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Investing in biodiversity: The conundrum faced by institutional investors[1]

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Abstract

69% of the world's plant and animal populations has been lost since 1970, with one of the main reasons being chronic underfunding. There is a huge need to match biodiversity conservation projects to appropriate capital suppliers in order to fill the 'nature finance gap', and institutional investors have the potential to do so. This paper aims to explore how feasible the biodiversity conservation market is for institutional investors. To answer this question, various biodiversity impact funds are compared to non-biodiversity impact funds, in terms of funding stage and size. To measure this, a one-way ANOVA test is conducted and shows that biodiversity funds do not significantly differ from non-biodiversity funds. In addition, a text analysis finds that the level of biodiversity conservation awareness is lacking among biodiversity fund managers. This means that additional measures, such as further research and increased educational initiatives, are necessary before institutional capital can be unlocked for biodiversity conservation.

Keywords: Biodiversity; Conservation Finance; Institutional Investors; Impact Investing; One-way ANOVA; Text Mining

JEL classification: G11; G23; Q57

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1 Introduction

According to the World Widelife Fund's (WWF) living planet report, there has been an average loss of 69% of the world's plant and animal populations since 1970 (Almond, Grooten, Juffe Bignoli & Petersen, 2022). The chronic underfunding of biodiversity conservation is one of the main reasons for this loss (Barbier, Burgess & Dean, 2018). Public and private philanthropic capital is primarily used to finance biodiversity conservation (Flammer, Giroux & Heal, 2023). This capital, however, has not been sufficient to significantly reduce the loss of biodiversity (Parker, Cranford, Oakes & Leggett, 2012; Huwyler, Käppeli & Tobin, 2016). There is thus a huge need to match nature conservation projects to appropriate capital suppliers and fill the so-called 'nature finance gap'. Institutional investors, such as pension funds which have a lot of capital to allocate, have the potential to make a large positive impact on biodiversity conservation.

The Convention on Biological Diversity (CBD) defines biodiversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems" (CBD, n.d. a). The Dutch pension fund Pensioenfonds Zorg en Welzijn (PFZW) wants to actively act against the ongoing loss of biodiversity through engagement with investee companies (PFZW, 2022; Menguzzo & Tupker, 2023). Their asset manager PGGM invests about €228 billion on behalf of PFZW. This amount, which is equivalent to 22% of the Dutch GDP (Centraal Bureau voor de Statistiek, 2024), holds significant potential for impact. However, PGGM states that it still faces difficulties when trying to integrate biodiversity into their investment strategy (Menguzzo, 2022). Unlike climate change mitigation, addressing biodiversity loss is much more challenging and requires numerous goals and metrics.

Healthy, productive ecosystems are necessary for the survival and wellbeing of humans and other species (Cosma, Rimo & Cosma, 2023). These ecosystems provide services and products which are essential to humanity, such as food, fibre, water regulation and purification, climate stabilisation, storm protection, recreation, and cultural or spiritual services (Meyers et al., 2020). Over the years, inadequate funding has been allocated to ensure the continued existence of these ecosystems, which has contributed to the loss of global biodiversity (Almond et al., 2022). According to Phenix Capital Group, an investment consultant focused on impact investing (Phenix Capital Group, n.d.), biodiversity is connected to almost every SDG (Phenix Capital Group, 2024). Therefore, it is crucial to understand how capital can be used to conserve biodiversity, so that institutional investors can address the deficiencies in the currently available funding (Cosma et al., 2023).

The Conservation Finance Alliance (CFA) defines conservation finance as "mechanisms and strategies that generate, manage, and deploy financial resources and align incentives to achieve nature conservation outcomes" (Meyers et al., 2020, p. 10). The history of conservation finance started already in the late 1970s (McFarland, 2018). Although the market for conservation finance is not new, institutional investors do not seem to be very active in this market yet. Research suggests that institutional investors do not invest in conservation projects because it is costly to search for funds with an attractive risk-return relationship (Huwyler et al., 2016). Institutional investors, such as pension funds, are financial-first investors who need to earn a sufficient return (Huppé & Silva, 2013). This can be done through impact investing. The goal to generate financial returns is what differentiates impact investments from grant funding and philanthropy (Höchstädter & Scheck, 2015). In recent years, biodiversity conservation has become increasingly important in impact investing. However, this thematic area is still considered to be very unknown by investors.

According to Thompson (2023), ambiguity exists in the literature regarding the viability of conservation investments. Some remain optimistic that conservation finance is able to deliver the predicted impact and financial returns (Cooper & Trémolet, 2019; Fitzgerald et al., 2020). However, there is also evidence that conservation investments fail to do so (Kish & Fairbairn, 2018; Mallin et al., 2019). If early conservation projects do not generate the forecasted returns, investors may withdraw their support. Moreover, investors might start to prioritise financial returns over making impact (Kish & Fairbairn, 2018). Therefore, a positive track record needs to be established in order for conservation finance to receive long-term support (Thompson, 2023).

The extant literature mainly outlines the current conservation finance market and the financial instruments used within this market (Meyers et al., 2020). The challenges that institutional investors face have to do with the lack of an established track record and the small sizes of biodiversity projects. In order to grow the conservation finance market to an institutional scale, projects have to be incubated, scaled, and mainstreamed (Huwyler et al., 2016). Additionally, blended finance could play an important role in making investing in nature conservation more attractive (Flammer et al., 2023). Impact-first investors, such as governments or philanthropists, should provide capital in the early-stages of a project due to it being high-risk and low-yield but having large impact (Huppé & Silva, 2013). Then, financial-first investors can invest at a larger scale when the project has been proven. Such an innovative fund structure could be key to unlocking large-scale investments within nature conservation. However, combining the different capital sources are a large challenge through specialised intermediaries is very costly.

There is a huge gap in the literature which is due to the fact that little research has been done on the topic of biodiversity finance (Karolyi & Tobin-de la Puente, 2023; Starks, 2023). Although some reports are consistent in their findings about the challenges that investors face

when investing in biodiversity conservation (Huwyler et al., 2016; Huppé & Silva, 2013), no papers directly measure the difference in biodiversity funds compared to other impact funds. It is crucial to do so, because while there appears to be a difference between biodiversity and non-biodiversity funds in theory, this difference has never been measured. In addition, no research has been conducted on the level of biodiversity conservation awareness among fund managers. Biodiversity conservation awareness is defined as how people understand the value of biodiversity and to what extent they know how to conserve it (Navarro-Perez & Tidball, 2012). Research has only been conducted on the level of biodiversity conservation awareness among the general public (Turner-Erfort, 1997; European Environment Agency, 2021), but not among fund managers. It is important to understand how much fund managers know about biodiversity conservation, because this influences the feasibility of the investment area. Therefore, this paper will bridge the gap in the research by examining the characteristics of biodiversity impact funds and fund managers and comparing these to other impact areas. Ultimately, the following research question will be answered:

TO WHAT EXTENT IS BIODIVERSITY CONSERVATION A FEASIBLE INVESTMENT AREA FOR INSTITUTIONAL INVESTORS?

This study will make a scientific contribution by filling the previously mentioned knowledge gap. By measuring the differences between biodiversity and non-biodiversity impact funds, this paper provides evidence on the factors that the literature assumes to hold back investors from investing in biodiversity. This study will also contribute to the literature by being the first to measure the level of biodiversity conservation awareness among fund managers. Furthermore, this research will direct the attention of finance and economics academics towards nature conservation, a topic that is currently mostly studied by environmental experts (Cosma et al., 2023).

