Accounting with the City Biodiversity Index in Sydney's Local Councils: Challenges and Opportunities

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Extended abstract

Purpose

Biodiversity supports and sustains the ecosystems of the world. However, despite its importance, it continues to decline at a rapid rate. Over the last two decades, numerous local municipalities worldwide have begun to act to preserve urban biodiversity, and one measure – The City Biodiversity Index (CBI) – has emerged as a popular technique to help cities evaluate their progress in biodiversity conservation activities. However, CBI has not yet been applied at smaller scales, such as local municipalities. This study was, therefore undertaken to investigate the opportunities and challenges of implementing CBI at the local municipality level.

To interrogate the motivations, challenges, and opportunities of CBI at a municipal level, the research question asked is: *What are the practical challenges and opportunities to implementing CBI within metropolitan Sydney's local councils?*

Research design and methods

Case studies on two local councils in the Sydney metropolitan comprising document analysis and semi-structured interviews provide the evidence for analysis. The six-stage hybrid approach described by Fereday and Muir-Cochrane (2006) was used to code and analyse the data, and the results are interpreted through the theoretical lens of stewardship, which is consistent with the prior literature on biodiversity conservation and biodiversity accounting.

Findings

Several findings emerge from the case evidence. First, shared stewardship between councils and communities is essential to biodiversity conservation. Second, a standardised framework for managing, monitoring, and reporting on conservation activities is needed for decision-making and comparability. The CBI framework is a good starting point and, with several modifications and adaptations, it could become a valuable shared technique at the municipal level. However, even though the councils already collect most of the information needed to apply the CBI indicators, much of it is scattered, unclear, or as yet undisclosed to the public. Further challenges to applying CBI include data availability and quality, robust definitions for some of the boundaries and assessment criteria, a lack of rigour in the sampling methodologies, and managing community perceptions. Particularly noteworthy is that community partnerships were emphasised as being important to both the creation of long-term datasets and to protecting biodiversity through campaigns and volunteering.

Research implications

This study contributes to the limited literature on accounting for biodiversity conservation by providing an analysis of the feasibility, challenges, and opportunities associated with using CBI as a local council technique for biodiversity accounting. The findings are specifically relevant to policymakers at the Convention for Biological Diversity (CBD) who have called for suggestions to improve CBI, and the Singapore government continues to develop the CBI framework. More broadly, this research is relevant to standard setters and policymakers at various level of the Australian government, as one of the key insights is that effective biodiversity accounting requires a coordinated, multi-level approach. Lastly, the study identifies the importance of community partnerships in biodiversity accounting, coupled with a call for further work in this area.

Keywords: City Biodiversity Index; Indicators; Urban biodiversity; Stewardship; Community partnership; Biodiversity monitoring

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Statement of originality

I certify that the work in this thesis entitled "Accounting with the City Biodiversity Index in Sydney's Local Councils: Challenges and Opportunities" has not previously been submitted for a degree nor has it been submitted as part of the requirements for a degree to any other university or institution other than Macquarie University. I also certify that the thesis is an original piece of research and it has been written by me. Any help and assistance that I have received in my research work and the preparation of the thesis itself have been appropriately acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Seerat Ul Urooj
4 November 2019

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CHAPTER ONE

The aim of this thesis is to investigate the opportunities and challenges of implementing the City Biodiversity Index (CBI) in Sydney's local metropolitan councils as an accounting technique for measuring, monitoring, and reporting on biodiversity conservation programs. There is limited literature on the use of the technique to account for biodiversity in local councils. Thus, this research should benefit various stakeholders such as the public sector, tertiary and research institutions, and biodiversity interest groups.

This chapter begins with an introduction to the significance of conserving biodiversity at the global, national, and local levels. A discussion on the role of accounting in measuring, evaluating, and disclosing activities to conserve biodiversity follows, along with the usefulness of the CBI as a monitoring and communication technique. Section 1.2 moves on to the need to preserve urban biodiversity and why CBI is a suitable framework for biodiversity management. The role of local councils in protecting biodiversity and their monitoring requirements is also discussed.

1.1 Introduction

Biodiversity is the variety of life in terrestrial, marine, and other aquatic ecosystems (Schneider *et al.*, 2014) and is one of the most critical components of environmental health. Biodiversity is crucial as it supports and sustains the ecosystems of the world (OECD, 2018), as well as providing vital benefits to economic and social systems at a global scale (Addison *et al.*, 2019). The indirect benefits of biodiversity include "nutrient cycling, habitat provisioning, pollination, erosion control and climate regulation" (OECD, 2018, p. 8). Both the anthropocentric and ecocentric perspectives emphasise the importance of biodiversity and the need to protect it. From an anthropocentric standpoint, both the quality of human life and economic growth is fundamentally dependent on sustaining biodiversity. From an eco-centric perspective, biodiversity is intrinsically valuable as it promotes the diversity of non-human lifeforms (Jones and Solomon, 2013).

However, despite biodiversity's importance, it continues to decline at a rapid rate (OECD, 2018; Addison *et al.*, 2019), and the decrease has been substantial enough that it is now threatening all forms of life on Earth (Jones and Solomon, 2013). The reason for the decline is overwhelmingly attributed to humanity's unsustainable use of natural resources, our recent changes in land-use practices, rising pollution levels, and the change in climate overall (Venter *et al.*, 2016; OECD, 2018). According to the United Nations' *Sustainable Development Goals*

Report, initiatives like sustainable forest management are showing some positive results, such as reductions in the rate of forest loss (United Nations, 2018a).

However, despite some improvements, not enough is being done. Land degradation is still rising as demand for food production and economic development increases (United Nations, 2018a). The global Red List index (RLI) of threatened species' survival is declining at an alarming rate – from 0.82 in 1993 to 0.74 in 2018. On this index, an RLI value of 0 means that all species on the list have become extinct (United Nations, 2018a). Research shows that 32% of terrestrial vertebrates are decreasing in population (Ceballos et al., 2017), and our current trajectory is to lose a further 10% by 2050 (OECD, 2018). These statistics provide an urgent impetus to act on biodiversity conservation to sustain the ecosystems upon which we and all other life depend (United Nations, 2018a).

In recognition of the threats to biodiversity and to emphasise its implementation of a strategic plan for biodiversity, on 22 December 2010, the United Nations declared 2011-2020 as the "Decade on Biodiversity" (United Nations Environment Programme, 2010). Two global commitments, the "Aichi Biodiversity Target"[1] and the "Sustainable Development Goals", are intended to prioritise the conservation of biodiversity by governments and societies by 2020 (UNEP, 2016).

The positive actions put in place by governments as a results of these commitments have seen biodiversity loss slow down, but efforts to combat the biodiversity crisis are still insufficient (Convention on Biological Diversity, 2018a; Addison *et al.*, 2019), and significant additional progress is essential if the UN's biodiversity conservation targets are to be achieved by 2020 (Convention on Biological Diversity, 2018a). Consequently, at the 14th United Nations Biodiversity Conference of the Parties (COP 14), 196 governments agreed to fast-track their progress in achieving the Aichi targets to reverse the biodiversity crisis at the global, national, regional, and local levels (Convention on Biological Diversity, 2018a).

[1] At the tenth meeting of the CBD Conference of Parties (COP10) in Nagoya, Japan in 2010, the "Strategic Plan for Biodiversity 2011–2020" was developed. The basis of the Strategic Plan is that biodiversity loss can only be effectively addressed with simultaneous and coordinated action at a number of levels, each of which is essential to achieve a lasting impact and to set us on a sustainable path to keep human societies within the limits of the planet's biological resources. The Strategic Plan includes an ambitious yet achievable set of 20 targets (the Aichi Biodiversity Targets), most with an end-point of 2020, ultimately aimed at achieving a 2050 vision of a world where biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people. (Secretariat of the Convention on Biological Diversity, 2012).

According to the COP 14 report, one of the drivers for achieving the Aichi targets is social sciences research on biodiversity (Convention on Biological Diversity, 2018a), which includes research on social and environmental accounting (SEA). Since accounting plays an essential role in shaping society, accounting for biodiversity is critical for addressing biodiversity loss (Jones and Solomon, 2013). Accountants have expertise in recording, measuring, and reporting financial data to assist users in their decision-making processes (Jones, 2014).

Applying the existing data, classifications, indices and the Aichi Targets to ecosystem accounting, could provide a reason for scientists, economists, accountants, land managers and public officials to work together on the development and use of accounts for biodiversity. Ecosystem accounting can help to show the benefits arising from protected areas (Vardon *et al.*, 2017). Accounting can also help to target particular areas, habitats or species for assistance. For example, habitats underrepresented in the protected area network (Aichi Target 11), and possible cost effective solutions for increasing these (e.g. expanding the protected area networks or implementation of schemes for the protection of habitats on private lands) (Vardon *et al.*, 2017).

There has been increased recognition of the critical role accounting has played in calling all stakeholders, including governments, to account for their contribution to the biodiversity crisis (Cuckston, 2018). The growing body of academic research on biodiversity conversation is bringing many theoretical and practical issues to light regarding the application of accounting to biodiversity conservation (Vardon *et al.*, 2017). Studies show that using appropriate indicators can lead to better stakeholder communication, improved policymaking, and more effective monitoring of biodiversity information and trends (Kohsaka, 2010).

Within the SEA literature, the 2013 special issue of *Accounting, Auditing & Accountability* on "Accounting for Biodiversity" houses a prominent concentration of relevant work. In the issue's overview, Jones and Solomon (2013) draw attention to four potential areas for further research on biodiversity accounting: reporting and valuation models in a real-life context, organisational communication practices, species-specific reporting, and biodiversity assurance. At present, biodiversity management and reporting are on the rise, but there is limited practical guidance on how to monitor biodiversity initiatives or how to benchmark the state of biodiversity, especially in the context of local urban councils.

The CBI framework is a monitoring and communication technique developed by the Singapore government for measuring biodiversity trends and the effectiveness of biodiversity initiatives in cities (Kohsaka, 2010). Since its inception, many cities around the world have found it to be

useful for managing and reporting on their conversation programs (Convention on Biological Diversity, 2018b), but it has not yet been adopted in Australia. Therefore, the purpose of this research is to evaluate whether CBI could be a desirable and feasible technique for Sydney's local metropolitan councils to address the challenges and opportunities in urban biodiversity conservation.

The research question of this study have been formulated specifically to address the gaps identified in the literature and to respond to calls made by scholars to further examine the applicability of CBI framework (Kohsaka and Okumura, 2014; Kohsaka and Uchiyama, 2017; Deslauriers *et al.*, 2018):

> RQ: What are the practical challenges and opportunities to implementing CBI within metropolitan Sydney's local councils?

The research outcomes will be of benefit to a) academics by extending the limited research literature on accounting for biodiversity conservation; b) policymakers at the Convention of Biological Diversity by providing feedback on the applicability of CBI to local councils in Sydney and, also, Australian government policymakers by highlighting potential improvements to the Australian Biodiversity Policy; and c) practitioners by exploring the issues associated with developing local biodiversity action plans and recommending modifications to the CBI to better fit municipal needs. In addition, the study contributes to our understanding of the importance of shared stewardship between local communities and councils for biodiversity conservation.

The following section discusses the importance of CBI and the role of local councils in conserving urban biodiversity.

1.2 Urban biodiversity and the City Biodiversity Index

The majority of the world's population lives in urban areas, and urban proliferation is only projected to accelerate. Therefore, managing biodiversity in cities is and will continue to be, a crucial issue. Globally, the number of people living in cities increased by 25% from 1950 to 2018 (United Nations, 2018b), and the United Nations forecasts that this number will increase to 68% by 2050 (United Nations, 2018b). According to the "Cities and Biodiversity Outlook Report", this expansion will be the largest in the history of planet Earth (Secretariat of the Convention on Biological Diversity, 2012), and it will present both challenges and opportunities. For example, while urbanisation will significantly affect the biodiversity of our ecosystems, if city planners incorporate biodiversity conservation into their expansion

strategies, “cities can promote economically, socially and environmentally sustainable societies” (United Nations Development Program, 2012, p. 35).

The role of cities and local authorities in contributing to biodiversity conservation was recognised from the outset at the 10th meeting of the Convention on Biological Diversity (COP 10) in both the “Strategic Plan for Biodiversity 2011-2020” and in the Aichi targets (United Nations Environment Programme, 2010). The Plan requires that, by 2020, each level of government should have in place: guidelines, monitoring, and evaluation tools; capacity-building programs; and biodiversity awareness campaigns to support the implementation of a biodiversity plan. The need for mainstreaming biodiversity into urban planning by the city councils was also highlighted at COP 14 (Convention on Biological Diversity, 2018a).

The role of local authorities in conserving biodiversity is crucial, as they are the custodians of biodiversity assets in their region (Barut *et al.*, 2016). Over the last two decades, numerous local municipalities around the globe have begun to take action to preserve urban biodiversity. They prepare local biodiversity strategies and action plans and implement biodiversity conservation projects for sustainable development (ICLEI/SCBD, 2017). The group Local Governments for Sustainability (ICLEI) cite six key drivers for incorporating biodiversity management into a local strategy/action plan, as shown in Figure 1.

Figure 1: Six key drivers for integrating biodiversity management into local action plans

Source modified and adapted from ICLEI/SCB, 2017.

In Australia, integrating and mainstreaming the elements of conserving biodiversity into management and action plans is underway – for example, "The Greening Sydney Plan" by the Council of the City of Sydney and "The Biodiversity Plan" by the City of Ryde. These two plans focus on promoting biodiversity and enhancing the habitat of their council area. A key aspect of these plans is to effectively monitor biodiversity loss and benchmark conservation levels, as monitoring and oversight of a council's efforts increase accountability (Barut *et al.*, 2016).

Monitoring, however, requires tools. At COP 10, local authorities were encouraged to use tools, such as CBI, for monitoring, evaluating, and benchmarking the biodiversity of a region (Convention on Biological Diversity, 2010). In fact, the government of Singapore specifically developed CBI as a self-assessment mechanism to help cities and local authorities accurately take stock of their biodiversity conservation activities (Chan *et al.*, 2014). At present, this is the only index designed to measure the ecological footprint of a city and evaluate the progress of its biodiversity conservation initiatives (Chan *et al.*, 2014; Ossola and Niemelä, 2018).

