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The biophilia hypothesis explored: regenerative urban green spaces and well-being in a Portuguese sample

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ABSTRACT

This paper considers the relationship between biophilia and well-being in a sample of users of urban green spaces in the city of Porto (Portugal) as a case study. The biophilia hypothesis is explored through the responses of 131 participants in a survey. Users of urban green spaces valued their provision of quiet and shade, with a high diversity of plant species and tranquillity. The survey also found that being satisfied with urban green spaces enhances self-perceived health status, which means that being satisfied with a green space that fulfils users' expectations can be a way to improve well-being in urban areas. Creating stimulating regenerative urban green spaces offers the possibility to experience significant connections to nature.

KEYWORDS

Biophilia; green spaces; well-being; regenerative; design

Introduction

Research related to the biophilia hypothesis has grown in recent decades. Biophilia is a term composed of two Greek root words, *bio* which means life, and *philia* which means friendship and which is often also translated as love. Biophilia is thus friendship, love, for life, and the term was first introduced in 1973 in Western literature by the German psychoanalyst Erich Fromm [1], who distinguished it from necrophilia, or a taste for the inanimate and the mechanical, for things that are dead. Later, the term was taken up by Edward O. Wilson [2], an American entomologist who described biophilia as the deep relationship that human beings have with nature. Wilson was interested in biophilia as an evolutionary adaptation to the living world, and he assumed a phylogenetic approach that proposed a set of inherited learning rules for biophilia as well as for its opposite, biophobia [3]. Fromm, on the other hand, conceptualised biophilia as a psychological

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orientation, and he focused on the developmental conditions for the biophilic personality. These two approaches are not opposed, but complementary and, together, they can be operationalised and tested to refute the more critical approaches to the biophilia hypothesis, which state that the concept is vague and that the research associated with it does not justify its psychological or social scope [4].

Recent works aimed to show that biophilia seems to be an interesting concept to deepen the relationship between health, regenerative planning and nature. Regenerative planning ‘... transcends and includes sustainability, in a holistic systems approach to reverse the degeneration of the earth’s natural systems, but also to design human systems that can coevolve with natural systems’ [5] (p.86). When applied to regenerative green spaces, this concept refers to the need to design using elements that enhance people-nature contact through a co-creation approach where citizens are part of this collective social construction. Co-creation of regenerative green spaces is a path towards inclusive and fair cities [6].

Individual and social well-being, as well as the promotion of biodiversity, urban cooling and oxygen production, CO₂ management and short food circuits, are important arguments for the development of sustainable and regenerative green spaces in cities [7–9]. They are aligned with the United Nations’ objectives for sustainable development [10].

This study aims to explore the biophilia hypothesis through a survey applied to a sample of Portuguese users of urban green spaces, a case study of the city of Porto. Firstly, the biophilia hypothesis will be framed in its relationship with mental health and well-being. Secondly, psychosocial evidence for biophilia will be discussed through the quantitative and qualitative interpretation of questionnaires on well-being. Thirdly, behavioural evidence for biophilia will be given, by considering the behaviours and uses of green spaces by the same population. In its final remarks, the paper will address how biophilic considerations may enhance well-being and health through the regenerative planning of sustainable green spaces. Therefore, the research questions are twofold: Can biophilia be identified through respondents’ answers to the survey? Can biophilia be identified through behaviours of those using green spaces?

Biophilia, mental health and well-being

One of the most studied aspects of biophilia research is the relationship between nature and mental health and well-being [11–13]. Classic studies have shown the restorative potential of exposure to natural elements on attention and mental life [14, 15]. A frequent explanation found in literature is the evasion effect provided by the sight of plants and trees, as well as the experience of perceptual fluency associated with immersion in green or blue spaces, such as the seaside. The human species is not pre-adapted to live in a gigantic megapolis, contacting hundreds of unknown people on the streets and in compact subways. Stress levels rise with overpopulation in animals and human beings, and together with sound and air pollution, these are the main factors for poor mental health and well-being [16–19].

It is accepted that health and well-being do not depend only on medicine or psychology, but also on the environments and cultures of everyday life [20]. The concept of ‘One Health’ advanced by the World Health Organization [21] is a transdisciplinary approach that recognises the interrelationship between people, animals, plants and the

environment. Factors like physical activity, air quality, biodiversity and engagement with nature may influence people's perception of environments and green spaces and affect overall bodily homeostasis [22–27].