In addition to its contribution to the literature, this paper will make a societal contribution. The results of this study will describe the current state of the biodiversity impact investment market and shed light on the challenges that institutional investors face. By identifying where the barriers lie, we can start to bridge the gap between nature conservation projects that demand capital and institutional investors who can provide it (Huwyler et al., 2016). Bridging this nature finance gap would help slow down biodiversity loss, which is crucial for life on earth as well as for the global economy, seeing that almost every sector and business is dependent on nature (KPMG, 2023).

According to a report by KPMG (2023), conserving nature could even generate $10 trillion a year through new businesses, resource efficiency, and cost reductions. These opportunities could in turn create over 400 million jobs around the world by 2030 (KPMG, 2023). Various studies state that financial institutions are also heavily reliant on biodiversity. For instance, a study by the Dutch Central Bank shows that 36% of the examined portfolio of Dutch financial institutions is highly dependent on nature (van Toor, Piljic, Schellekens, van Oorschot & Kok, 2020). However, it does have to be acknowledged that the constraints within conservation finance go further than a lack of funding as the effectiveness and impact of spending are limited by structural and political factors (Meyers et al., 2020).

To be able to answer the research question, a one-way ANOVA test is performed to determine whether the funding stage and fund size differs between biodiversity and non-biodiversity impact funds. In addition, a text analysis is performed on the fund descriptions to establish the level biodiversity conservation awareness among fund managers. Surprisingly, the one-way ANOVA shows that, on average, biodiversity funds are larger and in later funding stages than non-biodiversity funds. These findings, however, are insignificant which implies that there is no difference between biodiversity and non-biodiversity funds. This indicates that the funding stage and fund size are not barriers to the conservation finance market and should

not withhold institutional investors from investing. However, the text analysis shows that biodiversity fund managers do not use biodiversity keywords in their fund descriptions and thus do not have a high level of biodiversity conservation awareness. Due to the lack of common words in fund descriptions, investors might face trouble when searching for suitable biodiversity projects to invest in.

The remainder of this research paper will be structured as follows. Section 2 will contain an in-depth literature review about institutional investors and impact investing in biodiversity, as well as the challenges they face in doing so. Furthermore, the level of biodiversity conservation awareness will be examined. Section 3 will build on the literature review and use empirical results from prior studies to develop three hypotheses. Section 4 will explain the methods of data collection, namely the use of an existing impact fund database, and will describe the sample. The methods of data analysis, one-way ANOVA tests and a text analysis, will also be discussed in section 4. The results of this study will be discussed and interpreted in section 5. Lastly, the discussion, suggestions for future research, limitations, practical implications, and final conclusion will be discussed in section 6.

2 Literature review

2.1 Institutional impact investing

Institutional investors, such as pension funds, are 'financial-first' investors who have a fiduciary duty to their clients and beneficiaries (Huppé & Silva, 2013). A fiduciary relationship entails that the investor is in charge of investing the assets of a third-party beneficiary (Johnson, 2014). These beneficiaries are protected of being taken advantage of through certain legal principles. Therefore, institutional investors must manage assets in a way that serves the best interests of their beneficiaries. One of the principles of the fiduciary duty entails that institutional investors must be impartial between generations. Seeing that environmental changes, such as the loss of biodiversity, can lead to different risks and costs between generations, institutional investors have to account for them in their investment approaches (Johnson, 2014).

The institutional logic of investment consists of: (1) staying within the boundaries of fiduciary responsibility; (2) the investment size; (3) the investment manager's track record, and (4) the regulatory framework (Hummels & Fracassi, 2016). For institutional investors to perform their fiduciary duty, they need to receive a sufficient return on investment as well as manage social and environmental risks because beneficiaries' best interests can encompass more than just financial outcomes (Jansson, Sandberg, Biel & Gärling, 2014). This can be achieved through impact investing, which has three main criteria. Firstly, there needs to be the intention to create positive impact. Secondly, the output and outcomes have to be measurable. Lastly, the investment needs to generate financial returns. Impact investments thus aim not only for financial returns but also for social and environmental impact (Höchstädter & Scheck, 2015).

A large part of impact investments flows toward social development and environmental projects, such as poverty reduction and renewable energy, respectively (Thompson, 2023). In recent years, however, biodiversity has received more attention in impact investing strategies. Robeco, a Dutch global asset manager, aims to combat biodiversity loss through RobecoSAM Biodiversity Equities, a biodiversity impact fund (Robeco, 2022). The fund invests in companies that contribute to biodiversity conservation, reforestation, and eco-friendly building and manufacturing. Robeco highlights a few investment opportunities such as sustainable land use, freshwater networks, marine systems, and traceable products. However, while some institutional investors such as Robeco are expanding their investments in biodiversity conservation, many still face challenges in doing so (Hummels & Fracassi, 2016; Huwyler et al., 2016).

2.2 The current impact investing market

The European Venture Philanthropy Association (EVPA) published a report about the European impact investing market (Gaggiotti, Gianoncelli & De Felice, 2022). This report studies 285 organisations active in the impact investing market and finds that the largest share (36%) is represented by venture capital (VC) and private equity (PE) impact funds. Gompers and Lerner (2001, p. 146) define VC funds as "independent, professionally managed, dedicated pools of capital that focus on equity or equity-linked investments in privately held, high growth companies". Social impact venture capitalists (SIVCs) differ from traditional VCs due to their aim to create positive impact alongside targeting market-rate returns (Croce, Ughetto, Scellato & Fontana, 2021). While VCs seek high returns, it is often hard to identify nature conservation firms that satisfy these return requirements (Meyers et al., 2020). PE firms provide capital or support buyouts of private entities. They seek to generate returns over a predetermined lifetime.

The EVPA report finds that impact capital mainly flows toward climate action and innovation (Gaggiotti et al., 2022). In 2022, 46% of impact capital targeted climate action (SDG

13), 55% targeted reduced inequalities (SDG 10), and 62% targeted decent work and economic growth (SDG 8). Impact capital can target multiple SDGs at the same time, but only a small fraction was used to target biodiversity-related SDGs; 11% targeted life below water (SDG 14) and 12% targeted life on land (SDG 15). The European impact investment market, sized at approximately €80 billion, corresponds to a mere 0.5% of the mainstream European investment market (Gaggiotti et al., 2022). If only 11% and 12% of this capital targets SDG 14 and 15, respectively, the share of capital that is directed towards biodiversity-related SDGs is extremely small.

Impact funds exist mostly out of VC and growth equity funds, which are structured as traditional PE funds but with the intentionality of generating impact (Barber, Morse & Yasuda, 2021). Impact enterprises are often in the early stages of development and apply innovative business models to increase profitability and create social or environmental impact. These enterprises are in need of some sort of 'patient' capital which allows them to scale and prove their viability over a longer period of time (Huppé & Silva, 2013). Private and venture capital are sources of patient capital, due to their typical lifetime of 10 years (Barber et al., 2021). VC provides financing to early-stage companies which typically lack financial and market data (Ruhnka & Young, 1991). This creates a problem for institutional investors, because their policies call for funds with an established track record (CFA, 2014). Furthermore, impact investments typically have a small deal size, which might make them unattractive due to the relatively high transaction costs (Brest & Born, 2013). Both characteristics go against the institutional logic of investment mentioned in section 2.1.

