Valuing Nature

Ethical Considerations of Biodiversity in Sustainability Science

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Abstract:

Species extinction rates have during the last centuries reached levels leading scholars to proclaim a sixth mass extinction, even referred to as defining element of the Anthropocene. How humanity relates to nature and biodiversity has thus become part of how we delineate and describe the geological epoch we live in.
Sustainability science has since its origins built on a research agenda calling for an investigation of incentives for sustainable levels of interaction between society and nature. Biodiversity, as a conceptualisation that operates at the intersection of society and the environment, is in this regard an important concept. Biodiversity loss has also been identified as one of the four long-term challenges to achieve sustainability. However, debating conservation of biodiversity also means to discuss why its protection is of value.
Inspired by critical theory and the articulated need to remain sceptical of long-held beliefs, the study inquires how sustainability science conceptualises and values biodiversity in the sustainability discourse. Through conducting a qualitative content analysis of the three major journals of sustainability science, special attention is given to the issue of valuation as a motivating factor in policy recommendations.
The results summarise how sustainability science conventionally engages with biodiversity, how the field of study relates biodiversity conservation to development, and how biodiversity is predominantly valued in an anthropocentric utilitarian fashion, favouring ecosystem services as a conservation approach contributing towards human well-being.
The discussion part introduces biological integrity and bioabundance as alternatives to the conceptualisation of conservation according to diversity. Further, the results are critically discussed based anthropocentrism and ecocentrism as moral philosophy perspectives on granting moral relevance to entities. Here, materialistic and non-materialistic anthropocentrism is dismissed in favour of ecocentric environmental ethics built on deontology and virtue ethics. As normative ethical perspectives, deontology and virtue ethics enrich the debate concerning valuation and consequently provide new impetus for conservation and the relation of humanity with the environment in a climate changing world.
Sustainability science needs to develop an environmental ethic that balances nature's "purpose-for-us" with its "purpose-for-itself" as underlying mechanism of environmental degradation. Rather than following and promoting an ethic of "use of the environment" the field of studies should return to its search for incentives for achieving sustainable levels of nature-society interaction and reinvigorate the debate of how humans relate to nature.

Keywords: biodiversity, sustainability science, ecosystem services, valuation, anthropocentrism, critical theory

Word count: 13988

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A land ethic changes the role of homo sapiens from conqueror of the land-community to plain member and citizen of it. It implies respect for his fellow-members and also respect for the community as such.

- Aldo Leopold

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List of Abbreviations:

CBD	Convention on Biological Diversity
FAO	Food and Agriculture Organisation of the United Nations
MEA	Millenium Ecosystem Assessment
PNAS	Proceedings of the National Academy of Science
SS	Sustainability Science
SSPP	Sustainability: Science, Practice & Policy
TEEB	The Economics of Ecosystems and Biodiversity

PART I: FOUNDATIONS OF THE STUDY

1 Introduction

1.1 Motivation and Justification

Sustainability is often thought of in form of nature-society systems. The balance between resource extraction and renewal rates in nature over the long-term exemplifies what can be imagined as sustainable system. However, as the sustainability discourse has documented with the planetary boundaries approach (Rockström et al., 2009), the boundaries designating an ecological balance and a safe-operating space for humanity are either widely trespassed or closing in on their limits.

The relation of humanity with the environment has in this context produced the notion of the Anthropocene (Crutzen & Stoermer, 2000), which is described as an epoch marked by human disruption of natural processes fundamentally altering the geology and ecosystems of the Earth (Cudworth & Hobden, 2011, p. 45; Dalby, 2009). In search for a definition of the epoch, researchers have mostly looked at geologic features such as anthropogenic emissions of green house gases. Recently the discussion has however turned to the question whether the extinction rate of species is a further defining element of the Anthropocene (Braje & Erlandson, 2013). The often debated sixth mass extinction is presented in this context as a way to delineate the Anthropocene from the late Holocene (Dempsey, 2015).

A topic that is linked to the debate of extinction is biodiversity. Biodiversity, or biological diversity, is a concept that is used to describe the diversity within species, between species and of ecosystems (Convention on Biological Diversity (CBD), 1992). Further, the term has come to be an expression of a specific nature-society system conceptualisation. Understood as a source of information, a resource and a provider of services through the functioning of ecosystems, biodiversity is now a cornerstone in the debate for which purpose and how society relates to and values nature.

In Roman Altshuler's words, "[e]xperiences of value or obligation [are] not simply superfluous items in our mental repertoire. They serve to guide the transition between recognition of value on one hand, and appropriate action on the other" (Altshuler, 2014, p. 476). How we construct values of nature and how we express obligation towards our environment has consequently a bearing on the policies we design for the protection of the Earth and its nature. Valuation and its role in the overall task of attaining sustainability has been taken up in international agreements such as the recent Sustainable Development Goals (2016) which speaks of the need to "integrate ecosystem and biodiversity values into

national and local planning". Moreover, the Aichi Goals for Biodiversity express the aim that "[b]y 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably" (2011). Regarding valuation, the three big schools of Western moral philosophy, consequentialism with its utilitarian approach, deontology, and virtue ethics, provide different grounds for why we should care about nature. Seeing biodiversity as providing utility to humans means that we protect it in order to secure our own well-being. Versions of deontology may claim that there is a moral duty to refrain from destructive action. Lastly, virtue ethics argues for instance that destroying ecosystems or habitats runs against the virtue of respect for nature and should hence be avoided.

1.2 Research question and disposition

Sustainability science, a field that is concerned with nature-society systems and operates according to an agenda that seeks to inform policy, has identified biodiversity and its loss as one of the four challenges for achieving sustainability (Jerneck et al., 2011, p. 73). Given the implications that conceptualisations of biodiversity and valuation have on the ways we formulate policy, this study contributes to needed critical research in sustainability science (e.g. by Fischer et al., 2007) to scrutinise underlying and long-held beliefs in academia.

This study therefore seeks to answer the following research question:

- How does the sustainability science discourse engage with the concept of biodiversity and its forms of valuation?

As both the concept itself and the valuation tied to biodiversity are latent content in the literature, the study conducts a qualitative content analysis. In order to provide valid statements about sustainability science, the three mainstream journals of the field (Sustainability Science, Sustainability: Science, Policy and Praxis, Proceedings of the National Academy of Science: Sustainability Science) are analysed for how the biodiversity debate is presented in their publications dating from 2006 until 2015.

The results are discussed on the basis of anthropocentrism and ecocentrism as perspectives on granting moral significance, as well as in relation to normative moral philosophy. Arriving at answers to this question will provide new impetus for the debate of biodiversity as an element of sustainable nature-society systems and how best to argue for stopping trends such as species extinction and ecosystem destruction.

Following the introduction to the issue of biodiversity and its relevance, the thesis proceeds in its first part with a literature review of sustainability science and its research agenda as well as a review of biodiversity as an evolving concept in the academic literature since the 1980s. The second part contains chapters on the constructionist ontology and epistemology of the study and a description of the methods employed. The third part of the thesis presents the results of the text analysis, summarising the biodiversity discourse in sustainability science. The final part takes up the controversies surrounding the results. It adds to the debate of biodiversity by critically discussing the concept and its valuations as well as presenting alternative grounds for action in form ecocentric environmental ethics built on deontology and virtue ethics.

1.3 Why Biodiversity?

As historian Yuval Harari (2015) claims, a key difference between the species *homo sapiens* and other animals is their ability to collaborate with flexibility in large numbers. In contrast to ants with rigid collaboration structures in their hives, humans can change their collaboration structure in accordance with changes of shared meanings and inter-subjective truths which society is built on. This flexibility of mental institutions has been associated with increased chances of survival (Harari, 2015). Nevertheless have institutions such as consumption, lead to human behaviour in the past centuries that has been strongly liked to environmental degradation, placing the initial objective of securing humanity's survival in jeopardy (Meadows, Rome, & Associates, 1972; Rockström et al., 2009).

Given the significance of shared meaning for human collaboration in nature-society systems, it follows that a critical taking-apart of the constructs that lie at the heart of institutions like biodiversity is called for. Even though often defined differently, biodiversity stands for the "variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems" (CBD, 1992). What makes biodiversity particularly noteworthy in the sustainability debate is that it has been described as a boundary object (Büscher, 2014; Piechocki, 2007). Boundary objects are constructs that operate as communicative bridges between different disciplines and between academia, political actors, governments and other social institutions such as non-governmental organisations and social movements. Being of interest to a wide range of societal actors creates not only a strong base for action but also a divergence between action taken in regard to biodiversity.

For analytical purposes, biodiversity is interesting since the term operates conceptually at the intersection of the natural environment and societal sphere. It is devised by humans to describe features of their environment but at the same time reveals a great deal about society and its institutions. One hallmark of modern societies has been identified as the hierarchical ordering of the world that places nature at humans' disposal, a tendency that intensified over the past centuries (Ottman, 1982). Ryan Gunderson (Gunderson, 2014b) concluded from Ottman's statement that "modernity's inability to discover nature's purpose-for-itself is the cause of environmental degradation", which in its turn is described as "nature taking revenge upon the boundlessness of the will-to-control" (p. 631). The quest for articulating a purpose-for-itself in nature therefore relates back to the necessity of a debate about the valuation of biodiversity. This way the boundlessness of the will-to-control as the underlying mechanism of environmental degradation can be put under scrutiny.

In order to arrive at initial statements contextualising the study, the next section contains a literature review of sustainability science as the field of study the research relates to as well as a review of biodiversity, providing a historical background of the concept in academia.

2 Literature Review

2.1 Sustainability Science

Sustainability science regards itself as an emerging field of studies, characterised by its approach to conducting research. The collaboration across a variety of disciplines, natural and social science alike, as well as the inclusion of non-academic forms of knowledge have become a defining element of the field (Kates, 2011). Particularly the convening of ecology and economics have been highlighted as a form of academic collaboration for sustainability in this regard (Fischer et al., 2007). This approach to science evolved from the recognition that institutional divides and different disciplines represent a barrier to solving the complex issues of sustainability, environmental degradation and climate change. Instead, new institutional arrangements are needed (Kates et al., 2001).

