Sustainable organizations: The use of the ecosystem services concept in corporate sustainability

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Confirmation of authorship and publications

The candidate confirms that the work submitted is their own, except where work which has formed part of jointly authored publications has been included. The contribution of the candidate and the other authors to this work has been explicitly indicated below. The candidate confirms that appropriate credit has been given within the thesis where reference has been made to the work of others. This copy has been supplied on the understanding that it is copyright material and that no quotation from the thesis may be published without proper acknowledgement. The right of Angela Naomi Small to be identified as Author of this work has been asserted by Angela Naomi Small in accordance with the Copyright, Designs and Patents Act 1988.

I am the lead author for all three of the publications and a published precis in the Academy of Management Proceedings included within this thesis. The manuscripts that have been published or prepared for publications include:

- Introduction: Small, A. Russell, S. V. & Paavola, J. (2019). Corporate Environmental Sustainability and Ecosystem Services: A 21st Century Solution?. Precis In Academy of Management Proceedings (Vol. 2019, No. 1, p. 12858). Briarcliff Manor, NY 10510: Academy of Management.
- Chapter 2: Small, A.N. Paavola, J. and Owen. A (2022) Multi-level natural capital implementation within planetary boundaries. Business, Strategy and the Environment Journal [Accepted subject to revisions].
- Chapter 3: Small, A.N. Owen. A. and Paavola, J. (2021) A systems perspective of ecosystem services implementation for business. Business, Strategy and the Environment Journal [https://doi.org/10.1002/bse.2887].
- Chapter 4: Small, A.N. Owen. A. and Paavola, J. (TBD) A meta-analysis of cases implementing ecosystem services approaches in corporate sustainability practice. [In draft]

The manuscripts originate from my PhD research and I am responsible for the development of the research questions, methods, data collection and analysis throughout. My supervisors reviewed the manuscripts, recommending changes and edits before each submission and for any subsequent re-submissions as part of the peer review process.

Rationale for alternative format thesis

This thesis explores the use of ecosystem service approaches in corporate environmental sustainability from a management perspective. It is an interdisciplinary research project that draws on theories and frameworks from across the management, environmental and social science disciplines. The research objectives apply different theories or frameworks from across these disciplines which require rationalizing and grounding in the relevant literature. This is best achieved through three distinct academic papers rather than a monograph.

Acknowledgments page

As I write this I know that I will never do this acknowledgments page justice as there are so many people who have provided help and support throughout this research, to everyone who has helped me grow and complete this research over these last few years, thank you.

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Abstract

Human survival is dependent on a healthy ecosystem, the benefits and services it provides and the natural stocks from which they flow, yet unprecedented rates of decline in biodiversity continue, due to anthropogenic impacts. Ecosystem service approaches offer a different framing of the relationship between organizations and the ecosystem with growing use in corporate environmental sustainability, however there is limited critique of their implementation. I analyze how the concept of ecosystem service (ES) approaches are used in corporate environmental sustainability practice.

My doctoral research is divided into three parts. First is a literature review and conceptual paper on the implementation of ES approaches from a multi-level systems perspective, positioning the research in the multi-level systems literature for corporate environmental sustainability. Second is an in-depth study exploring personal narratives of practitioner experiences using ES approaches in a business setting, where practitioners are corporate sustainability professionals. Third, I critically analyze the corporate reports of 125 cases from 81 organizations who use and publicly report on their ES approaches to understand, through empirical evidence, how organizations are implementing these theoretical approaches.

I find that use of ES approaches in corporate practice enhances practitioner awareness of the environment as a system. Narratives illustrate that practitioners were more aware of temporal and spatial considerations in decision making. Awareness of where and when services are provided from the ecosystem leads to a need to consider a multi-level systems perspective in implementation, to account for the global and temporal attributes of the ecosystem. In examining how ES approaches are implemented, I find no evidence of awareness of the dependency of the organization on ecosystems, nor on the risks and opportunities to the organization from the ecosystem. Finally, the monitoring stages when using ES approaches are weak or poorly reported. For this reason, I advance the conceptual framework for implementation of ES for corporate environmental sustainability by including and highlighting the importance of evaluating and monitoring ES assessments.

The contributions of this research are threefold. First, I provide greater empirical evidence of ecosystem services in use by organizations. Second, I critique both strengths and weaknesses of organizational use of ecosystem services, and finally, I offer an advance in the conceptual framework of corporate use of ecosystem approaches.

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"Biological diversity" Biodiversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (CBD 1992). "Ecosystem services" Ecosystem services are the ecological characteristics, functions, or processes that directly or indirectly contribute to human wellbeing: that is, the benefits that people derive from functioning ecosystems" (Costanza et al. 2017, p. 3). "Ecosystem services approaches" "Ecosystem service approaches (ES approaches) - refers to both natural capital methods (the environmental asset stock) and ecosystem service methods (the flows of impacts and benefits received) (See Costanza et al. 2020 p. 4). "Natural capital" "Natural capital is the stock of properly functioning natural assets (such as forests, wetlands, rivers, coasts) that yield a flow of valuable goods and services into the future' (van den Belt & Blake, 2015, p. 668) "Social-ecological systems" Social ecological systems (SES) - interdependent and linked systems of people and nature that are nested across scales (Colding and Barthel 2019, p1).

Chapter 1 - Introduction

1.1 Overview

Humanity is currently exceeding sustainable planetary boundaries with unparalleled trends in climate change and biodiversity loss (Steffen et al., 2015). Humanity is dependent on a healthy ecosystem and the services it provides (Bateman & Mace, 2020; Cardinale et al., 2012; IPBES, 2019; Mace et al., 2014), yet unprecedented rates of biodiversity decline continue, due to anthropogenic impacts. Organizations, specifically businesses (Dyllick & Hockerts, 2002) play a key role in both using and protecting Earth's life-support systems. Organizations are intermediaries that convert natural resources into usable products which become the productive resources of the economy (Bansal, 2002; Shrivastava, 1995; Sukhdev, 2012). Many organizations are aware of the need to become more sustainable in this planetary context, with practitioners seeking theories and methods that can be used in practice (Hoffman & Jennings, 2021) to develop a sustainable relationship between businesses and biodiversity. The literature concerned with corporate environmental sustainability seeks to understand the relationship between corporate organizations and the ecosystem, which has shifted from a fringe topic to a field in its own right (Barkemeyer, Givry, & Figge, 2018; Hahn, Figge, Aragón-Correa, & Sharma, 2017). However, more needs to be done to reverse ecosystem decline; there is a disconnect between corporate environmental sustainability action and ecological health termed the corporate-ecological disconnect (Ahlström, Williams, & Vildåsen, 2020; Dyllick & Muff, 2016; Landrum, 2018; Maitland & Baets, 2021). The aim of this research is to understand the use of ecosystem service approaches in corporate environmental sustainability and how the implementation of these approaches can advance our understanding of the organization-environment relationship as a sustainable social-ecological system.

Biodiversity loss is one of the greatest challenges of our time (IPBES, 2019). The climate and ecological crisis (loss of biodiversity) are gaining global awareness, with growing societal pressure to act to reduce these planetary pressures (Steffen et al., 2015). Biodiversity is defined as the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part. It includes diversity within species, between species and of ecosystems (CBD, 1992) and it forms the basis for a healthy ecosystem. Ecosystem services (ES) are defined as "the ecological characteristics, functions, or processes that directly or indirectly contribute to human wellbeing: that is, the benefits that people derive from functioning ecosystems" (Costanza et al., 2017, p. 3) and place the ecosystem at the center of decision making (CBD, 2021). Ecosystem services assess the impacts and dependencies between supporting, regulating, provisioning and cultural services

which remain under-studied in management literature (Hahn et al., 2017). Natural capital is connected to ecosystem services as the environmental 'stock' that yields a flow of ecosystem services. I define natural capital as 'the stock of properly functioning natural assets (such as forests, wetlands, rivers, coasts) that yield a flow of valuable goods and services into the future' (van den Belt & Blake, 2015, p. 668). Scholars such as Guerry et al. (2015) and Costanza et al. (2020; 1997) emphasize the intertwined nature of these two concepts, as different stages along an ecosystem cascade (Potschin-Young et al., 2018). This research addresses the concepts together, looking at implementation of both ecosystem services and natural capital approaches, this is referred to throughout my research as implementation of ecosystem service (ES) approaches.

1.2 Research context

In this research I examine the interdisciplinary concept of ES approaches in the business context. ES approaches offers a widely accepted frame of nature as a system (Costanza & Kubiszewski, 2012). The strength of ES approaches are that the environment is no longer considered in terms of discrete environmental functions, but rather as an interrelated system of services and flows from stocks of nature for example carbon sequestration, on which human wellbeing depends. Both organizations (Emery, 1981) and the natural world (Griggs et al., 2014) can be considered open living systems (Kay, Regier, Boyle, & Francis, 1999). Therefore I adopt a systems approach for the purposes of my research, which is identified as a promising area of research when studying global environmental challenges for management theories (Wasieleski, Waddock, Fort, & Guimarães-Costa, 2020). In this section I provide a critical analysis of the literature which leads to the research gap this thesis addresses.

1.2.1 Planetary boundaries and biodiversity

The planetary boundary framework (Rockström, Richardson, Steffen, & Mace, 2018; Rockström et al., 2009; Steffen et al., 2015) articulates quantifiable and measurable targets to monitor the health of Earth's life-support systems. Rockström et al. (2009) identify nine planetary boundaries, with climate and biodiversity as core support systems that the other planetary boundaries relate to. While climate change has received some attention in management literature, the biodiversity boundary remains less studied (Hahn et al., 2017) a gap this research seeks to address. Although the planetary boundaries framework is not without its critics (Brook, Ellis, Perring, Mackay, & Blomqvist, 2013; Montoya, Donohue, & Pimm, 2018; Nordhaus, Shellenberger, & Blomqvist, 2012), it still provides the most widely accepted approach to understanding the condition of the Earth's life-support systems (Dempsey, 2015). Whiteman et al. (2013) highlight the importance of embedding the planetary boundary approach in management theory, with a particular focus on understanding the relationship between

business and biodiversity. Mace et al. (2014) focus their work on the planetary boundaries framework and biodiversity, and more recently on developing an equitable framework for ecosystem service and natural capital application (Bateman & Mace, 2020). Winn and Pogutz (2013) have envisioned a new horizon for biodiversity, ecosystem services and management literature by conceptualizing organizational ecosystem embeddedness, but further work is needed to bring management and planetary boundary scholarship together, particularly as regards implementation. Furthermore this dearth of management literature on biodiversity is amplified by the lack of interdisciplinary and transdisciplinary research in management scholarship (DeFries & Nagendra, 2017; Guimarães-Costa, Fort, Waddock, & Wasieleski, 2021), which is an important gap to address.

1.2.2 Corporate sustainability

In this research I study the relationship between human organizations and Earth's life-support systems, which I refer to as the organization-environment nexus. There are a number of definitions for the study of the relationship between the organization and the ecosystem in corporate environmental sustainability (CES) literature and for my purposes I define it as 'organizations that manage their relationship with the natural environment so as not to destroy the very life-supporting foundations provided by nature'(Winn & Pogutz, 2013, p. 1). While recognizing the broader discourse on the definitions of corporate sustainability, my focus is the natural environment. I suggest that there is a current gap in understanding of the natural environment (the biophysical and geophysical world) in the CES literature as it does not reflect the latest developments in natural sciences and the work on ES approaches. I focus specifically on the advances in knowledge offered by ES approaches which analyze in detail the benefits and services that the biosphere provides. Furthermore, where pioneering management literature does include ES approaches in corporate environmental sustainability, there is a gap in the literature exploring how ES approaches should be implemented at different levels in corporate environmental sustainability. I demonstrate how ES approaches are useful when applied at different levels, strengthening the connection between CES practice and the effect on global environmental sustainability.

1.2.3 Corporate environmental sustainability

Corporate environmental sustainability has existed for well over 50 years (Carroll, 1991) and is no longer a fringe topic (Whiteman et al., 2013). Yet, the practice of corporate environmental sustainability has yet to achieve the goal of reducing the effects of business activities on the rate of global environmental and social decline (Guimarães-Costa et al., 2021). Recognizing the relationship between human organizations and nature is complex and involves multiple governing, temporal and geographic scale, and CES research has a long way to go to

bridge this corporate-ecological disconnect (Ahlström et al., 2020). One example is the continued emphasis on organizations seeking 'win-win' strategies of saving planet and profit (Hahn, Figge, Pinkse, & Preuss, 2010), which is having a limited effect at the planetary scale (Whiteman et al., 2013; Young & Tilley, 2006). For this reason research should embrace the paradoxes of the global complex systems involved in sustainable business research (Hahn, Figge, Pinkse, & Preuss, 2018; Hahn, Pinkse, Preuss, & Figge, 2015).

Ecosystem services make visible the flow of benefits that people derive from nature as a complex system (Costanza et al., 2017). ES approaches analyze impacts (both positive and negative) on and dependencies between supporting, regulating, provisioning and cultural services (MA, 2005). ES approaches are one way to frame and understand the environment as a 'live' socio-ecological system. Natural capital is the 'stock' of environmental assets from which these ecosystem services flow thus it is 'the stock of properly functioning natural assets (such as forests, wetlands, rivers, coasts) that yield a flow of valuable goods and services into the future' (van den Belt & Blake, 2015, p. 668). Throughout my research, I will use the term ecosystem service (ES) approaches to refer to both natural capital (the environmental asset stock) and ecosystem service (the flows of impacts and benefits received). As illustrated in Figure 1 the two are intertwined and as Costanza et al. (2014) notes previous literature has erroneously assumed that natural capital directly contributes to human wellbeing, whereas it is the flows of ecosystem services when interacting with society that contribute to human well-being. This is a gap this research seeks to address by studying the whole process of natural capital and ecosystem services approaches in corporate environmental sustainability.

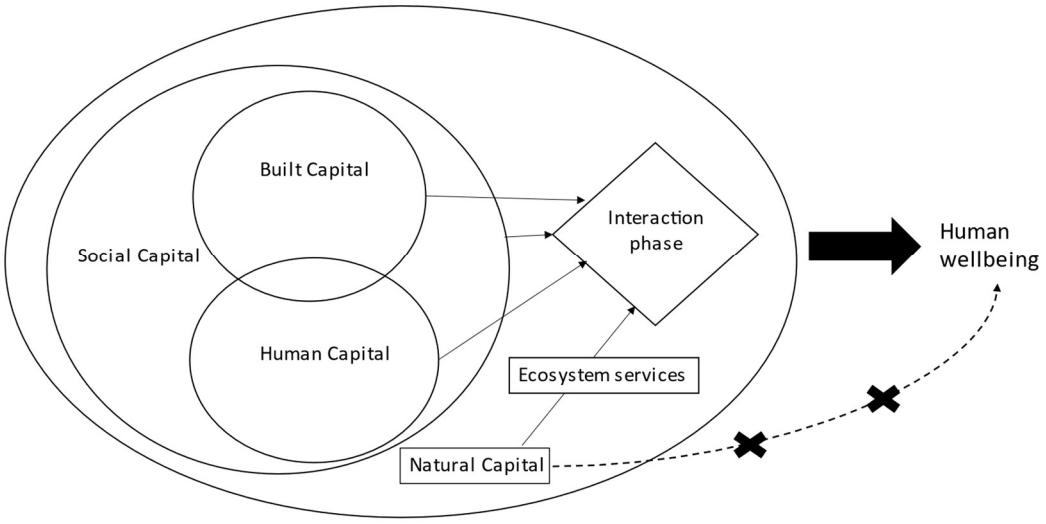

Figure 1 -Extract from Costanza et al, 2020 illustrating the connections between natural capital and ecosystems services.

[This figure illustrates the intertwined relationship between natural capital and ecosystem services and their contribution to human well-being. The crosses on the diagram illustrate the error in conceptualizing natural capital as directly contributing to wellbeing]

Defining the focus of study for this interdisciplinary research is an important and challenging task. The study of the environment is complex and multidisciplinary (Ojea, Martin-Ortega, & Chiabai, 2012) and defining the ecosystem and taxonomy of ecosystem services has been the subject of debate over the last 20 years (Almenar et al., 2021; Neßhöver, Prip, & Wittmer, 2015). Ecosystem services falls under the umbrella term Nature-based solutions (NBS) (Almenar et al., 2021). NBS is a broad concept (Potschin & Haines-Young, 2016) with the International Union for Conservation and Nature (IUCN) defining NBS as "actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits" (International Union for Conservation and Nature, 2021). One of the strengths of NBS is the focus on nature as a holistic concept however as scholars such as Nesshöver et al., (2017) note, there is a need for clarity of theories used under this umbrella. Under this umbrella concept my interest lies in implementing ES approaches to improve understanding of the health of the ecosystem, so that organizations can use that understanding to improve the relationship between businesses and the ecosystem, and thus reduce biodiversity loss.

Since the 1990s there has been extensive literature studying the ecosystem from the natural science disciplines, specifically the topics of ecosystem services. For the purposes of this research, I am particularly interested in concepts and approaches that analyze the stocks and flows of service and benefits from the ecosystem, thus approaches that analyze either the natural capital or ecosystems services for a given site, organization or supply chain. Ecosystem services are a direct link between natural capital, society and the economy (Banerjee et al., 2020). They are fundamentally connected and are two stages in one framework as illustrated in Figure 2 an extract from Bateman and Mace (2020).

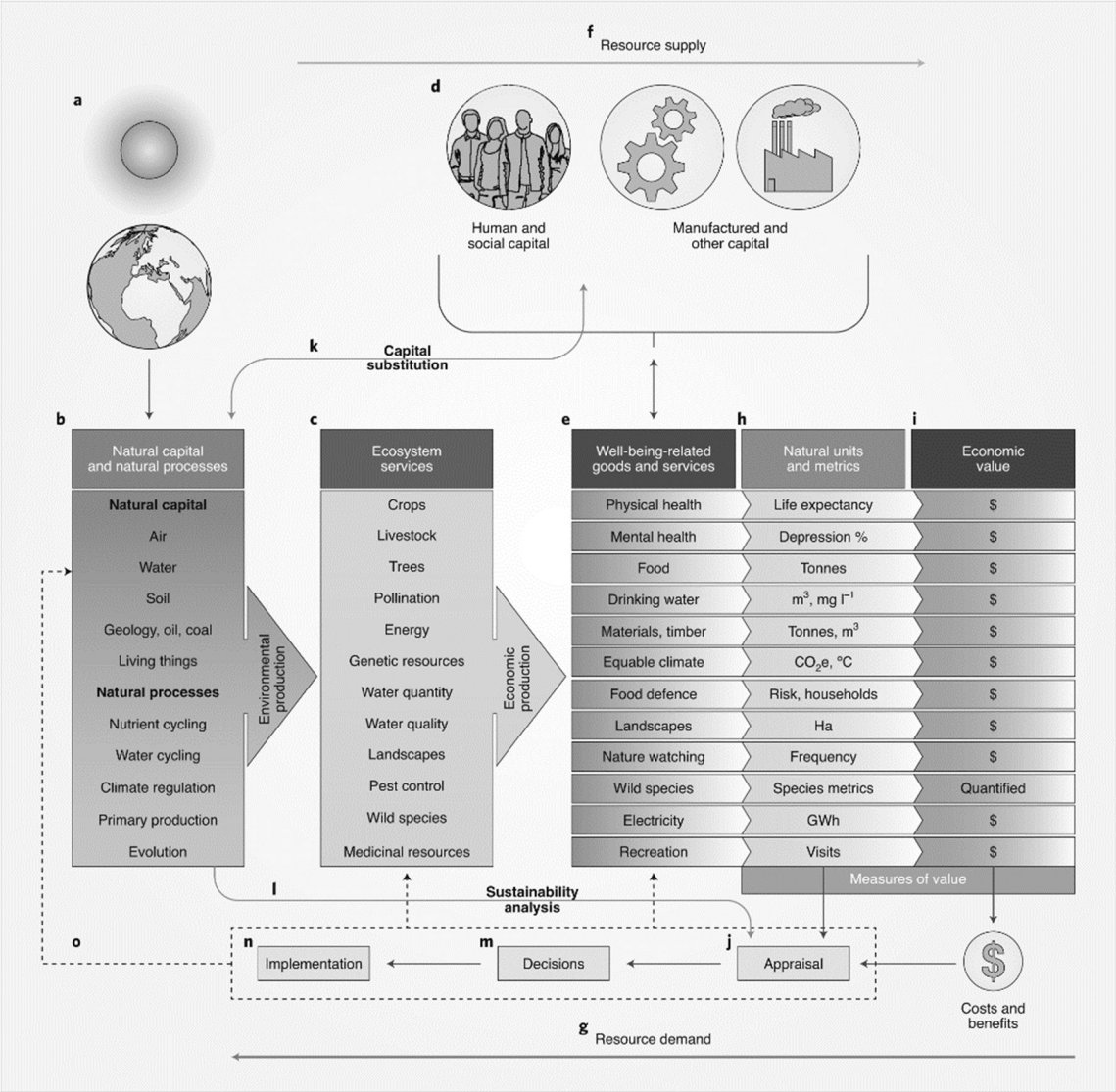

Figure 2 - Extract from Bateman and Mace 2020 published in Nature illustrating the fundamental connections between natural capital and ecosystem services approaches.

Ecosystem services flow from natural capital and cannot exist without it and natural capital is a stock that requires flows (ecosystem services) to release the benefits and services to society. This cascade of benefits is represented by Potschins-Young et al.'s (2018) cascade but has been illustrated since the Millennium Assessment (MA, 2005). My interest lies in looking at the whole construction of ecosystem service and natural capital approaches. Analyzing natural capital stock requires different techniques to analyzing the flows of benefits (ecosystem services), but they are in themselves one theory. For this reason, I choose to research them together as one topic for analysis.

Anthropogenic framing of the environment offers the potential to assign financial value to the environment, which is one part of natural capital and ecosystem service concepts. The

environmental value agenda is extensively debated in relation to natural capital approaches alongside normative concepts of value (Bateman & Mace, 2020; Costanza et al., 2017; Gómez-Baggethun, De Groot, Lomas, & Montes, 2010; Hernández-Blanco & Costanza, 2018). Whilst it is important to acknowledge that financial value may be assigned as part of both natural capital and ecosystem service analysis, it is not necessary. Metrics to account for natural capital are needed (van den Belt & Blake, 2015) but they do not need be financial (Costanza et al., 2017). Thus, a capitalist approach demanding maximum utility is not required as part of ecosystem service approaches: their purpose is to understand the value of the natural environment for the health and wellbeing of humanity, through accounting the stocks and flows using appropriate metrics. For the purposes of my research I do not assume that financial valuation is an essential part of ecosystem services approaches, but I acknowledge that it offers an important boundary concept for transdisciplinary collaboration (Steger et al., 2018). Further information on natural capital accounting and financialization can be found in the corporate accounting literature (Bartelmus, 2009; Bebbington & Unerman, 2020; Cuckston, 2019; Rhodes et al., 2018; Stefan Schaltegger, Etxeberria, & Ortas, 2017; Simnett & Huggins, 2015; Unerman, Bebbington, & O'Dwyer, 2018)

1.2.4 Systems theory for organizations

Systems thinking supports understanding of the complexities of economic, social and ecological systems (Holling, 2001) by portraying the world not as discretely compartmentalized units but rather as a network of overlapping and interrelated elements (Maon, Lindgreen, & Swaen, 2008): 'seeing interrelationships rather than things, […] seeing patterns of change rather than static snapshots' (Senge, 1990, p. 68). As I explore below, there is a large body of literature on systems thinking (Emery, 1981; Merali & Allen, 2011; Von Bertalanffy, 1972; Weinberg, 1975) which can be applied in many disciplines (Mingers & White, 2010), including to the role of corporations within social and ecological systems (Williams, Kennedy, Philipp, & Whiteman, 2017), I argue that both organizations and nature are discrete open systems combining into a new system of organizational use of ecosystem services.

Emery's (1981) work synthesises, scholarship from the 1930s to the 1970s to suggest that human organizations are living 'open systems' which are open to matter-energy exchanges with an environment. Angyal (1969) highlights the Gestalten properties of systems which suggest that a system is more than the sum of its parts. Emery and Angyal note that a system has dimensional domains such as time and space which is important for the purposes of my doctoral research, as Chapter 3 illustrates. Other early contributions include work on the open systems model (Katz & Kahn, 1978; Parsons, 2007), social technical systems (Trist & Emery, 1973) and adaptive systems (Katz and Kahn, 1978).

Management scholars noted in the 1990s the need for corporate environmental sustainability research to adopt a systems lens and to integrate insights from the natural world (Starik & Rands, 1995). Starik and Rands (1995) developed a multi-level multi-systems theory which incorporated 10 common characteristics of open systems (Katz & Kahn, 1978), only seven of which, the authors argued can be controlled. This theory introduced the consideration of ecological systems to corporate environmental sustainability literature and has been further developed by Aguilera et al. (2007), Wood (2010), Hahn et al. (2015), Starik and Kanashiro (2013, 2020) Grewatsch, Kennedy, & Bansal, (2021) and Small, Owen & Paavola (2021).

Williams et al. (2017) conducted a systematic literature review on systems thinking and organizational sustainability. They suggest that systems thinking offers a holistic lens for examining the role of corporations within ecological and social systems. Thus when considering the implementation of ecosystems services by organizations it is important to recognize the interconnections among the various parts of both ecological and social systems and to synthesize these into a cohesive view of the whole system (Anderson & Johnson, 1997). It is also important to recognize the bidirectional nature of the relationships between organizations and ecosystems. The interdependence between organizations and the natural environment is central to sustainability management, as organizations depend on the natural environment for inputs and organizational actions directly impact the natural environment including through feedback loops (Ahlström et al., 2020; Starik & Kanashiro, 2013; Starik & Rands, 1995; Williams et al., 2017; Winn & Pogutz, 2013). One way to apply systems thinking in organizations is through applying socio-ecological systems theory, as I elaborate on below.

1.2.5 Social Ecological Systems (SES)

Social Ecological Systems (SES) literature is well established (Colding & Barthel, 2019) in the natural sciences and growing in the management sciences (Williams et al., 2017). I define SES as interdependent and linked systems of people and nature that are nested across scales, emphasising that humans are part of, not apart from, nature (Bouamrane et al., 2016; Folke, 2006; Ostrom, 2009). Three SES frameworks dominate the literature (Colding & Barthel, 2019); the original framework (Folke, Berkes, & Colding, 1998) the robustness framework (Anderies, Janssen, & Ostrom, 2004), and the multitier framework (Ostrom, 2009). The multi-tier framework outlined by Ostrom (2009) is the broadest and most widely used theory offering a general framework for analysing the sustainability of socio-ecological systems (Baudoin & Arenas, 2020). With an emphasis on complexity and interdisciplinarity, Ostrom's framework helps to identify relevant variables for a single SES as well as providing a common set of variables for organizing research on similar SESs. Given the multitude of SES theories, Binder

et al. (2013) developed a methodology for comparing SES frameworks, which I use to frame part of the empirical analysis in Chapter 3.

SESs are complex adaptive systems (Hertz, Garcia, & Schlüter, 2020) which may be used to understand the relationship between the organization and the ecosystem. One important distinction is that SESs prioritize ecological perspectives and downplay social perspectives. This distinction was noted by Berkes in 2017;

> "social-ecological emphasizes that the two subsystems are equally important, whereas socio- is a modifier, implying a less than equal status of the social subsystem" (Berkes, 2017, p. 3).

Following this literature review, throughout this research I use SESs to reflect the stronger natural science or ecological focus in ecosystem service approaches. Berkes (2017) also emphasizes the importance of multilevel frameworks for organization-environment systems and the importance of the governance of SES to better manage the inherent uncertainty throughout these systems.

1.2.6 ES approaches as SES

Costanza (2017) suggests that the terminology of 'receiving services from nature' first appeared in literature in 1977. During the 1970s, ecosystem ecology and environmental and resource economics communities worked in parallel with limited contact and cross-fertilization (Costanza et al., 2017). The 1980s witnessed the emergence of 'ecological economics' (Costanza, 1989; Jansson, 1994), which sought to bridge the gap between the two research communities and the notion of ecosystem services was a key part of the solution they proposed (Costanza & Daly, 1992). Ecology and society were brought together and conceived as a SES. ES approaches are interdisciplinary; as Quintas-Soriano et al. (2018) note, ES approaches gained considerable traction as a way to communicate societal dependence on ecological life-support systems integrating perspectives from both the natural and social sciences. Costanza et al. (2014) have also critiqued some of the natural science literature for the view that ecosystem services directly contribute to human wellbeing. They highlight that ecosystems services importantly interact with other forms of capital e.g. human or manufactured before contributing to human wellbeing. This interaction often happens in organizations for profit or not-for-profit and governments, which is not well researched, a gap my research seeks to address.

1.2.7 ES approaches in management literature

In the management literature ES approaches remain under-studied. There are a number of studies theorizing use of ES approaches within corporate sustainability, but few that study in depth the implementation of ES approaches in practice. For example, Winn and Pogutz (2013)

discussed the contribution of ES approaches to corporate environmental literature and suggested a theory of corporate ecosystem embeddedness to highlight the impact businesses have on ecosystem services. They (Winn & Pogutz, 2013) highlighted the lack of empirical research on ES approaches and called for improving the knowledge base on the contribution of ES approaches to corporate environmental management. Later they employed a SES approach to examine one case study: the Italian multinational food company Barilla's use of sustainable agriculture (Pogutz & Winn, 2016). Vihervaara and Kamppinen (2010) explored the use of ES approaches in forestry organizations in Finland, finding that the adoption of ES approaches is increasing but that further stakeholder engagement is needed to mainstream them. D'Amato et al. (2018) considered ES approaches in the forestry sector of China, analysing the impact-dependency-response between organizations and ecosystems services. This provided an insight into use by a number of organizations in a specific region, finding promising uptake. Thompson (2019) examined Payment for Ecosystem Services (PES) and corporate environmental management in Thailand, suggesting that the PES may be used as a tool for philanthropy, stakeholder engagement and gaining a licence to operate. These papers illustrate that there are a number of scholars seeking to study ES approaches in a corporate sustainability context, however more needs to be done to analyse the implementation of ES approaches from theory to practice. This is a gap this research seeks to address.

