *One More at the Table* and *Stakeholder Opinion* – but these were subsumed into the other three themes for reasons explained in Section 4.4. Thematic Analysis is used throughout this thesis, I have placed an explanation of what it is and how I have used it throughout the thesis in the methods chapter – Chapter 6, please see Section 6.5 for more details.

4.4 Findings

Following the qualitative analysis of the selected thirty seven documents, three main themes were apparent. Firstly, the theme of *Access* i.e., the issues and debates surrounding the extent and manner the UK will allow other countries to fish in its newly defined waters, and vice versa. This first theme includes an initially separate theme which was deemed to be heavily related and so was incorporated into *Access*, the theme was *One More at the Table* i.e., points made in the literature deriving from the inclusion of an extra party at an already complex table of parties. The selected literature mentions, on a number of occasions, that certain problems arise because the UK is adding one more actor around a table of actors (the EU member states) who must negotiate between themselves. It became clear as analysis of the texts progressed that this theme was simply a subtheme of *Access*, with the main issues and talking points stemming from underlying access issues. Secondly, *Fishing Opportunities*, concerning the discussions, widespread in the literature, on the historical nature of European fishing rights and the different ways the UK is conceiving new fishing opportunities going forward. As with Access, this theme includes the originally

distinct theme of *Stakeholder Opinion* which centred on the literature that reviewed opinion of fisheries actors across Europe. However, upon review, it was clear that all the relevant points were discussing fishing opportunities and should therefore be subsumed into the *Fishing Opportunities* theme. *Devolution – Internal Governance of the UK*, forms the last theme. This theme centres on the sizeable section of the literature that addressed the problems associated with setting up a new fisheries settlement within the UK and the associated internal politics and governance problems that arise from this.

4.4.1 Access

The nature of the resource and the geography in question, the marine environment, necessitates that, upon leaving the EU, the UK arrange new cross-boundary agreements and subsequent institutions and regulation to work with its neighbours on transboundary issues (Boyes & Elliott, 2016). With a new Europe-wide allocation of TAC, access will then have to be negotiated with EU boats requesting access to the UK allocation of stocks and vice versa. This process is key to the future success and sustainability of European fishing as disagreement will negatively affect the collaboration required to manage such a resource (Phillipson & Symes, 2018). This has been conceived of as a choice between a "good neighbour" and "bad neighbour" approach: "good" is conciliatory and willing to negotiate substantial access while "bad" is declaring a unilateral TAC without agreement from the other parties, described as "bad" because this will inevitably lead to a tragedy of the commons and the unsustainable exploitation of the resource (Phillipson & Symes, 2018). A particular concern was raised concerning the mackerel fishery – already substantially shared with the Faroe Islands, Iceland and Norway – which has seen overfishing in recent years due to a lack of agreement on TAC distribution (Toumasatos & Steinshamn, 2018). A survey of fisher opinion in Scotland discovered that key Scottish stakeholders do not wish to see fishing rights taken from fellow fishers in Europe, rather, they expressed a desire to obtain more of the fishing rights over time (ten to fifteen years) while strengthening the country's negotiating position in the present (Forse et al., 2019).

Across the literature, authors were keen to point out that even though the UK will leave the CFP, the CFP itself is based on a foundation of international law that the UK will still be obliged to follow. In particular was the point that UNCLOS obliges the UK to allow neighbours access to "surplus" fish, especially if they have an historical connection (Appleby & Harrison, 2017; Cass, 2019; Ntona, 2016; Syreloglou et al., 2017). As the UK does not have enough fishing capacity to fish its relative share, there will be a surplus stock

that will need to be negotiated away to neighbouring countries. Other authors were keen to stress that "Brexit" will require the UK to declare a truly independent UK EEZ for the first time in its history as the UK's EEZ to date has, for the purposes of fishing at least, been part of the EU-wide EEZ. The point being that the UK will not revert back to a previous regime but instead be creating an entirely new one from scratch (Appleby & Harrison, 2017; Gallic et al., 2018).

The EU's position on access has been to attempt to keep things as close to the status quo as possible to ensure reciprocity and minimal legal disagreement (Sobrino Heredia, 2017). However, there are those across Europe who see the disruption brought about by Brexit and the loss of a substantial amount of the EU common stock as an opportunity to reform the CFP at a deeper level, including possible reform of the relative stability policy and the subsequent historical distribution of TAC (Sobrino Heredia, 2017; Stewart et al., 2019). Although it would be opposed by those member states that currently win more from this system than they would lose after a possible redistribution (e.g., Ireland), the disruption nevertheless opens a window to change an aspect of the CFP that is not easily changed under normal circumstances (Sobrino Heredia & Oanta, 2019). This is further stipulated by Harte et al. (2019) who argue that the UK's exit will weaken the EU's negotiating hand with all third parties as the result of a smaller asset pool, further stating that this could bring into question the CFP itself.

Much of the literature reviewed commented on the specific problems of having one more party around the shared pool of fisheries resources who could potentially deviate away from, or add extra complication to, managing the shared pool (Ntona, 2016). This has the potential of leading to de-harmonization between parties, or at least lowering the chances of success with Phillipson & Symes (2018) stating (regarding the UK and the EU):

> *"Reenergising the momentum towards a genuine regional/sea basin approach to marine management will be by far the greatest test, with the need for such collaboration amplified by the presence of two jurisdictions sharing the same stocks if not quite the same space"* (p.173).

The major concern here is on sustainability and a race to the bottom on setting a new TAC – the various parties must agree on a TAC, a sharing key for that TAC (such as zonal attachment or something similar to the UK's FQA system) and a shared management regime (Bartelings & Smeets Kristkova, 2018; Billiet, 2019; B.D Stewart & O'Leary, 2017).

In Ohms & Raakjær's (2019) scenarios analysis, a scenario entitled 'Fish Wars' – "Former friends turn into foes engaging in a merciless competition" (p.5) – builds on the "bad neighbour" idea, making the point that the rhetoric of the leave campaign on "Brexit" adopted the tone of "zero sum" and competition, indicating a propensity towards hard negotiation. Their conclusion is the intuitive one: the "harder" the negotiation, the less likely a sustainable outcome. Another aspect of this is the threat that TACs are set too high in order to keep parties at the negotiating table i.e., that to prevent negotiations breaking down in the first place, unsustainable TACs will be agreed for fear of the threat of unilateral TAC setting itself. Sustainability is therefore threatened from parties walking away from the table as well as from keeping them there through the setting of TACs that are too high (Carpenter, 2017).

A game theory assessment concluded the benefits of continued collaboration: by testing games in Mackerel fishing in which one set treats the UK and EU as one player and another which treated them as separate, the authors concluded that collaboration (agreement of joint TAC) led to higher stock levels: *"However, in order for cooperation to be achieved, the free-riding payoffs of the cooperating nations must not exceed their aggregate coalitional payoff"* (Toumasatos & Steinshamn, 2018, p.41). Put simply, this is the intuitive conclusion that the benefits to neighbouring countries from free riding on sustainable management practices of other countries must not exceed the benefits of engaging in those practices themselves.

Brexit disruption has led to questioning the manner in which fishing rights are enforced, with the criticism that the setting of a TAC leads fishermen to rush to fish what has been delegated available, leading to a trend of overfishing:

> "*The tragedy of the commons is inherent and that the damage caused by the transgressors is dispersed across all sharing the resource. Compensation does not remedy the situation because it quantifies the damage done in terms of loss of revenue for the Member States' fishing industries, whereas the damage done to the fish-stock cannot be redressed through compensation*." (Cass, 2019, p.134).

Additionally, leaving the EU can be construed as a general loss of power because, in a shared (common pool) system, removing oneself from the shared table equates to a loss of power as one limits one's influence over others who have influence over the resource (Carpenter, 2017). Carpenter states that this can only be countered by making sure that, as a brand-new party at the table, the UK be very engaged and aim to maximise engagement to make up for this loss following the "good neighbour" approach. This should be achieved through the UK dropping any combative language, agreeing to fixed shares to prevent

setting distinct unilateral quota, and making sure no hard borders be instated i.e., that there be mutually beneficial access.

4.4.2 Fishing Opportunities

The talking point of how to conceive of, design and distribute new fishing opportunities was central to the selected literature. This split along two lines: discussion around the legal perspectives surrounding historic right/relative stability, and the manner the UK will allocate fishing rights once removed from the CFP. In regard to historic right, there is agreement that historically-based fishing rights were first legally expressed in the London Convention, with a subsequent belief, as expressed by the UK government, that as the UK leaves the London Convention and the EU, it leaves its legal obligation to historical right (Appleby & Harrison, 2017; Ares, 2019b; DEFRA, 2018). However, others disagree that it is that simple based on the nature of the legal precedent as one set by custom, not contract (Kopela, 2019). From this reading, the fact these historical fishing rights were acquired by association with former (non-rights based) access to the high seas is important in defining the nature of such rights. They are not based on previous rights but on there being no right of access at all and so based on habitual behaviour over time. Kopela (2019) uses this as a basis for the firm conclusion that termination of the current regime does not necessarily lead to termination of the historical right. Her argument is that, whether explicitly stated, the historical rights within the treaties (London convention, CFP) cannot be annulled without explicit permission from the parties involved. Therefore, the historic rights run parallel to these treaties and do not disappear if one party leaves them. As stated above in the context of access, this opinion is held widely by those across the EU who stand to lose from the UK's exit from the fishing treaties, predicated on a disagreement of the manner in which historical right is conceived:

> *"A very direct articulation of this EU-27 point of view from an industry agent was: 'The British claim of getting back your waters is nonsense, because you never had them. Maybe for oil or gas but not for fish'."* (Gallic et al., 2018, p.34).

The preferred method among UK fishers for some form of zonal attachment (Section 4.2.3) is addressed widely in the selected literature (Billiet, 2019). The main thrust is that zonal attachment would not be a straightforward method regarding the highly mixed fish stocks found in UK waters. This is particularly true of fish stocks that are closer to boundary lines, such as in the Irish Sea and the English Channel, with authors having pointed out that applying a zonal attachment method would be easier for some fisheries than it is for others

e.g., the Scottish offshore fisheries are situated in large Scottish areas of EEZ set at a clear distance to boundary lines (Phillipson & Symes, 2018) in contrast to, say, shrimp fisheries in the Irish Sea that straddle the border with Ireland (O'Higgins & O'Hagan, 2019). The practical problem of determining the exact level of catch to be appropriated to the UK is also stated, as it would require referencing the ICES grid system[5] used to report catches across European Seas that do not line up with the EEZ borders (Gallic et al., 2018). Those who champion zonal attachment say it helps deliver a proportional share distribution thereby creating a yardstick that can help resolve disputes and facilitate successful negotiation. However, the new system would have to be phased in over time to help fisheries around Europe adjust as well as be regularly reassessed (every ten years or so) to allow changes required by changes in the underlying movements and behaviour of the fish (Stewart & O'Leary, 2017).

An alternative option discussed was that the UK could instate a management system that controls fishing effort through output, known as "days-at-sea" – licensing vessels to spend a certain amount of time a year at sea rather than distributing quota. This would be in contrast to control through an input system, of which quota systems are an example. However, the UK is limited in this because there cannot be a quota system on one side (EU) and a 'days-at-sea' system on the other (UK) as shared stock management would become almost impossible with two entirely different systems in play on either side of the border (Stewart & O'Leary, 2017). This means it would be difficult to set-up a new system that does not rely on the setting of a TAC – there would have to be a European-wide movement with all relevant parties changing their underlying systems away from quota to something along the lines of 'days-at-sea'.

Therefore, the disruption brought about by Brexit opens up the possibility of changing the overall fisheries system, but this is difficult from a stakeholder perspective due to the multitude of distinct interests i.e., some want a lot more change than others:

> *"The establishment of a market for a previously public right has fundamentally changed how stakeholders perceive ownership over fisheries resources. These views have in turn resulted in very different priorities over the future of Scottish fisheries"* (Weir & Kerr, 2020, p.8).

[5] The International Council for the Exploration of the Sea (ICES) is an intergovernmental body that conducts research into the marine ecosystems of the North Atlantic (ICES, 2020). It uses a grid system to map fish distributions which it subsequently uses to advise the EU on setting its yearly TAC. The grid cuts across maritime borders.

Overall, the point is that, at the more internal and local level, vested interests will make it difficult to radically alter the structure of the fishing fleet and the industry (Agnisola et al., 2019). Gains to the industry come mostly from increased fishing opportunity rather than a revamping of the opportunities already distributed – this is evidenced by the UK governments intention, as set out in Section 4.2, to maintain the status quo on the distribution of fisheries rights, only newly acquired fishing rights may come under a different system (Ares, 2019a). This was reflected in stakeholder interest lying more with the "external" rather than "internal", with a high rate of terms such as "our waters", demonstrating a lack of calls to reform the internal FQA system (Weir & Kerr, 2020). A reluctance to reform among key fishing stakeholders stands in contrast to others who have called for reforms to the FQA system, criticised for stifling social and ecological development through the instantiation of concentrated and powerful vested interests (Priddle, 2018).

The manner of enclosure across the EU has led to the accumulation of rights in fewer and fewer hands; a mass privatisation that has left the public without major benefit of what is often conceived of as a public resource (in fact, publics often incur a loss through subsidies and the cost of state-led management) (Carpenter & Kleinjans, 2017). As a result, some have called for the UK fish resources to be made more beneficial to the general public through management e.g., by linking fishing rights to social goods such as job creation, conservation gains etc., (Barnes et al., 2018; Priddle, 2018). Appleby et al. (2018) reference the criticism that it was not the EU that has made the UK sector undynamic, it was the badly enacted market-based system of Individual Transferable Quotas (ITQs[6]) (a UK competence). For them, "Brexit" represents the ability to renew the system away from this form of privatisation. However, they point out that much of this was "accidental privatisation" i.e., over time, the resource was privatised away in a manner that did not fully account for the effects the privatisation of the resource would have, explained by the sheer complexity of the heavily layered and complex fisheries governance system within, and throughout, the EU. As such, if a government is to create property rights within the fisheries coming out of the "Brexit" disruption, it should be very mindful of the long-life entrenchment that property rights entail. Property rights are not easily changed or amended once created – protected by laws and creating powerful vested interests that are

[6] The individual Transferable quota (ITQ) system is a potential sub-system of an individual Fish Quota (IFQs) system of which the UK's FQA system is an example. In an ITQ system, holders of fishing rights (quota) can engage in highly caveated trade to other potential holders of quota; quota can be bought and sold, representing the commodification of fishing rights on a market. UK fisheries are managed as an ITQ system, representing the privatisation and commodification of the right and ability to harvest the UK fish resource.

impediments to change – a problem when regarding such a dynamic resource as fish (Appleby et al., 2018).

4.4.3 Devolution, the Internal Governance of the UK

Internal to the UK, Scotland is by far the biggest fishing nation within the UK's four country system, but with no direct control over the formation of new fishing legislation, policy, and negotiation at the time of writing (2020) – the moment of "Brexit" disruption. This led some to point out that Scotland has already been quite limited, under the CFP and the UK concordant (Appleby & Harrison, 2017). The "Brexit" disruption poses the question: within the UK, which countries should have what powers regarding fishing? With the general opinion voiced that the UK must be the overall arbiter of fishing policy as only the UK government has responsibility over international relations, and therefore over the international negotiations the shared fisheries system requires, resulting in the need for a UK-wide framework (Appleby & Harrison, 2017; Bailey & Budd, 2019; McAngus et al., 2018, 2019).

This is demonstrated further in responses (McAngus et al., 2018, 2019) to the Fisheries Bill (see Ares, 2019), stating that it says little about the future of fisheries in any detail and point to the fact Marine Scotland (Scotland's fisheries management organisation) was largely uninvolved as an indication that the UK government has not set out on a policy of including the devolved administrations to the required degree:

> "*Consequently, the resulting bill has come under scrutiny in a number of key areas that could well have been avoided had the previous intergovernmental relations been conducted in this case. Evidence has shown that successful and sustainable fisheries management regimes in nearby independent coastal states (Iceland, Norway and the Faroe Islands) are based on cooperation and trust. The construction of post-Brexit legislation has certainly not taken these lessons on board*" (McAngus et al., 2019, p.806).

The bill does try to work out the devolution problem by setting up Joint Fisheries Statements – where all the administrations jointly set out their policies (DEFRA, 2018). But it states that fishing opportunities will be decided at UK level resulting in political fallout. The process of setting up an overall UK regime *"will require considerable internal diplomacy"* (Barnes et al., 2018, p.2).

A particular aspect of the current system that can now be addressed in the disruption is the over-centralised nature of the CFP, over the management of what is often a localised and dynamic resource:

> *"The centralised command and control model, with exclusive competence for the EU, has certainly been problematic; changing EU regulation requires having a voice in Brussels which has not always been possible for all fishermen."* (Appleby & Harrison, 2019, p.14).

Appleby et al. (2018) further develop this idea in another paper, in which the authors state that the literature is clear that such resources are always best managed locally, so that having them managed within the EU's "Byzantine" system leads to poor management, especially in terms of the sustainability of the stocks.

Further political fallout could occur through the deployment of a zonal attachment policy as the UK would receive a zonal quota only to then face calls to split that subsequent quota amongst the four nations accordingly, with Barnes et al. stating: *"What establishing a new principle of zonal attachment would mean for devolved administrations seeking their 'fair share' must also be handled with care"* (Barnes et al., 2018. p.3). If fishing was completely devolved, it would open another frontier internally, so, for example, English fishers would have to negotiate with the Scottish authorities creating a further complication in the already complex business of distributing fishing rights (Churchill, 2018). Alternatively, devolution opens up the possibility for a more tailored, localised form of management across the UK that could provide better management to suit each local situation, within the new UK-wide framework (Stewart & O'Leary, 2017). Alternatively, deviating systems could lead to unhealthy competition, with the four nations working to undercut one another including a potential race to the bottom on regulations (The Blue Marine Foundation, 2018).

As further indicator of potential political fallout internal to the UK, some regard Welsh fishermen as receiving less than their "fair" share of quota relative to stocks found within Welsh waters. The Climate Change, Environment and Rural Affairs committee of the Welsh Assembly has argued that the Welsh government should lobby the UK government for a greater share and, in light of Wales's lack of fishing capacity, should aim to lease such quota to elsewhere until it can build up its capacity (Climate Change, 2018).

4.5 Discussion

This section discusses the ways the three subheadings above relate to the common pool nature of the fish resources and what this teaches us about common pool resources generally. The rationale, as set out in the choice of review question (*How is the common pool nature of European fisheries being addressed in the context of the UK's ongoing exit from the European Union?*), is that the disruption to fisheries management across Europe caused by the UK's exit from the CFP will inevitably have to deal with the CPR nature of the resource and that studying this particular aspect should be instructive as to the management of CPRs generally but also contribute to understanding how to potentially manage Offshore Carbon.

4.5.1 Access

The key aspects surrounding access do not centre on the question of *whether* the UK gives access to neighbouring countries, but rather *how* it does so and to what extent. One of the key impetuses for the UK leaving the CFP is precisely to obtain this advantage and empower the UK's fisheries-negotiation position. From the perspective of common pool resource management however, the clear lesson is that this is less of an empowerment than what may be apparent. As Phillipson & Symes (2018) point out, the UK must adopt the "good neighbour" approach if it wishes to avoid the self-defeating outcome of a truculent negotiation leading to a unilateral approach. A divergence and disagreement between the UK and its neighbours will lead not only to serious and unhelpful diplomatic fallout (that could subsequently affect the UK/EU's standing in other areas) it will also lead to two potential outcomes: either the UK must invest heavily to monitor and enforce access to its waters or fail to do so, thereby imposing major costs in the former case and creating the conditions for overfishing and the unsustainable depletion of its stocks in the later. It is the perfect textbook example of the tragedy of the commons, as illustrated by the real-world example of the shared mackerel stocks. The overarching lesson: disagreement is not an option because disagreement is self-defeating for all parties involved. This is limited, however, by the lesson that running an agreement-at-all-costs approach can come at the cost of the sustainability of the fish stocks (through setting the TAC above sustainable levels to keep every party happy). These points demonstrate that the UK's position is therefore limited to the nuances surrounding *how* other countries access the UK EEZ and to what extent.

The overall perception may be that the UK will be able to exercise much more power and influence by having a seat of its own around the fisheries table. However, one of the overall rationales for the existence of the EU is the power gained from the pooling of various interests into one bloc; the EU subsumes member states' "seats" into one precisely to create this advantage. By leaving the EU table to sit on its own, the UK could be said to be diminishing its voice regarding a political organisation in which it previously held a significant influence. That influence will no longer hold sway in the same way and will have to be exercised away from the EU table. This diminishment in influence and contact could come to the UK's detriment and, overall, the detriment of the stocks if agreement is not made or TACs are set too high in order to ensure agreement.

The common sense of a "good neighbour" approach appears evident in the opinions of UK fishermen who, as pointed out, believe that an increase in UK fishing capacity must be phased in over time to allow neighbouring countries a reasonable amount of time to adjust to the changes, thereby helping to reduce the likelihood of dramatic disruption, the anger it engenders and the political fallout that would likely follow. However, as has been made clear by the UK government's own approach, this "good neighbourly" behaviour is required by international law anyway (UNCLOS). In this is evidence of UNCLOS as a relatively successful large-scale commons institution that largely succeeds in creating a framework in which all actors can mediate their varying interests, whether they go on to do so or not.

From the EU's perspective, the issue of access is a sore point for those who have always had access to the waters that are soon to be confined within the brand-new UK EEZ. It is not surprising therefore that the widespread position of the EU is one of status quo ante. However, as pointed out in Section 2.5, the literature highlights the fact that commons and commons users are highly political i.e., embedded in complex webs of competing interests, with users inhabiting different subjectivities that can never be fully reduced to a single unified outlook. The point that the CFP is being questioned internally, within the EU, is a reminder that the EU is itself an attempt at large scale commons governance – bringing as many relevant actors as possible under the same tent with various levels of endorsement and perceived success.

4.5.2 Fishing Opportunities

The conflicting opinions on the jurisprudence of historical right offers an insightful window into one of the corner stones underlying the CFP. Historical right is the justification for

how the CFP originally allocated the stocks to each member, providing the basis for perhaps the most contentious aspect of the policy. The conclusion Kopela (2019) draws (that terminating the current arrangement/agreement should not free the UK from its commitment to historical right) may end up being treated as esoteric in practice, but it nonetheless provides a viewpoint on rights that contains lessons as to the institutionalisation of CPRs. European fisheries, like the vast majority of CPRs, were used by people before enclosure. This pre-enclosure behaviour was respected and institutionalised within the CFP via historical right with the attendant effect of helping member states reach an agreement that could be considered fair while making sure fishing communities around Europe were not left destitute by a sudden and unprecedented enclosure. In this there is a lesson for the initial enclosing of a CPR – that the incorporation of existing behaviour is helpful in facilitating the required initial agreement between the various parties while limiting any injustice that could be conceived from the enclosure of something previously freely available. However, the clear downfall of historical right is the way it institutionalises a constant impediment to change. This unchangeable aspect of the distribution of member states' TACs has facilitated the culturing of grievances among those fishermen across the EU who have come to the opinion that their share is not a fair one. It defies one of the insights concerning commons management laid out in Chapter 2 – that the resource must be managed across time and should avoid the privileging of one particular period of time over others in order to accommodate various changes, from societal values to changes in the resource itself (particularly true of fish which are a highly dynamic and changeable resource).

Some of the problems associated with large scale CPRs are evident in the critiques of zonal attachment in which some fishers at one end of the country suggest a method that would advantage them at the expense of fishers at the other end who fish under different circumstances. The one-size-fits-all approach might work for a local industry under local circumstance, but apply that on a country-wide, or indeed continental-wide, scale and the system begins to generate problems under its lack of capacity to deal with specific circumstances. In contrast, the EU's CFP, far from universally lauded, allows for localised management once the TAC is distributed to each member (with some limiting regulations). The CFP is therefore an example of a (arguably) flexible arrangement that allows for differing approaches at different ends of a country, and different ends of the continent whether member states choose to take advantage of the flexibility or not. Indeed, as pointed out by some, many of the issues within UK fishing – e.g., consolidation of the stock in fewer and fewer hands or low levels of young people entering the industry – have arisen as a result of the privatised ITQ system preferred and implemented by successive UK

governments i.e., by aspects of a UK competence (Appleby et al., 2018). However, the argument that zonal attachment would help solve one of the CFP's ongoing problems – the grievances that arise over the perceived "unfair" distributions between member states – by creating a yardstick that intuitively approximates distribution of fishing rights to the physical distribution of the fish between EEZs, is a strong argument that would help to settle disputes, at least in theory. Alternatively, opponents of this view could simply say that there is already a yardstick on which European fishing is distributed: historical fishing patterns institutionalised within historic right and the policy of relative stability. This highlights the importance of thinking through the initial enclosure of a CPR with regard to the fact that the resource will have to be managed over time, with mechanisms built in to accommodate changing values – as Stewart & O'Leary (2017) touch on when they suggest a regular ten year reassessment of stock distributions for any new system. Another insight, following Agrawal's political critique of the commons (Section 2.5), and touched on in Section 4.5.1, is that any users within a CPR system will have multiple and often conflicting subjectivities resulting in conflicting interests. This reinforces that any newly emerging or initially enclosed CPR system must attempt to prevent the culturing of interests that diverge too much between users, as well as create mechanisms for compromise and alignment where possible.

The point that a "days at sea" system, if adopted by the UK, would diverge too much from the EU's quota-based system to be workable is an important reminder that even though the UK may be leaving the CFP, it is still required, by necessity, to engage with the CFP and is limited in its options as a result. When it comes to managing the highly mixed fisheries of the North Sea and surrounds, the UK cannot indulge in the idea of a completely separate regime – as implied in the very term "independent coastal state" – but must work with those with which it shares the resource, as demanded by the resource's common pool nature.

The calls for the public to receive more benefit from the resource than is currently the case speak to the thorny issue of ownership over CPRs. Generally, marine CPRs are not easily enclosed and therefore not easily privatised. When they are, the subsequent privatisation can be interpreted as particularly egregious considering the nature of the resource as having been traditionally *res communis/res nullius* (belonging to everyone/belonging to no one). The pseudo privatisation of UK fisheries within the ITQ system highlights the vulnerability of some natural resources to being institutionalised within specific forms of enclosure that create structures of vested interests that have a formative effect on the construction and conception of subjectivities (e.g., a fisherman with an ITQ holding will begin to think of themselves as an owner of fishing capital, influencing their perspective, politics and actions), as well as setting up legally enshrined private rights that can hobble attempts to

change the systems of management in a significant way. Once again, the lesson that the manner in which a CPR is enclosed (if at all) must be taken very seriously, particularly at the outset but also throughout the lifetime of the conception of the resource in order to avoid political fallout, the cultivation of resentments, and impediments to meaningful change.

4.5.3 Devolution, the Internal Governance of the UK

Although much of the initial focus of the UK's exit from the CFP has centred on the new relationship between the UK and EU, the other locus of the (UK-centred) literature has been on how the country should subsequently deal with the internal (intranational) division of fishing rights and management. The UK is a country of countries, so not only must it negotiate a new settlement with its neighbours, it must also do so within its own union. This layered governance is another complication on top of the already complex relations required to govern a continental-wide CPR. Although there is no evident intention to manage UK fisheries as an Ostrom-style commons, the general importance of building trust around the management of a CPR – one of the key insights of the Ostrom School – is mentioned within the layered governance context. The breakdown of trust between the UK government and the devolved governments does not bode well for the future management of a resource dependent on trust and mutuality for success. The large-scale CPR problem associated with inclusion of stakeholders at all levels rears its head here, with the attendant lesson that the resource will tend towards poor management if relevant stakeholders are not adequately involved at all levels (Stern, 2011).

The point that the disagreement between the UK and Scottish governments rests on the distribution of fishing opportunities (rather than the likes of power over external negotiations) points to the general reluctance to lose a competence one already holds (the reverse of: "you can't miss what you never had"). A disempowerment in this manner, conducted by a centralised authority, is a Leviathan/Hobbesian approach that may work in some ways (e.g., help reduce competition between regions, create uniformity of regulation) but will also likely lead to problems associated with Leviathan approaches to CPR management (e.g., stakeholder conflict and gaming of the system, problems associated with a one-size-fits-all approach, breakdowns in necessary consent). In other words, the centralised Leviathan approach the UK appears to be taking will likely lead to problems related to the social context of CPR management – upset people who feel left out and therefore more likely to be disruptive and more likely to enter into conflict. This prediction

is reinforced by historical patterns of behaviour, for example widespread poaching ("black fishing") in the 1990s by alienated and dispossessed UK fishermen, angry at a sudden drop in quota and a feeling of being largely shut out from the political processes controlling their livelihoods (Johnston, 2012). However, such agonising over the problems associated with too much centralisation may all be for nought as a degree of power retention at the UK level will not necessarily lead to such extreme feelings or the dramatic downfall of the fishing industry, the extent and manner in which it is done will determine its associated successes and failures. However, if the UK government does move to become an EU-in-miniature it must act thoughtfully to avoid the problems associated with the EU's ("Byzantine") distant and centralised approach that has done much to alienate fishermen across Europe.

This contrasts with the relevant points made in the literature that if fishing was fully devolved it could potentially lead the devolved nations to compete with one another in harmful ways, such as a race to the bottom on regulations or being more likely to engage in unsustainable fishing practices. It is apparent, therefore, that a degree of centralised control is required to hold each administration to a minimum standard and mediate between them on issues of opportunity sharing and conflict. One structural aspect of this that could prove problematic, peculiar to the UK, is that the UK Government is also the English government i.e., it would be both the arbiter of the UK framework as well as the manager of one of the devolved fishing administrations within that framework. This creates a potential conflict of interest that would have to be accounted for, most likely by making sure the UK-wide framework has some kind of guaranteed autonomy or is somehow presided over equally by each administration. However, an exciting aspect of the disruption brought about by the UK's exit from the CFP is the potential for the UK to develop a management system that truly incorporates both the dynamic nature of seafood resources, as well as the diversity of fishing that occurs across the UK i.e., to avoid the one-size-fits-all problems associated with treating all fishing in the same vein. The trade-off is one between devolving as much autonomy as possible while keeping things sufficiently coaligned within an overarching UK framework (which itself must link cohesively with the wider European framework).

4.6 Conclusion: Six Principles for Commons Governance

The systematically gathered literature on Brexit fisheries disruption offer instructive lessons on the management of marine common pool resources. By analysing the results

along the themes of access, fishing opportunities and the UK's internal governance, the literature provides Six Principles for commons governance. These principles have been derived from the review data and are:

1) **Maximum Cooperation:** The first lesson implied by the systematic literature review is that the UK cannot diverge (in terms of underlying system e.g., zonal attachment) too much from the EU due to the nature of the highly transboundary resource that forces co-management regardless of how much of an "independent coastal state" the UK declares itself to be. This means that disagreement is not an option if all parties intend their fishing industries across Europe to succeed i.e., cooperation is key to the success of a CPR.

2) **Cooperative Power vs Competitive Power:** The external influences gained by the UK leaving the EU table to become an independent party must be understood as coming at the expense of other influences internal to the EU, the trade-off may advantage the UK in some ways but will leave it unable to directly influence the decisions of the neighbours it must cooperate with by necessity i.e., spheres of influence are distinct aspects of the social-ecological frameworks governing and using CPRs, a party must be mindful of which spheres it has access to and which it does not.

3) **Maximum Inclusion:** Calls from within the EU to use the Brexit disruption to reform the CFP point to the wisdom of including as many people associated with the CPR in the governance of the CPR as is feasible, to ensure the system is fair and successful and there is sufficient buy-in, otherwise political fallout can be born from perceived resentments. This correlates with Rule 3 of Ostrom's 8 Design Rules (Table 2.2) – *Collective Choice* – one should maximise the involvement of as many stakeholders as is feasible in decision making.

4) **Temporal Variance:** The problems associated with historic right and the problems associated with a one-size-fits-all approach (as demonstrated in the calls for zonal attachment), demonstrate that a high degree of flexibility in the management of a CPR must be built into the governance system across both time and space. This is achieved across *time* by striking a balance between providing enough longevity to allow users to feel secure (e.g., secure enough to make financial investments) and creating rules and mechanism that allow adaptability to change.

5) **Spatial Variance:** The balance is achieved across *space* by ensuring as much local control of a resource as feasibly possible so that specific regions, practices, geographies, and communities can successfully incorporate their approaches and idiosyncrasies. These "across space and time" lessons should be especially heeded when regarding emerging resources that have yet to be institutionalised as the initial institutionalisation can create vested interests that can impede change over time or privilege certain sectors, regions and users over others.

6) **Internal Governance:** Lastly, another balance must be struck on the layered governance of any new fishing regime within and across a jurisdiction. As was evident with the political fallout between the UK and Scottish governments, the governance of large-scale commons resources is something conducted over various levels of government, internally (national) and externally (international), that requires a sophisticated and developed integration to prevent political fallout and mismanagement.

As this chapter of literature review is ultimately part of research regarding the potential governance of the emerging resource of Offshore Carbon, the Six Principles are applied to the context of OC in the proceeding chapter – a synthesis that brings the very different foci of the later three chapters together to discuss their cumulative implications for the novel governance of Offshore Carbon and the second half of the PhD thesis.

Chapter 5 |

Synthesis, Identification of Research Gaps and Research Questions

5.1 Introduction

This chapter synthesises and relates the main findings of the three preceding chapters of literature review to inform the thesis going forward. To do so, it synthesises the literature reviews of the preceding three chapters, explaining how they relate to and inform one another (Section 5.2); it elucidates research gaps derived from the literature reviews that call for an Offshore Carbon (OC) governance framework (Section 5.3); and outlines research questions in relation to the overall aim of informing the governance and management of OC (Section 5.4).

5.2 Literature Review Synthesis

This section highlights connections between the three preceding chapters. These connections are summarised in Figure 5.1 at the end of this section. Specifically, the section describes the relevant connections between two pairs of the preceding chapters of the literature review: the relation between Chapters 2 and 3, and the relation between Chapters 3 and 4. The relation between Chapters 2 and 4 is not discussed any further here as it would repeat the discussion in Chapter 4 which was an exploration of how the selected literature in the systematic review related to CPRs (i.e., how Chapter 4 relates to Chapter 2).

5.2.1 Synthesis of Chapters 2 and 3: Offshore Carbon as a Common Pool Resource

This section relates Chapters 2 and 3 by investigating whether OC can be considered a Common Pool Resource (CPR). My conclusion is that OC, as defined in Chapter 3, is a "blue" (i.e., coastal/marine) common pool resource. Before making the case, a short summary of the main points from both chapters follows. As stated in Chapter 2, a CPR is a resource system that produces economic goods and/or services that are *rival* and *non-excludable*. For a reminder of the four basic types of economic good, based on the relationship between exclusion and rivalry, see Table 2.1. Key to the development of research on common pool resources, and their unique needs, was the work of the Ostrom School which proved that a CPR need not necessarily be governed through centralised and dominating governance (i.e., Leviathan approaches) but instead could be governed in more localised, communal ways. Chapter 3 explored the concept of Blue Carbon (BC) and its definition, making the point of describing OC and arguing that OC is also being considered a BC pathway, if the offshore zone can be successfully included in carbon-based policies. Offshore Carbon is the term I have chosen to describe a specific constitution of carbon stock and flow defined as particulate organic carbon (POC), which is fixed and facilitated by a series of biological processes – the "biological pump" – and for which a sizable portion is ultimately stored long term in offshore sediments. This OC definition is therefore distinct from the other pools of marine carbon, such as dissolved organic and dissolved inorganic carbon.

5.2.1.1 Synthesis: The Argument for Offshore Carbon as a Common Pool Resource

For OC to be considered a CPR, it must meet the two requirements of being rival and non-excludable. However, to understand this better, we have to delve deeper into the notions of rivalry and excludability than were described in Chapter 2. According to Ostrom, the relationship between non-excludability and rivalry within a CPR system is such that they both apply to separate elements within that system rather than comprehensively across the whole (Ostrom, 1990). Within a CPR system then, the two elements exist within the following relationship: CPRs are those in which the *resource system* is non-excludable, and the *resource unit* is rival. The *resource system* is the overall (eco)system that contains the processes that give rise to, and maintain, whatever is appropriated e.g., for fisheries, the resource system is the ecosystem which gives rise to, and sustains, the fish throughout its lifecycle (a specific habitat within the sea); the *resource unit* is the element in the ecosystem which is appropriated i.e., the individual fish.

Another key component of a CPR is the *appropriators*, those actors within the system who acquire/utilise the resource. In the example just described, fishermen have access to a resource system that produces fish in a way which is often non-excludable, or at least very difficult to exclude. However, fish are rival and once a fisherman has caught the fish and appropriated it, the fish is now unable to be appropriated by the next fisherman thereby changing the resource from common pool to private via the exclusionary act of appropriating the fish. For a breakdown of the necessary components of a CPR and how they relate to the examples of fishing and OC, see Table 5.1.

Table 5.1 *The necessary components of a CPR for fish and offshore carbon*

Components of a CPR	**e.g., Fishing**	**e.g., Offshore Carbon**
Resource System (*non-excludable*)	Ecosystem that supports the fish i.e., fishing ground	Marine system that supports and facilitates the biological pump.
Resource Unit (*rival*)	Individual fish but also fish stocks and fish quota	Carbon stock, however conceived and measured, in marine sediments.
Resource Appropriators	Fishermen/Communities	National jurisdictions

Therefore, to establish whether OC can be regarded as a CPR, the relevant resource unit, resource system, and resource appropriators must be identified. In the context of this research thesis, the *resource unit* is stored carbon in shelf sea sediments. The *resource system* is that area which contains the entire process of OC flow (the fixing, transport, deposition and burial of OC) – this is the ecosystem which facilitates and maintains the "biological pump" (see Chapter 3, Section 3.3). This resource system is never completely self-contained as it is influenced by other processes that merge with the system at different points e.g., the North Sea could be conceived as a resource system for OC and as such it would be one informed and influenced by neighbouring bodies of water such as the English Channel and the North Atlantic Ocean, as well as from other geographic influences such as the many rivers that flow into it from the surrounding countries. The *resource*

appropriators in this case are nation states or some other form of political entity, such as a federalised state or suitably empowered municipality, which have political control over the seabed within their boundary[7].

On the subject of jurisdictions, if OC stocks and flows are to be conceptualised as a utilised natural resource and subject of governance, then it stands to reason that it be accounted for and institutionalised in some way. At the abstract level, in terms of appropriation, this is relatively straight forward in so much as the stored carbon belongs to whichever jurisdiction has control over the relevant area of shelf sea sediments in which it is stored[8]. Jurisdictions can "appropriate" the OC as an economic good in some manner e.g., as a recorded store of carbon on national carbon accounts (Thornton et al., 2019). Here we see more clearly why the carbon store is rival, to take the example of national carbon accounting: if one country records the offshore carbon stocks and flows on their national ecosystem/natural capital accounts, it stands to reason that a different country cannot record it on theirs as this would represent an illogical double-count akin to providing two different fishermen with the same quota of fish.

However, as is especially the case within marine environments in which water acts as a transport medium, the resource system – the large ecosystem that contains the "biological pump" – is vast, complex and often crosses multiple jurisdictions. This means that the resource system is shared and therefore difficult to manage in any significantly excludable way e.g., through the application of private property rights. This can be demonstrated by imagining the production of some marine snow e.g., through the faecal waste of a shoal of fish in Dutch waters. This marine snow is then transported by dominant currents into Belgian waters where it descends and is further transported into the French waters whereby a degree of the carbon within the marine snow is incorporated into the sediments within the French EEZ. In this hypothetical case the French Government can lay claim to that carbon (they can claim the resource unit) however construed, but the entire process that gave rise to that economic good is an international one within a shared system (a common pool) inside the North Sea; the "production" process is shared, the final economic good is not (or at least not initially). This in turn leads to potential questions over which party can claim which store and how such a shared resource system should be jointly managed.

A further complication regarding OC as a CPR is that even when ecosystems and appropriated resources do not change in any material sense, their category as a type of economic good (as public, private, common pool, or club) can change depending on the

[7] These appropriators are referred to generally as *jurisdictions,* throughout the research thesis.
[8] As determined by the international standard set by the UN Convention on the Law of the Sea (UNCLOS) via the institution of Exclusive Economic Zones (EEZs).

different ways in which the resource is conceptualised at different points (points of both time and space) by appropriators. For example, a shoal of fish is a common pool resource until it is appropriated, at which point the shoal becomes a private good (see Table 2.1 for guidance, the fish have gone from being non-excludable to excludable; common pool to private). Therefore, the resource unit may be considered a private good once it is clear that the OC "belongs" to one particular country or jurisdiction. This is because the unit has been sufficiently appropriated, it remains rival in such a context but is now excluded (just as with the fish example above).

However, the *overall* welfare benefit provided by OC storage in shelf sea sediments is a public good i.e., the carbon stored helps in creating an equitable climate which is an ecosystem service that is non-rival (the benefit i.e., an equitable climate, is not "used up" by one appropriator at the expense of another but instead enjoyed by everyone universally). So, although the ecosystem service of equitable climate is a public good, this service is ultimately provided by a resource (OC stocks) which is rival i.e., once accounted for, it cannot be accounted by a separate party. Crucially, the resource system remains a non-excludable common pool regardless of whether the resource unit has been excluded or not.

It is important to acknowledge that OC does not fit the definition of a CPR in a straightforward way and, although I have made the argument above for OC's status as such, the definition is open to debate. This centres on the appropriated resource unit within an OC system. With fish as a resource, the transboundary component is carried not only by the resource system, but by the resource units (the fish) themselves which are often migratory. Therefore, the fish need to governed/managed by all neighbouring parties with a stake in the fishery or the resource will likely be overexploited and damaged (tragedy of the commons). But the resource unit in OC's case is stationary and already contained, and excluded, within the jurisdiction of EEZs. In order for OC to follow a similar logic to fish as a CPR, then the flow of carbon within the resource system has to not only be a part of the definition of the resource, it also has to be amenable to management i.e. influenced or open to influence by neighbouring parties. It is only in influencing the flow of carbon in one part of the North Sea, for example, that a jurisdiction can influence the stocks in a neighbouring North Sea jurisdiction. Without that link, there is no connection between the jurisdictions and the manner in which they govern/manage their stocks is entirely up to them as it does not affect the other parties' stocks i.e., it is not a CPR in the classic sense. This issue is taken into account in the proceeding research and is discussed directly in Section 10.4.

To summarise, despite the problems associated with neighbours' abilities to influence one another attested to in the previous paragraph, in the case of shelf sea sediment carbon storage, it is the case that there is a non-excludable resource system (the "biological pump" within the marine ecosystem) with a rival resource unit (the carbon stock stored in a specific jurisdictional area of seabed sediment) and a potential plurality of resource appropriators (various political jurisdictions) who have incentive (carbon accounting/CC mitigation) to appropriate and manage the resource produced by the shared system: this is, descriptively, a common pool resource system following the strict Ostrom definition.

5.2.1.2 The Relevance of Offshore Carbon as a Common Pool Resource

What is the significance of a common pool resource categorisation? Put simply, the type of resource is directly related to the particular issues surrounding the management and governance of that resource and the subsequent methods employed to manage it successfully. These CPR-specific issues were discussed in Chapter 2, but the most relevant aspect is a CPR system's potential and tendency towards "overcrowding" or "overuse": the rivalry of the resource unit (as distinct from the non-rivalry of a public good) means the resource can be subtracted to the point of inefficiency or even exhaustion (the previously mentioned *Tragedy of the Commons*). Regarding the effect this has on natural resource management, Ostrom (1990) states:

> *"In a CPR, if problems associated with the appropriation of subtractable resource units become severe, local appropriators may refuse to undertake provision activities. No appropriation of a resource unit can occur without a resource system. Without a fair, orderly, and efficient method of allocating resource units, local appropriators have little motivation to contribute to the continued provision of the resource system"* (p.33)

In short, the resource system must be co-governed (and co-managed) by the plurality of appropriators to efficiently maintain the appropriation of the resource units. This co-governance is the key to successful utilisation of CPRs.

As argued, OC, as an economic good so defined, is a CPR. This suggests that investigations into ways in which to govern this resource should ensure to keep the resource's status as a CPR front and centre of the investigation. In order to do so, such research will require a clear understanding of the different resource components (unit, system, appropriators) and be built upon an understanding that the overall resource system is shared while the individual units are not, with the subsequent potential for mismanagement and non-cooperation between parties. Furthermore, the CPR nature of the resource, as suggested by

the literature, necessitates that a potential governance framework encapsulate a strategy to deal with the fair distribution of the resource units and facilitate correct stewardship of the provision provided by the resource system i.e., facilitate a shared responsibility to maintain the system among multiple appropriators and shared benefits.

5.2.2 Synthesis of Chapters 3 and 4: Fisheries Governance Principles for Blue Carbon

This section discusses how fisheries governance can inform the governance of OC, therefore relating the findings in Chapters 3 and 4. The systematic literature review (Chapter 4) derived six principles for successful governance of a blue common pool resource from an analysis of the disruption caused to the governance of European fisheries by the UK's exit from the European Union. The rationale for that focus was that European fisheries are:

- Marine resources within a shallow shelf sea.
- CPRs by definition.
- Have multiple – sometimes conflicting – resource appropriators.

These traits are shared by OC as a "blue" CPR with multiple resource appropriators. In both cases, the resources are bio-physical (embedded and informed by biological and physical processes in the environment) and are transported across jurisdictions by natural processes within a common pool. The key points of Chapter 3 were summarised in the last section, the Six Principles of Chapter 4 are found in Table 5.2, found at the end of this Section 5.2.