The success of nature programmes developed by the Nordic countries shows that exposure to green spaces for a few hours a month helps to reduce symptoms of anxiety and depression [28–30]. In England, the population studied by Mitchell and Popham [31] showed that simply living next to a green space increases physical and mental health and life expectancy, and this effect is especially visible in the most disadvantaged populations. According to Nisbet et al. [32], empirical observations show that time spent in green spaces, and frequency of contact, affect the feeling of belonging and pro-social and pro-environmental behaviours, that is, behaviour that seeks to minimise the negative impact and enhance the positive impact of one's actions. Distance from nature has the opposite effect, and people tend to seek out natural spaces less, even if this distance affects their health [33]. Thus, as Wilson [2] proposed, biophilia does not seem to be an innate mechanism of prompt response, but a process of learning, and probably of early imprinting, which is guided by spontaneous preferences and avoidances that are genetically prepared. If this statement is true, then the use of green spaces depends on an early and continued ontogenetic exposure, which provides an important argument for urban planners to include parks and pocket gardens in cities [3].

Indeed, urban parks and gardens are very important spaces when it comes to promoting the mental health of city dwellers [34]. Epidemiological research shows that schizophrenia is more common in cities, particularly in poor neighbourhoods without public gardens or parks [35, 36]. A Danish study [37] showed that children who lived during childhood in the absence of green spaces had an increased psychosis risk, compared to those who lived in green areas.

In summary, exposure to green spaces seems to have effects on positive social and environmental behaviour, reduce stress, help the restoration of directed attention, improve depressive symptoms as well as anxiety levels, enhance the feelings of happiness and of being connected [38]. Adding to the fact that urban parks are the lungs of the cities and home to biodiversity, time spent in gardens and parks is associated with general health improvement and spiritual awe.

Material and methods

Research design

Our research aims to explore if there is a relationship between biophilia and well-being in a sample of urban users of green spaces in the city of Porto (Portugal). We hypothesise that i) psychosocial evidence for biophilia and well-being will be found in the survey answers; and that ii) behavioural evidence for biophilia and well-being will be found in the use of urban green spaces through survey answers and photos. This is a cross-sectional exploratory study with urban green spaces users. An online survey was shared through Google Forms and applied to a sample of urban green space users. The survey comprises forty-five questions of which 90% are close-answer responses, organised in three main sections: i) the first one aims to know the socio-demographic profile of users of urban green spaces; ii) the second section seeks to know their

preferences and reasons why they choose an urban green space to visit; iii) the third one aims to discern their environmental concerns and social perceptions towards ecosystem services. For this paper, the first two sections will be analysed, aiming to explore if biophilia can be identified through the users' responses and its relationship with well-being. The responses were complemented with photos taken in the urban green spaces to discuss if users' behaviours can be considered biophilic and their relationship with well-being. The survey comprised questions that followed the proposition of Tokhmehchian and Gharehbaglou [39] that environment sensorial perception is triggered by space natural stimuli through experiential reception of the user which includes behaviour in green spaces, namely the contact with, experience and time spent in nature. The study was conducted according to the guidelines of the Helsinki Declaration and approved by the Ethics Committee of the University Fernando Pessoa (UFP).

Study area

This study was conducted in the coastal city of Porto, located in the North of Portugal, with an area of 41.42 km² and a population density of approximately 5000 inhabitants per km² [40]. During the 20th century, extensive and fragmented urbanisation led to a significant loss of a large part of the green structure in the city [41]. Nevertheless, several parks and public gardens are still scattered in the middle of the dense urban fabric, assumed to be socialisation and nature contact spots for city dwellers.

The total area of green spaces in the city comprises 13.0 km², representing 31.4% of the city area [42]; and this means 54.8 m² green space per inhabitant which exceeds the widely desirable value of 40 m² per inhabitant proposed by several authors [43, 44]. The value is very satisfactory when compared to cities with similar population structures, such as Amsterdam (54.7 m²), Athens (25.6 m²), Prague (74.6 m²) and Turin (43.1 m²) [45].

