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RESEARCH ARTICLE

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The impact of biodiversity information on willingness to pay

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Abstract

Biodiversity loss is one of the planetary boundaries that is most urgently in need of action. However, very little is known about the consumers' willingness to pay (WTP) for products with higher (or lower) levels of biodiversity performance. Therefore, this research was conducted to investigate how consumers' WTP is influenced by a product's impact on biodiversity. To address this question, we collected representative data from 524 German consumers in a survey-based experiment. Drawing on prospect theory, we identified the shape of the WTP reaction function for a given product in relation to its biodiversity performance. We demonstrate that consumers with sufficiently high levels of education and concern about biodiversity loss are willing to pay more for products with above-average biodiversity performance and less for products with below-average biodiversity performance. However, the extent to which a product outperforms the industry average does not influence consumers' increased WTP. From a sustainable development perspective, these observed patterns highlight the problematic contrast between the pressing need for substantial improvements in product biodiversity performance and the limited incentives provided by consumers. Consequently, the findings suggest that the incentives that consumers currently provide for corporate biodiversity management are insufficient to assist in staying within the planetary boundaries.

KEYWORDS
biodiversity footprint, consumer behavior, industrial ecology, prospect theory, sustainable consumption, willingness to pay (WTP)

1 | INTRODUCTION

To stay within the planetary boundaries, it is important that consumers value products with favorable environmental performance (e.g., Petersen et al., 2021; Sala et al., 2020). If consumers show higher levels of willingness to pay (WTP) for more environmentally friendly products, companies will have greater tangible incentives to operate in line with the planetary boundaries. A recent update of the planetary boundaries report revealed that particularly the boundary concerning the integrity of the biosphere is transgressed (Richardson et al., 2023).

Studies that quantify how consumers react to environmental product information exist only for some planetary boundaries. Environmental product information describes the positive or negative consequences a product exerts on the natural environment (cf. Stø et al., 2017). Most existing studies focus on climate change (e.g., Echeverría et al., 2014; Petersen et al., 2021; Pomarici et al., 2018). In contrast, it remains unclear how consumers react to varying degrees of quantitative biodiversity-related product information in terms of their WTP. However, due to the complex nature of biodiversity loss and the relatively low level of public awareness of it (Legagneux et al., 2018), consumers' reactions to biodiversity product information are likely to differ from information regarding other environmental aspects. Thus, it is highly relevant to replicate and extend earlier studies on consumers' WTP depending on, for example, climate change product information in the specific context of biodiversity. Furthermore, the lack of research on product biodiversity information poses a challenge for managerial decision-making, as managers are unaware of potential market incentives for improving a product's impact on biodiversity. From a sustainable development perspective, increasing consumers' WTP for environmentally friendly products is crucial to achieving the United Nation's Sustainable Development Goal 12 on sustainable production and consumption (Sala & Castellani, 2019). Therefore, we investigated how the marginal effect of positive (or negative) biodiversity information on WTP increases or decreases with progressively higher (or lower) levels of a product's biodiversity performance.

To address this research question, we collected representative data from 524 German consumers. Building on prospect theory, we identified the shape of the reaction function of WTP for a given product with respect to its biodiversity performance. We used the biodiversity footprint, an indicator that has recently been introduced to the industrial ecology discourse (e.g., Asselin et al., 2020; Wilting et al., 2021), to quantify a product's effect on biosphere integrity. The results highlight the problematic contrast between the pressing need for substantial improvements in product biodiversity performance and currently limited incentives from consumers.

2 | LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1 | Literature review

An earlier special issue in the *Journal of Industrial Ecology* identified the key role of consumers in sustainable development (Fedrigo & Hontelez, 2010; Krantz, 2010; Munasinghe, 2010; Tukker et al., 2010). In particular, Munasinghe (2010) argued for sustainable consumption for its vast potential. However, to activate this potential, managers require knowledge of how product-related sustainability information translates into respective consumption behaviors (e.g., Thøgersen et al., 2010; Vergragt et al., 2014). It has been shown that consumers prefer buying products with positive environmental information (e.g., Brunk & de Boer, 2020; de Jonge et al., 2015; Moosmayer, 2012). At the same time, consumers try to balance their preference for more environmentally friendly products with their reluctance to accept higher prices (e.g., Brécard et al., 2009; Vanclay et al., 2011). Specifically, in the context of climate change information, Petersen et al. (2021) analyzed WTP for products with quantitatively varying degrees of climate change performance. They showed that consumers are willing to pay more for products with better environmental performance, but this WTP surplus hardly depends on the magnitude of the products' performance above the industry average.

An important way to communicate environmental product information is quantitative indicators generated by industrial ecology research, such as carbon footprints or other life cycle assessment (LCA) information. Molina-Murillo & Smith (2009), for instance, found that LCA information positively influences consumers' intentions to purchase a product. Still, O'Rourke and Ringer (2016), as well as Hartikainen et al. (2014), identified a substantial need for further research on how quantitative information provided by industrial ecology research influences consumer decisions.

Regarding the effect that biodiversity-related product information exerts on WTP, far fewer studies exist than those on other environmentally relevant aspects. Given the urgency of the biodiversity crisis (e.g., Richardson et al., 2023), replications in the context of biodiversity are of great importance. Additionally, given the specificities of the biodiversity crisis (e.g., low levels of public awareness of it and its high complexity; Legagneux et al., 2018), it is worthwhile to replicate and specify existing studies on consumers' WTP in the context of biodiversity, as the specificities of this context are likely to yield specific patterns.

Recently, several methodological approaches have been developed to integrate the aspect of biodiversity in existing assessment methods of industrial ecology, such as LCA (e.g., Asselin et al., 2020; Liu & Bakshi, 2019; Wilting et al., 2021). Thus, indicators exist to quantify the impact of products on biodiversity. While decision-makers frequently struggle to draw relevant implications from these indicators (Ingram et al., 2022), guiding decision-makers through consumption decisions based on biodiversity-related product information is highly desirable because consumption plays a central role in causing biodiversity loss (Crenna et al., 2019).

Notably, most studies on WTP for biodiversity deal with citizens' WTP for governmental interventions to improve biodiversity (e.g., Khan et al., 2020; Rodriguez-Ortega et al., 2016) and not with consumers' WTP for biodiversity-friendly products. Further studies (e.g., Ghali, 2020; Jorge et al., 2020; Rödiger et al., 2016) have investigated consumers' WTP for organic products. However, in addition to biodiversity benefits, organic labels imply further benefits and do not indicate quantitative variations in biodiversity performance. Only a few studies have dealt with consumers' WTP for biodiversity-friendly products. Yabe et al. (2013) conducted a choice experiment among Japanese consumers. In that research, consumers chose between products with three qualitative levels of biodiversity impact. The findings indicated that many consumers pay little attention to biodiversity-related information, in contrast, for example, to information concerning their own health. Consequently, Yabe et al. (2013) concluded that "government support and public activities are indispensable for biodiversity conservation" (p. 22). Likewise, Khai and Yabe (2015) organized a choice experiment among Vietnamese consumers. They differentiated two levels of biodiversity improvements for rice and compared consumers' WTP for these products with their WTP for conventional rice. Most respondents were willing to buy the more environmentally friendly products and pay a price premium for higher levels of biodiversity performance. Last, Stampa and Zander (2022) conducted focus group discussions with German buyers of beef products. Their findings again showed that most consumers put only a little value on the biodiversity performance of products and struggle to differentiate between different levels of biodiversity friendliness. Thus, the authors revealed a low level of understanding concerning biodiversity among consumers and highlighted consequent challenges for communicating products' biodiversity performance.

None of the existing studies that were examined tested the effect of quantitatively varying degrees of a product's biodiversity performance on consumers' WTP. Thus, the shape of the WTP reaction function that depends on a product's biodiversity performance is unknown. Such knowledge would be important for supporting managerial decision-making, for example, identifying how different levels of biodiversity improvements are incentivized by consumers. In addition, policymakers need to be informed about the WTP reaction function of consumers to a product's biodiversity performance to assess how far market incentives will go in providing for sustainable development or whether interventions are needed.

