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Why people like or dislike large wood in rivers—a representative survey of the general public in Germany

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Abstract

For the restoration of medium and small rivers, the reintroduction of large wood (LW) is crucial. Despite the wide communication of the ecological key functions of LW, residents rejected its reintroduction in a restoration project at the river Mulde (Dessau-Roßlau, Germany). To determine whether this is a local or widespread phenomenon in Germany, we investigated (a) the German population's attitude toward LW, (b) preferred quantities of LW introduction, and (c) the effects of flood experiences and other sociodemographic characteristics on these preferences. We conducted a nationwide and representative online survey (n = 2,100), including rating-scale statements and a choice experiment (CE). Regarding the rating statements, we found that a majority of respondents (57–67%) is convinced of the advantages of LW reintroduction. However, 47–60% considered LW to be dangerous for canoeists or during floods. For the CE (n = 743), we defined an LW attribute and added information on possible effects. Conditional logit models showed a strong preference for the highest amount of LW, with an odds ratio 5.47 times higher than for the status quo without LW. We also found that personal flood experiences reduce the preferred LW quantities. In contrast, females, higher educational levels, the youngest and oldest age groups, and especially frequent river visitors preferred higher LW amounts. Since the commitment of young people to environmental issues is currently increasing, we believe that specific environmental education opportunities for this group located along the river can contribute significantly to increase acceptance.

KEYWORDS

choice experiment, flooding experience, general public, large wood, online survey, river landscapes, river restoration

1 | INTRODUCTION

Due to their habitat richness, rivers and their floodplains belong to the ecosystems with the highest biodiversity (Posthumus, Rouquette, Morris, Gowing, & Hess, 2010; Ward, Tockner, & Schiemer, 1999). They also provide other important ecosystem services such as retention of nutrients or possibilities for recreation (Böck, Polt, & Schülting, 2018; Hornung, Podschun, & Pusch, 2019).

However, humans have massively modified riverine ecosystems to meet their needs. For instance, large wood (LW) is still often removed from rivers for better navigability and flood protection (Hering et al., 2000; Wohl, 2014). Such developments have hampered the provision of many ecosystem services and threatened riverine biodiversity (Russi et al., 2013; Tockner & Stanford, 2002). In a near-natural state, LW is a key factor for structural diversity in rivers of forested landscapes (Gippel, 1995; Keller & Swanson, 1979). It promotes riverine biodiversity (Nagayama & Nakamura, 2010) and the retention of organic matter (Koljonen, Louhi, Mäki-Petäys, Huusko, & Muotka, 2012).

In the last decades, the European Union has increased their efforts to reverse this trend. For instance, the objectives of the Water Framework Directive (WFD, European Union, 2000) require the restoration of river ecosystems to a near-natural state. The member states are currently planning and implementing numerous river restoration projects (Speed et al., 2016). The success of these initiatives depends on the acceptance of restoration measures among the residents and stakeholders. To achieve acceptance, enabling stakeholder's participation and considering their preferences for landscape development are vital (Garcia, Benages-Albert, Buchecker, & Vall-Casas, 2019; Hernández-Morcillo, Plieninger, & Bieling, 2013). It is well documented that people prefer watercourses that they consider to be natural (Junker & Buchecker, 2008; Mutz et al., 2006). Additionally, Garcia et al. (2019) summarize that people prefer river landscapes that exhibit care and cleanliness, create a feeling of safety, and satisfy human needs such as the demand for outdoor recreation. Moreover, they documented that biophysical properties such as river structure and biodiversity affect these preferences.

Unfortunately, river restoration involving the reintroduction of LW can conflict with some of the preferences and demands outlined above. The project "Wilde Mulde" (WilMu) in Dessau-Roßlau (Germany) is a good example of such conflicts. Some residents, who suffered greatly in the 2002 flood disaster, rejected the LW introduction because they expected the fixed trees to increase flood risk and intensity. This observation prompted us to investigate whether this locally observed rejection of LW in medium-sized lowland rivers, which are not used for shipping, can also be identified in the general population of Germany. This question is highly relevant, as river restoration is a European objective and the preferences of the overall population must be weighed against local interests.

Previously conducted studies on the perception of LW can answer our questions only insufficiently. Either they focused on other river types did not address the general population (Chin et al., 2012; Ruiz-Villanueva et al., 2018) or they concentrated on river restorations without LW (BMUB & BfN, 2014; Rayanov et al., 2018). Accordingly, the objective of this research is to assess the public's perception of reintroducing LW for river restoration and their preferences for different quantities of LW in an exemplary medium-sized lowland river. To this end, we conducted a representative German-wide survey to address the following research questions:

1. Which shares of the German population perceive LW as a positive or negative element in lowland rivers?
2. Which quantities of LW do Germans prefer in the context of lowland river restoration?
3. Which sociodemographic factors influence the preferences for different amounts of LW and do flooding experiences lead to the rejection of higher quantities of LW?

In the following, the design of our survey and the applied methods are explained (Section 2). Afterward, we present our results (Section 3), discuss the methodology, and compare our results with other research outcomes (Section 4).

2 | METHODS

2.1 | Online survey

We designed a nation-wide online survey addressing the German residential population between 18 and 80 years (n = 2,100). A commercial survey institute (Eresult GmbH) was commissioned to draw a representative sample and to program and conduct the survey. Participants were selected from the online access panel "bonopolis.de," which comprises 60,000 German internet users. The selection was based on quotas for the features GENDER, AGE, EDUCATION LEVEL, and RESIDENTIAL REGION (Appendix A). The participants accessed the survey via a submitted link. As an incentive to participate, their accounts were credited with the equivalent of €5. The institute promised a response rate between 60 and 70%.

The survey was conducted within 1 week in February 2018. Previously, a qualitative pretest with an expert and a quantitative pretest with 100 participants were carried out. The questionnaire (Supplement 1) started with a short introduction that named LW reintroduction as an exemplary measure of river restoration. Next, we asked for the respondents' relationship to rivers (e.g., frequency of recreational river visits) and their experiences with flooding. While the quota-related attributes were surveyed at the beginning, the remaining demographic questions (e.g., on INCOME) were placed at the end.