As outlined in Appendix A, CBI consists of two parts: a profile with background information on the city; and 23 measurement indicators across the three core areas of native biodiversity, ecosystem services, and governance and management (Chan *et al.*, 2014). Local authorities measure their own performance by assigning a score from 0 to 4 to each indicator (Chan *et al.*, 2014). The *User's Manual on the Singapore Index on Cities' Biodiversity*, (i.e., the CBI manual), recommends conducting a full assessment every three years (Chan *et al.*, 2014).

Although CBI is not currently used in Australia, the "Green Sydney Plan" mentions it as best practice for biodiversity evaluation (City of Sydney Council, 2012). Likewise, the City of Melbourne proposes using CBI to help manage their biodiversity efforts (City of Melbourne, 2017; Kirk *et al.*, 2018). 26 cities have applied CBI around the world and 12 are in the process of applying it(Convention on Biological Diversity, 2018b). Cities that have applied the SI have found that the process facilitated capacity-building in biodiversity conservation; the indicators also functioned as biodiversity conservation guidelines; and the quantitative scoring assisted in setting priorities for conservation actions and budget allocation.

The remainder of this study is structured into four sections. Chapter 2 provides a summary of the literature on biodiversity accounting, local councils and their application of CBI, and the theory of stewardship. Chapter 3 describes the research methods used. Chapter 4 presents the results. Lastly, the findings, contributions, and implications of this study are discussed in Chapter 5.

CHAPTER TWO

This chapter provides a comprehensive and critical analysis of the relevant SEA and CBI literature. The aims of this chapter are to outline gaps found in the literature on accounting for biodiversity and introduce the research question designed to fill that gap. Some theoretical applications for this research are also identified.

2.1 A brief literature review

SEA research has a 30-year history (Mathews, 1997; Gray and Laughlin, 2012; Deegan, 2017), but only recently have researchers begun to explore specific elements of the biodiversity crisis (Hossain, 2017; Maroun *et al.*, 2018; Weir, 2018). Prior to 2017, there were few published studies that address the contemporary biodiversity crisis (Jones and Solomon, 2013; Atkins *et al.*, 2014).

The concept of sustainable development is recognised as a multi-level concept in SEA literature, where the levels of organisations are interdependent (Lamberton, 2005). Research exploring sustainability accounting at different levels, (e.g., community, regional, national), is necessary to exert adequate pressure to drive the transition to sustainability (Lamberton, 2005).

Of these studies, a significant stream focus on corporate reporting and disclosure (Cuckston, 2018), with most finding that reporting on corporate biodiversity reporting is infrequent and the information disclosed is insufficient for stakeholders to meaningfully assess the impacts of a corporation's activities on biodiversity (see Rimmel and Jonäll, 2013; van Liempd and Busch, 2013; Schneider *et al.*, 2014; Adler *et al.*, 2017; Adler *et al.*, 2018). Similarly, research suggests that local government authorities have lack of interest in disclosing biodiversity information, and particularly information about their strategic goals and plans (Schneider *et al.*, 2014; Barut *et al.*, 2016; Gaia and Jones, 2017). Obviously, a lack of interest in biodiversity does not bode well for an effective management and monitoring systems. The usefulness of the biodiversity information disclosed by local governments in New South Wales (NSW) has not escaped this scrutiny, with some reporting being called into question. For instance, most local government reports do not address the GRI 3.1 biodiversity performance indicators, nor do they disclose their biodiversity strategies and plans (Barut *et al.*, 2016).

In recent years, several city governments and academics have adopted CBI as a way of monitoring biodiversity conservation projects (see Kohsaka *et al.*, 2013; Kohsaka and Okumura, 2014; Uchiyama *et al.*, 2015; Deslauriers *et al.*, 2018). However, further research on CBI is called for. Prior studies on CBI implementations have focused on a city-level analysis

(Kohsaka *et al.*, 2013; Deslauriers *et al.*, 2018; Sahani and Raghavaswamy, 2018). Only a few studies have also considered municipalities (Kohsaka and Okumura, 2014; Uchiyama *et al.*, 2015; Kohsaka and Uchiyama, 2017). Further, most studies are multidisciplinary explorations into the feasibility of CBI to support reporting activities in different countries, especially Japan (Kohsaka *et al.*, 2013; Kohsaka and Okumura, 2014; Kohsaka and Uchiyama, 2017), although a couple of studies do focus on specific elements of CBI, such as improving how Indicator 2 is calculated (Deslauriers *et al.*, 2018), enhancing the CBI database (Uchiyama and Kohsaka, 2017), and expanding CBI to include indicators of land use (Uchiyama *et al.*, 2015).

Key challenges for using the CBI revealed in these studies range from the definition of indicators (Kohsaka *et al.*, 2013) to the difficulties with quantifying biodiversity given different base assumptions (Kohsaka and Okumura, 2014), to more practical concerns like the limited financial and human resources that commonly characterise municipal governments (Uchiyama *et al.*, 2015; Kohsaka and Uchiyama, 2017). Yet, despite these challenges, each investigation arrives at a similar conclusion – that there is merit in adopting CBI and users are encouraged to persist in finding solutions or modifications to overcome the challenges. These studies demonstrate CBI as a monitoring technique that generates meaningful results. Further, although the global CBI database is still under development, several useful datasets are available for conducting research and decision-making, such as datasets on land use (Uchiyama *et al.*, 2015). To date, there have been several 'modifications'. For example, Deslauriers *et al.* (2018) improved the method for measuring the connectivity of natural areas (CBI Indicator 2) and, as a result, there are now more options for increasing structural connectivity of natural areas. Connectivity can be more comprehensively quantified, and city planners find it easier to conduct their evaluations (Deslauriers *et al.*, 2018).

However, as the 10th anniversary of the CBI approaches, the Convention on Biological Diversity (2018b) stresses the need for feedback from all stakeholders – cities, subnational and federal governments, biodiversity practitioners, organisations, academics, and so on – to improve the applicability and shape of the index.

Thus, a further aim of this study is to broaden and extend prior work on the use of the CBI, especially drawing on the studies of Kohsaka and Okumura (2014) and Kohsaka and Uchiyama (2017). These two surveys, undertaken in Japan, indicate a lack of motivation by municipalities to conduct quantitative evaluations, such as CBI, to monitor biodiversity (Kohsaka and Uchiyama, 2017). One explanation for the lack of interest is limited knowledge on the part of the municipalities of how to apply and interpret evaluations of this kind (Kohsaka and

Uchiyama, 2017). The challenges of practically applying CBI are limited data, unclear definitions, boundaries and scale, what to include in the indicators, and overlapping indicators (Kohsaka *et al.*, 2013). Despite these challenges, CBI can be an effective technique in determining urban biodiversity loss (Kohsaka *et al.*, 2013). From a review on the applicability of CBI based on publicly-available data and interviews, Kohsaka and Okumura (2014) reach three conclusions: a) there is a need for CBI; b) there are challenges to its application, but there are also potential solutions; and c) a modified version of CBI could be developed that would be more suitable for the Japanese context (Kohsaka and Okumura, 2014). (It is worth noting, however, that the research methods used to review the publicly-available data in this study are not clear). These two studies by Kohsaka and Uchiyama (2017) and Kohsaka and Okumura (2014) provide a demonstration of how CBI can be applied in the Japanese context. However, there is no such study of CBI, or its application, in the Australian context. Hence, the research question to be explored in this study builds on these two exemplars. To interrogate the motivations, challenges, and opportunities of CBI at a municipal level, the research question asked is:

> What are the practical challenges and opportunities to implementing CBI within metropolitan Sydney's local councils?

The research question also evaluates the claims by the founders of CBI, the Singaporean government, in relation to the utility of the City Biodiversity Index (Chan *et al.*, 2014).

Kohsaka and Okumura (2014) lay out a methodology for reviewing and evaluating public documents to understand the challenges of applying CBI, which was followed in this study. The goal is to understand the applicability of CBI framework for biodiversity management and monitoring by Sydney's local councils. The literature study by Kohsaka and Okumura (2014) is used in this research study because it explains issues and opportunities for applying the 23 CBI indicators to propose a modified CBI within the Japanese context. With some adaptations to the categories of focus in Kohsaka and Okumura (2014), the analysis in this current study will centre on accounting for biodiversity by exploring: a) the need for an index by the councils; b) their opinions on the applicability of each CBI indicator ; and c) the challenges they perceive with economic valuations of biodiversity.

In answering the research question, this research makes the following contributions to the literature.

First, there is limited accounting research on biodiversity conservation, which this study will supplement by addressing how conservation programs should be measured, valued, and assessed in the context of local urban councils. In turn, this should help to improve biodiversity accounting and reporting.

Second, in relation to policy and practice, this study also contributes by providing feedback to the Convention on Biological Diversity on the applicability of CBI within local Sydney councils. The Convention is actively seeking feedback, suggestions, and topics for consideration to improve the CBI framework (Convention on Biological Diversity, 2018b).

Most importantly, the ultimate aim of this study is to improve urban biodiversity and, hence, to assist the Australian federal government with achieving its three goals to "connect people with nature, care for nature and build and share knowledge" (Commonwealth of Australia, 2017 p.7). Additionally, this research responds to the UN's target of addressing the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society (OECD, 2018). Lastly, raising the issue of how to implement the CBI at the municipal level will help local councils to improve their biodiversity action plans and framework for biodiversity management.

2.2 Theory – the concept of stewardship

The concept of stewardship is used as a theoretical lens throughout this study, which is not uncommon in the literature on biodiversity conservation (Mathevet *et al.*, 2018) and biodiversity accounting (Cuckston, 2017; Hossain, 2017). Stewardship means caring for resources by using them sustainably (Mathevet *et al.*, 2018), and stewardship theory holds that the local councils are the stewards of the environmental assets within their jurisdiction. The concept of stewardship appears in 62% of the publications in the journals on environmental science, ecology, and biodiversity conservation (Mathevet *et al.*, 2018). The concept of stewardship has also been used to articulate and describe stakeholder responses to sustainability challenges we face, such as the loss of biodiversity (Peçanha Enqvist *et al.*, 2018).

Stewardship theory emphasises co-operation and collaboration (Keay, 2017). In stewardship theory, stewards identify themselves with their organisation, its mission and objectives and they use their personal power instead of the institutional power rising from their position (Dumay, 2019).

Stewardship has salience within literature that address the management of natural resources in environmental sciences (Bennett *et al.*, 2018). Stewardship also has salience for accounting and

management scholars as a way of articulating organizational responsibilities. It extends an accountability focus and seeks to articulate the need to take care of and nurture resources for current and future generations and thereby inspire economic and organizational transformations towards sustainable development (Bebbington, 2019).

Bennett *et al.* (2018) present an integrated conceptual framework with the following elements: actions to protect and restore the environment; the actors who initiate those actions; the motivations to act (intrinsic and extrinsic); the capacity and resources available with which to take action; and complexity and rapidity as social and ecological factors of context. These elements demonstrate the ecological and social outcomes and impacts of acts of stewardship. Actors can intervene to support these acts of stewardship through different "leverage points" by providing incentives and resources, promoting specific actions, or monitoring and evaluating the outcomes. According to Bennett *et al.* (2018), this framework can be used to analyse the elements of stewardship in case studies or to evaluate the effectiveness of local programs (Bennett *et al.*, 2018). In this study, it is used to explore the interplay between CBI and stewardship in two of local councils.

This literature review reveals a gap in the previous SEA research that explores CBI in the Australian context and, more generally, at the local municipal level. In devising and answering the research question to fill that gap, the theory of stewardship and, specifically, the framework outlined by Bennett et al. (2018) offers elements of analysis that can be used to yield insights for improving the outcomes of environmental stewardship programs.

This chapter outlines the gaps found in the literature on accounting for biodiversity. It highlights two exemplar CBI literature studies that are used to build the research question for this study. The following chapter provides the method of how this study addresses the research gap.

CHAPTER THREE

3.1 Method

This chapter describes the research methods and techniques used to conduct the study, including the research paradigm, methods, data collection and analysis process, and the reliability, and validity of the results.

3.2 Research paradigm

The research question is "What are the practical challenges and opportunities to implementing the CBI within metropolitan Sydney's local councils?", and it is answered with an interpretivist paradigm. Interpretivism explores the 'reality of the world' through an individual's experiences and perceptions. Interpretivism accepts multiple perspectives from all participants, which helps researchers to capture in-depth insights into the data gathered (Thanh and Thanh, 2015).

Over the past three decades, use of the interpretivist paradigm in accounting research has increased (Lukka and Modell, 2017) and is making contributions to the accounting literature by focusing on human experiences to induce information diversity and richness. In interpretivist research, the investigator(s) develop an in-depth understanding of how accounting functions in a real-world context (Lukka and Modell, 2017). Interpretivists seek qualitative methods, such as case studies, to decipher reality by understanding the world through the eyes of the participants, which is challenging to capture through quantitative methods (Thanh and Thanh, 2015).

An interpretivist approach is appropriate for answering the research question in this study for several reasons. First, qualitative research methods are essential to accounting research because the results demonstrate how accounting can impact society in ways that cannot be described by numbers (Dumay and de Villiers, 2019). Second, the biodiversity crisis is an emerging challenge for society, and accounting for biodiversity makes organisations accountable for their activities – both positive and negative. Most pertinently, when an environmental element, such as biodiversity, is included in an organisation's strategy and decision-making processes, the phenomena under study become more complex. Accordingly, more nuanced research methods are required to gain insight into the issues. de Villiers *et al.* (2019) explains that by focusing only on positivistic techniques, researchers can only represent a small fraction of the issues in sustainability accounting studies. Further, the research question in this study demands in-depth insights into how accounting for biodiversity functions in a specific context, that is, the

biodiversity management and monitoring practices of two local Sydney councils. Only qualitative methods can provide such contextually-rich understandings.