1.3 Research rationale

The aim of this research is to contribute to the literature on corporate environmental sustainability and organizational use of ecosystem approaches by critically examining how ES approaches are being used in corporate environmental sustainability practice. The rationale for this is fourfold: to continue to bridge the disciplinary divides between the natural science and management literature; to study the concept of ES approaches in its entirety rather than specific methods of natural capital or ecosystem service assessment; to improve implementation of ES approaches in both theory and practice and finally view ES approaches through this systems theory lens in order to advance work on multi-level approaches to corporate environmental sustainability. Each of these rationales is explained in greater detail below.

I want to contribute to bridging the divide between the natural and management science literature on ES approaches in a business setting. Working across disciplinary boundaries is the only way that we can address the global challenges of our time, such as biodiversity loss or climate change. I seek to bring the latest research on ES approaches as a theory of nature-based solutions alongside the corporate environmental sustainability literature to advance the implementation of ES approaches use in both theory and practice. As noted above management scholars such as Hahn (2017), Pogutz and Winn (2016), and Tashman (2020) call for further

research in this area. Through interdisciplinary study of ES approaches in corporate environmental sustainability it will be possible to understand whether it is a theory which is able to contribute to reversing the ever-decreasing health of the biosphere.

Second, I want to research both natural capital and ecosystem service together as one concept. In the early stages of my research, I spent a lot of time reading and differentiating between ecosystem services or natural capital methods. To inform my thinking, my first data gathering exercise, after an extensive literature review, involved asking practitioners how they defined both terms and which term they used or associated with more. Following reading of the literature and analysis of my first empirical paper I concluded that both ecosystem service and natural capital concepts methods and tools were used in tandem and should not be treated as mutually exclusive. Natural capital stocks were being valued based on the potential flows they would provide (ecosystem benefits and services) and the ecosystem service methodologies were dependent on the release of natural stocks (natural capital). It is important in assessment and reporting to be clear which you are analyzing or reporting (i.e. stocks or flows), to use the correct methodology for each (Nesshöver et al., 2017) and to clearly delineate the boundary in order to eliminate double counting. However, fundamentally natural capital and ecosystem services are codependent. For this reason, I wish to study the concepts holistically for their contribution to corporate environmental sustainability theory and practice. Given that my research is at the organization-environment interface I chose to term this concept ES approaches as Organizations are connected to the environment by the flows of services, benefits and disbenefits that occur at the organization-environment nexus.

Third, I worked implementing ES approaches in an organizational context before coming to my PhD research and I want to bring these two worlds together to provide empirical evidence of ES approaches in practice. One of the rationales behind this research is to critically analyze the use of ES approaches to consider if, and how, they advance corporate sustainability practice. Having conducted a literature review I was surprised how little management literature there was on ES use in corporate sustainability practice as noted by Winn and Pogutz (2013):

> "While management scholarship and theory development might struggle to find ways to bridge relevant knowledge domains from natural and social sciences in order to account for, explain, and contribute to stemming or reversing current global trends of ecosystem degradation, business is charging ahead "(Winn & Pogutz, 2013, p.1).

Fourth, a further research rationale is to advance literature on biodiversity and systems theory for organizations. I am particularly interested in systems thinking for organizations, and the SES literature aligns with ES approaches as a SES theory. I wish to advance corporate

environmental sustainability management scholarship on biodiversity by bringing systems theory for corporate sustainability together with SESs to understand the implications of multiple levels in SESs for corporate environmental sustainability.

1.4 Aims and objectives

The aim of this research is to contribute to literature on corporate environmental sustainability and organizational use of ecosystem approaches by critically examining how ES approaches are being used in corporate environmental sustainability practice. This is achieved through the following three research objectives:

1. Consider how to implement ES approaches at multiple levels within planetary boundaries.
2. To analyze whether using ES approaches advances system thinking within corporate sustainability.
3. To identify what are the strengths and weaknesses in implementation of ES approaches.

1.5 Research strategy

1.5.1 Research philosophy

My research philosophy is an important predeterminate to the research strategy, design and all subsequent research activities. My research philosophy includes assumptions that relate to ontology, epistemology, axiology and methodology (Creswell & Poth, 2016). Reflecting on each, my ontology (assumption about the nature of reality) is that the world around us is subjective and variable (not objectively knowable and universally consistent). My epistemology is that the observer sees the world as determined by their own previous experiences rather than neutral and my axiology is that our research should have an aim beyond expanding knowledge for knowledge's sake, i.e. research should improve the world in some way. These perspectives illustrate that I am a constructivist. Specifically, I am a pragmatic constructivist: my research philosophy is constructivist but I am led by the research phenomena seeking to solve practical problems. Pragmatism accepts that there are singular and multiple realities that are open to empirical inquiry. The philosophy is led by the research phenomena, seeking to solve practical problems in the ''real world'' (Tashakkori & Creswell, 2007, p. 2); see also (Dewey, 2008; Rorty, 1999). Thus I believe the research aims and objectives are paramount and prompt all other aspects of the research. From this research perspective, I am drawn towards qualitative methods as a constructivist but focus on the practical implications of the research and on conducting research that best addresses the research problem (Creswell & Poth, 2016), which connects to my pragmatist beliefs.

From this position, my research takes a philosophically pluralistic standpoint, meaning I accept many diverse research philosophies rather than seeking an overarching criterion to decide between them as truth (Baghramian & Ingram, 2014). As a researcher I make no claim on the supremacy of one philosophy over another. I strongly believe humanity becomes richer and deeper through the multiplicity of research philosophies (Knudsen, 2003) and the previous dominance of positivism above all else has narrowed academic knowledge (Isaeva, Bachmann, Bristow, & Saunders, 2015). To explore my research phenomenon of the lived experiences of using ES approaches in corporate environmental sustainability practice in the UK and Europe I have chosen a qualitative research design in order to gather narratives and depth of understanding. I define qualitative research as:

> "… a situated activity that locates the observer in the world.
> It consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including fieldnotes, interviews, conversations, photographs, recordings, and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them." (Denzin & Lincoln, 2005, p. 3)

1.5.2 Research plan

From this research paradigm I have developed a qualitative research design which is focused on gathering real-world representations of implementing ES approaches in a corporate UK and Europe context. As my research aims to explore the implementation of ES approaches in an organizational setting, my qualitative research design has evolved over time and my research objectives have been refined as my knowledge of the real-world context has deepened. I have summarized my research design in Table 1 below, which illustrates how each research objective has prompted the research activity, method and analysis. Further information on the methodological approach and subsequent methods is provided in greater detail below.

Research Objective	Aim	Activity	Method	Analysis
RO1 - To consider how to implement ecosystem approaches at multiple levels within planetary boundaries	To conceptually map our implementation of ES at multiple levels	Develop a conceptual framework for implementation	Conceptual	Narrative literature review
RO2 - To analyze whether using ecosystem approaches advances system thinking within corporate sustainability	To gain greater depth and insight at the individual and organization level	Gather individual narratives on the use of ES approaches in corporate environmental sustainability	In-depth semi-structured interviews	Thematic analysis
RO3 – To consider what are the strengths and weaknesses in implementation of ES approaches	To gain a greater breadth of the use of ES approaches and identify common strengths and weaknesses	Conduct a desk study of corporate literature on the concept of ES in use.	Analyze publicly available corporate literature	Qualitative meta-analysis

Table 1- Research methodology summary

1.5.2.1 Methodological approach

The process of designing a qualitative study starts not with the methods but with the broad assumptions central to qualitative inquiry and often a theoretical lens that shapes the study (Creswell & Poth, 2016). The central assumptions in this research are that a) corporate environmental sustainability is the pursuit of a more sustainable relationship between the environment and organizations, and b) there is a need for organizations to be more sustainable and that ES approaches are used in corporate environmental sustainability practice to do this. Thus the central premise of this research is to explore the use of ES implementation in corporate environmental sustainability practice in pursuit of organizations operating within safe planetary boundaries (becoming more sustainable). Building on this central premise I view both the organization and environment as multilevel systems which forms the theoretical lens for the research.

Having identified the foci of my research I developed my research aim to critically examine how ES approaches are being used in corporate environmental sustainability practice. Under this research aim, my research objectives evolved over time as my knowledge of both the real-world context and the theoretical context deepened. This evolution led to the following research objectives:

1. To consider how to implement ecosystem service approaches at multiple levels within planetary boundaries.
2. To analyze whether using ecosystem service approaches advances system thinking within corporate sustainability.

3. To consider what are the strengths and weaknesses in implementation of ecosystem service approaches.

1.5.2.2 Research design

Within the context of this research philosophy and research aim my research design takes an inductive or emic approach, whereby I study scenes as they emerge from the field and then seek external theories to understand and relate to those observations.

> " Researchers using an inductive emic approach (a) begin with observing specific interactions; (b) conceptualize general patterns from these observations; (c) make tentative claims (that are then re-examined in the field); and (d) draw conclusions that build theory." (Tracy, 2012, p. 22).

In developing my research design I was mindful that I wished to conduct a PhD by publication, and I therefore sought to design three complementary research activities that may be published in their own right. Thus I began with observing specific interactions within the field and conducted a screening exercise of organizational use of ES approaches through analyzing membership of the then Natural Capital Coalition. This screening exercise helped to inform my research design by identifying a potential pool of participants for both my semi-structured interviews and my meta-analysis of cases. Further information on this screening exercise can be found below.

1.5.2.2.1 Screening exercise

Prior to designing my research strategy, I conducted a screening study using field-based data to gather a deeper picture of the research scene I was to study and to inform my research design. The screening study focused on the work of the then Natural Capital Coalition (NCC) [now the Capitals Coalition] a global membership initiative that brings organizations together to share knowledge of, and approaches to ecosystem services and natural capital. The initiative originates from the 'The Economics of Ecosystems and Biodiversity for Business Coalition' or TEEB for Business Coalition which started in 2012. This screening study analyzed the organizations to consider the sector, the size of the organization, the geographic remit of the organization and the commercial orientation (e.g. for profit, not-for-profit). I analyzed publicly available online information of 254 companies who identified themselves as members of the Natural Capital Coalition. Graph 1 summarizes one of the outputs from this screening study.

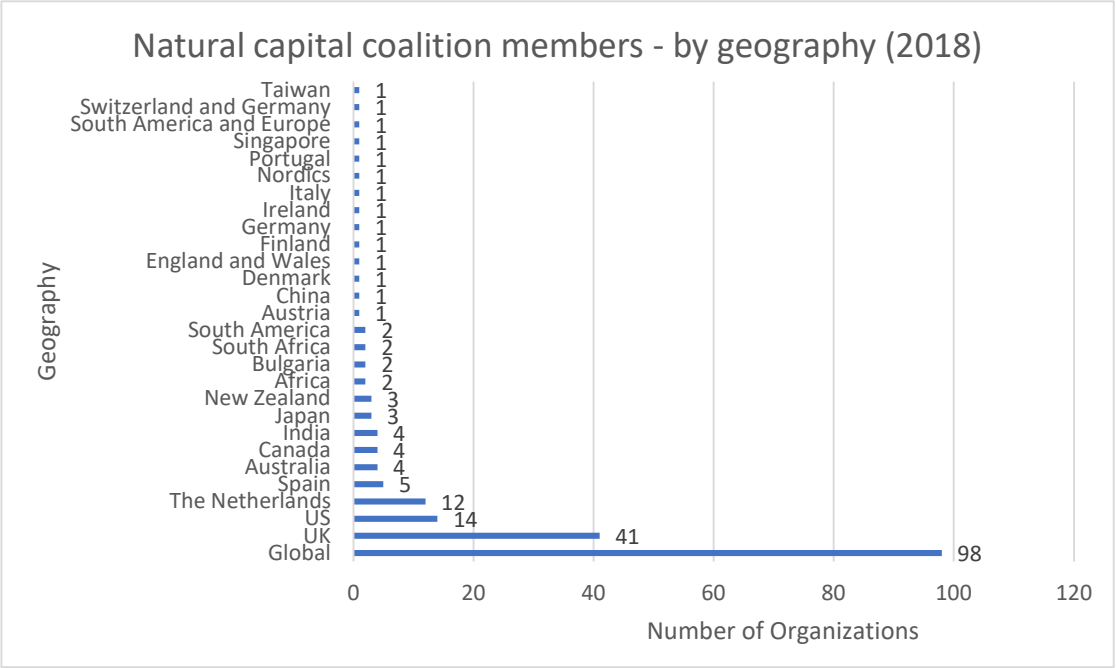

Figure 3 - Natural Capital Coalition by geography

Figure 3 suggests that organizations aligning and using ES concepts are based in a wide variety of countries or regions across the globe (analyzed by descriptions of company operation on the company website). Organizations that identified themselves as global organizations were the largest group at 38.5% (98 out of 254). The four other largest organization locations in decreasing order are the United Kingdom (16%), United States (5.5%), The Netherlands (4.5%), and Spain (1.9%). From the screening study I developed my sampling strategy to conduct my in-depth semi-structured interviews in the UK and European context: this is one of the largest geographic regions to use the concept at the time of analysis and from a practical perspective as I am based in the UK with an existing industry network.

1.5.3 Data collection methods and analysis

Qualitative methods typically rely on four methods for gathering data: 1) participation in setting; 2) direct observation; 3) interviewing; and 4) analyzing documents and material culture (Marshall & Rossman, 2014). My original research design sought to apply three of these methods: direct observation, interviewing and analyzing documents and material culture. Whilst I conducted participant observations in situ in an EU context, this did not complement other research lines of enquiry, so the data was not used as part of this research. Below I describe the two methods used and pursued to completion in the development of this doctorate. Further information on the methods adopted can be found in Section 3.3 of Chapter 3 and Section 4.3 of Chapter 4.

1.5.3.1 Semi-structured interviews

Interviews were adopted to explore in depth the topic of ES approaches in use, with a predominantly face-to-face semi-structured interview technique. This allowed the interviewee to explore the topic more widely and in their own words (Esterberg, 2002), whilst providing some structure to the conversation to cover standard topics. An interview protocol was developed to provide a standard structure for all participants, to ensure that each participant reflected on issues at multiple levels, in terms of themselves as an employee (the individual level) and the organizational use of ES approaches in corporate sustainability [Interview protocol included in Appendix B]. The semi-structured interview protocol was trialed ahead of use on participants and revised based on feedback from trial participants. Revisions following this trial included more prompts specific to each question included on the pro-forma to improve the flow of the interview, and a revision of timings to extend the time participants take on each question. A minimum of 20 participants was sought from a sample that used ES approaches in a business setting. This number was selected to provide an acceptable number of in-depth interviews for a robust qualitative research project with a view to future publication. In practice 30 participants were interviewed as multiple participants volunteered, and the analysis of the 30 participants illustrated that saturation was achieved.

The interviews were recorded verbatim and transcribed in full. Analysis was conducted in NVivo, using thematic coding as the appropriate method for identifying, analyzing, and reporting patterns (themes) within data (Braun & Clarke, 2006). Iterative analysis of the data was undertaken, first immersing myself in the data, then conducting a series of coding cycles, first with a primary coding cycle identifying descriptive codes and then a secondary coding cycle identifying themes and interpretive concepts. Between these coding cycles I revisited relevant literature to inform the secondary coding cycle (Tracy, 2012). A third cycle of coding was then undertaken, to analyze the data through a specific theoretical lens.

1.5.3.2 Qualitative meta-analysis of cases database

To conduct my breadth study of organizational use of ES approaches in corporate environmental sustainability, I gathered a range of publicly available cases of Organizations using ES approaches in their corporate sustainability practice. The sample for these cases was organizations that were members of, or aligned with the values of, the Capitals Coalition. Following the early screening exercise, I was aware of the industry organization the Natural Capital Coalition. Later in my research, I created the opportunity to work with the now Capitals Coalition, to help develop a database of cases using the secondary data of publicly available corporate reports and press releases. This database was used to form the basis for my breadth study.

A qualitative meta-analysis is a research design for synthesizing primary qualitative data from case studies (Habersang, Küberling-Jost, Reihlen, & Seckler, 2019). This method of analysis was chosen as the cases of organizational use of ES approaches were qualitative reports of a large sample size: 172 cases prior to application of the inclusion criteria. Meta-analysis offers a set of robust methodological choices and procedures aiming to enhance the predictive potential and practical usefulness of organizational and management theory (Hoon, 2013);

> "In general, a meta-analysis consists of three steps. The first step is the selection of relevant studies. Criteria for inclusion and exclusion of individual studies have to be defined. The second step is the classification of the information provided by the selected studies. The information is classified in order to translate it into a common language. In the third step, the classified information of all texts is then analyzed" (Hofmann, Hinkel, & Wrobel, 2011, p. 1107).

My qualitative meta-analysis was designed to adopt these three stages. First, I identified inclusion criteria for the relevant studies: Organizations were businesses (for profit) rather than government organizations or NGOs; the cases needed to focus on ES approaches and not just one environmental topic (e.g. climate change); and finally, the cases needed to be reported in enough depth to be used in analysis (i.e. a paragraph in a press release containing little technical detail was not included).

Second, following an initial review of the cases a set of classifications was established for each criterion being analyzed. Excel was used to develop the database, and so classifications were developed in a separate tab and drop-down boxes were developed in the primary database to ensure consistency and a common language in the final stage of analysis. The third stage was analysis of all texts using the classified criteria and thematic analysis.

1.5.3.3 Archetypal analysis

Archetypal analysis is a novel sustainability research method gaining traction particularly in global meta-analysis' of sustainability cases of socio-ecological systems (Eisenack, Oberlack, & Sietz, 2021). Archetypal analysis, in sustainability research, "is a comparative approach that seeks to identify recurrent patterns among cases in which general regularities that apply to all cases cannot be expected" (Eisenack et al., 2019, p. 1). A systematic literature review of archetypal analysis in sustainability research by Oberlack et al (2019) noted archetypal methods are most frequently used for qualitative, empirical, meta-analysis of global cases, frequently of socio-ecological systems. Given the development of the qualitative database of cases of ecosystem service approaches in use in organizations (as a socio-ecological system) across at a global scale, archetypal analysis was selected as an appropriate method to further analyze the data.

1.6 Novelty and contribution of the thesis

The use of ES approaches in an organizational context with a focus on empirical research is a rarely studied concept in management literature. I argue that the application of ES approaches in an organizational context carries important implications for advancing both theoretical and practical understanding of corporate environmental sustainability. In drawing these two broad fields of research together I make four key contributions:

1. Incorporating recent advances in natural science literature and our understanding of the environment with corporate environmental literature, in order to further theoretical understanding of corporate sustainability;
2. Providing greater empirical evidence of ecosystem service approaches by Organizations;
3. Developing a breadth study on organizational use of ecosystem services approaches and critiquing their use; and,
4. Advancing the conceptual framework of multi-level corporate use of ecosystem services approaches.

1.7 Positionality

Positionality refers to the social position of the researcher in relation to the participants, and is influenced by factors such as race, gender, education, class, family status and other social identities (Merriam et al., 2001). Positionality influences how research is conducted, its outcomes, and results (Rowe, 2014). Positionality is normally identified by locating the researcher in relation to three areas: (1) the subject under investigation; (2) the research participants; and (3) the research context and process (Holmes, 2020; Savin-Baden & Major, 2013).

Firstly, locating myself in relation to the subject. I was drawn to pursue funding for this PhD having studied environmental sciences with modules in environmental economics at undergraduate level and studying environmental consultancy at postgraduate level. I then worked in environmental consultancy for 10 years, the last two working with natural capital concepts for an international engineering consultancy. This is where my interest in implementing ES approaches in a business context came to the fore and I really wanted to study the concepts in greater depth. I started this research with an understanding of some of the methods and the orientation that ES approaches might advance practitioner's understanding, having previously experienced it in the field. However, I had also experienced the commodification and oversimplification of the natural system through ES approaches. I have been mindful at points throughout my research process that I may not have been critical enough

given my previous professional experience. I have been aware of a potential bias and regularly reviewed my positionality for influence on my research.

Secondly, locating myself in relation to the participants. I connected with research participants during attendance at industry conferences. Having previous industry experience, I was familiar with the process of professional networking and at the time had multiple roles within the University, including a teaching assistant role and a second research project. This allowed me to connect with potential participants from a range of perspectives and angles. The participants' perspectives on me and my research may have been influenced by my previous roles as well as other roles held within the university; however, it is difficult to understand the constructed identities both of myself as a researcher and their own constructed identity of themselves, as is the nature of this type of research.

Thirdly, locating myself in the research context and process. The research context was both desk-based at the Sustainability Research Institute (SRI) at the University of Leeds and within businesses across the UK and Europe. Having undergone the transition from industry to academia after becoming a chartered professional, returning to a business setting to conduct the interviews required me to take on a new role in a previously familiar context, i.e. as a researcher in a business setting. The first time I entered this situation I was aware of the change and spoke to my supervisors after the interview to check and reflect on gathering further data in the professional context. The research process also required some adjustment and in the early stages of this research I took time to adapt to the academic way of working as I was used to delivering to very tight programs, having a very structured scope of work and having a team of people I worked with on a regular basis.

1.8 Research ethics

Ethical approval was sought and awarded by the University of Leeds Ethics Review committee (AREA 17-175). The main concerns of the Committee were around ensuring anonymity for the participants and clarity for the participants on whether they were presenting their own views or the organizations' views, and ensuring no risk of participant identification. Prior to each semi-structured interview, participants were sent an information sheet and consent form and asked to sign either electronically or a hard copy. Verbal consent was again sought at the start of the interview, alongside consent to record the interview. Information regarding withdrawal from the study was offered as part of this research method, and I circulated my contact details in case there were any follow-up questions. For those who participated in the interview an email providing a summary of anonymized findings, along with a thank you, was circulated to all participants. The risk assessment was granted by the University of Leeds and the data will be stored until two years after publication or three years after data collection.

1.9 Outline and thesis structure

The remainder of the thesis is structured as follows. Chapter 2 is my first paper, titled "Multilevel natural capital implementation within planetary boundaries", which includes my conceptual framework for the implementation of ES approaches in corporate environmental sustainability. Chapter 3 is my second paper, titled "Organizational use of ecosystem service approaches: A critique from a systems theory perspective", which uses data from my semi-structured interviews with ES approaches practitioners. This is followed by Chapter 4, which includes my draft paper titled "Implementation of ES approaches in corporate sustainability: a breadth study". This is then followed by a discussion in Chapter 5 linking these three papers, illustrating the contributions of this doctoral research and drawing conclusions. Supplementary information is then included in the Appendices.

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Chapter 2 : Paper 1 - Multi-level Natural Capital Implementation Within Planetary Boundaries

Abstract

In this conceptual paper we argue there is an urgent need for research on multi-level natural capital approaches, to help humanity live within planetary boundaries. Natural capital approaches offer an advanced understanding of Earth's life support systems and their interaction with human well-being at multiple scales, particularly organizations. But the insights they offer are not yet reflected in corporate environmental sustainability literature, a gap this paper seeks to bridge. To date, research has focused on the rationale for corporate environmental sustainability (CES), with less emphasis on how to achieve it. We suggest a multi-level natural capital implementation framework for corporate environmental sustainability and explain how it advances the 'how' of natural capital implementation in CES by including scoping and monitoring phases and increasing awareness of natural resource dependencies, and how it advances multi-level environmental management theory.

Keywords: corporate environmental sustainability; natural capital; ecosystem services; multi-level organizational theory; planetary boundaries

2.1 Introduction

The greatest challenge in the 21st century is to safeguard Earth's life-support systems on which the welfare of current and future generations depend (Griggs et al., 2013). Organizations play a key role in using and protecting these life-support systems as intermediaries that convert natural resources into usable products (Bansal, 2002; Figge & Hahn, 2020). The development of sustainable organizations is steered, in part, by the concept of corporate environmental sustainability (CES) (Stead, 2015). Whilst CES has existed for decades and efforts have been made to bridge disciplinary silos there 'is still a long way to go' (Guimarães-Costa et al., 2021, p. 8), particularly in understanding the boundary between humanity and nature at multiple levels.

In this paper we focus on the relationship between human organizations and Earth's life support systems, which we refer to as the humanity-nature nexus. Whilst many definitions of CES exist we define it as 'business organizations [that] manage their interaction with the natural environment so as to preserve and maintain the earth's ecosystem' (Winn and Pogutz, 2013 p.3). While recognizing the broader discourse on the definitions of corporate sustainability, our focus is the natural environment. We suggest that the current understanding of nature (the biophysical and geophysical world) in the CES literature does not reflect the latest developments in natural sciences, specifically the advances in natural capital approaches which analyze in detail the benefits and services that the biosphere provides. We demonstrate how they are useful when applied at different levels, strengthening the connection between CES practice and the effect on global environmental sustainability. Further, we highlight a need for transdisciplinary academic discourse on corporate use of natural capital approaches given the continued ecosystem decline (Ripple et al., 2017) and practitioner use such as Tata, Kerring and Unilever (Pritchard and van der Horst, 2018).

A debate over the differences between ecosystem services and natural capital is increasingly agreeing that ecosystem services and natural capital are fundamentally intertwined (Potschin & Haines-Young, 2016). It is widely accepted that natural capital is the stock providing ecosystem functions and services: 'ecosystem services are the benefits people derive from ecosystems; they are provided by natural capital in combination with built, social, and human capital' (Hernández-Blanco & Costanza, 2018). We use the term 'natural capital' to refer to natural capital, ecosystem services and natural resources (understanding that biodiversity underpins all of the above) in line with Dickson et al. (2017) and van den Belt and Blake (2015, p. 668).

In what follows, we first synthesize the conceptual foundations of this paper, introducing the concepts of CES, planetary boundaries, multi-level theory for sustainability

management, the natural resource-based view, socio-ecological systems and natural capital approaches. We bring these concepts together as a multi-level natural capital implementation framework for CES and explain how it offers an improved understanding of the humanity-nature nexus at multiple scales. Finally, we discuss the implications for management scholarship and identify future research needs to advance CES with the preservation of Earth's life support systems within planetary boundaries.

2.2 Conceptual foundations

2.2.1 Corporate environmental sustainability

The relationship between human organizations and nature is complex and involves multiple political, temporal and geographic scales. CES research has not yet fully addressed the challenges this poses. One example is the continued emphasis on a neoclassical paradigm in management literature (Pirson, 2017) with organizations seeking 'win-win' strategies of saving planet and profit (Hahn et al., 2010), which nevertheless has limited effect at the planetary scale (Young & Tilley, 2006). This agenda is extensively debated in relation to natural capital approaches alongside normative concepts of value (Bateman & Mace, 2020; Costanza et al., 2017; Gómez-Baggethun et al., 2010; Hernández-Blanco & Costanza, 2018). Recent literature suggests natural capital approaches offer a boundary concept for transdisciplinary collaboration (Steger et al., 2018). Natural capital stocks are finite (Dyllick & Hockerts, 2002), have limited substitutability and contain 'opportunity costs' involving trade-offs particularly in relation to future generations (Bateman & Mace, 2020). Metrics to account for natural capital are needed (van den Belt & Blake, 2015) but they do not need be financial (Costanza et al., 2017). Thus, a capitalist approach demanding maximum utility is *not* required as part of natural capital approaches: their purpose is to understand the value of the natural environment for the health and wellbeing of humanity, through accounting the stocks and flows using appropriate metrics, not necessarily financial.

2.2.2 Planetary boundaries

Planetary boundary theory (Rockström et al., 2009; Steffen et al., 2015) articulates quantifiable and measurable targets to monitor the health of Earth's life support systems. Rockström et al. (2009) identify nine planetary boundaries, with climate and biodiversity boundaries as core support systems that all other planetary boundaries relate to. While climate change has received attention in management literature, the biodiversity boundary remains less studied (Hahn et al., 2017). Although planetary boundary theory is not without its critics (Brook et al., 2013; Nordhaus et al., 2012) it still provides the most widely accepted approach to understanding the condition of the Earth's life support systems (Dempsey, 2015).

Whiteman et al. (2013) have suggested a multi-level planetary boundary approach for CES at local, regional and planetary scale and Winn and Pogutz (2013) have envisioned a new horizon for biodiversity, ecosystem services and management literature by conceptualizing organizational ecosystem embeddedness, but further work is needed to bring management and planetary boundary scholarship together, particularly implementation. We suggest that the dearth of management literature on biodiversity is exacerbated by the lack of interdisciplinary and transdisciplinary research in management scholarship (DeFries & Nagendra, 2017; Guimarães-Costa et al., 2021) which is an important gap to address.

2.2.3 Multi-level approaches

Multi-level approaches have been developed for over forty years from a range of perspectives (Bronfenbrenner, 1979; Rousseau, 1985). Starik and Rands (1995) proposed a multi-level, multi-systems theory for understanding ecological sustainability in organizations. Recent applications of the multi-level, multi-systems concept at the meso level (organizations) include Aguilera (2007), Williams et al., (2017), Williams et al., (2019), Wood (2010) and Hahn et al., (2015). Starik and Kanashiro (2013) advanced multi-level theory for sustainability management by proposing a multi-level, multi-system perspective of a proto-theory of sustainability management (Starik & Kanashiro, 2013) and multi-level theory for sustainability management more broadly (Starik & Kanashiro, 2020). We focus on the environmental component of this sustainability management proto-theory.

Starik and Kanashiro (2013) highlight the importance of understanding the values of each level. Values are deeply held beliefs, assumptions, and desires that are often the basis for voluntary human action (Joyner & Payne, 2002). Understanding the values of actors (Whiteman & Cooper, 2000) at each level has a bearing on the stages of natural capital assessment as we will explain below. The proto-theory also emphasizes feedback, a core stage in our framework (Figure 4, Stage 6).