To address this research gap, we drew on prospect theory (e.g., Kahneman et al., 1991; Tversky & Kahneman, 1991). Key assumptions of prospect theory include reference dependence (i.e., decision-makers assess different options not in absolute terms but in relation to a reference point) and the so-called negativity bias (also known as loss aversion)—the assumption that negative deviations from the reference point cause stronger reactions than positive deviations of the same size. While prospect theory was originally formulated in the field of economics, its implications have been extended to various contexts and encompass consumer satisfaction and purchase intention (Mittal et al., 1998). In the context of sustainable consumption, (un)favorable deviations are typically framed as high (low) levels of a product's sustainability performance. Thus, transferring prospect theory to the field of environmental consumption leads to the suggestion that consumers assess a product's environmental performance not in absolute terms but in relation to a reference point (Grankvist et al., 2004; Petersen et al., 2021; van Dam & De Jonge, 2015).

2.2 | Development of hypotheses

A common implicit assumption is that there is a linear connection between a product's environmental performance and the consumers' WTP for the product (i.e., the better the environmental performance of a product, the higher the consumers' WTP) (e.g., Ha-Brookshire & Norum, 2011; Loureiro & Lotade, 2005; Zander & Hamm, 2010). However, previous empirical findings suggest nonlinear effects and have found indications for a negativity bias (e.g., Moosmayer, 2012; Petersen et al., 2021; van Dam & De Jonge, 2015). For example, Petersen et al. (2021) found that negative climate-relevant product information has a stronger effect on a consumer's WTP than quantitatively corresponding positive information. Given the specifics of the biodiversity crisis (i.e., its complexity and the relatively low level of public awareness of it) (Legagneux et al., 2018), it cannot be taken for granted that these findings from the context of climate change directly translate to the context of biodiversity. Hence, the first hypothesis aimed to replicate the negativity bias found by Petersen et al. (2021). In addition to the aforementioned specifics, the problem of biodiversity loss also shows many characteristics in common with climate change. For example, both environmental problems are typical public-good settings (Perman et al., 2011; Rands et al., 2010). Furthermore, as with greenhouse gas emissions, actions that cause biodiversity loss do not necessarily have immediate consequences that are readily visible to consumers; a time lag often exists between environmentally damaging actions and consequent negative environmental outcomes (Chen et al., 2023). Thus, we expected that earlier empirical findings on negativity bias could be replicated in the context of biodiversity:

H1. Negative deviations of a product's biodiversity performance from a given reference point will have a stronger effect on WTP than quantitatively corresponding positive deviations.

Furthermore, prospect theory assumes S-shaped utility functions, which take a value of zero at the reference point, rise above zero with increasing gains, and fall below zero with increasing losses. The slope of the reaction function levels off as deviations from the reference point increase in magnitude (Kahneman & Tversky, 1979; Kahneman et al., 1991). Transferring these theoretical considerations to the context of sustainable consumption, it can be expected that consumers' WTP for more sustainable products will only slightly increase if the degree of sustainability performance increases to even higher levels. Petersen et al. (2021) found an indication of such patterns in the context of climate change. Their results suggest that consumers are willing to pay more for products with better environmental performance, but this WTP surplus hardly depends on the magnitude of the product's performance beyond the industry average. Regarding products with worse-than-average environmental performance, Petersen et al. (2021) also found that the marginal effect of negative information declines with higher levels of deviations from the industry average. In the context of biodiversity-related product information, the focus group discussions conducted by Stampa and Zander (2022) suggest that most consumers struggle to distinguish between different levels of biodiversity performance. Building on these insights, we thus expected that we could replicate the findings of Petersen et al. (2021) on climate change product information in the context of biodiversity-related product information:

H2a. Positive deviations in a product's biodiversity performance from a given reference point will have a continually declining positive effect on WTP.

H2b. Negative deviations in a product's biodiversity performance from a given reference point will have a continually declining negative effect on WTP.

In the third hypothesis, we extend and specify the potential implications of prospect theory in the specific context of consumers' WTP reactions to biodiversity product information. Regarding the issue of climate change, consumers' reactions to related product information depend on their level of concern about climate change (Petersen et al., 2021). In general, we expect that in the context of biodiversity loss, the level of concern will also impact how strongly consumers react to the respective product information. It can even be expected that many consumers will not respond strongly to product biodiversity information (cf. Stampa & Zander, 2022; Yabe et al., 2013) for the following reasons. First, biodiversity is a highly complex phenomenon. For instance, the causes of biodiversity loss are more difficult to explain compared to the problem of climate change in which sources of greenhouse-gas emissions can be identified relatively clearly. The complexity of biodiversity is also reflected in the differentiation between functional and genetic biodiversity (Richardson et al., 2023), which is difficult to communicate to consumers. Second, despite the urgency of the biodiversity crisis, the issue of biodiversity loss receives far less public, corporate, and political attention than the climate change, for example (Legagneux et al., 2018). Thus, a relevant share of consumers will likely be characterized by relatively low levels of concern about biodiversity loss due to the high complexity of and the relatively low attention paid to this issue. Therefore, we expected that not all consumers would react to biodiversity product information. Rather, their WTP for products with varying degrees of biodiversity performance would depend on their individual level of concern about biodiversity loss:

H3. Consumers' level of concern about biodiversity loss will moderate the effect of biodiversity-related product information on WTP for the respective product.

3 | METHOD

3.1 | Sample and experimental design

We collected data from a population-representative sample of German consumers in September 2023. Quota targets for gender, age, and formal education were based on the most recent micro-census of the German population (Statistisches Bundesamt, 2023). A final sample of 524 respondents was used for the analysis.[1]

In an online questionnaire (see Supporting Information S2), each respondent was presented with three hypothetical purchase situations for a low-involvement product. For the study, a pack of eight rolls of toilet paper was chosen as the product offered, as the production and disposal of toilet paper has a notable impact on biodiversity. Thus, manipulating the biodiversity performance for this product seemed plausible.

In addition, toilet paper is purchased regularly by nearly all consumers, and its consumption is largely unaffected by external influences, such as short-term trends. We deliberately decided to only manipulate biodiversity product information and to keep contextual and situational factors constant, as the focus of this study was not to analyze the potential moderating effects of situational or contextual factors but to capture the general form of the WTP reaction function, which depends on product biodiversity information.

The respondents were asked to state their WTP for three variants of this product, which differed only with respect to their biodiversity performance (see Section 3.2 for the measurement of this variable). Presented to each respondent in random order, one product each showed average, inferior, and superior biodiversity performance. For methodological purposes, the three purchase scenarios (see Supporting Information S3) were separated by distraction tasks. Demographic screening questions were placed at the beginning of the questionnaire, and attitude measurements were placed at the end.

3.2 | Measurements

As a dependent variable, WTP in euros was directly entered by the respondents. This common procedure (e.g., Ha-Brookshire & Norum, 2011; Harms & Linton, 2016; Homburg et al., 2005) allowed the capture of the general form of the WTP reaction function and avoided anchoring and framing effects. To minimize potential problems associated with the use of stated preferences, we measured the degree to which respondents provided socially desirable answers and controlled for the potential influence of social desirability on WTP, as well as for sequence and fatigue effects.

To quantify the products' biodiversity performance, we used the product biodiversity footprint, a relatively recent measure introduced by Asselin et al. (2020). The product biodiversity footprint captures the direct and indirect biodiversity effects of a product along its entire supply chain. It allows for the communication of the relative potentially disappeared fraction of species within a year attributed to a product in question in a single comprehensible number. Our study thus examined whether consumers reacted to the product biodiversity information presented via this new measure.

To further ease the comprehensibility of the biodiversity product footprint, we presented it in relative terms, for example, by stating that the product offered had an impact on biodiversity that was twice as high as the average product, indicated by a biodiversity product footprint twice as high as the industry average. Acknowledging that multiple other reference points would be feasible as well (e.g., preserving the status quo of the ecosystem and conformity to planetary boundaries), we used the industry average as a reference point, as this was an established procedure (e.g., Petersen et al., 2021; Presley et al., 2010; van Dam & De Jonge, 2015) and allowed drawing meaningful managerial implications. This reference point uses the current context that managers are facing and reveals consequences that are associated with deviating from the current industry average. Similar to the method of Petersen et al. (2021), we varied the biodiversity performance stimulus at random by factors of up to five with respect to the industry average (i.e., products offered could be up to five times better or worse than the industry average). Thus, after a base-5 log transformation and a sign change, this resulted in a normalized range from −1 (worst) to +1 (best) for the measure used in the analysis model.[2]

Concern about biodiversity loss was measured in a similar fashion in analogy to Metag et al. (2017)'s concern about climate change inventory.[3] Social desirability was measured by Hays et al.'s (1989) five-item scale. To assess the items included in these scales, we used numerical rating scales that included verbal descriptions only for the extreme values. This allowed for the analysis of the responses as interval data. We used 5-point numerical rating scales in accordance with the original measurement constructs.