3.3 Research method

The research method selected is a case study analysis. Yin (2014) defines a case study as an investigation of a new area of research within a real-life situation. Case studies are useful for investigating complex issues as they allow for the research questions to be explored from multiple perspectives, which enhances data quality and internal validity (Baxter and Jack, 2008).

As biodiversity accounting is a new field, only a few studies on CBI's applicability to various contexts exist. Therefore, a case study approach is an appropriate way to understand the real-life challenges of monitoring and managing biodiversity within local councils. In addition, Ball (2005) and Thomson *et al.* (2014) both used a case study approach in their studies of environmental accounting in the context of local councils. Undertaking similar work should mean the results are more comparable.

At present, biodiversity management and reporting are on the rise, but there is limited practical guidance on how to monitor biodiversity initiatives or how to benchmark the state of biodiversity, especially in the context of local urban councils. The focus of study is the research is on local councils in an urban context, and specifically Sydney local councils (for reasons described in section 3.4).

The primary data sources were documents and semi-structured interviews. Document analysis is a qualitative social research method, in which rigorous analyses and interpretations of documents are undertaken by a researcher to provide meaning around the topic being studied (Bowen, 2009). This method relies on the systematic review and evaluation procedures that combine elements of both content and thematic analysis. Content analysis means identifying and categorising relevant passages of text or data, while thematic analysis involves recognising trends within the data to identify themes (Bowen, 2009). Content analysis is one of the primary methodologies used in SEA research. However, Guthrie and Abeysekera (2006) there is a need to combine content analysis with other research methods, such as case studies, interviews, and/or surveys, to provide a more robust and richer empirical understanding of SEA and its management, measurement and reporting. The source documents consisted of Council documents, such as Local Environmental Plans, Local Biodiversity Action Plans, Development Control Plans, Annual Reports, surveys, and other publicly-available documents and datasets.

The document analysis was supplemented by interviews, which is a research method used in conservation research as it allows an in-depth analysis of the topic of study (Young et al., 2018). The majority of the studies that use interviews do so to gain information on a specific conservation issue, to understand a process, or to strengthen the research design (Young et al., 2018). For this study, semi-structured interviews were appropriate because they allow the interviewer flexibility to ask additional questions and tease out more complex issues. The interviews followed the protocol described by Castillo-Montoya (2016), which consists of four elements: ensuring the interview questions are aligned with the research question; constructing an inquiry-based conversation; receiving feedback on the interview protocol; and piloting the interview protocol. The interviews conducted in this study were held, face-to-face, with individuals involved in biodiversity management and monitoring from the two local councils.

Combining document analyses with semi-structured interviews reveals themes from both methods, which enriches the research data, minimises bias, and improves the credibility of the study (Bowen, 2009). The systematic analyses of documents is also instrumental in preparing questions prior to the interviews as well as reviewing information after the interviews to identify similarities, differences, and general patterns (Bowen, 2009).

3.4 Data collection

Two local councils in metropolitan Sydney were chosen as the focus of the case studies because, while biodiversity conservation is essential at all levels of Australian governments, it is mentioned explicitly for councils. Through land management and biodiversity reforms, the New South Wales is transitioning to better ways of managing and assessing native vegetation and offset schemes. For example, the *Biodiversity Conservation Act 2016,* the Local Land Services Amendment Act 2016*, Biodiversity Conservation Regulations 2017,* and the State Environmental Planning Policy (Vegetation in Non-Rural Areas) 2017. In addition, the NSW Government is offering support and sponsored training to all its local councils to transition and implement biodiversity reforms.

The two councils selected were chosen for their specific characteristics as outlined in the Australian Classification of Local Governments (ACLG) (see, Table 1 and Appendix B), the availability of data for analysis, and their historical efforts to conserve biodiversity. For example, in their "Community Strategic Plan", one of the councils mentions that data to measure the progress of their projects is available in its *Four-Year Delivery Plan* and its *End of Term Report.* Each council was assigned a pseudonym – Alpha Council and Beta Council – to preserve anonymity. The ACLG classifies Australia's local governing bodies into 22 different

categories using a range of metrics, including their population, population density, the proportion of population that is urban, socioeconomic indicators, their capacity to deliver various services to the community, and many others (Commonwealth of Australia 2017). So, for example, a medium-sized council in a rural agricultural area would be classified as RAM – rural, agricultural, medium. As these are broad demographic classifications, there are often large differences between councils in the same category.

Table 1: Australian classification of local government

Council	Type	Classification	Size	Pop.	ID	Area (km^2)	% of Total Expenditure on Environment
Alpha (A)	Urban	Developed	Large (L)	>120,001	UDL	40.5	20.7
Beta (B)	Urban	Developed	Large (L)	>120,001	UDL	85.4	21.5

Source: The State of Local Government in NSW (2017)

Both councils chosen are classified as UDL – urban, developed, large. Both have approximately the same population and spend about the same percentage of their total expenditure on the environment. However, the land-use by each council differs, as shown in Figures 2 and 3. Alpha Council is a predominantly residential area, but it still has a substantial amount of commercial, industrial, and institutional land. Its total area of about 40 square kilometres also includes waterways and parklands that represents an area of remnant bushland. Beta Council also has a large residential focus. However, the majority of its 84 square kilometres is zoned as parks and bushland, a large proportion of which is a National Park. There is little commercial or industrial land.

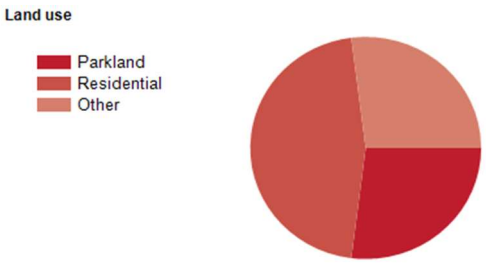

Figure 2: Land use by Alpha Council

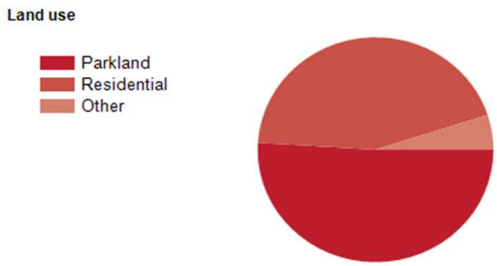

Figure 3: Land use by Beta Council

Source .id the population experts

The differences in the profiles of the two councils should help in understanding and exploring the various challenges different councils may have in applying the CBI framework. These differences will also help to inform a more flexible and generalised adapted CBI framework suited to councils with different characteristics in future.

The software tool NVivo was used to code the documents and interview transcripts. NVivo is a software tool for sorting, coding, and categorising data under analysis. Following recommendations by Bowen (2009), both the documents and the interview transcripts were coded in the same way. The coding procedure used is set out in Fereday and Muir-Cochrane (2006) and follows a six-stage hybrid (conductive and deductive) approach, as illustrated in Figure 4.

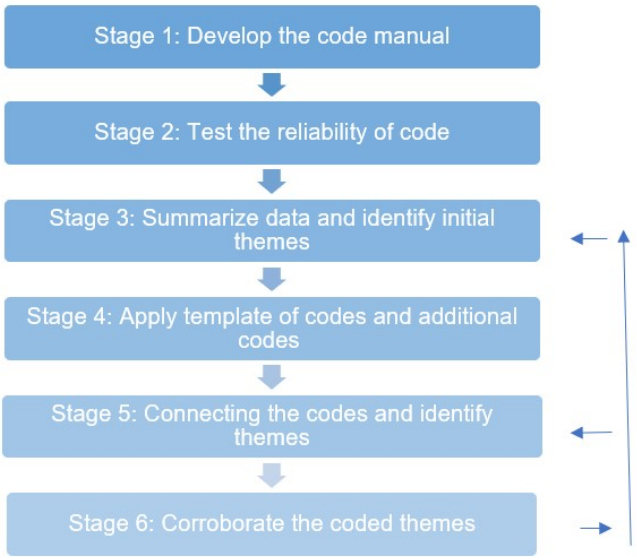

Figure 4: Data coding steps

(adapted from Fereday and Muir-Cochrane, 2006)

The procedure begins at stage 1- *develop the code manual* (Appendix C), with developing a template coding manual to follow as the documents are reviewed. This helps to maintain the consistency, and therefore the credibility, of the codes assigned. The thematic codes comprised three main elements: a label, a definition of the theme, and a description of the theme (Boyatzis, 1998). Stage 2- *test the reliability of code*, involves testing the reliability of the codes and applicability of the codes with sample documents. Three relevant documents from the councils' websites were selected as test pieces. Independent tests of reliability were conducted by both the researcher and supervsiors. The results were compared, and no adjustments to the codebook template were required. In Stage 3- *summarize data and identify initial themes*, the information is gathered and summarised into key points by critically listening to and reading the documents and transcripts. The answers to key interview questions, which were the same as those in Kohsaka and Okumura (2014), were noted as the initial themes in this process. The NVivo software coding occurs in Stage 4- *apply a template of codes and additional codes*, which

included developing more codes in addition to those in the coding manual as new themes emerged. Stage 5- *connecting the codes and identify themes,* is where the themes are connected to the codes within and across the datasets of the two councils to identify similarities, differences, and patterns. Stage 6- *corroborate the coded themes,* is a post-evaluation check of all previous stages to ensure all the themes and codes are representative of the raw data.

As illustrated in Figure 5, this study was conducted in two phases. The first phase involved analysing the council and other source of documents. The second phase involved semi-structured interviews.

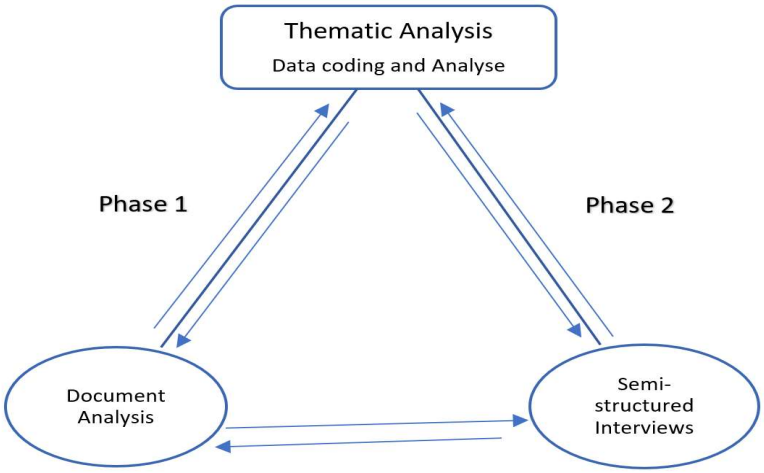

Figure 5 Two-Phase Data Collection and Analysis

The following seven steps involved in the document analysis were followed:

(i) *Identify the relevant documents:* 27 documents on biodiversity were found on the councils' websites (2523 pages in total), and additional documents at the national, state and regional levels were added for completeness. The documents were in the form of reports, studies, manuals, financial statements, policies, procedures, and planning documents. The information on the ten indicators were searched within the documents.

(ii) *Identify categories to guide data collection*: the first 10 CBI indicators, which measure native biodiversity, were selected for analysis.

The 23 CBI indicators are divided into three core compoments; the first 10 indicators represent the native bioidversity in the city, the next four describes the ecosystem services provided by biodiversity and the remaining 9 focuses on governance and management of

biodiversity. This study focused on the first core component that represents the native biodiversity in the city. This allows in-depth analysis of the results collected for the study.

(iii) *Build the codebook* (Stage 1, Figure 5): the CBI user manual provided the information for the labels, definitions, and descriptions of each of the ten codes.

(iv) *Test the codebook with sample documents* (Stage 2, Figure 4): three sample biodiversity-related documents were chosen from the council's website, and information on the ten CBI indicators was searched.

(v) *Filter out irrelevant documents*: the documents which contained the least information on indicators were filtered out, leaving 2031 pages to review.

(v) *Collect data*: the data on the CBI indicators were collected from the documents to understand the availability of information and ease of application of indicators for the councils.

(vi) *Code the data and identify themes* (Stages 3 to 6, Figure 4): the codes were identified, refined and grouped during this process. Please see Appendix C for a list of codes and subcodes. Supervisors independently coded the data to check the reliability.

The purpose of the interviews was to validate the findings from the document analysis and to discover information regarding the research question. First, the senior managers responsible for biodiversity management at each council were contacted via email to schedule a pilot interview. Two team leaders from Alpha and three team leaders from Beta attended the pilot interview, which was approximately 60 minutes long. These were informal interviews to guide further document analysis, identify relevant people to interview within the council, and review the interview questions to be asked later on. Only written notes were taken. After these interviews, the steps for Phase 1 were repeated to incorporate the suggestions from the pilot interviews.

The final interview questions were primarily drawn from Kohsaka and Okumura (2014) and complemented with findings from the document analysis and suggestions from the pilot interviews. The questions were:

- What biodiversity conservation activities and monitoring does the local council conduct?
- To what extent is the local council interested in CBI as a monitoring technique to measure urban biodiversity?
- What are the challenges of applying CBI as biodiversity management monitoring technique?

- What are the opportunities from applying CBI as biodiversity management monitoring technique?
- How applicable is each CBI indicator to your local council area?
- At what level (national, state, regional, or local) should biodiversity indicators be reported?
- Is the data available, either publicly or internally, to be able to measure biodiversity using CBI?
- Are the CBI indicators appropriate for measuring biodiversity within a local council?

From the pilot interviews, it was determined that a semi-structured interview with two team leaders from each council be sufficient (A1 & A2 for Alpha; B1 & B2 for Beta). See Appendix D for the list of interviewees and their designation. The interviewees were explicitly informed about their ethical rights to participate in the research, withdraw from the research, and the privacy protection protocols in place. Written consent was gained from the participants before starting the interviews. The interview with participants of Alpha (A1 & A2) took approximately 90 minutes, and 60 minutes for participants of Beta (B1 & B2). Both interviews were attended by the researcher and supervisors ; the supervisors largely observed, but occasionally provided clarity on some of the questions asked by the participants. During the interviews, the participants were given a briefing about the project, and semi-structured questions were asked related to the research question. The participants were given a chance to express their views in an unstructured conversation. The interviews were recorded, transcribed, entered into NVivo, and coded following the six-stage approach depicted in Figure 4.