Farinha-Marques [42] points out that when considering only public open green spaces with recreational functions – parks, gardens and garden squares –, this value significantly decreases to 7.8 m² per inhabitant (representing 17.7% of the proportion of the green space in the city). This is below the guideline proposed by the World Health Organization of 9.0 m² [46]. Farinha-Marques [47] identified and mapped 95 green spaces in the city which are fully accessible to the public and managed by the local authority. For this study, 25 urban green spaces were randomly selected to explore the biophilia hypothesis (Figure 1).

Sampling strategy

Because of the scope and nature of this research and since it was developed during the COVID-19 pandemic, we only collected 131 valid responses. But this is an exploratory study and the sample size is not determinant; the results should be understood as clues [48]. The inclusion criteria to participate in the study were: being able to read and write, being 18 years old or more and being a user of at least one of the twenty-five selected

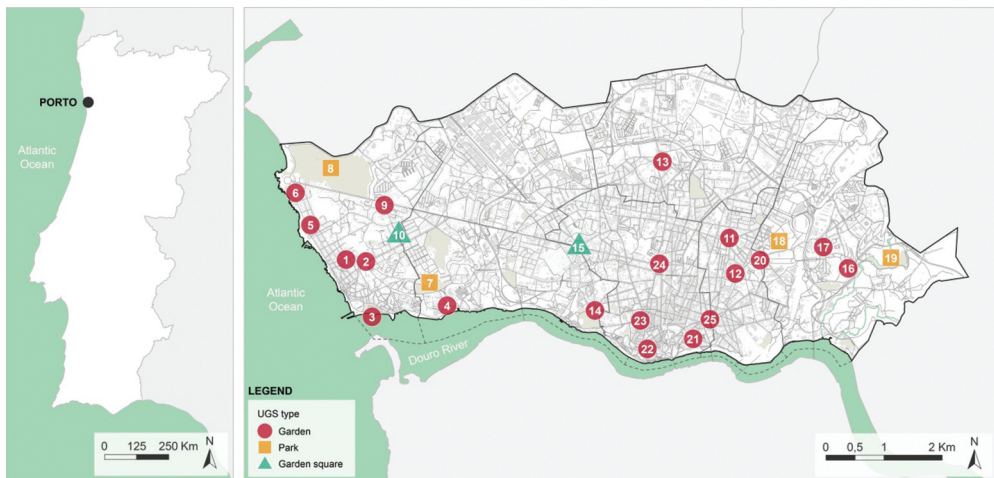


Figure 1. Urban green spaces studied location in the city of Porto, Portugal.
Source: Authors.

urban green spaces in the city. The survey link was made available through the social networks (Facebook, LinkedIn and ResearchGate), university networks, and personal mailing lists.

Data analysis

Statistical analysis was performed using the IBM® SPSS® Statistics 26.0 programme, calculating the absolute and relative frequencies for the categorical nominal variables. In situations of statistical inference, the Chi-Square test was used to test possible associations between users' satisfaction with urban green spaces and self-perceived health status. An exploratory factor analysis of the users' preferences was conducted. A principal component analysis with Varimax rotation was chosen to maximise the sum of the load variances of the factor matrix. The latent root technique was selected to extract the factors, in which only those that present Eigen values greater than 1 were considered significant. In all tests, a significance level of $p < 0.05$ was used.

Results and discussion

Psycho-social evidence for biophilia and well-being

These are tentative results, to be considered as an exploration. [Table 1](#) presents the socio-demographic profile of surveyed participants.

The sample is mostly composed of female participants (68.9%), adults (35–64 years old; 53.8%) and married (39.4%), which reflects the structure of Portuguese society [49], and parallels a previous study conducted by Madureira et al. [50]. As can be seen, 87.9% hold a university degree, 81.8% work and 51.5% state that they have a reasonable household income. Despite the high education level of the sample (87.9%), the study of

Table 1 – Socio-demographic profile of the sample ($n = 131$).