From the early 2000s onward the field of studies gained momentum in particular due to a growing scientific consensus on a pending climate crisis altering nature-society systems. Aided by political and public attention and the publication of reports documenting progressing environmental degradation (i.e. Meadows et al., 1972) the field solidified around the scientific project of elucidating policy pathways towards sustainability (United Nations, 1987). The core

challenge, indebted to the discourse and policy agenda of sustainable development, was understood to be the reconciliation of society's development goals with the planet's environmental limits over the long term (Clark & Dickson, 2003).

As a problem-driven field, sustainability science aims to bridge the gap from the global to the local and conducts research relevant to solving real-life problems that obstruct the attainment of sustainability (Kates et al., 2001). In order to systematically address the aforementioned tensions between environmental conservation and achieving economic growth, a series of core questions are devised to guide research. These questions address the relationship between nature and society by exploring, explaining and modelling it as well as incorporating findings into policy relevant statements (Kates et al., 2001). Noteworthy in the context of this study is the question concerning the incentive structures for achieving levels of sustainable interaction between societies and their environment .

Core Questions of Sustainability Science
• How can the dynamic interactions between nature and society--including lags and inertia--be better incorporated into emerging models and conceptualizations that integrate the Earth system, human development, and sustainability?
• How are long-term trends in environment and development, including consumption and population, reshaping nature--society interactions in ways relevant to sustainability?
• What determines the vulnerability or resilience of the nature-society system in particular kinds of places and for particular types of ecosystems and human livelihoods?
• Can scientifically meaningful "limits" or "boundaries" be defined that would provide effective warning of conditions beyond which the nature-society systems incur a significantly increased risk of serious degradation?
• What systems of incentive structures--including markets, rules, norms, and scientific information--can most effectively improve social capacity to guide interactions between nature and society toward more sustainable trajectories?
• How can today's operational systems for monitoring and reporting on environmental and social conditions be integrated or extended to provide more useful guidance for efforts to navigate a transition toward sustainability?
• How can today's relatively independent activities of research planning, monitoring, assessment, and decision support be better integrated into systems for adaptive management and societal learning?

Table 1: Core questions of sustainability science, from Kates et al. 2001

In contrast to problem-solving approaches, Fischer et al. (2007) highlighted in their article 'Minding the Sustainability Gap' the importance of critical research for the project of

sustainability science. They identified three research agendas; one dealing with the formulation of sustainability targets, a second that relates to policy specifically designed to guide society towards the aforementioned targets, and a third dealing with the underlying conceptualisations the other two agendas rely on. The critical agenda has as a task to analyse values, beliefs and motivations that are prevalent in the long-term trajectory of society. The authors argue in favour of strengthening the humanities and social sciences, naming moral philosophy explicitly as a prerequisite for long-term thinking in nature-society systems. This way, long-held beliefs in society can be recast in the light of otherwise unobtainable sustainability targets dictated by the natural sciences.

A pressing issue on the agenda of sustainability science is the observed loss of biodiversity during the past decades. Following Jerneck et al. (2011) the decrease in biological diversity is a challenge of the same order as climate change, water scarcity and land-use change. The issue also formed part of the widely recognised 'planetary boundaries'-approach based on a publication by Rockström et al. (2009). Here biodiversity loss is regarded as one of the nine fundamental planetary boundaries, further being the boundary that is the most exceeded (ibid, pp. 14-15). Bringing together different disciplines, recognising the downwards trajectory of biological diversity, showing interest in incentives for sustainable nature-society interaction and emphasising the need to critically scrutinise long-held beliefs - all of these components of sustainability science present convincing arguments for why a study of biodiversity in sustainability science is not only interesting but even very significant for the field of study itself and the society it operates for.

2.2. Biodiversity

Biodiversity is a concept that only recently entered the discourse of nature, environment and sustainability (Lanzerath, 2014). Nature conservation and the protection of endangered ecosystems and species predate the scientific framing of biodiversity. In the 1980s, and originally phrased as 'biological diversity', the concept developed in the United States of America, particularly due to the "US National Forum on BioDiversity" organised in 1986 by the American Natural Research Council and the Smithsonian Institute (Piechocki, 2007). Cutting out '-logical' as a signifier of natural science and instead using the contraction BioDiversity is claimed to have been a conscious decision to invite participation from and increase interest among social scientists for the conference (Piechocki, 2007; Takacs, 1996).

With a subsequent publication in 1988 documenting the conference, the book 'Biodiversity' by Edward Wilson and Frances Peter established biodiversity as an academic

concept (Wilson & Peter, 1988). In the early 1990s the concept reached intergovernmental organisations such as the United Nations when the UNESCO included biodiversity as an indicator in its programme titled “Man and the Biosphere” (Piechocki, 2007). In 1992 the Convention on Biological Diversity was adopted and subsequently signed by over 180 countries. The convention, apart from providing a definition, affirms that the conservation of biodiversity and the haltering of its loss are a common concern of humankind. Apart from the intrinsic and non-instrumental motivations for conserving biodiversity mentioned in its preamble, the convention assumed a leading role in governing the sustainable use and equitable sharing of benefits and resources, particularly genetic information (Hannigan, 2006, p. 131).

With entering the academic discourse, the concept of biodiversity also took root in national politics due to legislature passed to govern *in situ* biodiversity protection. From here it quickly took the form of signifying ‘endangered life on Earth’ thus implying an increasingly international governance scheme that was disconnected from its initial descriptive element. Instead biodiversity converted into a buzzword highlighting the need of conserving and protecting endangered species (Potthast, 2014).

Due to its characteristics as a boundary object spanning different disciplines and institutional discourses the term became politicised during the 1990s (Büscher, 2014). Büscher attributes this development to the plasticity of the term, a result of being concise and broad simultaneously. The critical potential derived from its many interpretations has fuelled debates surrounding the meaning of biodiversity and coalesced in the critique that biodiversity has been alienated from its original, academic meaning. This alienation is claimed to be the result of conservationists and economic actors reframing biodiversity in terms of ‘sustainable use’ and reconcilability with economic growth (ibid.). The Convention on Biological Diversity has also been accused of supporting this notion by delineating biological diversity as a resource in need of management, and thereby economic rationale, rather than a ‘common heritage’ (ibid.).

The ‘original meaning’ that biodiversity has been alienated from stems from the interdisciplinary field of ecology spanning biology, geography and earth sciences. However, pinpointing ecology as the ‘proprietor’ of the term biodiversity can be misleading since the growth of literature on the topic can even be attributed to the physical sciences, forestry and even economics (Wilson, 1997). Key characteristics of ecology are the study of dynamics and interactions of living organisms with their environment and between each other. Relevant for biodiversity in this context is the question concerning the relation between diversity and stability (Sarkar, 2005). The ecological perspective of biodiversity expanded into what is now known as biodiversity studies and eventually became a central focus of conservation biology

(Hannigan, 2006, p. 135). The research agenda of ecology, which was rooted in theoretical and practical explorations as well as modelling (Sarkar, 2005), provides practitioners and organisations of conservation with guidance. One of the outcomes of this research is the notion of ecosystem services, an idea that is explored in the next section.

2.2.1 Ecosystem Services

Awareness of the connection between human action and nature dates back centuries, as does the interest in how this relation affects human well-being (TEEB, 2010). In the 1970s humanity's dependence on nature for its well-being was recast in economic terms when Walter Westman (1977) asked in his research how much the services provided by nature were worth. The actual term of ecosystem services originates from a book linking species extinction with the provision of services in ecosystems (Ehrlich & Ehrlich, 1981). In the following decade the term was popularised and mainstreamed. This trend was matched with an increasing interest in the methods and tools of economic valuation before entering the policy discourse (Gómez-Baggethun, de Groot, Lomas, & Montes, 2010).

In the wake of the recognition during the 1970s and 1980s that ecosystem functions are imperilled by global developments such as environmental degradation, climate change and land-use change, the study of how nature produces services as well as the quantification of their provision and value has established the ecosystem services approach in economic approaches to the environment (Brockington, 2011). The Millennium Ecosystem Assessment (MEA) of 2005 and The Economics of Ecosystems and Biodiversity (TEEB; 2010) have underscored this connection and provided comprehensive studies of how ecosystem functions interact and produce value, mostly spelled in terms of exchange, rather than use value (Gómez-Baggethun et al., 2010). For this purpose the MEA distinguishes four categories of ecosystem services, "(1) provisioning services, referring to the material outputs from ecosystems, such as food, raw materials, freshwater, medicinal resources, (2) regulating services that include for instance local climate and air quality regulation, carbon sequestration and storage, moderation of extreme events, waste-water treatment, prevention of erosion and maintenance of soil fertility, pollination, biological control, (3) habitat or supporting services such as habitats for species, maintenance of genetic diversity, and (4) cultural services summarising those for recreation, mental and physical health, tourism, aesthetic appreciation and inspiration for culture, art and design, the spiritual experience and sense of place" (2005, pp. 1-2).

Research on biodiversity and ecosystem services started off with a confirmatory agenda exploring and proving the relationship between biodiversity and ecosystem services.

It only later evolved to be prescriptive in policy terms due to improved understanding of complexity and better metrics that made findings applicable in real cases of biodiversity loss (Naeem, Bunker, Hector, Loreau, & Perrings, 2009). The growing interest in ecosystem services even in biodiversity conservation has been ascribed to an acknowledgement that the value of nature has previously been underrepresented (Costanza et al., 1998). Instead the services had to be made measurable and tangible in order to convince people of the utility that a conserved ecosystem provides in terms of services rather than use value created by short-term resource exploitation (Costanza et al., 1998). Examples of ecosystem services related to biodiversity include amongst others pollination, protection against erosion, maintenance of soil fertility and genetic resources for medicine (FAO, 2016).