To safeguard against forms of common method bias and to control their effect at the item level, an unmeasured latent method factor was added to the model (see Podsakoff et al., 2003), with equal factor loadings on all rating scale items and correlations with the other latent factors constrained to zero.

A confirmatory factor analysis (CFA) demonstrated an excellent fit of the measurement model[4] to the data ($\chi^2/df = 90.8/52 = 1.75$, CFI = 0.986, TLI = 0.982, RMSEA = 0.038; e.g., Hair et al., 2019; Kline, 2015), and a non-significant correlation of concern about biodiversity loss with the social desirability factors (0.107 ± 0.062). The concern about biodiversity loss scale had a Cronbach's α of 0.951, and the social desirability scale had a Cronbach's α of 0.659.

3.3 | Model and analysis

Our analysis was based on the two-level repeated-measures structural equation model (e.g., Du Toit & Du Toit, 2008; Heck & Thomas, 2015) shown in Figure 1.[5] We analyzed the data using Mplus version 8 (Muthen & Muthen, 2017). Like Petersen et al. (2021), we modeled the within-subject variation of WTP as a function of a product's biodiversity performance, controlling for the measurement occasion. The random intercept and slopes of WTP were between-subjects latent variables (Preacher et al., 2016; Snijders & Bosker, 2012), dependent on concern about biodiversity loss, social desirability, and demographic controls.

The product's biodiversity performance enters the regression indirectly as two piecewise power functions [$f^+(x_{ij})$ and $f^-(x_{ij})$] of the absolute value of the logarithm of the relative biodiversity footprint, separated by the sign of the logarithm into a performance surplus and a performance deficit component. The exponents of the power functions indicate an increasing sensitivity (exponents > 1), decreasing sensitivity (exponents < 1), or linear response (exponents = 1) of WTP to biodiversity performance. The special case of a zero exponent implies a constant response for any amount of deviation from zero (i.e., the industry average biodiversity performance).

We considered the following nested sequence of models for estimating the exponents of the WTP reaction function and the remaining within-subjects and between-subjects model parameters:

- **Model 1**. Both exponents of the reaction function are fixed to a value of 1, so the reaction function is a piecewise linear function, linked at the origin.
- **Model 2**. Both exponents take the same value, estimated from the data, so the reaction function is symmetric about the origin, at which point its curvature changes from convex to concave (exponents < 1, in line with prospect theory) or from concave to convex (exponents > 1, contradicting prospect theory).
- **Model 3**. Both exponents are estimated independently, so the curvatures on either side of the origin are not linked a priori.

The exponents for models 2 and 3 were estimated by maximizing the profile likelihood for the varying parameter values.

4 | RESULTS

Table 1 shows the estimates for all models, along with robust standard errors (in parentheses). Figure 2 graphically represents the estimated differential WTP function dependent on the biodiversity performance of models 2 and 3.[6] According to robust likelihood-ratio tests, model 2 with

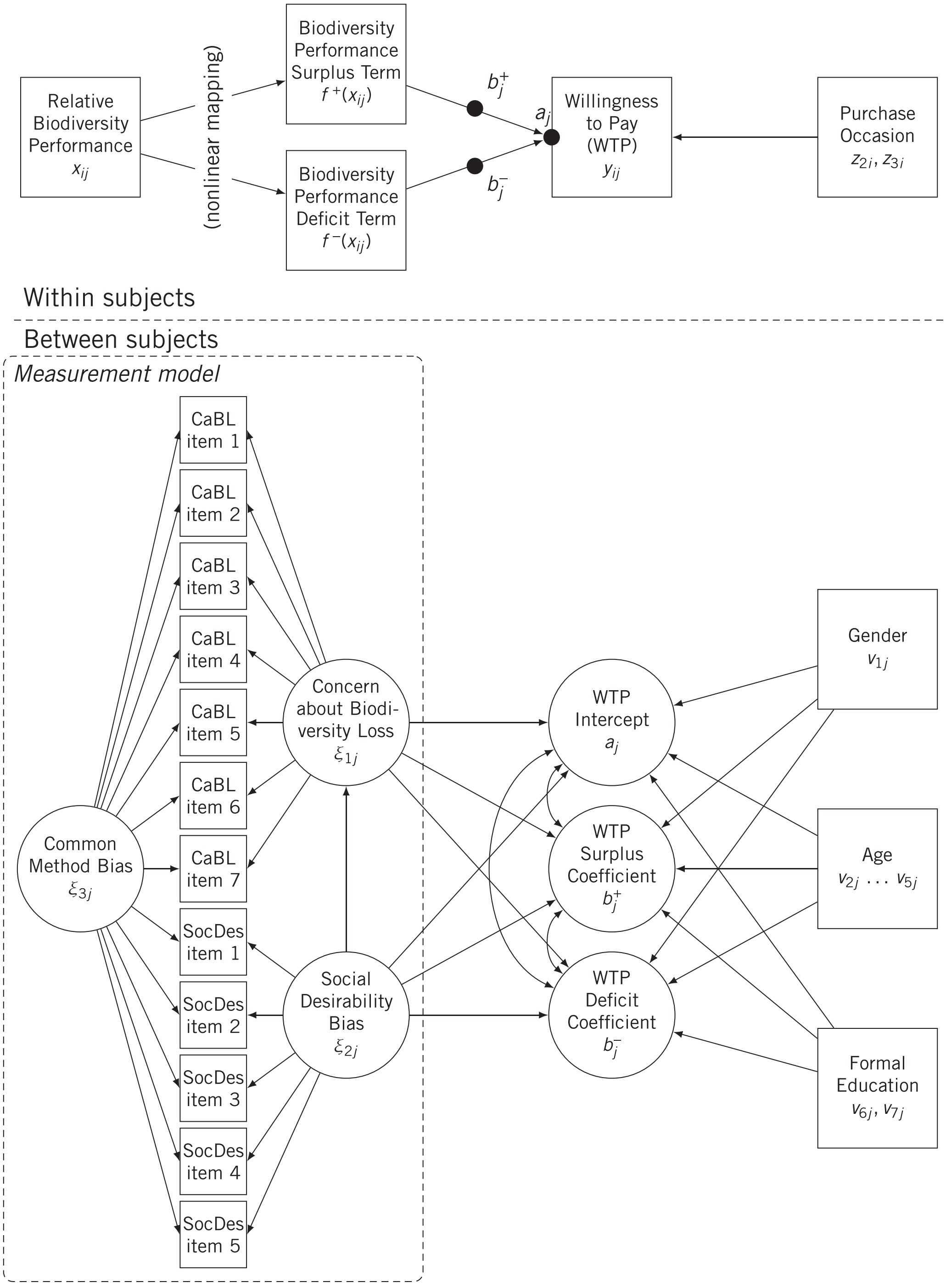

FIGURE 1 Summary of the two-level structural equation model used in the analysis. CaBL, concern about biodiversity loss; WTP, willingness to pay; SocDes, social desirability. Filled circles at the within-subject level represent random slopes (b_j^+, b_j^-) and the random intercept (a_j) modeled as latent variables at the between-subject level.

an estimated value of 0.12 for both exponents fit the data significantly better than model 1 with exponents fixed at 1.0 ($-2\Delta LL = 87.50$, scaled $\chi^2 = 59.32$, $df = 1$, $p < 0.001$) but worse than model 3 with exponents of 0.00 and 0.24 for the biodiversity performance surplus and deficit components, respectively ($-2\Delta LL = 25.82$, scaled $\chi^2 = 17.95$, $df = 1$, $p < 0.001$). Hence, we found that a model with differently shaped responses to the positive and negative deviations from industry average biodiversity performance provided the best fit. Thus, the consumers' WTP response to improved biodiversity performance was a constant WTP surplus, independent of the amount of improvement.

H1 hypothesized a stronger reaction to inferior biodiversity performance than to superior biodiversity performance. A comparison of the related random slope coefficients, which was only meaningful in model 2, in which the coefficients applied to identically shaped power functions, did not show stronger WTP effects for negative deviations. Thus, we could not confirm H1, which focused on negativity bias. Both an individual's concern

TABLE 1 Parameter estimates (and standard errors) for alternative analysis models.