The interviewers were also asked who the intended users or stakeholders of the potential reporting are and which groups might usefully seek 'decision-making' from what sort of reports?

3.5 Data coding and analysis

The codebook began with two nodes in NVivo: CBI indicators and Stewardship. Stewardship had two child nodes, Community Partnership and Reporting, which align with the theoretical framework of the study. The CBI indicators branch had a child node for each of the ten indicators, except for Indicators 4-8 which were grouped together. Hence, there were six child nodes in this branch. Subsequent sub-child nodes were added during the coding process to

highlight different sub-themes. Figure 6 shows the broad NVivo hierarchy. A full list of all the nodes and sub-nodes is provided in Appendix C.

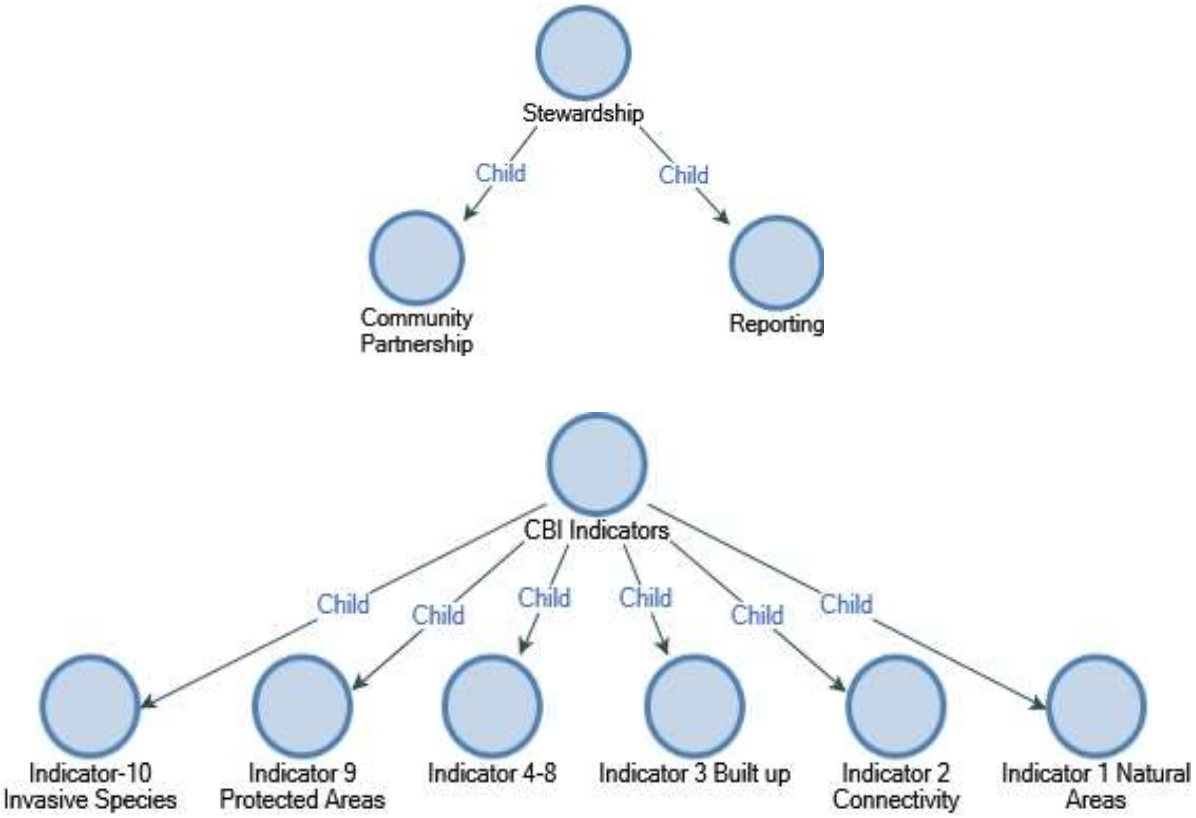

Figure 6: The NVivo node hierarchy

NVivo's in-built search function was used to explore the corpus. Figure 7 shows an example set of the results from a query about Indicator 2: Connectivity. Here, the codebook definition and description contain key terms related to this indicator, which become the search terms. In this case, these terms were: connectivity OR fragmentation OR corridor OR corridors OR "green corridors" OR "green corridor" OR "faunal crossings" OR "faunal crossing" OR "overarching canopies" OR "overarching canopy" OR link OR linked OR patches OR patch OR "patch size".

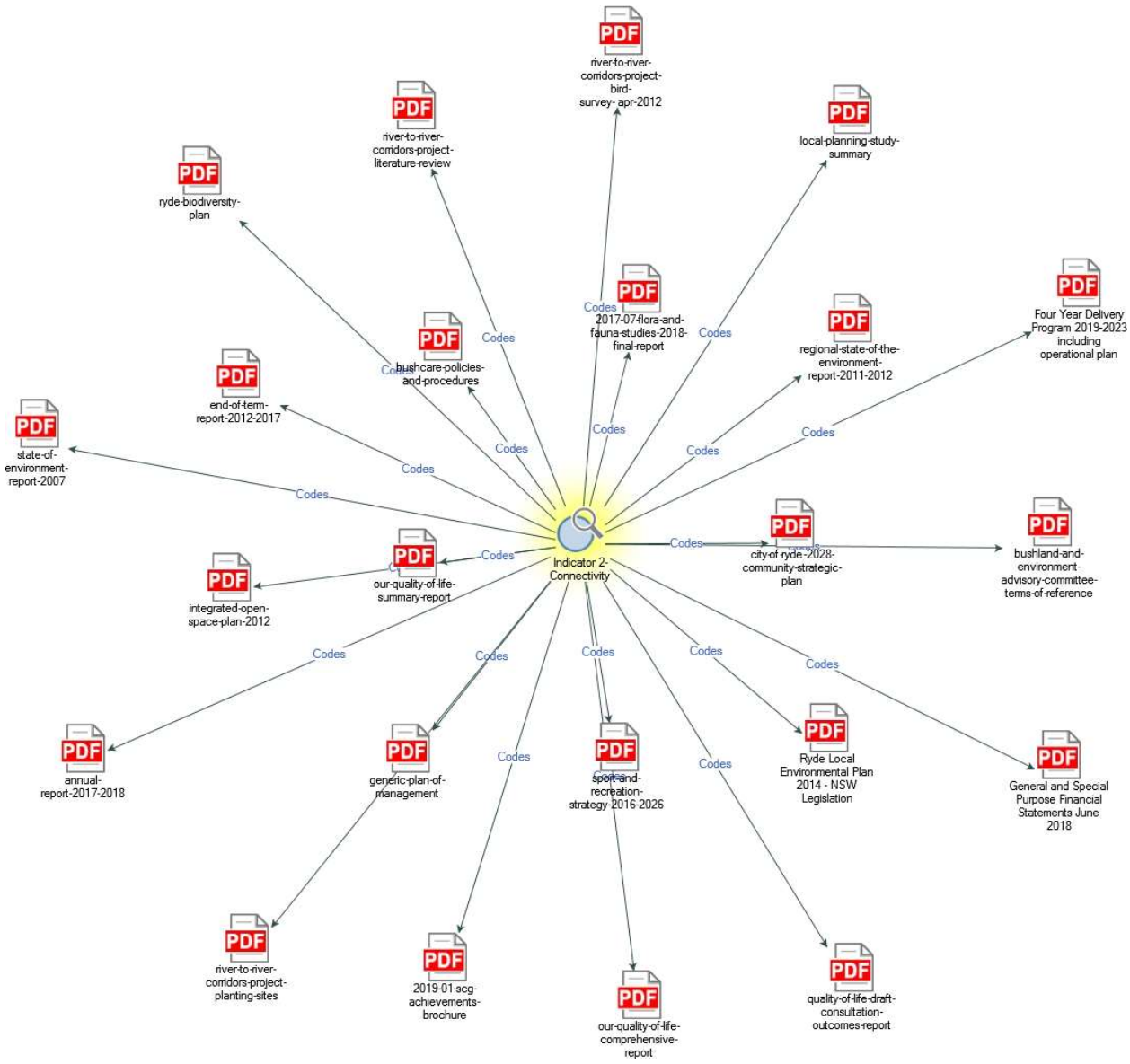

Figure 7: An example of NVivo's search results: connectivity

3.6 Reliability and validity

Various design tests can be used to evaluate the quality of case study research depending upon the research paradigm, such as construct validity, internal and external validity, and reliability. Riege (2003) recommends incorporating corresponding design tests, such as "credibility, transferability, dependability, and confirmability", to further enhance the quality of the case study method and these were the guidelines followed in this study.

Construct validity was created by collecting the data from two or more sources, (e.g., documents and interviews). The findings were shared with the participants to review and change unclear aspects. This technique maintains protection against researcher bias. Internal validity was

improved by using diagrams and illustrations to explain the two phases of data collection and analysis. External validity is increased by describing the research design in detail (see Figure 4), and explicitly explaining the scope and boundaries of the study. The CBI manual was used to drive the initial themes, and the findings were compared with an exemplar in the literature during the data analysis phase. The techniques used to increase reliability were interwoven into the case study protocols.

Design tests were also applied. Confirmability was established during the data collection and analysis phase by the participants who confirmed the findings of document analysis during the interview. The principal supervisor also conducted an independent test to confirm the accuracy of the data collected and analysed. The credibility of research was maintained through triangulation techniques, such as using multidisciplinary investigators (i.e supervisors from accounting and science-specific background) and methods for data collection and analysis. Transferability was attained by using specific procedures for coding and analysis, and dependability was achieved through supervisor examination.

The two-phase process of data collection and analysis within a case study setting outlined in this chapter is a valid approach to answering the research question (Yanow, 2007). A mixed-methods research design enables in-depth analysis of the topic of study (Young *et al.*, 2018). It enriches the research data, minimises bias, and improves the credibility of a research study (Bowen, 2009).

This chapter explained the research method used for this research study. The case study approach was adopted that included document analysis supported with semi-structured interviews. The chapter also describes research paradigm, data collection and analysis process, and concludes by considering the validity and reliability. In the next chapter, the key findings of the study are presented in detail.

CHAPTER FOUR

This chapter presents the findings of the study. The results are divided into three main sections. Section 4.1 provides an overview of the findings for each council. Section 4.2 outlines the councils' perceived challenges and opportunities in applying each of the 10 indicators. Section 4.3 focuses on the two themes within stewardship, being community partnership and reporting.

4.1 Overview of the results

The first, most obvious, findings pertain to the basic availability of biodiversity information. Multiple documents for both councils did contain biodiversity information but, largely, information relevant to the CBI indicators was either scattered, unclear, or not disclosed. Additionally, the amount of (public) disclosure increased with the level of government. For example, information on 90% of the CBI indicators was available in national documents, whereas the state and regional documents only contained information on 70% and 56% of the indicators, respectively. Documents at the local level only addressed 39% of the indicators.

The next findings relate to the challenges and opportunities of applying CBI, which were revealed during the interviews. Initially, the interviewees were not aware of any overarching framework for reporting on biodiversity information. However, they did believe that having a common framework and a standardised procedure to follow would be helpful in their efforts. Councils report on biodiversity as part of a whole range of different biodiversity reporting activity that occurs from the local council level right up to the state and federal levels. In considering the 10 indicators, both participants affirmed their importance and value for biodiversity management, monitoring, and decision making, as well as in communicating the state of biodiversity within their councils to their communities and higher authorities. However, they also raised several challenges with applying CBI, such as the availability and quality of data, defining the indicators, developing boundaries, inconsistency in sampling methodologies, and managing community perceptions. Notwithstanding these caveats, overall, the councils believed that adopting an appropriately modified version of the CBI framework for presenting the state of biodiversity within their area would be useful.

4.1.1 Document analysis

4.1.1.1 Scattered biodiversity data

Table 2 summarises the publicly-disclosed data on biodiversity for each of the 10 CBI indicators for each local council. The table 2 shows that from 27 documents reviewed, four key documents significantly represent information on the native biodiversity indicators within the two councils.

Table 2: Publicly-available data on the 10 CBI indicators

		CBI Native Biodiversity Indicators										Totals		
					Changes in the number of native species									
Report	**Year**	**1 Natural areas**	**2 Connectivity**	**3 Birds in built-up**	**4 Birds**	**5 Butterflies**	**6 Plants**	**7 Amphibians**	**8 Reptiles**	**9 Protected areas**	**10 Invasive Species**	**Yes**	**Some**	**No**
National														
Australia SoE	2016	No	Yes	Some	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	1	1
State														
NSW SoE	2018	No	Some	No	Yes	Yes	No	Yes	Yes	Yes	Yes	6	1	3
Regional														
Sydney Regional SoE	2012	Some	Some	Some	Some	Some	No	No	No	No	Some	0	5	4
Local – Alpha														
Flora & Fauna Survey	2018	Yes	Yes	Some	Yes	Some	Some	Yes	Yes	Some	No	5	4	1
Biodiversity Plan	2016	Yes	Yes	Some	Some	No	Some	No	Some	Some	No	2	5	3
Annual Report	2018	Some	Some	Some	No	No	Some	No	No	No	No	0	4	6
End of Term Report	2017	Yes	Some	Some	No	No	Some	No	No	No	No	1	3	6
Local – Beta														
Annual Report	2018	Some	No	Some	Some	No	Some	No	No	No	No	0	4	6
Biodiversity Policy	2016	Some	Some	Some	Some	No	Some	No	No	Some	Some	0	7	3
Fauna Mgmt Policy	2016	No	Some	Some	Some	No	Some	Some	Some	Some	No	0	7	3
Biodvs/Riparian Study	2016	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	9	0	1

Each Column/Colour Represents		
Yes		The document discusses the indicator at length
Some		The document mentions the indicator
No		There is no mention of the indicator

Each document, in Table 2, represents the level of information available to apply the specific CBI indicator at the local council level. The cells labelled as "yes' indicate the document has a significant amount of information on the components of the indicator and the users can apply the publicly-available information within the document to measure the indicator. For example, the indicator 1, *Proportion of Natural Areas in the City,* shows a "Yes" in Table 2, for Alpha's flora and fauna survey document. This means that the document flora and fauna survey have enough information to measure the proportion of natural area in the council. The cells which mention "somewhat" suggests that the document does not have enough information to measure the indicator and would require further details from other sources for its applicability. For example, the biodiversity plan document of Beta has "somewhat" information on the indicator 3, *Native Biodiversity in Built-Up Areas (Bird Species),* this means that the document has some information on this indicator but not enough to measure and will require additional information from the council and other sources. The cell with a "No" represent that the document does not mention anything about the indicator and cannot be measured using that specific document. For example, indicator 5 is labelled as "No" for most of the documents within the two councils, this means that measuring a *change in the number of butterflies* is difficult using the publicly-available documents as information is hardly available.