2.3 Challenges within the conservation finance market

When it comes to impact investing, finding suitable investment opportunities is the largest problem that institutional investors face (Hummels & Fracassi, 2016). Hummels and Fracassi (2016) suggest that institutional investors are challenged due to the investments being too small

or not having the right risk-return-impact profile. This view is shared by Huwyler et al. (2016), who give an overview of challenges within the conservation finance market. On the project side, there are five barriers to the growth of the conservation finance market. First, there are high costs involved in searching for conservation projects with good risk-return profiles due to an unstandardised process for tracking and evaluating. Huppé and Silva (2013) argue that, in general, there is a shortage of impact investments that meet investors' required rate of return. Second, there is a lack of developers who have a track record of cash-generating projects (Huwyler et al., 2016). Third, while collateral is able to significantly reduce financing costs, project developers often do not know what to use as collateral. Fourth, many projects are of small scale and thus have high transaction costs. Lastly, there is a lack of standardised frameworks for monitoring the impact of conservation projects (Huwyler et al., 2016).

There are three other challenges to the growth of conservation finance on the investor side (Huwyler et al., 2016). First, conservation projects have unpredictable underlying cash flow sources due to their small sizes. Second, product developers and investors typically do not know how to assess and balance risk, return, and impact. Third, as many projects are too small to be stand-alone investments, they need to be aggregated. However, the creation of a single investment project out of multiple stand-alone investments is challenging because of the diverse set of cash flows (Huwyler et al., 2016).

There are thus numerous barriers within the conservation finance market. Institutional investors may hesitate to invest in biodiversity because while their policies call for investments in funds with proven track records, these are limited. Moreover, the small deal sizes of biodiversity investments can be unattractive due to high transaction costs and unpredictable cash flows. Institutional investors, who want to invest large sums of money, would need to aggregate these small projects into a single investment, which poses significant difficulties.

Next to these challenges, it is important to know how much knowledge fund managers have about biodiversity conservation because this can influence the feasibility of the investment area.

2.4 Biodiversity conservation awareness

Research states that the lack of biodiversity conservation awareness is one of main causes of biodiversity loss (Navarro-Perez & Tidball, 2012; Ibrahim et al., 2023). Several surveys have been conducted to measure the level of biodiversity conservation awareness among the general public (Navarro-Perez & Tidball, 2012). A survey conducted in the Chicago area asked respondents about their familiarity with the term 'biodiversity' (Turner-Erfort, 1997). According to the results, definitions of the concept 'biodiversity' varied widely and few responses contained common, accepted elements of the definition of biodiversity. The results of this survey thus confirm low levels of biodiversity conservation awareness and suggest the failure of biodiversity education among the general public (Navarro-Perez & Tidball, 2012). Fiebelkorn and Menzel (2013) state that the level of biodiversity conservation awareness is dependent on cultural and geographical differences.

Despite the low level of public awareness, biodiversity conservation has become more important in national and international agendas in recent years, leading to agreements such as the CBD which has been approved by 196 countries (Navarro-Perez & Tidball, 2012; United Nations, n.d.). The CBD states that education is crucial to create biodiversity conservation awareness (Navarro-Perez & Tidball, 2012). Other organisations such as the Global Impact Investing Network (GIIN) have also recognised biodiversity as an important investment theme. The GIIN supports activities, education, and research in order to grow the impact investing market and added biodiversity to its Navigating Impact Project, in which experts do research and publish their findings (GIIN, n.d.). The CFA also helps educate finance professionals and practitioners on how they can use finance as a tool to conserve biodiversity (CFA, n.d.). The increase in conservation finance education for finance professionals and practitioners points to

a higher level of biodiversity conservation awareness among fund managers than among the general public. However, it is also important to know how deep this knowledge among fund managers goes.

2.5 Impact due diligence

According to Brest and Born (2013), impact fund managers have special expertise and knowledge in their own social or environmental niche markets. The general partner (GP) of a fund is expected to be familiar with his/her own field of investment (CFA, 2014). The GP typically also has an investment committee, of which the members have deep-rooted knowledge of the fund's target market. Moreover, fund managers often conduct due diligence (DD), which is defined as the rigorous assessment of a company's characteristics (Cumming & Zambelli, 2017). DD is especially important when it comes to PE financing, because the fund managers actively manage their portfolio companies.

In the context of impact investing, impact evaluation or impact due diligence (IDD) is the analysis, monitoring, and managing of intended and unintended consequences of a firm's activities (Eckerle & Terzedis, 2024). Through conducting IDD, fund managers can carefully screen portfolio companies and select those that have a positive effect on biodiversity. This helps fund managers increase their knowledge about which portfolio companies make a positive impact on biodiversity conservation through their activities.

3 Theoretical framework

3.1 Lack of an established track record

For-profit investors state that they are more motivated by making impact in nature conservation than by generating returns (Hamrick, 2016). However, when it comes to actually selecting projects to invest in, they seem to be more interested in meeting financial return targets than in making impact in nature conservation. For institutional investors to select cash-generating nature conservation investments, these need to have a sufficient track record. Such a track record would enable investors to select investments which are likely to generate returns (Huppé & Silva, 2013). Without an established track record, investors would have to make early-stage businesses 'investment ready' themselves. This is very risky, costly, and not likely to generate high returns in the short and medium run (Huppé & Silva, 2013). According to Chaplinsky and Gupta-Mukherjee (2016), investments in early-stage companies are usually the riskiest type of investments due to their lack of an extensive track record of performance. This leads to a higher failure rate than more mature companies have.

Respondents of the 2013 survey by J.P. Morgan and the GIIN state "the shortage of high quality investment opportunities with track record" to be one of the main challenges in the impact investing market (Saltuk, 2013, p. 9). Since then, however, impact investors have broadly recognised the progress in the impact investing market. According to the 2020 GIIN annual impact investor survey, 69% of the respondents state that there has been 'some progress' in the development of high-quality investment opportunities with a track record (Hand, Dithrich, Sunderji & Nova, 2020). 24% even state that there is 'significant progress' in this area. Thus, the general impact investing market is now characterised by more investment opportunities with an established track record. However, according to the European Investment Bank (2023), when looking specifically in the area of biodiversity and nature conservation,

track records are still scarce. Therefore, this seems to be one of the most predominant challenges within the biodiversity conservation market, even though the general impact investing market has progressed. As early-stage companies typically lack a track record (Chaplinsky & Gupta-Mukherjee, 2016), the following hypothesis is formulated:

HYPOTHESIS 1: BIODIVERSITY IMPACT FUNDS ARE IN EARLIER STAGES THAN NON-BIODIVERSITY IMPACT FUNDS

3.2 Deal size of investment opportunities

According to Huwyler et al. (2016), nature conservation projects are small-sized, on average. These projects are too small to be standalone investments and are thus less attractive for large institutional investors. This leads to high transaction costs because there are more transactions needed to reach a larger scale (Huwyler et al., 2016). Thus, the small-sized investment opportunities form another challenge for institutional investors to invest in the nature conservation market.

The Coalition for Private Investment in Conservation (CPIC) studied the investment instruments and deal sizes of nature conservation investments (Baralon et al., 2021). This research finds that conservation investments are mostly financed using private debt, real assets, and PE. Furthermore, they find that 70% of conservation investments have a deal size smaller than $1 million (Baralon et al., 2021). When looking at impact investments in all impact areas including healthcare and energy from the 2020 GIIN annual impact investor survey, it is notable that the deal sizes differ from that of conservation investments (Hand et al., 2020). The average deal size is $5 million, across all asset classes. For private debt, the average deal size is $3 million, while for real assets, the average deal size is $28 million. This shows that investments in the nature conservation market are smaller than those in other impact areas. Thus, the following hypothesis is formulated:

HYPOTHESIS 2: BIODIVERSITY IMPACT FUNDS ARE SMALLER THAN NON-BIODIVERSITY IMPACT FUNDS

3.3 Fund managers' biodiversity conservation awareness

According to prior research, the lack of biodiversity conservation awareness is one of the main causes of the loss of biodiversity (Navarro-Perez & Tidball, 2012; Ibrahim et al., 2023). A few studies have been conducted on how much knowledge people have about biodiversity and its conservation. These surveys find that the level of biodiversity awareness is low among the general public as they are unable to give correct definitions of the term 'biodiversity' (Turner-Erfort, 1997).