After introducing the research question, the purpose of the study and providing the academic background of the topic, the next part of the study presents the ontology, epistemology, methods as well as the theoretical considerations the study is built on.

PART II: THEORETICAL AND PRACTICAL MOTIVES

3 Framework

3.1 Ontology and Epistemology

The reality this study is interested in is the one constituted by words and expressions used to describe the state of unsustainability in social-ecological systems. This is to say that the ontological reality of the living environment is extended by its social and communicative sphere.

As elaborated previously, the term biodiversity developed rather recently in literature spanning the academic and political discourse. Within academia, the fields of biology, ecology and conservation biology subscribe to a natural science ontology rooted in realism. Particularly ecology with its focus on observing, modelling and theorising about the relations between living organisms and their environment follows these tracks. Ladle and Whittaker (2011), when describing the origins of conservation biology as the praxis oriented relation of ecology, make a striking point about the complexity of dealing with biodiversity. Based on Jeffries' argument (2006), their claim is that despite being a scientific and technical term, any study of biodiversity even has an ethical and social dimension. This assertion is important since it means that the questions surrounding the concept of biodiversity need to be approached even from its social meaning. As discourses do not stand alone but overlap and influence one another, the concepts of biodiversity and conservation evolved in a duet where meaning created in one sphere was adopted, elaborated on or rejected in another sphere, signifying a dialectical evolution.

In sustainability science a common mode of exploration is the transdisciplinary approach of collaboration amongst researchers from different disciplines, politicians and practitioners in order to solve problems of unsustainability in complex social-ecological systems. For this purpose scientific inquiry in this field of research necessarily invites perspectives from other disciplines and subsequently may adopt their vocabulary in a unifying fashion (L. Olsson, Jerneck, Thoren, Persson, & O'Byrne, 2015). To question and deconstruct this praxis, the present study does not examine epistemological or ontological foundations of work done in ecology and conservation biology, but the meaning that biodiversity has taken in the discourse produced by sustainability scientists as a result of integrating biodiversity loss as a core challenge of sustainability.

Inspired by Hannigan's analysis of biodiversity as a narrative and constructed problem based on claim-making by environmental social movements (Hannigan, 2006), this study places its spotlight on the scientific community of sustainability scientists. Subscribing

to a soft social constructionist ontology and epistemology is quintessential in this regard in order to avoid the fallacy of reducing environmental reality to nothing more than a narrative, since the threats to survival due to over-exploitation, environmental degradation and global warming are not governed by words alone. The central task at hand is further not to question the validity of documentations of species extinctions, habitat loss and declining wildlife abundance but to demonstrate that the social constructions that frame these issues form an integral part of the "dynamic social process of definition, negotiation and legitimation" (Hannigan, 2006, p. 31) - similarly expressed by Burningham and Cooper (1999, p. 304).

A constructionist approach of investigating the limitations of current conceptualisations within the academic discourse is not uncommon. Phenomenological constructionism has an articulated interest in how social groups and their dynamics administer the emergence and maintenance of environmental problems (Demeritt, 2002). In addition, studies conducted from within sociology of scientific knowledge based on a strong programme have attempted to study both sides of scientific controversies with regards to environmental problems by focusing on the constructions of nature evident in these debates (Demeritt, 2002). Whilst these kinds of studies initially rejected passing moral judgment on constructed phenomena or taking sides, Scott, Richards and Martin (1990) found that in reality the analyst's work is prone to favouring the underdog in the debate. To recognise the actuality of a weak programme of enquiry is thus more authentic than hiding behind the veil of neutrality of a positivist analysis of the scientific debate. This implies that a critical analysis of a scientific debate and participating groups also contributes to the debate itself.

3.2 Method

In scientific debate concepts and ideas are used in order to strengthen rational arguments. Apart from the form of the argument the choice of examples provides strength and reliability, enhancing the prospects of convincing the reader that the point raised is valid. Under these circumstances scientists tend to employ concepts that lend strength to their case, be it argumentative or in social sciences at times ethical and moral. Using a concept in an academic text is hence a conscious decision containing choice and purpose. It is therefore not only interesting but even conducive for a better understanding of the scientific debate to infer what lies behind these choices made by authors and what effect their utterances have conventionally (Vuori, 2008, p. 305).

In order to examine the meaning that the concept ‘biodiversity’ carries in the scientific community of sustainability scientists, a content analysis is conducted. Compared to previous works on biodiversity in other fields, such as Wilson (1988) and Takacs (1996), which respectively relied on contributions from authors in the field and interviews of leading researchers on biodiversity, this study commits to an unobtrusive method (Weber, 1990, p. 10). This allows for an analysis that distances itself from the praxis of biodiversity in ecology and conservation biology and instead focuses on the term as subject of interest in the interdisciplinary field of sustainability science, engaging particularly with the social sciences immersed the field.

The content analysis is qualitative due to its interest in latent meaning that is ‘hidden’ between the lines or behind expressions implying certain forms of reasoning and valuation (Halperin & Heath, 2012). In addition to the relevance of the concept for policy, the literature review produced in this study on different forms of conceptualisation and valuation implied in biodiversity contributes significantly to an evaluation of how sustainability scientists operate in relation to the research agenda identified during the early stages of the field of study.

For the content analysis three academic journals commonly regarded as the mainstream journals for publications in the field of sustainability science are chosen. These are ‘Sustainability Science’, ‘Sustainability: Science, Practice & Policy’ as well as the section in ‘Proceedings of the National Academy of Sciences of the United States of America’ (PNAS) titled ‘Sustainability Science’. For the purpose of the present study it is essential that the material analysed is unequivocally associated with sustainability science, a precondition that is met given the researchers submissions to and agreement to publish in the above mentioned journals. The publications were limited to the period of 2006 until the end of 2015. In 2006 the chosen journals were established, as well as that it was the year that PNAS established its section on sustainability science in its publications. Choosing 2015 made sure that the same period was covered due to different publication intervals among the journals. Further, only articles from these journals were included whilst commentaries and book reviews were excluded in order to retain focus on research activities dealing with biodiversity.

The journal issues were scanned for articles that were relevant to answering the research question in the sense that they took up the topic of biodiversity or related aspect that was raised during the biodiversity literature review (section 2.2). Due to the size of the corpus of literature, which spanned 10 years and in the case of PNAS weekly publications, the selection of articles to be examined was based on the titles and subtitles. The choice of keywords in titles and subtitles was based on the historical development of biodiversity in

ecology and the widely recognised praxis of ecosystem service approaches in conservation biology.

Biodiversity	Biology, Ecology	Operational schemes
biodiversity	species	ecosystem service
(biodiversity) hotspots	landscape	conservation
habitat fragmentation	biomes	reserve
land-use/ land-cover change	biotopes	agroforestry
	extinction	sustainable resource use
		refuge
		ecotourism

Table 2: List of keywords for identifying relevant articles

A large number of articles could be identified to be relevant since the term biodiversity was part of the title. Also the mentioning of conservation strategies and particular species or taxa investigated in the studies are interpreted to indicate that the article is in some regard working with or mentioning the concept of biodiversity. A number of publications from the journals referred to ecosystem services, particular biomes and biotopes, natural resource, land-use or environmental management and are thus included as well.

The texts are searched for sections containing '*divers*' as a way to account for different formulations of 'biodiversity', including 'biological diversity', 'diversity of species/ ecosystems/genes', 'genetic diversity', 'biologically divers' and others. In a next step the sections of the articles that referred to biological diversity were read closely and relevant sentences and segments transferred into a table. As a way of contextualising the extracted text segments, the introduction and conclusion parts of the articles were read to formulate a summarising statement about the article. Further influence on the summary came from the presence of signalling statements and keywords that expressed the employed conceptualisation of biodiversity in the article. For instance, human-wellbeing was understood as signalling the authors' understanding of biodiversity relating to how human living was affected by the presence of a diverse ecosystem. Similarly was proceeded with keywords such as 'resource', 'ecosystem service', 'carbon sequestration', 'extinction' but also broader statements referring to invasive species, agricultural praxes, development or the Convention on Biological Diversity. Taken together with the background information of the research and the initial literature review of sustainability science (2.1) and biodiversity (2.2),

the summarising statements provided the material on which broader, reoccurring discussions and topics in the literature are identified.

3.3 Contribution and Limitations

The contribution of this study to sustainability science as a field consists first and foremost in reminding the community of sustainability scientists about the weight the understanding of biodiversity and its valuation has for how we approach and formulate solutions. For this purpose the study provokes reflection and invites scholars to go back to the originally formulated research agendas established in the early hours of the field (Clark & Dickson, 2003; Kates et al., 2001). When it comes to discussing biodiversity within the frame of sustainable interactions in complex nature-society systems, the approach taken and its findings invite new forms of reasoning and arguing for why the biological diversity of ecosystems, species and genes is worthy of conservation. Lastly, this reinvigorates debates concerning the place of mankind as an element of nature.

Despite the potential to provoke and invite philosophically grounded debate on how we relate to nature, the scope of the conducted research is still limited. Due to the ongoing development and solidification of the field of study many researchers new to sustainability science may opt to publish in journals that are more closely related to the scientist's disciplinary background or that of their research. The inclusion of only three journals thus limits the generalisability of the findings. This means that this study cannot lay claim to be covering all sustainability science research published concerned with biodiversity, it rather covers the mainstream. Further it has to be proclaimed that the discursive use of biodiversity documented in this study cannot be solely associated with the opinion or conviction of the authors of the selected articles as the material is influenced by the editors of the chosen journals.

Lastly, the findings presented in part three refer only to the latent meaning of the texts themselves. The actual use of the concept of biodiversity also depends on the citation network surrounding the scientific publications of sustainability science and related disciplines. In order to uncover how meaning was established and evolved in this wider scholarly context, a diachronic analysis of the concept biodiversity is needed.