2.2 | Rating-scale statements

To achieve an understanding of the attitude within the population toward LW introduction (research question 1), we used a battery of seven randomly ordered rating-scale statements. These statements were based on researchers' hypotheses and stakeholders' objections stated in the WilMu-project and refer to possible negative and positive effects as well as to the general attitude toward LW reintroduction. The respondents were asked to express their opinion on a rating scale from 1 (=I totally disagree) to 6 (=I totally agree). Previously, some pictures of large dead trees in the Mulde River were shown for illustration.

To determine the respondents' attitudes toward LW from the answers, we calculated the share of respondents who disagreed with (rating levels 1 to 3) or agreed with a statement (rating levels 4 to 6). The results illustrate the perception of LW concerning various aspects such as flood risk or aesthetics.

2.3 | Choice experiment

To determine the amount of LW preferred by the respondents (research question 2), we designed a choice experiment (CE). This method has its origin in the characteristics theory of value (CTV) by Lancaster (1966). Following the CTV, individuals benefit not from a product itself but from its various attributes. Accordingly, the respondent's preferences for individual attributes can be determined. CEs were first applied in economic disciplines (Louviere, Hensher, & Swait, 2010). Meanwhile, they are also widespread in ecosystem services research (e.g., Cerda, Barkmann, & Marggraf, 2012; Decker & Watson, 2016).

We defined three attributes with four levels and a cost attribute with seven levels (Table 1). The attributes are based on a preliminary list of relevant attributes related to river landscapes, which was compiled from literature analysis and focus group discussions in the projects “RESI” and “In_StröHmunG” (Rayanov et al., 2018). According to our research questions, the “amount of large wood” (LW_a) is the most relevant attribute. We defined the “high” LW_a level to cover about 8% of the water surface, which approximates the “very good” ecological status (UBA, 2014) and the current maximum LW coverage of the water surface of all Mulde sections. Accordingly, “medium” was 4% of the water surface and “low” was 1%. The status quo (SQ) was defined as “no LW.”

We used high-resolution visualizations to illustrate the different LW_a levels in the CE. A photo of a Mulde River section served as a template. Additionally, we presented information on the effects of LW introduction on the state of the local FISH population and WATER purification. Their levels were directly correlated to the levels of the LW_a attribute and therefore not treated as separate attributes in the design and analysis of the CE. This was intended to bring the participants to a comparable level of information and to allow them to consider not only aesthetics but also the ecological value of LW in their decisions. The information was presented on an ordinal scale, which is the default information format in German landscape planning (Albert, Hauck, Buhr, & von Haaren, 2014). On separate pages of the survey, we gave the following explanations: Before the CE, we explained the correlations between LW_a and the information on FISH and WATER. After the CE, we clarified that these correlations are not derived from measurements so far, but that they are investigated in the WilMu project.

The remaining attributes should create a realistic choice situation that demands the respondents to weigh the advantages and disadvantages (trade-offs). “Land use” (LU) was chosen because of its visible impact on the landscape. It also allowed us to check, whether LW_a preferences depend on the landscape they are reintroduced in (more anthropogenic vs. more natural). The four levels of LU were also illustrated in the visualizations (Figure 1). The usability for recreation (UR) was introduced because it is often restricted with higher protection standards. A decrease in UR means a loss for respondents visiting river landscapes for recreational purposes. UR was implemented in the CE as a text attribute. Both LU and UR are considered to be highly relevant for the evaluation of river restorations (Garcia et al., 2019) and the recreational quality of rivers (Posthumus et al., 2010). To avoid direct and sometimes offensive questions on willingness to pay (WTP), we defined the cost attribute (CO) as a change in property tax (Cerda et al., 2012). Compared to the SQ, the change of CO could be

TABLE 1 Attributes, levels, and type of presentation in the CE

	Levels			
		Effects on:		
Attributes		FISH population	WATER purification	Presentation
Amount of large wood (LW_a)	None^{SQ}	Poor^{SQ}	Very low^{SQ}	LW_a: Visualization + text Effects: Text
	Low	Moderate	Low	
	Medium	Good	Medium	
	High	Very good	High	
Dominating land use in flood plain (LU)	Grassland^{SQ}			Visualization + text
	Forest			
	Farmland			
	Built-up environment			
Usability for recreation (UR)	Poor			Text
	Moderate			
	Good^{SQ}			
	Very good			
Cost attribute (CO) (taxes per househould an year)	−90 €; −60 €; −30 €; 0 €^{SQ}; +30 €; +60; € + 90 €			Text

Abbreviations: CE, choice experiment; SQ, status quo.

FIGURE 1 Exemplary high-resolution visualizations (Lenné 3D GmbH) showing the levels of the attributes "amount of large wood" (LW_a) and "land use" (LU). (1) no LW and built-up environment; (2) low LW_a and farmland; (3) medium LW_a and grassland; (4) high LW_a and forest. Respondents were able to enlarge the visualizations to the full-screen size [Colour figure can be viewed at wileyonlinelibrary.com]

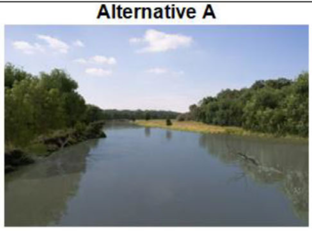
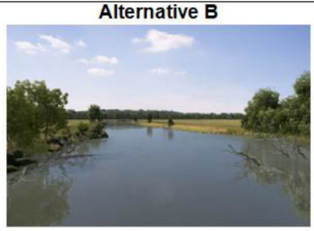
	Status quo	Alternative A	Alternative B
			
land use in floodplain	mainly grassland	mainly forest	mainly farmland
amount of large wood	none	low	high
state of local trout population	poor	moderate	very good
water purification	very low	low	high
recreation usability	good	moderate	poor
taxes per household and year	no change	+ 60 € (higher taxes)	- 30 € (lower taxes)
Select a card:	☐	☐	☐

FIGURE 2 Exemplary choice set [Colour figure can be viewed at wileyonlinelibrary.com]

positive or negative and was not directly related to the landscape changes.