Although the general public's level of biodiversity conservation awareness is low, it is expected that biodiversity fund managers have a high level of biodiversity awareness. Organisations such as the CFA have become increasingly important in recent years. Such initiatives help increase the level of biodiversity conservation awareness among finance professionals and practitioners through the sharing of knowledge on their platform (CFA, n.d.). The CFA, for example, offers a resource library and hosts webinars which cover conservation finance topics. Thus, it is expected that finance professionals and practitioners, amongst which fund managers, have a higher level of biodiversity conservation awareness than the general public. Additionally, impact fund managers have deep-rooted knowledge in the social or environmental markets that they are active in (Brest & Born, 2013). They typically also have a GP who is an expert in the field, along with an investment committee, of which the members have expertise as well.

Cumming and Zambelli (2017) state that DD is particularly important in PE financing. As biodiversity impact funds are often funded through PE and VC (Barber et al., 2021; Gaggiotti et al., 2022), it is expected that the fund managers conduct (I)DD on their portfolio companies. Through conducting IDD, fund managers screen portfolio companies and gain knowledge about

the intended and unintended consequences of their activities. Assuming that fund managers conduct IDD on their portfolio companies, they have increased knowledge about which projects and activities make a positive impact on biodiversity conservation. Therefore, biodiversity fund managers understand the value of biodiversity and how to conserve it, and the following hypothesis is formulated:

HYPOTHESIS 3: BIODIVERSITY IMPACT FUND MANAGERS HAVE A HIGH LEVEL OF BIODIVERSITY CONSERVATION AWARENESS

4 Empirical strategy

4.1 Data collection and description

To be able to test the previously formulated hypotheses, a database of various impact funds is needed to compare biodiversity funds to non-biodiversity funds. The list of impact funds is retrieved from ImpactAssets, following Barber et. al. (2021). Despite the database existing out of merely 155 impact funds, this choice is necessitated by the limited availability of other comprehensive databases that cover impact funds. ImpactAssets is a non-profit financial services company (CFA, 2014). The IA 50 database is a list of impact fund managers that is annually compiled by the Review Committee consisting of impact investment leaders (ImpactAssets, n.d.). The Review Committee selects fund managers according to a set of baseline criteria which include experience, scale, commitment to impact, and representation of approaches, asset classes, and impact areas. Few exceptions are made for those with unique strategies or underrepresented impact themes (ImpactAssets, n.d.). While the IA 50 may not be representative of the investable universe of impact funds, the funds are the most suitable for institutional investors due to the baseline criteria. The following information is collected from the IA 50 2024 database: (1) fund name; (2) total assets under management (AUM); (3) funding stage; (4) impact theme, and (5) fund description.

To know which impact funds can be classified as biodiversity funds, it is necessary to understand the different impact themes. In this study, an impact fund is classified as a biodiversity fund when at least one of its impact themes is ‘natural resources and conservation’ or ‘sustainable agriculture’ (*see appendix; table A1*). ‘Sustainable agriculture’ is classified as a biodiversity impact theme along with ‘natural resources and conservation’, after a discussion with expert Bernarda Coello. Biodiversity and agriculture are highly interrelated (CBD, n.d. b). According to the Food and Agriculture Organization (2018), agriculture is one of the largest

users of biodiversity. Transforming agriculture thus has the potential to reduce biodiversity loss and possibly even reverse it (FAO, 2018; Bruil, van den Berg, Doornbos & Oerlemans, 2021).

The database gives a total of 155 impact funds. Table 1 shows the share of impact funds with each of the following impact themes: (1) natural resources and conservation and (2) sustainable agriculture. The largest fraction of biodiversity funds exists out of funds that have sustainable agriculture as an impact theme.

TABLE 1. BIODIVERSITY FUNDS WITHIN SAMPLE

Impact theme	Number of observations	Fraction of sample (*N=155*)
Natural resources and conservation	27	17.42%
Sustainable agriculture	38	24.52%
Biodiversity	54	34.84%

4.2 Operationalisation of variables

Hypothesis 1 states that biodiversity impact funds are in earlier stages than other impact funds. To be able to test this, the dependent variable *Funding stage* is chosen. The independent variable is the dummy variable *Fund type* given a value of '1' when classified as a biodiversity fund and '0' otherwise. Within the database, there are five funding stages: (1) early (pre-seed, accelerator, angel); (2) growth; (3) late (series A/B); (4) multi-stage, and (5) unknown. If biodiversity funds are in earlier stages than other impact funds, it is expected that if the independent dummy variable is '1', the likelihood of the *Funding stage* being 'early' is higher.

Hypothesis 2 states that biodiversity funds are smaller than non-biodiversity funds. The dependent variable *Fund size* is used to test this. Again, the independent variable is the dummy variable *Fund type* given a value of '1' when classified as a biodiversity fund and '0' otherwise. Within the database, the AUM is divided into six categories: (1) <$25M; (2) $25-49M; (3) $50-99M; (4) $100-499M; (5) $500-999M, and (6) >$1B. The *Fund size* is classified as 'small' if the AUM are <$49M, 'medium' if the AUM are $50-499M, and 'large' if the AUM are >$500M.

If biodiversity funds are smaller than non-biodiversity funds, it is expected that if the independent dummy variable is '1', the likelihood of the *Fund size* being 'small' is higher.

Hypothesis 3 states that biodiversity fund managers have a high level of biodiversity conservation awareness. To be able to test this, the dependent variable *Fund description* is chosen. A *Fund description* is a short overview about the impact fund and its impact themes. The independent variable is again the dummy variable *Fund type* given a value of '1' when classified as a biodiversity fund and '0' otherwise. It is expected that if the independent variable is '1', words related to biodiversity will be used frequently in the *Fund description*. If the independent variable is '0', it is expected that words related to biodiversity will not be used.

Cooper et al. (2019) examines the frequencies of biodiversity keywords used across 31 different languages on social media, in online newspapers, and in internet searches. The keywords are based on the United Nations Environmental Program World Conservation Monitoring Center's (UNEP-WCMC) biodiversity glossary. Cooper et al. (2019) excludes uncommon terms as well as words with ambiguous homonyms. The following keywords are left: 'biodiversity', 'biosphere', 'deforestation', 'desertification', 'ecology', 'endangered species', 'endemic species', 'extinction', 'genetic diversity', 'habitat destruction', 'habitat fragmentation', 'invasive species', 'keystone species', 'natural capital', 'ocean acidification', 'species diversity', 'subspecies', 'sustainability', 'wildlife trade', 'climate change', 'protected area', and 'ecosystem service'. These biodiversity keywords are expected to be used frequently by biodiversity funds, not by non-biodiversity funds.

4.3 Descriptive statistics

The total sample exists out of 155 observations. In 66 cases, the *Funding stage is* unknown. These missing values are dropped for hypothesis 1, which leaves 89 observations. Table 2 shows the percentual distribution of the *Funding stage* within biodiversity funds (1) and non-biodiversity funds (0). 54.55% of all biodiversity funds are early-stage, 6.06% are in the growth

stage, 27.27% are in the late stage, and 12.12% are multi-stage. 50% of all non-biodiversity funds are in early-stage, 25% are in the growth stage, 16.07% are in the late stage, and 8.93% are multi-stage. Thus, most of the biodiversity and non-biodiversity funds are in the early stage.