A multi-level theory for sustainability management often includes macro, meso and micro levels (Cavagnaro & Curiel, 2017), but other combinations are possible. For example, Aguilera et al., (2007) developed their multi-level theory of social change in organizations at the individual, organizational, national and transnational levels. We recognize that in implementing natural capital approaches these levels vary depending on the context and application. We use “level” to refer to the scale of human social organization: micro, meso and macro; not the “level” of ambition or sophistication related to sustainability (Starik & Kanashiro, 2020). An example of the complexities of implementing multi-level sustainability management systems is offered by Arogyaswamy (2018) who proposed a time based multi-level measurement

framework in the US.

A systematic review of corporate responsibility literature conducted by Aguinis and Glavas (2012) suggested that only nine of the 181 reviewed papers explored organizational sustainability at multiple levels. Dyllick and Muff (2016) called this 'the big disconnect' where the impact of organization level activities is not reflected in planetary level deterioration. Heikkurinen and Mäkinen (2016) also suggested that the integration of different perspectives and levels of analysis has not been satisfactorily explored in corporate sustainability literature (see also Starik & Kanashiro, 2020). Most often multi-level analysis considers the organization (meso) interacting with global institutions (macro) (Frynas & Stephens, 2015). It is widely considered that multi-level analysis of CES offers great potential to move the literature forward (Hahn et al., 2017; Starik & Kanashiro, 2020; Van Marrewijk, 2003).

Starik and Kanashiro (2020) have suggested that multi-level sustainability theories better serve sustainable organizations by offering a holistic perspective on a complex problem, and by building in redundancy. Therefore, a group or location may compensate for another across or within levels in turn creating the potential for positive influences and collaborations across and within levels. They suggest that there are both opportunities and challenges at all levels in implementation; implementation does not necessarily ensure sustainability but offers a series of probabilities that need to be planned, implemented, and evaluated (Starik & Kanashiro, 2020). Because of the importance of planning and evaluation in implementation, we include both of them as stages in our implementation framework (Figure 4).

2.2.4 Resource Based View and Natural Resource Dependency Theory

The resource based view (RBV) of the firm was established in CES literature by Wernerfelt (1984, 1995) and Hart (1995). Barney (2001) outline the evolution of RBV research and note it has grown extensively. Tashman (2020) invigorates this literature by developing a natural resource dependency perspective, conceptualizing inter-organizational networks as socio-ecological systems and considering how elements of socio-ecological systems shape strategies to manage ecological scarcity and uncertainty. Figg and Hahn (2020) similarly develop this literature focusing on natural resource use and returns. The multi-level approach is promising in its focus on managing the natural resource dependency (Stage 3 in Figure 4) and uncertainty at the meso and macro levels.

2.2.5 Social Ecological Systems (SES)

Research on Socio-Ecological Systems (SES) has burgeoned to become a field in its own right (Colding & Barthel, 2019). We define SES as interdependent and linked systems of people and nature that are nested across scales (Bouamrane et al., 2016; Folke, 2006; Ostrom,

2009). Colding & Barthel (2019) suggest three seminal SES frameworks dominate the literature; the original framework (Berkes, and Folke, 1998) the robustness framework (Anderies et al., 2004), and the multi-tier framework (Ostrom 2007). Each are described briefly in turn below.

The original framework takes a systems perspective of both the ecological and social components of the framework building on Holling (1978). The framework focuses on institutions and property rights in the social realm while also emphasizing the importance of indigenous knowledge (compare Whiteman & Cooper (2000)). This original SES framework acknowledged that the social and ecological systems were subject to local (micro), regional (meso) and national (macro) influences (Folke et al., 1998).

The robustness framework sought to consider how robust an SES was by considering the resource, its governance system, and associated infrastructure. Robustness was defined for the purposes of SES as the maintenance of desired system characteristics despite fluctuations in the behavior of its component parts or its environment (Anderies et al., 2004).

The multitier framework outlined by Elinor Ostrom (2007, updated 2014) is the broadest theory offering a general framework for analyzing sustainability of socio-ecological systems (Baudoin & Arenas, 2018). With an emphasis on complexity and interdisciplinarity, this framework helped to identify relevant variables for a single SES as well as providing a common set of variables for organizing research on similar SESs.

Berkes (2017) emphasizes the importance of multi-level frameworks for human-nature systems and governance of SES in relation to inherent uncertainty. Our implementation framework embraces the multi-level, interdisciplinary complex nature of the interdependent and linked systems of people and nature.

2.2.6 Ecosystem services

In the late 20th century a new stream of research framed the biosphere in terms of functions and services that relate to human well-being, termed ecosystem services (MA, 2005; IPBES, 2017). Central to the concept is that human well-being is dependent on benefits provided by ecosystems. There are four groups of ecosystem services:

- Supporting services - services necessary for the production of all other services;
- Provisioning services - products obtained from the ecosystem;
- Regulating services - benefits obtained from regulation of ecosystem processes,
- Cultural services - non-material benefits obtained from the ecosystem.

The ecosystem service concept considers nature as a socio-ecological system, with a stronger focus on ecology. It includes a temporal aspect in its emphasis on the flows of services and their change over time. Ecosystem service literature has burgeoned over the past 30 years,

generating a wealth of evidence on ecosystem dynamics at multiple scales and across multiple socio-ecological systems, one example being firm's use of ecosystem service concepts in Thailand (Thompson, 2019).

The ecosystem service concept offers three key insights for the CES literature. First, the incorporation of spatial and temporal factors offers a finer granularity to understanding nature, ensuring that intergenerational and geospatial inequalities are acknowledged. It also suggests measurable attributes which facilitate monitoring of biodiversity loss and organizational progress in addressing that loss. Second, its anthropocentric framing of the environment (Van Wensem et al., 2017) facilitates a better understanding of the impacts and dependencies of the environment on organizations and humanity more widely. Third, the incorporation of social factors into ecosystem services help conceptualize nature as a socio-ecological system and foster a systematic and interdisciplinary approach to the environment. In what follows, we relate ecosystem services to natural capital literature.

2.2.7 Natural capital

Natural capital is the stock of nature's assets from which ecosystem services flow. Natural capital is the store of environmental benefits (analogous to a company balance sheet), ecosystem services are the flows of environmental benefits (analogous to an organizational input/output model). The key difference between natural capital theory and natural capitalism (Hawken, Lovins, & Lovins, 2013; Lovins, 2006) is that natural capital theory frames the environment as a non-substitutable asset that does not demand maximum utility (a neoliberal perspective) to be protected and enhanced.

There has been wide uptake of natural capital approaches in policy and corporate circles (Guerry et al., 2015). Winn and Pogutz (2013) suggested that organizations are often ahead of the academic management discourse in organizational use of natural capital. Recent management research has focused on planetary boundaries and sustainable entrepreneurship (Schaltegger, Beckmann, & Hockerts, 2018) and corporate reporting (Bjørn, Bey, Georg, Røpke, & Hauschild, 2017; Rhodes et al., 2018). Haffar and Searcy (2018), explore the relationship between the biospheric integrity boundary with company environmental target setting. D'Amato et al (2018) examined natural capital approaches in organizations in Finland and China, including ecosystem service benefits of the forestry. The authors develop a framework assessing and responding to corporate impacts, dependencies, risk and opportunities of ecosystem services. We suggest adding two additional stages to the framework, a scoping stage to understand value, scale and motivations, and a monitoring, evaluation and reporting stage. These additions are informed by Addison et al., (2020) who suggested a framework for

the development and use of biodiversity indicators in business. Neither of these frameworks take a multi-level perspective however: thus we advance both natural capital implementation and multi-level literature.

Whilst the challenge of how to apply natural capital approaches in organizations has received limited attention in the CES literature, industry initiatives such as The Economics for Ecosystems and Biodiversity for business (Sukhdev, Schröter-Schlaack, Nesshöver, Bishop, & Brink, 2010); the Natural Capital Protocol Principles and Framework (2016); and the World Resources Institute Corporate Ecosystem Services Review (2012) have done so. These industry initiatives would benefit from academic rigor and critique. For example, the globally applied Natural Capital Protocol omits a monitoring and feedback stage, fundamental to continuous improvement.

Natural capital approaches can reframe the environment as a non-substitutable or non-tradeable 'asset' which is measurable at multiple levels. This conceptualization can make three contributions to CES literature. First, the reframing of the humanity- nature nexus provides an anthropocentric framework of the environment as a non-substitutable asset which requires preservation or enhancement. Second, it increases the visibility of environmental impacts and dependencies that underpin the organization. Finally, the methodological compatibility with accounting practices allows multi-level comparisons facilitating monitoring of progress. We next discuss how these advancements may be conceptualized to advance multi-level natural capital implementation for CES.

2.3 Multi-level natural capital implementation framework

To link the literature on natural capital approaches with the literature in management science, we must recognize global environmental sustainability as a complex multi-level issue. Having outlined the core concepts of above, we propose a framework (Figure 4) to synthesize them to: 1) advance the 'how' of natural capital implementation in CES; 2) emphasize the scoping and monitoring phases in CES; 3) highlight natural resource dependency, and 4) advance multi-level environmental management theory.

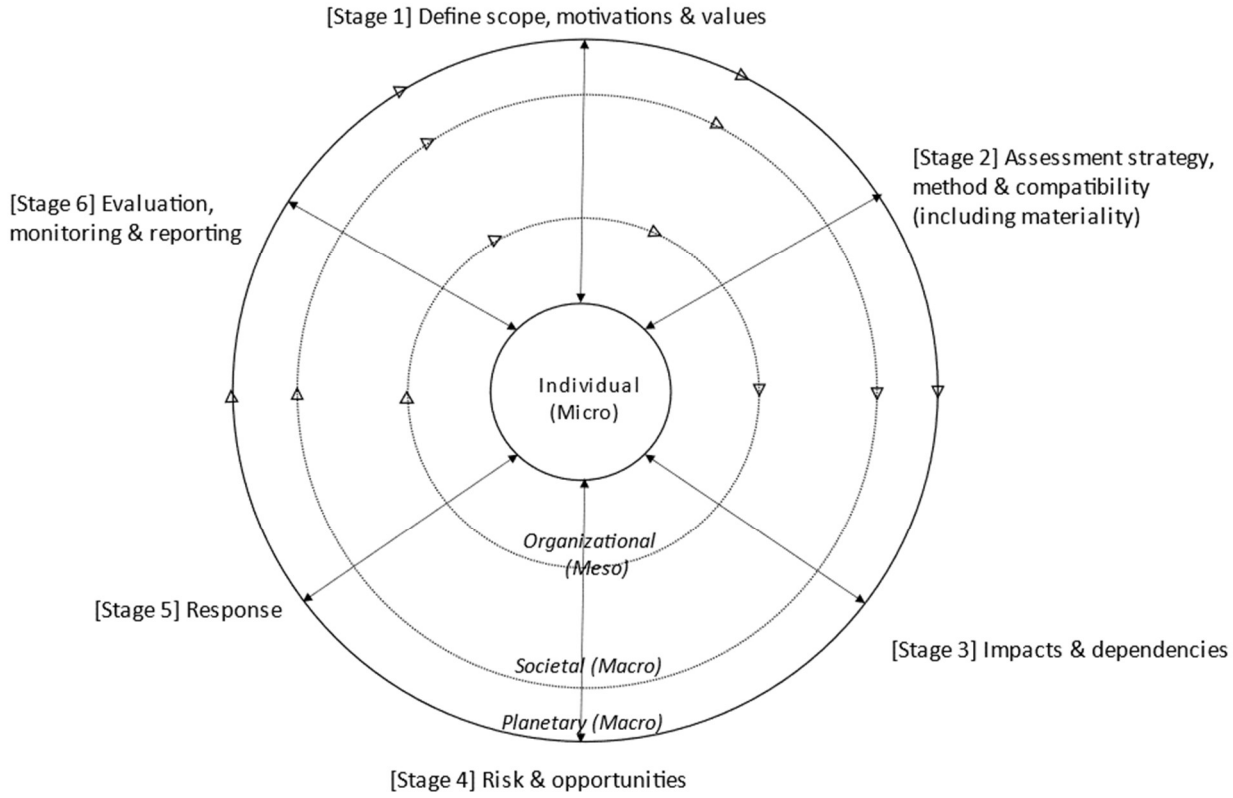

Figure 4 - A multi-level natural capital implementation framework for corporate environmental sustainability

This multi-level natural capital assessment framework helps better understand the humanity-nature nexus at multiple scales. By framing nature for the services it provides, and by understanding the humanity-nature nexus as a socio-ecological system, with temporal (including intergenerational) and spatial dimensions, we can advance both theory and practice. This implementation framework builds on the multi-level framework of Starik and Kanashiro (2013) and ecosystems service implementation framework of D'Amato et al., (2018). Our conceptual framework moves away from the input-through-output model which is embedded in the assessment stages (Stages 2-4) to broaden the focus on impacts, dependencies, risk and opportunities. There is a growing understanding of the finite nature of the planet, that substituting natural capital is not possible and the opportunity costs of damaging natural capital now for future generations. Below we consider each stage and level of our conceptual framework in turn, bringing these concepts together in Table 2, a matrix of multi-level natural capital implementation framework considerations.

2.3.1.1 Stages of implementation

Stage 1 – Define scope, motivations and values

The first stage of implementing a natural capital approach is often omitted in theory and practice (e.g. in (D'Amato et al., 2018)). As noted by Starik and Kanashiro (2020), understanding the values of the human organization and planning the scope of any assessment are crucial. It is important to define why the natural capital approach is adopted (the motivations), how doing so aligns with previous work, and the values at meso, micro and macro levels. Defining scope is important, i.e. what are the boundaries of the work? Does the approach study direct operations or the whole supply chain? Is it a trial exercise on a specific product to be scaled up in the future? These scoping issues are important to understand from a multi-level perspective. Furthermore, this stage 'closes the loop' using feedback and knowledge from previous environmental or natural capital work undertaken in Stage 6 to continuously build and inform action.

Stage 2 - Assessment strategy and method

The second stage of implementation focuses on the assessment strategy and method. The strategy is influenced by the level and type of decision that the assessment is looking to influence: is it an individual, project, organizational or societal decision? What level of detail is required to inform the decision? Natural capital assessments can be quantitative, qualitative or a combination and may or may not include monetary values. These factors should be considered individually and then across levels to facilitate knowledge sharing, partnership building and action. The skills, capacity and data at all levels forms the basis of the strategy and informs method selection, so work builds on existing environmental data, knowledge and action. There are many methods and tools to implement natural capital approaches. These allow for context and sector specificity in natural capital assessment when the correct methodology is selected for the correct case. A review of the different tools and methods is required in Stage 2, to record and justify the method adopted.

At Stage 2, a materiality assessment analyzes the full suite of natural capital impacts *and* dependencies for relevance and proportionality to the human organization, whether that is at a micro, meso or macro level. This materiality assessment defines the boundaries across the levels (e.g. micro, meso, macro) and across the supply chain. The materiality assessment scopes out what is not relevant in an assessment. It is important that the materiality assessment is transparent and published alongside the natural capital assessments to understand what has been omitted in one assessment which may need to be incorporated in another natural capital assessment (particularly across levels).

Stage 3 - Impacts and dependencies

The third stage appraises the natural capital impacts and dependencies at relevant level of analysis. Bateman and Mace (2020) suggest a natural capital assessment framework for sustainably efficient and equitable decision making. It is a clear, comprehensive and transparent framework for considering the natural capital impacts and dependencies at any level, embedding the input-process-output chain, with considerations of other forms of capital as well as opportunity costs to future generations natural capital. Like Starik and Kanashiro (2013) we believe the linear model of inputs-processes-outputs is an important part of analysis. However, literature has advanced to frame the humanity-nature nexus as including impacts (both positive and negative) and dependencies, embedding the inputs-processes-outputs chain within this assessment (Figure 4, Stage 2 and Stage 3). Furthermore, a time factor is part of Stage 3 as the natural capital assessment considers before and after a potential change. This temporal factor has often been omitted in implementation theories. Bateman and Mace (2020) note that the decision to deplete natural capital is a tradeoff with future generation's use of that natural capital (see also (Hahn et al., 2010; Slawinski & Bansal, 2015). This intergenerational consideration offers an advancement, embedding temporal considerations in CES.

Stage 4 - Risks and opportunities

Next it is necessary to review risks and opportunities, in the form a natural capital risk and opportunities register, to understand at which level the risks and opportunities lie. Applying a multi-level natural capital appraisal framework will allow consideration of whether the risks and opportunities are borne at the same or different levels as the impacts and dependencies. This provides greater clarity at each stage (e.g., Stage 3 and Stage 4) as well as a more holistic appraisal of the natural capital risks and opportunities, strengthening our understanding of the humanity-nature nexus.

Second, it is important to recognize that *opportunities,* not only risks*,* may arise from natural capital impacts and dependencies. There may be positive outcomes by building partnerships to manage common goods within or across levels. There may be a better understanding of the embeddedness of humanity within nature or better appreciation of the opportunity costs for future generations. Opportunities for by-products to be reused in the supply chain may emerge. Opportunities for economies of scale with other sectoral partners may reduce negative impacts. These opportunities are at the heart of the net gain literature, where a comprehensive review of natural capital impacts and dependencies offers opportunities to enhance some natural capital stocks where others have been negatively impacted. Finally, assessment of the natural capital risks and opportunities again involve a time factor. Future generations are considered in the risks and opportunities that may be present for each natural

capital stock at micro, meso and macro levels. This inter-generational sustainability consideration further advances both CES theory and, potentially, practice.

Stage 5 – Response

Following the assessment undertaken in Stages 2-4, it is necessary to reflect on the appropriate response. The response is the decision that an individual, organization or society makes to take action. Any decision response is also informed by the opportunity costs that decisions and actions are subject to, for other levels and parties, but also intergenerationally. For example, an organization could decide to take part in a watershed-level partnership to guarantee freshwater supply for irrigation of their crops or production processes. The clarity in our framework helps to ensure that the response is at an appropriate scale related to the impacts, dependencies risk and opportunities identified in the earlier stages of the natural capital appraisal (see Figure 4). This can facilitate sectoral or regional stakeholder partnerships to address natural capital issues. Responses may also build peer-to-peer initiatives to scale-up responses to natural capital degradation. Finally, it is important to reflect on the planned actions, to analyze any capital substitutions that have been assumed in the response. These capital substitutions may then be either reversed or trigger future actions to mitigate these substitutions, to reach a net zero natural capital impact at the appropriate level.

Stage 6 - Monitoring, evaluating and reporting

Stage 6 is essential to consider whether the response was successful and to feedback into the next iteration of a natural capital approach. Where the response has not achieved its aim, it is necessary to evaluate why this has happened and use that information to inform the next round of natural capital implementation.

A second component of stage 6 is the option to report on the natural capital approach to external parties. Information may be shared across levels, such as organizational accounts being shared with national accounts, or at the individual level e.g. with employees or stakeholders. Natural capital approaches may also form part of an integrated reporting process and be reported publicly on a regular basis.

Having reviewed Stages 1- 6 in Figure 4, we next focus on the multi-level components in our conceptual framework; micro, meso and macro levels. Micro level focuses on the individual, person or group. Meso level typically focuses on organization or nation and macro level the society or planet. We have deliberately chosen, micro, meso and macro to build in flexibility in application across these levels.

Individual (Micro)

At the micro level, individuals play a range of roles in the human organization-nature nexus. They may be consumers, employees, stakeholders, shareholders or citizens to name but a

few. We focus on individuals as members of an organization: as an employee, manager, shareholder, volunteer or non-executive board member. Natural capital approaches often originate from an individual such as a sustainability manager, the CEO or a passionate change agent. It may be that an individual initiates a micro, meso or macros level assessment (Figure 4) and influences the success, speed and achieved change. Given the transformation being sought, change agents (Benn, Dunphy, & Griffiths, 2014) can play a crucial role in implementation. They can bring energy, drive and knowledge to an organization in relation to natural capital. Harnessing the power of individuals to embed natural capital approaches across the human organization is crucial to successful implementation at all stage and scales. Furthermore, it is possible to undertake a natural capital assessment at the micro level to understand the impacts dependencies, risks and opportunities of a person and their lifestyle.

Organization (Meso)

The meso level focuses on a group of humanity such as an organization, a region or, potentially, a nation. At the meso level, a company or government may commit to integrated reporting or multi-capital monitoring, where natural capital is monitored and reported alongside other forms of capital. Whilst we have chosen to focus the meso level at the organization, and the macro level at the societal level, our framework is flexible so that the meso level could be the national accounts and the macro level a supra national organization. For this reason, stages one and two of our conceptual framework are vital to delineate the levels, boundaries and interactions in each context. The constant in our conceptual framework is that every application is bounded by and considered within planetary boundaries.

Societal (Macro)

We have divided the macro-level into societal – the human organization at national and international levels and the finite cap of this conceptual multi-level framework – the planet. Societal institutions seek to manage human interactions with public goods and services but to date the macro level has not been managed well, hence the unprecedented rate of biodiversity decline. International initiatives such as the Convention on Biological Diversity (CBD), the UN Sustainable Development Goals (SDGs), the United Nations (UN) Framework Convention on Climate Change (UNFCCC), and the UN Convention to Combat Desertification all aim to tackle the decline in natural capital (Banerjee et al., 2020). Much work is done by governing bodies to develop national and supranational natural capital assessments (a summary of the current progress is provided in Hein et al., (2020)).

Many countries have already undertaken national natural capital assessments which feed into policy, although this is still embryonic and often disjointed. The UN leads the System of National Accounts (SNA) which has recently been superseded by the System of

Environmental Economic Accounting (SEEA), with an aim to produce a UN standard by the end of 2021 (Hein et al., 2020; La Notte, Vallecillo, Marques, & Maes, 2019). These macro level assessments further advance use and understanding of natural capital approaches, however it is important to consider the multiple levels of natural capital assessments in order to start to understand how each level and assessment may inform the planetary scale.

Planetary (Macro – finite)

Planetary boundaries are the maximum level of analysis in our conceptual framework. Through application of natural capital approaches, changes in natural capital can be analyzed and quantified in a way which is compatible with the planetary boundaries framework, i.e. natural capital decisions are made with an awareness of current planetary boundary conditions. Further research is urgently needed to amalgamate insights from the transdisciplinary framework for biodiversity (Mace et al., 2014), similar to that of emerging research focusing on the planetary boundary of freshwater (Gleeson et al., 2020; Zipper et al., 2020).

We bring these stages and levels together in Table 2 below to illustrate how the implementation framework facilitates consideration of cumulative multi-level issues and interactions that occur at each stage and level.

Level / Stage	Micro	Meso	Macro
1. Scope	- Identify individual/leadership values and motivations and how this will shape the subsequent stages. - Plan the scope of Natural Capital (NC) assessment to be undertaken and justify. - Understand connection to other levels of analysis.	- Identify organizational values and motivations and how this will shape the subsequent stages. - Plan the level of NC assessment to be undertaken and justify. - Understand how this will feed into other levels of analysis.	- Understand regulatory and socio-political influences of assessment (if necessary, across geographies). - Plan the level of NC assessment to be undertaken and connect to Planetary Boundaries.
2. Assessment Strategy	- Delineate boundaries across levels, geographies and supply chain. - Analyze individual knowledge and resource capabilities. - Identify, engage and support change agents.	- Delineate boundaries across levels, geographies and supply chain. - Establish and justify natural capital method to be used, ensuring compatibility with micro/macro level assessments. - Develop an assessment strategy to common goods and services and record.	- Delineate boundaries across levels, geographies and supply chain. - Global/national collaborative assessment strategies. Produce guidance on methodologies and compatibility guidelines including information on common goods and services.

		- Analyze individual knowledge and resource capabilities. - Identify engage and support change agents.	
3. Impacts & Dependencies	- Conduct a balanced assessment ensuring a clear understanding of the individual/employee level dependence on NC e.g., food and fresh water.	- Transparent assessment of the positive/negative impacts and dependencies of 'common' goods and services. - Consideration of the feedbacks/interrelationships both within levels and across of each NC asset impacts and dependencies.	- Transparent assessment of the positive/negative impacts and dependencies of 'common' goods and services. - Consideration of the feedbacks/interrelationships both within levels and across of each NC asset impacts and dependencies.
4. Risk & Opportunities	- Consideration and positive framing of opportunities in sustainable accounting in NC. - Multi-level risk analysis identifying where risks lie both within levels and across.	- Consideration and positive framing of opportunities in sustainable accounting in NC. - Multi-level risk analysis identifying where risks lie both within levels.	- Consideration and positive framing of opportunities in sustainable accounting in NC. - Multi-level risk analysis identifying where risks lie both within levels
5. Response	- Reflection on Stages 3&4 leading to a decision on appropriate action within and across scales.	- Reflection on Stages 3&4 leading to a decision on appropriate action within and across scales.	- Reflection on Stages 3&4 leading to a decision on appropriate action within and across scales.
6. Evaluating, Monitoring & Reporting	- Individual evaluation of leaning outcomes and reflection following NC assessment, including changed values and behaviors. - Consideration of how evaluation of success and monitoring is compatible with meso and macro scale monitoring. - Evaluation of outcomes of Stage 1-6 and feedbacks and implication for the next iteration of implementation process.	- Consideration of how evaluation of success and monitoring is compatible with micro and macro scale monitoring. - Evaluation of outcomes of Stage 1-6 and feedbacks and implication for the next iteration of implementation process.	Consideration of how evaluation of success and monitoring is compatible with micro and meso scale monitoring. - Evaluation of outcomes of Stage 1-6 and feedbacks and implication for the next iteration of implementation process.

Table 2 - Multi-level natural capital implementation framework considerations by stage and level

2.4 Discussion

The multi-level natural capital implementation framework outlined above improves understanding of the humanity-nature nexus in four ways. First, it advances 'how' to apply natural capital approaches in corporate environmental scholarship, a gap identified in Whiteman et al., (2013). Second, the framework includes scoping and monitoring stages which responds to a deficiency in previous frameworks (Starik & Kanashiro, 2020). These stages – scoping and monitoring facilitate iterative improvements in implementation – close the process loop. Third, the framework advances our understanding of humanity's natural resource dependencies and associated risks (Figge & Hahn, 2020; Tashman, 2020). Finally, we advance work on multi-level CES as suggested by (Starik & Kanashiro, 2020; Williams et al., 2019) by adding granularity to the links across the humanity-nature nexus within planetary boundaries. We expand on each of these below.

2.4.1 Implementation framework for multi-level natural capital

Our framework offers practical insights into 'how' to implement natural capital in CES, in turn contributing to advancing literature on cumulative environmental impacts and impacts over time. To date, CES literature has not sufficiently discussed how to apply theory (Whiteman et al., 2013), specifically on natural capital approaches (van den Belt & Blake, 2015). Given global institutions such as the UN, World Bank and IPBES are monitoring the Earth's systems using natural capital approaches, it is important that businesses and management scholars also help to improve understanding of implementation. This is what this paper seeks to achieve.

The framework we propose for implementing natural capital approach also responds to the literature calling for greater embedding of temporal factors into decision making in two ways (Slawinski & Bansal, 2015): our framework considers opportunity costs to future generations by assessing the impact of depleting the stock of natural capital available for future use, and; monitoring (Stage 6) includes an appraisal of the outcomes of implementation, reviewing changes of the natural capital stock over time.

In addition, our framework identifies boundaries across levels, reducing the likelihood of double counting, and decreasing the likelihood of omissions from assessments, a risk noted in multi-tier assessments literature (e.g Banerjee et al., 2020). Acknowledging natural capital meso- or micro-level assessments are embedded within the macro-level assessment Figure 4 improves our understanding of the nature of each assessment. Thus, macro (societal) natural capital assessments monitor the state of the environment independently of the meso and micro level. This gives rigor to the implementation of multi-level natural capital assessments,

highlighting where specific natural capital assets are declining, and informs meso and micro level assessments. Thus, cumulative effects of micro and meso level natural capital assessment can be understood, as well as potential SES feedbacks that may not be fully identified at other levels of analysis. Furthermore, where organizations operate at an international or trans-national level, macro level analysis may highlight spatial inequalities in the operation of organizations and supply chains. Macro level natural capital assessments are vital as a 'check' to monitor larger natural capital stocks, and monitoring is essential to reduce their decline. Figure 4 contributes to this literature (e.g. Haffar & Searcy, 2018)) by highlighting how cumulative impacts of multiple natural capital assessment at multiple levels should be considered.

2.4.2 Scoping and monitoring

Our framework advances previous conceptual models by including scoping and monitoring stages. Including a scoping stage in our framework advances work on values, motivations and complexity of natural capital for CES. First, establishing values and motivations at the individual, organization and societal levels provides transparency and frames why the natural capital approach is important to the relevant actor. Values, deeply held beliefs and assumptions are important to understand in designing effective action. Our framework allows for a deeper understanding of values at all levels, particularly the micro level. Placing micro (individual) level values at the center of the human organizing framework emphasizes that individuals drive values at all levels (meso and macro) aligning with arguments from Whiteman & Cooper (2000) .

One of the challenges with natural capital frameworks is the complexity of impacts and dependencies across multiple scales and throughout the supply chain (standardized in Figure 4). Including a scoping stage improves the transparency of assessments and implicit assumptions, and also enables assessments to be undertaken at a scale appropriate to the decision the assessment needs to inform. Previous issues with complexity e.g.(Boiral, Heras-Saizarbitoria, & Brotherton, 2019) originate in part from poor scoping and planning stages and confusing nomenclature. Defining terms and how these relate to the specific assessment context, illustrates a depth of understanding and facilitates partnerships across levels and sectors. This then enables greater comparability between sectors, levels or context, and improves the relevance of an assessment to informing policy and decision-making practices at all levels.