The selected attributes resulted in $4^3 * 7^1 = 448$ possible combinations of the attribute levels. Since the introduction of LW is defined as an anthropogenic measure, no combination was interpreted as unrealistic. Thus, an orthogonal design with 32 cards was created using SPSS statistics (Version 25.0). Additionally, we defined an SQ-card. We arranged 16 choice sets consisting of the constant SQ and the two alternatives, "AltA" and "AltB" (Figure 2). We excluded an overlap of LW_a levels, paid attention to minimize the overlap of other attribute levels, and achieved level balance for LW_a, LU, and UR (Huber & Zwerina, 1996). The SQ represented a current river section without LW. The alternatives differed from the SQ in several of the four attributes. We created two variants that required every respondent to answer eight randomly ordered choice sets (Supplement 2). A subset of 743 respondents, which complied with the above-defined quotas, was included in the CE.

2.4 | Statistical analysis

We used RStudio (Version 1.1.453) with R (Version 3.51) for the statistical analysis of the CE. To determine the preferences for LW_a (research question 2), we performed conditional logit models (CLM) from the R-package "survival" (Therneau, 2018), initially omitting sociodemographic attributes. The advantage of this model is the possibility to consider that each respondent answered eight choice sets. We included alternative-specific constants (ASCs) to the models as placeholders for influences that cannot be explained by the parameters. To investigate the influence of sociodemographic characteristics on the selection of the LW_a levels (research question 3), we integrated these variables as interaction terms in the CLM, following the approach of Aizaki (2012). For this purpose, it was necessary to recode all levels of the choice attributes to dummy variables (1 = TRUE; 0 = FALSE). Specific, sociodemographic characteristics were also included as dummy variables or were ordinally scaled as for INCOME and EDUCATION (Appendix B).

3 | RESULTS

The aggregated percentages of disagreement (rating levels 1 to 3) and agreement (rating levels 4 to 6) are shown in Figure 3. Except for statement number 7, a majority approved each statement. The three statements on positive effects of LW (numbers 1, 3, and 4) achieved approval rates from 57% (water quality) to 66% (fish) and up to 67% (visual attractiveness). All in all, 58% agreed with the introduction of LW into the river closest to where they live, but almost a quarter of the respondents disagreed. The two statements on potential dangers of LW received high approval rates as well. It is particularly high for flood events with an agreement of 60%. Still, 47% feared dangers for paddlers. Furthermore, 28% agreed with statement 7 "In my opinion, LW does not belong into today's landscape." The no-response rates of the individual statements varied between 12 and 27%. The total

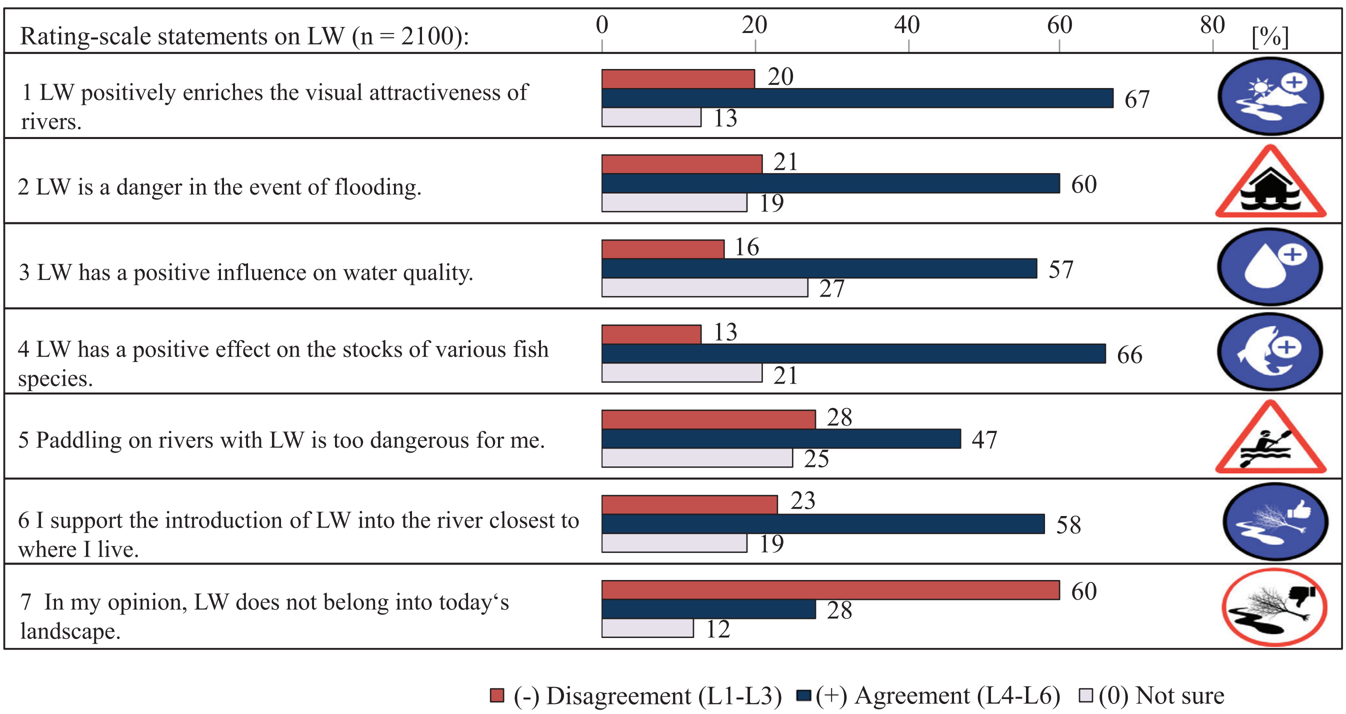


FIGURE 3 Percentages of disagreement and agreement to the rating-scale statements concerning LW [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 2 Outputs of CLM with and without sociodemographic interactions