TABLE 2: DISTRIBUTION OF FUNDING STAGES WITHIN SAMPLE

Funding stage	Number of biodiversity funds (1)	Fraction of sample (*N=33*)	Number non-biodiversity funds (0)	Fraction of sample (*N=56*)
Early	18	54.55%	28	50%
Growth	2	6.06%	14	25%
Late	9	27.27%	9	16.07%
Multi	4	12.12%	5	8.93%
Total	33	100%	56	100%

For hypothesis 2, the total sample size is 155, with 54 biodiversity funds and 101 non-biodiversity funds. Table 3 shows the percentual distribution of the *Fund size* within biodiversity funds (1) and non-biodiversity funds (0). Of all biodiversity funds, 33.33% is small, 48.15% is medium, and 18.52% is large. Of all non-biodiversity funds, 36.63% is small, 43.56% is medium, and 19.80% is large. Thus, most of the biodiversity and non-biodiversity funds are medium-sized.

TABLE 3: DISTRIBUTION OF FUND SIZE WITHIN SAMPLE

Fund size	Number of observations	Number of biodiversity funds (1)	Fraction of sample (*N=54*)	Number of non-biodiversity funds (0)	Fraction of sample (*N=101*)
Small	55	18	33.33%	37	36.63%
Medium	70	26	48.15%	44	43.56%
Large	30	10	18.52%	20	19.80%
Total	155	54	100%	101	100%

Table A2 of the appendix shows the frequency with which the previously mentioned biodiversity keywords are used in the *Fund description* of biodiversity and non-biodiversity

funds. ‘Biodiversity’ is mentioned six times by biodiversity funds. ‘Natural capital’ is mentioned once by a biodiversity fund. ‘Sustainability’ is mentioned nine times by biodiversity funds and seven times by non-biodiversity funds. ‘Climate change’ is mentioned nine times by biodiversity funds and six times by non-biodiversity funds. The remaining keywords are not mentioned.

4.4 Data analysis

4.4.1 Hypothesis 1: One-way ANOVA

To test the first hypothesis, a one-way analysis of variance (ANOVA) is used. As mentioned in section 4.2, the independent variable is *Fund type* and the dependent variable is *Funding stage*. Thus, there is only one dependent variable for hypothesis 1. This research aims to compare the means of the dependent variable, *Funding stage*, for two mutually independent groups. The first group exists out of 33 funds, while the second group exists out of 56 funds (*see table 2*). A one-way ANOVA compares the means of one dependent variable for two or more groups and tests whether there is a significant difference (Ross, Ross & Willson, 2017). This statistical test requires a sample size of at least 30 observations. The data used in this analysis meets this requirement, as the two groups both have more than 30 funds each. Furthermore, the two groups are of unequal size, which a one-way ANOVA allows for.

The dependent variable *Funding stage* is categorised as follows: early = 1, growth = 2, late = 3, and multi = 4. The null hypothesis states that there is no significant difference between the means of *Funding stage* of the two groups. It is expected that the mean of biodiversity funds is significantly smaller than that of non-biodiversity funds.

4.4.2 Hypothesis 2: One-way ANOVA

As mentioned in section 4.2, the independent variable is *Fund type* and the dependent variable is *Fund size*. Again, there is only one dependent variable for hypothesis 2. This research

aims to compare the means of the dependent variable, *Fund size*, for two mutually independent groups. The first group exists out of 54 funds, while the second group exists out of 101 funds (*see table 3*). A one-way ANOVA is used to test this hypothesis, as the data meets the same requirements mentioned in section 4.4.1.

The dependent variable *Fund size* is categorised as follows: small = 1, medium = 2, and large = 3. The null hypothesis states that there is no significant difference between the means of *Fund size* of the two groups. It is expected that the mean of biodiversity funds is significantly smaller than that of non-biodiversity funds.

4.4.3 Hypothesis 3: Text mining & Chi-square test

Text mining, which is the process of extracting information from unstructured text, is used to test hypothesis 3 (Hotho, Nürnberger & Paaß, 2005). The *Fund descriptions*, existing out of 17,909 words, are obtained from the IA 50 2024 database. This study follows the methodology explained in Lantz' (2013) book about machine learning with R. The *Fund descriptions* of biodiversity funds are labelled as '1', while that of non-biodiversity funds are labelled as '0'. The text data is then transformed into a 'bag-of-words' creating a variable that indicates whether the word appears while disregarding the order their appearance. The text mining package in R is used to clean the data by removing punctuation, numbers, and stop words. Through tokenisation, the text data is split into individual components, with each word becoming a single token. A sparse matrix is created in which the rows of the matrix indicate the *Fund description* of the different impact funds, while the columns indicate the words. The cells in the matrix show the frequency with which each word indicated in the column appears in the *Fund description* indicated by the row.

Thereafter, a naïve Bayes model is used for text classification. The naïve Bayes model is trained on part of the data (training data), which enables it to predict whether a text is from a biodiversity or non-biodiversity fund on the remaining data (testing data; Lantz, 2013). If there

is a high level of biodiversity conservation awareness among fund managers, biodiversity keywords will be used frequently. Consequently, if these keywords are used often, the model would be able to better predict whether a text is from a biodiversity fund or not due to the recognition of biodiversity keywords. The word counts from the sparse matrix are converted into factors that indicate whether the word appears or not. So, if the word count is greater than zero, it is replaced with the value '1' and if the word count is equal to zero, the value remains '0'. Following Lantz (2013), the sample is randomly split into two parts. 100 *Fund descriptions* are used to train the model, while the model makes predictions on the remaining 55 *Fund descriptions*. Thus, two sparse matrices are left: one for training and one for predicting. After the model has trained and predicts the classification of the 55 *Fund descriptions*, a table is created which compares the number of correctly predicted *Fund descriptions* to the true number of *Fund descriptions* in each *Fund type*.

To test the predictive power of the model, a Chi-square test is performed. This test compares the expected and observed counts of the model's classifications of the *Fund descriptions*. The expected frequency represents the counts anticipated if the model correctly classifies the *Fund descriptions*, while the observed frequency represents the counts based on the model's actual predictions. The formula for the Chi-square statistic is shown in equation 1, where O is the observed count in each cell and E the expected count in each cell (McHugh, 2013).

(1) $$\sum \chi^2_{i-j} = \frac{(O-E)^2}{E}$$

The expected frequency is 1 in the following cases: biodiversity funds (1) classified as non-biodiversity funds (0) and non-biodiversity funds (0) classified as biodiversity funds (1). These expected frequencies are 1 instead of 0, because it is expected that there is some kind of machine learning error in which the model cannot perfectly predict every *Fund description*. The calculated Chi-square statistic can then be used to find the p-value. The null hypothesis states that there is no significant difference between the expected and observed frequencies of

correctly and incorrectly classified *Fund descriptions*. This would imply that the model has (near) perfect predictive power, due to the recognition of common biodiversity keywords in the *Fund descriptions*. This, in turn, would point toward a high level of biodiversity conservation awareness among biodiversity fund managers.

5 Results and interpretation

5.1 H1: Funding stage

Table 4 shows the distribution of funding stages of biodiversity funds and non-biodiversity funds. There are 33 biodiversity funds of which 18 are in the early stage, 2 are in the growth stage, 9 are in the late stage, and 4 are multistage. There are 56 non-biodiversity funds of which 28 are in the early stage, 14 are in the growth stage, 9 are in the late stage, and 5 are multistage.