Unprecedented rates of environmental decline are in part due to poor evaluation and monitoring (Dyllick & Muff, 2016). Monitoring the natural capital stock following an action identifies whether the action was a success. This stage is essential to gather data to feed back into the next iteration of a natural capital appraisal. This stage is often poorly conducted or

omitted entirely. One example is that of the widely used industry standard, the Natural Capital Protocol, where implementation at the organizational level is detailed but monitoring, reporting and evaluating is not included (Capitals Coalition, 2016). Stage 6 of our framework (natural capital reporting, monitoring and evaluation) may have been omitted in previous frameworks, being considered 'someone-else's problem' e.g., national or international governance agencies should manage the global commons. However, the multi-level framework makes it clear that each level has a role in monitoring and evaluating natural capital, not least to monitor and evaluate the consequences of actions taken. Introducing Stage 6 advances previous conceptualizations by creating a closed loop process. For example, a fashion business may depend upon rainfall to irrigate crops that form the primary resources of the textile supply chain. Rainfall frequency and intensity is changing due to climate change. Monitoring changes in fresh water availability (from a previous natural capital assessment) can inform whether to broaden the scope of the next iteration of this company's natural capital assessment to understand the catchment-wide natural capital impact, dependencies, risks and opportunities of freshwater.

2.4.3 Highlighting natural resource dependencies

Dependencies of the individual, organization and society on nature have remained less well researched (Figge & Hahn, 2020). It is not well understood how the environment underpins business practice, not only directly, but also indirectly by sustaining the workforce e.g. food or fresh water. These natural capital dependencies have often been omitted entirely and as such are not well understood (La Notte & Rhodes, 2020). Our framework includes the assessment of dependencies as a stage in its own right, at micro, meso and macro levels. This speaks to literature on natural resource dependency perspectives (Tashman, 2020) by providing a framework to analyze humanities dependency on natural resources at multiple levels. This advances knowledge in both theory and practice.

2.4.4 Multi-level implementation within planetary boundaries

Our framework also advances literature by providing a way to implement natural capital approaches within the planetary boundaries. Natural capital impacts and dependencies may occur at multiple levels, which has created complexity and confusion in implementation to date (Banerjee et al., 2020). Figure 4 and Table 2 provide the means to understand these multi-level impacts and dependencies. Furthermore, the natural capital impacts and dependencies may not arise at the same level of appraisal e.g. a meso level appraisal may have macro level – planetary - impacts and dependencies.

By providing a standard structure to analyze multi-level issues, it is possible to build a cumulative picture both of multiple assessments within one level (e.g. all organizational impacts

(meso level)) and across levels (between micro, meso and macro). Planetary boundaries form the limits within which all other natural capital assessments are undertaken. Whilst further research is required to address practical implementation challenges (see Mace et al., 2014) such as governance issues of common goods within natural capital assessments, our framework provides a multi-level framework to advance this discourse. Furthermore, emphasizing that humanity comprises, and is part of, nature speaks to previous literature on organizational ecosystem embeddedness (Winn & Pogutz, 2013) as well as to the dependency of humanity on nature discussed in socio-ecological system literature (Ostrom, 2009; Pogutz & Winn, 2016). Our aim through this conceptualization is to reiterate that the decline of nature is ultimately the decline of humanity.

2.4.5 Challenges

Whilst we suggest that implementation of natural capital approaches in CES scholarship improves our understanding of the human-nature nexus, we also recognize there are practical challenges to implementation. These challenges include the 'greyness' of the boundaries between levels; methodological compatibility; and, a skills gap.

2.4.5.1 'Greyness' over levels - Organizations can be bigger than nations

Implementation of multi-level theory for the humanity–nature nexus within planetary boundaries implies an infinite number of possible connections. For this reason, a theoretical framework requires flexibility to be contextualized for each application. Like Starik and Kanashiro (2020), we have chosen, micro, meso and macro to allow flexibility in application. For example, a supra national organization such as Nestle or Unilever (both of whom use natural capital approaches) can transcend regional, or even national, (meso) level assessments. For this reason, Figure 4 is ultimately bounded at the macro scale by the planetary boundaries as the finite limit for all natural capital approaches. Thus, the supra national organization (meso level) may operate across much larger spatial scales than national natural capital accounts. To facilitate cross-level compatibility, supra national natural capital assessments should consider how they can inform and be informed by national and planetary level accounts in both Stages 1 and 2.

2.4.5.2 Methodological compatibility

As discussed above, many methods and tools exist for implementation of natural capital approaches (Guerry et al., 2015). These allow for context and sector specificity but challenge multi-level approaches, as different methodologies are incompatible across levels such as organization to planetary assessments. This challenge has been recognized at the macro and

meso level with national and international standard development (e.g, BS 8632 and EU INCA project). This should facilitate multi-level method compatibility and advance CES in future as discussed further in the previous section on meso levels.

2.4.5.3 Skills gap

Undertaking a natural capital assessment requires expertise, resource and knowledge management. This is often resolved by engaging knowledge partners e.g. academics or consultants to facilitate implementation. Such partnerships increase the likelihood the assessment will be robust but may leave a gap in embedding the results in the organization. Natural capital assessments, and their future use, may lose momentum once assessments are complete unless organizational change programs are undertaken (Benn et al., 2014).

Partnership with organizations such as the Capitals Coalition, Natural Capital Initiative or We Value Nature campaign can promote organizational awareness and use of natural capital concepts. Membership of, and partnership with, such organizations offers a range of resources, information sharing and networking opportunities to reduce gaps in knowledge. Some cross-sectoral initiatives have emerged from these organizations' memberships and from pioneering organization themselves. For example, the finance industry has become interested in use of natural capital approaches to appraise investment portfolios e.g., ABN AMRO and Bankinter. This has led to the production of sectoral guidance documents for the finance industry increasing natural capital implementation knowledge across the sector.

2.5 Conclusions and further research

Global environmental sustainability is a complex, multi-national, multi-system, and multi-level issue. CES scholarship seeks to address this complexity within the study of organizations, but the endeavor is still disconnected from the effect of humanity on nature. Multi-level natural capital approaches offer an opportunity to address this disconnect. Successful use of natural capital concepts could transform CES practice by advancing discussion of 'how' to implement natural capital approaches in CES, emphasizing scoping and monitoring phases, improving awareness of natural resource dependencies and by advancing multi-level environmental management theory for natural capital. There are limitations to this conceptualization, including the focus on a multi-level implementation framework rather than a multi-systems implementation framework. Williams et al., (2019) have sought to understand organizational resilience (i.e. meso scale) and dependence on socio-ecological systems (i.e. macro scale) providing a useful discussion of feedbacks in nested systems. We acknowledge this nested systems analysis suggests some value in another level of complexity to our multi-level systems analysis.

Similarly, at each stage we note the importance of the compatibility between natural capital methodologies deployed for different purposes. Much work still needs to be conducted to ensure compatibility between assessments at different levels and geographies. Transdisciplinary research connecting planetary boundary data from natural and social sciences, with national capital accounts and supranational corporate accounts is particularly important. Further research is needed to expand and explore this emerging area of CES scholarship. The multi-level implementation framework draws upon sustainability management theory and whilst we have focused on environment, an integrated approach broadening the scope to include social elements (including governance) could be beneficial. Furthermore, research exploring a specific natural capital asset e.g. timber production from source to the return to the biosphere across levels, could offer focused insight into the humanity-nature nexus. Such research could follow the flow of benefits and services through the Earth's systems, studying the human interactions throughout. Insights from this analysis could both inform knowledge of the health of an ecosystem, and identify potential risks in supply chains and would therefore continue to enhance scholarship on the application of 'how' to implement CES.

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Chapter 3 : Paper 2 – Organizational Use of Ecosystem Service Approaches: A Critique from a Systems Theory perspective

ABSTRACT

Although corporate environmental management theory is well established, there is limited research on the use and understanding of the ecosystem service (ES) approaches based on an advanced conceptualization of the environment in organizational practice. This article analyzes the use of ES approaches in organizations using a system theory lens, conducting empirical research on the contribution of ES approaches to corporate environmental management. Drawing from 30 semi-structured interviews with ES practitioners from private, policy and third sector organizations we find that ES approaches provide practitioners with an advanced understanding of the environment as a system, the interconnections between the organization and the environment, and a better awareness of temporal and physical attributes of the environment. Over-emphasis on ecological systems, limited acknowledgement of the nesting of the social system within the ecological system, and limited detailed practitioner knowledge are barriers for advancing the use of the ES approaches in corporate sustainability practice.

Keywords: *Ecosystem Services, Natural Capital, Corporate Environmental Management, Socio-ecological Systems, Systems Theory, Sustainable Development*

3.1 Introduction

Economic growth results in adverse environmental impacts such as the loss of biodiversity (Steffen et al., 2015). The global rate of species extinction is accelerating and the health of ecosystems on which humans and other species depend is deteriorating more rapidly than ever (IPBES, 2019). Organizations play a key role in humanity's relationship with nature as the intermediaries that convert natural resources into usable products, and the productive resources of the economy (Sukhdev, 2012). Growing management literature is exploring sustainability for the Anthropocene (Etzion, 2007; Hoffman & Georg, 2018; Hoffman & Jennings, 2015; Williams et al., 2017). We seek to advance corporate environmental sustainability literature on biodiversity loss by examining the practitioner use of ES approaches through a systems theory lens:

> "sustainability is a systems-based concept and, environmentally at least, only begins to make any sense at the level of ecosystems and is probably difficult to really conceptualize at anything below planetary and species levels" (Gray, 2010, p. 48).

While a range of corporate environmental sustainability approaches exist (Welford, 2016), few corporations positively influence the intertwined system of people and planet: the literature refers to this as the corporate-ecological disconnect (Ahlström et al., 2020; Hahn et al., 2017; Starik & Kanashiro, 2013; Whiteman et al., 2013). Researchers have identified a need for a better understanding of the use of corporate environmental sustainability approaches in practice (Ahlström et al., 2020; Williams et al., 2019). This article examines the use of ecosystem service (ES) approaches in organizations and how they advance systems thinking in corporate environmental sustainability practice. We do this by conducting empirical research on experiences of representatives of organizations using ES approaches.

ES approaches make visible the benefits that people derive from nature (Costanza et al., 2017). They assess impacts on and dependencies between supporting, regulating, provisioning and cultural services which remain under-studied in management literature (Hahn et al., 2017). The concept of natural capital is linked to ecosystem services as the environmental 'stock' that yields a flow of ecosystem services. We define natural capital as 'the stock of properly functioning natural assets (such as forests, wetlands, rivers, coasts) that yield a flow of valuable goods and services into the future' (van den Belt & Blake, 2015, p. 668). Biodiversity (biological diversity) underpins both ecosystem services and natural capital as the variability among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part and it includes diversity within species, between species and of ecosystems (CBD, 1992). In what follows, we will use the term ecosystem service (ES) approaches to refer to both natural capital approaches (the

environmental asset stock) and ecosystem service approaches (the flows of impacts and benefits received).

ES approaches are one of a number of ways to account for biodiversity, a growing stream of research in both accounting and management literature, other methods include: stewardship accounting (Jones & Solomon, 2013; Siddiqui, 2013; Skouloudis, Malesios, & Dimitrakopoulos, 2019), certifiable standards (Boiral, Heras-Saizarbitoria, & Brotherton, 2018; Cuckston, 2018; Schaltegger & Beständig, 2010) corporate reporting (Atkins, Gräbsch, & Jones, 2014; Boiral et al., 2019) and offsetting (Cuckston, 2019; Gamarra, Lassoie, & Milder, 2018; Tregidga, 2013). Roberts et al. (2021) conduct a systemic literature review of biodiversity and extinction accounting from 2013-2020 who find this a growing and essential area of work, with limited empirical research gathering primary data through depth interviews, a gap we seek to address. We contribute to the management literature and the established field of business and the natural environment (Hoffman & Georg, 2018; Hoffman & Jennings, 2021) seeking to better understand the corporate-ecological disconnect (Ahlström et al., 2020) and for this reason focus on ES approaches as a socio-ecological system through a systems theory lens for corporate sustainability.

ES approaches offer a widely accepted framing of nature as a system (Costanza et al., 2017) in which the environment is no longer considered in terms of discrete functions but rather as an interrelated system of services on which human wellbeing depends. Both organizations (Emery, 1981; Pratt, Gordon, & Plamping, 2005) and the natural world (Griggs et al., 2014) can be considered open living systems. Management literature has sought to understand the nexus between the organization (a social system) and the environment (an ecological system) as a system (Starik & Rands, 1995; Williams et al., 2017). Seminal work by Emery (1969) and Katz and Kahn (1978) suggested that organizations are living open systems, often described as organizational ecosystems. Starik and Rands' (1995) multi-level, multi-systems theory incorporated the environment in organizational systems thinking and is an important foundation for our research. More recently, Williams et al. (2017) conducted a systematic literature review on systems thinking and organizational sustainability, suggesting systems thinking provides an antidote to earlier scholarly silos. Framing organizations as open systems embedded in the environment helps reveal systemic limits to growth, including finite planetary resources and the dependency of organizations on the environment (Haffar & Searcy, 2018).

ES approaches conceptualize the environment as a socio-ecological system (SES). They are well established in the natural science literature with a range of methodologies and tools developed over the last two decades (Biggs et al., 2021; Potschin & Haines-Young, 2016; Sukhdev et al., 2010). Ahlstrom et al. (2020) note that SES research on corporate perspectives

in management literature are mainly theoretical and lack empirical insights. This paper seeks to contribute to this literature by providing empirical knowledge on organizational use of ecosystem service approaches through an SES lens.

The contributions of our paper are twofold. First, we provide empirical evidence on the use of ES approaches in organizations and their contribution to corporate environmental sustainability. Second, we outline how this evidence fits within a theoretical framework aiming to advance systems thinking about SES in organizations.

We will first outline the literature on systems thinking for sustainability management, socio-ecological systems, natural capital and ecosystem services approaches and outline our framework. Second, we present the methods and results from our empirical findings and discuss the implications of these findings in the context of the literature. Finally, we summarise our contributions, discuss limitations and future research and conclude.

3.2 Literature review

3.2.1 Systems thinking in organizations

Systems thinking helps understand the complexities of economic, social and ecological systems (Holling, 2001) by portraying the world not as discretely compartmentalized units but rather as a network of overlapping and interrelated elements (Maon et al., 2008): 'seeing interrelationships rather than things, […] seeing patterns of change rather than static snapshots' (Senge, 1990, p. 68). There is a large body of literature on systems thinking (Emery, 1981; Merali & Allen, 2011; Von Bertalanffy, 1972; Weinberg, 1975) which can be applied in many disciplines (Mingers & White, 2010), including to the role of corporations within social and ecological systems (Williams et al., 2017) as both organizations and nature are discrete open systems combining into a new system of organizational use of ecosystem services.

Emery's (1981) work synthesises earlier scholarship from the 1930's to the 1970's to suggest that human organizations are living 'open systems' which are open to matter-energy exchanges with an environment. Angyal (1969) highlights the Gestalten properties of systems which suggest that a system is more than the sum of its parts. Emergy and Angyal note that a system has dimensional domains such as time and space on which we will elaborate later. Other early contributions include work on the open systems model (Katz & Kahn, 1978; Parsons, 2007), social technical systems (Trist & Emery, 1973) and adaptive systems (Katz and Kahn, 1978).

Management scholars noted in the 1990s the need for corporate environmental sustainability research to adopt a systems lens and to integrate insights from the natural world (Starik & Rands, 1995). Starik and Rands (1995) developed a multi-systems and multi-level theory which incorporated 10 common characteristics of open systems (Katz & Kahn, 1978)

only 7 of which the authors argued can be controlled. This theory introduced the consideration of ecological systems to corporate environmental sustainability literature and it has been further developed by Aguilera et al., (2007), Wood (2010), Hahn et al., (2015), Starik and Kanashiro (2013, 2020) .

Williams et al., (2017) conducted a systematic literature review on systems thinking and organizational sustainability. They suggest that systems thinking offers a holistic lens to examine the role of corporations within ecological and social systems. Thus, when considering the use of ecosystems services by organizations it is important to recognize the interconnections among the various parts of both ecological and social systems and to synthesize these into a cohesive view of the whole system (Anderson & Johnson, 1997). It is also important to recognize the bidirectional nature of the relationships between organizations and ecosystems. The interdependence between organizations and the natural environment is central to sustainability management as organizations depend on the natural environment for inputs and organizational actions directly impact the natural environment including through feedback loops (Ahlström et al., 2020; Starik & Kanashiro, 2013; Starik & Rands, 1995; Williams et al., 2017; Winn & Pogutz, 2013). One way to apply systems thinking in organization is through applying socio-ecological systems theory, as we expand on below.

3.2.2 Socio-ecological Systems (SES)

Socio-Ecological Systems (SES) literature is well established (Colding & Barthel, 2019) in environmental sciences and growing in the management sciences (Williams et al., 2017). We define SES as interdependent and linked systems of people and nature that are nested across scales, emphasising that humans are part of, not apart from, nature (Bouamrane et al., 2016; Folke, 2006; Ostrom, 2009). Three SES frameworks dominate the literature (Colding & Barthel, 2019); the original framework (Folke et al., 1998) the robustness framework (Anderies et al., 2004), and the multitier framework (Ostrom, 2009). The multitier framework outlined by Ostrom (2009) is the broadest and most widely used theory offering a general framework for analyzing the sustainability of socio-ecological systems (Baudoin & Arenas, 2020). With an emphasis on complexity and interdisciplinarity, it helps identify relevant variables for a single SES as well as providing a common set of variables for organizing research on similar SESs. Given the multitude of SES theories, Binder et al. (2013) developed a methodology for comparing SES frameworks. which we use to frame part of our empirical analysis.

3.2.3 ES approaches as a socio-ecological system

Costanza (2017) suggests that the terminology of ‘receiving services from nature’ first appeared in literature in 1977. During the 1970s, ecosystem ecology and environmental and

resource economics communities worked in parallel with limited contact and cross-fertilization (Costanza et al., 2017). The 1980's witnessed the emergence of 'ecological economics' (Costanza, 1989; Jansson, 1994) which sought to bridge the gap between the two research communities and the notion of ecosystem services was a key part of the solution (Costanza & Daly, 1992). Ecology and society were brought together through a systems lens and conceived as a socio-ecological system. Ecosystem service approaches are interdisciplinary; as Quintas-Soriano et al. (2018) note, ES approaches gained considerable traction as a way to communicate societal dependence on ecological life-support systems that integrates perspectives from both the natural and social sciences.

Costanza et al. (2014) have also critiqued some of the natural science literature for a view that ecosystem services directly contribute to human wellbeing. They highlight that ecosystems services importantly interact with other forms of capital before contributing to human wellbeing. This interaction often happens in organizations, governmental, for profit or not-for-profit.

3.2.4 SES in management literature

In the management literature ES approaches remain under-studied. Winn and Pogutz (2013) discussed the contribution of ES approaches to corporate environmental literature and suggested a theory of corporate ecosystem embeddedness to highlight the impact businesses have on ecosystem services. They (Winn & Pogutz, 2013) highlighted the lack of empirical research on ES approaches and called for improving the knowledge base on the contribution of ES approaches to corporate environmental management. Later they employed a SES approach to examine the Italian multi-national food company Barilla's use of sustainable agriculture (Pogutz & Winn, 2016). Vihervaara and Kamppinen (2010) explored the use of ES approaches in forestry organizations in Finland, finding that the adoption of ES approaches is increasing but that further stakeholder engagement is needed to mainstream them. D'Amato et al. (2018) considered ES approaches in the forestry sector of China, analysing the impact-dependency-response process between organizations and ecosystems services. Thompson (2019) examined Payment for Ecosystem Services (PES) and corporate environmental management in Thailand, suggesting that the PES may be used as a tool for philanthropy, stakeholder engagement and gaining a licence to operate.

3.2.5 Advancing systems thinking in corporate sustainability through SES

There are multiple SES theories seeking to understand the nested interactions between society and nature which differ in terms of their goals, disciplinary background, applicability,

temporal, social and spatial focus, and conceptualization of social and ecological systems. Binder et al. (2013) suggests a framework for analysing SES theories by considering:

- How are social and the ecological systems and their dynamics conceptualized?
- How are interactions and dynamics between social and ecological systems conceptualized?
- To what extent are social and ecological systems treated with the same analytical depth?

Binder et al. (2013) examines 10 SES theories including the ES approaches and Elinor Ostrom's (2009) multitier framework. We have summarised the analysis in Table 3 which suggests that the ES approaches are conceptually stronger for ecological systems than for social systems. For example, ES approaches currently fail to adopt a multi-level approach to social systems (Citation to be inserted after blind reviews). This limits the understanding of the dynamics and feedbacks between these levels when only one level (society) is considered. ES approaches have a stronger focus on the impacts of the social system on the ecological system and are weaker in acknowledging the reciprocity between the social and ecological systems as well as the feedbacks between these systems. Finally, ES approaches emphasize the ecological system over the social system. Ostrom's SESF framework is more advanced than ES approaches in light of this framework.

	ES approaches	Socio-Ecological Systems Framework (SESF)
Q1 How are the social and the ecological systems and their dynamics conceptualized?	Conceptualization of the social systems and its dynamics	
	The social system is conceptualized as human beings as the users of the ecological system and acting as valuing agents. They translate the basic ecological structures and processes into value-laden entities.	The social system is composed of resource users (actors) and the governance system that influences the actions of the users by defining rules as well as monitoring and sanctions mechanisms.
	a) Conceptualizes the hierarchical levels of the social system (e.g. individual, group, organization, society) only at the society level.	a) Conceptualizes the hierarchical levels of the social system (e.g. individual, group, organization, society) at all levels.
	b) The approach only considers interactions between levels at the macro scale (society level).	b) The approaches consider two-way interactions between all hierarchical levels.
	c) The approach does not consider social dynamics i.e., whether the framework explicitly conceptualize feedbacks within and between the social levels.	c) The approach considers social dynamics textually by including variables such as "information sharing," "deliberation processes," and "self-organization activities" grouped under the label "interaction".
	Conceptualization of the ecological system and its dynamics	
	The ecological system (ecosystem) is conceptualized from an ecocentric perspective focusing on ecosystem	The ecological system is conceptualized from an anthropocentric perspective as

	functions. To ensure the continued availability of ecosystem functions, the use of the associated goods and services should be limited to sustainable use levels.	resource system, e.g., water, forest, with corresponding resource units, e.g., water quantity, trees etc.
	Spatial scale: Can be applied at any scale; but favors regional, national scale	Spatial scale: local, regional and national scales
	No interactions between scales considered.	The ecological system could potentially be studied at any scale. Interactions between scales are named but not further conceptualized.
	Dynamics are not considered in the conceptualization.	The dynamics are considered by a number of variables (natural language descriptions) of the resource system and resource units such as growth rate, equilibrium properties, and productivity.
Q2 How are the interaction and the dynamics between the social and the ecological systems conceptualized?	The social system changes the services that can be provided by the ecological system.	The actors use resources impacting on the ecological system and may cause externalities in related SES. These externalities feedback to the social system in that the productivity of the system changes affecting the harvesting rates.
	a) Interaction type: the social system impacts the ecological system.	a) Interaction type: there is a reciprocity between the social and the ecological systems.
	b) Feedbacks between the systems are not considered.	b) Feedbacks between the resource conditions and the rules determining the harvesting rates of the resource.
Q3 To what extent are the social and the ecological systems treated equally with respect to analytical depth?	Degree of equal representation of social and ecological: Emphasizes the ecological system over the social system.	Degree of equal representation of social and ecological: has the most balanced conceptualization of the social and ecological systems.

Table 3 - Comparison of SES frameworks (content adapted from Binder et al. 2013)

In what follows, we will first present common themes from practitioner experiences to shine a light on the use of ES approaches in corporate environmental sustainability practice and the perceived changes the ES approaches have led to in practice. We then delve deeper into these empirical findings using the analytical framework of Table 3 through the lens of SES theory, analysing how our findings support or contradict SES theoretical approaches for

corporate environmental sustainability and how this relates to advances in systems thinking for corporate environmental sustainability.

3.3 Methods

3.3.1 Research design

We sought to analyze the ES approaches in organizational settings and to explore employee narratives on how its use advances environmental management practice. A qualitative approach was adopted to understand individual experiences from the use of ES approaches in organizations (Tracy, 2012). We sampled participants from different types of organizations and provide further information on the method, sample and data analysis below.

3.3.1.1 Key informant interviews

Two key informant interviews were held to aid the development of the interview protocol for the semi-structured interviews. Key informants should be experienced, savvy in the scene and articulate stories and explanations that others would not (Tracey 2012). Our selection criteria for key informants included: seniority in the field (director or above); years of relevant experience (15 years or above) and prominence in the field (had contributed to expert industry guidance or conference). Informants were engaged through professional networks and selected from different types of organizations, one from for-profit and one from a third sector organization.

3.3.1.2 Participants

Referral sampling was used to recruit participants. Participants were initially recruited through industry networks and based on the lead author's attendance at industry conferences on ES approaches between May 2018 and February 2019. Following the initial contacts participants were asked to suggest further practitioners who might be interested in taking part. An overview of the participants is provided in Table 4. Twenty-six interviews were conducted face-to-face, two via video conferencing and two via telephone. Participants had an average of 16 years industry experience and over half of the respondents were director level or above. Participants were recruited from over 20 organisations which included for example Lafarge Holcium, PWC, Yorkshire Water, UK Forestry Commission, WBCSD and AECOM. Interviews took place between October 2018 and February 2019 at participants' place of employment. Participants either directly worked on ES approaches, advised other on how to use ES approaches or managed teams who worked with ES approaches.

Organization type		Discipline		Seniority		Education Level	
Private (for profit)	8	Economist	8	Director	16	Doctorate	7
Consultancy (for profit)	8	Environment	19	Senior	11	Postgraduate	16
Public	7	Engineering	2	Junior	3	Undergraduate	7
Third sector	7	Law	1				

Table 4 - Participant information (units = counts)

3.3.1.3 Procedure

Participation was voluntary and normal ethical procedures were followed. The interviews lasted on average 56 minutes, with the shortest being 32 minutes and the longest 73 minutes. The participants were first asked to introduce themselves and talk about their role in their organization, then questions were asked on participants' definitions of ecosystem services and natural capital and their understanding of both. Following this, participants were asked about the opportunities and barriers of using ES approaches for both the employee and organization; the changes they have experienced, specifically asking if using ES approaches had changed the way they think about the environment, and if so, how? The interview ended with a discussion on future use of ES approaches. The interview proforma is included in the supplementary information.

3.3.2 Data analysis

The interviews were transcribed, read through and on a second read a short synopsis was produced to summarize 'what strikes me as a researcher?' and 'what is happening here?' (Creswell 2007 p153). Once all interviews were completed and transcribed, the primary cycle coding began using NVivo 12. Coding is 'the active process of identifying data as belonging to, or representing, some type of phenomenon' (Tracey 2012 p 209). Primary-cycle coding involved multiple reviews of material and assigning words or phrases that capture its essence. Throughout the coding process the constant comparative method (Charmaz, 2006) was used to compare the data to each code, and either adjust the code or divide the codes into two new ones. Secondary-cycle coding moved beyond descriptive codes to analytical codes: reflections identified the themes of time, systems and physical risk as prevalent. Following a second review of the literature, a third phase of coding was undertaken, using the analytical framework included in Table 1. To structure the analysis of our empirical findings, data analysis first took the form free coding through primary and secondary cycle coding, identifying themes. Another literature review was subsequently undertaken reflecting on our empirical data and then analyzed using our analytical framework in Table 1 to glean further insight through the SES systems thinking lens. In what follows, we first report our results, and then relate them in

discussion to the literature to establish the contribution of ES approaches in advancing knowledge on systems thinking in corporate environmental sustainability practice.

3.4 Results

The participants were encouraged to consider the use of ES approaches at the individual and organizational level in a series of open questions to shed light on the use of ES approaches and the difference it is perceived to make. In what follows, we will first present the themes which illustrate practitioner perceptions. Secondly, we reflect on the empirical data analysis applying the theoretical frame in Table 3; this allows us to analyze our findings through an SES lens for systems thinking in sustainability management.

3.4.1 Empirical findings – practitioner experiences

Four interesting themes emerged from the empirical analysis of practioner experiences of using ES approaches: ES approaches changed practitioner understanding of 'the environment'; highlighted the physicality of the environment; introduced a time dimension into management and provided the basis for a systems overview of how their organisation related to the natural environment.

3.4.1.1 Changed understanding of the environment

Two thirds of the participants suggested that the use of ES approaches had changed their understanding of the environment. This is illustrated by a quote from a director of a global management consultancy:

> "[Organizations are] thinking about what their place is in the future. And whether they use the language of natural capital, or whatever, they're recognizing […] it's no longer an option for them to create enormous negative environmental impacts. And if they have, really major dependencies, if they interact really closely with the environment on a day-to-day basis, then […] they need to be acutely aware of whether that environment is still we're going to be there to provide for them in the future." (Participant 28)

This highlights a greater awareness of the connections between the organization and the environment in terms of both impacts and dependencies, as well as a heightened awareness of the temporal nature of the environment. The use of the ES approaches also raises awareness of the finite limits and boundaries of the environment and the environment as a 'flow' (rather than as a 'stock'), although the participant goes on to suggest that further research is required to understand what this means for corporate environmental practice.

> "It is actually around real environments thresholds and limits, and how do we integrate those into our thinking about natural capital and […] we sort of assume

> that those future flows will happen and not worry nearly enough about what thresholds and environmental change mean for those future flows" (Participant 28).

3.4.1.2 Physicality of nature

Over half of the respondents considered that using ES approaches helped manage the risks associated with dependency on the physicality of the natural environment. These risks included an awareness of the geographical location of the environment as noted by two participants:

> "It leads one down the pathway of understanding where that natural capital is, what it's condition is and then by extension the ecosystem services" (Participant 7).
>
> "...looking not only at your impacts, but also your dependencies on the environment, and how those vary across different geographies is a thought process that's not written into any other business process" (Participant 27).

The physical location of the environment on which organizations are dependent is made more explicit by the use of ES approaches. This includes "de-risking your supply chain" (Participant 24) when using ES approaches. Another participant noted that "there are serious business risks in everything we do, where we don't store and protect natural capital" (Participant 18). The ES approaches thus improve awareness of the dependency of the organization on the physical environment and the potential risks associated with it.

