HortScience 60(9):1478–1485. 2025. https://doi.org/10.21273/HORTSCI18638-25

Backyard Biophilia: A Survey Instrument to Measure an Attraction to Biodiversity in the Home Garden

Vanessa Woods
Evolutionary Anthropology, Duke University, Durham, NC, USA; and Horticultural Science, North Carolina State University, Raleigh, NC, USA

Lorrie Schmid
Social Science Research Institute, Duke University, Durham, NC, USA

Hsuan Chen and Melinda Knuth
Horticultural Science, North Carolina State University, Raleigh, NC, USA

Keywords. backyard biophilia, biodiversity conservation, biophilia, biophilia reactivity hypothesis, human-plant interaction, urban ecology

Abstract. **Biodiversity is threatened by rapid urbanization, yet research on people's attraction to biodiversity remains scarce. The Biophilia Reactivity Hypothesis proposes biophilia, defined as an attraction to biodiversity, as a temperament trait. We developed a short survey instrument to measure Backyard Biophilia (BB)—an attraction to biodiversity in the home garden—and tested it on a representative convenience sample (n = 2031). The BB scale met the first criteria for a temperament trait, individual variability along a normal distribution, as well as good internal consistency, and a two-factor solution (Gardening for Wildlife and Lawn and Order). Higher BB scores correlated with increased proenvironmental behaviors and were inversely correlated with biophobia, defined as a fear or aversion to biodiversity. BB was also negatively correlated with income, with the lowest income bracket showing the highest attraction to biodiversity. These findings emphasize the importance of understanding individual preferences in biodiversity conservation, particularly in residential settings, and suggest that the BB scale could provide initiatives aimed at fostering biophilic connections across diverse urban environments.**

Biodiversity loss is an issue of global concern. Closely tied to ecosystem collapse and climate change, it was recently identified by the World Economic Forum as the second greatest threat to our global future (World Economic Forum 2024). In 1984, E.O. Wilson (1984) proposed *biophilia* as an additional conservation ethic—an "innate tendency to focus on life and life-like processes," later expanded to mean "the innately emotional affiliation of human beings to other living organisms" (Wilson 2007). Wilson framed biophilia as a universal human trait, arguing that without the natural world, people would suffer. Although he did not specify how this suffering might manifest, more recent research has linked biodiversity loss—and the climate risks that accompany it—to elevated rates of mental illness (Comtesse et al. 2021) and increased mortality from diseases associated with modern urban lifestyles (Pontzer et al. 2018).

Despite decades of advocacy from scientists, policymakers, and conservationists (Sarkar 2021), biodiversity continues to decline. International treaties on biodiversity conservation aim to meet their targets (Bjorkland and Bjorkland 2021; Hoffman et al. 2022), and human-driven extinction is estimated to be occurring at roughly 1000 times the natural background rate (Pimm et al. 2014). Conservation efforts have historically focused on wilderness areas under threat from development (Di Marco et al. 2019) but there is growing recognition of the need to protect and promote biodiversity within urban, suburban, and peri-urban environments. Cities and towns, when designed intentionally, can function as biodiversity refugia, supporting local and migratory species (Knapp et al. 2021). Since the early 2000s, urban biodiversity has been included in global conservation goals, but like broader targets, these efforts remain underachieved. Current projections suggest that a third of terrestrial vertebrates will lose habitat due to urban expansion by 2050 (Simkin et al. 2022).

There are likely many reasons for the mismatch between intention and action in biodiversity conservation, including economic shortfalls, and lack of education and awareness (Simkin et al. 2022). In the past decade, there has been growing interest in the social dimensions of conservation, including how people perceive and interact with biodiversity in urban settings. Understanding these human dimensions—especially affective and behavioral responses to biodiversity—may be key to more effective urban conservation strategies. Emerging evidence suggests that proenvironmental behaviors and environmental orientations are psychologically variable—shaped by exposure, experience, and cultural context (Larson et al. 2015). Jennings et al. (2016), for instance, argue that cultural ecosystem services and social determinants of health should be central to urban sustainability planning, particularly in communities facing systemic inequities in greenspace access.

These psychological and social gradients also influence how people respond to biodiversity itself. Peterson et al. (2012) found that landscaping preferences were shaped by neighborhood norms, race, and income, with African American and higher-income residents showing stronger preferences for turfgrass over native plant gardens—highlighting both cultural values and environmental justice dynamics. The well-documented "luxury effect" further illustrates this pattern: wealthier neighborhoods often exhibit higher biodiversity due to differences in historical zoning, landscaping investment, and ecological management (Hope et al. 2003; Leong et al. 2018). Yet this does not mean all residents value biodiversity equally. These findings reinforce the need to move beyond assumptions of uniform biophilia and toward a framework that recognizes individual variability.

Although the biophilia hypothesis is widely cited in research linking natural environments to human health and well-being—especially in horticulture and urban planning (Hall and Knuth 2020; Lefosse et al. 2023; Ríos-Rodríguez et al. 2024)—its foundational claims have been questioned. Wilson (1984) proposed biophilia as an innate and universal human affinity for life and life-like processes, but these claims were never empirically tested in a rigorous or falsifiable way (Joye and De Block 2011; Woods and Knuth 2023). Moreover, much of the literature assumes a general "nature" effect, with limited specificity about what "nature" entails (Howlett and Turner 2024; Jimenez et al. 2021; Silva et al. 2024).

In the Biophilia Reactivity Hypothesis, biophilia is defined as a temperament trait, specifically an attraction to biodiversity (Woods and Knuth 2023). A temperament trait is defined as a biologically based individual difference in emotional reactivity, self-regulation, and behavior, which appears early in life and remains relatively stable over time (Rothbart et al. 2007). In contrast to a more general concept of "nature," biodiversity—defined as the variety and variability of life at all levels (Watson et al. 2019)—offers a measurable construct. Biodiversity can be assessed at the ecosystem, species, and genetic levels using established scientific tools, from satellite mapping and

Accepted for publication 5 Jun 2025. Received for publication 24 Apr 2025.
Published online 5 Aug 2025.
We thank Grainne Fitzsimons and Walter Sinnott-Armstrong for their expert consultation during the development of the Backyard Biophilia scale. Their insights into psychological measurement and philosophical framing were invaluable. We are also especially grateful to the anonymous reviewer, whose thoughtful and constructive feedback greatly improved the quality of this manuscript.
The authors declare no competing interests.
V.W. is the corresponding author. E-mail: v.woods@duke.edu.

species transects to molecular markers. Framing biophilia in relation to biodiversity allows for more precise and comparable assessments than generalized notions of "nature."

Yet research remains mixed on whether biodiversity directly shapes human preferences or well-being. Some studies show that people can perceive and prefer biodiversity: in urban greenspaces, individuals have correctly identified and favored more species-rich environments (Lindemann-Matthies 2010; Meyer-Grandbastien et al. 2020), and national parks with greater biodiversity attract more visitors (Siikamäki et al. 2015). Fuller et al. (2007) found that perceived plant richness—closely matching actual species richness—was positively associated with well-being.

In other cases, perceptions of biodiversity influence responses more than biodiversity itself. Cameron et al. (2020) found that perceived avian richness, even when inaccurate, correlated more strongly with well-being than actual diversity. Similarly, Dallimer et al. (2012) showed that well-being was tied to subjective impressions of biodiversity, even when people failed to accurately identify more biodiverse environments.