Model	(1)	(2)	(3)
Shape parameters of WTP reaction function			
Exponent of biodiversity performance surplus	1.00	0.12	0.00
Exponent of biodiversity performance deficit	1.00	0.12	0.24
Fixed main effects on WTP			
Intercept	3.95***	3.86***	3.85***
	(0.13)	(0.14)	(0.14)
Biodiversity performance surplus	0.08	0.23*	0.23*
	(0.15)	(0.10)	(0.09)
Biodiversity performance deficit	0.52	0.21	0.19
	(0.29)	(0.16)	(0.18)
Concern about biodiversity loss	0.07	0.07	0.06
	(0.06)	(0.06)	(0.06)
Social desirability bias	0.14	0.16	0.16
	(0.09)	(0.09)	(0.09)
Female	−0.26**	−0.24**	−0.24**
	(0.09)	(0.09)	(0.09)
18–29 years old	0.05	0.10	0.12
	(0.20)	(0.19)	(0.19)
30–39 years old	0.29	0.36*	0.37*
	(0.17)	(0.18)	(0.18)
50–59 years old	−0.01	0.04	0.05
	(0.15)	(0.15)	(0.15)
60 years old and above	−0.03	0.02	0.04
	(0.12)	(0.13)	(0.13)
Low education level	−0.03	−0.00	0.01
	(0.10)	(0.10)	(0.10)
High education level	0.13	0.14	0.15
	(0.11)	(0.11)	(0.11)
Purchase occasion 2	0.01	0.02	0.02
	(0.04)	(0.04)	(0.04)
Purchase occasion 3	0.03	0.05	0.04
	(0.05)	(0.05)	(0.05)
Interaction effects on WTP			
Biodiversity performance surplus × …			
Concern about biodiversity loss	0.24**	0.16***	0.14***
	(0.07)	(0.04)	(0.04)
Social desirability bias	−0.09	−0.06	−0.05
	(0.11)	(0.07)	(0.06)
Female	0.02	−0.03	−0.03
	(0.12)	(0.07)	(0.07)
18–29 years old	0.06	−0.13	−0.15
	(0.30)	(0.17)	(0.16)
30–39 years old	−0.02	−0.15	−0.14
	(0.22)	(0.15)	(0.14)

(Continues)

TABLE 1 (Continued)

Model	(1)	(2)	(3)
50–59 years old	0.08	−0.05	−0.06
	(0.23)	(0.14)	(0.12)
60 years old and above	0.01	−0.14	−0.15
	(0.20)	(0.12)	(0.12)
Low education level	−0.12	−0.16	−0.16
	(0.17)	(0.10)	(0.09)
High education level	0.41*	0.23*	0.19*
	(0.17)	(0.10)	(0.09)
Biodiversity performance deficit × …			
Concern about biodiversity loss	0.52***	0.30***	0.33***
	(0.10)	(0.06)	(0.06)
Social desirability bias	−0.08	−0.03	−0.03
	(0.18)	(0.10)	(0.11)
Female	0.21	0.15	0.16
	(0.20)	(0.11)	(0.12)
18–29 years old	−0.07	−0.07	−0.06
	(0.43)	(0.24)	(0.26)
30–39 years old	0.03	0.08	0.12
	(0.36)	(0.21)	(0.23)
50–59 years old	−0.05	0.03	0.08
	(0.32)	(0.18)	(0.20)
60 years old and above	−0.13	−0.02	−0.01
	(0.30)	(0.17)	(0.19)
Low education level	0.05	0.06	0.05
	(0.23)	(0.13)	(0.14)
High education level	0.76**	0.46**	0.53**
	(0.26)	(0.15)	(0.16)
Fixed effect of social desirability bias on …			
Concern about biodiversity loss	0.16	0.16	0.16
	(0.10)	(0.10)	(0.10)
Variance/residual variance of …			
Concern about biodiversity loss	0.87***	0.87***	0.87***
	(0.08)	(0.08)	(0.08)
Social desirability bias	0.38***	0.38***	0.38***
	(0.07)	(0.07)	(0.07)
Common method factor	0.16***	0.16***	0.16***
	(0.03)	(0.03)	(0.03)
Random effects on WTP			
Residual variances			
Between-subject random intercept	0.81***	0.79***	1.00***
	(0.18)	(0.21)	(0.24)
Random slope biodiversity performance surplus	0.18	0.14	0.55
	(0.32)	(0.35)	(0.35)

(Continues)

TABLE 1 (Continued)

Model	(1)	(2)	(3)
Random slope biodiversity performance deficit	2.35***	1.07**	1.84**
	(0.62)	(0.33)	(0.55)
Within-subject residual	0.36***	0.26	0.04
	(0.08)	(0.13)	(0.18)
Covariances			
Intercept and slope biodiversity performance surplus	0.02	0.04	−0.18
	(0.13)	(0.16)	(0.17)
Intercept and slope biodiversity performance deficit	0.06	0.06	0.28
	(0.27)	(0.20)	(0.26)
Slopes biodiversity performance surplus and biodiversity performance deficit	0.46	0.17	−0.06
	(0.31)	(0.20)	(0.23)
Model fit			
Natural logarithm of likelihood (LL)	−9876.62	−9832.87	−9819.96
Akaike information criterion (AIC)	19907.24	19821.74	19797.93
Bayesian information criterion (BIC)	20319.97	20239.83	20221.37
Likelihood-ratio test versus model 2			
-2ΔLL	87.50***		
Scaled χ^2; *df*	59.32; 1		
Likelihood-ratio tests versus model 3			
-2ΔLL	113.32***	25.82***	
Scaled χ^2; *df*	76.83; 2	17.95; 1	
Hypothesis H1 (not generally supported)			
Fixed main effects on WTP			
Biodiversity performance surplus		0.23*	0.23*
		(0.10)	(0.09)
Biodiversity performance deficit		0.21	0.19
		(0.16)	(0.18)
Likelihood-ratio test for equality of fixed main and interaction effects of surplus and deficit			
-2ΔLL		11.55	
Scaled χ^2; *df*		10.71; 9	
Hypothesis H2 (supported)			
Shape parameters of WTP reaction function			
Exponent of biodiversity performance surplus			0.00
Exponent of biodiversity performance deficit			0.24
Likelihood-ratio test for $\eta+ = 1$			
-2ΔLL			50.79***
Scaled χ^2; *df*			34.96; 1
Likelihood-ratio test for $\eta- = 1$			
-2ΔLL			76.78***
Scaled χ^2; *df*			54.24; 1

(Continues)

TABLE 1 (Continued)

Model	(1)	(2)	(3)
Hypotheses H3 (supported)			
Interaction effects on WTP			
Biodiversity performance surplus × Concern about biodiversity loss		0.16***	0.14***
		(0.04)	(0.04)
Biodiversity performance deficit × Concern about biodiversity loss		0.30***	0.33***
		(0.06)	(0.06)

Note: Model 1 assumes a linear relationship between a products' biodiversity footprint and WTP; model 2 assumes that the reaction function is symmetric about the origin; model 3 does not a priori assume a symmetric reaction function about the origin.Abbreviations: WTP, willingness to pay; χ^2, Chi-square statistic of model fit; df, degrees of freedom; ΔLL, change in the natural logarithm of likelihood as an indicator for model fit (multiplied by a factor of −2 for technical reasons).
**p* < .05; ***p* < .01; ****p* < .001.

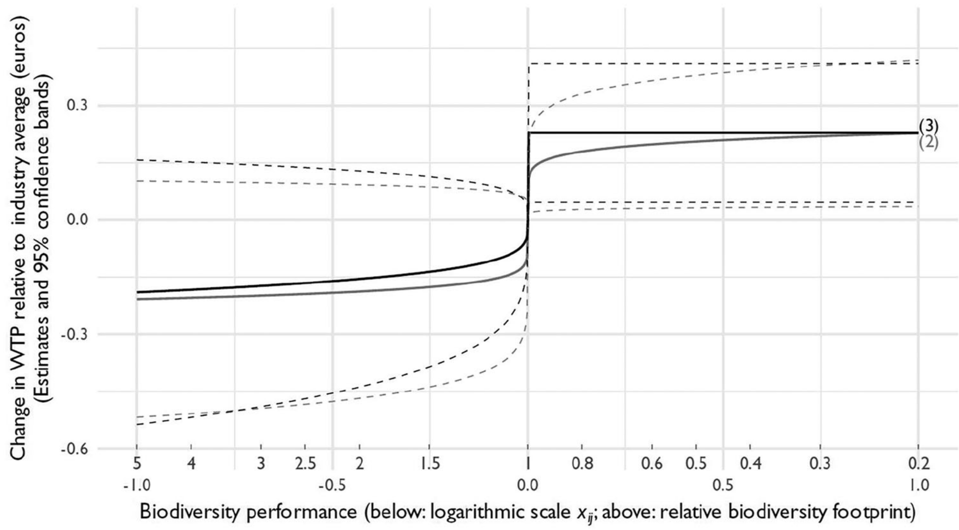

FIGURE 2 Estimated differential willingness to pay (WTP) function dependent on biodiversity performance. The figure displays the WTP for a reference subject of models 2 and 3 (as summarized in Table 1), including the 95% confidence bands (dashed lines). A reference subject is a respondent with average levels of concern about biodiversity loss and social desirability, aged 40 to 49 years, of male gender and medium education level. The underlying data for this figure are available in Table 1 (model 2 [gray line] and model 3 [black line]).