4 Theory

The present study does not seek to develop a theoretical framework by applying or critiquing previous work, rather, it takes impetus from theory in order to identify where to look and what to look for in the material. In this regard critical theory assumes importance as it inspires to evaluate the status quo of social reality. Its aspiration is to reveal possibilities for change as well as elements that can be fostered and developed upon (Marcuse, 2009).

The reference to moral philosophy and its debate concerning anthropocentrism and ecocentrism represents the second angle to approach the topic. It guides the fundamental questions of biodiversity valuation away from methodology on how value is made quantifiable and comparable. Instead the distinction between human and nonhuman-centred moral perspectives helps to direct the study towards what values and obligations actually operate the debate.

Lastly, reference to the three big schools of Western moral philosophy operationalises the perspectives on moral considerability into a formulation of ethics. Elaboration on utilitarianism, deontology and virtue ethics consequently helps the project of critical theory by making explicit current practices, but also enabling the imagination of alternatives to the status quo in sustainability science.

4.1 Critical Theory

The present study relates to critical theory in two distinct meanings. On the one hand it acknowledges the differentiation between problem-solving and critical theory popularised by Robert Cox (1981). On the other hand the study is indebted to the Frankfurt School and the first-generation critical theory writings that it produced.

Fischer et al. (2007) developed in their article on the ‘sustainability gap’ a critique of short-term pragmatism that is rooted in the dominant governmental and institutional set-up and therefore does little to break the “trajectory of increasing un-sustainability” (p. 623). What instead is called for is a stronger incorporation of the humanities and social sciences to lead discussions on values and foundational issues in the otherwise largely natural science-run discourse of environmental degradation and unsustainability (Fischer et al., 2007). Based on the distinction Robert Cox (1981) made, the type of research that exposes long-held beliefs and values differs from the problem-solving theory approach in that it critically questions how a status quo came about and which concepts and institutions form part of the

power relations as they stand at that moment. Placing the concept of biodiversity under scrutiny is a constituent of this type of research.

The interest in power relations is not a stand-alone element of what Cox identified as critical theory but also has a long tradition in Marxist theory. It also featured in the agenda pursued at the Institute for Social Research at the Goethe-University in Frankfurt, better known as the Frankfurt School. The sociological legacy of early Frankfurt School writings, particularly Horkheimer, Adorno and Marcuse, consists of a framework relating humanity's domination of nature to the domination of humans in society and the domination of human nature itself (Gunderson, 2014a). The rejection of instrumental rationality as mastery over nature, contextualised as "society's troubling relationship with animals" (Gunderson, 2014a, p. 285), this strand of sociology serves as inspiration for the present review of sustainability science. It is however important to highlight that taking inspiration from the Frankfurt School does not equate to an epistemological interest in human-non-human-animal relations alone. Since biodiversity refers to species, genetic and ecosystem diversity, an openness to natural holism is necessary. An interest in biodiversity has too often been attacked for resulting in oversimplifications and regarding the term as synonym for species diversity, a fallacy that has to be avoided (Dempsey, 2015).

4.2 Anthropocentrism and Ecocentrism

The way we conceptualise the relation of nature and society in sociological terms is closely connected to views originating in moral philosophy. Where a perspective places intrinsic value and how this value is regarded to stand in relation to instrumental values (*summum bonum*, the principle of value hierarchy) results in different conclusions that set anthropocentrism and ecocentrism apart. That intrinsic values do exist but need to be located is assumed since the alternative would lead to value regression in which instrumental values are contingent on other instrumental values (Markku, 1997b). Apart from ethical considerations aesthetics can provide yet another motivation for conservation stemming from outside moral philosophy. For this study aesthetics is however not engaged with in a philosophical manner but instead simplified and grouped under non-materialistic anthropocentric views of the environment

Anthropocentrism describes the centrality of humans in experience and valuation. It places the "treatment of nonhuman nature outside the realm of morality except insofar as it has an effect on our fellow humans" (McShane, 2014, p. 84). Thus, for anthropocentrism the satisfaction of human interests is an intrinsic value, it provides the *summum bonum*. In order

to satisfy human needs, other things, including nature, are of instrumental value as they are means to serve human preferences (Markku, 1997a). Anthropocentric views of nature can further be subdivided into two different sets of perspectives. The materialistic strand places nature and its resources completely at human disposal, meaning that nature exists for the use by humans for their well-being and subsistence. This conceptualisation is often associated with processes of commodification and a reliance on the market as an allocation principle (Lambacher, 2007). The second set is non-materialistic but instead has human experience of nature as its focal point. Here rituals, religion, traditions, recreation and aesthetic experience are characteristically elements that grant nature value in the eye of the beholder. Traditionally anthropocentrism has been regarded as a perspective that tends to rely on instrumental rationality (Lambacher, 2007). Constraints on human behaviour in nature, for instance in the context of biodiversity, are contingent on how the actions of someone affect the satisfaction of preferences of another human.

Ecocentrism on the other hand grants moral relevance to natural wholes of which humans are conceived as being part of rather than separate from. This holistic perspective maintains that ecosystems are objects of moral consideration (Lambacher, 2007). A distinct feature of ecocentrism is its regard for holism in contrast to individualism. So whilst anthropocentrism may allow human preferences to be directed exclusively towards human well-being, even if these preferences are destructive to the environment, ecocentrism claims that the satisfaction of these preferences creates disvalue to the ecological community at large and therefore also to humans (McShane, 2014). Ecocentrism is also attentive to and cognisant of the relations and interdependencies between entities of a community as a whole. Consequently it a perspective that goes beyond materialism in that it values the non-material bonds between elements as constitutive of the value of the ecological whole (McShane, 2014). Often articulated views of ecocentrism are those advanced by Aldo Leopold (the ‘land-ethic’) and Arne Naess (deep ecology). Both versions of ecocentrism have had an impact on political ecology, inspiring green parties and social movements (McShane, 2014).

4.3 Normative Moral Philosophy

The perspectives of anthropocentrism and ecocentrism find their application for environmental ethics in the schools of moral philosophy described in this section. In normative ethical theory utilitarianism presents the most widely accepted consequentialist theory. The rightness of an act is in this case determined by the Good alone that the act

produces. In its utilitarian version, this theory hence advocates the course of action that provides the most utility towards the attainment of happiness, commonly expressed as the “greatest happiness for the greatest number” (Happiness Principle) (Gunn, 2008). Due to the reliance on happiness non-sentient entities such as in-animate objects, species and ecosystems are excluded from moral relevance. Despite sentient individual organisms’ potential of relevance, utilitarianism is commonly associated with anthropocentrism (Gunn, 2008).

The second school that takes judgments of actions as foundational is deontology. In deontology it is however the Right of an action that provides moral guidance. Therefore this school of moral philosophy describes duty and obligation as ground to act on, most famously in the anthropocentric human dignity proposition by Kant, saying to “treat others as ends withal and never as means only” (Callicott, 2015, p. 60). Ecocentric deontological ethics in contrast advocates intrinsic values in nature, such as in ecological communities, as commanding obligation and duty (Katz, 1985).

Virtue ethics are different from utilitarianism and deontology in that they do not establish rules concerning moral action but instead infer about what virtues of an agent are conducive of a good life. Human flourishing, or eudaemonia, is regarded as the guiding principle. “The claim […] is that a virtuous person is happier—or at least living a better life, eudaimonia—and the virtuous person is, in turn, one who has the virtues” (Altshuler, 2014, p. 472). Further, this means that cruelty towards animals, for instance, is not problematised on the grounds that it might convert into cruelty towards other people, but rather since cruelty in and of itself is a vice and therefore should be refrained from.

After having presented the framework and method as well as the theoretical underpinnings of the study, the next part proceeds with the presentation of the results.

PART III: DISCOURSE OF BIODIVERSITY IN SUSTAINABILITY SCIENCE

5 The Idea of Biodiversity in Sustainability Science Literature

5.1 Results overview

The analysis of the mainstream journals of sustainability science was based on an initial list of 105 articles that corresponded to the selection criteria described above. Of this number only 79 were found to directly engage with the topic of biodiversity, 55 of these stemming from Proceedings of the National Association of Science, nine from Sustainabiliy: Science, Practice & Policy and 15 from the Sustainability Science journal. The articles that were not included in the final list where those that did mention for instance a biotope in the title but did not make any statements about its biodiversity. Similarly, articles referring to ecosystem services within for instance the context of a reserve did not necessarily pursue any connection with the biological diversity of the area.

The second section of the results (5.2) will summarise how sustainability scientists conceptualise and employ biodiversity in their research. It will bring forward in which way sustainability science problematises the issue of a continuing loss of diversity as well as which approaches are suggested as solutions.

The third section of this chapter (5.3) places the issue of biodiversity loss in the context of sustainable development as the most common governance approach of the field of study. In total there were 15 articles found that engage in this debate, most referring to conservation and development. Whilst the topical nexus binding together poverty alleviation and nature protection is not new (Hannigan, 2006, p. 127), the focus of some authors was projected forward and directed at agriculture and the relation between conservation, agricultural intensification and food security.

The fourth section provides an answer to which forms of valuation are expressed in the literature about biological diversity. The first sub-section (5.4.1) summarises the results indicating that biodiversity is linked to utility. Almost a quarter of the articles (19 out of 79) did make this connection. This corresponds to being the single biggest group of articles making statements about the value of biodiversity, mostly interpreted as being essential for human well-being due to connected ecosystem services. The second sub-section (5.4.2) highlights those cases in which authors in a differentiated manner participate in the discussion concerning the value ascribed to biodiversity. Authors in this group show awareness of alternative forms of valuation and separate between utility and other reasons for conservation such as aesthetic and cultural reasons.