On the other hand, some studies report no strong preference for biodiverse landscapes. Qiu et al. (2013) found that although people could distinguish between low- and high-biodiversity park areas, they preferred more open and less complex vegetation. Martín-López et al. (2007) reported that people often valued charismatic fauna or large trees but had neutral or negative responses to invertebrates and microorganisms—and were generally unwilling to pay to protect them.

In addition to attraction to biodiversity, it is important to consider the opposite tendency: biophobia, or aversion to certain life forms. Although biophilia is often explored in relation to mental health and positive affect, biophobia—though common—is rarely discussed in this context. Specific phobias of animals (especially snakes, spiders, and insects) are among the most prevalent, affecting up to 10% of Americans (Stinson et al. 2007). Many people also experience fear of certain animals (e.g., snakes or spiders) without meeting the criteria for a specific phobia. These fears tend to emerge early in life and often persist, impacting both behavior and well-being (Ollendick et al. 2002).

The relationship between biophilia and biophobia has not been directly tested. However, if biophilia is conceptualized as a temperament trait—something that varies between individuals and emerges early—then an inverse relationship with biophobia would be predicted. Individuals with strong aversions to biodiversity may show low levels of biophilia, whereas those drawn to complex biological environments may exhibit low biophobia.

Over the past 2 decades, a variety of survey instruments have been developed to assess people's connection to the natural world, including some that touch on biodiversity. Tools such as the Nature Relatedness Scale (Nisbet et al. 2009) and the Wildlife Values Orientation Survey (Manfredo et al. 2018) demonstrate strong internal reliability and are positively associated with proenvironmental behaviors (Schultz 2001). These scales often include items referencing wilderness or natural areas, which are generally more biodiverse, but they do not explicitly measure attraction to biodiversity nor do they frame this attraction as a temperament trait. To evaluate biophilia as a temperament trait, the first requirement is evidence of individual variability. Specifically, biophilia scores should approximate a normal distribution, without ceiling or floor effects or pronounced skew (Haslam 2020).

Backyard biophilia. As the global population shifts rapidly from rural to urban environments, the most immediate and accessible form of biodiversity for many people is found in their own backyards (Cox et al. 2017). Urban and suburban gardens play a critical role in local biodiversity conservation, as emphasized by researchers advocating for more ecologically beneficial landscaping practices (Beumer and Martens 2015; Tallamy 2020). Due to their heterogeneity and fragmentation, estimating the cumulative size of domestic gardens is challenging. Yet in the United Kingdom, gardens make up nearly 50% of urban green space (Evans et al. 2009), and in the United States, a recent estimate identified more than 130 million gardens—covering more than 30% of the total land area, nearly three times the land protected in designated conservation areas (Lerman et al. 2023).

These gardens provide important ecosystem services: they can serve as wildlife corridors, improve water filtration, reduce urban heat, and support a surprising amount of biodiversity. Native and even endangered species may find refuge in domestic gardens (Akinnifesi et al. 2010; Soanes and Lentini 2019). For example, Eumaeus butterflies, once thought extinct in the United States, were found thriving in more than 300 backyard colonies in Florida thanks to ornamental cycads—their host plant—being cultivated in home landscapes (Ramirez-Restrepo et al. 2016). However, traditional landscaping preferences in the United States, with their focus on turfgrass and exotic species, can also increase the number of herbicides and pesticides in local waterways, introduce invasive species, and drain council water supplies amid higher temperatures and increasing drought (Wang XianZhong and Clark 2017).

In the existing literature, there is no scale that specifically measures individual variability in attraction to biodiversity within the domestic garden—an essential context for testing biophilia as a temperament trait. This gap is particularly relevant for the Biophilia Reactivity Hypothesis, which predicts meaningful variation in people's attraction to biodiversity, including in their own backyards. Some research hints at individual variability: for example, Kurz and Baudains (2012) found that although general preferences for high- and low-habitat gardens were mixed, members of native plant societies preferred more biodiverse gardens. Children, by contrast, have shown preferences for more traditional yards over wilder, biodiverse alternatives (Hand et al. 2017). Other studies suggest that neighborhood norms shape landscaping choices, with residents often assuming that turfgrass is the favored standard—even when personal preferences differ (Peterson et al. 2012). Still, none of these studies developed a scale to systematically measure these preferences. Lerman et al. (2023) found that the "luxury effect" extended to domestic gardens, with wealthier neighborhoods supporting greater biodiversity, but no study has yet explored how individual attraction to backyard biodiversity relates to socioeconomic status.

To address this gap, we developed the BB scale—a new instrument designed to measure individual attraction to biodiversity in the home garden. If biophilia is a temperament trait, we would expect BB scores to show individual variability, approximating a normal distribution without ceiling or floor effects or significant skew.

This study had three core objectives. First, we validated the BB scale as a measure of individual attraction to biodiversity in domestic gardens. Second, we examined whether demographic variables—including income—predict variation in BB. Third, we tested the criterion validity of the scale by examining whether BB scores are inversely related to biophobia and positively associated with proenvironmental behavior. Together, these objectives aim to clarify who expresses high biophilic reactivity in urban and suburban contexts, and whether this trait predicts meaningful environmental engagement.

As biodiversity is increasingly threatened by urbanization, and calls for biodiversity conservation intensify, it is critical to understand what biophilia is, how it relates to biodiversity, and who might be most likely to embrace biodiversity in the home garden and act as agents for cultural change.

Methods

Participants. All procedures and materials were approved by the North Carolina State University Institutional Review Board (IRB) (Protocol #26247). In Dec 2023, a representative convenience sample of 2169 US adults (aged 18 and older) was recruited through Prolific. Participants who did not complete the BB survey ($n = 136$) or who were younger than 18 ($n = 2$) were excluded from analysis. The final sample included 2031 participants (Table 1). A priori power analysis confirmed that this sample size exceeded the minimum required to detect a medium effect size with adequate statistical power (Faul et al. 2007). All analyses were conducted using SPSS (version 29.0.0).

Phase 1. Developing the BB scale. During this phase, the research team conducted interviews with seven experts in landscape design, psychology, evolutionary anthropology, and survey methodology. Each hour-long interview focused on identifying existing items that might tap into attraction to biodiversity

Table 1. Demographic characteristics of study participants compared with US Census data.

Demographic categories	Convenience sample n = 2031 Frequency	%	US Census %
Gender			
Male	979	48	49
Female	1012	50	51
Age, yr			
18–24	209	10	7
25–34	418	21	14
35–44	348	17	13
45–54	358	18	12
55–64	413	20	13
65+	283	14	17
Ethnicity			
White/Caucasian	1625	80	76
Black/African American	252	12	14
Asian	121	6	6
Other/mixed	62	3	4
Highest level of education			
High school or less	270	14	37
Some college but no degree	398	20	15
Associate's or technical degree	234	12	10
Bachelor's degree	788	39	23
Graduate degree	336	17	14
Household income			
Less than $25,000	246	12	16
$25,000–$49,999	496	24	18
$50,000–$74,999	408	20	16
$75,000–$99,000	332	16	13
$100,000–$149,999	335	16	17
$150,000 or more	183	9	20

Sample size for the Backyard Biophilia survey was n = 2031. US Census estimates are based on national data (US Census Bureau 2020). Percentages may not total 100 due to rounding. Education percentages refer to adults aged 25 and older. Income reflects annual household income.

and generating new items suited to measuring this construct. Based on these conversations, 28 candidate items were developed. Of these, six were selected for piloting.