As the table shows, of the 27 documents reviewed for Alpha, only four contained a substantial amount of information on biodiversity. These four documents are included in Table 2. However, an important finding is that several of this information would meet the disclosure requirements for some of the indicators. For example, three of the four documents highlight that Alpha already complies with Indicators 1 and 2 – the proportion of natural areas and connectivity measures to counter fragmentation.

Publicly-available information for the other indicators, however, was limited and a follow-up during the interview was required to determine whether more data was available internally. For example, there was not enough publicly-available information to confirm whether Alpha can use Indicator 3: Bird species in built-up areas, but all four documents implied that more information was, in fact, available to the council internally. For the other indicators, such as Indicator 10: Invasive species, there was no publicly-available information.

In contrast to Alpha, most of Beta's information on the ten CBI indicators could be found within just one document – the "Biodiversity and Riparian Lands Study", which contains information on 9 out of the 10 indicators. Beta's disclosures were, therefore, less scattered than Alpha's, but

they were difficult to find, given that the lands study was thick and a technical 180-page document.

Overall, Table 2 highlights that data on the ten indicators is scattered across a range of documents and, notwithstanding Beta's "Biodiversity and Riparian Lands Study", there was no single document that represents the state of biodiversity within either council area. Further, neither council publicly discloses information on all 10 CBI indicators. Alpha only publishes substantial information on five indicators, while Beta publishes information on nine indicators, but it is buried in a thick document. Neither mode of presentation is easy for stakeholders to use, understand, or interpret.

4.1.1.2 Biodiversity disclosures by the level of government

The following Figure 8 and Table 2 above provide information about the amount of data that is available at each level of government on the 10 CBI indicators. It is evident that the higher the level of government, the more information is available. For example, 90%, 70% and 56% of information on indicators are publicly accessible at National, State and Regional level compared to only 39% of information on indicators is publicly accessible at the local level. Additionally, generally, only one document was needed to find biodiversity information about all 10 CBI indicators at higher levels of government as opposed to the 27 sources needed across the two local councils.

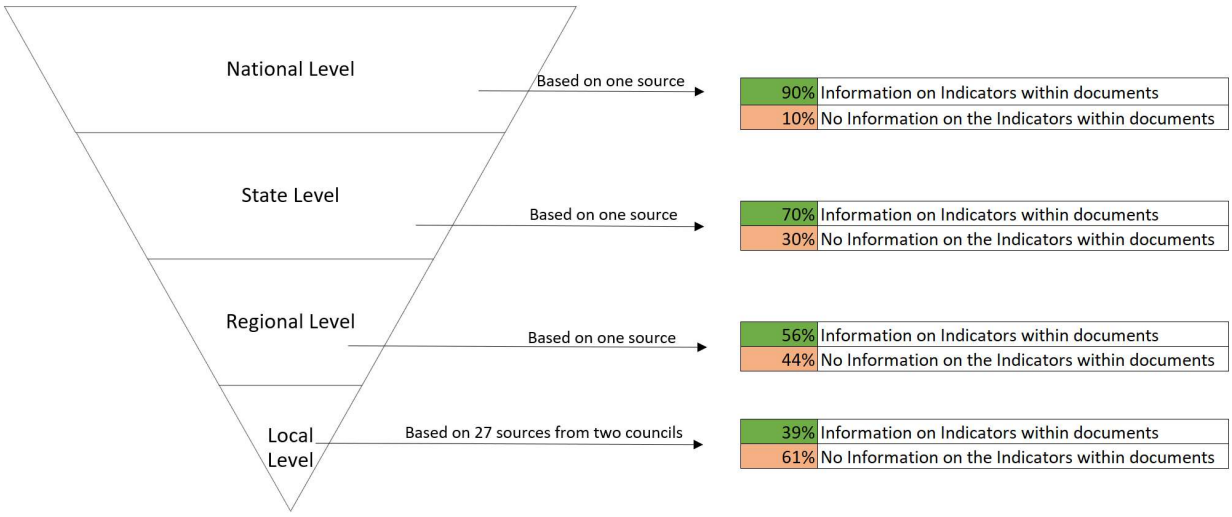

Figure 8: Availability of information by level of Australian governments

4.1.2 Interview analysis

The answers to the interview questions are summarised in Table 3 about the 10 CBI indicators. Overall, the participants found most of the indicators (with a few exceptions) to be a good starting point for both measuring biodiversity within their council area and developing a common framework across all councils. For example, B1 suggested that capturing this kind of data and providing a snapshot of biodiversity using CBI would be valuable and be useful for resource allocation.

Table 3: Summary of interview results

CBI indicators	**Council**	**Is it a useful* indicator?**	**Is this information publicly available?**	**Is this information internally available?**	**Appropriate reporting level(s)?**	**Highlighted issues/ other notes**
Indicator 1 Natural areas	Alpha	Yes	Yes	Yes	state regional local	Data accuracy and outdated data are issues
	Beta	Yes	Yes	Yes	state regional local	Clarity on the definition of natural areas and level of disclosure required
Indicator 2 Connectivity	Alpha	Yes	Yes	Yes	regional local	Available data is of poor quality
	Beta	Yes	Yes	Yes	regional local	Complexity around what parameters are meaningful
Indicator 3 Bird species in built-up areas	Alpha	Yes	No	No	local micro	No current data collection, but could be done with community assistance.
	Beta	Yes	Yes	Yes	local micro	Using data from backyard bird count and getting the ratio of the birds from the natural urban index is a better measure
Indicators 4-8 Changes in the number of species	Alpha	Yes	Yes (Except few)	Yes	state local	Data is not reflective of what is happening in the broader area
	Beta	Yes	Yes (Except few)	Yes	all	Birds, frogs, and plants are the best choice. Change over time could be measured better by adding an urban index.
Indicator 9 Protected areas	Alpha	Yes	Yes	No	state	LEP zoning may include roads that do not qualify as protected. Definition of zones needs to be clarified.
	Beta	Yes	Yes	No	state	Legal level of protection between councils may not reflect the actual level of protection.
Indicator 10 Invasive species	Alpha	Yes	No	Yes	state local	The positive news is received better than negative news. Making disclosures to an external audience is a complicated process.
	Beta	Yes	No	Yes	state local	There should be two separate indicators to measure invasive flora and invasive fauna.

*All be it to different degree

Both council interviewees stated that they already produce most of the information needed to apply the indicators, even if only internally, with the exception of data on protected areas. Yet both also pointed out the need for a structured and comparable approach to managing, measuring, and reporting on biodiversity for the information to be useful over time and between councils. They saw CBI as a valuable biodiversity accounting technique in this regard. But they also saw a need for some modifications to the framework before it could be appropriately applied to Sydney's local councils. For example, both Alpha and Beta interviewees highlighted that several indicators are not good representations of native biodiversity in their regions, such as Indicator 6: Changes in the number of native butterflies species, which may be suitable for measuring biodiversity in tropical regions like Singapore but not for sub-tropical regions like Sydney. Other suggested modifications focused on the clarity of the definitions within some of the indicators, determining boundaries, and revising some of the calculation methodologies. The challenges raised in applying CBI included data accuracy, i.e., the lack thereof in the data they were collecting; difficulties with data mapping; a lack of formal processes for bird counting activities; issues with on-going monitoring and sampling methodologies; managing community perceptions; and the need for community participation. The challenges and opportunities raised are discussed more specifically in Section 5.3.

When asked to verify whether data on each of the 10 indicators was available publicly, B2 confirmed that data for most of the indicators had been publicly disclosed by either: the council itself; by other government organisations or portals, such as the Environment, Energy and Science Group and Sharing and Enabling Environmental Data; or by non-government organisations, such as Birds Australia or the Atlas of Living Australia. A1 acknowledged that the quality of the data they shared publicly was questionable. Also worthy of note is that neither council discloses information on Indicator 10: Invasive species. The reason is that they believed that their local community perceives positive information better than negative information. Moreover, reporting and disclosing information about invasive species to an external audience is a complicated process.

Table 3 also summarises the viewpoints of interviewees from councils' on the levels they saw most appropriate as reporting on the CBI indicators. On most CBI indicators, their views coincide. For example, interviewees from both councils feel that Indicator 3: Bird species in built-up areas should be reported at a micro-level as well as the local level, given the nature of data. In addition, A1 believes that the council and community collaboration would be essential

in gathering the data to properly measure Indicator 3, while B1 mentions that Beta already has a community program in place for this very purpose and suggests it would be a better approach than the CBI method.

Overall, the results of the document analysis and interview revealed several of the challenges and opportunities of applying CBI within the two councils. The following sections detail the applicability of each specific CBI indicator.

4.2 The applicability of the ten CBI indicators

This section presents the findings relating to the challenges, opportunities, and applicability of each of the 10 indicators.

Indicator 1 reflects the proportion of natural areas in a region. It is important because natural areas are thought to contain the most biodiversity. Indicator 2 is a measure of the extent to which the natural areas in a region are connected. Indicator 3 measures the number of bird species in built-up areas. Indicators 4 through 8 monitor changes in the number of native species of various taxonomic groups. Indicator 9 measures the proportion of natural areas that are protected, and Indicator 10 reflects the proportion of invasive species in a region, as opposed to native species because invasive species are a major threat to native species.

Interviewees from both councils found all indicators to be useful or of some benefit to their biodiversity management, monitoring, and/or reporting activities, with the exception of Indicator 9: Protected areas, where the views were mixed. The following subsections present the results for each indicator group in more detail.

4.2.1 Indicator 1: Proportion of natural area

> *Natural ecosystems harbour more species than disturbed or manmade landscapes, hence, the higher the percentage of natural areas compared to that of the total city area gives an indication of the amount of biodiversity there* (Chan et al., 2014, p. 11).

Alpha and Beta both suggest that measuring natural areas is a good indicator of biodiversity because natural areas contain the most biodiversity and would be of benefit. Additionally, the data needed to measure the amount of natural area in each region is available internally and externally, although its quality may be questionable. Both councils also agree that this indicator should be reported at both the state and local level to reach a broader representation of biodiversity across the state.

One of the biodiversity documents explains the importance of conserving natural areas within their council for the community:

> *Participants from all age groups emphasised the conservation of natural areas as they give Beta character and make it a 'sanctuary' that people come home to. Community participants also identified the need for tighter controls and enforcement on development affecting trees and natural areas through the building approval and enforcement processes* (Beta Biodiversity and Riparian Lands Study, p. 29).

Both councils collect the data required to implement Indicator 1. However, Alpha highlights concerns relating to the accuracy of data, explaining that no mapping of natural areas has been undertaken since 2001 and, in the intervening period, several areas have seen significant planting and reforestation efforts. A published Alpha survey report even recommends to "update mapping of natural areas to reflect current extents of natural areas in each park. This is especially important for all endangered ecological communities" (p.453).

Alpha mentioned that how a piece of land is categorised also impacts the accuracy of data, as well as what should or should not be included in a 'natural area classification'. For instance, there might be vast areas that are fully vegetated, and could look like bushland, but they are not categorised as community land and would not be measured. At present, Alpha uses the methodology described in *The Native Vegetation of the Sydney Metropolitan Area. Volume 1: Technical Report. Version 3.0* (Office of Environment and Heritage (OEH), 2016) to classify the most likely vegetation that would exist on a site as a guide for revegetation activities in reserve. In these volumes, the Department of Planning, Industry and Environment (formerly the OEH) communicates local and regional patterns in species assemblages called 'plant community types' (PCTs) as the finest level of vegetation classification in NSW. The volumes are intended to be used for vegetation maps, as regulatory tools, for local land use, and for management planning. However, the modelling accuracy of PCTs varies from 45% to 75% depending on the quality of descriptive data. A2 suggests that this could be improved with more survey data.

Interviewees of Beta also indicated that the definition of a natural area needed to be strengthened by looking at structured vegetation and suggested using the definition of natural area in the Local Government Act (1993). This definition would make it easier to disclose how much natural area a council has. However, the bushland within a council can be of different qualities; some may be predominately native, some not. Therefore, B2 suggests that the

difference in patch sizes should also be taken into consideration, that is, deciding "how much should the councils amalgamate different patches". As they explained in their study.

> *An assessment of vegetation connectivity and patch size was undertaken as part of the mapping process to enable protection/consideration of more connected and larger patches of vegetation. … A review of Formal Reserve patch size within and adjacent to (Beta) was undertaken to assist in the identification of core areas to be connected. This included mapping areas into 5 classes based on patch size (ha)* (Beta Biodiversity and Riparian Lands Study, p. 60).

B2 suggested that at a base level, "knowing how many natural areas a council have, is still a valid question", and this could be the simplest indicator. They could also then have a high-level indicator based on information around the vegetation structures and patch sizes for areas outside those that can be stated by a simple indicator. In time, the councils could work up to using top-level indicators that, say, give vegetation communities integrity scores. "This would probably be the most accurate way of looking at it". However, this final stage would require time and effort and may only be useful for some councils, while others may be better off with a generic indicator. It was noted that the level of indicator chosen by a council should not entirely focus on the actual level of biodiversity. Rather, it would demonstrate the "depth of inquiry" and "level of confidence" attained by a council in measuring biodiversity through Indicator 1.

Additionally, according to B2, Indicator 1 should not be restricted to only council-managed land. Capturing state and private land would bring useful insights.

