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Biodiversity management: A supply chain practice view

Asta Salmi [a,*], Anne M. Quarshie [b], Joanna Scott-Kennel [c], Anni-Kaisa Kähkönen [d]

[a] University of Oulu, Oulu Business School, P.O. Box 8000, FI-90014, Finland
[b] Turku School of Economics, 20014 University of Turku, Finland
[c] University of Waikato, Waikato Management School, Private Bag 3105, Waikato Mail Centre, Hamilton, 3240, New Zealand
[d] LUT University, Business School, P.O. Box 20, FI-53851, Lappeenranta, Finland

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ABSTRACT

This paper addresses biodiversity management in supply chains. Biodiversity loss is one of the most critical environmental issues currently facing the planet, and yet, rather surprisingly, has received little attention by management scholars and researchers in supply chain management. This paper aims for greater theoretical and practical understanding of the issue by examining firms' purchasing and supply chain management practices that specifically relate to managing biodiversity. This qualitative study involves interviews with representatives of six firms and other organizations in Finland and New Zealand. The research shows how these firms adopt or develop biodiversity management practices that reduce or eliminate negative biodiversity outcomes or even contribute to biodiversity restoration and regeneration. Using an inductive theory building approach and integrating insights from the supply chain practice view into theorizing, this paper develops a theoretical framework of practices adopted and developed by firms to manage biodiversity.

1. Introduction

Biodiversity loss is one of the most pressing environmental challenges facing the planet (Crist et al., 2017; Steffen et al., 2015) and a significant contributor to other grand challenges, including pandemics and livelihood crises (Dasgupta, 2021; World Economic Forum, 2022). While scientists warn that a mass extinction event is already under way (Ripple et al., 2017; IPBES et al., 2019), the signs of biodiversity reduction are often invisible or appear disconnected from the activities that caused them (Stager, 2018). In many industries, the negative impacts on biodiversity are greatest where resources and raw materials are produced or extracted – at the sub-tier supplier level. This suggests that purchasing executives and managers are well-positioned to influence biodiversity management practices and biodiversity impacts within their supply chains.

Although a widespread awareness of the biodiversity loss problem is still lacking amongst most business managers, many forerunner firms have begun to examine and address their biodiversity performance outcomes (or impacts) (GlobeScan and Sustainability, 2021). Many of these firms have also adopted or developed biodiversity management practices that can help to tackle the loss of biodiversity that results from, or is otherwise connected with, their products and business operations. Reduction, or at most elimination of harm is typically the main objective of such practices, but the most advanced restorative or regenerative approaches seek to create positive outcomes that reverse or exceed (some of) the negative outcomes caused by the firm's operations and supply network, or even allow ecosystems to become self-sustaining (United Nations Environment Programme, 2021; WBCSD, 2021).

So far, however, biodiversity management has received little attention in the management research field (Whiteman et al., 2013; Hahn and Tampe, 2021). The same is true in the purchasing and supply chain management (PSCM) fields. In the sustainable supply chain management (SSCM) domain (Carter and Rogers, 2008; Seuring and Müller, 2008), environmental sustainability has raised considerable interest (Tate et al., 2013; Lintukangas et al., 2016; Longoni and Cagliano, 2018), but there has been scant focus on biodiversity (Matthews et al., 2016; Quarshie et al., 2016; Salmi and Quarshie, 2017). The limited number of studies that have examined biodiversity-related topics have largely been studies of impacts, challenges, and opportunities in primary sectors, including agriculture (Bragaglio et al., 2018) and extractive industries (Betancur-Corredor et al., 2018; Kobayashi et al., 2014). Little attention has been paid to biodiversity-respectful PSCM.

* Corresponding author.
E-mail addresses: asta.salmi@oulu.fi (A. Salmi), anne.quarshie@utu.fi (A.M. Quarshie), joanna.scott-kennel@waikato.ac.nz (J. Scott-Kennel), anni-kaisa.kahkonen@lut.fi (A.-K. Kähkönen).

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The purpose of this study is to improve theoretical understanding of biodiversity management in PSCM. To this end, this research adopts a qualitative approach involving interviews with biodiversity experts and representatives of firms who have taken an active approach to managing biodiversity in their supply chains (Corbin and Strauss, 2014). Specifically, the paper seeks to better understand the PSCM practices that firms have adopted or developed together with their supply chain members and other stakeholders to tackle biodiversity loss. The paper puts forward the following research questions: *How do firms manage biodiversity in their supply networks? What intra- and interorganizational practices are adopted or developed by firms to reduce or eliminate negative biodiversity outcomes and/or to increase positive outcomes?* The empirical data was collected from six firms operating in primary and secondary industries in countries whose economies rely heavily on natural resources: Finland and New Zealand. Through a grounded theory building approach and by integrating insights from the supply chain practice view (Carter et al., 2017) into the theorizing (Gehman et al., 2018), we develop a model that incorporates a comprehensive set of biodiversity management practices adopted or developed by these firms, as well as the biodiversity performance outcomes of their practices they aspire to.

There are several reasons why this study treats biodiversity as a unique environmental issue in PSCM. First, the magnitude of the biodiversity loss problem is challenging to grasp even for experts (Whiteman et al., 2013; Steffen et al., 2015). Second, the biodiversity concept is associated with multiple meanings, which make it problematic to interpret (Quarshie et al., 2021). Third, the destruction of biodiversity is difficult to observe, even when its scale is massive (IPBES et al., 2019), or is happening right in front of one's eyes (Stager, 2018). Finally, while firms are generally able to influence their own sustainability practices and performance, and those of their direct suppliers (Cousins et al., 2019; Sancha et al., 2019), it is more difficult to tackle issues at the sub-tier supplier level (Villena and Gioia, 2018; Marttinen and Kähkönen, 2022) where biodiversity loss is often manifest. Thus, firms' biodiversity management practices in supply chains deserve much greater research attention.

The focus of this paper is on PSCM practices that are adopted or developed for the purpose of biodiversity management. This research considers biodiversity management as an umbrella term incorporating a set of practices aimed at one or more of the following biodiversity performance outcomes: 1) reducing negative biodiversity outcomes; 2) eliminating (altogether) negative biodiversity outcomes; 3) restoring and strengthening biodiversity, and 4) regenerating biodiversity (i.e., building capacity for biodiversity to become self-sustaining). For the sake of brevity, the term biodiversity management is used to cover these different practices.

The main contributions of this study are as follows. First, the study conceptualizes biodiversity as a relevant and practicable element of sustainable supply chains and their management, worthy of scholarly attention. Thus, the research seeks to fill a gap within the existing sustainability research in PSCM, which has largely focused on other sustainability issues, practices designed to reduce harm, and the financial or sustainability performance outcomes of such practices (Pagell and Shevchenko, 2014; Quarshie et al., 2016). Second, the paper advances theory development in this area by building a theoretical framework focused on intra- and interorganizational practices through which firms and managers can pursue intended biodiversity outcomes in their supply chains. While the study indicates the challenges relating to biodiversity management, it extends prior understanding by explicating several novel, imitable PSCM practices that relate specifically to biodiversity management. Finally, by focusing on practices adopted or developed by firms actively reducing and eliminating negative biodiversity outcomes, and even restoring and regenerating biodiversity, this inductive study offers learning opportunities for other firms and organizations.

2. Theoretical background

2.1. The loss of biodiversity in Finland and New Zealand

Biodiversity can be understood as the variability of life on the planet (CBD, 2000), including diversity within species (i.e., genetic diversity), as well as the diversity of species and of broader ecosystems (Grigg, 2007). The majority of the world's biodiversity hotspots are in the tropics where land is fertile and productive (Hanski, 2016, p. 60, 69). However, every country's biodiversity is unique with ecosystems that have their own characteristics and vulnerabilities (Kauppinen, 2019; Dasgupta, 2021). Therefore, preserving biodiversity requires attention at global, national and local levels, as well as engagement from all; including individuals, governments, nonprofit organizations, and especially, corporations and their supply chains (Ripple et al., 2017).

Destruction of nature in the past 50 years has been more dramatic than any other time in the history of mankind, and it is inextricably linked to human economic activity (WWF, 2016; Stockholm Resilience Centre, 2018). The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES et al., 2019) estimates that up to a million plant and animal species may be at risk of extinction. Furthermore, IPBES identifies the five most important direct drivers of biodiversity loss as: 1) changes in land and sea use; 2) direct exploitation of organisms (i.e., animals and plants); 3) climate change; 4) pollution; and 5) invasive migratory species. Indirect drivers and root causes behind these direct drivers include global mega trends and other phenomena, such as over-consumption of resources, rising standards of living, population growth, and unsustainable production patterns (Crist et al., 2017; IPBES et al., 2019).

To launch a global response to the biodiversity loss crisis, the United Nations (UN) negotiated an international biodiversity agreement in Rio de Janeiro in 1992, and the agreement entered into force the following year. So far, the agreement has been ratified by 196 parties (Ministry of the Environment, 2022a). In 2010, the agreement was complemented by the so-called Aichi targets, which sought to halt biodiversity loss internationally by 2020. Of the 20 international targets, none were fully achieved by that date (Pelli, 2021). Implementation of the agreement was further refined and reinforced at a two-stage global UN Biodiversity Conference (COP-15) held in 2021 and 2022 (UNEP, 2021; Ministry of the Environment, 2022a). The overall outcome of the final meeting in Montreal, December 2022, was to adopt a new global biodiversity agreement, which aspires to halting and reversing biodiversity loss by 2030 (CBD, 2022a). Finland and New Zealand are amongst the participating countries. Finland is also committed to the European Union's biodiversity strategy, which aims to halt biodiversity loss within the Union and to set biodiversity on a path to recovery by 2030 (Ministry of the Environment, 2022a; 2022b).

In Finland, land area accounts for about 78%; marine areas 13%; and inland waters 9% of the country's entire territory (Hyvärinen et al., 2019). Nearly three quarters of the land area is covered by forests and peatland (Ministry of the Environment, 2014; 2022b). According to the Sustainable Development Report 2021 (Sachs et al., 2021), Finland is ranked the world's highest performing country overall in sustainable development. However, significant challenges remain for Finland in meeting both biodiversity-related UN sustainable development goals; "Life below water" and "Life on land". For example, the latest national assessment of threatened species in Finland in 2019 actually indicated that there was greater loss of biodiversity, as measured by the number of threatened species (Hyvärinen et al., 2019). Of the 22,418 species evaluated, 11.9% (or 2667 species) were identified as threatened, compared to 10.5% (i.e., 2247 species) in the 2010 assessment (Rassi et al., 2010; Hyvärinen et al., 2019). The largest numbers of threatened species and natural habitats were found in Southern Finland, where land

use pressures are the most significant (Auvinen et al., 2020). Partly because 90% of forests in Finland are commercial (Ministry of the Environment, 2014), changes in the forest environment were observed to be the most significant threat to biodiversity (Hyvärinen et al., 2019). These changes included forest management and harvesting activities, the reduction of old and natural forests, and decreasing amounts of dead wood. Based on the national assessment, the second most significant threat to biodiversity in Finland is the overgrowing of open habitats. The issue is interconnected with increasing farm sizes, intensifying land use, and changes in agricultural production practices. Other direct pressures on Finnish nature include changes in land use (e.g., due to construction), climate change, pollution, and eutrophication of the Baltic Sea, while indirect pressures, such as rising living standards, overconsumption, and global trade, also contribute to biodiversity loss (Hyvärinen et al., 2019; Auvinen et al., 2020).

