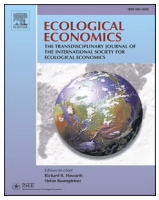
Ecological Economics 236 (2025) 108681

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon



Public perceptions of biodiversity and the value of its conservation

Kennet Uggeldahl [a,*], Søren Bøye Olsen [a], Thomas Lundhede [a,b], Jette Bredahl Jacobsen [a]

[a] Department of Food and Resource Economics, University of Copenhagen, Rolighedsvej 23, 1958 Frederiksberg, Denmark
[b] Department of Agricultural Economics, Extension and Rural Development, University of Pretoria, Hatfield, South Africa

ARTICLE INFO

JEL:
Q51
Q57

Keywords:
Biodiversity
Q-methodology
Stated preference methods
Valuation
IPBES framework

ABSTRACT

Nature and biodiversity are in an unprecedented decline. One of the main policy solutions for reversing this trend involves putting a monetary value on biodiversity impacts. However, one of the concerns about valuing changes in biodiversity using economic valuation methods revolves around the methodological assumption that the public accurately and adequately understands and perceives this inherently abstract and complex concept. Yet, few studies have investigated what the public actually perceives as biodiversity, and what their perceptions of its value are. We use Q-methodology to explore this. We find that the public's *perceptions of biodiversity* to a large degree align with the main elements of the scientific definitions of the concept, and also include concepts linked to biodiversity, such as naturalness, connectedness and balance. Further, we find perceptions of the *value of biodiversity conservation* to include instrumental as well as intrinsic values, with specific arguments such as a human responsibility to protect nature and biodiversity playing an important part. Our findings suggest that using more comprehensive representations of changes in biodiversity in stated preference studies, rather than the commonly used simplifying indicators, better aligns with people's underlying perceptions of the good being valued.

1. Introduction

The unprecedented decline in nature and the accelerating rates of species extinction (IPBES, 2019), have made biodiversity an increasingly focal topic for policymakers, and a wide variety of arguments for the conservation of biodiversity have been proposed. These range on a continuum where the extremes are highlighted by the dichotomy of whether nature should be protected for its own sake, or for our sake. Pluralism between these two extremes has been argued to be the norm within conservation practice (Armsworth et al., 2007) and also expressed by conservation practitioners (Berry et al., 2018; Primmer et al., 2017; Sandbrook et al., 2011). Utilitarian arguments have also increasingly been emphasized within conservation through the adoption of the concept of ecosystem services, which make the link between nature and human wellbeing explicit. The argument for this emphasis has been that "Nature for nature's sake resonates only with the already converted." (Armsworth et al., 2007, p. 1383). That human wellbeing depends on nature is also the main message in the recent policy-driven Dasgupta review (Dasgupta, 2021), which highlights the necessity of properly accounting for the value of nature in policymaking if the degradation of nature and biodiversity is to be reversed.

In a democracy, the opinions and preferences of the public should guide policymakers, also in matters related to conservation. Generally, surveys can be useful for assessing these opinions. Stated preference methods are often used to measure public preferences for biodiversity conservation measures and initiatives, and to estimate the value the public places on such conservation efforts in monetary units (see e.g. Hanley and Perrings, 2019). The outcome of such stated preference studies will depend on how the public perceives and understands the good in question, e.g. biodiversity. The public's low knowledge and poor understanding of the inherently complex concept of biodiversity has thus been used to question the appropriateness and validity of valuing changes in biodiversity using stated preference methods (Hanley et al., 1995; Bartkowski et al., 2015; Farnsworth et al., 2015). Hence, monetary values of biodiversity have been disregarded in some integrative approaches (e.g. Bateman et al., 2014).

Yet, despite the fundamental role in guiding conservation decisions in general, and the use of stated preference methods in particular, little is known about the perceptions of biodiversity held by the public (Bele and Chakradeo, 2021), or about the perceptions of the value of biodiversity. With this in mind, this study contributes to the literature by investigating two questions using an online Q-methodology study:

* Corresponding author.
E-mail address: kcu@ifro.ku.dk (K. Uggeldahl).

https://doi.org/10.1016/j.ecolecon.2025.108681
Received 18 April 2024; Received in revised form 25 April 2025; Accepted 9 May 2025
Available online 19 May 2025

1. What does the public associate with the concept of biodiversity?
2. What are the public's perceptions of the value of biodiversity conservation?

Furthermore, we investigate the correlation between the answers to these questions, identifying whether a certain perception of biodiversity is related to particular elements of biodiversity being perceived as valuable. We discuss the implications of the findings for the valuation of biodiversity using stated preference studies.

Past studies on people's perceptions of biodiversity have often considered a specific context, such as ecosystems or habitats (e.g. forests in Bakhtiari et al., 2014), natural areas of special interest (e.g. the Cairngorms National Park in Scotland in Fischer and Young, 2007), and urban green space (e.g. Campbell-Arvai, 2019). In contrast, we contribute to the literature by investigating the perceptions of biodiversity in a more general setting. While our study is not completely free of contextualization, as it concerns biodiversity in Denmark, it is arguably more generalizable than previous site- or habitat-specific studies.

2. Theory & Method

2.1. Values of nature & biodiversity

Nature and biodiversity provide multiple values and benefits to humans, and many concepts and frameworks exist to conceptualize these values (see e.g. IPBES, 2022). The aim of the current study is to provide input on how to ensure alignment between people's perception of the good when environmental valuation is conducted. Within valuation studies, values are often classified based on the concept of total economic value (TEV), where value is defined through the human use (e.g. direct or indirect use value, or option values related to the future use) or non-use (e.g. existence value or bequest or altruistic values) of the good. This, and the closely related, although more mission driven, concept of ecosystem services, which is one of the most widely referenced concepts when it comes to the values of nature, have been criticized for their narrow and anthropocentric focus on values (Anderson et al., 2022). In a recent assessment, IPBES (2022) presents a broader values typology which synthesizes multiple theoretical perspectives on values, based on concepts such as worldviews, broad values and specific values, and their relationships. These are organized and communicated using "Life frames", reflecting distinct sets of values found in the typology. The typology and the concepts they are based on will be the basis for the interpretations of the perspectives extracted from the Q-methodology studies, particularly the second Q-study concerning people's perceptions of the value of biodiversity. The typology is presented in Table 1, adapted from IPBES (2022, Figure SPM 2).

Worldviews can be considered the top level concept which shape people's values. The two dominant worldviews characterizing nature valuation studies are anthropocentrism and bio/ecocentrism (IPBES, 2022). A bio−/ecocentric worldview emphasizes that nature has a right to exist, and has intrinsic value, i.e. value on its own irrespective of its contribution to human wellbeing. On the other hand, an anthropocentric worldview implies that the value of nature is determined though its contribution to human wellbeing. Pluricentrism is more focused on the relationships between humans and nature.

Broad values act as guiding principles in life, and specific values relate to nature's importance or contribution in a particular situation. The ecosystem services concept, and the related TEV framework for measuring the monetary equivalent of the specific values, to a high degree fall under instrumental values, which are related to the direct usefulness for humans. In contrast to instrumental values, intrinsic values reflect the inherent worth of nature as an end in itself, independent of any reference to humans. Relational values reflect the value derived from people-nature interactions, and interactions among people through nature. While the TEV and ecosystem services concepts are per definition anthropocentric, and thus mainly serve to distinguish elements of instrumental value, some of the value categories of the TEV framework can also be seen as related to intrinsic (e.g. existence value) and relational values (e.g. recreational and bequest values).