	CLM without sociodemographic interactions				CLM including sociodemographic interactions			
Attribute: Level	Coefficient	SD	z-value	Pr(>|z|)	Coefficient	SD	z-value	Pr(>|z|)
ASC AltA	−0.518	0.09	−6.02	1.7E-09***	−0.461	0.09	−5.08	3.9E-07***
ASC AltB	−0.329	0.09	−3.78	0.0002***	−0.242	0.09	−2.62	0.0088**
LW_a: Low	1.198	0.07	16.32	<2E-16***	0.829	0.16	5.05	4.4E-07***
LW_a: Medium	1.475	0.08	19.51	< 2e-16***	0.739	0.17	4.34	1.4E-05***
LW_a: High	1.700	0.06	27.61	<2E-16***	1.005	0.15	6.60	4.1E-11***
LU: Built-up	0.165	0.06	0.79	0.4317	0.020	0.06	0.32	0.7498
LU: Farmland	0.310	0.07	2.45	0.0145*	0.150	0.07	2.10	0.0354*
LU: Forest	0.047	0.06	5.63	1.8E-08***	0.296	0.06	5.11	3.3E-07***
UR: Poor	−0.267	0.06	−4.53	6.0E-06***	−0.282	0.06	−4.51	6.6E-06***
UR: Moderate	−0.038	0.07	−0.57	0.5714	−0.055	0.07	−0.79	0.4306
UR: Very good	0.142	0.07	2.03	0.0428*	0.124	0.07	1.67	0.0949
CO: Costs (taxes)	−0.004	0.00	−7.67	1.7E-14***	−0.004	0.00	−7.34	2.2E-13***

Sociodemographic interactions:		CLM without sociodemographic interactions				CLM including sociodemographic interactions			
Attribute: Level	LW_a-level	Coefficient	SD	z-value	Pr(>|z|)	Coefficient	SD	z-value	Pr(>|z|)
GENDER: Female	Low	–	–	–	–	0.137	0.09	1.46	0.1436
	Medium	–	–	–	–	0.272	0.10	2.79	0.0054**
	High	–	–	–	–	0.267	0.09	2.98	0.0029**
AGE: Under 30	Low	–	–	–	–	0.296	0.15	2.03	0.0421*
	Medium	–	–	–	–	0.323	0.15	2.13	0.0336*
	High	–	–	–	–	0.324	0.14	2.31	0.0211*
AGE: 60 +	Low	–	–	–	–	0.059	0.11	0.56	0.5791
	Medium	–	–	–	–	0.165	0.11	1.48	0.1391
	High	–	–	–	–	0.270	0.10	2.64	0.0082**
FREQUENT RIVER VISITS	Low	–	–	–	–	0.270	0.10	2.77	0.0057**
	Medium	–	–	–	–	0.544	0.10	5.31	1.1E-07***
	High	–	–	–	–	0.646	0.09	6.84	8.1E-12***
EDUCATION LEVEL	Low	–	–	–	–	0.033	0.05	0.70	0.4831
	Medium	–	–	–	–	0.122	0.05	2.51	0.0121*
	High	–	–	–	–	0.109	0.04	2.45	0.0144*
INCOME	Low	–	–	–	–	0.034	0.04	0.90	0.3705
	Medium	–	–	–	–	0.026	0.04	0.66	0.5092
	High	–	–	–	–	0.017	0.04	0.47	0.6422
RESIDENT REGION: East	Low	–	–	–	–	−0.162	0.15	−1.09	0.2763
	Medium	–	–	–	–	0.045	0.15	0.29	0.7697
	High	–	–	–	–	−0.184	0.14	−1.31	0.1918
FLOOD EXP.: Personal/danger	Low	–	–	–	–	0.105	0.13	0.79	0.4288
	Medium	–	–	–	–	−0.357	0.14	−2.58	0.0100*
	High	–	–	–	–	−0.450	0.13	−3.55	0.0004***
McFadden R2 adjusted:		0.19				0.20			
AIC:		10,637				9,599			
Log likelihood		−5,307				−4,766			
Observations:		5,944				5,440			
Individuals:		743				680			

Abbreviations: ASC, alternative specific constants; CLM, conditional logit model; LU, land use in floodplain; LW_a, amount of large wood; UR, usability for recreation.

$^*p \le .05$; $^{**}p \le .01$; $^{***}p \le .001$.

distribution of answers to the rating-scale statements is presented in Supplement 3.

From the CE, 5944 decisions were available for analysis (Table 2). In about 16% of the decisions, participants chose the SQ card, while AltA accounted for 38% and AltB for 46%. The three levels of LW_a were all favored over the SQ (no LW), as illustrated by the positive signs of the coefficients (1.2–1.7) and z-values (16.3–27.6). These values exceed those of all other attributes and are highly significant ($p < .001$).

Unexpectedly, all LU levels, including "built-up environment" and "farmland," were preferred to the SQ (grassland). The P-values of "farmland" and "forest" are significant, and "forest" reached the highest z-value (5.63). As expected, both a decrease in UR and an increase in CO were rejected. Inversely, an improvement of UR was preferred. These results are significant, except for the moderate UR level.

In the CLM including sociodemographic interactions, n is smaller than 743 respondents due to denied answers on FLOOD EXPERIENCES and INCOME (Table 2). Firstly, the variable FREQUENT RIVER VISITS achieved the highest positive z-values (2.77; 5.31; 6.84) of all attribute levels and highly significant *p*-values (below .01) throughout. Secondly, it was observed that women preferred the two highest LW_a levels more than men (z = 2.78 and 3.01). A similarly strong effect in favor of higher quantities is related to a rising EDUCATION LEVEL ($p < .02$). In contrast, no significant influence of increasing INCOME could be observed. The same applies to the RESIDENTIAL REGIONS we analyzed, but negative coefficients for respondents living in the former GDR occurred twice. Respondents with personal FLOOD EXPERIENCE preferred the SQ and the low LW_a level, illustrated by negative z-values (−2.58; −3.55) and significant P-values for the two higher quantities. Differentiated results are available for the AGE attributes. Participants in the oldest group (60+) strongly preferred the highest LW_a level ($p = .008$). For respondents in the youngest age group (below 30), positive z-values and significant P-values (below .05) were calculated for all LW_a levels. Thus, present LW was strongly preferred over no LW, but no specific quantity was preferred. Combining these findings, middle-aged respondents preferred no or less LW.