New Zealand's landscapes are spectacularly diverse – sand dunes, active volcanoes, braided rivers, alps, and fiords – where 152 major classes, and 71 rare, ecosystems have developed over centuries (Singers and Rogers, 2014). Just over half of New Zealand's land is now occupied by agricultural activities (e.g., farms, plantations, and commercial forestry), predominately in the fertile lowlands. Indigenous forests now only account for one quarter of the land area (CBD, 2022b), with the remainder in scrub, grasslands, alpine desert, mountainous regions and wetland/freshwater areas (Ministry for the Environment & Statistics NZ, 2021). New Zealand is considered to be a biodiversity 'hotspot', as most of its 80,000 endemic species, including all frogs and reptiles, over 90% of insects and 80% of vascular plants have evolved in relative isolation from the rest of the world (CBD, 2022b). Up to 80% of indigenous species occur in the marine environment, which accounts for 96% of New Zealand's territory. In the Sustainable Development Report of 2021, New Zealand was ranked as the 23rd most sustainable country (Sachs et al., 2021). According to the report, however, significant challenges remain in terms of meeting the sustainable development goal of "Life below water". Further, New Zealand's score for "Life on land" is decreasing, and areas of native ecosystems continue to shrink, mainly through conversion to agriculture or forestry (Ministry for the Environment & Statistics NZ, 2021). At last count (note assessment dates differ by type of fauna, see NZ Threat Classification System, https://nztcs.org.nz/report-search), 799 threatened and 2741 at risk species were identified in New Zealand – indicative of fragile ecosystem health and biodiversity under threat (CBD, 2022b). Direct and indirect drivers of biodiversity reduction include introduction and invasion of alien species and predators, habitat modification and other human activities, grazing animals, climate change, pollution, and fertilizer runoff from farms. The marine environment is also pressured by discharges of pollution, stormwater, nutrients, and sediments, as well as modern inshore and offshore fishing and trawling practices. While freshwaters in New Zealand are generally clean, aspects of water quality and quantity are deteriorating rapidly in areas affected by heavy land use (Ministry for the Environment & Statistics NZ, 2021).

Overall, biodiversity loss is a relevant issue for all firms, but especially those that rely on significant land or sea areas, or have a heavy dependence on natural resources, such as those in agriculture, horticulture, forestry, mining, and fishing. In these industries, land conversion and deforestation, intensive or changing production and harvesting practices, raw material use, pesticide and agrochemical use, and pollution threaten ecosystems, habitats, and species (WWF, 2012; Hanski, 2016). Firms operating in these and other industries (e.g., causing large emissions) have significant potential to address their negative and positive environmental impacts not only through the adoption or development of sustainable and biodiversity-related practices and business models (Winn and Pogutz, 2013; Feger and Mermet, 2022), but also through their supply chain management practices. Extant corporate sustainability and responsibility research proposes adoption of biodiversity management practices that relate to biodiversity commitments (Zu Ermgassen et al., 2022); corporate accountability and stakeholder impression management (Boiral, 2016; Roberts et al., 2022); and circular economy principles (Ruokamo et al., 2023). Tackling biodiversity issues in extended supply chains also requires the adoption or development of sustainable and biodiversity-related PSCM practices.

2.2. Sustainable and environmental PSCM practices

In business practice, sustainability is increasingly addressed as a strategic issue. To this end, there continues to be greater emphasis placed on reporting of corporate vision, search for (economic) value-creation opportunities, and the internal integration of sustainability rather than a focus on radical change along the entire supply chain, including potentially harmful business models and practices of suppliers, stakeholders, and partners. This is due, at least in part, because negative environmental and social sustainability impacts that occur in multi-tier, often geographically or operationally distant supply chains remain particularly entrenched and challenging for firms to address (Villena and Gioia, 2018; Simpson et al., 2021). The greater the spatial (or temporal or relational) distance between (sub-)suppliers and the focal firm, the larger the likelihood of disassociation between firms and their biodiversity impacts in the supply chain. However, several notable and highly publicized instances of questionable supply chain practices (e.g., Apple's mineral extraction activities, Nike's sweatshops) have served to bring the responsibility of corporates more sharply into focus. SCM can serve as a critical mechanism for addressing biodiversity issues because of its boundary-spanning role and its interface towards suppliers. Indeed, SSCM has the capacity to reach both local suppliers in close proximity, as well as those more distant.

In the SCM discipline, research on sustainability and responsibility continues to grow steadily (Johnsen et al., 2017; Matos et al., 2020), and there is a comprehensive body of knowledge on how firms seek to create more sustainable (or less harmful) supply chains (Pagell and Shevchenko, 2014; Matthews et al., 2016). SSCM is defined by Carter and Rogers (2008, p. 386) as "the strategic, transparent integration, and achievement of an organization's social, environmental, and economic goals in the systemic coordination of key interorganizational business processes for improving the long-term economic performance of the individual firm and its supply chains". According to Pullman et al. (2009, p. 39), firms are engaged in "certain sustainability practices that align with their desired performance outcomes", and Kähkönen et al. (2018) state that sustainability is implemented in PSCM using sustainable supply management practices. Vachon and Klassen (2006, p. 796) argue that green supply chain practices "comprise a series of inter-organizational activities", and Hollos et al. (2012, p. 2974) define green practices as "the buying firm's efforts for waste reduction and preservation of natural resources in its own operations and the operations of the members of its supplier base". What is common to these definitions is that sustainable PSCM practices are seen as the firms' own and/or inter-organizational efforts and activities that delineate the ways of implementing PSCM principles and strategies in ways that align with the firm's sustainability performance outcomes.

A large number of PSCM studies propose and discuss more specific sustainability practices (Beske et al., 2014; Marshall et al., 2015), sustainable supplier development practices (Sancha et al., 2015, 2019), and/or green supply chain practices (Vachon and Klassen, 2006; Hoejmose et al., 2014; Li and Huang, 2017). The broad range and variety of practices used by firms is demonstrated by, for example, Tate et al. (2012), who found 61 environmental SCM practices. Several studies also provide categorizations of practices. For instance, Vachon and Klassen (2006) note that buyers can choose two approaches to environmental SCM; externalization or internalization including external and internal practices, while Hoejmose et al. (2014) distinguish between cooperative and coercive practices. Li and Huang (2017) note that green supply chain practices range from reactive monitoring of environmental management programs to more proactive practices. Marshall et al. (2015) distinguish between process-based and market-based environmental

SCM practices where the former include environmental supply chain monitoring and environmental SCM systems and the latter include new product and process development and supply chain strategy redefinition with an environmental perspective.

A widely used categorization of PSCM practices in previous research is collaboration practices and assessment practices (Klassen and Vachon, 2003; Gimenez and Tachizawa, 2012). Klassen and Vachon (2003) see the former as collaborative activities that aim to achieve sustained improvements in environmental performance. Collaboration practices include supplier training and education (Cousins et al., 2004; Klassen and Vachon, 2003; Sancha et al., 2019), exchanging knowledge and expertise (Klassen and Vachon, 2003; Rao and Holt, 2005; Vachon and Klassen, 2006), jointly solving sustainability problems (Vachon and Klassen, 2006; Lee and Klassen, 2008; Grimm et al., 2014), and jointly developing new sustainability solutions (Vachon and Klassen, 2006, 2008; Lee and Klassen, 2008). Assessment or monitoring practices, on the other hand, are based on arm's length activities and are described by Klassen and Vachon (2003, p. 339) as "evaluative activities taking the form of information gathering by manufacturers to assess and to monitor environmental management and performance of their suppliers". Assessment practices include supplier audits (Grimm et al., 2014; Marshall et al., 2015; Sancha et al., 2019) and questionnaires (Bowen et al., 2001; Vachon and Klassen, 2006), codes of conduct (Vachon and Klassen, 2006), environmental certifications and standards (Grimm et al., 2014; Hoejmose et al., 2014; Marshall et al., 2015), environmental management systems (Cousins et al., 2004; Vachon and Klassen, 2006), monitoring of suppliers' environmental performance (Bowen et al., 2001; Cousins et al., 2004; Lee and Klassen, 2008), and penalty clauses (Rao and Holt, 2005), rewards and incentives (Bowen et al., 2001; Rao and Holt, 2005; Marshall et al., 2015) relating to sustainability performance.

One key focus area in previous studies has been the diffusion of practices to the firm's suppliers and supply base. Tate et al. (2013) make an important contribution to this discussion by investigating diffusion of environmental business practices among suppliers and highlighting that high embeddedness in networks increases diffusion. Similarly, Meqdadi et al. (2020), who analyze monitoring and mentoring strategies for supplier engagement in sustainability, show how intensive interaction during mentoring activities facilitates diffusion of practices in supply networks. Furthermore, as noted by Pagell and Wu (2009), a key component of a sustainable supply chain is reconceptualizing the chain to include different actors, even nontraditional partners, such as non-governmental organizations.

While these and other conversations advance theoretical understanding of how firms can reduce negative sustainability impacts in their (multi-tier) supply chains through the adoption or development of environmental/sustainable PSCM practices, relatively few studies aim to generate understanding of more fundamentally novel PSCM approaches and practices. Montabon et al. (2016) present an alternative logic to conventional SCM – one that strives for true, ecologically-dominant sustainability where practices are optimized to eliminate harm with a long-term view, rather than to maximize profits in the short-term. Because impacts of firms' activities on biodiversity are often seen only after a significant lapse of time, consideration of this challenge falls into the area of truly sustainable supply chains (Pagell and Shevchenko, 2014; Montabon et al., 2016), which operate within broader social and ecological systems.

Even more importantly, we found very little inquiry into how firms and other organizations manage, protect and regenerate *biodiversity* in their operations and supply chains (also Salmi et al., 2019). Among the exceptions are Roberts et al.'s (2022) study, which suggests that incentives and awards can also be important in biodiversity management, and Boiral et al. (2018) who examine the role that standards can play in biodiversity management. Moreover, Duensing et al. (2023) interview expert stakeholders on the risks and mitigation of wildlife trafficking in supply chains. While the need for PSCM research on biodiversity is clear, the management (and study) of biodiversity beyond the firm to include the supply chain is confounded by several factors. First, the fact that (positive and negative) effects of biodiversity management are both difficult to discern and often realized far from the original buying firm and second, that they may not provide immediate (economic) benefits to the virtuous firm. This makes for a challenging setting in which to draw conclusions between biodiversity practices and performance (i.e. biodiversity outcomes). Thus, this study integrates theoretical insights from the supply chain practice view (Carter et al., 2017) to focus primarily on the biodiversity management practices of firms.

2.3. The supply chain practice view

The studies discussed above show scholarly interest in practices that advance sustainability in supply chains. While the term 'practices' is widely adopted, studies tend to give little attention on the actual concept and move quickly into describing the operations and activities that firms perform. For instance, Vachon and Klassen (2006) define green supply chain practices as 'activities' relating to either environmental monitoring or environmental collaboration, and Meqdadi et al. (2020) tend to use the term activities interchangeably with practices when investigating sustainability strategies.

The term practice has been used in the social sciences for a long time, basically in the meaning of "largely unconscious yet shared and recognizable ways of doing things" (Jarzabkowski et al., 2016, p. 271). Management scholars have investigated practices for over two decades, and the Strategy-as-Practice (SAP) perspective has become an increasingly important stream of strategy studies (Whittington, 2006; Vaara and Whittington, 2012; Jarzabkowski et al., 2016). Whittington (2006, p. 629), who treats strategy as something people *do*, notes that some practices "can sweep whole economies" and therefore, SAP has been used to investigate "how such strategy practices are developed and disseminated, both inside and outside organizations". Bromiley and Rau (2014) propose a practice-based view (PBV) with a focus on strategy research that is relevant to practitioners and considers generally applicable firm practices. Consequently, they define a practice "as a defined activity or set of activities that a variety of firms might execute" (Bromiley and Rau (2014), 1249).

SCM researchers have also shown an increasing interest towards conceptualization of practices, and the PBV has appeared in scholarly work on operations management (Bromiley and Rau, 2016a) and SCM (Carter et al., 2017). Yet, there is a wide variation in how the concept of practice is understood and used; different streams build on different ontological and epistemological assumptions despite using the same term. (For this discussion see e.g., Jarzabkowski et al., 2016; Bromiley and Rau, 2016b). Many aspects of SAP and PBV resonate with the approach used in the present study. For example, this research focuses on qualitative accounts of what firms (and managers within them) do and aims to explicate current biodiversity management practices to encourage their acknowledgement and dissemination. Given our interest in PSCM, we build on the work of Carter et al. (2017) in particular, who propose a supply chain practice view (SCPV).