The first key principle drawn from the SLR in Chapter 4 is that fisheries governance should strive for minimal divergence with neighbouring jurisdictions which share the common pool, in terms of policy and approach. The reasoning for this is simple: the more divergence, the greater the complication of the situation and therefore the greater the chance of failure (with "failure" defined as unilateralism and accompanying unsustainable use of the resource that causes harm to the resource and its generating system). This suggests strongly that an emerging OC governance framework could benefit from an application of the same logic. If one jurisdiction uses a completely different way of measuring carbon stores, for example, or applies a completely different policy intervention for its management than a neighbouring jurisdiction, then the two jurisdictions could find it much harder to agree on how to manage the system cooperatively as a whole or may even enter into conflict. The required cooperation of governance and management could also be applied, not just between jurisdictions, but between entire programmes of integrated CC

mitigation, or other such related programmes, that may already exist across a given resource area. The key aspects in which to aim for minimal divergence, based on the example provided by European fisheries, include the likes of policy, units of measure, enforcement, review, and scientific study. The application of these insights, however, will depend on the manner in which the resource is utilised and whether there is agreement across jurisdictions to govern and manage the resource along similar lines. This poses a pertinent question for any research aiming to inform the governance of OC: How could the resource be utilised? And what policy actions are available regarding OC?

The second key principle of Chapter 4 relates to the nature of power and international collaboration. Regarding fisheries and Brexit, the UK is set to enter a trade-off: it will lose its cooperative power by removing itself from a table around which it held major influence in order to gain the power inherent in setting up a separate independent table. This trade-off is detrimental, potentially to the UK, but mostly to the resource itself. This is because, ancillary to this point, a key lesson from commons studies is that competitive governance of a CPR will tend towards tragedy; that cooperative governance is normally the best for sustaining such a resource and ensuring its efficient use. This principle also helps to facilitate the previously discussed conclusion regarding minimum divergence. For OC governance then, the principle suggests that an OC system would benefit from a cooperative approach from the get-go; that, ideally, there should be one table created and not a series of competing independent tables. It further suggests that the aim should be for long lasting, inclusive, and cooperative governance rather than the creation of separate and diverging power structures across the resource area.

The third key principle of Chapter 4 builds on points made in the commons literature (as highlighted in Chapter 2) that CPRs tend to benefit greatly from the maximum inclusion of as many stakeholders associated with the resource and resource system as possible. This ensures buy-in to the governance and management approach which in turn facilitates its sustainability and effectiveness. It follows therefore that such an approach could greatly benefit OC governance. This, however, poses some important questions for OC governance: who would be the relevant actors involved in an OC system – Industry Actors? Governments? Publics? At what level, just national/international or municipal/local as well? Following that last question – would it be possible to include local communities and bottom-up structures so not everything is being decided by negotiators in board rooms at the international level?

The fourth principle derived from the study of European fisheries centres on the flexibility of the system of governance *over time*. As highlighted in the literature, the CFP has suffered

over the years due to an inability to change at pace to meet the needs and wants of the resource users, changing principles (such as the growing need for sustainability), and changes in the resource itself. The difficulty with European fisheries is that its international governance was built upon already existing fishing practices, however disjointed, across Europe, and so was designed to integrate fishing communities from across Europe on a basis of historical precedent. A potential OC governance framework need not be so limited at the offset as it would be built upon a newly conceived, emerging resource. It is sensible to see this as a great advantage for OC governance, unimpeded by systems already in place it can build-in flexibility and mechanisms that allow for change at different junctures. The literature suggests, however, that the key to this will be working out the balance of creating enough stability that it reassures resource appropriators, strengthening their confidence (e.g., to make financial investments, give governments confidence in negotiated settlements etc.), but enough flexibility that it can adapt to changes in the resource and resource users. However, this principle and its integration into an OC governance system poses an important question: are there any already existing structures and institutions that should be included i.e., would it be as much of a clean slate as anticipated? Further, how would a governance framework for OC create the fine balance needed between building both flexibility and stability into the system? Have other frameworks managed this, if so, how? If not, why?

The fifth principle highlighted by Chapter 4 states that a CPR governance framework benefits not just from considering the resource across time, but also across space. European fisheries must incorporate a large amount of variance across many dimensions found spatially (across the given resource area) such as type of fishing, species, local cultures and communities and their specific needs etc. From this it is clear that fisheries are complex, requiring many aspects to be included into a framework of governance. But is the same true for OC? It is sensible to assume there will be some spatial variance – at the very least, differences in stored-carbon density – but it is not clear if OC will have the same level of biophysical and socio-economic complexity as fisheries. This, therefore, is an important question for OC governance: what spatial variations might exist across a given OC resource area? Leading to a subsequent question: how could any potential variance be included to avoid conflict and resource management break down? This point is linked to the principles regarding *Maximum Integration* and *Maximum Inclusion* in that the potential issues that could arise over spatial variance could be mitigated by successfully involving as many stakeholders as possible and facilitating a maximum inclusion of relative factors at the offset.

The sixth, and final, identified principle of Chapter 4 is that governance is both an internal as well as an external affair i.e., a CPR governance framework exists at multiple levels, not just one between various jurisdictions, but within those jurisdictions themselves. This one is heavily linked to the principles described before but simply further suggests that the same principles should also be applied within a jurisdiction rather than just in between. For OC governance, it echoes questions in relation to maximum inclusion, for example: can municipal and local governing structures be included? Is it possible to include local communities and bottom-up structures?

Figure 5.1 follows below summarising the main points of the synthesis between the three chapters of literature review. Additionally, Table 5.2. summarises the Six Principles of Chapter 4 and their relation to OC.

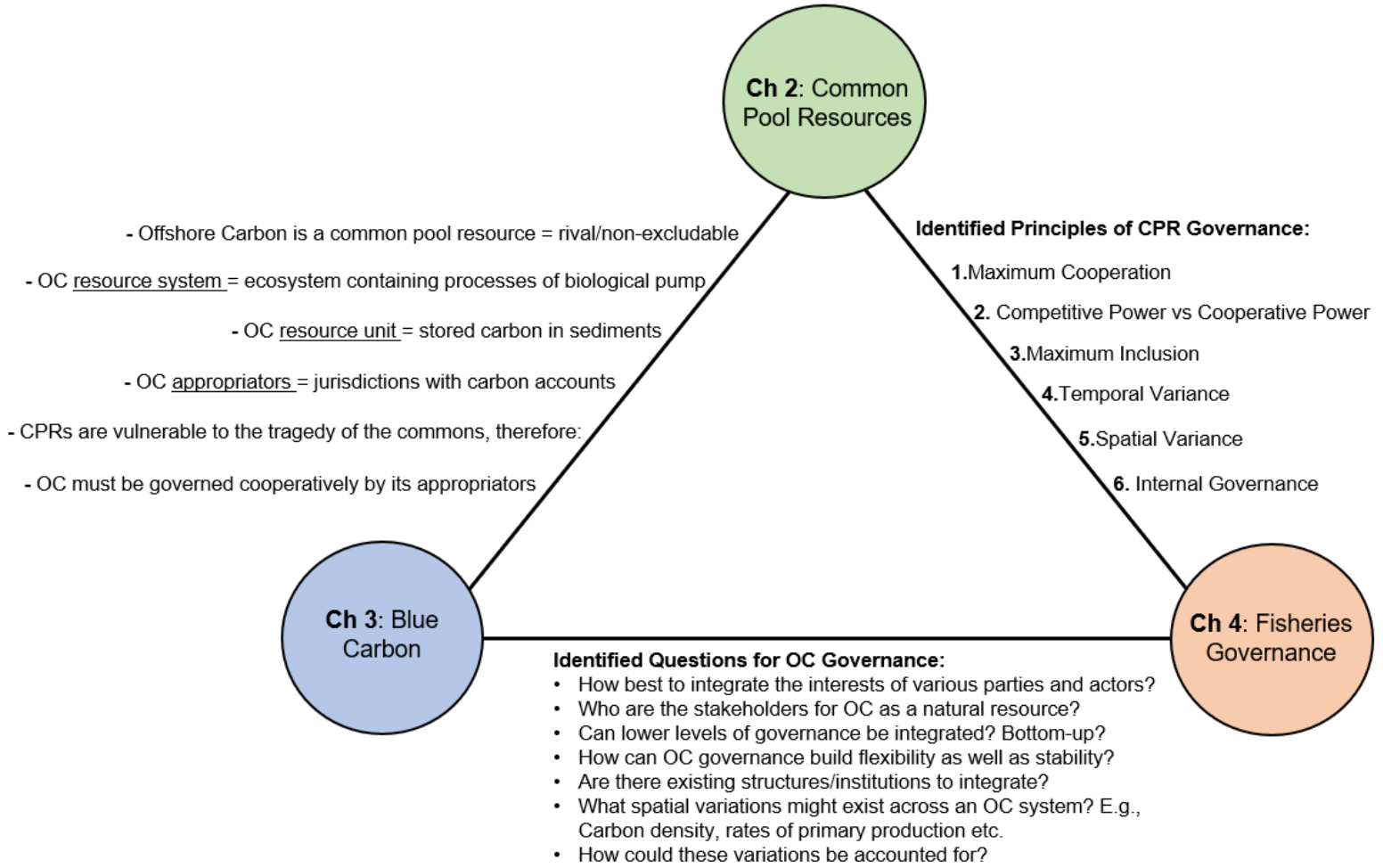


Figure 5.1 *Summary of the main points of this synthesis chapter and relation between the three chapters of the literature review undertaken, organised as:*
Chapters 2 and 3: *Offshore Carbon defined as a common pool resource*.
Chapters 2 and 4: *The identified Six Principles for commons governance following the systematic literature review of Brexit fisheries literature.*
Chapters 3 and 4: *The key questions that arise when applying the identified principles in Chapter 4 to Offshore Carbon governance.*

Table 5.2 *Summary of Chapter 4 Six Principles and implications for offshore carbon*

Principle	Implications for Offshore Carbon Governance
1. Maximum Cooperation	• Integration of OC governance across jurisdictions would benefit OC governance. • OC could benefit from cooperation across related programmes as well as between countries/jurisdictions. • Key aspects for minimal divergence: policy, units of measure, enforcement, review, scientific study etc.
2. Competitive Power vs Cooperative Power	• A collective and cooperative regime of governance between jurisdictions is ideal for facilitating principle 1. • Build long lasting, inclusive, cooperative governance rather than separate and diverging power structures to develop across the resource area. • This is actually an empowerment of the individual jurisdictions, not a diminishment of them, if structured well.
3. Maximum Inclusion	• Successful CPR governance regime to include as many stakeholders as possible, applicable also to OC governance. • The maximum inclusion imperative stimulates key questions for the research thesis: is it possible to include local communities and bottom-up structures? Who would be the stakeholders involved in an OC system? At what level, just national/international or municipal/local as well?
4. Temporal Variance	• OC is entirely new, emerging resource, so potential OC governance structure will benefit from a tabula rasa by not being hampered by already existing structures – but are there existing structures/institutions to be included i.e., would it be as much of a clean slate as anticipated? • Initial set-up must integrate temporal nature of OC and create structures that enable balance between stability and stakeholder confidence on one side and a degree of flexibility on the other.
5. Spatial Variance	• OC governance may have spatial variance, but generally, utilisation of OC can sensibly be anticipated as being less complex as it is unlikely to involve as many diverging aspects, such as those applicable to fishing. Leads to key question for OC: how much spatial variations could exist across a given resource area? • Subsequent question: how could potential variance be integrated to avoid conflict and resource management break down? • Potential issues over spatial variance could be mitigated by successfully involving as many stakeholders as possible and facilitating a maximum integration/cooperation from offset.
6. Internal Governance	• Principles regarding integration be applied from the local level up (internal to the jurisdiction) as well as along/between national levels (linked to principle 1). • An OC governance regime to cover aspects internal to a jurisdiction and not just between them.

5.3 Research Gaps and Challenges for the Governance and Management of Offshore Carbon

This section describes research gaps related to offshore carbon in the literature. It also identifies the need for an OC governance framework, required to facilitate the utilisation of OC in a comparable way to conventional coastal BC. It begins however, in Section 5.3.1, by defining Governance and governance frameworks.

5.3.1 What is a Governance Framework?

The subject of this thesis is Offshore Carbon, but there is a secondary subject: governance frameworks. Governance framework is a complex term which can have a number of different interpretations, stemming from the interpretive nature of the word "governance", as Paavola et al. (2009) state:

> "*Environmental Governance is in many ways a similar concept to sustainable development. It provides a degree of integration across various perspectives, interests and approaches, and yet it continues to mean different things for different people."* (p.148).

The sheer number of different things that can be the subject of governance means there can be "various perspectives, interests, and approaches" for governance too, highlighting the need to make the term "governance", as used in this thesis, explicit.

The vagueness of the term "governance" can be countered by understanding the key aspects that run through most definitions of it. To use two examples, for Hatfield-Dodds et al. (2007):

> "*Governance refers to the institutional arrangements which shape actors' decisions and behaviour, including the exercise of authority within groups or organizations (such as firms or nations)"* (p.3).

And for Graham et al. (2003) governance is:

> "*the interactions among structures, processes and traditions that determine how power and responsibilities are exercised, how decisions are taken, and how citizens or other stakeholders have their say*" (p.ii).

The common threads between both definitions concern:

- **power** ("decisions", "exercise of authority", "power and responsibilities are exercised"),
- **actors** ("actor's…groups, organizations", "citizens and stakeholders"),
- and **structural relations** ("institutional arrangements", "structures, processes and traditions").

From the above interpretations of governance, it becomes clear that it is ultimately concerned, at the essential level, with *interaction*. Governance is about relationships between various actors confined by rules and structures of interaction which themselves dictate who or what holds power (the ability to make and enforce decisions) in relation to an overall purpose or aim.

In relation to the governance of large-scale public projects, Klakegg et al. (2008) define a governance framework as "*an organized structure established as authoritative within the institution, comprising processes and rules established to ensure projects meet their purpose*" (p.530). This definition is almost the same as those for governance in general but with the addition of "an organized structure". A framework, therefore, is the structural representation of governance, rather than something additional to it. To set out a formal definition for the purposes of this research thesis then:

> A **governance framework** is a conceptual structure that sets out the relationships between the relevant actors and the distribution of responsibilities, remits, and decision-making power between those actors, regarding an overarching aim or purpose.

5.3.2 The Research Gap

As highlighted at the beginning of Chapter 3, the attempt to both measure, account for, and then conserve/enhance the ecosystem service provided by BC habitats is to help reduce the emission of carbon compounds into the atmosphere and thereby help minimise global warming and draw down historical emissions[9]. As an attempt to extend the BC concept beyond the coastal zone, the same could be said of the impetus behind governing OC. More specifically, an initial goal could be to place the OC resource in a governance framework that facilitates the accounting of the resource on national carbon accounts (Luisetti et al.,

[9] Alongside other "ecosystem services" such as coastal flood protection and biodiversity enhancement.

2020). Such practice is key to facilitating national commitments to the United Nations Framework Convention on Climate Change (UNFCCC), specifically Article 4, which states:

> "*All Parties…Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases*" (UNFCCC, 1992, p.5, author's emphasis).

However, for OC, accounting would be very challenging, due to the mentioned uncertainty around its measurement, and given the common pool nature of OC, it may even create friction between the actors involved if not managed appropriately. Ecosystems in the marine zone have been largely ignored as relevant carbon pools for national carbon accounting (Cooley et al., 2019). In Luisetti et al. (2020), a direct call for a sedimentary carbon (i.e., OC) governance framework is made stating that, "*any policy framework for areas beyond national reporting boundaries has yet to emerge*" (p.6), providing direct evidence of an observed gap in required research to advance the aim of OC governance for the purposes of climate change mitigation, especially in light of the internationally shared (non-exclusionary) nature of the resource system in contrast to the rival nature of the resource unit.

For the last fifteen years or so, the emphasis in BC research has been on conceptualising the conventional BC ecosystems, plugging gaps in the knowledge of how these ecosystems sequester and store carbon (Macreadie et al., 2019; Thomas, 2014). The next stage is to further place this knowledge into practical management actions and governance strategies. This is therefore one of the main justifications for this research thesis. It is important to point out that this is particularly true of OC (and marine sea grasses) as mangroves and salt marshes have received more attention in terms of practical management actions and policies (Jakovac et al., 2020). Questions in this regard centre on the best management for enhancing carbon flow – fixation, transportation, deposition and burial – rather than storage because, as a process and flow rather than stationary stock, it is more complex to address from the standpoint of governance and management. This is especially true in the case of offshore carbon pools, due to the large scale of the resource system, the mobility of the carbon, as well as the international nature of its governance and appropriation. Highlighted by the preceding literature reviews, is the challenge of deciding how to co-manage a common resource system with various levels of carbon fixation, transportation and deposition across the resource area, as well as how to allocate the rival resource units in a way that satisfies each party.

An important problem for BC generally, and by extension OC specifically, identified in the literature, is the problems associated with measuring carbon, especially in terms of understanding its origin and pathways in the offshore zone (Macreadie et al., 2019). This is one of the key areas requiring development in order to move forward the utilisation of BC and OC ecosystems for the purpose of CC mitigation. Finding ways to determine where carbon in certain carbon pools has come from would make it easier to govern and manage OC within systems that contain various jurisdictions because it would help towards answering questions such as: which jurisdiction has predominantly contributed the carbon in a given store and therefore which jurisdiction has more responsibility regarding its fixation and transportation (i.e., its flow; its genesis within the ecosystem)? This relates to the preceding literature reviews, as it was highlighted in Chapter 3, that there are still questions over the measures and estimates of the carbon deposits as well as their attendant fluxes and processes. It is sensible to state that a resource will be very difficult to manage if it is difficult to measure.

Measurements of carbon are also key for economic carbon valuation and accounting. Interest in BC valuation has risen over time (Barbier et al., 2011; Thomas, 2014). This is because the language of economics and valuation allows BC to be included in a greater number of policy projects and management strategies[10] (Duarte et al., 2013). Certainty in BC valuations, whether coastal or offshore, is notoriously difficult to achieve when the uncertainty surrounding the carbon science is high (Luisetti et al., 2014). This research thesis helps in moving the socio-economic research on OC forward by questioning and analysing how OC stocks, and the biological pump that feeds them, can be governed. This contributes to the economic-carbon remit by providing (or moving towards) a governance framework for the governance of carbon stores across borders – a suitable framework for carbon governance cannot be provided until a clear understanding of intra- and inter-national transboundary responsibilities and privileges are gained and embedded within any conceived governance framework (Luisetti, et al., 2020).

5.4 Forward Look and Research Questions

This section describes the chosen research questions of the research thesis based on the literature review and related lessons learned, and the research gaps identified. I firstly

[10] This valuation drive has focused on the conventional coastal BC ecosystems but with attendant arguments from some researchers that the deep sea carbon stores could be worth considerably more in economic terms when compared to coastal BC ecosystems (Barange et al., 2017)

grouped all of the derived questions from Section 5.2.2 (listed in Figure 5.1) that arise when applying lessons on fisheries governance to potential OC governance, as well as key questions that arise throughout the literature review, to help derive the overall question groupings as a way to conceive the most pertinent research questions for the thesis. This grouping is displayed in Table 5.3. The major groups centred on the type of question: what/why, who, and how. And from each of these three groupings the thesis research questions have been derived (Sections 5.4.1 – 5.4.3). Therefore, this section aims to set out the three questions and the rationales behind them.

Table 5.3 *Research Questions*

Type of Question	Relevant Derived Questions (Section 5.2.2)	Remarks	Research Question
1. Why and What	• Why is there a need to govern OC? What is the utilisation i.e., what policy intervention could be employed? • What spatial variations might exist across an OC system? • How best to integrate the various parties?	These questions are highly exploratory, they ask what/how but are ultimately based on why i.e., to answer them an understanding of why OC needs governance is required. They come down to understanding the resource and the way(s) it can be utilised by people.	**1.** What are the policy options for utilising offshore carbon for the purpose of climate change mitigation?
2. Who	• Who are the stakeholders for OC as a natural resource? • Are there existing structures/institutions to include? • How best to include the various stakeholders?	These questions centre on who the individual parties/actors are – not so much individuals as organisations, institutions, networks and stakeholders. This makes intuitive sense in light of OC's CPR nature – commons are managed across different groups, so what are/could be the groups?	**2.** Who would be the relevant actors in offshore carbon governance?
3. How	• Can the number of interested parties be kept to a minimum? How? • Can lower levels of governance be integrated? Bottom-up? • How can OC governance build flexibility as well as stability? • How could spatial variations be accounted for? • How can changes that occur over time be incorporated?	These questions centre on governance in practice – how can the what/why/and who be brought together in implementation? Further, how can such a conceived system avoid troubles associated with other CPR governance systems, like fishing?	**3.** How do the findings inform a governance framework(s) for offshore carbon?

5.4.1 Research Question 1: What are the policy options for utilising offshore carbon for the purpose of climate change mitigation?

Following from grouping 1 in Table 5.3, it is apparent that an important gap in the conceptualisation of OC governance is its overall utilisation. Therefore, before a governance framework for offshore carbon can be informed and conceived, the policy interventions available for OC governance and management needs to be explored and defined. A governance framework must be geared to a particular end and a particular solution (or set of solutions as the case may be). This is essentially a *what* question (what are the possible uses of the resource? The possible influences human beings can have the on the resource and to what end? But it stems from the *why* – why manage it in the first place? As stated above, offshore carbon is being conceptualised as a novel natural resource (an emerging resource) because it is a natural carbon sequestration and storage system in the age of climate change, under the pressing policy need to combat climate change and reach an equitable climate. More specifically, natural carbon stocks and flows (be that terrestrial, atmospheric, coastal, or marine) are being valued and incorporated into various policy interventions to help nation states (and organisations and individuals) meet their commitments to combating climate change, as described regarding conventional blue carbon in Chapter 3.

But what are the policy interventions available for offshore carbon management? As an emerging resource, yet to be conceived within any system of CC mitigation, the initial options for OC (beyond the initial recording of stocks on carbon accounts) first require exploration. This was a pertinent initial question because all further questions concerning governance will be dependent on the overall aim of governance i.e., the central policy. By "policy" here I refer specifically to the policy of use (the utilisation). It is conceivable that natural resources can be utilised in various ways (even their non-use is a form of negative utilisation), as is the case with OC. For example, as a natural carbon sequestration and storage system, it could be used in ways similar to other carbon resources such as BC and rainforests/peatlands. This includes economic instruments such as Payments for Ecosystem Services (PES) or carbon credits, as well as more direct "command and control" options such as taxes and subsidies. It includes questions concerning conservation and whether OC can be integrated into existing policies concerning conservation (conservation being a "use" in its own right).

5.4.2 Research Question 2: Who would be the relevant actors in offshore carbon governance?

It is clear from the literature review on European fishing post-Brexit, placing an established CPR in context, that a CPR is embedded within a highly connected web of institutions, governments, and stakeholders i.e., actors. This is also a grouping of the questions that arise within the preceding chapters (2 in Table 5.3), asking the question *who*? Therefore, the rationale for RQ2 is simple: running alongside a better understanding of policy interventions (RQ1), a governance framework, following the definition of governance framework in Section 5.3.1, will need a clear understanding of the actors who operate within the framework given their importance as key constituent parts. As laid out in the definition, the governance framework sets out the relationships between the actors, their responsibilities and remits, and the distribution of power between them. None of these things can be studied further without a better understanding of the relevant actors themselves.

5.4.3 Research Question 3: How do the findings inform a governance framework(s) for offshore carbon?

The aim of asking RQ3 is to bring together the insights gained from asking the preceding two questions in earlier research within the thesis to inform later research more directly addressing governance frameworks. Category 3 in Table 5.3 groups the pragmatic how-questions that arise from reviewing the literature. It demonstrates that a clear question-grouping concerns the practical application of an OC governance that is required in order to successfully take into account the dominant lessons of CPR governance. RQ3, therefore, follows from the previous two RQs in order to meet the initial remit of the thesis – to inform a governance framework for OC. As such, this question stems from the literature, but it is also the natural next step after asking, and answering, RQs 1 and 2, and in relation to the overarching purpose of the thesis.

5.5 Summary

This research thesis is concerned with natural resource management and environmental governance. Specifically, as derived from the literature, the resource in question is *Offshore Carbon*. OC is defined as a natural system of carbon sequestration and storage in which particulate organic carbon (POC) is fixed, transported, deposited and buried by natural

systems (the biological pump i.e., the flow) with a significant portion eventually stored for the long term in shelf sea sediments (the stock). Crucially, such a resource can be conceived of as different types of economic good in different contexts, spatially and over time. Primarily, it is a common pool resource system. The argument for this is that it contains the three components of a CPR system, following Elinor Ostrom: a resource system, a resource unit, and resource appropriators. The resource system is the overall geographic area and ecosystem that facilitates the biological pump and hosts the seabed sediments. The resource unit is the carbon ultimately measured when stored within the sediments (carbon stock). The appropriators are nation states or *jurisdictions*. The significance of OC as a CPR is that any resource governance must be embedded in issues surrounding collective action problems and the requirement that a shared system of responsibility and management be conceived between the various appropriators by necessity i.e., it dictates the type of governance OC requires as one of international co-governance.

The main gap in the literature that justifies this research is largely that there is very little research on the topic of OC as a natural resource/ecosystem service/nature-based solution akin to conventional BC. As an emerging resource therefore, it requires initial conceptual and hypothetical research to begin to explore the possibility of OC as a methodology of CC mitigation. There are calls for the inclusion of OC and shelf sea sediments in carbon management strategies to aid efforts in CC mitigation. The calls for a governance framework for OC stem from the research on BC and looks to extend the BC remit to include other forms of marine-based carbon sequestration and storage. These calls for further research also stem from research on the economics of carbon, which have to date largely been focussed on costal BC when in a "blue" (coastal/marine) context.

The various literature reviews undertaken for this thesis inform the aim and research questions. Together, these elements provide the foundations of this thesis and are the basis of the proceeding research to contribute to the overarching purpose of informing a governance framework for offshore carbon. In the following chapters, the application of a variety of methods is described, with the subsequent findings laid out and discussed. The thesis methodology is justified and explained in the next chapter, Chapter 6 – Methods.

Chapter 6 |

Methods

6.1 Introduction

This chapter explains and justifies the chosen methodologies, with specific regard to discussing the justifications and limitations. The practical manner in which each of the methods were applied – the processes of data collection and participant selection – are explained in each subsequent research chapter (Chapters 7, 8 and 9). The chosen research methods are semi-structured interviews (Chapter 7), and a scenarios analysis (Chapter 8) in combination with an online open-question survey (Chapter 9). Chapter 4 is also an empirical chapter utilising the method of systematic literature review (SLR). This, however, was part of the literature review and the justification and rationale of the use of SLR is explained within the chapter (see Section 4.1).

Interview and survey are both social scientific methods aimed at generating data from human participants. In each case, the participants involved were knowledge experts in fields related to OC with the rationale that such experts would be best placed to offer insights that would answer the given research questions. As explained in Section 1.2, the novelty of OC as an emerging resource and potential method of CC mitigation means there are no existing OC *actualities* to act as subjects of research i.e., there are no currently existing OC policies, institutions, specialists, regulations etc. Hence the adoption of a strategy of participant consultation with knowledge experts in adjacent fields in order to discover insights that could potentially inform OC from similar contexts. Specifically, the adjacent fields utilised were blue carbon, marine governance, environmental governance in

general, fisheries governance more specifically, environmental economics, and natural resource management. The selection of the given populations and their recruitment are described in more detail in each of the relevant chapters (Chapters 7 and 9).

This chapter explains, justifies, and explores the limitations of each of the three methods: interview (in Section 6.2), scenarios analysis (6.3), and survey (6.4). It then does the same with the method of analysis used throughout – thematic analysis (6.5). This is followed with a discussion of alternative methods that were considered and why they were not considered suitable for this research (6.6).

6.2 Semi-Structured Interview

This section sets out the justification and limitations of semi-structured interviews. It begins with a short explanation of the different types of social-scientific interview followed by how the interviews were realised in practice. The process of data collection, the findings, and a discussion of the findings are described in Chapter 7.

There are three broad categories of interview in social research: structured, semi-structured, and flexible (following Bryman et al., 2021). Structured interviews follow a set script of questions with no deviation from the script, used in quantitative research, often with the use of scales e.g., "please indicate on a scale of 0 to 5 your preference for…". Flexible interviews are the opposite in that there is often no script or simply a small set of prompts, this allows the interviewer to talk naturally with their interviewee and explore the topic of research in a more informal and naturalistic way. Flexible interviews are therefore used in qualitative research in which the researcher is looking for "*rich, detailed answers*" (Bryman et al., 2021, p.426). Semi-structured interviews are another method of qualitative interview but lie between the other two by following a set interview script of questions in which the interviewer has a degree of control to direct the interview in meaningful directions by deviating from the script if they think that helps collect the "rich and detailed" data required of qualitative research. At the same time, the script offers consistency between interviews (especially if there is more than one interviewer conducting separate interviews). For this thesis, the interviews were qualitative and semi-structured, for reasons stated in Section 6.2.1, leading to the collection of transcripts of qualitative textual data. Twenty experts in blue carbon, marine governance, environmental economics, fisheries governance, and some governmental policy experts were interviewed. For a breakdown of participant recruitment and other processes involved in the interviews, please see Section 7.2.

6.2.1 Semi-Structured Interview – Justification

Qualitative Interviewing is a well-established method in the research of the governance and management of natural resources (Biggs et al., 2021; Bryman et al., 2021; Cundill & Fabricius, 2010; de Vos et al., 2019; Newing, 2011). As such, its use as a method requires no justification in and of itself, what is required is a justification for its use in this particular project. Essentially, the reason stems from OC's nature as an emerging resource. As explained in more detail in Section 6.6, the methods available to research OC, as something which exists as an idea, or concept, are limited. A fundamental way one can explore an idea is in conversation with knowledgeable people, it is much harder with other potential methods in the social scientist's toolbox that require the subject of research exist beyond the concept stage. Additionally, the literature review was wide-ranging and touched on multiple aspects, which in turn raised a number of possible subjects for further research, and the research questions themselves. A good, comprehensive way to explore a wide range of subjects is via a semi-structured interview, allowing for in-depth and qualitative conversation on a range of eclectic subjects e.g., BC concepts such as leakage and the use of economic instruments, or aspects of governance such as monitoring and conflict mediation. The interviewer being able to adapt the semi-structured interview to the individual's expertise and confidence with given subjects, while still remaining consistent with what is broadly addressed in each interview (something a flexible interview approach would find it challenging to facilitate). Such a thing cannot be done with alternative social methodologies e.g., an institutional analysis, or is much harder to achieve with the likes of, for example, a document analysis.

6.2.2 Interview – Limitations

The key limitations of semi-structured interviews are true of all qualitative research (Bryman et al., 2021). The first is the inability to generalise from the data to a given population – my results did not verify if all experts in fisheries governance believe proposition A, or that all environmental economists believe in position B. This is because the population interviewed was not large enough and working to achieve such a thing with the time consuming and complex job of semi-structured interviewing would be impractical. But also, importantly, generalisation is not the intention. Instead, in this thesis at least, the unpacking and exploration of a concept to gain important insights was the intention, hence the use of qualitative approaches in the first place.

The second major limitation lies with the focus on the individual researcher and their interpretation, which can lead to inadvertent biasing of the results as a subsequent result of the necessary involvement of their own subjective viewpoint i.e., no matter how hard a scientist may try to render themselves the perfectly neutral researcher of scientific folklore, they can never completely achieve such a thing, as Sokloradis (2009) states:

> "*The notion of the researcher being separate from the subject of research is neither desirable nor possible. As a qualitative researcher I understand that no matter how faithfully a researcher adheres to scientific methods (qualitative or quantitative), research outcomes are neither totally objective nor unquestionably certain*." (p.722).

A double-edged nature can be interpreted in the semi-structured interview, lying in its inherent flexibility, which allows the interviewer enough liberty to contrive the interview on the fly; to adapt the needs of the research questions to the answers that are given in the moment. This is "double-edged" in that such flexibility could be regarded as "unscientific", generating results that are difficult, if not impossible, to replicate (Biggs et al., 2021). But it is also the nature of human-generated data that, even if one were to follow a strict survey script, highly amenable to reproduction, the answers given may change depending on a wide number of variables: from something as dramatic as the participant having recently suffered a bereavement, to something more mundane such as skipping breakfast. Each would likely affect the individual being interviewed to such an extent that the pure replicability, characteristic of the natural sciences, becomes unobtainable. Indeed, semi-structured interview was chosen precisely to enable the elicitation of individuals' perspectives and views, which can be rich and complex and generate such forms of data; these were deemed valuable at this stage of the development of the notion of OC as a form of BC.

6.3 Scenarios Analysis

Scenarios Analysis is the creation and interpretation of narrative story lines for the primary purpose of facilitating strategic conversations and, eventually, the decision-making process (Schwartz, 1991). Originating in the defence sector and in business, it is not a method of prediction – scenarios are not foretelling what *will* happen – but rather an exploration of what *could* happen in order to inform the chosen strategies of a country, organisation, business, individual etc. (Bradfield et al., 2005). The point is to help organisations and the

like to view things from an angle they would not normally, in order to shore-up their positions and strategies. This means the process is geared towards facilitating decision-making and the outlining of possible strategies i.e., approaches. Which is why it was utilised in this thesis to advance the research on OC.

Scenarios analysis originated in business but has increasingly been used in social ecological systems research from the local level, where the emphasis is often on stakeholder engagement (Oteros-Rozas et al., 2015), up to the global level, where they are used to inform decision making and facilitate large scientific studies and models (Kok et al., 2017). A recent paper by Mclaren & Corry (2021) discuss the utilisation of future practices – which include scenarios – concerning geoengineering opportunities that, like OC, are emerging and yet to be realised in practice:

> *Geoengineering technologies do not yet exist as technical systems… In other words geoengineering exists in the form of 'future practices'… future practices are not simply imaginings but are underpinned by socio-material objects, 'future objects', including models, scientific apparatus, scenarios, pictorial or textual representations… future practices matter because they not only describe or project possible futures, but also affect the future – they are constitutive 'techniques of prospection', especially when backed by material, cultural and political resources of production.* (p. 22, author's emphasis)

The utilisation of the specific futures technique of scenarios analysis in this thesis is a similar attempt to create "future objects" for OC to "affect the future" as a "technique of prospection". Affecting the future comes in the form of utilising the scenarios in conjunction with the survey to discover insights into the potential governance of OC, acting to "prospect" some of the more detailed nuances and themes that arise regarding OC's governance at this early stage in OC's development as a "future practice".

6.3.1 Scenarios Analysis – Justification

There were three main reasons for adopting a scenarios analysis approach following the interviews, with each centering on the approach's suitability for furthering the central purpose of the thesis:

- Informing next steps: It falls to this project, as a novel project at the beginning of OC governance research, to discover key research gaps and work out the next steps for OC governance. The scenarios can be used as tools ("techniques of

prospection"), not only to help conceptualise the topic for future research, but also to help further explore the topic, as is demonstrated in Chapter 9, and so can be instrumental to this central purpose.

- OC's novelty requires imagining: As discussed above in Section 6.3, at this stage in OC's development, very little has been researched on the topic and there are no specific OC policies, or governances in play. With limited examples of other emerging natural resources similar to OC to study, anyone coming to understand OC as a method of CC mitigation will find it difficult to imagine and build upon. Therefore, if OC is an emerging resource, it is self-evident to state that creating potential futures – scenarios, or "future artifacts" – grounded in existing research, both my own and others, have the potential to be highly instructive for developing future OC governance insights.

- A focus on strategy: As stated above, scenarios were first developed in the business community with an eye to helping major businesses strategise and prepare for unforeseen future changes (Schwartz, 1991; Van Der Heijden, 2005). Therefore, the central purpose of scenarios is to devise strategies i.e., different approaches that can be taken. Scenarios can therefore help anyone interested in OC as a method of CC mitigation to better understand the different ways it could develop and gain form.

6.3.1.1 Justification – Intuitive Logics Approach

There are a number of different techniques and approaches within scenarios analysis (Biggs et al., 2021). The approach I chose is called *Intuitive Logics* (IL), sometimes known as the *2x2 Double Uncertainty Matrix*, or the *GBN Method*. First developed by the Global Business Network (hence GBN Method) to help businesses and corporations prepare for unexpected events in the future, IL normally works by having knowledgeable participants brainstorm the most uncertain and high impact factors affecting a central issue or question (Biggs et al., 2021; Rhydderch, 2017; Schwartz, 1991). These are then ranked by participants on their uncertainty and their impact, with the most uncertain and the highest impact factors chosen as the two dimensions that form a 2x2 matrix. Each quadrant of the matrix is therefore clearly defined from the next and so each provides a different scenario. These quadrants/scenarios are then elaborated upon to form distinct narratives of the future. Crucially, although it is possible to combine this approach with modelling and quantitative

data, the approach is fundamentally qualitative and intuitive. The researcher(s) then extrapolate logical conclusions from the participant's 2x2 table to examine what will affect the issue over time within a particular quadrant. IL was chosen for the following reasons:

- No numerical models required: Other approaches, such as *La Prospective* (Godet, 1986), require the inclusion of data derived from models, or some model component. As there are no appropriate model data for OC governance, I needed to use an approach that does not utilise models.

- Highly adaptive: Each utilisation of scenarios by researchers is typically slightly different from the next, including IL (Rounsevell & Metzger, 2010). So, there is inbuilt flexibility to the method in general. This made it adaptive to my and the project's requirements and constraints. Such limitations being a general lack of previous research on the topic and a lack of familiarity with the topic among potential participants if a participatory scenarios approach was taken.

- Well established: IL is one of the most established methods of scenarios analysis (Biggs et al., 2021), allowing me to be more confident in the application of a method that was brand new to me. As well as helping to deal with a key limitation of scenarios – the possible perception of illegitimacy, especially among people ignorant of futures techniques. A more established method would be perceived as more legitimate.

- Relatively straight forward implementation: IL has a fairly straight-forward, step-by-step process that can be followed in a straight-forward manner. This makes it a practical choice in light of resource and time constraints and followed a logic of keeping things simple and not over-complicating matters, where possible.

Scenarios as a technique are highly adaptive, with a high level of variability between studies in the manner they are used and implemented (Biggs et al., 2021). For example, although some studies use participatory workshops to brainstorm the factors and the two dimensions, others use Delphi surveys or other forms of participatory data collection to construct the scenarios (Ho, 1998). In this thesis, I decided to use the interview data from the preceding interview study (Chapter 7) to construct the set of scenarios described in Chapter 8. This is because I believe the interview data provide a swathe of expert opinion on the topic, enough to form the basis for an Intuitive Logics scenarios analysis.

Additionally, because there is so little research on OC governance, there are no previous studies from which to draw evidence, causing me to be quite reliant on my own research.

Part of the decision for this approach came after reading a study in which Ho (1998) constructed initial scenarios and backcasted participant feedback through a Delphi Study, providing an example of how to go about utilising scenarios with a backcasted approach. Additionally, Muskat et al. (2012) provide an example of using interview data for initial scenario construction:

> *"The in-depth scenarios…were then constructed using a qualitative approach based upon an in-depth, thematic analysis of the expert interviews, whereby the specific expert knowledge was used to build scenarios according to the given descriptors*" (p.16).

Reading studies such as these encouraged me to design my scenario analysis along similar lines. Additionally, they help to emphasise how adaptive and interpretive scenarios analyses – and futures techniques in general – are, with each instantiation different from the next.

6.3.2 Scenarios Analysis – Limitations

The limitations of scenarios are, as with interviews, "double-edged", in that they can act as benefits or hindrances depending on perspective. Some of the major issues in scenarios relate to participatory scenarios (most scenario analyses are participatory) related to participant selection, poor facilitation and problems of power inequality among participants (Biggs et al., 2021). My analysis avoided these problems by basing the scenarios on the interview data (alongside the insights of the literature review). Although the interviews were technically participatory, the participants were not interviewed together, or required workshops and facilitation, avoiding many of the pitfalls identified above. However, the double edge here is that my avoidance of a participatory approach is itself a limitation. Although derived from the preceding research, the building of the scenarios was done by myself only, meaning they were limited by my perspective, temperament, inherent biases etc. I accounted for this by following the most systematic method I could find – the GBN method – in order to more strictly structure my scenario building, helping to remove myself from the process as much as possible. Additionally, the arguments concerning researcher influence voiced in Section 6.2 also apply here.

As has been emphasised, there is no stringent set scenarios method and scenarios approaches are highly adaptive. Although this allows scenarios approaches to be very enabling, with different research projects able to adapt an approach specific to its needs and limitations, it can (the double edge) lead to a problem of legitimacy, especially among people in fields that do not utilise scenarios often. A healthy scepticism should be welcomed, but as emphasised in the scenarios literature, scenarios are not predictive but tools of strategy and facilitation (Biggs et al., 2021; Oteros-Rozas et al., 2015; Schwartz, 1991). Their explicit intent is to help people *think* about and *discuss* an issue, topic, or idea.

6.4 Open-Question Survey

This section sets out the justification and limitations of a qualitative, open question survey, used in combination with the scenarios. It begins with a short explanation of how the survey was realised in practice. The process of data collection, findings and a discussion of the survey findings are described in Chapter 9.

Following (Bryman et al., 2021), a survey is a form of self-completion questionnaire and can be seen as similar to interviews in that a participant(s) is asked a question of some kind. Whether a researcher is present determines whether the method is interview (researcher present) or survey (participant completes the questions themselves). As with interview, the type of questions can vary depending on the type of data being pursued – closed questions (i.e., questions that can be answered with "yes" or "no", or with a limited number of answers) and those designed on a numeric scale for quantitative data, and open questions that look to discover more in-depth and rich results for qualitative data.

For this thesis, a qualitative survey was conducted online, asking seven, open, in-depth questions (i.e., questions that do not lead to one-word answers or the ticking of boxes but sentences of written response). As OC is not a topic that is well known outside of a very small population of researchers, the participants were asked to read some information on OC and to read over four scenarios (as described in Chapter 8) derived from the preceding research before completing the online survey. They were invited to do this via a *Storymap,* an online webpage depicting the required information. More details on the survey are provided in Chapter 9 (Section 9.3).

6.4.1 Open-Question Survey – Justification

To use scenarios as "techniques of prospection" (following Mclaren & Corry (2021) above), it was necessary to combine them with a method of data collection i.e., a form of "prospecting". A qualitative survey approach was chosen for very similar reasons as those for interview, namely that the strategy to engage with knowledge experts to research OC governance at this early stage of OC as a concept is supported well by a qualitative survey. Additionally, the scenarios could be easily utilised in combination with a survey by preceding it – asking the participants to read over the scenarios before answering the survey questions and keeping them in mind throughout.

The survey was an open-questions survey (i.e., utilised open-ended questions, which means that the participant is free to say all that is appropriate related to that question) which allowed the participants to delve into as much depth as they wished for as many of the questions they wished to answer. This gave the participants the freedom to express their particular expertise and prevented any bias from, or behaviours of, an interviewer (or researcher) present that may have influenced their responses. It meant they had time to complete the task and could skip forward or backwards to change their answers if they wished. The downside of using an open question survey was that participants were not obliged to answer every question and could skip the majority if they so wished. Additionally, the answers did not facilitate any reasonable quantification of the data which a closed-questions survey (in this case respondents are given a list of potential answers to choose from) would have allowed. The justification for the use of open questions lies in the type of data deemed most valuable at this stage of OC's development, open questions facilitate the collection of knowledge from knowledge experts, giving them enough freedom of expression to do so effectively.

Regarding the use of the storymap service in the survey, *Esri's ArcGIS Storymap* application allows anyone to produce what Esri refers to as a "storymap" – an online, browser-based web page in which one is invited via a web link to scroll down the page, through different sections, reading any prose, diagrams, maps, pictures etc., put in place by the storymap author. Importantly, the process tells a story and is designed to be read chronologically, section by section. I decided to use this service for the following practical reasons:

- It facilitated precisely what was needed which was to convey information about OC and the project to the survey participants while also displaying the scenarios and providing a link to the online survey.

- It was free to use and anyone anywhere in the world can access it as long as they have connection to the internet and access to a web browser.
- It is very easy and intuitive to use. I did not have to learn complex web-building or web design concepts to build a website from scratch, which was the initial plan before I learned of Storymap. This saved time and allowed me to be more efficient.

6.4.2 Open-Question Survey – Limitations

Although surveys can of course be used to collect quantitative data, in this thesis they were utilised to collect qualitative answers of substantial text (a paragraph or so for each answer), so, as with the interviews, transcripts of textual data were collected. As these two methods were utilised to collect similar data end-products, and they are the most widely utilised methods of data collection in qualitative social science (Bryman et al., 2021), their limitations are highly similar. As such, regarding some of the limitation of surveys, please see Sections 6.2.2 above, with further points made as to qualitative limitations in Section 6.5.2 below.

6.5 Thematic Analysis

The interviews and survey asked the participants questions that produced in-depth, qualitative answers in written English (i.e., a transcript), and therefore required a qualitative textual analysis. There are only a few established options for doing so, these are outlined in Section 6.5.1, alongside a justification for why I utilised thematic analysis (TA), and thematic analysis only, throughout this thesis to analyse the SLR, interview and survey data. Differentiated from other approaches to qualitative analysis by its lack of a clear origin, and that it only involves itself in the analysis of the data, not collection of data, or production of original theory, TA uses coding to sort the data into “super ordinate constructs”, or themes (Langdridge & Hagger-Johnson, 2013). This section first justifies and then discusses the limitations of choosing TA, and TA only, in Sections 6.5.1 and 6.5.2 respectively. Then, in 6.5.3, I explain the process of thematic analysis I put into practice following data collection.