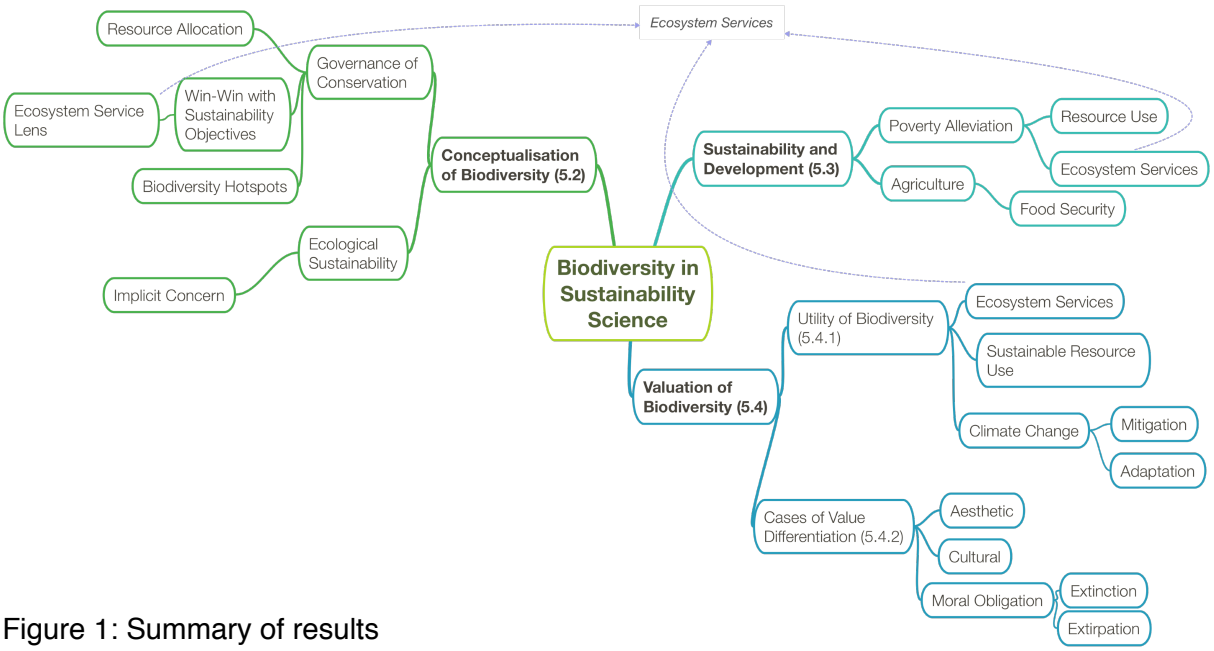

Figure 1: Summary of results

5.2 Biodiversity in Discourse, Conservation and Sustainability Praxis

The analysed sustainability science literature revealed that the concern for biodiversity evolves around current conservation praxis and how conservation overlaps and provides win-win situations for sustainability. A reoccurring concept in this regard is the notion of biodiversity hotspots where a number of studies were situated. Also, governance enhancements such as more efficient resource allocation and an ecosystem service lens were brought up repeatedly.

Conserving the diversity of biological life has been identified in the literature as an integral part of sustainability. The relation between biodiversity and sustainability is however at times postulated differently. For instance, Aryal, Brunton, Ji, Barraclough & Raubenheimer (2014) and Schroeder (2008) make reference to ecological sustainability, positing that in order to be ecologically sustainable, ecosystems and biodiversity are necessarily preserved. Strassburg et al. (2014) take a more general approach by including biodiversity under the umbrella term of a "long-term sustainability challenge" (p. 131). Xie et al. (2011) on the other hand refer to traditional agricultural systems in order to highlight that these systems succeeded in delivering food whilst protecting biodiversity, a feature that the authors identify as a sustainable system. In contrast, other authors (e.g. Driscoll et al., 2014; Dullinger et al., 2013; Essl et al., 2011; Gadda & Gasparatos, 2009; Haberl et al., 2007; Laurance et al., 2006; and Radeloff et al., 2010) remain vague in regard to how biodiversity ties to

sustainability. Driscoll et al. (2014) for instance argue that “[e]nvironmental weeds threaten biodiversity, compromise ecosystem function, and cost billions of dollars to manage each year” (p. 16622). Their formulation presents well-established arguments concerning the use value of ecosystems due to their function as well as an explicit reference to monetary value expressed in dollars lost due to management costs. The threat to biodiversity on the other hand is a vague mentioning; the authors remain implicit in this case as to why loss of biodiversity would be of concern.

Making conservation praxis more efficient was a concern in the literature, particularly in regard to resource allocation and spending, management schemes as well as governance approaches. When giving possible management improvements the focus tended to be on how to make enhanced information and data sets available or where and how to enact locally-adjusted management plans (Asner et al., 2009; Candace & Shannon, 2008; Caro, Delibes-Mateos, Viñuela, López-Lucero, & Arroyo, 2015; and Somanathan, Prabhakar, Mehta, & Ostrom, 2009). Secondly, authors investigated how biodiversity conservation schemes could provide win-win situations with other objectives of sustainability such as increased performance of ecosystem services or contributions to poverty alleviation (Andam et al., 2010; Ferraro, Hanauer, & Sims, 2011; Phelps, Carrasco, Webb, Koh, & Pascual, 2013; and Yoshikawa et al., 2011). Andam et al. (2010) found in this context “that protecting biodiversity can contribute to both environmental sustainability and poverty alleviation, two of the United Nations Millennium Development Goals” (p. 9999). Golden et al. (2011) argue in the same vein and integrated the issue of environmental protection in a biodiversity hotspot with that of health, looking at wildlife huntings effect on animal populations and the nutrition of children. Their conclusion is that in the future “conservation policy makers and health practitioners must implement integrated conservation and development solutions to mitigate both the effects of wildlife loss on human health and livelihoods, and the potentially severe consequences to biodiversity” .(ibid, p. 19655)

Biodiversity hotspots were mentioned in seven more articles (Bode et al., 2008; Chen, Lupi, He, Liu, & Daily, 2009; Kark, Levin, Grantham, Possingham, & Kareiva, 2009; Kumar & Takeuchi, 2009; Seto, Güneralp, & Hutyra, 2012; Strassburg et al., 2014; Zimmerer, 2013). The concept was proposed by Myers (1988) and describes areas with high percentages of endemism, often measured with endemic plant species found in the region as well as high levels of habitat loss (Zachos & Habel, 2011). Designating biodiversity hotspots was a reaction to the need to streamline conservation funding and to direct it at those places where a large number of species could be protected in a coordinated fashion. Of sustainability science articles relying on biodiversity hotspots four employed it as a criterion for choosing their study site (Kark et al., 2009; Kumar & Takeuchi, 2009; and Zimmerer,

2013). The other studies were conducted in reference to how human behaviour and process such as urbanisation may impact the diversity contained in hotspots (Chen et al., 2009; and Seto et al., 2012). Bode et al. (2008) used the idea to proof that conservation spending has to take into consideration socioeconomic factors when making decisions on which taxonomic groups to protect. Often authors expressed hopes that conservation praxes that contributed to win-win situations would have a better chance of succeeding in their social and ecological objectives, thereby mutually strengthening the commitment to sustainability.

Another reoccurring interest was how conservation decisions, particularly about resource allocation, are being made. The expressed concern related in several cases to cost-effectiveness, as for instance highlighted by Somanathan et al. (2009): “Conserving wild areas in developing countries is generally less costly and has higher benefits in terms of biological diversity than doing the same in developed countries” (p. 4143). Also Carwardine el al. (2008) point to the need to improve investment decisions, given that “[t]he identification of priority areas for biodiversity conservation at a global scale is essential for informing the strategic allocation of globally fungible resources […]” (p. 11446).

For further governance improvements the authors looked at synergies that had been overlooked or were underrepresented until that point. One possibility taken up by authors was the potential of an ecosystem service lens in conservation (e.g. in Berkes, 2007; Goldman, Tallis, Kareiva, & Daily, 2008; Kenward et al., 2011; Naidoo et al., 2008; P. Olsson, Folke, & Hughes, 2008). Kenward et al. (2011) express their interest for ecosystem services in the aim of their study, which was to “identify governance strategies that may benefit three conservation outcomes, namely: (i) enhancing delivery of ecosystem services; (ii) ensuring sustainable use of natural resources; and (iii) maintaining biodiversity” (p. 5308). Also a strengthening of stakeholder participation (Bateman et al., 2015; Berkes, 2007; and Richardson et al., 2009) and an enhanced focus on biodiversity hotspots (Chen et al., 2009) were proposed for the future.

Aside from the topics covered in this section, sustainability science often refers to development as an element that features in biodiversity conservation. How this relation plays out is described in the next section.

5.3 The Conservation-Development Nexus

The publications from the three sustainability science journals frequently engaged with the debate surrounding conservation taking place in areas subject to sustainable development plans. A particular concern in this regard was the reconcilability of limited access to natural

resources due to conservation with the prospects of reducing poverty. Further interest was directed at the relation between biodiversity conservation and a growing world population in need of agricultural products. In order to combine food security with biodiversity protection authors proposed an ecosystem service approach.

The conservation-development nexus is especially evident in studies that investigate poverty alleviation alongside nature reserves and restoration practices, often in developing countries (e.g. Andam et al., 2010; Birch et al., 2010; Phelps et al., 2013). Researchers have therefore been looking into the reality of win-win situations for biodiversity protection in areas with high diversity and poverty - such as ecotourism (Berkes, 2007; Goldstein et al., 2006; Zhenguo, Lee, & Xueli, 2009), but also whether such protection can result in the perpetuation of poverty traps (Ferraro et al., 2011; Halpern et al., 2013; Nautiyal, 2011). Ferraro et al. (2011) claim in this context that "[a] fundamental concern surrounding the establishment of protected areas, particularly in developing countries, is that ecosystem conservation goals may conflict with poverty alleviation goals by reducing incomes or perpetuating poverty traps" (p. 13913). Birch et al. (2010), however, arrive at the conclusion that conservation as restoration and poverty reduction are compatible: "Given the evidence that restoration can enhance both ecosystem services and biodiversity, reforestation of degraded lands provides an opportunity to achieve both conservation and socioeconomic development goals" (p. 21928). In general terms, the possible conflict between protection of nature on the one hand and resource use on the other is to be considered to run along the lines of short-term versus long-term gains (Koh, Ghazoul, & Polasky, 2010).