The initial items focused on preferences for gardens that support biodiversity, such as wild, messy gardens rich in plant and animal life, contrasted with traditional landscaping that favors turfgrass and ornamental simplicity. One item assessed enjoyment of natural sounds, such as birds and insects, and two items contrasted preferences for natural spaces vs. indoor environments. Each item was rated on a six-point Likert scale (1 = strongly disagree, 6 = strongly agree), which excluded a neutral midpoint to reduce ambivalence in responses.

All items were reviewed by three expert consultants for clarity and relevance. During preliminary review, one item was identified as double-barreled and was split into two separate questions. Another item comparing natural and indoor spaces was removed after analysis showed it did not correlate well with the remaining items. In follow-up discussions, experts raised the concern that stated preferences for biodiverse gardens may not reflect lived experience—especially for participants with limited access to private green space. To address this, each preference item was paired with a behavioral follow-up. For example, the item "I like gardens that attract all kinds of wildlife" was paired with "My garden attracts all kinds of wildlife." This resulted in a final scale of 10 items, combining preferences with self-reported experiences.

To assess distributional characteristics, the Kolmogorov-Smirnov test was used, as recommended for large samples (Mishra et al. 2019), and histograms, skewness, and kurtosis were examined. An exploratory factor analysis (EFA) was conducted using maximum likelihood extraction and Direct Oblimin rotation, based on the assumption that underlying factors may be correlated. Factors were retained based on eigenvalues ≥ 1 and scree plot interpretation. Communalities and pattern matrices were reviewed to interpret the factor structure and the full 10-item BB scale is provided in Supplemental A.

Phase 2. Demographic correlates of BB. In Phase 2, we examined the relationship between BB scores and various demographic variables to determine if certain demographic groups are more attracted to biodiversity. Pearson's correlation coefficients were calculated to assess the strength and direction of associations between BB scores and continuous demographic variables (e.g., age, income). For categorical variables (e.g., gender, race), independent samples *t* tests or one-way analyses of variance were conducted to compare mean BB scores across groups. Effect sizes are reported to interpret the magnitude of differences. A multiple linear regression model was developed to examine the combined influence of demographic predictors (age, gender, race, education, and income) on BB scores. This analysis helps determine the unique contribution of each demographic variable while controlling for the others. In cases of multiple comparisons, appropriate corrections were applied.

Phase 3: Criterion validity—relationships with biophobia and environmental behavior. In the final phase, we tested whether BB scores predicted meaningful outcomes by examining their relationships with both biophobia and self-reported environmental behavior. These analyses aimed to assess the criterion validity of the BB scale.

Biophobia was measured using four relevant items from the Chapman Survey of American Fears, assessing fear of insects, animals, reptiles, and sharks. One item included both dogs and rats ["How afraid are you of animals (dogs, rats, etc.)?"]; although these animals differ in affective valence for many Americans, we retained the item for consistency with the original scale. Responses were recorded on a four-point Likert scale and reverse-coded so that higher scores reflected less fear (1 = Very afraid, 4 = Not at all afraid). As a result, lower biophobia scores represent greater fear or aversion to animals. We predicted a positive correlation between BB and biophobia—individuals more attracted to biodiversity should report less fear of animals. Pearson correlations were used to test this prediction, and a multiple linear regression model was conducted to examine whether biophobia independently predicted BB scores while controlling for demographic variables.

Environmental behavior was assessed using a subset of seven items from the *General Ecological Behavior (GEB) Scale* (Kaiser 1998), one of the most frequently used and validated scales to measure proenvironmental behavior across various domains. This subset included four items reflecting general ecological actions (e.g., recycling, energy conservation), two items on environmental organization involvement, and one item reflecting biophobia-related behavior ("If there are insects in my home, I kill them with a chemical insecticide," reverse-coded). Items were binary (yes/no), and most reflected moderate to high-effort behaviors, with one ("I collect and recycle used paper") categorized as low-effort.

A random subsample (n = 1152) received these GEB items. We hypothesized that higher BB scores would positively correlate with proenvironmental behavior. Both correlation and regression analyses were conducted to evaluate the predictive relationship between BB and behavioral outcomes.

Together, these analyses provide initial evidence that BB scores are associated not only with emotional dispositions toward biodiversity (biophobia) but also with concrete environmental behaviors—supporting the BB scale's theoretical and applied relevance.

Results

We organized the results into three phases, aligned with the study's primary objectives. In Phase 1, we evaluated the psychometric properties of the newly developed BB scale. We assessed its factor structure using EFA. In Phase 2, we tested whether BB scores were associated with demographic variables such as income, race, gender, and education. In Phase 3, we examined the criterion validity of BB by testing its associations with biophobia and proenvironmental behavior.

Phase 1. Backyard biophilia. To examine the underlying structure of the BB scale, we conducted an EFA using principal component extraction. Table 2 presents the communalities for each of the 10 items, indicating the proportion of variance each item shares with the extracted factors. All items showed moderate to strong communalities, supporting their inclusion in the scale.

EFA revealed a clear two-factor solution accounting for 58% of total variance. Factor 1, Gardening for Wildlife, included six items reflecting attraction to biodiverse, natural garden features (e.g., "I like gardens that attract all kinds of wildlife"). Factor 2, Lawn and Order, included four reverse-coded items reflecting preference for manicured, ornamental spaces (e.g., "I like well-manicured lawns"). The eigenvalues for the two factors were 3.71 and 2.07, accounting for 37% and 21% of variance, respectively. The full 10-item BB scale showed strong internal consistency (Cronbach's α = 0.80).

Distribution of BB. Because the BB scale demonstrated good internal consistency and a coherent factor structure, the next step was to assess the distribution of BB scores in the convenience sample (n = 2031). The mean score was 3.7 (SD = 0.02), with a 25th percentile of 3.1 and a 75th percentile of 4.2. The distribution showed slight right skewness (0.36) and a kurtosis of –0.07, indicating only minor deviation from normality and slightly lighter tails. Although the Kolmogorov-Smirnov test was significant (0.06, $P < 0.001$), rejecting the null hypothesis of normality, such results are common in large samples (Altman and Bland 1995). Visual inspection via histogram confirmed a distribution that approximates normality (Fig. 1).

Phase 2. Demographic data. Demographic categories of education, income, gender, and race were used in a multiple linear regression predicting BB. Categorical variables (sample type, gender, and race) were dummy coded. The overall model was significant, $F(7, 2025)$ = 22.70, $P < 0.001$, explaining 7% of the variance in BB (R^2 = 0.073, Adjusted R^2 = 0.070).

Among individual predictors, income was significantly associated with BB (B = −0.065, SE = 0.013, β = −0.121, $P < 0.001$), indicating that individuals with higher income reported lower BB scores. The effect was small (sr = −0.11) but consistent, with BB decreasing as income increased. This reflects a modest inverse linear relationship between socioeconomic status and BB, with income uniquely explaining ∼1.2% of the variance. Post hoc comparisons using Bonferroni correction showed that individuals in the lowest income group (<$25K) had significantly higher BB scores (M = 3.84, SD = 0.88) than those in the highest income group (>$150K, M = 3.42, SD = 0.81), $P < 0.001$. These results suggest a small but significant inverse relationship between income and mean BB score.