Concerning our research questions, we found that a positive perception of LW prevails in the German population. This is reflected already by high approval rates (57–67%) for rating-scale statements on positive effects and the introduction of LW. However, about half of the respondents also fear potential dangers, especially in connection with floods. This confirms that river restoration of this kind is likely to cause concern and rejection by residents. Furthermore, all LW amounts were preferred to the wood-free SQ in the CE, and the highest LW_a level was preferred most.

The odds ratio is a more explicit way to illustrate the preferences. It is obtained by multiplying the base of the natural logarithm (≈2.71) with the coefficients. For the highest LW_a level, the odds ratio is 5.47 (Figure 4). According to the model, this means that this level is chosen 5.47 times as often as the SQ (medium: 4.37; low: 3.31). This indicates a high support level for LW introduction.

Regarding the effects of sociodemographic characteristics, an odds ratio > 1 says that a person with a particular characteristic is more likely to choose a certain LW_a level than the comparison group (Figure 4). For the variable with the strongest effect, FREQUENT RIVER VISITS, this means that people who visit rivers at least once a week have almost twice as much probability (1.91) of choosing the high LW_a level than the other respondents (medium: 1.72, low: 1.31). With odds ratios higher than 1.3, the probabilities for women (for medium and high LW_a level), people under 30 years (all levels), and the oldest group (only high level) are increased by about a third. Also, people of a higher education level are more likely to choose high amounts of LW. Respondents with personal experience of flooding are about one third less likely to choose the two higher LW_a levels (odds ratio < 1). Increasing INCOME and living in the former GDR showed no significant effects.

4 | DISCUSSION

In comparison to other photo-based surveys and our rating-scale statements, the CE provided clues regarding the preferred amount of LW. It also allowed us to compare the preferences for LW_a with other attributes. Both aspects are important regarding future restoration projects. Furthermore, the use of adjustable visualizations, all based on a single template, enabled us to control the levels of our visual attributes LW_a and LU and to minimize the influences of other visual parameters such as light effects, weather, or the perspective on respondent's decisions (Ode, Fry, Tveit, Messager, & Miller, 2009). This differs from most studies about the perception of LW in watercourses (Chin et al., 2012), which follow the methodology of Piégay et al. (2005). This approach uses a questionnaire with photos of various rivers and streams.

On the other hand, the orthogonal design may have negatively influenced the validity of the results. A D-efficient design may have better met the quality criteria given by Huber and Zwerina (1996). Nevertheless, along with orthogonality, we ensured level balance for all attributes, except CO, and handled minimal overlap as described in Section 2.3. Therefore and because orthogonal designs are still widely applied (Barreiro-Hurle, Espinosa-Goded, Martinez-Paz, & Perni, 2018), we believe to have found a good compromise between the design complexity and possible quality deficiency.

Of course, the transferability of our results to river landscapes in hilly or mountainous areas or diverging-sized rivers is limited by our focus on medium-sized lowland rivers. The comparison of different river types must consider several parameters such as different landscape characteristics, human characteristics, and preferences, as well as the interactions between these parameters (Garcia et al., 2019). For instance, Zhao, Luo, Wang, and Cai (2012) found a high degree of correlation regarding preferred landscape characteristics in 23 different riverine landscapes. In contrast, Rayanov et al. (2018) calculated significant differences in the WTP for different levels of bank revitalization between the rivers Aller and Nahe. Pflüger, Rackham, and Larned (2010) also found disparities in preferences for different-sized