The life frames can be used to illustrate the ways in which people conceptualize how nature matters, and reflect prioritization of different sets of broad and specific values. The frames overlap, but considering the specific values, the "Living from" frame emphasizes instrumental values and relational values, where these are related to sustaining nature for a prosperous human life. The "Living in" frame includes more considerations fitting an ecocentric worldview, such as intrinsic values, while still also including the anthropocentric instrumental values, such as recreational value. An eco-centric worldview characterizes the "Living with" frame, emphasizing intrinsic values and life-supporting values underpinning life on earth. In the "Living as" frame, the emphasis is on relational values.

In the interpretation of results from the Q-methodology studies in Section 4 we will use the broader IPBES typology and the life frames to describe the overall motivations for protecting nature, and further describe how these are related to value categories in the TEV framework, which the statements in the Q-studies largely are based on.

2.2. Q-methodology

The research questions in this paper are explored using Q-methodology, a semi-quantitative way to structure and identify different subjective viewpoints, perspectives and understandings that are shared by groups of individuals (Watts and Stenner, 2012). It is well suited for acquiring structured qualitative knowledge concerning people's perceptions of and preferences for relatively unfamiliar and complex goods such as environmental goods. As such, it has been suggested for informing and qualifying the survey development phase of the more quantitatively oriented stated preferences methods in general (Armatas et al., 2014; Jensen, 2019), and biodiversity valuation in particular (Strange et al., 2024).

Q-methodology essentially relies on asking a sample of individuals to sort a set of items related to a specific subject into a predefined distribution, *the sorting grid*, indicating a relative ranking of the items. Depending on the context, the items can be statements, pictures, objects, descriptions of behavior etc., and the scale of the sorting grid should logically correspond to the specific character of the items, e.g., ranging from "most unimportant" to "most important", or from "completely disagree" to "completely agree". Observed rankings from a number of individuals can then be analysed to identify clusters of respondents, often referred to as factors, that share a similar understanding or perspective of the specific subject in question.[1]

Q-methodology consists of these general stages:

1) Development of the study, including selection of the *Q-set*, i.e. the relevant statements/items that cover the subject of interest. The selections of items is often inspired by previous Q-studies, literature reviews, as well as focus groups and interviews with key stakeholders and experts.
2) Collection of the data, i.e. the *Q-sorts*, represented by the sorting of the *Q-set* into a predefined sorting grid, by the participants of the study. Traditionally collected though physical interviews or focus groups, but recently also using online surveys (see e.g. Meehan et al., 2022).
3) Data analysis. It should be noted that there is not a single mathematically optimal solution for how many factors, i.e. clusters of

[1] In theory, a respondent loading onto a factor means that the sorting of the statement is highly correlated with the factor. In practice, the significant correlations between respondents' sorts and the idealized sorts representing the factor, are often positive, indicating a strong agreement with the identified factor. However, these could also be negative, indicating strong disagreement.

Table 1
The IPBES typology for understanding values of nature.

Worldview	Anthropocentric	Anthropocentric	Bio−/ecocentric	Pluricentric
Broad values	Prosperity, livelihood	Belonging, Health	Stewardship, responsibility	Oneness, harmony with nature
Specific values:				
- Instrumental	X	X	X	
- Intrinsic		X	X	X
- Relational	X	X	X	X
Life frame	"Living from"	"Living in"	"Living with"	"Living as"

respondents sharing a similar perspective, to extract from the data, and that the decision usually involves a compromise between complexity and interpretability (Watts and Stenner, 2012).

4) Interpretation of the results. The results of the analysis are usually presented as the idealized Q-sorts, i.e. the distributions of the items to the sorting grid (see Fig. 1) which represent the shared perspective by the identified factors (groups of respondents). In interpreting the results, the focus is particularly on the most positive or negative items within a factor, as well as items that differentiate the factors from each other, referred to as *distinguishing statements* when the difference between factors is statistically significant. Interpretation can be aided by crib sheets, constructed by listing the statements a factor ranks the highest and lowest, and statements ranked higher or lower in the factor than in any of other factors (Watts and Stenner, 2012), as well as by the comments left by the respondents.

The stages are applied in the empirical case in Section 3.3. More elaborate and general accounts of the method, analysis and interpretation are given in e.g. Brown (1980), Watts and Stenner (2012) or Webler et al. (2009).

2.3. Empirical case

The two overall questions posed to respondents in the Q-methodology studies in this paper are:

1) What do you associate with biodiversity?
2) Why is protecting biodiversity important to you?

To answer the questions, the same respondents were asked to sort a set of statements in two Q-studies. The statements were identified based on literature, expert interviews, individual interviews and focus group interviews. The statements are largely based on the concept of TEV, and different value scales such as the new environmental paradigm (Dunlap and Van Liere, 1978) and the environmental attitude inventory (Milfont and Duckitt, 2010), as well as the elements that enter into various biodiversity metrics such as the Essential Biodiversity Variables (Pereira et al., 2013), the Biodiversity Intactness Index (Scholes and Biggs, 2005), and the IUCN Red List Index. This was supplemented with informal interviews with biodiversity experts and lay people. Furthermore, three semi-structured focus groups with lay people were conducted in March and April 2022 with the aim of identifying relevant statements for the Q-set. The composition of the focus groups aimed to maximize the diversity between groups, so as to capture a broad