Apart from the debate of how conservation of biological diversity affects the chances for economic development, research has focused on the relation between agriculture and biodiversity. One reason for this interest is the projected population growth during the next decades accompanied with an increased need for food. Given the prospect of further intensification in agricultural production in order to contribute to food security, Clough et al. (2011) explored the increased pressure put on biodiversity. Under these circumstances synergies between biodiversity protection, ecosystem function understood as services (for instance in the case of pollination) and food production were investigated (Fischer et al., 2010; Hill, Miller, Newell, Dunlop, & Gordon, 2015; Phelps et al., 2013; Werling et al., 2014). Chan and Daily (2008) as well as Mendenhall, Sekercioglu, Brenes, Ehrlich and Daily (2011) call for the harmonisation of agricultural production and biodiversity conservation. Snapp et al. (2010) elaborate on conservation and development in the African case of stalling agricultural productivity under conditions of decreased rain fall. They come to the conclusion that legume diversification can positively contribute to environmental and food security. Further than discussing development, poverty alleviation and agriculture, agrobiodiversity

was raised as a topic in two articles (Rasul, 2009; and Zimmerer, 2013). Agrobiodiversity is a rather recent concept that is related to and derives from the notion of biodiversity. In 1999 the Food and Agriculture Organisation of the United Nations defined it as "[t]he variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture, including crops, livestock, forestry and fisheries. It comprises the diversity of genetic resources (varieties, breeds) and species used for food, fodder, fibre, fuel and pharmaceuticals. It also includes the diversity of non-harvested species that support production (soil micro-organisms, predators, pollinators), and those in the wider environment that support agro-ecosystems (agricultural, pastoral, forest and aquatic) as well as the diversity of the agro-ecosystems" (FAO, 1999).

The employment of the concept in the sustainability science literature is at the moment limited, proponents of the concept however echo similar concern over the utility of biodiversity to human well-being as highlighted in the next section.

5.4 Valuation of Biodiversity in Sustainability Science

5.4.1 Utility of Biodiversity

As discussed in the literature review of biodiversity (section 2.2), the conservation of diversity in the biosphere is regularly brought into relation to ecosystem services. The attempt to provide a strong case in favour of conservation activities is made by reference to the utility and contribution to human well-being that comes from ecosystem function. Valuing biodiversity in a utilitarian way is the main approach in the sustainability science literature with almost a quarter of the reviewed articles arguing in this fashion.

A number of articles build their argument on the connection between biodiversity and regulating and provisioning ecosystem services (Berkes, 2007; Nautiyal, 2011; Nelson et al., 2008; Reyer, 2009; Werling et al., 2014). This relation of utility and biodiversity is for instance obvious when Reyer (2009) states that "[t]he Amazon region harbors enormous plant and animal biodiversity that provides substantial regional and global ecosystem services" (p. 38). A further statement that expresses the weight of utility in the debate is made by Subramanian (2010) explaining that her "paper seeks to focus on the place of biodiversity in the discourse on sustainability, through the lens of biodiversity as a commodity that provides utility (whether monetary or not) to human well-being" (p. 80).

Many authors rely for their expressions of utility on economic valuations, as for instance in the sustainable use of biodiversity and its products (e.g. Kenward et al., 2011;

Subramanian, 2010; Walker et al., 2009) or through calculations of monetary worth of ecosystem services (Liu, Li, Ouyang, Tam, & Chen, 2008). Their concern is summarised by Alger (2006) when discussing the significance of "a continuing policy lag that delays even further the comprehensive incorporation of the total cost of biodiversity and ecosystem service loss in the prices of goods (e.g., soybeans, minerals, timber, bushmeat) […]" (p. 30).

Furthermore, articles that exhibit the triangulation of biodiversity, utility and ecosystem services make a case for identifying win-win situations and trade-offs between environmental protection and services provided by ecosystems (Mycoo & Gobin, 2013; Nautiyal, 2011). Halpern et al. (2013) posit that "[t]rade-offs can place in conflict those who prioritize economic versus biodiversity (or service) value; but in other cases, biodiversity conservation and economic value positively covary, such that strategic planning can deliver win–win solutions" (p. 6629). Some authors take up the notion of strategic planning and turn ecosystem services into a design principle (e.g. Goldman et al., 2008; Kenward et al., 2011; Naidoo et al., 2008; and Richard, 2008). The central idea behind these proposals is to identify co-benefits and use these to guide the planning of protected areas and reserves. Goldman et al. (2008) explain the advantages by saying that "[e]cosystem service approaches to conservation offer a promising way to align conservation and production, simultaneously enhancing human well being and protecting Earth's biodiversity and life-support systems" (p. 9445).

The overlap of outcomes resulting from the categories of biodiversity conservation and ecosystem services is also referred to in the climate change discourse. Articles relating to this topic generally bring up biodiversity as a contributor to binding climate warming carbon (e.g. Goldstein et al., 2006; Rasul, 2009; Seto et al., 2012; Snapp et al., 2010; Vincent et al., 2014; and Wright & Wimberly, 2013). This connection gets emphasised particularly as a synergy of biodiversity protection and carbon sequestration through forest conservation (Ahrends et al., 2010). In addition to climate change mitigation, the diversity of species and ecosystems is also explored in the context of adaptation as resilience. Maintaining diverse ecosystems is found to be conducive of systemic resilience to climatic change in a marine and riverine context (Brander, 2007; and Poff, Olden, Merritt, & Pepin, 2007). Brander (2007) expresses this link by reminding readers about "the role biodiversity plays in maintaining ecosystem services and, in particular, resilience to climate change" (p. 19710). Similarly Petterson and Glavovic (2013) express their concern over that "[m]uch marine biodiversity remains unknown […], despite its importance in being strongly correlated with ecosystem productivity, ecosystem stability, and ecosystem service delivery" (p. 12).

Despite utility being the dominant framing of biodiversity valuation transpiring from the literature, some authors are attentive to alternative value formulations. These will be explored in the next section.

5.4.2 Cases of Value Differentiation

Discussions concerning other values of biodiversity apart from utility are engaged with only in a few publications. Some authors make valuation the core topic of their work whilst others make only short statements that exhibit awareness of the debate surrounding biodiversity in sustainability science.

The most common alternative form of valuation is to align biodiversity with cultural and/or aesthetic value (Bohnet & Konold, 2015; Clough et al., 2011; Goldstein et al., 2006). In the case of landscape management Bohnet and Konold (2015) declare that "[the] primary goal is to maintain cultural landscapes that play an important role in preserving biological diversity by, for example, keeping the landscape open, and contributing to the aesthetic qualities of the landscape". Aesthetic reasons are nevertheless not treated as an exclusive case for conservation, rather "[c]onservation of biodiversity in human-modified landscapes is [regarded as] necessary to protect rare and common species of aesthetic and cultural interest and to maintain ecosystem services, which are ensured by high species diversity" (Clough et al., 2011, p. 8311).

Another alternative formulation is presented in the article by Fikret Berkes in which he explicitly mentions a "moral imperative for conserving global biodiversity" and weighs it against the "moral imperative of protecting human rights and entitlements" (2007, p. 15191). Similarly, Joern Fischer et al. (2010), despite mentioning ecosystem services, take the step of saying that biodiversity is valuable in its own right (p. 19597), signalling a reference to an intrinsic value of biodiversity.

The most comprehensive approach to valuation of biodiversity in the journals of sustainability science was presented by Karp et al. (2015). Here the authors engage with the issue of valuation of conservation objectives. They propose a typology of action taken for the preservation of nature that separates between extinction risk (also elaborated on for the case of birds in Pimm, Raven, Peterson, Şekercioğlu, & Ehrlich, 2006), extirpation risk, evolution, naturalness, provisioning services, regulating services and cultural services.

The next part of the study will proceed with the discussion of the results presented up to this point. Analogous to the structure among the results chapters, the discussion will at first take up the issue of conceptualisation of biodiversity before turning to its valuation.

PART IV: CONSIDERATIONS OF BIODIVERSITY AND ITS VALUE

6 Critique of Biodiversity and its Instrumental Valuation

6.1 Biointegrity and Bioabundance as Alternative Concepts

Despite being widely used, the idea of biological diversity is not uncontested in academia. In this section two alternative conceptualisations describing nature are presented, providing perspective for how objectives for conservation can be related to in sustainability science research. The central concern of presenting biointegrity and bioabundance is not their soundness in ecological terms (even though compelling arguments in this direction exist), but rather to demonstrate how diverging conceptualisations pose challenges to the current research focus in sustainability science.

Already in 1994, only two years after the Convention on Biological Diversity was signed, Angermeier and Karr published an often cited article comparing biological diversity with biological integrity, another concept describing the composition of nature (Angermeier & Karr, 1994). Both concepts developed roughly during the same decade but with diversity being applied to terrestrial ecosystems whereas integrity was mostly operationalised in aquatic systems. Biological integrity was defined in 1981 by Karr and Dudley as “the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organisation comparable to that of a natural habitat of the region” (Karr & Dudley, 1981, p. 56). In their comparison the authors conclude that biological integrity is a more appropriate policy goal than that of protecting diversity. Angermeier and Karr (1994) fear that preference for biodiversity endangers the functioning of the ecosystem, given that diversity management goals favour higher diversity and productivity whilst misjudging ecological balances related to the integrity of the ecosystems. By retaining objectives related to diversity, practices embracing human interference, such as artificial nutrient enrichment or introduction of non-endemic species, persist as priority despite their detrimental consequences to integrity.