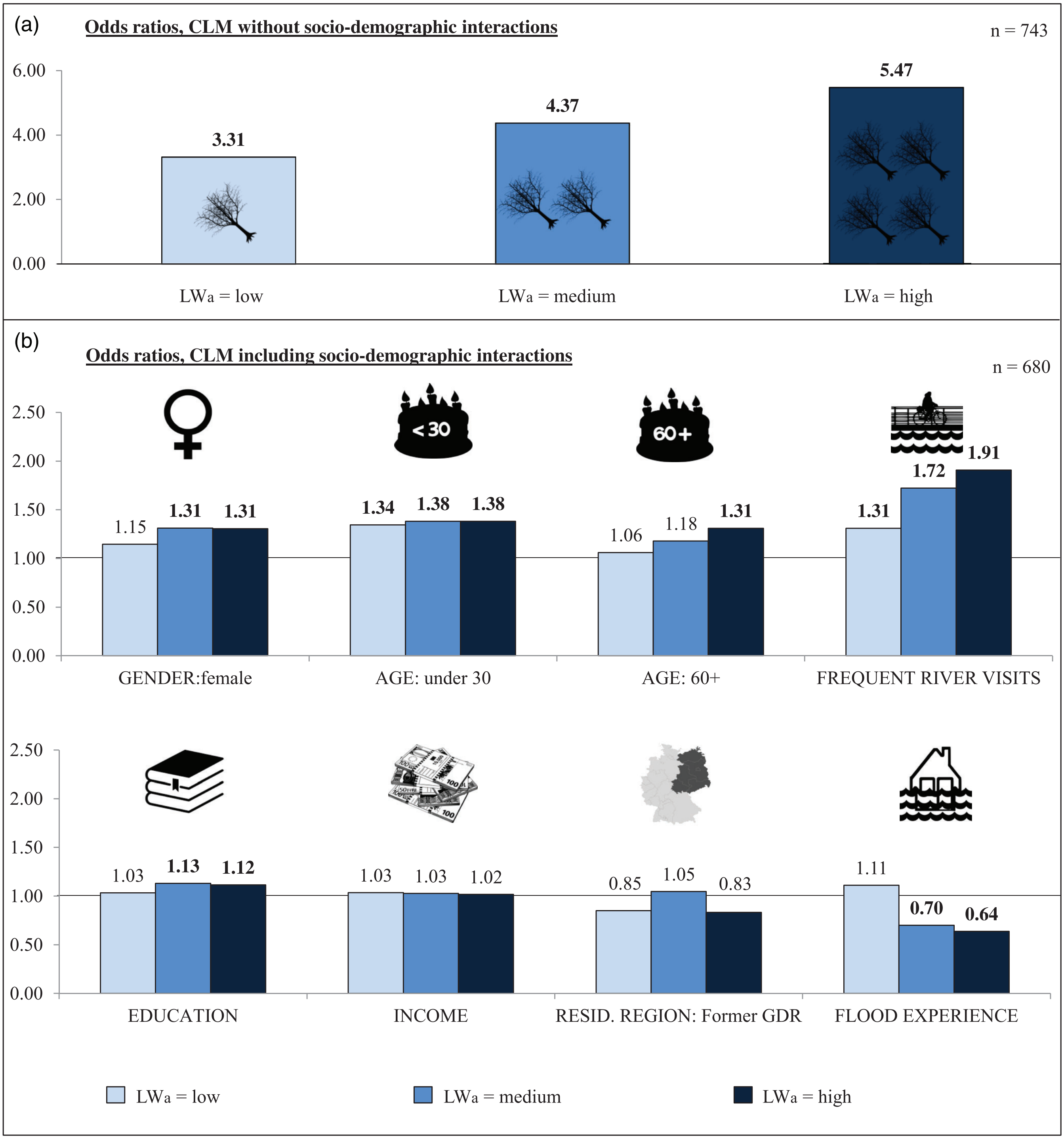


FIGURE 4 Odds ratios of LW_a levels (a) and sociodemographic effects (b). In (a), the values represent the factor by which the LW_a level is more likely to be chosen compared to the SQ. In (b), odds ratios >1 represent groups that have a higher choice probability for the respective LW_a level. Odds ratios <1 represent groups that have a lower choice probability than the comparison group. Corresponding P-values <.05 are boldly printed [Colour figure can be viewed at wileyonlinelibrary.com]

rivers, especially concerning their flow. To determine which LW amounts are preferred across different landscape types, we suggest dividing the participants into several equal groups. For each group, a similar CE could be conducted, which differs in the visualized landscape type (e.g., lowland, hilly, and mountainous) or river size.

The previously cited photo-based studies (Chin et al., 2012) did not investigate differences between large rivers and small streams. Moreover, most of the surveys polled undergraduate students and were not administered to the broad public. Two studies also focused on experts (Chin et al., 2012; Wyzga, Zawiejska, & Le Lay, 2009), and

Ruiz-Villanueva et al. (2018) surveyed residents from different regions. Interestingly, these studies revealed a predominantly negative attitude toward LW.

Of particular interest are findings of Piégay et al. (2005). Respondents rated photographs including wood as more natural, less aesthetically pleasing, more dangerous, and in need of improvement. Only students from Oregon, Sweden, and Germany showed different attitudes, which argues for the relevance of cultural background. The Germans considered the scenes with LW to be more aesthetically pleasing, which supports our findings. On the other hand, students from Germany and Oregon considered photographs without wood to be more dangerous (Piégay et al., 2005). However, the Germans associated scenes containing wood with dangers for sporting activities, whereas they associated scenes containing no wood more with flood danger (Mutz et al., 2006). The authors concluded that the German population appears to be comparatively aware of environmental issues. While explicit information about German inhabitants is lacking, a representative photo-based survey in Switzerland indicated that eco-morphological quality and aesthetics correlate more positively than expected. Accordingly, more natural rivers and streams, including LW as a structural element, are preferred to modified watercourses (Junker & Buchecker, 2008).

Our assumption that personal FLOOD EXPERIENCE leads to a rejection of high amounts of LW was confirmed by our analysis. This finding is supported by a review of Garcia et al. (2019) documenting that flood experience can influence the acceptance of river restorations. However, a Spanish study detected only small differences among residential populations in regions that were either recently affected by flooding or that were spared. Residents in recently flooded regions rated scenes without wood as less in need of improvement (Ruiz-Villanueva et al., 2018). The authors concluded that flood experiences are not primarily relevant in this context.

Regarding the variable RESIDENTIAL REGION, participants living in the former GDR showed no significant differences. This differs from the findings of Rayanov et al. (2018), who observed that respondents of their East German study areas were less likely to choose measures to improve naturalness or accessibility. Internationally, regional differences in the perception of LW were detected in Spain (Ruiz-Villanueva et al., 2018), between eight states in the US (Chin et al., 2008), and between 10 countries (Le Lay et al., 2008; Piégay et al., 2005). Summarizing, regional differences in landscape preferences are not uncommon, but for Germany, other sociocultural factors play a bigger role.

According to our analysis, the variable FREQUENT RIVER VISITS was most correlated to the preference for high LW_a levels. We assume that the ecological intactness of rivers, which was associated with the attribute LW_a in our CE, is probably more relevant to these individuals because they experience riverscapes as part of their everyday life. This is confirmed, for instance, by Zander, Garnett, & Straton (2010: 2524), who proved that people who have visited (tropical) rivers or lived near to them have "a higher WTP for cultural, environmental, and recreational values" than people who did not. Also, Ruiz-Villanueva et al. (2018) identified frequency and reason for the river visit as one of the most important explanations for positive perceptions of LW. On the other hand, place attachment can lead to the rejection of restoration intentions (Garcia et al., 2019). Perhaps, the rare choices of the SQ point out that knowledge about the benefits of such measures can counter this.

In this context, we noted that the EDUCATIONAL LEVEL of the respondents remained relevant, despite the additional information on the effects of LW introduction. This is illustrated by the corresponding significant P-values. The no-response rates of up to 27% of the rating-scale statements additionally indicate that the general public lacks vital information about river restoration. Such knowledge gaps between laypersons and experts (Chin et al., 2012; Ruiz-Villanueva et al., 2018) as well as among members of different disciplines (Mutz et al., 2006; Wyzga et al., 2009) are well documented.

Furthermore, our observation that people of younger AGE in particular show high preferences for the presence of LW is in line with outcomes of other CEs indicating that younger people are more open to changes in the landscape than older people who prefer the SQ (Garcia et al., 2019; Meyerhoff & Liebe, 2009). The additionally detected preference of the oldest group for the high LW_a level could be related to a higher nature awareness in this generation (BMUB & BfN, 2014). GENDER-related differences as in our study were not found in international studies on LW (Ruiz-Villanueva et al., 2018). In contrast, investigations on the perception of ecosystem services have repeatedly revealed differences between males and females (Fortnam et al., 2019). However, they do not point in a clear direction, whereby generalizing conclusions are not possible.