Overall, Indicator 1 would be relatively easy for councils to apply if it were based on a simple definition of a natural area. It would only require updates to the currently-available data and some clarity around the definition and boundaries of what constitutes a natural area. A more comprehensive definition that incorporated land categorisations, vegetation structures, patch sizes, integrity scores, and so on, would take more time and skill to implement but would enhance the depth of inquiry and level of confidence in Indicator 1.

4.2.2 Indicator 2: Connectivity measures to counter fragmentation

> *Fragmentation of natural areas is one of the main threats to the sustainability of biodiversity in a city. Hence, it has been selected as an indicator to chart possible future trends… to encourage positive actions to increase connectivity or reduce barriers to connectivity, it would be more meaningful to measure connectivity rather than fragmented plots* (Chan et al., 2014, p. 12).

At a rudimentary level, information on the corridors, connected areas, and fragmented plots are available both internally and externally for measuring Indicator 2. Both councils agree that reporting on connectivity is important at a state, regional, and local level if wildlife corridors are to be better connected overall.

Calculating Indicator 2 requires satellite imagery, which A1 says they have difficulties with mapping. A2 acknowledges that some of the connections stated in Alpha's biodiversity map are "probably a bit arbitrary", and that they "will try to drill down further to get a realistic figure". Aerial photos are reasonably good indicators of connectivity as councils can usually identify local connections simply by looking, but it is pointed out that only a few of the visible connections could have been included in a Biodiversity Plan as future corridors to enhance the connectivity. A1 explains:

> *Those corridor maps do not necessarily sit particularly well with me. There could have been some corridors included and some removed. … From aerial mapping, you cannot see the quality of the vegetation to see if there is a connectivity value in those actual spaces that are on the ground. For example, you could have Agave plants next to something else.*

Connectivity is important to Alpha. In fact, one of the targets in their Biodiversity Plan is to achieve a measurable increase in connectivity to enhance habitat values:

> *Corridors and Connectivity: linking the landscape: Corridors connect larger habitat patches allowing movement of species and/or genetic interchange among native flora and fauna – thereby maintaining biodiversity.*

Accordingly, Alpha feels Indicator 2 is aligned with their vision and support it as a useful measure. However, they feel the quality of connectivity can be questioned and, by the CBI guide, is mainly based on how a council chooses to assess it. Therefore, the challenge is not in identifying whether a connection exists, but rather how to reliably assess the quality of that connection.

Beta also supports Indicator 2 as a good measure of biodiversity, and they are already collecting some data. For example, their biodiversity land study provides an explanation of vegetation community mapping, connectivity, and patch sizes:

> *An assessment of vegetation connectivity and patch size was undertaken as part of the mapping process to enable protection/consideration of more connected and larger patches of vegetation* (Beta Biodiversity and Riparian Lands Study, p.39).

It was also confirmed in the interview that, if parameters such as patch size are given to them, they can easily run a report through the system. The only complexity is working out which parameters are meaningful. Therefore, B1 suggests using the connectivity criteria in the Biobanking Assessment Methodology prepared by the Department of Environment and Climate Change NSW.

Further, interviewees of both councils agree that Indicator 2 should be identified at the regional and local levels, as evidenced in multiple documents.

> *The Biodiversity plan has identified the values and threats to biodiversity values within [Alpha] and has identified wildlife corridors on a local and regional scale. These corridors currently provide a degree of connectivity between bushland reserves but also identify potential infill areas that require revegetation to link reserves and improve the degree of connectivity*(Alpha Biodiversity Plan).
>
> *The rapid assessment of biodiversity within [Xyz area] was undertaken by the [Xyz management authority]. This involved identifying a network of regional corridors to connect areas of priority habitat and reserved lands in the catchment. These broader-scale corridors follow contiguous native vegetation and form links between habitats currently managed for conservation* (Beta Biodiversity and Riparian Lands Study).
>
> *By recognising and seeking to protect areas of Regional and Local Fauna Habitat, [Beta] intends to support the role of native fauna in the ecosystem, facilitating their continued survival, as well as preserving their social and cultural importance for the community" (Beta Biodiversity and Riparian Lands Study).*

Moreover, B1 suggests that the data for Indicator 2 should be managed at the state level and used at the local and regional levels for measuring connectivity. The council understands the need for aggregate data at a regional level to ensure habitat connections are not limited to small council areas.

Overall, the above findings provide key insights into the applicability of Indicator 2. It is considered to be a useful indicator and is widely reported. However, given that the quality of corridors cannot be entirely determined based on aerial photos, efforts have been made to conduct more sophisticated analysis at a regional level. This information could be included in council-level reporting.

4.2.3 Indicator 3: Bird species in built-up areas

> *Built-up areas and brownfield sites do harbour biodiversity, e.g., birds, like swallows and swiftlets, nest under roofs of buildings… By enhancing certain features in such areas, the biodiversity could be improved. Hence, native biodiversity in built-up areas and brownfield sites should be an indicator* (Chan et al., 2014, p. 13).

The key insight for this indicator, shared by both the councils, is that collecting accurate data for this indicator is best done with community participation. Alpha does not have a formal data collection process; hence, they do not report on it internally or externally. Beta does have some data, and so they do report on it. However, both mentioned that information from the backyards of residents and other privately-owned areas is crucial to their efforts. Therefore, Indicator 3 should not only be reported at the local level but also at the micro-level within the community.

In the last few years, both councils have been actively involved in the Birds in Backyards data collection program run by BirdLife Australia. Birds in Backyards is:

> *… a community monitoring activity where it could just be a family sitting in the backyard counting kookaburras. All local bird watchers upload the data to an online database so that they could be submitting it every month. Now the quality of the data you might question* (A1).

A1 sees the potential in taking a citizen science approach to gather the data "as there is lots of data out there", confirming the idea is on the council's planning agenda. B2 notes that, even though the quality of the data from the backyard program may not be reliable, it may still be useful. They suggest that using the urban bird species ratio found in the Urban Bird Index (Smith and Smith, 2005) would, in their opinion, be a better approach for measuring birds. Beta's Biodiversity Plan defines the ratio:

> *The Bush/Urban Bird Index is a comparative measure of the proportion of bird species denoted as 'Urban birds' to those denoted as 'Bush birds'.*

Overall, the need for an indicator that measures biodiversity in built-up areas is considered important by the councils, and that counting birds in an urban setting relies heavily on residents to report their own observations. Currently, the Birds in Backyards program is helping to furnish both councils with data. However, its accuracy and quality is not verified. Therefore, the councils need a formal and more rigorous scientific protocol that involves community collaboration.

4.2.4 Indicators 4 - 8: Changes in the number of native species

> *The change in the number of native species is used for Indicators 4 to 8. The three core groups are Indicator 4: vascular plants; Indicator 5: birds; Indicator 6: butterflies. These groups have been selected as data are most easily available and to enable some common comparison. Cities can select any two other taxonomic groups for indicators 7 and 8* (Chan et al., 2014, p. 14).

With the exception of butterflies, the data to measure the number of native species is currently internally available within both councils and has been reported externally to some extent. Alpha finds reporting of Indicators 4-8 most useful at the state and local levels, whereas Beta suggests that reporting of these indicators is integral at all geographic levels if appropriate conservation and sustainability strategies are to be developed.

Indicators 4-8 are the only CBI indicators that measure change over time. These indicators "require a number" and then a "change in number" to understand improvement in native biodiversity. Alpha measures the abundance and distribution of flora and fauna in 20x20m quadrants each decade. The first survey occurred in 2008 and again in 2018. The results show a decline in species, but A2 believes that the data gathered may not be reflective of what is happening in actual terms. For example, several new bird species have been spotted in some quadrants, while others have disappeared. The document analysis reveals some of the difficulties with making comparisons of biodiversity over time:

> *While diversity remains high, there has been multiple "losses and gains" in species recorded. This needs to be taken with caution, however, and a good understanding of some of the contextual factors that may have contributed to the perceived changes. These factors include: Survey effort; Survey equipment (more, better in 2018); Stochastic events outside the Local Government Areas (LGA) such as localized flowering events; Stochastic events inside the LGA such as localized flowering events; Local weather conditions – extremely dry hot summer is 2016 and 2017; and Regional & national weather conditions impacting the arrival and departure times of migrant species* (Alpha Flora and Fauna Survey).

Moreover, there is a limitation of human variability. A2 explains that a sampling methodology only leads to useful and comparable results if the quadrant measurements are done with a camera monitoring the species 24/7 under differing conditions, such as locations and seasons, but where those differing conditions can be replicated each time the sampling is conducted, (e.g., a decade later).

B2 highlights that the data for these indicators is available from the non-government organisation Atlas – The Living Australia (ALA). It is captured at the local level and then uploaded to ALA. B2 also suggests incorporating an urban index to measure changes in the number of species.

Neither council considered Indicator 6: Change in the number of butterflies to be useful. Butterflies are prevalent in tropical regions, but Sydney has a sub-tropical climate where changes in the number of frogs are a much better indicator of biodiversity. B2 indicates that "after birds, frogs are considered second best, and the community loves them."

Overall, interviewees of the councils' agree that measuring the change in the number of native species using Indicators 4-8 has great value, if carefully quantified. The indicators are easily applicable if the selection of core native species is slightly altered to birds, frogs, and plants to suit Sydney's climate conditions.

4.2.5 Indicator 9: Proportion of protected natural area

> *"Protected or secured natural areas indicate the city's commitment to biodiversity conservation. Hence, the proportion of protected or secured natural areas is an important indicator"* (Chan et al., 2014, p. 15).

This indicator garnered the least consensus between the two councils. Alpha felt that measuring the amount of protected natural area was useful to them. However, Beta indicated it was only valuable at the state level and otherwise of little use. Both councils claimed state-level reporting as appropriate because, in almost all local council cases, some territory is controlled at the state level or above.

It was not made clear in either the documents or the interviews as to whether the councils had access to information on protected natural areas. In the documents, information about Indicator 9 was not disclosed at all by Alpha, and in only one of Beta's documents:

> *The NSW Office of Environment and Heritage (OEH) has over 820 protected areas in NSW (including 4 reserves covering over 1700 ha within Beta). These are classified according to their use, location and fragility. … This zone is intended to enable management and appropriate use of lands that are identified by OEH as protected areas. These include National Parks and Nature Reserves. It is also intended to apply to sites proposed to be reserved under this Act to protect their environmental significance. The permissible land uses are set through the standard LEP instrument,*

like those governed by the NSW National Parks and Wildlife Act 1974 (E1 – National Parks and Nature Reserves).

At the state and national levels, disclosures like this become more detailed. For example, the NSW State of the Environment Report (2018) mentions:

> *Since 2015, the area of land in national parks and nature reserves has increased by 31,900 hectares. The representativeness and comprehensiveness of protected areas in NSW are improving with significant additions to underrepresented areas, but some bioregions and vegetation classes are still underrepresented, particularly in the central and western regions.*

A1 also highlights that there are varying degrees and spheres of protection – from an entire nature reserve to one tree on a piece of private property. Additionally, both councils state that some areas of conservation are outside their control. B2 explains:

> *The protection of natural areas is very bureaucratic. And we have got different tiers of conservation such as the National Park being in zone E1, up at the top, and then conservation areas in zone E2. Some might be under a biobanking agreement, then some reserves will not have a biobanking agreement. There might be a recreation zone. So, there are all these different ways and classifying it, hence [it] may not be indicative at the local level.*

B2 further clarifies that not every council tries to legally increase the conservation status of their reserves, which means some areas are technically reserves, but they are not legally protected. So the differences in legal levels of protection between councils may not be reflective of actual levels of protection. A better measure at the local level suggested by B2 would be to answer the question: "How active is the council in making areas of conservation value legally protected?"

A2 suggests that the Local Environmental Plan (LEP) zonings are a realistic benchmark for classifying whether council areas are protected. However, the zones can include adjoining land or roadways, etc., so councils must be careful to look for these in the total stated area of an LEP zone. Moreover, the LEP zonings have not been updated for the past five years and may not be indicative of what is happening on the ground – although it was noted that Alpha is currently in the process of updating their LEP framework.

Overall, the conclusion reached by the participants is that Indicator 9 is more useful at the state level than the local level (if useful at all), due to varying degrees of protection and the limited

control councils have over some of the important protected areas in their region. The LEP maps provide some raw data on protected areas, but they need to be updated and the numbers need to separate areas of actual protection from infrastructure, such as roadways. A better indicator suggested is to measure how actively a council is in trying to legally protect areas for conservation.

4.2.6 Indicator 10: Invasive species

> *Invasive alien species out-compete native species and, thus, threaten the survival of native species and the integrity of ecosystems. As cities are very open to an influx of alien species, this indicator measures the status of this threat* (Chan et al., 2014, p. 16).

The CBI Indicator 10: Invasive species was felt to be helpful for resource allocation and decision making. A2 mentions Indicator 10 as being useful for their on-ground projects, such as targeting contractors and local land services to work under the Greater Sydney Weed Allocation Management Plan:

> *This is something that the councils want to track because we want to see if they're increasing or decreasing the number, particularly species such as rabbits, foxes and weed species* (A2).

Alpha internally measures feral species but does not publish the information externally to avoid negative community perceptions. From a community point of view, both Alpha and Beta consider it better to disclose positive indicators rather than negative ones. A1 and A2, for example, conjectures about the community's reaction to disclosures of the number and photos of issues like carcass disposal. They go on to explain that if the council reports they are losing canopy at a rate of knots because people are illegally cutting down trees, it would spark interest in the community. Yet the fall out from this kind of disclosure can sometimes be very detrimental to what the council is trying to achieve. Hence, they believe that limiting such disclosures to manage perceptions and community expectations is necessary to achieve their objectives:

> *There was a number of reasons for our feral animal control program. So, the more signage we put up, the more notices we do, the crankier upset phone calls we get for the animal protection* (A1).

> *We made the Sydney Morning Herald headlines because of advertising the programme we were doing a year ago, and it sparked a Sydney wide feral animal campaign around*

> *feral foxes in (Alpha). We relaunched the program this year, and we still carry out all the legal requirements around, such as the house signposting, notifications and the backup plans for our vets. And not a problem this year. Besides, we got better results than we have ever had. It is managing community perception* (A2).