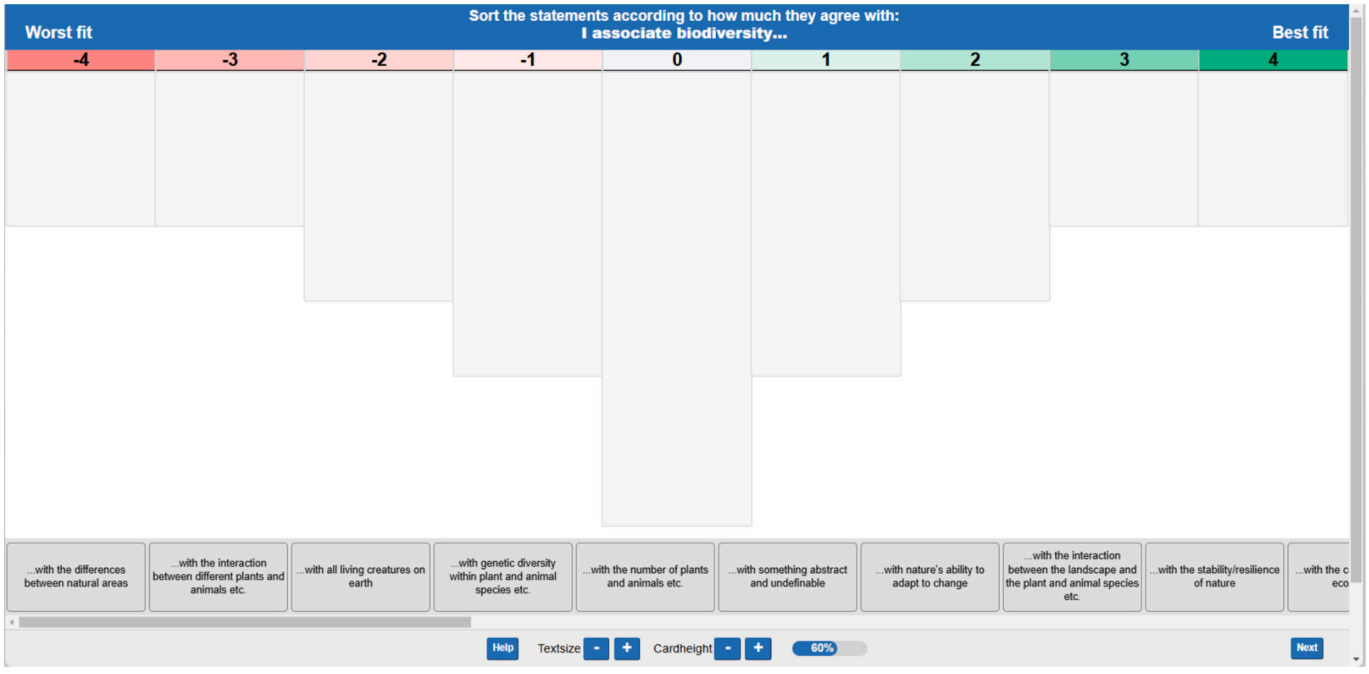


Fig. 1. The sorting grid used in the study, translated from the Danish version shown to respondents. Above the grid in the middle, the text asked respondents to sort the statements according to how well they fit with "I associate biodiversity…" (first Q-sort) or to sort the statements after "Why the protection of biodiversity is important to you" (second Q-sort). The endpoints of the scale stated (from left to right) "Worst fit" and "Best fit" (first Q-sort) and "Least important" and "Most important" (second Q-sort). The statements, displayed in the row below the sorting grid, are sorted by dragging and dropping them into the relevant columns of the grid. The number of statements per column was fixed according to the following schedule −4(2), −3(2), −2(3), −1(4), 0(6), 1(4), 2(3), 3(2), 4(2). See arguments for and against fixing the distribution in e.g. (Watts and Stenner, 2012, p.77).

spectrum of associations and viewpoints. Table 2 presents information about the development and pre-testing of the study, and demographics of the participants.

The final statements (*Q-sets*) to be sorted by respondents, contained 28 statements in each Q-study (see Tables 3 and 4). Respondents sorted these on a nine-point (−4 to +4) sorting grid presented in Fig. 1. Respondents were presented with the statements in a random order.

The Q-sorting was subsequently tested in individual and focus groups interviews in April and June 2022. This resulted in no additions or subtractions from the Q-set, but the wording of some statements were changed to avoid confusion.

The final setup and instructions was tested in three online interviews with respondents who had completed the survey in in August and September 2022. The interviews confirmed that the instructions were clear and self-contained, and the respondents did not express any technical difficulties in conducting the Q-sorting.

The final survey was structured as follows. Respondents were first asked about demographic characteristics and their knowledge of the term biodiversity. This was followed by the two Q-sorts, where all respondents first sorted the items related to the statement "*I associate biodiversity [with]…*" after which they were asked to sort the items related to the second question "*Why is protecting biodiversity important to you?*". The endpoints of the sorting grid were labelled "*Worst fit*" – "*Best fit*" and "*Least important*" – "*Most important*", for the first and second Q-sort, respectively. The sorting started by respondents being presented with the statements in a random order, and conducting a rough sorting of the Q-set into three piles representing the left, middle and right side of sorting scale. Once this was done, respondents were asked to place the items into the sorting grid. After having completed this, respondents had the option of elaborating on the two statements that had been rated lowest and highest on the scale, as well as providing comments on the sorting tasks and statements in general.

Table 2
Demographics of respondents included in the development of the study. M and F refers to male and female respectively.

Pretest method & Objective	Time period (2022)	#male	#female	Age-range	Description
Focus group interviews: Development of concourse	March	1	5	20–25	BSc. Students at Copenhagen University
	March	4	1	17–18	High school students from Northern Zealand
	April	4	2	25–70	Residents from Copenhagen
	April	2	0	35, 64	Employees of a youth college on Funen
Focus group interviews: Testing of Q-study (Manual Q-sorting)	June	1	4	29–71	Residents from Copenhagen
	June	2	3	29–72	Residents from suburban Copenhagen
	June	0	1	67	Resident from western Zealand
	August	1	0	41	Resident from Northern Jutland
Online interviews: Testing of Q-study (Online Q-sorting)	September	0	1	44	Resident from Central Denmark Region
	September	0	1	44	Resident from Central Denmark Region
	September	0	1	31	Resident from Northern Jutland

2.4. Data

The online Q-sorting was implemented using the EQ Web Sort version 1.0.2 (Banasick, 2022), which was embedded into the SurveyXact (https://www.surveyxact.com/) online questionnaire tool. Respondents were recruited through the market research company Norstat's pre-recruited panel in November 2022. In total 489 answered the first Q-sort and 345 the second. Out of these, 323 respondents successfully completed both Q-sorts, which is the sample used in the analysis. While we did not record the total time to complete the full survey, the 5 % trimmed mean for the combined time used for answering the two Q-sorts was 21 min, and the median 19 min. The analysed sample is slightly younger and more educated compared to the average Danish population (see supplementary material, Table S1.1.)

It is worth noting that as the respondents enter as variables in the analysis, a large number of respondents is not needed – half as many as there are items is often applied (Watts and Stenner, 2012). Zabala et al. (2018) reports that the number of respondents in Q-studies with a conservation context typically range from 26 to 46, and that only few studies have samples beyond 100 respondents. Note also that the objectives of a Q-methodology study is usually only to establish the existence of viewpoints, rather than generalize these to the entire population. For the purposes of other research questions not reported here, we opted for a rather large sample of respondents for the analysis.

3. Results and factor interpretations

The data from both Q-sorts were analysed using the 'qmethod' package in R (Zabala, 2014). Factors were extracted using Principal Component Analysis, and rotated using the Varimax procedure. The number of factors extracted for both Q-studies was based on multiple criteria, namely a scree analysis of the eigenvalues of the unrotated factors (see supplementary material, figs. S2.1 and S3.1), and the relatively small additions to the total variance explained by extracting additional factors. Furthermore, the correlations between factors within the Q-sorts, coupled with the interpretability of the individual factors, was also used in deciding on the number of factors to be extracted. For the first Q-sort concerning perceptions of biodiversity, five factors were extracted, while four factors were extracted for the second Q-sort concerning motivations for biodiversity conservation.

The results are presented in Tables 3 and 4, which show the factor arrays, i.e. the idealized Q-sorts for the extracted and rotated factors. The factor interpretations take departure in the factor arrays and the subsequent crib sheets (see supplementary material), augmented by the comments left by respondents and the focus groups interviews underlying the development of the study.

3.1. Perceptions of biodiversity

Table 3 presents the five factor solution to the first Q-sort, where respondents were asked to sort the statements based on the question:"*I associate biodiversity [with…]*". In total, 63 % of the sample loaded on one of the five factors, with 35 % loading on the first. The solution explained 59 % of the total variance in the data, which is quite typical for Q-studies (Carmenta et al., 2017). The correlations between factor z-scores (see supplementary material, Table S2.1) showed a relatively high correlation between the first four factors (0.37–0.55), and an almost uncorrelated fifth factor (−0.13 – (−0.03)).

While no consensus statements are identified, some common

Table 3
The 28 statements relating to perceptions of biodiversity and the factor arrays for a five perspective solution. The statement scores represent the values in the sorting grid (Fig. 1), with +4 (−4) indicating statements which respondents in that specific factor associate most (least) with biodiversity. A color gradient has been added to visualize the strength of agreement (dark green is most agree, dark red is least agree). Distinguishing statements are marked with an asterisk, representing a significant difference ($p < 0.05$) in the z-scores between the specific factor and all other factors.