Race was also a significant predictor of BB. Black participants scored significantly lower than White participants (B = −0.55, SE = 0.06, β = −0.22, $P < 0.001$), and Asian participants also scored lower than White participants (B = −0.30, SE = 0.08, β = −0.08, $P < 0.001$). Participants identifying as Other/Mixed did not significantly differ from White participants (B = 0.09, SE = 0.09, β = 0.02, P = 0.341). Because the survey followed US census conventions, Hispanic/Latino identity was not separately coded, and prior research suggests most Hispanic respondents select either "Other" or "White" as their racial identification (Dowling 2004). Given this ambiguity and the lack of a significant effect for the Other/Mixed category, further research is needed to clarify the role of Hispanic identity in BB outcomes.

Gender was a significant predictor, with female participants scoring higher than male participants and non-binary participants combined (B = 0.126, SE = 0.037, β = 0.074, $P < 0.001$), although the unique variance explained was small (sr = 0.07).

Education and age were not significant predictors of BB, and their contributions to the overall model were negligible. Full results are presented in Supplemental Tables 1 and 2.

Phase 3. Criterion validity: Relationships with biophobia and environmental behavior To assess the criterion validity of the BB scale, we examined its associations with both biophobia and self-reported environmental behavior.

A Pearson correlation revealed a significant negative association between BB and biophobia (r = –0.278, $P < 0.001$), indicating that individuals who reported greater fear of animals were less likely to report an attraction to biodiversity. A linear regression analysis further confirmed this relationship: the model was significant, $F(1, 2425)$ = 203.43, $P < 0.001$, explaining 7.7% of the variance in BB scores (R^2 = 0.077, Adjusted R^2 = 0.077).

BB was also significantly positively correlated with environmental behavior (r = 0.320, $P < 0.001$), suggesting that individuals who engaged in more proenvironmental actions tended to express a stronger attraction to biodiversity. To explore this relationship in greater detail, we conducted Pearson correlations between BB and each of the seven individual environmental behavior items. Logistic regression analyses confirmed that BB significantly predicted several of these behaviors, particularly those involving consumer choices. The strongest effects were found for pesticide avoidance and plastic reduction, whereas behaviors like organizational membership showed weaker or nonsignificant effects (Table 3).

Across all phases, results support the psychometric strength and conceptual utility of the BB scale. In Phase 1, the BB scale demonstrated a reliable two-factor structure and a distribution consistent with the expectations for a temperament trait. In Phase 2, BB was significantly predicted by income, race, and gender, with lower-income and female participants reporting greater attraction to biodiversity. In Phase 3, BB showed theoretically consistent relationships with both biophobia and environmental behavior, offering initial evidence of criterion validity. These results support the use of BB as a tool for understanding individual variability in biodiversity preference, particularly within urban and residential contexts.

Discussion

This study aimed to develop and validate the BB scale, a tool designed to measure individual attraction to biodiversity in the home garden. In doing so, we tested the Biophilia Reactivity Hypothesis, which proposes that biophilia is not a human universal, but a temperament trait—a stable, individual difference in responsiveness to nature, particularly biodiversity. We assessed the scale's structure, demographic predictors, its relationship to biophobia (an aversion to biodiversity), and its capacity to predict real-world environmental behavior.

Results from EFA revealed a two-factor structure. The first factor, *Gardening for Wildlife*, reflects a preference for messy, biodiverse gardens that support a wide range of living organisms. The second, *Lawn and Order*, captures an affinity for simplified, manicured landscapes often seen in conventional urban or suburban yards. Importantly, communalities for all 10 items were moderate to high (ranging from 0.52 to 0.64), demonstrating that the scale captures meaningful variance in people's preferences for backyard biodiversity (Table 4).

This variability fulfills the first criterion of a temperament trait: individual variability. Across a large sample (n = 2031), BB scores ranged widely, indicating that biophilia is not uniformly

Table 2. Communalities from exploratory factor analysis of the Backyard Biophilia scale (n = 2031). Extraction method: principal component analysis.

Item no.	Items	Comm for CS n = 2031
1	I like wild, messy gardens full of different plants.	.64
2	I like gardens that attract all kinds of wildlife.	.62
3	I have a wild, messy garden full of different plants.	.54
4	My garden attracts all kinds of wildlife.	.56
5	I like simple, uncluttered gardens, with a few well-placed trees and bushes.	.56
6	I have a simple, uncluttered garden, with a few well-placed trees and bushes.	.54
7	I like well-manicured lawns.	.64
8	I have a well-manicured lawn.	.59
9	I gravitate toward natural spaces.	.57
10	I like listening to natural sounds, like birds and insects.	.52