3.4.1.3 Time

Over half of the respondents brought up greater awareness of the need for long term thinking, it is "about long termism rather than short termism" (Participant 20). Another participant noted:

> "It's a human flaw isn't it that we would pursue short term gain and we then damage the long term. [..] that's why we use the rebuilding of natural capital" (Participant 6).

Participants offered examples of greater awareness of the temporal aspects of the environment as a result of using ES approaches. First is the realisation of the error of considering environmental impacts as externalities: "if you're looking, with a long-term timeframe, in reality, nothing is ever truly an externality" (Participant 2). Second, the intergenerational tensions become visible when considering nature over a long timeframe: "our grandchildren and our great grandchildren may want something different out of that same environment" (Participant 13). Third, the urgency or lack of time to take action to keep within potential

environmental thresholds: “there’s a pending threat that we’re reaching thresholds with regards to the environment that are totally irreversible” (Participant 17). This suggests that the use of ES approaches raised the participants’ awareness of the temporal dimensions of the environment, including the need to consider longer time horizons.

3.4.1.4 Systems Overview

Over half of the participants noted greater awareness of the environment as a system or of the relationship between the organization and the environment being a further “interlinked system”(Participant 6). Participant 6 went on to suggest that “It's the idea of, the multiple benefits coming out and actually kind of reinforcing each other. And actually, I don't think I fully appreciated the contribution the environment makes.” Another participant noted that the use of ES approaches “really changed the way that people think about the systems and the processes” (Participant 10). Furthermore, Participant 2 noted “it's all about systems, holistic approach, rather than just looking at these key things [....] and missing out on opportunities to link it up with other areas.” Finally, one participant notes the systems attributes throughout the supply chain:

> “The aggregate natural capital rule - and so whatever, wherever you are in your supply chain, or your business model, you're using natural capital, you have to have something somewhere that puts it back and restores itself, so the balance is correct” (Participant 18).

The use of the ES approaches in an organizational context thus increases the awareness of the systemic attributes both of the environment, and the organization’s relationship with it. Next, we analyze the material in light of the framework communicated in Table 1 to establish how our findings compare to theoretical advances in SES use in corporate environmental sustainability.

3.4.2 Empirical findings as they relate to theoretical advances

A further four themes emerge when we examine what our empirical data offers to advance understanding of social and the ecological systems and how their dynamics are conceptualized. These are: a greater understanding of the ecological system at multiple levels, a limited understanding of the social system and a limited understanding of the relationship, nested nature and reciprocity between the social and ecological system.

3.4.2.1 Understanding of the ecological system

ES approaches conceptualize ecological systems from an ecocentric perspective focusing on ecosystem functions that provide goods and services. Analysis of the ecological system can be undertaken at any scale but the national scale is most often considered without

giving attention to interactions between scales. In contrast the SESF conceptualizes the ecological system from an anthropocentric perspective acknowledging all scales and feedbacks between them. Below we report participant's understanding of the ecological systems, multiple scales and feedbacks.

Participants were aware of nature as a system as they highlighted the "interconnectedness of the environment" (Participant 20) stating they didn't realise how a "piece of land and the natural environment can be such a multi-tasker" (Participant 6). Participant 11 noted that "we are modelling all the underlying biological cycles [….] and we did that before and after, so we can see what it was doing".

Some participants were also aware of the need to consider the ecological system at different scales. Participant 13 for example noted that different organizational interventions could lead to "different levels or different types or qualities of goods and services". Participant 11 in turn noted that "on a national scale …. [natural capital] could promote the green economy …. But ultimately, I think it creates opportunity for everyone whether it is at a very personal level through health and wellbeing."

Participants also raised the theme of feedbacks and dynamics. Participant 13 noted that "understanding the ecology sufficiently that you can tweak a little something to get out the ecosystem services you want, you don't destroy the system, but you understand the system to the extent that you can modify". Participant 18's comment noted in 4.1 above also provides an example of participants' concern with the theme of feedbacks and dynamics. These participants acknowledge the dynamics within the ecological system as well as the interactions between the ecological and social system.

Our findings suggest that most participants understood the ecological systems and whilst theoretically using ES approaches, there should be limited knowledge of multiple levels and the feedbacks across these levels, our findings suggests that some practitioners using ES approaches did report an awareness of multiple levels and potential feedbacks within the ecological system.

3.4.2.2 Understanding of the social system

ES approaches conceptualize the social system of human beings as users of the ecological system and acting as valuing agents. They conceptualize the hierarchical levels of the social system (e.g. individual, organization, society) without consideration of the dynamics between levels. In contrast SESF conceptualizes the social system as a series of actors and the governance system that influences their actions. It considers the social systems to have a multi-level structure and acknowledges the two-way interactions between these levels. Fewer

participants manifested an understanding of the social systems. But one participant suggested that:

> "We have to think more strategically, as agencies, political government agencies, I think we need to think more strategically society and business to look at the systems using natural capital and ecosystem services, as a system and collective" (Participant 14).

This participant had an embryonic understanding of the social dynamics, noting "don't just look at your business, what are all of the other businesses within your sector? And what about all of the other businesses across sectors that are having the impact?".

Our empirical findings of ES approaches in use supports the theoretical proposition that social systems are less well conceptualized in ES approaches, and that in practice less well acknowledged or understood, with only one of our 30 participants explicitly discussing the social systems. The participant acknowledged the multi-level properties of the social system and potential for feedbacks identifying need for future research to advance SES within corporate environmental sustainability.

3.4.2.3 Understanding of interaction and the dynamics between the social and the ecological systems

The ES approaches understand that the social system is impacting on the ecological system without considering the reciprocity of interactions between the two systems unlike the SESF. The majority of the participants did not have firm views on whether the social system impacted the ecological system or whether there is a reciprocity between the two systems, they just considered that there was a connection. Participant 14 noted "how the various systems connect and how people connect to those systems". Participant 6 noted that the use of ES approaches leads for better decision making because of better understanding of the links between social and ecological systems:

> "really difficult to make good decisions about things that are very interlinked, like with, you know, so many of the decisions we have to make are kind of at the intersection of finance and society and the environment [….] it can be really, really complicated. And so, I like the idea of being able to make well informed decisions".

Participant 9 considered that "it's not only important to understand the relationship with your business directly, and the environment, but also indirectly via society". These findings suggest there is an embryonic awareness that the two systems are linked e.g. the social and ecological system are linked, however practitioner understanding of the whole systems of the organization and nature is limited – this supports the literature on corporate-ecological

disconnect. Whilst the potential exists through ES approaches to make the impacts of the social system on the ecological systems more prevalent or in the optimum the reciprocity between these two systems. Our findings produce limited evidence that practitioners are thinking or aware of the interaction and dynamics between the two systems.

3.4.2.4 Understanding of the equity between the two systems

As there was a limited depth in the awareness of the social and ecological systems interacting, no participants explicitly considered the importance of balance between consideration of the social and ecological systems. This suggests there are limits to practitioner understanding of ES approaches, practitioners are aware the two systems exists and that there is an interaction between these systems, however these is limited consideration of how this new system operates and the equity between these systems. Having presented the empirical results, we will now discuss our findings in relation to the literature on ES approaches in corporate environmental sustainability and socio-ecological systems from a systems thinking sustainability management perspective.

3.5 Discussion

We found that practitioners using ES approaches had an awareness that environmental benefits and impacts were associated with a specific geography and that there is a need to consider temporal and systemic aspects of both the environment and the organization. Our findings resonate with theoretical propositions that ES use advances knowledge of space and time attributes of nature and provides empirical support for this. Each of these advances are discussed below.

3.5.1 Space and physical attributes

Our empirical findings of a greater awareness of the physical attributes of the environment provides empirical evidence advances in sustainability systems theory (Bansal & Knox-Hayes, 2013) and ES in corporate environmental management theory (van den Belt & Blake, 2015). Furthermore, these findings support Whiteman et al., (2013) who argues that a greater awareness of the spatial attributes of the environment raises the awareness of the global nature of environmental problems and the risks as a finite physical object with planetary boundaries. Our empirical findings support this proposition – the participants' awareness of the physicality lead them to be aware of planetary limits of "real environmental thresholds and limits" (Participant 28). This evidence of an awareness of the physicality of nature suggests that ES approaches in corporate environmental sustainability can translate theory into practice and advance the impact and progress on corporate environmental sustainability operating within planetary boundaries.

This is a knowledge gap in the literature linking planetary boundary work with corporate environmental sustainability practice. For example, Whiteman et al. (2013) and Haffar et al. (2018) argue that there is little organizational scholarship focusing on the application of environmental thresholds and limits. Haffar et al. (2018) highlight that environmental target setting is organization centric in its framing with little recognition for ecological thresholds. Our findings suggest that the use of ES approaches could address this issue as it raises awareness of ecocentric boundaries as ES approaches have a stronger focus on the ecological system compared to other SES.

3.5.2 Time

The consideration of time is well-established in the corporate environmental sustainability literature but remains a core challenge in corporate practice (Kim, Bansal, & Haugh, 2019; Slawinski & Bansal, 2015). Greater awareness of the dynamism of nature acknowledges that the environment is not static. Whilst impacts and dependencies may be understood at one point in time, they may change over a longer timeframe. This dynamism is difficult to build into corporate environmental management (see Kim et al., 2019). Our findings suggest that there is a greater awareness of both time and space as domains of systems theory (Angyal, 1969; See Emery, 1981). We suggest these are fundamental concepts to advancing sustainability systems theory as the ecological system holds a physicality. Through this physicality there is an awareness of the finite nature of the physical attribute within the planetary system. This finality raise important issues of planetary boundaries (Haffar & Searcy, 2018; Mace et al., 2014; Whiteman et al., 2013) and time (incorporating intergenerational equality and urgency of action)(Bansal & Knox-Hayes, 2013; Kim et al., 2019; Slawinski & Bansal, 2012). A greater awareness of the temporal attributes of the environment highlights the consequence of not having time, e.g. appreciating that half of the world's species has been made extinct through human influence since the 1970's (IPBES 2019). We suggest that use of ES approaches can higlight the urgency of addressing the unsustainable relationships in the corporate ecological disconnect.

3.5.3 System attributes

Our research provides evidence that ES approaches increase systems thinking in corporate environmental sustainability practice. The enhanced systems thinking is important in supporting corporate environmental sustainability, acknowledging it is complex and interventions or changes in any one system (e.g. the organization, the environment or the organization-environment system) may result in unintended feedbacks and dynamics – potentially creating a system not within planetary boundaries.

Sustainable organizational systems literature (e.g. Williams et al., 2017; 2019) has suggested the potential for advances in corporate sustainability by using ES approaches (Pogutz & Winn, 2016; Winn & Pogutz, 2013) and the importance of embracing socio-ecological systems thinking (Baudoin & Arenas, 2018) but a gap persists in both of these areas with regard to empirical research (Ahlström et al., 2020). We sought to provide empirical insights into organizational use of ecosystem service approaches and its potential contribution to corporate environmental sustainability. Our empirical insights illustrate a raised awareness of the environment, and the relationship between the organization and the environment as systems (with limited depth in this understanding). Our research further emphasizes this advance in systems thinking as time and space are the fundamental dimensional attributes in a system (see Emery, 1981) and understanding these dimensional attributes is a foundation to understanding the system attributes.

Next, we delve deeper into these empirical findings using the analysis framework of Table 1 to view the empirical data through the lens of SES theory, analysing how our findings support or contradict SES theoretical approaches for corporate environmental sustainability and how this relates to advances in systems thinking for corporate environmental sustainability.

3.5.4 ES approaches as they relate to SES theory

With our SES analytic framework, we can understand in more detail how our practitioners understand the social and the ecological systems and their dynamics. Our findings supported the theoretical proposition that ES approaches are ecocentric and there is an embryonic awareness of the social and ecological system being connected. However, applying out theoretical framework our empirical findings suggest a number of limitations of ES approaches which hinder advancement of socio-ecological systems thinking for sustainable organizations. The limitations are threefold: bias of ES approaches to ecological systems over social systems; limited understanding of the whole system, feedbacks, dynamics and the nested nature of the social systems within the ecological system; and practitioner knowledge of theory in implementation.

3.5.4.1 <u>Ecocentric</u>

The practitioners indicated that ES approaches are ecocentric discussing in detail the ecological system and its framing as opposed to the whole socio-ecological system. This bias in ES approaches is important for practitioners to be aware of in implementation, in that additional compatible social system approaches are needed for a holistic corporate sustainability strategy. ES approaches should be used in corporate *environmental* sustainability and its eco-centric nature should be understood. This finding contributes to corporate environmental sustainability

literature, e.g. Haffar et al. (2018) who critique target setting in organizations towards planetary boundaries as being too organization centric. Using an ES frame can conceptualize the organization-environment system with a stronger bias towards the ecological system.

The conceptual bias towards ecological systems in ES the approaches is not well understood by practitioners. Our empirical findings found limited awareness among our participants of the social systems. All bar one participant were not aware of the multiple levels of the social system or the interactions between these levels. There is no consideration of the governance of the social system in ES approaches (a core component of SESF) and our empirical findings suggest practitioners are not aware of this. This gap resonates with Costanza et al. 2014 criticism of ES approaches lacking of consideration of interactions with other systems such as social systems. The ES approaches are a corporate environmental sustainability method with an ecocentric framing. Additional complimentary corporate social sustainability methods should be used in tandem and then consideration how these two methods mesh together to form a new socio-ecological system. This is theoretically challenging and an SES such as Elinor Ostrom's SESF provides a much stronger platform to consider social and ecological systems. Speaking to the systems literature defining the difference between socio-ecological systems and social ecological systems, our empirical evidence supports the discussion that ES approaches are socio-ecological systems (see Berkes, 2017, p. 3), emphasising the ecological systems over the social system. Further work is needed to advance SES for systems thinking within sustainability management to advance both theory and practice in this area.

3.5.4.2 Links between the social and ecological systems

The use of the ES approaches does increase the practitioner knowledge of the interlinkedness of social and ecological systems: there is limited understanding of the complex relationships between the two systems. This decreases the likelihood that practitioners understand that the organization depends upon the ecological system which underpins the society. The interdependence between organizations and the natural environment is central to a systemic sustainability management given that organizations depend on the natural environment for inputs and organizational actions directly impact the natural environment through feedback loops (Starik & Kanashiro, 2013; Williams et al., 2017). Awareness of the bidirectional nature of the interaction between the two systems is not evident among participants. This bidirectionality proposed in Ostrom (2009) is necessary to understand that the organization and ecological system itself creates a new system with feedbacks, dynamics and gestalt properties. Whilst sustainability systems literature and SES literature have both considered the theoretical implications of this organization-environment system, use of ES approaches is having limited

impact on practitioner knowledge of this co-dependency. This suggests that ES approaches may not advance corporate environmental sustainability in practice.

Our findings also suggest that there is limited systems thinking in practice, particularly that social systems are nested within the ecological systems. Whilst some participants acknowledge there may be environmental thresholds and limits, most participants lack a deeper understanding of the embeddedness of social systems within the ecological system, or that the social system is dependent on and constrained by the capacity, health and functioning of the ecological system (see Haffar & Searcy, 2018).

3.5.4.3 Implementing theory

The detail in the conceptualization of ES approaches as an SES for corporate environmental sustainability are missed by practitioners in implementation. No practitioner stated an awareness that using ES approaches had a stronger focus on the ecological system, or the need to consider multiple levels, feedbacks and dynamics within and across the system. These attributes of ES approaches as an SES in corporate environmental management are fundamental to advance practitioner understanding and progress towards correcting the corporate-ecological disconnect. Furthermore, the lack of detailed understanding offers the potential for ES approaches to be misused and inform decisions with a bias. This would be an interesting research enquiry exploring how the bias towards the ecological system in this SES influences the decision and outcome in corporate environmental sustainability use.

ES approaches offer both advancements and limitations in corporate environmental sustainability emphasizing the time, space and systems attributes. Viewed through an SES lens the limitations of ES approaches are prevalent, highlighting the bias of ES approaches, poor conceptualization of the social systems being nested within the ecological system and practitioner knowledge of theory.

3.6 Conclusion

We sought to explore the potential of the ES approaches to advance corporate sustainability by using a systems theory lens. The contributions of our paper are twofold. First, we provide empirical evidence on the use of ES approaches in organizations regarding their contribution to corporate environmental sustainability. Second, we outline how this evidence fits within a theoretical framework aiming to advance systems thinking about SES in organizations.

Our findings suggest that the ES approaches do raise the awareness of the environment as a system, the need to consider the social and the environment as two systems interacting as well as the dynamism and physicality of the systems. However, our findings also suggest three-

fold limitations in ES approaches: the bias of ES approaches to ecological systems over social systems; poor conceptualization of the social systems as being nested within the ecological system, and practitioner knowledge of theory. Our research has improved the understanding of the benefits of the ES approaches and challenges of its implementation by analysing theoretical SES propositions against empirical evidence of ES practitioners finding the detail on ES conceptualizations can be lost in implementation.

A limitation of our research is that it is based on self-reporting - a longitudinal study to explore the changes that result from the adoption of ES approaches over time would help address the limitation. We also considered ES approaches as a whole. Yet different tools and methods relative to stocks and flows have their own strengths and weaknesses. A critical analysis of specific examples of the existing tools would improve the evidence base to inform the 'how' to implement ES approaches as an SES to inform corporate sustainability. Research could consider the use of ES approaches at the individual, organization, societal and global level to provide more insight into levels of organizational change that occurs due to ES approach use. Furthermore, research exploring how the bias towards the ecological system in this SES influences the decision and outcome could advance corporate environmental sustainability both theory and practice.

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Chapter 4 : Paper 3 - A meta-analysis of cases implementing ecosystem services approaches in corporate sustainability practice

ABSTRACT

Humanity is dependent on a healthy ecosystem and the services it provides, yet unprecedented rates of decline due to anthropogenic impacts on biodiversity continue. Ecosystem service and natural capital approaches offer a different framing of the relationship between organizations and the ecosystem with growing use in corporate environmental sustainability, however there is limited critique of their implementation. Analyzing 125 case studies from 81 companies we find appraisals lack an understanding of the dependencies, risks and opportunities between the organization and the ecosystem, and there is almost no reported monitoring and evaluation of the assessment. Our contributions are threefold, first providing greater empirical evidence of ecosystem services approaches in use by corporations, second, we analyze implementation from theory to practice and consider areas for improvement and third use archetypal analysis to discuss patterns across the global implementation of ES approaches in corporate sustainability reporting.

Keywords: ecosystem services assessment, natural capital, natural resource dependency, corporate environmental sustainability

4.1 Introduction

Humanity is currently exceeding sustainable planetary boundaries with trends in climate change and biodiversity loss declining at unprecedented rates (Steffen et al., 2015). Businesses have an important role in helping humans live within sustainable boundaries through corporate sustainability (Hoffman & Georg, 2018). This paper focuses on the health of the biosphere by analyzing the use of ecosystem service approaches by business. Biological diversity (biodiversity) underpins the health of the ecosystem and the services it provides (Harrison et al., 2014). There is a growing interest, and use, by organizations of both ecosystem service and natural capital approaches (the stock from which these services flow) which we refer to as Ecosystem Service approaches (ES) (Figge & Hahn, 2021; Guerry et al., 2015; Hahn et al., 2017; Tashman, 2020). There is a dearth of empirical evidence of organizational use of ES approaches (Ahlström et al., 2020; D'Amato, Li, Rekola, Toppinen, & Lu, 2015; Whiteman et al., 2013; Winn & Pogutz, 2013) with a few exceptions (D'Amato et al., 2015, 2018; Pogutz & Winn, 2016; Thompson, 2019). The aim of this paper is to explore the implementation of ES approaches in corporate reporting. We do this through a meta-analysis of 125 case studies in 81 organizations. Using thematic analysis we analyze the case studies using the expanded D'Amato's (2018) conceptual framework provided in Small et al., (in press) illustrating implementation of ES approaches in corporate environmental sustainability.

ES approaches make visible the benefits that people derive from nature (Costanza et al., 2017), they are defined as "the benefits people derive from ecosystems"(MA, 2005). They analyze impacts (both positive and negative) on and dependencies between supporting, regulating, provisioning and cultural services (MA, 2005). Natural capital is the 'stock' of environmental assets from which these ecosystem services flow thus it is 'the stock of properly functioning natural assets (such as forests, wetlands, rivers, coasts) that yield a flow of valuable goods and services into the future' (van den Belt & Blake, 2015, p. 668). In what follows, we will use the term ecosystem service (ES) approaches to refer to both natural capital concepts (the environmental asset stock) and ecosystem service concepts (the flows of impacts and benefits received).

Whilst there is a growing amount of management literature studying the relationship between the ecosystem and the organization, scientific evidence on the health of the biosphere continues to point to an ever declining trend (IPBES, 2019). More needs to be done to reverse this corporate-ecological disconnect (Ahlström et al., 2020; Whiteman et al., 2013) by studying and sharing how organizations are implementing corporate environmental sustainability theories and learn lessons for both theory and practice.

Our contributions are threefold. First, we provide greater empirical evidence of ecosystem services in corporate environmental sustainability practice across multiple geographies and sectors. Second, we analyze implementation of ES approaches from theory to practice and consider areas for improvement. Third we use archetypal analysis to discuss patterns across the global implementation of ES approaches in corporate sustainability reporting these being: Multi-National Corporate use of profit and loss methods; Consumer facing organizations all reporting on climate change; and a global spread of ES approaches in use from resource based industries.

In what follows, we will first outline the relevant literature on corporate environmental sustainability, integrated reporting, corporate environmental reporting, ES approaches and ES implementation theories and methods. Second, we present the methods adopted to analyze the cases and present the results. Third, we discuss the implications of our findings in the context of the literature. Finally, we conclude, with a discussion on the limitations of our study and areas for future research.

4.2 Literature review

4.2.1 Corporate environmental sustainability

Research on the relationship between organizations and the ecosystem in management literature has a long history. Starik and Rands (1995), Gladwin (1992), and Shrivastava (1995) firmly place ecological sustainability as a field in its own right in management literature in the 1990's. Shrivastava (1995) noted that organizations were key drivers of development and yet they remained under studied as a source of environmental problems. Gladwin et al. (1995) discussed biophysical boundaries noting that some management research proceeds as if organizations lack biophysical foundations. Starik and Rands (1995) developed a multi-level, multi-systems theory for ecological sustainability for organizations a theory building on systems theory for organizations with a focus on ecology. Since the 1990's theories such as a (natural) resource-based view of the firm (Hart, 1995; Tashman, 2020), institutional theory (Hoffman & Jennings, 2015) industrial ecology (Erkman, 1997; Yeo et al., 2019), environmental management tools and systems (Schaltegger, Burritt, & Petersen, 2017; Welford, 2016) have all formed important theories in advancing literature on corporate ecological sustainability. However, corporate environmental sustainability action is having little observable effect on the decline in the health of the biosphere, termed the corporate-ecological disconnect (Ahlström et al., 2020). More research is needed analyzing corporate environmental sustainability action taken in the 'real world' to better understand the connect between theories and practice and reduce this corporate-ecological disconnect. This is a gap this paper seeks to address.

As we enter the 2020s corporate environmental sustainability discourse must continue to seek ways to adapt to a new transformational era where humanity is a dominant planetary force (Hoffman & Jennings, 2021). This transition is only possible at a planetary and system wide scale (Howard-Grenville & Lahneman, 2021). Theories at the ecosystem level, such as ES approaches could present opportunities for this new transition (Howard-Grenville & Lahneman, 2021; Mace et al., 2014; Macellari, Gusmerotti, Frey, & Testa, 2018; Pogutz & Winn, 2016; Whiteman et al., 2013). Through analysis of empirical use of ES approaches we seek to identify whether implementation of ES approaches could contribute to this next 'wave' in the corporate sustainability transition (Hoffman & Georg, 2018). This offers a promising avenue of research which may seek to address this current gap in the literature.

4.2.2 Corporate reporting

Corporate reporting is well established in both management and accounting literature (Boiral, 2016; Unerman et al., 2018). Corporate reporting and disclosure can either be mandatory or voluntary where voluntary reporting is understood as sharing information not required by laws or regulations (Lev, 1992). Where corporate reporting is voluntary, corporate reporting particularly in relation to environmental and social topics, facilitates company legitimacy amongst a broad stakeholder groups (Montabon, Sroufe, & Narasimhan, 2007) and helps retain an organization's 'public license to operate' (Deegan, 2002). Corporate reporting has expanded to report on issues not captured in financial dimensions of reporting, focusing on environmental and social dimensions which we previously considered 'externalities' to the financial operations of the business (Unerman et al., 2018). There has been a burgeoning amount of literature on corporate environmental reporting and disclosure (Bebbington & Unerman, 2020; Boiral, 2016; Boiral et al., 2019; Gray & Bebbington, 2000) and whilst both theory and practice are expanding, more needs to be done to help bridge the gap between corporate disclosure and corporate action reversing environmental decline on a planetary scale.

There is a growing area of accounting research and practice seeking to account for companies' social and environmental impacts, studying both what is reported and how it is reported. As Hoffman and Georg (2018) note this research focuses on accounting techniques, and in particular, the more technical aspects of how to account for activities not traditionally included within financial accounting called integrated reporting (Bebbington & Unerman, 2020; Unerman et al., 2018), which is synonymous with the term value reporting (Livesey & Kearins, 2002). Value reporting seeks to provide more transparent information to multiple users beyond the investor (Clark Williams, 2008). Both integrated and value reporting focuses on illustrating to stakeholders a broader definition of value beyond tradition financial value metrics, illustrating other forms of capital such as cultural, intellectual, human, manufacturer or natural

capital. It is in this integrated reporting context that many of the case studies on ES approaches are reported.

Whilst the trend of corporate environmental reporting is promising the depth, quality and robustness of the reporting is varied. One of the biggest criticisms of corporate environmental reporting and disclosure is the potential to misrepresent organizational environmental performance (Boiral & Henri, 2017; Gray, 2010; Kareiva, McNally, McCormick, Miller, & Ruckelshaus, 2015; Milne & Gray, 2013), or "greenwashing" (Lyon & Maxwell, 2011). This misrepresentation can exacerbate an unsustainable relationship between the organization and environment and erode stakeholder confidence (Montabon et al., 2007). To build stakeholder confidence and concerns relating to a potential lack of transparency, there has been a growing tendency for companies to independently assure their sustainability reports (Braam, de Weerd, Hauck, & Huijbregts, 2016) through use of certification and independent consultants.

There are a number of certified standards for corporate reporting, such as International Integrated Reporting Framework (Simnett & Huggins, 2015) or Global Reporting Index (GRI) (Christofi, Christofi, & Sisaye, 2012; Hedberg & Von Malmborg, 2003; Herzig & Schaltegger, 2006), however corporate environmental reporting frameworks using natural capital and ecosystem services are still in their infancy. There are a number of very promising standards such as BS 8632 or EU INCA project (see Hein et al., 2020 for a useful summary of standards), however an international standard to independently verify reports applying ES approaches is not yet available. Given the lack of transparency and independent critique of ES approaches in corporate environmental reporting it is important that research is conducted analyzing implementation of ES approach in corporate environmental sustainability practice, a gap this paper seeks to address.

4.2.3 Ecosystem services approaches in corporate environmental sustainability

In management literature ES approaches remain under-studied in corporate environmental sustainability literature (Hahn et al., 2017). Whiteman et al. (2013) discuss corporate ecological sustainability within planetary boundaries to try and shift the focus of corporate environmental sustainability beyond a growth based paradigm (seeking eco-efficiency and win-win strategies) to a steady state paradigm understanding the nested nature of the organization within the planet. Through highlighting the dependency of the organization on a healthy ecosystem, it highlights the organization is only as healthy as the ecosystem it operates within. Winn and Pogutz (2013) build on this idea, developing the ecosystem embeddedness theory discussing the contribution of ecosystem services approaches to corporate environmental

literature to highlight the impact businesses have on ecosystem services. These seminal studies develop conceptual work on why understanding corporate ecological embeddedness is important. Building on these concepts emergent papers sought to explore the links between ecosystems, biodiversity and corporations by considering dependency, impact, risk, opportunity and response practice (Hanson, Ranganathan, Iceland, & Finisdore, 2008; Sukhdev et al., 2010). This literature seeks to develop the perspective that organizations depend on the ecosystems both directly and indirectly, whilst organizations may create ecosystem impacts and disservices as well as opportunities. This theoretical perspective is relevant as we seek to find empirical evidence of understanding this dependency of the organization on the ecosystem in our case study analysis.

Similarly, there is a growing body of literature on natural capital accounting within the accounting literature. The emergence of British Standard BS86342, facilitates a growing standardization in practice on how to account for natural capital. ES approaches, incorporating natural capital, are one of a number of ways to account for biodiversity. Furthermore, there is a growing strand of biodiversity accounting research (Atkins et al., 2014; Boiral, 2016; Boiral, Heras-Saizarbitoria, & Brotherton, 2018; Cuckston, 2019; Jones & Solomon, 2013), but as yet it has not been embedded into wider organizational research. Other accounting methods contributing to understanding the ecosystem within corporate reporting include: stewardship accounting (Jones & Solomon, 2013; Siddiqui, 2013; Skouloudis et al., 2019), certifiable standards (Boiral et al., 2018; Cuckston, 2018; Schaltegger and Beständig, 2010) and offsetting (Cuckston, 2019; Gamarra et al., 2018; Tregidga, 2013).

4.2.4 Implementation of ES approaches

ES approaches conceptualize the environment as either a capital stock or part of a socio-ecological system providing environmental functions and services to human health and wellbeing. The approaches are well established in the natural science literature with a range of methodologies and tools developed over the last two decades to conceptualize this (Biggs et al., 2021; Potschin & Haines-Young, 2016; Sukhdev et al., 2010). There is a raised awareness that organizations have a relationship with the environment in which they operate and leading organizations continue to try better ways of understanding and accounting for the impacts, dependencies and opportunities of this relationship (Pogutz & Winn, 2016). However, Ahlstrom et al. (2020) note that research on corporate perspectives of ecosystem services approaches are mainly theoretical and lack empirical insights. This paper seeks to contribute to the gap in this literature by providing a breadth study improving empirical knowledge on organizational use of ES approaches.