Importantly, Carter et al. (2017) add to previous studies by extending the practice-based view beyond the focal organization to the interorganizational level of analysis. They define "an interorganizational SCM practice as a specific activity or a set of activities that spans different formal organizations and that other supply chain dyads or networks can imitate" (Carter et al., 2017, p. 116). Moreover, the authors note the conceptual difference between interorganizational SCM practices and intra-organizational SCM practices because the former are only effective if there are mutual efforts from two or more organizations.

According to the PBV (and SCPV), practices are considered to be imitable and transferable (Bromiley and Rau, 2014, 2016a). Carter et al. note that any practice can be implemented in different ways, for instance, by being coupled with less imitable resources of the firm. They suggest that "less imitable resources may simply appear to be less

imitable (and actually be practices) because we have not yet identified those resources and helped to make them more tangible for managers" (2017, p. 118). This point of explicating and making practices more tangible would in our view, help managers and firms address such complicated tasks as biodiversity management.

Building on Bromiley and Rau (2014, 2016a) and Carter et al. (2017), this study focuses on PSCM practices in biodiversity management which are imitable and transferable. When firms explicate their practices, they make them more tangible and visible, and thus potentially imitable. Given the prevailing neglect of (or only recent attention to) biodiversity issues, it is important to explicate firms' initial efforts to preserve biodiversity. Furthermore, this paper investigates intra- and interorganizational practices adopted or developed by firms in an effort to manage and exert beneficial sustainability outcomes in the supply chain (Carter and Rogers, 2008; Montabon et al., 2016; Carter et al., 2017), with a specific focus on biodiversity. As practices and outcomes are not always proximate in terms of locality or time, this study not only considers the biodiversity performance outcomes aspired to, or achieved by the firm, but also illustrates how they may be pursued through various immediate and intermediate targets set by the firms, and measured with related indicators (also see SBTN (Science Based Targets Network), 2020). Crucially, our focus is not just the firm itself. An important issue of the SCPV (Carter et al., 2017, p. 117) is supply chain performance throughout the chain; that is, relational performance, which "pertains to performance outcomes jointly generated in an exchange relationship … derived primarily from the use of interorganizational SCM practices and represents value added above and beyond what an individual supply chain partner could achieve." By focusing on PSCM practices in biodiversity management, this study addresses such jointly generated performance outcomes.

3. Methodology

This research adopts a qualitative methodology (Corbin and Strauss, 2014; Gehman et al., 2018). Detailed knowledge of typical or possible practices for addressing biodiversity is rather lacking in prior literature, thus this study employs an inductive approach and multiple types of empirical data (i.e., interviews, field research and archival materials). The focus is the local and international supply chains of six firms in the textiles, forestry, hospitality, fishing, apiculture and horticulture sectors. Biodiversity is an important issue for these firms, their suppliers and their industries worldwide (WWF, 2012; Hanski, 2016; Salmi and Quarshie, 2017). As the study examines (intra- and interorganizational) PSCM practices that address the issue of biodiversity, we targeted organizations known for their work related to sustainability and biodiversity management. We collected data from firms operating in Finland and New Zealand to provide understanding of biodiversity management practices across different cultural, natural and institutional contexts, but where economic commonalities exist. Both countries are small open economies that not only face the challenge of global competition, but also rely heavily on international economic activity (Scott-Kennel, 2007; Benito et al., 2010). Both countries face biodiversity challenges in the investigated sectors.

The sampling process involved searching sustainability-related professional associations' websites and other relevant forums, as well as asking professional and academic experts in the area of sustainability to suggest names of firms that actively addressed biodiversity in their operations and supply chains. In Finland, the authors interviewed three biodiversity experts in the field; two represented nonprofit organizations that work closely with Finnish firms to advance sustainability, and the third was from a governmental agency in Finland. These discussions lasted, on average, nearly 2 h each. In New Zealand, the project and possible firms were discussed (via email) with a private consultant specializing in sustainability in business, and two coordinators of a government funded, industry-level sustainability project focused on agriculture. These exchanges provided the researchers with a deeper understanding of the biodiversity issue, initial views on how various industries impact on biodiversity, and how firms might address biodiversity loss. Moreover, we received suggestions on possible firms to include in the study.

Through this process, we identified six firms, known for their work for biodiversity (for instance, they had launched biodiversity-related programs or activities, or had been acknowledged for their expertise or actions to care for and preserve nature through national or international awards). These firms were approached, the research explained and knowledgeable informants willing to talk about their biodiversity management practices identified. These informants held sustainability, corporate responsibility, purchasing, SCM, or communications-related posts at managerial level, or directors' or chief executive officer roles. For the sake of anonymity, the results are presented using pseudonyms for the firms.

During the first round of data collection, semi-structured personal interviews were conducted with 12 informants from the six firms. Each firm had two informants (participating in separate or joint interviews), with the exception of the aquaculture firm with a sole informant (the current manager for sustainability), and the hospitality firm, which had three informants. The 13 interview events (one in aquaculture, two in forestry, horticulture and apiculture, respectively; and three in textiles and hospitality, respectively) lasted, on average, 60 min. The interview themes and questions focused on the relevance of biodiversity to the organization's operations; strategies as well as intra- and interorganizational practices related to biodiversity management in supply chains; collaboration with other organizations in this area; and the outcomes of these practices. These interviews and a major part of data collection took place mid-2017 through to mid-2018.

In order to complement the initial data and refine analyses, we continued data collection late in 2020 and early in 2021. The firm informants were approached via email and asked more detailed questions on the same themes addressed previously. Three respondents offered responses via email, and two gave follow-up interviews on the topic. One firm did not provide a follow-up response (due to recent changes in personnel); thus, we drew on secondary, publicly available material covering the most recent developments at this firm. Therefore, the final data set included 18 interviews (including three pilot interviews) with representatives of six firms and other organizations, three email responses, archival data, and field research notes. The main aim of conducting two rounds of data collection was to ensure that we had rich, accurate and updated information on the firms' biodiversity management practices and their outcomes.

In addition to collecting interview and written response data, we conducted field research and retrieved relevant documents and other archival materials from all firms. The field research events included biodiversity-related workshops (two full-day training events and one 3-h seminar) organized for firms by a leading corporate sustainability network, as well as an academic biodiversity seminar. Archival materials were collected from the firms' and their suppliers' websites, corporate sustainability and responsibility reports, annual reports, industry and non-government organization (NGO) publications, and other relevant sources. Triangulation of primary and secondary data, including that from non-firm sources, informed and validated our research on firm practices from both the firms', and external perspectives and sources.

The analysis of the empirical data relied on a grounded theory (i.e., data-driven) approach (Nag et al., 2007; Denk et al., 2012; Corbin and Strauss, 2014). The focus on firms – all with substantive biodiversity efforts – aimed to achieve rich data around different biodiversity management practices from different perspectives, contexts, and industries. This approach enabled us to focus on specific biodiversity practices, then extrapolate these practices to anticipated and actual biodiversity performance outcomes.

The process of the data analysis was as follows. First, we wrote basic descriptions of the six sampled firms and their activities. Second, while

we had started developing initial concepts and themes during data collection, in the main data analysis and reporting stage, we began to search more systematically for patterns related to biodiversity management in the interview transcripts and notes, and other materials (Gioia et al., 2013; Gehman et al., 2018). Several researchers were responsible for independently analyzing the data from all cases to arrive at a rich and full set of evidence, and then further analysis and refinement of coding took place through a series of joint discussions between the authors. To further refine the main concepts and themes, we searched for emerging similarities and differences in the data to discern the firms' intra- and interorganizational sustainability and biodiversity management practices, and the actual or anticipated biodiversity performance outcomes of the practices. These concepts were then grouped into more abstract themes and categorized within aggregate dimensions that incorporated relevant insights from previous literature (e.g., WBCSD, 2021), which formed the basis for a theoretical model highlighting and illustrating the main findings.

4. Findings

4.1. The sampled firms and reported biodiversity management practices

This section presents the findings of the empirical study. First, Table 1 describes the sampled firms, representing six different sectors. Then, the main findings related to the intra- and inter-organizational biodiversity management practices adopted or developed by these firms are presented. Finally, the section focuses on the biodiversity performance outcomes, indicative of the broader challenges faced by firms, their partners in the supply chain and at industry level, that emerged from the data.

In Finland, the firms operate in the following sectors; textiles, forestry, and hospitality (restaurant), while the firms in New Zealand represent aquaculture (fishing), horticulture (importer/reseller), and apiculture (honey). The sizes of the firms vary from small (less than 20 employees) to large global firms (with tens of thousands of employees worldwide). One firm has predominantly local supply chains, and the others source globally, or have both local and global supply chains. Depending on their industry and focus, the firms are linked to the topic of biodiversity (and sustainability) in various ways, as shown in Table 1.

Fig. 1 illustrates the data structure (the first-order concepts, second-order themes, and aggregate dimensions) that emerged from analysis. The analysis identified four broad sets of practices (aggregate dimensions) adopted for biodiversity management: 1) Intraorganizational practices within the firm (including both strategic and operational aspects); (interorganizational) practices with 2) suppliers; 3) partners and other stakeholders; and 4) customers and distributors (retailers and consumers). Further analyses and refinement of the constructs resulted in nine themes related to the firms' biodiversity management practices.

The initial data analyses found a wide range of intra- and interorganizational practices adopted or developed by the firms to manage biodiversity in their own operations, and in their supply chains with other actors or stakeholders. Table 2(a-d) presents the biodiversity practices adopted by firms across various sectors by firm, and supply chain actors. The following discussion explains the nine main themes (sets of practices) in more detail and offers illustrative quotes from the interviews and provides support to the data coding and analysis.

4.2. Intraorganizational practices

The first overarching dimension of the research concerns the intra-organizational practices for managing biodiversity developed or adopted by the sampled firms. This dimension includes three themes, as follows.

The first theme that emerged from data on the firms' intra-organizational practices was referred to as *Adopting biodiversity-supportive vision, strategy and values*. This theme included three practices: "Developing a vision that supports biodiversity/sustainability," "Embedding biodiversity/sustainability in strategy, core business, and/or business model," and "Nurturing organizational values that support biodiversity/sustainability" (see Table 2, and Fig. 1). Most of the firms were characterized by a corporate vision – promoted across the organization – that was highly supportive of biodiversity and/or sustainability. For instance, as asserted by the apiculture firm: *"The firm is founded on the belief of ecology and biodiversity. That was the first thing. The*

Table 1
The sampled firms and sectors.