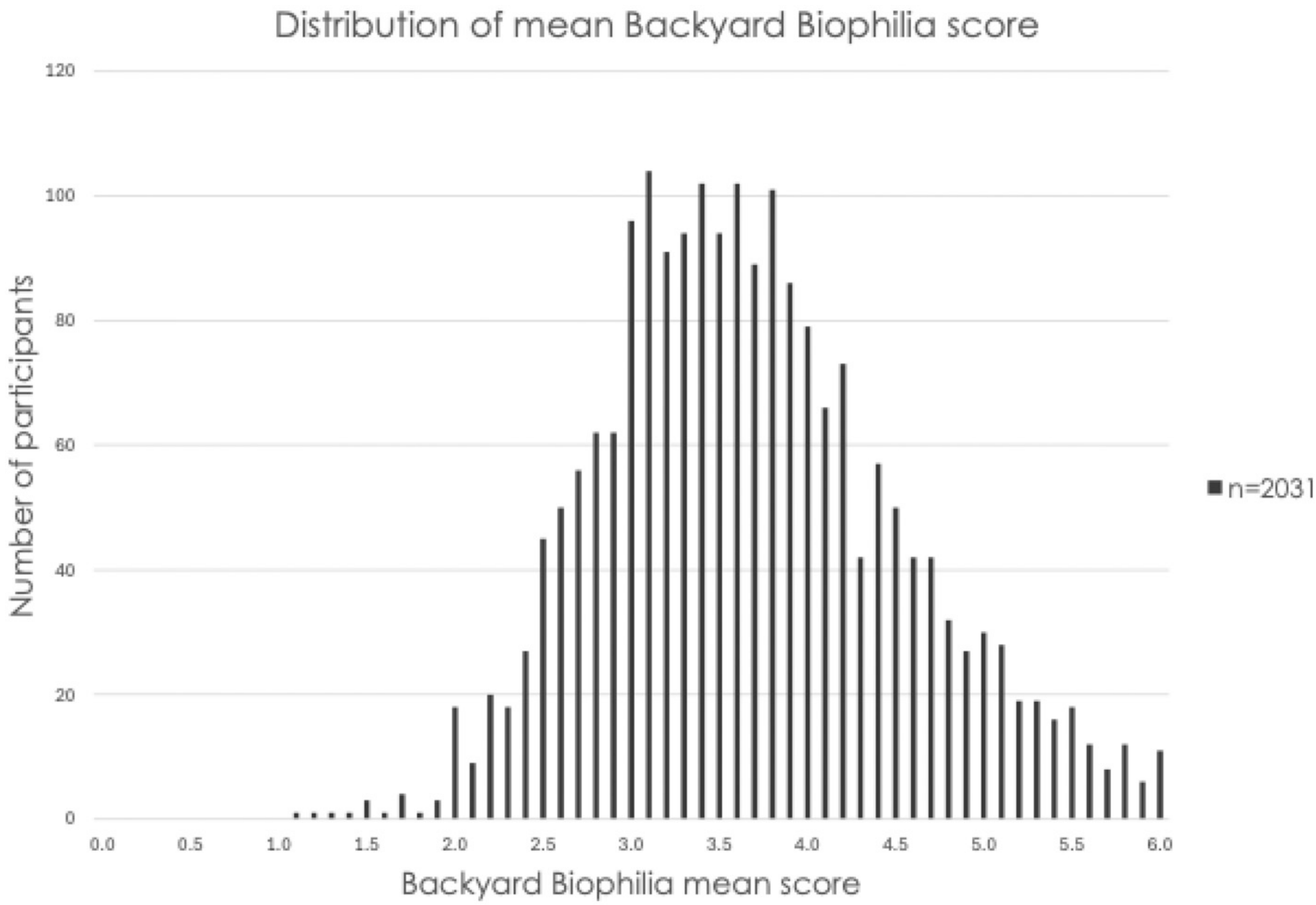

Fig. 1. Histogram of Backyard Biophilia (BB) scale scores. Displayed is the frequency distribution of BB mean scores in the convenience sample (n = 2031), demonstrating a near-normal distribution with slight right skew.

distributed. Some individuals showed strong affinity for biodiverse environments and others preferred highly structured, low-diversity spaces. This heterogeneity directly supports the Biophilia Reactivity Hypothesis and challenges universalist assumptions about human–nature relationships.

Income was the strongest demographic predictor of BB. In the representative convenience sample, BB increased as income level decreased. People with an annual household income of less than $25,000 had the highest BB mean, suggesting that those with the lowest income are most attracted to biodiversity in and around where they live (Fig. 2).

Access to natural spaces has been suggested as an important remedy for urban distress (Asamoah 2021), urban areas characterized by high poverty, crumbling infrastructure, and a lack of public amenities (Dasgupta et al. 2022). Urban areas with more greenspaces may have fewer health inequities (Schinasi et al. 2023) and greenness is weakly associated with children rising out of poverty (Browning and Rigolon 2019). However, there has been little research on the effects of biodiversity on those in poverty in the United States and other developed nations (Dean et al. 2011), and the mechanism by which increased access to biodiversity may improve the mental and physical health of those in poverty. Our results support the idea that those in the lowest socioeconomic status are more attracted to biodiversity in and around the home garden. These results are notable because they distinguish between general greenspace and green cover in the home garden and as items specifically to the type of environment that hosts biodiversity.

Conversely, individuals in the highest income brackets exhibited the lowest BB scores, despite the well-documented "luxury effect" in which biodiversity tends to be higher in wealthier neighborhoods (Hope et al. 2003; Leong et al. 2018). This suggests that actual exposure to biodiversity and preference for it do not necessarily align—a key insight for designing conservation interventions that rely on public support.

Our findings on race also align with previous research by Peterson et al. (2012), which found that Black Americans tend to prefer traditional turfgrass landscaping over more biodiverse or native plant gardens. In our sample, Black participants scored significantly lower on the BB scale than White participants, suggesting a lower preference for backyard biodiversity. These results support the notion that landscaping preferences are shaped by cultural norms and historical neighborhood expectations, particularly among marginalized groups. However, caution is warranted in interpreting these findings: our survey followed US census conventions and did not distinguish Hispanic/Latino ethnicity independently from racial categories. Prior research suggests that Hispanic individuals are likely underrepresented or misclassified in racial data (Dowling 2004), limiting our ability to assess variation within this population. Future studies should explicitly examine Hispanic/Latino identity and other intersectional factors to fully understand how cultural context shapes biophilic preferences.

The scale also performed well on predictive and convergent validity tests. As hypothesized, BB was negatively associated with biophobia, including fear of snakes and stinging insects—common backyard animals that often elicit strong reactions. This supports the idea that biophobia may act as a psychological barrier to ecological engagement, and that those with higher BB scores are more comfortable coexisting with everyday wildlife.

In addition, BB scores were positively correlated with proenvironmental behaviors, especially those directly related to household and garden management, such as pesticide avoidance, energy conservation, and sustainable shopping. These relationships underscore the relevance of biophilic preferences not just as abstract attitudes but as meaningful predictors of environmental action.

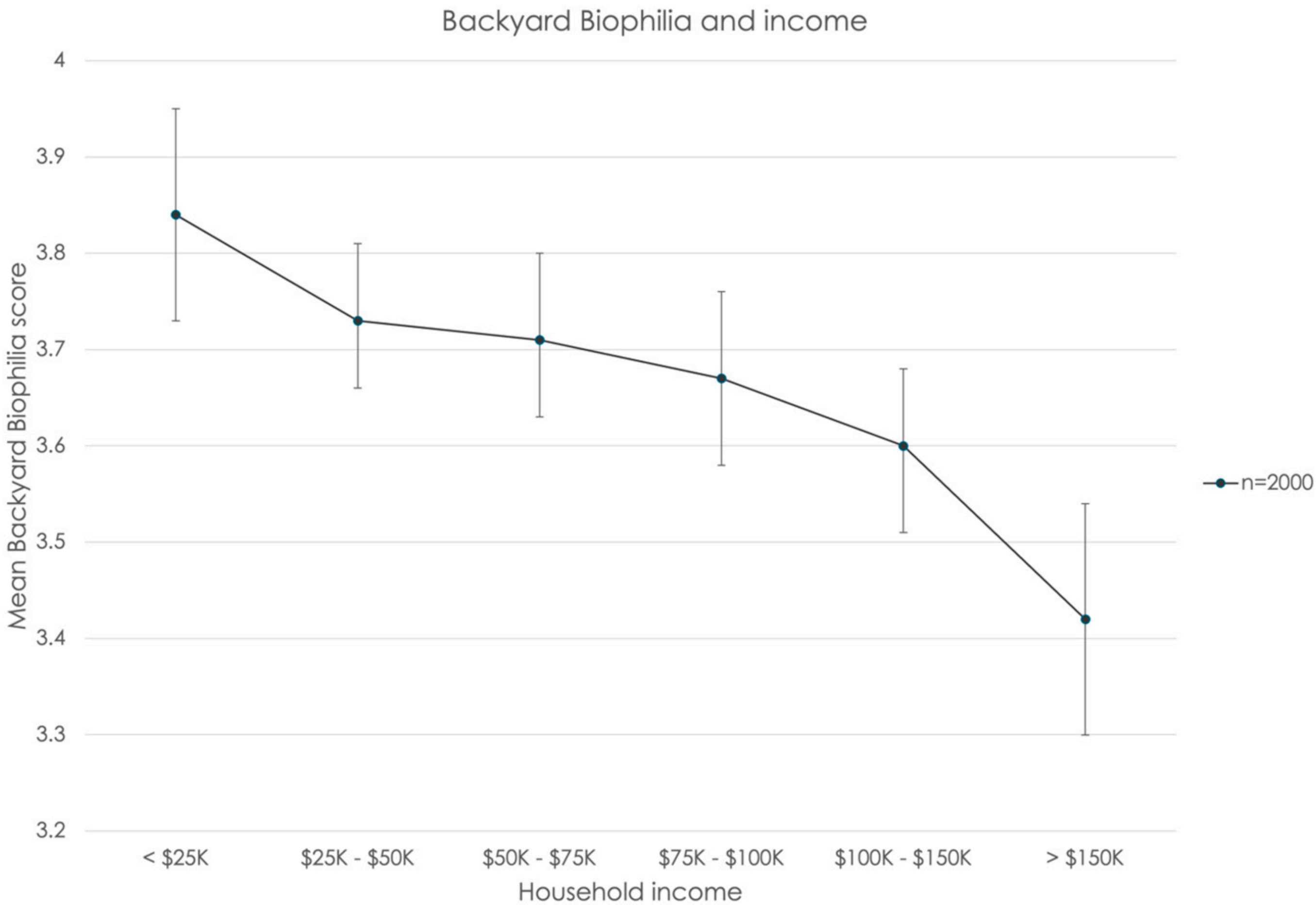

Fig. 2. Linear regression of household income and Backyard Biophilia (BB) scores in the convenience sample. Error bars represent 95% confidence intervals for mean BB scores. The trend suggests a negative association between income and BB, in which lower-income participants report higher levels of BB compared with higher-income participants (n = 2000).