TABLE 4: FUNDING STAGE DISTRIBUTION

Funding stage	Biodiversity (1)	Non-biodiversity (0)
Early (1)	18	28
Growth (2)	2	14
Late (3)	9	9
Multi (4)	4	5
Total	33	56

As can be seen in table 5, the mean of biodiversity funds is equal to 1.969697 while the mean of non-biodiversity funds is lower and equal to 1.8392857. This means that, on average, non-biodiversity funds tend to be closer to the early stage than biodiversity funds. This is not in line with the expectation that biodiversity funds are in earlier stages than non-biodiversity funds. Therefore, the funding stage should not be a reason for investors not to invest in biodiversity funds. However, as the p-value of 0.5780 is above the significance level of 0.05, the null hypothesis cannot be rejected. This suggests that there is insufficient evidence to conclude that there are differences in the means of funding stage of biodiversity versus non-biodiversity impact funds.

According to the institutional logic of investment, investments are suitable if the investment manager has a long-standing, established track record (Hummels & Fracassi, 2016). In the impact investment market, however, the lack of such a track record forms a challenge (Saltuk,

2013). According to prior research, it is expected that biodiversity funds are in earlier stages and therefore have a less established track record than non-biodiversity funds (Huwyler et al, 2016; Hand et al., 2020). The results of this study contradict this statement, as they show that biodiversity funds are in later stages than non-biodiversity funds. However, the insignificant results imply that biodiversity funds do not differ from non-biodiversity funds in terms of track record which suggests that biodiversity funds are not less suitable for institutional investors than non-biodiversity funds.

TABLE 5: ONE-WAY ANOVA 1

Fund type	Mean	Std. dev.	Freq.
Biodiversity (1)	1.969697	1.1587938	33
Non-biodiversity (0)	1.8392857	1.0050199	56
Total	1.8876404	1.0599979	89

Source	Analysis of variance SS	df	MS	F	Prob>F
Between groups	.353136096	1	.353136096	0.31	0.5780
Within groups	98.5232684	87	1.13245136		
Total	98.8764045	88	1.12359551		

5.2 H2: Fund size

Table 6 shows the distribution of fund sizes of biodiversity funds and non-biodiversity funds. There are 54 biodiversity funds of which 18 are small, 26 are medium, and 10 are large. There are 101 non-biodiversity funds of which 37 are small, 44 are medium, and 20 are large.

TABLE 6: FUND SIZE DISTRIBUTION

Funding stage	Biodiversity (1)	Non-biodiversity (0)
Small (1)	18	37
Medium (2)	26	44
Large (3)	10	20
Total	54	101

As can be seen in table 7, the mean of biodiversity funds is equal to 1.8518519 while the mean of non-biodiversity funds is lower and equal to 1.8316832. This means that, on average, non-biodiversity funds tend to be smaller than biodiversity funds, although the difference in mean is quite small. This is not in line with the expectation that biodiversity funds are smaller than non-biodiversity funds. However, as the p-value of 0.8696 is above the significance level of 0.05, the null hypothesis cannot be rejected. This suggests that there is insufficient evidence to conclude that there are differences in the means of fund size of biodiversity versus non-biodiversity impact funds.

Impact funds need to be large enough to be appropriate for institutional investors (Brest & Born, 2013). Huwyler et al. (2016) state that the small average deal size of biodiversity projects is a prominent barrier for institutional investors. The findings of other reports suggest that investments in biodiversity are smaller than of those in other impact areas (Baralon et al., 2021; Hand et al., 2020). It is therefore expected that biodiversity funds have a smaller deal size than non-biodiversity funds. The results of the one-way ANOVA show that biodiversity funds are larger in terms of AUM than non-biodiversity funds, which contradicts the expectation. However, the results are insignificant which implies that biodiversity funds and non-biodiversity funds do not differ in terms of size. Again, this suggests that biodiversity funds are not less suitable for institutional investors than non-biodiversity funds.

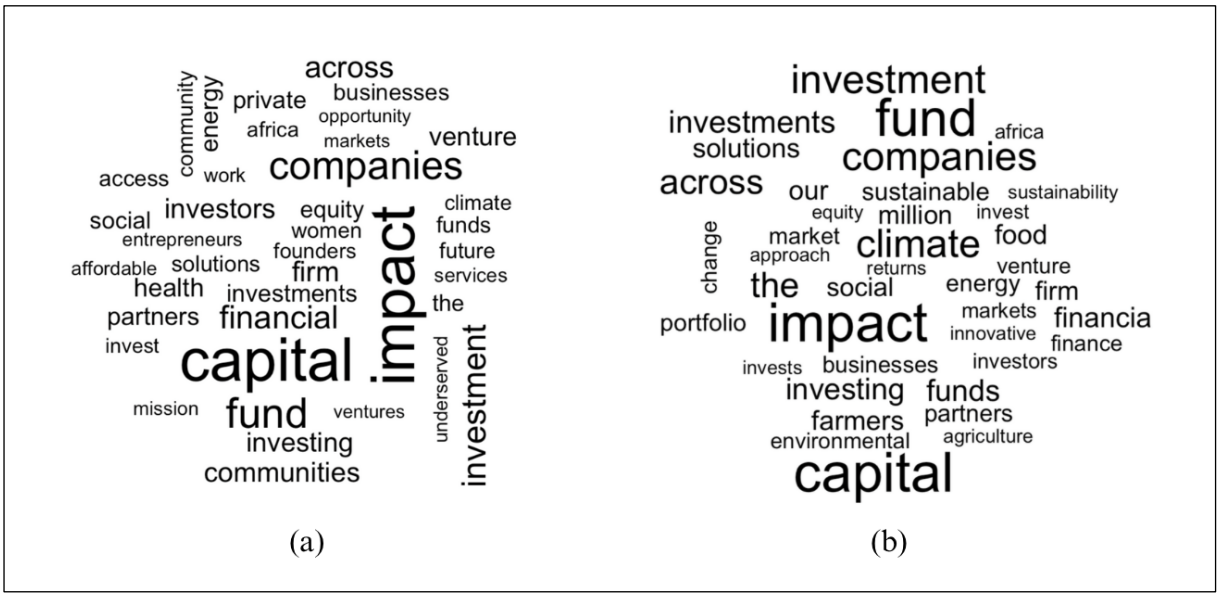
TABLE 7: ONE-WAY ANOVA 2

Fund type	Mean	Std. dev.	Freq.
Biodiversity (1)	1.8518519	.71129453	54
Non-biodiversity (0)	1.8316832	.73578947	101
Total	1.8387097	.72509624	155

Source	Analysis of variance SS	df	MS	F	Prob>F
Between groups	.014313259	1	.014313259	0.03	0.8696
Within groups	80.9534287	153	.529107377		
Total	80.9677419	154	.525764558		

5.3 H3: Biodiversity conservation awareness

FIGURE 1: WORD CLOUDS FOR NON-BIODIVERSITY (A); AND BIODIVERSITY (B) FUNDS



As can be seen in figure 1, two word clouds are formed to compare the most frequently used words in the *Fund descriptions* per *Fund type*. The larger the font size of the word, the larger the representation of the word in the text. Figure 1a shows the word cloud generated from the *Fund description* of non-biodiversity funds. As can be seen in the word cloud, the three most used words are 'capital', 'impact', and 'fund'. However, these words do not say anything about

the impact focus of the funds. The impact focus is reflected by used words such as ‘communities’, ‘health’, ‘energy’, and ‘equity’. The word cloud does show ‘climate’, while ‘climate change’ is one of the biodiversity keywords mentioned in section 4.2. However, climate is much broader than biodiversity, as climate change itself poses a threat to biodiversity (Bellard, Bertelsmeier, Leadley, Thullier & Courchamp, 2012). The word cloud does not show any other biodiversity keywords, which is in line with the expectation.