Gender	%
Feminine	68.9
Masculine	31.1
Age group	
18-34	32.6
35-64	53.8
65 =>	13.6
Marital Status	
Married	39.4
Divorced	12.1
Single	36.4
Unmarried union	9.8
Widowed	2.3
Education	
University level	87.9
Non-university level	12.1
Work condition	
Active	81.8
Inactive	6.8
Student	9.8
Retired	1.5
Household income	
Very uncomfortable	0.8
Uncomfortable	7.6
Reasonable	51.5
Comfortable	33.3
Very comfortable	6.8
Housing typology	
With access to a collective garden, belonging to residents of the housing stock	16.7
With access to a private garden	31.8
With access to a public garden	9.1
With no access to a garden	42.4

Madureira et al. [50] has also found a similar percentage of residents with a university degree (75.6%). This evidence is important since Kellert [51] believes that biophilia is mediated by an adequate education and socio-cultural background. Further, 42.4% reported not having access to a garden, either public or private. Although Fonseca et al. [52] say that having a private garden is not a reason to use less the public ones, the results of the present study strengthen the idea that providing universal access to public urban green spaces is crucial.

Table 2. Usage profile of the sample surveyed ($n = 131$).

Do you visit the green space every week?	%
Yes	35.6
No	64.4
Do you visit this space regardless of the seasons?	
Yes	87.9
No	12.1
Whom do you usually visit this green space with?	
Friends/colleagues	21.2
Family	43.2
Alone	23.5
Boyfriend/Girlfriend	12.1

Concerning the usage profile (Table 2), the participants revealed that 35.6% visit the urban green space every week, which is significantly below the results found in Madureira et al. [50]. Nevertheless, visiting the green space every week is a clear sign of the need to be in contact with nature, which is corroborated by the 87.9% of respondents that confirm visiting the urban green space whatever the season, especially with the family (43.2%). Furthermore, Stokes [53] states that this daily and/or weekly contact with nature is a sign of, and encourages, biophilia and nature orientation. Moreover, Vidal et al. [54] find that users that frequently visit green spaces recognise that plants and animals have the same right to exist as human beings.

Regarding the reasons that underlie the choice of the green space users, the results indicate that the natural environment of the space (17%) is the main motive, followed by its aesthetics dimension (15%) and the peacefulness of the space (3%).

When asked about users' preferences regarding urban green spaces, tranquillity (96.2%), feeling of security (94.0%) and the existence of shady places (92.4%) are the most valued indicators. Besides, the diversity of plants (81.1%) emerged as one of the most preferred by users (Table 3), converging with literature on biophilia and well-being.

An exploratory factor analysis was carried out to identify the main factors associated with users' preferences regarding green spaces (Table 4). All the indicators of users' preferences were retained, since they presented values above 0.5. Furthermore, the KMO found was 0.85 and the Bartlett test = 1460.6 ($p < 0.001$), which is considered satisfactory. To test the reliability of the indicators, the Cronbach Alpha (α) was calculated to measure the internal consistency. As shown in Table 4, for the twenty-four items an $\alpha = 0.898$ was found, considered excellent ($\alpha > 0.8$). Six factors were extracted.

Table 3. Preferences indicators when choosing a green space ($n = 131$).

Indicators	Not important	Indifferent	Important	Total
	(%)	(%)	(%)	(%)
Cleaning and maintenance	2.3	1.5	96.3	100
Diversity of species (plants)	2.3	16.7	81.1	100
Diversity of species (animals)	9.9	31.8	58.4	100
Existence of water	3.8	9.1	87.1	100
Existence of sufficient benches	4.5	12.9	82.5	100
Security	2.3	3.8	94	100
Tranquillity	2.3	1.5	96.2	100
Existence of a playground	18.9	28.8	52.3	100
Possibility of doing physical activity/sports	8.4	23.5	68.2	100
Existence of cafe/restaurant	11.4	28	60.6	100
Existence of car park	11.4	15.9	72.7	100
Existence of a public toilet	2.3	8.3	89.4	100
Green space size	3.8	26.5	69.7	100
Existence of quiet and private places	5.3	9.8	84.9	100
Existence of shady places	1.6	6.1	92.4	100
Frequency of many visitors	22.8	43.2	34	100
Inserted in an urban and busy area	22.7	42.4	34.8	100
Proximity to public transport	9.1	17.4	73.5	100
Accessibility for people with disabilities	4.5	11.4	84.1	100
Existence of cultural/recreational programming	12.1	25.8	62.2	100
Proximity to the area of residence	5.3	32.6	62.1	100
Quality of the surrounding area	3	14.4	82.6	100
No offensive odours	3	6.1	90.9	100
No disturbing noises	3.8	5.3	90.9	100

Table 4. Exploratory factor analysis of users' preferences regarding green spaces.