However, several limitations should be acknowledged. First, all environmental behavior measures were self-reported, which may be subject to social desirability bias or inaccuracies in recall. Participants might overreport environmentally friendly behaviors or underreport actions that conflict with proenvironmental norms. Second, although BB was associated with several proenvironmental behaviors, the effect sizes were generally modest, and some behaviors—such as organizational membership—were not significantly predicted. This suggests that biophilia may be more strongly tied to everyday consumer choices than to civic engagement or institutional activism. Third, the cross-sectional design limits causal inference. Although BB scores were correlated with behavior and biophobia, we cannot determine the directionality or underlying mechanisms of these associations. Finally, our sample, although demographically diverse, was drawn from a convenience pool and may not fully represent the broader US population. Future studies using longitudinal or experimental designs, along with behavioral observation, would provide stronger tests of the BB scale's predictive power.

Together, these findings offer compelling support for the Biophilia Reactivity Hypothesis by demonstrating that attraction to biodiversity varies meaningfully across individuals and predicts real-world attitudes and behaviors. The BB scale captured consistent individual differences aligned with demographic patterns, emotional dispositions (biophobia), and environmentally relevant behaviors. The scale's two-factor structure reflects both aesthetic and ecological orientations toward domestic landscapes, highlighting how preferences for biodiversity are embedded in everyday choices about how people engage with their surroundings.

This has broader implications for biodiversity conservation in general. Most conservation efforts emphasize protecting wilderness areas, but urban gardens, which collectively represent vast green infrastructure, are critical for supporting biodiversity (Lerman et al. 2023). Some have argued that a lack of action toward biodiversity conservation, both at a local and global level, may be due to inadequate education, or the disconnect between people and nature

However, some people may be more attracted to a biodiverse world than others. Rather than trying to convince everyone to

Table 3. Regression analyses predicting environmental behaviors from Backyard Biophilia.

Environmental behavior	B	*SE*	β	*t*	*P*	Exp(B)	R^2	Difficult
Avoiding insecticides	0.35	0.05	0.2	7.1	<0.001	1.42	0.04	Normal
Buying loose produce	0.28	0.05	0.17	5.45	<0.001	1.32	0.03	High
Wearing a sweater to conserve heat	0.23	0.05	0.14	4.87	<0.001	1.26	0.02	Normal
Buying milk in returnable bottles	−0.16	0.08	−0.05	−1.88	0.060	0.86	0.0	High
Membership to environmental organizations	0.03	0.08	0.01	0.43	0.667	1.03	0.0	High
Recycling paper	0.08	0.05	0.05	1.58	0.115	1.08	0.0	Easy
Donate to environmental organizations	0.12	0.05	0.07	2.24	0.026	1.12	0.0	Normal

N = 1152. B = unstandardized coefficient; *SE* = standard error; β = standardized coefficient; Exp(B) = odds ratio from logistic regression; R^2 (Nagelkerke) represents the variance explained in each logistic model. Difficulty categories are based on behavioral ease: Easy, Normal, High (Kaiser 1998).

Table 4. Pattern matrix factor loadings from exploratory factor analysis of the Backyard Biophilia (BB) scale.

	Factor loading	
BB item	Gardening for wildlife	Lawn and order
1. I like wild, messy gardens full of different plants.	.55	
2. I like gardens that attract all kinds of wildlife.	.75	
3. I have a wild, messy garden full of different plants.	.57	
4. My garden attracts all kinds of wildlife.	.76	
5. I like simple, uncluttered gardens, with a few well-placed trees and bushes. (R)		.72
6. I have a simple, uncluttered garden, with a few well-placed trees and bushes. (R)		.75
7. I like well-manicured lawns. (R)		.77
8. I have a well-manicured lawn. (R)		.78
9. I gravitate toward natural spaces.	.77	
10. I like listening to natural sounds, like birds and insects.	.74	
Eigenvalue	**3.71**	**2.07**
Eigenvalue = % of variance	**37%**	**21%**

Factor loadings ≥ 0.40 are shown (n = 2031). A two-factor solution was extracted using principal component analysis with oblimin rotation. Factor 1 (gardening for wildlife) and Factor 2 (lawn and order preference, reverse-coded items) had eigenvalues of 3.71 and 2.07, accounting for 37% and 21% of the variance, respectively. Together, the two factors explained 58% of the total variance and represent subdimensions of the higher-order construct BB. The full 10-item scale demonstrated strong internal consistency (Cronbach's α = 0.80).

make the major changes that scientists agree biodiversity conservation requires, more targeted messaging toward those who are more likely to become early adopters might catalyze cultural change.

Limitations and Future Directions

Although this study offers initial support for the Biophilia Reactivity Hypothesis, several limitations and future research directions should be noted. First, the data were collected from a US-based adult sample, reflecting a broader trend in environmental psychology in which studies are concentrated in high-income, developed nations. Cross-cultural research is urgently needed to determine whether biophilic reactivity manifests similarly across different ecological, economic, and sociocultural contexts.

Second, if biophilia is a temperament trait, it should emerge early in life and show relative stability. Future research should test children to determine whether individual differences in attraction to biodiversity are observable in early developmental stages.

Third, although the sample was demographically diverse, Hispanic and Latino identity was not separately analyzed because of the structure of census-based racial categories. Future studies should explicitly include and disaggregate these populations to better understand how biophilic preferences vary across cultural and ethnic lines.

Finally, although the BB scale captures attraction to biodiversity in domestic gardens, this represents only one context of biophilic expression. Future iterations should broaden the scale's scope to include additional domains, such as tolerance for wildlife in and around the home, willingness to travel to biodiverse environments (biophilic tourism), and other forms of biodiversity engagement. Existing validated instruments, such as the Nature Relatedness Scale, could be integrated to enrich measurement and assess overlapping or complementary dimensions of biodiversity attraction.

By addressing these limitations, future research can deepen our understanding of biophilia as a temperament trait and its role in conservation behavior across life stages, cultures, and environmental contexts.

Conclusion

Forty years after E.O. Wilson (1984) introduced the biophilia hypothesis, there remains limited empirical evidence to validate its predictions. The Biophilia Reactivity Hypothesis, which frames biophilia as a temperament trait rather than a universal affinity for nature, provides a testable and measurable framework for understanding individual variability in biodiversity attraction. The BB scale represents a critical step in this direction, offering a novel tool for assessing biodiversity preferences in urban and residential settings. Key findings from this study highlight that biophilia is not evenly distributed across populations, with lower-income individuals exhibiting a greater attraction to biodiversity. It could be that biodiversity is most important to those experiencing urban distress, and increasing biodiversity in these areas could be a simple initiative to ameliorate both environmental and psychological stress in those who need it most.