about biodiversity loss and their education level interacted significantly with a product's biodiversity performance. The effect of these interactions was illustrated by a floodlight analysis (Spiller et al., 2013), shown in Figure 3, which displays the 95% confidence bands for the conditionally expected reaction function coefficients at varying levels of concern regarding the biodiversity loss scale and low, medium, and high levels of formal education.[7] This shows that although the average effect of inferior biodiversity performance on WTP was not significant, it did demonstrate a statistically significant effect for more than 80% (i.e., those most concerned with biodiversity loss) of the highly educated population and still around 30% of respondents with lower amounts of formal education. The significant main effect of superior biodiversity performance can be seen to vary in a similar pattern, resulting in a significant price premium accepted by more than 90% of the highly educated, but only by 10% of the population with a low level of formal education.

Both components of the WTP reaction function exhibited shapes characterized by exponents significantly below 1.0, which provided support for hypotheses H2a and H2b. The constant price premium for any above-average level of biodiversity performance can be seen as the most extreme form of diminishing returns conceivable, deforming the positive branch of the S-shaped reaction function predicted by prospect theory to the right angle of a step function.[8]

H3 implied an interaction between concern about biodiversity loss and biodiversity performance. This interaction was not only visible in the floodlight analysis but was also highly statistically significant (0.14*** and 0.33***, respectively, for the interaction with superior and inferior performance, respectively, in model 3), thus supporting H3.[9] Concern about biodiversity loss reinforces that the response to inferior biodiversity performance was twice as much as the response to superior performance, as visualized by the steeper slopes on the left of Figure 3. Hence, for sufficiently high concern about biodiversity loss, the WTP response to inferior performance is stronger than that to quantitatively equal superior performance,

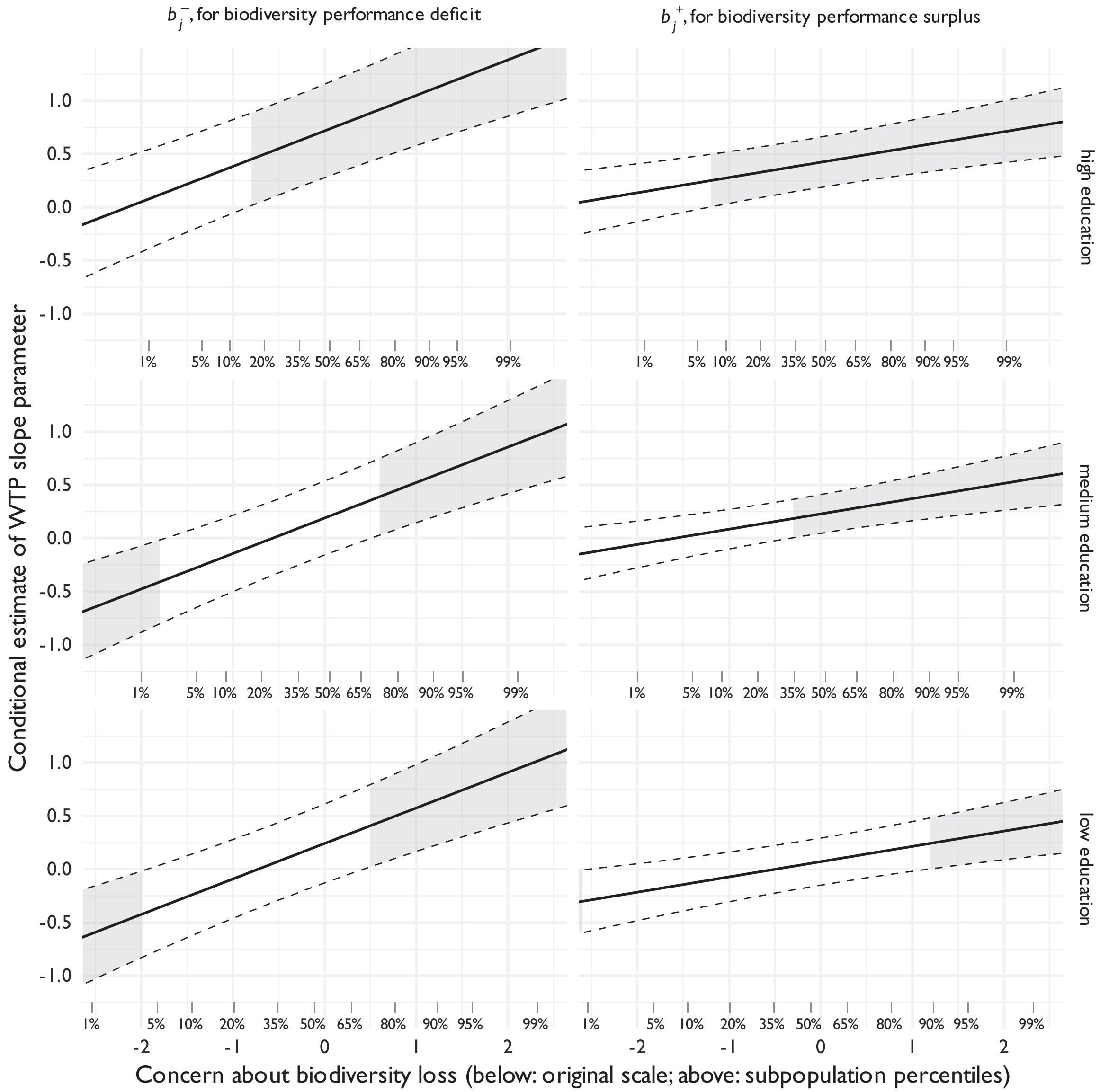

FIGURE 3 Floodlight analysis of varying effects of biodiversity performance on willingness to pay (WTP). Dashed lines represent boundaries of 95% confidence bands, and shaded areas mark ranges of the control variables where the effects are significant (i.e., the confidence bands do not include zero). The underlying data for this figure are available in Table 1 (model 3).

reflecting the negativity bias hypothesized in H1. Therefore, the lack of support for H1 should not be mistaken for refuting the existence of a negativity bias. Rather, our results show that a negativity bias existed only for those consumers with high levels of concern about biodiversity loss.

Except for the interaction effects of education and a gender main effect (women's WTP was lower by 0.24 euros; B = -0.24**), none of the demographic control variables had a significant impact.[10] Social desirability had no significant effect on either concern about biodiversity loss (0.16) or WTP (0.16), and there was no significant order or fatigue effect distinguishing the three purchase occasions ($-2\Delta LL = 0.928$, scaled $\chi^2 = 0.942$, $df = 2$, $p = 0.624$). A summary of the hypothesis tests and their results can be found at the end of Table 1.

5 | DISCUSSION

To the best of our knowledge, this study was the first to specifically test how different quantitative levels of a product's biodiversity performance influence WTP. We have shown that consumers' reactions to product biodiversity information can be explained by prospect theory. First, consumers' WTP relationship with biodiversity product information can be described as strongly reference-dependent. Second, we confirmed the aspect of diminishing sensitivity, as consumers' additional increase (decrease) in WTP diminished with additional distance from the reference point (cf. Kahneman et al., 1991; Tversky & Kahneman, 1991). In so doing, we also challenge the common implicit assumption that there is a linear connection between a product's environmental performance and consumers' WTP for a product (e.g., Ha-Brookshire & Norum, 2011; Loureiro & Lotade, 2005; Zander & Hamm, 2010).