Indicators	Extracted factors					
	1	2	3	4	5	6
Cleaning and maintenance	0.745					
Security	0.640					
Tranquillity	0.661					
Existence of quiet and private places	0.452					
No offensive odours	0.866					
No disturbing noises	0.862					
Diversity of species (plants)		0.738				
Diversity of species (animals)		0.723				
Existence of water		0.622				
Existence of sufficient benches		0.518				
Existence of shady places		0.455				
Proximity to public transport			0.683			
Accessibility for people with disabilities			0.495			
Existence of cultural/recreational programming			0.493			
Proximity to the area of residence			0.651			
Quality of the surrounding area			0.652			
Existence of cafe/restaurant				0.756		
Existence of car park				0.830		
Existence of a playground				0.869		
Existence of a public toilet				0.683		
Frequency of many visitors					0.833	
Inserted in an urban and busy area					0.848	
Possibility of doing physical activity/sports						0.681
Green space size						0.710
Variance explained (%)	37.9	8.4	6.4	5.8	5.5	4.9

Notes: Extraction method – Principal components. Varimax rotation with Keiser normalisation. Extraction criterion: Eigenvalues > 1. Total variance explained by extracted components: 68.9%; KMO = 0.85 Bartlett's test: $\chi^2 = 1460.6$, $p < 0.001$. Each colour represents a different factor. Cronbach Alpha = 0.898.

Factor 1 aggregates the indicators that relate to physical and sensorial conditions of the green space, and it is the one that mostly explains the variance of the model (37.9%). This factor shows that users valued peaceful and quiet green spaces that provide pleasant odours and sounds from nature [11], contributing to well-being and enhancing biophilia. Factor 2, explaining 8.4% of the model variance, combines a set of indicators that refer to natural elements in green spaces, namely plants and animal species diversity, as well as the presence of shade (associated with the density of trees) and the benches, providing the opportunity to relax and contemplate. This factor shows that users prefer green spaces where natural resources are stimulating, diverse and well represented, linking to Factor 1 to reveal a distinct biophilic approach. This factor shows that users prefer green spaces where natural resources are stimulating, diverse and well represented, linking to Factor 1 to support biophilic evidence. With less explanatory power of the model are the Factors 3, 4, 5 and 6. These represent indicators associated with green spaces' infrastructures, accessibility and size. These results suggest that users are more attentive to the natural elements and the soundscape and odours of the green spaces than the provision of benches and waste bins, or accessibility. This is because the preference for natural elements is a sign of biophilia – merely because these urban green spaces safeguard plants and other living things [11].

Table 5. Association between users satisfaction with urban green spaces and self-perceived health status ($n = 131$).

Urban green spaces users satisfaction	Self-perceived health status (n; %)				
	1 – I am not feeling very well	2	3	4	5 – I feel very well
1 – totally dissatisfied	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
2	0 (0.0)	0 (0.0)	2 (100)	0 (0.0)	0 (0.0)
3	0 (0.0)	0 (0.0)	4 (20.0)	15 (75.0)	1 (5.0)
4	1 (1.5)	4 (6.1)	13 (19.7)	37 (56.1)	11 (16.7)
5 – totally satisfied	6 (13.6)	0 (0.0)	7 (15.9)	17 (38.6)	14 (31.8)

$\chi^2 (12) = 30.529; p < 0.002$

Regarding the self-perceived health status, 50.0% of the users stated that they were feeling well. The survey also revealed that 27.3% of respondents believe that there is a relationship between their physical and mental health status and the frequency of contact with urban green spaces. Table 5 shows the results of the association between satisfaction with urban green spaces and self-perceived health status

A significant association between the level of users' satisfaction and their self-perceived health status was identified ($p < 0.05$). The results suggested that the users who are most satisfied with the urban green spaces are those that present better self-perceived health status. This means that being satisfied with a green space, which meets the expectations of its users, can be a way to improve well-being and health since environmental preferences can affect human behaviour [55]. Although the natural affinity with life and nature is recognised [2], biophilia seems to be stimulated by visiting green spaces that meet the needs of the users [3].