References Cited

Akinnifesi FK, Sileshi GW, Ajayi OC, Akinnifesi AI, de Moura EG, Linhares JF, Rodrigues I. 2010. Biodiversity of the urban homegardens of São Luís city, Northeastern Brazil. Urban Ecosyst. 13(1):129–146. https://doi.org/10.1007/s11252-009-0108-9.

Altman DG, Bland JM. 1995. Statistics notes: The normal distribution. BMJ. 310(6975):298. https://doi.org/10.1136/bmj.310.6975.298.

Asamoah J. 2021. Beyond sustainability: Biophilia as a tool for regenerative urban design (Master's thesis). University of Maryland, College Park, MD, USA.

Beumer C, Martens P. 2015. Biodiversity in my (back) yard: Toward a framework for citizen engagement in exploring biodiversity and ecosystem services in residential gardens. Sustain Sci. 10(1):87–100. https://doi.org/10.1007/s11625-014-0270-8.

Bjorkland R, Bjorkland R. 2021. Reversing global biodiversity declines: Mainstreaming biodiversity conservation into decision-making at national and local scales. MIT SPR. 2:31–39. https://doi.org/10.38105/spr.c3vlezkmiz.

Browning MH, Rigolon A. 2019. Could nature help children rise out of poverty? Green space and future earnings from a cohort in ten US cities. Environ Res. 176:108449. https://doi.org/10.1016/j.envres.2019.04.016.

Cameron RW, Brindley P, Mears M, McEwan K, Ferguson F, Sheffield D, Jorgensen A, Riley J, Goodrick J, Ballard L. 2020. Where the wild things are! Do urban green spaces with greater avian biodiversity promote more positive emotions in humans? Urban Ecosyst. 23:301–317.

Comtesse H, Ertl V, Hengst SM, Rosner R, Smid GE. 2021. Ecological grief as a response to environmental change: A mental health risk or functional response? Int J Environ Res Public Health. 18:734.

Cox DT, Shanahan DF, Hudson HL, Fuller RA, Anderson K, Hancock S, Gaston KJ. 2017. Doses of nearby nature simultaneously associated with multiple health benefits. Int J Environ Res Public Health. 14(2):172. https://doi.org/10.3390/ijerph14020172.

Dallimer M, Irvine KN, Skinner AM, Davies ZG, Rouquette JR, Maltby LL, Warren PH, Armsworth PR, Gaston KJ. 2012. Biodiversity and the feel-good factor: Understanding associations between self-reported human well-being and species richness. BioScience. 62:47–55.

Dasgupta S, Mukherjee A, Kumar A, Gupta A. 2022. Urban distress: An emerging framework for understanding urban vulnerabilities in India. Center for Policy Research.

Dean J, van Dooren K, Weinstein P. 2011. Does biodiversity improve mental health in urban settings? Med Hypotheses. 76(6):877–880. https://doi.org/10.1016/j.mehy.2011.02.040.

Department of Economic and Social Affairs, UN. 2018. World urbanization prospects: The 2018 revision. https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html. [accessed 12 Apr 2023].

Di Marco M, Ferrier S, Harwood TD, Hoskins AJ, Watson JEM. 2019. Wilderness areas halve the extinction risk of terrestrial biodiversity. Nature. 573(7775):582–585. https://doi.org/10.1038/s41586-019-1567-7.

Dowling JA. 2004. The lure of whiteness and the politics of "otherness": Mexican American racial identity (PhD Diss). University of Texas at Austin, Austin, TX, USA.

Evans KL, Newson SE, Gaston KJ. 2009. Habitat influences on urban avian assemblages. Ibis.