Concerning WTP for products with above-average biodiversity performance (H2a), we even found a constant WTP premium. This finding supports Stampa and Zander's (2022) suggestion that consumers do not distinguish between different magnitudes of positive biodiversity product information. Interestingly, this result also resembles insights gained on sustainable investments. Heeb et al. (2023) showed that, while investors are willing to pay more for sustainable investments, their WTP does not depend on the magnitude of the impact created. They suggested that this pattern could be due to a rather emotional and not primarily rational, calculative reasoning of investors, which could also explain the patterns observed in our study. An alternative explanation for the constant WTP premium could be that biodiversity loss is more complex than other environmental issues and less prominent in public debate than climate change (Legagneux et al., 2018). Thus, consumers may have found it particularly difficult to use information about the magnitude of biodiversity improvements in this context.

Likewise, the finding that no negativity bias could be observed in our data can also be explained by the complexity of biodiversity information and its relatively low level of public attention (Legagneux et al., 2018) when compared to other contexts where earlier research found a negativity bias concerning the influence of environmental product information on WTP or purchase intent (e.g., Moosmayer, 2012; Petersen et al., 2021; van Dam & De Jonge, 2015). Such an explanation aligns with our finding that among respondents with high levels of concern about biodiversity loss, negativity bias did exist. Thus, our results are in line with the analysis of Grankvist et al. (2004), who also found that a negativity bias concerning environmental product information existed only among consumers with higher levels of environmental concern.

Last, our study showed that consumers' level of concern about biodiversity loss moderated the effect of biodiversity-related product information on WTP. Consequently, the higher the level of concern about biodiversity loss, the stronger consumers respond to quantitative variations in biodiversity-related product information. This finding also implies that some consumers do not react to product biodiversity information at all. While earlier studies generally concluded that positive environmental information stimulates purchase behavior (e.g., Brunk & de Boer, 2020; de Jonge et al., 2015; Moosmayer, 2012), our results confirm the insight by Stampa and Zander (2022) that most German consumers disregard biodiversity product information and offer an explanation for Yabe et al.'s (2013) related finding that many consumers pay only little attention to biodiversity-related product information. In analyzing the influence of socio-demographic variables on WTP for biodiversity-friendly products, we showed that highly educated consumers were particularly receptive to biodiversity product information.

6 | CONCLUSIONS

6.1 | Implications

This study suggests that only companies whose products' biodiversity performance is slightly below or equal to the industry average face a strong incentive to improve the biodiversity performance of their products based on consumers' WTP. In contrast, consumers' WTP does not present incentives for companies offering products that are already better than the industry average to further improve biodiversity performance. Similarly, consumers' WTP does not set substantial incentives for small improvements in products with biodiversity performance substantially below the industry average.

Still, the findings also show that among consumer segments with higher levels of education or higher levels of concern about biodiversity loss, different patterns emerge. Companies offering products with outstanding product biodiversity performance are advised to specifically address these consumer segments, as in the mass market, only weak incentives for offering such products exist.

From the perspective of opportunistic sustainability management, our findings thus suggest that companies operating in the mass market should aim to outperform the industry average only by small margins because further improvements are not likely to be rewarded with additional WTP. However, it is implausible that such small improvements will be sufficient for moving conditions back within the limits of the planetary boundaries. Hence, it is indispensable to create further incentives for companies to effectively manage their biodiversity impacts.

First, the lack of sufficient incentives created by mass-market consumers highlights the importance of financial markets, as, for example, reflected in the initiative of the WWF and AXA (2019) to integrate biodiversity into investment strategies. Indeed, Paetzold and Busch (2014) highlight that wealthy investors could provide strong incentives for sustainable development but also identify the gap between actual and expected engagement of investors as a substantial obstacle. Furthermore, Busch et al. (2022) showed that companies can link specific environmental performance improvements (regarding CO_2 emissions or water management) to financial performance. Still, little is known about how biodiversity improvements are linked to firms' financial performance. Our findings indicate that biodiversity might be relevant for profit by showing that primarily offering products with inferior biodiversity performances entails a risk for firm performance when such performance deficits are communicated. Thus, investors should not only pay attention to biodiversity-harming products but also to possible regulations aimed at increasing transparency regarding products' biodiversity performance.

Second, there is a need for interventions that go beyond opportunistic intention. As our findings reveal a strong orientation of consumers toward reference points, governments, corporate managers, and NGOs are challenged to raise those reference points, for example, via educational campaigns. To create incentives for substantial improvements in products' biodiversity performance in mass markets, it will be particularly important to stimulate the awareness of consumers with low levels of concern about biodiversity loss and low levels of education. Still, our findings also show that when biodiversity product information is communicated to consumers, most consumers react to the information. Thus, a mandatory labeling scheme on product biodiversity information could raise consumers' awareness regarding the biodiversity impacts of products. Because the monetary incentives provided by consumers' WTP are particularly small for products with above-average biodiversity performance and for products with biodiversity performances strongly below the industry average, policies could additionally consider introducing subsidies for products outperforming the industry average by far or banning products with biodiversity performances strongly below the industry average.

Overall, we have shown that biodiversity footprint information can stimulate purchasing behavior and can be used to inform managerial decision-making. In addition, our findings emphasize that consumers alone will likely provide insufficient incentives to achieve substantial improvements in biodiversity conservation.

6.2 | Limitations

The methodological design used in this study had particular limitations. First, the dependent variable represented WTP as reported in a survey-based experiment rather than as observed in actual purchase decisions. While we acknowledge the potential issues associated with directly eliciting WTP (Auger & Devinney, 2007; Breidert et al., 2006), this approach helped to mitigate anchoring and framing effects and was suitable for capturing the overall shape of the WTP reaction function. To reduce problems associated with socially desirable responses, we measured the degree of potential social desirability bias in our data and controlled for the potential influence of social desirability on WTP.

As a second limitation, we did not manipulate the context (e.g., online vs. stationary shopping) because the focus of this study was to analyze the general form of the WTP reaction function based on the products' biodiversity information. Likewise, we focused solely on one potential method of conveying information about environmental product performance to consumers. To reduce problems associated with comprehensibility, we used the biodiversity product footprint (Asselin et al., 2020), which summarizes the total biodiversity impact of a product in one number and thus allows consumers to directly compare different products.

6.3 | Future research

Future research should address the above-mentioned limitations and attempt to confirm our findings using real-choice experiments. For this purpose, conjoint analyses could also be used to capture interaction effects with different product characteristics, such as product quality. Furthermore, future studies could manipulate many of the factors we held constant to focus on the general shape of the WTP reaction function based on biodiversity product information. Such factors include variations in the marketing channel (e.g., online vs. stationary shopping), context (shopping alone vs. with friends), different means of communicating product biodiversity footprints (e.g., on products or via news articles), and using different indicators, such as using absolute values of biodiversity footprints instead of relative comparisons with the industry average. Likewise, the effect we found for a typical low-involvement product should also be sought in complementary product categories, such as lifestyle products. Perhaps most importantly, future studies should manipulate the reference point to test whether the strong reference dependence of consumers also remains for more ambitious reference points, such as conformity to the planetary boundaries.

This study aimed to replicate established findings on consumers' WTP depending on climate change product information in the context of biodiversity. Future studies should follow this path and analyze how far these findings can be replicated in additional sustainability domains, such as water footprints, animal welfare, and labor conditions.

Last, earlier research showed that when strategically addressing environmental issues, companies can link their improvement regarding many environmental issues (such as CO_2 emissions and water management) to creating profits (e.g., Busch et al., 2022). In the context of biodiversity management, no such analyses appear to exist. Still, our findings suggest that it is worth investigating such a link, as, at least for some customer segments, improvements regarding biodiversity are likely to result in higher WTP and thus increase corporate returns.

In the *Journal of Industrial Ecology's* special issue on "Sustainable Production and Consumption," Munasinghe (2010) argued that sustainable consumption plays a key role in sustainable development; he claimed that "ordinary citizens … are often ahead of political leaders in terms of willingness to address … sustainable development issues" (p. 6). It goes beyond the scope of this article to systematically assess this claim. Still, regarding biodiversity, our findings suggest that relying solely on the willingness of ordinary consumers to address biodiversity loss will hardly suffice to motivate companies to operate in line with the planetary boundary on biodiversity. Future research should thus elaborate more closely on the design of specific governmental interventions, as well as management measures that aim at activating the potential of sustainable consumption for biodiversity restoration.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Notes

[1] Quota targets and actual sampling frequencies are given in Supporting Information S1. Respondents failing an attention check were not included in the sample.

[2] The rationale behind this transformation is that a linear reaction function of WTP with respect to this transformed measure would imply that any given factor or percentage of biodiversity performance improvement (or deterioration) generates a constant price premium (or reduction) irrespective of the reference point from which this improvement (or deterioration) takes place.