	Statement	P1		P2		P3		P4		P5	
1	...with the number of different plants and animals etc.	4		-2	*	3		2	*	0	
2	...with genetic diversity within plant and animal species etc.	3	*	-2		-1		3	*	0	
3	...with the number of plants and animals etc.	0	*	-1		4	*	2	*	-1	
4	...with how much new organic matter nature creates through, for example, photosynthesis	-3		0		-4		0		1	*
5	...with the difference between plant and animal species etc.	4	*	-1	*	-2		1	*	-2	*
6	...with the differences between natural areas	1	*	0	*	-2		-2		-1	
7	...with wild nature	1	*	3	*	1	*	-1	*	-4	
8	...with unmanaged nature - an absence of human influence	0		3	*	2	*	0		-4	
9	...with naturalness	-1		2	*	0		0		-3	*
10	...with the diversity of nature	3		4		4		0		0	
11	...with something humans do to improve what we get from nature	-4		-3	*	-3		-4	*	2	
12	...with man-made, planned, and cared for and planted nature	-3		-4		-3		-4		3	
13	...with the complexity of an ecosystem	2		1	*	2		-3	*	4	
14	...with the interaction between different plants and animals etc.	2		1		0		4	*	2	*
15	...with the interaction between the landscape and the plant and animal species etc.	2	*	1		-1		-2		0	
16	...with the state of nature	0		0	*	1		-1		1	
17	...with the vitality of nature	-2		2		0	*	2		-2	
18	...with the balance of nature	1		2	*	2	*	-1	*	0	*
19	...with the stability/resilience of nature	0		0		0		1		3	
20	...with nature's ability to adapt to change	0	*	1		-1	*	0	*	1	*
21	...with endangered plant and animal species etc.	1		-3	*	3	*	-1	*	0	
22	...with iconic Danish plant and animal species etc.	-2		-2		0	*	-2		-3	
23	...with the life we cannot see	-2	*	0		0		0		-1	
24	...with something abstract and undefinable	-4		-4		-4		-3		-2	*
25	...with all living creatures on earth	-1	*	-1	*	1		4	*	2	
26	...with the conditions for life on earth	-1	*	0	*	1	*	3		4	*
27	...with natural biological processes, e.g. decomposition and grazing	0	*	4	*	-1	*	1		1	*
28	...with physical landscapes, e.g. hills, valleys, rivers, lakes and the sea	-1		-1		-2		1	*	-1	*
	Number of loading sorts (of which negative loadings)	112 (1)		44 (0)		21 (2)		14 (2)		11 (4)	
	% explained variance	20.1		10.9		8.8		5.2		4.9	

elements or themes emerge that cut across many of the identified perspectives. In these themes, biodiversity is associated with the "connectedness" of nature (s13, s14), "diversity" in some form (s1, s10), and the "balance" and "stability" of nature (s18, s19). Interestingly, the other statements regarding some of the consequences of biodiversity (s16, s17, s20), do not evoke either strong or negative associations with biodiversity across perspectives, and differences between perspectives are small, with s17 being a slight exemption. It might be that some of these indifferences are due to the terms in the statements themselves being unclear to respondents, making respondents more likely to place them in the middle of the sorting grid.

The fifth perspective provides the most differing view of biodiversity, where it to a large degree is associated with human management of nature (s11, s12) - the two statements that all the other perspectives agreed with the least. None of the perspectives seem to associate biodiversity with something abstract (s24), nor with iconic species (s22).

We find no considerable differences between the main demographics of the respondents in the different perspectives (see Table S2.2 in the supplementary material). However, respondents in perspectives one and five, as well as the respondents not clearly loading on any perspective, or loading highly on more than one perspective, seemed to have a slightly higher level of education. Furthermore, respondents in perspectives one and three, as well as the respondents not assigned to any perspective, stated higher levels of knowledge of biodiversity compared to respondents in the other perspectives.

3.1.1. *Perspective 1: Diversity – on all levels*

The first perspective highlights that biodiversity is what is in the name – the diversity of life. As one respondent commented: "*Bio = life; diversity = variety. Therefore, biodiversity means a variety of life.*" (all comments by respondents have been translated from Danish). The perspective puts most emphasis on diversity, variation and difference between species (s1,s2, s5) and of nature in general (s10). This focus on

Table 4
The 28 statements relating to motivation for biodiversity protection and the factor arrays for a four perspective solution. The statement scores represent the values in the sorting grid (Fig. 1), with +4 (−4) indicating statements respondents in that specific factor found most (least) important. A color gradient has been added to visualize the strength of agreement. Distinguishing statements are marked with an asterisk.

	Statement	P1		P2		P3		P4	
1	Because the fact that biodiversity exists is valuable to me – even without it being experienced	-1		0		0		-2	
2	Because just the fact that nature is well is valuable to me	-1	*	1		1		0	*
3	Because biodiversity, in itself, is valuable - regardless of what we humans think	0	*	2	*	4	*	-1	*
4	Because nature, in itself, has a right to exist	0	*	4	*	3		3	
5	Because humans have a responsibility to protect biodiversity	1		4	*	2	*	1	
6	Because it creates a better relationship between people and nature	-1		-1		-1		-1	
7	Because it is important for our Danish culture and identity	-4		-4		-4		-4	
8	Because it may be necessary for human survival	4	*	1		1		-1	*
9	Because biodiversity supports all life on earth	2	*	3		3		4	*
10	Because biodiversity makes nature a little more enchanting	-4	*	-2	*	-1	*	0	*
11	Because it is important that there are areas where people do not come	-2		1	*	-2		-4	*
12	Because biodiversity contributes to the production of a lot of products, e.g. food	1	*	-4	*	-2	*	0	*
13	Because biodiversity can contribute to slowing down climate change	4	*	2	*	-4	*	2	*
14	Because biodiversity can contribute to countering the consequences of climate change	3		3		-3	*	0	*
15	Because biodiversity can contribute to our physical and mental health	0		-1	*	-2	*	0	
16	Because we do not know the consequences of losing biodiversity	3	*	0	*	4	*	-3	*
17	Because biodiversity can improve nature's ability to resist and adapt to change	2	*	2		2		2	
18	Because we do not know what biodiversity can contribute with the future	1	*	-1	*	0	*	-3	*
19	Because we should be able to enjoy/benefit from biodiversity in the future	1		0		1		0	
20	Because biodiversity increases the joy of experiencing nature	-3	*	-1	*	0	*	1	*
21	Because biodiversity gives us nature experiences we could not otherwise have	-2	*	-3	*	0	*	1	*
22	Because biodiversity makes the landscape more beautiful to look at	-3	*	-3		-3		2	*
23	Because biodiversity can contribute to us seeing more plant and animal species	0		0		1	*	4	*
24	Because biodiversity can be valuable for future generations	2		1		2	*	1	
25	Because future generations should have the same opportunities that we have had	0		0		0	*	3	*
26	Because it is valuable to me that others can benefit from biodiversity	-1		-2		-1		-2	*
27	Because biodiversity can be valuable to other people	0	*	-2	*	-1		-1	
28	Because the fact that we try to do something for nature is valuable in itself	-2		0		0		-2	
	Number of loading sorts (of which negative loadings)	99 (3)		65 (3)		44 (0)		21 (2)	
	% explained variance	17.5		12.6		9.3		5.6	

diversity is not limited to the species level, but also includes genetic diversity (s2). Furthermore, ecosystem diversity (s6) is rated highest across the five perspectives. The interaction between the landscape and species (s15) is also emphasized higher in this perspective than in the others. Respondents in this perspective do not perceive biodiversity as something abstract and undefinable (s24), something we cannot see (23), nor is it perceived as something related to humans (s11, s12). Primary production (s4) and biological process (s27) are not highly associated with biodiversity either. Relative to the other perspectives, biodiversity is not seen as related to the conditions for life on earth (s26).