Previous studies have also found that a high level of quality of life and well-being is associated with good experiences in urban green spaces [56, 57], which are nature spots and a personal refuge in the middle of the dense urban fabric.

Behavioural evidence for biophilia and well-being

Biophilia can be inferred from behaviour. Figure 2 shows behaviours (activities) of users of Porto's urban green spaces.

To walk (which can be translated as walking through the green space) emerged as one of the most performed activities according to the sample (26%), being followed by 'to relax' (14%).

Alongside the survey results, behavioural evidence on biophilia and well-being can be identified through Figures 3 and 4. The green spaces illustrated by the figures demonstrate the attractions of green spaces in an urban environment [55].

The 'argument' for biophilia is both subjective and objective. Open spaces, where nature may be entered and enjoyed, balance the stresses and limitations of urban life. Open spaces allow the urban resident to reflect in peace. Human beings can thus be free and at one with themselves and with nature. A study conducted by Totaforti [55] found biophilia can be enhanced through nature contact (senses) but also by just observing the surrounding space (Figure 3A).

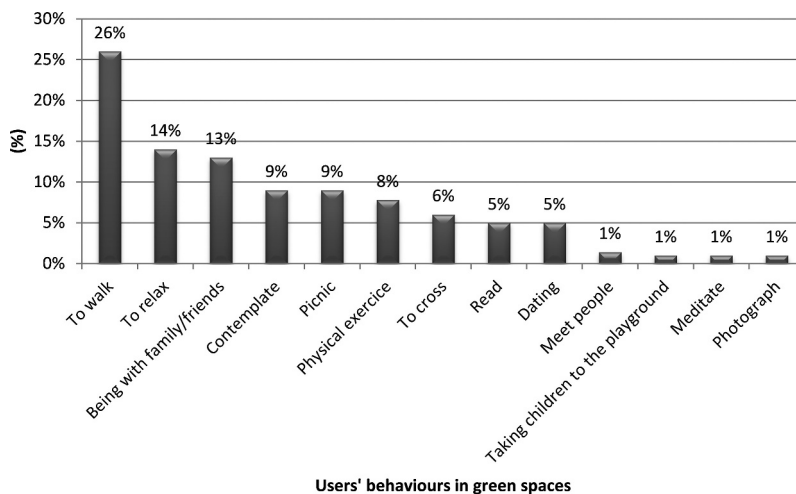


Figure 2. Users' behaviours performed at green spaces ($n = 131$).



Figure 3. A – Western city park (Figure 1, urban green space number 8). User contemplates the landscape (March 2020); B – Passeio Alegre Garden (Figure 1, urban green space number 3). Users gathered by a tree, enjoying its shade on a sunny and very hot day (August 2021). Both green spaces were awarded the 'Green Flag' in 2019, for the high quality of their management and maintenance. Source: Authors.



Figure 4. A – Arca d’Água garden (Figure 1, urban green space number 13). Users at a picnic under a tree (September 2020); B – Palácio de Cristal garden (Figure 1, urban green space number 14). Users lying on the grass in shade on a summer day (August 2020).

Source: Authors.

Final remarks on planning and design of biophilic green spaces

Nature diversity, its complexity and its maintenance level may enhance nature experiences and support biophilia in urban green spaces. This exploratory study aimed to explore the relationship between biophilia and well-being in a sample of 131 users of urban green spaces in the city of Porto (Portugal). The results suggest that users tend to find in urban green spaces a connection with nature. Users tend to value urban green spaces that provide quiet and shade areas, with a high diversity of plant species and tranquillity. The survey also found that being satisfied with urban green spaces enhances self-perceived health status, which means that being satisfied with a green space that fulfils users’ expectations can be a way to improve well-being in urban areas. The pleasure in nature, the perception of health and well-being goes with pro-environmental behaviours, favouring conservation of natural resources. This can be enhanced by citizens’ participation in the design of regenerative urban green spaces.

The design of urban green spaces in their relationship with buildings and streets can offer people a more vital environment. Biophilia speaks of the need to affiliate with nature and other living elements. Urban green spaces should be increased not only because of their ecological effects like air cleansing, urban heat reduction, biodiversity and restoration, but because they can promote eco-social well-being, worldwide.

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