4.2.5 Empirical studies on ES approaches

In the management literature ES approaches remain under-studied. Winn and Pogutz (2013) discussed the contribution of ecosystem services approaches to corporate environmental literature and suggested a theory of corporate ecosystem embeddedness to highlight the impact businesses have on ecosystem services. Winn and Pogutz (2013) highlighted the lack of empirical research on ES approaches and call for improving the knowledge base on the contribution of ES approaches to corporate environmental management. Later they build on this theory paper and examine the Italian multi-national food company Barilla's use of sustainable agriculture (Pogutz & Winn, 2016) and their application of ES approaches in practice. Vihervaara and Kamppinen (2010) explored the use of ES approaches in forestry organizations in Finland, finding that the adoption of ES approaches is increasing but that further stakeholder engagement is needed to mainstream them. Furthermore, Thompson (2019) examined Payment for Ecosystem Services (PES) and corporate environmental management in Thailand, suggesting that the PES may be used as a tool for philanthropy, stakeholder engagement and gaining a licence to operate.

Some grey literature work has been undertaken with studying ES approaches in the private sector (Pritchard and van der Horst D., 2018) reviewed 42 case studies that publicly shared their experience of natural capital assessments using content analysis. They found that most of the organizations engaging with NC approaches already had a long history of corporate sustainability, they also found there was a growing interest in the area amongst businesses.

This paper builds on the earlier work of D'Amato et al. (2018) who studied ES approaches in the forestry sector of China, analyzing the impact-dependency-response process between organizations and ecosystems services. They interviewed 20 practitioners from five case study organizations in China from the forestry sector. From this they developed a framework representing the process of assessing and responding to corporate impacts and dependencies on ecosystem services, and identification of related business risks and opportunities. This is a foundational paper for this research; we seek to continue to gather empirical research by conducting a breadth study using this conceptual framework analyzing 125 case studies from 80 global organizations. We advance this conceptual framework in our paper Small et al., (In press) by adding two additional stages as summarized in Figure 1 and use the structure of stages 1- 6 in our thematic analysis of the case studies.

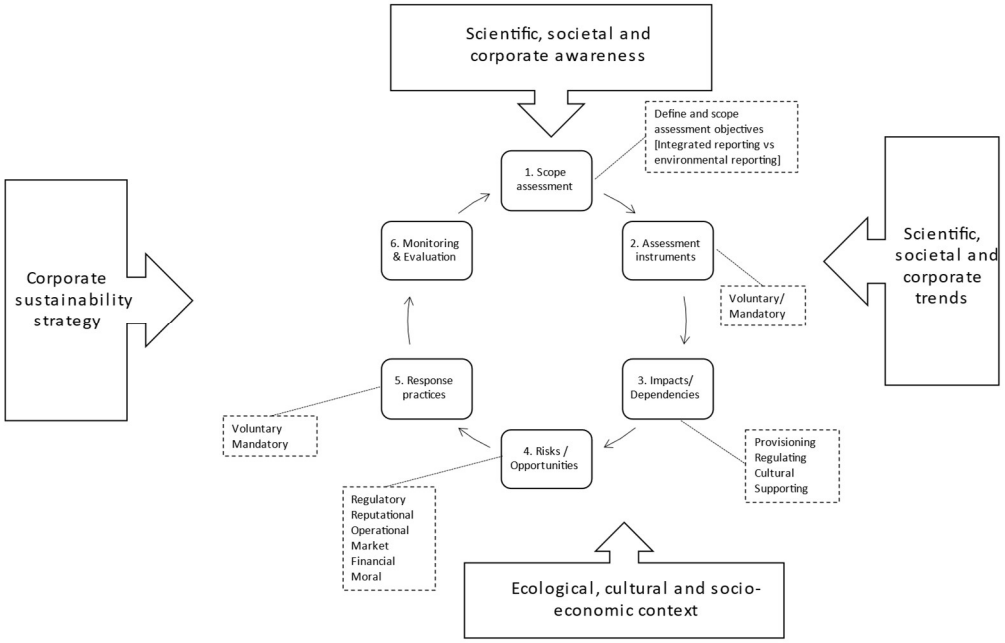

Figure 5 - Advanced conceptualization of ES implementation in corporate sustainability (Simplified extract from Small et al., (in Press))

We have used the conceptual diagram in Figure 5 and analyzed a series of case studies against the analytical framework. In addition to descriptive criteria of the corporate report i.e. type and size of organization, we analyzed: the scope of the assessment (Stage 1); the assessment instrument (Stage 2); the ecosystem impacts and dependencies assessed (Stage 3); the ecosystem risk and opportunities (Stage 4); the response practice (Stage 5); and monitoring and evaluation (Stage 6). This framework provided the structure to critically analyze the implementation in practice of ecosystem services approaches in corporate sustainability practice.

4.3 Method

4.3.1 Research design

We sought to analyze organizational use of ES approaches across a range of organization size, geography and sector, to explore how implementation of ES approaches relates and could advance environmental management practice. Using an abductive qualitative approach we explore implementation of ES approaches in context through a multiple case review of corporate reports. We chose an abductive qualitative approach in order to appreciate the nuances of application in 'real world' setting whilst allowing opportunities to spot patterns across a large number of cases, as possible in a meta-analysis (Rudel, 2008). For this reason, we initially conduct a thematic meta-analysis of the case studies implementing ES approaches in

corporate environmental sustainability reporting after which we complement this first stage analysis with a second stage of analysis using archetypal analysis seeking observable patterns across groups within the data.

4.3.2 Case study database

To analyze the implementation of ES approaches in corporate environmental sustainability requires the collation of numerous examples of organizational use of ecosystem services approaches; thus, a case study database of real-world applications of corporate reports was compiled for this research. A case study investigates a contemporary phenomenon in its real-world context (Yin, 2017) and the review of a document is an unobtrusive method rich in portraying the values and beliefs of participants in the setting (Marshall & Rossman, 1989). The development of the case study database was conducted in partnership with the Capitals Coalition who had a list of companies that were known to the organization or part of the coalition; authors worked with the coalition to develop the database for the coalition's purposes. Using this list a separate database of case studies was created for this research. To be included in the database a case study was an example of natural capital methods being used in an organization at a product, site or organizational scale. Information on each case study was compiled using the corporate reports or corporate materials produced in each case. Thus, if a natural capital account for the organization was included for three consecutive years as part of corporate integrated reporting procedures, this counted as 3 cases. Following compilation, the database was filtered to focus only on private sector organizations as this is the focus of our research. Each case study included descriptive information such as the organization name, sector, type, size, case study date, format, size and scale of case study, primary terminologies and definitions used, section of supply chain included in the case study, as well as contents our analytical framework. The six stages of our analytical framework Figure 5) were incorporated in the database to provide an initial structure to the database. The database was constructed in Microsoft Excel with a methodological tab to explain the core stages of the development, providing transparency in analysis and a clear audit trail. The database comprised a series of headings along the top and where relevant each column included a series of drop-down criteria to standardize analysis. These headings and drop-down criteria allowed the database to be filtered to analyze specific themes or research lines of inquiry.

4.3.3 Qualitative thematic meta-analysis

A qualitative meta-analysis is a research design for synthesizing primary qualitative data from case studies (Habersang et al., 2019). This method of analysis was chosen as the cases of organizational use of ES approaches were publicly available qualitative reports of a

large sample size; 172 cases prior to application of the inclusion criteria. Meta-analysis offers a set of robust methodological choices and procedures aiming to enhance the predictive potential and practical usefulness of organizational and management theory (Hoon, 2013).

> "In general, a meta-analysis consists of three steps. The first step is the selection of relevant studies. Criteria for inclusion and exclusion of individual studies have to be defined. The second step is the classification of the information provided by the selected studies. The information is classified in order to translate it into a common language. In the third step, the classified information of all texts is then analyzed" (Hofmann et al., 2011, p. 1107).

Our qualitative meta-analysis was designed to adopt these three stages. First, identifying inclusion criteria: organizations were businesses (for profit) rather than government or NGO organizations; the cases needed to focus on a range of ecosystem services and not just climate change; and finally, the cases needed to be reported in enough depth to be used in analysis (i.e. a paragraph in a press release containing little technical detail was not included). Second, following an initial review of the cases a set of classifications were established for each criterion being analyzed. These criteria were developed and recorded in a separate tab in Microsoft Excel and drop-down boxes developed in the primary database to ensure consistency and common language in the final stage of analysis. The third stage of analysis is the analysis of all texts using the classified criteria.

4.3.3.1 Descriptive analysis

Prior to undertaking the meta-analysis, it is necessary to first ascertain certain descriptive characteristics of each case study. This helped to develop the database, is useful in later stages of analysis and facilitates the development of inclusion and exclusion criteria necessary in the meta-analysis. These descriptive characteristics included the organization, name, type, size, sector, geography. The type of organization analyzed whether it was business to consumer (B2C) or business to business (B2B) organization. This did not make a difference in those engaging with ES approaches being 49% and 42% respectively (the remaining 9% were investor organziations). The sectors which the case studies originated from are illustrated in Table 5 with the three largest sectors being materials such as ArcelorMittal, Dow Chemicals, Tata Steel and Consumer discretionary e.g. Kering or Unilever, the third highest sector with case studies is the financial sector such as ABN AMRO or BNP Paribas. Those sectors reliant on primary resources from the ecosystem such as the materials sector are the most frequent case study available within our database.

Sector	Results	
Materials	33	26%
Consumer Discretionary	32	26%
Financials	19	15%
Utilities	12	10%
Consumer Staples	9	7%
Energy	5	4%
Industrials	4	3%
Health Care	4	3%
Telecommunication Services	3	2%
Real Estate	3	2%
Information Technology	1	1%
Sum	125	100%

Table 5 - Case studies by sector

External expertise was used in the majority of case studies with consultants (41%) being used in the case studies, then internal (22%) with many cases not stating where the expertise came from (37%). As mentioned previously, this may be to offer a level of assurance to the implementation of ES approaches which we will expand on further in the discussion.

4.3.3.2 Thematic coding

Thematic coding is a method for identifying, analyzing, and reporting patterns (themes) within data (Braun & Clarke, 2006). For our purposes we use the themes identified in our adapted conceptual framework (Figure 5) to conduct thematic coding (Terry, Hayfield, Clarke, & Braun, 2017) and populate each stage with the data emerging from analysis of the corporate reports. Thematic codes were developed using the six stages in Figure 5. Previous codes included in D'Amato's et al. (2018) analysis were used in the first iteration of coding for Stages 2-5. A second iteration of coding was undertaken and additional secondary codes were developed, so that a final iteration of coding was undertaken using standardized coding criteria. We have chosen thematic analysis of corporate documents to achieve the breadth study to gather the quantity of data required, whilst interviews were used in D'Amato et. al., (2018) this was not considered appropriate or practical to gather the quantity of data required in the breadth study.

4.3.4 Archetypal analysis

Following the thematic coding of our meta-analysis, a further literature review was conducted to expand the analysis to further explore the implementation of ES approaches in practice. One rapidly developing approach to study the sustainability of social-ecological systems in inter- and transdisciplinary settings is archetypal analysis (Eisenack et al., 2019). It is a novel approach in sustainability research (Eisenack et al., 2021). A systematic literature review of archetypal analysis in sustainability research by Oberlack et al (2019) noted archetypal methods are most frequently used for qualitative, empirical, meta-analysis of global cases frequently of socio-ecological systems. For example archetypal analysis was used in the assessment of future interactions between nature and society in the Intergovernmental Platform for Biodiversity and Ecosystem Services (Harrison et al., 2018; IPBES, 2019). In relation to sustainability research, archetypes are defined as "depicting representative patterns of human–nature interactions" (Sietz et al., 2019, p. 33). Given the development of the qualitative database of cases of ecosystem service approaches in use in organizations (as a socio-ecological system) across at a global scale, archetypal analysis was selected as an appropriate method to further analyze our data.

The core features of archetypal analysis are there are recurrent patterns that hold across the phenomena of interest (Eisenack, 2012), that there are multiple models within the meta data (Oberlack et al., 2019), and that attribute of cases are described with an intermediate degree of semantic abstraction (Eisenack, 2012) thus abstraction should be general enough to be potentially found in more than one case, but not so abstract that it explains every case.

> "This makes the archetype approach particularly useful when dealing with heterogeneous set of cases where there is a need to compare, generalize, or transfer insights across multiple cases. Archetypal analysis identifies a suite of archetypes to explain the phenomenon of interest. This approach enables researchers to capture critical details of heterogeneous cases while generalizing across them" (Oberlack et al., 2019, p. 26).

In the context of our research, the phenomena of interest is the use of ES approaches in corporate environmental sustainability where recurrent patterns are observable, the multiple models within the meta data are the different models and methods used in the ES approaches and finally that abstraction across the cases can be general without being homogenous.

The type of archetypal analysis conducted for our research is systems archetypes, identifying and explaining common patterns as building blocks in the systems of concern to achieve cumulative learning from cases (Oberlack et al., 2019). Therefore we understand the relationship between the organization and the ecosystem as a socio-ecological system and are

seeking patterns within the groups (or building blocks) that provides evidence and learning of implementation of ES approaches in corporate environmental sustainability reporting practice. The identification of archetypes can either be inductive, thus identifying similar social-ecological patterns in a large number of locations (Sietz et al., 2017), or deductive, i.e. actively seeking manifestations of a particular theory (Manuel-Navarrete, Gomez, & Gallopín, 2007). For the purposes of our analysis we use inductive methods to identify archetypes, by systematically organizing the data by each database criterion (i.e. business type or geographic location) and analyze this reorganized and grouped data for patterns and observations.

4.4 Results

Our breadth study analyzes 125 case studies from 81 organizations where ES approaches are used and publicly reported. The aim of this analysis is to understand how theory is being applied in practice and share experience of their use.

4.4.1 Analysis of cases studies using our conceptual framework (Figure 1)

Applying D'Amato's 2018 framework for each case study we analyze 1) which assessment method was used and whether it was mandatory or voluntary. 2) The impact/dependency 3) Risk 4) Response practice (mandatory or voluntary) and 5) Opportunity. We further expand their conceptual framework to include a scoping stage (Stage 1 – what scale and boundary did they use in the assessment) and monitoring stage (Stage 6 – what monitoring and evaluation was committed to or undertaken), results from each of these stages are detailed below.

4.4.1.1 Stage 1 - Scope of the assessment

The majority of assessments were undertaken across the organization (51%), followed by assessments for a specific site (22%), section of the business (20%) or product (10%) with just 1% of the case studies not stating the boundaries of the assessment. The case studies were largely at an international scale (46%), national scale (26%), site (20%) or unknown scale (2%). Our results illustrate that ES approaches are being used at scale and across organizations in their corporate environmental sustainability practice.

The majority of case studies scoped their assessments on their direct operations (58%) with the next highest being throughout their supply chains (18%), with either upstream and direct operations (7%), or direct operations and downstream (5%) the two next most frequent cases. Twelve percent of the case studies did not state the scope of their supply chain analysis. As a knowledge of ES approaches in corporate environmental sustainability is emergent, organizations seek to scope the assessment to the direct operations of the company. Our findings suggest that the majority of case studies focus assessments on their direct operations, which

aligns with previous literature (see D'Amato et al., 2018). Our findings suggests that there is an awareness of the need to include their supply chain with organizations conducting ES assessments including some elements (e.g. upstream or downstream supply chain) in almost a third of cases. This illustrates there is an intent to expand and advance the use of ES approaches in their corporate environmental sustainability practice.

4.4.1.2 Stage 2 - Assessment instruments

All of the assessments reported in the case studies were voluntary. Table 6 details the methods that were used in each case study.

Method	Results	
Natural capital assessment	39	31%
IP&L	30	24%
Bespoke	20	16%
EP&L	9	7%
Multi capitals assessment	9	7%
Truvalue	5	4%
Unknown	4	3%
Lifecycle assessment	3	2%
Ecosystem services valuation	2	2%
TEEB	2	2%
Biodiversity assessment	2	2%
Sum	125	100%

Table 6 - Assessment methods used

Specific natural capital and ecosystem service assessments were the majority method used across the case studies (31%) with integrated profit and loss accounting the second most applied method in the natural capital case studies. The use of ES approaches in reporting illustrates the shift in corporate environmental reporting to include wider concepts of value. Furthermore our results illustrates that the profit and loss accounting method, one type of ES approach made up 31% of the total assessment instruments used across our database (24% Integrated Profit and Loss plus 7% Environmental Profit and Loss). This suggests that compatibility with current organizational accounting methods (e.g. the concepts of Profit and Loss) may be prevalent when choosing the ES approach for the organization.

4.4.1.3 Stage 3 - Impacts and Dependencies

4.4.1.3.1 Assessment impacts

In most cases an appraisal of the impacts (both positive and negative) was conducted with 89% of the cases providing detail of the impacts of the business on the environment. The remainder did not include an appraisal whether positive or negative on the environment, thus the case study was a high-level exercise with limited detail. This illustrates that some of the cases

(11%) whilst promoting themselves as engaging with ES approaches had little depth of analysis risking greenwashing. This is an important result that illustrates the implementation of ES approaches can misused or misunderstood undermining the credibility of the corporate report and threatening the social license to operate.

Table 7 below illustrates the positive impacts included in the assessments. Alongside the impacts we include the ecosystem service type. The highest frequently reported ES positive impacts across the cases were carbon sequestration and water quality, both of which are regulating services and biodiversity as a provisioning service. Furthermore Table 7 below highlights that some of the assessments analysed in the meta-analysis include impacts and criteria that are not an ecosystem service. This is illustrates that there are some deviations from theory in implementing ES approaches and that many of the criteria included in the impact assessments are historic environmental management assessment criteria. This will be expanded on in the discussion section.

Ecosystem service type	Positive impacts	Results	
		No. Cases	% of database
Regulating service	Carbon sequestration	19	24%
Regulating service	Water quality	10	13%
Provisioning service	Biodiversity	8	10%
Cultural service	Recreation	6	8%
Cultural service	Health and wellbeing	5	6%
Regulating service	Air quality	4	5%
Not an ecosystem service	Energy	3	4%
Not an ecosystem service	Alternative materials	3	4%
Not an ecosystem service	Land restoration/conservation	3	4%
Not an ecosystem service	Secondary resources	3	4%
Regulating services	Flood attenuation	3	4%
Regulating services	Pollination	3	4%
Regulating services	Soil quality	2	3%
Provisioning	Food security	2	3%
Provisioning	Timber	1	1%
Cultural service	Education and research	1	1%
Provisioning	Seedling production	1	1%
Regulating	Waste	1	1%
Cultural services	Spiritual and cultural	1	1%
Sum		79	100%

Table 7 - ES impacts (positive) assessed in each case

Table 8 illustrates the negative impacts appraised in the case study assessments with climate regulation and Green House Gas (GHG) emissions (including carbon emissions) and water quality the most frequent impacts assessed with air quality (emissions excluding greenhouse gases) the third most frequently reported impacts assessed. This focus on climate change may be as a result of the growing societal pressure to report on these issues. The focus on the negative impacts on organizations on water quality is an interesting finding and does suggest and awareness of the potential scarcity of fresh water and the dependence of humanity on fresh water.

Service type	Negative impacts	Results	
Regulating	GHG	58	21%
Regulating	Water quality	56	21%
Regulating	Air pollution	36	13%
Not an ES	Land use	22	8%
Regulating	Waste	22	8%
Provisioning	Biodiversity	20	7%
Provisioning	Fiber or Material use	13	5%
Not an ES	Energy	12	4%
Regulating	Soil quality/ pollution	9	3%
Cultural	Health and wellbeing	7	3%
Cultural	Recreation/visual amenity	4	1%
Cultural	Noise	4	1%
Provisioning	Food security	3	1%
Regulating	Pollination	2	1%
Provisioning	Timber	1	0%
Cultural	Livelihoods	1	0%
Sum		271	100%

Table 8 - ES impacts (negative) assessed in each case

4.4.1.3.2 Assessment of dependencies

Far fewer assessment included an appraisal of the dependencies of the organization on the environment with only 29% of the cases including an appraisal of the dependencies of the organization on the ecosystem. This is a key finding of this research as will be expanded on in the discussion. Implementing ES approaches in corporate sustainability practice should in theory raise awareness of the dependency of the organization on the environment. For those organizations that do report on the dependencies, dependency on fresh water is the most reported dependency (37%) with biodiversity the second most reported (16%) and climate regulation the third most reported dependency (9%). A broad spectrum of dependencies was then reported across the exceptional case studies that reported on their ecosystem dependencies, these dependencies included being reliant on pollination, disease regulation and soil fertility.

The results illustrate that where dependencies are analyzed and reported the dependencies are far reaching, however very few of the case studies analyzed in this meta-analysis include an assessment of how the organization is dependent on the services provided by the ecosystem.

4.4.1.4 Stage 4 – Risks and Opportunities

The risks are regularly mentioned in the case studies, often in the rationale section for undertaking the assessment, however in the majority of cases (55%) no detail was provided describing what these risks are either to the business or the ecosystem. In the instances where risks were stated, climate change was the highest (12%) and fresh water second highest (8%), the remaining 25% of reported risks were spread across a diverse range of ecosystem service risks reported in one or two cases.

The opportunities were similarly rarely mentioned with 60% of the cases studies not reporting the opportunities of ES within their business operations. Where opportunities were reported the most reported was the ability to share knowledge on ecosystem services (8%) and build partnerships (2%). The remaining opportunities were spread across a diverse range of opportunities specific to each case.

4.4.1.5 Stage 5 – Response practice

Having implemented an assessment of the relationship between the organization and the assessment (at whatever scope chosen) a reader might expect a report to contain a commitment to take action in some way. Our findings illustrate that 39% of the cases analyzed did not provide detail on any action to be taken, or how they would respond to the findings of the ES assessment. For those that did provide detail the greatest response was to continue reporting (17% of the cases), with further commitments (4%) to embed within the business and share knowledge (4%). This suggests that ES assessments are not translating into action in the cases included within this meta-analysis.

4.4.1.6 Stage 6 – Monitoring and Evaluation

Reviewing the cases in our meta-analysis only one of the 125 cases stated they would monitor the KPIs they established as part of the ES assessment. This is a big gap in the implementation of ES assessments and hinders continuous learning in the application of ES assessments. This also suggests that the implementation of ES approaches in corporate sustainability falls short in the later stages of theory when the organization is required to use the assessment to affect change. This is a shortcoming of the current implementation of implementation of ES approaches in corporate environmental sustainability practice. As the corporate reporting literature previously highlights (see Braam et al., 2016), third party assurance would enhance the implementation of ES approaches from theory to practice to audit

changes that have been reported on in an organization from previous years. This will be expanded on in greater detail in the discussion.

4.4.2 Archetypal analysis

Building on the results from the first stage of analysis we sought to spot patterns or archetypes in groups of cases, by understanding that each case is an analysis and report of a socio-ecological system (i.e. the relationship between the organization and environment) and that each case applies different tools across a global context. The results from our analysis found three observable archetypes namely; multi-national corporations (MNC) predominately use integrated reporting methods; consumer-oriented organizations all use ES approaches to report on climate change; and organizations reliant on the sale on global ES (e.g. forestry or water utility) demonstrate global application of ES approaches in corporate reporting. Each of these findings are expanded on below.

4.4.2.1 Multi-national corporations (MNC) and use of ES approaches in integrated profit and loss reporting

Grouping the cases by organization type we found that the multi-national corporations such as Kerring or Coca Cola are predominately using integrated profit and loss or environmental profit and loss methods to incorporate ES approaches within their corporate reports. Results from our meta-analysis suggest that over half of the cases of Multi-National Corporations implementing ES approaches use a profit and loss method either an integrated profit and loss (IPL) or environmental profit and loss (EP&L) methodology. Comparing this to the whole sample as illustrated in Table 2 where these profit and loss methods made up only 31% of the sample it suggests there is a preference for MNCs to use methodologies that integrate with existing wider corporate reporting procedures. Our findings support previous literature such as (Pritchard and van der Horst D., 2018) suggesting multi-national corporations have an established method for reporting that they wish to align with.

4.4.2.2 Consumer facing organizations and inclusion of climate change in ES approaches

Grouping the consumer facing organizations within our meta-analysis we sought to identify patterns in the reported impacts within their ES assessments. Where the analysis of ES impacts were reported on, all of the cases (35) analyzed their impacts on climate change as part of their ES approach. Whilst all cases went on to analyze a range of other ES dependent on their scoping exercise, sector and business type, this result suggests a consumer need to report on the impacts of the organization on the climate change agenda.

4.4.2.3 Global representation of resource-based industries (forestry and water utilities) using ES approaches in corporate reporting

Grouping the cases by geography there was a pattern that ES based industries (i.e. organizations that are directly reliant on the sale of an ES stock) such as forestry or water utilities have a global presence in the case study database. This grouping of case studies covers 6 of the 7 continents of the world (with the 7th being Antarctica). For example, the global spread of case studies for these organization types include; forestry in the US, Russia, Latin America, Denmark and the Republic of Congo; tea and coffee production in India and Columbia; salmon fishing in Norway and the UK; and finally, water utilities or management in the UK, Australia and Switzerland. Whilst the broader database illustrates a global spread the uptake of ES approaches across these sectors is an interesting archetype within our meta-analysis that will be explored further in the context of the literature below.

4.5 Discussion

Our research provides empirical evidence that organizations are using ES approaches in corporate reports. It further demonstrates that the application is across a range of organization types from business to business and business to consumer, and across a range of scales with global analysis of direct operations the most frequent. The first section of discussion draws on our advanced conceptual corporate ES approaches implementation framework (Figure 5) and discusses the strengths and weaknesses of current practice in corporate use of ecosystem services approaches through this theoretical lens. The second section of our discussion builds on the archetypal analysis and considers the implications within the context of previous the literature of the findings from the archetypes. The third section brings these two levels analysis together and discusses the implications of the archetypes in the context of the strengths and weakness of ES approaches in corporate sustainability.

4.5.1 Implementation of ES approaches from theory to practice

It is clear that the detail and assessments get weaker through the stages, stage 1-3 contain more detail than the latter stages 4-6. From the second section of stage 3 (dependencies) through to stage 6 most case studies are very scant in detail. Below we discuss the strengths and weaknesses of the current practice in relation to the literature.

4.5.1.1 Strengths found in implementation of theory

Applying our analytical framework, the following three strengths are observed in implementation of corporate ES approaches: good scoping of assessments (stage 1) with common themes across scales, sectors and regions and global reach; stage 2 all case studies

were voluntary initiatives often by investors and stage 3, good understanding of the impacts particularly in relation to climate change and water use.

The meta-analysis of case studies illustrates that the ES approaches focused most frequently on climate change issues, then water use and quality and finally and less frequently biodiversity. These are common environmental themes in corporate environmental sustainability. Given the urgency of the climate change agenda for corporate environmental sustainability (Gulluscio, Puntillo, Luciani, & Huisingh, 2020; Wright, Nyberg, De Cock, & Whiteman, 2013) it is important and valuable that climate change issues are the most frequently included impact in the assessment. This is particularly true given the intricate links between climate change and biodiversity loss (Steffen et al., 2015). This consistent consideration of impacts at a global scale and across sectors and regions helps to progress global action towards reversing current climate change trends. Our meta-analysis suggests that ES approaches have a global reach that are being used across sectors, geographies and supply chains. ES approaches are adopted across a range of scales and geographies, organization types and sectors. These common themes offer organizations the opportunity to provide finer granularity in their corporate environmental sustainability reporting by implementing ES approaches which account for the stocks and flows from the ecosystems to the organization. This finer granularity has the potential to improve corporate environmental sustainability reporting.

Our analysis highlighted that multiple investment organizations produced case studies or illustrative examples of investment projects where ecosystem service approaches were being used to inform investment selection. The voluntary nature of all of the case studies alongside the interest from the investment sector suggests there is interest from the finance sector in understanding ecosystem risks and opportunities for investment. The case studies provided from the investment sector varied in depth, breadth and application but illustrates the demand from financial investors to use the method. ES approaches are being used to inform the viability or riskiness of the business or project. This suggests there is an increased awareness of environmental risk to business, but also that there may be a greater demand from stakeholders seeking to make or justify sustainable or ethical investments. This demand from investors emphasizes the need for independent assurance or certifiable standard in ES use in corporate environmental reporting to avoid potential greenwash. Whilst using ES approaches to inform investment decision making may significantly advance corporate environmental sustainability action, this will only be the case where the ES approach is both robust and transparent, and to win the trust of stakeholders, independently assured.

Finally, the assessments focused on impact of the organization on the ecosystem. The analysis showed organizations were aware of the impacts that the organization was having on

the ecosystem, with previous methodologies adopted such as Life Cycle Assessment helping to inform their ecosystem service approach. ES approaches can build on previous environmental sustainability initiatives such as managing fresh water use, where there is an alignment of scope and an understanding of ES methods. Whilst there are some strengths to using ES approaches in corporate environmental sustainability it is an important method to consider whether it is contributing to corporate environmental sustainability. The following section discusses the weaknesses of the approach.

4.5.1.2 Weaknesses found in implementation of theory

Through our meta-analysis of the case studies, it is clear that more needs to be done to improve implementation of ES approaches with many weaknesses and gaps in implementation. These include three weaknesses, these being; limited analysis and reporting of the dependencies (Stage 3); similarly limited reporting of the risks, opportunities (Stage 4); and limited analysis of monitoring and evaluation (Stage 5) of the assessment.