In conclusion, our survey adds momentum to the implementation of the WFD in Germany and provides arguments for including LW as a central element in the restoration of medium-scale lowland rivers. The results should encourage planners to consider specific characteristics of the local population, such as flood experiences. Furthermore, the local population should be informed and involved from the very beginning, especially potentially adversary stakeholders. Referring to the III-Framework (Interactive, Integrative, and Iterative) of Chin et al. (2012), we highlight the importance of flagship projects like WilMu to demonstrate the personal benefits as well as the benefits for the ecosystem to the public. Regarding the personal characteristics that we have identified as relevant, specific environmental education opportunities for children, adolescents, and young adults located along the river seem particularly promising for increasing acceptance. As the awareness of this young generation for environmental problems has recently increased, they could be important supporters.

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DATA AVAILABILITY STATEMENT

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

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REFERENCES

Aizaki, H. (2012). Basic functions for supporting an implementation of choice experiments in R. *Journal of Statistical Software*, *50*(2), 1–24.

Albert, C., Hauck, J., Buhr, N., & von Haaren, C. (2014). What ecosystem services information do users want? Investigating interests and requirements among landscape and regional planners in Germany. *Landscape Ecology*, *29*(8), 1301–1313. https://doi.org/10.1007/s10980-014-9990-5

Barreiro-Hurle, J., Espinosa-Goded, M., Martinez-Paz, J. M., & Perni, A. (2018). Choosing not to choose: A meta-analysis of status quo effects in environmental valuations using choice experiments. *Economia Agraria y Recursos Naturales*, *18*(1), 79. https://doi.org/10.7201/earn.2018.01.04

BMUB – Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit, BfN - Bundesamt für Naturschutz (2014). Naturbewusstsein 2013: Bevölkerungsumfrage zu Natur und biologischer Vielfalt Leben. Natur. Vielfalt - die Strategie. Berlin: BMUB.

Böck, K., Polt, R., & Schülting, L. (2018). Ecosystem Services in River Landscapes. In S. Schmutz & J. Sendzimir (Eds.), *Aquatic ecology series: Riverine ecosystem management: Science for governing towards a sustainable future* (Vol. 8, pp. 413–433). Cham: Springer International Publishing.

Cerda, C., Barkmann, J., & Marggraf, R. (2012). Application of choice experiments to quantify the existence value of an endemic moss: A case study in Chile. *Environment and Development Economics*, *18*(2), 207–224. https://doi.org/10.1017/S1355770X12000472

Chin, A., Daniels, M. D., Urban, M. A., Piégay, H., Gregory, K. J., Bigler, W., … Wohl, E. (2008). Perceptions of wood in rivers and challenges for stream restoration in the United States. *Environmental Management*, *41*(6), 893–903. https://doi.org/10.1007/s00267-008-9075-9

Chin, A., Laurencio, L. R., Daniels, M. D., Wohl, E., Urban, M. A., Boyer, K. L., … Gregory, K. J. (2012). The significance of perceptions and feedbacks for effectively managing wood in rivers. *River Research and Applications*, *30*(1), 98–111. https://doi.org/10.1002/rra.2617

Decker, K. A., & Watson, P. (2016). Estimating willingness to pay for a threatened species within a threatened ecosystem. *Journal of Environmental Planning and Management*, *60*(8), 1347–1365. https://doi.org/10.1080/09640568.2016.1221797

European Union (2000). Directive of the European Parliament and of the Council 2000/60/EC establishing a framework for community action in the field of water policy (Water Framework Directive).

Fortnam, M., Brown, K., Chaigneau, T., Crona, B., Daw, T. M., Gonçalves, D., … Schulte-Herbruggen, B. (2019). The gendered nature of ecosystem services. *Ecological Economics*, *159*, 312–325. https://doi.org/10.1016/j.ecolecon.2018.12.018

Garcia, X., Benages-Albert, M., Buchecker, M., & Vall-Casas, P. (2019). River rehabilitation: Preference factors and public participation implications. *Journal of Environmental Planning and Management*, *2019*, 1–22. https://doi.org/10.1080/09640568.2019.1680353

Gippel, C. J. (1995). Environmental hydraulics of large Woody debris in streams and Rivers. *Journal of Environmental Engineering*, *121*(5), 388–395. https://doi.org/10.1061/(ASCE)0733-9372(1995)121:5(388)

Hering, D., Kail, J., Eckert, S., Gerhard, M., Meyer, E., Mutz, M., … Weiss, I. (2000). Coarse Woody debris quantity and distribution in central European streams. *International Review of Hydrobiology*, *85*, 5–23. https://doi.org/10.1002/(SICI)1522-2632(200003)85:1<5::AID-IROH5>3.0.CO;2-X

Hernández-Morcillo, M., Plieninger, T., & Bieling, C. (2013). An empirical review of cultural ecosystem service indicators. *Ecological Indicators*, *29*, 434–444. https://doi.org/10.1016/j.ecolind.2013.01.013

Hornung, L. K., Podschun, S. A., & Pusch, M. (2019). Linking ecosystem services and measures in river and floodplain management. *Ecosystems and People*, *15*(1), 214–231. https://doi.org/10.1080/26395916.2019.1656287

Huber, J., & Zwerina, K. (1996). The importance of utility balance in efficient choice designs. *Journal of Marketing Research*, *33*(3), 307–317. https://doi.org/10.1177/002224379603300305

Junker, B., & Buchecker, M. (2008). Aesthetic preferences versus ecological objectives in river restorations. *Landscape and Urban Planning*, *85*(3-4), 141–154. https://doi.org/10.1016/j.landurbplan.2007.11.002

Keller, E. A., & Swanson, F. J. (1979). Effects of large organic material on channel form and fluvial processes. *Earth Surface Processes*, *4*(4), 361–380. https://doi.org/10.1002/esp.3290040406

Koljonen, S., Louhi, P., Mäki-Petäys, A., Huusko, A., & Muotka, T. (2012). Quantifying the effects of in-stream habitat structure and discharge on leaf retention: Implications for stream restoration. *Freshwater Science*, *31*(4), 1121–1130. https://doi.org/10.1899/11-173.1

Lancaster, K. J. (1966). A new approach to consumer theory. *Journal of Political Economy*, *74*(2), 132–157.