[3] As the transgression of the biodiversity loss-related planetary boundary parallels that of climate change, we left the wording of all items unchanged except for the substitution of the term "climate change" with "biodiversity loss."

[4] The measurement model used for the CFA can be seen on the left-hand side of the between-subjects portion of the model shown in Figure 1; in the CFA, a correlation between concern about biodiversity loss and social desirability was modeled instead of the regression shown for the analysis model. The results of the CFA are provided in Supporting Information S4.

[5] A formal representation of the analysis model is shown in Supporting Information S5.

[6] The raw distribution of WTP responses is shown in Supporting Information S6.

[7] Concern about biodiversity loss quantiles marked on the abscissae of Figure 3 was calculated from estimated scores for low, medium, and high education sub-populations. The shaded areas within the confidence bands highlight the regions beyond the respective Johnson–Neyman points (Spiller et al., 2013) where the respective coefficients are estimated to significantly differ from zero. The cross-tabulation of education and concern about biodiversity loss in the graphs should not be mistaken as hinting at the existence or the absence of an interaction between the two, as this was not examined in the model.

[8] See the WTP functions predicted for population averages of the continuous and reference values of categorical control variables in Figure 2; when comparing the functions predicted by models 2 and 3, it should be kept in mind that the graphs do not reflect the different WTP intercepts, which would compensate for the apparent level shift.

[9] To exclude an influence of the biodiversity performance of products presented to the respondents on their concern about biodiversity loss elicited later, we ran both a multiple linear regression of concern about biodiversity loss on each presented product's biodiversity performance and a simple linear regression of concern about biodiversity loss on all three products' average biodiversity performance. None of the effects were statistically significant (–0.041, $p = 0.739$; 0.052, $p = 0.694$; and –0.046, $p = 0.720$, respectively, for the multiple regression; and –0.048, $p = 0.886$, for the simple regression), which would seem to indicate that no such influence was present.

[10] There was no significant age effect according to the omnibus test ($-2\Delta LL = 6.74$, scaled $\chi^2 = 5.95$, $df = 4$, $p = 0.203$); hence, the significance of the age group dummy for those 30 to 39 years old should be discounted.

REFERENCES

Asselin, A., Rabaud, S., Catalan, C., Leveque, B., L'Haridon, J., Martz, P., & Neveux, G. (2020). Product biodiversity footprint—A novel approach to compare the impact of products on biodiversity combining life cycle assessment and ecology. *Journal of Cleaner Production*, *248*, Article 119262. https://doi.org/10.1016/j.jclepro.2019.119262

Auger, P., & Devinney, T. M. (2007). Do what consumers say matter? The misalignment of preferences with unconstrained ethical intentions. *Journal of Business Ethics*, *76*(4), 361–383.

Brécard, D., Hlaimi, B., Lucas, S., Perraudeau, Y., & Salladarré, F. (2009). Determinants of demand for green products: An application to eco-label demand for fish in Europe. *Ecological Economics*, *69*(1), 115–125. https://doi.org/10.1016/j.ecolecon.2009.07.017

Breidert, C., Hahsler, M., & Reutterer, T. (2006). A review of methods for measuring willingness-to-pay. *Innovative Marketing*, *2*(4), 8–32.

Brunk, K. H., & de Boer, C. (2020). How do consumers reconcile positive and negative CSR-related information to form an ethical brand perception? A mixed method inquiry. *Journal of Business Ethics*, *161*(2), 443–458.

Busch, T., Johnson, M. P., & Schnippering, M. (2022). A change will do you good: Does continuous environmental improvement matter? *Organization & Environment*, *35*(4), 551–578.

Chen, X., Wang, Q., Cui, B., Chen, G., Xie, T., & Yang, W. (2023). Ecological time lags in biodiversity response to habitat changes. *Journal of Environmental Management*, *346*, Article 118965.

Crenna, E., Sinkko, T., & Sala, S. (2019). Biodiversity impacts due to food consumption in Europe. *Journal of Cleaner Production*, *227*, 378–391. https://doi.org/10.1016/j.jclepro.2019.04.054

de Jonge, J., van der Lans, I. A., & van Trijp, H. C. M. (2015). Different shades of grey: Compromise products to encourage animal friendly consumption. *Food Quality and Preference*, *45*, 87–99. https://doi.org/10.1016/j.foodqual.2015.06.001

Du Toit, S. H. C., & Du Toit, M. (2008). Multilevel structural equation modeling. In J. de Leeuw & E. Meijer (Eds.), *Handbook of multilevel analysis* (pp. 435–478). Springer.

Echeverría, R., Hugo Moreira, V., Sepúlveda, C., & Wittwer, C. (2014). Willingness to pay for carbon footprint on foods. *British Food Journal*, *116*(2), 186–196.

Fedrigo, D., & Hontelez, J. (2010). Sustainable consumption and production. *Journal of Industrial Ecology*, *14*(1), 10–12. https://doi.org/10.1111/j.1530-9290.2009.00219.x

Ghali, Z. Z. (2020). Effect of utilitarian and hedonic values on consumer willingness to buy and to pay for organic olive oil in Tunisia. *British Food Journal*, *122*(4), 1013–1026.

Grankvist, G., Dahlstrand, U., & Biel, A. (2004). The impact of environmental labelling on consumer preference: Negative vs. positive labels. *Journal of Consumer Policy*, *27*(2), 213–230.

Ha-Brookshire, J. E., & Norum, P. S. (2011). Willingness to pay for socially responsible products: Case of cotton apparel. *Journal of Consumer Marketing*, *28*(5), 344–353. https://doi.org/10.1108/07363761111149992

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Cengage.

Harms, R., & Linton, J. D. (2016). Willingness to pay for eco-certified refurbished products: The effects of environmental attitudes and knowledge. *Journal of Industrial Ecology*, *20*(4), 893–904.

Hartikainen, H., Roininen, T., Katajajuuri, J. M., & Pulkkinen, H. (2014). Finnish consumer perceptions of carbon footprints and carbon labelling of food products. *Journal of Cleaner Production*, *73*, 285–293.

Hays, R. D., Hayashi, T., & Stewart, A. L. (1989). A five-item measure of socially desirable response set. *Educational and Psychological Measurement*, *49*(3), 629–636.

Heck, R. H., & Thomas, S. L. (2015). *An introduction to multilevel modeling techniques: MLM and SEM approaches using Mplus*. Routledge.

Heeb, F., Kölbel, J. F., Paetzold, F., & Zeisberger, S. (2023). Do investors care about impact? *The Review of Financial Studies*, *36*(5), 1737–1787.

Homburg, C., Koschate, N., & Hoyer, W. D. (2005). Do satisfied customers really pay more? A study of the relationship between customer satisfaction and WTP. *Journal of Marketing*, *69*, 84–96.

Ingram, J. C., Bagstad, K. J., Vardon, M., Rhodes, C. R., Posner, S., Casey, C. F., Glynn, P. D., & Shapiro, C. D. (2022). Opportunities for businesses to use and support development of SEEA-aligned natural capital accounts. *Eco-System Services*, *55*, Article 101434. https://doi.org/10.1016/j.ecoser.2022.101434

Jorge, E., Lopez-Valeiras, E., & Gonzalez-Sanchez, M. B. (2020). The role of attitudes and tolerance of ambiguity in explaining consumers' willingness to pay for organic wine. *Journal of Cleaner Production*, *257*, 120601. https://doi.org/10.1016/j.jclepro.2020.120601

Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1991). Anomalies: The endowment effect, loss aversion, and status quo bias. *Journal of Economic Perspectives*, *5*(1), 193–206.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, *47*(2), 263–291.

Khai, H. V., & Yabe, M. (2015). Consumer preferences for agricultural products considering the value of biodiversity conservation in the Mekong Delta, Vietnam. *Journal for Nature Conservation*, *25*, 62–71. https://doi.org/10.1016/j.jnc.2015.02.004

Khan, S. U., Liu, G., Zhao, M., Chien, H., Lu, Q., Khan, A. A., & Ali, M. A. S. (2020). Spatial prioritization of willingness to pay for ecosystem services. A novel notion of distance from origin's impression. *Environmental Science and Pollution Research*, *27*(3), 3100–3112. https://doi.org/10.1007/s11356-019-06538-4

Kline, R. B. (2015). *Principles and practice of structural equation modeling* (4th ed.). Guilford Press.