Key sector	Textiles	Forestry	Hospitality	Aquaculture	Horticulture	Apiculture
Firm	Design, manufacture, retail of textiles Design in Finland, manufacturing in Europe, >100 employees	Forest-based bioindustry Global operations: production facilities and customers world-wide, ca. 20,000 employees	Restaurant, Pizza and fast-food chains Runs one of the largest restaurant chains in the Nordics, operating (franchising) ca. 300 restaurants in Finland	Fishing/Aquaculture (Fish, mussels) A large quota holder in NZ,>1,000 employees	Banana importer and retailer Seller of FairTrade bananas in NZ, <20 employees	Honey & nature reserve Production of Manuka honey, sold in 20+ countries,750-ha private nature reserve, <20 employees
Country	Finland	Finland	Finland	New Zealand	New Zealand	New Zealand
Supply chains	Global Difficult to trace used raw materials to the farm-level - the most important production countries (for cotton) include India, Pakistan, Turkey and the USA	Local & Global Suppliers across dozens of countries. Only accepts legal and controlled wood, and will not purchase wood from rainforests or from plantations that are located on converted forests	Local & Global The Group's sourcing and logistics firm sources nearly all the products and ingredients used, and buys products directly from a few dozen suppliers, domestically (e.g., dairy, meat) and internationally (e.g., pineapple, tuna, prawn)	Local Supply chain consists of several hundred independent sharefishers, dozens of fishing vessels and six processing sites	Global Sources bananas from small (non-plantation) family operated farms belonging to a Fairtrade certified cooperative in El Guabo, Ecuador	Local & Global Vertically integrated production of honey
Link to biodiversity/ sustainability topic	Business and products derive from natural resources; cotton being the most important raw material. Focus on sustainability, circularity and transparency	Business combines forestry and bioeconomy, and is based on sustainably sourced wood	Focus on fresh, safe, and sustainable ingredients. Focus on topics relevant to the customer: e.g., use of sustainable fish and mostly domestic ingredients	Focus on sustainable fishing, oriented toward biodiversity preservation. Aims at minimizing by-catch, eliminating harm to endangered species	Focus on support for suppliers, Fairtrade and organic practices that promote biodiversity on family-owned banana plantations	Restoration work recreating wetlands, planting natives, and controlling pests and weeds. Strong biodiversity focus. Ecotourism destination

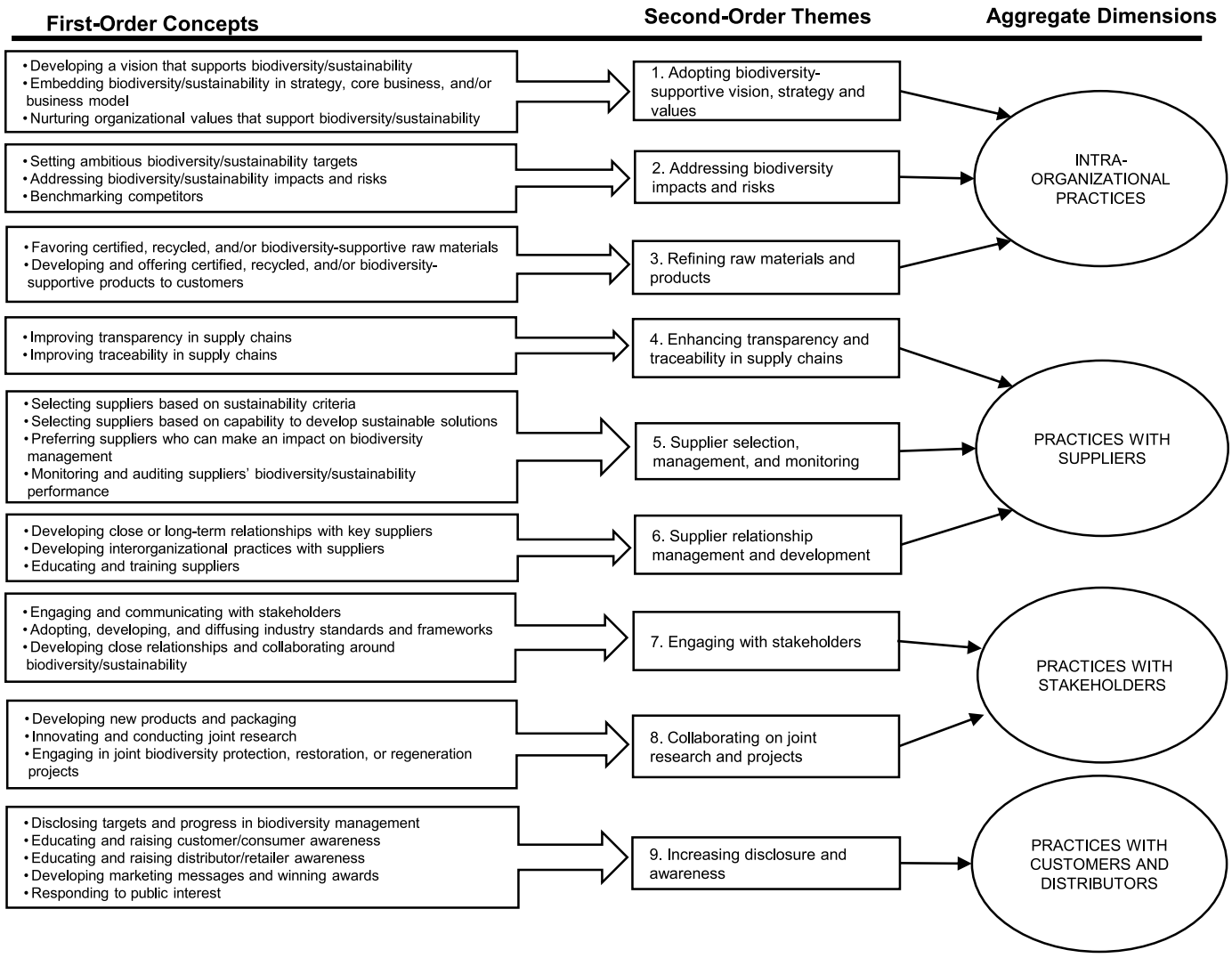

Fig. 1. Data coding of biodiversity management practices.

honey came much later after that." Interviewees explained that biodiversity/sustainability was centrally embedded into their strategy, core business (operations and supply chains), and/or business model. For example, the textiles firm was piloting a closed-loop business model, and the apiculture firm stated it had become biodiversity positive: *"And it doesn't have to be an 'if' or an 'or', you can have a business and be biodiversity-positive. (apiculture)."* Finally, the nurturing of values supportive of biodiversity/sustainability also emerged as an important activity for some of the study participants. For instance, the textiles firm noted that "*We have very strong values and if something is in accordance with our values and the right thing to do, then we do it, regardless of what the consequences might be*."

The second theme was *Addressing biodiversity impacts and risks*, which centered on highly tangible firm activities. The three practices were "Setting ambitious biodiversity/sustainability targets," "Addressing biodiversity/sustainability impacts and risks," and "Benchmarking competitors." The first practice, setting ambitious biodiversity/sustainability targets, concerned various types of targets and indicators prioritized by the interviewed firms. For example, the forestry firm noted that "*In 2018, we introduced our new commitment with a goal of net positive impact on biodiversity in three key areas: forest management, conservation, and projects and collaboration.*" The apiculture firm was proud not just to be carbon neutral, but also biodiversity positive (although the respondent acknowledged that customers did not always appreciate what that meant, and they have now labelled their packaging 'nature-positive'). The second practice, addressing biodiversity/sustainability impacts and risks, related to the firms' own operations and their supply chains. The sampled firms especially paid attention to direct (negative and positive) biodiversity impacts and risks related to: land and sea use; (over) exploitation and use of species; greenhouse gas emissions; other sources of pollution; and invasive species, for example. They also assessed several indirect impacts and risks, such as water use and wastage of natural resources, which may pose threats to or otherwise influence biodiversity. Addressing biodiversity/sustainability impacts and risks involved the firms seeking to reduce their negative impacts and risks, as well as trying to grow their positive impacts on biodiversity. The latter could happen through the protection, restoration and/or regeneration of ecosystems or the flora and fauna within those ecosystems. For example, the apiculture firm, in addition to having a million-tree pledge for restoring, noted that *"A range of invasive plant species threaten our local ecosystems. We control the worst of these."* Sometimes, competitors were acknowledged. One firm also emphasized their aim to benchmark, or indeed set standards, for competitors and others to follow. The hospitality firm noted that "*We joined the Commitment2050 initiative, and we were one of the first companies [in Finland] to join."* The apiculture firm developed the Bio Value Index (BVI) and habitat biodiversity counter, which seeks to measure the biodiversity value of specific plants and habitats, and to help measure the impact of a firm's activities through

Table 2a
Intraorganizational biodiversity management practices (i.e. buying firm practices).

Themes	Textiles	Forestry	Hospitality	Aquaculture	Horticulture	Apiculture
1 Adopting biodiversity-supportive vision, strategy and values	Embedding sustainability in core business and supply chains	Embedding sustainability in core business	Sustainability as driver of all activity	Embedding sustainability and biodiversity in core business, business model, and across all operations. Embedding biodiversity considerations in ethical code and sustainability policies	Firm founders positively influence team members to be more sustainability conscious and considerate of environmental biodiversity in day-to-day operations	Emphasis on being biodiversity positive (rather than simply carbon neutral)
	Training employees on sustainability	Biodiversity targets integrated into firm's overall sustainability goals	Embedding sustainability in core business	Highlighting environmental best practices in trainings	Business strategy based on sustainability umbrella, with focus on biodiversity and Fairtrade principles	Biodiversity and environmental preservation recognized as core goals, funded by complementary commercial activities (honey, eco-tourism)
	Piloting a closed-loop business model	The pricing mechanism of financing linked to long-term biodiversity and climate targets.	Sustainability program recognizes biodiversity as an emerging theme (as part of climate-related work)	Empowering staff to innovate and to act on biodiversity	Values oriented to good for the growers, the land and consumers	Following restoration/ regeneration principles (e.g., establishing diverse ecosystems; maximizing local biodiversity; maximizing carbon storage; reinforcing the water cycles; allowing for commercial use, and measuring and learning)
2 Addressing biodiversity impacts and risks	Calculating the carbon footprint of supply chain	Analysing risks related to biodiversity/ sustainability	Ambitious targets related to sustainability	Assessing biodiversity/ sustainability risks/ impacts in own operations and for key suppliers	Assessing biodiversity impacts in supply chains, such as impacts on water, soil health and recycling of soft plastic	Clear targets and professional measurement (e.g. goal of one million trees planted, monitoring or species return and regeneration, measurement of carbon stored in wetlands, fish varieties, birds, trees, water quality, insects)
	Calculating water footprint of most significant product categories	Analysing risks related to water use	Reducing food waste at restaurants (e.g. through inventory control and by using an app to sell excess portions)	Benchmarking competitors	Carbon offsets ensure supply chain for bananas is carbon-neutral	Carbon footprint linked to the accounting system
	Mapping and reducing water use and pollution in supply chain to safeguard biodiversity	Ambitious sustainability and biodiversity targets	Calculating and reducing product carbon footprints	Reducing biodiversity impacts of harvesting/ fishing (e.g. adapting fishing methods to minimise accidental by-catch, avoiding fishing areas with young fish stocks, prohibiting use of fish aggregation devices (FADs) in tuna fishing), electronic monitoring of catch (by species and size) to preserve breeding capacity and diversity, zero tolerance for overfishing, underreporting or discarding catch		Development of Bio Value Index (BVI), a restoration framework that recognizes biodiversity in ecosystems, and carbon sequestration through native planting differs by species (e.g. rate of growth, duration of growth, and wood density)
	Investigating possibilities to calculate biodiversity footprint (of parent firm)	Biodiversity program	Piloting electric and biogas cars in food deliveries	Frequent relocation of activities (e.g. salmon farms) to prevent water pollution		Renewable energy use
	Analyzing environmental risks for all manufacturers of licensed products	Promoting sustainable forestry management and harvesting practices (e.g. promoting mixed forests)	Enhancing energy efficiency	Improving resource efficiency and reduction of waste (e.g. in relation to salmon feed, zero fish waste policy, adherence to fishing quotas)		Reducing, reusing, and recycling materials, and monitoring these practices

(*continued on next page*)

Table 2a (*continued*)

Themes	Textiles	Forestry	Hospitality	Aquaculture	Horticulture	Apiculture
	Ambitious sustainability targets	Promoting voluntary efforts to protect large areas of forests	Using renewable energy	Reducing emissions		Restoring and replanting native forests, wetlands and coastal dunes (some 350,000 trees planted to-date, approx. 30-50,000 per annum)
	Reducing waste	Identification of valuable sites and habitats to not be touched at all	Reducing carbon footprint, plastic and other waste in supply chain	Technological development and investments to reduce biodiversity impacts in own operations and supply chains		
	Increasing resource efficiency (e.g. in packaging) Reducing carbon emissions in own operations and supply chain	Reducing own carbon footprint and the overall carbon footprint of supply chain	Reducing water use in supply chain by using recycled working clothes	Restoration/regeneration of ecosystems (e.g., mussel reefs)		
3 Refining raw materials and products	Increasing the use of ecological raw materials (e.g. certified (organic, Fairtrade, and BCI), linen, recycled)	Certification	Biodiversity-friendly product development (e.g. vegetarian and vegan)	Certification (e.g., MSC, Best Aquaculture Practices, A + Aquaculture, Seafood Watch)	Sourcing from family operated farms, planted with multiple species and less use of machinery fostering biodiversity	Responsibly harvested honey and low hive concentration
	Improving quality and longevity of products	Accepting legal and controlled wood only	Biodiversity-friendly ingredient choices (e.g. vegetarian and vegan)	Focusing on value creation (i.e. greater value for every kg of raw material), rather than volume-driven commodity business		Relationships with local nurseries and seed suppliers based on biodiversity principles
	Developing repair services for products	Reduction of water use	100% MSC certified seafood	Developing new (e.g. vegetarian) products and following market developments		Compostable packaging innovation (skincare)
	Decreasing chemical use in products/ production		Increasing the share of domestic ingredients (e.g. 100% domestic meat) Environmentally-sound (e.g., FSC-certified) packaging materials	Facilitating customers' and consumers' sustainable choices by adopting product and operations standards (e.g., MSC, Best Aquaculture Practices, A + Aquaculture, Seafood Watch)		

encouraging biodiversity, rather than solely carbon sequestration, in the hope this would become industry standard.