151(1):19–39. https://doi.org/10.1111/j.1474-919X.2008.00898.x.
Faul F, Erdfelder E, Lang A-G, Buchner A. 2007. G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 39(2):175–191. https://doi.org/10.3758/bf03193146.
Fuller RA, Irvine KN, Devine-Wright P, Warren PH, Gaston KJ. 2007. Psychological benefits of greenspace increase with biodiversity. Biol Lett. 3(4):390–394. https://doi.org/10.1098/rsbl.2007.0149.
Hall CR, Knuth MJ. 2020. An update of the literature supporting the well-being benefits of plants: Part 4–Available resources and usage of plant benefits information. J Environ Hortic. 38(2):68–72. https://doi.org/10.24266/0738-2898-38.2.68.
Hand KL, Freeman C, Seddon PJ, Recio MR, Stein A, Van Heezik Y. 2017. The importance of urban gardens in supporting children's biophilia. Proc Natl Acad Sci USA. 114(2):274–279. https://doi.org/10.1073/pnas.1609588114.
Haslam N. 2020. Bell-shaped distribution of personality traits, p 441–443. In: Zeigler-Hill V, Shackelford TK (eds). Encyclopedia of personality and individual differences. Springer, New York, NY, USA. https://doi.org/10.1007/978-3-319-28099-8_1975-1.
Hoffman SJ, Baral P, Rogers Van Katwyk S, Sritharan L, Hughsam M, Randhawa H, Lin G, Campbell S, Campus B, Dantas M, Foroughian N, Groux G, Gunn E, Guyatt G, Habibi R, Karabit M, Karir A, Kruja K, Lavis JN, Lee O, Li B, Nagi R, Naicker K, Røttingen J-A, Sahar N, Srivastava A, Tejpar A, Tran M, Zhang Y-Q, Zhou Q, Poirier MJP. 2022. International treaties have mostly failed to produce their intended effects. Proc Natl Acad Sci USA. 119(32):e2122854119. https://doi.org/10.1073/pnas.2122854119.
Hope D, Gries C, Zhu W, Fagan WF, Redman CL, Grimm NB, Nelson AL, Martin C, Kinzig A. 2003. Socioeconomics drive urban plant diversity. Proc Natl Acad Sci USA. 100(15):8788–8792. https://doi.org/10.1073/pnas.1537557100.
Howlett K, Turner EC. 2024. Research on the benefits of nature to people: How much overlap is there in citations and terms for 'nature' across disciplines? People and Nature. 6(1):27–40. https://doi.org/10.1002/pan3.10573.
Jimenez MP, DeVille NV, Elliott EG, Schiff JE, Wilt GE, Hart JE, James P. 2021. Associations between nature exposure and health: A review of the evidence. Int J Environ Res Public Health. 18(9):4790. https://doi.org/10.3390/ijerph18094790.
Joye Y, De Block A. 2011. 'Nature and I are two': A critical examination of the biophilia hypothesis. Environmental Values. 20(2):189–215. https://doi.org/10.3197/096327111X12997574391724.
Kaiser FG. 1998. A general measure of ecological behavior. J Applied Social Pyschol. 28(5):395–422. https://doi.org/10.1111/j.1559-1816.1998.tb01712.x.
Knapp S, Aronson MFJ, Carpenter E, Herrera-Montes A, Jung K, Kotze DJ, La Sorte FA, Lepczyk CA, MacGregor-Fors I, MacIvor JS, Moretti M, Nilon CH, Piana MR, Rega-Brodsky CC, Salisbury A, Threlfall CG, Trisos C, Williams NSG, Hahs AK. 2021. A research agenda for urban biodiversity in the global extinction crisis. BioScience. 71(3):268–279. https://doi.org/10.1093/biosci/biaa141.
Kurz T, Baudains C. 2012. Biodiversity in the front yard: An investigation of landscape preference in a domestic urban context. Environment and Behavior. 44(2):166–196. https://doi.org/10.1177/0013916510385542.
Larson LR, Stedman RC, Cooper CB, Decker DJ. 2015. Understanding the multi-dimensional structure of pro-environmental behavior. J Environ Psychol. 43:112–124.
Lefosse D, Timmeren van A, Ratti C. 2023. Biophilia upscaling: A systematic literature review based on a three-metric approach. Sustainability. 15:15702.
Leong M, Dunn RR, Trautwein MD. 2018. Biodiversity and socioeconomics in the city: A review of the luxury effect. Biol Lett. 14(5):20180082. https://doi.org/10.1098/rsbl.2018.0082.
Lerman SB, Larson KL, Narango DL, Goddard MA, Marra PP. 2023. Humanity for habitat: Residential yards as an opportunity for biodiversity conservation. BioScience. 73(9):671–689. https://doi.org/10.1093/biosci/biad061.
Lindemann-Matthies P, Junge X, Matthies D. 2010. The influence of plant diversity on people's perception and aesthetic appreciation of grassland vegetation. Biol Conserv. 143:195–202. https://doi.org/10.1016/j.biocon.2009.10.003.
Manfredo MJ, Sullivan L, Don Carlos A, et al. 2018. America's wildlife values: The social context of wildlife management in the US. Colorado State University, Fort Collins, CO, USA.
Martín-López B, Montes C, Benayas J. 2007. The non-economic motives behind the willingness to pay for biodiversity conservation. Biological Conservation. 139(1–2):67–82. https://doi.org/10.1016/j.biocon.2007.06.005.
Meyer-Grandbastien A, Burel F, Hellier E, Bergerot B. 2020. A step towards understanding the relationship between species diversity and psychological restoration of visitors in urban green spaces using landscape heterogeneity. Landscape and Urban Planning. 195:103728. https://doi.org/10.1016/j.landurbplan.2019.103728.
Mishra P, Pandey CM, Singh U, Gupta A, Sahu C, Keshri A. 2019. Descriptive statistics and normality tests for statistical data. Ann Card Anaesth. 22:67–72.
Nisbet EK, Zelenski JM, Murphy SA. 2009. The nature relatedness scale: Linking individuals' connection with nature to environmental concern and behavior. Environment and Behavior. 41(5):715–740. https://doi.org/10.1177/0013916508318748.
Ollendick TH, King NJ, Muris P. 2002. Fears and phobias in children: Phenomenology, epidemiology, and aetiology. Child Adolesc Ment Health. 7:98–106.
Peterson MN, Thurmond B, McHale M, Rodriguez S, Bondell HD, Cook M. 2012. Predicting native plant landscaping preferences in urban areas. Sustainable Cities and Society. 5:70–76. https://doi.org/10.1016/j.scs.2012.05.007.
Pimm SL, Jenkins CN, Abell R, Brooks TM, Gittleman JL, Joppa LN, Raven PH, Roberts CM, Sexton JO. 2014. The biodiversity of species and their rates of extinction, distribution, and protection. Science. 344:1246752.
Pontzer H, Wood BM, Raichlen DA. 2018. Hunter-gatherers as models in public health. Obes Rev. 19(Suppl 1):24–35. https://doi.org/10.1111/obr.12785.
Qiu L, Lindberg S, Nielsen AB. 2013. Is biodiversity attractive? On-site perception of recreational and biodiversity values in urban green space. Landscape and Urban Planning. 119:136–146. https://doi.org/10.1016/j.landurbplan.2013.07.007.
Ramírez-Restrepo L, Koi S, MacGregor-Fors I. 2017. Tales of urban conservation: Eumaeus butterflies and their threatened cycad host-plants. Urban Ecosyst. 20:375–378.
Ríos-Rodríguez ML, Rosales C, Hernández B, Lorenzo M. 2024. Benefits for emotional regulation of contact with nature: A systematic review. Front Psychol. 15:1402885. https://doi.org/10.3389/fpsyg.2024.1402885.
Rothbart MK, Sheese BE, Posner MI. 2007. Temperament and emotion regulation, p 331–350. In: Gross JJ (ed). Handbook of emotion regulation. Guilford Press, New York, NY, USA.
Sarkar S. 2021. Origin of the term biodiversity. BioScience. 71(9):893–893. https://doi.org/10.1093/biosci/biab071.
Schinasi LH, Kondo MC, Edwards J, Clougherty JE, De Roos AJ, Bilal U. 2023. Does urban greenspace reduce mortality inequalities based on poverty, race, or both in Philadelphia, PA? J Urban Health. 100(4):686–695. https://doi.org/10.1007/s11524-023-00748-5.
Siikamäki P, Kangas K, Paasivaara A, Schroderus S. 2015. Biodiversity attracts visitors to national parks. Biodivers Conserv. 24:2521–2534.
Silva A, Matos M, Gonçalves M. 2024. Nature and human well-being: A systematic review of empirical evidence from nature-based interventions. J Environ Plant Manage. 67:3397–3454.
Simkin RD, Seto KC, McDonald RI, Jetz W. 2022. Biodiversity impacts and conservation implications of urban land expansion projected to 2050. Proc Natl Acad Sci USA. 119(12):e2117297119. https://doi.org/10.1073/pnas.2117297119.
Soanes K, Lentini PE. 2019. When cities are the last chance for saving species. Front Ecol Environ. 17(4):225–231. https://doi.org/10.1002/fee.2032.
Stinson FS, Dawson DA, Chou SP, Smith S, Goldstein RB, Ruan WJ, Grant BF. 2007. The epidemiology of DSM-IV specific phobia in the USA: Results from the National Epidemiologic Survey on Alcohol and Related Conditions. Psychol Med. 37:1047–1059.
Tallamy DW. 2020. Nature's best hope: A new approach to conservation that starts in your yard. Timber Press, Portland, OR, USA. The Economist. 2022. The Economist Yearbook. vol. 2025.
US Census Bureau. 2020. ACS demographic and housing estimates. U.S. Dept. Commerce. https://data.census.gov/. [accessed 14 Jan 2024].
Watson R, Baste I, Larigauderie A, Leadley P, Pascual U, Baptiste B, Demissew S. 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES Secretariat, Bonn, Germany. p. 22–47. https://doi.org/10.5281/zenodo.3553579.
Wilson EO. 1984. Biophilia. Harvard University Press, Cambridge, MA, USA.
Wilson EO. 2007. Biophilia and the conservation ethic, p 249–257. In: Penn D, Mysterud I (eds). Evolutionary perspectives on environmental problems. Springer, New York, NY, USA.
Woods V, Knuth M. 2023. The biophilia reactivity hypothesis: Biophilia as a temperament trait, or more precisely, a domain-specific attraction to biodiversity. J Bioecon. 25(3):271–293. https://doi.org/10.1007/s10818-023-09342-w.
World Economic Forum. 2024. The global risks report 2024. https://www.weforum.org/publications/global-risks-report-2024/. [accessed 5 Dec 2024].
XianZhong W, Clark PB. 2017. The environmental impacts of home and community gardening. CABI Rev. 1:1–14.