Alpha believes that invasive species are a major threat to biodiversity and an invasive species indicator is an important management and decision-making technique, which is why reporting is more extensive for internal audiences. But, in terms of council-level external reporting, the main difficulties would be in determining the best way to report the indicator. All councils are already required to report sightings of invasive weeds to the Department of Primary Industries along with the areas that have been treated, but Alpha has fallen behind in these reports due to a temporary gap in personnel. Another issue with external reporting is that the numbers can fluctuate considerably for both flora and fauna. For instance, the council may place a control on an invasive species in a particular park that reduces the species to zero, only for it to return next season.

B2's suggestion for a better measure is to calculate the percentage of invasive species in an area in terms of its impact, (i.e., whether a weed species is having a low, medium, or high impact on an area). And what that impact is should be stated qualitatively. This data is broadly available and is relatively straightforward to apply at the council level. For example, existing weed mapping activities already provide information about the intensity of weeds. B2 further explains that large organisations such as the Australian Wildlife Conservancy may find Indicator 10 to be a useful measure "*as they usually report on areas that are predator-free"*. But, at Beta, such a measure does not exist as, for councils, it is more about weed mapping and weed density. Introducing Indicator 10 might encourage them to look at problem species, such as rats, cats, dogs, foxes, and rabbits. It would be easy for Beta to determine whether those five species were active in the area. To this end, B2 recommends having two separate indicators for invasive species – one for flora and another for fauna.

Like Alpha, Beta also did not want to disclose information about invasive species. Beyond the distaste for such material in the community, they also do not want to advertise areas they think may be valuable to poachers. Similarly, disclosing information about a critically endangered flower is also not a good idea. Those areas could be flooded with people taking photos, or worse, which would only exacerbate the problem. For these reasons, B2 suggests OEH should

de-identify the results and that people should need a license to view the location of endangered species.

In summary, measuring invasive species is valuable to the decision making of both councils. Information on invasive species, particularly weeds, is collected and reported internally. Hence, reporting this information externally would be logistically straightforward, and likely at both the state and local levels. The challenge lies in the desire to report this information externally as, according to them, the community would not find the information palatable. In addition, disclosing some information could even be to the detriment of a conservation program.

4.3 Environmental stewardship

The second aspect of this research was to explore the impacts and interrelations of CBI with stewardship in the context of Sydney local councils. The results of this analysis follow.

The biodiversity plans of both councils recognise their role as stewards of the ecologies they govern and their responsibilities towards managing and protecting the natural assets in their region. Further, the Local Government Act 1993 specifies a strong set of principles for the care and protection of the local environment, good governance, and ecologically sustainable development. The governance and management frameworks of both councils incorporate these principles. The councils also promote environmental stewardship through interventions, such as educating the community about biodiversity or their feral animal management programs.

The document analysis reveals that shared environmental stewardship is important to the councils if they are to deliver positive biodiversity outcomes. Both their biodiversity plans highlight that the council and community together have a duty of care to protect biodiversity. In Alpha's words: "As city dwellers, Council and its residents have a responsibility for stewardship of biodiversity, its management and protection." (Alpha's Biodiversity Plan, p. 1). Beta's biodiversity policy statement also makes mention of a duty to conserve:

> *Both the uniqueness and significance of local biodiversity is recognised as forming part of a wider regional, national and global network of ecological systems which Council, together with the community, has a duty to conserve* (Beta's Biodiversity Plan, p.7).

The sentiments expressed in the interviews support this position, with two strong emerging themes: a partnership with the local community and communicating stewardship in the form of reporting. These findings are discussed in detail in the next subsections.

4.3.1 Stewardship and community partnership

The findings from interviews with Beta demonstrate that this council seek to inspire stewardship within the community. Beta believes that the community are the stewards, and councils are responsible for managing and facilitating that stewardship within the community. In other words, protecting biodiversity is a responsibility shared between the council and the community. They highlight that community stewardship is an important part of protecting biodiversity if not least because they do not directly manage private land.

Alpha explains, in their documents and interviews, that community stewardship in their local council is integral to regenerating and preserving the extensive bushland in their area through the Bushcare program. This program asks volunteers to put time and energy into taking care of the natural reserves and public spaces in their region, and so brings an indirect sense of ownership over the land and its preservation. Moreover, the program creates a social connection between the council and the community, along with opportunities for the council to teach its residents how to foster biodiversity.

Shared stewardship between councils and the community is important for several reasons. A2 points out that: “No council has all the resources to be able to delegate to carry out regeneration work at the level that we'd all like, including weed control.” Each person fosters their own sense of care and ownership towards conserving biodiversity. The flow-on effects from being able to generate interest in protecting the bushland come from people living close to these areas. The communities then foster that sense of care for the natural environment. Further, A2 mentions that education is a major component of encouraging that sense of care within the community.

A1 explains that volunteers had been working to regenerate bushland in some of their reserves long before the council started a formal Bushcare program to support them. “So, in some ways, the community has been a driver for achieving stewardship by helping build the program and progressing it to what it is now.”

As urban areas expand, the need for stewardship to preserve biodiversity becomes more pressing. Partnering with the community helps councils to achieve their conservation targets by creating “pockets of biodiversity” (A1). Without these, councils would be restricted to cultivating biodiversity in only those green spaces in the public domain. An example of one of these pockets is Alpha’s nine-kilometre corridor project that connects native habitats through a vast residential area. The project is funded by a grant and involves face-to-face education with residents to foster stewardship at the micro-level in people’s backyards:

> *The council educated the community on the importance of native plants, to foster small bird habitats, to increase biodiversity in the spaces that otherwise would have been fragmented if they had been left to the natural corridors that did exist. So, in that sense, stewardship is hugely important* (A2).

Overall, the two councils view stewardship as a partnership between the council and community, where the responsibility for supporting and managing effective biodiversity conservation projects is shared.

4.3.2 Stewardship and reporting

Alpha and Beta agree that communicating the stewardship roles of councils and the community is essential. Alpha sets corporate targets for its stewardship responsibilities, such as the number of active volunteers and conservation groups in their area. Progress towards these targets is reported in their Annual Report and their annual Environment Sustainability Report as well. A2 explains that the community has also played a considerable role in reporting:

> *The initial flora and fauna studies that were conducted back from 2006 – (Alpha) suspects the community largely drove that because the council did not have any baseline data on what exactly there is in the park. The community well supported it and it was something they may have been talking about for many years before (Alpha) had the opportunity to do it when the funding was available. This is a bit of a close connection with the number of community members related to protection and active management in some of the reserves.*

A2 also spoke of the many external stakeholders and interest groups that have helped to prevent some of the natural reserves from becoming garbage dumps. For example, the Flora and Fauna Preservation Society has been running a campaign to save the reserves in the area since the 1960s in support of the council's efforts. The lesson is that sometimes the community can have more influence over itself than the council:

> *And then there are also other community groups that sprung up, we the friends of … I think they have probably been quite successful in various campaigns at different times to help protect areas. I think some of the communities can have more influence sometimes than the council, advocacy staff and others* (A2).

Alpha's experience highlights that there are many ways to communicate stewardship to the community and for the community to report stewardship back to them: through annual reports, studies, campaigns, funded projects, and education. For Alpha, one of the most effective

methods of fostering stewardship and reaching their conservation goals has been to let the community exert pressure on itself.

Chapter 4 presented findings of the study into three sections. First, an overview of the findings for each councils is provided, Second, the chapter outlines councils' perceived challenges and opportunities in applying each of the 10 indicators. Lastly, the two themes within stewardship, being community partnership and reporting, are put forward.

The next chapter discusses the results of this study.

CHAPTER FIVE

This chapter is organised into four sections. Section 5.1 discusses how the results of the study have answered the research question and the impacts on stewardship theory. Section 5.2 discusses the opportunities and challenges with applying CBI in Sydney's local councils. Section 5.3 considers the contribution and wider implications of the study. Section 5.4 outlines the limitations of the study and concludes with directions for future research.

5.1 Discussion

Conserving biodiversity is a complex but essential undertaking for the survival of life on Earth. Measuring the impacts of conservation projects is vital in the urban landscape, and monitoring tools, such as CBI, can help. In NSW, biodiversity conservation is being enforced through offset schemes and reforms to improve land management practice and use (NSW Office of Local Government, 2018). In support of these efforts, this research has been conducted to explore whether CBI is a feasible and/or appropriate technique to help Sydney's local councils monitor, manage, and report on their biodiversity conservation activities. The objective of the study is to examine the extent to which CBI will improve the current biodverisity accounting practices at a local council level. An analysis of two case subjects was directed towards uncovering the opportunities and challenges CBI presents in the municipal context. The role and impact of stewardship and its interrelations with the councils, the communities, and CBI forms part of this context. By examining these issues, this study contributes to the academic literature on accounting for biodiversity and stewardship theory, to CBI and government policymakers, and to practice knowledge for Sydney local councils. The literature on accounting for biodiversity is limited and has mostly focused on reporting. Hence, this study, in a small way, begins to fill

a large gap in our much-needed understanding of biodiversity indicators, action plans, monitoring practices and accountability.

Through their plans and actions, the two councils can demonstrate their role as stewards of the natural environment. As Australia's local-level government, councils have legislative responsibilities towards governance and a duty of care to protect the local environment within a framework of sustainable development. Stewardship in public authorities has already been examined in the literature. For example, Gaia and Jones (2019) explored "biodiversity duty" in English councils, finding they support sustainable development objectives through the decision making and the management of public land.

Many of the interventions by the two local councils seek to promote stewardship through education and volunteering programs. However, there is a vital need to evaluate how effective these local initiatives are in achieving their goals, promoting biodiversity, and fostering stewardship in the community.

The findings from this study highlight the importance of shared stewardship between local communities and councils for biodiversity conservation. Notably, the interviewees emphasised the importance of community partnerships in the creation of long-term datasets, as well as in protecting biodiversity through campaigns and volunteering. This finding accords with the prior literature on public participation in nature conservation, where decision-makers focus on mobilising their constituents to assist with data collection and other community projects (Shirk *et al.*, 2012; Sakurai *et al.*, 2015; Millar, 2019). Community participation through a citizen science approach is considered to be a cost-effective method of monitoring and conserving biodiversity. In contrast to Kohsaka and Uchiyama (2017), these Sydney councils speak of an active community that works to conserve biodiversity and even instigates their own projects and data collection efforts.

The key results of the study indicate that these metropolitan councils of Sydney acknowledge the importance of biodiversity and are interested in improving their efforts to conserve biodiversity in their region. And both councils see potential in the CBI framework for helping them in these efforts. Both councils already have data on many of the 10 CBI indicators. Several are reported externally; others internally. Their levels of disclosure are also higher than those found in other studies of the public sector (Barut *et al.*, 2016; Gaia and Jones, 2019), as well as the corporate sector (Rimmel and Jonäll, 2013; Atkins *et al.*, 2014; Adler *et al.*, 2018). Further, Alpha and Beta have detailed, up-to-date biodiversity strategies and plans, unlike the findings in other studies (Barut *et al.*, 2016; Gaia and Jones, 2019). However, it is worth noting that

greater levels of the disclosure may have been observed in this study because documents were reviewed at multiple levels of government, whereas the prior studies only examined a single level of reporting.

Despite the relative availability of biodiversity information, an important finding is that the information is scattered across various documents and formats, which makes it difficult for stakeholders to gain a comprehensive picture of the current state of biodiversity within a local council area. Prior studies have reported similar conclusions, citing the difficulties stakeholders have in making a meaningful assessment of an organisation's biodiversity impacts (Rimmel and Jonäll, 2013; van Liempd and Busch, 2013; Adler *et al.*, 2018; Gaia and Jones, 2019). Part of the problem is variability in the sources, which was also an issue raised by the two councils.

From the analysis of the document and the council workers, the finding is that there is a need for a standardised approach to measuring and reporting on biodiversity. Additionally, a common framework, such as CBI, would allow for comparisons across councils and at different levels of government. This call for standardised biodiversity accounting and reporting concurs with prior calls for a standard sustainability reporting framework for national, regional, and local levels of government (Goswami and Lodhia, 2014; Barut *et al.*, 2016).

5.2 Opportunities and challenges

Several opportunities and challenges to implementing CBI within Sydney local councils were raised, although none were particularly insurmountable. The results suggest that it would be straightforward for the two local councils to create most of the 10 CBI indicators, albeit with modifications and drawing on sources both internal and external to the councils. Using an index would create many opportunities, such as: a path to standard biodiversity monitoring framework at the municipal level; the ability to track species trends over years; the ability to compare information between councils; decision-making and planning support; methods for evaluating the progress of biodiversity initiatives; and effective ways to communicate the results of those efforts to the community, other levels of government, and other stakeholders.

However, applying the CBI framework also presents challenges, such as how to keep data up-to-date, how to improve the quality of data, defining the boundaries of indicators, methodological issues, and developing a formal process of data collection for indicators where information is not gathered internally. The councils can improve the depth of biodiversity examination and enhance the level of confidence on measuring biodiversity by incorporating elements such as categorisation of land, the structure of vegetation, defining patch size and

assigning integrity scores, within indicators. For example, determining connectivity requires a more sophisticated form of analysis, which demands higher skills and qualitative data that is not necessarily readily available. Another challenge for councils is to develop an approach for reporting negative indicators, such invasive species, to mitigate adverse reactions by the community that may inhibit the effectiveness of conservation programs.

Many of these findings contradict Kohsaka and Okumura's (2014) study of the application of CBI in the Japanese context. Their study suggests that local governments do not have sufficient data, skills, or capacity to define, measure, and monitor the more complex indicators, especially Indicators 1 and 2, which measure natural areas and their connectivity. Other challenges revealed from the analysis have support in the literature, particularly those surrounding issues with terminology, methodology, and transporting concepts from one institutional level to another (Kohsaka and Okumura, 2014). The prior study on the usefulness of the CBI by Kohsaka and Okumura (2014) in Japan reasoned that improvements in Indicators 4-8, which measure changes in the number of native species, may only be due to improved monitoring skills or statistical measurement techniques – not because biodiversity had improved. In addition, factors such as the location, the season, the period of measurement, etc. all need to be consistent to accurately measure changes in biodiversity over time. If the methods and methodologies do not prescribe these consistencies then the results cannot be trusted – especially comparative results. For example, measurement of butterflies was chosen as an important element in Index as butterflies are an important species in Singapore due to the tropical climate. In Australia, however, due to the sub-tropical climate, butterflies may not be the best indicator. This finding from the research study informs that context is important and therefore the CBI should at least be adaptable for different contexts.