The third theme was *Refining raw materials and products,* which related to both inputs and outputs of (firm or supplier) production. The theme consisted of two practices: "Favoring certified, recycled, and/or biodiversity-supportive raw materials" and "Developing and offering certified, recycled, and/or biodiversity-supportive products to customers". Indeed, the sampled firms actively or exclusively favored certified (e.g., Fairtrade or organic), recycled, or otherwise biodiversity-supportive supplies and raw materials, as the following quotes suggest: *"MSC certification does not really guarantee anything, but from our perspective, it is the best possible way, at the moment, to ensure that we have responsibly-fished tuna or caught shrimp on top of the pizza"* (hospitality) and; *"What we can do is that in the purchasing stage we can choose to buy certified cotton, organic and Fairtrade, and it is in our strategy too that we will increase that"* (textiles). Some of the firms were also striving to ensure that their own products were certified, recyclable and biodiversity supportive. These firms were actively engaged in developing improved alternatives to current offerings, as evidenced by the following quote: *"Every extra banana that we sell [as certified] is an opportunity for farmers to convert over to organic and Fairtrade or to grow more [of these] bananas"* (horticulture).

4.3. Interorganizational practices

The second overarching dimension focused on interorganizational practices is arranged by supply chain actors, namely suppliers (and sub-suppliers); stakeholders (e.g., government agencies, nonprofit organizations, and local and international institutions); and customers and distributors (including retailers, agents, and consumers).

Three new themes emerged from the data for *suppliers*. Theme four was related to *Enhancing transparency and traceability in supply chains* and consisted of two practices: "Improving transparency in supply chains" and "Improving traceability in supply chains". Firms that had global or otherwise complex upstream supply chains were more likely to engage in one or both practices. For example, the textiles firm noted that *"Transparency is our key driver. We openly disclose our suppliers on the firm website – so that anyone can check issues … And if there are any problems, we want to know about those*." The forestry firm in turn explained that *"We are able to trace 100% of the raw materials (wood), and source all of the raw materials from suppliers covered by the supplier code."* In contrast, firms in the horticulture and apiculture sectors, which would have greater transparency and traceability of upstream supply chains due to certifications and local sourcing did not specifically refer to these activities in the interviews.

The fifth theme was *Supplier selection, management, and monitoring*, which included four practices: "Selecting suppliers based on sustainability criteria," "Selecting suppliers based on capability to develop sustainable solutions," "Preferring suppliers who can make an impact on biodiversity management," and "Monitoring and auditing suppliers' biodiversity/sustainability performance". The data suggested supplier selection based on sustainability criteria (e.g., codes of conduct and sustainability certifications) was critical to all sample firms. According to the firm involved in the horticultural sector, for instance, *"The*

Table 2b
Interorganizational biodiversity management practices with suppliers.

Themes	Textiles	Forestry	Hospitality	Aquaculture	Horticulture	Apiculture
4 Enhancing transparency and traceability in supply chains	Improving transparency Improving traceability Publishing lists of suppliers and sub-suppliers	Improving transparency Improving traceability Collecting and monitoring data related to key biodiversity indicators	Improving transparency	Improving transparency Improving traceability from ship to plate	Fairtrade and organic certification	Carbon negative and biodiversity positive
5 Supplier selection, management, and monitoring	Selecting suppliers who match own values and meet environmental criteria Supplier management and relationships Evaluating suppliers Supplier auditing (direct risk-country suppliers)	Assessing and recognizing risky suppliers Constantly evaluating and developing suppliers' performance Supplier auditing 1st & 2nd tier supplier evaluation on sustainable purchasing principles, code of conduct, long-term contracts	Supplier selection, negotiations and contracts guided by sustainability, values, code of conduct Supplier code of conduct with strict sustainability (e.g., biodiversity) requirements and recommendations Auditing of suppliers by firm itself and by third-parties where needed	Supplier selection, sustainability criteria/ evaluation Supplier management Auditing and monitoring (related to certifications)	Fairtrade focus on education and strict requirements relating to biodiversity for farmers (suppliers) Using Fairtrade partners and industry cooperative to guide selection and management of suppliers	Selecting local suppliers with biodiversity principles
6 Supplier relationship management and development	Development project with suppliers on water impacts Close collaboration with most important suppliers Encouraging most important suppliers to decrease emissions and increase use of renewable energy	Developing long-term supplier relationships Training and guidance to all actors at the grassroots level to ensure that forestry management and harvesting practices take biodiversity into account	Continuous collaboration with and support to key suppliers Developing long-term partnerships with key suppliers Supporting supplier sustainability efforts (e.g. pineapple) Visits with sub-tier suppliers, personal relationships Open communication and joint problem solving with suppliers	Commitment to ongoing relationships	Support of local research into news strains, pest control, irrigation systems, packaging and waste, underplanting and soil science supportive of biodiversity Engagement, direct communication, visitation and support of Fairtrade & organic farmers in supply chain Encouraging shift to organic practices Returns to farmers rather than retailers	Working with suppliers toward more sustainable substitutes for current packaging (e.g. without non-compostable silicon lining inside) Relationships with local nurseries and seed suppliers on biodiversity principles Pest/weed control neighboring properties

Fairtrade mark ensures growers are getting a fair price, supports *the communities and educates growers on sustainable farming practices to promote biodiversity."* In some instances, capability to develop sustainable solutions and address environmental risks were included as a part of strict supplier selection criteria. As an example, the hospitality firm noted that *"Together with our purchasing firm, we are pushing to have ASC certification for Finnish salmon – because that does not exist yet. So, we are helping to push it and we* support *having it in Finland."* In particular, firms with complex upstream supply chains highlighted the significance of risk management. The firms preferred (e.g. powerful or influential) suppliers that were able to exert positive impact on overall biodiversity management in the supply chain and had adopted best practice product and operations standards. This was explained in the following comment: *"One criterion in supplier selection, relating to biodiversity, too, is that we aim to select partners who are vertically integrated and control as much of the supply chain as possible. In our case, they buy the cotton, make yarn, weave, print and sew the final product – so they have the possibility to influence"* (textiles). Practices related to monitoring and auditing were also important to this firm: *"To some extent we visit the suppliers. But it is best that a third party does the auditing. … we trust the BSCI audits."* The importance of monitoring and auditing suppliers' biodiversity/sustainability performance was noticed to grow along with the increasing complexity of supply chain or supplier relationships.

The sixth theme, *Supplier relationship management and development* involved three practices: 1. "Developing close or long-term relationships with key suppliers"; 2. "Developing interorganizational practices with suppliers" and; 3. "Educating and training suppliers." These practices were widely utilized amongst the sample firms and allowed them to work closely together with their suppliers also on biodiversity management. Practices that ensured close or long-term relationships with suppliers were emphasized. For instance, *"We deal with the suppliers directly, without any wholesalers or middlemen in between, so we know exactly where the pineapple comes from. We even know the people there personally – let alone the domestic producers who are in a very important role*" noted the hospitality firm, while the representative of the forestry firm said: *"We engage in long-term co-operation with selected suppliers to optimize cost, quality, sustainability, and innovation"*. Furthermore, joint interorganizational practices were developed as shown in the comment by the forestry firm *"Our continuous teamwork with our suppliers ensures the efficiency, transparency and responsibility of our entire supply chain"*. Education and training of suppliers involved close contacts. The representative of the horticulture firm said that *"We have a direct connection with our growers as well. I personally went over there and met all our growers. And they're always coming up with new techniques to improve*

Table 2c
Interorganizational biodiversity management practices with stakeholders.

Themes	Textiles	Forestry	Hospitality	Aquaculture	Horticulture	Apiculture
7 Engaging with stakeholders	Industry collaboration	Stakeholder engagement	Multi-stakeholder collaboration	Following MSC Chain of Custody requirements	Organic industry collaboration and leadership at local and global levels	Engagement with local/ national land care and sustainability groups who monitor and measure progress (e.g. Dept. of Conservation, Queen Elizabeth II Trust and Landcare)
	Engagement and dialogue with NGOs around transparency, risk assessment, and product quality/ sustainability	Promoting standards to partners	Supporting industry and civil society efforts (e.g. development of certified salmon production)	Leading, chairing, and/ or joining in multi-stakeholder or industry initiatives that seek to e. g. improve productivity and sustainability	CEO, as Chair or Board member of multiple sustainability-oriented industry organizations, maintains strong and meaningful relationships with partners that share their mission, and can collectively create greater impact	Engagement with key international agencies (e. g. World Economic Forum) to advocate and educate around biodiversity-based carbon credit calculation
	Engagement with regulators around industry sustainability issues	New approaches for stakeholder engagement; finding ways to turn potential conflict situations into cooperation	Promoting industry standards	Diffusing and adopting leading industry standards	Monthly speaking event on sustainability topics with business leaders	Working with international partners, stakeholders and institutions (e.g. The Long Run and the Pacific Security Council) on adoption of alternative carbon footprint frameworks based on biodiversity principles
8 Collaborating on joint research and projects		Biodiversity projects with stakeholders	Participating in a research project that seeks to develop networks and solutions related to re-useable product and raw material packaging	Partnering with competitors, NGOs, governments, and researchers to restore and regenerate ecosystems (e.g. mussel reefs), to reduce risks faced by species (e.g. Maui dolphin), and to decrease contacts with sea birds (e.g. black petrel) through development of new technologies (e.g. seabird-smart vessels) and techniques	Collaboration with international organizations for protection of biodiversity; research on new, disease resistant varieties	Collaboration with international packaging organizations for development of leak-proof compostable packaging for cosmetics
		Participating in voluntary project activities to protect forests (e.g. establishment of a new national park)		Partnering with competitors, government and researchers to develop Precision Seafood Harvesting technology, which may eliminate traditional trawl nets Enhanced breeding programs (e.g. for mussels)	Funding support via Fairtrade (partner) for establishment of bio-fermentary plant (fertilizer), plastic recycling and reuse, reduction of water use and replanting of forests in El Guabo area	Relationships with supporting agencies, scientific institutions, schools and community groups for research, education (e.g. bees in schools programme)

[biodiversity]." Even the firm in the fishing sector whose supplier base was primarily local paid careful attention to supplier assessment: *"We categorize our suppliers and perform sustainability/environmental risk assessments for key suppliers – this focuses our efforts amongst the many thousands of suppliers to those where we can have the largest impact. Within those assessments, we identify biodiversity factors amongst other environmental items which may be impacted through our purchasing decisions"*. Overall, these practices contributed to joint biodiversity preservation efforts between the firms and their suppliers.