First, we find no evidence that use of ES approaches makes clear the dependency of the organization on the ecosystem for its services. Whilst theoretically it is a stage in the assessment process, very few case studies include and report on the dependencies of the organization on the ecosystem. Poor analysis of the dependencies of the organization on the ecosystem illustrates a lack of understanding how the environment underpins the organization (Tashman 2020) or ecosystem embeddedness (Winn and Pogutz 2013). This dependency is crucial to shifting the perception that the organization is separate from nature, it is necessary to understand that the organization depends on the ecosystem for its services with the organization nested within the planetary ecosystem. This understanding of dependency is necessary to then understand that the health of the organization is directly related to the health of the ecosystem it operates within. Appreciating whether the lack of assessing dependency in the assessment is due to poor implementation of ES approaches or whether it is due to a lack of knowledge is difficult to ascertain. Furthermore, it is noted that highlighting the dependency of an organization on specific ecosystem services may have commercial sensitivities which could reduce the amount of information in the public domain, however across the meta-analysis little to no dependencies on the ecosystem are included.

The scarcity of natural resources and the services that flow from the ecosystem has drawn attention in the management literature more recently; Figge and Hahn (2021) discuss the importance of understanding the scarcity and constraints of natural resources on firms. Whilst in theory these risk and opportunities should be assessed in Stage 5 of the conceptual framework for implementing ES approaches, we found little empirical evidence in our meta-analysis. Understanding these risks and gathering more data on the implication of resource scarcity on

sustainable business is an important research area to address. Furthermore, whilst natural resource dependency is a requirement in ES approaches it is poorly implemented and is a weakness in the cases studied. This will hinder decision making in corporate environmental sustainability practice, if cases that use ecosystem services approaches, have a poor understanding of stage 5 (dependencies and opportunities) in their assessments. Furthermore, some case studies stated that managing risks was a motivator for using ecosystem service approaches but provided no detail on the risks that were included in analysis. This has the potential to undermine the corporate report and open to criticism of greenwashing.

Furthermore, there is limited analysis of the opportunities associated with taking an ecosystems approach. Our analysis finds a good understanding of the impacts of the organization on the ecosystem, an important and weaker stage is to consider the opportunities of the business and ecosystem relationship. Switching from the negative to positive framing of the organization-ecosystem relationship is an important stage in engaging with a broader audience as well as understanding the symbiotic relationship that is the organization-ecosystem nexus. For example, it may be restoring peatland in upland areas of a water catchment for a water utility company may offer both recreational opportunities for organizational stakeholders, but may reduce water treatment costs further down the catchment due to nature based solutions improving water quality before entering the mechanical water treatment facility; one famous case being the Catskill watershed supplying New York City.

Finally, there was little circularity included in the assessments with an absence in the reporting of any monitoring or evaluation of the assessments. Including a monitoring stage is essential to identify if actions taken as a consequence of the appraisal were successful in achieving the aims and objectives established in the scoping stage. Furthermore, evaluating the appraisal provides an opportunity to reflect on data and processes that worked well and those that did not, offering an important opportunity to learn and improve on the next iteration of the appraisal. Understanding that the ecosystem and business are both evolving over time it is important to conduct iterations of ES approaches over time to monitor change and progress over time. This closed loop cyclical process is crucial to continuous improvement in the health of the ecosystem. This may in part be due to weaknesses in industry guidance such as the natural capital protocol which omits the monitoring of the assessment and is not cyclical. This leads to poor implementation of ES approaches. Our analysis suggests that ES assessments are conducted in a linear way, so it is not intended that the assessment feeds into standard business cycles or that the assessments will be repeated. Thus, it is not a closed loop process, but potentially a one-off, undermining the momentum needed for continuous improvement in advancing towards a sustainable relationship between the organization and the environment.

4.5.2 Advancing the implementation of the conceptual framework

Implementation of theory in practice can often be challenging, making empirical evidence particularly for theories seeking to contribute to reversing the continued ecological crisis and decline in biospheric health. We find that the implementation of ES approaches gets weaker the further through the conceptual implementation framework organizations progress. Thus Stages 1-3 are generally better implemented than the second of half of Stage 3 through to Stage 6. This may be due to the fact that these are the more time, data intense or uncertain stages of implementation or simply that momentum is lost following an initial level of enthusiasm for using ES approaches. It is important this is addressed to improve the implementation of ES approaches in practice.

The circularity of the conceptual framework is crucial for implementation of ES approaches. The Natural Capital Protocol (a dominant industry guidance with global application) is linear and does not include the circularity. This is a flaw, missing opportunities for assessments to track progress over time. Finally, the process and assessment themselves should be evaluated for areas which worked well or data that would help strengthen the next iteration of an ES assessment. The analysis of previous ES assessments should be used to inform subsequent decision making on future ES approaches or nature-based approaches. This closed loop process is an important contribution which should be embedded in implementation.

4.5.3 Archetypes in organizational use of ES approaches and their implications

4.5.3.1 Multi-national companies (MNC) and use of ES approaches in integrated reporting

Our analysis finds MNCs more frequently use integrated profit and loss methods to ES approaches which aligns with integrated reporting methods. This finding supports previous literature (see Pritchard van der Horst D., 2018) but provides a bigger empirical evidence base to suggest a preference for use of integrated profit and loss methods in corporate reporting. Positioning this finding within the literature, it is understood that MNCs often have an established reporting procedure which is being independently assured (see Braam et al., 2016). This established method and culture of reporting may constrain the tools and methods that are used in ES approaches as the data that is gathered seeks to fit within these established reporting frameworks. As noted earlier in the literature review, to date there are no certifiable standards against which to audit ES approaches in corporate reporting. As many MNCs commit to third party audit and certification this may play a role in the implementation of detailed ES approaches at scale. Until standardized methods for ES approaches are available ES approaches may be kept on the periphery of corporate reporting.

4.5.3.2 Consumer facing organizations and their inclusion of climate change in ES approaches

The climate crisis is gaining greater and greater traction in society with the emergence of the Youth Movement and global change makers such as Greta Thumberg. Scholars such as Hahn et al (2017) note that climate change is receiving greater attention while ecosystem services approaches are less well studied. This proposition in literature is evident in our empirical analysis. Consumer facing organization that receive their social license to operate from a broad range of stakeholders in society place a strong importance on the climate change agenda. Whilst carbon sequestration is an ecosystem service itself and therefore forms a part of ES approaches, this should be included only as part of a broader ES approach in order to be theoretically robust. It is promising that consumer facing organizations are undertaking and reporting on climate change impacts and opportunities within the reporting of ES approaches. However a robust ES assessment should include all ecosystem services material to the organization, not just the ecosystem services that stakeholders wish to see reported. This finding reiterates the need for independent certification and standards for corporate reporting on ES approaches to avoid misrepresentation and potential greenwashing (Boiral & Henri, 2017; Lyon & Maxwell, 2011).

4.5.3.3 Global representation of resource-based industries using ES approaches in corporate reporting

Our findings suggest that resource-based industries implement of ES approaches in their corporate reporting across most continents on the planet. Resource-based industries such as forestry or water utility companies have a high level of corporate ecological embeddedness (see Whiteman, 2010; Winn & Pogutz, 2013). This higher level of ecological embeddedness (awareness of the embedded characteristic of the organizations position in the environment) suggests that no matter where on the planet the organization is operating it should be mindful on the impacts and dependencies that are occurring between the organization and the environment. Furthermore, organizations such as Sveaskog, a Swedish forestry company, are dependent on the health of the forest ecosystem in order to produce timber to sell to their consumers. This direct relationship between the health of the ecosystem and the primary product that is being sold may attribute in part why there is such a global spread of cases studies of ES approaches in corporate reporting.

Furthermore, these resource-based industries are seeking to manage the global commons with the sectors covering human use of water, timber or more widely forests and food supply such as tea, coffee or fisheries. We are moving into the age of the Anthropocene where the biggest planetary force is humans (Hoffman & Jennings, 2021) and there is emerging

recognition that in order to managing impacts it is necessary to take an ecosystem or planetary scale approach (see Howard-Grenville & Lahneman, 2021). This global use of ES approaches in corporate reporting in specific sectors does illustrate the potential for use cumulatively at this scale. Our empirical findings supports the idea that theories at the ecosystem level, such as ES approaches could present opportunities for this new sustainability transition (Bateman & Mace, 2020; Howard-Grenville & Lahneman, 2021; Mace et al., 2014; Macellari et al., 2018).

4.5.4 Cumulative implications from our thematic and archetypal analysis and their contributions

Having discussed the implications of thematic and archetypal analysis individually, we consider the cumulative implications, by taking each archetype and discussing them in relation to our previous strengths and weaknesses of ES implementation discussion. We find three points for further discussion. First is that the use of ES approaches in corporate reporting for MNCs holds potential for standardization and an opportunity for independent voluntary certification. Second, consumer facing organizations could establish best practice in how to consider climate change in ES approaches and similarly seek independent certifiable standards. Finally, resource-based industries offer great opportunities to advance both monitoring and evaluation practice and raising sectoral awareness of the organizational dependency on the environment. We provide further detail on each point below.

First, use of ES approaches in corporate sustainability reporting for MNC's holds potential for standardization and an opportunity for independent voluntary certification once standards have been developed. Given the current homogenous nature of the scope and methods currently used in each MNC case study, reaching a consensus across the archetype may be initially be easier to obtain, than a consensus across all organizations. This standardization and independent verification would improve robustness and reduce the charges of green washing particularly in these global organizations. This offers significant opportunities for further research.

Second, consumer facing organizations may drive for a certifiable standard of ES implementation to facilitate their stakeholder license to operate, particularly in relation to consideration of climate change in ES approaches. Given climate change is consistently included in ES approaches by consumer facing organizations there is significant opportunity to establish best practice on how to incorporate climate change agendas within ES approaches, particularly when considering boundaries between different organizations, or between levels such as national and organization level climate change agendas. This would offer a great advance to ES implementation in corporate environment sustainability and contribute to

reversing both the global climate and biodiversity crisis. Given the ever-growing societal pressure on consumer facing organizations to demonstrate action on climate change, developing best practice techniques embedding carbon accounting within ES approaches, then developing independent verification could maximize the opportunity of this consistently reported ES in this archetype.

Third and finally, resource-based industries offer opportunities for sectoral advances in monitoring and evaluation across multiple scales, for example relating site NC applications to national, international and global levels applications, as the archetype identified that resource-based industries are using ES approaches at a range of levels as well as geographies. Furthermore, there is a great opportunity for this sector to emphasize the dependencies of organizations on a health ecosystem. If widespread knowledge and data sharing occurred between organization and their stakeholders e.g. organizations with community groups or between similar organizations, a true picture of the impacts and dependencies of the sector could be shared across multiple organizations. This offers a great potential for the true dependency of the sector as a whole on the ecosystem. This is a fundamental weakness across the implementation of ES approaches in corporate sustainability and cross-sectoral sharing and implementation of this approach offers a significant opportunity to shift organizational awareness of the dependency on the environment. Policy makers and practitioners should encourage this peer-to-peer knowledge sharing to raise awareness of the sectoral dependency on the ecosystem and the urgency and importance of advancing sustainable business practices,

4.6 Conclusion

Biodiversity loss due to anthropogenic impacts is happening at an unprecedent rate and further research is required to understand the relationship between corporate organizations and the ecosystem to help humanity operate within sustainable planetary boundaries. Corporate reporting and disclosure on environmental issues, is one mechanism used by organizations to share with stakeholders their wider value contributions to society. Through this lens we analyze the implementation of ES approaches in corporate sustainability reporting, conducting a meta-analysis of 125 case studies implementing ES approaches in their publicly available corporate reports. The aim of this research is to provide empirical evidence and critically analyze corporate use of ecosystem service approaches in corporate reporting. The contributions of this paper are threefold. First, we provide greater empirical evidence of ecosystem services in corporate environmental sustainability practice. Second, we provide a breadth study of ES approaches in practice. Third, we use archetypal analysis to discuss patterns across the global implementation of ES approaches in corporate sustainability reporting.

Limitations of this research are that they are based on publicly available information and thus are a self-report of actions within the organization. Further data triangulating this information with personal narratives of specific cases would provide greater detail to this breadth study. Furthermore, the sample was developed in tandem with the Capitals Coalition, thus case studies were selected for companies who were part of the Coalition and had chosen to connect themselves with an industry body championing the use of ecosystem services and natural capital approaches. Future research areas include analysis of the methods and tools used in each of the corporate reports to understand nuances in different methods. Additional research conducting a longitudinal study where corporate reports over a specific time period e.g. 10 years are analyzed for the different corporate environmental sustainability theories used and the implications would provide an interesting research line of inquiry building on this research paper. Finally, comparing corporate reporting with corporate action and the consequential biophysical measure within the scope of the ES assessment used either for one organization or multiple organizations would help improve corporate environmental reporting theory and practice in the future.

This paper suggests that ES approaches have the potential to advance corporate environmental sustainability reporting practice where they are implemented successfully, although there are a number of weaknesses currently observed in practice. Our archetypal analysis suggests implementation would be strengthened through certifiable standards for use in practice and finds that ES theories offer the potential planetary or system wide approach to the transition towards the new transformational era of the Anthropocene. It is imperative that further research is conducted in this area if we are to reverse the unprecedented rate of biodiversity loss at a planetary scale.

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Chapter 5 – Discussion and Conclusions

5.1 Overview

This chapter begins by reiterating the aims and objectives of my doctoral research, and discussing the cross-cutting themes. From this perspective I provide detail on how this body of research contributes to theory and practice both individually and as a doctoral study. Next, I discuss future directions emerging from this research and discuss the strengths and limitations of this work. I conclude with a summary of the overall project.

Biodiversity loss is one of the greatest challenges of our time (IPBES, 2019). The climate and ecological crisis (loss of biodiversity) are gaining global awareness with a growing societal awareness to act to reverse these planetary pressures. Organizations are aware of the need to become more sustainable in this planetary context, seeking theories and methods that can be used to help develop sustainable business practices (Hoffman & Jennings, 2021). Situated in this context, my doctoral research seeks to explore the implementation of ecosystem services (ES) approaches in corporate environmental sustainability theory and practice. Through my research I find the following common themes across the papers, these being: the need for systems thinking, multiple levels of analysis, consideration of organizational resource dependency and a need to focus on implementation. Bringing these themes together I contribute to management literature in four ways. First, by widening empirical evidence on systems thinking for corporate environmental sustainability. Second, by providing empirical evidence of advanced time and space attributes in corporate environmental sustainability. Third, through providing greater interdisciplinary research by bringing the natural and management literatures together, and finally by advancing multi-level theory for implementation of ES approaches in corporate environmental sustainability. Each of which are built on in the following chapter.

5.2 Overarching research aims, objectives and summary of findings

5.2.1 Aim and objectives

The aim of this research is to critically examine how the concept of ES approaches are being used in corporate environmental sustainability practice. This is achieved through the following three research objectives:

a) To consider how to implement ecosystem service approaches at multiple levels within planetary boundaries.

b) To analyze whether using ecosystem service approaches advances system thinking within corporate environmental sustainability.

c) To identify the strengths and weaknesses in implementation of ecosystem service approaches.

5.2.2 Summary of findings

5.2.2.1 How to implement ecosystem approaches at multiple levels within planetary boundaries

To address this research objective, in Chapter 2 I develop a new conceptual framework to illustrate how to implement ES approaches at multiple levels within planetary boundaries. To do this I review the literature on corporate ecological sustainability from a multi-level systems perspective and position the ES approaches literature in this context. In the paper I summarize ES approaches for a management audience and position these approaches as one corporate environmental sustainability theory, from this platform I then develop the conceptual framework for successful multi-level implementation. Through this literature review I find a gap in the amount of management literature on ecosystem services implementation as highlighted by Whiteman et al., (2013), Hahn et al., (2017) and Tashman (2020) which reiterates the need for my research. Furthermore, the literature review highlighted a need for greater empirical research from a multi-level systems perspective on corporate sustainability use of ecosystem approaches (Starik & Kanashiro, 2020) which supports my further empirical research. Previous literature by D'Amato et al., (2018) includes a conceptual framework illustrating the process of assessing and responding to corporate impacts and dependencies on ecosystem services, and identifies related business risks and opportunities. This formed the basis of my thinking for the conceptual diagram. Reviewing their work I noted there were no considerations of scope, or monitoring and evaluation in their conceptual framework and added these stages in line with more recent literature (Addison et al., 2020; Starik & Kanashiro, 2020). Furthermore, I also included the multi-level component in the conceptual framework to consider planetary boundaries (Mace et al., 2014; Starik & Kanashiro, 2020; Starik & Rands, 1995). I therefore develop a conceptual framework to map out multi-level considerations at each stage of implementation when implementing ecosystem approaches in corporate environmental sustainability. I do this both by including the scoping and monitoring stages of implementation (a gap in previous implementation frameworks) as well as advancing multi-level theory for ES approaches in corporate environmental sustainability.

Having developed the conceptual framework in Chapter 2 I use this framework in paper Chapter 4 to structure my meta-analysis of case studies. Connecting the initial research in Chapter 2 (the development of my conceptual framework) with the empirical evidence of a large number of 'real world' cases of ES approaches in corporate practice. This builds a further layer of evidence and analysis that helps to inform the 'how' to implement ES approaches at multiple

levels within planetary boundaries. The meta-analysis in Chapter 4 suggests the ES approaches are being used at different levels but within the sample we analyzed there was little connection to the other levels of analysis within each case. This suggests that a conceptual framework explicitly linking each level of analysis through the process of ES implementation would help practitioners to understand the multi-level context within which their ES case is positioned. Thus, the development of a multi-level implementation framework would be helpful for practitioners to, consider the interactions between micro, meso and macro levels of analysis at each stage. For example, many of the corporate ES approaches analyzed in the meta-analysis are for sites, products, or organizations where there are national ES accounts. At the scoping stage, and throughout the ES appraisal it is important that the company acknowledge and understands the connections between the national ES appraisal and the company appraisal. Being aware of this organization-national boundary may facilitate both the company and national ES appraisals, as information is shared and partnerships develop. Further, both the company and national appraisal fit within the planetary scale ES appraisals conducted by the IPBES. It is important that at the scoping stage and throughout the process of implementing ES approaches an understanding of the connections, boundaries and feedbacks are acknowledged at each of these scales.

5.2.2.2 Use of ecosystem service approaches and whether they advance system thinking within corporate environmental sustainability

To analyze the use of ES approaches in a business setting in Chapter 3 I gather empirical data that draws on the personal narratives of 30 practitioners using ES approaches in a business setting. Following an inductive review of this qualitative research, common themes of systems, time and space emerged from the practitioner narratives. These findings connect with the literature review conducted for Chapter 2, such as Grewatsch, Kennedy and Bansal's (2021) paper on tackling wicked problems with systems thinking in strategic management, and reiterated the need for the systems framing across my research. Furthermore, the attributes of time and physicality noted in the systems literature (Starik & Kanashiro, 2020) were further inductive findings from my empirical work, for this reason I revisited the literature on systems thinking and ES approaches to explore this line of research. To address this objective of whether ES approaches advance systems thinking, I needed a framework which illustrated what an 'advance' in systems thinking would look like. I selected Binder et al.'s (2013) review of Social-ecological systems (SES) which compares 10 SES theories and I compared ES approaches with the more advanced SESF framework from Elinor Ostrom (Binder et al., 2013; Ostrom, 2009; Partelow & Winkler, 2016). This comparator could then be used to illustrate

whether my empirical findings illustrated an advance in systems thinking for corporate sustainability.

Using this systems theory lens, I analyzed the responses for advancements in understanding the social systems, the ecological system and the combined socio-ecological system. I find ES approaches raise the awareness of the environment as a system, and the need to consider the social and the environment as two systems interacting as well as the dynamism and physicality of the systems. This advances both theory and practice as decision makers in a business setting appreciate the complexity of the environment when considered as a system (Saviano, Barile, Farioli, & Orecchini, 2019). The potential links between unintended changes across the system from one anthropogenic trigger (Laspidou, Mellios, Spyropoulou, Kofinas, & Papadopoulou, 2020) and the need to build resilience to avoid these unintended consequences (Williams et al., 2019).

In addition, my findings provide empirical evidence advancing the literature on time in corporate environmental sustainability. Hahn et al., (2010) note that time is an important dimension which needs to be better understood in corporate sustainability, a current gap in both theory and practice. Temporal dimensions represent a core area which require trade-offs in corporate sustainability. It is only through having an awareness of the time dimension involved in decision making that it is possible to be aware of the trade-offs involved in making decision on the business use of the ecosystem (Hörisch, Wulfsberg, & Schaltegger, 2020). Therefore, my findings suggesting that ES approaches advance practitioner awareness of time in relation to managing the relationship between the organization and the environment. This represents an advance within the corporate environmental sustainability literature.

Finally the greater awareness of the physicality of the environment, that the environment is fixed to a geography and is finite contributes to literature on the sense of place literature and ecological embeddedness (Pogutz & Winn, 2009; Whiteman, 2010; Whiteman & Cooper, 2011). Previous theories on ecological embeddedness such as Winn and Pogutz's (2013) theoretical model of organizational ecosystem embeddedness have built on these concepts but our research provides further empirical evidence that these concepts go hand in hand and advance knowledge of the ecosystem in a business setting. These attributes of time and space, or the physicality of the environment, are noted in the systems theory literature as important attributes of a physical system. As noted in the literature section of my introduction, a system has dimensional domains such as time and space (Emery, 1981), thus this research advances practitioner awareness of the dimensional domains of the environment as a system.

5.2.2.3 Strengths and weakness in implementation of ecosystem service approaches.

In order to understand the strengths and weakness in implementation I draw on all three research papers. Chapter 4 provides a breadth analysis of implementation of ES approaches in corporate practice reviewing publicly available corporate documents that implement ES approaches. Through analysing these cases against my conceptual framework in Chapter 2, I am able to study the strengths and weaknesses in implementing ES approaches comparing theory to practice. I apply the conceptual analysis developed in Chapter 2 to analyze the cases. The study is a qualitative meta-analysis that analyzes 125 cases in 81 organizations of the implementation of ES approaches in practice.

Through this analysis I find the strengths are that the scope of the approaches are clear and frequently well defined, even though this is a new stage in my conceptual framework. This is an interesting finding as it suggests that organizations are more advanced than current theory on how to implement ES approaches in corporate environmental sustainability. This suggests organizations appreciate the importance of the scoping stage when implementing ES approaches or perhaps more broadly the importance of scoping in the corporate environmental sustainability context. Furthermore, I find that ES approaches are common across geographies and used across scales which are two strengths in implementation. This is particularly evident in resource-based industries. Common approaches allow compatibility across companies and countries which helps to bring partners and regions together to share knowledge and work towards the complex challenges of reversing the unprecedented global biodiversity loss. Furthermore, the motivations of many of the cases in the meta-analysis, and a number of cases themselves were from investment firms, indicating an interest from investors looking to invest (and evidence their investment) in nature positive schemes. This is one application of ES approaches (and a strength in implementation) which could positively contribute to reversing the unsustainable relationship between the organization and the environment. Thus, successful implementation of ES approaches at multiple levels can evidence more sustainable relationships in the organization-environment nexus and be used to justify further focus and funding for nature positive projects. Finally, the meta-analysis illustrates that ES approaches are strong in illustrating a depth and breadth of understanding of the impacts between the organization and the ecosystem particularly on the topics of climate change and water use. This deep understanding of the impacts on the organization on a further planetary boundary (climate change) and a finite global resource (water) contribute to broader sustainability agendas and illustrate ES approaches may contribute to wider corporate sustainability agendas.

Conversely through my analysis I find there are a number of weaknesses in implementation of ES approaches that are evident through the meta-analysis of cases. The

dependency of the organization on ecosystem services lacks elaboration or detail in reporting or are not considered in the case studies. Not understanding or acknowledging the dependency on the ecosystem undermines the use of ES approaches in corporate environmental sustainability. It may be that organizations are aware of the dependencies but choose not to report on them in publicly available information, however in this instance it creates an information bias that stakeholders may not be aware of when reading the implementation of ES approaches by the organization. As a consequence, this may lead both practitioners and stakeholders to believe the organization is not or less dependent on the ecosystem than is actual in the real-world context. This could be considered greenwashing and is a fundamental weakness of the cases studied in the meta-analysis. This finding of a lack of awareness of the dependency of the organization is further supported by the analysis undertaken in Chapter 3. Furthermore, my findings suggest further weaknesses in reporting on both the risks and opportunities associated with ES approaches. This provides evidence, through reported use of ES approaches, of a real disconnect between the social system (the organization) and the ecosystem. Again, this finding is reiterated through analysis of the in-depth interviews with practitioners in Chapter 3. Finally, in applying our conceptual framework for implementation there is a real weakness in monitoring and evaluating the ES approaches, with almost no reported monitoring and evaluation of the assessments. Again, it may be that approaches are evaluated but they are not included in the report, however given the breadth of the weakness across almost all reports indicates it is likely that many ES approaches are not evaluated. This has significant implications for the potential contribution of these approaches to corporate environmental sustainability practice, if these approaches are not monitored or evaluated, it is not possible to understand whether the appraisal and the actions taken within them have a positive (or negative) influence on the organization-environment nexus. Thus, it is impossible to know whether actions taken will have a positive or negative impact on the overall aims of corporate environment sustainability. Without information on the success of the implementation of ES approaches it is entirely unknown whether each organization has improved or worsened their relationship with the environment. This is a fundamental flaw in current implementation of ES approaches in corporate environmental sustainability. It is hoped that through inclusion of the monitoring and evaluation stage in my conceptual diagram this will raise practitioners' awareness of the need to evaluate ES approaches and in turn improve, both theory and practice in corporate environmental sustainability. Each of these weaknesses identified above is a weakness in the process of implementing ES approaches in corporate environmental sustainability. As noted in Chapter 4 practice would greatly benefit from a standardized auditable method for implementing ES

approaches in corporate environmental sustainability practice to ensure robust implementation from theory to practice.

Furthermore, weaknesses in ES implementation were identified in Chapter 3 these being: the bias of ES approaches to ecological systems over social systems; poor conceptualization of the social systems as being nested within or dependent on the ecological system, and practitioner knowledge of these limitations. These limitations are important for practitioners to understand that ES approaches should only be used to understand the relationship between the organization and the environment and within this there should be additional studies to consider the actor network and governance of the socio-ecological system being considered. Considerations of these two social components (actor network and governance) advances the socio-ecological system of ES approaches to the social-ecological system of Elinor Ostrom's Socio-ecological systems framework (SESF). Knowledge of these limitations are useful for practitioners to include in their corporate practice to facilitate a holistic corporate sustainability assessment. Without these connections to wider social systems there is the potential for ES approaches not to acknowledge the importance of social actors and governance in the management of the global ecosystem and in turn discount the social components of developing a sustainable relationship between the organization and environment within safe planetary boundaries.

5.3 Bringing research themes together

5.3.1 Systems research

The planetary boundary of biosphere integrity establishes the thresholds for a healthy ecosystem so that it may continue to provide goods and services that humanity relies upon for its survival (Cardinale et al., 2012; Mace et al., 2014). By establishing this threshold it highlights the risk of these benefits disappearing due to biodiversity loss (Hurley & Tittensor, 2020). The aim of this doctorate is to contribute research that frames both organizations and the ecosystem as systems, with organizational systems, nested within the ecosystem, which in turn is bounded by the systems thresholds of the planet. It is through this systems lens that we can understand the multiple levels that each of these systems operate and how any analysis of the ecosystem must understand each of the levels in order to operate within the global biodiversity threshold. Therefore, through this systems lens I specifically seek to advance corporate environmental sustainability literature on biodiversity loss examining the implementation of ES approaches at multiple levels in corporate environmental sustainability through a systems theory lens:

> "sustainability is a systems-based concept and, environmentally at least, only begins to make any sense at the level of ecosystems and is probably difficult to

> really conceptualize at anything below planetary and species levels" (Gray, 2010, p. 48).

It is through this systems theory lens that I address the wicked problem of biodiversity loss. As identified by Grewatsch et al., (2021) taking a systems lens in management scholarship is a novel approach and allows the complexities of maintaining a sustainable relationship between the organization and the environment to be understood in a holistic form. This is an important and emerging research lens in management scholarship as it moves away from the traditional reductionist approach to wicked problems to embrace socio-ecological systems in their wicked complexity (Grewatsch et al., 2021).

By adopting a system theory lens to understand implementation of ES approaches in corporate environmental sustainability I identified a gap in the literature adopting a multi-level systems approach for ES implementation in organizations. Building on previous ES implementation literature I develop a conceptual framework for implementing ES approaches from a multi-level perspective within planetary boundaries. This conceptual framework emphasizes the importance of micro, meso and macro level analysis at each stage of implementing ES approaches allowing for feedback loops to be considered throughout implementation. This conceptual framework takes a systems perspective to implementing ES approaches within planetary boundaries in accordance with Gray (2010), Whiteman et al., (2013) and Hurley and Tittenson (2020). Furthermore, it advances knowledge of the global biospheric integrity planetary boundary within implementation of ES approaches and corporate environmental sustainability practice. Raising awareness of the complexity of the systems, the potential for feedback loops and the global biospheric limits in implementation of ES approaches in corporate setting helps companies to understand their position in the greater global context of biodiversity loss. It is through this global framing and the need to work together across scales and geographies that we can attempt to reduce biodiversity loss on a planetary scale.

Second, in Chapter 3 and Chapter 4 my empirical evidence suggested that implementation of ES approaches in corporate environmental sustainability practice advanced knowledge of the environment as a system. Greater systems thinking offers an advancement in implementation of corporate environmental sustainability practice (Williams et al., 2017) as well as enhanced organizational resilience (Williams et al., 2019), as practitioners become aware of the interconnected nature of the environment, the potential trade-offs in decision making and, in theory, dependency between the organization and the ecosystem (Ahlström et al., 2020). However, as we will discuss in the next section my empirical findings in both Chapter 3 and Chapter 4 contradict this heightened awareness of the dependency of the

organization-environment system. In practice we found no evidence of an awareness the organization was dependent on the ecosystem for its continued survival (the nested nature of the organization being within the ecosystem) only that the environment was a system and the organization a further system that are connected. These empirical findings are helpful to challenge much of the systems theory literature which suggests that the dependence of the organization on the ecosystem is made more evident to corporate environmental sustainability practitioners. Specifically, through evidence from Chapter 4 it was possible to conclude the later stages of implementing organizational use of ES approaches, including dependencies, risks, monitoring and evaluation, were not well reported and likely not well implemented. From this it is possible to recommend to policy makers and practitioners that greater emphasis is made to the later stages of implementation of ES approaches to ensure the momentum is maintained when adopting the theory in practice. This emphasis in the latter stages of the implementation process is essential to address weaknesses in practice, such as poor awareness of dependencies, and limited monitoring and evaluation. Without these improvements in implementation of ES approaches in practice, the theory of ES approaches does not advance corporate environmental sustainability practice.