In accordance with ecocentrism, biological integrity is understood as comprising the biotic elements as well as the processes maintaining these elements within an ecosystem, thus giving relevance to non-material aspects compared to the biological diversity approach. Consequently, integrity is less prone to simplify the complex natural reality as often is the case with biodiversity, where species richness and diversity become the denominator of biodiversity at large. This common issue of ecologically inappropriate operationalisation (Büscher, 2014; Dempsey, 2015; Hannigan, 2006) was even documented in the sustainability

science literature (section 5.3) and will potentially lead to less favourable policy outcomes (Angermeier & Karr, 1994).

Even though to claim that biological integrity is in a position to replace biodiversity as a central component of sustainability scientists' work is far-fetched, it remains vital to stay attentive and openminded when it comes to dominant frameworks and their alternatives. In the case of integrity this point proves to be quite strong given its potential to re-conceptualise the debate about conservation and its role in sustainability based on alternative valuations that this concept invites for. Instead of tying conservation to instrumental forms of valuation, such as documented in section 5.4.1, biological integrity places value on what Karp et al. (2015) placed in their overview of valuation of conservation objectives under naturalness and evolution values. Further can it be imagined that emphasising integrity rather than diversity increases the strength of deontological impulses to not overexploit resources or refrain from activities related to extinction and extirpation risk. When it comes to nature-society interaction, biological integrity provides thus both incentives and guidance for action compared to biodiversity, which needs interpretation to produce advice.

Another potential challenge to the primacy of biodiversity in sustainability science approaches to nature-society systems is the notion of biological abundance. Recent studies have repeatedly highlighted the importance of abundance for overall functioning of ecosystems. In the context of climate change mitigation, which in the sustainability science discourse relates to biodiversity synergies with carbon sequestration, recent publications emphasise the importance of animal rather than plant abundance for carbon fixation (Roman & McCarthy, 2010; Schmitz et al., 2014; Subalusky, Dutton, Rosi-Marshall, & Post, 2015).

Combined, these findings challenge the present understanding in the sustainability science literature of tying biodiversity conservation to ecosystem service approaches based on forest conservation, since animal abundance has so far been ignored as a contributing factor. Apart from questioning the emphasis of proposed practises, considerations of bioabundance also weaken the justification of channeling conservation effort on the identified biodiversity hotspots. Utilising the idea of biodiversity hotspots (section 5.2) is a controversial act since the concept has become widely criticised. Not only does the designation of hotspots necessarily lead to what can be called 'coldspots' where conservation simply is not as deemed as efficient or profitable (Kareiva & Marvier, 2003). But also are such approaches to biodiversity protection vulnerable to accusations of arbitrary valuation based on diversity figures rather than function. Kareiva and Marvier therefore protest that "[i]f we measure success simply by tallying up total species protected, we risk the folly of allowing major ecosystems to degrade beyond repair simply because they do not provide lengthy species lists" (2003, p. 347).

As a recent publication by Steffen et al. (2015) documents, the two approaches of biological integrity and bioabundance represent not mutually exclusive alternatives for understanding our environment. Rather, in the updated publication on the planetary boundaries approach first presented by Rockström et al. (2009), the authors rely on both conceptualisations for the formulation of the planetary boundary called 'biosphere integrity' (p. 6), which previously was referred to as 'rate of biodiversity loss'. The new category encompasses both genetic diversity and functional diversity. The two indicators exhibit an appreciation of the ideas of biointegrity and bioabundance, whilst moving away from the biodiversity approach. Despite the fact that the extinction rate is still used as control variable for genetic diversity due to a lack of alternative data, the authors are aware of the limitations this indicator brings along. For future assessments of the planetary boundary the researchers hope therefore to have gathered enough data to rely on biome integrity as a more appropriate control variable. For functional diversity the authors refer to the Biodiversity Intactness Index (BII) and population abundance relative to preindustrial levels to determine the boundary between the safe-operating space and the zone of uncertainty where possible irreversible effects can be the consequence (Steffen et al., 2015). Seeing the environment through another lens than biodiversity leads us to reconsider the dominant framings that come along with biodiversity, namely utility and the conservation-development controversy. Their underlying anthropocentric utilitarianism is discussed in the upcoming sections.

6.2 Disputing the Utilitarianism of Instrumental and Economic Valuations

Expressing the value of biodiversity as providing utility to human well-being due to ecosystem services is the dominant framing of biodiversity in sustainability science, as documented in section 5.4.1. Framing conservation of biodiversity in this manner has however been challenging since the connection between biodiversity and human well-being is not as straightforward as, for instance, water purification. Nevertheless did the adoption of market-based schemes such as payment for ecosystem services (PES) push the approach to new contexts of application and consequently even succeeded in shifting the development-conservation debate. The insights attained from this combination added to the understanding of the reconcilability between nature conservation and development (Gómez-Baggethun et al., 2010).

The utility approach implied by ecosystem services means to place humans hierarchically above nature and as the sole beneficiary of nature. This anthropocentric view of the worth of biodiversity and reasons to care about its decline are described as an attempt

to strengthen the case for conservation by translating the otherwise ecologically descriptive term into an essential element of life-support (Costanza et al., 1998; Dempsey, 2015). This section intends to refute this ethical perspective.

Relying on utilitarianism to argue for nature conservation has from early on drawn criticism for the "arbitrary nature of its criterion of moral considerability" (Pluhar, 1983, p. 112). To exclude nonhuman animals from moral considerability based on species-membership has been called speciesism (Gunn, 2008). Further has been argued that the approach hollows out motivation as to why we conserve elements of the planet given that their protection is contingent on our socially-learned interest (Krieger, 1973).

In addition to the criticism built on moral considerations, opposition against the current praxis in conservation has the foundations of economic theory as its starting point. This line of critique emphasises that the idea of *homo oeconomicus* as a blueprint human always seeking greatest personal advantage (Brzezicka & Wisniewski, 2014, p. 358) does not have sustainable development as meaningful interest (Faber, Petersen, & Schiller, 2002). Rather, as Kremser (2013) has shown, the *homo oeconomicus* idea only represents an academic axiom used for the emancipation of the field of economics from the social sciences and philosophy, moving economics towards natural sciences instead. As Birnbacher (2014) argues in the context of biodiversity valuation, "economists subscribe to some variant of welfarism (such as utilitarianism) or to some other monistic value system, whereas environmentalists typically favour pluralistic value systems" (p. 45). He explains this tendency among economists by the fact that value monism implies the possibility of substitutability, "whereas value pluralism does not" (p. 46). Behavioural economics have also taken up the charge and argue that decision-making of individuals is more nuanced than the homo oeconomicus allows for (Brzezicka & Wisniewski, 2014).

Tying the theoretical discussion of economics to the observed debate in sustainability science the conservation-development nexus (section 5.3) reveals a similar point. Biodiversity conservation is regularly placed as antagonistic to economic development, with the central task for future sustainability being the identification of win-win situations. Particularly the issue of food security and intensified agricultural production have in this context been strongly liked to biodiversity loss and hence need better plans of action. According to N. Czap, H. Czap, Lynne and Burbach (2015) the commonly assumed best praxis built on utilitarianism by providing economic incentives to prioritise long-term interests such as conservation over short-term economic gains is not the best solution just yet. Building on the weight of compassion and empathy in decision making (Singer & Klimecki, 2014) as well as following findings in behavioural economics, their research documents that empathy and nudging combined provide more positive results than the economic incentive

alone. Furthermore, their findings suggest that “empathy nudging can counteract the elimination of a financial incentive” (Czap et al., 2015, p. 154).

A second set of critique of committing to anthropocentric valuations of biodiversity has followed similar lines of argument as the criticism directed at payment for ecosystem service approaches at large (Arsel & Büscher, 2012; McAfee, 2012). Controversy surrounds mostly what is described as the commercialisation of biodiversity in form of biodiversity offsetting (MacDonald & Corson, 2012; Spash, 2015). Adopted by policy makers after a growing interest within the conservation community, biodiversity offsetting represents a next step to integrate development and protection of diversity (Coralie, Guillaume, & Claude, 2015; Dauguet, 2015). The means for achieving the goal of ‘no net loss’ in what is mostly related to species diversity (Gardner et al., 2013), biodiversity banks are established that can operate either commercially or non-commercially (Froger, Menard, & Meral, 2015). The central idea behind biodiversity offsetting is that the loss of habitat and hence loss in biodiversity, for instance due to development projects, is compensated for at another site which in exchange gains protection and becomes subject of restoration projects.

Critics of offsetting schemes have repeatedly documented that biodiversity banks fail to achieve their proclaimed goal of ‘no net loss’ (Gardner et al., 2013). Also, opponents of this market-based approach have pointed to the fact that plans of action often rely on dubious operationalisations with limited measurability (Maron et al., 2012). Particularly the issues of measurability and adequacy of offsetting operationalisation draws critique from ecocentric perspectives. Due to the emphasis ecocentrists place on ecological wholes, they criticise approaches taken by banks in which they use biological individualism as indicator for ‘no net loss’. Further do critics voice scepticism about the possibility of offsetting loss given the complexity of ecosystems and our imperfect knowledge about them (Maron et al., 2012).

This section set out to refute anthropocentric utility approaches. This was done on basis of their shortcomings in terms of moral considerability, weaknesses in underlying theoretical economics and by an extentionist argument starting from the praxis of biodiversity offsetting. The following section complements the argument by critiquing non-materialistic aspects inherent to anthropocentric valuations of biodiversity.

6.3 Disputing the Utility of Anthropocentric Valuations

A critique of economic rationale does not necessarily cover all possible points raised against anthropocentric approaches to biodiversity valuation. After having dismissed the underlying reasons for conservation, its methodology and its consequences, biodiversity conservation may still give primacy to human experience. As documented in the results section, a number

of analysed articles displays awareness of alternatives to the instrumental valuations covered by ecosystem services. Instead, these rely on aesthetic experience and cultural services (5.4.2).