The seventh theme, *Engaging with stakeholders*, involved three practices related to close relationships with international and local stakeholders, including NGOs, competitors and industry, government agencies, multi-stakeholder initiatives, and civil society actors. Such collaborators were critical for seeking synergy and impact beyond the firm's activities alone. Practices were identified as; "Engaging and communicating with stakeholders," "Adopting, developing, and diffusing industry standards and frameworks," and "Developing close relationships and collaborating around biodiversity/sustainability." Engagement and communication with stakeholders focused on biodiversity and sustainability issues and risks, other industry issues, conflict situations, advocacy efforts, and progress measurement, for example. The aquaculture firm noted the wide variety of stakeholders involved: "*So, looking at what was important to both our external and internal stakeholders - from policy makers, regulators, through to our customers/ consumers through to civil society."* The firms who referred to adopting, developing, and diffusing industry standards (e.g., aquaculture and forestry), appeared to promote especially high-level or leading industry standards to their stakeholders. The aquaculture firm works with multiple NGOs and government agencies to help save endangered marine species, introducing *"electronic monitoring and observation cameras –*

Table 2d
Interorganizational biodiversity management practices with customers and distributors.

Themes	Textiles	Forestry	Hospitality	Aquaculture	Horticulture	Apiculture
9 Increasing disclosure and awareness	Sustainability reporting	Sustainability reporting	Sustainability reporting	Sustainability reporting	Consumer education (e.g. website, marketing) and community engagement and awareness around sustainability and biodiversity at the source	Substantiation of claims around biodiversity in order to build trust with customers and consumers
	Increasing customer/ consumer awareness of sustainability and biodiversity	Public commitments to biodiversity action and sustainability	Customer/consumer education and awareness raising on environmental sustainability (e.g. marine ecosystems)	Consumer education via media, marketing, website	Sharing and celebrating the message of biodiversity through education and media engagement	Consumer education (e. g. in labels, social media, webpages, marketing)
	Public commitments to sustainability	Sharing information on awards (e.g. EcoVadis Platinum recognition for responsibility performance)	Active communication with customers	Raise industry and consumer awareness of biodiversity, and its importance to NZ ecosystems	In-schools education programme on organic sourcing	Distributor engagement and education relating to brand and biodiversity message
	Encouraging customers to return end-of-life products and developing circular solutions		Facilitating customers' sustainable choices	Engaging in open and transparent communication and dialogue	Growing market share or organic banana retail in NZ to 8% from 0%	Sharing the message of sustainability and biodiversity through education, engagement and credibility (awards)
	Sustainability-related activism		Developing product labels related to carbon footprints Reducing customers' food waste (by considering product portion sizes and communicating) Ambitious public commitments to sustainability (e.g. carbon neutral products by 2030)	Using observation cameras in response to increased public interest in fishing activities		Greater awareness through multiple awards, clearly oriented to sustainability and biodiversity

which [the firm] supports*, promotes, and has targets for"* and states that such "*partnerships can be very powerful in their ability to drive towards beneficial outcomes across stakeholders"*. The forestry firm noted that *"Working with NGOs, government agencies and educational institutions, we have developed new metrics to monitor forest health, increased our understanding of rare and endangered species and promoted conservation practices worldwide."* The firm continued, *"We have stakeholder projects, of which some are research-focused and others emphasize collaboration, either locally or nationally. The idea is that we are not active alone but work with our stakeholders …. this includes collaboration with environmental NGOs and other local actors"*. Close relationships and collaborations with various stakeholders were helpful for tackling industry-wide issues and seeking to create greater impact.

The eighth theme, related but distinct to the previous one, was *Collaborating on joint research and projects*. This theme included three practices related to broader collaboration and projects with various types of stakeholders, namely, "Developing new products and packaging," "Innovating and conducting joint research," and "Engaging in joint biodiversity protection, restoration, or regeneration projects." The development of more sustainable and biodiversity-supportive products and packaging was undertaken through international industry partnerships by the apiculture firm: "*We've worked with some of the leading companies in the world to find a sustainable lining*". Innovating and conducting joint research focused on advancing new technologies, (production or harvesting) techniques, and disease resistant plant varieties at supplier level but with assistance from the focal firms, was supported by the horticulture firm. The forestry firm emphasized the importance of early engagement in collaborative projects: "*Integration of research results and our involvement already in the planning phase of research [projects] is increasingly emphasized here, in partnerships and in all projects*." Collaboration with different partners in actual biodiversity protection, restoration and regeneration projects was brought up by the aquaculture firm as well: *"We are working on several partnership projects to improve biodiversity outcomes. In particular, our work with the Maui-63 team and collaboration with NGOs, government, other fishing companies, and researchers to improve understanding of, reduce risks to, and improve outcomes for the Maui dolphin"*. The apiculture firm engaged in local partnerships for dune restoration, "*we have a very rare species, a rare plant on the dune, and the Department of Conservation, the regional council and QEII Trust are all working with us on this particular piece of land*". Such projects involved joint efforts by the firms and external stakeholders such as NGOs and government agencies to establish a new national park (e.g., forestry), mussel reef restoration (e.g., aquaculture) and ecosystem regeneration activities (e.g., apiculture).

Finally, one broad theme emerged for customers and distributors. This ninth theme was *Increasing disclosure and awareness*, consisting of five interrelated practices; "Disclosing targets and progress in biodiversity management," "Educating and raising customer/consumer awareness," "Educating and raising distributor/retailer awareness," "Developing marketing messages and winning awards," and "Responding to public interest." Disclosure of targets and progress in biodiversity management was frequently integrated into the firms' more general sustainability reporting and communication efforts. This is partly due to the complexities of the issues, as shown in the following comment: *"Maybe it is difficult to talk to consumers about biodiversity because a pretty substantial percentage of people do not know what is means, and because no one craves biodiversity*-supporting *pizza"* (hospitality). Disclosed targets also involved public commitments to biodiversity/sustainability, such as, a 100 million tree pledge to restore farmland to native habitat (apiculture) and the launch of a biodiversity program (forestry). Some of the firms were also actively engaged in raising consumer awareness of biodiversity issues as well as promoting biodiversity-friendly and sustainable lifestyles. For example, *"We focus on educating through storytelling and connecting people back to not just the growers of the products, but*

also the land that the bananas are grown on" (horticulture). Distributor/retailer education efforts focused more on key messages and product features relating to biodiversity and sustainability. For instance, the textiles firm explained that *"Our customers ask almost nothing about sustainability. … For our sustainability-related projects, we inform the retailers – give instructions on how to inform consumers about them*".

Most of the firms in this study had developed key marketing messages and won awards highlighting their efforts in the sustainability and biodiversity preservation spaces. For example, the apiculture firm won *"the most prestigious restoring nature* award *in New Zealand … the most sustainable business in New Zealand in every category"*. Responding to public interest involved responsiveness to and in-depth engagement with customers and the public, including two-way communication and education: *"Events like Organics Week have been a great platform to educate consumers about the importance of organic farming and consumption, and to promote why biodiversity in New Zealand is so important"* (horticulture). Examples of specific firm activities included encouraging customers and consumers to adopt sustainable lifestyles or return end-of-life products (e.g., textiles) as well as allowing customers to observe relevant firm activities through observation cameras (e.g., fishing).

4.4. Biodiversity performance outcomes

Firms adopting biodiversity management practices can aspire to, and achieve, very different biodiversity performance outcomes. Integrating insights from literature (WBCSD, 2021), biodiversity performance outcomes were divided into four categories in this study. The categories represent a continuum from simply doing less harm to strongly positive sustainable regeneration, namely; 1. *Reduction* of negative biodiversity outcomes; 2. *Elimination* of negative biodiversity outcomes; 3. *Restoration* of biodiversity, and 4. *Regeneration* of biodiversity that is self-sustaining. Specific examples of such outcomes, either achieved, or aspired to by the firms, were derived from the data and are presented in Table 3.

Reduction of negative biodiversity outcomes involves partially eliminating harm to ecosystems, species and genetic diversity, while elimination means fully eliminating the harms in question. Restoration of biodiversity refers to a positive strengthening of biodiversity, while regeneration of biodiversity entails activities that result in ecosystems and other forms of biodiversity becoming self-sustaining (WBCSD, 2021). Any one firm is likely to end up with a range of biodiversity performance outcomes as a result of its different biodiversity management and other practices. The net outcomes associated with the firm's practices, and those of their suppliers, can lie anywhere on the continuum (or outside of it if the firm is not successful in improving its biodiversity-related performance or exerts a worsening degenerative impact).

In some cases, the firms' biodiversity management focuses directly on achieving one or a set of these biodiversity outcomes. One example of this is the observed return of 71 (including 22 endangered) native species of bird; and the reintroduction of 93 native plant species to the area restored by the apiculture firm in New Zealand. In other cases, the firms set targets, which would indirectly affect biodiversity performance outcomes. For instance, some of the firms emphasized the need to save water from their own, or their suppliers' operations, led to water being more readily available for plants and animals.

The analysis, despite our concentration on firms focused on biodiversity, shows that biodiversity management is still a relatively novel topic. While this research sought to identify practices that focus exclusively on biodiversity, the firms would often also report practices relating to (environmental) sustainability more generally. Moreover, there are several interlinkages and multidirectional effects of the firms' practices. For instance, emissions and climate change are a direct driver of biodiversity loss, and biodiversity loss in turn exacerbates climate change. Some of the practices also have cascading outcomes. For example, dissemination of the most effective practices in forest management and harvesting (e.g., adopted in the forestry firm's own forests) to other privately-owned forests through long-term contracts and supplier development could contribute to beneficial outcomes for biodiversity in other areas in Finland and potentially other key source countries. Finally, development of biodiversity indices and indicators by the apiculture firm, if adopted by government(s) and other firms, could contribute to habitat biodiversity protection by linking biodiversity-supportive activities to economic payback (similar to carbon credits). This shows the intertwined and complex nature of the issues, particularly when linking specific practices to outcomes. Our illustration of the biodiversity management practices of the firms in our sample, however, is one step towards raising awareness of the issue, possible interlinkages and desirable outcomes.

5. Model of biodiversity management in PSCM

Given the broad range of biodiversity management practices and the complex nature of biodiversity performance outcomes, it is imperative to take a holistic view on how buying firms can, together with their various supply chain members, combat biodiversity loss. This empirical study revealed 28 intra- and interorganizational practices adopted or developed by firms for biodiversity management, that is, practices that sought to achieve biodiversity performance outcomes in firms' own operations and along their supply chains. Examples of specific biodiversity performance outcomes were also derived from our data and they relate to reducing and eliminating the firms' negative biodiversity outcomes, as well as increasing their positive biodiversity outcomes by restoring and regenerating biodiversity.

Fig. 2 presents a theoretical model of biodiversity management in PSCM, which illustrates intraorganizational and interorganizational biodiversity management practices identified in the study, classified into nine key themes (see also Table 2 for the practices, and Fig. 1 for the data coding), along with biodiversity performance outcomes either aspired to, or achieved by the firms. The empirical results highlight the importance of interorganizational practices with suppliers and various supply chain members, suggesting that intraorganizational practices by the firm alone are not enough to address biodiversity.

Fig. 2 further specifies that while some biodiversity performance outcomes are immediate targets of the firm's biodiversity management activities, other biodiversity performance outcomes may only be achieved via intermediate targets. Immediate targets can relate to reducing or eliminating potentially harmful interactions and contacts with a threatened species (which helps to preserve the species), or increasing and strengthening biodiversity via restoring or regenerating a particular ecosystem or species of flora or fauna in a specific place, for example. In these cases, biodiversity performance outcomes can be expected to follow directly (even if with a time lag) from the firm meeting its immediate targets. Other times, the firm's targets can relate to issues that function as more of a mediator of the actual biodiversity performance outcomes. For example, the firm may wish to improve the biodiversity-related knowledge and capabilities of its suppliers, or to increase the biodiversity awareness of its customers and distributors. Even if the firm achieves such objectives, they may not directly result in biodiversity performance outcomes. Nevertheless, they can help to spur further action and/or effects, which in turn may result in biodiversity performance outcomes. Overall, the findings point to the need to examine and consider different chains of causation that exist between specific firm practices, its targets (and indicators used to measure the achievement of them), and biodiversity performance outcomes.