Le Lay, Y.-F., Piégay, H., Gregory, K. J., Chin, A., Dolédec, S., Elosegi, A., … Zawiejska, J. (2008). Variations in cross-cultural perception of riverscapes in relation to in-channel wood. *Transactions of the Institute of British Geographers*, *33*, 268–287.

Louviere, J. J., Hensher, D. A., & Swait, J. D. (2010). *Stated choice methods: Analysis and applications* (p. 402). Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511753831

Meyerhoff, J., & Liebe, U. (2009). Status quo effect in choice experiments: Empirical evidence on attitudes and choice TaskComplexity. *Land Economics*, *85*(3), 515–528.

Mutz, M., Piégay, H., Gregory, K. J., Borchardt, D., Reich, M., & Schmieder, K. (2006). Perception and evaluation of dead wood in streams and rivers by German students. *Limnologica*, *36*(2), 110–118. https://doi.org/10.1016/j.limno.2006.01.001

Nagayama, S., & Nakamura, F. (2010). Fish habitat rehabilitation using wood in the world. *Landscape and Ecological Engineering*, *6*(2), 289–305. https://doi.org/10.1007/s11355-009-0092-5

Ode, A., Fry, G., Tveit, M. S., Messager, P., & Miller, D. (2009). Indicators of perceived naturalness as drivers of landscape preference. *Journal of Environmental Management*, *90*(1), 375–383. https://doi.org/10.1016/j.jenvman.2007.10.013

Pflüger, Y., Rackham, A., & Larned, S. (2010). The aesthetic value of river flows: An assessment of flow preferences for large and small rivers. *Landscape and Urban Planning*, *95*(1–2), 68–78. https://doi.org/10.1016/j.landurbplan.2009.12.004

Piégay, H., Gregory, K. J., Bondarev, V., Chin, A., Dahlstrom, N., Elosegi, A., … Zawiejska, J. (2005). Public perception as a barrier to introducing wood in rivers for restoration purposes. *Environmental Management*, *36*(5), 665–674. https://doi.org/10.1007/s00267-004-0092-z

Posthumus, H., Rouquette, J. R., Morris, J., Gowing, D. J. G., & Hess, T. M. (2010). A framework for the assessment of ecosystem goods and services; a case study on lowland floodplains in England. *Ecological*

Economics, *69*(7), 1510–1523. https://doi.org/10.1016/j.ecolecon.2010.02.011

Rayanov, M., Dehnhardt, A., Glockmann, M., Hartje, V., Hirschfeld, J., Lindow, M., … Welling, M. (2018). Der ökonomische Wert von Flusslandschaften für Naherholung: Eine Zahlungsbereitschaftsstudie in vier Regionen Deutschlands. *Hydrologie Und Wasserbewirtschaftung*, *62*(6), 410–422. https://doi.org/10.5675/HyWa_2018.6_4

Ruiz-Villanueva, V., Díez-Herrero, A., García, J. A., Ollero, A., Piégay, H., & Stoffel, M. (2018). Does the public's negative perception towards wood in rivers relate to recent impact of flooding experiencing? *Science of The Total Environment*, *635*, 294–307. https://doi.org/10.1016/j.scitotenv.2018.04.096

Russi, D., Brink, P. T., Farmer, A., Badura, T., Coates, D., Förster, J., … Davidson, N. (2013). *TEEB: The economics of ecosystems and biodiversity for water and wetlands* (p. 76). London, England: Institute for European Environmental Policy.

Speed, R., Yuanyuan, L., Tickner, D., Huojan, H., Naiman, R. J., Jianting, C., … Yu, W. (2016). *River restoration: A strategic approach to planning and management* (p. 204). Paris: UNESCO Publishing.

Therneau, T. M. (2018). Package 'survival': Survival Analysis. Retrieved from https://github.com/therneau/survival.

Tockner, K., & Stanford, J. A. (2002). Riverine flood plains: Present state and future trends. *Environmental Conservation*, *29*(3), 308–330. https://doi.org/10.1017/S037689290200022X

UBA - Umweltbundesamt. (2014). Hydromorphologische Steckbriefe der deutschen Fließgewässertypen: Anhang 1 von „Strategien zur Optimierung von Fließgewässer-Renaturierungsmaßnahmen und ihrer Erfolgskontrolle (UBA-Texte 43/2014). Dessau-Roßlau.

Ward, J. V., Tockner, K., & Schiemer, F. (1999). Biodiversity of floodplain river ecosystems: Ecotones and connectivity. *Regulated Rivers: Research & Management*, *15*, 125–139. https://doi.org/10.1002/(SICI)1099-1646(199901/06)15:1/3<125::AID-RRR523>3.0.CO;2-E

Wohl, E. (2014). A legacy of absence. *Progress in Physical Geography*, *38*(5), 637–663. https://doi.org/10.1177/0309133314548091

Wyzga, B., Zawiejska, J., & Le Lay, Y.-F. (2009). Influence of academic education on the perception of wood in watercourses. *Journal of Environmental Management*, *90*(1), 587–603. https://doi.org/10.1016/j.jenvman.2007.12.013

Zander, K. K., Garnett, S. T., & Straton, A. (2010). Trade-offs between development, culture and conservation-willingness to pay for tropical river management among urban Australians. *Journal of Environmental Management*, *91*(12), 2519–2528. https://doi.org/10.1016/j.jenvman.2010.07.012

Zhao, J., Luo, P., Wang, R., & Cai, Y. (2012). Correlations between aesthetic preferences of river and landscape characters. *Journal of Environmental Engineering and Landscape Management*, *21*(2), 123–132. https://doi.org/10.3846/16486897.2012.695738

SUPPORTING INFORMATION

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

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