6.5.1 Thematic Analysis – Justification

A stated in Section 6.5, a degree of coding and sorting into themes is often necessary with qualitative textual data. TA enables the organisation of a large amount of textual data into discreet and informative categories. By creating *themes*, the data could be understood and interpreted in relation to the research aims and overriding research question. The justification for why only TA was used lies in understanding the other options of analysis available and why they were not appropriate for this thesis research. Following Bryman et al (2021), there are four broad strategies for qualitative transcript data analysis, one of which is the chosen TA. The other three are outlined below with an explanation as to their (un)suitability relative to the type of data and the research aims for both interview and survey.

Analytical Induction: an iterative process in which an explicit hypothesis is derived from a given research question. The data are then continually checked for whether they back-up the hypothesis or deviate from it. If a deviation is encountered, the researcher then chooses to reformulate the hypothesis to incorporate the deviation, or the hypothesis is redefined to explicitly exclude the deviation.

- This was not appropriate because no hypothesis was derived from the research questions. Indeed, the research questions are explorative, not hypothetical. The intended purpose was to essentially place the idea (OC governance) in front of a knowledgeable population and record how they reacted to certain questions with no presupposed idea of what the responses would be.

Grounded Theory: a well-established method utilising thematic coding, grounded theory explicitly aims to produce original theory from qualitative data (Walsh, 2014). The researcher engages in an iterative process in which the data are analysed and interpreted throughout the process of data collection, and after collection has finished. Bryman et al. state that "*given the many facets of grounded theory, it can be tricky to identify what the approach is and what it is not, as it can appear very similar to a simple inductive analysis*" (2021, p.527). This is exacerbated by the long-running disagreement among established social scientists as to what *exactly* constitutes the grounded approach. Key to the approach is its aim to produce a theory and the constant, iterative manner in which the researcher engages with the qualitative data to do so.

- The Grounded approach was not suitable for this study because I did not set out with the intention of producing a theory. Although producing a theory could be worthwhile and a fruitful pursuit for OC governance, I do not believe it was

appropriate to pursue at the given stage in OC's development as a concept i.e., I did not believe at the given stage of the research that there was enough existing underlying research and expertise on OC governance on which to build a theory.

Narrative Analysis: here, the emphasis shifts from working out what is present in the data – as is the case with *Thematic* and *Grounded*, the coding strategies – to working out how participants have interpreted whatever is the focus of the study e.g., not the subject 'raising children', but how the participants have made sense of their experiences of raising children. This strategy therefore places value in gaining a qualitative understanding of the stories people tell themselves and others. As such, the researcher must have a clear intention to conduct a narrative analysis before collecting data as it greatly influences the type of questions asked and the methodology applied e.g., asking an interview question such as "tell me a time when…", rather than, say, "what do you think of…".

- Narrative analysis was quickly deemed inappropriate for this study as the subject of research was not how those with experience working in fields adjacent to OC governance have interpreted their experiences of their field, but their knowledge of the subject itself i.e., the participant is not the subject of the research.

In the absence of more original options for an analysis of textual, qualitative data, I was left, by a process of elimination, with the remaining approach – the standard thematic analysis – for both the interviews and survey responses.

6.5.2 Thematic Analysis – Limitations

The limitations of TA are very similar to those of qualitative methods and analysis in general, which were already addressed in Section 6.2.2: namely problems of replicability, and reliance on the researcher and their interpretation of the data. Both can lead to issues of perceived legitimacy and the same can be said of the main form of qualitative analysis in this thesis – TA. Used in all three empirical chapters (Chapters 4, 7, and 9), this thesis relies heavily on TA. As argued above, this was because I believed the other options of analysis were not appropriate and that the standard qualitative methods of interview and survey were the most appropriate for this research at this time (themselves often heavily reliant on at least a degree of coding and TA). Regardless of how the decision was justified, the use of thematic analysis could be construed as an *over*-reliance.

To address this, I reference the arguments already made regarding the use of qualitative methods in general, given the limitations between TA and qualitative analysis are so similar. I argue that the thesis was, from the outset, a social scientific exploration of governance. This entailed the use of qualitative methodologies which in turn are heavily reliant on coding and the creation of themes. A different method of analysis would have been utilised to introduce some diversity, but as explained in Section 6.5.1, none of the other methods of analysis were appropriate relative to the chosen methods.

Addressing the points made in Section 6.2.2 regarding researcher-interpretation in the context of analysis, TA places great emphasis on the researcher themselves and their ability to interpret the data, subject to their in-built prejudices, predilections, and general thoughts on the topic of research. Watts (2014) advises researchers account for this by attempting to understand the participants' first person perspectives throughout the analysis:

> *"Most qualitative methods focus…on the understanding, interpretation and explication of meaning. To conduct this kind of semantic analysis, to properly interpret what the words of a specific participant mean, it is first necessary to understand those words (and perhaps even the participant) on their own terms…Closeness to the data is duly achieved by understanding each participant's words, from his or her own perspective, and hence according to the terms that individual has set. It will be achieved, in other words, by adopting and maintaining a first-person perspective during data analysis."* (p.4)

Hence the manner I constructed my analysis, as set out in Section 6.5.3 below, utilising an inductive first-person approach for the initial and 1st order coding. Key here also is Watt's point that TA concerns the understanding of *meaning*, which is measured inductively at first to ensure the participant has been properly understood from their perspective, then deductively after this initial viewpoint has been captured. Again, I constructed my TA following this logic, to account for the potential problems regarding rigour and bias in the researcher.

Section 6.5.3 points out that the survey data were analysed slightly differently than the interviews, helping to highlight an important point regarding TA, that it is adaptive, as Finlay (2021) states:

> "*Importantly, the form of* [thematic] *analysis engaged depends on the research and methodological context as well as on the type of data collected, the researcher's own preferences, and what is required by others (e.g., the journal, examiners)."* (p.114).

Hence my survey analysis adopting a more literal and descriptive coding to suit its distinct purpose and design. It was still inductive and 1st person, but not relying so heavily on suspending my own "self" from the research as there was much less room for interpretation when compared with the interview data.

6.5.3 Thematic Analysis – Process

The analysis for both the interviews and surveys was inductive at most points of analysis i.e., I did not approach interpretation of the data with a set of preconceived categories or a set theory but rather aimed to regard the data from the interviewees' first-person perspectives. This is in contrast to a possible deductive approach which aims to interpret the data through a given theory or set of predefined categories. This distinction is sometimes referred to as *closeness* (inductive, 1st person) and *distance* (deductive, 3rd person) (Watts, 2014). However, qualitative analysis usually trades between inductive and deductive at different stages depending on the aims of the analysis, as was the case with the analyses is this thesis, conducted across stages (as depicted in Figure 6.1).

After the first inductive read-through to take note of initial thoughts and interpretations, the themes in the data were determined through the standard qualitative research practice of coding. The coding was conducted in three stages – 1st order to 3rd order – for each transcript following (Langdridge & Hagger-Johnson, 2013), and utilising *Lumivero's NVivo* software. The 1st stage used an inductive and descriptive approach to ascertain meaning across the data. This entailed reading the transcripts and highlighting the relevant content descriptively, on the participant's terms (from their first-person perspective).

The 2nd stage also employed an inductive approach but to a lesser extent. The 2nd order coding interpreted the data but still remained "close" to the data i.e., I did not reference external theories or categories. It involved grouping the relevant descriptive codes into apparent themes, or "super ordinate constructs" (Langdridge & Hagger-Johnson, 2013).

The 2nd order stage was followed by a 3rd stage involving "pattern coding" in which I grouped the thematic groups into wider categories and groupings – which were placed relative to the wider conceptual and theoretical context of the field, as informed by the literature review and wider literature.

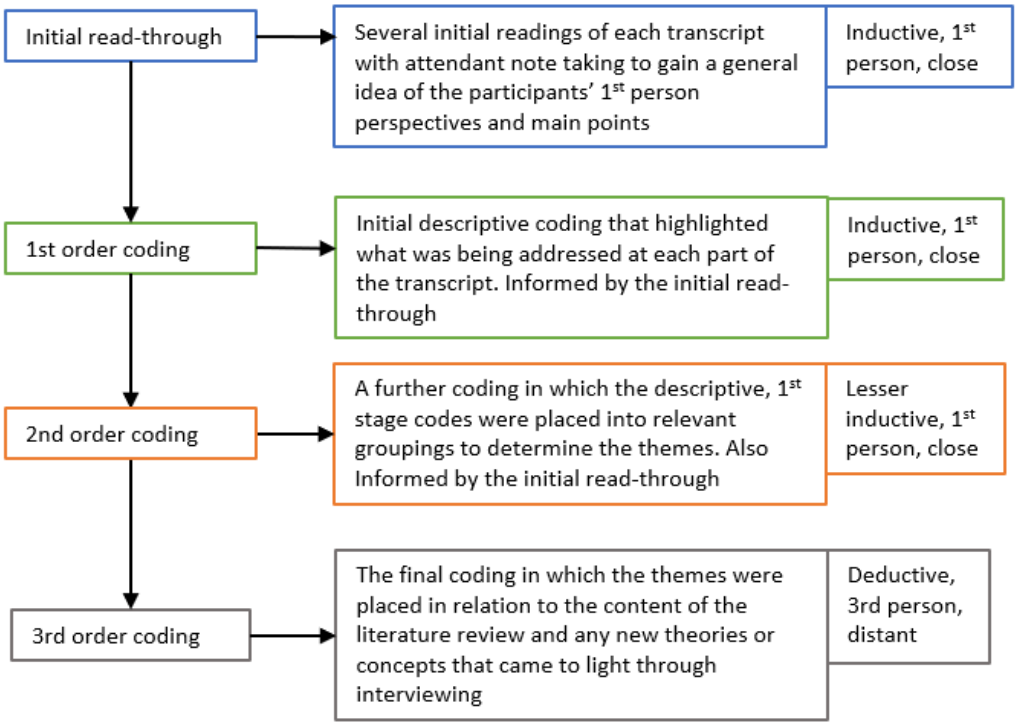


Figure 6.1 *The different progressive stages of the qualitative analysis.*

However, when it came to analysing the surveys (Chapter 9), the 2nd order coding was deemed superfluous because the participants gave much more descriptive answers i.e., answers to be taken at face value and not constitutive of underlying meanings that could be said to be "hiding under the words". But this was by intention. For Chapter 9, the intent was to utilise the scenarios to spur the thinking of the participants regarding much more direct questions of governance than were put to the interviewees.

6.6 Alternative Methodologies Explored

There are two major aspects of OC that greatly limited the type of methods that could be employed to answer the research questions: its novelty, and its nature as a concept, rather than something that exists in some form of actual practice. Novelty means that the questions needing asked at this stage in OC's development as an idea and method of CC mitigation are fundamental, foundational, conceptual and highly explorative. They are not questions of detail, minutiae or specifics. For example, researching the specifics of contriving an actual carbon credits system for OC would not be appropriate at this stage, rather, more appropriate are foundational questions asking what a carbon credits approach might entail

for OC, or whether it would even be feasible. Only some methods in the social science toolbox are appropriate for such questions e.g., qualitative interview.

The fact that OC does not exist beyond the realm of ideas, means there were no quantitative aspects of the real world to measure[11], no existing networks to be subject to a network analysis, no OC institutions for an institutional analysis etc. The thesis could have adopted a comparative approach – as was done with the SLR in Chapter 4 – and looked at comparable networks, institutions etc., and measured them in a comparative way i.e., if existing institution A is structured similar to a potential OC institution B, then via an institutional analysis, we can learn insights regarding A that could be logically applied to B. But again, as the research questions were very foundational by necessity, a comparative approach with alternative methods would still rely on answers to more foundational questions yet to be answered such as "is OC as a method of CC mitigation feasible in the first place"?

As a dominant strategy of expert participant consultation was taken, for reasons outlined in Section 6.1, other participatory methods were explored. In particular, Q-Methodology and the use of a workshop instead of survey following the scenarios. Q-Method, following (Watts & Stenner, 2012), asks participants to sort a number of written statements, depicted on an online software or on physical cards, according to instruction e.g., sort into preference, least preferred to most preferred. This is done following a set structure so the results can then be placed through a factor analysis (a type of statistical analysis, often using computer software). The result is that each participant produces a "Q-sort" (an individual assortment of the given statements) which are then related to the others and dominant groupings of the sorts are created systematically i.e., the factor analysis is able to group similar answers together given the distribution of the statements within each of the Q-sorts relative to one another. The researcher then engages in a qualitative and interpretive exercise of reading all of the grouped Q-sorts to understand why the factor analysis has grouped them together. This process therefore creates groupings of *subjectivities* which are then interpreted by the researcher.

This later point is why it was deemed inappropriate for this thesis. Q-Method lends itself to understanding how a particular population is split in its interpretation of a given subject e.g., what are the views of secondary school children in UK schools on homework? In other words, there has to be a variety of subjective viewpoints in a population in order to utilise

[11] For a social scientist at this stage in OC's governance research at least, obviously there are plenty of quantifiable measures that can be collected for OC, in the physical sciences and economics.

Q-Method. But with OC, as a novel concept, it is not established enough for different viewpoints to have formed yet in the given population; most participants would be very unsure and unconfident when sorting their OC Q-Sort.

Unlike Q-method, a workshop approach following the scenarios, instead of online survey, would have been very possible. Indeed, it was explored as an option, as was the option of doing both in combination (throughout the process of survey data collection, the possibility of workshopping remained on the table). The choice to go with survey or workshop could have gone either way and there was no standout reason for either. As such, I decided on survey, having been inspired by other studies, referenced above, that utilised Delphi in combination with scenarios, and because survey would allow me to recruit participants from much further afield (workshop participants having to come mostly from the UK) (Ho, 1998; Muskat et al., 2012). Additionally, as set out in Section 9.3.7, when the decision was made to pursue a workshop alongside the survey, I sense-checked if potential participants would be willing and able to attend. The general response was negative, given time constraints and a general wariness and lack of confidence discussing such an unfamiliar topic.

The Covid-19 pandemic also influenced my research, limiting the manner in which I could apply the research methods, rather than the methods themselves. The UK went into lockdown in March 2020 – six months into my first year of thesis research. There were then two more lockdowns over the course of 2020 and 2021, with attendant changes to the way people were working (working from home, at a distance etc.) and a move away from in-person interaction and events. As such, the interviews were all conducted online, in spite of the initial intention to do these in person (at least those based in the UK). It is difficult to know what impact this had on the interviews. Covid-19 also affected my options for constructing the scenarios. Although lockdowns had finished by the time these were planned (Autumn 2021), the culture of safety and caution that had been engendered regarding meeting in large groups made it difficult to know if potential participants would attend a workshop or similar event. As such, I decided to build the scenarios myself using the interview data, coupling these with an online survey, rather than organising specific workshops to discuss the scenarios with people in person and online.

Chapter 7 |

Expert Views on the Conception and Realisation of Offshore Carbon

7.1 Introduction

Building upon the research in preceding chapters (the SLR on European fisheries governance and literature review synthesis), this chapter sets out to explore key components of a hypothetical policy for the natural carbon sequestration and storage system represented by OC. To do so, twenty in-depth, qualitative interviews were conducted with experts in fields related to OC. The rationale for doing so was detailed in Sections 6.1 and 6.2. The interviews were then analysed using a thematic analysis, as outlined in Section 6.6. The over-arching themes regard the conceptual underpinnings of an OC realisation as well as its eventual implementation, which include aspects such as institutions, carbon accounting, and politics. The findings offer foundational insights, including three main foci on the future of OC governance: different ways to conceive of OC's value; the potential for political cooperation regarding OC, both between jurisdictions and between different uses of the marine zone; and the importance of exploring the different ways human beings disrupt OC systems. These three "hinges" can be summarised as *Value*, *Political Cooperation* and *Disruption*.

The chapter begins with a detailed description of the process of data collection in Section 7.2. Then, nine subthemes are relayed and explained under two overarching subthemes in the findings Section 7.3. This is followed by a discussion of the findings in 7.4. The chapter finishes with a conclusion in 7.5.

7.2 Data Collection

The choice of qualitative interview was explained and justified in Chapter 6 – Section 6.2. Here, the process by which the interviews were conducted and completed is set out. First, the aims of the interviews in relation to the research questions and the interview protocol are explained. Secondly, the process of deciding upon and searching for participants is described. This is followed by ethics and data protection, piloting, and finishes with a note on the participant response rate. As explained in Chapter 6, the interviews were analysed using a thematic analysis. For more information on the analysis, please refer back to Section 6.5. The information in this section is supplemented by Appendix 2, which sets out the interview protocol, and Appendix 3, a Project Summary that was sent to each interview participant to read in order to provide context, in preparation for the interview.

7.2.1 Interview Aims and Interview Protocol

To answer research questions 1[12] and 2[13], semi-structured interviews were identified as an effective method to gather data deemed valuable at this stage of the development of offshore carbon as a topic. To determine the most pertinent questions to ask the interviewees, I broke the research questions down into their component research aims to determine the broad areas of questioning that could then derive more exact questions for the interview protocol. This process was also informed by the conclusions of the previous systematic literature review in Chapter 4. This led to the following research aims.

Research Aim 1 (from RQ1): *To discover if OC governance is feasible.*

Research Aim 1 emerged on reflection of the following question: Is there some facet of the resource or geopolitics that make an application of policy and management of OC untenable? As recognition of OC as a resource is emerging, and has yet to be situated in practice, an OC system could be a potentially untenable one. (See Figure 7.1).

Research Aim 2 (from RQ1): *To discover viable policy options for the utilisation of OC i.e., to discover how the resource can be applied to climate change mitigation.*

[12] Research Question **1**: *What are the policy options for utilising OC for the purpose of climate change mitigation?*
[13] Research Question **2**: *Who would be the relevant actors in OC Governance?*

For a natural resource like fish, which is acted upon directly, it is clear at the conceptual level how the resource can be utilised – in this case harvested and consumed. But for a resource such as OC, the possible utilisation is not as clear cut. Is it placed within national carbon accounts, and how so? Can it be commodified and bought/sold? Would that help mitigate CC? Could it be protected by regulations that preserve its storage and perhaps even enhance its sequestration? Before the project can inform governance of OC as a resource, an understanding of how the resource could be utilised is required (see Figure 7.2)

Research Aim 3 (from RQ2): *To gain insights into how an OC governance system could be organised in terms of organisations i.e., to discover what institutions would be needed and the possible stakeholders involved*.

This aim directly stems from research question 2 (*Who would be the relevant actors in OC Governance?*). Once an understanding of how the resource can be used is gained (RQ1), understanding the institutions and organisations required to take the utilisation closer to a practical reality will be key. A central focus of this thesis is to explore question surrounding an OC realisation, and an understanding of required institutions is needed to do so. Additionally, an understanding of key actors and stakeholders is also beneficial to these ends.

As a result of the designated research aims, the interview protocol was structured under three main subheadings: Utilisation, Actors, and Governance. With the first addressing research aims 1 and 2, the second addressing research aim 3, and the last addressing aspects of governance general to the project. The protocol was developed over numerous draft attempts in consultation with my supervisory team. The suitability of the protocol to stimulate relevant[14] answers from participants was the main concern of piloting, as described in Section 7.2.7. The interview protocol can be found in Appendix 2.

[14] With "relevant" referring to data that can be said to answer the research questions

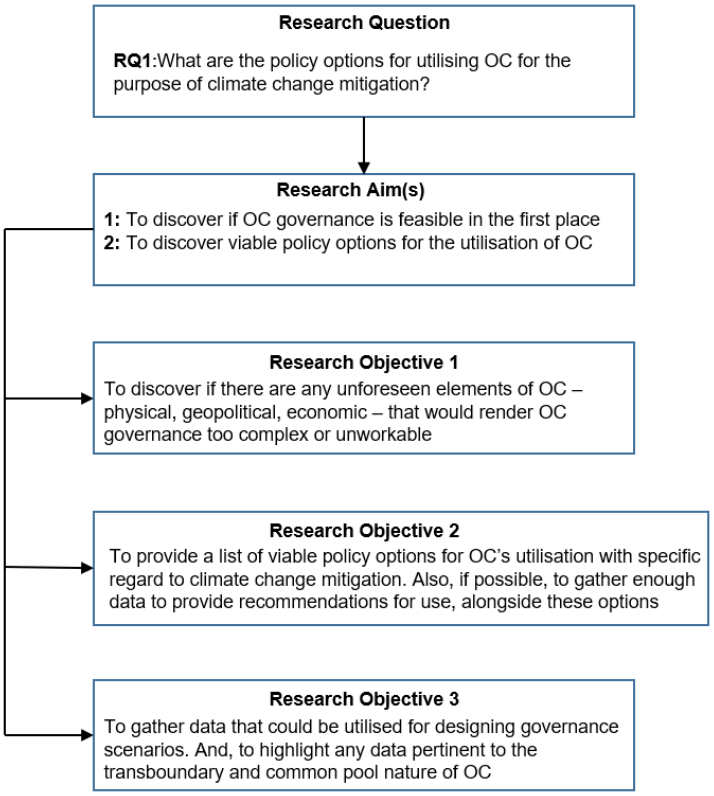


Figure 7.1 *Research Question 1, breakdown of research aims and objectives.*

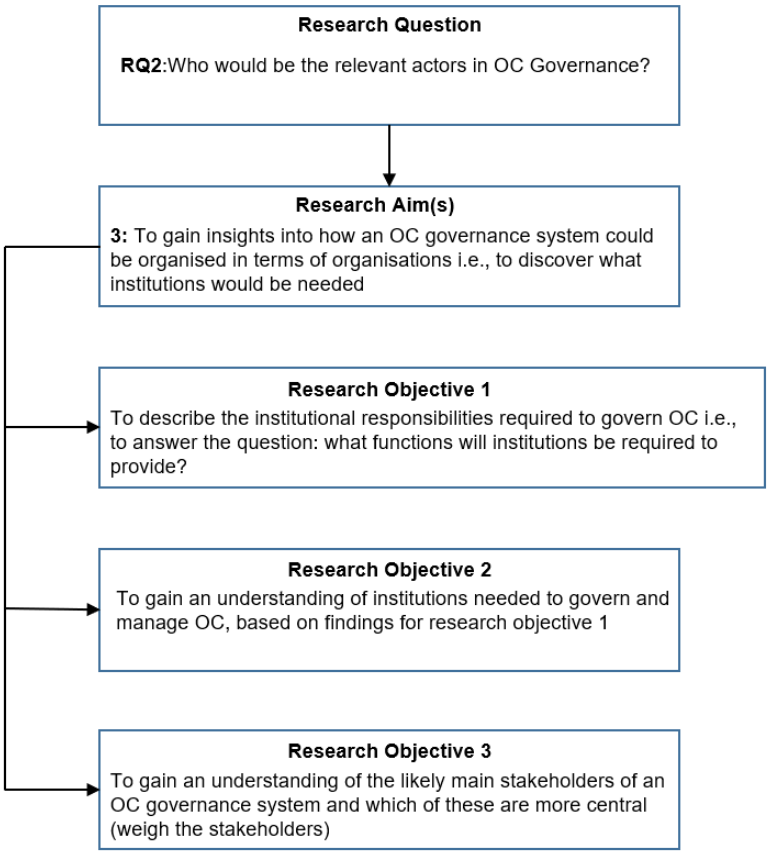


Figure 7.2 *Research Question 2, breakdown of research aims and objectives.*

7.2.2 Participant Characteristics

The overall aim of the semi-structured interviewing was to draw on the expertise and knowledge of established researchers in the fields associated with the project. The participant characteristics were derived from the needs of the research questions and associated research aims. In relation to chosen participants, the needs associated with each research question were determined and laid out, as reported in Table 7.1. The justification for the inclusion of a participant was therefore dependent on expertise and the manner such expertise could be drawn on to answer the research questions and aims. As such, the participants were selected (based on the selection criteria outlined in Table 7.1) in relation to their anticipated ability to answer questions relevant to the overall topics as well as ability to understand the content of such questions and the subjects of the project.

Table 7.1 *Participant Requirements following the research questions.*

Research Question	**Participants need to:**
Research Question1: *What are the policy options for utilising OC for the purpose of climate change mitigation?*	• Be able to advise and discuss policy options – different ways carbon can be utilised to the end of climate change mitigation. • Have an understanding of OC, at least a basic enough understanding to apply their expertise[15]. • Be comfortable with such concepts as climate change, environmental governance (especially marine governance), carbon sequestration and storage, and basic biogeochemistry (enough to properly understand the nature of OC).
Research Question 2: *Who would be the relevant actors in OC Governance?*	• An understanding of institutions, rules, regulations, stakeholders and organisations regarding natural resource management. • Need not be specific to carbon governance, could be general – any insights regarding the listed was considered valuable. • Have enough expertise to advise on institutional functions and key stakeholders.

Following this break-down of the requirements relative to the research questions, the following participant characteristics were derived:

- **Knowledge:** The participants were primarily chosen for their specific knowledge and insight on the given topics. It stands to reason that in order to offer expert

[15] This was mitigated slightly by a short information document (Project Summary) preceding the interviews which explained the concept and stated precisely what was meant by *offshore carbon* (see Appendix 3).

advice, the participants must be experts, and this is regarded, primarily, as a factor of knowledge.

- **Experience:** The participants were required to not simply be embedded in relevant research field(s) but also required to be senior in experience (e.g., a professor rather than a PhD researcher). This characteristic is related to *Knowledge* but instead emphasises the degree to which the knowledge is held, as measured by experience. This was in order to ensure the participants would have enough knowledge to answer the relatively demanding questions sufficiently.
- **Policy Experience:** Some connection to either studying policy related aspects, or working to develop policy, or working with government and governmental organisations was deemed essential as the questions in the interview protocol (as pertaining to the research questions) require insights on how human beings and societies can act upon a natural resource. Experience working with and/or studying policy, or working directly with governmental organisations, was therefore deemed a strong marker that such an individual would be able to not only answer the questions in the protocol but answer them well.
- **International with particular regards to Europe:** Participants could be from anywhere in the world as long as their expertise was relevant[16]. There was, however, a slight bias towards Europe following a focus on the Northwest European shelf within the main body of literature that acted to highlight the gap in the literature and act as the impetus for this thesis (Luisetti, 2019, 2020, Diesing, 2017).

7.2.3 Relevant Fields of Participant Expertise

Four fields of expertise were identified in relation to the literature review and overall aims of the PhD project: Blue Carbon; Marine Governance; Fisheries Governance; and Economics. The field 'Government' was also added to take account of practitioners working with carbon policy.

<u>Blue Carbon</u>

This PhD project stems from the field of Blue Carbon and aims to extend the thinking and conclusions of BC research from the current focus on the coastal zone to the offshore zone.

[16] Here, "be from anywhere in the world" simply refers to their main base – where they currently work – and the main geographic focus of their own research and work, if indeed they have one.

As such, the inclusion of BC as one of the fields of participant expertise is self-evident. BC researchers are particularly well suited to addressing the research questions because they are already comfortable thinking about and discussing such aspects as carbon biogeochemistry, carbon economics, carbon management, environmental governance, and policy (to greater and lesser extents).

Marine Governance

As with BC, this thesis is embedded in the field of marine governance and centres on aspects of the subject natural resource as a common pool, transboundary resource that will require at least a minimal level of international management and cooperation. So, here, marine governance refers more specifically to the international and transboundary governance of marine resources as a field of expertise. However, as many marine resources and issues are international in nature, this describes a large section of the overall marine governance field, perhaps even the majority. Again, as a result, its inclusion as one of the fields of participant expertise is self-evident when placed in relation to the literature review and aims of the thesis.

Economics

Here, economics refers more specifically to those with experience of environmental economics, with a lean towards marine resource economics, such as fisheries or BC economics. The rationale for including economics as a field of expertise is that economists are well placed to offer insights on the economic utilisation of the resource, which is anticipated as a dominant aspect of a potential governance of OC (as is the case with BC – carbon accounting, valuation, the use of carbon credits, carbon trading programmes etc.).

Fisheries Governance

Fish are perhaps the most highly governed and managed marine common pool resource, and, as such, it is reasonable to think that fish, as a resource, will have valuable lessons for OC, as a resource. Although one provides a kind of "passive" use value and the other a more "active" use value (i.e., OC is left alone simply to exist and keep carbon out of the atmosphere, fish are actively harvested and consumed – this idea of "active" and "passive" value is discussed in more detail in Section 7.4.2), they are nonetheless both resources that require at least a minimal amount of international co-management due to the mobility of the resource across the marine zone. It is therefore reasonably anticipated that, although not a perfect analogue, there are enough similarities that useful lessons and insights in fisheries governance can be utilised to better understand the potential governance of OC.

Government

A fifth area of expertise was constituted upon successfully obtaining enough interviews with practitioners who work in government and in policy areas appropriate to the study e.g., fisheries social science and the intersection between fisheries and climate change. I have simply referred to this category as *Government* and it represents a potentially wide range of viewpoints. However, it constitutes a coherent grouping due to the common experience that comes from working in government and experience of bringing policy ideas to life. Indeed, it is this facet that makes such viewpoints valuable in regards the thesis: an insider's perspective on bringing policy to life will self-evidently inform the research questions concerning OC policy, for all three of the main foci: utilisation, actors and governance in the round.

7.2.4 Participant Recruitment: Search

An initial search was conducted to gather a number of potential participants (approximately 90) that could then be reduced to a smaller selection of candidates for the final outreach and engagement. I decided to search each participant field of expertise separately in order to obtain a minimum number of names for each field[17]. There were four main approaches to the search:

- Literature review: I searched the reference list included in my literature review and picked out publications with authors deemed likely to meet the participant characteristics. I then systematically searched for details on each author of each selected publication. Authors were then measured against the participant characteristics and either added to the list of potential candidates or rejected. This search was effective, accounting for around a third of the final names.
- Organisation search: I used web searches to find organisations relevant to the fields of participant expertise. Examples of BC organisations found included *The Blue Carbon Initiative* and *The Scottish Blue Carbon Forum*. From these organisations' websites I was able to find biographies and profiles of key members. Although this represented the smallest search, it was quite effective, especially for the BC field.
- Google Scholar search: After these first two initial search methods, I filled-out the bulk of the rest of the list using *Google Scholar* to search for relevant publications

[17] This was determined in relation to the total number of desired interviews (approx. 20-25), with 5 for each "minor" field of fisheries governance and economics, for each tier, and 7 for the "major" fields of BC and marine governance. Government contacts were gained entirely through outreach and snowballing so are not applicable here.

on the given fields using certain search terms and confining the date of publication to the last ten years[18]. Most of the names were found this way.

- Expert Consultation: I also utilised a contact in the UK Government to ask for advice on including government workers involved in the given fields in the hope of including participants outside of academic research[19]. This resulted in three government contacts who were added to the finalised list of initial contacts. Additionally, my supervisory team, who are embedded in these fields of expertise, were also asked to offer opinions on the found participants (non-government) as well as to offer suggestions. A relatively high number of the final participants were found through supervisor consultation, especially in the economics field.
- Snowballing: Six of the final participants were found by asking participants for any contacts they thought would be suitable given the types of questions asked, known as 'snowballing'. Each individual suggested was put through the same coding process (see Section 7.2.5) as the others before being deemed as appropriate participants.

By the end of this initial search process, 87 names had been collected with at least 10 in each field of expertise. Some fields were more fruitful than others – BC and Marine Governance in particular as these two were key to the literature review and candidates in these fields had a more relevant knowledge base and were therefore more likely to meet the participant characteristics. As a result of this, more potential candidates were chosen from these fields for final outreach, as I explain in the following section.

7.2.5 Participant Recruitment: Selection

The process of selection was two-fold: a run-through of each candidate (identified in the manner explained in Section 7.2.4) to subjectively determine an initial ranking, followed by a more refined process based on coding each candidate numerically against the participant characteristics (see Table 7.2 for an example). The initial subjective run-through was simply a process of reading over each candidate's profile and biography (such as university staff profiles or *LinkedIn* accounts), as well as taking into account their research

[18] I decided to confine the search to the last ten years to help keep the searches manageable but also as older publications may have offered potential candidates that had since moved organisation or had retired i.e., candidates that would be harder to search out, and whose expertise may now be possibly out of date.

[19] I chose to consult with a contact on this as government scientists do not have public-facing profiles like academics, making them impossible to search for without collaboration.

output (published papers, books etc.) and using my subjective judgement to place the candidates into initial tiers – primary, secondary, remainder – for each field of expertise. After this initial process, there were around 30 candidates in each tier. This included five candidates in each tier for Economics and Fisheries Governance, but seven each for BC and Marine Governance. This higher number in the later fields was justified, as mentioned in Section 7.2.4, by a greater "closeness" to the project (the knowledge bases of these fields more closely line up with the aims and focus of the thesis) and the tendency for candidates in these fields to better meet the participant characteristics.

I also used, to a lesser extent, the affiliated *country* and *organisation* of a participant to help decide the initial sort. I used these classifiers to help create a more even spread in participants so as to avoid emphasising any particular organisations or countries, with many of the secondary choices based on providing a back-up from a given organisation if the primary candidate from that organisation was not available for interview. The purpose of this was to help avoid any "*siloing"* i.e., collecting an overabundance from a given in-group who work under similar conditions and so could have similar viewpoints.

After this initial sorting, I then proceeded to devise a numerical coding system and subsequently score each candidate (see Table 7.2). As described in Section 7.2.2, there are four participant characteristics with each given a number. A higher number represented a closer proximity to the given characteristic.

However, I deemed the first characteristic – *Knowledge* – to be binary (either the individual had sufficient knowledge of the relevant field of expertise, or they did not – the degree to which they held this knowledge was instead measured by the *Experience* characteristic). *Knowledge*, therefore, was not judged as a matter of degree and it was mostly very clear, upon reading profiles and biographies, if the person had the required knowledge base. As a binary, the individual would either have a score of 1 or 0. All participants scored as 0 in this case were automatically discarded and were never added to the initial collection of names. Therefore, all candidates on the list were given an automatic score of 1 in relation to *Knowledge*, cancelling out *knowledge* as a relevant score within the scoring system.

However, the fourth characteristic – *International with bias towards Europe* (abbreviated to '*Location'*) – avoided the same redundancy as it was possible to place it in the scoring system by allocating an extra score to all European-focused researchers to factor-in the slight European bias. I made the decision to allocate a score of 0 to all international candidates (those whose work has been primarily outside Europe) and a score of 1 to any whose work has centred on Europe (the smallness of this score reflects that this is only a slight bias).

For the remaining characteristics – *Experience* and *Policy* – I decided to score the candidates on a 0-5 range as these could be measured as a matter of degrees. These judgements were made subjectively based on the information at hand (profiles, biographies, websites, and publications). In this context a 0 represented no evidence whatsoever of a candidate's suitability to the given characteristic, while a 5 represented extensive and world-leading strength in the characteristic. To illustrate this: an example of a candidate who received 5 for each characteristic held a professorship at a leading university for over thirty years with more than 150 published papers alongside several books and book chapters. Alongside this, they had extensive experience working for governmental organisations such as The World Bank or The United Nations, making them a very strong candidate (score 5) for the *Policy* characteristic. In contrast, a colleague of this candidate, at the same university, was strongly embedded in the relevant field of expertise but had graduated from their PhD only five years before. They had only recently become an assistant professor so were not quite far enough along in their career to be judged a 4 or 5 for *Experience*, so they were given a 3 (avoiding 2 because they had a number of very relevant publications). Their experience on policy development and governmental work was also not as developed having been on a couple of governmental consultative committees, giving them a score of 2 for *Policy*.

As a result of the devised scoring system, the total number of points available to a candidate was 11. An example of a set of scores is provided in Table 7.2:

Table 7.2 *Example of characteristic coding*

Name	**~~1. Knowledge~~**	**2. Experience**	**3. Policy**	**4. Location**	**Total**
Candidate A	~~1~~	5	5	0	**10**
Candidate B	~~1~~	4	3	0	**7**
Candidate C (Civil Servant)	~~1~~	?[20]	5	1	**6+**
Candidate D	~~1~~	5	2	1	**8**

As a result of the scoring process, the initial lists of primary and secondary candidates did change as some were deemed to be better candidates than initially thought with others deemed to be weaker i.e., obtained a lower score. These were swapped where possible to

[20] The experience of any government contacts could not be ascertained through web searches, so I was unable to score this and instead had to ascertain *Experience* after I had contacted them directly. They were each given 5 for policy for their direct connection with government and policy development work in situ.

reflect the scoring system with some secondary candidates being dropped all together into the remainder tier. As such, the scoring system acted as a strong complement to the initial subjective judgement of candidates, helping to refine the list to those more appropriate. However, the initial sorting was respected as much as possible in order to maintain balance across other factors such as organisation and geographic location. After this process, the finalised list of potential candidates included 27 in the primary list with a further 27 as back-ups in the secondary list. The distribution was: 7 each for BC and marine governance, and 5 each for economics and fisheries governance. The primary list included the 3 government worker names provided by a government contact.

I aimed for around 20-25 interviews with an absolute maximum of 30 and a minimum of at least 15. I deemed over 30 interviews to be too much for the scope of the PhD project and 15 was chosen because any less would not provide enough data sufficient for the scope of a PhD project. Overall, however, I set out to follow one of the standard rules of semi-structured interviewing – stopping when participants started to significantly repeat what others were saying (Bogner et al., 2009; Keats, 2000). These numbers state the original intention; the final distribution of interviews is described in Section 7.2.8.

7.2.6 Ethics and Data Protection

The semi-structured interviews research proposal received ethical approval from The University of East Anglia's Science Research Ethics Committee in December 2020, following the University's set procedures regarding research that involves human subjects.

Participants' data and identities were kept secure. Data management followed the 2018 General Data Protection Regulation Act (UK) and the University of East Anglia Research Data Management Policy (2019). Participants are pseudonymised in this research.

7.2.7 Piloting

Two pilot interviews were conducted before the primary candidates were approached. They were initially drawn from the secondary tier of potential participants but after a number of negative answers from secondary candidates, one of the primary UK government contacts replied in the affirmative and so I used them as a second pilot. Therefore, the final pilot interviews were one economist from the secondary tier and a government worker from the primary tier with a focus on fisheries social science and governance. The purpose of the

pilot was to establish if there were any problems with the interview process and the suitability of the interview protocol in facilitating relevant answers in relation to the research questions.

In both cases, the practical process of the interviews was deemed to work well with no problems regarding recording, use of the video conference application (*Microsoft Teams*), or timing (both were completed in around fifty minutes – well within the hour allocated).

As for the interview protocol (Appendix 2), some minor changes were made:

- Question 7's wording was changed to move the focus away from "stakeholders" to "actors" more generally. This was in response to basic answers to the stakeholder question i.e., they both answered with an obvious "anyone with a stake in the marine environment is a stakeholder", so was not deemed useful. Changing the focus opened the potential answers up and gave the candidates more scope to be creative with their answer.
- I combined questions 9 and 10 – referring to current institutions and any potential new ones required, respectively – as it became evident that asking about current and potentially new institutions in one question stimulated the same kind of answers and thinking i.e., asking one after the other seemed like I was asking them to repeat what they had just said.
- Upon discussion with my supervisory team, I also added a new question: *Are you aware of any recent or upcoming innovations or advancements that could be put towards offshore carbon?* This was as a result of this question coming up organically during the interview process, in relation to the pilot participants' answers. As such, it was deemed a good idea to place it formally within the protocol, especially given its potential to illicit stimulating answers.

The general lesson of piloting was the easily inferred point that the answers given (and the ability to answer) were highly dependent on the participant's field of expertise. It was valuable to have this point verified early in the process in order to make sure I was mindful of this fact when conducting the interviews to come. Almost every candidate, bar a few exceptions, were quite unconfident answering some of the questions while being very confident with others. Following from the same conclusion for the piloting process – I believe this was highly dependent on field of expertise. Seeing this highlighted in the pilot interviews before I properly started meant I could be more aware, as the interviewer, of participants' ability to answer some questions and not others. This led to greater sensitivity and reassurance given that any answer is useful data and to emphasise to interviewees that

if they did not have anything they wished to say to a question in particular, it was fine to move on to the next one.

Additionally, halfway through the interviews, I ran a preliminary data analysis on six interviews (mixed primary and secondary candidates) to have a feel of preliminary findings and the use of thematic analysis. It was difficult at that stage however to ascertain the overarching themes and my own lack of familiarity with the data at that time meant the preliminary analysis was not particularly successful in terms of coming up with definitive themes. However, upon reflection, some of the subthemes, such as *Political Cooperation* and *Disruption*, had begun to emerge and become evident.

7.2.8 Participant Response

The final number of participants interviewed was twenty. Table 7.3 provides an pseudonymised list of the final selection of potential participants – those I contacted; the twenty who were interviewed are highlighted.

Although I had produced a list of secondary and even tertiary candidates to fall back on in case of a low response rate from the primary group, I only needed to draw on the secondary list for four contacts (with all four agreeing to interview). This was the result of the relatively high response rate from the primary candidates. Twenty people agreeing to interview out of thirty nine contacted is a (slightly more than) 50% rate of positive response. Only five contacts did not respond at all with four categorised as "maybe" – these were individuals who agreed to interview but struggled to accommodate an interview at the time. We therefore settled on the agreement that I would contact them in later months if I still needed interviews, which I did not. Six contacts, over a quarter of the final participants, were retrieved via snowballing. Each field of expertise is represented by three participants in the final list, except Marine Governance on six and BC on five. As stated in Section 7.2.5, I was aiming for between fifteen and thirty interviews with at least three interviews in each field of expertise except marine governance and BC which required at least five interviews. This was achieved.

Table 7.3 *List of contacted experts for interview*

Number	Primary/Secondary	Field of Expertise	Contacted	Agree?	Participant Number
1	Primary	Marine Governance	17/02/21	/	
2	Secondary	Marine Governance	02/03/21	Y	**10**
3	Primary	Marine Governance	08/03/21	Y	**4**
4	Primary	Marine Governance	08/03/21	N	
5	Primary	Marine Governance	08/03/21	N	
6	Primary	Marine Governance	08/03/21	Y	**11**
7	Primary	Marine Governance	08/03/21	N	
8	Primary	Marine Governance	08/03/21	N	
9	Primary	Marine Governance	08/03/21	/	
10	Snowball	Marine Governance	14/04/21	Y	**6**
11	Snowball	Marine Governance	14/04/21	Y	**18**
12	Snowball	Marine Governance	03/05/21	Y	**20**
13	Primary	Blue Carbon	17/02/21	N	
14	Primary	Blue Carbon	08/03/21	Maybe	
15	Primary	Blue Carbon	08/03/21	Y	**7**
16	Primary	Blue Carbon	08/03/21	N	
17	Primary	Blue Carbon	08/03/21	Maybe	
18	Primary	Blue Carbon	08/03/21	N	
19	Primary	Blue Carbon	08/03/21	Maybe	
20	Primary	Blue Carbon	08/03/21	/	
21	Primary	Blue Carbon	08/03/21	Y	**13**
22	Snowball	Blue Carbon	23/03/21	Y	**5**
23	Secondary	Blue Carbon	23/03/21	Y	**9**
24	Snowball	Blue Carbon	13/04/21	Y	**19**
25	Secondary (Pilot)	Economics	25/02/21	Y	**1**
26	Primary	Economics	08/03/21	N	
27	Primary	Economics	09/03/21	Y	**12**
28	Primary	Economics	08/03/21	/	
29	Primary	Economics	08/03/21	N	
30	Secondary	Economics	09/03/21	Y	**8**
31	Primary	Fisheries	08/03/21	Y	**17**
32	Primary	Fisheries	08/03/21	/	
33	Primary	Fisheries	08/03/21	Maybe	
34	Primary	Fisheries	08/03/21	Y	**16**
35	Primary	Fisheries	08/03/21	Y	**14**
36	Primary	Government	08/03/21	N	
37	Primary	Government	08/03/21	Y	**15**
38	Primary (Pilot)	Government	08/03/21	Y	**2**
39	Snowball	Government	11/03/21	Y	**3**

7.3 Findings

The thematic analysis identified two overarching themes, each with their own set of subthemes. These themes are *Conception* – concerning the underlying idea and requirements of an OC conception, and *Implementation* – concerning the different aspects of how an OC conception could be realised. Each theme can be thought of respectively as

OC-*Idea* (Conception), and OC-*Practice* (Implementation). The findings from the thematic analysis are presented here categorised under each theme.

7.3.1 Conception

As emphasised in previous chapters, an initial focus of this thesis must necessarily lie at the conceptual level for something that remains a concept and has yet to be fully realised. This was acknowledged by the participants in their responses. As such, the idea of OC as a concept was one of the clear, stand out themes of the findings with almost all (seventeen out of twenty) participants referring to elements categorised under this theme. These elements were further broken down into four subthemes: *Definition*, *Strategy*, *Disruption*, and *Political Cooperation*.

7.3.1.1 Definition

Largely expressed as key prerequisites for making an OC realisation workable, participants stated a need to define various aspects of OC including the physical nature of the resource, its "boundary", its underlying resource unit, its flows and how each of these relate to a conception of *value* for OC. Put simply, a system that utilises and governs an OC resource cannot do so successfully unless these aspects are defined and in terms that can be agreed between different parties.