Importantly, both immediate and intermediate targets may span different locations and members of the supply chain. For instance, the firm may set targets both for itself and its suppliers for decreasing water pollution. Any reductions in water pollution may help to restore biodiversity especially in the vicinity of the pollution source(s), but some effects are likely to extend even further. Or the firm may seek to increase the share of certified raw materials in its overall sales, which may

Table 3
Biodiversity performance outcomes – examples from the sampled firms[a].

Biodiversity outcomes	Textiles	Forestry	Hospitality	Aquaculture	Horticulture	Apiculture
Reduction of negative biodiversity outcomes (degeneration)	Decrease in the use of toxic chemicals (through certification and raw material choice)	Decrease in share of forests that lack the features typical of natural forests (e.g. volume of broadleaved tree species, diverse forest age structure and diverse forest structure) in commercial forests.	Decrease in carbon emissions in restaurants	Minimization of by-catch and under-size fish as not included as quota	Decrease in the use of toxic chemicals (through certified Fairtrade and organic sourcing)	
		Decrease in carbon emissions caused by own operations and supply chains	Increase in recycling rate and reduction in waste	Less frequent contact with endangered species		
		Minimization of invasive alien species presence in key areas	Decrease in fuel use	Sustainably managed fish and seafood stocks (which promote preservation of species)		
		Increase in share of certified wood fibre	Decrease in pesticide use in supply chains			
			Decrease in product carbon footprints			
			Reduced pressure for land conversion, e.g., in biodiversity hotspot areas			
			Sustainably managed fish and seafood stocks (which promote preservation of species)			
Elimination of negative biodiversity outcomes	Substituting cotton for other, more environmentally friendly raw materials (e.g., linen and recycled materials)	Increase in share and area of protected forests from all own forests (eliminates negative outcomes in the forests left out of commercial use)	Achieve net zero carbon footprint for certain products (by 2030)	Reduced nutrient enhancement preserves original habitat	Eliminate monoculture farming of single species	No use of toxic chemicals
				Eliminate fatal interactions with endangered marine mammals (target is for no fatal interactions to occur)	Eliminate use of toxic chemicals	
				Preservation of endangered species (e.g. birds, dolphins)		
				Wild mussel spat preserved for breeding variation		
Restoration of biodiversity		Increase in number of restoration projects	Restoration of soil and water quality (e.g. in pineapple production)	Restored native mussel stocks and ecosystems (which provide ecological service, habitat provision and biodiversity outcomes)	Restoration of mountain ecosystems including soils, increased flora, fauna and insect life	Restoration of native forests and wetlands
		Increase in share of forests that have features typical of natural forests.			Restoration of water resources and quality	Restoration of diverse and extensive food supply for exotic and native fauna (i.e., birds, bees)
		Restoration of forest structure and valuable habitats (e.g. by increasing deadwood and natural forests)				
		Restored water resources				
Regeneration of biodiversity		Increase in share and area of protected forests (allows regeneration of those ecosystems). Areas are designated for conservation based on law, or voluntarily, due to their conservation value.			Regeneration of forests and intercropping of multiple plant species	Extensive biodiversity enhancement of air, water, soil (sand) quality that is self-sustaining in the local area
					Ecologically-based agricultural practices regenerate biodiversity of species	

[a] *There were no specific biodiversity performance outcomes of interest in the particular area in our main data sources if there is a blank space. The listed biodiversity performance outcomes are examples of sought after and/or achieved outcomes.*

indirectly cause further biodiversity performance outcomes at its own and/or suppliers' raw material production or extraction sites in various locations. Overall, the firm's various immediate and intermediate targets have potential to directly and indirectly cause multiple types of biodiversity performance outcomes to materialize in various locations globally, and along supply chains, at different points in time. Thus, achievable biodiversity performance outcomes could be expected to include the reduction and elimination of negative biodiversity outcomes and/or the restoration and regeneration of biodiversity. If the firm's (and other actors') intraorganizational and interorganizational practices are truly effective, the overall (net) performance outcomes could even entail the regeneration of biodiversity.

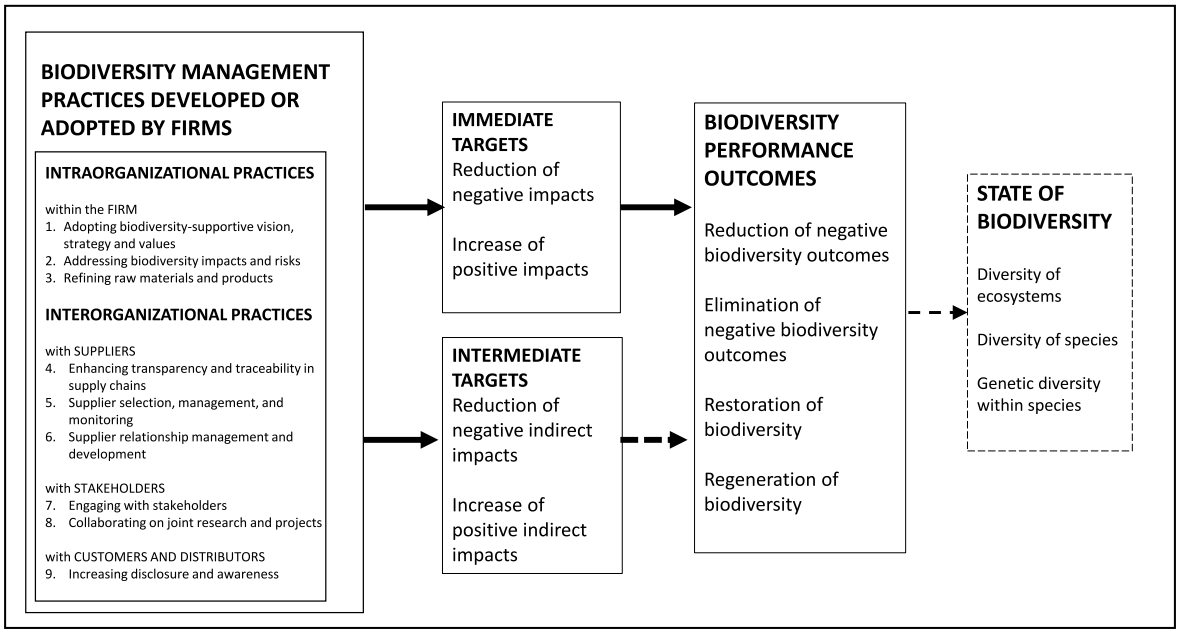

Fig. 2. Model of biodiversity management in PSCM.

Finally, our model emphasizes that the firm's biodiversity management practices, immediate and intermediate targets, and biodiversity performance outcomes are ultimately expected to influence the state of biodiversity (i.e., the diversity of ecosystems, the diversity of species, and/or genetic diversity within species). Biodiversity is always local, and changes to the state of biodiversity also occur in specific locations. In many cases, changes to the state of biodiversity are time-consuming and difficult to observe and measure. Depending on how ambitious and effective the firm's (entire range of adopted and developed) practices are, the firm's overall (net) performance outcomes may vary from degenerative to regenerative. However, any firm can continue to have various types of negative and/or positive impacts on the state of biodiversity in different locations. For example, if a firm is successful in restoring or regenerating a depleted animal population in a specific location (e.g., through a specific joint project), the achieved outcomes are likely to affect the genetic diversity of that species (in that location), but it may also produce further (positive and/or negative) changes in the state of other species and/or ecosystems in the same area. At the same time, the firm in question may continue to contribute to climate change (a driver of biodiversity loss) through its emissions. Even if the firm manages to lower its emissions, the remaining emissions will continue to contribute to climate change and hence nature loss globally.

However, as most of the firms in this study are large or medium-sized firms with local and global supply chains, the culmination of their practices can have multiple types of effects on the state of biodiversity in locations across the globe. Many of their influences on biodiversity are local to their own operations, main sourcing areas, sub-tier suppliers' production areas (in Finland, in New Zealand, regionally, and/or globally), and/or customers' product use areas. However, biodiversity performance outcomes and ultimate changes in the state of biodiversity are not limited to these areas, as some of the firms' practices, immediate and intermediate targets, can result in global changes, dissemination and adoption of practices via more distant supply chain members, other stakeholders, governments, and even a well-informed activist public. Although beyond the scope of our data, there can be also synergistic – cascading – influences of firm practices, partnering, and public perception on biodiverse-related action and subsequent beneficial outcomes for the state of biodiversity.

6. Discussion

The empirical investigation of firms' biodiversity management practices and biodiversity performance outcomes makes several contributions to PSCM research. This section outlines how the focus on biodiversity adds to and refines the existing research and theoretical understanding of SSCM. Then, the section discusses the main contributions of the study in the light of the SCPV.

6.1. Contributions to sustainable supply chain management research and theory

The main contribution of this study to the SSCM research area is the developed model of biodiversity management in PSCM, which incorporates altogether 28 practices, grouped under nine broad themes, and links them with actual or aspired to biodiversity performance outcomes. Previous studies, such as Vachon and Klassen (2006) and Gualandris et al. (2014), state that both internal firm and external supply chain practices are needed in managing environmental sustainability, because the former improve the sustainability performance of a firm and the latter improve the sustainability performance of the supplier base. Combined, they will contribute to improved sustainability outcomes. The sample firms in this study actively engaged in developing or adopting both intraorganizational and interorganizational practices specifically for managing biodiversity across their supply chains.

As far as intraorganizational practices are concerned, this study reveals several examples of proactive approaches (Li and Huang, 2017) to biodiversity management being adopted. This is partly because of the purposeful selection of firms known for their biodiversity management work and operations in industries where biodiversity (nature) is particularly at risk. Concern for environmental or biodiversity issues was an integral part of operations for all these firms. As a result of this core focus, firms had adopted many novel intraorganizational biodiversity management practices, such as addressing their biodiversity impacts, nurturing organizational values that support biodiversity/sustainability, and favoring certified, recycled, and/or biodiversity-supportive raw materials. Previous research (Paulraj et al., 2017) has shown that moral intrinsic motives based on genuine concern

for the environment are one of the key drivers of sustainable PSCM practices and targets. The present study suggests that internal motivation of the firm (e.g., personal interest of the founding member, CEO, or manager) was an important force for several firms that led them to pay attention to biodiversity and adopt concrete practices to preserve it.

However, intraorganizational practices are not enough for tackling biodiversity loss. In addition to stressing and reporting on their own actions (Boiral, 2016), the firms involved a range of other actors in their activities aimed at tackling biodiversity loss and developed several unique practices that involved different members of their supply chains. Previous literature on SSCM depicts both transactional and collaborative strategies with practices based on assessment and collaboration (Klassen and Vachon, 2003; Sancha et al., 2019). The sample firms used assessment-based practices, such as relying on sustainability criteria (e.g., standards and codes of conduct) or the capability to develop sustainable solutions in selecting suppliers. However, many of their practices related specifically to biodiversity management. Moreover, supplier engagement in biodiversity management was reinforced through various supplier relationship management and development activities. Overall, the importance of collaboration with suppliers and other supply chain members cannot be overstated, as positive joint action reinforces sustainable change and enlarges the impact beyond the boundaries of the firm (e.g., Tate et al., 2013; Beske et al., 2014; Touboulic and Walker, 2015). Like previous research (Vachon and Klassen, 2006; Grimm et al., 2014; Hoejmose et al., 2014), the results of this study show that assessment and reporting practices form only the most basic level of assurance of biodiversity management and performance in supply chains. Collaborative practices are significant in extending sustainability across the entire supply chain and supply networks (Pagell and Wu, 2009; Meqdadi et al., 2020) and can be expected to positively influence biodiversity performance outcomes (Sancha et al., 2019). Marshall et al. (2015, p. 676) found that practices based on collaboration "focus on changes to the fundamental nature of the supply chains' products and business models". This study's findings support these assertions, specifically from the biodiversity perspective, finding that firms rely on engagement and collaboration with a variety of stakeholders when adopting and developing biodiversity management practices in the supply chain.