3.1.2. *Perspective 2: Naturalness*

The second perspective also highlights that biodiversity is about diversity (s10). However, this is not perceived as genetic diversity (s2), species diversity (s1, s3), nor as all living creatures on earth (s25). Particular about this perspective is the association of biodiversity with wild (s7) and unmanaged nature (s8), as well as with the concept of naturalness (s9) and generally the absence of human influence. In this perspective, biodiversity is to a higher degree associated with natural biological processes (s27), and the balance of nature (s18). The comments highlight that an absence of human influence is seen as a prerequisite for a natural balance, and that this balance is achieved through natural processes. As mentioned by a respondent, when nature is "*untouched by human hands, nature takes care of itself. There will be room for animals and different plants*". Along the lines of the first perspective, and as could be expected given the focus on naturalness, biodiversity is not perceived as something related to humans (s11, s12) or something abstract (s24). Neither is it specifically related to endangered plant and animal species (s21).

3.1.3. *Perspective 3: Diversity – of species*

While we find that the emphasis on diversity continues in the third perspective (s1, s10), this perspective is characterized by focusing more on species abundance (s3) and on specific species – both endangered

(s21) and iconic (s22) – than in any of the other perspectives. Biological processes (s4, s27), nature's resilience and ability to adapt to change (s19, s20), and the physical landscape are to a lesser degree associated with biodiversity in this perspective. The association of biodiversity with endangered species might not imply that biodiversity per se is associated with endangered species, but rather that respondents associate biodiversity with its decline or loss. This is illustrated by a respondent's comments regarding statement 21: "*the biodiversity debate is primarily about endangered species*" and "*both plant and animal species are in sharp decline*".

3.1.4. Perspective 4: Diversity – as functionality

The fourth perspective emphasizes more all-encompassing, abstract and normative concepts compared to perspectives 1, 2 and 3. Biodiversity is perceived as encompassing all living creatures (s25), the interactions between species (s14), as well as genetic diversity (s2). On the more normative side, statements regarding the conditions for life on earth (s26) and the vitality of nature (s17) are also associated with biodiversity. However, relative to all other perspectives, physical landscapes (s28) are to a higher degree seen related to biodiversity, but not in terms of the difference between natural areas (s6). Interestingly, some of the statements least related with biodiversity contain similar abstract and normative concepts that respondents most associated with biodiversity. Biodiversity is not perceived as something abstract and undefinable (s24), the complexity of an ecosystem (s13), nor the state (s16) or balance of nature (s18). Similarly to perspectives 1,2 and 3, biodiversity is not perceived as something related to humans (s11, s12).

3.1.5. Perspective 5: Human intervention - Complexity & Conditions

The fifth perspective makes some departures from the other perspectives, by associating biodiversity with human management (s12), and to some degree viewing nature as a resource base (s4, s11). Based on the comments, human management is seen as means of supporting and conserving biodiversity. This is highlighted in a general comment from a respondent loading onto the factor: "[…]. *Humans can accelerate biodiversity.*", as well as in a comment regarding statement 12: *"…we can plan our way out […] plant what is missing and take care of what is left.*" On the other hand, the perspective also associates biodiversity with the complexity of an ecosystem (s13) as well as the conditions (s26), state (s16) and resilience of nature (19), but not its vitality (s17). Relative to the other statements, biodiversity is to a higher degree seen as something abstract (s24), and clearly not related to wild (s7) and untouched nature (s8) – nor naturalness (s9).

3.2. Perceptions of the value of biodiversity conservation

Table 4 presents the four factor solution to the second Q-sort, where respondents were asked to sort the statements based on the question: Why is biodiversity protection in Denmark important for you? In total 71 % of the sample loaded on one of the four factors, with 31 % loading on the first. The solution explained 45 % of the total variance in the data. The correlations between factor z-scores indicate relatively high correlation between the first two factors (0.51), as well as the second and third factors (0.53), with the remaining correlations ranging between 0.25 and 0.37 (see supplementary material, Table S3.1).

Similar to the first Q-sort, no consensus statements are found. However, a number of statements have been placed in the positive end of the scale in all perspectives. These signal a general agreement on the importance of protecting biodiversity due to its essential role in supporting all life on earth (s9), and its resilience value (s17). Other arguments for the conservation of biodiversity that cut across the perspectives include the intrinsic value of nature (s4), a human responsibility for its protection (s5), and bequest value (s24). Arguments that are not seen as important in any perspective are related to altruistic values (s26), and to what could be called relational and spiritual values (s6, s7). We find that the identified perspectives can be related to the different IPBES life frames, although none of the perspectives seem to match the pluricentric "living as" frame.

In terms of demographics, based on pairwise chi-square tests there is a statistically significant larger share of older (p-value <0.04) and male (p-value <0.03) respondents in the third perspective (see supplementary material, Table S3.2), except that the difference in age is not significant between perspectives three and four (p-value: 0.24). There is also a tendency for respondents in perspectives three and four to have slightly longer educations. In terms of the geographical distribution of the respondents or the stated knowledge of biodiversity, no differences between groups are found.

3.2.1. Perspective 1. Living from nature: Instrumental values (Anthropocentric)

The first perspective regarding the reasons for protecting biodiversity emphasizes the dependence between human existence and biodiversity (s8), and the benefits of biodiversity in terms of both combating (s13) and mitigating the effects of climate change (s14). Taken together with the relatively high rating, compared to the other perspectives, of statement 12 regarding the importance of protecting biodiversity as an input in production, respondents in the first perspective seem to hold a mostly anthropocentric view of the value of biodiversity, mainly focused on instrumental values, in line with a "Living from" nature life frame. This viewpoint is also highlighted by many of the comments from respondents that load onto this perspective, such as this comment on why statement 13 was rated as most important: "*Climate change can have serious consequences for us as humans. It is therefore important that we do what we can to slow down or meet the consequences*", as well as the relatively low ratings on statement considering the more inherent values of biodiversity and its conservation (s2, s4, s28). Based on this interpretation, the importance of protecting biodiversity due to the unknown consequences of losing it (s16) and the potential future benefits (s18), can be seen as indicating insurance and option values, i.e. securing the flow of the instrumental values attached to biodiversity. For respondents in this perspective, the value of protecting biodiversity does not stem from experiencing it (s20, s21, s22), nor is it due to the importance of biodiversity for national culture and identity (s7).

3.2.2. Perspective 2. Living with nature: Stewardship & Responsibility (Ecocentric)

The second perspective stands in contrast to the anthropocentric viewpoint expressed in the first perspective, by emphasizing the inherent value of nature (s4), and the responsibility of humans to protect biodiversity (s5). This more ecocentric viewpoint is further supported by comments such as: *"… humans are the most dangerous threat to the earth, climate and nature. We have a great responsibility to recreate and repair what we have destroyed",* as well as the statement about undisturbed nature (s11) being relatively more important in this perspective compared to the others. Similarity, the statements about existence value (s1, s2) also received higher ratings than in the first perspective. Similar to the first perspective, the second perspective is also related the value of protecting biodiversity to mitigate climate change (s13, s14). The low importance placed on statements regarding conservation for the sake of experiencing biodiversity (s21, s22) or for the sake of production (s12) emphasize the eco-centric viewpoint of this perspective, which generally fits well into the "Living with" nature life frame.