Physically, the point that an OC resource is mixed with other resources and across various geographies was emphasised with the subsequent advice that a holistic, integrated approach to OC governance be adopted out of physical necessity, if not by choice. For example, Participant (P)13-BC emphasised the role of rivers as sources of carbon in shallow shelf seas and advised that river output be regarded as one of the main, if not the most manageable, facet of an OC system. Therefore, it was suggested that, physically, the resource should be regarded as including terrestrial aspects such as rivers as part of the definition of the physical system.

These are issues of physical boundaries, related to carbon flow, but also mentioned were the abstract legal and governance boundaries as aspects that require definition with particular emphasis on the difficulty of bounding something which is not discrete i.e., not easily separated from things around it and therefore difficult to wall off and exclude, following OC's nature as a CPR. The solution to this depends on a clear understanding of

the interaction between "unit" and system. For a resource such as fish, the unit is clearly the individual fish (however measured e.g., by tonnes) or even the right to fish (e.g., quota and fixed points allocations). In order to be governable and utilised successfully OC will require something similar in order to create a useful quantification for legal purposes, as one participant elucidated:

> *"I suppose, from a legal point of view, it's defining the units of analysis which is important. So obviously, for example, in fisheries, is it the fish, or is it the right to fish? And they're distinctive elements. But also, as you pointed out here, you've got a resource system, then you've got a component of a resource system and you've defined it spatially, as it were. But then you think about well, actually, where do you draw the lines, you know, is it particulates and are the particulates distinctive or are they seen more like a fungible good? So, effectively, one particulate that's holding carbon is the same as another particulate and they move around, they're hard to identify individually. So how do you apply things like ownership and things to that? So, from my point of view, always having that ability to clearly conceptualise what the unit is and whether you can bound that unit and define that unit is important as a steppingstone towards whatever governance regime that you put in place".* (Participant 17-Fisheries)

Related to the link between unit and system, an understanding of carbon flows in this environment was highlighted as a particularly difficult aspect that could fundamentally undermine any attempt at a coherent OC realisation. Some argued that the scientific understanding of the physical flow of carbon (through its primary production, transportation, suspension, resuspension, and storage) is too incomplete and, as a result, people looking into similar issues tend to focus solely on stock in order to simplify it. The understanding of flows requires maturation before an OC realisation can be made feasible. However, there were a number of other participants who disagreed, stating that key numbers could be identified and then a simplified; model-based understanding could be feasibly developed given enough research effort.

The stock and processes will need a value ascribed to them, but this will be fundamentally challenging as it is quite arbitrary and very difficult to quantify. When pressed on value as a topic, participants made the following points:

- There are many kinds of value inherent in a resource (social, historical, ecological, cultural etc.) that are quite often ignored due to difficulty in measuring them – these are often side lined for the (relatively) more easily measured economic value.

- The value of the resource, however construed, must be tagged to the underlying physical resource no matter how abstract it becomes.
- An OC governance will have to define where the value of OC lies and how it should be understood as any governance framework must be built around such an interpretation of value.
- Value is socially constructed so the resource will be socially embedded by necessity and is highly subjective; attempts should be made to ensure social (and other) values of OC are not ignored in favour of economic value.
- Following from this idea, the accounting process itself acts to reduce the value of ecosystems and functions to economic values and this is a concern because it fits the narrative of our dominant political economy: that if something does not have an economic value, then it has no value whatsoever.

P9-BC linked to something P14-Fisheries stated that countries holding large OC deposits are not receiving any value out of it for themselves (beyond the climate change mitigation, which is universal) and in this sense should represent a "negative fish stock", a burdensome resource which has a positive value in a universal context but a negative one in particular contexts, from the perspective of jurisdictions and appropriators.

7.3.1.2 Strategy

This subtheme relates to the conceptual aspects of *how* an OC conception should be realised strategically (distinguished from the aspect of OC's definition presented above) by setting out guidelines and key principles. A key first point to make is that a small number of the participants voiced a concern that pursuing an OC realisation, while conceptually interesting, is not an efficient use of time and resources given the nature of the climate emergency as one in which time is at a premium. However, this will change as time goes on, with P9-BC stating that, as climate change ramps up, carbon will likely become the "*currency of the 21st century*", at which point OC becomes more and more important as the social and economic value of natural carbon storage processes increases.

A large proportion of the participants emphasised that simplicity should be a prerequisite of any OC realisation, both in devising the underlying principles and rules of utilisation and governance, as well as in defining and communicating the concept. This is in order to acquire buy-in from decision makers and publics – particularly important given OC's complex biophysical underpinnings – and in order to facilitate agreements and co-management between jurisdictions. The desire for simplicity extended into the overall

approach with some favouring a nonmarket-based approach not linked to complex quantifications and accounting (requiring definitions, agreements, uniformity of quantifications, and all other complexities associated with valuation) but instead a conceptually simple strategy of management interventions that are not tagged to measuring value, such as designating no-trawl zones, linking with conservation. This was itself linked to the frequently voiced idea of zoning as a method of implementation i.e., instead of governing the whole North Sea for OC, for example, specific areas rich in carbon deposits within the North Sea should be identified and managed for their OC content. Some mentioned that an OC realisation should also be wary of bureaucracy and attempt to minimise it where possible as highly bureaucratic approaches can be easily gamed and lead to the appearance of adherence to regulation even when not much has changed in practice.

Some participants discussed the need for OC to have a "theory of change" and set out clearly what its goals and objectives are. This is crucial for the creation of an OC realisation but also in understanding if such a realisation is successful – the terms of success must be defined to enable evaluation. Potential objectives and goals were not offered but simply stated as a necessary part of the strategy that an OC realisation must address.

7.3.1.3 Disruption

The manner in which human beings affect the offshore carbon system – i.e., the way it is *disrupted* (either through addition or subtraction of carbon) – was a main focus of interviews for many of the participants with many of their answers contingent on gaining a fuller understanding of how human beings interact with and affect OC processes and storage. The participants were largely split on whether there is a significant enough anthropogenic effect on OC to justify any governance in the first place, with the point emphasised that it is not natural resources that are governed so much as the humans who interact with those resources – if there is no significant interaction, then there are no significant interventions, and therefore no significant governance required. For those who believed there was a significant disruption, the problem centred not on the existence of such but on how difficult it is to measure and then how to attribute increases/decreases in carbon to certain interventions. This greatly limits management interventions as it would be very difficult to measure the effectiveness of an intervention due to difficulty in measuring the outcomes of that intervention within the challenging and large-scale marine environment.

Potential significant disruption (with the understanding that "disruption" can refer to significant subtraction and/or addition of carbon to both OC stocks and flows) was identified in three major forms:

- Mechanical disturbance of the sediments and sediment degradation e.g., marine construction and bottom trawling.
- Influences on the biological processes that facilitate carbon processes in the offshore environment, particularly the degradation of such processes e.g., the mass removal of biota following large-scale industrial fishing.
- The movement of carbon from terrestrial sources via rivers and sewage systems into the offshore zone e.g., agricultural runoff.

In some cases, depending on the concentrations of carbon in a particular area, simply protecting the area from degradation is a meaningful intervention in respect of the carbon potentially released to the atmosphere via its degradation. P13-BC compared OC stores to peatlands which are very difficult to extend (increase in size) due to the long-term nature of peatland formation (it takes a very long time and so peatland-extension is not a practical intervention); if destroyed – due to the high concentrations of carbon in peatlands – the impact can be devastating to climate change mitigation efforts.

7.3.1.4 Political Cooperation

An approach I describe as *Cooperationist* was widely advocated among the participants with two main cooperations posited for an OC realisation: a degree of integration with the other ecosystem services and resources in the marine zone (the co-benefits approach), especially biodiversity and conservation; and cooperation of governance between jurisdictions.

On the co-benefits approach, many argued the separation of carbon processes from the other adjacent ecosystem services and processes was impossible and so a co-benefits approach is required by necessity. This can be imagined in various ways e.g., an area of seabed that acts as an important feeding ground for juvenile fish may also be dense in OC, so any conservation policy regarding the feeding ground could combine with an OC policy to maximise benefits and the chance of success. This approach would help OC gain traction among decision makers and publics due to its relative lack of appeal (P2-Government: *"this is just mud essentially"*) by being attached to other more popular causes such as

biodiversity and wildlife protection. Converse to this however, P18-MarineGov pointed out that if it was a more "standalone" resource (i.e., not integrated) then it would be more likely to gain dedicated resources and funding streams. While if it is integrated, it may just disappear behind more popular and appealing co-benefits; the measure of how "standalone" it should be is a function of its importance.

Others argued that OC should be seen as a component of a wider marine spatial planning approach. This would allow people to understand both the negatives and positives of a given policy on carbon. A small number of the interviewees brought up the private sector as also representing a potential component of cooperation. Specifically, one that could help create buy-in, allowing an organisation some means to deal with the environmental problems that may arise from their actions, for example, through carbon credits, or through positive public relations.

OC should also be incorporated into existing remits and institutions, with the European institution OSPAR[21] used as an example by various participants as it already deals with fishing, the EU, Regional Marine Fisheries Organisations etc. Some participants mentioned that they thought this would only really work in Europe as other regions lack capacity i.e., other regions tend not to have the same level of cross-national cooperation and the advanced governance structures to facilitate such. Political cooperation should not necessarily be regarded as the easy path, it will mean disruption to a range of already existing remits, institutions, policies etc., which could cause difficulties in application.

7.3.2 Implementation

The Implementation theme reflects the data that touch on the more practical aspects of what an OC realisation would have to do in practice. The topics under this theme concern economic aspects – carbon accounting and the use of economic instruments – as well as anticipated political aspects – institutions and their responsibilities, the scale of governance, and the various political issues that arise with the governance of large-scale CPRs. Each of these aspects form the subheadings of this theme.

[21] *The Convention for the Protection of the Marine Environment of the North-East Atlantic* (called OSPAR after the Oslo (1972) and Paris (1974), conventions that were predecessors of OSPAR (1992)). The OSPAR convention acts to regulate European standards on various uses of and interactions with the marine zone in the North East Atlantic including oil & gas, pollution and levels of biodiversity (OSPAR, 2021)

7.3.2.1 Carbon Accounting

Although touched on under separate subthemes, a number of direct points were made about carbon accounting. OC will suffer from the problems found with carbon accounting generally: a lack of uniformity in measurement and standardisation across different countries, regions and organisations; avoiding leakage and the problem of double counting; and the fact that accounting is a complex and labour-intensive practice that requires capacity and expertise that many countries do not have. However, the inherent international nature of OC could act as an incentive to at least regionalise a carbon methodology and standardisation. Participants 12-Economics and 13-BC stressed the point that carbon accounting is used within cost benefit analyses to measure progress and efficacy of policy, not necessarily to facilitate commodification or monetization, for example:

> *"In many countries the government requires that cost benefit analysis is conducted not because the cost benefit analysis is going to be used to charge someone, but because we want to know on net is this a good policy or bad policy. So, in that case this kind of carbon accounting should be included in those cost benefit analyses with all the uncertainty that goes with it. But we do that all the time with cost benefit analysis. We have some costs and benefits that are very concrete, others that are more uncertain and we use those uncertainty bars when we look at the final net benefit. And that's really important because that will show you, yes, this action costs this much money, but look at the accounting of all the potential benefits we should do that with all the ecosystem services".* (Participant 12-Economics)

Others voiced a reticence regarding carbon accounting, stating that accounting is a way for society to understand and therefore to value something but there is concern that economic accounting leads to a commodification which was judged a reduction that could distract from meaningful action and overlook the other important values and aspects of a given ecosystem or resource:

> *"What makes me uncomfortable is this idea that we have to value it, and then trade it, and then bring it into our capitalist economic society otherwise it is meaningless. So, I kind of have this uncomfortable tension between the pragmatist, which is "you are doing important work, because we don't see it, we don't account for it, if we don't account for it, we don't value it etc." But I am uncomfortable that we are still reducing it down, ultimately to an accounting and that will invariably end up an economic value"* (Participant 14-Fisheries)

7.3.2.2 Economic Instruments

The use of economic instruments[22] in an OC realisation was seen as very problematic for a number of reasons but the main one concerned difficulty in obtaining the data required to make such instruments work: the economic benefit accrued must be tagged to a particular intervention and if there is uncertainty as to the outcomes of interventions then benefits cannot be correctly distributed. It is also very difficult to measure if the instrument is actually helping to mitigate against climate change and measurements also require human capital – experts who can undertake the required studies at regular intervals – and such expertise is regarded as being in short supply. This was the reason why a high number of participants suggested that voluntary credits where the more viable option rather than carbon offsets as credits are not contingent on a full understanding of the numbers and offsets have a tendency to lead to leakage and have been known to actually exacerbate climate change by giving polluters licence to keep polluting. Offsets are also deemed inappropriate for nature-based solutions and habitat protection; their use is more successful through energy schemes within the energy sector. However, a number of participants stated that the numbers need not be demonstrative of a complete knowledge of carbon fluxes and levels within certain areas as economics could model and abstract the numbers in a way that might render the use of economic instruments viable.

Economic instruments were seen as incentive based polices, in opposition to legislative (regulatory) policies, with some emphasising that they are very tricky in an OC context due to the aforementioned measurement problem and an additional underlying problem for OC: the lack of a strong incentive e.g., there are clear incentives to fish in certain areas – jobs, GDP growth, acquisition of valuable food product, stakeholder interest, political capital etc., – but the only incentive to protect or extend OC is the wider, universal good of climate change mitigation which is far more distant and intangible than opposing incentives (c.f., problems identified with valuing OC beyond economic value in Section 7.3.1.1).

There was a notably expressed apprehension from three of the participants in particular (P1-Economics, P9-BC and P14-Fisheries) as to the political economy of economic instruments and the monetization of OC resources inherent in the natural capital approach,

[22] The participants were asked about economic instruments generally, no particular instrument was put to them. Those who responded to the questions regarding instruments mentioned carbon offsetting and voluntary carbon credits.

deeming such instruments too neoliberal[23]. The problem being one of dissonance between neoliberal norms and the actions required to combat climate change in general with neoliberal approaches deemed ineffectual at combating climate change and part of a wrong-headed mind set as to how to approach environmental problems in the first place – environmental degradation has occurred due to capitalist exploitation and so such methods of exploitation (financing, accounting, economic instruments, commodification etc.) cannot logically be the solution to the problems they have caused. It was anticipated that neoliberal approaches (which economic instruments were characterised) will begin to become less popular as their ineffectuality becomes increasingly clear and that instead direct management interventions will become dominant:

> *"Is that [*an OC economic instrument*] going to work in some kind of international market for trading credits? I'm not optimistic that it would. I think you just invest in those nature-based solutions. And in my personal and informed opinion we're trying to shoehorn into this capitalist neoliberal market view of the world the kind of activities that we need to happen and so now we start to talk about "natural capital". I mean, the phrase ecosystem services was coined by a bunch of guys in the 60s to try and make politicians understand that a forest is important. So, what I think is going to happen increasingly is that, as climate change continues to ramp up, it's just: the stuff that we have to be doing is the stuff that we have to be doing... So, my feeling is that within a market framework, within the kind of old-world view of neoliberal capitalist market dynamics, we can try and shoehorn it in, but I think that eventually those things are just going to fade away and we're just going to be doing what we need to do and part of that is going to have a carbon focus"* (Participant 9-BC)

7.3.2.3 Institutions

It was emphasised by some participants that any institutional responsibilities will be dependent on the underlying conceptualisation especially regarding ownership and rights. Regular monitoring and the collection of data was voiced as the main responsibility of institutions in order to maintain an understanding of the effects of interventions (this links

[23] Neoliberalism is a theory of political-economic practices, globally dominant over the last four or so decades, characterised by privatisation, the diminishment of labour union power, financialisaton, and the primacy of free markets, private property rights and free trade (Harvey, 2005)

with the rest of the findings above concerning the need for sufficient data). Furthermore, institutions will have to ensure that the link between rights and responsibilities, as well as the link between intervention and reward, be maintained in order to establish genuine incentives and reward those who are making sacrifices for climate change mitigation via OC i.e., rebates or benefits from any economic instruments must be tied to given interventions made by countries and organisations. Enforcement was also seen as a key responsibility, but institutions will require meaningful power and resources in order to meet the enforcement remit (again, however, the need for enforcement will be highly dependent on how an OC realisation is conceived and therefore what kind of enforcement would be required). A responsibility to bring wider society and publics into the process was also stated – to set up and ensure a listening process that enables people to raise complaint or issue with any OC realisation.

There was a general bent in the data that any institutional responsibilities should be shared where possible between jurisdictions following a CPR logic – the good (CC mitigation) is a universal one and so the responsibility should be shared where possible. Participants opined that this would help create consensus between jurisdictions and prevent gaming of the system through the aligning of incentives. This would also help facilitate monitoring as such a thing would have to be done at an international or regional level and a shared institutional remit would ensure standardisation of measurement and the sharing of expertise across borders. Additionally, as OC is a resource that could be interpreted as a liability ("negative"[24]), rather than an asset, sharing responsibility for the cost of the "liability" across jurisdictions and a collective institution(s) would help any countries hosting large OC stocks shoulder the "burden" of OC.

Participants were largely agreed that no new institution(s) should be required to govern and manage OC due to the existence of a large number of already existing marine governance institutions and organisations around the world with which OC could be integrated or incorporated. New institutions would also be difficult to organise and set up and so would act as a stumbling block to OC's initial development. If OC grows in importance, it may need its own institution but until that is known, then integration into existing institutional remits would be optimal. However, there were some dissenting voices that prevented this view from becoming a generally held opinion. Some argued the question was an empirical one dependent on how an OC realisation would be conceived and put into practice as it may require bespoke and idiosyncratic governance that cannot be subsumed by existing structures. This is largely dependent on the given actors and their needs and responsibilities.

[24] Following the description of OC as a "negative fish stock", see Section 7.3.1.1.

Others stated that the opinion to say no to new institutions was often born from a reluctance to invite more bureaucracy but that sometimes the only way to develop something is by creating some new bureaucracy and this is simply something we have to learn to live with; the antipathy towards bureaucracy should not deter people from using bureaucratic methods if they are proven to work, however tedious.

7.3.2.4 Scale

A clear preference for OC to be governed at the regional level was dominant due to the large scale of the geographic area in which OC is located. It could be successfully interpreted as a regional commons akin to fish: in a European context there are already existing regional governances that OC could tap into such as OSPAR and regional fisheries organisations with a strong case to use something similar to the CFP in terms of distribution and calculation. However, some stated that the regional scale itself is too small relative to the nature of carbon in the oceans:

> *"It's the Delta* [the measure of net flux between stored carbon and the water column], *it's not the stock* [that is the relevant measure]. *And it is the cumulative Delta across borders. And it's this Delta that's shared across the ocean. So just like carbon is a global stock, we should think of carbon sediments as something that we need to understand globally if we're going to really understand whether we're having a positive or negative impact on this carbon"* (Participant 12-Economics)

A truly integrated approach at the global level is much more difficult to put into practice and this was acknowledged; the global scale was voiced as an ideal lining up with the true nature of carbon in the oceans, even if difficult in practice. A more globalised response would require robust international institutions, but they can sometimes falter due to their distance from people and publics. This is why participatory governance is often broken down to the smallest unit. Contrary to regional and global preferences of scale, others argued to think instead at the individual project scale, rather than in terms of geographic area – aligning with a zoning approach.

P2-Government warned that scale can be challenging if different people and components within a resource management system are out of sync in terms of scale (both scales of space and time) e.g., policy makers work on national and yearly scales while individual fishermen work at their local level and in real time. This need not necessarily be a problem; it just has

to be kept in mind and accounted for in a governance framework.

7.3.2.5 Politics

Participants were keen to highlight a number of political issues they saw as being crucial to both the feasibility and success of an OC realisation. The most prominent concerned achieving suitable levels of interest and buy-in from decision makers and publics with some believing carbon in marine sediments to be so uncharismatic and complex a resource that an OC realisation would be very unlikely to gain political and media traction and therefore unlikely to be realised in the first place. From a decision maker's point of view, their time and attention will already be in high demand in a crowded field and so getting them to care about and action an OC realisation will be very difficult. This can be countered if there is enough interest among the public but this itself is difficult and unlikely because of OC's aforementioned lack of appeal and the relatively high level of explanation and education needed to make people OC-literate. Publics and decision makers can too easily ignore OC due to it being out of sight and far away from peoples' immediate lives.

High levels of interest and value among the general public was also seen as necessary to give decision makers enough confidence to confront opposing stakeholder interests. For example, a no-trawl ban in a given area, placed on the fishing industry, may be a possible OC intervention that would likely cause conflict between fishing interests and the wider public interest to mitigate climate change. Having a high level of public sympathy and buy-in towards OC would give decision-makers the confidence to confront opposing interests, such as the fishing industry in the given example.

> *"So, I think that it would be very difficult to incentivize choosing offshore carbon or, you know, policies that benefit offshore carbon most of the time, which will be at the cost of other industries that are a lot more visible, that have people that will be directly affected or lose their livelihood because of those policies. So, unless that can be properly incentivized, it'll be very difficult to make meaningful change".* (Participant 3-Government)

As such, decision makers will need things simplified and be given concrete numbers in order to bring OC to life and make it more understandable and relevant for the people involved. CC itself is not enough of a hook and incentive to action due to its own complexity and the problems that have plagued CC as a political issue for decades i.e., problems associated with decision makers making anti-climate decisions such as giving

permission for oil drilling and coal mining. In relation to BC, it too has been difficult to politicise and has often required integration with other co-benefits and ecosystem services to garner sufficient political attention, something OC could learn from.

Also expressed was an apprehension that OC could be abused in a number of ways that have been seen with the governance and management of other natural resources elsewhere. The two main concerns were the use of OC as a "greenwash" – a way for governments and companies to say they are doing something about climate change in order to distract from other environmentally damaging practices and decisions, described as "look over there" behaviour. The problem of "look over there" was associated among some participants with a critique of the practice of offsetting in general, which they believed has too often been used to demonstrate action on climate change that has turned out to be largely ineffectual. Power over OC has the potential to also be abused between nation states, as explained here by P20-MarineGov:

> *"But I think the tricky part there is that when other countries, let's say, for instance, support Brazil for preserving the Amazon, then they can also start claiming rights, and then you always have these power relationships that develop when such things happen, especially when this exchange is happening between more economically powerful countries towards less strong ones. So sometimes you might want to do good with such an approach* [collective, international co-management] *but, in the end, you're just enhancing this power game"* (Participant 20-MarineGov)

7.4 Discussion

The findings are discussed here under the two overarching themes – Concept and Implementation.

7.4.1 Concept

The participants were unable to fully articulate a definition of OC, focussing on physical processes and states (see Section 7.3.1.1), mostly due to the complexity of the OC system, their unfamiliarity with an emerging topic, and the time constraints of a one-hour interview. What they offered was the key insight of the need to look at the process of definition from an holistic, ecosystems point of view, as exemplified in P13(-BC)'s points on the influence

of rivers on shelf sea carbon (see 7.3.1.1). With up to one third of POC in continental shelf margins estimated as originating from terrestrial sources via rivers, there is a clear argument that terrestrial sources be considered in OC's conceptualisation (Cartapanis et al., 2018). This, however, as interviewees indicated, brings its own challenges including potential double-counting (that carbon accounted for in the marine zone may have already been accounted and budgeted in terrestrial accounts elsewhere) (Fu et al., 2011; Mengis et al., 2023). Including rivers and terrestrial sources compounds the already existing complexity associated with governing a resource at OC's scale, already involving many jurisdictions. Therefore, the inclusion of the whole pathway of carbon – from mountain to seabed – would greatly complicate an OC conception and this must be weighed against the overall feasibility of an OC realisation.

The insistence by some participants that if the required research was undertaken then a model understanding of the carbon flows at such scales would be sufficient to inform governance interventions speaks to the potential feasibility of this resource overall but highlights one of the most important aspects of OC's feasibility: the need and ability to determine the key measurements required and the subsequent processes of obtaining those measurements to facilitate a model understanding. It is important to note that not all participants shared the same faith in modelling with some stating that the real difficulty lies with decision makers who will want to know with a high degree of confidence if any policy interventions devised are having the desired effect, especially if said policy interventions come at high financial cost.

Another way of looking at the issue of measuring and defining exactly what is included in the term *offshore carbon* is to say that decisions need to be made on defining the relevant *flows* of carbon and their measurements. As identified in Section 3.3, this is not straight forward with questions surrounding which pools of carbon to include (e.g., just POC or DOC as well?) and, indeed, whether there is an argument to ignore the complexity of flow by focusing solely on stock, if that is even possible. If OC is a CPR because of the nature of OC's flows, it stands to reason that advancing an OC conception will require more research on offshore carbon flows to better understand what is manageable and the extent of understanding of any given flow that is required.

Running alongside any definition of physical flows and boundaries are the definitions of legal and governance boundaries. P17(-Fisheries)'s point that there is a fundamental need to define OC's "unit" – the quantitative measure of OC – is fundamental to actioning any realisation of OC as a practical necessity. But this highlights another key question hanging over an OC realisation: how to define such a unit? The participants offer some general

suggestions – that it should be quantifiable, tagged to the underlying physical resource (i.e., it cannot be completely abstract), and be embedded in whatever definition of value is to be given to OC.

The idea of the "negative fish stock" offers a stark reminder that, from many points of view, not least the host jurisdiction, OC can be interpreted as *not* a resource to be exploited, and from which money can be made, but a burden to be shouldered (i.e., a "burden" in the sense the carbon stock is a responsibility for which the protection or even enhancement may well come at great economic cost in terms of management costs and lost opportunity costs from limits on industries such as fishing and energy). As seen with non-use[25] resources, this is linked with any definition or interpretation of value given to the resource, with the attendant result that it is often valued as less than other "opposing" use-resources (Leonard & Regan, 2019). To further explain: the essential act upon an OC stock is one of protection, and therefore not a more "direct", or "active" act such as extraction. Although this protection has a highly valuable purpose – CC mitigation, itself inclusive of economic values – it is nonetheless a burden for the host jurisdiction especially in regard to the fact that protection suggests prohibition of activities which impinge on the resource, activities which will also have economic value. Protection tends not to make money while opposing uses ("opposing" in the sense that they may be prohibited by an OC policy e.g., fishing) tend to i.e., there are significant opportunity costs to OC's conservation and protection. Compare, for example, OC conservation with one of its main rivals, fishing: a ban on bottom trawling in an area would likely lead to a loss of the economic value (jobs, GDP, supply chain etc.) generated from the fishing. Hence, "negative fish stock", a stock that comes at a cost by prohibiting the exploitation of other, more profitable resources.

One way to overcome OC's current lack of active economic value is by giving it one: finding a way for OC to be utilised via economic instruments or the like, hence attempts at contriving economic values for such resources (e.g., carbon offsetting etc.) (Farber et al., 2002; Helm, 2004), and hence a number of participants' concern that OC could be reduced to an economic value only, lose its wider non-use values in the process, and even have its primary use-value as a carbon store become secondary to any newly contrived economic value that may be ascribed to it. A key conclusion can be drawn here, that determining whether an OC realisation can be given an economic value is a fundamental necessity to

[25] Following (Ozdemiroglu & Hails, 2016), non-use value splits into three types in environmental economics: (1) Bequest value, whereby the resource will not be used in order to maintain it for future generations; (2) Altruistic value, whereby the resource will not be used in order to preserve it for others within our lifetimes; And (3) Existence value – the value nature has as an end in itself.

any OC conception going forward. If it can, then it may be able to side-step the problems associated with the difficulty of valuing resources that, to put it bluntly, do not make money. If not, then, following the logic of most of the interviewees, many of the interventions and governance options available will be very similar to those available to conservation (i.e., "passive" economic value) and speaks to the benefits of integrating with other co-benefits and ecosystem services.

The interviewees' advice to keep any OC realisation simple seems wise in light of the underlying physical complexity of the resource as well as its large-scale and international nature. It links to the preference for a non-monetary value approach by suggesting an OC realisation stay away from the complexities of quantification, rights and property that would likely stem from a money-value approach. However, as some participants pointed out, how simple one can approach the utilisation and governance of a resource is often dependent on its underlying complexity, and so the options for simplifying OC may be limited. It nonetheless highlights the importance of keeping simplification in mind as a general rule of approach when investigating and exploring potential options for an OC realisation. The same can be said of ocean zoning and how OC could fit into marine spatial planning that allocates certain areas for specific practices (McGrath, 2004). Zoning would help to simplify an OC realisation but may not help keep the number of jurisdictions involved to a minimum e.g., if the zone does not include parts of France's EEZ, then does France need to be involved? In some cases, yes, France would still need to be involved because zoning only simplifies management and interaction of the *stock*, the problems associated with flow would still persist – after all, the designation of a zone on a map is simply the creation of yet another man-made border that flows of carbon in the marine environment simply ignore.

The centrality of the disruption theme in the data points to the importance of gaining a clearer understanding of the effects of human action on OC. Given the strong arguments made by the interviewees for a better understanding of disruption, it is sensible to interpret that this should be regarded as a key priority for researching OC going forward. An OC realisation is only feasible if there are significant interventions to be made e.g., banning bottom trawling in certain areas; reducing levels of industrial fishing; creating a voluntary credits system to utilise OC's natural capital potential etc. As P19-BC pointed out, the main form of disruption (addition or subtraction of carbon from the stock) for *BC* comes in the form of coastal degradation, whereas for *OC* the emphasis will more likely lie on the degradation of biological processes alongside the degradation of the seabed itself. This fits

into both "active" and "passive"[26] value approaches as highlighted by the comparison with peatlands – large stocks of OC in certain areas may be very dense and so simply protecting them from degradation ("passive"[27]) could feasibly act as a significant contribution (by not adding a positive emission of carbon to the atmosphere). This requires both a better scientific understanding of whether human action does have an effect on OC but, further to this, an understanding also of the *significance* of any influence with a subsequent decision made as to what constitutes "significant".

The prevalence of opinion on the importance of integrating an OC realisation with other ecosystem services, both in conception and implementation, reflects the wider work on Integrated Coastal Zone Management (Ballinger et al., 2010; Clark, 1997; Gallagher, 2010), Marine Spatial Planning (Collie et al., 2013; Douvere, 2008.; Santos et al., 2019), and the complexity of marine governance (Boyes & Elliott, 2014; Taljaard et al., 2019) that are prevalent in marine governance literature and natural resource management. Put simply, these theories of resource management build on lessons learned from previous research experience that aspects of the marine and coastal zones cannot be managed in isolation and that success depends on an holistic approach. The question for such theoretical approaches then is if, and how, to place OC into existing marine spatial plans and remits – just what does OC's integration look like? This represents potential pitfalls for an OC realisation as integration into existing governance policies, remits, institutions etc., could act to dilute such a realisation with OC being ignored behind other marine issues that are perceived as greater priority. If a "passive"-value approach is taken with OC, then the advice to link with other "passive"-value activities and issues in the marine zone seems intuitive following the common sense of grouping similar aspects and issues together to collectivise their influence and therefore their effectiveness. The preservation and conservation of the seabed and the potential reduction of industrial fishing, to preserve biodiversity and a healthy marine environment, are the logical allied issues of an OC realisation, as pointed out by the participants.

Some may ask what would be the alternative to integration? That surely OC must necessarily be something that is integrated into the already crowded marine governance

[26] As stated in Section 7.2.3 on the difference between fish and OC, this thesis makes the assertion that OC primarily has a "passive" use-value i.e., the resource is not to be acted upon directly but left alone, as opposed to the "active" use-value of fish which are acted upon directly through extraction and consumption.

[27] The use of "passive" here refers to those natural resources that are *not* actively harvested and exploited, such as an ecosystem under conservation. This is opposed to "active" natural resources which are physically acted upon and exploited, often in the form of extraction, such as fish, timber, minerals etc. It Is not meant to undermine the very active nature of most conservation.

space? So here, the alternative is the "standalone" approach. "Standalone" can be imagined as giving OC its own specific organisations, institutions, policies, government teams, international meetings etc. "Standalone" OC would be considered a new resource sitting alongside fishing, oil & gas, renewables etc., rather than a new aspect of existing resources and their use. The points made that "standalone" would be very difficult in practice due to OC's lack of relevant importance and uncertainty is important to note – integration may be the only option. P16(-Fisheries)'s insight is particularly important here: OC's "Standalone-ness" is a function of its importance; it may well be that OC gains its own government departments and the like as it progresses (or as climate change becomes an even more pressing concern) but at the initial stage it must necessarily exist more as an addendum to already existing marine policy and organisational remits.

7.4.2 Implementation

The challenges participants highlighted on carbon accounting are highlighted in the literature: the lack of uniformity in measurement and methods across organisations and borders (Bowen & Wittneben, 2011; Hartmann et al., 2013); leakage and making sure what is accounted for equates to actual, commensurate reductions/additions of emissions and levels of carbon (Brander et al., 2021); and the need to build competence and expertise (Ascui & Lovell, 2012). However, some inroads have been made to create consistency and uniformity in environmental accounting in recent years, including with carbon accounting e.g., The UN System of Environmental-Economic Accounting — Central Framework (United Nations, 2014). This points to what many participants were calling for – the creation of established rules, measurements, and norms to standardise practice globally.

P14-Fisheries related carbon accounting to an implied assertion on value i.e., carbon accounting acts to place an economic value on nature with associated issues. But others pointed out this is not necessarily the point of accounting; it primarily acts as a ledger that allows governments to understand how a standing stock is changing over time and therefore indicate the efficacy of policy interventions and decisions. This is also related to the institutional level of carbon accounting with three main levels identified: scientific, governmental, and corporate, each with their own purposes and goals (Schaltegger & Csutora, 2012). The point being that how accounting is done and for what ends are open to interpretation and decision.

The problems identified with creating economic instruments around OC mirror the problems associated with accounting: (1) the need for high levels of complex data that are

difficult to obtain; (2) the difficulty in understanding the overall impact on climate change and emissions (i.e., are the interventions actually commensurate in reducing emissions?); (3) and a lack of expertise to facilitate the necessary processes. This mirroring suggests that these are general problems associated with quantifying a natural resource, especially one that is highly complex, large-scale and has a more passive value. The conclusion drawn by many of the participants was that these problems render economic instruments more or less untenable for a resource such as OC, especially in any early realisations. Again, as with discussion on carbon flows, this was countered by those more hopeful that key measurements can be obtained and a model understanding constructed. There is therefore a divide among the participants with some doubtful that a comprehensive enough understanding of OC flows and system can be obtained and others positive that understandings of flow, and therefore certain management interventions like economic instruments, could be made possible with a better understanding of key measurements and models. This opens up a major avenue of future research on OC as a topic: the model-understanding. It would need to address whether a model understanding is possible, how such an understanding could/should interpret and conceive of flows, what it would require to work i.e., the key measurements, and whether such an understanding could facilitate management interventions.

The critique of economic instruments as too neoliberal reflects the apprehension, voiced elsewhere by other participants, that a translation of OC into economic instruments (with an attendant underlying economic value) will act as a harmful reduction. This could then leave an OC realisation open for use in *greenwashing* or having its efficacy overstated (i.e., that it is not actually acting to sequester as much carbon as advertised, if at all[28]). This also reflects a wider conflict in environmental research over the last few decades: that between those who believe the natural capital approach to be sensible pragmatism – a translation of environmental issues into the language of decision makers and international finance/companies/corporations – and those who, like some of the participants, see it as a dangerous reduction that fails to properly address the underlying problems (Read & Cato, 2014). In terms of the research aims, this is significant for any potential utilisation as an economic utilisation that employs some form of economic instrument will have to wade into the natural capital debate and take a position across this dividing line, illuminating one of the more contentious and political aspects of the development of OC as an idea. P9(-BC)'s assertion that the drive to utilise economic and financial instruments, in any ecosystem-service context, OC or otherwise, is merely an attempt to "shoehorn" current

[28] C.f. the critique of carbon offsetting (Böhm et al., 2012; Lovell et al., 2009; Watt, 2021)

neoliberal habits into modern problems and will likely die away as the problems become more acute is one worth exploring in a wider sense. It raises questions such as: how long will a neoliberal mind-set last? Will continued environmental break-down threaten neoliberal norms; have they begun to already? Could it indeed represent the end of neoliberalism itself? And it highlights the place of political economy in determining the shape and character of an OC realisation, something to keep in mind if OC is to develop further.

The points made by participants regarding institutions were consistent with conclusions in the conservation science and marine governance literature regarding marine protected area management (Fox et al., 2012; Jentoft et al., 2007). These centre primarily on the responsibilities for monitoring (Addison et al., 2015; Gill et al., 2017; Perkins et al., 2021), enforcement (Causey, 1995; Monteiro et al., 2009) and stakeholder conflict (Bellanger et al., 2020; Gaebel et al., 2020). Monitoring complex ecosystems to understand their overall health and the effects of interventions has always been a difficult challenge but the problems are exacerbated for OC as a system of carbon production that covers huge areas, involving many different flows and influences – as already touched on extensively. As stated by the participants, the need for enforcement would be highly dependent on the interventions devised, but, again, is a difficult thing to do in practice due to the sheer scale of the area needing monitored and controlled – as seen with large-scale marine conservation (Pendleton et al., 2018). Another correlation lies in the points made on involving different stakeholders, such as publics, and acting to mediate between these different groups. These similarities act to reinforce the integration approach i.e., integration with conservation, as institutional remits and responsibilities within marine conservation would synchronise neatly with those for OC and allow the two fields to work to reinforce one another.

The widespread opinion that, certainly in a European context, but also a global one, there is no need to devise and enact new institutions to manage an OC realisation is consistent with literature that argues that there are too many organisations and institutions acting within the marine sphere already (Boyes & Elliott, 2014). This overabundance acts to silo actions and people who, it is argued, should be acting in tandem given the correlations between their responsibilities, acting to overcomplicate an already complex system of remits and responsibilities. Again, the preference for no new institutions acts as an endorsement for integration and for OC to be placed as a component of already existing governance infrastructure; an addendum to existing remits and responsibilities, rather than a brand new “standalone” system of governance. This view is, however, mediated by important points made that integration is not necessarily the easier path as it would require complex changes to existing systems, but also that OC may very well be so different a

resource/ecosystem service/nature-based solution that it requires idiosyncratic governance and therefore more of its own governance infrastructure than initially assumed. This highlights an important question for OC going forward: can OC be integrated into existing governance institutions, how so, and would that be optimal?

The vast majority of participants followed the intuitive conclusion that a large-scale resource (regional/global) should be governed at the regional/global level. This links with points made that regional-level institutions would be optimal for aligning interests and incentives, and therefore success in governance. The implication is that the resource was viewed as a collective resource, a CPR in which many jurisdictions have an interest and a responsibility, aligning with the OC-as-a-CPR position adopted by this thesis.

The political aspects mentioned under the Politics subtheme were not anticipated or asked of directly. They were points that participants wanted to emphasise that act to highlight the centrality of these kind of political issues to their work within the various expert fields surveyed. The problem of buy-in is one encountered by any issue or concern that must garner attention in a crowded field (Hart et al., 2015; Newig, 2016). The emphasis on the need to involve the public indicates that these experts think that an OC realisation cannot be a completely technocratic endeavour. This highlights some potential questions and pitfalls for an OC realisation centred on asking just how much public buy-in is really required to motivate decision makers to advocate an OC realisation and how can that be done in light of OC's detachment from peoples' everyday lives, its inaccessibility and its general lack of appeal? In regard to governance, it posits a problem for any governance structure – how to incorporate publics as stakeholders, if possible? How to involve publics is not a new problem for marine governance or natural resource management (as highlighted in Chapter 2) but it is famously difficult at the large-scale. As such, a perception of the public as a national-level public, or even regional/continental, as opposed to local, will be required e.g., this could be imagined, combining it with the ownership problem in Section 7.3.1.1 on definition, as conceiving of areas of large concentrations of OC as areas of public ownership in which the (national/regional) public have a direct stake. It stands to reason that OC, as a large-scale, "passive" resource, could learn, again, from conservation in this regard.

The call to keep things simple for the benefit of the decision-making process correlates with the advice on adopting simplicity as a general approach. Once again highlighting the benefits of keeping any OC realisation as simple as possible to increase the likelihood of a realisation in the first place and its subsequent success.

The concerns regarding greenwashing and power plays between countries are an important reminder of the more negative aspects that can arise from the necessary politicisation of a natural resource, especially one that is shared. Normally aimed at corporations and the private sector, greenwashing was brought up by participants in regard to governments and highlights the potential for some governments to use certain programmes to demonstrate progress on environmental issues only to then approve, for example, new oil drilling licenses. Problems that can arise within the international relations between interested parties can lead to uneven power dynamics and potential political injustice, as has been observed with REDD+ schemes in the Amazon – the benefits of the offsetting can quite often come at the expense of local communities and native inhabitants and the rules of the governance and implementation of the schemes decided by the big players who are paying the most money, rather than the local people or host jurisdiction (Corbera & Schroeder, 2011; Poudyal et al., 2018).

7.5 Conclusions

In this subheading I summarise how the findings relate to the research aims directly and then highlight how the conclusions of the interviews informed the next stages of the research that followed.

Regarding research aim 1 – *To discover if OC governance is feasible in the first place* – the participants offered a number of points. Much of OC's feasibility lies with obtaining sufficient appropriate measurements; this involves identifying what these measurements are and exploring the use of a model understanding. In order to do this, key aspects of OC's definition need to be made clear, including defining the physical resource, especially its flows, and the parameters of its conception in law i.e., its legal and conceptual boundaries e.g., defining its economic unit. OC faces a problem of flows i.e., difficulty in measuring and understanding them – something experienced by the governance of many other natural resources, from rivers to fish. Addressing the problem will require a better understanding of carbon's movement and processes in the offshore environment.

Further, there are issues on the lack of uniformity on accounting and instruments across jurisdictions and organisations, a lack of required expertise (i.e., human capital), and a lack of surety on whether such economic uses have a significant effect on climate change mitigation, and to what extent. These limit the potential for OC to develop other forms of value, namely monetary value. With the attendant suggestion that OC may have to remain

a non-monetary, "passive" resource. Overall, an OC realisation is feasible but is highly conditional on addressing problems of definition, measurement, flow and economics.

Relevant to research aim 2 - *To discover viable policy options for the utilisation of OC i.e., to discover how the resource can be applied to climate change mitigation* – many of the points emerge from the Disruption subtheme i.e., the manner OC can be utilised relies heavily on determining how, and to what extent, human beings disrupt the natural cycle of carbon sequestration that occurs under OC. As this is still not sufficiently understood, it is difficult to devise policies on how best to utilise the system. Not only must more research be conducted to determine the answer to what can be called the "Disruption Problem" (how can/do human beings add or subtract from this system? And to what extent?), a normative decision needs to be made on what counts as "significant". For example, if bottom trawling in the North Sea is proven to cause a negative effect on the OC system, then at what stage is such an effect deemed relevant enough to warrant, say, a ban on bottom trawling in certain areas? Regardless of the disruption problem, as highlighted by the "negative fish stock" idea, a key aspect of OC's potential development rests with the idea of the resource as "passive" and coming at a monetary cost through lost opportunity costs (a collective burden to be shouldered) and the possibility of making it more "active" by giving it monetary value through some form of economic mechanism/instrument. In regard to the later, the participants were sceptical due to the sheer complexity of the environment and general disregard towards offsetting.

This highlights an important point for OC governance as a topic to take into account going forward: exploring the different possibilities for the interpretation of OC's value. If it remains typically "passive", then the political cooperation approach comes to the fore as it would help to maximise the collective clout of combining the interests of different non-monetary and non-use aspects of the marine zone together (e.g., combining with conservation). This relates to the other main aspect to be explored for the topic going forward – what is the potential for political cooperation, both with other non-monetary resources (i.e., the co-benefits approach) and between jurisdictions in joint governance approaches?

Regarding research aim 3 – *To gain insights into how an OC governance system could be organised in terms of organisations i.e., to discover what institutions would be needed and the possible stakeholders involved* – the participants offered some important insights. Firstly, there was a general bent towards *not* devising new institutions or organisations to manage OC unless an unseen idiosyncratic aspect of OC requires separate governance infrastructure. The subsequent point, therefore, is that an OC realisation will require a

degree of integration into already existing remits and organisations. How to do so becomes an important question for any OC realisation going forward. There was wide-spread agreement that the resource should be governed at the regional level, as a regional resource. And the institutional responsibilities involved mirror those of marine conservation – monitoring, enforcing, and stakeholder management – highlighting again the link with other marine non-monetary resources.

In summary then, I believe the interview study highlighted three main aspects on which the future of the topic of OC governance hinges: (1) Value; (2) Political Cooperation; and (3) The Disruption Problem. Can OC be defined as a more "active" resource via some kind of monetary value? If so, it may be able to side-step some of the issues associated with other "passive" resources, but this comes with the attendant question of how to make OC such. If it remains "passive", its governance changes based on it acting like a "negative fish stock", a difficult burden to deal with rather than a useful resource to exploit. The importance of political cooperation implies questions of how to cooperate and to what extent, and to explore the potential for OC to link with other marine uses i.e., the co-benefits approach. And the Disruption Problem opens up questions concerning the governance of the different potential disruptions that an OC environment is vulnerable to. Going forward, I refer to these three aspects as the "three hinges". The next chapter of the thesis looks to futures methodologies, namely a scenarios analysis, to conceive of hypothetical governance scenarios.