Respondents appear to have internalized the unique nature of the biodiversity issue (Quarshie et al., 2021) and thus understood the criticality of a holistic and engaging approach when tackling biodiversity loss. Biodiversity initiatives and projects also often involved collaboration with various stakeholders beyond the supply chain (e.g., NGOs, regulators, and researchers), as well as engagement with customers and distributors. As Wieland (2021) argues, enhancing biodiversity requires fundamental changes not only to the actions of firms, but participation from and interaction with society and different stakeholders. Indeed, our data suggests boundary spanning interorganizational practices that improve transparency and traceability of complex supply chains, as well as encourage stakeholder participation in innovating and joint research projects, and engaging them in joint biodiversity protection, restoration, or regeneration projects (see also Pagell and Wu, 2009; Quarshie et al., 2016).

Although the analysis in this paper focused on identifying the biodiversity management practices, it also identified performance outcomes relating to biodiversity. The model depicts conceptually important causal relationships between biodiversity management practices, targets and (aspired or actual) biodiversity performance outcomes. The immediate and intermediate targets of firms can contribute to the aspired performance outcomes (namely, reduction and elimination of harms and restoration and regeneration of biodiversity) and ultimately influence the state of biodiversity (in specific localities). Where truly effective, such outcomes will lead to a greater diversity of ecosystems, animal and plant species, as well as genetic diversity within species. The study, however, could not confirm particular causal relationships or examine the effectiveness of specific (sets of) practices on particular outcomes. It was also beyond the scope of this study to examine whether the identified practices (e.g., biodiversity protection or restoration projects) were employed by the firms in a sufficiently ambitious or extensive way, or whether the firms would have needed additional practices to reach the aspired outcomes. Yet, specific outcomes have been revealed for some firms; for example, in the case of the apiculture firm, the restoration and return of fish, bird, plant, and insect life in New Zealand has been observed to lead to measurable increases in biodiversity. Although some (positive) localized impacts are already occurring, often results may take a long time to appear, or be subtle or mixed. It is also difficult to discern the impact of individual practices from the impact of other extraneous factors, and to confirm causation between sets of practices and intended outcomes.

Indeed, the firms in this study also had to tackle the question of how to measure their progress towards the immediate and intermediate targets and outcomes. Different indicators were used, depending on the context of operations, and some significant development work on measurement indicators took place as well (also SBTN, 2020). Understandably, the firms were not able to measure the biodiversity performance of the entire supply chain but were mostly focused on a limited number of specific targets and related indicators. Overall, the results show the importance of both intraorganizational and interorganizational activities in biodiversity management and pave the way for further analysis of the performance of the entire supply chains (Carter et al., 2017) when tackling biodiversity loss.

6.2. Contributions to supply chain practice research and theory

This study advances understanding of innovative PSCM practices that aim to address the issue of biodiversity along supply chains. It provides empirical confirmation of previous scholarly work on practice-based views in operations management (Bromiley and Rau, 2016b) and SCM (Carter et al., 2017). Specifically, explicating and disseminating certain practices more widely is expected to contribute to their imitation and transfer across firms (Bromiley and Rau, 2014, 2016b). Our analysis of the defined (Bromiley and Rau, 2014) and specific (Carter et al., 2017) activities, namely biodiversity management practices in supply chains, provides conceptual support to previous studies by identifying and linking general PSCM practices to biodiversity-supportive businesses, and ultimately to performance outcomes. The finding that firms emphasize interorganizational PSCM practices involving various types of supply chain members is interesting given that these require efforts from other organizations as well and are therefore conceptually different from intraorganizational practices (Carter et al., 2017).

According to Carter et al. (2017, p. 120), there is a need to "focus on the imitable practices that help improve the social and/or environmental sustainability level of the large mass of average-performing supply chains rather than identifying the hard-to-imitate resources of the sustainability leaders." This study identifies imitable practices developed and adopted by firms that are known for their biodiversity-related work. Unifying aspects across the sampled firms include incorporating biodiversity (and sustainability) considerations into their business strategies, approaching biodiversity as an integral part of their business operations, and operating in global industries known for adverse environmental impacts on biodiversity (WWF, 2012; Hanski, 2016). Encouragingly, the sample firms favored a medium-to long-term approach toward biodiversity management, which is imperative for tackling the challenge of biodiversity loss. Ensuring that promising supply chain practices developed or adopted by the firms are more visible and thus more imitable by other firms will contribute to greater possibilities for biodiversity-respectful business and (sought after) biodiversity performance outcomes in the long term.

Finally, this study suggests that firms should adopt a broader view of the value of biodiversity to the firm, in the supply chain, and for customers, society, and nature itself (IPBES et al., 2022). While many biodiversity management and sustainability practices, such as reduction

of waste or energy use, are associated with economic savings or gains, other practices may be more difficult to justify, as their (perceived) costs may be larger than their anticipated benefits (Tate et al., 2013). Indeed, one of the respondents acknowledged that: "*What we are doing makes zero commercial sense – I'll just say that – putting it out there, biodiversity is not something you do for any commercial reasons*." Yet, all sampled firms stressed the urgency of tackling biodiversity loss. The views and the adopted practices found through this research may signal emerging attention to and desire to develop (even if in small steps) truly sustainable supply chains and more comprehensive views of the value of nature (Pagell and Shevchenko, 2014; Montabon et al., 2016; IPBES et al., 2022).

7. Conclusions

This study set out to identify practices that firms have proactively adopted or developed to manage biodiversity loss in their own operations and in their supply chains, and to increase awareness of the importance of biodiversity – as opposed to just sustainability – in their markets, industries, and operating countries. Our approach to investigating these practices, that is, what firms actually do (Whittington, 2006; Carter et al., 2017) to combat the biodiversity challenge contributes to understanding of current developments in SSCM and shifts biodiversity management more centrally into the agenda of SSCM researchers. To address a significant omission in previous literature and theory, this study identifies and analyses relevant PSCM practices, as well as examines the biodiversity performance outcomes pursued by the firms. The results reveal novel practices and specific activities and in doing so, demonstrate the multiplicity of active responses possible to address biodiversity reduction. Further, sustainable PSCM practices that enhance biodiversity across the entire supply chain should include both firms' intra- and interorganizational practices. Biodiversity practices extend beyond the firms' boundaries to incorporate supply chain actors, stakeholders, governmental agencies, NGOs etc., across and within different localities and industries.

The main contributions of this study include the conceptualization of biodiversity as a relevant and practicable element of SSCM, and identification of practices and outcomes as summarized in the model of biodiversity management practices in supply chains (Fig. 2). By identifying a broad range of practices, organized into nine themes, our study provides a starting point for understanding firms' strategies and potential outcomes. The model, together with illustrations of the identified constructs (in Table 2a–d) and potential mediators, contribute to our understanding of imitable and transferable practices in biodiversity management.

This study also has its limitations. First, its scope is limited to examination of biodiversity management practices (and performance outcomes) adopted, developed, and aspired to by six firms from Finland and New Zealand. Further research including different types of firms and organizations from various industries, sectors, and countries is needed, as is first-hand understanding of how other actors and stakeholders (e.g., parties in industry, consumers, and policy makers) act on this environmental challenge, and how their involvement might (positively) affect biodiversity in other firms' and organizations' supply chains. Second, the scope of our study did not extend to analysis of actual performance outcomes associated with specific practices. Hence, more detailed investigations of the effectiveness of individual practices and their linkages to specific, measurable targets and biodiversity outcomes is needed. Further, analysis and monitoring of biodiversity performance, biodiversity 'footprints' of firms and their supply chains as a whole, and the imitable and inimitable resources required to adopt biodiversity management practices presents a promising way forward for researchers and managers alike.

8. Managerial and policy implications

The value of the model (and related tables) to managers derives especially from explicit illustration of specific biodiversity management practices. Indeed, by describing altogether 28 practices developed or adopted by the sampled firms across multiple industries, they become more relatable, tangible and consequently, more imitable (Carter et al., 2017). Overall, the specific sets of activities, immediate and intermediate targets, and the sought-after outcomes revealed by this study make them relevant for firms interested in doing their share to halt and reverse biodiversity loss.

Biodiversity management has so far received only limited attention from managers (Whiteman et al., 2013; Quarshie et al., 2021), who face the challenges of linking actions to outcomes that are obscured by temporal, spatial and relational distance, as well as the abstract nature of the concept of biodiversity itself. This study contributes to understanding of how firms can take meaningful action now. It suggests that firms consider both intraorganizational and interorganizational practices involving their various supply chain partners (Montabon et al., 2016). Adopting a biodiversity-supportive vision, strategy, and values can be particularly helpful for ensuring that firms' biodiversity management activities align with their core business, while setting ambitious targets and addressing biodiversity impacts and risks provide a starting point for firms' biodiversity management work overall. As for interorganizational practices with suppliers, enhancing transparency and traceability in supply chains are critical activities for understanding where (along supply chains and globally) firms have significant impacts on biodiversity. Supplier selection, management, and monitoring practices, as well as the supplier relationship management and development practices identified in this study, are especially relevant to advancing biodiversity management among first-tier (and potentially second-tier) suppliers. Many opportunities for seeking biodiversity performance outcomes (e.g., at the sub-tier supplier level) can also be leveraged through stakeholder engagement, collaboration and joint research practices. Biodiversity impacts occurring at production and/or harvesting sites may also be addressed through (intraorganizational) practices related to refining raw materials and products. Moreover, engaging in joint biodiversity protection, restoration, or regeneration projects near the firm's major operations or supply chain locations can help support international commitments to protect and restore ecosystems (e.g., CBD, 2022a). Firms' practices related to disclosure and awareness can be helpful for creating broader action and effects related to biodiversity management.

While measurement and monitoring of the outcomes of biodiversity management practices in different locations along the firms' supply chains is problematic, data provides examples of both sought-after and achieved outcomes (e.g., changes to flora/fauna counts) that extend beyond more generic yardsticks used to assess sustainability. Furthermore, the findings shed light on the immediate and intermediate targets set by the firms (see also SBTN, 2020). While industry differences exist, the findings of this study can be helpful for firms who are in the process of developing such targets.

This study also provides insights to policy makers faced with the daunting task of implementing ambitious international biodiversity goals and targets. Following recent adoption of a new global biodiversity framework (CBD, 2022a), the next crucial task in many countries is to integrate biodiversity more explicitly into national policy and guidance documents, regulations, and self-regulatory frameworks, and to propose steps toward implementation. Large and transnational companies are expected to start assessing and disclosing their biodiversity-related risks as well as dependencies and impacts on biodiversity. The findings of this study suggest government requirements, encouragement and support for ambitious actions that encompass not just the firms' own operations but also their supply chains. Finally, as the issue of biodiversity is clearly

challenging to understand and to address, regulators and policymakers need to actively resource those actions that build greater awareness of, and address firm impacts on biodiversity. To conclude, this study contributes to this awareness and shows how firms can be part of the solution – rather than part of the problem – by developing novel PSCM practices that contribute to reversing biodiversity loss.

Author statement

Asta Salmi: Conceptualization, Methodology, Data collection, Formal Analysis, Validation, Visualization, Writing (Original draft, Review and Editing).

Anne M. Quarshie: Conceptualization, Methodology, Data collection, Formal Analysis, Validation, Visualization, Writing (Original draft, Review and Editing).

Joanna Scott-Kennel: Conceptualization, Methodology, Data collection, Formal Analysis, Validation, Visualization, Writing (Original draft, Review and Editing).

Anni-Kaisa Kähkönen: Visualization, Writing (Original draft, Review and Editing).

Declaration of competing interest

None.

Data availability

The data that has been used is confidential.

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