Third, through the consideration of ES approaches as a socio-ecological system in the corporate environmental management literature it is possible to advance the corporate sustainability literature on socio-ecological systems providing empirical evidence of the theoretical proposition that ecosystem approaches are biased towards the ecological system (Binder et al., 2013). Thus, ES approaches are socio-ecological systems theories rather than the balanced social-ecological systems theories (Baudoin & Arenas, 2020) such as Elinor Ostrom's SESF (Ostrom, 2009). This empirical insight highlights the importance of understanding the governance and social actors involved in the context of the ES approach in order to compensate for the ecological bias within the theoretical application of ES approaches in corporate environmental sustainability. This has important implication in both policy and practice as complementary considerations of governance and social actors across the implementation of ES approaches should be considered through supporting social impact appraisals.

5.3.2 Multiple levels of analysis

Across the research I have studied the implementation of ES approaches in organizations with an awareness of multiple levels. The primary level of study is the organization, and implementation of ES approaches in corporate environmental sustainability. However, ecosystems do not fit neatly into bounds of societal constructs, and thus should be considered across the individual, societal and planetary level. In studying implementation of corporate environmental sustainability theories there has been too little research studying

concepts at multiple levels (Heikkurinen & Mäkinen, 2016). When reviewing literature this became an evident and interesting theme both in the management literature (Aguilera et al., 2007; Arogyaswamy, 2018; Hitt, Beamish, Jackson, & Mathieu, 2007; Starik & Kanashiro, 2013, 2020) and the ecosystem service approaches literature (Brady, Hristov, Wilhelmsson, & Hedlund, 2019; Guerry et al., 2015; Schleyer, Görg, Hauck, & Winkler, 2015). Given the severity and ongoing biospheric decline over recent decades while corporate environmental sustainability theories have been developed and implemented, I was particularly interested in contributing to this multi-level literature when studying implementation of ES approaches. The aim of adopting this multi-level perspective is to maximise the impact of this research for practitioners, such that it may be useful for policy makers, business managers and academia alike. Starik and Rands (1995) multi-level theory for organizational ecological sustainability and now their latest paper advancing multi-level sustainability theory (Starik & Kanashiro, 2020) forms the foundation for much of this research.

I use these theories in my research and build on them in relation to implementation of ES approaches in an organizational context. In Chapter 2 I developed the conceptual framework for ES implementation in an organizational setting embedding multi-level theory in the framework. In Chapter 3 the semi-structured interviews are structured to prompt respondents to consider their responses in relation to multiple levels, their individual perspective and the organization that they represent. In Chapter 4 the levels of analysis sought information describing at which level ES approaches were being used. Given both the social system of the individual employee, the organization, the national and transnational system and the ecosystem of the site, the national and the global scale can be considered at multiple levels. Thus, throughout my research on the organization-environment nexus as a social-ecological system I argue a multi-level approach is important to provide the boundaries illustrating how each system fits in context to others, as well as to establish the boundaries of an assessment in the multi-level context.

Finally, it is through multiple levels of analysis that it is possible to build partnerships and co-create knowledge that may positively contribute to reversing the decline of our ecosystems. For example, by understanding the connection between individual impacts, company and national accounts it deepens our knowledge of the impacts and opportunities across the organization-environment nexus. It is through taking these multi-level approaches that we can truly understand the global context to use of ES approaches and contribute to reversing global biodiversity decline. Furthermore, by mapping the multiple levels of analysis in ES approaches it is possible to enhance the social systems, to develop partnerships within and across each level, allowing co-creation of solutions to environmental challenges that may not fit

within physical or social boundaries i.e. a watershed crossing regional or national boundaries. This facilitation of partnerships and co-creation of solutions to global environmental challenges can contribute to reversing the planetary boundary overshoot of biospheric health.

5.3.3 Implementation of ES approaches in advancing corporate environmental sustainability

Corporate environmental sustainability discourse has advanced beyond justifying its presence in management literature, yet more remains to be done to monitor progress and achievements in corporate environmental sustainability practice. This research suggests that advances in interdisciplinary natural and social science literature, specifically on ES approaches, reframe and allow a better understanding of the organization-environment nexus. Ecosystem services and natural capital frameworks offer significant improvements on 'how' to understand the environment (Bateman & Mace, 2020; Guerry et al., 2015), and thereby can help to better implement and monitor corporate environmental sustainability theory and practice.

This research advances corporate environment sustainability literature and practice by continuing to bridge the divide between the conservation literature and the management literature. This brings together the literature on corporate environmental sustainability and ecosystem approaches for a management audience. The ongoing theme being to address the important disconnect between management and natural science literature, to help organizations apply the latest research, to inform corporate environmental sustainability action and to reduce negative organizational effects on an ecosystem currently in decline (Ahlström et al., 2020).

In bridging the disciplinary divide my focus was on the 'how' to implement ES approaches. There a numerous methods and tools for ES analysis (Bateman & Mace, 2020; Harrison et al., 2018; Hein et al., 2020; La Notte et al., 2019) but fewer studies on the process of implementation in an organizational context (D'Amato et al., 2018). The overarching theme throughout my research is to focus on the 'how' is it best to use ES approaches to advance towards a more sustainable organizational-environment nexus. My findings suggest that ES approaches have their limitations in the Anthropocene but ES approaches when implemented fully is one way to nudge environmental practice forwards awaiting a transformational global implementation theory. Too much focus has been to divide between the theories of natural capital and ecosystem services. Theoretically they are two stages along a process (Potschin-Young et al., 2018), as illustrated in Chapter 1 (Bateman & Mace, 2020; Costanza, 2020). Practitioners are aware of the debate around the difference between ecosystem service and natural capital and spoke of this openly. As we focus on the how these approaches are used, we have studied them as one concept as the boundary in application becomes blurred. Throughout this research we have built on this theoretical and empirical premise in studying both ecosystem

services and natural capital approaches together to explore how the concept in its entirety contributes to corporate environmental sustainability.

5.3.4 Natural resource dependency of businesses

A further cross cutting theme throughout this research is the theory of natural resource dependency of the organization. As illustrated in the introduction, natural resource dependency theory emerges from the established literature on resource dependency theory in management literature. In theory, the aim of ES approaches is to highlight the impacts and dependencies of society (in this application the organization) on the ecosystem (Bateman & Mace, 2020; D'Amato et al., 2018; Watson & Newton, 2018). The management literature has, through resource dependency theory, sought to highlight these impacts and dependencies in corporate environmental sustainability (Drees & Heugens, 2013; Hillman, Withers, & Collins, 2009) . Tashman (2020) develops the management literature by reversing this perspective, acknowledging that resource scarcity and uncertainty is a reality and theorizing the implications of this on the organization. The natural resource dependency theory perspective, conceptualizes inter-organizational networks as socio-ecological systems and considers how elements of socio-ecological systems shape strategies to manage ecological scarcity and uncertainty. Figg and Hahn (2020) similarly develop this literature focusing on natural resource use and returns. Natural resource dependency theory offers a promising advancement in management literature embedding ES approaches into practice, bringing biodiversity and biospheric health to the forefront of managers minds, placing greater emphasis on the uncertainties of biodiversity loss within corporate sustainability (Stappmanns, Vogel, & Walls, 2021).

Review of this literature leads the reader to expect that use of ES approaches highlights the dependency of the organization on the ecosystem. In theory implementation of ES approaches can raise awareness of the uncertainty or risks associated with the dependency of the organization on the ecosystem. In Chapter 2 I advance this literature by illustrating in my conceptual framework that the organization is dependent on the ecosystem at multiple levels. However my empirical findings in both Chapter 3 and Chapter 4 find no evidence of this heightened awareness of dependency, nor of natural resource uncertainty, with limited disclosure of either in corporate reports (Stappmanns et al., 2021). Chapter 3 does find empirical evidence of participants noting use of ES approaches as a method to manage risks; however, this is not extrapolated to discuss these risks as the dependency of the organization on the environment. Chapter 4 analyzes the case studies and finds no detailed assessments of the dependency of the organization on the ecosystem across the whole data set (125 case studies). In a few instances the introductory text acknowledges the organization is dependent on the environment, however in the implementation of ES approaches, the dependencies are not

described, measured or included in reporting. This is a discrepancy between theory and practice in organizational use of ES approaches. The rationale requires further research to understand why this discrepancy exists.

5.4 Contributions of the research

The aim of this research is to critically examine how the concept of ES approaches are being used in corporate environmental sustainability practice. Through the three research papers addressing each research objective and the cross-cutting themes discussed above there are four core contributions of this research. These are first, empirical evidence of ES approaches advancing systems thinking in corporate environmental sustainability practice. Second, empirical evidence of ES approaches embedding the attributes of temporal and physical considerations in corporate sustainability practice. Third, bridging disciplinary divides between natural and management science, through this research. Fourth, a theoretical contribution by advancing multi-level theory for ES approaches in use for corporate environmental sustainability through a new conceptual diagram. I take each in turn and provide further detail below.

First, the research suggests that ES approaches advance systems thinking in corporate environmental sustainability. Building on Starik and Kanashiro (2013, 2020) systems theory and Williams et al., (2017) systems thinking for sustainability management, I narrow the scope of my research to corporate environmental sustainability. My research provides empirical evidence to support the theoretical paper from Ahlstrom et al. (2020) on the use of ES approaches and resilience for corporate sustainability. Further Chapter 4 provides a breadth study of ES approaches in corporate environmental sustainability practice, by advancing D'Amato et al.,'s (2018) research, to expand the study for a bigger and global sample.

Second, research on temporal and physicality issues in corporate sustainability is still in its infancy (Gao & Bansal, 2013; Orlikowski & Yates, 2002; Slawinski, Pinkse, Busch, & Banerjee, 2017) with ongoing challenges as to how to embed intergenerational tensions (Hahn et al., 2015; Slawinski & Bansal, 2015) in corporate environmental sustainability practice. This evidence of an awareness of place and sense of physicality in corporate environment sustainability advances practitioner awareness and environmental decision making (Bansal & Knox-Hayes, 2013; Whiteman, 2010; Whiteman & Cooper, 2000). The findings from this research contribute to literature and suggest that ES approaches are one way to embed an awareness of the physicality of the environment in corporate environmental sustainability practice. Through application of ES approaches, practitioners understand the attributes of the environment in a great depth which in turn changes their understanding of the environment for the better and consequential decision making. Evidence of a greater awareness of these physical

attributes of time and space also contributes to literature on paradoxes in corporate environmental sustainability as it is through the heightened awareness of each attribute that practitioners can understand the tensions and paradoxes required in decision making. My research finds that using ES approaches in corporate environmental sustainability emphasizes the temporal nature of the environment to practitioners. Evidence of this raised awareness of temporal issues in environmental management in a business context can advance the implementation of this literature.

Third, my research bridges both the disciplinary divides of conservation and management literature as well as the academic/practice divide. My research has brought the literature together forming the foundation for all three research papers and continues to contribute to interdisciplinary research on corporate environmental sustainability. Furthermore, in addition to the theoretical call for further research on ES approaches in corporate sustainability, we note, that organizations are voluntarily using ES approaches to understand their organizational impacts and dependencies on the environment with little academic critique. This is an important contribution of my research bringing empirical evidence of organizations' use of ES approaches and offering critical analysis. An illustration of this industry use is provided in an industry synthesis report, which reviewed 42 case studies of global private sector organizations using and/or publishing material on the ecosystem service and natural capital concepts. The cases include Shell, Mars, Nestlé, Wal-Mart, Nissan as well as Coca Cola, Dell, Akzo Nobel, Tata, Kerring (incorporating Gucci and Puma) and Unilever (Pritchard and van der Horst D., 2018). While implementation of ES approaches has proliferated in practice, there is less attention to these concepts in corporate environmental sustainability literature (Ahlström et al., 2020). Thus, I contribute to the call for research in this area to ensure academic research can critique, inform, and be informed by corporate environmental sustainability in practice.

Fourth, my research contributes to literature on implementation of ES approaches in corporate environmental sustainability through development of a conceptual framework for multi-level natural capital implementation for corporate environmental sustainability. This contributes to literature by taking a multi-level approaches to ES implementation, which is a gap in the previous literature (Starik & Kanashiro, 2020) on ES implementation for corporate environmental sustainability. Furthermore my conceptual framework advances the process of ES implementation for corporate environmental sustainability by including the two stages of scoping and monitoring and evaluation advancing D'Amato's (2018) previous framework. This advancement contributes to the literature on the scoping of corporate sustainability initiatives (Starik & Kanashiro, 2020) and the importance of monitoring, evaluating corporate sustainability initiatives (Whiteman et al., 2013).

5.5 Implications of the research

The implications of this research are sixfold, which we first summarize. First, adoption of the conceptual framework in practice would help maximise the benefits and minimise the disbenefits of implementing ES approaches in practice. Second, the findings of this research emphasizes the need to focus on the later stages of the implementation process of ES approaches in corporate environmental sustainability practice to maintain robustness and momentum. Third, to be aware of the limitations of ES approaches as a socio-ecological system to help policy makers and practitioners better apply complementary supporting measures to boost social systems understanding within the organization-environmental nexus. Fourth, to be aware that the theory and practice are currently juxtaposed as to whether ES approaches enhances awareness of the dependency of the organization on the environment, suggesting the need for greater research to explain organization-environment dependency. Fifth, the bridging role this research offers to policy makers and practitioners bringing business leaders, policy makers and conservation scientists together to deepen their understanding of the natural resource dependencies. Finally, through greater empirical evidence of the use of ES approaches, policy makers and practitioners are more informed of the strengths and weaknesses of ES approaches in use as well as the role of certifiable standards in this area. This can lead to better-informed decisions as to whether to implement ES approaches in their own corporate environmental sustainability practice as well as whether to seek independent validation or certification.

First by developing and promoting adoption of the conceptual framework for multi-level implementation of ES approaches for corporate environmental sustainability we facilitate improved implementation of ES approaches in corporate sustainability practice. Through mapping out the process across multiple levels, not only should this improve practice but facilitate analysis across multiple levels and similarly building partnership working across these multiple levels through an awareness of interactions and boundaries with other sections of global society. Through this improved understanding that each ES approach does not occur in isolation but within a broader context this may facilitate partnership working, sharing knowledge and information and co-creation of solutions to environmental challenges in practice.

Second, through analysis of implementation using the conceptual framework, and knowledge that the latter stages of the process are less well implemented (these being Stage 3 Impacts and Dependencies, Stage 4 Risks and Opportunities, Stage 5 Responses, and Stage 6 Monitoring, Evaluation and Reporting), it is possible to recommend an additional focus is applied to the latter stage of ES approaches i.e. Chapter 2, Figure 1 Stage 3 onwards. This is so that it may improve the implementation of ES approaches in corporate sustainability practice.

The implications of this are that the benefits of ES approaches in corporate environmental sustainability may be maximised and it may be possible to more clearly ascertain whether actions taken through ES approaches positively contribute to both organizational sustainability commitments and wider national, international and planetary targets and boundaries.

Third, observing and highlighting the ecological bias in the socio-ecological system of ES approaches for corporate environmental sustainability can allow both policy makers and practitioners to complement adoption of ES approaches with supporting approaches to consider the governance and social actors involved, alongside further social systems appraisals. Highlighting this bias is important in practice to improve practitioner understanding and facilitate a balanced appraisal. Raising awareness of potential bias in ES approaches emphasizes the need for voluntary or mandatory certifiable standards. This has important implications for policy makers, potential investors and wider stakeholders to ensure robustness in use of ES approaches in corporate sustainability reporting.

Fourth, although the awareness of the business being dependent on nature should in theory be increased through the use of ES approaches, my findings showed no evidence of this. This has implications for management research as a contradictory finding to the current discourse. Emerging literature suggests that there may be hesitancy to publicly disclose the dependencies of the organization on the environment (Stappmanns et al., 2021). This would align with my findings that there was limited publicly available information. However, my empirical findings from the semi-structured interviews also suggested that whilst there was an awareness of the dependency of the organization on the environment, the detail behind these dependencies was not well understood. Therefore, that the natural resource dependency of the business is an important area of future research particularly in practice. Poor understanding and limited public disclosure hinder the advancement of corporate environmental sustainability as it is necessary to understand the organization depends on the environment and ultimately bounded by planetary limits or boundaries. This conceptual shift in understanding that the organization is nested within the environment, which is nested within planetary boundaries is fundamental to advancement of corporate sustainability theory and practice.

Fifth, this research brings together a series of disciplines both in theory and practice which may play a boundary function, offering a safe space for policy makers and practitioners to try to account and value for the environmental impacts and dependencies that organizations have on the ecosystem. This boundary function evident in this research has notable implications as it emphasizes the need for a safe multi-disciplinary space to work though the practical detail of implementation ES approaches in corporate sustainability at specific scales, geographies and across partners. This research implication confirms the major contributions of industry

organizations such as the Capitals Coalition, the World Business Council for Sustainability Development, Business for Nature or the We Value Nature Campaign which aim to provide this multi-sectoral, global partnership working on ES approaches in policy and business.

Finally, through collation and appraisal of multiple applications of the ES approaches in a business setting I provide a greater body of empirical evidence of ecosystem service approaches in corporate environmental sustainability. This allows advancements in corporate use of ES approaches for environmental sustainability and expands research in this area. Furthermore, this database provides the evidence to practitioners that ES approaches are being used at global scale and across a breadth of sectors. This provides empirical evidence for practitioners that may learn from peers and provide confidence in applying ES approaches in their organization. This may facilitate use on a global scale and help practitioners advance their awareness of the environment as a system. The implications of this peer-to-peer support is significant as it can facilitate sectoral partnerships as well and regional partnerships to accelerate implementation of ES approaches and deepen understanding at different levels and scales. Furthermore, policy makers can use the evidence from this research to understand current business practice in this area and seek to develop stretching and ambitious policy agenda's relevant to the scale or geography being considered. This contributes to literature calling for further advancement of ES approaches in use to move forward both corporate environmental sustainability literature and practice.

5.6 Limitations and future research directions

5.6.1 Limitations

As with any research inquiry there are limitations to the research. The limitations of this research are that Chapter 4 was based on secondary data in the form of publicly available information, thus there has the potential for bias within the reports reviewed. Furthermore, as the documents are publicly available there may be information which is sensitive to the business that are not suitable for a public audience that is withheld in the corporate documents. This could create a bias within the documents. As all documents reviewed within the meta-analysis are publicly available information this bias is consistent across the whole sample. Furthermore, across the whole research project the research was all conducted in English. For the semi-structure interviews participants were from the UK and Europe, for some participants English was not their first language. This may have influenced the narratives in the semi-structured interviews, although all participants conducted their business operations in English and thus held a high proficiency in the English language. In terms of sampling, both for the semi-structured interviews and the meta-analysis, conducting the research in English only may have

led to a bias in my sample towards English speaking organizations and countries. This is an acknowledged limitation within this research.

The case study database in Chapter 4 originated from early work with the Capitals Coalition, and comprises known organizations to this coalition that have developed case studies on implementation on ES approaches. Developing the database with origins to one organization could lead to a bias within the sample. The Capital Coalition is one of the leading industry bodies guiding implementation of natural capital and ES approaches. During the screening stage of this research, I compared the natural capital coalition with the other leading industry organization in this area: The Natural Capital Project. By comparing the Capital Coalition members with members of the Natural Capital Project I found significant overlap in the membership organizations. For this reason, it was decided the bias should be acknowledged as a limitation to my research but was considered unlikely to materially affect the research.

Finally, the latter stages of the research (the last two years conducted part-time) were conducted during the global pandemic. This changed the global context to the research and whilst all data gathering had been conducted prior to the global pandemic it is worth noting as a potential limitation to the overall doctoral research and has presented challenges to everyone's continued delivery of research.

5.6.2 Future research directions

5.6.2.1 Natural Resource Dependency Theory

A future avenue of research stemming from this research is to study the natural resource dependency theory of ES approaches in practice. Through the natural resource dependency theory lens, it would be possible to provide further detail on why organizational dependency is not publicly disclosed, whether this is because the assessment detail is not provided in ES approaches when used in corporate sustainability practice or whether it is known and not reported. This would also contribute to the organizational resilience in corporate sustainability from a social-ecological context (Williams, Whiteman, & Kennedy, 2021) and understanding whether improved understanding of the dependencies within the social-ecological system improves resilience in the business. However, if these dependencies are not known this resilience does not exist within the organization.

5.6.2.2 Multi-level systems advancements

My research focuses on the organization-environment nexus and studies this through a system theory lens. The next stage of this research would be to build on the multi-level perspective and include the social systems in analysis, such that rather than being a socio-ecological systems with a bias towards the ecological system, both social and ecological

systems would be equal (as depicted in Elinor Ostrom's SESF (Ostrom, 2009). This would build on my research and include the social systems of governance and actors in the conceptual framework developed in Chapter 2. This conceptual framework would become a multi-level, multi-systems framework. Future research could investigate governance of biodiversity both at the organization level (Boiral et al., 2019) but also at territorial, national or international level as illustrated in my conceptual framework. This builds on my findings in Chapter 3 where the social-ecological systems framework (SESF) is more advanced than ES approaches, as social considerations such as actors and governance are taken into account. Some early research is emergent in this area looking at a specific ecosystem services such as freshwater and the governance structure for managing this global ES (Baudoin & Arenas, 2018).

5.6.2.3 Further empirical research by specific ecosystem service, ecosystem service method, by sector or geography.

Further empirical research evidence on the use of ES approaches in corporate environmental sustainability practice would be useful. This could include studying specific sector use of ES approaches in corporate environmental sustainability to consider sectoral specific issues in implementation. Further research studying one ecosystem service across the multiple levels identified in my conceptual framework, either for a geographic region or across a supply chain would bring greater depth to understand the feedbacks and interactions of each ES in the multi-level system. Further empirical research analyzing each ES implementation method using our conceptual diagram would allow critical analysis of the different ES methods for use in corporate environmental sustainability. Finally, comparison of the implementation of this conceptual framework for organizations or supply chains based within different geographies would bring interesting insights and greater depth of knowledge, advancing implementation of ES approaches in corporate environmental sustainability practice and scholarship.

5.7 Conclusions

Global environmental sustainability is a complex, multi-national, multi-system, and multi-level issue. Corporate environmental sustainability scholarship seeks to address this complexity within the study of organizations, but the endeavor is still disconnected from the effect of humanity on nature. Corporate use of multi-level ES approaches holds the potential to offer an opportunity to address this disconnect. The aim of this research was to critically examine how the concept of ES approaches are being used in corporate environmental sustainability practice. We do this through considering: how to implement ES approaches at multiple levels within planetary boundaries; whether using ES approaches advances system thinking within corporate sustainability; and, what are the strengths and weaknesses in

implementation of ES approaches? Following an introduction that situates these research questions within the literature, I provide detail on my research philosophy, methods and research design, then each of these research objectives is addressed in separate research papers included in Chapters 2 - 4. Crosscutting themes, contributions and implications are then discussed within this discussion chapter.

To conclude, successful use of ES approaches could transform corporate environmental sustainability practice by emphasizing scoping and monitoring phases, improving awareness of the environment as a system, with physical and temporal attributes and by advancing multi-level environmental management theory for ES approaches. My findings suggest that ES approaches do advance systems thinking in practice and an awareness of the temporal and spatial attributes of the environment. However, there are numerous limitations of implementing ES approaches from theory to practice. These limitations include, a bias of ES approaches towards the ecological system with limited inclusion of actor networks and governance in ES approaches. A discrepancy between theory and practice in understanding and analyzing the dependency of the organization on the ecosystem, and the lack of implementation of monitoring of the ES assessment and feedback to future ES approaches (making it uncertain whether the outcomes of the ES approach has successfully contributed to the sustainability aims).

Organizational use of ES approaches does advance some aspects of corporate environmental sustainability however the limitations in implementations are great. Through this research and the development of the multi-level conceptual diagram for implementation of ES approaches in corporate environmental sustainability it is hoped that many of these weaknesses can be addressed to better contribute to the improving the organization-environment nexus at all levels. This research suggests that ES approaches could offer a global theory to contribute to transformational change reversing biodiversity loss at a planetary scale. However, my empirical findings suggest implementation of ES approaches can nudge towards improved practice within corporate environmental sustainability, but they may not be the transformational theory that is required to reverse biodiversity loss in the Anthropocene.

Living within planetary boundaries is essential to the continued survival of humanity, with organizations playing an important role in operating within these planetary limits. The ecological crisis and understanding how to reverse current biodiversity loss is an important area of research for corporate sustainability specialists, with ecosystem service approaches offering a promising but limited advance in this ongoing global challenge.

5.8 References

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Appendix A – Ethics Approval

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ESSL, Environment and LUBS (AREA) Faculty Research Ethics Committee
University of Leeds

Dear Angela

Title of study: **Sustainable organisations: the use of the ecosystem service concept in corporate sustainability.**

Ethics reference: **AREA 17-175**

I am pleased to inform you that the above research application has been reviewed by the ESSL, Environment and LUBS (AREA) Faculty Research Ethics Committee and following receipt of your response to the Committee's initial comments, I can confirm a favourable ethical opinion as of the date of this letter. The following documentation was considered:

Document	Version	Date
AREA 17-175 Ethics table Jul 2018 General comments (2).docx	1	0608/18
AREA 17-175 Angela Craddy _Ethical_Review_Form_V6 revised (1).doc	2	0608/18
AREA 17-175 AS_Interview protocol semi structured_Draft v2_Ethics.docx	1	0608/18
AREA 17-175 Information Sheet_AC PhD Online survey V3 Final.doc	2	0608/18
AREA 17-175 Information Sheet_AC PhD Semi-structured interviews V4 Final_revised.doc	2	0608/18
AREA 17-175 Information Sheet_AC PhD Longitudinal interviews V4 Final_revised.doc	2	0608/18
AREA 17-175 Angela PhD Phs 2 consent_formlowrisk.doc	2	0608/18
AREA 17-175 AC Fieldwork_Assessment_Form_medium_risk_final_protected_nov_15_V2 Final.doc	2	0608/18

Committee members made the following comments about your application:

- It would be a good idea to provide a specific date for the deadline for withdrawal of participation in the final version of their information sheet.

Please notify the committee if you intend to make any amendments to the information in your ethics application as submitted at date of this approval as all changes must receive ethical approval prior to implementation. The amendment form is available at http://ris.leeds.ac.uk/EthicsAmendment.

Please note: You are expected to keep a record of all your approved documentation and other documents relating to the study, including any risk assessments. This should be kept in your study file, which should be readily available for audit purposes. You will be given a two week notice period if your project is to be audited. There is a checklist listing examples of documents to be kept which is available at http://ris.leeds.ac.uk/EthicsAudits.

We welcome feedback on your experience of the ethical review process and suggestions for improvement. Please email any comments to ResearchEthics@leeds.ac.uk.

Yours sincerely

Jennifer Blaikie
Senior Research Ethics Administrator, the Secretariat
On behalf of Dr Kahryn Hughes, Chair, AREA Faculty Research Ethics Committee

CC: Student's supervisor(s)

Appendix B - Interview Protocol

Interview protocol – PhD Phase 2

Semi-structured interviews

1. Pre-interview checks	Timing

• Introductions and thank you's.
• Purpose of interview
  o To explore the use of natural capital and how it contributes to creating sustainable organisations.
  o To gather personal perspectives and views on the topic (no right or wrong responses).
  o To explore the issue at multiple levels from a personal to global perspective.
• Length: Approximately 1 hour
• Check the participant has read the information sheet and signed the consent form.
• Check the participant is ok for the interview to be recorded.
• Confirm participant happy to continue and check if any questions before doing so.
	5 minutes

2. Warm-up phase	
• Please could you tell me a little bit about your background and current role in the organisation?	5 minutes
3. Definitions	
• Could you tell me from your perspective what natural capital or ecosystem services means?	10 minutes
4. Motivation	
I would like to talk about your thoughts on the motivation for use of natural capital/ecosystem services concepts • What do you think are the motivations for using natural capital/ecosystem services concepts are?	15 minutes

• Do you think the concept of natural capital/ecosystems services is helpful or a hinderance? Please could you explain: *Prompts* *Could you expand on that a little more? What do you mean by that?*	
5. Opportunities	
• What do you think are the opportunities for using natural capital/ecosystem services concepts? • How have these opportunities changed over time? Could you reflect on which level you are describing? And what timeframe?	10 minutes
6. Barriers	
• Conversely, what do you think are the barriers for using natural capital/ecosystem services concepts? • How have these barriers changed over time? Could you reflect on which level you are describing? And what timeframe?	10 minutes
7. Changes	
• Do you think your using ES/NC concepts…….. o Changes the way you think about the environment? o Changes the way you think about value? o Changes anything else?	5 minutes
8. The future	
• What is the future for ES/NC use in organisations? • From your perspective what further research needs to be done to advance the use of ES/NC concepts by organisations.	5 minutes
9. Reflections, thanks and any other questions?	
Many thanks for taking part in the research. We have reached the conclusion of the session. On reflection is there anything else you would like to add or note on this topic? The next stage will be to analyse these initial results. Just a reminder that you are more than welcome to withdraw from the study up until data analysis is complete, this is anticipated to be August 2019. The final part of the research will be a longitudinal study partnering with practitioners to explore the day-to-day challenges and opportunities over a 6 month period. This will involve six approximately 30 minute telephone interviews. If you would be interested in taking part please let me know.	5 minutes

Thank you once again for your participation today in this important research.	