3.2.3. Perspective 3. Living in/with nature: Stability (Anthropocentric/ Ecocentric)

Perspective three is similar to the second perspective, with high ratings on statement related to a more ecocentric viewpoint (s3,s4, s5), and lower ratings on more anthropocentric statements (s12, s22). As one participant explicitly notes as an explanation for the low rating on statement 12: *"…there is a need to distance ourselves from a utilitarian understanding of biodiversity. Biodiversity has an intrinsic value in itself that has nothing to do with people's living conditions"*. However, the third

perspective places more emphasis on uncertainty related to loosing biodiversity (s16, s19) and the responsibility towards future generations (s24). Both intrinsic and bequest values are evident from a comment on statement 5:*"Protecting nature is our responsibility - not just for future generations but because nature has as much right to be here as we do"*. While the statements relating to uncertainty were interpreted as focusing on instrumental values in the first perspective, here they might be more related to relational values, despite explicitly not being more or less emphasized (s6, s7) than in other perspectives. Contrary to the two previous perspectives, the benefit of protecting biodiversity in terms of climate change (s13, s14) isnot seen as important in this perspective. Protecting biodiversity for the sake for of experiencing nature (s20, s21) is not as unimportant as in the previous perspectives, perhaps reinforcing the assumption that relational values and people-nature interactions are more important in this perspective than in the two previous perspectives. Based on the comments, the respondents loading onto this perspective reject the link between biodiversity conservation and climate change, specifically the idea that protecting biodiversity will have an impact on the effects of climate change. In terms of life frames, the perspective seems to fall within both the "Living in" and "Living with" nature. However, as one reviewer pointed out, some aspects of the perspective could also be interpreted as coming close to "Living as" nature, if the underlying driver for the rating is "eco-realism", i.e. acknowledging the facts about nature and people's relation with it.

3.2.4. Perspective 4. Living in nature: Experiencing nature (Anthropocentric)

One of the defining characteristics in the fourth perspective, is that the importance of protecting biodiversity is related to the enjoyment of experiencing nature, as indicated by the high rating of statement 23, and expressed in this general comment: *"For me personally, the diversity increases the joy of experiencing both the 'wild' nature and my own backyard"*. Furthermore, while the absolute ratings are not in the highest range for statements s20, s21, s22 and s10, which all relate to experiencing nature, they are all distinguishing for this perspective and relatively higher rated than in the other perspectives. Similar, the statement about the importance of untouched nature is rated as the least important (s11). Existence value is not an important driver for the conservation of biodiversity in this perspective, indicated by the relatively low rating of statements 1 and 3, however, nature's right to existence is still rated among the most important reasons for conservation. While biodiversity conservation is seen as important as it supports all life on earth (s9) it is less so because it might be necessary for human survival (s8). This highlights the anthropocentric viewpoint of this perspective - biodiversity conservation is seen as important for "nature", which is something separate from humans. In terms of the IPBES typology, the life frame that best aligns with how the perspective relates to nature would be "living in", given the mix of instrumental and intrinsic values, but with a slightly more anthropocentric worldview relative to perspectives two and three.

3.3. Relationship between perspectives

Fig. 2 presents the Pearson's r rank correlation coefficients between the factor loadings for all perspectives from the two Q-studies, based on all respondents. Generally, the results indicate that the factor loadings for any of the first four perspectives of biodiversity are correlated with the loadings on the two more ecocentric perspectives of its value. This connection to ecocentric values seems to be most prominent for respondents loading onto the third and fourth perspective of biodiversity, as the correlations to both the ecocentric value perspectives are significant. Although not statistically significant at conventional levels (*p*-value: 0.20), there is a negative correlation between the third perspective of biodiversity and the most anthropocentric perspective on its value. This might be related to a more traditional view of biodiversity

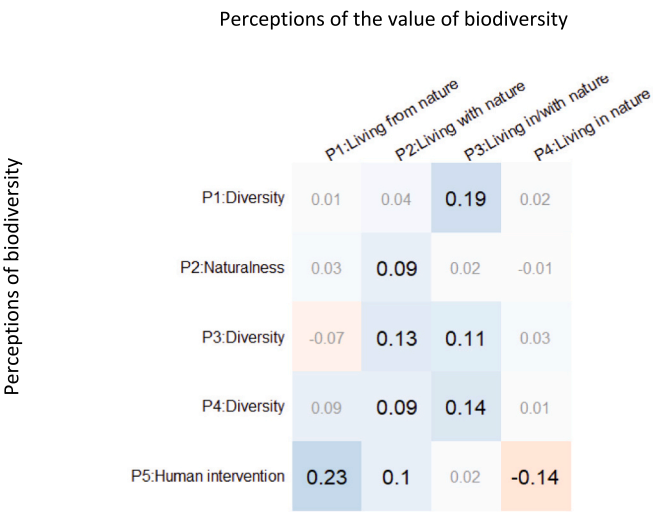


Fig. 2. Pearson's r rank correlation coefficients between the factor loadings for all perspectives from the two Q-studies (Q1 = rows, Q2 = columns), estimated based on all respondents. Correlations in the bigger typeface are significant at the 0.1 level.

and its conservation which highlights the protection and existence of endangered species in their own right.

As could be expected, the loadings on the fifth perspective of biodiversity, associated with the human management of nature for the benefit of humans, are positively correlated with loadings on the most anthropocentric view of the value of protecting biodiversity. However, the loadings for the fifth perspective are also positively correlated with the most ecocentric value perspective. This might be due to the shared emphasis in the two value perspectives on climate regulating and life-supporting values (albeit for different reasons: sustenance in "Living from", and species survival in "Living with"), which can be seen as related to the associations of biodiversity as the state and condition of nature in the fifth perspective of biodiversity. The fifth perspective on biodiversity is negatively correlated with the fourth value perspective ("Living in").

It should be noted that Fig. 1 only depicts the relationships between factor loadings, and should not be interpreted as indicating the distribution of participants across the different combinations of perspectives in the two Q-sorts. For instance, the mean loadings on the value perspectives is the highest for the anthropocentric value perspective, irrespective of which perspective of biodiversity respondents significantly load on.

4. Discussion & Conclusions

The lacking awareness and understanding of biodiversity by the general public has been seen as a prohibiting factor for including the public opinion in decision-making related to biodiversity, and as a particular problem for valuing biodiversity with stated preference methods. Recent studies have called for more thorough investigations of people's perceptions of biodiversity, which could be used to better understand and potentially alleviate this problem (Strange et al., 2024). This study answers this call, by investigating people's perception of biodiversity and their perception of the value of biodiversity conservation, in a generic setting, contrary to past studies with a focus on particular ecosystems or habitats. While emphasis on specific locations is useful for project specific decision making, a generic setting may better reflect what is at stake for largescale policy efforts to conserve biodiversity.

So, how does the public understand and perceive biodiversity? Many studies find that the public generally thinks of biodiversity at the species level and define it as the variety of species (both animals and plants) or

more generally as the variety of living things (e.g. Buijs et al., 2008; Cerda and Bidegain, 2018; Fischer and Young, 2007; Norton et al., 2021). Diversity on the ecosystem level is mentioned less often, and diversity on the genetic level even more seldom, if at all. However, Bakhtiari et al. (2014) find that a holistic view of biodiversity as a combination of animals, plants and microorganisms, rather than simply species richness, is dominant. Buijs et al. (2008) and Fischer and Young (2007) also highlight that the public understanding of biodiversity is not limited to descriptive definitions of the concept, but that the mental constructs and social representations of biodiversity held by the public also include normative components and associations to other concepts. These include concepts such as natural, wild, and untouched nature, a general absence of human influence (Bakhtiari et al., 2014; Fischer and Young, 2007; Norton et al., 2021) and a positive state of nature in general (Fischer and Young, 2007). Related to the concept of naturalness are the concepts of interconnectedness and balance (e.g. in term of food chains) which have also been found to be elements of people's mental constructs of biodiversity (Bakhtiari et al., 2014; Buijs et al., 2008; Fischer and Young, 2007). However, contrary to the concept of untouched nature, there are also studies finding that some people associate biodiversity with action-related terms (Levé et al., 2019; Norton et al., 2021) or understand it as a tool for maintaining ecosystems (Bakhtiari et al., 2014).