Chapter 8 |

Bringing Offshore Carbon Governance to Life, a Scenarios Analysis

8.1 Introduction

In this chapter I explain how I created a set of scenarios, using scenarios analysis, for the purpose of informing the governance of offshore carbon. Four scenarios were produced to aid expert participants in a survey on OC governance, which forms the focus of the next chapter. As such, Chapters 8 and 9 should be understood as being in combination, with the scenarios analysis constituting the first half, and the survey the second. As explained in Chapter 6, Section 6.3.1, the scenarios were written using an established method – the *Intuitive Logics* approach – and are based on the insights gathered in the preceding systematic literature review and interview study. In Chapter 6, I explain why I chose a scenarios analysis at this stage of the thesis, followed by a justification for Intuitive Logics (Section 6.3.1). Here, in Section 8.2, I explain the process of scenario creation, by first explaining the Intuitive Logics approach, and then setting out each of the 5 main steps – each providing the proceeding subheadings: Stating the focal question; Identifying key factors and driving forces; Defining the scenario logic; Describing the scenarios; and ending with a note on relating that back to the focal question.

8.2 Intuitive Logics – 5 Steps

Peter Schwartz, the founder of the GBN (Global Business Network) approach, sets out the process as following 8 steps (Schwartz, 1991). It is therefore typical to follow these 8 steps when constructing an Intuitive Logics scenario analysis. Rounsevell & Metzger (2010), however, simplify these to 5 overall steps by combining Schwartz's steps 2, 3 and 4 (now step 2 combined), and ditching step 8 which is about relating the implications of the scenarios to business decisions. Here, the combining of steps 2, 3, and 4 is a tidying up of very similar steps into one without any major change within each step. Step 8 is discarded as it is not necessarily relevant to academic research concerning the environment. I have chosen to interpret the two approaches in a slightly modified 5 steps, following closely Rounsevell & Metzger. The 5 steps are as follows:

1	Identify the Focal Question	Identify and state clearly the overall aim of the analysis.
2	Identify the Key Factors and Driving Forces	Identify the drivers and factors that affect the issue directly, indirectly and over time. Identify which are the most important and uncertain.
3	Define the Scenario Logic	Define the framework (the 2x2 matrix) in which the two chosen drivers/factors form the necessary dimensions.
4	Build and describe the Scenarios	Develop the four quadrants into fleshed out scenarios and narratives. Describe the scenarios systematically.
5	Discuss implications for the Focal Question	Relate the developed scenarios back to the focal question and discuss initial implications for each.

Figure 8.1 *The Intuitive Logics approach in 5 steps (derived from Schwartz, 1991, and Rounsevell & Metzger, 2010). These form the chosen approach to scenario building, as outlined in Section 8.2.*

The slight modification is that I have changed the wording of step 4 to "build and describe the scenarios", following Schwartz, as opposed to Rounsevell & Metzger's "describe scenario assumptions", because it more directly describes the process at the given stage. Each of the steps is elaborated upon in their corresponding subheading. Within these subheadings, I also explain how I have undergone each step to construct the scenarios, in relation to the interview data, which form the basis of the scenario construction.

8.2.1 Step 1: The Focal Question

As stated in various literature concerning scenarios methodology (Biggs et al., 2021; Bishop et al., 2007; Rhydderch, 2017), all scenario analyses must be conducted around a focal question in order to keep the focus and purpose of the scenarios process in place throughout (much like the use of the review question in a systematic literature review, and research questions in general). According to Rhydderch *"Too many scenario exercises fail because the question addressed is not clearly defined*" (2017, p.6). So, to set the question, focus was placed on the central purpose of this thesis (and the central concern of research question 3[29]) which is to inform the creation of a governance *framework* for the utilisation of offshore carbon sequestration and storage in wider climate change mitigation strategies. The use of scenarios needed to be geared towards this end. Therefore, the scenarios were built on the following focal question:

Focal Question: *What are the main potential approaches to offshore carbon governance?*

The question focuses on "approaches" because, as something so underdeveloped, the general approach taken towards OC is something that has yet to be defined and explored, especially in light of the many potentially different ways for OC governance to be realised. The question requires that I define who is taking the approach. In this case, the interview data suggest the approach would be taken by various interests in the given OC system, from private sector operators to non-governmental organisations (NGOs) and publics, but with an emphasis on governments as they are the only stakeholders who typically have purview over such a large geographical system, and because national governments are typically the designers and instigators of environmental governance, at least initially. Chapter 7 has

[29] Research Question 3: *How do the findings inform a governance framework(s) for offshore carbon?*

already identified some of the major factors that the future approach taken by a government, or governments, would need to consider and which could greatly alter any approach taken e.g., levels of cooperation with co-benefits, the exploration of different conceptions of OC's value etc.

The relation between the focal question for scenario construction and research question 3 lies in how the scenarios focal question informs governance frameworks. It does so in that any framework conceived must take an overall approach to the governance of OC: does such a framework take a heavily integrationist or isolationist approach? Is it built around only one of the potential disruptions to OC processes or a number of them? Exploring some of the major potential approaches through the use of scenarios – narratives and storylines that bring such approaches to life – should be highly instructive for anyone looking to research OC governance further, and for the overall purpose of bringing OC, as a natural resource/nature-based solution/ecosystem service, closer to conception.

8.2.2 Step 2: Key Factors and Driving Forces

In order to build scenarios, the key factors surrounding the central issue and the driving forces that will likely affect the evolution of the issue over time must be identified (Schwartz, 1991). A *driving force* is something that will greatly influence the way the issue evolves *over time*, a variable, and can be both external or internal to the issue (Van Der Heijden, 2005). The intuitive logics approach is often used to help businesses forecast and strategise. In such a business context, key driving forces are often the like of market forces and demographics – large-scale influences the company/organisation/government cannot directly control but must take into account and adapt to. *Key factors*, on the other hand, are more general and can be more directly influenced and controlled, they are any significant factors that could have an effect in determining the answers to the focal question. As such, there can be overlap between some driving forces and some key factors. An example from this scenarios analysis is the Political Cooperation/Geopolitics driving force which is a variable that no one organisation controls, as geopolitics and international relations are highly variable, but can nevertheless have a potentially high degree of influence over OC based on the stance taken by political actors towards political cooperation.

From these driving forces and key factors, the main dimensions deemed to be both *most uncertain* and *most influential* are determined (in relation to the focal question), which in turn form the dimensions for the scenario matrix from which the scenarios are derived and

differentiated. The selection of the two axes – Political Cooperation and Climate Change – is described and justified below.

The key factors and driving forces were derived by myself from the interview data of Chapter 7, as listed in Tables 8.1 and 8.2. This was conducted by reading the interview findings and extracting the key points from each of the major and minor themes of the data. I then determined if the key points from each subtheme met the definition of a key factor or driving force, in relation to the focal question.

Table 8.1 *The Key Factors derived from the interview data.*

Key Factor	**Significance to governance approach**	**Examples from the data**
Types of Value	Will other types of value be incorporated, e.g., cultural, historical, social etc.? How?	*"I would probably say that equally you've got to take into account the wider societal factors and values that you can't simply isolate [it], that you see the counting of carbon as a discrete measure. Because the construction of value is always a social thing and that means that it will depend upon the context within which it's constructed."* Participant 19 (P19)
"Negative fish stock"	OC is largely a burden to be shouldered rather than asset to exploit. There are a number of ways governments and publics could interpret this facet of OC. It links with the value hinge.	*"Yeah, it's like a negative fish stock…Yes, it provides benefit to the world, but it's actually negative on the host agencies because it interferes with the ability to do something"* (P14)
Disruptions and their extents	How humans are actually acting on and influencing the OC system is hugely influential on the approach taken (the disruption hinge).	*"If… you're going to allow trawling as usual, that could have a negative impact on those carbon stores. So, any action taken to limit trawling, that increases the amount of carbon that's held in these sediments, you should be able to get credit for in some way. So, I see the problem is just understanding what is the ultimate impact of an action taken on the final fate of carbon?"* (P12)
Appeal: OC's lack of general appeal to the	Means it is likely to lose out to competing uses/issues. This links with climate change as a driving force as this factor	"I*n the designation of the protection of the seabed, we actually know that muddy sediments are probably the most important places for storing carbon. But mud*

public and decision makers	changes the more severe climate change becomes.	*isn't always the most iconic sell, and you don't see the banner 'Save the Mud', you might see the banner 'Save the Flame Shell Mussel Bed'"* (P13)
Measurements: Lack of key measurements	Uncertainty on whether key measures needed will be obtained. The approach will be limited by the information obtained and obtainable.	*"The real issue here is that you've got this huge scientific uncertainty in the natural sciences. There's quite a lot of uncertainty in the economics as well, because there's lots of different costs you can use for carbon…Huge uncertainty here in the natural sciences, huge uncertainty here in the social sciences, multiply them together and like your degree of uncertainty is astronomical."* (P1)
Cooperative Capacity	Some parts of the world (countries) have more scope for cooperation due to the prevalence (or lack) of existing institutions and practices (e.g., the European Union and OSPAR in Europe).	*"Even though blue carbon is being worked into NDC's at a feverous pace, I worry that countries are making commitments that they don't have the capacity to fulfil because we need that sort of local and regional capacity to do that science and understanding"* (P19)

Table 8.2 *The Driving Forces derived from the interview data.*

Driving Force	**Significance to governance approach**	**Examples from the data**
Climate Change: The extent and success of tackling CC	Major driving force – the less successful at addressing CC in coming decades, the more OC rises in importance.	"*So as climate change ramps up and the demand increases because everybody's got to buy carbon, then that drives funding, and it will come to blue carbon and question for you is how can you make that work for the open ocean?* (P9)
Carbon Accounting	The need for NDCs and robust carbon accounts is driving the idea of OC forward at this stage. The importance and evolution of carbon accounting will affect the importance of OC.	*"So, I think: are there problems with the global carbon accounting system? Yes. Can there be more stringent rules and avoidance of double accounting, etc.? Yes, but that's not specific to the coastal zone"* (P7)

Geopolitical Cooperation: the appetite for collaboration and integration between states	Could greatly determine the approach taken – highly dependent on the political will for cooperation over the next few decades.	"*Then there are questions to do with getting cooperation between governments. So, if it's a common pool resource and if it's something which straddles different states, that requires agreement and standards across states*." (P17)
Private Sector: interest from large companies to invest in nature-based solutions	The more of a culture of this develops, the more incentive to make OC happen in the first place and the more of a natural capital (e.g., use of economic instruments) approach is taken.	"*And this would have potentially quite significant area of interaction with the private sector. Because, you know, we always want to talk about governance, we tend to look at governments, national government. But actually, if the private sector knew that there's some sort of marine carbon process that includes carbon budgeting and carbon cycles, they could actually engage better*" (P16)
Natural Capital culture	Like with **Private Sector**, this helps drive forward such things as economic instruments and finding economic value in OC. Lends itself to a more natural capital approach to OC's governance.	"*And in my personal and informed opinion we're trying to shoehorn into this capitalist neoliberal market view of the world the kind of activities that we need to happen and so now we start to talk about "natural capital".* (P9)
Marine Spatial Planning culture	The general culture of MSP across marine science and governance pushes a cooperative approach.	"*But it* [utilising OC] *is worth it from a point of view of marine spatial planning and the potentials that would bring in terms of better considering how to manage the marine environment*" (P16)
Standardisation	The need to standardise carbon measurements across regions (if not globally) pushes a cooperative approach.	"*I think that the biggest obstacle to holism is that the data are still siloed. So, the data we need to really create bigger holistic models, even when it's aggregated at a national level, it usually is difficult to then combine that with data outside of the EEZ*" (P12)
Political Economy	The (stated) diminishment of neoliberalism and the rise of new political economics could create different political-economic approaches and attitudes with alternative ideas for realising OC.	"*So, my feeling is that within a market framework, within the kind of old world view of neoliberal capitalist market dynamics, we can try and shoehorn it in, but I think that eventually those things are just going to fade away and we're just*

		going to be doing what we need to do" (P9)
Public Support	Can OC advocates garner enough public and political support to help OC be realised? The more support, the more it is in the public eye – this could greatly affect the approach taken.	"*If there's a lack of knowledge about something within the broader public it's difficult to then motivate political change."* (P17)

After evaluating the key factors and driving forces, I determined that the chosen two dimensions would be *Geopolitical Cooperation* as the most influential and *Climate Change* as the most uncertain, for the following reasons:

Geopolitical Cooperation (most influential): Political Cooperation was identified as one of the three hinges[30] in Chapter 7 (Section 7.5) both because of its prevalence as a theme within the interview data and because it centres on one of the central concerns of governance in general – to what extent, and how, should something (an institution, a stakeholder group, a remit, a jurisdiction etc.) cooperate and integrate with another, in respect to OC? By including political cooperation as a dimension in the scenarios, I would go on to be able to use the scenarios analysis to take forward one of the three major avenues of OC research (the 3 hinges) identified by the interview study. Specifically, political cooperation here refers to that between nation states in a shared regional space (e.g., the Northwest European Shelf). The other aspect of political cooperation identified in the interview data was that between different uses of the marine zone – the co-benefits approach – which was not included in the definition of this dimension. This was for reasons of simplicity: if "Geopolitical Cooperation" encompassed both that between nation states and between co-benefits then it would overcomplicate the dimension and therefore overcomplicate the creation and interpretation of the scenarios. Having said that, Geopolitical Cooperation was chosen because it also acted as a broad-church dimension, taking into account aspects of some of the other factors and forces e.g., *Measurements* and *Standardisation*.

[30] The three "hinges" identified by the interview study represent the three main avenues for further research on OC governance, as identified by the interview study: (1) Political Cooperation – the potential and extent for both political integration between nation states and jurisdictions as well as between co-uses and benefits in the marine zone; (2) Value: The potential to explore different conceptions of OC's value, and (3) Disruption – the need to understand more deeply the anthropogenic effects on the OC system, as it is these disruptions that are ultimately governed.

Climate Change (most uncertain): As the issue underpinning the need for OC research, climate change was, naturally, discussed in general ways throughout the interview study. As stated in Section 7.3.1.2, when asked whether an OC conception should go ahead and if further developing the idea would be valuable, some interviewees stated that it was dependent on how severe the effects of climate change develop over the coming decades; the more severe, the more important climate change will be as a political issue and therefore the more governments will look for strategies to mitigate it, including the utilisation of OC. This dynamic seemed a pivotal driving force to the progress of OC and any strategies that could be adopted. Additionally, this dimension offers a strong partner dimension to Geopolitical Cooperation in offering a dimension measured as change in the physical-environmental sphere as opposed to the political-social sphere represented by Geopolitical Cooperation. Although the severity of climate change will be determined within the political and social spheres, it is nonetheless a global-scale phenomenon that occurs in the natural world and is very difficult for any one agency (e.g., a single national government or organisation) to control, rendering it a powerful and important driving force with great influence over the development of OC. The uncertainty stems from not knowing how climate change, and its global mitigation, will progress given the lack of progress on mitigating climate change by the biggest polluters, alongside other contributing factors of uncertainty, such as the uncertain long-term effects of greater ocean temperatures, or the eventual extent of glacial and sea-ice melt, to name two examples.

8.2.3 Step 3: Scenarios Logic

At this stage, the underlying logic to the scenarios is described in the form of explanations of the two dimensions – what is envisioned by, for example, "more political cooperation" or "decreased effects of climate change"? – and structurally in Figure 8.2, which displays the two dimensions in a 2x2 matrix. The logics explained here are based on reasonable inferences and paint broad stroke descriptions of potential outcomes that may result under each dimension, following the findings of the interview study and the systematic literature review in Chapter 4. These logical contexts, so described, in their various combinations, form the bases of each scenario.

8.2.3.1 Political Cooperation Logic

Greater political cooperation will necessarily be founded on a more common-pool-resource view of regional resources (c.f. European fish stocks), with a subsequent perception and belief engendered in publics and decision makers of OC as a shared resource rather than a solely national one. The "negative fish stock" point highlights how this may be interpreted less as a shared *ownership* and more of a shared *responsibility* – a shared shouldering of the burden. It would also represent the furthering of the Marine Spatial Planning ethos and approach. In practical terms, actual cooperation can be imagined as the creation of shared institutions (or the expansion of remits held by already existing institutions e.g., OSPAR in a European context) with a shared marine carbon budget/account that would have to be split in some manner between the participant nation states. Such things would facilitate the sharing of expertise and human capital, rather than each country having to train and find their own, as well as a standardisation of carbon measurement techniques and processes across the given region.

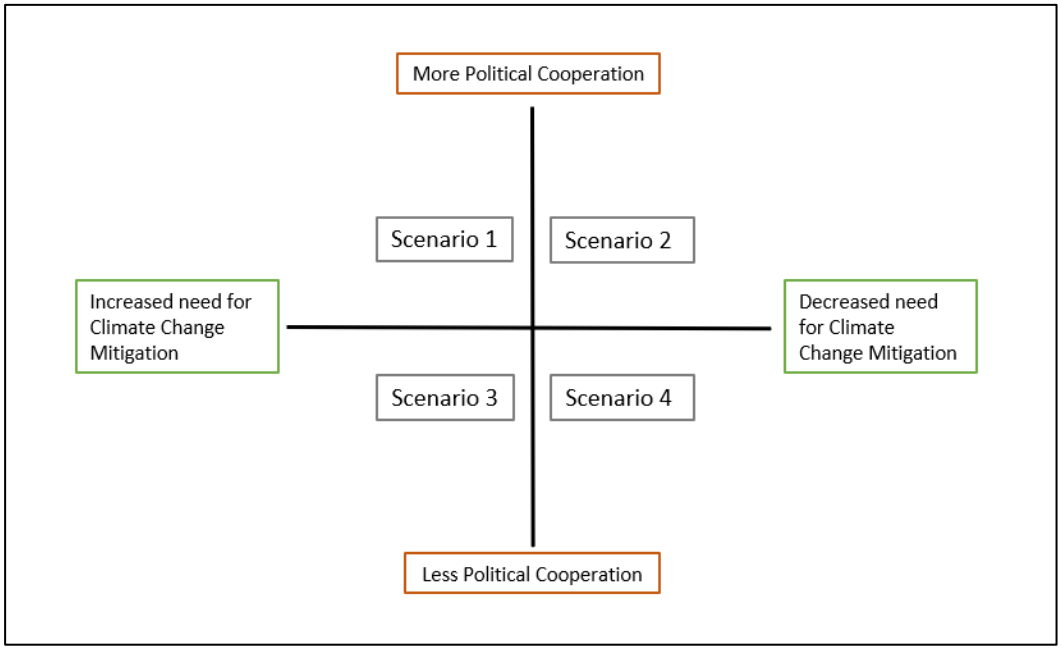


Figure 8.2 *The Scenario 2x2 Matrix with dimensions along greater to lesser Political Cooperation and increased and decreased need for climate change mitigation.*

A greater political cooperation approach may intuitively be seen as less cumulative work than if it is done individually as the work is shared and spread around. However, political cooperation requires a large amount of political work that must be maintained past the initial set-up (c.f. again with European fish resources and the yearly negotiations over quota alongside the near constant management of the various stakeholder interests and conflicts). This requires a high level of political and human resources which could hobble the ability

of resource-poor regions to engage in such a cooperative system. Indeed, a greater cooperation approach may both ease conflicts and tensions or help exacerbate conflicts especially in regard to any policy interventions devised in relation to potential disruptions. For example, in a European context, if fishers are banned from bottom trawling, the Dutch contingent may see this as greatly unfair on their fishing industry and take issue, leading to political fallout and conflict, despite a high level of political cooperation. At the same time, if constructed well, the internationally cooperative governance system could provide the processes required to ease the tension and help mitigate the conflict. As was pointed out in Chapter 4, more voices sat around a shared table means more opportunities for dissent and more groups to keep happy; the maintenance of this represents a high volume of political work. It can also slow down the initial set-up of processes and institutions as well as make it difficult for the system to respond quickly or create and instigate reforms and changes.

The extent of political cooperation would be highly dependent on the real-world geopolitics of given regions and the actual international relations between states. If states are not on good terms, the likelihood of a cooperative approach is greatly diminished. However, for the purpose of constructing scenarios, the scenarios analysis assumed favourable geopolitics in both the greater and lesser political cooperation ends of the dimension. This was to simplify the scenarios and to allow the context of political cooperation to focus on aspects of governance rather than potential political futures, which could be very speculative and require strong justification.

In regard to *less* political cooperation, the opposite of what is pointed out for more cooperation is assumed i.e., nation states develop their own, standalone systems of offshore carbon governance leading to potential conflicts over distribution of carbon stocks and questions over who is responsible for which stocks and the flows that feed them. Any conflicts will have to be dealt with outside of a cooperative system. Less cooperation entails a lack of standardisation over measurements and processes as well as inequality of practice, with some states better able to engage in the necessary management processes of monitoring, enforcement etc. due to an uneven distribution of resources and expertise. In this context, the possible policy interventions (policies that act upon potential disruptions) will be limited to those a state controls rather than those that affect the entire region, and therefore the OC resource in its more complete sense i.e., states are limited to policy interventions that affect the stocks and will find it difficult to implement any interventions that affect flow.

8.2.3.2 Climate Change Logic

The axis between the two end points of Increased Effects of Climate Change and Decreased Effects is essentially one that describes a scale of urgency. Put simply, with greater increases in the effects of CC over the next few decades the urgency for governments and others to respond will increase. Greater urgency lights a fire under the development of OC (and decreased dims the fire), with reasonable inferences that can be drawn from this. Under increased effects and greater urgency, decision makers and publics will begin to open their minds to incorporating new tactics in their CC strategies, including utilising previously unused systems such as OC. This will embolden decision makers to champion OC interventions and be more willing to engage in political conflict with opposing stakeholders such as, potentially, the fishing industry. However, it is also conceivable that under such conditions, there may be a scramble of competing approaches to tackling CC that may require competition between one another for public and political attention in what could become a crowded field. Indeed, increased effects of CC creates the conditions for greater investment and experimentation with direct carbon dioxide removal, including processes that utilise marine primary production and OC. In a world where OC is more likely to be conceived and championed, it will be more likely to have allocated to it more governance infrastructure and resources and, for example, less likely to be merely an addendum to existing fisheries policy or simply seen as something to be merged with existing or emerging co-benefits, such as conservation and biodiversity programmes.

In a world where the effects of CC are decreased i.e., less than anticipated, either because governments have been effective in mitigating levels of greenhouse gases in the atmosphere or other mitigation policies have been successful in dealing with some of the bigger problems that arise from CC, then naturally OC will not be given much political capital, from either publics or decision makers. This in turn will likely lead to an OC conception as being a minor tactic, if one at all, within wider CC strategies. Any interventions devised will struggle to win favour over already existing vested interests, especially those that are "better" for the economy, like fishing (which facilitates jobs, food security, culture, tax revenue etc.). This means it is more likely to be integrated as a co-benefit within wider marine spatial plans and policies.

8.2.4 Step 4: The Scenarios

In this section the four scenarios are described as narratives, laying out four different futures, and subsequently four different approaches, to OC governance. In order to flesh

out the scenarios, it helped for me to place them in a specific geographic location. As such, the scenarios have been located in the Northwest European shelf (NWES). This is because the NWES is an extensive shallow-shelf sea and is strongly representative of the issues that arise from governing and managing a regional-sized resource in an area that is shared among multiple nation states i.e., the NWES is a good example of a large sea inclusive of various interested parties who are forced to work with one another. Additionally, as stated in Section 7.2.2, there is a European/UK/North Sea focus in the main literature that lies at the foundation of this thesis (Luisetti, 2019, 2020, Diesing, 2017). Each scenario is accompanied by an original illustration commissioned for the thesis.

Scenario 1 – Joint Interventions

- **High levels** of Cooperation and **Increased** need for Climate Change Mitigation

The increasingly dramatic and destabilising effects associated with climate change have created greater incentive to more aggressively address it. As a result, attention has turned to the stocks and flows of carbon found in the offshore zone of the world's regional seas to help in mitigation. In Europe, the European Union, Norway, Iceland, the Faroe Islands and the United Kingdom formed *The European Offshore Carbon Initiative* (EOCI), a shared regional institution with responsibility for administering the offshore carbon component of the *Common Carbon Policy* (CCP). The CCP treats all the offshore carbon measured in the Northwest European shelf (NWES) as one collective pool and distributes the carbon stock to the participating countries relative to the size of the countries' EEZs, for the purposes of carbon budgets and national accounts. The shared responsibility led to a European-wide standardisation of practices regarding measurement and calculation. Expertise is shared, with countries contributing what they can.

Buoyed by widespread public support, decision makers have felt bold enough to implement policy interventions that have proved unpopular in some quarters but popular with the public, including a ten-year moratorium on all bottom trawling in the Northwest European Shelf. During the moratorium, scientists across the world were invited to engage in a comprehensive monitoring and evaluation programme that assessed social and economic impacts, and ecosystem change, alongside the effects on carbon sequestration and storage. This was to garner whether the policy was having enough of a positive effect to counter the lost economic outcomes of banning such a form of fishing, and to what extent such fishing could be reintroduced, if at all. Additionally, a new component was added to the yearly measurements and declarations of fishing quota across Europe: the estimated effect on the OC carbon cycle (a kind of carbon cost) of fishing a said amount of a species. As the effects are negative, this acted as a control on total allowable catches, acting to reduce the overall fishing quotas across Europe for many key species. This in turn led to a push back from the fishing industry which later lost traction in light of the generally held belief among the public that such polices are necessary, with fishermen increasingly perceived as "eco-pariahs" looking out for their own interests at the expense of climate mitigation.

Scenario 2 – Joint Agreement

- **High levels** of Cooperation and **Decreased** need for Climate Change Mitigation

General success in cutting global emissions have led governments and others to begin looking deeper at natural methods of carbon sequestration and storage, including the use of the offshore carbon system. To this end, governments across Europe agreed to work together to manage what is widely regarded as a shared, integrated carbon system. A new offshore carbon remit was created for the OSPAR Commission, responsible for measuring and monitoring as well as for devising policy interventions that could improve and develop the Northwest European Shelf's (NWES) capacity for carbon capture and storage. This has led to the main intervention of linking all marine conservation in the NWES zone by creating shared standards and policies, including a no trawl ban within the network, alongside some impediments to other forms of fishing in these areas. It is believed that the no trawl ban will protect the areas richest in carbon storage while still allowing some trawling to go on across the NWES. The new, but relatively muted, restrictions on fishing have been implemented with the aim of increasing the biological sequestration of carbon, although this has yet to be determined as effective.

The interventions proposed and administered by OSPAR have been met with fierce resistance from the fishing lobby across Europe who, due to a decrease in interest in climate change among publics and decision makers, have been successful in watering down the policy implementations, mostly through resisting the proposed extension of the marine conservation network. Indeed, some nation states believed the system would be so detrimental to their fishing industries they came close to leaving the OC OSPAR agreement altogether. Only the robust in-built systems of negotiation and facilitation stopped some countries from leaving the agreement by keeping open a space for deliberation. This has required a large amount of political work, with the sharing and pooling of expertise and funds, to meet each party's needs and demands.

Scenario 3 – Haphazard Interventions

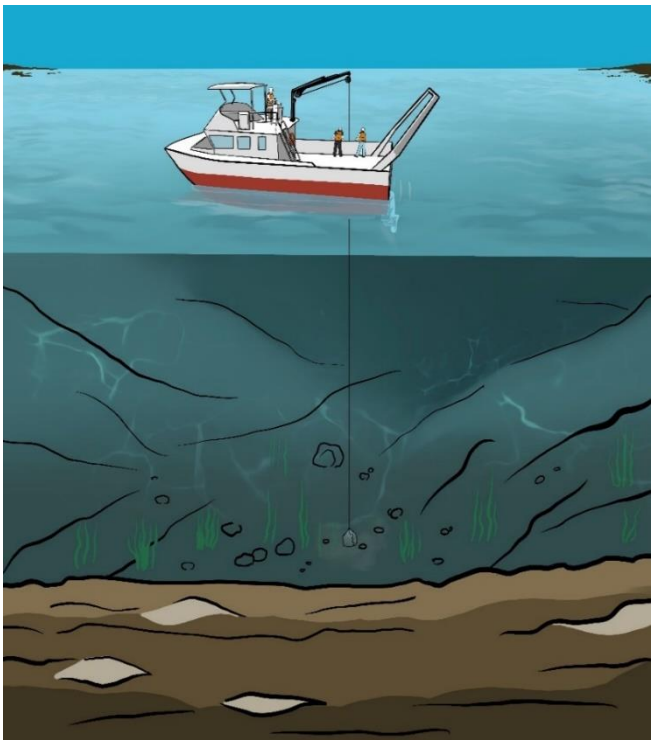
- **Low levels** of Cooperation and **Increased** need for Climate Change Mitigation

Governments the world over have largely failed to address climate change and meet their targets on greenhouse gas reduction. As the societal, economic, and political problems associated with higher global temperatures have built up, publics and campaigners across Europe have placed pressure on governments and political parties to expand the actions taken to address the issue, including the better utilisation of natural systems of carbon sequestration and storage. Despite wide-spread support for offshore carbon interventions, a joint OC initiative, proposed by the European Union, was rejected after significant disagreements between the NWES nation states on the extent of disruption to the fisheries sector and food security. As a result, each country manages their own OC initiatives with various implementations being adopted. For example, Norway has decided on a complete ban on bottom trawling within its EEZ while the UK has opted for a partial ban in areas of high carbon concentration.

Different standards and techniques of measurement between states mean it is difficult to ascertain the region-wide effects of the various interventions with some measures demonstrating that the carbon storage capacity of the NWES has been boosted considerably with others far more conservative and doubtful there has been a significant change. These discrepancies have been pounced on by the detractors of offshore carbon, mainly the fishing industry and anti-environmental media, who argue that OC interventions are ineffective and should therefore stop. Further disagreement and political fallout has occurred between states as the result of some believing they have been sacrificing more to boost the collective system than others. This has led to some nation states abandoning the utilisation of OC all together, believing there to be no point if the system is not managed collectively and fairly. Disinterest in offshore carbon has also followed from an increase in investment in carbon capture technology and direct carbon dioxide removal technologies, which have begun to garner more political attention. Therefore, the utilisation of OC for climate change mitigation can only be called partially successful at best, with wide-spread uncertainty as to the efficacy of the haphazard interventions.

Scenario 4 – After Thought

- **Low levels** of Cooperation and **Decreased** need for Climate Change Mitigation



With national climate change targets largely being met, the issue of climate change has dropped down the public and political estimations of importance. As a result, there is little interest in utilising offshore carbon beyond being a minor component of strategies to draw-down the historical emissions from the atmosphere. This has meant little to no effort has been placed into attempts to amalgamate the approaches of the various states bordering the NWES, despite arguments by some academics and researchers that any OC utilisation should ideally involve a joint approach, given the common pool nature and large scale of the resource in question. As such, small-scale OC policies have been advanced within some of the more environmentally conscious governments across the NWES. This has mostly taken the form of measuring areas rich in carbon seabed storage and using the data to argue for the extension of existing marine conservation policies and approaches. These arguments have largely fallen on deaf ears with decision makers seeing no gain in pursuing OC initiatives, instead seeing political losses as a result of potential fallout with politically powerful and antagonistic interests, such as the fishing lobby.

8.2.5 Step 5: Implications for Focal Question

The intention of constructing the 4 scenarios was to utilise them as aides in further research on OC governance. As stated above, this was to give form to something that has yet to be realised in actuality, helping any participants in OC governance research picture how OC could potentially be realised. In the following Chapter, I describe how I used the scenarios in combination with an online survey of environmental governance experts to ask further questions on OC governance, building on the research outcomes of the thesis to this point. Step 5 of the scenarios process requires discussion of the implications of the scenarios for the focal question – *What are the main potential approaches to offshore carbon governance?* The survey of experts in the following chapter is the process of discussing these implications. By surveying experts, in conjunction with the scenarios, valuable insights are gained on how OC could develop going forward, what it means for OC's governance, and by extension, what it would mean for any devised frameworks of governance.

Chapter 9 |

Open Question Survey: Building on Preceding Findings

9.1 Introduction

The aim of this chapter is to utilise the scenarios from Chapter 8 (see Section 8.2.4), themselves derived from the previous work in the thesis (the semi-structured interviews and the systematic literature review), in combination with a survey study to build on the outcomes of the previous chapters and offer findings that can help answer research question 3 – *How do the findings inform a governance framework(s) for offshore carbon?* Section 9.2 lays out the research aims in relation to this research question. Section 9.3. explains the various components of the process of data collection. Section 9.4 relates the findings, while 9.5 discusses them. The chapter therefore explains the process of surveying environmental governance experts followed by a description and discussion of the resulting findings.

9.2 Research Aims

As with the previous interview study, I decided to break down the remaining research question (RQ3) into its component research aims to determine the broad areas of questioning that could inform the questions for the survey (outlined in Section 9.3.2 below).

This led to the following research aims. A break-down of the research questions, aims, and then objectives, for RQ3 is summarised here in Figure 9.1.

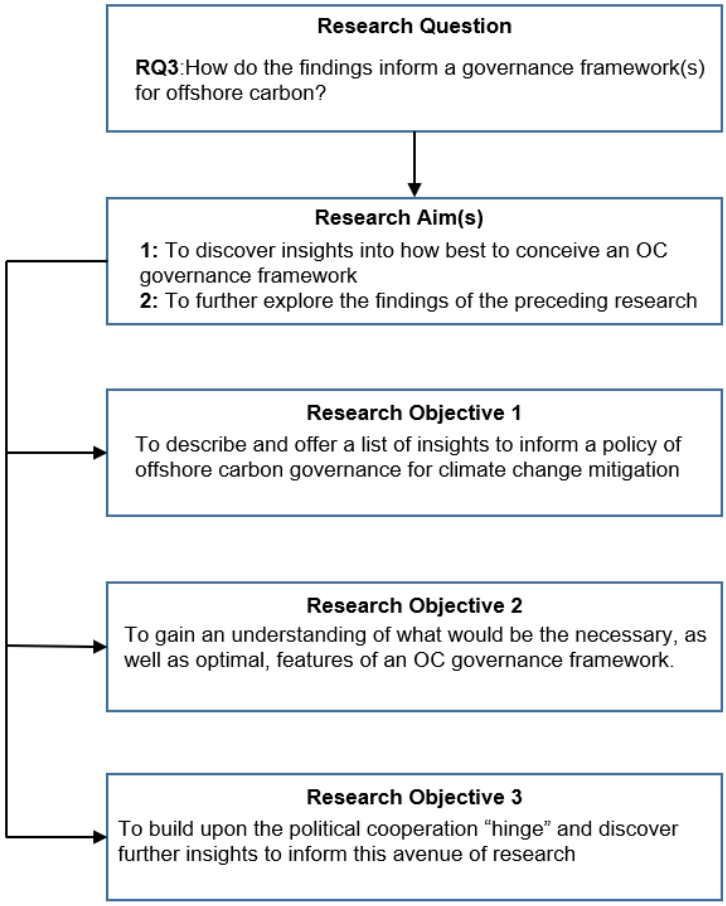


Figure 9.1 *Research Question 3, breakdown of research aims and objectives.*

9.3 Data Collection

This research project was designed as an online survey of professionals with working knowledge of environmental governance, utilising the derived scenarios to aid participants in answering the survey questions. As OC is not an established concept, I needed to devise a way to describe to the participants what OC is while also depicting the scenarios for their perusal. As mentioned in Section 6.4, this was achieved through the use of the *Environmental Systems Research Institute's* (Esri) ArcGIS Storymap service[31]. The participants were invited to scroll down through the storymap, and then follow a link at the end to an online survey hosted by Microsoft Forms via my university's Microsoft service, hosted on The University of East Anglia servers. The following sub-sections describe and

[31] https://storymaps.arcgis.com/

justify the storymap and its features, the survey questions, piloting, ethics and data protection, and participant response. For an explanation and discussion of the use of qualitative survey as a methodology, see Section 6.4. As a reminder, the survey results were analysed using a thematic analysis, as laid out and explained in Section 6.5.

9.3.1 The Storymap and Scenarios

As explained and justified in Section 6.4.1, Esri's ArcGIS *Storymap* was used to display the scenarios to the participants, alongside an explanation of the basic information required to understand questions on the novel topic of OC governance.

The finished storymap can be found at the following URL:

https://storymaps.arcgis.com/stories/5aa81691b28e45918b036ef74eb38c98

As a reader of this thesis, I invite you to follow the link and read the storymap for yourself, to gain an understanding of what the participants experienced.

The storymap contains the following sections:

1. Introduction: outline of the research project to provide the participant with an understanding of what the survey is about and the process they were about to engage in.
2. The Rationale: as an emerging topic of research, it was important to give the participants a basic idea of the rationale behind the project and why OC is being explored as a natural resource/ecosystem service/nature-based solution. The storymap is about giving the participants context to help them make sense of the questions asked in the survey.
3. What is Offshore Carbon?: here offshore carbon is defined and explained, as defined by the thesis. This section was therefore very important as it gave them essential information they needed to participate in the survey. This part therefore introduced bias into the study as any definition and conception of OC offered would begin to colour the manner in which the participant's would answer the questions. This was unavoidable given the participants' need to be given a definition of OC in order to answer the survey. The definition given was the one used throughout the research.
4. The Disruption Problem: The findings in chapter 7 demonstrated how important it was to understand the disruptions on OC in order to subsequently understand its governance. By making this explicit to the participants, they could gain an

understanding of OC as novel and dependent on knowing more about how humans disrupt it. This would help them understand that the process requires imagining and to keep an open mind as to the type and extents of disruption, and therefore to the types and extents of suggested interventions in the scenarios.

5. Context – Northwest European Shelf (NWES): As the scenarios are based in the NWES (for reasons explained in Section 8.2.4), explaining this to the participants would help them understand why the scenarios are based there, but it also gave an opportunity to tell them that it was not particularly relevant to how they answer the survey, it is simply to give context to the scenarios.
6. Context - Estimated Distribution of Seabed Carbon Stocks: This section was included to provide participants with a quantification of OC mitigation potential to help them conceptualise OC and gain a fuller understanding of its potential for climate change mitigation.
7. The Process: succinct description of the scenarios – what they are, the intention behind them, and how they were produced. This was for those participants interested in the methodology details. I stated in the instruction to skip this section at the beginning of this heading if the participant was not interested in learning more about scenarios.
8. The Scenarios: The four scenarios (as laid out in Section 8.2.4) with attendant illustrations. This is followed by instructions to follow a hyperlink to the online survey.

9.3.2 The Survey

The survey questions focussed on aspects that will inform an OC governance framework. The survey questions were derived from two main aspects in conjunction:

a) Facets a governance framework needs to address and incorporate, and that a study such as this could make a valuable contribution towards, as derived from:
b) the findings of the preceding research[32]: the Six Principles on CPR governance from Chapter 4, the outcomes of synthesising the literature review sections of the thesis in Chapter 5 (as well as the definition of *governance framework* set out in Section 5.3.1), the findings of the interview study in Chapter 7, and the derived scenarios themselves. It stands to reason the survey protocol would incorporate points from these findings. Additionally, the explicit intention from the beginning

[32] A direct expression of research aim 2

was to utilise the scenarios to aid in the respondents' answers, which meant incorporating and referencing the content of the scenarios in the survey questions. The derived aspects of a governance framework are listed in Table 9.1

Table 9.1 *Key Aspects of Governance*

Key Aspect of Governance	For Example
Remits and responsibilities	• Monitoring • Enforcement • Decision making inc. policy and approach • Updating and continuous review
General approach and strategy	• e.g., Commons approach and commons theory • e.g., Avoiding unilateralism
Actors	• Key stakeholders identified • Roles defined • Responsibilities and power distributed

In Table 9.2, I state each of the finalised survey questions, offer a justification for asking them, and make explicit the intention behind them. There is a running theme in regard to the intention behind each question that should be apparent – best practice. How have other situations dealt well with these general governance problems and can OC copy them? The hope was that this survey would highlight such insights.

Table 9.2 *The survey questions, their justifications and intention*

Question	Justification and Intention
1. *Scenarios 1 and 2 depict two different approaches towards the institution that manages offshore carbon. Thinking about institutions in general, are there any existing institutions that, in your view, incorporate characteristics useful to consider in relation to OC governance? If so, which and why?*	This continues a line of questioning on actors that runs throughout the thesis and is built on the theme of institutions found within the interview data, and thus the use of institutions in the scenarios. Due to the centrality of institutions to the work so far, and governance in general, it was pertinent to ask a question about them directly, leaving it to the participant to highlight what lessons existing institutions could offer up for OC.

	The intention here is to find best practice and innovation in institutional structure and management that could be useful for OC to consider incorporating. It is therefore a highly practical question, relating to institutions in practice, rather than theory.
2. *It has been argued that governance of natural resources and ecosystem services benefits greatly from public involvement and should try to involve publics where possible. Given what you've learned about OC from the storymap, are there any ways of involving publics in governance that would work well for OC governance specifically? What, in your view, would be the challenges?*	In the scenarios (and interview findings), publics play a crucial role in determining how OC is addressed and developed, if at all. The centrality of publics as actors in this sphere led to this question and to specifically relate it to the general idea across commons studies, and governance research, of involving publics as much as possible. As involving publics is difficult for a large-scale resource like OC, and difficult to imagine, the question sought to draw on participant's experience to see if they could offer any insights on this.
3. *Throughout the scenarios, there are many issues surrounding the fishing industry. This is because any future OC policy interventions will likely involve some form of limitation on fishing and other disruptive industries. Thinking of other natural resource management and environmental governance situations in which a disruptive industry needs to be limited, what, from such examples, are the key insights on the elements in a governance framework that act to limit the negative impacts of disruptive industries? Do you think they could be made to work for OC?*	The literature (and previous research in this thesis) indicates that appropriate incorporation and mechanisms for dealing with disruptive stakeholders is front and centre to whether or not that resource is governed successfully. Here, "Disruptive Industries" refers to those industries that significantly disrupt the natural environment and are normally extractive. For example, the timber industry in forests, the beef industry in the rainforest, or the mining industry in general. For OC, it specifically refers to industries that may have an effect on the addition or subtraction of carbon from a designated area of OC sink e.g., fishing or marine construction. The fishing industry looms large in the scenarios and so it is correct to infer that how a governance framework "deals" with this key stakeholder (and other potential disruptors) is crucial to any future successful OC conception. This question was asked to elicit responses about the best ways to engage with disruptive/extractive stakeholders that would work for OC, given OC's limitations.
4. *In scenario 1, (a) important measurements and data required for the system to work have been universalised and (b) responsibility for them shared among the parties involved. In your view,*	Information and the necessity for large amounts of it were frequent mentions in the interviews and play a prominent role in the scenarios.

in the context of environmental governance, are there strategies and mechanisms for the sharing and pooling of information, and creation of information protocols, that have worked well? If so, which are these? Why have they worked well? If not, why have they failed?	This question was framed to focus on a specific aspect of the transboundary nature of OC, rather than ask a general question on transboundary governance that could be answered with reference to the literature.
***5.** In scenario 3, there is an increase in interest towards direct carbon dioxide removal technologies, such as iron fertilisation, as a new intervention. How do you envisage an OC governance framework could incorporate the inclusion of new interventions in the future? i.e., in your view, what are the best mechanisms that help a governance framework adapt to changes in how a resource is utilised over time?*	This question builds directly on one of the 'Six Principles for Commons Governance' highlighted in Chapter 4[33] - that governance needs to incorporate variance in a resource and its use *over time.* And that often a governance regime's failure can be attributed to its lack of flexibility and ability to change when needed.
***6.** In regard to a future OC governance, if all constraints were removed and you were in charge of developing a successful[34] governance of offshore carbon as a natural resource, what would you do in the short to medium term e.g., in terms of setting rules, strategy, or policy frameworks?*	This question is not derived in the same way as the others (i.e., from a-b above). Instead, the question stems from a standard script used by futures experts when consulting people during a process of scoping and initial scenario building[35]. Its use by futures professionals encouraged me to think about using it in my own study. This question is a general, catch-all question near the end to give the participant a chance to add anything they thought of as they were going through the exercise. Asking them what they would do if setting up a governance regime for OC allowed them the freedom to focus on their specialities and expertise and invited them to apply it to the context of OC.
7. Finally, have you come across any recent developments or insights in environmental governance, in research or in practice, that could be applied to OC's	As with 6, this question is not derived from the a-b list, but follows a similar logic to the preceding question only this time focusing on innovations and anything new – directly requesting information on novel developments

[33] See Section 4.6.

[34] At this point in the survey, I defined success for the participants as: "a meaningful addition of carbon to sediment stocks, and / or the successful prevention of a meaningful level of subtraction of carbon from the stocks."

[35] This question has its origin in work I conducted with a futures consultancy – *The School of International Futures* (SOIF) – during an internship in Spring 2022. I have no publication to reference. However, it was written down as an idea from documents and discussions internal to SOIF. SOIF's website can be found here: https://soif.org.uk/

potential governance? Would you please share these here?	that might not be prevalent in the literature. A very similar question was asked of the interviewees in the interview study. This question was asked here at the end for the same reason it was during the interviews: the participant population represented a specialised community of people who may have insights on topics that are not yet published or collated. This question was to catch any new developments that might not be available for me as a researcher to access easily.

Conspicuous by its absence is a question directly addressing one of the overarching aspects of a future OC governance – transboundary cooperation between jurisdictions[36]. This was to be discussed directly with an earlier iteration of the survey script asking a direct question on this. But it fast became clear in consultation with my supervisory panel, that the question was too general and would likely elicit uninteresting answers or even simply instruction to search the literature on this topic. So, it was rationalised, that if the topic of transboundary cooperation was to be addressed, it would need to be in asking about something more specific, that a governance framework would benefit from knowing. The decision was made to ask about the sharing, specifically, of information and information protocols across borders, in Q4. This was because it came up as a topic in the interviews and was prominent as a concept in the scenarios.