The problems of anthropocentric valuation in this regard derive from the heightened valuation of meaning and experience compared to ecological function. Whilst forms of valuation based on indigenous knowledge may retain an underlying ecocentric perspective, recent policy advances propagating ecotourism as a source of income commit to anthropocentric views. Policy proposals arguing in this direction have been documented in this study as part of the conservation-development nexus (section 5.3). Consequences of strengthening aesthetics in landscape management are praxes that disregard the integrity of an ecosystem and its functions which are grounded in non-materialistic elements explored in ecology. Heink and Jax (2014) refer to dominating mental frames of species richness in a similar argument. They argue that the dominance of species richness as a measure of biodiversity results in misconceptions of the term biodiversity, which in science refers to the compositional, structural and functional character of diversity within an ecosystem. In praxis, as Hannigan observes (2006), some species (often described as charismatic or majestic animals) become a centrepiece of conservation whilst other living organisms such as fungi only gain a fraction of the attention (p. 129). Furthermore, ecotourism approaches attract other harms such as hotel development which may result in further depletion of local resources (Hannigan, 2006, p. 134). Investment and management choices are in this context therefore not based on ecological concern but on the weight of popular and dominant mental frames of biodiversity which appreciate experience whilst disregarding function.

The sustainability science literature reviewed in this study suggests that a materialistic focus, exemplified by the attention paid to species, is evident in the field. Tsuji et al. (2011) for instance document how the introduction of controlled species in bamboo forests can serve as successful pest-control. In their findings they conclude that biodiversity is necessary for the sustainable regulation of large-scale forests, equating the introduction of a few species with biodiversity (p. 106). Similarly, Naughton-Treves (2006) argue for the selection of their study sites based on the species richness and endemism in Peru and Ecuador. A strong species focus can also be found in the works of Clough et al. (2011), Snapp et al. (2010) and a recent study published by Driscoll et al. (2014) on environmental weeds and their effect on biodiversity. To focus on particular species and equate them with biodiversity is not only ecologically unsound; since it leads to a distortion of the analytical potential of the concept. It may even lead to policy choices that produce negative knock-on effects (Heink & Kowarik, 2010).

Further, the management of ecosystems according to human experience of it may fall victim to the fallacy William Cronon has called ‘getting back to the wrong nature’ (Cronon, 1996). The argument of this critique against the management of habitat and the environment is that the praxis is objectionable due to its role in rationalising conquest and colonisation as well as that what is regarded as pristine wilderness can be ecologically unsound because of wrong mental frames despite benevolent intention (Thompson, 2010).

Even though the arguments presented here against popular conceptualisations of biodiversity based on anthropocentric forms of valuation are hardly exhaustive, the issues taken up add to the critique of the concept as such and its position in the sustainability discourse. How the field of sustainability science engages with biodiversity has a profound impact on how we choose to value the diversity of life and policy action to conserve it. Relying on utility as the main reason to protect and conserve nature equates to value monism, which in turn is not only associated with substitutionally thinking despite imperfect knowledge about nature but also means to simplify the debate in society about how to interact with nature.

Following Pluhar (1983) “[a]n ethic is environmental if and only if it accords moral standing to some non sentient beings. Some plants, natural objects, or systems must count as being valuable in their own right. An ethic which classifies all such beings as merely instrumentally valuable would be, in Tom Regan's words, an ethic "for the use of the environment," not an environmental ethic” (ibid, p. 111). The next chapter will therefore turn to alternative approaches to the utilitarianism problematised here.

7 Environmental Ethics for Sustainability Science

7.1 Ecocentric Deontology for an Avoidance of Nature Exploitation

With value formulations based on utility being the dominant approach to biodiversity conservation in sustainability science, alternatives based on ecocentrism offer different motivations for the protection of nature. The first alternative presented here is an environmental ethic coming from an ecocentric deontology perspective as developed by Hugh McDonald (2001).

The centrepiece of McDonald's ethic is the holistic assertion that all life is conditioned by the biosphere which therefore has intrinsic value and takes moral priority in the construction of duties (p. 422). As such, humans are obligated in a first order to the biosphere and only in second order to singular species. In McDonald's word "obligations to the wild are […] i.e. to preserve the freedom of wild individuals to autonomy, freedom from the restrictions of domestication and the property of wild species, the autonomy of habitats. Leaving alone also involves not killing wild individuals" (p. 427). These obligations are however not to be extended to every individual of a species, but rather the superseding biosphere which means that the interest of one species, including homo sapiens, can not be universal (McDonald, 2001).

Coming from a psychological background but relating to ethical decision making, Baron and Spranca (1997) discuss the related matter of protected values. Protected values are those that can not be incorporated in trade-offs due to their nature of being immeasurable (ibid, p.2). The authors investigated the resistance to trade-offs for instance in accepting money as compensatory for the destruction of a forest area (ibid, p. 4). The explanation the study arrives at is that protected values are derivates from rules prohibiting particular kinds of action (ibid, p. 2), meaning that they originate in deontological ethical positions. In the same vein the categories extinction and extirpation risk, as mentioned in section 5.4.2 about alternative valuations in sustainability science, can be described as grounded in deontological standards. Karp et al. (2015) refer in their case to a duty that obligates humans to not commit certain acts (e.g. force species into extinction or decimate their abundance).

The case in favour of committing to a deontological environmental ethic refers back to the debate concerning the intrinsic value of ecological wholes such as communities. This, in turn, leads to the conclusion that the intrinsic worth obligates humanity to refrain from acts of substitution (Birnbacher, 2014). By sanctioning behaviour that transforms, exploits or harms the integrity of the biosphere, the duty-based environmental ethic supports the notion of

strong sustainability with restricted substitutionality, compared to weak sustainability which is the currently dominating view in sustainability science (Dedeurwaerdere, 2013).

7.2 Environmental Virtue Ethics for Sustainability

The second alternative approach to the utilitarian ethics of sustainability science comes from virtue ethics. When it comes to environmental virtues, Altshuler (2014) suggests that "what makes the destruction of nature wrong is that it displays character traits unsuitable to human beings, such as cruelty or a failure to appreciate beauty" (p. 471).

Apart from eudaemonic approaches in virtue ethics that may constitute an anthropocentric ethic, virtue ethics also constructs virtue through a constitutivist strategy. According to Altshuler, this strategy poses that the recognition of humans' animal nature gives rise to moral significance even in nonhuman nature, including plants and ecosystems. By recognition of similarities, such as feeling displeasure, humans are capable of transferring the valuation of what is good for oneself onto other natural beings. This way wanton acts that may endanger the good of natural beings are ruled out.

Inspired by Thomas E. Hill Jr., Geoffrey Frasz (1993) favoured an ecocentric ethic that had humility as its primary virtue. The explanation for why humility is a central environmental virtue is given by considering its opposite, the vice of arrogance (Frasz, 1993, p. 265). Seeing oneself set-apart from nature, with organisms as resource, means to be ignorant of the complexity of nature-society systems and ones place within these (ibid, p. 266). From this perspective it is the endorsement of humility and, as others would add, a feeling of gratitude towards nature (Altshuler, 2014), that would lead to a stop in the decline of biodiversity.

Despite the fact that environmental virtue ethics is still debated it provides a way forward in giving answers to the question posed by sustainability science question concerning incentives for sustainable nature society interactions. As Rottman (2014) hypothesises, ecocentric ethic approaches are more robust in providing environmentally sound judgements given their interest in long-term effects of actions. A sustainability science debate on biodiversity enriched with deontology and virtue ethics would therefore only contribute to finding the answers the field of studies and society are looking for.

8 Conclusion

The way we conceptualise and understand the issues surrounding biodiversity has an important bearing on what kind of solutions we seek. This holds also true for the value we attribute to the biosphere and in which ways we feel obligated by nature. Sustainability science has recognised the loss of biological diversity as one of the central issues of sustainability. Further does the field welcome critical reflection and questions concerning the sustainable interaction between nature and society based on rules and norms. Given the emphatic interest in the field, this study investigated the concept of biodiversity in sustainability science literature as an expression in nature-society systems.

In so far as the three mainstream journals of sustainability science are indicative of the field of study at large, sustainability science relates to biological diversity predominantly from a utility perspective. The approach is facilitated by the ecosystem service lens that seeks to emphasise the contribution of the environment to humanity's well-being. Further, the field seeks to contribute to the success of biodiversity conservation by making sure that resources are efficiently allocated and that operational schemes are developed that provide win-win situations between different objectives of sustainability. Lastly, sustainability science engages in the debate of sustainable development where it shows interest as to whether conservation and development can go hand in hand.

The value monism of assessing the environment according to its instrumental value towards the satisfaction of human interest represents an anthropocentric mode of reasoning that supports the idea of substitutability. This notion was contested on grounds of alternative conceptualisations of nature composition, namely biological integrity and bioabundance as well as ethical considerations. For the ethical critique of current valuations in sustainability science, the moral perspective of ecocentrism was combined with the moral philosophy schools of deontology and virtue ethics. The implications of subscribing to an deontological ethic is the increased sense of obligation towards nature and a case in favour of strong sustainability. Virtue ethics on the other hand provides arguments for conservation based on ecocentric virtues such as humility and gratitude and the avoidance of cruelty and arrogance.

Ultimately, Fischer et al. (2007) argued convincingly that in order to close the sustainability gap we must be willing to engage in an analysis of foundational issues that goes beyond "[…] institutional arrangements […] and must confront the ethical and normative dilemmas of modern consumer and aspirational societies" (p. 623). Thus far sustainability science has failed to participate in the "constructive discussion aimed at identifying core

values that can be sustained and that are worth sustaining" (ibid) when it comes to the biological diversity of planet Earth.

Leading an open discussion that builds on value pluralism is therefore the route to go beyond an "ethic of the use of the environment" and instead establish a balance between nature's "purpose-for-us" and nature's "purpose-for-itself". In order to achieve this we need to continue questioning our long-held beliefs and hold academia, including sustainability science, to the standards it sets for itself.

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