Our results corroborate previous findings that perceptions also include concepts linked to biodiversity, such as naturalness, complexity, connectedness and balance. These findings, in the more generic setting employed in our study, point to these concepts not being imposed on people by aspects of the survey design, such as associations with specific locations, habitats or ecosystems. Our results also indicate that public perceptions of biodiversity to a large degree resonate with scientific definitions, including the many aspects of diversity. This indicates that the concerns relating to the methodological reliance on the public's perceptions and understandings of biodiversity when assessing the economic value of biodiversity using stated preference methods, may not be particularly problematic – if thoroughly described and tested.

The nuanced view of biodiversity indicates that the simplistic indicators of biodiversity often used to communicate the impacts of changes in biodiversity to respondents in stated preference studies (Strange et al., 2024), like the "number of species" or "habitat coverage", may be too reductionist to capture people's full value of the impact on biodiversity. Rather, our findings support the use of more composite indices of biodiversity as they better align with respondents' perceptions of biodiversity, and thus potentially provide better and more complete value estimates. A closer alignment of the used measure and the perceptions of the good, and hence the welfare value generating aspects of the good, is also emphasized by Boyd et al. (2023) and Boyd et al. (2016). The explicit non-association of biodiversity and iconic species also highlights concerns regarding the use of species indicators in stated preference methods, similar to the issue raised in Jacobsen et al. (2008).

In terms of the public perceptions of the value of biodiversity, Bakhtiari et al. (2014) find that the motivations among the public in Denmark and Sweden to protect forest biodiversity can be categorized based on whether people hold a more ecocentric or a more anthropocentric attitude towards the environment. Similar categorizations can be found among conservation professionals (Berry et al., 2018; Primmer et al., 2017; Sandbrook et al., 2011). In terms of the most frequently mentioned instrumental values related to forest biodiversity, Bakhtiari et al. (2014) find insurance (related to the resilience of the forest), aesthetic and recreational values. The mere existence of a variety of species was also one of the most mentioned values, which depending ones overall worldview, can be interpreted as either an instrumental or intrinsic value.

Our results regarding the publics' perceptions of the value of conserving biodiversity indicate a similar division of respondents along an ecocentric – anthropocentric gradient as has been found in previous studies, albeit mostly among conservation professionals. Furthermore, we found it useful to use the IPBES classifications of *living from*, *in*, *with* or *as nature* to interpret the results. We note that the "Living as" frame, with emphasis on intrinsic and relational values but not instrumental values, did not fit well with any of our interpretations of the extracted perspectives from the Q-studies, apart from a limited resonance to perspective three. Instrumental values were generally found to be important in the conservation of biodiversity, as were values related to the uncertainties associated with biodiversity loss. Furthermore, stewardship of nature, and the responsibility to conserve biodiversity, are also found to be important motivations for its protection, and they cut across the identified perspectives. This can be linked to both intrinsic and instrumental (nonuse, existence) value, depending on one's overall worldview. Typically, the distinction between the two is based on intrinsic value being "the knowledge of something being good for nature" (more ecocentric worldview) and instrumental value being "the individual's utility of something being good for nature, because they find it important" (more anthropocentric worldview). However, this is a distinction made only from the analyst's point of view, not the individual.[2] Given that this distinction is important in a stated preference valuation context, as intrinsic values cannot be captured by the method, we attempted to design the statements 1 and 2 (instrumental non-use value), and 3 and 4 (intrinsic value), in Table 4 to specifically reflect this distinction. The results suggest that intrinsic values are emphasized more than their instrumental counterparts, but that the distinction between arguments linked to intrinsic and instrumental values is not obvious, suggesting that the two may in reality be difficult or even impossible to entirely disentangle. This remains a challenge for stated preference studies.

While the results from a Q-methodological study are generally only used to uncover the existence of certain perspectives, and not their prevalence, our relatively large sample might to some degree allow us to generalize the findings to the Danish population, and thus offer some policy implications. While our study does not offer guidance on the means by which a policy target should be reached, the nuanced perceptions of biodiversity held by most of the respondents lends itself to support generally aiming for broad and multifaceted policy goals and measures, as opposed to focusing on more narrow and simplistic goals such as the protection of an individual (indicator) species. The anthropocentric value perspectives held by the majority of the respondents also indicate that policy goals should be communicated through their tangible benefits to humans, as also highlighted by the quote from Armsworth et al. (2007, p. 1383) in the opening paragraph of this paper.

We acknowledge that it could be questioned to what degree finding a broad and nuanced perspective of biodiversity that resonates with scientific definitions is an artefact of the study itself. Similar to the discovered preferences hypothesis put forth by Plott (1996), it is possible that perceptions of complex concepts like biodiversity are also "discovered" and shaped during the process in which they are explored. The statements that people were asked to assess, while based on focus group discussions, included many of the statements which figure in scientific definitions. Consequently, the finding that no perspective matched the pluricentric "Living as" frame, might be due to the low number of pluricentric statements. Furthermore, it is unclear to what degree respondents considered some of our statements as unclear or needing further explanation (e.g. statements s16, s17, s20, as highlighted in section 3.1), or to what degree similar statements (e.g. s1 and s2) were seen as overlapping, and how this this affected respondents in their sorting.

Finally, our conclusions concerning the valuation of biodiversity

[2] Think of the word knowledge: you may interpret my value of biodiversity as being based on my knowledge of its existence, but for me the knowledge is only of importance if it actually exists. Hence 'knowledge' is observed from the outside.

using stated preference methods need further research to be confirmed. Whether the use of more composite indices of biodiversity, compared to the more simplistic indicators often used in the past, will lead to more valid and/or complete value estimates calls for empirical verification in practice. However, it is also unclear if such a measure, which captures the concept as described by ecologists, and perceived and understood by the public, exists and is practically measurable (Mace, 2014; Pereira et al., 2013). We echo the suggestion by Strange et al. (2024) concerning the need of forming interdisciplinary research teams including biodiversity valuation experts and conservation scientists to answer these questions.

CRediT authorship contribution statement

Kennet Uggeldahl: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Søren Bøye Olsen:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Thomas Lundhede:** Writing – review & editing, Writing – original draft, Supervision, Funding acquisition, Conceptualization. **Jette Bredahl Jacobsen:** Writing – review & editing, Writing – original draft, Supervision, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors gratefully acknowledge funding from the Independent Research Fund Denmark project “Developing and testing a new measure for including biodiversity in economic modelling” [Grant no: 0219-00010B].

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecolecon.2025.108681.

Data availability

Data will be made available on request.

References

Anderson, C.B., Athayde, S., Raymond, C.M., Vatn, A., Arias, P., Gould, R.K., Kenter, J., Muraca, B., Sachdeva, S., Samakov, A., Zent, E., Lenzi, D., Murali, R., Amin, A., Cantú-Fernández, M., 2022. Chapter 2: Conceptualizing the diverse values of nature and their contributions to people. In: Balvanera, P., Pascual, U., Christie, M., Baptiste, B., González-Jiménez, D. (Eds.), Methodological Assessment Report on the Diverse Values and Valuation of Nature of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES Secretariat, pp. 1–125.

Armatas, C.A., Venn, T.J., Watson, A.E., 2014. Applying Q-methodology to select and define attributes for non-market valuation: a case study from Northwest Wyoming, United States. Ecol. Econ. 107, 447–456.

Armsworth, P.R., Chan, K.M.A., Daily, G.C., Ehrlich, P.R., Kremen, C., Ricketts, T.H., Sanjayan, M.A., 2007. Ecosystem-service science and the way forward for conservation. In: Conservation Biology, 21. Wiley Online Library, pp. 1383–1384. Issue 6.

Bakhtiari, F., Jacobsen, J.B., Strange, N., Helles, F., 2014. Revealing lay people’s perceptions of forest biodiversity value components and their application in valuation method. Glob. Ecol. Conserv. 1, 27–42.