9.3.3 Participants

The populations invited to survey were defined as academic researchers, government professionals, and NGO professionals, with working experience and expertise in environmental governance or adjacent topics such as natural resource management or ecosystem services. The inclusion/exclusion criteria were:

1. **Working knowledge of environmental governance:** This can be any kind of natural environment and in regard to any kind of natural resource. Much of this criterium rests on the term "working" – intending that the individual must have experience of environmental governance in a professional capacity e.g., through

[36] Which would be a direct expression of research aim 2, and research objective 3

academic research, through policy development, through direct management of a landscape, working in an NGO on these topics, a mix of these etc.

2. **Any career stage:** Individuals were approached from a range of career stages with the idea being that early career participants, although less experienced, may have novel points of view that could prove valuable. However, in combination with the previous specification, there had to be some substantial evidence of their "working knowledge", e.g., a PhD student would need to have a relevant published paper(s), or have been working in natural resource management before becoming a student.
3. **Competence with English:** The storymap and the survey are in English, the whole process is an exercise in the English language, so it is self-evident that their ability with the English language would have to be fairly well developed in order to complete the task.

I settled on the three chosen populations because they were regarded as an invaluable resource of knowledge on the given topics and are populations that could offer original insights on OC governance; the same rationale as for the interview participants in Chapter 7, as explained in Section 6.1. The original intention was to survey the three defined populations but, at first, academic researchers were surveyed as the initial systematic search method for finding academics did not translate well for the other two populations. The process required potential participants have online public-facing profiles in order to find them, which government and NGO workers tend not to have but which academics are obliged to have as part of their employment. However, as the data collection progressed, the other two populations – government and NGO workers – were drawn on due to a lack of response from the academic population, as explained in the following sections.

9.3.4 Participant Search Process

This section describes the processes by which I identified potential participants and the manner in which I contacted them. It is organised under each of the three populations surveyed: Academic researchers, government professionals, and NGO professionals.

9.3.4.1 Participant Search Process – Academic Researchers

The main specification for the potential participants was that they be able to knowledgably answer questions pertaining to environmental governance and natural resource

management – that they have working experience with such. In order to find and collect academic researchers with such working experience, a systematic method of search was devised, as outlined in this section.

To begin, international university rankings were used to discover the institutions that ranked highest in the areas of geography and environmental governance-adjacent subjects. This was to help limit the number of universities searched to keep the process manageable. The idea being that after a number of universities had been chosen, it would be followed by a further systematic search of each universities' relevant departments' academic-staff-biographies to ascertain whether the researcher met the participant specifications. This means there were two phases to the search: a) an initial university search to discover which universities should be subsequently searched for b) the individual researcher search to discover which individuals should be contacted with a survey request email. Examples of the results of search a) are recorded in Appendix 4, Tables A.8-A.10, and the results of search b) are recorded in Table A.11 in Appendix 5.

- **Search a) – University Search – process**: For the university search, the *Guardian University Guide*, the *Times Higher Education University rankings*, and the *QS World University rankings*[37] were explored as tools to discover the highest ranked universities in the chosen countries or regions, in regard to the chosen subject areas. For efficiency, instead of using all three ranking guides, the decision was made to utilise only the Times ranking as it had the best search function for the needs of the search i.e., a search function that broke-down the search by country, subject area, and specific ranking (the relevant rankings in this case were judged to be *number of citations*, and *research output*[38]). The online ranking guide was then used to search a combination of these search parameters which are outlined in Table 9.3.

[37] Guardian: https://www.theguardian.com/education/ng-interactive/2022/sep/24/the-guardian-university-guide-2023-the-rankings ;
Times: https://www.timeshighereducation.com/world-university-rankings ;
QS: https://www.topuniversities.com/university-rankings/world-university-rankings/2023

[38] As opposed to other rankings on the Times list, such as "student satisfaction", which were deemed irrelevant to the needs of the study.

Table 9.3 *University search: the four search combinations – UK example*

Country	Subject Area	Ranking
UK	Geography	Number of Citations
UK	Geography	Research Output
UK	Environmental Science	Citations
UK	Environmental Science	Research

- **University Search – country categories**: The four combinations of searches displayed in Table 9.3 were then repeated for the USA, Ireland, New Zealand, Australia and Canada – the Anglophone countries. These Anglophone countries were prioritised and searched directly because they facilitate the English language requirement of the survey participants, stated in Section 9.3.3. However, the international language of research and science is English, so three more groups were searched to broaden the scope to include countries outside the Anglophone world. These non-Anglophone searches were each a combination of countries rather than one standalone i.e., country groupings. These were East Asia, Europe, and a category entitled "Rest of World". These regions were grouped together for the search in order to keep the search manageable – looking for the top ten universities in every European country, for instance, would take a very long time and this was deemed unnecessary to find sufficient participants for the study. This was facilitated by the *Times University Ranking* search facility as the regions of *Asia*, *Europe*, and *International* were selectable. The top 20 universities for each of the four searches outlines in Table 9.3 (excluding any in the Asia category that were not East Asia[39]) were recorded. I separated East Asia and Europe out specifically as their own categories, and not, say, South America, because they dominated the *rest-of-the-world* category if they were included (i.e., most of the highest-ranking universities in the world are from the Anglophone countries, Europe and East Asia).

- **University Search – record**: I recorded the top universities for each country category in relation to the size of the country's (or country grouping's) university sector(s), which loosely coincide with the size of their populations. As such, I

[39] East Asia being defined as China, Japan, South Korea, Taiwan, Hong Kong and Macau. The Times University Ranking is dominated by East Asian countries and universities within the wider Asia category, so the choice was made to make East Asia its own category and add the remaining Asian universities to the "Rest of World" category.

recorded top 20 universities for the *UK, USA, Europe, East Asia* and *Rest of World*. Top 10 for *Australia* and *Canada*. And top 5 for *New Zealand* and *Ireland*. In Appendix 4, Tables A.8-A.10 provide three examples of the nine country searches to help illustrate the manner the search was conducted and recorded.

- **University Search – final selection of searched universities**: As there were four searches per country/country group, all the searches were synthesised to find the final universities in each grouping. To do so, I tallied how many times a university appeared in all four searches – the universities with the highest tallies were added to a finalised list for that country/country-grouping (see Appendix 4 for examples of the record of the tallies). It was this finalised list of universities that were searched for academic participants using online academic staff biographies on university websites. If a number of universities ended up with the same score, I then went back to the Times ranking and checked the overall ranking (so not research or citation rankings, or by subject such as Geography, but overall) for the given universities – whichever ones scored highest were added to the final list. This was repeated until the quota was met. Initially, however, only half the total universities for each country category were searched from this final list (so 10 in UK, 5 in Australia, for example) because searching the universities was very time consuming and was greatly delaying the beginning of data collection. However, as explained in Section 9.3.7 below, all the final-recorded universities were eventually searched due to a low response rate from the initial selection.

- **Search b) – Individual Researcher Search – process:** The finalised list of universities was then used to subsequently search for suitable candidates to send survey request emails. This researcher- search was conducted by reading the online biographies of researchers in departments deemed relevant to the content of the survey and wider PhD project (e.g., Geography, Environmental Science, International Development etc.) on the websites of each finalised university. If a candidate was deemed qualified, they were added to the record and sent a survey request email to their professional email address. A record of the finalised universities and the number of researchers found for each, resulting from this process, can be seen in Table A.11 in Appendix 5. As can be seen from the record, many of the universities did not provide anyone deemed qualified to contribute to the study whereas some provided a disproportionately high number. I believe this is a result of the tendency for universities to specialise and act as hubs for certain

specialisms and foci i.e., some universities on the list simply had more natural-resource-management, or environmental-governance focused researchers than others, regardless of any university ranking. The process relied heavily on my own subjective judgement of a potential participant's suitability, as was the case with the process of interview participant recruitment described in Chapter 7 (see Section 7.2.5). This was conducted with the inclusion/exclusion criteria strictly in mind. Often it was very clear from the type of publications and/or the descriptions of their specialisms and research foci, whether someone was qualified.

9.3.4.2 Participant Search Process – Government Professionals

As part of my PhD programme, I had what my doctoral training pathway[40] calls an *Independent Research Impact Adviser* (IRIA) who's role was to offer independent advice to help maximise the impact my research could have outside of academia. My adviser was a social scientist working for DEFRA – the Department for Environment, Food and Rural Affairs – the UK Government's environment ministry. In order to contact people in government who would be able to answer the survey, I asked my IRIA to act as a point of contact and disseminate the email on my behalf among their colleagues, trusting in my IRIA's experience with the topics at hand (environmental marine governance and natural resource management) to know who would make a suitable candidate. This way I was able to contact, through my IRIA, government professionals working in the UK's environment ministry and other associated institutions such as the *Joint Nature Conservation Committee* and the *Marine Management Organisation*. This was required as there was no clear way for me to independently search for and check potential participants within government. A clear limitation here is the reliance on the IRIA's judgement in picking relevant colleagues. However, this is balanced out by the self-selecting nature of the survey – anyone who thought themselves unqualified after reading the dissemination email would rule themselves out and not complete the survey.

9.3.4.3 Participant Search Process – NGO Professionals

To search for environmental non-governmental organisations (NGOs) likely to have employees qualified to answer the survey, I initially accessed the UK government's official

[40] The ARIES Doctoral Training Pathway

charity registers, one for England and Wales, and another for Scotland [41]. These registers are a good source of information regarding NGOs because, as the official government register of charities, they include all registered NGOs working in the UK, making them very comprehensive. They also have a detailed online search function which allowed for more exacting searches. A complication with these registers is that NGOs are not always registered under their public-facing name, but rather the Trust that acts as an overriding funding body, which can have a completely unrelated name. As such, some relevant NGOs were missed as a result of this aspect in these initial charity-register searches that would go on to be found as the result of supplementing these registers with other directories, as explained below.

In the registers' search functions, the purpose of the charity was specified by selecting the option that lined up best with environmental concerns[42]. Initially, in this first phase of search, the geographical spread was limited to just those operating/based mainly in the UK. This was due to my location in the UK, and the relative closeness to the project's geographical focus on the Northwest European Shelf, as well as to mirror the UK nature of the government participants. An additional reason for a UK focus was to control the number of search results – without it, the number was too high to manageably search.

In a second phase, because of a lack of results in the initial search, it was decided to supplement the charities register search by using directories of environmental NGOs on *Wikipedia*[43] – one for the UK, the US, and for international. Google was also used to search directories of marine and oceans focused NGOs, which resulted in finding two useful directories[44]. The reason for this supplementation with less reliable directories was to act to compensate for the problem of some NGOs not registered under their name on the charities registers; to catch some that may have been missed. The decision to broaden the search to international directories was made in order to increase the number of NGOs, as

[41] The Charity Commission for England and Wales website https://www.gov.uk/government/organisations/charity-commission
And the OSCR Scottish Charity Register website https://www.oscr.org.uk/about-charities/search-the-register/register-search/

[42] The "Environment, Conservation, and Heritage" category in the English and Welsh register, and "The advancement of environmental protection or improvement" in the Scottish

[43] Wikipedia UK list: https://en.wikipedia.org/wiki/Category:Environmental_charities_based_in_the_United_Kingdom ; US list https://en.wikipedia.org/wiki/List_of_environmental_and_conservation_organizations_in_the_United_States; International list: https://en.wikipedia.org/wiki/List_of_environmental_organizations.

[44] Marine Bio: https://www.marinebio.org/conservation/marine-conservation-biology/organizations/; and the United Nations: https://www.un.org/depts/los/Links/NGO-links.htm

the UK focus was leading to a fairly small number of relevant organisations. I controlled this by limiting the International NGOs to just those operating in the marine and oceans contexts. The strength of these less official directories compared to the official registers is that they provide the NGO by public-facing name, not by their registered charitable Trust, so were easier to identify. The potential downside of using this type of directories is that they are unofficial and therefore can be unreliable in terms of being comprehensive and up to date. As a result, every NGO found via *Wikipedia* – that had, or was likely to have, a UK presence – was crossed-checked with the official government registers (finding their register-name, if different from their public-facing name) to make the findings from the less official directories more robust. As can be seen in Appendix 6, a number of the found NGOs were found in both official registers and unofficial.

The subsequent lists of charities and NGOs from each directory and register were searched and those identified as possible candidates, based on their name and focus, were assigned to an initial group for further investigation. Table A.12, in Appendix 6, provides the list of organisations within this initial group to be further investigated. The initial search process of the directories – resulting in the list in Table A.12 – eliminated the majority of options from the various directories and registers as most clearly had a specialism that had little to do with the survey's content e.g., *Sustrans* (UK walking and cycling charity) or *Just Stop Oil* (anti-fossil fuel campaign group).

The second step was to further investigate each chosen organisation's website to gain a sense of whether or not it contained individuals who could answer the survey i.e., be able to answer in-depth questions regarding natural resource management and environmental governance. This was assessed by investigating the work and focus of the organisation (with some having far more focus on research, landscapes and natural resources), as well as gauging how many people the organisation employs (with smaller organisations being deemed less likely to have suitable survey candidates). Therefore, some well-known environmental NGOs like *Greenpeace* and *Friends of the Earth* were excluded because they have more of a focus on campaigns and politics, not research and management of natural areas. An instructive example is the *Zoological Society of London* (ZSL) which nearly made the final list. It was clear ZSL employs research staff and very knowledgeable people, but the focus is on wildlife and wildlife conservation which was deemed too different from the large-scale landscape and geography context of the survey i.e., it was thought people at ZSL would be confused by the survey focus and find it difficult to answer as it does not focus on any specific species. Organisations with a marine focus were more likely to be chosen due to their greater closeness to the project. The search process resulted

in a final list of 21 environmental NGOs to be contacted for distributing and disseminating the survey. The final list can be found in Table 9.4.

Table 9.4 *List of contacted NGOs*

NGO Name
World Land Trust
Marine Conservation Society
Centre for Agriculture and Bioscience International
Blue Marine Foundation
WWF
World Resources Institute
RSPB
Rainforest Foundation UK
International Institute for Environment and Development (IIED)
Fauna and Flora International
Conservation International
Biodiversity International
Rewilding Britain
The Woodland Trust (various Trusts across the UK)
Blue Ventures
Ocean Conservancy
Resources For the Future (RFF)
Marine Conservation Institute
Coral Reef Alliance
Nature Conservancy
Oceana

The NGOs were contacted via a dissemination email in which the recipient was asked to help by disseminating the survey request email (essentially the same one sent to academic researchers) throughout their organisation or directly to people they believed to be qualified, or departments deemed relevant. The limitation of this is that it relied on people in charge of general public-facing email accounts (such as enquiry email addresses) to engage and help with dissemination. A dissemination request email was required as I had no direct contacts within any of these organisations and very few have public-facing profiles (like academics do), so there were very few ways of finding specific individuals.

The one exception to this was *The World Resource Institute* which does have public-facing profiles. With this, relevant people were identified and emailed directly, exactly the same as the process for academic researchers.

9.3.5 Piloting

There were two stages of piloting: An initial pilot to check the step-by-step process was working well, and whether the instructions were sufficient for end-users. And a second analysis pilot, an initial analysis of the first three survey responses to determine if there were any issues with how the participants were answering the questions, and whether the data collected were able to fit well into the chosen method of analysis.

As for the first stage, a number of colleagues with experience in social science, including my supervisory team, were asked if they could follow the process as if they were an original participant. This involved reading the initial request email, following the given links, reading through the storymap, and populating the survey questions. They were asked to highlight any issues with the process e.g., typos, broken links, something not making sense. As well as provide feedback as to the readability of each stage e.g., could it be made more succinct? And to check for any issues concerning bias or leading questions. All of the practical processes worked well with little feedback in this regard. There were some comments regarding shortening some of the survey questions as they were interpreted as being a little too long, often asking three questions within the question. This was followed through by my revising of the survey questions and shortening questions 2 and 5. Overall, this stage of piloting was successful with minimal changes made to the process.

The second round of piloting involved an initial analysis of the first three survey responses to gain an idea of how the respondents were answering the questions. They were told prior to the survey to leave any questions blank if they were not sure how to answer them – this being justified due to the wide-ranging nature of the questions. As such, none of the pilot responses answered all seven questions. This was anticipated and not an issue for the study as any data on any of the topics under question was regarded as potentially valuable and therefore worth collecting. Additionally, the respondents did seem to be more confident answering some questions than others due to their experience with certain topics over others, helping to justify the chosen approach of making each question optional. Answers, however, did tend to be short with some respondents choosing to offer one or two sentences at most, or, in one case, one-to-two-word answers (this particular example was “cleaned”

from the data, i.e., removed as a viable response and not included in the completed findings).

Following reflection on the first three responses, I did not decide to change the survey questions in any significant way. This was due to the anticipation that most respondents would only answer some of the questions and not all of them, so that had been taken account of from the beginning. And that the general lack of substance in some of the responses would be countered by acquiring many responses – the rationale being one of casting a wide net, even if some respondents gave minimal responses, cumulatively this would add up to a substantial data collection. This however, proved to be the wrong approach as my eventual response rate was very low – this is explained in Section 9.3.7 and reflected upon in Section 9.5.2.

9.3.6 Ethics and Data Protection

The scenarios-survey research proposal received ethical approval from The University of East Anglia's Science Ethics Committee in September 2022, following the University's set procedures regarding research that involves human subjects.

Participants' data and identities were kept secure, with the identities of the participants kept anonymous, if they chose to remain anonymous. Data management followed the 2018 General Data Protection Regulation Act (UK) and the University of East Anglia Research Data Management Policy (2019).

9.3.7 Response

When the data collection period was halfway through the initial phase, it was clear there were not enough responses to finish the study. As such, the decision was made – in collaboration with my supervisory panel – to extend the surveyed populations by a) increasing the number of academic researchers contacted, and b) going back to my original intention of also surveying government and NGO professionals with working experience in environmental governance and natural resource management.

a) was initiated first by increasing the number of universities that were searched for academic participants (see Section 9.3.4.1 for a break-down of this process), and b) was initiated through the processes outlined in Sections 9.3.4.2 and 9.3.4.3.

The survey period was extended from the 31st of March 2023 to 31st May 2023, with an overall data collection period of just over six months. This resulted in a total of 12 responses with 2 responses "cleaned" from the data due to poor quality (i.e., in both cases only two or three questions were answered, using only two- or three-word answers), leading to a final result of 10 responses: 7 Academic[45], 3 Government, and 0 NGO.

When the new approaches did not begin to yield a sizeable increase in responses, an entirely new approach was discussed with my supervisory panel in which an in-person workshop would be held with invited experts to discuss OC governance and the survey questions in person. The thinking was this would complement any survey responses received and create a mixed-methods approach, thereby strengthening the study results. Before doing all the work of organising a workshop, I decided to sense-check whether anyone identified would be able to attend such an event before the end of May 2023 by sending sense-check emails to 20 of the UK-based academics on the survey list. Of those that responded, the general consensus was that they would likely be unable to attend such an event due to a lack of available time, but also because of a lack of confidence with the subject. For my reflection on the poor response rate and how it affected the findings, please see Section 9.5.2. I would like to stress, however, that enough data were collected to complete the study and provide valuable findings, which follow in the next subheading.

9.4 Findings

The findings were organised into themes following a thematic analysis. The themes of the data largely follow the given subjects of each question. The questions in the survey directly requested prescriptive answers and were structured to elicit advice on how to construct an OC governance framework. As a result, the findings are described below in normative language, following the manner in which they were broadly delivered by the participants.

9.4.1 Institutions

This theme stems from the first question in the survey which specifically asks the participants to offer lessons learned regarding other institutions that could be applied to

[45] The overall number of potential academic participants asked was 170. This led to 7 responses, so a response rate of 4.1%. Because the request email was disseminated on my behalf to NGO and government populations, I have no information on how many people were eventually asked to complete the survey from these two groups.

OC. Any institutions devised or utilised will have to be focussed on providing the evidence-base for facilitating decision-making, alongside the decision-making framework and provision of legal advice to member parties. The initial primary purpose of an institution would be to set agreed positions and goals for the signed-up parties to structure their approaches to OC governance, and guide decision making. Any institutions(s) should be weary of protecting its autonomy and safeguard against capture by vested interests. The corruption and ineffectiveness of terrestrial carbon markets[46] was cited as an instructive example in combatting this latter point, especially in regard to transparency and scientific credibility. An institution(s) can also be hampered in its goals by wider, large-scale issues and a lack of ability in dealing with them. An example given was the Great Barrier Reef Marine Park Authority's lack of power in dealing directly with climate change despite the major influence of climate change on the reef.

9.4.2 Publics

Regarding the position and involvement of publics in an OC governance, the respondents were focussed on two aspects deemed challenging: educating and informing publics on OC and making them care enough to be involved or concerned in the first place. There was general consensus that public involvement is good (following the strong tradition of this in the democratisation of governance literature) but that this engagement must be well-informed in order to be of any use i.e., informed public judgement, not just public involvement. An informed public would know what the proposal is, why it is being proposed, its main benefits, and its drawbacks. A difficulty with this can be publics' focus on coastal spaces and issues, within the wider marine context. This is because of the closeness of the coastal zone to the everyday lives of publics, in turn highlighting the importance of making OC relevant to publics by teaching them why OC is relevant to their lives. This would ensure publics care enough to be involved in the first place and can be achieved by communicating in clear terms, using non-technical language, the consequences of an OC realisation. This could be achieved by communicating in local and more specific terms i.e., make any actions achievable, and clear in their intention and eventual impact on the given public in their area. Additionally, it is important to make sure carbon storage is not the only factor taken into account, with the wider interests of publics – such as

[46] The terrestrial carbon markets refer to the commodities market in carbon, as expressed in the form of carbon offsets, carbon credits, and emissions allowances. The carbon markets were founded in 1997 following the Kyoto Protocol and have been vulnerable to various forms of fraud and corruption ever since (Dobson, 2015; Dwyer & Mowry, 2021)

biodiversity, economy, and community – also taken into consideration by any approach to OC.

9.4.3 Disruptive Industries

When asked on how best to limit the negative effects of disruptive industries[47] – the focus of question 3 – the participant response was highly prescriptive, following the manner in which the question was asked. An OC governance framework must make sure to involve all relevant actors early on to ensure they understand, and possibly shape, the agenda and the structure of responsibilities and remits, and that this responsibility should be shared where possible. The approach would benefit from being wide-ranging and involving as many tactics as are effective within a wider strategy: regulation, financial incentives and compensation, facilitation of new technologies and practices, and trust-building with those involved in the disruptive industry. Which tactics are adopted will depend on the idiosyncrasies of the given geography, politics of the given region, the different stakeholders involved etc. Any approach must be mindful of the full effects of displacing disruptors, including potentially leading to greater damage to the ecosystem or increased GHG emissions. Regulation is most effective when there is robust and consistent monitoring, something that is difficult for OC, but it could benefit from leveraging existing fisheries monitoring processes.

The role of, and controls on, disruptive industries are an inevitably political aspect of any OC governance and, as such, will require sustained political mobilisation to act as a counterweight to the interests that incentivise the disruptive industries, with one respondent stating that sustained political mobilisation is the only thing that ever limits disruptive industries. In reference to this point, eco-labelling and campaigns on the consumption side of the economy have helped with fishing and other issues, although it is unclear how the adoption of similar approaches for OC would work. A potential approach is to help given industries to adapt rather than enter into a political conflict with them, helping also to involve local publics and their interests. This is dependent on their being a potential compromise; where no one exists, then an OC governance system, or rather those in charge of its governance and management, would need to acquire the means to enter into conflict with opposing stakeholders – whether those means be legal, regulatory, or political.

[47] See question 3 in Table 9.2 for an explanation of disruptive industries.

Any approaches taken to limit negative effects of disruptive industries will be vulnerable to an inequal distribution of responsibility and limitation. Small players, such as small-scale fishers, or smaller countries/jurisdictions, can potentially end up bearing the brunt of limitations. This can result from the bigger players having more political clout, greater access to decision-makers, more money and resources, and be bigger receivers of subsidies etc., which help them avoid the worse aspects of any limitations. Smaller players can be supported through the influence of other bigger players such as publics, NGOs, political parties etc.

9.4.4 Information

This theme concerns systems of information sharing and the standardisation of measurements across organisations. The information sharing mentioned in scenario 1 (see Section 8.2.4) was met with doubt by some respondents and questioned as to whether information sharing is a desirable aim in the first place. Information sharing works well when there are networks of organisations that are well-aligned with one another and have formal processes and structures in place. However, this requires a high level of political work, requiring scientific and political debate as to how to standardise and determine which are the best measures to use. Information can also be treated as a commodity, privatised and withheld behind commercial licences and property rights. This is costly and may be unnecessary; instead of focussing on measuring and accounting for the carbon, an entirely different strategy of regulating practices that are harmful while incentivising practices that are known to be beneficial could be adopted – in which high level monitoring is abandoned – mentioned in reference to *Parametric Management*[48] in fisheries. Where there was more belief in the desirability and usefulness of information sharing then common rules of good governance were referenced: partnerships will require strong and knowledgeable leadership, an equal say between partners, funding to provide a secretariate, and a joint agreement on any information sharing protocols adopted.

9.4.5 Adaptation

This theme centres on the respondents' opinions as to how an OC governance framework

[48] Parametric management in fisheries is the idea that instead of measuring the standing stocks of fish every year (or so), fisheries management should instead measure the ecosystem factors – a range of parameters – that influence the health of highly "chaotic" fish stocks (Acheson & Wilson, 1996).

can adapt to unforeseen changes that may influence it over time. The main points focussed on the need for robust mechanisms of review and supervision to be built into the framework. However, not much was said on how this could be achieved – a key finding in itself, in that it suggests governance adaptation can be seen as a difficult issue for governance experts to discuss, with no set or standardised approach they felt confident enough to reference. One suggestion mentioned was adaptation through a *Reflexive Law*[49] approach, taking on board the insights into work on adaptation and resilience in law. Another major point is that adaptation can be built into the system by adopting a position of diversity within and across jurisdictions: instead of a standardisation of approach regarding policy, interventions, measurements etc., different areas and groups/jurisdictions could be encouraged to take on different approaches, to build in resilience and find best practice. Anything that is successful can then in turn be adapted into the collective OC system as a whole.

9.5 Discussion

Here, the findings of the survey are reflected upon and discussed. I begin by addressing the major points within the themes, followed by a reflection on the low response rate and choice of methodology.

9.5.1 Discussion of the Themes

There is a strong correlation between the survey findings and the interview findings regarding institutions (one of the sub themes of the interview chapter – see Section 7.3.2.3): that the main responsibility will be regular monitoring and data collection to facilitate decision-making, and that any institution(s) will have to ensure the decision-making process is well-structured to ensure fairness between different interested parties. This

[49] Although quite complex, built on a body of jurisprudence and legal theory, *reflexive law*, at its simplest, is the idea that most systems self-regulate to some degree. So, if an external system (such as a national legal system) attempts to regulate a different, established, self-regulating system (for example, a local fishery) it must do so *reflexively* by incorporating the self-regulating aspects as much as possible (Teubner, 1993). For example, an established fishing practice embedded within the behaviour of a local fishing community (which is self-regulating) should be incorporated into the national legal system as close to the way it has established itself, in order to ensure future compliance and success. It can be summarised as the incorporation of self-regulation into regulation.

strongly suggests that any governance framework conceived going forward keep these points central to any decisions regarding the use and conception of either existing or new institutions. This, however, is the only correlation, the survey respondents do not mention the prominent point in the interviews that no new institutions be conceived where possible nor was there much mention of sharing responsibilities and remits across jurisdictions. This is likely the result of the different questions put to the participants. A focus instead was placed on the potential of capture by vested interests and how institutions will have to be structured to minimise the chances of this. To this point, the terrestrial carbon markets were mentioned, referring to the proven vulnerability of the carbon markets to corruption including the sale of fake offsets, collusion at auction, and manipulation of environmental measurements (Dobson, 2015). As a result of this kind of corruption over the decades-long lifetime of carbon markets, governance and regulation changes have been put forward as the main solutions, built around maximum transparency and the placing of safeguards within the governance architecture at points of vulnerability. Although an OC realisation could be a very different thing to, for example, a carbon credit scheme, the suggestion put forward by the survey findings of learning from the anti-corruption governance in carbon markets indicates a potentially fruitful avenue of further research that could work to strengthen any future OC realisation.

When asked about involving publics, the survey respondents largely agreed with the interview participants in believing a) publics should be encouraged to be involved in order to ensure an OC realisation is conceived in a way that has buy-in from publics and therefore longevity, and b) that the difficulty lies in ensuring publics are properly educated and informed on OC. In regard to a governance framework, this suggests that publics, and their education on the matter, be included within the framework, if possible. This inclusion will have to allow for a method of education and informing of the public, as well as a way to include them in decision-making, even if that involvement is only one of pressuring decision-makers i.e., people with more direct control.

However, the inclusion of publics is still arguable given the distant nature of the resource from the majority of people's lives, even including coastal inhabitants, and given the nature of OC's complexity and large-scale. Indeed, it could be argued that there is a *tendency* within the literature and in natural resource management practice to suggest that publics be heavily involved in such things (McCool & Guthrie, 2001; Ostrom, 1990; Parkins & Mitchell, 2005; Steelman & Ascher, 1997). And that perhaps both the interviewees and survey respondents have mentioned these points on publics reflexively in relation to this bent within the literature, as well as from their own work on other such matters that, in many cases, will be more directly linked to *local* communities and publics. The point being

that this suggestion of heavy public involvement may be rather shallow and may not be fully cognisant of the sheer difficulty of doing so for OC. As mentioned in Chapter 2 (Section 2.7), OC falls prey to all six of the listed challenges that make it much harder to govern a large-scale-commons as opposed to a local-scale, and it is these challenges that make involving publics at such scales particularly difficult[50]. The involvement of publics at such levels further complicates an already complex tableau of potential international-level agents and organisations.

Having stated this, the main bent in the findings for both the interviews and the survey demonstrate that the majority of participants imagine the roles of publics as being one centred on pressuring decision-makers to make positive decisions regarding OC, rather than through direct involvement on decisions. In this regard, the non-direct nature of such an involvement means there may not be any need to involve some kind of direct publics-involvement-mechanism within a governance framework, but rather a means for publics to place pressure on those with power within the framework. A further investigation into how this is best achieved could yield important lessons for an OC framework going forward, opening up the possibility of exploring more deliberative and participatory forms of governance for OC, in relation to publics.

The survey findings follow Ostrom (1990) in suggesting rule 3 of her 8 rules (Section 2.5), that as many people affected by the system be involved in its governance, including those involved in disruptive industries. This also lines-up with the Six Principles derived from the systematic literature review in Chapter 4, specifically 'Maximum Inclusion'[51]. Indeed, it is a key overarching finding common throughout the literature reviewed (including systematically reviewed) and among the populations invited to interview and survey: exclusion is corrosive and will lead to negative outcomes. But inclusion comes with its own risks, as pointed out by the survey participants: including actors from industries potentially highly antagonistic to the goals of an OC realisation (the goal being, very generally, conservation and/or extension of the carbon stocks and flows in the offshore zone) may make such a realisation vulnerable to being overly influenced by such industry actors, and therefore potentially undermined by them, as was touched on above in reference to carbon market corruption. In order to realise 'Maximum Inclusion' in practice then, requires precisely that which was identified by survey findings – a governance framework that allows disruptive industries to be included without allowing them too much influence and

[50] Especially regarding challenges: 2) Population scales; 3) Individual disconnect; 4) Greater Divergence of Interest; and 5) Plurality of views (Section 2.7).

[51] Principle 3 Maximum Inclusion: "[include] as many people in the governance of a CPR as is feasible, to ensure the system is fair and successful and there is sufficient buy-in, otherwise political fallout can be born from perceived resentment" (Section 4.6).

opportunities for corruption. The suggestions regarding anti-corruption governance mechanisms in relation to carbon market corruption offer, again, a potential avenue to further explore this need. But what is clear from the findings is the necessity of doing so for any conceived governance framework.

The findings on disruptive industries bend, perhaps inevitably, towards the more political aspects of OC and there is considerable overlap with the politics theme from the interview findings. This overlap can be found in the voicing of the same warning that smaller players in collaborative endeavours, whether they be smaller nations states, smaller organisations, or smaller publics, can often find themselves on the wrong end of an unequal distribution of power and responsibilities. This warning in turn leads to a concluding lesson for any governance framework: that it should find a way to build in equity and fairness for smaller players within any given realisation. This is a difficult task and one that will have inevitably been encountered in other natural resource management situations, providing potentially instructive examples.

The other correlation with the politics theme from the interviews (in relation to both the Disruptive Industries and Information theme within the survey findings) lies in the point regarding the need for sustained political work – negotiation, mediation, monitoring, review etc., – and that this is costly and time consuming, requiring sustained political will to maintain. In other words, it is a potential weakness for an OC realisation in the first instance. This is an impediment that will require a solution. A potential approach to deal with it is to learn from a key point in the interview findings – that any realisation should be kept as simple as possible in its strategy and execution; that any devised policy be one that does not require too much in the way of manpower or resources, with obscurity on what "too much" means in practice.

The mention of parametric governance in relation to information sharing was perhaps one of the more stand out opinions within the survey data. Parametric governance/management, in this context, is placed in contrast to numerical management in fisheries, in which the dominant assumption is that the amount of fishing effort on a given stock is directly correlated to the sustainability of that stock (Acheson & Wilson, 1996). With such an approach, fishing effort can be managed with rules to lower fish mortality or with quota. This has been argued against as too simplistic – that fish stocks are embedded within highly complex systems (ecosystems) which are themselves hugely influential on the health of the stock (Wilson & Dickie, 1995). The numerical model does not sufficiently take into account this complexity – described as "chaos" by Acheson and Wilson. They argued instead that the approach taken should focus more on a range of variables such as fishing

practices and ecological variables – a range of different *parameters* – in an approach they called parametric management: *"The goal of parametric management is not to attempt to control yields of fish but to maintain the system in a state where the normal range of variability is preserved*" (Acheson & Wilson, 1996, p.585). In relation to governance, they argue that a parametric approach reduces the cost of measurement and enforcement – perhaps the two main responsibilities of a natural resource management institution. Thereby allowing for more simplified and effective institutions that can operate in resource poor areas.

Dickie & Wilson argue that, in the context of fisheries, a parametric approach therefore necessitates a hierarchical governance structure – that the governance must mirror the structure of the ecosystem from the large-scale down to more localised pockets (1995). However, this advice does not necessarily run contra to the localism-is-best approach, and polycentrism, associated with commons studies and the Ostrom School. This is because Dickie and Wilson argue that, within a parametric approach, management should be localised where possible and managed at the smallest scale possible, with the scale determined by the size of the ecosystem process/factor being considered. From this understanding of parametric governance, we can see the appeal of thinking about a parametric approach for OC, which is itself, like fish, a highly complex and large-scale (some could argue "chaotic") resource. If such an approach could be devised – i.e., a series of ecosystem factors decided and governance of those factors distributed between various parties at relative scales – it would help eliminate some of the bigger problems facing an OC conception identified in this thesis: collecting large-scale measurements, devising potentially contentious models, appealing for limited resources including political resources, deciding how any OC stock should be distributed between various parties etc. As such, it is a highly valuable suggestion worth exploring to a greater degree in future OC governance research.

The Adaptation theme correlates naturally with two of the derived lessons from the conclusions of Chapter 4 – 'Temporal Variance' and 'Spatial Variance' [52]. These work in combination to emphasise the importance of a governance regime that is flexible in allowing for and facilitating the incorporation of local practices, values and existing systems, while also providing means to adapt as factors inevitably change over time.

[52] *Temporal* and *Spatial Variance*: that any devised governance framework contain mechanisms that allow for a degree of security for resource users but nonetheless allow for review and change at set times (for example, a review and update process every ten years) in order to achieve successful governance across time. Across space, this is achieved by localising the resource-use/governance where possible and, akin to reflexive law, facilitating the incorporation of local practices, geographies, and regulations.

Suggestions from respondents on how to achieve this for OC governance provide further instructive avenues of research to inform a governance framework going forward. One example provided was *Reflexive Law* (see footnote 49) – the approach that established, self-regulating processes and systems be incorporated into formal law and regulation – providing an avenue of future research that incorporates a major aspect of governance, the law (so far not touched upon in much depth by this thesis or the data collected). A reflexive approach has the potential to assist a future OC realisation by learning from previous reflexive approaches where one has been applied. This is particularly useful here given the novelty of OC and the fact that any newly contrived OC regulation will be introduced into contexts with existing regulation and behaviours among users of an OC environment, such as fishers. All the main points on adaptation, and indeed the derived lessons from Chapter 4 mentioned here, inevitably have considerable cross-over with the established theory of *Adaptive Governance* – a theory of natural resource and ecosystem services management that states that institutional arrangements evolve to facilitate the needs of the community of users under changing circumstances[53] (Folke et al., 2005; Hatfield-Dodds et al., 2007). A further investigation into what the literature on *Reflexive Law* and *Adaptive Governance* can teach OC governance is warranted.

9.5.2 Reflection on Response Rate and Methods

The survey study was limited by the poor response rate reported in Section 9.3.7. This has resulted in a shorter findings section when compared to the interview chapter. The result is that the breadth of expert opinion captured by the study is relatively small. Also, there were not enough data to measure and understand differences between different groups of participants, research-foci, or locations, which could have proved instructive. However, the research aims were to capture insights that could inform a governance framework for OC, not to extrapolate general trends of belief among a given population. In other words, any suggestions from anyone with relevant experience is valuable in regard to the research aims. Furthermore, enough data were collected to inform research aim 2 – to further explore the findings of the preceding research – as has been done when comparing the survey findings to the findings of the interviews and literature reviews throughout this section.

In retrospect, the poor response rate may have been mitigated if the choice had been made

[53] More formally: "*Adaptive governance refers to the evolution of the rules and norms that promote the satisfaction of underlying human needs and preferences given changes in understanding, objectives, and the social, economic and environmental context*." (Hatfield-Dodds et al., 2007 p.4)

to collect data via a workshop from the beginning, instead of online survey, as is more typical with scenario analyses. However, the attempt to do so later in the study's development via an initial sense-check resulted in a poor response rate, suggesting the problem lies with the study populations themselves as professionals lacking the time required, with accompanying feelings of unfamiliarity leading to a wariness and lack of confidence with a novel topic such as OC governance.

The use of scenarios and the subsequent choice to convey them via a storymap meant the respondents did not come to the study with a completely fresh perspective. The scenarios and the way they were described, alongside the information I decided was necessary to give the respondents the context required to engage with a novel topic, will have had some influence on the opinions of the respondents and introduced a degree of bias e.g., situating the scenarios in the NWES may have limited respondents' ability to imagine OC in different contexts. This, however, was unavoidable. The whole point of engaging in a scenarios analysis was to give form to something – an OC realisation – that does not yet have form to assist qualified people to think about the topic at hand. And as the topic is novel, the participants needed to be introduced to OC and taught what it is and the general ideas behind the research. Doing so without introducing some bias or influencing the responses, at least to some degree, would be impossible. The scenarios, the way they were conveyed, and the attendance of necessary background information were necessary limitations of the study.

9.6 Conclusions

The scenarios-survey study was successful in achieving the research aims (see Figure 9.1 in Section 9.2). In regard to research aim 1, a number of insights were gained on how best to conceive an OC governance framework, as described in section 9.4 and discussed in 9.5. This resulted mostly in collecting ideas for further research, which require further extrapolation and examination before they can offer their full value to any further work on conceiving OC governance frameworks. These ideas for further research are discussed in Chapter 10. Research aim 2 was achieved in two ways – the preceding research formed the basis of the scenarios and the survey questions, and the survey findings were compared to the findings of the preceding research throughout the discussion. The next Chapter – Chapter 10 – is a final discursive chapter. It brings some of the ideas and convergences of the findings that began to be discussed here in Chapter 9 and develops them further to summarise and understand the full breadth of the thesis findings in relation to one another

and the wider purpose of the thesis: to inform a governance framework(s) for offshore carbon.

Chapter 10 |

Towards a Governance Framework

10.1 Introduction

This chapter focusses on answering the three research questions by drawing upon the findings and discussions of the preceding chapters and existing literature. It considers the major contributions of the research overall and concludes the thesis by proposing avenues for future research. To do so, the chapter is structured on the research questions, related to the definition of governance that I state in Section 5.3.1, based on Hatfield-Dodds et al. (2007), and Graham et al. (2003):

> *"Governance is about relationships between various actors confined by rules and structures of interaction which themselves dictate who or what holds power (the ability to make and enforce decisions) in relation to an overall purpose or aim".*

The three central foci of the research questions (i.e., utilisation, actors, and governance framework) have provided three common threads of enquiry throughout the research. Because the findings have already been discussed extensively throughout the thesis within the empirical chapters – Chapters 4, 7, and 9 – the focus here lies in discussing the dominant and more pertinent points that have arisen when all of the findings are placed in relation to one another, in order to answer the research questions.

Thus Section 10.2 addresses RQ1 on utilisation, 10.3 addresses RQ2 on actors, and 10.4 addresses RQ3 on governance frameworks. The contributions of the thesis are then

summarised in Section 10.5, followed by a description of the major limitations of the research in 10.6. Section 10.7 then completes the thesis by setting out the avenues for future research.

10.2 Utilisation and Policy Interventions

RQ.1 *What are the policy options for utilising offshore carbon for the purpose of climate change mitigation?*

The focus of research question 1 was the need to understand the manner in which the OC system will be utilised in mitigating CC, as it is to date not sufficiently understood, and constitutes a key component of a governance framework. Following from the interviews, the anthropogenic influences on OC were identified as "disruptions" (see Section 7.3.1.3 for a breakdown of the main categories of disruption) with subsequent policy interventions inferred and placed as central components of the scenarios (Chapter 8). Given the paucity of extant research on disruptions to OC, a major finding from the current work (and one of the main answers to RQ1) is that more research is required into the anthropogenic effects on OC for a clearer understanding of possible policy interventions, and given its centrality to governance, this proposed research should be a priority. This is reflected in the recent literature with Howard et al. (2023) stating:

> "*At this time, a change in policy* [regarding sedimentary carbon and other offshore pathways being included in existing blue carbon policy] *is not warranted because the science does not yet demonstrate that there are sustainable human actions that would greatly increase the carbon sink of the open ocean*." (pp. 10)

The thesis' findings offer further insights on the utilisation of OC, beyond the disruption problem, which are brought together here with a discussion of the key points.

In Chapter 7 (see Section 7.4.1), OC was discussed as a resource that comes as a burden to the host jurisdiction – a potential liability, more than a potential asset, in the perceptions of appropriators (i.e., nation states). Expressed as a "negative fish stock", when placed in direct comparison with fish, this highlights how OC – when conceived as a natural resource – could be understood as one that national jurisdictions (and other potential appropriators) would rather *not* have within their boundaries, in contrast to the way resources are normally regarded as useful assets to exploit and enable the economy. This "negative fish stock" interpretation, (i.e., OC as "burden"), has serious ramifications for OC's future and its

governance. The main one being that jurisdictions that host sizeable OC stocks may demonstrate reluctance to manage them for CC mitigation in the first place, or be motivated to water down any policy regarding OC. This is backed by the interview findings (Section 7.3.1.4) which suggested gaining the support and attention of decision makers would be difficult for OC, especially if it conflicts with other opposing uses. However, this support may be easier to gather than expected if CC continues to generate the extreme weather and disruptions of recent years, as mentioned by the interview participants (Section 7.3.1.2) and highlighted in the scenarios (Section 8.2.4) – the more disruption associated with CC increases, the more political attention OC, as a mitigation strategy, is likely to be given. It suggests that an approach to an initial OC realisation (see Section 1.2.1 for the definition of the term *OC realisation*) may be one similar to that taken with rainforests – if the host jurisdiction is to maintain a stock for the good of all humankind, then humankind in principle should compensate the host jurisdiction for the lost economic activity (opportunity costs) resulting from protecting and enhancing the OC stocks. The pursuit of a programme similar in intention to, for instance, REDD+ could help an OC realisation become established in the first place by making the protection of the stock a more desirable activity for the host jurisdictions. The attendant difficulty would be in asking related jurisdictions to engage in such regarding a resource not nearly as charismatic in public consciousness as the rainforests – as interview participant 2 reminded us, "*this is just mud"*. This issue of OC as a "burden", however, is essentially one of ownership – the stock may lie in the EEZ of one jurisdiction, but unlike rainforests, the flows that feed the stock are generated across borders within the water column, so it is complex to define how much of the OC system can be said to "belong" to a given jurisdiction. If OC is conceived as a common pool resource (CPR), in the perspectives of the relevant political actors, then it could help with the initial establishment of an OC utilisation and support all jurisdictional actors in a given region take a more collective ownership of the OC system akin to the approach Europe takes towards its CPR fish stocks.

The analysis of the CPR nature of European fisheries in Chapter 4 highlighted, however, that a more collectivist approach can be politically fraught and complex. Despite this, there is good reason to believe that the main issues that have arisen with European fisheries would not surface with a collectivist CPR governance of OC because of key differences between OC and fish, as resources (the CPR nature of OC is directly addressed in Section 10.4 below). As highlighted by Chapter 4, the root problem affecting European fisheries relations is historical right, and the historically embedded nature of European fishing before enclosure and the creation of the Common Fisheries Policy. Additionally, fishing has resource appropriators and their communities, which come with attendant political

perspectives and needs. OC, in contrast, is not historically embedded, and the nature of its "appropriation" is such that there are no communities of people dependent on the resource for their livelihoods and is therefore less political currently than fish as a resource. This bodes well for the relation between jurisdictions in governing the resource but may yet prove problematic if policy interventions create a conflict between an OC governance and other established practices in the marine zone, as is likely and as was illustrated in Scenarios 1 through 3 (see Section 8.3.4) e.g., in Scenario 1, a ten year moratorium on bottom trawling elicited widespread protests by fishing actors across Europe; and in Scenario 3, confusion around the effectiveness of interventions is used to push an agenda that leads to the breakdown of cooperation between states.