Krantz, R. (2010). A new vision of sustainable consumption. *Journal of Industrial Ecology*, *14*(1), 7–9. https://doi.org/10.1111/j.1530-9290.2009.00220.x

Legagneux, P., Casajus, N., Cazelles, K., Chevallier, C., Chevrinais, M., Guéry, L., Jacquet, C., Jaffré, M., Naud, M.-J., & Noisette, F. (2018). Our house is burning: Discrepancy in climate change vs. biodiversity coverage in the media as compared to scientific literature. *Frontiers in Ecology and Evolution*, *175*, 297310.

Liu, X., & Bakshi, B. R. (2019). Ecosystem services in life cycle assessment while encouraging techno-ecological synergies. *Journal of Industrial Ecology*, *23*(2), 347–360.

Loureiro, M. L., & Lotade, J. (2005). Do fair trade and eco-labels in coffee wake up the consumer conscience? *Ecological Economics*, *53*(1), 129–138.

Metag, J., Füchslin, T., & Schäfer, M. S. (2017). Global warming's five Germanys: A typology of Germans' views on climate change and patterns of media use and information. *Public Understanding of Science*, *26*(4), 434–451. https://doi.org/10.1177/0963662515592558

Mittal, V., Ross, W. T., Jr., & Baldasare, P. M. (1998). The asymmetric impact of negative and positive attribute-level performance on overall satisfaction and repurchase intentions. *The Journal of Marketing*, *62*(1), 33–47.

Molina-Murillo, S. A., & Smith, T. M. (2009). Exploring the use and impact of LCA-based information in corporate communications. *The International Journal of Life Cycle Assessment*, *14*(2), 184–194.

Moosmayer, D. C. (2012). Negativity bias in consumer price response to ethical information. *Business Ethics: A European Review*, *21*(2), 198–208.

Munasinghe, M. (2010). Can sustainable consumers and producers save the planet? *Journal of Industrial Ecology*, *14*(1), 4–6. https://doi.org/10.1111/j.1530-9290.2009.00215.x

Muthén, B. O., & Muthén, L. K. (2017). *Mplus: Statistical analysis with latent variables. User's guide* (8th ed.). Muthén and Muthén.

O'Rourke, D., & Ringer, A. (2016). The impact of sustainability information on consumer decision making. *Journal of Industrial Ecology*, *20*(4), 882–892.

Paetzold, F., & Busch, T. (2014). Unleashing the powerful few: Sustainable investing behaviour of wealthy private investors. *Organization & Environment*, *27*(4), 347–367.

Perman, R., Ma, Y., Common, M., Maddison, D., & McGilvray, J. (2011). *Natural resources and environmental economics* (4th ed.). Pearson Education Limited.

Petersen, L., Hörisch, J., & Jacobs, K. (2021). Worse is worse and better doesn't matter? The effects of favorable and unfavorable environmental information on consumers' willingness to pay. *Journal of Industrial Ecology*, *25*(5), 1338–1356. https://doi.org/10.1111/jiec.13141

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*(5), 879–903.

Pomarici, E., Asioli, D., Vecchio, R., & Næs, T. (2018). Young consumers' preferences for water-saving wines: An experimental study. *Wine Economics and Policy*, *7*(1), 65–76. https://doi.org/10.1016/j.wep.2018.02.002

Preacher, K. J., Zhang, Z., & Zyphur, M. J. (2016). Multilevel structural equation models for assessing moderation within and across levels of analysis. *Psychological Methods*, *21*(2), 189–205.

Presley, A., Meade, L., & Sarkis, J. (2010). Benchmarking for sustainability: An application to the sustainable construction industry. *Benchmarking: An International Journal*, *17*(3), 435–451.

Rands, M. R. W., Adams, W. M., Bennun, L., Butchart, S. H. M., Clements, A., Coomes, D., Entwistle, A., Hodge, I., Kapos, V., Scharlemann, J. P. W., Sutherland, W. J., & Viram, B. (2010). Biodiversity conservation: Challenges beyond 2010. *Science*, *329*(5997), 1298–1303.

Richardson, K., Steffen, W., Lucht, W., Bendtsen, J., Cornell, S. E., Donges, J. F., Drüke, M., Fetzer, I., Bala, G., Von Bloh, W., Feulner, G., Fiedler, S., Gerten, D., Gleeson, T., Hofmann, M., Huiskamp, W., Kummu, M., Mohan, C., Nogués-Bravo, D., … Rockström, J. (2023). Earth beyond six of nine planetary boundaries. *Science Advances*, *9*(37), Article 2458.

Rödiger, M., Plassmann, S., & Hamm, U. (2016). Organic consumers' price knowledge, willingness-to-pay and purchase decision. *British Food Journal*, *118*(11), 2732–2743.

Rodríguez-Ortega, T., Bernués, A., & Alfnes, F. (2016). Psychographic profile affects willingness to pay for ecosystem services provided by Mediterranean high nature value farmland. *Ecological Economics*, *128*, 232–245.

Sala, S., & Castellani, V. (2019). The consumer footprint: Monitoring sustainable development goal 12 with process-based life cycle assessment. *Journal of Cleaner Production*, *240*, Article 118050.

Sala, S., Crenna, E., Secchi, M., & Sanyé-Mengual, E. (2020). Environmental sustainability of European production and consumption assessed against planetary boundaries. *Journal of Environmental Management*, *269*, Article 110686.

Snijders, T. A. B., & Bosker, R. J. (2012). *Multilevel analysis: An introduction to basic and advanced multilevel modeling* (2nd ed.). Sage.

Spiller, S. A., Fitzsimons, G. J., Lynch, J. G., Jr., & McClelland, G. H. (2013). Spotlights, floodlights, and the magic number zero: Simple effects tests in moderated regression. *Journal of Marketing Research*, *50*, 277–288.

Stampa, E., & Zander, K. (2022). Backing biodiversity? German consumers' views on a multi-level biodiversity-labeling scheme for beef from grazing-based production systems. *Journal of Cleaner Production*, *370*, 133471. https://doi.org/10.1016/j.jclepro.2022.133471

Statistisches Bundesamt. (2023). Altersstruktur der Bevölkerung in Deutschland zum 31. Dezember 2022 [Age structure of the population of Germany as of December 31, 2022]. genesis.destatis.de.

Stø, E., Strandbakken, P., Scheer, D., & Rubik, F. (2017). Background: Theoretical contributions, eco-labels and environmental policy. In F. Rubik & P. Frankl (Eds.), *The future of eco-labelling: Making environmental product information systems effective* (pp. 16–45). Routledge.

Thøgersen, J., Haugaard, P., & Olesen, A. (2010). Consumer responses to ecolabels. *European Journal of Marketing*, *44*(11/12), 1787–1810.

Tukker, A., Cohen, M. J., Hubacek, K., & Mont, O. (2010). The impacts of household consumption and options for change. *Journal of Industrial Ecology*, *14*(1), 13–30.

Tversky, A., & Kahneman, D. (1991). Loss aversion in riskless choice: A reference-dependent model. *The Quarterly Journal of Economics*, *106*(4), 1039–1061.

Vanclay, J. K., Shortiss, J., Aulsebrook, S., Gillespie, A. M., Howell, B. C., Johanni, R., Maher, M. J., Mitchell, K. M., Stewart, M. D., & Yates, J. (2011). Customer response to carbon labelling of groceries. *Journal of Consumer Policy*, *34*(1), 153–160.

van Dam, Y. K., & De Jonge, J. (2015). The positive side of negative labelling. *Journal of Consumer Policy*, *38*(1), 19–38.

Vergragt, P., Akenji, L., & Dewick, P. (2014). Sustainable production, consumption, and livelihoods: Global and regional research perspectives. *Journal of Cleaner Production*, *63*, 1–12.

Wilting, H. C., Schipper, A. M., Ivanova, O., Ivanova, D., & Huijbregts, M. A. J. (2021). Subnational greenhouse gas and land-based biodiversity footprints in the European Union. *Journal of Industrial Ecology*, *25*(1), 79–94. https://doi.org/10.1111/jiec.13042

WWF, & AXA. (2019). *Into the wild: Integrating nature into investment strategies.*

Yabe, M., Hayashi, T., & Nishimura, B. (2013). Economic analysis of consumer behavior and agricultural products based on biodiversity conservation value. In *Multifunctional agriculture, ecology and food security: International perspectives* (pp. 21–37). Nova Science.

Zander, K., & Hamm, U. (2010). Consumer preferences for additional ethical attributes of organic food. *Food Quality and Preference*, *21*(5), 495–503.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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