Banasick, S., 2022. EQ Web Sort, GitHub Repository. https://github.com/shawnbanasick/eq-web-sort.

Bartkowski, B., Lienhoop, N., Hansjürgens, B., 2015. Capturing the complexity of biodiversity: a critical review of economic valuation studies of biological diversity. Ecol. Econ. 113, 1–14.

Bateman, I.J., Harwood, A.R., Abson, D.J., Andrews, B., Crowe, A., Dugdale, S., Fezzi, C., Foden, J., Hadley, D., Haines-Young, R., 2014. Economic analysis for the UK national ecosystem assessment: synthesis and scenario valuation of changes in ecosystem services. Environ. Resour. Econ. 57, 273–297.

Bele, A., Chakradeo, U., 2021. Public perception of biodiversity: a literature review of its role in urban green spaces. J. Landsc. Ecol. 14 (2), 1–28.

Berry, P.M., Fabók, V., Blicharska, M., Bredin, Y.K., Llorente, M.G., Kovács, E., Geamana, N., Stanciu, A., Termansen, M., Jääskeläinen, T., 2018. Why conserve biodiversity? A multi-national exploration of stakeholders’ views on the arguments for biodiversity conservation. Biodivers. Conserv. 27 (7), 1741–1762.

Boyd, J., Ringold, P., Krupnick, A., Johnston, R.J., Weber, M.A., Hall, K., 2016. Ecosystem services indicators: improving the linkage between biophysical and economic analyses. Int. Rev. Environ. Resour. Econ. 8 (3–4), 359–443.

Boyd, J., Johnston, R.J., Ringold, P., 2023. Biophysical measures to support analysis and communication of existence values. Int. Rev. Environ. Resour. Econ. 17 (2–3), 153.

Brown, S.R., 1980. Political Subjectivity: Applications of Q Methodology in Political Science (No Title).

Buijs, A.E., Fischer, A., Rink, D., Young, J.C., 2008. Looking beyond superficial knowledge gaps: understanding public representations of biodiversity. Int. J. Biodivers. Sci. Manage. 4 (2), 65–80.

Campbell-Arvai, V., 2019. Engaging urban nature: improving our understanding of public perceptions of the role of biodiversity in cities. Urban Ecosyst. 22 (2), 409–423.

Carmenta, R., Zabala, A., Daeli, W., Phelps, J., 2017. Perceptions across scales of governance and the Indonesian peatland fires. Glob. Environ. Chang. 46, 50–59.

Cerda, C., Bidegain, I., 2018. Spectrum of concepts associated with the term “biodiversity”: a case study in a biodiversity hotspot in South America. Environ. Monit. Assess. 190 (4), 1–11.

Dasgupta, P., 2021. The Economics of Biodiversity: The Dasgupta Review. Hm Treasury.

Dunlap, R.E., Van Liere, K.D., 1978. The “new environmental paradigm.”. J. Environ. Educ. 9 (4), 10–19.

Farnsworth, K.D., Adenuga, A.H., De Groot, R.S., 2015. The complexity of biodiversity: a biological perspective on economic valuation. Ecol. Econ. 120, 350–354.

Fischer, A., Young, J.C., 2007. Understanding mental constructs of biodiversity: implications for biodiversity management and conservation. Biol. Conserv. 136 (2), 271–282.

Hanley, N., Perrings, C., 2019. The economic value of biodiversity. Ann. Rev. Resour. Econ. 11, 355–375.

Hanley, N., Spash, C., Walker, L., 1995. Problems in valuing the benefits of biodiversity protection. Environ. Resour. Econ. 5, 249–272.

IPBES, 2019. Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES secretariat Bonn, Germany.

IPBES, 2022. In: Pascual, U., Balvanera, P., Christie, M., Baptiste, B., González-Jiménez, D., Anderson, C.B., Athayde, S., Chaplin-Kramer, R., Jacobs, S., Kelemen, E., Kumar, R., Lazos, E., Martin, A., Mwampamba, T.H., Nakangu, B., O’Farrell, P., Raymond, C.M., Subramanian, S.M., Termansen, M., Vatn, A. (Eds.), Summary for Policymakers of the Methodological Assessment Report on the Diverse Values and Valuation of Nature of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES Secretariat, pp. 1–37. https://doi.org/10.5281/zenodo.6522392.

Jacobsen, J.B., Boiesen, J.H., Thorsen, B.J., Strange, N., 2008. What’s in a name? The use of quantitative measures versus ‘Iconised’species when valuing biodiversity. Environ. Resour. Econ. 39, 247–263.

Jensen, A.K., 2019. A structured approach to attribute selection in economic valuation studies: using q-methodology. Ecol. Econ. 166, 106400.

Levé, M., Colléony, A., Conversy, P., Torres, A.-C., Truong, M.-X., Vuillot, C., Prévot, A.-C., 2019. Convergences and divergences in understanding the word biodiversity among citizens: a French case study. Biol. Conserv. 236, 332–339.

Mace, G.M., 2014. Biodiversity: Its meanings, roles, and status. In: Helm, Dieter, Hepburn, Cameron (Eds.), Nature in the Balance: The Economics of Biodiversity. Oxford.

Meehan, K., Ginart, L., Ormerod, K.J., 2022. Short take: Sorting at a distance: Q methodology online. In: Field Methods, 34. SAGE Publications Sage CA, Los Angeles, CA, pp. 82–88. Issue 1.

Milfont, T.L., Duckitt, J., 2010. The environmental attitudes inventory: a valid and reliable measure to assess the structure of environmental attitudes. J. Environ. Psychol. 30 (1), 80–94.

Norton, B.A., Shang, B., Ramsey, A.D., Sheffield, D., 2021. Definitions of biodiversity from urban gardeners. J. Urban Ecol. 7 (1).

Pereira, H.M., Ferrier, S., Walters, M., Geller, G.N., Jongman, R.H.G., Scholes, R.J., Bruford, M.W., Brummitt, N., Butchart, S.H.M., Cardoso, A.C., 2013. Essential biodiversity variables. Science 339 (6117), 277–278.

Plott, C.R., 1996. Rational individual behavior in markets and social choice processes: the discovered preference hypothesis. In: Rational Foundations of Economic Behavior, pp. 225–250.

Primmer, E., Termansen, M., Bredin, Y., Blicharska, M., García-Llorente, M., Berry, P., Jääskeläinen, T., Bela, G., Fabok, V., Geamana, N., 2017. Caught between personal and collective values: biodiversity conservation in European decision-making. Environ. Policy Gov. 27 (6), 588–604.

Sandbrook, C., Scales, I.R., Vira, B., Adams, W.M., 2011. Value plurality among conservation professionals. Conserv. Biol. 25 (2), 285–294.

Scholes, R.J., Biggs, R., 2005. A biodiversity intactness index. Nature 434 (7029), 45–49.

Strange, N., Ermgassen, S. Zu, Marshall, E., Bull, J.W., Jacobsen, J.B., 2024. Why it matters how biodiversity is measured in environmental valuation studies compared

to conservation science. Biol. Conserv. 292, 110546. https://doi.org/10.1016/j.biocon.2024.110546.
Watts, S., Stenner, P., 2012. Doing Q methodological research: theory, method & interpretation. In: Doing Q Methodological Research, pp. 1–248.
Webler, T., Danielson, S., Tuler, S., 2009. Using Q method to reveal social perspectives in environmental research. In: Greenfield MA: Social and Environmental Research Institute, 54, pp. 1–45.
Zabala, A., Sandbrook, C., Mukherjee, N., 2018. When and how to use Q methodology to understand perspectives in conservation research. Conserv. Biol. 32 (5), 1185–1194.