The thesis also addressed economic instruments (such as techniques of carbon offsetting) and economic valuation given their current use in terrestrial carbon stocks and conventional BC. Although something to be devised at a later stage, if at all, economic instruments represent a possible utilisation of the OC system and a distinct form of appropriation. The interview participants, by no means a representative sample of academic researchers, were sceptical of the use of such instruments for OC. As a reminder (see Section 7.3.2.2), there were two main reasons: 1) scepticism regarding obtaining sufficient measurements for the complex OC system, and 2) an opposition towards what were characterised as neoliberal approaches, seen as ineffectual and ideologically driven. As qualitative data, the opinions voiced cannot be generalised as one representing the majority of the scientific researcher community, so the findings do not allow the drawing of strong conclusions on the use of economic instruments, and they therefore remain a valid focus for future research. Despite this, the key limitations to OC governance research, discussed extensively in this thesis, are such that economic instrument research may not be seen as a priority at this stage; a clearer scientific understanding of OC's flow, of the disruptions, and subsequent interventions are needed first in order to then consider and perhaps develop appropriate economic instruments based on solid scientific grounds. What the findings do suggest is that there may be more wide-spread opinion formed, or forming, against market-based interventions, such as economic instruments. The academic researchers who participated in the interviews and survey were not the subjects of my research, but it could be enlightening to undertake research of their opinions, as a population of study, regarding market-based interventions and economic instruments in the context of environmental governance and management. If the opinion is widespread, then the reasons such researchers give for their doubts could offer valuable insights for policy makers deciding whether to incorporate market-based interventions and the use of economic instruments in the future, in many natural resource contexts including that of OC.

In summary, RQ1 was answered directly in Section 7.5, and informed throughout, as discussed here. The first and main point is that future OC policy (i.e., the manner OC is potentially utilised by human systems of management and governance as a means of CC mitigation) is highly dependent on better answering three main questions. These are: 1) what are the meaningful anthropogenic disruptions upon the OC system?; 2) what is the definition of "meaningful" in this case? (i.e., where is the cut-off point between a meaningful and unmeaningful addition or subtraction of carbon to/from the OC system?); and 3) what are the suitable policy interventions that follow from 1 and 2? Until more complete answers to these questions can be provided, only so much can be learned and developed regarding OC as a method of CC mitigation, and its governance. One of the two research aims under RQ1, as described in Figure 7.1, was to discover whether an OC governance would be feasible in the first place. In conclusion, the findings suggest that OC governance would indeed be possible but is highly dependent on acquiring the relevant data regarding the significant CO_2 fluxes involved in the process of carbon sequestration and storage and whether any management interventions are having the intended effect of facilitating CC mitigation. This governance and management of OC will therefore depend on having a better understanding of the biophysical processes of the resource to facilitate a more complete definition and conception of OC. Expressed as a "negative fish stock" by one of the interviewees, the fact of OC's nature as a potential burden that could prevent host jurisdictions from exploiting economic opportunities that clash with OC (i.e., to incur lost opportunity costs), suggests that some way to share the burden of the stock could prove central to ensuring the instigation of an OC realisation in the first place, and the continued management of potential interventions through collaboration of related jurisdictions.

10.3 Actors

RQ2. *Who would be the relevant actors in offshore carbon governance?*

The subject of research question 2, actors, as identified in Chapter 5, represent a core aspect of governance. The direct answer to RQ2 is essentially *any actor-groups with a stake in the OC system, or who are affected by any OC interventions*. Understanding such is dependent on the given geographical and real-world context and any OC policies eventually adopted. Despite this self-evident, direct answer, the question's more specific underlying purpose was to help facilitate the exploration of actors as a subject of study. As argued, actors are essential components of governance frameworks, so any knowledge gained on

actors as a subject is valuable to informing governance and any frameworks. Here, the main insights from the findings concerning actors are brought together and discussed.

The focus is on who should be involved in a framework for governance of OC and to what extent. The term "new governance" (Howlett & Rayner, 2006) has been coined to account for a shift in attitudes that has occurred towards the governance of natural resources in the last two decades or so as broadening and acknowledging the importance of the involvement of various groups of actors, namely state, private, and civil society, and shifting away from the historical focus on government action and behaviour only. Key to the idea behind "new governance" is that successful governance is determined by how well these various groups are integrated and included. Throughout the research, participants have mentioned the inclusion of the private sector and other stakeholders – including, extensively, publics – with the attendant point that it is difficult to know what would be achievable for OC in this regard. The participants' view of including a variety of stakeholders in governance – reinforced by the commons literature (see Section 2.5) – speaks to the value of pursuing *Maximum Inclusion*[54] for OC governance by building-in mechanisms of inclusion to involve different kinds of actors, from civil society to the private sector.

Publics, as a group of actors and one that could potentially be included in OC governance, were mentioned to a surprising degree in the interview study which prompted a question concerning publics in the survey. I have suggested, in Chapter 9 (Section 9.5.1), that this may be due to a propensity among experts to think of and mention certain stakeholder groups that are often prominent in the natural resource literature and discourse – such as publics and indigenous groups – when this may not be entirely appropriate for OC as a large-scale transboundary resource that is out of sight for most members of most publics. Given the expert-level knowledge needed, and the international nature of regulation required, OC governance may need to be highly technocratic, at least to a certain degree. However, OC governance could provide an opportunity for including publics in large-scale commons governance to provide positive input (e.g., prompting decision-makers to make decisions that are beneficial to the aims of governance). Nevertheless, in my view, it seems an unnecessary extra complication in what is already a very complex endeavour, especially considering the problems of governing large-scale commons. As pointed out in Section 9.4.2 by the survey participants, it would likely require educating a public largely lacking in awareness and knowledge of OC and its functions, as well as engendering in them an interest in OC. Both seem unlikely given questions over how such would be achieved, by

[54] One of the Six Principles of commons governance identified by the systematic literature review (Section 4.7) – that as many stakeholders affected should be included, where possible c.f. Ostrom's 8 Rules – rule 3 Collective Choice (Section 2.5).

whom, and indeed whether it would be worth it given other possibly more important areas for educating publics on climate change e.g., the importance and necessity of moving to electric vehicles and mass transit (Egbue & Long, 2012). As such, in my view, the suggestion to involve publics in OC governance is highly questionable but remains an interesting idea that perhaps could prove beneficial at a later stage as an original attempt to involve publics to enhance a large-scale CPR governance, perhaps together with a wider drive to involve publics in BC generally.

As identified in Section 7.3.1.3, and explored in Chapter 9, the major disruptions to OC centre on extractive industries, such as fishing and mining, and others with a vested interest in activities that involve the disturbance of OC stocks and flows. As such, the incorporation and management of stakeholders potentially antagonistic to the purpose of an OC governance is a key task for any governance framework going forward. Seabed mining offers an instructive example of how this can be done for an emerging resource, with its widespread adoption of a precautionary approach and the nurturing of close ties between the mining industry and wider actors to ensure proper environmental monitoring and understanding of the long term effects of disruption (Lodge et al., 2014; Wang et al., 2023). To do so, mining governance has included regulation (e.g., the international seabed authority's requirement for all contractors to complete marine baseline assessments) and collaboration between political, scientific, and commercial actors (e.g., the MIDAS project) (Gjerde et al., 2016), acting to build trust and demonstrating the use of techniques to incorporate potentially antagonistic interests, as was advised by the survey participants (see Section 9.4.3).

Managing Impacts of Deep seA reSource exploration, MIDAS was a multidisciplinary research programme held between 2013-16 to assess the impacts of deep sea mining, including the close involvement of industry, small and midsize enterprises, civil society and regulators (Gjerde et al., 2016). It proves highly instructive for OC with key similarities, not least the focus on a seabed that is difficult to monitor and is vulnerable to human action. The work of MIDAS produced an environmental management framework, identified technology gaps for monitoring deep sea ecosystems, and worked with lawmakers towards the development of a deep-sea mining code. All three of these outcomes can be regarded as important ambitions and next steps for OC. It suggests a *MIDAS-for-OC* could be highly beneficial in helping to progress OC as a potential natural resource and method of CC mitigation. Despite the achievements of MIDAS, deep sea mining remains controversial with the UK recently joining other countries such as Brazil, France and Germany in placing a temporary moratorium until more scientific information is acquired (Dempsey, 2023).

Seabed mining, however, is emerging and therefore not historically embedded, so a precautionary approach and the adoption of effective techniques for collaboration and control of disruptive industries can be adopted from the outset. This contrasts sharply with fishing, which, as illustrated in the scenarios (see Section 8.2.4, especially scenarios 1 and 2), is a major potential antagonist of OC. As mentioned above, many of the root conflicts and issues in European fisheries stem from the long-established nature of fishing practices (expressed through *historical right*) which have been upset and changed numerous times, with varying political results, throughout recent history. The introduction of (potentially) yet more regulation to control fishing may well act to antagonise a fishing industry already highly politicised and disgruntled (to greater and lesser extents) by existing fisheries governance, at least in a European context. Conversely, the collaborative involvement of fishing actors in the design and implementation of OC policy interventions may be easier as a result, given fishing actors heavy involvement in fisheries governance already (e.g., the requirement to engage with fisheries monitoring techniques, such as onboard vessel monitoring, and the negotiation of annual stocks involving fishing industry representatives across Europe). The potentially fraught relationship with fisheries actors points to the sensible inclusion of them from the very early stages (See Principle number 3 - *Maximum Inclusion*, in Sections 4.6 and 5.2.2) and the value of giving such actors a meaningful – but of course not controlling – influence over the design and implementation of OC policy, both initially and ongoing.

Additionally, as pointed out in chapters 4 and 9, the fishing sector is not a homogenous group with one singular interest, but instead a varied and conflicting web of sometimes competing interests. Therefore, it is not enough to say that fisheries actors must be included, but also a division devised such that the group termed "fishing actors" is itself representative of the whole of that interest group affected by OC, and not just dominant players. Fisheries actors, and associated communities, rely on the fish resource for livelihood, as well as cultural identity. Therefore, any attempts to limit fishing activity must be done so with well-developed and comprehensive scientific data to justify any reduction in fishing that could negatively affect fishing actors, their communities, and the wider economy. As ever with natural resource management, a balance must be struck between exploitation of the resource, the interests of the communities that rely on the resource, and unsustainable damage to the ecosystem. Once again, where that balance rests for OC in relation to fishing disruptions cannot be determined until a fuller understanding of the physical OC system, and the anthropogenic effects upon it, is obtained.

10.4 Governance Framework

RQ3. *How do the findings inform a governance framework(s) for offshore carbon?*

Several insights were gained regarding the creation of a governance framework for OC that supplement those discovered through RQs 1 and 2. Although there are many facets to a governance framework, the conclusions drawn here come directly from the findings and literature studied, contributing to the development of a potential governance framework for OC. Here I report the main characteristics such a potential OC governance framework will have to consider.

In Section 5.3.1, following Klakegg et al. (2008, p.530) and the preceding definition of governance in general, I define a governance framework as being:

> *"a conceptual structure that sets out the relationships between the relevant actors and the distribution of responsibilities, remits, and decision-making power between those actors, regarding an overarching aim or purpose."*

The overarching aim of this thesis, is to inform the creation of such a conceptual governance structure for OC. The findings of the thesis offered insights on many of the different elements outlined in the definition of governance framework above: informing the overarching aim, aspects surrounding actors and their interactions, and the different approaches that could be taken for OC governance, with some insights into the details of the identified responsibilities and remits (namely monitoring – discussed in this subheading – and how to successfully incorporate potentially antagonistic stakeholders). Under this subheading, these elements, and the potential structure of governance in the form of a framework, are explored, and their implications discussed. The subheading begins however, with an in depth look at OC's definition, its relevance as a CPR, and the subsequent influence this has on governance frameworks.

It is important to begin with a discussion of the conceptualisation of OC because alternative ways of conceiving it, especially at this early stage of its exploration and understanding, are possible and have a substantial effect on governance. For example, as mentioned in Section 3.3, the language of carbon *pathways* is becoming increasingly popular in the BC literature (Christianson et al., 2022; Collins et al., 2022; Herr et al., 2017; Howard et al., 2023). With the pathways conception, the focus lies on understanding specific pathways of carbon within a geographical area, rather than the ecosystem of that area as a whole; to use a simple metaphor – taking a slice of the cake, rather than looking at the whole thing. In Howard et al.'s (2023) paper, the separate pathways of wild macroalgae, cultivated macroalgae, sedimentary carbon, and marine fauna (e.g., whale carbon) (among others) are

all addressed and examined as standalone BC subjects. This stands in contrast to the approach of this thesis, following carbon accounting and valuation attempts, which took many of these pathways (albeit with a more microalgae/plankton focus) and combined them into a single "resource" i.e., the whole cake (Luisetti et al., 2019). The logic of using the pathways approach means the complex system can be broken down into more manageable, and therefore arguably more governable, segments and provide a potentially much more practical, and therefore more fruitful, approach. Although this may seem antithetical to the dominant idea of a whole ecosystem approach as most suitable within ecosystem management, the sheer complexity of the marine zone demands that some form of simplification take place (as argued by the interview participants); the individual pathways approach provides some of this simplification and does not preclude some joined-up approaches and management/governance *between* pathways, once established.

Developments in the definition of BC within the wider literature, concerning pathways, have occurred during the evolution of this thesis. The definition now has a stricter emphasis on the idea that, to be BC, an ecosystem, or aspect of an ecosystem, must be proven to be amenable to management (and not just hypothetically so) (IPCC, 2019, 2021). This has led to a view that the POC/biological pump pathway is not practically amenable to management and therefore cannot be considered a BC pathway, in its own right, at this stage (Howard et al., 2023) (this was touched on by the findings in this thesis, articulated in the form of the 'Disruption Problem' i.e., the uncertainty surrounding policy interventions – OC's manageability – means it is difficult to advance OC as a form of BC (Sections 7.3.1.3 and 7.4.1)). Only the sediment stocks may therefore be considered for BC status with the POC/biological pump, understood as having an influence but not constituting the resource. The pathways conception could therefore potentially contradict the conception of OC used throughout this thesis as one which fully encapsulates the flow of carbon, in the form of the biological pump pathway, as a constituent part of the "natural resource" of OC i.e., the flow has been conceived throughout as a potentially manageable aspect – as was outlined to the survey participants via the storymap and the scenarios. For example, one of the types of disruptions identified in Chapter 7 (Section 7.3.1.3) concerned degradation of the flow of carbon i.e., the biological pump. An example of a potential intervention that would represent a management of the flow is the large-scale carbon dioxide removal strategy of ocean fertilisation (as was suggested to the survey participants via Scenario 3 and in the Storymap), with iron fertilisation acting as a specific example. The Iron theory, put forward by J. H. Martin (1990), states that iron is a limiting micronutrient in ocean-based primary production. The theory states that if iron levels were to be artificially enhanced, then hypothetically there would be an increase in primary

production (and it would therefore act as a catalyst for the biological pump, leading to a greater draw down of carbon from atmosphere to ocean). The theory has been proven by a number of experiments to be correct (e.g., Bakker et al., 2005), leading some to stipulate that a large-scale geoengineering projects involving fertilising the oceans with iron could be a viable option for combatting CC (Powell, 2008). Such interventions would be OC policy interventions, as understood by this project and conception of OC used throughout. This remains hypothetical as there are many attendant challenges and complications, especially with reference to the uncertainty of the effects of such an engineering technique in the ocean now and into the future, but it nonetheless represents a possible utilisation and management of OC's flows.

But if following the arguments above, the flow is defined as not currently manageable, and the resource is conceived as stock only, it brings into possible question whether OC is indeed a CPR. This is because the CPR status is dependent on there being a non-exclusionary component that allows neighbouring jurisdictions to affect others nearby through their actions (or non-action) e.g., imagine if France begins utilising iron ocean fertilisation as a technique of geoengineering, and, as a result, increases primary production to the extent that levels of carbon in the UK's stock increase. In the France hypothetical example, the actions of a neighbouring country affect the resource appropriated by another country because it is part of a resource system that is non-exclusionary (as explained and outlined in Section 5.2.1.1). But if OC flow is defined as not amenable to management, then one country cannot, by definition, affect the stock in a neighbouring country.

The idea, growing in the literature, that the POC/biological pump cannot be considered BC (as the pathway is not amenable to management) is only valid due to a lack of evidence that the given pathway can be meaningfully and practically affected by human action, as understanding of POC currently indicates. Nevertheless, whether currently considered BC or not, we know that there are viable, potential offshore carbon pathways that are transboundary, and that link the actions of one jurisdiction to the resource held by another. The main examples of this are both wild macroalgae and cultured macroalgae, because the algae can break off and drift into neighbouring seas and break down into marine snow. The macroalgae pathways are themselves considered BC pathways (Ortega et al., 2019), each of which are segments of the wider "whole cake" approach taken in the conception of OC stated in this thesis.

Another hypothetical example of a flow-based OC intervention (as opposed to stock-based i.e., interventions that influence the seabed), similar to the iron fertilisation case, would be to calculate and manage fishing quota with a new carbon component added as a factor that

influences the final calculation and distribution of quota. In such an imagined case, the EU, for example, could, hypothetically at least, calculate how much carbon would be removed from the OC system, and the OC stocks, if a said amount of a stock was fished to a certain extent that year. If the number was considered "too high" within the wider context of CC emissions targets, then fishing quota could be reduced to help mitigate CC (we can go further and imagine a carbon offsetting scheme in which fishermen still receive the quota but are paid not to fish a set amount of it by organisations looking to offset). This idea was placed as a potential policy intervention in Scenario 1 to help emphasise that it is not just the OC stocks that may be potentially managed for OC in the future. Although such an imagined intervention is fraught with questions and possible issues, it nonetheless acts as an example of the potential management of OC flows (indeed, one could argue OC flows are already managed through fisheries management regardless of any stipulated carbon calculations).

These examples – iron fertilisation, macroalgae, and a fish-carbon-calculation – although somewhat hypothetical, are instructive because they teach us an important lesson about the structure of OC, not only as a natural resource, but as a CPR. A more nuanced understanding of OC can be gained if the OC resource is conceived as constitutive of three stages: from *Origin*, through *Migration*, to *Destination* with the understanding that the resource is different, qualitatively speaking, at these three different stages. As the evidence currently stands, the resource is manageable (and therefore governable) both at the *Origin* (sometimes, e.g., macroalgae but not microalgae[55]) and *Destination* (stock) stages. Currently, this does not hold for the stage of *Migration* and movement in the middle of the pathway, when in a state of "marine snow"/POC/marine biota (as the evidence currently stands at least, as made clear by the above examples regarding ocean fertilisation and carbon-based controls on fishing, it is hypothetically possible that the migration stage of flow could be manageable in the future given more information and innovations in management interventions). For a breakdown of the qualitative differences between the three stages of OC as a resource (as derived from the literature and findings of this thesis), see Table 10.1.

[55] As argued by (Howard et al., 2023), there are no conceivable ways, realistically at this point in the development of OC, to manage microalgae as something that occurs at the microscopic level yet is measured and understood on the large-scale. There is of course potential, as highlighted by direct carbon dioxide removal strategies example e.g., iron ocean fertilisation. But none of these are feasible and amenable to management as things stand. Macroalgae, on the other hand, is manageable e.g., kelp reforesting or seaweed farming.

Figure10.1 *The three stages of offshore carbon (author's own)*

OC Stage	Physical State	Qualities
Origin	Point of biological **fixation** e.g., microalgae/macroalgae; also, carbon transported from rivers and coastal areas.	• Potentially manageable (e.g., macroalgae wild/cultivated). • Difficult to measure but some forms of origin-OC are measurable e.g., estimated carbon contained in an area of kelp forest. • *OC-Origin* can be construed as BC depending on origin source (e.g., potentially macroalgae). • Occurs within a non-excludable resource system.
Migration	Particulate organic carbon (POC) i.e., carbon in the form of marine snow and all marine biota including the carbon within the bodies of animals and marine plants, biological detritus such as faeces, scales, body parts etc., and carcasses. Carbon in the form of **transportation**, and **deposition**.	• Not amenable to management for carbon, as things stand. • Very difficult to measure as a whole. • Due to obscurity over management, *OC-Migration* is not BC. • Mostly occurs within a non-excludable resource system (water column) but deposition occurs upon and (slightly) within the seabed which is an excludable system.
Destination	Carbon buried in sediments *for the long term* (**Stock**). Carbon in the form of **burial** and **storage**.	• Very amenable to potential management. • *Relatively* easy to measure. • Due to amenability of potential management, *OC-Destination* is BC. • The seabed is excludable but is informed by the water column immediately above it which forms part of a non-excludable resource system.

The defining lesson of the preceding paragraphs in this subheading is that OC is only a CPR, that requires co-governance by necessity, because of the connections its flow (*Migration*) state creates across appropriating jurisdictions, as reported in the examples above, whether the flow is managed or not; the flow occurs within a non-exclusionary resource system and connects neighbouring jurisdictions, making them co-responsible. Although *OC-Migration* may not be strictly BC, it is nonetheless a constitutive stage of OC as a natural resource and it is precisely this stage that connects the appropriators, rendering

this resource a CPR. Indeed, if OC flow was not manageable, (i.e., governed and managed as sediment stock only) then OC would lose its CPR status because then the focus would lie entirely on the stock in the seabed (*OC-Destination*) and the seabed is highly excludable and is excluded currently under the existing institution of EEZs. The seabed acts, in essence, like land, perhaps the default example of historically excludable resources. When a resource is rival (and sediment stocks meet the definition of rival), but excludable, then the good is private, not common pool (see Figure 2.1); private goods do not *necessarily* require international co-governance. This contrasts with conventional BC in which the flows of carbon are much less meaningful regarding governance, in virtue of conventional BC flows being non-migratory (i.e., there is no equivalent *OC-Migration* stage for conventional BC).

Throughout, the findings have suggested that joined-up approaches could act to universalise standards, policy and measurement. These approaches could allow for better resource sharing, including the sharing of expertise and lead to a better protection and enhancement of the stocks, which is the overall process of CC mitigation in this case. The literature and the findings of this thesis strongly support that the position that OC is a CPR and would benefit greatly from being governed as such. A strong conclusion of this thesis, therefore, is that an OC governance framework be based on an understanding of the resource as a CPR, as being made up of three qualitatively different stages, and actively construct the governance around these i.e., seek to maximise the co-governance across appropriating jurisdictions.

Besides the above points on how to conceive OC and its CPR nature, a number of more specific points on constructing governance frameworks were addressed throughout the research, which form the focus of the rest of this subheading.

A key component of any OC governance framework will be the institution(s) given responsibility over OC. There was a strong preference among interview participants for no new institutions for OC governance, favouring instead the expansion of existing remits to incorporate an OC component. The main facet of OC that creates the most difficulty regarding governance, as pointed out above, is the *OC-Migration* phase (i.e., the difficult to manage form of the resource while in a state of transportation and deposition), but some existing international marine institutions already deal with resources that also have complex migratory stages such as marine pollution and fish. Both OSPAR and HELCOM[56],

[56] *The Baltic Marine Environment Protection Commission*, or *Helsinki Commission* (HELCOM) is an international body set up to facilitate better marine ecosystem health in the Baltic Sea. It acts as

to use two European examples close to the geographical area of interest of this thesis (the Northwest European Shelf (NWES)), already deal with several "action areas" as diverse as fishing, industrial pollution, and marine energy, many of which are highly relevant to OC, however conceived. Indeed, these existing examples of marine governance institutions suggest it would be very possible to integrate an OC component. But this will initially require a close examination of an international institution like OSPAR, for example, or some other equivalent elsewhere, to ascertain how an OC component could be included, either as its own "action area" or integrated into a relevant existing area (e.g., fisheries management).

An important caveat, however, is that if existing institutions take responsibility for OC, then OC, by extension, will also be subject to any limitations already built into such institutions i.e., any flaws existing will continue and negatively affect the newly integrated OC. How these limitations would affect an OC realisation would also have to be a subject of any enquiry into OC's potential institutional integration. Nonetheless, such an integration would also assist with issues emergent from the research in this thesis, regarding the high amount of political work and expertise required (with an organisation like OSPAR already engaged in such political and expert work), and the need to work across jurisdictions and other intersecting institutions (OSPAR works closely with the Northeast Atlantic Fisheries Organisation, for example). The hopeful conclusion for OC here is that there seems to be no good reason to reinvent the wheel. Regarding a governance framework, most of the architecture of such will already be built into such institutions, requiring amendments depending on how OC is conceived and in relation to the meaningful disruptions identified and policy interventions conceived. Looking into the option of inserting OC within an existing institution and governance framework offers one of the most fruitful areas for further research of OC governance.

Nevertheless, one potential challenge of incorporating OC into existing institutions and structures of governance is whether or not it would allow for sufficient adaptability to change (as in all forms of change that could affect an OC governance: environmental, societal, political, economic etc.). Running throughout the findings, from the Six Principles of commons governance in Section 4.6 to the adaptation theme in Section 9.4.5, the ability for a governance regime to change over time, for both political and physical-environmental reasons, has been stated as key to the success of an OC governance. A key finding from

an institution with a secretariat and signatory members who organise a joined-up approach in managing a wide-variety of "action areas" (such as industry and farming) to minimise pollution (Haldin et al., 2022).

Chapter 4 is that initial enclosure of a CPR can often make or break the success of its subsequent management, as was demonstrated by the example of the Common Fisheries Policy which embedded historical practices through the policy of *Historical Right*, thereby creating issues in European fisheries that exist to this day e.g., resentment among British fishers as a result of their perception that they did not receive a fair national share of the European stocks relative to how many stocks are found in UK waters. But if OC is integrated into existing governance architecture, an OC realisation will not have a chance to implement this idea. Regarding suggested future research on OC's incorporation into existing governance, as illustrated above, the adaptability of institutions or governances studied should form one of the foci of future research, given its centrality to the findings. Research could do this, for example, following advice from survey participants, by analysing methods of evaluation and review within the institution, especially in regard to the timing of review and whether there are genuine opportunities for future generations to make meaningful changes. For example, exploring the presence, or lack thereof, of a mechanism built within the institutional structure that allows the structure itself to come under review on a regular basis, and change as a result of that review.

A particularly interesting finding from the survey in Chapter 9 (see Section 9.4.5), which addressed adaptability, contradicted a widely held view, expressed in the findings throughout this thesis, that regimes of governance should aim for integration and uniformity across a given resource area. Instead, encouraging initial diversity, i.e., not aiming for uniformity in approach and execution of governance, could prove highly constructive for an emerging resource like OC. This could be imagined as the exploration of a variety of different policy interventions in different parts of a given area e.g., the NWES, and perhaps realised in various ways e.g., a total ban on bottom trawling in a certain area vs a partial ban elsewhere. This smorgasbord approach would then be monitored and measured to find which interventions worked best, and what issues of governance arose. Such an experimental approach would be complex and difficult to coordinate, but would be highly original and potentially very beneficial for an emerging resource such as OC. A comparison can be found in the approach to marine mining which, through the precautionary approach and the exploration of different types of mining in different parts of the global seabed, could be said to be engaged in a coordinated experiment in marine mining's potential and attendant exploration of its costs and benefits. However, such a thing would be a struggle for an OC governance framework because a diversity of approaches would mean the need for a diversity of experts, political labour, and political will, all of which, according to the findings, are often found in short supply.

Regardless of any other decisions made regarding OC and its governance, a key finding of the research is that a key responsibility, and essential component of a governance framework, concerns monitoring (see Sections 9.4.4 and 9.5.1, it is also rule 4 of Ostrom's 8 Design Rules). Specifically, the monitoring of the resource itself, as well as the monitoring of the societal and economic impacts that any interventions and governance decisions may have. The defining characteristic of such monitoring will be its complexity, requiring the collection of data within, and understanding the environment of, a wide regional area, involving potentially large numbers of diverse actors. This monitoring complexity was identified by the findings as something that could prove highly problematic to the creation of an OC governance in the first place because if such data are unobtainable, or prohibitively difficult to obtain, then a coherent OC governance cannot take place[57]. Hence the suggestions for simplification e.g., the creation of suitable models for a model-based approach (Section 7.3.1.1) or adopting a parametric approach (Section 9.5.1). These two examples providing potentially very beneficial avenues for future research (see Section 9.5.1 for more detail on this particular point of discussion). Here, it is important to highlight that any governance framework conceived will need to have monitoring as a central concern and find a way to deal with OC's complexity through a suitable reduction and simplification, whether that be through modelling or otherwise.

A key suggestion from the findings lies in creating uniformity of measurements and standards across the relevant area. This is already in progress regarding ecosystem accounts with the *System of Environmental-Economic Accounting* (SEEA), set up by the United Nations, providing an established framework[58], which may also accommodate the incorporation of OC. Specific ocean guidelines are under development by the *Global Ocean Accounts Partnership (GOAP)*, which looks at joining up various nation states' ocean-based environmental accounts, providing a wealth of monitoring resources to draw on (Milligan et al., 2022).

[57] This is because without sufficient data, it is impossible to know if any interventions are having the desired effect, or to ensure they are not having a negative effect.

[58] The framework "contains the internationally agreed standard concepts, definitions, classifications, accounting rules and tables for producing internationally comparable statistics and accounts" (United Nations, 2023)

10.5 Thesis Contributions

This thesis is the first attempt – to the best of the author's knowledge – to research the governance of OC, an emerging form of blue carbon. Although this attempt has presented challenges in undertaking this work (including understanding the concept of OC itself and the most pertinent questions to ask), it brings original contributions to existing work. Indeed, the overall contribution of this thesis can be considered as providing greater focus and clarity to an emerging topic, providing a better understanding of foundational issues and the ways the issues could be explored if these are to be further developed for OC governance – this section sets out these new foundations.

10.5.1 Offshore Carbon as a Developing Concept

Much of the contributions of the findings of this thesis have related to the conceptualisation of OC and how it could be conceived going forward (indeed, it was one of the overarching themes in Chapter 7). This is directly linked to governance, and governance frameworks, by the argument that much of the governance of a natural resource is decided by how the resource is conceived. As different conceptions are possible, so too are different subsequent governances. The thesis puts forward and strongly argues that OC is a CPR and that, as a result, it would benefit greatly from being governed internationally across borders.

This thesis has put forward the value of understanding OC as having three main constitutive parts, each with different qualitative characteristics: *OC-Origin, OC-Migration,* and *OC-Destination* (see Table 10.1). Thus, conceptualising OC as a "resource of parts" helps to clarify whether OC meets the definition of BC, and whether it is indeed a CPR. *OC-Destination* (i.e., OC when in the state of long-term storage in seabed sediments) is the only stage amenable to management as the evidence currently stands, and this is likely to remain true until more research is conducted that brings greater clarity regarding the flows of OC in the vast marine environment. Although certain forms of carbon at the *OC-Origin* stage can be considered as manageable (for example macroalgae), and other forms of carbon at the *OC-Migration* stage (such as forms of geoengineering and carbon-based fishing controls) may be conceived as manageable in the future, deciding whether and how they could be managed should form part of the focus of future research into OC policy interventions. The resulting conclusion regarding governance frameworks is to ensure such frameworks incorporate and understand OC as a "natural resource of parts" in order to build an efficient governance around it, with a focus on *OC-Destination* where the CC mitigation service can be clearly identified. In any case, all parts of OC must be understood and

considered, even if there are no devised policy interventions that directly affect them, as these could still affect OC governance.

The findings of this thesis have emphasised the centrality and importance of understanding the anthropogenic effects on OC, as these dictate the possible policy interventions, expressed as the Disruption *"hinge"* in Section 7.5. The governance of OC will depend entirely on these possible interventions which should be regarded as essential elements of its conception as a governed resource. Due to this centrality, gaining a better understanding of the disruptions, and the creation of subsequent policy interventions, should be seen as the top priority for developing OC further as a possible method of CC mitigation.

Conceiving of OC as a "negative fish stock" (OC more as liability, rather than asset) allows for a better understanding of how possible appropriators (i.e., nation states) will likely view OC. Likely policy interventions suggest there will be lost opportunity costs that could be seen unfavourably by some OC actors, not least jurisdictional-appropriators and the decision makers that run them. This problem is heightened by limited political resources, the limited knowledge surrounding OC as a novel system of carbon sequestration and storage, and OC's uncharismatic quality ("this is just mud essentially" i.e., people are less likely to be interested in it as a method of CC mitigation when compared to more popular causes, such as rainforests (see Section 7.3.1.4)). This reinforces the lessons learned concerning OC as a CPR: that OC, as a regional, transboundary resource, would benefit from being governed collectively, with a similar attitude taken to seabed stocks as towards rainforests and other terrestrial stocks. If the stocks are a burden that come at economic cost to the host jurisdiction, then other jurisdictions with a stake in CC mitigation (i.e., all of them) should take on at least a degree of responsibility towards the burden or help compensate the host for lost opportunity costs. To this, the value hinge mentioned in the conclusions of Chapter 7 speaks to the usefulness of devising economic instruments for OC, turning OC, conceptually, into a more "active" resource capable of generating economic returns of its own, beyond the more "passive" economic returns (mentioned briefly by participants in this study) of CC mitigation (itself nevertheless representative of a high degree of economic value, and potentially generator of gains through offsetting practices), and incentivising host jurisdictions to favour OC policies by replacing lost opportunity costs in other areas (e.g., lost fishing output). If successful, the devising of economic instruments would then place less pressure on conceiving OC as a "shared burden" between jurisdictions as the host would then have enough economic incentive to protect the stocks regardless of support from other jurisdictions. Understanding the economic potential of OC and related governance challenges remains an important avenue of research for OC. Although the participants interviewed in this thesis were either neutral

or negative towards OC-economic-instruments, the value inherent in potentially altering OC's conception from "liability" to "asset", via the devising of suitable and effective economic instruments, warrants further investigation. The lesson to be learned from the findings, however, is that this should be approached with a very healthy scepticism as to the effectiveness of such instruments and that it should be understood as an approach favoured by the dominant political economy, one which is interpreted by some as being in a state of flux and decline (Elhefnawy, 2022; Rambarran, 2015).

10.5.2 Perspectives for a future OC Governance Framework

This subsection brings together the major conclusions in the above sections on the conceptualisation of OC as CPR to highlight how this thesis contributes to moving *towards a governance framework for OC.*

The findings of this thesis advise integrating an OC framework within existing marine governance architecture and institutions, where possible. This could act to limit the amount of political work and resources required to make an OC realisation happen in the first place, as well as reduce confusion over what institutions have remit over what areas and uses of the marine zone. Such an integration must consider the ability of existing governance architecture to adjust and adapt over time and incorporate regional and spatial variances. The thesis findings suggest strongly that a successful natural resource governance is dependent on the ability of governance to adjust in these ways and accommodate a variety of users and needs. Such mechanisms of adjustment can be incorporated into the framework via providing for regular and meaningful review and evaluation and by minimising vested interests from forming (e.g., refraining from using private property as a means of enclosure).

The thesis findings also point to the wisdom that an OC framework would benefit greatly from realising the principle of *Maximum Inclusion* – aiming to incorporate as many stakeholders with an interest as possible. The proper inclusion of government, private and civil society actors, alongside (potentially) publics would help to limit possible conflicts and help optimise any CC mitigation, the overarching purpose of an OC governance. This can be achieved by ensuring all parties, especially those most affected, are given a suitable level of influence and voice in decision-making regarding OC interventions. This is particularly true of any potentially antagonistic interests, with particular regard to already highly politicised fishing actors (the most likely to be disrupted by OC policy interventions), as a group of actors with varying and sometimes conflicting interests. A

balance needs to be struck between giving meaningful influence without it undermining the CC mitigation purpose of OC. How to strike such a balance was not gained from the research findings, but suggestions from the findings regarding anti-corruption mechanisms, and examples being set by seabed mining, provide avenues of further research to develop a better understanding in this regard.

An OC framework will benefit from proper carbon accounting, measurements, and monitoring. Any potential utilisation of the OC system for CC mitigation will require highly robust and widely accepted methods of monitoring given how OC's success will be determined by such measurements. This will be challenging for OC due to the scale and difficulty of the environment. Measurement and monitoring of OC may benefit therefore by attempting a simplification via a model understanding or perhaps by adopting (if incorporated governance architecture allows) a parametric approach that aims to limit the complex measurements and instead simply aim to maximise the conditions that are known to increase sequestration, or at least best protect existing stocks. Any governance framework will have monitoring as one of its key responsibilities, perhaps the main responsibility (besides facilitating decision making regarding policy interventions). Innovative monitoring techniques could aim to create a uniformity of practice and measures, which is developing at speed through existing ecosystem and carbon accounting work (Milligan et al., 2022; United Nations, 2023). These standards and methodologies being developed could be incorporated into an OC framework as they, and OC governance, evolve.

10.5.3 Direct Derivatives of the Research

The research has produced Six Principles for commons governance (see Section 4.6 for a description of the principles, and 5.2.2 for how they relate to OC) and developed four future scenarios for OC governance (Section 8.2.4). These are direct contributory derivatives of the research, as explained here.

The Six Principles of Commons Governance

The work of the systematic literature review (Chapter 4, Section 4.6) contributed the six principles of commons governance. The Six Principles represent a verification and alignment of existing conclusions in commons studies. They line up with the outcomes of the Ostrom School, principle 1 and 3 in particular (*Maximum Integration* and *Maximum Inclusion*) which correlate with Ostrom's 3rd rule of commons governance – *Collective Choice*, as many people are affected must be included (Ostrom, 1990). Chapter 4 pointed

out the wisdom of this in the context of European fisheries but also provides a clear guiding idea for OC to take on board going forward. Principles 4 and 5 – *Temporal* and *Spatial Variance* – correlate with the critique of the commons approach as one that can lead to entrenched privileging that can come at the expense of emerging uses of the ecosystem and future generations.

Not all six principles derived from the systematic literature review were reflected in the findings of this research. For example, Principle 6 – *Internal Governance* – was not addressed by the findings that follow in the research after Chapter 4. This is likely because of a lack of questions and focus on the internal governance of national jurisdictions (intranational governance) as a result of the more international focus of this thesis. However, what individual jurisdictions could do with the governance of OC within their own borders remains an important facet of any governance. Principle 6 therefore offers a valuable reminder to keep internal governance (i.e., intranational governance within a jurisdiction) in mind as a potentially very important facet of any future OC governance realisations. As for Principle 2 – *Cooperative Power vs Competitive Power*, it was touched on by the findings but not as directly as the others. It states that jurisdictions should aim to avoid unilateralism in natural resource use by minimising competitive spheres of power. This principle has therefore found more general expression in the findings via the vindication of a CPR approach (i.e., international co-governance and joined-up approaches) as optimal for OC governance.

The Six Principles generally help to provide guidance as to good practice in commons governance, as derived from an analysis of the changes occurring to commons fisheries governance via the UK's exit from the EU (i.e., a real-world example of large-scale commons governance), but may be seen as redundant in the light of existing guidance, such as Ostrom's eight rules. As stated above, the Principles' value lies therefore in acting to verify and vindicate existing contributions of commons studies (as well as providing initial guidance on the formation of the research questions for this thesis). Nonetheless, they may be useful to other commons studies as a result of being a more direct expression of commons governing rules regarding large scale, marine commons, as opposed to, for example, Ostrom's eight rules which were focussed more on local-scale commons.

The Four Scenarios

As direct products of the research, the four scenarios in Chapter 8 offer imagined narratives of OC that act to bring to life something that is limited by its status as a concept and not a realised activity i.e., as a "future practice", following Mclaren & Corry (2021). Derived

from the literature and the interview data, the scenarios built on preceding research to help bring clarity to what can be a challenging to imagine in practice. The scenarios – called "future objects", or "techniques of prospection" following (Mclaren & Corry, 2021) in Section 6.3.1 – can be used by future researchers to provide opportunities on what research questions are most pertinent at this time, to use as contrasts to different conceptions of OC, or to critique and expand upon, and in the process, "prospect" the idea further. As stated in Section 6.3, the value of the scenarios is as tools, facilitating the exploration of imagined futures for something that has yet to gain form by providing substance and context that can guide future research. More specifically, as is the intention of the GBN method (Section 6.3.1), they provide a means to strategise the approach that can be taken towards OC's realisation and governance. Regardless of whether or how future research engages with the scenarios, there are now imagined OC realisations to engage with.

10.6 Reflections on Limitations

Much of the value of the thesis research stems from OC's novelty as a concept. But, as emphasised in Chapter 6 (Section 6.6), this novelty also lies at the heart of the major limitations of the research. When the research for this thesis began, there was no extant research on offshore-carbon-governance (to the best of my knowledge), and with no real-world example of OC in practice, the research had a very small basis of knowledge on which to build. This meant that the research was focussed on questions that would help to build the missing foundations in order to address the gap in the literature. With little existing direct literature to act as guide, knowing *what* to ask was a central challenge to the thesis work. This limitation of a low amount of extant research to build on was dealt with by adopting a strategy of learning from and building on the many adjacent fields, including carbon accounting, commons studies, fisheries governance and blue carbon, which constituted the key bases of the literature reviews undertaken.

At the beginning of the project, there was obscurity around what OC was, therefore much of the initial work was built around exploring what OC is or, rather, what it *could* be. As has been discussed, there are potentially many different ways for OC to be conceived and it was initially unclear which conception should be adopted to facilitate the research aims. A different conception will have likely led to different findings. The thesis was therefore shaped by the definition and conception I chose to work with, based on existing work (as discussed in Section 10.4). This is particularly true regarding OC's status as a CPR which is conceptually difficult to understand and opens to debate whether OC would fit into

existing CPR frameworks. This CPR conceptual ambiguity further added to the difficulties associated with OC's conceptualisation mentioned in this paragraph. Hence my acknowledgement of how conceptualisations of OC in the future may affect its governance and management.

Methodologically, the novelty of OC means there are very few individuals with insights on OC, either in terms of expertise, employment, or as existing stakeholders. As a social scientist, I was therefore limited in who I could invite to take part in my research. The research focusses on knowledge experts for reasons stated in both Chapters 1 and 6, who offered their time voluntarily to contribute to this work. But such experts found some aspects of the research challenging at points due to their unfamiliarity with the topic and its conceptual nature. This will have affected their responses in some cases. Furthermore, the nature of OC as a topic of study, and its novelty, greatly limited the range of methods I could employ, as explained in more detail in Section 6.6. Also explained in Section 6.6 are the limitations presented by the Covid-19 pandemic and my reflections on them.

A final limitation can be found in the poor response rate to the survey, which was discussed in more detail in Section 9.5.2. Suffice to say, with a higher response rate, the data would have been richer and provided more insights to help answer RQ3. Although the data collected did contain interesting and informative findings, the method's full potential, with only 10 respondents, was not met. One way this challenge could perhaps be met in the future is by providing some form of reward for completing the survey or undertaking the survey differently perhaps as semi-structured interviews or over a different duration of time.

10.7 Avenues for Future Research

This thesis is a novel and original attempt to research the emerging natural resource of Offshore Carbon. As such, the topic, offshore-carbon-governance, as one that is still in its infancy, has tremendous potential to evolve and develop in several directions. This thesis has provided a firm foundation, and in so doing, has highlighted important avenues for future research.

A first avenue concerns the two main foundation blocks of OC governance – *Disruption* and *Conception.* Regarding definition and conception, the fact that OC has yet to be given a definitive name (although *sedimentary carbon pathway* seems to be emerging as dominant in the most recent literature (Graves et al., 2022; Howard et al., 2023)) or a

defining conceptualisation (e.g., does it include the complex flow – microalgae and the biological pump – or not?) demonstrate that OC is still emerging and there are various perspectives as to how it could be conceived. Addressing this, in collaboration with the wider research community, is one of the top priorities. Researching the most likely disruptions (mechanical disturbance of the seabed e.g., bottom trawling; degradation of OC flows e.g., commercial fishing; and the influences of coastal and terrestrial inputs e.g., agricultural pollution via rivers), their existing management, and policy interventions based on such disruptions is another important area of work this thesis points to. These policy interventions could then provide a new focus for future governance research. Importantly, the extent of the anthropogenic effects on the OC system will also determine whether such policy interventions would have a sizeable enough effect on CC mitigation, thereby determining whether OC could indeed be a viable method of CC mitigation in the first place – and therefore help illuminate whether it is worth pursuing an OC realisation within the wider context of climate change mitigation.

A second avenue is about aspects concerning utilisation and calls for further research stemming from other lessons learned regarding OC's utilisation as a natural resource, ancillary to those that follow from the disruption problem. For example, researching how OC could be valued and whether it can change from a "passive" resource – the negative fish stock – to a more "active" resource. This could be developed by analysis of existing resources that act as important stores in need of protection, and how such deal with being "passive" in the sense described in this thesis – an exploration of the idea of creating shared ownership and financial support for caretaking an important stock in the context of CC. Indeed, building on OC's definition as a CPR, and the problems associated with it (see Sections 5.2.1.1 and 10.4), the research calls into question our dominant understanding of large-scale CPRs and whether a redefinition is required to incorporate those resources that have a shared resource system but not necessarily shared resource units. Especially in light of resources that are not "used up" in their utilisation/appropriation but are instead preserved. An exploration of this and the complexities surrounding OC's (and other major carbon stores') CPR status could lead to a more sophisticated understanding of CPRs in general. Additionally, there is still scope to develop an economic instrument(s) approach for OC, although this is perhaps something to be further researched at a later stage in OC's development.