Figure 1b shows the word cloud generated from the *Fund description* of biodiversity funds. As can be seen in the word cloud, the three most used words are ‘capital’, ‘impact’, and ‘fund’, which is equal to the non-biodiversity funds. As stated previously, these words do not reflect the funds’ investment focus. Words such as ‘farmers’, ‘agriculture’, and ‘food’ are depicted in the world cloud. This could be due to funds focused on ‘sustainable agriculture’ also being classified as biodiversity funds (*see appendix; table A1*). The word cloud shows the words ‘climate’ and ‘sustainable’, while ‘climate change’ and ‘sustainability’ are biodiversity keywords. However, climate and sustainability are both are much broader than biodiversity (Bellard et al., 2012). Other biodiversity keywords are not seen in the word cloud, which is not in line with the expectation.

Table 8 presents the performance of the naïve Bayes model. The testing data exists out of 55 impact funds. Out of the 39 non-biodiversity funds, the model correctly predicts the fund type 32 times, resulting in an accuracy of 82.1% for this group. However, in 17.9% of cases, the model incorrectly classifies a non-biodiversity fund as a biodiversity fund. For the 16 biodiversity funds, the model accurately predicts the fund type 10 times, which corresponds to a lower accuracy rate of 62.5%. This indicates a weaker predictive power for biodiversity funds, with the model incorrectly classifying 37.5% of them as non-biodiversity funds. This shows that the naïve Bayes model is worse at classifying *Fund descriptions* from biodiversity funds than from non-biodiversity funds.

TABLE 8: NAÏVE BAYES MODEL PERFORMANCE

	Non-biodiversity (0)	Biodiversity (1)	Row marginals
Non-biodiversity (0)	32 (82.1%)	7 (17.9%)	39
Biodiversity (1)	6 (37.5%)	10 (62.5%)	16
Column marginals	38	17	N = 55

The Chi-square test is performed on the results from the naïve Bayes model shown in table 8. Table 9 presents the expected values and Chi-square values per cell. The Chi-square values are summed to obtain the Chi-square statistic of 63.62. The degrees of freedom of a two-by-two table is equal to 1 (McHugh, 2013) and corresponds to critical value of 3.841, assuming a significance level of 0.05 (National Institute of Standards and Technology, n.d.). Since, the Chi-square statistic of 63.62 is greater than the critical value of 3.841, the null hypothesis is rejected. There is a significant difference between the expected and actual frequencies. Thus, the naïve Bayes model does not have (near) perfect predictive power.

It is expected that biodiversity fund managers have a high level of biodiversity conservation awareness due to the increasing initiatives that help educate finance professionals and practitioners (CFA, n.d.). In addition, fund managers often conduct IDD (Cumming & Zambelli, 2017) and therefore gain knowledge about biodiversity and its conservation. The word cloud in figure 1b shows that the descriptions of biodiversity funds do not contain biodiversity keywords. Due to this lack of corresponding words, the naïve Bayes model is unable to predict that these belong to biodiversity funds. As in Turner-Erfort's (1997) survey results, in which the general public gives varying definitions for the term 'biodiversity', biodiversity fund managers use different words to describe their funds. The lack of corresponding biodiversity keywords suggests that biodiversity fund managers do not have a high level of biodiversity conservation awareness, which is not in line with the expectation.

TABLE 9: CELL EXPECTED VALUES AND (CELL CHI-SQUARE VALUES)

	Non-biodiversity (0)	Biodiversity (1)
Non-biodiversity (0)	38 (0.95)	1 (36)
Biodiversity (1)	1 (25)	15 (1.67)

$\chi^2 = 63.62$

5.4 Robustness check

As there is no universal classification for impact fund sizes, a robustness check is performed to test whether the previously stated result for hypothesis 2 still holds when *Fund size* is classified differently. The *Fund size* is now classified as 'small' if the AUM are <$25M, 'medium' if the AUM are $25-499M, and 'large' if the AUM are >$500M. The *Fund size* distribution within biodiversity funds (1) and non-biodiversity funds (0) is shown in table A3 of the appendix. Another one-way ANOVA test is run (*see appendix; table A4*). The previous result still holds.

6 Discussion and conclusion

6.1 Discussion

The loss of biodiversity is a widespread problem and unlocking institutional capital might be the solution. However, very little research has been conducted on the topic of biodiversity finance, which has led to a huge gap in the literature (Karolyi & Tobin-de la Puente, 2023; Starks, 2023). Prior literature sketches the current state of the nature conservation market and states that institutional investors might be reluctant to invest in biodiversity conservation due to a shortage of projects with a well-established track record as well as due to their small deal sizes (Huwyler et al., 2016). However, it has not yet been measured whether biodiversity funds actually differ from other impact funds in terms of these characteristics.

The previous section shows that when comparing biodiversity to non-biodiversity funds, they do not differ in funding stage and size. Thus, when looking at these two characteristics, biodiversity funds are not less suitable for institutional investors than funds in other impact areas. While this result implies that institutional investors should be able to invest in biodiversity funds, this does not happen. On the one hand, this could mean that institutional investors do not invest in biodiversity for another reason. One explanation is that another characteristic differs between biodiversity and non-biodiversity funds. This in line with Huwyler et al. (2016) who suggest that next to track record and size, institutional investors do not invest in biodiversity because it is hard to find those with a good risk-return objective. Various other papers also state that the risk-return objective forms a prominent challenge for institutional investors (Huppé, 2013; Hummels & Fracassi, 2016; Saltuk, 2013; Huppé & Silva, 2013). However, these studies do not distinguish between different impact areas. On the other hand, these results could mean that impact funds in general lack an established track record and

are too small. This suggests that the entire impact investment market is not yet suitable for institutional investors.

Additionally, it has not been researched whether biodiversity fund managers possess sufficient knowledge about biodiversity conservation. In recent years, more and more organisations such as the CFA have been established. These initiatives have helped with the education of finance professionals and practitioners, such as fund managers (CFA, n.d.). This led to the expectation of fund managers having a high level of biodiversity conservation awareness. However, the results show that they still do not fully understand the concept of biodiversity and how to describe their funds in order to attract investors. Although biodiversity fund managers do not use biodiversity keywords in their fund descriptions, they do use words related to agriculture. While biodiversity and agriculture are strongly interrelated (CBD, n.d. b), biodiversity encompasses much more than sustainable agriculture. This narrow focus on agriculture could indicate tunnel vision among fund managers, in which they exclude other biodiversity aspects such as reforestation.

Phenix Capital Group offers a possible explanation for the lack of common biodiversity keywords in the fund descriptions. Their impact report examines a database of impact funds and classifies the following SDGs as biodiversity-related SDGs: life on land (SDG 15), zero hunger (SDG 2), clean water (SDG 6), and life below water (SDG 14; Phenix Capital Group, 2024). The report states that biodiversity is interconnected with almost every SDG. But while biodiversity is mostly associated with SDGs 14 and 15, there is no SDG that specifically targets biodiversity. Due to biodiversity being related to many SDGs, but not a specific one, fund managers might have different understandings of biodiversity and therefore use different words to describe their funds. Mahmood and Guo (2023) state that it is difficult for investors to navigate biodiversity investments due to the wide variety of terminology. Therefore, institutional investors who are searching for suitable funds might not be able to find them when

reading the fund descriptions. This could explain why institutional investors do not invest in biodiversity funds.