Other areas of departure between the two studies occur with Indicators 9 and 10. Natural area protection is not under the control of Japanese local councils, whereas for Sydney local councils, some of these areas fall under their authority and some do not. With Indicator 10, Japanese local councils do not maintain data on invasive species, while Sydney councils do. Notably, both the Sydney councils in this study find reporting on invasive species to be problematic, and so they only tend to report internally with limited external disclosures.

5.3 Contributions and wider implications

This study is, to the best of my knowledge, one of the first to explore the application of CBI as a technique for monitoring and accounting for biodiversity by the local councils in Sydney, Australia. The results of this study highlight that the local councils, in partnership with the

community, reflect aspects of stewardship theory in their biodiversity management and disclosure practices. Stewardship theory explains that the community and local councils are stewards of biodiversity within their councils, regions and consequently, together they have a "duty of care" to conserve and improve biodiversity. As stated in prior literature, stewardship theory emphasises co-operation and collaboration (Keay, 2017), although this hasn't been fully recognised in accounting for biodiversity – i.e. that a biodiversity accounting framework needs collaboration to be explicitly recognised as the data may be coming not from 'professionals' but interested citizens, which can have important implications in terms of quality and deicision-making.

The findings here highlight the need for a common framework to account and report on matters of biodiversity across the councils in Sydney and, by implication, local governments in other regions. This research contributes to the limited literature on accounting for biodiversity conservation by providing an analysis of aspects of the CBI framework, which is a technique that regions may wish to adopt. It also extends prior literature which has argued that stewardship disclosures are a flexible way for companies to voluntarily disclose information to investors and other stakeholders (Dumay, 2019)

Moreover, these research findings are relevant to standard-setters and policymakers at the local, regional, state, national, and international level, as one of the key insights revealed is that effective biodiversity accounting requires a coordinated, multi-level approach. The concept of sustainable development is recognised as a multi-level concept in SEA literature, where the levels of organisations are interdependent (Lamberton, 2005). Research exploring sustainability accounting at different levels, (e.g., community, regional, national), is necessary to exert adequate pressure to drive the transition to sustainability (Lamberton, 2005). Therefore, it is valuable to use indicators that combine different levels of aggregated economic and environmental figures to communicate with different levels of management and other stakeholders. Many stakeholders, including government, industry, environmental groups, investors, and consumers, are increasingly demanding information on the state of the environment and the environmental impacts of public and private sector activity. The integration of SEA and SEA reporting at national, state, and regional levels will provide better information on the condition of the environment, the impacts of economic activity, and the effectiveness of expenditure on actions in reducing and eliminating those impacts. Previous research on SEA has focused predominantly on corporations. Environmental impact, however, does not reside solely within the private sphere of one organisation. It is also the responsibility of governments at the local, state, and federal levels. This research extends the SEA literature

(Bebbington, 2019) by investigating biodiversity disclosures and management at the lowest levels of the Australian government – local councils – using the CBI framework.

The study higlights concerns about shortcomings with disclosing particular elements of the information on indicators, publicly. This higlights utility of CBI as a universal 'boiler plate' accounting tool. A range of critiques of the CBI emerge in the findings of the study, such as, how connectivity should be measured, how birds should be measured, how some indicators may have some value, but would be best measured at another level, and not in this micro council context. The findings represent that there is a significant and nuanced critique of the utility of the CBI in a council context. Biodiversity is complex, and the complexity of accounting approach is also evident. The last finding from this research is the critical importance of community partnerships in biodiversity accounting and disclosures. There is limited SEA literature on partnerships (for example Fiedler, 2007; Glennie, 2013) focusing on community partnerships with private organisations to attain positive environmental outcomes. Fiedler (2007) mentions these partnerships make a valuable contribution to the local and national environmental agenda and should not be undervalued by governments. This study provides insights into the importance of community partnerships with local councils to monitor and manage biodiversity. This finding calls for further research to understand the dynamics of community partnerships with local councils, such as the motivations for collaboration and ways each group can mutually benefit from working together.

5.4 Limitations and opportunities for further research

This research study is subject to a number of limitations. First, when conducting a qualitative research study, it is important to acknowledge investigator bias. Triangulating the methods used helped to mitigate bias in interpreting the results.

Second, only two local councils were analysed – in particular, two local metropolitan councils. Conceivably, these results could be generalised to other similar councils in Australia, but a more comprehensive understanding would be obtained by studying additional council categories. Therefore, future studies might investigate Australian regional and rural councils or councils of different sizes. Appendix B details the other classifications for councils that might be considered in future studies.

Third, there are 23 CBI indicators, but only 10 indicators were included in this analysis. Further research would be needed to understand a complete application of the CBI framework and its indicators, even within the Sydney local councils analysed. Of the remaining indicators, four-

measure the ecosystem services provided by biodiversity, such as water, climate, and recreational activities. The other nine pertain to governing and managing biodiversity through budget allocations, projects and initiatives, strategic plans and action plans, institutional capacity, participation and partnership, and education and awareness.

Fourth, the interviewees were the biodiversity managers of two councils, which comprised four individuals. Future research could include greater numbers of councils as well as more participants from each council as well as related stakeholders.

Fifth, for the indicators 4 - 8: “change in number of native species”, the index selects 3 core groups (vascular plants, birds and butterflies) for measuring bioidversity and allows selection of any 2 other taxonomic groups for Indicators 7 and 8. This study only addressed the 3 core indicators which were part of only two biological kingdoms (plants and animals) out of five. The index enables the cities to select other taxonomic groups such as “fungi”(Chan *et al.*, 2014) which is another biological kingdom. Future research can include the species from three remaining biological kingdom in CBI to measure biodiversity.

Further avenues for research also include implementing the CBI framework on national and state level within Australia. A revised or improved CBI framework that is suitable at each level of government can be investigated further.

Chapter 5 focused on discussion of the results of the study to answer the research question and the impacts on stewardship theory. The discussion continues with understanding the opportunities and challenges with applying CBI in Sydney’s local councils. It also considers the contribution and wider implications of the study. Lastly, the chapter outlines the limitations of the study and concludes with directions for future research.

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Appendix A – City Biodiversity Index Framework

Table 4: Framework of the Singapore Index on Cities' Biodiversity

SINGAPORE INDEX ON CITIES' BIODIVERSITY			
PART I – Profile of the City	Location and size (geographical coordinates (latitudes and longitudes); climate (temperate or tropical); rainfall/precipitation (range and average); including maps or satellite images where city boundaries are clearly defined)		
	Physical features of the city (geography, altitude, area of impermeable surfaces, information on brownfield sites, etc.)		
	Demographics (including total population and population density; the population of the region could also be included if appropriate, and for the purpose of placing it in the regional context)		
	Economic parameters (Gross Domestic Product (GDP), Gross National Product (GNP), per capita income, key economic activities, drivers and pressures on biodiversity)		
	Biodiversity features (ecosystems within the city, species within the city, quantitative data on populations of key species of local importance, relevant qualitative biodiversity data)		
	Administration of biodiversity (relevant information includes agencies and departments responsible for biodiversity; how natural areas are protected (through national parks, nature reserves, forest reserves, secured areas, parks, etc.)		
	Links to relevant websites including the city's website, environmental or biodiversity themed websites, websites of agencies responsible for managing biodiversity		
PART II - Indicators	Core Components	Indicators	Maximum Score
	Native Biodiversity in the City	1. Proportion of Natural Areas in the City	4 points
		2. Connectivity Measures	4 points
		3. Native Biodiversity in Built Up Areas (Bird Species)	4 points
		4. Change in Number of Vascular Plant Species	4 points
		5. Change in Number of Bird Species	4 points
		6. Change in Number of Butterfly Species	4 points
		7. Change in Number of Species (any other taxonomic group selected by the city)	4 points
		8. Change in Number of Species (any other taxonomic group selected by the city)	4 points
		9. Proportion of Protected Natural Areas	4 points
		10. Proportion of Invasive Alien Species	4 points
	Ecosystem Services provided by Biodiversity	11. Regulation of Quantity of Water	4 points
		12. Climate Regulation: Carbon Storage and Cooling Effect of Vegetation	4 points
		13. Recreation and Education: Area of Parks with Natural Areas	4 points
		14. Recreation and Education: Number of Formal Education Visits per Child Below 16 Years to Parks with Natural Areas per Year	4 points
	Governance and Management of Biodiversity	15. Budget Allocated to Biodiversity	4 points
		16. Number of Biodiversity Projects Implemented by the City Annually	4 points
		17. Existence of Local Biodiversity Strategy and Action Plan	4 points
		18. Institutional Capacity: Number of Biodiversity Related Functions	4 points
		19. Institutional Capacity: Number of City or Local Government Agencies Involved in Inter-agency Co-operation Pertaining to Biodiversity Matters	4 points
		20. Participation and Partnership: Existence of Formal or Informal Public Consultation Process	4 points
		21. Participation and Partnership: Number of Agencies/Private Companies/NGOs/Academic Institutions/International Organisations with which the City is Partnering in Biodiversity Activities, Projects and Programmes	4 points
		22. Education and Awareness: Is Biodiversity or Nature Awareness Included in the School Curriculum	4 points
		23. Education and Awareness: Number of Outreach or Public Awareness Events Held in the City per Year	4 points
		Native Biodiversity in the City (Sub-total for indicators 1-10)	**40 points**
		Ecosystem Services provided by Biodiversity (Sub-total for indicators 11-14)	**16 points**
		Governance and Management of Biodiversity (Sub-total for indicators 15-23)	**36 points**
		Maximum Total:	**92 points**

Extracted from User's Manual on the Singapore Index on Cities ' (Chan et al., 2014)

Appendix B – Classification System

Table 5: Structure of the classification system

Step 1	Step 2	Step 3	Identifiers	Category
URBAN (U)				
Population more than 20 000 OR If population less than 20 000, EITHER Population density more than 30 persons per square kilometre OR 90 per cent or more of the local governing body population is urban	CAPITAL CITY (CC)	Not applicable		UCC
	METROPOLITAN DEVELOPED (D) Part of an urban centre of more than 1 000 000 or population density more than 600 per square kilometre	SMALL MEDIUM LARGE (L) VERY LARGE (V)	up to 30 000 30 001–70 000 70 001–120 000 more than 120 000	UDS UDM UDL UDV
	REGIONAL TOWNS/CITY (R) Part of an urban centre with population less than 1 000 000 and predominantly urban into	SMALL MEDIUM LARGE (L) VERY LARGE (V)	up to 30 000 30 001–70 000 70 001–120 000 more than 120 000	URS URM URL URV
	FRINGE (F) A developing LGA on the margin of a developed or regional urban centre	SMALL MEDIUM LARGE (L) VERY LARGE (V)	up to 30 000 30 001–70 000 70 001–120 000 more than 120 000	UFS UFM UFL UFV
RURAL (R)				
A local governing body with population less than 20,000 AND Population density less than 30 persons per square kilometre AND Less than 90 per cent of local governing body population is urban	SIGNIFICANT GROWTH (SG) Average annual population growth more than three per cent, population more than 5000 and not remote	Not applicable		RSG
	AGRICULTURAL (A)	SMALL MEDIUM LARGE (L) VERY LARGE (V)	up to 2000 2001–5000 5001–10 000 10 001–20 000	RAS RAM RAL RAV
	REMOTE	EXTRA SMALL (X) SMALL MEDIUM LARGE (L)	up to 400 401–1000 1001–3000 3001–20 000	RTX RTS RTM RTL

Appendix C – Nvivo Nodes and Sub-nodes

Table 6: List of Nvivo nodes and sub-nodes

CBI Indicators

Indicator 1 Natural Areas
Accuracy of Data
Categorization of Land
Local Level Vs State Level Measure

Indicator 2 Connectivity
Difficulty in Mapping the Data
Quality of Data

Indicator 3 Built up
Community-based Bird Count Activities
No Formal Bird Count Activities
Quality of Data
Community Involvement
Usefulness of Indicator 3

Indicator 4-8
Butterflies
Data Availability and Quality
Issues in Sampling Methodology
Measuring Change

Indicator 9 Protected Areas
Aggregation of Protected Area
Re-evaluating the Zones
State vs Local Level

Indicator-10 Invasive Species
Communication
Reporting
Fluctuation in Species
Managing Community Perception
Not Published
Positive vs Negative Indicators

Stewardship

Community Partnership
Baseline Data Gathering
Community Involvement
Community Monitoring Activities
Biodiversity Drivers
Education
Sense of Ownership/Care
Limited Resources
Social Connection

Reporting
Corporate Targets
Community Reporting

Appendix D – Interview Participants

Table 7: Interview participants and duration of interviews

Council	**Participant ref.**	**Participant role**	**Duration (Minutes)**
Alpha	A1	Environmental Manager	90 minutes
Alpha	A2	Natural Area Coordinator	
Beta	B1	Team Leader Natural Areas	60 minutes
Beta	B2	Natural Areas Program Leader	

Appendix E- Interview Questions

The interview Questions were as below:

• What biodiversity conservation activities and monitoring is conducted by the local councils?

• To what extent are the local council interested in CBI application as a monitoring tool to measure urban biodiversity?

•What are the challenges to applying CBI as biodiversity management monitoring tool?

•What are the opportunities to apply CBI as biodiversity management monitoring tool?

Additional questions on individual indicators that were asked are summarized in table 3:

- Is it a useful* indicator?
- Is this information publicly available?
- Is this information internally available?
- Appropriate reporting level(s)?

Appendix (ethics approval) of this thesis has been removed as it may contain sensitive/confidential content