A third avenue concerns aspects related to actors. An unequivocal finding is that as many actors as are affected be included in OC's governance – the *Maximum Inclusion* principle identified in Chapter 4. But inclusion at the large-scale and regional level is challenging due to the reasons outlined in Section 2.7. So, researching how relevant actors – civil

society, private organisations, publics, researchers etc. – can be included, within a given context, would provide important insights that could inform future OC governance. This thesis has explored some of the aspects surrounding this but there are still many unknowns.

Finally, there are a few avenues of further research that more directly address the construction of governance frameworks. The proposition that an entirely new framework may not be necessary if OC can instead be incorporated into existing governance architecture requires further research because of the pros and cons discussed in this thesis. This could be achieved through a close examination of existing institutions, regulations and governance across a given region where there is interest in OC – the NWES providing an intuitive example (including the likes of OSPAR, the EU, and HELCOM) given its centrality in this thesis. Also, considering that adaptability is often central to success, such an analysis of existing architecture would benefit from including research on any such institutions' ability to incorporate changes and adapt over time. And, given the centrality of monitoring as a key responsibility of governance, and how this has been identified as particularly difficult for OC, more research into the possibility of creating a model-based understanding of the complex OC system, alongside the potential for a parametric approach to be adopted, has the potential to help OC governance deal with one of its greatest challenges.

Bringing this thesis to a close, the avenues for future research provide guidelines for the further development of the idea of Offshore Carbon as a method of climate change mitigation, within the context of governance. The thesis has created new foundations for this emerging topic of OC-governance that can now be developed further to enable the emergence of a potentially valuable means of climate change mitigation to bring to bear within wider climate change strategies.

Appendices

Appendix 1. Systematic Literature Review – Search Process and Results

Chapter 4 of the thesis was a systematic literature review i.e., a *systematic* approach to the literature search was taken, following a set method to answer the review question. This appendix provides a step by step of the processes undertaken – on both the literature search and the analysis of the search results – as well as the complete search record.

The Review Question: *How is the common pool nature of European fisheries being addressed in the context of the UK's ongoing exit from the European Union?*

Literature Search

Search Databases

The online databases chosen for the literature search were:

- Scopus
- Web of Science
- Google Scholar
- Science Direct
- Proquest

These were chosen as standard academic literature search databases that included a wide range of academic disciplines. A wide range was required as the review question was embedded in various overlapping topics: natural resource governance, fisheries, political ecology, political economy, governance, international relations, common pool resources etc. This is in contrast to, say, medical science, in which search databases more specific to such a discipline would have been more suitable e.g., Pubmed and MEDLINE.

As for grey literature, advice was given by senior colleagues to check OpenAIRE and Google. Additionally, a direct search of relevant government websites (UK government, the EU, and the various devolved UK governments) was deemed necessary as two of the main topics of the review – fisheries and Brexit – are government competencies.

As the 'Brexit' vote was confirmed in 2016, all the chosen documents were published between 2016 and 2020 with the database searches limited to these years.

Search Terms

- The key search terms were derived from the review question: *How is the common pool nature of European fisheries being addressed in the context of the UK's ongoing exit from the European Union?*
- Each term was chosen to represent and combine the three main topics implicit in the review question: (1) The UK's exit from the EU ("Brexit"), (2) The European fishing sector, and (3) The common pool nature of European fish resources.
- The key search terms decided were:

    - (1) Brexit
    - (1) EU exit
    - (1) European Union exit
    - (2) Fish (amended by Boolean operators to include fisheries, fishing etc.)
    - (2) Common Fisheries Policy
    - (3) Common pool
    - (3) Common pool resources
    - (3) Commons
    - (3) Marine governance
    - (3) Marine resources

- (1) was difficult as "Brexit", although widely used, is nonetheless colloquial and not an official governmental term for the UK's exit from the European Union. As such, longer search terms such as [United Kingdom exit from European Union] were trialled in the initial searches but proved too complicated for the search engines utilised i.e., the results were not relevant. However, "Brexit" as a term, despite being unofficial, did produce sizeable and meaningful results. As the search developed and the results helped determine successful terms, *Brexit* was chosen as the main search term that provided relevant results for the UK's exit from the EU. Brexit as a term was used to control the number of hits in order to ensure relevance and so was utilised in every combination with other search terms. The rationale for this was that combining (2) and (3) terms, without (1) terms, produced a huge number of hits covering the scope of all fisheries literature, which is extensive. Whereas, relative to the fisheries and commons literature, there are not nearly as many documents on the UK's exit from the EU. Using (1) terms in each search therefore acted as a control, ensuring maximum relevance with minimum search hits.

- (2) was relatively straight forward for incorporating into the search, requiring no more than *fish* combined with certain search operators to include any suffixes: in Google Scholar the operator is a ~ (making, *fish~)*; in standard Boolean searches the operator is * (making, *fish**). These terms where sufficient to incorporate the fishing industry focus in the search. Other terms, *seafood* and *seafood industry,* were trialled but were not successful in bringing about relevant searches. The results were regarded as low in number and too specific to the perspective of fishing as an industry or business rather than the context of natural resource management and questions concerning common pool resources. However, the term *Common Fisheries Policy* was used to incorporate any documents that discussed the policy itself and that may not mention much about fishing directly, as can be seen from the search record the inclusion of this term proved useful in eliciting successful hits.
- (3) was more complicated. Similar to (1), the third focus of the review question is rather wordy with *common pool resources* or *common pool resource management* being the shortest ways to incorporate them into a search. As such, the terms *commons* or simply *common pool* were trialled with varying success, as can be seen in the search record. With (3), more search terms were used to broaden the search, whereas (1) and (2) were covered sufficiently with, largely, *fish** and *Brexit,* i.e., these terms led to successful searches with documents relevant to (1) and (2) with little need for other terms. As the common pool nature of the resource may not be directly stated in a document, but discussed nonetheless, it was decided that the terms *marine governance* and *marine resources* could also provide relevant results, especially when combined with terms that limited the results to documents that discussed Brexit or European fisheries.

Search History

- A history of the search is provided by the search record below, in the series of tables A.2-A.7. The record is a series of tables for each web database used. The number of hits is recorded followed by the number of hits that were clicked on for further investigation, followed by the number of those deemed relevant enough to undergo the inclusion/exclusion reading (these later types are referred to as "saved hits").
- Important points in the search record:
    - Scopus and Web of Science were the first databases searched and so both demonstrate initial search terms that were abandoned in later searches: '*(United Kingdom) AND Exit AND (European Union) AND fish*',* and

'Brexit AND common'*. As stated above (and can be seen in the comments), these were abandoned as search terms because they did not elicit enough hits, elicited far too many to be manageable and/or produced hits that were not applicable to the review question and purpose.

- *'(EU exit) AND fish*'* was kept as a search term despite not being as successful as '*Brexit'* in order to ensure any documents discussing the UK's exit from the EU but did not use the term "Brexit" within the document, would be included.
- The search term *'Brexit AND [Common Pool Resources]'* was kept throughout despite not producing much in the way of saved hits. This was simply in case other searches (especially Google) ended up producing documents where others had failed.
- There was a high degree of overlap throughout the search, with many search terms producing very similar hits and saved hits. Most saved hits recorded throughout the process had already been collected at an earlier search – in particular the first few searches on Web of Science and Scopus.
- The initial searches on Science Direct demonstrate the decision to include *Common Fisheries Policy* as a search term to be a pertinent one – as can be seen with a comparison between the terms *'Brexit AND fish*'* and '*Brexit AND (common fisheries policy)'* with both producing 13 clicked hits but the former producing no saved hits and the later producing 11 (although all of these were already collected from previous searches).
- For searches that produced more than 200 hits (particularly true of Google), the decision was made to check the first 200 in order to keep the search process manageable. This number was decided after I tested how many hits it took before hits became irrelevant to the search. The general point of irrelevance was around 100 hits. 200 was chosen, therefore, to ensure no relevant hits passed the review search by, but still kept the number low enough to be manageable.
- Grey literature: The grey literature search came last with some of the saved hits having already been collected from the previously used databases. The successful results were government documents that discussed the intention of the UK Government regarding fishing and Brexit going forward or documents from NGOs and think tanks (such as *The Blue Marine Foundation* and *The New Economics Foundation*), found via Google and OpenAIRE.

Inclusion/Exclusion Process

The Inclusion/Exclusion process occurred after the search (i.e., after each search term was processed through each of the chosen search engines). The inclusion and exclusion criteria chosen reflected the search criteria as derived from the review question:

a) should be published in English or have an English language abstract available;
b) should address European fisheries;
c) should address the UK's exit from the European Union i.e., "Brexit";
d) can be said to say something about the common pool nature of the fish resource

The first criterion was simply to ensure documents I would be able to read. The other three are tagged to the same three general topics derived from the review question, as pointed out for the search: The UK's departure from the EU, European fishing, and the common pool nature of the resource. For criterion (d), "say something about…" is rather vague and therefore potentially problematic. However, the justification for this is that documents might not necessarily address common pool resources directly. As such, "something about" allows a degree of interpretation by the researcher, necessary for judging whether a document does indeed "say something about" common pool resources. It is acknowledged however, that in this lay a heavy degree of subjectivity on the part of myself and is one potential aspect from which a different researcher may derive different results. Ideally, this would be mitigated by involving several researchers in the judgement of whether a document should be included but the search and inclusion/exclusion was undertaken by myself only. However, the process was informed with advice from my supervisory panel.

Results

The number of unique "saved hits" after the search process finished was forty eight. I then read over these forty eight documents to judge whether they met the inclusion/exclusion criteria. Of the forty eight, eleven did not meet the criteria. One document was rejected for only mentioning Brexit in passing and so not to enough significance, and another for not addressing fisheries to a great enough extent. The rest were rejected for not saying something significant regarding the common pool nature of the resource. Table A.1 details the final thirty seven documents used in the review:

Table A. 1 *Final selected papers for review (grey literature highlighted in grey)*

Number	Author(s)	Year	Title	Type	Journal/Institution	Publisher
1	Jeremy Phillipson, David Symes	2018	'A sea of troubles': Brexit and the fisheries question	Peer-reviewed Article	Marine Policy	Elsevier
2	Tim O'Higgins, Anne Marie O'Hagan	2019	A return to the tragedy of the commons? Brexit trade-offs and spatial analysis, an Irish perspective	Peer-reviewed Article	Marine Policy	Elsevier
3	Thomas Appleby, James Harrison	2017	Brexit and the Future of Scottish Fisheries – Key Legal Issues in a Changing Regulatory Landscape	Peer-reviewed Article	Journal of Water Law	Lawtext
4	Stephanie Weir, Sandy Kerr	2020	Enclosing the right to fish: A Q-study into fishers' attitudes to rights in Scottish fisheries	Peer-reviewed Article	Ocean and Coastal Management journal	Elsevier
5	Giulia Agnisola, Stephanie Weir, Kate Johnson	2019	The voices that matter: A narrative approach to understanding Scottish Fishers' perspectives of Brexit	Peer-reviewed Article	Marine Policy	Elsevier
6	Sophia Kopela	2019	Historic fishing rights in the law of the sea and Brexit	Peer-reviewed Article	Leiden Journal of International Law	Cambridge University Press
7	Andy Forse, Benjamin Drakeford, Jonathan Potts	2019	Towards managing the United Kingdom's fisheries: A Brexit view from Scotland	Peer-reviewed Article	Marine Policy	Elsevier
8	Thomas Appleby and James Harrison	2019	Taking the Pulse of Environmental and Fisheries Law: The Common Fisheries Policy, the Habitats Directive, and Brexit	Peer-reviewed Article	Journal of Environmental Law	Oxford University Press
9	Stijn Billiet	2019	Brexit and Fisheries: Fish and Chips Aplenty?	Peer-reviewed Article	The Political Quarterly	Wiley-Blackwell
10	Craig McAngus, Christoperh Huggins, John Connolly, Arno Van Der Zwet	2019	Brexit, Fisheries and Scottish Devolution: An Intergovernmental Disruption	Peer-reviewed Article	The Political Quarterly	Wiley-Blackwell
11	Verena R. Ohmsa, Jesper Raakjær	2019	The future of the Pelagic Advisory Council: Repositioning the organization in the face of BREXIT	Peer-reviewed Article	Marine Policy	Elsevier
12	Craig McAngus, Christoperh Huggins, John Connolly, Arno Van Der Zwet	2018	Brexit and the future of UK fisheries governance: learning lessons from Iceland, Norway and the Faroe Islands	Peer-reviewed Article	Contemporary Social Science	Routledge, Taylor & Francis Group
13	David Bailey & Leslie Budd	2019	Brexit and beyond: a Pandora's Box?	Peer-reviewed Article	Contemporary Social Science	Routledge, Taylor & Francis Group
14	José Manuel Sobrino Heredia, Gabriela A. Oanta	2019	The legal impact of the common fisheries policy on the Galician fisheries sector	Peer-reviewed Article	Ocean and Coastal Management journal	Elsevier
15	Bertrand Le Gallic, Simon Mardle and Sébastien Metz	2018	Brexit and Fisheries: A Question of Conflicting Expectations	Peer-reviewed Article	EuroChoices	Wiley-Blackwell
16	Evangelos Toumasatos, Stein Ivar Steinshamn	2018	Coalition Formation with Externalities: The Case of the Northeast Atlantic Mackerel Fishery in a Pre- and Post-Brexit Context	Peer-reviewed Article	International Game Theory Review	World Scientific
17	Michael Harte, Rachel Tiller, George Kailis, and Merrick Burden	2019	Countering a climate of instability: the future of relative stability under the Common Fisheries Policy	Peer-reviewed Article	ICES Journal of Marine Science	Oxford University Press
18	Robin Churchill	2018	They're Scotland's Fish! Implications of Brexit for Scots Fisheries Law	Peer-reviewed Article	Edinburgh Law Review	Edinburgh University Press
19	Griffin Carpenter, Richard Kleinjans	2017	EU Common Fisheries Policy is bound for a Brexit shake-up	Academic Blog	The London School of Economics	LSE

Number	Authors (s)	Year	Title	Type	Journal/Institution	Publisher
20	Richard Barnes, Chris Williams, Bryce Stewart, Bethan O'Leary, Thomas Appleby, Griffin Carpenter	2018	Brexit and fishing: How can the UK deliver a 'successful' fisheries policy after Brexit?	Academic Blog	The London School of Economics	The London School of Economics
21	Suzanne J. Boyes, Michael Elliott	2016	Brexit: The marine governance horrendogram just got more horrendous!	Peer-reviewed Article	Marine Pollution Bulletin	Elsevier
22	Craig McAngus, Christopher Huggins, John Connolly, Arno Van Der Zwet	2018	The Politics and Governance of UK Fisheries after Brexit	Magazine Article	Political Insight Magazine	SAGE Publications
23	Erin Priddle	2018	How the government can use quotas to build a sustainable future for UK fishing	Academic Blog	The London School of Economics	The London School of Economics
24	Mara Ntona	2016	A Legal Perspective on the Value of Scotland's EU Membership for Sustainable Fisheries	Policy Report	University of Centre of Environmental Law and Governance	University of Strathclyde Press
25	Thomas Appleby, Emma Cardwell, and Jim Pettipher	2018	Fishing rights, property rights, human rights: the problem of legal lock-in in UK fisheries	Peer-reviewed Article	Elementa Science of the Anthropocene	University of California Press
26	Miss Sofia Syreloglou, Professor Yvonne Baatz, Mr Richard Coles, Professor Dominic, Hudson, Professor Simon Quinn, Professor Andrew Serdy, Professor Michael Tsimplis , Mr Robert Veal and Dr Jingbo Zhang	2017	The UK maritime sectors beyond Brexit	Academic Report	The University of Southampton	The University of Southampton
27	Bryce D. Stewart, Bethan C. O'Leary, Charlotte Burns, Adam P. Hejnowicz, Viviane Gravey, Kevin Hicks, Fay M. Farstad, Sue E. Hartley	2019	Making Brexit work for the environment and livelihoods: Delivering a stakeholder informed vision for agriculture and fisheries	Peer-reviewed Article	People and Nature	British Ecological Society
28	Heleen Bartelings, Zuzana Smeets Kristkova	2018	Impact of hard Brexit on European fisheries: Scenario analysis using the MAGNET model	Report	Wageningen University and Research	Wageningen University and Research
29	Elena Ares	2019	Fisheries and Brexit	Briefing Paper	House of Commons Library (UK Gov)	House of Commons Library (UK Gov)
30	Stewart, B.D. and O'Leary, B.C	2017	Post-Brexit Policy in the UK A New Dawn? Fisheries, Seafood and the Marine Environment	Academic Report	K in a Changing Europe, Economic and Social Research Council	
, , 31	Sobrino Heredia, J M	2017	Research for PECH Committee - Common Fisheries Policy and BREXIT, Legal Framework for Government	Policy Report	European Parliament	
32	George Cass	2019	Alternatives to the Common Fisheries Policy? The Future of the UK's Fisheries Post-Brexit	Peer-reviewed Article	The Plymouth Law & Criminal Justice Review	Plymouth University
33	Climate Change, Environment and Rural Affairs Committee	2018	The Impact of Brexit on Fisheries in Wales	Committee Report	The Welsh Assembly	The Welsh Assembly
34	Environment Secretary (Rt. Hon Michael Gove)	2018	Sustainable fisheries for future generations	Parliamentary Report	UK Government Department of the Environment, Food and Rural Affairs	DEFRA
35	Griffin Carpenter	2017	Not in the Same Boat: The Economic Impacts of Brexit Across UK Fishing Fleets	Policy Report	New Economics Foundation	NEF
36	Blue Marine Foundation	2018	FISHING IN TRANSITION An update on Brexit negotiations and likely outcomes for the fishing and seafood sectors	Conference Report	Blue Marine Foundation	Blue Marine Foundation
37	Elena Ares	2019	the Fisheries Bill	Briefing Paper	House of Commons Library (UK Gov)	House of Commons Library (UK Gov)

Table A. 1 Continued *Final selected papers for review, grey literature highlighted in grey*

Table A. 2 *Database:* ***Scopus***

Date	Search Term	Hits	Clicked hits	Saved hits	Comments
16/04/2020	Brexit AND fish*	34	25	22	Good initial haul of papers
17/04/2020	Brexit AND (common fisheries policy)	12	11	11	All 11 already collected from previous search
18/04/2020	Brexit AND common*	326	NA	NA	Too many hits – term deemed too complex
18/04/2020	Brexit AND (common pool resource*)	1	0	0	Term does not appear to work
18/04/2020	Brexit AND (marine governance)	5	3	3	
21/04/2020	Brexit AND (marine resource*)	3	2	2	
22/04/2020	(United Kingdom) AND Exit AND (European Union) AND fish*	0			Term too complex
22/04/2020	(EU exit) AND fish*	4	1	0	Term not very successful

Table A. 3 *Database:* ***Web of Science***

Date	Search Term	Hits	Clicked Hits	Saved Hits	Comments
17/04/2020	Brexit AND fish*	32	27	24	Very similar results to Scopus
17/04/2020	Brexit AND (common fisheries policy)	15	13	13	All 13 saved hits already collected
18/04/2020	Brexit AND common*	238	NA	NA	Same as Scopus for this search term
18/04/2020	Brexit AND (common pool resource*)	1	0	0	Search term not producing hits
18/04/2020	Brexit AND (marine governance)	3	2	2	
21/04/2020	Brexit AND (marine resource*)	3	2	2	
22/04/2020	(United Kingdom) AND Exit AND (European Union) AND fish*	0			Search term not working
22/04/2020	(EU exit) AND fish*	8	1	0	Term not successful

Table A. 4 *Database:* ***Science Direct***

Date	Search Term	Hits	Clicked Hits	Saved Hits	Comments
17/04/2020	Brexit AND fish*	106	13	0	SD is Scopus but internal to Elsevier - it provided more hits but less exacting to the search
17/04/2020	Brexit AND (common fisheries policy)	53	13	11	All 11 already collected
18/04/2020	Brexit AND common*	84	3	3	
18/04/2020	Brexit AND (common pool resources)	119	2	2	
18/04/2020	Brexit AND (marine governance)	52	8	8	
21/04/2020	Brexit AND (marine resource*)	56	9	8	
22/04/2020	(EU exit) AND fish*	304	7	5	Checked first 200, all 5 saved hits already collected

Table A. 5 *Database:* ***Google Scholar***

Date	Search Term	Hits	Clicked Hits	Saved Hits	Comments
17/04/2020	Brexit AND ~fish	6710	21	7	~ is Google scholar equivalent of * | too many hits to be manageable, checked over the first 200. Much more grey literature
17/04/2020	Brexit AND (common fisheries policy)	3960	39	26	too many hits to be manageable, checked over the first 200 | 22 already collected, 4 new
18/04/2020	Brexit AND commons	45,000	NA	NA	Too many hits
18/04/2020	Brexit AND (common pool resources)	7,750	NA	NA	Too broad - Term amended to Brexit AND (common pool resources) AND ~fish (see next line)
18/04/2020	Brexit AND (common pool resources) AND ~fish	1,750	14	8	First 200 checked
18/04/2020	Brexit AND (marine governance)	5,280	20	17	First 200 checked
21/04/2020	Brexit AND (marine resources)	6,700	32	22	First 200 checked
22/04/2020	(EU exit) AND ~fish	9,900	8	3	First 200 checked

Table A. 6 *Database:* ***Proquest***

Date	Search Term	Hits	Clicked Hits	Saved Hits	Comments
17/04/2020	Brexit AND fish*5	5	0	0	*5 required under boolean operatives for Proquest (it finds the root word and all truncated words up to and inc that num of letters) e.g., *3 will find fishery but not fisheries
17/04/2020	Brexit AND (common fisheries policy)	169	4	2	Both papers already collected
18/04/2020	Brexit AND (common pool resources) AND fish*5	56	0	0	No relevant papers
18/04/2020	Brexit AND (marine governance)	165	1	1	
21/04/2020	Brexit AND (marine resources)	215	5	2	
22/04/2020	(EU exit) AND fish*5	7	0	0	(EU exit) continues to be unsuccessful

Table A. 7 *Grey Literature Search*

Database	Date	Search Term	Hits	Clicked Hits	Saved Hits	Comments
Gov.uk	23/04/2020	Brexit fisheries	168	1	1	Sifted with 'Environment' [Topic], 'Commercial Fishing, Fisheries and Vessels' [sub-topic], 'Research and Statistics' & 'Policy Papers and Consultations' [document type]
Gov.scot	23/04/2020	Brexit fisheries	13	1	0	
Gov.scot	23/04/2020	Fisheries	17	0	0	
Gov.wales	23/04/2020	Direct Sift	NA	2	0	Direct sift = Checked the directory of published documents on website without using a search engine.
Europa	24/04/2020	Direct Sift	NA	1	1	
Google	23/04/2020	Brexit and fisheries policy	954,000	23	7	Checked first 200 hits

	23/04/2020	Governing UK fisheries after Brexit	650,000	13	5	Checked first 200 hits
	23/04/2020	Brexit and the common fisheries policy	432,000	9	5	Checked first 200 hits
	23/04/2020	Brexit and marine governance	2.46 million	14	5	Checked first 200 hits
	23/04/2020	Brexit and common pool resources	1.54 million	5	1	Checked first 200 hits
	23/04/2020	EU Exit fisheries	2.23 million	7	0	Checked first 200 hits
	23/04/2020	EU Exit common fisheries policy	3.34 million	2	2	Checked first 200 hits
OpenAIRE	24/04/2020	Brexit fish*	8	4	4	
	24/04/2020	Brexit common fisheries policy	7	3	3	
	24/04/2020	EU exit fish	2	0	0	
	24/04/2020	Brexit marine resources	2	1	1	
	24/04/2020	EU exit	875	NA	NA	Tried 'EU exit' to check if a relevant search term. 875 hits prove it is a valid term but too general to be useful

Table A. 7 Continued *Grey Literature Search*

Appendix 2. Interview Protocol

(A) Policy/Utilisation

1. Would you please tell me briefly what your background and expertise are in your field?
2. Were you able to read the project summary? What were your thoughts?
3. If the natural resource you are familiar with could be managed differently, what would you change?
    - Prompts: The one main thing you'd change, 3 main things
4. What immediate similarities and dissimilarities do you see between [**interviewee's field**] and this proposed Offshore Carbon resource?
5. What are the ways you see Offshore Carbon being *used* to mitigate climate change?
6. Are there any policies or instruments that stand out for you to achieve this?
    - Prompts: e.g., PES, carbon credits, subsidies, taxes, policies linked to conservation
7. Do you have any initial thoughts on what may facilitate or prevent the successful use of Offshore Carbon for climate change mitigation?

(B) Actors

8. Who do you think would be the main stakeholders in an Offshore Carbon system?
9. What do you think would be the main institutional responsibilities required by an Offshore Carbon system?
10. Can you think of any existing institutions that could be included or would need to be included?
11. Do you envisage the need for new institutions? What characteristics would they have/need?

(C) Governance

12. What in your view would be the main issues and challenges in the governance of Offshore Carbon? Are any of these similar / different to those encountered in your field?
13. The research is focusing on Offshore Carbon as an internationally governed resource at the level of nation states, but do you have any thoughts on its potential use and management at a more local, small-scale?
    - Prompts: Does OC have potential to be a more localised resource, in the same way some fishing or blue carbon initiatives are local and small-scale. If so, how?
14. Before we finish the interview, is there anything you would like to add or any questions you have for me?
    - Is there anyone else you suggest I speak to?

Appendix 3. Project Summary Preceding the Interviews

This is the project summary document I sent to the interview participants before the interview. Its purpose is to give them some context before the interview in order to help them understand why I requested to interview them and what I will be interviewing them on.

Project Summary

PhD Research Title: *The Future Governance of 'Blue' Common Pool Resources: What do Fisheries and 'Blue' Carbon have in Common? An International Framework.*[59]

By Jack Smith, University of East Anglia

Aims of the Research

My PhD research aims to study the natural carbon sequestration and storage provided by marine systems and is embedded within the wider field of nature-based solutions to climate change. The specific form of carbon sequestration and storage – referred to as *Marine Carbon*[60] (described below) – is considered an "emerging" resource in that it is not currently utilised in any meaningful way in terms of governance, management, or policy, but has the potential for some form of utilisation and incorporation into systems and strategies of climate change mitigation. The aim of this research is to extend the ideas and concepts found in *Blue Carbon* initiatives, with their focus on coastal carbon deposits, out to sea and into the marine zone. This brings attendant problems associated with marine resources that surround the nature of the resource as migratory, transboundary, and therefore difficult to access/manage (similar to fish).

More specifically, the project aims to inform the design and creation of a governance and management framework for marine carbon to facilitate climate change mitigation.

[59] This was an earlier iteration of my thesis title (As a reminder, the interviews occurred in Spring 2021)

[60] *Marine Carbon* was the name I used initially in the first half of the PhD project to refer to what would become *offshore carbon*.

Marine Carbon

The subject natural resource of the PhD is Marine Carbon. Carbon comes in many forms in the marine zone so in this research "marine carbon" refers specifically to carbon in the following processes/states:

Sequestration[61]**(Flow)**: Particulate Organic Carbon (**POC**) produced through biological processes in the water column (informed by some other factors such as river output) – known as the "*biological pump"*.

Storage (Stock): The carbon stored long term in the sediments of shallow shelf-seas.

This system of sequestration and storage is considered an economic good as it provides the ecosystem service of climate change mitigation by transporting carbon from the atmosphere and storing it away long term in sediments.

Marine Carbon as an Internationally Shared Resource

As is especially the case within marine environments in which water acts as a transport medium, the resource system – i.e., the large ecosystem that contains the "biological pump" – which produces the carbon and facilitates sequestration, is vast, complex and often crosses multiple jurisdictions (this I am calling the *marine carbon system* – that system which gives rise to the carbon [sequestration] and contains the sediments in which the carbon is stored). This means that the system that gives rise to the resource is, at least partially, shared and co-managed (see Figure 1). This can be demonstrated by imagining the production of some marine snow (**POC**), let's say through the faecal waste of a shoal of fish in French waters. This marine snow may then be transported by currents into Belgian waters where it descends and is further transported into Dutch waters whereby a degree of the carbon within the marine snow is incorporated into the sediments within the Dutch Exclusive Economic Zone (EEZ). In this hypothetical case the Dutch Government can lay claim to that carbon (once it is stored in Dutch sediments) however construed, but the entire process that gave rise to that resource is an international one within a shared system inside the North Sea; the production process is shared, the final resource (economic good) is not.

[61] As one of my participants pointed out, my use of the word sequestration was wrong in this document. Sequestration occurs right at the point the carbon is moved from being a state still available to the atmosphere to the state of long-term storage. So, in OC's case, sequestration occurs at the burial stage in the seabed. All preceding stages are not sequestration but classed as something else e.g., transportation or deposition.

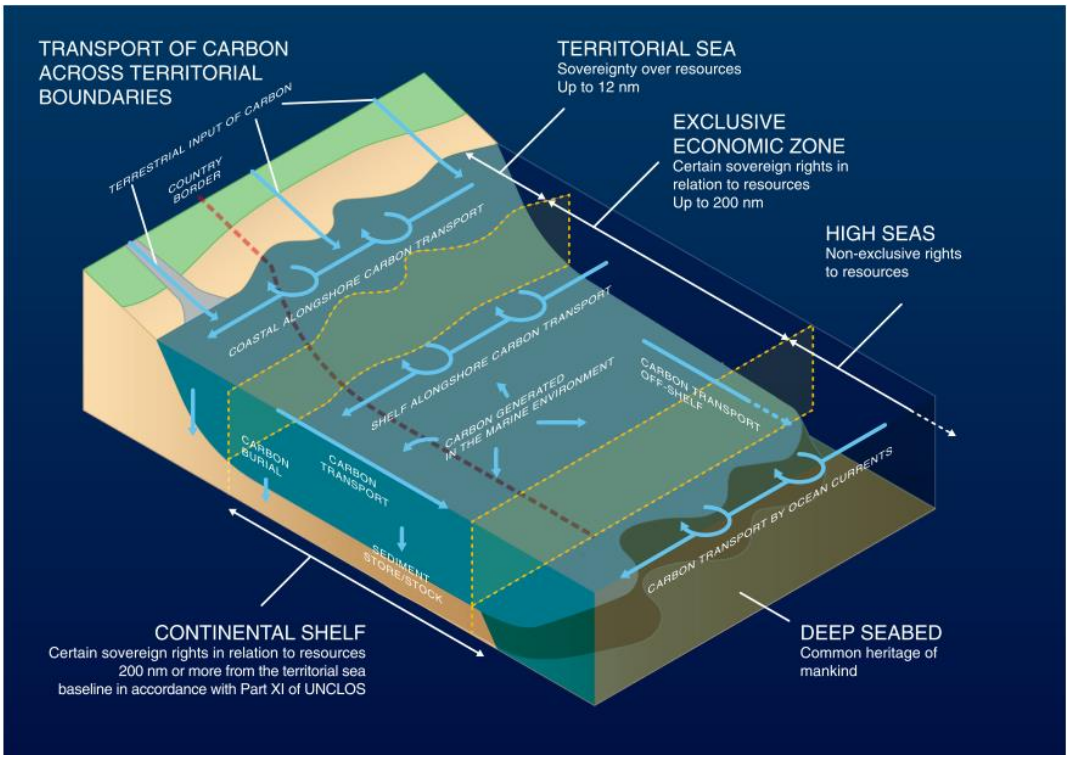


Figure A. 1 *The transport of offshore carbon across territorial boundaries (Source:* Luisetti et al. (2020), 'Climate action requires new accounting guidance and governance frameworks to manage carbon in shelf seas', Nature Communications, 11*)*

Appendix 4. Survey Participation: University Search Record

Here, three examples of the university search record for the survey in Chapter 9 are displayed. Each country (UK, USA, Canada, Australia, Ireland, New Zealand), or country group (Europe, East Asia, "Rest of World") was searched and recorded in the same manner.

The three examples given here are the UK search in Table A.8, the Canadian search in Table A.9, and the East Asia search in Table A.10. The Canadian search only recorded ten for each search, with the overall aim to acquire a top ten, rather than top twenty. This was to reflect the smaller size of the Canadian university sector. This was the same for Australia, with New Zealand and Ireland recording a top 5 (they needed to be smaller as Ireland and New Zealand do not have twenty universities in the first place, let alone a *top* twenty).

The "Tally" refers to that described in Section 9.3.4.1, that in order to determine the final list of 20, 10, or 5 universities for the respective countries (or country groupings), the four separate searches within each country search needed to be synthesised. Each university was given a tally based on how many of the four separate search combinations they appeared on. For example, in the UK search, Oxford University appears in all four searches (Geography-citations/Geography-Research/Env science-citations/Env science-research) so gets a tally of 4. But the University of Swansea only appears in the Geography-citations and Env science-citations searches, so receives a tally of 2. These tallies were then used to determine the finalised lists. This is explained further in Section 9.3.4.1.

Table A. 8 *UK university search results*

Country	Subject	Citations or Research	Top 20 Universities	Tally
UK	**Geography**	**Citations**	Oxford	4
			Leicester	2
			Bristol	4
			King's College London	4
			UCL	4
			Queen Mary London	4
			Edinburgh	4
			Cambridge	4
			Lancaster	2
			Glasgow	4
			Newcastle	2
			Birmingham	4
			LSE	4
			UEA	2
			Exeter	4

			U West of England	2
			Southampton	4
			Manchester	3
			Swansea	2
			Dundee	1
		Research	Oxford	
			Cambridge	
			UCL	
			Edinburgh	
			LSE	
			Manchester	
			Bristol	
			Warwick	1
			Leeds	1
			Southampton	
			Sheffield	1
			Birmingham	
			Durham	2
			Nottingham	2
			York	2
			St Andrews	2
			Exeter	
			Queen Mary	
			King's College London	
	Env Science etc.	**Citations**	Oxford	
			Leicester	
			Bristol	
			Imperial College London	2
			King's College London	
			UCL	
			Queen Mary	
			Edinburgh	
			Cambridge	
			Lancaster	
			Glasgow	
			Newcastle	
			Birmingham	
			LSE	
			UEA	
			Exeter	
			West of England	
			Southampton	
			SRUC (Scotland's rural college)	1
			Swansea	

		Research	Oxford	
			Cambridge	
			Imperial College	
			UCL	
			Edinburgh	
			LSE	
			King's College London	
			Manchester	
			Bristol	
			Glasgow	
			Leeds	
			Southampton	
			Sheffield	
			Birmingham	
			Durham	
			Nottingham	
			York	
			St Andrews	
			Exeter	
			Queen Mary	

Table A. 9 *Australia university search results*

Country	**Subject**	**Citations or Research**	**Top 10 Universities**	**Tally**
Canada	**Geography**	**Citations**	McMaster U	4
			U Toronto	4
			U British Columbia	4
			U Ottawa	4
			McGill U	4
			Simon Fraser U	2
			U Calgary	4
			U Montreal	4
			U Victoria	2
			U Manitoba	2
		Research	U Toronto	
			U British Columbia	
			McGill U	
			U Montreal	
			U Alberta	2
			McMaster U	
			U Waterloo	2
			U Ottawa	
			Western U	2

			U Calgary	
	Env Science etc.	**Citations**	McMaster U	
			U Toronto	
			U British Columbia	
			U Ottawa	
			McGill U	
			Simon Fraser U	
			U Calgary	
			U of Montreal	
			U of Victoria	
			U of Manitoba	
		Research	U Toronto	
			U British Columbia	
			McGill U	
			U of Montreal	
			U of Alberta	
			McMaster U	
			U of Waterloo	
			U of Ottawa	
			Western U	
			U Calgary	

Table A. 10 *East Asia university search results*

Country	Subject	Citations or Research	Top 20 Universities	Tally
East Asia	**Geography**	**Citations**	Chinese University Hong Kong	4
			Changsha University Science and Tech	2
			U Hong Kong	4
			Wuhan U	2
			Tsinghua U	4
			ZheJiang Normal U	2
			WenZhou U	1
			Shenzhen U	2
			Peking U	4
			University of Science & tech of China	4
			Xiamen U	1
			Guangzhou U	1
			Sun-Yat Sen U	1
			Fudan U	3
			Nanjing U	3
			Seoul National	3
			Kyung Hee U	1

			Zhejiang U	3
			East China Normal U	1
			Korea U	2
		Research	TsingHua U	
			Peking U	
			U of Tokyo	2
			Kyoto U	2
			Seoul National U	
			Fudan U	
			Zhejiang U	
			U of Hong Kong	
			U Science & tech of China	
			Tohoku U	2
			Chinese U of Hong Kong	
			Osaka U	2
			Nanjing U	
			National Taiwan U (NTU)	2
			Nagoya U	1
			Tongji U	1
			Korea U	
			Beijing Normal U	1
			Xi'an Jiaotong U	1
			Kyushu U	1
	Env Science etc.	**Citations**	Chinese University of Hong Kong	
			Southern University of science and tech (China)	1
			Changsha U of science & tech	
			Sejong U	1
			U of Hong Kong	
			Wuhan U	
			Huazhing U of science & tech	1
			Tsinghua U	
			HK U of Science & tech	2
			Hunan U	1
			Zhejiang Normal U	
			Hong Kong Polytechnic U	2
			Shenzhen U	
			Ulsan National Institute of tech	1
			Peking U	
			City U of HK	1
			Nankai U	1
			Macau U of Science & Tech	1
			U of Science & tech of China	
			U of Macau	1

	Env Science etc.	**Research**	Tsinghua U	
			Peking U	
			U of Tokyo	2
			Shanghai Jiao Tong U	1
			Kyoto U	
			Seoul National U	
			Fudan U	
			Zhejiang U	
			U of Hong Kong	
			Yonsei U (Seoul Campus)	1
			Korea Advanced Institute of Science & tech	1
			U of Science & Tech of China	
			HK U of science & tech	
			Tohoku U	
			Chinese U of Hong Kong	
			Osaka U	
			Nanjing U	
			Tokyo Institute of tech	
			HK Polytechnic U	
			National Taiwan U	

Appendix 5. Survey Participation: University Researcher Participant Outreach Record

In this Appendix, in Table A.11, the finalised universities from the universities search are listed, and the number of academic researchers that were deemed as appropriate survey participants from those universities are recorded. Table A.11 lists each searched university and the number of researchers found deemed appropriate for participation in the survey.

Table A. 11 *Academic researcher participant search record*

Country	University	Participants Found
UK	Oxford	3
	Cambridge	1
	University College London	
	Exeter	4
	Bristol	1
	King's College London	2
	Queen Mary University London	
	Edinburgh	5
	Glasgow	
	Birmingham	3
	LSE	2
	Southampton	
	Manchester	1
	Leicester	
	Lancaster	4
	Newcastle	3
	York	4
	Nottingham	2
	Durham	1
	Imperial College London	
USA	Harvard	
	University of Washington	8
	University of Chicago	
	Northwestern University	2
	University California, Berkley	2
	University Pennsylvania	
	University California, Santa Barbara	1

	University California, Los Angeles	
	Yale	
	Columbia	
	John Hopkins	
	Princeton	1
	MIT	
	Cornell	1
	California Institute of Technology	
	Stanford	1
	University California, San Diego	
	Georgia Institute of Technology	
	U Arizona	6
	U Minnesota	2
Canada	McMaster University	2
	University of Ottawa	2
	University of British Columbia	2
	University of Calgary	1
	University of Montreal	
	University of Toronto	4
	McGill University	2
	University of Alberta	4
	University of Waterloo	5
	Western University	
Australia	University of Adelaide	2
	Monash university	3
	University of Sydney	2
	University of Western Australia	2
	University of Queensland	3
	University of Melbourne	2
	UNSW Sydney	4
	Australian National University	3
	Macquarie University	
	University of Technology Sydney	
Ireland	Trinity College Dublin	1
	University of Galway	
	University College Dublin	
	Maynooth University	
	University College Cork	

New Zealand	University of Auckland	4
	University of Waikato	1
	University of Otago	3
	Victoria University of Wellington	3
	Auckland University of Technology	1
Europe	Heidelberg University	
	University of Amsterdam	3
	Utrecht University	9
	University of Groningen	
	LMU Munich	
	KU Leuven	
	University of Helsinki	1
	University of Zurich	1
	University of Bonn	
	Delft University of Technology	
	Paris Sciences et Lettres - PSL Research University Paris	
	RWTH Aachen University	
	Humboldt University, Berlin	1
	Free University of Berlin	
	Ghent University	3
	Aarhus university	
	Universite Paris Cite	
	University of Bern	11
	Karolinska Institute	
	ETH Zurich	1
East Asia	Chinese University of Hong Kong	3
	University of Hong Kong	3
	Tsinghua University	6
	Peking University	
	The University of Science and Technology of China	
	Fudan University	1
	Nanjing University	1
	Seoul University	
	Zhejiang University	1
	University of Tokyo	
	Changsha University of Science & Technology	
	Wuhan University	
	Shenzhen University	

	Korea University	
	Kyoto University	
	Tohoku University	
	Osaka University	
	National Taiwan University (NYU)	
	Hong Kong University of Science and Technology	
	Hong Kong Polytechnic University	
Rest of World	King Abdulaziz University (Saudi Arabia)	
	University of Cape Town (South Africa)	2
	United Arab Emirates University (UAE)	
	University of Sao Paulo (Brazil)	
	Tel Aviv University (Israel)	1
	University of Witwatersrand (South Africa)	
	Hebrew University of Jerusalem (Israel)	1
	Qatar University (Qatar)	
	Stellenbosch University (South Africa)	1
	King Saud University (Saudi Arabia)	
	Damietta University (Egypt)	
	University of Cape of Coast (Ghana)	
	University of Hail (Saudi Arabia)	
	Aswan University (Egypt)	
	University of Lagos (Nigeria)	
	Jazan University (Saudi Arabia)	
	Imam Mohammad Ibn Saud Islamic University (Saudi Arabia)	
	University of Campinas (Brazil)	
	University of Kwazulu-Natal (South Africa)	
	University of Malaya (Malaysia)	

Appendix 6. Survey Participation: NGO Search Record

Here is displayed the record of the found NGOs that were considered for outreach and contact, in support of the NGO search process described in Section 9.3.4.3. This is the record of all those NGOs found via the search that were then further researched to assess their viability as an organisation that would contain individuals likely to meet the criteria required to answer the survey. The table states the name of the NGO, the manner in which it was found (i.e., which database – the different databases are described in Section 9.3.4.3), with the organisations that were eventually contacted highlighted in grey (these organisations are listed in Table 9.4).

Table A. 12 *List of set aside NGOs that were further investigated as to their suitability for participant outreach (selected organisation for outreach highlighted in grey)*

Name	**Found in this Database**
Friends of the Earth Scotland	Scottish Charity Register (Reg)
World Land Trust	UK Charity Reg - England/Wales + Wikipedia List
Marine Conservation Society	UK Charity Reg - England/Wales + Wikipedia List
JNCC	Wikipedia List
Institution of Environmental Sciences	Wikipedia List
Institute of Environmental Management and Assessment	Wikipedia List
Friends of the Earth (EWNI)	UK Charity Reg - England/Wales + Wikipedia List
Environmental Law Foundation	UK Charity Reg - England/Wales + Wikipedia List
Centre for Agriculture and Bioscience International	UK Charity Reg - England/Wales + Wikipedia List
Blue Marine Foundation	UK Charity Reg - England/Wales + Wikipedia List
The Association for Environment Conscious Building	Wikipedia List
Zoological Society London	UK Charity Reg - England/Wales + Wikipedia List
WWF	Scottish Charity Reg
World Resources Institute	Wikipedia List
Wetlands International	Wikipedia List
Royal Society for the Protection of Birds (RSPB)	Scottish Charity Reg
The Rainforest Alliance	UK Charity Reg - England/Wales + Wikipedia List
Rainforest Foundation UK	Wikipedia List
(IUCN) International Union for Conservation of Nature	UK Charity Reg - England/Wales + Wikipedia List
Marine Stewardship Council	UK Charity Reg - England/Wales + Wikipedia List
International Rivers	Wikipedia List

International Institute for Environment and Development (IIED)	UK Charity Reg - England/Wales + Wikipedia List
Greenpeace	UK Charity Reg - England/Wales
Fauna and Flora International	UK Charity Reg - England/Wales + Wikipedia List
Conservation International	UK Charity Reg - England/Wales + Wikipedia List + MarineBio List
Biodiversity International	Wikipedia List
Conserve Global	UK Charity Reg - England/Wales
Rewilding Britain	UK Charity Reg - England/Wales
Plantlife International	UK Charity Reg - England/Wales
Wildfowl and Wetlands Trust	UK Charity Reg - England/Wales
Sustain: The Alliance for Better Food & Farming	UK Charity Reg - England/Wales
The Green Alliance Trust	UK Charity Reg - England/Wales
Soil Association Ltd.	Scottish Charity Reg
Game and Wildlife Conservation Trust	Scottish Charity Reg
The Woodland Trust	Scottish Charity Reg
Wildfish Conservation	Scottish Charity Reg
The Land Trust	Scottish Charity Reg
Blue Ventures	Wikipedia List
Ocean Conservancy	Wikipedia list - US specific
Ocean's Alliance	Wikipedia list - US specific
Resources For the Future (RFF)	Wikipedia list - US specific
Marine Conservation Institute	UN Oceans List
Coral Reef Alliance	UN Oceans List
Nature Conservancy	Marine Bio List
Oceana	Marine Bio List

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