6.2 Suggestions for future research

While this paper brings us one step closer to unlocking institutional capital for biodiversity conservation, a lot remains to be done. Despite the results showing that the funding stage and fund size do not differ between biodiversity funds and non-biodiversity funds, there might be other issues that distinguish them. As mentioned previously, the lack of a good risk-return-impact profile can withhold institutional investors from investing in a biodiversity fund (Hummels & Fracassi, 2016; Huwyler et al., 2016). Further research that measures the difference between the risk-return-impact profile of biodiversity funds and other impact funds may be a fruitful next step.

Moreover, the measurement of fund managers' level of biodiversity conservation awareness through an analysis of fund descriptions may lack precision. Future research may benefit from additional and more detailed qualitative methods. The use of survey questions might be better able to measure the level of biodiversity conservation awareness among fund managers, following prior research (Turner-Erfort, 1997; European Environment Agency, 2021).

Fiebelkorn and Menzel (2013) study teachers' understanding of biodiversity and find that respondents perceive biodiversity differently depending on their cultural background and location. The authors state that the lack of a common definition leads to varying and biased understandings of biodiversity. Seeing that the understanding of biodiversity and biodiversity itself is location-bound, future research might be improved by taking the location of the fund's portfolio companies into account.

6.3 Practical implications

This study's findings has implications for policymakers, fund managers, and institutional investors. As biodiversity funds do not differ from other impact funds, in terms of funding stage and size, they are not less suitable for institutional investors to invest in. However, when looking at the results of the text analysis, it becomes clear that fund managers do not have the level of knowledge that is expected. Fund managers seem to have different understandings of biodiversity and its conservation, which poses a challenge. First and foremost, this implies that policymakers need to direct more attention towards biodiversity conservation awareness in order to streamline the concept's meaning. This can be done through increased communication, education, and awareness strategies for fund managers (Navarro-Perez & Tidball, 2012). Concretely, policymakers can organise educational initiatives, such as biodiversity conventions, and standardise frameworks to help fund managers understand the meaning of biodiversity conservation.

Despite the literature suggesting a high level of biodiversity conservation awareness among fund managers, the results show that they either seem to have a lack of knowledge or a wrong approach when it comes to their fund descriptions. Moreover, the lack of biodiversity-related words in their fund descriptions can lead to institutional investors not being able to find suitable funds to invest in. Thus, fund managers need to engage in educational initiatives, such as those mentioned above. Once there is a more streamlined meaning of biodiversity conservation, fund managers can start using biodiversity keywords in their fund descriptions. By using such a common language, it will become easier for fund managers to attract institutional capital.

Lastly, it becomes apparent that the biodiversity impact investment market might still not be feasible yet for institutional investors. This indicates that additional measures are necessary before institutional investors can start investing in biodiversity conservation on a large scale. As mentioned previously, further research on the risk-return objective of biodiversity

investments is needed, along with measures to mainstream the concept of biodiversity conservation and develop a common language.

6.4 Limitations

While this study attempts to fill the large gap in the literature by measuring the difference between biodiversity funds and other impact funds, some limitations still exist. First and foremost, the sample size of the used database is relatively small, which limits this study's validity and reliability (Charter, 2010). Ross et al. (2017) state that a small sample size increases the risk of a Type II error. This means that the probability of failing to reject the null hypothesis when it actually should be rejected would decrease with a larger sample size.

Second, the funds that are classified as biodiversity funds are not likely to be 100% focused on conserving biodiversity, as most funds from the IA 50 2024 database have more than one impact investment focus. The database does not clarify what share of the capital is directed towards biodiversity. MSCI Research makes a distinction between biodiversity-related funds and pure-play-biodiversity funds (Mahmood & Guo, 2023). Biodiversity-related funds are those that are thematically linked to biodiversity but focus on broader areas such as the environment, ecology, sustainable resources, or the circular economy, while pure-play-biodiversity funds focus only on biodiversity. The results of this study may therefore differ when only classifying pure-play-biodiversity funds as biodiversity funds.

Third, although prior research states that institutional investors might not invest in biodiversity projects due to the lack of an attractive risk-return objective (Huwyler et al., 2016), this paper does not measure this characteristic. Due to a lack of data on the IA 50 2024 funds' risk and return, it is impossible for this to be taken into account. However, this still forms a limitation because the current literature suggests that it may be a significant barrier for institutional investors.

Lastly, when testing the third hypothesis, this paper assumes that the expected frequency is 1 in the case of biodiversity funds (1) being classified as non-biodiversity funds (0) and non-biodiversity funds (0) being classified as biodiversity funds (1). Thus, the expected frequency is below 5 in two out of four cells (50%). However, a Chi-square test might not be suitable if more than 20% of the cells have an expected frequency below 5 (Özdemir & Eyduran, 2005).

6.5 Conclusion

This paper is the first to measure the differences between biodiversity funds and funds in other impact areas and finds that they do not differ in terms of funding stage and size. This suggests that biodiversity funds are not less suitable than non-biodiversity funds in terms of these characteristics. However, more research is needed on other factors that might differ between biodiversity and non-biodiversity funds, such as the risk-return-impact profile. Additionally, this paper finds that the level of biodiversity conservation awareness is lacking among biodiversity fund managers. All in all, this points toward the conclusion that biodiversity is not a feasible investment area for institutional investors yet. This paper may motivate academics and policymakers to take additional steps, such as more research on the risk-return-impact objective of biodiversity funds, the standardisation of frameworks, and the creation of a common biodiversity language, in order to unlock the much-needed institutional capital.

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8 Appendices

TABLE A1: CLASSIFICATION OF IMPACT THEMES

Impact investment focus	Biodiversity?
Affordable housing and community development	0
Arts and culture preservation	0
Clean technology, alternative energy, and climate change	0
Demographic-based impact	0
Diversity, equity, and inclusion	0
Education	0
Fair trade	0
Global health	0
Job creation and workforce development	0
Place-based impact	0
Media, technology, and mobile	0
Microfinance, low-income financial services, and microinsurance	0
Natural resources and conservation	1
Nutrition, health, and wellness	0
Racial equity and justice	0
Small/medium business development	0
Sustainable agriculture	1
Water and sanitation	0
Diversified	0

TABLE A2: DEGREE OF FREQUENCY OF BIODIVERSITY KEYWORDS

Keyword	Biodiversity funds (1)	Non-biodiversity funds (0)
Biodiversity	6	0
Biosphere	0	0
Deforestation	0	0
Desertification	0	0
Ecology	0	0
Endangered species	0	0
Endemic species	0	0
Extinction	0	0
Genetic diversity	0	0
Habitat destruction	0	0
Habitat fragmentation	0	0
Invasive species	0	0
Keystone species	0	0
Natural capital	1	0
Ocean acidification	0	0
Species diversity	0	0
Subspecies	0	0
Sustainability	9	7
Wildlife trade	0	0
Climate change	9	6
Protected area	0	0
Ecosystem service	0	0

TABLE A3: ROBUSTNESS CHECK FUND SIZE DISTRIBUTION

Funding stage	Biodiversity (1)	Non-biodiversity (0)
Small (1)	13	27
Medium (2)	31	54
Large (3)	10	20
Total	54	101

TABLE A4: ROBUSTNESS CHECK ONE-WAY ANOVA

Fund type	Mean	Std. dev.	Freq.
Biodiversity (1)	1.9444444	.65636698	54
Non-biodiversity (0)	1.9306931	.68201797	101
Total	1.9354839	.67108576	155

Source	Analysis of variance SS	df	MS	F	Prob>F
Between groups	.006653891	1	.006653891	0.01	0.9037
Within groups	69.3481848	153	.45325611		
Total	69.3548387	154	.450356096		